ANNEX B3.2.5

Sediment Sampling and Analysis

This document has been written in line with the requirements of the RAPID gate two guidance and to comply with the regulatory process pursuant to Severn Trent Water's and Affinity Water's statutory duties. The information presented relates to material or data which is still in the course of completion. Should the solution presented in this document be taken forward, Severn Trent Water and Affinity Water will be subject to the statutory duties pursuant to the necessary consenting process, including environmental assessment and consultation as required. This document should be read with those duties in mind.

Grand Union Canal Transfer SRO
Affinity Water, Severn Trent Water, Canal & River Trust

Grand Union Canal Strategic Resource Option

Sediment sampling and analysis report

October 2022

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Grand Union Canal Strategic Resource Option

Sediment sampling and analysis report

October 2022

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Contents

Tables

Figures

Tables - Appendices

Figures - Appendices

Glossary

A&E	Accident and Emergency
CSM	Cohesive Strength Meter
EIA	Environmental Impact Assessment
GUC	Grand Union Canal
HSE	Health and Safety Executive
INNS	Invasive non-native species
OSGB	Ordnance Survey of Great Britain
NG	No guideline available
NMBAQC	National Marine Biological Analytical Quality Control
PAH	Polynuclear aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PPE	Personal Protective Equipment
PSA	Particle size analysis
RAMS	Risk Assessment and Method Statement
S.D.	Standard deviation
SQG	Sediment quality guidelines
SS	Sediment sample
TEL	Threshold effect level
TOC	Total organic carbon
T_{sed}	Thickness of sediment removed from GUC and connected waterbody cores
UKAS	United Kingdom Accreditation Service
UNESCO	United Nations Educational, Scientific and Cultural Organization
WFD	Water Framework Directive
WGS	World Geodetic System
WwTW	Water Treatment Works

1 Introduction

1.1 Background

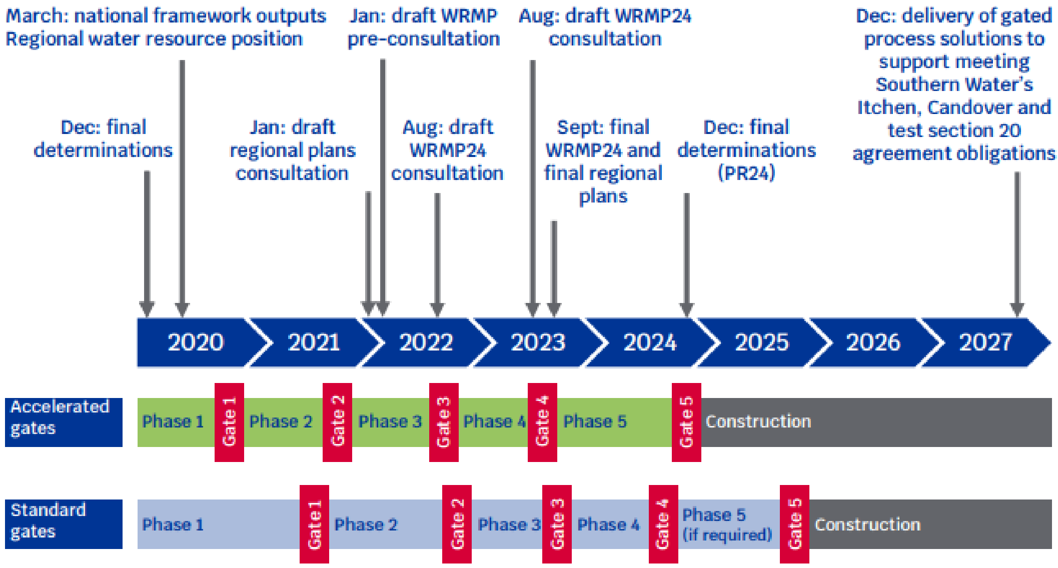
Ofwat, the economic regulator for the water and sewerage sectors in England and Wales, has identified the potential for water companies to jointly deliver strategic water resource schemes to secure long-term water supply resilience while protecting the environment.

The Regulatory Alliance for Progressing Infrastructure Development (RAPID) has been established, comprised of representatives from Ofwat, the Environment Agency and the Drinking Water Inspectorate to support the progression of these Strategic Resource Options (SROs). RAPID has produced guidance for progressing each SRO which is aligned to a formal gated process to ensure that at each gate:

- Companies are progressing strategic water resource solutions that have been allocated funding at PR19 or have subsequently joined the programme.
- Costs incurred in doing so are efficient.
- Solutions merit continued investigation and development during the period 2020 to 2025.

The timelines for the assessment gates are shown in Figure 1.1. The Grand Union Canal (GUC) SRO is on the standard gate timeline and is currently at Gate 2.

Figure 1.1: Gated process for potential strategic regional water resource solutions[1]



1.2 Grand Union Canal SRO

The GUC SRO has been jointly developed in partnership between Severn Trent Water (STW), Affinity Water (AW) and the Canal & River Trust (the Trust). At the start of Gate 1, a long list of sub-option routes was derived for the GUC SRO. The discharge options were then shortlisted to three route options by the start of Gate 2 based on the following criteria: environmental and societal impacts; operational flexibility and resilience; operational and embedded carbon; and cost. Of these, Option

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[1] Source: Regulators' Alliance for Progressing Infrastructure Development, Forward programme 2021-22,March 2021, available online at https://www.ofwat.gov.uk/wp-content/uploads/2021/03/RAPID-Forward-programme-2021_22.pdf, accessed 07/03/2022.

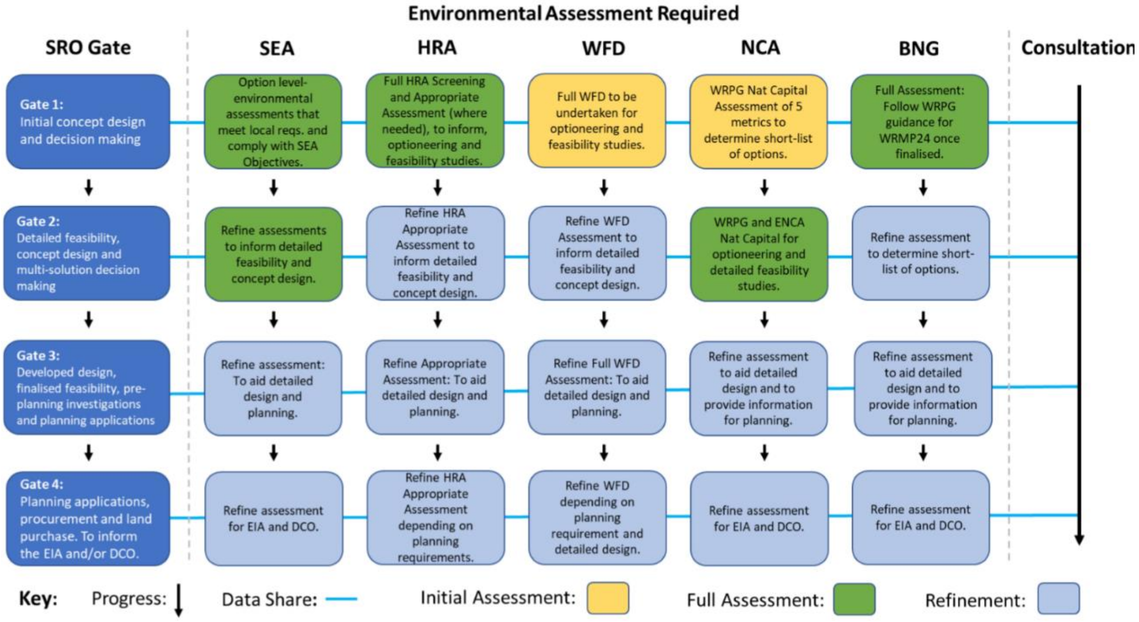
Route 3 was selected. Optioneering was also undertaken concerning abstraction locations. A site at Leighton Buzzard was ultimately selected. Further details on the optioneering process can be found in the Gate 2 submission.

The single solution assessed at Gate 2 includes the pipeline from Minworth to Atherstone (Route 3), the canal transfer to Leighton Buzzard and the abstraction and treatment works at this location (hereafter referred to as 'the scheme'). It will be assessed in the following Gate 2 Environmental assessments:

- Environmental Appraisal Report (EAR) (Annex B3.3.5)
- Fish survey report (Annex B3.2.3)
- Habitats and protected species desk study (Annex B3.2.6)
- Habitats Regulations Assessment (HRA) (Annex B3.3.3)
- Invasive and non-native species (INNS) survey report (Annex B3.2.4)
- Natural Capital and Biodiversity Net Gain (BNG) (Annex B3.3.2)
- Sediment report (Annex B3.2.5)
- Strategic Environmental Assessment (SEA) (Annex B3.3.1)
- Waterbody connections report (Annex B3.2.1)
- Water Framework Directive (WFD) Assessment (Annex B3.3.4).

Figure 1.2 shows the integration of the statutory assessment reports (i.e., SEA, HRA, WFD, NCA/BNG) RAPID gated process. This schematic is taken from the All Companies Working Group (ACWG) guidance released in Gate 1. While this is still broadly relevant and followed, it has been somewhat superseded by the RAPID Gate 2 guidance[2], which the Gate 2 assessments have followed.

Figure 1.2: Environmental Assessment Integration with SRO Gates[3]



	Environmental Assessment Required					
SRO Gate	SEA	HRA	WFD	NCA	BNG	Consultation
Gate 1: Initial concept design and decision making	Option level-environmental assessments that meet local reqs. and comply with SEA Objectives.	Full HRA Screening and Appropriate Assessment (where needed), to inform, optioneering and feasibility studies.	Full WFD to be undertaken for optioneering and feasibility studies.	WRPG Nat Capital Assessment of 5 metrics to determine short-list of options.	Full Assessment: Follow WRPG guidance for WRMP24 once finalised.	
Gate 2: Detailed feasibility, concept design and multi-solution decision making	Refine assessments to inform detailed feasibility and concept design.	Refine HRA Appropriate Assessment to inform detailed feasibility and concept design.	Refine WFD Assessment to inform detailed feasibility and concept design.	WRPG and ENCA Nat Capital for optioneering and detailed feasibility studies.	Refine assessment to determine short-list of options.	
Gate 3: Developed design, finalised feasibility, pre-planning investigations and planning applications	Refine assessment: To aid detailed design and planning.	Refine Appropriate Assessment: To aid detailed design and planning.	Refine Full WFD Assessment: To aid detailed design and planning.	Refine assessment to aid detailed design and to provide information for planning.	Refine assessment to aid detailed design and to provide information for planning.	
Gate 4: Planning applications, procurement and land purchase. To inform the EIA and/or DCO.	Refine assessment for EIA and DCO.	Refine HRA Appropriate Assessment depending on planning requirements.	Refine WFD depending on planning requirement and detailed design.	Refine assessment for EIA and DCO.	Refine assessment for EIA and DCO.	

Key: Progress: ↓ Data Share: — Initial Assessment: 🟨 Full Assessment: 🟩 Refinement: ▨

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[2] Strategic regional water resource solutions guidance for gate two, Regulators' Alliance for Progressing Infrastructure Development, February 2022, available online at https://www.ofwat.gov.uk/wp-content/uploads/2022/02/Strategic-regional-water-resource-solutions-guidance-for-gate-two_Feb_2022.pdf, accessed 09/02/2022.

[3] Source: All Companies Working Group, WRMP environmental assessment guidance and applicability with SROs, Mott MacDonald, October 2020

1.3 Scheme description

The scheme is shown in Figure 1.3 and described in detail in Annex A1, Engineering CDR (WSP, 2022). It will comprise a transfer rising main from Minworth Wastewater Treatment Works (WwTW) to the Coventry Canal at the top of Atherstone lock flight. Once outside the Minworth site and past the M42 and HS2 corridors, the rising main will pass through agricultural land until reaching the outskirts of Atherstone, a small market town within North Warwickshire. The rising main will discharge to the canal side at Coleshill Road, via a new discharge structure sized to avoid deleterious flow velocities and shears.

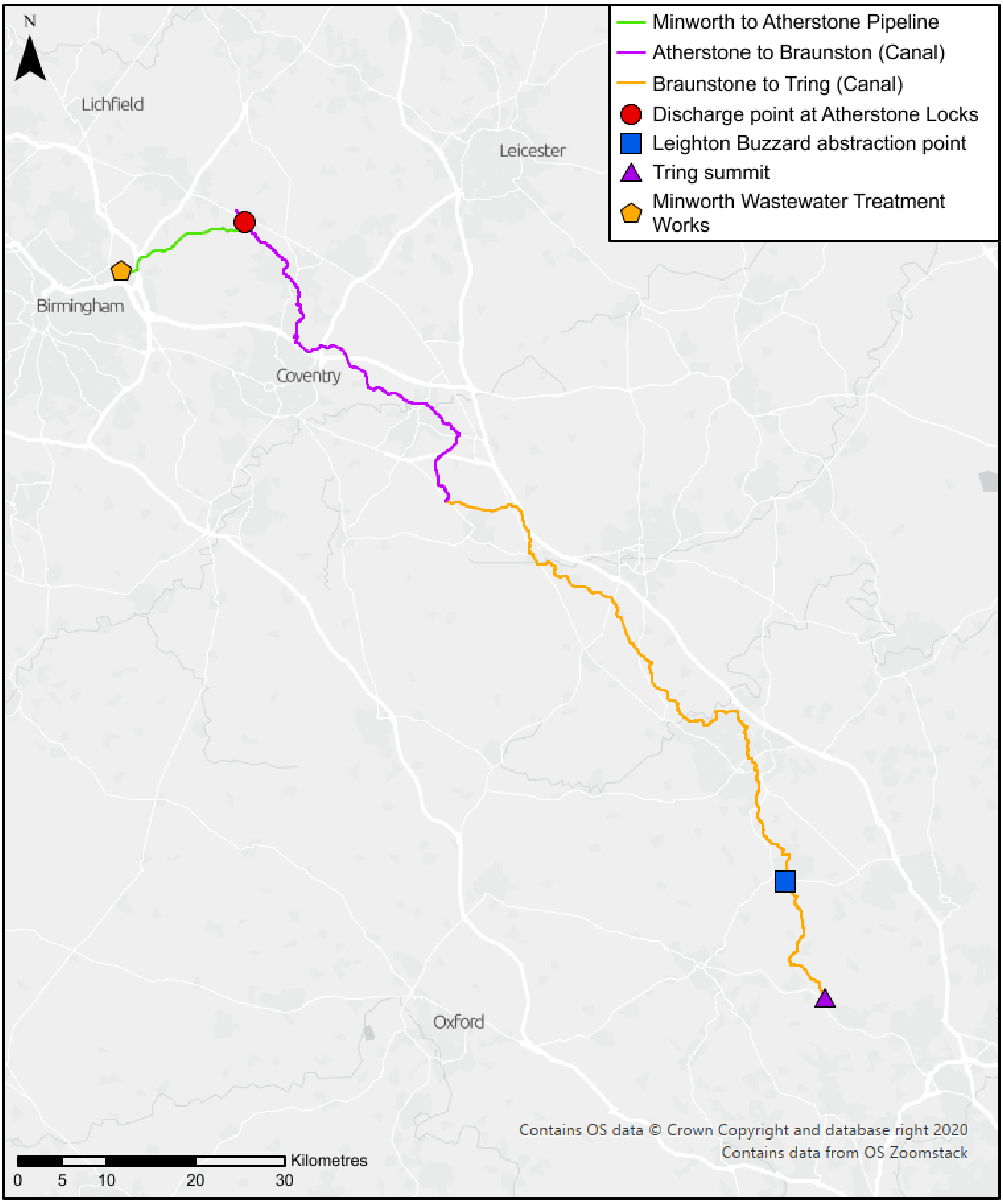
Transferred water will then progress along the Coventry Canal by gravity into the Oxford Canal at Hawkesbury Lock. Flows must bypass the Hawkesbury lock via a low lift pumping station. The Oxford Canal will then convey the water to the Grand Union Canal at Braunston. Most of the flow along the Oxford Canal will be by gravity. However, a pumping station will be required to bypass the locks at Hillmorton.

At Braunston, a bypass pumping station will be required to lift flows near Braunston Marina to the top lock just before the Braunston Tunnel. From Braunston to the abstraction and treatment site at Leighton Buzzard, four additional lock bypass pumping stations will be required south of Milton Keynes at Fenny Stratford, Stoke Hammond, Three Locks and Leighton. The Grand Union Canal section will require eight gravity bypasses around “downflow” locks at the Wilton Marine Lock Flight, Stoke Bruerne Lock Flight and Cosgrove Lock.

Water will be abstracted from the Grand Union Canal, south of the A4146 bridge, after the River Ouzel. The site currently proposed at Gate 2 for the treatment works is on relatively flat land slightly raised from the river and canal. However, further investigations will be carried out at Gate 2/3 to determine the precise location. The flow will therefore need to cross the River Ouzel within a new, short pipeline and be pumped into an operational raw water storage reservoir before gravitating into the first stage of treatment. Additional interstage pumping in the treatment works will be required with final high lift pumps transferring potable treated water to a new clean water holding tank at the existing Chaul End Water Supply Reservoir (WSR).

During the option selection process, it was determined this option would have the least overall cost, lowest environmental impact and most significant opportunity for net gain and public benefit, as described in Annex A1, Engineering CDR (WSP, 2022). The slightly higher operational cost compared to Route 1, due to the longer transfer from Minworth to Atherstone, can be partially offset by energy recovery from the break tank to outfall.

Figure 1.3: The GUC scheme



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Contains data from OS Zoomstack

1.4 Purpose of the report

The Gate 1 WFD assessment[4] identified risks associated with water quality, flow changes, sediment mobilisation, and potential contamination concerns. This Sediment Sampling Report presents work undertaken as part of the Gate 2 submission to RAPID for the GUC SRO. The sediment sampling has

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[4] Grand Union Canal Strategic Resource Option, Gate 1 Water Framework Directive Assessment: Level 2 Assessment (Mott MacDonald, May 2021)

been designed to be sufficient in spatial scale to understand variations in bed sediment properties and quality and to help identify potential sediment transport mobilisation and pathways.

1.5 Assumptions and Limitations

The following assumptions have been used within the assessments:

- The design assumptions stated in the WSP Gate 2 Position Paper - Route Selection technical note[5] can be applied to the Gate 2 Environmental Assessments, including the assumption that >50mm depth change requires towpath raising is valid.
- The assessment is based on 100% utilisation of the SRO to assess the scheme at maximum potential impact.
- Tring summit represents the SE limit of influence of the SRO.
- The volume of water passing NW (after discharging from the pipeline) due to the locks opening at Atherstone is deemed to be of minimal change.
- The discharge quality from Minworth WwTW is acceptable to the EA, enabling water to be discharged to the GUC.
- The sensitivity of the gas chromatograph limits the minimum concentrations reported in the laboratory analysis, therefore, plots show the minimum values detected by the equipment.
- Without *in situ* data, it is usually assumed that critical shear stress for deposition τ_{critD} = 0.08N/m^2.
- In keeping samples equidistant, some canal pounds were omitted. However, there are gradients in pollutants related to the location of past and present-day industry; thus, the sampling scheme captures this.
- In all cases, samples were prepared for particle size and chemical analysis by homogeneously mixing the upper 20cm of each undisturbed core.

1.6 Report structure

- Section 2: describes the sediment sampling protocols, particle size analysis (PSA), determination of *in-situ* sediment entrainment thresholds and chemical analysis for heavy metals, PAHs and PCBs.
- Sections 3 to 5: present results from the various analyses of particle size, *in-situ* sediment entrainment thresholds and chemical analysis.
- Section 6: discusses the results of sediment and water sample analyses against a background of theoretical sediment dynamics and sediment quality guidelines.
- Section 7: concludes the study and makes recommendations for further work.
- Section 8: provides a list of publications and reports in this document.

Detailed laboratory results and other relevant information are presented in Appendices A to H.

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[5] Gate 2 Position Paper - Route Selection, WSP Technical Note, 25 January 2022

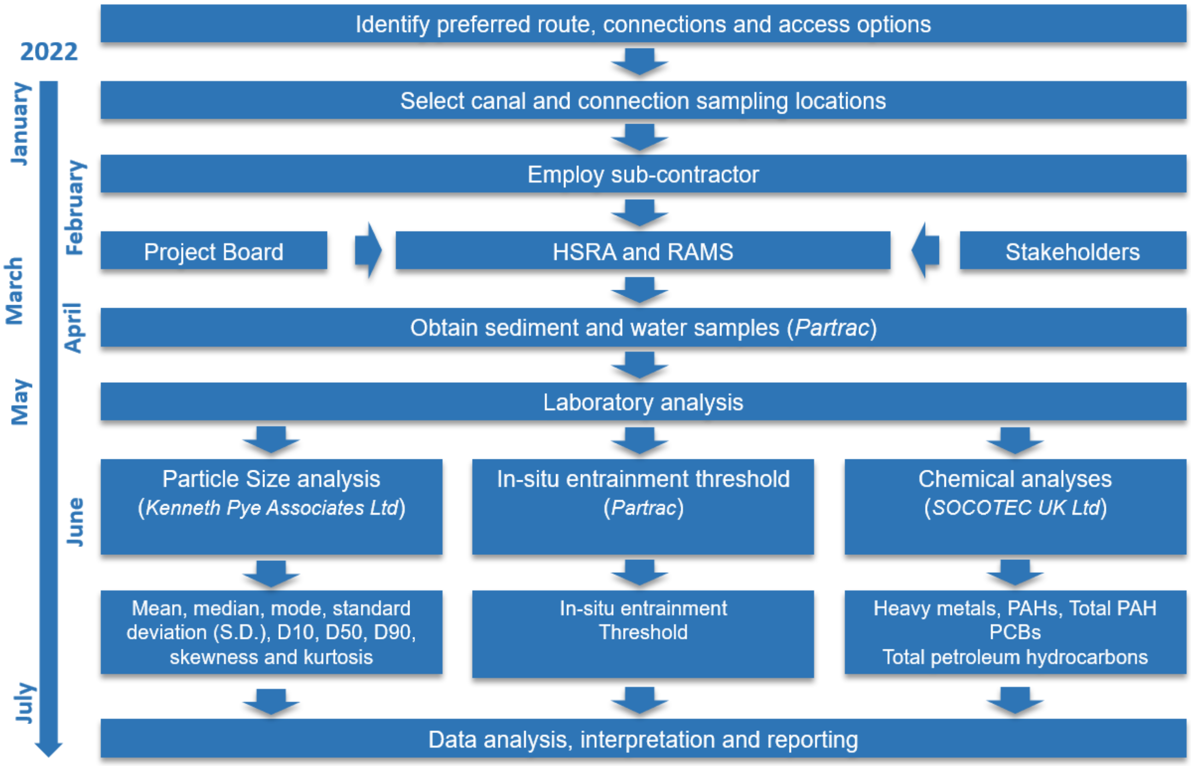
2 Methodology

2.1 Background

Existing numerical modelling undertaken by JBA[6] has shown that the scheme will increase the flow speed along the GUC. Since the canal flow speed determines sediment mobilisation, transport and accretion, any changes to flow velocity brought about by the scheme may affect the dynamic behaviour of the canal bed sediments, and any increases in sediment resuspension and transport could affect water quality if the disturbed sediments are contaminated. A theoretical framework considering relevant sediment dynamics, including skin friction, critical bed shear stress, settling velocity, suspended sediment concentration profiles, sediment deposition, and sediment resuspension, is provided in Appendix A. The following sections draw on this information to support the present analysis and interpretation of canal sediment dynamics.

A schematic diagram showing the links between the various elements of the work described in this report is shown in Figure 2.1.

Figure 2.1: Schematic diagram showing the timeline and links between the various elements of the work described in this report.



Source: Mott MacDonald, 2022

2.1.1 Sediment sampling locations

In selecting sediment sampling locations, a safe, consistent and systematic approach was adopted to resolve spatial variability in the physical and chemical properties of the canal bed sediments along the preferred route. The selection process also ensured, as far as practicable, that samples were obtained in each major canal pound. Samples were taken on foot at locations identified in the

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[6] Jeremy Benn Associates Ltd (2022), Final modelling report, Annex A2.4.

Waterbody Connections Study (Mott MacDonald, 2022) to be potentially sensitive and representative of other local connected waterbodies. Although relatively small in number, the connected waterbody samples nevertheless enable discrimination between the canal and connected waterbody sediment particle size and chemistry (Sections 3, 4 and 5). The EA was consulted as part of the Mott MacDonald connected waterbodies work. The outcomes of these discussions guided the selection of the connecting waterbody sampling locations.

Mott MacDonald undertook an initial desktop assessment of the scheme (Figure 1.3) using Google Earth images and identified, using the criteria outlined above, possible sediment sampling locations on the basis that samples would be collected from a vessel. However, before survey mobilisation, sections of the canal were closed for maintenance, and it was necessary to identify new sediment sampling locations accessible by foot. The final sample locations (Figures 2.5 and 2.6 and Table 2.1 and Table 2.2) were, therefore, a mixture of sampling from a vessel (Figure 2.2) and by foot. The locations included most of the canal pounds[7] and the important connected waterbodies identified in the Waterbody Connections report (Annex B3.2.1).

Samples were taken on foot at locations identified in the Waterbody Connections Study (Mott MacDonald, 2022) to be potentially sensitive and representative of other local connected waterbodies. Although relatively small in number, the connected waterbody samples nevertheless enable discrimination between the canal and connected waterbody sediment particle size and chemistry (Sections 3, 4 and 5).

Figure 2.2: The narrow boat used for the sampling campaign (rented from The Wyvern Shipping Co. Ltd.)

Source: Partrac (2022)

2.1.2 Determining sediment properties and processes

It was considered that the following properties best characterised the physical and chemical characteristics of the sediments:

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[7] In keeping samples equidistant, some canal pounds were omitted. However, there are gradients in pollutants related to the location of past and present day industry and thus the sampling scheme captures this.

- Particle size to define other particle properties such as settling velocity, cohesive/non-cohesive behaviour etc
- In-situ entrainment threshold to define the flow velocity/bed shear stress required to initiate particle motion
- Chemistry, including heavy metals, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and total petroleum hydrocarbons typically quantified in chemeical analyses undertaken for sediments

A sampling strategy was devised to obtain suitable samples for the various analyses that captured the geographical variability in sediment properties along the length of the scheme.

2.2 Sampling methodology

2.2.1 Bottom sediments

Using a large-bore sediment sampler unit supplied by Aquatic Research Instruments of Idaho, USA (Figure 2.3), sediment samples were obtained at 47 locations along the scheme (Table 2.1, Figure 2.5) and seven connected waterbody locations (Table 2.2, Figure 2.6 and Mott MacDonald, 2022). Samples were taken at potentially sensitive sites and representative of other connected waterbodies in the locality (refer to the Waterbody Connections report (Annex B3.2.1) for further information about connected watercourses).

Figure 2.3: Large-bore sediment sampler unit supplied by *Aquatic Research Instruments* used to obtain bottom sediment samples.

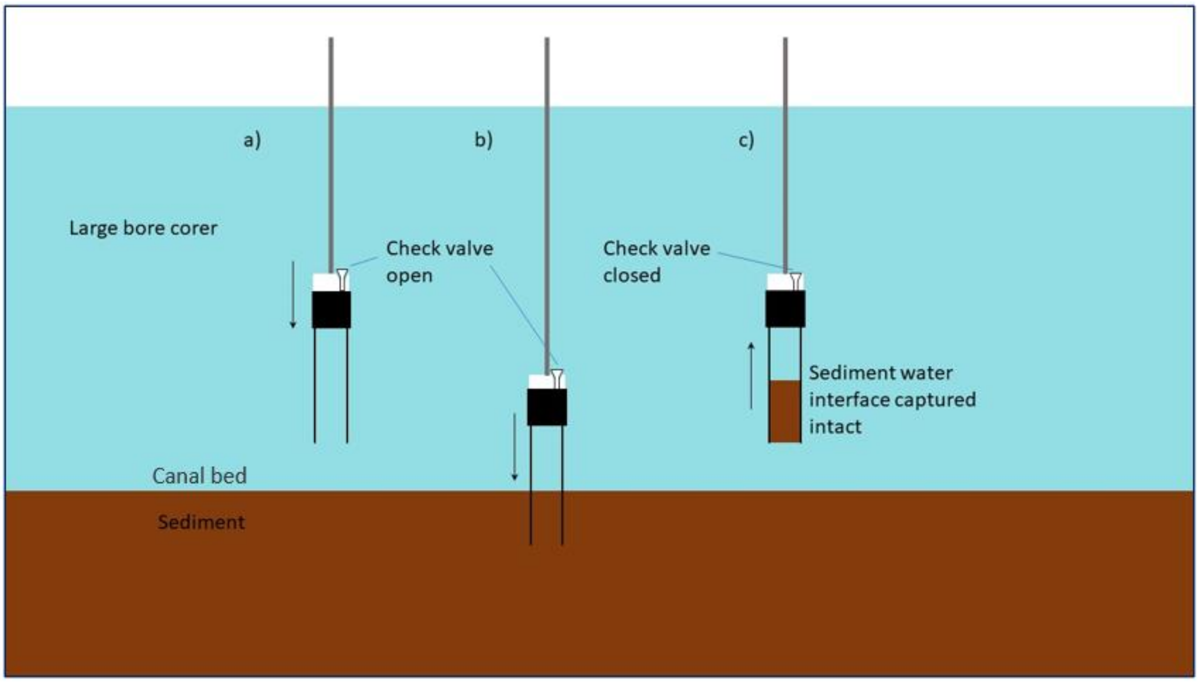
Source: Partrac, 2022

Sampling (Figure 2.4) involved:

- Placing the assembled corer vertically into the water column with sufficient connecting rods for the water depth at that location to be sampled. As the corer is lowered through the water column, the one-way check valves allow the tube to fill with water.
- When the corer reaches the river/canal bed, it is pushed slowly but firmly, from above into the sediment to a minimum depth of 10cm below the bed surface to sample/capture the sediment-water interface. The one-way check valve allows any water displaced by this action to flow out of the top of the corer.

- The corer is then slowly pulled upwards, and the check valve closes immediately and creates a seal and vacuum. The vacuum seal from above and the "plug" of sediment in the core tube retain the sampled sediment-water interface intact within the core tube. Immediately upon recovery, the core is kept vertical, and a white polyethene plug (95mm diameter) with a thick double "O"-ring seal is inserted into the base of the tube to maintain the seal and prevent any leakage.
- The clear core tube containing the sediment-water interface is separated from the check valve assembly.
- The core is capped at both ends with tightly fitting orange polyethene caps and stored upright.

Figure 2.4: Schematic of the large bore corer being: a) lowered to the river canal bed (check valve open); b) sampling the sediment-water interface (check valve open); and c) check valve closes, and sediment-water interface is retrieved intact.



Source: Partrac, 2022

Grid references for continued monitoring locations redacted

Table 2.1: Location of canal sediment samples GUC 1 to GUC 47.

Sample ID	Longitude	Latitude	Location[8]	Sample ID	Longitude	Latitude	Location
GUC 1	[redacted]	[redacted]	Middle of canal	**GUC 25**	[redacted]	[redacted]	Middle of canal
GUC 2	[redacted]	[redacted]	Middle of canal	**GUC 26**	[redacted]	[redacted]	Middle of canal
GUC 3	[redacted]	[redacted]	Canal bank	**GUC 27**	[redacted]	[redacted]	Middle of canal
GUC 5	[redacted]	[redacted]	Canal bank	**GUC 28**	[redacted]	[redacted]	Middle of canal
GUC 6	[redacted]	[redacted]	Canal bank	**GUC 29**	[redacted]	[redacted]	Middle of canal

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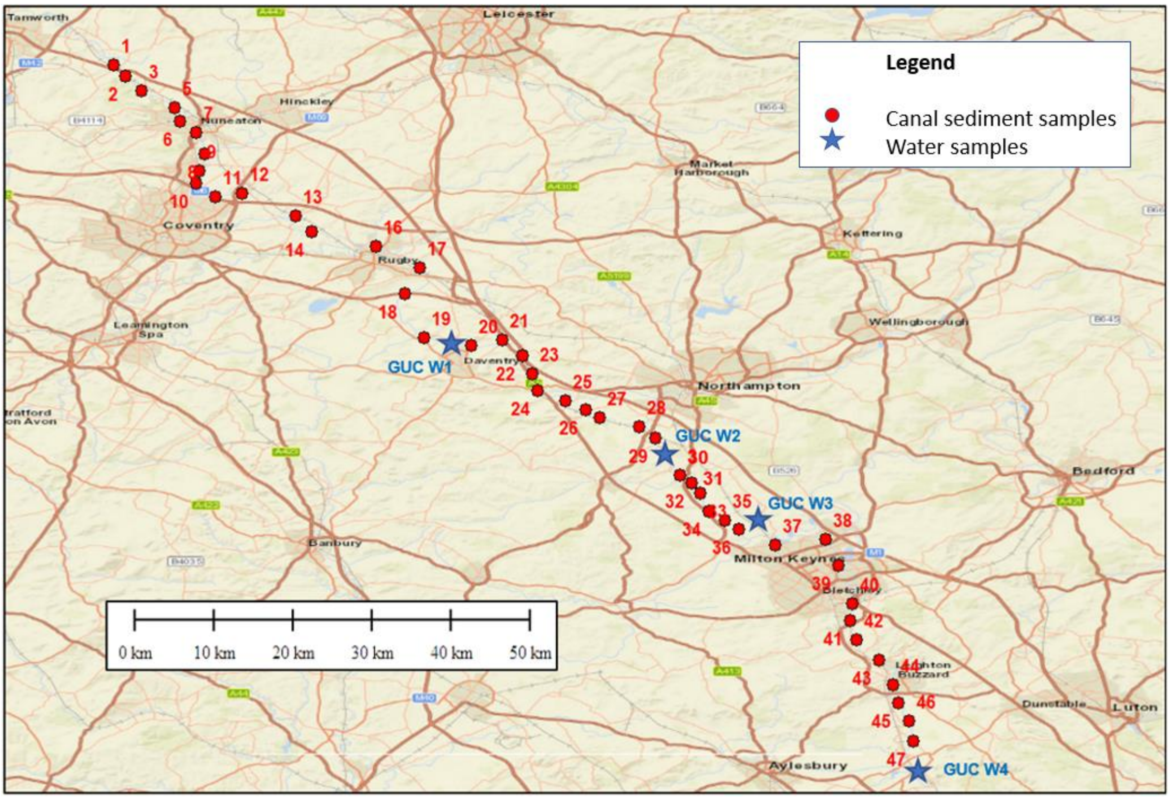
[8] Locations at each point (i.e. middle of canal, edge of canal etc) were chosen on the basis of accessibility, navigation hazard and health and safety with sample locations chosen to be as consistent as possible.

Grid references for continued monitoring locations redacted

Sample ID	Longitude	Latitude	Location[8]	Sample ID	Longitude	Latitude	Location
GUC 7	[redacted]	[redacted]	Canal bank	**GUC 31**	[redacted]	[redacted]	Middle of canal
GUC 8	[redacted]	[redacted]	Canal bank	**GUC 32**	[redacted]	[redacted]	Middle of canal
GUC 9	[redacted]	[redacted]	Canal bank	**GUC 33**	[redacted]	[redacted]	Middle of canal
GUC 10	[redacted]	[redacted]	Canal bank	**GUC 34**	[redacted]	[redacted]	Middle of canal
GUC 11	[redacted]	[redacted]	Canal bank	**GUC 35**	[redacted]	[redacted]	Middle of canal
GUC 12	[redacted]	[redacted]	Canal bank	**GUC 36**	[redacted]	[redacted]	Middle of canal
GUC 13	[redacted]	[redacted]	Middle of canal	**GUC 37**	[redacted]	[redacted]	Middle of canal
GUC 14	[redacted]	[redacted]	Canal bank	**GUC 38**	[redacted]	[redacted]	Middle of canal
GUC 16	[redacted]	[redacted]	Canal bank	**GUC 39**	[redacted]	[redacted]	Middle of canal
GUC 17	[redacted]	[redacted]	Canal bank	**GUC 40**	[redacted]	[redacted]	Middle of canal
GUC 18	[redacted]	[redacted]	Canal bank	**GUC 41**	[redacted]	[redacted]	Middle of canal
GUC 19	[redacted]	[redacted]	Middle of canal	**GUC 42**	[redacted]	[redacted]	Middle of canal
GUC 20	[redacted]	[redacted]	Middle of canal	**GUC 43**	[redacted]	[redacted]	Middle of canal
GUC 21	[redacted]	[redacted]	Middle of canal	**GUC 44**	[redacted]	[redacted]	Middle of canal
GUC 22	[redacted]	[redacted]	Middle of canal	**GUC 45**	[redacted]	[redacted]	Canal bank
GUC 23	[redacted]	[redacted]	Middle of canal	**GUC 46**	[redacted]	[redacted]	Canal bank
GUC 24	[redacted]	[redacted]	Middle of canal	**GUC 47**	[redacted]	[redacted]	Canal bank

Figure 2.5: Location of canal sediment samples GUC 1 to GUC 47 (red dots) and water sampling (see section 2.2.3) points (Section 2.2.3) GUC W1 to GUC W4 (blue stars).



Source: Mott MacDonald & Partrac (2022)

Grid references for continued monitoring locations redacted

Table 2.2: Location of connected waterbody sediment samples

Sample ID	Longitude	Latitude	Connected waterbody	Sample ID	Longitude	Latitude	Connected waterbody
GUC C1	[redacted]	[redacted]	Withy Brook	**GUC C5**	[redacted]	[redacted]	River Tove
GUC C2[9]	[redacted]	[redacted]	Rains Brook	**GUC C6**	[redacted]	[redacted]	River Ouzel
GUC C3	[redacted]	[redacted]	River Nene	**GUC C7**	[redacted]	[redacted]	River Ouzel
GUC C4	[redacted]	[redacted]	River Tove	**GUC C8**	[redacted]	[redacted]	River Ouzel

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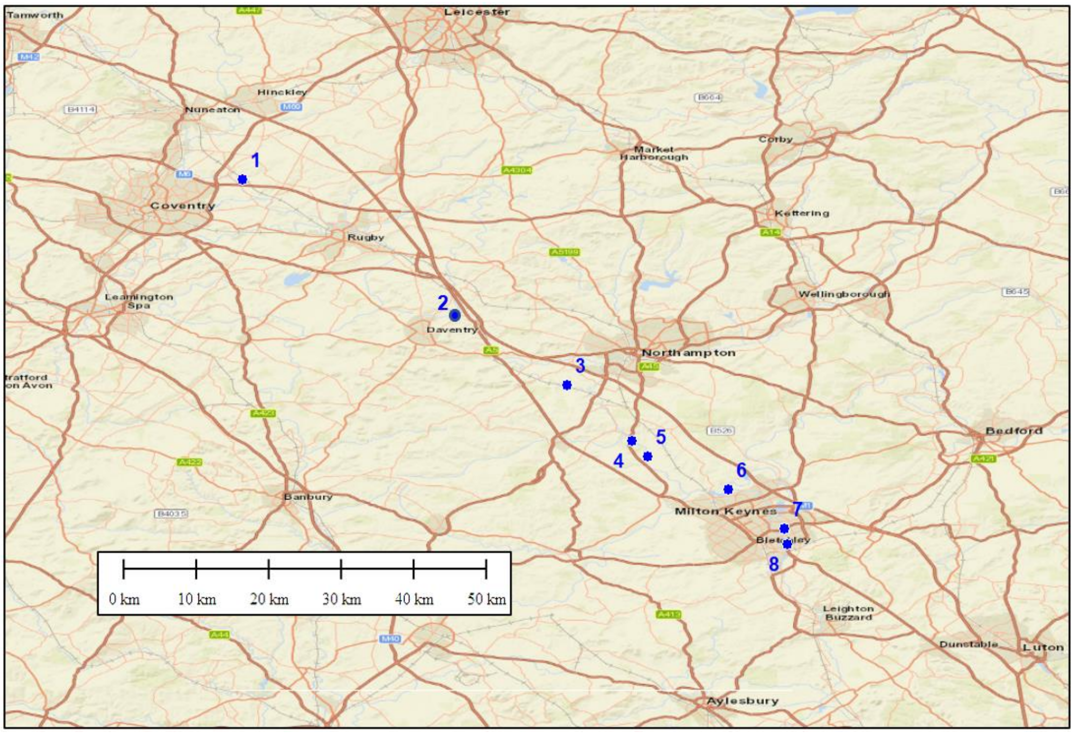
[9] Due to coarse sediments on the bed, it was impossible to acquire a core sample at the planned location GUC C2.

Figure 2.6: Location of connected waterbody sediment samples



Source: Mott MacDonald, 2022

It was not possible to obtain samples at some locations for the following reasons:

- GUC 4 and 15: the material was not consolidated enough. There were greater than ten attempts at multiple nearby locations without success.
- GUC 30: the canal bed was almost impenetrable. A small amount of material 1 to 2cm thick was retrieved comprising very stiff grey clay (possibly the canal lining of the canal channel), with very loosely consolidated organic matter on the surface. No samples could be taken for laboratory analysis.
- Connected waterbody site C2: the bed sediment was composed primarily of pebbles, and no sample could be taken after greater than ten attempts at multiple nearby locations.

2.2.2 Sampling procedure

All sediment sampling operations were undertaken using a well-established '*clean hands* - *dirty hands*' approach to avoid and sample contamination whereby:

- *'Dirty hands'* were responsible for the preparation of the sampler ancillaries (i.e. except the sample container itself), operation of any machinery (e.g., winch), and all other activities that did not involve direct contact with the sample.
- *'Clean hands'* were responsible for all operations involving contact with the sampler, preparing and priming the sampler and transferring the sample[s] to the sample containers.

Only *'Clean hands'* were permitted to have contact with the sampler, collect the sediment sample and inspect it. If the sample was acceptable, *'Dirty hands'* recorded an assessment of sample quality and took a digital photograph. In addition, the following information was recorded:

- Sample volume (approximately)

- A sediment description following BS5930:2015, included texture, particle shape (if apparent to the naked eye), consistency, colour (according to the Munsell Colour System[10]), smell/odour, stratification, presence of debris; and presence of surface biology (in/epifauna).

A table describing the sediment samples and photographs of sample cores from the canal and connected waterbodies are provided in Appendix C.

2.2.3 Water samples

As part of the present investigation, it was speculated that canal traffic might result in canal bed sediment resuspension, primarily through propeller wash[11]. Evidence for bed disturbances by canal traffic is reported in Section 6.5. In a preliminary investigation to test this hypothesis, water samples were obtained at intervals of -30s, +30s, +5 min, +10 min and +20 min before and after the passage of a canal vessel by bank side extension of the water sample (see Figure 2.7) to the centre of the channel to ensure safe sample collection. This process was repeated close to sampling points GUC 45 (GUC W1) and GUC 3 (GUC W2) and at sampling points GUC 33 (GUC W3) and GUC 45 (GUC W4), Table 2.3 and Figure 2.5.

Water samples were obtained using a van Dorn water sampler (Figure 2.7) and stored in clean bottles following the same established *'clean hands - dirty hands*' approach described above.

Figure 2.7: Van Dorn water sampler comprising a falling weight (messenger), horizontal water bottle, and rope.

Source: Partrac, 2022

Grid references for continued monitoring locations redacted

Table 2.3: Location of water samples GUC W1 to GUC W4.

Sample ID	Longitude	Latitude	Sample ID	Longitude	Latitude
GUC W1	[redacted]	[redacted]	GUC W3	[redacted]	[redacted]
GUC W2	[redacted]	[redacted]	GUC W4	[redacted]	[redacted]

2.3 Storage and analysis of samples[12]

2.3.1 Storage

Storage of the sediment and water samples involved:

- Transfer the samples to a secure, cool and darkened storage location
- Checking that the Sample Registration Form matched the Sample Master Sheet
- Checking sample labels were not lost or damaged

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[10] https://munsell.com/color-blog/munsell-color-order-system-what-is-it-and-how-is-it-used/

[11] The disturbed mass of air or water pushed aft (or fore when in reverse) by the propeller of a propeller-driven watercraft.

[12] Refer to Appedix B.6.5 for a detailed description of sample storage and analysis.

2.3.2 Sample metadata

The following metadata was documented:

- Equipment checks performed during mobilisation
- The time, location and water depth where a sample was taken
- The description of the sample
- Digital images of the sediment sample
- Weather and canal boat traffic conditions at the time of sample acquisition

2.3.3 Sample labelling

Samples were labelled to show: (a) sediment sample (SS) number and location; (b) time, day, month and year; and (c) sample locations using latitude and longitude and OSGB coordinates.

2.3.4 Records of field activities

Daily progress reports detailing all sediment sampling operations during the field campaign spanning 9 April 2022 to 12 May 2022 are provided in Appendix D.

2.4 Sample analyses

The samples were analysed using the approaches described below to determine their physical and chemical properties, as reported in Section 3. In all cases, samples were prepared for PSA and chemical analysis by homogeneously mixing the upper 20cm of each undisturbed core.

2.4.1 PSA

Kenneth Pye Associates Ltd conducted a PSA of all samples[13] following the NBMAQC scheme best practice guidance (Mason, 2011). Since sediments with a diameter >2mm were not present in any of the samples, sieving techniques were not required, and the analyses were performed using laser diffraction (Beckman Coulter LS Particle Size Analyzer, Figure 2.8).

Figure 2.8: Beckman Coulter LS particle size analyser

Source: https://www.beckman.com/particle-size-analyzers/ls-13-320 (Accessed 9 June 2022)

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[13] http://www.kpal.co.uk/

2.4.2 *In-situ* entrainment threshold

The *in-situ* entrainment threshold (τ_o) defines the bed shear stress that is just sufficient to mobilise the surficial layer of sediment. This threshold was measured using a portable cohesive strength meter (CSM, Figure 2.9). When testing the sediment surface, the air cylinder is used to pressurise the water reservoir, and a water jet is fired into the sensor head placed on top of the sediment sample under testing. The pressure (and hence the water jet power) is increased incrementally until a drop in the sensor's light transmission reading indicates that the sediment has mobilised.

During the GUC sampling campaign, it was found that the first few centimetres below a core sample's surface layer were highly unconsolidated in several cases. Removing this sediment to reveal more consolidated sediments below and obtaining CSM measurements was necessary. The depth of the sediment layer removed is given in Figure 4.1 and Table 6.9. Further consideration of this procedure is given in Section 6.2.

Figure 2.9: CSM; the portable instrument used to measure the critical entrainment stress of canal bed and connected waterbody sediments.

Source: Partrac, 2022

Tolhurst et al. (1999) described the design and function of the device. They developed an equation (Eq. 1) to relate vertical jet pressures P (in PSI) for suspension of grains to equivalent horizontal bed shear stresses (τ_o in N/m^2), (Black, 2007; Vardy et al., 2007).

$$\tau_o = 66.7\left(1 - e^{(-P/310.1)}\right) - 195.3\left(1 - e^{-P/1622.6}\right) \qquad \text{Eq. 1}$$

The τ_o values reported here are based on this approach. All outputs from the *in-situ* CSM tests showing time-series of transmission (%) and horizontal shear stress (N/m^2) are included in Appendix E.

2.4.3 Chemical analyses

SOCOTEC UK Ltd[14], a UKAS-accredited laboratory, undertook chemical analyses of all the canal bed and connected waterbody sediments and water samples. The company's robust extraction and analytical procedures have been developed specifically for complex sediment samples. As agreed by the client, the present study focussed on:

- Heavy metals: arsenic as As, cadmium as Cd, copper as Cu, lead as Pb, mercury as Hg, nickel as Ni, total chromium as Cr and zinc as Zn

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[14] https://www.socotec.co.uk. A detailed list of all analyses the laboratory can undertake is given in https://www.ukas.com/wp-content/uploads/schedule_uploads/00002/1252Testing-Multiple.pdf

- Polynuclear aromatic hydrocarbons (PAHs): acenaphthene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene and pyrene
- Total PAH 16
- Polychlorinated biphenyls (PCBs): PCB 101, PCB 118, PCB 138, PCB 153, PCB 180, PCB 28 and PCB 52
- Total petroleum hydrocarbons (>C8-C40)
- Total moisture
- A description of the solid material

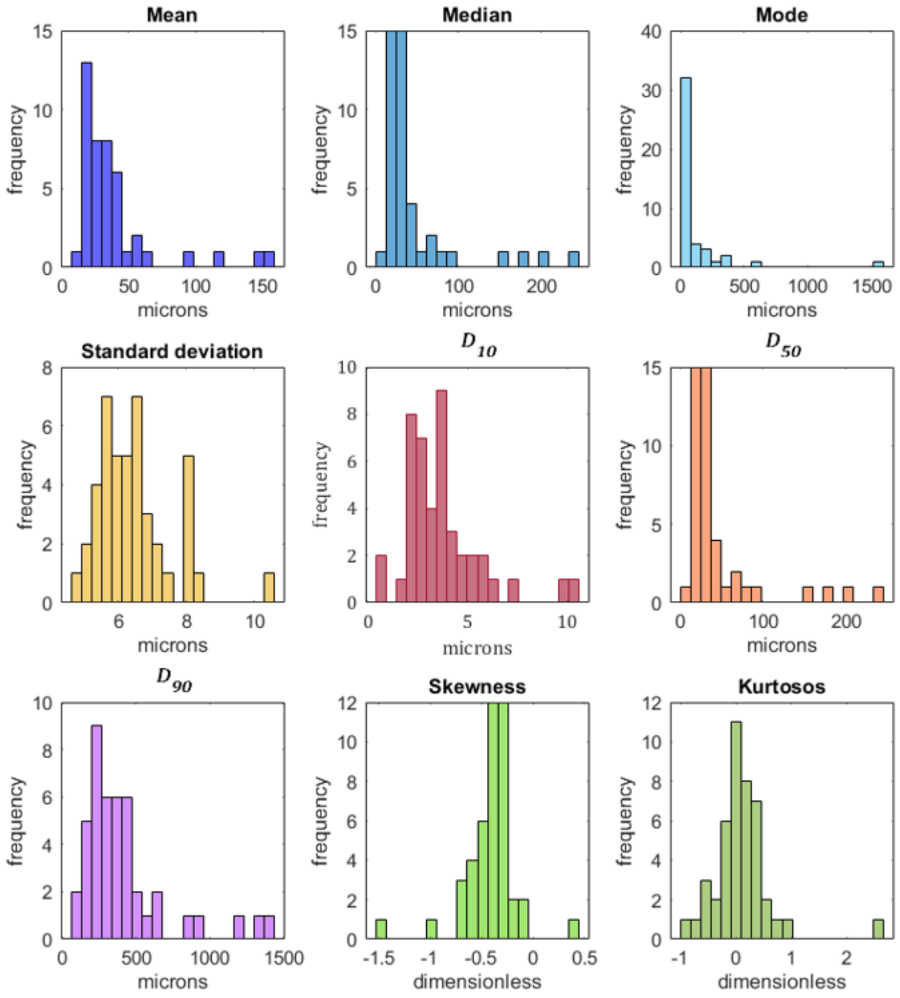
For further information on the HWOL (HazWasteOnline) acronym system, please refer to One Touch Data Ltd. (2021).

3 Results 1: PSA

The size of particles comprising the canal bed sediments determines their physical and chemical behaviour, including the entrainment threshold for mobilisation, settling velocity, cohesiveness and potential to adsorb and store pollutants. A summary of the PSA data in Table 3.1 gives the mean, median, Sauter mean diameter D(3,2), mode, standard deviation (S.D.), D_{10}, D_{50}, D_{90}, skewness and kurtosis of the grain size distribution. The PSA data are also provided in Appendix F, where plots of the grain size distribution and a table of summary statistics are provided for canal bed samples GUC 1 to GUC 47 and connected waterbody samples GUC C1 and GUC C3 to GUC C8.

Data in Table 3.1 are shown graphically in Figure 3.1. This figure shows frequency distributions of the mean, median, Sauter mean diameter D(3,2), mode, standard deviation (S.D.), D_{10}, D_{50}, D_{90}, skewness and kurtosis calculated using data from analysis of all 47 GUC bed sediment samples. The dominance of clay and silt-size particles less than 63 microns (µm) is evident. As particle size is a key property determining sediment mobility, it indicates how these sediments may respond to increases in flow speeds. In all cases, the PSA data show that the mean particle diameter is around 20µm, and thus, the sediments possess cohesive properties.

Figure 3.1: Histograms summarising PSA results for samples GUC 1 to GUC 47.



Source: Mott MacDonald, 2022

Table 3.1: Summary of PSA for samples GUC 1 to GUC 47 and GUC C1, and GUC C3 to GUC C8 (identified by blue text).

Sample	Mean µm	Median µm	D(3,2) µm	Mode µm	S.D. µm	D_{10} µm	D_{50} µm	D_{90} µm	Skewness	Kurtosis
GUC 1	49.54	68.56	4.92	324.4	7.23	3.89	68.56	465.1	-0.603	-0.243
GUC 2	22.00	20.11	3.25	11.29	6.35	2.53	20.11	257.2	-0.306	-0.025
GUC 3	21.83	21.40	3.25	12.40	6.21	2.44	21.40	228.3	-0.371	0.048
GUC 4	No data									
GUC 5	27.86	25.66	4.16	13.61	6.10	3.45	25.66	326.7	-0.321	0.035
GUC 6	30.83	30.22	4.34	12.40	6.42	3.29	30.22	354.7	-0.381	-0.187
GUC 7	20.49	19.73	3.85	12.40	4.97	3.48	19.73	153.3	-0.463	0.638
GUC 8	119.20	175.90	8.05	1584.00	8.12	6.47	175.9	1426.0	-0.688	-0.141
GUC 9	38.27	38.47	4.71	12.40	6.57	4.23	38.47	464.9	-0.378	-0.0018
GUC 10	24.98	20.14	3.02	10.29	7.99	2.15	20.14	434.4	-0.169	-0.482
GUC 11	61.99	86.82	5.05	116.30	8.04	3.85	86.82	894.6	-0.545	-0.132
GUC 12	27.35	28.46	3.51	11.29	6.70	2.72	28.46	305.3	-0.409	-0.119
GUC 13	24.09	25.15	3.37	34.58	6.49	2.54	25.15	279.5	-0.336	-0.0018
GUC 14	44.85	60.83	5.17	168.90	6.22	4.17	60.83	377.4	-0.684	0.2
GUC 15	No data									
GUC 16	94.94	148.30	6.75	223.40	7.97	5.22	148.3	1165.0	-0.702	-0.059
GUC 17	144.10	206.40	9.33	203.50	5.51	10.42	206.4	841.9	-1.523	2.678
GUC 18	7.66	9.41	1.54	34.58	5.79	0.56	9.41	60.6	-0.448	-0.48
GUC 19	29.84	34.92	4.33	41.68	5.65	3.59	34.92	249.3	-0.579	0.4
GUC 20	26.54	27.89	3.76	14.94	6.02	3.02	27.89	262.2	-0.454	0.224
GUC 21	18.49	16.72	2.96	13.61	6.25	2.08	16.72	249.9	-0.247	-0.064
GUC 22	54.46	61.69	6.31	116.30	6.50	5.56	61.69	622.8	0.445	-0.0029
GUC 23	28.15	26.70	3.91	12.40	6.51	3.14	26.7	350.0	-0.306	-0.07
GUC 24	19.00	18.45	3.14	13.61	5.88	2.42	18.45	204.7	-0.266	0.272
GUC 25	36.75	25.38	4.32	13.61	7.95	3.49	25.38	615.4	-0.137	-0.558
GUC 26	157.40	245.60	10.80	269.2	6.63	9.85	245.6	1359.0	-1.009	0.759
GUC 27	54.15	75.91	5.09	140.10	7.07	4.29	75.91	568.8	-0.634	0.024
GUC 28	21.43	20.79	2.96	12.40	6.64	2.24	20.79	250.4	-0.320	-0.037

Sample	Mean µm	Median µm	D(3,2) µm	Mode µm	S.D. µm	D_{10} µm	D_{50} µm	D_{90} µm	Skewness	Kurtosis
GUC 29	20.32	19.71	3.53	13.61	5.48	2.87	19.71	179.6	-0.342	0.437
GUC 30	No data									
GUC 31	38.74	38.21	4.57	28.70	6.95	3.58	38.21	509.9	-0.373	-0.162
GUC 32	16.13	17.85	2.78	28.70	5.57	1.90	17.85	138.2	-0.475	0.184
GUC 33	29.46	29.45	4.22	13.61	6.09	3.56	29.45	315.0	-0.367	0.128
GUC 34	19.08	17.70	3.38	12.40	5.44	2.91	17.70	173.5	-0.304	0.459
GUC 35	19.47	18.27	3.40	12.40	5.42	2.92	18.27	179.1	-0.360	0.423
GUC 36	36.73	32.87	4.67	12.40	6.99	3.76	32.87	470.3	-0.282	-0.353
GUC 37	22.43	19.54	3.89	13.61	5.54	3.47	19.54	222.1	-0.249	0.375
GUC 38	37.48	35.89	5.40	13.61	5.88	4.82	35.89	361.2	-0.384	0.128
GUC 39	16.45	16.48	3.29	13.61	4.90	2.57	16.48	127.5	-0.500	0.483
GUC 40	40.75	37.12	7.66	26.14	4.71	7.31	37.12	320.7	-0.384	0.869
GUC 41	36.13	32.66	6.04	16.40	5.35	5.51	32.66	334.3	-0.326	0.377
GUC 42	30.70	34.23	3.44	127.6	7.594	2.27	34.23	411.6	-0.397	-0.384
GUC 43	38.83	36.87	5.76	14.94	5.68	5.19	36.87	366.9	-0.399	0.269
GUC 44	37.25	39.04	5.56	14.94	5.60	4.73	39.04	345.6	-0.447	0.332
GUC 45	19.76	18.62	1.99	567.70	10.44	0.82	18.62	483.1	-0.137	-0.916
GUC 46	20.14	19.96	3.49	19.76	5.86	2.17	19.96	220.0	-0.239	0.210
GUC 47	30.31	30.96	3.30	324.40	8.37	1.94	30.96	460.2	-0.304	-0.653
GUC C1	106.80	295.9	5.03	390.90	9.58	3.56	295.90	975.1	-0.955	-0.078
GUC C2	No data									
GUC C3	20.84	22.42	2.32	28.70	8.31	1.16	22.42	320.2	-0.355	-0.636
GUC C4	32.25	34.07	4.67	31.5	5.80	3.87	34.07	293.2	-0.438	0.296
GUC C5	6.518	8.22	1.41	28.70	5.56	0.46	8.22	55.88	-0.481	-0.556
GUC C6	44.99	52.43	7.61	72.94	4.89	6.18	52.43	309.2	-0.584	0.694
GUC C7	27.01	26.16	3.59	12.40	7.05	2.53	26.16	378.4	-0.263	-0.289
GUC C8	86.01	181.90	6.91	471.10	8.21	4.84	181.90	820.0	-0.646	-0.474

Source: Mott MacDonald & Partrac (2022)

Table 3.2 shows the average, standard deviation, minimum and maximum values for mean, D_{10}, D_{50} and D_{90} values derived from the PSA of GUC canal bed sediment samples 1 to 47.

Table 3.2: Average, standard deviation, minimum and maximum values for mean, D_{10}, D_{50} and D_{90} from GUC canal bed sediment samples 1 to 47.

PSA	Average (µm)	S.D. (µm)	Minimum (µm)	Maximum (µm)
Mean	40.5	32.9	7.7	157.4
D_{10}	3.7	1.9	0.6	10.4
D_{50}	51.4	62.8	9.4	295.0
D_{90}	429.5	309.4	60.6	1426.0

Source: Mott MacDonald & Partrac (2022)

Table 3.3 shows the average, standard deviation, minimum and maximum values for mean, D_{10}, D_{50} and D_{90}.

Table 3.3: Average, standard deviation, minimum and maximum values for mean, D_{10}, D_{50} and D_{90} from connected waterbody bed sediment samples 1 and 3 to 8.

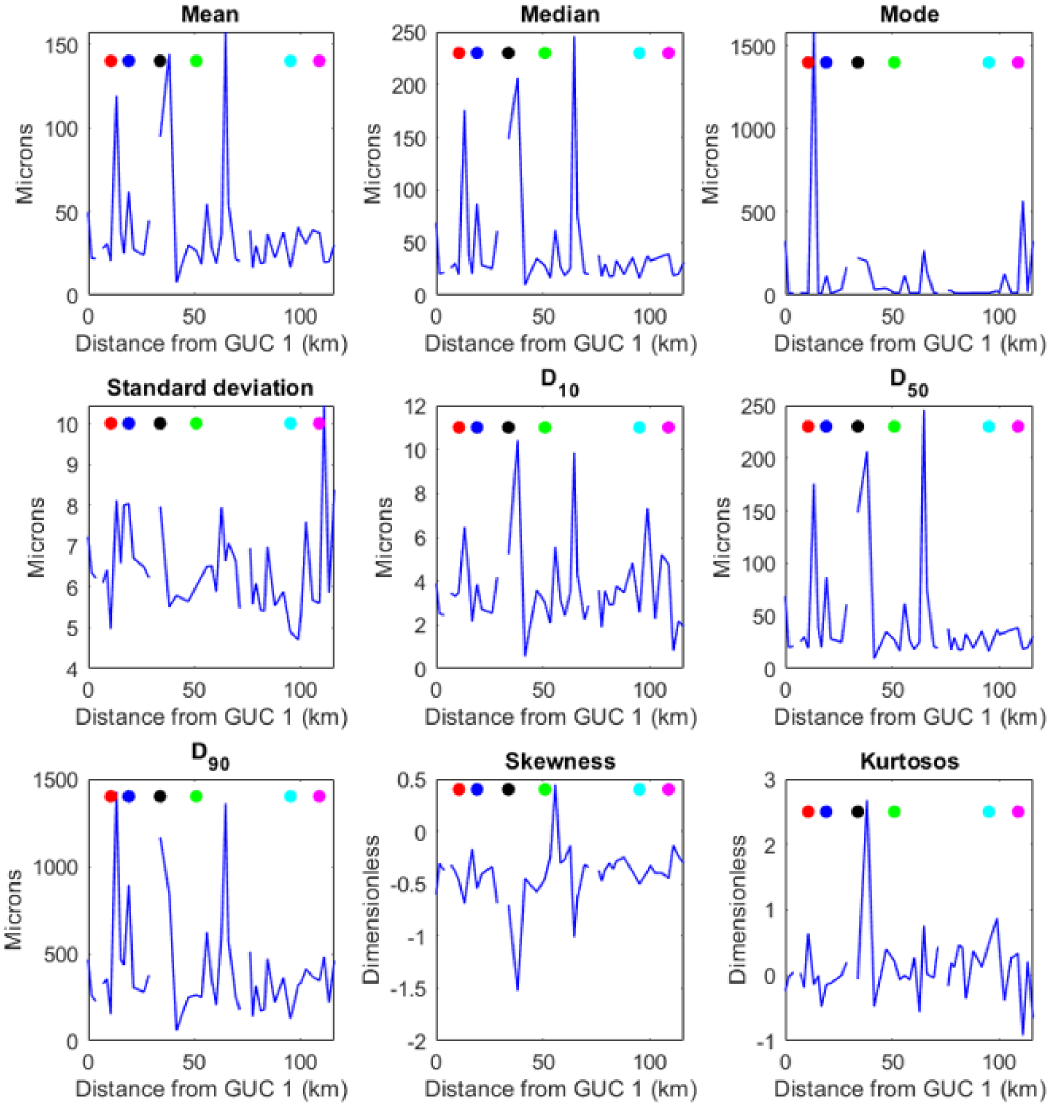
PSA	Average (µm)	S.D. (µm)	Minimum (µm)	Maximum (µm)
Mean	36.3	27.5	6.5	86.0
D_{10}	3.2	2.2	0.5	6.2
D_{50}	54.2	64.2	8.2	181.9
D_{90}	362.8	250.2	55.9	820.0

Source: Mott MacDonald & Partrac (2022)

In Figure 3.2, PSA results for samples GUC 1 to GUC 47 are plotted against the approximate distance south of the GUC sample location 1 (Figure 3.1). Solid circles on the plots show the approximate location of Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta). No trends are evident in these data.

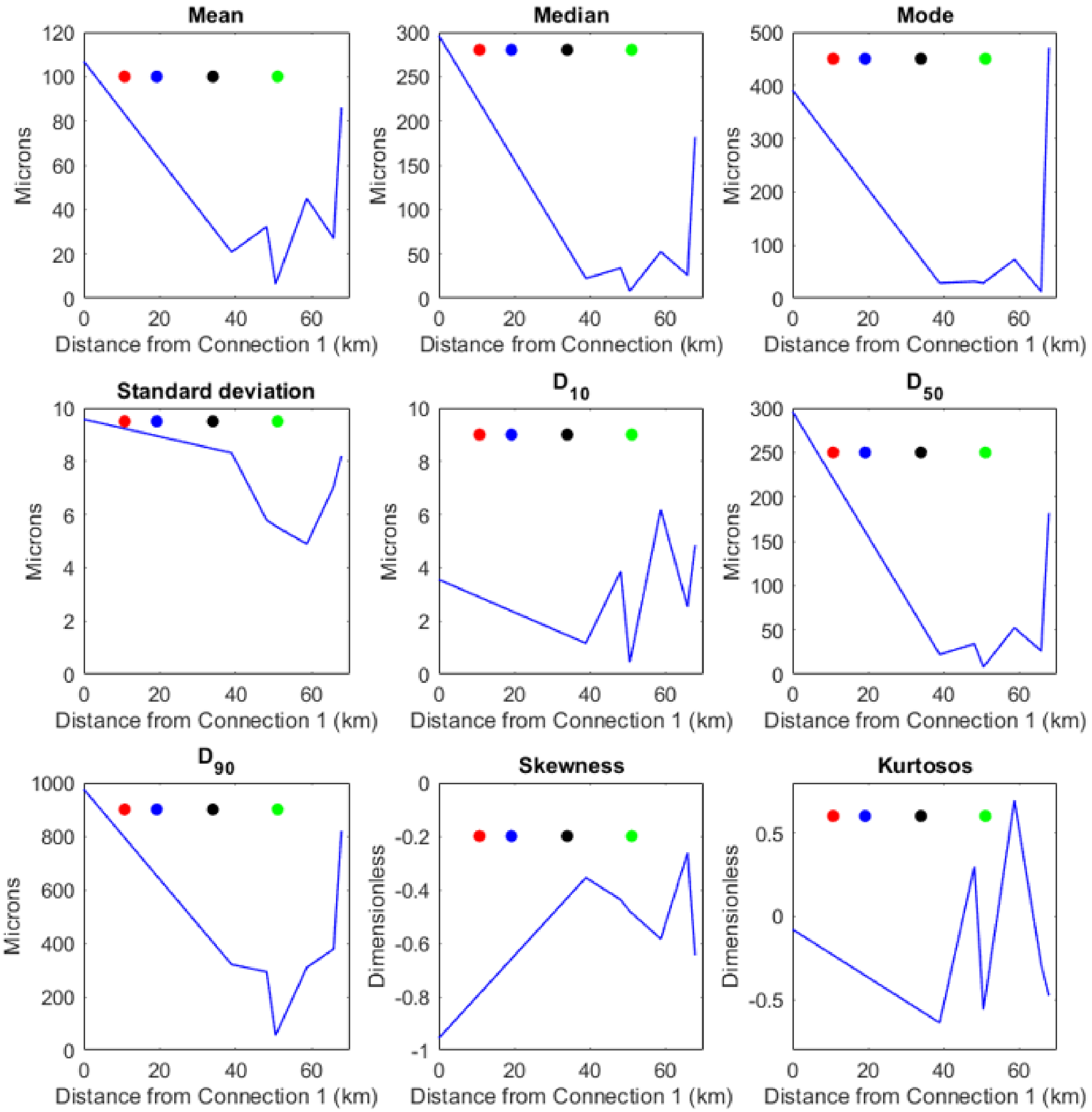
PSA results for connected waterbody samples GUC C1 to GUC C8 plotted against the distance south of GUC C1 are shown in Figure 3.3. These sparse data indicate that sediments from the northern locations are coarser than those from the south. Although clay and silt size particles dominate at all sites, it is evident that locations GUC C1 and GUC C8 have coarser bed sediments than GUC C3 to GUC C7. Due to the relatively small number of connected waterbody samples, histograms showing PSA data are not included in this report.

Figure 3.2: PSA results for samples GUC 1 to GUC 47 plotted against distance south of GUC sample 1 (Figure 2.5). Solid circles show the approximate location of Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta).



Source: Mott MacDonald & Partrac (2022)

Figure 3.3: PSA results for samples GUC C1 to GUC C8 plotted against distance south from GUC C1 (Figure 2.5). Solid circles show the approximate location of Nuneaton (red), Coventry (blue), Rugby (black) and Daventry (green).



Source: Mott MacDonald & Partrac (2022)

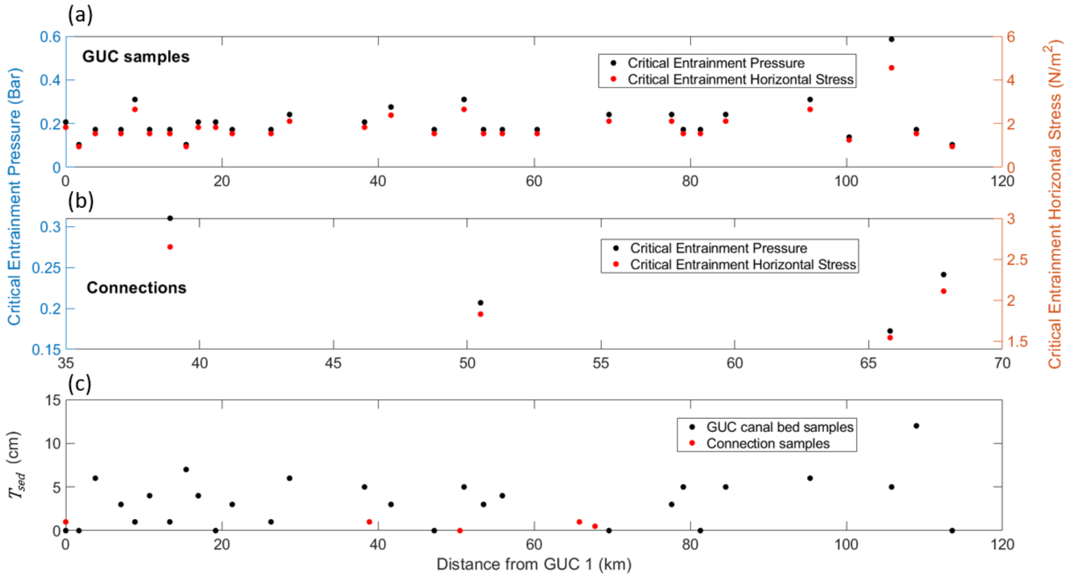
4 Results 2: *In-situ* entrainment threshold

The horizontal entrainment shear stress defines the shear stress required to mobilise the bed sediments. When linked with numerical model predictions of shear stress[15] for the baseline and the scheme, these data will enable an assessment of sediment mobility potential during water transfer.

As noted above, it was necessary to remove the first few upper centimetres of highly unconsolidated 'sediment' from cores (Figure 4.1 and Table 6.9) to reveal the more consolidated sediments below and obtain CSM measurements. Partrac reported that these materials had no measurable shear strength and are, therefore, most likely organic in origin.

The results of the CSM analyses in Figure 4.1 show: (a) critical entrainment pressures (Bar) and horizontal entrainment shear stress (τ_O, N/m^2) for GUC samples 1 to 47; (b) critical entrainment pressures and horizontal entrainment shear stress for connected waterbody samples C1 to C8 (excluding C2); and (c) the thickness of sediment removed from GUC and connected waterbody cores (T_{sed}) required to obtain CSM data. These data are also tabulated in Table 4.1.

Figure 4.1: CSM results



Source: Mott MacDonald, 2022; Partrac, 2022

Grid references for continued monitoring locations redacted

Table 4.1: Locations and CSM measurements of the horizontal entrainment shear stress (τ_o). Missing shear strength values reflect inconclusive CSM test results where spikes were seen in the transmission value. In other cases, samples were too weak for effective CSM measurements.

Location	Longitude	Latitude	CSM measurement τ_o (N/m^2)
GUC 1	[redacted]	[redacted]	1.83
GUC 2	[redacted]	[redacted]	0.95
GUC 3	[redacted]	[redacted]	1.54

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[15] The bed shear stress data from the JBA Gate 2 model were unavailable at the time of undertaking the analyses.

Grid references for continued monitoring locations redacted

Location	Longitude	Latitude	CSM measurement τ_o (N/m^2)
GUC 4	[redacted]	[redacted]	
GUC 5	[redacted]	[redacted]	1.54
GUC 6	[redacted]	[redacted]	2.65
GUC 7	[redacted]	[redacted]	1.54
GUC 8	[redacted]	[redacted]	1.54
GUC 9	[redacted]	[redacted]	0.95
GUC 10	[redacted]	[redacted]	1.83
GUC 11	[redacted]	[redacted]	1.83
GUC 12	[redacted]	[redacted]	1.54
GUC 13	[redacted]	[redacted]	1.54
GUC 14	[redacted]	[redacted]	2.11
GUC 15	[redacted]	[redacted]	-
GUC 16	[redacted]	[redacted]	-
GUC 17	[redacted]	[redacted]	1.83
GUC 18	[redacted]	[redacted]	2.38
GUC 19	[redacted]	[redacted]	1.54
GUC 20	[redacted]	[redacted]	2.65
GUC 21	[redacted]	[redacted]	1.54
GUC 22	[redacted]	[redacted]	1.54
GUC 23	[redacted]	[redacted]	-
GUC 24	[redacted]	[redacted]	1.54
GUC 25	[redacted]	[redacted]	-
GUC 26	[redacted]	[redacted]	-
GUC 27	[redacted]	[redacted]	-
GUC 28	[redacted]	[redacted]	2.11
GUC 29	[redacted]	[redacted]	-
GUC 30	[redacted]	[redacted]	
GUC 31	[redacted]	[redacted]	-
GUC 32	[redacted]	[redacted]	2.11
GUC 33	[redacted]	[redacted]	1.54
GUC 34	[redacted]	[redacted]	1.54
GUC 35	[redacted]	[redacted]	-
GUC 36	[redacted]	[redacted]	2.11
GUC 37	[redacted]	[redacted]	-
GUC 38	[redacted]	[redacted]	-
GUC 39	[redacted]	[redacted]	2.65
GUC 40	[redacted]	[redacted]	-
GUC 41	[redacted]	[redacted]	1.25
GUC 42	[redacted]	[redacted]	-
GUC 43	[redacted]	[redacted]	4.55
GUC 44	[redacted]	[redacted]	1.54
GUC 45	[redacted]	[redacted]	-
GUC 46	[redacted]	[redacted]	0.95
GUC 47	[redacted]	[redacted]	-

Grid references for continued monitoring locations redacted

Location	Longitude	Latitude	CSM measurement τ_o (N/m^2)
GUC C1	[redacted]	[redacted]	-
GUC C2	[redacted]	[redacted]	-
GUC C3	[redacted]	[redacted]	2.6
GUC C4	[redacted]	[redacted]	-
GUC C5	[redacted]	[redacted]	1.8
GUC C6	[redacted]	[redacted]	-
GUC C7	[redacted]	[redacted]	1.5
GUC C8	[redacted]	[redacted]	2.1

Source: Mott MacDonald & Partrac, 2022.

Average, standard deviation, minimum and maximum values for measured τ_o values for GUC canal bed sediment samples 1 to 47, and connected waterbody are tabulated in Table 4.2.

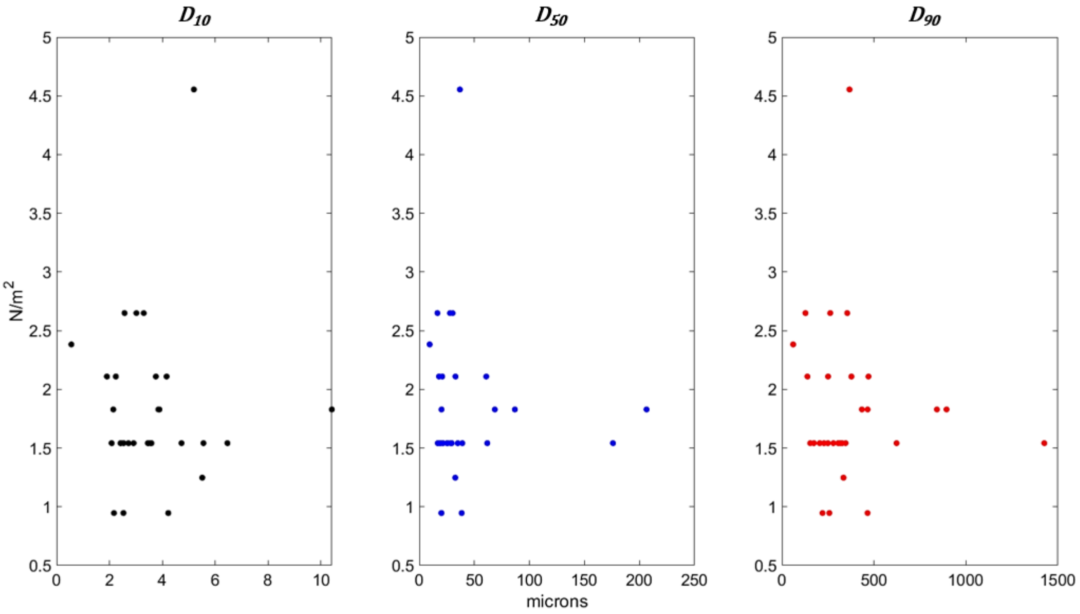
Table 4.2: Average, standard deviation, minimum and maximum values for measured τ_o and T_{sed} values for GUC canal bed sediment samples 1 to 47 and connected waterbody samples.

Parameter	Average	S.D.	Minimum	Maximum
τ_o for GUC 1 to 47 (N/m^2)	1.82	0.67	0.95	4.55
τ_o for connected waterbody (N/m^2)	2.00	0.41	1.50	2.60
T_{sed} for GUC 1 to 47 (cm)	3.1	2.4	0.0	12.0
T_{sed} for connected waterbody (cm)	0.4	0.4	0.0	1.0

Source: Mott MacDonald & Partrac (2022)

Figure 4.1 shows a wide scatter of points describing the weak relationship between grain size and critical horizontal shear stress measured by the CSM for D_{10}, D_{50} and D_{90} values for GUC sediment samples. Given that the sediment samples are relatively closely graded, these results indicate that the shear strength is governed by geographical variations in sediment consolidation and cohesion.

Figure 4.2: Relationship between grain size and critical horizontal shear stress measured by the CSM for D_{10}, D_{50} and D_{90} values for GUC sediment samples.



Source: Mott MacDonald, 2022; Partrac, 2022

5 Results 3: Chemical analyses

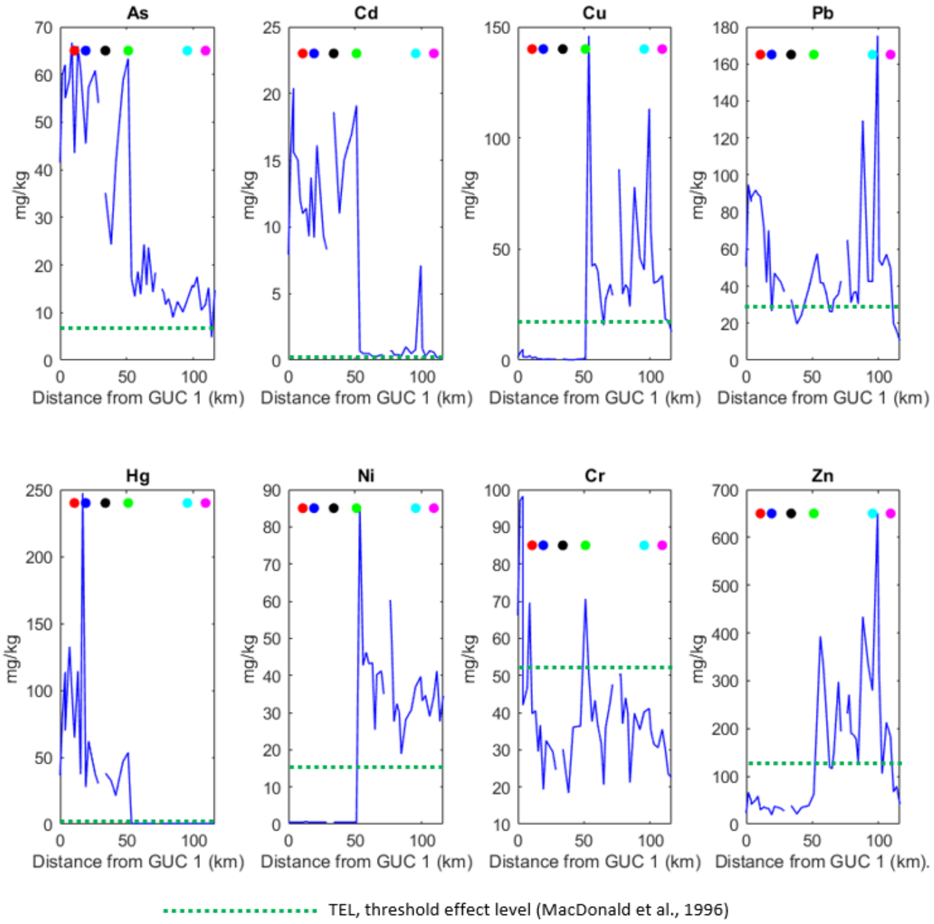
5.1 Sediments

5.1.1 Heavy metals in canal sediments

In Figure 5.1, chemical analysis results for samples GUC 1 to GUC 47 are plotted against the distance south of GUC sample location C1 (Figure 2.5) for heavy metals arsenic as As, cadmium as Cd, copper as Cu, lead as Pb, mercury as Hg, nickel as Ni, total chromium as Cr and zinc as Zn. The solid circles on each plot show the approximate location of urban centres, including Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta). Threshold effects level (TEL) values defined in Section 6.3 are also shown on these plots.

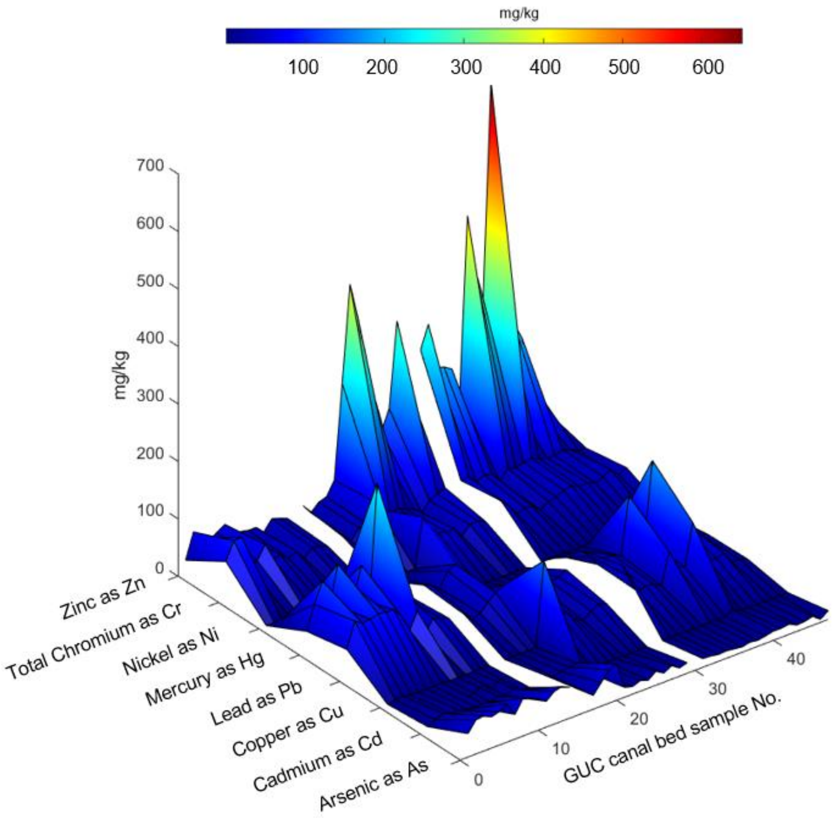
These data are also plotted as a surface in Figure 5.2 to assist visualisation of the data. The spatial differences in heavy metal contamination are discussed further in Section 6.3.

Figure 5.1: Chemical analysis results for samples GUC 1 to GUC 47 plotted against distance south from GUC C1 (Figure 2.5) for heavy metals. Solid circles show the approximate location of Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta). Threshold effects level (TEL) values are defined in Table 6.1.



Source: Mott MacDonald & Partrac (2022)

Figure 5.2: Surface plot showing chemical analysis results for samples GUC 1 to GUC 47 for heavy metals

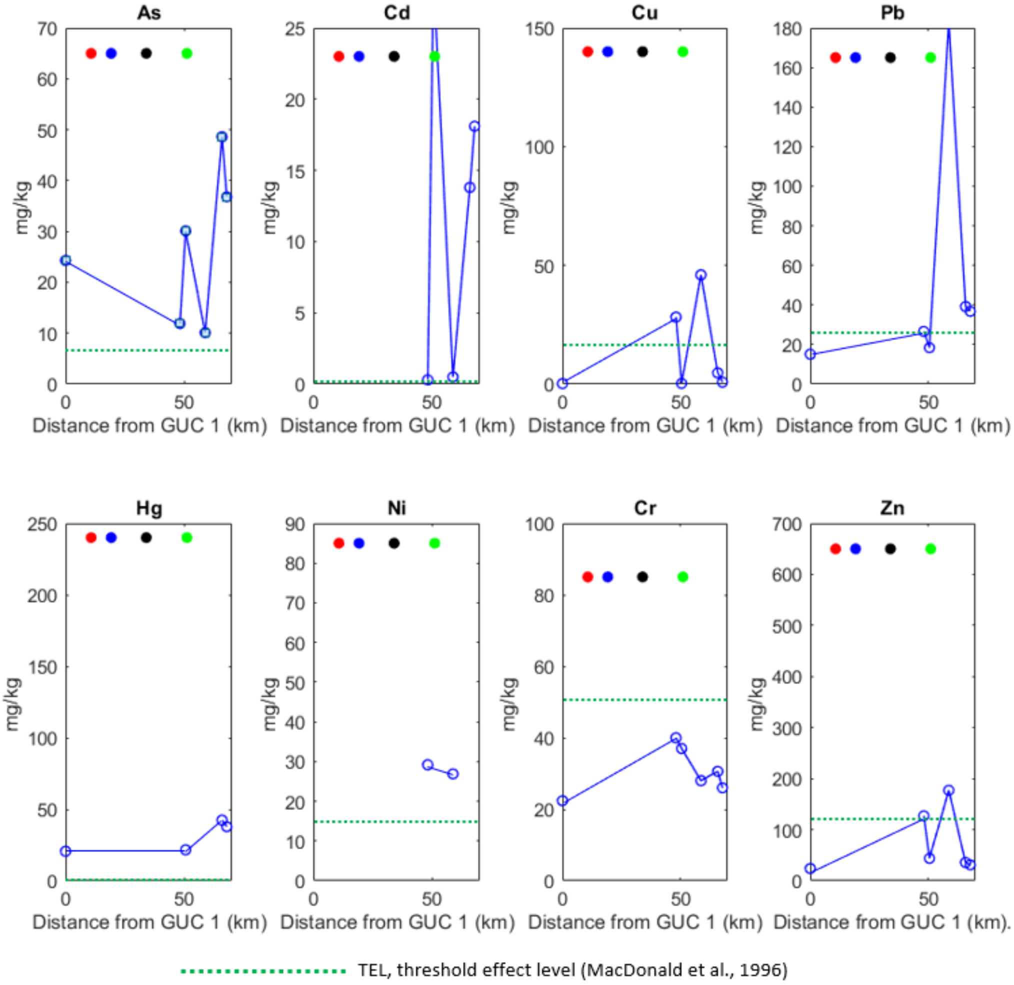


Source: Mott MacDonald & Partrac (2022)

5.1.2 Heavy metals in connected waterbody sediments

In Figure 5.3, chemical analysis results for connected waterbody GUC C1 and GUC C3 to GUC C8 are plotted against the distance south of GUC sample location C1 (Figure 2.5), showing heavy metals arsenic as As, cadmium as Cd, copper as Cu, lead as Pb, mercury as Hg, nickel as Ni, total chromium as Cr and zinc as Zn. The solid circles on each plot show the approximate location of urban centres, including Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta).

Figure 5.3: Chemical analysis results for connected waterbody samples GUC C1 and GUC C3 to GUC C8 plotted against distance south of GUC C1 (Figure 2.5) for heavy metals. Solid circles show the approximate location of Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta). Threshold effects level (TEL) values are defined in Table 6.1.



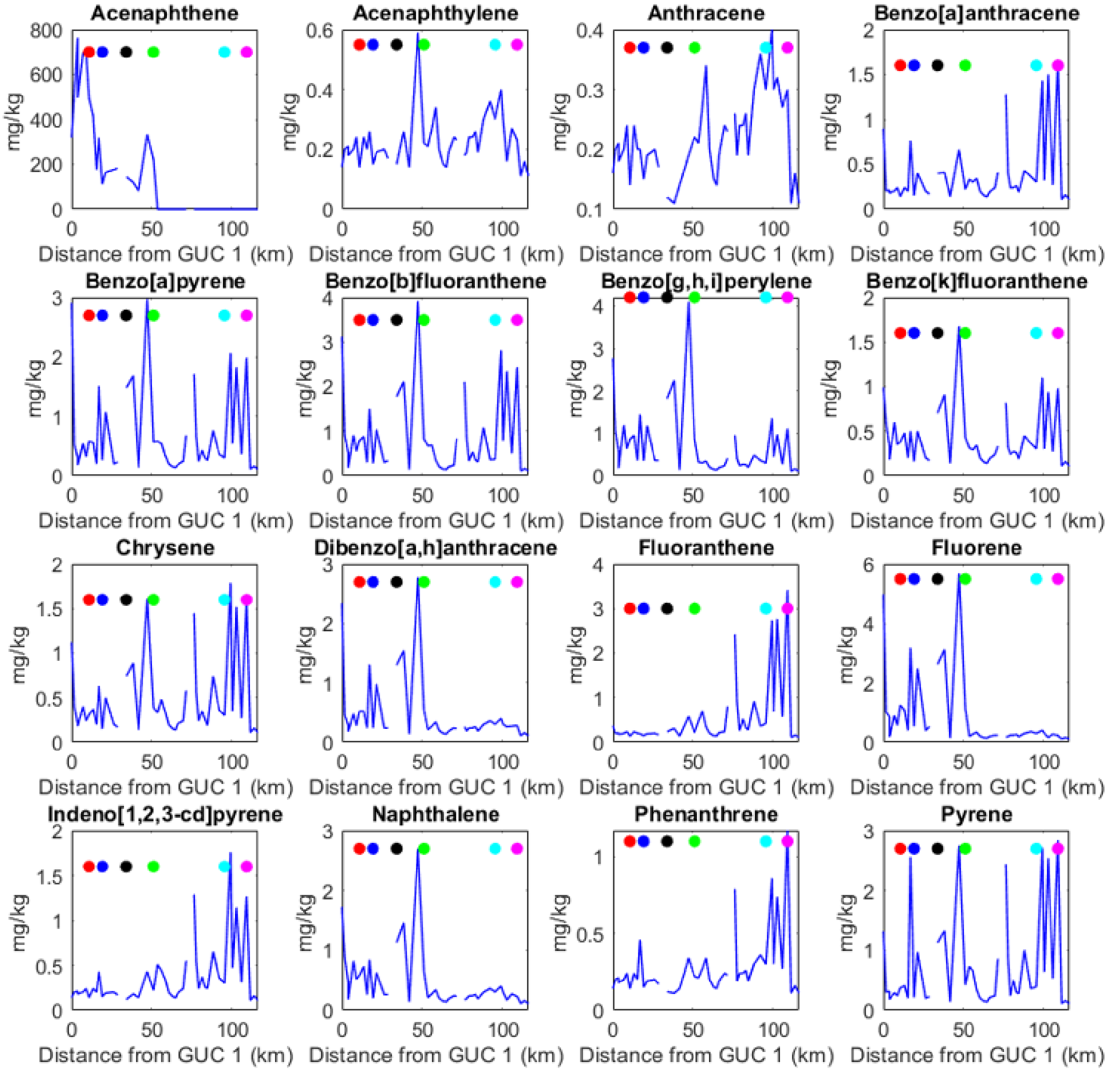
Source: Mott MacDonald & Partrac (2022)

5.1.3 PAHs in canal sediments

Figure 5.4 shows chemical analysis results for samples GUC 1 to GUC 47 plotted against the distance south of GUC 1 (Figure 2.5) for: polynuclear aromatic hydrocarbons (PAHs), including acenaphthene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, bBenzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene and pyrene. Solid circles show the approximate location of Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta). It is noted that the sensitivity of the gas chromatograph limits the minimum concentrations reported in the SOCOTEC analysis. Thus, all the plots in Figure 5.4 show the minimum values detected by the equipment. Threshold effects level (TEL) values defined in Table 6.1 are not shown in this figure since the measured values exceed TEL by around three orders of magnitude.

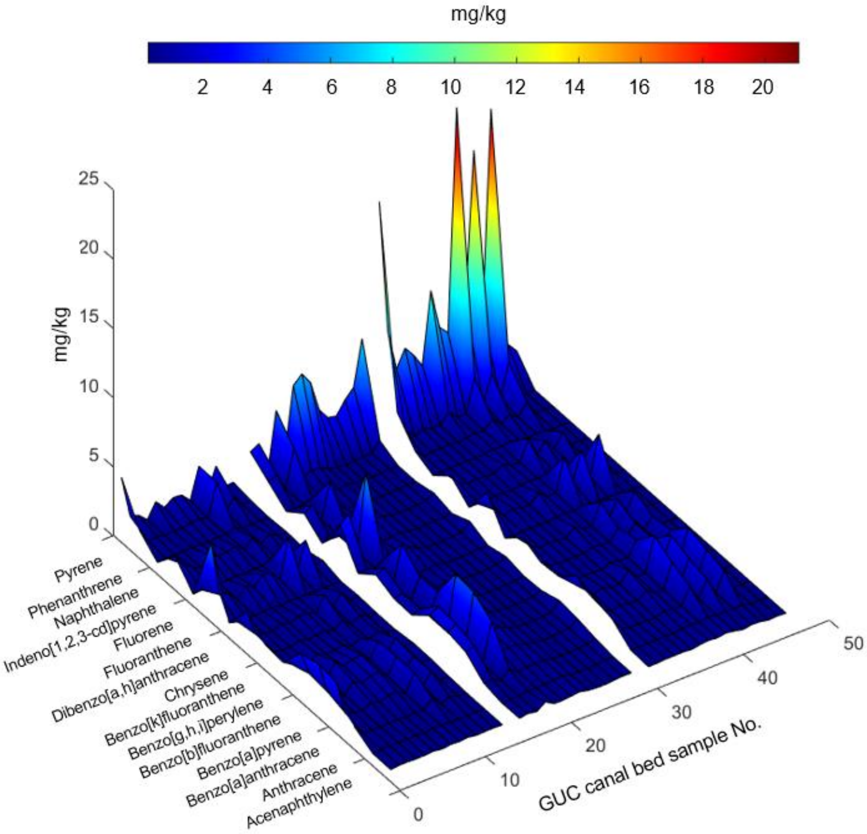
These data are also plotted as a surface in Figure 5.5 to assist visualisation of the data. The spatial differences in PAHs contamination are discussed further in Section 6.3.

Figure 5.4: Chemical analysis results for samples GUC 1 to GUC 47plotted against distance south from GUC C1 (Figure 2.5) for PAHs. Solid circles show the approximate location of Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta).



Source: Mott MacDonald & Partrac (2022)

Figure 5.5: Surface plot showing chemical analysis results for samples GUC 1 to GUC 47 plotted against distance south from GUC C1 (Figure 2.5) for PAHs. Acenaphthene is not plotted owing to order of magnitude difference with other PAHs (Figure 5.4).



Source: Mott MacDonald & Partrac (2022)

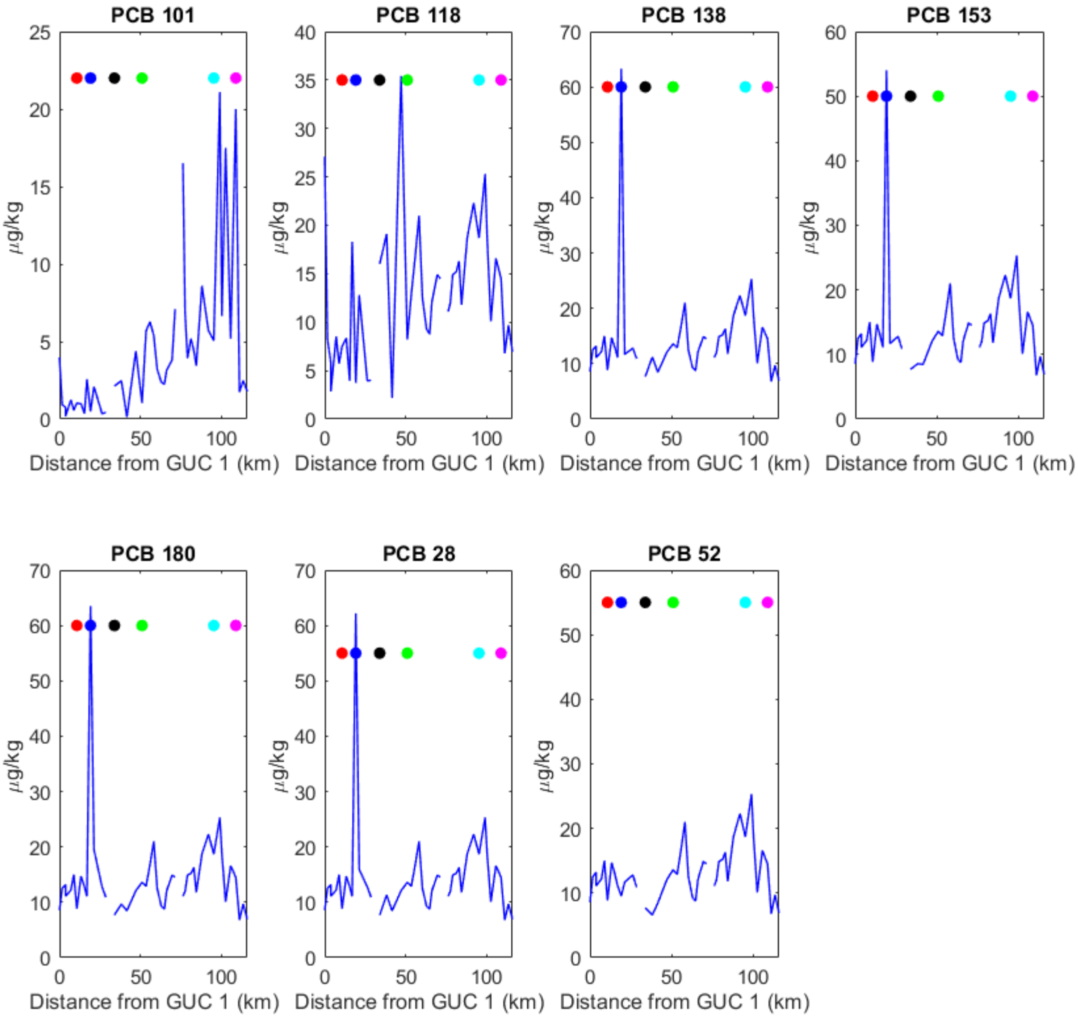
5.1.4 PAHs in connected waterbody sediments

Plots showing geographical differences are not included in this report owing to low measured PAH concentrations in the connected waterbody samples. Instead, the reader is referred to the tabulated data in Table G.14 in Appendix G.

5.1.5 PCBs in canal sediments

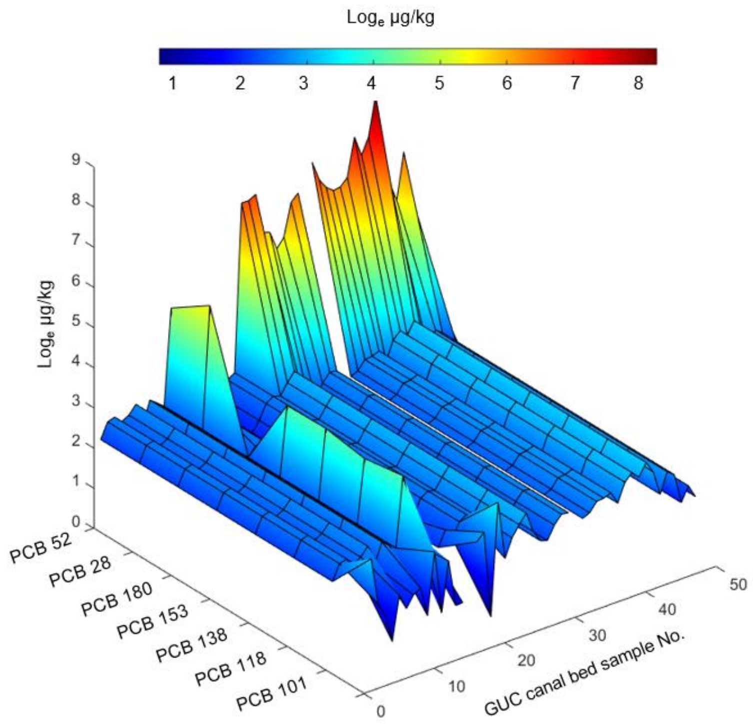
Figure 5.6 shows samples GUC 1 to GUC 47 plotted against the distance south of GUC 1 (Figure 2.5) for PCBs, including PCB 101, PCB 118, PCB 138, PCB 153, PCB 180, PCB 28 and PCB 52. Solid circles show the approximate location of Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta). These PCB data are also presented as a surface plot in Figure 5.7.

Figure 5.6: Chemical analysis results for samples GUC 1 to GUC 47 plotted against distance south of GUC C1 (Figure 2.5) for PCBs. Solid circles show the approximate location of Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta).



Source: Mott MacDonald, 2022; Partrac, 2022

Figure 5.7: Surface plot showing chemical analysis results for samples GUC 1 to GUC 47 plotted against distance south from GUC C1 (Figure 2.5) for PCBs. PCB concentration (µg/kg) is shown on a $\log_e$ scale.



Source: Mott MacDonald & Partrac (2022)

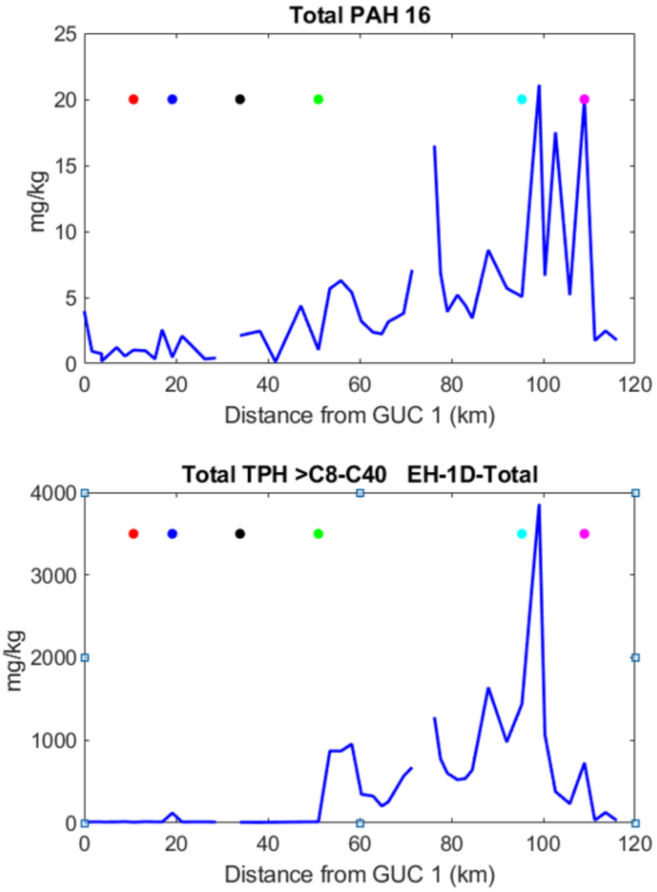
5.1.6 PCBs in connected waterbody sediments

Plots showing geographical differences are not included in this report owing to low measured PCB concentrations in the connected waterbody samples. Instead, the reader is referred to the tabulated data in Table G.14 in Appendix G.

5.1.7 Total PAH 16 and Total TPH >C8-C40 EH-1D-Total in canal sediments

Plots in Figure 5.8 show chemical analysis results for samples GUC 1 to GUC 47 plotted against distance south from GUC C1 (Figure 2.5) for Total PAH 16 and Total TPH >C8-C40 EH-1D-Total. Solid circles show the approximate location of Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta).

Figure 5.8: Time-series plot showing chemical analysis results for samples GUC 1 to GUC 47 plotted against distance south from GUC C1 (Figure 2.5) for Total PAH 16 and Total TPH >C8-C40 EH-1D-Total. Solid circles show the approximate location of Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta).

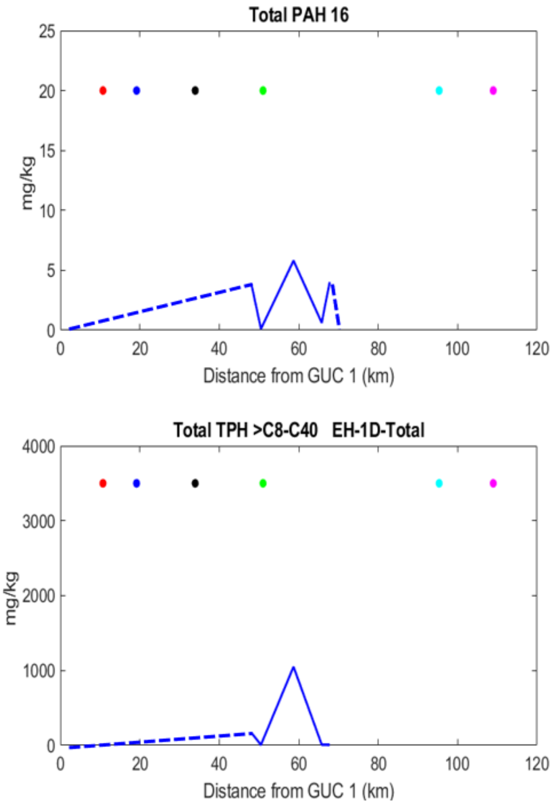


Source: Mott MacDonald & Partrac (2022)

5.1.8 Total PAH 16 and Total TPH >C8-C40 EH-1D-Total in connected waterbody sediments

Plots in Figure 5.9 show chemical analysis results for connected waterbody samples GUC 1 and GUC C3 to GUC 8 plotted against distance south from GUC C1 (Figure 2.5) for Total PAH 16 and Total TPH >C8-C40 EH-1D-Total. Solid circles show the approximate location of Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta).

Figure 5.9: Time-series plot showing chemical analysis results for connected waterbody samples C1 and C3 to C8 plotted against distance south from GUC C1 (Figure 2.5) for Total PAH 16 and Total TPH >C8-C40 EH-1D-Total. Solid circles show the approximate location of Nuneaton (red), Coventry (blue), Rugby (black), Daventry (green), Milton Keynes (cyan) and Leighton Buzzard (magenta



Source: Mott MacDonald & Partrac (2022)

5.2 Sediment resuspension by canal vessels

5.2.1 PSA

A summary of the PSA for water samples GUC W1, GUC W2, GUC W3 and GUC W4 (Figure 2.5) is shown in Table 5.1, giving the mean, median, Sauter mean diameter D(3,2), mode, standard deviation (S.D.), D_{10}, D_{50}, D_{90}, skewness and kurtosis of the grain size distribution. The PSA data are also shown in Appendix H, where plots of the grain size distribution and a summary statistics table are provided.

Table 5.1: Summary of PSA for water samples GUC W1, GUC W2, GUC W3 and GUC W4.

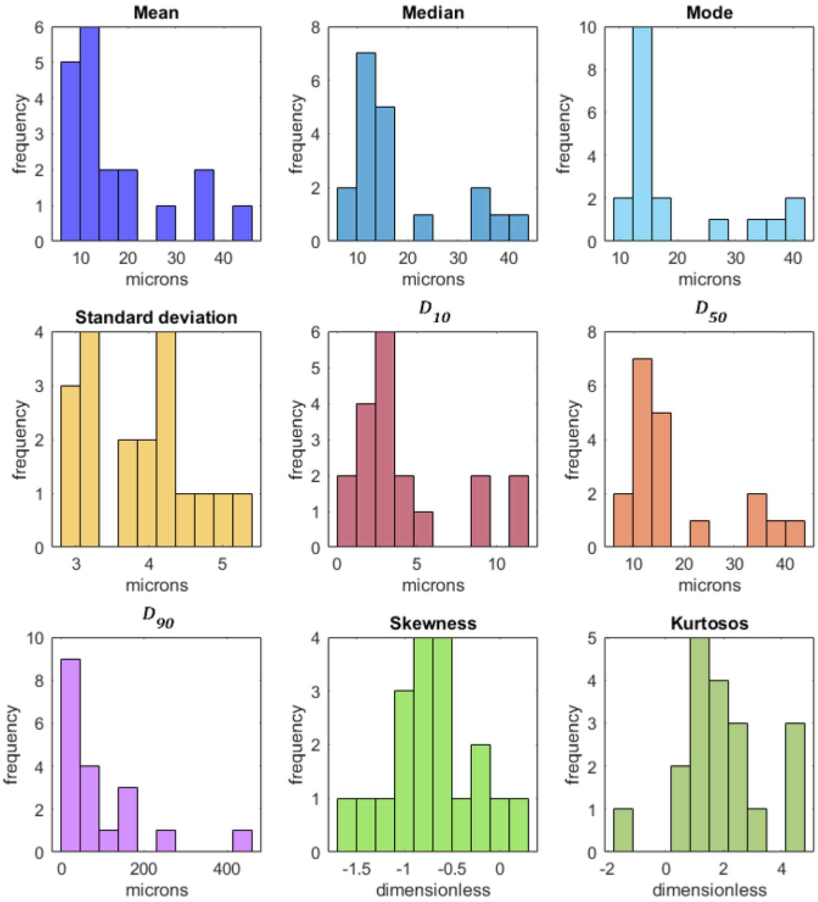
Sample	Mean µm	Median µm	D(3,2)	Mode µm	S.D. µm	D_{10} µm	D_{50} µm	D_{90} µm	Skewness -	Kurtosis -
GUC W1 T-30S	13.8	13.9	3.2	14.9	4.4	3.0	13.9	75.3	-0.218	1.802
GUC W1 T+30S	17.3	17.0	3.5	16.4	4.7	3.3	17.0	145.5	-0.321	1.198
GUC W1 T+5M	11.9	13.3	3.0	14.9	3.8	2.8	13.3	44.9	-0.666	2.267
GUC W1 T+10M	15.7	14.9	3.1	13.6	5.1	2.7	14.9	146.7	-0.268	0.828
GUC W1 T+20M	18.9	17.3	3.6	14.9	5.3	3.2	17.3	182.2	-0.085	0.877

Sample	Mean µm	Median µm	D(3,2)	Mode µm	S.D. µm	D_{10} µm	D_{50} µm	D_{90} µm	Skewness -	Kurtosis -
GUC W2 T-30S	10.5	12.0	2.4	12.4	4.2	1.8	12.0	51.6	-0.767	-1.300
GUC W2 T+30S	6.6	8.4	1.8	11.3	4.1	0.7	8.3	28.3	-0.811	0.803
GUC W2 T+5M	9.1	10.5	2.2	12.4	4.2	1.3	10.5	44.7	-0.672	1.155
GUC W2 T+10M	6.4	8.0	1.7	10.3	4.0	0.7	8.0	28.4	-0.886	0.902
GUC W2 T+20M	8.1	10.1	2.2	12.4	3.7	1.4	10.1	30.3	-1.080	1.708
GUC W3 T-30s	9.5	10. 7	4.1	12.4	3.0	2.3	10.6	31.9	-0.570	1.422
GUC W3 T+30s	12.1	13.6	5.2	14.9	2.9	3.6	13.5	39.3	-0.880	1.764
GUC W3 T+5m	11.6	13.2	4.5	14.9	2.9	3.3	13.2	36.4	-1.039	2.452
GUC W3 T+10m	12.9	14.7	4.6	16.4	3.0	3.8	14.6	40.7	-1.117	2.892
GUC W4 T-30s	37.9	32.6	10.9	34.6	4.2	9.4	32.6	456.6	0.266	1.506
GUC W4 T+30s	18.4	22.5	4.8	28.7	3.2	5.5	22.5	56.4	-1.696	4.317
GUC W4 T+5m	28.8	33.3	7.3	37.9	3.2	8.6	33.3	86.8	-1.304	4.745
GUC W4 T+10m	35.6	38.4	10.0	41.6	3.1	11.0	38.3	115.4	-0.994	4.443
GUC W4 T+20m	45.6	43.0	11.7	41.6	3.6	11.6	43.0	240.8	-0.532	2.169

Source: Mott MacDonald & Partrac (2022)

Data in Table 5.1 are shown graphically in Figure 5.10. This figure shows frequency distributions of the mean, median, Sauter mean diameter D(3,2), mode, standard deviation (S.D.), D_{10}, D_{50}, D_{90}, skewness and kurtosis calculated using data from analysis of all the 47 GUC bed sediment samples. The dominance of clay and silt-size particles significantly less than 63µm is evident.

Figure 5.10: Histograms summarising PSA results for all water samples.



Source: Mott MacDonald & Partrac (2022)

5.2.2 Chemical analyses

As all water samples showed low concentration values for all determinants, the results of the chemical analyses are not presented graphically in this report. A summary of the average, SD, minimum and maximum values for samples from GUC W1, GUC W2, GUC W3 and GUC W4 is provided in Appendix I.

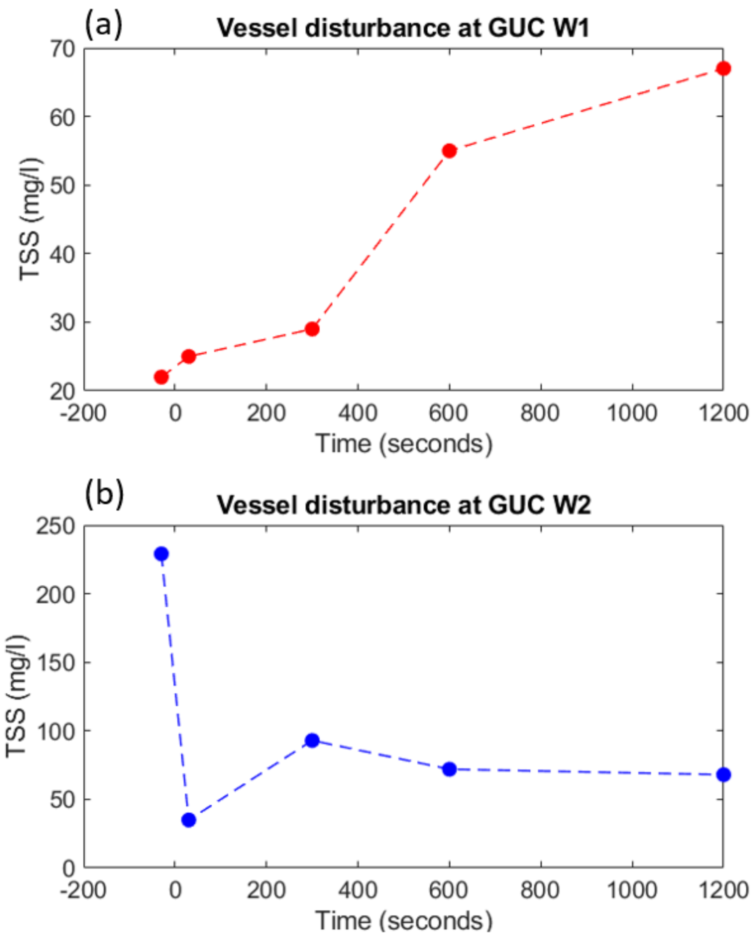
5.2.3 Total suspended solids (TSS)

Grid references for continued monitoring locations redacted

The total suspended solids in the water samples were obtained at time intervals of -30s, +30s, +5 min, +10 min and +20 min before and after the passage of a canal vessel at sampling points GUC W1 ([redacted]) and GUC W2 ([redacted]) were obtained through laboratory analysis. The results are shown in Figure 5.11.

It is noted that due to an error, water samples obtained at GUC W3 and GUC W4 were disposed of before undertaking analysis for TSS.

Figure 5.11: TSS in water samples before and after the passage of a canal vessel



Source: Mott MacDonald, 2022

6 Discussion

6.1 Particle size

The PSA analysis revealed geographical differences in values for mean, median, Sauter mean diameter D(3,2), mode, standard deviation (S.D.), D_{10}, D_{50}, D_{90}, skewness and kurtosis. Overall, the grain size characteristics of the canal bed sediments were relatively invariant (Figure 3.2), with average D_{10} and D_{50} values of 3.7µm and 51.4µm being in the clay size range. No trends emerge; the data show peak values superimposed on relatively stable along-canal values.

Values for D_{90} showed greater variation between samples owing to the inclusion of some coarse particles in some of the samples, as reflected in the relatively high standard deviation value. In common with the canal bed sediments, clay and silt-size sediments dominate the bed sediment samples from the connected waterbodies. The presence of coarse particles tends to skew the average D_{90} value. This effect is also reflected in the geographical differences between connected waterbody sample properties (Figure 3.3). Not surprisingly, given the different lithologies and environments, these data exhibit relatively large spatial differences in mean, median, Sauter mean diameter D(3,2), mode, standard deviation (S.D.), D_{10}, D_{50}, D_{90}, skewness and kurtosis.

Although the separation between sample points is typically around 3km, it is believed the present data provide a broad characterisation of the grain size distribution of the canal bed sediments. However, we do not have information from this initial investigation of the sediment composition. Specifically, what proportion of the deposits are organic in origin remains unknown.

6.2 Entrainment threshold

The CSM measurements used the critical entrainment pressures to derive the horizontal entrainment shear stress (t_o). The data for the canal samples (Figure 4.1a) showed relatively small geographical variations in the measured value of t_o with mean and standard deviation values of 1.82N/m^2 and 0.67N/m^2, respectively. The four connected waterbody locations (as shown in Table 2.2) tested had average and standard deviation values of 2.00N/m^2 and 0.41N/m^2, respectively. These are approximately 50% less than the canal locations and indicate that the flow more easily mobilises sediments on the bed of the natural watercourses. The PSA data provide no obvious explanation for the observed difference in shear strength between the canal sediments and the connected waterbodies. However, it is suggested that the greater shear strength of the canal bed sediments reflects the clay lining used during canal construction to minimise water losses.

The thickness of sediment removed from GUC cores (T_{sed}) was greater and required for the connected waterbody cores (Table 4.2). No relationships between τ_o and D_{10}, D_{50} and D_{90} values were evident (Figure 4.2). The requirement reported by Partrac to remove the upper few centimetres of sediment from the bed sediment core to run the CSM test indicates the highly unconsolidated nature of the upper sediment layers, which comprise a mixture of recently deposited organic and mineral particles.

6.3 Sediment quality guidelines

Canal sediments can act as sinks for various contaminants, including heavy metals from multiple sources, such as industrial and wastewater discharges (Stephens et al., 2001). The present analyses cannot identify the age or provenance of any contamination, and comments are restricted only to the laboratory results.

Our attempt to define what might be considered an ‘acceptable’ level of contamination for canal sediments failed to identify any specific guidance. Instead, we refer here to advise in the literature provided for coastal and estuarine sediments (e.g. MacDonald et al., 1996; Burton, 2002; Crane, 2003). A summary of the *threshold effects level* (TEL) defined by MacDonald et al. (1996) is shown in Table 6.1. TEL provides guidance on the concentration of a chemical below which adverse effects rarely occur (MacDonald et al., 1996). TEL values have been selected for the present assessment as they are the most conservative values identified in the reviewed literature. We have also been provided with prescribed concentration values (PCV) and environmental quality standards (EQS) from the UK water industry. A summary of relevant data is shown in Table 6.2. Without specific guidance for UK canal sediments, it is believed TEL guidelines assist in classifying sediment samples collected from the GUC as: (a) toxic, with concentrations exceeding TEL; or (b) non-toxic, with no exceedances of the TEL.

Table 6.1: Threshold effect level TELs for sediments in coastal and marine waters[16].

Substance	TEL
Metals (SQGs in mg/kg)	
Arsenic	7.2
Cadmium	0.7
Chromium	52.3
Copper	18.7
Lead	30.2
Mercury	0.1
Nickel	15.9
Zinc	124.0
PCBs; (SQOs in µg/kg)	
Total PCBs	21.6
PAHs; (SQGs in µg/kg)	
Acenaphthene	6.7
Acenaphthylene	5.9
Anthracene	46.9
Fluorene	21.2
Naphthalene	34.6
Benz(a)anthracene	74.8
Benzo(a)pyrene	88.8
Chrysene	108.0
Dibenzo[a,h]anthracene	6.2
Fluoranthene	113.0
Pyrene	153.0
Total PAHs	1684.0

Source: MacDonald et al. (1996)

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[16] TEL, threshold effect level (MacDonald et al., 1996)

Table 6.2: Prescribed concentration values (PCV) and environmental quality standards (EQS) for determinants from the UK water industry.

Substance	Mean annual EQS	Maximum allowable EQS	PCV
Metals (in µg/l)			
Arsenic	-	-	10
Cadmium	0.25	1.5	5
Chromium	-	-	50
Copper	-	-	2000
Lead	-	-	10
Mercury	-	0.07	1
Nickel	-	-	20
Zinc	-	-	-
PAHs; (SQGs in µg/l)			
Anthracene	0.1	0.1	-
Benz(a)anthracene	74.8	693.0	261.0
Benzo(a)pyrene	0.00017	0.027	0.01
Benzo(b)fluoranthene	-	0.017	-
Benzo(g,h,i)perylene	-	0.0082	-
Benzo(k)fluoranthene	-	0.017	-
Fluoranthene	0.0063	0.12	4
indeno(1,2,3-cd)pyrene	-	-	-
Naphthalene	2	130	-
Total PAHs	-	-	0.1

Source: MacDonald et al. (1996)

The PCV and EQS values in Table 6.2 are expressed in units of µg/l, making the values incompatible with our present analysis expressed in mg/kg or µg/kg. We estimate that one kg of sediment would occupy a volume of 0.625litres, assuming a bulk sediment density of 1600kg/m^3. Thus, contained within that volume, we measure concentrations that exceed PCV and EQS values by a wide margin. However, given the incompatibility between values for bed sediment and water samples, these observations must be treated with caution.

To illustrate the magnitude of measured pollution level in the canal sediments along the preferred route, Figure 5.1 and Figure 5.3 show TEL values for heavy metals. Table 6.3 shows TEL values for metals and PAHs alongside the mean and average measured values for each determinant and the mean and maximum exceedance above TEL values for each determinant. In all cases, the measured values exceed TEL values (note units for PAHs).

Table 6.3: TEL values for metals and PAHs with the mean and average measured values for each determinant and the mean and maximum exceedance above TEL values for each determinant.

Metals	TEL (mg/kg)	Average measured (mg/kg)	Maximum measured (mg/kg)	Mean exceedance of TEL	Max. exceedance of TEL
Arsenic	7.2	30.7	66.7	4.3	9.3
Cadmium	0.7	6.5	20.4	9.3	29.1
Chromium	52.3	40	98.2	0.8	1.9

Metals	TEL (mg/kg)	Average measured (mg/kg)	Maximum measured (mg/kg)	Mean exceedance of TEL	Max. exceedance of TEL
Copper	18.7	26.9	145.9	1.4	7.8
Lead	30.2	51.7	175.3	1.7	5.8
Mercury	0.1	70.7	247.4	707.0	2474.0
Nickel	15.9	36.6	85	2.3	5.3
Zinc	124	148.4	651.1	1.2	5.3
PAHs	**TEL (µg/kg)**	**Average measured (mg/kg)**	**Maximum measured (mg/kg)**	**Mean exceedance of TEL**	**Max. exceedance of TEL**
Acenaphthene	6.7	338.57	763.7	50532.8	113985.1
Acenaphthylene	5.9	0.32	0.59	54.2	100.0
Anthracene	46.9	0.25	0.32	5.3	6.8
Fluorene	21.2	1.81	5.69	85.4	268.4
Naphthalene	34.6	0.79	2.7	22.8	78.0
Benz(a)anthracene	74.8	0.72	1.64	9.6	21.9
Benzo(a)pyrene	88.8	0.93	2.97	10.5	33.4
Chrysene	108	0.71	1.79	6.6	16.6
Dibenzo[a,h]anthracene	6.2	0.76	2.78	122.6	448.4
Fluoranthene	113	0.92	3.42	8.1	30.3
Pyrene	153	0.98	2.84	6.4	18.6

Mott MacDonald, 2022

In the sections below, we have referenced the measured concentrations of heavy metals, PAHs and PCBs in the sediments to the threshold effect level TEL (MacDonald et al., 1996) in Table 6.1. We believe these threshold levels better reflect the potential environmental impacts of the pollutants within the canal sediments should they become mobilised.

6.3.1 Heavy metals

6.3.1.1 Canal sediments

Several interesting trends in the data can be seen in Figure 5.1:

- As, Cd and Hg have the highest concentrations in the northern section of the GUC.
- As values reduce almost linearly from the north (GUC 1) to the south (GUC 47).
- Cd and Hg values show a marked decrease at around 50km south from GUC 1 (Daventry) and remain low up to GUC 47.
- Ni, Cu and Zn values increase sharply at around 50km south from GUC 1 (Daventry) and remain at around that value to GUC 47.
- Pb and Zn values also increase at around 50km south from GUC 1 (Daventry) and remain at a relatively high value to around GUC 44 before reducing again to low values.

The average, minimum and maximum values for heavy metals from GUC canal bed sediment samples 1 to 47 are summarised in Table 6.4. TEL limits are shown in Figure 5.1. They indicate that except for total chromium as Cr, heavy metal concentrations exceed the TEL threshold at most sampling locations. In the most contaminated sites, the concentration of arsenic as As, Cadmium as Cd, lead as Pb and mercury as Hg exceed TEL values by 9, 2, 5 and 2000, respectively. It is noted that concentrations of cadmium as Cd and mercury as Hg at sampling locations up to 50km south of GUC1 greatly exceed TEL and probably reflect former industrial activities. The data show the highest concentrations of copper as Cu, lead as Pb, nickel as Ni, and zinc as Zn in the region between 50 to 120km south of sampling location GUC 1.

Table 6.4: The average, minimum and maximum values for heavy metals from GUC canal bed sediment samples 1 to 47 (units mg/kg).

Heavy metal	Average mg/kg	Minimum mg/kg	Maximum mg/kg	TEL mg/kg
Arsenic as As	30.7	4.8	66.7	7.2
Cadmium as Cd	6.5	0.2	20.4	0.7
Copper as Cu	26.9	0.2	145.9	18.7
Lead as Pb	51.7	10.6	175.3	30.2
Mercury as Hg	70.7	21.3	247.4	0.1
Nickel as Ni	36.6	0.7	85.0	15.9
Total Chromium as Cr	40.0	18.4	98.2	52.3
Zinc as Zn	148.4	19.7	651.1	124

Source: Mott MacDonald & Partrac (2022)

6.3.1.2 Connected waterbodies

The average, minimum and maximum values for heavy metals in connected waterbody samples C1 and C3 to C8 are summarised in Table 6.5. For each metal, average connected waterbody values are less than the average values for the canal bed sediments. Values for arsenic as As, copper as Cu, lead as Pb, mercury as Hg, nickel as Ni, total Chromium as Cr and zinc as Zn are approximately 10%, 50%, 9%, 61%, 24%, 27% and 54% less than in the canal sediments, respectively. Nevertheless, concentrations of arsenic as As, cadmium as Cd, copper as Cu, lead as Pb and mercury as Hg exceed the TEL threshold in all cases (Figure 5.3).

While there are no distinct geographical differences, the data indicate that the higher heavy metal concentrations are associated with GUC C4 to GUC C8 (Figure 5.3).

Table 6.5: Average, minimum and maximum values for heavy metals from connected waterbody sediment samples 1 to 8 (units mg/kg).

Heavy metal	Average mg/kg	Minimum mg/kg	Maximum mg/kg	TEL mg/kg
Arsenic as As	27.7	10.10	48.60	7.2
Cadmium as Cd	16.0	0.3	34.0	0.7
Copper as Cu	13.3	0.2	46.0	18.7
Lead as Pb	47.3	12.2	182.9	30.2
Mercury as Hg	27.5	15.5	42.4	0.1
Nickel as Ni	28.0	26.9	29.2	15.9
Total Chromium as Cr	29.2	20.7	40.0	52.3
Zinc as Zn	68.3	24.0	177.1	124

Source: Mott MacDonald & Partrac (2022)

6.3.2 PAHs

6.3.2.1 Canal sediments

The average, minimum and maximum values for PAHs in GUC samples 1 to 47 are summarised in Table 6.6. Figure 5.4 and Figure 5.5 show that concentration values for most PAHs vary by no more than two or three times the minimum value. While fluorene values peak at around six times the measured minimum value, acenaphthene has: (a) the most significant variation with values around 600 mg/kg around GUC 1; (b) a decrease in values to less than 0.2mg/kg around 50km south of GUC 1 (Daventry). These trends in the data are also evident in the surface plot in Figure 5.5.

Table 6.6: The average, minimum and maximum values for PAHs from GUC canal bed sediment samples 1 to 47 (units mg/kg). Locations are shown in Figure 5.4. TEL values (Table 6.1) are also shown (note the units).

Substance	Average mg/kg	Minimum mg/kg	Maximum mg/kg	TEL (µg/kg)
Acenaphthene	338.57	80.60	763.70	6.7
Acenaphthylene	0.32	0.15	0.59	5.9
Anthracene	0.25	0.16	0.32	46.9
Benzo[a]anthracene	0.72	0.30	1.64	74.8
Benzo[a]pyrene	0.93	0.23	2.97	88.8
Benzo[b]fluoranthene	1.08	0.20	3.92	-
Benzo[g,h,i]perylene	0.95	0.18	4.10	-
Benzo[k]fluoranthene	0.60	0.16	1.68	-
Chrysene	0.71	0.21	1.79	108
Dibenzo[a,h]anthracene	0.76	0.24	2.78	6.2
Fluoranthene	0.92	0.19	3.42	113
Fluorene	1.81	0.40	5.69	21.2
Indeno[1,2,3-cd]pyrene	0.66	0.18	1.76	-
Naphthalene	0.79	0.17	2.70	34.6
Phenanthrene	0.64	0.11	1.17	-
Pyrene	0.98	0.21	2.84	153

Source: Mott MacDonald & Partrac (2022)

6.3.2.2 Connected waterbodies

The average, minimum and maximum values for PAHs in connected waterbody samples C1 and C3 to C8 are summarised in Table 6.7.

Table 6.7: The average, minimum and maximum values for PAHs from connected waterbody sediment samples 1 to 8 (units mg/kg). TEL values (Table 6.1) are also shown (note the units).

Substance	Average mg/kg	Minimum mg/kg	Maximum mg/kg	TEL (µg/kg)
Acenaphthene	<0.13	<0.11	<0.16	6.7
Acenaphthylene	<0.13	<0.11	<0.16	5.9
Anthracene	<0.24	<0.11	0.69	46.9
Benzo[a]anthracene	<0.72	<0.11	2.98	74.8
Benzo[a]pyrene	<0.76	<0.11	3.01	88.8
Benzo[b]fluoranthene	<0.84	<0.11	3.24	-
Benzo[g,h,i]perylene	<0.41	<0.11	1.37	-
Benzo[k]fluoranthene	<0.38	<0.11	1.35	-
Chrysene	<0.59	<0.11	2.26	108
Dibenzo[a,h]anthracene	<0.18	<0.11	0.41	6.2
Fluoranthene	<1.09	<0.11	4.47	113
Fluorene	<0.13	<0.11	<0.16	21.2

Substance	Average mg/kg	Minimum mg/kg	Maximum mg/kg	TEL (µg/kg)
Indeno[1,2,3-cd]pyrene	<0.50	<0.11	1.73	-
Naphthalene	<0.13	<0.11	<0.16	34.6
Phenanthrene	<0.33	<0.11	1.15	-
Pyrene	<1.00	<0.11	4.02	153

Source: Mott MacDonald & Partrac (2022)

Regarding sediment quality guidelines for PAHs, the most striking feature of the measured data is the magnitude of the concentrations, irrespective of the determinants considered. TEL are in units of µg/kg (Table 6.1). However, the units used for the canal bed sediments are in units of mg/kg. Consequently, in all cases, the measured PAH concentrations are three orders of magnitude greater than the TEL values (Fig. 5.3, Table 6.3). For that reason, TEL values are not shown in Figure 5.4.

While the PAH concentrations in the connected waterbody samples are significantly lower than those in the canal sediments, the measurement units are also in mg/kg. However, except for Acenaphthene, the measured values of PAHs are less than those that the present analysis methods can detect. It remains unclear, therefore, if PAH concentrations in the connected waterbody samples exceed the TEL.

6.3.3 PCBs

The laboratory measurements only provided detection of PCBs down to a minimum detection level; thus, concentration values are generally reported as being less than a stated value (Appendix G). PCB concentrations in marine sediments reported by various authors and summarised in Combi *et al*. (2016) typically range between 1 to 100µg/kg. It is beyond the scope of the present study to comment on the significance of the measured PCB contamination in the canal and connected waterbody sediment samples other than to say the values are typical of those reported elsewhere for various sediments and soils.

6.3.3.1 Canal sediments

Geographical variation in the measured concentration of the seven detected PCBs is shown in Figure 5.6. In most cases, PCB concentration values are low. There is a distinct spike in values for PCB 118, PCB 138, 153 and 180 in the Coventry region, where concentrations reach around 60µg/kg.

The measured concentration of the seven detected PCBs in the connected waterbody sediments was less than the concentrations measured in the canal bed sediments. The laboratory detection level limited the determination of absolute values.

6.4 Comparison between the canal and connected waterbody sediments

Values and differences between the canal and connected waterbody bed sediment chemistry are shown in Table 6.8. The comparisons are made between the connected waterbody sample and the geographically closest canal sample. Difference values shade green demote a higher concentration of a given substance in the canal sediments. Difference values shade orange demote that the concentration of a given substance in the canal and connected waterbody sediments are the same. Difference values shade red denotes a higher concentration of a given substance in the connected waterbody sediments.

The dominance of the green shading in Table 6.8 shows that the canal sediments are more contaminated than the sediments obtained in the connected waterbodies. However, there are some exceptions. For example, in five of the seven connected waterbody samples, cadmium concentrations are significantly higher than in the adjacent canal bed samples. Similarly, arsenic concentration in four out of the seven analysed connected waterbody samples is significantly higher than in the adjacent canal bed samples. Sediments from connected waterbody 8 (Milton Keynes) have higher concentrations of three heavy metals, 11 PAHs and one PCB.

It remains unclear if sediment contamination in the tested connected water courses originates from the canal or other sources. The present data cannot establish this, and this should therefore be investigated at Gate 3.

Table 6.8: Values and differences between the canal and connected waterbody sediment chemistry. Difference values shade green demote higher concentration of a given substance in the canal sediments. Difference values shade orange demote that the concentration of a given substance in the canal and connected waterbody sediments are the same. Difference values shade red demote higher concentration of a given substance in the connected waterbody sediments.

	GUC C1	GUC 13	Difference	GUC C3	GUC 29	Difference	GUC C4	GUC 34	Difference	GUC C5	GUC 36	Difference	GUC C6	GUC 40	Difference	GUC C7	GUC 42	Difference	GUC C8	GUC 43	Difference
Arsenic as As	24.3	60.8	36.5	32.7	18.40	-14.30	11.90	12.90	1.00	30.1	9.00	-21.10	10.10	15.70	5.60	48.6	17.50	-31.10	36.8	10.50	-26.30
Cadmium as Cd	34	9.3	-24.7	16.7	0.3	-16.40	0.3	0.4	0.10	28.9	0.3	-28.60	0.5	7.10	6.60	13.8	0.3	-13.50	18.1	0.7	-17.40
Copper as Cu	0.2	0.4	0.2	0.2	29.30	29.1	28.20	34.00	5.80	0.3	24.20	23.90	46.00	113.20	67.20	4.7	34.70	30.00	0.8	35.70	34.90
Lead as Pb	15.1	41.9	26.8	12.2	42.70	30.50	26.60	36.60	10.00	18.4	30.40	12.00	182.90	175.30	-7.60	39.2	51.20	12.00	36.8	57.20	20.40
Mercury as Hg	20.6	37.3	16.7	15.5	0.50	-15	0.50	0.50	🟧	21.6	0.50	-21.10	0.50	0.50	🟧	42.4	0.50	-41.90	37.8	0.50	-37.30
Nickel as Ni	0.5	0.5	🟧	0.5	35.00	34.5	29.20	32.40	3.20	0.5	18.90	18.40	26.90	39.70	12.80	0.5	34.60	34.10	0.5	29.00	28.50
Total Chromium as Cr	22.4	29.5	7.1	20.7	47.60	26.90	40.00	44.00	4.00	37	21.20	-15.80	28.00	41.10	13.10	30.6	31.50	0.90	26	30.60	4.60
Zinc as Zn	24	32.8	8.8	39.6	194.00	154.40	127.20	185.90	58.70	43.8	128.60	84.80	177.10	651.10	474.00	35.7	105.40	69.70	31.1	212.70	181.60
Acenaphthene	76.3	176.6	100.3	75.7	0.23	-75.47	0.24	0.24	🟧	119.2	0.19	-119.01	0.35	0.40	0.05	197.7	0.16	-197.54	221.5	0.27	-221.23
Acenaphthylene	0.11	0.2	0.09	0.12	0.23	0.11	0.24	0.24	🟧	0.11	0.19	0.08	0.35	0.40	0.05	0.16	0.16	🟧	0.13	0.27	0.14
Anthracene	0.11	0.2	0.09	0.12	0.23	0.11	0.24	0.24	🟧	0.11	0.19	0.08	0.35	0.40	0.05	0.16	0.32	0.16	0.13	0.27	0.14
Benzo[a]anthracene	0.11	0.2	0.09	0.12	0.41	0.29	0.24	0.24	🟧	0.11	0.19	0.08	0.35	1.43	1.08	0.16	1.50	1.34	0.69	0.27	-0.42
Benzo[a]pyrene	0.11	0.2	0.09	0.12	0.68	0.56	0.24	0.43	0.19	0.11	0.26	0.15	0.35	2.07	1.72	0.29	1.82	1.53	2.98	0.36	-2.62
Benzo[b]fluoranthene	0.11	0.3	0.19	0.12	0.84	0.72	0.24	0.53	0.29	0.11	0.31	0.20	0.47	2.82	2.35	0.46	2.34	1.88	3.01	0.5	-2.51
Benzo[g,h,i]perylene	0.11	0.36	0.25	0.12	0.41	0.29	0.24	0.27	0.03	0.11	0.2	0.09	0.35	1.35	1.00	0.61	0.97	0.36	3.24	0.27	-2.97
Benzo[k]fluoranthene	0.11	0.2	0.09	0.12	0.33	0.21	0.24	0.27	0.03	0.11	0.19	0.08	0.35	1.10	0.75	0.36	0.94	0.58	1.37	0.27	-1.10
Chrysene	0.11	0.2	0.09	0.12	0.58	0.46	0.24	0.35	0.11	0.11	0.19	0.08	0.35	1.79	1.44	0.23	1.52	1.29	1.35	0.27	-1.08
Dibenzo[a,h]anthracene	0.11	0.24	0.13	0.12	0.23	0.11	0.24	0.24	🟧	0.11	0.19	0.08	0.35	0.40	0.05	0.33	0.26	-0.07	2.26	0.27	-1.99
Fluoranthene	0.11	0.2	0.09	0.12	0.81	0.69	0.24	0.52	0.28	0.11	0.28	0.17	0.39	2.74	2.35	0.16	2.77	2.61	0.41	0.57	0.16
Fluorene	0.11	0.4	0.29	0.12	0.23	0.11	0.24	0.24	🟧	0.11	0.19	0.08	0.35	0.40	0.05	0.63	0.16	-0.47	4.47	0.27	-4.20
Indeno[1,2,3-cd]pyrene	0.11	0.2	0.09	0.12	0.55	0.43	0.24	0.37	0.13	0.11	0.24	0.13	0.35	1.76	1.41	0.16	1.14	0.98	0.13	0.31	0.18
Naphthalene	0.11	0.26	0.15	0.12	0.23	0.11	0.24	0.24	🟧	0.11	0.19	0.08	0.35	0.40	0.05	0.41	0.17	-0.24	1.73	0.27	-1.46
Phenanthrene	0.11	0.2	0.09	0.12	0.23	0.11	0.24	0.24	🟧	0.11	0.19	0.08	0.35	0.86	0.51	0.16	0.74	🟥	0.13	0.27	0.14
Pyrene	0.11	0.2	0.09	0.12	0.86	0.74	0.24	0.5	0.26	0.11	0.28	0.17	0.36	2.72	2.36	0.17	2.54	2.37	1.15	0.53	-0.62
Total PAH 16	**0.11**	**0.35**	**0.24**	**0.12**	**7.10**	**6.98**	**3.84**	**5.19**	**1.35**	**0.11**	**3.44**	**3.33**	**5.80**	**21.10**	**15.30**	**0.62**	**17.50**	**16.88**	**4.02**	**5.19**	**1.17**
PCB 101	1.69	3.96	2.27	1.9	14.50	12.60	15.00	15.20	0.20	1.83	11.80	9.97	22.00	25.30	3.30	5.02	10.10	5.08	27.2	16.60	-10.60
PCB 118	6.61	12.8	6.19	7.43	14.50	7.07	15.00	15.20	0.20	7.15	11.80	4.65	22.00	25.30	3.30	9.73	10.10	0.37	7.91	16.60	8.69
PCB 138	6.61	12.8	6.19	7.43	14.50	7.07	15.00	15.20	0.20	7.15	11.80	4.65	22.00	25.30	3.30	9.73	10.10	0.37	7.91	16.60	8.69
PCB 153	6.61	12.8	6.19	7.43	14.50	7.07	15.00	15.20	0.20	7.15	11.80	4.65	22.00	25.30	3.30	9.73	10.10	0.37	7.91	16.60	8.69
PCB 180	6.61	12.8	6.19	7.43	14.50	7.07	15.00	15.20	0.20	7.15	11.80	4.65	22.00	25.30	3.30	9.73	10.10	0.37	7.91	16.60	8.69
PCB 28	6.61	12.8	6.19	7.43	14.50	7.07	15.00	15.20	0.20	7.15	11.80	4.65	22.00	25.30	3.30	9.73	10.10	0.37	7.91	16.60	8.69
PCB 52	6.61	12.8	6.19	7.43	14.50	7.07	15.00	15.20	0.20	7.15	11.80	4.65	22.00	25.30	3.30	9.73	10.10	0.37	7.91	16.60	8.69
Total TPH >C8-C40 EH_1D_Total	**6.61**	**12.8**	**6.19**	**7.43**	**673.00**	**665.57**	**168.00**	**523.00**	**355.00**	**7.15**	**641.00**	**633.85**	**1050.00**	**3860.00**	**2810.00**	**9.73**	**379.00**	**369.27**	**7.91**	**232.00**	**224.09**

6.5 Sediment resuspension by canal vessels

Sediments in the water samples were very fine (D10 <10µm). At each measurement location, no trends in the particle size distribution were detectable before or after the vessel's passage. Indeed, the typical grain size distribution in the water samples did not change significantly after a vessel had passed the sampling location, implying little bed resuspension of the canal bed sediments.

However, this interpretation of bed disturbance by canal vessels is not supported by the contradictory time history of TSS at sites GUC W1 and GUC W2 (Figure 5.11). This figure shows TSS values at GUC W1 increasing from around 20mg/l before a vessel passed the sampling point to approximately 70mg/l 20 minutes later. In contrast, at GUC W2, TSS values initially decline from a high value of around 250mg/l to approximately 40mg/l around the time the vessel passes the sampling location. After that, TTS increases to around 100mg/l before slowly reducing to approximately 50mg/l. These two tests cannot establish a direct relationship between vessel-induced disturbance to the bed sediments and the concentration of suspended sediments in the water column.

Suppose the initial decrease in TSS from 230mg/l to 40 mg/l at GUC W2 is treated as an anomaly. In that case, the TSS data are GUC W1, and GUC W2 show a trend not dissimilar to that reported by Zeckoski (2010) in Appendix A.5, where TSS values are observed to increase by up to 70mg/l following the passage of a vessel on the canal.

As all water samples showed low concentration values for all determinants, these measurements imply that layers of the canal sediment containing measurable concentrations of heavy metals, PAHs and PCBs had not been disturbed in an undefined period before obtaining the samples. This inference can be used to inform follow on study, with a recommendation that fFurther data be obtained at Gate 3 to reduce the present uncertainty regarding sediment resuspension by canal traffic, which will be investigated further at Gate 3.

6.6 Potential sediment mobility

The Gate 2 JBA hydrodynamic model provided this study[17] flow velocity data at GUC sediment sampling locations for the baseline and proposed scheme cases. These data are summarised in Table 6.9, which gives locations and maximum[18] (V_{max}) flow velocity values from the JBA model for the baseline and scheme cases. In an email, JBA note that:

- Due to flow lag effects during the model runs, the velocity at some locations does not represent velocities when the water transfer rate reaches 115Ml/d;
- GUC sampling location 31 will be bypassed; and
- GUC sampling locations 45, 46 and 47 are not included as they are south of the proposed abstraction route.

Table 6.9: Locations and predicted maximum (V_{max}) flow velocity values for the baseline and scheme cases.

Grid references for continued monitoring locations redacted

Location	Longitude	Latitude	Baseline model V_{max} (m/s)	Scheme model V_{max} (m/s)
GUC 1	[redacted]	[redacted]	0.059	0
GUC 2	[redacted]	[redacted]	0.033	0.080
GUC 3	[redacted]	[redacted]	0.090	0.087
GUC 4	[redacted]	[redacted]		
GUC 5	[redacted]	[redacted]	-	0.068
GUC 6	[redacted]	[redacted]	-	0.128
GUC 7	[redacted]	[redacted]	-	0.137

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[17] 30 August 2022, Paul Eccleston, JBA Consulting, Pipe House, Lupton Road, Wallingford, OX10 9BS, UK.

[18] We focus on the maximum flows as potentially these will have the greatest capacity to mobilise canal bed sediments.

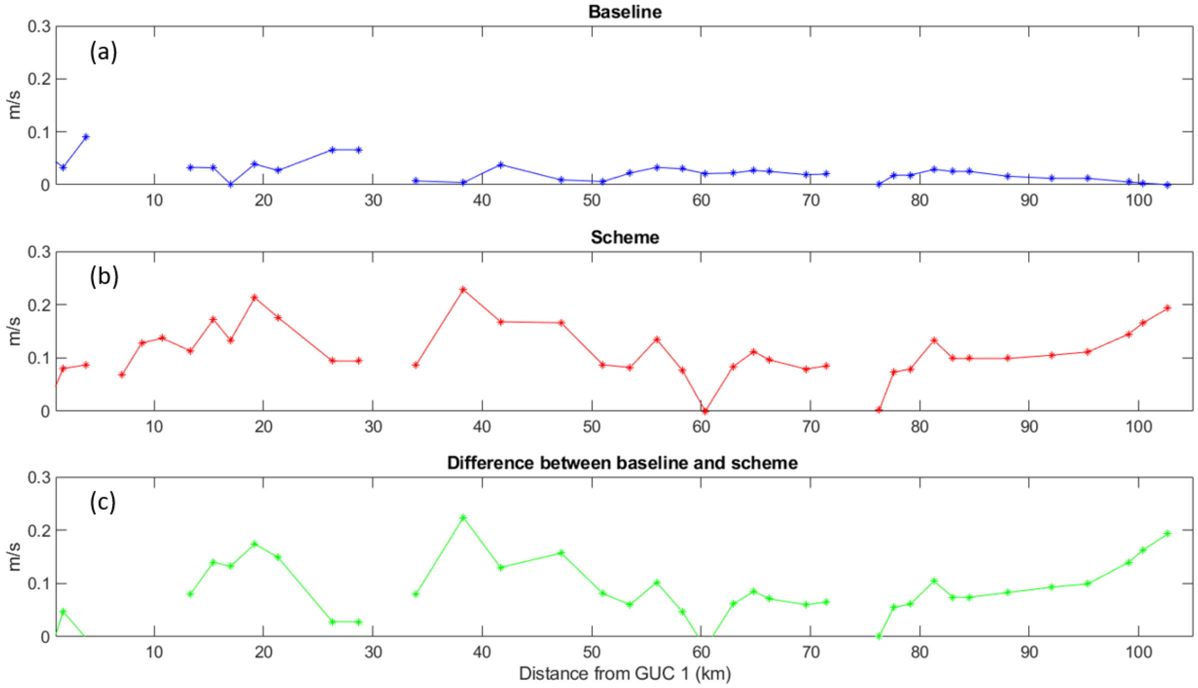
Grid references for continued monitoring locations redacted

Location	Longitude	Latitude	Baseline model V_{max} (m/s)	Scheme model V_{max} (m/s)
GUC 8	[redacted]	[redacted]	0.033	0.113
GUC 9	[redacted]	[redacted]	0.032	0.172
GUC 10	[redacted]	[redacted]	0.001	0.133
GUC 11	[redacted]	[redacted]	0.039	0.213
GUC 12	[redacted]	[redacted]	0.027	0.176
GUC 13	[redacted]	[redacted]	0.066	0.094
GUC 14	[redacted]	[redacted]	0.066	0.094
GUC 15	[redacted]	[redacted]		
GUC 16	[redacted]	[redacted]	0.007	0.087
GUC 17	[redacted]	[redacted]	0.004	0.228
GUC 18	[redacted]	[redacted]	0.038	0.168
GUC 19	[redacted]	[redacted]	0.009	0.166
GUC 20	[redacted]	[redacted]	0.006	0.087
GUC 21	[redacted]	[redacted]	0.022	0.082
GUC 22	[redacted]	[redacted]	0.033	0.135
GUC 23	[redacted]	[redacted]	0.030	0.077
GUC 24	[redacted]	[redacted]	0.021	0
GUC 25	[redacted]	[redacted]	0.022	0.083
GUC 26	[redacted]	[redacted]	0.027	0.112
GUC 27	[redacted]	[redacted]	0.025	0.096
GUC 28	[redacted]	[redacted]	0.019	0.079
GUC 29	[redacted]	[redacted]	0.020	0.085
GUC 30	[redacted]	[redacted]		
GUC 31	[redacted]	[redacted]	0.001	0.002
GUC 32	[redacted]	[redacted]	0.018	0.073
GUC 33	[redacted]	[redacted]	0.018	0.079
GUC 34	[redacted]	[redacted]	0.029	0.133
GUC 35	[redacted]	[redacted]	0.025	0.099
GUC 36	[redacted]	[redacted]	0.025	0.099
GUC 37	[redacted]	[redacted]	0.016	0.099
GUC 38	[redacted]	[redacted]	0.012	0.105
GUC 39	[redacted]	[redacted]	0.012	0.111
GUC 40	[redacted]	[redacted]	0.005	0.145
GUC 41	[redacted]	[redacted]	0.003	0.165
GUC 42	[redacted]	[redacted]	0	0.193
GUC 43	[redacted]	[redacted]	0.008	0.125
GUC 44	[redacted]	[redacted]	0.074	0.150

Source: Mott MacDonald and JBA, 2022.

The data in Table 6.9 are plotted in Figure 6.1, which shows predicted maximum and minimum flow velocity values for the (a) baseline and (b) scheme from the JBA Gate 2 model. Sub-plot (c) shows the differences between baseline and scheme values. Looking at the average maximum flow speed values from all sampling locations, the JBA Gate 2 model predictions show a fourfold (400%) increase from 0.026m/s for the baseline case to 0.11m/s for the scheme. No geographical trend in these data can be observed.

Figure 6.1: Predicted maximum and minimum flow velocity values for the (a) baseline and (b) scheme from the JBA Gate 2 model. Sub-plot (c) shows the differences between baseline and scheme values.



Source: Mott MacDonald & JBA, 2022.

Predicted maximum flow velocity values were used to calculate the maximum bed shear stress (τ_{max}) for the baseline and scheme cases (Eq. A1) and to assess potential sediment mobility, assuming a typical range of drag coefficient (Cd) values of 0.001 and 0.0025 for mud (Soulsby, 1997; Table 6.10). Also included in Table 6.10 are data showing the thickness of the sediment layer removed from cores before CSM measurements were possible and the CSM measurements of the entrainment threshold bed shear stress (τ_o), (Section 2.4.2). Maximum bed shear stress (τ_{max}) for the baseline and scheme cases are also shown in Figure 6.2. No geographical trend in these data can be observed.

Table 6.10: (a) GUC sample locations; (b) maximum bed shear stress values for the baseline and scheme cases for Cd values of 0.001 and 0.0025; (c) thickness of sediment layer removed before CSM measurements were possible; and (d) CSM measurements of entrainment threshold bed shear stress (τ_o).

Grid references for continued monitoring locations redacted

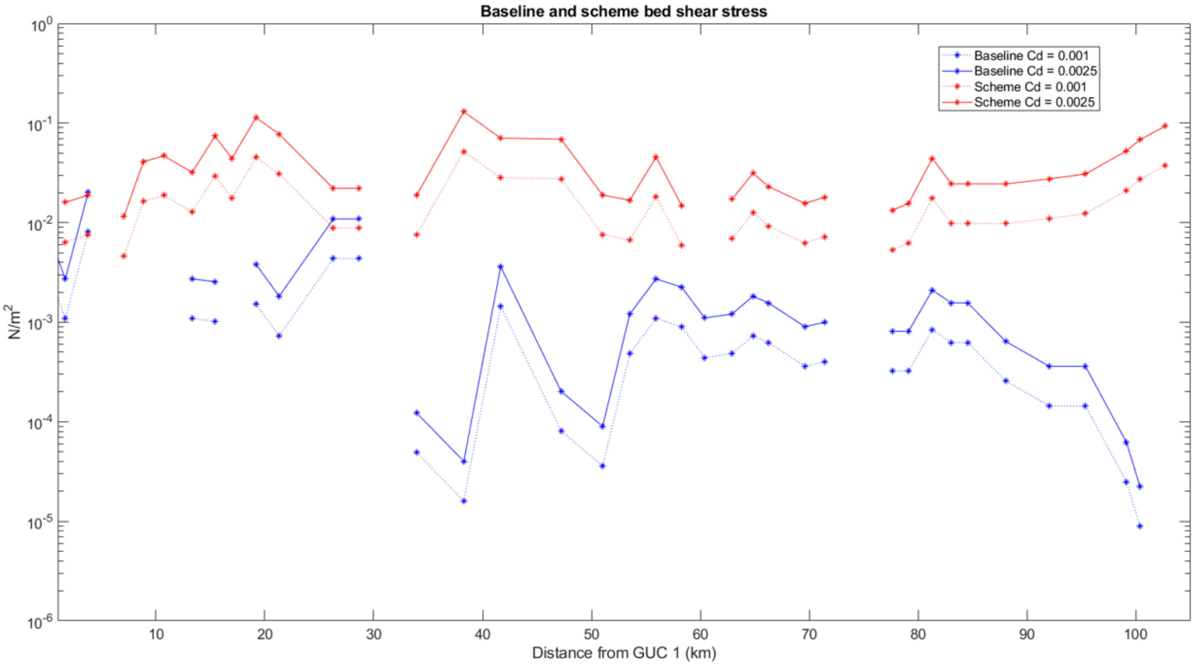
Location	Longitude	Latitude	Baseline model τ_{max} Cd = 0.001 (N/m^2)	Scheme model τ_{max} Cd = 0.001 (N/m^2)	Baseline model τ_{max} Cd = 0.0025 (N/m^2)	Scheme model τ_{max} Cd = 0.0025 (N/m^2)	Sediment removed before CSM (cm)	CSM measurement τ_o (N/m^2)
GUC 1	[redacted]	[redacted]	0.00348	0.00870	0.0000	0.0000	3.0	1.83
GUC 2	[redacted]	[redacted]	0.00109	0.00272	0.0064	0.0160	1.5	0.95
GUC 3	[redacted]	[redacted]	0.00810	0.02025	0.0076	0.0189	2.5	1.54
GUC 4	[redacted]	[redacted]						
GUC 5	[redacted]	[redacted]	0.00000	0.00000	0.0046	0.0116	2.5	1.54
GUC 6	[redacted]	[redacted]	0.00000	0.00000	0.0164	0.0410	4.5	2.65
GUC 7	[redacted]	[redacted]	0.00000	0.00000	0.0188	0.0469	2.5	1.54
GUC 8	[redacted]	[redacted]	0.00109	0.00272	0.0128	0.0319	2.5	1.54
GUC 9	[redacted]	[redacted]	0.00102	0.00256	0.0296	0.0740	1.5	0.95

Grid references for continued monitoring locations redacted

Location	Longitude	Latitude	Baseline model τ_{max} Cd = 0.001 (N/m^2)	Scheme model τ_{max} Cd = 0.001 (N/m^2)	Baseline model τ_{max} Cd = 0.0025 (N/m^2)	Scheme model τ_{max} Cd = 0.0025 (N/m^2)	Sediment removed before CSM (cm)	CSM measurement τ_o (N/m^2)
GUC 10	[redacted]	[redacted]	0.00000	0.00000	0.0177	0.0442	3.0	1.83
GUC 11	[redacted]	[redacted]	0.00152	0.00380	0.0454	0.1134	3.0	1.83
GUC 12	[redacted]	[redacted]	0.00073	0.00182	0.0310	0.0774	2.5	1.54
GUC 13	[redacted]	[redacted]	0.00436	0.01089	0.0088	0.0221	2.5	1.54
GUC 14	[redacted]	[redacted]	0.00436	0.01089	0.0088	0.0221	3.5	2.11
GUC 15	[redacted]	[redacted]						
GUC 16	[redacted]	[redacted]	0.00005	0.00012	0.0076	0.0189	-	-
GUC 17	[redacted]	[redacted]	0.00002	0.00004	0.0520	0.1300	3.0	1.83
GUC 18	[redacted]	[redacted]	0.00144	0.00361	0.0282	0.0706	4.0	2.38
GUC 19	[redacted]	[redacted]	0.00008	0.00020	0.0276	0.0689	2.5	1.54
GUC 20	[redacted]	[redacted]	0.00004	0.00009	0.0076	0.0189	4.5	2.65
GUC 21	[redacted]	[redacted]	0.00048	0.00121	0.0067	0.0168	2.5	1.54
GUC 22	[redacted]	[redacted]	0.00109	0.00272	0.0182	0.0456	2.5	1.54
GUC 23	[redacted]	[redacted]	0.00090	0.00225	0.0059	0.0148	-	-
GUC 24	[redacted]	[redacted]	0.00044	0.00110	0.0000	0.0000	2.5	1.54
GUC 25	[redacted]	[redacted]	0.00048	0.00121	0.0069	0.0172	-	-
GUC 26	[redacted]	[redacted]	0.00073	0.00182	0.0125	0.0314	-	-
GUC 27	[redacted]	[redacted]	0.00063	0.00156	0.0092	0.0230	-	
GUC 28	[redacted]	[redacted]	0.00036	0.00090	0.0062	0.0156	3.5	2.11
GUC 29	[redacted]	[redacted]	0.00040	0.00100	0.0072	0.0181	-	-
GUC 30	[redacted]	[redacted]						
GUC 31	[redacted]	[redacted]	0.00000	0.00000	0.0000	0.0000	-	-
GUC 32	[redacted]	[redacted]	0.00032	0.00081	0.0053	0.0133	3.5	2.11
GUC 33	[redacted]	[redacted]	0.00032	0.00081	0.0062	0.0156	2.5	1.54
GUC 34	[redacted]	[redacted]	0.00084	0.00210	0.0177	0.0442	2.5	1.54
GUC 35	[redacted]	[redacted]	0.00063	0.00156	0.0098	0.0245	-	-
GUC 36	[redacted]	[redacted]	0.00063	0.00156	0.0098	0.0245	3.5	2.11
GUC 37	[redacted]	[redacted]	0.00026	0.00064	0.0098	0.0245	-	-
GUC 38	[redacted]	[redacted]	0.00014	0.00036	0.0110	0.0276	-	-
GUC 39	[redacted]	[redacted]	0.00014	0.00036	0.0123	0.0308	4.5	2.65
GUC 40	[redacted]	[redacted]	0.00003	0.00006	0.0210	0.0526	-	-
GUC 41	[redacted]	[redacted]	0.00001	0.00002	0.0272	0.0681	2.0	1.25
GUC 42	[redacted]	[redacted]	0.00000	0.00000	0.0372	0.0931	-	-
GUC 43	[redacted]	[redacted]	0.00006	0.00016	0.0156	0.0391	8.5	4.55
GUC 44	[redacted]	[redacted]	0.00548	0.01369	0.0225	0.0563	2.5	1.54

Source: Mott MacDonald, JBA & Partrac, 2022.

Figure 6.2: Maximum bed shear stress (τ_{max}) for the baseline and scheme cases obtained using Eq. A1, assuming drag coefficient (Cd) values of 0.001 and 0.0025. Note: the vertical axis uses a log scale.



Source: Mott MacDonald & JBA, 2022.

CSM measurements show that, generally, τ_o of the canal bed sediments ranges between 1.5N/m^2 to 2N/m^2 with a mean value of 1.85N/m^2 (Table 6.10). These values correspond approximately to the bulk density of the bed sediments in the range of 1500kg/m^3 to 1800kg/m^3 (Eq. A4, Figure A.2). They are typical for cohesive sediment with some degree of consolidation.

The maximum (τ_{max}) and minimum (τ_{min}) bed shear stress predictions derived from the JBA flow velocity data for the baseline and scheme cases (Table 6.10, Figure 6.2) are significantly less than the measured τ_o values (mean values of 0.006N/m^2 and 0.037N/m^2, Cd = 0.0025, for baseline and scheme cases, respectively). Even the maximum predicted bed shear stress value derived from the JBA flow velocity data for the scheme case (0.13N/m^2) is an order of magnitude less than the measured τ_o values for the sediments lying beneath the very weak uppermost deposits that were removed to enable CSM measurements. On the basis of this evidence, it can be concluded that the sediments lying beneath the very weak uppermost deposits will remain immobile when the water transfer scheme is operational.

However, the shear strength of the first few centimetres of canal bed sediment could not be determined using the CSM, nor was the chemistry of this superficial layer analysed separately. Therefore, it remains possible that if the surficial sediments are contaminated, the increased flows in the canal due to the scheme may increase mobilisation and affect water quality.

7 Conclusions and recommendations

A summary of conclusions and recommendations from the study is provided in Table 7.1.

Table 7.1: Summary of conclusions, recommendations and rationale.

Conclusion	Recommendation	Rationale
Chemical analysis data show some trends and spikes that indicate variance in determinant concentrations along the length of the canal.	In Gate 3, a recently developed remote sensing technique could increase the resolution of the sampling.	It is possible that chemical contamination could be higher than the detected spikes.
Single samples obtained at a given location in Gate 2 may not fully represent the conditions at that location.	Repeat sampling at least twice at a given location in Gate 3	Due to local spatial variability, single samples may falsely assess the sediment properties at a given site.
The analysis in Gate 2 did not distinguish between the sediment layers that reflect the depositional history and shear strength of the canal bed sediments.	Use the shear strength of the sediments to define the depositional layers for subsequent analyses.	To distinguish between and characterise sediment layers that may be mobilised and those that will not.
The analysis of sediment properties in Gate 2 delivered the first-order characteristics considered most relevant to the Gate 2 feasibility study.	Analyses to distinguish between organic and inorganic sediments and measurements of sediment density in Gate 3 will be useful.	These data may be required to support any empirical interpretations and/or numerical modelling of canal bed sediment dynamics that may proceed in Gate 3.
The Gate 2 sampling and analysis procedures may not reflect the *in situ* characteristics of the sediments due to disturbance by the sampling method.	Obtain *in situ* measurements using, for example, a portable annular flume.	To determine the *in situ* entrainment threshold, erosion and deposition rates at locations along the canal. Water samples collected during these measurements would enable the quantification of contaminants released into the water after various periods of exposure to incremental increases in flow speeds.
The JBA Gate 2 model predictions for all GUC sampling locations show a threefold increase in average flow speeds from 0.037m/s for the baseline case to 0.11m/s for the scheme.	The model outputs need to be validated against field measurements.	Accurate flow velocity data is essential for assessing potential canal bed sediment mobility.
The CSM measurements only represent near-surface sediment layers in the sample core with some measurable shear strength. The highly unconsolidated and probably recently deposited surficial sediments reported for many samples are significantly more mobile	Obtain *in situ* measurements using, for example, a portable annular flume.	The upper layers of less consolidated sediments are likely to be affected by any increases in flow speed associated with water transfer. Since the present chemical analyses considered contaminants in the sample core *en masse*, the nature of these sediments and whether or not they contain contaminants were not determined. These uncertainties require addressing in Gate 3.
The study could not identify defined standards for sediment quality in canals, and we were guided instead on advice for estuarine and coastal sites.	Consult with Regulators and stakeholders and, if possible, establish the concentrations of heavy metals, PAHs and PCBs in canal sediments that might be considered tolerable or toxic for the environment and human consumption.	Even the best study of sediment mobility will be subject to some uncertainty. Thus, the potential for mixing contaminated sediment with water transfer remains a possibility, however remote.

Conclusion	Recommendation	Rationale
The determinands tested were selected as being good indicators of sediment contamination.	Future chemical analyses undertaken in Gate 3 could extend the range of determinands, taking guidance from the Regulators on which chemicals to prioritise.	There remains a potential for the presence of unidentified harmful substances within the canal sediments.
Analysis of water samples obtained before and after the passage of canal vessels gave contradictory results.	The study is extended in Gate 3.	The results for TSS and contaminants before and after the passage of canal vessels were inconclusive

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Appendices

A. Canal sediment dynamics: theoretical background

The present scope of work is concerned with the acquisition and analysis of sediments from the GUC canal bed to define their physical properties and to identify the presence of contaminants. When combined with the water quality and modelling workstreams undertaken by other consultants, the present results will contribute to the understanding of how sediment mobility and water quality may be modified by increases in flow speeds attributable to water transfer through the network.

In the absence of any direct measurements, it is necessary to employ empirical means to predict the dynamic behaviour of sediments. This section of the report describes the equations used to calculate some key sediment properties. For completeness, we consider both non-cohesive (e.g. sand) and cohesive (e.g. mud) sediments. A more detailed treatment of non-cohesive and cohesive sediments is given by Soulsby (1997) and Whitehouse et al. (1970), respectively.

A.1 Skin friction

The skin friction bed shear stress (τ_{skin}) is the force applied to the canal bed by the moving water. It refers only to the drag on surficial sediment particles and is responsible for the mobilisation and transport of sediments. In its simplest form, the quadratic friction law states

$$\tau_{skin} = \rho C d U^2 \qquad \text{Eq. A1}$$

where ρ is the fluid density (*c*. 1000kg/m^3 for canal water), Cd is a drag coefficient (typically in the range of 0.001 to 0.0025 for muddy sediments without bedforms), and $\overline{U}$ is the depth-mean flow velocity.

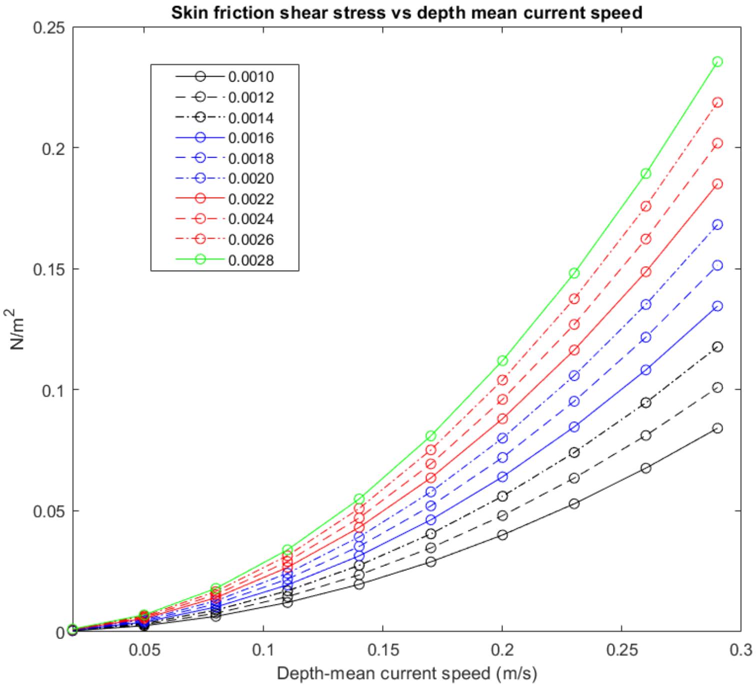
Alternatively, τ_{skin} can be related to the grain size of the bed sediments through a best power-law fit

$$\tau_{skin} = \left(\overline{U}\frac{1}{7}\left(\frac{D_{50}}{h}\right)^{1/7}\right)^2 \rho \qquad \text{Eq. A2}$$

where D_{50} is the median grain diameter and h is the flow depth. The relationship between the skin friction bed shear stress and depth-mean current speed for a range of drag coefficient values is shown in Figure A.1. It shows that relatively small increases in flow speed results in a more significant increase in skin friction bed shear stress, so that, for example, with Cd = 0.0025, a 50% increase in flow speed from 10cm/s to 15cm/s results in a 124% increase in τ_{skin} from 0.025N/m^2 to 0.056N/m^2.

The power-law relationship between τ_{skin} and flow speed is important when considering the impact of water transfer in the network as any localised increases in flow speeds resulting from the transfer will result in a disproportionate increase in τ_{skin} and may lead to sediment mobilisation and transport in canal pounds where sediments are immobile in the present flow regime. This aspect of canal bed sediment behaviour is considered further in the report using empirical predictions outlined below and measurements of bed shear strength obtained during the sediment sampling campaign.

Figure A.1: Skin friction bed shear stress against depth mean current speed for a range of drag coefficient values (0.001 to 0.028) typifying canal sediments.



Source: Mott MacDonald, 2022

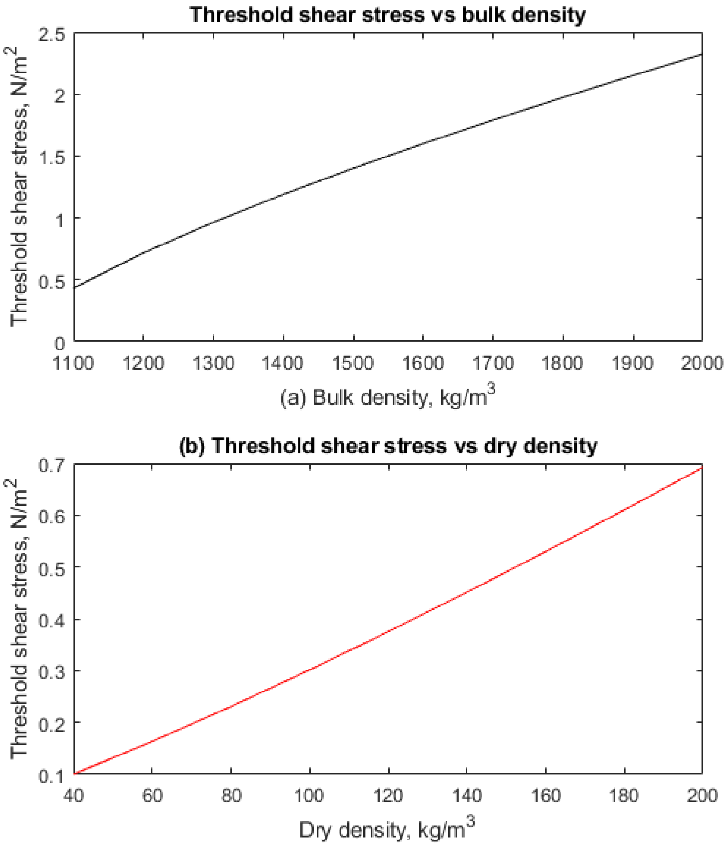
A.2 Critical bed shear stress

The critical bed shear stress (τ_{crit}), or entrainment threshold, is defined as the skin friction bed shear stress (τ_s) required to give rise to the incipient motion of the bed sediments. For the scheme, this is an important parameter since any increase in flow speed will increase τ_s and may lead to new or enhanced sediment mobilisation. For cohesive sediments, two equations are relevant:

$\tau_{crit} = E1{C_m}^{E2}$,	Thorn & Parsons (1990)	Eq. A3
$\tau_{crit} = E3(\rho_B - 1000)^{E4}$,	Mitchener et al. (1996)	Eq. A4

where C_m is the dry density, default values for the coefficients $E1$ and $E2$ are 0.0012 and 1.2, respectively, ρ_B is the bulk density of the bed, and default values for the coefficients $E3$ and $E4$ are 0.015 and 0.73, respectively (Figure A.2). To use these equations in practice requires data on dry and bulk sediment density, which may not be readily available. In the absence of these data, recourse must be made to published values in the literature that most closely relate to the sedimentary environment.

Figure A.2: Critical bed shear stress for a range of dry and bulk density values for cohesive sediments.



Source: Mott MacDonald, 2022

For non-cohesive sediments with 0.01mm < $D_{50} < 10$mm

$$\tau_{crit} = g\ \theta_{crit}\ (\rho_s - \rho) D_{50} \qquad \text{Eq. A5}$$

(Figure A.3), where the Shields parameter

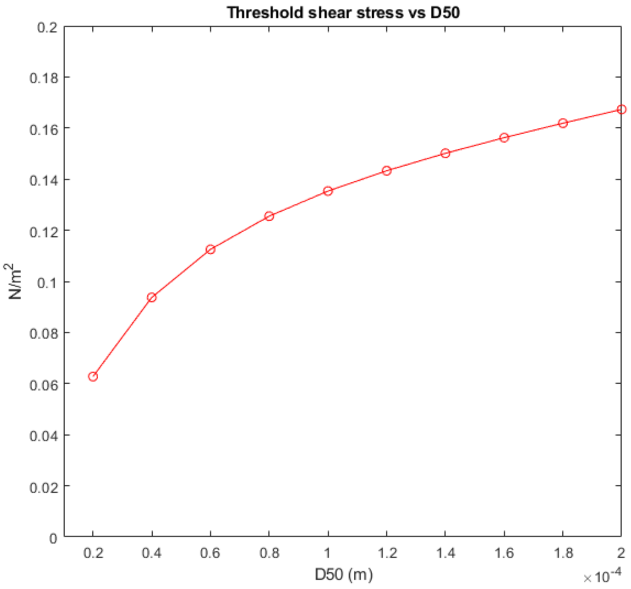
$$\theta_{crit} = \frac{0.3}{1+1.2D_{50}} + 0.055[1 - exp(-0.020D_*)]\ , \qquad \text{Eq. A6}$$

Soulsby (1997), and the dimensionless grain size

$$D_* = \left[\frac{g(s-1)}{\upsilon^2}\right] D_{50} \qquad \text{Eq. A7}$$

where $s = \rho_s - \rho$ and υ is the kinematic viscosity of water (approximately 1.36 x 10^{-6} m^{2}s^{-1}).

Figure A.3: Critical bed shear stress for a range of $D50$ values for non-cohesive sediments.



Source: Mott MacDonald, 2022

For a range of bulk and dry density values likely to characterise canal sediments, τ_{crit} values for cohesive sediments are significantly higher than for non-cohesive sediments. This is attributable to the small size of mud and silt particles that present a hydraulically smooth surface to the flow. It is further noted that τ_{crit} values for non-cohesive sediments are reduced as sediment consolidation increases. In numerical models, different τ_{crit} values are ascribed to different cohesive sediment layers. Low values represent the most recently deposited surficial floc layer, and higher values reflect sediment consolidation with depth.

A.3 Suspended sediment concentration profiles

When resuspended by whatever means, the concentration of suspended particles tends to decrease with distance from the bed. Since the physical characteristics of the suspended sediment concentration profile affects light penetration and organisms in the water column, any hydraulic changes that affect the sediment concentration profile associated with water transfer through the network require consideration. In the canal, the vertical distribution of resuspended non-cohesive sediments would be expected to conform approximately with the following two equations:

(a) if eddy diffusivity varies linearly with distance above the bed, the power-law profile applies in the form

$$C(z) = C_a \left(\frac{z}{z_a}\right)^{-b}, \qquad \text{Eq. A14}$$

where C is the suspended sediment concentration at height z, C_a is the reference concentration at height z_a, and b is the Rouse number or suspension parameter; and

(b) if eddy diffusivity varies parabolically with distance above the bed, the Rouse profile applies in the form

$$C(z) = C_a \left(\frac{z}{z_a} . \frac{h-z_a}{h-z}\right)^{-b} ,\qquad \text{Eq. A15}$$

where

$$b = \frac{w_s}{\kappa u_*} ,\qquad \text{Eq. A16}$$

$$C_a = \frac{0.00156T_s}{1+0.0024T_s} ,\qquad \text{Eq. A17}$$

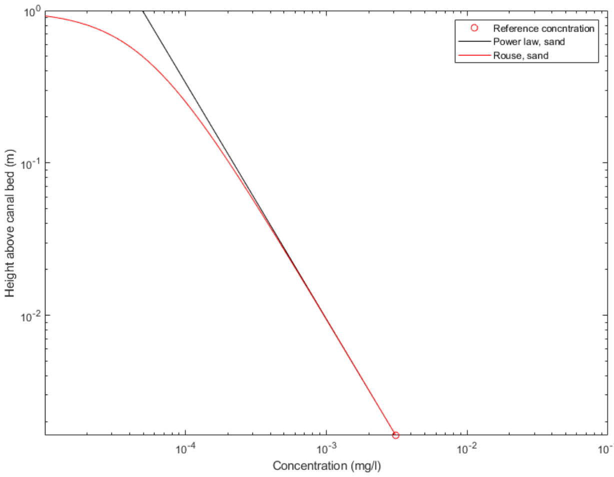
$$T_s = \frac{\tau_{skin}-\tau_{crit}}{\tau_{crit}} \text{ and}\qquad \text{Eq. A18}$$

$$z_a = \frac{26.3\tau_{crit}T_s}{\rho g(s-1)} + \frac{D_{50}}{12} ,\qquad \text{Eq. A19}$$

where κ is von Kármáns constant (0.4) and u_* is the shear velocity $(\tau_{skin}/\rho\ )^{1/2}$.

An example of Rouse and power-law suspended sediment concentration profiles plotted using log-log axes is shown in Figure A.4.

Figure A.4: Predicted suspended sediment concentration profiles for non-cohesive sediment (Eq. A13 and Eq. A14) for w_s= 0.01m/s, τ_{skin} = 1.5N/m^2, τ_{crit} = 0.5N/m^2 and D_{50} = 100μm.



Source: Mott MacDonald, 2022

For cohesive sediments, the diffusion concentration profile is appropriate in the form

$$\frac{C_m}{C_b} = \left[1 + B\left(\frac{z}{h}\right)\right]^{1/m} \text{, Whitehouse et al. (2000)}\qquad \text{Eq. A20}$$

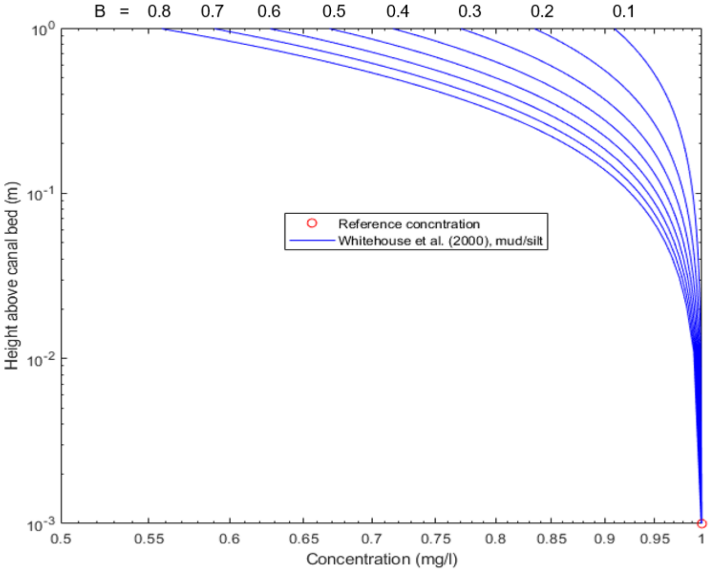
where

$$B = \frac{mw_{50b}}{0.0025\bar{U}}\qquad \text{Eq. A21}$$

and w_{50b} is the median settling velocity immediately above the bed.

Examples of predicted concentration profiles for cohesive sediments is shown in Figure A.5.

Figure A.5: Predicted suspended sediment concentration profiles for cohesive sediment (Eq. A19) with C_b= 1, w_{50b}= 0.0002m/s, m = 1, $\overline{U}$ = 0.5m/s and B in the range 0.1 to 0.8.



Source: Mott MacDonald (2022)

A.4 Sediment deposition

When the flow velocity falls below certain thresholds (which depend on the particle size and density), bedload ceases, and sediment is dropped from suspension (Lawrence & Atkinson, 1998). If the deposition occurs in a spatially defined area, it can produce bedforms on many scales, from ripples through to bars, spits and islands. Deposition produces a corresponding reduction in flow cross-section and is therefore self-limiting and often cyclic.

While the water transfer in the canal is unlikely to increase sedimentation rates due to the higher flow speeds, it remains possible that the higher suspended loads may find areas favourable to deposition, and local siltation may increase.

In still water, the rate of cohesive sediment deposition can be defined using C_b and w_{50b} in the form

$$\frac{dm}{dt} = -C_b w_{50b} \qquad \text{Eq. A22}$$

The equation shows that the concentration will decrease through time as sediment deposits on the bed, and the deposition rate will also decrease. Without *in-situ* data, Eq. A21 must be used with caution.

In flowing water, the rate of cohesive deposition depends on τ_{skin} and the critical shear stress for deposition τ_{critD}

$$\frac{dm}{dt} = -\left(1 - \frac{\tau_{skin}}{\tau_{critD}}\right) C_b w_{50b} \qquad \text{Eq. A23}$$

Without *in situ* data, it is usually assumed that τ_{critD} = 0.08N/m^2.

A.5 Sediment resuspension

In addition to enhanced sediment mobility that may result from water transfer through the network, sediment resuspension is associated with lock gate movements and various vessels using the canal for leisure purposes (*cf*. Karaki & Van Hoften, 1975; Hilton & Phillips, 1982; Beachler & Hill, 2003). As an example, Figure A.6 shows the typical sediment plume associated with a barge navigating a canal.

Figure A.6: Aerial photo of boat and sediment plume on the Kennet and Avon Canal.

Source: From Zeckoski (2010). bing.com, © 2010, Microsoft Corporation, NAVTEQ, Intermap, and Getmapping plc.

In a detailed study of the Kennet and Avon canal, Zeckoski (2010) quantified the increase in suspended sediment concentration associated with lock gate movements and various vessel types using the canal (Table A.1). In summary, excluding outliers, the average sediment concentration stirred up by boat passage above the background was 23mg/l (median 18mg/l, range 1.8mg/l to 70mg/l); and by lock movements (increases only), 36.6mg/l (median 19.7mg/l, range 0.1mg/l to 87.7mg/l).

Table A.1: Suspended sediment concentration increases due to boat passage (from Zeckoski, 2010).

Collection period	Boat width	Suspended sediment concentration (mg/l)	Collection period	Boat width	Suspended sediment concentration (mg/l)
2008	Wide	36.8	2009	Narrow	27.6
2008	Narrow	8.5	2009	Narrow	4.6
2008	Two Narrow	14.0	2009	Two Narrow	1.8
2008	Narrow	31.5	2009	Narrow	12.1
2008	Narrow	12.1	2009	Wide	193.8
2008	Narrow	23.3	2009	Narrow	44.3
2008	Narrow	147.8	2009	Narrow	70
2009	Wide	259.3	2009	Narrow	2.1
2009	Narrow	3.2	2009	Wide	61.7
2009	Narrow	10.3	2009	Narrow	26

Hilton & Phillips (1982) investigated boat traffic effects on turbidity and found a correlation between boat activity and turbidity. Assuming that the settlement of resuspended sediment follows an exponential decay model:

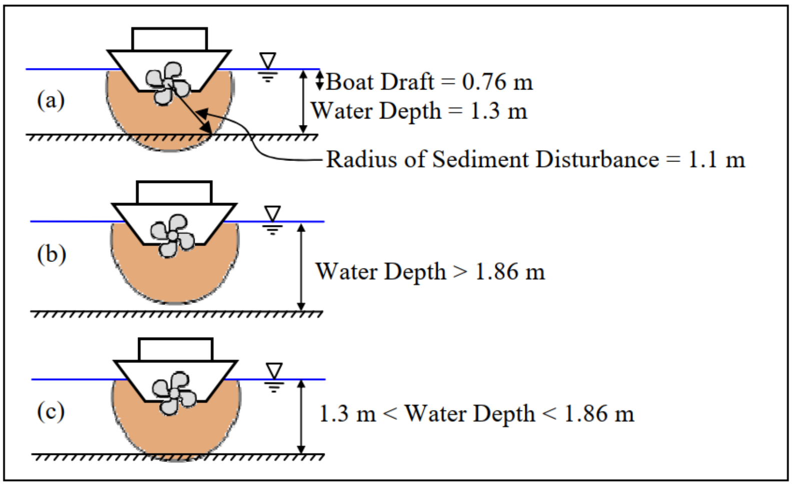
$$T_{total} = T.\sum_{p=1}^{p=n} e^{-k^{(ts-tp)}} \qquad \text{Eq. A24}$$

$$T_{mean} = T_0.\sum_{p=1}^{p=n} e^{-k^{(ts-tp)}} + T_B \qquad \text{Eq. A25}$$

T_{total} = total mass of suspended solids in the water column over 1m of bank length (g/m), T = mass of solids induced by a single boat passage (g/m travelled), n = number of boats, k = settlement rate coefficient, ts = time of sampling, counted from arbitrary starting time, tp = time of passage of the pth boat, counted from the same arbitrary starting time as ts, T_{mean}= concentration of suspended solids (g/m³), $T_o = T/A$, the suspended sediment concentration generated by the passage of a single boat (g/m³), A = cross-sectional area of the waterbody, m² and T_B = background suspended solids concentration when there is no boat activity (g/m³). Hilton & Phillips (1982) report values for k of 0.0146 and 0.012 and values for T_0 of 0.156 and 0.148FTU. Interestingly, their model indicates that high concentrations of suspended sediments generated by boat traffic should return to the normal background level after around 5 hours. In the context of the present study, this indicates that even in a moderate current of 5cm/s, resuspended sediments could travel nearly 1km.

Equations A24 and A25 provide a guide to expected increases in suspended sediments due to the passage of vessels. In reality, other factors such as the vessel characteristics, channel width and depth and the nature of the bed sediments add further complexity (e.g. Figure A.7). For that reason, measurements of suspended sediment in the GUC before and after vessel passage were obtained at two locations. The results are presented and discussed in Section 6.5.

Figure A.7: Influence of water depth on boat-disturbed sediment.



Source: Zeckoski (2010)

B. Risk Assessment and Method Statement

This Risk Assessment and Method Statement (RAMS) outlines Partrac's planned operational procedure and risk assessment at sediment sampling inception. Additional sections have been added to cover practices associated with COVID-19. This document was submitted to the client and was approved before the commencement of operations. All site personnel involved in operations were required to read and sign the RAMS before commencing the survey operations.

B.1 Scope of work

Mott MacDonald commissioned Partrac. Ltd to carry out sediment sampling at 55 specified locations along the length of the GUC. Specifically, the sediment-water interface and overlying waters were sampled, and sediment samples were collected from the surface of the sediment cores and the overlying waters for subsequent laboratory analysis, including:

- Sediment surface critical entrainment stress - measured in the core samples via CSM – sediment only
- Settling velocity – sediment only
- Sediment grain size distribution – sediment and water samples
- Metal concentrations (As, Cd, Cr, Cu, Hg, Pb, Ni and Zn) - sediment and water samples
- PCBs (ICES 7) - sediment and water samples
- PAH's (EPA16) - sediment and water samples
- Total hydrocarbons - sediment and water samples

B.2 Sampling locations

Sediment samples will be collected at 55 specified locations along the length of the GUC and its tributary waterways. Maps of the sampling locations in Section 2 are shown in Figure 2.5 and Figure 2.6, and Table 2.1 and Table 2.2 provide the coordinates.

B.3 SourceSourceEquipment and tasks

B.3.1 Sediment core sampling

The sediment samples will be collected using a *large-bore sediment sampler unit* supplied by Aquatic Research Instruments of Idaho, USA (Figure B.8).

Figure B.8: Large-bore sediment sampler unit.

Source: Partrac (2022)

B.3.2 Tasks

An overview of the survey team and the tasks to be performed on-site is shown in Table B.2.

Table B.2: Survey team and tasks to be performed on-site.

Author names redacted

Participants	Position	Done Before?
[redacted]	Associate Director / Survey Lead	Y
[redacted]	Consultant / Surveyor	N
Tasks	**Who Performs?**	**Who Supervises?**
Sediment corer deployment	Partrac	Partrac
Verification of deployment coordinates and water depth	Partrac	Partrac
Recovery of sediment coring equipment	Partrac	Partrac
Environmental Precautions	**Responsible person**	**Supervisor**
Suitability of environmental conditions	Partrac	Partrac

B.4 Access to the sampling sites

Partrac proposed two alternative methods for undertaking the physical sampling of the sediments from the watercourses to be sampled: (a) on foot from the canal towpath and bridges (B.4.1); or (b) from a hired Narrowboat (B.4.2).

B.4.1 Sampling from the river/watercourse bankside or bridge

- Partrac's survey team will wear appropriate clothing PPE for the conditions anticipated at each site. Each member will wear a self-inflating life jacket while within 2m of the watercourse.
- Sampling from the canal bankside (towpath) or bridge will be completed at up to 55 locations
- A site survey undertaken via Google Earth identified safe access/egress arrangements for all of the sampling locations.
- Geospatial control is provided by the WGS Lat/Long coordinate data provided by the client, which delineates the location of the Watercourse Bank or Bridge sampling points.
- Samples will be collected with the large-bore sediment sampler unit.
- Retrieved sediment/water interface core samples will be capped and sealed at both ends and stored upright for later sampling and analysis.

B.4.2 Sampling from the Narrowboat

- Partrac's survey team will wear appropriate clothing PPE for the conditions anticipated at each site. Each member will wear a self-inflating life jacket while sampling over the watercourse.
- At each sampling location, the vessel will be stationary and, if possible, tied off to the bank during sampling operations.
- The vessel will keep to the side/bank and will not block navigation during sampling operations.
- Sampling operations will only be conducted when considered safe to do so and when no other vessel traffic or water users are nearby.
- Sampling will be completed on the waterside of the boat (toward the centre of the channel) at up to 55 locations
- A site survey undertaken via Google Earth identified safe access/egress arrangements for all of the sampling locations.
- Geospatial control is provided by the WGS Lat/Long coordinate data provided by the client, which delineates the location of the sampling points.
- Samples will be collected with the large-bore sediment sampler unit.
- Retrieved sediment/water interface core samples will be capped and sealed at both ends and stored upright for later sampling.

At all locations, the Survey Lead will be Dr Matt Wright, who has extensive experience (25+ years) of experience collecting samples from marine and fresh waterbodies.

B.5 Assessment of weather and mobilisation

Mobilisation to the site will be initiated once a suitable weather window is identified using a combination of weather forecasts. Once the decision to mobilise has been made, forecasts will continue to be monitored. On the day of the survey, the suitability of conditions and impact on operations will be assessed, with the final decision to mobilise being made by the Partrac Survey Lead.

B.6 Operations

Operations are planned to be completed by two Partrac personnel, with minimal interaction with external contractors to satisfy COVID-19 procedures. The work is expected to take between 6 and 10 days, with 6 to 10 locations visited each day.

B.6.1 Pre-mobilisation

- Preparation of coring equipment at Partrac's warehouse.
- Ordering of sample receptacles from the external laboratory (delivery to Partrac).
- Confirmation of suitable weather conditions.

- Confirmation of access and go ahead with the client.

B.6.2 Pre-operations (at each sampling location)

- On-site assessment of weather conditions and suitability for operations.
- Toolbox Talk is to be completed on-site by the Survey Lead.
- Final verification of coordinates and anticipated water depth.

B.6.3 Responsibilities

- Coordination of equipment: Survey Lead.
- Positioning: Survey Lead.

B.6.4 Field operations – sediment sampling

- A plumb line will be used to measure water depth at the survey location.
- The coring equipment will be assembled appropriately to the water depth.
- The coring equipment will be lowered into the water column from the bridge or towpath.
- The retaining rope attached to the coring equipment will be held.
- One team member will have control of the coring equipment.
- The deployment position will be confirmed, and the water depth recorded.
- The coring equipment will be slowly lowered to just above the canal bed.
- The deployment position will be recorded.
- The coring equipment will then be lifted vertically out of the water.
- Once at the surface, the core tube will be checked to confirm that a suitable sediment-water interface sample has been collected. If this is the case, it will be capped and sealed at the bottom end.
- The depth of sediment in the core will be measured and recorded.
- The core will then be capped and sealed at the top and stored upright in a cool, dark container.
- The team will move on to the next sampling location.

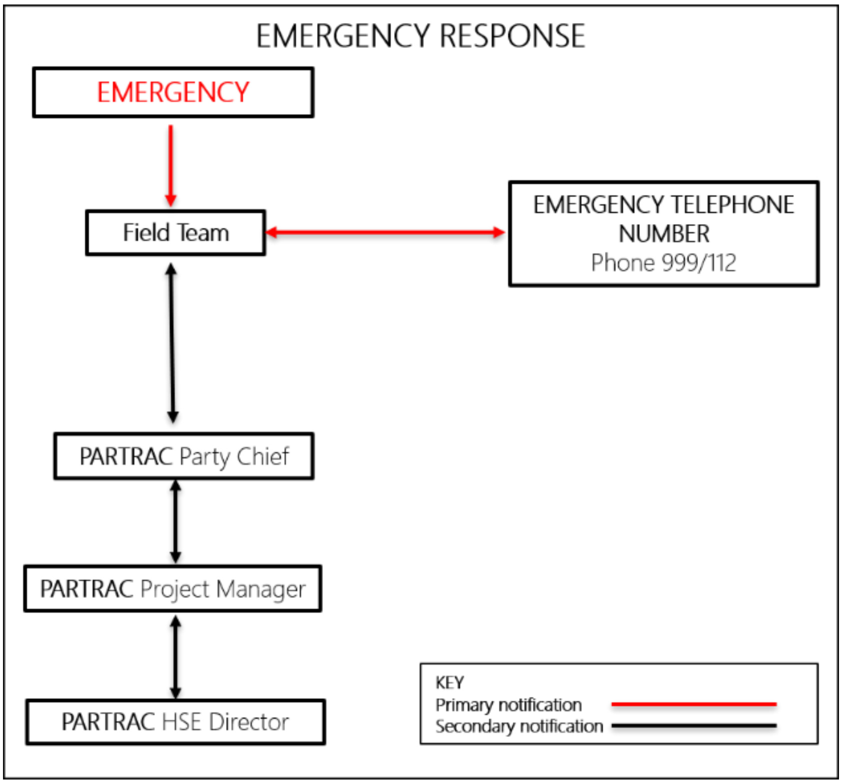
B.6.5 Post field operations

- By foot: Upon return to the vehicle, the sample cores will be securely stored (upright) and transported back to accommodation for sampling that evening.
- From a Narrowboat: the sample cores will be securely stored (upright) for sampling that evening.
- Once back at the accommodation, the surface of the sediment in each core tube will be analysed with the CSM to test the critical entrainment shear stress of the sediment.
- Following CSM testing, the core sediment (nominally the upper 5 cm of material) will be subsampled for shipping to the laboratory for analyses.
- The collected samples will be couriered to the external laboratory for analysis (detailed above).

B.7 Emergency Response Procedure

The Partrac Emergency Response Procedure is outlined in Figure B.9.

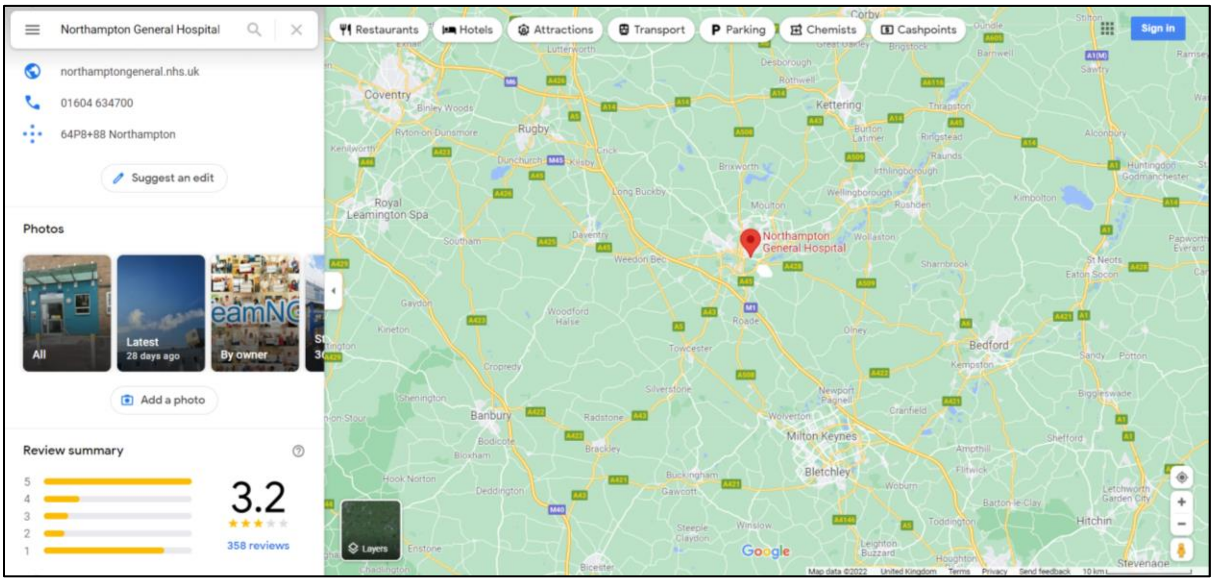
Figure B.9: Emergency Response Procedure.



Source: Partrac (2022)

The closest General Hospital / Accident & Emergency Department to the measurement locations is Northampton General Hospital (Figure B.10, Table B.3). Contact details for the other hospitals with A&E department along the scheme (from North to South) are shown in Table B.4.

Figure B.10: Location of nearest General Hospital to measurement sites.



Northampton General Hospital

northamptongeneral.nhs.uk

01604 634700

64P8+88 Northampton

Source: Partrac (2022)

Table B.3: Contact details for the nearest General Hospital.

Hospital	Address	Phone Number
Northampton General Hospital	Cliftonville, Northampton NN1 5BD	01604 634700

Table B.4: Contact details for the other hospitals with A&E department along the Grand Union Canal Sample route (from North to South).

Hospital (North to South)	Address	Contact details / Phone Number
George Eliot Hospital	College St, Nuneaton, CV10 7DJ	http://www.geh.nhs.uk/ 024 7615 3761
University Hospital Coventry	Clifford Bridge Rd, Coventry, CV2 2DX	http://www.uhcw.nhs.uk 024 7696 4000
Northampton General Hospital	Cliftonville, Northampton, NN1 5BD	https://www.northamptongeneral.nhs.uk/ 01604 634700
Milton Keynes University Hospital	Standing Way, Eaglestone, Milton Keynes MK6 5LD	http://www.mkhospital.nhs.uk 01908 660033

B.8 Health, safety & environmental risk assessment

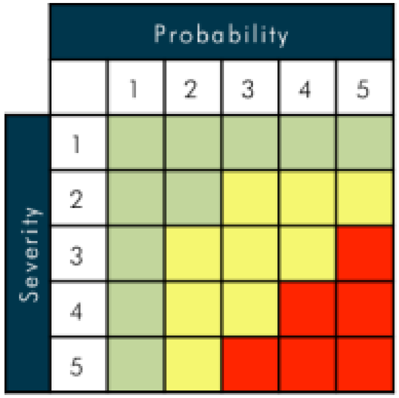
Due to the dynamic nature of operations, the on-site risks will be re-assessed and controlled. The Survey lead will complete this. All survey personnel involved in the works will be required to read and sign this document. This RAMS is to be issued promptly in advance of works to make amendments if necessary. The output is to be re-circulated to all relevant parties. In addition to this Risk Assessment, personnel are required to participate in Toolbox Talks which also require sign-off by all personnel involved.

Health, safety and environmental incidents will be reported to the client at the earliest safe opportunity. Incidents requiring reporting to the HSE will be declared as soon as reasonably practicable.

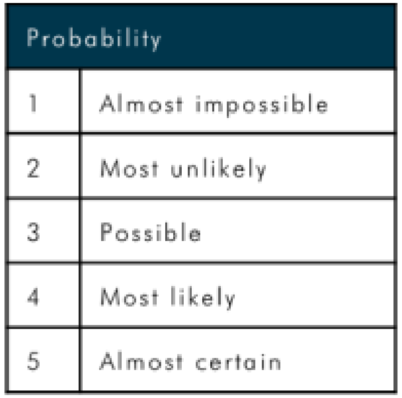
A copy of the Risk Assessment will be available to all persons who could be affected and will be stored on Partrac's server. A hard copy will be prepared for the Project Folder that will accompany the survey team offshore. All documentation supporting the Risk Assessment, including the Toolbox Talk form and Safety Observations Cards, will also accompany the survey team on mobilisation.

B.8.1 Health & safety risks & control Measures

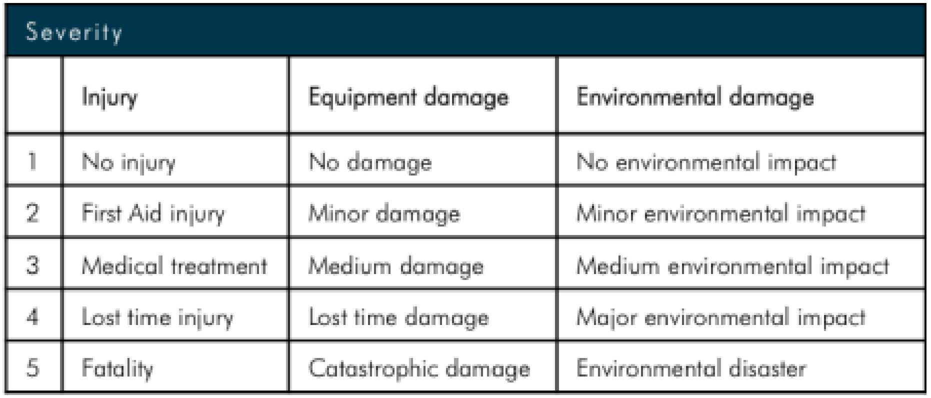
The risks are assessed using the following scoring system:



Severity \ Probability	1	2	3	4	5
1	🟩	🟩	🟩	🟩	🟩
2	🟩	🟩	🟨	🟨	🟨
3	🟩	🟨	🟨	🟨	🟥
4	🟩	🟨	🟨	🟥	🟥
5	🟩	🟨	🟥	🟥	🟥



Probability	
1	Almost impossible
2	Most unlikely
3	Possible
4	Most likely
5	Almost certain



Severity			
	Injury	Equipment damage	Environmental damage
1	No injury	No damage	No environmental impact
2	First Aid injury	Minor damage	Minor environmental impact
3	Medical treatment	Medium damage	Medium environmental impact
4	Lost time injury	Lost time damage	Major environmental impact
5	Fatality	Catastrophic damage	Environmental disaster

Legend		
🟩	Low risk	No further action required
🟨	Medium risk	Risk only acceptable after approval by project director
🟥	High risk	Unacceptable as risk after mitigation, find alternative

B.8.2 Health and Safety Risk Assessment

Activity	Loading of equipment to a vehicle										
Item	Task	Hazard	Consequence	Initial Risk			Control Measures	Residual Risk			Unacceptable Tolerable
				P	S	R		P	S	R	Acceptable
1.	Lifting < 50 kg	Personal injury	Lost time injury	2	4	8	Toolbox Talk. Use of appropriate PPE. Never stand underneath load or between a fixed structure and load.	2	4	8	Tolerable
2.	Lifting > 50 kg	Personal injury	Injury / fatality	2	5	10	Tested, certified, and inspected lifting equipment only e.g., pallet lifter, forklift, or harbour crane. Trained, certified and qualified lifting operators only. Toolbox Talk. Lift Plan. Use of appropriate PPE. Use of Banksman Use of Tag lines. Never stand underneath load or between a fixed structure and load Use of appropriate PPE (gloves, steel toe footwear).	1	5	10	Acceptable
3.	Vehicle weight capacity	Over-loading vehicle	No Injury	2	1	2	Distribute weight equally. Weights of items are known, and total weight can be verified. Verification of vehicle payload weight from equipment requisition form. Ensure two drivers.	2	1	2	Acceptable

Activity	Loading / unloading of equipment to vessel										
Item	Task	Hazard	Consequence	Initial Risk			Control Measures	Residual Risk			Unacceptable Tolerable
				P	S	R		P	S	R	Acceptable
1.	Manual handling of items	Poor lifting posture. Dropping weight onto feet or another person. Crushing injury. Falling, slipping.	Musculoskeletal injury. Loss of equipment to the water. Lost time injury. Damaged equipment.	2	4	8	Assume correct posture and procedures for lifting. 25 kg maximum lift per person. When weight exceeds 25kg, pair up with a colleague or use mechanical means (HIAB/ Forklift). All loads are to be kept as close to the body as possible ensuring good body posture is maintained. Plan the route to prevent contact with possible tripping hazards. All Partrac personnel have completed manual handling training. Use of required PPE (gloves, lace-up safety boots, overalls, lifejacket, hard hat with chin strap, safety glasses).	1	5	5	Acceptable

Activity	Setting up / commissioning of equipment										
Item	Task	Hazard	Consequence	Initial Risk			Control Measures	Residual Risk			Unacceptable Tolerable
				P	S	R		P	S	R	Acceptable
1.	Set up of electrical survey equipment.	Electrocution.	Injury / fatality.	2	5	10	All equipment to be utilised is to be CE marked and manufactured to a European standard.	1	5	10	Acceptable

Activity	**Setting up / commissioning of equipment**										
Item	**Task**	**Hazard**	**Consequence**	**Initial Risk**			**Control Measures**	**Residual Risk**			**Unacceptable** **Tolerable** **Acceptable**
				P	**S**	**R**		**P**	**S**	**R**	
							All portable electrical appliances are PAT tested with evidence of certification. All cables and hoses are to be routed as safely as possible to prevent tripping hazards. Keep all electrical equipment indoors where possible. Use weather-proof extension cables and boxes to cover multi-plugs and connections. Power down all equipment before disconnecting. Mandatory PPE must be utilised at all times (flame retardant overalls, lace-up safety boots, matting).				

Activity	**Deployment / recovery of equipment**										
Item	**Task**	**Hazard**	**Consequence**	**Initial Risk**			**Control Measures**	**Residual Risk**			**Unacceptable** **Tolerable** **Acceptable**
				P	**S**	**R**		**P**	**S**	**R**	
1.	Assessment of weather and canal conditions.	Canal and weather conditions leading to unsafe operations.	Injury / fatality. Damage to equipment. Incorrect equipment deployment. Loss of equipment.	2	5	10	Review weather forecasts. Assess conditions before departing for site. Re-assess conditions on site. Survey Lead to have ultimate control over Go/No Go based on site conditions. Do not commence operations if in doubt.	1	4	4	**Acceptable**

Activity	Deployment / recovery of equipment										
Item	Task	Hazard	Consequence	Initial Risk			Control Measures	Residual Risk			Unacceptable Tolerable Acceptable
				P	S	R		P	S	R	
2.	Lifting equipment.	Struck / crush.	Injury / fatality	3	5	15	Tested, certified, and inspected lifting equipment only. Trained lifting operators only. Use of Banksman. Use of Tag lines. Toolbox Talk. Lift Plan. Never stand underneath load or between a fixed structure and load. Use of required PPE (gloves, lace-up safety boots, overalls, lifejacket, exposure protection).	2	5	10	Tolerable
3.	All works alongside the canal / watercourse.	Falling in the water.	Injury / fatality.	3	5	15	Use of required PPE. No lone working. Day light working only.	1	5	5	Acceptable

Activity	Deployment / recovery of equipment										
Item	Task	Hazard	Consequence	Initial Risk			Control Measures	Residual Risk			Unacceptable Tolerable
				P	S	R		P	S	R	Acceptable
4	All works alongside the canal / watercourse	Contact with microorganisms in the water such as Leptospirosis (Wiels disease) and Tetanus	Severe illness / fatality	3	5	15	All field survey staff to be briefed on potential dangers and to be provided with an Information card for workers and supervisors working in high exposure areas. Provides infection prevention advice and symptom information to help prevent serious illness Use of required PPE (Nitrile Gloves). Follow good basic hygiene including regular hand-washing and avoiding hand to mouth/eye etc contact. Wash cuts and grazes immediately with soap and running water Cover all cuts, abrasions and other breaks in the skin with waterproof dressings and/or gloves.	1	5	5	Acceptable
5.	Survey operations.	Weather deterioration during survey work.	Injury.	3	4	12	Weather forecasts will be obtained prior to survey operations each day. If weather conditions exceed workable conditions, all work will be halted,	1	4	4	Acceptable
6.	Survey operations.	Working outside of daylight hours.	Injury / fatality	2	5	10	Only operate during daylight hours.	1	5	5	Acceptable

B.8.3 Environmental Risk Assessment

Activity	Environmental Risk Assessment						
Item	Task	Hazard	Consequence	Initial Risk	Control Measures	Residual Risk	Unacceptable Tolerable

				P	S	R		P	S	R	Acceptable
1.	Recovery of all deployed materials.	Hazard canal users. Non-compliance with ISO14001. Company policy.	Minor environmental impact	2	2	4	Design of system has been thoroughly tested. All positions marked to within +/- 5m.	2	2	4	Acceptable
2.	Disposal of batteries.	Battery leakage to the environment.	Minor environmental impact	2	2	4	All batteries are kept and returned to Partrac's warehouse. Batteries are disposed of by 'BatteryBack plc' and the according documentation provided.	2	2	4	Acceptable
3.	Lost equipment	Lost through recovery failure.	Loss of equipment	2	2	4	Use of appropriate and tested equipment. Experienced personnel. Experienced procedural methods.	2	2	4	Acceptable
4.	Exposure	Rain/snow, cold/hot weather, wind.	Operative experiences extreme cold, wet, hypothermia, sun burn.	3	3	9	Use of appropriate PPE minimises exposure to conditions including waterproof jacket and trousers, overalls, gloves, and warm clothing in cold weather. Avoid sunburn through use of sunscreen.	1	1	1	Acceptable

B.8.4 COVID-19 Risk Assessment

Activity	COVID-19 Risk Assessment										
Item	Task	Hazard	Consequence	Initial Risk			Control Measures	Residual Risk			Unacceptable Tolerable
				P	S	R		P	S	R	Acceptable

Activity	COVID-19 Risk Assessment										
1.	Working on projects plus travelling with others	Transfer of the Corona Virus	Illness from COVID-19, either to the individual or to others following transfer of the virus.	3	5	15	Only essential work and travel. Follow Gov. and NHS advice: If you show any C19 symptoms, you must self-isolate, and you must not engage in any work. No more than two people to work together and to maintain 2m distance as much as practicable. Where work requires closer proximity than 2m, controls will be implemented to ensure that the risk of transmission is reduced to as low as practicably possible (see next risk item). Follow Partrac cleaning, hand washing & respiratory hygiene guidelines at all times.	2	5	10	**Tolerable**
2.	Work requires closer proximity than 2m	Transfer of the Corona Virus	Illness from COVID-19, either to the individual or to others following transfer of the virus.	3	5	15	Additional PPE is to be used including face masks, nitrile type gloves, personal hand sanitiser and wipes, and a thermometer. Protective glasses, whilst issued in standard kit, should be worn to 'remind' personnel not to touch their eyes. Minimise duration of the activity where possible and safe to do so. Interacting with other personnel such as sub-contractors, within a 2 m radius is to be avoided where practicable and safe to do so. Follow Partrac cleaning, hand washing & respiratory hygiene guidelines always.	2	5	10	**Tolerable**
3.	Staying in a hotel / self-contained accommodation	Transfer of the Corona Virus	Illness from COVID-19, either to the individual or to others following transfer of the virus.	3	5	15	Overnight accommodation is to be avoided if journeys and operations can be completed within a 14-hour day (drive sharing essential).	2	5	10	**Tolerable**

Activity	COVID-19 Risk Assessment										
							Follow additional COVID hygiene regimes stipulated by accommodation providers. Personnel are required to clean down surfaces, handles etc. in accommodation, prior to use. Follow Partrac cleaning, hand washing & respiratory hygiene guidelines at all times.				
4.	Access to sampling sites	Transfer of the Corona Virus	Illness from COVID-19, either to the individual or to others following transfer of the virus.	3	5	15	Maintain social distancing and avoid any passers-by when accessing the site. Use protective gloves (EN 374) when opening gates that are exposed to the public. Follow Partrac cleaning, hand washing & respiratory hygiene guidelines always.	2	5	10	**Tolerable**

B.9 COVID-19 policy summary

Partrac is committed to the safety of all personnel, sub-contractors and to the wider community, and we will do our utmost to maintain the necessary controls and protective measures at all times, adhering to government advice and industry practice.

- Screening - All personnel are being issued a thermometer. It is requested that all staff using the office/warehouse or who are likely to go on survey use this daily.
- Hand washing & respiratory hygiene - Everyone is required to follow the general principles to help prevent the spread of the virus, whether in the office, warehouse or at project sites.
- Cleaning - maintain the highest standards of hygiene and cleanliness.
- Social Distancing - Staff should observe a 2 m social distance rule where practicable and safe.
- PPE - Additional PPE includes face masks, nitrile-type gloves, personal hand sanitiser and wipes, and a thermometer.
- Travel - Vehicles will have reduced occupancy where practicable (max. two people per vehicle).
- Accommodation - Accommodation providers should provide details of additional COVID19 hygiene regimes.

B.10 Survey lead's responsibilities

The Survey Lead has the responsibility to ensure that:

- All work is carried out following this RAMS document.
- Correct PPE is being worn by all members of the survey team during all work operations.
- Toolbox Talks are carried out before operations.
- A weather forecast is reviewed before operations and monitored during the survey.

B.11 Maintenance and monitoring of control measures

- Review Risk Assessment before work commencing and re-state all the risks to all personnel involved;
- Ensure PPE is well maintained and serviced before fieldwork.
- No lone working on-site – a minimum of two staff always present.
- Toolbox Talks are to be conducted before any operations.

B.12 PPE requirements

Each person must have the Personal Protective Equipment (PPE) listed in Table B.5. Check your equipment, paying particular attention that all life jackets are in-date and that you are satisfied that they have been tested.

Table B.5: PPE requirements.

Item Number	Description	Issued in the standard kit?
1.	Lifejacket	Y
2.	Waterproofs	Y
3.	High visibility vest	Y
4.	Gloves	Y

B.13 Signatories

Each person in the survey team must read and sign this Risk Assessment prior to the commencement of mobilisation.

I understand the risks involved as described throughout this document for the activity described in Section 1 (Method Statement) of this document. Any additional risks not identified before the survey will be outlined in the Toolbox Talks, for which additional signatures will be required. Updates to this document may be requested via the Project Director Sam Athey (Partrac Ltd).

Person (Print name)	Position	Signature	Date
	Survey Lead		
	Surveyor		
	Client Representative		

B.14 Emergency Contacts

Contact names redacted

Company /Organisation	Name / Position	Phone	Mobile	E-mail
Partrac	[redacted]	[redacted]	[redacted]	[redacted]
Partrac	[redacted]	[redacted]	[redacted]	[redacted]
Partrac	[redacted]	[redacted]	[redacted]	[redacted]
Partrac	[redacted]	[redacted]	[redacted]	[redacted]
Partrac	[redacted]	[redacted]	[redacted]	[redacted]
Mott MacDonald	[redacted]	[redacted]	[redacted]	[redacted]
Mott MacDonald	[redacted]	[redacted]	[redacted]	[redacted]
Canal and Rivers Trust	[redacted]	[redacted]	[redacted]	[redacted]

Hospitals with A&E	Address	Contact details
George Eliot Hospital	College St, Nuneaton, CV10 7DJ	024 7615 3761
University Hospital Coventry	Clifford Bridge Rd,Coventry, CV2 2DX	024 7696 4000
Northampton General Hospital	Cliftonville, Northampton, NN1 5BD	01604 634700
Milton Keynes University Hospital	Standing Way, Eaglestone, Milton Keynes MK6 5LD	01908 660033

Grid references for continued monitoring locations redacted

C. Sediment description

Table C.6: The location, date, and time of sampling and a description of each sample collected.

Sample ID	Latitude	Longitude	Date	Time	Description of sediment core and CSM Run ID (depth down core at which CSM run was performed, if not on sediment surface)
GUC 1	[redacted]	[redacted]	2022/05/10	17:30	Brown organic silt Turn to dark grey and gets coarser CSM run 26 @ surface
GUC 2	[redacted]	[redacted]	2022/05/10	18:40	Olive brown-grey fine silt, gloopy CSM run 29 @ surface
GUC 3	[redacted]	[redacted]	2022/05/10	19:00	Olive brown fine silt After 6 cm turns to battleship grey CSM run 30 @ 6 cm downcore
GUC 4	[redacted]	[redacted]	-	-	The sample was not collected as the material was unconsolidated and very little of it is left in the tube after retrieval (not adequate for laboratory processing)
GUC 5	[redacted]	[redacted]	2022/05/10	19:45	Battleship grey silt CSM run 31 @ 3 cm downcore
GUC 6	[redacted]	[redacted]	2022/05/10	20:05	Olive grey silt CSM run 32 @ 1 cm downcore
GUC 7	[redacted]	[redacted]	2022/05/10	20:25	Olive grey, gloopy silt after 10 cm slightly darker CSM run 33 @ 4 cm downcore
GUC 8	[redacted]	[redacted]	2022/05/10	20:45	Olive brown-grey organic silt After 6 cm turns darker grey and much more solid CSM run 36 @ 1 cm downcore
GUC 9	[redacted]	[redacted]	2022/05/10	21:00	Olive brown, fine silt, gloopy CSM run 37 @ 7 cm downcore
GUC 10	[redacted]	[redacted]	2022/05/11	15:40	Olive brown-grey organic silt, gloopy Got slighter coarser with depth CSM run 40 @ 4 cm downcore
GUC 11	[redacted]	[redacted]	2022/05/11	16:05	Olive brown, solid consistency CSM run 39 @ surface
GUC 12	[redacted]	[redacted]	2022/05/11	16:30	Olive brown-grey organic silt, less viscous 10 cm down, moves to coarser firmer sediment and changes to battleship grey CSM run 41 @ 3 cm downcore
GUC 13	[redacted]	[redacted]	2022/05/11	18:05	Olive brown-grey organic silt Turns more clay like consistency with depth CSM run 38 @ 1 cm downcore
GUC 14	[redacted]	[redacted]	2022/05/10	13:10	Olive brown-grey organic silt CSM run 23 @ 6 cm downcore
GUC 15	[redacted]	[redacted]	-	-	The sample was not collected as the material was unconsolidated and very little of it is left in the tube after retrieval (not adequate for laboratory processing)
GUC 16	[redacted]	[redacted]	2022/05/10	11:50	Olive brown, grey silty sand CSM not possible

Grid references for continued monitoring locations redacted

Sample ID	Latitude	Longitude	Date	Time	Description of sediment core and CSM Run ID (depth down core at which CSM run was performed, if not on sediment surface)
GUC 17	[redacted]	[redacted]	2022/05/10	10:25	Olive brown-grey silty sand Gets sandier with depth CSM run 20 @ 5 cm downcore
GUC 18	[redacted]	[redacted]	2022/05/10	09:55	Olive brown-grey silt 4 cm it changes to a battleship grey, silty clay CSM run 21 @ 3 cm downcore
GUC 19	[redacted]	[redacted]	2022/05/09	17:20	Olive brown-grey organic silt CSM run 25 @ surface
GUC 20	[redacted]	[redacted]	2022/05/09	16:45	Olive brown-grey organic silt CSM run 24 @ 5 cm downcore
GUC 21	[redacted]	[redacted]	2022/05/09	16:05	Olive brown-grey organic silt After 5 cm goes to dark grey silt CSM run 22 @ 3 cm downcore
GUC 22	[redacted]	[redacted]	2022/04/11	13:50	0 - 4 cm: Olive brown-grey organic silt 4 - 30 cm: grey/brown mud (silt&clay) CSM run 10 @ 4cm downcore
GUC 23	[redacted]	[redacted]	2022/04/11	13:05	0 – 12cm: Olive brown-grey organic silt grading into grey/brown mud (silt&clay) CSM run not possible
GUC 24	[redacted]	[redacted]	2022/04/11	12:25	0 - 5 cm: Olive brown-grey organic silt 5 - 25 cm: grey/brown mud (silt&clay) and gravel CSM run 12
GUC 25	[redacted]	[redacted]	2022/04/11	11:20	0 - 2 cm: Olive brown-grey organic silt 5 - 25 cm: grey/brown mud (silt&clay) and gravel CSM run 12 @ surface
GUC 26	[redacted]	[redacted]	2022/04/11	10:40	0 - 8cm: brown organic sandy gravel CSM run not possible
GUC 27	[redacted]	[redacted]	2022/04/11	09:45	0 - 10 cm: Olive brown-grey organic silt 10 - 20 cm: grey/brown mud (silt&clay) CSM run not possible (to soft/liquified)
GUC 28	[redacted]	[redacted]	2022/04/10	19:00	0 - 5 cm: Olive brown-grey organic silt 5 - 40 cm: grey/brown mud (silt&clay) CSM run 8
GUC 29	[redacted]	[redacted]	2022/04/10	18:05	0 - 4 cm: Olive brown-grey organic silt 4 - 30 cm: grey/brown mud (silt&clay) CSM run not possible
GUC 30	[redacted]	[redacted]	-	-	Very stiff battleship grey clay (small amount left in core tube on retrieval) 10+ attempts made to retrieve an adequate sample; insufficient sample retrieved for laboratory processing
GUC 31	[redacted]	[redacted]	2022/04/12	11:05	0 - 4 cm: Olive brown-grey organic silt 4 - 15 cm: grey/brown mud (silt&clay) with occasional gravel fragments CSM run not possible (could not push out of tube, sediment locked in)
GUC 32	[redacted]	[redacted]	2022/04/10	13:40	0 - 10 cm: Olive brown-grey organic silt 10 - 18 cm: grey/brown mud (silt&clay) CSM run 9 @ 3 cm downcore

Grid references for continued monitoring locations redacted

Sample ID	Latitude	Longitude	Date	Time	Description of sediment core and CSM Run ID (depth down core at which CSM run was performed, if not on sediment surface)
GUC 33	[redacted]	[redacted]	2022/04/12	11:50	0 - 5 cm: Olive brown-grey organic silt 5 - 12 cm: grey/brown mud (silt&clay) CSM run 15 @ 5 cm downcore
GUC 34	[redacted]	[redacted]	2022/04/12	13:15	0 - 8 cm: Olive brown-grey organic silt 8 - 25 cm: dark grey/brown mud (silt&clay) CSM run 16 @ surface
GUC 35	[redacted]	[redacted]	2022/04/09	19:05	0 - 20 cm: Olive brown-grey organic silt, stiffer below 12cm 20+ cm: dark grey/brown mud (silt&clay) CSM run not possible; too soft/liquified in upper 12 cm
GUC 36	[redacted]	[redacted]	2022/04/12	14:15	0 - 5 cm: Olive brown-grey organic silt 5 - 20 cm: dark grey/brown mud (silt&clay) CSM run 14 @ 5 cm downcore
GUC 37	[redacted]	[redacted]	2022/04/09	17:25	0 - 15 cm: Olive brown-grey organic silt, stiffer below 12 cm 15+ cm: dark grey/brown mud (silt&clay) CSM run not possible; too soft/liquified in upper 12 cm
GUC 38	[redacted]	[redacted]	2022/04/09	15:40	0 - 15 cm: Olive brown-grey organic silt, stiffer below 15 cm 15+ cm: dark grey/brown mud (silt&clay) CSM run not possible; too soft/liquified in upper 12 cm
GUC 39	[redacted]	[redacted]	2022/04/09	17:05	0 - 30 cm: Olive brown-grey organic silt 30+ cm: dark grey/brown mud (silt&clay) CSM run 3 @ 6 cm downcore
GUC 40	[redacted]	[redacted]	2022/04/09	12:25	0 - 12 cm: Olive brown-grey organic silt 12+ cm: stiff dark grey silt clay CSM run not possible (could not push out of tube, sediment locked in)
GUC 41	[redacted]	[redacted]	2022/04/13	10:52	0 - 11 cm: Olive brown-grey organic silt with occasional gravel fragments 11 - 36 cm: dark grey silt clay CSM run 19 @ 11 cm downcore
GUC 42	[redacted]	[redacted]	2022/04/09	10:45	0 - 3 cm: Olive brown-grey organic silt with occasional gravel fragments 3 - 15 cm: grey silt clay with occasional gravel fragments CSM run not possible (could not push sample out of tube, sediment locked in)
GUC 43	[redacted]	[redacted]	2022/04/09	09:00	0 – 5 cm: Olive brown-grey organic silt grading into 5+ cm Grey silt clay CSM run 6 @ 5 cm downcore
GUC 44	[redacted]	[redacted]	2022/04/13	16:50	0 - 12 cm: Olive brown-grey organic silt 12 - 30 cm: dark brown/grey silt clay CSM run 17 @ 12 cm downcore

Grid references for continued monitoring locations redacted

Sample ID	Latitude	Longitude	Date	Time	Description of sediment core and CSM Run ID (depth down core at which CSM run was performed, if not on sediment surface)
GUC 45	[redacted]	[redacted]	2022/04/13	16:25	0 - 1 cm: Olive brown-grey organic silt with occasional gravel fragments 1 - 7 cm: stiff battleship grey clay CSM run not possible (could not push sample out of tube, sediment locked in)
GUC 46	[redacted]	[redacted]	2022/04/13	15:20	0 - 10 cm: Olive brown-grey organic silt 10 - 18 cm: dark brown/grey silt clay CSM run 18 @ surface
GUC 47	[redacted]	[redacted]	2022/04/13	14:45	0 - 5 cm: Olive brown/grey organic silt 5 - 12 cm: stiff battleship grey clay CSM run not possible (could not push sample out of tube, sediment locked in)
GUC C 1	[redacted]	[redacted]	2022/05/11	17:40	Brown sand, mixed with roots CSM run 43 @ 1 cm downcore
GUC C 2	[redacted]	[redacted]	-	-	Sample not collected, the area of sampling (and ~250m upstream and downstream) was too stony
GUC C 3	[redacted]	[redacted]	2022/05/12	17:00	Olive brown-grey silt 10 cm down, turns to gunmetal grey CSM run 44 @ 1 cm downcore
GUC C 4	[redacted]	[redacted]	2022/04/10	14:15	0 - 6 cm: Dark brown organic silt 6 - 25 cm: dark grey / black mud (silt/clay) CSM run not possible
GUC C 5	[redacted]	[redacted]	2022/05/12	15:30	Brown, fine sand coarser with depth CSM run 45 @ 0 cm downcore
GUC C 6	[redacted]	[redacted]	2022/04/12	16:10	0 - 30 cm: Dark brown organic silt CSM run not possible
GUC C 7	[redacted]	[redacted]	2022/05/12	13:40	Gun metal grey silt Slightly darker (to battleship grey) CSM run 46 @ 1 cm downcore
GUC C 8	[redacted]	[redacted]	2022/05/12	13:20	Dark grey coarse sand with organic roots No change CSM run 47 @ 0.5 cm downcore

Figure C.11: Photographs of the collected canal core samples


GUC 1


GUC 2


GUC 3


GUC 5


GUC 6


GUC 7


GUC 8


GUC 9


GUC 10


GUC 11


GUC 12


GUC 13


GUC 14


GUC 16


GUC 17


GUC 18


GUC 19


GUC 20


GUC 21


GUC 22


GUC 23


GUC 24


GUC 25


GUC 26


GUC 27


GUC 28


GUC 29


GUC 31


GUC 32


GUC 33


GUC 34


GUC 35


GUC 36


GUC 37


GUC 38


GUC 39


GUC 40


GUC 41


GUC 42


GUC 44


GUC 45


GUC 46


GUC 47

Figure C.12: Photographs of the collected connected waterbody core samples

GUC C3 GUC C4 GUC C5 GUC C6 GUC C7 GUC C8

D. Daily Progress Reports

Contact names redacted

D.1 M5404.05.01.D01.s01 - DPR GUC Sampling 09-04-2022

Project	M5040	**Project/Contract No.**	Grand Union Canal
Document No	M5030.05.01.D01.s01	**Revision/Series**	Sediment Sampling
Document Title	**DAILY PROGRESS REPORT**		

Location	Grand Union Canal Linslade - Cosgrove	**Vessel**	Juniper
Date	9 April 2022	**Personnel**	[redacted]
Weather	Very Good		
Wind Speed	N/A	**Sea state**	N/A

LOCAL TIME	OPERATIONS SUMMARY
0800	Leave Berth at Linslade
0905	Toolbox talk, Sample site 43
10:45	Sample site 42
12:25	Sample Site 40
14:10	Sample Site 39
15:45	Sample Site 38
17:30	Sample Site 37
19:10	Sample Site 35
19:45	Berth at Cosgrove

WORK PLANNED FOR THE NEXT 24 HRS
Extract Lab samples from sampling tubes, run CSM on Samples sediment surface Continue along Grand Union Canal collecting samples
HSE
Completed without incident
CLIENT ACTIONS REQUIRED
None

	Name	Signature
PARTRAC	[redacted]	
Client	[redacted] (Mott MacDonald)	10.04.2022

D.2 M5404.05.01.D01.s02 - DPR GUC Sampling 10-04-2022

Contact names redacted

Project	M5040	**Project/Contract No.**	Grand Union Canal
Document No	M5030.05.01.D01.s02	**Revision/Series**	Sediment Sampling
Document Title	**DAILY PROGRESS REPORT**		

Location	Grand Union Canal Linslade – Cosgrove	**Vessel**	Juniper
Date	10 April 2022	**Personnel**	[redacted]
Weather	Very Good		
Wind Speed	N/A	**Sea state**	N/A

LOCAL TIME	OPERATIONS SUMMARY
0800	Commence CSM measurements and sediment sub sampling
1200	CSM and subsampling complete
1200	Depart berth at Cosgrove
13:45	Sample site 32
14:15	Sample Site Connected waterbody 4
1700	Sample Site 30 – Canal bed almost impenetrable, small amount of material 1-2cm thick retrieved. Very stiff grey clay (canal lining?), soupy organic fluff above. No sample taken for lab analyses
1807	Sample Site 29
19:30	Berth at Bilsworth
19:30	Sample Site 28

WORK PLANNED FOR THE NEXT 24 HRS
Extract Lab samples from sampling tubes, run CSM on Samples sediment surface Continue along Grand Union Canal collecting samples
HSE
Completed without incident
CLIENT ACTIONS REQUIRED
None

	Name	Signature
PARTRAC	[redacted]	
Client	[redacted] (Mott MacDonald)	11.04.2022

D.3 M5404.05.01.D01.s03 - DPR GUC Sampling 11-04-2022

Project	M5040	**Project/Contract No.**	Grand Union Canal
Document No	M5030.05.01.D01.s03	**Revision/Series**	Sediment Sampling

Contact names redacted

Document Title	**DAILY PROGRESS REPORT**		

Location	Grand Union Canal Blisworth to Whilton Marina	**Vessel**	Juniper
Date	11 April 2022	**Personnel**	[redacted]
Weather	Very Good		
Wind Speed	N/A	**Sea state**	N/A

LOCAL TIME	OPERATIONS SUMMARY
0700	Commence CSM measurements and sediment sub sampling
0830	CSM and subsampling complete
0830	Depart berth at Blisworth
09:45	Sample site 27
1040	Sample Site 26
1120	Sample Site 25
1225	Sample Site 24
1305	Sample site 23
1350	Sample Site 22 at Whilton Marina; turn boat around to head south back towards Linslade
1915	Berth at Stoke Bruerne

WORK PLANNED FOR THE NEXT 24 HRS
Extract Lab samples from sampling tubes, run CSM on Samples sediment surface Continue South along Grand Union Canal collecting samples
HSE
Completed without incident
CLIENT ACTIONS REQUIRED
None

	Name	Signature
PARTRAC	[redacted]	
Client	[redacted] (Mott MacDonald)	12.04.2022

D.4 M5404.05.01.D01.s04 - DPR GUC Sampling 12-04-2022

Project	M5040	**Project/Contract No.**	Grand Union Canal
Document No	M5030.05.01.D01.s04	**Revision/Series**	Sediment Sampling
Document Title	**DAILY PROGRESS REPORT**		

Contact names redacted

Location	Grand Union Canal Stoke Bruerne to Fenny Stratford	**Vessel**	Juniper
Date	12 April 2022	**Personnel**	[redacted]
Weather	Very Good		
Wind Speed	N/A	**Sea state**	N/A

LOCAL TIME	OPERATIONS SUMMARY
0730	Commence CSM measurements and sediment sub sampling
0830	CSM and subsampling complete
0830	Depart berth at Stoke Bruerne
1100	Sample site 31
1145	Sample Site 33
1215	Stopped to collect Sample at Connected waterbody 5; no access to water course from the towpath; Private land
1315	Sample Site 34
1415	Sample Site 36
1610	Sample Connected waterbody 6
1930	Berth at Fenny Stratford

WORK PLANNED FOR THE NEXT 24 HRS
Extract Lab samples from sampling tubes, run CSM on Samples sediment surface Continue South along Grand Union Canal collecting samples
HSE
Completed without incident
CLIENT ACTIONS REQUIRED
None

	Name	Signature
PARTRAC	[redacted]	
Client	[redacted] (Mott MacDonald)	13.04.2022

D.5 M5404.05.01.D01.s05 - DPR GUC Sampling 13-04-2022

Project	M5040	**Project/Contract No.**	Grand Union Canal
Document No	M5030.05.01.D01.s05	**Revision/Series**	Sediment Sampling
Document Title	**DAILY PROGRESS REPORT**		

Location	Grand Union Canal Fenny Stratford to Linslade	**Vessel**	Juniper
Date	13 April 2022	**Personnel**	[redacted]

Contact names redacted

Weather	Very Good		
Wind Speed	N/A	**Sea state**	N/A

LOCAL TIME	OPERATIONS SUMMARY
0730	Commence CSM measurements and sediment sub sampling
0830	CSM and subsampling complete
0830	Depart berth at Fenny Stratford
1050	Sample Site 41
1450	Sample Site 47
1520	Sample Site 46
1600	collect Water Sample at site 45 as large canal boat (towing another large boat) passes by
1625	Sample Site 45
1650	Sample Site 44;
1730	Commence CSM measurements and sediment sub sampling
1930	CSM and subsampling complete

WORK PLANNED FOR THE NEXT 24 HRS
Return Narrowboat; package samples to be couriered to laboratory; return to Newcastle
HSE
Completed without incident
CLIENT ACTIONS REQUIRED
None

	Name	Signature
PARTRAC	[redacted]	
Client	[redacted](Mott MacDonald)	14.04.2022

D.6 M5040.05.01.D02.s01 - DPR GUC Sampling 09-05-2022

Project	Grand Union Canal	**Project/Contract No.**	M5040
Document No	M5040.05.01.D02	**Revision/Series**	S1
Document Title	**DAILY PROGRESS REPORT**		

Location	Grand Union Canal	**Vessel**	N/A
Date	09/05/22	**Personnel**	[redacted]
Weather	Sunny		

Contact names redacted

Wind Speed	N/A	**Sea state**	N/A

LOCAL TIME	**OPERATIONS SUMMARY**
08:30	Partrac staff load the van
09:30	Depart Devon
13:30	Arrive at accommodation in Daventry
14:30	Depart for Site 21
16:05	Collected sediment at Site 21
16:45	Collected sediment at Site 20
17:20	Collected sediment at Site 19
17:30	Depart site and head back to accommodation

WORK COMPLETED/COMMENTS/PROBLEMS ENCOUNTERED
Collect sediment samples 21, 20, and 19.
WORK PLANNED FOR THE NEXT 24 HRS
Finish collecting the first 7 samples, before meeting [redacted] at 13:30
HSE
None

	Name	**Signature**
PARTRAC	[redacted]	
Client	[redacted](Mott MacDonald)	10.05.2022

D.7 M5040.05.01.D02.s02 - DPR GUC Sampling 10-05-2022

Project	Grand Union Canal	**Project/Contract No.**	M5040
Document No	M5040.05.01.D02	**Revision/Series**	S2
Document Title	**DAILY PROGRESS REPORT**		

Location	Grand Union Canal	**Vessel**	N/A
Date	10/05/22	**Personnel**	[redacted]
Weather	Sunny		
Wind Speed	N/A	**Sea state**	N/A

Contact names redacted

LOCAL TIME	OPERATIONS SUMMARY
09:00	Partrac staff head for Site 18, via the shop for supplies
09:55	Collected sediment at Site 18
10:25	Collected sediment at Site 17
10:45	Head to shops to buy required items for CSM processing
11:50	Collected sediment at Site 16
12:30	Could not collect sediment sample at Site 15, the material was not consolidated enough. There were 10+ attempts at multiple nearby locations
13:10	Collected sediment at Site 14 and headed for Site 1 to meet [redacted]
14:00	Meet [redacted] at Site 1 and have lunch
14:30	Started CSM processing of the first 7 samples
17:30	Collected sediment at Site 1
18:00	Finished processing the first 7 samples plus Site 1
18:10	[redacted] depart for site 2, [redacted] heads home
18:40	Collected sediment at Site 2
19:00	Collected sediment at Site 3
19:30	Could not collect sediment sample at Site 4, the material was not consolidated enough. There were 10+ attempts at multiple nearby locations
19:45	Collected sediment at Site 5
20:05	Collected sediment at Site 6
20:25	Collected sediment at Site 7
20:45	Collected sediment at Site 8
21:00	Collected sediment at Site 9
21:30	[redacted] arrive back at accommodation

WORK COMPLETED/COMMENTS/PROBLEMS ENCOUNTERED

Finished collecting first batch of 7 sediment samples (18,17,16, 14 – could not collect 15).
Met [redacted] for processing the first batch of 7, plus Site 1.
Collected second batch of 7 (2,3,5,6,7,8,9 – could not collect Site 4).

WORK PLANNED FOR THE NEXT 24 HRS

Process the second batch of 7 samples
Collect another batch of 7 sediment samples
Collect a water sample

HSE

None

	Name	Signature
PARTRAC	[redacted]	
Client	[redacted] (Mott MacDonald)	11.05.2022

Contact names redacted

D.8 M5040.05.01.D02.s03 - DPR GUC Sampling 11-05-2022

Project	Grand Union Canal	**Project/Contract No.**	M5040
Document No	M5040.05.01.D02	**Revision/Series**	S3
Document Title	**DAILY PROGRESS REPORT**		

Location	Grand Union Canal	**Vessel**	N/A
Date	11/05/22	**Personnel**	[redacted]
Weather	Heavy rain (morning) cloudy (afternoon)		
Wind Speed	N/A	**Sea state**	N/A

LOCAL TIME	OPERATIONS SUMMARY
08:30	Partrac staff head out to get tarp
08:45	Setting up for CSM processing
09:15	Started CSM processing of second batch of 7 sediment samples
12:30	Finished sampling, writing up notes and doing project admin
14:00	Stopped for lunch
14:30	Head to Site 10
15:40	Collected sediment at Site 10
16:05	Collected sediment at Site 11
16:30	Collected sediment at Site 12
17:00	Have trouble accessing Site C1, negotiate alternative access with land owner
17:40	Collected sediment at Site C1
18:05	Collect sediment at Site 13 and wait for canal boat to do water sampling
18:45	No canal boat came, so heading to Site C2
19:05	Arrive at Site C2 but no sample could be taken after 10+ attempts at multiple nearby locations. The area was too stoney.
19:30	Depart site and head back to the accommodation.

SERVICE VISIT DETAILS

Mooring No. & Instrument	Serial	Deployment/Recovery Time & Location
N/A	N/A	N/A

WORK COMPLETED/COMMENTS/PROBLEMS ENCOUNTERED

Finished collecting sediment for the main canal sites (10,11,12,13).

Started collecting samples at the 6 connected waterbody sites – collected sediment at C1, could not obtain from site C2

WORK PLANNED FOR THE NEXT 24 HRS

Process the remaining samples.
Collect sediment from the remaining connected waterbody s
Collect water samples

HSE

None

CLIENT ACTIONS REQUIRED

None

Contact names redacted

	Name	Signature
PARTRAC	[redacted]	
Client	[redacted](Mott MacDonald)	13.05.2022

Contact names redacted

D.9 M5040.05.01.D02.s04 - DPR GUC Sampling 12-05-2022

Project	Grand Union Canal	**Project/Contract No.**	M5040
Document No	M5040.05.01.D02	**Revision/Series**	S4
Document Title	**DAILY PROGRESS REPORT**		

Location	Grand Union Canal	**Vessel**	N/A
Date	12/05/22	**Personnel**	[redacted]
Weather	Sunny/cloudy		
Wind Speed	N/A	**Sea state**	N/A

LOCAL TIME	OPERATIONS SUMMARY
08:30	Setting up for CSM processing
09:00	Started CSM processing 6 sediment samples collected yesterday
11:45	Collect water sample set W1 from location close to Site 19
12:10	Head to Site C8
13:05	Arrive at Site C8 and look for access.
13:20	Collected sediment at Site C8 (from nearby bridge)
13:40	Collected sediment at Site C7
15:30	Collected sediment at Site C5
16:25	Arrive at near to Site C3
16:30	Collect water sample set W2 near to site C3
17:00	Collect sediment at Site C3
17:45	Arrive back at accommodation
18:00	Set up for CSM processing
18:30	Processed the remaining sediment samples
20:30	Finished processing the samples

SERVICE VISIT DETAILS		
Mooring No. & Instrument	**Serial**	**Deployment/Recovery Time & Location**
N/A	N/A	N/A

WORK COMPLETED/COMMENTS/PROBLEMS ENCOUNTERED

Finished collecting sediment samples from the connected waterbody s sites (C3,C5,C7,C8).
Processed all remaining samples

WORK PLANNED FOR THE NEXT 24 HRS

Tidy up the paperwork ready for the delivery of the samples
Box up the samples and drop them off at the collection point
Head back to Devon

HSE

None

CLIENT ACTIONS REQUIRED

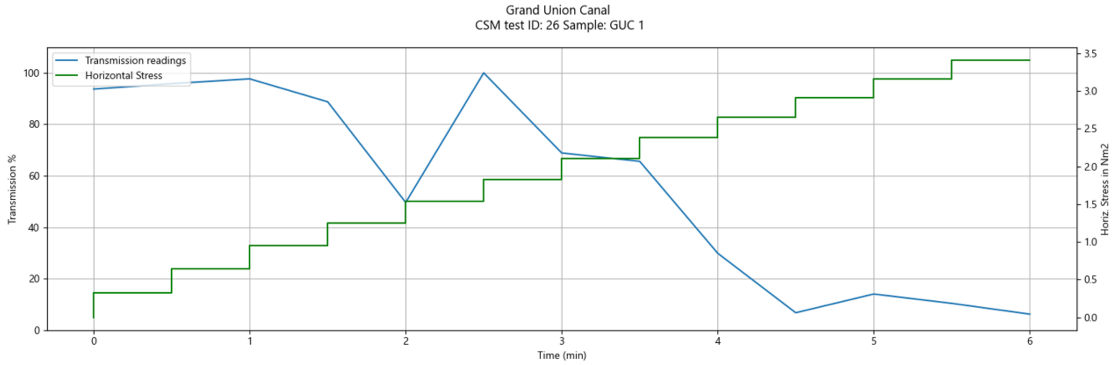
None

Contact names redacted

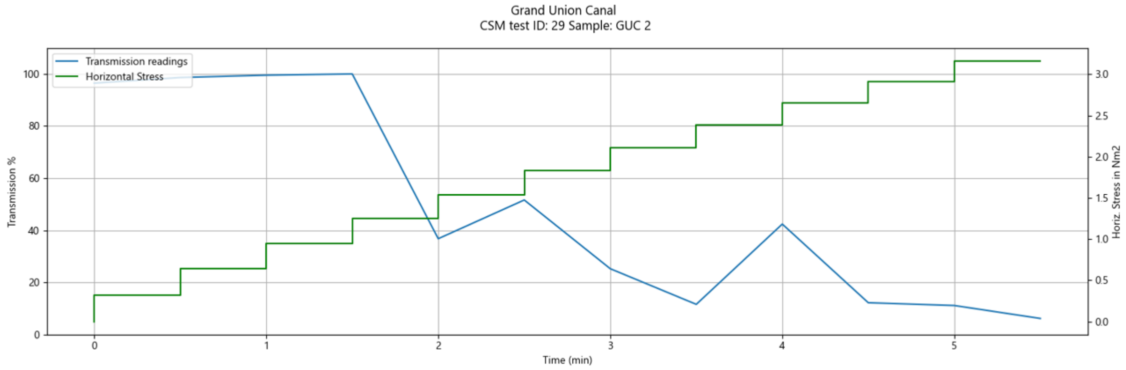
	Name	**Signature**
PARTRAC	[redacted]	
Client	[redacted] (Mott MacDonald)	13.05.2022

E. CSM results

E.1 CSM results for GUC 1



E.2 CSM results for GUC 2

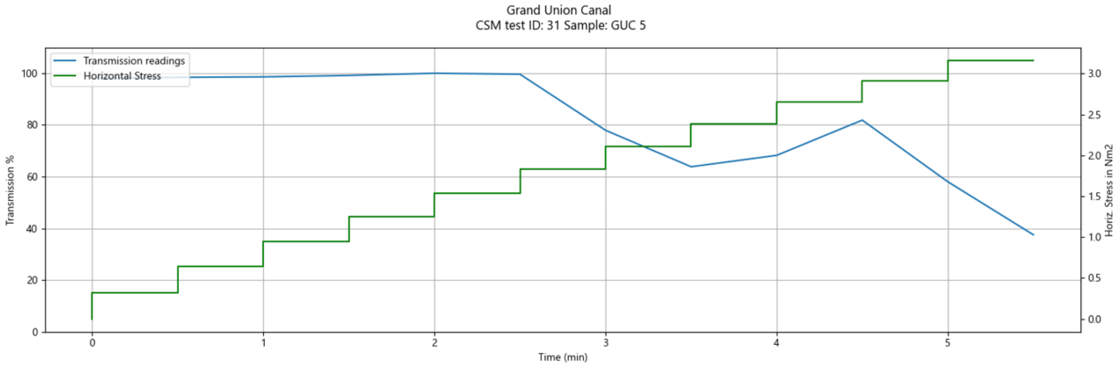


E.3 CSM results for GUC 3

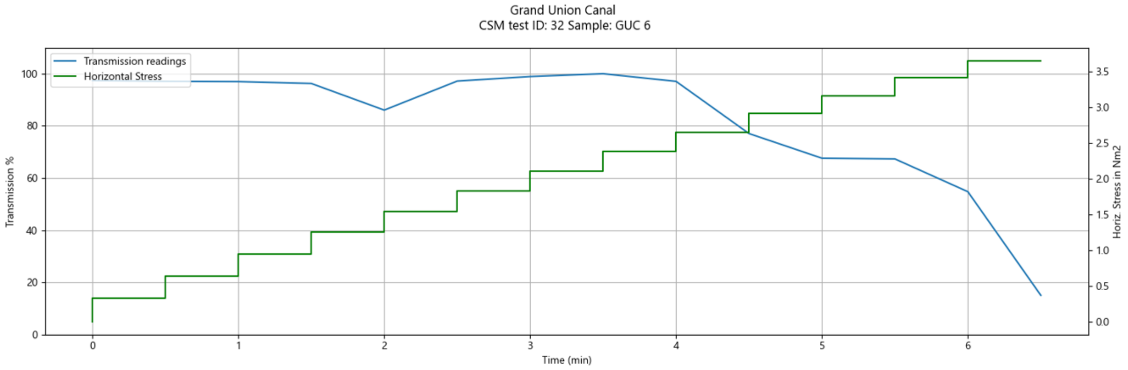
E.4 CSM results for GUC 4

Sample unsuitable for testing

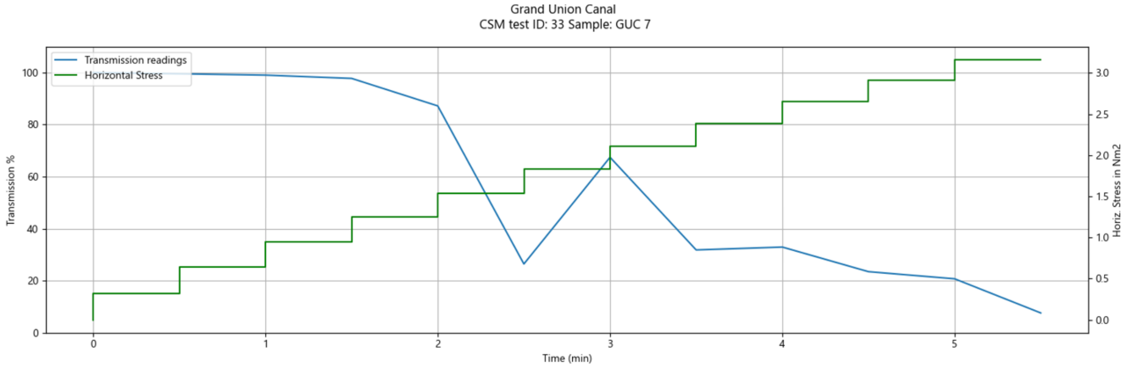
E.5 CSM results for GUC 5



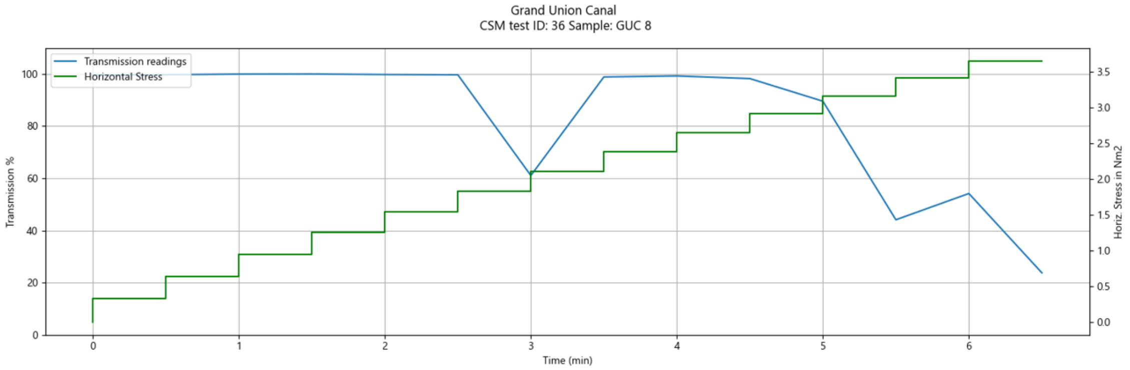
E.6 CSM results for GUC 6



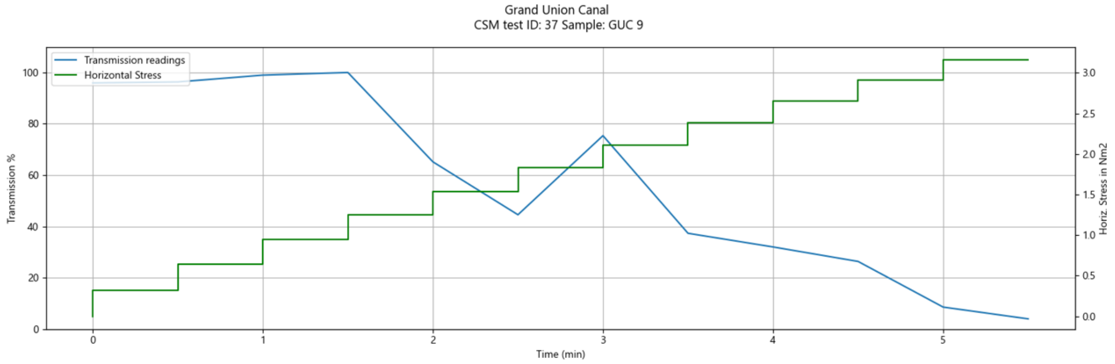
E.7 CSM results for GUC 7



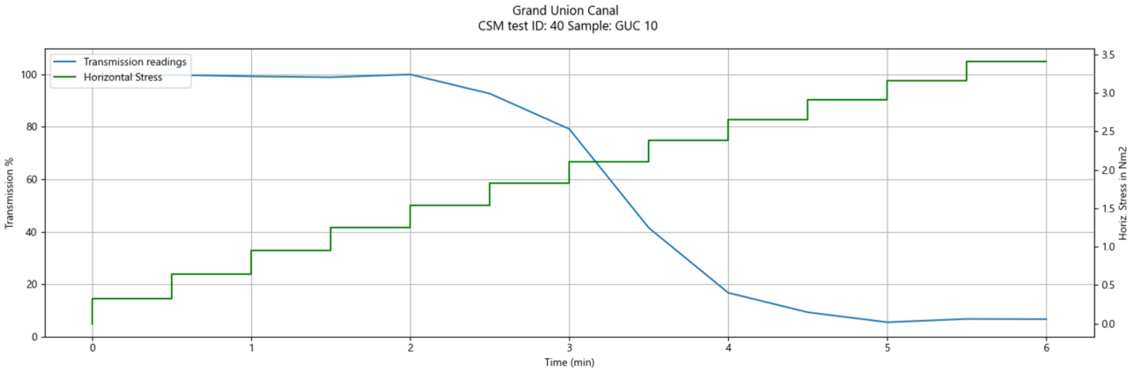
E.8 CSM results for GUC 8



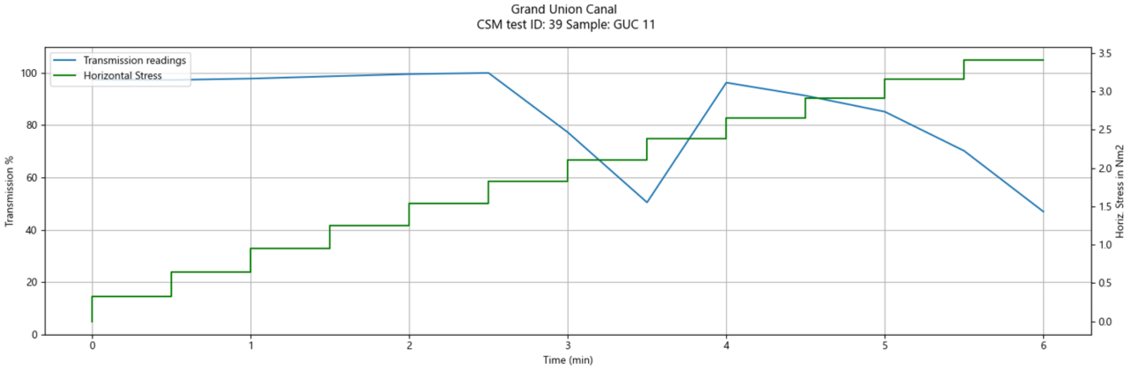
E.9 CSM results for GUC 9



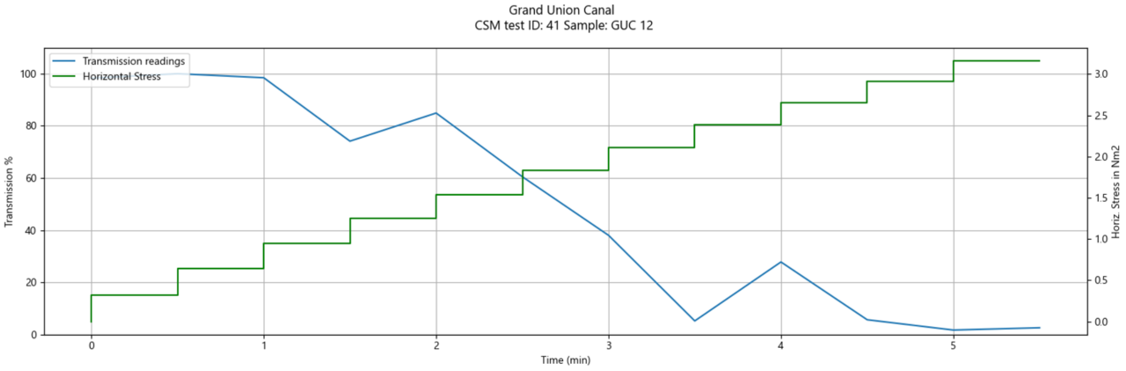
E.10 CSM results for GUC 10



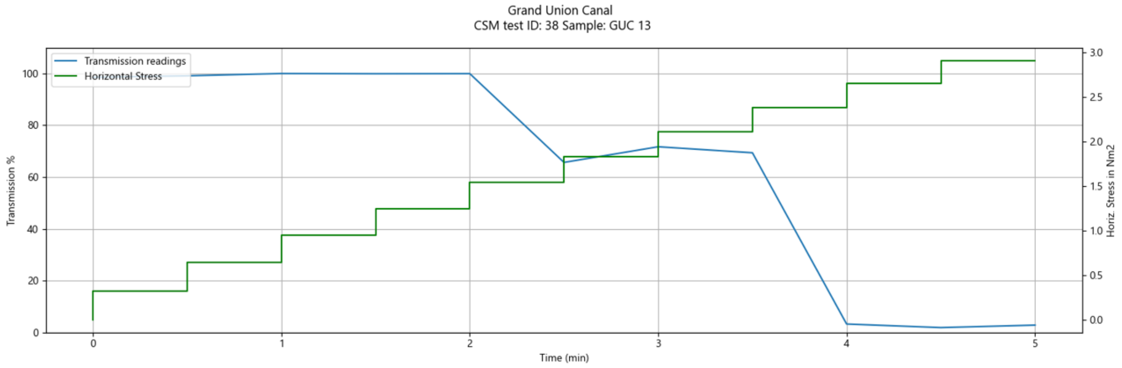
E.11 CSM results for GUC 11



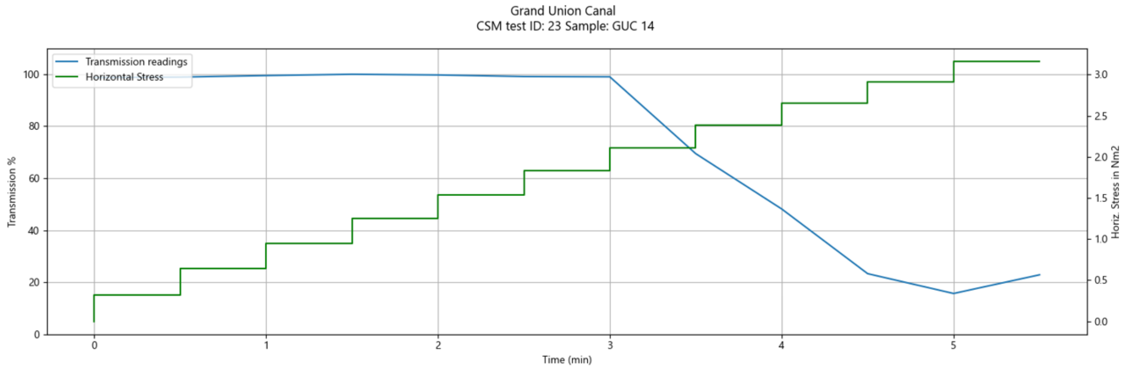
E.12 CSM results for GUC 12



E.13 CSM results for GUC 13



E.14 CSM results for GUC 14



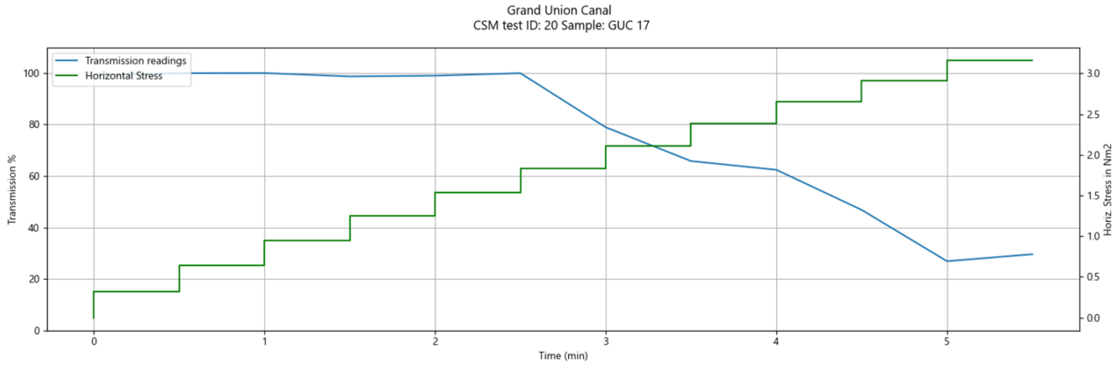
E.15 CSM results for GUC 15

Sample unsuitable for testing

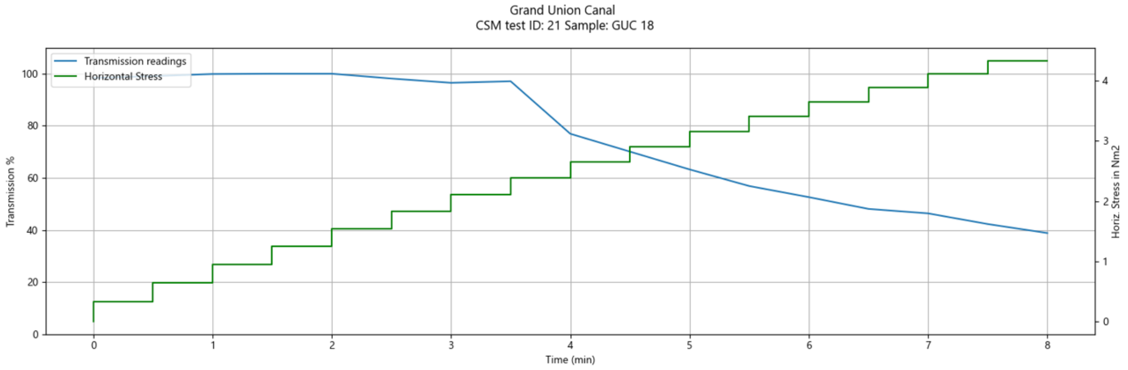
E.16 CSM results for GUC 16

Sample unsuitable for testing

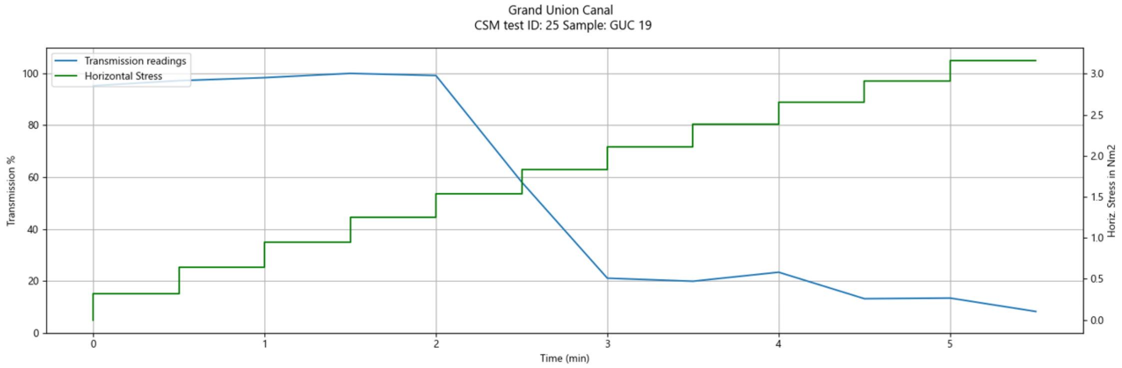
E.17 CSM results for GUC 17



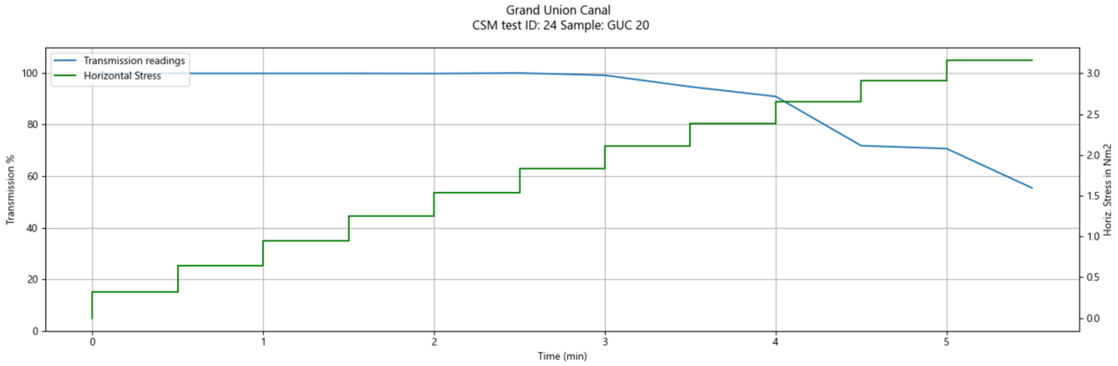
E.18 CSM results for GUC 18



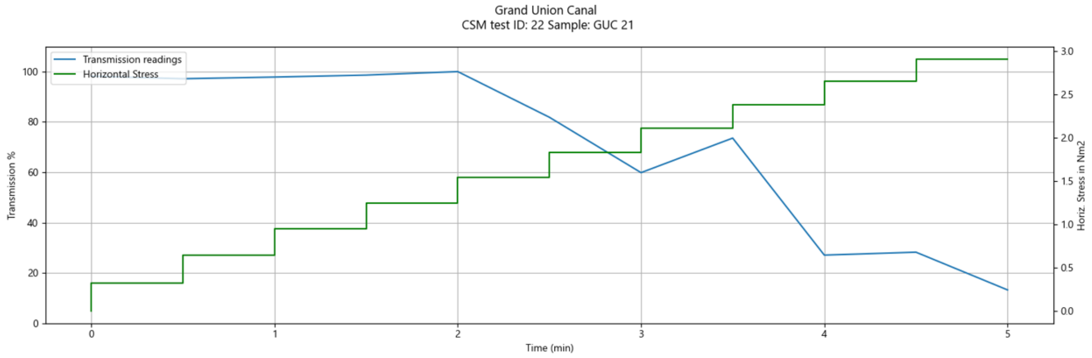
E.19 CSM results for GUC 19



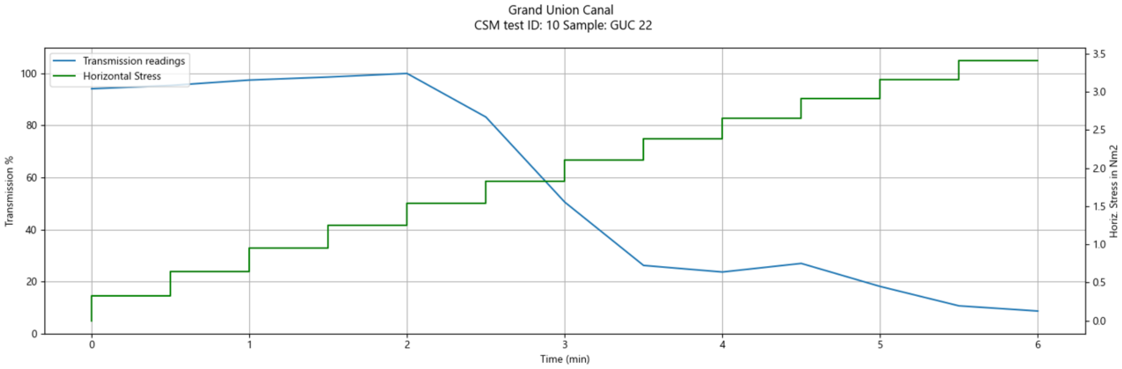
E.20 CSM results for GUC 20



E.21 CSM results for GUC 21



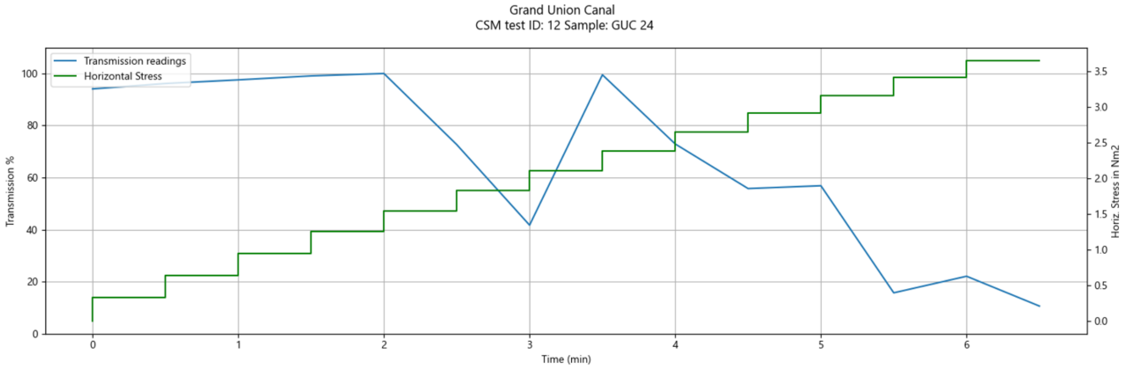
E.22 CSM results for GUC 22



E.23 CSM results for GUC 23

Sample unsuitable for testing

E.24 CSM results for GUC 24



E.25 CSM results for GUC 25

Sample unsuitable for testing

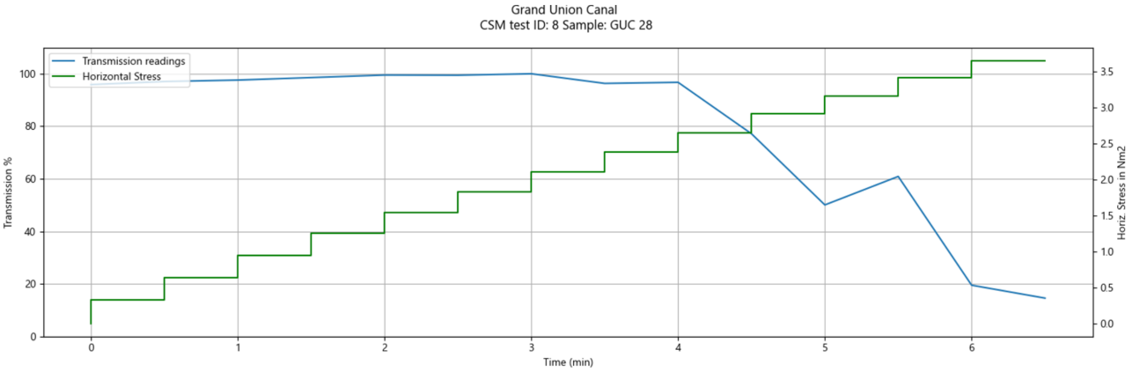
E.26 CSM results for GUC 26

Sample unsuitable for testing

E.27 CSM results for GUC 27

Sample unsuitable for testing

E.28 CSM results for GUC 28



E.29 CSM results for GUC 29

Sample unsuitable for testing

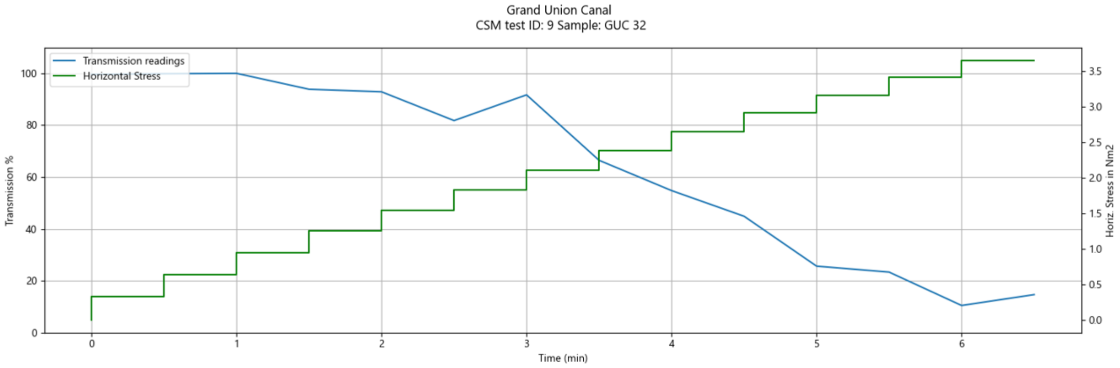
E.30 CSM results for GUC 30

Sample unsuitable for testing

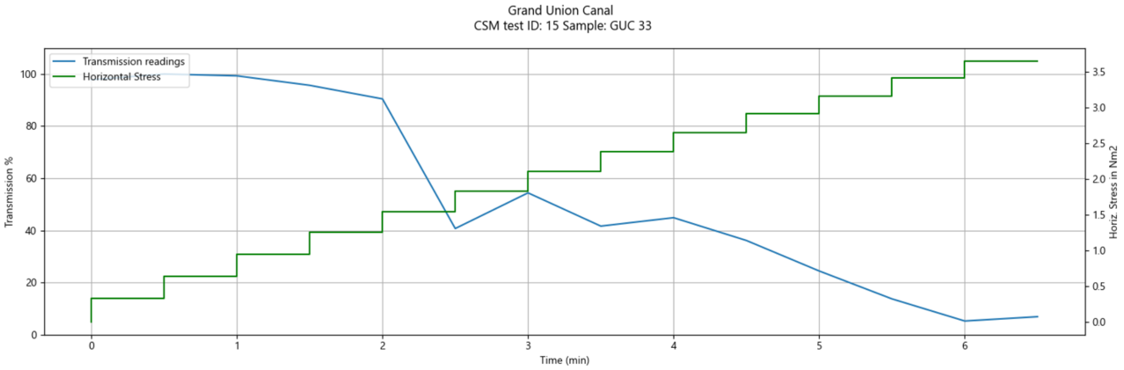
E.31 CSM results for GUC 31

Sample unsuitable for testing

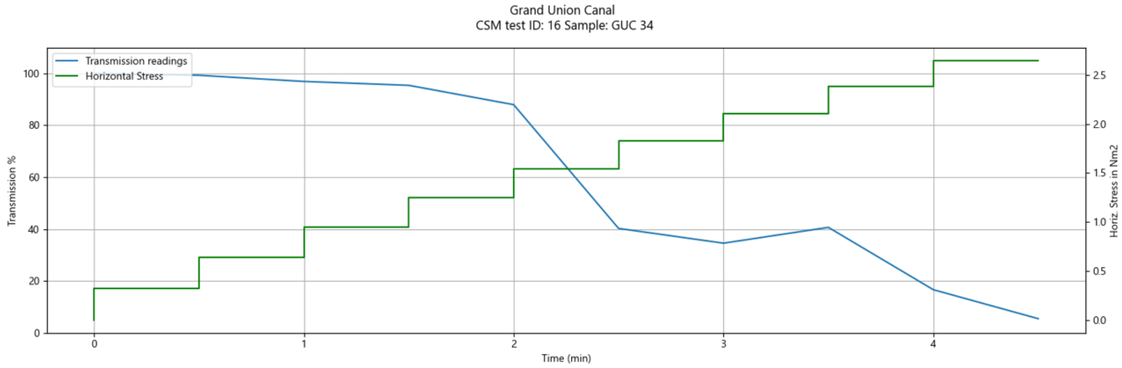
E.32 CSM results for GUC 32



E.33 CSM results for GUC 33



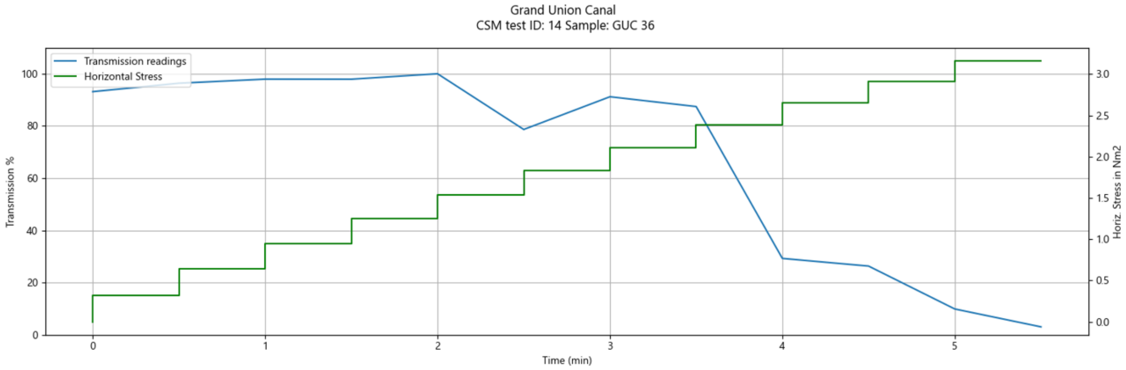
E.34 CSM results for GUC 34



E.35 CSM results for GUC 35

Sample unsuitable for testing

E.36 CSM results for GUC 36



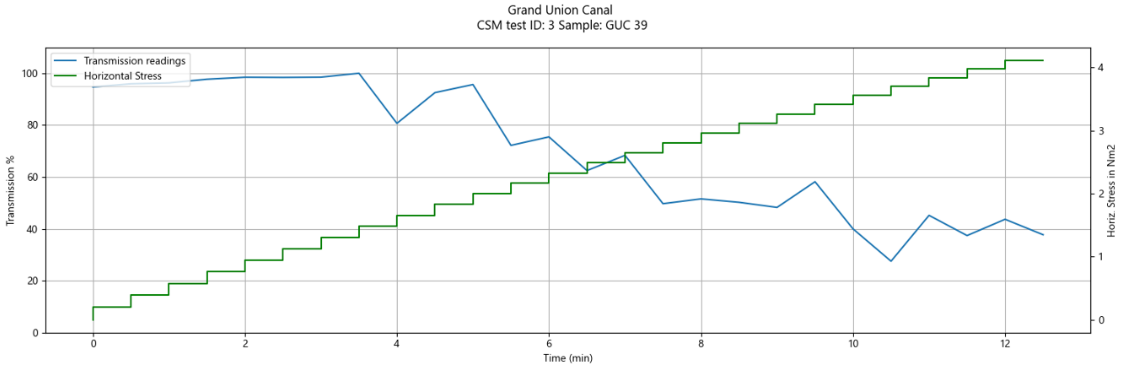
E.37 CSM results for GUC 37

Sample unsuitable for testing

E.38 CSM results for GUC 38

Sample unsuitable for testing

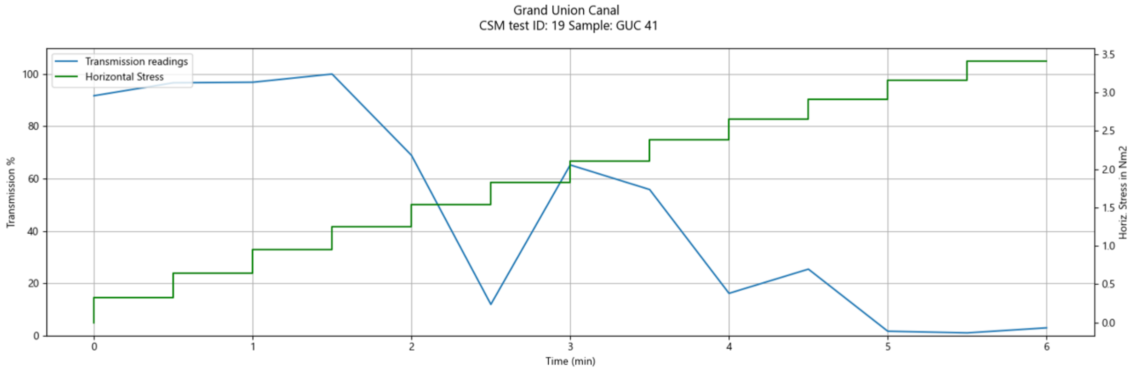
E.39 CSM results for GUC 39



E.40 CSM results for GUC 40

Sample unsuitable for testing

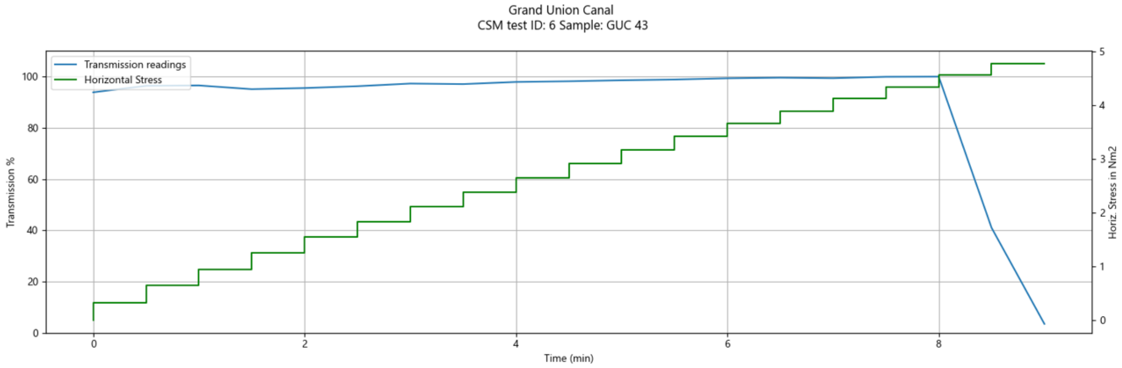
E.41 CSM results for GUC 41



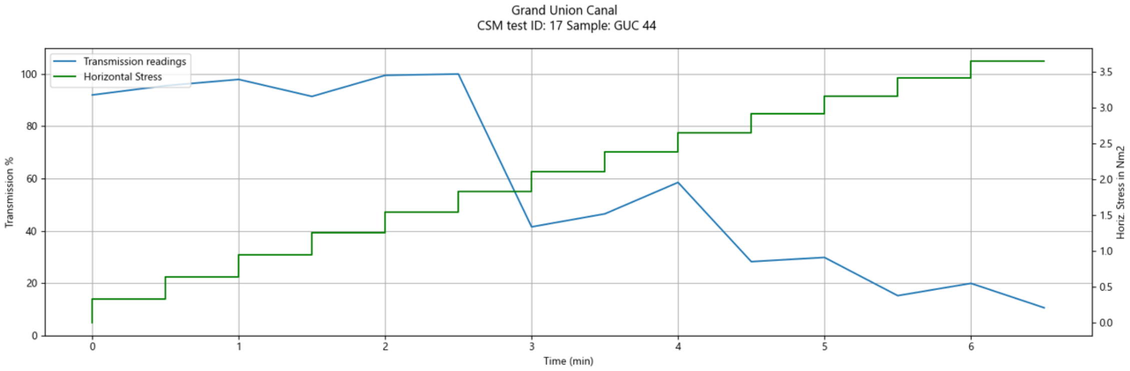
E.42 CSM results for GUC 42

Sample unsuitable for testing

E.43 CSM results for GUC 43



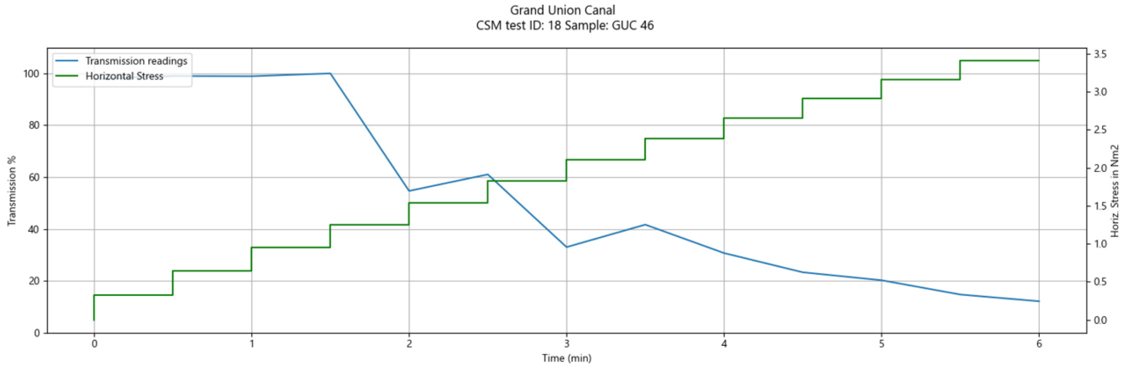
E.44 CSM results for GUC 44



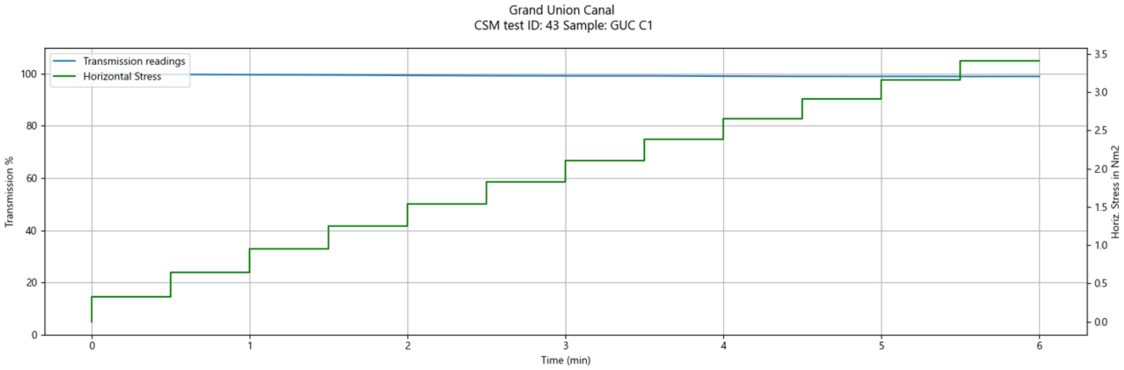
E.45 CSM results for GUC 45

Sample unsuitable for testing

E.46 CSM results for GUC 46



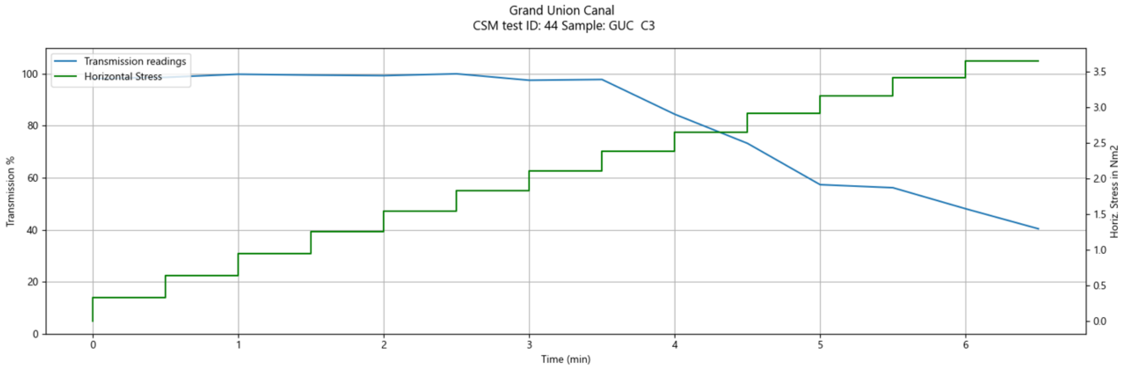
E.47 CSM results for GUC C1



E.48 CSM results for GUC C2

No sample obtained

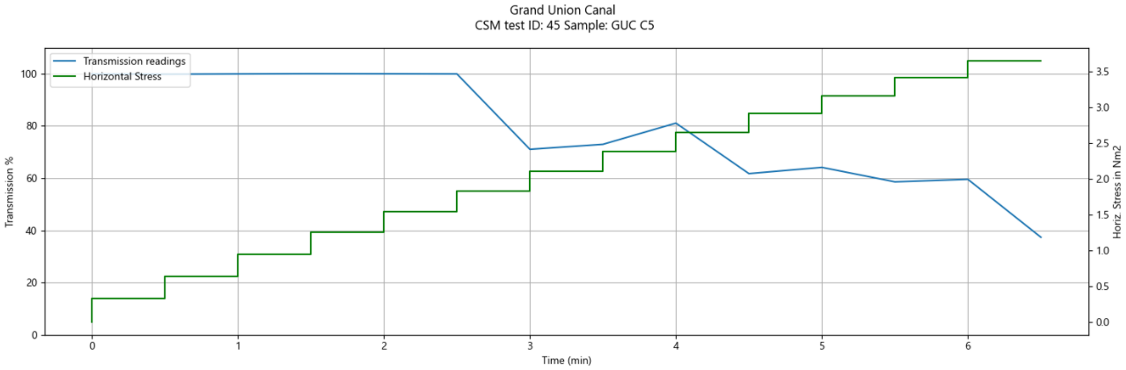
E.49 CSM results for GUC C3



E.50 CSM results for GUC C4

Sample unsuitable for testing

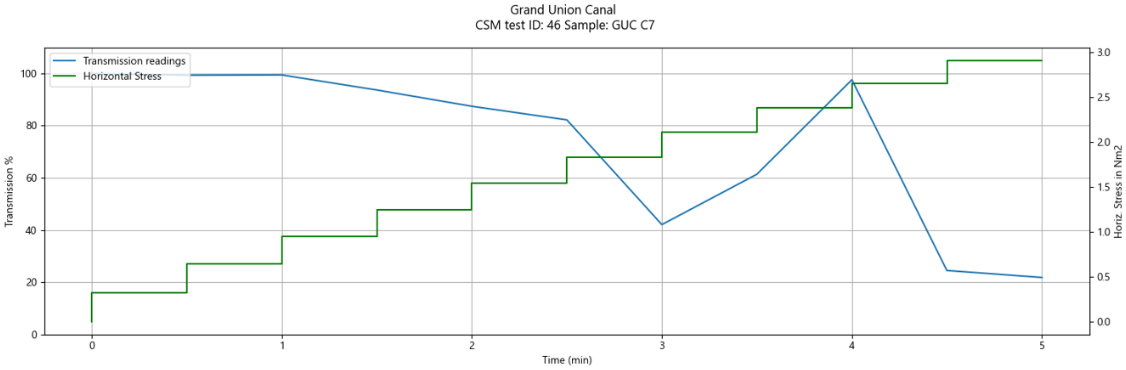
E.51 CSM results for GUC C5



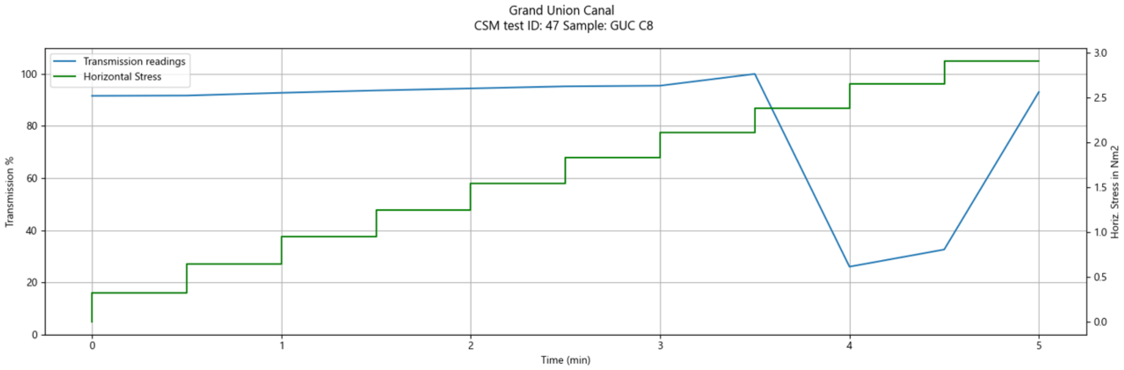
E.52 CSM results for GUC C6

Sample unsuitable for testing

E.53 CSM results for GUC C7

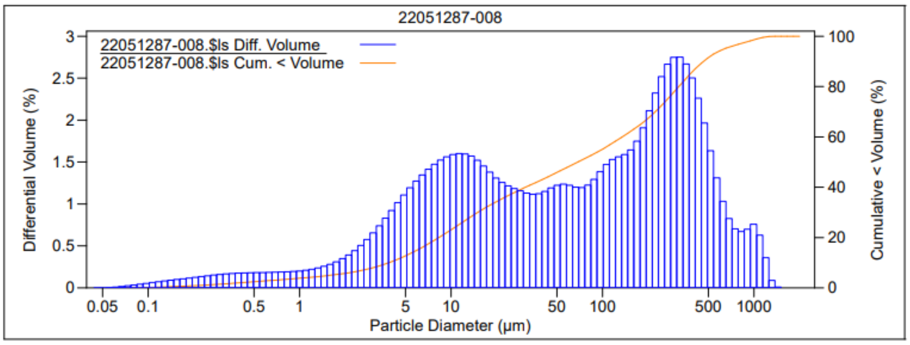


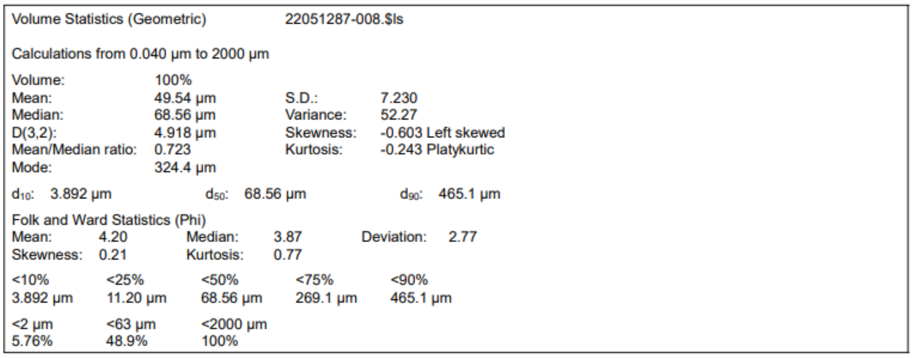
E.54 CSM results for GUC C8



F. PSA for sediments

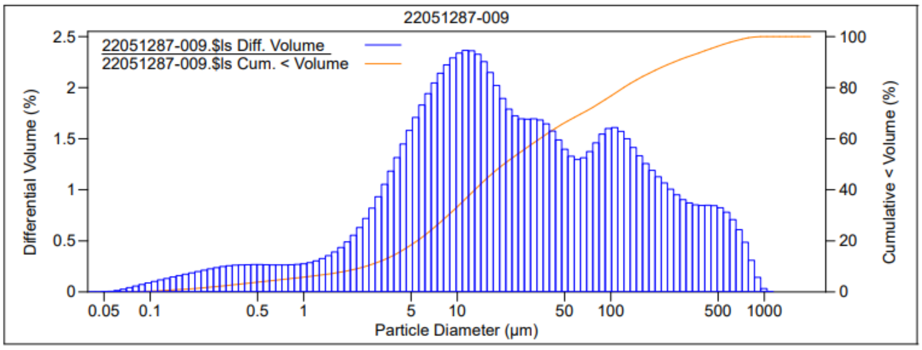
F.1 PSA results for GUC 1

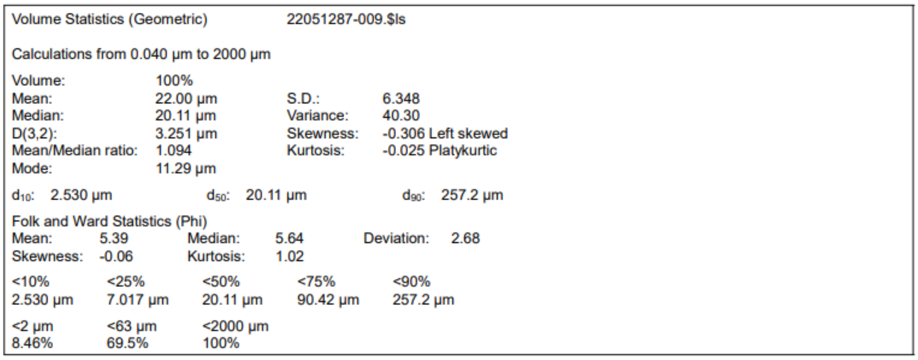




```
Volume Statistics (Geometric)            22051287-008.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                49.54 µm          S.D.:         7.230
Median:              68.56 µm          Variance:     52.27
D(3,2):              4.918 µm          Skewness:     -0.603 Left skewed
Mean/Median ratio:   0.723             Kurtosis:     -0.243 Platykurtic
Mode:                324.4 µm

d10:  3.892 µm         d50:  68.56 µm            d90:  465.1 µm

Folk and Ward Statistics (Phi)
Mean:        4.20        Median:     3.87        Deviation:    2.77
Skewness:    0.21        Kurtosis:   0.77

<10%          <25%          <50%          <75%          <90%
3.892 µm      11.20 µm      68.56 µm      269.1 µm      465.1 µm

<2 µm         <63 µm        <2000 µm
5.76%         48.9%         100%
```

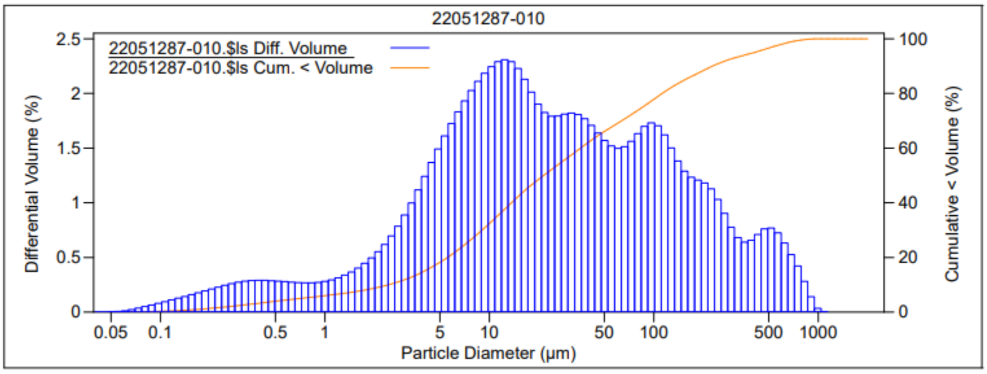
F.2 PSA results for GUC 2





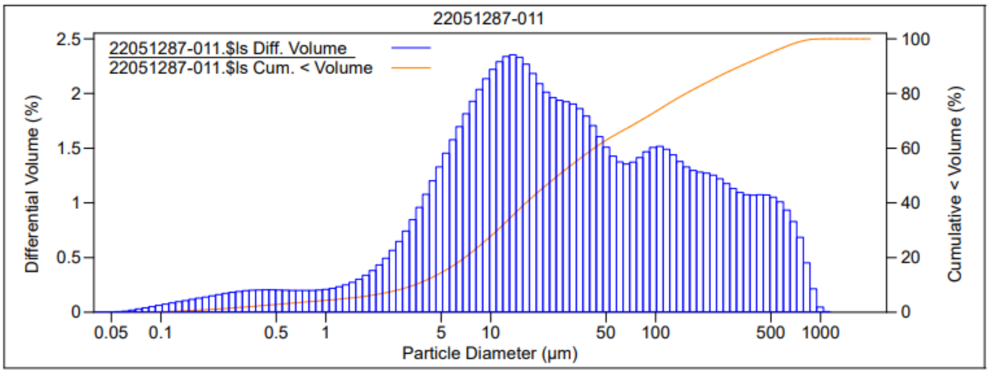
```
Volume Statistics (Geometric)            22051287-009.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                22.00 µm          S.D.:         6.348
Median:              20.11 µm          Variance:     40.30
D(3,2):              3.251 µm          Skewness:     -0.306 Left skewed
Mean/Median ratio:   1.094             Kurtosis:     -0.025 Platykurtic
Mode:                11.29 µm

d10:  2.530 µm         d50:  20.11 µm            d90:  257.2 µm

Folk and Ward Statistics (Phi)
Mean:        5.39        Median:     5.64        Deviation:    2.68
Skewness:    -0.06       Kurtosis:   1.02

<10%          <25%          <50%          <75%          <90%
2.530 µm      7.017 µm      20.11 µm      90.42 µm      257.2 µm

<2 µm         <63 µm        <2000 µm
8.46%         69.5%         100%
```

F.3 PSA results for GUC 3



```
Volume Statistics (Geometric)          22051287-010.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                21.83 µm       S.D.:         6.212
Median:              21.40 µm       Variance:     38.58
D(3,2):              3.246 µm       Skewness:     -0.371 Left skewed
Mean/Median ratio:   1.020          Kurtosis:     0.048 Leptokurtic
Mode:                12.40 µm

d10:   2.438 µm             d50:   21.40 µm             d90:   228.3 µm

Folk and Ward Statistics (Phi)
Mean:        5.40        Median:      5.55         Deviation:     2.65
Skewness:    -0.01       Kurtosis:    1.05

<10%          <25%          <50%          <75%          <90%
2.438 µm      7.200 µm      21.40 µm      85.66 µm      228.3 µm

<2 µm         <63 µm        <2000 µm
8.75%         69.8%         100%
```

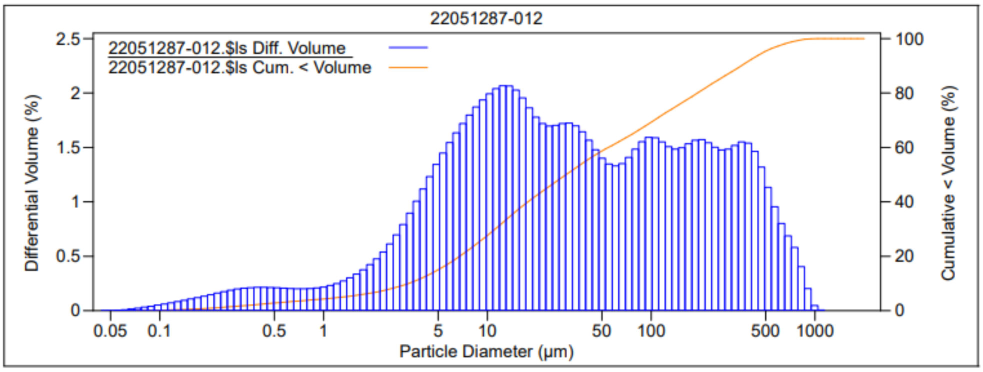
F.4 PSA results for GUC 4



```
Volume Statistics (Geometric)          22051287-011.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                27.86 µm       S.D.:         6.104
Median:              25.66 µm       Variance:     37.25
D(3,2):              4.164 µm       Skewness:     -0.321 Left skewed
Mean/Median ratio:   1.086          Kurtosis:     0.035 Leptokurtic
Mode:                13.61 µm

d10:   3.455 µm             d50:   25.66 µm             d90:   326.7 µm

Folk and Ward Statistics (Phi)
Mean:        5.02        Median:      5.28         Deviation:     2.60
Skewness:    -0.08       Kurtosis:    0.97

<10%          <25%          <50%          <75%          <90%
3.455 µm      8.846 µm      25.66 µm      110.3 µm      326.7 µm

<2 µm         <63 µm        <2000 µm
6.42%         66.4%         100%
```

F.5 PSA results for GUC 5 No Data

F.6 PSA results for GUC 6



Volume Statistics (Geometric) 22051287-012.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	30.83 µm	S.D.:	6.416
Median:	30.22 µm	Variance:	41.16
D(3,2):	4.336 µm	Skewness:	-0.381 Left skewed
Mean/Median ratio:	1.020	Kurtosis:	-0.187 Platykurtic
Mode:	12.40 µm		

d_{10}: 3.298 µm d_{50}: 30.22 µm d_{90}: 354.7 µm

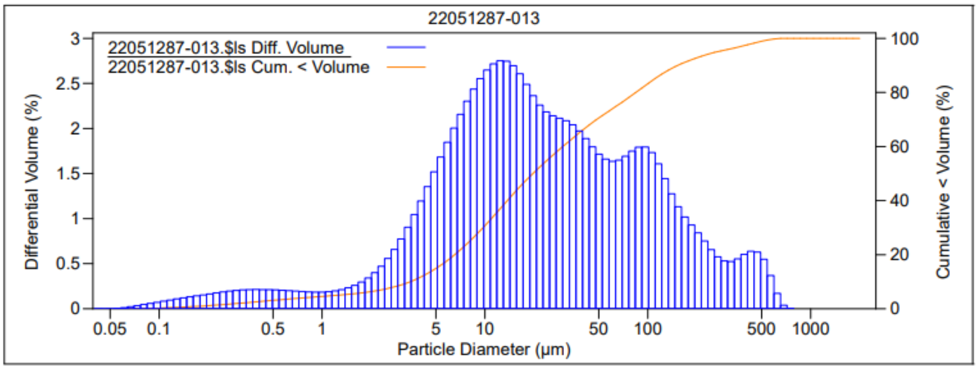
Folk and Ward Statistics (Phi)

Mean:	4.88	Median:	5.05	Deviation:	2.67
Skewness:	-0.02	Kurtosis:	0.87		

<10%	<25%	<50%	<75%	<90%
3.298 µm	8.796 µm	30.22 µm	141.4 µm	354.7 µm

<2 µm	<63 µm	<2000 µm
6.59%	62.0%	100%

F.7 PSA results for GUC 7



Volume Statistics (Geometric) 22051287-013.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	20.49 µm	S.D.:	4.971
Median:	19.73 µm	Variance:	24.71
D(3,2):	3.847 µm	Skewness:	-0.463 Left skewed
Mean/Median ratio:	1.038	Kurtosis:	0.638 Leptokurtic
Mode:	12.40 µm		

d_{10}: 3.476 µm d_{50}: 19.73 µm d_{90}: 153.3 µm

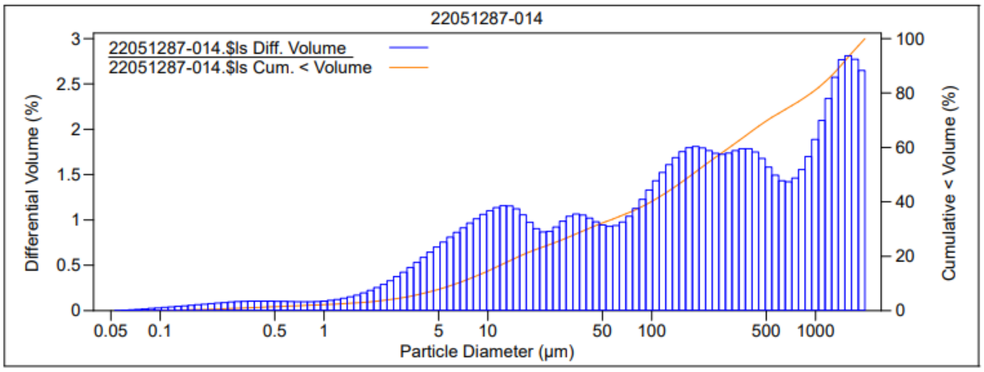
Folk and Ward Statistics (Phi)

Mean:	5.49	Median:	5.66	Deviation:	2.24
Skewness:	-0.05	Kurtosis:	1.06		

<10%	<25%	<50%	<75%	<90%
3.476 µm	8.072 µm	19.73 µm	64.36 µm	153.3 µm

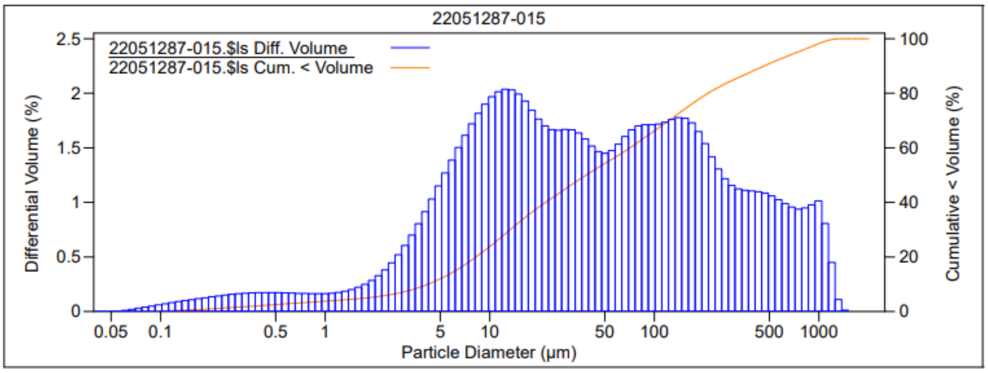
<2 µm	<63 µm	<2000 µm
6.34%	74.6%	100%

F.8 PSA results for GUC 8



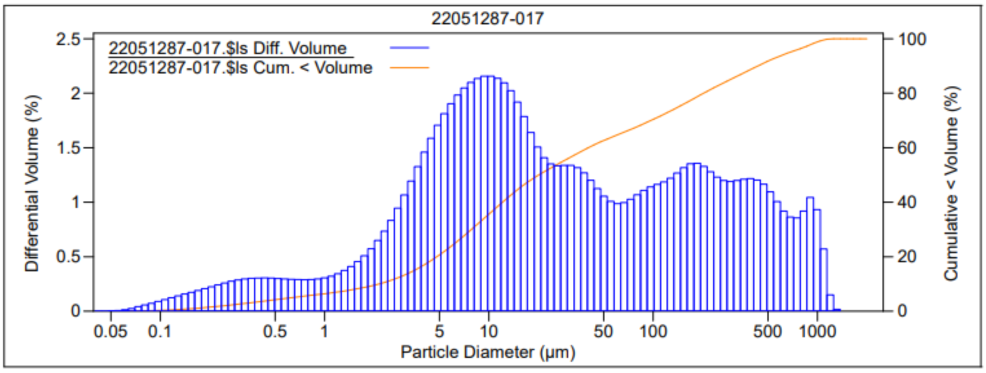
```
Volume Statistics (Geometric)          22051287-014.$ls

Calculations from 0.040 µm to 2000 µm

Volume:             100%
Mean:               119.2 µm          S.D.:          8.121
Median:             175.9 µm          Variance:      65.96
D(3,2):             8.046 µm          Skewness:      -0.688 Left skewed
Mean/Median ratio:  0.678             Kurtosis:      -0.141 Platykurtic
Mode:               1584 µm

d10:  6.466 µm              d50:  175.9 µm              d90:  1426 µm

Folk and Ward Statistics (Phi)
Mean:        2.93          Median:     2.51          Deviation:   3.04
Skewness:    0.24          Kurtosis:   0.78

<10%         <25%          <50%          <75%          <90%
6.466 µm     25.67 µm      175.9 µm      699.6 µm      1426 µm

<2 µm        <63 µm        <2000 µm
3.36%        34.5%         100%
```

F.9 PSA results for GUC 9



```
Volume Statistics (Geometric)          22051287-015.$ls

Calculations from 0.040 µm to 2000 µm

Volume:             100%
Mean:               38.27 µm          S.D.:          6.573
Median:             38.47 µm          Variance:      43.20
D(3,2):             4.714 µm          Skewness:      -0.378 Left skewed
Mean/Median ratio:  0.995             Kurtosis:      -0.0018 Platykurtic
Mode:               12.40 µm

d10:  4.227 µm              d50:  38.47 µm              d90:  464.9 µm

Folk and Ward Statistics (Phi)
Mean:        4.59          Median:     4.70          Deviation:   2.67
Skewness:    -0.02         Kurtosis:   0.91

<10%         <25%          <50%          <75%          <90%
4.227 µm     10.58 µm      38.47 µm      159.7 µm      464.9 µm

<2 µm        <63 µm        <2000 µm
5.31%        57.9%         100%
```

F.10 PSA results for GUC 10



Volume Statistics (Geometric) 22051287-017.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	24.98 µm	S.D.:	7.997
Median:	20.14 µm	Variance:	63.96
D(3,2):	3.021 µm	Skewness:	-0.169 Left skewed
Mean/Median ratio:	1.240	Kurtosis:	-0.482 Platykurtic
Mode:	10.29 µm		

d_{10}: 2.146 µm d_{50}: 20.14 µm d_{90}: 434.4 µm

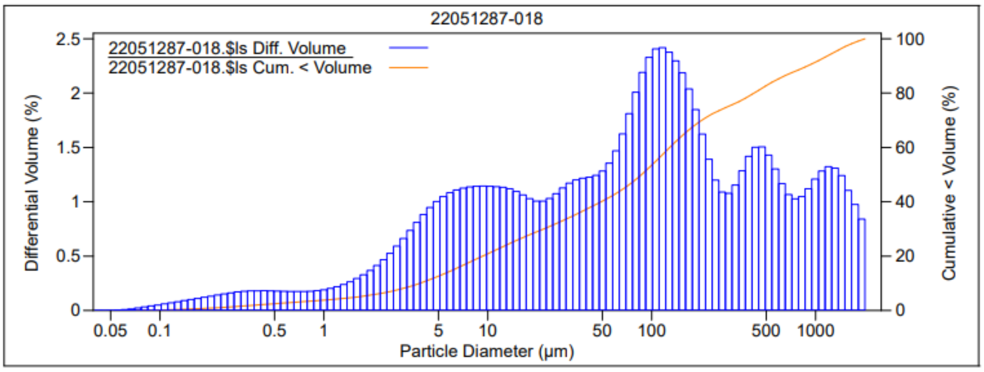
Folk and Ward Statistics (Phi)

Mean:	5.18	Median:	5.63	Deviation:	3.07
Skewness:	-0.11	Kurtosis:	0.91		

<10%	<25%	<50%	<75%	<90%
2.146 µm	6.228 µm	20.14 µm	143.0 µm	434.4 µm

<2 µm	<63 µm	<2000 µm
9.52%	65.1%	100%

F.11 PSA results for GUC 11



Volume Statistics (Geometric) 22051287-018.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	61.99 µm	S.D.:	8.037
Median:	86.82 µm	Variance:	64.59
D(3,2):	5.051 µm	Skewness:	-0.545 Left skewed
Mean/Median ratio:	0.714	Kurtosis:	-0.132 Platykurtic
Mode:	116.3 µm		

d_{10}: 3.854 µm d_{50}: 86.82 µm d_{90}: 894.6 µm

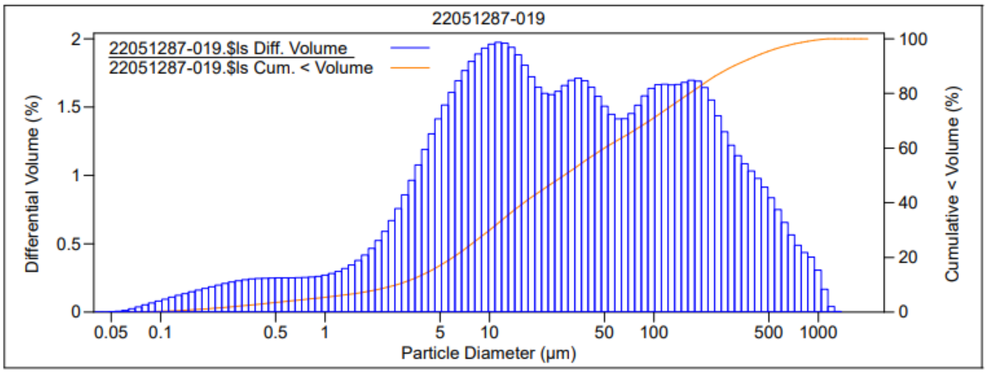
Folk and Ward Statistics (Phi)

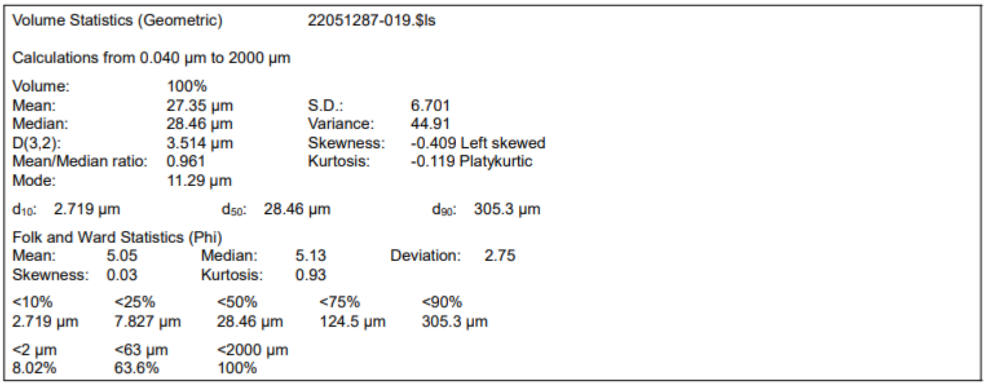
Mean:	3.88	Median:	3.53	Deviation:	3.05
Skewness:	0.18	Kurtosis:	0.90		

<10%	<25%	<50%	<75%	<90%
3.854 µm	14.06 µm	86.82 µm	292.0 µm	894.6 µm

<2 µm	<63 µm	<2000 µm
5.79%	43.7%	100%

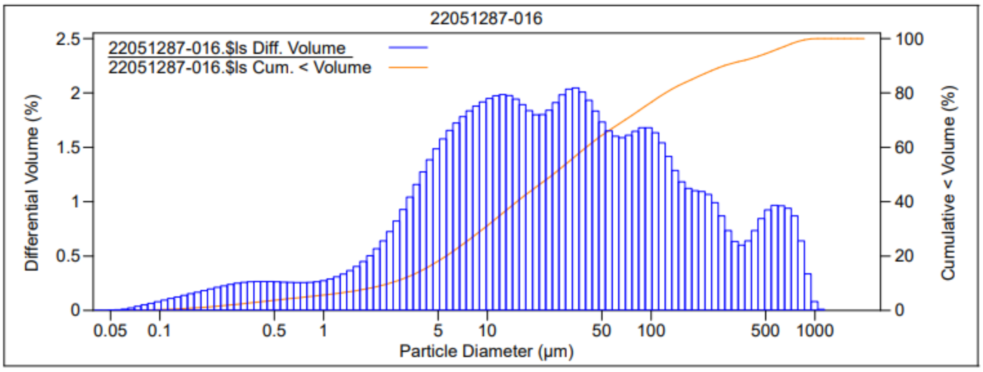
F.12 PSA results for GUC 12

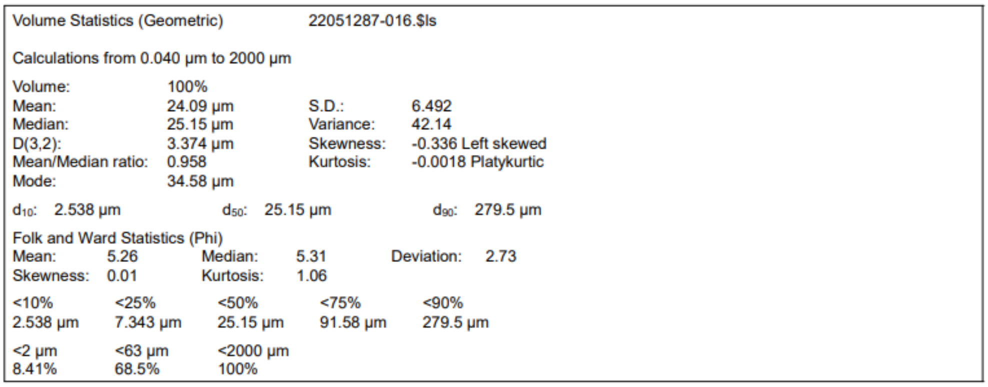




```
Volume Statistics (Geometric)          22051287-019.$ls

Calculations from 0.040 µm to 2000 µm

Volume:            100%
Mean:              27.35 µm        S.D.:        6.701
Median:            28.46 µm        Variance:    44.91
D(3,2):            3.514 µm        Skewness:    -0.409 Left skewed
Mean/Median ratio: 0.961           Kurtosis:    -0.119 Platykurtic
Mode:              11.29 µm

d10:   2.719 µm         d50:   28.46 µm         d90:   305.3 µm

Folk and Ward Statistics (Phi)
Mean:       5.05       Median:     5.13         Deviation:    2.75
Skewness:   0.03       Kurtosis:   0.93

<10%        <25%        <50%        <75%        <90%
2.719 µm    7.827 µm    28.46 µm    124.5 µm    305.3 µm

<2 µm       <63 µm      <2000 µm
8.02%       63.6%       100%
```

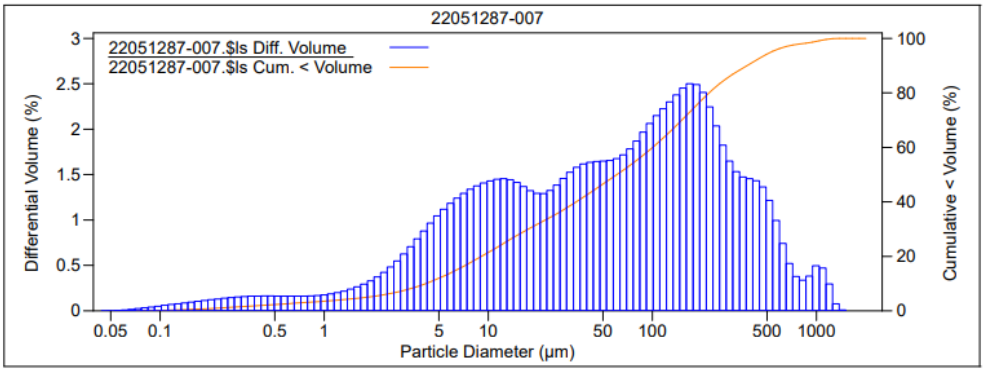
F.13 PSA results for GUC 13





```
Volume Statistics (Geometric)          22051287-016.$ls

Calculations from 0.040 µm to 2000 µm

Volume:            100%
Mean:              24.09 µm        S.D.:        6.492
Median:            25.15 µm        Variance:    42.14
D(3,2):            3.374 µm        Skewness:    -0.336 Left skewed
Mean/Median ratio: 0.958           Kurtosis:    -0.0018 Platykurtic
Mode:              34.58 µm

d10:   2.538 µm         d50:   25.15 µm         d90:   279.5 µm

Folk and Ward Statistics (Phi)
Mean:       5.26       Median:     5.31         Deviation:    2.73
Skewness:   0.01       Kurtosis:   1.06

<10%        <25%        <50%        <75%        <90%
2.538 µm    7.343 µm    25.15 µm    91.58 µm    279.5 µm

<2 µm       <63 µm      <2000 µm
8.41%       68.5%       100%
```

F.14 PSA results for GUC 14



Volume Statistics (Geometric) 22051287-007.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	44.85 µm	S.D.:	6.224
Median:	60.83 µm	Variance:	38.73
D(3,2):	5.168 µm	Skewness:	-0.684 Left skewed
Mean/Median ratio:	0.737	Kurtosis:	0.200 Leptokurtic
Mode:	168.9 µm		

d_{10}: 4.165 µm d_{50}: 60.83 µm d_{90}: 377.4 µm

Folk and Ward Statistics (Phi)

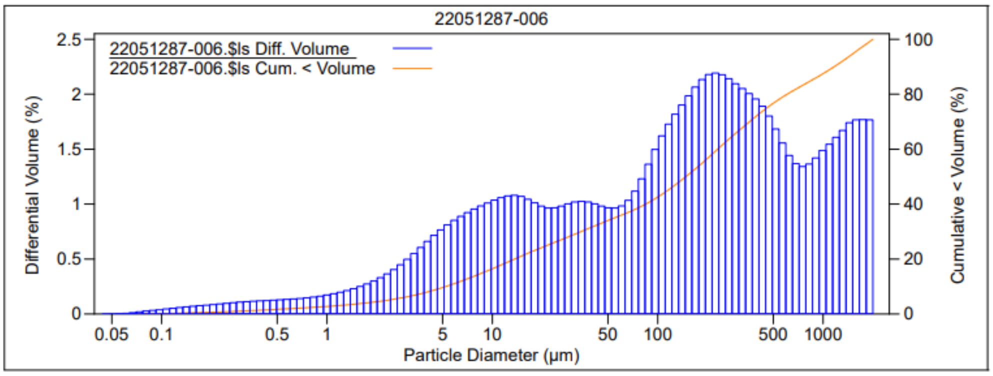
Mean:	4.38	Median:	4.04	Deviation:	2.56
Skewness:	0.21	Kurtosis:	0.87		

<10%	<25%	<50%	<75%	<90%
4.165 µm	12.61 µm	60.83 µm	182.7 µm	377.4 µm

<2 µm	<63 µm	<2000 µm
5.32%	50.6%	100%

F.15 PSA results for GUC 15 No data

F.16 PSA results for GUC 16



Volume Statistics (Geometric) 22051287-006.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	94.94 µm	S.D.:	7.967
Median:	148.3 µm	Variance:	63.48
D(3,2):	6.746 µm	Skewness:	-0.702 Left skewed
Mean/Median ratio:	0.640	Kurtosis:	-0.049 Platykurtic
Mode:	223.4 µm		

d_{10}: 5.216 µm d_{50}: 148.3 µm d_{90}: 1165 µm

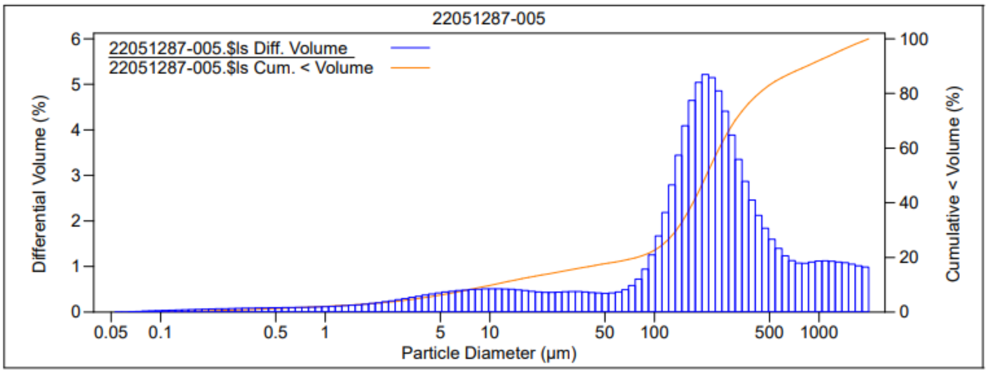
Folk and Ward Statistics (Phi)

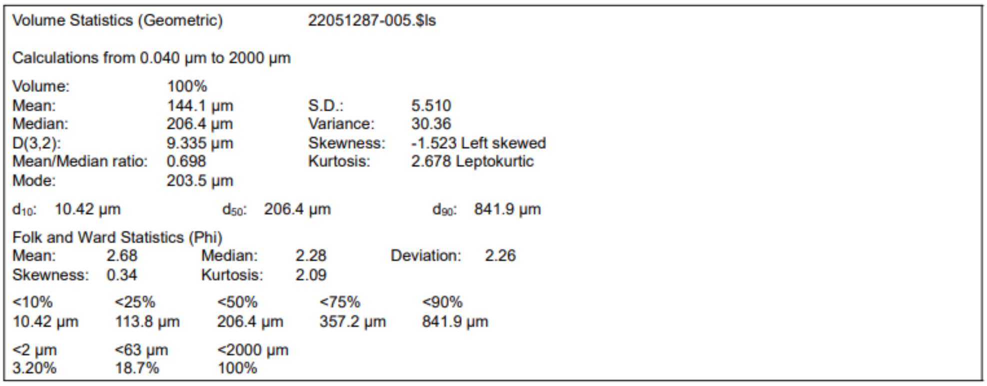
Mean:	3.26	Median:	2.75	Deviation:	3.01
Skewness:	0.26	Kurtosis:	0.87		

<10%	<25%	<50%	<75%	<90%
5.216 µm	21.53 µm	148.3 µm	457.7 µm	1165 µm

<2 µm	<63 µm	<2000 µm
4.47%	36.4%	100%

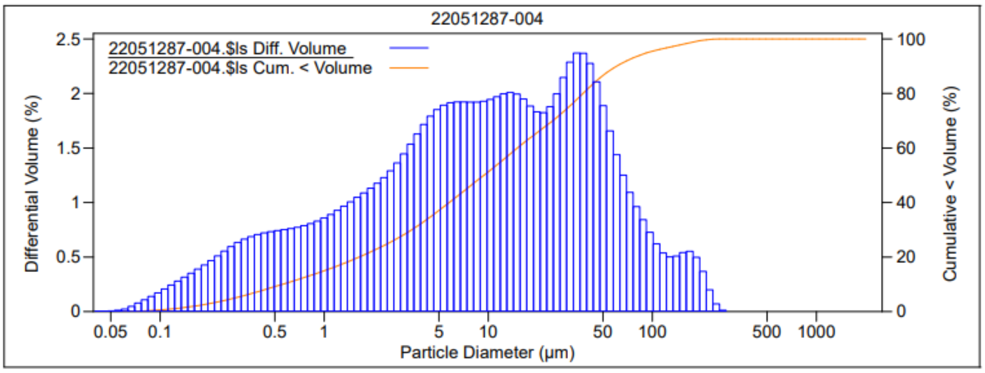
F.17 PSA results for GUC 17

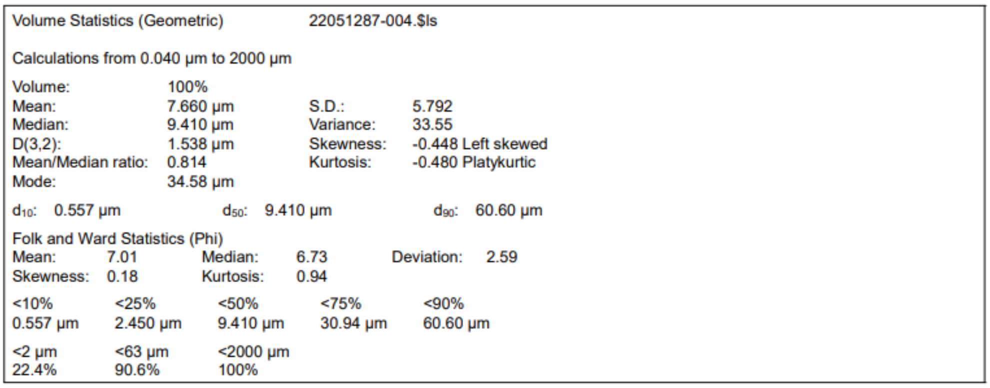




```
Volume Statistics (Geometric)          22051287-005.$ls

Calculations from 0.040 µm to 2000 µm

Volume:             100%
Mean:               144.1 µm        S.D.:          5.510
Median:             206.4 µm        Variance:      30.36
D(3,2):             9.335 µm        Skewness:      -1.523 Left skewed
Mean/Median ratio:  0.698           Kurtosis:      2.678 Leptokurtic
Mode:               203.5 µm

d10:   10.42 µm              d50:   206.4 µm              d90:   841.9 µm

Folk and Ward Statistics (Phi)
Mean:        2.68        Median:      2.28        Deviation:     2.26
Skewness:    0.34        Kurtosis:    2.09

<10%         <25%         <50%         <75%         <90%
10.42 µm     113.8 µm     206.4 µm     357.2 µm     841.9 µm

<2 µm        <63 µm       <2000 µm
3.20%        18.7%        100%
```

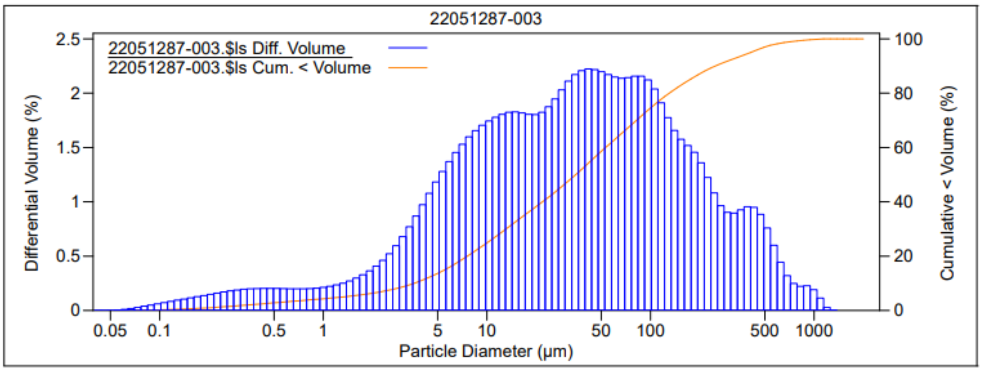
F.18 PSA results for GUC 18





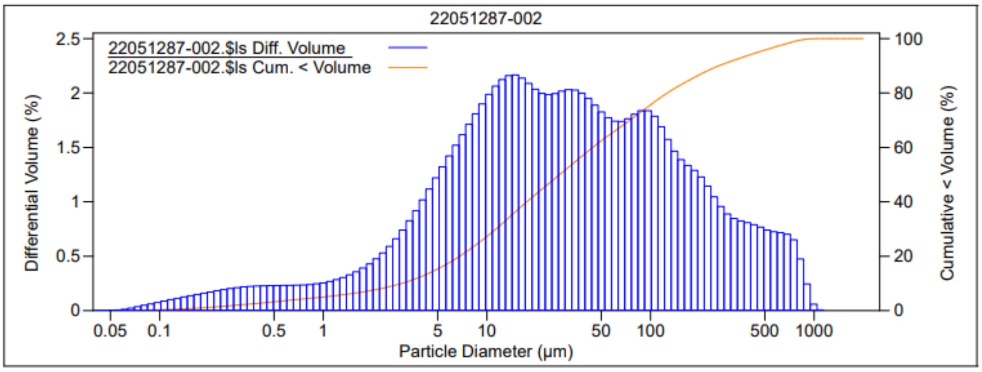
```
Volume Statistics (Geometric)          22051287-004.$ls

Calculations from 0.040 µm to 2000 µm

Volume:             100%
Mean:               7.660 µm        S.D.:          5.792
Median:             9.410 µm        Variance:      33.55
D(3,2):             1.538 µm        Skewness:      -0.448 Left skewed
Mean/Median ratio:  0.814           Kurtosis:      -0.480 Platykurtic
Mode:               34.58 µm

d10:   0.557 µm              d50:   9.410 µm              d90:   60.60 µm

Folk and Ward Statistics (Phi)
Mean:        7.01        Median:      6.73        Deviation:     2.59
Skewness:    0.18        Kurtosis:    0.94

<10%         <25%         <50%         <75%         <90%
0.557 µm     2.450 µm     9.410 µm     30.94 µm     60.60 µm

<2 µm        <63 µm       <2000 µm
22.4%        90.6%        100%
```

F.19 PSA results for GUC 19



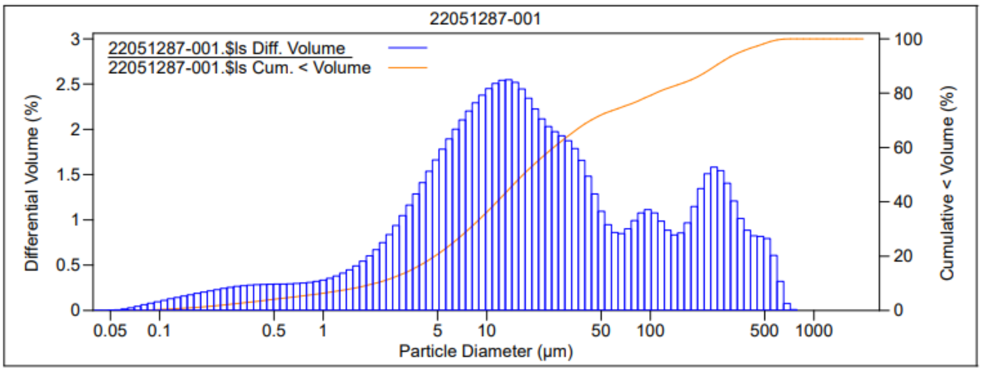
```
Volume Statistics (Geometric)            22051287-003.$ls

Calculations from 0.040 µm to 2000 µm

Volume:             100%
Mean:               29.84 µm          S.D.:        5.647
Median:             34.92 µm          Variance:    31.89
D(3,2):             4.326 µm          Skewness:    -0.579 Left skewed
Mean/Median ratio:  0.855             Kurtosis:    0.400 Leptokurtic
Mode:               41.68 µm

d10:   3.589 µm            d50:   34.92 µm            d90:   249.3 µm

Folk and Ward Statistics (Phi)
Mean:       4.95       Median:     4.84        Deviation:    2.45
Skewness:   0.10       Kurtosis:   1.01

<10%         <25%        <50%        <75%        <90%
3.589 µm     10.08 µm    34.92 µm    102.2 µm    249.3 µm

<2 µm        <63 µm      <2000 µm
6.36%        63.9%       100%
```

F.20 PSA results for GUC 20



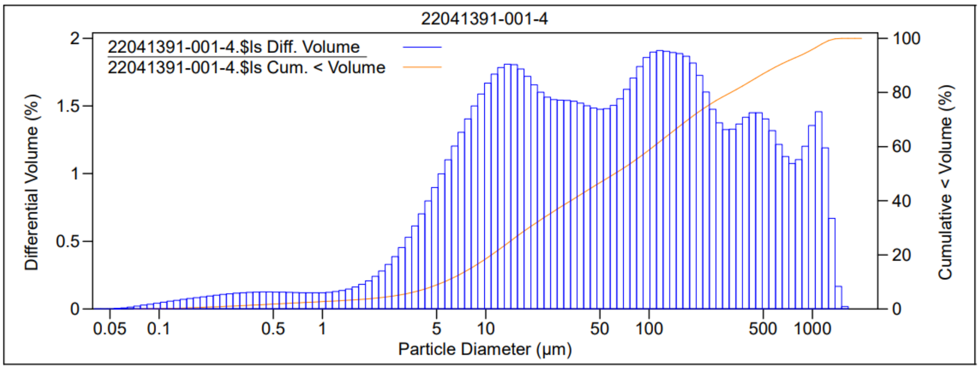
```
Volume Statistics (Geometric)            22051287-002.$ls

Calculations from 0.040 µm to 2000 µm

Volume:             100%
Mean:               26.54 µm          S.D.:        6.023
Median:             27.89 µm          Variance:    36.28
D(3,2):             3.761 µm          Skewness:    -0.454 Left skewed
Mean/Median ratio:  0.952             Kurtosis:    0.224 Leptokurtic
Mode:               14.94 µm

d10:   3.021 µm            d50:   27.89 µm            d90:   262.2 µm

Folk and Ward Statistics (Phi)
Mean:       5.11       Median:     5.16        Deviation:    2.58
Skewness:   0.03       Kurtosis:   1.05

<10%         <25%        <50%        <75%        <90%
3.021 µm     8.951 µm    27.89 µm    96.89 µm    262.2 µm

<2 µm        <63 µm      <2000 µm
7.46%        66.7%       100%
```

F.21 PSA results for GUC 21



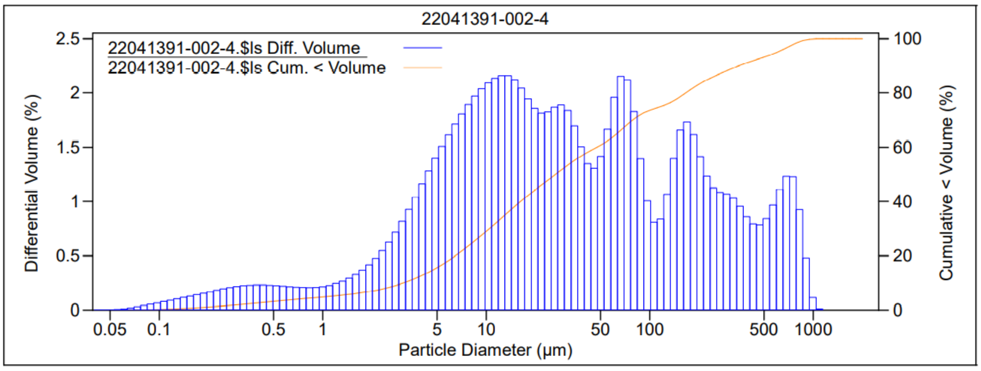
```
Volume Statistics (Geometric)            22051287-001.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                18.49 µm          S.D.:          6.249
Median:              16.72 µm          Variance:      39.06
D(3,2):              2.961 µm          Skewness:      -0.247 Left skewed
Mean/Median ratio:   1.106             Kurtosis:      -0.064 Platykurtic
Mode:                13.61 µm

d10:   2.082 µm               d50:   16.72 µm              d90:   249.9 µm

Folk and Ward Statistics (Phi)
Mean:        5.53          Median:      5.90          Deviation:     2.73
Skewness:    -0.09         Kurtosis:    1.07

<10%          <25%          <50%          <75%          <90%
2.082 µm      6.236 µm      16.72 µm      68.13 µm      249.9 µm

<2 µm         <63 µm        <2000 µm
9.72%         74.3%         100%
```

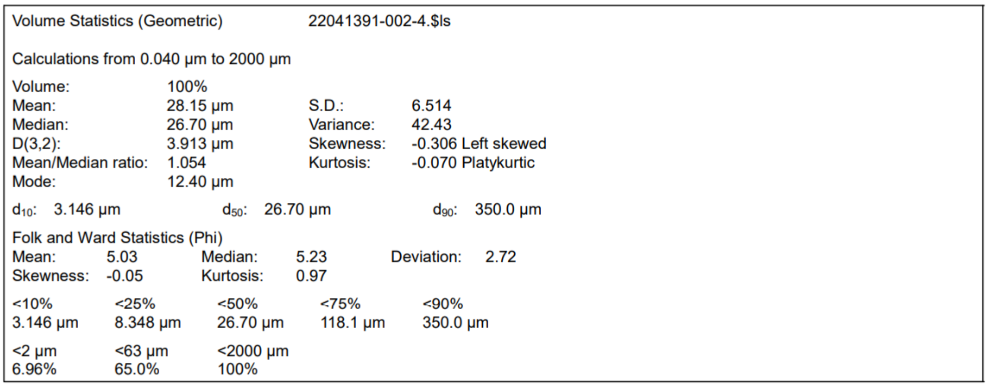
F.22 PSA results for GUC 22



```
Volume Statistics (Geometric)            22041391-001-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                54.46 µm          S.D.:          6.501
Median:              61.69 µm          Variance:      42.26
D(3,2):              6.312 µm          Skewness:      -0.445 Left skewed
Mean/Median ratio:   0.883             Kurtosis:      -0.0029 Platykurtic
Mode:                116.3 µm

d10:   5.561 µm               d50:   61.69 µm              d90:   622.8 µm

Folk and Ward Statistics (Phi)
Mean:        4.05          Median:      4.02          Deviation:     2.66
Skewness:    0.04          Kurtosis:    0.85

<10%          <25%          <50%          <75%          <90%
5.561 µm      14.12 µm      61.69 µm      227.5 µm      622.8 µm

<2 µm         <63 µm        <2000 µm
3.85%         50.3%         100%
```

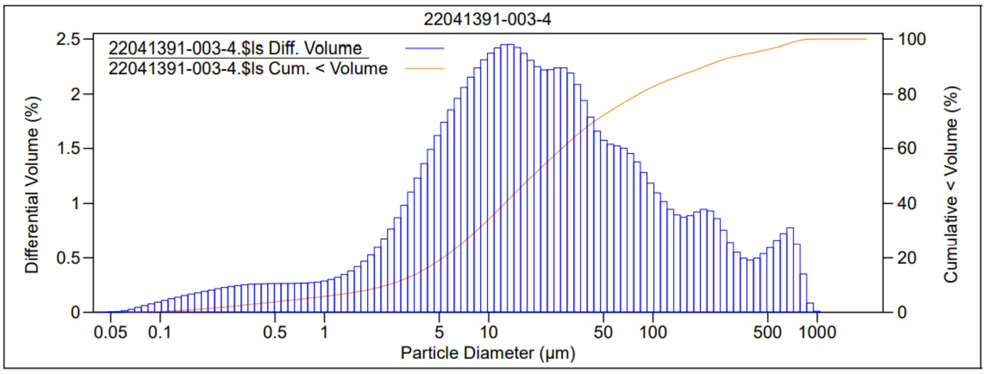
F.23 PSA results for GUC 23

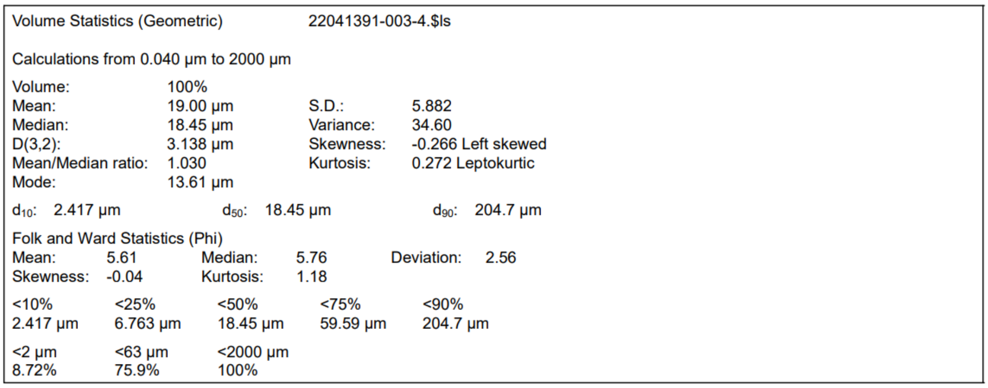




```
Volume Statistics (Geometric)            22041391-002-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                28.15 µm         S.D.:          6.514
Median:              26.70 µm         Variance:      42.43
D(3,2):              3.913 µm         Skewness:      -0.306 Left skewed
Mean/Median ratio:   1.054            Kurtosis:      -0.070 Platykurtic
Mode:                12.40 µm

d10:   3.146 µm            d50:   26.70 µm             d90:   350.0 µm

Folk and Ward Statistics (Phi)
Mean:        5.03         Median:      5.23         Deviation:    2.72
Skewness:    -0.05        Kurtosis:    0.97

<10%          <25%          <50%          <75%          <90%
3.146 µm      8.348 µm      26.70 µm      118.1 µm      350.0 µm

<2 µm         <63 µm        <2000 µm
6.96%         65.0%         100%
```

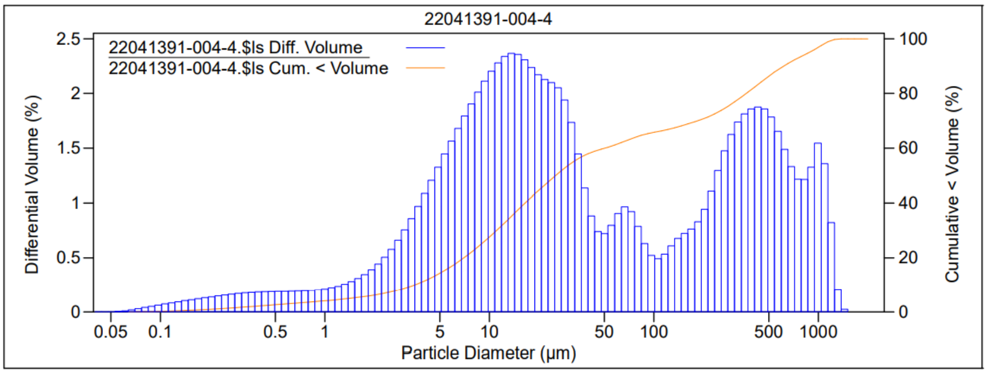
F.24 PSA results for GUC 24





```
Volume Statistics (Geometric)            22041391-003-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                19.00 µm         S.D.:          5.882
Median:              18.45 µm         Variance:      34.60
D(3,2):              3.138 µm         Skewness:      -0.266 Left skewed
Mean/Median ratio:   1.030            Kurtosis:      0.272 Leptokurtic
Mode:                13.61 µm

d10:   2.417 µm            d50:   18.45 µm             d90:   204.7 µm

Folk and Ward Statistics (Phi)
Mean:        5.61         Median:      5.76         Deviation:    2.56
Skewness:    -0.04        Kurtosis:    1.18

<10%          <25%          <50%          <75%          <90%
2.417 µm      6.763 µm      18.45 µm      59.59 µm      204.7 µm

<2 µm         <63 µm        <2000 µm
8.72%         75.9%         100%
```

F.25 PSA results for GUC 25



Volume Statistics (Geometric) 22041391-004-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	36.75 µm	S.D.:	7.946
Median:	25.38 µm	Variance:	63.14
D(3,2):	4.315 µm	Skewness:	-0.137 Left skewed
Mean/Median ratio:	1.448	Kurtosis:	-0.558 Platykurtic
Mode:	13.61 µm		

d_{10}: 3.499 µm d_{50}: 25.38 µm d_{90}: 615.4 µm

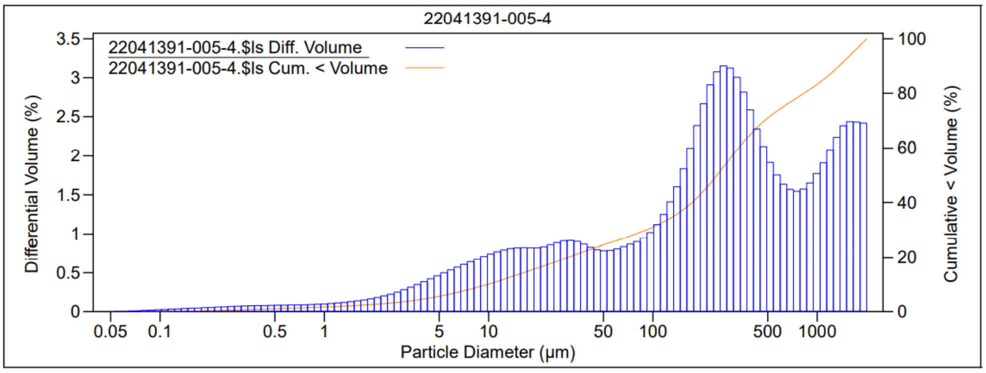
Folk and Ward Statistics (Phi)

Mean:	4.65	Median:	5.30	Deviation:	2.99
Skewness:	-0.21	Kurtosis:	0.77		

<10%	<25%	<50%	<75%	<90%
3.499 µm	8.929 µm	25.38 µm	277.5 µm	615.4 µm

<2 µm	<63 µm	<2000 µm
6.23%	61.9%	100%

F.26 PSA results for GUC 26



Volume Statistics (Geometric) 22041391-005-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	157.4 µm	S.D.:	6.626
Median:	245.6 µm	Variance:	43.90
D(3,2):	10.80 µm	Skewness:	-1.009 Left skewed
Mean/Median ratio:	0.641	Kurtosis:	0.759 Leptokurtic
Mode:	269.2 µm		

d_{10}: 9.845 µm d_{50}: 245.6 µm d_{90}: 1359 µm

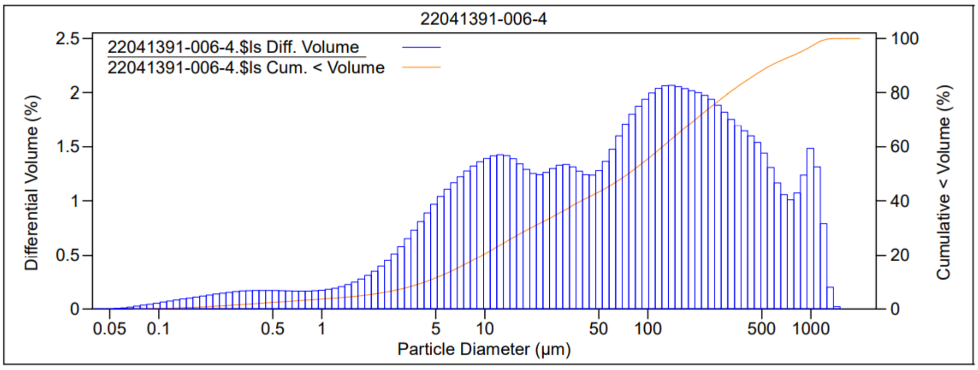
Folk and Ward Statistics (Phi)

Mean:	2.54	Median:	2.03	Deviation:	2.72
Skewness:	0.31	Kurtosis:	0.99		

<10%	<25%	<50%	<75%	<90%
9.845 µm	52.60 µm	245.6 µm	617.9 µm	1359 µm

<2 µm	<63 µm	<2000 µm
2.65%	26.5%	100%

F.27 PSA results for GUC 27



Volume Statistics (Geometric) 22041391-006-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	54.15 µm	S.D.:	7.070
Median:	75.91 µm	Variance:	49.99
D(3,2):	5.087 µm	Skewness:	-0.634 Left skewed
Mean/Median ratio:	0.713	Kurtosis:	0.024 Leptokurtic
Mode:	140.1 µm		

d_{10}: 4.291 µm d_{50}: 75.91 µm d_{90}: 568.8 µm

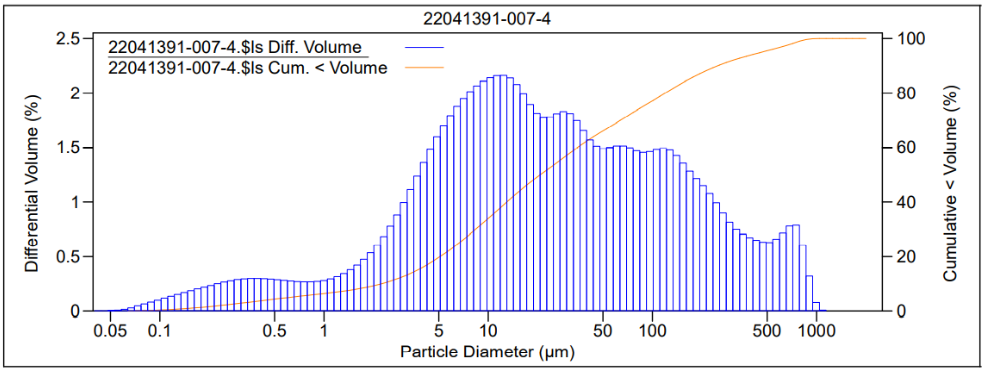
Folk and Ward Statistics (Phi)

Mean:	4.06	Median:	3.72	Deviation:	2.79
Skewness:	0.19	Kurtosis:	0.87		

<10%	<25%	<50%	<75%	<90%
4.291 µm	13.46 µm	75.91 µm	245.8 µm	568.8 µm

<2 µm	<63 µm	<2000 µm
5.38%	46.7%	100%

F.28 PSA results for GUC 28



Volume Statistics (Geometric) 22041391-007-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	21.43 µm	S.D.:	6.639
Median:	20.79 µm	Variance:	44.08
D(3,2):	2.958 µm	Skewness:	-0.320 Left skewed
Mean/Median ratio:	1.031	Kurtosis:	-0.037 Platykurtic
Mode:	12.40 µm		

d_{10}: 2.241 µm d_{50}: 20.79 µm d_{90}: 250.4 µm

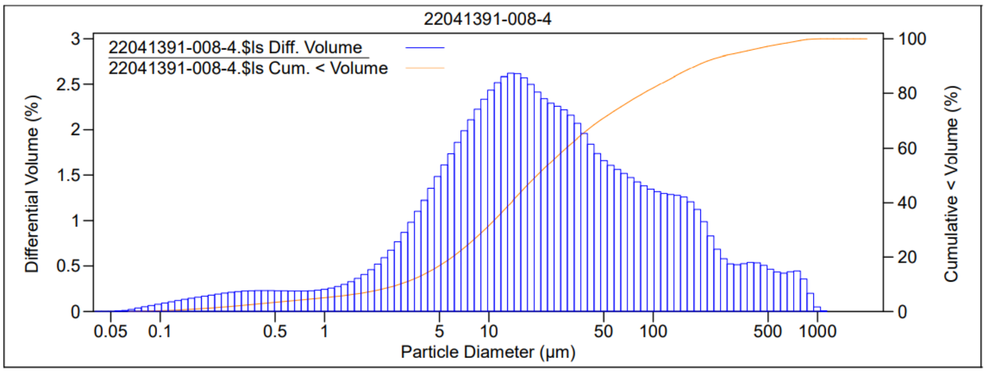
Folk and Ward Statistics (Phi)

Mean:	5.42	Median:	5.59	Deviation:	2.77
Skewness:	-0.02	Kurtosis:	1.05		

<10%	<25%	<50%	<75%	<90%
2.241 µm	6.633 µm	20.79 µm	87.25 µm	250.4 µm

<2 µm	<63 µm	<2000 µm
9.26%	69.8%	100%

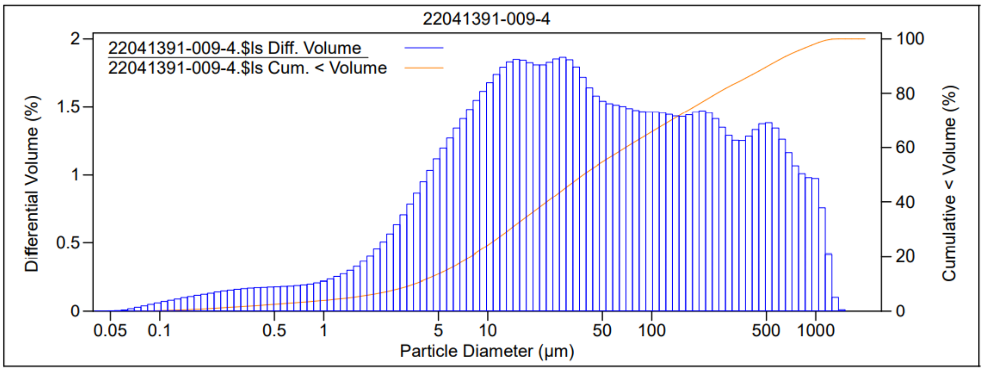
F.29 PSA results for GUC 29



```
Volume Statistics (Geometric)              22041391-008-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:               100%
Mean:                 20.32 µm            S.D.:         5.475
Median:               19.71 µm            Variance:     29.98
D(3,2):               3.527 µm            Skewness:     -0.342 Left skewed
Mean/Median ratio:    1.031               Kurtosis:     0.437 Leptokurtic
Mode:                 13.61 µm

d10:   2.871 µm                 d50:   19.71 µm                 d90:   179.6 µm

Folk and Ward Statistics (Phi)
Mean:        5.50        Median:      5.67           Deviation:    2.43
Skewness:    -0.04       Kurtosis:    1.13

<10%           <25%           <50%           <75%           <90%
2.871 µm       7.638 µm       19.71 µm       63.33 µm       179.6 µm

<2 µm          <63 µm         <2000 µm
7.56%          74.9%          100%
```

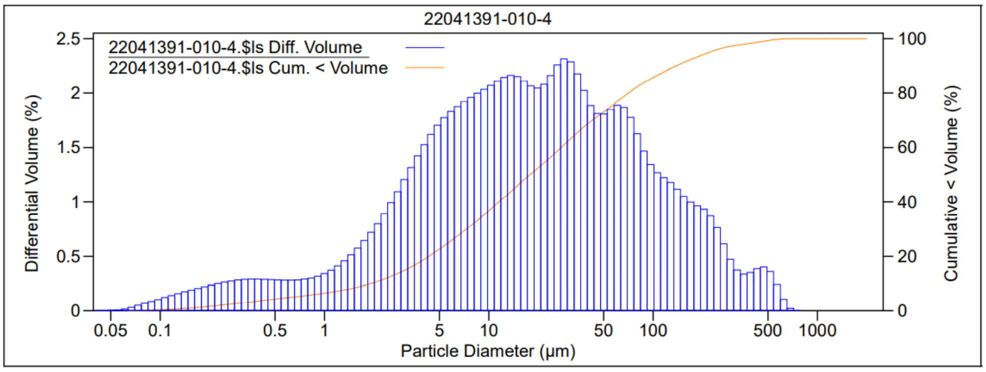
F.30 PSA results for GUC 30 No data

F.31 PSA results for GUC 31



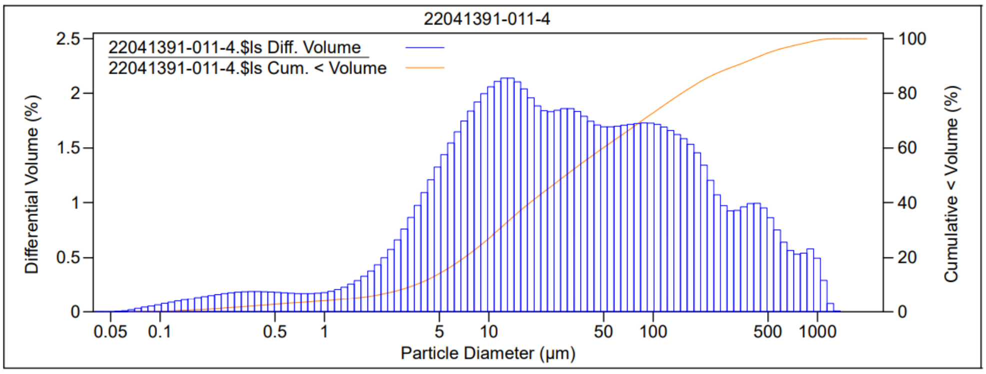
```
Volume Statistics (Geometric)              22041391-009-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:               100%
Mean:                 38.74 µm            S.D.:         6.951
Median:               38.21 µm            Variance:     48.32
D(3,2):               4.569 µm            Skewness:     -0.373 Left skewed
Mean/Median ratio:    1.014               Kurtosis:     -0.162 Platykurtic
Mode:                 28.70 µm

d10:   3.578 µm                 d50:   38.21 µm                 d90:   509.9 µm

Folk and Ward Statistics (Phi)
Mean:        4.56        Median:      4.71           Deviation:    2.81
Skewness:    -0.02       Kurtosis:    0.90

<10%           <25%           <50%           <75%           <90%
3.578 µm       10.57 µm       38.21 µm       181.6 µm       509.9 µm

<2 µm          <63 µm         <2000 µm
6.19%          58.4%          100%
```

F.32 PSA results for GUC 32



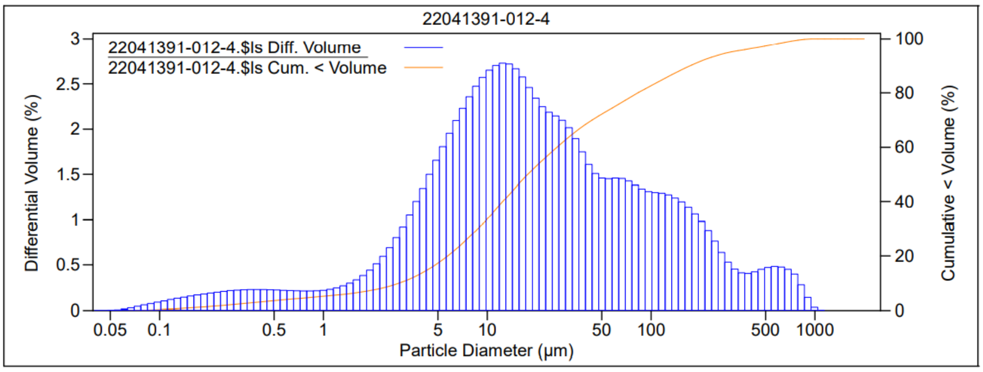
```
Volume Statistics (Geometric)              22041391-010-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:               100%
Mean:                 16.13 µm          S.D.:          5.568
Median:               17.85 µm          Variance:      31.00
D(3,2):               2.783 µm          Skewness:      -0.475 Left skewed
Mean/Median ratio:    0.904             Kurtosis:      0.184 Leptokurtic
Mode:                 28.70 µm

d10:    1.904 µm              d50:    17.85 µm              d90:    138.2 µm

Folk and Ward Statistics (Phi)
Mean:        5.84           Median:       5.81          Deviation:     2.47
Skewness:    0.08           Kurtosis:     1.06

<10%          <25%          <50%          <75%          <90%
1.904 µm      5.673 µm      17.85 µm      55.06 µm      138.2 µm

<2 µm         <63 µm        <2000 µm
10.4%         77.7%         100%
```

F.33 PSA results for GUC 33



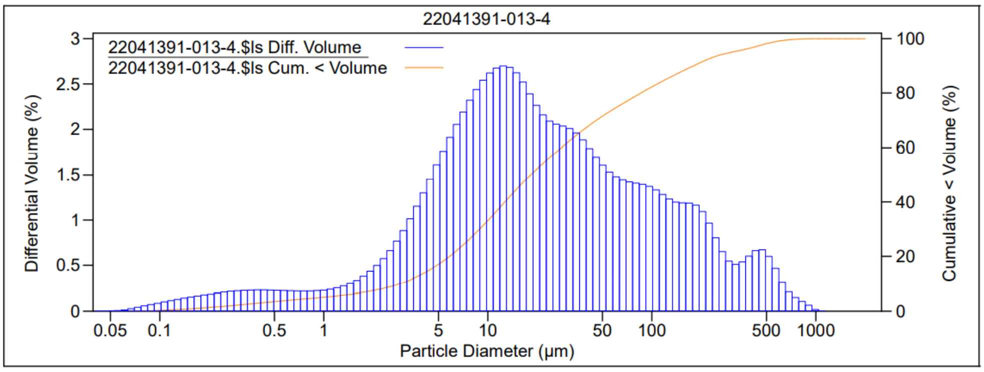
```
Volume Statistics (Geometric)              22041391-011-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:               100%
Mean:                 29.46 µm          S.D.:          6.086
Median:               29.45 µm          Variance:      37.04
D(3,2):               4.224 µm          Skewness:      -0.367 Left skewed
Mean/Median ratio:    1.001             Kurtosis:      0.128 Leptokurtic
Mode:                 13.61 µm

d10:    3.559 µm              d50:    29.45 µm              d90:    315.0 µm

Folk and Ward Statistics (Phi)
Mean:        4.98           Median:       5.09          Deviation:     2.55
Skewness:    -0.02          Kurtosis:     0.95

<10%          <25%          <50%          <75%          <90%
3.559 µm      9.110 µm      29.45 µm      112.4 µm      315.0 µm

<2 µm         <63 µm        <2000 µm
6.07%         64.3%         100%
```

F.34 PSA results for GUC 34



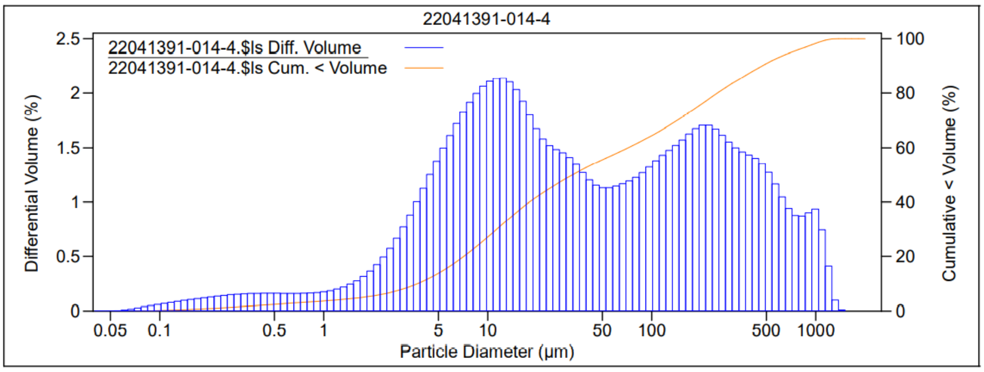
```
Volume Statistics (Geometric)          22041391-012-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:             100%
Mean:               19.08 µm          S.D.:          5.436
Median:             17.70 µm          Variance:      29.55
D(3,2):             3.384 µm          Skewness:      -0.304 Left skewed
Mean/Median ratio:  1.078             Kurtosis:      0.459 Leptokurtic
Mode:               12.40 µm

d10:   2.914 µm              d50:   17.70 µm              d90:   173.5 µm

Folk and Ward Statistics (Phi)
Mean:        5.58        Median:    5.82        Deviation:    2.40
Skewness:    -0.07       Kurtosis:  1.11

<10%         <25%         <50%         <75%         <90%
2.914 µm     7.187 µm     17.70 µm     60.04 µm     173.5 µm

<2 µm        <63 µm       <2000 µm
7.39%        75.8%        100%
```

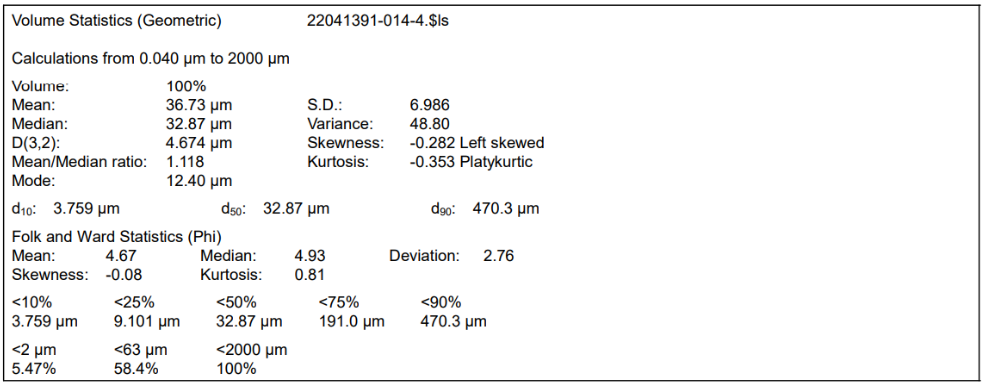
F.35 PSA results for GUC 35



```
Volume Statistics (Geometric)          22041391-013-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:             100%
Mean:               19.47 µm          S.D.:          5.417
Median:             18.27 µm          Variance:      29.34
D(3,2):             3.404 µm          Skewness:      -0.360 Left skewed
Mean/Median ratio:  1.065             Kurtosis:      0.423 Leptokurtic
Mode:               12.40 µm

d10:   2.924 µm              d50:   18.27 µm              d90:   179.1 µm

Folk and Ward Statistics (Phi)
Mean:        5.55        Median:    5.77        Deviation:    2.41
Skewness:    -0.06       Kurtosis:  1.11

<10%         <25%         <50%         <75%         <90%
2.924 µm     7.327 µm     18.27 µm     61.92 µm     179.1 µm

<2 µm        <63 µm       <2000 µm
7.46%        75.3%        100%
```

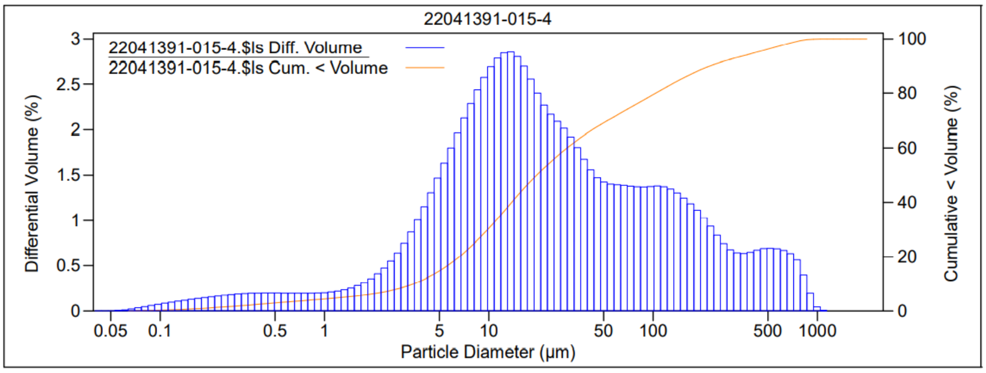
F.36 PSA results for GUC 36

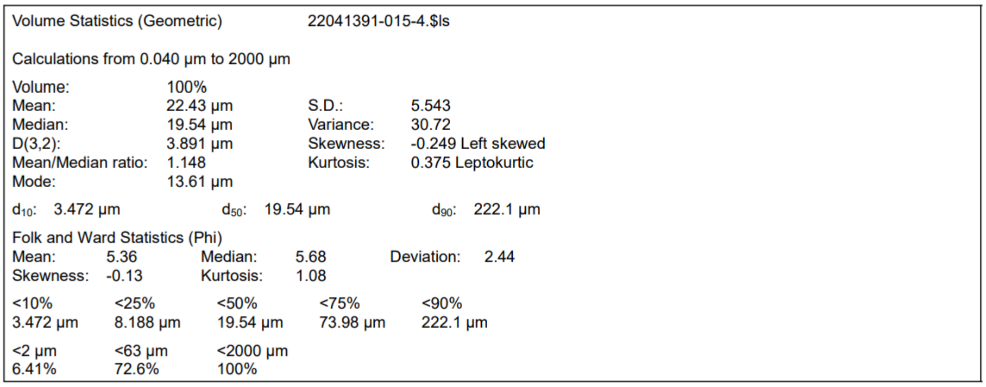




```
Volume Statistics (Geometric)          22041391-014-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                36.73 µm          S.D.:         6.986
Median:              32.87 µm          Variance:     48.80
D(3,2):              4.674 µm          Skewness:     -0.282 Left skewed
Mean/Median ratio:   1.118             Kurtosis:     -0.353 Platykurtic
Mode:                12.40 µm

d10:  3.759 µm           d50:  32.87 µm           d90:  470.3 µm

Folk and Ward Statistics (Phi)
Mean:       4.67       Median:     4.93       Deviation:   2.76
Skewness:   -0.08      Kurtosis:   0.81

<10%         <25%         <50%         <75%         <90%
3.759 µm     9.101 µm     32.87 µm     191.0 µm     470.3 µm

<2 µm        <63 µm       <2000 µm
5.47%        58.4%        100%
```

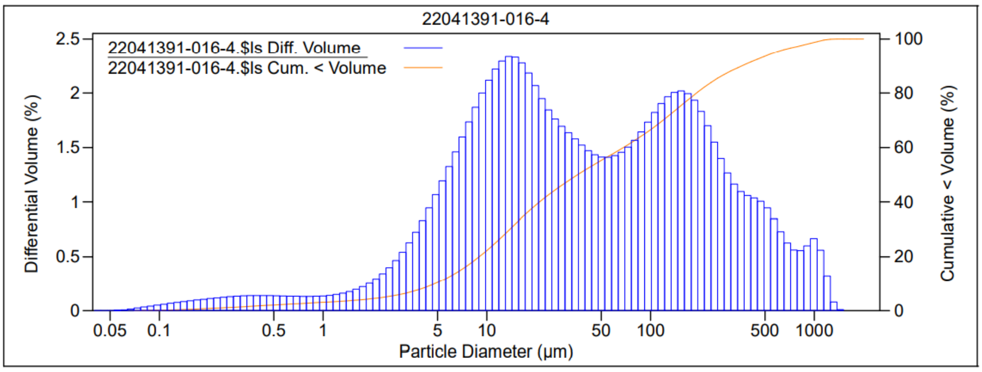
F.37 PSA results for GUC 37





```
Volume Statistics (Geometric)          22041391-015-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                22.43 µm          S.D.:         5.543
Median:              19.54 µm          Variance:     30.72
D(3,2):              3.891 µm          Skewness:     -0.249 Left skewed
Mean/Median ratio:   1.148             Kurtosis:     0.375 Leptokurtic
Mode:                13.61 µm

d10:  3.472 µm           d50:  19.54 µm           d90:  222.1 µm

Folk and Ward Statistics (Phi)
Mean:       5.36       Median:     5.68       Deviation:   2.44
Skewness:   -0.13      Kurtosis:   1.08

<10%         <25%         <50%         <75%         <90%
3.472 µm     8.188 µm     19.54 µm     73.98 µm     222.1 µm

<2 µm        <63 µm       <2000 µm
6.41%        72.6%        100%
```

F.38 PSA results for GUC 38



Volume Statistics (Geometric) 22041391-016-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume: 100%
Mean: 37.48 µm S.D.: 5.884
Median: 35.89 µm Variance: 34.63
D(3,2): 5.402 µm Skewness: -0.384 Left skewed
Mean/Median ratio: 1.044 Kurtosis: 0.128 Leptokurtic
Mode: 13.61 µm

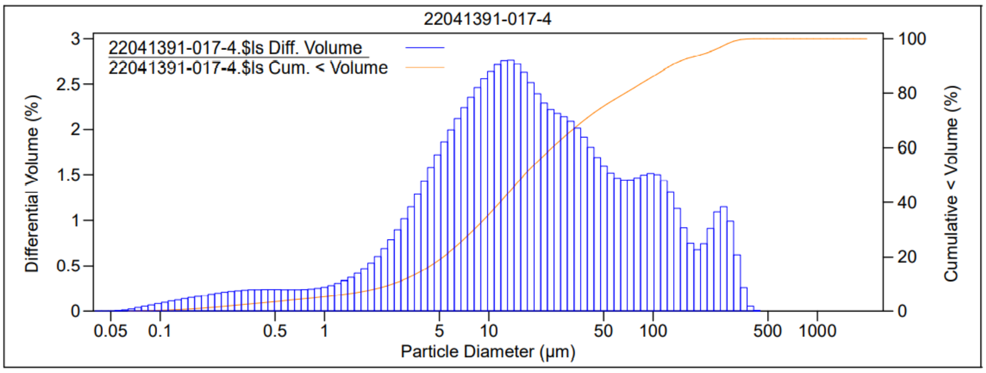
d_{10}: 4.818 µm d_{50}: 35.89 µm d_{90}: 361.2 µm

Folk and Ward Statistics (Phi)
Mean: 4.66 Median: 4.80 Deviation: 2.45
Skewness: -0.05 Kurtosis: 0.87

<10%	<25%	<50%	<75%	<90%
4.818 µm	11.26 µm	35.89 µm	150.8 µm	361.2 µm

<2 µm	<63 µm	<2000 µm
4.43%	58.7%	100%

F.39 PSA results for GUC 39



Volume Statistics (Geometric) 22041391-017-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume: 100%
Mean: 16.45 µm S.D.: 4.902
Median: 16.48 µm Variance: 24.03
D(3,2): 3.294 µm Skewness: -0.500 Left skewed
Mean/Median ratio: 0.999 Kurtosis: 0.483 Leptokurtic
Mode: 13.61 µm

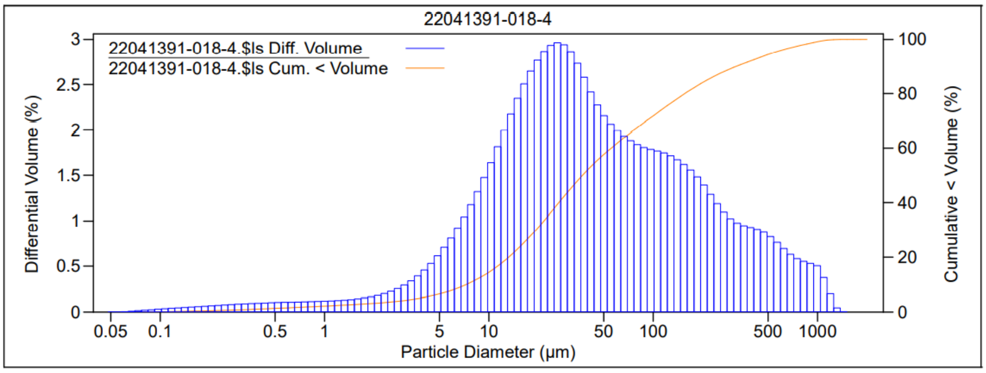
d_{10}: 2.572 µm d_{50}: 16.48 µm d_{90}: 127.5 µm

Folk and Ward Statistics (Phi)
Mean: 5.78 Median: 5.92 Deviation: 2.29
Skewness: -0.02 Kurtosis: 1.12

<10%	<25%	<50%	<75%	<90%
2.572 µm	6.658 µm	16.48 µm	49.46 µm	127.5 µm

<2 µm	<63 µm	<2000 µm
8.18%	79.0%	100%

F.40 PSA results for GUC 40



Volume Statistics (Geometric) 22041391-018-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume: 100%
Mean: 40.75 µm S.D.: 4.709
Median: 37.12 µm Variance: 22.17
D(3,2): 7.656 µm Skewness: -0.384 Left skewed
Mean/Median ratio: 1.098 Kurtosis: 0.869 Leptokurtic
Mode: 26.14 µm

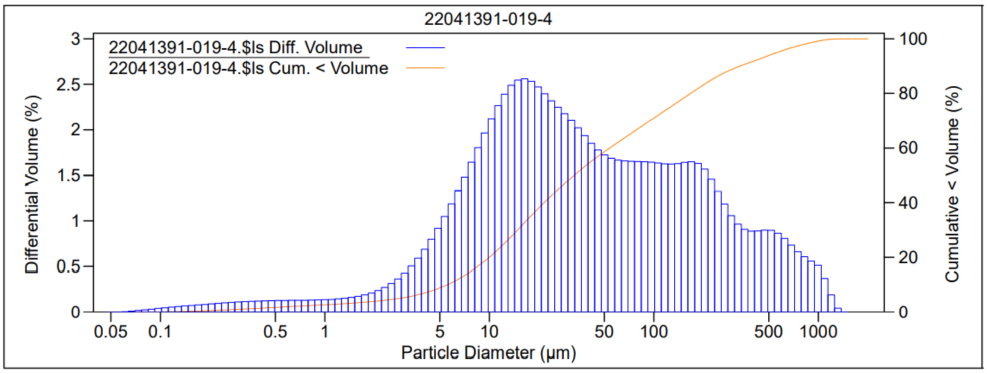
d_{10}: 7.310 µm d_{50}: 37.12 µm d_{90}: 320.7 µm

Folk and Ward Statistics (Phi)
Mean: 4.53 Median: 4.75 Deviation: 2.13
Skewness: -0.12 Kurtosis: 1.02

<10%	<25%	<50%	<75%	<90%
7.310 µm	16.19 µm	37.12 µm	118.1 µm	320.7 µm

<2 µm	<63 µm	<2000 µm
3.19%	62.7%	100%

F.41 PSA results for GUC 41



Volume Statistics (Geometric) 22041391-019-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume: 100%
Mean: 36.13 µm S.D.: 5.354
Median: 32.66 µm Variance: 28.66
D(3,2): 6.043 µm Skewness: -0.326 Left skewed
Mean/Median ratio: 1.106 Kurtosis: 0.377 Leptokurtic
Mode: 16.40 µm

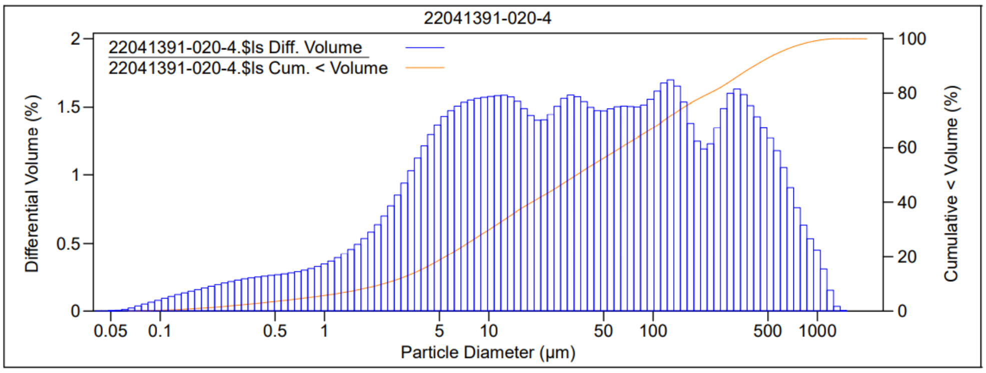
d_{10}: 5.515 µm d_{50}: 32.66 µm d_{90}: 334.3 µm

Folk and Ward Statistics (Phi)
Mean: 4.70 Median: 4.94 Deviation: 2.33
Skewness: -0.11 Kurtosis: 0.94

<10%	<25%	<50%	<75%	<90%
5.515 µm	12.31 µm	32.66 µm	126.0 µm	334.3 µm

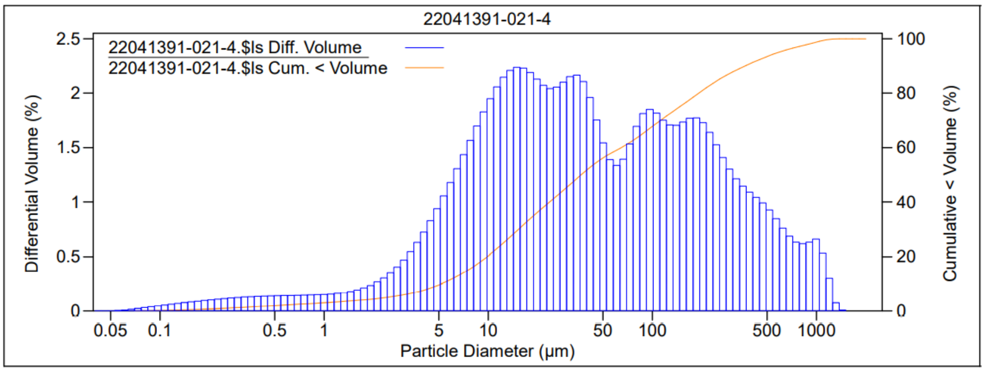
<2 µm	<63 µm	<2000 µm
4.01%	62.8%	100%

F.42 PSA results for GUC 42



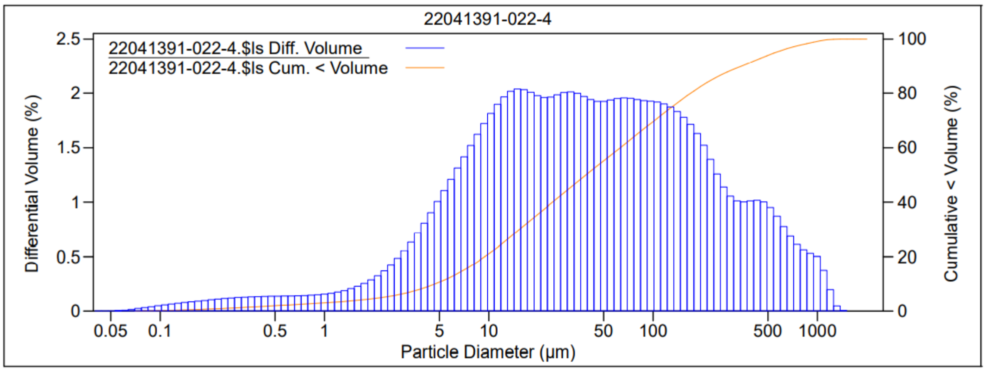
```
Volume Statistics (Geometric)          22041391-020-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                30.70 µm          S.D.:         7.594
Median:              34.23 µm          Variance:     57.68
D(3,2):              3.437 µm          Skewness:     -0.397 Left skewed
Mean/Median ratio:   0.897             Kurtosis:     -0.384 Platykurtic
Mode:                127.6 µm

d10:   2.274 µm            d50:   34.23 µm            d90:   411.6 µm

Folk and Ward Statistics (Phi)
Mean:        4.86        Median:      4.87        Deviation:    2.97
Skewness:    0.07        Kurtosis:    0.89

<10%          <25%          <50%          <75%          <90%
2.274 µm      7.409 µm      34.23 µm      154.5 µm      411.6 µm

<2 µm         <63 µm        <2000 µm
9.11%         59.8%         100%
```

F.43 PSA results for GUC 43



```
Volume Statistics (Geometric)          22041391-021-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                38.83 µm          S.D.:         5.680
Median:              36.87 µm          Variance:     32.26
D(3,2):              5.761 µm          Skewness:     -0.399 Left skewed
Mean/Median ratio:   1.053             Kurtosis:     0.269 Leptokurtic
Mode:                14.94 µm

d10:   5.198 µm            d50:   36.87 µm            d90:   366.9 µm

Folk and Ward Statistics (Phi)
Mean:        4.60        Median:      4.76        Deviation:    2.42
Skewness:    -0.06       Kurtosis:    0.91

<10%          <25%          <50%          <75%          <90%
5.198 µm      12.43 µm      36.87 µm      147.0 µm      366.9 µm

<2 µm         <63 µm        <2000 µm
4.35%         59.6%         100%
```

F.44 PSA results for GUC 44



Volume Statistics (Geometric) 22041391-022-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	37.25 µm	S.D.:	5.604
Median:	39.04 µm	Variance:	31.40
D(3,2):	5.561 µm	Skewness:	-0.447 Left skewed
Mean/Median ratio:	0.954	Kurtosis:	0.332 Leptokurtic
Mode:	14.94 µm		

d$_{10}$: 4.728 µm d$_{50}$: 39.04 µm d$_{90}$: 345.6 µm

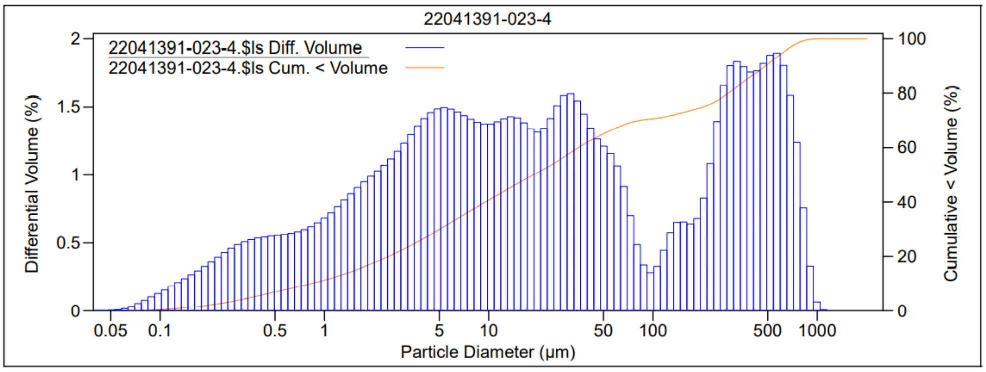
Folk and Ward Statistics (Phi)

Mean:	4.66	Median:	4.68	Deviation:	2.41
Skewness:	0.01	Kurtosis:	0.95		

<10%	<25%	<50%	<75%	<90%
4.728 µm	12.14 µm	39.04 µm	130.6 µm	345.6 µm

<2 µm	<63 µm	<2000 µm
4.59%	59.9%	100%

F.45 PSA results for GUC 45



Volume Statistics (Geometric) 22041391-023-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	19.76 µm	S.D.:	10.44
Median:	18.62 µm	Variance:	109.0
D(3,2):	1.998 µm	Skewness:	-0.137 Left skewed
Mean/Median ratio:	1.061	Kurtosis:	-0.916 Platykurtic
Mode:	567.7 µm		

d$_{10}$: 0.819 µm d$_{50}$: 18.62 µm d$_{90}$: 483.1 µm

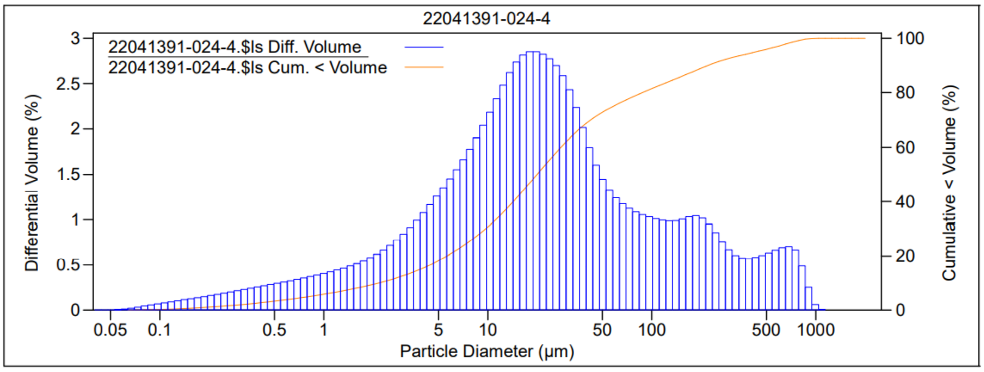
Folk and Ward Statistics (Phi)

Mean:	5.48	Median:	5.75	Deviation:	3.55
Skewness:	-0.02	Kurtosis:	0.76		

<10%	<25%	<50%	<75%	<90%
0.819 µm	3.603 µm	18.62 µm	201.2 µm	483.1 µm

<2 µm	<63 µm	<2000 µm
17.7%	67.9%	100%

F.46 PSA results for GUC 46



Volume Statistics (Geometric) 22041391-024-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	20.14 µm	S.D.:	5.861
Median:	19.96 µm	Variance:	34.35
D(3,2):	3.488 µm	Skewness:	-0.239 Left skewed
Mean/Median ratio:	1.009	Kurtosis:	0.210 Leptokurtic
Mode:	19.76 µm		

d_{10}: 2.169 µm d_{50}: 19.96 µm d_{90}: 220.0 µm

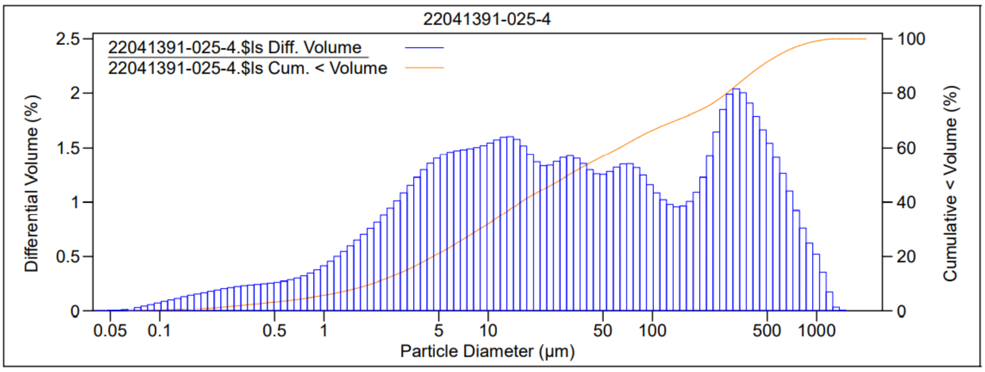
Folk and Ward Statistics (Phi)

Mean:	5.51	Median:	5.65	Deviation:	2.60
Skewness:	-0.03	Kurtosis:	1.26		

<10%	<25%	<50%	<75%	<90%
2.169 µm	7.607 µm	19.96 µm	58.26 µm	220.0 µm

<2 µm	<63 µm	<2000 µm
9.47%	76.0%	100%

F.47 PSA results for GUC 47



Volume Statistics (Geometric) 22041391-025-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	30.31 µm	S.D.:	8.370
Median:	30.96 µm	Variance:	70.06
D(3,2):	3.300 µm	Skewness:	-0.304 Left skewed
Mean/Median ratio:	0.979	Kurtosis:	-0.653 Platykurtic
Mode:	324.4 µm		

d_{10}: 1.937 µm d_{50}: 30.96 µm d_{90}: 460.2 µm

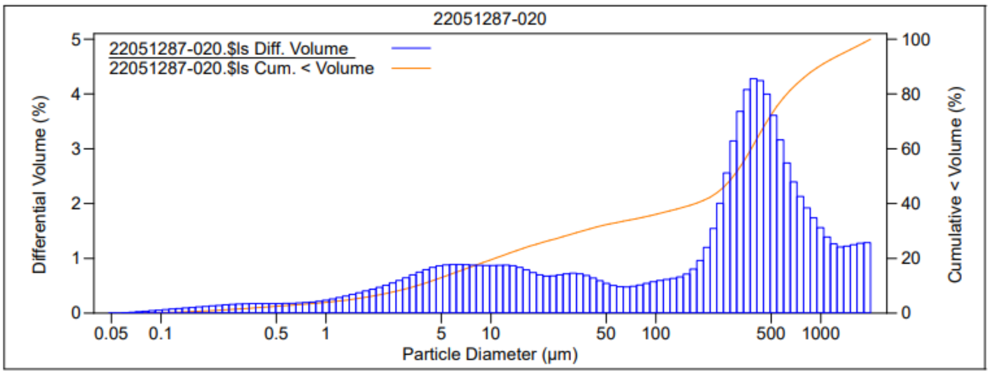
Folk and Ward Statistics (Phi)

Mean:	4.91	Median:	5.01	Deviation:	3.11
Skewness:	0.02	Kurtosis:	0.78		

<10%	<25%	<50%	<75%	<90%
1.937 µm	6.402 µm	30.96 µm	214.1 µm	460.2 µm

<2 µm	<63 µm	<2000 µm
10.3%	60.1%	100%

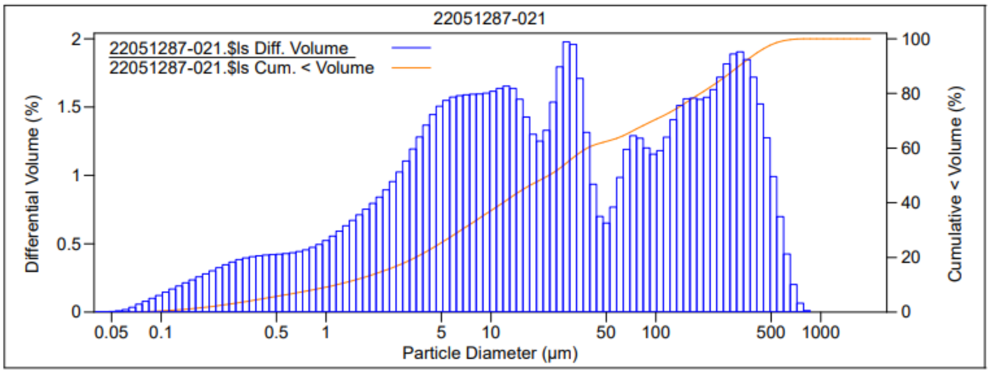
F.48 PSA results for Connected waterbody 1



```
Volume Statistics (Geometric)          22051287-020.$ls

Calculations from 0.040 µm to 2000 µm

Volume:             100%
Mean:               106.8 µm       S.D.:         9.578
Median:             295.9 µm       Variance:     91.74
D(3,2):             5.025 µm       Skewness:     -0.955 Left skewed
Mean/Median ratio:  0.361          Kurtosis:     -0.078 Platykurtic
Mode:               390.9 µm

d10:   3.557 µm             d50:   295.9 µm              d90:   975.1 µm

Folk and Ward Statistics (Phi)
Mean:       3.13        Median:      1.76          Deviation:    3.18
Skewness:   0.58        Kurtosis:    0.84

<10%          <25%          <50%          <75%          <90%
3.557 µm      18.48 µm      295.9 µm      535.8 µm      975.1 µm

<2 µm         <63 µm        <2000 µm
6.42%         33.5%         100%
```

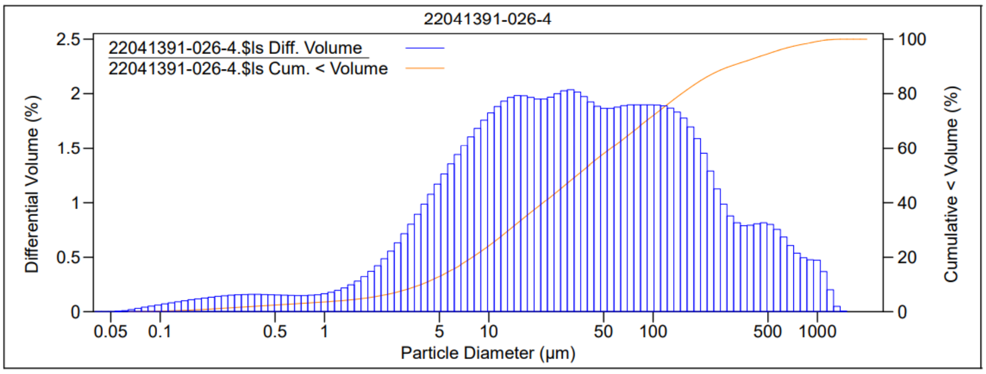
F.49 PSA results for Connected waterbody 2 No data

F.50 PSA results for Connected waterbody 3



```
Volume Statistics (Geometric)          22051287-021.$ls

Calculations from 0.040 µm to 2000 µm

Volume:             100%
Mean:               20.84 µm       S.D.:         8.315
Median:             22.42 µm       Variance:     69.14
D(3,2):             2.323 µm       Skewness:     -0.355 Left skewed
Mean/Median ratio:  0.930          Kurtosis:     -0.636 Platykurtic
Mode:               28.70 µm

d10:   1.162 µm             d50:   22.42 µm              d90:   320.2 µm

Folk and Ward Statistics (Phi)
Mean:       5.41        Median:      5.48          Deviation:    3.15
Skewness:   0.06        Kurtosis:    0.85

<10%          <25%          <50%          <75%          <90%
1.162 µm      4.897 µm      22.42 µm      137.9 µm      320.2 µm

<2 µm         <63 µm        <2000 µm
14.0%         64.5%         100%
```

F.51 PSA results for Connected waterbody 4



Volume Statistics (Geometric) 22041391-026-4.$ls

Calculations from 0.040 μm to 2000 μm

Volume:	100%		
Mean:	32.25 μm	S.D.:	5.801
Median:	34.07 μm	Variance:	33.65
D(3,2):	4.669 μm	Skewness:	-0.438 Left skewed
Mean/Median ratio:	0.947	Kurtosis:	0.296 Leptokurtic
Mode:	31.50 μm		

d_{10}: 3.870 μm d_{50}: 34.07 μm d_{90}: 293.2 μm

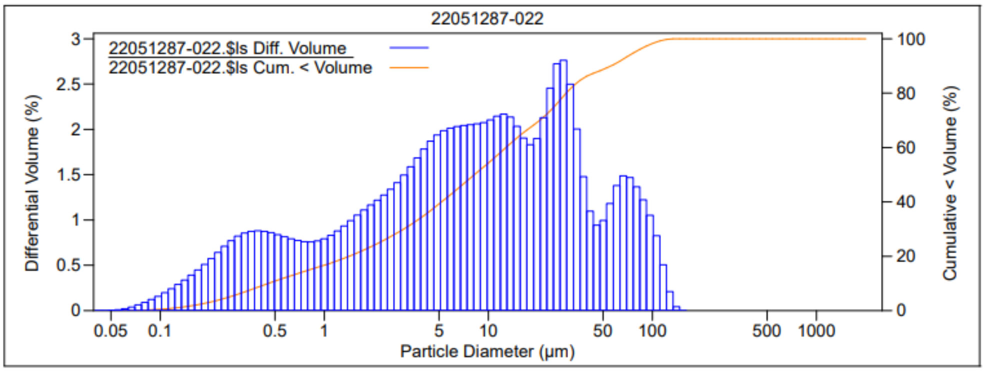
Folk and Ward Statistics (Phi)

Mean:	4.88	Median:	4.88	Deviation:	2.47
Skewness:	0.02	Kurtosis:	0.97		

<10%	<25%	<50%	<75%	<90%
3.870 μm	10.41 μm	34.07 μm	116.0 μm	293.2 μm

<2 μm	<63 μm	<2000 μm
5.45%	62.6%	100%

F.52 PSA results for Connected waterbody 5



Volume Statistics (Geometric) 22051287-022.$ls

Calculations from 0.040 μm to 2000 μm

Volume:	100%		
Mean:	6.518 μm	S.D.:	5.562
Median:	8.223 μm	Variance:	30.94
D(3,2):	1.414 μm	Skewness:	-0.481 Left skewed
Mean/Median ratio:	0.793	Kurtosis:	-0.556 Platykurtic
Mode:	28.70 μm		

d_{10}: 0.455 μm d_{50}: 8.223 μm d_{90}: 55.88 μm

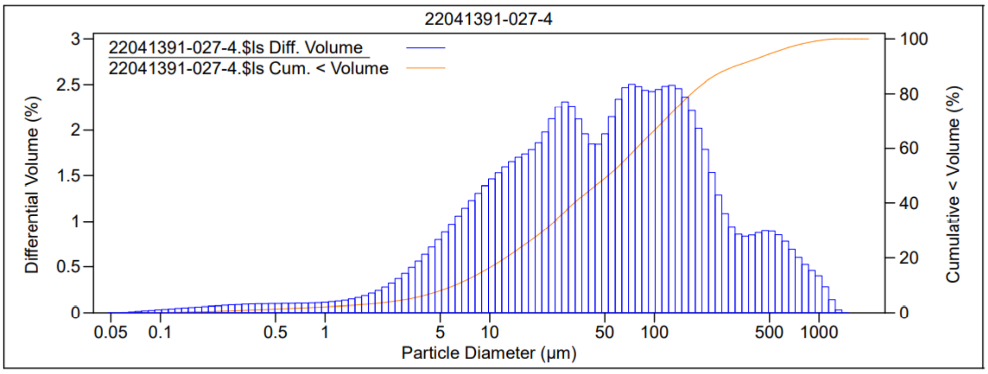
Folk and Ward Statistics (Phi)

Mean:	7.28	Median:	6.93	Deviation:	2.56
Skewness:	0.21	Kurtosis:	0.95		

<10%	<25%	<50%	<75%	<90%
0.455 μm	2.160 μm	8.223 μm	25.18 μm	55.88 μm

<2 μm	<63 μm	<2000 μm
24.0%	91.7%	100%

F.53 PSA results for Connected waterbody 6



Volume Statistics (Geometric) 22041391-027-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume: 100%
Mean: 44.99 µm S.D.: 4.893
Median: 52.43 µm Variance: 23.94
D(3,2): 7.611 µm Skewness: -0.584 Left skewed
Mean/Median ratio: 0.858 Kurtosis: 0.694 Leptokurtic
Mode: 72.94 µm

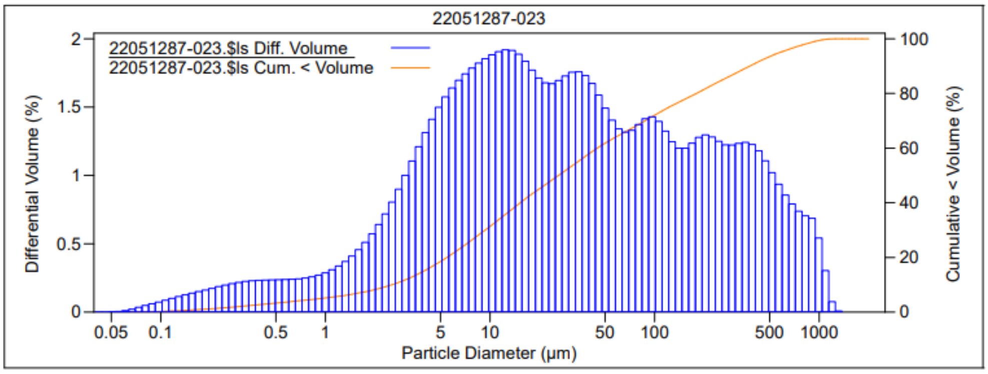
d_{10}: 6.181 µm d_{50}: 52.43 µm d_{90}: 309.2 µm

Folk and Ward Statistics (Phi)
Mean: 4.42 Median: 4.25 Deviation: 2.20
Skewness: 0.10 Kurtosis: 0.98

<10%	<25%	<50%	<75%	<90%
6.181 µm	16.50 µm	52.43 µm	137.4 µm	309.2 µm

<2 µm	<63 µm	<2000 µm
3.24%	54.4%	100%

F.54 PSA results for Connected waterbody 7



Volume Statistics (Geometric) 22051287-023.$ls

Calculations from 0.040 µm to 2000 µm

Volume: 100%
Mean: 27.01 µm S.D.: 7.048
Median: 26.16 µm Variance: 49.67
D(3,2): 3.587 µm Skewness: -0.263 Left skewed
Mean/Median ratio: 1.033 Kurtosis: -0.289 Platykurtic
Mode: 12.40 µm

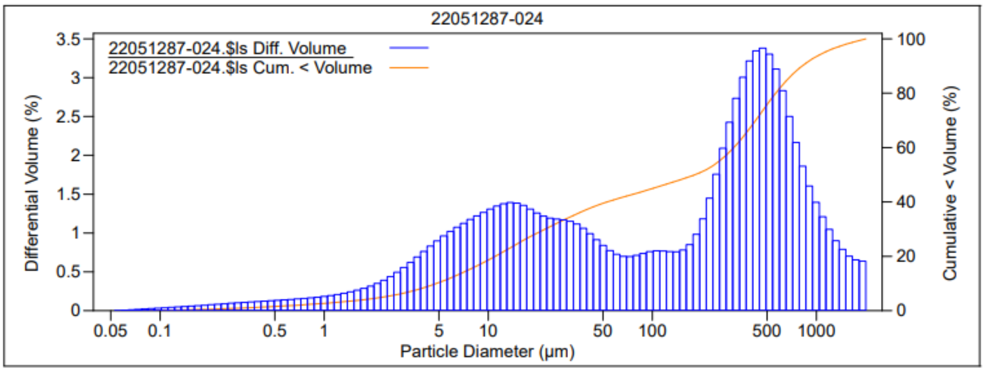
d_{10}: 2.533 µm d_{50}: 26.16 µm d_{90}: 378.4 µm

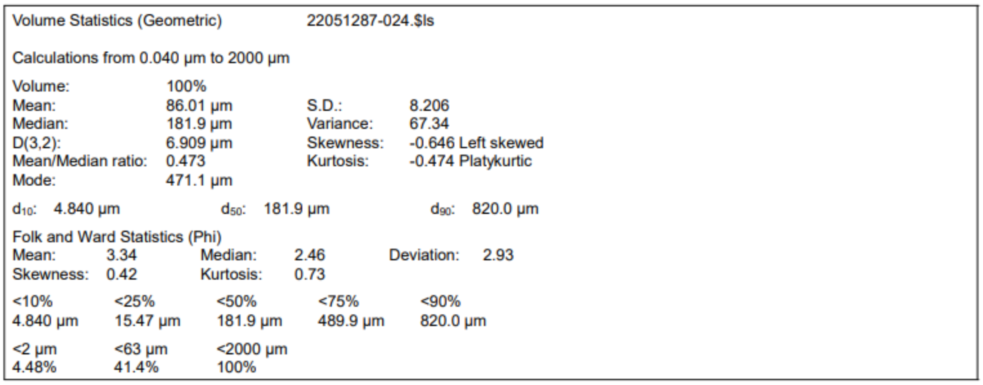
Folk and Ward Statistics (Phi)
Mean: 5.06 Median: 5.26 Deviation: 2.86
Skewness: -0.03 Kurtosis: 0.93

<10%	<25%	<50%	<75%	<90%
2.533 µm	7.224 µm	26.16 µm	122.7 µm	378.4 µm

<2 µm	<63 µm	<2000 µm
8.23%	65.2%	100%

F.55 PSA results for Connected waterbody 8





```
Volume Statistics (Geometric)                  22051287-024.$ls

Calculations from 0.040 µm to 2000 µm

Volume:            100%
Mean:              86.01 µm         S.D.:         8.206
Median:            181.9 µm         Variance:     67.34
D(3,2):            6.909 µm         Skewness:     -0.646 Left skewed
Mean/Median ratio: 0.473            Kurtosis:     -0.474 Platykurtic
Mode:              471.1 µm

d10:   4.840 µm              d50:   181.9 µm              d90:   820.0 µm

Folk and Ward Statistics (Phi)
Mean:       3.34          Median:     2.46          Deviation:    2.93
Skewness:   0.42          Kurtosis:   0.73

<10%         <25%         <50%         <75%         <90%
4.840 µm     15.47 µm     181.9 µm     489.9 µm     820.0 µm

<2 µm        <63 µm       <2000 µm
4.48%        41.4%        100%
```

G. Chemical analysis for GUC and connected waterbody sediments

G.1 Result Report Notes

Please note the following information when examining the chemical analysis results presented in the Appendix of the report.

G.1.1 Letters alongside results

Table G.7: The following letters alongside results signify that the result has associated report notes.

Letter	Meaning	Letter	Meaning
A	Due to the matrix of the sample the laboratory has had to deviate from our standard protocols to be able to process the sample and provide a result. Where applicable the accreditation has been removed and this should be taken into consideration when utilising the data.	E	Due to recoveries beyond our calibration range and following the maximum size of dilution allowed, the result cannot be quantified and as such the result will appear as a greater than symbol (>) with the accreditation removed. This data should be used for indicative purposes only.
B	The QC associated with this result has not wholly met the QMS requirements, the accreditation has therefore been removed. However, the Laboratory has confidence in the performance of the method as a whole and that the integrity of the data has not been significantly compromised.	F	Based on the sample history, appearance and smell a dilution was applied prior to testing . Unfortunately, the result is either above (>) or below (<) our calibration range. Results above our calibration range have accreditation removed. The data should be used for indicative purposes only.
C	Due to matrix interference the internal standard and/or surrogate has not met the QMS requirements. This should be taken into consideration when utilising the data.	G	The day 5 oxygen reading was below the capability of the instrument to detect; therefore, the calculated BOD has been reported unaccredited for guidance purposes only.
D	A non-standard volume or mass has been used for this test which has resulted in a raised detection limit.		

G.1.2 HWOL acronyms

Table G.8: HWOL[19] acronym key

Acronym	Description
HS	Headspace Analysis
EH	Extractable Hydrocarbons - i.e everything extracted by the solvent(s)
CU	Clean up - e.g. by florisil, silica gel
1D	GC - Single coil gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics only
AR	Aromatics only
+	Operator to indicate cumulative e.g. EH_CU+HS_1D_Total

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[19] https://www.hazwasteonline.com/wp-content/uploads/2021/04/HWOL-Acronym-System.pdf (accessed 9 June 2022)

G.1.3 Accreditation column of the analysis report (Accred)

U = UKAS accredited analysis

M = MCERT accredited analysis

N = Unaccredited analysis

G.1.4 Other notes

- Any units marked with ^ signify results are reported on a dry weight basis of 35 º C
- All air-dried and ground samples (ADG) are oven-dried at less than 35º C
- Any units marked with ^ signify results are reported on a dry weight basis of 35 º C
- Any samples marked with * are not covered by our scope of UKAS accreditation. If applicable, further report notes have been added
- Any samples marked with ‡ have had MCERTS accreditation removed for this result
- Any samples marked with a tick in the deviant table is deviant for the specific reason
- Any samples reported as IS, NA, ND mean the following
- IS = Insufficient Sample to complete analysis
- NA = Sample is not amenable for the required analysis
- ND = Results cannot be determined

Table G.9: Chemical analysis of canal bed sediments GUC 1 to GUC 10 (SOCOTEC UK Ltd.)

Analysis	Method	MDL	Units	Accred	GUC1	GUC2	GUC3	GUC4	GUC5	GUC6	GUC7	GUC8	GUC9	GUC10
Arsenic as As	ICPMSS	0.3	mg/kg^	UM	41.5	59.9	62	55	59	66.7	43.5	65.9	60.8	54.8
Cadmium as Cd	ICPMSS	0.2	mg/kg^	UM	7.9	15.2	20.4	15.6	15	12	11	11.4	9.3	13.7
Copper as Cu	ICPMSS	1.6	mg/kg^	UM	1.4	3.3	4.9	1.5	1.4	2	1	1.4	0.4	0.7
Lead as Pb	ICPMSS	0.7	mg/kg^	UM	50.4	94.8	85.6	87.8	91.8	89.6	88.2	71.4	41.9	70.1
Mercury as Hg	ICPMSS	0.5	mg/kg^	UM	36.3	77.9	113.7	69.9	132.6	99.9	64.6	114.5	37.3	247.4
Nickel as Ni	ICPMSS	2	mg/kg^	UM	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	<0.5
Total Chromium as Cr	ICPMSS	1.2	mg/kg^	UM	66.1	97	98.2	42	46.7	69.6	39.7	40.5	29.5	36.6
Zinc as Zn	ICPMSS	16	mg/kg^	UM	22.5	66.6	48.2	41.4	50	58.8	30	35.9	32.8	32.6
Acenaphthene	PAHMSUS	0.08	mg/kg^	UM	317.3	520.1	763.7	495.6	697.4	702.5	496	414.7	176.6	317.7
Acenaphthylene	PAHMSUS	0.08	mg/kg^	U	<0.14	<0.20	<0.21	<0.18	<0.20	<0.24	<0.14	<0.24	<0.20	0.26
Anthracene	PAHMSUS	0.08	mg/kg^	U	0.16	<0.20	<0.21	<0.18	<0.20	<0.24	<0.14	<0.24	<0.20	0.2
Benzo[a]anthracene	PAHMSUS	0.08	mg/kg^	UM	0.9	<0.20	<0.21	<0.18	<0.20	<0.24	<0.14	<0.24	<0.20	0.76
Benzo[a]pyrene	PAHMSUS	0.08	mg/kg^	UM	2.91	0.52	0.3	<0.18	0.54	0.32	0.58	0.56	<0.20	1.51
Benzo[b]fluoranthene	PAHMSUS	0.08	mg/kg^	UM	3.12	0.91	0.51	<0.18	0.91	0.55	0.79	0.88	0.3	1.5
Benzo[g,h,i]perylene	PAHMSUS	0.08	mg/kg^	UM	2.77	1.06	0.57	0.18	1.19	0.63	0.86	0.95	0.36	1.44
Benzo[k]fluoranthene	PAHMSUS	0.08	mg/kg^	UM	0.99	0.59	0.33	<0.18	0.6	0.35	0.38	0.48	<0.20	0.5
Chrysene	PAHMSUS	0.08	mg/kg^	UM	1.12	0.4	0.21	<0.18	0.4	0.24	0.31	0.37	<0.20	0.63
Dibenzo[a,h]anthracene	PAHMSUS	0.08	mg/kg^	UM	2.34	0.46	0.28	<0.18	0.48	0.28	0.52	0.52	0.24	1.31
Fluoranthene	PAHMSUS	0.08	mg/kg^	UM	0.37	<0.20	<0.21	<0.18	<0.20	<0.24	<0.14	<0.24	<0.20	0.19
Fluorene	PAHMSUS	0.08	mg/kg^	UM	4.99	1.01	0.86	<0.18	0.9	0.57	1.25	1.08	0.4	3.18
Indeno[1,2,3-cd]pyrene	PAHMSUS	0.08	mg/kg^	UM	<0.14	<0.20	<0.21	<0.18	<0.20	<0.24	<0.14	<0.24	<0.20	0.43
Naphthalene	PAHMSUS	0.08	mg/kg^	UM	1.72	0.88	0.47	<0.18	0.82	0.52	0.58	0.73	0.26	0.84
Phenanthrene	PAHMSUS	0.08	mg/kg^	UM	<0.14	<0.20	<0.21	<0.18	<0.20	<0.24	<0.14	<0.24	<0.20	0.46
Pyrene	PAHMSUS	0.08	mg/kg^	UM	1.32	0.3	0.31	<0.18	0.29	<0.24	0.37	0.41	<0.20	2.56
Total PAH 16	PAHMSUS	1.28	mg/kg^	U	3.98	0.93	0.75	<0.18	1.23	0.57	1.03	0.98	0.35	2.57
PCB 101	PCBECD	5	µg/kg^	UM	27.1	8.27	5.84	2.85	8.52	5.72	7.51	8.36	3.96	18.3
PCB 118	PCBECD	5	µg/kg^	UM	<8.55	<12.5	<13.2	<11.1	<12.2	<15.0	<8.85	<14.7	<12.8	<11.1
PCB 138	PCBECD	5	µg/kg^	UM	<8.55	<12.5	<13.2	<11.1	<12.2	<15.0	<8.85	<14.7	<12.8	<11.1
PCB 153	PCBECD	5	µg/kg^	UM	<8.55	<12.5	<13.2	<11.1	<12.2	<15.0	<8.85	<14.7	<12.8	<11.1
PCB 180	PCBECD	5	µg/kg^	UM	<8.55	<12.5	<13.2	<11.1	<12.2	<15.0	<8.85	<14.7	<12.8	<11.1
PCB 28	PCBECD	5	µg/kg^	UM	<8.55	<12.5	<13.2	<11.1	<12.2	<15.0	<8.85	<14.7	<12.8	<11.1
PCB 52	PCBECD	5	µg/kg^	UM	<8.55	<12.5	<13.2	<11.1	<12.2	<15.0	<8.85	<14.7	<12.8	<11.1
Total TPH >C8-C40 EH_1D_Total	TPHFIDUS	10	mg/kg^	UM	<8.55	<12.5	<13.2	<11.1	<12.2	<15.0	<8.85	<14.7	<12.8	<11.1
Total moisture at 35°C	CLANDPREP	0.1	%	N	994	1860	1630	505	2290	1330	1010	1370	415	807
Description of Solid Material	CLANDPREP		-	N	SILT	SILT	SILT	SILT	SILT	SILT	SILT	SILT	SILT	SILT

Table G.10: Chemical analysis of canal bed sediments GUC 11 to GUC 20 (SOCOTEC UK Ltd.)

Analysis	Method	MDL	Units	Accred	GUC11	GUC12	GUC13	GUC14	GUC15	GUC16	GUC17	GUC18	GUC19	GUC20
Arsenic as As	ICPMSS	0.3	mg/kg^	UM	45.5	57.3	60.8	54	No data	35.1	24.3	41	58.8	63.3
Cadmium as Cd	ICPMSS	0.2	mg/kg^	UM	9.2	16.1	9.3	8.3	No data	18.6	11	15	16.9	19.1
Copper as Cu	ICPMSS	1.6	mg/kg^	UM	0.3	0.5	0.4	0.5	No data	0.5	0.2	<0.2	0.5	0.6

Analysis	Method	MDL	Units	Accred	GUC11	GUC12	GUC13	GUC14	GUC15	GUC16	GUC17	GUC18	GUC19	GUC20
Lead as Pb	ICPMSS	0.7	mg/kg^	UM	26.5	47	41.9	37	No data	32.8	19.6	24.4	38.7	50.2
Mercury as Hg	ICPMSS	0.5	mg/kg^	UM	27.7	62	37.3	30.3	No data	38.1	32.4	21.3	47	53.4
Nickel as Ni	ICPMSS	2	mg/kg^	UM	<0.5	<0.5	<0.5	<0.5	No data	<0.5	<0.5	<0.5	<0.5	<0.5
Total Chromium as Cr	ICPMSS	1.2	mg/kg^	UM	19.3	32.5	29.5	24.6	No data	30.2	18.4	36.1	36.4	70.6
Zinc as Zn	ICPMSS	16	mg/kg^	UM	19.7	37.2	32.8	27.5	No data	38.8	21.4	34.6	38.9	62.8
Acenaphthene	PAHMSUS	0.08	mg/kg^	UM	111.2	164.9	176.6	182.3	No data	143.5	118.9	80.6	332.4	220.8
Acenaphthylene	PAHMSUS	0.08	mg/kg^	U	<0.15	<0.19	<0.20	<0.17	No data	0.15	0.26	<0.14	0.59	<0.22
Anthracene	PAHMSUS	0.08	mg/kg^	U	<0.15	<0.19	<0.20	<0.17	No data	<0.12	<0.11	<0.14	<0.19	<0.22
Benzo[a]anthracene	PAHMSUS	0.08	mg/kg^	UM	<0.15	0.4	<0.20	<0.17	No data	0.4	0.41	<0.14	0.66	<0.22
Benzo[a]pyrene	PAHMSUS	0.08	mg/kg^	UM	0.26	1.07	<0.20	0.23	No data	1.48	1.68	<0.14	2.97	0.57
Benzo[b]fluoranthene	PAHMSUS	0.08	mg/kg^	UM	0.28	1.04	0.3	0.34	No data	1.78	2.11	<0.14	3.92	0.83
Benzo[g,h,i]perylene	PAHMSUS	0.08	mg/kg^	UM	0.35	1.18	0.36	0.36	No data	1.82	2.25	<0.14	4.1	0.88
Benzo[k]fluoranthene	PAHMSUS	0.08	mg/kg^	UM	0.16	0.5	<0.20	<0.17	No data	0.7	0.91	<0.14	1.68	0.43
Chrysene	PAHMSUS	0.08	mg/kg^	UM	<0.15	0.5	<0.20	<0.17	No data	0.74	0.89	<0.14	1.61	0.39
Dibenzo[a,h]anthracene	PAHMSUS	0.08	mg/kg^	UM	0.24	0.98	0.24	0.24	No data	1.3	1.54	<0.14	2.78	0.55
Fluoranthene	PAHMSUS	0.08	mg/kg^	UM	<0.15	<0.19	<0.20	<0.17	No data	0.24	0.31	<0.14	0.58	<0.22
Fluorene	PAHMSUS	0.08	mg/kg^	UM	0.53	2.49	0.4	0.52	No data	2.63	3.12	<0.14	5.69	1.14
Indeno[1,2,3-cd]pyrene	PAHMSUS	0.08	mg/kg^	UM	<0.15	<0.19	<0.20	<0.17	No data	<0.12	0.18	<0.14	0.43	<0.22
Naphthalene	PAHMSUS	0.08	mg/kg^	UM	0.2	0.63	0.26	0.26	No data	1.13	1.46	<0.14	2.7	0.66
Phenanthrene	PAHMSUS	0.08	mg/kg^	UM	<0.15	<0.19	<0.20	<0.17	No data	<0.12	0.11	<0.14	0.34	<0.22
Pyrene	PAHMSUS	0.08	mg/kg^	UM	0.21	0.97	<0.20	0.23	No data	1.13	1.33	<0.14	2.75	0.42
Total PAH 16	PAHMSUS	1.28	mg/kg^	U	0.49	2.09	0.35	0.43	No data	2.13	2.47	<0.14	4.38	1.04
PCB 101	PCBECD	5	µg/kg^	UM	3.74	12.8	3.96	4	No data	16	19.1	<2.17	35.4	8.22
PCB 118	PCBECD	5	µg/kg^	UM	63.3	<11.7	<12.8	<10.9	No data	<7.70	11.2	<8.47	<12.1	<13.6
PCB 138	PCBECD	5	µg/kg^	UM	54	<11.7	<12.8	<10.9	No data	<7.70	8.56	<8.47	<12.1	<13.6
PCB 153	PCBECD	5	µg/kg^	UM	63.5	19.5	<12.8	<10.9	No data	<7.70	9.67	<8.47	<12.1	<13.6
PCB 180	PCBECD	5	µg/kg^	UM	62.2	15.9	<12.8	<10.9	No data	<7.70	11.3	<8.47	<12.1	<13.6
PCB 28	PCBECD	5	µg/kg^	UM	9.55	<11.7	<12.8	<10.9	No data	<7.70	<6.61	<8.47	<12.1	<13.6
PCB 52	PCBECD	5	µg/kg^	UM	230	16.9	<12.8	<10.9	No data	<7.70	<6.61	<8.47	<12.1	<13.6
Total TPH >C8-C40 EH_1D_Total	TPHFIDUS	10	mg/kg^	UM	120	11.8	<12.8	<10.9	No data	<7.70	<6.61	<8.47	<12.1	<13.6
Total moisture at 35°C	CLANDPREP	0.1	%	N	438	610	415.00	550	No data	934	475	52	1020	1040
Description of Solid Material	CLANDPREP		-	N	SILT	SILT	SILT	SILT	No data	SILT	SILT	SILT	SILT	SILT

Table G.11: Chemical analysis of canal bed sediments GUC 21 to GUC 30 (SOCOTEC UK Ltd.)

Analysis	Method	MDL	Units	Accred	GUC21	GUC22	GUC23	GUC24	GUC25	GUC26	GUC27	GUC28	GUC29	GUC30
Arsenic as As	ICPMSS	0.3	mg/kg^	UM	**17.20**	**13.40**	**18.60**	**13.90**	**24.30**	**15.80**	**23.70**	**14.30**	**18.40**	No data
Cadmium as Cd	ICPMSS	0.2	mg/kg^	UM	**0.70**	0.5	0.5	0.5	0.3	<0.2	0.3	0.4	0.3	No data
Copper as Cu	ICPMSS	1.6	mg/kg^	UM	**145.90**	42.40	43.40	40.10	24.50	15.80	27.20	34.20	29.30	No data
Lead as Pb	ICPMSS	0.7	mg/kg^	UM	**57.50**	42.00	41.40	36.20	26.40	26.20	32.80	35.70	42.70	No data
Mercury as Hg	ICPMSS	0.5	mg/kg^	UM	**<0.5**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	No data
Nickel as Ni	ICPMSS	2	mg/kg^	UM	**85.00**	42.70	46.20	43.10	43.40	25.40	40.20	41.20	35.00	No data
Total Chromium as Cr	ICPMSS	1.2	mg/kg^	UM	**50.60**	37.60	43.30	36.40	31.80	20.60	35.80	42.80	47.60	No data
Zinc as Zn	ICPMSS	16	mg/kg^	UM	**225.20**	392.90	329.80	240.90	119.50	116.30	150.20	297.50	194.00	No data
Acenaphthene	PAHMSUS	0.08	mg/kg^	UM	**<0.21**	<0.27	<0.34	<0.20	<0.15	<0.14	<0.19	<0.24	<0.23	No data

Analysis	Method	MDL	Units	Accred	GUC21	GUC22	GUC23	GUC24	GUC25	GUC26	GUC27	GUC28	GUC29	GUC30
Acenaphthylene	PAHMSUS	0.08	mg/kg^	U	**<0.21**	<0.27	<0.34	<0.20	<0.15	<0.14	<0.19	<0.24	<0.23	No data
Anthracene	PAHMSUS	0.08	mg/kg^	U	**<0.21**	<0.27	<0.34	<0.20	<0.15	<0.14	<0.19	<0.24	<0.23	No data
Benzo[a]anthracene	PAHMSUS	0.08	mg/kg^	UM	**0.33**	0.3	<0.34	<0.20	<0.15	<0.14	<0.19	<0.24	0.41	No data
Benzo[a]pyrene	PAHMSUS	0.08	mg/kg^	UM	**0.58**	0.54	<0.34	<0.20	<0.15	<0.14	<0.19	<0.24	0.68	No data
Benzo[b]fluoranthene	PAHMSUS	0.08	mg/kg^	UM	**0.67**	0.68	0.35	<0.20	<0.15	<0.14	0.20	<0.24	0.84	No data
Benzo[g,h,i]perylene	PAHMSUS	0.08	mg/kg^	UM	**0.32**	0.3	<0.34	<0.20	<0.15	<0.14	<0.19	<0.24	0.41	No data
Benzo[k]fluoranthene	PAHMSUS	0.08	mg/kg^	UM	**0.31**	0.29	<0.34	<0.20	<0.15	<0.14	<0.19	<0.24	0.33	No data
Chrysene	PAHMSUS	0.08	mg/kg^	UM	**0.33**	0.48	<0.34	<0.20	<0.15	<0.14	0.21	<0.24	0.58	No data
Dibenzo[a,h]anthracene	PAHMSUS	0.08	mg/kg^	UM	**<0.21**	<0.27	<0.34	<0.20	<0.15	<0.14	<0.19	<0.24	<0.23	No data
Fluoranthene	PAHMSUS	0.08	mg/kg^	UM	**0.47**	0.7	<0.34	<0.20	<0.15	<0.14	0.22	<0.24	0.81	No data
Fluorene	PAHMSUS	0.08	mg/kg^	UM	**<0.21**	<0.27	<0.34	<0.20	<0.15	<0.14	<0.19	<0.24	<0.23	No data
Indeno[1,2,3-cd]pyrene	PAHMSUS	0.08	mg/kg^	UM	**0.51**	0.44	<0.34	<0.20	<0.15	<0.14	<0.19	<0.24	0.55	No data
Naphthalene	PAHMSUS	0.08	mg/kg^	UM	**<0.21**	<0.27	<0.34	<0.20	<0.15	<0.14	<0.19	<0.24	<0.23	No data
Phenanthrene	PAHMSUS	0.08	mg/kg^	UM	**<0.21**	<0.27	<0.34	<0.20	<0.15	<0.14	<0.19	<0.24	<0.23	No data
Pyrene	PAHMSUS	0.08	mg/kg^	UM	**0.73**	0.66	<0.34	<0.20	<0.15	<0.14	0.21	<0.24	0.86	No data
Total PAH 16	PAHMSUS	1.28	mg/kg^	U	**5.68**	6.28	5.39	<3.20	<2.38	<2.25	3.16	<3.81	7.10	No data
PCB 101	PCBECD	5	µg/kg^	UM	**<12.9**	<16.8	<21.0	<12.5	<9.31	<8.77	<12.1	<14.9	<14.5	No data
PCB 118	PCBECD	5	µg/kg^	UM	**<12.9**	<16.8	<21.0	<12.5	<9.31	<8.77	<12.1	<14.9	<14.5	No data
PCB 138	PCBECD	5	µg/kg^	UM	**<12.9**	<16.8	<21.0	<12.5	<9.31	<8.77	<12.1	<14.9	<14.5	No data
PCB 153	PCBECD	5	µg/kg^	UM	**<12.9**	<16.8	<21.0	<12.5	<9.31	<8.77	<12.1	<14.9	<14.5	No data
PCB 180	PCBECD	5	µg/kg^	UM	**<12.9**	<16.8	<21.0	<12.5	<9.31	<8.77	<12.1	<14.9	<14.5	No data
PCB 28	PCBECD	5	µg/kg^	UM	**<12.9**	<16.8	<21.0	<12.5	<9.31	<8.77	<12.1	<14.9	<14.5	No data
PCB 52	PCBECD	5	µg/kg^	UM	**<12.9**	<16.8	<21.0	<12.5	<9.31	<8.77	<12.1	<14.9	<14.5	No data
Total TPH >C8-C40 EH_1D_Total	TPHFIDUS	10	mg/kg^	UM	**871.00**	870.00	954.00	347.00	326.00	203.00	255.00	567.00	673.00	No data
Total moisture at 35°C	CLANDPREP	0.1	%	N	**61.10**	70.20	76.20	60.00	46.30	43.00	58.70	66.40	65.50	No data
Description of Solid Material	CLANDPREP		-	N	**SILT**	SILT	SILT	SILT	SILT	SILT	SILT	SILT	SILT	No data

Table G.12: Chemical analysis of canal bed sediments GUC 31 to GUC 40 (SOCOTEC UK Ltd.)

Analysis	Method	MDL	Units	Accred	GUC31	GUC32	GUC33	GUC34	GUC35	GUC36	GUC37	GUC38	GUC39	GUC40
Arsenic as As	ICPMSS	0.3	mg/kg^	UM	15.00	14.20	11.70	12.90	11.10	9.00	12.30	10.10	12.70	15.70
Cadmium as Cd	ICPMSS	0.2	mg/kg^	UM	0.7	0.7	0.4	0.4	0.4	0.3	1.00	0.5	0.8	7.10
Copper as Cu	ICPMSS	1.6	mg/kg^	UM	86.00	60.40	29.80	34.00	32.40	24.20	77.90	46.10	40.70	113.20
Lead as Pb	ICPMSS	0.7	mg/kg^	UM	64.90	50.50	31.10	36.60	36.90	30.40	129.40	42.60	42.50	175.30
Mercury as Hg	ICPMSS	0.5	mg/kg^	UM	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel as Ni	ICPMSS	2	mg/kg^	UM	60.30	46.80	27.60	32.40	30.00	18.90	28.20	30.70	37.00	39.70
Total Chromium as Cr	ICPMSS	1.2	mg/kg^	UM	50.20	50.30	37.00	44.00	39.80	21.20	39.80	35.40	40.20	41.10
Zinc as Zn	ICPMSS	16	mg/kg^	UM	231.20	270.90	190.50	185.90	177.50	128.60	433.50	334.10	279.60	651.10

Analysis	Method	MDL	Units	Accred	GUC31	GUC32	GUC33	GUC34	GUC35	GUC36	GUC37	GUC38	GUC39	GUC40
Acenaphthene	PAHMSUS	0.08	mg/kg^	UM	<0.18	<0.19	<0.24	<0.24	<0.26	<0.19	<0.30	<0.36	<0.30	<0.40
Acenaphthylene	PAHMSUS	0.08	mg/kg^	U	<0.18	<0.19	<0.24	<0.24	<0.26	<0.19	<0.30	<0.36	<0.30	<0.40
Anthracene	PAHMSUS	0.08	mg/kg^	U	0.26	<0.19	<0.24	<0.24	<0.26	<0.19	<0.30	<0.36	<0.30	<0.40
Benzo[a]anthracene	PAHMSUS	0.08	mg/kg^	UM	1.28	0.4	<0.24	<0.24	<0.26	<0.19	0.43	<0.36	<0.30	1.43
Benzo[a]pyrene	PAHMSUS	0.08	mg/kg^	UM	1.71	0.66	0.24	0.43	0.3	0.26	0.76	<0.36	0.3	2.07
Benzo[b]fluoranthene	PAHMSUS	0.08	mg/kg^	UM	2.11	0.87	0.33	0.53	0.35	0.31	1.08	<0.36	0.37	2.82
Benzo[g,h,i]perylene	PAHMSUS	0.08	mg/kg^	UM	0.96	0.4	<0.24	0.27	<0.26	0.2	0.48	<0.36	<0.30	1.35
Benzo[k]fluoranthene	PAHMSUS	0.08	mg/kg^	UM	0.82	0.32	<0.24	0.27	<0.26	<0.19	0.45	<0.36	<0.30	1.10
Chrysene	PAHMSUS	0.08	mg/kg^	UM	1.45	0.56	<0.24	0.35	<0.26	<0.19	0.74	<0.36	<0.30	1.79
Dibenzo[a,h]anthracene	PAHMSUS	0.08	mg/kg^	UM	0.26	<0.19	<0.24	<0.24	<0.26	<0.19	<0.30	<0.36	<0.30	<0.40
Fluoranthene	PAHMSUS	0.08	mg/kg^	UM	2.43	0.89	0.26	0.52	0.33	0.28	0.92	<0.36	0.42	2.74
Fluorene	PAHMSUS	0.08	mg/kg^	UM	<0.18	<0.19	<0.24	<0.24	<0.26	<0.19	<0.30	<0.36	<0.30	<0.40
Indeno[1,2,3-cd]pyrene	PAHMSUS	0.08	mg/kg^	UM	1.29	0.54	<0.24	0.37	<0.26	0.24	0.65	<0.36	<0.30	1.76
Naphthalene	PAHMSUS	0.08	mg/kg^	UM	<0.18	<0.19	<0.24	<0.24	<0.26	<0.19	<0.30	<0.36	<0.30	<0.40
Phenanthrene	PAHMSUS	0.08	mg/kg^	UM	0.79	<0.19	<0.24	<0.24	<0.26	<0.19	<0.30	<0.36	<0.30	0.86
Pyrene	PAHMSUS	0.08	mg/kg^	UM	2.44	0.86	0.24	0.5	0.3	0.28	1.00	<0.36	0.39	2.72
Total PAH 16	PAHMSUS	1.28	mg/kg^	U	16.50	6.86	3.93	5.19	4.42	3.44	8.60	<5.71	5.07	21.10
PCB 101	PCBECD	5	µg/kg^	UM	<11.1	<12.0	<14.9	<15.2	<16.3	<11.8	<18.7	<22.3	<18.7	<25.3
PCB 118	PCBECD	5	µg/kg^	UM	<11.1	<12.0	<14.9	<15.2	<16.3	<11.8	<18.7	<22.3	<18.7	<25.3
PCB 138	PCBECD	5	µg/kg^	UM	<11.1	<12.0	<14.9	<15.2	<16.3	<11.8	<18.7	<22.3	<18.7	<25.3
PCB 153	PCBECD	5	µg/kg^	UM	<11.1	<12.0	<14.9	<15.2	<16.3	<11.8	<18.7	<22.3	<18.7	<25.3
PCB 180	PCBECD	5	µg/kg^	UM	<11.1	<12.0	<14.9	<15.2	<16.3	<11.8	<18.7	<22.3	<18.7	<25.3
PCB 28	PCBECD	5	µg/kg^	UM	<11.1	<12.0	<14.9	<15.2	<16.3	<11.8	<18.7	<22.3	<18.7	<25.3
PCB 52	PCBECD	5	µg/kg^	UM	<11.1	<12.0	<14.9	<15.2	<16.3	<11.8	<18.7	<22.3	<18.7	<25.3
Total TPH >C8-C40 EH_1D_Total	TPHFIDUS	10	mg/kg^	UM	1280.00	776.00	602.00	523.00	537.00	641.00	1640.00	978.00	1440.00	3860.00
Total moisture at 35°C	CLANDPREP	0.1	%	N	54.90	58.40	66.40	67.20	69.40	57.50	73.30	77.60	73.20	80.20
Description of Solid Material	CLANDPREP		-	N	SILT	SILT	SILT	SILT	SILT	SILT	SILT	SILT	SILT	SILT

Table G.13: Chemical analysis of canal bed sediments GUC 41 to GUC 47 (SOCOTEC UK Ltd.)

Analysis	Method	MDL	Units	Accred	GUC41	GUC42	GUC43	GUC44	GUC45	GUC46	GUC47
Arsenic as As	ICPMSS	0.3	mg/kg^	UM	15.40	17.50	10.50	11.70	15.20	4.80	14.70
Cadmium as Cd	ICPMSS	0.2	mg/kg^	UM	0.9	0.3	0.7	0.6	0.2	<0.2	<0.2
Copper as Cu	ICPMSS	1.6	mg/kg^	UM	58.00	34.70	35.70	38.20	18.60	17.60	12.80
Lead as Pb	ICPMSS	0.7	mg/kg^	UM	54.00	51.20	57.20	49.80	19.80	15.80	10.60
Mercury as Hg	ICPMSS	0.5	mg/kg^	UM	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel as Ni	ICPMSS	2	mg/kg^	UM	33.20	34.60	29.00	34.30	41.20	27.60	34.50
Total Chromium as Cr	ICPMSS	1.2	mg/kg^	UM	35.30	31.50	30.60	35.50	30.30	23.40	22.60

Analysis	Method	MDL	Units	Accred	GUC41	GUC42	GUC43	GUC44	GUC45	GUC46	GUC47
Zinc as Zn	ICPMSS	16	mg/kg^	UM	310.70	105.40	212.70	182.90	67.60	79.00	42.10
Acenaphthene	PAHMSUS	0.08	mg/kg^	UM	<0.30	<0.16	<0.27	<0.23	<0.11	<0.16	<0.11
Acenaphthylene	PAHMSUS	0.08	mg/kg^	U	<0.30	<0.16	<0.27	<0.23	<0.11	<0.16	<0.11
Anthracene	PAHMSUS	0.08	mg/kg^	U	<0.30	0.32	<0.27	0.3	<0.11	<0.16	<0.11
Benzo[a]anthracene	PAHMSUS	0.08	mg/kg^	UM	0.32	1.50	<0.27	1.64	<0.11	<0.16	<0.11
Benzo[a]pyrene	PAHMSUS	0.08	mg/kg^	UM	0.54	1.82	0.36	1.99	<0.11	<0.16	<0.11
Benzo[b]fluoranthene	PAHMSUS	0.08	mg/kg^	UM	0.79	2.34	0.5	2.43	<0.11	<0.16	<0.11
Benzo[g,h,i]perylene	PAHMSUS	0.08	mg/kg^	UM	0.44	0.97	<0.27	1.11	<0.11	<0.16	<0.11
Benzo[k]fluoranthene	PAHMSUS	0.08	mg/kg^	UM	<0.30	0.94	<0.27	0.98	<0.11	<0.16	<0.11
Chrysene	PAHMSUS	0.08	mg/kg^	UM	0.35	1.52	<0.27	1.60	<0.11	<0.16	<0.11
Dibenzo[a,h]anthracene	PAHMSUS	0.08	mg/kg^	UM	<0.30	0.26	<0.27	0.28	<0.11	<0.16	<0.11
Fluoranthene	PAHMSUS	0.08	mg/kg^	UM	0.69	2.77	0.57	3.42	<0.11	<0.16	<0.11
Fluorene	PAHMSUS	0.08	mg/kg^	UM	<0.30	<0.16	<0.27	<0.23	<0.11	<0.16	<0.11
Indeno[1,2,3-cd]pyrene	PAHMSUS	0.08	mg/kg^	UM	0.47	1.14	0.31	1.27	<0.11	<0.16	<0.11
Naphthalene	PAHMSUS	0.08	mg/kg^	UM	<0.30	0.17	<0.27	<0.23	<0.11	<0.16	<0.11
Phenanthrene	PAHMSUS	0.08	mg/kg^	UM	<0.30	0.74	<0.27	1.17	<0.11	<0.16	<0.11
Pyrene	PAHMSUS	0.08	mg/kg^	UM	0.64	2.54	0.53	2.84	<0.11	<0.16	<0.11
Total PAH 16	PAHMSUS	1.28	mg/kg^	U	6.65	17.50	5.19	20.00	<1.74	<2.48	<1.78
PCB 101	PCBECD	5	µg/kg^	UM	<18.8	<10.1	<16.6	<14.5	<6.78	<9.69	<6.95
PCB 118	PCBECD	5	µg/kg^	UM	<18.8	<10.1	<16.6	<14.5	<6.78	<9.69	<6.95
PCB 138	PCBECD	5	µg/kg^	UM	<18.8	<10.1	<16.6	<14.5	<6.78	<9.69	<6.95
PCB 153	PCBECD	5	µg/kg^	UM	<18.8	<10.1	<16.6	<14.5	<6.78	<9.69	<6.95
PCB 180	PCBECD	5	µg/kg^	UM	<18.8	<10.1	<16.6	<14.5	<6.78	<9.69	<6.95
PCB 28	PCBECD	5	µg/kg^	UM	<18.8	<10.1	<16.6	<14.5	<6.78	<9.69	<6.95
PCB 52	PCBECD	5	µg/kg^	UM	<18.8* B	<10.1* B	<16.6* B	<14.5* B	<6.78* B	<9.69* B	<6.95* B
Total TPH >C8-C40 EH_1D_Total	TPHFIDUS	10	mg/kg^	UM	1070.00	379.00	232.00	727.00	30.80	127.00	29.80
Total moisture at 35°C	CLANDPREP	0.1	%	N	73.40	50.60	69.90	65.40	26.30	48.40	28.10
Description of Solid Material	CLANDPREP		-	N	SILT	SILT	SILT	SILT	CLAY	SILT	SILT

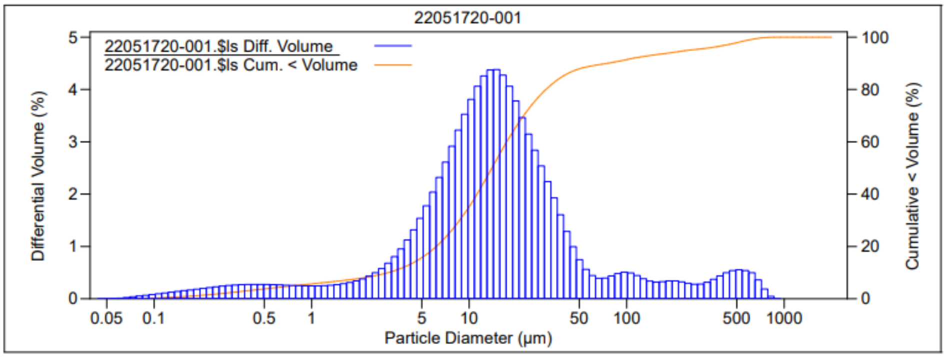
Table G.14: Chemical analysis of connected waterbody sediments GUC C1 to GUC C8 (SOCOTEC UK Ltd.)

Analysis	Method	MDL	Units	Accred	GUC C1	GUC C2	GUC C3	GUC C4	GUC C5	GUC C6	GUC C7	GUC C8
Arsenic as As	ICPMSS	0.3	mg/kg^	UM	24.3	No data	32.7	11.90	30.1	10.10	48.6	36.8
Cadmium as Cd	ICPMSS	0.2	mg/kg^	UM	34	No data	16.7	0.3	28.9	0.5	13.8	18.1
Copper as Cu	ICPMSS	1.6	mg/kg^	UM	0.2	No data	<0.2	28.20	0.3	46.00	4.7	0.8
Lead as Pb	ICPMSS	0.7	mg/kg^	UM	15.1	No data	12.2	26.60	18.4	182.90	39.2	36.8
Mercury as Hg	ICPMSS	0.5	mg/kg^	UM	20.6	No data	15.5	<0.5	21.6	<0.5	42.4	37.8
Nickel as Ni	ICPMSS	2	mg/kg^	UM	<0.5	No data	<0.5	29.20	<0.5	26.90	<0.5	<0.5
Total Chromium as Cr	ICPMSS	1.2	mg/kg^	UM	22.4	No data	20.7	40.00	37	28.00	30.6	26

Analysis	Method	MDL	Units	Accred	GUC C1	GUC C2	GUC C3	GUC C4	GUC C5	GUC C6	GUC C7	GUC C8
Zinc as Zn	ICPMSS	16	mg/kg^	UM	24	No data	39.6	127.20	43.8	177.10	35.7	31.1
Acenaphthene	PAHMSUS	0.08	mg/kg^	UM	76.3	No data	75.7	<0.24	119.2	<0.35	197.7	221.5
Acenaphthylene	PAHMSUS	0.08	mg/kg^	U	<0.11	No data	<0.12	<0.24	<0.11	<0.35	<0.16	<0.13
Anthracene	PAHMSUS	0.08	mg/kg^	U	<0.11	No data	<0.12	<0.24	<0.11	<0.35	<0.16	<0.13
Benzo[a]anthracene	PAHMSUS	0.08	mg/kg^	UM	<0.11	No data	<0.12	<0.24	<0.11	<0.35	<0.16	0.69
Benzo[a]pyrene	PAHMSUS	0.08	mg/kg^	UM	<0.11	No data	<0.12	<0.24	<0.11	<0.35	0.29	2.98
Benzo[b]fluoranthene	PAHMSUS	0.08	mg/kg^	UM	<0.11	No data	<0.12	<0.24	<0.11	0.47	0.46	3.01
Benzo[g,h,i]perylene	PAHMSUS	0.08	mg/kg^	UM	<0.11	No data	<0.12	<0.24	<0.11	<0.35	0.61	3.24
Benzo[k]fluoranthene	PAHMSUS	0.08	mg/kg^	UM	<0.11	No data	<0.12	<0.24	<0.11	<0.35	0.36	1.37
Chrysene	PAHMSUS	0.08	mg/kg^	UM	<0.11	No data	<0.12	<0.24	<0.11	<0.35	0.23	1.35
Dibenzo[a,h]anthracene	PAHMSUS	0.08	mg/kg^	UM	<0.11	No data	<0.12	<0.24	<0.11	<0.35	0.33	2.26
Fluoranthene	PAHMSUS	0.08	mg/kg^	UM	<0.11	No data	<0.12	<0.24	<0.11	0.39	<0.16	0.41
Fluorene	PAHMSUS	0.08	mg/kg^	UM	<0.11	No data	<0.12	<0.24	<0.11	<0.35	0.63	4.47
Indeno[1,2,3-cd]pyrene	PAHMSUS	0.08	mg/kg^	UM	<0.11	No data	<0.12	<0.24	<0.11	<0.35	<0.16	<0.13
Naphthalene	PAHMSUS	0.08	mg/kg^	UM	<0.11	No data	<0.12	<0.24	<0.11	<0.35	0.41	1.73
Phenanthrene	PAHMSUS	0.08	mg/kg^	UM	<0.11	No data	<0.12	<0.24	<0.11	<0.35	<0.16	<0.13
Pyrene	PAHMSUS	0.08	mg/kg^	UM	<0.11	No data	<0.12	<0.24	<0.11	0.36	0.17	1.15
Total PAH 16	PAHMSUS	1.28	mg/kg^	U	<0.11	No data	<0.12	<3.84	<0.11	5.80	0.62	4.02
PCB 101	PCBECD	5	µg/kg^	UM	<1.69	No data	<1.90	<15.0	<1.83	<22.0	5.02	27.2
PCB 118	PCBECD	5	µg/kg^	UM	<6.61	No data	<7.43	<15.0	<7.15	<22.0	<9.73	<7.91
PCB 138	PCBECD	5	µg/kg^	UM	<6.61	No data	<7.43	<15.0	<7.15	<22.0	<9.73	<7.91
PCB 153	PCBECD	5	µg/kg^	UM	<6.61	No data	<7.43	<15.0	<7.15	<22.0	<9.73	<7.91
PCB 180	PCBECD	5	µg/kg^	UM	<6.61	No data	<7.43	<15.0	<7.15	<22.0	<9.73	<7.91
PCB 28	PCBECD	5	µg/kg^	UM	<6.61	No data	<7.43	<15.0	<7.15	<22.0	<9.73	<7.91
PCB 52	PCBECD	5	µg/kg^	UM	<6.61	No data	<7.43	<15.0* B	<7.15	<22.0* B	<9.73	<7.91
Total TPH >C8-C40 EH_1D_Total	TPHFIDUS	10	mg/kg^	UM	<6.61	No data	<7.43	168.00	<7.15	1050.00	<9.73	<7.91
Total moisture at 35°C	CLANDPREP	0.1	%	N	69.4	No data	63.7	66.70	46.40	77.30	738	2010
Description of Solid Material	CLANDPREP		-	N	SAND	No data	SILT	SILT	CLAY	SILT	SILT	SILT

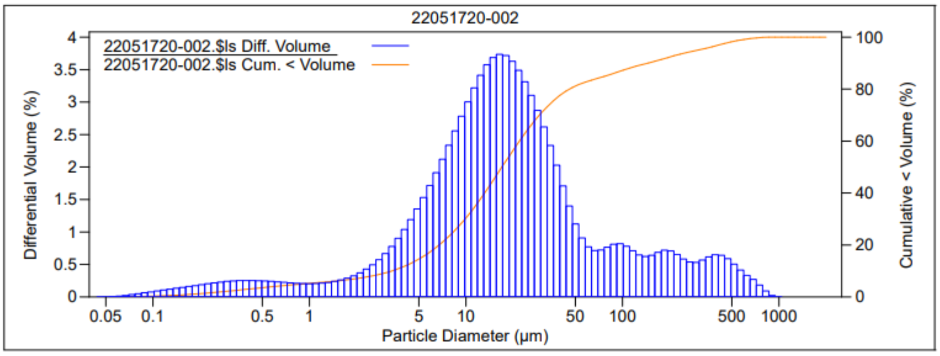
H. PSA for water samples

H.1 W1 T-30s



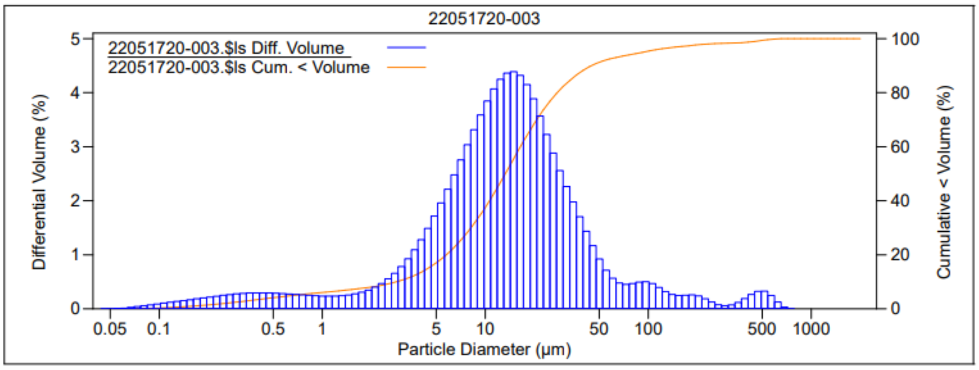
```
Volume Statistics (Geometric)          22051720-001.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                13.77 µm          S.D.:         4.414
Median:              13.97 µm          Variance:     19.49
D(3,2):              3.247 µm          Skewness:     -0.218 Left skewed
Mean/Median ratio:   0.985             Kurtosis:     1.802 Leptokurtic
Mode:                14.94 µm

d10:   3.062 µm             d50:   13.97 µm             d90:   75.35 µm

Folk and Ward Statistics (Phi)
Mean:        6.18        Median:     6.16         Deviation:    1.98
Skewness:    0.01        Kurtosis:   1.91

<10%         <25%        <50%        <75%        <90%
3.062 µm     7.466 µm    13.97 µm    25.73 µm    75.35 µm

<2 µm        <63 µm      <2000 µm
7.76%        89.2%       100%
```

H.2 W1 T+30s



```
Volume Statistics (Geometric)          22051720-002.$ls

Calculations from 0.040 µm to 2000 µm

Volume:              100%
Mean:                17.30 µm          S.D.:         4.773
Median:              17.00 µm          Variance:     22.78
D(3,2):              3.520 µm          Skewness:     -0.321 Left skewed
Mean/Median ratio:   1.018             Kurtosis:     1.198 Leptokurtic
Mode:                16.40 µm

d10:   3.366 µm             d50:   17.00 µm             d90:   145.5 µm

Folk and Ward Statistics (Phi)
Mean:        5.76        Median:     5.88         Deviation:    2.18
Skewness:    -0.05       Kurtosis:   1.64

<10%         <25%        <50%        <75%        <90%
3.366 µm     8.310 µm    17.00 µm    35.50 µm    145.5 µm

<2 µm        <63 µm      <2000 µm
7.04%        83.4%       100%
```

H.3 W1 T+5 min



Volume Statistics (Geometric) 22051720-003.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	11.88 µm	S.D.:	3.882
Median:	13.30 µm	Variance:	15.07
D(3,2):	3.042 µm	Skewness:	-0.666 Left skewed
Mean/Median ratio:	0.893	Kurtosis:	2.267 Leptokurtic
Mode:	14.94 µm		

d_{10}: 2.865 µm d_{50}: 13.30 µm d_{90}: 44.91 µm

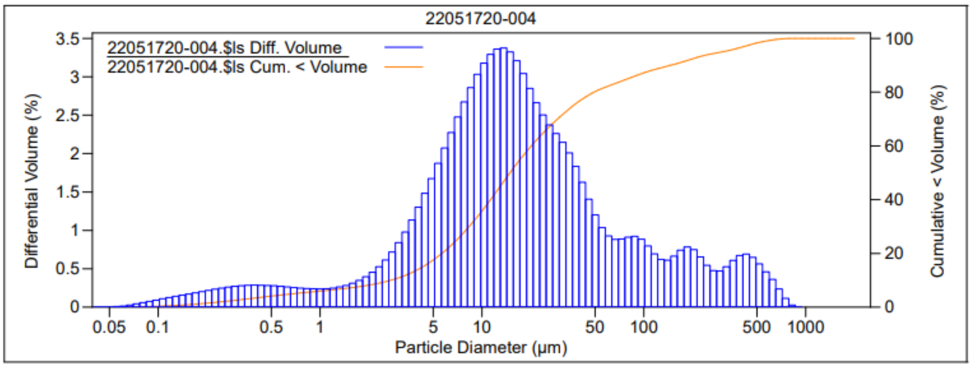
Folk and Ward Statistics (Phi)

Mean:	6.30	Median:	6.23	Deviation:	1.77
Skewness:	0.14	Kurtosis:	1.65		

<10%	<25%	<50%	<75%	<90%
2.865 µm	6.982 µm	13.30 µm	23.69 µm	44.91 µm

<2 µm	<63 µm	<2000 µm
8.04%	93.0%	100%

H.4 W1 T+10 min



Volume Statistics (Geometric) 22051720-004.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	15.72 µm	S.D.:	5.106
Median:	14.94 µm	Variance:	26.07
D(3,2):	3.080 µm	Skewness:	-0.268 Left skewed
Mean/Median ratio:	1.052	Kurtosis:	0.828 Leptokurtic
Mode:	13.61 µm		

d_{10}: 2.741 µm d_{50}: 14.94 µm d_{90}: 146.7 µm

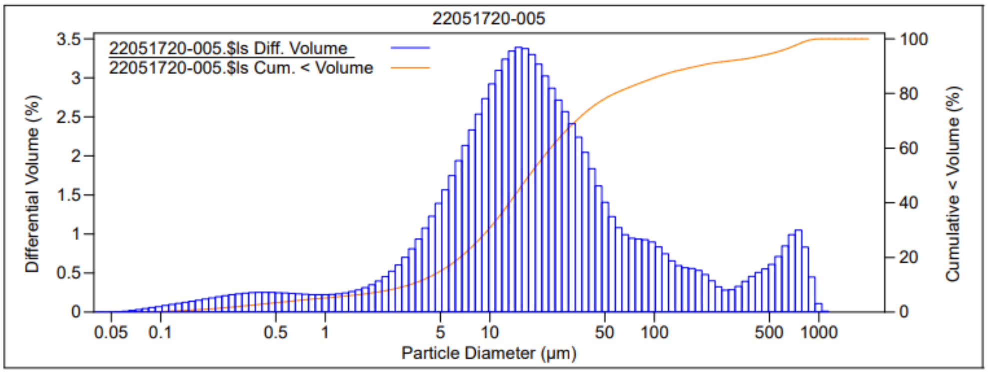
Folk and Ward Statistics (Phi)

Mean:	5.88	Median:	6.07	Deviation:	2.33
Skewness:	-0.07	Kurtosis:	1.51		

<10%	<25%	<50%	<75%	<90%
2.741 µm	6.992 µm	14.94 µm	36.69 µm	146.7 µm

<2 µm	<63 µm	<2000 µm
8.16%	82.7%	100%

H.5 W1 T+20 min



Volume Statistics (Geometric) 22051720-005.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	18.94 µm	S.D.:	5.356
Median:	17.35 µm	Variance:	28.69
D(3,2):	3.608 µm	Skewness:	-0.085 Left skewed
Mean/Median ratio:	1.092	Kurtosis:	0.877 Leptokurtic
Mode:	14.94 µm		

d_{10}: 3.256 µm d_{50}: 17.35 µm d_{90}: 182.2 µm

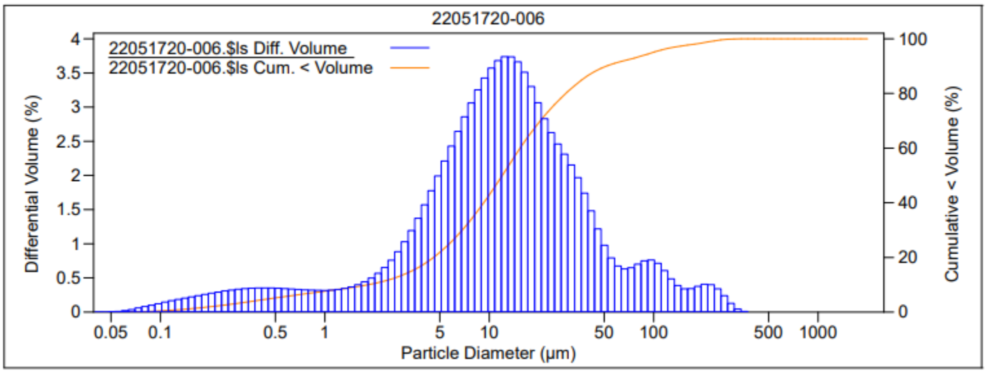
Folk and Ward Statistics (Phi)

Mean:	5.66	Median:	5.85	Deviation:	2.38
Skewness:	-0.11	Kurtosis:	1.59		

<10%	<25%	<50%	<75%	<90%
3.256 µm	8.137 µm	17.35 µm	41.85 µm	182.2 µm

<2 µm	<63 µm	<2000 µm
7.17%	81.1%	100%

H.6 W2 T-30s



Volume Statistics (Geometric) 22051720-006.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	10.51 µm	S.D.:	4.220
Median:	12.01 µm	Variance:	17.81
D(3,2):	2.451 µm	Skewness:	-0.767 Left skewed
Mean/Median ratio:	0.875	Kurtosis:	1.300 Leptokurtic
Mode:	12.40 µm		

d_{10}: 1.830 µm d_{50}: 12.01 µm d_{90}: 51.61 µm

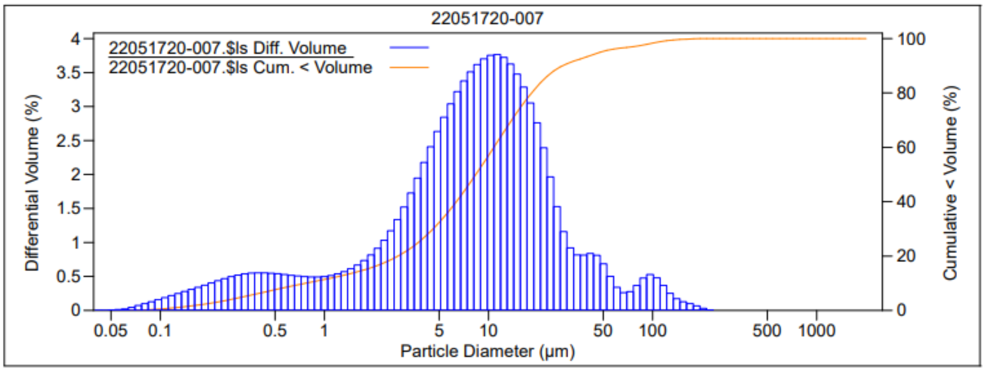
Folk and Ward Statistics (Phi)

Mean:	6.44	Median:	6.38	Deviation:	1.98
Skewness:	0.13	Kurtosis:	1.52		

<10%	<25%	<50%	<75%	<90%
1.830 µm	5.722 µm	12.01 µm	24.19 µm	51.61 µm

<2 µm	<63 µm	<2000 µm
10.5%	91.6%	100%

H.7 W2 T+30s



Volume Statistics (Geometric) 22051720-007.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	6.623 µm	S.D.:	4.107
Median:	8.378 µm	Variance:	16.87
D(3,2):	1.773 µm	Skewness:	-0.811 Left skewed
Mean/Median ratio:	0.791	Kurtosis:	0.803 Leptokurtic
Mode:	11.29 µm		

d_{10}: 0.769 µm d_{50}: 8.378 µm d_{90}: 28.32 µm

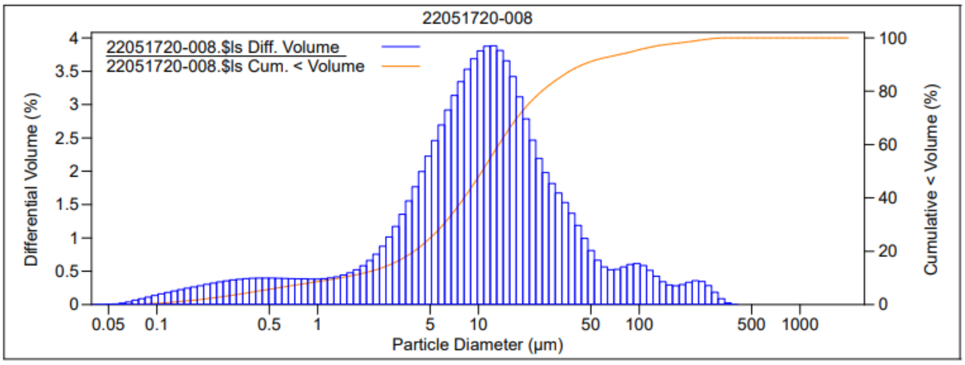
Folk and Ward Statistics (Phi)

Mean:	7.15	Median:	6.90	Deviation:	1.94
Skewness:	0.26	Kurtosis:	1.42		

<10%	<25%	<50%	<75%	<90%
0.769 µm	3.731 µm	8.378 µm	15.83 µm	28.32 µm

<2 µm	<63 µm	<2000 µm
16.0%	96.5%	100%

H.8 W2 T+5 min



Volume Statistics (Geometric) 22051720-008.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	9.133 µm	S.D.:	4.266
Median:	10.53 µm	Variance:	18.20
D(3,2):	2.217 µm	Skewness:	-0.672 Left skewed
Mean/Median ratio:	0.868	Kurtosis:	1.155 Leptokurtic
Mode:	12.40 µm		

d_{10}: 1.378 µm d_{50}: 10.53 µm d_{90}: 44.70 µm

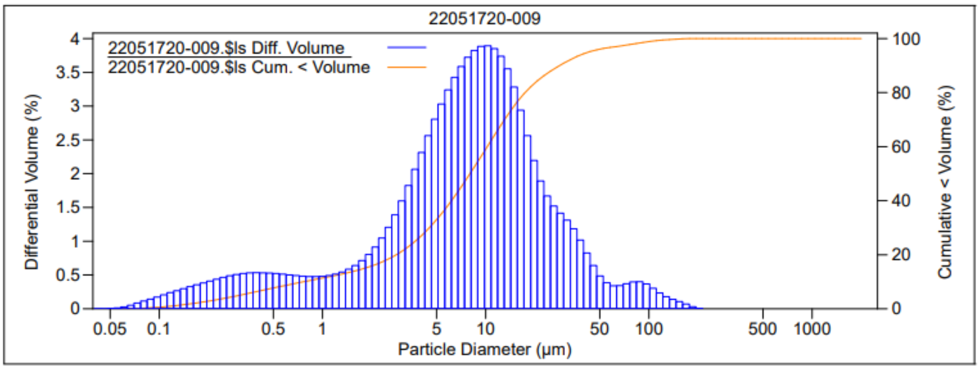
Folk and Ward Statistics (Phi)

Mean:	6.66	Median:	6.57	Deviation:	2.00
Skewness:	0.14	Kurtosis:	1.58		

<10%	<25%	<50%	<75%	<90%
1.378 µm	5.023 µm	10.53 µm	20.35 µm	44.70 µm

<2 µm	<63 µm	<2000 µm
12.0%	92.8%	100%

H.9 W2 T+10 min



Volume Statistics (Geometric) 22051720-009.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	6.389 µm	S.D.:	4.031
Median:	8.023 µm	Variance:	16.25
D(3,2):	1.724 µm	Skewness:	-0.866 Left skewed
Mean/Median ratio:	0.796	Kurtosis:	0.902 Leptokurtic
Mode:	10.29 µm		

d_{10}: 0.767 µm d_{50}: 8.023 µm d_{90}: 28.45 µm

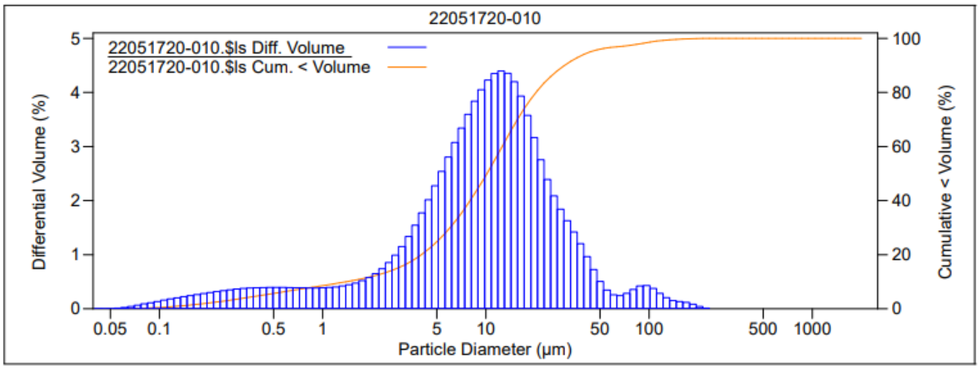
Folk and Ward Statistics (Phi)

Mean:	7.17	Median:	6.96	Deviation:	1.91
Skewness:	0.26	Kurtosis:	1.45		

<10%	<25%	<50%	<75%	<90%
0.767 µm	3.705 µm	8.023 µm	14.95 µm	28.45 µm

<2 µm	<63 µm	<2000 µm
15.9%	97.0%	100%

H.10 W2 T+20 min



Volume Statistics (Geometric) 22051720-010.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	8.109 µm	S.D.:	3.714
Median:	10.15 µm	Variance:	13.79
D(3,2):	2.208 µm	Skewness:	-1.081 Left skewed
Mean/Median ratio:	0.799	Kurtosis:	1.708 Leptokurtic
Mode:	12.40 µm		

d_{10}: 1.395 µm d_{50}: 10.15 µm d_{90}: 30.39 µm

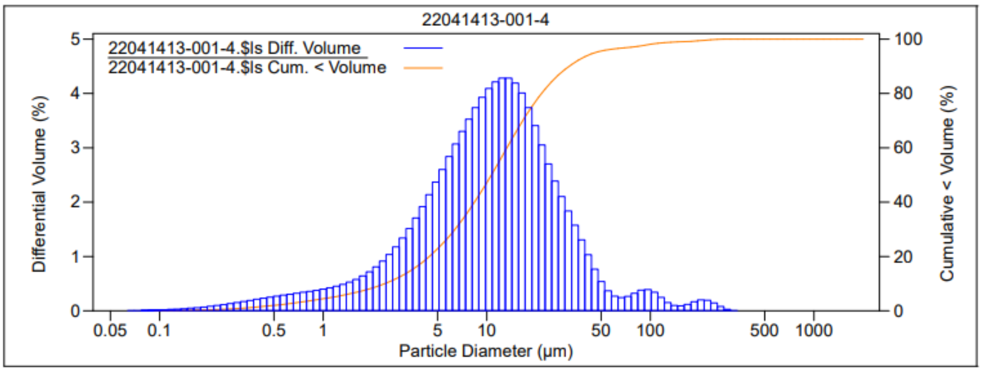
Folk and Ward Statistics (Phi)

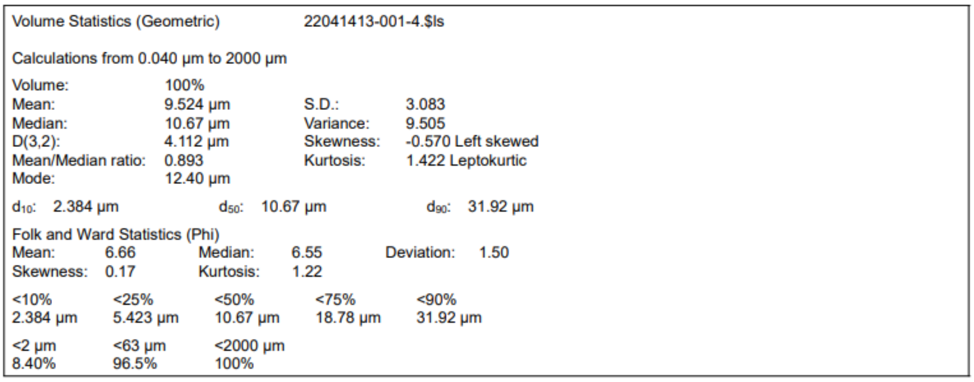
Mean:	6.79	Median:	6.62	Deviation:	1.73
Skewness:	0.27	Kurtosis:	1.51		

<10%	<25%	<50%	<75%	<90%
1.395 µm	5.050 µm	10.15 µm	17.65 µm	30.39 µm

<2 µm	<63 µm	<2000 µm
11.9%	96.9%	100%

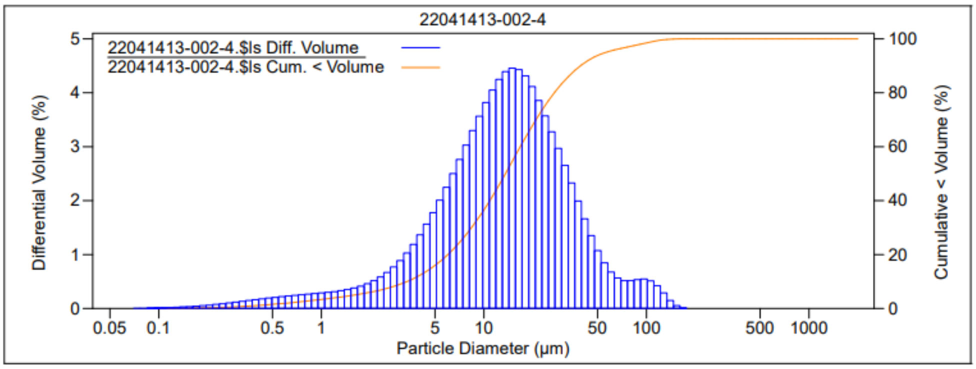
H.11 W3 T-30s

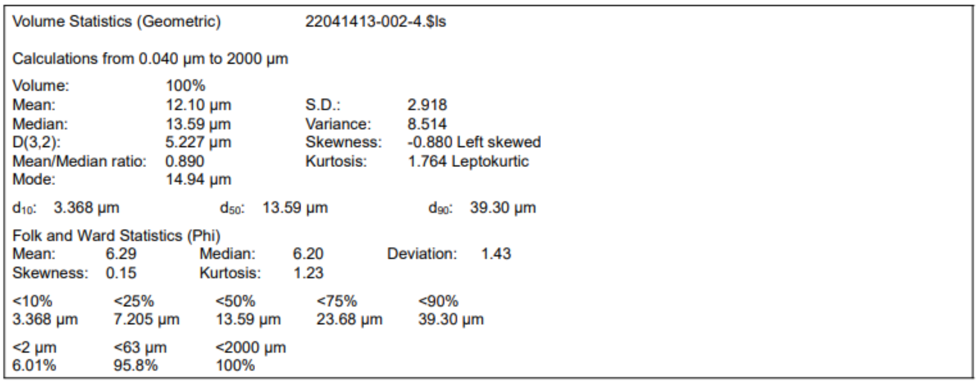




```
Volume Statistics (Geometric)          22041413-001-4.$ls

Calculations from 0.040 μm to 2000 μm

Volume:             100%
Mean:               9.524 μm        S.D.:        3.083
Median:             10.67 μm        Variance:    9.505
D(3,2):             4.112 μm        Skewness:    -0.570 Left skewed
Mean/Median ratio:  0.893           Kurtosis:    1.422 Leptokurtic
Mode:               12.40 μm

d10:   2.384 μm          d50:   10.67 μm           d90:   31.92 μm

Folk and Ward Statistics (Phi)
Mean:       6.66      Median:     6.55      Deviation:    1.50
Skewness:   0.17      Kurtosis:   1.22

<10%        <25%        <50%        <75%        <90%
2.384 μm    5.423 μm    10.67 μm    18.78 μm    31.92 μm

<2 μm       <63 μm      <2000 μm
8.40%       96.5%       100%
```

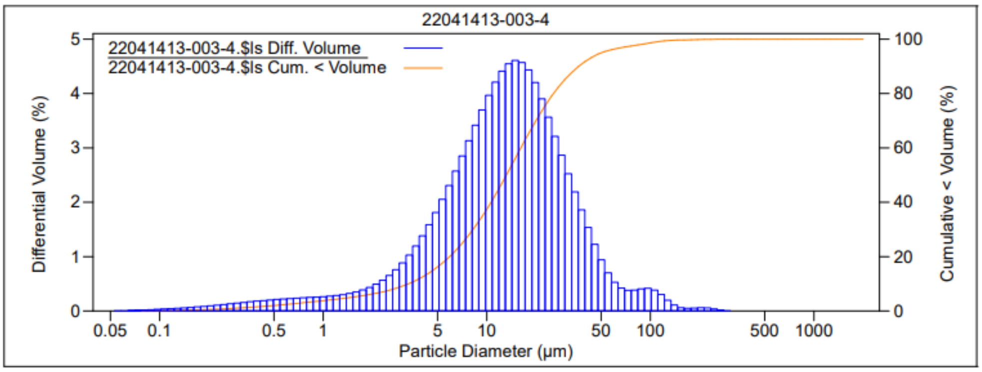
H.12 W3 T+30s





```
Volume Statistics (Geometric)          22041413-002-4.$ls

Calculations from 0.040 μm to 2000 μm

Volume:             100%
Mean:               12.10 μm        S.D.:        2.918
Median:             13.59 μm        Variance:    8.514
D(3,2):             5.227 μm        Skewness:    -0.880 Left skewed
Mean/Median ratio:  0.890           Kurtosis:    1.764 Leptokurtic
Mode:               14.94 μm

d10:   3.368 μm          d50:   13.59 μm           d90:   39.30 μm

Folk and Ward Statistics (Phi)
Mean:       6.29      Median:     6.20      Deviation:    1.43
Skewness:   0.15      Kurtosis:   1.23

<10%        <25%        <50%        <75%        <90%
3.368 μm    7.205 μm    13.59 μm    23.68 μm    39.30 μm

<2 μm       <63 μm      <2000 μm
6.01%       95.8%       100%
```

H.13 W3 T+5 min



Volume Statistics (Geometric) 22041413-003-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume: 100%
Mean: 11.57 µm
Median: 13.20 µm
D(3,2): 4.505 µm
Mean/Median ratio: 0.877
Mode: 14.94 µm

S.D.: 2.965
Variance: 8.789
Skewness: -1.039 Left skewed
Kurtosis: 2.452 Leptokurtic

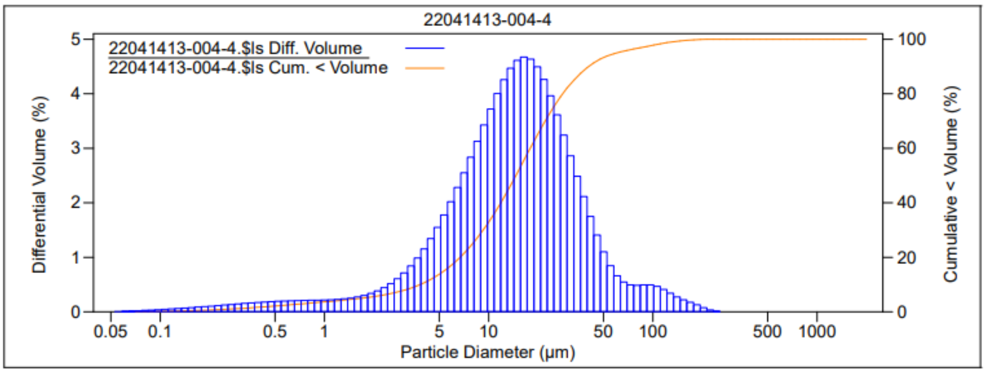
d_{10}: 3.322 µm d_{50}: 13.20 µm d_{90}: 36.48 µm

Folk and Ward Statistics (Phi)
Mean: 6.34 Median: 6.24 Deviation: 1.41
Skewness: 0.17 Kurtosis: 1.26

<10%	<25%	<50%	<75%	<90%
3.322 µm	7.095 µm	13.20 µm	22.46 µm	36.48 µm

<2 µm	<63 µm	<2000 µm
6.24%	96.6%	100%

H.14 W3 T+10 min



Volume Statistics (Geometric) 22041413-004-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume: 100%
Mean: 12.92 µm
Median: 14.68 µm
D(3,2): 4.589 µm
Mean/Median ratio: 0.880
Mode: 16.40 µm

S.D.: 3.024
Variance: 9.145
Skewness: -1.117 Left skewed
Kurtosis: 2.892 Leptokurtic

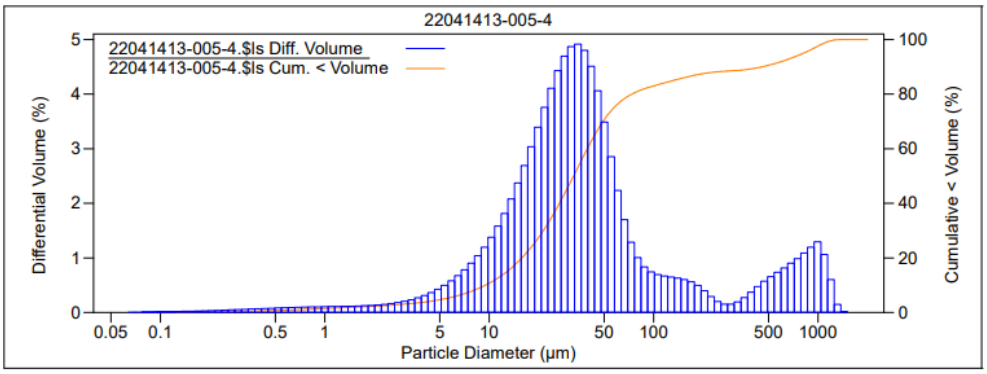
d_{10}: 3.829 µm d_{50}: 14.68 µm d_{90}: 40.71 µm

Folk and Ward Statistics (Phi)
Mean: 6.18 Median: 6.09 Deviation: 1.41
Skewness: 0.16 Kurtosis: 1.29

<10%	<25%	<50%	<75%	<90%
3.829 µm	7.990 µm	14.68 µm	24.81 µm	40.71 µm

<2 µm	<63 µm	<2000 µm
5.58%	95.3%	100%

H.15 W4 T-30s



Volume Statistics (Geometric) 22041413-005-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	37.96 µm	S.D.:	4.174
Median:	32.62 µm	Variance:	17.42
D(3,2):	10.86 µm	Skewness:	0.266 Right skewed
Mean/Median ratio:	1.164	Kurtosis:	1.506 Leptokurtic
Mode:	34.59 µm		

d_{10}: 9.496 µm d_{50}: 32.62 µm d_{90}: 456.6 µm

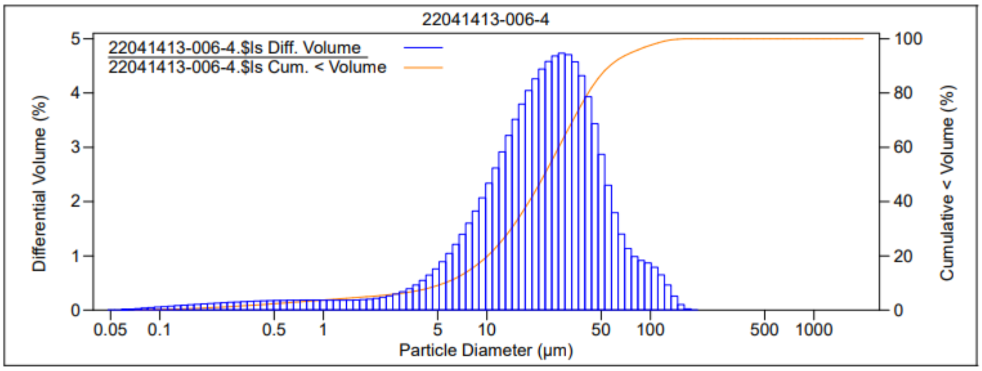
Folk and Ward Statistics (Phi)

Mean:	4.76	Median:	4.94	Deviation:	1.87
Skewness:	-0.23	Kurtosis:	1.84		

<10%	<25%	<50%	<75%	<90%
9.496 µm	18.64 µm	32.62 µm	57.26 µm	456.6 µm

<2 µm	<63 µm	<2000 µm
2.32%	77.4%	100%

H.16 W4 T+30s



Volume Statistics (Geometric) 22041413-006-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	18.44 µm	S.D.:	3.153
Median:	22.52 µm	Variance:	9.944
D(3,2):	4.837 µm	Skewness:	-1.696 Left skewed
Mean/Median ratio:	0.819	Kurtosis:	4.317 Leptokurtic
Mode:	28.70 µm		

d_{10}: 5.525 µm d_{50}: 22.52 µm d_{90}: 56.42 µm

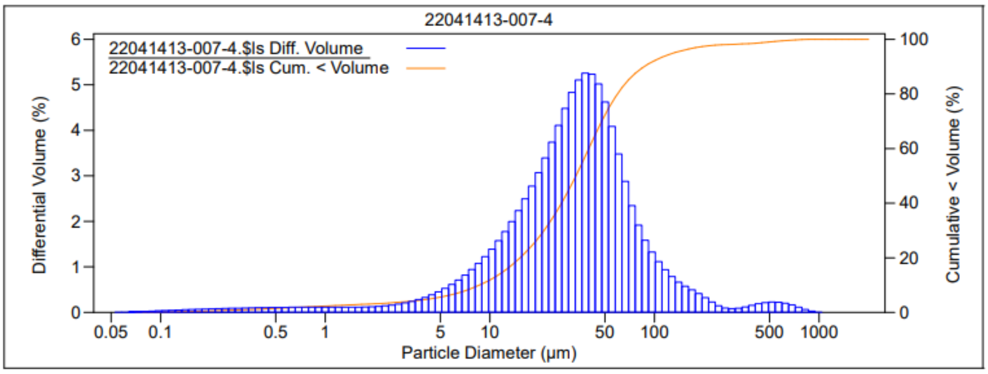
Folk and Ward Statistics (Phi)

Mean:	5.60	Median:	5.47	Deviation:	1.42
Skewness:	0.25	Kurtosis:	1.35		

<10%	<25%	<50%	<75%	<90%
5.525 µm	12.13 µm	22.52 µm	37.27 µm	56.42 µm

<2 µm	<63 µm	<2000 µm
5.09%	92.3%	100%

H.17 W4 T+5 min



Volume Statistics (Geometric) 22041413-007-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume: 100%
Mean: 28.81 µm S.D.: 3.166
Median: 33.34 µm Variance: 10.02
D(3,2): 7.301 µm Skewness: -1.304 Left skewed
Mean/Median ratio: 0.864 Kurtosis: 4.745 Leptokurtic
Mode: 37.97 µm

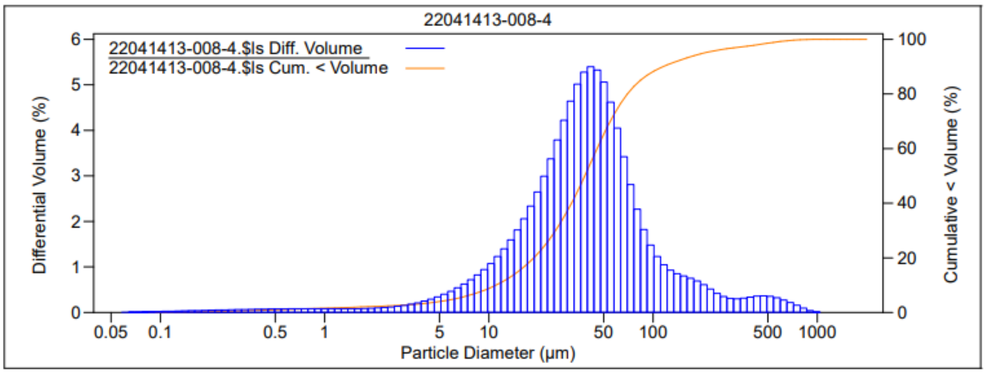
d_{10}: 8.666 µm d_{50}: 33.34 µm d_{90}: 86.83 µm

Folk and Ward Statistics (Phi)
Mean: 5.03 Median: 4.91 Deviation: 1.34
Skewness: 0.18 Kurtosis: 1.31

<10%	<25%	<50%	<75%	<90%
8.666 µm	18.35 µm	33.34 µm	52.97 µm	86.83 µm

<2 µm	<63 µm	<2000 µm
3.16%	82.0%	100%

H.18 W4 T+10 min



Volume Statistics (Geometric) 22041413-008-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume: 100%
Mean: 35.62 µm S.D.: 3.076
Median: 38.38 µm Variance: 9.461
D(3,2): 10.02 µm Skewness: -0.994 Left skewed
Mean/Median ratio: 0.928 Kurtosis: 4.443 Leptokurtic
Mode: 41.68 µm

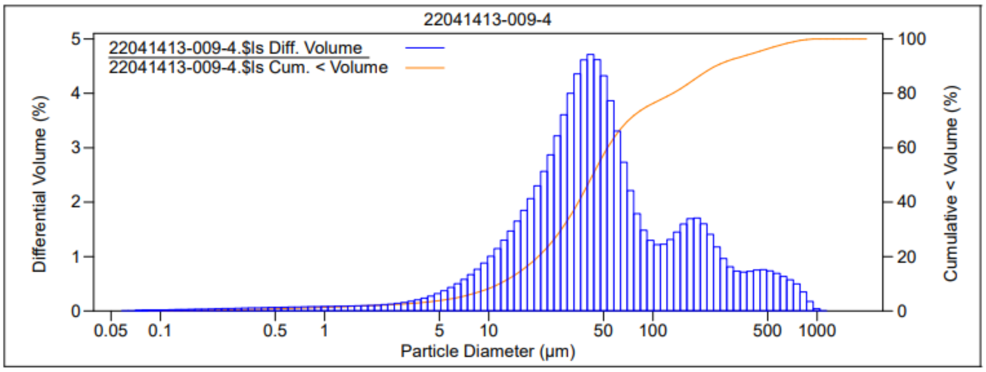
d_{10}: 11.05 µm d_{50}: 38.38 µm d_{90}: 115.4 µm

Folk and Ward Statistics (Phi)
Mean: 4.77 Median: 4.70 Deviation: 1.35
Skewness: 0.06 Kurtosis: 1.41

<10%	<25%	<50%	<75%	<90%
11.05 µm	22.22 µm	38.38 µm	61.28 µm	115.4 µm

<2 µm	<63 µm	<2000 µm
2.19%	76.2%	100%

H.19 W4 T+20 min



Volume Statistics (Geometric) 22041413-009-4.$ls

Calculations from 0.040 µm to 2000 µm

Volume:	100%		
Mean:	45.62 µm	S.D.:	3.596
Median:	43.01 µm	Variance:	12.93
D(3,2):	11.69 µm	Skewness:	-0.532 Left skewed
Mean/Median ratio:	1.061	Kurtosis:	2.169 Leptokurtic
Mode:	41.68 µm		

d_{10}: 11.63 µm d_{50}: 43.01 µm d_{90}: 240.8 µm

Folk and Ward Statistics (Phi)

Mean:	4.34	Median:	4.54	Deviation:	1.74
Skewness:	-0.14	Kurtosis:	1.27		

<10%	<25%	<50%	<75%	<90%
11.63 µm	23.96 µm	43.01 µm	91.35 µm	240.8 µm

<2 µm	<63 µm	<2000 µm
2.00%	66.7%	100%

I. Water sample analysis results

Table I.15: Average, minimum and maximum values for heavy metals from GUC W1 at -30s, +30s, +5 min, +10 min and +20 min (units mg/kg).

Substance	Average	Minimum	Maximum
Arsenic as As	0.0020	0.0020	0.0020
Cadmium as Cd	<0.00002	<0.00002	<0.00002
Copper as Cu	0.0022	0.0020	0.0030
Lead as Pb	<0.001	<0.001	<0.001
Mercury as Hg	<0.00003	<0.00003	<0.00003
Nickel as Ni	<0.0003	<0.0003	<0.0003
Total Chromium as Cr	0.0010	0.0010	0.0010
Zinc as Zn	0.0358	0.0070	0.0590

Table I.16: Average, minimum and maximum values for polynuclear aromatic hydrocarbons (PAHs) from GUC W1 at -30s, +30s, +5 min, +10 min and +20 min (units µg/kg).

Substance	Average	Minimum	Maximum
Acenaphthene	<0.01	<0.01	<0.01
Acenaphthylene	<0.01	<0.01	<0.01
Anthracene	<0.01	<0.01	<0.01
Benzo[a]anthracene	0.0150	0.0100	0.0200
Benzo[a]pyrene	0.0200	0.0100	0.0300
Benzo[b]fluoranthene	0.0225	0.0100	0.0400
Benzo[g,h,i]perylene	0.0200	0.0200	0.0200
Benzo[k]fluoranthene	0.0100	0.0100	0.0100
Chrysene	0.0150	0.0100	0.0200
Dibenzo[a,h]anthracene	<0.01	<0.01	<0.01
Fluoranthene	0.0300	0.0200	0.0400
Fluorene	<0.01	<0.01	<0.01
Indeno[1,2,3-cd]pyrene	0.0200	0.0100	0.0300
Naphthalene	<0.01	<0.01	<0.01
Phenanthrene	0.0150	0.0100	0.0200
Pyrene	0.0200	0.0100	0.0400

Table I.17: Average, minimum and maximum values for polychlorinated biphenyls (PCBs) from GUC W1 at -30s, +30s, +5 min, +10 min and +20 min (units µg/kg).

Substance	Average	Minimum	Maximum
PCB 101	<0.01	<0.01	<0.01
PCB 118	<0.01	<0.01	<0.01
PCB 138	<0.01	<0.01	<0.01
PCB 153	<0.01	<0.01	<0.01
PCB 180	<0.01	<0.01	<0.01
PCB 28	<0.01	<0.01	<0.01
PCB 52	<0.01	<0.01	<0.01

Table I.18: Average, minimum and maximum values for heavy metals from GUC W2 at -30s, +30s, +5 min, +10 min and +20 min (units mg/kg).

Substance	Average	Minimum	Maximum
Arsenic as As	0.0024	0.0020	0.0030
Cadmium as Cd	<0.00002	<0.00002	<0.00002
Copper as Cu	0.0015	0.0010	0.0020
Lead as Pb	<0.001	<0.001	<0.001
Mercury as Hg	<0.00003	<0.00003	<0.00003
Nickel as Ni	0.0018	0.0010	0.0020
Total Chromium as Cr	0.0010	0.0010	0.0010
Zinc as Zn	0.0218	0.0100	0.0430

Table I.19: Average, minimum and maximum values for polynuclear aromatic hydrocarbons (PAHs) from GUC W2 at -30s, +30s, +5 min, +10 min and +20 min (units µg/kg).

Substance	Average	Minimum	Maximum
Acenaphthene	<0.01	<0.01	<0.01
Acenaphthylene	<0.01	<0.01	<0.01
Anthracene	<0.01	<0.01	<0.01
Benzo[a]anthracene	0.0150	0.0100	0.0200
Benzo[a]pyrene	0.0200	0.0100	0.0300
Benzo[b]fluoranthene	0.0300	0.0200	0.0400
Benzo[g,h,i]perylene	0.0200	0.0100	0.0300
Benzo[k]fluoranthene	0.0100	0.0100	0.0100
Chrysene	0.0150	0.0100	0.0200
Dibenzo[a,h]anthracene	<0.01	<0.01	<0.01
Fluoranthene	0.0267	0.0200	0.0400
Fluorene	<0.01	<0.01	<0.01
Indeno[1,2,3-cd]pyrene	0.0200	0.0100	0.0300
Naphthalene	<0.01	<0.01	<0.01
Phenanthrene	0.0100	0.0100	0.0100
Pyrene	0.0267	0.0200	0.0400

Table I.20: Average, minimum and maximum values for polychlorinated biphenyls (PCBs) from GUC W2 at -30s, +30s, +5 min, +10 min and +20 min (units µg/kg).

Substance	Average	Minimum	Maximum
PCB 101	<0.01	<0.01	<0.01
PCB 118	<0.01	<0.01	<0.01
PCB 138	<0.01	<0.01	<0.01
PCB 153	<0.01	<0.01	<0.01
PCB 180	<0.01	<0.01	<0.01
PCB 28	<0.01	<0.01	<0.01
PCB 52	<0.01	<0.01	<0.01

Table I.21: Average, minimum and maximum values for heavy metals from GUC W3 at -30s, +30s, +5 min and +10 min (units mg/kg).

Substance	Average	Minimum	Maximum
Arsenic as As	<0.01	<0.01	<0.01
Cadmium as Cd	<0.01	<0.01	<0.01
Copper as Cu	0.0010	0.0010	0.0010
Lead as Pb	<0.01	<0.01	<0.01
Mercury as Hg	<0.01	<0.01	<0.01
Nickel as Ni	0.0010	0.0015	0.0013
Total Chromium as Cr	<0.01	<0.01	<0.01
Zinc as Zn	<0.01	<0.01	<0.01

Table I.22: Average, minimum and maximum values for polynuclear aromatic hydrocarbons (PAHs) from GUC W3 at -30s, +30s, +5 min and +10 min (units µg/kg).

Substance	Average	Minimum	Maximum
Acenaphthene	<0.01	<0.01	<0.01
Acenaphthylene	<0.01	<0.01	<0.01
Anthracene	<0.01	<0.01	<0.01
Benzo[a]anthracene	<0.01	<0.01	0.0100
Benzo[a]pyrene	<0.01	<0.01	<0.01
Benzo[b]fluoranthene	0.0100	0.0100	0.0100
Benzo[g,h,i]perylene	0.0100	0.0100	0.0100
Benzo[k]fluoranthene	<0.01	<0.01	<0.01
Chrysene	<0.01	<0.01	<0.01
Dibenzo[a,h]anthracene	<0.01	<0.01	<0.01
Fluoranthene	<0.01	<0.01	<0.01
Fluorene	<0.01	<0.01	<0.01
Indeno[1,2,3-cd]pyrene	<0.01	<0.01	<0.01
Naphthalene	<0.01	<0.01	<0.01
Phenanthrene	<0.01	<0.01	<0.01
Pyrene	<0.01	<0.01	0.0100

Table I.23: Average, minimum and maximum values for polychlorinated biphenyls (PCBs) from GUC W3 at -30s, +30s, +5 min and +10 min (units µg/kg).

Substance	Average	Minimum	Maximum
PCB 101	<0.01	<0.01	<0.01
PCB 118	<0.01	<0.01	<0.01
PCB 138	<0.01	<0.01	<0.01
PCB 153	<0.01	<0.01	<0.01
PCB 180	<0.01	<0.01	<0.01
PCB 28	<0.01	<0.01	<0.01
PCB 52	<0.01	<0.01	<0.01

Table I.24: Average, minimum and maximum values for heavy metals from GUC W4 at -30s, +30s, +5 min, +10 min and +20 min (units mg/kg).

Substance	Average	Minimum	Maximum
Arsenic as As	<0.001	<0.001	<0.001
Cadmium as Cd	0.00003	0.00003	0.00003
Copper as Cu	0.0010	0.0010	0.0010
Lead as Pb	<0.001	<0.001	<0.001
Mercury as Hg	<0.001	<0.001	<0.001
Nickel as Ni	0.0012	0.0012	0.0012
Total Chromium as Cr	<0.001	<0.001	<0.001
Zinc as Zn	<0.001	<0.001	<0.001

Table I.25: Average, minimum and maximum values for polynuclear aromatic hydrocarbons (PAHs) from GUC W4 (units µg/kg).

Substance	Average	Minimum	Maximum
Acenaphthene	<0.001	<0.001	<0.001
Acenaphthylene	<0.001	<0.001	<0.001
Anthracene	<0.001	<0.001	<0.001
Benzo[a]anthracene	0.0100	0.0100	0.0100
Benzo[a]pyrene	<0.001	<0.001	<0.001
Benzo[b]fluoranthene	0.0100	0.0100	0.0100
Benzo[g,h,i]perylene	<0.001	<0.001	<0.001
Benzo[k]fluoranthene	<0.001	<0.001	<0.001
Chrysene	<0.001	<0.001	<0.001
Dibenzo[a,h]anthracene	<0.001	<0.001	<0.001
Fluoranthene	0.0100	0.0100	0.0100
Fluorene	<0.001	<0.001	<0.001
Indeno[1,2,3-cd]pyrene	0.0100	0.0100	0.0100
Naphthalene	<0.001	<0.001	<0.001
Phenanthrene	<0.001	<0.001	<0.001
Pyrene	0.0100	0.0100	0.0100

Table I.26: Average, minimum and maximum values for polychlorinated biphenyls (PCBs) from GUC W4 at -30s, +30s, +5 min, +10 min and +20 min (units µg/kg).

Substance	Average	Minimum	Maximum
PCB 101	<0.01	<0.01	<0.01
PCB 118	<0.01	<0.01	<0.01
PCB 138	<0.01	<0.01	<0.01
PCB 153	<0.01	<0.01	<0.01
PCB 180	<0.01	<0.01	<0.01
PCB 28	<0.01	<0.01	<0.01
PCB 52	<0.01	<0.01	<0.01

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