# Particle Size Analysis Component Annual Report
# Scheme Operation 2025/2026 (Year 32)


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**PARTICLE SIZE COMPONENT ANNUAL REPORT FROM APEM Ltd**

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**SCHEME OPERATION – 2025/26 (Year 32)**

## Linked Documents (hyperlinked in this report):

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## 1. Introduction

The NE Atlantic Marine Biological Analytical Quality Control (NMBAQC) scheme is a quality assurance scheme developed on behalf of the UK competent monitoring authorities (CMAs). Its principal aim is to provide assessment of marine biological data contributing to UK national or European monitoring programmes.

The scheme also aims to develop and promote best practice in relation to sampling and analysis procedures through a range of training exercises, workshops, and literature guides.

The scheme includes seven biological components, each with its own set of training exercises and/or assessment modules.

APEM Ltd has been the administrative contractor for the Particle Size component since 2014 (Scheme year 21).

The Particle Size (PS) component of the scheme comprises two modules:

- The PS Ring Test (PS)
- The PS – Own Sample (PS-OS)

The PS module followed the same format as 2024/25; a series of exercises involved the distribution of test materials to participating laboratories and the centralised examination of returned data and samples.

The PS-OS module, introduced in the 2014/15 Scheme year, followed the same logistical format as the previous year. Selected participant samples are re-analysed by the NMBAQC Scheme PSA contractor, and the results are compared. The Particle Size Own Sample module is a training/audit module, and the purpose of this module is to examine the accuracy of particle size analysis for participants' in-house samples.

Seventeen laboratories signed up to participate in the 2025/26 PS module exercises (PS96, PS97, PS98 and PS99); seven were government laboratories and ten were private consultancies. Eleven laboratories signed up to participate in the PS-OS module exercises (PS-OS34, PS-OS35 and PS-OS36); six were government laboratories and five were private consultancies.

To reduce potential errors and simplify administration, Lab Codes were assigned with a prefix to determine the Scheme component; all codes for the Particle Size component were prefixed with "PSA_".

As in previous years, some laboratories elected to be involved in limited aspects of the Scheme. Competent monitoring authorities (CMAs) completing PSA in support of biological analysis for monitoring programmes (including in assessment of MPA (Marine Protected Areas), as evidence under MSFD (Marine strategy framework directive) and WFD (Water Framework Directive), as well as the CSEMP (Clean Seas Environmental

Monitoring programme), must participate in this component of the Scheme. The Scheme is aware of other PSA methodologies (*e.g*. those used in the Regional Seabed Monitoring Plan) and encourages those involved in any relevant PSA monitoring programmes to participate in this Scheme, especially where pass/fail criteria can be used to assess overlapping aspects of different methodologies.

### 1.1 Assessing Performance

For 2025/26 (Scheme Year 32) both the PS and PS-OS reports followed a similar format, with each sample analysis section broken down for review, including sieve processing, laser processing and final data. Laboratories received a "Good" or "Review" flag based on their results; "Review" flags had accompanying comments as to where errors have been made and how to correct them. Review flags could be upgraded to "GOOD – following remedial action" provided the participant supplied evidence of completing required actions or re-submitted results within a month of the issue of the interim report.

### 1.2 Statement of Performance

Each participating laboratory received a copy of the interim results for each exercise; these included a summary of results provided by each laboratory and a basic discussion of any major outliers. Once any remedial actions, re-submissions and minor data changes were completed by participants a final version of each report was made available on the Scheme website. Further details and analysis can be found in this report.

At the end of the Scheme year each laboratory received a 'Statement of Performance' document (SoP), which included a summary of results for each of the Scheme's modules and details the resulting flags where appropriate. These statements were first circulated with the 1998/1999 annual report for the purpose of providing proof of Scheme participation and for ease of comparing year on year progress.

## 2. Summary of PSA Component

### 2.1 Introduction

The two 2025/26 year PSA modules, PS and PS-OS are described in more detail below. A brief outline of the information obtained from the module is given, together with a description of the preparation of the necessary materials and brief details of the processing instructions given to each of the participating laboratories.

### 2.2 Logistics

The labelling and distribution procedures employed previously have been maintained and specific details can be found in the Scheme's annual reports for 1994/95 and 1995/96 (Unicomarine, 1995 & 1996). Email was the primary means of communication for all participating laboratories. This has considerably reduced the amount of paper required for the administration of the Scheme.

## 2.3 Data returns

Spreadsheet based workbooks for each circulation were distributed to participating laboratories via email and data returned to APEM Ltd via the NMBAQC Scheme email address (nmbaqc@apemltd.co.uk). In this and previous Scheme years slow or missing returns for exercises lead to delays in processing the data and resulted in difficulties with reporting and rapid feedback of results to laboratories. Reminders were distributed shortly before each exercise deadline.

## 2.4 Confidentiality

To preserve the confidentiality of participating laboratories, each was identified by a four-digit Laboratory Code prefixed with "PSA_", to identify the scheme component. At the start of the scheme year each participant was given a confidential, randomly assigned 2025/26 (Scheme Year 32) Lab Code. Codes are prefixed with the Scheme year to reduce the possibility of obsolete codes being used inadvertently by laboratories, *e.g.* Laboratory number twelve in Scheme Year thirty-two (2025/26) was recorded as PSA_3212.

# 3. Particle Size Analysis (PS) Module

## 3.1 Description

This component examined the percentage of sediment found in each half-phi interval from the particle size analysis of replicate sediment samples. Four samples of sediment, one fine (PS98), one coarse (PS97) and two mixed (PS96 and PS99) were distributed in 2025/26. The samples were distributed in two stages; the first circulation (PS96 and PS97) was sent to participants on 3rd November 2025 and the second circulation (PS98 and PS99) was sent on the 25th February 2026. For each circulation participants were given approximately 6 weeks to complete their analysis and send completed workbooks via email to APEM Ltd. PS96, PS98 and PS99 were derived from natural marine sediments whilst PS97 replicates were prepared from a mixture of natural sediment and artificially prepared commercial aggregates; all replicates were prepared at APEM's Letchworth laboratory as described below.

### *3.1.1 Asbestos testing*

Following participant concerns raised during Scheme Year 25 (2018/2019) about the possible presence of asbestos in natural sediments used to create the PS exercises, all natural sediments were sent for asbestos testing prior to the creation of the samples. Sediments were only used when they had tested negative for asbestos; any that tested positive were disposed of either in a landfill that has a specific permit authorising it to accept asbestos or in a non-hazardous waste landfill, provided it is self-contained. Details and results of asbestos testing can be requested by emailing APEM's NMBAQC email address. Following the Particle Size workshop in 2022, guidance was provided to labs on how to mitigate against asbestos exposure in the possibility that it might be contained within the sediment. It is now assumed that participants have integrated asbestos risks into their internal SOP's and therefore natural sediments are no longer pre-screened.

### 3.1.2 Preparation of the Samples

The first PS circulation, PS96, was a mixed sample created using 300g of muddy sand from Silvertown, Thames, pre-sieved over a 1mm sieve to remove any larger particles, combined with 357g of known quantities of gravel from the River Urr, Scotland (split into half-phi intervals by dry sieving using a mechanical sieve shaker).

The second exercise, PS97, was a coarse sediment created by combining 500g of coarse sand from the West of Orkney with known quantities of aggregate pea shingle (split into half-phi intervals by dry sieving using a mechanical sieve shaker).

The third exercise, PS98, was created from natural sediment from The Wash. Approximately 10 litres of visually similar sediment were collected and returned to the laboratory where it was wet sieved at 1.0mm to remove any particles larger than 1.0mm. Sediment that passed through the 1.0mm sieve was retained in a large tray, mixed and left to settle; excess water was removed before it was cored into replicate samples of approximately 200 grams in weight.

The fourth replicate, PS99 was created using known quantities of cockle shells split into half-phi intervals by dry mechanical sieve shaker and sand from The Wash.

Five replicate samples from each of these exercises were sent to Kenneth Pye Associates Ltd (KPAL) for particle size analysis to assess the degree of inter-sample variation and to produce benchmark data. Where laser diffraction analysis was required, these replicates were analysed using a Beckman Coulter LS13320 laser diffraction instrument. The remaining replicates were randomly assigned to participating laboratories and distributed according to the Scheme timetable. Spare replicates were kept at the APEM Ltd. Letchworth laboratory in case of problems such as damaged samples during delivery or significant processing errors.

### 3.1.3 Analysis required

The participating laboratories were required to conduct particle size analysis on the samples following the NMBAQC Scheme's best practice guidance for particle size analysis to support biological data (NMBAQC Best Practice Guidelines (Mason, 2022)), either in-house or using a subcontractor. A summary of the sample as a written description of the sediment characteristics was to be recorded, with a qualitative visual assessment made prior to processing, using the Folk (1954) textural classification. In addition, the percentages of gravel, sand and silt/clay and any use of peroxide treatment or chemical dispersant were to be noted. Also requested was a breakdown of the particle size distribution, expressed as a weight or volume percentage at half-phi ($\phi$) intervals, for each of the raw sieve data (>1mm), the raw laser data (<1mm) and the final merged dataset.

The 2025/26 workbooks followed the format of the updated 2022/23 workbooks to help enable the continuity of data through the workbook. All sieve and laser data are now entered into a single worksheet, with conditional formatting to flag up red cells to indicate possible data entry errors. Data provided in the "Laser Metadata" spreadsheet tab were for analytical purposes only and were not published in the Interim Results reports. Benchmark metadata were included in each sample report for participants to see how the Benchmark Lab analysed each sample.

Approximately six weeks were allowed for the analysis of the first pair of PS samples sent out (PS96 & PS97) and approximately six weeks for the second pair (PS98 & PS99).

## 3.2 Results

### *3.2.1 General comments*

Seventeen laboratories subscribed to the exercises in 2025/26. For the first circulation (PS96 and PS97), eight subscribing participants provided results on time, eight participants requested extensions and one (PSA_3217) did not submit data or provide any further communication indicating non-participation. Of the participants requesting extensions, two (PSA-3203 and PSA_3216) have not provided any data to date. For the second circulation (PS98 and PS99) thirteen participants provided results on time, two participants requested an extension, one (PSA_3217) did not submit data or provide any further communication indicating non-participation and one lab (PSA_3211) provided communication of non-participation.

Most participating laboratories now provide data in the requested format, although some variations remain. As reported previously, it should be remembered that the results presented may be from a more limited number of analytical laboratories than is immediately apparent since this component of the Scheme is often sub-contracted by participants to one of a limited number of specialist laboratories. In scheme year 30 it was agreed with the technical manager that up to three submissions per replicate sample could be made before a second replicate sample would have to be paid for.

Detailed results for each exercise (PS96, PS97, PS98 and PS99) have been reported to the participating laboratories; additional comments are provided below.

### *3.2.2 Analysis of sample replicates (Benchmark Data)*

Five replicate samples of the sediment used for the four PS distributions were analysed by KPAL to examine variability and establish benchmark data that participant results can be compared with. Replicate samples supplied by APEM were analysed, where required, using Endecotts British Standard 300mm and 200mm test sieves, Endecotts EFL 2000/2 and Retsch AS2001 Control ‘g’ sieve shakers and a Beckman Coulter LS13320 laser size analyser. In previous Scheme years replicates were analysed by both laser diffraction and sieve/pipette methods; however, as all participating laboratories are now conducting less than 1mm analysis by laser diffraction the testing of replicates for 2023/24 was undertaken only using a laser diffraction instrument.

The analysis results for the benchmark replicates were assessed by APEM to analyse the variability between the replicates and to establish the reproducibility of the samples. The analysis showed an overview of the sample including percentage Gravel, Sand and Mud along with a description of the sediment using the textural group from a Gradistat (Blott & Pye, 2001) output of the final data, e.g. Slightly Gravelly Muddy Sand. The processing of the sample was split into sieve and laser analysis.

Sieve analysis is displayed in a table with the raw weight recorded in each half phi interval from -6.5 to 0.0phi and the weight of the less than 1mm oven dried sample plus any sediment from the base pan of the sieve shaker. The percentage of sediment lost or gained during the sieving process was recorded. The percentage weight in each half-phi category is also displayed graphically in a bar chart for visual comparison.

Laser analysis included a table of the final laser data for each replicate with Gradistat outputs along with a graph showing the differential and cumulative percentage. The triplicate analysis undertaken to obtain the final laser data was presented in a table in Appendix 1. For each replicate sample the Coefficient of Variation (CV) was calculated for the $D_{10}$, $D_{50}$ and $D_{90}$ particle size in microns. The CV is most commonly expressed as the standard deviation as a percentage of the mean and describes the dispersion of a variable in a way that does not depend on the variables' measurement units. A low CV indicates a smaller amount of dispersion in the variable. BS ISO 13320 states that good laser reproducibility is shown for replicates when the %CV is <3% for the $D_{50}$ and <5% for the $D_{10}$ and $D_{90}$, all limits are doubled when the $D_{50}$ was less than 10µm. In reality 3% and 5% are low and greater variability is expected in natural sediment samples therefore a maximum of 20% will be used as guidance.

Benchmark analysis of the replicates for sample PS96 indicated an average composition of 53.55% gravel, 28.23% sand and 18.45% mud, and was classified as 'Muddy Sandy Gravel' according to the Blott & Pye (2012) scheme. The replicates were analysed by dry sieving and laser. The sieve data shows a very low percentage (-0.01% – 0.00%) loss or gain during the sieving process. On average, 353.12g of sediment greater than 1mm was recorded and 175.38g of sediment less than 1mm was recorded. The laser analysis produced a polymodal distribution with the primary mode at 106.7µm, secondary mode at 13.3 µm and the tertiary mode at 426.8µm for BM Reps 1 and 2, and at 853.5µm for BM Reps 3 -5. Analysis of the triplicate laser analysis for each replicate sample showed that the %CVs for the $D_{10}$, $D_{50}$ and $D_{90}$ were well within the acceptable limits and therefore the replicates were deemed to have good reproducibility. Results for the individual replicates are provided in Tables 1, 2, 3, 4 and 5, and are displayed in Figures 1, 2, 3and 4 in the PS96 Report.

Sample PS97 was a coarse sediment and contained an average of 65.66% gravel, 33.71% sand and 0.63% mud, classified as a 'Sandy Gravel' according to the Blott & Pye (2012) scheme. The replicates were analysed by dry sieving and laser analysis. The sieve data shows a very low percentage (-0.02% – -0.01%) loss or gain during the sieving process. On average, 1014.13g of sediment greater than 1mm was recorded and 500.92g of sediment less than 1mm was recorded. Laser data produced consistent results between the replicates with a unimodal distribution and the primary mode at 853.5µm. Triplicate laser analysis showed low variation, with %CV well below acceptable levels for each statistic. Results for the individual replicates are provided in Tables 1, 2, 3, 4 and 5, and are displayed in Figures 1, 2,3 and 4 in the PS97 Report

Sample PS98 was a fine sample and contained an average of 0.06% gravel, 72.97% sand and 26.97% mud, classified as a 'Slightly Gravelly Muddy Sand' according to the Blott & Pye (2012) scheme. The replicates were analysed by sieve and laser analysis. Only small quantities of sediment greater than 1mm were recorded (on average 0.15g). Laser analysis produced a unimodal distribution with the primary mode at 213.4µm. The triplicate laser analysis showed low percentage variation and was below the acceptable levels for all statistics. Results for the individual replicates are provided in Tables 1, 2, 3, 4 and 5, and are displayed in Figures 1, 2,3 and 4 in the PS98 Report.

Sample PS99 was a mixed sediment sample containing an average of 17.46% gravel, 80.13% sand and 2.41% mud, classified as 'Gravelly Sand' according to the Blott & Pye (2012) scheme. The replicates were analysed by dry sieving and laser. The sieve data shows a very low percentage (-0.03% – 0.08%) loss or gain during the sieving process. On average, 68.92g of sediment greater than 1mm was recorded and 325.41g of sediment less than 1mm was recorded. The laser analysis produced a bimodal distribution with the primary mode at 603.5µm and the secondary mode at 213.4µm. Analysis of the triplicate laser analysis for each replicate sample showed that the percentage CVs for the $D_{10}$, $D_{50}$ and $D_{90}$ were well within the acceptable limits and therefore the replicates were deemed to have good reproducibility. Results for the individual replicates are provided in Tables 1, 2, 3, 4 and 5, and are displayed in Figures 1, 2, 3 and 4 in the PS99 Report.

#### *3.2.3 Results from participating laboratories*

In each of the PS96, PS97, PS98 and PS99 reports, data provided by the participants are displayed in a series of tables and figures for comparison with each other and with the Benchmark Data. The Participant section provides three tables of data, the first outlining an overview of summary data including equipment and methodology used, the use of any chemical dispersants or pre-treatments, the percentage gravel, sand, and silt/clay recorded as well as the participants' post-analysis sediment descriptions. The second table provides the raw sieve weights for each half-phi interval submitted by each participant including the less than 1mm weights for the sieve shaker base pan fraction and the wet-separated and oven dried fraction and in the third table the final laser data submitted by each participant is shown. Tables showing the results of the triplicate laser analysis supplied and the Coefficient of Variance of the $D_{10}$, $D_{50}$ and $D_{90}$ are available in Appendix 1. These tables are accompanied by a series of graphs and bar charts which allow the results to be visually compared. Appendix 2 shows the data used to create the percentage gravel, sand, silt, and clay bar-charts. The final merged data submitted by each participant and the benchmark laboratory are provided in Appendix 3 and a graphical comparison of individual sieve results are shown in Appendix 4.

##### *3.2.3.1 Ninety-sixth distribution – PS96*

Figures 1 and 2 show there was good agreement for PS96 between the results for the Benchmark replicates and those supplied by the participating laboratories. PSA_3210 re-submitted data following the interim report; an issue with less than 1mm oven dried weight was corrected where a data entry error was detected and the wet weight was entered rather than the dry weight.

The summary data (Table 6 in the exercise report) showed that none of the participants used chemical dispersants or peroxide pre-treatments. All but three laboratories (PSA_3202, PSA_3205 and PSA_3207) followed the NMBAQC methodology. Those that followed differing methodologies did not provide any details on how their methodology differed from the NMBAQC method. All participants bar one (PSA_3205) recorded a Gradistat textural group of 'Muddy Sandy Gravel'. Participant PSA_3205 recorded less sand and a higher proportion of mud with the sample described as 'Muddy Gravel'. Percentage gravel ranged from 51.62% (PSA_3206) to 62.66 (PSA_3210), with an average of 55.30% (SD=3.17), sand ranged from 17.25% (PSA_3205) to 28.86% (PSA_3206), with an average of 25.37% (SD = 3.32) and the percentage of mud ranged from 16.05% (PSA_3211) to 26.33% (PSA_3205) with an average of 19.36% (SD=2.52).

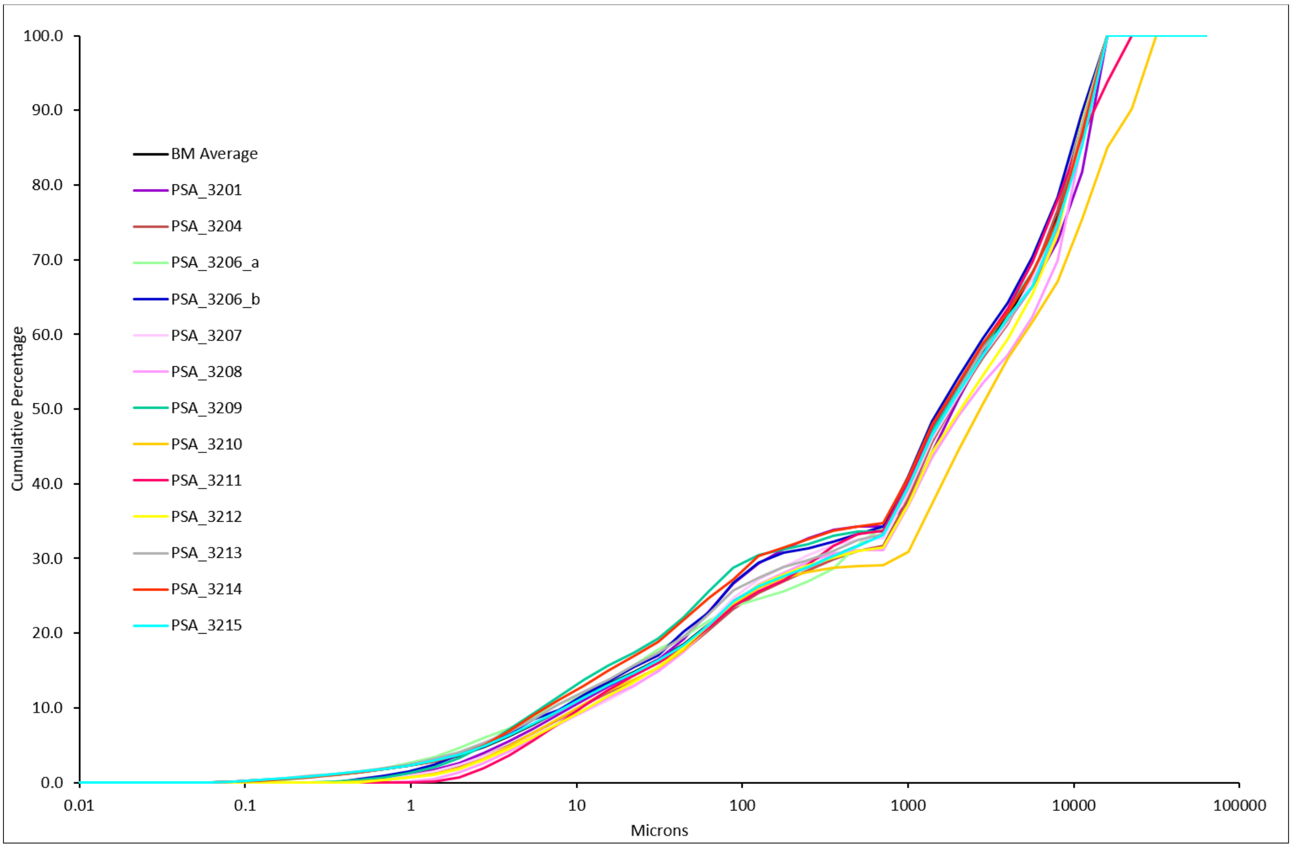


**Figure 1. Particle size distribution curves for sediment distributed as PS96.**

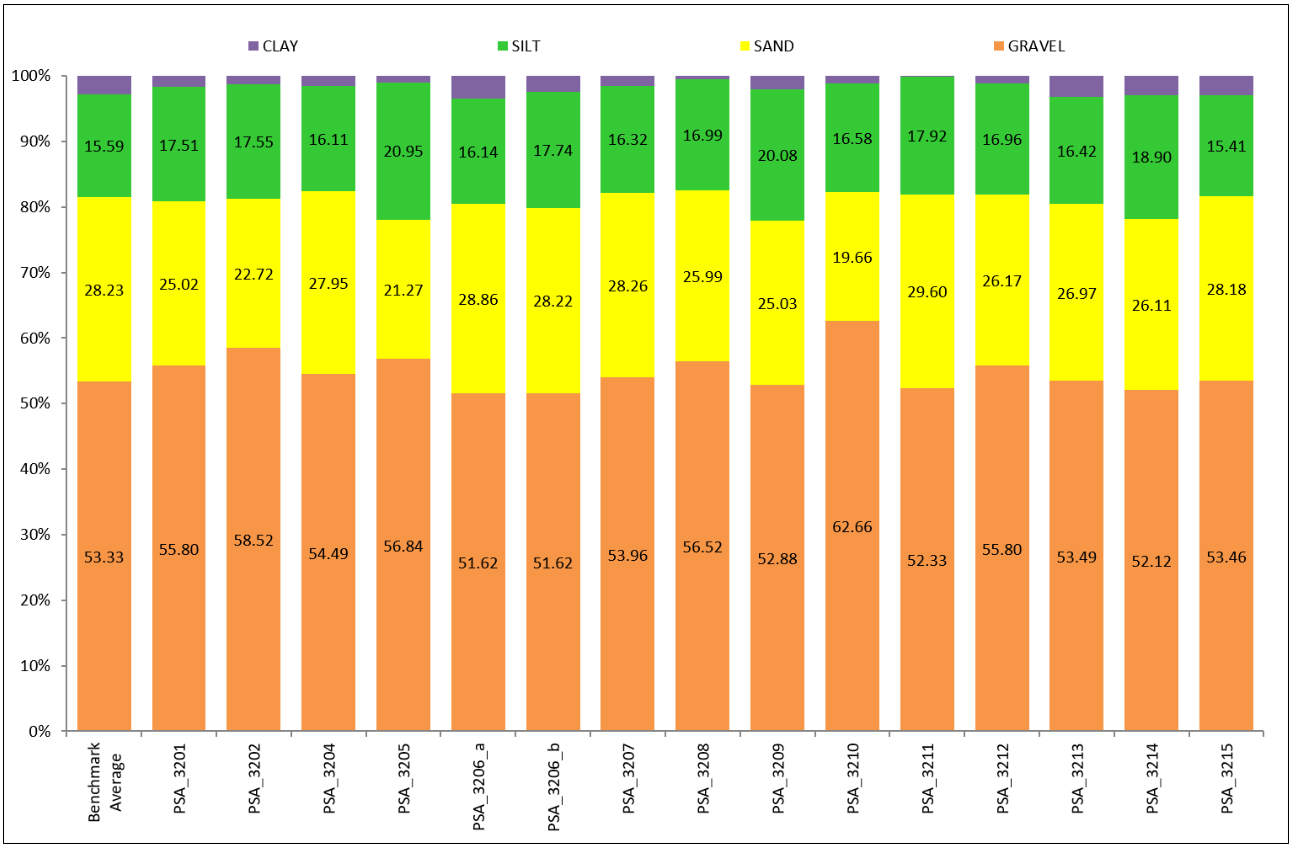


**Figure 2. Stacked column chart showing the percentage gravel, sand, silt, and clay for sediment distributed as PS96.**

Laser data showed some variation in the amount of fine material recorded in relation to the model of laser analyser used. Those participants using Beckman Coulter instruments (PSA_3213, PSA_3214, PSA_3215 and the Benchmark Lab) recorded an average percentage clay of 2.95% compared to an average of 1.27% for those using Malvern Mastersizer instruments. Participant PSA_3206_b were an outlier to this trend and recorded 2.42% mud whilst using a Malvern Mastersizer. The Beckman Coulter LS13320 which uses a PIDS (Polarization Intensity Diffraction Scattering) system at the finer end, rather than diffraction, so provides better sensitivity than the Malvern system which employs diffraction of two different wavelengths of light (red and blue). Participant PSA_3206_a is the only laboratory to use a Fritsch laser analyser, which recorded the highest percentage of clay (3.38%). The data showed a variety of modes were recorded. One lab (PSA_3207) recorded a unimodal distribution with the mode at 75.5µm, six other participants also recorded the primary mode at 75.5µm but either produced bi-, tr- or poly-modal distributions. Six participants recorded bi-, tri-or poly-modal distributions with the primary mode at 106.7µm. One participant (PSA_3202) produced a bimodal distribution with the primary mode at 53.35µm and one lab (PSA_3214) recorded a polymodal distribution with the primary mode at 150.9µm. Figure 3 below shows that most participants follow a similar distribution to the Benchmark data. Participants PSA_3202 and PSA_3205 display a distribution that is different from the Benchmark data and other participants but similar to each other. Participants PSA_3206 and PSA_3214 produced data with significant fluctuations with several sharp peaks and dips and PSA_3211 showed varying distributions between each laser run.

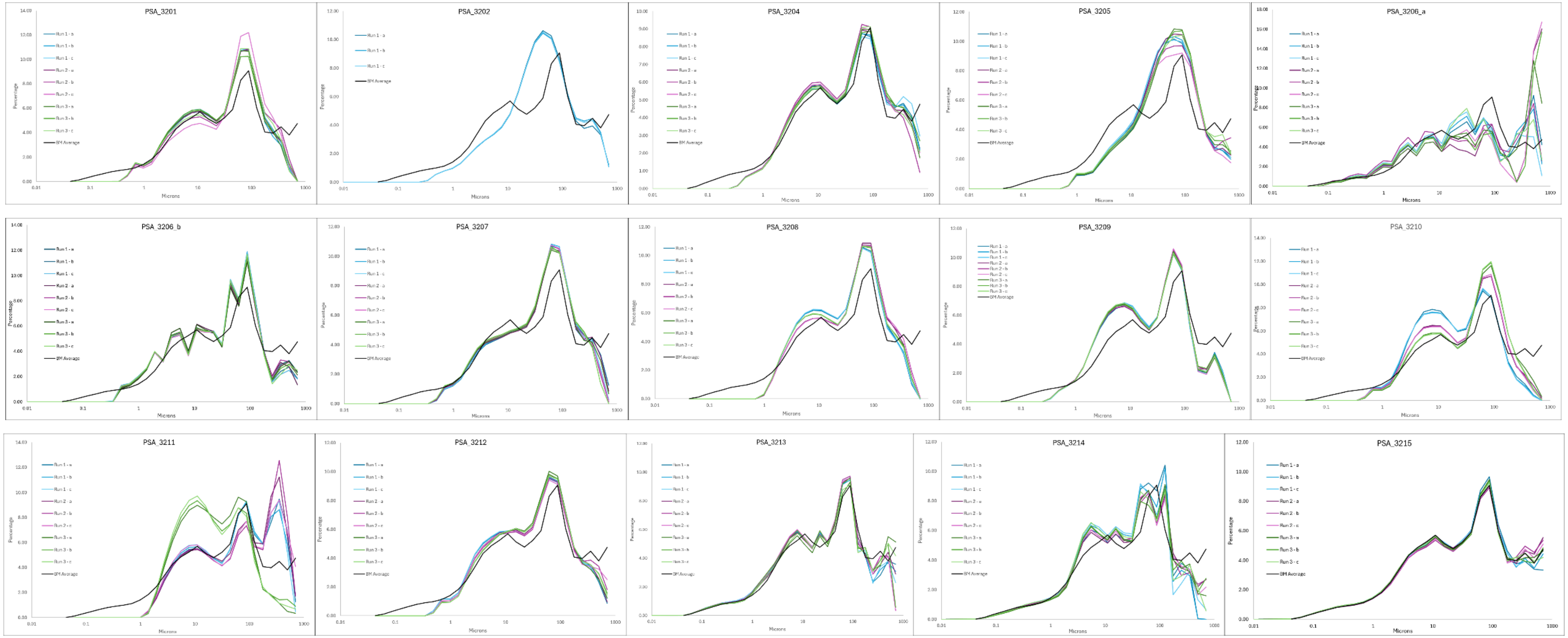


**Figure 3. PS96 laser replicate data for all participants**

#### *3.2.3.2 Ninety-seventh distribution – PS97*

There was generally good agreement for PS97 between the results from the analysis of the benchmark replicates and those from the participating laboratories (see Figures 4 and 5). Participants PSA_3202 and PSA_3205 chose not to participate in this module due to the high proportion of sediment greater than 2mm – this was communicated with the submission of data for PS96. Participant PSA_3210 recorded a lower percentage of gravel compared to other participants however after investigation it appeared that there was an issue with the replicate composition and their data was deemed to be 'Good'. Participant PSA_3206_a were asked to review their laser result due recording much higher percentage of mud compared to the Benchmark Data and other participants, however, at the time of writing no results have been re-submitted.

All participants had a Gradistat textural group of 'Sandy Gravel' excluding the outlier of PSA_3206_a which described the sample as 'Muddy Sandy Gravel'. Percentage gravel ranged from 60.24% (PSA_3210) to 67.10% (PSA_3212) with an average of 65.70% (SD=1.74), the percentage sand ranged from 26.62% (PSA_3206_a) to 39.76% (PSA_31PSA_3210) with an average of 33.63% (SD=2.73) and the percentage of mud ranged from 0.00% (multiple participants) to 7.40% (PSA_3206_a) with an average of 0.69% (SD=2.03).

All but one laboratory (PSA_3207) that submitted data followed the NMBAQC methodology. Those that followed differing methodologies did not provide any details on how their methodology differed from the NMBAQC method. All participants analysed the sample using both sieve and laser analysis.

The average weight of participant material greater than 1.0mm was 999.04g (SD=55.49) and the average weight of less than 1.0mm was 501.13g (SD=61.72) compared to Benchmark results of 1013.63 (>1.0mm) and 500.92g (<1.0mm).

All participants and the Benchmark lab produced a unimodal laser distribution with the primary mode recorded at 853.5µm. Laser data showed some variation in the amount of fine material recorded in relation to the model of laser analyser used. Those participants using Beckman Coulter instruments (PSA_3213, PSA_3214, PSA_3215 and the Benchmark Lab) recorded an average percentage mud of 0.55% compared to 0.00% for those using Malvern Mastersizer instruments. The exception was the Fritsch analyser which recorded a much higher percentage of mud (7.40%).

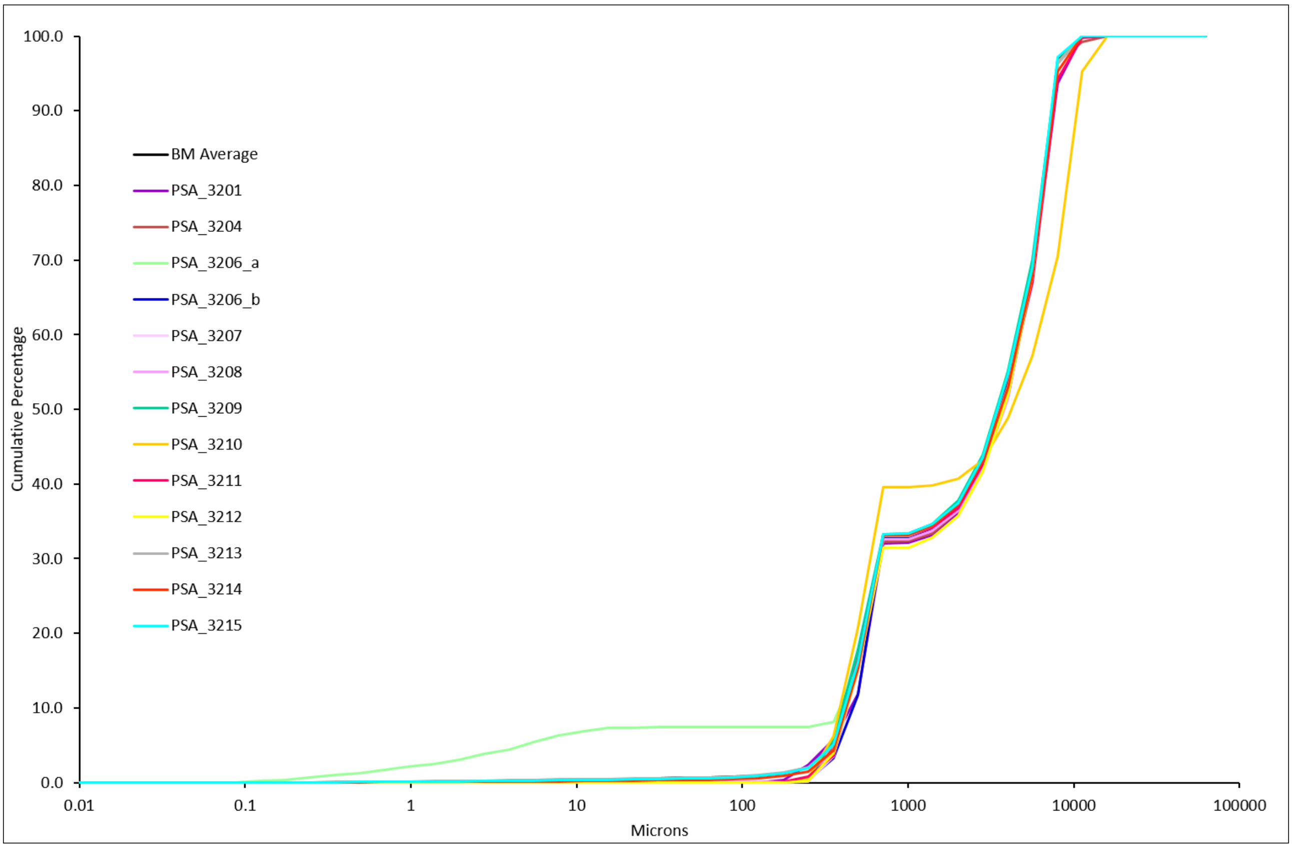


**Figure 4. Particle size distribution curves for sediment distributed as PS97.**

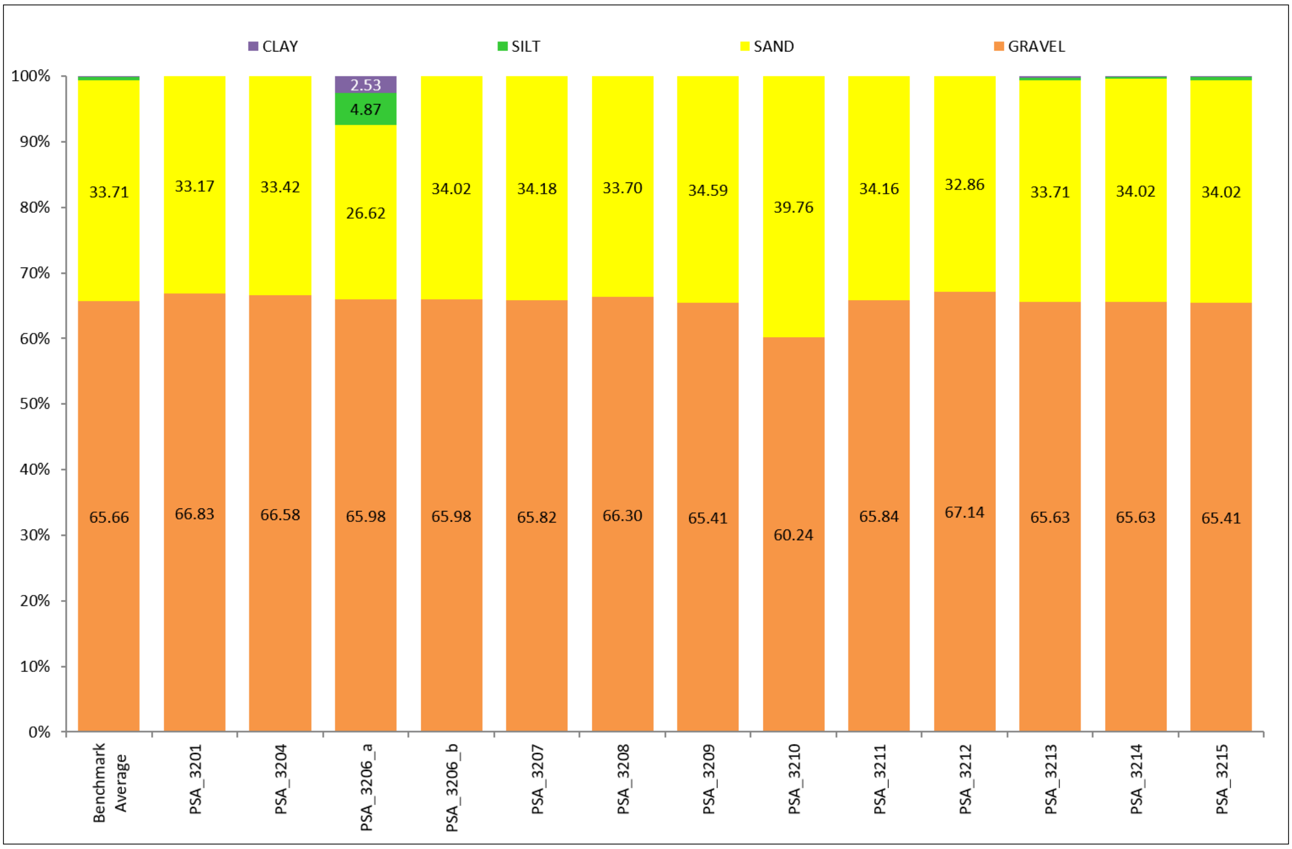


**Figure 5. Stacked column chart showing the percentage gravel, sand, silt, and clay for sediment distributed as PS97.**

### 3.2.3.3 Ninety-eighth distribution – PS98

As Figures 6 and 7 show there was some variation between the results reported by the participating laboratories and those obtained for the benchmark replicates for PS98. This sample was created using natural sediment and although there was a concerted effort to homogenise the bulk material it was expected that there would be more variation between participant results.

Despite the variation, participants either recorded a Gradistat textural group of 'Muddy Sand' or 'Slightly Gravelly Muddy Sand', with those recording the later recording less than 1g of sediment greater than 1mm. Gravel composition ranged from 0.00% (multiple labs) to 0.27% (PSA_3207) with an average of 0.07% (SD+0.08), sand composition ranged from 66.51% (PSA_3207) to 86.06% (PSA_3203) with an average of 75.70% (SD=5.48) and mud composition ranged from a minimum of 13.88% (PSA_3203) to a maximum of 33.22% (PSA_3207) with an average of 24.22% (SD=5.47).

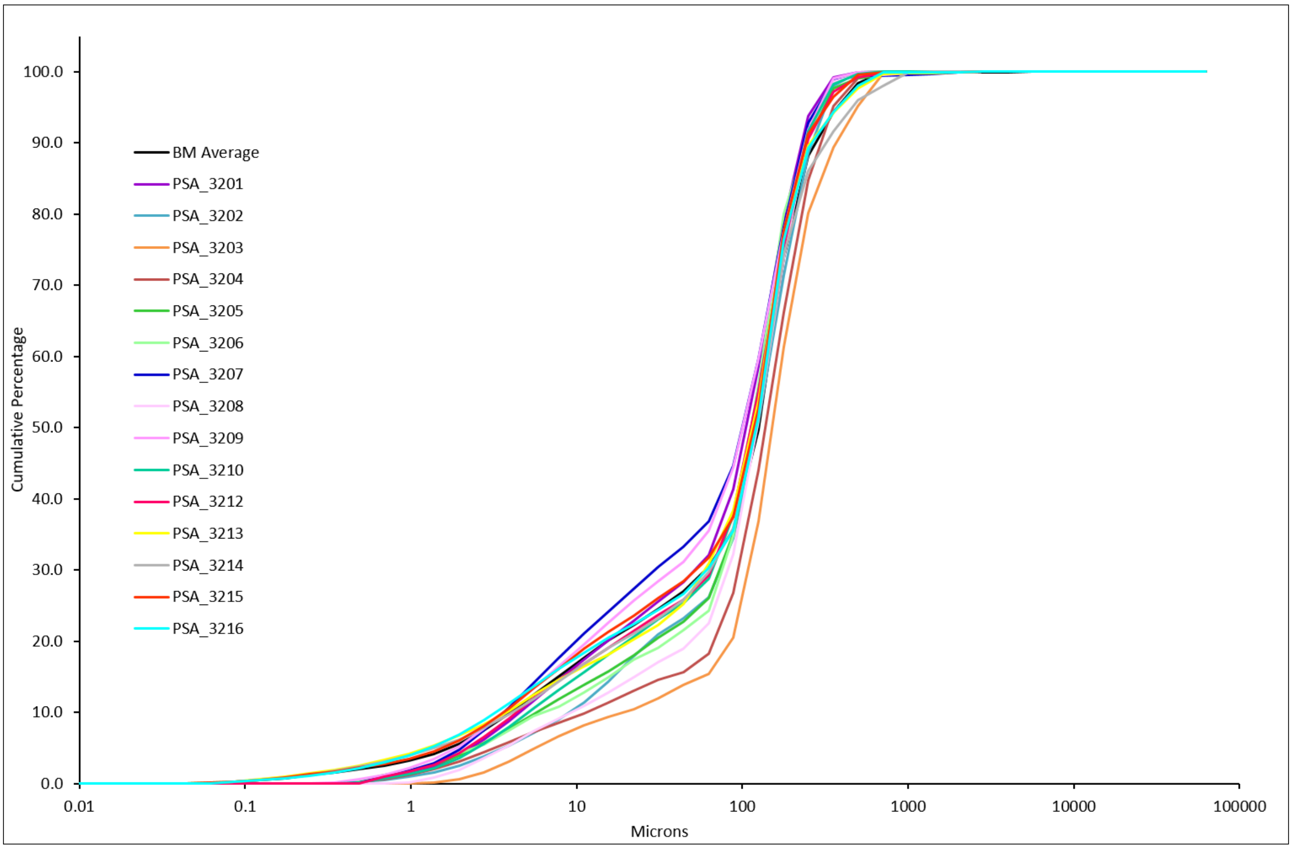


**Figure 6. Particle size distribution curves for sediment distributed as PS98.**

The majority of participants produced a unimodal laser distribution with the primary mode at 213.4µm. PSA_3202, PSA_3207 and PSA_3209 recorded a bimodal distribution with the primary mode at 213.4µm and secondary modes recorded at 26.7 µm, 9.4 µm and 18.9 µm respectively. PSA_3205 recorded a bimodal distribution with the primary mode at 53.4µm and the secondary mode at 426.8µm.

The sample showed some variation in the amount of clay recorded in relation to the model of laser analyser used. Those participants using Beckman Coulter instruments (PSA_3213, PSA_3214, PSA_3215, PSA_3216 and the Benchmark Lab) recorded an average percentage clay of 4.75% which was higher than those using Malvern Mastersizer instruments which had an average of 2.11% clay. The Beckman Coulter LS13320 which uses a PIDS (Polarization Intensity Diffraction Scattering) system at the finer end, rather than diffraction, so provides better sensitivity than the Malvern system which employs diffraction of two different wavelengths of light (red and blue).

No participants re-submitted data for PS98 following the circulation of the interim report.


**Figure 7. Stacked column chart showing the percentage gravel, sand, silt, and clay for sediment distributed as PS98.**

### *3.2.3.4 Ninety-nineth distribution – PS99*

There was good agreement in results between the laboratories and the benchmark data (see Figures 8 and 9). PSA_3202 and PSA_3205 follow a different method to the NMBAQC and only sieve at 1phi interval above 1mm or do analyse material greater than 1mm therefore their data has been omitted from Figure 8 as it is not comparable with other participant data.

All participants had a Gradistat textural group of 'Gravelly Sand' expect for PSA_3205 who recorded the sample as 'Sand' however they do not process the sediment greater than 1 mm. Excluding PSA_3205, percentage Gravel ranged from 16.37% (PSA_3214) to 19.60% (PSA_3212) with an average of 17.72% (SD=1.06). The percentage of sand ranged from 75.30% (PSA_3201) to 82.93% (PSA_3203) with an average of 79.94% (SD=2.15). The percentage mud ranged from 0.01% (PSA_3210) to 5.26% (PSA_3201) and the average was 2.31% (SD=1.58).

The weight of sediment greater than 1mm was fairly consistent across the results with a low of 61.50g (PSA_3214) and a high of 72.88g (PSA_3210), however the sieve analysis shows variation in the percentage retained in each half=phi interval. This can be attributed to the sediment type; the material making up the greater than 1mm fraction was predominantly natural cockle shells which were more prone to breakdown during re-analysis depending on the time and magnitude of each sieve shaker.

The laser analysis showed some differences in distribution. Six participants produced a unimodal distribution with the primary mode at 213.4 µm whilst two labs produced bimodal distributions with the primary mode still at 213.4 µm but with secondary modes at 426.8 µm (PSA_3206) and 603.5 µm (PSA_3213). Three participants and the Benchmark lab recorded the primary mode at 603.5 µm and the secondary mode at 213.4 µm and two labs recorded unimodal distributions with the primary mode at 301.80 µm (PSA_3202) and 426.80 µm (PSA_3204).

No participants re-submitted data for PS99 following the circulation of the interim report.

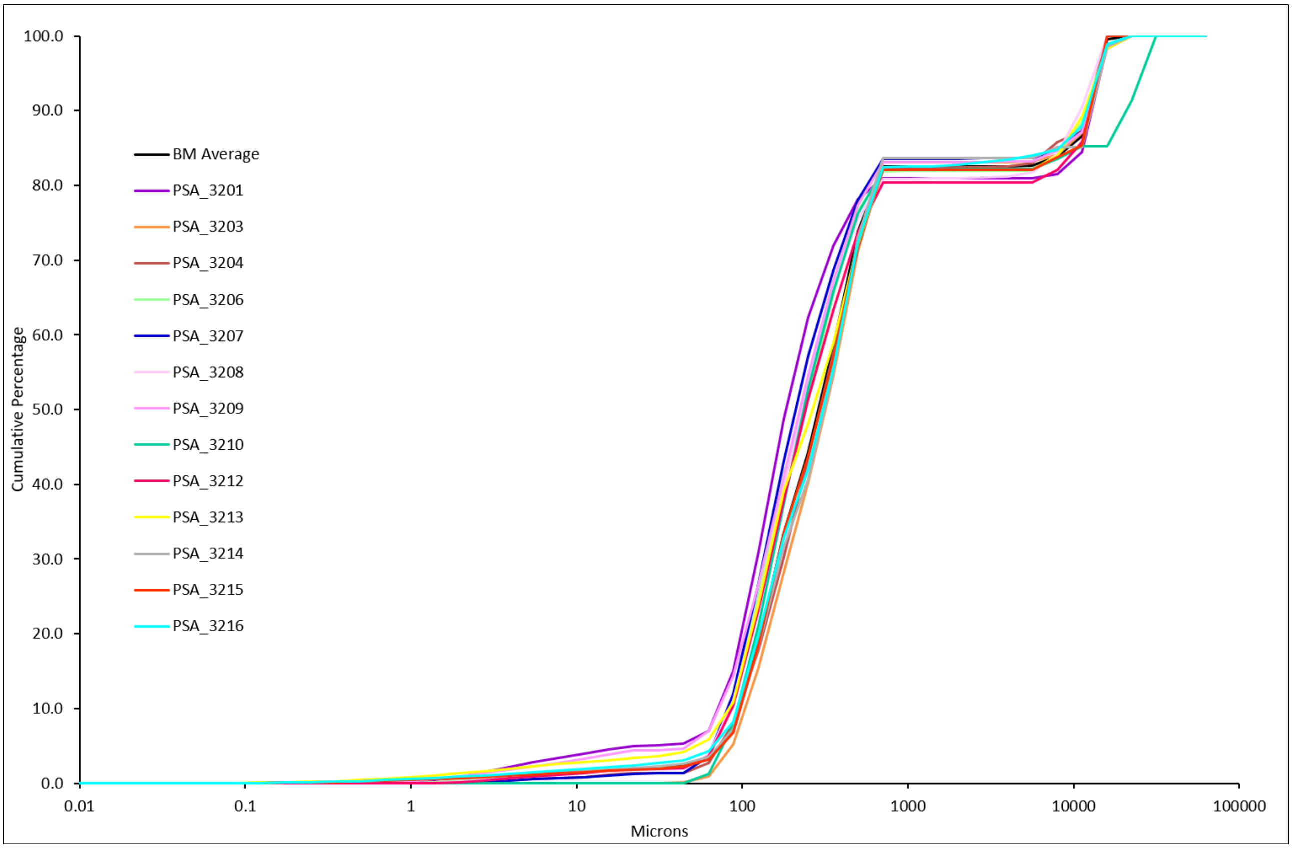


**Figure 8. Particle size distribution curves for sediment distributed as PS99.**

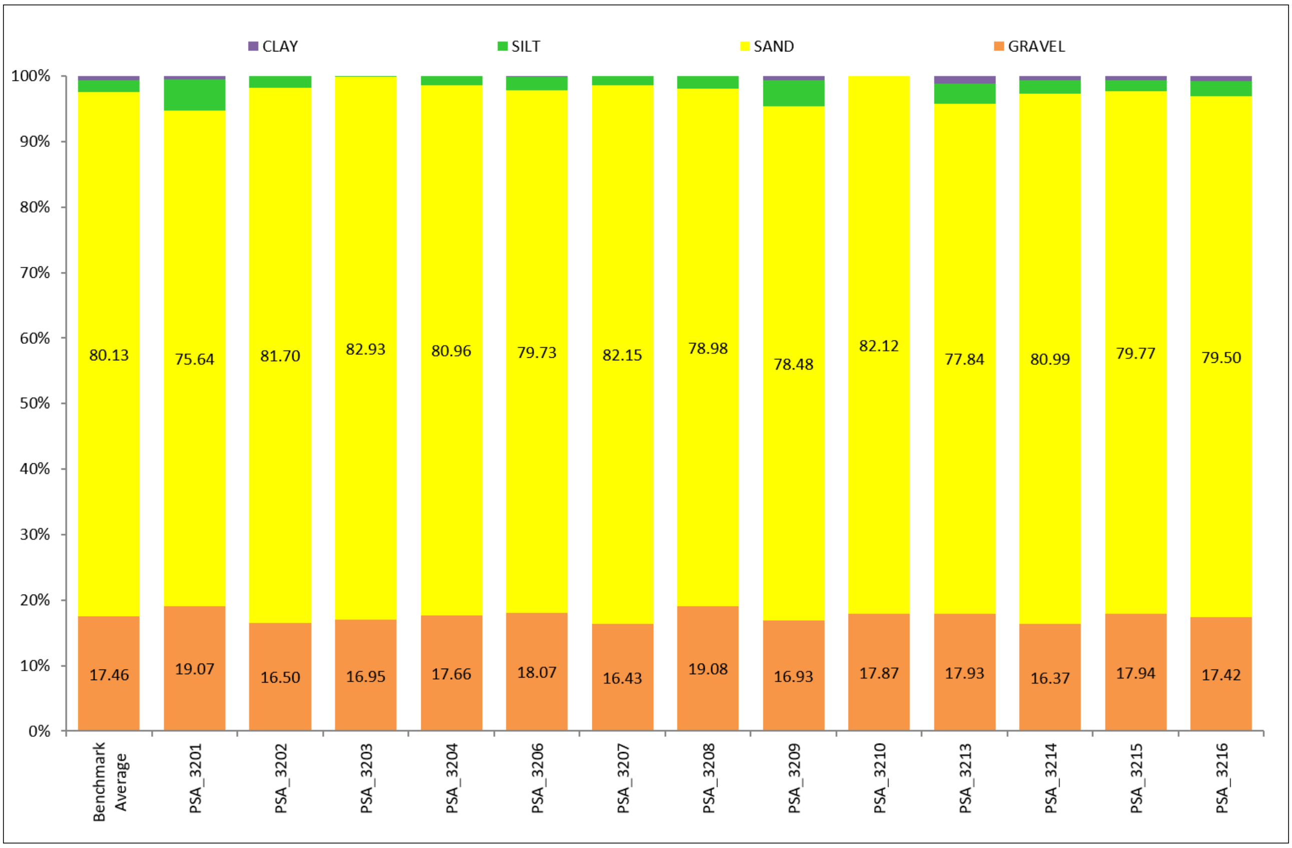


**Figure 9. Stacked column chart showing the percentage gravel, sand, silt, and clay for sediment distributed as PS99.**

### 3.2.4 Discussion

The exercise reports show that most participants follow the NMBAQC methodology for these exercises, those that followed a different methodology (PSA_3202, PSA_3205 and PSA_3207) did not provide details on how their methodology differed from that of the NMABQC. PSA_3202 and PSA_3205 only process sediment greater than 1.0mm at one-phi intervals and therefore are not directly comparable with other participants or the Benchmark lab.

#### 3.2.4.1 Sieve Analysis (>1mm)

Three exercises contained larger quantities of sediment greater than 1mm (PS96, PS97 and PS99), some participants recorded small (<1g) quantities of sediment greater than 1mm in PS98. Figure 10 (below) shows there was generally good agreement between participant data and the Benchmark data for PS96 and PS97. There was more variation within PS99, the contributing factor to these differences is most likely to be due to the fact that the greater than 1mm fraction consisted of natural cockle shells which are more prone to breaking up during analysis whereas PS96 and PS97 were made up of aggregate material or gravel which is less likely to break down during the mechanical sieving process. There are less stringent guidelines on sieving times and amplitude and there are varying sieve times and amplitudes used among participants. The benchmark lab recorded a sieve time of 10mins and amplitude of 1.5mm/'g'. Of the sieve metadata provided by participants, sieve time varies from 5 to 25 minutes; sieve amplitude units of measurement vary due to differing brands of sieve shaker with results provided from 1mm/'g' to 2.1mm/'g', 40Hz and Level 5 or Level 6. All these differences will affect the breakdown of particles particularly in natural, shelly sediment.

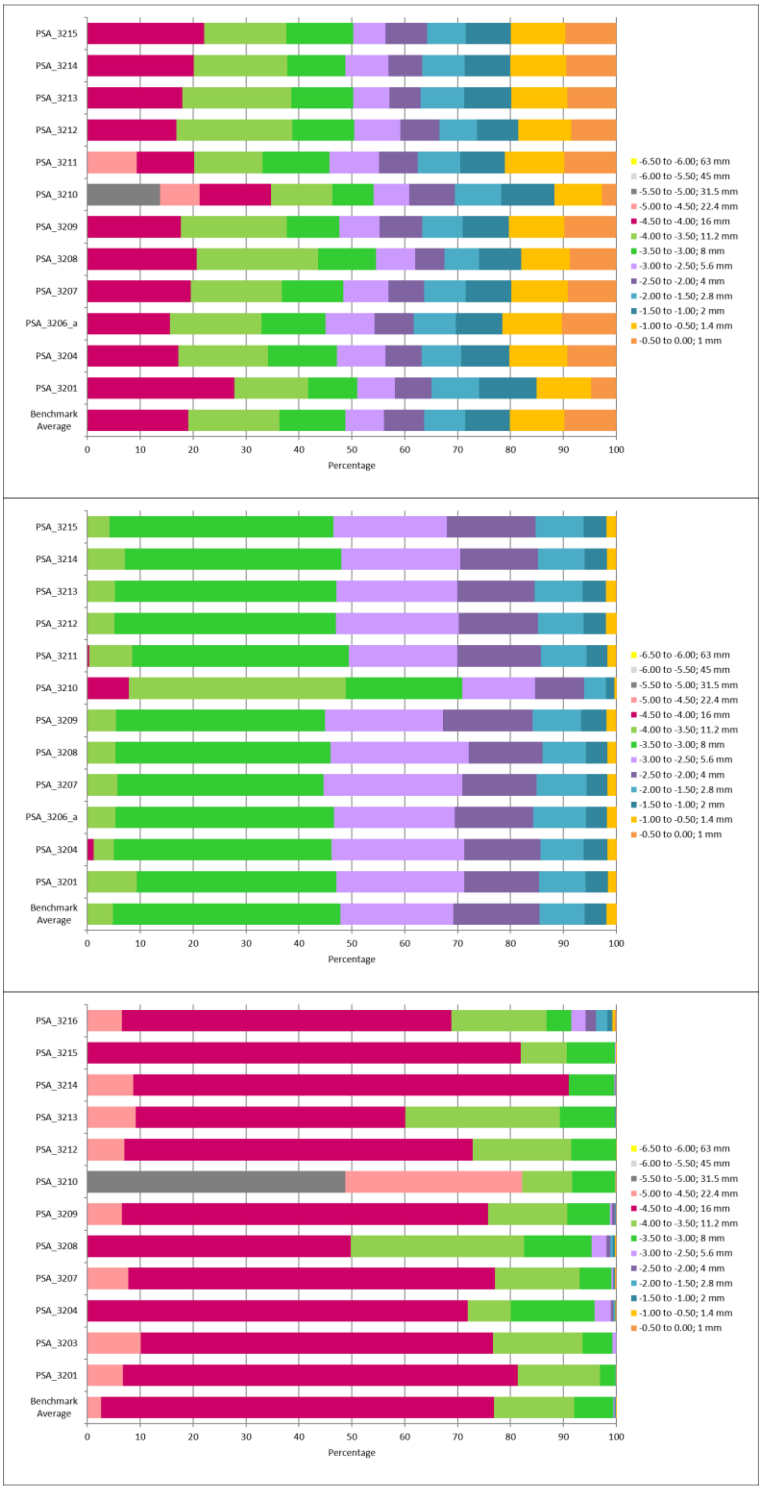


**Figure 10**. **Bar charts showing raw sieve data as percentages in each half-phi interval for PS96 (top), PS97 (middle) and PS99 (bottom).**

### 3.2.4.2 Laser Analysis (<1mm)

Figure 11 shows the differential curves for the laser data for each exercise. Although the results continue to show improvement from previous years, laser analysis remains the main source of variability between participants. All participants re-scaled their laser data to 100% before merging with the sieve data; where the laser replicate data provided included sediment >1mm, data were re-scaled to include only the <1mm fractions for comparisons with benchmark and other participant data.

As in previous years it was apparent in the exercises that required laser analysis and had a significant mud fraction (PS98 and PS96) that there were some differences in results depending on which laser instrument was being used. The participants using the Beckman Coulter and Fritsch instruments recorded on average approximately 5% more clay than those using Malvern instruments. The Beckman Coulter instruments have greater measurement sensitivity and along with the Fritsch analyser were the only instruments capable of detecting particles below 0.345µm. The results obtained using the Beckman Coulter instruments also showed a much greater degree of similarity to each other than those using generated using the Malvern instruments. However, there were still slight differences detected between the participants using Coulter instruments, which could be due to differences in the samples supplied to each lab, different sub-sampling, sample dispersion and/or sample presentation procedures being used.

These differences between laser manufacturers were taken into consideration when comparing participant data with the Benchmark data especially where participants used the Malvern analysers as the Benchmark data is created using a Beckman Coulter.

Laser metadata are very important in helping to identify where possible mistakes are made and whether it is an issue with the laser or a sample preparation problem. For this reason, provision of metadata is a compulsory requirement. The majority of participants supplied laser metadata in the current year, PSA_3207 only provided laser model and dispersion unit.

The NMBAQC recommends using the Mie Theory model, a Particle Refractive Index of 1.55 and a Particle Absorption Index of 0.1, the dispersant used is water which has a Refractive Index of 1.33. Based on the information supplied, most participants are now using the NMBAQC Guidance recommendations. Participants that were not following the recommendations were reminded to do so in their results.

For Exercises PS96 and PS97 all participants that submitted metadata were using the Mie Theory analysis model apart from PSA_3211 who used the Fraunhoffer model. For PS98 and PS99 all participants that submitted metadata were using the Mie Theory analysis model apart from PSA_3203 who used the Fraunhoffer model. All of the participants that provided metadata information used a Particle Absorption Index of 0.1 apart from PSA_3208 who used a Particle AI of 0.01. Most participants used a Particle Refractive Index of 1.55 while two participants used a Particle Refractive Index of 1.52 (PSA_3201 and PSA_3205). All participants using Beckman Coulter laser analysers used the PIDS (Polarized Intensity Differential Scattering) system as the fines extension; all participants using Malvern Mastersizer instruments used both the red and blue light wavelengths.

There remains a degree of variation in the pump and stirrer speeds and the use of ultrasonics. These factors are probably mostly responsible for the variation in the laser size distributions seen in Figure 11. It is not always obvious why a result appears to be different without detailed laser metadata. In addition to laser instrument set-up conditions and performance there are other factors that could be affecting the results, including sample preparation, sample dispersion methods and sample presentation to the laser instrument, about which little or no information has been provided.

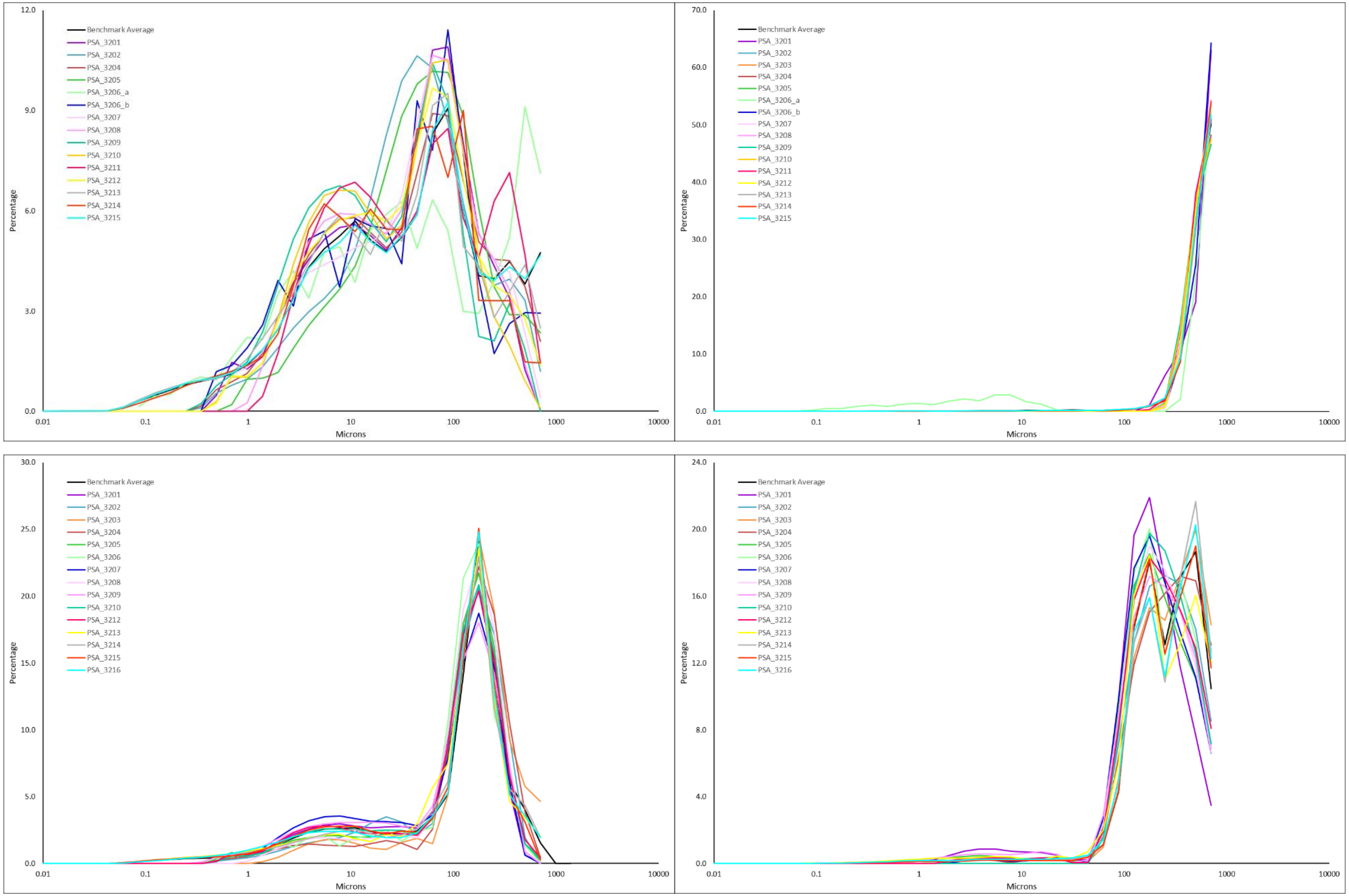


**Figure 11**. **Differential final laser data provided by participants for exercises PS96 (top left), PS97 (top right), PS98 (bottom left) and PS99 (bottom right).**

### 3.2.5 *Application of NMBAQC Scheme Standards and Laboratory Performance*

One of the key roles of the Particle Size Analysis component of the NMBAQC Scheme is to assess the reliability of data collected as part of the Clean Seas Environment Monitoring Programme (CSEMP; formerly UK NMMP) and Water Framework Directive (WFD) monitoring programmes. With this aim, performance target standards were defined for certain Scheme modules and applied in 1996/97 (Scheme year three). These standards were the subject of a review in 2001 (Unicomarine, 2001) and were altered in Scheme year eight; each performance standard is described in detail in the Description of the Scheme Standards for the Particle Size Analysis Component document. An overall summary of the data reported by each participant is presented in each of the PS exercise reports, and along with this each participant receives a results table outlining their individual performance. In previous years laboratories meeting or exceeding the required standard for a given exercise would be considered to have performed satisfactorily for that particular exercise; a flag indicating a "Pass" or "Fail" would be assigned to each laboratory for each of the exercises concerned. As the Pass/Fail criteria are still under review for the PS exercises, in 2025/26 (Scheme year 32) a "Good" or "Review" flag has been issued for Sieve analysis (>1mm), Laser Analysis (<1mm) and Final Data. This aims to highlight any potential errors but will not be used to assess the performance of a laboratory. As this is a training exercise rather than a proficiency test, participants are encouraged to review their results especially where "Review" flags have been issued and can re-submit improved data after the issue of the interim report. Each laboratory was issued with a Statement of Performance certificate outlining their results and participation in the Scheme.

# 4. Particle Size Own Sample Analysis (PS-OS) module

## 4.1 Description

The Particle Size Own Sample (PS-OS) module was first introduced in Scheme year 21 (2014/15) as a training/audit module and now is in its tenth year of operation. Participants' "own" samples are re-analysed by the NMBAQC Scheme PSA contractor and the results are compared. The purpose of this exercise is to examine the accuracy of particle size analysis for participants' in-house samples. In its first year (2014/15) the PS-OS exercises carried a trial Pass/Fail criterion based on the correlation between the participant data and the AQC data. After discussions between KPAL, APEM and the Scheme's PSA Technical Manager (Claire Mason, Cefas), it was decided that a more simplistic approach to analysing the results would be more appropriate in identifying errors in participants' results. The results now follow a similar format to the PS exercises and were split into sieve processing, laser processing and final data. Participants received a "Good" or "Review" flag based on their results. Where a "Review" flag was issued comments were supplied detailing problems that had arisen and where to find information to help address them.

### 4.1.1 *Analysis required*

Laboratories were requested to submit details of a survey with at least 12 samples from their previous year's Clean Seas Environment Monitoring Programme (formerly NMMP) samples, or similar alternative sampling programmes (if not responsible for CSEMP samples), along with the associated PSA data. Once these data were provided, three samples were randomly chosen by APEM Ltd to be re-analysed by the NMBAQC Scheme's PSA contractor.

Spreadsheet based workbooks were distributed to each participating laboratory via email for each PS-OS exercise. These were to be returned to APEM Ltd via the NMBAQC Scheme email address (nmbaqc@apemltd.co.uk).

In each workbook a written description of the sediment classification was to be recorded, a visual estimate was made prior to analysis and a post analysis classification based on the percentages of gravel, sand and silt/clay and the Folk (1954) terminology. Any use of hydrogen peroxide treatment or chemical dispersant was also to be recorded. Also requested was a breakdown of the particle size distribution of the sediment, expressed as a weight or weight percentage of sediment in half-phi ($\phi$) intervals, as well as sieve and laser metadata to provide insight into laboratory procedures, especially for the laser analysis.

The different components of each PS-OS sample (< 1mm, > 1mm and laser sub-sample) were to be sent to APEM's Letchworth laboratory to be passed on to the NMBAQC Scheme PSA contractors. The two sets of results were then compared by APEM Ltd.

Following on from delays resulting from the Covid-19 pandemic the timetable for the PS-OS module was altered to allow participants more time to submit data and to speed up reporting of results to participants. Participants who took part in Batch 1 submitted data by 28th November 2025, had samples selected by the 12th December 2025 and reports were issued at the end of March 2026; Batch 2 submitted data by 27th March 2026, had samples selected by the 1st May 2026 and reports were issued by the end of August 2026.

## 4.2 Results

### *4.2.1 General comments*

Eleven laboratories initially subscribed to the PS-OS module in 2025/26 with one participant (PSA_3210) having multiple entries to allow more submissions. Two participants, PSA_3218 and PSA-3219 did not submit any data; their non-participation was communicated and one lab (PSA_3216) asked for an extension. At the time of writing the data and sample had been submitted however the AQC analysis was still underway . Four participants submitted data in Batch 1 and five participants submitted data in Batch 2.

Each laboratory received detailed comparisons of their data with the re-analysis results obtained by the NMBAQC Scheme's contractor. Where the original analysis was performed by the Scheme's contractor an external auditor was used to re-analyse the samples. Results were split into sieve processing, laser processing and final data. At the end of each report participants received a "Good" or "Review" flag based on their results; where "Review" flags were issued, comments were made on errors that had arisen and where possible information was provided to help resolve problems.

Most of the laboratories that provided samples provided all necessary fractions of their sample for re-analysis; participant PSA_3203 provided a dried laser sub-samples and therefore this required re-wetting and mixing into a soft but stiff paste consistency in order to extract representative laser subsamples. Participant PSA_3209 bagged the sediment retained on each sieve in the original analysis separately. The AQC laboratory noted that this makes it difficult to empty 100% of the sample from the bags, potentially leading to slight underestimation of the sample weight, although every effort was made to extract as much sediment as possible. There is no need to bag each individual sieve fraction, particularly as this only serves to hamper rather than hinder any reanalysis. PSA_3209 also provided three laser subsample pots per sample, the AQC lab noted that for this AQC it defeats the purpose of being able to assess how representative the subsampling process has been from a single pot.

There was generally good agreement between the participants and the AQC results, particularly in terms of basic sediment textural classification (see Table 2 - differences are highlighted in blue).

**Table 1. Gradistat sediment descriptions from the primary data and the AQC re-analysis.**

| Lab | Sample | Primary Sediment Description | AQC Sediment Description |
|---|---|---|---|
| PSA_3203 | PS-OS 34 | Gravelly Mud | Gravelly Muddy Sand |
| | PS-OS 35 | Gravelly Muddy Sand | Gravelly Muddy Sand |
| | PS-OS 36 | Muddy Gravel | Muddy Gravel |
| PSA_3208 | PS-OS 34 | Gravelly Muddy Sand | Gravelly Muddy Sand |
| | PS-OS 35 | Slightly Gravelly Muddy Sand | Slightly Gravelly Muddy Sand |
| | PS-OS 36 | Slightly Gravelly Sandy Mud | Slightly Gravelly Muddy Sand |
| PSA_3209 | PS-OS 34 | Mud | Mud |
| | PS-OS 35 | Muddy Sandy Gravel | Muddy Sandy Gravel |
| | PS-OS 36 | Sandy Mud | Sandy Mud |
| PSA_3210 | PS-OS 34 | Gravelly Muddy Sand | Gravelly Muddy Sand |
| | PS-OS 35 | Gravelly Mud | Gravelly Mud |
| | PS-OS 36 | Gravelly Muddy Sand | Gravelly Muddy Sand |
| PSA_3210 (PSA_3220) | PS-OS 34 | Slightly Gravelly Sandy Mud | Slightly Gravelly Sandy Mud |
| | PS-OS 35 | Slightly Gravelly Sand | Slightly Gravelly Sand |
| | PS-OS 36 | Slightly Gravelly Sand | Slightly Gravelly Sand |
| PSA_3210 (PSA_3221) | PS-OS 34 | Slightly Gravelly Sandy Mud | Slightly Gravelly Sandy Mud |
| | PS-OS 35 | Slightly Gravelly Muddy Sand | Slightly Gravelly Muddy Sand |
| | PS-OS 36 | Slightly Gravelly Sand | Slightly Gravelly Muddy Sand |
| PSA_3210 (PSA_3222) | PS-OS 34 | Slightly Gravelly Sand | Slightly Gravelly Muddy Sand |
| | PS-OS 35 | Slightly Gravelly Sand | Slightly Gravelly Sand |
| | PS-OS 36 | Gravelly Sand | Gravelly Sand |
| PSA_3210 (PSA_3223) | PS-OS 34 | Slightly Gravelly Muddy Sand | Slightly Gravelly Muddy Sand |
| | PS-OS 35 | Slightly Gravelly Sand | Sand |
| | PS-OS 36 | Slightly Gravelly Sand | Slightly Gravelly Sand |
| PSA_3210 (PSA_3224) | PS-OS 34 | Slightly Gravelly Sand | Slightly Gravelly Sand |
| | PS-OS 35 | Sand | Sand |
| | PS-OS 36 | Slightly Gravelly Sand | Slightly Gravelly Sand |
| PSA_3210 (PSA_3225) | PS-OS 34 | Slightly Gravelly Sand | Slightly Gravelly Sand |
| | PS-OS 35 | Slightly Gravelly Muddy Sand | Slightly Gravelly Muddy Sand |
| | PS-OS 36 | Slightly Gravelly Muddy Sand | Slightly Gravelly Muddy Sand |

| Lab | Sample | Primary Sediment Description | AQC Sediment Description |
|---|---|---|---|
| PSA_3212 | PS-OS 34 | Slightly Gravelly Muddy Sand | Slightly Gravelly Muddy Sand |
| | PS-OS 35 | Slightly Gravelly Sandy Mud | Slightly Gravelly Sandy Mud |
| | PS-OS 36 | Gravelly Sand | Gravelly Sand |
| PSA_3213 | PS-OS 34 | Gravelly Muddy Sand | Gravelly Muddy Sand |
| | PS-OS 35 | Gravelly Sand | Gravelly Sand |
| | PS-OS 36 | Slightly Gravelly Sand | Slightly Gravelly Sand |
| PSA_3214 | PS-OS 34 | Sandy Mud | Sandy Mud |
| | PS-OS 35 | Mud | Mud |
| | PS-OS 36 | Gravelly Muddy Sand | Gravelly Muddy Sand |
| PSA_3215 | PS-OS 34 | Muddy Sand | Muddy Sand |
| | PS-OS 35 | Gravelly Muddy Sand | Slightly Gravelly Muddy Sand |
| | PS-OS 36 | Muddy Sand | Muddy Sand |
| PSA_3216 | PS-OS 34<br>PS-OS 35<br>PS-OS 36 | Data not available at time of writing. | Data not available at time of writing. |

The differences in sediment description in PSA_3203 PS-OS 34 are caused by differences in the laser data leading to a 10% difference in the overall percentage sand and mud reported. PSA-3203 was asked to review all their laser analysis.

The differences in sediment description in PSA_3208 PS-OS 36 were also caused by differences in the laser data. This participant requested the sample be returned to them so further investigation could be undertaken. At the time of writing no update on the investigation has been provided.

The remaining differences were all caused by small differences that meant the data crossed the threshold be given an alternate description. PSA_3210 has three samples where the sediment description was different from the AQC. All were caused by small differences in the data, a 5% difference in mud for PSA_3221 PS-OS 36 and PSA_3222 PS-OS 34, and 0.01% gravel recorded by the primary analyst in PSA_3223 PS-OS 35 caused the sample to be described as Slightly Gravelly Sand as opposed to Sand.

In PSA-3215 PS-OS 35 the primary analyst recorded the sample as Gravelly Muddy Sand whereas the AQC data recorded the sample as Slightly Gravelly Sand, this difference was caused by a 0.16% difference in the gravel component.

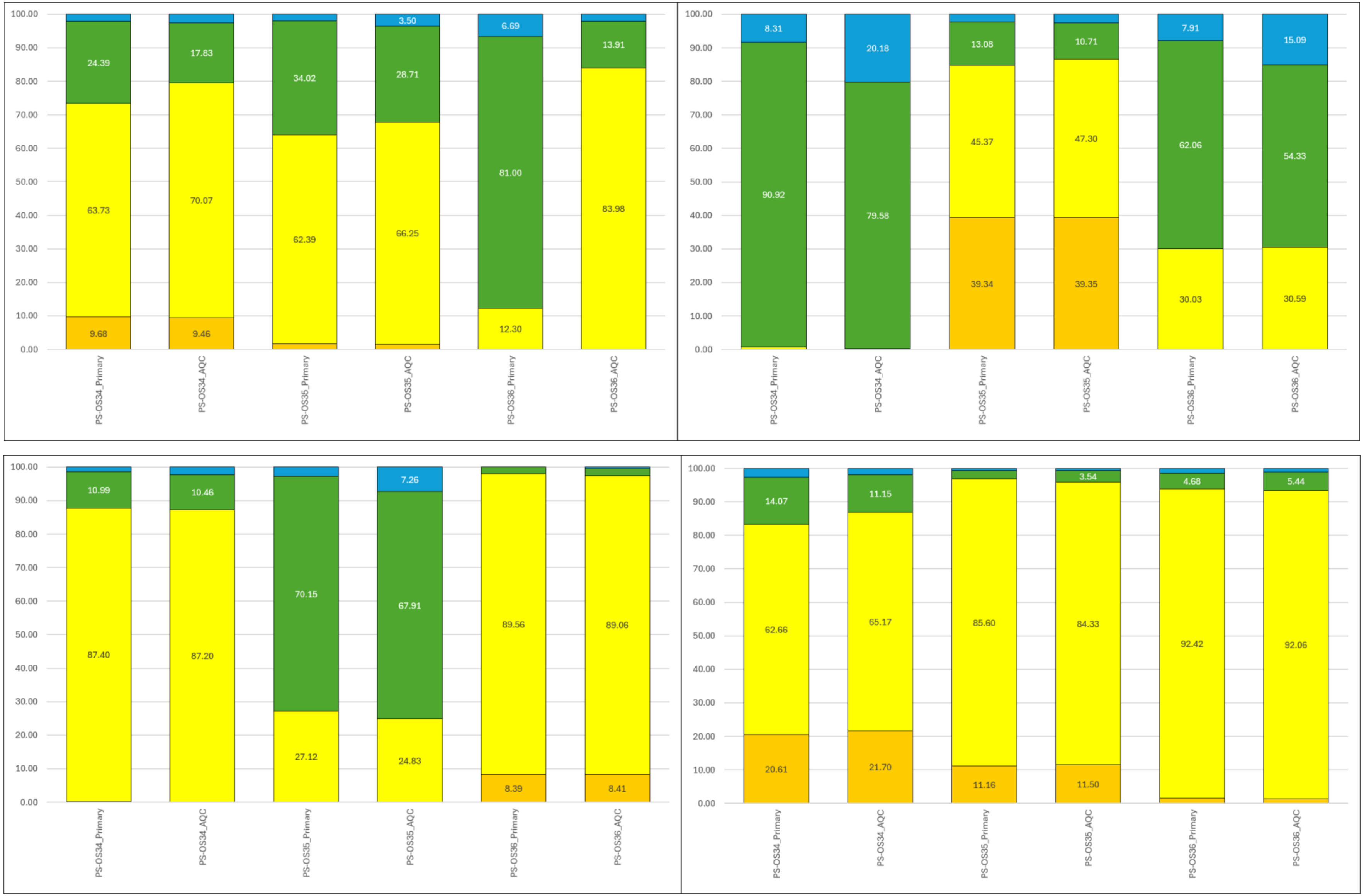


**Figure 12. Bar charts showing percentage gravel, sand, silt, and clay in the PS-OS module from Batch 1 laboratories PSA_3208 (top left), PSA_3209 (top right), PSA_3212 (bottom left and PSA_3213 (bottom right).**

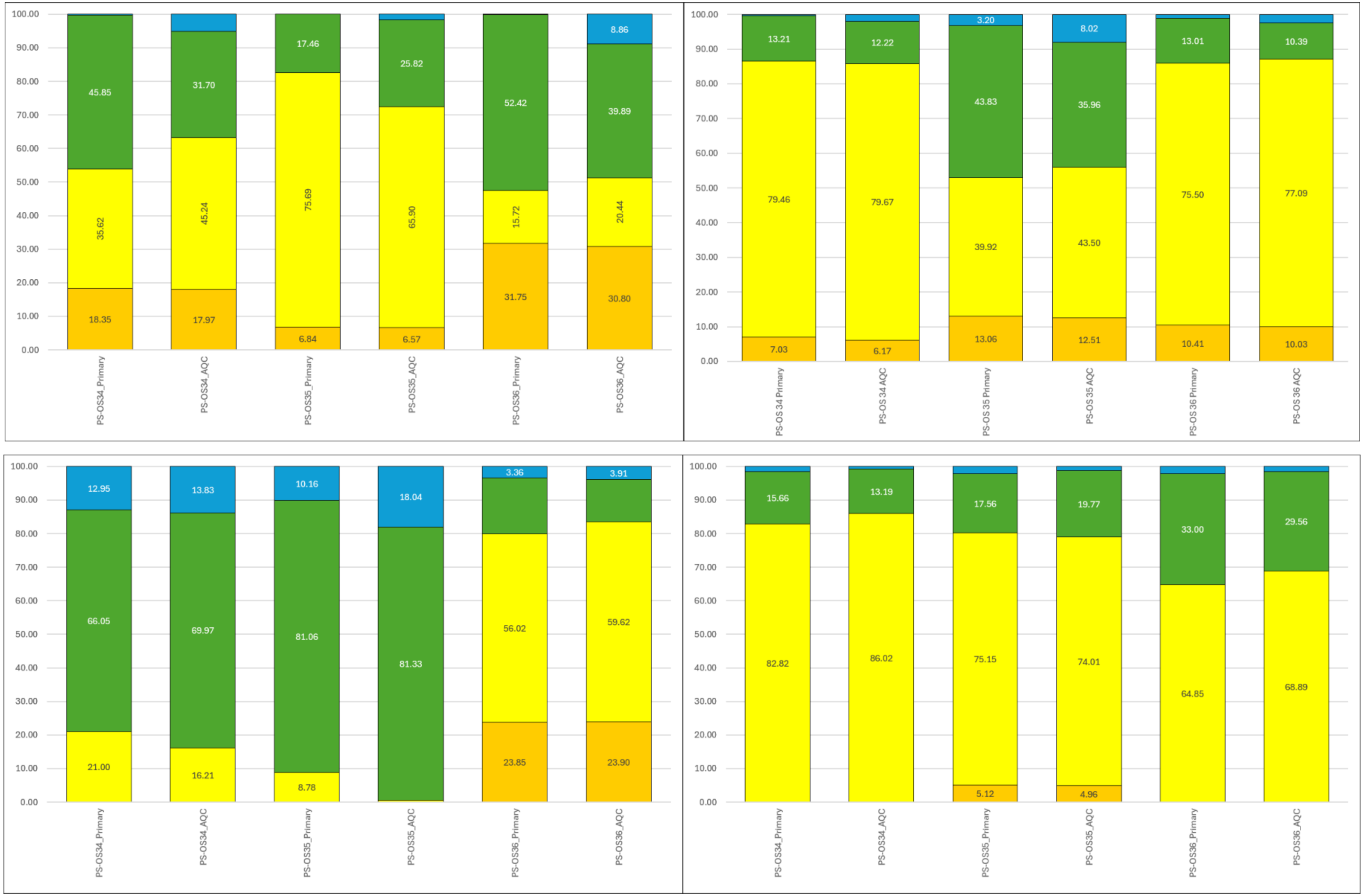


**Figure 13. Bar charts showing percentage gravel, sand, silt, and clay in the PS-OS module from Batch 2 laboratories PSA_3203 (top left), PSA_3210 (top right), PSA_3214 (bottom left) and PSA_3215 (bottom right).**

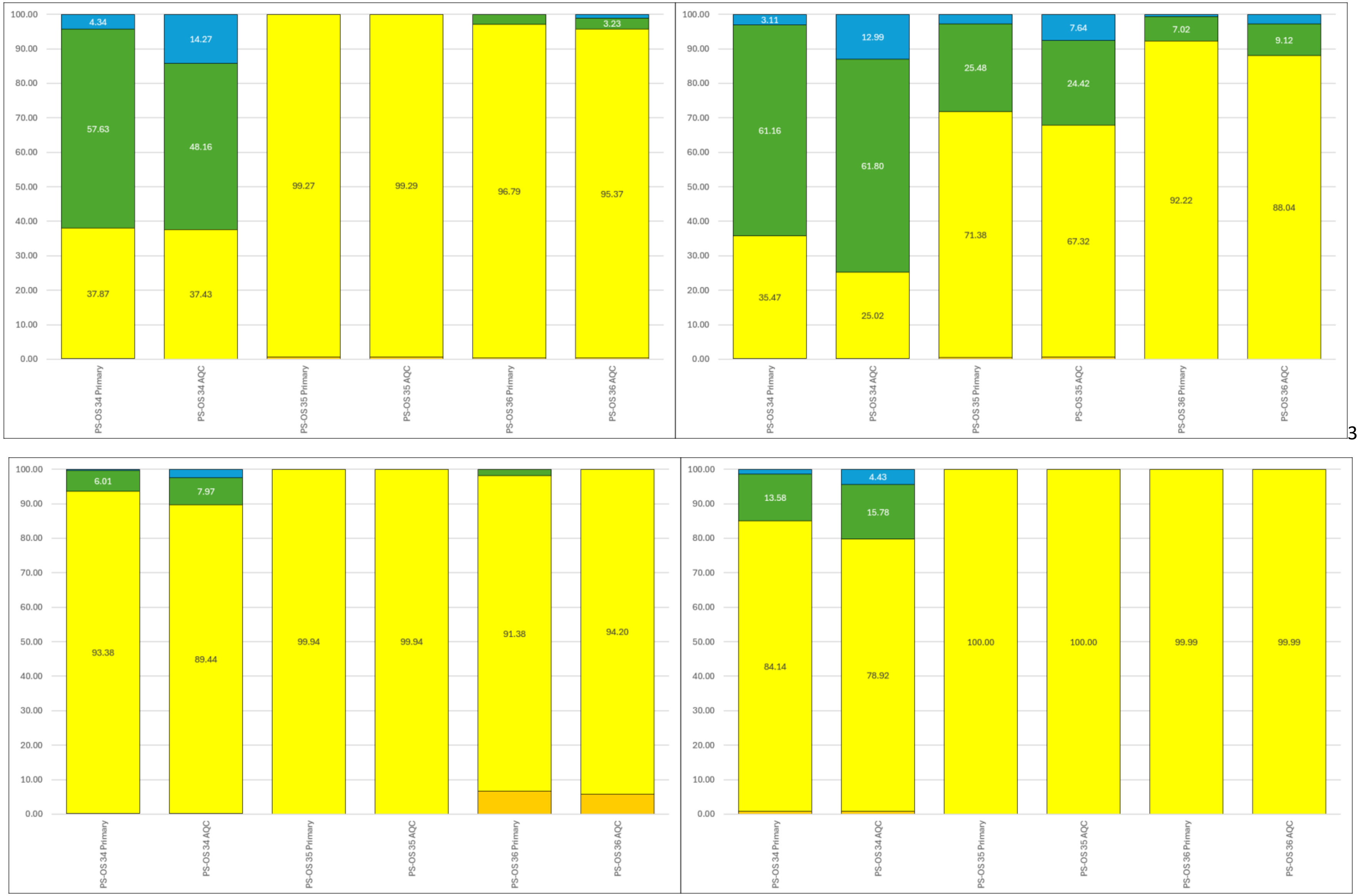

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**Figure 14**. **Bar charts showing percentage gravel, sand, silt, and clay in the PS-OS module from Batch 2 laboratories PSA_3220 (top left), PSA_3221 (top right), PSA_3222 (bottom left) and PSA3223 (bottom right).**

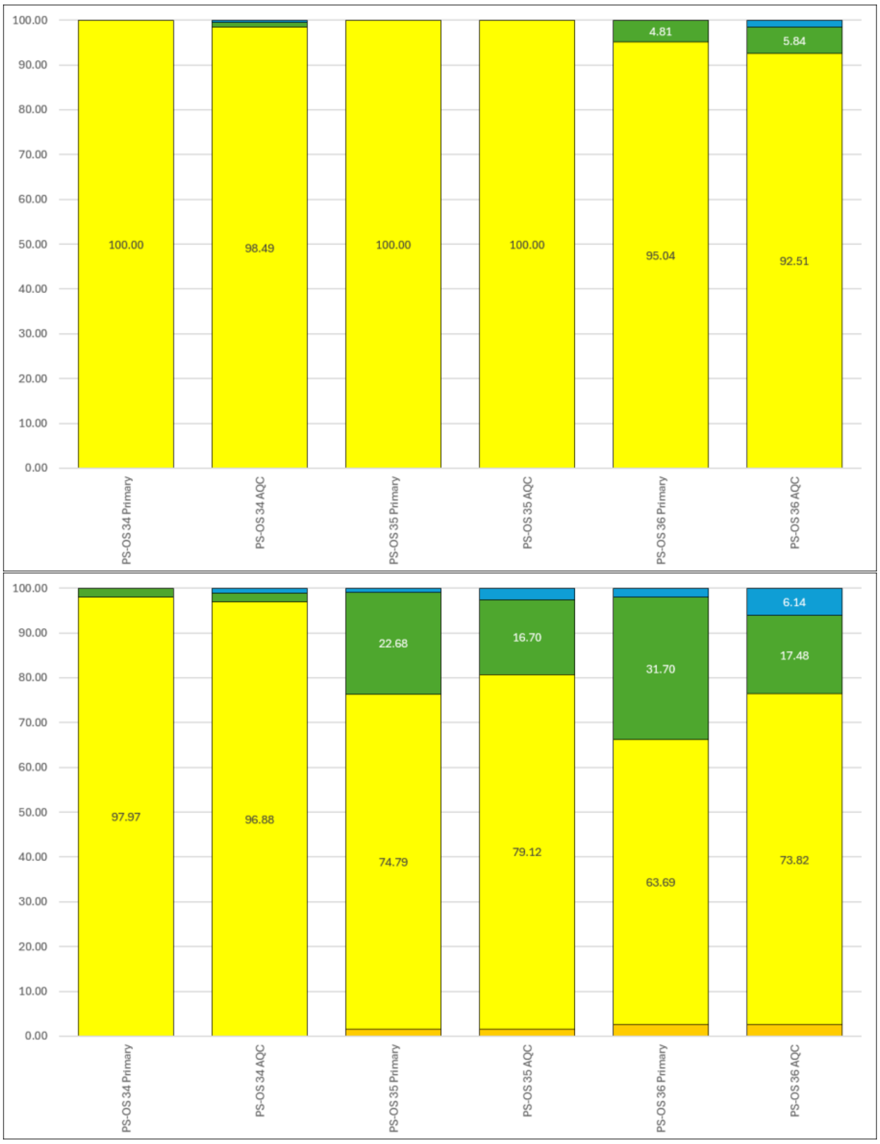


**Figure 15**. **Bar charts showing percentage gravel, sand, silt, and clay in the PS-OS module from Batch 2 laboratories PSA_3224 (top) and PSA_3225 (bottom).**

The greater than 1mm data created by dry sieving was in general very good, there were a few discrepancies, but these are to be expected due to factors such as breakage of particles during repeat analysis and variations in sieving time and vibration amplitude. The wet separation for PSA_3203 did not appear to have been very efficient, with a relatively large weight recorded in the pan fraction. In the case of PS-OS 35 and particularly PS-OS36, it appears as though the screening has effectively removed some of the coarse sand (in the range 500-1000 µm), and therefore the laser subsample is depleted in this range, leading to a 'gap' in the combined size distribution (see Figure 16).

Small amounts of variability particularly in percentage clay shown in Figures 12 - 15 can be explained by differing laser instruments used by the AQC lab and participants. As discussed earlier in this report, the Malvern Mastersizer 2000 and 3000 instruments do not have the same resolution as the Coulter LS13320, especially at the finer end; the Coulter uses a PIDS (Polarization Intensity Differential Scattering) system at the bottom end, rather than diffraction, so provides better sensitivity than the Malvern system which employs diffraction of two different wavelengths of light (red and blue). Often the Coulter system reports higher mud content than the Malvern machines and the distributions produced by the Malvern tend to be more smoothed, and less able to identify discrete size modes. The output size distribution from the Malvern instruments machines is very dependent on the diffraction pattern interpretation model used; this can be selected by the operator as "General Purpose, Unimodal, and Multimodal etc." and can give rise to uncertainty. There is no such specification requirement with the Coulter instruments.

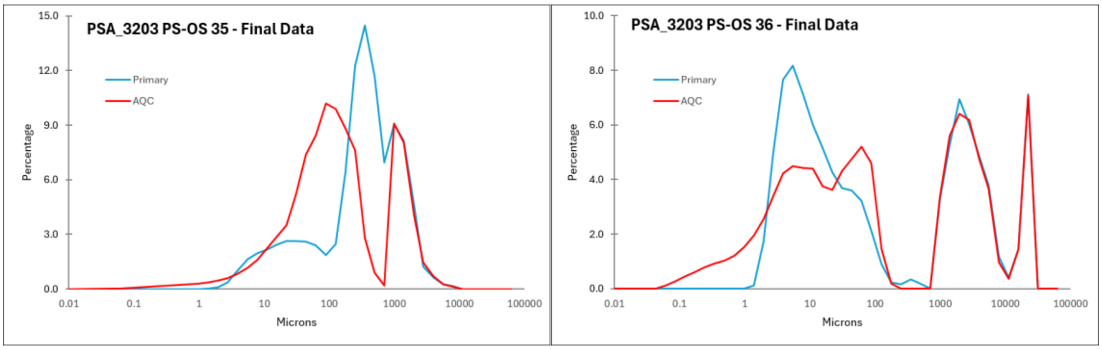


**Figure 16**. **Final data for PSA_3203 PS-OS 35 and PS-OS 36..**

A few laser results showed very different distributions to the AQC re-analysis (Figure 16) and when this was the case, participants were asked to review their primary data. PSA_3208 were undertaking an internal review following the result of their PS-OS 36 result – at the time of writing no conclusions of this review had been communicated. The laser subsamples sent by PSA_3203 appeared to be a small portion of the <1mm oven dried fraction which required re-wetting and mixing into a soft but stiff paste consistency in order to extract representative laser subsamples. This could account for some of the differences seen.

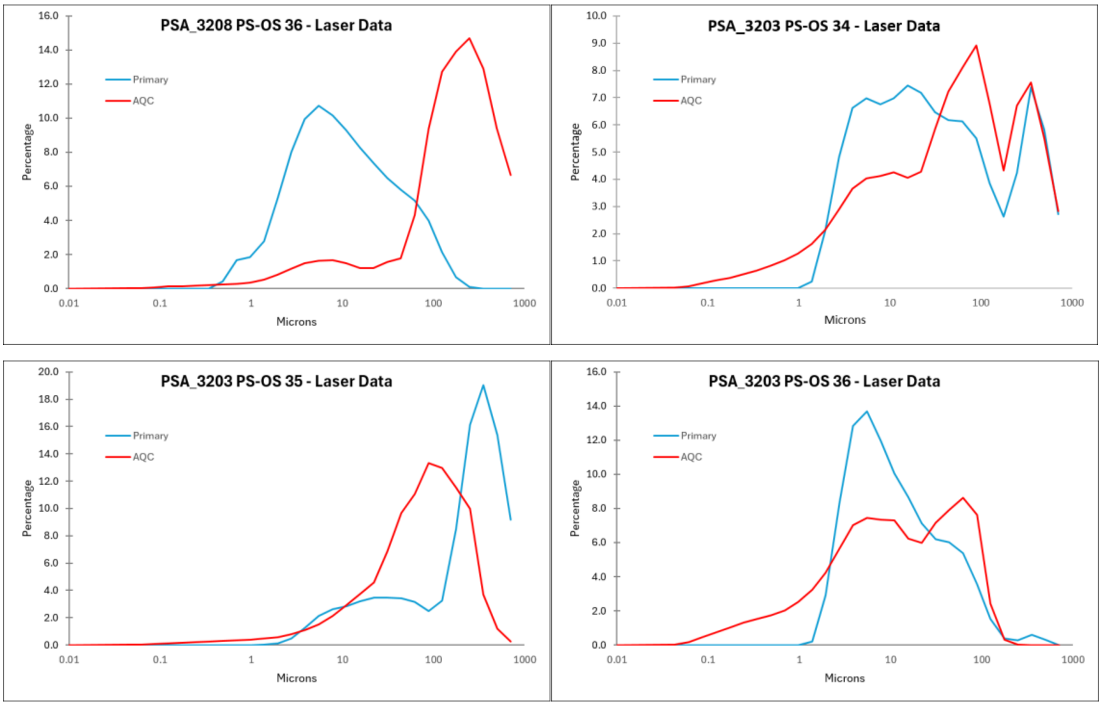


**Figure 17. Laser distribution graphs for samples where participants were asked to review their primary data.**

## 4.3 Discussion

Most re-analysis provided good correlation between the primary analysis and AQC however, as in previous years, differences in laser analysis are still the main area of concern in the PS-OS samples. The interpretation of the methodology set out in the NMBAQC Best Practice Guidelines (Mason, 2022), in particular how the laser analysis is undertaken still appears to be a possible issue in some cases. These guidelines, originally written in 2011, were based on the widespread use at that time amongst participants of Malvern Instruments laser diffraction instruments that have 15 – 25 second standard run times and generally are restricted to the analysis of material < 1mm in size. The original methodology suggested that:

1. A homogenised sub-sample of approximately 100ml is taken from the bulk sample for laser analysis (Laser Pot).

2. A small representative sub-sample is taken from the Laser Pot and passed through a 1mm sieve using as little water as possible (Replicate 1).

3. All of Replicate 1 is then run through the laser at the desired obscuration, producing three run results.

Steps 2 and 3 are then repeated to create Replicates 2 and 3, giving a final result of 9 runs to create the final laser data, the average of these 9 runs.

The completion of nine analyses, and subsequent merging of results is necessarily a time-consuming process, especially if standard run times longer than 15 to 25 seconds are used (e.g. 60 seconds is standard with Beckman Coulter instruments (if the PIDS system is activated). It has been demonstrated by KPAL that, for most samples, there is little practical benefit in routinely carrying out analysis of three replicate sub-samples if samples are homogenised properly both before the laser sub-sample is taken from the bulk sample and when the test sample is taken from the laser sub-sample, and the sample is adequately dispersed prior to presentation to the instrument. In relatively rare instances where samples consist very largely of > 1mm size material and it is impractical to obtain a representative laser sub-sample from the bulk sample, more consistent laser results can be obtained by taking a laser sub-sample from the wet separated < 1mm fraction of the sediment, rather than from the bulk sample.

Where samples display, or are suspected of, unstable behaviour, such as time-dependent agglomeration, one or more repeat runs of the same test sample should be carried out, and additional replicate test samples analysed. Sometimes this may require repeat runs of more than three replicates to fully characterise agglomerative behaviour, and to establish the best dispersal procedures required to obtain repeatable results (e.g. ultrasonic treatment before as well as during the analysis run, and/or use of chemical dispersants). If the laser sub-sample is visually heterogeneous, and/or during the preparation of the test sample it is observed that small amounts of sand are present within a mainly muddy matrix, two or more test samples should be analysed. Additionally, for QA purposes, it is good practice to carry out at least duplicate analysis on 1 in 10 samples. The guidance has been updated to incorporate most of these findings and recommendations, with some further follow up expected at future NMBAQC PSA workshops. The most recent version of the guidance can be viewed in Mason (2022).

The returns for the 2025/26 PS-OS module showed that most laboratories in routine case work only run one laser test sample, with, for QA demonstration purposes, replicates run every 10th, 20th or 50th sample, dependent on sediment type (less frequently for well sorted uniform sand samples than for poorly sorted muddy sand and muddy sandy gravel mixtures). The results obtained by KPAL, for the NMBAQC replicates samples prepared by APEM since 2014/15, demonstrate that the high degree of repeatability which can be obtained when strict analysis protocols are followed, and that a high degree of confidence can be placed in the results obtained for any individual analysis.

## 5. Conclusions and Recommendations

A number of observations may be made based on the results of the exercises described above. The following is a summary of the major points of importance.

1. **<u>Laboratories should ensure that they follow the NMBAQC methodology when participating in the Particle Size (PS) Ring Test</u>**. The PS Ring Test is designed to test whether all participants are getting comparable results when they follow the same methodology. It is therefore important that only the NMBAQC methodology (Mason, 2022) is used where possible and that results for 3 x 3 laser analyses are provided. If an alternate methodology has been used it is imperative that the differences to the NMBAQC methodology are shared so that results can be fairly assessed. Participants who do not have access to a laser analyser will be permitted to use alternate methods for samples that contain sediment less than 1mm as long as the method used is detailed in the summary section of the workbook. Participants can choose to opt out of either the sieve or laser aspects if they do not routinely undertake that type of analysis. The participant must let the administrator know at the start of the scheme year if they wish to opt out of any analysis. Results will only be provided for the analysis that was undertaken and a note will be put on the Statement of Performance that the participant has opted out of certain points.

   Samples for the PS-OS module can be analysed following alternative in-house methods however these must be thoroughly described and the participant should be aware that re-analysis will be undertaken following the NMBAQC methodology. Samples provided for PS-OS which have been routinely analysed do not necessarily have to provide 3 x 3 laser analysis data but should show that appropriate QC checks have been carried out, including on the final data set.

2. **<u>The current NMBAQC Scheme Pass/Fail criteria for the PS modules are under review</u>**. Currently results are broken down for review, including sieve processing, laser processing and final data. Laboratories then received a "Good" or "Review" flag based on their results; "Review" flags came with accompanying comments as to where mistakes have been made and how to correct them. Certain parameters are assessed within each process. This includes the percentage loss/ gain and base pan weight for the sieving. Coefficient of Variance of the laser replicates and mode of the final laser distribution. This approach was thought to be more informative and would help participants to identify errors and correct any issues for future exercises. Following the

publication of 'Statistical comparisons of sediment particle size distributions' (Barry *et al*., 2021) in Continental Shelf Research, data from previous and future reports will trial this new statistical method of comparing the benchmark and participant data to understand if we can achieve a pass/ fail criteria for the particle size component, with the possibility of a report detailing the outcomes available in the next couple of scheme years.

3. **A Review is not a failure.** Although every attempt is made to ensure that all replicates are as similar as is humanly possibly there will naturally be some variation, particularly in natural mud samples. A review flag is just to point out that your analysis differs from that of the Benchmark Lab and other participants. We encourage participants to review their data and if required request a new replicate or ask for their replicate to be re-analysed by the Benchmark Lab for a comparison.

4. **A comparison study for different laser manufacturers and models is currently underway.** This study is being run by Cefas alongside the NMBAQC Scheme and will help to assess the variation between different laser models for different sediment types including muds, sandy muds and muddy sands. Once complete, data and outcomes obtained will be discussed at a NMBAQC workshop and published in the NMABQC PSA guidance document.

5. **A PSA workshop is being planned for 2026/ 27** and will present the data and outcomes of the laser comparison study as well as a potential "training" session on the NMBAQC methodology to participants who are new to particle size or require a refresher.

## 6. References


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