

Laboratory QA Summary

CW4CB Task 5, Phase I

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Submitted to:

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1. Introduction

The Bay Area Stormwater Agencies Association (BASMAA) contracted with Applied Marine Sciences, Inc. (AMS) to support implementation of CW4CB Task 5. As part of its contract with BASMAA, AMS is providing project quality assurance for all Task 5 activities. Don Yee at SFEI is the Project QA Officer (QAO), and has completed data review of Task 5 Phase 1 (T5P1) analytes. Task 5 Phase II is anticipated to be implemented in calendar year 2014. Below are narrative summaries of reviews of QA/QC samples analyzed with reported field samples for T5P1 activities. QA/QC samples were evaluated using the procedures and measurement quality objectives (MQOs) described in the project QAPP (BASMAA 2013).

2. Task 5 Phase 1

Task 5 Phase 1 field monitoring was conducted in April, July, and August, 2013. ALS Global / Columbia Analytical Services (ALS) analyzed water runoff and sediment samples for conventional analytes, Hg, and PCB. Soil Control Lab (SCL) analyzed water samples for several conventional analytes.

QC results generally met project MQOs, with some minor deviations, particularly for PCBs. Contamination was found in PCB blanks, likely affecting results for some of the lowest concentration congeners reported, which were censored (not reported) in samples as a result. Samples also showed moderate to large variation in replicates, particularly for fractionated samples, where subsampling heterogeneity and small fractions sizes may contribute to measurement uncertainty. For analytes showing large variation (>50% RPD), results were flagged as estimated. Details on the individual data submittals by various labs are provided below. All data should be considered preliminary until release of final data submittal by BASMAA.

2.1. Water Conventional Analytes – SCL

Particle size fractions, total and volatile suspended solids, settleable solids, SSC, and turbidity in some runoff samples collected for Task 5 Phase 1 were analyzed by SCL. Samples were collected April 4, 5, & 10, 2013 and were analyzed April 5 & 10, 2013.

2.1.1. Sensitivity

Most analytes were measurable with exception of some analyte/matrix/fraction combinations.. such as settleable solids in a <25 um runoff matrix, not detected in any samples.

2.1.2. Blanks

These conventional analytes were not detected in blanks.

2.1.3. Recovery

Recovery samples are not typically run for these conventional analytes.

2.1.4. Precision

Precision was within the 25% MQO (QAPP Table 26-7) when analytes could be detected sufficiently above the MDL in both lab replicates, although for many analytes precision could not be evaluated due to low concentrations or non-detects.

2.2. Water Conventional Analytes (SSC) – ALS

SSC in water samples collected for Task 5 Phase 1 was analyzed by ALS. Samples were collected August 3 & 21, 2013 and were analyzed August 15 & 26, 2013. SSC was reported for 2 samples. Blank and (duplicate) LCS samples were also reported.

2.2.1. Sensitivity

Sensitivity was sufficient so no non-detects were reported.

2.2.2. Blanks

SSC was not detected in blanks.

2.2.3. Recovery

Recovery for LCSs averaged 6.0% error. Although no recovery targets for SSC are provided in the project QAPP, results were within the QAPP Table 26-6 target 80-120% recovery (20% error) for other water quality conventional analytes.

2.2.4. Precision

Precision on LCS lab replicates was acceptable, averaging 4.1% RPD, within the 25% MQO (QAPP Table 26-7).

2.3. Water PCBs – ALS

PCBs in water samples collected for Task 5 Phase 1 were analyzed by ALS. Samples were collected April 4, August 3 & 21, 2013 and were analyzed May 1 to 6, and September 5, 2013. PCBs in whole water, <25um, and dissolved fraction were reported for 6 sites (including a set of field replicates), with the August samples reported unfractionated for 2 sites. Blank, lab duplicate, LCS, and MS samples were reported.

2.3.1. Sensitivity

Around 70 to 80% of the target analytes had non-detects for PCBs, ranging from around 10 to 100% of the samples (depending on the PCB, and the fraction it was sought in). Dissolved fraction samples had the highest proportion of non-detects (likely due to lower concentrations).

2.3.2. Blanks

A number of PCBs were detected in blanks, with some censored for exceeding 10% of field concentrations in all samples (20% of the PCB analytes in the dissolved fraction). The <25 um fraction had 10% of the analytes censored in all samples, and the unfractionated water samples had no PCBs censored completely, but several PCBs with half or more of the results censored..

2.3.3. Recovery

Recovery for LCSs averaged <30% error (within the QAPP Table 26-9 target 70-130% recovery for CRMs). One of the 3 analytes in the MS was slightly outside of the QAPP 50-150% target and was flagged but not censored.

2.3.4. Precision

Precision on lab replicates was variable, with RPD >50% for around 4/5 of the analytes in whole water samples (lab replicates), 1/3 of the analytes in the dissolved fraction (field replicates), but mostly within

the 25% MQO (QAPP Table 26-1) for the <25 um fraction.. The RPDs over 50% in whole water samples may represent subsampling issues, and in dissolved fractions, lower concentrations. For any given analyte, the field replicate RPD was generally larger than for lab replicates, supporting the notion that part of the variation arises from sampling or subsampling heterogeneity in the particulate phases. Analytes with RPDs over the MQO 25% were flagged, and analytes in fractions with RPDs >50% were additionally flagged as estimated due to the large uncertainty.

2.4. Water Mercury – ALS

Mercury in water samples collected for Task 5 Phase 1 was analyzed by ALS. Samples were collected April 4, 2013 and were analyzed April 8, 2013. Mercury in whole water was reported for 6 samples (including 1 field replicate). Blank, LCS, and MS/MSD samples were also reported.

2.4.1. Sensitivity

Sensitivity was sufficient so no non-detects were reported.

2.4.2. Blanks

Blank concentrations averaged below the detection limit.

2.4.3. Recovery

Recovery for LCS and MS/MSD samples averaged 13 and 23% error respectively (within the QAPP Table 26-8 target 75-125% recovery (25% error) for mercury).

2.4.4. Precision

Precision on field replicates was 59 % RPD, outside the 25% MQO (QAPP Table 26-1), so results were flagged for marginal precision.

2.5. Sediment Grainsize and Total Solids – ALS

Conventional analytes in sediment samples collected for Task 5 Phase 1 were analyzed by ALS. Samples were collected July 25, 2013 and were analyzed August 6, 2013. Sediment grainsizes were reported in 5 field samples, with 1 lab and 1 field replicate, and total solids reported for 17 samples, with 3 field replicates and 3 lab replicates.

2.5.1. Sensitivity

Sensitivity was sufficient so no non-detects were reported.

2.5.2. Blanks

Blanks are typically not reported for these conventional analytes.

2.5.3. Recovery

Recovery samples are typically not run or reported for these conventional analytes.

2.5.4. Precision

Precision on lab replicates was within the 25% MQO target (QAPP Table 26-1) for the grainsize fractions, except for various sand fractions, all with lab RPDs > 50%, so results were flagged for marginal precision and noted as estimated values due to the large precision uncertainty.

2.6. Sediment PCBs – ALS

PCBs in sediment samples collected for Task 5 Phase 1 were analyzed by ALS. Samples were collected July 25, 2013 and were analyzed August 17 to 29, 2013. PCBs in <2mm sediment were reported for 8 samples (including 1 lab and 1 blind field replicate). Blank, LCS, and MS/MSD samples were also reported.

2.6.1. Sensitivity

Only 4 congeners had non-detects reported in one sample.

2.6.2. Blanks

Concentrations of several congeners were detected in the blank above 2x the MDL, and PCBs 128/166, 141, and 158 were above 10% of the concentration in one sample, which was censored.

2.6.3. Recovery

Recovery for MS/MSD samples was not calculated because the spiking level was not sufficiently above (at least double) the native concentration to be quantified reliably. LCS recoveries errors were all 16% or better, well within the QAPP Table 26-2 target 70-130% recovery (30% error) for CRMs.

2.6.4. Precision

Precision on lab replicates was above the 25% RPD MQO (QAPP Table 26-1) for about half the analytes and flagged, with PCB 8 and 95 above 50% RPD, so those congeners were flagged as estimated due to large precision uncertainty.

2.7. Sediment Mercury – ALS

Mercury in sediment samples collected for Task 5 Phase 1 was analyzed by ALS. Samples were collected July 25, 2013 and were analyzed August 9, 2013. Mercury was reported for 8 samples (including 1 lab and 1 blind field replicate). Blank, LCS, and MS/MSD samples were also reported.

2.7.1. Sensitivity

Sensitivity was sufficient so no non-detects were reported.

2.7.2. Blanks

The blank concentration was below the detection limit.

2.7.3. Recovery

Recovery for LCS and MS/MSD samples averaged 5% error or better (within the QAPP Table 26-4 target 75-125% recovery (25% error) for mercury).

2.7.4. Precision

Precision on lab and field replicates was 2% and 23% RPD respectively, within the 25% MQO (QAPP Table 26-4).

3. References

BASMAA, 2013. *Quality Assurance Project Plan: Clean Watersheds for a Clean Bay – Implementing the San Francisco Bay's PCBs and Mercury TMDLs with a Focus on Urban Runoff, EPA San Francisco Bay Water Quality Improvement Fund Grant # CFDA 66.202, Revision 1*. Prepared by Applied Marine

Sciences, Inc. August 15, 2013.

Laboratory QA Summary

CW4CB Task 5

December 11, 2015

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1. Introduction

The Bay Area Stormwater Agencies Association (BASMAA) contracted with Applied Marine Sciences, Inc. (AMS) to support implementation of CW4CB Task 5. As part of its contract with BASMAA, AMS is providing project quality assurance for all Task 5 activities. SFEI has completed final data review of Task 5 analytes for water years 2014 (WY2014) and 2015 (WY2015). Below are narrative summaries of reviews of QA/QC samples analyzed with reported field samples for the project. QA/QC samples were evaluated using the procedures and measurement quality objectives (MQOs) described in the project QAPP (BASMAA 2013). A separate memo will address possible implications of reporting of blank contaminated samples used in this project as compared to others (e.g. SF Bay RMP), which may censor blank biased results.

Task 5 field monitoring data assessed during this review encompasses water quality and sediment monitoring conducted at structural treatment facilities installed at Leo Ave. in San Jose (LEO), Bransten Rd in the Pulgas Creek watershed in San Carlos (PUL), two tree wells within the Ettie Street Pump Station watershed in West Oakland (ETT); San Pablo Ave. in El Cerrito (ELC), West Cutting Blvd. in Richmond, and Sutter St. in Vallejo (VAL). All monitoring was conducted between February 2014 and April 2015. Analytical laboratories employed for each study, along with analyses conducted by each, are described in the sections that follow. In some cases, data for specific analytes from multiple sampling efforts were batched and reviewed together to increase efficiency of data management and quality assurance process. The text below reflects these groupings where applicable.

2. CW4CB T5P2 WY2014

2.1. Water Hg and Pb - ALS

Mercury and lead in water samples collected by AMS was analyzed by ALS. Samples were collected between February 8, 2014 and March 31, 2014, and were analyzed between February 27, 2014 and April 11, 2014. Total mercury results were reported for 29 water samples, 2 MS/MSDs, 3 equipment blanks, 1 field blank, and 21 method blanks. Two batches contained no water sample results, but only equipment blanks. Total lead results were reported for 29 water samples, 4 lab replicates, 4 MS/MSDs, 3 equipment blanks, 1 field blank, 6 method blanks, and 6 laboratory control samples (LCS) samples. One batch contained no water sample results, but only equipment blanks.

Samples were analyzed less than 6 months following acidification satisfying the specified holding time criteria (BASMAA 2013).

2.1.1. Sensitivity

Sensitivity was sufficient with no non-detects reported for mercury and lead.

2.1.2. Blanks

Mercury and lead was not found in the method blanks at concentrations over the detection limit. Field blanks were examined with mercury found in one field blank at a concentration well below the average mercury concentration in the water samples (0.91 compared to 16.53 ng/L).

2.1.3. Recovery

Recoveries for total mercury and lead matrix spike results with an average error of 4.44% and 4.46%, respectively, were well below the 25% target (QAPP Table 26-8 target 75-125% recovery (25% error)). LCS samples were also examined for lead, no LCS samples were analyzed for mercury, and the average error of 4.77% was also below the 25% target.

2.1.4. Precision

Precision on lab replicates for lead, no lab replicates were reported for mercury, with an average RPD of 0.85% was well below the 25% MQO (QAPP Table 26-8), and so no results were flagged for marginal or poor precision. LCS and matrix spike replicates were examined for lead, and matrix spike replicates for mercury, with the average RPDs being less than the 25% target MQO (ranging from 0.55% to 2.09%).

2.2. Water PCBs - ALS

PCBs in water samples collected by AMS were analyzed by ALS. Samples were collected between February 8, 2014 and March 31, 2014 and were analyzed between March 21, 2014 and May 14, 2014. The 40 PCB congeners reported by the Regional Monitoring Program for Water Quality in the San Francisco Estuary¹ were reported in the total fraction for 29 water samples. Lab replicates, method blanks, matrix spike/matrix spike replicate (MS/MSD), field blank, and laboratory control samples (LCS) were also reported.

No samples exceeded the 1 year until extraction and 1 year after extraction holding time specified in the QAPP (BASMAA 2013).

2.2.1. Sensitivity

A majority of the PCB congeners, 80% (37 out of 46 PCBs reported in field samples) had some non-detects (NDs), ranging from 7 to 47%. None of the PCBs had extensive NDs (>50% NDs), although PCB 008 and Total Dichlorobiphenyls were close with 47% of results being NDs.

2.2.2. Blanks

Some blank contamination was found for PCB 129/138/163, PCB 132, PCB 147/149, PCB 174, Total Heptachlorobiphenyls, Total Hexachlorobiphenyls, and Total PCBs. All were flagged with the non-censoring qualifier VIP (analyte detected in field or lab generated blank, flagged by QAO) as a warning, except for 10% of PCB 129/138/163, 23% of PCB 132, 17% of PCB 147/149, 17% of PCB 174, 7% of Total Heptachlorobiphenyls, 13% of Total Hexachlorobiphenyls, and 10% of Total PCBs results, which were flagged with the non-censoring qualifier VJ (estimated value - EPA Flag, flagged by QAO), and a compliance code of Est to indicate the results are estimates, because the results were <10x the blank concentration.

The field blank was examined, but not used in the evaluation with blank contamination found in the single field blank for PCB 044/47/65, PCB 129/138/163, PCB 132, PCB 147/149, PCB 153/168, PCB 180/193, PCB 187, Total Heptachlorobiphenyls, Total Hexachlorobiphenyls, Total PCBs, and Total Tetrachlorobiphenyls, but at levels that were generally less than 1% of the average concentration measured in the field samples (the exception was PCB 044/47/65 at 3.5%).

2.2.3. Recovery

¹ The RMP 40 list of PCBs has been the historic suite of PCB congeners analyzed by BASMAA agencies.

Laboratory control samples (LCSs) were used to evaluate accuracy. Only three PCBs (PCB 105, PCB 118, and PCB 156/157) reported in the field samples were included in the LCS samples. The recoveries for PCB 105, PCB 118, and PCB 156/157 were good (within the 50-150% recovery (50% error) QAPP Table 26-9 target for PCBs). The average error for PCB 105, PCB 118, and PCB 156/157 was good, 5.72%, 3.8% and 6.67% respectively, well below the target MQO of 25%. Only 3 out of the 26 reported analytes in the matrix spike and LCS samples were in the RMP 40 target analytes; although a range of PCB homologs were included in the LCS, some interferences are congener specific and would not necessarily be identified in the LCS.

2.2.4. Precision

Lab replicates were used to evaluate precision for the PCBs, except for PCB 105, PCB 118, and PCB 156/157, which were evaluated using the laboratory control sample replicates. PCB 187, Total Heptachlorobiphenyls, and Total Tetrachlorobiphenyls had average RPDs above the target MQO of 25% (QAPP Table 26-9) and were flagged with the non-censoring qualifier VIL (RPD exceeds control limit, flagged by QAO) as having marginal precision. Total Heptachlorobiphenyls and Total Tetrachlorobiphenyls had average RPDs >50% and were assigned the additional qualifier of VJ and compliance code of Est to indicate estimated values.

2.3. Water TOC - ALS

Total organic carbon (TOC) in water samples collected by AMS was analyzed by ALS. Samples were collected between February 8, 2014 and March 31, 2014, and were analyzed between February 18, 2014 and April 22, 2014. TOC in the total fraction were reported for 29 water samples, 29 lab replicates, MS/MSDs, field blank (and field blank lab replicate), method blanks, and laboratory control sample (LCS) samples. Two samples and their lab replicates exceeded the 28-day holding time specified in the QAPP, and were flagged with the qualifier VH (Holding time violation occurred, flagged by QAO).

2.3.1. Sensitivity

The detection limits were above the project QAPP target of 0.01% for TOC, but all TOC results were above the detection limits (TOC MDs ranged from 0.07 to 2%).

2.3.2. Blanks

TOC was not found in the blanks at concentrations over the detection limit (all NDs). Field blanks were examined, but not used in the evaluation, with average TOC found in the field blanks at a concentration well below the average TOC in the water samples (0.105 versus 14.32 mg/L).

2.3.3. Recovery

Matrix spike samples were used to evaluate the accuracy of Total Organic Carbon. Recoveries were good, with an average error of 3.6% that was well within the target MQO of 80-120% (QAPP Table 26-6). LCS recovery samples were examined and the average 6.69% error was well within the target for TOC.

2.3.4. Precision

Lab replicates were used to evaluate precision for TOC. The average TOC RPD of 2.72% was less than the target MQO of 25%. LCS and matrix spike replicates were also examined, but not used for the evaluation, with the average RPDs, likewise, less than the 25% MQO target (1.41% and 1.97%, respectively).

2.4. Water Turbidity - SCL

Turbidity in water samples collected by AMS was analyzed by SCL. Samples were collected between February 8, 2014 and March 31, 2014, and were analyzed between February 10, 2014 and April 1, 2014. Turbidity in the total fraction was reported for 25 water samples, 3 blind field replicates, 5 lab replicates, and 7 method blanks.

No holding time is specified in the BASMAA QAPP for Turbidity, but all samples were analyzed within the method recommended and SWAMP criterion of a 48-hr hold time.

2.4.1. Sensitivity

Sensitivity was sufficient with no non-detects reported for turbidity.

2.4.2. Blanks

Turbidity was not found in the blanks at concentrations over the detection limit (all NDs).

2.4.3. Recovery

No spiked samples were analyzed/required per the QAPP.

2.4.4. Precision

Lab replicates were used to evaluate precision for turbidity. The average turbidity RPD of 1.49% was less than the target MQO of 25%. Field replicates (combined with lab replicates) were examined but not used in the evaluation of Turbidity with the average RPD, likewise, less than the 25% target MQO (4.48%).

2.5. Water TSS, SSC, and Settleable Solids - SCL

Total Suspended Solids (TSS), Suspended Sediment Concentration (SSC), and Settleable Solids in water samples collected by AMS were analyzed by SCL. Samples were collected between February 8, 2014 and March 31, 2014, and were analyzed between February 10, 2014 and April 5, 2014. Total Suspended Solids (TSS) were reported for two fractions, particulate and volatile, in 26 water samples, 3 blind field replicates, and 5 lab replicates. Suspended Sediment Concentration (SSC) was reported for 26 water samples and 3 blind field replicates. Settleable Solids was reported for 25 water samples, 3 blind field replicates, and 4 lab replicates.

Method blanks were also analyzed, but two batches, one for Settleable Solids and the other for TSS contained no method blanks so the results in those batches were flagged with the qualifier VBS to indicate insufficient QA procedures.

Several results (2 Settleable Solids and 4 Total Suspended Solids (2 Particulate and 2 Volatile fraction)) were flagged with the qualifier VH (Holding time violation occurred, flagged by QAO) for exceeding the specified 7-day holding time listed in the QAPP (BASMAA 2013).

2.5.1. Sensitivity

Sensitivity was sufficient with non-detects reported for only Settleable Solids (28% NDs).

2.5.2. Blanks

TSS, SSC, and Settleable Solids were not found in the blanks at concentrations over the detection limit (all NDs).

2.5.3. Recovery

No spiked samples were analyzed/required per the QAPP.

2.5.4. Precision

Lab replicate samples were used to evaluate precision for Settleable Solids and TSS results; no lab replicates were reported for SSC. The average RPDs were good, all less than the target MQO of 25% (Settleable Solids 3.51%, TSS/Particulate 4.48%, and TSS/Volatile 4.78%). Field replicates were used to evaluate the SSC results with the average RPD of 66.31% being greater than the 25% target MQO. SSC results were flagged with the qualifier VIL (RPD exceeds control limit, flagged by QAO). Since the average RPD for SSC was >50%, results were also flagged with the code VJ, and assigned a compliance code of "Est" to indicate estimated values. Field replicates (combined with lab replicates) were examined, but not used in the evaluation, of Settleable Solids and TSS (both fractions) with the average RPDS less than the 25% target MQO, except for Settleable Solids with an average RPD of 32.81%.

2.6. Water Particle Size Distribution - SCL

Particle Size Distribution in water samples collected by AMS was analyzed by SCL. Samples were collected between February 8, 2014 and March 31, 2014, and were analyzed between February 13, 2014 and April 2, 2014. Results were reported for 6 analyte/matrix combinations: Suspended Sediment Concentration (SSC) for 3 matrices (runoff, particulate, 63 to <500 um; runoff, particulate, 500 to <2000 um; runoff, particulate, >2000 um), Total Suspended Solids (TSS) for two matrices (runoff, particulate, 1 to <25 um; runoff, particulate, 25 to <63 um), and Total Suspended Solids and Salts for one matrix (runoff, <1 um) in 26 runoff samples. Four lab replicates, 3 blind field replicates, and 4 method blanks were also reported. Fractions $\geq 63\mu\text{m}$ were reported as SSC because the whole sample was analyzed, $<63\mu\text{m}$ were reported as TSS since only a subsample was measured for each of those fractions.

Four samples (21 results) were flagged with the qualifier VH (Holding time violation occurred, flagged by QAO) for holding times exceeding the 7 days specified in the BASMAA QAPP.

2.6.1. Sensitivity

Non-detects were reported for the majority of the analyte/matrix combinations (5 out of 6: 84%) ranging from 3 to 86% NDs. Extensive NDs ($\geq 50\%$) were reported for Suspended Sediment Concentration/runoff, particulate, 500 to <2000 um and Suspended Sediment Concentration/runoff, particulate, >2000 um (62% and 86%, respectively). No NDs were reported for the Total Suspended Solids and Salts/ runoff, <1 um analyte/matrix combination.

2.6.2. Blanks

SSC, TSS, and Total Suspended Solids and Salts were not measured in any of the lab blanks (all non-detects).

2.6.3. Recovery

No spiked samples were analyzed/required per the BASMAA QAPP.

2.6.4. Precision

Lab replicate samples were used to evaluate precision for the two TSS matrices (runoff, particulate, 1 to <25 um and runoff, particulate, 25 to <63 um) and the one Total Suspended Solids and Salts matrix (runoff, <1 um). Average RPDs were less than the target MQO of 25% (15.48%, 7.58%, and 6.84%, respectively).

Field replicates (no lab replicates analyzed) were used to evaluate the precision of the three SSC matrices (runoff, particulate, 63 to <500 um; runoff, particulate, 500 to <2000 um; and runoff, particulate, >2000 um), with the average RPDs greater than the 25% target MQO for both the “runoff, particulate, 63 to <500 um” and “runoff, particulate, 500 to <2000 um” matrices (35.13% and 92.27%, respectively). The SSC/runoff, particulate, 63 to <500 um, and SSC/runoff, particulate, 500 to <2000 um results were flagged with the non-censoring qualifier VIL; the results for the SSC/runoff, particulate, 500 to <2000 um combination were assigned a compliance code of Est and flagged with the additional code of VJ because the average RPD was >50%. The SSC matrix “runoff, particulate, >2000 um” RPDs were not calculable due to non-detect results, so could not be evaluated.

Field replicates were examined, but not used to flag the precision for the two TSS matrices (runoff, particulate, 1 to <25 um; runoff, particulate, 25 to <63 um) and the one Total Suspended Solids and Salts matrix (runoff, <1 um). Average RPDs were 60.94%, 22.02%, and 9.71%, respectively.

3. CW4CB T5P2 WY2015

3.1. Sediment Hg - ALS

Mercury in a sediment sample collected by AMS was analyzed by ALS. Sample was collected on October 30, 2014, and was analyzed on November 24, 2014. Total mercury results were reported for 1 sediment samples 1 lab replicate, 1 matrix spike/matrix spike replicate, 1 method blank, and 1 laboratory control sample (LCS).

Holding time for the method used by ALS is listed as 28 days, with the sediment sample kept refrigerated at 4 degrees centigrade. However, since we are basing the QA review on what is stated in the BASMAA QAPP, the mercury results were flagged with the non-censoring code “VH” for holding time violation as the sample was not analyzed within 14 days of collection, or thawing after freezing (sample was not frozen but kept refrigerated at 4 degrees centigrade, and analyzed 25 days after collection).

3.1.1. Sensitivity

Sensitivity was sufficient with no non-detects reported for mercury.

3.1.2. Blanks

Mercury was not found in the method blank at concentrations over the detection limit.

3.1.3. Recovery

Recoveries for total mercury matrix spike results with an average error of 17.85% were below the target MQO of 25% (QAPP Table 26-4 target 75-125% recovery (25% error)). LCS sample was examined, but not used for the evaluation; with the average error of 4.02% well below the 25% target.

3.1.4. Precision

Precision on the lab replicate for mercury with an average RPD of 2.71% was well below the 25% target MQO (QAPP Table 26-4). The RPD for the matrix spike replicate was likewise well below the target MQO of 25% (RPD = 0.72%).

3.2. Sediment PCBs - ALS

PCBs in a sediment sample collected by AMS were analyzed by ALS. Sample was collected on October 30, 2014, and was analyzed on February 23, 2015. PCB results were reported for 49 PCB congeners (including co-elutions and totals) in 1 sediment sample, 1 method blank, and 1 laboratory control sample (LCS). One "Other Client Sample" and associated lab replicate and matrix spike/matrix spike replicate from a different batch (K1500147) were used by the lab for QA purposes, and were included in the review (records were flagged with the qualifier of DS (Batch Quality Assurance data from another project)).

3.2.1. Sensitivity

Method detection limits were sufficient with non-detects (NDs) reported for only PCB 061 and PCB 093/100, both had extensive NDs (NDs>50%), with NDs of 100% and 67%, respectively.

3.2.2. Blanks

About 22% (11 out of the 49 PCBs) of the analytes were found in the blank. PCB 044/47/65, PCB 052, PCB 070/74/76, PCB 153/168, PCB 180/193, PCB 194, Total Heptachlorobiphenyls, Total Hexachlorobiphenyls, Total Octachlorobiphenyls, Total PCBs, and Total Tetrachlorobiphenyls were flagged with the non-censoring qualifier VIP (analyte detected in field or lab generated blank, flagged by QAO) as a warning.

3.2.3. Recovery

Laboratory control samples (LCSs) were used to evaluate accuracy because matrix spikes were not useable having not been spiked at concentrations high enough to avoid analytical variability in the native sample concentrations from dominating the recovery calculations. The case narrative for batch K1500147 had the information. "The percent recoveries for (MS) and 04 (MSD) were below the percent recovery. This can be attributed to the matrix of the sample and the additional copper clean up".

The average error for PCB 105, PCB 118, and PCB 156/157 was good, 8.98%, 7.76% and 7.95% respectively, well below the target MQO of 25% (within the 50-150% recovery (50% error) within QAPP Table 26-2 target for PCBs). Only 3 out of the 26 reported analytes in the LCS sample were in the RMP 40 target analytes; although a range of PCB homologs were included in the LCS, some interferences are congener specific and would not necessarily be identified in the LCS.

3.2.4. Precision

Lab replicates were quite variable for most analytes. Average RPDs ranged from 9% to 126% with 38 out of 47 (81%) of the analytes having RPDs greater than the target MQO of 25%, so were flagged with the non-censoring qualifier VIL. About 80% (30 out of 38) of the analytes had average RPDs >50% and were flagged with the QACode of VJ and a compliance code of Est to indicate estimated values. Matrix spike replicates were examined, but not used in the evaluation, and were much less variable. PCB 105, PCB 118, and PCB 156/157 had average RPDs below the target MQO of 25% (16.01%, 6.84%, and 4.47%, respectively).

3.3. Sediment Bulk Density – ALS

Bulk Density in a sediment sample collected by AMS was analyzed by ALS. Sample was collected on October 30, 2014, and was analyzed on December 5, 2015. Bulk Density results were reported for 1 sediment sample. Bulk Density result was flagged with the non-censoring qualifier VH for holding time violation as the sample was not analyzed within the 7 days specified in the BASMAA QAPP (was analyzed 36 days after collection).

3.3.1. Sensitivity

Sensitivity was sufficient with no non-detects reported for Bulk Density.

3.3.2. Blanks

No lab blanks were analyzed/required per the QAPP for Bulk Density.

3.3.3. Recovery

No spiked samples were analyzed/required per the QAPP for Bulk Density.

3.3.4. Precision

Precision could not be evaluated as no replicates were analyzed. The Bulk Density result was flagged with the non-censoring qualifier VBS to indicate insufficient QA procedures.

3.4. Sediment TOC – ALS

Total organic carbon (TOC) in a sediment sample collected by AMS was analyzed by ALS. Sample was collected on October 30, 2014, and was analyzed on November 26, 2015. TOC results were reported for 1 sediment sample, 1 method blank, and 1 laboratory control sample (LCS).

TOC result was flagged with the non-censoring qualifier VH for holding time violation as the sample was not analyzed within the 7 days specified in the BASMAA QAPP (was analyzed 27 days after collection).

3.4.1. Sensitivity

The detection limits were above the project QAPP target of 0.01% for TOC, but all TOC results were above the detection limits (TOC MDL 0.02%).

3.4.2. Blanks

TOC was not found in the method blank at a concentration over the detection limit (ND).

3.4.3. Recovery

Laboratory Control Sample (LCS) was used to evaluate the accuracy of TOC, and the recovery was good, with an average error of 1.45%, that was well within the target MQO of 80-120% (BASMAA QAPP Table 26-1).

3.4.4. Precision

Precision could not be evaluated as no replicates were analyzed. The TOC result was flagged with the non-censoring qualifier VBS to indicate insufficient QA procedures.

3.5. Sediment Total Solids – ALS

Total Solids in a sediment sample collected by AMS was analyzed by ALS. Sample was collected on October 30, 2014, and was analyzed on November 19, 2015. Total Solids results were reported for 1 sediment sample, and 2 lab replicates.

Total Solids were flagged with the non-censoring qualifier VH for holding time violation as the sample was not analyzed within the 7 days specified in the BASMAA QAPP.

3.5.1. Sensitivity

Sensitivity was sufficient with no non-detects reported for Total Solids.

3.5.2. Blanks

No lab blanks were analyzed/required per the QAPP for Total Solids.

3.5.3. Recovery

No spiked samples were analyzed/required per the QAPP for Total Solids.

3.5.4. Precision

Lab replicates were used to evaluate the precision of Total Solids, and the average RPD of 13.05% was below the 25% target MQO (QAPP Table 26-1).

3.6. Sediment Grainsize – ALS

Grainsize in a sediment sample collected by AMS were analyzed by ALS. Sample was collected on October 30, 2014, and was analyzed on November 17, 2015. Grainsize in 9 fractions (from <75 to <0.005 mm) using the ASTM scale were reported in sediment samples for 1 sediment field samples. Some of the ASTM sizes are slightly offset from the ranges requested in the project QAPP. No other sample types were reported. Note: the various fractions for the sample summed to ~118%.

Results exceeded the 7-day holding time specified in the QAPP for grainsize analysis so were flagged with the non-censoring flag of VH.

3.6.1. Sensitivity

No method detection or reporting limits were provided, but all analyte/fraction combinations had reported results.

3.6.2. Blanks

No method blanks were analyzed/required per the QAPP for Grainsize.

3.6.3. Recovery

No spiked samples were analyzed/required per the QAPP for Grainsize.

3.6.4. Precision

Precision could not be evaluated as no replicates were analyzed. Grainsize results were flagged with the non-censoring qualifier VBS to indicate insufficient QA procedures.

3.7. Water Hg and Pb - ALS

Mercury in water samples collected by AMS was analyzed by ALS. Samples were collected between October 31, 2014 and April 25, 2015, and were analyzed between November 11, 2014 and May 5, 2015. Total mercury (49 of total samplewater and 22 of samplewater, <10 um) results were reported for 71 water samples and total lead (total samplewater) results were reported for 49 water samples. Blind field replicates, method blanks, field blanks, and laboratory control samples (LCS) were also reported.

3.7.1. Sensitivity

Sensitivity was sufficient with no non-detects reported for mercury and lead.

3.7.2. Blanks

Mercury and lead were found in one or more of the method blanks at concentrations over the detection limit, and results in batches with blank contamination were flagged with the qualifier VIP (Analyte detected in lab generated blank, flagged by QAO).

In addition to the lab blanks analyzed, the Project also analyzed two types of field blanks: two standard tubing blanks on Cflex and FEP tubing, and a third equipment blank that incorporated the filtering apparatus used to collect the field-filtered fraction, all of which were non-detects (NDs) or detected not quantifiable (DNQ) estimated values.

3.7.3. Recovery

Recoveries for total mercury and total lead were good, with average errors around 9% and <3%, respectively, well below the 25% target (QAPP Table 26-8 target 75-125% recovery (25% error)).

3.7.4. Precision

Precision on lab replicates for lead was very good, with an average RPD <5% well below the 25% MQO (QAPP Table 26-8). Mercury field replicates were somewhat more variable, with RPDs averaging around 65%; no lab replicates were analyzed. Much of that may be the consequence of the heterogeneity of field sampling combined with low concentrations: matrix spike replicate RPDs were generally under 5%. Mercury results were flagged with the qualifier VIL (RPD exceeds control limit, flagged by QAO) for variable precision.

3.8. Water PCBs - ALS

PCBs in water samples collected by AMS were analyzed by ALS. Samples were collected between October 31, 2014 and February 6, 2015, and were analyzed between December 26, 2014 and February 27, 2015. PCB results were reported for 82 PCB congeners (including co-elutions and totals) in 36 field samples (25 fraction of samplewater and 11 fraction of samplewater, <10 um), blind field replicates, method blanks, field blanks, and laboratory control samples (LCS).

3.8.1. Sensitivity

About a dozen of the individual PCB congeners had extensive non-detects (NDs>50%) for the whole water samples collected, and the problem was slightly exacerbated in the <10um filtered samples, which generally would have lower concentrations for any given site (and thus more NDs).

3.8.2. Blanks

About 35% (29 out of the 82 PCBs) of the analytes were found in the blank and were flagged with the non-censoring qualifier VIP (analyte detected in field or lab generated blank, flagged by QAO) as a warning. Because many of the sample results, particularly in the <10um fraction, were not much above the MDLs in the first place, many of the PCB congener results were flagged with the qualifier VJ as estimated since 10% or more of reported concentrations could be just blank contamination for those congeners.

3.8.3. Recovery

Laboratory control samples (LCSs) were used to evaluate accuracy. Only three PCBs (PCB 105, PCB 118, and PCB 156/157) reported in the field samples were included in the LCS samples. The recoveries for PCB 105, PCB 118, and PCB 156/157 were good (within the 50-150% recovery (50% error) QAPP Table 26-9 target for PCBs) with average errors <10%, well below the target MQO of 25%.

3.8.4. Precision

Field replicates were used to evaluate precision for the PCBs, as the usual sample size would not permit sufficient material for a split for lab replicate analysis. RPDs for about a dozen PCBs were over the target MQO of 25% (QAPP Table 26-9) and were flagged with the non-censoring qualifier VIL (RPD exceeds control limit, flagged by QAO) as having marginal precision, ones with RPDs over 140% were flagged as estimated (VJ) due to precision uncertainty in addition to the precision flag (VIL) indicating deviations from the QAPP target.

3.9. Water TOC - ALS

Total organic carbon (TOC) in water samples collected by AMS was analyzed by ALS. Samples were collected between October 31, 2014 and April 25, 2015, and were analyzed between November 25, 2014 and May 19, 2015. TOC in the total fraction were reported for 49 water samples, field blind replicates, lab replicates, MS/MSDs, field blank (and field blank lab replicate), method blanks, and laboratory control samples (LCS) samples.

3.9.1. Sensitivity

The detection limits were above the project QAPP target of 0.01% for TOC, but all TOC results were above the detection limits (TOC MDLs ranged from 0.07 to 0.4%).

3.9.2. Blanks

TOC was found in one or more of the method blanks at concentrations over the detection limit, and results in batches with blank contamination were flagged with the qualifier VIP (Analyte detected in lab generated blank, flagged by QAO). Only one TOC result was not at least 10x the blank result, so that result was also flagged as estimated (VJ).

3.9.3. Recovery

Recoveries for TOC were good, with average errors typically <3%, well below the 25% target (QAPP Table 26-6 target 75-125% recovery (25% error)).

3.9.4. Precision

Precision on lab replicates for TOC was very good, with an average RPD <5% well below the 25% MQO (QAPP Table 26-6).

3.10. Water Turbidity – SCL

Turbidity in water samples collected by AMS was analyzed by SCL. Samples were collected between October 31, 2014 and April 25, 2015 and were analyzed between November 1, 2014 and April 26, 2015. Turbidity results were reported for 49 water samples, blind field replicates, lab replicates and method blanks.

No holding time listed in BASMAA QAPP for turbidity. All samples were analyzed within the SWAMP criteria of a 48-hr hold time.

3.10.1. Sensitivity

Sensitivity was sufficient with no non-detects reported for turbidity.

3.10.2. Blanks

Turbidity was not measured in the method blanks at concentrations above the method detection limits (all NDs)

3.10.3. Recovery

No spiked samples were analyzed/required per the QAPP for turbidity.

3.10.4. Precision

Lab replicate samples were used to evaluate the precision of the turbidity results. The average RPD of 3.95% was less than the target MQO of 25%. Field replicates (combined with lab replicates) were examined but not used for the evaluation, with the average RPD of 6.83% being less than the 25% target MQO (RPD for field replicates alone was 14.5%).

3.11. Water TSS, SSC, and Settleable Solids - SCL

Total Suspended Solids (TSS), Suspended Sediment Concentration (SSC), and Settleable Solids in water samples collected by AMS were analyzed by SCL. Samples were collected between October 31, 2014 and April 25, 2015, and were analyzed between November 1, 2014 and May 1, 2015. Results were reported in 10 analyte/fraction/matrix combinations for 49 field samples as shown in the table below.

AnalyteName	FractionName	MatrixName
Settleable Solids	Particulate	runoff
Suspended Sediment Concentration	Particulate	runoff
Suspended Sediment Concentration	Particulate	runoff, particulate, >2000 um
Suspended Sediment Concentration	Particulate	runoff, particulate, 500 to <2000 um
Suspended Sediment Concentration	Particulate	runoff, particulate, 63 to <500 um
Total Suspended Solids	Particulate	runoff
Total Suspended Solids	Particulate	runoff, particulate, 1 to <25 um
Total Suspended Solids	Particulate	runoff, particulate, 25 to <63 um
Total Suspended Solids	Volatile	runoff
Total Suspended Solids and Salts	Total	runoff, <1 um

Blind field replicates, lab replicates, method blanks, and one “other client sample” were also analyzed. All samples were analyzed within a 7-day holding time.

3.11.1. Sensitivity

Sensitivity was generally sufficient, with extensive non-detects (NDs>50%) reported for Suspended Sediment Concentration/Particulate/runoff, particulate, >2000 um (~57% NDs), and less frequent, non-detects (NDs) reported for these analyte/fraction/matrix sets: a) Settleable Solids/Particulate/runoff, b) Suspended Sediment Concentration/Particulate/runoff, particulate, 500 to <2000 um, c) Suspended Sediment Concentration/Particulate/runoff, particulate, 63 to <500 um, and d) Total Suspended Solids and Salts/Total/runoff, <1 um, with ~41%, ~36%, ~25%, and ~2% NDs, respectively.

3.11.2. Blanks

None of the 10 analyte/fraction/matrix combinations were found in the method blanks at concentrations over the method detection limit (all non-detects).

3.11.3. Recovery

Accuracy was not evaluated as no spiked samples were analyzed/required per the QAPP.

3.11.4. Precision

Lab replicate samples were used to evaluate the precision of the results except for Suspended Sediment Concentration. The average RPDs for the Total Suspended Solids and Total Suspended Solids and Salts were all less than the 25% target MQO (see table below). Settleable Solids with an average RPD>25%, but less than 50%, were flagged with the non-censoring qualifier of VIL (RPD=35%).

Field replicates (combined with lab replicates) were examined but not used for the evaluation, with the average RPDs ranging from 13% for Total Suspended Solids/Particulate/runoff, particulate, 25 to <63 um to 55% for Suspended Sediment Concentration/Particulate/runoff, particulate, 500 to <2000 um (RPDs for field replicates alone ranged from 15% to 55%).

AnalyteName	RPDlab	RPDfield
Settleable Solids/Particulate/runoff	35%	36%
Total Suspended Solids/Particulate/runoff	10%	17%
Total Suspended Solids/Particulate/runoff, particulate, 1 to <25 um	9%	10%
Total Suspended Solids/Particulate/runoff, particulate, 25 to <63 um	6%	13%
Total Suspended Solids/Volatile/runoff	7%	15%
Total Suspended Solids and Salts/Total/runoff, <1 um	6%	15%
Suspended Sediment Concentration/Particulate/runoff		15%
Suspended Sediment Concentration/Particulate/runoff, particulate, 500 to <2000 um		55%
Suspended Sediment Concentration/Particulate/runoff, particulate, 63 to <500 um		34%
Suspended Sediment Concentration/Particulate/runoff, particulate, >2000 um	all<3 times MDL	

4. References

BASMAA, 2013. *Quality Assurance Project Plan: Clean Watersheds for a Clean Bay – Implementing the San Francisco Bay’s PCBs and Mercury TMDLs with a Focus on Urban Runoff*, EPA San Francisco Bay Water Quality Improvement Fund Grant # CFDA 66.202. Prepared by Applied Marine Sciences, Inc. August 15, 2013.

Laboratory QA Summary

CW4CB Task 5

October 5, 2016

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1. Introduction

The Bay Area Stormwater Agencies Association (BASMAA) contracted with Applied Marine Sciences, Inc. (AMS) to support implementation of CW4CB Task 5. As part of its contract with BASMAA, AMS is providing project quality assurance for all Task 5 activities. SFEI has completed final data review of Task 5 Phase 3 analytes for water year 2016 (WY2016). Below are narrative summaries of reviews of QA/QC samples analyzed with reported field samples for the project. QA/QC samples were evaluated using the procedures and measurement quality objectives (MQOs) described in the project QAPP (BASMAA 2013). A separate memo previously addressed possible implications of reporting of blank contaminated samples used in this project as compared to others (e.g. SF Bay RMP), which may censor blank biased results; the impacts are relatively small other than in low concentration samples.

Task 5 Phase 3 field monitoring data assessed during this review encompasses water quality and sediment monitoring conducted at bioretention/bioswale demonstration projects in Richmond and San Carlos. Analytical laboratories employed for each study, along with analyses conducted by each, are described in the sections that follow. In some cases, data for specific analytes from multiple sampling efforts were batched and reviewed together to increase efficiency of data management and quality assurance process. The text below reflects these groupings where applicable.

2. CW4CB T5P3

2.1. Water Mercury – ALS

Mercury in water samples collected by AMS was analyzed by ALS. Samples were collected between December 10, 2015 and January 17, 2016, and were analyzed between December 17, 2015 and January 28, 2016. Total mercury results were reported for 18 water samples (influent and effluent) and two matrices (samplewater and samplewater, <10 um). One matrix spike/matrix spike replicate (MS/MSD), 3 field replicates, and 12 method blanks were also analyzed in 4 batches. Data were reported not blank corrected.

Samples were analyzed less than 12 days after collection or better, following acidification, satisfying the 6 month holding time criteria specified (BASMAA 2013).

2.1.1. Sensitivity

Sensitivity was sufficient with no non-detects reported for mercury.

2.1.2. Blanks

Mercury was found in at least one blank in 3 out of the 4 lab batches. Results were flagged VIP (analyte detected in field or lab generated blank, flagged by QAO) as a warning, and results <10x the blank

concentration were flagged with the non-censoring qualifier VJ (estimated value - EPA Flag, flagged by QAO), with a compliance code of Est to indicate the results are estimates.

2.1.3.Recovery

Recoveries for total mercury matrix spike results with an average error of 28% were just above the 25% target (QAPP Table 26-8 target 75-125% recovery (25% error)). All results were flagged with the qualifier VIU (percent recovery exceeds laboratory control limit, flagged by QAO) to indicate marginal recovery.

2.1.4.Precision

Precision for mercury was evaluated using field replicates as no lab replicates were analyzed. The average RPD of 0.2% was well below the 25% target MQO (QAPP Table 26-8). The matrix spike samples were examined, but not used for flagging. The average matrix spike RPD of 1.7% was also well below the target MQO.

2.2. Water Lead - ALS

Lead in water samples collected by AMS was analyzed by ALS. Samples were collected between December 10, 2015 and January 17, 2016, and were analyzed between December 22, 2015 and January 27, 2016. Total lead results were reported for 14 water samples (influent and effluent) for one matrix (samplewater). Four matrix spike/matrix spike replicates (MS/MSDs), 3 field replicates, 4 lab replicates, 4 method blanks, and 4 laboratory control samples (LCS) were also analyzed in 4 batches. Data were reported not blank corrected.

Samples were analyzed within 28 days after collection or better, well within the 6 months at room temperature (following acidification) as specified in the BASMAA QAPP (BASMAA 2013).

2.2.1.Sensitivity

Sensitivity was sufficient with no non-detects reported for lead.

2.2.2.Blanks

Lead was not found in any of the method blanks at concentrations above the method detection limit.

2.2.3.Recovery

Recoveries for total lead matrix spike results with an average error of 4% were well below the 25% target (QAPP Table 26-8 target 75-125% recovery (25% error)). The laboratory control samples were examined, but not used for flagging, and with an average error of 5% were also less than the 25% target MQO.

2.2.4.Precision

Precision for lead was evaluated using the lab replicates. The average RPD of 8% was well below the 25% target MQO (QAPP Table 26-8). Field replicates (combined with lab replicates), matrix spike

replicates, and laboratory control sample replicates were examined, but not used for flagging. The average RPDs in all cases, 7%, 1.3%, and ~4% respectively, were well below the target MQO.

2.3. Water PCBs - ALS

PCBs in water samples collected by AMS were analyzed by ALS. Samples were collected between December 10, 2015 and January 17, 2016 and were analyzed between January 22, 2016 and February 8, 2016. The 40 PCB congeners reported by the Regional Monitoring Program for Water Quality in the San Francisco Estuary¹ were reported in the total fraction for 21 water samples, including five field replicates, although many of the samples collected on the same day were separated by an hour, or sometimes more, so it is not clear if these represent field replicates that are meant to have similar concentrations. Four method blanks and 13 laboratory control samples (LCS) were also analyzed in 5 lab batches.

All samples were analyzed within 60 days, well within the 1 year holding time specified (BASMAA 2013).

2.3.1. Sensitivity

Sensitivity was sufficient with no non-detects (NDs) reported for most analytes. None had extensive NDs (>50% NDs), though PCB 008 had ~22% (4 samples), while PCB 195 and 201 had 1 ND each.

2.3.2. Blanks

A number of PCBs were detected in blanks, mostly the lighter congeners. Blank concentrations were greater than 10% of field sample concentrations for over half the samples for many of the lighter congeners (PCB 31 & lower), with those results flagged as estimated. PCB 194 also had nearly 30% of results flagged as estimated due to blank contamination.

2.3.3. Recovery

Laboratory control samples (LCS) were the only recovery samples provided; all the recoveries were good within the 50-150% recovery (50% error) allowed (QAPP Table 26-9 target for PCBs). Only 3 out of the 26 reported analytes in the LCS samples were in the RMP 40 target analytes; although a range of PCB homologs were included in the LCS, some interferences are congener specific and would not necessarily be identified in the LCS.

2.3.4. Precision

Although numerous samples were collected from a site within a day, the majority of them differed in sample time by an hour or more so were likely not expected to have similar concentrations. Blank spike replicates were very consistent, with all RPDs <10%, below the target MQO of 25% (QAPP Table 26-9).

2.4. Water TOC - ALS

Total organic carbon (TOC) in water samples collected by AMS was analyzed by ALS. Samples were collected between December 10, 2015 and January 17, 2016, and were analyzed between December 22, 2015 and January 29, 2016. TOC in the total fraction were reported for 28 water samples (influent and effluent) for one matrix (samplewater). Matrix spike/matrix spike replicates (MS/MSDs), 6 field

¹ The RMP 40 list of PCBs has been the historic suite of PCB congeners analyzed by BASMAA agencies.

replicates, 17 lab replicates, 5 method blanks, and 5 laboratory control samples (LCS) were also analyzed in 5 batches. Data were reported not blank corrected.

Samples were analyzed 20 days after collection or better, well within the 28 days (following acidification) specified (BASMAA 2013).

2.4.1. Sensitivity

The detection limits were above the project QAPP target of 0.01% for TOC, but all TOC results were above the detection limits (TOC MDLs ranged from 0.07 to 2%).

2.4.2. Blanks

TOC was not found in the method blanks at concentrations above the method detection limit (all non-detects).

2.4.3. Recovery

Matrix spike samples were used to evaluate the accuracy of Total Organic Carbon. Recoveries were good, with an average error of 1.2% that was well within the target MQO of 80-120% (QAPP Table 26-6). LCS recovery samples were examined and the average 5% error was well within the target MQO of 25% for TOC.

2.4.4. Precision

Lab replicates were used to evaluate precision for TOC. The average TOC RPD of 6.2% was less than the target MQO of 25% (QAPP Table 26-6). Field replicates (combined with lab replicates), matrix spike replicates, and laboratory control sample replicates were examined, but not used for flagging. The average RPDs in all cases, 22%, 0.2%, and ~3% respectively, were below the target MQO.

2.5. Water Turbidity - SCL

Turbidity in water samples collected by AMS was analyzed by SCL. Samples were collected between December 10, 2014 and January 17, 2016, and were analyzed between December 11, 2015 and January

19, 2016. Turbidity in the total fraction was reported for 14 water samples, blind field replicates, lab replicates and method blanks were also analyzed in 3 lab batches. Data were reported not blank corrected.

No holding time is specified in the BASMAA QAPP for Turbidity, but all samples were analyzed within 72-hours of collection.

2.5.1.Sensitivity

Sensitivity was sufficient with no non-detects reported for turbidity.

2.5.2.Blanks

Turbidity was not found in the blanks at concentrations over the method detection limit (all non-detects).

2.5.3.Recovery

No spiked samples were analyzed/required per the QAPP.

2.5.4.Precision

Lab replicates were used to evaluate precision for turbidity. The average turbidity RPD of 9.3% was less than the target MQO of 25%. Field replicates (combined with lab replicates) were examined but not used for flagging; with the average RPD of 23% being also less than the 25% target MQO.

2.6. Water TSS, SSC, and Settleable Solids - SCL

Total Suspended Solids (TSS), Suspended Sediment Concentration (SSC), and Settleable Solids in water samples collected by AMS were analyzed by SCL. Samples were collected between December 10, 2015 and January 17, 2016, and were analyzed between December 101, 2015 and January 19, 2016.

Results were reported in 10 analyte/fraction/matrix combinations for 14 water samples as shown in the table below.

AnalyteName	FractionName	MatrixName
Settleable Solids	Particulate	runoff
Suspended Sediment Concentration	Particulate	runoff
Suspended Sediment Concentration	Particulate	runoff, particulate, >2000 um
Suspended Sediment Concentration	Particulate	runoff, particulate, 500 to <2000 um
Suspended Sediment Concentration	Particulate	runoff, particulate, 63 to <500 um
Total Suspended Solids	Particulate	runoff
Total Suspended Solids	Particulate	runoff, particulate, 1 to <25 um
Total Suspended Solids	Particulate	runoff, particulate, 25 to <63 um
Total Suspended Solids	Volatile	runoff
Total Suspended Solids and Salts	Total	runoff, <1 um

Blind field replicates, lab replicates (except for Suspended Sediment Concentration), and method blanks were also analyzed in 3 lab batches (the three Total Suspended Solids/Particulate matrices were analyzed in 6 batches). Data were reported not blank corrected.

All samples were analyzed within the specified 7-day holding time listed in the QAPP (BASMAA 2013).

2.6.1.Sensitivity

Sensitivity was generally sufficient, with extensive non-detects (NDs>50%) were reported for Settleable Solids/Particulate/runoff (~90%), Suspended Sediment Concentration/Particulate/runoff, particulate, >2000 um (~82%), and Suspended Sediment Concentration/Particulate/runoff, particulate, 500 to <2000 um (53%). Suspended Sediment Concentration/Particulate/runoff, particulate, 63 to <500 um had ~35% non-detects.

2.6.2.Blanks

TSS, SSC, and Settleable Solids were not found in the blanks at concentrations over the method detection limit (all non-detects).

2.6.3.Recovery

No spiked samples were analyzed/required per the QAPP.

2.6.4.Precision

Lab replicate samples were used to evaluate the precision of the results except for Suspended Sediment Concentration. The average RPDs for the Total Suspended Solids and Total Suspended Solids and Salts were all less than the 25% target MQO (QAPP Table 26-7) as shown in the table below. Settleable Solids with non-detects for all pairs could not be evaluated.

Field replicates (combined with lab replicates) were examined but not used for flagging (no lab replicates were run for SSC so the RPD's shown are for blind field replicates alone), with the average RPDs ranging from 11.72% for Total Suspended Solids/Volatile/runoff to 163% for Suspended Sediment Concentration/Particulate/runoff, particulate, >2000 um.

AnalyteName	RPDlab	RPDfield
Total Suspended Solids/Particulate/runoff, particulate, 25 to <63 um	10.81%	44.15%
Total Suspended Solids and Salts/Total/runoff, <1 um	8.75%	20.20%
Total Suspended Solids/Particulate/runoff	7.68%	13.99%
Total Suspended Solids/Particulate/runoff, particulate, 1 to <25 um	5.78%	28.55%
Total Suspended Solids/Volatile/runoff	4.01%	11.72%
Suspended Sediment Concentration/Particulate/runoff		105.19%
Suspended Sediment Concentration/Particulate/runoff, particulate, 500 to <2000 um		151.72%
Suspended Sediment Concentration/Particulate/runoff, particulate, 63 to <500 um		161.26%
Suspended Sediment Concentration/Particulate/runoff, particulate, >2000 um		163.61%
Settleable Solids/Particulate/runoff	All pairs non-detects	

3. References

BASMAA, 2013. *Quality Assurance Project Plan: Clean Watersheds for a Clean Bay – Implementing the San Francisco Bay’s PCBs and Mercury TMDLs with a Focus on Urban Runoff*, EPA San Francisco Bay Water Quality Improvement Fund Grant # CFDA 66.202. Prepared by Applied Marine Sciences, Inc. August 15, 2013.