

# Laboratory QA Summary

## CW4CB Task 5

December 11, 2015

**Submitted to:**

Mr. Geoff Brosseau  
Bay Area Stormwater Management Agencies Association (BASMAA)  
P.O. Box 2385  
Menlo Park, CA 94026  
info@BASMAA.org

**Submitted by:**

A P P L I E D  
*ummarine*  
S C I E N C E S

4749 Bennett Drive, Suite L  
Livermore, CA 94551  
925-373-7142

## 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 Estuary<sup>1</sup> 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***

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<sup>1</sup> 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.