COORDINATED MONITORING PROGRAM FOR GUADALUPE RIVER WATERSHED MERCURY TMDL

AGREEMENT NO. A4123A

MONITORING PLAN (2018 TO 2023)

Prepared for

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1 INTRODUCTION

In 2008, the San Francisco Bay Regional Water Quality Control Board (SFRWQCB) amended the Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) to establish new water quality objectives, Total Maximum Daily Loads (TMDLs), and an implementation plan to address mercury pollution in the Guadalupe River Watershed[1]. That amendment imposed surface water, sediment, and fish tissue objectives to restore and protect beneficial uses in waters of the Guadalupe River Watershed and required development of a monitoring program to assess the effectiveness of management actions.

The first cycle of monitoring for this TMDL was conducted between 2011 and 2016, and is reported in the Guadalupe River Coordinated Monitoring Program 5-Year Report (AECOM 2017). Sampling was conducted at the USGS gage above Highway 101 to assess mercury loads during the 2014-2015 season. Four storms were sampled: one in December, two in February, and one in April. Depth-integrated, flow weighted suspended samples were collected during each of these storms and were analyzed for total and dissolved mercury, and total and dissolved methylmercury. Age 1 fish were collected from five streams and three reservoirs during 2011, 2012, and 2016. Fish tissue sampling in 2016 was conducted early in the season (May) to correspond with the avian breeding season, whereas fish sampling in 2011 and 2012 was conducted in June in streams and August-September in the reservoirs.

The SFRWQCB's California Water Code Section 13267 letter of 29 June 2017 specifies the required monitoring for the second cycle of monitoring in the Guadalupe river watershed. The required monitoring focuses on collection of fish tissue mercury concentrations to determine spatial and temporal patterns, and on large storm monitoring of suspended sediment and mercury to assess loading to San Francisco Bay. The letter specifies the questions to be resolved, locations to be sampled, and frequency of sampling. The specific monitoring objectives are presented in Section 1.3 of this plan. Sampling methods and procedures are provided in Section 3.3; analytical methods are provided in Section 3.5; and data analysis and reporting are described in Section 3.8.

[1] https://www.waterboards.ca.gov/rwqcb2/water_issues/programs/TMDLs/guadaluperivermercurytmdl.html

1.1 PROJECT ORGANIZATION

The Santa Clara Valley Water District (District), the County of Santa Clara, Guadalupe Rubbish Disposal Company, and the Midpeninsula Regional Open Space District have joined to implement a Coordinated Monitoring Program (CMP) to address requirements in the TMDL for mercury in the Guadalupe River watershed. This phase of the CMP is administered by the District.

The District's project manager for this work is Ms. Kirsten Struve. The District and CMP partners have selected a team consisting of Tetra Tech and Wetland Research Associates (WRA) to perform the required monitoring. Dr. Ted Donn of Tetra Tech will oversee the proposed study including sampling, reporting and technical tasks and overall project management. David Pizzi will provide guidance on the sampling of stormwater and collection of stormwater samples. Gary Wortham will conduct the field sampling of storm water and sediment and will also serve as QA Coordinator for the project. Dan Chase of Wetlands Research Associates (WRA) will be responsible for obtaining all regulatory permits for collection of fish tissue samples and will have primary responsibility for the collection of fish tissue in creeks and Lake Almaden.

1.2 PROJECT DEFINITION AND BACKGROUND

The Guadalupe River watershed covers approximately 160 square miles, draining portions of the eastern Santa Cruz Mountains to San Francisco Bay (Figure 1-1). The watershed contains eight reservoirs, which are used for flood control, drinking water storage, groundwater recharge, and recreation (including Calero Reservoir, Almaden Reservoir, Guadalupe Reservoir, Lake Almaden, Lake Elsman, Lexington Reservoir, and Vasona Reservoir). Streamflow in the Guadalupe River system is from south to north.

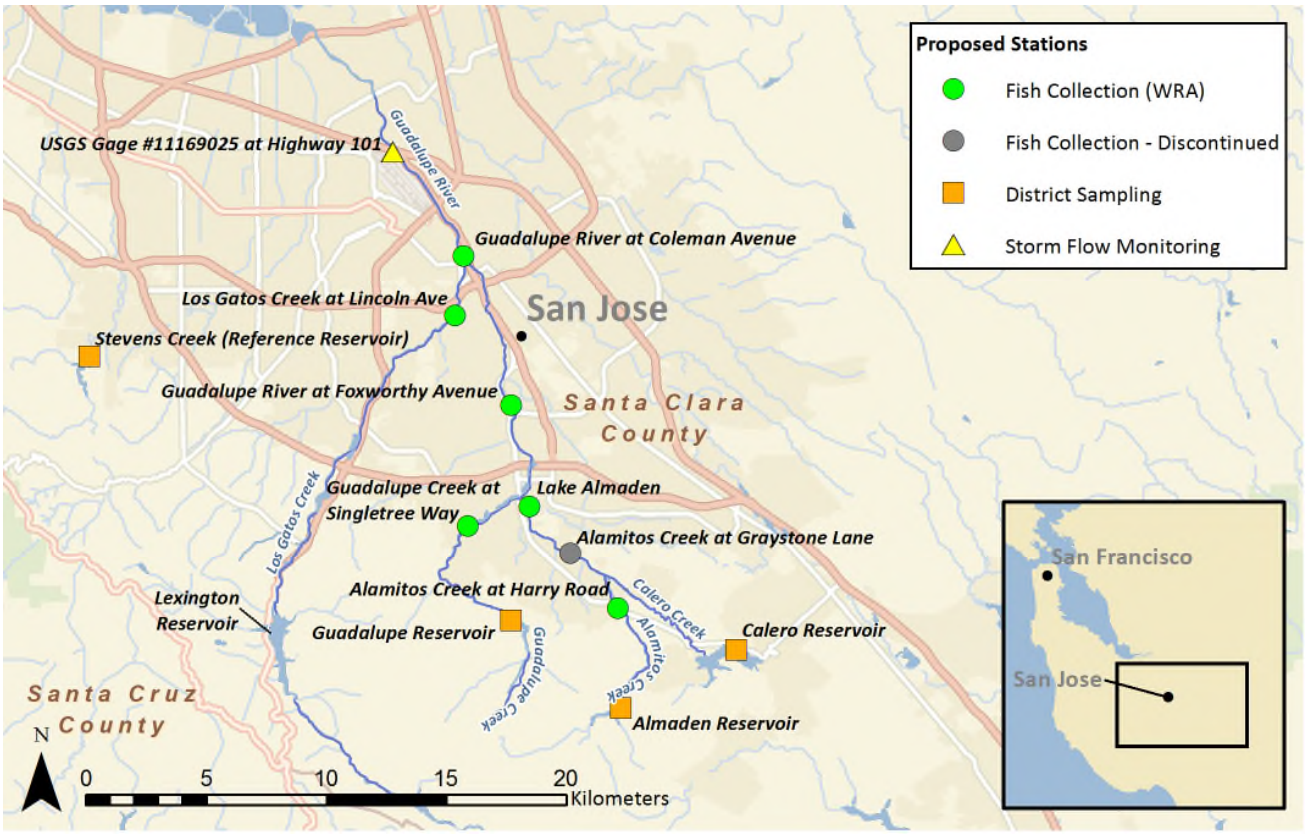

Figure 1-1 Sampling locations within the Guadalupe River watershed.

The Guadalupe River watershed lies within a region naturally enriched in mercury. The New Almaden Mining District, located in the headwaters of the Guadalupe River watershed, was the largest-producing mercury mine in North America (and fifth largest in the world). Mining waste continues to be the largest source of mercury to the watershed and has contributed to the mercury-contaminated sediments deposited in Almaden, Guadalupe, and Calero Reservoirs and to higher levels of mercury in deposits in Guadalupe Creek, Alamitos Creek, Almaden Lake, and Guadalupe River. Fish collected from creeks and reservoirs downstream of the New Almaden Mining District often contain high concentrations of mercury in its bioavailable form of methylmercury.

Remediation effectiveness indicators for fish tissue monitoring are monitoring endpoints that are designed to be sensitive to changes in mercury exposures in both space and time. In the Guadalupe River watershed these include young-of-year California roach in creeks and rivers and age-1 largemouth bass in reservoirs. The TMDL target for mercury in fish tissue of these species is 0.05 mg/kg fish for 5-15 cm length fish (SFRWQCB 2008). The current waste load allocation for mercury in the Guadalupe River is 9.4 kg per year, or an annual median concentration of 0.2 mg mercury per kg suspended sediment on a dry weight basis.

1.3 PROJECT OBJECTIVES AND KEY QUESTIONS

1.3.1 STORM FLOW MONITORING

The key questions to be addressed by the storm flow monitoring program are:

1. What is the mercury load from Guadalupe River delivered to San Francisco Bay in large storms?
2. What component of these storm loads are from each of legacy mining and urban stormwater runoff sources?

The objective of storm flow monitoring is to allow estimation of total mercury loading to San Francisco Bay. To accomplish this objective, it is necessary to establish the relationships between flow, suspended sediment concentration, and mercury concentration. Therefore, sampling will be conducted during two large storms during each of two water years. Each storm will be sampled eight times over the hydrograph, targeting 4 samples on the rising limb and four samples on the falling limb of the hydrograph. By catching both the rising and falling limbs of the hydrograph, with a range of flow rates, the Tetra Tech team will be able to determine if there are any differences in transport based on changes in the flows. A US D-95 depth integrating sampler will be used to collect subsamples across the width of the stream, thereby allowing collection of depth-integrated, flow-weighted samples.

Storm flow sampling will be conducted at USGS gage #11169205 located on Guadalupe River above Highway 101. This gage was installed in May 2002. The gage provides instantaneous (i.e., 15-minute interval) flow readings which are reported both as instantaneous discharge and as daily average discharge. In addition, a Forest Technology Systems Limited model DTS-12 turbidity sensor was installed in November 2002 and is operated during the rainy season between October 1 and April 30 each year. The USGS website reports the daily average total suspended solids (TSS) concentration and calculated sediment load in tons per day based on the data from this sensor. Data from the turbidity sensor will be used in the calculation of mercury loads. Funding for the flow gage (approximately two-thirds) and turbidity sensor is provided by the Santa Clara Valley Water District as part of their contribution to the Coordinated Monitoring Program.

1.3.2 FISH TISSUE MONITORING IN STREAMS AND LAKE ALMADEN

The key questions to be addressed by the fish tissue monitoring program are:

1. What is the temporal trend in fish tissue mercury concentrations in remediation effectiveness indicators in Lake Almaden, Guadalupe, Almaden, and Calero Reservoirs, Alamitos and Guadalupe Creeks, and the Guadalupe River?
2. Is there a temporal trend in fish tissue mercury concentrations at reference sites, and if so, how does it inform interpretation of remediation effectiveness indicators?

The objective of the fish tissue monitoring is to determine tissue burdens of total mercury in whole, young-of-year fish in streams and Lake Almaden to determine temporal trends

in these remediation indicators. These data will be integrated with reservoir sampling being conducted by the District. The data will be analyzed to determine the effectiveness of upstream remediation actions on the concentration of mercury in tissue of stream fish. The data will also be analyzed to determine whether the fish tissue burdens represent a risk to piscivorous birds.

2 STORM THRESHOLD EVALUATION

The SFRWQCB's California Water Code Section 13267 letter of 29 June 2017 requires that the District and CMP partners:

- Monitor one storm of 25 year or higher return interval; if monitored successfully, the Water Board plans to credit this monitoring towards future mercury monitoring requirements; and
- Sample up to two storms in two separate years (up to four storm events) that meet large storm threshold in upper watershed.

The District and CMP partners have selected a team consisting of Tetra Tech and Wetland Research Associated (WRA) to perform the required monitoring (Section 1.1).

This section provides definition of the 25-year storm flow based on storm return frequencies modeled on data from the USGS gage above Highway 101, and provides a rationale for defining a "large storm" within the Guadalupe River watershed. The resulting large storm threshold will be used as one criterion to determine when mobilization should occur. Flow data will be evaluated after the storm event to determine whether it met all mobilization criteria and to improve the use of the mobilization criteria in subsequent storm events.

Previous studies (Tetra Tech 2005; McKee et al. 2017) have shown that the majority of mercury is transported via suspended sediment transport during storms. This is consistent with the findings of Edwards and Glysson (1999) regarding the quantity of sediment transport during large storms. Between January 7 and 13, 2017, a sampling team from the San Francisco Estuary Institute (SFEI) sampled a large storm flow event at the USGS Highway 101 gage (#11169025). This storm peaked at an instantaneous flow of 4,090 cfs on January 8, 2017, and 5,490 cfs on January 11 (McKee et al. 2017). During this storm an estimated 70 kg of total mercury were transported downstream of the gage. A subsequent storm on February 21, 2017 had peak flows of 6,340 cfs and approximated a 5-year return interval storm.

The District has calculated design flows at multiple points within the Guadalupe River watershed, including at USGS gage 11169205 (Table 2-1) (Xu 2018). The locations and

gages considered in the District's analysis had varying periods of record. Based on these results, a storm with a 25-year return interval is estimated to have peak instantaneous flows of 10,790 cfs at the USGS gage at Highway 101, and a storm with a 2-year return interval is estimated to have peak instantaneous flows of 3,610 cfs.

Table 2-1
Modeled Instantaneous (15-minute) Peak Flow in Guadalupe River

		Instantaneous Peak Flow (cfs)					
Location	**Drainage Area (mi^2)**	**2-Year**	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**
Guadalupe R d/s Canoas Creek	89.1	2,530	4,870	6,270	8,870	11,700	14,370
Guadalupe R. @ West Alma Ave.	92.8	2,620	5,000	6,420	9,030	11,880	14,580
Guadalupe R. u/s Los Gatos Creek	95.8	2,670	4,990	6,400	9,090	12,000	14,700
Guadalupe R. d/s Los Gatos Creek	150.8	3,320	6,060	7,720	10,470	14,260	17,970
Guadalupe R. @ Hwy 17	154.8	3,390	6,150	7,840	10,430	14,410	18,170
Guadalupe R @ Hwy 101 (USGS #11169205)	**162.1**	**3,610**	**6,470**	**8,200**	**10,790**	**14,770**	**18,600**
Guadalupe R. @ Hwy 237	171.5	3,880	6,530	8,280	11,360	15,230	19,020

The primary question to be answered through this analysis is "What constitutes a large storm?" Instantaneous flows at the USGS gage 11169205 above Highway 101 were downloaded for the period of record from May 2002 through May 2018. Storm flows are clearly seasonal and occurred between October and April (Figure 2-1).

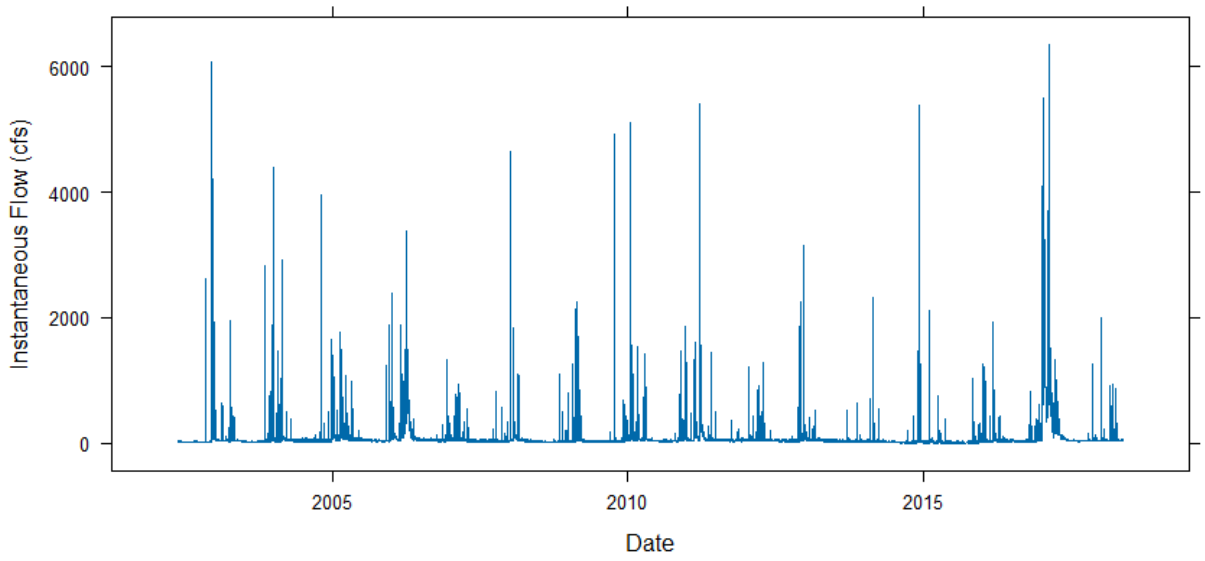

Figure 2-1 Historical instantaneous flows at USGS gage 11169025 above Highway 101.

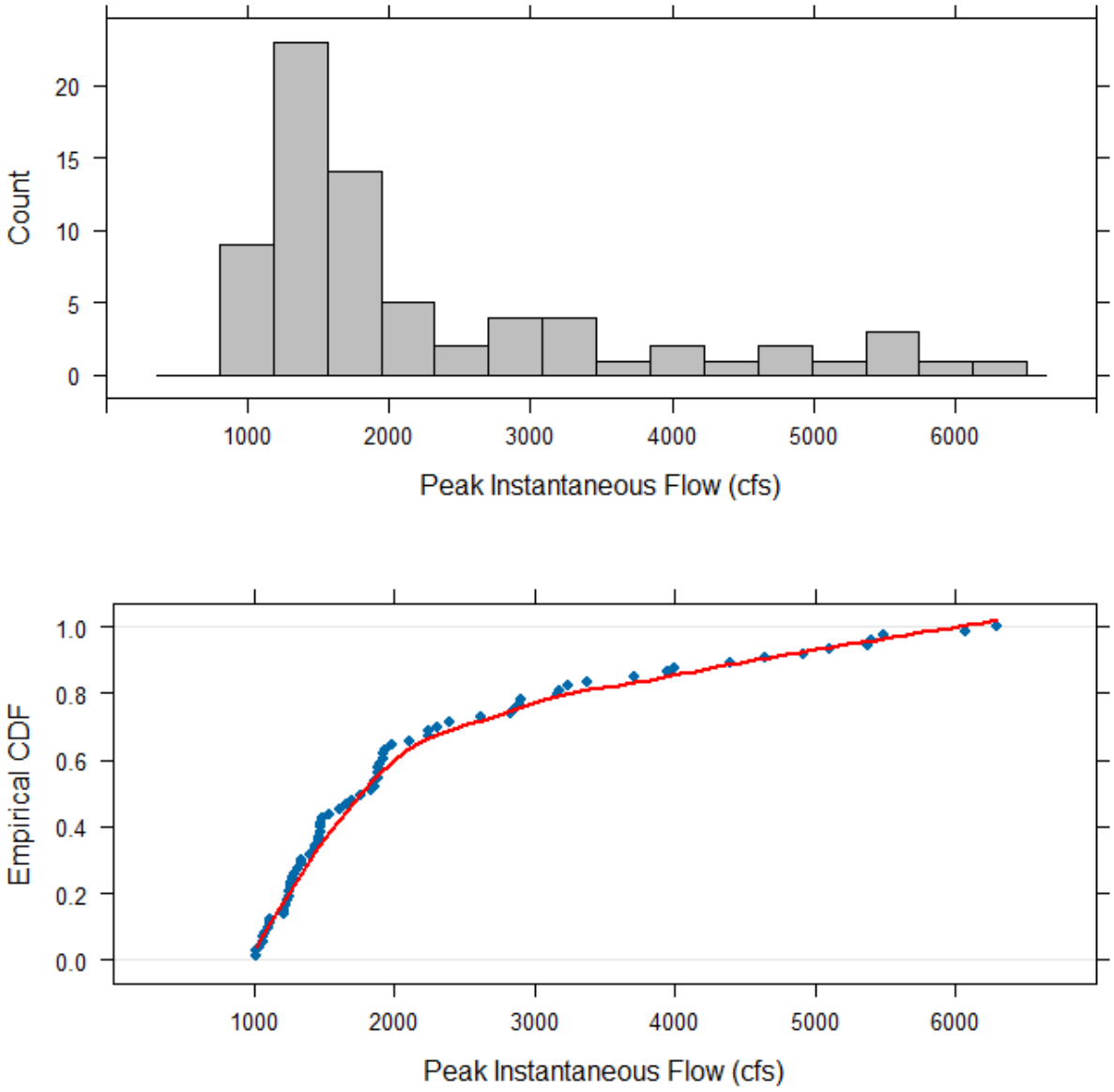

Figure 2-2 Distribution of peak instantaneous storm flows occurring between 2002 and 2018.

The instantaneous flow data were reviewed in detail to determine the maximum discharge during each storm. Seventy-three storms with peak discharges of greater than 1,000 cfs were identified (Figure 2-1). On average 4.5 storms were measured each year over the 16-year period of record. The majority of these storms had peak discharges of between 1,000 and 2,000 cfs (Figure 2-2). Fifty percent of the storm discharges were less than 1,800 cfs; 60 percent were less than 1,920 cfs; and 80 percent were less than 3,170 cfs. Peak instantaneous storm discharge was 6,340 cfs. approximating a 1 in 5-year storm and occurred only once during the period of record.

Data are also available on the USGS website for gage #11169000 (Guadalupe River downstream of Los Gatos Creek). This gage was in operation from 1930 through 2003, a period of 73 years. Only one storm (instantaneous flow of 11,000 cfs) over the 73-year period met the 1 in 25-year discharge rate (Table 2-1). However, five storms exceeded the 1 in 10-year flow of 7,720 cfs. This suggests that it is possible that a storm with a 5-year return interval may be observed at the proposed sampling location, but that a 1 in 25-year storm is unlikely.

Therefore, to be reasonably assured of being able to sample two "large" storms in each of two monitoring years, the monitoring effort will target storms with predicted instantaneous flow greater than 1,800 cfs. Based on the historic record, these discharge levels would be exceeded in 40 to 50 percent of the storms. Should weather conditions favor collection of a larger storm, efforts would be made to collect during that storm. However, due to climate change and recent drought cycles, storm return frequencies based on the historic data may not represent future conditions.

Dry-season base flows occurred between May and September of each year. These instantaneous flows ranged from 4.4 cfs to 1,440 cfs and averaged 29.8 cfs (Figure 2-3). The higher flows tended to be associated with late season storms in May of 2003, 2005, 2011, and 2015. Seventy-five percent of the dry season flows were less than 35 cfs, and 95 percent of the flows during the May to September period were less than 53.7 cfs. Therefore, a maximum base flow is expected to be approximately 55 cfs.

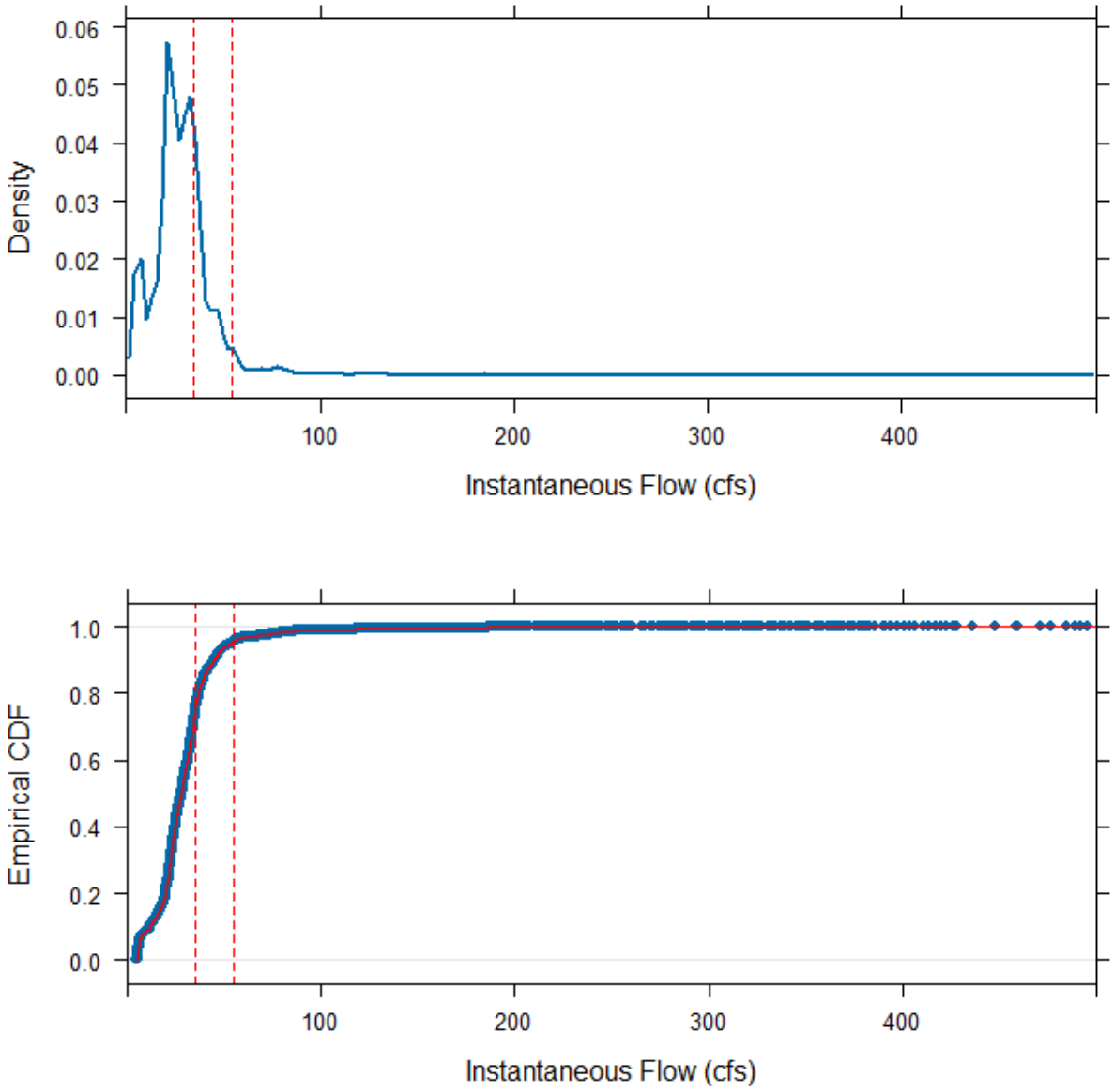

Figure 2-3 Distribution of instantaneous base flows during the months of May through September between 2002 and 2018. Vertical lines represent flows of 35 and 55 cfs.

Several potential storm discharge flows have been identified in the previous discussion. Based on the District's flow modeling, a peak instantaneous flow of 10,790 cfs at the USGS gage above Highway 101 represents a 25-year return interval, while a discharge of 3,610 cfs represents a 2-year return interval. Review of historic data at the Highway 101 gage indicates that dry season baseflow is approximately 35 to 55 cfs. Fifty percent of the observed storm discharges exceeded 1,800 cfs, and 40 percent exceeded 1,920 cfs. To be assured of sampling a large storm, the monitoring team will attempt to sample storms with predicted discharges of at least 1,800 cfs. If storms of this magnitude, or greater, are

monitored during the first or second years, a higher storm threshold (e.g., >3,610 cfs for 2-year return interval) may be proposed to the SFRWQCB.

2.1 MOBILIZATION CRITERIA

This section defines the mobilization criteria for storm sampling. These criteria will be used as guidelines to determine optimal sampling conditions. Efforts will be made to meet the majority of these criteria prior to mobilization. However, the field team may be mobilized if conditions indicate that there is a high potential for high flows originating in the upper watershed. The decision to mobilize will be made by the Tetra Tech project manager and the field team lead.

Multiple factors can affect storm discharge in the Guadalupe River, including rainfall, reservoir levels, and amount of rain (season-to-date).

Rainfall is the primary cause of flows in the Guadalupe River system. However, the effects of rainfall on peak flow rates can be mitigated by other factors. Rainfall may infiltrate to groundwater or be trapped by reservoirs, before runoff to surface streams.

The District's ALERT system provides real-time information on rain gages throughout the six watersheds within their system (SCVWD 2018a). Key rainfall gages in the upper Guadalupe River watershed are identified in Table 2-2. These rainfall gages are located either near or just above the mercury-impaired reservoirs in the Guadalupe River watershed.

Table 2-2
Rainfall Gages in Guadalupe River Watershed

ALERT ID	Site Description
2081	Mount Umunhum (6069)
1536	Guadalupe (6123)
2080	Almaden (6004)
1527	Vasona Pump (6125)
2065	Alamitos (6001)

Rainfall (season-to-date) is also an important consideration. Early in the rainy season, the majority of the rainfall will either be captured by the reservoirs or infiltrate to groundwater. Once the ground has become saturated, a greater portion of the rainfall from a given storm will become surface runoff and end up as stream flow that can transport suspended sediments and associated mercury.

Reservoirs within the Guadalupe system are designed to capture and retain rainfall for domestic uses, flood control, and groundwater recharge, and therefore will reduce flows in the river system until the water supply volume is filled. Currently there are three mercury-impaired reservoirs that are part of the Guadalupe River Watershed TMDL and

one reservoir (i.e., Lexington) that was used as a reference reservoir for development of the Guadalupe River watershed mercury TMDL (Table 2-3).

Table 2-3
Reservoirs in Guadalupe River Watershed

Station Number	ALERT ID	Site Description	Spillway Elevation (feet)	Capacity (acre-feet)	Drainage Area (sq. mi.)	Status
4001	2090	Almaden Reservoir	608.8	1,586	12.0	Part of TMDL
4003	2094	Calero Reservoir	483.5	9,934	6.9	Part of TMDL
4006	2092	Guadalupe Reservoir	617.3	3,415	5.9	Part of TMDL
4007	-	Lexington Reservoir	649.9	19,044	36.9	Reference for TMDL dev.

The Division of Safety of Dams has placed capacity restrictions on the Almaden Reservoir; the reservoir is limited to 1,260 acre-feet capacity (M. Seelos 2018). Almaden Reservoir has a catchment area of 12.0 square miles (Table 2-3). Two inches of rain within this catchment is equivalent to 1,280 acre-feet of water which approximates the current allowed capacity. Therefore, any storm of 2 inches or more (after season-to-date rainfall is greater than 7-inches) would require water to be released or spill from Almaden Reservoir.

Likewise, the Guadalupe Reservoir is maintained at a maximum height of 18 feet below the spillway crest due to concerns about dam safety in the event of a large earthquake (Santa Clara Valley Water District, 2018b), and has an allowed capacity of 2,738 acre-feet. This project is currently in the design phase with retrofitting to take place between 2020 and 2024. Two inches of rain within this catchment is equivalent to 629 acre-feet of water which is approximately 23 percent of the allowed capacity.

Two inches of rain in the Calero Reservoir catchment area represents approximately 7 percent of current capacity.

McKee et al. (2017) have hypothesized that annual mercury transport is maximized after a large storm has mobilized the sediments in the watershed, and that transport will remain high in subsequent storms. They proposed that a storm similar in magnitude to the February 2017 storm would be sufficient to achieve this mobilization and identified a set of conditions that would likely result in releases from the reservoirs should a minimum of 2-inches of rain fall in the watershed above the reservoirs. Once these conditions are achieved, any additional rain throughout the Guadalupe River watershed would likely result in runoff sufficient to achieve flows at the USGS gage at Highway 101 similar to the February 2017 storm. McKee et al. (2017) estimated that storms of similar magnitude to the February 2017 storm would occur at a frequency of about 1 in 5 years.

This monitoring plan proposes six mobilization criteria. The first two criteria must be met before mobilization for monitoring will be considered. Field teams will not be mobilized

until (1) season to date rainfall is greater than 7-inches at the majority of the five upper watershed rain gages (Table 2-2); and (2) baseflow at the USGS highway 101 gage (#11169025) exceeds the dry season flows (i.e., 55 cfs).

Once the above conditions are met, the decision to mobilize will be dependent on the 4 criteria described in Table 2-4. These criteria are required by the SFRWQCB based on the recommendations made in the McKee et al. (2017) report. The overall goal of these criteria is to ensure that monitoring occurs during conditions when mercury is likely to be mobilized from the upper watershed. Therefore, the criteria focus on the occurrence of large storms in the upper watershed after soils have been reasonably saturated.

Table 2-4
Mobilization Criteria

Criteria	Tier	Threshold	Comment
1. **Predicted stormflow at USGS Highway 101 gage** To comply with this criterion, the field sampling team will evaluate CNRFC forecast flow.	1	>1,800 cfs	50% storms exceed this volume
	2	>1,920 cfs	40% storms exceed this volume
	3	>3,610 cfs	2-year return interval
2. **Storm forecast for upper watershed**. To comply with this criterion, the project team will evaluate the forecast for the upper watershed, which is defined as the catchment area above the four reservoirs in the Guadalupe River Watershed (see Table 2-3). The Weather Prediction Center (WPC), accessible through the CNRFC website, provides quantitative precipitation forecasts (QPF) for the region at multiple time scales of up to one week.	1	N/A	Assures rainfall at mines
	2	>6 inches	
	3	>12 inches	
3. **6-hour rainfall forecast of greater than 2 inches at Quicksilver County Park**. To comply with this criterion, the project team will evaluate whether the following forecasts exceed the criteria. The Weather Prediction Center (WPC), accessible through the CNRFC website, provides quantitative precipitation forecasts (QPF) for the region at multiple time scales of up to one week. In addition, using data available on the NOAA website, Tetra Tech has developed a tool that can be used to forecast rainfall at a specific geographic location such as Quicksilver County Park. Both tools will be used to estimate when a 6-hour rainfall of greater than 2-inches is likely to occur.	1	>0.5 inches	Assures rainfall at mines
	2 & 3	>2 inches	Assures significant rainfall at mines
4. **Almaden Reservoir is near capacity**. To comply with this criterion, the project team will	1	N/A	

evaluate whether Almaden Reservoir's capacity exceeds 10 percent based on the District's ALERT system. Given the currently limited capacity and large catchment area, any storm greater than 2-inches is likely to fill Almaden Reservoir.	2 & 3	>10% full	

The above criteria will be applied as shown in Figure 2-4. Initially, the mobilization criteria will allow smaller storms to be sampled. However, as the number and magnitude of storms increases, the criteria become more stringent thereby selecting for larger storms.

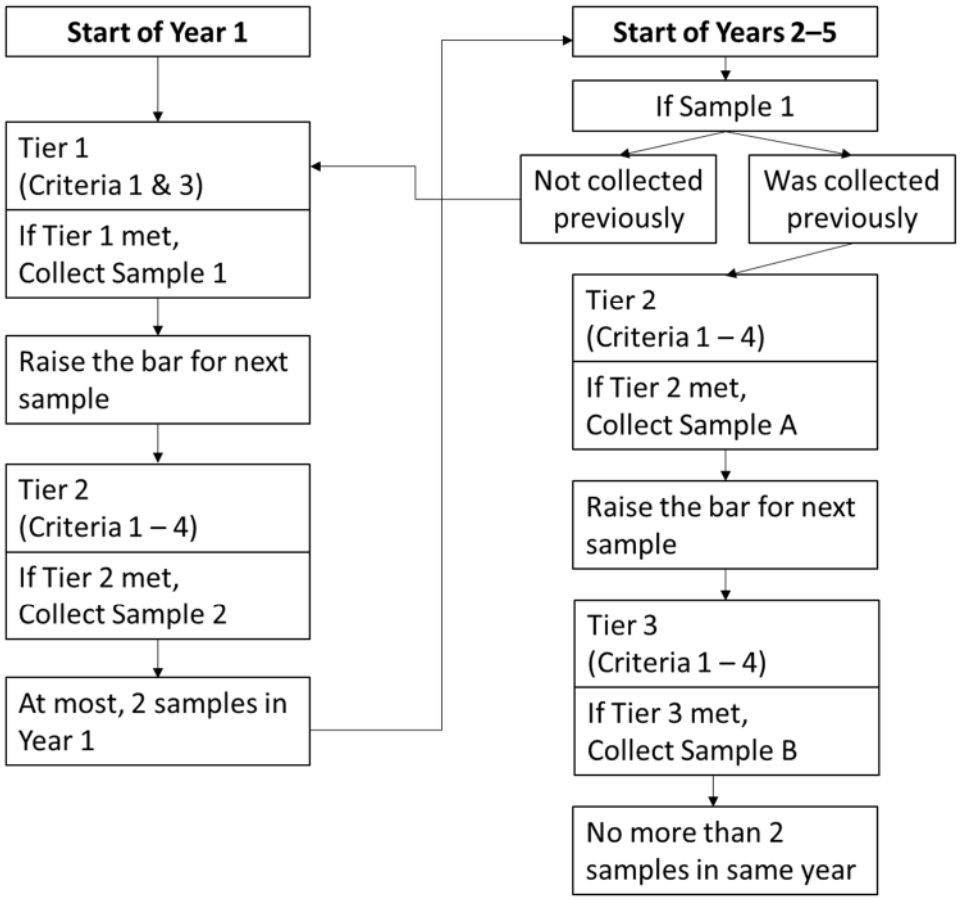

Figure 2-4 Flow chart for application of mobilization criteria. Criteria become more stringent as more storms have been sampled.

During the monitoring cycle, the project team will evaluate the watershed conditions on a regular basis. The frequency of evaluation will increase to twice daily when storms are forecast, and season-to-date rainfall nears 7 inches in the upper watershed. The field sampling team lead has the authority to mobilize, or not mobilize for sampling after evaluating whether the above mobilization criteria are satisfied.

The project team will monitor rainfall, reservoir, and streamflow status through the District's ALERT system throughout the rainy season when storms are forecast. The project team will also monitor the California Nevada River Forecast Center (CNRFC) (NOAA 2018), which models predicted flows in the Guadalupe River at the Highway 101 USGS gage for 5 days into the future. The Weather Prediction Center, also accessed through the CNRFC, provides quantitative precipitation forecasts (QPF) for the region at multiple time scale of up to one week. We will also use the tool that Tetra Tech has developed to forecast rain fall at a geographic location, specifically around Quicksilver County Park.

When a peak instantaneous flow within the desired range (>1,800 cfs) is forecast at the USGS gage above Highway 101, and rainfall is occurring in the upper watershed, the project team will mobilize for sampling. The project team will attempt to sample two large storms in each of two years over five wet seasons (beginning in fall 2018 and ending in spring 2023). To ensure that the required data are obtained, the project team will attempt to monitor the first storm that is expected to result in 1,800 to 1,900 cfs at the gage (criterion 1), or that meets criterion 2.

Should a sampling effort be conducted because it meets the above mobilization criteria, it will count for one of the up to four required sampling events, regardless of actual flow during storm at USGS gage above Highway 101.

3 Quality Assurance Project Plan (QAPP) and Sampling and Analysis Plan (SAP)

3.1 PROJECT TASKS

Work to be done in this project has been divided into the following major tasks:

1. Storm Flow Monitoring
2. Permit Acquisition
3. Fish Tissue Monitoring in Streams and Lake Almaden
4. Data Reporting and Data Management

A summary of the planned field sampling and related quality assurance/quality control (QA/QC) procedures is presented below.

3.1.1 STORM FLOW MONITORING

Storm flow monitoring will be conducted during two of the five years of this monitoring cycle. During each of those two years, two large storms (see Section 2) will be sampled if criteria are met. If a storm with a 25-year return interval (instantaneous flow > 10,790 cfs; Table 2-1) is forecast, it will be monitored. Each monitored storm will be sampled eight times over the hydrograph, targeting four samples on the rising limb and four samples on the falling limb of the hydrograph. A US D-95 depth integrating sampler will be used to collect subsamples across the width of the stream, thereby allowing determination of depth-integrated, flow-weighted sample (McGregor 2000). By catching both the rising and falling limbs of the hydrograph, the Tetra Tech project team will be able to determine if there is any difference in transport based on changes in the flows.

3.1.2 PERMIT ACQUISITION

Permits will be needed for fish sampling from the California Department of Fish and Wildlife. WRA will contact the Department and will facilitate acquisition of the necessary permits as well as follow-up with permit requirements (e.g., project updates, incidental catch of protected species, etc.).

3.1.3 FISH TISSUE MONITORING IN STREAMS AND LAKE ALMADEN

Fish tissue monitoring will be conducted in each of two years during the monitoring cycle. These data will be integrated with reservoir sampling being conducted by the District during the same year that creek and lake sampling is conducted. The District's *Guadalupe Watershed TMDL Fish Monitoring Plan* is attached as Appendix B. The data will be analyzed to determine the effectiveness of upstream remediation actions on the health of stream fish. The data will also be analyzed to determine whether the fish tissue burdens represent a risk to piscivorous birds.

3.1.4 REPORTING AND DATA MANAGEMENT

Procedures for data management and for analysis and reporting are provided in Sections 3.7 and 3.8

3.2 QA MEASURES AND CRITERIA

3.2.1 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The data quality objectives for the field sampling programs are to obtain valid data that meet requested reporting limits for listed parameters in water and fish samples. The chemical concentration data from field sampling will be evaluated based on accuracy, precision, representativeness, comparability, and completeness, as discussed later in this section. Chemical concentrations in water and tissue samples will be quantified by certified analytical laboratories using standard USEPA or proprietary methods. The methods used for the analytical techniques, reporting limits, holding times, preservatives, and container type and size for the parameters in water and tissue are provided in Table 3-5.

Analytical precision will be evaluated by analysis of duplicate samples. Laboratory duplicates will be analyzed at a frequency of no less than one per 10 samples. Duplicate analysis of a sample on the same instrument will provide instrumental precision data. The relative percent difference (RPD) of duplicates will be calculated as follows:

$$RPD = \frac{C_1 - C_2}{(C_1 + C_2)/2} \times 100\%$$

where C1 and C2 are concentrations of analyte in duplicate samples 1 and 2. A control limit of 25% will be used for relative percent difference. Frequencies of duplicate samples for the laboratory analyses in water are 10 percent. An estimate of field variability will be obtained by comparing the original and field replicate samples. The field replicate sample is collected at a given location in quick succession after the original sample, and is designated as a different sample.

Accuracy of analytical data will be evaluated by analyzing reference materials and spiked samples. Reference materials will be run with each batch of samples during laboratory

analyses. Confidence intervals supplied with reference samples will be used as control limits at the 95% confidence level. The relative percent error (RPE) of standards will be calculated as follows:

$$RPE = \frac{C_1 - C_0}{C_0} \times 100\%$$

where C1 is the concentration analyzed in the sample and C0 is the true concentration.

Matrix spike/matrix spike duplicate (MS/MSD) samples will be used to assess the recovery of various analytes and to detect matrix interferences. The MS/MSD samples will be prepared by adding analyte at the level present in the sample, or at the concentration of the mid-range calibration standard, whichever is higher. Spike recovery will be calculated as follows:

$$\%\text{Recovery} = \frac{A_s - A_o}{S} \times 100\%$$

where As is the amount of analyte in the spiked sample, Ao is the amount of analyte in a non-spiked sample, and S is the amount of spike added. Control limits of 75 to 125% will be used for percent recovery for in the matrix spike samples. The frequency of matrix spike samples will be one per batch of 20 samples. A comparison of results is also made by computing the relative percent difference between the MS and MSD samples.

Representativeness is the degree to which the data precisely and accurately represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter that is maximized by ensuring that sampling locations are selected properly and that a sufficient number of samples are collected.

Completeness is the measure of the percentage of the data that can be used to evaluate project objectives. Completeness will be reported as the percentage of all measurements judged representative and useful. The following equation will be used to determine completeness:

$$\%Completene\ ss = \frac{V}{T} \times 100\%$$

where

%C	=	Percent completeness
V	=	Number of measurements judged valid
T	=	Total number of measurements.

3.3 SAMPLING METHODS

This section describes the recommended methods and procedures that will be used to collect samples, including the QA/QC samples. All samples will be handled in accordance with EPA-approved procedures and chain-of-custody guidelines. Methods have been selected to provide the required precision, accuracy, and detection limits to meet the objectives of this project. All field measurements will be performed by qualified, trained individuals with calibrated instruments and within appropriate analytical holding times.

3.3.1 SURVEY LOCATIONS

The proposed survey locations were determined based on the requirements of the Regional Water Quality Control Board (2017) 13267 letter, consistency with previous sampling efforts, and review by the Santa Clara Valley Water District (District) (Table 3-1; Figure 1-1). The USGS gage above Highway 101 (#11169025) will be used for storm flow monitoring and estimation of mercury loads.

The remaining locations represent areas within the Guadalupe River Watershed where target fish species can be sampled to help monitor trends in fish tissue mercury concentrations and temporal trends in mercury loading. The identified water body is anticipated to be sampled at these specific locations (Table 3-1); however, uncontrollable factors (i.e. drought) may require a sample site(s) to be moved to a nearby location in the same target water body. Such adaptive sampling approach was required with the previous 5-year monitoring period (AECOM 2017) and may again be necessary given the variable climatic and stream flow conditions of the Guadalupe River Watershed Sample. In the event that such a situation arises, the alternative sample site will be confirmed with District to ensure the location will be consistent and comparable to the prior sampling in the target water body.

Fish tissue sampling in the reservoirs, creeks and Lake Almaden is required to take place twice over a five-year period between water year 2019 and water year 2023 (i.e. October 1, 2018 through September 30, 2023). Fish sampling at each location will occur over a one-week period between June 1 and September 30, with sampling likely happening in the latter portion of the time window, when target fish should be larger, habitat area will be reduced, and the potential to encounter protected steelhead will be lower. Sampling is anticipated to take place once in 2019 and then again in 2020 or 2021. The table identifies fish tissue collection locations that will be sampled by the CMP project team, and separately by the District. The monitoring program includes a reference site for stream fish (Los Gatos Creek) and a control site (Stevens Creek) for reservoir sampling. Stevens Creek reservoir serves as a positive control for the District's oxygenation effectiveness study. Lexington Reservoir also served as the reference site for the development of the Guadalupe River watershed mercury TMDL.

Table 3-1
Proposed Sampling Locations

Sampling Location	Latitude	Longitude	Target Water Body	Activity or Target Species
USGS Gage 11169025	37.373889	-121.931944	Guadalupe River above Highway 101	Storm flow; TSS, Mercury
Sampling Locations to be Collected by WRA				
Alamitos Creek at Harry Road	37.201529	-121.829007	Alamitos Creek	Age 0+ California roach
Guadalupe Creek at Singletree Way	37.233111	-121.898727	Guadalupe Creek	Age 0+ California roach
Guadalupe River at Foxworthy Avenue	37.278207	-121.877991	Guadalupe River	Age 0+ California roach
Guadalupe River at Coleman Avenue	37.334536	-121.899469	Guadalupe River	Age 0+ California roach
Lake Almaden	37.24015	-121.869773	Lake Almaden	Age 1 largemouth bass
Los Gatos Creek at Lincoln Ave (reference site)	37.312500	-121.904444	Los Gatos Creek	Age 0+ California roach
Sampling Locations to be Collected by DISTRICT				
Stevens Creek (Control reservoir)	37.298611	-122. 076111	Stevens Creek Reservoir	Age 1 largemouth bass
Almaden Reservoir	37.164217	-121.828026	Almaden Reservoir	Age 1 largemouth bass
Calero Reservoir	37.185448	-121.773798	Calero Reservoir	Age 1 largemouth bass
Guadalupe Reservoir	37.197621	-121.879113	Guadalupe Reservoir	Age 1 largemouth bass

[1] The Alamitos Creek at Greystone Lane site, while previously sampled, is recommended to be discontinued, as tissue burdens are not different than at Harry Road.

[2] Age 0+ corresponds to young of year fish that are less than year in age.

3.3.2 STORM FLOW SAMPLING

The following standard operating procedure was prepared to describe how to collect samples of suspended sediment transported during storm flows in the Guadalupe River near the Highway 101 crossing as a surrogate for the suspended sediment load delivered into the San Francisco Bay. The suspended sediment load will inform the mercury loading, so the following suspended sediment sampling procedures have been adapted to accommodate clean sampling methods to avoid contamination of mercury samples (EPA Method 1669). The following procedures describe how to sample a depth-integrated, suspended sediment concentration.

The field team will collect depth-integrated water samples using a US D-95 sampler at a single vertical located approximately 1 m from the turbidity sensor at the USGS Highway

101 gage. This methodology is consistent with that used in previous studies at this location, including the McKee et al. (2017) and the AECOM (2017) Cycle 1 monitoring report.

The US D-95 suspended sediment and water quality sampler was developed to meet the requirement for a suspended-sediment sampler capable of collecting noncontaminated samples for trace-element analysis in streams less than 15 feet deep. The sampler collects a water-sediment sample at an inflow efficiency ranging from 0.9 to 1.1 and remains stable in stream velocities ranging from 1.7 to 6.7 feet per second (ft/sec). The bronze body casting is coated with plastic and the tail section is constructed from plastic to reduce potential contamination when used for trace-element sampling. The sampler is designed to accept either the 1-liter (L) Teflon or 1-L plastic bottle and the US D-77 sediment sampler cap and nozzles.

Sampling Equipment

1. US D-95 suspended sediment and water quality sampler with associated Teflon cap, Teflon nozzles, gaskets, and 1-L sample jars, including spares of each
2. Sediment sampling crane (usually a USGS Type A or USGS Type E heavy-duty sediment sampling crane)
3. Sounding reel (usually a USGS Type B or USGS Type E-53 sounding reel)
4. Basic maintenance tools such as screwdrivers, wrenches, and pliers
5. Stopwatch
6. Thermometer
7. Containers to collect composited sample (10-L fluorinated HDPE carboy)
8. Field data sheets (Appendix A)
9. Pencils and permanent markers
10. Camera

Safety Equipment

1. Printed copy of the project Health and Safety Plan
2. First aid kit
3. High visibility clothing
4. Appropriate footwear
5. Traffic control cones and signs
6. Bolt/cable cutters (to cut the cable to the sampler in case of emergency)

3.3.2.1 Mobilization

As discussed in Section 2, once the mobilization criteria have been met and the decision to mobilize made (Table 2-4 and Figure 2-4), the project team will mobilize to collect suspended sediment and water (mercury) samples from the Guadalupe River above Highway 101. Samples will be collected at eight points in the storm hydrograph, such that four samples will be collected during the rising leg of the hydrograph and four samples will be collected during the falling leg of the hydrograph.

McKee et al. (2017) state that it takes 5 to 6 hours for water from the upper watershed to reach the Highway 101 gage. Therefore, sampling will not start until 5-6 hours after rain starts to fall in the upper watershed (Quicksilver County Park).

Timing for collection of subsequent samples will be dependent on the expected shape of the flood hydrograph, which is dependent on the magnitude and duration of the storm. Eight flood hydrographs were selected from the 73 observed storms at the Highway 101 gage to cover the range of peak flows that are likely to be monitored (1,490 to 6,300 cfs). The time from the start of the hydrograph (i.e. flow greater than baseflow) to the peak flow, and the time from the peak flow until the flow returned to baseline were measured from the hydrographs. These values were then plotted and regressed against the peak flow from that storm (Figure 3-1 and Table 3-2). The average duration of the rising leg was 15 hours. The average duration of the falling leg was 52 hours. However, the duration of the hydrograph legs is dependent on flow, and there is substantial variation in duration.

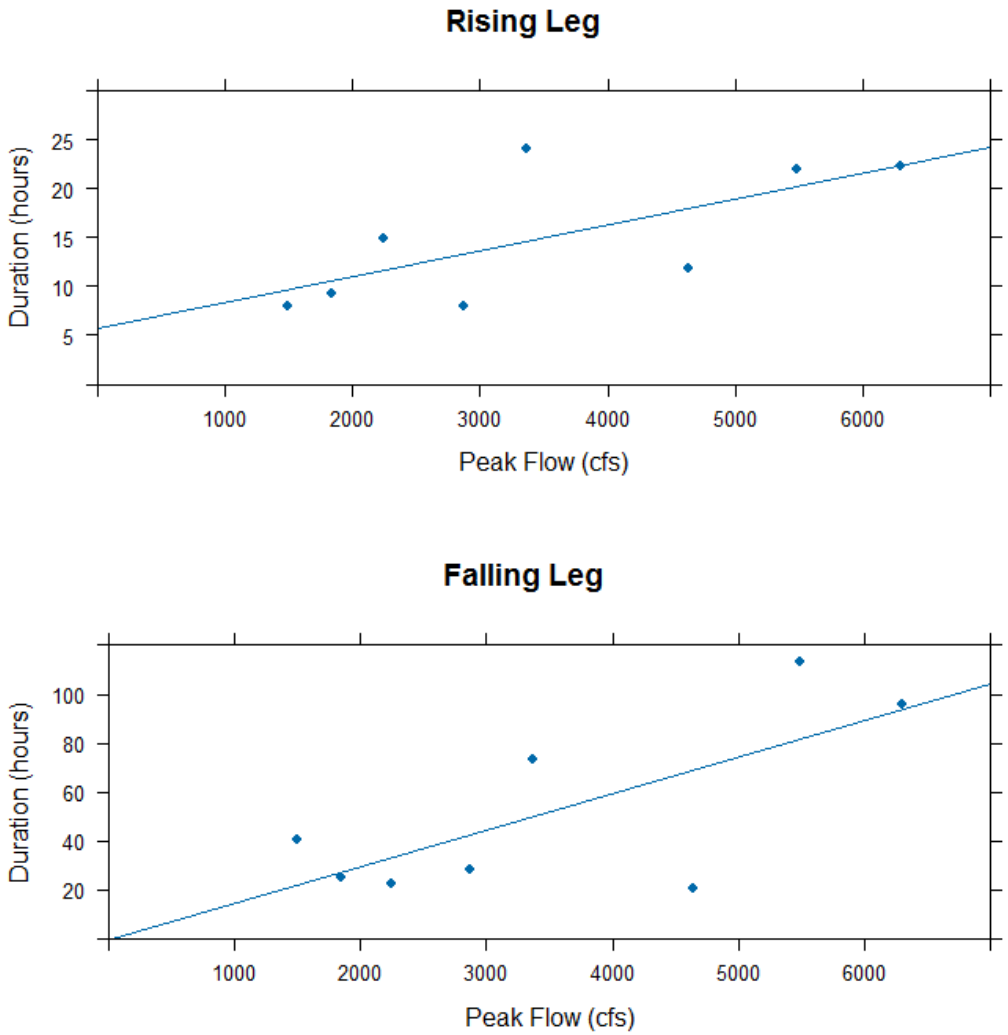

Figure 3-1 Duration of rising and falling legs of selected storms relative to peak flow.

Table 3-2
Results of Regressions of Hydrograph Durations on Peak Flow.

Hydrograph Leg	Intercept	Slope	r^2	p
Rising leg	5.68	0.00265	0.47	0.06
Falling leg	-0.31	0.0149	0.52	0.045

Sampling frequency will be determined based on expected peak flow for the forecast storm and storm duration and will be estimated using the above results. The first sample will be collected starting 5 to 6 hours after the start of rainfall in Quicksilver County Park, to correspond to the expected start of the flow from the upper watershed. The next three samples will be equally spaced over the expected duration of the rising leg. During the falling leg of the hydrograph, samples will be collected at equal time intervals over the expected duration. Sampling intervals may be adjusted based on actual field conditions at the time of sampling.

Sampling equipment and supplies will be maintained ready for mobilization throughout the rainy season, which begins on October 1.

3.3.2.2 Set-Up

The following paragraphs describe measurements to be taken prior to collecting the first sample.

Determine Flow Velocity, Maximum Depth

Estimate the flow velocity at the sampling location (within 1-m of USGS turbidity sensor). One way to make this estimate is to drop a floatable object (such as a stick, an apple, or an orange) from the upstream side of the bridge and time how long it takes to float to the downstream side of the bridge. The flow velocity (in feet per second) can then be calculated by dividing the distance from the upstream side of the bridge to the downstream side of the bridge by the time (recording using the stopwatch) it took the object to travel this distance. Assuming a logarithmic velocity profile, the ratio of the surface velocity to the depth-averaged velocity is 1.16, so the calculated surface velocity should be divided by 1.16 to estimate the depth-averaged velocity. Repeating this process several times will provide a more accurate estimate of the flow velocity. The depth and velocity, coupled with the nozzle size, are used to estimate the recommended, or at least appropriate, transit rate using charts presented in McGregor (2000) and provided in Appendix A. McGregor (2000) notes that the recommended sample volume collected with the US D-95 sampler is 800 mL (0.8 L), so the transit rate is adjusted to ensure the sample volume and the deepest and fastest vertical does not exceed the recommended sample volume.

Determine Transit Rate

The sampling method requires that all verticals be traversed using the transit rate established at the deepest and fastest vertical in the cross section to ensure the sample volume does not exceed the recommended sample volume of 0.8-L at any vertical. The

descending and ascending transit rates must be equal during the sampling traverse of each vertical, and they must be the same at all verticals. By using this equal-transit-rate technique with a standard depth-integrating sampler at each vertical, a volume of water proportional to the flow in the vertical will be collected.

An initial estimate of the transit rate at the deepest and fastest part of the channel can be estimated from the figures in Appendix A, but only trial and error at this location will be able to determine the exact transit rate for the sampling without overfilling the sample bottle.

Select Nozzle Size

Each suspended-sediment sampler is equipped with a set of nozzles specifically designed for the particular sampler. The correct size of nozzle to use for a given situation must often be determined by trial. It is best to use the largest nozzle possible that will permit depth integration without overfilling the sample bottle or exceeding the maximum transit rate (about 0.4 of the mean velocity in the sampled vertical for most samplers with pint containers).

Possible errors caused by using too small a nozzle are usually minor when dealing with fine material (less than 0.062 mm), but tend to increase in importance with increasing particle size. Small nozzles also are more likely than large ones to plug with organic material, sediment, and ice particles. This means that problems with nozzles can exist even when sampling streams transporting mostly fine material.

All sampler nozzles, gaskets, and air exhausts, as well as the other necessary equipment, should be checked regularly and replaced or serviced if necessary. If a sample bottle does not fill in the expected time, the nozzle or air-exhaust passages may be partly blocked. The flow system can be checked by sliding a length of clean rubber or plastic tubing over the nozzle and blowing through the nozzle with a bottle in the sampler. When air pressure is applied in this manner, circulation will occur freely through the nozzle, sample container, and out the air exhaust. Obstructions can be cleared by removing and cleaning the nozzle and (or) air exhaust, using a flexible piece pre-cleaned tubing. This procedure should be adequate for most airway obstruction problems.

Nozzle Velocity Error

The nozzles are cut and shaped externally and internally to ensure that the velocity of water after entering the nozzle is within 8 percent of the ambient stream velocity when the stream velocity is greater than 1 ft/s. It has been found that a deviation in intake velocity from the stream velocity at the sampling point causes an error in the sediment concentration of the sample, especially for sand-sized particles. Therefore, careful selection of the appropriate nozzle size is required.

Bottle Fill/Overfill

When sampling it is important to not fill the sample bottle to more than 80-percent of the capacity of the bottle (i.e., 0.8-L for a 1-L bottle). When the sample in the container reaches the level of the air exhaust (approximately 80-percent), the flow rate drops, and

circulation of the streamflow in through the nozzle and out through the air-exhaust occurs. Because the velocity of the water flowing through the bottle is less than the stream velocity, the coarser particles will settle out, causing the concentration of coarse particles in the bottle to increase. In case of overfill, the bottle will be emptied and used again without additional washing or rinsing.

Sediment from Channel Bed Entering the Nozzle
Striking the sampler nozzle into a dune or setting the sampler too deeply into the soft channel bed can bias the sampled sediment concentration. Because most of the sand is transported near the bed it is essential that the transit direction of the sampler be immediately reversed as the tail vane of the sampler touches the bed. Field staff will control the direction of the sampler by manually reversing the direction of the sounding reel.

Decanting Procedures
It is important to fully empty the bottle of all sediment as well as all liquid when transferring the sample to the carboy to be composited. Leave enough sample in the bottle after initially decanting most of the sample so that the sample can be swirled in the bottle to facilitate removal of coarser sand particles. During the decanting procedure, check to ensure that all visible sediment particles are transferred to the carboy.

3.3.2.3 Collecting Samples

1. Enter the information determined following procedures described previously onto the field data sheet
2. Position the crane at the sampling station
3. Using clean-hands technique, insert a bottle into the sampler and ensure the nozzle and cap are properly seated
4. Look upstream to check for oncoming debris
5. Lower sampler until the lower edge of the tail vane is touching the water, allowing the sampler to align itself with the flow. Zero out the depth gage on the sounding reel by setting the depth to -0.4 feet (corresponding to the 4.8-inch distance for the unmeasured zone between the lower edge of the tail vane and the centerline of the nozzle). This will provide an estimate of the depth at the vertical, but it will be biased high because of the drag-induced downstream drift as the sampler is lowered through the water column.
6. Establish the transit rate using the largest-possible diameter nozzle at the deepest and fastest vertical
7. Lower sampler through water column to the channel bed at established transit rate
8. Note depth of the channel bed from sounding reel
9. Record these depths on the field data sheet. These depths will helpful on subsequent measuring efforts or if a sample needs to be repeated.
10. Upon contact with streambed immediately reverse direction and raise the sampler at the same established transit rate until it is clear of the water
11. As the sampler is raised from the water watch to see if any water exits the nozzle, if so the bottle has been overfilled and the sample needs to be repeated
12. Remove the sample bottle from the sampler

13. Check the sample
14. If the sample volume exceeds the allowable limit of 80% full, discard the sample (swirl bottle using decanting procedure described above) and resample. If the sample volume exceeds allowable limits for subsequent samples the established transit rate needs to be increased and all previous samples need to be discarded and resampled at the increased transit rate.

    Visually inspect the sample by swirling the water in the bottle, holding it up toward the sun, and observing the quantity of sand particles collected at the bottom. If there is an unusually large quantity or a difference in the quantity of sand between bottles, that sample should be discarded, and another sample should be collected. An excessive amount of sand indicates the nozzle of the sampler may have dove into the bed (or more likely a bedform such as a dune).
15. Multiple verticals collected at the sampling location will be composited in one larger container (carboy) until sufficient volume (1.5 to 2 liters) has been collected to allow all analyses to be completed. Take care when pouring from the sample bottle into the container that no water splashes out. Leave enough sample in the bottle after initially decanting most of the sample so that the sample can be swirled in the bottle to facilitate removal of coarser sand particles as described above. The bottle cannot be washed, and if the next sample needs to be repeated, leaving sand in the sample bottle will decrease the composited sediment concentration.
16. When the final subsample is collected and composited, close the carboy, and thoroughly mix the sample. Collect the following subsamples using clean-hands – dirty-hands technique: total mercury, dissolved mercury, methylmercury, and totals suspended solids. Properly label the samples with site, date, time, analyses, preservative, and field technicians' names. Place the individual samples on ice.
17. Record on the field data sheet the time the sample collection started and stopped. The concentration of sampled suspended sediment can be converted into a transport rate if the flow is known. Because the USGS operates the flow gaging station immediately below this bridge, noting the time of the sample will allow for accurate determination of the flow as recorded by the gaging station.

3.3.3 FISH TISSUE COLLECTION

WRA fisheries biologists will sample at 6 locations (5 streams and Lake Almaden) as outlined in Table 3-1 as part of the Guadalupe River Watershed Mercury Project. These locations were determined based on the requirements of the Regional Water Quality Control Board (2017) 13267 letter, consistency with previous sampling efforts, and review by the District. All locations sampled during AECOM's efforts in 2016 will be sampled again, with three exceptions. Alamitos Creek was sampled from two locations in 2016, one at Graystone Lane and one at Harry Road in San Jose. Upcoming sampling of Alamitos Creek will be done exclusively from Harry Road. Sample results from the Graystone Lane location and the Guadalupe Creek at Singletree Way were found to be statistically the same, therefore it was determined that sampling both locations was not necessary. In addition, two new sampling locations are added for upcoming sampling.

Los Gatos Creek and Stevens Creek reservoir will be sampled, with Los Gatos Creek serving as a reference site (as recommended by the District), and Stevens Creek serving as the control reservoir (a positive control site for the District's oxygenation effectiveness study). The locations represent areas within the Guadalupe River Watershed where target fish species can be sampled to help monitor trends in fish tissue mercury concentrations and temporal trends in mercury loading. The identified water body is anticipated to be sampled at these specific locations (Table 3-1); however, uncontrollable factors (i.e. drought) may require a sample site(s) to be moved to a nearby location in the same target water body. Such adaptive sampling approach was required with the previous 5-year monitoring period (AECOM 2017) and may again be necessary given the variable climatic and stream flow conditions of the Guadalupe River Watershed Sample. In the event that such a situation arises, the alternative sample site will be confirmed with the District and Tetra Tech to ensure the location will be consistent and comparable to the prior sampling in the target water body.

Each location is required to be sampled twice over a five-year period of water years 2019 through 2023 (i.e. October 1, 2018 through September 30, 2023). Fish sampling at each location will occur over a one-week period between June 1 and September 30, with sampling likely happening in the latter portion of the time window, when target fish should be larger, habitat area will be reduced, and the potential to encounter protected steelhead will be lower. Sampling is anticipated to take place once in 2019 and then again in 2020 or 2021. Table 3-1 provides the sample site locations to be surveyed by WRA and the District, respectively. Timing and coordination between WRA and District for the sample periods will be coordinated, within reason, to the fish tissue monitoring conducted by the District for the twice annual sampling events in the reservoirs (Table 3-1). Additional detail on the District fish tissue sampling program can be found in the SCVWD (2017) *Guadalupe Watershed Mercury TMDL Fish Monitoring Plan* (Appendix B). Only the years of District reservoir fish sampling that coincide with fish sampling in the creeks and Lake Almaden will be included in the CMP reports.

3.3.3.1 Fish Sample Permit

The collection of native and sport fish for scientific research requires authorization from the California Department of Fish and Wildlife (CDFW) through the Scientific Collector Permit (SCP) program. California roach is a native species; however, does not have a protected status (i.e. species of special concern nor state/federal protection). Largemouth bass, along with the other potential sunfish, catfish, and crappie species, are non-native sport fish that similarly lack a protected status. For the purposes of collecting the target fish species, WRA will apply to CDFW for authorization to conduct the sampling activities identified in this plan. It is anticipated that SCP authorization from CDFW will take 9-12 months, because CDFW is requiring a federal permit to be issued (or in process) for SCP's that include work in anadromous streams (see permit discussion continued below). The SCP would cover fish tissue collection activities for the 2019-2023.

No protected species are targeted for collection activities; however, protected species may occur within portions of the sampled watershed. Steelhead (*Oncorhynchus mykiss*) is

a federal threatened species protected by the Endangered Species Act that may occur in portions of the Guadalupe River Watershed and could be incidentally captured during stream and Lake Almaden sampling efforts. WRA will apply for incidental take coverage with the National Marine Fisheries Service (NMFS) to cover WRA's fish sampling efforts in anadromous streams. Coverage will be acquired through Section 10 or Section 4(d) of the Endangered Species Act. Information provided for either permit is similar; however, the timeline and permit duration are different. The timeline to receive a Section 10 permit is approximately 12 months but the permit is typically valid for a five-year period. The application for the Section 4(d) coverage can only be submitted during one window of time, November, and all applications are reviewed with approvals issued the following February or March. The review period for Section 4(d) is shorter; however, the permit coverage is required to be renewed annually.

WRA has completed initial coordination with the District and NMFS regarding the permitting strategy. Only a small number of steelhead (juveniles) are anticipated to be encountered and NMFS advised that either Section 10 or 4(d) coverage would be appropriate. Despite regional occurrences, "take" of other species protected by the state or federal Endangered Species Acts is not anticipated to occur and will be further minimized and avoided through the incorporation of practices to avoid California red-legged frog. Additionally, while federal coverage for incidental take of steelhead will be acquired, WRA will also incorporate minimization and avoidance practices to reduce the number of steelhead encountered.

3.3.3.2 Approach

The procedures employed by AECOM during sampling efforts in 2016 will be adhered to as closely as possible by WRA. There will be no major changes in sampling procedures. A crew of 2-4 biologists will utilize a combination of equipment to capture target fish at each sample location (Table 3-1). All sampling efforts will take place during daylight hours. Mobilization and de-mobilization to sampling sites may take place during dawn and dusk, but all active sampling will take place during the day time. As reported by AECOM (2017), overnight setting of minnow traps was successful in yielding target species. Therefore, minnow traps may be left to fish overnight; however, biologists will only check traps during daylight hours. Seine nets, block nets, dip nets will serve as the primary method of fish collection. Where feasible and to supplement netting, minnow traps will be used in and around structure of the habitat within the sample location. Minnow traps will be baited with cat food and set for a period of between 1 and 24 hours. The number of minnow traps, if used, will be determined by biologists after a preliminary walkthrough of the sample location. At sample locations where habitat structure would preclude netting, and where protected species are assessed to be unlikely to occur, a backpack electrofisher (i.e. Smith-Root LR-24) will be utilized for target fish collection. Electrofishing would be led by an experienced fisheries biologist and would follow the National Marine Fisheries Services' (NMFS) *Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act* (NMFS 2000). Temperature, dissolved oxygen (DO), pH, and specific conductivity (SC) will be measured at each sampling location prior to sampling efforts using a handheld pH meter and YSI meter. Meters will be calibrated according to manufacturer's instructions prior to

the start of sampling. One set of readings will be taken 6 inches below the water's surface, and one set taken from 6 inches above the bottom of the water body. All measurements will be recorded onto a data sheet. Water temperature will be monitored throughout the collection process, and where electrofishing occurs, specific conductivity will also be monitored.

Age 0+ (i.e. young of year or up to a one-year-old fish) California roach (*Lavinia symmetricus*) will be targeted in each creek location (Table 3-1). As reported by AECOM (2017) and SCVWD (2004) age 0+ California roach tend to be small in the Guadalupe River Watershed and can range in size from 2.5 to 5.5 cm in fork length (FL). Within this size range, and to maintain consistency with previous sampling efforts, California roach measuring 4 cm FL (+/- 0.5 cm) will be targeted for tissue preservation and mercury analysis.

Within the Guadalupe Watershed, a morphologically similar species to California roach occurs. Hitch (*L. exilicauda*) appear similar to, and can hybridize with, California roach. To distinguish the two species, dorsal fin ray counts will be performed on all captured *Lavinia* in the target size range; as the California roach has 7-9 dorsal fin rays and the hitch has 10-13 dorsal fin rays (Moyle 2002).

Age 1 largemouth bass (*Micropterus salmoides*) (55 to 102 mm) will be targeted in Lake Almaden to correspond to fish collected in the reservoirs by the District, and fish at or over 60 mm will be kept. The Guadalupe River Coordinated Monitoring Plan (CMP; URS 2010) recommended that the minimum size of largemouth bass retained be at least 6 cm FL. Based on the results of previous sampling at this location as outlined in the *Guadalupe River Coordinated Monitoring Program 5-Year Report* (AECOM 2017), age 1+ largemouth bass collected in spring (May) were smaller than 6 cm FL, however collection in Cycle 2 is planned to occur between June 1 and September 30, with sampling likely happening during the latter half of that time window.. In accordance with methods outlined in the AECOM report, if necessary, smaller largemouth bass will be combined into composite samples.

Sampling guidelines provided in the Regional Board's Section 13267 letter allow for the collection of alternative age 0+ predatory fish if the primary target species cannot be collected (SFRWQCB 2017). If California roach or largemouth bass are not captured during sampling efforts, biologists will retain the following species as outlined in the Regional Board sampling guidelines (RWQCB 2011): green sunfish (*Lepomis cyanellus*), bluegill (*L. macrochirus*), redear sunfish (*L. microlophus*), black crappie (*Pomoxis nigromaculatus*), or catfish (*Ictalurus* and *Ameiurus* spp.). Previous fish sampling efforts demonstrated that age 0+ bluegill (4.0 to 6.0 cm FL [Moyle 2002]) were available as substitutes for largemouth bass in some locations.

All captured fish will be immediately moved into either a 5-gallon bucket, or cooler filled with freshwater. Both the cooler and bucket will be aerated with a battery powered air pump to prevent hypoxia. To allow for identification of *Lavinia* spp. and measurement, captured target fish will be anesthetized in a 5-gallon bucket containing MS-222, a fish

anesthetic. Fish will be left in this bucket for no more than 3 minutes. Fish will then be identified, and any fish that resembles California roach will be verified by counting dorsal fin rays to ensure the morphologically similar hitch are not collected for tissue analysis.

All fish collected will be identified and measured (fork length, FL). Fish that do not meet the target criteria (3.7 to 5.5 cm FL for California roach, up to 9.0 cm FL for largemouth bass, and 4.0 to 6.0 cm FL for bluegill [AECOM 2017]) will be placed into a bucket for recovery, measured, and released where captured once deemed by the biologists to have recovered. Target fish that are captured will be weighed using an electronic scale, rinsed with deionized water, sacrificed, and placed into a sealed labeled Ziploc bag. Bags will be labeled with unique identification numbers, placed on dry ice to be flash frozen, and transferred to the designated laboratory with a completed chain of custody.

Twenty (20) target fish will be collected from each sample location; when necessary and in accordance with previous sampling efforts (AECOM 2017), composite samples will be taken to ensure sufficient biomass for laboratory analysis. In sampling locations where numerous fish are caught, size and numbers will be estimated to minimize handling time and potential mortality.

3.3.3.3 Power Analysis

Power analyses were conducted based on the results of the fish sampling efforts conducted in cycle 1 to estimate an appropriate number of fish to be collected at each location during cycle 2 (AECOM 2017). The results of the power analyses are reported as the minimum detectable difference between samples as a percentage of the mean concentration. Factors affecting the minimum detectable difference include sample size and variation among individual measurements within the sample (i.e., the coefficient of variation). In addition, fish size can also affect mercury concentration in an individual.

Estimates of the coefficient of variation in fish tissue mercury concentrations were obtained from Tables 3-5 and 3-6 in the AECOM (2017) report. The measured CV's varied between 0.2 and 0.4. A power of 0.8 and a confidence level (α) of 0.05 were assumed for this analysis.

The most recent fish tissue mercury concentrations averaged approximately 0.43 mg/kg (wet weight) (AECOM 2017), whereas the TMDL objectives for fish tissue are 0.05 mg/kg (wet weight) for 5-15 cm fish and 0.1 mg/kg (wet weight) for 15-35 cm fish. To achieve the TMDL targets, tissue burdens will need to be reduced by 88 percent. Therefore, the sampling design must be able to detect a change of this magnitude or smaller.

Three sets of power analyses were performed. The first assumed that the fish tissue concentrations at the 5 river stations were being compared using analysis of variance (ANOVA) (Figure 3-2). The test statistic was the non-central F-distribution. For a sample size of 20 fish, the minimum detectable difference ranged from 22% for a CV=0.20 to

45% for a CV=0.40. For a CV=0.30, the minimum detectable difference ranged from 27% at a sample size of 30 fish to 49% at a sample size of 10 fish.

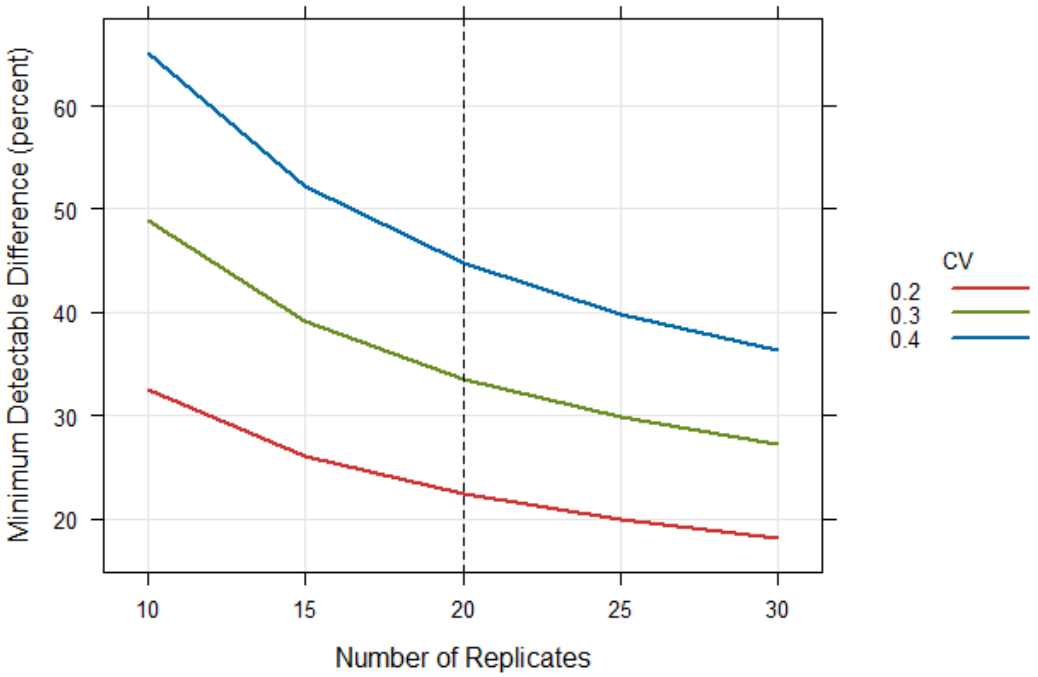

Figure 3-2 Minimum detectable difference, as percent of the mean, relative to sample size between 5 stations for three levels of CV.

The second set of power analyses modeled the result of a t-test between two stations, or between two different years at the same station (Figure 3-3). For a sample size of 20 fish, the minimum detectable difference ranged from 18% for a CV=0.20 to 36% for a CV=0.40. For a CV=0.30, the minimum detectable difference ranged from 22% at a sample size of 30 fish to 40% at a sample size of 10 fish.

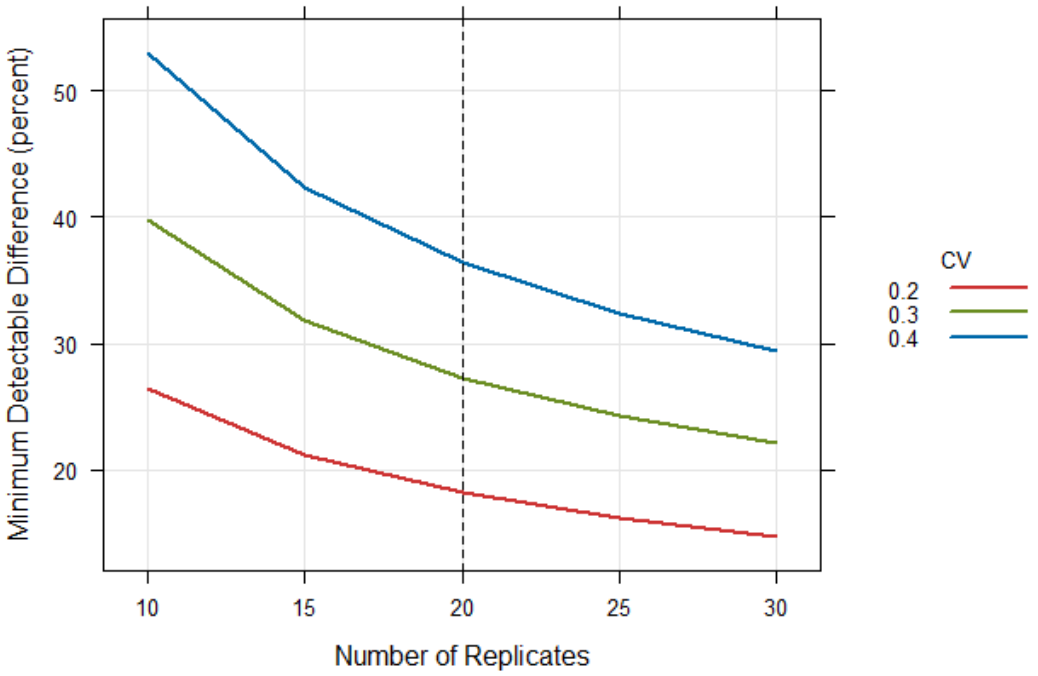

Figure 3-3 Minimum detectable difference, as percent of the mean, relative to sample size between 2 stations (or years) for three CVs.

As is evident from the above analyses, the minimum detectable difference decreases as the CV decreases and the number of observations per sample increases. Little can be done to reduce the natural variability in fish tissue concentrations collected in the field. However, sample size can be adjusted. The sampling design must balance the desired level of precision, the practicalities of collection of the required number of fish, and the cost of additional analyses, as well as consistency with previous surveys. Previous sampling for fish tissue has utilized a sample size of 20 fish. To ensure consistency with previous surveys and to control overall project cost, it is recommended that a sample size of 20 continue to be targeted. A reduction in sample size is not recommended. Furthermore, a sample size of 20 fish will be sufficient to determine whether the target fish tissue concentrations have been met.

Fish size is known to affect tissue mercury concentration, particularly in larger individuals. As the sampling effort will focus on collecting fish of a similar age, this effect may be small. To assess the potential influence of fish size on mercury concentration, a regression of concentration against size (or weight) will be performed for individual survey locations. Should an effect of size on mercury concentration be observed, the analysis of differences in tissue concentration will be conducted using analysis of covariance (ANCOVA) which will control for the effect of size and improve the ability to detect differences between locations.

The third set of power analyses was conducted to determine the ability to detect long-term trends in fish tissue mercury concentrations. For trend monitoring based on

sampling at regular intervals, statistical power is determined by the underlying sample variability in the fish tissue mercury concentrations, the level of change in tissue concentrations, and the level of sampling effort. The sampling design characteristics considered in these analyses included:

- Three levels of variability in the monitoring-parameter population, corresponding to the low to medium sample variability measured in previous sampling efforts. The variability was specified as a coefficient of variation (ratio of the population standard deviation to the population mean). The selected values were 0.2, 0.3 and 0.4
- Three levels of change in fish tissue mercury concentrations: 10% change over 10 years, an annual percent change (APC) of 1%; 22% change over 10 years, APC = 2%; and 35% change over 10 years, APC = 3%
- Two levels of sample frequency. In the first subset of these analyses, annual sampling was simulated. Biennial sampling was simulated is the second subset of analyses; sampling was simulated in years 1, 3, 5, …, but the rate of change (APC) was applied annually. For each combination of the CV and APC values, the duration of the sampling effort varied from 5 to 25 years. The number of samples per sampling event was fixed at 20.

For each set of design parameters, 10,000 sampling events were simulated. For the individual simulations, a *t* test was conducted to test the significance of the slope coefficient from the linear regression trend line. The proportion of significance test results in the 10,000 simulations provided the estimate of the statistical power (the probability of detecting the simulated trend).

The results for the annual sampling simulations are summarized in Table 3-3. The probability of detection (power) is presented for the selected levels change (APC), sample variability (CV), and number of samples (n = 20, not shown in table). The results indicate that with the background level of variability represented by CV values between 0.2 and 0.3 and the collection of 20 samples per year for 10 years, the probability of detecting a change of 22% (APC = 2%) occurring over the 10-year sampling period is highly likely (highlighted results). If the CV is higher, e.g., 0.4, the ability to detect this level of change will require a slightly longer period of sampling. For example, Analyses 23 and 24 show that the probability of detecting an annual percent change of 2% in mercury tissue concentrations is 0.65 and 0.98 for 10 and 15 years of sampling, respectively. The probability of detecting the higher simulated level of change in fish tissue mercury concentrations (35 % change over 10 years, APC = 3%), is greater than 0.91 for all levels of sample variability considered in these analyses.

The results of the simulated biennial sampling are presented in Table 3-4. The results provide a direct comparison with the annual sampling strategy. For example, the design parameters for Analyses 1 – 3 differ from Analyses 28 – 30 only in the sample frequency: annual versus biennial. The difference in the sample frequency reduces the power. Comparing Analyses 2 and 29 shows that the power is reduced by a factor of 3.6. Additionally, the time required to establish a high level of confidence in detecting the change is fish tissue mercury concentration (e.g., power $\geq$ 0.8) is increased. For example, in an extreme case represented by Analyses 10 – 12 and Analyses 38 – 42, the number of

years to achieve a level of power = 0.8 is 15 years for annual sampling and more than 20 years for biennial sampling.

Table 3-3
Power Analysis for Simulated Annual Sampling[1]

Analysis	Sampling Frequency	Coefficient of Variation (CV)	Sampling Program Duration (years)	Annual Percent Change (APC)	Power
1	Annual	0.2	5	1	0.17
2			10		0.65
3			15		0.98
4			5	2	0.4
5			10		0.99
6			15		0.99
7			5	3	0.67
8			10		0.99
9			15		0.99
10	Annual	0.3	5	1	0.12
11			10		0.38
12			15		0.8
13			5	2	0.23
14			10		0.85
15			15		0.99
16			5	3	0.41
17			10		0.99
18			15		0.99
19	Annual	0.4	5	1	0.1
20			10		0.26
21			15		0.59
22			5	2	0.17
23			10		0.65
24			15		0.98
25			5	3	0.28
26			10		0.91
27			15		0.99

[1] The highlighted simulations are discussed in the text.

Table 3-4
Power Analysis for Simulated Biennial Sampling

Analysis	Sampling Frequency	Coefficient of Variation (CV)	Sampling Program Duration (years)	Annual Percent Change (APC)	Power
28	Biennial	0.2	5	1	0.04
29			10		0.18
30			15		0.70
31			20		0.96
32			5	2	0.14
33			10		0.68
34			15		0.99
35			5	3	0.32
36			10		0.97
37			15		0.99
38	Biennial	0.3	5	1	0.03
39			10		0.08
40			15		0.34
41			20		0.64
42			25		0.95
43			5	2	0.07
44			10		0.33
45			15		0.93
46			5	3	0.14
47			10		0.68
48			15		0.99
49	Biennial	0.4	5	1	0.02
50			10		0.05
51			15		0.19
52			20		0.38
53			25		0.74
54			5	2	0.04
55			10		0.18
56			15		0.70
57			20		0.95
58			5	3	0.08
59			10		0.40
60			15		0.98

3.3.3.4 Decontamination Methods

All equipment used for fish tissue sampling will be decontaminated following use according to the California Department of Fish and Wildlife (CDFW) *Aquatic Invasive Species Decontamination Protocol* (CDFW 2013) to prevent the spread of chytrid fungus. Decontamination will occur within two days after use of equipment, using Quaternary Disinfectant Cleaner (10.14 percent didecyl dimethyl ammonium chloride) at a 1-ounce to 1-gallon water ratio.

For sampling locations that are directly connected to each other, sampling will be arranged so the most upstream locations are sampled first, followed by the downstream sites. Equipment in between these sampling locations will be rinsed, but not disinfected. If new decontamination procedures developed over the five years of sampling period, the District will take the lead to review and approve changed decontamination procedures.

3.3.3.5 Standard Operating Procedures

The procedures employed by AECOM during sampling efforts in 2016 will be adhered to as closely as possible by WRA. There will be no major changes in sampling procedures. The following standard operating procedures are provided for the fish collection methods described in this monitoring plan. While the specifics of each sample pass may vary due to field and site conditions, the following steps will guide the work. Standard operating procedures for the collection of water quality parameters are also included below.

Seine Nets

- The seine net used will be either 10-foot by 4-foot with 1/8" mesh or 20-foot by 4-foot net with 1/4" mesh, depending on sampling site conditions.
- Operate seine nets with two biologists, in water depths of no greater than 4 feet
- Pull net through the water, ensuring the lead line maintains contact with the bottom and the float line remains on the surface
- Purse net together at the end of each pass and pull up on shore to allow for sampling of catch
- Clear net of debris prior to each pass

Dip Nets

- Dip nets are variable in size and will be selected based on site conditions. Sizes may include 21” x 17" D ring with a 1" mesh, 18” x 15" with a 1/4" mesh, or 12” x 7" D ring with a 1/16" mesh.
- Dip nets will be operated by a single biologist in variable water depths where the biologists has stable footing
- Pull net through the water in a figure eight pattern and/or pull up into overhanging banks or accessible cover
- Net should be removed from water facing up such that the dip net frame is fully emerged from the water and moved to shore to allow for sampling of catch
- Clear net of debris prior to each pass

Minnow Traps

- Minnow traps to be used will be 16 ½-inches long and 9-inches in diameter with a 5/16th -inch mesh.
- Bait traps with partially opened tins of cat food
- Traps will be attached to shore with a retrieval line, then set into target micro habitats within sampling location
- Set traps for anywhere between 1 and 24 hours
- Retrieve traps from shore for catch processing

Electrofisher

- The selected electrofisher unit will be the Smith Root LR-24 with adjustable output voltage at 50-990V in 5V steps.
- Use of the electrofisher will follow the National Marine Fisheries Services' (NMFS) *Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act*.
- Measure water temperature and conductivity prior to sampling to evaluate electrofisher settings.
- The amperage and voltage controls on the electrofisher will be set at the minimum settings required to capture fish and will be based on the measured conductivity.
- If possible, block nets will be set downstream from the sampling location to capture any missed fish.
- One biologist will systematically move anode through water, while a second biologist will closely follow the anode with a dipnet, netting any fish that surface.
- Avoid contact between fish and the anode.
- Keep aerated buckets and coolers nearby to allow for quick transfer of catch.

Water Quality

- Prior to fish collection, a handheld YSI unit (model 85) will be used to collect temperature, dissolved oxygen, and specific conductivity, and a handheld pH unit will be used to collect pH.
- All water quality parameters will be measured 6 inches from the surface, and again 6 inches from the bottom of the water body.
- The probe for each device will be left in the water for a minimum of one minute prior to taking readings to ensure temperature stabilization.
- All units will be properly calibrated prior to use in accordance with their user manuals.
- All measurements will be recorded onto a data sheet.

3.3.3.6 California Red-legged Frog Avoidance

Sample locations with potential for California red-legged frog (CRLF, *Rana draytonii*) will be checked by biologists experienced in the identification and ecology of CRLF prior to the start of any fish sampling activities. Biologists will use binoculars to scan the sample location from a distance before completing the pre-sample survey on foot in the sample location. Attention will be paid to the banks surrounding the creeks and lake. If

any CRLF are located, the sampling location will be moved to a nearby location in the same water body, and the new survey location checked.

3.3.3.7 Steelhead Avoidance

Incidental take coverage will be acquired through Section 10 or 4(d) of the Endangered Species Act. While federal authorization to handle and release steelhead will be acquired prior to sampling in anadromous waters, WRA will still implement minimization and avoidance measures to reduce the potential of encountering steelhead while sampling. The anticipated sampling dates will fall within the CDFW and NMFS environmental work window for steelhead (June 1 through November 30). The work window is the period of time when protected steelhead are least likely to be migrating through the water body or occur in sensitive life history stages (i.e. eggs or fry). The period corresponds to the warmer summer and fall water temperatures that tend to restrict steelhead to cool, well shaded, perennial water habitats. The target species (i.e. California roach) is more tolerant of warm water and habitat that is less suitable for steelhead, allowing for a wider range of habitats to be sampled. Therefore, the likelihood of capturing steelhead during sampling activities will be low; as the specific habitat sampled and methods used will be led by an experienced fisheries biologist.

A fisheries biologist will conduct a reconnaissance site visit to the sample locations during the survey window to identify suitable habitat areas to sample and appropriate equipment for the site to aide in the preparation and reduce the expected amount of in-water time and disturbance when the fish collection events occur. Sampling will comply with the NMFS and CDFW permits, which includes following the NMFS *Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act* (NMFS 2000) when using a backpack electrofisher.

In the unlikely event a steelhead is captured during fish collection, the fish will be released immediately from the net or immediately after recovery if encountered during electrofishing. Sampling activities and reporting of incidental take of steelhead will comply with the NMFS and CDFW permits.

3.4 SAMPLE DOCUMENTATION AND SHIPMENT PROCEDURES

Chain-of-custody records are used to document sample collection, analyses required, sample custody, and transportation to the analytical laboratory for analysis. All samples will be accompanied by a chain-of-custody record. A separate form will be completed, signed, and transported with each cooler containing samples to the laboratory. The chain-of-custody record identifies the contents of each sample cooler, the analyses to be performed, and maintains the custodial integrity of the samples. Corrections on sample forms can be made by placing a single line through the mistake and initialing and dating the change. The correct information would then be entered above, below, or after the mistake. Generally, a sample is considered to be in someone's custody if it is either in someone's physical possession, in someone's view, or locked and kept in a secured area that is restricted to authorized personnel. Until the samples are transported to the individual laboratory, the custody of the samples is the responsibility of the sampling

team. A copy of the original chain-of-custody records will be included in the project report.

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. The samples will have preassigned, identifiable, and unique numbers. At a minimum, the sample labels will contain the following information: site name, sample location and depth, date of collection, analytical parameter(s), any method of sample preservation, and sampler's name.

3.4.1 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Sample containers will be labeled at the time of collection. Labels will include the sample number, location, date, time and the field sampler's initials. A Field Log will be completed during the collection of each sample. Field Log entries will include the following information:

- Sample
- Sampler's name(s)
- Date and time of sample collection
- Preliminary sample descriptions
- Weather conditions at time of sampling.

As conditions in the field may vary, it may become necessary to implement minor modifications to the sampling plan. Any variances will be recorded in a bound field notebook.

A Chain-of-Custody form will be completed for each group of samples collected on the same day, and will be used to transfer samples to laboratory personnel. Chain-of-Custody entries will include the project name, field samplers, sample numbers, sample types, number of containers, comments and signatures relinquishing the samples. Field documentation will be completed using indelible ink, with any corrections made by drawing a single line through the error and entering the correct value.

Water samples will be placed in coolers with ice or ice-equivalent immediately and chilled to 4 °C or less, but not freezing. Preservatives for total mercury and methylmercury, will be added to the appropriate sample bottles by the laboratory prior to sample collection. Any such bottles will be labeled with the parameter name and the specific preservative added (e.g., H_2SO_4). Fish tissue samples do not need to be chemically preserved in the field but will be frozen.

3.4.2 PACKAGING PROCEDURES

All samples will be placed in a sturdy, insulated cooler with ice, ice-equivalent or dry-ice. When ice is used, the drain plug of the cooler will be secured with fiberglass tape to prevent melting ice from leaking out of the cooler. Ice used to cool samples will be double-sealed in two Ziploc plastic bags and placed on top and around the samples to chill them to at least 4 °C. The bottom of the cooler will be covered with bubble wrap to prevent breakage during shipment. The screw caps will be checked for tightness and, if

not full, a mark will be made noting the sample volume level of liquid samples on the outside of their sample bottles with indelible ink. The bottle/container tops and sample labels will be secured with clear tape. All sample containers will be placed in heavy-duty plastic bags and wrapped in bubble wrap to prevent breakage. All samples will be placed in coolers with the appropriate chain-of-custody form. All forms will be enclosed in a large plastic bag and affixed to the underside of the cooler lid. Empty space in the cooler will be filled with bubble wrap or Styrofoam peanuts to prevent movement and breakage during shipment. Each ice chest will be securely shut. The laboratories will be notified of the sample shipment schedule. The schedule will be arranged so that the samples will arrive on a work day, and not during the weekend.

Water samples collected for total mercury and methylmercury will be sent to Eurofins Frontier Global Sciences in Bothell, Washington. Samples collected for total suspended solids will be sent to Enthalpy Laboratory in Berkeley, California.

For biota samples collected during the sampling, the analytical laboratory Eurofins Frontier Global Sciences will be used. All samples that will be analyzed for mercury will be sent to Eurofins Frontier Global Sciences in Bothell, Washington. As stated above, all fish collected for mercury analysis will be kept cold at <4 °C until all specimens have been collected.

3.5 ANALYTICAL METHODS AND QA REQUIREMENTS

3.5.1 ANALYTICAL METHODS

Standard analytical methods will be used for all analyses and will be consistent with previous surveys (Table 3-5). The sample containers will be provided by the subcontracted analytical laboratories. Analytical methods, reporting limits, sample container types and preservation are provided in Table 3-5.

Table 3-5
Planned Analytical Methods for Aqueous and Fish Tissue Samples

Parameter	Matrix	Method[1]	Method Reporting Limit[2,3]	Holding Time	Preservative (Type & Amount)	Bottle Type	Bottle Size
Total Suspended Solids	Water	EPA 160.2	0.5 mg/L	7 Days	None	HDPE	500 mL
Total Mercury	Water	EPA 1631E	0.50 ng/L	6 mos.	H_2SO_4	PTEG	250 mL
Dissolved Mercury	Water	EPA 1631E	0.50 ng/L	6 mos.	None; H_2SO_4 once filtered	PTEG	250 mL
Methyl Mercury	Water	EPA 1630/FGS-70	0.05 ng/L	6 mos.	H_2SO_4	Glass	250 mL
Total Mercury (wet weight)	Tissue	EPA 1631B	0.80 ng/g	6 mos.	Frozen	Zip-lock bag	Zip-lock bag

Notes:
[1] Methods are the same as used in the Cycle 1.
[2] Reporting limits for mercury in fish tissue and Total Suspended Solids are lower than in Cycle 1. Reporting limits for total and dissolved mercury and methylmercury are consistent with Cycle 1.
[3] Method detection limits (MDLs) may vary if samples are diluted; actual sample-specific MDLs will be provided.

3.5.2 QUALITY CONTROL REQUIREMENTS

Care will be taken to ensure the collection of representative water and tissue samples. Equipment/field blanks will be used to aid in the identification of problems due to field contamination. Laboratory duplicates will be used to assess the precision of analytical methods. The selected analytical laboratories have rigorous quality control programs, including analysis of reagent blanks, method blanks, certified standards, and matrix spikes (Table 3-6). Due to the limited number of water and suspended sediment samples to be collected during each sampling event, that analytical laboratory will be requested to run one set of QA samples for each survey. One set of QA samples will be run for every batch of 20 fish tissue samples submitted. The QA/QC programs for the selected analytical laboratories will be provided upon request.

Table 3-6
Quality Control Criteria for Analysis of Parameters in Water

QA Sample	QA Measure	Minimum Frequency	Acceptance Limits	Corrective Action
Parameters (TSS)				
Laboratory Duplicate	Precision	Once every 20 samples or every analytical batch, whichever contains fewer samples	$\pm$ 25% of other 2 replicates	Accepting the data and acknowledging the level of uncertainty with a written explanation
Other Parameters				
Method Blank	Accuracy	Once every 10 samples or every analytical batch, whichever contains fewer samples	< PQL	Reanalysis of samples Amending analytical procedures, or Accepting the data and acknowledging the level of uncertainty with a written explanation
Laboratory Duplicate	Precision	Once every 20 samples or every analytical batch, whichever contains fewer samples	$\pm$25% of other 2 replicates	Reanalysis of samples Accepting the data and acknowledging the level of uncertainty with a written explanation
Matrix Spike and MSD Samples	Precision and Matrix Interference	Once every 20 samples or every analytical batch, whichever contains fewer samples	71% $\leq$ %R $\leq$ 125%	Amending analytical procedures, or Accepting the data and acknowledging the level of uncertainty with a written explanation

PQL = Practical Quantification Limit

Equipment Blanks – Equipment rinseate samples will be prepared by pumping high-purity water through the water sampling equipment. Equipment blanks will be prepared once prior to the commencement of sample collection and each time that the sampling train is modified. These samples will be analyzed for each parameter type. The purpose of these samples is to determine if any cross-contamination occurred due to inadequate cleaning of equipment.

Field Replicates – Extra water, sediment and biota samples will be collected to prepare blind replicate samples at a rate of one sample of each type per ten samples. These samples are labeled as if they are a distinct location, so that the laboratory cannot tell that the samples are field replicates. These samples provide information on the variability of successive samples taken at the same location. Tissue and sediment samples are not true duplicates but provide an estimate of the field variability.

Laboratory Quality Control Samples – Laboratory duplicates and matrix spike/matrix duplicate (MS/MD) samples are needed for the chemical analyses. The MS/MD samples are used to determine percent recoveries of the reference standards and matrix spikes and are used to detect matrix interferences. The laboratory duplicate samples are used to determine the relative percent differences, which can be used to detect laboratory equipment problems such as drift in calibration. Blank spike samples and blank duplicates are also prepared to determine if any laboratory contamination has occurred and to determine the method detection limit. Preservative blanks are also prepared in the laboratory. The frequency of these QA/QC samples and actions that can be taken are shown in Table 3-6. A quality assurance/quality control (QA/QC) summary form will be completed by the laboratory for water, sediment, and tissue samples. The sample numbers for all QA/QC rinseate samples, laboratory QC samples, and duplicates will be documented on this form.

Field and Laboratory Data and QA/QC Reporting

The laboratory will provide all sample results and a QA/QC summary and case narrative and maintain a full data package for detailed data validation, if requested. The QA/QC data will be reviewed to determine if percent recoveries of the standard and matrix spike samples are within acceptable ranges, and if the relative percent differences are within the prescribed tolerance limits. Equipment field blanks will be checked to see if any compounds were detected. Standard USEPA procedures for qualifying the data if any compounds are detected in the blanks will be followed. The relative percent differences between field replicates will be determined to estimate the field variability. The field replicates and laboratory duplicates are used to determine if there are any systematic biases in the analyses. The laboratory data results, the QA/QC results with a summary of the implications of the QA/QC results, and copies of the chain-of-custody forms will be included in the project report. Field measurements such as water temperature will also be included in the project data reports.

3.5.3 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

All field instruments will be inspected and calibrated prior to visiting the field. All laboratory equipment will be inspected and calibrated according to manufacturer guidelines prior to and at the end of sampling analysis. If sample drift or anomalous readings are noticed, the instrument will be recalibrated in the field.

Each of the selected analytical labs has a rigorous instrument maintenance regime.

Inspection/Acceptance Requirements for Supplies and Consumables – Sample containers will be specifically prepared by the subcontracted analytical laboratories for each sampling event. This ensures that all containers have been recently prepared. The analytical laboratories will prepare each container using the appropriate standard methods for the analytical technique to be used on its contents. All sample containers will be visually inspected before use.

3.5.4 LABORATORY QUALITY CONTROL PROCEDURES

Initial calibration procedures determine how the laboratory instruments are performing. An initial calibration develops a calibration curve using reference standards for each parameter analyzed. Initial calibration is performed on a frequency required by the analytical method. Typically, the frequency of calibration is performed with each analytical batch of samples, at a maximum of once per batch. It may be performed more (or less) frequently depending on instrument stability.

Continuing calibration is performed during the analytical process to verify that the initial calibration is still applicable. Generally, continuing calibration is performed using check standards, though a replication of the initial calibration may be required instead. Check standards are run after every 20 samples, or as required by the method. Calibration range criteria are applied to determine if the instrument is performing optimally and measuring acceptably. The criteria are often expressed as a range of percent recovery of the initial calibration value. The criteria are narrower than precision and accuracy requirements of the measurements themselves, typically no worse than 80 to 120 percent or as required by the standard method. The results of all calibration procedures, initial and continuing, are recorded in QA/QC notebooks and/or instrument logbooks.

Corrective action procedures may be required as the result of audited or self-discovered nonconformance with predetermined QA/QC criteria. The corrective action system functions to identify, document, and prevent recurrence of out-of-control situations. These situations include, but are not limited to, quality assurance acceptance limits being exceeded, deviations from normally expected results, divergence from SOPs and abnormalities in sample handling. Each nonconformance is documented by recording the circumstances in a Corrective Action Report. Documentation of corrective action steps includes problem identification, investigation, action to eliminate the problem, and verification that the problem has been solved.

3.5.5 DATA VALIDATION AND USABILITY

All analytical laboratories will be instructed to submit their analytical results as a PDF image of the analytical report and as Excel data tables including the analytical results of submitted samples and laboratory QA samples and data qualifiers. This facilitates the evaluation of data quality and the association of appropriate data qualifiers in the final data sets reported to the District. The review and evaluation of data quality will follow current U.S. Environmental Protection Agency (USEPA 2010) guidance for performance-based data. Tetra Tech has assigned Mr. Gary Wortham to conduct a complete review of all data quality prior to performing data tabulation, analysis, and

reporting. During the validation process, a data quality report will be prepared and data quality flags will be assigned to each analytical result.

3.6 TRAINING REQUIREMENTS

The field sampling effort will be led by Gary Wortham. Mr. Wortham has more than 27 years of experience in the environmental sciences, with expertise in water and sediment quality analytical and field sampling methodologies and project design as well as project QA/QC; QAPP development; sampling plan implementation and data interpretation; analytical chemical laboratory management; project design; aquatic system data analyses; federal and state water quality regulations; field monitoring (including training field staff on the proper application of the USEPA's ultra-clean sampling method for low-level mercury and water, sediment and habitat assessments); marine and freshwater systems aquatic toxicity methods development; and Health & Safety policy implementation. Mr. Wortham will ensure that field staff are trained on proper sampling techniques. The Tetra Tech project manager and other proposed field staff are familiar with sampling requirements and ultra-clean sampling methods. Tetra Tech has other staff who routinely provide QA and data validation support.

Mr. David Pizzi, P.E., will provide instruction and training to the field crew on the set-up and use of the US D-95 sampler prior to mobilization for the first storm. Mr. Pizzi may also be present during the initial sampling event. It is anticipated that a single training event will be required for the field staff. Should Mr. Pizzi cease working for Tetra Tech during the course of this project, other staff within his group will be selected to replace him.

Complete vitae for the investigators can be provided upon request.

3.7 DATA ACQUISITION AND MANAGEMENT

Survey data will be compiled into a project database for flows, water quality, and fish tissue concentrations.

3.7.1 DATA MANAGEMENT

The analytical laboratories will provide from the results of their analyses to Tetra Tech as hard-copy (or PDF) reports and as electronic data deliverables (EDDs). The EDDs will reduce the likelihood of transcription errors and increase data reliability. Upon arrival of the EDDs from the laboratories, checks of the database against the laboratory data sheets will be conducted to ensure accuracy. Data collected in the field will be manually entered into the database. Manually entered data will be double checked for accuracy. All data will be merged into a single Excel database and tabular summaries prepared for each sample matrix.

3.7.2 ASSESSMENTS AND RESPONSE ACTIONS

Project assessment will include regular observation of field sampling, sample handling, sample preparation, sample analysis, data evaluation and verification of quality control. Ted Donn will be responsible for periodic monitoring of field activities and assuring that all field personnel are adequately trained for the sampling method requirements. Deviations from sampling and analytical protocols will be addressed by Ted Donn.

3.8 DATA ANALYSIS AND REPORTING

Data from previous TMDL monitoring efforts will be obtained from the District in electronic form. These data will include storm flow measurements, TSS concentrations and loads, and mercury loading estimates as well as fish tissue mercury levels.

For each sampled storm event, Tetra Tech will tabulate the following parameters:

- Peak instantaneous flow at the USGS Highway 101 gage,
- TSS data from USGS gage.
- Peak instantaneous flow at each of the District's monitoring points along the creeks,
- Reservoir status, pre-storm,
- Cumulative rainfall during storm event,
- Year-to-date rainfall, pre-storm,
- Suspended solid load, and
- Total mercury load.

Compilation of these data will allow development of a predictive tool to estimate when high flow conditions are likely to occur and estimate mercury loads from those storms. The key relationship will be that between peak flow and total mercury load.

3.8.1 MERCURY LOADING

To resolve the questions on mercury loads (see SFBRWQCB June 2017 letter), statistical analyses will be conducted to understand the relationships between mercury concentration, suspended solids, and instantaneous flow. The following plots will be constructed:

- Plot of instantaneous flow, mercury concentration, and suspended sediment concentration (measured and from the USGS gage) versus time for each sampled storm event.
- Plot of mercury and suspended sediment concentration versus instantaneous flow for each sampled storm event, and for all combined events.
- Plot of mercury versus suspended sediment for each sampled storm event.

Consistent with the approach used by AECOM (2017), Tetra Tech will calculate regressions of suspended sediment and total mercury against concurrently measured flow during each storm event. These regressions will be used to develop a predictive relationship between these variables to allow calculation of mercury loading during the storm. Similar to the approach used in the cycle 1 five-year report (AECOM 2017), the

regressions will be used to predict instantaneous mercury loads for each 15-minute period during the storm hydrograph. These instantaneous loads will then be summed over the period of the storm to estimate the total storm load (i.e., linear interpolation method).

An alternative method to calculate loads is to calculate the flow-weighted average concentration based on the concentrations and flows associated with each sample. This value can then be multiplied by the average of the 15-minute flows during the storm times the storm duration to calculate the total load (i.e., flow-weighted mean concentration method).

The regressions calculated from monitored storms can be applied to the instantaneous flow data collected at the USGS gage (#11169025) to provide estimates of loading during storms that were not measured.

Tetra Tech will use flow data from the upper watershed (USGS Gage #11167800 on Guadalupe River at Almaden Expressway) to assess the relative contribution of urban and legacy mining loads to the total load at Highway 101 (AECOM 2017). In addition, Tetra Tech will obtain available flow data from the lower portions of each tributary to the Guadalupe River to provide an alternative estimate of contributions from the urban sources.

The project team will prepare an analysis of the McKee et al. (2017) criteria relative to storm flow at the USGS gage at Highway 101 for large storms that occur during cycle 2 of the monitoring program. This analysis will allow the criteria to be better defined.

3.8.2 FISH TISSUE

The objectives of the fish monitoring are described in Section 1.3. The present section describes the analyses that will be conducted to address those objectives. Specifically, the June 2017 letter from the SFBRWQCB:

Questions to be resolved:

- What is the temporal trend in fish tissue mercury concentrations in remediation effectiveness indicators in Lake Almaden, Guadalupe, Almaden, and Calero Reservoirs, Alamitos and Guadalupe Creeks, and the Guadalupe River?
- Is there a temporal trend in fish tissue mercury concentrations at reference sites, and if so, how does it inform interpretation of remediation effectiveness indicators?

The fish tissue data to be included in the annual reports will include those data collected by the Tetra Tech/WRA team and those fish tissue results concurrently obtained from the District's reservoir sampling program. The Water Board anticipates collecting additional fish mercury data from both Stevens Creek and Lexington Reservoirs in 2019. These data will be included in the annual report if fish tissue sampling is conducted by WRA in creeks during 2019. Otherwise, those data will be included in the District's biennial report.

The first step in analyzing the data on temporal changes in fish tissue concentrations will be to plot the data. All individual fish tissue data will be tabulated and plotted, including data collected for the TMDL staff report and data from Cycle 1. These graphs will allow a visual assessment of any potential trends as well as providing an estimate of the variability associated with fish tissue concentrations of mercury. Several plot types will be used to assess the mercury concentrations in fish tissue. Typical plots will include:

- Box-and-whisker plots of tissue mercury concentration by each survey location for the survey year.
- Scatter (x-y) plots of individual fish mercury concentrations for each stream sampling point and reservoir against time.
- Fish tissue mercury concentrations will be plotted against fish length for each sampling location to assess the effect of length on concentration.

Analysis of Variance (ANOVA) will be used to test for differences between survey locations, or between years at a given location. If a relationship between fish length and mercury concentration is evident, or fish lengths between samples are different, an analysis of covariance (ANCOVA) will be conducted to remove the effect of fish length on the results. The analyses will include an evaluation of the distribution of the errors to ensure that they meet the assumption of normality (Zuur et al. 2007). If the errors are not normally distributed, the data will be transformed to obtain normality.

Temporal trends in fish tissue mercury concentrations will be analyzed using the non-parametric Mann-Kendall test on Sen's slope. Historical and newly collected fish tissue data will be combined to explore the existence of temporal trends. Tetra Tech will also analyze the data using multiple regression techniques, including the use of mixed models that can incorporate additional sources of variability, such as the influence of fish length on mercury concentration (Zuur et al. 2007). The objective of these analyses will be to determine if there is a temporal trend in fish tissue concentration.

4 PROJECT SCHEDULE

Fish sampling in the creeks is currently proposed for late season of 2019 and 2020/21, with sampling to coincide with the District's reservoir sampling, to the extent possible. The schedule for storm flow sampling is dependent on rainfall and cannot be predicted at this time. However, efforts will be made to sample storms that meet the sampling criteria as soon as possible.

At the end of each year during which monitoring (mercury loading, or fish tissue sampling) occurs, a brief annual report that summarizes the year's sampling and transmits the field and laboratory data results will be prepared. The draft annual report will be submitted to the District within 60 days after completion of the field work for the year. The final draft report will be provided to the SFRWQB within 90 days of completion of field sampling.

The final draft Five-Year report that will discuss all activities performed during this monitoring cycle will be provided to the SFRWQCB by 26 January 2024 under the worst-case assumption where the second fish collection occurs in October 2023. Should fish be collected as proposed in 2021, then the final draft Five-Year report will be submitted by December 31, 2023.

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APPENDIX A
FIELD DATA SHEETS

BEDLOAD AND SUSPENDED SEDIMENT SAMPLING FORM

Bridge: _____ Date: _____
Crew: _____ Start Time: _____
Weather: _____ Finish Time: _____
0+00 Lat: _____ 0+00 Long: _____
Flow Width: _____ Spacing: _____
Comments: *(e.g., type, sampler, nozzle, container, duration, transit rate)*

Sample #	***From Sta***	***To Sta***	***Location***	***Depth (ft)***	***Notes*** *(i.e., piers, velocity, temperature)*
1					
2					
3					
4					
5					
6					
7					
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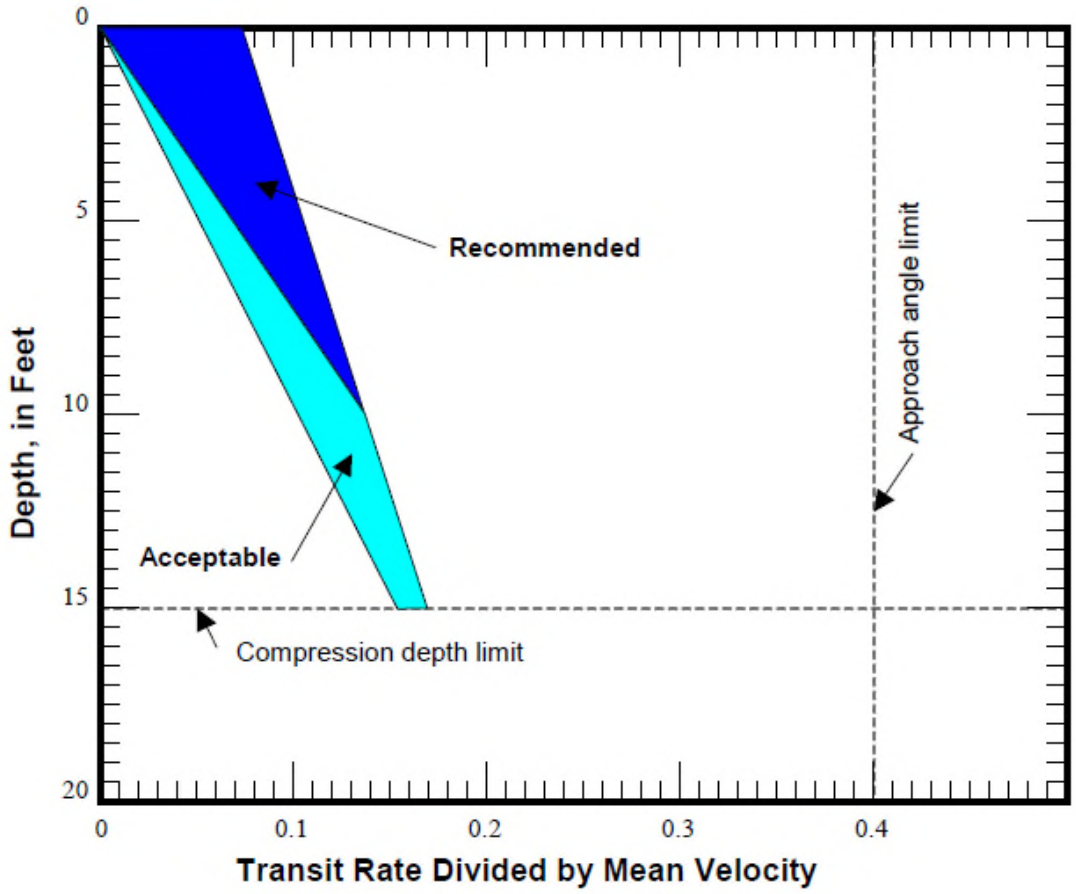
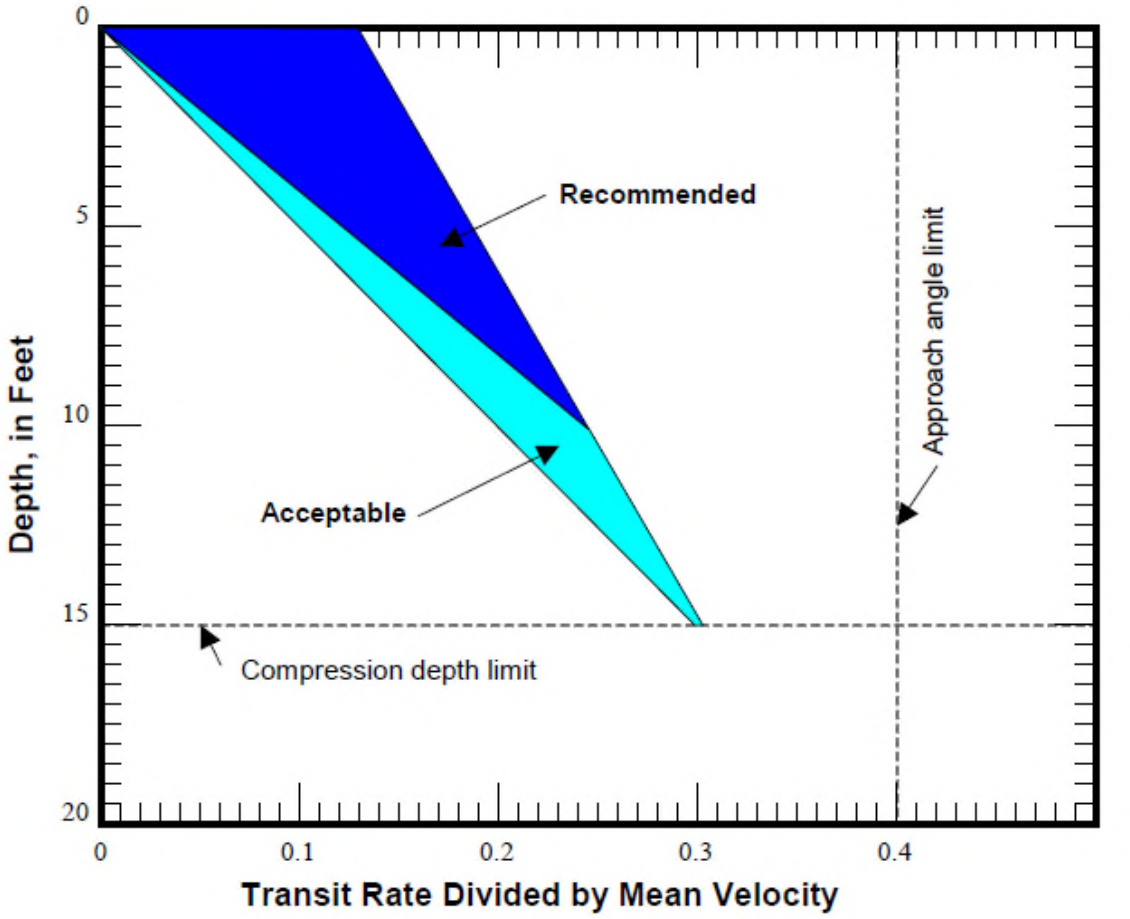


Note: The following configuration and volumes were used to produce this diagram. The total volume of the sampler container is 1,265 mL, which includes a "Teflon" bottle, bottle adapter and US D-77 cap. The maximum recommended sample volume is 800 mL. The maximum acceptable sample volume is 1,000 mL.

Figure 13. Transit Rate Diagram for US D-95, 3/16-inch Teflon Nozzle

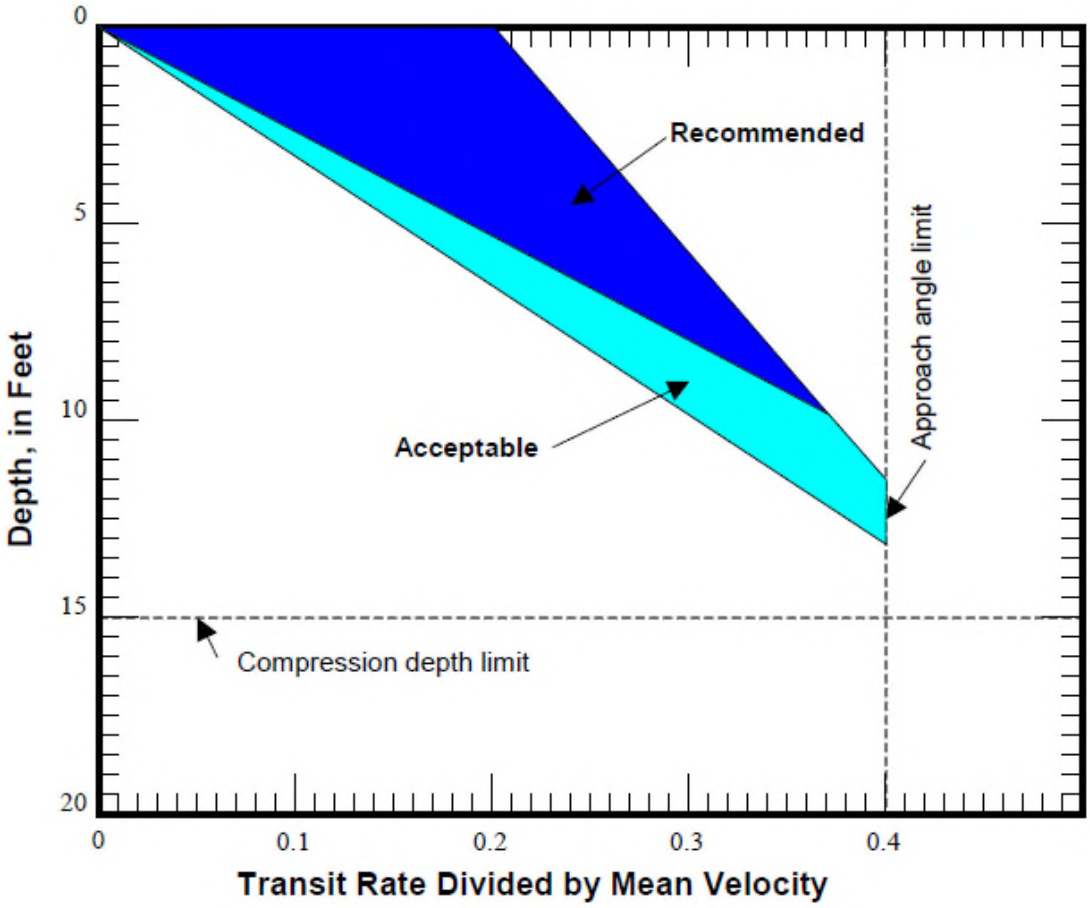
From McGregor (2000)



Note: The following configuration and volumes were used to produce this diagram. The total volume of the sampler container is 1,265 mL, which includes a "Teflon" bottle, bottle adapter and US D-77 cap. The maximum recommended sample volume is 800 mL. The maximum acceptable sample volume is 1,000 mL.

Figure 14. Transit Rate Diagram for US D-95, 1/4-inch Teflon Nozzle

From McGregor (2000)



Note: The following configuration and volumes were used to produce this diagram. The total volume of the sampler container is 1,265 mL, which includes a "Teflon" bottle, bottle adapter and US D-77 cap. The maximum recommended sample volume is 800 mL. The maximum acceptable sample volume is 1,000 mL.

Figure 15. Transit Rate Diagram for US D-95, 5/16-inch Teflon Nozzle

From McGregor (2000)

APPENDIX B
GUADALUPE WATERSHED MERCURY TMDL FISH MONITORING PLAN (SCVWD 2017)