Coyote Creek Watershed Reassessment 2020 Ambient Stream Condition Survey Design and Monitoring Plan: A Review of the Original 2010 Survey Design and Development of the 2020 Reassessment Strategy

Santa Clara Valley Water District (Valley Water) MOU (A3812M) Amendment 2: Task Order 01: Safe, Clean Water and Natural Flood Protection Program: Priority D, Project D5 Coyote Creek Watershed Reassessment 2020

Submitted by: San Francisco Estuary Institute (SFEI)
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INTRODUCTION

The Safe, Clean Water and Natural Flood Protection Program (SCW) of the Santa Clara Valley Water District (Valley Water) has five priorities including restoring wildlife habitat and protecting open space (Priority D). The SCW Project D5 Ecological Data Collection and Analysis[1] creates a comprehensive watershed database that tracks stream ecosystem conditions helping Valley Water, other County agencies and organizations make informed watershed and asset management decisions. Valley Water collaborating with the San Francisco Estuary Institute – Aquatic Science Center (SFEI-ASC) for over a decade, recently completed the first baseline assessment of five major watersheds in Santa Clara County (Figure 1). In order of descending size, the watersheds are: the upper Pajaro River, Coyote Creek, Guadalupe River, Lower Peninsula, and West Valley watersheds. The D5 Project has two main objectives:

Objective 1: Establish the baseline profile of stream ecosystem conditions for each of the 5 major watersheds;

Objective 2: Reassess stream condition in the 5 major watersheds to determine if their ecological conditions are maintained or improved.

Stream ecosystem conditions are assessed using the United States Environmental Protection Agency's (USEPA) Level 1-2-3 approach[2]. Since 2010, with support from SFEI-ASC and field survey consultants, the D5 Project completed the first baseline assessment of each of these five watersheds, thus meeting Objective #1. The baseline assessments included characterizing the abundance and distribution of streams and wetlands (USEPA Level 1), and assessing the overall condition of streams in each watershed based on the California Rapid Assessment Method (CRAM 2008, USEPA Level 2). The five baseline watershed assessments and synthesis report are available on the D5 and SFEI-ASC internet sites. The focus of this report is on the Level 2 study design and sample draw for the first D5 reassessment of Coyote Creek watershed.

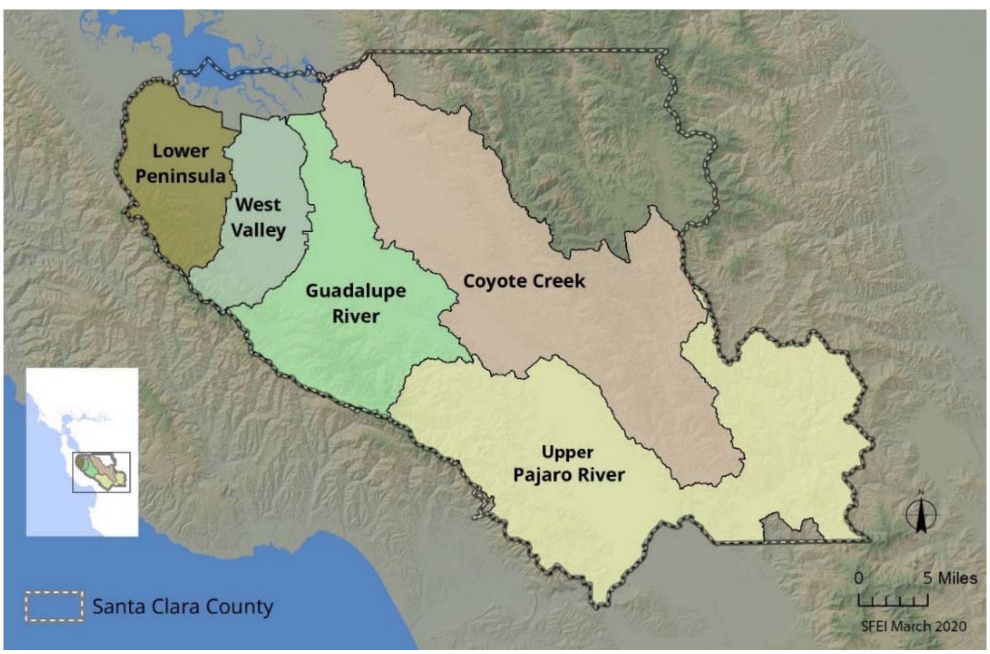

Figure 1. Map of Santa Clara County's five watersheds surveyed by the D5 Project

[1] https://www.valleywater.org/project-updates/d5-ecological-data-collection-and-analysis

[2] https://www.epa.gov/wetlands/wetlands-monitoring-and-assessment

Project D5's baseline assessments establish a monitoring and assessment framework for evaluating the performance of Valley Water's stewardship actions, such as protecting and restoring healthy riparian areas, floodplains, managing invasive plants, improving fish passage and spawning habitat, as well as capital flood projects, and maintenance to stabilize stream channels.

The D5 Project supports Valley Water's SCW One Water Plan[3]. Several of the One Water Objectives include performance targets that employ CRAM Riverine assessments for performance tracking (Objectives E, F, and G)[4]. Objective G (Resilient habitats and resources for native species) includes landscape-scale performance targets based on the D5 Project's ambient stream condition surveys.

To create a comprehensive watershed database to track stream ecosystem conditions for coordination across Valley Water Programs and projects, collaboration between Valley Water and its local stakeholders, and to support project monitoring and assessments at a regional scale, the D5 Project's results are publically available on the online EcoAtlas Information system[5]. The D5 ambient surveys also help determine the watershed profiles of stream condition needed by Valley Water to implement the new procedures[6] promulgated by the State Water Resources Control Board for siting and evaluating the performance of mitigation and restoration projects.

For more information about Valley Water's baseline watershed assessments and their utility in regional planning and performance tracking, please refer to the *Santa Clara County Five Watersheds Assessment: A synthesis of Ecological Data Collection and Analysis conducted by Valley Water* (Lowe *et al.* 2020)

Beginning with the Coyote Creek watershed in 2020, Project D5 will reassess streams in the five major watersheds after ten years to determine if conditions have been are maintained or improved over the last decade, and to prioritize and adjust stewardship actions in the context of climate and land use change. This will meet Objective #2 of the D5 Project.

This technical report describes the ten-year ambient stream condition reassessment survey design and monitoring plan (or *strategy*) for the Coyote Creek watershed. Because the reassessment will employ (*and modify)* the 2010 sample draw, essential background information about the original 2010 probability-based survey design, sample draw, and field assessment outcomes are provided. The design changes are intended to support Valley Water's current management priorities including the Stream Maintenance Program (SMP) and One Water Plan.

BACKGROUND: 2010 COYOTE CREEK WATERSHED SURVEY

All 5 of the ambient watershed stream condition assessments applied the USEPA's Generalized Random Tessellation Stratified (GRTS) survey design and analysis methods to measure overall ecological condition of streams in each watershed employing CRAM. GRTS is a probabilistic monitoring method designed to provide a statistically sound analysis of conditions for an entire watershed from a representative sample of watershed sites. CRAM generates condition scores based on standardized, semi-quantitative, visible field indicators that do not require the collection or processing of materials from the field, but use field measurements of key stream channel, riparian, and buffers. CRAM is a recommended "Level 2" i.e., (rapid) method of the Wetlands and Riparian Area Monitoring Plan (WRAMP)

[3] https://www.valleywater.org/your-water/one-water-plan

[4] https://onewaterplan.wordpress.com/measuring-progress/

[5] https://www.ecoatlas.org/about/#landscape-profile

[6] State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State (posted 05/14/19): https://www.waterboards.ca.gov/water_issues/programs/cwa401/docs/procedures_conformed.pdf

of the Wetland Monitoring Workgroup of the CA Water Quality Monitoring Council (CWMW 2010). The United States Army Corps of Engineers (USACE) encourages using CRAM to assess impacts and design mitigation[7].

The 2010 ambient stream condition survey in the Coyote Creek watershed employed the CRAM Riverine Field Book (CRAM Module v5.0.2) to assess the ecological condition of streams in two sampling strata within the watershed: 1) the entire Coyote Creek watershed; and 2) the Upper Penitencia subwatershed. Besides contributing to the Coyote Creek watershed assessment as a whole, the Upper Penitencia stratum served as an area of interest (comprised of 30 CRAM sites) that established a separate baseline stream condition assessment to support Valley Water's Asset Management Program (AMP).

GRTS employs the R programing package *spsurvey* that includes sample design, sample draw, and data analysis tools for both linear (e.g., streams) and area (e.g., wetlands, lakes) resources. *Spsurvey* sample draw inputs include a sample frame, which is a geographic information system (GIS) dataset or shapefile of the stream, wetland or lacustrine resource to be sampled, and the design parameters, such as the number of target sites, oversample sites, and strata included in the survey design. The *spsurvey* analysis outputs consist of cumulative distribution function (CDF) estimates, plots, and percentile tables. For more information about GRTS and *spsurvey* please refer to the online documentation[8].

2010 Survey Design and Sample Draw

Below are the original input parameters of the 2010 Coyote Creek Watershed sample draw. They are included in this report because this information is important for the analysis phase of any subsequent watershed surveys that employ the original sample draw.

The draw was an "*Unequal Stratified GRTS Sample Draw*" that included two strata (i.e., Upper Penitencia subwatershed and the rest of the Coyote Creek watershed) and allocated sites across multiple stream orders (Strahler 1957):

Sample Frame: Coyote Creek fluvial stream network, Strahler stream orders 2-7, of the Bay Area Aquatic Resources Inventory (BAARI) Geographic Information System (GIS) data
Input Projection = Geographic Coordinate System (GCS); Datum = GCS North American Datum (NAD) 83
Survey Design = GRTS
Resource Type = Lines
Target Sample Draw Size = 76 total
Oversample = 3x
Panels = 1
Strata = 2 regions[9] (Coyote Creek watershed not including Upper Penitencia = COY, and Upper Penitencia subwatershed = UP)
Multi-density Categories (mdcaty) = 6 : Based on six Strahler stream orders (2-7) as mapped in BAARI v0, the following number of sites were 'requested' for each stream order[10]:
COY stream order reaches: n=46

[7] https://www.spk.usace.army.mil/Media/Regulatory-Public-Notices/Article/479440/spk-2012-00005-cram/ and https://www.spd.usace.army.mil/Portals/13/docs/regulatory/mitigation/MitMon.pdf

[8] https://CRAN.R-project.org/package=*spsurvey*; *https://archive.epa.gov/nheerl/arm/web/html/userguide.html*

[9] The whole Coyote Creek Watershed is comprised of both regions (COY + UP).

[10] Note: *mdcaty* is used in unequal probability sample draws. It disproportionally allocates more (or fewer) sites to the various stream orders than might be proportionally allocated in an equal probability sample draw based on stream length. The sample draw output may not match the requested inputs because of the spatial balance and random nature of the underlying calculations.

"2"=20, "3"=12, "4"=6, "5"=3, "6"=2, "7"=3
UP stream order reaches: n=30
"2"=13, "3"=6, "4"=3, "5"=8

Table 1 summarizes the GRTS design input parameters and outputs for the 2010 sample draw. It includes the requested number of target sites by stratum and Strahler stream order, and the final sample draw outputs for the 76 target sites. Oversample sites, used as replacements for target sites, are not included in Table 1 because they do not contribute to the initial sample draw weights. This information is necessary to adjust the final sample weights prior to data analysis for any survey that employs the 2010 sample draw. Figure 2 shows the distribution of the target 76 sites from the 2010 sample draw color coded by Strahler stream order.

Table 1. Initial number of sites ‘requested’ in the 2010 Coyote Creek GRTS survey sample draw by Stratum and Strahler stream order, and the final number of sites from the sample draw output for the target sites. Strata: COY = Coyote Creek watershed not including UP, and UP = Upper Penitencia subwatershed

Stratum and Steam Order	Number of Target Sites Requested in Original Sample Draw	Number of Target Sites in Sample Draw Output	Original Sample Weight (meters)	Total Sample Weight by Region (Strata) and Stream Order (meters)*
COY	**46**	**46**		**935,290 (92%)**
2	20	19	20,679	413,573
3	12	10	20,275	243,300
4	6	10	20,582	123,489
5	3	2	20,624	61,872
6	2	2	20,703	41,407
7	3	3	17,216	51,649
UP	**30**	**30**		**75,961 (8%)**
2	13	12	2,495	32,434
3	6	2	2,520	15,119
4	3	6	2,464	7,391
5	8	10	2,627	21,017
Total	**76**	**76**		**1,011,251**

* Original Sample Weight x Number of Sites Requested in Original Design (matches the BAARI GIS sample frame stream length)

Each site has a sample weight that represents a portion of the original sample frame. The Coyote Creek watershed ambient stream condition survey sample weights represent a portion of the BAARI GIS stream network by stratum and Strahler stream order (in meters). The number of target sites requested in the original sample draw, for each stratum and stream order, times the corresponding sample weight will equal the total length of stream network by stratum and stream order in the original sample frame (see Table 1). Prior to generating the CDF estimates, which are the main analysis outputs of the GRTS *spsurvey* package, sample weights are adjusted based on the site review and final outcome of the field assessments.

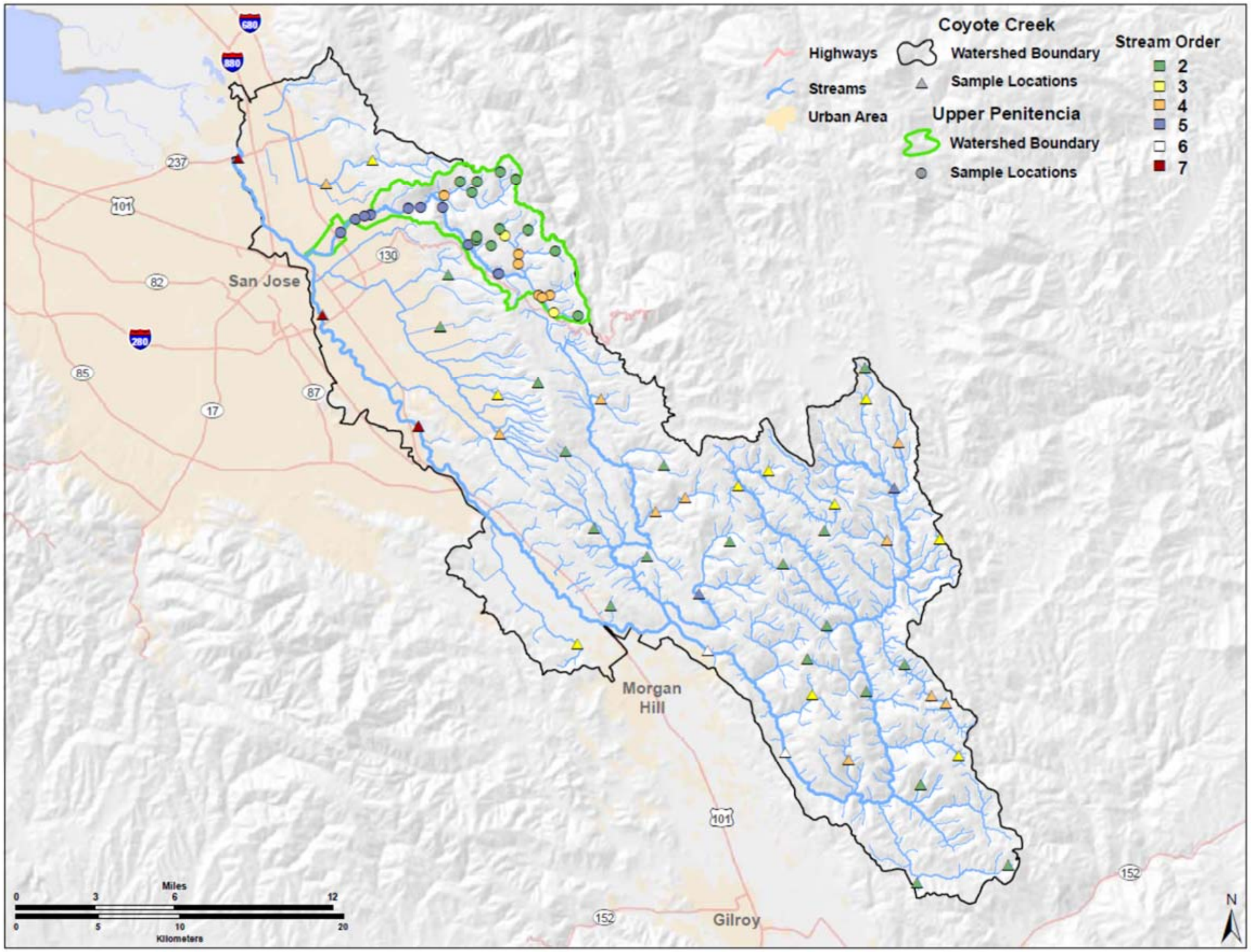

Figure 2. Distribution of the 2010 Coyote Creek watershed stream condition survey's target sites from the sample draw (n=76) color coded by Strahler stream order. The Upper Penitencia subwatershed (green watershed boundary) was a separate stratum in the sample draw with a higher density of sites per stream length to support a separate watershed assessment of that tributary (n=30).

Each site from a GRTS sample draw has a sample weight that represents a portion of the original sample frame (i.e., stream length, or area of a wetland or lake). For the D5 Project's Coyote Creek watershed ambient stream condition surveys, sample weights represent a portion of the stream network by stratum and Strahler stream order 2 and higher (in meters). The number of target sites requested in the survey design inputs, for each stratum and stream order, times the corresponding sample weight will equal the total length of stream network (in meters) by stratum and stream order in the original sample frame (see Table 1, above). Prior to generating the CDF estimates, which are the main analysis outputs of the GRTS *spsurvey* package, sample weights are adjusted based on the site review and final outcome of the field assessments.

Review of Candidate Sites and Final Outcome of the 2010 Stream Condition Survey

GRTS surveys are ideally carried out by sampling sites in sequential order (i.e., in the numerical order they are drawn from the sample frame), which maintains the spatial balance and distribution of sites across the study area. However, in practice, field surveys are often unsuccessful at sampling all the target sites in a sample draw in sequential order, due to site misclassification or inaccessibility. The review of candidate sites for accessibility and the landowner permission process often results in dropping a portion of the target sites and replacing them with oversample sites.

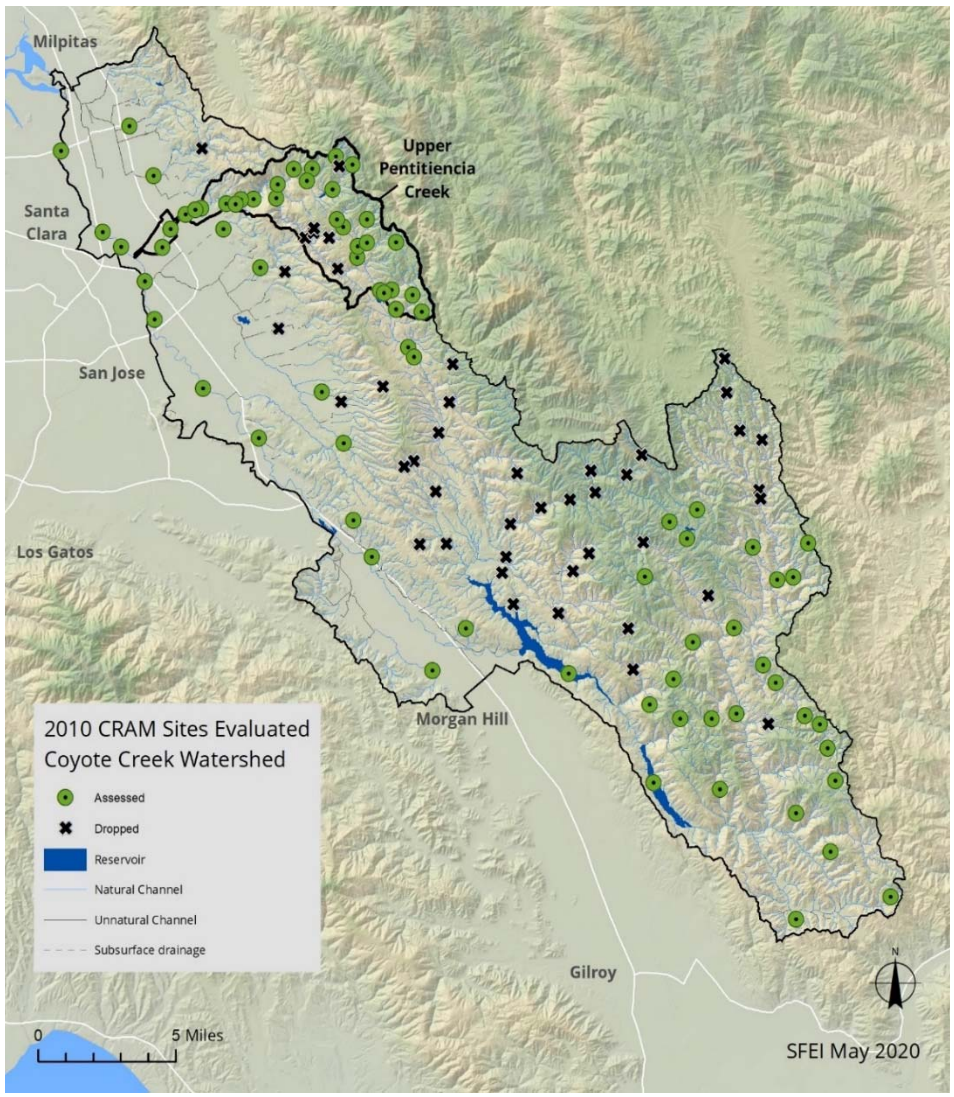

Figure 3. The distribution of the candidate sites that were reviewed and assessed for the 2010 Coyote Creek watershed baseline stream condition survey. The green dots indicate sites that were successfully assessed (n=77), and black X's indicate the sites that were dropped and replaced by oversample sites (n=45).

The final outcome of the 2010 ambient stream condition survey of Coyote Creek watershed site review and field assessments resulted in 122 candidate sites being reviewed in sequential order (Figure 3). CRAM field teams successfully assessed 77 sites across the entire watershed (30 sites in the Upper Penitencia sub watershed and 47 sites across the rest of the Coyote Creek watershed). 45 sites were dropped because they were not accessible (18), access was denied (21); they were too unsafe to assess (5), or the site was misclassified (1).[11]

Table 2 lists the final number of candidate sites that were reviewed, dropped[12], and successfully assessed in the 2010 baseline stream condition survey. The final adjusted sample weights were calculated based on the outcome of the site reviews and final field results and used in the data analysis phase to generate the CDFs presented in the D5 Project's synthesis report: *Santa Clara County Five Watersheds Assessment: A synthesis of Ecological Data Collection and Analysis conducted by Valley Water* (March 2020)[13], which combined the GRTS ambient survey results from all five watersheds to summarize and compare the overall conditions of streams among watersheds, subregions, ecoregions, and statewide.

Table 2. Number of sites and their final adjusted sample weights for the 2010 Coyote Creek watershed baseline stream condition survey. Strata: COY = Coyote Creek watershed not including UP, and UP = Upper Penitencia subwatershed

Stratum and Steam Order	Number of Dropped Sites	Number of Dropped Non-Target Sites	Non-Target Sample Weight (meters)	Number of Sampled Sites	Final Adj. Sample Weight (meters)	Total Number of Sites (Evaluated and Dropped + Sampled)	Total Final Adj. Sample Weight (meters)*
COY	**37**	**1**	**11,488**	**47**		**85**	**923,802 (92%)**
2	18	1	11,488	17	23,652	36	402,085
3	9			12	20,275	21	243,300
4	5			9	13,721	14	123,489
5	5			1	61,872	6	61,872
6				2	20,703	2	41,407
7				6	8,608	6	51,649
UP	**7**			**30**		**37**	**75,961 (8%)**
2	4			10	3,243	14	32,434
3				4	3,780	4	15,119
4				6	1,232	6	7,391
5	3			10	2,102	13	21,017
Total	**44**	**1**	**11,488**	**77**		**122**	**999,763**

* (Final Adj. Sample Weight x Number of Sampled Sites) - Non-Target Sample Weight = the BAARI GIS sample frame stream length - the stream length represented by the Non-Target site

2010 Baseline Ambient Survey Results

The final report for the 2010 Coyote Creek Stream Ecosystem Condition Profile Report[14] is available online. It briefly summarizes the CRAM ambient stream condition survey results and compares the Coyote Creek watershed (as a

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[11] The location was not a stream and therefore did not meet the definition of the target population defined by CRAM.

[12] The one non-target site (which was not an acceptable stream site to assess using the CRAM Riverine module), is included in the table because it has a separate sample weight that factors into the final adjusted sample weights.

[13] Link to the D5 Project webpage that includes downloadable copies of the individual watershed and synthesis reports: https://www.valleywater.org/project-updates/d5-ecological-data-collection-and-analysis

[14] EOA & San Francisco Estuary Institute. March 2011. Ecological Monitoring & Assessment Framework: Stream Ecosystem Condition Profile: Coyote Creek Watershed Including the Upper Penitencia Creek Subwatershed. Final Technical Report #2. Prepared for the Santa Clara Valley Water District by EOA, Inc. and the San Francisco Estuary Institute. Oakland, CA. p 109. https://www.sfei.org/documents/ecological-monitoring-assessment-framework-stream-ecosystem-condition-profile-coyote-creek

whole) to the Upper Penitencia subwatershed. In general, the overall ecological condition of streams within the two watersheds were similar (Figure 4).

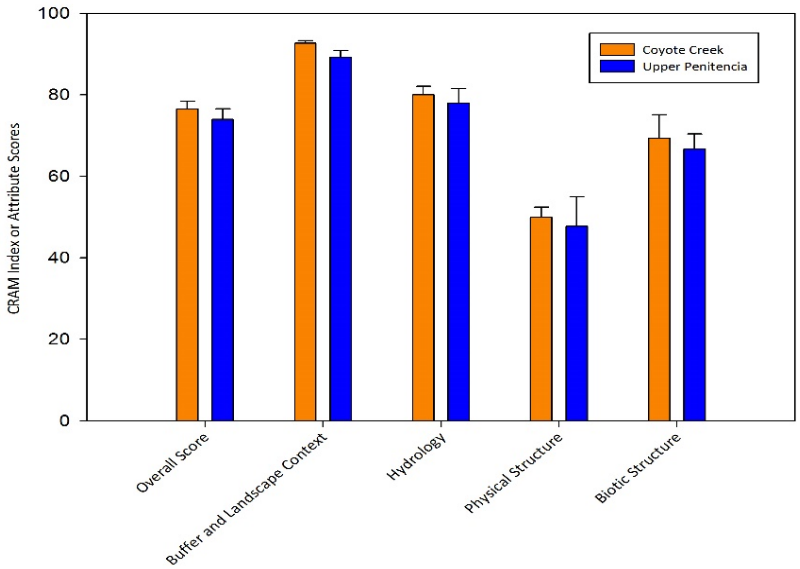

Figure 4. CRAM Overall Score (or Index Score) and Attribute Scores for the 2010 ambient survey of streams in the Coyote Creek watershed (orange bars, n=77) and the Upper Penitencia subwatershed (blue bars, n=30). Each bar represents the 50th percentile (median) of stream miles, based on the corresponding cumulative distribution function (CDF) estimates. Error bars are the upper 95% confidence intervals for the 50th percentile scores.

SYNTHESIS OF THE D5 PROJECT'S FIVE WATERSHED ASSESSMENTS

The D5 Project has synthesized an overall watershed condition report for Santa Clara County based on the five ambient watershed assessments completed since 2010 for Coyote Creek, Guadalupe River, Upper Pajaro River, Lower Peninsula, West Valley watersheds.[15] The synthesis report compares these watershed to each other and to watersheds in other ecoregions and statewide, based on the abundance and condition of streams, and the abundance and diversity of other wetlands types.

Figure 5 shows the final distribution of CRAM sites and overall ecological condition of the first baseline stream assessments completed for all five watersheds, color-coded by their condition class. The three spatial strata were employed in the D5 Project's synthesis report to characterize differences in stream condition between major land use categories: 1) developed *Lowland Valley* that generally identifies the edge of urban development and agriculture; 2) less developed *Foothills* located between the Lowland Valley and the Valley Water Stream Maintenance Program (SMP) 1,000 ft. boundary[16]; and 3) *Headwaters* of largely undeveloped areas upstream of the SMP boundary.

The D5 Project's use of CRAM and EcoAtlas supports coordination across Valley Water programs, collaboration with local watershed stewardship partners, and the watershed approach features in the new State guidelines for mitigation planning and assessment. TheD5 Project intends to characterize the overall distribution, abundance, diversity and ecological conditions of streams and other aquatic resources of each of the five major watersheds in Santa Clara County once every 10 years. These assessments are likely to focus on the Lowland Valley and Foothills

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[15] Link to the Valley Water D5 Project webpage that includes downloadable copies of the individual watershed reports and the combined synthesis report: https://www.valleywater.org/project-updates/d5-ecological-data-collection-and-analysis

[16] Valley Water's SMP works to improve the environment, reduce the risk of flooding and keep communities safe. The SMP actively manages streams below the 1,000-foot elevation contour throughout the County.

areas to better assess the performance of resource management activities within the SMP's management area, while maintaining the ability to assess the overall condition of streams at the watershed scale.

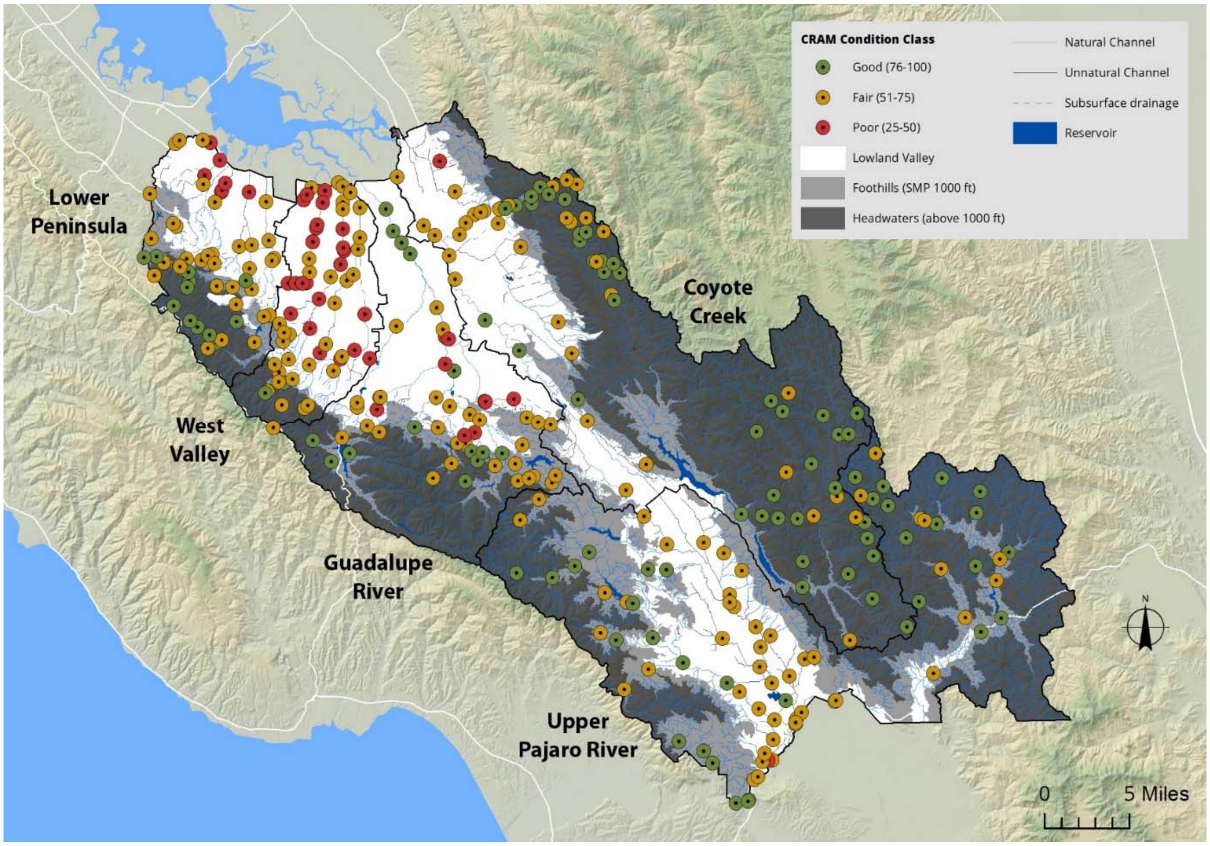

Figure 5. Distribution of CRAM sites for the baseline stream condition surveys in the five major watersheds of Santa Clara County. The sites are color-coded by their condition class based on their CRAM Index Score. Red= poor condition (scores 25-50); yellow = fair condition (scores 51-75); green = good condition (scores 76-100).

2020 CRAM Stream Condition Reassessment Strategy

The 2020 Coyote Creek watershed reassessment is designed to meet the two D5 Project objectives (see page 1), while improving support for the SMP and One Water, by helping to consistently assess the overall condition of streams based on CRAM. The project team consulted with Tony Olsen[17] to develop the following approach for reassessing the Coyote Creek watershed in 2020.

Survey Design

The 2020 reassessment survey design reconfigures the original 2010 sample draw strata into two new analytical strata: the Headwaters, and the SMP Area. In other words, the Lowland Valley and Foothills strata of the synthesis report are being combine into a single stratum. A subset of the sites will be the original sites to assess local change,

[17] USEPA's lead GRTS developer and statistician with USEPA's Monitoring Design and Analysis Team at the National Health and Environmental Effects Research Laboratory (Western Ecology Division in Corvallis, Oregon)

and new sites will be added to 1) fill in the spatial gaps in the Headwaters (we hope to assess some of the dropped sites in the 2010 field survey (see Figure 4), and 2) increase the number of sites in the SMP Area.

Table 3 lists the number of sites assessed, final adjusted sample weights, and stream lengths (in meters) from the 2010 baseline ambient stream condition survey, grouped by the original 2010 strata and stream orders, and by the proposed 2020 strata. Of the 77 sites successfully assessed across the watershed, 49 sites were located in the Headwaters, and 28 sites in the SMP Area.

Table 3. Number of CRAM sites assessed and their final adjusted sample weights for the 2010 Coyote Creek watershed stream condition survey redistributed between the two proposed 2020 strata: (1) Headwaters, and (2) the combined Lowland Valley and Foothills)i.e., the SMP Area).. The percent contribution to total stream length, by stratum, are listed in parentheses. COY = Coyote Creek watershed not including UP, and UP = Upper Penitencia subwatershed.

Stratum and Stream Order	Number of Sites Assessed in 2010			Final 2010 Sample Weight*	Estimated Stream Length (meters)		
	Headwaters	SMP Area	Total		Headwaters	SMP Area	Total
COY	**28**	**19**	**47**		**624,006 (92%)**	**299,796 (94%)**	**923,802 (92%)**
2	16	1	17	23,652	378,433	23,652	402,085
3	5	7	12	20,275	101,375	141,925	243,300
4	6	3	9	13,721	82,326	41,163	123,489
5	1		1	61,872	61,872	0	61,872
6		2	2	20,703	0	41,407	41,407
7		6	6	8,608	0	51,649	51,649
UP	**21**	**9**	**30**		**57,045 (8%)**	**18,916 (6%)**	**75,961 (8%)**
2	10		10	3,243	32,434	0	32,434
3	4		4	3,780	15,119	0	15,119
4	6		6	1,232	7,391	0	7,391
5	1	9	10	2,102	2,102	18,916	21,017
Total	**49**	**28**	**77**		**681,051 (68%)**	**318,711 (32%)**	**999,763 (100%)**

* Final adjusted sample weights; when multiplied by the total number of sites assessed estimates stream length (in meters)

The 2020 reassessment will survey the Upper Penitencia Creek subwatershed as part of the Coyote Creek watershed as a whole. Specifically, the number of sites will be proportionally allocated to Upper Penitencia based on the amount of stream miles it contributes to the watershed as a whole. Table 3 shows that the Upper Penitencia subwatershed contributes 8% of stream miles to the whole Coyote Creek Watershed, and streams in the Headwaters contribute 8%, and SMP Area contribute 6%, respectively). For example, if we are targeting a total of 30 sites in the Headwaters then 8% of 30 is 2.4 and (rounding up) that means that 3 of the 30 sites will be assessed in the Upper Penitencia Headwaters. Similarly, 6% of 47 target sites in the SMP Area is 2.84 or 3 sites of the 47 will be assessed in the Upper Penitencia subwatershed SMP Area.

To further inform the allocation of sites between strata, a power analysis was conducted to evaluate sample size, using the standard deviation for the population mean CRAM Index Score estimates[18] from the 2010 baseline survey,

[18] Specifically, we use the standard deviation from the *population mean* from the *spsurvey cont.analysis* function output ('Pct' table). For more information See: https://archive.epa.gov/nheerl/arm/web/html/userguide.html

and employing an online statistical application developed by Russ Lenth at the University of Iowa[19]. Two-sample and one-sample t-tests were run at different power levels representing the worst-case (unpaired sites) and best-case (all paired sites) analysis scenarios for the two strata to be sampled in 2020 (SMP Area and Headwaters). The worst-case, two-sample t-test (unpaired sites) scenario means that none of the 2020 sites would be revisit sites of the 2010 survey. The best-case, one-sample t-test (all paired sites) scenario means that all the 2020 sites would be revisit sites of the 2010 survey.

Table 4 presents the sample size results at four different power levels. The input parameters for each t-test included the empirical standard deviation of the population mean from the 2010 survey (Headwaters = 6, and Lowland Valley and Foothills = 12), an estimated difference in the means (or effect size) of 7 CRAM points[20], and a two-tailed Alpha level of 0.1.

The worst-case, two-sample t-test results showed that a sample size of 51 sites in the SMP Area would provide 90% power to detect a 7 point difference in the mean population estimate (alpha = 0.1 and standard deviation = 12), while the best-case, one-sample t-test indicated that only 27 sites would be needed to achieve the same power level as long as all the sites were paired. The power analysis results for the Headwaters suggest that far fewer sites would be needed for the Headwaters than the SMP Area (alpha = 0.1 and standard deviation = 6).

Table 4. Sample size estimates based on two-sample and one-sample t-tests at different power levels for the two strata to be surveyed in the 2020 Coyote Creek watershed reassessment. Tests represent the worst-case (unpaired sites) and best-case (all paired sites) scenarios.

Power Level	SMP Area		Headwaters	
	Two-sample t-test (unpaired sites)	One-sample t-test (paired sites)	Two-sample t-test (unpaired sites)	One-sample t-test (paired sites)
0.9	51	27	13	8
0.8	37	20	10	6
0.7	28	15	8	5
0.6	22	12	6	4

The power analysis indicated that reducing the number of sites in the Headwaters in order to add more sites to the SMP Area would not significantly reduce the power to detect a 7 point change in the population mean CRAM Index Score for the Headwaters stratum.

Based on design changes made by the project team, the results of the power analyses, and the fact that Valley Water wants to increase the number of sites within the SMP Area, the project team decided to allocate 47 target sites to the SMP Area, and 30 target sites to the Headwaters, for a total of 77 target sites across the whole watershed. The estimated margin of error[21] with this distribution of sites is expected to be ±3.5 for the SMP Area, and ±2.2 for the Headwaters.

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[19] Website: Russ Lenth – Department of Statistics and Actuarial Science – University of Iowa Java Script Applet at: http://homepage.divms.uiowa.edu/~rlenth/Power/#download

[20] A difference of 7 CRAM points was selected because that is the estimated precision for CRAM Index Scores. Data Quality Assurance Plan for CRAM, California Wetland Monitoring Workgroup, version 7; October 2018 at: https://www.cramwetlands.org/sites/default/files/CRAM%20data%20QA%20plan%20v7-2018.10.pdf

[21] Employing the confidence interval 'CI around a mean' tool from the Russ Lenth Java applet (http://homepage.divms.uiowa.edu/~rlenth/Power/#download) and based on the standard deviations from the 2010 population mean estimate and confidence level (alpha) of 0.90.

Monitoring Plan

The 2020 Coyote Creek watershed stream condition reassessment survey will begin field assessments in the summer of 2020. CRAM field teams will assess 77 sites in streams across the watershed (30 in the Headwaters and 47 in the SMP Area). Table 5 shows the distribution of sites between the 2010 and 2020 strata. As mentioned above, the number of target sites allocated to the Upper Penitencia subwatershed (original stratum from the original 2010 sample draw) is proportional to the amount of stream miles it contributes to the watershed as a whole (see Table 3).

Table 5. Number of sites to assess in the 2020 Coyote Creek watershed reassessment by the new strata and from the original sample draw.

Subregion	COY*	UP*	Total
Headwaters	27	3	**30**
Lowland Valley & Foothills	44	3	**47**
Total Watershed	**71**	**6**	**77**

An Excel and KMZ file of the Coyote Creek sample draw sites were submitted to Valley Water to support the 2020 Coyote Creek Watershed Reassessment (see Appendix A for more information). The project team will review the 2020 candidate sites in sequential order (i.e. in the numerical order in which they were drawn from the sample frame while considering the new strata), including any of the dropped sites from the 2010 survey (Figure 6). The physical, safe accessibility of each candidate site will be determined. If the site is physically accessible, then written permission will be requested from the property owners before any assessment of the site is attempted.

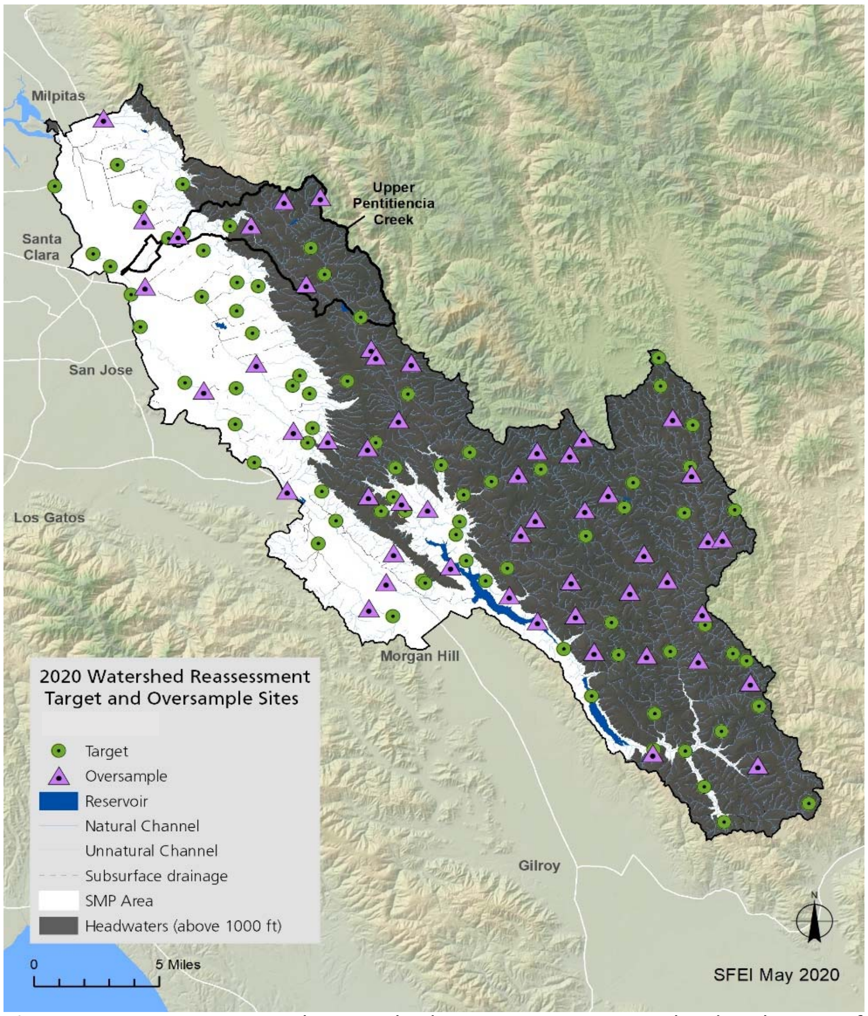

Figure 6. 2020 Coyote Creek watershed reassessment sites. The distribution of candidate sites to be reviewed for the 2020 Coyote Creek watershed stream condition reassessment survey. The green dots indicate target sites (n=77), and purple triangles indicate a subset of the available candidate replacement

The sampling approach is to revisit as many 2010 sites as possible (in their sequential order) until the target number of assessed sites in each stratum is reached (see Table 5). Because we are reducing the total number of sites assessed in the

Headwaters, we expect that most of the 2010 Headwater sites will be revisited. In contrast, since we are increasing the number of assessments in the SMP Area, many sites in that stratum will be new. Appendix B includes a flow chart and step-by-step guidance for correct placement of the CRAM assessment area for revisited and new sites.

We expect that some sites will be dropped due to access issues and thereafter replaced with oversample sites. The reason for dropping a site will be reported to the project team, and used in the final sample weight adjustments. To identify the next available oversample site, the logistics team will evaluate the next site in the list that has the *same stratum and stream order* as the dropped site. The field work will be complete when the field teams have successfully sampled the target number of assessments (total 77; 47 in the SMP Area, and 30 in the Headwaters).

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Appendix A – Files Submitted to Support the 2020 Coyote Creek Watershed Stream Condition Reassessment Survey

An Excel and KMZ file were submitted to the Valley Water D5 Project leads to support the 2020 Coyote Creek Watershed Reassessment. The files included the following information:

Excel File: "Coyote Creek_2020 Site Evaluation Tracking_v4 submitted.xlsx".

1. **Original 2010 sample draw with SiteID in the format reported in eCRAM (n=304)**. This TAB (*"ALL Orig Smpl Draw & 2010 Stat"*) is both an archive of key information from the original draw and a record of the outcome of the site evaluations completed for the 2010 baseline survey (indicating if the site was sampled or not, and reasons why sites were dropped). As mentioned above, key information from the original sample draw is used to adjust the final sample weights in the data analysis phase of an ambient survey.

   Sites that were successfully assessed in 2010 include additional information including the eCRAM latitude and longitude (the centroid location of the CRAM Riverine v5.0.2 assessment area polygon entered into the eCRAM database - www.cramwetlands.org), field Practitioner comments (if reported), and additional notes that may be helpful to the 2020 logistics team when reviewing candidate sites. The 2010 field Practitioners often included important information regarding access to a site or having to move the site away from the original target location following pre-established guidelines for how to place the CRAM assessment area.

2. The first two tabs in the Excel file are subset of the Original 2010 Sample Draw. They include a total of 128 *candidate* sites that will be initially evaluated by the 2020 logistics team. They are split into two separate tabs because they represent 2010 revisit sites and previously unsampled sites. The two kinds of sites have different latitudes and longitudes: revisit sites show the eCRAM centroid locations because field teams will use the same assessment area polygon to complete the 2020 survey; the previously unsampled site latitudes and longitudes indicate the downstream location to place the CRAM assessment area. (The graphical information system (GIS) support team who will help the logistics team identify property ownership surrounding the sites will handle the location information for the two kinds of sites differently as will the field teams.)

The logistics team will use the Excel file to track and report on their candidate site evaluation outcomes noting sites that are successfully sampled and sites that are dropped. The team will document the reason for dropping candidate sites using the choices provided in the spreadsheet (or new ones, only if warranted) and select a candidate replacement site. To select a replacement site (oversample site) go to the next available site (in sequential order of the SiteID) that has the same sample weight category "SmplWgtCat_OrigDraw" as the dropped site. This is an important step as it will make the final sample weight adjustments easier during the data analysis phase.

A KMZ file: Coyote Creek Sample Draw KMZ_for CRAM Stream Survey 2020_v1.kmz

The Google Earth KMZ file was provided to support the site evaluation process and development of CRAM field packets. The KMZ includes

1. D5 watershed boundaries (all five watersheds and PAIs a draft I used when developing the synthesis report)
2. Coyote Creek 2010 original sample frame (BAARI stream orders 2-7) from the original 2010 sample draw
3. CRAM sites (points) that match the Excel file lat/longs.

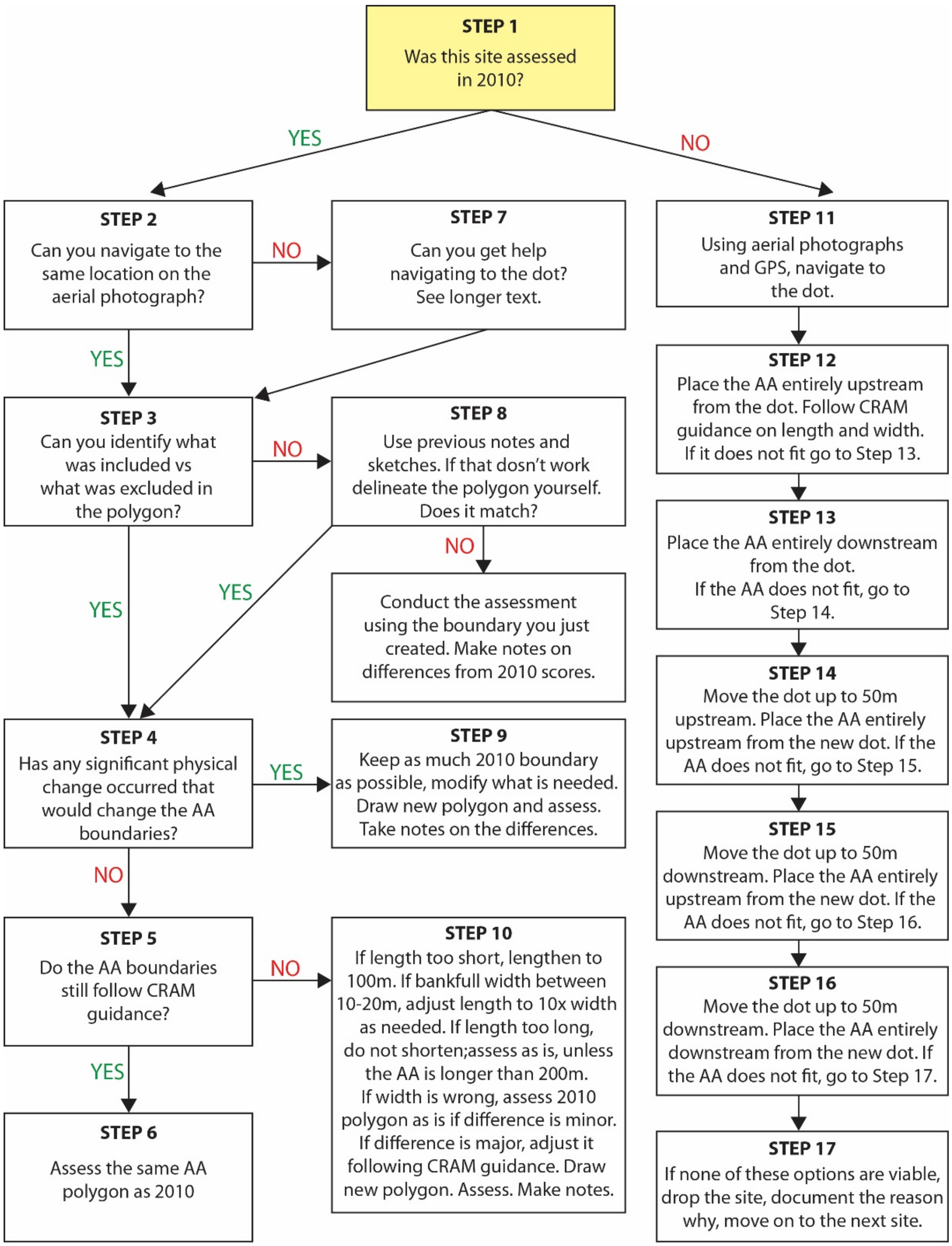
   There are several ways to view the sites:

   a. Lat/Longs from the entire original 2010 sample draw (n=304) - white dots with Site_ID visible
   b. eCRAM centroid Lat./Long. for the 2010 sites that were successfully assessed (n=77) - green droplets
   c. eCRAM assessment area polygons for the 2010 sites that were successfully assessed (n=77) in red[22].
   d. Lat/Longs of the sites that were evaluated but dropped in 2010 (n=45) - red droplets with a letter indicating the reason the site was dropped:
      i. L = landowner denied
      ii. A = no access (no way to reach the site)
      iii. N = non-target site (only 1 not on a stream)
      iv. S = safety issues

[22] Note that one polygon (UP-190) was accidentally mapped in the wrong location. So, if field teams go back to that site, they will want to go to the original sample draw lat/long and place one end of the AA at the waterfall (this site is colored red in the excel spreadsheet with notes).

Appendix B – Draft Field Guidance for Placing CRAM Assessment Areas

The following flowchart and step-by-step guidance was drafted to help field teams consistently and correctly place the CRAM Riverine assessment areas (AAs) for both revisit and new sites in the 2020 Coyote Creek watershed stream condition reassessment survey. These methods will be field tested and may be revised with a final version included in the final Coyote Creek watershed reassessment report.



Supporting Step-by-Step Guidance:

Step 1: Was this site assessed in 2010? If yes, go to Step 2. If no, go to Step 11.

Step 2: This site was assessed in 2010. Look at the AA polygon on the aerial photograph. Can you navigate to this same location? If yes, continue to Step 3. If no, go to Step 7.

Step 3: Can you identify what is included within the polygon versus what was excluded? If yes, continue to Step 4. If no, go to Step 8.

Step 4: Has any significant physical change occurred (e.g. stream meander, landslide, bank revetment/lay back, floodplain creation) that would change the AA boundaries? If no, continue to Step 5. If yes, go to Step 9.

Step 5: Do the AA boundaries as drawn still follow guidance in the CRAM field book for how to set up an AA (including the channel, the active floodplain, and any essential riparian area)? If yes, continue to Step 6. If no, go to Step 10.

Step 6: Assess the same AA polygon as was assessed in 2010.

Step 7: You are unable to navigate to the 2010 polygon. Are you physically unable to get there? Is there another way to try? Can the landowner provide any advice? Are you having difficulty with the GPS signal? If so, are you able to navigate via the aerial photograph and estimating distances? Is it a safety hazard? If so, stop- remain safe.

In the Lowland Valley, you should be able to navigate via landmarks, fence lines, or individual trees. Turn on maps on your phone to help show you where you are. However, if you are in the remote parts of the upper watershed and under thick canopy cover, sometimes navigation can be tricky. If you can't get out of the canopy to get signal, use the topographic maps to help locate yourself using tributaries, bends in the creek, compass directions indicating the direction that the creek is flowing, etc. Are the 2010 field photographs helpful? Try your best to replicate the 2010 polygon. In these situations the creek corridor is typically fairly homogenous, and small differences of 10-20m in location likely will not cause a difference in the score. Do the best that you can. Go to Step 3. If you are completely unable to get to the polygon, go back to the office and talk it through with Doug.

Step 8: You are having trouble identifying what is included in the 2010 AA polygon. Does the previous site packet have any notes, sketches, or plant lists that will help? Following the established CRAM guidance for setting up an AA, decide for yourself what should be included in the polygon. Does this then match the polygon boundaries? If yes, go to Step 4. If no, continue on conducting the assessment utilizing the AA boundaries that you just defined and drew. Check in with the 2010 assessment for each metric to see if/how scores might be different. Make notes on the differences and the reason(s) why. To confirm, go Step 4 to see if physical change has occurred.

Step 9: Physical change has occurred at the site since 2010. Keep as much of the 2010 boundary as possible (that follows the CRAM guidance on setting up AAs), but modify the AA polygon as needed to represent the current conditions on the ground. Draw a new polygon. Make notes on what/where has changed. Begin your assessment.

Step 10: The boundaries of the 2010 AA polygon do not follow the CRAM guidance on how to set up an AA. Is the length wrong? If the 2010 AA is less than 100m (and bankfull width is less than 10m), automatically increase the length to 100m, redraw the polygon, assess the new polygon, and make notes. If the 2010 AA should have been between 100-200m (based upon bankfull width), but it seems like the practitioners made a mistake, then lengthen the AA to the appropriate length, redraw the polygon, assess the new polygon, and make notes. If the 2010 AA was too long, do NOT shorten the AA; instead assess using the 2010 polygon as drawn. Make notes. If the 2010 AA is longer than 200m, shorten the AA to 200m, redraw the polygon, assess the new polygon, and make notes.

Is the width wrong? In general, we want to default to assessing the 2010 polygon as closely as possible. However, the practitioners could have made a very egregious error in the width. If the width is only "wrong" by a little bit (e.g. a single tree width), assess the 2010 polygon as is, but make notes on how you think the polygon should change. If the width is very much wrong (e.g. they did or did not include the active floodplain), draw a new AA following the CRAM guidance, and assess it, making lots of notes about how the score has changed due to the new polygon. Try to only adjust the width if absolutely necessary.

Step 11: This site was NOT assessed in 2010. Using aerial photographs and GPS, navigate to the dot for this assessment provided by the sample draw. Continue to Step 12.

Step 12: Using the dot as the downstream boundary for the AA, place the AA entirely upstream from the dot. Follow the CRAM guidance for total length of the AA (10x bankfull width, within the bounds of 100-200m), and for the lateral boundaries (include the channel, the active floodplain, and any essential riparian area). Draw the AA boundary, and continue with your assessment. If the AA does not fit, go to Step 13.

Step 13: If the AA does not fit entirely upstream of the dot (a significant tributary confluence exists, a feature that controls the flow of water or sediment exists, a channel constriction, a major change in gradient, a major change in confinement, the channel goes underground, a major change in channel character (e.g. entirely forested to entirely clearcut), etc.) place the AA entirely downstream from the dot, with the dot defining the upstream boundary. If the AA does not fit, go to Step 14.

Step 14: If the AA does not fit entirely downstream of the dot, then move the dot up to 50m upstream, and place the AA upstream from the new dot. If the AA does not fit, go to Step 15.

Step 15: If this does not work, then move the dot downstream up to 50m, and place the AA upstream from the new dot. If the AA does not fit, go to Step 16.

Step 16: If this does not work, then move the dot downstream up to 50m, and place the AA downstream from the new dot. If the AA does not fit, go to Step 17.

Step 17: If none of these options are viable, drop the site, document the reason why, and move on to the next site that is prepared for assessment.