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West Valley Watershed Assessment 2018:

Baseline Ecological Condition Assessment of Southwest San Francisco Bay Creeks in Santa Clara County; Calabazas, San Tomas Aquino, Saratoga, Sunnyvale East and West

Report prepared for the **Santa Clara Valley Water District**
Safe, Clean Water and Natural Flood Protection Program
Ecological Data Collection and Analysis Project (Priority D5)

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SCVWD Agreement #A4077F (CAS# 4802)
SFEI- ASC Project #4097 Task 004
SFEI Contribution #944

Date: May 2019

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Acknowledgements: This project was made possible by a collaborative team effort with the Santa Clara Valley Water District (Valley Water) staff and its consultants. We would like to acknowledge funding from Valley Water's Safe, Clean Water and Natural Flood Protection Program Priority D5 Project, and work by lead unit manager Lisa Porcella with staff who contributed significantly to this watershed assessment: Clayton Leal, Shawn Lockwood, Jennifer Watson, Zooey Diggory, Jessica Blakely, John Chapman, Chris Pilson, Suzanne Remien, Chris Van Amburg, and Jeff Lewis. Michael Baker International was the consulting field team: Richard Beck, Stephen Anderson, Ryan Phaneuf, Anisha Malik, Chris Johnson, Tom Millington, Ashley Spencer, Linda Nguyen, and Josephine Lim.

Cite this report as:

Lowe, Sarah, Micha Salomon, Sarah Pearce, Josh Collins, and Douglas Titus. 2019. West Valley Watershed Assessment 2018: Baseline Ecological Condition Assessment of Southwest San Francisco Bay Creeks in Santa Clara County; Calabazas, San Tomas Aquino, Saratoga, Sunnyvale East and West. Technical memorandum prepared for the Santa Clara Valley Water District – Safe, Clean Water and Natural Flood Protection Program, Priority D5 Project. Agreement #A4077F-Task 4. San Francisco Estuary Institute, Richmond, CA. Available at: http://www.valleywater.org/SCW-D5.aspx

Executive Summary

This report describes baseline information about the amount and distribution of aquatic resources, and evaluates the overall ecological conditions of streams using the California Rapid Assessment Method (CRAM), for the West Valley watershed in Santa Clara County; consisting of Sunnyvale East and West Channels, Calabazas Creek, San Tomas Aquino and Saratoga creeks (subsequently referred to in this document as San Tomas-Saratoga), and many smaller tributaries.

The Santa Clara Valley Water District (Valley Water) Safe, Clean Water and Natural Flood Protection Program has many priorities, including Priority D for restoring and protecting vital wildlife habitat, and providing opportunities for increased access to trails and open space. The D5 Project focuses on ecological data collection and analysis at a watershed scale to support - Valley Water and other County agencies and organizations in making informed ecological asset management decisions. The key performance indicators (KPIs) for D5 are to:

1. Establish new or track existing ecological levels of service for streams in 5 watersheds.
2. Reassess streams in 5 watersheds to determine if ecological levels of service are maintained or improved.

The West Valley watershed is the fifth and final watershed-wide aquatic resource inventory and stream condition survey completed by the D5 Project. The West Valley watershed covers approximately 85 square miles with creeks flowing northward from the Santa Cruz Mountains into south San Francisco Bay and its tidal wetlands. It is the smallest watershed of the five major watersheds in the county and is located in the northwest region of Santa Clara County, south of the Lower Peninsula watershed (which was assessed by the D5 Project in 2016). The main creek systems in the watershed include Sunnyvale East and West Channels, Calabazas Creek, and San Tomas-Saratoga Creeks. The cities in the watershed include Cupertino, Sunnyvale, Mountain View, Los Altos, Los Altos Hills and Palo Alto. The top of the watershed extends up the eastern side of the Santa Cruz Mountains with the highest peaks reaching to about 2,500 feet. The upper watershed is largely open space, natural lands, or lightly grazed with some rural residential properties. Development is largely restricted in the upper watershed because of the steep terrain.

-Valley Water owns about fifteen percent (15%) of the streams (about 37 miles) in the West Valley study area: six, thirteen, and seventeen miles of streams in Sunnyvale East and West Channels, Calabazas Creek, and San Tomas-Saratoga Creeks primary areas of interest (PAIs), respectively. These Valley Water-owned reaches provide an opportunity for Valley Water to improve the ecological conditions of the streams in the watershed. Nearly one third of the surface stream network in the West Valley watershed is on protected lands, located mostly in the upper watershed, and about 60% of the stream miles are located below Valley Water's Stream Maintenance Program (SMP) 1,000-foot elevation boundary.

A probability-based field survey of the ecological condition of streams in the West Valley watershed was completed in 2018 using CRAM. The 60 assessments within the watershed were used to develop Cumulative Distribution Function (CDF) estimates of the proportion of streams in good, fair, or poor ecological condition with known levels of confidence. The use of a standardized probabilistic survey design and CRAM allows Valley Water to compare stream conditions within and between Santa Clara County watersheds and other regions.

Channels in the foothills are typically in fair condition (Index Scores 51-75). They retain their natural structure and vegetation, but are affected by adjacent land uses and changes in hydrology. Stream reaches in poor condition (Index Scores ≤50) are located in mainstem channels in the highly urbanized alluvial plain near the Baylands. Many of those channels have been engineered over the past 150 years and development tends to extend right up to the channel banks.

Figure E1 shows the proportion of streams in poor, fair, and good ecological condition for the West Valley watershed and its sub-watersheds using CRAM. Figure E2 compares the ecological condition of streams in the five major watersheds within Santa Clara County, and other northern California regions, and statewide. Streams in the West Valley watershed are largely in fair ecological condition (76%) based on CRAM Index Scores, 7% of the streams are in good condition, and 17% in poor condition.

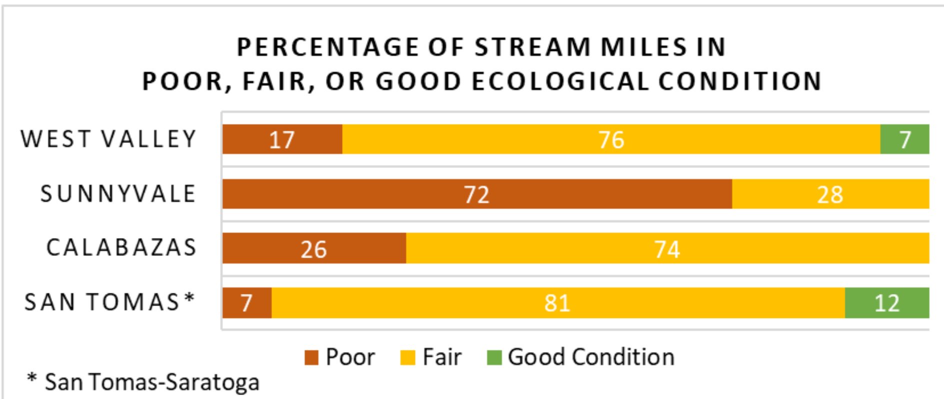

Figure E1. Percent of stream miles in the West Valley watershed study area and its three PAIs in poor, fair, and good ecological condition. The three classes of condition correspond to three equal-intervals of the full range of possible CRAM Index Scores: Poor 25-50, Fair 51-75, and Good 76-100.

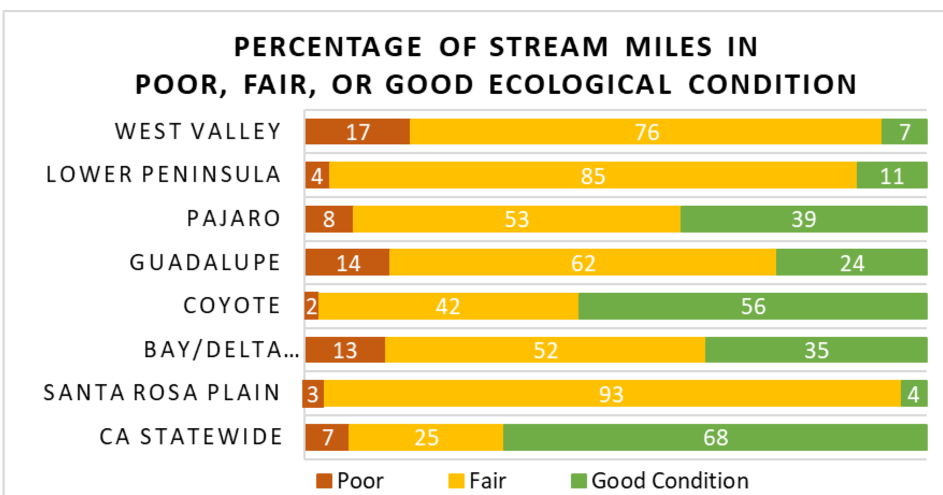

Figure E2. Percent of streams in poor, fair, or good ecological condition for the five major watersheds in Santa Clara County, other north coast regions, and statewide - based on probabilistic surveys using CRAM.

CRAM includes a stressor checklist that records the presence of ecological stress as observed in the field. Although variable throughout the watershed, the most common and significant stream and riparian area stressors observed in the West Valley watershed include transportation corridors, urban/residential development, engineered channels, and lack of treatment of invasive plants. Addressing the sources of stress in the channel or in the buffer is a way to improve the overall ecological condition of streams in the watershed.

Another summary measure employed by the D5 Project is the Ecological Service Index (ESI), which indicates the level of service (LOS) provided at a watershed scale. The ESI is a single number that represents the sample-weighted average CRAM Score for an entire watershed or its sub-watersheds (or PAIs). Figure E3 shows the ESI scores for the 5 major watersheds and their sub-watersheds (or PAIs). Higher ESI scores indicate that streams in the watershed are generally in better ecological condition. ESIs are another way to compare ecological conditions across watersheds or track change over time.

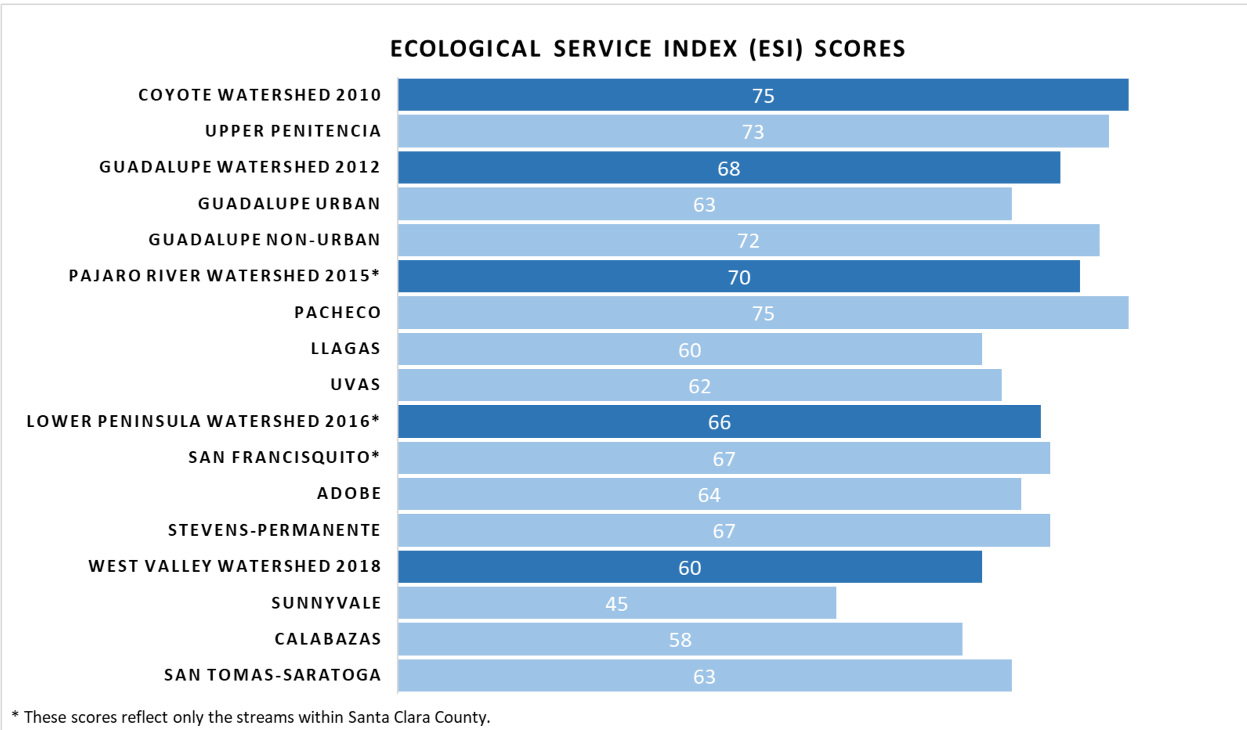

Figure E3. Bar chart comparing Ecological Service Index (ESI) scores from Valley Water's five major watersheds (dark blue) and their PAIs (light blue).

The West Valley watershed had the lowest ESI scores of the five Priority D5 Project CRAM stream condition assessments. This is due (in part) to the watershed having the highest proportion of development, the highest proportion of engineered channels, and the lowest proportion of upper watershed (higher elevation) streams, compared to the other watersheds.

List of Abbreviations

AA	Assessment Area
ABAG	Association of Bay Area Governments
BAARI	Bay Area Aquatic Resources Inventory
BMP	Best Management Practices
CARI	California Aquatic Resources Inventory
CDF	Cumulative Distribution Function
CPAD	California Protected Areas Database
CRAM	California Rapid Assessment Method
CWMW	California Wetland Monitoring Workgroup
CWQMC	California Water Quality Monitoring Council
DEM	Digital Elevation Model
EMAF	Environmental Monitoring and Assessment Framework
EMAP	Environmental Monitoring and Assessment Program
ESI	Ecological Service Index
FSD	Fluvial Subsurface Drainage
GIS	Geographic Information System
GRTS	Generalized Random Tessellation Stratified
HCP	Habitat Conservation Plan
HUC 10	Hydrologic Unit Code 10
IPCC	International Panel on Climate Change
KPI	Key Performance Indicator
LID	Low Impact Development
LOS	Level of Service
NHD	National Hydrography Database
NWI	National Wetlands Inventory
PAI	Primary Area of Interest
PSA	Perennial Stream Assessment
RipZET	Riparian Zone Estimation Tool
SFEI	San Francisco Estuary Institute
SMP	Valley Water's Stream Maintenance Program
SWAMP	Surface Water Ambient Monitoring Program
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
Valley Water	Santa Clara Valley Water District
WRAMP	Wetland and Riparian Area Monitoring Plan

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Introduction and Background

This report describes the amount and distribution of aquatic resources in the West Valley watershed in Santa Clara County based on the Bay Area Aquatic Resource Inventory (BAARI v2.1, 2018), and characterizes the baseline ecological conditions of streams in the watershed using a spatially balanced random survey design and the California Rapid Assessment Method (CRAM) to assess stream condition. The main creek systems in the West Valley watershed consist of Sunnyvale East and West Channels, Calabazas Creek, and San Tomas-Saratoga creeks.

Background

In 2010, when Valley Water embarked on the Coyote Creek watershed assessment, the California Wetland Monitoring Workgroup (CWMW), of the California Water Quality Monitoring Council (CWQMC), officially endorsed the watershed approach to environmental monitoring and assessment described in the State's Wetland and Riparian Area Monitoring Plan (WRAMP) for use statewide. It recommended standardized data collection, online access to data, and the 3-level wetland monitoring and assessment framework recommended by the United States Environmental Protection Agency (USEPA) to establish baseline conditions and support state and federal wetland protection policies, resource planning, and performance tracking.

The 3-level framework includes: "landscape-based" information that employs geographic information system (GIS) data of mapped aquatic resources or other environmental measures (Level-1); field-based "rapid condition assessments" of those mapped resources using a probability-based sampling design (Level-2); and "intensive site-specific evaluations" that can include discrete water quality or ecological field sampling (Level 3) to further investigate and address ecological condition or other regulatory requirements.

A watershed approach for aquatic resource management, tracking, and protection is a stated priority for administering the Clean Water Act according to the USEPA and US Army Corps of Engineers (USACE). By utilizing the online EcoAtlas and CRAM data management and aquatic resource tools developed to support the statewide WRAMP framework, the D5 Project is consistent with the state's standardized monitoring and assessment recommendations and Valley Water's watershed and countywide planning and stewardship actions. EcoAtlas is a web-based service that makes wetland monitoring data available to the public, resource managers, and scientists through its interactive data visualization, download, and summary tools. It includes a map interface with many kinds of ecological data to choose from including: the California Aquatic Resources Inventory (CARI), historical ecology (in some areas), CALVEG, hydric soils, and other kinds of spatial data. It also supports a Project Tracker (a restoration and mitigation project management tool used for planning, implementing, and monitoring wetland projects), and is the online access point for CRAM, the California Stream Condition Index (CSCI), and some CEDEN data collected across California. EcoAtlas allows Valley Water staff (and the public) to access and summarize CARI, CRAM, and other environmental and census information for Santa Clara County, which is summarized on-line or in a downloadable PDF file using the Landscape Profile Tool.

Priority D5 Project Overview

The Santa Clara Valley Water District (Valley Water) Safe, Clean Water and Natural Flood Protection Program has many priorities, including eight projects under Priority D for "restoring and protecting vital wildlife habitat and providing opportunities for increased access to trails and open space." In 2010, during the development of the foundational roots of the Priority D5 Project that focuses on Ecological Data Collection and Analysis, Valley Water implemented a watershed approach to environmental monitoring and assessment in the Coyote Creek watershed to characterize the amount, distribution and condition of aquatic resources in the watershed. The project employed CARI and CRAM tools, and a spatially balanced, statistical ambient survey design to assess the condition of streams in the watershed (EOA & SFEI 2011).

The D5 Project has since completed baseline assessments to characterize the amount and distribution of aquatic resources and the ecological condition of streams in five major watersheds in Santa Clara County including: Coyote Creek, Guadalupe River, Upper Pajaro River, Lower Peninsula, and West Valley (Figure 1). The 2018 West Valley assessment (reported here) is the last baseline condition assessment. Future reassessments will be compared to the baseline watershed assessments to evaluate change over time.

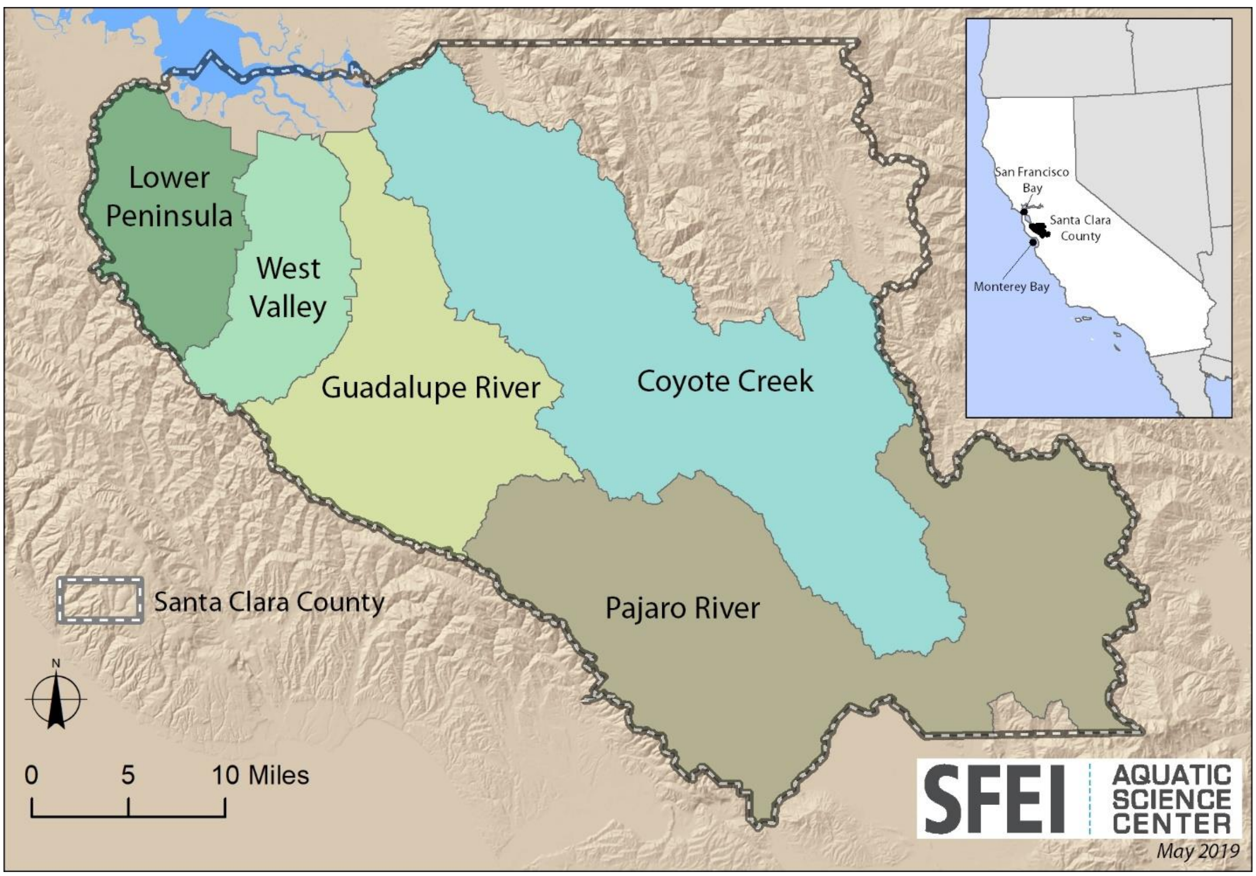

Figure 1. Map of Valley Water's five watersheds in Santa Clara County located in the South San Francisco Bay Area, California. The Pajaro watershed drains to Monterey Bay.

The key performance indicators (KPIs) for the D5 Project are to:

1) Establish new or track existing ecological levels of service for streams in 5 watersheds.
2) Reassess streams in 5 watersheds to determine if ecological levels of service are maintained or improved.

ESIs calculated for the streams in Valley Water's 5 watersheds and PAIs define an ecological level of service (LOS) based on the results of probability-based ambient stream condition surveys using CRAM. Over time, the LOS of reassessed watersheds will track change in the condition of streams in each watershed and its PAIs due to Valley Water's (and others') environmental management activities, changes in land use, and climate change. Alternatively, Valley Water's natural resource decision-makers could choose to set specific ecological LOS goals with the intention of implementing management actions to improve ecological conditions in specific watersheds or PAIs. Valley Water's One Water Program is currently developing these goals.

Management Questions

A fundamental purpose of Valley Water's D5 Project's monitoring and assessment framework is to align the collection and analysis of ecological data with the needs of water resource decision-makers. This is achieved by carefully developing management questions (or ecological concerns) that the data should address. Management questions can be general and overarching, or very specific. They can evolve over time based on monitoring findings and management needs. The purpose is to link monitoring and assessment efforts to trackable management questions that support an adaptive management strategy to protect aquatic resources and their beneficial uses. This report presents the baseline monitoring and assessment data to support the following management questions for the West Valley watershed. The questions are organized around the first two levels of the D5 Project's 3-level monitoring and assessment framework described above.

Level 1: Geospatial, landscape-based, resource management questions regarding extent, distribution, and ownership:

1. What is the distribution, quantity, and diversity of aquatic resources in the watershed and PAIs?
    a. How many miles of streams exist (including natural and unnatural stream lengths, if possible to identify within the GIS dataset)?
    b. What is the extent and distribution of non-riverine wetlands?
    c. What is the extent and distribution of stream-associated riparian areas?
2. How do the modern-day aquatic resources compare to historical extents within the low-lying, valley floor areas for which there is historical ecology GIS data?
3. Other landscape-level questions about streams and stream condition:
    a. What amount/percent of streams and other wetland types are below Valley Water's Stream Maintenance Program (SMP) 1,000-foot elevation boundary?

b. What amount and proportion of the streams are Valley Water-owned (designated as Valley Water fee title/ownership)?

c. What proportion of the streams are on publicly owned lands based on the California Protected Areas Database (CPAD)?

Level 2: Rapid assessment-based resource management questions regarding the ecological condition of streams evaluated for the watershed as a whole and individual PAIs using CRAM:

1. What are the overall ecological conditions of streams based on CRAM?
2. What are the likely ecological stressors influencing stream condition?
3. What are the Ecological Service Indexes (ESIs) for streams in the watershed?

West Valley Watershed Setting

The West Valley watershed covers approximately 78 square miles of northwest Santa Clara County, south of the Lower Peninsula watershed. Major cities include Cupertino, Sunnyvale, Mountain View, Los Altos, Los Altos Hills and Palo Alto. The three main sub-watersheds include Sunnyvale East and West Channels, Calabazas Creek, and San Tomas-Saratoga creeks. Each of these areas were defined as D5 Project PAIs. The creeks in the West Valley watershed flow north down the eastern slopes of the Santa Cruz Mountains into the tidal wetlands of south San Francisco Bay. Watershed elevation ranges from 3,200 feet at the top of the watershed in the Santa Cruz Mountains to sea level as the creeks flow into South San Francisco Bay. The active San Andreas Fault runs through the watershed, providing a mechanism for landslides and weakening of bedrock leading to episodically high sediment loads in some creeks.

Among the five Valley Water watershed designations, the West Valley watershed is the smallest (Table 1). It covers only 7 percent (%) of the total 5-watershed extent, and includes only 4% of the stream resources (not counting 1st order streams). Table 1 lists the watershed study area extents and stream lengths for the five major watersheds within Santa Clara County (areas do not include the majority of the tidal baylands). The D5 Project plans to repeat the ambient stream condition assessments in each watershed to track change in conditions over time.

Table 1. Total watershed area and miles of stream network (includes surficial and sub-surface drainage) assessed by Valley Water's D5 Project in Santa Clara County.

	Total Watershed Area			Total Miles of Streams by Watershed		
Watershed Name	**Square Miles**	**Acres**	**% of Total Area**	**Length (Miles)***	**% of Total Miles***	**Additional Miles of 1st Order Stream Reaches**
Coyote Creek	350	224,228	34%	1,245	35%	1,615
Guadalupe River	170	108,694	16%	464	13%	589
Pajaro River	361	230,922	35%	1,472	41%	NA*
Lower Peninsula	85	54,144	8%	244	7%	279
West Valley	78	49,787	7%	141	4%	116
Total	**1,042**	**667,775**	**100%**	**3,563**	**100%**	**2,595***

* The BAARI 1st order steams were not included in these columns to allow comparison of the relative amounts of stream miles between watersheds in Santa Clara County. This was necessary because BAARI does not extend into the upper Pajaro watershed (therefore the Pajaro watershed stream assessments employed Valley Water's '*Creeks*' GIS layer, which does not include the same detailed mapping of 1st order stream reaches as mapped using BAARI mapping protocols).

The headwaters of the watershed support mixed evergreen (Douglas fir/redwood) and oak/broadleaf woodland forest, interspersed with oak savannah, annual grassland, and chaparral habitats. The hillslopes are steep, and therefore headwater channels tend to be narrow with steep gradients. In the mid-region of the watershed, mountains transition to lower elevation foothills and slopes become gentler, stream orders increase, and the lower gradient channels become wider. The foothills support mixed oak/broadleaf woodland forest, oak savannah, annual grasslands, and chaparral. Although there are many open-space areas and parks, the area southwest of Highway 85 is densely urban, and transitions into rural-residential properties situated in the foothills.

As the streams flow out of the foothills and onto the alluvial plains, they become wider and less steep, and typically have been modified and/or channelized to reduce flooding and to accommodate residential and commercial land uses, which often extend right up to the top of the channel banks. The lowest stream reaches in the watershed are generally artificial lengths of flood control channel that direct flow out through the Baylands and into South San Francisco Bay. Historically, these channels were distributaries on the alluvial plain (SFEI 2010). Today, some reaches in the lower watershed have a buffer of riparian vegetation, while other reaches are concrete trapezoidal channels without any riparian zone.

Methods

Level-1: GIS-based Landscape Level Assessment Methods

1. Identify the best available digital stream network and wetlands data

Two GIS datasets were reviewed with D5 Project staff to identify the best available digital map of streams and wetlands in West Valley: the Bay Area Aquatic Resources Inventory (BAARI v.2, created 6/30/2015) and Valley Water's Santa Clara County Creeks layer (11/30/2004). The BAARI map displays linear and polygonal GIS datasets of streams and other wetlands created by SFEI in 2015 (through separate funding). It is an intensification of the National Hydrography Database (NHD) and National Wetlands Inventory (NWI) data for San Francisco Bay, and is integrated into CARI (the standardized, statewide aquatic resource base map accessible interactively online at www.EcoAtlas.org).

The D5 Project team determined that BAARI streams were more detailed and appropriate for the West Valley watershed aquatic resources assessment and stream condition survey. The data layer included detailed mapping of 1st order streams, and the stream reaches were attributed with Strahler stream order numbers (Strahler 1952, 1957) used in the ambient stream condition survey's design and sample draw procedures. In comparing the GIS datasets, the team identified three engineered channel reaches that were in the Santa Clara County *Creeks*

GIS dataset from Valley Water but not in BAARI (Figure 2). Those channels were added to BAARI, which prompted a new version of BAARI, which also included new updates in Marin and Sonoma Counties (v2.1 wetlands and streams, updated 12/28/2017).

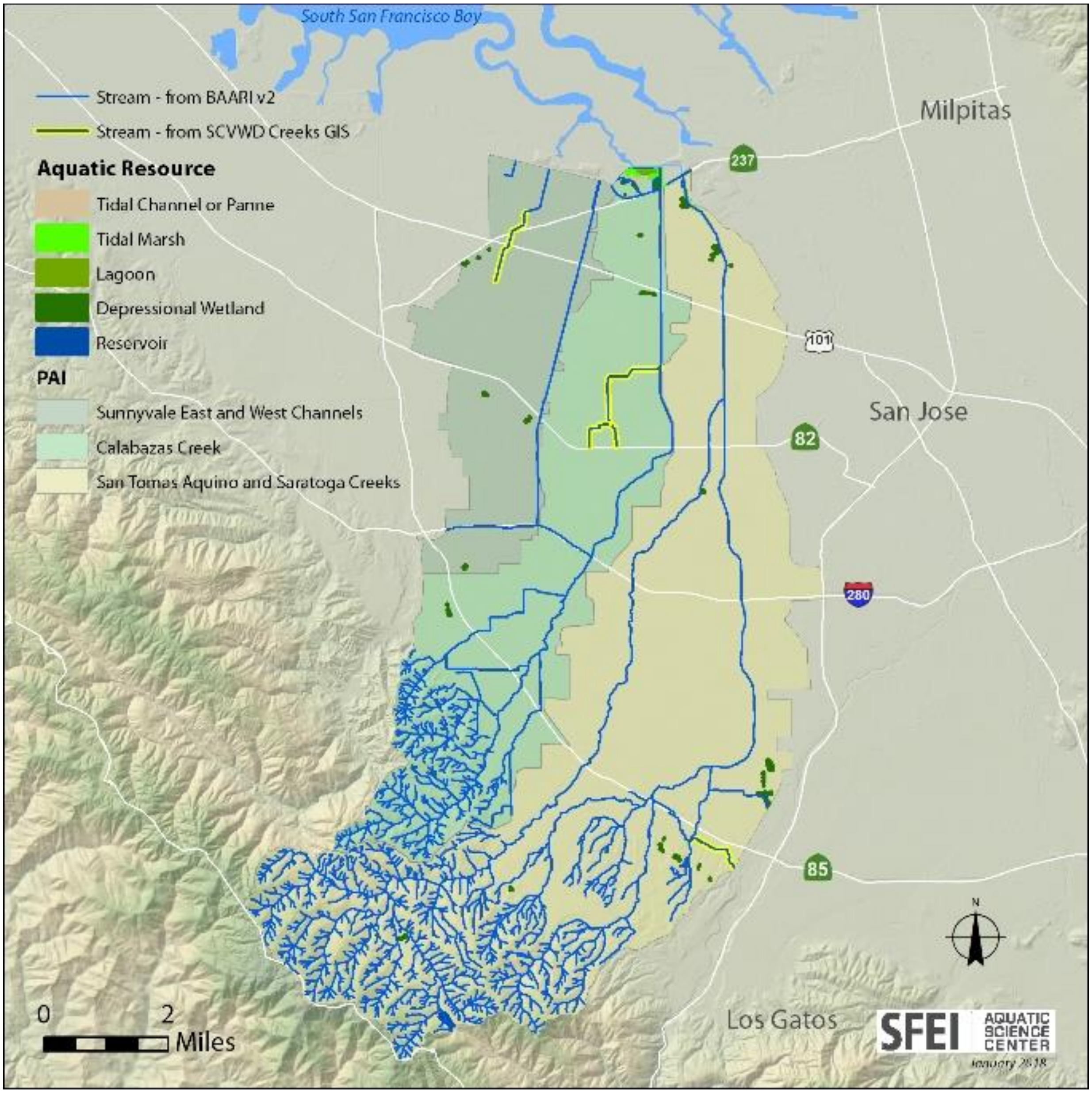

Figure 2. Map depicting the West Valley watershed's stream network, and highlighting (in yellow) three engineered channel reaches that were added to the updated BAARI v2.1 GIS stream layer based on the D5 Project team's review of available GIS datasets for the region.

The updated BAARI v2.1 stream and wetland datasets were used in the 2018 West Valley watershed assessment to characterize the amount, distribution and diversity of streams and wetlands in the study area, and the streams layer was subset to create the surficial streams GIS layer that served as the sample frame for the Level-2 ambient stream condition survey in the watershed (described below).

2. Determine the study area extent and PAIs

The ‘*SCVWD Major Watersheds’* GIS-layer (2011)[1], provided to SFEI by Valley Water’s GIS staff, served as the foundation for identifying the study area extent for West Valley. The study area was expanded to include areas north of Highway 237 adjacent to south San Francisco Bay: 1) an fluvial portion of the channel in an area immediately west of Moffett Field in the lowest reaches of the Sunnyvale East and West watersheds, and 2) a relatively short reach of tidal channel that boarders Baylands Park, in the Calabazas PAI (Figure 3).

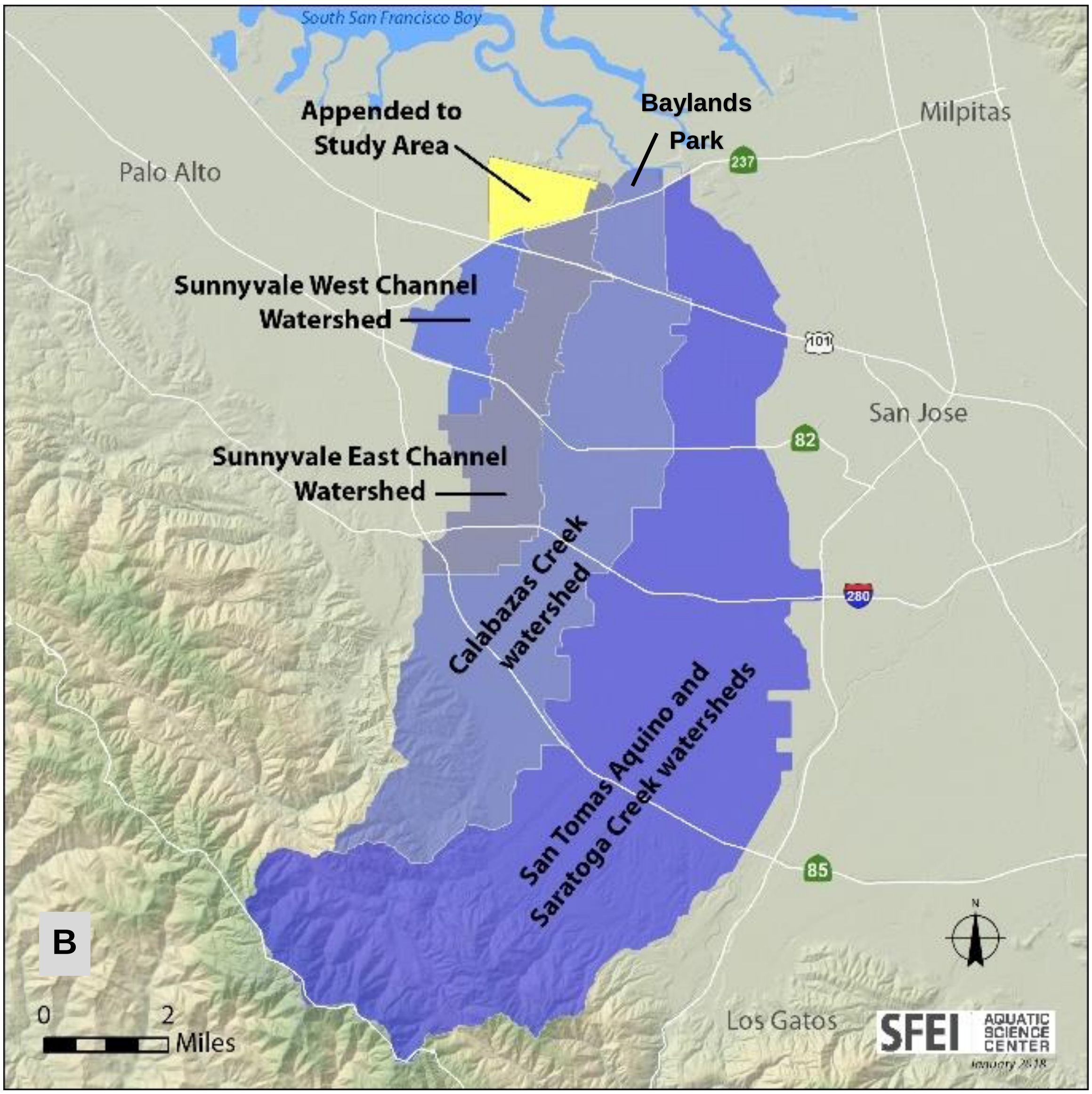

Figure 3. Map depicting the full study area extent, including the appended study area (yellow area) in the lower reaches of the watershed (north of Highway 237), Baylands Park, and the four sub-watersheds within the West Valley watershed.

[1] Publication Date: 09/01/2011 (internal draft)

Finally, the project team identified three PAIs comprised of one or more sub-watersheds for the 2018 West Valley Watershed Assessment:

1) Sunnyvale East and West Channels (Sunnyvale),
2) Calabazas Creek (Calabazas), and
3) San Tomas Aquino and Saratoga Creeks (San Tomas-Saratoga).

Please refer to the Project's Task 002 memorandum titled "West Valley Watershed Assessment 2018: Study Area Extent, Stream Survey Design, Sample Frame, and Sample Draw" (Lowe *et al*., February 2018) for more information.

3. Estimate riverine riparian extents using the Riparian Zone Estimation Tool v2.0 (RipZET)

RipZET (SFEI 2015) employs digital vegetation, aquatic resource, and elevation data within a GIS and Excel platform to estimate riparian habitat extents based on topographic slope, density and height of mapped vegetation. It has three main components: core code, modules, and output. The core code prepares the input GIS layers used by the modules. The Hillslope and Vegetation Processes modules are run separately for a geographic area defined by the user. Each module generates a GIS dataset that represents riparian habitat extent based on their respective modelled riparian functions.

The maximum riparian habitat extent from both modules is summarized according to the concept of "functional riparian width." According to this concept, the kinds of ecological functions that a riparian area can provide depends on its structure, which includes topographic slope, density and height of vegetation, plant species composition, and soil type. Some key riparian functions include wildlife support, runoff filtration, input of leaf litter and large woody debris (allochthonous inputs), shading, flood hazard reduction, groundwater recharge, and bank stabilization (Collins et al. 2006). For any given structure, the levels of specific functions within a riparian area depend on its width and length. Wider and longer riparian areas tend to support higher levels, and a greater number of riparian functions than shorter and narrower areas (Wenger 1999). The concept of functional riparian width is central to the riparian definition recommended by the National Research Council (NRC 2002) and integral to many riparian design and management guidelines (e.g., Johnson and Buffler 2008).

RipZET GIS outputs are not regarded as riparian *maps* per se because they do not depict boundaries based on field observations. Instead, they represent modelled areas where riparian functions are likely to be supported based on hillslope and vegetation processes. The module outputs can be overlaid to estimate the maximum riparian extent for all riparian functions represented by both modules.

The D5 Project's West Valley watershed assessment (2018) ran RipZET's Hillslope and Vegetation modules on the following vegetation and elevation GIS datasets:

- USDA Forest Service CALVEG data Zone 6 - Central Coast, published in 2014 and using imagery from 1997-2013;
- BAARI v.2.1; and

- USGS National Elevation Dataset, 10-meter node Digital Elevation Model (DEM) for topography.

RipZET results are presented in this memo as a map of the overlaid Vegetation and Hillslope Processes GIS layers, and a table that summarizes the estimated number of stream miles and acres of riparian habitat by functional width class (based on the output from RipZET's Vegetation module[2]) per Collins et al. (2006).

4. List the GIS datasets used in the landscape analysis of streams and wetlands

To characterize the amount, distribution, and diversity of aquatic resources in the West Valley watershed, and to summarize the stream condition survey results in a watershed context, SFEI employed the BAARI v.2.1 GIS layer and other geospatial data provided by the District or available online as referenced below:

- BAARI v.2.1, Mapping Methods
- Santa Clara County line GIS layer (Valley Water 2007)
- Valley Water's SMP 1,000-foot elevation boundary. The SMP boundary is based on 2006 LiDAR contour datasets (Valley Water 2006)
- Valley Water -owned lands from Valley Water's fee title GIS layer (2009 [Unpublished]). Data layer was provided in August 2016
- California Protected Areas Database (CPAD, GreenInfo Network 2017)
- Association of Bay Area Governments' (ABAG) 2005 land use layer. Urban/Non-Urban attributes were added to the stream and wetland GIS layers by intersecting them with a modified version of the ABAG-2005 land use layer. ABAG land use classes 'Agriculture', 'Forest Land', and 'Rangeland' were classified as 'Non-Urban' and the rest of the classes were classified as 'Urban'.
- Santa Clara County Historical GIS Data
  - SFEI, 2015. "Santa Clara Valley Historical Ecology GIS Data version 2" Accessed [30 August 2016]. Data are available to download at: http://www.sfei.org/content/santa-clara-valley-historical-ecology-gis-data.
  - The final report based on this Historical Ecology study was completed by SFEI in 2010 and is available online: *Historical Vegetation and Drainage Patterns of Western Santa Clara Valley: A technical memorandum describing landscape ecology in Lower Peninsula, West Valley, and Guadalupe Watershed Management Areas*.
- The USDA Forest Service CALVEG (Zone 6 - Central Coast) data were used by RipZET to assign tree heights to estimate stream riparian extents using the Vegetation Processes module.
- The USGS National Elevation Dataset (10-meter DEM). Available at: https://lta.cr.usgs.gov/products_overview/

[2] Note that riparian length and area for each width class is calculated for the left and right stream banks separately. Therefore, the estimated riparian stream miles are the sum of both banks divided by two. The total stream miles in the riparian functional width class summary table will not add up to the total stream network length (based on the linear stream GIS flow-line down the thalweg of the channels). This is because the buffered thalweg line used by RipZET is an estimate of the left and right stream banks.

Level-2: Rapid Assessment of Stream Condition Methods

1. Develop a probability-based stream condition survey design and sample draw

The D5 Project's watershed-wide stream condition assessments consist of statistically based random survey designs and sample draws that characterize the baseline condition of streams in the five main watersheds in Santa Clara County with a known level of confidence. The D5 Project employs the USEPA's recommended Generalized Random Tessellation Stratified (GRTS) survey design and analysis tools for monitoring and assessing aquatic resources. The National Environmental Monitoring and Assessment Program (EMAP; Messer et al. 1991; Diaz-Ramos et al. 1995; Stevens and Olsen 2003; Stevens and Olsen 2004) developed the GRTS survey design and analysis methodology, which includes online documentation and the 'spsurvey' programing package to support GRTS. *Spsurvey* is an R programing language package that includes sample design, sample draw, and analysis tools for both *linear* (e.g. streams) and *area* (e.g. wetlands, lakes, etc.) resources.

The GRTS survey design and sample draw for the West Valley streams (a linear resource) employed the BAARI v2.1 GIS-based stream network as the sample frame. The GRTS sample draw selects sampling sites (CRAM Assessment Areas or AAs) in a spatially balanced random manner across the sample frame, and assigns a 'sample weight' to each site. Each site represents a proportion of the stream resource[3]. When analyzed, the CRAM survey results estimate the proportions of stream resources that are likely to have a particular ecological condition score with a known level of confidence.

The BAARI v.2.1 streams GIS dataset was modified for the CRAM stream condition survey design as follows:

- Only stream reaches within the West Valley study area extent (described above) were included in the sample frame.
- First order headwater streams were dropped because the Riverine CRAM module does not adequately assess them[4].
- Underground stream drainage features, identified in BAARI as fluvial subsurface drainage (FSD), were not included.

These modifications are consistent with the D5 Project's previous Santa Clara County watershed assessments, as well as other riverine assessments conducted regionally and statewide, making it possible to compare the West Valley stream condition assessment to these other assessments.

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[3] The following link (presentation by Tony Olsen of USEPA) provides a good visual overview of GRTS. http://acwi.gov/monitoring/conference/2006/2006_conference_materials_notes/WorkshopsandShortCourses/Spatial_Sampling_Workshops_Olsen/Surve_%20Design_Short_Courses/GRTS_Site_Selection.pdf

[4] BAARI first order stream reaches are much more detailed than the NHD, Valley Water GIS creeks layer, and most other stream datasets in California. It is generally not necessary to drop first order streams from NHD datasets because they usually represent higher order reaches.

The final West Valley sample frame (a GIS shapefile) represents 137 miles of surficial streams, which is a little over half of the total stream network in the watershed. The sample frame was imported into the R *spsurvey* statistical software package to complete the CRAM sample draw.

Stratification of a GRTS sample draw increases the efficiency of a survey design yet maintains its unbiased nature. By increasing the proportion of sites in areas of particular interest (i.e., specific PAIs or higher stream orders on the valley floor), one can improve the confidence levels around the means in those areas, while preserving the ability to evaluate conditions in the watershed as a whole. The West Valley CRAM ambient stream condition survey design was stratified to increase the number of sites in the lower elevation streams (below the 1,000 ft. SMP boundary) and to redistribute the number of sites among the PAIs to ensure that the Sunnyvale PAI had a minimum of ten sites. The final stratified sample draw targeted 50 CRAM AAs distributed across three PAIs. The streams surveyed included fluvial reaches of Strahler stream orders 2 through 6. A total of 10 target AAs were located in the Sunnyvale PAI, 17 in the Calabazas PAI, and 23 in the San Tomas-Saratoga PAI (Figure 4).

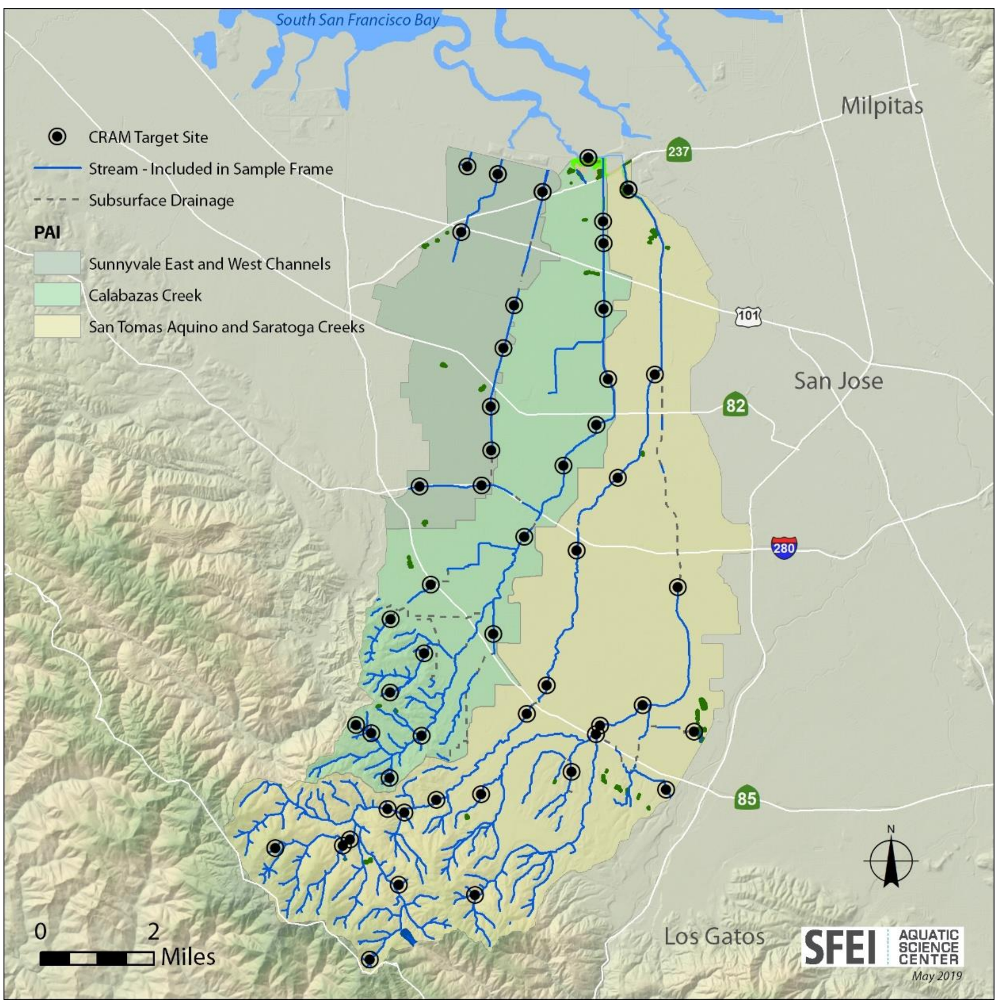

Figure 4. Map of the 50 targeted CRAM stream condition sites in the West Valley watershed. The sample frame (surficial, fluvial streams of Strahler stream orders 2-6) is shown in blue and subsurface drainage, which connects the stream network, is shown as dashed black lines.

An oversample draw was included with three times the number of target sites for each PAI. Oversample AAs replace target AAs that are inaccessible or not able to be measured for any reason. Oversample AAs can also be used in intensification studies or for other probability-based stream assessments Valley Water may be interested in. As mentioned above, the sample draw was stratified to ensure that the Sunnyvale PAI had a minimum of ten target AAs, and to force more AAs into lower elevation stream reaches than would have been assigned without stratification.

2. Conduct a field survey to assess the ecological condition of streams using CRAM

Valley Water and its consultants conducted an ambient field survey of stream conditions at 60 sites in the West Valley watershed study area using the CRAM Riverine Field Book (V6.1)[5]. Prior to implementing the CRAM field survey in 2018, Valley Water conducted site reconnaissance to prepare for the field season. At that time, field teams found that several target sites, adjacent to the Bay, were tidally influenced with visible salt-tolerant vegetation along some channel banks. Review of the previous ambient stream surveys of the other D5 Project watersheds indicated that only one or two tidally influenced sites were assessed. The West Valley watershed stream survey design included 10 tidally influenced sites. Because so many sites were located in the tidal reaches of the watershed, the project team increased the survey design to 60 sites. A total of 60 sites were assessed during the field season (the original 50 target sites (a mix of fluvial and tidal locations) plus an additional 10 fluvial oversample sites) in the event that the project decided to drop out the tidal reaches from the study area extent. Tidally influenced sites were assessed with both the *Tidal Riverine* and *Riverine* CRAM modules in order to be able to analyze those sites separately or together (as warranted).

Field teams consisted of trained CRAM Practitioners from Valley Water, SFEI, and Michael Baker International who conducted the field survey in May through July 2018. CRAM scores were recorded on field sheets and entered into the online CRAM data management system[6]. Through this system, CRAM assessment scores are verified for accuracy in data entry and completeness, and made publicly available online through EcoAtlas[7]. These standardized, online tools support users in managing CRAM field data and support public access to monitoring data statewide. The distributions of all available CRAM results are visible on an interactive CARI basemap, can be downloaded as .csv files, and summarized in a downloadable .pdf report that dynamically estimates the amount, diversity, and condition of aquatic resources in a user-defined landscape profile report. The final CRAM results from the West Valley watershed stream condition survey can be downloaded from EcoAtlas and are listed in Appendix A.

[5] 2013.03.19_CRAM Field Book Riverine 6.1.pdf
[6] http://www.cramwetlands.org/
[7] Project Name = 'SCVWD Lower Peninsula Watershed Stream Condition Assessment 2016'. (Note: CRAM assessments where the landowner requested results be kept private are not visible on EcoAtlas, however, results are calculated into EcoAtlas summary measures.)

Two field intercalibration exercises were conducted during the CRAM field season to document and compare consistency among the CRAM field Practitioners, and to provide a forum for additional training on the CRAM methodology. These exercises are opportunities for additional CRAM training and help reduce Practitioner-introduced variation, which is unavoidable in large surveys where many field teams are involved in data collection. The results of the CRAM intercalibration exercises were summarized and submitted to Valley Water in a separate memorandum.

During the field survey, Practitioners occasionally encountered target sites that could not be assessed, and were replaced by oversample sites. It was assumed that: 1) sites were dropped due to random or unforeseen circumstances (e.g. because they were inaccessible, permission to enter was denied by the property owner, or the site was not actually located on a stream); and 2) replacement sites drawn from the oversample list maintain the spatial balance of assessments across the sample frame (or stream network in this case). To assure the second assumption holds, oversample sites selected in sequential order. However (in practice), the final distribution of assessed sites may result in some areas being underrepresented.

In previous watershed assessments (conducted by the D5 Project), inaccessible areas were considered similar enough to sampled areas; therefore, the final stream condition estimates were applied to the whole watershed. The project team decided that the inaccessible areas were sufficiently similar to the assessed areas within the study are and therefore, the stream condition estimates in this report apply to the whole West Valley watershed.

3. Complete Data Analyses of the CRAM Stream Survey

Analysis of the West Valley watershed CRAM data evaluated Index and Attribute scores. Sample weights were adjusted based on the original GRTS sample weights to account for replacement and the added sites. The statistical analyses were conducted with the spsurvey statistical library (Kincaid and Olsen 2016) and R programing language (version 3.2.3), which is a software environment for statistical computing and graphics specific for GRTS survey designs. The spsurvey analysis outputs consisted of cumulative distribution function (CDF) estimates, plots, and percentile tables of CRAM Index and Attribute scores.

A CDF plot enables a user to visually evaluate and compare the percent of the resource (in this case – stream miles within the study area) versus CRAM ecological condition scores. Figure 5 presents an *example* CDF curve for a watershed stream condition survey based on CRAM. The black line indicates the estimated mean CRAM Index Score (x-axis) for any percentage of stream length in the watershed (y-axis). The red lines indicate the 95% confidence intervals around the mean. Confidence intervals are generally wider when there is a lot of variation in condition within a surveyed area or when only a few sites (AAs) represent a large proportion of the surveyed area.

Reading the horizontal and vertical arrows in the figure, one would say that 50% of the streams in the watershed have an Index Score of 65 or lower. Interpreting the red confidence intervals in the example CDF, one would say (with 95% confidence) that half of the streams in the watershed have a CRAM Index Score estimated to be between 63 and 71.

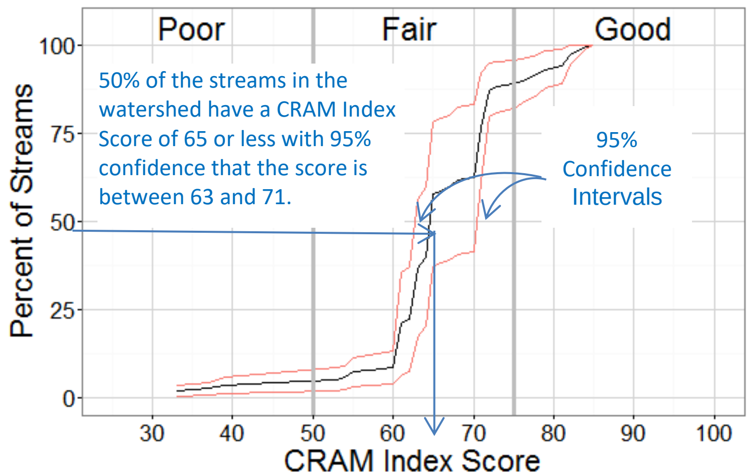

Figure 5. Example CDF curve for a watershed-based stream condition assessment based on CRAM.

A CDF curve that is shifted to the right reflects relatively better ecological conditions (higher CRAM scores) and conversely a curve that is shifted to the left reflects relatively poorer ecological conditions (lower CRAM scores). A convex downward curve (one that starts with a steep slope upward that decreases) indicates a higher proportion of stream miles with low CRAM condition scores, compared to the convex upward curve (one that starts with a gradual upward slope that increases) indicates a lower proportion of stream miles with low condition scores (as seen in Figure 5).

Three standard CRAM ecological health classes (also called condition classes) represent streams that are in poor, fair, or good condition. These classes were defined as the tertiles of the maximum range of possible CRAM Index (or Attribute) scores. That is, poor condition scores range from 25 to 50, fair condition scores range from 51 to 75, and good condition scores range from 76 to 100. These 'health classes' can be represented in bar charts or on the CDF plots as a way to bin the CRAM scores to facilitate reporting, comparison, and evaluation.

Another summary measure employed by Valley Water is the Ecological Service Index (ESI), which is a single number that represents measure of overall watershed condition. Valley Water developed the ESI in 2011 for the Coyote Creek watershed assessment (EOA and SFEI 2011), and have calculated ESIs for each of the D5 Project's stream condition surveys. This first set of ESI scores form the five watershed-wide ambient stream condition surveys represents the D5 Project's baseline condition measures for each watershed and their PAIs.

An ESI is calculated as the sum of individual CRAM Index Scores from the CDF estimate multiplied by the proportion of stream length represented by each score:

ESI = ∑ (CRAM Index Score X Estimated proportion of stream length represented by each Score)

Valley Water could base management priorities (or set management goals) by identifying 'target ESI thresholds'[8] for each PAI or the watershed as a whole. Progress towards meeting those thresholds could be tracked over time, and adopted into Valley Water's watershed management plans as ecological condition metrics. Although Valley Water has not yet set any 'target ESI thresholds' for the West Valley watershed, the ESIs developed for the 2018 stream survey can be used as the baseline condition and compared to future, repeated, watershed-wide condition surveys in order to evaluate change over time. It is also possible to calculate ESIs for the CRAM Attributes, if warranted.

Results

Level-1 Distribution and Abundance of Aquatic Resources

Figure 6 shows the distribution of streams and wetlands (the aquatic resources) in the D5 Project's West Valley watershed study area from BAARI v2.1. It includes the linear stream network (surficial natural and unnatural channels and connecting subsurface drainage features), and polygonal wetlands (lacustrine (reservoirs), depressional wetlands (ponds), tidal marsh, pannes, and lagoon wetland types). Only a small portion of the tidal wetlands that connect the watershed to San Francisco Bay are included in this assessment and therefor it does not characterize the tidal wetlands within the adjacent Baylands. The following Level-1 management questions were addressed based on these spatial data.

- How many miles of streams are there in the West Valley watershed within Santa Clara County?

The West Valley watershed encompasses about 78 sq. miles (50,000 acres) and includes about 257 miles (414 kilometers) of fluvial streams and sub-surface drainage channels based on BAARI v2.1 (Strahler stream orders 1 through 6).

The streams in the Sunnyvale PAI are about 10 miles of engineered channels or subsurface drainage and comprise only 4% of the whole stream network within the West Valley watershed. The Calabazas PAI has over 70 miles of streams that comprise 28% of the whole stream network. 1/3 of those streams are engineered channels or subsurface drainage (16 and 7 miles, respectively). The other 2/3 are largely natural and located in the upper watershed (50 miles). The San Tomas-Saratoga PAI is the largest sub-watershed in the West Valley watershed. It has about the same amount of engineered channels and subsurface drainage as the Calabazas PAI (16 and 6 miles, respectively), yet has three times more miles of natural streams located in the upper watershed (153 miles).

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[8] Note: 'Target ESI thresholds' were defined as an Ecological Levels of Service (LOS) in the original Coyote Creek Plan and Technical Report #2 (EOA and SFEI 2011), then adopted as KPIs for Valley Water's D5 Project.

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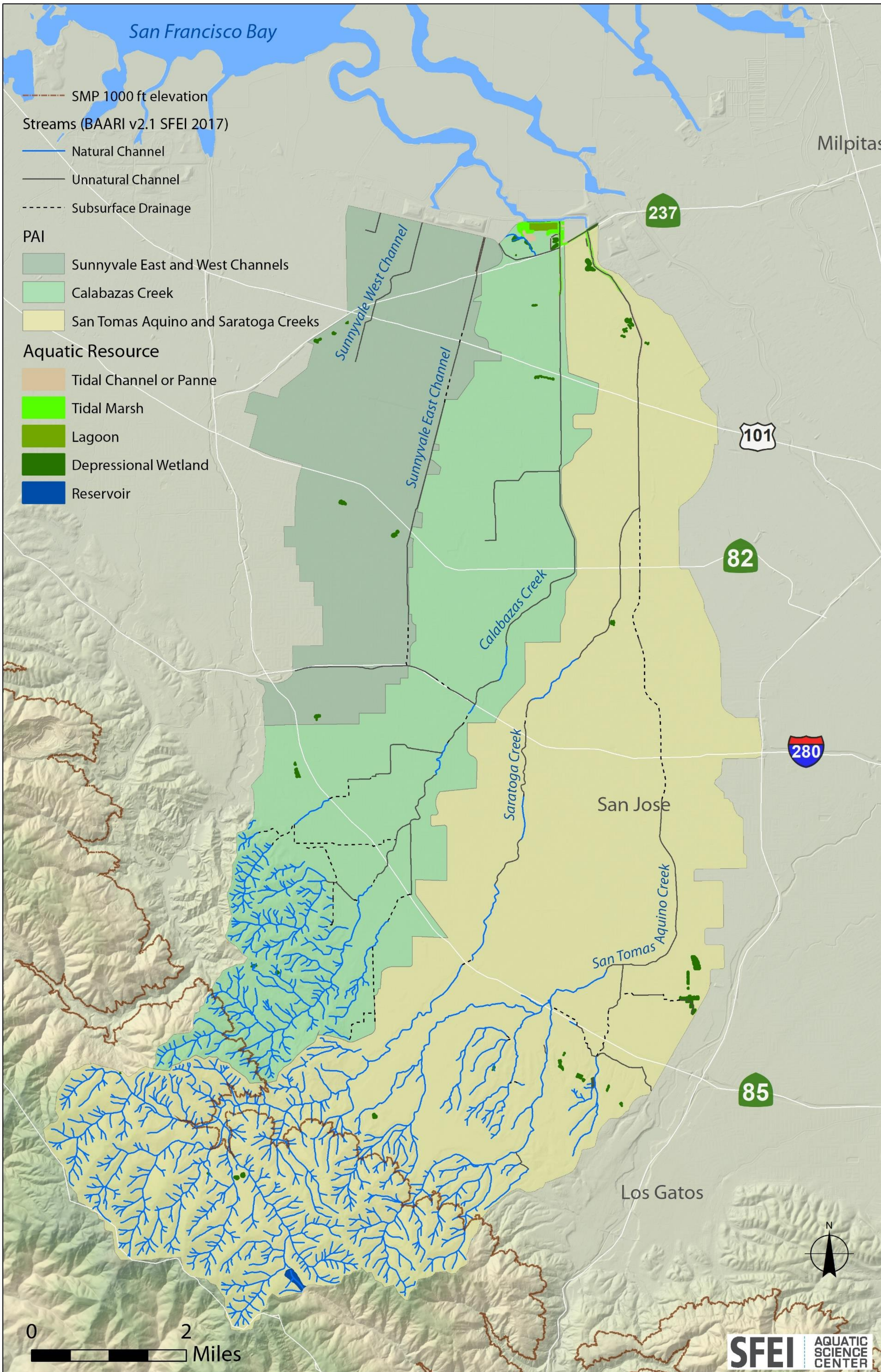

Figure 6. Map of the aquatic resources in the West Valley watershed study area based on BAARI v.2.1.

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Table 2 summarizes the miles of streams in the West Valley watershed and its PAIs by stream network type.

Table 2. Miles of streams in the West Valley watershed and its PAIs by stream type

Stream Type	Sunnyvale	Calabazas	San Tomas-Saratoga	Total
Fluvial Natural	0	50	153	203
Fluvial Artificial	9	15	15	39
Fluvial Subsurface Drainage	1	7	6	14
Tidal Artificial*	0	0.6	0.5	1
Total surficial stream miles	**9**	**66**	**168**	**243**
Total subsurface drainage miles	**1**	**7**	**6**	**14**
Total miles	**10**	**73**	**174**	**257**
Percent of watershed	**4%**	**28%**	**68%**	**100%**

* Lists only the miles of tidal channels within the study area. It is not representative of the amount of natural or artificial tidal channels within the Baylands at the base of the West Valley watershed.

- How many acres of non-riverine wetlands are there within the watershed?

Table 3 summarizes the acres of non-riverine wetlands in the West Valley watershed and its PAIs. Figure 7 is a larger image of the Sunnyvale Baylands Park and immediate area shown in Figure 5. It more clearly shows the extent of tidal wetlands listed in Table 3.
The tidal wetlands represent only the wetlands within the study area, which are located primarily in the Sunnyvale Baylands Park, north of Highway 237 at the mouth of Calabazas Creek (Figures 6 & 7). Some tidal vegetation extends along the tidal channels at the mouths of Calabazas and San Tomas Aquino Creeks.

Table 3. Total acres of non-riverine wetlands in the West Valley watershed study area by PAI and wetland type, based on BAARI wetlands v.2.1

PAI	Depressional Natural	Depressional Unnatural	Lacustrine Unnatural (Reservoir)	**Total Acres Non-tidal Wetlands**	Lagoon Perennial Unnatural	Tidal Ditch	Tidal Marsh Flat	Tidal Panne	Tidal Vegetation	**Total Acres Tidal Wetlands**
Sunnyvale		6		**6**		5				**5**
Calabazas		13		**13**	20	0.2	1	8	30	**60**
San Tomas-Saratoga	0.3	44	16	**60**		1	4	0.4	13	**18**
Total Acres	**0.3**	**63**	**16**	**80**	**20**	**6**	**5**	**8**	**43**	**82**

The Calabazas Creek PAI contains the most tidal wetlands in the study area, totaling 60 acres. The San Tomas-Saratoga PAI contains areas of tidal vegetation and tidal marsh flat in the wide tidal channel area between levees, while the Sunnyvale PAI does not contain any tidal non-riverine wetlands. The three PAIs also contain depressional wetlands and the San Tomas-Saratoga PAI has the Lake Ranch Reservoir in the upper watershed. Unnatural depressional wetlands comprise the largest total acreage, and include features such as golf course ponds, percolation ponds, ponds that are amenities (e.g. in housing developments, at Great America, and in Sanborn County Park), and water treatment ponds.

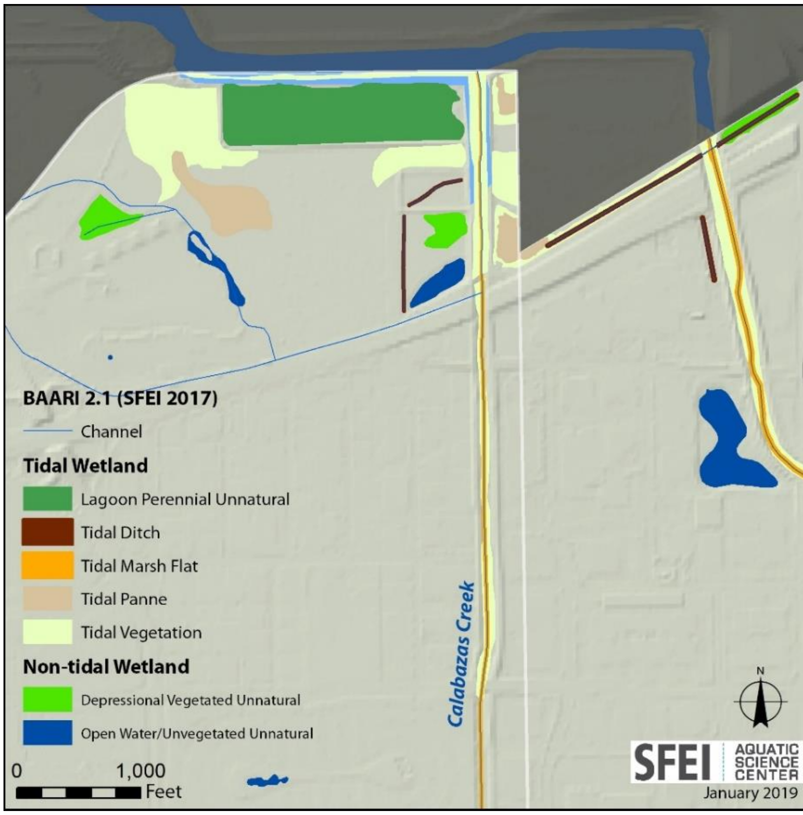

Figure 7. Larger image of the tidal wetlands in the Sunnyvale Baylands Park and immediate area shown in Figure 5 (at the base of the Calabazas PAI). It shows only the tidal wetlands within the West Valley study area (and listed in Table 3), but does not show the full extent of the non-tidal wetlands found throughout the watershed.

- What is the extent and distribution of the stream-associated riparian areas?

Riparian areas adjoin waterways and water bodies, including wetlands (Brinson *et al.* 2002). Riparian areas vary in function or value (i.e., the services or benefits riparian habitat provides) primarily depending on their width, such as wildlife support, runoff filtration, input of leaf litter and large woody debris, shading, flood hazard reduction, groundwater recharge, and bank stabilization (Collins et al. 2006). Wider areas tend to provide higher levels of more functions.

RipZET outputs estimated riparian habitat extents as GIS shapefiles. Figure 8 is a map of the West Valley watershed RipZET output, which overlays the extents of vegetation (green) and hillslope (brown) processes on a single map. Figures 9 and 10 chart the miles and acres of riparian habitat by functional width class for vegetation and hillslope processes, respectively.

Table 4 lists the estimated miles of stream riparian areas in the West Valley watershed study area by functional riparian width class. Classes are based on general relationships between riparian width and vegetation-based riparian function as summarized by Collins *et al.* (2006). A riparian function is assigned to a width class, if the class is likely to support a high level of the function. The estimated stream miles and acres of riparian area are from the output of the RipZET vegetation module[9]. Riparian width classes reflect natural demarcations in the lateral extent of major riparian functions (Collins *et al.* 2006).

Table 4. Estimated amount of stream lengths (miles) and stream-associated riparian areas for each of the five riparian functional width classes associated with vegetative processes in the West Valley watershed.

Riparian Width Class (m)	Miles (Km)	Acres (Ha)	% Total Length	Shading	Bank Stabilization	Allochthonous Input	Runoff Filtration	Flood Dissipation	Groundwater Recharge	Wildlife Support
0 - 10	104 (168)	120 (48)	41%							
10 - 30	31 (50)	587 (238)	12%							
30 - 50	47 (76)	1550 (627)	18%							
50 - 100	6 (10)	319 (129)	2%							
>100	66 (106)	4789 (1938)	26%							

[9] Note: The riparian length and area for each width class is calculated for the left and right stream banks separately. Therefore, the estimated riparian stream miles are the sum of both banks divided by two. Total miles in Table 4 will not sum to the total stream network length (flow-line down the thalweg of the channels). This is partly because the shape of the stream network is slightly altered by buffering of the GIS-based thalweg flow-line to estimated left and right stream banks; and partly because subsurface drainage features are not included in the estimate of riparian zones.

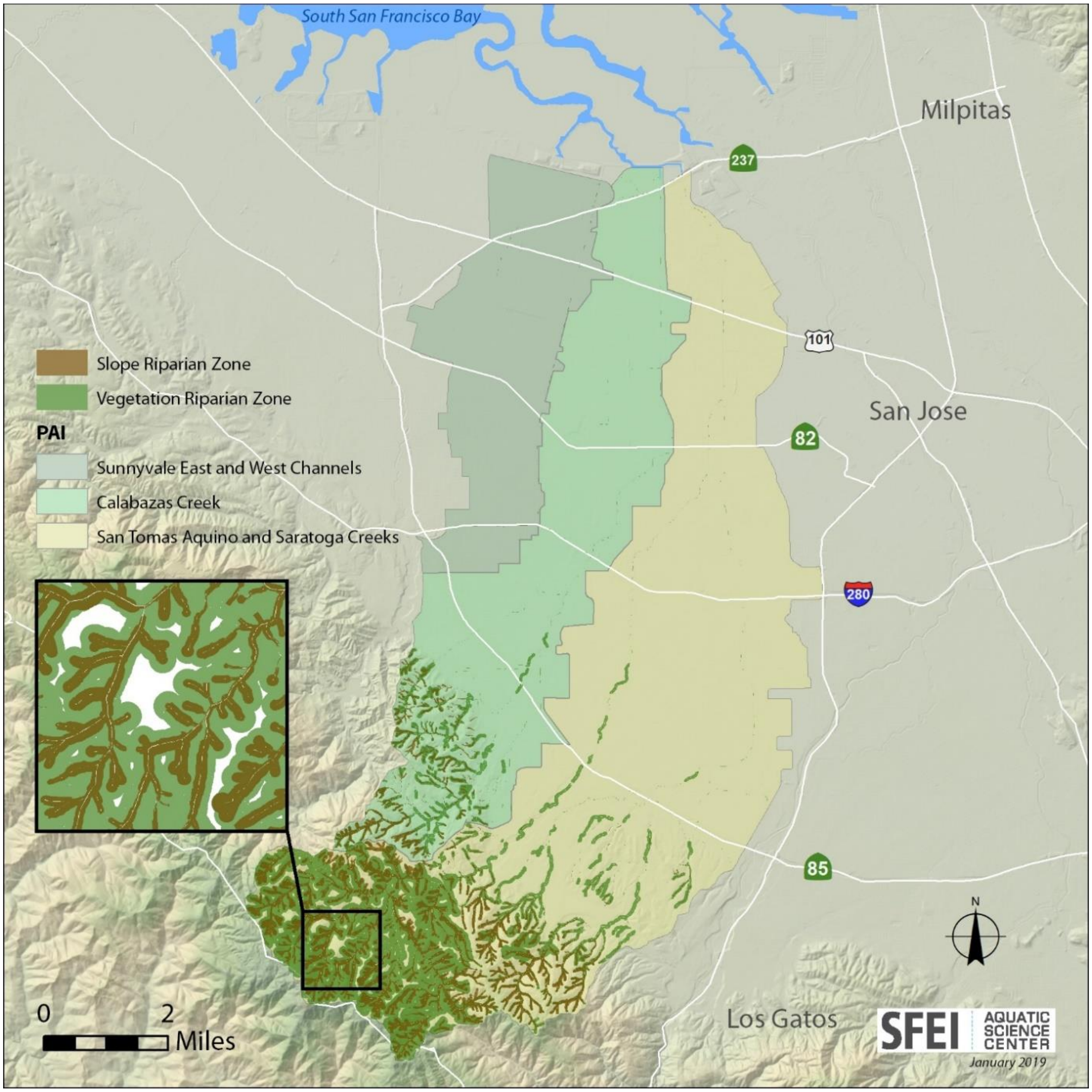

Figure 8. Map of RipZET output for the West Valley watershed, which estimates the extent of riparian vegetative and hillslope processes along the surficial streams in the watershed.

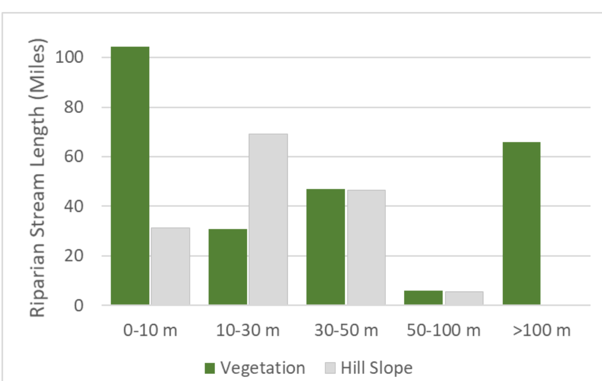

Figure 9. Estimated miles of surficial streams by riparian functional width classes (m = meters).

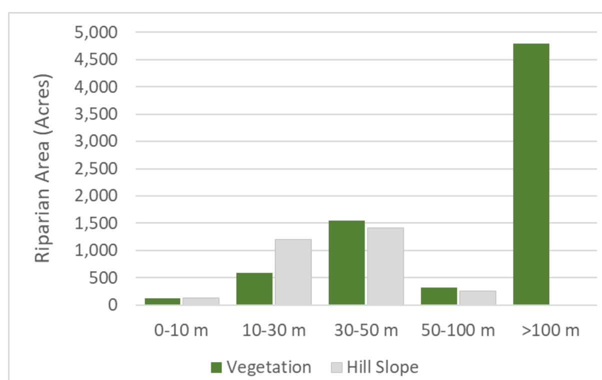

Figure 10. Estimated acres of riparian area by riparian functional width classes (m = meters).

- How do the modern-day aquatic resources compare to historical extents within the low-lying, valley floor areas for which there is historical ecology information?

Figure 11 shows the historical (circa 1850) and modern aquatic resources in the West Valley watershed (within the valley floor) for which there are overlapping historical ecology data from the Western Santa Clara Valley Historical Ecology Study (SFEI 2010) and BAARI v.2.1.

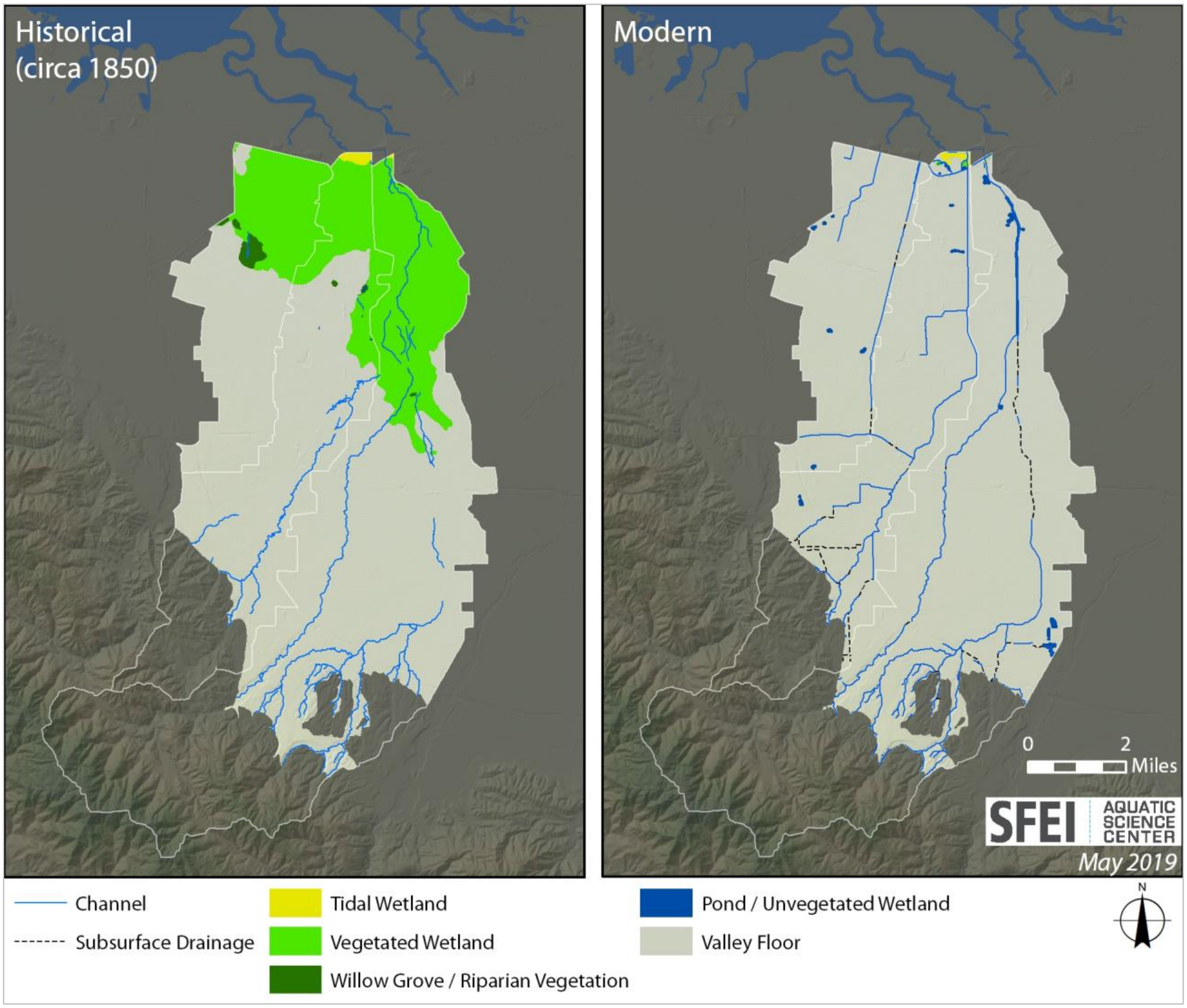

Figure 11. Maps of the historical (circa 1850) and current aquatic resources in the West Valley watershed (valley floor areas) for which there are overlapping historical ecology spatial data from the *Western Santa Clara Valley Historical Ecology Study* (SFEI 2010) and BAARI streams v.2.1.

Historically, all the West Valley streams spread out into undefined channels on the valley floor. Calabazas, San Tomas-Saratoga Creeks spread into shallow, discontinuous distributary channels around the 100-200 ft elevation contour, either sinking into the coarse sediments of their alluvial fans, or spreading into wet meadows, marshes, and willow groves. The creeks often connected via surface waters during high flows (SFEI 2010). These distributaries deposited fine Oxnard silt loam, a soil type that "puddles readily" and likely would have remained seasonally inundated (SFEI 2010).

Further downslope, surface and shallow subsurface waters from the three creeks, which flowed in diffuse, disconnected distributary channels, coalesced and created Sanjon Creek, which fed the sloughs and marshes downstream in the Baylands. Because the head of Sanjon Creek was closest to the terminus of Saratoga Creek, early settlers connected the two via a ditch. As more artificial hydrologic connections were built, the historical location of the Sanjon Creek watercourse became known as San Tomas Aquino Creek (SFEI 2010).

Drainage in the West Valley watershed was extensively altered during the late 1800s and early 1900s. The Sunnyvale area historically was not drained by defined creeks (Figure 10). The modern Sunnyvale East and Sunnyvale West Channels are engineered channels that were created to drain historical wet meadow and willow grove areas on the valley floor. The modern watershed contains an extensive network of mostly engineered surface channels, and subsurface drainage pipes that connect key portions of the stream network in the lower elevation stream reaches (Figures 5 and 10). The highly-developed areas also have an extensive urban storm drain system, while streams in the upper watershed remain largely unmodified.

Figure 12 compares the amount of natural stream miles that existed historically (circa 1850) to current, modern day streams in the valley floor area as depicted in Figure10 (above).

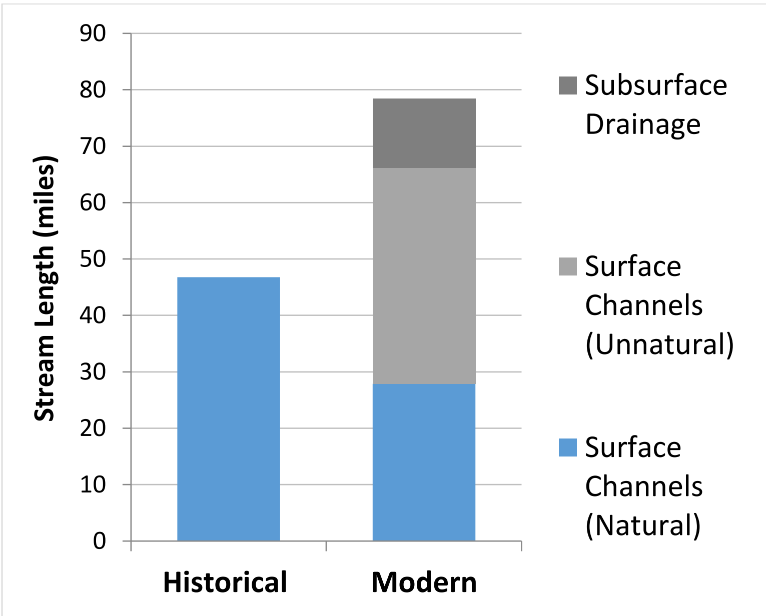

Figure 12. Comparison of the amount of historical and modern streams (by stream type) for the West Valley watershed valley floor as depicted in the maps in Figure10.

- Other landscape based Level-1 questions:
  - What amount and proportion of streams are within the SMP 1,000-foot elevation boundary?
  - What amount and proportion of the streams are Valley Water-owned (based on Valley Water's fee title GIS layer (August 2016)?
  - What amount and proportion of the streams are in protected areas (based on CPAD 2017)?

Figure 13 shows a map of Valley Water-owned lands (Valley Water's fee title GIS dataset, August 2016), protected lands (based on the CPAD 2017), and the SMP 1,000 ft boundary within the West Valley watershed study area. Valley Water owns about 36 miles of the streams (about 15% of the surficial streams) in the West Valley watershed study area, mostly along engineered channels in the urban, lower watershed. It owns 6 of the 9 miles of channels in the Sunnyvale PAI, and 13 and 17 miles of streams in the Calabazas, and San Tomas-Saratoga PAIs, respectively (Figure 13 and Table 5). Almost 30% of the surficial streams (about 70 miles of streams) are on protected lands, the majority of which are undeveloped streams in the upper watershed. Nearly 60% of the surficial streams (140 miles) are below Valley Water's SMP 1,000-foot elevation boundary.

Table 5. Summary of the amount of surficial streams within the West Valley watershed study area (and its three PAIs) that are located within the SMP boundary, Valley Water-owned property, or protected land. Please note that these numbers will not sum to the total stream miles as they are not mutually exclusive. They are presented here side-by-side simply for comparison.

Primary Area of Interest (PAI)	Total Stream Miles	Within SMP (<1,000 ft.)	Valley Water Owned	Within Protected Lands
Sunnyvale	9	9	6	0
Calabazas	66	60	13	9
San Tomas-Saratoga	168	71	17	61
West Valley Total	**243**	140	36	70

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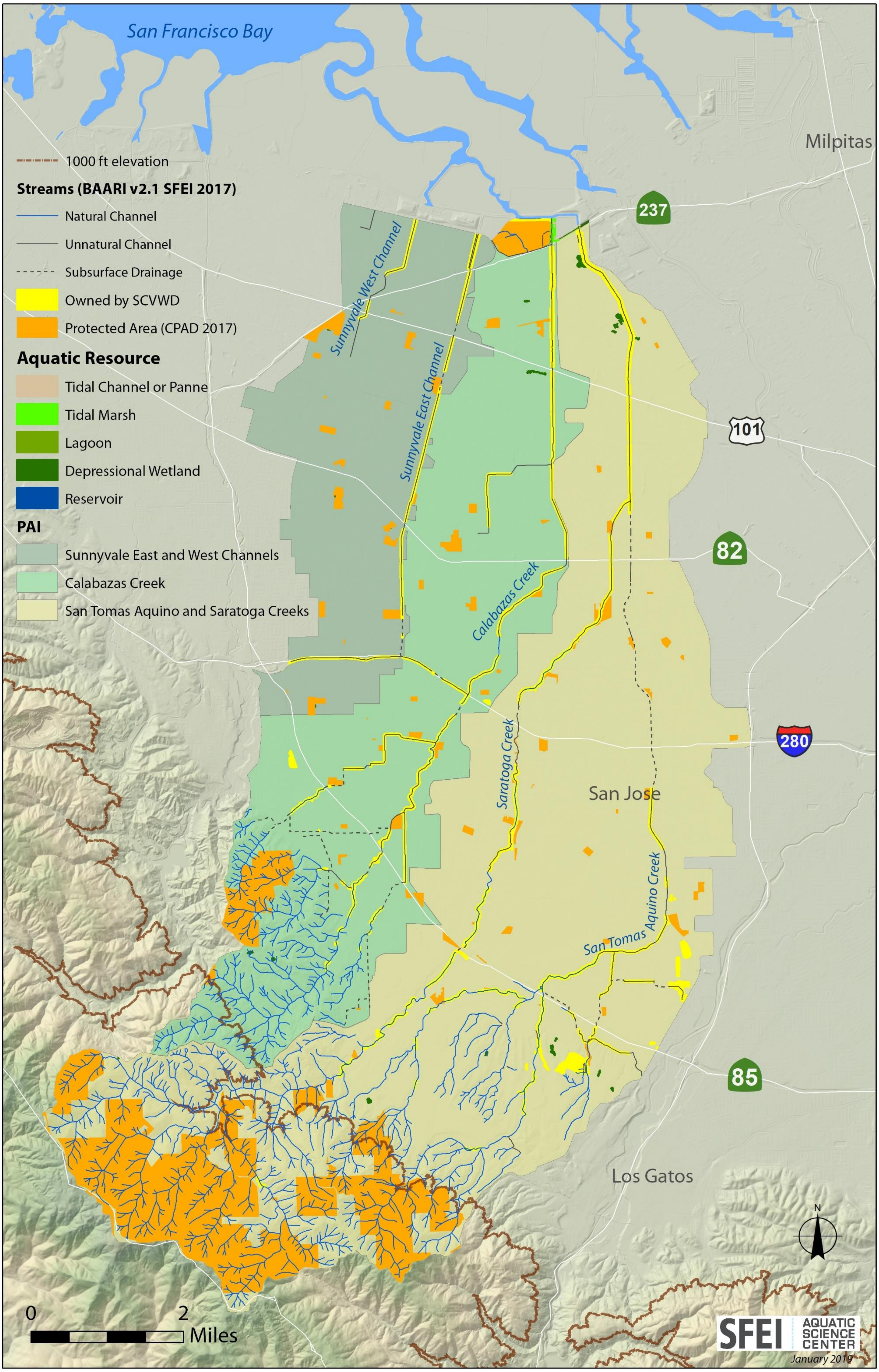

Figure 13. Map of Valley Water-owned and other protected areas, based on Valley Water's fee title (August 2016) and the CPAD (2017) GIS datasets, overlaid on a map of the BAARI v2.1 streams and wetlands.

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Level-2 Stream Ecosystem Condition based on CRAM

CRAM provides numerical scores to estimate the overall potential of a wetland and its adjacent riparian area to provide high levels of the ecological services expected of the area given its type, condition, and environmental setting. CRAM scores are based on visible indicators of physical and biological form and structure relative to statewide reference conditions.

Valley Water and its consultants assessed 60 CRAM AAs within the West Valley watershed study area in the summer of 2018. This memorandum summarizes those results to:

1. characterize the overall ecological condition of the streams in the whole watershed, and its three PAIs, and compare the overall condition of streams in the West Valley watershed to other watersheds and regions;
2. identify and compare observed ecological stressors that might be impacting stream health within the three PAIs; and
3. calculate the baseline ESIs of streams in the watershed as a whole and of its three PAIs.

The D5 Project initially planned to assess 50 AAs in the watershed. Of those 50 AAs, nine were rejected[10] and replaced with oversample AAs. In addition, new GIS data that marked the locations of the head-of-tide within the West Valley study area indicated that 10 of the final, accessible CRAM AAs were downstream of the head-of-tide markers and likely tidal. CRAM guidance states that, when it is unclear which wetland Module to use, field teams should assess a site using the two most appropriate CRAM Modules and use the higher CRAM scores in the final site evaluation. By doing this, it essentially "gives credit" to the functions and services that the wetland is providing, rather than penalizing it by assessing the site with an inappropriate Module.

The tidally influenced sites (below the head-of-tide markers) were assessed with both the Riverine and Tidal Riverine CRAM Modules in order to determine which Module resulted in higher CRAM scores. Field observations at the 10 sites indicated that some locations were clearly tidally influenced, while others were less certain because field indicators were very subtle. The project team later compared the Tidal Riverine and Riverine CRAM scores and selected Riverine Module scores to include in the watershed wide condition assessment because those scores were almost always higher than the corresponding Tidal Riverine scores.

The project team added 10 additional fluvial oversample AAs to the West Valley survey design in order to maintain the original target number of 50 AAs in the *fluvial* reaches of watershed (in the event that the team decided to drop the tidally influenced reaches from the West Valley study area). The rationale behind increasing the number of AAs was to maximize the number of samples in each PAI to reduce uncertainty in the final CDF estimates. Table 6 summarizes the final numbers of AAs that were targeted, assessed, dropped, and tidally influenced.

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[10] Rejected (or dropped) AAs were not assessed because permission to enter was denied, or the site was inaccessible (e.g., steep terrain, excessive distance from road, or inundated with impenetrable noxious vegetation [e.g. blackberries, poison oak]).

Table 6. Summary of targeted, assessed, rejected, and tidally influenced CRAM stream condition survey AAs in the West Valley watershed and its PAIs (2018)

Primary Area of Interest (PAI)	Targeted AAs	Assessed AAs	Rejected AAs	Tidally Influenced AAs
Sunnyvale	10	16	2	6
Calabazas	17	19	3	2
San Tomas-Saratoga	23	25	4	2
Total	**50**	**60**	**9**	**10**

Figure 14 shows the final distribution of the initial candidate CRAM AAs that were either assessed or rejected, and identifies the tidally influenced AAs that were assessed with both the Riverine and Tidal Riverine CRAM Modules.

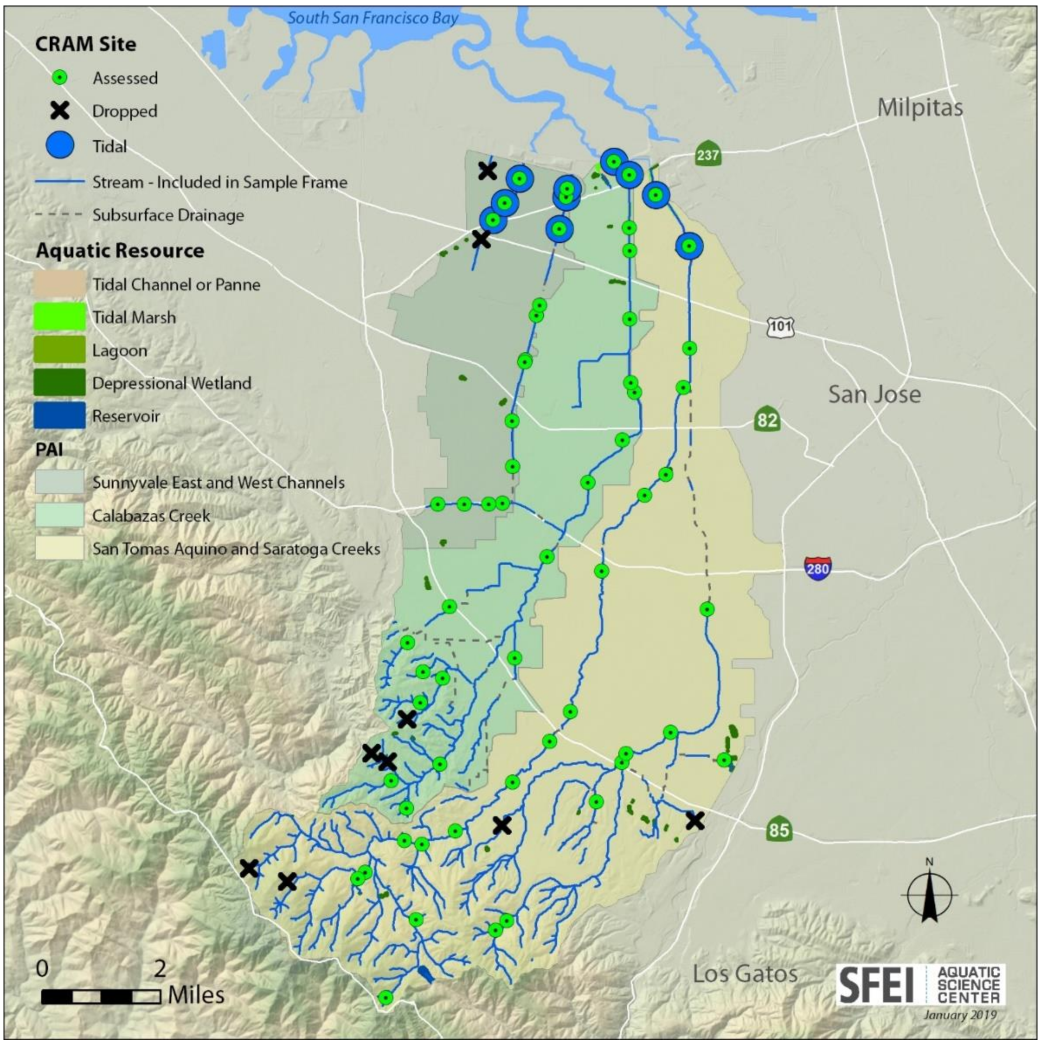

Figure 14. Map showing the distribution of the assessed (green dots), rejected (black **x**'s), and tidally influenced (blue circles) CRAM stream condition assessment sites in the West Valley watershed (2018).

- What is the overall ecological condition of streams in the West Valley watershed within Santa Clara County?

The following summaries present the spatial distribution of the CRAM stream condition Index Scores across the West Valley watershed and its PAIs based on the standard ecological condition classes (or health classes) of good, fair, and poor condition as described in the Methods section, and estimates of the relative amounts (or percentages) of stream miles in good, fair, or poor condition based on the probability based survey CDFs. The CDF curves are presented for the CRAM Index and component Attribute Scores to further compare the ecological condition of the streams between PAIs, Valley Water's five major watersheds, the Delta eco-region, and statewide.

In general, streams in the West Valley watershed can be generally characterized as in fair condition. However, a large portion of the urban streams are in poor condition. Figure 15 summarizes the relative percent of stream miles in good, fair, or poor ecological condition based on the CRAM Index Score CDF estimates for the West Valley watershed and its PAIs.

- 7% of the streams in the watershed are in good condition (CRAM Index Scores 76-100),
- 76% of the streams in the watershed are in fair condition (Index Scores of 51 to 75), and
- 17% of the streams are in poor condition (Index Scores 25-50). These stream reaches are located in the urban lower watershed.

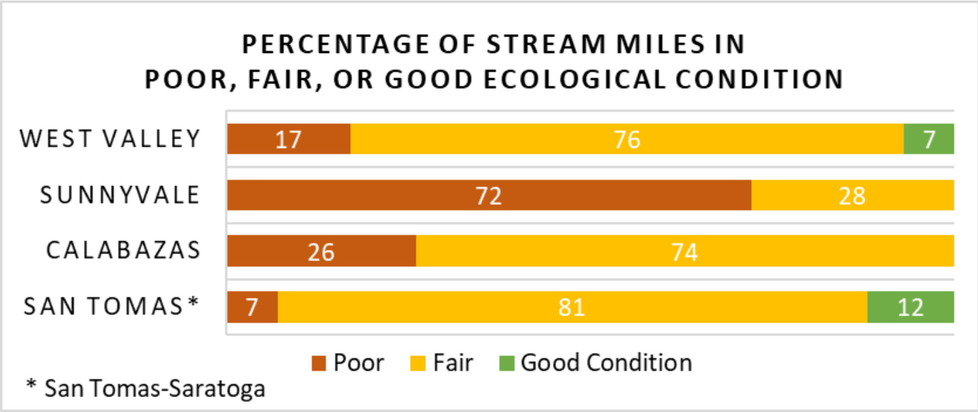

Figure 15. Percent of stream miles in the West Valley watershed study area and its three PAIs in poor, fair, and good ecological condition based on three equal-interval health classes (tertiles) of the CRAM Index Score CDF estimates (≤50, 51-75,>75, respectively).

At the sub-watershed level, streams in the Sunnyvale PAI are in the poorest ecological condition with 72% of the streams in poor condition and 28% in fair condition. The Calabazas PAI has the reverse with 26% of its streams in poor condition and 74% in fair condition. The San Tomas-Saratoga PAI (which includes San Tomas Aquino and Saratoga Creeks, and most of the upper watershed reaches within the whole West Valley watershed) has only 7% of its stream miles in poor condition, 81% in fair condition, and 12% in good condition.

Figure 16 shows the spatial distribution of the overall ecological condition of streams across the West Valley watershed based on the CRAM Index Scores grouped by the three ecological health classes.

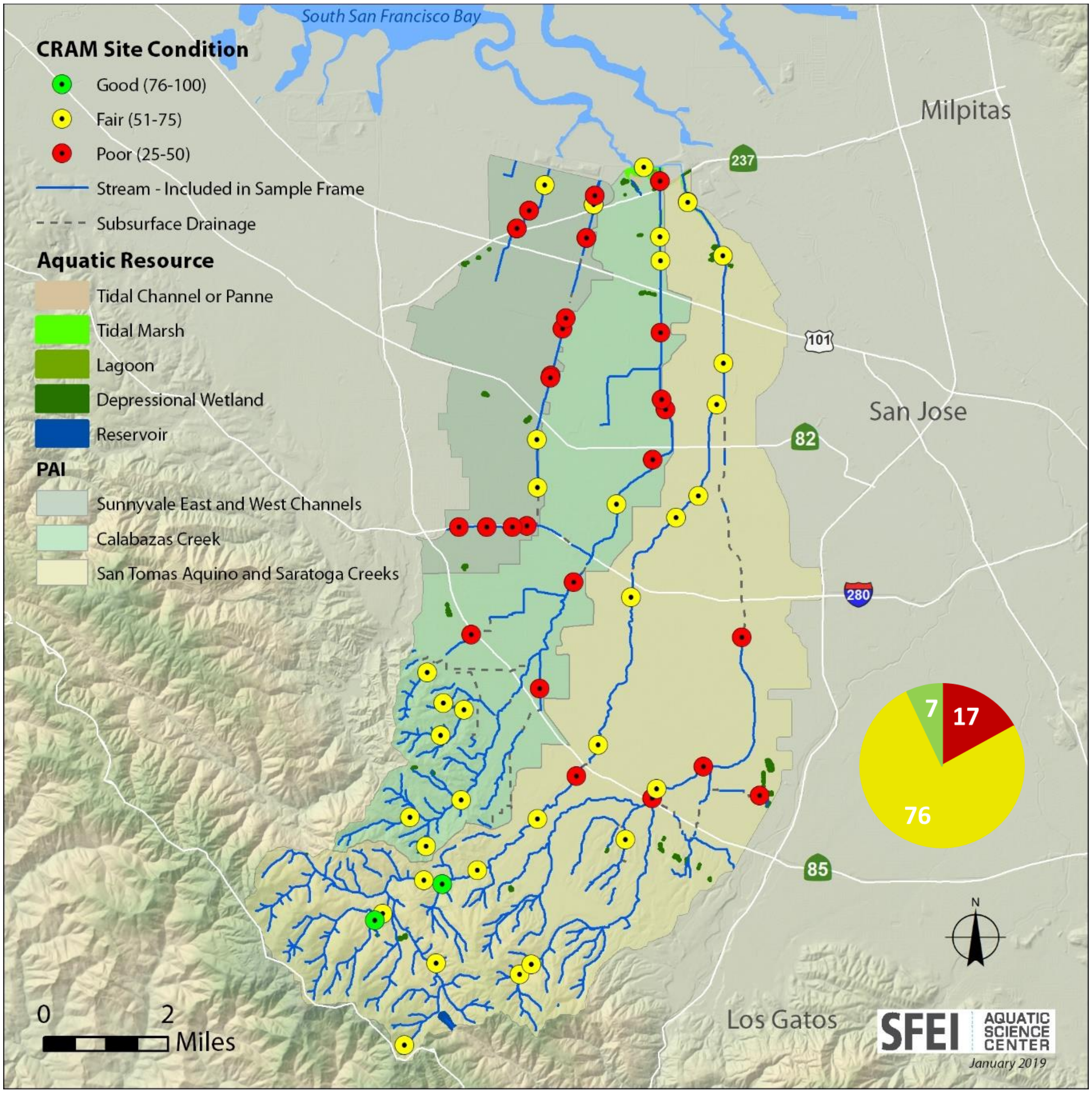

Figure 16. Map of the 2018 stream condition survey AAs for the West Valley watershed and its PAIs indicating overall ecological condition: poor, fair, and good ecological condition (CRAM Index Scores ≤50, 51-75,>75, respectively). The pie chart depicts the estimated proportion of stream miles in each health class.

The upper watershed is largely undeveloped even though there are some residences, a few vineyards, and Highways 9 and 35 pass through it. It is characterized by steep hillslopes that support forests and chaparral, and is drained by steep, low-order, and narrow channels. Aside from channel reaches immediately adjacent to houses or roads, the stream network does not show any adverse anthropogenic impacts. Because of these landscape characteristics (steep topography, low channel order, and relatively homogenous forest vegetation), the upper watershed streams are relatively simple in terms of their morphology, physical structure, and vegetation community.

The majority of the CRAM assessments in the upper watershed indicate that the streams are in fair condition with a majority of Index Scores ranging from 70 to 75 (only two sites were in good condition with Index Scores of 85 and 76). Inspecting the Metric scores for these sites reveals the reasons why these relatively natural sites are scoring in the 70s. These channels are steep and low-order (headwater channels), and are showing some signs of incision. The channels generally do not have much topographic complexity, nor a floodplain area that would provide hydrologic connectivity. The homogenous forest canopy means that these sites will have few vegetative co-dominant species and low horizontal interspersion.

The upper watershed stream reaches of the Calabazas Creek PAI are slightly different. These sites are entirely in fair condition, with Index Scores ranging between 55 and 71. This upper watershed is significantly more developed with large rural residential properties and vineyards. The stream channels tend to be slightly less steep, but still largely narrow and morphologically simple. Only a small portion of the hillslopes in this PAI are forested or covered in chaparral, but the majority of the channel length in the upper watershed has a narrow, but relatively intact riparian corridor (refer to the RipZET output in Figure 7, above). The CRAM scores in the upper portion of this watershed have lower Landscape and Buffer Context Attribute scores as well as Hydrology Attribute scores compared to the San Tomas-Saratoga PAI. This is largely due to the greater amount of development in these upper reaches. The Physical Structure Attribute scores are similar between the upper watersheds in both PAIs, because of their similar narrow and simple morphology. The Calabazas PAI has comparable to slightly better Biotic Structure Scores in the upper watershed reaches than the San Tomas-Saratoga PAI, likely due to the greater heterogeneity caused by breaks in the riparian canopy, which allows other species to grow, as well as potential contribution of species diversity associated with the residential landscaping. Drilling down to the Attribute scores provided a better understanding of why the upper watershed stream reaches were mostly in fair condition: those stream reaches have generally retained their morphology and riparian vegetation structure despite the influence of low to moderate development.

The lower watershed sites in all three PAIs are in ‘fair’ and ‘poor’ condition. These channel reaches are heavily impacted by the dense adjacent development and modified hydrology. Most of the lower watershed reaches are engineered channels, designed and managed for efficient flow conveyance. CRAM assessments in these stream reaches score poorly in the Buffer and Landscape Context Attribute due to the immediately adjacent development, often including roads, fences, houses, and/or industrial/commercial buildings. These streams score poorly in the Hydrology Attribute due to modified hydrology from the developed area, the history of channel incision, and often narrow channels with steep banks. Physical Structure scores poorly because many of these channels are a homogenous trapezoidal shape or a highly simplified natural channel. CRAM Biotic Structure Scores are generally low due to the lack of woody vegetation in the riparian corridor, the dominance of weedy and sometimes invasive species, and management that prioritizes maintaining low vegetative roughness. Figure 17 shows photographic examples of different stream reaches within the West Valley watershed study area with a range of CRAM condition scores.

Figure 17. Photographic examples of different stream reaches within the West Valley watershed study area with a range of CRAM condition scores. Upper left: CC-136 (Index = 38). Upper right: SV-002 (Index = 40). Lower left: ST-059 (Index = 54). Lower right: ST-046 (Index = 85).

The CDF plots of CRAM Index and Attribute scores from the West Valley ambient stream condition survey are presented in Figures 18 and 19. Each curve represents the estimated ecological condition (CRAM Index or Attribute scores 25-100) on the x-axis versus the proportion of stream resources (percent of stream miles) on the y-axis for the watershed as a whole or its component PAIs as explained in the Methods section. Differences in the shape of the curves and the left/right position of the curves indicate differences in the percent of stream miles with a particular condition score (or less) with a known level of confidence (the red lines indicate the upper and lower 95% confidence intervals). A CDF curve that is shifted to the right reflects relatively better ecological conditions (higher CRAM scores) and conversely a curve that is shifted to the left reflects relatively poorer ecological conditions (lower CRAM scores). A convex downward curve (one that starts with a steep slope upward that decreases) indicates a higher proportion of stream miles with low CRAM condition scores, compared to the convex upward curve (one that starts with a gradual upward slope that increases) indicates a lower proportion of stream miles with low condition scores.

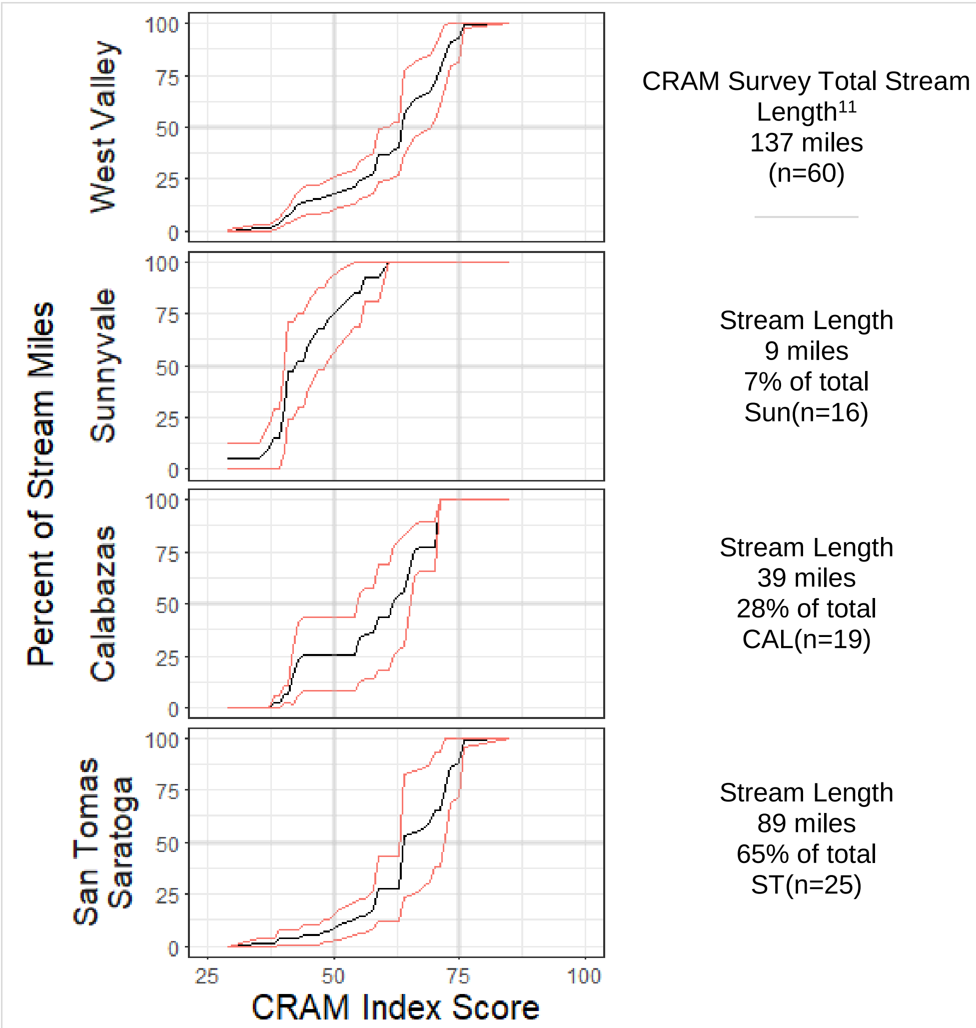

Figure 18. CDF plots of the CRAM Index Scores for the West Valley watershed ambient stream condition survey (2018) and its three PAIs comparing the relative conditions of streams within each region.

The CRAM Index CDF curve for the Sunnyvale PAI was visibly (and statistically) different from the CDF curves for both the Calabazas and San Tomas-Saratoga PAIs, which were not

[11] The stream lengths presented here do not include 1st order streams or subsurface drainage as mapped in BAARI v.2.1. They represent the total length of the streams in the CRAM stream condition survey's sample frame (see the methods section for more information).

significantly different from each other based on a Wald F test[12] (Appendix B lists the results of those tests).

Knowing the general stream and landscape characteristics within each PAI helps to interpret the shapes of the CDF results. All the surficial streams in the Sunnyvale PAI are engineered channels located in the urban, lower reaches of the West Valley watershed. Those reaches are typically incised earthen trapezoidal channels, managed for efficient flood conveyance, with little physical or vegetative complexity. The Calabazas PAI is largely urban yet extends up into undeveloped areas in the Santa Cruz Mountain foothills where natural stream reaches comprise about 1/3 the total stream miles in the sub-watershed (refer to Table 2 on page 17). The stream reaches in the Calabazas PAI range from concrete trapezoidal channels, to more natural channels that are still modified (e.g. with rock gabions or riprap), to narrow and simple natural channels in the foothills. The San Tomas-Saratoga PAI is the largest sub-watershed in the West Valley watershed with the most stream miles. It has the most high-elevation stream reaches that are largely undeveloped. Similar to the Calabazas PAI, the channels in the San Tomas-Saratoga PAI also range from concrete trapezoidal channels in the low elevation urban areas, to narrow and simple natural channels in the foothills, with some complex natural, pool-riffle reaches in the high elevation upper watershed. Similar to Calabazas, natural stream reaches comprise about 1/3 of the total stream miles in the San Tomas-Saratoga PAI, although there are three times more miles of natural streams in this sub-watershed (Table 2).

Figure 19 shows the CDF for CRAM Index (for reference) and Attribute scores in a matrix of small plots to visually compare differences and similarities in stream conditions between PAIs at the Attribute level.

The Buffer and Landscape Context Attribute CDF curves indicate that the majority of stream miles in the watershed are in good condition with only 37% (95%CL between 25-50%) of stream miles in the watershed with scores of 75 or less. The Sunnyvale Buffer CDF is visibly (and statistically) different from the CDF curves for both the Calabazas and San Tomas-Saratoga PAIs, which are not significantly different from each other based on a Wald F test. 40% (95%CL between 21-49%) of the stream miles in the Sunnyvale PAI have poor Buffer condition (Buffer Scores ≤ 50). The Buffer CDFs for the Calabazas and San Tomas-Saratoga PAIs are relatively flat (meaning they start with a gradual upward slope that increases at higher CRAM scores), and indicate that most of the stream miles in those PAIs have fair to good buffer conditions. These differences are largely a reflection of the relative proportions of stream miles in the undeveloped upper watersheds of each PAI and does not mean that the buffer conditions in the urban, highly developed areas of the sub-watersheds are necessarily different from one another. Further review of the CRAM Buffer Metrics might show differences in the buffer conditions in the urban streams between PAIs.

The Hydrology Attribute CDF curves are generally similar between the watershed and the individual PAIs, with the majority of stream miles in the ‘fair’ condition class (scores between 51-75). However, the San Tomas-Saratoga CDF is visibly (and statistically) different from the CDF curves for both the Sunnyvale and Calabazas PAIs, which are not significantly different from each other based on the Wald F test. This difference is likely because the San Tomas-Saratoga PAI is shifted slight to the right compared to the other PAIs: it has the highest hydrologic condition score in the watershed and has only 9% of streams in poor Hydrologic condition (scores ≤ 50) where Sunnyvale and Calabazas PAIs have 37% and 51% of streams in poor

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[12] Wald and Rao-Scott statistical test (Kincaid 2016, Gitzen *et al*. 2012) is a function in the spsurvey data analysis package to identify significant differences between the CDFs of the West Valley PAIs.

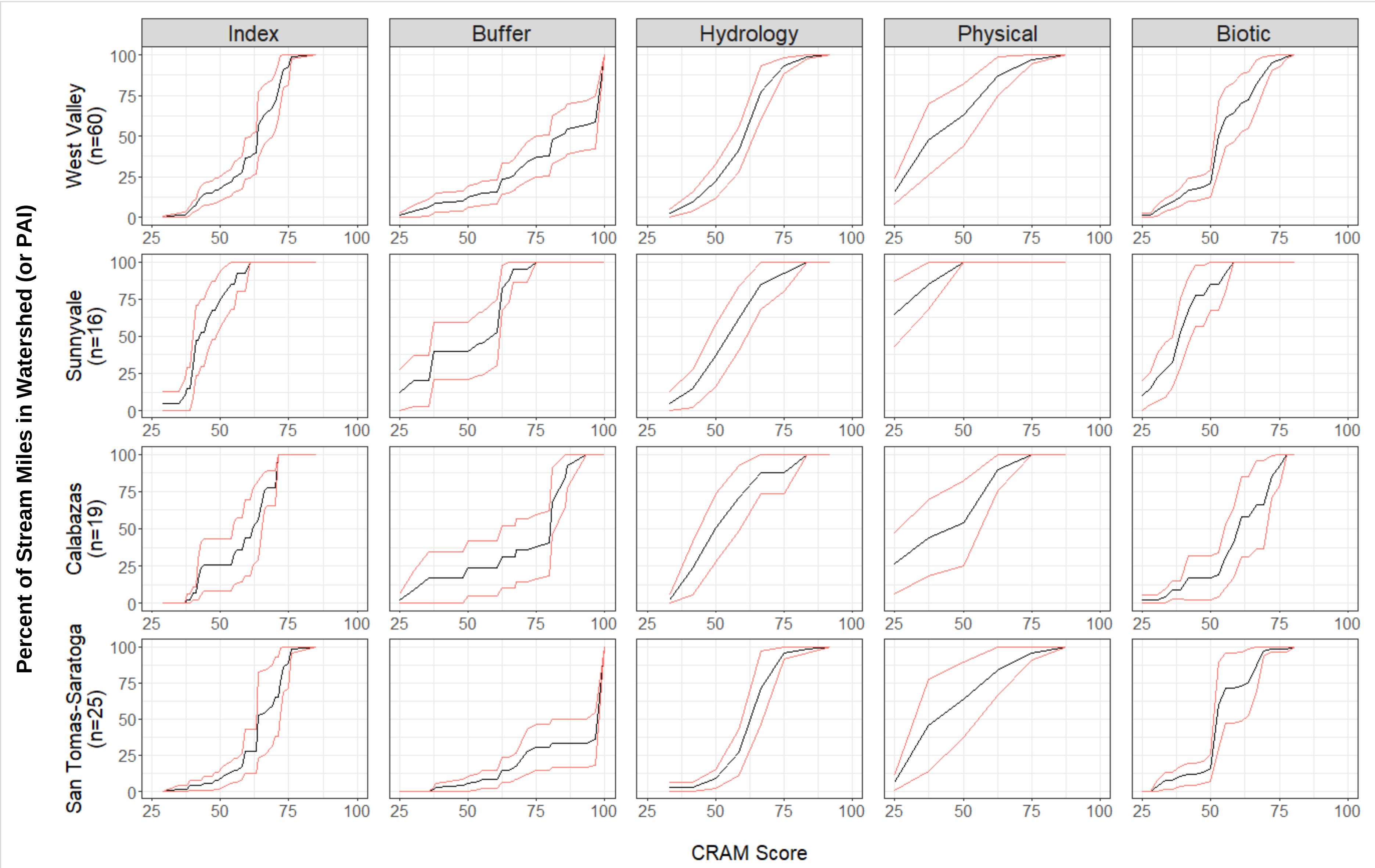

Figure 19 CDF plots of CRAM Index and Attribute Scores for the West Valley study area and its three PAIs.

hydrologic condition (respectively). These Hydrology Scores (largely in fair ecological condition) reflect the urbanized watershed, and its modified hydrology (water source) and incision (due to hydromodification impacts and increased channel network connectivity). The prevalence of narrow and deep channels that do not connect to a floodplain, including natural stream reaches in the upper watersheds and engineered channels in the urban areas, also contribute to the lower CRAM Hydrology Scores.

The Physical Structure Attribute CDF curves (Figure 18 above) indicate generally poor overall condition across the watershed and in each PAI (however, the 95% CLs are highly variable). All the CDF curves are shifted to the left (compared to the other Attributes), indicating lower Physical Structure condition scores in general. The Sunnyvale PAI is an extreme example (with 100% of the stream miles having Physical Structure Scores of 50 or less). The ‘poor’ and ‘fair’ conditions across the watershed and component PAIs are influenced by the amount of engineered channel in the watershed. These channels are often constructed with a uniform shape and uniform slopes. They lack micro- and macro-topographic complexity, and typically do not support a variety of structural patch types. In addition, the natural stream reaches in the upper watershed of the West Valley study area tend to have low physical complexity largely due to the steep hillslopes. Physical Structure represents an aspect of the stream condition that could be an opportunity for restoration/mitigation/enhancement projects in the future. Drilling down to better understand the CRAM Physical Structure Metric scores can help planners and engineers identify the kinds of physical functions to improve.

And lastly, the Biotic Structure Attribute CDF curves indicate that over half of the stream miles in the watershed have ‘fair’ condition scores (largely in the 50s). Again, the Sunnyvale PAI CDF is shifted to the left, representing the dominance of channel length with managed (e.g. mowed) herbaceous vegetation and only scattered overstory trees or shrubs. These scores could be improved by planting overstory vegetation where space is available and flood conveyance requirements allow. In all PAIs, invasive vegetation is contributing to the lower scores, and represents an opportunity for improvement. We also find that the upper watershed stream lengths typically have ‘fair’ condition scores; in many reaches the stream does not have a complex understory, contributing to the lower scores.

- What are the watershed and PAI ESIs for the 2018 CRAM stream condition survey?

An ESI is a numerical statistic, developed for the D5 Project that represents the sample weighted average CRAM score for a watershed or PAI. It is developed from the CRAM Index Score CDF estimates. The ESI can be used to track stream ecosystem condition over time and could be the basis for establishing a quantitative ecological LOS, or benchmarks of performance for each PAI or the watershed as a whole.

Baseline ESIs for the West Valley watershed study area and its three PAI’s are presented graphically in Figure 20, and listed below with their 95% confidence interval ranges (in parentheses), and the number of AAs assessed in each area. West Valley ESI scores:

- West Valley watershed: **62** (58-66) n=60
- Sunnyvale: **45** (41-50) n=16
- Calabazas: **59** (53-65) n=19
- San Tomas-Saratoga: **65** (60-70) n=25

The West Valley ESIs range from 45 to 65 and indicate that the streams within the Sunnyvale PAI are generally in poor condition, while streams in the Calabazas and San Tomas-Saratoga PAIs are generally in fair condition. These ESI represent the 2018 baseline ecological condition of streams in the watershed and its PAIs and can be compared to the other Priority D5 Project baseline stream condition assessments (presented below).

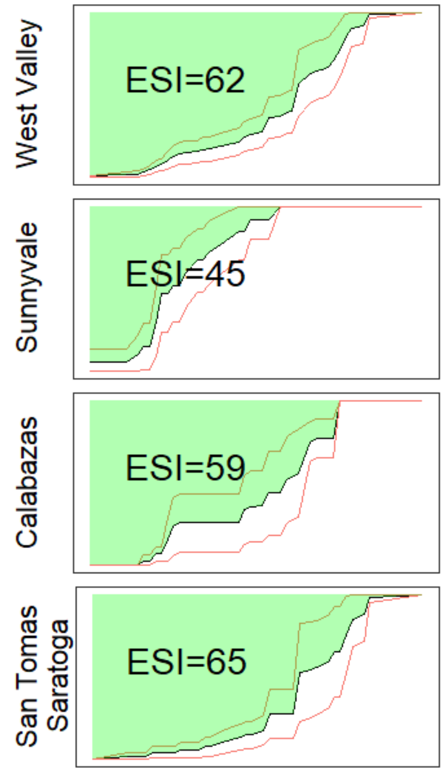

Figure 20. ESIs for the West Valley watershed and its PAIs based on the 2018 stream condition survey CRAM Index Scores

- How does the overall ecological condition of streams in the West Valley watershed compare to other Valley Water watersheds, and other regions?

The D5 Project's ambient stream condition assessments can be used to compare Valley Water watersheds to other watersheds, regionally and statewide, because they employ the same probability-based (GRTS) survey design and CRAM field assessment methods. Figure 21 compares the overall ecological condition of streams in Santa Clara County's five major watersheds and other regions, based on their CRAM ecological health classes. The bar chart shows the relative proportions of stream miles in poor, fair, and good ecological condition based on the Index Score and standard CRAM tertiles (25-50 poor, 51-75 fair, and 76-100 good condition, respectively).

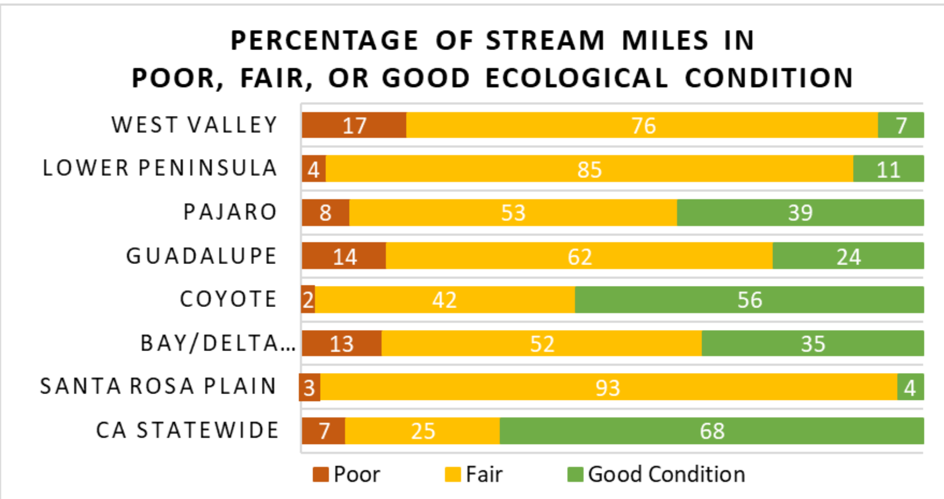

Figure 21. Comparison of the percent of streams in poor, fair, or good ecological condition in Valley Water's five major watersheds within Santa Clara County, other nearby regions, and statewide based on the standard CRAM Index Score health classes (tertiles).

The probability-based CRAM stream condition surveys represented in Figure 20 were completed by Valley Water's D5 Project, SFEI, and the California Surface Water Ambient Monitoring Program's (SWAMP 2016) Perennial Stream Assessment Program (PSA[13]) over the past decade:

- West Valley watershed: n=60 (Valley Water 2018)
- Lower Peninsula watershed: n=54 (Valley Water 2016[14])
- Upper Pajaro River watershed: n=81 (Valley Water 2015)
- Guadalupe watershed: n=53 (Valley Water 2012)
- Coyote Creek watershed: n=77 (Valley Water 2010)
- Bay/Delta Ecoregion CDF: n=40 (subset of PSA 2008-2014)
- Santa Rosa Plain - WRAMP demonstration project: n=30 (SFEI 2013[15])
- Statewide Perennial Stream Assessment: n=765 (SWAMP-PSA and Southern California Stormwater Monitoring Coalition 2008-2014[16])

Table 7 further compares the overall ecological condition of streams in Santa Clara County's five major watersheds using the D5 Project's calculated stream ESI scores.

Table 7. Comparison of stream ESIs in Santa Clara County watersheds based on Valley Water's D5 Project's CRAM ambient stream condition surveys (2010 – 2018).

Watershed	ESI (95% CI)	ESI for PAIs (95% CI)		
		Sunnyvale	Calabazas	San Tomas-Saratoga
West Valley (2018)	**62**	**45**	**59**	**65**
	(58-66)	(41-50)	(53-65)	(60-70)
		San Francisquito*	Adobe	Stevens-Permanente
Lower Peninsula (2016)	**66**	**67**	**64**	**67**
	(63-77)	(61-73)	(57-71)	(63-71)
		Pacheco*	Llagas	Uvas
Upper Pajaro (2015)	**70**	**75**	**60**	**62**
	(63-77)	(70-80)	(56-65)	(49-75)
		Non-urban	Urban	
Guadalupe (2012)	**68**	**72**	**63**	
	(65-71)	(70-75)	(57-68)	
		Upper Penitencia		
Coyote Creek (2010)	**75**	**73**		
	(72-78)	(70-75)		

*only stream reaches within Santa Clara County

[13] http://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/

[14] Valley Water watershed assessments available at http://www.valleywater.org/SCW-D5.aspx

[15] Collins *et al.* 2014.

[16] Perennial Stream Assessment Program of the Stated Water Resources Control Board; http://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/

- What are the likely stressors impacting stream condition based on the CRAM Stressor Checklist?

CRAM includes a stressor checklist of up to 52 different stressors (depending on the Module) where field teams answer two questions for each stressor:

1. Is the stressor visibly present?
2. Do they expect the stressor to significantly and adversely influence the AA, based on a list of standard indicators and sets of considerations?

A CRAM stressor is defined as an anthropogenic perturbation within the AA or its environmental setting that is likely to negatively influence the condition and function of the wetland or stream. Stressors for hydrology, physical structure, and biotic structure must be evident within 50 meters of the AA, and buffer and landscape context stressors must be present within 500 meters of the AA in order for the field team to record them.

Table 8 lists the most common and significant CRAM stressors in the West Valley watershed and its PAIs. It summarizes 1) the percentage of AAs where the stressor was observed within the watershed or PAI, and 2) the percentage of AAs where the observed stressor was thought to have a significant and adverse impact on the AA.

For the purposes of this report, the most common stressors were defined as those that were observed within at least 25% of the AAs in the West Valley watershed, or at least one of its PAIs. Some stressors were commonly observed but did not always show a significant and adverse impact on ecological condition – those stressors are listed in blue in Table 8.

Table 8 also indicates which stressors respond to management efforts, because negative effects of some stressors can be mitigated through the presence of riparian buffers and/or changes in stream and riparian management practices.

The four most common and significant stressors that have an impact on the overall stream conditions in the West Valley watershed and its PAIs include:

- Urban residential
- Transportation corridor
- Engineered channel (riprap, armored channel bank or bed)
- Lack of treatment of invasive plants adjacent to AA or buffer

Many of these urban stressors are ubiquitous and intrinsic to highly developed areas and are difficult to eliminate. Therefore, one would expect stressors such as transportation corridors, urban residential, and non-point source discharges to be common in urban areas.

It should be noted that the relative importance of different stressors and their significant impact on the stream is disregarded by CRAM. The Practitioner is not asked to rank stressors, nor provide any additional information about the frequency, duration, or extent of the stress. The Checklist simply records the presence or absence of the stressor, and then adds a subjective determination about whether the stressor is causing a significant negative effect upon the AA. Practitioners are taught that stressors should be considered significant if they are directly affecting the score of any given CRAM Metric within the AA, or if the activity is clearly affecting morphology, function, or other natural processes within the stream.

Table 8. Summary of CRAM stressors that were observed in at least 25% of the field assessments in the West Valley watershed or at least one of its PAIs (2018). Some stressors were commonly observed (blue text), but did not show significant and adverse impacts on ecological condition. An 'X' indicates if the stressor is responsive to changes in buffer condition and/or in-stream management practices.

Attribute	CRAM Stressor	Percent of AAs where stressor was observed				Percent of AAs where stressor was considered significant enough to impact condition				Responsive to Changes in Buffer Condition	Responsive to In-stream Management Practices
		Whole Watershed	Sunnyvale	Calabazas	San Tomas-Saratoga	Whole Watershed	Sunnyvale	Calabazas	San Tomas-Saratoga		
Buffer & Landscape Context	Urban residential	87	94	89	80	27	38	32	15	X	
	Transportation corridor	85	100	74	85	24	31	21	20	X	
	Industrial/commercial	35	69	21	20	7	25	0	0	X	
	Sports fields & urban parklands (incl. golf courses)	42	50	37	40	7	0	11	10	X	
	Active recreation (off-road vehicles, mountain biking, hunting, fishing)	16	6	26	15	0	0	0	0	X	
	Passive recreation (e.g. bird watching, hiking)	40	38	32	50	0	0	0	0	X	X
Hydrology	Engineered channel (riprap, armored channel, bed)	51	56	58	40	27	19	42	20		X
	Non-point Source discharges	85	100	79	80	15	0*	26	15	X	X
	Flow obstructions (culverts, paved crossings)	42	63	32	35	4	6	5	0		X
Physical Structure	Vegetation management	44	50	47	35	4	0	11	0	X	X
	Trash or refuse	45	63	37	40	0	0	0	0	X	X
	Grading/compaction (N/A for restoration areas)	15	19	0	25	0	0	0	0	X	
Biotic Structure	Lack of treatment of invasive plants adjacent to AA or buffer	45	63	42	35	16	31	11	10	X	
	Lack of vegetation management to conserve natural resources	22	25	26	15	11	19	5	10	X	X
	Excessive human visitation	33	31	32	35	9	0	11	15	X	
	Predation and habitat destruction by non-native vertebrates (e.g., Virginia opossum and feral pets)	53	63	47	50	0	0	0	0	X	

* It is possible that significant impact was not properly recorded for this stressor, because it seems unlikely that streams in the highly urban Sunnyvale PAI indicated 100% presence of non-point source discharges but none were significantly and adversely impacting the ecological conditions of the channels.

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Appendix A

West Valley Watershed Assessment 2018: CRAM Stream Condition Survey Results

Figure A1. Map of final CRAM assessment areas (AAs) with SiteID labels

Table A1. CRAM assessment scores with site information

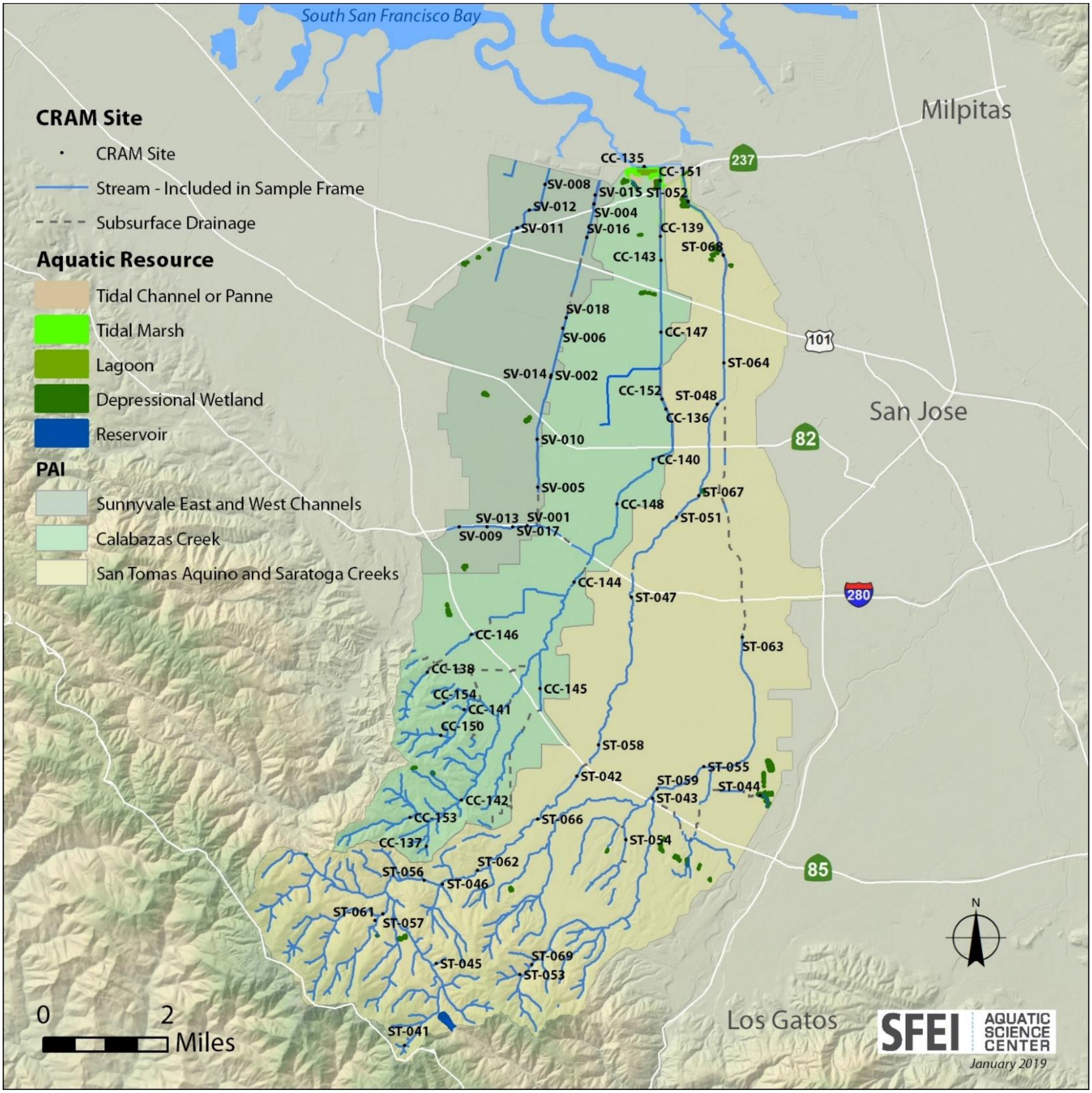

Figure A1. Map of Valley Water's D5 Project's ambient stream condition survey sites completed in the West Valley watershed May-July 2018 (with site IDs).

Appendix Table A1. 2018 West Valley watershed CRAM stream survey results including assessment area (AA) siteIDs, eCRAM AARowIDs, visit date, basic wetland type and area information, and CRAM Index and Attribute Scores. Seven of the sixty AAs are not listed here because the landowners did not want the specific field assessment results published.

Site ID	AARow ID	Visit Date	Wetland Class	Wetland Subclass	Hydroregime (Riverine)	AA Size (ha)	Bankfull Width (m)	Flowing Water	Index Score	Buffer and Landscape Context	Hydrology	Physical Structure	Biotic Structure
Primary Area of Interest: Calabazas Creek (Calabazas)													
CC-135	6540	5/22/2018	riverine	riverine non-confined	perennial	0.82	15	1	**58**	75.00	83.33	37.50	36.11
CC-136	6338	5/3/2018	riverine	riverine confined	perennial	0.21	5	1	**38**	50.00	41.67	25.00	36.11
CC-138	6472	7/18/2018	riverine	riverine non-confined	intermittent	0.27	1.34	0	**55**	35.75	50.00	75.00	61.11
CC-139	6456	7/17/2018	riverine	riverine non-confined	perennial	0.17	5.33	1	**64**	75.00	58.33	62.50	58.33
CC-140	6439	6/12/2018	riverine	riverine confined	perennial	0.11	5	1	**42**	67.67	41.67	25.00	33.33
CC-143	6431	6/12/2018	riverine	riverine non-confined	perennial	0.39	6.4	1	**67**	80.63	83.33	50.00	55.56
CC-144	6339	5/3/2018	riverine	riverine confined	perennial	0.25	7.2	1	**44**	25.00	58.33	37.50	55.56
CC-145	6340	5/3/2018	riverine	riverine confined	intermittent	0.13	3.4	0	**43**	62.50	41.67	25.00	41.67
CC-147	6341	5/4/2018	riverine	riverine confined	perennial	0.16	6	1	**40**	67.67	41.67	25.00	25.00
CC-148	6416	5/21/2018	riverine	riverine confined	perennial	0.16	8.73	1	**63**	50.00	66.67	75.00	61.11
CC-151	6533	6/14/2018	riverine	riverine non-confined	perennial	0.17	5	1	**56**	79.75	83.33	25.00	36.11
CC-152	6477	6/14/2018	riverine	riverine confined	perennial	0.17	1.9	1	**40**	50.00	33.33	25.00	52.78
CC-153	6454	7/18/2018	riverine	riverine non-confined	perennial	0.13	2.33	1	**71**	86.42	58.33	62.50	77.78
CC-154	6453	7/13/2018	riverine	riverine non-confined	intermittent	0.27	0.83	0	**62**	93.29	66.67	25.00	61.11
Primary Area of Interest: San Tomas Aquino and Saratoga Creeks (San Tomas-Saratoga)													
ST-041	6469	7/17/2018	riverine	riverine non-confined	perennial	0.14	3.55	1	**72**	100.00	66.67	50.00	69.44
ST-042	6418	5/22/2018	riverine	riverine non-confined	perennial	0.21	6.7	1	**44**	38.25	50.00	37.50	50.00
ST-043	6415	5/22/2018	riverine	riverine non-confined	ephemeral	0.10	5.2	0	**48**	62.50	75.00	25.00	30.56
ST-044	6430	5/24/2018	riverine	riverine non-confined	intermittent	0.14	5.9	0	**39**	37.50	58.33	25.00	33.33
ST-046	6342	5/4/2018	riverine	riverine non-confined	perennial	0.42	7.43	1	**85**	96.54	91.67	87.50	63.89

Site ID	AARow ID	Visit Date	Wetland Class	Wetland Subclass	Hydroregime (Riverine)	AA Size (ha)	Bankfull Width (m)	Flowing Water	Index Score	Buffer and Landscape Context	Hydrology	Physical Structure	Biotic Structure
ST-047	6452	7/17/2018	riverine	riverine non-confined	intermittent	0.29	7.35	0	**54**	53.96	58.33	37.50	66.67
ST-048	6332	5/3/2018	riverine	riverine non-confined	perennial	0.15	8.73	1	**51**	48.25	50.00	62.50	41.67
ST-051	6337	5/3/2018	riverine	riverine confined	ephemeral	0.30	6.58	0	**58**	62.50	58.33	50.00	61.11
ST-052	6537	5/22/2018	riverine	riverine confined	perennial	0.28	10	1	**66**	75.00	83.33	50.00	55.56
ST-053	6545	7/12/2018	riverine	riverine confined	perennial	0.47	2.3	1	**73**	100.00	75.00	62.50	55.56
ST-054	6451	7/19/2018	riverine	riverine non-confined	perennial	0.09	1.98	1	**59**	71.67	58.33	37.50	66.67
ST-055	6333	5/2/2018	riverine	riverine confined	ephemeral	0.17	3.5	0	**39**	66.46	33.33	25.00	30.56
ST-056	6335	5/4/2018	riverine	riverine non-confined	perennial	0.27	6.88	1	**75**	96.54	66.67	87.50	50.00
ST-057	6475	6/13/2018	riverine	riverine non-confined	perennial	0.41	5.8	1	**69**	100.00	75.00	50.00	52.78
ST-059	6336	5/4/2018	riverine	riverine non-confined		0.14	6.45	0	**54**	55.17	50.00	62.50	47.22
ST-061	6474	7/26/2018	riverine	riverine non-confined	perennial	0.29	4.1	1	**76**	100.00	75.00	75.00	52.78
ST-062	6447	5/2/2018	riverine	riverine non-confined	perennial	0.21	8	1	**75**	80.63	66.67	87.50	63.89
ST-063	6334	5/3/2018	riverine	riverine confined	ephemeral	0.29	6.43	0	**35**	50.00	33.33	25.00	33.33
ST-064	6428	5/24/2018	riverine	riverine non-confined	perennial	0.13	10.6	1	**51**	62.50	58.33	50.00	33.33
ST-066	6501	8/6/2018	riverine	riverine non-confined		0.16	5.2	0	**58**	62.50	58.33	37.50	72.22
ST-067	6432	6/12/2018	riverine	riverine confined	perennial	0.15	6.2	1	**67**	67.25	58.33	62.50	80.56
ST-068	6457	7/13/2018	riverine	riverine non-confined	perennial	0.27	4.6	1	**68**	75.00	83.33	75.00	38.89
ST-069	6535	8/30/2018	riverine	riverine confined	perennial	0.14	4.2	1	**70**	100.00	66.67	62.50	52.78
Primary Area of Interest: Sunnyvale East and West Channels (Sunnyvale)													
SV-001	6365	5/21/2018	riverine	riverine confined		0.05	1.9	0	**41**	64.88	50.00	25.00	25.00
SV-002	6446	5/1/2018	riverine	riverine non-confined	intermittent	0.17	4	0	**40**	25.00	66.67	25.00	41.67
SV-004	6409	5/23/2018	riverine	riverine non-confined	perennial	0.11	4.6	1	**61**	62.50	83.33	50.00	50.00
SV-005	6366	5/21/2018	riverine	riverine non-confined	intermittent	0.05	2.2	0	**54**	66.46	66.67	25.00	58.33
SV-006	6367	5/23/2018	riverine	riverine non-confined	perennial	0.11	4.1	1	**45**	37.50	50.00	37.50	55.56

Site ID	AARow ID	Visit Date	Wetland Class	Wetland Subclass	Hydroregime (Riverine)	AA Size (ha)	Bankfull Width (m)	Flowing Water	Index Score	Buffer and Landscape Context	Hydrology	Physical Structure	Biotic Structure
SV-008	6411	5/23/2018	riverine	riverine non-confined	perennial	0.11	5	1	**51**	75.00	58.33	25.00	44.44
SV-009	6417	5/21/2018	riverine	riverine confined	intermittent	0.07	0.75	0	**43**	62.50	58.33	25.00	25.00
SV-010	6429	5/24/2018	riverine	riverine non-confined	ephemeral	0.07	1.9	0	**56**	60.75	75.00	50.00	38.89
SV-011	6546	7/11/2018	riverine	riverine confined	perennial	0.03	3	1	**29**	25.00	33.33	25.00	33.33
SV-012	6413	5/24/2018	riverine	riverine non-confined	perennial	0.05	2.8	1	**49**	62.50	50.00	37.50	44.44
SV-013	6442	6/11/2018	riverine	riverine confined	intermittent	0.10	1.1	0	**41**	62.50	41.67	25.00	36.11
SV-014	6441	6/11/2018	riverine	riverine non-confined	intermittent	0.19	3.2	0	**47**	62.50	58.33	25.00	41.67
SV-015	6541	7/11/2018	riverine	riverine non-confined	perennial	0.06	3.9	1	**38**	37.50	50.00	25.00	38.89
SV-016	6466	7/16/2018	riverine	riverine non-confined	perennial	0.11	5	1	**40**	37.50	58.33	25.00	38.89
SV-017	6440	6/12/2018	riverine	riverine confined	intermittent	0.14	1.6	0	**37**	53.96	41.67	25.00	27.78
SV-018	6482	7/10/2018	riverine	riverine non-confined	perennial	0.08	4.13	1	**41**	30.17	66.67	37.50	30.56

Appendix B

Wald F Test Results Comparing CDFs of the West Valley Watershed PAIs

Wald and Rao-Scott statistical test (the Wald F test) is a function in the GRTS spsurvey data analysis package used to identify significant differences between the CDF estimates for the West Valley PAIs. Below is a table that list the results. grey = significantly different (p-value <0.05). Note: the San Tomas PAI listed below is the San Tomas-Saratoga PAI.

PAI_1	PAI_2	Indicator	Wald_F	Degrees_of_ Freedom_1	Degrees_of_ Freedom_2	p_Value
Calabazas	San Tomas	Index	2.31	2	41	0.112
Calabazas	Sunnyvale	Index	9.11	2	31	0.001
San Tomas	Sunnyvale	Index	48.99	2	37	0.000
Calabazas	San Tomas	Buffer	1.18	2	41	0.318
Calabazas	Sunnyvale	Buffer	15.55	2	31	0.000
San Tomas	Sunnyvale	Buffer	41.52	2	37	0.000
Calabazas	San Tomas	Hydrology	6.17	2	41	0.005
Calabazas	Sunnyvale	Hydrology	0.34	2	31	0.713
San Tomas	Sunnyvale	Hydrology	3.46	2	37	0.042
Calabazas	San Tomas	Physical	2.75	2	41	0.076
Calabazas	Sunnyvale	Physical	5.64	2	31	0.008
San Tomas	Sunnyvale	Physical	17.43	2	37	0.000
Calabazas	San Tomas	Biotic	2.89	2	41	0.067
Calabazas	Sunnyvale	Biotic	14.25	2	31	0.000
San Tomas	Sunnyvale	Biotic	6.20	2	37	0.005