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December 20, 2019

Mr. Jack Xu  
Santa Clara Valley Water District  
jxu@valleywater.org

**Subject: Los Gatos Creek Independent QC and Revisions to FINAL HEC-RAS model**

Dear Mr. Xu:

This letter represents a review of the HEC-RAS model for Los Gatos Creek from downstream of Highway 280 to the confluence with Guadalupe River. It is intended to accompany the memo produced by Valley Water, attached as Appendix B, to document the changes made to the modeling to date. A summary is provided for the items in the model which were changed in order to provide a basis for a concurrence memorandum to establish the revised model as the Best Available to use in planning for the Diridon Area.

Model History:

- Los Gatos Creek 2D RAS provided by Valley Water dated 08.27.18
- Updated Los Gatos Creek 2D RAS provided by Valley Water dated 05.23.19
- Los Gatos Creek 2D RAS updated by S&W dated 07.19.19
- Los Gatos Creek 2D RAS updated by S&W dated 10.18.19
- Los Gatos Creek 2D RAS updated by S&W dated 12.19.19

Revisions made between the May and December versions:

1. Updated land cover n-values map layer to correct for transposition of areas identified as roads and buildings, respectively
2. Corrected flipped cross sections 3658 and 3759
3. Updated bank station locations for cross sections from 5959 to the confluence with Guadalupe River from the low flow to the top of the channel
4. Independently computed and calibrated channel bed n value, composited cross section values and removed horizontally varied roughness for cross sections from 5959 to the confluence.
5. Updated 2D boundary condition of Guadalupe River downstream of the confluence to allow flow back into the channel for conformance to upstream assumptions.
6. Revised 2D area grid size from 50 ft square to 10 ft square
7. Reduced computation interval from 1 minute to 5 seconds; reduced mapping output interval from 5 minutes to 30 seconds.

The methodologies used for the basis of revisions is described in more detail below:

## Bank Stations

HEC-RAS defaults to compositing horizontally varied n-values for bank slopes greater than 5H:1V. Placing main channel bank stations at top of channel results in a high RAS composited n-value (example XS 5959 of 0.082 or XS 2723 of 0.071), which ranks at the high end of ten composite equations detailed in Appendix A. Note that RAS utilizes one of these ten equations which assumes each part of the cross sectional area has the same mean velocity and all are equal to the mean velocity of the whole section.<sup>1</sup> This assumption does not seem particularly valid with a widely varying roughness across the channel section. Placing bank stations at the top of the low flow channel calculates a low RAS composite Manning's "n". This results in high channel velocities generally above 10 ft/s and up to 16 ft/s<sup>2</sup>.

As the intent of the model is to run nearly bank full events, and banks at the low flow underestimate the influence of the vegetated slopes, banks at the top of the channel are considered to be the appropriate location. Additionally, the shape of the channel varies along the reach from Interstate 280 to the confluence but is generally trapezoidal with an incised low flow without prominent floodplain benches, which further supports placing model banks at the top of the channel. There is a significant difference in composite roughness when moving the model main channel bank stations from the low flow to the top of the channel with no other modifications as seen in Figures 1-4.

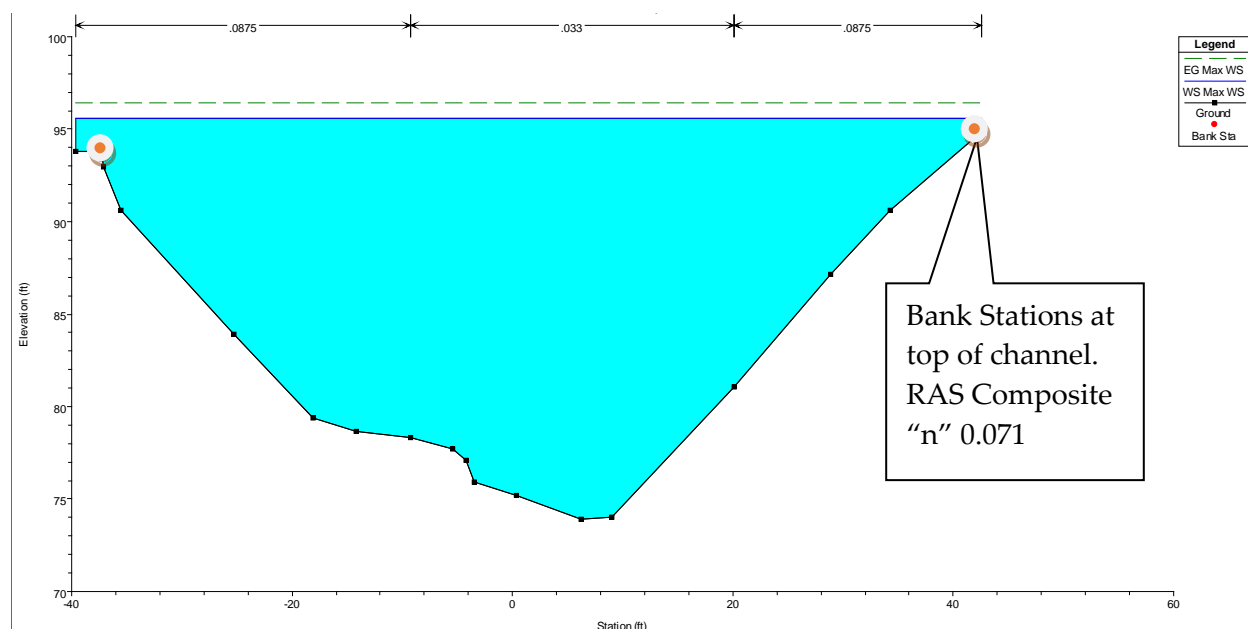


Figure 1: XS 2723 Downstream of Montgomery Road Culvert – Banks at Top

<sup>1</sup> Chow equation 6-17, 1959  $n_c = [1/P \sum (n_i^3 P_i)]^{2/3}$

<sup>2</sup> Greater velocities occurred near the confluence, but were found to be a result of normal depth tailwater assumption

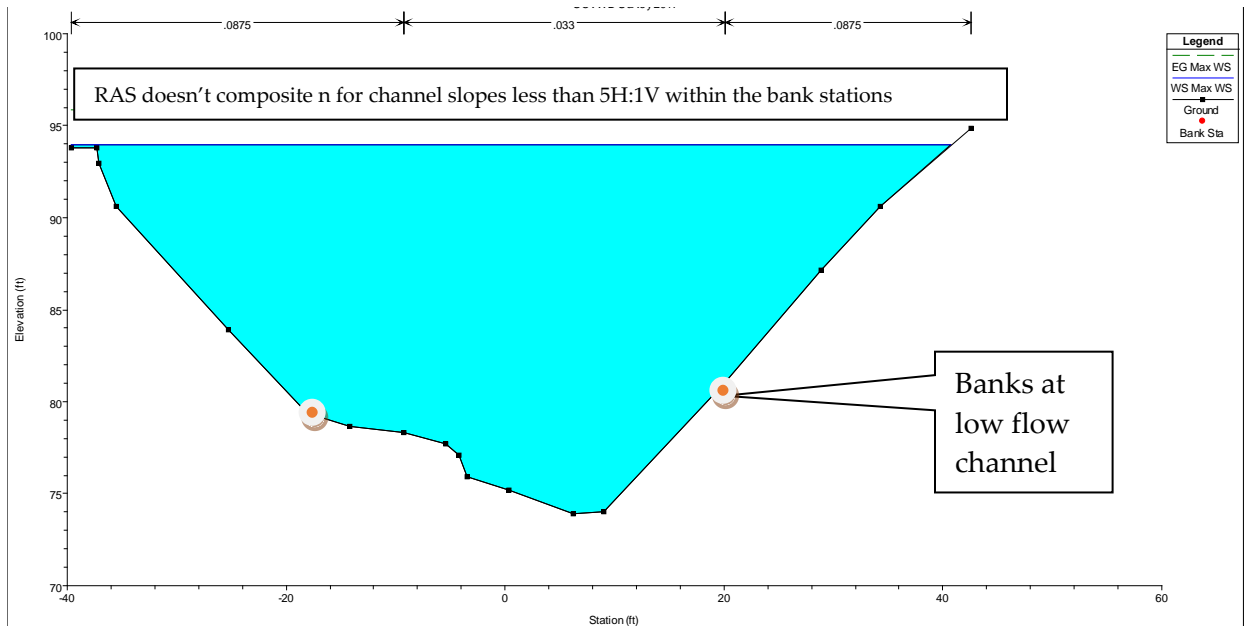


Figure 2: XS 2723 Downstream of Montgomery Road Culvert – Banks at Low Flow

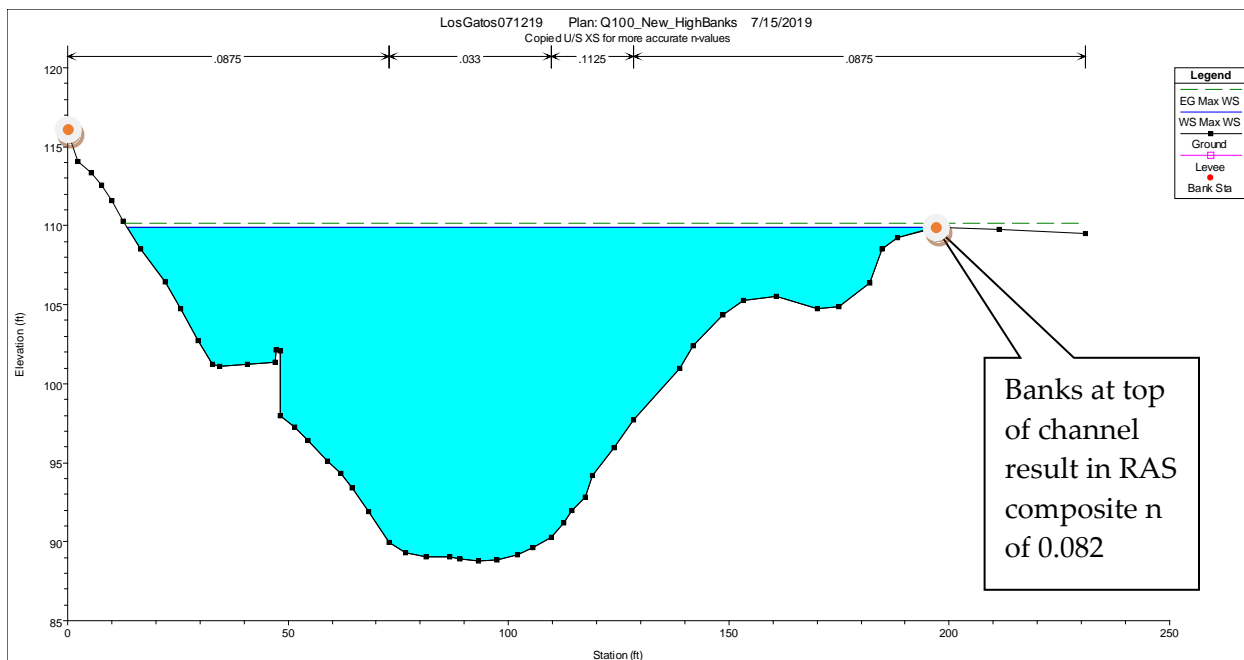


Figure 3: XS 5959 Downstream of Highway 280 – Banks at Top

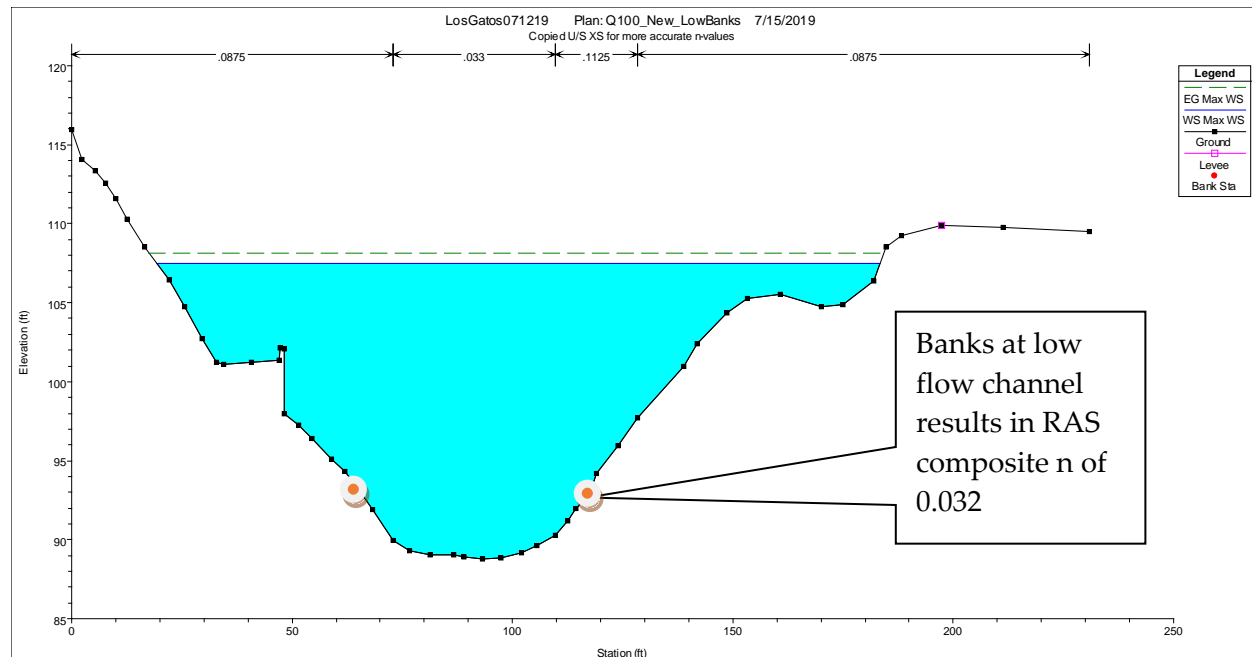


Figure 4: XS 5959 Downstream of Highway 280 – Banks at Low Flow

### Calibrated and Composited Manning's n

The goal became to independently develop a composite roughness to input into the RAS model in order to bypass the model's single equation composite calculation and the influence of the location of the main channel bank stations. The RAS composited n-value appears to be too conservative for the observed roughness utilizing the horizontally varied n from the Valley Water model (May 2019). Therefore, an attempt is made to use observed flow and stage data to calibrate composite roughness during the lower flow events and back calculate the bank roughness.

S&W performed a sensitivity analysis on composite manning's roughness with the banks at the top of channel. The model was run in mixed flow steady state for the three recorded events in 2017 and the high water mark event in 2019. Steady state was deemed appropriate as there was no overbank flooding; thereby limiting the calibration to the in-channel model. The three 2017 events were gauged at Lincoln Avenue for stage and flow. It was found that at the calibration event flow rates, the water surface at the gauge location is not sensitive to changes in channel "n" due to the hydraulics associated with the weir drop structure at the gauge location. While this provides greater confidence in the stage and flow measurements, the gauge cannot be reliably used to calibrate "n" and therefore, the three 2017 events are studied no further.

The 2019 high water mark event had a relatively low flow rate of 1,280 cfs when compared to the bank full flow, which resulted in a maximum flow depth of approximately 6 feet that only partially interacted with the vegetated banks. The high water marks near Santa Clara Street Bridge appear to be influenced by backwater from Guadalupe River as they are inconsistent with the upstream high water marks and causes calibrating to them to result in an unlikely channel bed roughness. It is also understood that there was a reasonably high flow in Guadalupe River at the time of the measurements that could contribute to the tailwater effect. The high water mark just upstream of the re-built 2017 Caltrain RR Bridge at cross section 4428 is also not sensitive to channel roughness as it is at critical depth. That leaves the high water marks at Auzerais Avenue Bridge and San Fernando

Street Bridge. These high water marks calibrate best to a composite n-value of approximately 0.02-0.03 which allows the conclusion that the low flow channel is clean and straight.

The composite roughness for the calibration event water depth was entered into the composite n-value spreadsheet in order to back calculate the vegetated bank n-values. The composite roughness spreadsheet compared 10 different methodologies. Using a low flow channel “n” of 0.025, the bank roughness was calculated to be approximately 0.05. However, the depth of flow in the calibration event did not significantly interact with the banks. In the absence of larger-event flow and stage data, field observation, published values and engineering judgement must be used to supplement the back calculation of the bank roughness values from the 2019 calibration event.

S&W also performed a creek walk and input the observed data into the Cowen’s methodology to independently develop n-values. This generally resulted in low flow n-values of 0.025 and banks of 0.065. Valley Water’s similar analysis resulted in higher “n” values that were within a standard deviation from those developed by S&W.

Ultimately, the Valley Water bank “n” values from the May 2019 model were used for the bank n-values with a low flow of 0.025 from the calibration described above. A composite roughness is calculated for each of the cross sections downstream of Highway 280 (XS 5959) to the confluence (XS 73) as shown in the attached spreadsheet<sup>3</sup>. The horizontally varied n-value is removed and replaced by the calculated composite n to the top of the channel banks of 0.033-0.074, with the lower values representing bridges and other cross section specific variations.

### **Starting Water Surface Elevation Boundary Condition**

The downstream boundary condition of normal depth is compared to the 10- and 100-year FEMA water surface elevations of 80 and 83.3 feet NAVD88 respectively in Guadalupe River at the confluence of Los Gatos Creek. The mapped extents of flooding are found to be substantially similar regardless of these three conditions and therefore insensitive to the boundary assumption.

### **Grid Size**

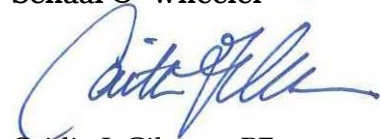
The 2D area grid size is reduce from the May 2019 model from 50 feet square to 10 feet square. The intent is to provide better refinement in the surface to more accurately map surface flooding and to better encompass features such as roadways.

### **Computational Interval**

In order to provide smoother outputs and more accurately calculate the two-dimensional floodplain, the model computation time was reduced from 1 minute to 5 seconds, and the mapping output interval was reduced from 5 minutes to 30 seconds.

Sincerely,

**Schaaf & Wheeler**



Caitlin J. Gilmore, PE  
Senior Project Manager

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<sup>3</sup> LOS GATOS\_Composite n Calcs\_09.03.2019.xlsx

# APPENDIX A

## Composite Roughness Calculations

In one-dimensional open channel flow analysis, “Manning’s  $n$ ” is used to represent the retarding forces to flow imposed by the channel bed and banks. Roughness elements along the wetted perimeter of Los Gatos Creek may vary across an individual cross section. For instance, the channel cross section might contain elements of grassed banks, mature riparian vegetation including trees, shrubs or brush, emergent wetland areas and/or open water. To compute water surface elevations in a channel with variable roughness using a one-dimensional model (i.e. with a mean velocity), it is necessary to estimate an effective (composite) roughness value for each cross section. This memorandum documents the estimation of composite roughness values for the typical cross sections of Los Gatos Creek between Interstate 280 and the confluence with Guadalupe River.

### Methodology

Methods for computing the apparent roughness coefficient based on a weighted distribution of roughness elements are available in the literature. Soong and Hoffman<sup>1</sup> present ten methods for determining a weighted roughness coefficient, which are summarized by Table A-1.

### Composite Roughness Calculations

The attached spreadsheets present composite roughness calculations for each of the representative typical reach cross sections. The composite roughness estimate used is an average of nine of the ten methods shown in Table A-1. Composite roughness estimates achieved using the Lotter Equation (Equation 1) appear to be low outliers and have therefore been discarded from the averages based on engineering judgment. Manning’s roughness coefficients for each type of channel vegetation are shown in Table A-2.

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<sup>1</sup> Soong, Ta Wei and Hoffman, Matthew J., “Effects of Riparian Tree Management on Flood Conveyance Study of Manning’s Roughness in Vegetated Floodplains with an Application on the Embarras River in Illinois,” Illinois Department of Natural Resources, February 2002.






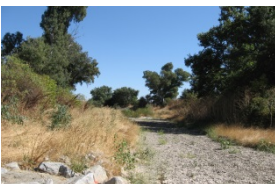
**Table A-1**  
**Equations for Computing Composite Channel Roughness**

Equation	Literature Reference	Basic Assumption	Reference Equation
$n_c = \frac{PR^{5/3}}{\sum \frac{P_i R_i^{5/3}}{n_i}}$	Lotter (1933)	Total discharge is sum of subarea discharge.	1
$n_c = \frac{\sum (n_i P_i R_i^{1/3})}{PR^{1/3}}$		Total shear force is sum of subarea shear forces. $V_i/V = (R_i/R)^{1/2}$	2
$n_c = \frac{\sum (n_i P_i / R_i^{1/6})}{P / R^{1/6}}$		Same as (2) but $V_i/V = 1$	3
$n_c = \left[ \frac{1}{P} \sum (n_i^2 P_i) \right]^{1/2}$	Pavlovskii (1931) Einstein and Banks (1950)	Total resistance force is sum of resistance forces.	4
$n_c = \left[ \frac{1}{P} \sum (n_i^{3/2} P_i) \right]^{2/3}$	Horton (1933) Einstein (1934)	$V = V_i$ ; $S = S_i$ ; $A = \sum A_i$	5
$n_c = \frac{P}{\sum (P_i / n_i)}$	Felkel (1960)	Manning's Eq. with $R_i/R = 1$	6
$n_c = \frac{\sum (n_i P_i)}{P}$		Component roughness linearly proportional to wetted perimeter.	7
$n_c = \exp \left[ \frac{\sum P_i h_i^{3/2} \ln n_i}{\sum P_i h_i^{3/2}} \right]$	Krishnamurthy and Christiansen (1972)	Logarithmic velocity distribution over depth h for wide channel.	8
$n_c = \frac{\sum n_i A_i}{A}$	USACE (1968) Cox (1973)		9
$n_c = \left[ \frac{\sum (n_i^{3/2} A_i)}{A} \right]^{3/2}$	Colebatch (1941)	Same as Eq. 1	10

Key to Parameters

- $x_i$  = parameter in the  $i^{\text{th}}$  subarea
- $X$  = parameter for entire cross section
- $n$  = Manning's roughness coefficient
- $P$  = wetted perimeter
- $A$  = cross sectional area
- $R$  = hydraulic radius
- $V$  = flow velocity
- $S$  = energy gradient

**Table A-2**  
**Channel Roughness Elements**

Type ID	Description	Representative Species	Maintenance Regimen	Sample Image	Manning's "n"
a	Riparian Forest	Oak, white alder, willows, bay laurel, sycamore and riparian scrub such as coffeeberry, wild rose	No maintenance		0.10
b	Willow Bank	Arroyo willow	Prevent encroachment into channel bed and grassed floodway		0.08
c	Braided Floodplain	Sandbar willow, mulefat	No maintenance		0.07
d	Streamside scrub	Coffeeberry, mugwort, blackberry, wild rose; oak on top of bank	No maintenance		0.06
e	Grassed floodway	Native grasses and forbs, hydroseeded	Remove woody vegetation		0.04
f	Channel bed	Sands, gravels, some cobbles, intermittent boulder clusters	Remove woody vegetation, excess sediment		0.025





# TECHNICAL MEMORANDUM

**PROJECT:** Los Gatos Creek Modeling & Mapping

**DATE:** May 23<sup>rd</sup>, 2019

**SUBJECT:** 2D Hydraulic Model Details & Results Analysis  
(Update)

**PREPARED:** Jack Xu, PE, CFM

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## 1. PURPOSE

This report serves to document assumptions and methodology in preparing the Los Gatos Creek 2D hydraulic model. In addition, commentary is provided on differences between the current results and previous District assumptions and FEMA FIS (Flood Insurance Study) results. An analysis of the resulting floodplain and possible mitigation opportunities are discussed as well.

An update to the model in May 2019 with additional cross sections was done.

## 2. DATASET

### GEOMETRY

The underlying dataset for most of the model was obtained from the Watershed Maintenance Unit. This model (hereby referred to as the base model) was built by a consultant (ESA) through a contract with the District. The goal of this contract was to build up to date models of streams and to put together quantitative relationships between roughness, sedimentation, and freeboard to identify thresholds at which maintenance would be required.

The origins of the data and parameters set in the base model are described in the ESA hydraulic modeling report<sup>1</sup>. To summarize:

- Existing models were used as a starting point for geometry.
- Old geometry was reviewed and updated with new surveys.
- Bridges and culverts were from as-built construction drawings.

After a creek walk and cursory review of the geometry, additional cross sections<sup>2</sup> were commissioned to further define areas of hydraulic change, specifically near the Montgomery Street and San Carlos Street crossings near downtown San Jose. Discrepancies were also

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<sup>1</sup> ESA Consultants. Santa Clara Valley Water District Stream Maintenance Guidelines. Year 1 Hydraulic Modeling Report. DRAFT. April 2017.

<sup>2</sup> SCVWD Survey Request #2018\_081

found for the upstream drop structures. Small changes to calibrate low flow and to stabilize the unsteady model were also made. The final geometry data stretches from the confluence of Guadalupe River to the toe of Vasona Dam. All data is in NAVD88 datum.

In the May 2019 update, additional District surveys were added from I-280 to the confluence with the Guadalupe River. This was to support the Los Gatos Creek Restoration Project limits.

### 1D CHANNEL ROUGHNESS

The base model roughness values from the ESA study were averaged along reaches of the creek. This was to help build their quantitative relationships and assist in maintenance decisions. However, the current study updated these roughness values to observations from field visits.

Roughness values were based on Cowan's method<sup>3</sup>, which considers different physical parameters and weights them into a single composite roughness. This was done laterally along the cross sections for banks, floodplains, and the main channel. A table summarizing the roughness values, along with pictures, is in the Appendix.

### 2D TERRAIN

The 2D floodplain is a 5-foot square resolution DEM (Digital Elevation Model), built off 2006 LiDAR data.

### 2D TERRAIN ROUGHNESS

The 2D roughness was based on District guidance<sup>4</sup>, which combined three separate datasets together:

- Road Alignment Data
- Building Footprint Data
- National Land Cover Dataset (NLCD) Data

A specific roughness was assigned for each of these layers as outlined below in Table 1.

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<sup>3</sup> Cowan, W.L., 1956, Estimating hydraulic roughness coefficients: Agricultural Engineering, v. 37, no. 7, p. 473-475.

<sup>4</sup> SCVWD, Jack Xu. Hydraulic Modeling – 2D HEC-RAS 5.0 Floodplain Roughness. 4/12/2016.

**Table 1: 2D Roughness Values**

Land Cover Name	Source	n-Value
Barren Land Rock/Sand/Clay	NLCD	0.025
Cultivated Crops	NLCD	0.06
Deciduous Forest	NLCD	0.1
Developed, High Intensity	NLCD	0.025
Developed, Low Intensity	NLCD	0.035
Developed, Medium Intensity	NLCD	0.035
Developed, Open Space	NLCD	0.03
Emergent Herbaceous Wetlands	NLCD	0.045
Evergreen Forest	NLCD	0.1
Grassland/Herbaceous	NLCD	0.03
Mixed Forest	NLCD	0.1
Open Water	NLCD	0.005
Pasture/Hay	NLCD	0.035
Shrub/Scrub	NLCD	0.04
Woody Wetlands	NLCD	0.005
NoData	NLCD	0.03
Building*	GIS - Other	1.0
Street	GIS - Other	0.02

### 3. CALIBRATION

Three locations were chosen for calibration. Two of these, at Lark and Lincoln, have District stream gauges installed recording creek levels. The third, at Montgomery Culvert, is based on eyewitness accounts.

Table 2 details stream flow measurements performed by District staff during the 2017 wet year, and the corresponding stages recorded by the stream gauge. The flows were inputted into the model, and the resulting WSEL was compared to the recorded stage. Local gauge stage was converted to elevation datum from a surveyed shift.

The roughness and geometry were tweaked for the calibration. Overall, results are very reasonable, given the flow measurement quality. However, it is important to note that these locations are only small snapshots of the entire creek, and the results of this calibration should not be used as a blanket validation for the entire model. It is recommended that further calibration should be performed when additional high-water marks become available.

In the May 2019 update, high water marks collected during the 2018-2019 wet season were used to validate the model in steady state. The peak flow was low, approximately 1,280cfs at the Lincoln Gauge, and field visits indicate that mainly the low flow channel was utilized, leaving much of the upper vegetated banks dry. The validation results varied, with the model predicting the WSEL well or predicting them high. Slight adjustments were made to reduce the WSEL at locations with larger variance by reducing the roughness below bridges and dialing down some energy loss coefficients at bridges, but overall the high WSEL output remained. More drastic modifications were not pursued since the high water mark was below most vegetation, where the most variation would arguably occur. Figure 1 below shows the profile plot with the high water marks in red.



### MONTGOMERY CULVERT VEGETATION

Since 2017, the District has since trimmed the vegetation hanging over the culvert. The 1D model geometry contains two cases – one with the 2017 condition of the vines, and one with the post-clearing. The 2D model, and subsequent flood mapping and results, will utilize the post-clearing scenario without the vines. Figure 2 below shows the extent of the vines, before and after vegetation removal.

**Figure 2: Montgomery Street Culvert Vegetation (Before [Top] & After [Bottom])**



## 4. BOUNDARY CONDITIONS

### FLOW

To map the floodplain, flow hydrographs from the 2009 USACE Guadalupe Hydrology Report<sup>5</sup> were used. This study is the basis for design flows used in the Guadalupe River Flood Control Project and includes a study of the Los Gatos Creek system. Table 3 below details the hydrologic peak flows for the 1% flood between the Flood Insurance Study and the USACE flows used in the current study. It is important to clarify that these flows are not necessary what is experienced in the hydraulic model due to routing techniques and capacity restrictions, and merely a comparison of the hydrology used.

**Table 3: Hydrology 1% Flow Comparison**

Location	FIS Flow (cfs)	USACE Flow (cfs)
Below Vasona Dam	6,950	7,730
Upstream of Guadalupe River Confluence	7,980	8,274

Flow locations into the hydraulic model were determined by large storm drain trunks, splitting flows from hydrologic sub-basins depending on the contributing area.

### GUADALUPE RIVER

The downstream boundary condition was assumed to be a normal depth slope equal to the average channel bed slope for Guadalupe River. The resulting model WSEL at the downstream end of Los Gatos Creek was compared to the 100-yr run for Guadalupe River at the confluence, and found to be higher, verifying the use of this method.

In addition, 2D overland flow was allowed to enter Guadalupe River and leave the model domain downstream. The River was not explicitly modeled in 1D, but in the 2D LiDAR terrain. This section of Guadalupe River has a design 100-yr capacity of 14,700cfs due to a previous USACE project, while the estimated maximum flow that can make it to this section on Guadalupe is about 9,000cfs. Therefore, the assumption of available capacity for the River to handle the overland flow is valid.

## 5. RESULTS

Results show flooding for the 50-yr and 100-yr (2% and 1%) events. For the 50-yr, there is very minor breakout near Auzerais Avenue and the Caltrain Bridge, as well as street flooding downstream of Montgomery Street. In the 100-yr event, results indicate widespread flooding bounded by I-280 to the south, CA-87 to the east, and the Creek to the west. In addition, sheet flow flooding breaks out along the west bank, flowing north towards Julian Street.

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<sup>5</sup> USACE San Francisco District. Guadalupe Watershed Hydrologic Assessment. April 2008. Final Update: November 2009.

The culvert at Montgomery Street appears to be the first breakout point *if* the vines grow over the opening, with an estimated capacity of 3,800cfs. If the vines are cleared, the culvert has a much higher capacity, moving the first breakout point along the creek between West San Fernando Street and Park Avenue.

After the May 2019 update, 50-yr flooding was eliminated due to a slight water surface decrease with the new hydraulics and cross sections. Likewise, the 100-yr flood footprint was reduced on the east side due to lowered overflow from the Montgomery Avenue culvert.

Preliminary flooding maps are presented in Figure 3, comparing the old output footprint versus the new output footprint.

## **6. FLOOD INSURANCE STUDY DISCUSSION**

The Flood Insurance Studies for Los Gatos Creek assumed a full 100-yr capacity due with no FEMA regulatory floodplain. However, the high-water mark at the Montgomery Street culvert in 2017 suggests that actual capacity is likely much smaller.

Analysis was done to determine why the FIS model showed no flooding, while the current study shows flooding beginning in the 50-yr event. The peak flows are similar, but the FIS model assumes a channel roughness value of 0.045 throughout the entire creek reach, from bank to bank. This is a gross underestimate of actual vegetation growth in the channel and appears to be the main source of difference. It is unknown why the FIS had such a low roughness.

Select channel cross sections were also compared, but with only slight differences. The downstream boundary condition for the FIS model was more conservative than the current study as well.

As a final check, the existing model was run with a roughness value of 0.045, which was the original FIS roughness. The results from that run indicate no flooding during the 100yr event, verifying the consistency of the models barring the roughness.

## **7. FLOODPLAIN IMPACTS**

A parcel count was performed on the floodplain for the 100yr event, and it is estimated floodwaters will impact around 500 parcels. This count excludes incidental land, such as empty parking lots and parks. Figure 3 overlays the affected parcels, along with flooding depths demarcated at the 1' flood depth.

## **8. LOCAL MITIGATION OPPORTUNITIES**

### CREEK VEGETATION REMOVAL

It is possible to contain the 100yr flood if the general roughness of the channel is brought back within the original 0.045 assumption in the Flood Insurance Study. Vegetation removal would need to occur from the confluence of Guadalupe River to I-280, which is approximately one mile. The District has land fee or easement for approximately 90% of that mile.

From field visits and aerial imagery, a significant amount of vegetation would need to be removed to reach the necessary roughness value. A detailed biological and vegetation survey would need to be performed to accurately assess the feasibility of this option. Anecdotal evidence suggests mostly native vegetation. In addition, there would be ongoing commitment costs for stream maintenance to keep the creek in that condition.

#### FUTURE LAND DEVELOPMENT & CREEK IMPROVEMENTS

Google Corporation is currently in the process of acquiring large swaths of land adjacent to the Creek near the flooding area to build a new office campus (Figure 4). It is important to note that since the situation is currently unfolding with Google's plans, it is difficult to determine how large Google's footprint will be, and what locations along the creek can be fixed if Google can produce a mixed-use project. There are several flooding locations that are upstream of the future Google campus. These would need to be District projects.

Table 4 below suggests possible creek improvements that would be the most feasible based on very preliminary analysis of the hydraulic model. Feasibility mainly rests on right of way and land ownership. The alternatives generally come in two types: an underground bypass culvert or floodplain widening. Both types perform the same function by reducing the water surface in the creek by increasing conveyance area.



**Table 4: Conceptual Options**

#	Spill Location	Type	Limits	Improvement Details	Land	Feasibility
1	1-3	Floodplain	Santa Clara St to Montgomery Street	Channel floodplain widening (50'-100') on one side of the creek for ~1,700'. Existing main low flow channel and opposite bank left as-is.	Google* SCVWD	High. Floodplain land will need to be allowed to flood.
2	1-3	Bypass	Santa Clara St to Montgomery Street	Underground concrete bypass culvert parallel to creek for ~1,700'. Culvert appx 15'H by 20'W to handle 2,000 – 3,000cfs.	Google* SCVWD	High. Existing land can be developed at current grade.
3	4	Floodplain	Montgomery Street to RxR	Channel floodplain widening (50'-100') on one side of the creek for ~650'. Existing main low flow channel and opposite bank left as-is.	Google SCVWD	High. Floodplain land will need to be allowed to flood.
4	4	Bypass	Montgomery Street to RxR	Underground concrete bypass culvert, appx 12'H by 12'W, parallel to the creek for ~650' to handle 1,500 – 2,000cfs.	Google SCVWD	High. Existing land can be developed at current grade.
5	5	Floodplain	Caltrain RxR to Auzerais Ave	Channel floodplain widening (50'-100') on one side of the creek for ~500'. Existing main low flow channel and opposite bank left as-is.	Private	Med – Low. 5-6 Parcels to be acquired.
6	4-5	Bypass	Montgomery Street to Auzerais Ave	Underground concrete bypass culvert, appx 12'H by 12'W, parallel to the creek for ~1,300' to handle 1,500 – 2,000cfs.	Private Google SCVWD	Med – Low. 5-6 Parcels to be acquired, or easement to tunnel under.

Looking at current Google land acquisition, it is likely that these parcels will be bought as well in the future.

**Table 5: Alternatives**

<b>Alt</b>	<b>Type</b>	<b>Limits</b>	<b>Improvement Details</b>	<b>Conceptual Options Utilized</b>
A	Floodplain	Santa Clara St to Auzerais Ave	Channel floodplain widening (50'-100') on one side of the creek for ~2,850'. Existing main low flow channel and opposite bank left as-is. Floodplain can be widened on either side of creek.	1, 3, 5
B	Bypass	Santa Clara St to Auzerais Ave	Two underground concrete bypass culverts parallel to the creek: 1) ~1,700', 15'H by 20'W to handle 2,000 – 3,000cfs from Santa Clara Street to Park Avenue. 2) ~1,300', 12'H by 12'W to handle 1,500 – 2,000cfs from Montgomery Street to Auzerais Avenue.	2. 6



Figure 3: 100yr (Left) and 50yr (Right) Floodplains. (Green footprint is the old model results, blue footprint the new)





Figure 4: Land Ownership and Spill Locations





Figure 5: Alternative 1

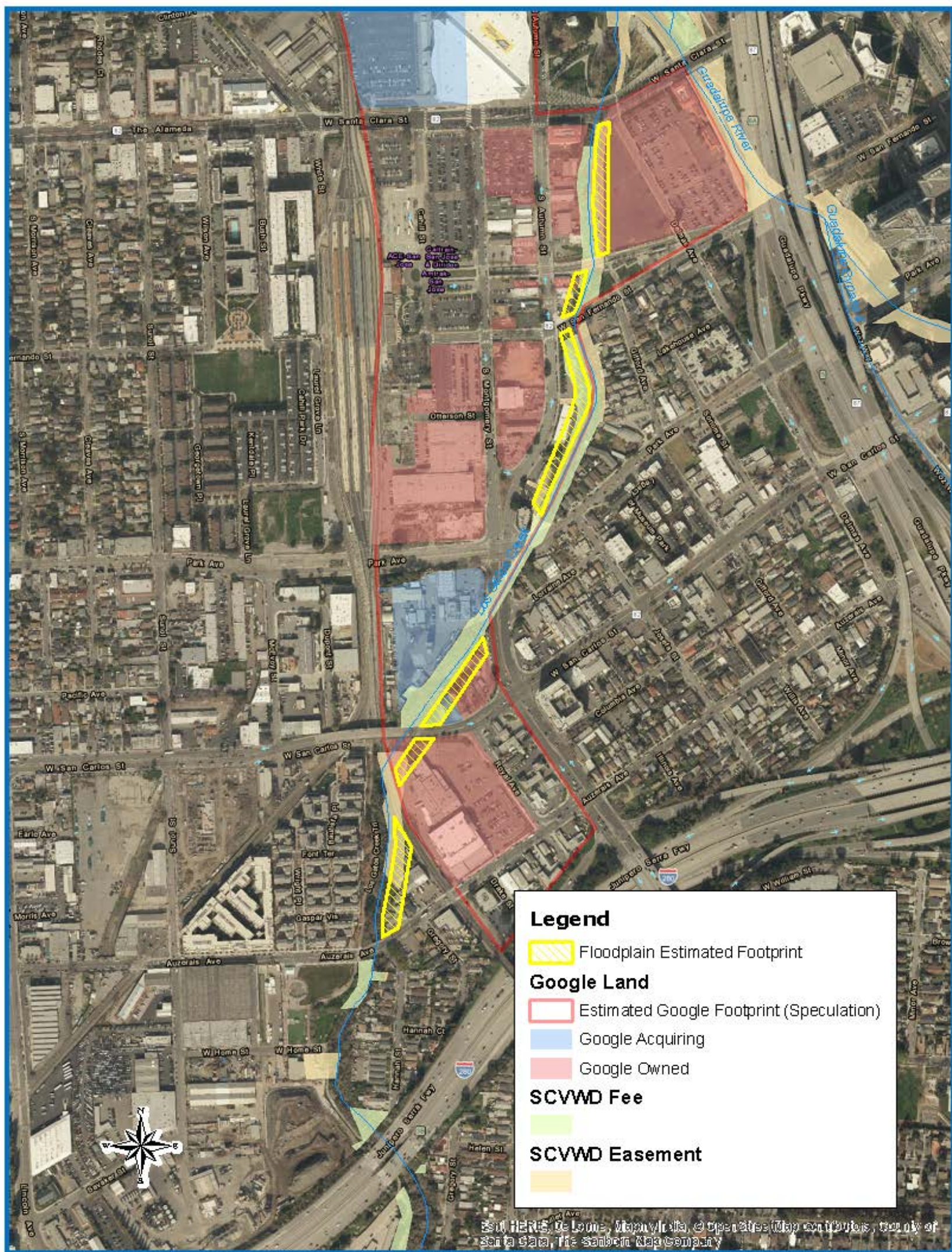
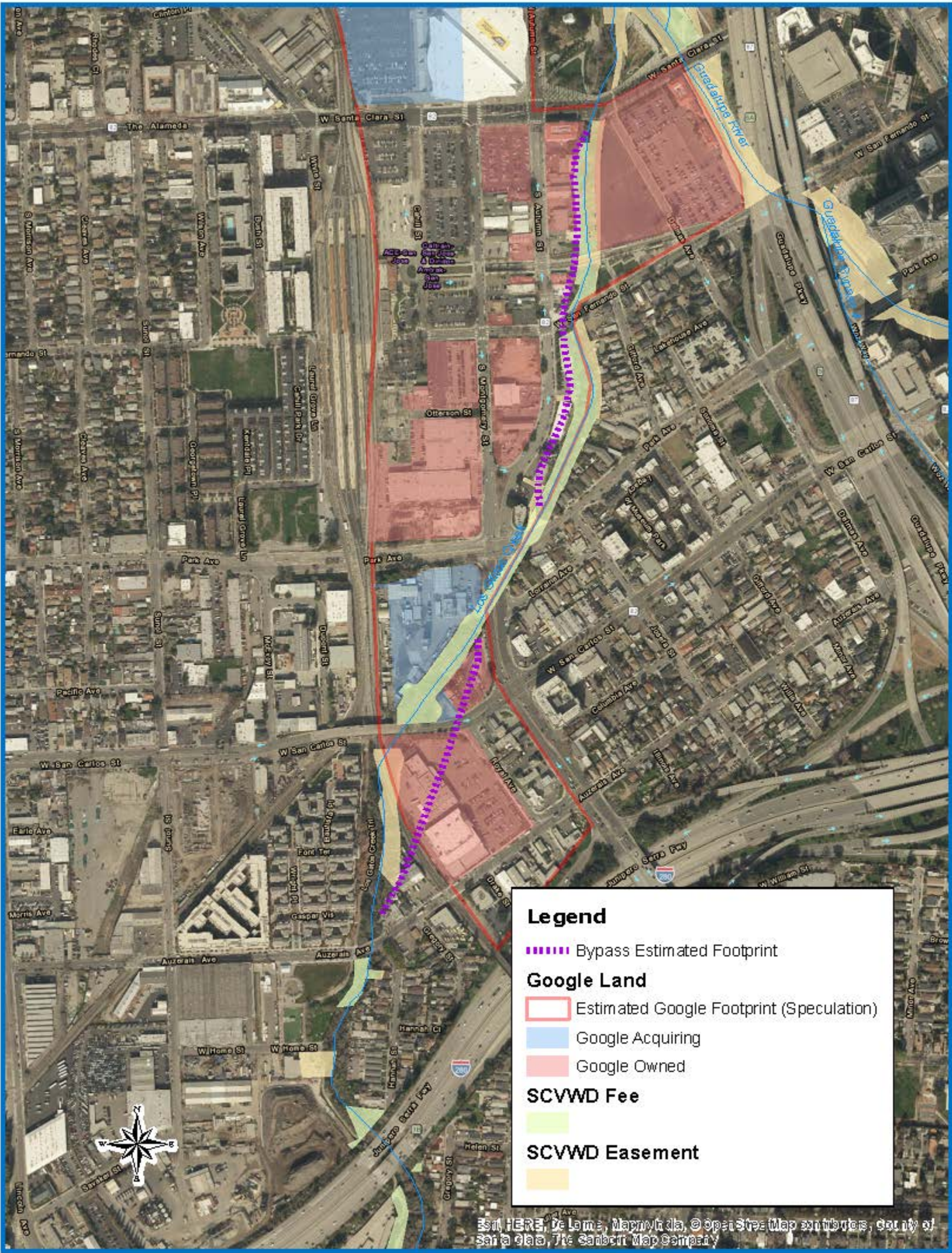


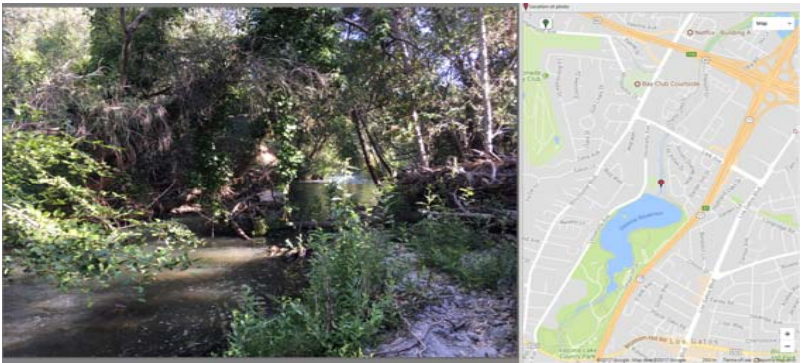


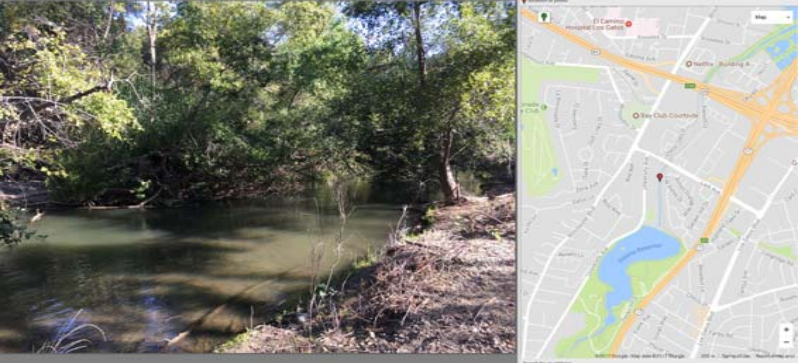
Figure 6: Alternative 2






APPENDIX  
LOS GATOS CREEK MODEL 1D ROUGHNESS VALUES

41962.09	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth	Coarse	Coarse	Fine	Earth	
Irregularity, $n_1$	Minor	Minor	None	Minor	Minor	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	Minor	Minor	None	Minor	Minor	
Vegetation, $n_4$	Extreme	Very Large	None	Large	Medium	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.1125	0.0915	0.024	0.0805	0.0575	

41091.89	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth	Earth	Fine	Earth	Earth	
Irregularity, $n_1$	Minor	Minor	None	Minor	Minor	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	Minor	Minor	None	Minor	None	
Vegetation, $n_4$	Extreme	Extreme	Small	Medium	Medium	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.1125	0.1125	0.038	0.0575	0.045	

40266.61	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth	Earth	Fine	Earth	Earth	
Irregularity, $n_1$	Minor	Minor	None	Minor	Minor	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	Minor	None	None	None	Minor	
Vegetation, $n_4$	Large	Small	None	Small	None	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.0725	0.035	0.028	0.035	0.0375	

APPENDIX  
LOS GATOS CREEK MODEL 1D ROUGHNESS VALUES

40039.74	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth	Earth	Fine	Earth	Earth	
Irregularity, $n_1$	Minor	Minor	Minor	Minor	Minor	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	Minor	Minor	None	Minor	Minor	
Vegetation, $n_4$	Large	Very Large	Small	Extreme	Very Large	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.0725	0.0875	0.043	0.1125	0.0875	

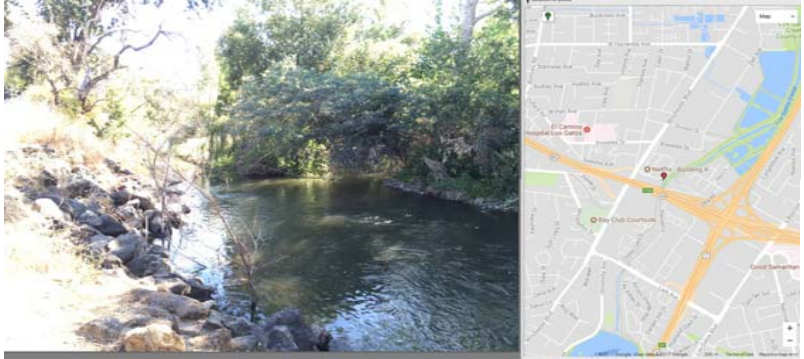
39242.97	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking @ LOB)
Bed Material, $n_b$	Earth	Earth	Fine	Earth	Earth	
Irregularity, $n_1$	Moderate	Moderate	Minor	Minor	Minor	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	Minor	Minor	None	Minor	None	
Vegetation, $n_4$	Medium	Large	None	Large	Medium	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.0625	0.0775	0.033	0.0725	0.045	

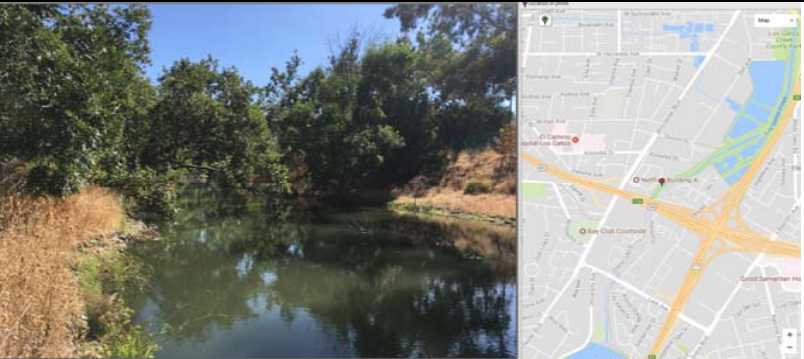
38506.66	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking U/S)
Bed Material, $n_b$	Earth	Earth	Coarse	Earth	Earth	
Irregularity, $n_1$	Minor	Minor	Minor	Minor	Minor	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	Minor	Minor	None	Minor	Minor	
Vegetation, $n_4$	Medium	Large	None	Medium	Medium	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.0575	0.0725	0.029	0.0575	0.0575	



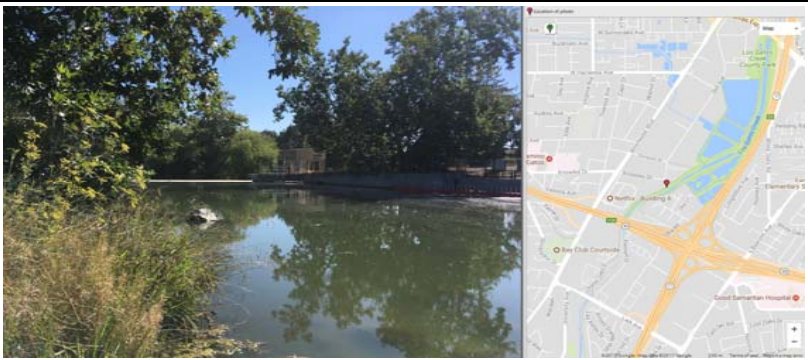
APPENDIX  
LOS GATOS CREEK MODEL 1D ROUGHNESS VALUES

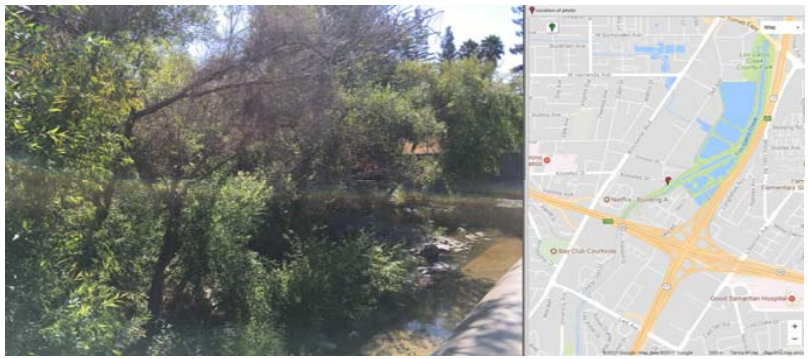
37959.19	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Rock	Earth	Coarse	Earth	Rock	N/A
Irregularity, $n_1$	Severe	None	None	None	Severe	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	None	None	None	None	None	
Vegetation, $n_4$	None	None	Small	Small	None	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.045	0.02	0.034	0.03	0.045	

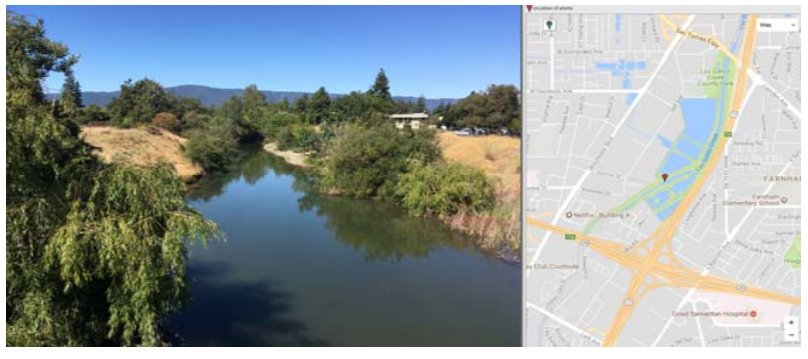
37699.46	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth	Rock	Coarse	Fine	Earth	
Irregularity, $n_1$	Minor	Severe	None	Minor	Minor	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	None	None	Minor	Minor	Minor	
Vegetation, $n_4$	Medium	Medium	None	Large	Medium	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.045	0.065	0.0365	0.0805	0.0575	

36755.72	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth		Fine		Earth	
Irregularity, $n_1$	Minor		Minor		Minor	
Variation, $n_2$	None		None		None	
Obstruction, $n_3$	None		None		None	
Vegetation, $n_4$	Medium		None		Medium	
Sinuosity, $m$	Minor		Minor		Minor	
Manning's $n$	0.045	#N/A	0.033	#N/A	0.045	

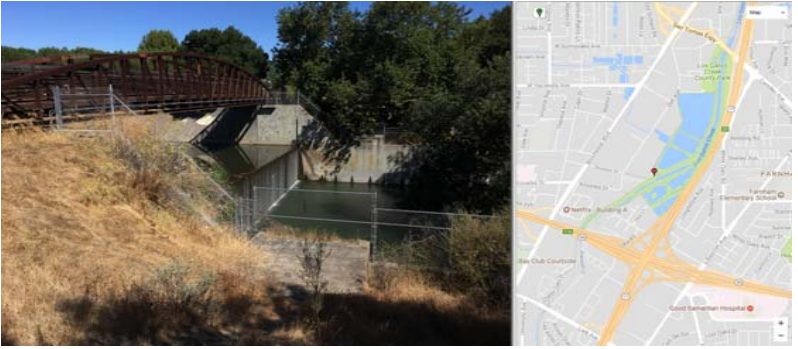
APPENDIX  
LOS GATOS CREEK MODEL 1D ROUGHNESS VALUES


36234	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth		Concrete/Dirt		Concrete/Asphalt	
Irregularity, $n_1$	Minor					
Variation, $n_2$	None					
Obstruction, $n_3$	None					
Vegetation, $n_4$	Medium					
Sinuosity, $m$	Minor					
Manning's $n$	0.045	#N/A	#N/A	#N/A	#N/A	

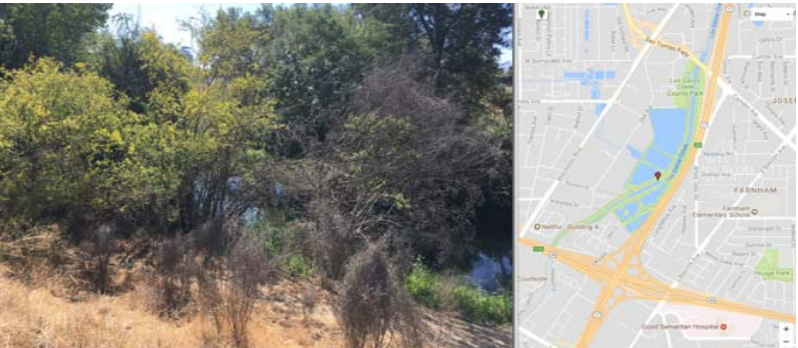
36127.25	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$			Coarse			
Irregularity, $n_1$			Minor			
Variation, $n_2$			None			
Obstruction, $n_3$			Minor			
Vegetation, $n_4$			Very Large			
Sinuosity, $m$			Minor			
Manning's $n$	#N/A	#N/A	0.0915	#N/A	#N/A	

35156.82	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking U/S)
Bed Material, $n_b$	Earth	Fine	Fine	Fine	Earth	
Irregularity, $n_1$	None	Minor	None	Minor	None	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	None	None	None	None	None	
Vegetation, $n_4$	Small	Medium	None	Medium	Small	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.03	0.053	0.028	0.053	0.03	

APPENDIX  
LOS GATOS CREEK MODEL 1D ROUGHNESS VALUES

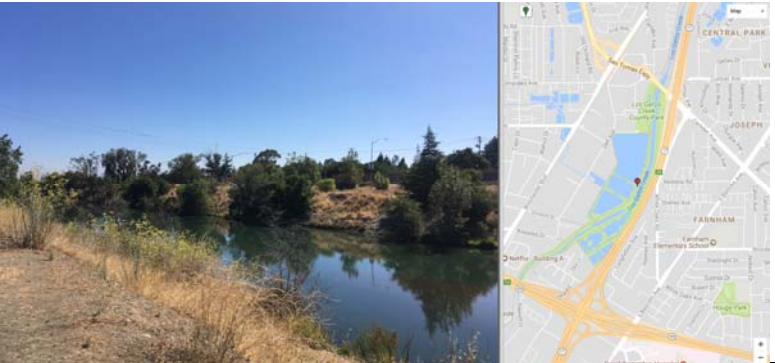
35147	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking @ ROB)
Bed Material, $n_b$	Concrete		Dirt		Concrete	
Irregularity, $n_1$						
Variation, $n_2$						
Obstruction, $n_3$						
Vegetation, $n_4$						
Sinuosity, $m$						
Manning's $n$	0.015	#N/A	0.02	#N/A	0.015	


34981.81	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth		Coarse		Earth	
Irregularity, $n_1$	None		Minor		None	
Variation, $n_2$	None		None		None	
Obstruction, $n_3$	None		Minor		None	
Vegetation, $n_4$	Small		Very Large		Small	
Sinuosity, $m$	Minor		Minor		Minor	
Manning's $n$	0.03	#N/A	0.0915	#N/A	0.03	

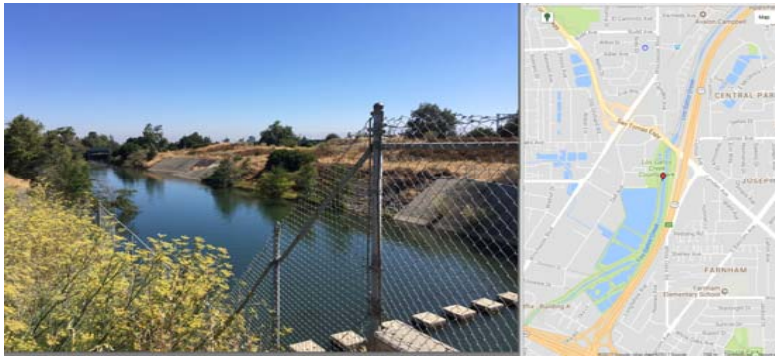
34293.88	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth	Fine	Fine	Fine	Earth	
Irregularity, $n_1$	None	Minor	None	Minor	None	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	None	Minor	None	None	None	
Vegetation, $n_4$	Small	Large	None	Medium	Small	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.03	0.0805	0.028	0.053	0.03	




APPENDIX  
LOS GATOS CREEK MODEL 1D ROUGHNESS VALUES


33477.19	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth	Earth	Fine	Earth	Earth	
Irregularity, $n_1$	None	Minor	None	Minor	None	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	None	None	None	None	None	
Vegetation, $n_4$	Small	Medium	None	Medium	Small	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.03	0.045	0.028	0.045	0.03	


31859	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Concrete		Dirt		Concrete	
Irregularity, $n_1$						
Variation, $n_2$						
Obstruction, $n_3$						
Vegetation, $n_4$						
Sinuosity, $m$						
Manning's $n$	0.015	#N/A	0.02	#N/A	0.015	

31710.26	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth		Fine		Earth	
Irregularity, $n_1$	None		None		None	
Variation, $n_2$	None		None		None	
Obstruction, $n_3$	None		None		None	
Vegetation, $n_4$	Medium		None		Medium	
Sinuosity, $m$	Minor		Minor		Minor	
Manning's $n$	0.04	#N/A	0.028	#N/A	0.04	


APPENDIX  
LOS GATOS CREEK MODEL 1D ROUGHNESS VALUES

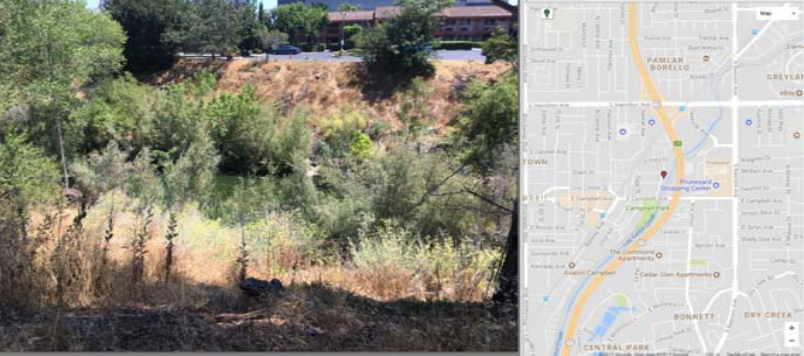
30980.49	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth		Fine		Earth	
Irregularity, $n_1$	None		None		None	
Variation, $n_2$	None		None		None	
Obstruction, $n_3$	None		None		None	
Vegetation, $n_4$	Small		None		Small	
Sinuosity, $m$	Minor		Minor		Minor	
Manning's $n$	0.03	#N/A	0.028	#N/A	0.03	

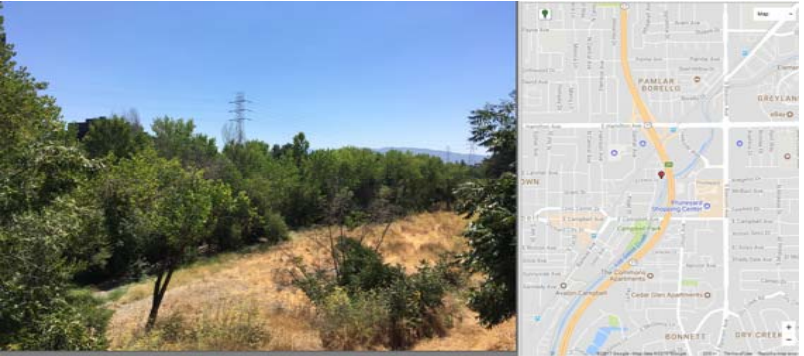
30850.01	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Trail		Concrete		Concrete	
Irregularity, $n_1$						
Variation, $n_2$						
Obstruction, $n_3$						
Vegetation, $n_4$						
Sinuosity, $m$						
Manning's $n$	0.03	#N/A	0.015	#N/A	0.015	

30385.63	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth	Coarse	Coarse	Coarse	Earth	
Irregularity, $n_1$	Minor	Minor	Minor	Minor	Minor	
Variation, $n_2$	None	None	Minor	None	None	
Obstruction, $n_3$	None	Minor	None	Minor	None	
Vegetation, $n_4$	Medium	Very Large	None	Very Large	Medium	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.045	0.0915	0.034	0.0915	0.045	

APPENDIX  
LOS GATOS CREEK MODEL 1D ROUGHNESS VALUES

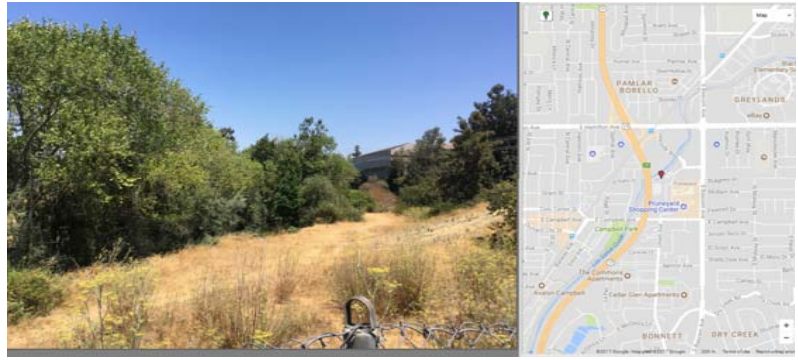
24499.3	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth		Coarse		Earth	
Irregularity, $n_1$	None		Minor		None	
Variation, $n_2$	Minor		None		None	
Obstruction, $n_3$	None		None		Moderate	
Vegetation, $n_4$	Small		Small		None	
Sinuosity, $m$	Minor		Minor		Minor	
Manning's $n$	0.035	#N/A	0.039	#N/A	0.065	


24221.66	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking @ ROB)
Bed Material, $n_b$	Earth	Earth	Coarse	Earth	Earth	
Irregularity, $n_1$	Minor	Minor	Minor	Minor	Minor	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	None	Minor	None	Minor	None	
Vegetation, $n_4$	Large	Very Large	Small	Medium	Medium	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.06	0.0875	0.039	0.0575	0.045	

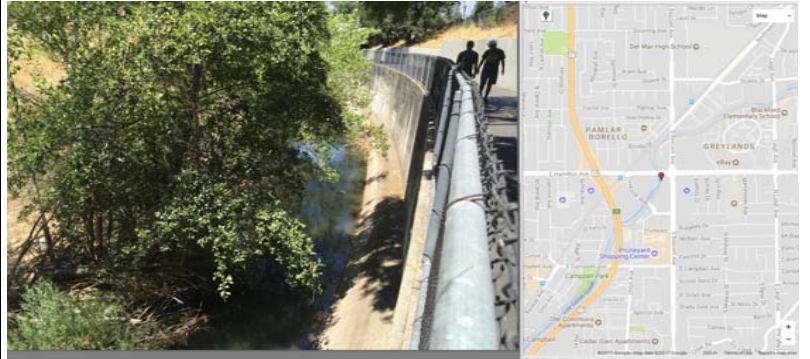
23243.67	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking U/S)
Bed Material, $n_b$	Earth	Earth	Coarse	Earth	Earth	
Irregularity, $n_1$	Minor	Minor	Minor	Minor	Minor	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	None	Minor	None	Minor	None	
Vegetation, $n_4$	Medium	Very Large	Small	Large	Medium	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.045	0.0875	0.039	0.0725	0.045	




APPENDIX  
LOS GATOS CREEK MODEL 1D ROUGHNESS VALUES


22700.63	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth	Earth	Coarse		Earth	
Irregularity, $n_1$	Minor	Minor	Minor		Minor	
Variation, $n_2$	None	None	None		None	
Obstruction, $n_3$	None	Minor	Minor		None	
Vegetation, $n_4$	Small	Very Large	None		Medium	
Sinuosity, $m$	Minor	Minor	Minor		Minor	
Manning's $n$	0.035	0.0875	0.0415	#N/A	0.045	

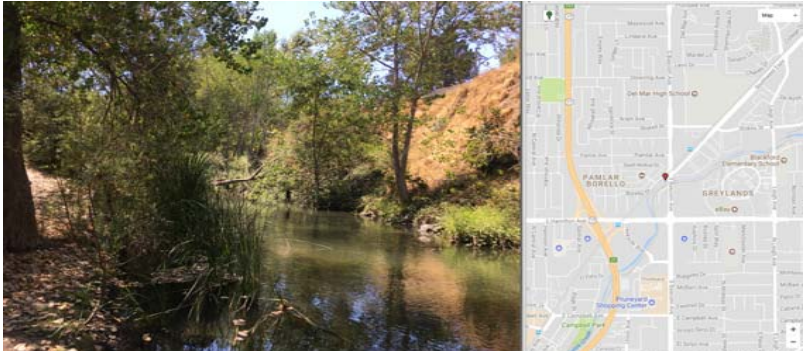
21809.27	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Coarse	Earth	Coarse	Earth	Path	
Irregularity, $n_1$	Moderate	Minor	Minor	Minor		
Variation, $n_2$	None	None	None	None		
Obstruction, $n_3$	None	Minor	None	Minor		
Vegetation, $n_4$	None	Large	None	Very Large		
Sinuosity, $m$	Minor	Minor	Minor	Minor		
Manning's $n$	0.034	0.0725	0.029	0.0875	#N/A	

21272.99	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth	Coarse	Coarse		Path	
Irregularity, $n_1$	Minor	Minor	None			
Variation, $n_2$	None	None	None			
Obstruction, $n_3$	None	None	None			
Vegetation, $n_4$	Medium	Medium	None			
Sinuosity, $m$	Minor	Minor	Minor			
Manning's $n$	0.045	0.049	0.024	#N/A	#N/A	

APPENDIX  
LOS GATOS CREEK MODEL 1D ROUGHNESS VALUES

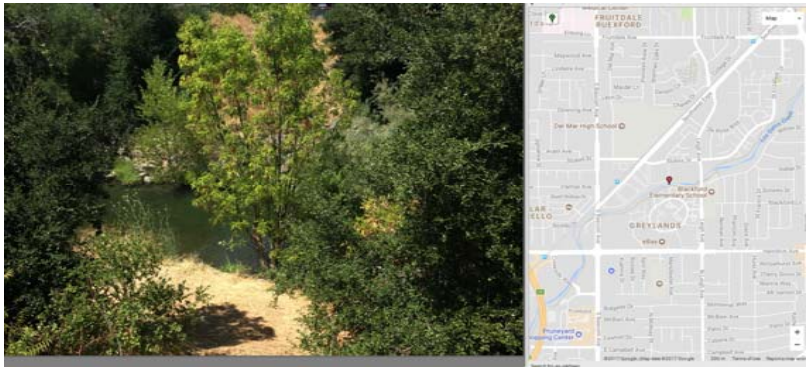
20804.19	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth		Earth	Earth	Path	
Irregularity, $n_1$	Minor		Minor	Minor		
Variation, $n_2$	None		None	None		
Obstruction, $n_3$	None		None	Minor		
Vegetation, $n_4$	Large		None	Very Large		
Sinuosity, $m$	Minor		Minor	Minor		
Manning's $n$	0.06	#N/A	0.025	0.0875	#N/A	

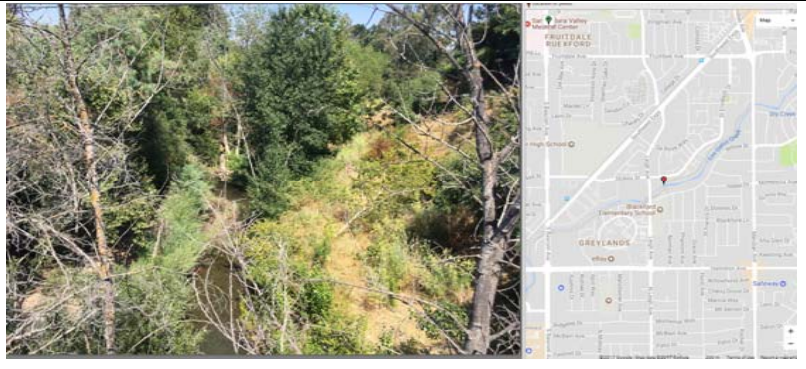
20352.46	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth		Earth	Earth	Earth	
Irregularity, $n_1$	Minor		Minor	Minor	Minor	
Variation, $n_2$	None		None	None	None	
Obstruction, $n_3$	None		None	None	None	
Vegetation, $n_4$	Medium		None	Very Large	Small	
Sinuosity, $m$	Minor		Minor	Minor	Minor	
Manning's $n$	0.045	#N/A	0.025	0.075	0.035	

19915.39	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking U/S)
Bed Material, $n_b$	Earth	Earth	Coarse	Earth	Earth	
Irregularity, $n_1$	Minor	Minor	Minor	Minor	Minor	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	None	Minor	None	Minor	None	
Vegetation, $n_4$	Medium	Very Large	None	Very Large	Medium	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.045	0.0875	0.029	0.0875	0.045	

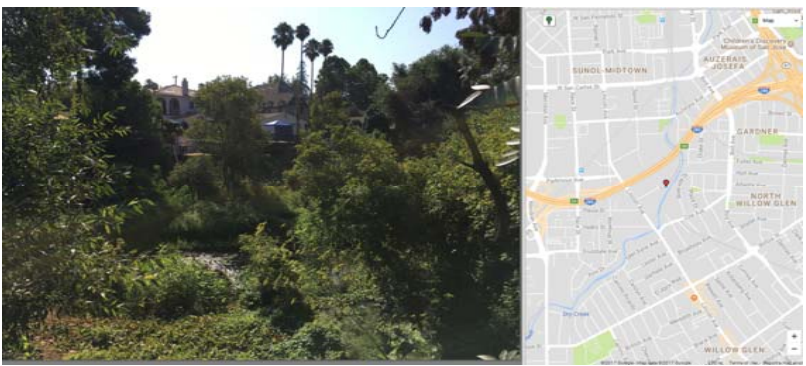


APPENDIX  
LOS GATOS CREEK MODEL 1D ROUGHNESS VALUES


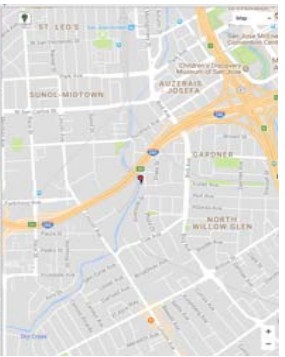
19421.24	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking @ LOB)
Bed Material, $n_b$	Earth	Earth	Coarse	Earth	Earth	
Irregularity, $n_1$	Minor	Minor	Minor	Minor	Minor	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	None	Minor	None	Minor	None	
Vegetation, $n_4$	Small	Very Large	None	Very Large	Medium	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.035	0.0875	0.029	0.0875	0.045	


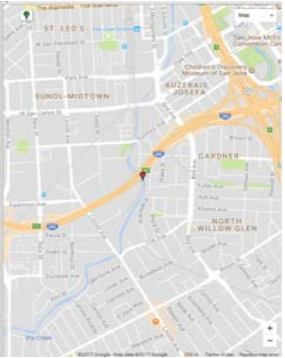
16644.44	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth	Earth	Coarse	Earth	Earth	
Irregularity, $n_1$	Minor	Minor	Minor	Minor	Minor	
Variation, $n_2$	None	None	None	None	None	
Obstruction, $n_3$	None	Minor	None	Minor	None	
Vegetation, $n_4$	Small	Very Large	None	Very Large	Medium	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.035	0.0875	0.029	0.0875	0.045	

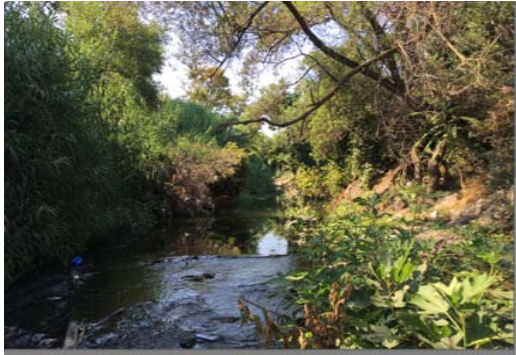
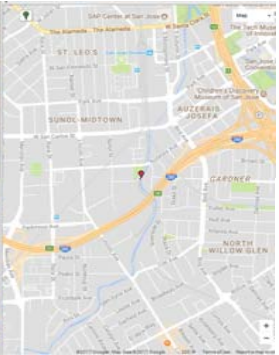
Meridian to Lincoln Avenue (125+00 to 70+00 - No accessibility. Relied on ESA Photo and Google Earth remote sensing, combined with existing knowledge from other reaches

6926.636	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking @ ROB)
Bed Material, $n_b$	Earth		Coarse		Earth	
Irregularity, $n_1$	Minor		Minor		Minor	
Variation, $n_2$	None		None		None	
Obstruction, $n_3$	Minor		None		Minor	
Vegetation, $n_4$	Very Large		None		Very Large	
Sinuosity, $m$	Minor		Minor		Minor	
Manning's $n$	0.0875	#N/A	0.029	#N/A	0.0875	

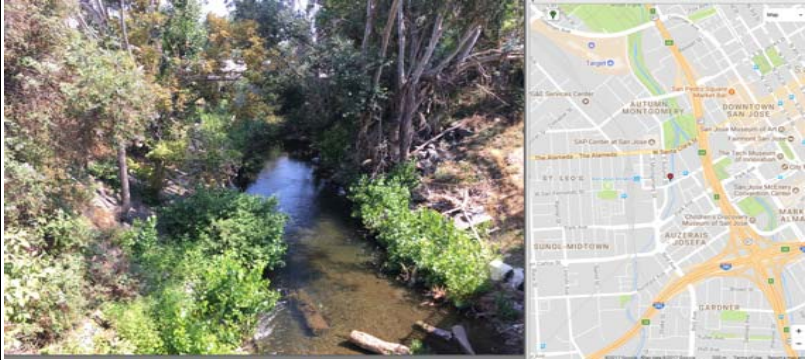
APPENDIX  
LOS GATOS CREEK MODEL 1D ROUGHNESS VALUES

6395.346	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth	Coarse	Fine	Rock	Earth	 
Irregularity, $n_1$	Minor	Minor	Minor	Minor	Minor	
Variation, $n_2$	None	None	None	Minor	None	
Obstruction, $n_3$	Minor	None	None	None	Minor	
Vegetation, $n_4$	Extreme	Small	None	Small	Very Large	
Sinuosity, $m$	Minor	Minor	Minor	Minor	Minor	
Manning's $n$	0.1125	0.039	0.033	0.045	0.0875	

6145.357	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth	Earth	Coarse	Earth		 
Irregularity, $n_1$	None	Minor	Minor	Minor		
Variation, $n_2$	None	None	None	None		
Obstruction, $n_3$	None	None	None	None		
Vegetation, $n_4$	None	Small	None	None		
Sinuosity, $m$	Minor	Minor	Minor	Minor		
Manning's $n$	0.02	0.035	0.029	0.025	#N/A	

5959	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking U/S)
Bed Material, $n_b$	Earth		Coarse	Earth	Earth	 
Irregularity, $n_1$	Minor		Minor	Minor	Minor	
Variation, $n_2$	None		None	None	None	
Obstruction, $n_3$	Minor		None	Minor	Minor	
Vegetation, $n_4$	Very Large		None	Extreme	Very Large	
Sinuosity, $m$	Minor		Minor	Minor	Minor	
Manning's $n$	0.0875	#N/A	0.029	0.1125	0.0875	

APPENDIX  
LOS GATOS CREEK MODEL 1D ROUGHNESS VALUES

2723.69	Left Bank	Left Floodplain	Main Channel	Right Floodplain	Right Bank	Photo (Looking D/S)
Bed Material, $n_b$	Earth		Coarse		Earth	
Irregularity, $n_1$	Minor		Minor		Minor	
Variation, $n_2$	None		None		None	
Obstruction, $n_3$	Minor		None		Minor	
Vegetation, $n_4$	Very Large		None		Very Large	
Sinuosity, $m$	Minor		Minor		Minor	
Manning's $n$	0.0875	#N/A	0.029	#N/A	0.0875	