UPPER GUADALUPE RIVER
FLOOD RISK MANAGEMENT PROJECT
San José, California

Economics and Other Social Affects Analysis

Appendix B

DRAFT INTEGRATED
GENERAL REEVALUATION REPORT
& SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT

November 2022

US Army Corps of Engineers®
San Francisco District

Valley Water

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Acronyms and Abbreviations

AEP	Annual Exceedance Probability
AER	Aquatic Ecosystem Restoration
AQMD	Air Quality Management District
BA	Biological Assessment
BCR	Benefit Cost Ratio
BMPs	Best Management Practices
BO	Biological Opinion
CAR	Coordination Act Report
cfs	Cubic Feet per Second
dB	Decibel
dBA	A-Weighted Decibel
District	San Francisco District
DOT	Department of Transportation
EA	Environmental Assessment
ECC	Economic Reevaluation Report
EIA	Economic Impact Area
EOP	Environmental Operating Principles
EOs	Executive Orders
EQ	Environmental Quality
FRM	Flood Risk Management
FWCA	Fish and Wildlife Coordination Act
FWS	Fish and Wildlife Service
FY	Fiscal Year
GIS	Geographic Information System
GRR	General Reevaluation Report
GRR/EA, or Integrated Report	General Reevaluation Report/Environmental Assessment
GWIWG	Guadalupe Watershed Integration Working Group
H&H	Hydraulics and Hydrology
IPRs	In-Progress Reviews
Ldn	Day-Night Level
LERRDs	Lands, Easements, Rights-of-Way, Relocations, and Disposal
LPP	Locally Preferred Plan
LRR	Limited Reevaluation Report
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NFS	Non-Federal Sponsor
NMFS	National Marine Fisheries Service

NNBF	Nature and Nature-Based Features
OMB	Office of Management and Budget
OMRR&R	Operations, Maintenance, Repair, Replacement and Rehabilitation
OSE	Other Social Effects
PAR	Population at Risk
P&G	Principles and Guidelines
PDT	Project Delivery Team
PED	Preconstruction Engineering Design
RED	Regional Economic Development
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board
SCVWD	Santa Clara Valley Water District
UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
Valley Water	Santa Clara Valley Water District
VTA	Valley Transit Authority
WRDA	Water Resources Development Act
WRRDA	Water Resources Reform and Development Act

1 Background Information

1.1 General

This appendix presents an economic evaluation of the riverine flood risk reduction measures for the Upper Guadalupe General Re-Evaluation Report. The evaluation area includes a portion of the Upper Guadalupe watershed in south central San Jose, California. The report was prepared in accordance with Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, and ER 1105-2-101, Planning Guidance, Risk Analysis for Flood Damage Reduction Studies. The National Economic Development Procedures Manual for Flood Risk Management and Coastal Storm Risk Management, prepared by the Water Resources Support Center, Institute for Water Resources, was also used as a reference, along with the User's Manual for the Hydrologic Engineering Center Flood Damage Analysis Model (HEC-FDA).

The economic appendix consists of a description of the methodology used to determine National Economic Development (NED), Regional Economic Development (RED), and Other Social Effects (OSE) benefits. The NED damages and costs were calculated using FY 2022 price levels. Costs were annualized using the FY 2023 Federal discount rate of 2.5 percent and a period of analysis of 50 years with the year 2026 as the base year. The expected annual damage and benefit estimates were compared to the annual construction costs and the associated OMRR&R costs for each of the project measures.

1.2 National Economic Development Benefit Categories Considered

The NED procedure manuals for riverine and urban areas recognize four primary categories of benefits for flood risk management measures: inundation reduction, intensification, location, and employment benefits. The majority of the benefits attributable to a project measure generally result from the reduction of actual or potential damages caused by inundation. Inundation reduction includes the reduction of physical damages to structures, contents, and vehicles and indirect losses to the national economy.

1.2.1 Physical Flood Damage Reduction

Physical flood damage reduction benefits include the decrease in potential damages to residential, commercial, public, and industrial structures, their contents, and the privately owned vehicles associated with these structures.

1.2.2 Emergency Cost Reduction Benefits

Emergency costs are those costs incurred by a community during and immediately following a major storm. The cost of debris removal from inundated residential and non-residential structures was the only emergency cost reduction benefit considered for this analysis.

1.2.3 NED Benefit Categories NOT Considered

The following NED benefit categories were not addressed in this economic appendix. These categories were excluded from the NED analysis because other regionally specific or nationally specific studies and reports were not available to source the assumptions to calculate them, or the NED category was not determined to either provide more than 1-3 percent of overall existing condition damages or qualify as a NED benefit.

- Costs associated with evacuation and reoccupation activities before, during and following a flood event incurred by property owners and governments.
- Indirect losses to the national economy as a result of disruptions in the production of goods and services by industries affected by the storm or riverine flooding
- Increased cost of operations for industrial facilities following a flood event relative to normal business operations
- Physical loss of agricultural crops grown to be sold for commercial profit

1.3 Regional Economic Development

When the economic activity lost in a flooded region can be transferred to another area or region in the national economy, these losses cannot be included in the NED account. However, the impacts on the employment, income, and output of the regional economy are considered part of the RED account. The input-output macroeconomic model RECONS can be used to address the impacts of the construction spending associated with the project alternatives.

1.4 Other Social Effects

The Other Social Effects (OSE) account includes impacts to socially vulnerable populations, life safety, and loss of economic vitality, and community optimism. Impacts on these topics are a natural outcome of civil works projects and are discussed in the OSE account. The economics team evaluated outcomes of the various alternatives on socially vulnerable populations using the Center for Disease Control's Social Vulnerability and US. Census Bureau statistics. Additionally, the PDT evaluated the life safety risk to unhoused persons using human stability criteria from LifeSim 2.0. A LifeSim model assessing the risk of life loss in the study area will be performed post-TSP.

2 Description of the Study Area

2.1 Geographic Location

The Upper Guadalupe study area is located in the northwest portion of Santa Clara County in central San Jose. The study area is largely urban with mostly residential structures. An inventory of residential and non-residential structures was developed using the National Structure Inventory (NSI) version 2.0 for the portions of the county impacted by riverine flooding. The structure inventory for the economic analysis includes all structures within the extent of inundation for the 0.2% annual exceedance probability (AEP) event in the future without project condition. Figure 1 shows the structure inventory and boundaries of the counties and municipalities.

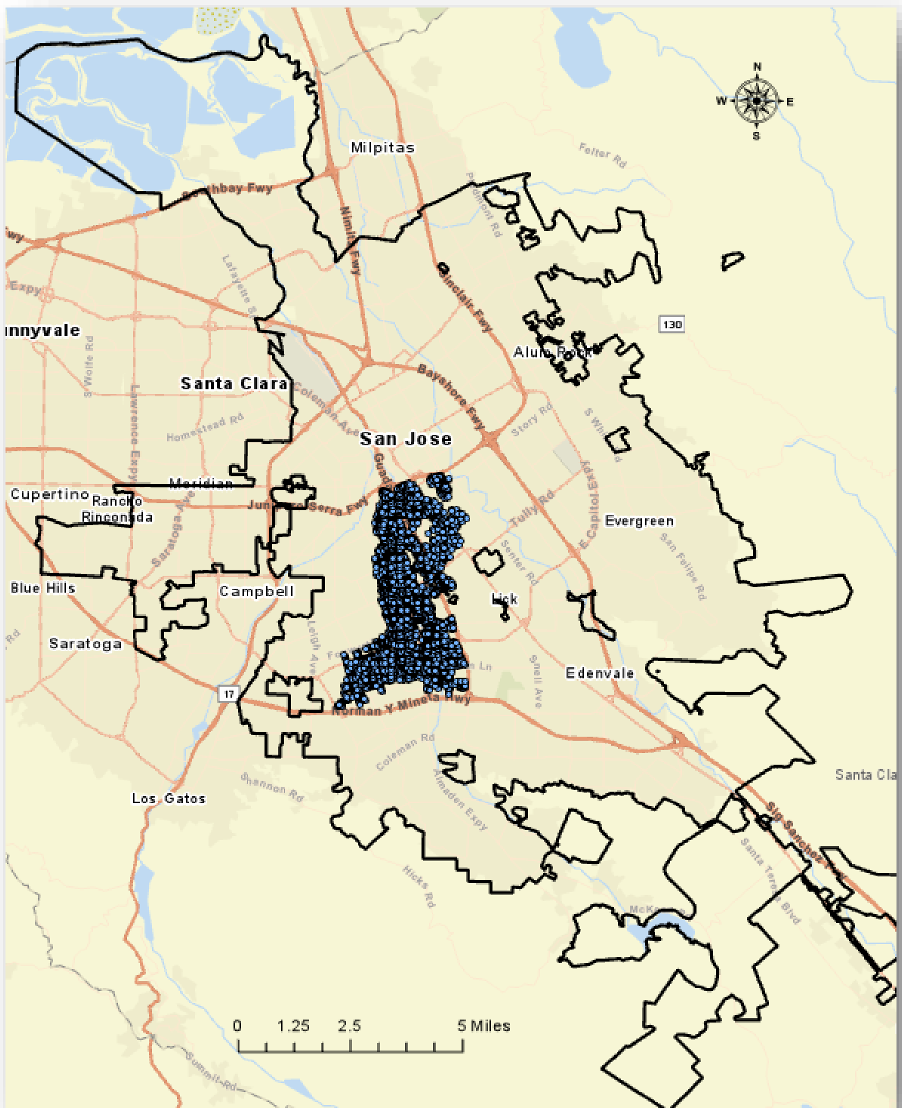


Figure 1: Geographic Location

2.1.1 Flooding Impact Areas / Economic Reaches

The study area was divided into flooding impact areas, or economic reaches, which were delineated by the economist in coordination with the full USACE team to analyze the impacts from flooding and potential benefits of the alternatives. The economic reaches begin with Flooding Impact Area 1, which is the furthest downstream, and numerically increase while moving upstream and ending with Flooding Impact Area 11.

Table 1 shows the structure count by flooding impact area and structure type (residential and non-residential). Non-residential structures include commercial, industrial, and public structures. The study area has a total of 7,567 structures. Figure 2 shows the study area flooding impact area / economic reach boundaries.

Table 1: Structure Count by Reach and Type

Structure Count by Flooding Impact Area, or Economic Reach			
Flooding Impact Area / Economic Reach	Residential	Non-Residential	Total
1	809	315	1124
2	243	19	262
3	1214	25	1239
4	2397	35	2432
5	469	3	472
6	249	25	274
7	466	9	475
8	253	7	260
9	378	14	392
10	548	23	571
11	45	21	66
All Reaches	7071	496	7567

2.1.1.1 Flooding Impact Area / Economic Reach Delineations

The study area reaches were designed to break down the study area into separable parts, each with a unique set of attributes. The team paid special attention to OSE concerns like life safety, unhoused population, and social vulnerability along with typical hydraulic considerations like flood source and maximum depth. This allowed the team to quantify how well our plans serve and impact disadvantaged communities in effort to fully address comprehensive documentation of benefits.

The following criteria was used to delineate the study flooding impact areas (shown in Figure 2), and is shown in Table 2:

- Flood Source
- Max Depth Rating (0.2% AEP)
- Social Vulnerability
- Structure Characterization
- Unhoused Rating

Flooding Impact Area 1 experiences flooding from Upper Guadalupe in a quick progressing flat sheet flow that blankets a large swath of diverse-use development. Flooding Impact Area 1 hosts significant commercial and industrial activity and is highly trafficked during the daytime by a transient population. Structures in this area tend to be more depreciated with high concern for overall social vulnerability. Flooding Impact Area 1 also hosts the highest number of unhoused encampments and an overall high rating for life safety.

Flooding Impact Area 2 is impacted by flooding from the Upper Guadalupe with consequences mainly impacting single occupancy residential structures. Flooding Impact Area 2 has a large number of unhoused encampments, the majority of which are located near the channel where flood depths and velocities are greatest posing a major life safety risk. Flooding Impact Area 2 has moderate to high impacts related to social vulnerability.

Flooding Impact Area 3 experiences flooding from the overtopping of a levee at confluence with Guadalupe River. Flooding in Flooding Impact Area 3 is shallow and slow moving and will impact lower lying residential structures and street parked vehicles. In general, this area does not have any unhoused or social vulnerability concerns.

Flooding Impact Area 4 encounters comingled flooding from overflow of natural banks along Guadalupe River and Ross Creek. Flooding in Flooding Impact Area 4 is shallow and slow moving and will impact lower lying residential structures and street parked vehicles. In general, this area does not have any unhoused or social vulnerability concerns.

Flooding Impact Area 5 is flooded by the Upper Guadalupe River. Flooding in Flooding Impact Area 5 is shallow and slow moving and will impact lower lying homes and street parked vehicles. In general, this area does not have any unhoused or social vulnerability concerns.

Flooding Impact Area 6 is impacted by floodwaters from Upper Guadalupe. It is unique from its neighboring Flooding Impact Area 1 primarily by its low-lying terrain that supports moderate flood depths for the neighborhood of highly concentrated multi-family residential buildings. In combination with high flood depths, social vulnerability is equally as high of a concern. Unhoused encampments do populate the area, but in far less concentration relative to Flooding Impact Areas 1 and 2.

Flooding Impact Area 7 is impacted by floodwaters from Canoas Creek. Floodwaters in this area exceed 5 feet in highly populous areas, such as two manufactured home neighborhoods, both of which has extremely limited egress routes in the event of a flood. While unhoused encampments are not known to populate this area, this reach ranks high in social vulnerability concerns.

Flooding Impact Area 8 is impacted by floodwaters from Canoas Creek. Floodwaters in this area exceed 5 feet in highly populous areas. Flooding Impact Area 8 differs from Flooding Impact Area 7 in that the flooding mostly impacts single family residential homes rather than the manufactured home neighborhoods in Flooding Impact Area 7. Flooding Impact Area 8 has moderate to high social vulnerability concerns.

Flooding Impact Area 9 impacted by floodwaters from Canoas Creek and Guadalupe River. Flooding in Flooding Impact Area 9 is shallow and slow-moving impacting low-lying residential structures and street parked vehicles. Social vulnerability is of moderate concern, with higher concentration of social vulnerability in the southern region of Flooding Impact Area 9.

Flooding Impact Area 10 experiences flooding from Guadalupe River. Floodwaters in this area are shallow, not exceeding 3 ft, mainly impacted low lying residential homes and street parked cars. There are some unhoused encampments but generally the social vulnerability is not a concern.

Flooding Impact Area 11 is impacted by floodwaters from Ross Creek. Flooding in Flooding Impact Area 11 is shallow and slowing and will impact mostly street parked cars. There are few unhoused encampments in Flooding Impact Area 11 and the area has low social vulnerability concerns.

Table 2: Flooding Impact Area Important Characteristics

Flooding Impact Area	Flood Source	Max Flood Depth Rating (0.2 % Annual Exceedance Probability)	Social Vulnerability	Structure Characterization	Number of Unhoused Encampments
1	Guadalupe River	Moderate (3-5ft)	High	Mixed use	High
2	Guadalupe River	Shallow (<3)	Moderate to High	Residential (single occupancy)	High
3	Guadalupe River	Shallow (<3)	Low	Residential (single occupancy)	Low
4	Ross Creek/ Guadalupe	Shallow (<3)	Low	Residential (single occupancy)	Low
5	Upper Guadalupe	Shallow (<3)	Low	Residential (single occupancy)	Low
6	Canoas Creek	Moderate (3-5ft)	High	Residential (multi-family occupancy)	Low
7	Canoas Creek	Deep (>5 ft)	Moderate to High	Residential (single occupancy, high manufactured home representation)	Low
8	/Canoas Creek	Deep (>5 ft)	Moderate	Residential (single occupancy)	Low
9	Canoas Creek	Shallow (<3)	Moderate	Residential (multi-family occupancy)	Low
10	Guadalupe River	Shallow (<3)	Low	Residential (single occupancy)	Moderate
11	Ross Creek	Shallow (<3)	Low	Residential (single occupancy)	Low

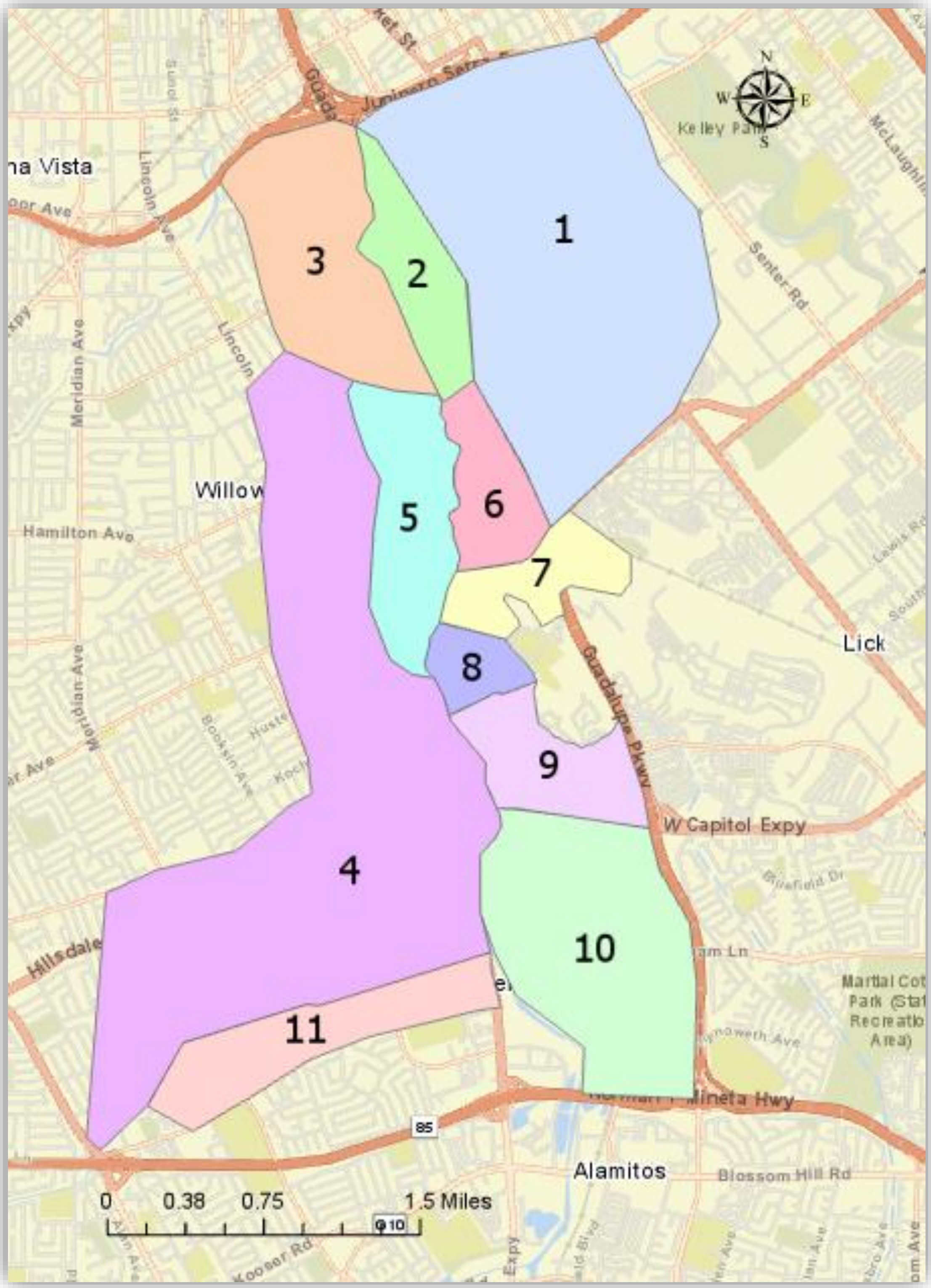


Figure 2: Flooding Impact Areas

2.2 Land Use

The total number of acres of developed agricultural, and underdeveloped land in Santa Clara County are displayed in Table 3. As shown in the table, 13.35% of Santa Clara County is developed land. There are 51,885 acres of developed land, 12,768 acres of agricultural land, and 323,942 acres of undeveloped land. The study area is located in the San Jose city center which is mostly comprised of developed land.

Table 3: Land Use

Land Class Name	Acres	Percentage of Total
Developed Land	51,865	13.35%
Agricultural Land	12,768	3.29%
Undeveloped Land	323,942	83.37%
Total	388,576	100%

3 Socioeconomic Setting

3.1 Early History of the Santa Clara Valley

The Native Ohlone peoples have occupied the South San Francisco Bay area since approximately 500 AD and engaged primarily in sustainable fishing, hunting, and farming activities. In 1769, Spanish explorers arrived in California. They began to establish settlements, military presidios, and missions, often relying on the forced labor of the Ohlone peoples to accomplish the Spanish Crown's goals (Park & Pellow, 2004).

The late 19th and 20th centuries saw increased farming and cannery growth across the South San Francisco area. The demand for farming and cannery labor initiated a wave of migration to the region, primarily from China and Japan. Immigrants often worked in hazardous conditions and faced discrimination and violence from white landowners, who thought they had an exclusive right to command the land and natural resources of the region. The mid-20th century saw a series of significant strikes and labor conflicts as immigrants sought justice against racially biased pay scales, low wages, and hazardous working conditions (Park & Pellow, 2004).

In the mid-20th century, Santa Clara Valley's economy transitioned to a new, post-agricultural economy focused on electronics production. Large corporations, such as IBM and FMC, began to expand their plants in the region. Ultimately, this led to the creation of ethnic pockets; workers of color lived in more decrepit areas in the Santa Clara Valley, while white workers lived in more affluent communities (Park & Pellow, 2004).

3.2 Current Social Landscape

The City of San Jose is located in Santa Clara County, California. It is considered part of the Bay Area (comprised of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Solano, Sonoma, and Santa Clara Counties), which has a total population of over seven million people (2020 estimates). Between 2000 and 2020, the City of San Jose's population increased by approximately 13.22 percent, which is somewhat below county, national, and state averages for population growth (see Table 4).

Table 4: Population Trends, 2000-2020 Estimates

`	**Population**			**Percent Change**		
Geographical Area	2000	2010	2020	2000 to 2010	2010 to 2020	2000 to 2020
The City of San Jose	894,943	945,942	1,013,240	5.67%	7.11%	13.22%
Santa Clara County	1,682,585	1,781,642	1,936,259	5.89%	8.68%	15.08%
California	33,871,648	37,253,956	39,538,223	9.99%	6.13%	16.73%
United States	281,421,906	308,745,538	331,449,281	9.71%	7.35%	17.78%
Source: U.S. Census Bureau & Bay Area Census						

Most of the people living in the City of San Jose are White (see Table 5), followed by Asian (37.2 percent) and Hispanic/Latino (31 percent). The City of San Jose and Santa Clara County both have higher percentages of Asian persons and smaller percentages of White and Black/African American persons living in the area than state and national figures. Figure 3, derived from the Centers for Disease Control and Prevention's Social Vulnerability Index (SVI) data, shows the range of minority populations (persons of color) in each reach in the study area. Figure 4 shows the number of persons who speak English "less than well."

Table 5: Racial Composition of the Study Area, U.S. Census Bureau July 2021 ACS Estimates[1]

Race	City of San José	Santa Clara County	California	United States
White alone, not Hispanic or Latino	25.1%	82.2%	35.2%	59.3%
Black or African American	2.9%	1%	6.5%	13.6%
American Indian and Alaskan Native	0.6%	1.1%	1.7%	1.3%
Asian alone	37.2%	2.5%	15.9%	6.1%
Native Hawaiian and Other Pacific Islander alone	0.5%	0%	0.5%	0.3%
Hispanic or Latino	31%	8.5%	40.2%	18.9%

Source: U.S. Census Bureau Population Estimates, July 2021, ACS data

[1] The percentages in this table do not perfectly add up to 100 percent for several reasons: 1) race and ethnicity is self-reported and subjective information; 2) respondents can check as many or as few boxes as they like; 3) the table may not be showing everything possible on the survey instrument; 4) identification of Hispanic/Latino is not considered an identification of race.

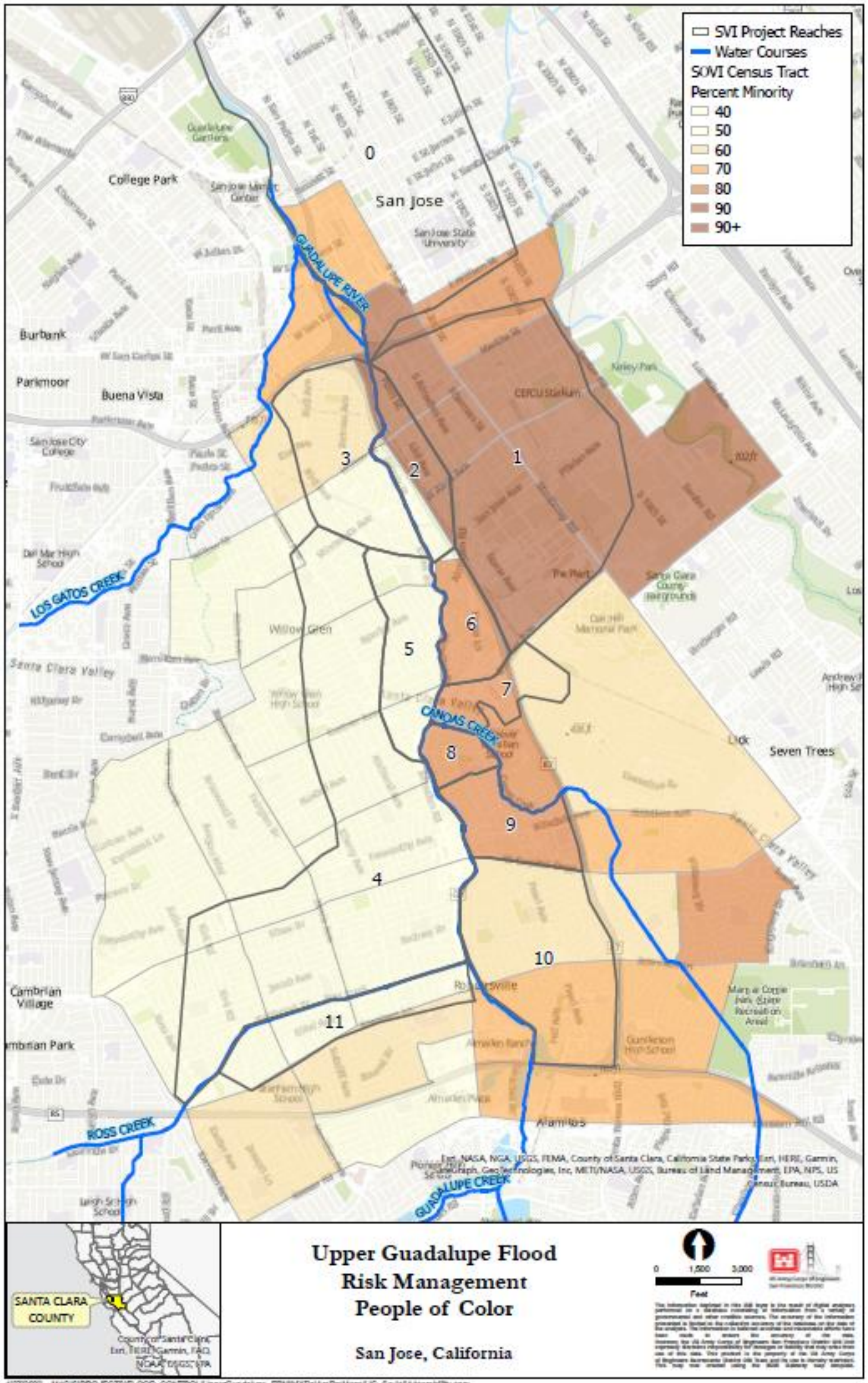


Figure 3: Minority Population

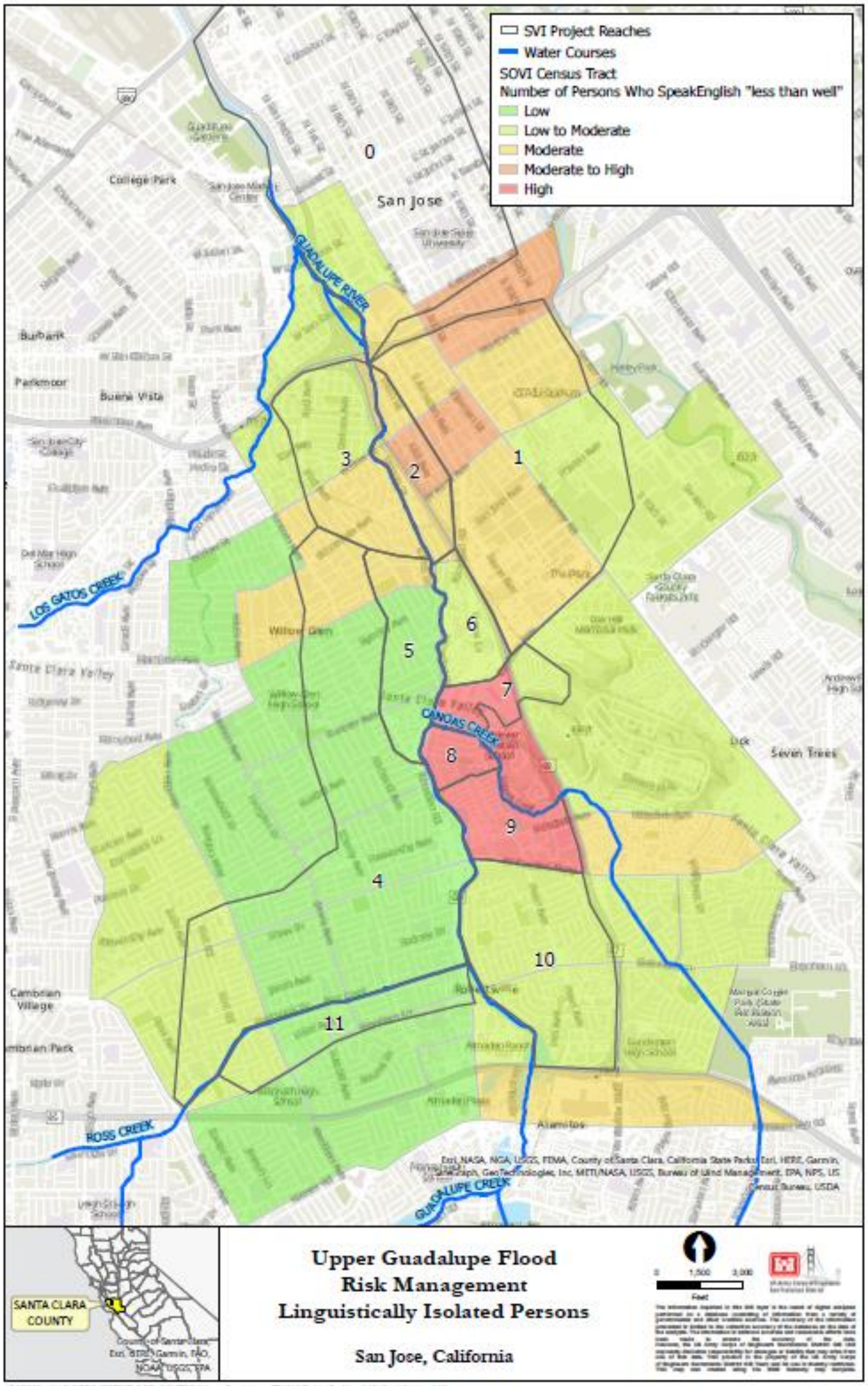


Figure 4: Distribution of Persons Who Speak English "Less than Well"

The percentage of persons under five years living in the City of San Jose closely mirrors county, state, and national figures (see Table 6). The percentage of persons under 18 years and over 65 years is consistent across all localities. The percentage of female persons in the City of San Jose similarly mirrors county, state, and national figures.

Table 6: Age Characteristics

Statistic	City of San Jose	Santa Clara County	California	United States
Persons under 5 years	5.9%	5.4%	5.8%	5.7%
Persons under 18 years	22%	21.2%	22.4%	22.2%
Persons 65 years and over	13%	14.5%	15.2%	16.8%
Female persons	49.4%	49.1%	50%	50.5%

Source: U.S. Census Bureau, July 2021 ACS data

Approximately 85 percent of persons aged 25 years or older held a high school degree or higher between in the City of San Jose (see Table 7). This figure is relatively consistent with state data, but lower than county and national averages. Both the City of San Jose and the County of Santa Clara had a higher percentage of 4-year college graduates than California and the United States during the same period. Figure *5* shows the distribution of persons without a high school diploma.

Table 7: Education, 2016-2019 Estimates

Education	City of San Jose	Santa Clara County	California	United States
High school graduate or higher	85%	88.7%	83.9%	88.5%
Bachelor's degree or higher	44.8%	53.5%	34.7%	32.9%

Source: U.S. Census Bureau ACS data, 2016-2020

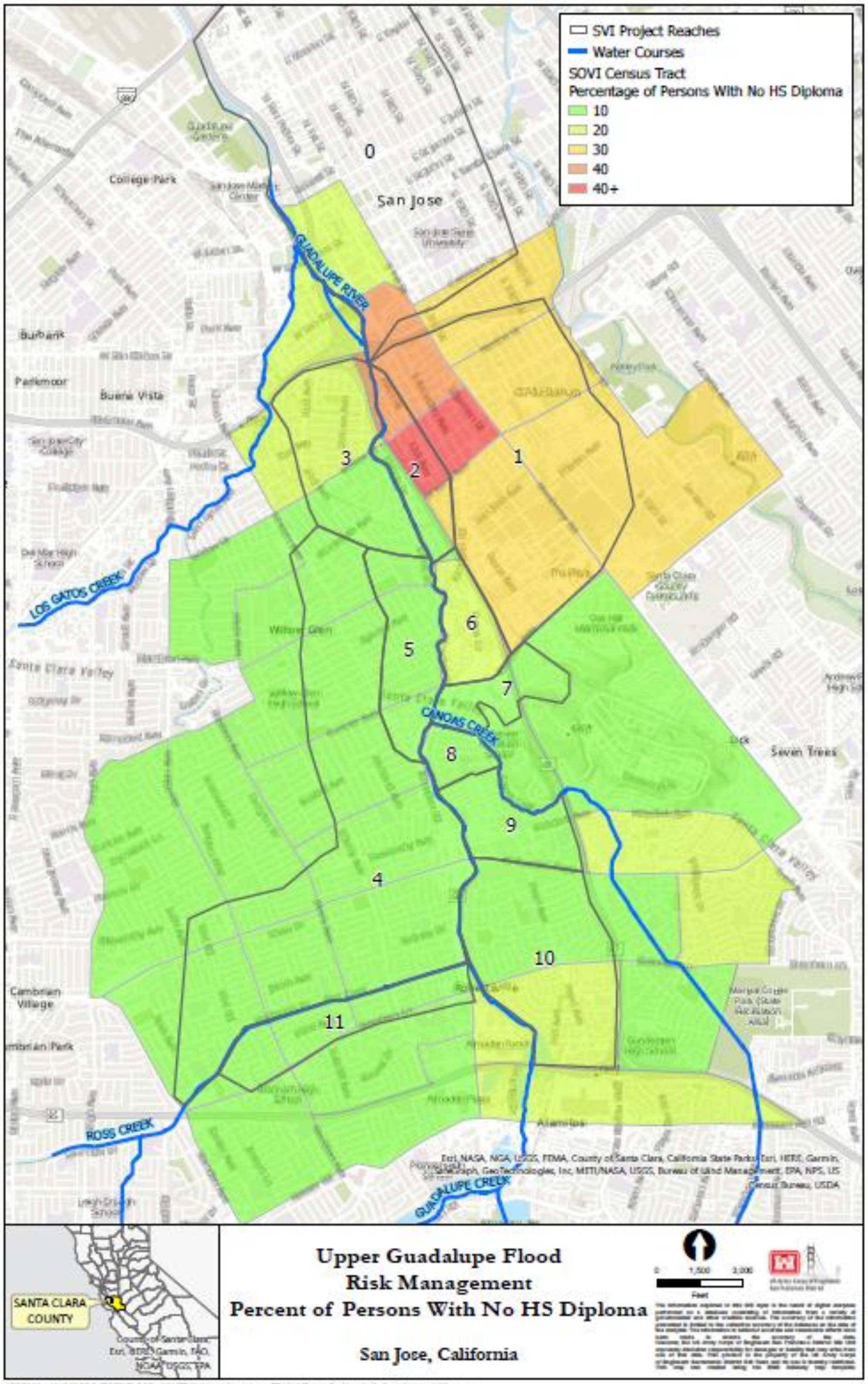


Figure 5: Percent of Persons Without a High School Diploma

In 2020, the largest-employing private high-level industries in Santa Clara County were service-producing, followed by professional and business services and goods-producing industries (see Table 8). Average annual wages per employee were highest for the information industry, followed by manufacturing and goods-producing industries. Major private-sector employers in the region include Adobe Inc, Advanced Micro Devices Inc, Applied Materials Inc, and Cisco Systems Inc, amongst others.

Table 8: Private Average Employment and Payroll Statistics, Santa Clara County, 2020

High-Level Industry	Annual Average Employment	Total Annual Wages	Annual Wages per Employee
Service-producing	743,334	$113,796,750,885	$153,090
Goods-producing	217,030	$48,905,999,885	$225,342
Natural resources and mining	3,256	$161,460,827	$49,591
Construction	48,456	$4,602,383,157	$94,981
Manufacturing	165,318	$44,142,155,213	$267,013
Trade, transportation, and utilities	115,839	$9,406,995,133	$81,208
Information	104,554	$35,552,201,883	$340,036
Financial activities	37,396	$6,114,511,460	$163,505
Professional and business services	232,187	$45,882,280,211	$197,609
Education and health services	160,718	$13,065,530,691	$81,295
Leisure and hospitality	71,643	$2,673,900,008	$37,322
Other services	20,995	$1,101,264,102	$52,454
Unclassified	2	$67,397	$38,513

Source: U.S. Bureau of Labor Statistics: Quarterly Census of Employment and Wages, Year 2020

Out of the public sector, the local and federal governments employed the largest share of workers in 2020 (see Table 9). Average weekly pay was highest for federal government workers.

Table 9: Government Average Employment Statistics, Santa Clara County, 2020

Government Employment	Average Monthly Employment	Total Annual Payroll ($1,000)	Average Weekly Pay
Federal Government	10,503	$1,107,848	$2,028
State Government	6,488	$454,375	$1,355
Local Government	73,860	$6,664,166	$1,735

Source: Employment Development Department Quarterly Census of Employment and Wages (QCEW), Year 2020

The City of San Jose had a lower household income than Santa Clara County, but a higher median income than the State of California and the United States between 2015 and 2019 (see Table 10). Per capita income was lower in the City of San Jose than Santa Clara County, but higher than state and national averages between the same period. Poverty rates were higher in San Jose than Santa Clara County, but lower than in California and the United States. Several census tracts in flooding impact area one experience over 20% poverty (see Figure 6).

Table 10: Median Household Income and Poverty

Regional Income and Poverty Data	City of San Jose	Santa Clara County	California	United States
Median Household Income (in 2020 dollars)	$117,324	$130,890	$78,672	$64,994
Per Capita Income in Past 12 months (in 2020 dollars)	$49,207	$59,297	$38,576	$35,384
Persons in Poverty	8.3%	6.6%	12.3%	11.6%

Source: U.S. Census Bureau, 2016-2020 ACS data

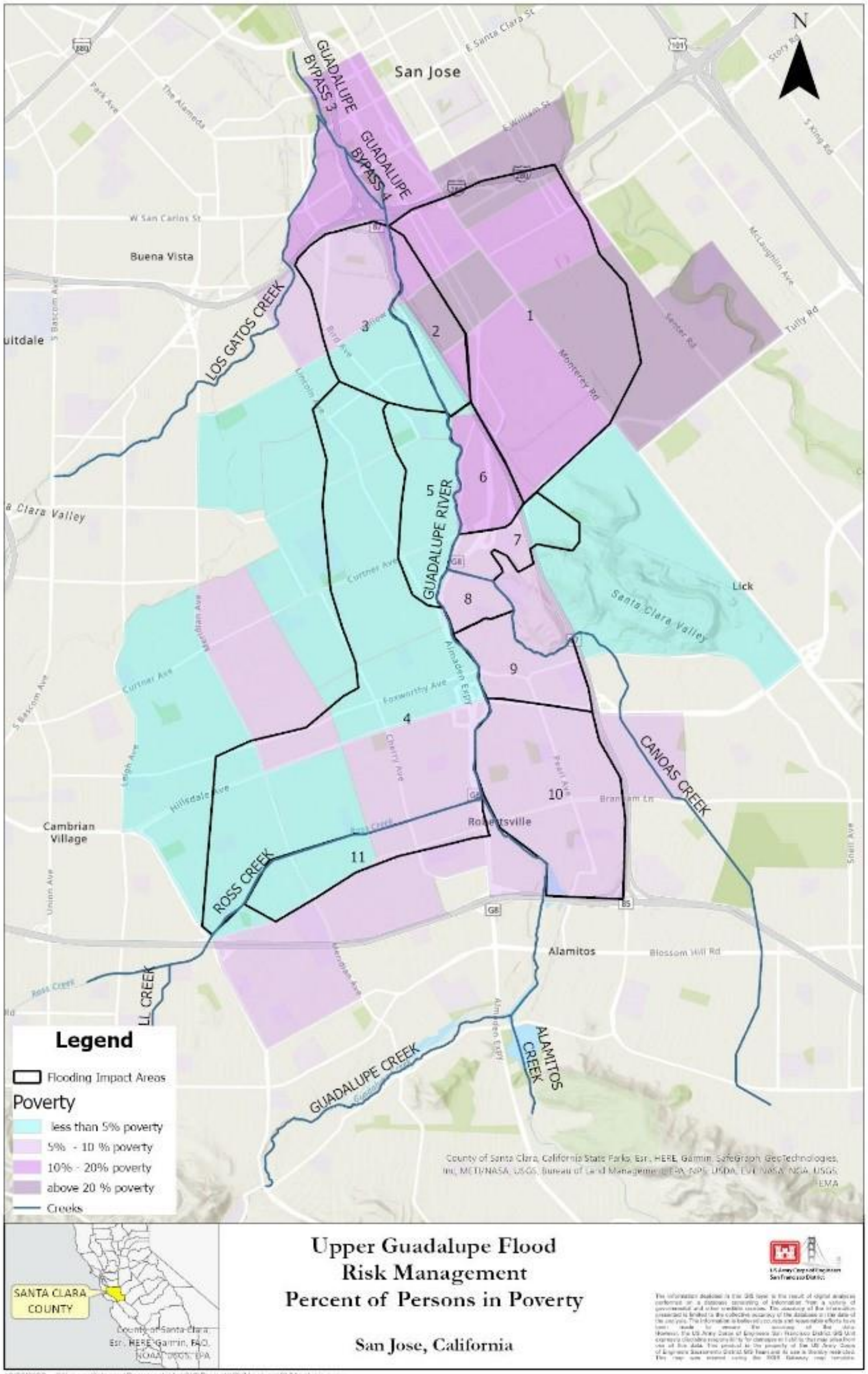


Figure 6: Percent of Persons in Poverty

In 2019, the unhoused population in the City of San Jose was approximately 6,097 persons, which is a significant increase from prior years (see

Table ***11***). Of the persons surveyed in 2019, 84 percent were unsheltered and 16 percent were sheltered. Of those, 476 individuals were veterans (60 percent of which were unsheltered). Most persons experiencing homelessness were Latino/Hispanic and White males over the age of 25 (Applied Survey Research , 2019).

In 2019, the Santa Clara County Homeless Census and Survey found that Black/African Americans and Hispanic/Latinx populations experiencing homelessness were overrepresented in the overall population. Nineteen percent of Black/African Americans experienced homelessness but only constituted 3 percent of the population in Santa Clara County. Nearly 43 percent of Hispanic/Latinx persons experienced homelessness and constituted only 26 percent of the total population (Applied Survey Research , 2019).

Table 11: Unhoused Population in Santa Clara County, Years 2007-2019

Individuals Experiencing Homelessness	
Year	Population
2007	4,309
2009	4,193
2011	4,043
2013	4,770
2015	4,063
2017	4,350
2019	6,097

The unemployment rate of Santa Clara County between 1990 and 2020 was generally lower than the unemployment rate of California and the nation. In 2010, the unemployment rate of Santa Clara County and California far exceeded that of the United States (see Table 12).

Table 12: Average Annual Unemployment Rate

Average Annual Unemployment Rate, 1990 – 2020				
	1990	**2000**	**2010**	**2020**
Santa Clara County	3.97%	3.06%	10.66%	7.23%
California	5.79%	4.93%	12.46%	10.28%
United States	5.62%	3.97%	9.6%	8.09%

Source: Federal Reserve Bank of St. Louis (FRED). 1990-2020

4 Recent Flood History

The Upper Guadalupe study area and the city of San Jose regularly experiences riverine flooding from the Guadalupe River and its tributaries. In January 1995, major flooding on the Guadalupe River and Canoas Creek resulted in approximately $1.6 million in damages. The study area has also been affected by riverine flooding in 1983, 1982, 1980 and 1978.

Figure 7: Flooding from the Guadalupe River

4.1 Critical Infrastructure

Critical infrastructure in the Upper Guadalupe study area includes five schools and one fire station. There are three schools just outside the extent of the future without project 0.2% AEP event floodplain. Only two of the identified critical infrastructure – University Preparatory Academy and Canoas Elementary School have flood depths that exceed their foundation heights at the 1% AEP. Figure 8 shows the critical infrastructure at the future without project 1% AEP event.

The Valley View, Bypass, and Combination Plans remove all critical infrastructure from the 1% AEP event floodplain. The Low Scope plan leaves one critical infrastructure, Canoas Creek Elementary School, within the 1% AEP floodplain. The Nonstructural Only Plan protects two critical infrastructure through elevation or dry floodproofing. The remaining critical infrastructure would still be at risk of flood damages and life safety hazards associated with high flood depths and velocities.

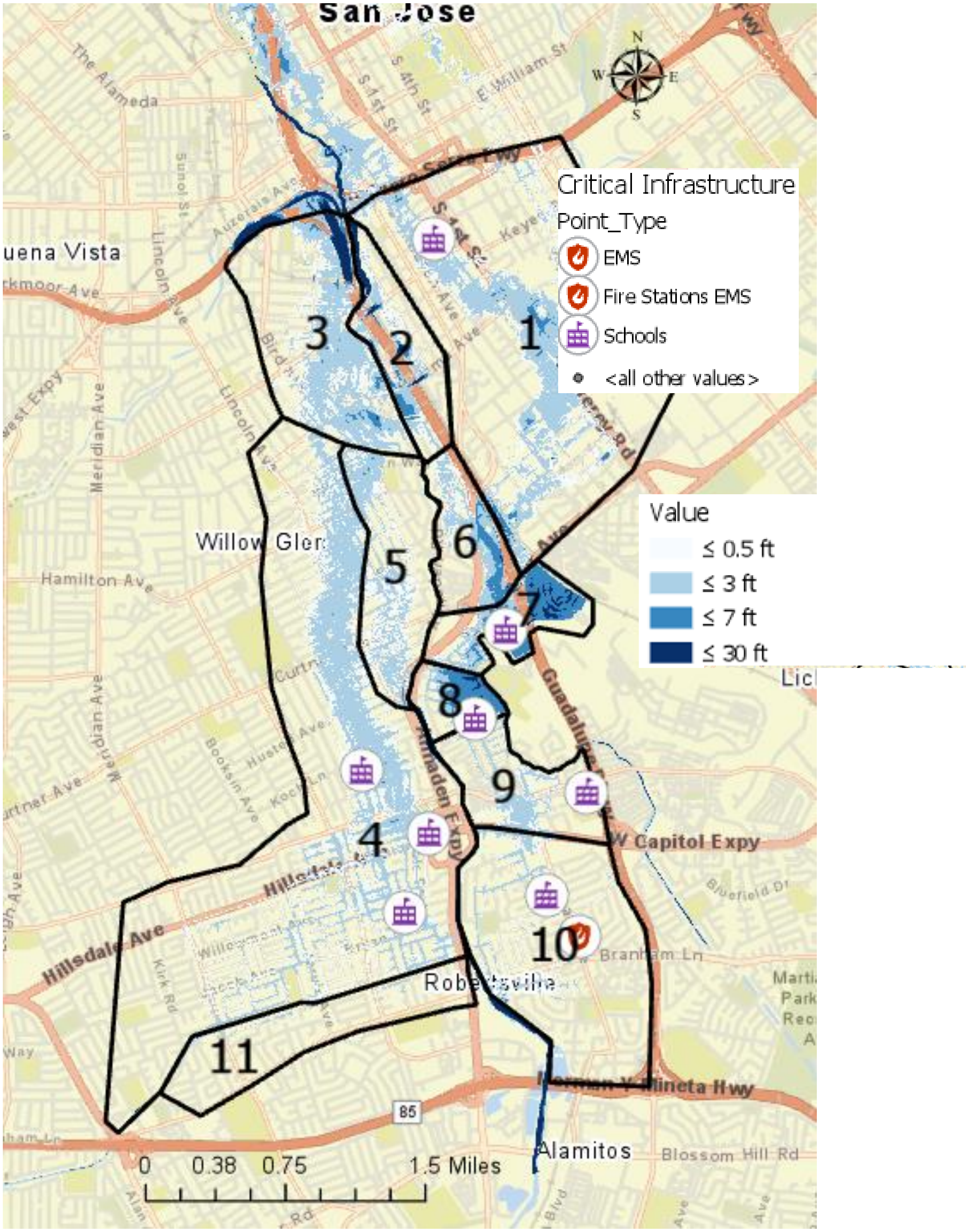


Figure 8: Critical Infrastructure

5 5 Scope of Study

5.1 Problem Description

The study area is a dense urban setting that experiences recurring flooding from the Upper Guadalupe River and its tributaries resulting in significant economic damages and continued risk to the surrounding community (see Figure 9). Flood risk management is the only authorized purpose for the study. Recreation features may be added, if economically justified, within the limits specified by ER 1105-2-100. A total of 8 alternatives were developed for the final array; of these, five alternatives were carried forward. Table 13 shows these plans and their descriptions.

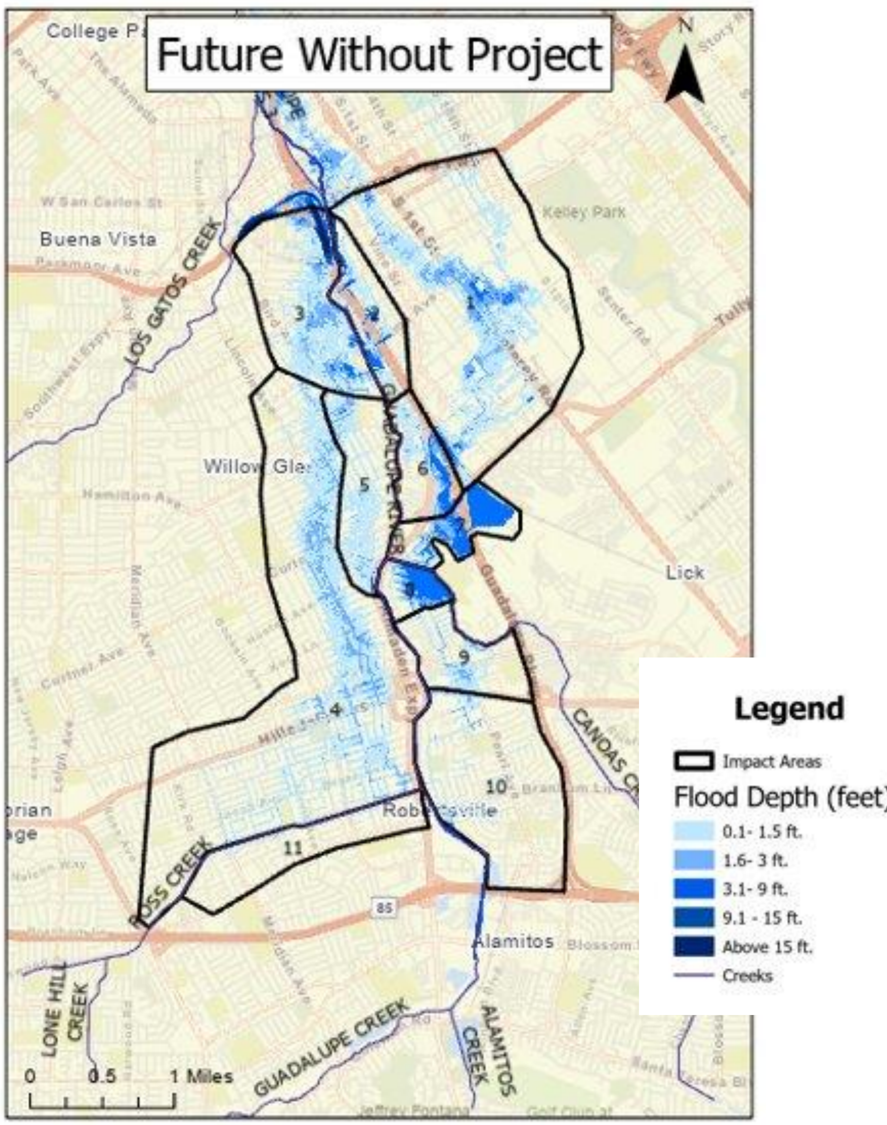


Figure 9: Existing Condition Flood Depths, 1% AEP Event

Table 13: Final Array of Alternatives

Final Array of Alternatives	
Alternative 1: No Action	Describes what would happen without federal action as a part of this project. Used for comparison with action alternatives to assess the benefits of the alternatives, and any impacts from the project.
Alternative 2b: Modified Valley View Plan (previous NED plan)	Uses channel widening and bypasses, culvert, and bridge replacements, as well as floodwalls on the tributaries to increase channel capacity and reduce flood damages.
Alternative 3b: Modified Bypass Plan (previous authorized plan, partially constructed)	This plan also uses channel widening on the eastern bank of the Guadalupe River, with even more bypass features that will include alcoves to provide connectivity to the main channel. This plan would include gravel augmentation (rip rap) and fishponds, as well as culvert/bridge replacements throughout the system.
Alternative 4: Nonstructural Only	Targeted nonstructural includes elevating residential structures and floodproofing nonresidential structures up to 3ft.
Alternative 7: Low Scope Plan	The lower scoped alternative is focused on seeing if there is a lower cost plan that may be justified. This plan includes many of the features in the combination plan with a reduced number of culverts and floodwalls.
Alternative 8b: Combination Plan	This plan combines engineering with nature features, such as floodplain reconnection/restoration in the constricted portions of the mainstem of the Guadalupe River, with traditional flood risk management features, such as floodwalls on the tributaries. The Combination Plan also includes gravel augmentation and alcoves, as well as bridge/culvert replacement at the most restricting pinch points in the system.

6 Economic and Engineering Inputs to the HEC-FDA Model

6.1 HEC-FDA Model Overview

The Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) Version 1.4.3 USACE-certified model was used to calculate the damages and benefits for the Upper Guadalupe evaluation. The economic and engineering inputs necessary for the model to calculate damages for the project base year (2026) include the existing condition structure inventory, contents-to-structure value ratios, first floor and ground elevations, depth-damage relationships, and without-project and with-project stage-probability relationships.

The uncertainty surrounding each of the economic and engineering variables was also entered into the model. Either a normal probability distribution, with a mean value and a standard deviation, or a triangular probability distribution, with a most likely, a maximum and a minimum value, was entered into the model to quantify the uncertainty associated with the key economic variables. A normal probability distribution was entered into the model to quantify the uncertainty surrounding the first floor elevations . A 50-year period of record was used to quantify the hydrologic uncertainty or error surrounding the discharge-probability relationships in consultation with the H&H engineer.

6.2 Economic Inputs to the HEC-FDA Model

6.2.1 Structure Inventory

A structure inventory of residential and non-residential structures for the study area was obtained using the National Structure Inventory (NSI), version 2.0. The NSI was originally created by USACE to simplify the GIS pre-processing workflow for the Modeling Mapping and Consequence center (MMC) and was recently upgraded to version 2 using upgraded data sources and algorithms. The NSI 2.0 database was significantly improved through various techniques described in subsequent sections.

NSI 2.0 sources its structural attribute data from tax assessed parcel data (available through CoreLogic), business location data available through Esri/Infogroup, and HAZUS (where other datasets were unavailable). NSI 2.0 data is not an exact representation of reality, but rather contains many county-level, state-level, or regional assumptions applied to individual structures, often by random assignment. As such, while county or other large aggregations of structures will be accurate on average, individual structure characteristics may not be accurate. Although these and other accuracy issues exist, the NSI 2.0 dataset functions as an available common and consistent standard for the United States. The chief advantage of NSI 2.0 over other national datasets is its spatial accuracy, which is a significant improvement over the census block level accuracy that NSI 1.0 relied on.

Occupancy Types. The NSI 2.0 database comes with its own list of occupancy types, which describes the type of structure more than simply residential or non-residential. Occupancy types are important because they are used to assign depth-damage relationships to determine the rate at which a structure is damaged given a depth of water. This study utilized these three different occupancy types:

1. **NSI 2.0 –** Occupancy type descriptions come with the original NSI 2.0 data and were the starting point for the study. NSI 2.0 occupancy types were verified during sampling.

2. **Marshall and Swift** – To estimate costs per square foot for structures, the NSI 2.0 occupancy types were converted to Marshall and Swift occupancy types. In general, there was a unique Marshall and Swift occupancy type to match to each NSI 2.0 occupancy type. Professional judgment was used when combining occupancy types based on how the structure would be damaged.

3. **Depth-Damage Relationships** – Neither the NSI 2.0 nor Marshall and Swift occupancy types matched the occupancy types required to use for the depth-damage relationships that were selected for the local flooding conditions. Professional judgment was used again to sort each structure type into the most representative occupancy type that the depth damage relationships offered.

Structure Values

As previously identified in the description of NSI 2.0, the national database has limitations and oversimplifications that lead to unacceptable levels of uncertainty for a feasibility level study. To overcome the limitations and reduce uncertainty, Marshall and Swift was used to reevaluate the depreciated replacement values and multiple statistically significant samples were performed to ensure an accurate representation of structural attributes. This process is further described below.

Application of Marshall and Swift

The 2021 Marshall and Swift catalog was used to assign a depreciated replacement cost per square foot value to residential structures. Square footage estimations were gathered in windshield survey of the entire study area and include a confidence interval to account for uncertainty. The Marshall and Swift valuation allows the user to customize the following primary items: structure type, quality of construction, and class (masonry or frame).

- Exterior Wall Type - Replacement costs per square foot were provided for four exterior walls types (wood frame or masonry). A detailed windshield survey and structure inventory data from 2018 was utilized to verify the exterior wall type for each individual structure in the structure inventory.

- Build Quality – Build quality of a structure helps determine how high the starting cost per square foot should be for structures. A combination of windshield survey and old structure inventory data was used to assign structures with the appropriate build quality.

- Depreciation – Depreciation of a structure is based on the observed condition (effective age) of the structure and can be described as the structure's wear and tear since it was constructed or last rehabilitated. Data about the depreciation of the structure was collected in the windshield and assigned to the individual structure.

- Regional - A regional adjustment factor was applied to the overall Marshall and Swift multiplier to account for construction costs consistent with the Santa Clara County, California area (see Table 14)

The formula to determine depreciated replacement value for structures is simplified as follows:

$$Cost\ per\ sq\ ft * \ of\ sq\ ft\ * Depreciation\ factor$$

Table 14: Marshall and Swift Effective Age Multipliers

	ADJUSTED MULTIPLIERS										
	poor	low cost	fair/lc	fair	fair-avg	avg	avg-good	good	good-very	very good	excellent
	2	3	4	5	6	7	8	9	10	11	12
Ag/Storage-C	0	0	0	46.16	46.16	46.16	53.62	61.08	30.54	0	0
Ag/Storage-D	21.34	24.54	27.75	30.95	34.16	37.36	44.69	52.01	26.01	0	0
Ag/Storage-S	20.38	23.27	26.16	29.05	31.94	34.83	41.3	47.76	23.88	0	0
Airport Terminal-A	0	236.81	0	0	167.92	335.84	406.88	477.92	528.15	578.39	678.85
Auditorium	0	0	0	0	140.56	281.12	332.66	384.2	424.81	465.42	546.63
Auto Dealer-C	0	99.48	0	0	73.06	146.11	174.87	203.63	101.81	0	290.67
Auto Dealer-D	0	92.68	0	0	68.92	137.85	165.5	193.14	96.57	0	278.81
Auto Dealer-S	0	88.71	0	0	66.15	132.3	160.22	188.13	94.06	0	0
Auto Parts	22.87	24.74	26.61	28.48	30.35	32.21	38.66	45.11	45.11	45.11	45.11
Auto Repair-C	58.04	64.12	70.2	76.28	82.36	88.44	105.02	121.61	134.69	147.77	173.93
Auto Repair-D	52.01	57.14	62.27	67.4	72.53	77.66	91.94	106.23	106.23	106.23	0
Auto Repair-S	46.7	51.46	56.22	60.97	65.73	70.49	84.24	97.98	97.98	97.98	0
Auto Sales-D	76.56	87.18	97.8	108.42	119.05	129.67	155.68	181.68	201.83	221.98	
Bank-D	177.24	192.93	208.63	224.32	240.02	255.71	305.47	355.24			
Church	137.18	152.33	167.49	182.64	197.8	212.95	254.92	296.89	321.76	346.63	396.37
Club House	96.58	108.54	120.49	132.45	144.4	156.35	188.23	220.11	241.36	262.61	305.12
Community Recreation (	142.31	153.32	164.32	175.33	186.33	197.34	228.46	259.58	280.83	302.08	
Convenience Market	102.02	108.72	115.41	122.11	128.81	135.51	152.74	169.96	178	186.04	202.12
Convention Center	135.48	147.25	159.01	170.78	182.54	194.3	225.42	256.54	273.24	289.94	
Country Club	146.49	160.91	175.33	189.75	204.17	218.59	253.51	288.42	313.09	337.76	387.09
Day Care Centers	129.85	142.86	155.86	168.86	181.87	194.87	225.64	256.41	276.92	297.44	338.46
Department Store - B	0	0	207.45	207.45	207.45	207.45	238.41	269.37	285.24	301.11	332.84
Department Store - C	0	0	175.65	175.65	175.65	175.65	197.6	219.56	236.97	254.39	289.21
Elementary School	165.57	177.29	189.01	200.73	212.45	224.18	257.88	291.57	312.82	334.07	376.56
Fire Station-D		124.03	139.72	155.42	171.11	186.81	230.45	274.08			405.77
Fraternity-D						170.02	197.34	224.66			286.9
Gas Station Mini-Mart	187.57	195.99	204.42	212.84	221.26	229.68	249.59	269.49	240.19	210.89	210.89
Government		169.51	186.85	204.18	221.52	238.86	278.15	317.45			
Greenhouse	6.68	7.53	9.55	11.56	14.64	17.73	17.73	17.73	17.73	17.73	17.73
Hangar - D	52.2	57.88	63.55	69.23	74.91	80.59	80.59	80.59	80.59	80.59	80.59
Hangar - S	46.26	51.81	57.36	62.91	68.46	74.01	89.87	105.74	120.19	134.64	163.54
Hangar-C	57.85	64.12	70.38	76.65	82.91	89.18	106.5	123.82	138.56	153.3	182.78
High School	164.47	175.82	187.18	198.53	209.89	221.25	249.08	276.92	295.97	315.02	353.11
Home for Elderly-A	2397.26	1966.83	1536.4	1105.97	675.54	245.12	279.82	314.52	314.52	314.52	314.52
Home for Elderly-B	162.58	174.35	186.11	197.87	209.63	221.39	252.53	283.66	283.66	283.66	283.66
Home for Elderly-C	135.35	147.25	159.15	171.05	182.95	194.85	226.08	257.32	257.32	257.32	257.32
Home for Elderly-D	132.07	144.21	156.35	168.5	180.64	192.79	224.66	256.54	256.54	256.54	256.54
Home for Elderly-S	0	0	0	0	87.05	174.1	204.09	234.08	234.08	234.08	234.08
Hotels - A	186.42	199.34	212.26	225.18	238.1	251.02	285.72	320.42	338.51	356.6	392.78
Hotels - B	168.12	179.88	191.64	203.4	215.17	226.93	258.06	289.19	305.8	322.4	355.61
Hotels - D	156.73	166.98	177.23	187.47	197.72	207.97	228.46	248.95	263.75	278.55	308.15
Industrial - R&D - A	104.41	113.38	122.35	131.32	140.29	149.26	175.81	202.36	222.1	241.83	281.3
Industrial - R&D - B	98	106.45	114.9	123.35	131.8	140.25	165.79	191.32	210.74	230.16	269
Industrial - R&D - D	66.48	73.99	81.5	89.01	96.52	104.03	128.94	153.85	171.06	188.28	222.71
Industrial/Storage-A	74.81	80.37	85.93	91.49	97.06	102.62	120.92	139.21	139.21	139.21	0
Industrial/Storage-C	42.93	47.91	52.88	57.85	62.83	67.8	82.18	96.55	109.63	122.71	148.87
Industrial/Storage-D	38	42.49	46.98	51.47	55.95	60.44	73.44	86.45	86.45	86.45	0
Industrial/Storage-S	35.95	40.18	44.41	48.64	52.87	57.1	69.79	82.47	94.28	106.09	129.7
Industrial-C	52.7	58.22	63.75	69.28	74.81	80.33	95.81	111.29	111.29	111.29	111.29
Industrial-D	46.89	52.01	57.14	62.27	67.4	72.53	87.18	101.83	101.83	101.83	101.83
Industrial-R&D-C	72.23	80.33	88.44	96.55	104.65	112.76	138.92	165.09	186.09	207.1	249.11
Industrial-S	43.35	48.29	53.22	58.15	63.09	68.02	82.3	96.57	96.57	96.57	96.57
Laundromat	125.56	125.56	125.56	125.56	125.56	125.56	125.56	125.56	125.56	125.56	125.56
Library	0	160.78	174.17	187.57	200.97	214.37	251.88	289.4	330.74	372.08	480.8
Liquor Store	91.84	97.86	103.88	109.89	115.91	121.93	137.13	152.32	159.85	167.38	182.43
Market	90.53	98	105.46	112.93	120.39	127.86	145.08	162.31	171.88	181.45	200.59
Medical Office		165.37	178.38	191.4	204.42	217.43	251.88	286.33	305.09	323.85	361.36
MH-Double	51.3	57.47	63.64	69.81	75.02	80.23	91.03	101.82	109.92	118.02	141.17
MH-Double-Garage	0	39.15	42.52	45.89	49.26	52.62	61.74	70.85	80.92	90.99	106.65
MH-Single	59.98	65.18	70.39	75.6	80.23	84.85	95.65	106.45	114.17	121.88	143.48

MH-Single-Garage	0	39.15	42.52	45.89	49.26	52.62	61.74	70.85	80.92	90.99	106.65
Middle School	162.64	172.89	183.15	193.41	203.66	213.92	238.83	263.74	280.59	297.44	331.14
Multiple Residences	79.32	87.29	95.25	103.22	111.19	119.16	140.79	162.43	177.23	192.03	221.63
Multiple Residences 2	0	227.49	0	254.48	267.97	281.47	314.24	347.01	173.51	0	435.7
Multiple Residences 2-G	0	84.25	91.94	99.63	107.33	115.02	135.9	156.78	171.06	185.35	213.92
Multiple Residences-Ga	0	87.29	95.25	103.22	111.19	119.16	140.79	162.43	177.23	192.03	221.63
Neighborhood Shopping	99.56	108.27	116.97	125.68	134.39	143.09	160.88	178.68	89.34	0	0
Neighborhood Shopping	93.4	101.82	110.25	118.67	127.09	135.51	152.74	169.96	84.98	0	0
Office-A	196.45	209.86	223.26	236.66	250.07	263.47	306.36	349.25	372.23	395.2	441.16
Office-B	186.55	199.7	212.86	226.02	239.18	252.34	294.91	337.49	360.32	383.15	428.82
Office-C	108.64	123.28	137.92	152.56	167.2	181.84	219.59	257.35	285.09	312.82	368.3
Office-D	100.68	114.84	129	143.17	157.33	171.49	206.71	241.93	268.34	294.76	347.58
Office-S	93.06	105.38	117.7	130.01	142.33	154.65	190.28	225.91	225.91	225.91	225.91
Outbuilding-Utility Build	0	0	0	0	21.31	42.61	50.96	59.3	29.65	0	0
Parking Structure	58.53	62.93	67.34	71.75	76.15	80.56	92.06	103.57	103.57	103.57	
Police Station	155.26	169.51	183.76	198.02	212.27	226.53	263.51	300.5			
Post Office	0	0	0	0	98.9	197.8	228.57	259.34	277.66	295.97	295.97
Restaurant	121.92	135.51	149.1	162.69	176.28	189.87	218.2	246.52	283.27	320.02	419.55
Restaurant - Fast Food-D	129.39	143.93	158.48	173.03	187.57	202.12	233.51	264.9	307.01	349.11	460.89
Restrooms D	122.34	169.96	185.35	200.73	216.12	231.5	272.53	313.55	341.39	369.23	424.91
Retail Store-C	86.88	96.15	105.43	114.7	123.98	133.25	154.45	175.65	191.17	206.69	237.73
Retail Store-D	81.35	90.34	99.34	108.33	117.33	126.32	146.61	166.9	182.21	197.52	228.15
Retail Store-S	75.71	84.89	94.06	103.24	112.42	121.6	142.63	163.66	163.66	163.66	163.66
School	175.41	187.2	198.99	210.78	222.57	234.37	268.27	302.17	323.54	344.92	387.66
Self-storage Warehouse	53.63	59.84	66.06	72.28	78.5	84.71	102.2	119.69	59.84	0	0
Service Station	111.12	136.48	143.01	149.53	156.06	162.58	178.99	195.4	195.4	195.4	195.4
SFR15-C	128.04	157.25	164.77	172.29	179.81	187.33	206.23	225.14	225.14	225.14	225.14
SFR15-C-GARAGE	0	65.11	70.41	75.71	81.01	86.31	100.69	115.08	130.22	145.36	169.59
SFR15-D	143.15	175.82	184.23	192.63	201.04	209.45	230.58	251.72	251.72	251.72	251.72
SFR15-D-GARAGE	0	85.77	93.6	101.43	109.26	117.09	138.35	159.6	174.14	188.69	217.77
SFR2-C	162.61	199.71	209.26	218.81	228.36	237.91	261.92	285.93	285.93	285.93	285.93
SFR2-C-GARAGE	0	65.11	70.41	75.71	81.01	86.31	100.69	115.08	130.22	145.36	169.59
SFR2-D	181.8	223.29	233.97	244.64	255.32	266	292.84	319.68	319.68	319.68	319.68
SFR2-D-GARAGE	0	85.77	93.6	101.43	109.26	117.09	138.35	159.6	174.14	188.69	217.77
SFR-B	96.54	106.53	116.52	126.51	136.86	147.22	176.44	205.66	224.9	244.13	294.44
SFR-B-GARAGE	0	65.69	71.03	76.38	81.73	87.07	101.59	116.1	131.37	146.65	171.09
SFR-C	91.66	109.22	119.53	129.85	140.92	152	182.93	213.86	233.72	253.58	305.52
SFR-C-GARAGE	0	65.69	71.03	76.38	81.73	87.07	101.59	116.1	131.37	146.65	171.09
SFR-D	86.53	103.22	112.71	122.2	132.07	141.93	169.64	197.34	214.8	232.25	279.31
SFR-D-GARAGE	0	85.77	93.6	101.43	109.26	117.09	138.35	159.6	174.14	188.69	217.77
Supermarkets-C	111.1	116.59	122.08	127.57	133.06	138.55	154.07	169.59	177.54	185.49	201.39
Theater-Cinema-C	98.32	113.47	128.63	143.78	156.61	169.43	205.18	240.93	269.69	298.44	357.51
Vacant	0	0	0	0	0	0	0	0	0	0	0
Warehouse-C	42.93	47.91	52.88	57.85	62.83	67.8	82.18	96.55	109.63	122.71	148.87
Warehouse-D	38	42.49	46.98	51.47	55.95	60.44	73.44	86.45	86.45	86.45	86.45
Warehouse-S	35.95	40.18	44.41	48.64	52.87	57.1	69.79	82.47	94.28	106.09	129.7

6.2.2 Inventory and Values

A typical study includes vehicles parked in the garage of the house in which the vehicles have the same geographical location and water surface elevation as the structure. In performing the windshield survey, the economics determined at a significant number of vehicles were parked on the street. Thus, the economics team created a vehicle inventory that included vehicles parked in the garage (vehicles at the structure) and street parked vehicles. Table 15 shows the quantity of vehicles and structures in the economic inventory.

Vehicles at the Structure The 2020 census shows that in Santa Clara County there is 1.89 cars for every residential structure. Assuming half of these cars are parked on the street, the economics team applied one vehicle at the structure for each residential structure in the inventory. Vehicles at the structure have the same water surface elevation as the related structure.

Street Parked Vehicles The density of street parked cars was determined by performing a google street view windshield survey using a representative sample of streets and measuring how many cars per foot were parked on each street. The sample of streets from various neighborhoods in the study area showed that, on average, there were cars parked every 100 feet. This number was applied to all streets in the study area (excluding interstate or major roadways where street parking is unlikely).

Vehicle Value The Manheim Used Car Index was used to calculate the average used car value. The average price of used vehicle in 2022 was $28,980. This value was applied to both vehicles at the structure and street parked vehicles.

Table 15: Vehicles and Structures in the Economic Inventory

Vehicles and Structures in Economic Inventory	
Vehicles at the Structure	7,071
Street Parked Vehicles	6,079
Structures	7,567

6.2.3 Elevation Data and Sampling Attributes

Elevation data associated with the ground surface, foundation heights, and first floors of structures are critical to the economic analysis and feasibility of studies. Given the low-resolution of foundation height data provided with the NSI 2.0 database, a windshield survey of the entire study area was performed to improve the estimates associated with foundation and subsequent first floor elevations. The survey was also utilized to measure a handful of other structural attributes, detailed later in this section.

Ground Surface Elevations

Topographical data was provided by the USACE H&H Engineer. The LiDAR data was used to assign ground elevations to structures.

First Floor Elevations

The ground elevation was added to the height of the foundation of the structure above the ground to obtain the first-floor elevation of each structure in the study area.

First Floor Uncertainty

Uncertainty surrounding foundation heights. In the FDA model the first-floor uncertainty is normally distributed 0.6 for residential, public, industrial, and commercial buildings. This is based on the standard deviation of the first floor surveyed in the windshield survey. Additional surveys will be performed post-TSP to further refine the first-floor uncertainty.

Depth-Damage Relationships

Each occupancy type has its own depth-percent of value damaged curves for structure and contents. The USACE generic depth-damage relationships for one-story and two-story residential structures with and without basement from EGM 04-01, and EGM 01-03 were used in the analysis.

Site-specific non-residential depth-damage relationships were not available for this study area. The depth-damage functions for non-residential structures were based on the data presented from "Depth –Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVR) in Support of the Lower Atchafalay Reevaluation and Morganza to the Gulf, Louisiana Feasibility Studies" Final Report, Volume I, prepared by Gulf Engineers & Consultants for the USACE New Orleans District.

Of the four different curves available in the Morganza to the Gulf report short duration freshwater depth damages were deemed most appropriate for this study area.

Uncertainty in the Depth-Damage Relationships

For residential structures, a normal distribution with a standard deviation for each damage percentage provided at the various increments of flooding was used to determine the uncertainty surrounding the generic depth-damage relationships used for residential structures and vehicles. This information for residential structures was also sourced from EGM 04-01 and EGM 01-03.

For nonresidential structures, a triangular distribution for each damage percentage at the various increments of flooding was used to determine the uncertainty surrounding the depth-damage relationships for nonresidential structures. Information for uncertainty surrounding non-residential structures was sourced from the Lower Atchafalaya Reevaluation and Morganza to the Gulf, Louisiana Feasibility Studies Depth-Damage report.

6.3 Engineering Inputs to the HEC-FDA Model

6.3.1 Stage Probability Relationships

Stage-probability relationships were provided for the existing without-project condition (2026) and future without-project condition (2076). Future condition hydraulics are equal to existing condition hydraulics, as no change is expected.

The H&H engineer provided stages from HEC-RAS for eight AEP events including the 50% (2-year), 20% (5-year), 10% (10-year), 4% (25-year), 2% (50-year), 1% (100-year), 0.5% (200-year), and 0.2% (500-year). The without-project water surface profiles were based on riverine flood events. Hydraulic data was provided in geo-referenced 2D format.

6.3.2 Uncertainty Surrounding Stage Probability Relationships

A 50-year equivalent record length, provided by the H&H engineer, was used to quantify the uncertainty surrounding the stage-probability relationships for the study area. Based on this equivalent record length, the HEC-FDA model calculated the confidence limits surrounding the stage-probability functions.

6.3.3 Stage-Discharge Relationships

Stage-discharge relationships were provided for the existing without-project condition (2026) and future without-projection condition (2076).

The H&H engineer provided flow in cubic feet/second (cfs) at upstream locations for Canoas Creek, Ross Creek, and Upper Guadalupe River for each of the eight AEP events. The flow provided by the H&H engineer was combined with stages to create a rating curve.

6.3.3.1 Uncertainty Surrounding Stage-Discharge Relationships

A normal probability distribution of 0.7 ft was used to quantify the uncertainty surrounding the stage-discharge relationships for the study area. The 50-year equivalent record length was extended to the rating curve as well. The H&H engineer selected a 50-year equivalent record length and 0.7 ft normal probability distribution for all frequencies in rating curve during the calibration of the H&H model.

7 National Economic Development (NED) Flood Damage and Benefit Calculations

7.1 HEC-FDA Model Calculations

The HEC-FDA model was utilized to evaluate flood damages using risk-based analysis. Damages were reported for each of the eleven study area reaches. A range of possible values, defined by the probability distributions for each economic variable (first floor elevation, structure and content values, and depth-damage relationships), were entered into the HEC-FDA model to calculate the uncertainty surrounding the elevation-damage, or stage-damage, relationships for structures and contents. The model also used equivalent record length to determine the hydrologic uncertainty surrounding the discharge-probability relationships.

The possible occurrences of each variable are determined through a Monte Carlo process, which samples random values from each defined probability distribution. The number of iterations performed affects the simulation execution time and the quality and accuracy of the results. This process was conducted simultaneously for each economic and hydrologic variable. The resulting mean value and probability distributions represent an estimate of the full set of possible outcomes.

7.1.1 Stage-Damage Relationships with Uncertainty

The HEC-FDA model used the economic and engineering inputs to generate a stage-damage relationship for each structure category in the study area under existing conditions (2026). The possible occurrences of each economic variable were derived by Monte Carlo simulation. A total of 1,000 iterations were executed in the model for the stage-damage relationships. The sum of all sampled values was divided by the number of samples to yield the expected value for a specific simulation. A mean and standard deviation were automatically calculated for the damages at each stage.

7.1.2 Discharge-Probability Relationships with Uncertainty

The HEC-FDA model used an equivalent record length of 50 years for each study area reach to generate a discharge-probability relationship with uncertainty for the without-project condition under base year (2026) conditions through the use of graphical analysis. The hydraulic engineer selected 50 years to represent the length of records analyzed during the calibration process that the hydraulic model underwent. The model used the eight stage-probability events together with the equivalent record length to define the full range of the discharge-probability functions by interpolating between the data points. Confidence bands surrounding the discharge for each of the probability events were also provided.

7.1.3 Stage-Discharge Relationships with Uncertainty

The HEC-FDA model used engineering inputs to create a rating curve that transforms the discharge-probability relationship and stage-damage relationship to form a stage-probability relationship. The model used the eight annual exceedance probability events to create the bounds for the rating curve. The stage-probability relationship is used to calculate the expected annual damage. The stage-discharge relationship includes uncertainty bands of 0.7ft around the stage.

7.1.4 Without-Project Expected Annual Damages

The model used Monte Carlo simulation to sample from the stage-probability curve with uncertainty. For each of the iterations within the simulation, stages were simultaneously selected for the entire range of probability events. The sum of all damage values divided by the number of iterations run by the model yielded the expected value, or mean damage value, with confidence bands for each probability event. The probability-damage relationships are integrated by weighting the damages corresponding to each magnitude of flooding (stage) by the percentage chance of exceedance (probability). From these weighted damages, the model determined the expected annual damages (EAD) with confidence bands (uncertainty). For the without-project alternative, the expected annual damages (EAD) were totaled for the study area to obtain the total without-project EAD under base year (2026) conditions. Table 16 displays the damages by reach and type of structures that are damaged for the year 2026 under without-project conditions.

Table 16: Existing Condition Total Economic Damage by Reach and Structure Type for 2026 ($1000s)

Reach	Non-Residential	Residential	Auto	Total
1	$3,646	$378	$233	$4,256
2	$259	$21	$18	$298
3	$66	$758	$484	$1,308
4	$391	$592	$563	$1,545
5	$10	$168	$158	$336
6	$782	$5,668	$235	$6,685
7	$1,363	$3,306	$467	$5,136
8	$543	$957	$286	$1,787
9	$352	$56	$162	$570
10	$236	$57	$165	$458
11	$0	$30	$120	$150
Total	$7,648	$11,990	$2,890	$22,528

7.2 Structure Inventory Adjustments for High Frequency Inundation

Adjustments were made to the structure inventory to more accurately reflect the most-likely future without-project and with-project conditions. Under without-project and with-project conditions, residential and non-residential structures that were identified as being inundated above the first-floor elevation from the 50% (2-year) and 20% (5-year) AEP events were modified to have the 2-year and 5-year stages below the ground surface elevation by at least nine feet to ensure high frequency damages were mitigated in the existing and future without-project conditions. This adjustment is consistent with the FEMA floodplain regulations that require residents to rebuild above the base flood elevation after a structure receives greater than 50 percent damage to the structural components as a result of a flood.

7.3 With-Project Expected Annual Damages

The alternatives were run through HEC-FDA, which allows for determining damages reduced by damage category. Table 17 shows the damages reduced and residual damages for each plan. The Valley View Plan, Bypass Plan, and Combination Plan are most effective at reducing damages, while the Low Scope Plan and Nonstructural Plan show the greatest remaining residual risk.

Table 17: With-Project Expected Annual Damages (Residual Risk) by Damage Category ($1,000s) for Final Array of Alternatives

Alternative	Residential Damages	Non-Residential Damages	Total With-Project Damages	Damages Reduced
Alt 1. No Action	$11,990	$10,537	$22,528	
Alt 2b. Modified Valley View Plan	$236	$231	$467	$22,061
Alt 3b. Modified Bypass Plan	$300	$348	$649	$21,879
Alt 4. Nonstructural – 25YR	$6,267	$6,343	$12,610	$9,918
Alt 7. Low Scope Plan	$1,223	$1,235	$2,457	$20,071
Alt 8b. Combination Plan	$297	$641	$939	$21,589

8 Project Costs

8.1 Construction Schedule

For the purposes of computing interest during construction (IDC), construction of the project alternatives is expected to begin in the year 2026 and will continue for a period of 7 years. Interest during construction was calculated using a mid-year payment schedule and 2.5% discount rate.

Cost estimates for the structural alternatives final array were developed by the San Francisco District Cost Engineering Branch. An abbreviated cost risk analysis was completed to determine the contingencies used for all structural plans. The Bypass Plan and Low Scope plan have a contingency of 40% and the Valley View Plan and Combo Plan have a contingency of 41% added to the base estimate.

Operations, maintenance, relocations, rehabilitation, and repair (OMRR&R) costs associated with each of the structural measures was estimated by the cost engineering branch. OMRR&R associated with the nonstructural measures is not in the current estimate but will be added in the next phase of the study.

8.2 Non-Structural Costs

The TSP level nonstructural cost estimates for the focused array were developed by the New Orleans District Economics. A 40 percent contingency was applied to all nonstructural cost estimates during the TSP milestone. The contingency represents the uncertainty regarding the cost and schedule risk of these measures. The contingency amount was computed during an abbreviated cost risk analysis using some of the most significant factors impacting cost associated with the Upper Guadalupe General Reevaluation Study.

Residential Structures

The estimate of the cost to elevate all residential structures was computed once model execution was completed. Elevation costs were based on the difference in the number of feet between the original first floor elevation and the target elevation for each structure in the HEC-FDA module. The number of feet that each structure was raised was rounded to next highest 1-foot increment. Elevation costs by structure were summed to yield an estimate of total structure elevation costs.

The cost per square foot for raising a structure was based on data obtained during interviews in 2008 with representatives of three major metropolitan New Orleans area firms that specialize in the structure elevation. Composite costs were derived for residential structures by type: slab and pier foundation, one story and two-story configuration, and for mobile homes. These composite unit costs also vary by the number of feet that structures may be elevated. Table 18 displays the costs for each of the five residential categories analyzed and by the number of feet elevated. The costs in this table do not include contingency, or any other supporting cost such as construction management or PED.

The cost per square foot to raise an individual structure to the target height was multiplied by the average footprint square footage of each structure's occupancy type to compute the costs to elevate the structure. The total costs for all elevated structures were annualized over the 50-year period of analysis of the project using the FY23 federal discount rate of 2.5 percent. The square foot costs for elevation was price indexed to FY22 price levels by the New Orleans District Cost Engineering Branch.

Table 18: Nonstructural Elevation Costs for Residential Structures ($/Sq. Ft)

Height	1STY-PIER	1STY-SLAB	2STY-PIER	2STY-SLAB	MOBILE
[ft.]	[$]	[$]	[$]	[$]	[$]
N/A	0	0	0	0	0
1	134	151	147	166	74
2	134	151	147	166	74
3	139	154	153	170	74
4	139	159	153	182	91
5	139	159	153	182	91
6	142	163	156	183	91
7	142	163	156	183	91
8	146	168	159	190	91
9	146	168	159	190	91
10	146	168	159	190	91
11	146	168	159	190	91
12	146	168	159	190	91
13	147	173	163	201	91
14	147	173	163	201	91
15	147	173	163	201	91
16	147	173	163	201	91

Non-residential Structures – Dry Floodproofing

The dry floodproofing costs were applied to all non-warehouse, non-residential structures. Separate cost estimates were developed to flood proof non-residential structures based on their square footage. Table 19 shows a summary of square footage costs for dry floodproofing and excludes contingency. These costs were developed for the Draft Nonstructural Alternatives Feasibility Study, Donaldsonville LA to the Gulf evaluation (September 14, 2012) by contacting a local contractor (Arcadis) and were adopted for this study due to the similarity in the structure types between the two study areas. Again, final cost estimates are expressed in FY 2022 prices. As shown in Table D:2-3 (RS Means Cost per Square Foot Statistics by Occupancy Type), nearly all of the structures eligible for dry floodproofing were applied a cost estimate of $194,982 since the average square footage by occupancy type was less than 30,000. Average square footage of an occupancy type would have had to exceed 30,000 square feet to increase to a cost estimate of $460,722. The square foot costs for dry floodproofing was price indexed to FY22 price levels by the New Orleans District Cost Engineering Branch.

Table 19: Nonstructural Dry Floodproofing Costs for Non-residential Structures ($).

Square Footage	Cost
1,000	194,982
10,000	194,982
20,000	194,982
30,000	460,722
40,000	460,722
50,000	460,722
60,000	460,722
70,000	460,722
80,000	460,722
90,000	460,722
100,000	460,722
>= 110,000	1,138,909

8.3 Annual Project Costs

Table 20: Annual Project Costs, 50-year Period of Analysis.

	Alternative				
	Alt 2b: Valley View	**Alt 3b: Bypass Plan**	**Alt 4: Nonstructural**	**Alt 7: Low Scope**	**Alt 8b: Combination**
First Cost	$325,263,875	$510,822,076	$ 260,782,923	$ 131,309,143	$152,827,418
Interest During Construction	$30,187,262	$45,928,258		$ 11,887,159	$13,808,256
Total Investment Cost	$355,451,137	$556,750,334	$ 260,782,923	$ 143,196,302	$166,635,674
Annualized Project Costs	$12,533,000	$19,630,000	$ 8,741,000	$5,049,000	$5,875,000
Annual OMRR&R	$1,253,300.00	$1,963,000	-	$504,900	$587,500
Total Annual Costs	$13,786,300	$21,593,000	$8,741,000	$5,553,900	$6,462,500

9 Results of the Economic Analysis

9.1 Net Benefit Analysis

9.1.1 Calculation of Net Benefits

The net benefits for the alternatives were calculated by subtracting the annual costs from the expected annual benefits. The net benefits were used to determine the economic justification of the alternatives. Net benefit calculations for the with-project condition were computed using the HEC-FDA model that contained the exceedance probability stage damage relationships for the study. Table 21 shows the net benefits and benefit-cost ration for the alternatives.

Table 21: Economic Net Benefits and BCR of Alternatives Carried Forward

Alternative	Average Annual Costs	Average Annual Benefits	Net Annual Benefits	Benefit to Cost Ratio
2b - Valley View Plan (NED Plan from 1998 Feasibility Study)	$13.95M	$22.06M	$8.11M	1.58
3b - Bypass Plan (previous authorized plan, partially constructed)	$21.23M	$21.885M	$0.65	1.03
4 - Non-Structural Only	$9.9M	$9.22M	$0.72M	1.08
7 – Low Scope Plan	$5.50M	$20.07M	$14.58M	3.65
8b – Combination Plan	**$6.38M**	**$21.59M**	**$15.21M**	**3.38**

The plan that reasonably maximizes net benefits and is therefore the NED plan is Alternative 8, the Combination Plan alternative. The Combination Plan and Low Scope Plan are within 6% of each other so the Low Scope Plan will be carried forward to further analysis in case it becomes the NED plan. Table 21 shows the cost benefit summery of the NED plan and the Low Scope Plan.

9.2 Risk Analysis

The risk analysis is a section of the report that discusses the risk and uncertainty associated with the HEC-FDA model and the economic benefits. The HEC-FDA model was utilized for the existing condition and with project alternatives. The risk analysis uses expected annual damages instead of equivalent annual damages since future conditions are the same as existing conditions.

Benefit Exceedance Probability Relationship

The HEC-FDA model incorporates the uncertainty surrounding the economic and engineering inputs to generate results that can be used to assess the performance of proposed plans. The HEC-FDA model was used to calculate expected annual without-project and with-project damages and the damages reduced for each of the project alternatives. Table 22 shows the mean expected annual benefits and the benefits at the 75, 50, and 25 percentiles for the NED plan (Alternative 8b: Combination Plan) and Alternative 7: Low Scope. These percentiles reflect the percentage chance that the benefits will be greater than or equal to the indicated values. The table indicates the percent chance that the expected annual benefits will exceed the expected annual costs therefore the benefit cost ratio is greater than one and the net benefits are positive.

Table 22 can be understood to show that there is a 75% chance that the expected annual damages reduced (annual benefits) of the NED plan will exceed $7688, and therefore a 75% chance that the BCR will exceed 1.2.

Table 22: Probability Benefits Exceed Costs (NED).

NED Plan	0.75	0.5 (Median)	Mean	0.25
Total Average Annual Cost	$6,380			
Total Average Annual Benefits	$7688	$17,068	$21,589	$30,883
Net Benefits	$1,306	$10,685	$15,207	$24,501
BCR	1.2	2.67	3.338	4.84

FY 2023 price levels
50-year period of analysis
2.5% discount rate

9.3 Project Performance

ER 1105-2-101, Risk Assessment for Flood Risk Management Studies, provides the requirement to describe project performance by annual exceedance probability (AEP), assurance (conditional non-exceedance probability), and long-term exceedance probability (LTEP). Project performance describing these attributes is computed within HEC-FDA and is based on a target stage (traditionally the 0.01 AEP). The performance for the Existing Condition and Combination Plans are shown below.

Table 23: Project Performance Existing Conditions

	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
Reach Name	Median	Expected	10	30	50	10%	4%	2%	1%	0.40%	0.20%
1	5%	5%	41%	79%	93%	94%	41%	17%	8%	3%	1%
2	4%	5%	39%	77%	92%	95%	44%	19%	9%	3%	1%
3	4%	5%	39%	77%	91%	96%	45%	19%	9%	3%	2%
4	5%	5%	39%	78%	92%	95%	41%	17%	11%	3%	1%
5	4%	5%	37%	75%	90%	97%	48%	21%	10%	4%	2%
6	5%	5%	40%	79%	93%	94%	41%	17%	8%	3%	1%
7	5%	6%	43%	82%	94%	88%	40%	19%	11%	4%	2%
8	5%	6%	44%	82%	94%	88%	40%	19%	11%	4%	2%
9	2%	3%	25%	58%	77%	98%	74%	46%	30%	14%	8%
10	2%	3%	23%	55%	74%	100 %	77%	45%	26%	12%	7%
11	6%	35%	99%	100 %	100 %	54%	47%	40%	33%	26%	23%

Table 24: Project Performance Combination Plan

	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
Reach Name	Median	Expected	10	30	50	10%	4%	2%	1%	0.40%	0.20%
1	5%	5%	40%	79%	93%	94%	41%	17%	8%	3%	1%
2	4%	5%	39%	77%	92%	95%	44%	19%	9%	3%	1%
3	4%	5%	38%	77%	91%	96%	45%	19%	9%	3%	2%
4	0%	0%	4%	12%	20%	100%	100%	97%	82%	62%	48%
5	4%	4%	37%	75%	90%	97%	48%	21%	10%	4%	2%
6	5%	5%	40%	79%	92%	94%	42%	18%	8%	3%	1%
7	0%	0%	3%	9%	14%	100%	100%	97%	89%	78%	71%
8	0%	0%	3%	9%	14%	100%	100%	98%	89%	78%	71%
9	2%	3%	25%	58%	77%	98%	74%	46%	29%	14%	8%
10	2%	3%	23%	55%	74%	100%	77%	45%	26%	12%	7%
11	0%	8%	57%	92%	99%	87%	83%	78%	71%	64%	60%

9.3.1 Compliance with 1990 WRDA

Section 308 of the Water Resource Development Act (WRDA) 1990 limits structures built or substantially improved after July 1, 1991 in designated floodplains not elevated to the 1% AEP flood elevation from being included in the benefit base of the economic analysis. An evaluation of the available parcel data, the structure inventory, and the 100-year flood model shows that none of the structures included in the structure inventory were built after July 1991 with a FFE below the 100-year flood level. One neighborhood in Reach 9 was built after July 1991 but the flooding in Reach 9 is street flooding mostly impacting street parked vehicles.

10 Other Social Effects (OSE)

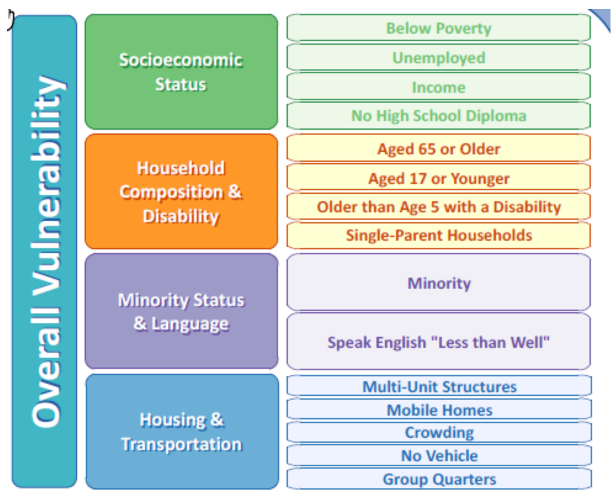
10.1 Background

In March 2022, the Assistant Secretary of the Army (ASA) office issued implementation guidance for the Biden administration's Environmental Justice (EJ) and Justice40 initiatives. The implementation guidance directs the USACE planning teams to go beyond "doing no harm" and to focus on outreach activities to integrate and involve disadvantaged communities early on and throughout the planning process. In addition, the memorandum directs the USACE to provide at least 40 percent of investments in climate, critical clean water, and waste infrastructure (benefits) to disadvantaged communities (Office of the Assistant Secretary Civil Works , 2022).

Because the Administration's default Quality Climate and Economic Justice Screening Tool (CEJST) is still in beta version, the CDC's Social Vulnerability Index (SVI) tool was used to screen for and identify disadvantaged communities for the Upper Guadalupe Flood Risk Management Project. The tool was used to measure impacts to the OSE account from the no-action, non-structural, and structural alternatives.

10.2 Center of Disease Control Social Vulnerability Index (SVI)

SVI data was used to identify socially vulnerable communities and to see how various alternatives would affect the people in each socially vulnerable group (either positively or negatively) as part of the OSE assessment. The SVI uses U.S. Census data to determine the relative social vulnerability of every census tract. It ranks each tract on 14 social factors and identifies and maps communities most likely needing support during and after a hazardous event such as flooding (see Figure 10). These factors are aggregated into four main "themes:" Socioeconomic, Household Composition and Disability, Minority Status and Language, and Housing Type and Transportation. The sum of all four themes reflects the overall percentile tract summary ranking, or overall theme, for each Census tract. Figure 11 shows the rankings of the census tracts within each flooding impact area.



Along with the rankings, the SVI databases include all the census variables listed above. Graphic adapted from the North Carolina Preparedness and Emergency Response Research Center.

Figure 10: SVI Theme Construction

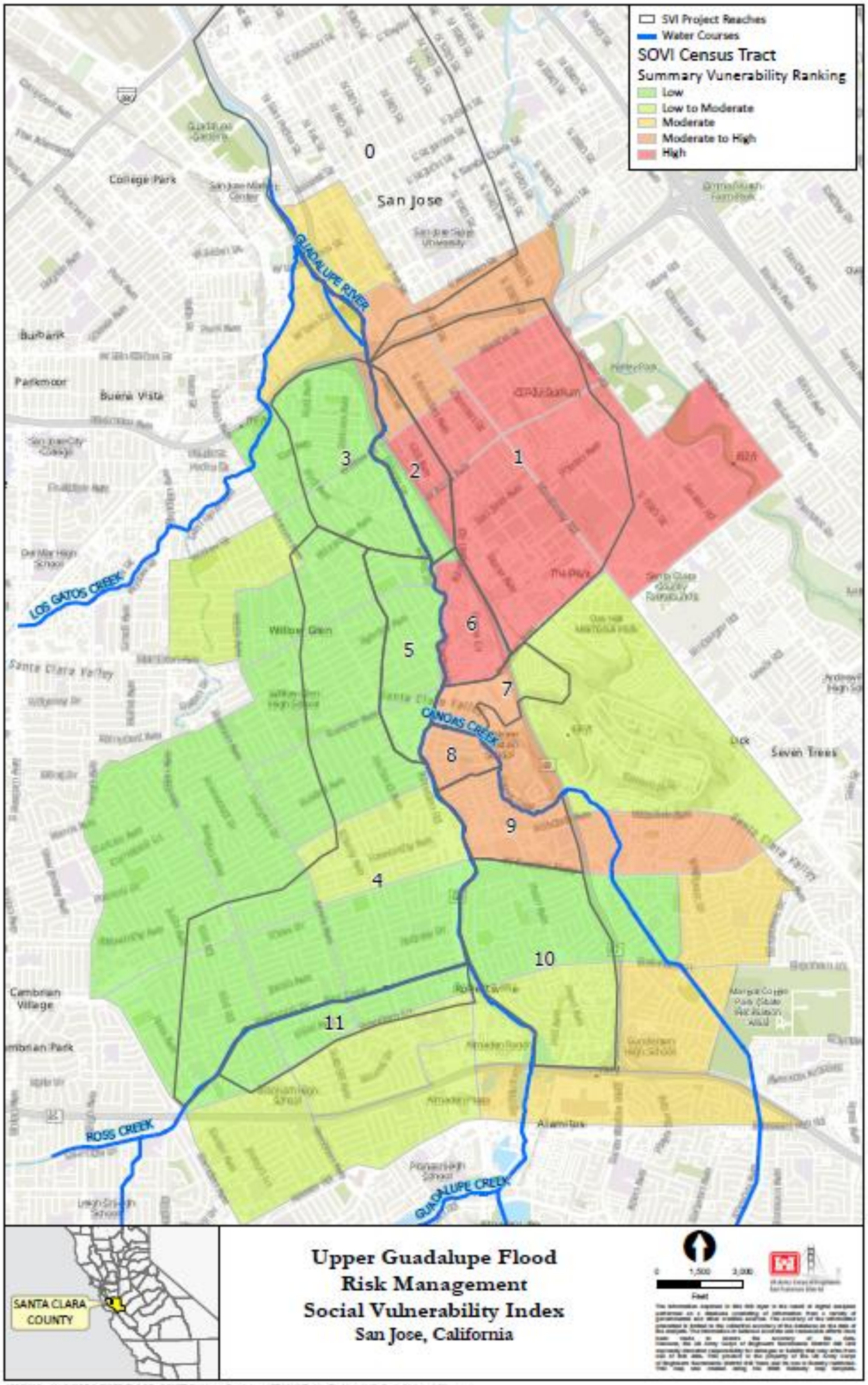


Figure 11: Socially Vulnerable Flooding Impact Areas

10.2.1 SVI vs. CESJT

Unlike the SVI tool, which classifies social vulnerability into five categories ranging from "low to "high," the CEJST tool produces a binary output, where 0 is defined as a non-disadvantaged census tract and 1 is defined as a disadvantaged census tract (see Figure 11). Both tools classify flooding impact area 1 as "socially vulnerable" or "disadvantaged." However, there is a discrepancy between the classification of flooding impact areas 7, 8, and 9. While the CEJST tool does not consider all of these flooding impact areas as disadvantaged, according to the SVI tool, these reaches are "moderately" socially vulnerable.

The economic analysis in this report considers flooding impact areas 1, 2, 6, and 7 as "socially vulnerable." Flooding impact area 7 was included in this designation, despite conflicting data from the CEJST tool, because it contains a dense mobile home park with only one route for evacuation out of the area. Flooding impact areas 8 and 9 were excluded from the socially vulnerable designation (despite them being "moderately" socially vulnerable according to the SVI tool) because this was not confirmed by the CEJST tool or other agencies' screening methods.

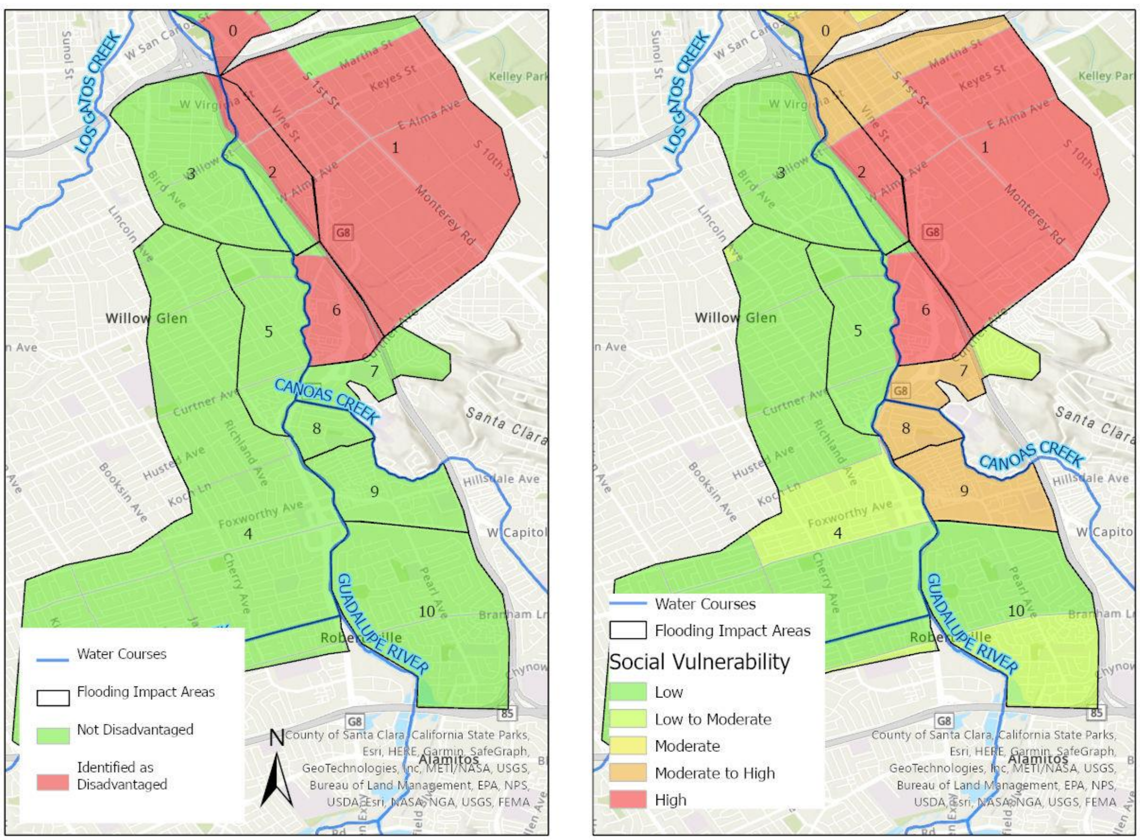


Figure 12: CEJST Tool (left) vs. SVI Tool (right)

10.3 Analysis of Alternatives

10.3.1 Without Project Condition

The population at risk (PAR) is approximately 3,490 persons in the 1% ACE floodplain and 5,726 persons in the .2 % floodplain (excluding the houseless). The PAR was estimated by multiplying the number of residential structures receiving at least some damage by 2.97, the U.S. Census Bureau's estimate for the average number of persons per household in Santa Clara County in 2022. The PAR is likely to be bigger than the one calculated here, since persons not facing floodwaters directly could encounter disruptions in utilities, transportation methods, and other indirect effects of flooding.

There is a large population of socially vulnerable people residing in the .1% ACE event; approximately 50.7% of persons reside in moderate and high socially vulnerable areas (flooding impact areas 1, 2, 6, and 7). Approximately 49.4% reside in non-socially vulnerable areas (flooding impact areas 3, 4, 5, 9, 10, and 11). Automobiles could be inundated by as much as 8.3 ft. of water at the 1 % AEP event and could reach as high as 9.4 ft. at the .2 % AEP event. Damages are in the hundreds of millions. Table 25 shows the structure distribution, PAR, maximum depths, and total damages at structure by occupancy type at the 1% AEP and the .2% AEP events.

Table 25: PAR, Structure Distribution, Max Depth, and Total Damages

Occupancy Type	1% AEP	.2% AEP	Max depth at 1% AEP (feet)	Max Depth at .2% AEP (feet)	Total Damages at 1% AEP	Total Damages at .2% AEP
Autos	7,553	9,996	8.3	9.4	$72 M	$118 M
Commercial	81	136	3.3	4.7	$35 M	$93 M
Industrial	118	174	4.4	5.5	$82 M	$130 M
Public	21	29	2.5	3.3	$63 M	$88 M
Residential	1,175	1,928	6.4	7.9	$323 M	$472 M
Population at Residential Structures	3,490	5,726				

Furthermore, flooding can contribute to deleterious other social effects, such as health and safety effects, including risks of injury or death, reductions in the community's economic vitality, and loss of community optimism about the future (Institute for Water Resources, 2013). Figure 13, from the Institute for Water Resources, shows several different avenues through which hazardous flooding could affect local communities (see Figure 13).

Key Human Needs Dimensions	Human Needs Focusing Questions for OSE Analysis	OSE Factors Listed in ER 1105-2-100 Planning Guidance Notebook
Health and Safety – of themselves and families	What risks and benefits to human health and safety are posed by conditions?	– Effects on security, life, health and safety – Effects on emergency preparedness
Social Vulnerability and Resilience – ensuring that the requirements of special needs populations in the community are adequately addressed	What risks to special needs populations in the community are posed by conditions?	– Effects on security, life, health and safety – Effects on emergency preparedness
Economic Vitality – having a stable or growing economic base with access to good jobs	How are jobs, incomes, employment opportunities, and population growth of communities likely to be affected by conditions?	– Long-term productivity effects including maintenance and enhancement of productivity of resources for use by future generations – Effects on the fiscal condition of the state and local sponsor – Effects on real incomes
Social Connectedness – sustaining a sense of connection to the community and neighborliness	How are community interpersonal networks, leadership, vision for the future, and relationships among voluntary organizations likely to be affected by conditions?	– Urban and community impacts – Effects on population distribution and composition – Displacement of people, businesses, and farms
Identity – feeling pride in the community, pitching in to help the community bounce back after problems	How are communities' sense of civic pride and willingness to help the community likely to be affected by conditions?	– Other effects as relevant
Participation – feeling that one's participation is valued and recognized in community decision making	Are opportunities for all affected groups' participation provided for in all phases of the planning process?	– Other effects as relevant
Leisure and Recreation – having access to healthy and safe outdoor recreation	How are leisure and recreational opportunities affected by conditions?	– Effects on educational, cultural, and recreation opportunities

Figure 13: Other Social Effects Guideline Factors

10.3.1.1 Life Safety

The LifeSim default stability criteria function was used to classify depth, velocity, and velocity-depth combinations into "low," "medium," and "high" life safety hazard zones (see Figure 14). The critical threshold for velocity was set to 9.8 ft/s, while the critical threshold for velocity*depth was set to 6.46 ft squared/s. The critical threshold for depth is 4 ft. If the velocity and velocity*depth thresholds are exceeded, this would constitute a "high" life safety hazard zone. If the depth threshold is exceeded, this would constitute a "moderate" life safety hazard zone because the risk to life would be dependent upon if pedestrians could swim.

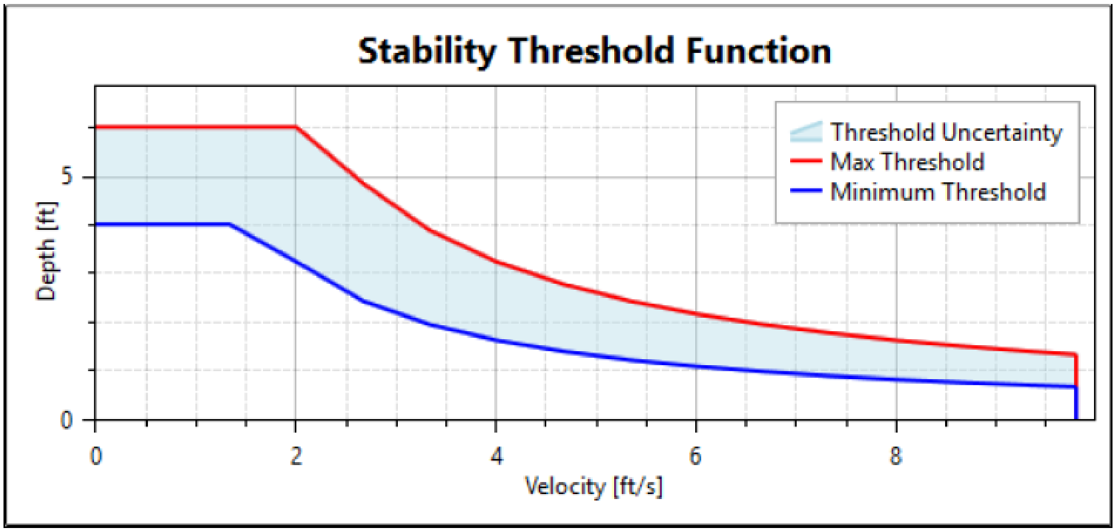


Figure 14: Human Stability Threshold Function, *LifeSim 2.0 Technical Reference Manual*

This analysis does not consider the life safety risk to persons in structures or in vehicles on roadways; rather, the analysis assumes a "worst case scenario" event where persons are openly caught in fast-moving and deep floodwater. Analyzing structure and vehicle stability is outside of this scope, but preliminary assessments suggest there may be pockets of where floodwaters reach hazardous depths, velocities, and velocity-depth combinations (see Figure 15). The PDT fully intends to implement a LifeSim assessment post-TSP and will conduct a breach analysis to determine the incremental life loss of project implementation.

Another component of the PAR, which was not included in calculations above, is comprised of encampments living in or near the channel, where velocities, depths, and velocity-depth combinations pose a significant life safety hazard to these transient, vulnerable persons. There are approximately 33 homeless camps and over 134 persons that will likely be touched by open floodwater at the 1% ACE event. Figure 15 shows the distribution of homeless camps in the project area that could be impacted by floodwater.

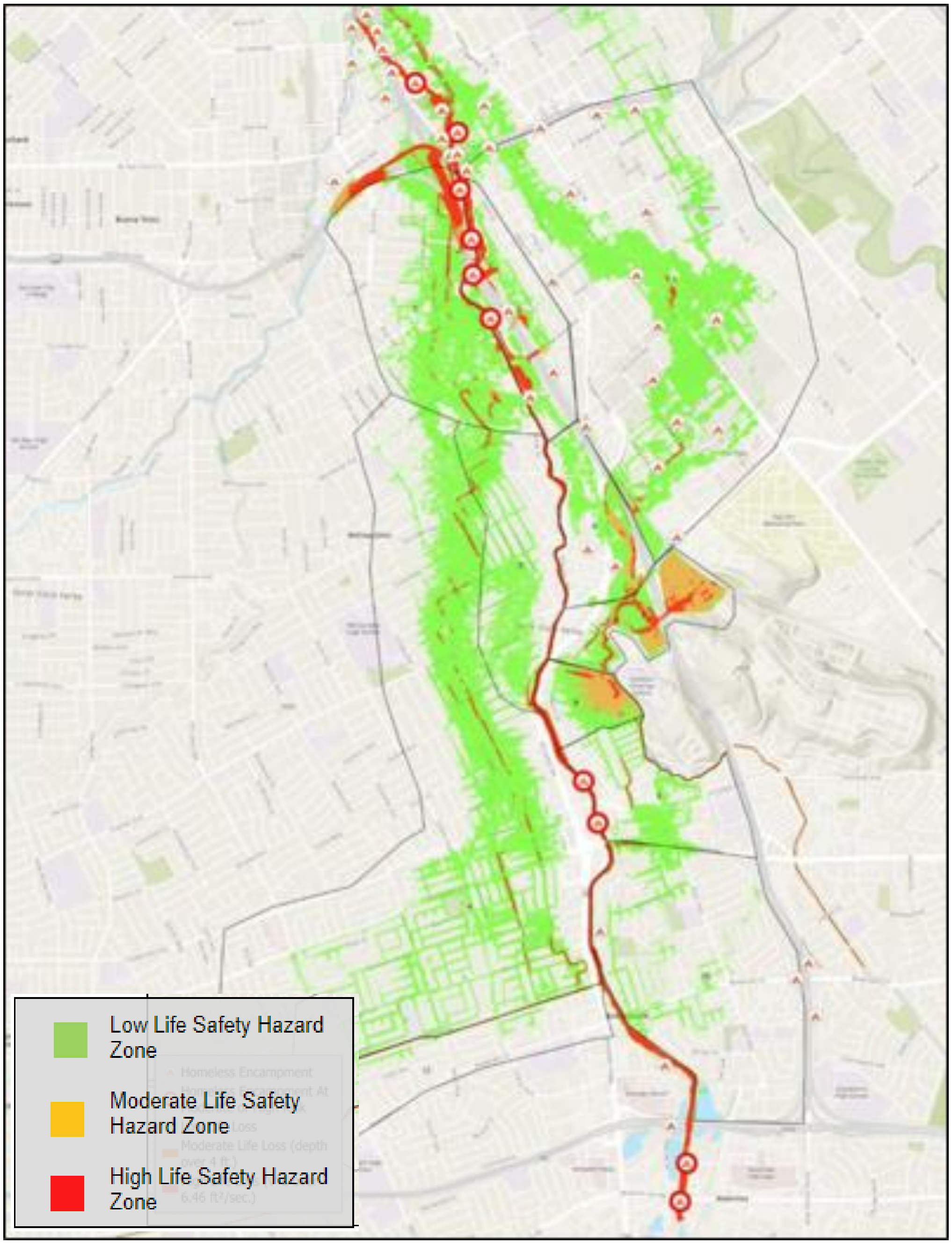


Figure 15: Encampments, 1% AEP Event

10.3.1.2 Non-structural Alternatives

The non-structural alternatives consider the elevation of residential structures to the 1% AEP event and 3ft dry floodproofing on commercial structures. While this option would be highly effective at reducing flood risk to damageable property, it would likely not reduce the amount of high and moderate hazard life safety pockets in the area. In addition, such activities would significantly disrupt the community by dispersing residents and business activity. This would adversely impact hundreds of families and relationships in the community. While targeted nonstructural activities could be pursued intentionally in socially vulnerable areas, this could disrupt community cohesion, social connectedness, identity, and other factors shown in Figure 13.

While floodproofing and elevation may yield some benefits, signage and early flooding warning systems may be more cost-effective nonstructural measures to pursue and can even be more effective than traditional nonstructural methods in reducing the life safety risk to vulnerable populations. It is important to note that all structural plans considered in this analysis include nonstructural measures such as those listed above.

10.3.1.3 Persons Removed from the Floodplain

In general, all structural alternatives are expected to contribute positively to the OSE factors listed in Figure 13**Figure *13***. To determine the effects on social vulnerability and resilience (as defined in the USACE OSE Primer) more quantitatively for each alternative, the PDT looked at the change in the number of persons removed from the 1% AEP floodplain by plan. All alternatives, excluding the nonstructural alternative, significantly reduce the PAR, which was estimated by multiplying the number of residential structures by 2.97 (the U.S. Census Bureau's estimate for the average number of persons per household in Santa Clara County in 2022). Table 26 shows the percent of persons removed from the 1% AEP floodplain by plan using this study's definition of socially vulnerable census tracts. Table 27 replicates this analysis but does not consider flooding impact area 7 as socially vulnerable and shows what the analysis would look like if the administration's CEJST tool was utilized without deeper knowledge of the study area. There is no significant difference between the results from both tools, though the nonstructural reduction does differ somewhat under the CEJST tool. This could be because there are few residential structures in flooding impact area 6; the affected structures could be industrial or commercial in nature.

Table 26: Percent of Persons Removed from the Floodplain by Plan

Percent of Persons and Structure removed from the 1% AEP by Plan, $0 Damages or Greater (SVI Tool)					
Statistic (excluding cars)	**Alt 2b: Valley View**	**Alt 3b: Bypass Plan**	**Alt 4: Nonstructural**	**Alt 7: Low Scope**	**Alt 8b: Combination**
Residential Population at Residential Structures in Socially Vulnerable Flooding Impact Areas (Reaches 1, 2, 6, and 7)	-99.3%	-100.0%	-74.8%	-100.0%	-99.7%
Residential Population at Residential Structures in all Other Flooding Impact Areas (3, 4, 5, 8, 9, 10, and 11)	-97.9%	-99.8%	-32.5%	-80.3%	-99.1%
Total Population at Residential Structures in Study Area	-98.6%	-98.9%	-54.0%	-71.2%	-99.4%

Table 27: Percent of Persons Removed from the Floodplain by Plan, CEJST Tool

Percent of Persons and Structure removed from the 1% AEP by Plan, $0 Damages or Greater (CEJST Tool)					
Statistic (excluding cars)	**Alt 2b: Valley View**	**Alt 3b: Bypass Plan**	**Alt 4: Nonstructural**	**Alt 7: Low Scope**	**Alt 8b: Combination**
Residential Population at Residential Structures in Socially Vulnerable Flooding Impact Areas (Reaches 1, 2, and 6)	-99.3%	-100.0%	-76.2%	-100.0%*	-99.7%
Residential Population at Residential Structures in all Other Flooding Impact Areas (3, 4, 5, 7, 8, 9, 10, and 11)	-97.9%	-99.8%	-31.1%	-80.3%	-99.1%
Total Population at Residential Structures in Study Area	-98.6%	-98.9%	-54.0%	-71.2%	-99.4%

*Though benefits serve the socially vulnerable flooding impact areas, there is residual risk in these reaches that exceeds all other structural plans, which is important to note from an equity standpoint.

10.3.1.4 Life Safety

All structural alternatives successfully minimize the high and moderate life safety hazard zones in the study area (see Figure 16 and Figure 17). While this is not a substitute for LifeSim 2.0, the analysis is informative of the magnitude of potential consequences related to life safety hazards in the study area and what each plan does to reduce the residual risk of flooding. Most of the residual flooding is nuisance flooding, but the Low Scope plan does have residual life safety hazard zones in flooding impact area 8. There is also a lingering hazard in the northern portion of flooding impact areas 2 and 3 where there is a highway underpass and light rail station.

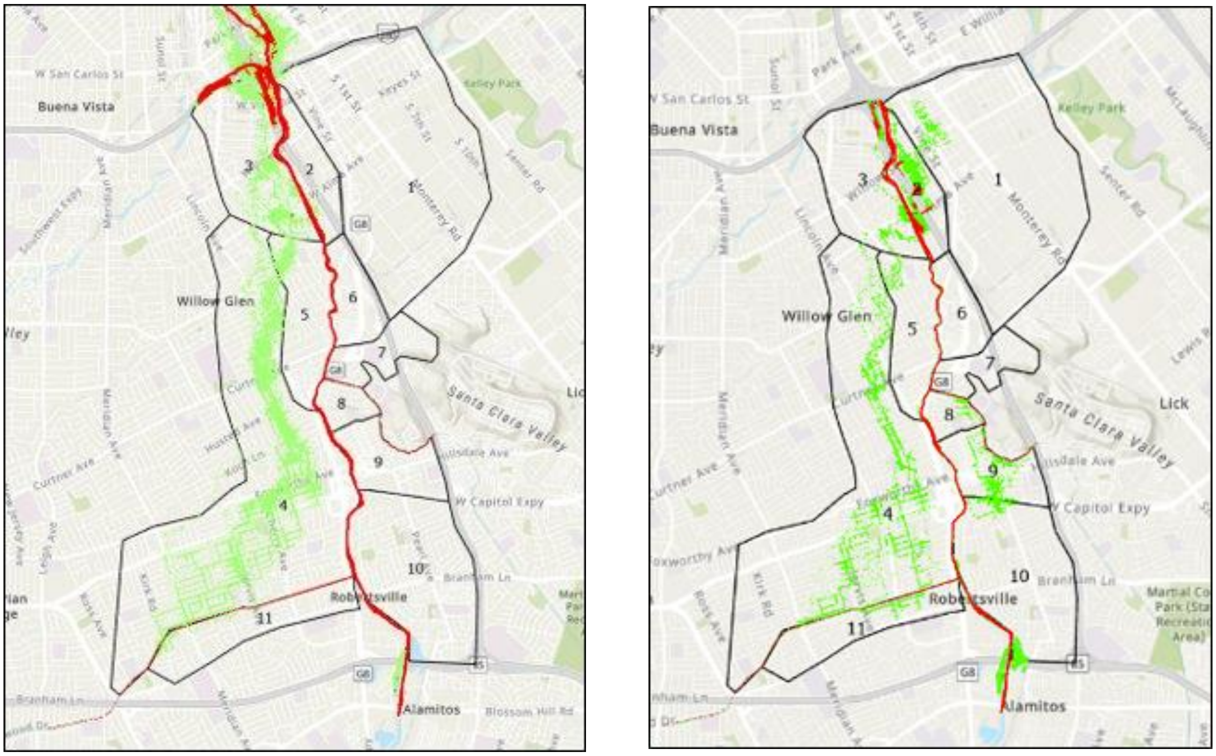


Figure 16: Valley View (left) and Combination (right) Life Safety Hazard Zones, 1% AEP

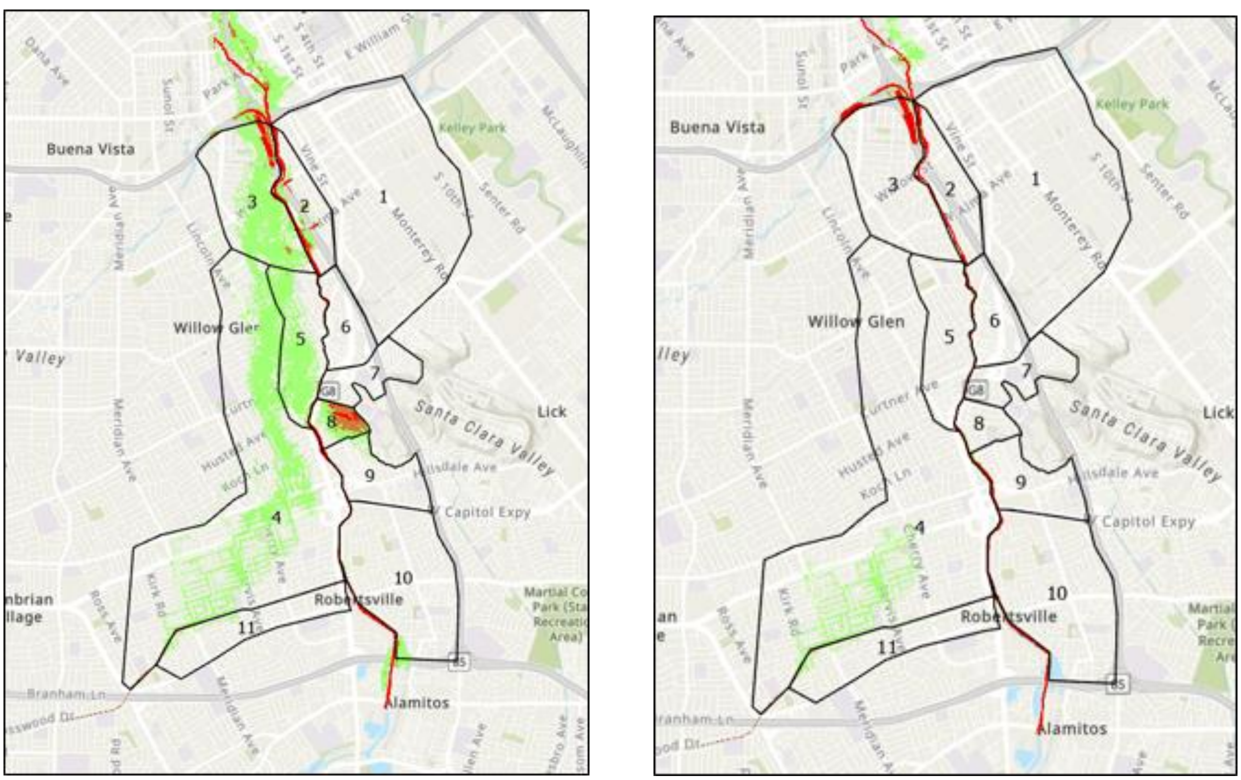


Figure 17: Low Scope (left) and Bypass (right) Life Safety Hazard Zones, 1%AEP

10.4 Public Involvement and the Justice 40 Initiative

The Implementation of Environmental Justice and the Justice40 Initiative guidance directs the USACE to improve outreach and access to USACE Civil Works information and resources. It directs USACE to work with and "accommodate and encourage participation of all communities as partners in the assessments of needs, studies, planning development, and implementation" (Department of the Army, 2022).

To comply with this directive, the USACE conducted two public meetings (in 2021 and 2022) to solicit stakeholder input on the Upper Guadalupe project. The USACE worked with local organizations and the NFS to advertise these events, the purpose of which was to capture the local community's input regarding project alternatives and their impacts on all affected communities. The 2021 public meeting was held virtually and received little attendance or input from the public. In contrast, the 2022 meeting was held in person and was generally successful due to the turnout and level of participation from community members. Public comments ranged from inquiries into who was responsible for encampment-generated trash and debris to inquiries regarding fallen trees, groundwater contamination, and local tribe consultation. Additional comments inquired about recreational improvements near Ross Creek, which the USACE and NFS are investigating for potential integration into project alternatives. In addition, the USACE is working with community members to generate a comprehensive list of tribes who may have a stake in project formulation, though it is difficult to maintain this channel of communication with members of the public.

In this study, socially vulnerable communities receive approximately 75.9 % in benefits (reduced damages) from the Combination Plan. Overall, the study meets and exceeds the Justice40 implementation guidance's directives.

11 Regional Economic Development (RED)

The U.S. Army Corps of Engineers (USACE) Institute for Water Resources, Louis Berger, and Michigan State University have developed a regional economic impact modeling tool, RECONS (Regional Economic System), that provides estimates of jobs and other economic measures such as labor income, value added, and sales that are supported by USACE programs, projects, and activities. This modeling tool automates calculations and generates estimates of jobs, labor income, value added, and sales using IMPLAN® multipliers and ratios, customized impact areas for USACE project locations, and customized spending profiles for USACE projects, business lines, and work activities. RECONS allows the USACE to evaluate the regional economic impact and contribution associated with USACE expenditures, activities, and infrastructure.

Construction costs were used to estimate the regional economic impacts of all alternatives in Santa Clara County. Generally, the higher the cost of construction, the higher the RED benefits for that alternative. Table X shows the construction costs for all plans. The Bypass Plan produces the highest amount of output ($373.1 M), followed by the Nonstructural Plan ($304.6 M), the Valley View Plan ($233.7 M), the Combination Plan ($83.9 M), and the Low Scope Plan (59.4 M). Table 29 shows a comparison of RECONS results for all plans.

Table 28: Construction Costs, 2020 Price Level

Alternative	Construction Cost
Alt 2b: Modified Valley View Plan	$200.1 M
Alt 3b: Modified Bypass Plan	$319.4.M
Alt 4: Nonstructural (25 YR)	$260. 8 M
Alt 7: Low Scope	$50.9 M
Alt 8b: Combination	$71.8 M

Table 29: Comparison of Alternatives in RED, Local Impacts, 2022 Price Level

Alternative	Output	Jobs	Labor Income	Gross Regional Product*
Alt 2b: Modified Valley View Plan	$233.7 M	1,543.5	$147.4 M	$164.5 M
Alt 3b: Modified Bypass Plan	$373.1M	2,463.3	$235.3 M	$262.5 M
Alt 4: Nonstructural (25 YR)	$304.6 M	2,011	$192 M	$214.3 M
Alt 7: Low Scope	$59.4 M	392.8	$37.5 M	$41.8 M
Alt 8b: Combination	$83.9 M	554.5	$52.9 M	$59 M
*Gross Regional product is defined as the sum of employee compensation, proprietor income, other property type income, and indirect business taxes.				

12 References

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