People walking along a beach. Photo by Thomas Hawk licensed under CC BY-NC 2.0.

Chapter 2.6

VULNERABLE COMMUNITIES

The effects of climate change and sea level rise will not be felt by all people equally. Even in cases where flooding is comparable, existing social and economic conditions, as well as potential contamination burdens, will influence how severe the disruption will be across households. Understanding how flooding will impact communities that face social and economic marginalization is critical to ensuring equitable outcomes for adaptation planning.

ART Bay Area acknowledges the disproportionate impact on communities that are subject to historic and ongoing marginalization, especially low income and communities of color, and seeks to ensure that adaptation solutions are ones that address, rather than deepen, inequity and injustice. The ART Bay Area assessment of vulnerable communities explores sea level rise risk to areas with high concentrations of households that experience economic and social marginalization, and areas that have a high level of pollution burden.

The following Key Takeaways listed highlight significant findings from the regional analysis of the potential risk of impacts from flooding for residential units in vulnerable communities across the nine-county San Francisco Bay Area. More detailed findings from both the qualitative and quantitative analyses follow.

Understanding how flooding will impact communities that face social and economic marginalization is critical to ensuring equitable outcomes for adaptation planning.

IN THIS SECTION

2.6.1 Key Takeaways

- Communities with high social and economic vulnerability will be impacted by sea level rise as early as 12" Total Water Level (TWL).
- Vulnerable communities are often co-located with areas of high contamination. Many of these contaminants may become mobilized in the event of a flood, which could impact public health and make cleanup and recovery more challenging for already strained populations.
- Gentrification and flooding are dual drivers of displacement and pose risks to socially vulnerable populations. In almost all locations where social vulnerability is present, gentrification and displacement are either ongoing or pose potential threats to community cohesion.
- Early risk of impacts occurs in specific communities including San Rafael in the North Bay and San Jose in the South Bay but become more widespread as sea level rise increases.
- Long term worsening consequences from flooding become increasingly concentrated in high density areas in San Jose, San Francisco, and Oakland.
- There are specific block groups that heavily drive some increases in residential units exposed to flooding, especially for socially vulnerable households in San Francisco near Mission Creek.

Communities living adjacent to Phillips 66 Refinery in Pinole. Photo by SF Baykeeper, Robb Most, and LightHawk.

2.6.2 Regional Analysis of Vulnerable Communities

OVERVIEW

Considering social vulnerability is critical in land use planning and decision making, as regional and city planning have contributed to social and economic marginalization in the past.[1,2,3] Intergenerational poverty, health disparities, and land ownership in the region have all been influenced by city and regional planning practices.[4,5]

In planning for future flooding, solutions that could deepen inequity and increase vulnerability are counter to ART Bay Area's Resilience Goals (which can be found in Chapter 1.0 Introduction). The Regional Working Group called out the importance of addressing inequities throughout the Resilience Goals—the Society and Equity section of the Resilience Goals are highlighted in Figure 2-69. Analysis of the region's vulnerable communities explores the vulnerabilities and consequences to current and future flooding from sea level rise and storm events. This analysis includes multiple components of the vulnerable communities, including:

- Social Vulnerability
- Contamination Vulnerability

Assessing social vulnerability to understand climate risk is complementary to the work of environmental justice, defined in California state law as "the fair treatment of people of all races, cultures, and incomes with respect to development, adoption, implementation, and enforcement of environmental laws, regulations, and policies."[6] As BCDC has recently amended the Bay Plan to consider environmental justice (2019), ART Bay Area includes an assessment of impacts to vulnerable communities due to flooding. As a result of stakeholder input and the desire to align data with community needs, contamination was added as a second tier of analysis.

A critical facet of this analysis is that vulnerability ranking is derived from population characteristics that are tied to where people live. By using demographic information sourced from Census data, this regional system assessment looks at a snapshot of the characteristics of people living in households in specific locations. Because ART Bay Area has defined 'vulnerable communities' as critical for protection, there is a need to carefully consider any adaptation actions that could diminish the ability of households with characteristics that are tied to vulnerability to stay in those homes. This is especially important given the threat of gentrification and displacement in the communities we assessed.

ART Frames of Sustainability

Society and Equity Resilience Goals

Protect and improve all Bay Area communities', and particularly vulnerable communities', ability to access services, affordable and safe housing for all income levels, a healthy environment, diverse jobs, transportation, recreation, education, information, and opportunities for advancement, while avoiding displacement whenever possible and creating structures for equitable relocation when necessary.

Prioritize the empowerment of vulnerable communities subjected to disproportionate environmental and socioeconomic burdens to lead efforts to improve resilience in their communities through development of community leaders, community engagement, funding mechanisms, and education forums.

Build on existing community strengths and social capital to increase political power, access to funding, and control in inclusive decision-making processes.

Figure 2-69. Society and Equity is one of four categories of project Resilience Goals developed in ART Bay Area with input and feedback from the Regional Working Group.

In this analysis, we used two different methodologies to assess regional vulnerable communities. The first is a data-driven quantitative assessment of regional exposure and consequences of flooding for block groups in identified 'vulnerable communities'. The second methodology and approach to evaluating the vulnerable communities included a detailed qualitative assessment on a subset of block groups in the region to understand and describe the characteristics and nuances of vulnerability. Vulnerability statements are described in this section that resulted from detailed qualitative assessments. Methodologies are in the Appendix.

This section will discuss details of the regional system assessed, results of the analyses, and discussion on what this means for the region moving forward.

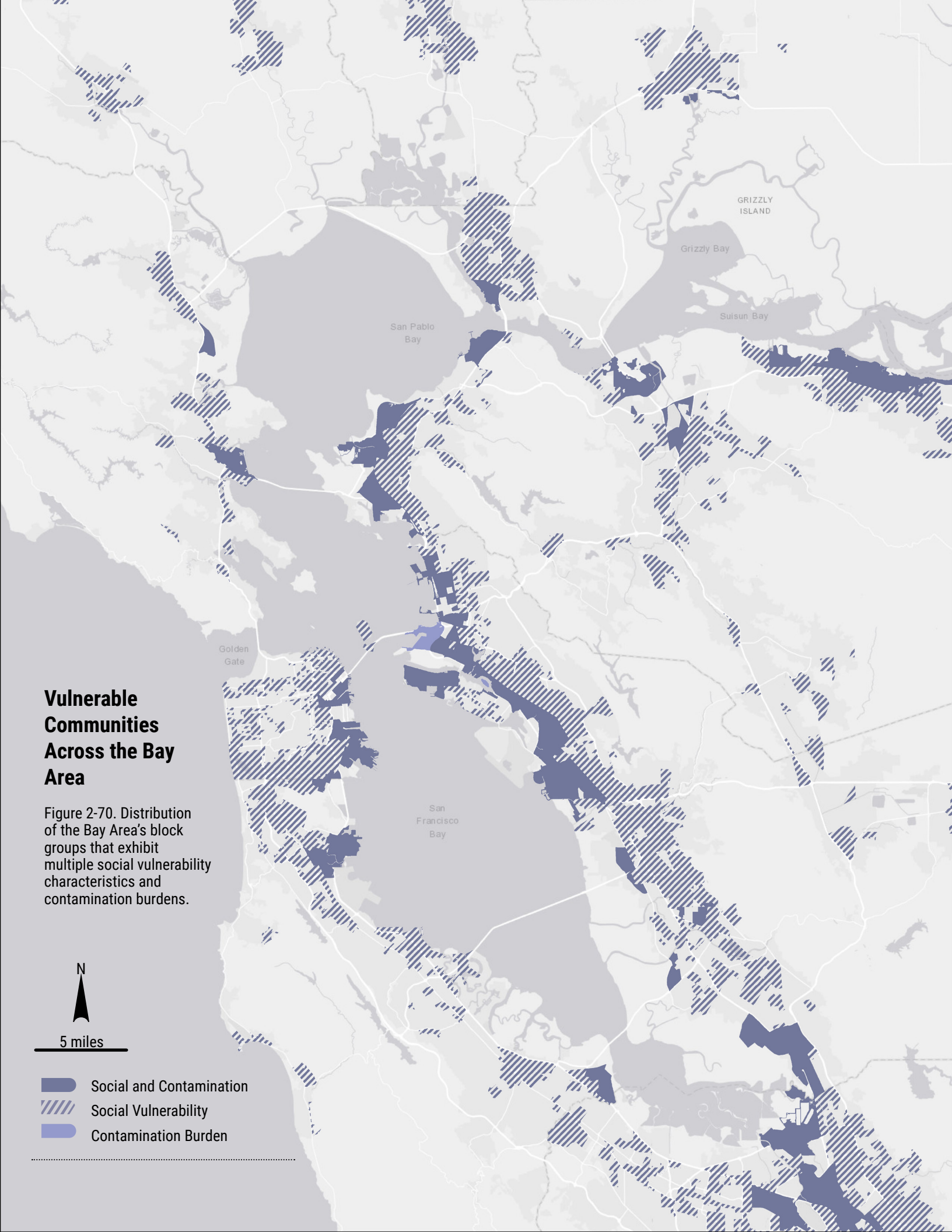
MAPPING SOCIAL VULNERABILITY AND CONTAMINATION BURDEN

Definitions of social vulnerability vary across contexts and screening tools. In the context of hazard mitigation, resilience, and climate adaptation planning, 'social vulnerability' often refers to social and economic barriers that diminish the capacity to prepare for, respond to, and recover from a harmful event such as a flood. The goal of mapping social vulnerability with sea level rise is to identify areas where people will be impacted more heavily by flooding due to preexisting social and economic stressors. There is precedent for similar mapping tools that illuminate social vulnerability as a critical element to consider in planning, including CalEnviroScreen 3.0.

The ART program previously developed a place-based method for analyzing social vulnerability to hazard (flood and seismic) risk. Creating a new mapping tool was particularly important, as CalEnviroScreen 3.0 uses Census tracts, not blocks, which does not give high enough resolution to capture key communities in the Bay Area.[7]

The method was developed for the *2015 Stronger Housing Safer Communities* project, a partner effort between BCDC and the Resilience Program at the Association of Bay Area Governments to better understand and characterize housing and community vulnerability to flooding and earthquakes, and to develop strategies to reduce these vulnerabilities.[8]

An advisory committee of recognized experts, including community advocates, developed criteria for vulnerabilities and strategies based on professional experience, local knowledge, and consultation of academic and federally sponsored research. The methodology and mapping have been further refined through review from organizations such as the Bay Area Regional Health Inequities Initiative,[9] Resilient Communities Initiative,[10] the Resilient by Design Bay Area Challenge,[11] and the ART Bay Area Regional Working Group. We hope to update these as understandings of social vulnerability mapping evolve.



Vulnerable Communities Across the Bay Area

Figure 2-70. Distribution of the Bay Area's block groups that exhibit multiple social vulnerability characteristics and contamination burdens.

REGIONAL ASSESSMENT APPROACHES

This section provides an overview of the findings of the two approaches to assess impacts from sea level rise to communities that face social and economic marginalization and/or contamination burden. The two approaches were based on a quantitative, regional data-driven analyses that incorporated the ART assessment method and qualitative, in-depth vulnerability assessments.

Regional Data-Driven Consequence Results

This portion of the quantitative assessment is based on data-driven results from the analyses of region-wide consequence indicators. First, flood exposure of vulnerable community block groups with social vulnerability and contamination vulnerability using the Metropolitan Transportation Commission/Association of Bay Area Governments (MTC/ABAG) 2010 parcel data were analyzed to understand the extent and timing of exposure at ten different total water levels (TWLs). Two consequence indicators were then identified and analyzed to measure the magnitude of flooding impacts on vulnerable communities. Consequence from flooding were calculated by the total exposure of 2010 Residential Housing Units occurring in block groups with moderate, high, or highest social vulnerability or contamination vulnerability, which are described in greater detail in the next section. Table 2-3 indicates the two vulnerable communities indicators of consequence analyzed.

Indicators of Consequence for Vulnerable Communities

Regional System	Asset Type	Consequence Indicator	Unit of Measurements
Vulnerable Communities	**Social Vulnerability**	Residential Units 2010	Number of residential units impacted
	Contamination	Residential Units 2010	Number of residential units impacted

Table 2-3. Indicators used to measure consequence for Vulnerable Communities in ART Bay Area.

Individual Qualitative Assessment Results

The second portion of the assessment is based on qualitative, neighborhood-scale vulnerability assessments conducted through desktop research using flood maps and supported with Regional Working Group input. This method entailed a detailed assessment on a subset of vulnerable communities that are in proximity to other regional systems impacted. Vulnerability statements described in this section resulted from the qualitative assessment.

Structure of Vulnerable Communities Analyses

Prior to sharing the results of the Vulnerable Communities regional system analyses, this section provides additional details on the mapping methodologies for social vulnerability and contamination vulnerability, including an identification of indicators (or characteristics) used to describe the Vulnerable Communities.

Following this, the regional system results will describe exposure and consequence of both social vulnerability and contamination vulnerability compared to one another.

Together, the results from the quantitative and qualitative analyses provide an overall picture of our region's potential risk to future flooding for Vulnerable Communities. Details on different methodologies can be found in the Appendix.

View of Bayview and Hunters Point in San Francisco, CA. Map data ©2019 by Google Earth Pro.

2.6.3 Characteristics and Ranking of Social Vulnerability and Contamination

ART BAY AREA SOCIAL VULNERABILITY CHARACTERISTICS AND RANKING

The social vulnerability indicators used in ART Bay Area do not represent all socioeconomic characteristics but include those indicators which specifically contribute to increased vulnerability to hazards. These characteristics are not transposable with "disadvantaged communities," which have a specific definition in state law. Disadvantaged communities include environmental hazards and adverse health impacts, such as poor air quality and respiratory health issues. To incorporate these elements of disadvantage, tools such as CalEnviroScreen are cross-referenced in ART Bay Area. Other community vulnerability mapping tools are those from the MTC/ABAG and the Bay Area Air Quality Management District (BAAQMD), which are partner agencies working at the regional scale. Displacement screening was added after the project's Regional Working Group made it clear that it is necessary to consider displacement in early stages of planning and analysis and not only considered when evaluating the impacts of potential adaptation strategies later in the project.

The following section outlines and describes the social vulnerability rankings and indicators used in ART Bay Area. A list of the twelve indicators can be found in Figure 2-71.

SOCIAL VULNERABILITY CHARACTERISTICS:

- Very Low Income
- Not U.S. Citizens
- Without a Vehicle
- People with Disability
- Single Parent Households
- Communities of Color
- Limited English Proficiency
- Without a High School Degree
- Young Children Under 5
- Severely Housing Cost Burdened
- Older Adults
- Renters

Figure 2-71. Twelve indicators were used to identify characteristics and combinations of characteristics that diminish the capacity to prepare for, respond to, and recover from a harmful event such as a flood.

Social vulnerability was ranked using a triggering methodology. Block groups that have a concentration of individuals or households with a particular vulnerability characteristic that is either in the 70th percentile or 90th percentile are counted towards a "total count". Each block group was given a total count of indicators that scored above the two triggering rates. Indicators in each category are counted the same, when in real life they do not contribute equally to vulnerability. For example, income may contribute more to community vulnerability than the presence of young children, but it is difficult to quantify how much more. The combination of both these characteristics results in higher vulnerability than either one on its own, which is why a total count method is used. Rankings of social vulnerability were assigned by looking at the distributions of the data.

Block groups labeled "**Highest social vulnerability"** have:

- 8 or more social vulnerability indicators with rates in the 70th percentile, relative to the nine-county Bay Area; and/or
- 6 or more social vulnerability indicators with rates in the 90th percentile, relative to the nine-county Bay Area

Block groups labeled "**High social vulnerability"** don't meet criteria in "Highest" category, and have:

- 6-7 indicators in the 70th percentile; and/or
- 4-5 indicators in the 90th percentile

Block groups labeled "**Moderate social vulnerability"** don't meet criteria in "Highest" and "High" categories, and have:

- 4-5 indicators in the 70th percentile; and/or
- 3 indicators in the 90th percentile

SOCIAL VULNERABILITY RANK:

- [X] **Highest**
- [X] **High**
- [X] **Moderate**
- [ ] Low

Block groups with "Highest", "High" or "Moderate" social vulnerability were identified and included in the Regional and Local Assessments.

Block groups labeled "**Low social vulnerability"** don't meet any of the criteria above, and those labeled **"Not calculated"** contained characteristics that were not estimated in the American Community Survey, due to low population and other factors leading to low survey response.

SOCIAL VULNERABILITY CHARACTERISTICS DESCRIPTIONS

Very Low Income

Income level affects most aspects of life. Having a lower income lessens the ability to prepare for, respond to, and recover from a hazard event. Inadequate or unsafe housing, societal marginalization, inadequate infrastructure and access to services all afflict the poor. Low-income people have been found to be more vulnerable to hazards, including being less likely to evacuate during a hazard.[12] In some regions, higher incidences of vector-borne disease have been found in low-income populations.[13] Populations with lower incomes have less access to insurance and entitlement programs, less of an ability to pay for medical care, are more likely to live in housing with poor conditions, and have less options for rebuilding and/or relocating housing.[14] A similar characteristic is used in the *Stronger Housing, Safer Communities* project, CalEnviroScreen 3.0, California Department of Water Resources (DWR) disadvantaged community designation, and MTC's Communities of Concern. [15] [16] [17] [18] [19] [20] [21] [22] [23]

Not U.S. Citizen

In the recent U.S. political climate, anti-immigrant rhetoric from the federal government as well as stringent immigration policy has created an environment of constant fear and anxiety among many immigrant families and communities across the U.S. This constant state of elevated stress can reduce one's ability to cope with external shocks such as natural disasters. Additionally, rules proposed by the federal government could jeopardize people's ability to qualify for citizenship and/or put people at an increased risk for deportation. In fear of what these rules could mean, many immigrant families are disenrolling from crucial public programs, cancelling medical appointments, and requesting to have their information purged from all systems.[24] [25] [26] [27] If this retreat from public services continues, many immigrant families will not be able to meet their basic needs, rendering them more vulnerable to any hazard. Additionally, many of the people targeted by these potential policies are low-income and in poor health, both additional vulnerability characteristics. As mentioned above, many non-U.S. citizen communities have limited English proficiency, adding to their vulnerability to hazards. [28] [29] [30] [31]

Public transportation provides critical services for people in the Bay Area, but disruptions to public transit can also disproportionately impact those without vehicles. Photo by Zeyi Fan licensed under CC BY-NC 2.0.

Without a Vehicle

During a flood or hazard event, services such as public transportation may be disrupted. Access to a vehicle is both important for evacuation during emergencies and for commuting and accessing services if transit service is disrupted after a flood event. This vulnerability may be exacerbated because elderly populations or people with disabilities may be unable to drive and low-income households are less likely to own a vehicle. In addition, households are increasingly encouraged to go car-free to contribute to reductions in greenhouse gas emissions. A similar characteristic is used in the *Stronger Housing, Safer Communities* project, and MTC's Communities of Concern. [32] [33] [34] [35]

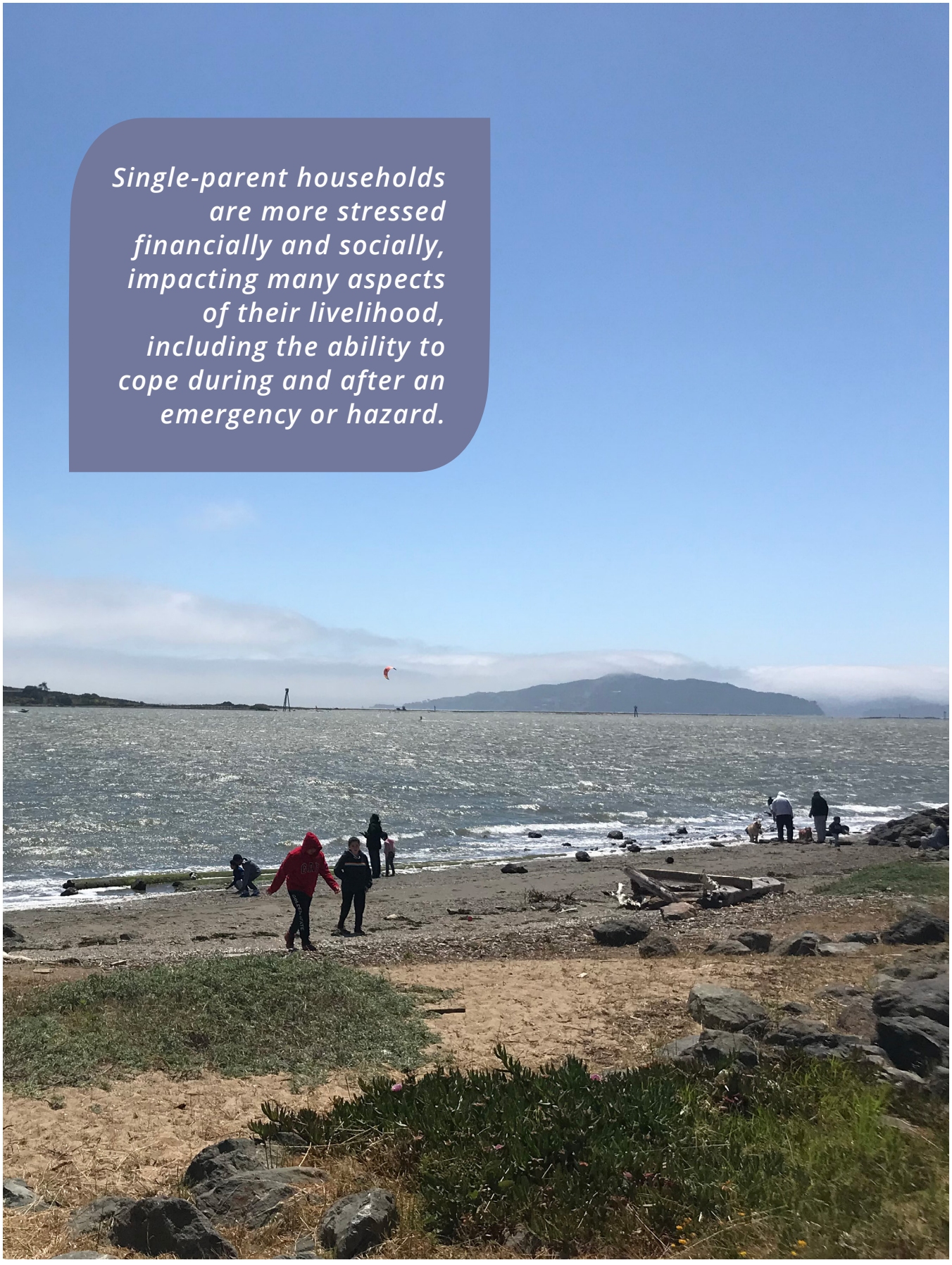
People with Disability

People with disabilities experience impairments in cognitive, physical, and/or sensory functions. While the needs of people with disabilities are specific and varied, all will face disproportionate impacts from climate change and generally face greater obstacles in society. Obstacles include exclusion in the workforce, limited economic opportunities, and reduced capacity to adapt to societal and economic changes. Changes which require relocation are detrimental to people with disabilities as they disrupt personal support networks, healthcare services, accessible and safe housing, and more.[36] Specific accommodations are needed for the safe evacuation and shelter of people with disabilities during an emergency.[37]

The needs of people with disabilities are often not adequately addressed in disaster relief and recovery plans, if they are addressed at all,[38] and often experience "invisibility" from decision-makers.[39] Communication materials and methods often do not adequately accommodate those with impaired cognitive function, hearing, or vision,[40] and information available to first responders may be limited about the location and specific needs of people with disabilities. People with disabilities are more vulnerable to power outages because they are likely to rely on delivered medical supplies and services that need continued electricity for specialized equipment. A similar characteristic is used in the *Stronger Housing, Safer Communities* project, and MTC's Communities of Concern.[41] [42] [43] [44] [45] [46] [47]

Single-Parent Households and Families

Single-parent households are more stressed financially and socially, impacting many aspects of their livelihood, including the ability to cope during and after an emergency or hazard. As the single parent must balance work with the care of dependents, it becomes more difficult to pay for childcare and continue to meet the specific care needs of dependents, particularly for young children—this may become problematic both during an emergency or hazard event and during recovery. Single-parent households are more likely to require public assistance, more affected by a disruption of services, more at risk of income loss, and face other obstacles during recovery. There can be limited information available about the locations and specific needs of single-parent households, and they can experience more difficulties in evacuation. A similar characteristic was used in MTC's Communities of Concern designation.[48] [49]



Single-parent households are more stressed financially and socially, impacting many aspects of their livelihood, including the ability to cope during and after an emergency or hazard.

Families enjoying the Bay during a sunny, windy day in Richmond, California. Photo by Jaclyn Mandoske, BCDC.

Communities of Color

Communities and People of Color (POC) may face additional obstacles to preparing for and recovering from a flood event, due to historic and ongoing racism. The grouping used with the term People of Color should not be taken to mean that people of different ethnicities and races experience the same burdens. Present and historical inequities in economic, political, and social systems result in adverse impacts to populations of color, including higher instances of adverse health conditions, higher likelihood of living in housing of inadequate quality and/or in a hazard zone, limited economic opportunities and access to the decision-making process, tenuous relationships with first responders, and more. The Race Counts initiative, launched in 2017, quantifies racial disparities in California across numerous topic areas. Across the U.S., mortality rates from asthma—which is worsened by mold growing in damp or wet structures—for Black populations are 3 times higher than for White populations.[50] Research following a 2006 flood in El Paso, Texas identified those with Hispanic ethnicity as a significant risk factor after controlling for other socioeconomic factors such as age and housing quality.[51] A similar characteristic is used in the *Stronger Housing, Safer Communities* project and MTC's Communities of Concern. [52] [53] [54] [55] [56] [57] [58]

Limited English Proficiency

Limited English proficiency has been found to result in racial discrimination—this discrimination combined with language difficulties have been associated with reduced socioeconomic status, reduced quality of life, and increased stress.[59] Linguistically isolated households face disproportionate environmental hazard risks, and have been independently related to cancer risk and proximity to toxic facilities.[60] Limited English speakers are more likely to report difficulties in accessing medical care, accessing health-related information, and delayed access to care.[61] Planning activities and materials are often not conducted and prepared in appropriate languages, restricting the political power of limited English proficiency communities, and putting them at greater risk during hazard events. Other materials are frequently English-only, including communication during emergencies and information about aid available during the following recovery. In the Bay Area, many limited English proficiency communities are also resource-constrained renters often living in overcrowded housing, resulting in intensified risks.[62] A similar characteristic was used in *Stronger Housing, Safer Communities*, CalEnviroScreen 3.0, and MTC's Communities of Concern designation.[63] [64] [65] [66] [67] [68] [69] [70]

Without a High School Degree

Higher educational attainment relates to many aspects of resilience and wellbeing, such as, but not limited to, more access to government services and the political system, greater lifetime earnings, enhanced mobility, and has been associated with better health outcomes.[71] Hazard warning information, recovery materials, and planning processes are often not written for audiences with lower educational attainment. A similar characteristic was used in both *Stronger Housing, Safer Communities* and CalEnviroScreen 3.0. [72] [73] [74] [75] [76] [77] [78]

Young Children Under 5

Young children are more physically impaired by floodwater covering walkways, more likely to come into contact with contaminated water, have more sensitive immune systems susceptible to disease and exhaustion, and are more vulnerable to the effects of climate change.[79] An association between rain events and children's emergency department visits has been observed.[80] Young children have greater care needs which still need to be met during a hazard event. These include daycare or other childcare services, or specific material needs, such as formula and diapers. Sufficient information is often not available about the locations and specific needs of young children, and they can experience more difficulties in evacuation.

A family explores the view of the Bay Area near the Lawrence Hall of Science in Berkeley, California. Photo by John Morgan licensed under CC BY 2.0.

Severely Housing-cost Burdened [81]

Housing affordability is important to health, resilience, and wellbeing.[82] [83] Housing affordability for both renters and owners is an existing challenge in the Bay Area that will compound the number of community members displaced by a natural disaster. Much of the region is already cost-burdened with housing, spending 50 percent or more of income on housing. After a disaster, if many housing units are lost, a constrained market may drive up the cost of housing even further. Loss or damage of housing that results in increased costs to either renters or home-owners will likely increase the number of permanently displaced Bay Area residents—finding housing that is affordable and near jobs, schools, medical facilities, and other services on which they rely will be challenging (see *Stronger Housing, Safer Communities*). Rental households which are housing-cost burdened have been associated with adverse health conditions and lower educational outcomes in children.[84] Conditions where there are unaffordable housing options and/or households are severely housing-cost burdened can contribute to community instability and crime.[85] A similar characteristic was used in *Stronger Housing, Safer Communities*, CalEnviroScreen 3.0, and MTC's Communities of Concern designation.[86] [87]

Older Adults

Older adults are also more physically impaired by floodwater covering walkways, more susceptible to disease and exhaustion, more likely to have a declining health, pre-existing health condition and/or a disability, and more vulnerable to climate change health effects.[88] Older adults are more likely to need special food, medications, and medical equipment, making them more vulnerable to power outages and other impacts of hazards. Sufficient information is often not available about the locations and specific needs of older adults, and they can experience more difficulties in evacuation. Cognitive function declines as we age, making processing information and responding during a disaster more difficult for the elderly. Older adults can be on a limited fixed-income and have less financial ability to respond to or recover from a hazard. Older adults which live alone are particularly vulnerable. A similar characteristic is used in the *Stronger Housing, Safer Communities* project and MTC's Communities of Concern.[89] [90] [91] [92] [93]

Renters

Renters have less control over the condition of housing than those who own their homes. Renters have a limited ability to make repairs or improvements, such as flood proofing, and less information about hazards. During disaster recovery periods, information about financial aid and resources from federal programs are focused on homeowners. Rental households are more likely to be low-income and endure greater health impairments due to housing unaffordability. Renters are vulnerable to eviction and face greater risk of displacement—an extensive problem in the Bay Area. A similar characteristic is used in the *Stronger Housing, Safer Communities* project, CalEnviroScreen 3.0, and MTC's Communities of Concern.[94] [95] [96] [97] [98] [99] [100] [101] [102]

The Bay Area is home to a large population of individuals who rent their homes, including people who live in creekside communities such as El Cerrito. Photo by BCDC.

ART BAY AREA CONTAMINATION RANKING

Contamination burden ranking followed a similar methodology to social vulnerability ranking. For each block group, the number of characteristics (in this case, pollution types) in the 70th and 90th percentiles determined the contamination vulnerability rank.

Contamination indicators represent degradation or threats to communities and the natural environment from pollution. The presence of contaminated lands and water raises health and environmental justice concerns, which could worsen with flooding and sea level rise. A percentile score for the severity of contamination in each block group was calculated using data compiled by California Environmental Protection Agency (CalEPA) Office of Environmental Health Hazard Assessment for use in the Environmental Effects category of CalEnviroScreen 3.0. The following section outlines and describes the contamination rankings and indicators used in ART Bay Area. A list of the five contamination types can be found in Figure 2-72.

- **Hazardous cleanup activities:** Land with hazardous substances undergoing cleanup actions, original source data from the California Department of Toxic Substances Control (DTSC) and United States Environmental Protection Agency (US EPA) (Superfund Sites);
- **Groundwater threats:** Sites that may impact groundwater and require cleanup, original source data from State Water Resources Control Board;
- **Hazardous waste facilities:** Presence of hazardous waste generators and permitted facilities that are involved in the treatment, storage, or disposal of hazardous waste, original source data from DTSC;
- **Impaired water bodies:** Water bodies that do not meet water quality standards, listed as impaired under Section 303(d) of the Clean Water Act, original data from the State Water Resources Control Board; and
- **Solid waste facilities:** Presence of solid waste sites and facilities, original source data from CalRecycle and DTSC.

CONTAMINATION BURDEN TYPES:

- Hazardous Cleanup Activities
- Groundwater Threats
- Hazardous Waste Facilities
- Impaired Water Bodies
- Solid Waste Facilities

Figure 2-72. Five types of contamination were used to identify contamination burdens that impact communities around the Bay Area.

Chevron oil refinery in Richmond, California adjacent to communities. Photo by SF Baykeeper, Cole Burchiel, and LightHawk.

Similar to social vulnerability, contamination vulnerability was ranked using a triggering methodology. Rankings of contamination vulnerability were assigned by looking at the distributions of the data.

Block groups labeled "**Highest contamination vulnerability"** have:

- 4 or more contamination indicators with rates in the 90th percentile, relative to the state; and/or
- Total contamination score above 90th percentile, relative to the state

Block groups labeled "**High contamination vulnerability**" don't meet criteria in the "Highest" category, and have:

- 5 indicators in the 70th percentile; and/or
- Total contamination score between 80th – 90th percentile

Block groups labeled "**Moderate contamination vulnerability**" don't meet criteria in the "Highest" and "High" categories, and have:

- 4 indicators in the 70th percentile; and/or
- Total contamination score between 70th – 80th percentile

Block groups labeled "**Lower contamination vulnerability**" don't meet any of the criteria above.

CONTAMINATION BURDEN:

- [X] **Highest**
- [X] **High**
- [X] **Moderate**
- [ ] Low

Block groups with "Highest", "High" or "Moderate" contamination were identified and included in the Regional Assessment.

2.6.4 Regional Vulnerable Community System Results

REGIONAL EXPOSURE

Block Groups with Social Vulnerability

The bar graph below shows the total area of socially vulnerable block groups flooded at each total water level both in total acres and as a percent of the regional total acres within all vulnerable community block groups that rank moderate, high, or highest for social vulnerability (Figure 2-73). This graph illustrates the relative magnitude of exposure in the Bay Area as compared to the region. Illustrating the data in this way shows that the area of socially vulnerable block groups potentially impacted by flooding may be small compared to the system as a whole, but because this relatively small percentage represents many thousands of housing units, the impacts will still be significant. Many of the exposed acres are in high density urban areas, especially at higher water levels.

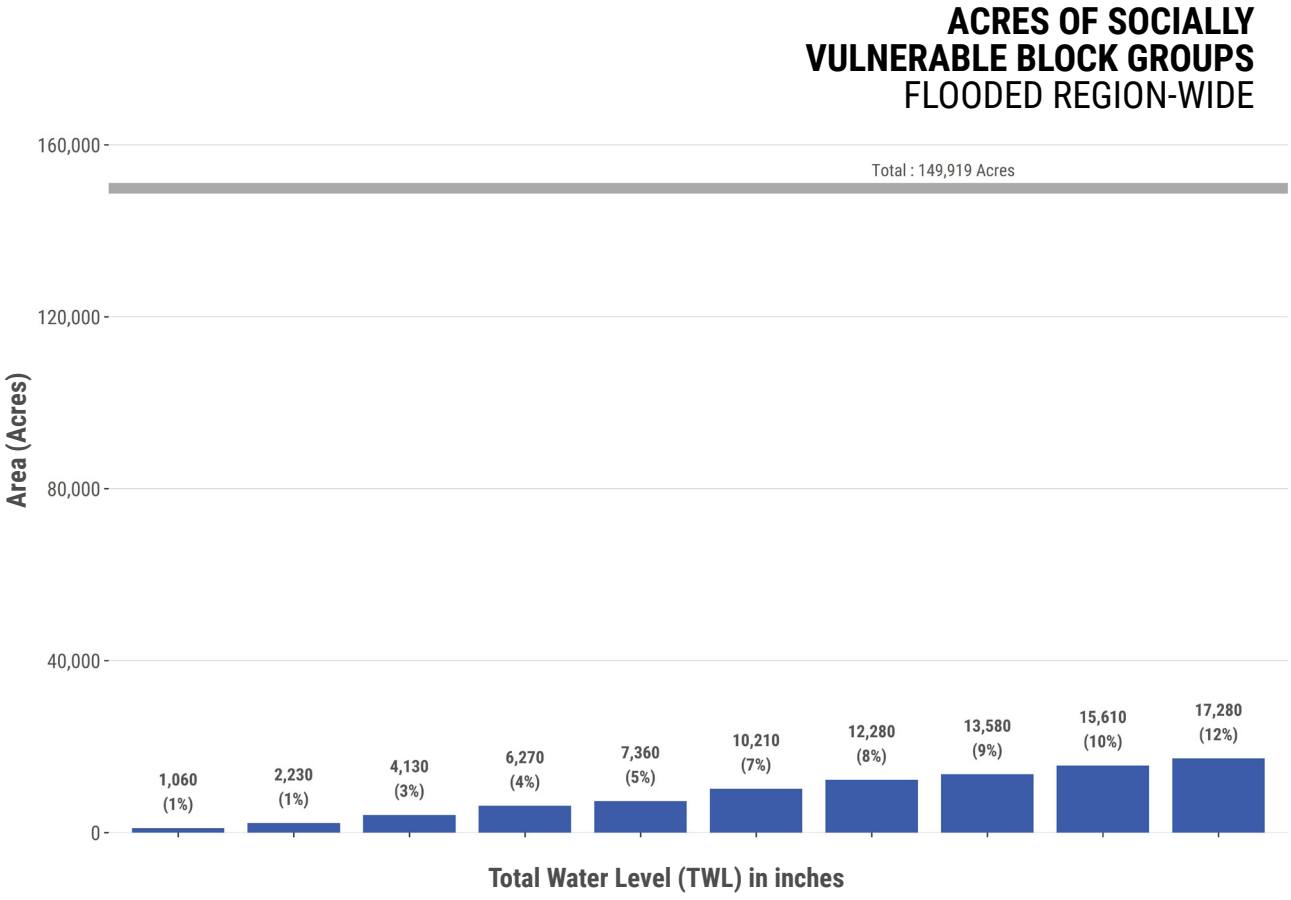


Figure 2-73. Regional exposure of block groups with social vulnerability by flooding. Values in parenthesis reflect the percent of acres exposed to flooding at each TWL compared to all socially vulnerable block groups in the nine-county region.

Figure 2-74 identifies which counties have the highest percent of area of socially vulnerable block groups exposed to flooding in the region. Exposure affects the degree of impacts and consequences. More widespread exposure amplifies impacts and consequences, and early exposure provides much less time to prepare, which may also amplify impacts and consequences. These nuances are important to bear in mind throughout the following sections describing regional consequence results.

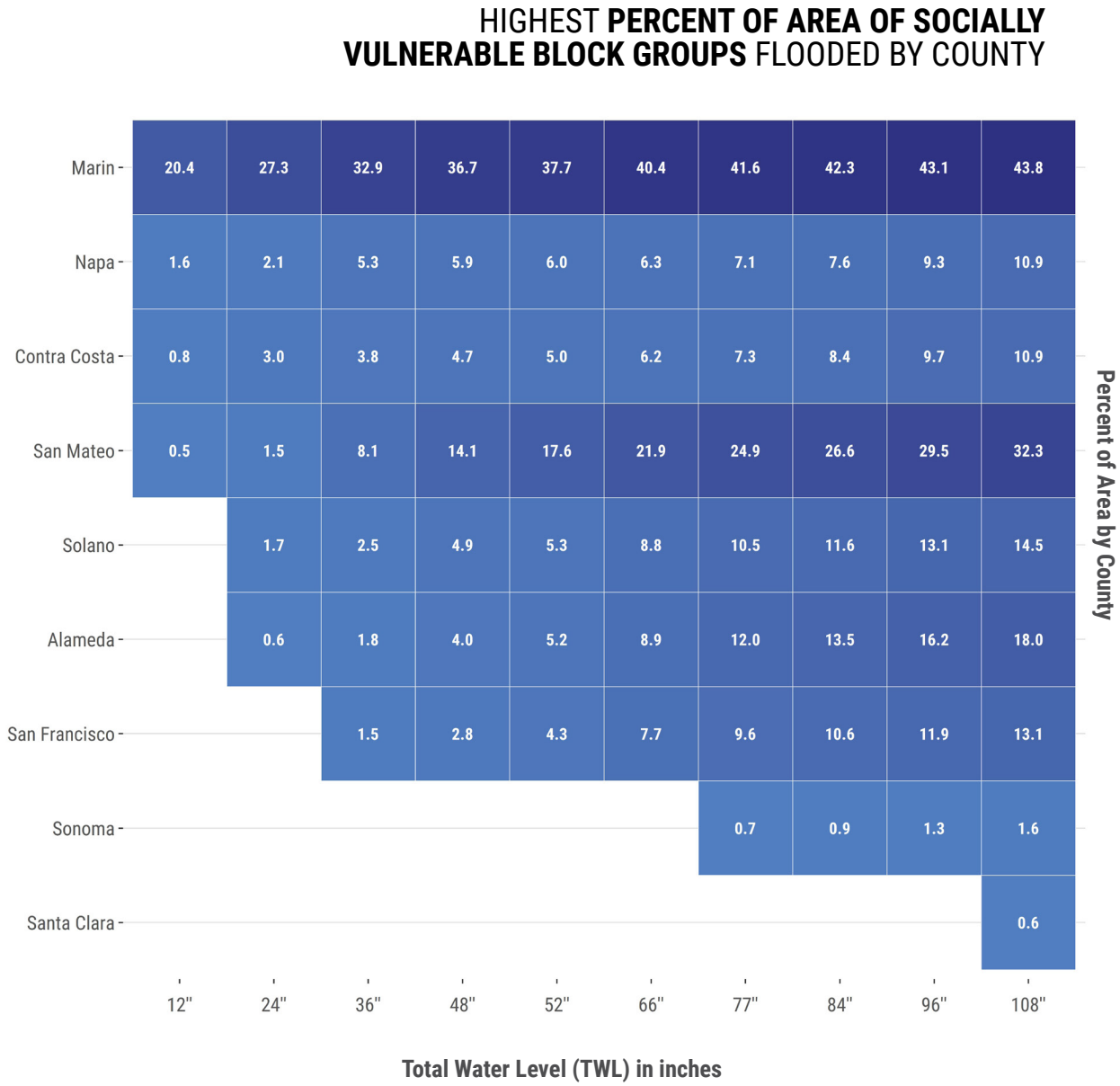


Figure 2-74. Counties with highest percent of areas with block groups with social vulnerability exposed to flooding at ten TWLs. Darker colors reflect greater consequences from flooding.

Block Groups with Contamination Vulnerability

The bar graph below shows the total area of block groups that are ranked as moderate, high, or highest contamination burden that are flooded at each total water level both in total acres and as a percent of the regional total of acres within all contaminated block groups that rank moderate, high, or highest for contamination burden (Figure 2-75). This graph illustrates the relative magnitude of exposure in the Bay Area as compared to the region. Illustrating the data in this way shows that the areas of contaminated block groups potentially impacted by flooding are relatively small at early water levels, but steadily increases as waters rise. By 108" TWL, over 30 percent of the region's area in block groups with moderate, high, or highest contamination burden is exposed.

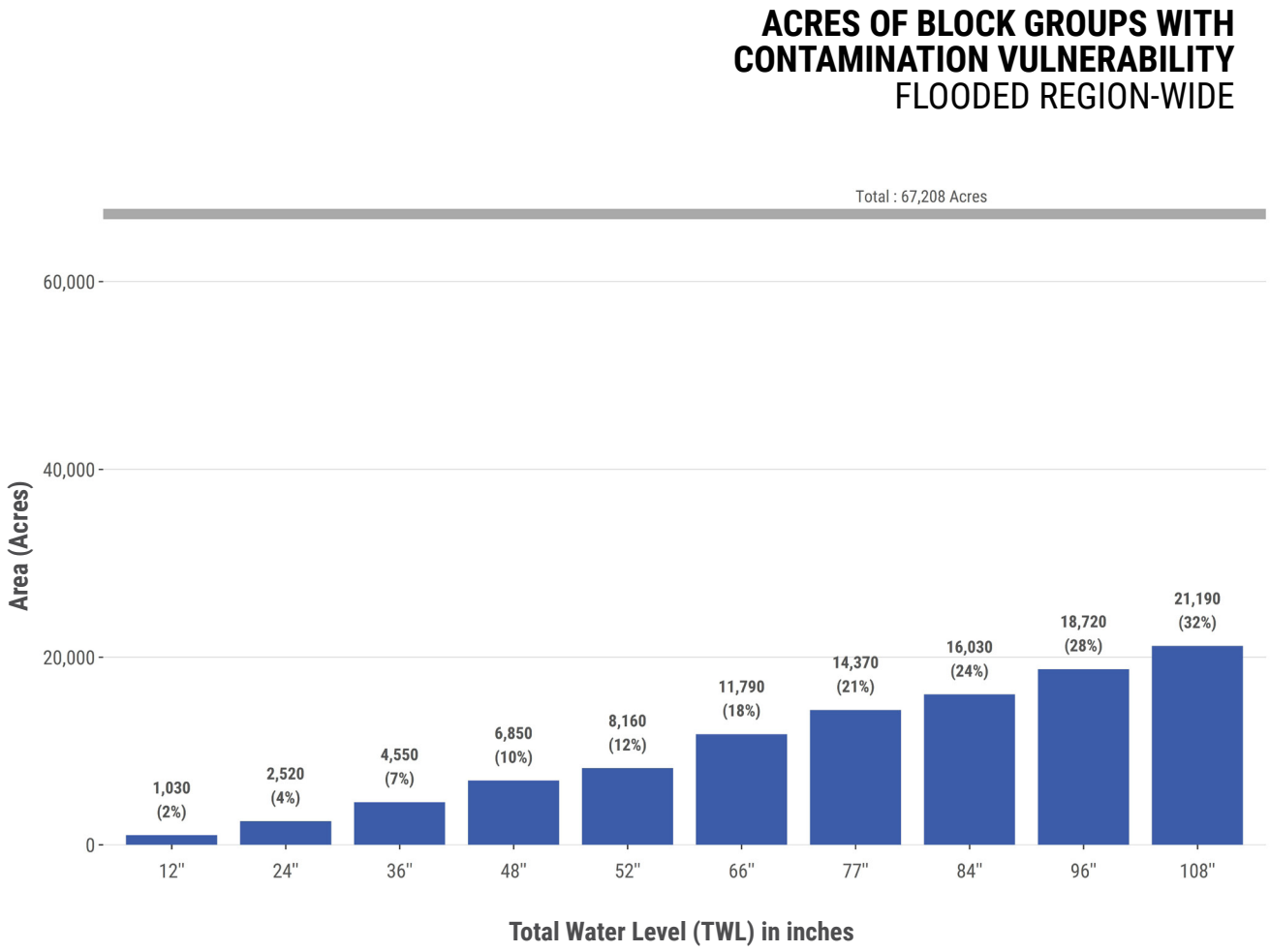


Figure 2-75. Regional exposure of block groups with contamination vulnerability by flooding. Values in parenthesis reflect the percent of acres exposed to flooding at each TWL compared to all block groups with contamination vulnerability in the nine-county region.

This could cause serious threats to public health and compounds the risks to socially vulnerable communities, as contamination burden and social vulnerability are predominantly co-located. Especially at later water levels when high density urban areas are becoming exposed, each additional acre exposed may have an even higher consequence for households. Figure 2-76 identifies which counties have the highest percent of area of contamination vulnerability block groups exposed to flooding in the region.

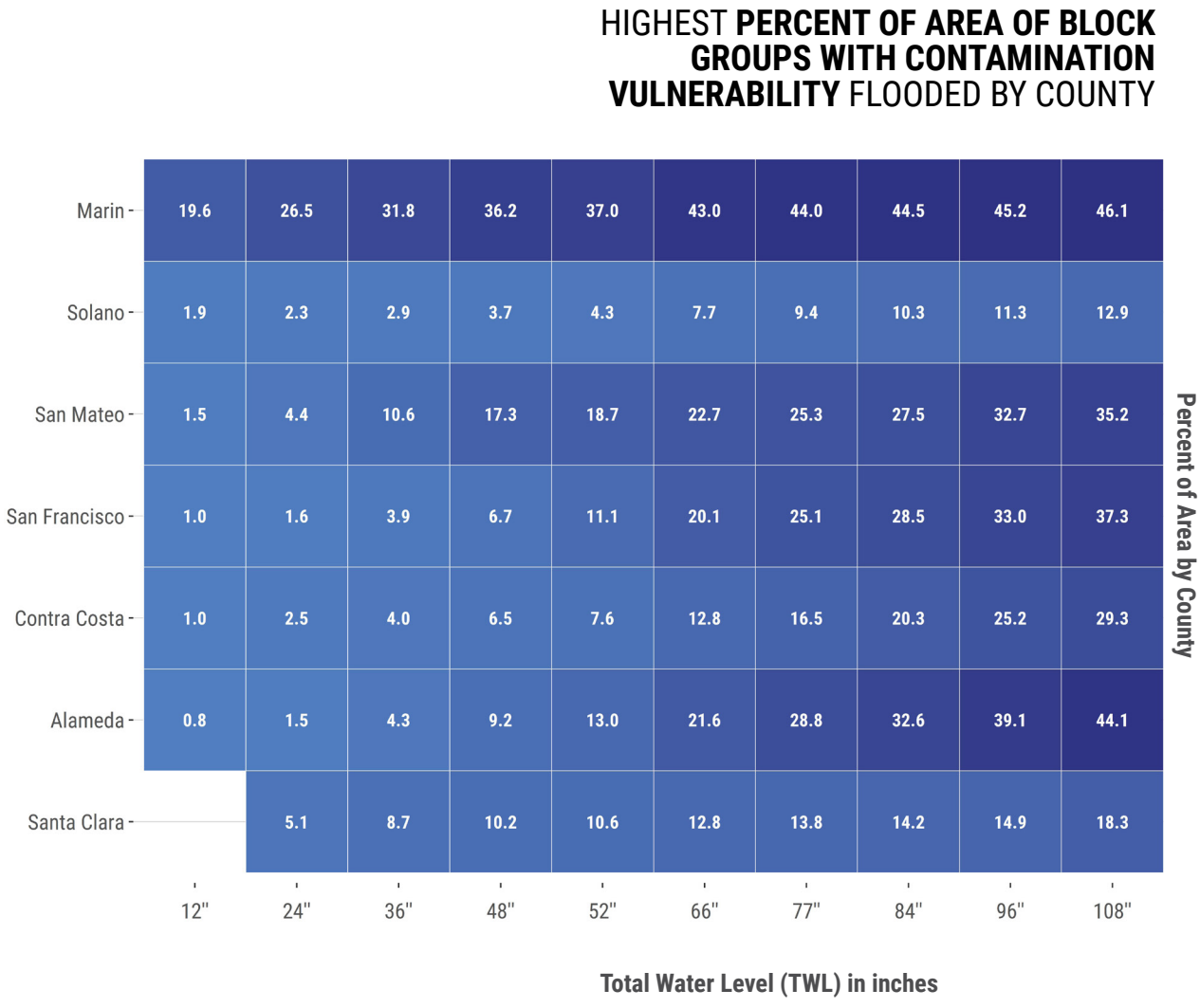


Figure 2-76. Counties with highest percent of areas with contamination vulnerability block groups exposed to flooding at ten TWLs. Darker colors reflect greater consequences from flooding.

REGIONAL CONSEQUENCE

Residential Units with Social and Contamination Vulnerability

Residential units that are socially vulnerable are exposed as early as 12" TWL. As water levels rise, there is a steady increase in residential units exposed (Figure 2-77). The increases of impacts between water levels vary, with an average increase of 9,584 additional residential units exposed between each water level.

The largest increase of 15,496 residential units exposed occurs between 52" and 66" TWL. By 108" TWL, a total of 91,464 residential units will be exposed. If we assumed the standard 2.5 occupants per residential unit, that's 228,660 people impacted, roughly the population of Fairfield.

Residential units vulnerable to contamination are exposed as early as 12" TWL. As water levels rise, there is a steady increase in residential units exposed. At 52" TWL total residential units exposed jumps from 27,948 to 39,155, the largest increase between water levels. By 108" TWL, 51,332 units that have moderate, high, or highest contamination burden may be impacted. This poses significant risk of pollutant mobilization, creating the potential for high occurrence of human exposure to contaminants, impacting health risk.

Households in the South Bay during dusk. Photo courtesy of Resilient By Design photographer Karl Nielsen.

TOTAL RESIDENTIAL UNITS WITH SOCIAL VULNERABILITY AND CONTAMINATION VULNERABILITY IMPACTED BY FLOODING REGION-WIDE

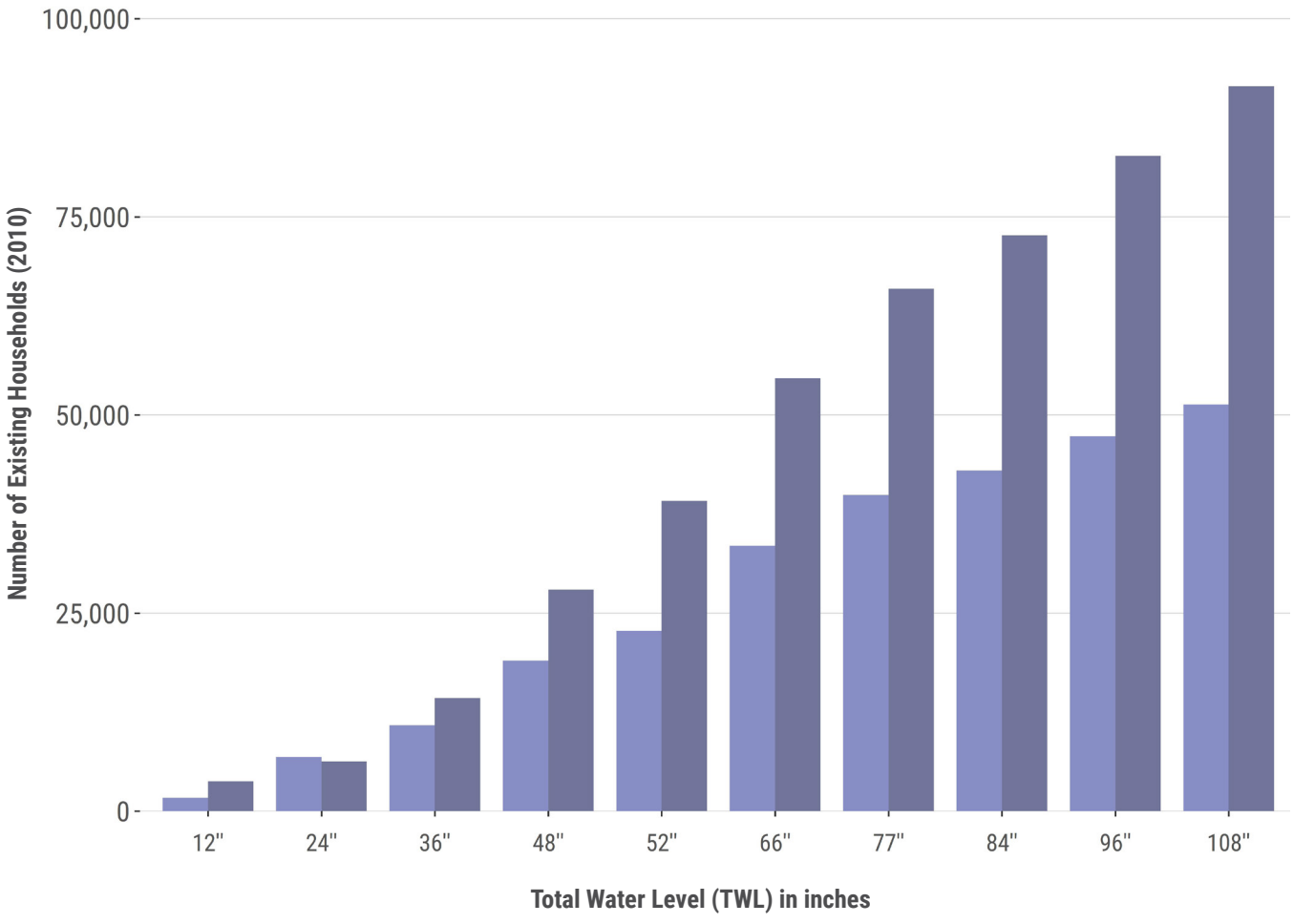


Figure 2-77. Regional impacts to residential housing units from flooding at ten TWLs as measured by two indicators: block groups with social vulnerability and block groups with contamination vulnerability. Results are aggregated across the nine-county region.

TRENDS AND DRIVERS AROUND THE REGION

Residential Units with Social Vulnerability

The earliest impacts to residential households are concentrated in Marin County, with San Rafael accounting for much of this impact at 12" TWL (Figure 2-78). Block groups exposed in San Rafael at this water level are characterized as 'Highest social vulnerability'. Households exposed in Marin at 12" TWL total 2,809. Block groups in San Rafael occur at the highest frequency in the top five residential units impacted until 52" TWL, making Marin County by far the most impacted until 36" TWL.

As water levels increase, impacts begin to spread out across the Bay and are depicted spatially in maps of consequence in Figure 2-80. The South Bay, especially the Alviso area and Alameda, begin to show up by 24" TWL and 36" TWL, respectively. By 66" TWL, block groups in the Mission Creek area, Foster City and the San Francisco waterfront all occur in the top five for residential units impacted. Once high-density areas in Foster City, San Francisco and the Alviso area are impacted, they remain in the top five for residential units impacted until 108" TWL, with the addition of block groups near Milpitas at 96" TWL.

The regional increase in exposure between 52" and 66" TWL is in part driven by one densely populated block group in the Mission Islais community. This block group is not exposed until 36", but by 48" TWL this is the block group with the most impacted residential units. Between 52" and 66" TWL this block group sees an increase of 1,708 residential units exposed. At 66" TWL this block group has the most socially vulnerable residential units exposed, at 3,689 units higher than the next highest block group. This block group has by far the most residential units exposed all the way until 108" TWL. By 108" TWL, Alameda has the most socially vulnerable units exposed, totaling 25,673 units.

Residential Units with Contamination Vulnerability

At the earliest water levels, San Rafael is a significant driver of total residential units with contamination burden impacted (Figure 2-79, Figure 2-80). At 24" TWL, impacts spread out across the Bay. Solano, Santa Clara, San Mateo, San Francisco, and Alameda counties begin to see impacts in the thousands by 36" TWL. As this TWL increase, one block group in San Jose jumps from 4,131 to 6,379 residential units, an increase of 2,248 residential units exposed. These two block groups remain the highest consequence block groups until 108" TWL, with no increase in total residential units exposed over that time in Santa Clara, and an increase to 5,367 in Mission Islais. The largest impacts by 108" TWL occur in Alameda County, as large swaths of densely populated areas are inundated. Residential units that are vulnerable to contamination exposed by 108" TWL total 55,332.

COUNTIES WITH THE HIGHEST **SOCIALLY VULNERABLE RESIDENTIAL UNITS** IMPACTED BY FLOODING

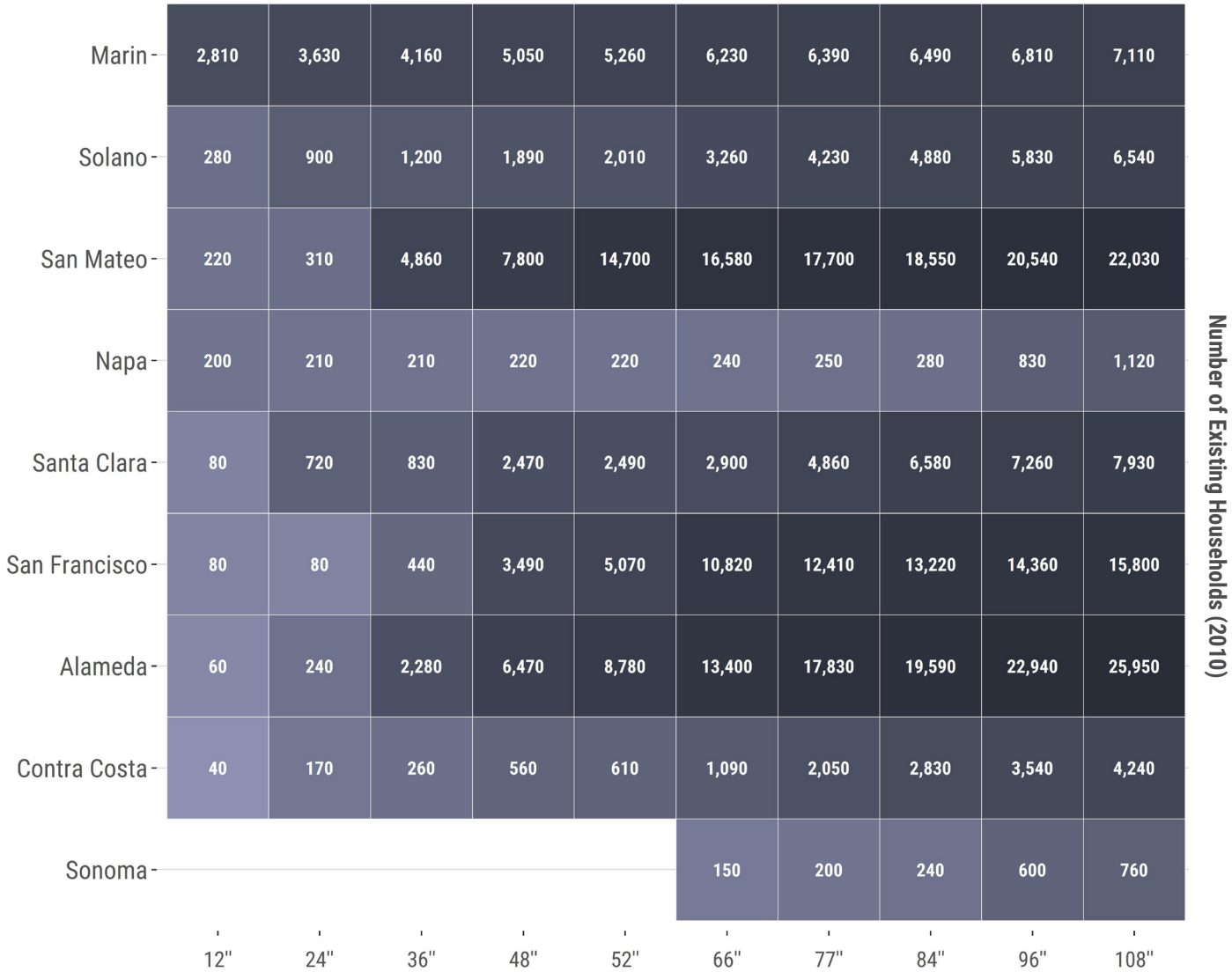


Figure 2-78. Counties with highest impacts to socially vulnerable residential units from flooding at ten TWLs as measured by impacts to 2010 residential units. Darker colors reflect greater consequences.

*San Rafael is by far the **hardest hit in the region** at earliest total water levels. Along the Canal District, socially vulnerable and contaminated areas will be hit with flooding as early as 12" TWL.*

COUNTIES WITH THE HIGHEST **RESIDENTIAL UNITS WITH CONTAMINATION VULNERABILITY** IMPACTED BY FLOODING

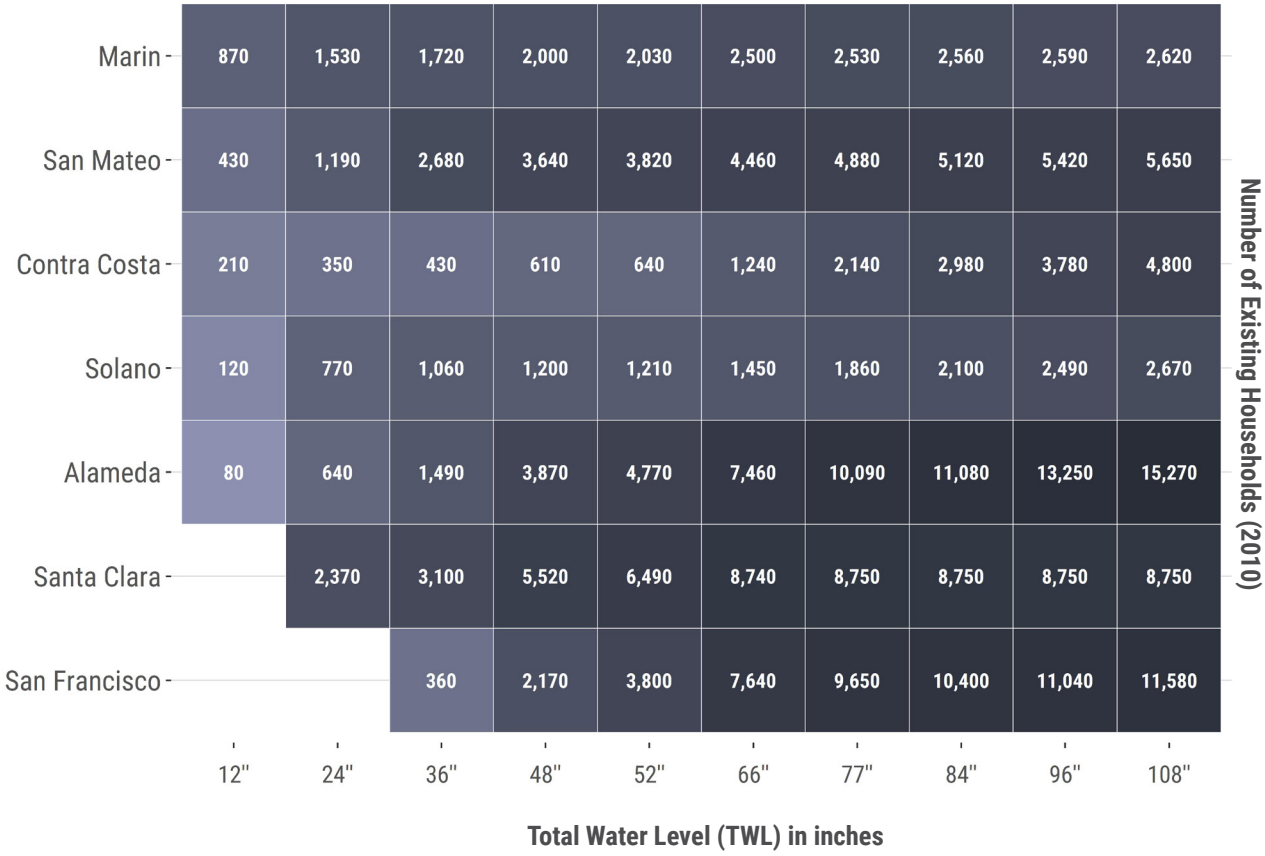


Figure 2-79. Counties with highest impacts to residential units with contamination vulnerability from flooding at ten TWLs as measured by impacts to 2010 residential housing units. Darker colors reflect greater consequences.

SHORT CASE STUDY

LINKING REGIONAL CONSEQUENCE RESULTS TO LOCAL ASSESSMENTS

San Rafael is by far the hardest hit in the region at earliest total water levels. Along the Canal District, socially vulnerable and contaminated areas will be hit with flooding as early as 12" TWL. This area has the highest population of low-income and limited English proficiency households within the County, which contributes to challenges in accessing critical services in the event of flooding.

Residents in this area experience worse health disparities, earn lower incomes, and have lower life expectancies than the County average. Many Canal District residents are spending more than a third of their income on rent and overcrowding is common. According to UC Berkeley's ***Urban Displacement Project***, census tracts in the Canal District are classified as being at risk of gentrification and displacement and losing low-income households.

In order to holistically address flooding and related risks in the San Rafael Canal District, the Multicultural Center of Marin (formally, the Canal Welcome Center) along with Shore Up Marin are working to build community resilience.[103] These vulnerabilities are shared across systems. Within this area, the Downtown San Rafael Priority Development Area (PDA) is at risk, as well as the Bay Trail and Water Trail Priority Conservation Areas (PCAs) and various transportation assets including US-101, I-580, the San Rafael Downtown SMART, and the San Rafael Transit Center.

In addition to the regional assessment, ART Bay Areas assessed individual assets in each of the four region systems and the results are communicated in local assessments of shared vulnerabilities and consequences.

These can be found in Chapter 3.0 Local Assessments of the ART Bay Area report, with local assessments available for individual download.

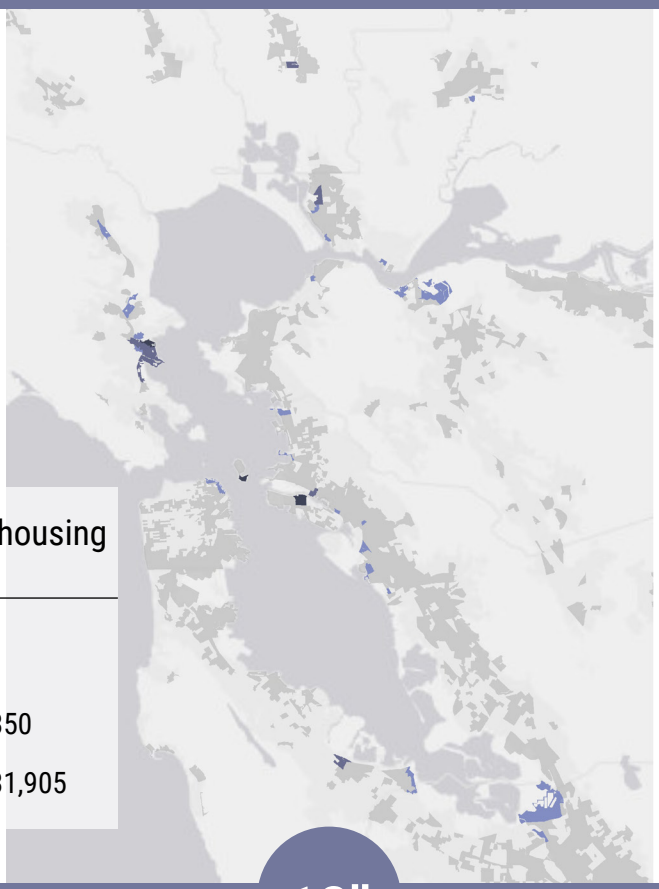
Homes bordering the San Rafael Canal. Photo by SF Baykeeper, Cole Burchiel, and LightHawk.

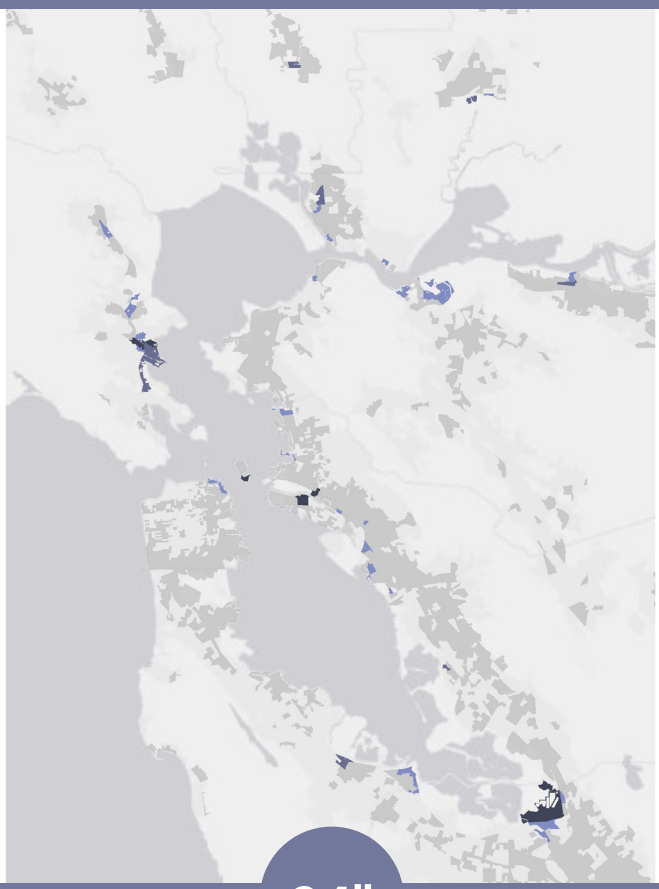
CONSEQUENCES OF FLOODING

Vulnerable Communities

Social and Contamination Vulnerability

Block Groups with Social Vulnerability Impacted by Flooding





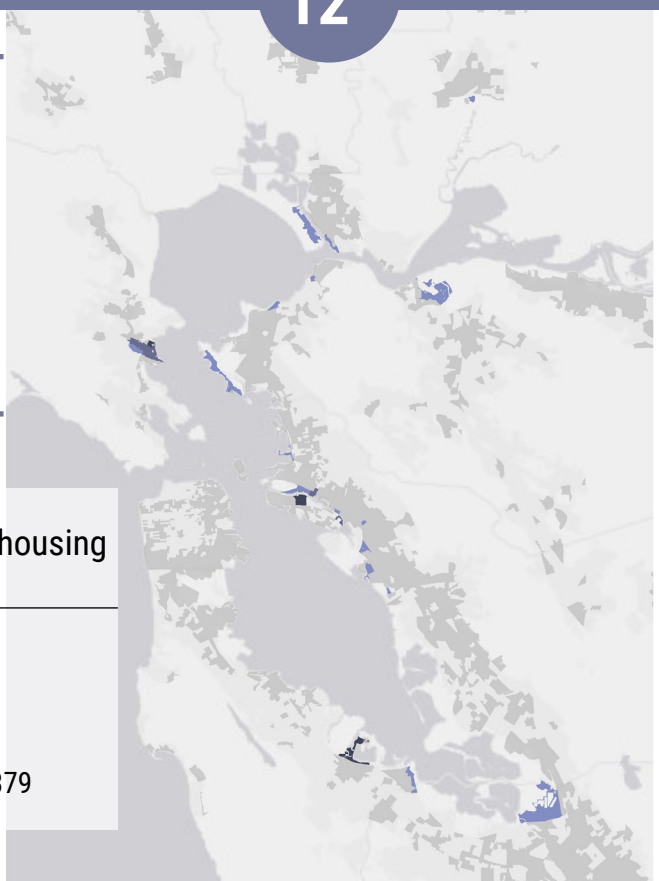
# of residential housing units (2010)

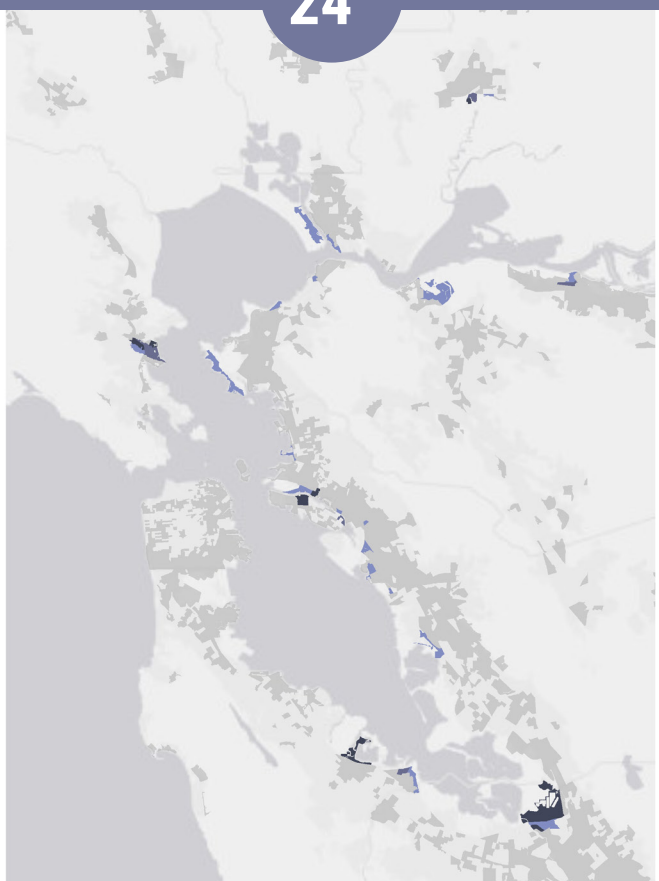
- 1 to 440
- 441 to 2,350
- 2,351 to 31,905

12"

24"

Block Groups with Contamination Vulnerability Impacted by Flooding

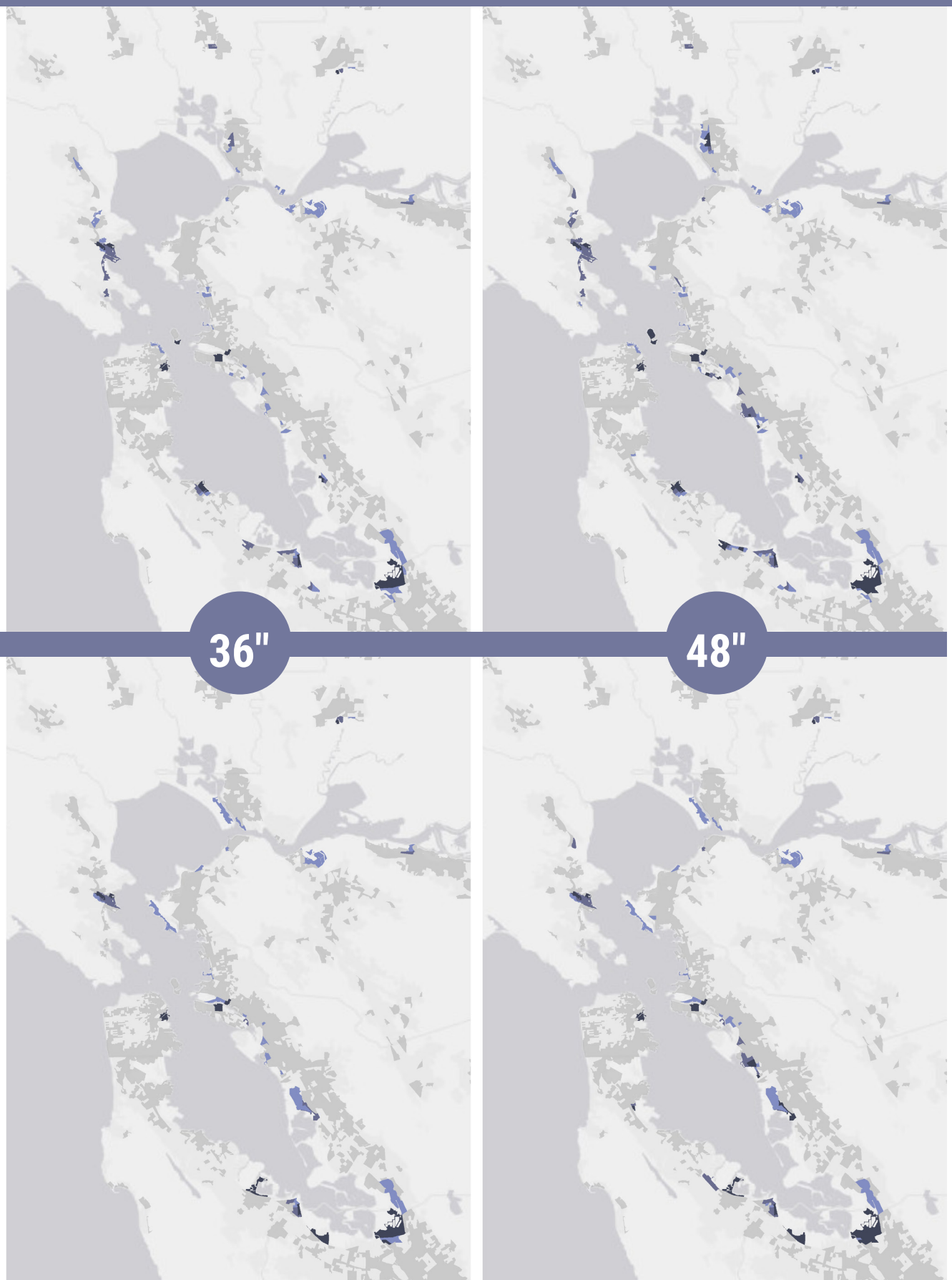




# of residential housing units (2010)

- 0 to 78
- 79 to 293
- 294 to 6,379

Figure 2-80. Maps depicting the consequences of flooding for two Vulnerable Community indicators: Existing residential housing units in block groups with Social Vulnerability and Contamination Vulnerability at 12", 24" 36" and 48" TWL. Block groups with any portion exposed to flooding are considered impacted. Maps below show entirety of impacted block groups, not extent of exposure.



AN IMPORTANT NOTE ON CONSEQUENCE

To calculate consequence, a key assumption made in this analysis is that once a parcel is exposed to flooding, even marginally, the entire number of residential units in that parcel is considered impacted. This assumption reflects a conservative understanding that flooding has many direct and indirect impacts on a person's ability to enjoy their home. Indirect impacts such as flooding of walkways, foundations, and electrical systems may all contribute to displacement. Since we don't have data to reflect these indirect impacts, we maintain the assumption that any flooding to a parcel impacts all the people living in it.

This assumption works well for small parcels, but for large parcels it serves as a limitation to the analysis. Large undeveloped parcels (e.g. former military lands) that have large projected growth for 2040 show high numbers of residential units impacted when exposed to flooding even though the flooding may not be in the location where future development may occur. A related but separate limitation of this analysis is the existence of parcel boundaries that extend bayward of the high tide line. These parcel boundaries intersect even small amounts of flooding despite the fact that no buildings exist in these parts of the parcel and inaccurately indicate impacted residential units. The ART team performed a manual inspection and corrected for this issue for the top five block groups for both indicators. Future efforts should be made to refine parcel boundaries for current and future developed areas on the shoreline.

A key assumption made in this analysis is that once a parcel is exposed to flooding, even marginally, the entire number of residential units in that parcel is considered impacted.

Top and bottom photos: Views of the shoreline in the South Bay during King Tides in January 2020 show how close our communities live to the rising Bay. Photos by SF Baykeeper, Cole Burchiel, and LightHawk.

2.6.5 Vulnerable Community Vulnerability Statements

This portion of the assessment is based on results from the in-depth vulnerability assessments conducted on a subset of vulnerable communities in the region. Qualitative vulnerability assessments were conducted to gain a more nuanced understanding of specific vulnerabilities for vulnerable communities identified. These individual assessments were then compiled into a series of Local Assessments that dive into specific localities around the region. For details on this section, please see Section 3.0 Local Assessments – Local Vulnerability, Regional Impacts.

While the vulnerabilities listed do not necessarily apply to every vulnerable community in the entire region, they represent consistent themes and findings from the local vulnerability assessments conducted on a subset of localities.

Contamination vulnerability and social economic vulnerability are often co-located

Across the Bay, areas that are socially and economically vulnerable are also often areas that are vulnerable to contamination. This could create conditions where communities that are subject to the most social and economic marginalization are further impacted by the mobilization of contaminants in the event of a flood. This could impact communities' ability to return to their homes and can contribute to negative health impacts both during and after a flood. These findings are consistent with concerns from environmental justice communities that have raised the issue of contaminant mobilization in the event of a flood.

Across the Bay, areas that are socially and economically vulnerable are also often areas that are vulnerable to contamination.

Vulnerable households that are vulnerable to flooding are also experiencing gentrification and displacement

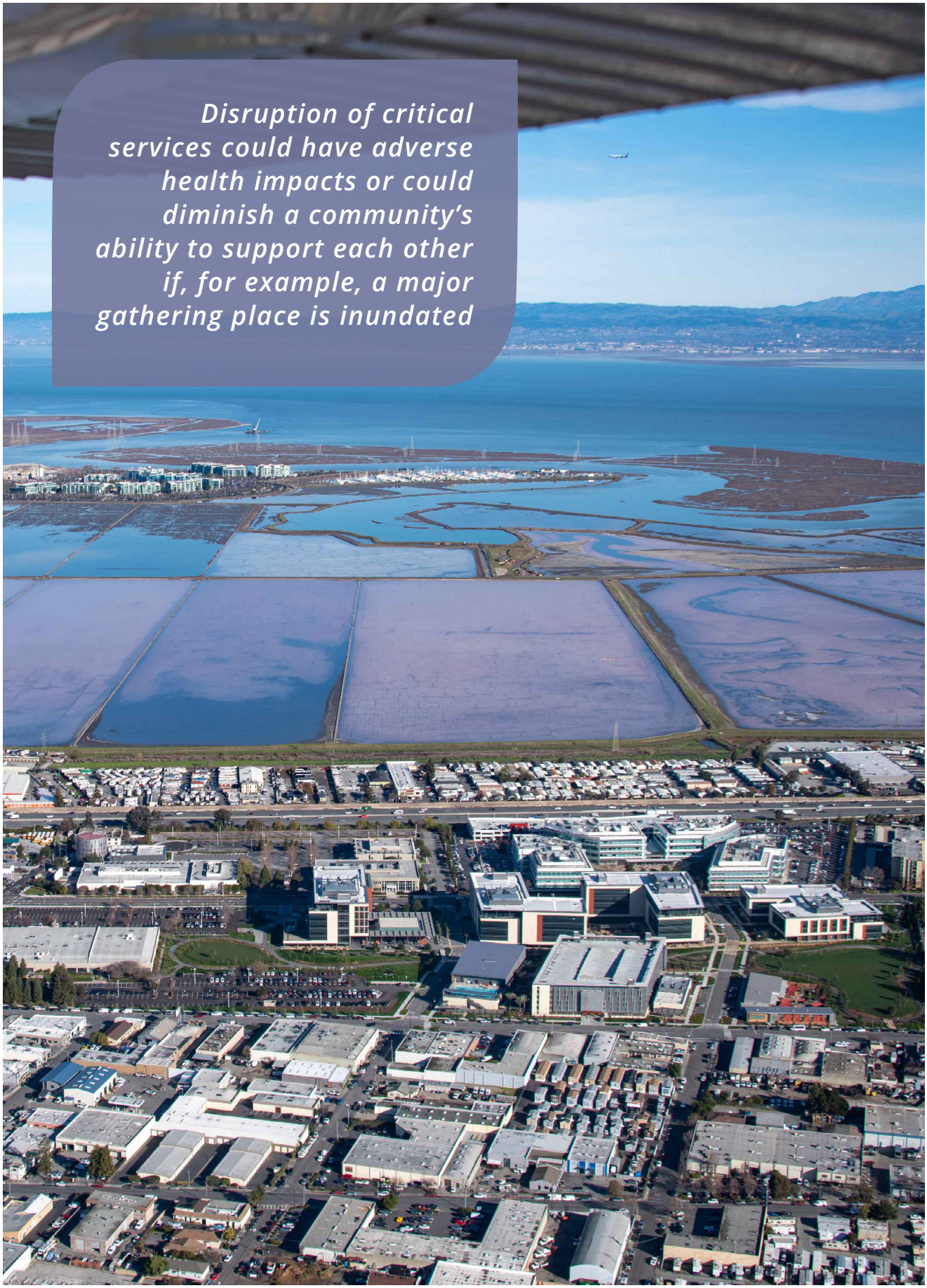
Across the Bay, communities that are vulnerable to contamination and experience social and economic marginalization are being impacted by the housing crisis. Gentrification and displacement are impacting at least some block groups in all areas that are impacted by flooding up to 108" TWL. These impacts will hit low-income and communities of color especially hard, as has been the case in cities such as Oakland and San Francisco.

Community members enjoy the waterfront at Heron's Head park in San Francisco. Photo by the Port of San Francisco licensed under CC BY 2.0.

As flooding begins to impact existing housing stock, it will only increase these pressures. It is especially important to ensure that any measures that address flooding vulnerability do not add to or increase pressures from gentrification. Populations with these characteristics have limited capacity to endure any other housing-related costs, such as flood proofing, recovery after a flood, or relocation. Additionally, many communities have very low housing vacancy rates, which makes temporarily or permanently relocating residents affected by flood events challenging. Displaced residents may not have access to equivalent or affordable replacement housing near the jobs, schools, services, and facilities they rely on.

Vulnerable households that may be impacted by flooding have characteristics that make it more difficult to access emergency services

Various characteristics, including limited English proficiency and households with individuals that have disability considerations, very young (Under 5) and/or older (65 and older living alone) residents can impact a household's ability to access emergency services in the event of a flood. Outreach and preparedness efforts are not always tailored to each community, which may leave some communities further disadvantaged. Decision-makers and emergency responders have limited information about the specific characteristics or needs of individuals or households. This makes preparing for and response to flooding and other climate emergencies more difficult.



Flight over Redwood City looking out into the Bay during King Tides in January 2020. Photo by SF Baykeeper, Robb Most, and LightHawk.

Critical facilities that vulnerable communities rely on may also be impacted by flooding, which may further increase vulnerability

The emergency service facilities, schools, churches, and health clinics that communities rely on are also vulnerable to flooding. Disruption of critical services could have adverse health impacts or could diminish a community's ability to support each other if, for example, a major gathering place is inundated. Decision-makers and emergency responders have limited information about the specific characteristics or needs of individuals or households. This makes preparing for and responding to flooding and other climate emergencies more difficult.

Homelessness and flood risk

This assessment does not include impacts to vulnerable populations that are unhoused. Short and long-term homeless communities will also be impacted by flooding and may not have the resources to prepare for or respond to a flood event. There also may be diminished access to emergency alert systems which would otherwise help communities prepare in the case of a flood event. There is also a co-location of potentially flooded areas such as embankments or natural areas with some homeless communities. First responders may also not be aware of the location of unhoused communities or individuals, which will make preparedness and emergency response more challenging.

Network impacts and transportation data vulnerability

There is a lack of information on the demographic characteristics of people utilizing various transportation systems across the Bay. Because of this, there is a limited ability to assess impacts to vulnerable communities that come from transportation-related impacts. Because low income communities and communities with a high percentile of people without a car disproportionately use public transportation, impacts to those systems may be particularly critical to consider.

There is a lack of information on the demographic characteristics of people utilizing various transportation systems across the Bay.

2.6.6 Vulnerable Communities Conclusions

Communities in the Bay Area that currently face social and economic marginalization, especially low-income and communities of color, may be heavily impacted by sea level rise in the coming decades. These vulnerable communities are normally co-located with contamination. The compounding pressures of public health impacts, displacement and gentrification, and ongoing and deepening wealth inequity are all highly relevant to the impacts of sea level rise, and adaptation planning should ensure that both current and future issues are addressed.

If the goal is to protect communities and neighborhoods that are vulnerable to displacement from sea level rise, displacement from gentrification or stagnant wages should be just as relevant. If communities are displaced due to gentrification, the prioritization and designation of vulnerable communities would change. Put simply, if the presence of vulnerable communities allows for a locality to be prioritized for adaptation, those adaptation solutions should ensure the communities are not displaced.

The public health impacts of contamination mobilization will be felt much farther away than just in the areas where pollution is present. Without adaptation and remediation, pollutants may be mobilized into and around the Bay, putting human health and natural ecosystems at risk across the region. Remediation of contaminated sites that accounts for sea level rise now will both lower current health impacts to the vulnerable communities in which these polluted areas are located and ensure that there are not even broader impacts as sea levels rise.

BCDC's Environmental Justice Bay Plan Amendment, a response to the ongoing momentum of the Environmental Justice movement, acknowledges that the co-location of contaminated sites in low-income and communities of color is a historic and ongoing injustice. Contaminant remediation and a commitment to prevent low income and communities of color living on or near polluted sites should be pursued as a step toward adapting the Bay to future rising sea level.

Homes line the shoreline near Hamilton wetlands. Photo by SF Baykeeper, Robb Most, and LightHawk.

Methodology and Limitations

METHODOLOGY

Consequence indicators for social and contaminant vulnerability were developed as a regional screening tool to help identify locations where households are at greater risk of impacts from sea level rise due to existing social and economic conditions. Locations were identified using a triggering level methodology developed by the Metropolitan Transportation Commission to identify Communities of Concern (CoC). The triggering level methodology identifies US Census block groups that are above a specific concentration of individuals or households with a particular characteristic. The triggering levels, which are reported as a percent, are determined for each indicator by calculating the regional mean + ½ standard deviation. This methodology only looks at the co-occurrence of these factors individually and does not address intersectionality of any confluence of characteristics.

Calculations and threshold determinations are based on data from the nine-county Bay Area region (Table 2-4). Many complementary tools generate percentiles of vulnerability for a given location relative to the rate in the state or country. When working with socioeconomic data—such as looking at income or housing costs—it is more representative to compare Bay Area geographies with Bay Area geographies, as "statewide scoring can mask important within-region inequities, which can make these areas fall below the regulatory radar screen."[104]

The data was compiled for use in regional analysis, hazard planning, and research, and can be overlaid and intersected with different geospatial extents of hazard zones—such as future elevated water levels due to sea level rise. Locational precision is useful in these overlay analyses, and so the smallest geographical unit available for the data, the block group,[105] is used. Estimates from the American Community Survey (ACS) at the block group scale have greater uncertainty than estimates at larger scales, as the aggregates of larger numbers of survey responses will result in smaller margins of error. It is recommended to use both the estimate and the margin of error provided for each characteristic in the dataset, generating a range instead of a definitive count. Additionally, even the smallest available spatial unit of analysis from the census is not able to capture variabilities among individual households or among neighborhoods.

ArcGIS shapefiles are available for use in mapping and analysis and can be downloaded from the ART Program's Maps and Data Products page.

Data Used for ART Vulnerable Communities Assessment Methodology

Social Vulnerability Characteristic	Measure	70th Percentile	90th Percentile	2012-2016 ACS Table Number	ACS Universe
Very low Income	% People under 200% poverty rate; and/or % Households with income less than 50% of Area Median Income	30% ; 35%	50% ; 52%	C17002: Ratio of income to poverty level in the past 12 months; and/or B19001: Household income in the past 12 months (in 2016 inflation-adjusted dollars) with Dept. of Housing and Community Development State Income Limits for 2016	Population for whom poverty status is determined & Households
Not U.S. citizens	% People not U.S. citizens	17%	26%	B05002: Place of birth by nativity and citizenship status	Total population
Without a vehicle	% Households without a vehicle	9%	22%	B25044: Tenure by vehicles available	Occupied housing units
People with disability	% Households with 1 or more persons with a disability	26%	35%	B22010: Receipt of food stamps/ snap in the past 12 months by disability status for households	Households
Single parent families	% Single parent families	11%	21%	B11004: Family type by presence and age of related children under 18 years	Families

Table 2-4. Table of socioeconomic characteristics that may increase vulnerability. Calculations and threshold determinations are based on data from the nine-county Bay Area region and described in table. ACS stands for the American Community Survey dataset.

Data Used for ART Vulnerable Communities Assessment Methodology

Communities of Color	% People of Color	70%	91%	B03002: Hispanic or Latino origin by race	Total population
Limited English proficiency	% Limited English-speaking household	11%	21%	C16002: Household language by household limited English speaking status	Households
Without a high school degree	% People 25 years and older without a high school degree	15%	30%	B15003: Educational attainment for the population 25 years and over	Population 25 years and over
Under 5	% People under 5	7%	10%	B01001: Sex by age	Total population
Severely housing cost burdened	% Households spending greater than 50% income on housing; renter-occupied and/or owner-occupied	32% ; 20%	47% ; 33%	B25070: Gross rent as a percentage of household income in the past 12 months & B25091: Mortgage status by selected monthly owner costs as a percentage of household income in the past 12 months	Renter-occupied housing units & Owner-occupied housing units
65 and over living alone	% Households with 1 or more people 65 years and over	11%	19%	B11007: Households by presence of people 65 years and over, household size and household type	Households
Renters	% Renter occupied households	58%	81%	B25003: Tenure	Occupied housing units

Table 2-4 (cont). Table of socioeconomic characteristics that may increase vulnerability. Calculations and threshold determinations are based on data from the nine-county Bay Area region and described in table. ACS stands for the American Community Survey dataset.

LIMITATIONS

This methodology is appropriate for local to regional scale planning but should not be used for project reviews or environmental assessments. Screening tools generate a total vulnerability "score" which may or may not satisfactorily represent vulnerability in any given location and may not be the best way to understand each community's unique challenges. Conducting supplemental analysis to the screening analysis can provide a more comprehensive understanding.

This analysis should be considered a starting place. "Ground truthing" in the areas identified through a robust, community-driven engagement process is the first step to using this analysis to properly inform planning. In-depth vulnerability assessments at the site scale, conducted in partnership with the communities being assessed, will yield critical additional insights.[106]

In attempting to define and map social vulnerability, several programmatic limitations within ART Bay Area emerged that should be considered carefully when using this tool:

- Lack of resources for community engagement and ground-truthing during the course of the project;
- Results are tied to impacts on people's homes from flooding, not all the various systems, such as transportation, they rely on;
- The analyst team, in general, has a lack of lived experience and expertise with social and contamination vulnerability characteristics as studied;
- The ART Bay Area program dealt with turnover and, at times, a lack of continuity in relationship building and assessment;
- Due to the nature of this type of approach, there is a top-down and external definition of social vulnerability that was broached with, but not vetted though, the communities that were mapped; and
- The approach does not include positive qualitative characteristics, such as community cohesion and social capital, which also could have benefitted from further community engagement.

Within our programmatic scope, we determined the best methodology for mapping and comparison. The following also presented limitations to our methodology that should be considered:

- Characteristics included are only those with publicly available data that can be consistently compared (quantitatively) across the nine county Bay Area region. Not all characteristics that influence community vulnerability are included in this dataset.

- Residential sea level rise exposure was calculated using the most current data available in 2018, and exposures to very high levels of sea level rise (which correspond with later time horizons) should be used cautiously as they were not calculated using future population projections.

Use limitations to consider when working with American Community Survey (ACS) data

ACS estimates are available by geographical unit, in this dataset the block group, and do not represent where people actually live within that block group. Statistical testing to determine significance is recommended to definitively state that values in one block group are different than another block group. Statistical testing was not conducted for every block group in the Bay Area, as this dataset functions as a regional screening tool. ACS data are reported with an estimate and a margin of error, which represents 90 percent confidence that the actual value is within that range. In instances where the margin of error represents over half the estimate, this data should be treated as unreliable. For more information, refer to: *ACS Handbook for Data Users* (Researchers).

Endnotes

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