

STRATEGY TO ADVANCE FLOOD PROTECTION, ECOSYSTEMS AND RECREATION ALONG SAN FRANCISCO BAY (SAFER BAY)

SAFER Bay Interior Drainage Report

Job # MLPK.10.25

October 1, 2026

PREPARED FOR:

City of Menlo Park
701 Laurel Street
Menlo Park, CA 94025

CITY OF MENLO PARK

SCHAAF & WHEELER
CONSULTING CIVIL ENGINEERS

4699 Old Ironsides Drive, Suite 350, Santa Clara, CA 95054
info@swsv.com

SAFER Bay
Interior Drainage Report

CITY OF MENLO PARK

Principal-in-Charge

Charles D. Anderson, President



Prepared by

SCHAAF & WHEELER
CONSULTING CIVIL ENGINEERS

4699 Old Ironsides Drive, Suite 350, Santa Clara, CA 95054
info@swsv.com

Table of Contents

Table of Contents ..... **i**
List of Figures ..... **ii**
List of Acronyms ..... **iii**
1. Introduction **1**
2. Hydrology and Boundary Conditions **1**
2.1 Sea Level Rise 2
2.2 Future Precipitation 3
3. Integrated Model Updates **5**
3.1 Proposed Project 5
4. Updated Model Results **8**
4.1 Existing Condition 9
4.2 No Project with Year 2100 Climate Change 10
4.3 Project Completion 11
4.4 Project Completion with 3.5 feet SLR 12
4.5 Project Completion with Year 2100 Climate Change 13
4.6 Project Benefit with Year 2100 Climate Change 14
4.7 Effect of Climate-Change Precipitation Increases 15
5. Conclusions **15**
Appendix A Integrated Catchment Model ..... **A**

List of Figures

Figure 2-1: Hydrologic Modeling Regions 2
Figure 2-2: 10-year Harmonic Tide Cycles with and Without Sea Level Rise 3
Figure 2-3: Balanced 100-year Storm Intensities 4
Figure 3-1: Menlo Park SAFER Bay Flood Protection Terrain Model 6
Figure 3-2: Menlo Park SAFER Bay Drainage Structures 7
Figure 3-3: Existing Condition (Top) and Project-Modified (Bottom) Catchments 8
Figure 4-1: 100-year Floodplain - Existing Conditions 9
Figure 4-2: 100-year Floodplain - No Project with Year 2100 Climate Change 10
Figure 4-3: 100-year Floodplain after Project Completion 11
Figure 4-4: 100-year Floodplain after Project Completion with 3.5 feet SLR 12
Figure 4-5: 100-year Floodplain After Project Completion with Year 2100 Climate Change 13
Figure 4-6: 100-year Floodplain with Year 2100 Climate Change – Project Benefit 14
Figure 4-7: 100-Year Floodplain after Project Completion – Effect of Precipitation Increase 15

List of Acronyms

Acronym	Description
ac-ft	Acre-foot (unit of volume)
BFE	Base flood elevation
cfs	Cubic feet per second
CIP	Capital Improvement Program
ET	Evapotranspiration
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
HEC-HMS	Hydrologic Engineering Center's Hydrologic Modeling System
ICM	Integrated Catchment Model
NAVD	North American Vertical Datum of 1988
NFIP	National Flood Insurance Program
PG&E	Pacific Gas and Electric Company
SAFER Bay	Strategy to Advance Flood Protection, Ecosystems Restoration and Recreation along San Francisco Bay
SFCJPA	San Francisquito Creek Joint Powers Authority
SLR	Sea level rise
USGS	United States Geological Survey

1. Introduction

Schaaf & Wheeler is contracted by the City of Menlo Park (City) to design reaches of the Strategy to Advance Flood Protection, Ecosystems and Recreation Along San Francisco Bay (SAFER Bay) project that are within the City's limits. The purpose of this Interior Drainage Report is to identify impacts on interior drainage (i.e. floodplains on the land side of the proposed new levee) caused by the proposed flood protection project. Flood protection elements within the project reaches currently being designed by Menlo Park and East Palo Alto consist of levees, floodwalls, and hybrid levee/floodwalls from Bedwell Bayfront Park to the Dumbarton Bridge Approach in Menlo Park and from north of Bay Road to San Francisquito Creek in East Palo Alto. Sherwood Design Engineers is contracted by City of East Palo Alto to design reaches of the project in East Palo Alto. This effort to study interior drainage is coordinated between the two cities and their designers.

The San Francisquito Creek Joint Powers Authority (SFCJPA) separately contracted with Schaaf & Wheeler to update the integrated floodplain model for the San Francisquito Creek watershed. This Interior Drainage Report includes by reference the SFCJPA report, concurrently prepared. The SFCJPA effort builds on existing models, expanding the extents of the 1D and 2D ICM to fully encompass Menlo Park and East Palo Alto. The Integrated Catchment Model (ICM) has been refined to better reproduce documented flooding in East Palo Alto, Menlo Park, and Palo Alto during the New Years Eve 2022 storm event, and to evaluate a 70-year storm event with a 7,200 cfs peak discharge. This report is appended in its entirety.

The SFCJPA model is used as reported herein to evaluate the proposed SAFER Bay project and future climate conditions based on the project design criteria and comments from the Bay Conservation and Development Commission (BCDC) Engineering Criteria Review Board (ECRB).

2. Hydrology and Boundary Conditions

Rainfall-runoff modeling has been completed using two separate models: 1) a calibrated HEC-HMS model and 2) an Integrated Catchment Model. San Francisquito Creek upstream of Junipero Serra Boulevard is primarily a rural watershed, with incised natural channels. Schaaf & Wheeler maintains a well-calibrated HEC-HMS model of the watershed draining to the USGS gage at Stanford, including baseflow calibration to match the discharge hydrograph for the New Years Eve 2022 storm. To simplify the ICM effort, discharge at the USGS gage is placed in the ICM as a boundary condition, defined by HEC-HMS model results.

The Adobe and Barron Creek watershed is not included in the San Francisquito Creek ICM. However, its drainage area remains an important source of runoff influx to Palo Alto Flood Basin, which has influence on Matadero Creek backwater and, to some extent, discharge rates for the Matadero Pump Station. For that reason, Adobe and Barron Creek drainage areas are also evaluated in the calibrated HEC-HMS model, with output used as boundary conditions for the Palo Alto Flood Basin in ICM.

Urban drainage areas that discharge primarily to pipe systems in the ICM are represented by catchments in ICM. Catchment hydrologic model methods and inputs have been composited from prior efforts in Palo Alto, East Palo Alto, and Menlo Park. Rainfall is used as a direct boundary condition input. A total of 38 rainfall timeseries profiles are applied, with 100-year, 72-hour depths varying between 5.5 and 9.5 inches.

The study watershed is approximately 85 square miles, encompassing drainage areas to Atherton Channel, San Francisquito Creek, and the Palo Alto Flood Basin (Matadero, Adobe, and Barron Creeks). The three primary hydrologic model regions are shown in Figure 2-1

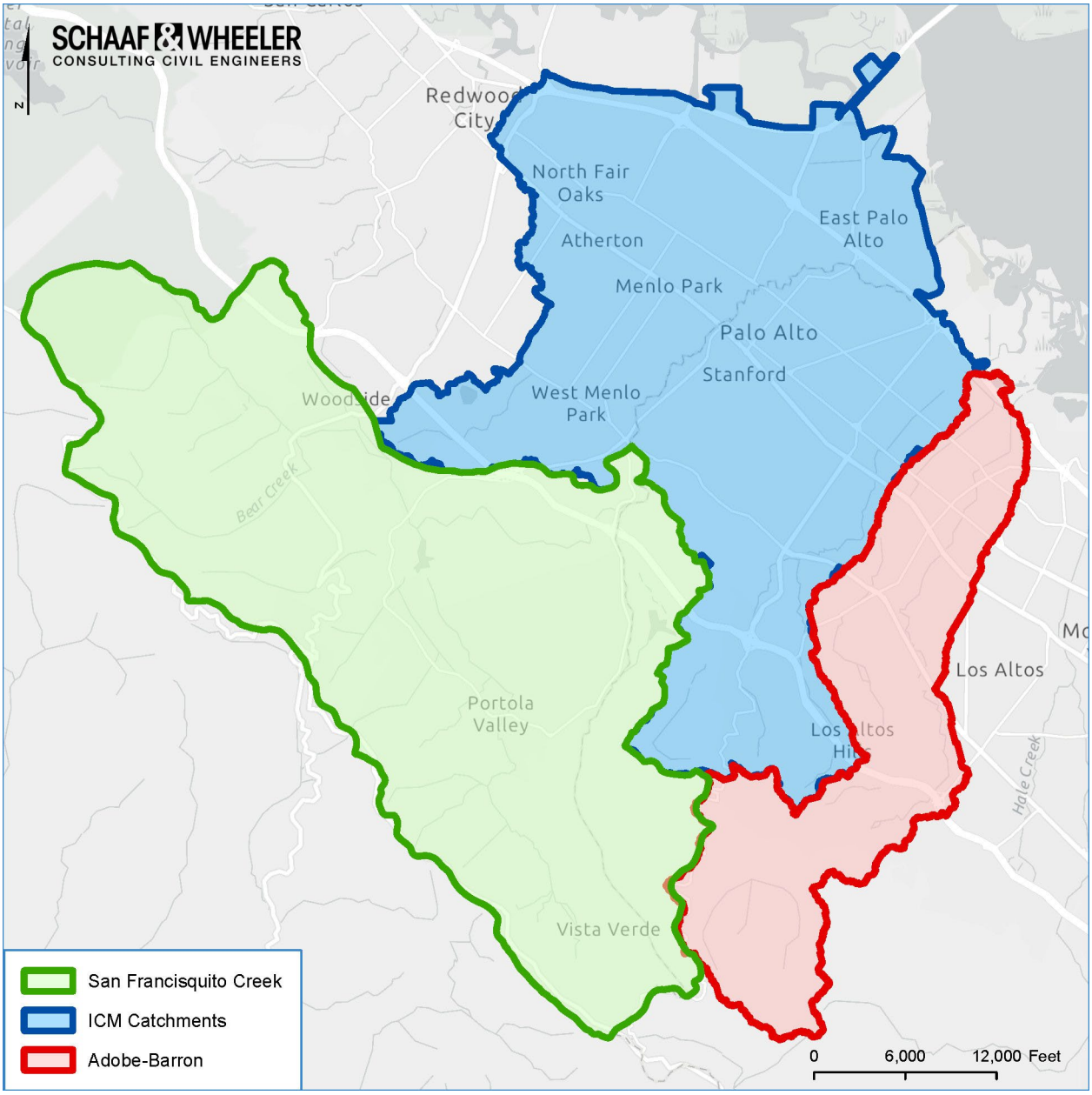


Figure 2-1: Hydrologic Modeling Regions

2.1 Sea Level Rise

A sea level rise allowance of 3.5 feet is applied in the model to reflect the SAFER Bay project design criterion. Guidance from the California Ocean Protection Council Science Advisory Team report, “Rising Seas in California: An Update on Sea Level Rise Science,” (2024) predicts that sea level rise will continue and accelerate throughout this century and into the next century. The exact sea level rise conditions that will occur are not precisely known at this time, because specifics about future greenhouse gas emissions and climate response are not fully known.

Considering a range of scenarios, sea level rise by 2100 is projected to be between three and nearly seven feet in San Francisco Bay. San Francisco is the closest tide gauge to SAFER Bay for which sea-level rise projections are provided. The California OPC's "Strategic Plan to Project California's Coast and Ocean," (2020) identified its strategy as ensuring resiliency to 3.5 feet of sea level rise. SAFER Bay adopted this sea level rise target.

Harmonic tide cycles used in the ICM are shown in Figure 2-2, excerpted from Appendix A. Sea level rise is applied uniformly to all tidal datums. In the model, the lunar day (24.84 hours) is repeated and shifted as necessary to model the peak higher high water occurring coincidentally with peak runoff from the storm events. (Appendix A contains further details regarding the selection of tidal boundary conditions.)

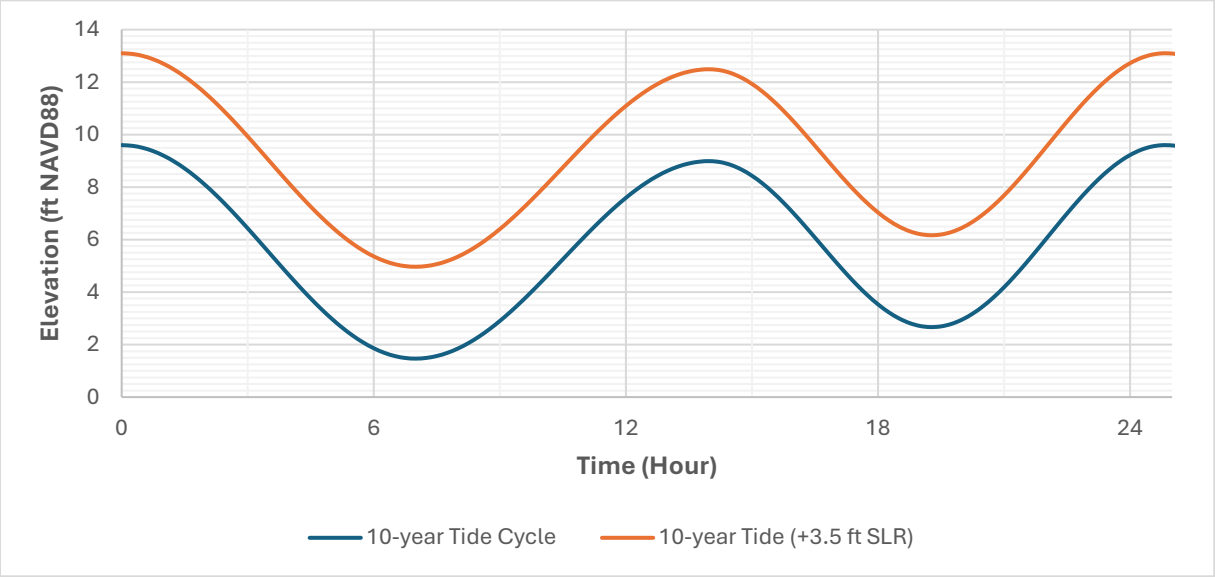


Figure 2-2: 10-year Harmonic Tide Cycles with and Without Sea Level Rise

2.2 Future Precipitation

While the project is primarily intended to provide protection from tidal flooding, interior drainage analysis with climate change includes the impacts of increased precipitation behind the levees. Precipitation increases for this study are based on the San Francisco Public Utilities Commission (SFPUC) 2023 "San Francisco Bay Area Precipitation in a Warmer World" study (Mak et al, 2023). This study applies precipitation scaling factors for year 2100, based on a 24-hour storm event and SSP3-7.0 climate change scenario (medium-to-high emissions). Adopted storm duration rainfall scaling factors from this climate change scenario are:

Maximum 3 hours	Increase 49.8%
Maximum 6 hours	Increase 44.6%
Maximum 24 hours	Increase 38.5%

Since this study utilizes the statistically balanced 72-hour pattern applied to the San Francisquito Creek watershed for the SFCJPA 2026 modeling effort, a 38.5 percent increase in rainfall depth is also maintained for the 72-hour duration.

The precipitation pattern is based on the December 1955 storm event, which is commonly used throughout the San Francisco and Monterey Bay regions to develop design discharge estimates. The storm has been re-balanced using local MetStat precipitation-frequency data. Schaaf & Wheeler previously calibrated local hydrologic model parameters based on this storm event at four gages (San Francisquito Creek, Saratoga Creek, Coyote Creek, and Arroyo Hondo). The calibrated modeling was further improved and verified (including baseflow parameters) for the New Years Eve 2022 storm event - closely reproducing the discharge hydrograph at the San Francisquito Creek gage. Precipitation pattern balancing and model calibration are discussed in greater detail in the SFCJPA modeling report.

Precipitation depths vary by a considerable amount from upper watersheds to the low-lying urban areas. Three-day, 100-year storm depths vary from 5.5 inches near the San Francisco Bay to 12.2 inches in the Bear Creek drainage area, increasing to about 6.6 inches and 14.5 inches, respectively, for the climate change scenario. An example of statistically balanced ICM precipitation intensity input is provided in Figure 2-3 for a 100-year, 72-hour precipitation depth of seven inches. (Appendix A provides more details on statistically balancing storm patterns.)

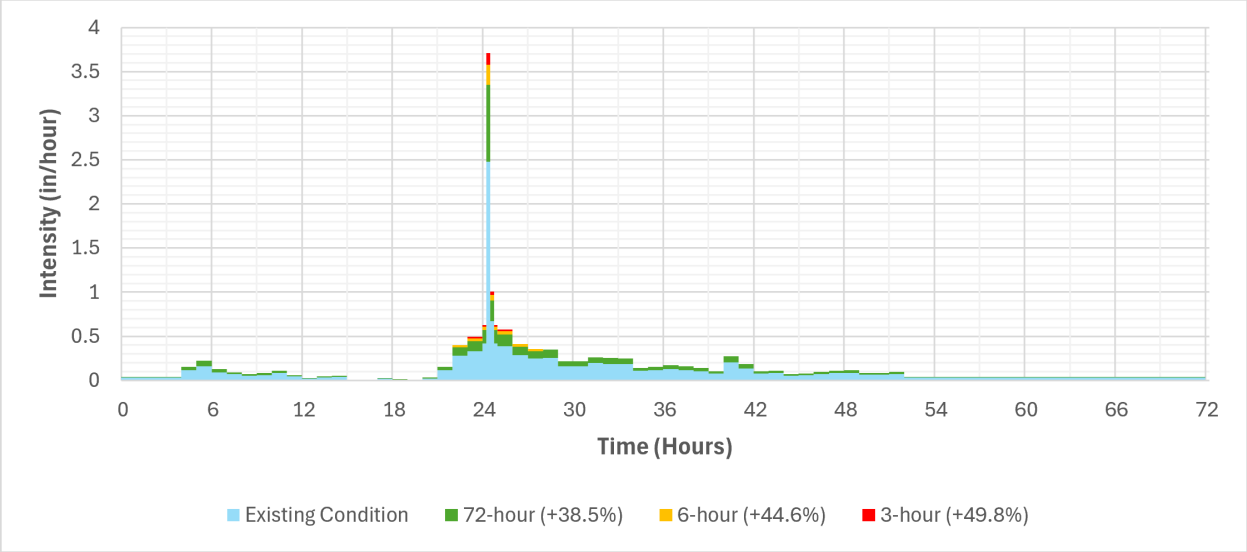


Figure 2-3: Balanced 100-year Storm Intensities

3. Integrated Model Updates

3.1 Proposed Project

The following modifications are made to the San Francisquito Creek ICM to represent the proposed SAFER Bay project in East Palo Alto and Menlo Park:

- Modifications to the LiDAR terrain based on project grading, fully integrating the post-project topography into the model terrain
- Mesh edits, enforcing the crest of the proposed levee as a breakline to ensure that the tidal boundary condition does not erroneously overtop the improved levees and floodwalls
- Base linear structure elements defined to represent floodwalls
- Additional base linear structure elements defined to represent presumed coastal protection projects outside of the scope of the SAFER project that would provide equal protection against tidal overtopping
- Culvert/outfall added to drain PG&E property on Bayfront Expressway through the proposed levee by gravity during low tides
- Catchment modifications along Bayfront Expressway, representing minor changes to runoff patterns caused by the project (e.g. levee backslope draining towards Bayfront Expressway)
- Additional drainage infrastructure, including an open channel and intake structure between the proposed levee and Bayfront Expressway

LiDAR and post-project terrains are shown in Figure 3-1, including a short reach of flood wall proposed east of the Meta headquarters at the Ravenswood tide gate and pump station outfalls. The locations of post-project outfalls and the new interior drainage intake are shown in Figure 3-2. Modifications to the model are shown in the ICM modeling environment in Figure 3-3, where drainage catchment areas and interior drainage infrastructure are affected by the project. The drainage channel is modeled as a vee-ditch with a minimum depth of approximately two feet and 4:1 side slopes.



Figure 3-1: Menlo Park SAFER Bay Flood Protection Terrain Model

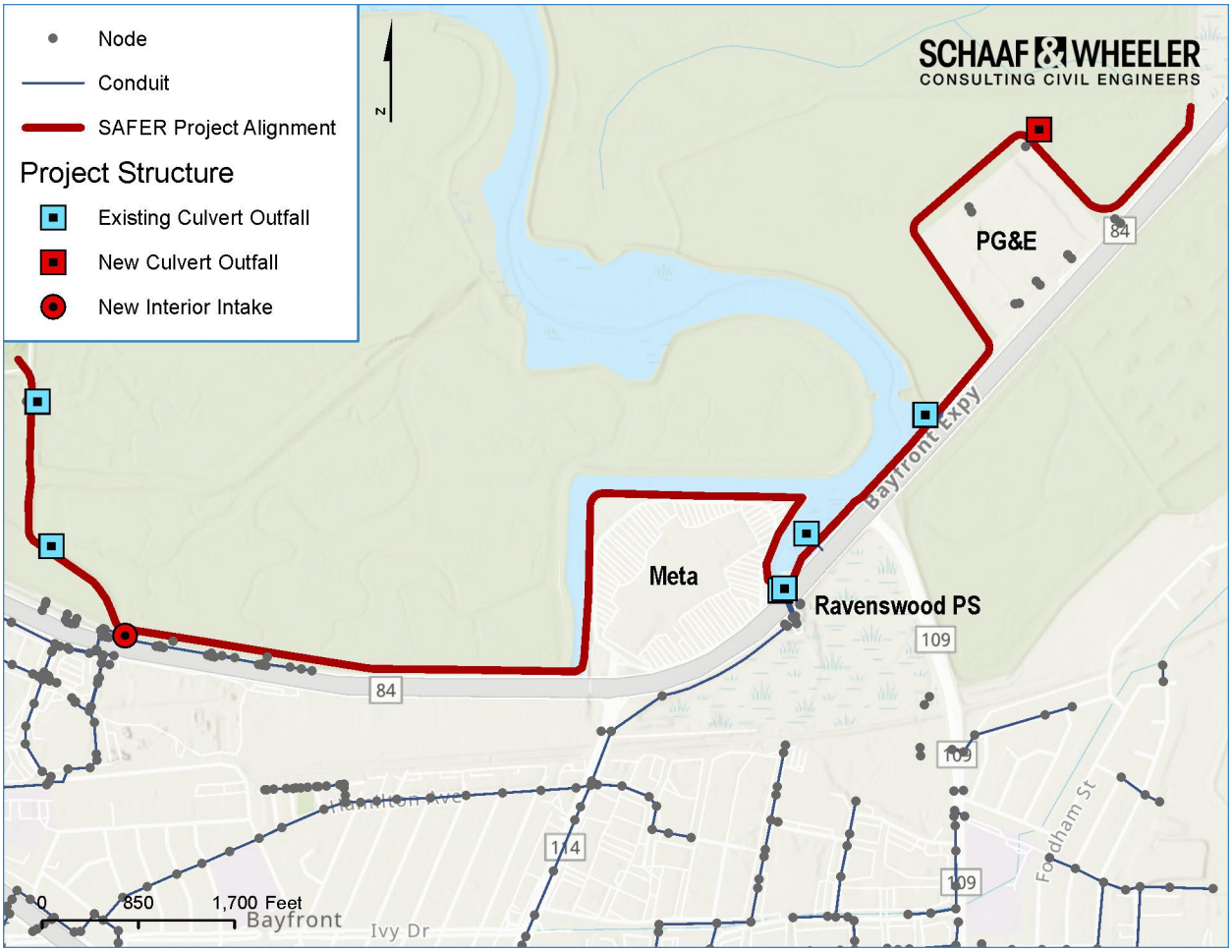


Figure 3-2: Menlo Park SAFER Bay Drainage Structures

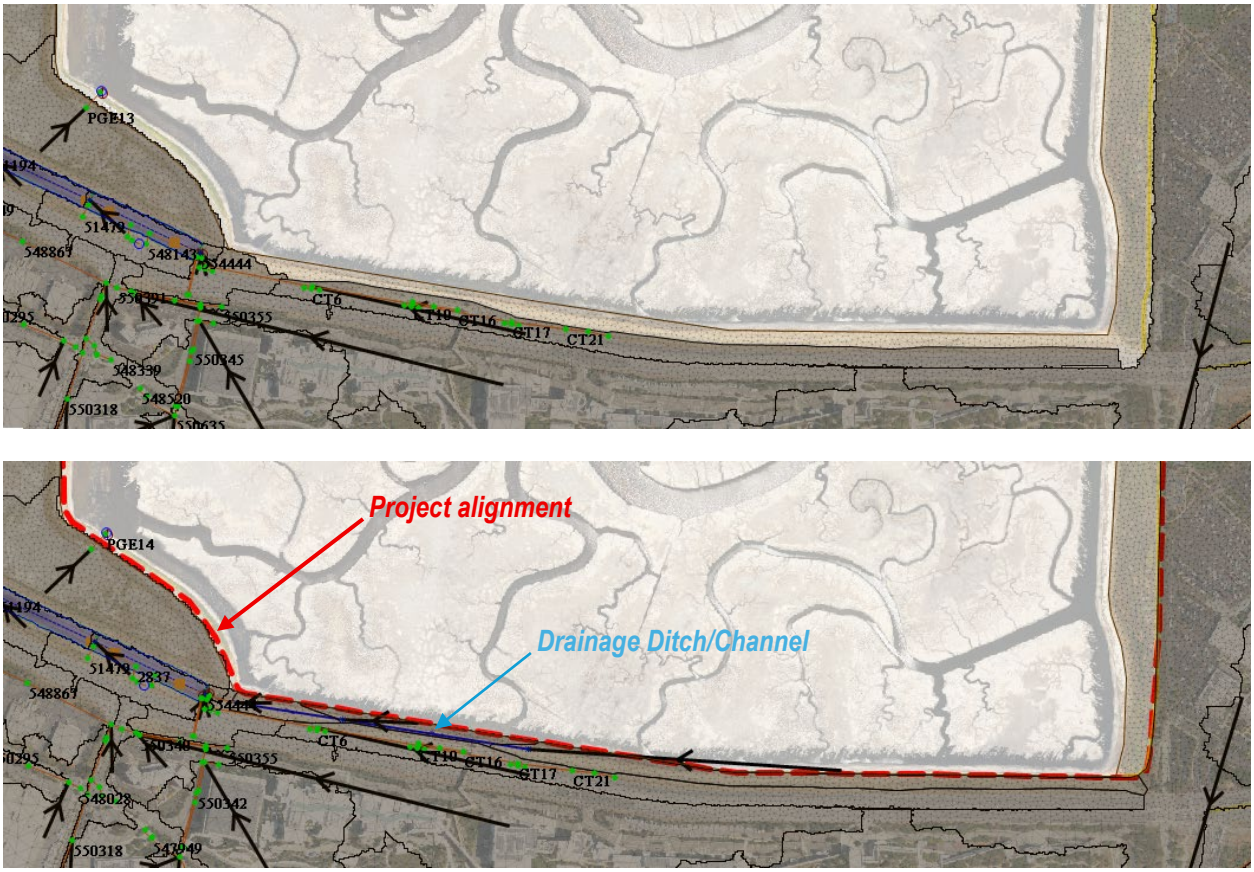


Figure 3-3: Existing Condition (Top) and Project-Modified (Bottom) Catchments

4. Updated Model Results

The following 100-year floodplain scenarios have been evaluated:

- Existing Condition
- No Project, with year 2100 climate change (scaled precipitation and 3.5 feet of SLR)
- Project Completion, with existing precipitation and tidal conditions
- Project Completion, with 3.5 ft of SLR
- Project Completion, with year 2100 climate change (scaled precipitation and 3.5 feet of SLR)

4.1 Existing Condition

Flood depths shown in Figure 4-1 represent existing coincident (compound) 100-year flooding conditions without the SAFER Bay project. (Note that Figure 4-1 and other similar figures presented herein are not intended to provide BFEs or be representative of a FIRM prepared in conformance with FEMA Guidelines and Specifications. For example, levee accreditation or the lack thereof is not considered.)

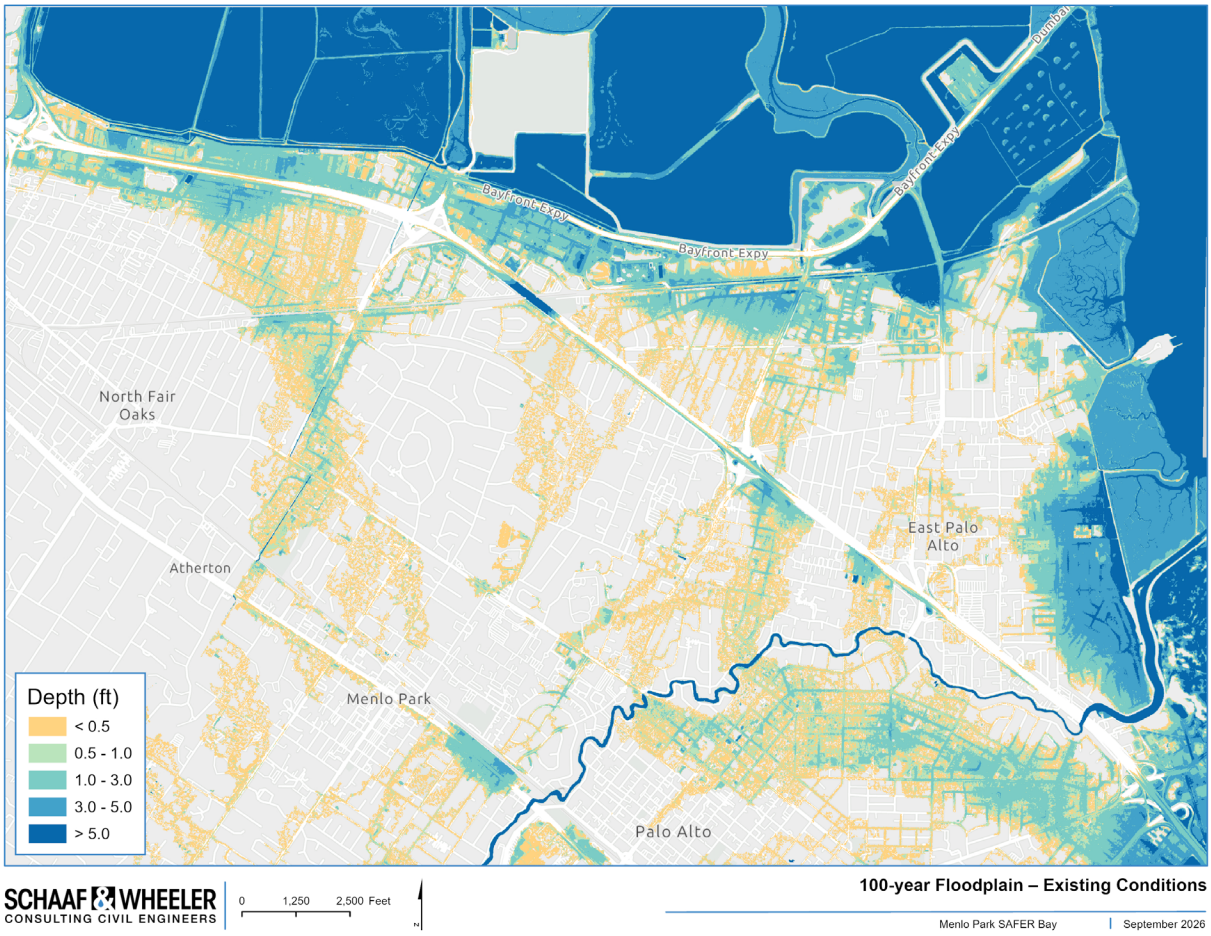


Figure 4-1: 100-year Floodplain - Existing Conditions

4.2 No Project with Year 2100 Climate Change

The impact of year 2100 climate change (3.5 feet of sea level rise and the scaled SSP3-7.0 increase in precipitation) without the flood protection project is increased flooding depth from both tidal and interior drainage sources, as demonstrated by Figure 4-2. Note that flood depths are calculated as the worst-case superposition of one percent annual exceedance fluvial runoff against a 10-year coincident tide and a “level pool” 100-year stillwater tide elevation, to capture compound flooding. Note also that the benefits of future flood protection projects on San Francisquito Creek are not considered.

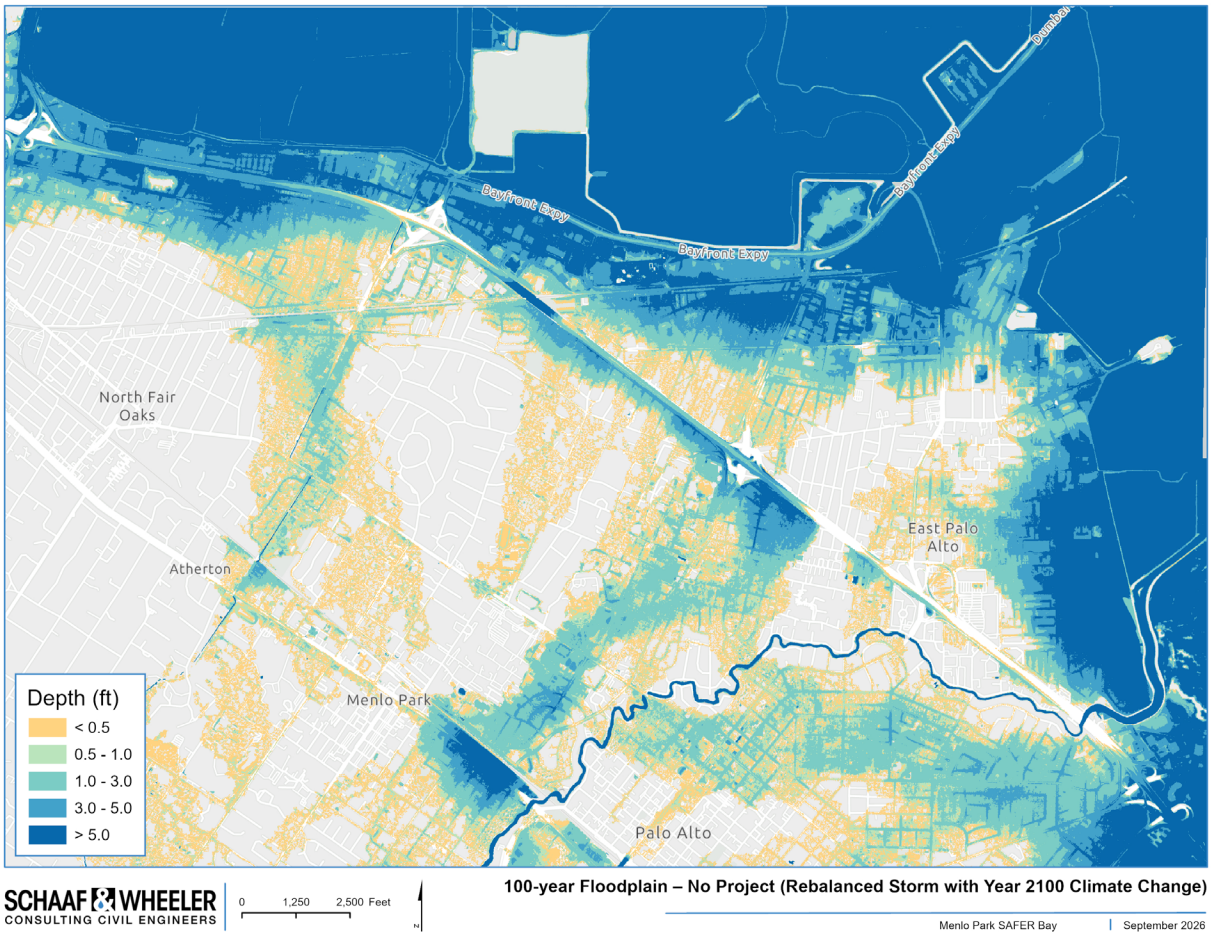


Figure 4-2: 100-year Floodplain - No Project with Year 2100 Climate Change

4.3 Project Completion

The benefit of the project under assumed 2030 tidal and precipitation conditions (no change from current conditions) is the elimination of flooding from tidal sources, as shown in Figure 4-3. The Project includes SAFER Bay levees and floodwalls shown as solid magenta lines in Figure 4-3 and the future levee segments required to provide contiguous projection, which are shown as dashed magenta lines in the figure. All project design elements in Menlo Park, including local drainage improvements along State Highway 84 and drainage for the newly isolated interior basins between the PG&E substation and outboard levee alignment are included in the ICM evaluation and in post-project flood inundation mapping presented herein.

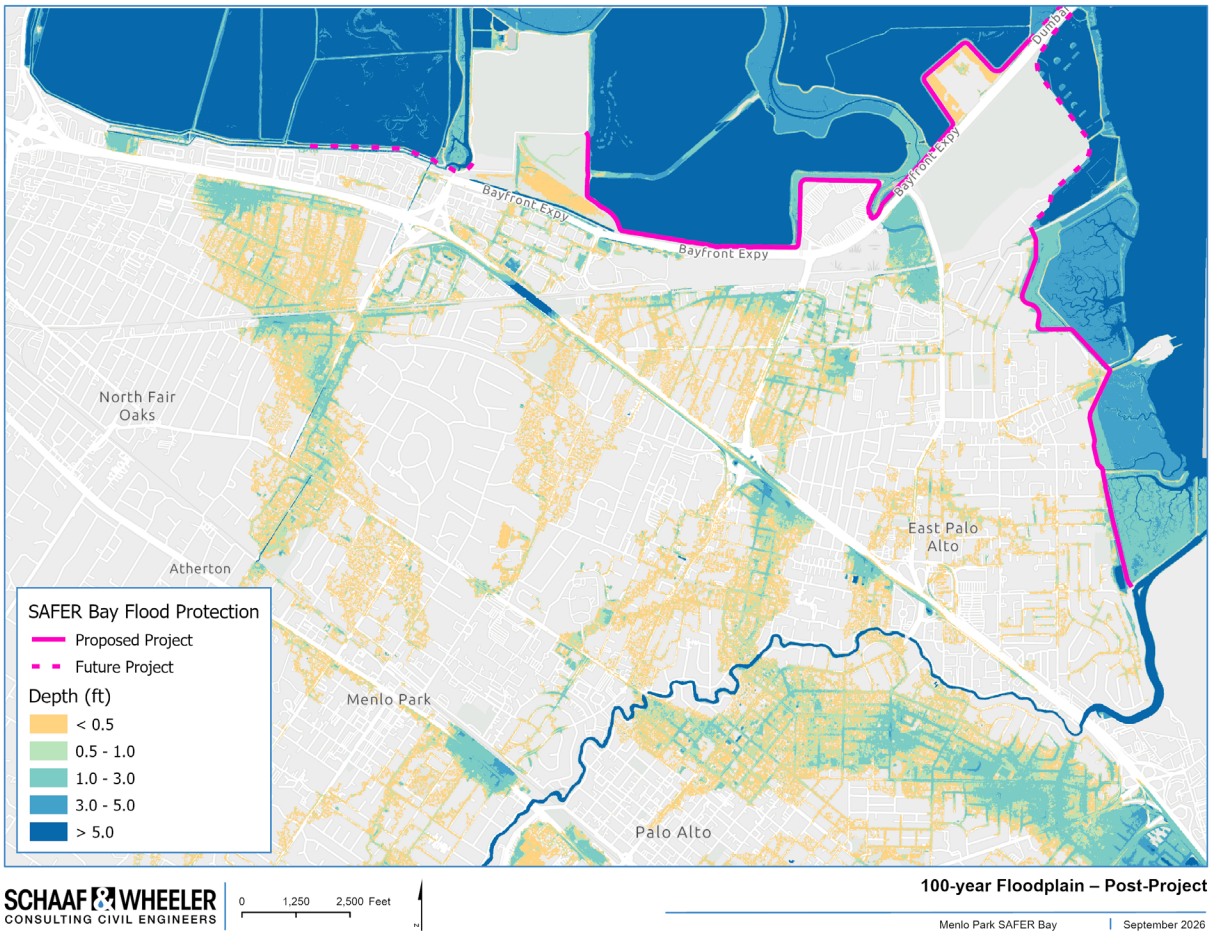


Figure 4-3: 100-year Floodplain after Project Completion

4.4 Project Completion with 3.5 feet SLR

As designed, the project provides protection and current NFIP freeboard against 100-year San Francisco Bay flood hazards with 3.5 feet of sea level rise, thus meeting the SAFER Bay general criterion. This level of protection is shown in Figure 4-4. Directly comparing this level of 100-year interior inundation to that shown in Figure 4-2 demonstrates Project betterment of interior drainage conditions near the shoreline without any worsening of those conditions away from the shoreline and the influence of the tidal boundary. This scenario is mapped to reflect SAFER Bay's original design criteria for meeting NFIP levee accreditation criteria with 3.5 feet of future sea level rise, which is expected to occur by year 2086 assuming California Sea Level Rise Guidance (2024) "Intermediate-High" scenario.[1] Thus, the project has at least a 50-year design life if constructed in the early 2030s.

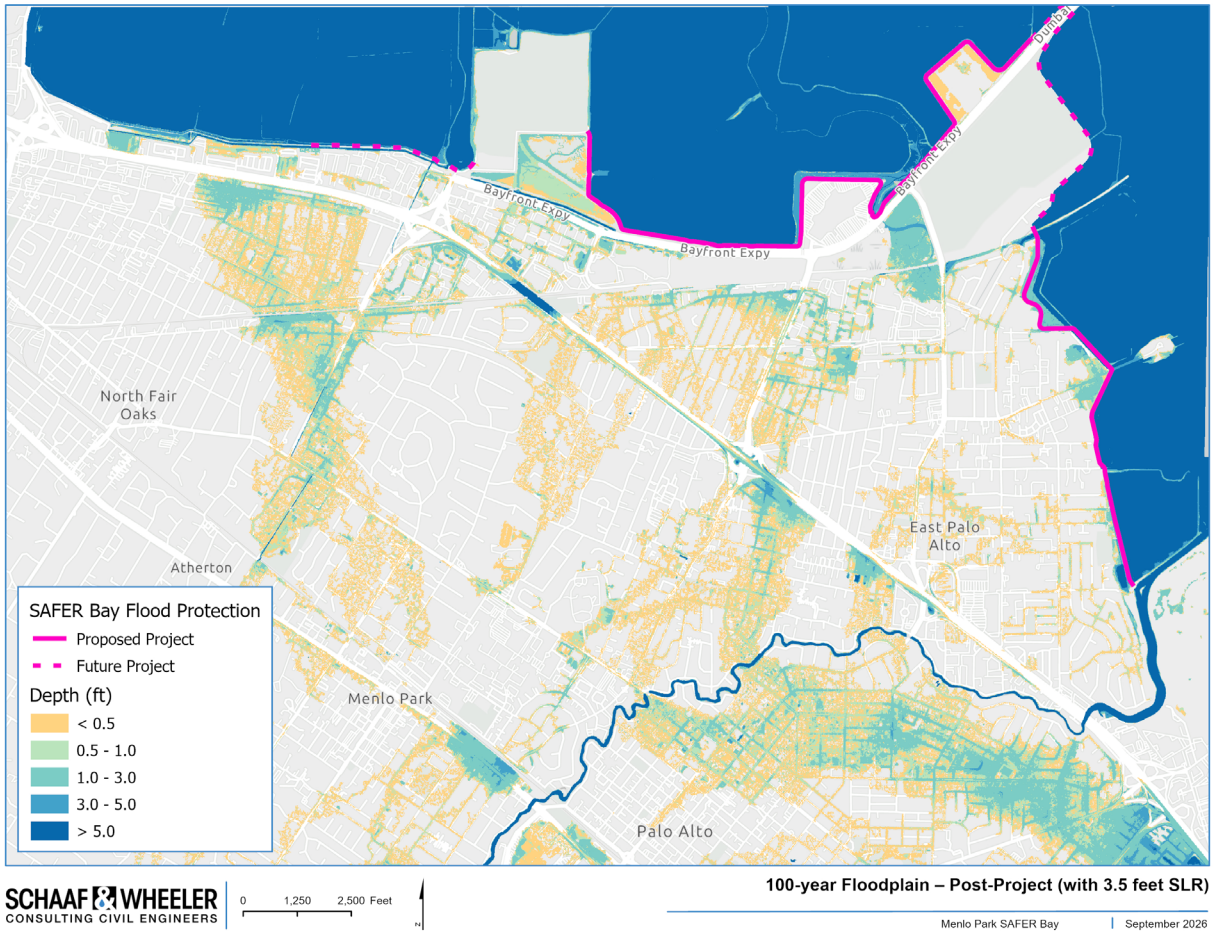


Figure 4-4: 100-year Floodplain after Project Completion with 3.5 feet SLR

[1] *California Sea Level Rise Guidance: 2024 Science and Policy Update*. 2024. California Sea Level Rise Science Task Force, California Ocean Protection Council, California Ocean Science Trust.

4.5 Project Completion with Year 2100 Climate Change

Adding increased precipitation as a climate change impact increases interior fluvial-sourced flood depths without diminishing the reduction in flooding from tidal sources, as reflected in Figure 4-5. Increased flooding depth due to interior drainage from increased precipitation is unchanged compared to the year 2100 climate change scenario without the SAFER Bay project (Figure 4-2), since the project only addresses and impacts tidal flooding. Note that the benefits of future flood protection projects on San Francisquito Creek are not considered.

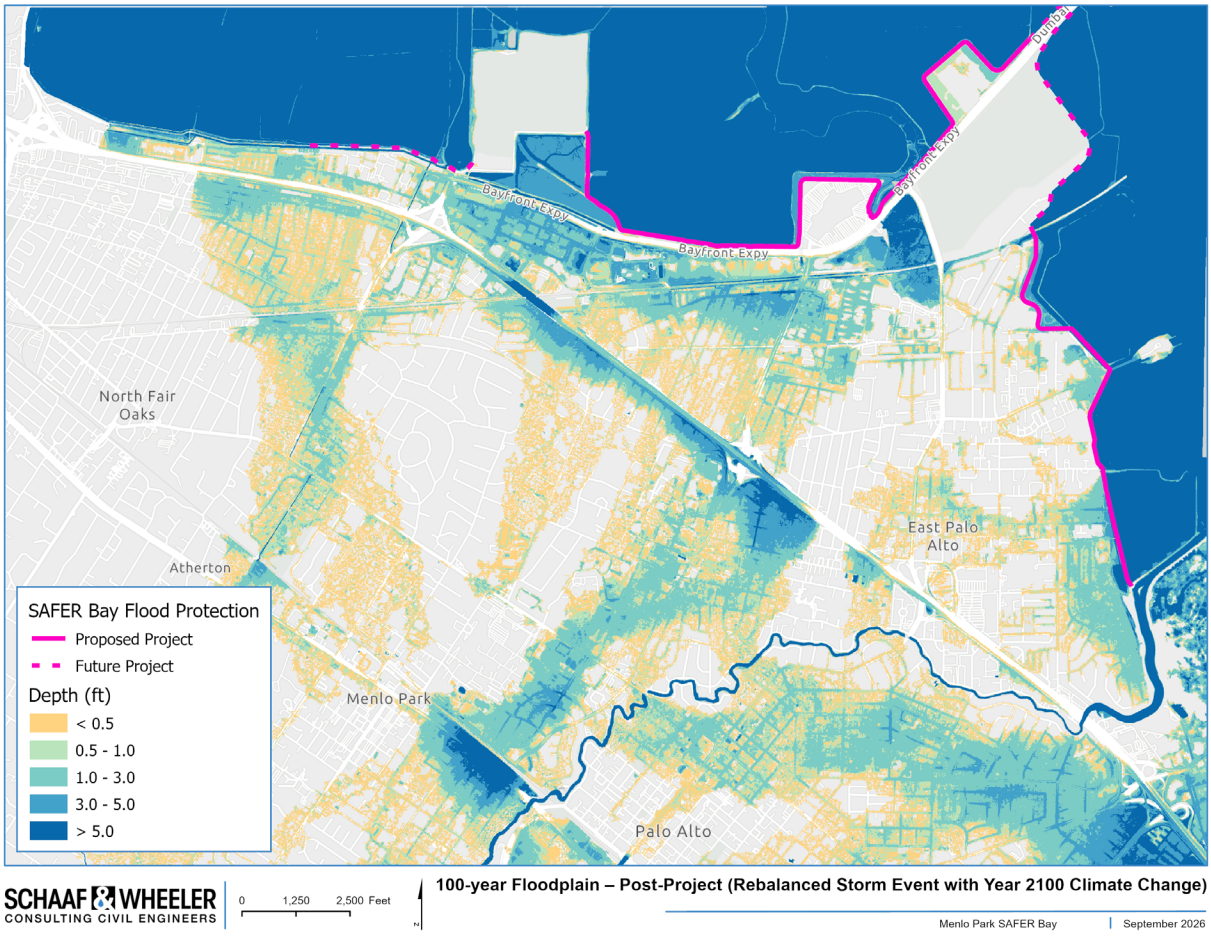


Figure 4-5: 100-year Floodplain After Project Completion with Year 2100 Climate Change

4.6 Project Benefit with Year 2100 Climate Change

The difference between flooding in Year 2100 with or without the flood projection project is the removal of the tidal floodplain on the landside of the project. A comparison of projected 100-year flooding in year 2100 as affected by the SAFER Bay project is provided as Figure 4-6. Red shading shows the extent of flooding that would be eliminated by project completion. Blue shading shows the residual 100-year flooding unaffected by project completion.

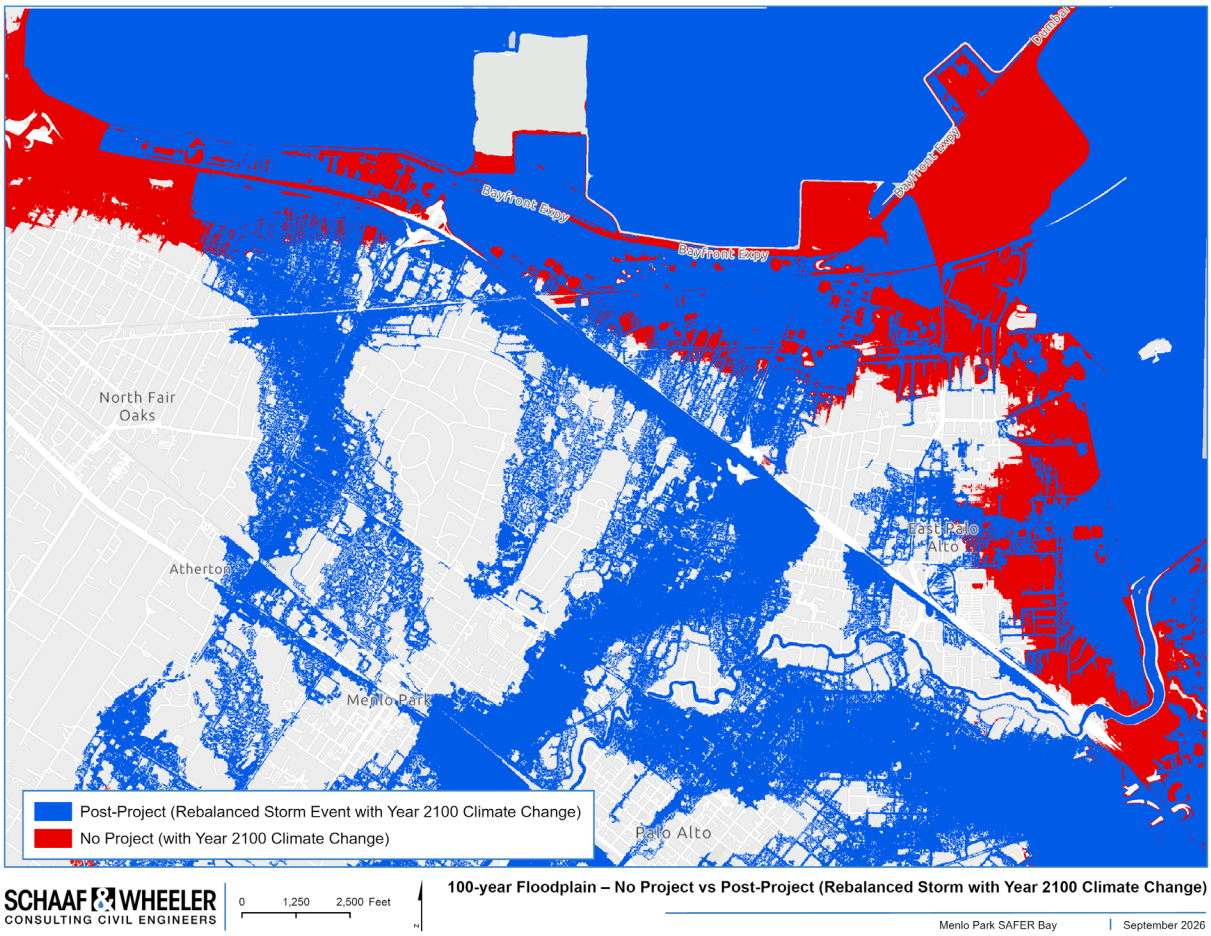


Figure 4-6: 100-year Floodplain with Year 2100 Climate Change – Project Benefit

4.7 Effect of Climate-Change Precipitation Increases

Figure 4-7 isolates climate-change impacts to those driven by projected increases in precipitation after project completion, assuming 3.5 feet of future sea level rise. Increased flooding due solely to the SSP3-7.0 scaled increase in 100-year precipitation are isolated in red-orange shading.

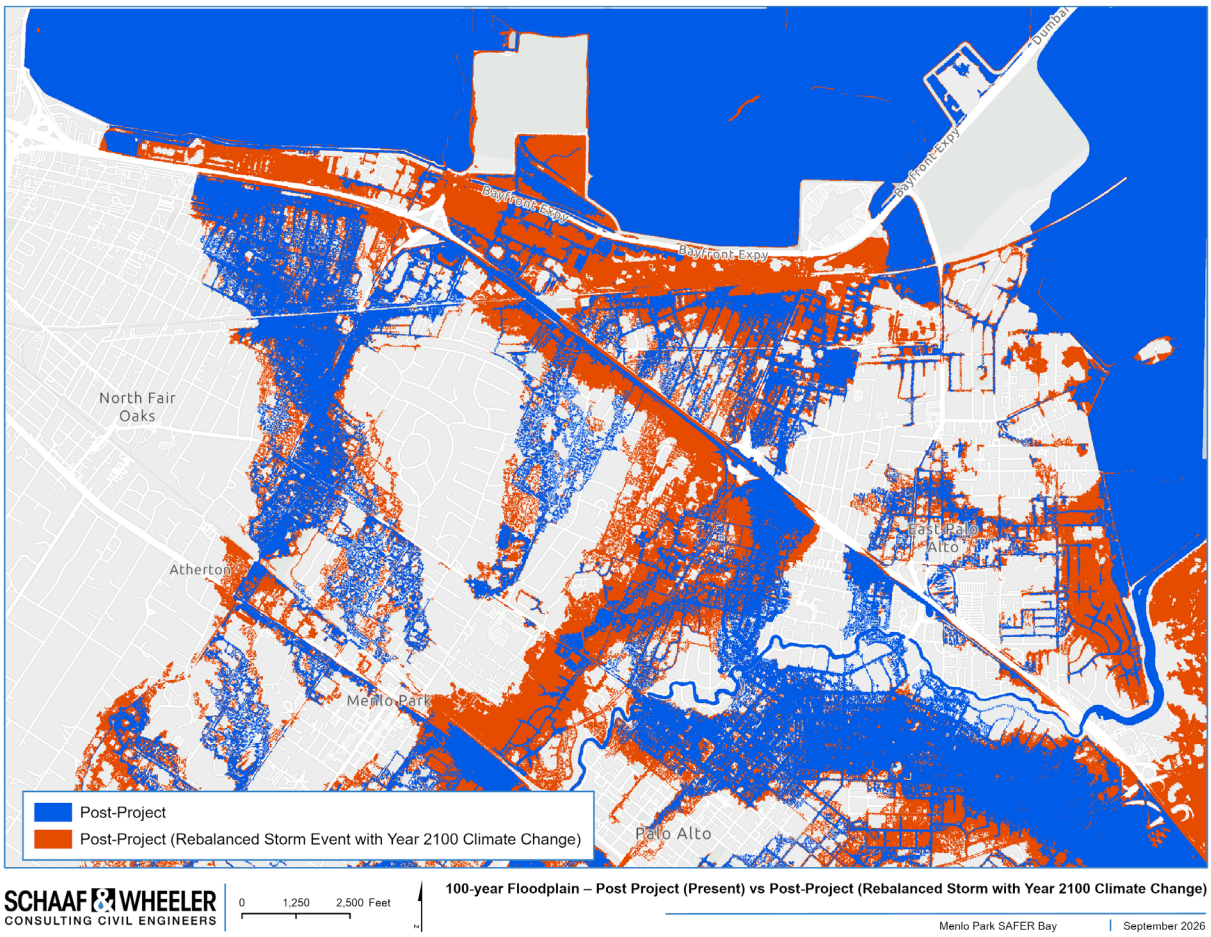


Figure 4-7: 100-Year Floodplain after Project Completion – Effect of Precipitation Increase

5. Conclusions

Using the San Francisquito Creek watershed Integrated Catchment Model demonstrates that SAFER Bay project meets its design criterion of providing protection against 100-year coastal flood hazards from San Francisco Bay with 3.5 feet of future sea level rise without creating an adverse impact to existing interior flooding from fluvial sources away from the shoreline.

With or without project completion, East Palo Alto and Menlo Park will need to be evaluated interior drainage through the lens of level of service and that evaluation could be affected by future climate change, particularly an increase in precipitation, which is not for the SAFER Bay project to address. Precipitation increases are likely to be more impactful on interior drainage than sea level rise.

This Page is Left Blank Intentionally

Appendix A Integrated Catchment Model

The San Francisquito Creek Integrated Floodplain Model Update report is appended in its entirety.