# CITY OF MORRO BAY

## COMMUNITY VULNERABILITY AND RESILIENCE ASSESSMENT

## DRAFT


*Prepared for:*

CITY OF MORRO BAY
595 HARBOR STREET
MORRO BAY, CA 93442

*Prepared by:*

Michael Baker
INTERNATIONAL

1026 CHORRO STREET, SUITE 225
SAN LUIS OBISPO, CA 93401

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# 1. INTRODUCTION

## 1.1 BACKGROUND

*Plan Morro Bay* will be the City's guiding document for development and conservation through the year 2040. The research conducted in the Community Baseline Assessment and the Community Vulnerability and Resilience Assessment (CVRA) is the technical basis for informing important *Plan Morro Bay* policy and land use decisions.

### WHAT IS RESILIENCE?

The Rockefeller Foundation defines urban resilience as "the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience."

The Community Baseline Assessment provides a comprehensive overview of existing and historical conditions in the City of Morro Bay as of June 2016. The CVRA provides a best estimate of likely future conditions, based on local demographic projections and the most recently available scientific projections of future climate conditions, given current trends.

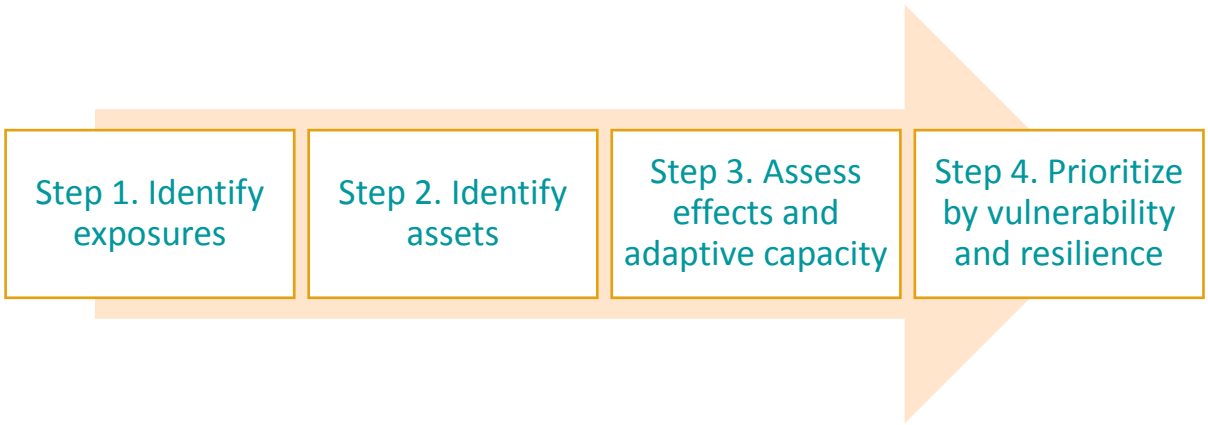
Like most long-range plans, *Plan Morro Bay* considers the expected changes to population and the economy, and the needs of the community as a result of these changes. *Plan Morro Bay* also considers expected changes to the environment and the climate. The CVRA supports demographic, economic, and climate change-related decisions by describing the relevant changes likely to occur in the city through 2040. The CVRA then builds from the Community Baseline Assessment conclusions to identify priority assets and discusses how those assets are currently vulnerable or resilient to demographic, economic, and climate change.

# 1.2 METHOD

This vulnerability and resiliency assessment was completed using a four-part process consistent with the approach provided by the California Adaptation Planning Guide (Figure 1). The process addresses the following questions:

1. What demographic conditions or climate change-related hazards (known as exposures) could occur in the planning area?
2. What structures or populations in the planning area (known as assets) could be affected by the exposures?
3. How would changes to demographics, the economy, or climate change-related hazards affect assets (known as effects), and how are those assets currently prepared to deal with such impacts (known as adaptive capacity)?
4. What topics should adaptation strategies address (which assets are the most vulnerable? which are the most resilient?)?

Figure 1
Vulnerability and Resilience Assessment Process




This report uses the *Plan Morro Bay* Community Baseline Assessment and California Adaptation Planning Guide to identify specific assets in Morro Bay, which can include physical properties or structures, land use categories, neighborhoods, key services and functions, natural resources, and specific populations. To identify vulnerability and resilience, this report first identifies how each exposure would affect each asset, and how each asset might already be prepared to mitigate those effects. To determine the

effects and adaptive capacity of individual assets, the authors looked at the Community Baseline Assessment and numerous studies on the results of climate change and demographic changes and assigned a qualitative score for each. This report provides summaries and key outcomes from the vulnerability and resiliency assessment process; Appendix A provides a more detailed discussion of the methods used in this assessment, as well as the specific effect, adaptive capacity, and vulnerability scores for each asset.

# 1.3 ORGANIZATION

The CVRA is generally organized by Community Baseline Assessment chapters and covers the following topics[1]:

- Land use
- Infrastructure
- Natural resources
- Parks, recreation, and open space
- Water and water quality

Each topic section includes a brief description of the assets included in the study and a description of how each exposure generally affects these assets. Each section then presents key conclusions. The descriptions and conclusions in each section are supported by analysis as reported in Appendix A.

*[1] Due to topic overlap, some of the chapters have been combined (e.g., transportation and infrastructure are presented here as a single topic). The CVRA does not include Community Baseline Assessment chapters that address topics where projected conditions are not expected to produce noticeable changes over baseline conditions (e.g., noise).*

# 2. PROJECTED CONDITIONS

As the City plans for 2040, it is important to consider expected changes in socioeconomic and environmental conditions. This chapter provides the best available demographic, economic, and climate change-related hazard projections for the City of Morro Bay.

## 2.1 DEMOGRAPHIC CHANGE

This section provides population and employment estimates for Morro Bay through 2040 using San Luis Obispo Council of Governments (SLOCOG) projections. The SLOCOG projections are the best available local information. Future population and employment levels could be influenced by factors not considered in these projections, including the adoption and implementation of *Plan Morro Bay*. An understanding of expected demographic conditions absent changes to the existing planning framework (known informally as "business-as-usual" conditions) allows the City to understand where *Plan Morro Bay* could have the most positive influence.

### Population

Between 2000 and 2010, Morro Bay experienced a population decrease of 0.8 percent. Morro Bay's population in 2015 was around 10,640 people.

Table 1 provides SLOCOG growth projections developed in 2009 for 2020 through 2040. From the 2010 population of 10,246, the low end projection for community growth is a 10 percent increase by 2040, or an additional 991 residents. The high projection for population growth in Morro Bay shows a 12 percent increase, or an additional 1,266 residents by 2040. This growth is expected to occur steadily over time, with an average growth of 2.5 percent every five years in the low growth scenario, and 3.3 percent every five years in the high growth scenario.

Based on the 2015 figure of 10,640 residents, it is clear that the SLOCOG projections underestimated near-term growth. However, for forecasting purposes, the SLOCOG long-term growth forecast represents the best available information. As a result of Measure F, Morro Bay's population growth is currently capped at a total of 12,200 residents. This cap can only be exceeded with a popular vote.

Table 1
Population Projections

| | 2015 | 2020 | | 2025 | | 2030 | | 2035 | | 2040 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2015 (Observed) | Low | High | Low | High | Low | High | Low | High | Low | High |
| Population | 10,640 | 10,244 | 10,244 | 10,450 | 10,509 | 10,708 | 10,842 | 10,969 | 11,177 | 11,237 | 11,512 |
| Change from 2010 (10,246) | 3.85% | -.02% | -.02% | 1.99% | 2.57% | 4.51% | 5.82% | 7.06% | 9.09% | 9.67% | 12.36% |

*Sources: SLOCOG 2011; DOF 2015*

# Age

In 2014, residents age 50 and older represented 51.3 percent of the population; over 23 percent of Morro Bay residents are at least 65 years of age. Indications are that Morro Bay will continue to be a city with a large proportion of elderly residents.

The California Department of Finance estimated that in 2010, individuals 65 years of age or older made up 15.3 percent of the population in San Luis Obispo County. This proportion is expected to climb steadily to 26.6 percent by 2040, and it is likely that Morro Bay will experience a similar change in demographics as the entire county. Moreover, while all age groups over 65 years of age will become a larger segment of the population by 2040, the number of San Luis Obispo County residents over 85 years of age will grow fastest. This increase in the number of older adults may lead to specific challenges for the Morro Bay community, such as age-specific health concerns (e.g., cognitive health issues, vulnerability to extreme heat), mobility limitations, and shifting housing stock needs.

# Employment

SLOCOG projections anticipate slow but steady economic growth in the planning area through 2040. The low growth scenario estimates an increase of 700 jobs between 2020 and 2040, with slower growth (100 new jobs added every five years) between 2020 and 2025 and larger growth from 2025 to 2040 (200 new jobs added every five years). A high growth scenario assumes that 1,100 jobs are added between 2020 and 2040, with 300 new jobs added every five years, except between 2030 and 2035, where only 200 new jobs are anticipated (Table 2).

Table 2
Employment Projections

| | 2020 | | 2025 | | 2030 | | 2035 | | 2040 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Low | High | Low | High | Low | High | Low | High | Low | High |
| Employment | 4,000 | 4,000 | 4,100 | 4,300 | 4,300 | 4,600 | 4,500 | 4,800 | 4,700 | 5,100 |

*Source: SLOCOG 2009*

# 2.2 ECONOMIC CHANGE

Chapter 5.0 of the Community Baseline Assessment provides an overview of existing economic conditions and market trends in the planning area. Although no market forecast was conducted as part of *Plan Morro Bay*, reasonable expectations about future economic conditions can be extrapolated. This section provides the future focused information of the Community Baseline Assessment chapter with the intent of outlining economic conditions that could affects city assets through 2040.

## Educational Attainment

The majority of jobs created in San Luis Obispo County over the next 10 years will require some post-high school education. Communities with capacity for growth are those that are able to attract and retain knowledge workers. In Morro Bay, roughly 49 percent of the adult population has an associate's degree or higher, compared to 39 percent of the population in the state as a whole, and 37 percent nationally. Morro Bay also has a higher than average share of adults with graduate or professional degrees. Educational attainment appears to be highest among 35- to 44-year-olds in Morro Bay, who tend to be more educated than both younger and older generations. The share of 25- to 34-year-olds in the community with a bachelor's degree or higher is below the state average, while the educational attainment of all older cohorts is above the state average. This indicates that younger residents who are attracted to the community, or remain in the community after high school, are likely to be less educated. This could become more pronounced as this lower-educated cohort ages into their 50s through 2040.

## Resident Employment

From 2010 to 2015, Morro Bay's labor force has remained flat, while the statewide labor force has grown by about 4 percent. However, unemployment rates are very low in Morro Bay at only 3.9 percent, well below the statewide average of 6.2 percent. Morro Bay's economy was less impacted by the recession than other communities in the state. Unemployment in Morro Bay peaked at 7.9 percent in 2010 during the recession when the state was experiencing unemployment levels of over 12 percent. This may be partially a result of the city's residents of retirement age. In 2015, 23 percent of Morro Bay residents were over 65, compared to 12 percent statewide. Additionally, communities with higher educational attainment are often less impacted during recessionary periods. Morro Bay has a higher share of workers in food preparation and education occupations than the state as a whole. The share of residents in higher skilled occupations, such as management, science, computers, and engineering, is the same as the state average. If another economic downturn occurs within the planning period, history implies that local residents would be relatively well equipped to maintain employment.

## Jobs

Data reporting employment by industry sector reflects employment by place of work, not by place of residence. The distribution of employment by industry is somewhat different in Morro Bay than in the state as a whole. Morro Bay has a much greater share of jobs in hospitality-related sectors (retail, accommodations, and food service) and somewhat more jobs in the health care sector, which may be related to the aging population. However, the city has a lower share of jobs than the state in almost all other sectors, indicating a significant lack of diversity in the local economy. This lack of diversity and focus on visitor-serving jobs may leave the city vulnerable to macro-economic downturns if visitors lose the economic ability to travel to Morro Bay.

## Business Size

About 78 percent of business establishments in Morro Bay have fewer than 10 employees, compared to 74 percent of establishments in the state overall. Only 1 percent of establishments in Morro Bay have 50 or more employees. As Morro Bay tries

to accommodate a more diverse economic base through 2040, the City may need evaluate the incentives and regulations for nonresidential uses and spaces.

## Taxable Sales

Taxable sales are a key indicator of local economic conditions, particularly in an economy that is heavily reliant on tourism. Total taxable sales grew by 25 percent overall in Morro Bay between 2009 and 2014 (California BOE 2014), although sales grew by 32 percent statewide. During this same time period, San Luis Obispo County experienced an overall increase of 47 percent and outperformed the state in terms of percentage growth in sales by retail sector in most categories.

Detailed data on collections by industry is not available at the city level, but from 2009 to 2014, Morro Bay experienced a 29 percent increase in retail and food sales, which was offset by a 14 percent decline in nonretail sales. The share of nonretail sales in Morro Bay (6 percent) is significantly lower than the state (32 percent). A large reliance on retail sales tends to create greater instability in sales tax revenues, which makes the city especially vulnerable to economic downturns.

## Retail Market Leakage and Surplus

Leakage occurs when local demand exceeds local supply. A sales leakage indicates that people living in the trade area are (a) shopping outside of it, or (b) consuming less than expected given their income level. This condition indicates an opportunity for new retailers to enter the trade area or for existing retailers to extend their marketing outreach. Surplus occurs when supply of a product or service in the trade area exceeds demand. Sales surplus indicates that: (a) retailers are attracting shoppers that live outside the trade area, or (b) people living in the trade area consume more than is expected given their income level. As of 2016, retail leakage occurred in the following seven categories: 1) Apparel and Accessories; 2) Home Furniture; 3) Sporting Goods, Hobby, Books; 4) Convenience Stores; 5) Specialty Foods; 6) Restaurants, Bars (no leakage in full-service restaurants or bars); and 7) General Merchandise Stores. The Morro Bay trade area data indicates that an additional 552,489 square feet of retail space could be supported by these industries.

Morro Bay's larger visitor population will drive many future purchases (e.g., convenience stores, specialty food markets, possibly sporting goods and hobby items). Given the proximity to the City of San Luis Obispo market, it is likely that some of the leakage will never be captured by Morro Bay (e.g., apparel, general merchandise, home furnishings). Some of the shopping in Morro Bay appears to have been replaced with online shopping, a trend likely to continue through the planning horizon.

# 2.3 CLIMATE CHANGE

The earth's changing climate is a global issue that has the potential to create specific problems for Morro Bay. Hazards that are expected to worsen with climate change and have local consequences include sea level rise, drought, severe weather, flooding, extreme temperature, and wildfire conditions.

These changes have the potential to affect both physical structures and public health. Considering the aging population, it is especially crucial to analyze the impacts these risks have to senior citizens and those with disabilities or chronic illness.

## Sea Level Rise and Coastal Hazards

Coastal resources in Morro Bay are diverse and include natural resources such as Morro Rock, Morro Bay Estuary, and sandy beaches backed by dunes and bluffs. Sea level rise can potentially increase the exposure of coastal resources to hazards such as flooding resulting from extreme coastal wave runup and creek discharge events, inundation resulting from daily tides, and bluff and dune erosion resulting from a large wave event.

There is broad agreement in the scientific community that the earth is predicted to warm and that sea levels will rise as a result of the thermal expansion of water and increased contributions from melting glaciers (CO-CAT 2013; CCC 2015). Though there is consensus among the scientific community on these concepts, the timing and severity of sea level rise is relatively uncertain and depends on region-specific conditions. Best available science anticipates that Morro Bay could experience up to 5.5 feet of sea level rise by the year 2100 in a high range scenario. Table 3 shows sea level rise projections

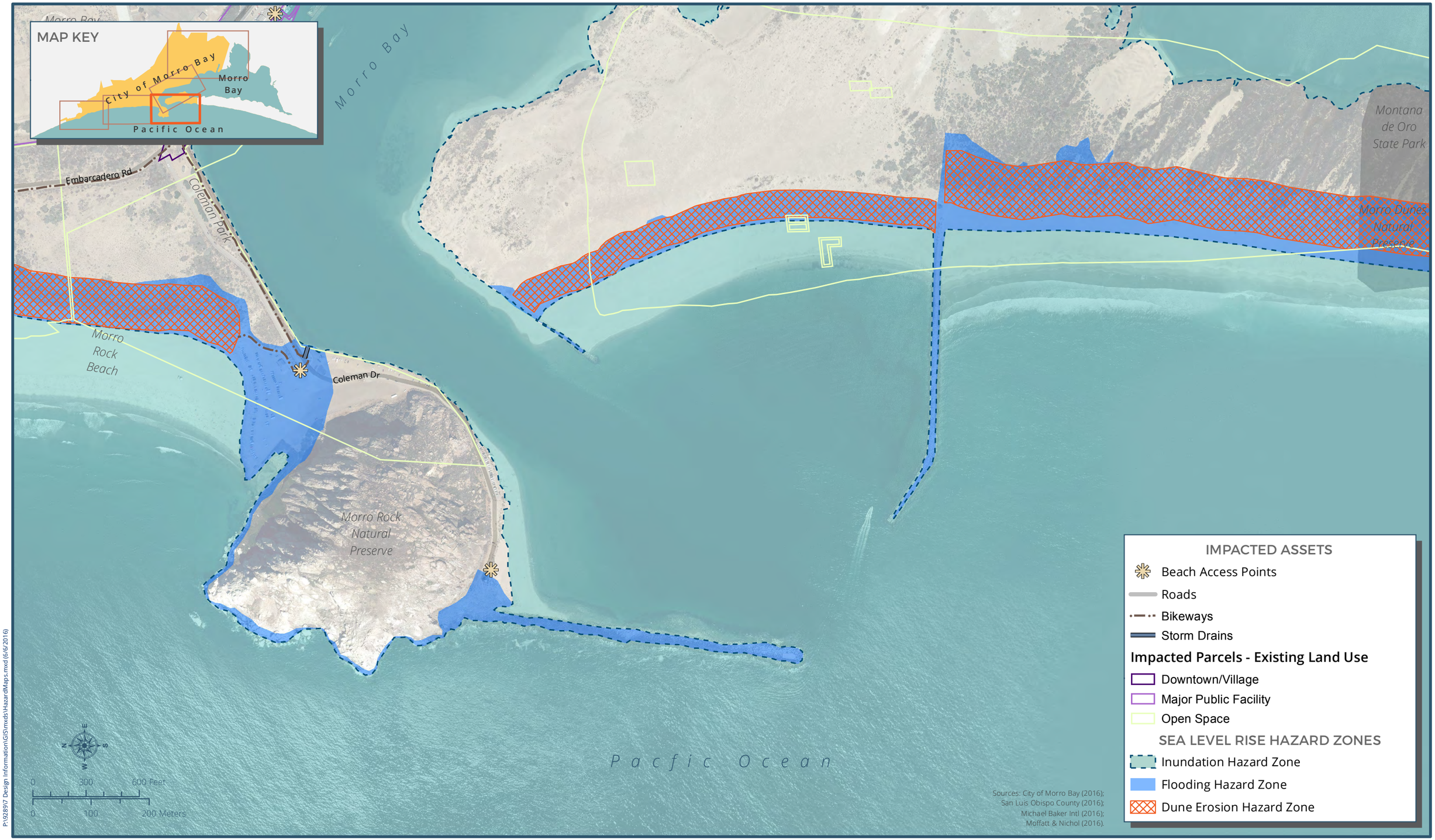
for Morro Bay. Figures 2 through 6 illustrate projected coastal hazards as the result of sea level rise in 2050.[2]

Table 3
Sea Level Rise Projections

| Year | Projected Sea Level Rise (ft) | Projection Uncertainty (ft, +/-) | Low Range (ft) | High Range (ft) |
|---|---|---|---|---|
| 2030 | 0.5 | 0.2 | 0.2 | 1.0 |
| 2050 | 0.9 | 0.3 | 0.4 | 2.0 |
| 2100 | 3.1 | 0.8 | 1.5 | 5.5 |

*Source: National Research Council of the National Academies 2012*

*[2] 2050 sea level rise projections are presented due to their proximity to the Plan Morro Bay planning horizon of 2040. For a full description of sea level rise modeling and the expected impacts of coastal hazards in 2016, 2050, and 2100, see Community Baseline Assessment Chapter 3.0 (Coastal Resilience)*

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Plan MORRO BAY

**FIGURE 2: YEAR 2050 SEA LEVEL RISE HAZARDS**

Plate 1 of 5

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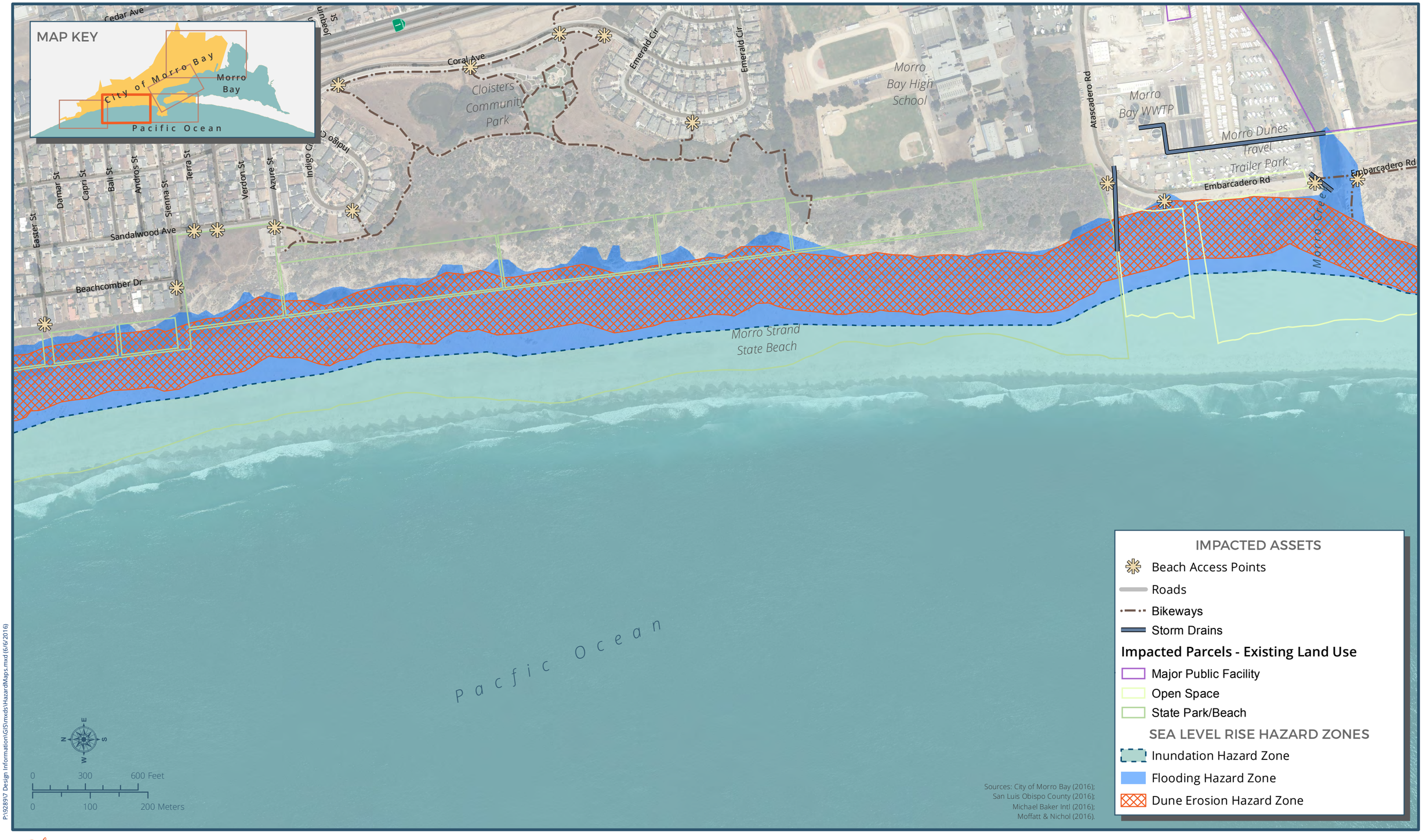


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Plan MORRO BAY

**FIGURE 3: YEAR 2050 SEA LEVEL RISE HAZARDS**

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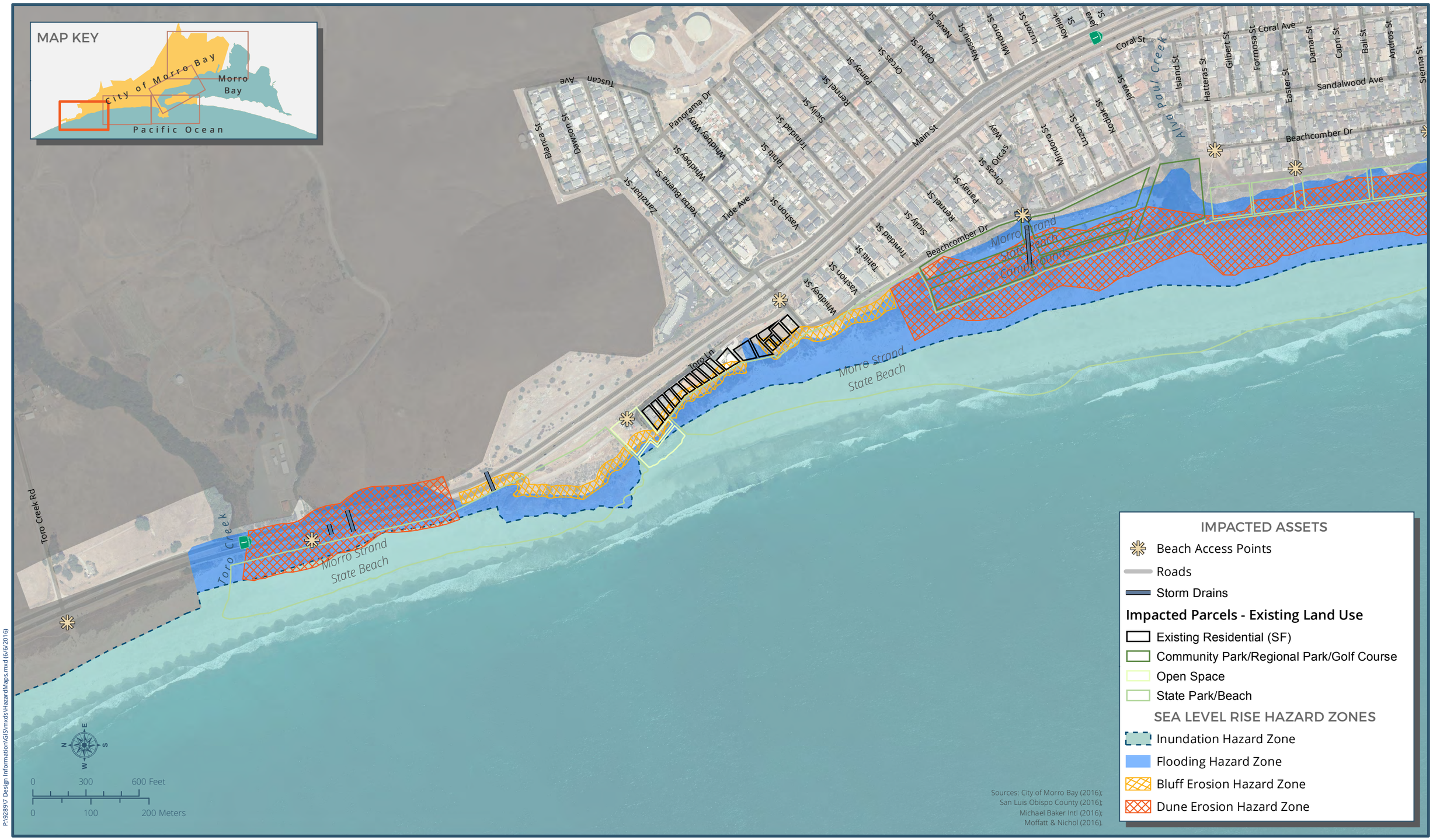


Plan MORRO BAY

**FIGURE 4: YEAR 2050 SEA LEVEL RISE HAZARDS**

Plate 3 of 5

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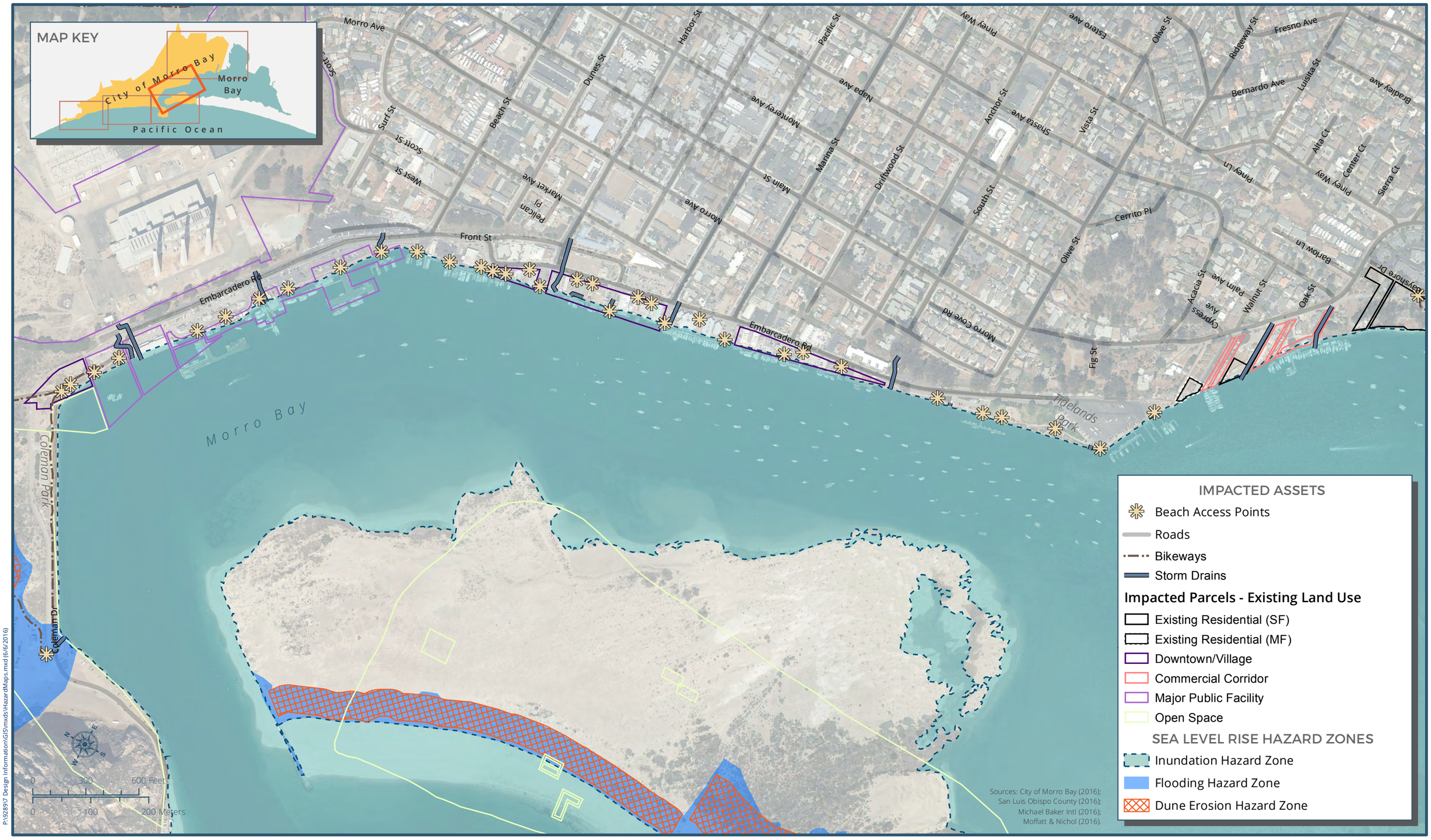


Plan MORRO BAY

**FIGURE 5: YEAR 2050 SEA LEVEL RISE HAZARDS**

Plate 4 of 5

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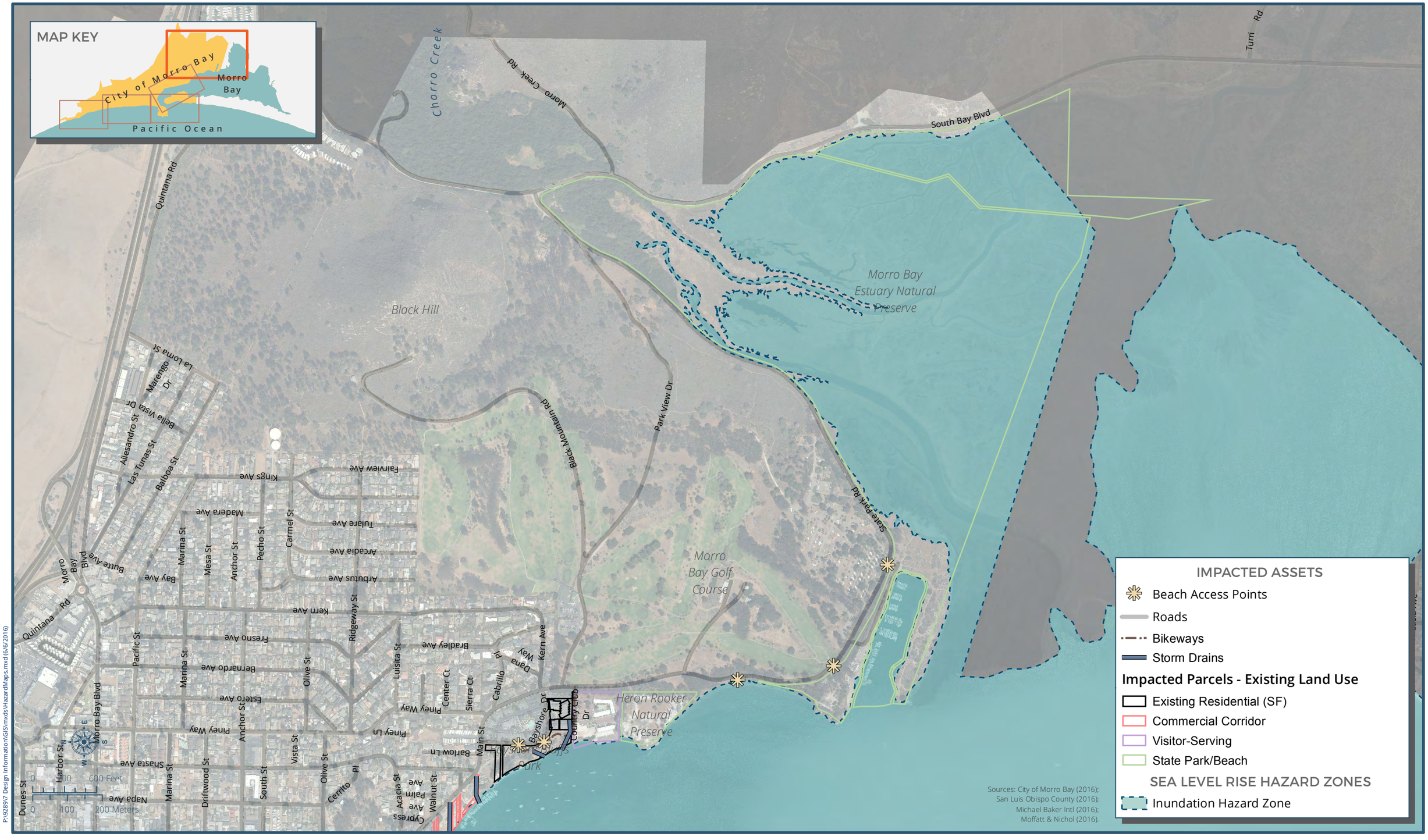


Plan MORRO BAY

**FIGURE 6: YEAR 2050 SEA LEVEL RISE HAZARDS**

Plate 5 of 5

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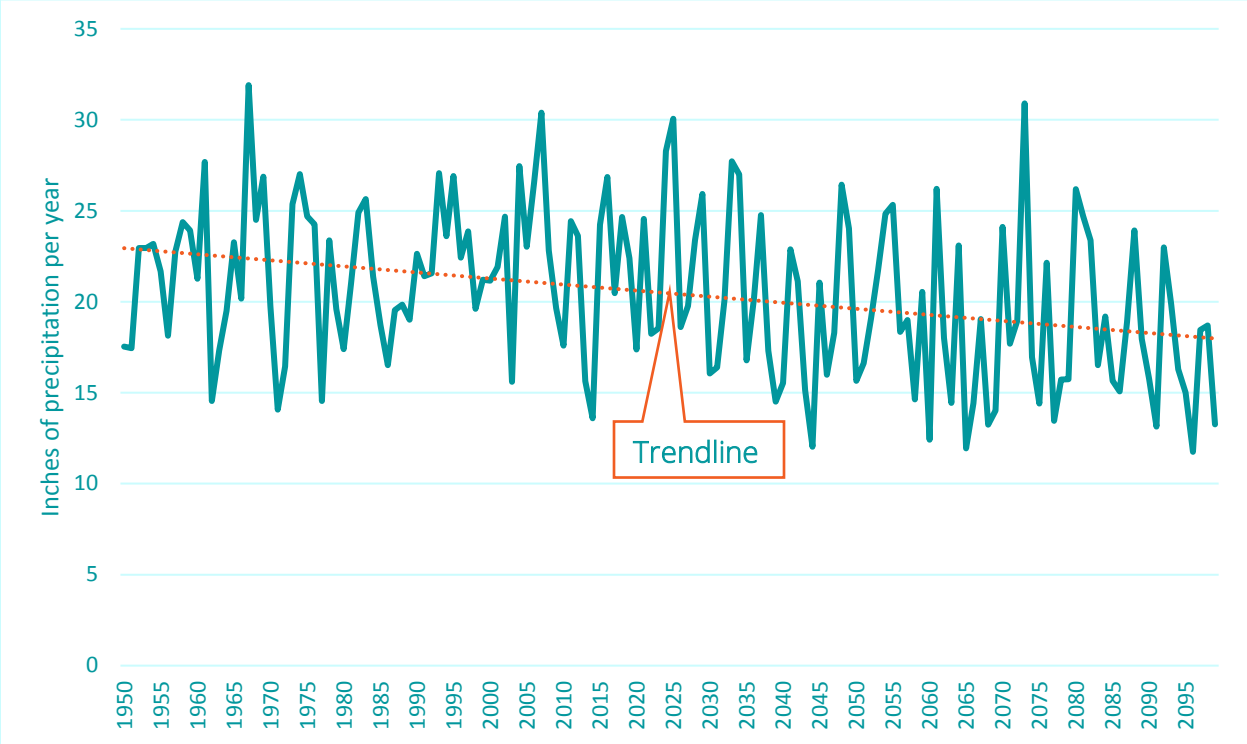
# Drought

While occasional droughts are a regular feature of California's climate, scientists anticipate that droughts in Morro Bay and the wider Central Coast region will become more frequent and more severe as a result of climate change. The Central Coast region is expected to see a decline in precipitation of about 2 inches by 2050, and of about 3-4 inches by 2100 (CNRA and Cal OES 2012), meaning that precipitation levels would decline from approximately 17 inches annually to approximately 15 inches annually by 2050, and to 13–14 inches annually by 2100 (WRCC 2015). This may cause a decline in local and statewide surface water and groundwater supplies. Figure 7 shows the expected changes in local precipitation levels.

Figure 7
Annual Precipitation in Morro Bay, 1950–2100




*Source: CEC 2016*

Similar trends are expected in the Sierra Nevada, which is the current source of a large portion of Morro Bay's water. Additionally, due to warmer temperatures, more precipitation in the Sierra Nevada is expected to fall as rain instead of snow, and snow that does fall is expected to melt faster (CNRA and Cal OES 2012; CEC 2012), further

decreasing water supplies. Recent studies also suggest that the drought which began in 2012 was exacerbated by climate change, and that similar drought conditions may occur more frequently in the future (Williams et al. 2015).

## Severe Weather and Flooding

Floods in Morro Bay are primarily caused by strong rainstorms. Although Morro Bay is expected to see an overall decline in annual precipitation as the result of climate change, some evidence suggests that climate change may increase the threat of flooding due to changes in the frequency and intensity of strong storms called atmospheric river (AR) events. Recent studies suggest that Northern California will experience an increase in the number of AR storms annually, although the average intensity of each storm will remain unchanged. In contrast, Southern California will experience approximately the same number of AR storms each year, but the average intensity of each storm is expected to rise by 10% to 20% (Oskin 2014). It is not yet known whether the Central Coast will see either one or the other of these changes in AR storms, both changes, or neither.

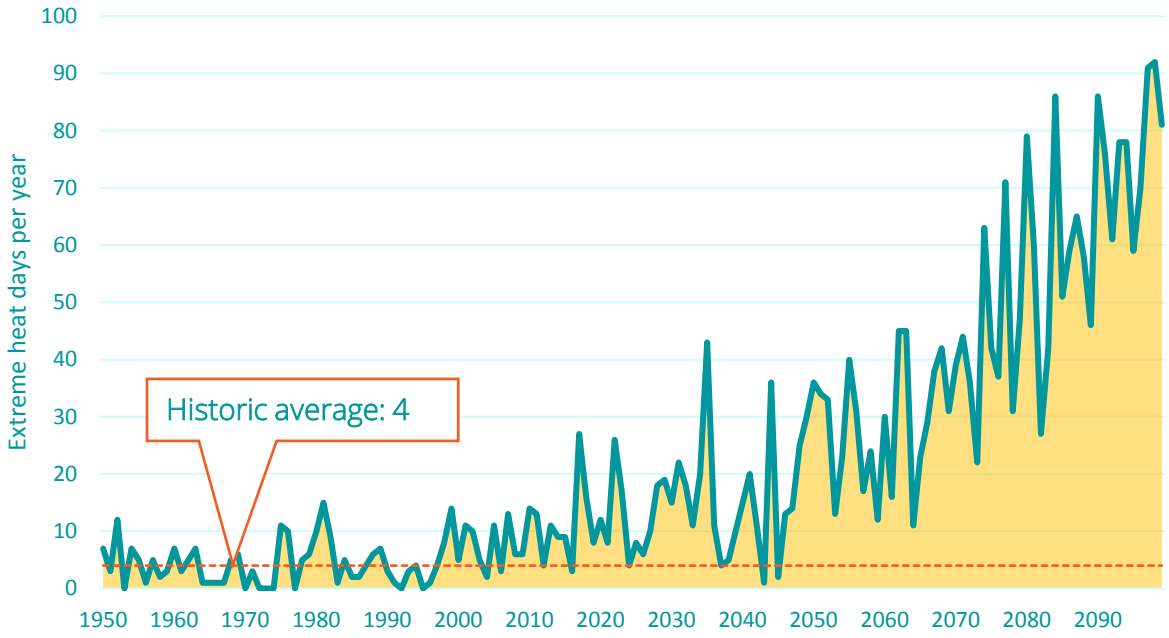
More frequent drought conditions resulting from climate change can also increase flood risks. Drought in California is expected to increase as a result of climate change because of multiple factors, and dry conditions cause soil to harden and become less permeable (CNRA and Cal OES 2012). During successive rain events, water is not absorbed into soil as quickly or effectively as it would be under normal conditions, causing increased flood risks due to ponding or increased runoff.

## Temperature

Morro Bay's Mediterranean climate is tempered by cool ocean weather, historically creating a mild, consistent temperature year round. Climate change is expected to cause an increase in both average daily temperatures and extreme heat days in Morro Bay. In 2010, the average annual temperature was 58.38ºF; it is expected to rise to 59.46ºF by 2040. Although an increase of just over one degree may not seem substantial, this change in temperature can elevate the intensity of heatwaves, alter storm patterns, and increase overall stress on vulnerable populations, including the elderly and persons with respiratory and cardiovascular conditions.

In addition to daily average temperatures, the number of extreme heat days (in Morro Bay, extreme heat is identified as days exceeding 82°F) is also expected to rise. In 2010, there were 14 extreme heat days; as many as 20 to 40 extreme heat days are anticipated each year by 2040. Figure 8 shows anticipated changes in extreme heat days in Morro Bay.

Figure 8
Extreme Heat Days in Morro Bay, 1950–2100




*Source: CEC 2016*

# Wildfire

Wildfires are a regular part of the ecosystem in large sections of California, and they have occurred occasionally near Morro Bay. Climate change is likely to affect many factors that influence wildfires, such as temperatures, precipitation levels, and drought. By the end of this century, Morro Bay is expected to see mild increases in areas burned by wildfires, up to 15 percent more than current conditions (CEC 2016).

# 3. VULNERABILITY AND RESILIENCE

This chapter reviews the priority assets in each of the Community Baseline Assessment chapters for vulnerability and resiliency to demographic and climate change. The sections are organized by Community Baseline Assessment topic, as described in Section 1.3, and include reviewed assets, descriptions of vulnerability and resiliency by demographic, economic, and climate change exposure, and summary conclusions. Appendix A provides additional detail supporting the conclusions presented herein.

## 3.1 LAND USE

### Assets Exposed to Change

Most vulnerable land use assets are found in areas with an elevated threat from hazards such as wildfires and floods. This includes multiple coastal land use types such as coastal industry, visitor-serving commercial, and recreational facilities. A number of land use assets also may face increased pressure from Morro Bay's growing population and economy, such as local agriculture and the community's housing stock.

Twelve different types of land use assets are vulnerable to demographic and climate change. Changes in temperature are expected to affect the largest number of land use assets. The land use assets evaluated in this assessment are:

- State-owned open space
- Beaches
- Coastal zone accommodations
- Commercial fishing infrastructure
- Agriculture
- Housing stock
- RV parks
- The Embarcadero
- Strip commercial
- Downtown
- Highway 1 commercial
- Hillside neighborhoods

### Land Use Asset Vulnerability

#### Population Change

Increases in year-round and seasonal residents, as well as changes in timing and volumes of visitors, all influence (and may be influenced by) changes in land use in Morro

Bay. If the city's current growth cap of 12,200 residents remains, the impacts of permanent resident growth may be limited, but seasonal resident numbers may continue to grow, creating additional demand of residential land uses. Additional housing, increased road capacity, and more shopping and commercial resources are all potential services demanded by a growing population.

Consideration of the demographics of Morro Bay's anticipated population is essential for planning future land uses. A growing and aging senior population will require different amenities than young professionals and families. Walkable neighborhoods, diverse transit options, and adequate community-serving commercial uses can serve a changing population within the existing boundaries of development. Additionally, some of this growth may occur in areas that were previously undeveloped, called greenfields. While anticipated population growth may not warrant additional greenfield development, lands surrounding the city may be vulnerable to development pressures, limiting the supply of open space. Infill development may be a response to this demand, allowing the City to enhance and increase residential density in the downtown or on existing underutilized sites. Table A-2 provides additional detail.

## Employment Change

Much like potential land use demands spurred by projected population growth, an upsurge in jobs may increase the development pressure upon undeveloped space that could support commercial or office development. These impacts vary by the type of job growth anticipated, which is not analyzed in this report due to lack of available data. Table A-3 provides additional detail.

## Extreme Heat

The economic productivity and vitality of certain land uses in Morro Bay is threatened by both rises in ambient temperatures as well as extended heat waves. Many of the main commercial areas, such as the Embarcadero, may experience reduced foot traffic in high heat periods. Additionally, the State Park and Estuary may experience degradation in habitat quality (MBNEP 2012). Although extreme heat will not alter basic land use characteristics, it may decrease the number of visitors to these areas. Table A-4 analyzes the risk posed by the effects of extreme heat on different land use types in Morro Bay.

## Wildfire

Wildfire threatens to damage properties and facilities located near the inland periphery of the community, particularly in southeast Morro Bay. Exposed areas include agricultural lands, residential areas, and parks and open space, as well as infrastructure located in these areas. In addition to burn damage, smoke from wildfires can be detrimental to public health. As mentioned in the Community Baseline Assessment, natural habitats in Morro Bay are likely adapted to wildfire conditions (UCCE 2016), but the recreational and aesthetic value of these areas may be diminished by occasional fire outbreaks. Table A-5 provides additional detail on the assets at risk from wildfires.

## Drought

Local drought conditions threaten to affect agricultural lands and natural open spaces in Morro Bay. Agriculture relies on groundwater resources, which could encounter shortages in a prolonged drought. Natural open spaces rely on precipitation and thus could go without water during a drought. The native plant species in these areas such as chaparral and scrublands are likely well adapted to drought, and so should be able to avoid substantial damage (CDFW 2016). However, drought conditions may become severe and/or frequent enough to exceed the tolerance of these species, particularly in the second half of the twenty-first century, creating a loss of habitat diversity (Loarie et al. 2008). Droughts in the northern Sierra Nevada, where much of the water for Morro Bay's homes and businesses originates, may cause frequent water shortages in the community. If there is insufficient water for new development, this may potentially limit both population and economic growth to levels below those established by Measure F. Table A-6 provides additional detail on the threat posed by drought conditions.

## Flooding

Numerous land uses in Morro Bay are located in flood-prone areas, and buildings of all types may be damaged by floodwaters. Assets currently at risk of flooding are expected to remain at risk, and risk levels may increase as flooding becomes more frequent and/or more severe because of climate change, although specific changes in degrees of severity, number of flood events, or the size of affected areas remain unknown and are the subject of ongoing research (CNRA and Cal OES 2012; Oskin 2014). Flood events can erode soil and plants, harming agricultural activities and landscaped areas. Floods may also compound other hazards, such as landslides.

Numerous strategies are available to Morro Bay landowners to reduce flood risks, such as site planning, effective drainage, and low-impact design (LID) strategies. These approaches may be expensive or otherwise infeasible to implement in some situations. Table A-7 provides additional detail regarding flood risks to land use assets.

### Sea Level Rise

Many of Morro Bay's coastal land uses are threatened by sea level rise, as discussed in the Community Baseline Assessment. Increases in the sea level may increase the risk of flooding in coastal areas during storm events or high tides. Beaches and dunes along the coast may face increased erosion, and some shoreline areas may face sustained inundation, although this is not a broadly anticipated condition until the year 2100. Shrinking beachfront areas may reduce accessibility to the coast for residents and visitors, and inland land uses are anticipated to become increasingly vulnerable as dunes erode, limiting natural barriers to storm surges and high tides. Table A-8 provides additional detail about sea level rise-related risks to land use assets.

## Land Use Conclusions

### Residential Land Uses in Morro Bay are Poorly Prepared for Future Changes

A majority of the housing stock was constructed prior to 1970. Typically, housing over 30 years old needs some rehabilitation, such as plumbing, roof repairs, or foundation work. In Morro Bay, nearly 70 percent of housing units were built over 30 years ago. Of this, 20 percent to 25 percent of the housing stock was identified in the Housing Element as in need of rehabilitation (City of Morro Bay 2014). Anticipated future conditions, such as increases in extreme temperatures, stronger storms, and mounting demand for housing supply, make the City's existing housing stock particularly vulnerable to demographic and climate-related changes. Specific advances in building technologies since the 1970s include better insulation, more efficient heating and cooling systems, and building practices that are more resilient to increased temperatures, flooding, earthquakes, and fires.

Extreme temperatures are of particular concern to senior and disabled populations, which have a harder physiological time remaining cool on high heat days. When paired with the high costs of cooling a home with inefficient insulation and an outdated cooling

system, extreme temperatures can prove burdensome to Morro Bay's aging population, especially those with low and fixed incomes. Newer homes are subject to more regimented building codes. To the extent that population growth in Morro Bay leads to new development of single- and multi-family housing, efficiency will be included in these buildings. However, the modest anticipated growth in population, and the 12,200-person growth cap established by Measure F, would not substantially increase demand for new homes. Therefore, it is important to focus on addressing existing shortcomings in the current residential housing stock.

## Maintaining Equitable Access to Coastal Accommodations will be Challenging

The assessment of existing visitor-serving overnight accommodation options in Morro Bay presented in the Community Baseline Assessment finds that the City is in compliance with affordability provisions identified by the California Coastal Commission. With over 60 percent of options at or below the statewide lodging rate average of $118.07 per night, there is no immediate anticipated vulnerability of inaccessible access to coastal accommodations.

Campgrounds in state parks provide a low-cost alternative to hotels, but such facilities may be occasionally unusable due to increased flooding and erosion as a result of sea level rise.

## Agricultural Lands May Be Less Viable Due to Drought

Agricultural land in Morro Bay covers approximately 271 acres of the community (approximately 6 percent). This land, which is used for both raising crops and as grazing land for animals, helps support the local economy and contributes to Morro Bay's small-town appeal. However, climate change threatens the viability of agricultural land in a number of ways, which may prove difficult or expensive for farmers to respond to. Extreme heat and other changes in temperature may affect various crops, including strawberries, lettuce, avocados, broccoli, nuts, citrus, grapes, and stone fruit such as apricots and peaches (CEC 2012; CDFA 2013). Some crops only thrive in a particular temperature range, and some require temperatures at a specific time of the year in order to mature.

An increase in extreme heat and a general warming of average temperatures may shift Morro Bay's climate outside of the preferred temperature conditions for these crops,

potentially causing a decline in productivity and a reduction in agricultural output. Increases in flood conditions may cause greater erosion, leading to a loss of nutrient-rich topsoil and requiring extensive (and expensive) soil replacement and nourishing to reverse. Depending on the timing of flood events and their severity, floodwaters may also wash away or destroy entire plants, particularly early in the growing season when the plants are less hardy. If farmers are unable to replace the plants, they may face economic hardship.

The most severe climate change-related threat to agricultural land is drought. Groundwater is the primary source of water for agriculture, and there is no alternative source of water available for cropland and grazing land. Groundwater is somewhat resistant to drought conditions, but is still vulnerable to long-term droughts. Additionally, if increased groundwater pumping is required to meet community water demand during droughts, this could make less water available to support agriculture. To avoid groundwater disruption, it is imperative that the City and other agencies work with local farmers and ranchers to ensure a sustainable supply of groundwater.

### Hillside Areas are at Risk of Landslides from Increased Frequency of Intense Storms

The hillside neighborhoods along Morro Bay's eastern edge are popular with residents and visitors alike for their views. However, the presence of steep slopes in and near these neighborhoods means that they are at risk of landslides, and such risks may increase as the frequency of intense storms increases. Intense rainfall can saturate the soil of a slope, causing it to lose stability. If stability continues to decline, eventually the slope is unable to support itself and a landslide occurs. Landslides near hillside neighborhoods could damage or destroy buildings, leading to injuries or loss of life. They may also block roads, cutting off access to some areas, and can damage infrastructure. There are a number of strategies that landowners can use to make their properties more resilient to landslides, but such strategies may not be effective in all instances, or they may be too expensive.

# 3.2 INFRASTRUCTURE

## Assets Exposed to Change

Energy, transportation, water and wastewater, sanitation, and telecommunications services and infrastructure systems are at risk from demographic and climate-related changes in Morro Bay. Demographic changes may put increased stress on these systems, while climate change threatens to compound hazard situations that may damage or disrupt infrastructure networks. Even if the physical infrastructure is unharmed by a change, there is still a risk that services which use the infrastructure may be disrupted (e.g., extreme heat events can cause electricity blackouts without physically harming power lines).

Fourteen distinct infrastructure assets in Morro Bay are threatened by demographic and climate change. Changes in flood frequency and intensity are expected to affect the greatest number of infrastructure assets. The infrastructure assets evaluated in this assessment are:

- Electrical lines
- Morro Bay Substation
- Natural gas pipes
- Water pipes
- Groundwater wells
- Wastewater infrastructure
- Stormwater infrastructure
- Local roadways
- Highway 1
- Highway 41
- Public transportation infrastructure
- Freight movement
- Sanitation infrastructure
- Telecommunications infrastructure

## Infrastructure Asset Vulnerability

### Population Change

The anticipated rise of population in Morro Bay through 2040 would increase demand on existing critical infrastructure. New homes and additional residents similarly increase use of facilities such as roads and highways. Table A-10 summarizes the anticipated impacts of these increases on infrastructure in the city.

## Employment Change

Similar to impacts anticipated from a rise in population in Morro Bay, an increase in jobs also places increased demand on critical infrastructure. New commercial development and additional employees place additional pressure on facilities such as roads and highways. Table A-11 shows anticipated impacts of these increases on infrastructure in the city.

## Extreme Heat

Extreme temperatures place stress on certain infrastructure, specifically electrical lines. Efficiency losses and service interruptions in electrical service can be costly for both residents and businesses. Roads are sometimes vulnerable to cracking and buckling in extreme temperatures. However, Morro Bay's mild coastal climate limits the likelihood of these impacts, which often require multiple days of triple-digit temperatures. Table A-12 shows anticipated impacts of extreme heat on infrastructure in Morro Bay.

## Wildfire

Parts of the electrical lines and telecommunication systems that serve Morro Bay lie in fire-prone areas and so may be damaged by wildfires, although redundancies and existing risk reduction strategies can considerably reduce vulnerability. Wildfires can occur outside of wildfire-prone areas and wildfires can travel into urban areas, so infrastructure located outside of wildfire hazard zones faces some degree of risk, albeit reduced. Table A-13 identifies the infrastructure assets that are at risk from wildfire events.

## Drought

The infrastructure most at risk from drought events in Morro Bay is its water and wastewater systems. The community's groundwater wells can be stressed in times of prolonged or severe drought, and alternative sources of water may not be readily available. Drought can cause damage to wastewater systems, requiring increased maintenance and added costs. While drought can also affect hydroelectric facilities and could reduce the supply of electricity to the community, there are sufficient alternative power plants in California to compensate, although this may lead to increased economic

and environmental impacts (Gleick 2016). Table A-14 shows the risk to Morro Bay's infrastructure from drought conditions.

### Flooding

As mentioned in the Community Baseline Assessment, Morro Bay has numerous infrastructure assets located in the 100-year and 500-year floodplains which could be damaged during a flood event. Floodwaters can topple utility poles, dig up roadways and buried utility pipes, or inundate infrastructure-supporting facilities. By disrupting infrastructure, floods could cut off energy, telecommunications, transportation and access, and other key services to parts or all of Morro Bay for the duration of the flood, and potentially for a longer period of time. Table A-15 shows the infrastructure assets at risk from flooding.

### Sea Level Rise

Morro Bay has a number of infrastructure assets located in low-lying areas near the coast, including transportation infrastructure and wastewater facilities. As sea levels continue to rise, these facilities may face increased flooding risk and other potential damage, which may potentially reduce their ability to provide service to Morro Bay residents and visitors. Table A-16 presents the infrastructure assets that may be affected by sea level rise.

## Infrastructure Conclusions

### A Growing Service Population Places Additional Stress on Multiple Infrastructure Assets

Increasing numbers of new residents and employees in Morro Bay through 2040 will place additional pressure on infrastructure. Roads, sidewalks, and parks will all experience increases in use, which may generate additional wear and tear. The severity of these impacts will depend on transportation patterns in future years, including if more people in the city use public transit or ride bikes, rather than drive, which could slow impacts on infrastructure. The City's ability to alter maintenance schedules to accommodate new growth in the community enhances adaptive capacity.

New residents and employees will also increase demand on water resources, even if this growth is accommodated by water-efficient infill development. Because of Morro Bay's reliance on groundwater, an increased rate of withdrawal may deplete groundwater basins at a faster rate than anticipated. The total 2040 water demands are estimated in the City of Morro Bay Urban Water Management Plan (UWMP), using 2011 SLOCOG forecasts. This plan provides water use targets and supply information through 2020 (City of Morro Bay 2016a). Drilling additional wells or increasing the depth of existing wells to match demand is costly and increases risk of saline intrusion. The City is able to adapt to this vulnerability through continued management of groundwater resources and increased efficiency in new and existing development. Morro Bay's UWMP states that if there are at least three drought years in a row, water supplies may be less than half of what is typically available. The UWMP identifies various restrictions and fee structures that can address future water shortages (City of Morro Bay 2016a).

## More Frequent Electricity Shortages are Likely

Morro Bay's electrical grid consists of high-voltage power transmission lines, lower-voltage power distribution lines, and the Morro Bay Substation, which is responsible for distributing energy from the high-voltage transmission lines to the power distribution lines, and ultimately to individual buildings. While the electrical grid only occasionally experiences a shortage of electricity, the grid remains vulnerable to disruption.

Of the climate change-related hazards that may affect Morro Bay, extreme heat poses the greatest threat to the electrical grid. During very high temperatures, electrical equipment often performs at a reduced capacity. Additionally, electricity use is often highest during extreme heat events as more people use air conditioning units. These two factors combine to place considerable stress on the electrical grid, increasing the chance of power outages (EPA 2015a). A power outage during extreme heat events is particularly dangerous, as people may not be able to maintain a comfortable indoor temperature, increasing the risk of heat-related illnesses.

Other hazards may also increase the risk of grid failure. The Morro Bay Substation is located in a flood hazard zone, and while any flood event would likely have to be substantial to cause damage, any disruption of the substation could potentially cause power outages for portions or all of Morro Bay. Flood and fire events may also damage or destroy electrical lines, although such infrastructure is usually hardened against these events, and there are sufficient redundancies in the electrical grid that should avoid

power outages or limit them to small areas. Morro Bay has limited control over the local electrical network, as it is primarily owned by the Pacific Gas and Electric Company (PG&E), the local electrical utility.

The City can work with PG&E to support hardening of the community's electrical grid, reducing the chance of damage during a natural hazard event. The City can also act independently of PG&E to improve energy independence by promoting energy efficiency, energy conservation, and local renewable energy generation and storage. Such actions reduce dependency on the grid, decreasing the amount of stress placed on the network. They also help to ensure that homes and businesses can continue to function when power outages occur.

## Vulnerability of Morro Bay's Roadway Network May Worsen Infrastructure Quality and Increase Maintenance Costs

In addition to increased use and pressure from a growing economy and population, the street and highway network faces limited impacts from the effects of climate change. High temperatures can cause pavement to soften and expand, creating ruts and potholes (EPA 2016). While the city's temperate coastal climate reduces the risk of sustained heat waves over 100° F, a higher frequency of extreme heat days may hasten the degradation of roads. This is of particular concern on main routes, such as Highway 1 and SR 41, which are key evacuation routes for the city.

Many local roads in Morro Bay are located within flood hazard zones, and some lie within the sea level inundation zone. Floodwaters from storms or increased sea levels can wear away the road surface or the substrate, causing damage that can require repair. Water may also pond on the road surface, creating a safety risk. Where local control exists, Morro Bay can increase reflectivity and improve drainage to reduce the impacts of heat and flooding on roadways. Existing partnerships with Caltrans can increase Morro Bay's ability to better protect city roads that are under state control.

## Morro Bay's Wastewater Treatment Plant May Be Damaged or May Face Service Disruptions from Flooding and Sea Level Rise

Morro Bay's existing wastewater treatment plant is located within a flood hazard zone and in the expected sea level rise inundation zone. While the plant is not expected to be permanently underwater, occasional flooding and inundation may be damaging. Such

events could require the plant to be shut down, leaving Morro Bay without a means of treating wastewater. Additionally, such a shutdown could lead to a release of untreated or partially treated wastewater into the Pacific Ocean through outfall facilities. Such materials may have substantial impacts on environmental health, and could also create human health hazards if people are exposed to the accidentally released material.

The vulnerability of the existing wastewater treatment plant highlights the need to construct a new plant, the Water Reclamation Facility (WRF). While the City has not yet selected a location for the WRF, the potential locations lie outside the sea level rise inundation zone, although likely also face a reduced risk of flooding. Situating the WRF outside of these hazard zones will help ensure continued operations of the facility, and minimize the chance of human and environmental health risks from accidental releases of untreated wastewater.

# 3.3 NATURAL RESOURCES

## Assets Exposed to Change

Morro Bay has 11 different natural resource assets that may be affected by demographic or climate change. These assets include a variety of different habitats, species, and communities. Natural resource assets in Morro Bay help preserve the biological integrity of the wider Central Coast ecosystem and provide scenic and recreational benefits to the community. Drought and extreme temperatures are expected to affect the greatest number of natural resource assets in Morro Bay. The natural resource assets evaluated in this assessment are:

- Herbaceous habitat
- Riparian habitat
- Shrubland habitat
- Dune habitat
- Wetland habitat
- Woodland habitat
- Morro Bay Estuary
- Special-status species
- Sensitive plant communities
- Critical habitat
- Wildlife movement corridors

# Natural Resource Asset Vulnerability

## Population and Employment Change

To the extent that anticipated increases in population and employment lead to the construction of new homes and businesses in areas that were previously undeveloped, unprotected habitats may be threatened by new development if any occurs outside of the existing developed areas. Table A-18 summarizes the impacts of population and economic change on Morro Bay's natural resource assets.

## Extreme Heat

Extreme temperatures can affect natural resources by altering the conditions that have historically sustained a community of plants or animals. These changed conditions can introduce heat stress, introduce invasive species, and diminish the strength of symbiotic relationships. Additionally, preserving undeveloped, natural areas may help build community-wide resilience to extreme temperatures by minimizing the urban heat island effect. Table A-19 shows how extreme heat may affect Morro Bay's natural resources.

## Wildfire

The various natural resources within or adjacent to Morro Bay's wildfire-prone areas are at risk of being burned. While native resources in California, including those in Morro Bay, are largely adapted to wildfire and can recover by themselves through natural processes, natural resources with nonnative components, such as woodlands with fire-prone eucalyptus trees, may be at greater risk. Additionally, resources that can recover on their own may take a long time to do so, degrading the biological integrity of the ecosystem for a lengthy period until the recovery is complete. Table A-20 identifies the effects of changes in wildfire events on Morro Bay's natural resource-related assets.

## Drought

Drought is a recurring feature of California's climate, and many natural resources in the state are adapted to frequent dry periods. However, climate change is expected to cause an increase in more severe, longer-lasting drought events, and such events may exceed

the capacity of some natural resources to fully recover. Riparian and wetland habitats are particularly vulnerable, as intense droughts may cause long-term damage to riparian areas and wetlands may be highly sensitive to changes in nutrients and water salinity caused by drought conditions. Table A-20 shows how drought can affect natural resources in Morro Bay.

### Flooding

Large sections of Morro Bay lie within flood hazard zones, which contain a number of natural resources. Some habitats within these areas may be vulnerable to damage from floodwaters, which could in turn harm the sensitive species that rely on these habitats. Some natural resources may also be indirectly damaged by floodwaters, primarily by contamination from sediments and pollutants carried into the habitat by flood runoff. Table A-21 discusses the effects of changes in flood patterns on Morro Bay's natural resources.

### Sea Level Rise

Some of Morro Bay's natural resources, including dune, estuarine, and wetland habitats, are vulnerable to the effects of sea level rise. Dune habitats face increased erosion and loss as a result of sea level rise. A key risk in estuarine and wetland habitats is from higher salinity levels as sea levels increase, temporarily or permanently altering the chemistry and nutrients in these habitats, which could in turn affect the plants and animals living there. Table A-22 shows how Morro Bay's natural resources may be affected by sea level rise.

## Natural Resources Conclusions

### Morro Bay's Permanent and Temporary Wet and Semi-Wet Habitats Are at Risk of Degradation and Potential Loss of Special-Status Species Because of Drought, Flood, and Sea Level Rise Hazard Events

Morro Bay has a number of habitats that are permanently or temporarily wet or partly wet. This includes riparian areas, wetlands, the Morro Bay Estuary, and ephemeral wetlands such as vernal pools. These habitats provide extensive scenic and recreational benefits to residents and visitors, support local biological integrity, and are home to a

number of sensitive species. However, drought and flood events, as well as the increasing threat of sea level rise, may threaten the overall health of these ecosystems, harming the plant and animal species that rely on these habitats.

Drought is a prime concern for Morro Bay's riparian habitats. While most riparian species are well adapted to California's regular drought regime, climate change may cause an increase in longer-lasting, more severe droughts that may exceed the natural capacity of these species to survive in dry conditions. Riparian habitats would still likely be able to recover, but the more extreme nature of the events could result in more extensive damage to the habitat, leading to a longer recovery. Temporary wetlands can also suffer during drought conditions. While these habitats normally only have water for part of the year and the species that live in them are adapted to dry conditions, droughts could result in no water or very little water for an entire year or longer. Without at least some access to water, ephemeral wetland species may have to seek alternate habitats for survival, which may not always be accessible (CDFW 2016).

Local wetlands may be at risk from both drought and sea level rise. Droughts cause a decline in freshwater and a corresponding increase in saltwater from the ocean. Sea level rise increases the amount of saltwater entering the habitat, which may limit the inflow of freshwater or restrict freshwater conditions to smaller portions of the wetlands. The water in a wetland therefore becomes saltier during drought conditions and with sea level rise, potentially altering the ecosystem's nutrient balance with harmful implications for the species that rely on these habitats. While there is some natural variability in salinity and nutrient levels in wetlands, these climate change-related hazards may push these variables beyond their normal range, particularly if sea levels become high enough to permanently or frequently inundate wetland areas.

The impact of flood events on Morro Bay's wet and semi-wet habitats is more limited. The substantive threat from flooding is to riparian habitats. During flood events, the force of the floodwaters could cause direct harm to plants and animals, clog the habitat with debris, and alter the streambed and banks. These are all regular occurrences in riparian habitats and it is likely that the ecosystem could effectively recover, although the habitat may be substantively degraded until cleanup and recovery happens. Floodwaters often carry pollutants and sediments, which could enter riparian areas and prove harmful to the ecosystem. A hazardous material, such as a sufficient quantity of a toxin, may harm riparian species if it enters the ecosystem. Given the importance of Morro

Bay's permanent and temporary wet and semi-wet habitats, it is key for the City to protect these ecosystems from natural hazards such as droughts and floods.

### Climate Change May Degrade Wildlife Movement Corridors, Decreasing Connectivity

Wildlife movement corridors are key linkages between natural areas that allow species to move from location to location without having to traverse potentially dangerous urban environments. This allows the species a larger range, improving biological diversity and preventing species from being concentrated in a small area where they are more at risk from harmful conditions. Riparian areas such as creeks are prime corridors, but long stretches of trees or other natural landscaping can also provide connectivity at a community scale. Connectivity is already low in Morro Bay, making wildlife movement corridors that exist more important. Morro Bay's riparian areas are vulnerable to drought and flood conditions, which may deprive the habitat of necessary water and cause physical damage to the ecosystem. This is harmful to species that live in riparian habitats, and may also reduce the ability of some areas to serve as wildlife corridors (e.g., species living in the natural areas east of Morro Bay who use the creek beds to travel to the ocean to feed). Given the importance of wildlife movement corridors to the local ecosystem and their scarcity in the community, continued protection of these connections will help maintain a high degree of biological integrity in Morro Bay and in the wider region.

# 3.4 PARKS, RECREATION, AND OPEN SPACE

## Assets Exposed to Change

Community Baseline Assessment Chapter 11.0 identifies the parks and recreation resources and coastal access points in the planning area. Key assets from Chapter 11 were assessed for exposure to the climate change impacts expected to happen in Morro Bay by 2040. Table A-24 provides climate change exposure by asset.

Twenty-five distinct park-related assets in Morro Bay may be affected by demographic and climate change. Such assets include both physical parks and recreation facilities, as well as recreation-related services and programs. Changes in population and employment are expected to affect the greatest number of these assets. Sea level rise

is the primary climate exposure for most of the physical parks and recreation assets in the community. Drought, the second most frequent climate-related concern for physical amenities, has already played a role in limiting resources such as showers and drinking fountains provided at certain facilities and will increase the operating cost of facilities with maintained grassy areas. The parks, recreation and open space-related assets in Morro Bay that were evaluated as part of this assessment are:

- Community Center
- Veteran's Memorial Building
- Morro Bay Teen Center and Skate Park
- Anchor Memorial Park
- Centennial Parkway
- City Park
- Cloisters Park
- Coleman Park
- Del Mar Park
- Lila Keiser Park
- Mariner Memorial Park
- Monte Young Park
- Tidelands Park
- Morro Bay Bike Park
- Bayshore Bluffs Park
- Morro Rock Beach
- North Point Park
- Morro Strand State Beach
- State Marine Recreational Management Area
- Morro Bay State Park
- Recreational Services – Administration
- Recreational sports
- Youth and senior services
- Coastal access
- Special events

# Parks, Recreation, and Open Space Asset Vulnerability

## Population Change

Anticipated population growth in Morro Bay to 12,200 or beyond through 2040 will place increasing strain on the City's recreation services and programs. Unless parks and open space acres are expanded, the City's current ratio of 28 park acres per thousand people is also anticipated to decrease. However, the existing strength of Morro Bay's coastal access and parks programs means that the City will be more prepared to adapt to population changes.

In addition, the proportion of Morro Bay residents over 50 is expected to remain the highest share of any demographic group. The City will need to continue to strengthen its relationship with Morro Bay Senior Citizens Inc. or provide new and additional senior services and programs through the recreation and parks department. Table A-25

identifies the effects of population change on Morro Bay's parks and recreation-related assets.

Morro Bay's recreation services are used not just by year-round community members, but also by seasonal residents and visitors. The City's existing ratio of park acres per thousand people accommodates state requirements even when visitors are considered, but the growth of seasonal residents and visitors may create continued demand for additional parks and recreation resources.

## Employment Change

Increased economic activity in Morro Bay and the growth in the number of people working in the community is likely to place some strain on the City's parks and recreation assets, although at a relatively minor level. The growth in the number of people working in Morro Bay is likely to cause some increase in demand for recreation services, but when measured independently of increased growth in the number of residents, this rise in demand is expected to be small.

While some people use recreational services where they work, they are more likely to use these services in the community where they live, which is less likely to cause strain on Morro Bay. Increased economic activity does have the potential to limit coastal access if expanded commercial development occurs along the Embarcadero, but the City already has access to regulatory mechanisms that can prevent this from happening. Table A-26 shows how employment changes may affect parks and recreation-related assets in Morro Bay.

## Extreme Heat

Extreme heat can be a serious problem for Morro Bay's parks and recreational assets, as temperatures rise and as heat waves become more frequent and more severe. Extreme heat can threaten the viability of plants in Morro Bay's parks, particularly turf surfaces on playing fields, which may be less resistant to extreme heat and for which heat-resistant alternatives may be less available, more expensive, or politically unpopular. Higher temperatures can kill turf outright, make it more susceptible to damage or disease, or shorten its lifespan and require more frequent replacement.

Individuals using the City's recreational services, particularly those activities that take place outdoors, are also vulnerable to extreme heat. Elderly individuals and children face a greater risk of heat-related illnesses during high temperatures, and athletes are likewise threatened due to intense outdoor activity. Recreational programs intended for these groups may have to be moved indoors, or shifted to earlier in the morning or later in the evening so as to avoid the hottest parts of the day. However, depending on facility and staff availability and participants' schedules, viable alternatives may not exist, and such services may have to be halted during heat waves. Table A-27 shows the effects of extreme heat on Morro Bay's parks and recreation-related assets.

## Wildfire

Wildfire is primarily a concern around the edges of Morro Bay, where the city limits abut wildland areas in what is known as the wildland-urban interface (WUI). While most of the community's parks and recreation assets are located outside of the WUI and therefore are generally not a risk from wildfires, fire may threaten Morro Bay State Park, part of which lies within the community.

While the park is not under the City's jurisdiction, it does provide numerous recreation benefits to community residents, and visitors to the park from outside the region help to support tourism in Morro Bay. Like many ecosystems in California, the habitats in the park are well adapted to occasional wildfires (CDFW 2016), but fire events can substantially damage the appeal of the park to visitors and reduce its recreational benefit. Increases in wildfire potential may therefore harm Morro Bay State Park as a recreation asset to the community. Table A-28 shows how changes in wildfire events may affect Morro Bay's parks and recreation-related assets.

## Drought

Drought conditions may harm the vegetation and landscaping in Morro Bay's parks and recreation assets, reducing their usefulness from a recreational activity perspective. Plants which require substantial rainfall and/or irrigation may become drought-stressed and weaken or die. This can be of particular concern to playing fields, which may become unusable if much of the turf is dead. Without the use of artificial or drought-tolerant turf on playing fields, the death of the turf may prevent the City from holding some outdoor recreational services and programs. Such programs may be moved indoors or to other facilities if this is an option, but alternatives are not always available. To a lesser extent,

Morro Bay State Park and ornamental landscaped areas also face some vulnerability from drought. The ecosystems in Morro Bay State Park are adapted to drought conditions and should not suffer long-term damage as a result, although some temporary harm may occur. While landscaped areas could be damaged permanently by drought if the plants are not suited to these conditions, the ornamental nature of these installations means that the community is unlikely to be harmed or otherwise substantially affected by such a loss. Table A-29 presents the effects of drought conditions on Morro Bay's parks and recreation-related assets.

## Flooding

Flood events can damage numerous park and recreational assets in Morro Bay, although risk of damage to these assets is relatively low. The primary threat from flooding is to Morro Bay's outdoor playing fields and to recreational services.

Intense rains can wash away plants and topsoil, causing large muddy patches in fields that can persist for a long time after floodwaters recede. Such damage to turf reduces its usefulness as a playing field, and in the case of more substantial damage, may render the field unusable until the turf is replaced. This in turn can harm recreational services that depend on these fields, as these services may have to be suspended until the turf is repaired if there are no suitable alternative sites. Event services in Morro Bay may be similarly harmed if the fields where these events are held are damaged. Some landscaped areas and recreational facilities are somewhat vulnerable to flood events as well (although less so than other assets), and there may be increased costs to the City to repair or replace affected facilities, especially turf. Table A-30 shows how flood events may affect the parks and recreation-related assets in Morro Bay.

## Sea Level Rise

Many of Morro Bay's recreational assets along the coast are threatened by sea level rise, through impacts such as flooding, dune erosion, and high surf events. Increases in the sea level may increase the risk of flooding along coastal areas during storm events or high tides, reducing beach access temporarily and threatening essential support infrastructure, such as parking lots and restrooms. Beaches and dunes along the coast may face increased erosion, and sea level rise may lead to shrinking coastal assets, minimizing beach availability and access. Table A-31 presents the effects of sea level rise on Morro Bay's parks and recreation-related assets.

# Parks, Recreation, and Open Space Conclusions

## Growing Senior Populations Could Strain Age-Specific Recreational Programs and Resources

Approximately 2,400 people, or 23 percent of the Morro Bay community population, are at least 65 years of age or older. The number of elderly individuals in Morro Bay will grow as the population increases, and elderly persons are likely to make up a larger proportion of community residents in future years. Greater numbers of elderly residents and their specific requirements for parks and recreational assets are likely to increase demand for recreational programs that are popular with seniors, potentially requiring the City to hire new staff or secure additional venues to keep up with demand.

Elderly residents face increased vulnerability from some climate change-related natural hazards. Elderly residents are more susceptible to health risks posed by extreme heat, such as heat exhaustion and heat stroke, than other adults. Accordingly, the City will have to ensure that elderly persons face minimal exposure to extreme heat during recreational activities and that City-owned recreational facilities can provide some degree of protection from extreme heat, even as heat waves become more frequent and more intense.

## Community Services Offered by Morro Bay State Park Could Experience a Loss of Scenic Value and Recreational Opportunities Due to Wildfire and Other Natural Hazards; However, the Park's Natural Resources are Adaptive to These Hazards

Large sections of Morro Bay State Park, including some sections within the city limits, are within areas at high or very high risk of wildfires. Wildfires can move quickly through the terrain and burn vast swaths of vegetation, and can be exacerbated by other natural hazards such as drought, heat waves, and intense winds. If a wildfire were to burn large sections of Morro Bay State Park, the loss of some scenic value could cause attendance at the park to decline. The recreational appeal of the park would likely decline until plants in the burned areas begin to regrow, and it may be some time before the ecosystem recovers sufficiently to bring visitor numbers back to normal levels. City residents would likely be harmed by a decrease in suitable open space for recreation activities, and the Morro Bay economy may be affected by a decline in visitors to the park. Drought could

also have a similar effect on the ecosystem of Morro Bay State Park, although damage and any resulting drop in attendance would likely be minor and would occur over a longer period of time. Wetlands, intertidal, and subtidal habitats are expected to be impacted by increased tidal inundation in 2030. Impacts will be more significant in 2050 and beyond, as steep topography and development limit the ability of habitats to adapt.

### The Quality and Availability of Park Space and Recreational Fields May Be Degraded

The damage to the turf and underlying soils of playing fields from natural hazards can make the fields less usable for recreation activities. Play on the fields may be more difficult or more dangerous (e.g., dry grass and soil creates a harder surface for players to fall on), or parts or all of a field may need to be closed until it can be repaired or replaced. This can reduce the amount of space available for recreational activities, meaning that some programs may have to curtail activities. This may also put available playing fields under more stress, subjecting them to more damage.

Floods, droughts, and extreme heat can damage ornamental landscapes in the same manner as playing fields. These landscapes may be less susceptible to damage, since there are more plants available for use in these areas than in playing fields, including many native plants that are resistant to conditions such as drought and extreme heat. Damage to ornamental plantings is also less harmful, as these provide a scenic passive benefit rather than direct use for activities. However, although less harmful, such damage can decrease the aesthetic appeal of a park and make people less inclined to visit.

### Older Facilities Will Be Additionally Strained by More Extreme Temperatures

One of the easiest ways to reduce exposure to extreme heat events is to move indoors. However, in some cases, building interiors may only offer a minor improvement. Poorly designed buildings with minimal insulation, large unshaded windows that face the sun's direction, or buildings without sufficient ventilation can be almost as warm inside as out. This can be of particular concern in coastal climates, where buildings often lack air conditioning units that can compensate for these shortcomings. Without a sufficiently cool indoor temperature, participants in indoor recreation programs may face the same heat-related health risks as participants in outdoor activities. Older buildings, which may have been ideally suited to climate conditions at the time they were constructed, may

not be as appropriate for future climate conditions with an anticipated increase in the frequency and intensity of extreme heat events.

### Sea Level Rise Can Cause Increased Erosion and Inundation of Beaches and Dunes, Causing a Loss of These Environments

Under existing conditions, beaches and dunes are among the most exposed resources along the open coastline. Erosion and flooding associated with extreme storm events can result in significant loss of beach area and dune habitat. The sandy beaches are more resilient than dunes and typically regain width during calm wave conditions. Once eroded, the dune system takes a longer time to reestablish and is less resilient to impacts from extreme storms. Loss of beach area and reduced effectiveness of the dune system are anticipated starting in 2030, largely as a result of flooding and erosion. Erosion at beaches and state parks may impact recreational opportunities as sand and dune areas become squeezed between rising seas and upland development. Storm protection provided by beaches, dunes, and bluffs will be degraded as erosion progresses inland, which can result in damage to roadways, residential parcels, and commercial parcels currently fronted by these features.

# 3.5 WATER AND WATER QUALITY

## Assets Exposed to Change

Community Baseline Assessment Chapter 14.0 identifies existing conditions related to water and water quality. Key assets from Chapter 14.0 were reviewed for exposure to the demographic and climate change impacts expected to occur in Morro Bay by 2040.

Nine water and water quality-related assets in Morro Bay are potentially affected by future demographic and climate change, including local water bodies and watersheds, sources of water, and water quality. Drought affects the greatest number of items and has already played a role in limiting available water resources and degrading water quality. Changes to flooding and increases in population are other key exposures that threaten many water and water quality-related assets in the community. The water and water quality-related assets evaluated in this assessment are:

- Morro Bay Watershed
- Cayucos Creek/Whale Rock Watershed
- Chorro Creek system
- Los Osos Creek system
- Stormwater infrastructure
- Groundwater resources
- SWP water
- Water quality thresholds
- Morro Bay Estuary

# Water and Water Quality Asset Vulnerability

## Population Change

Anticipated population growth in Morro Bay to 12,200 or beyond through 2040 will place increasing strain on the City's water resources and infrastructure. Increased demand for a decreased water supply may lead to restrictions on water use and impact the health of the waters in and around Morro Bay. Population growth has the ability to impact both the quantity and quality of the surrounding watershed. One potential impact is an increase in development of homes and commercial resources on previously undeveloped land. As more roofs, roads, and sidewalks are constructed, there is a decrease in pervious surfaces where rainfall can be infiltrated into the ground. When these areas of natural infiltration are removed, stormwater flows over the new pervious surfaces, picking up pollutants from shingles, cars, and other roadway contaminants. These are then ushered into storm drains which drain directly into the ocean. Developing new homes and businesses in existing, underutilized developed areas keeps the ratio of impervious surfaces to people lower than if the growing population spills into previously undeveloped lands

Additionally, an increase in population leads to a higher demand for resources. Even under the current growth cap established by Measure F, new residents will create additional need for water use inside and outside of the home. Seasonal residents and visitors create demand for water beyond annual residents. Visitor-serving businesses, such as hotels and restaurants, require water for laundry, pools, and dining. Conservation programs for year-round water use reductions may target homeowners, while visitor-serving amenities may require other avenues for water savings. As impacts of climate change worsen, surface water resources and State Water Project (SWP) allocations may become increasingly unreliable. The City's groundwater resources (Morro Groundwater Basin and Chorro Groundwater Basin) are both bordered by the Pacific Coast. As surface water resources are diminished, additional demand may be met

by groundwater resources, but rising sea levels and increased withdrawal rates may make the basins more vulnerable to saltwater intrusion. Table A-33 presents the effects of population changes on Morro Bay's water and water quality-related assets.

## Employment Change

Increased economic activity in Morro Bay and the growth in the number of people working in the community is likely to place some strain on the City's water supply and resources in a manner similar to population growth. Impervious development on lands that were previously used for agriculture, open space, or other green space increases stormwater runoff and pollution into adjacent water bodies. Keeping new commercial development, as expected with the anticipated jobs growth through 2040, in existing, underutilized urban plots will reduce new impervious surfaces and minimize stormwater pollution. Depending on the nature of new and growing businesses, demands on limited water supply may also be increased, especially in new industrial uses. Table A-34 shows how economic change may affect water and water quality-related assets in Morro Bay.

## Extreme Heat

Extreme heat can increase the rate of evapotranspiration, increase stress on landscaped areas, and exacerbate other natural hazards, such as drought and wildfire. This may increase demands for already diminished water supply. Extreme temperatures may also increase water temperatures in delicate ecosystems such as the Morro Bay Estuary. This threatens the efficacy of species and may threaten the quality of the estuary, a source of visitor attention and related revenue for this City. Table A-35 shows the effects of extreme heat on Morro Bay's water and water quality-related assets.

## Wildfire

The primary threat from wildfires comes from increased runoff. When a wildfire burns an area, it removes most of the plant material that helped to hold the soil together and slow down surface water. Without the benefits of vegetation, precipitation that falls onto a burn area can easily run off, carrying sediments and any pollutants along with it. When this runoff washes into water bodies such as creeks or estuaries, it can lead to poor water quality (CNRA and Cal OES 2012). This can hurt plants and animals that live in or around the water body, and may also diminish the viability of recreational activities such as fishing and swimming. In Morro Bay, the Morro Bay Watershed faces the greatest risk

from wildfire, as the Chorro Creek system that makes up part of the watershed runs through areas deemed a high or very high wildfire risk. The Los Osos Creek also drains areas of elevated wildfire risk and is part of the Morro Bay Watershed. Although Los Osos Creek is not located within Morro Bay city limits, it may have indirect impacts on beach water quality within the city. The Cayucos/Whale Rock Watershed drains an area that is considered a moderate fire hazard zone, and so the risk of damaging runoff is less, although still present. Table A-36 shows how changes in wildfire events may affect Morro Bay's water and water quality-related assets.

## Drought

Drought has extensive effects on water and water quality-related assets in Morro Bay, including riparian and aquatic ecosystems, water infrastructure, and water quality and availability. Impacts to water availability are the most severe, as both primary sources of Morro Bay's water are threatened by droughts. The SWP uses water from the northern Sierra Nevada, an area which is expected to see a large decline in precipitation levels, reducing the amount of water available for the numerous communities throughout California that rely on this water source. Morro Bay's groundwater basins, the other source of water for the community, are somewhat protected from drought, but can still be harmed if chronic drought reduces the amount of water entering the groundwater basin. At the same time, drought may lead to more groundwater pumping, placing further stress on the basins. Creeks and watersheds could be affected by drought if there is less water in the creek beds, which, depending on the severity of the drought, could have biological, scenic, and recreational impacts. It is possible that water quality could be harmed by drought because less water in creeks means that sediments and pollutants are concentrated, although depending on the specific hydrology some water quality issues may also improve during droughts. There are also impacts to the stormwater infrastructure in Morro Bay and the Morro Bay Estuary, although these impacts are likely to be limited. Table A-37 shows how droughts can affect water and water quality-related assets in Morro Bay.

## Flooding

The primary risk to the water and water quality-related assets in Morro Bay from flood events is to water quality. Floodwaters pick up sediments and pollutants such as spilled chemicals and automotive fluids, pesticides and fertilizers from agricultural areas, and trash. This runoff eventually winds up in local creeks and other water bodies where it

can affect water quality. When the creeks enter the ocean, areas near the outlet can also suffer from reduced water quality. This can create a human health risk from recreational activities in affected water bodies, such as swimming or fishing. These sediments and pollutants can also harm the biological integrity of riparian and coastal habitats, although such impacts are generally minimal in riparian or coastal habitats unless there are substantial changes in the surrounding land uses that cause a major increase in runoff pollutants. Flood events may similarly affect the Morro Bay Estuary, although estuarine habitats are usually well suited at filtering sediments and pollutants from water. There are also potential impacts to stormwater infrastructure such as storm drains, although effective cleaning and other maintenance can minimize these effects. Table A-38 shows how flooding may affect water and water quality-related issues in Morro Bay.

### Sea Level Rise

Sea level rise primarily threatens Morro Bay's water supply and some water and water quality-related infrastructure, and is not expected to affect local creeks or watersheds. Increases in sea levels are likely to cause saltwater to intrude into local groundwater basins, which in turn may make them unusable as a source of water or may require salinity treatment before the water can be used. Rising sea levels may affect the community's storm drains, decreasing their effectiveness. Sea level rise could also cause increased flooding and erosion in the Morro Bay Estuary, changing nutrient and salinity levels. These changes in turn may affect the estuarine ecosystem, and may reduce the estuary's value as a scenic and recreational destination. Table A-39 describes how sea level rise may affect Morro Bay's water and water quality-related assets.

## Water and Water Quality Conclusions

### Changing Urban Form May Disrupt Watershed Function

Through 2040, Morro Bay is expected to experience a 12–15 percent increase in population, subject to existing growth limits, and a 17–25 percent increase in jobs. New businesses and residents will create additional demands on resources across the region. A part of this demand will come from the location of these new homes and commercial areas. If these new buildings are developed in previously undeveloped areas, such as agricultural lands and open spaces, the amount of permeable groundcover in the

watersheds that encompass Morro Bay could be reduced (EPA 2015b). These changes can alter the natural processes of the watershed.

Covering these areas with impervious surfaces, such as streets, sidewalks, and buildings, would increase the volume of stormwater runoff into storm drains, as well as the volume of pollutants from ground contaminants. This increased volume and decreased quality of stormwater runoff has watershed level impacts, and can further diminish water quality around stormwater outfalls along Morro Bay's coast.

Prioritizing residential and commercial infill in existing, underutilized developed parcels, as well as development of green infrastructure and low-impact development, will minimize the increase in impervious surfaces and allow the City to focus on compliance with municipal separate storm sewer system (MS4) and National Pollutant Discharge Elimination System (NPDES) permits in the city.

The anticipated economic and residential growth in Morro Bay through 2040, detailed above, will also have consequences for demand on water resources. Landscaping of new development, industrial uses, water for homes and businesses, and support of community services (e.g., parks) all demand water. This increased demand will coincide with anticipated decreases in availability. As surface water supplies are diminished as a result of ongoing drought, pressure will likely fall on the City's groundwater resources.

Both Morro and Chorro Groundwater Basins border the Pacific Ocean, making them vulnerable to seawater intrusion. This has been identified as an issue for city wells connecting to shallow groundwater resources. Overdrafting the basins creates a pull for saline ocean water to come in, contaminating the groundwater resource. Strict attention to groundwater management, increased efficiency of community water use, and increased development of low-impact homes and businesses will reduce pressure on the city's water supply in the face of increased growth and demand.

### Morro Bay's Water Sources May Be Increasingly Unreliable under Climate Change Conditions

In Morro Bay's UWMP, the City anticipated supplying approximately 61 percent of its water from local groundwater sources and approximately 26–39 percent from the SWP beginning in 2020, with an option for recycled water to make up 13 percent of the community's water supply beginning in 2025 (City of Morro Bay 2016a). However, the

City has relied much more heavily on SWP water than expected. In 2015, water from the SWP supplied approximately 87 percent of Morro Bay's water, and treated groundwater made up 13 percent. Morro Bay is allocated up to 1,313 acre-feet of water from the SWP, which exceeds current and projected community water use for drinkable water through at least 2040 (City of Morro Bay 2016a, 2016b).

This current heavy reliance on the SWP renders Morro Bay's water supply extremely vulnerable to supply disruptions because of drought. The SWP water comes primarily from the Feather River in the northern Sierra Nevada. Recent state studies project a significant decline in precipitation (as much as 10 inches fewer by 2100) and a more than 60 percent drop in accumulated snow by 2090 as a result of climate change (CNRA and Cal OES 2012). These changes will make less water available for communities throughout the state that receive water from the SWP. Climate change is also expected to cause more frequent, more intense, and longer-lasting droughts statewide, exacerbating water supply concerns.

Water from the SWP is already in short supply. Although Morro Bay's maximum allocation of water from the SWP could meet the community's needs for drinkable water (City of Morro Bay 2016a), the City almost never receives its maximum allocation. Since 2005, Morro Bay's deliveries from the SWP have never been above 60 percent of the City's maximum allocation, and in some years the City has received no SWP water at all (City of Morro Bay 2016b). As the effects of climate change become more pronounced, and as statewide population growth places greater demand on the SWP, total deliveries from the SWP may decrease.

Morro Bay's groundwater supplies are more resilient to drought conditions than the SWP, although still vulnerable. Relatively short and/or mild droughts are unlikely to affect groundwater levels to any substantial degree. However, long-lasting and/or severe droughts, such as the statewide drought that began in 2012, are likely to reduce the amount of water entering the groundwater basins and cause a drop in groundwater levels. Studies suggest that these kinds of droughts are likely to occur more frequently in the future because of climate change.

Morro Bay is able to receive as much as 1,147 acre-feet of water from groundwater basins, although since 1998, the City has pumped no more than 354 acre-feet from groundwater, due to the availability of water from the SWP (City of Morro Bay 2016b). While this suggests that Morro Bay could pump more groundwater as deliveries from

the SWP become less reliable, this may not be a viable option. Morro Bay's groundwater allocation can be curtailed during drought years, and recent legislation meant to ensure sustainable use of groundwater basins means that Morro Bay's allocation may be permanently decreased in future years.

Because of climate change and other factors, Morro Bay's water supplies are at risk, and there is a chance that the City may be unable to receive a sufficient supply of water to meet its needs in future years. Increasing the diversity of the City's water supply can help address this risk. For example, by decreasing reliance on the SWP, Morro Bay can become more resilient to drought conditions in the northern Sierra Nevada. New sources of water, such as the WRF, and increased use of the City's existing desalination plant can also help increase diversity of water sources. In addition to improving diversity of sources, the City should prioritize water conservation strategies, as these will maximize resilience against supply interruptions and shortages.

## Floods and Wildfires Will Increasingly Threaten Water Quality in Riparian and Coastal Areas

Rainfall events, particularly intense rains that lead to floods, create runoff that flows into the ocean, either directly or indirectly via local creeks. This runoff often carries sediments and pollutants, including agricultural chemicals and waste products, particles of automotive chemicals from roads, debris and trash that collects in storm drains, and a number of other materials. Materials in runoff can pollute local water bodies. Trash can physically accumulate in the water bodies, endangering animals and reducing scenic benefits. Sediments can alter the clarity of the water, affecting aesthetics and potentially harming the plants and animals that live in it. Toxins and other hazardous materials may also harm plants and wildlife, and in some cases can create human health risks. Beaches in the region are occasionally closed after rains, when runoff causes an increase in the concentrations of pathogens or pollutants near the shore.

In many instances the harmful effects of runoff, while not insubstantial, do not constitute a major hazard. Creek and coastal ecosystems can usually survive these occasional influxes of sediments, toxins, and debris. Estuarine habitats such as the Morro Bay Estuary are able to remove some of the sediment and pollutant load from runoff water, helping to decrease the hazard. Creek or beach closures are a temporary inconvenience and generally do not affect the overall recreation opportunities in the community. However, changes to flood and wildfire regimes in the area may make runoff a more

severe issue. Vegetation in an area helps to hold soil together and to slow down and absorb water, reducing runoff into local water bodies, and by extension, reducing the sediment and pollutant load. After wildfires, when the vegetation is burned and has not had time to recover, runoff volumes become greater. The overall wildfire risk in and around Morro Bay is expected to slightly increase (up to 15 percent) by 2100. Parts of local creek systems and watersheds include areas that are considered high or very high fire hazard severity zones, and therefore are more likely to burn. Flood events in the community are expected to become more frequent and/or more severe, exacerbating the intensity of runoff both inside and outside of burn areas. These changes can lead to greater sediment and pollutant loads in local water bodies, creating more substantial impacts.

The City has a number of tools available to help reduce threats to water quality from runoff. Wildfire prevention efforts can reduce the number of areas burned, and erosion control measures both within and outside of burn areas can decrease sediment and pollutant loads by minimizing runoff. Proper cleaning and maintenance of storm drains helps to keep trash and debris out of local water bodies, and limits on the use of toxic or other hazardous materials reduce the chance that these compounds will end up in creeks and oceans. However, runoff is ultimately a natural process that cannot be entirely stopped, and some sediments and pollutants will always end up in Morro Bay's water bodies. Prompt notifications and actions such as closures and cleanup activities can reduce the risk to both natural ecosystems and human health.

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# APPENDIX A – VULNERABILITY AND RESILIENCE ASSESSMENT METHOD AND TABLES

The first step in the vulnerability and resilience assessment is to identify which changes, or exposures, are expected to occur in Morro Bay. Two of these changes, demographic and economic changes, are expected to occur as a regular consequence of community and regional growth. They are not caused by a specific factor, but are the natural outcome of a growing population and efforts to improve local economic conditions. The other changes, those which are related to climate change, are taken from the California Adaptation Planning Guide (APG), which identifies the climate change-related effects that are expected to occur in the Central Coast region.

To prepare a list of assets which may be affected by demographic and climate-related changes, the authors reviewed the Community Baseline Assessment and identified the specific assets discussed. These assets may include specific structures or properties, neighborhoods, land use categories, key services, natural resources, key services, and individuals or populations, among others. The authors also reviewed the APG to include any other assets recommended by state guidance. The authors then removed assets that were not likely to be affected, based on their understanding of the effects of demographic changes and climate change.

For each asset, the authors assigned an impact and an adaptive capacity score based on various studies and familiarity with local conditions. The impact score reflects the severity of the effects that the demographic and climate change-related exposures are expected to have on the assets. For each asset and exposure pair, the authors assigned a score of Low (1),

Moderate (2), or High (3). [3] In accordance with APG guidance, the authors considered the following questions for each asset and exposure when determining the impact score:

### For population-related assets

- How severe are the hardships that the population could face?
- Is there a risk of injury or death?
- How many people could reasonably be affected?
- What is the duration of the effects, and how long would they remain severe?

### For all other assets

- Is the asset in an area that faces an elevated risk for a hazard, or could the risk zone expand to include the asset?
- What is the value of the asset to the community, including both monetary and intangible value?
- How many people benefit from the asset?
- Can the asset continue to provide some or all of its benefits if it is affected?
- Would damage to the asset or its destruction create a risk of injury or death?

The authors also created an adaptive capacity score for each asset and exposure pair, which reflects whether the asset can reasonably adapt to the conditions created by the exposure using existing resources (finances, site design, etc.). As

[3] *The numbers provide a qualitative assessment for comparison purposes and do not directly correspond to a specific measurement.*

with the impact scores, the authors assigned a score of Low (1), Moderate (2), or High (3) for each asset and exposure pair. [4] The authors considered the following questions for each asset and exposure pair when determining the adaptive capacity score, based on APG guidance:

### For population-related assets

- Are there existing or planned policies or programs to assist people in responding to the exposure, and how easy is it for people to receive help?
- Do people have the financial means to reasonably respond?
- Are there alternatives to affected assets?
- Are there other barriers, such as technology or political will, that could delay, weaken, or prevent a response?

### For all other assets

- Are there existing or planned policies to guide response activities?
- Do the asset owners have the financial means to repair or rebuild the asset so it can continue to provide benefits?
- Would repair or reconstruction occur automatically by the owners (either voluntary or mandated by existing laws)?
- Are there alternative assets that can provide similar benefits while repair or reconstruction activities occur?
- Are there any other substantial barriers to effective response?

[4] *The numbers provide a qualitative assessment for comparison purposes and do not directly correspond to a specific measurement*

Lastly, the authors combined the impact and adaptive capacity scores together to produce a final vulnerability score, ranging from Low (3) to High (9). This score reflects the asset's overall vulnerability to the specific demographic or climate change-related effect.

# A.1 LAND USE EXPOSURES, VULNERABILITY, AND RESILIENCE

Table A-1
Land Use Assets Exposed to Demographic Change and Climate Change Hazards

| Assets | Demographics | Economics | Climate Change | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temp. | Wildfire | Drought | Flood | SLR |
| State-owned open space | | | | ○ | ○ | | ○ |
| Beaches | | | | | | | ○ |
| Coastal zone accommodations | | ○ | | | | | ○ |
| Commercial fishing infrastructure | | | ○ | | | | |
| Agriculture | ○ | ○ | ○ | ○ | ○ | ○ | |
| Housing stock | ○ | | ○ | | | | |
| RV parks | | | | | | ○ | |
| The Embarcadero | | | ○ | | | | ○ |
| Strip commercial | | ○ | | | | ○ | |
| Downtown | ○ | ○ | | | | | |
| Highway 1 commercial | | ○ | | | | ○ | |
| Hillside neighborhoods | | | | ○ | | ○ | |

Table A-2
Land Use Asset Vulnerability to Population Change

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Agriculture | Prime and nonprime agricultural land may face increasing residential development pressures as Morro's Bay population grows through 2040. | Low (1) | Prime agricultural lands are protected under the Coastal Act. All agricultural lands in Morro Bay are in the Coastal Zone, limiting the impact of development pressures. | Moderate (2) | Moderate (5) |
| Housing stock | A majority of Morro Bay's housing stock was built prior to 1970, with nearly a quarter in need of rehabilitation. Population growth will increase demand for adequate, safe housing. | High (3) | Infill development in underutilized areas may provide opportunity for developers and the City to rebuild and enhance older housing. Efficiency programs may also encourage existing homeowners to improve insulation or cooling capacity. | Moderate (2) | Moderate (7) |
| Downtown | If a majority of growth and new housing is anticipated within existing boundaries of developed areas, downtown may face additional pressure for new residential developments. | Low (1) | Density bonuses, zoning revisions, and prioritization of coastal access and visual resources will allow the City to encourage development of additional homes in the downtown. | Moderate (2) | Moderate (5) |

Table A-3
Land Use Asset Vulnerability to Economic Change

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Coastal zone accommodations | Affordability of coastal accommodations is paramount to preserving coastal access for all. While Morro Bay currently provides accessible resources for overnight visitors, continued economic development in the coastal zone may threaten this affordability. | Moderate (2) | Preserving the broad range of accommodation options, including RV parks, motels, and B&Bs, and encouraging development of additional visitor-serving accommodations will help Morro Bay maintain affordability of coastal zone accommodations. | Moderate (2) | Moderate (6) |
| Agriculture | Prime and nonprime agricultural land may face increasing commercial development pressures as Morro Bay faces economic and employment growth through 2040. | Low (1) | Prime agricultural lands are protected under the Coastal Act. All agricultural lands in Morro Bay are in the coastal zone, limiting the impact of development pressures. | Moderate (2) | Moderate (5) |
| Commercial uses (strip, downtown, Highway 1) | A changing economy and new jobs may present new demands on commercial developments. Existing, low-density development may face pressure for higher intensity or multi-benefit uses. | Moderate (2) | Projections of economic sectors will allow the City to best anticipate commercial space needs, and encourage infill development in existing, underutilized spaces to preserve undeveloped lands and encourage walkability. | Low (1) | Moderate (5) |

Table A-4
Land Use Asset Vulnerability to Extreme Heat

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Commercial fishing infrastructure | A small but vital part of Morro Bay's economy, the fishing industry depends on the vitality of the fish and crustaceans in the bay and adjacent ocean. Extreme temperatures may decrease these aquatic populations, impacting the economy and need for commercial fishing infrastructure in Morro Bay. | Moderate (2) | Continued economic analysis and support for aquatic conservation efforts can buoy the industry, but some anticipated impacts may be beyond local control. | High (3) | Moderate (7) |
| Agriculture | The City's limited agricultural operations include farmland and pasture. Some agricultural crops, such as fruits, nuts, and vegetables, are vulnerable to decreased yields as a result of increasingly extreme temperatures. Others, such as grasslands, are more resilient. | Low (1) | Support for local farmers, including preservation of surrounding open space to minimize the urban heat island effect, may decrease the impacts of extreme temperature increases. Accommodations for increased water needs may also be considered for prime agricultural land. | High (3) | Moderate (6) |
| Housing stock | A majority of Morro Bay's housing stock was built prior to 1970, with a quarter in need of rehabilitation. Older homes are less likely to have adequate insulation, posing a threat to residents. Elderly residents in old homes may be especially harmed by rising temperatures, especially if they are homebound and don't have the physical or financial resources to cool themselves. | High (3) | The City can provide cooling centers to support the vulnerable populations living in older housing stock, and keep a list of residents who should be alerted in extreme heat events. City-led efforts to increase efficiency, insulation, and cooling capacity in existing homes may allow older homeowners to stay in their residences for longer. | Moderate (2) | Moderate (7) |

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| The Embarcadero | Trips to the Embarcadero, which thrives on visitors and residents strolling along the street and visiting individual shops and restaurants, may be diminished on high heat days, potentially minimizing economic vitality in the region. | Moderate (2) | A high heat day for Morro Bay is any day above 82 degrees Fahrenheit, which may not be prohibitive to all visitors. Additionally, the City can support efficiency and cooling efforts of Embarcadero businesses to support visitor levels even in extreme heat events. | Low (1) | Moderate (5) |

Table A-5
Land Use Asset Vulnerability to Wildfire

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| State-owned open space | Parts of Morro Bay State Park lie within high and very high fire hazard zones. Fire damage to open space lands in the park may decrease their scenic and recreational value, reducing the number of visitors and causing a decline in visitor-related tourism economic activity. | Moderate (2) | The natural ecosystem of Morro Bay State Park is adapted to wildfires and should recover by itself from any conflagrations. The risk of damage to the scenic and recreational amenities can be reduced with effective fire prevention strategies, but after a fire the only effective option is to allow the natural recovery to continue. | High (3) | Moderate (7) |
| Agriculture | The agricultural land in Morro Bay is located adjacent to a moderate fire hazard zone. The risk of wildfire affecting agricultural activities is not great, but the possibility exists that a fire in the nearby area could cross into agricultural lands. On cropland, irrigation systems can help prevent the spread of fire. | Low (1) | Grazing land is likely to remain relatively undamaged, as there are no assets of value. However, if cropland is burnt, there is no effective way to restore the crops short of replanting. | Moderate (2) | Moderate (5) |
| Hillside neighborhoods | Morro Bay's hillside neighborhoods back up against areas of moderate fire hazard. Although the risk of wildfire in these areas is less compared to other fire hazard zones, the risk is still present, and homes may be damaged or destroyed. | Low (1) | Various home and landscape design features can help reduce the risk of fire damage, while an accessible street layout helps facilitate evacuations and improve fire response times. These strategies can improve resiliency to fire, although not eliminate it completely. Making some of these changes may be difficult in established neighborhoods. | Moderate (2) | Moderate (5) |

Table A-6
Land Use Asset Vulnerability to Drought

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| State-owned open space | The natural landscape of Morro Bay State Park could be stressed by drought. The lack of water for plants may make it less attractive for visitors, causing a downturn in attendance and related economic activity. | Low (1) | Native plant species are likely drought-tolerant and able to effectively recover by themselves. However, during recovery, attendance may be lower due to a decline in the park's scenic characteristics, and the only effective strategy is to allow the ecosystem to recover in its own time. | Low (1) | Low (4) |
| Agricultural | Agricultural land in Morro Bay receives water through dedicated private wells. While groundwater resources are less affected by drought than surface water, long-term drought can cause groundwater levels to drop, reducing available supplies for agricultural land. Overpumping of groundwater can exacerbate supply shortages. If the water supply is insufficient, or if water prices increase, current agricultural activities may not be economically viable. | High (3) | Water conservation efforts can help keep groundwater levels high during droughts. Recent laws will help manage groundwater resources more sustainably to prevent overpumping. However, in the event that droughts do affect groundwater supplies, replacement water supplies may be unavailable or prohibitively expensive. Farmers may have to curtail agricultural activities or switch to less water-intensive products. | High (3) | High (8) |

Table A-7
Land Use Asset Vulnerability to Flood

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Agricultural | Floodwaters can wash away nutrient-rich topsoil. More severe floods may also damage crops or wash away small plants. While any area may experience these runoff impacts, the problem may be particularly severe for agricultural areas in the floodplain. | Moderate (2) | Drainage systems, contouring of the land, and other strategies can help slow down and capture floodwaters, reducing the potential for damage. However, the effects of floods may not be fully mitigated. | Moderate (2) | Moderate (6) |
| RV parks | Some RV parks lie within the floodplains, and so are at risk of damage from flood events. Significant floods may damage RVs themselves, creating a risk of injury. Less substantial flood events may still damage RV park infrastructure, making them less appealing to visitors and reducing tourism activity. | Moderate (2) | Various drainage and design strategies can divert water away from RV areas or key infrastructure, or slow it down to reduce the risk of damage. Infrastructure can also be hardened to be more resilient to floods. It is possible that these upgrades could pose a cost burden. | Low (1) | Moderate (5) |
| Strip commercial | Some strip commercial properties lie within the 100-year or 500-year floodplain. As a result, they may be damaged during flood events. | Moderate (2) | Good drainage systems and effective application of LID strategies can reduce flood risks by slowing down and diverting water away from buildings. It is possible that the cost of such retrofits may be substantial. | Low (1) | Moderate (5) |

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Highway 1 commercial | Commercial facilities adjacent to Highway 1 near Morro Creek and Alva Paul Creek are within existing floodplains and vulnerable to flood events. | Moderate (2) | Commercial facilities can improve their resistance to flood events by using LID strategies and effective drainage systems. While some flood risk will remain, these techniques can reduce the threat substantially if properly implemented, although some property owners may face a substantial cost. | Low (1) | Moderate (5) |
| Hillside neighborhoods | Some hillside neighborhoods near creeks are at risk of inundation during flood events, which may damage buildings or pose a health/safety risk. Additionally, homes near hills are at risk of landslides, which may occur as a consequence of heavy rains. | Moderate (2) | Homes can make themselves more resilient to flood events with strategies such as LID techniques and well-designed drainage systems. While walls can offer some protection from landslides, they may be unable to substantially reduce the risk. The cost of these improvements for homeowners may be prohibitive in some instances. | Moderate (2) | Moderate (6) |

Table A-8
Land Use Asset Vulnerability to Sea Level Rise

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| State-owned open space | Sea level rise threatens to inundate a number of physical structures in state-owned open spaces, including parking lots, restrooms, utility infrastructure, and marinas. Parking and access areas will likely face increased flooding. Dunes are expected to erode inland and may no longer existing in some locations. | High (3) | Many physical facilities cannot easily be moved or protected, and so options to protect such features are limited. While some natural features may be able to adapt, a number of features that cannot naturally migrate inward could be temporarily inundated or permanently lost. Temporary inundation of parking and access areas will likely require increased maintenance, leading to higher costs. Marina structures will likely need to be retrofitted to accommodate higher sea levels. | High (3) | High (8) |
| Beaches | Approximately 68 acres of beaches are expected to be impacted by inundation, flooding, and erosion due to sea level rise by 2050. The amount of beach area providing recreational and storm protection benefits is expected to shrink. | High (3) | In some areas, beach nourishment or dune replenishing may help mitigation losses due to sea level rise. However, these options may not be feasible in locations close to coastal development, such as homes or businesses. | Moderate (2) | Moderate (7) |
| Coastal zone accommodations | Low-cost accommodations such as the Morro Strand Campground are expected to be exposed to the effects of sea level rise, including occasional flooding and erosion, although such events are not expected to substantially degrade the quality of the facility within the planning horizon. | Low (1) | Increased cleaning will likely be necessary to maintain functionality of the campgrounds, driving up costs. Although the campgrounds themselves may not be substantially damaged, these facilities cannot be relocated and adaptive strategies may not always be feasible. | Moderate (2) | Moderate (5) |

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| The Embarcadero | By 2050, some buildings along the Embarcadero may face increased exposure to coastal flooding, particularly during high tides and storms. Such events are likely to be episodic without substantial disruption to the buildings themselves. | Low (1) | Modifications to individual buildings may be necessary to accommodate the increased water levels. The buildings themselves have only limited options, as they cannot be easily relocated and there is no space for protective features. | Moderate (2) | Moderate (5) |

# A.2 INFRASTRUCTURE

Table A-9
Infrastructure Assets Exposed to Demographic Change and Climate Change Hazards, 2040

| Assets | Demographics | Economics | Climate Change | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temp. | Wildfire | Drought | Flood | SLR |
| Electrical lines | | | ● | ● | ● | ● | |
| Morro Bay Substation | | | | | | ● | |
| Natural gas pipes | | | | | | ● | |
| Water pipes | | | | | | ● | |
| Groundwater wells | ● | ● | | | ● | | |
| Wastewater infrastructure | ● | ● | | | ● | ● | ● |
| Stormwater infrastructure | | | | | ● | ● | |
| Local roadways | ● | ● | ● | | | ● | ● |
| Highway 1 | ● | ● | ● | | | ● | ● |
| Highway 41 | ● | ● | ● | | | ● | |
| Public transportation infrastructure | | | | | | ● | |
| Freight movement | | | | | | ● | |
| Sanitation infrastructure | | | | | | ● | |
| Telecommunications infrastructure | | | | ● | | | |

Table A-10
Infrastructure Asset Vulnerability to Population Change

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Groundwater wells | Anticipated increases in population through 2040 may put stress on groundwater resources, causing existing wells to run dry if not drilled deep enough. | Moderate (2) | The planned construction of up to four new wells may appropriately provide infrastructure to meet anticipated future demand Water use reduction strategies may help prevent groundwater overdraft or saline intrusion. | Moderate (2) | Moderate (6) |
| Wastewater infrastructure | Anticipated increases in population through 2040 will generate a proportional increase in wastewater. A failure to accommodate this may lead to unsanitary discharges and violation of local water quality permits. | Moderate (2) | Although details are uncertain, the City's planned construction of a wastewater treatment plant provides an opportunity to efficiently and effectively serve the wastewater demands of an expanding population by building capacity for more connections to the plant. | Low (1) | Low (3) |
| Local roadways, Highway 1, and Highway 41 | Anticipated increases in Morro Bay residents will lead to an increase in the number of cars using local roads and highways that traverse the city. This may hasten the degradation of roadways. | Moderate (2) | The City's budget process can allow for a modified maintenance schedule to account for increased intensity of uses of roadways. Development that is amenable to alternative modes of transportation, such as walking and biking, may also reduce the pressure on vehicle-serving amenities. | Low (1) | Low (3) |

Table A-11
Infrastructure Asset Vulnerability to Economic Change

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Groundwater wells | Anticipated job growth and economic activity through 2040 may put additional demand on groundwater resources, causing existing wells to run dry if not drilled deep enough. | High (3) | The planned construction of up to four new wells may appropriately provide infrastructure to meet anticipated future demand Water use reduction strategies for businesses may help prevent groundwater overdraft or saline intrusion. | Moderate (2) | Moderate (7) |
| Wastewater infrastructure | Anticipated increases in employment and economic activity through 2040 will generate a proportional increase in wastewater. A failure to accommodate this may lead to unsanitary discharges and violation of local water quality permits. | Moderate (2) | Although details are uncertain, the City's planned construction of a wastewater treatment plant provides an opportunity to efficiently and effectively serve the wastewater demands of an expanding commercial activity and new employees by building capacity for more connections to the plant. | Low (1) | Moderate (6) |
| Local roadways, Highway 1, and Highway 41 | Anticipated increases in Morro Bay residents will lead to an increase in the number of cars using local roads and highways that traverse the city. This may hasten the degradation of roadways. | Moderate (2) | The City's budget process can allow for a modified maintenance schedule to account for increased intensity of uses of roadways. Development that is amenable to alternative modes of transportation, such as walking and biking, may also reduce the pressure on vehicle-serving amenities. | Low (1) | Moderate (6) |

Table A-12
Infrastructure Asset Vulnerability to Extreme Heat

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Electrical Lines | Extreme heat can decrease power line performance and cause stress on the grid, affecting electrical service without physically harming the wires. This can threaten energy supply to the city in times when electricity is crucial for cooling critical facilities and vulnerable populations. | High (3) | Updating electricity infrastructure with more insulated technologies can reduce the impact of extreme temperatures, but much of this is outside of the City's purview. Continue working with utility providers to ensure best available technologies are used to increase resilience of the city's grid. Microgrids, powered by local power generation from solar, can provide "islanding" capabilities, allowing Morro Bay to support key operations without connection to the grid in times of energy emergency. | Moderate (2) | Moderate (7) |
| Local roadways, Highway 1, and Highway 41 | Extreme temperatures can cause asphalt and pavement to melt, buckle, or crack. These impacts can be costly to repair and create difficult driving conditions. | Moderate (2) | Using high-albedo paving or asphalt to repair or replace roadways can diminish the impact of high temperatures on local roadways and highways. | Moderate (2) | Moderate (6) |

Table A-13
Infrastructure Asset Vulnerability to Wildfire

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Electrical lines | Morro Bay's electrical lines cross through wildfire-prone areas, and so may be damaged or destroyed by wildfires. However, most of these areas are deemed only moderate fire hazard zones, and so the risk is comparatively low. | Low (1) | There is sufficient redundancy in the electrical grid that the loss of one key power line should not cause widespread outages, although small-scale disruptions may occur. Maintaining defensive space around power lines can help reduce the risk of fire damage. Undergrounding power lines can also help significantly, although this can be very expensive. | Low (1) | Low (4) |
| Telecommunications infrastructure | Many of the telecommunication systems that serve Morro Bay, such as data cables or cellular towers, are located entirely or partially in wildland areas, and so are at risk of wildfires. Damage or destruction of these facilities could cause communication service disruptions in Morro Bay. These facilities are predominantly in moderate risk areas, which means that the risk is comparatively low (but still present). Many facilities are also underground, further reducing the risk. | Low (1) | There are likely sufficient redundancies in the telecommunications network that the loss of some facilities are unlikely to cause long-term and/or widespread outages, although small-scale instances of degraded or disrupted service may occur. Maintaining defensive space around infrastructure helps reduce the likelihood of fire damage. Undergrounding infrastructure also helps, although this is expensive and may not be an option for all infrastructure types. | Low (1) | Low (3) |

Table A-14
Infrastructure Asset Vulnerability to Drought

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Electrical lines | During droughts, less electricity can be generated from hydroelectric facilities, decreasing available electric sources. Without a replacement supply of electricity and/or reductions in electricity use, shortages and stress on the grid may occur. | Moderate (2) | Alternative sources of energy are readily available, usually natural gas. These resources are currently abundant and cost-effective, although there are consequences from increased use of natural gas. | Low (1) | Low (3) |
| Groundwater wells | Drought conditions are unlikely to cause physical damage to groundwater wells, but droughts can make less groundwater available. While groundwater is more resilient to drought than surface water, long-term drought conditions can cause groundwater levels to drop. This problem can be magnified if the drought makes less water available from other sources, leading to increases in groundwater pumping. Drought conditions can also cause brackish water to flow into groundwater basins. | Moderate (2) | Strategies that increase the amount of permeable groundcover help to recharge groundwater resources, although this may not always be effective. Water conservation efforts and recent groundwater management laws will help prevent overpumping. Saltwater infiltration can be prevented though desalination and other mitigation strategies, but these approaches are often expensive. | High (3) | Moderate (7) |
| Wastewater infrastructure | Water conservation techniques during drought conditions can cause solids to back up in wastewater pipes, damaging the pipes and pump systems. | Moderate (2) | Short of increasing the flow of wastewater through pipes, which can defeat the benefits of water conservation, the only solution is generally increased maintenance, which can be expensive. | Moderate (2) | Moderate (6) |

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Stormwater infrastructure | During droughts, debris can build up in storm drains and related infrastructure, damaging systems and causing blockages during precipitation events. | Moderate (2) | Regular maintenance keeps stormwater infrastructure clear of debris and in good working order. However, this increased maintenance may stress available funds in some instances. | Low (1) | Moderate (5) |

## Table A-15
## Infrastructure Asset Vulnerability to Flood

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Electrical lines | Some aboveground power lines, including high-voltage lines, cross through flood hazard zones. Floodwaters can topple poles supporting power lines or damage other electrical infrastructure, causing outages. | Low (1) | Floods are more likely to damage local distribution lines, causing minor outages. Only severe floods could likely damage the major transmission lines that could cause regional blackouts. Redundancies in the electrical system could prevent severe power outages for most flood events. Additionally, infrastructure can be hardened against flood events, although there may be added cost. | Low (1) | Low (4) |
| Morro Bay Substation | The Morro Bay substation sits in a flood hazard zone, and so is vulnerable to flood events. Sufficient damage to the substation could cause power outages for large sections of Morro Bay. It would likely take a substantial flood to damage the substation. | Moderate (2) | The substation can be retrofitted to be more resilient against flood events, although this brings with it extra costs and is outside of the City's control. There are redundancies in the electrical grid, although they are limited. | Moderate (2) | Moderate (6) |

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Natural gas pipes | Floodwater can damage natural gas pipes and supporting infrastructure. Damage to natural gas infrastructure runs the risk of service outages, fires, or explosions. Such damage usually only occurs after severe flooding. | Low (1) | Most natural gas infrastructure is underground and so somewhat protected from flood events, although there are still ways for water to get into the system or to damage infrastructure. There are strategies to harden natural gas infrastructure against flood events, but they can be expensive. | Moderate (2) | Moderate (5) |
| Water pipes | In a sufficiently large flood event, water pipes and related infrastructure could be damaged, interrupting water service in parts of the community. | Low (1) | Water pipes and related infrastructure are mostly underground, and so protected to some degree by floodwaters, although they are not immune to flood events. Water pipes are under the City's control and so could feasibly be hardened, although there may be substantive costs. | Low (1) | Low (4) |
| Wastewater infrastructure | Flooding can cause damage to wastewater infrastructure, particularly sewer backup events that can cause wastewater pipes to back up into building interiors. These events can cause substantial property damage and may pose a health threat. | Moderate (2) | Private property owners and the City can install backwater prevention valves to reduce the risk of sewer backup, and use pipes and other infrastructure that are harder to damage in a flood event. While there may be added costs from these features, the City controls the sewer lines and so is more able to make these improvements. | Low (1) | Moderate (5) |

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Stormwater infrastructure | The volume of water generated by flood events can exceed the capacity of storm drains and related infrastructure, potentially causing ponding or damage to the infrastructure itself. Such events can exacerbate flood conditions by creating areas of standing water. | Low (1) | The City can design stormwater infrastructure to handle the expected water capacity, and maintain it effectively to minimize the chance of blockages or damage. However, such actions may be expensive and/or time-consuming. | Moderate (2) | Moderate (5) |
| Local roadways (local, collector, and arterial) | Many local roads in Morro Bay are within flood hazard zones. Floodwaters can wear away the road surface or the substrate, causing damage that can require significant repair work. Water may also pond on the road surface itself, creating a safety risk. | Moderate (2) | Roads can be engineered to better resist damage from flood events, and increased drainage can help improve resilience to ponding. These methods can effectively reduce vulnerability, although there are increased costs associated with these retrofits. The road network in most parts of Morro Bay is redundant, so alternative paths are often available. | Low (1) | Moderate (5) |
| Highway 1 | Several parts of Highway 1 in Morro Bay are in flood hazard zones, as are parts of the roadway both north and south of the community. Floodwaters can damage roadways or render them impassable due to ponding. If this occurs along Highway 1, it can cut off parts or all of Morro Bay from the region. | Moderate (2) | Roads can be engineered with improved drainage and more resilient surfaces and substrates, allowing them to resist damage or loss of access due to ponding. The added cost may create barriers, and Highway 1 is under state control, which may limit feasibility in some instances. Additionally, effective alternatives for regional access are highly limited, increasing the impacts of any disruption. | Moderate (2) | Moderate (6) |

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Highway 41 | Highway 41 is within a flood hazard zone near its junction with Highway 1. As such, there is an increased risk that Highway 41 may be damaged by floodwaters or otherwise rendered impassable due to ponding. | Moderate (2) | Highway 41 is not a critical roadway to Morro Bay to the same degree as Highway 1, although it still provides important access east of the community. Like other roadways, Highway 41 can be engineered to be more resilient to flood events, but this can be expensive and requires increased coordination with state agencies. | Low (1) | Moderate (5) |
| Public transportation infrastructure | During severe flood events, bus stops and supporting transit facilities may be damaged by floodwaters. Damage to roads or ponding on road surfaces may also render roads impassable, requiring the suspension or rerouting of transit routes. | Moderate (2) | Although bus stop amenities can be harmed by floodwaters, the bus stops themselves can continue to function. Bus routes can be rerouted or rescheduled as needed, although this may create challenges for people without other means of transportation. | Low (1) | Moderate (5) |
| Freight movement | If roadways are damaged or rendered impassable by floodwaters, it can impede the movement of goods in and out of Morro Bay homes and businesses. Delivery and pickup of freight may take longer or be halted while flood conditions exist. | Moderate (2) | Most flood situations will abate within a few days, and any substantial damage to roadways can be patched quickly as an emergency repair. Disruption to freight movement is likely to be temporary and not likely to cause substantive problems, although chronic flood conditions may result in greater effects. | Low (1) | Moderate (5) |
| Sanitation infrastructure | Waste collection bins can be damaged or destroyed by floods, depriving properties of waste collection until backup bins are obtained. Service may also be disrupted if roads are damaged or impassable. | Low (1) | Any interruption to waste collection service is likely to be temporary, limited to the flood event period itself, and would likely recover fast enough to avoid significant disruptions. However, options to actually reduce vulnerability may prove difficult. | Low (1) | Low (4) |

Table A-16
Infrastructure Asset Vulnerability to Sea Level Rise

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Wastewater infrastructure | The current wastewater treatment plant lies within the sea level rise inundation zone, and could be exposed to damage from flooding and erosion. Such events could cause a disruption in service, resulting in overflows and releases of untreated and partially treated wastewater. This in turn poses substantial human and environmental health risks. | High (3) | As currently situated, there are no feasible opportunities for retreat. The use of barriers and hardening of infrastructure may help reduce the risk, but such actions are expensive and may not always be effective. Morro Bay currently lacks any alternative for wastewater treatment if the existing plant is partially or entirely taken offline. | High (3) | High (8) |
| Local roadways | There is a risk of inundation, erosion, or other impacts to multiple local roadways, including access to Morro Rock via Coleman Drive. Such effects of sea level rise can render roads impassable, creating traffic delays that create problems for the wider community. These events can also substantially increase roadway maintenance and repair costs. | Moderate (2) | Although the area of affected roadways is small relative to the entire community, alternative transportation routes may not exist. While increased drainage systems and other roadways design features may provide some protection, these strategies may prove insufficient. | Moderate (2) | Moderate (6) |
| Highway 1 | Sea level rise is expected to cause temporary inundation of Highway 1 near Toro Creek at the north end of the community. While such events are intermittent, Highway 1 may be impassable during these periods. As a result, Highway 1 may have increased maintenance and repair needs. | Moderate (2) | Highway 1 is the sole roadway connecting Morro Bay to communities farther north. If Highway 1 at Toro Creek is flooded and unusable, there is no alternative way in or out of Morro Bay to the north. | High (3) | Moderate (7) |

# A.3 NATURAL RESOURCES

Table A-17
Natural Resource Assets Exposed to Change

| Assets | Demographics | Economics | Climate Change | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temp. | Wildfire | Drought | Flood | SLR |
| Herbaceous habitat | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | | |
| Riparian habitat | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | |
| Shrubland habitat | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | | |
| Dune habitat | | | | | | | ⊙ |
| Wetland habitat | | | ⊙ | | ⊙ | | ⊙ |
| Woodland habitat | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | | |
| Morro Bay Estuary | | | ⊙ | | ⊙ | ⊙ | |
| Special-status species | | | ⊙ | ⊙ | ⊙ | ⊙ | |
| Sensitive plant communities | | | ⊙ | | ⊙ | ⊙ | ⊙ |
| Critical habitat | | | ⊙ | ⊙ | ⊙ | ⊙ | |
| Wildlife movement corridors | ⊙ | ⊙ | | ⊙ | ⊙ | ⊙ | |

Table A-18
Natural Resource Asset Vulnerability to Population and Economic Change

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Herbaceous habitat | Herbaceous habitat to the east of Highway 1, as well as at the northern edge of the city, may be vulnerable to habitat loss if new residential development is located in those areas. | Moderate (2) | Limiting greenfield development through infill incentives may be effective in preserving herbaceous habitat. | Moderate (2) | Moderate (6) |
| Riparian habitat | The small amount of riparian habitat in Morro Bay may face limited development pressure, although this may be less feasible for developers, as the land may be at a greater flood risk. | Low (1) | Limiting development in critical riparian areas may be successful in protecting riparian areas. Development bonuses for increased development may also support preservation of this habitat. | Moderate (2) | Moderate (5) |
| Shrubland habitat | Shrubland habitat in Morro Bay is concentrated along the Morro Bay State Marine Reserve and on Black Hill. | Low (1) | Development bonuses for increased development may support preservation of this habitat. | Moderate (2) | Moderate (5) |
| Woodland habitat | Woodland habitat around the base of Black Hill, west of Morro Bay State Park, and west of Highway 1 in central Morro Bay all may be vulnerable to new residential development. | Moderate (2) | Limitations on hillside development can increase the City's protection of these areas. Development bonuses for increased development may also support preservation of this habitat. | Low (1) | Moderate (5) |
| Wildlife movement corridors | Construction of new roads and buildings in any previously undeveloped areas in Morro Bay may cause disruption to wildlife movement corridors in the city. | Low (1) | Because the City is already largely less permeable for habitat connectivity, there is little the City can do to prevent further disruption of wildlife movement. | Moderate (2) | Moderate (5) |

## Table A-19
## Natural Resource Asset Vulnerability to Extreme Heat

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Habitats, Species | Increased heat in Morro Bay can place stress on plant species, change the flora and fauna that flourish there, and encourage invasion of new, nonnative species that are better adapted to higher temperatures. | High (3) | The City can protect the habitat by managing invasive species, supporting planting of native species, and seeking to minimize other impacts such as the urban heat island effect. However, these responses may not be able to protect habitat and dependent species against heat stress. | Moderate (2) | Moderate (7) |
| Morro Bay Estuary | Rising temperatures can warm the estuary's shallow waters, altering the makeup of aquatic species that live there. | High (3) | While the City can support the estuary through preservation and restoration, temperature impacts cannot be managed directly, thus reducing the adaptive capacity of the estuary. | Moderate (2) | High (8) |

## Table A-20
## Natural Resource Asset Vulnerability to Wildfire

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Herbaceous habitat | Some of Morro Bay's herbaceous habitat is adjacent to areas of moderate fire risk. Fire can burn herbaceous plants, directly injure or kill animals, or indirectly harm animals by destroying plants that herbaceous-dwelling animals rely on. | Moderate (2) | California's herbaceous habitats, including those found in Morro Bay, are well adapted to wildfire, and are capable of recovering on their own. The habitat will be degraded immediately after a fire, but generally will recover quickly without any long-term harm. | Low (1) | Low (3) |

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Riparian habitat | Some Morro Bay riparian habitats are in areas of elevated wildfire risk, and so are subject to direct damage by wildfires. Wildfires in surrounding areas may cause an increase in runoff to riparian habitats, increasing pollutant and sediment load in riparian areas. | Moderate (2) | Riparian habitats burned by wildfires are likely to recover naturally, although recovery may be slow and may be stalled by future fire events. Riparian habitats will eventually flush sediment and pollutant loads out of water bodies. | Low (1) | Moderate (5) |
| Shrubland habitat | Large amounts of Morro Bay's shrubland habitat are in areas of elevated wildfire risk or are adjacent to these areas. As such, they are at direct risk of damage from wildfires. Shrubland animal species may also be harmed if the plants they rely on are burned by wildfires. | High (3) | The shrubland habitats in Morro Bay, including chaparral and coastal shrub, are well adapted to wildfire events, and are a necessary feature of the ecosystem in some instances. Shrubland habitat should recover fully from wildfire events, although the habitat may be temporarily degraded while recovery occurs. | Low (1) | Moderate (5) |
| Woodland habitat | Some of Morro Bay's woodland habitat is in or directly adjacent to areas of elevated wildfire risk. As such, these habitats may be damaged by wildfires, and animal species in these habitats may be harmed. Eucalyptus woodlands are of particular concern, as these nonnative trees are highly flammable and build up debris quickly, making them more vulnerable to wildfires and allowing them to spread fires more easily. | High (3) | Many native woodland plant species are fairly adapted to wildfires, and may emerge from less severe blazes without substantial damage. These species can also recover by themselves from fire events, although woodland regrowth is a slow process. Despite their susceptibility to wildfires, eucalyptus trees can also regrow naturally. However, the long recovery process may be harmful to animal species who cannot move to alternative woodland habitat. | Low (1) | Moderate (6) |

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Special-status species | Numerous species of special status live in or adjacent to wildfire-prone areas in Morro Bay. Such species may be directly harmed by wildfires, or may be indirectly harmed if plant species they rely on are damaged by wildfire events. | Moderate (2) | Some species live in habitats where wildfires are a regular occurrence. These species may be able to evade substantial damage, or can recover quickly from wildfire events. However, species that are less used to wildfires may face greater harm or recover more slowly. | Moderate (2) | Moderate (6) |
| Critical habitat | Critical habitat for the California red-legged frog is located in and adjacent to wildfire-prone areas. This habitat may be damaged or destroyed by wildfire, reducing the size of the frog's habitat in Morro Bay. | High (1) | Like most other habitats in California, the riparian vegetation that the frog lives in is adapted to recurring wildfires, and can recover by itself after a wildfire occurs. However, burned areas may not be able to effectively support California red-legged frogs until sufficient recovery has occurred. | Low (1) | Moderate (6) |
| Wildlife movement corridors | Most of Morro Bay has a low degree of habitat connectivity, reducing the severity of any effects to existing corridors. However, there may still be key corridors within the community subject to damage by wildfire. | High (3) | The habitats that form key wildlife connections in Morro Bay are likely resistant to wildfires, and so can naturally recover. However, it may be some time before the ecosystem recovers enough to fulfill its earlier connectivity functions. Additionally, changes from wildfire to other habitats in the area may make existing corridors less valuable, even once they recover. | Moderate (2) | Moderate (7) |

Table A-21
Natural Resource Asset Vulnerability to Drought

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Herbaceous habitat | Substantive droughts may damage or kill herbaceous habitat plants, weakening the ecological integrity of the habitat and harming native species. However, small droughts are unlikely to have a severe effect. | Moderate (2) | Herbaceous habitats are unlikely to be heavily damaged by small droughts, and can recover naturally from larger droughts. Recovery is likely to occur quickly, but there may still be short-term habitat disruption while recovery is going on. | Low (1) | Low (3) |
| Riparian habitat | Creeks in Morro Bay often dry up during dry periods, including in drought conditions. This reduced water availability may be harmful to the plants and animals living in riparian areas. | High (3) | Most small creeks in California are intermittent, and creeks frequently dry up during periods with little rain. As such, most plants and animals are adapted to these conditions and can recover with minimal damage. However, long-term severe droughts may do permanent damage to riparian species, causing a loss of biological integrity until the habitat can fully replenish itself. | Moderate (2) | Moderate (7) |
| Shrubland habitat | In a major drought, shrubland habitat plants and animals may not receive enough water, potentially causing individuals to die off and weakening the habitat's overall integrity. | Moderate (2) | Droughts are a regular feature of California's climate, and the plants and animals of shrubland habitats are well adapted to drought conditions. While it is possible that a very severe drought could cause substantive harm, the adaptive features of shrubland habitat species should help prevent large-scale damage. | Low (1) | Low (3) |

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Wetland habitat | As wetlands receive some water from the ocean, droughts will not deprive Morro Bay's wetlands of water. However, drought conditions will likely result in less freshwater and more saltwater in the estuary, potentially changing the nutrient balance of the habitat and affecting species who rely on a specific salinity level. | Moderate (2) | California's wetlands should be adapted to droughts, which are a regular feature of California's climate. However, more severe droughts, beyond normal conditions, may result in nutrient and salinity levels in wetland habitats that exceed ranges that plant and animal species are adapted to. | Moderate (2) | Moderate (6) |
| Woodland habitat | A lack of water can cause woodland plants to be drought-stressed, making them more susceptible to death or disease, and in turn harming the biological integrity of the habitat. | High (3) | Many woodland trees in Morro Bay are highly resistant to drought, and should be largely unaffected by most droughts. While severe droughts could cause more widespread damage, any harm to the ecosystem is likely to be within levels that woodland plants and animals are already adapted to. | Low (1) | Moderate (6) |
| Morro Bay Estuary | During droughts, less freshwater flows into the estuary, causing an increase in salinity levels as more seawater flows in. These changes in salinity levels can also affect the nutrient levels in the estuary. | Moderate (2) | Morro Bay's estuarine habitats are generally adapted to drought conditions, as they are a regular feature of the local climate. Many species in the estuary itself are likely already resistant to changes in salinity and nutrients, and can migrate to other areas as needed. It is possible that severe droughts can weaken the estuary's biological integrity, but it is likely to recover when normal conditions return. | Low (1) | Moderate (5) |

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Special-status species | Special-status plants and animals may be harmed during drought conditions if there is insufficient water to carry out their normal biological activities. | High (3) | Special-status species are likely to be native species, and given the frequency of drought conditions in California, are likely adapted to drought conditions. Unless drought conditions are very severe, it is unlikely that these species will be substantively harmed by drought. | Low (1) | Moderate (5) |
| Sensitive plant communities | The terrestrial sensitive plant communities in Morro Bay could be harmed if they fail to receive enough water during drought conditions. Wetland communities may also be affected during droughts due to saltwater intrusion and potential changes in nutrient levels. | High (2) | Morro Bay's sensitive shrubland plant communities are highly resistant to droughts and should be largely unaffected. Wetland sensitive plant communities may be more susceptible and could take a longer period of time to recover, although it is likely that any damage from droughts would not be permanent. | Low (1) | Moderate (6) |
| Critical habitat | Critical habitat for the California red-legged tree frog may be affected by droughts. A decrease in available water may make the habitat less able to support the frog. | High (3) | The wetland, riparian, and ephemeral pond habitats that the frog lives in could be damaged by drought. While some of these habitats can resist drought conditions, the chance of damage increases as the drought persists and/or is more severe, and there may not be sufficient alternative habitat in the area. | Moderate (2) | Moderate (7) |
| Wildlife movement corridors | While most habitats should continue to function as wildlife movement corridors during drought conditions, it is possible that dry riparian areas may no longer provide effective connectivity for some species. | Moderate (2) | The connectivity benefits of most habitats should remain despite drought conditions. However, species that rely on riparian corridors and require water or damp habitats may be unable to use these corridors during drought conditions, and alternatives may be limited. | Moderate (2) | Moderate (6) |

Table A-22
Natural Resource Asset Vulnerability to Flood

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Riparian habitat | During flood events, increased levels of sediments and pollutants can wind up in surface creeks due to runoff, which may harm riparian plants and animals. The force of the water may directly harm species. Floodwaters may also alter the creek's bed and banks, although such effects are likely to be localized. | Moderate (2) | While creeks should be able to eventually flush out sediments and pollutants, some harmful compounds may linger for some time, continuing to cause biological damage that riparian species are not adapted to resist. Changes to the physical structure of riparian habitats are a regular feature of the ecosystem and are unlikely to substantively affect biological integrity. | Moderate (2) | Moderate (6) |
| Morro Bay Estuary | Floodwaters entering the estuary can carry elevated levels of sediments and pollutants. While these contaminants may be harmful to plants and animals in the estuary, they are unlikely to be in a high enough concentration to cause substantive damage. | Low (1) | The Morro Bay Estuary can likely remove elevated levels of contaminants through natural processes of inflow and outflow. While some contaminants may prove difficult or slow to flush out, it is unlikely that floodwaters alone would bring in sufficient levels of such contaminants to cause substantive harm. | Low (1) | Low (4) |
| Special-status species | A handful of special-status species live in areas with an elevated flood risk. Such species may be harmed directly by floodwaters, or they could be indirectly harmed if ecosystems that they rely on are damaged. | Moderate (2) | Most special-status species within the flood risk zones are riparian species, and so are likely adapted to floodwaters. While they could still be harmed in a severe flood, it is likely that such species would be able to recover fairly effectively. | Low (1) | Moderate (5) |

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Sensitive plant communities | Some sensitive scrubland and wetland plant communities are in flood-prone areas, and so could be damaged by floodwaters. | Moderate (2) | Morro Bay's sensitive plant communities in flood-prone areas are all coastal or wetland areas, and so should be highly adapted to floodwaters. It is unlikely that floods would do any substantive or long-term damage to these communities. | Low (1) | Low (3) |
| Critical habitat | Some critical habitat in Morro Bay lies within the floodplain, and thus is vulnerable to damage by floodwaters. The species that rely on these habitats may in turn be harmed by any damage to their ecosystems. | Moderate (2) | The key species in Morro Bay's critical habitat are generally adapted to wet environment, and so may be able to survive relatively unharmed. However, the force of the floodwaters may still cause direct harm, and floodwaters may damage or destroy important feeding, mating, or other living spaces. | Low (1) | Moderate (5) |
| Wildlife movement corridors | Floodwaters may directly damage wildlife movement corridors or render them impassable, making them less useful for local species. | High (3) | The temporary condition of floods would likely only render wildlife movement corridors impassable for a short period of time, and thus floods are not likely to substantively affect ecosystem connectivity. However, floods may do long-term damage to some corridors, which could reduce connectivity for a lengthier period of time. | Low (1) | Moderate (6) |

Table A-23
Natural Resource Asset Vulnerability to Sea Level Rise

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Dune habitats | Morro Bay's dune habitats are a key natural resource. In addition to their recreational and economic value, they support a unique ecosystem that is threatened by sea level rise. Increased sea levels can cause rapid erosion of dune habitats, particularly during coastal storms and very high tides. | Moderate (2) | Dune habitats are naturally adapted to changes in sea levels, and commonly advance or retreat as conditions allow. In some areas, dunes may be able to retreat as sea level rise increases, preserving the ecosystem during the planning horizon. However, in areas where dunes are backed by development, this retreat may not be possible. Dunes may also be eventually unable to retreat if sea levels advance to the point where there is insufficient beach space for any dune habitat. | Moderate (2) | Moderate (6) |
| Wetland habitat | Sea level rise will likely result in more saltwater and less freshwater in Morro Bay's wetlands, changing the salinity and nutrient balance of the ecosystem. As a result, species that rely on specific salinity and nutrient levels may face challenges, particularly if sea level rise begins to affect wetland areas on a more permanent basis. | Moderate (2) | The amount of saltwater and freshwater in wetlands is inherently variable, and wetland species are adapted to some changes. However, if sea level rise results in frequent temporary increases in salinity, or the wetlands are permanently inundated, these changes may exceed ranges that are viable for wetland species. | High (3) | Moderate (7) |

| Asset | Impact | IM-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Sensitive plant communities | Some sensitive wetland plant communities could be at risk of the increased salinity and changing nutrient levels brought about by sea level rise, as a result of temporary or permanent inundation of wetland habitats from sea level rise. | Moderate (2) | While Morro Bay's sensitive plant communities within wetland habitats should be adapted to changes in salinity and nutrient levels, the changes brought on by sea level rise (particularly by permanent inundation) may exceed acceptable ranges. This could cause the range of these communities to shrink to less-affected areas of local wetlands, in turn shrinking the habitat for species that rely on these plant communities. | Moderate (2) | Moderate (6) |

# A.4 PARKS, RECREATION, AND OPEN SPACE

Table A-24
Parks, Recreation, and Open Space Assets by Exposure

| Assets | Demographics | Economics | Climate Change | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temperature | Wildfire | Drought | Flood | SLR |
| Community Center | ● | ● | | | ● | | |
| Veteran's Memorial Building | ● | ● | | | ● | | |
| Morro Bay Teen Center and Skate Park | ● | ● | ● | | ● | | |
| Anchor Memorial Park | ● | ● | ● | | | | |
| Centennial Parkway | ● | ● | ● | | | | |
| City Park | ● | ● | ● | | | | |
| Cloisters Park | ● | ● | ● | | ● | | |
| Coleman Park | ● | ● | ● | | ● | | |
| Del Mar Park | ● | ● | ● | | ● | | |
| Lila Keiser Park | ● | ● | ● | | | | |
| Mariner Memorial Park | ● | ● | ● | | | | |
| Monte Young Park | ● | ● | ● | | | | |
| Tidelands Park | ● | ● | ● | | | | |
| Morro Bay Bike Park | ● | ● | ● | | | | |
| Bayshore Bluffs Park | ● | ● | | | | | |
| Morro Rock Beach | ● | ● | | | ● | | ● |
| North Point Park | ● | ● | | | | | |
| Morro Strand State Beach | ● | ● | | | | | ● |
| State Marine Recreational Management Area | ● | ● | | ● | | | ● |
| Morro Bay State Park | ● | ● | | ● | ● | | ● |
| Recreation Services – Administration | ● | ● | ● | | | | |
| Recreational sports | ● | ● | ● | | ● | ● | |
| Youth & senior services | ● | ● | ● | | | | |
| Coastal access | ● | ● | | | | ● | ● |
| Special events | ● | ● | | | ● | ● | |

Table A-25

Parks, Recreation, and Open Space Asset Vulnerability to Population Change

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Recreation services and programs | Population growth in age groups served by recreation services may face increasing crowding and inaccessibility of programs as demand grows. | High (3) | With rising population, the City can choose to use additional revenue from sales, income, and property taxes to support expansion of recreation services and programs. | Low (1) | Moderate (6) |
| Proportion of parks to population | As population increases, demand on parks, recreation services, and open space will decrease the acres of parks per thousand people. | Low (1) | Parks dedication and development, as well as preservation of existing open spaces through infill development, will allow the City to keep its parks ratio above the Quimby Act Standard. | Low (1) | Low (3) |
| Youth and Senior Services | If the City's proportion of residents 50 and older carries forward through the City's projected population growth, additional programs and services will be needed to support this population. | High (3) | Existing partnership with Morro Bay Senior Citizens, Inc. can be strengthened to serve this growing population at existing service levels. | Low (1) | Moderate (6) |

Table A-26

Parks, Recreation, and Open Space Asset Vulnerability to Employment Change

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Coastal access along the Embarcadero | Projected job growth may reflect increased commercial development along the Embarcadero. Currently, gaps between businesses provide access to the coastline. | Moderate (2) | Regulatory barriers already exist that prevent coastal access from being impinged on. | Low (1) | Low (3) |
| Recreation workforce | The City's aging population indicates a growing number of retirees, while the employment growth projection estimates more jobs. The City will need to be able to provide recreation services for both new employees and their families and a large number of senior citizens. | High (3) | The City's existing services may be able to account for the relatively small increase in participation that could occur as the result of an increase in employment. | Low (1) | Moderate (5) |

Table A-27

Parks, Recreation, and Open Space Asset Vulnerability to Extreme Heat

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Community buildings (e.g., Community Center, Teen Center) | Increased cooling costs, particularly if used for cooling centers during extreme heat events. | Moderate (2) | Teen Center located in newer building; options already exist for low interest energy efficiency financing. Additionally, the Teen Center can serve as a valuable resource for socially vulnerable youth to visit on high heat days. | Low (1) | Low (3) |
| Parks with turf playing surfaces | Increased irrigation needs would affect Del Mar, Cloisters Park, and school fields where recreation programs take place. | High (3) | Improved irrigation timing, development of shade structures, and increased access to recycled water can reduce heat impacts to playing fields. | Moderate (2) | Moderate (7) |
| Recreation program participants | Extreme heat days may pose health hazards to recreational sports participants, especially young athletes and senior participants. | High (3) | Shade structures may help keep players cool, but many activities cannot be moved indoors and may need to have shifted schedules for early morning or late evening play. | Moderate (2) | Moderate (7) |
| Recreation programs and services | Increased health concerns for seniors, young children, and the chronically ill when exposed to high heat during outdoor recreation programs. | High (3) | Some activities can be moved indoors with cooling abilities, but many outdoor sports programs will be difficult to relocate and may be subject to cancellation in extreme heat events. | Moderate (2) | High (8) |
| Aging populations | As the largest proportion of Morro Bay's population remains individuals greater than 50 years old, extreme heat events pose serious health impacts to that population. | High (3) | The City's partnership with the Senior Center can be strengthened to increase availability of cooling centers, transportation to and from cooling centers, and other health resources. | Low (1) | Moderate (7) |

Table A-28

Parks, Recreation, and Open Space Asset Vulnerability to Wildfire

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Morro Bay State Park | Part of the park lies within high and very high fire hazard zones. Wildfires may destroy vegetation and decrease appeal of facilities. | Moderate (2) | Park maintenance can take preventative steps to reduce wildfire risk (e.g., brush clearing), but such actions will not prevent wildfires from occurring. Fire is a natural part of most California ecosystems and the park will likely recover, but it will be less appealing as a recreational facility during the recovery phase. | High (3) | Moderate (7) |

Table A-29

Parks, Recreation, and Open Space Asset Vulnerability to Drought

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Playing fields | Turf may be drought-stressed, causing it to turn brown or die if drought severity requires cutbacks in irrigation. | Moderate (2) | Recycled water systems can provide irrigation services, replacing potable water. Playing fields may also be replaced with artificial turf. However, both options may be expensive and politically unpopular. | Low (1) | Moderate (7) |
| Landscaped areas | Landscaping trees and plants can die or become vulnerable to pests due to drought stress. | Moderate (2) | Recycled water systems can continue to irrigate landscaped areas, although such systems may be expensive and/or unpopular. Drought-vulnerable plants can be replaced with drought-tolerant species. | Low (1) | Moderate (5) |
| Recreation services and programs | Outdoor recreation programs may be harmed if playing fields or other necessary facilities are drought-stressed. | Moderate (2) | Facilities can be irrigated with recycled water or replaced with artificial turf, but such steps may be expensive and/or unpopular. In some instances, organizers may have to find alternative activities or facilities. | Moderate (2) | Moderate (6) |
| Morro Bay State Park | Natural landscape may be drought-stressed, which may decrease its appeal as an outdoor recreation facility. | Low (1) | Plants are native species and are likely already drought-tolerant; thus the ecosystem can recover by itself. However, attendance may be lower during drought conditions. | Low (1) | Low (4) |

Table A-30

Parks, Recreation, and Open Space Asset Vulnerability to Flood

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Playing fields | Flood events may inundate fields, limiting use and damaging turf. Floods may cause soil runoff. | High (3) | Grading or other landscaping improvements may improve drainage in some instances, but options are limited. | Low (1) | Moderate (6) |
| Landscaped areas | Floods can damage or wash away plants and cause loss of topsoil. | Low (1) | Improved drainage systems or the use of LID strategies can help reduce impacts. | Moderate (2) | Moderate (5) |
| Beaches | Heavy rainfall can cause increased erosion of sand. | Low (1) | Normal littoral drift action should replenish sand, but process may take time. | Low (1) | Low (3) |
| Community/teen centers | Community or teen centers can be at risk of flooding, particularly if they are located within a flood hazard zone. Flooded structures may not be able to provide services for some time. | Moderate (2) | Facilities outside of a flood protection zone can take basic protective action to reduce their vulnerability. The City can retrofit buildings within flood hazard zones to incorporate flood-resilient features. | Low (1) | Moderate (5) |
| Recreation services and programs | Flood conditions may damage facilities or fields where programs are held. Field damage may create chronic service interruptions. | Moderate (2) | The City can retrofit buildings to reduce flood vulnerability, but there are few options to reduce the vulnerability of playing and recreational fields. | Moderate (2) | Moderate (6) |
| Play areas | Water may accumulate in play areas. | Low (1) | The City can install superior drainage systems or use low-impact development features to reduce ponding. | Low (1) | Low (3) |

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Event services | It may be difficult or impossible to hold outdoor special events during flooding. Indoor special events can proceed if building is not threatened, but attendance may be low. | Moderate (2) | Outdoor events can be moved indoors as needed, but events remain vulnerable to low attendance during flood events. | Moderate (2) | Moderate (6) |
| Youth and senior services | Outdoor programs likely cannot be held during flood events. Indoor events can occur during flooding, providing the venue is not threatened, but attendance may be low. | Moderate (2) | Outdoor programs can be moved indoors to safe venues. The City can retrofit facilities to be more resilient to flood events, particularly for sites in flood hazard zones, but little action can be taken to improve attendance for events held during flood events. | Moderate (2) | Moderate (6) |
| Hardscaped facilities (skate park, plazas, ball courts, etc.) | Floodwaters can pond on the surface, making use temporarily difficult or impossible. | Moderate (2) | The City can install improved drainage to reduce the risk of standing water during flood events. | Low (1) | Moderate (5) |

Table A-31

Parks, Recreation, and Open Space Asset Vulnerability to Sea Level Rise

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Morro Rock Beach | Beaches will continue to provide recreation and storm protection with a reduced but sizeable beachfront under predicted inundation levels. Inundation, dune and bluff erosion, and flooding are all anticipated to incur additional disruptions to recreational opportunities. Additional parking and access corridor areas will be exposed to flooding in the vicinity of Morro Rock and will require clearing following a high surf event. | High (3) | Temporary inundation of parking and access areas will likely require increased maintenance, leading to higher costs. With sustained sea level rise, loss of beach area may be unavoidable, but enrichment of sands and dunes may resist these changes. | Moderate (2) | Moderate (7) |
| Morro Strand State Beach | The Morro Strand campground will be exposed to additional flooding and erosion; along with clearing, minor adaptation may be required to maintain functionality. Beaches will continue to provide recreation and storm protection with a reduced but sizeable beachfront under predicted inundation levels. | High (3) | Reinforcement of infrastructure at the State Beach, such as parking and restrooms, can build resilience to temporary inundation, although this will likely require increased maintenance costs. With sustained sea level rise, loss of beach area may be unavoidable, but enrichment of sands and dunes may resist these changes. | Moderate (2) | Moderate (7) |

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| State Marine Recreational Management Area | Rising sea levels will hasten flooding and dune erosion, both increasing the ecological and economic vulnerability of the State Marine Recreational Management Area. Where possible, restoration efforts may be needed to reestablish features like dunes and habitats. Dunes will continue to erode inland toward development and may no longer exist in some areas. | Moderate (2) | Dunes and dune habitats represent a significant natural resource in the state parks as they are actively restored and preserved. Some natural features may adapt in this horizon; however, many features may be lost and unable to naturally migrate inland. Restoration and reinforcement of these resources builds adaptive capacity. State and federal interest in the Recreational Management Area as a significant natural resource buoys financial and political adaptive capacity. | High (3) | High (8) |
| Morro Bay State Park | Though economic impacts to the physical structures (e.g., asphalt paving, restrooms, some utilities and marina facilities) in the affected state parks would be relatively low, loss of these amenities would be significant since these features may not be easily or realistically moved inland. While coastal access and recreational opportunities are still projected to be viable, high surf events are anticipated to increase in frequency, rising the number of disruptions to recreational opportunities. | Moderate (2) | The state park marina will be largely unaffected as floating docks, gangways, and fixed access ways should be able to accommodate higher water levels. Natural features in the state parks have an elevated vulnerability, due to low adaptive capacity to migrate inland and moderate to high resource sensitivity. Dunes are not expected to naturally reestablish following loss from erosion; because dunes and habitat areas can be lost or diminished, dune and beach erosion may result in significant impacts. This can be adapted by reinforcement and restoration of natural infrastructure. | High (3) | High (8) |

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Coastal Access | Seven coastal access points are anticipated to be impacted by sea level rise in 2050, as well as 28,329 linear feet of trails and lateral access. These impacts are largely expected to be a result of coastal flooding and dune erosion, but represent only incremental increases from 2030 and require minor or no remediation. | Low (1) | Access ways can often naturally adapt to increased water levels and erosion, although some minor repair and adaptation measures may be needed. Waterfront access ways on fixed or floating structures will continue to provide access as long as they are located at an elevation above predicted water levels or are able to accommodate increased water levels. | Low (1) | Low (3) |

# A.5 WATER AND WATER QUALITY

Table A-32

Water and Water Quality Assets Exposed to Demographic Change and Climate Change Hazards

| Assets | Demographics | Economy | Climate Change | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temp. | Wildfire | Drought | Flood | SLR |
| Morro Bay Watershed | O | O | | O | O | O | |
| Cayucos Creek/Whale Rock Watershed | O | O | | O | O | O | |
| Chorro Creek system | O | O | | O | O | O | |
| Los Osos Creek system | O | O | | O | O | O | |
| Stormwater infrastructure | O | O | | | O | O | O |
| Groundwater resources | O | O | O | | O | | O |
| SWP water | O | O | O | | O | | |
| Water quality thresholds | O | O | O | O | | O | |
| Morro Bay Estuary | | | O | O | O | O | O |

Table A-33
Water and Water Quality Asset Vulnerability to Population Changes

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Morro Bay Watershed | Increased development in portions of the watershed previously zoned as agricultural land may increase imperviousness, runoff, and pollutants into the watershed. | Moderate (2) | Confining development within the urban core to mitigate a potential increase in impervious surfaces. | Low (1) | Moderate (5) |
| Cayucos Creek Whale Rock Watershed | Increased development in portions of the watershed previously zoned as agricultural land may increase imperviousness, runoff, and pollutants into the watershed. | Moderate (2) | Confining development within the urban core to mitigate a potential increase in impervious surfaces. | Low (1) | Moderate (5) |
| Chorro Creek system | Increased development in portions of the watershed previously zoned as agricultural land may increase imperviousness, runoff, and pollutants into the watershed. | Moderate (2) | Confining development within the urban core mitigate a potential increase in impervious surfaces. | Low (1) | Moderate (5) |
| Los Osos Creek system | Increased development in portions of the watershed previously zoned as agricultural land may increase imperviousness, runoff, and pollutants into the watershed. This creek system is in the area most likely to experience new development. | High (3) | Confining development within the urban core to mitigate a potential in impervious surfaces, and promoting runoff management (such as LID) to reduce impacts in the Los Osos Creek System. | Moderate (2) | Moderate (7) |

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Stormwater infrastructure | Increased development in portions of the watershed previously zoned as agricultural land may increase imperviousness, runoff, and pollutants into the watershed. Existing stormwater infrastructure may not be large enough to handle increased runoff. | High (3) | Confining development within the urban core to mitigate a potential in impervious surfaces. | Low (1) | Moderate (6) |
| Groundwater resources | Increased withdrawal rate without time to recharge. | High (3) | Water use restrictions on new developments, minimization of new landscaped areas, and other drought-friendly methods can reduce strain on groundwater resources. | Moderate (2) | High (8) |
| SWP water | Increased demand statewide may decrease allocations. | High (3) | Water use restrictions on new developments, minimization of new landscaped areas, and other drought-friendly methods can reduce strain on imported water resources. | Moderate (2) | Moderate (7) |
| Water quality thresholds | Increased development to support a growing population may lead to stormwater runoff. | Moderate (2) | MS4 and NPDES permit compliance provides the City with the tools to identify and prevent water quality violations from runoff. Preserving greenfields in favor of urban infill will minimize impervious surfaces. | Low (1) | Low (3) |

Table A-34
Water and Water Quality Asset Vulnerability to Employment Change

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Morro Bay Watershed | Increased development in portions of the watershed previously zoned as agricultural land may increase imperviousness, runoff, and pollutants into the watershed. | Moderate (2) | Confining commercial development within the urban core to mitigate a potential in impervious surfaces. | Low (1) | Moderate (5) |
| Cayucos Creek Whale Rock Watershed | Increased development in portions of the watershed previously zoned as agricultural land may increase imperviousness, runoff, and pollutants into the watershed. | Moderate (2) | Confining commercial development within the urban core to mitigate a potential in impervious surfaces. | Low (1) | Moderate (5) |
| Chorro Creek system | Increased development in portions of the watershed previously zoned as agricultural land may increase imperviousness, runoff, and pollutants into the watershed. | Moderate (2) | Confining development within the urban core to mitigate a potential in impervious surfaces. | Low (1) | Moderate (5) |
| Los Osos Creek system | Increased development in portions of the watershed previously zoned as agricultural land may increase imperviousness, runoff, and pollutants into the watershed. | High (3) | Confining commercial development within the urban core to mitigate a potential in impervious surfaces. | Moderate (2) | Moderate (7) |
| Stormwater infrastructure | Increased development in portions of the watershed previously zoned as agricultural land may increase imperviousness, runoff, and pollutants into the watershed. Existing stormwater infrastructure may not be large enough to handle increased runoff. | High (3) | Confining commercial development within the urban core to mitigate a potential in impervious surfaces. | Low (1) | Moderate (6) |

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Groundwater resources | Increased withdrawal rate without time to recharge. | Moderate (2) | Water use restrictions on new developments, minimization of new landscaped areas, and other drought-friendly methods can reduce strain on groundwater resources. | Moderate (2) | Moderate (6) |
| SWP water | Increased demand statewide may decrease allocations. | Moderate (2) | Water use restrictions on new developments, minimization of new landscaped areas, and other drought-friendly methods can reduce strain on imported water resources. | Moderate (2) | Moderate (6) |
| Water quality thresholds | Increased development to support a growing population may lead to stormwater runoff. | Moderate (2) | MS4 and NPDES permit compliance provides the City with the tools to identify and prevent water quality violations from runoff. Preserving greenfields in favor of urban infill will minimize impervious surfaces. | Low (1) | Low (3) |

Table A-35
Water and Water Quality Asset Vulnerability to Extreme Heat

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Groundwater resources | Extreme temperatures can increase residential, landscape, and industrial water demands, putting additional pressure on groundwater resources. | Low (1) | Restrictions on watering times and consumption can be used to promote effective groundwater management. | Moderate (2) | Moderate (5) |
| SWP water | Extreme temperatures can increase residential, landscape, and industrial water demands, putting additional pressure on imported water resources. | Low (1) | Restrictions on watering times and consumption can be used to promote effective management of imported water resources. | Moderate (2) | Moderate (5) |
| Morro Bay Estuary | Increased warming is expected to elevate the presence of bacteria and pathogens in the estuary. This can harm the overall health of the estuary and threaten vulnerable species | High (3) | Continued research and understanding of best practices, as well as national support by the Morro Bay National Estuary Program, will help the City ensure its development practices and response to extreme temperatures support effective estuary management. | Low (1) | Moderate (7) |

Table A-36
Water and Water Quality Asset Vulnerability to Wildfire

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Morro Bay Watershed | Runoff into creeks and other water bodies increases after wildfires. Parts of the watershed are within a high or very high fire hazard zone, so the risk of increased runoff of sediments and pollutants is higher in these areas. | Moderate (2) | Preventative wildfire control measures can help reduce the risk of wildfires, while erosion control measures in recently burnt areas can reduce runoff. Such actions can be effective, but some runoff will continue. | Moderate (2) | Moderate (6) |
| Cayucos Creek Whale Rock Watershed | Runoff into water bodies will likely increase after a wildfire due to a lack of vegetation and ground cover. The watershed is entirely in a moderate fire hazard zone, reducing the risk of a substantive fire, and by extension the increase in runoff. | Low (1) | Wildfire prevention activities can reduce the risk of a blaze and erosion control can be used on burnt areas to reduce runoff, although runoff cannot be entirely negated. | Moderate (2) | Moderate (5) |
| Chorro Creek system | The Chorro Creek system includes areas within a high and very high fire hazard zone, and so is susceptible to increased runoff from recently burnt areas. | Moderate (2) | Runoff from burn areas and the sediments it carries cannot be blocked. However, erosion control measures put into place after a wildfire can help to reduce runoff to some degree. Wildfire prevention actions can also decrease the chances of increased runoff. | Moderate (2) | Moderate (6) |

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Los Osos Creek system | Parts of the Los Osos Creek system are within a very high fire hazard zone. These areas are more likely to experience wildfires, which lead to an increase in sediment runoff into creeks. | Moderate (2) | Wildfire prevention can reduce the risk of burns (and by extension, runoff), and erosion control measures after a burn occurs can decrease runoff into creeks. Some runoff will occur regardless of what steps are taken. | Moderate (2) | Moderate (6) |
| Water quality thresholds | The increased sediment load washed into local creeks can raise the concentrations of dissolved and suspended solids, various metals, nutrients, and other pollutants. | High (2) | Wildfire prevention can reduce the chance of fires that lead to increased runoff, while erosion control can reduce runoff from burnt areas. However, the ability to effectively remove these sediments from natural creek systems is limited. | Moderate (2) | Moderate (7) |
| Morro Bay Estuary | Although the estuary is not located in a wildfire-prone area, the sediment loads from runoff in wildfire burn areas can wash into the estuary, affecting nutrient loads and potentially causing contamination. | Low (1) | Estuaries and wetlands are naturally effective at filtering out sediment and pollutants, and so can likely cope with the impacts of runoff with only short-term and limited harm to biological integrity. However, toxic materials may take longer or prove more difficult to flush out. | Low (1) | Low (4) |

Table A-37
Water and Water Quality Asset Vulnerability to Drought

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| All creeks and watersheds | Droughts cause a decline in creek water levels and water flow, which can have impacts for the plants and animals in the riparian habitat. It can also reduce a creek's benefit to people, such as its recreational value. Recreational and scenic benefits may be significant, but riparian plants and animals should be able to generally survive and so biological impacts are likely to be minimal. | Moderate (2) | The creeks' biological systems are acclimated to droughts as a regular feature of California's climate, and so they are already capable of adapting. However, benefits to people may be more disrupted, and alternative unaffected creeks are generally not available. | Moderate (2) | Moderate (6) |
| Stormwater infrastructure | Debris and pollutants can build up in stormwater infrastructure during droughts. | Moderate (2) | Regular cleaning during droughts can remove any debris and ensure effective operation, although this maintenance may require additional funding. | Low (1) | Moderate (5) |
| Groundwater resources | Groundwater resources are somewhat cushioned by drought. However, long-term drought conditions can cause groundwater levels to drop substantially, particularly if the drought causes increases in groundwater pumping. | Moderate (2) | Low-impact development (LID) can assist with groundwater recharge, as can dedicated groundwater infrastructure. However, complete groundwater recharge can be unfeasibly expensive, especially for an area with a fairly small population. Water conservation efforts and recent groundwater management laws will help prevent overpumping. | High (3) | Moderate (7) |

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| SWP water | SWP water is drawn from the northern Sierra Nevada, which is highly susceptible to drought. | High (3) | Water conservation efforts can reduce demand for SWP water, but there is no sufficient alternative water supply. | High (3) | High (8) |
| Water quality thresholds | Drought conditions can cause sediments and pollutants to become more concentrated in some water bodies due to reduced dilution and increased evaporation. However, sediments and pollutant levels drop in other water bodies due to decreased runoff. | Low (1) | Decreasing the concentration of pollutants in natural water bodies, or removing these pollutants, is a difficult and expensive process. | High (3) | Moderate (6) |
| Morro Bay Estuary | Drought conditions reduce the inflow of freshwater and allow more seawater to intrude further into the estuary, changing nutrient balances. | Moderate (2) | As droughts are a recurring and occasional part of the climate in Morro Bay, the estuary habitat is generally adapted to drought conditions. The consequences to the estuary are likely to be temporary and the habitat should be able to recover on its own, although severe and chronic droughts may have more substantive impacts. | Low (1) | Moderate (5) |

Table A-38
Water and Water Quality Asset Vulnerability to Flood

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| All creeks and watersheds | Floodwaters can carry sediment and pollutants into the creek system, creating potential water quality issues. The force of the water can also damage vegetation, and change the creeks' beds and banks. However, physical impacts are likely to be highly localized, and changes to water quality are unlikely to substantially harm the creek system. | Low (1) | Sediments and pollutants should be flushed through the system without causing serious issues, unless hazardous materials or other harmful compounds are present in the runoff. While consequences to recreational and scenic benefits are unlikely to be significant, people can seek out undamaged parts of the creek or other creeks if necessary. Physical changes to the creek are a regular part of the habitat and the ecosystem can recover naturally. | Low (1) | Low (4) |
| Stormwater infrastructure | Intense rainfall can overwhelm storm drains and other infrastructure, causing ponding and potentially damage to the infrastructure itself. | Low (1) | Infrastructure can be adequately sized to handle flood events, and maintained regularly to reduce the risk of damage. However, such actions may be expensive and take a considerable amount of time. | Moderate (2) | Moderate (5) |
| Water quality thresholds | Runoff during floods can carry sediments and other pollutants, particularly during the first major flood of the wet season. This can lead to unsafe water quality after storms, particularly near creek outlets. | Moderate (2) | While the impact from each flood is only temporary, water quality may be degraded for a long period if there is a series of intense rainfall events. Cleanup options are limited, although beach closures and appropriate notifications can reduce the health risk. | Moderate (2) | Moderate (6) |

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Morro Bay Estuary | The increased sediment and pollutant load in floodwaters can affect the short-term health of the estuary ecosystem, although damage is unlikely to be serious or chronic. | Low (1) | Estuaries are typically effective at cleaning pollutants out of water. While the estuary may be adapted to short-term influxes of sediment or pollutants of natural origin, it may be less able to cope with increased levels of any artificial pollutants. The estuary will likely eventually flush itself out, although the recovery process may be slower. | Low (1) | Low (4) |

Table A-39

Water and Water Quality Asset Vulnerability to Sea Level Rise

| Asset | Impact | I-score | Adaptive Capacity | AC-Score | Vulnerability |
|---|---|---|---|---|---|
| Stormwater infrastructure | While not identified as a discrete impact, sea level rise may place additional stress on Morro Bay's stormwater infrastructure, especially in high tide events if seawater is pushed back through the stormwater system, potentially creating local flooding and water quality problems. | N/A | LID may provide capacity to reduce input of stormwater into storm drains, reducing pressure. Consideration of sea level rise when planning for changes to the wastewater treatment plant may help ensure long-term health of the city's water infrastructure. | N/A | N/A |
| Groundwater resources | As sea levels rise, saltwater has the ability to migrate inland through man-made and natural channels, drainage structures, soils, and underground pathways. The migration of saltwater that results in intrusion can impact freshwater resources, including surface waters and groundwater, both of which Morro Bay depends on for water resources. While this effect is difficult to quantify, the potential for sea level rise impact is present. | N/A | Reducing water use to limit groundwater extraction can slow the potential for saltwater intrusion. Increased monitoring and research can enhance groundwater management capacity to limit salinity. | N/A | N/A |
| Morro Bay Estuary | Flooding, dune erosion, and increased salinity from sea level rise all impact the health of the Morro Bay Estuary. The migration of saltwater results in salinity changes that can lead to a variety of ecological and agricultural resource impacts. | High (3) | Estuaries are adaptive, but an increase in salinity may disturb the balance and threaten the vitality of certain species. Restoration of protective habitats can help protect sensitive habitats and species from changing habitats. | High (3) | High (8) |

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