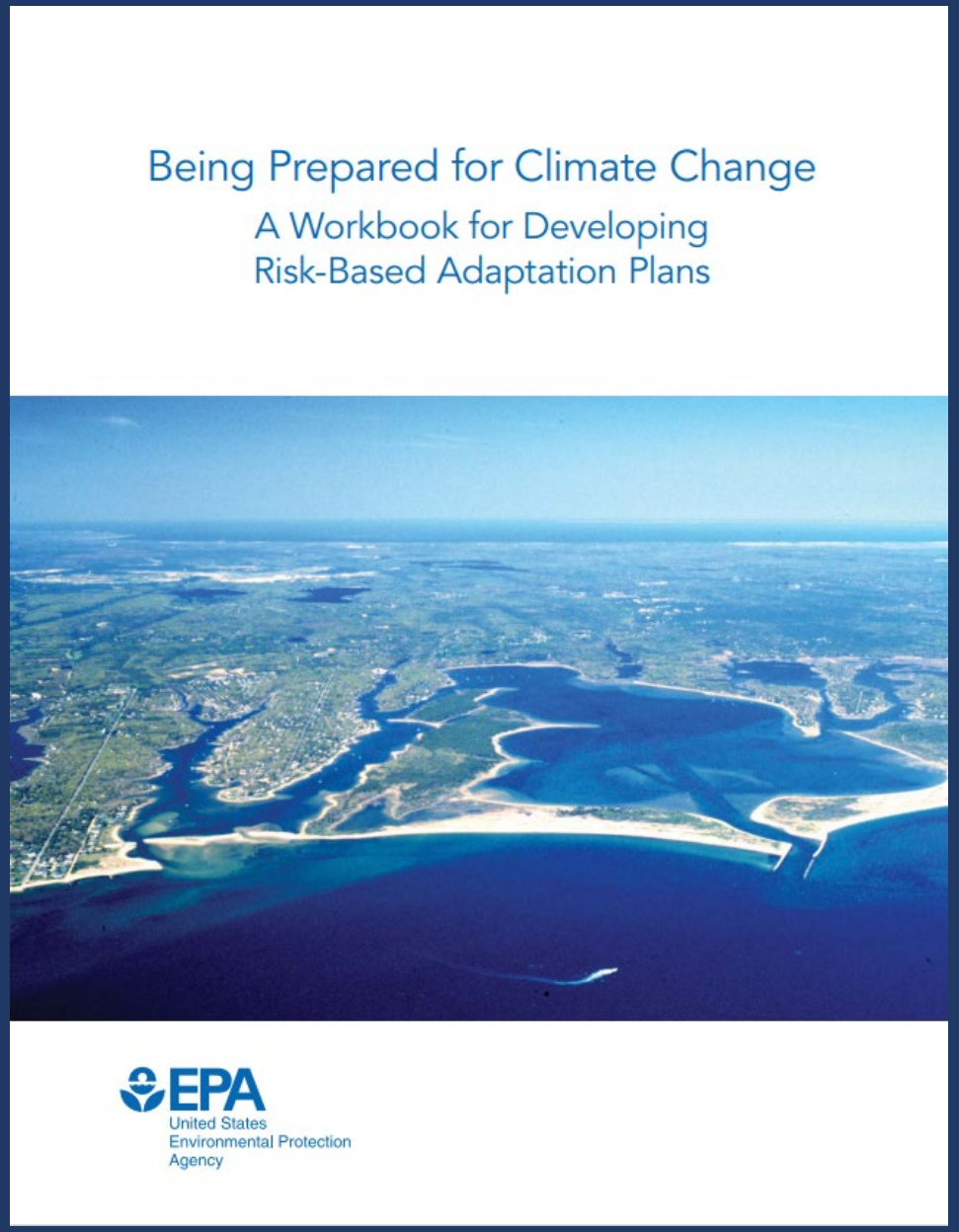
# Climate Change Adaptation

**Adaptation**: measures taken to adapt to current or expected impacts of climate change

- Identifying Climate Vulnerabilities
- Developing Adaptation Strategies

# Overview

- Vulnerability and Risk Assessment
- Climate stressors, associated vulnerabilities and risks, and adaptation actions
- Adaptation Strategies




Last updated October 6, 2022

## 1 Identify Climate Stressors & Vulnerabilities

| Climate Stressor | | Vulnerability |
|---|---|---|
| Sea Level Rise | | |
| Flooding | | |
| Extreme Precipitation | | |
| Drought | | |
| Increasing Temperatures | | |
| Wildfire | | |

## 2 Assess Risk to each Vulnerability

| Likelihood of occurrence | Consequence of impact: Low | Consequence of impact: Medium | Consequence of impact: High |
|---|---|---|---|
| High | MEDIUM | HIGH | HIGH |
| Medium | LOW | MEDIUM | HIGH |
| Low | LOW | LOW | MEDIUM |

## 3 Assign Risks an Adaptation Action

**Adaptation Actions**

# 1 VULNERABILITY IDENTIFICATION

- **Considered sea level rise, flooding, extreme precipitation, drought, increasing temperatures, and wildfire as relevant climate stressors in the vulnerability and risk assessment.**

| Climate Stressor | | Vulnerability |
|---|---|---|
| Sea Level Rise |  | |
| Flooding |  | |
| Extreme Precipitation |  | |
| Drought |  | |
| Increasing Temperatures |  | |
| Wildfire |  | |

**Table 1. Range of Climate Change considered in Risk Assessment**

| Climate Stressor | Historic Annual Average (1961-1990) | Mid-Century (2035-2064) | End-Century (2070-2100) | | Potential Change |
|---|---|---|---|---|---|
| | | | Medium Emissions | High Emissions | |
| Maximum Temperature (°F) | 67.4 | 71.0 | 71.3 | 74.0 | +3.9 to 6.6 |
| Minimum Temperature (°F) | 47.5 | 51.1 | 51.3 | 54.1 | +3.8 to 6.6 |
| Number of Extreme Heat Days (89.4°F) | 2 | 6 | 7 | 13 | +5 to 11 |
| Sea Level | Current (0 ft) | + 0.6 ft | +2.4 ft | + 5.4 ft | +0.6 to +5.4 |
| Precipitation (inches) | 14.2 | 14.1 | 14.1 | 14.4 | -0.1 to +0.2 |
| Flooding Events | 2 | 4 | 4 | 28 | +2 to 26 |
| Average Annual Area Burned (acres) | 252.7 | 311.1 | 300.1 | 296.5 | +43.8 to 58.4 |

# 2 RISK ASSESSMENT

- **Each vulnerability identified is assigned a risk based on the likelihood of occurrence and consequence should they occur.**

*Likelihood*

**High – Almost certain to occur**
**Medium – Moderate likelihood**
**Low – Unlikely to occur**

*Consequence*

**Major – systemwide damage and system failure, severe financial impact, or severe adverse human health effects**
**Moderate – some consequence to public health, safety, function, and/or any other metric of concern.**
**Minor – no impact on system function, low financial losses, and no adverse human health effects**

| Likelihood of occurrence | Minor | Moderate | Major |
|---|---|---|---|
| High | MEDIUM | HIGH | HIGH |
| Medium | LOW | MEDIUM | HIGH |
| Low | LOW | LOW | MEDIUM |

**Consequence of impact**

# 3 ADAPTATION ACTIONS

- **High risk vulnerabilities are the most pressing concern and require action to mitigate risk and improve resilience. Moderate risk vulnerabilities are less urgent, but still require action. Low risk vulnerabilities will be accepted for now, but the District will continue to monitor them.**

***High Risk*** → **Assign Adaptation Action**

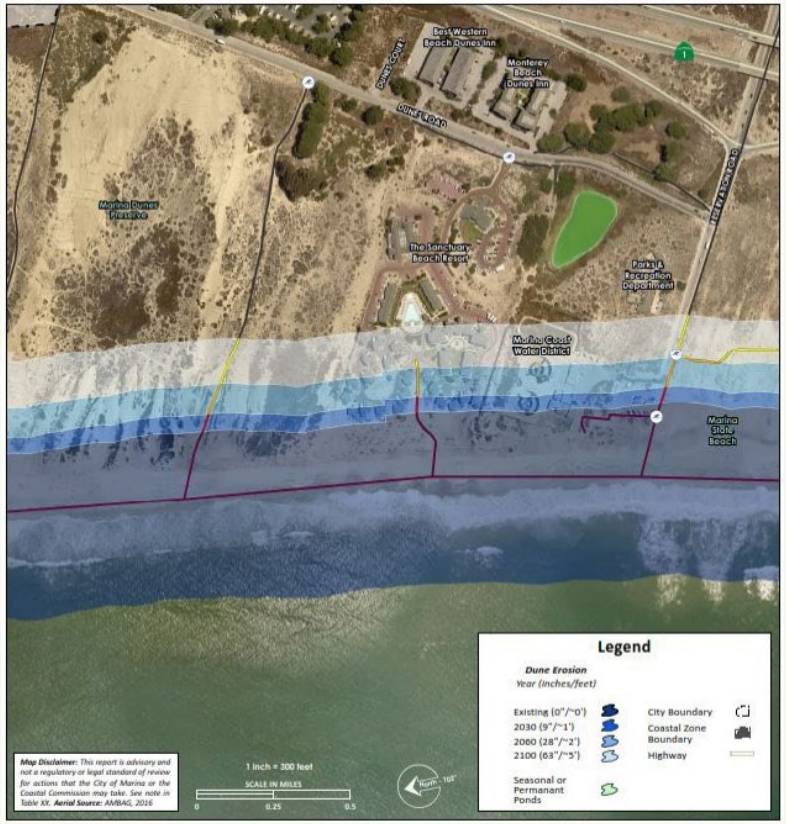
***Moderate Risk*** → **Assign Adaptation Action**

***Low Risk***

# VULNERABILITY AND RISK ASSESSMENT RESULTS



- Stillwell Hall completed in 1943 with 400 feet of separation from dune edge
- From 1943 to 1950, over 300 feet of that buffer was lost to erosion




**COASTAL REGIONAL SEDIMENT MANAGEMENT PLAN FOR SOUTHERN MONTEREY BAY**

Prepared for

Association of Monterey Bay Area Governments

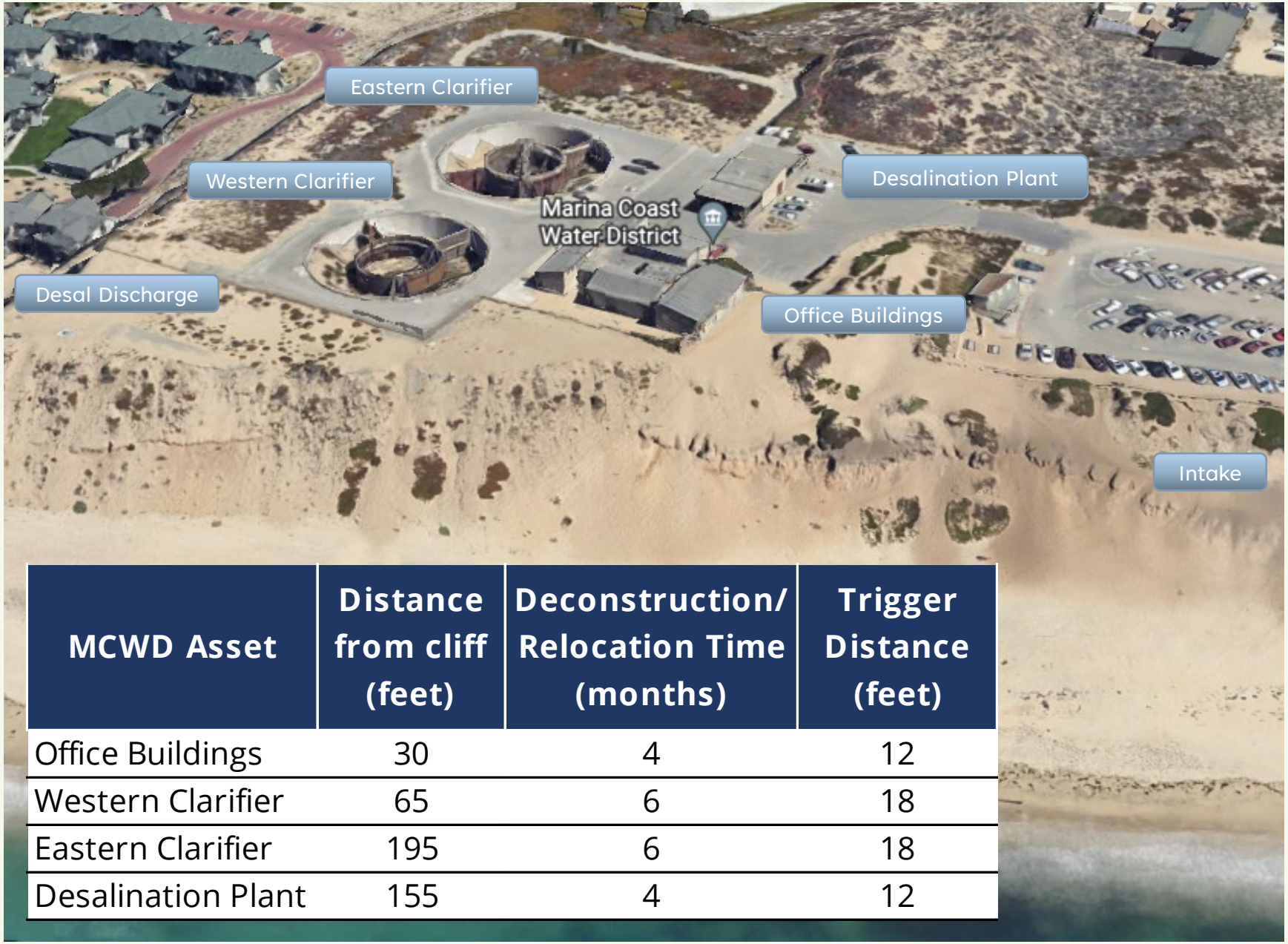
Prepared by

Philip Williams & Associates, Ltd.

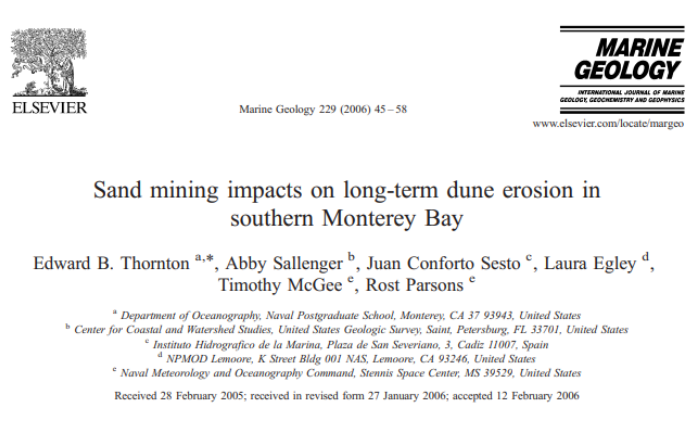
with

Ed Thornton
Jenifer Dugan
Halcrow Group

November 3, 2008




| MCWD Asset | Distance from cliff (feet) | Deconstruction/ Relocation Time (months) | Trigger Distance (feet) |
|---|---|---|---|
| Office Buildings | 30 | 4 | 12 |
| Western Clarifier | 65 | 6 | 18 |
| Eastern Clarifier | 195 | 6 | 18 |
| Desalination Plant | 155 | 4 | 12 |



ELSEVIER

Marine Geology 229 (2006) 45–58

MARINE GEOLOGY

www.elsevier.com/locate/margeo

Sand mining impacts on long-term dune erosion in southern Monterey Bay

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- Assume the erosion rate is 3 feet per year (CCC)
- Erosion rate jumps to ~39 feet per year during an El Nino storm event (3ft/mo)
- Annual rate could decrease by 70% or more due to the closing of the CEMEX plant

# HOW ARE RISING SEA LEVELS, FLOODING, AND EXTREME PRECIPITATION EVENTS PROJECTED TO AFFECT OPERATIONS?

| | 2020 | 2050 | 2100 |
|---|---|---|---|
| Precipitation | 12-15 inches | 11-18 inches | 11-17 inches |
| Flooding events | 1 | 4 | 4 |
| Sea Level Rise | Current (0 ft) | +1.7 ft | +5.6 ft |

**Table L: Roadway Segments Potentially Affected by Wildfire Fire Hazards**

| Roadway Segments | Roadway Segments |
|---|---|
| Ocean View Boulevard within Pacific Grove | Ocean View Boulevard and 9th Street |
| Ocean View Boulevard and Reeside Avenue | Del Monte Avenue within Monterey |

Source: Compiled by LSA Associates, Inc. (2021).

**Table M: Roadway Segments Potentially Affected by Flood Hazards**

| Roadway Segments | Roadway Segments |
|---|---|
| Ocean View Boulevard within Pacific Grove | Ocean View Boulevard and 9th Street |
| Ocean View Boulevard and Reeside Avenue | Del Monte Avenue within Monterey |
| Del Monte Boulevard and Canyon del Rey Boulevard and SR 218 | Del Monte Boulevard and Cabrillo Highway (SR 1) |
| Reservation Road within Marina | Cabrillo Highway (SR 1) within Moss Landing |

Source: Compiled by LSA Associates, Inc. (2021).
SR = State Route

**Table N: Roadway Segments Potentially Affected by Landslide Hazards**

| Roadway Segments | Roadway Segments |
|---|---|
| Ocean View within Pacific Grove | Ocean View Boulevard and 9th Street |
| Ocean View and Reeside Avenue | Del Monte Avenue within Monterey |
| Del Monte Boulevard and Canyon del Rey Boulevard (SR 218) | Del Monte Boulevard and Carrillo Highway (SR 1) |
| Reservation Road within Marina | Cabrillo Highway (SR 1) within Moss Landing |
| Cabrillo Highway (SR 1) North | Hitchcock Road within Salinas |

Source: Compiled by LSA Associates, Inc. (2021).

Monterey OneWater CAP


Sea Level Rise and Coastal Flooding Impacts (noaa.gov)

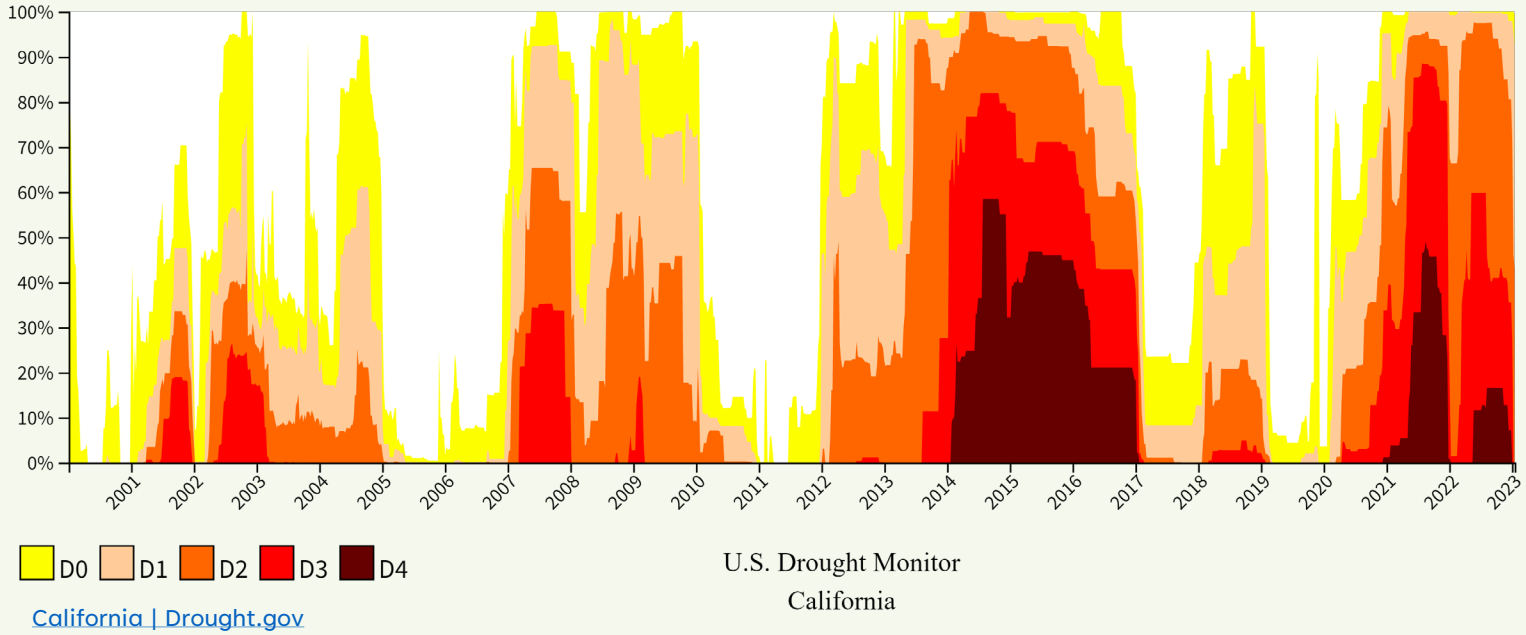

ArcGIS - FEMA 100 Year Flood CT- Target Areas

# HOW ARE RISING SEA LEVELS, FLOODING, AND EXTREME PRECIPITATION EVENTS PROJECTED TO AFFECT OPERATIONS?

| Climate Stressor | Vulnerability |
|---|---|
| **Sea Level Rise** | Infrastructure at the end of Reservation Road is vulnerable to coastal erosion |
| | Seawater intrusion from increased seawater pressure |
| **Flooding** | Infrastructure may be vulnerable to flooding |
| | Personnel may be unavailable due to road closure |
| | *Inundation and Infiltration* |
| | Scouring may occur under critical infrastructure |
| **Extreme Precipitation** | Infrastructure may be vulnerable to extreme storm damage |
| | Infrastructure may be subject to scouring |

| | Vulnerability | Adaptation Action |
|---|---|---|
| **A** | Infrastructure at the end of Reservation Road is vulnerable to coastal erosion | A1. Managed retreat -- move facilities inland<br>A2. Reinforce dunes to slow erosion process |
| **D** | Seawater intrusion from increased seawater pressure and lack of percolation | D1. Move wells inland<br>D2. Participation in regional water demand strategies<br>D3. Participation in possible seawater intrusion barrier |
| **H** | Infrastructure may be subject to scouring from flooding or extreme precipitation<br>Wildfire erosion could affect strucutral integrity and function | H1. Armoring and reinforcements at vulnerable facilities |
| **I** | Personnel safety<br>Personnel may be unavailable due to road closure | I1. Alternative work schedules<br>I2. Provide personal protective equipment (PPE) |

# HOW IS DROUGHT PROJECTED TO AFFECT OPERATIONS?




California | Drought.gov

U.S. Drought Monitor
California

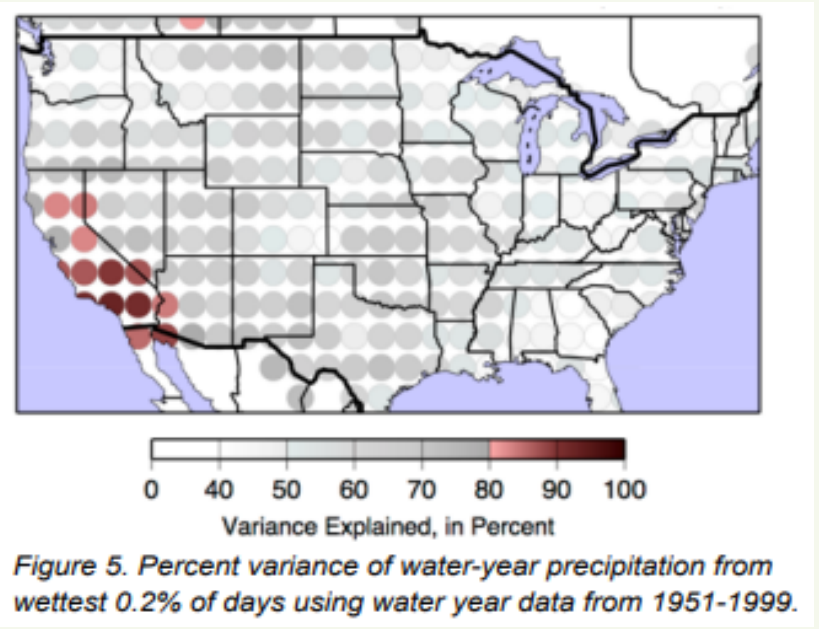



*Figure 5. Percent variance of water-year precipitation from wettest 0.2% of days using water year data from 1951-1999.*

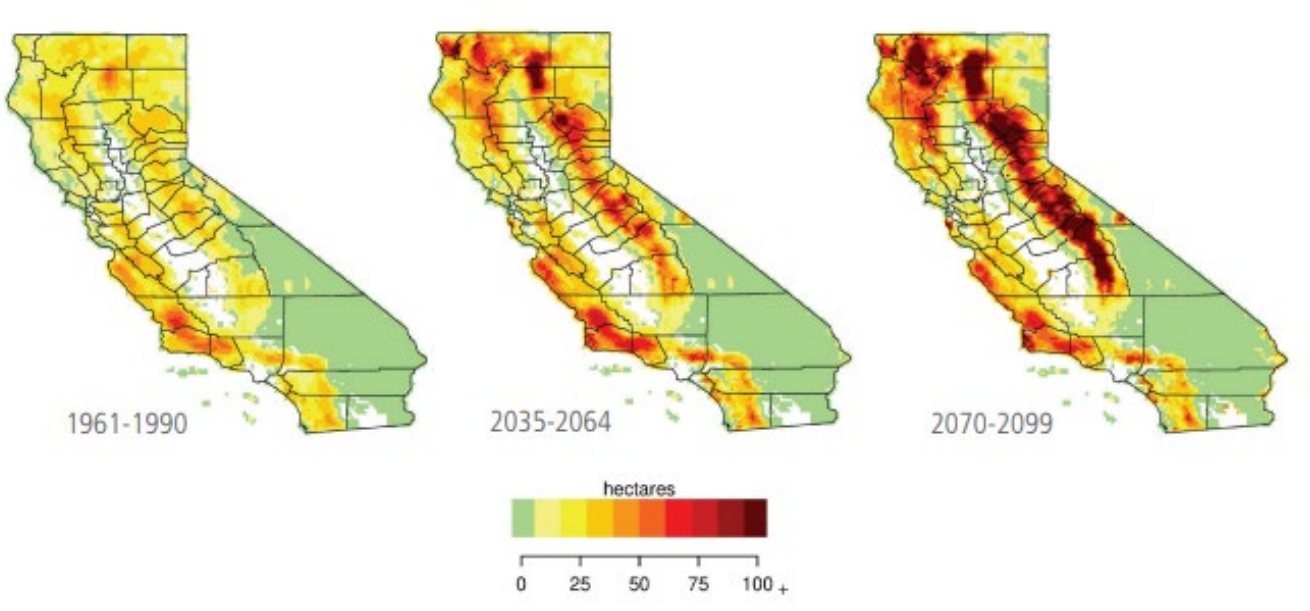
https://cwc.ca.gov/-/media/CWC-Website/Files/Documents/2019/08_August/Dettinger_CA_Precipitation.pdf

# HOW IS DROUGHT PROJECTED TO AFFECT OPERATIONS?

| Climate Stressor | Vulnerability |
|---|---|
| **Drought** | Water source insecurity (quality) |
| | Seawater intrusion from lack of percolation (rainfall/river) |
| | Asset impact from drought (wells) |
| | *Increased pumping costs* |
| | *Loss of revenue* |

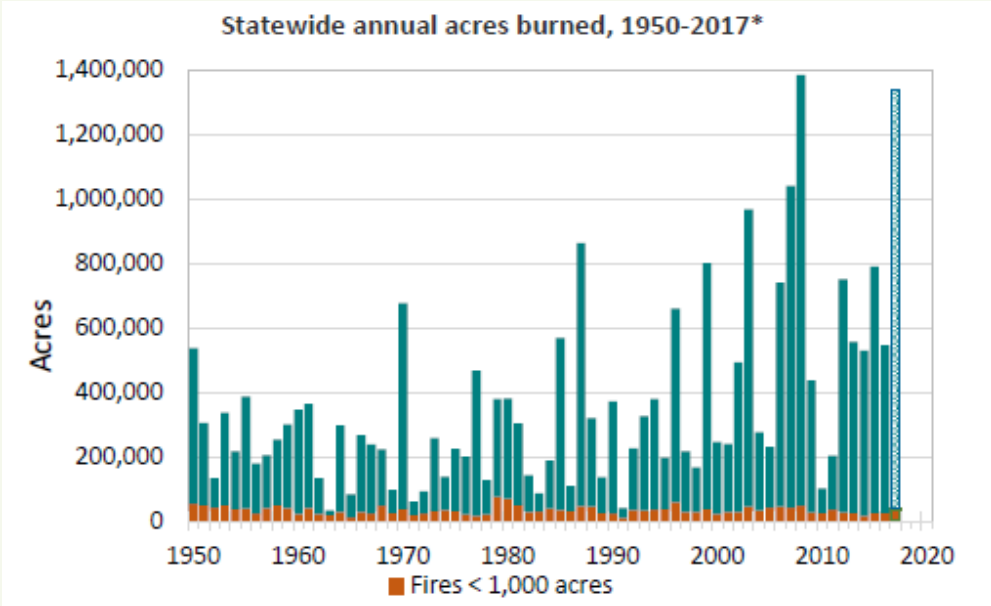
| | Vulnerability | Adaptation Action |
|---|---|---|
| **B** | Water source insecuity (quality) | B1. Water shortage contingency plan<br>B2. Drought-resistant/alternate source development (recycled, surface, desalination) |
| **D** | Seawater intrusion from increased seawater pressure and lack of percolation | D1. Move wells inland<br>D2. Participation in regional water demand strategies<br>D3. Participation in possible seawater intrusion barrier |
| **F** | Asset impact from drought | F1. Lower pump levels in existing wells<br>F2. Relocate wells inland |

# HOW ARE WILDFIRES AND INCREASING TEMPERATURES PROJECTED TO AFFECT OPERATIONS?




https://www.energy.ca.gov/sites/default/files/2019-11/20180827_Summary_Brochure_ADA.pdf

| | 2020 | 2050 | 2100 |
|---|---|---|---|
| Temperature | 66-67 F | 68-72 F | 69-74 F |
| Extreme heat days (98% percentile) | 1-4 | 3-9 | 3-28 |




Source: CalFire 2018

# HOW ARE WILDFIRES AND INCREASING TEMPERATURES PROJECTED TO AFFECT OPERATIONS?

| Climate Stressor | Vulnerability |
|---|---|
| **Increasing Temperatures** | *Extreme heat impact on infrastructure* |
| | *Warmer temperatures may increase demand for water* |
| | Personnel safety |
| | Increased Public Safety Power Shutoffs (PSPS) |
| | *Increased costs* |
| **Wildfire** | Infrastructure may be vulnerable to wildfire damage |
| | Pipeline collapse |
| | Increased wildfires may lead to erosion |

| | Vulnerability | Adaptation Action |
|---|---|---|
| **C** | Infrastructure may be vulnerable to wildfire damage | C1. Create defensible space<br>C2. Evacuation plan |
| **E** | Pipeline collapse | E1. Incident operational support |
| **G** | Increased public safety power shutoffs (PSPS) | G1. Install, prepare, and activate backup generators |
| **H** | Infrastructure may be subject to scouring from flooding or extreme precipitation<br><br>Wildfire erosion could affect strucutral integrity and function | H1. Armoring and reinforcements at vulnerable facilities |
| **I** | Personnel safety<br><br>Personnel may be unavailable due to road closure | I1. Alternative work schedules<br>I2. Provide personal protective equipment (PPE) |

- **The compiled list of potential adaptation actions will serve as a framework for MCWD.**

| | Vulnerability | Adaptation Action |
|---|---|---|
| A | Infrastructure at the end of Reservation Road is vulnerable to coastal erosion | A1. Managed retreat -- move facilities inland<br>A2. Reinforce dunes to slow erosion process |
| B | Water source insecuity (quality) | B1. Water shortage contingency plan<br>B2. Drought-resistant/alternate source development (recycled, surface, desalination) |
| C | Infrastructure may be vulnerable to wildfire damage | C1. Create defensible space<br>C2. Evacuation plan |
| D | Seawater intrusion from increased seawater pressure and lack of percolation | D1. Move wells inland<br>D2. Participation in regional water demand strategies<br>D3. Participation in possible seawater intrusion barrier |
| E | Pipeline collapse | E1. Incident operational support |
| F | Asset impact from drought | F1. Lower pump levels in existing wells<br>F2. Relocate wells inland |
| G | Increased public safety power shutoffs (PSPS) | G1. Install, prepare, and activate backup generators |
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**For more information,**
**visit** www.mcwd.org