AGENDA

Executive Committee Agenda

Committee Members
Mark A. Murphy, Chairman
Gene Hernandez, Vice Chairman
Lisa A. Bartlett
Andrew Do
Michael Hennessey
Steve Jones
Joseph Muller

Orange County Transportation Authority
Headquarters
Conference Room 07
550 South Main Street
Orange, California
Monday, October 3, 2022 at 9:00 a.m.

Any person with a disability who requires a modification or accommodation in order to participate in this meeting should contact the Orange County Transportation Authority (OCTA) Clerk of the Board's office at (714) 560-5676, no less than two business days prior to this meeting to enable OCTA to make reasonable arrangements to assure accessibility to this meeting.

Agenda Descriptions

Agenda descriptions are intended to give members of the public a general summary of items of business to be transacted or discussed. The posting of the recommended actions does not indicate what action will be taken. The Committee may take any action which it deems to be appropriate on the agenda item and is not limited in any way by the notice of the recommended action.

Public Availability of Agenda Materials

All documents relative to the items referenced in this agenda are available for public inspection at www.octa.net or through the Clerk of the Board's office at the OCTA Headquarters, 600 South Main Street, Orange, California.

Meeting Access and Public Comments on Agenda Items

Members of the public can either attend in-person (subject to OCTA's Coronavirus (COVID-19) safety protocols) or listen to audio live streaming of the Board and Committee meetings by clicking the below link:

Board of Directors - Live and Archived Audio (octa.net)

Members of the public may address the Board of Directors regarding any item two ways:

In-Person Comment

Members of the public may attend in-person (subject to OCTA's COVID-19 safety protocols) and address the Board regarding any item. Members of the public will be required to complete a COVID-19 symptom and temperature screening.

Please complete a speaker's card and submit it to the Clerk of the Board (or notify the Clerk of the Board the item number on which you wish to speak). Speakers will be recognized by the Chairman at the time the agenda item is to be considered. A speaker's comments shall be limited to three minutes.

Written Comment

Written public comments may also be submitted by emailing them to ClerkOffice@octa.net, **and must be sent by 5:00 p.m. the day prior to the meeting**. If you wish to comment on a specific agenda Item, please identify the Item number in your email. All public comments that are timely received will be part of the public record and distributed to the Board. Public comments will be made available to the public upon request.

Call to Order

Pledge of Allegiance

Director Jones

Special Calendar

There are no Special Calendar matters.

Consent Calendar (Items 1 and 2)

All items on the Consent Calendar are to be approved in one motion unless a Committee Member or a member of the public requests separate action or discussion on a specific item.

1. Approval of Minutes

Recommendation

Approve the minutes of the September 2, 2022 Executive Committee meeting.

2. Orange County Transportation Authority Code of Conduct
Karen DeCrescenzo/Maggie McJilton

Overview

As required by the Federal Transit Administration and organizational best practices, the Orange County Transportation Authority maintains a written code of conduct to provide direction to officers, employees, agents, and members of the Board of Directors on appropriate and professional behavior in conducting the business of the Orange County Transportation Authority.

Recommendation

Receive and file as an information item.

Regular Calendar

3. Orange County Transportation Authority Natural Hazard Mitigation Plan
Matt Ankley/Jennifer L. Bergener

Overview

As part of a comprehensive emergency management program, the Orange County Transportation Authority has developed a Natural Hazard Mitigation Plan. This plan evaluates natural hazard impacts to the Orange County Transportation Authority's operations and provides mitigation strategy recommendations to reduce or eliminate risks from those identified hazards.

Recommendations

A. Adopt the Orange County Transportation Authority Natural Hazard Mitigation Plan, as approved by the California Office of Emergency Services and the Federal Emergency Management Agency.

B. Direct staff to implement the annual Natural Hazard Mitigation Plan review to ensure the plan remains accurate and in compliance with state and federal regulations.

C. Direct staff to update the Natural Hazard Mitigation Plan every five years to maintain compliance with the state and federal agency requirements.

4. Measure M2 Streets and Roads Program Milestone
Francesca Ching/Kia Mortazavi

Overview

Approximately one-third (32 percent) of the voter-approved Measure M2 local transportation sales tax revenue is dedicated to maintaining streets, synchronizing traffic signals, and improving local streets and roads to deliver a safer, more efficient roadway network. In September 2022, the Measure M2 Streets and Roads program surpassed $1 billion in funding allocations and distributions. This report commemorates this achievement and highlights the related accomplishments and benefits.

Recommendation

Receive and file as an information item.

5. Measure M2 Next 10 Delivery Plan: Market Conditions Key Indicators Analysis and Forecast
Francesca Ching/Kia Mortazavi

Overview

At the direction of the Board of Directors, the Orange County Transportation Authority monitors construction market conditions. Annually, a report on Market Conditions Key Indicators Analysis and Forecast is presented to the Board of Directors to provide insight into potential project delivery cost drivers that could affect the Measure M2 Next 10 Delivery Plan. The last effort was presented to the Board of Directors on October 11, 2021. An updated forecast has been prepared and a presentation on the results of this effort is provided.

Recommendation

Continue to monitor market conditions key indicators and provide updates to the Board of Directors as appropriate.

Discussion Items

6. Directions 2045 – Long-Range Transportation Plan - Board of Directors Workshop Preview
Gregory Nord/Kia Mortazavi

Overview

Staff will discuss the upcoming Board of Directors Workshop on the Long-Range Transportation Plan. This will include an overview of topics to be discussed at the Workshop, including the Long-Range Transportation Plan. Paths to Success and the proposed Short-Term Action Plan that outlines planning activities to be pursued by the Orange County Transportation Authority over the next few years.

7. Public Comments

8. Chief Executive Officer's Report

9. Committee Members' Reports

10. Closed Session

There are no Closed Session items scheduled.

11. Adjournment

The next regularly scheduled meeting of this Committee will be held at **9:00 a.m. on Monday, November 7, 2022,** at the OCTA Headquarters, Board Room, 550 South Main Street, Orange, California.

Committee Members Present
Mark A. Murphy, Chairman
Gene Hernandez, Vice Chairman
Lisa Bartlett
Andrew Do
Michael Hennessey
Steve Jones
Joseph Muller

Staff Present
Darrell E. Johnson, Chief Executive Officer
Jennifer L. Bergener, Deputy Chief Executive Officer
Andrea West, Interim Clerk of the Board
Gina Ramirez, Clerk of the Board Specialist, Senior
Allison Cheshire, Clerk of the Board Specialist, Senior
Cassie Trapesonian, General Counsel
OCTA Staff

Committee Members Absent
None

Call to Order

The September 2, 2022, Executive Committee regular meeting was called to order by Chairman Murphy at 9:02 a.m.

Consent Calendar (Items 1 and 2)

1. Approval of Minutes

A motion was made by Director Do, seconded by Director Jones, and declared passed by those present, to approve the August 1, 2022, minutes of the Executive Committee meeting.

2. Measure M2 Quarterly Progress Report for the Period of April 2022 Through June 2022

A motion was made by Director Do, seconded by Director Jones, and declared passed by those present, to receive and file as an information item.

Regular Calendar

3. City of Santa Ana Parking Revenue Losses and Additional Security Costs

Victor Velasquez, Department Manager, Financial Planning and Analysis, provided an overview of this item.

A motion was made by Director Do, seconded by Director Murphy, and declared passed by those present, to provide up to $679,748 to the City of Santa Ana, based on actual losses in parking revenues and verifiable additional costs incurred between February 2022 and December 2022.

Discussion Items

4. Public Comments

There were no public comments received.

5. Chief Executive Officer's Report

Darrell E. Johnson, Chief Executive Officer, provided an update on the following:

- Excellence in Public Information Communications awards
- OCTA 50th Anniversary Celebration

6. Committee Members' Reports

Chairman Murphy noted street closures due to the International Street Fair in Orange over the weekend.

7. Closed Session

There were no Closed Session items scheduled.

8. Adjournment

The meeting adjourned at 9:22 a.m.

The next regularly scheduled meeting of this Committee will be held at **9:00 a.m. on Monday, October 3, 2022,** at the OCTA Headquarters, Board Room, 550 South Main Street, Orange, California.

ATTEST

Gina Ramirez
Clerk of the Board Specialist, Senior

October 3, 2022

To: Executive Committee

From: Darrell E. Johnson, Chief Executive Officer

Subject: Orange County Transportation Authority Code of Conduct

Overview

As required by the Federal Transit Administration and organizational best practices, the Orange County Transportation Authority maintains a written code of conduct to provide direction to officers, employees, agents, and members of the Board of Directors on appropriate and professional behavior in conducting the business of the Orange County Transportation Authority.

Recommendation

Receive and file as an information item.

Background

The Federal Transit Administration (FTA) requires that all funding recipients maintain a written code of conduct, or standards of conduct, that will govern the actions of its officers, employees, Board Members, or agents engaged in the award or administration of sub-agreements, leases, third-party contracts, or other arrangements supported with federal assistance.

The Orange County Transportation Authority (OCTA) last updated and adopted the Code of Conduct Policy on November 9, 2020.

Discussion

The OCTA Code of Conduct Policy (Attachment A) requires that employees, agents, and members of the Board of Directors (parties) exercise the highest level of ethical behavior in the conduct of OCTA business. It includes expectations that these parties comply with the law, as well as with the letter and spirit, of the Code of Conduct.

Consistent with FTA requirements and codes of conduct adopted by other public agencies, the OCTA Code of Conduct prohibits both real and apparent conflicts

of interest and includes procedures for identifying and preventing such conflicts. As a means of promoting a strong ethical culture at OCTA, the Code of Conduct also includes reiterations of existing OCTA policies or federal and state laws prohibiting discrimination, retaliation, sexual harassment, and other inappropriate behavior.

The section of the Code of Conduct related to gifts is a required element of a written code of conduct as provided in OCTA's Master Agreement with the FTA. The rules prohibit OCTA employees, agents, and members of the Board of Directors from accepting any gifts, gratuities, favors, or anything of monetary value from contractors, subcontractors, bidders, or proposers on federally funded OCTA contracts. On non-federally funded contracts, gifts totaling less than $520 from other sources would be permitted so long as designated employees, as defined in OCTA's Conflict of Interest Policy, report the gifts on their annual Statements of Economic Interests in accordance with state law. This gift limit is updated biennially, and the Code of Conduct presented herewith has been updated to reflect changes made and effective as of 2021.

Changes to 2022 Code of Conduct Policy are summarized below:

1. Section V. L, the word "telephone" was removed;

2. Section VII. B was revised to update the division name;

3. Section VII. B was revised to remove reference to the specific type of discipline that will result from a policy violation;

4. Section V. F was revised to mirror changes to Title 2 of California Code of Regulations Section 18940.2 as it relates to gifts.

The Code of Conduct is provided to employees on their date of hire and biennially thereafter, with acknowledgement of receipt required.

Summary

The Orange County Transportation Authority Code of Conduct was developed to provide direction to Orange County Transportation Authority employees, agents, and the Board of Directors on matters related to behavior while conducting Orange County Transportation Authority business.

Attachment

A. Orange County Transportation Authority Code of Conduct Policy

Prepared by:

Karen DeCrescenzo
Human Resources Manager
(714) 560-5547

Approved by:

Maggie McJilton
Executive Director, People and Community Engagement
(714) 560-5824

~~Human Resources and Organizational Development~~People and Community Engagement

Chief Executive Officer

CODE OF CONDUCT POLICY

Policy#: PACE~~HROD~~-BOD- **Origination** 07/13/2009 **Revised Date:** ~~11/09/2020~~08/26/22

I. PURPOSE

The purpose of this policy is to provide the guidelines and expectations to all Orange County Transportation Authority (OCTA) employees regarding the conduct that is expected both at and away from work. OCTA is a public agency that shall conduct its business with integrity in an honest and ethical manner. Any attempt to evade or circumvent any requirements of this policy or of any rules or laws applicable to OCTA and its employees is improper.

II. ORGANIZATIONAL UNITS AFFECTED

This policy applies to all OCTA employees. For purposes of the Code of Conduct, OCTA employees shall mean and include employees, members of the Board of Directors, and agents of OCTA. OCTA employees shall comply with the letter and spirit of this policy and the law.

The Human Resources Department shall be responsible for the administration of this policy and maintenance of employee acknowledgements of receipt.

III. POLICY

A. OCTA employees shall conduct OCTA's business in compliance with the law, regulations, OCTA policies, and good judgment based on OCTA's values and goals. OCTA employees shall avoid speech or behavior that is likely to create an appearance of impropriety.

B. It is up to each OCTA employee to maintain a professional, safe, and productive work environment. OCTA employees shall treat each other professionally and with courtesy at all times. Differences of opinion on work issues should be expressed in a constructive manner that promotes sharing ideas and effective teamwork to resolve problems to meet the challenges of OCTA.

IV. DEFINITIONS

Not applicable.

V. PROCEDURE

A. Non-D~~d~~iscrimination

No person shall be discriminated against in employment because of race, color, creed, religion, sex, gender (including pregnancy, childbirth, breastfeeding) gender identity, gender expression, genetic information, ancestry, age, national origin, marital status,

sexual orientation, military and veteran status, physical or mental disability, or any other status protected by applicable federal or state statutes, except where a bona fide occupational qualification applies.

B. Workplace Harassment

1. No OCTA employee or person associated with OCTA shall engage in sexual harassment. Sexual harassment includes any sexual advances or requests for sexual favors which are unwelcome or where submission to or rejection of such conduct is used as the basis for employment or business decisions. Sexual harassment also includes verbal, visual, and/or physical conduct of a sexual nature, which creates an intimidating, hostile, or offensive working environment.

2. No OCTA employee or person associated with OCTA shall engage in harassment based on race, color, religion, creed, ~~,~~ ancestry, sex (including pregnancy, childbirth, and breastfeeding and medical conditions related to pregnancy, childbirth, and breastfeeding), gender, gender identity, gender expression, sexual orientation, marital status, medical condition, genetic information, military and veteran status, age, physical or mental disability, national origin, transgender, or any other legally protected status as established by federal or state law. Harassment includes verbal, visual, and/or physical conduct. Such conduct constitutes harassment when the submission to the conduct is made an explicit or implicit condition of employment, submission to or rejection of the conduct used as the basis for an employment decision, or the harassment interferes with an employee's work performance, or creates an intimidating hostile or offensive work environment. Workplace harassment, discrimination, or retaliation will not be tolerated whether by OCTA employees, vendors of OCTA, customers, or other third parties.

C. Relationships With Contractors

OCTA business shall be conducted in a manner above reproach, with impartiality, and without bias. Particularly in relationships with contractors and potential contractors, OCTA employees must avoid any actual or appearance of conflict of interest or impropriety.

D. Use of OCTA Assets

OCTA employees shall not use any OCTA assets for personal gain or for any purpose other than OCTA business. Subject to the restrictions in this section and if permitted by the employee's supervisor, some occasional and limited personal use is allowed so long as it does not interfere with the performance of the employee's duties and does not result in any additional expense to OCTA. However, OCTA telephones, computers, e-mail, or internet access shall not be used for e-mail chain letters, for religious or political advocacy, for excessive personal communications, for personal financial gain, to seek outside employment, for any purpose that could reasonably be viewed as abusive, harassing, hostile, or intimidating to OCTA customers or employees, to access entertainment or sexually explicit sites, or for any use otherwise prohibited by

law. OCTA reserves the right to monitor and review all records of usage by OCTA employees of any OCTA assets. No use of OCTA telephones, computers, e-mail or internet access, or any use of any other OCTA asset shall be private to the employee, and no OCTA employee shall be given any basis for an expectation of privacy in any such use.

E. Confidential Information

OCTA employees shall maintain the confidentiality of any confidential information related to contracts, construction, procurement, litigation strategy, personnel files, employee medical information, or other proprietary information to which they have access through their employment with OCTA. Such confidentiality shall be maintained during and after employment with OCTA. OCTA employees shall not use confidential information for any purpose other than in the performance of their job for the benefit of OCTA. Confidential information shall only be disclosed to authorized persons.

F. Gifts

1. OCTA employees or immediate family members shall neither solicit nor accept gifts, gratuities, favors, or anything of monetary value, except unsolicited items of nominal intrinsic value from any OCTA contractor, subcontractor, bidder, or proposer for an OCTA contract which is federally- funded. A bidder/proposer is a party which has submitted a bid or proposal for an active procurement which has not been awarded or otherwise concluded.

2. Designated OCTA employees may not accept gifts totaling more than $5020 pursuant to Title 2 of California Code of Regulations Section 18940.2, or over the amounts allowed pursuant to Government Code Sections 89502 and 89503 as adjusted biennially in a calendar year from a single source other than one identified in paragraph one1 above.

3. For purposes of this code, a gift shall have the meaning it is defined to have in the California Political Reform Act (Act) and the regulations issued pursuant to the Act.

G. Conflicts of Interest

1. A conflict of interest, or at least an appearance of impropriety, exists when the interests, investments, outside employment, or personal enterprises of the employee or a member of his or her immediate family could compromise the employee's duty of loyalty, or otherwise conflict with or appear to conflict with his or her job performance, objectivity, impartiality, or ability to make fair business decisions in the best interest of OCTA. A conflict of interest may arise in any situation in which an OCTA employee is in a position where he or she could use his or her contacts or position in the agency to advance the private business or financial interests of the employee or his or her immediate family, whether or not at the expense of OCTA. An OCTA employee may also have a conflict of interest if called upon to make a decision concerning a person or entity that the employee worked for during the previous 12 months.

2. An OCTA employee who has a conflict of interest shall not participate in the making of any decision or contract in which the employee has a financial interest.

3. Any OCTA employee with such conflict of interest must disqualify himself or herself from making, participating in the making, or in any way attempting to use his or her official position to influence OCTA's decision in which he or she knows, or has reason to know, that he or she has a financial interest. An OCTA employee should also disqualify himself or herself from participating in an OCTA decision where the employee does not have a disqualifying financial interest, but where the making of the decision will have some other significant effect on the employee, or a member of his or her immediate family.

4. Any OCTA employee who may have a conflict of interest as described in paragraphs one~~1~~ or two~~2~~ relative to a prospective contractor, subcontractor, bidder or contract, or any other OCTA decision or issue, must advise his or her supervisor of the possible conflict of interest at the earliest possible time.

5. Upon request, ~~the~~ General Counsel shall advise an OCTA employee and his or her supervisor regarding whether it is appropriate for an OCTA employee to participate in a decision involving a possible conflict of interest.

H. Incompatible Activities

No OCTA employee shall engage in any outside activity that is inconsistent, incompatible, or that interferes with his or her ability to efficiently and effectively carry out his or her OCTA duties. Incompatible activities include, but are not limited to, any of the following:

1. The use for private gain or advantage of the employee's OCTA time, facilities, equipment or supplies, or the badge or uniform, prestige, or influence of the employee's OCTA employment.

2. Receipt or acceptance by the employee of any money or other consideration from anyone other than OCTA for the performance of an act which the employee, if not performing such act, would be required or expected to render in the regular course or hours of OCTA employment or as part of the employee's duties.

3. Time demands from outside activities that would interfere with the ability of the OCTA employee to devote his or her full work time, attention, and efforts to his or her OCTA duties.

I. Override of Controls

Control activities, such as authorization, documentation, reconciliation, security, and separation of duties are designed to ensure the integrity of financial and accounting information, promote accountability, and prevent fraud. All OCTA employees are responsible for knowledge of, and compliance with, OCTA policies and procedures that outline control activities and requirements. No OCTA employee shall engage in activities resulting in an override of controls outlined in OCTA policies and procedures.

J. Duty to Report

Each OCTA employee is obligated to report to his or her supervisor, the Internal Auditor, Human Resources staff, the Chief Executive Officer (CEO), or ~~the~~ General Counsel any facts made known to the employee which show that an OCTA contractor or OCTA employee has engaged in business practices regarding an OCTA matter which appears to be unethical, or which violates OCTA policy, or applicable state or federal law.

K. Whistleblower Protection

OCTA is committed to fair treatment of all its employees and recognizes its responsibility under state and federal law to protect from punishment and harassment any person who reports a potential ethics issue, whether or not the allegation is found to have merit. The report may be made anonymously. OCTA shall not take any act nor threaten any action against any OCTA employee as a reprisal for making a report under state or federal whistleblower laws, unless the report was made, or the information was disclosed with the knowledge that it was false or with willful disregard for its truth or falsity.

L. Ethics Hotline

OCTA shall maintain a ~~telephone~~n Ethics Hotline for any employee, vendor, or member of the public to anonymously report any suspected fraud, waste, abuse, and illegal or unethical behavior. The report shall be confidential. Reports to the Ethics Hotline will be administered by the Internal Audit Department for review and investigation by the appropriate department. For information on the options for filing a report through the Ethics Hotline, go to http://octa.net/About-OCTA/Who-We-Are/Internal-Audit/Fraud-Hotline/ or call 877-315-9918.

M. Product Endorsement and Participation in Case Studies

1. Employees, in their capacity as an OCTA employee, shall not endorse a product, service, or company or comment upon that product, service, or company if it is the intent of the solicitor of the endorsement, or of the vendor or manufacturer of that product or service, to use such comments for purposes of advertisement, marketing or sales, without prior consent of the CEO or designee. OCTA Board M~~m~~embers, in their capacity as an OCTA Board M~~m~~ember, are discouraged from endorsing a product, service, or company for purposes of advertisement, marketing or sales.

2. Employees, in their capacity as an OCTA employee, are not prohibited from responding to inquiries regarding the effectiveness of products or services used by OCTA unless the employee is aware that it is the inquirer's intention to use those comments for purposes of advertisement, marketing, or sales.

3. Employees, in their capacity as an OCTA employee, shall not participate in a case study of products or services for advertisement, marketing, or sales purposes by any person or organization outside of OCTA, without the consent of their e~~E~~xecutive d~~D~~irector.

M. Duty to Cooperate

OCTA employees, in their capacity as an OCTA employee, shall cooperate fully with judicial bodies and courts, and with workplace investigative personnel~~,~~; appear before them upon request~~,~~; and answer all questions truthfully, concerning their conduct in office or the performance of their official duties or matters within their knowledge pertaining to the property or affairs of OCTA.

VI. EXCEPTIONS

A. The provisions of Government Code Section 87406.3 shall apply with equal force and effect to each individual who is appointed as a public member of the OCTA Board of Directors (Board), the same as members of the Board ~~of Directors~~ who are elected officials.

B. This means that a public member of the Board ~~of Directors~~ shall not, for a period of one year after leaving that office, act as an agent or attorney for or otherwise represent for compensation any other person by communicating with an OCTA employee if the communication is made for the purpose of influencing administrative or legislative action, or proceeding involving the issuance, amendment, awarding, or revocation of a permit, license, grant or contract, or the sale or purchase of goods or property.

VII. PROVISIONS AND CONDITIONS

A. All OCTA employees have a responsibility to conduct OCTA's business in compliance with this policy. ~~The~~ General Counsel shall investigate alleged violations of this policy. In the event ~~the~~ General Counsel determines that a violation has occurred, ~~the~~ General Counsel's finding shall be reported to the CEO who shall take such action, which may include notification to the Board ~~of Directors~~, as is appropriate under the circumstances. Any violation of a provision of this policy which is based upon a state or federal law may also be enforced by any appropriate enforcement agency.

B. A violation of this policy by an OCTA employee may result in the imposition of discipline, up to and including dismissal. The appropriate discipline will be determined by the employee's supervisor in consultation with the division executive director of the organization unit in which the employee works and the Executive Director of ~~Human Resources and Organizational Development~~People and Community Engagement. ~~The discipline imposed will depend upon the severity of the violation and may be progressive unless the violation is determined to be so serious as to warrant more severe action initially.~~ The imposition of discipline by OCTA for a violation of this policy, when such violation is also a violation of state or federal law, shall not affect the ability of any appropriate prosecutorial agency to seek the imposition of any penalty allowed by law for such violation.

C. Acknowledgement of Receipt of Code of Conduct – New OCTA employees will receive a copy of this policy upon commencement of employment and will sign an

acknowledgement of receipt. Thereafter, all employees will receive a copy of this policy once every two ~~(2)~~ years, and they will be required to sign an acknowledgement of receipt.

VIII. RELATED DOCUMENTS

A. Code of Conduct Policy Acknowledgement Form

B. Workplace Harassment & Discrimination Prevention Policy (EO-HR-400WHDP)

END OF POLICY

October 3, 2022

To: Executive Committee

From: Darrell E. Johnson, Chief Executive Officer

Subject: Orange County Transportation Authority Natural Hazard Mitigation Plan

Overview

As part of a comprehensive emergency management program, the Orange County Transportation Authority has developed a Natural Hazard Mitigation Plan. This plan evaluates natural hazard impacts to the Orange County Transportation Authority's operations and provides mitigation strategy recommendations to reduce or eliminate risks from those identified hazards.

Recommendations

A. Adopt the Orange County Transportation Authority Natural Hazard Mitigation Plan, as approved by the California Office of Emergency Services and the Federal Emergency Management Agency.

B. Direct staff to implement the annual Natural Hazard Mitigation Plan review to ensure the plan remains accurate and in compliance with state and federal regulations.

C. Direct staff to update the Natural Hazard Mitigation Plan every five years to maintain compliance with the state and federal agency requirements.

Background

Hazard mitigation planning reduces risks to people and property and improves organizational resiliency by minimizing the impact of disasters. Effective hazard mitigation planning also reduces the cost of recovering from a disaster. Hazard mitigation plans identify a comprehensive list of regional hazards that can occur and define a list of mitigation measures related to those hazards. Additionally, for the Orange County Transportation Authority (OCTA) to receive pre- and post-disaster mitigation funds from the Federal Emergency Management Administration (FEMA) or the California Office of Emergency Services (CalOES),

OCTA must have a current FEMA-approved Hazard Mitigation Plan (Plan). This Plan must be updated annually and re-approved by CalOES, FEMA, and OCTA's Board of Directors (Board) every five years. With approval by the Board, this will be the first version of the Plan (Attachment A).

Discussion

Hazard mitigation planning can help reduce loss of life and property by minimizing the impact of disasters and is the cornerstone of every community's approach to reducing vulnerabilities to disasters. The Federal Disaster Mitigation Act of 2000, Title 44 Code of Federal Regulations 201.6, requires states and local entities to adopt this approach to reduce losses, become more resilient, and qualify for pre- and post-disaster mitigation funding by way of grants.

The proposed Plan outlines a five-phase approach to developing mitigation recommendations: establishing a Hazard Mitigation Planning Steering Committee comprised of internal and external stakeholders, conducting an inventory of OCTA assets and risk assessment against known natural hazards in the OCTA operating area, engaging OCTA customers and community, development of recommended mitigation strategies to address risks, and the Plan adoption, implementation, and maintenance.

In all, 12 categories of hazards were identified and prioritized. The top four hazards include wildfire, earthquake, epidemic/pandemic, and severe weather. Each hazard section of the Plan details magnitude, frequency, and the potential impact to OCTA operations and its ridership.

From this detailed analysis, 24 mitigation strategies are recommended, spanning several OCTA service areas and in some cases, involving governmental and agency partners throughout the planning area. These strategies address the following eight areas:

- Public education
- Pandemic after-action reports
- Protection of infrastructure from flooding/erosion
- Climate change
- Earthquake/seismic risks
- Multi–hazard protection
- Employee education
- Wildfire mitigation

On May 27, 2022, this Plan was reviewed and approved by both FEMA and CalOES and now qualifies OCTA to pursue pre- and post-disaster mitigation funding following Board approval and promulgation of the Plan. The Plan must be reviewed annually by the Hazard Mitigation Planning Steering Committee, revised in 2026, and resubmitted to FEMA and CalOES for approval for OCTA to remain eligible to receive pre- and post-disaster mitigation funding.

Summary

The California Office of Emergency Services and the Federal Emergency Management Agency encourage local agencies to develop and maintain a Hazard Mitigation Plan that can help to reduce the loss of life and property by minimizing the impact of disasters. With the adoption of the Orange County Transportation Authority Natural Hazard Mitigation Plan and direction from the Board of Directors to fully implement the plan, the Orange County Transportation Authority will be eligible to apply for pre- and post-disaster grant funding.

Attachments

A. Orange County Transportation Authority Natural Hazard Mitigation Plan
B. Orange County Transportation Authority Natural Hazard Mitigation Plan – Appendix D. Planning Process and Public Outreach

Prepared by:

Matt Ankley
Emergency Management Specialist,
Security and Emergency Preparedness
(714) 560-5961

Approved by:

Jennifer L. Bergener
Deputy Chief Executive Officer
(714) 560-5462

ATTACHMENT A

Orange County Transportation Authority Natural Hazard Mitigation Plan

"Our mission is to develop and deliver transportation solutions to enhance the quality of life and keep Orange County moving"

OCTA

2022

Orange County Transportation Authority 2022 Natural Hazard Mitigation Plan

October 10, 2022

Prepared for:

Orange County Transportation Authority

550 South Main Street

Orange, CA 92868

Draft

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Acknowledgments

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Consultants

- Trevor Clifford, Project Manager, WSP
- Jessica Forbes-Guerrero, Senior Mitigation Planner, WSP
- Colleen Kragen, Mitigation Planner, WSP
- Brennah McVey, GIS Analyst, WSP
- Dane Kovaleski, Mitigation Planner, WSP

Special Acknowledgements

The creation of this plan would not have been possible without the dedication and commitment to the planning process by the personnel and customers of the Orange County Transportation Authority (OCTA), particularly the OCTA 2022 Hazard Mitigation Plan Steering Committee.

We greatly appreciate their time and dedication.

Executive Summary

The Orange County Transportation Authority's (OCTA) 2022 Hazard Mitigation Plan (HMP) is a stakeholder-driven, risk-informed, and capabilities-based strategic planning document that aspires to identify and recommend prioritized strategies to mitigate the potential impacts of natural hazards within OCTA's service area. This plan demonstrates OCTA's commitment to protecting its customers, assets, and the environment from the effects of natural hazards through mitigation and enables access to federal funding to support this commitment.

Establishing the HMP Steering Committee

To oversee development of the HMP, the OCTA Executive Committee formed an 18-person Steering Committee, listed in Table 0-1. The Steering Committee included personnel from departments across OCTA, local jurisdictions within OCTA's service area, regional bodies, and community-based organizations. The Steering Committee participated in four workshops, beginning July 2020 and ending May 2021. These workshops were:

- **Workshop 1:** Hazard Mitigation Planning Overview and Project Kickoff
- **Workshop 2**: Risk Assessment
- **Workshop 3:** Mitigation Strategy
- **Workshop 4:** Draft Plan Review

Workshop materials (i.e., agenda, slide deck, sign-in sheet, worksheet(s), and summaries) are available in Appendix D for review, documenting the plan development and decision-making process.

Table 0-1 – Steering Committee Members

Name	Entity	Title	Department/Office
Matt Ankley	OCTA	Emergency Management Specialist	Chief Executive Office
Katrina Faulkner	OCTA	Manager, Security, and Emergency Preparedness	Chief Executive Office
Megan Abba	OCTA	Communications Specialist	Chief Executive Office
Jason Lee	OCTA	Project Manager, Metrolink Expansion	Capital Programs
George Olivo	OCTA	Program Manager of Facilities Engineering	Capital Programs
Charlie Larwood	OCTA	Manager of Planning and Analysis	Planning
Marissa Espino	OCTA	Community Relations Specialist	External Affairs
Chris Damyen	OCTA	Manager of Facilities Maintenance	Operations
Cleve Cleveland	OCTA	Manager, OC Streetcar	Operations
Dinah Minteer	OCTA	Manager of Regional Rail	Operations
Ethan Brown	Orange County Sheriff's Department	Emergency Management Coordinator	Emergency Management Division
Randy Harper	Orange County Sheriff's Department	Emergency Management Coordinator	Emergency Management Division
Rudy Emami	City of Anaheim	Director	Public Works

Name	Entity	Title	Department/Office
Mike Davis	City of Irvine	Assistant Director	Transportation
Bill Murray	City of Garden Grove	Director	Public Works
Brett Canedy	City of Mission Viejo	Transportation Analyst	Transportation
Taig Higgins	City Santa Ana	Principal Engineer	Public Works
Anna Lowe	San Diego Association of Governments	Senior Regional Planner	Regional Planning
Dan Phu	OCTA	Program Manager, Project Development	Planning
Lauren Sato	OCTA	Transit Analyst, Project Development	Planning

Defining the Planning Area

During Workshop 1 – Hazard Mitigation Planning Overview and Project Kickoff, the Steering Committee agreed that the OCTA 2022 HMP planning area should be defined by OCTA's service and assets, which operate in all of Orange County, the southern end of Los Angeles County, and a small portion of northern San Diego County. The Steering Committee agreed that the OCTA HMP planning area should include considerations for customers, staff, property, infrastructure, and the natural environment.

Population numbers and past annual bus ridership numbers inform OCTA planning area service and population trends. In 2019, bus ridership was approximately 35.5 million total boardings for the year and 19 average boardings per day for each bus stop. While OCTA owns and maintains the busses, bus bases, and some transit hubs, cities own the bus stops residing in their jurisdictions. Beyond the extensive bus transportation network, OCTA has a partnership with passenger rail carriers Metrolink and Amtrak, who connect major destinations and employment centers in Ventura, Los Angeles, Orange, Riverside, San Bernardino, and San Diego counties (Orange County Transportation Authority). In this case, OCTA maintains the rail right-of-way in partnership with the shared Metrolink and Amtrak corridors, while local cities own and operate the stations and stops.

OCTA also offers flexible services across the entire area through ride-share and vanpool programs. The OC Streetcar route is projected to be complete in 2024 and will connect to Metrolink, Amtrak's Pacific Surfliner, and the Santa Ana Regional Transportation Center (Orange County Transportation Authority). These and other transportation services link together to furnish numerous options for travel across the planning area. While the OC Streetcar project rail system was started when this plan was approved, certain components (the Maintenance Facility and Tran Wash Facility) were still in development and not part of this plan. Future revisions of the HMP will incorporate these facilities. Figure 10 is a map of the coverage area and critical transportation systems. OCTA assets directly considered in the development of this plan are listed in Table 0-2 on the following page.

Table 0-2 – OCTA Assets

Facility	Latitude	Longitude
Garden Grove Base	33 45' 49" N	117 55' 25" W
Santa Ana Base	33 42' 12" N	117 55' 32" W
Irvine Sand Canyon Base	33 40' 43" N	117 45' 19" W
Irvine Construction Circle Base	33 41' 46" N	117 49' 24" W
Anaheim Base	33 51' 26" N	117 53' 30" W
Newport Beach Transportation Center	33 36' 51" N	117 52' 06" W
Golden West Transportation Center	33 44' 03" N	117 59' 58" W
Laguna Hills Transportation Center	33 36' 25" N	117 42' 20" W
Fullerton Transportation Center	33 52' 10" N	117 55' 20" W
Fullerton Park-and-Ride	33 51' 31" N	117 58' 44" W
Brea Park-and-Ride	33 55' 32" N	117 52' 53" W
Administrative Facility 550/600	33 46' 44" N	117 52' 04" W
Transportation Security Operations Center	33 49' 54" N	117 56' 02" W

Identifying + Assessing Natural Hazard Risks in the Planning Area

The purpose of a risk assessment is to describe the type, location, and extent of every natural hazard that could occur in the planning area. Informed by qualitative and quantitative methods, the risk assessment includes information on previous occurrences of hazard events within the planning area and informs the probability of future hazard events. Additionally, the risk assessment consists of an exposure and vulnerability assessment for OCTA customers, assets, and the planning area's environment.

During Workshop 2 – Risk Assessment, the Steering Committee qualitatively identified and assessed natural hazard risks in the planning area. To do so, Steering Committee members independently ranked each hazard based on the perceived severity, magnitude, frequency, onset, and duration for the potential worst-case and the most likely scenarios; Appendix A includes definitions of each criterion. The Steering Committee identified 12 natural hazards of concern within the planning area, which were consolidated into seven (7) to improve the accessibility and utility of the plan. The result is that the hazard profile for flooding includes sea level rise and coastal erosion, and the severe weather profile includes drought, extreme heat, and storm surge, as shown in Table 0-3.

Table 0-3 – OCTA Hazard List

No.	Initial HMP Hazard Profile	Consolidated Hazard Profile
1	Earthquake	
2	Epidemic/Pandemic	
3	Flooding	Sea Level Rise and Coastal Erosion
4	Mass Earth Movements	
5	Severe Weather Events	Drought, Extreme Heat, storm Surge
6	Tsunami	
7	Wildfire	

Following the hazards' qualitative identification and scoring, a quantitative analysis used geospatial hazards information where available and generated a series of hazard-specific maps indicating the extent of the hazard risk. Tabular outputs showed the exposure and vulnerability of critical infrastructures and facilities, and customers. The methodology and results of this analysis are discussed further in Part 2 of the plan, Risk Assessment.

Engaging OCTA's Customers and Greater Community

The Steering Committee developed and implemented a community engagement strategy to solicit input from OCTA customers and the greater community throughout the planning process. The strategy included an online survey, an open house, and a 30-day review and comment period of the plan; the strategy and results are discussed at length in Part 1 of the HMP, while the complete materials are available in Appendix D. The following objectives guided the development and implementation of the strategy:

- Identify and engage OCTA customers and community members through a social media campaign
- Distribute a survey to OCTA customers and community members to identify and prioritize hazards, provide mitigation strategies, sign-up to stay engaged in the planning process
- Encourage participation in an HMP draft plan review open house, including targeted invites to those persons who signed up to stay engaged in the planning process
- Solicit written feedback on the draft HMP during the open house and by making it available online

Over 300 OCTA customers and community members participated in the survey, approximately one-third of which provided their emails to stay engaged throughout the planning process.

Developing the Mitigation Strategy

During Workshop 3 – Mitigation Strategy, the Steering Committee developed goals and strategies for the OCTA 2022 HMP by reviewing the OCTA customer and community member survey responses on risks and strategies, comparing them to their own assessment in Workshop 2, and reviewing OCTA's capabilities to mitigate hazards; capabilities include planning and regulatory, administrative and technical, and financial, which are discussed in Section 3.5 of this plan. The stakeholder and community-member driven, risk-informed, and capability-based goals and strategies for the OCTA 2022 HMP are:

1. Support OCTA policies, plans, people, and programs to maintain an integrated transportation system that supports the diverse transportation needs of Orange County.
2. Minimize vulnerabilities to protect people, property, the natural environment and keep Orange County moving.
3. Ensure resilience-oriented decisions incorporate regional collaboration and enhanced partners.
4. Promote community engagement through transparent public outreach that is equitable and accessible to everyone in the community.

The Steering Committee established 24 strategies to achieve the mitigation goals outlined in this plan, reducing, or eliminating losses resulting from natural hazards. The mitigation strategies are as follows:

Table 0-4 – OCTA Mitigation Strategies

#	Description
1	Increase public education and outreach by creating a new dedicated hazard webpage to share climate information changes and OCTA mitigation/preparedness measures.
2	Contribute to internal and regional after-action reports for the COVID-19 pandemic to identify critical strategies that need to be completed to reduce risks to the community from future pandemics. These recommendations should be included in future updates of the HMP.
3	Partner with other agencies to implement additional measures to protect coastal rail infrastructure as appropriate in southern Orange County. (Aligns with *OC Rail Defense Against Climate Change Plan*)
4	Partner with other agencies to study potential erosion control and stormwater measures.
5	Regularly obtain the most recent recommended future heavy precipitation and flow estimates and compare these to the current 100-year high confidence heavy precipitation and flow estimates used for infrastructure design. Determine which estimates should be used to minimize risks to infrastructure over the lifecycle. (Aligns with *OC Rail Defense Against Climate Change Plan*)
6	Regularly review and update the data used to calculate the rail zero-stress temperature to account for current and projected climate change and stress newly installed and existing rail based on this information. (Aligns with *OC Rail Defense Against Climate Change Plan*)
7	Evaluate and develop recommendations to retrofit OCTA critical facilities to address seismic risks.
8	Assess and implement engineering options at OCTA bus bases for hardening fuel storage and fueling facilities against seismic and other hazards.
9	Develop site-specific response plans and structures for worksites using SEMS/NIMS principles.
10	Continue OCTA vulnerability assessments for all hazards.
11	Share vulnerability assessment data with partner agencies. Encourage train station amenities to help riders during extreme heat and other severe weather events, including additional shaded or covered areas and seating, restrooms, and cooling mechanisms. Provide accurate information on train schedules to minimize waiting times. (Aligns with *OC Rail Defense Against Climate Change Plan*)
12	Expand internal communications and preparedness education about potential hazards, including what to do during and after a hazard event.
13	Perform fuel modifications on OCTA conservation properties to provide proper clearance near habitable structures per local fire authority standards. Assess opportunities to replace invasive species and plant fire-adapted native plants to prevent invasive species from becoming re-established, minimizing the risk of wildfires.
14	Evaluate stormwater runoff systems at critical OCTA facilities and infrastructure. As appropriate, upgrade stormwater runoff management at OCTA critical facilities and infrastructure.
15	Continue to use the most current geographic information systems (GIS) data layers in the hazard reduction decision-making processes.
16	Regularly assess the planning area's evacuation routes and pickup points. Coordinate with the County Emergency Management Division and cities to provide the most efficient and effective evacuation transportation support.
17	Support cities and the county in the planning area with evacuation education and public outreach related to OCTA.
18	Evaluate transit options for providing transit services during a disaster event. (Aligned with *OC Transit Vision*.)
19	Promote the use of new technology in hazard mitigation and emergency preparedness.
20	Continue to develop new and evaluate existing climate change goals and policies as new scientific data and models become available.

#	Description
21	Incorporate data from the 2022 OCTA HMP, mitigation strategies, and risk reduction principles into future updates of agency plans related to hazard mitigation.
22	Develop and improve communication redundancies to ensure effective internal and external communication in a hazard event.
23	Prepare and implement fire management plans, invasive species control, public education and awareness, and enhanced security measures to mitigate the potential for wildfire on conservation properties. Consider closure of conservation properties during times of high fire risk. (Aligned with resource management plans.)
24	Monitor and address adverse effects from properties adjacent to conservation properties. (Aligned with resource management plans.)

Writing, Implementing, + Maintaining the HMP

The Steering Committee developed the OCTA 2022 HMP over approximately nine months with extensive stakeholder and community member involvement. The planning process, including all workshop and community member engagement materials, is documented in Appendix D. The plan meets or exceeds the requirements established under 44 CFR 201.6 – Local Mitigation Plans (Code of Federal Regulations, 2013), as indicated in the FEMA Region IX Local Mitigation Plan Review Tool in Appendix E.

Once the HMP has been approved by OCTA, it is submitted to the California Office of Emergency Services (CalOES) and FEMA Region IX for review and pre-adoption approval. The review process is documented via the FEMA Region IX Local Mitigation Plan Review Tool and an official Approval Pending Adoption (APA) letter from FEMA. Upon receiving the APA letter, OCTA has 12 months to formally adopt the HMP via resolution and inform FEMA that it has been adopted. Once adopted, OCTA is eligible to apply for and receive federal hazard mitigation grant funding.

Over the next five-year period, OCTA will implement the strategies listed in the HMP to realize its goals. HMP implementation will be led by the OCTA Office of Security and Emergency Preparedness and supported by the Steering Committee. The Steering Committee will meet annually to review action implementation, changes in natural hazard risks, update mitigation capabilities, reassess opportunities to continue engagement of OCTA customers and community members, and integration with other relevant plans and programs; the Progress Reporting template in Appendix B will be used to document this process. In five years, OCTA will undertake a comprehensive plan update informed by these annual reports.

OCTA 2022 Hazard Mitigation Plan

Part 1: Planning Process Overview

Part 1

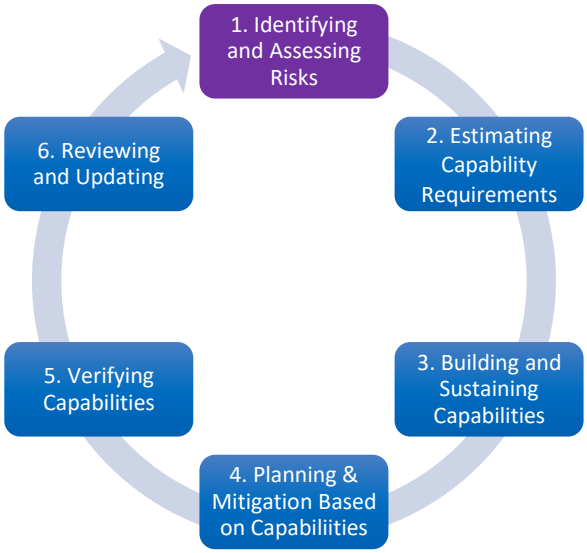
1 Introduction to Hazard Mitigation Planning

1.1 What is Natural Hazard Mitigation Planning?

Hazard mitigation uses long- and short-term strategies to reduce or alleviate the loss of life, personal injury, and property damage resulting from a disaster. It involves planning efforts, policy changes, programs, studies, improvement projects, and other strategies to reduce hazard impacts. Mitigation plans are vital to breaking the cycle of disaster damage, reconstruction, and repeated damage.

The Department of Homeland Security's (DHS) Comprehensive Preparedness Guide 201 states that natural hazards are acts of nature, such as earthquakes, tornadoes, pandemics, or epidemics. Additionally, Title 44 of the Code of Federal Regulations (CFR) Part 201 – Mitigation Planning, Section 201.2, defines hazard mitigation as "any action taken to reduce or eliminate the long-term risk to human life and property from natural hazards" (Code of Federal Regulations, 2013, p. 364). There are textboxes throughout this plan highlighting the HMP's compliance with relevant CFRs.

Figure 1-1 National Preparedness System (Department of Homeland Security, 2011)



To develop and implement practical hazard mitigation strategies, communities apply a planning process that mirrors the DHS's *National Preparedness System* (Figure 1-1). This system defines the planning steps to prepare for all hazards. These components establish a consistent approach to facilitate decision making, resource allocation, and measure progress towards the *National Preparedness Goal*. The system assesses the Nation's core capabilities across five mission areas. Step four of the system highlights the necessity and application of mitigation measures. Hazard mitigation planning results in a plan with clear strategies to reduce natural hazard risks to people, property, assets, and the planning area's environment.

1.1.1 The 2000 Disaster Mitigation Act

Before 2000, federal disaster funding focused on relief and recovery after a disaster occurred, with a limited budget for hazard mitigation planning in advance. On October 30, 2000, Congress passed the 2000 Disaster Mitigation Act (DMA), amending the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 and shifting the federal emphasis toward planning for disasters before they occur (Title 42 of the United States Code Section 5121 et seq.) (Federal Emergency Management Agency, 2019). The 2000 Act replaced the previous mitigation planning section (409) with a new mitigation planning section (322).

44 CFR Section 201.6

Local Mitigation Plans outline an entity's commitment to reducing risks associated with natural hazards.

The DMA requires state, local, and tribal government entities to develop and adopt the FEMA-approved hazard mitigation plans as a condition for federal disaster grant assistance (FEMA, 2007). Section 322 emphasized the need for state, tribal, and local entities to coordinate and collaborate on mitigation planning and implementation efforts (FEMA, 2007). Additionally, Section 322 established the legal basis for the (FEMA's) mitigation plan requirements for the Hazard Mitigation Assistance grant programs.

The DMA encourages cooperation among state, local, and tribal authorities in pre-disaster planning and emphasizes community-based planning before disasters occur. The act also promotes sustainability, including the sound management of natural resources, local economic and social resiliency, and addressing hazards and mitigation in the most extensive possible social and economic context. The enhanced planning network described in the DMA helps local organizations and governments articulate precise needs for mitigation, resulting in a faster allocation of funding and more cost-effective risk-reduction projects.

1.1.2 OCTA's Response to the 2000 Disaster Mitigation Act

OCTA developed its first HMP in 2022, satisfying the requirements of the 2000 DMA and enabling access to federal hazard mitigation grant funding. This HMP assesses the risks posed by natural hazards and identifies current capabilities for reducing those risks within OCTA's service area (i.e., planning area).

1.2 Purposes for Hazard Mitigation Planning

OCTA developed the 2022 HMP to identify and prioritize mitigation strategies. These strategies reduce or alleviate risks from natural hazards, reducing the loss of life, personal injury, and property damage for OCTA and its customers. The plan establishes a roadmap for OCTA to mitigate hazards within the service area and help OCTA coordinate and collaborate with its planning partners. The HMP meets the following objectives:

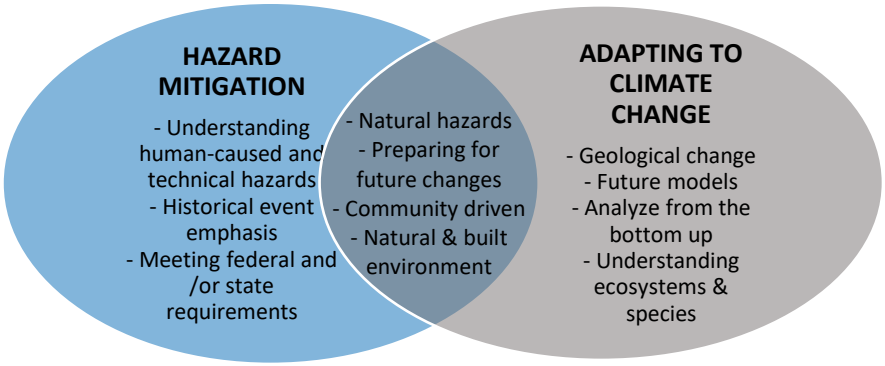
- Enables access to federal grant funding to reduce disaster risk through mitigation strategies
- Meet or exceed the DMA 2000 requirements
- Complete a risk assessment focusing on hazards of concern within the planning area
- Ensure compliance with state and federal hazard mitigation planning requirements
- Review existing OCTA policies, plans, and programs to identify opportunities for integration of hazard mitigation principles and cooperation with planning partners
- Identify high-priority projects to mitigate natural hazards that can be funded and implemented

1.3 Hazard Mitigation and Climate Adaptation Planning

1.3.1 Climate Change Adaptation and the OCTA 2022 Hazard Mitigation Plan

Climate adaptation planning is similar to natural hazard mitigation planning in that both are adjustments to mitigate the impacts of hazards. However, climate adaptation planning only focuses on climate-related issues (e.g. extreme temperatures, flooding), and natural hazard mitigation planning accounts for climate issues and others. While climate change itself is not a hazard, it may change the characteristics of a hazard within the planning area (e.g., extent). Figure 1-2 shows the similarities and dissimilarities between the two (ICLEI Local Governments for Sustainability USA, 2015).

Figure 1-2 – Hazard Mitigation and Climate Adaption Planning Relationship (ICLEI Local Governments for Sustainability USA, 2015)



Climate change adaptation strategies enable communities to reduce vulnerability to all types of natural hazards by predicting these changes and increasing local capacity to adapt (California Emergency Management Agency and Natural Resources Agency, 2012). The strategies developed may range from short- to long-term and from high-level, broad strategies to detailed, "shovel-ready" projects.

Table 1-1 below describes the California Adaptation Planning Guide, Planning for Adaptive Communities recommendations, and where OCTA's HMP incorporates them.

Table 1-1 – Climate Adaptation Strategies in the Hazard Mitigation Plan (California Emergency Management Agency and Natural Resources Agency, 2012)

Climate Adaptive Planning Recommendations	Location in the OCTA HMP
Assessing exposure to climate change impacts	Sections 5 to 11 – individual hazard profiles
Assessing community sensitivity to the exposure	Sections 5 to 11 – individual hazard profiles
Assessing potential impacts	Sections 5 to 11 – individual hazard profiles
Evaluating existing community capacity to adapt to anticipated impacts	Section 3.5 – hazard mitigation capabilities and capacity assessment
Evaluating risk and onset, meaning the certainty of the projections and speed at which they may occur	Sections 5 to 11 – individual hazard profiles
Setting priorities for adaptation needs	Section 12 – mitigation strategy
Identifying strategies	Section 12.1.1 – mitigation strategies
Evaluating and setting priorities for strategies	Section 12.1 – mitigation goals
Establishing phasing and implementation	Section 12.4 – plan implementation and maintenance strategy

1.3.2 Responding to California SB 379

California SB 379, which amended Section 65302 of the Government Code, requires the safety elements of city and county general plans to be reviewed and updated to include climate adaptation and resiliency strategies (California Legislative Information, 2015). The updated safety elements must consist of a climate change exposure assessment, adaptation and resilience applications, and manageable implementation measures (Alliance of Regional Collaboratives for Climate Adaptation, 2016).

As an agency, OCTA is not required to complete a general plan under California SB 379 (Alliance of Regional Collaboratives for Climate Adaptation, 2016). However, OCTA chose to address climate change throughout the HMP in line with the bill to inform future updates of the County of Orange General Plan and city general plans. The correlation between the bill's elements and OCTA's 2022 HMP is in Table 1-2.

Table 1-2 – OCTA Alignment with California's Climate Change SB 379 (Alliance of Regional Collaboratives for Climate Adaptation, 2016)

New Safety Elements	Location in the OCTA HMP
Assessing exposure to climate change impacts	Part 2 – Risk Assessment
A set of adaptation and resilience goals, policies, and objectives based on the information specified in the vulnerability assessment	Part 3 – Mitigation Strategy
A set of feasible implementation measures designed to carry out the goals, policies, and objectives identified in the adaptation objectives	Part 3 – Mitigation Strategy

1.4 Who Will Benefit from this Plan?

Whole Community Approach

Engaging private and nonprofit sectors in hazard preparedness and mitigation to build a more hazard resilient nation.

All stakeholders and community members that directly or indirectly rely on OCTA's services ultimately benefit from this HMP. The HMP strives to reduce the risk for customers of OCTA, particularly within the service area. It provides a viable planning framework for all foreseeable natural hazards that may have a negative effect. Participation in developing the plan by stakeholders and community members ensures that outcomes will be mutually beneficial for OCTA and the whole community. This plan provides solutions that other entities can use and benefit from and can cooperatively implement. The plan's goals and recommendations lay the groundwork for developing and implementing local mitigation activities and partnerships.

1.5 Contents of the HMP

This HMP has three primary parts:

- **Part 1** – Planning Process and Community Profile
- **Part 2** – Risk Assessment
- **Part 3** – Mitigation Strategy

Each part includes elements required under federal guidelines. Additionally, DMA compliance requirements are cited at the beginning of plan sections to illustrate compliance and highlight each section's importance and utility to the reader. The HMP appendices provide details and supporting data:

- **Appendix A** – Acronyms and Definitions
- **Appendix B** – OCTA HMP Annual Progress Report
- **Appendix C** – Mitigation Action Evaluation Forms
- **Appendix D** – Planning Process and Public Outreach
- **Appendix E** – FEMA Review Tool
- **Appendix F** – HMP Adoption Resolution
- **Appendix G** – Hazards
- **Appendix H** – References

1.5.1 Plan Approach

The OCTA 2022 HMP development process followed these steps:

- Secure grant funding
- Form a planning team
- Define the planning area
- Establish a steering committee
- Coordinate with other agencies
- Review existing programs
- Engage the public

1.5.2 Funding

OCTA received a FEMA Pre-Disaster Hazard Mitigation Grant to support plan development. Grant funding covered 75 percent of the cost to create this plan. OCTA provided additional funding through local funds.

2 HMP Methodology

2.1 Overview

The OCTA 2022 HMP process:

- Formed the planning team
- Included OCTA's response to the 2000 DMA
- Defined the planning area
- Established a steering committee
- Conducted a risk assessment
- Reviewed existing programs
- Engaged the public

2.2 Formation of the Project Team

The OCTA 2022 HMP was developed by OCTA staff with the assistance of professional services consultants, referred to as the Project Team; this included:

- Matt Ankley, Emergency Management Specialist, OCTA
- Eric Grobmyer, Emergency Management Specialist, OCTA
- Katrina Faulkner, Security and Emergency Preparedness Manager, OCTA
- Trevor Clifford, Project Manager, WSP
- Colleen Kragen, Mitigation Planner, WSP
- Brennah McVey, GIS Analyst, WSP
- Dane Kovaleski, Mitigation Planner, WSP

2.3 Formation of the Steering Committee

Hazard mitigation planning enhances collaboration and support among parties whose interests can be affected by hazard losses. A broad range of stakeholders can identify and create partnerships to achieve a shared vision for the community by working together. To oversee the HMP development, OCTA formed an 18-person Steering Committee, listed in Table 2-1. The committee members included local government representatives in the planning area and key OCTA staff representing all staff, sites, departments.

Workshop materials (i.e., agenda, slide deck, sign-in sheet, worksheet(s), and summaries) are available in Appendix D for review, documenting the plan development and decision-making process.

Table 2-1 – Steering Committee Members

Name	Entity	Title	Department/Office
Matt Ankley	OCTA	Emergency Management Specialist	Chief Executive Office
Katrina Faulkner	OCTA	Manager, Security, and Emergency Preparedness	Chief Executive Office
Megan Abba	OCTA	Communications Specialist	Chief Executive Office
Jason Lee	OCTA	Project Manager, Metrolink Expansion	Capital Programs
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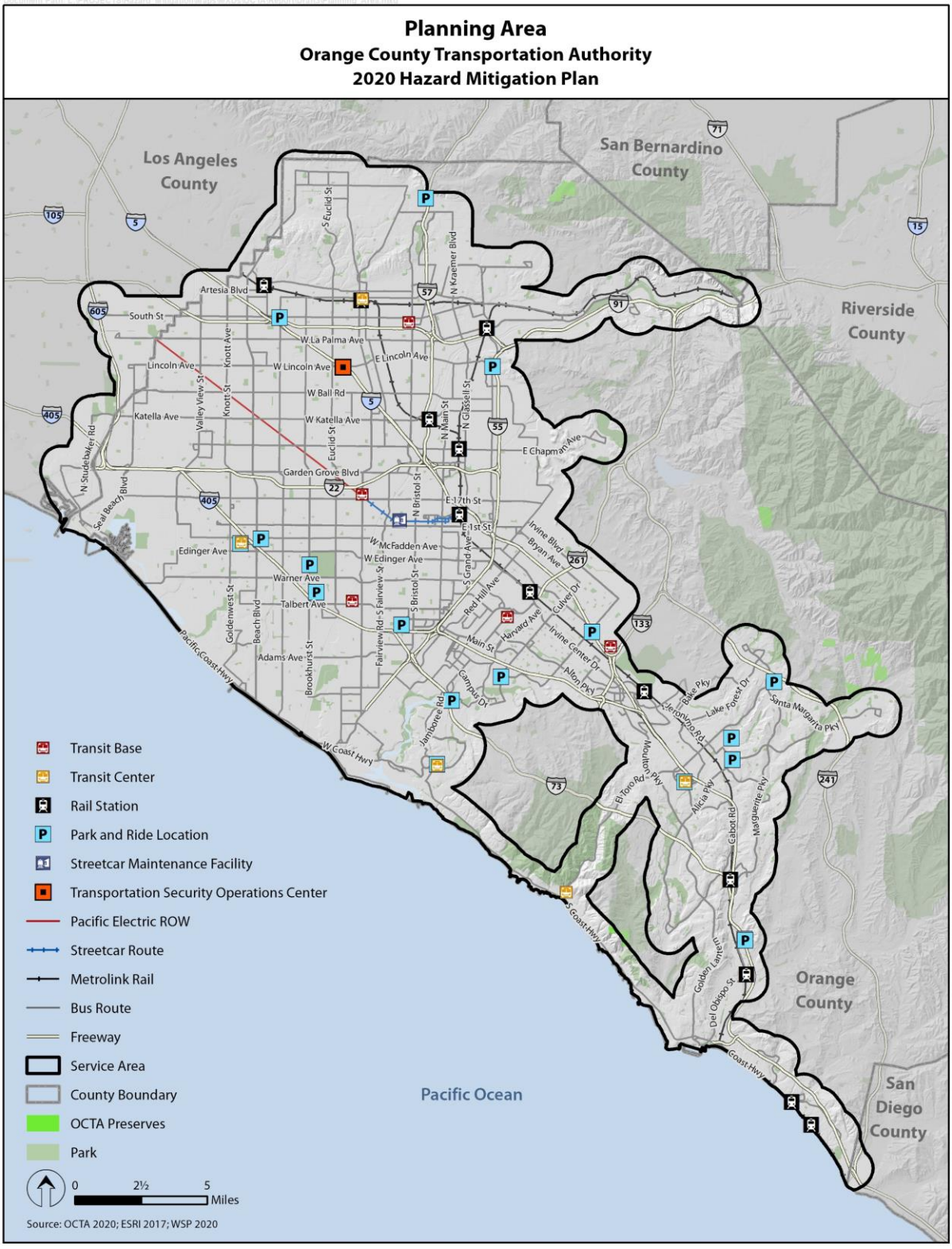
Mike Davis	City of Irvine	Assistant Director	Transportation
Bill Murray	City of Garden Grove	Director	Public Works
Brett Canedy	City of Mission Viejo	Transportation Analyst	Transportation
Taig Higgins	City Santa Ana	Principal Engineer	Public Works
Anna Lowe	San Diego Association of Governments	Senior Regional Planner	Regional Planning

2.4 Defining the Planning Area

The OCTA 2022 HMP planning area is synonymous with the OCTA service area; it covers Orange County and small portions of Los Angeles and San Diego County. The Steering Committee agreed that the OCTA HMP should incorporate all customers and owned and operated assets within the service area; Section 3.1.1 further discusses the OCTA service area. Figure 2-1 on the next page illustrates the planning boundary and key area elements.

Figure 2-1 – OCTA Planning Area and Related Transportation Systems Map. ***OCTA does not own all map items.***



2.5 Community Engagement

44 CFR Section 201.6(b)

The planning process must include open public involvement with opportunity for the public to comment on the plan draft and before the plan is approved.

The Project Team and OCTA's Department of Community Relations developed and implemented a community engagement strategy to solicit input throughout the planning process. The strategy included an online survey, an open house, and a public review of the HMP. Results from these engagements are discussed in sub-sections 2.5.1 to 2.5.3 below, while all materials are available in Appendix D. The following objectives guided the development and implementation of the strategy:

- Identify and engage OCTA customers and community members through a social media campaign
- Distribute a survey to OCTA customers and community members to identify and prioritize hazards, provide mitigation strategies, sign-up to stay engaged in the planning process
- Encourage participation in an HMP draft plan review open house, including targeted invites to those persons who signed up to stay engaged in the planning process
- Develop an OCTA Office of Security and Emergency Preparedness webpage to host the plan for review octa.net/HMP
- Solicit written feedback on the draft HMP during the open house and by making it available online

Figure 2-2 – Orange County Transportation Authority's Public Survey Shared on Twitter

Figure 2-3 – Orange County Transportation Authority's Online Hazard Mitigation Public Survey Available in English, Spanish, and Vietnamese

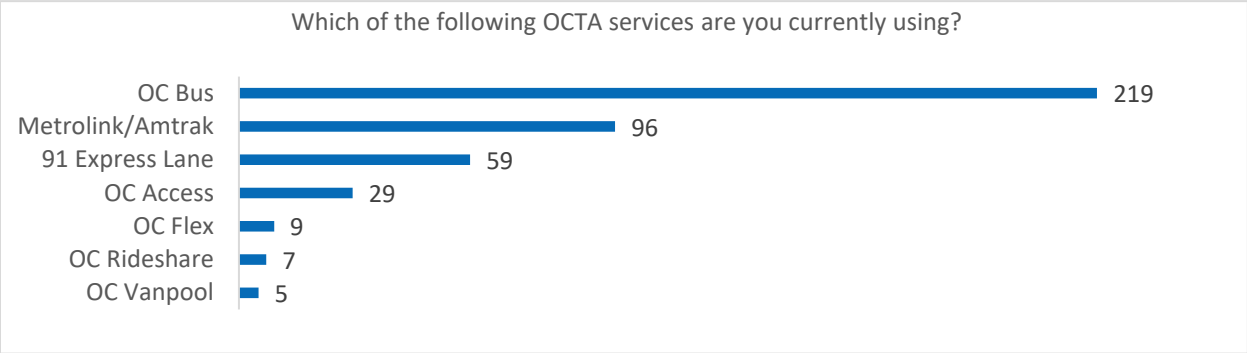
OCTA successfully marketed the hazard mitigation survey to customers and community members through the OCTA Twitter feed (Figure 2-2) and OCTA blog (Figure 2-3). The survey was available in English, Spanish, and Vietnamese to ensure a diverse, equitable, and inclusive community engagement. Doing so ensures the OCTA 2022 HMP is responsive to the whole community's values, concerns, and ideas.

2.5.1 Orange County Transportation Authority Customer Hazard Mitigation Survey Results

In December 2020, OCTA shared the 13-question online OCTA 2022 Hazard Mitigation Survey in English, Spanish, and Vietnamese. OCTA received responses from 348 customers, including five in Spanish and four in Vietnamese. Over 120 survey respondents (35 percent) indicated that they would like to stay engaged in the planning process and provided their email to do so. The transportation method most used

by survey participants is OC buses by far, with Metrolink/Amtrak in second, and the OC Vanpool is the least used by respondents. Figure 2-4 shows OCTA's services most used by survey participants.

Figure 2-4 – Customer Survey Response for OCTA Services Used



Customers identified their top three hazards that could impact their commute the most. The top three were earthquakes, which came in at the highest, then epidemic/pandemics, and wildfires not far behind. Conversely, the lowest three hazards were mass earth movements, flood, sea-level rise (SLR), and tsunamis, which were considered least likely to impact participants' commute.

Figure 2-5 – OCTA Survey Results for the Top Three Hazards Potentially Impacting Participants' Commutes

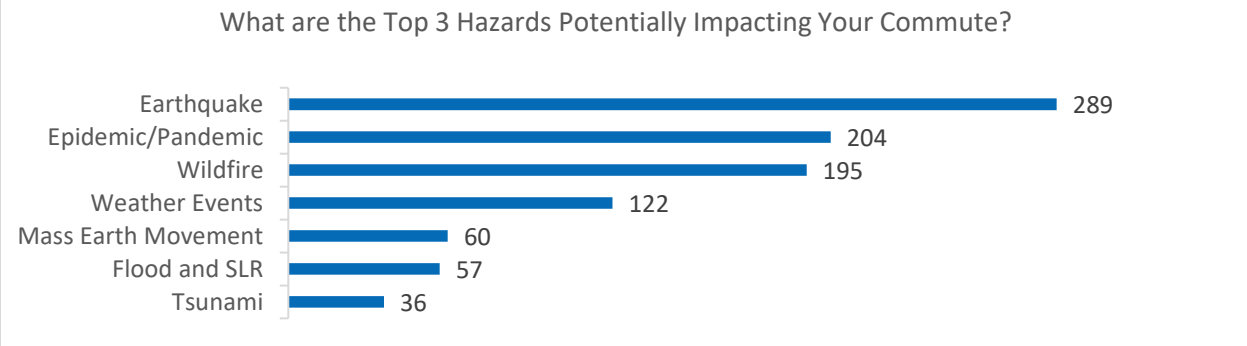
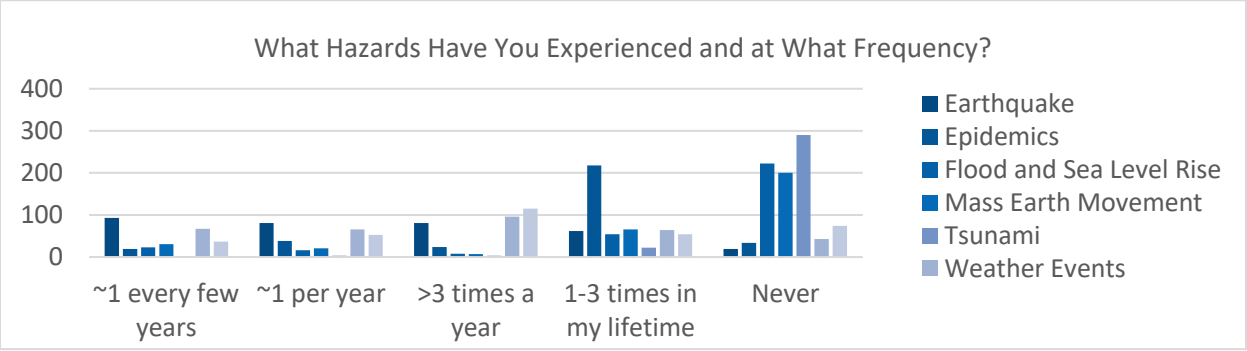


Figure 2-6 reveals the customer survey responses to the hazards they have experienced and how often. Earthquakes were one of the most experienced hazards with the highest frequency, approximately once per year to once every few years. Due to the COVID-19 pandemic occurring during the HMP development, most customers reported experiencing an epidemic/pandemic one to three times in their lifetime. In contrast, few participants had experienced mass earth movements or tsunamis.

Figure 2-6 – OCTA Survey Results for What Hazards Participants Experienced and at What Frequency



2.5.2 Online Open House

Figure 2-7 – OCTA's Online Open House Registration Page

OCTA hosted a one-hour open house with customers and community members on June 16, 2021, to discuss the plan development process and solicit input on the plan. The discussion revolved around natural hazards, exposure, and vulnerability (i.e., risk). The survey also asked participants what strategies they would like to see OCTA implement to mitigate risks in the planning area. Similar to OCTA's marketing campaign for the survey, OCTA leveraged its Twitter and blog platforms to encourage broad participation.

2.5.3 Hazard Mitigation Plan 30-day Review Period

OCTA invited customers and community members to participate in all phases of the HMP development process and comment on HMP drafts. The OCTA website will continue to provide up-to-date information on the HMP here: http://www.octa.net/Projects-and-Programs/Plans-and-Studies/Hazard-Mitigation-Plan/?frm=13645/

Figure 2-8 – OCTA's Hazard Mitigation Plan Webpage

Overview

The Orange County Transportation Authority (OCTA) is developing a hazard mitigation plan designed to support current OCTA emergency and crisis management plans and to strengthen the organization's preparedness to natural hazards. Examples of natural hazards include flooding, earthquakes, and wildfires. The plan will also enable OCTA to access federal funding, opening opportunities to put additional or enhanced resilience measures in place.

Objectives

- Ensure all State and Federal outreach requirements for a Hazard Mitigation Plan are met.
- Work collaboratively with stakeholders to address natural hazard preparation.
- Share the public comment process with all interested parties and make it easy and accessible for all communities to be able to comment.

2.6 Coordination with Other Agencies

44 CFR Section 201.6(b)(2)

Jurisdictions also need to provide an opportunity for neighboring communities, local and regional hazard mitigation involved government agencies, agencies that regulate development, businesses, academia, private, and non-profit groups to be involved in the planning process.

OCTA invited local jurisdictions, special districts, and community-based organizations to participate in the OCTA 2022 HMP Steering Committee and support the HMP planning process through workshops, surveys, and the draft HMP review. Invitees included but were not limited to:

- The County of Orange
- The San Diego Association of Governments
- The City of Anaheim
- The City of Irvine
- The City of Garden Grove
- The City of Mission Viejo
- The City of Santa Ana

OCTA asked all the above agencies to review the draft HMP via email by the Project Team. A complete draft plan was sent to Cal OES and FEMA Region IX for pre-adoption review and approval to ensure DMA 2000 compliance.

2.6.1 Review of Policies, Plans, and Programs

44 CFR Section 201.6(b)(3)

States that other plans, studies, reports, and technical information related to the mitigation plan should be reviewed and incorporated where applicable.

The following OCTA policies, plans, and programs informed the HMP development:

- OCTA 2014-2019 Strategic Plan
- OCTA 2018 Long-Range Transportation Plan
- OCTA 2018 OC Transit Vision Plan
- OCTA 2020 Emergency Operations Plan (EOP)
- OCTA 2019 Crisis Communications Annex
- OCTA 2018 Continuity of Operations Plan (COOP)
- OCTA 2016 Threat and Hazard Identification Risk Assessment (THIRA)
- OCTA Capital Programming Policies Update 2019

Other agency policies, plans, and programs that informed the HMP's development include:

- 2015 County of Orange and Orange County Fire Authority Local Hazard Mitigation Plan
- 2019 County of Los Angeles All-Hazards Mitigation Plan Public Draft
- 2018 County of San Diego Multi-jurisdictional Hazard Mitigation Plan
- 2018 State of California Hazard Mitigation Plan
- 2020 City of Garden Grove Local Hazard Mitigation Plan (draft)

The review of these policies, plans, and programs informed the development of the OCTA 2022 HMP. Existing OCTA plans were reviewed to develop the goals in this HMP, supporting OCTA's overarching missions and objectives. The natural hazards and mitigation strategies in OCTA's THIRA, EOP, and COOP were evaluated during the HMP initial planning stage to ensure continuity between these plans. Specifically, the 2016 THIRA identified a list of natural hazards and capabilities to mitigate them, creating a baseline for the 2022 HMP hazard identification and risk assessment. Figure 2-1 shows OCTA's planning area and the counties covered; the county HMPs provided foundational information for this HMP.

2.7 Plan Development Chronology and Milestones

Table 2-2 – Steering Committee Meetings

Date	Event	Description
June 19, 2020	Release a request for proposals to develop their HMP	Secure contractor support to facilitate the development of OCTA's HMP
August 12, 2020	Steering Committee Workshop #1 Project Kickoff	- Overview of hazard mitigation planning process, purpose, and requirements - Project overview for the HMP - Community engagement - Activity 1, hazard identification and ranking - Activity 2, capability assessment - Next steps and action items
November 3, 2020	Steering Committee Workshop #2 Risk Assessment	- Overview of progress from Workshop 1 - Activity 1, risk assessment worksheet - Went through the hazard maps - Next steps and action items
December 2020	Public Survey	OCTA issued a survey to gather public feedback on area hazards. OCTA shared the survey link on its blog and social media accounts.
January 20, 2021	Steering Committee Workshop #3 Mitigation Strategy	- Overview of the planning process since Workshop 2 - Reviewed the public survey results - Identified OCTA's HMP goals - Activity 1, developing mitigation strategies worksheet - Activity 2, prioritizing strategies worksheet
May 25, 2021	Steering Committee Workshop #4 Draft Plan Review	- Reviewed hazard mitigation plan and CFR compliance - Validated hazard mitigation capabilities and capacity - Finalized goals, strategies, and implementation - Established plan maintenance protocol and committee - Discussed public open house and 30-day review period
June 21, 2021	30-day Public Comment Period	Provided OCTA customers and the public an opportunity to review and comment on the plan prior to approval.
June 30, 2021	Public Open House	Hosted a two-hour virtual open house with OCTA customers and the public to discuss the hazard mitigation planning process, and review and solicit feedback on the plan.
August 5, 2021	Draft Plan Submission to Cal-OES	- CalOES must review and approve the plan prior to submission / review by FEMA
March 30, 2022	Plan Submission to FEMA	- FEMA review of plan
April 27, 2022	Plan Pre-Adoption Approval from FEMA	-Approval of plan pending OCTA Board of Directors (Board) adoption
October 10, 2022	Final Plan Approval	- Pending- OCTA Board approval of plan

3 Orange County Transportation Authority Profile

3.1 History of the Orange County Transportation Authority

OCTA was established in 1991 when seven separate transportation planning agencies consolidated to become OCTA (OCTA, 2018). The service area started in the City of Santa Ana, eventually expanding to all of Orange County and a small section of San Diego County. Since 1991, OCTA was an integral part of the growing community and economy of Orange County, providing vital commuter services to residents and visitors. Over the years, OCTA successfully implemented numerous transportation projects and services directly or in conjunction with other agencies that included over a billion bus passenger trips, an estimated 62 million Metrolink riders, over 200 miles of freeway lanes, and approximately 2,000 synchronized traffic signals installed (OCTA, 2018).

3.1.1 Orange County Transportation Authority Service Area

Figure 2-1 is the planning area map. OCTA administers vital transportation support to the planning area and communities by reducing congestion, expanding travel efficiency, and improving travel safety (Orange County Transportation Authority, n.d.). Service includes an extensive bus network of 60 routes that travel in small local areas and throughout the larger Orange County community (Orange County Transportation Authority, n.d.). The OCTA Station link connects Metrolink stations with prominent employment centers (Orange County Transportation Authority, n.d.). OCTA is currently expanding services with the addition of a new streetcar.

3.1.2 Geographic Setting and Visitors

At 799.8 square miles, Orange County sits along the California coast, with Los Angeles County to the north and San Bernardino County and Riverside County to the northeast. The Cleveland National Forest borders the County's inland side, which runs into San Bernardino County to the east. Within Orange County, there are 34 cities, John Wayne, and Fullerton airports, three harbors, 28 colleges and universities, 33 public libraries, and 25 hospitals (California State University Fullerton, 2022). The County boasts a few major amusement parks, including Disneyland, Knott's Berry Farm, Soak City Water Park, Knott's Independence Hall (Go-California, n.d.). Additionally, 25 regional and wilderness parks are featured on the County's visitor website that encompasses 39,000 County acres (Orange County, n.d.). On the Pacific coastline of Orange County is a beautiful 42 mile stretch of recreational beachfront and the coastal cities of San Clemente, Dana Point, Laguna Beach, Newport Beach, Huntington Beach, and Seal Beach (Visit Anaheim, n.d.). ABC Eyewitness News reported on a study by CIC Research that showed Orange County had more than 50 million visitors in 2018 (De Nova, 2019). These visitors have a direct impact on OCTA's planning area, customers, and infrastructure.

3.1.3 Planning Area Demographics

The 2018 US Census Bureau projected population numbers, past annual bus ridership counts, and GIS layers inform OCTA planning area service trends. Resident population and demographics for the OCTA planning area are from 2018 US Census Data and California State University's 2022 Orange County Progress Report, which estimates nearly three million residents. Bus ridership is the total number of times a bus is boarded in a day. In 2019, OCTA's annual ridership included approximately 35.5 million boardings.

Protecting vulnerable populations that are at a higher risk is a primary goal of hazard mitigation planning. FEMA defines these populations as low-income households, senior citizens, disenfranchised minorities,

those that speak English as a second language or not at all, and children (FEMA, 2009). Demographics of these vulnerable groups in the planning area are:

- **Hispanic or Latino** – 34.1 percent
- **Black, American Eskimos, or Hawaiian/Pacific Islanders** – less than one percent of the population
- **Asian (not mixed)** – 21.9 percent
- **65 years or older** – 11.5 percent
    - This population group is more vulnerable because they may need more support and/or resources after an earthquake, such as medical care, mobility, or transportation support.
- **Under 19 years old** – 27.4 percent
    - The statistics for youth go up to age 19, though only individuals under 18 are vulnerable populations as they are legally dependent on adults and usually require adult supervision, especially during a disaster. Additional challenges arise when children are away from their guardians, such as during daycare or school.
- **Five years and older speak a language other than English at home** – 44.5 percent
    - Residents who speak a language other than English may have difficulty understanding the level of risk related to warnings or alerts.
- **Population that speaks little to no English** – 9.8 percent
- **Qualify as living below the poverty level** – 13.0 percent

Households below the poverty level are more vulnerable because they have less financial security, which may prevent them from preparing for a disaster. Low-income households are also more likely to rent, potentially leaving them without a home if their rental is significantly damaged (Lazo, Bostrom, Morss, Demuth, & Lazrus, 2015).

It is critical to identify potentially vulnerable populations during HMP development to establish mitigation strategies that account for special considerations to protect these populations. Each of the hazard profiles assesses risk for vulnerable populations in Sections 5 to 11.

3.1.4 Daily Commuter Population

Orange County commuting trends have steadily increased with a rise in employment numbers, 1.39 million in 2010 to 1.52 million in 2015 (OCTA, 2018). The largest employment centers are in central and north Orange County, with several other employment areas spread throughout the County (See Figure 3-0). More residents commute into Orange County than residents in Orange County commute to other counties.

The OCTA Long-Range Transportation Plan incorporates the California Department of Finance 2016 commuter map for Orange County, illustrated in Figure 3-1 on the next page (Orange County Transportation Authority,2018). During these peak transit times, a hazard can significantly impact the transportation infrastructure as more customers rely on OCTA services. OCTA risk assessment and hazard mitigation strategies consider the issues associated with high-traffic commuter hours. The OCTA Long-Range Transportation Plan incorporates the California Department of Finance 2016 commuter map for Orange County, illustrated in Figure 18 on the next page (Orange County Transportation Authority, 2018). During these peak transit times, a hazard can significantly impact the transportation infrastructure as more customers rely on OCTA services. OCTA risk assessment and hazard mitigation strategies consider the issues with high-traffic commuter hours.

Figure 3-0 – 2019 Employment Density of Orange County. (Orange County Transportation Authority, 2019)

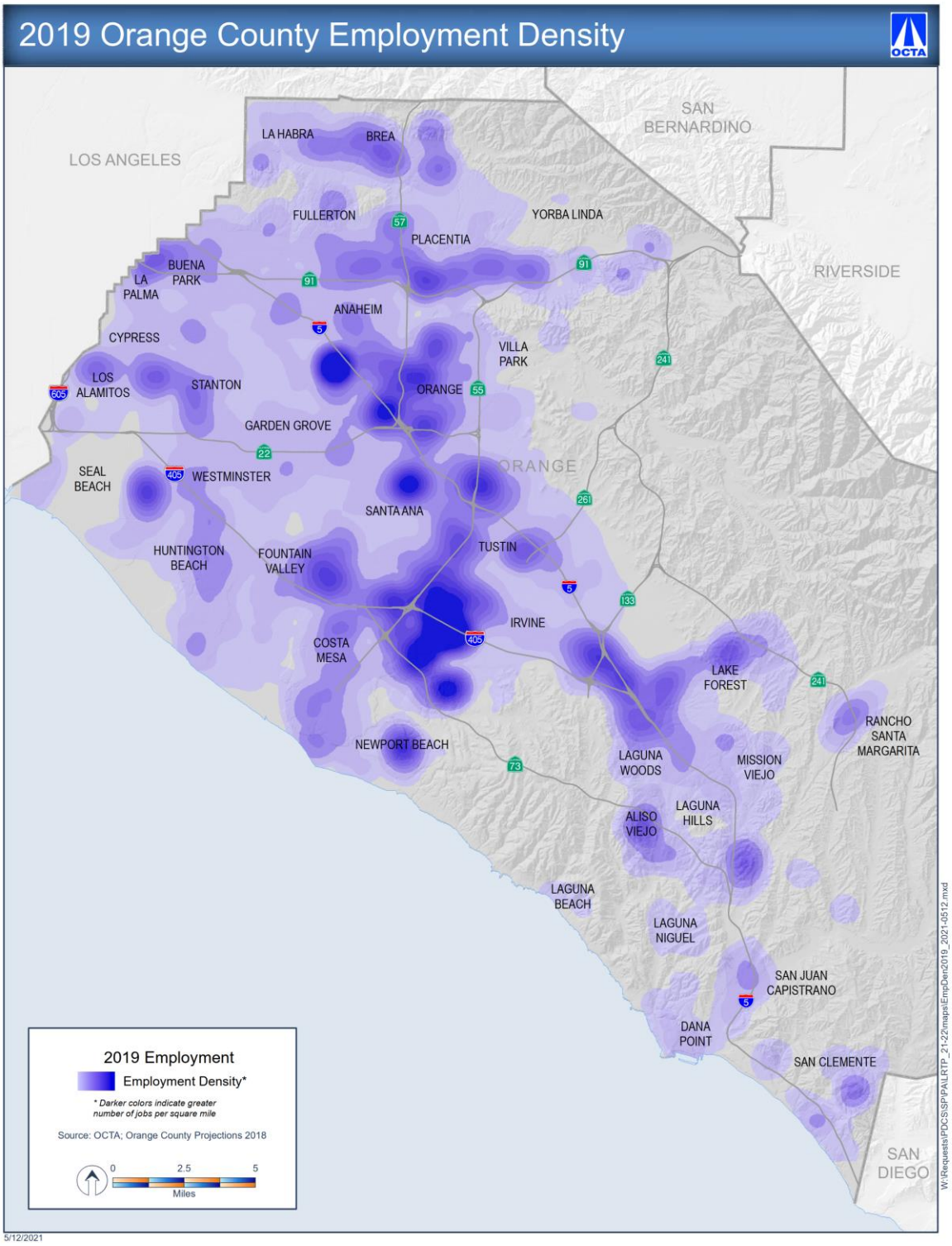
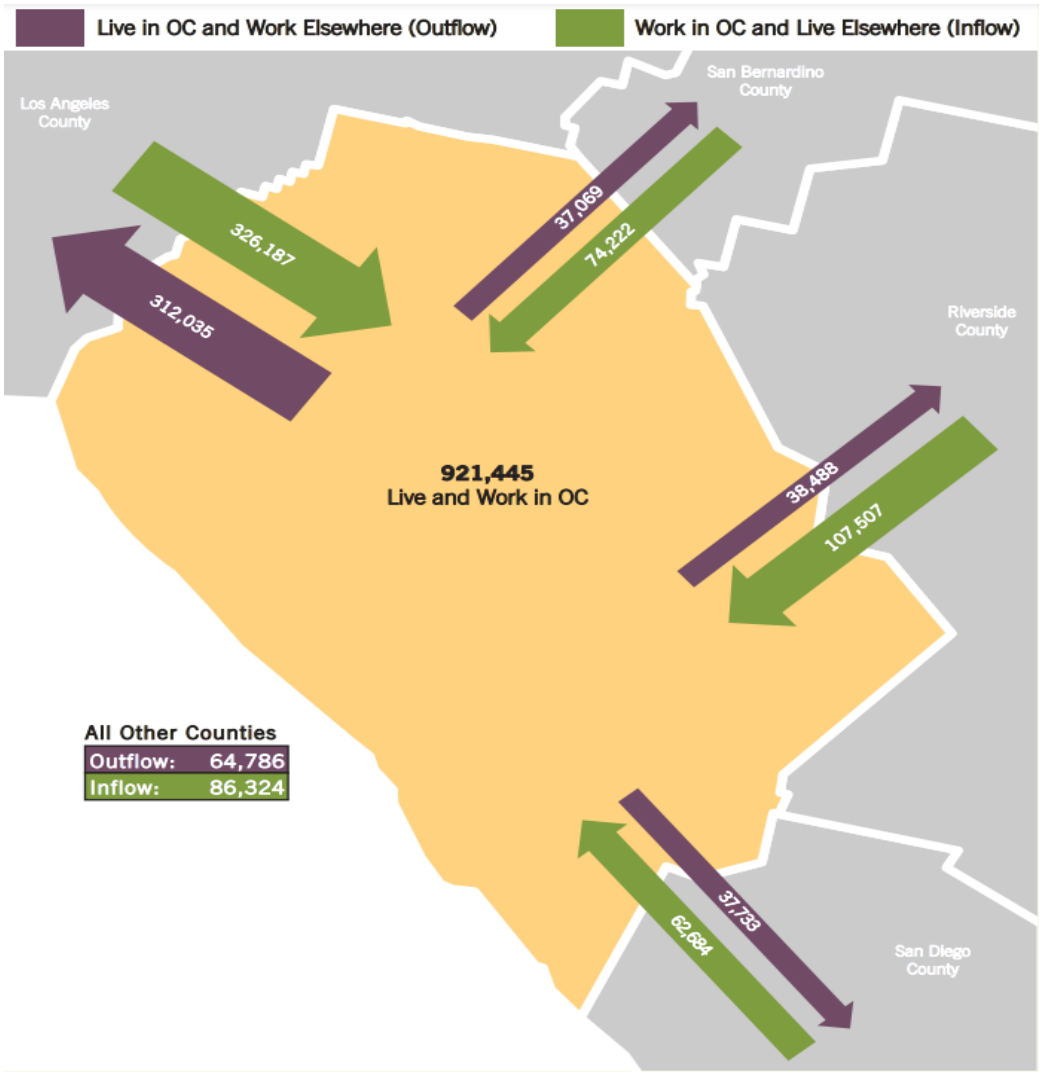


Figure 3-1 – 2016 Commuter Flow in and out of Orange County (OCTA, 2018)



3.2 Physical Setting

3.2.1 Geology and Topography

The OCTA service area lies between the Pacific Ocean to the west, the Santa Ana Mountain range in the east, and the Puente Hills to the southeast. Historically, shallow seawater covered most of the County (Irvine Valley College). This water coverage influenced the County's coastal geology and topography with marine water deposits, including fossils, shells, sand, and small rocks (Irvine Valley College). As a result, the coastline varies from wide sandy beaches to rocky shores and tall sand and clay cliffs.

The geology of the highest peaks of the Santa Ana Mountain range is metasedimentary rocks (Irvine Valley College). Over time, mass earth movements, erosion, and river flooding, transported boulders, rocks, gravel, sand, and silt to the valleys and coastal plain below (County of Orange and Orange County Fire Authority, 2015). As a result, the range's current geology is primarily rock and sediment washed down and fallen from the mountains (County of Orange and Orange County Fire Authority, 2015).

3.2.2 Climate

Figure 3-2 shows National Climatic Data Center (NCDC) Orange County average annual temperatures. NWS San Diego weather station annual and seasonal statistics are in Table 3-1.

Figure 3-2 – Orange County Average Annual Temperatures From 1981-2021 (National Centers for Environmental Information, 2021)

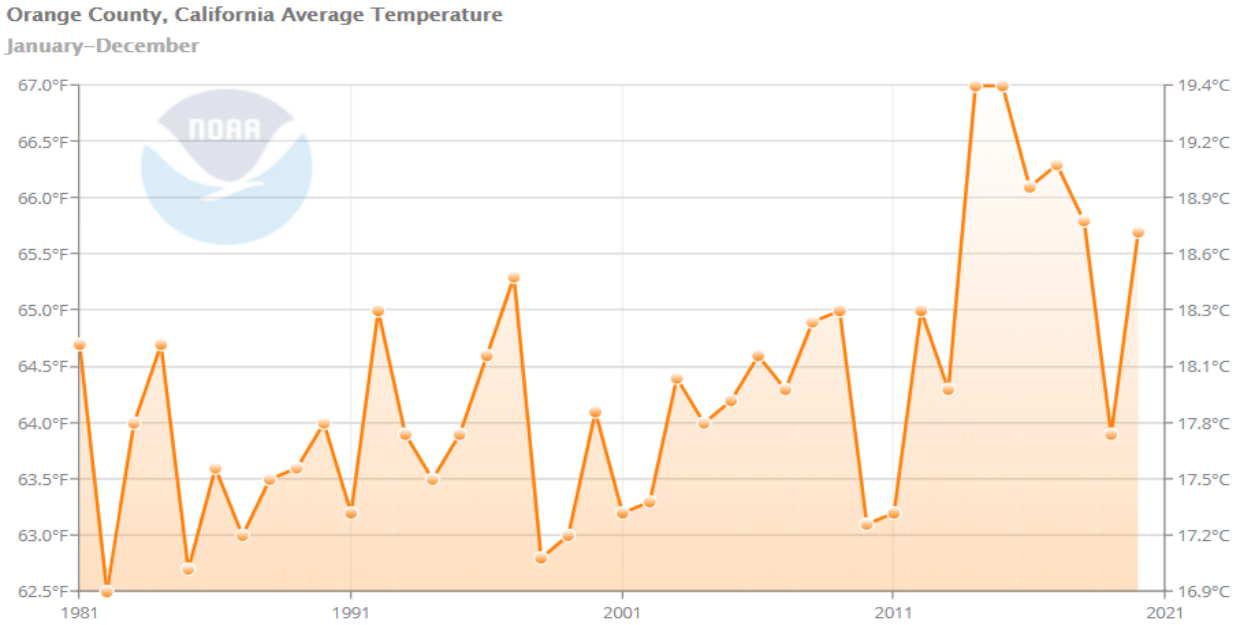


Table 3-1 – Normal Temperatures in °F and Precipitation in Inches Recorded at the San Diego Miramar NAS Weather Station (National Centers for Environmental Information, 2020)

Season	Max Temperature	Minimum Temperature	Average Temperature	Precipitation
Annual	73.4	55.1	64.2	11.48
Winter	67.1	47.1	57.1	6.95
Spring	69.9	52.9	61.4	2.70
Summer	79.3	63.1	71.2	0.19
Autumn	77.1	57.2	67.2	1.64

3.3 Future Trends in Development

Changes in development mean recent development, potential/planned development, or conditions that may affect the jurisdiction's risks and vulnerabilities (e.g., climate change, projected population growth). Ridership has steadily decreased on a long-term basis since 2012 due to an increase in private vehicle access and new ride-hail services. With the expected growth, continued investment in the transportation system will prevent crowded roadways, increased commute times, and strained infrastructure (Orange County Transportation Authority, 2018). To

44 CFR Section 201.6(c)(2)

Hazard mitigation plan risk assessments must provide a basic description of land use and projected development trends in the community.

manage the expected growth and minimize mass earth movement hazards in the planning area, OCTA follows State and local regulations.

The OC General Plan Chapter X: Housing Element estimates future population numbers, characteristics, and housing needs. Orange County most recently updated the plan's housing element in 2013, where expected growth from 2000-2012 was 7.4 percent (Orange County, 2013). Additionally, the US Census Bureau predicts Orange County's population will increase by 5.5 percent between 2010 and 2019 (United States Census Bureau, 2018). Therefore, it is essential to reevaluate future population predictions when these sources are updated next.

3.4 Orange County Transportation Authority Organizational Structure

3.4.1 Leadership

The OCTA Board consists of 18 individuals representing all of Orange County. Elected Orange County Board of Supervisors fill five Board positions. Ten Board positions are filled by City Members appointed by the Orange County City Selection Committee. Two positions are filled by public members appointed by the OCTA Board. The 18th member is the California Department of Transportation (Caltrans) District Director, who serves ex-office (Orange County Transportation Authority, 2020). The Chief Executive Officer (CEO) leads OCTA's staff of 1,500 members and is responsible for projects, programs, and services for the more than three million Orange County residents (Orange County Transportation Authority, n.d.). Along with the Board, the CEO is responsible for managing an annual budget of $1.4 billion. The Board applies these funds to freeways, streets, rail, countywide buses, commuter rail, paratransit services, and the 91 Express Lane projects (Orange County Transportation Authority, n.d.).

3.4.2 Public Participation and Committees

OCTA understands citizen feedback is essential to planning and actively encourages public participation and input on programs, studies, and projects. OCTA solicited input through public meetings, open houses, workshops, online surveys, newspaper ads, and focus groups (Orange County Transportation Authority, n.d.). OCTA has three public committees that offer project-specific input from the community. State legislation requires these committees to meet regularly. OCTA committees include the Citizens Advisory Committee, Accessible Transit Advisory Committee, and Taxpayer Oversight Committee (Orange County Transportation Authority, n.d.).

3.5 Hazard Mitigation Capabilities and Capacity Assessment

To ensure that the OCTA 2022 HMP is a capabilities-based plan, the Project Team, with input from the Steering Committee, completed a comprehensive hazard mitigation capabilities and capacity assessment during Workshop 1 – Project Kickoff Meeting. First, the Steering Committee identified OCTA's current resources, abilities, and local area agreements that support the hazard mitigation plan. Next, OCTA's capabilities were weighed against each hazard, their level of exposure, and the planning area's vulnerability to determine the level of risk. The assessment evaluated the following resource groups:

- Planning and Regulatory
- Administrative and Technical
- Financial
- Education and Outreach

3.5.1 Planning and Regulatory

Planning and regulatory capabilities include the plans, policies, codes, and ordinances that mitigate impacts from hazards.

Plan Title	Yes/No Year	Does the plan address the hazards?	How does the plan identify projects to include in the mitigation strategies?	How can the plan be used to implement mitigation strategies?
Transit Master Plan	Yes, 2014	The plan does not explicitly identify the hazards in the HMP.	This strategic plan includes a section for other plan integration. This process allows OCTA to assess the HMP mitigation strategies in conjunction with the strategic plan updates.	This HMP will be reviewed when the strategic plan is updated. In addition, OCTA will consider how the HMP mitigations support the strategic plan's goals, encouraging mitigation action implementation.
Next 10 Delivery Plan	Yes, 2017	The plans outline OCTA's goals and objectives to utilize sound business practices and multiple efficient transportation options but do not explicitly identify the hazards in the HMP.	During plan updates, OCTA will review the HMP and identify mitigations strategies that help meet OCTA's business plan and capital plan goals.	The business and capital plans are updated regularly, with the most recent plan revised to address the 2021-2030 time frame. In the next update, OCTA will include identifying beneficial mitigation strategies. This process supports mitigation action implementation.
Annual Budget Plan	Yes, 2020	OCTA's annual budget plan incorporates the financial breakdown for projects, including the mitigation strategies in the HMP.	The HMP mitigation strategies will be evaluated as part of next year's budget planning process.	Next year's budget plan will include the funds allocated for the HMP mitigation strategies.
Local Emergency Operations Plan	Yes, 2020	OCTA's EOP contains emergency procedures to prepare for and minimize risks during an emergency, from the following hazards - cybersecurity, earthquake, explosive incident, power outage, and a pandemic.	In the next EOP update, the HMP will be reviewed to include the same hazards and identify mitigation strategies related to emergency preparedness.	In the next update, OCTA will consider how the HMP mitigation strategies support the EOP goals, encouraging mitigation action implementation.

Plan Title	Yes/No Year	Does the plan address the hazards?	How does the plan identify projects to include in the mitigation strategies?	How can the plan be used to implement mitigation strategies?
Continuity of Operations Plan	Yes, 2018	OCTA's COOP outlines processes and procedures to continue critical operations during an emergency. The plan refers to the 2016 THIRA for hazards addressed in the COOP.	In the next COOP update, the HMP will be reviewed to include the same hazards and identify mitigation strategies related to continuity of operations.	In the next update, OCTA will consider how the HMP mitigation strategies support the COOP goals, encouraging mitigation action implementation.
California Transportation Plan	Yes, 2016	This plan improves environmental and health outcomes with climate change considerations for transportation. It does not identify the hazards in the HMP but works to minimize climate change impacts affecting the hazards.	Climate change impacts each hazard, increasing frequency, and severity. This plan supports the HMP mitigation strategies with responsible development that protects the environment as much as possible.	This HMP will be reviewed when the transportation plan is updated. OCTA will consider how the HMP mitigations support the transportation plan's goals, encouraging mitigation action implementation.
Environmental Cleanup Program	Yes, 2020	This program allocates funds for controlling transportation-generated pollution, allowing County jurisdictions to meet the Clean Water Act. It does not identify the hazards in the HMP but works to minimize climate change impacts affecting the hazards.	Climate change impacts each hazard, increasing frequency, and severity. This plan supports HMP mitigation strategies with clean water projects that protect the environment as much as possible.	This HMP was reviewed alongside the Environmental Cleanup Program. OCTA considered how the HMP mitigations support the cleanup programs' goals, encouraging mitigation action implementation.
Climate Change Resiliency Plan	Yes, Board Approval Pending 2023	This plan is designed around climate change mitigations and protecting the environment.	Climate change impacts each hazard, increasing frequency, and severity. This plan supports the HMP mitigation strategies by laying out a plan to reduce climate change's impact on the organization and the planning area.	This HMP will be used to understand climate change impacts on OCTA operations better, thereby helping to anticipate and plan projects required to mitigate the effects of climate change.

Plan Title	Yes/No Year	Does the plan address the hazards?	How does the plan identify projects to include in the mitigation strategies?	How can the plan be used to implement mitigation strategies?
M2 Natural Community/ Habitat Conservation Plan	Yes, 2017	This plan focuses on managing natural preserves and flora, and fauna found there.	As part of the management plan, a separate Fire Management Plan, Fire Response Plan, and Erosion Control plan are maintained.	The HMP can be used to understand further hazards and plan projects to reduce losses in the wildland/urban interface.

Rate the Overall Planning Capabilities				
Very Low	Low	Moderate	High	Very High
			X	

How can the OCTA expand Planning Capabilities and reduce risks?
This HMP will help inform planners on OCTA risks, thereby enhancing OCTA's ability to safeguard the community and environment.

National Flood Insurance Program (NFIP)			
NFIP Entry Date	Current Effective Map Date	Number of Policies	Amount of Coverage (in $)
N/A	N/A	N/A	$0

Special districts, like OCTA, are not eligible to participate in the NFIP.

3.5.2 Administrative and Technical

Administrative and technical capabilities include staff and their skills and resources that may be leveraged for mitigation planning and implementation.

Administration	Yes/No	Is coordination effective?
Regional Planning Committees and other Groups	Yes	Yes, OCTA participates in several regional committees that address transportation, air quality, and environmental issues.
Hazard Mitigation Steering Committee	Yes	Yes. The Mitigation Planning Committee was established during the OCTA 2022 HMP planning process and has agreed to meet annually to review hazards and a hazard mitigation capability.
Maintenance programs to reduce risk (e.g., tree trimming, clearing drainage systems)	Yes	Yes, OCTA has multiple maintenance programs to protect the environment and reduce hazard risks. These programs are in their plans (included in the first table in Section 3.3).

Administration	Yes/No	Is coordination effective?
Mutual aid agreements (e.g., inter-local agreements)	Yes	Yes. OCTA remains engaged in local mitigation efforts through the Orange County Operational Area Agreement related to OCTA operations and adjusts accordingly.

Staff	Yes/No	Is staffing adequate to support regulations?	Is coordination effective between staff and agencies?	Is staff trained on hazards and mitigation?
Operations COO	Yes	Yes	Yes	Yes
Government Relations Executive Director	Yes	Yes	Yes	Yes
Emergency Management Specialist	Yes	Yes	Yes	Yes
Capital Programs Director	Yes	Yes	Yes	Yes
GIS Coordinator	Yes	Yes	Yes	Yes
External Affairs Department	Yes	Yes	Yes	Yes
Planning Department	Yes	Yes	Yes	Yes
Risk Management Department	Yes	Yes	Yes	Yes
Health, Safety, and Environmental Compliance Department	Yes	Yes	Yes	Yes

Technical	Yes/No Year Adopted	Has the capability been leveraged to assess or mitigate risk?
Hazard Data and Information	Yes, 2016	Yes
Grant Writing/Management Services	Yes	Yes
HAZUS Analysis	Yes 2021	Yes

Rate the Overall Administrative and Technical Capabilities				
Very Low	Low	Moderate	High	Very High
			X	

How can OCTA expand Administrative and Technical Capabilities and reduce risks?
As hazard datasets continue to be refined, OCTA can use the information to inform and improve the prioritization of projects to mitigate hazard impacts.

3.5.3 Financial

Financial capabilities include funding sources that do not need to be repaid (e.g., government grants, taxes, user fees, and philanthropic sources) and finance (e.g., bonds, private lending).

Funding Resource	Access/ Eligibility (Yes/No)	Has funding been leveraged for hazard mitigation? If so, how?	If not, could funding be used for mitigation, and how?
Capital Improvement Project Funding	Yes	OCTA continues to remove non-native invasive plants from the OCTA-owned mitigation properties. The removal of these weeds increases the fire resiliency of these lands, which is extremely important as they occur within very high risk fire areas.	
Authority to levy taxes for specific purposes (e.g., special assessment districts)	Yes	Measure M2 project added a 30-year half-cent sales tax for transportation improvements. This plan is not directly related to HMP hazards, but environmental care and protection can positively impact natural hazard risks.	
FEMA Hazard Mitigation Grant Program	Yes	OCTA applied for and received funding from FEMA's Hazard Mitigation Grant Program to fund the development of this plan.	
Other Federal Funding Programs	Yes	*FEMA*: Transit Security Grant Program; Flood Mitigation Assistance; Building Resilient Infrastructure Communities (BRIC). *Federal Railroad Administration*: Consolidated Rail Infrastructure and Safety Improvements *FTA Formula Programs:* 5307 Urbanized Area Formula; 5337 State of Good Repair. *Federal Highway Administration*: Surface Transportation Block Grant	*FTA 5337*: State of Good Repair (to repair facilities at the rail stations & in rail ROW, for example); Transit Security Grant Program: for security patrols/deterrence & Be the One campaign – public awareness of human trafficking
State Funding Programs	Yes	*Caltrans Adaptation Planning Grant Program*: funding current rail defense against climate change study; *Caltrans Systemic Safety Analysis Report*: Countywide safety analysis; *Caltrans Sustainable Communities Program*: Bus Stop Safety and Accessibility Plan (12 busiest transit areas in the county)	
Insurance Products	-		

Rate the Overall Financial Capabilities				
Very Low	Low	Moderate	High	Very High
			X	

How can OCTA expand Financial Capabilities and reduce risks?
OCTA can work with Orange County **Operational Area Emergency Management** to manage risk-reducing projects within OCTA's service area. Through this effort, the OCTA Grants Department is seeking opportunities to identify co-benefits for mitigation projects with upcoming grant applications for programs that otherwise would not be addressing resilience.

3.5.4 Education and Outreach

Education and outreach capabilities include ongoing programs that local-to-federal government, nonprofit, and other organizations provide to communities. OCTA can leverage these programs to implement hazard mitigation strategies and build community resilience. The tables below indicate which of the following programs currently exist and how they are or could be used to mitigate hazards and build resilience.

Program/ Organization	Year	Identify the program and describe how it relates to resilience and mitigation
The Great Shake Out	since 2012	OCTA participates annually, raising awareness among ridership and employees, improving system resilience during an emergency
Emergency Preparedness Month	Since 2018	OCTA participates annually, raising awareness among ridership and employees, improving system resilience during an emergency
Disaster Service Worker Program	Since 2016	OCTA participates annually, raising awareness among ridership and employees, improving system resilience during an emergency

How can OCTA expand Education and Outreach Capabilities and reduce risks?
OCTA has identified an action to develop a public-facing webpage to maintain hazard mitigation and disaster preparedness resources for riders and employees. **Each year, because of extreme heat or cold, Orange County opens warming and cooling centers, and OCTA can help improve access by communicating locations to ridership.** OCTA has been asked to and will be participating in emergency preparedness fares with local jurisdictions within its service area. OCTA is actively participating in hazard mitigation planning processes with local jurisdictions within its service area.

OCTA 2022 Hazard Mitigation Plan

Part 2: Risk Assessment

Part 2

4 Risk Assessment

4.1 Introduction

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage from identified hazards. This process allows emergency management personnel to establish hazard mitigation priorities. The probability of a hazard occurring, exposure, and vulnerability of populations, property, critical infrastructures, and facilities determines the planning area's risk level. The process focuses on these elements:

- **Hazard identification and ranking** – Determine the hazards that may impact a jurisdiction.
- **Exposure identification** – Estimate the total number of people and properties in the jurisdiction likely to experience a hazard event if it occurs.
- **Vulnerability identification and loss estimation** – Assess the potential impact of a hazard on the populations, properties, environment, and critical infrastructures and facilities within a planning area and their capacity to mitigate its effects. Then estimate the potential life and economic losses and possible costs avoided from mitigation strategies taken.

44 CFR Section 201.6(c)(2)

Requires a risk assessment that provides a factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable jurisdictions to identify and prioritize appropriate mitigation strategies to reduce losses from identified hazards.

4.2 Methodology

Qualitative and quantitative methods for describing and analyzing each hazard informed the hazard profiles in Sections 5 through 11. These profiles included the planning area's hazard risk, including: exposure and vulnerability of populations, properties, and critical infrastructures and facilities. Risk exists where a structure, population, and/or infrastructure are exposed and vulnerable to a particular hazard. If there is no exposure or vulnerability, there is no risk from the hazard. The HMP incorporates mitigation strategies to minimize or remove exposures and/or vulnerabilities, reducing or removing the risk.

4.2.1 Qualitative Methods – Identifying and Prioritizing Hazards of Concern

The Steering Committee identified and prioritized the hazards included in the HMP by assessing the probability, frequency, magnitude, severity, and warning time of each within the planning area. The Steering Committee ranked the hazards based on their subjective assumptions of the most likely and worst-case scenarios. When assessing the hazards, the Steering Committee considered the exposure and vulnerability of populations, properties, and critical infrastructures and facilities within the planning area. In 2016, OCTA completed a THIRA, which identified the following natural hazards with the potential to affect OCTA's service area:

1. Earthquake
2. Epidemic
3. Flood
4. Pandemic
5. Wildfire

The OCTA 2022 HMP aligned with the OCTA 2016 THIRA and expanded the HMP hazards to incorporate sea level rise, coastal erosion, tsunami, and severe weather. The Steering Committee initially defined 12

hazard profiles, and throughout the plan development, condensed a few closely related hazards; the resulting hazard profiles in Table 4-1 below are in the OCTA 2022 HMP.

Table 4-1 – Steering Committee Hazard Ranking Results

Hazard Profiles	Worst-Case	Most-Likely	Section/Page
Earthquake	2	2	5, page 38
Epidemic/Pandemic	3	3	6, page 51
Flooding (including Sea Level Rise, and Coastal Erosion)	5	5	9, page 58
Mass Earth Movement	6	6	8, page 73
Severe Weather (including Drought, Extreme heat, and Storm Surge)	4	4	9, page 86
Tsunami	7	7	10, page 102
Wildfires	1	1	11, page 110

Hazard survey results are in Tables 4-2 and 4-3. The variables of severity, magnitude, frequency, onset, and duration are scored one to five, where one is the lowest and five is the highest. The hazard ranking is from one to seven, where one is at the top and seven is at the bottom. High-priority hazards are those hazards that scored in the top one-third of survey results, lower-priority hazards follow.

Table 4-2 – OCTA Worst-Case Scenario Hazard Ranking

	Severity	Magnitude	Frequency	Onset	Duration	Average	Rank
Wildfire	3.82	4.18	4.55	4.18	2.91	3.93	1
Earthquake	4.09	4.18	2.82	5.00	2.27	3.67	2
Epidemic/ Pandemic	4.18	4.27	1.55	2.91	4.18	3.42	3
Severe Weather	3.05	3.09	3.50	2.57	3.02	3.05	4
Flooding	2.85	2.97	3.18	2.61	3.18	2.96	5
Mass Earth Movement	3.73	3.00	1.45	4.18	1.82	2.84	6
Tsunami	2.55	2.45	1.91	3.73	1.82	2.49	7

Table 4-3 – OCTA Most-Likely Scenario Hazard Ranking

	Severity	Magnitude	Frequency	Onset	Duration	Average	Rank
Wildfire	3.73	3.64	4.45	4.00	3.55	3.87	1
Earthquake	3.09	3.82	3.09	4.82	1.91	3.35	2
Epidemic/ Pandemic	4.00	4.00	1.18	3.00	4.09	3.25	3
Severe Weather	2.59	2.75	3.39	2.61	3.05	2.88	4
Flooding	2.64	2.48	3.00	2.39	3.24	2.75	5
Mass Earth Movement	2.18	2.09	1.64	3.36	1.73	2.20	6
Tsunami	2.18	2.18	1.09	3.45	2.00	2.18	7

While the above table shows the seven consolidated hazard identification and ranking results, the survey results for all 12 unconsolidated results are available in Appendix D and G. Of the consolidated hazards (i.e., sea level rise, coastal erosion, drought, extreme heat, and storm surge), did not score in the top one-third of the survey results and are therefore not high-priority hazards on their own. This means that they may not have received mitigation strategies.

4.2.2 Quantitative Methods – Map-based Risk Assessment

The HMP includes the most current and accurate scientific data available. However, not all hazards had geospatial data available. Spatial data sets were retrieved from federal, state, county, and other applicable databases when available. These data sets determined the extent of each hazard, exposure, and vulnerability (i.e., risk). The HMP analysis assessed exposure and vulnerability levels related to people, property, critical infrastructure, and facilities within the planning area. GIS software produced numeric results and risk maps added to the hazard profiles in Sections 5 through 11 of this HMP. The maps also highlight where the hazards intersected with populations, properties, and critical infrastructures and facilities.

Hazards with available geospatial data were analyzed using GIS software to identify the planning area's risk vulnerability and exposure levels. The risk assessment incorporated the populations and socially and economically vulnerable populations when available, although the data was not available for all hazards. Additionally, the GIS analysis factored in the economic value of exposed structures and the overall hazard exposure of structures in the planning area.

4.2.2.1 HAZUS-MH Earthquake Assessment

The earthquake hazard risk assessment involved a HAZUS-MH analysis. HAZUS-MH is a GIS-based program used to support the development of risk assessments as required under the DMA. The HAZUS-MH software program quantitatively assesses risk to estimate damages and losses associated with some natural hazards. HAZUS-MH is FEMA's nationally applicable, standardized methodology and software program that contains modules for estimating potential losses from several types of hazards.

4.2.2.2 Exposures

OCTA Ridership – Annual bus ridership numbers inform OCTA planning area service and population trends. Bus ridership in 2019 was approximately 35.5 million total boardings for the year and 19 average boardings per day for each bus stop. Every time someone rides a bus, it is a "boarding." Boardings do not account for how many individuals ride OCTA buses; for example, one person can ride four buses in a day, which is four boardings.

Population Exposure – To estimate the population exposure for the planning area, the total population was based on US Census Bureau 2018 data and distributed across the OCTA GIS map data. The population data covers the entire service area for OCTA. Each hazard profile lists the population exposed to the hazard, broken down into vulnerable population demographics where the information is available. Socially vulnerable population categories include language, race, age, poverty, and disability. Vulnerable population definitions and demographics for the planning area are in Section 3.1.3. The hazard profiles assess risk for vulnerable populations to each hazard, detailed in Sections 5 to 11.

Structural Economic Exposure – Each hazard profile assesses disaster risk for OCTA owned structures in the planning area and includes potential damage to OCTA assets and critical facilities, their contents (e.g., vehicles), and total economic losses; they are:

Table 4-4 – OCTA Assets

Facility	Latitude	Longitude
Garden Grove Base	33 45' 49" N	117 55' 25" W
Santa Ana Base	33 42' 12" N	117 55' 32" W
Irvine Sand Canyon Base	33 40' 43" N	117 45' 19" W
Irvine Construction Circle Base	33 41' 46" N	117 49' 24" W
Anaheim Base	33 51' 26" N	117 53' 30" W
Newport Beach Transportation Center	33 36' 51" N	117 52' 06" W
Golden West Transportation Center	33 44' 03" N	117 59' 58" W
Laguna Hills Transportation Center	33 36' 25" N	117 42' 20" W
Fullerton Transportation Center	33 52' 10" N	117 55' 20" W
Fullerton Park and Ride	33 51' 31" N	117 58' 44" W
Brea Park and Ride	33 55' 32" N	117 52' 53" W
Administrative Facility 550/600	33 46' 44" N	117 52' 04" W
Transportation Security Operations Center	33 49' 54" N	117 56' 02" W

OCTA has identified the following types of facilities from the above list as critical facilities:

- Transportation Security Operations Center
- Transit Bases

FEMA defines critical facilities as all human-made structures or improvements that due to their function, size, service areas, or uniqueness have the potential to cause serious bodily harm, extensive property damage, or impact socioeconomic activities if the facilities are damaged, destroyed, or vital services are impaired (Federal Emergency Management Agency, 2007).

OCTA does not have any repetitive loss properties.

4.2.3 Data Sources

Table 4-5 below lists the data and data sources used to develop maps and tables.

Table 4-5 - Geographic Information System Data Sources

Data	Source
OCTA 2022 Facilities	OCTA 2022
OCTA 2019 Ridership	OCTA 2022
Base Map	ESRI 2017
Wildland Urban Interface (WUI)	CalFIRE 2019
100-Year Storm Surge	US Geological Survey (USGS) 2018
COVID-19	California Department of Health 2020
Flood	FEMA

Data	Source
Landslide Susceptibility & Mapped Landslide Features	California Department of Conservation 2018, Wills, C. J., Perez, F. G., and Gutierrez, C. I., 2011, Susceptibility to deep-seated landslides in California: California Geological Survey, Map Sheet 58
Average Maximum Temperature Increase	Scripps 2018
Post-Fire Soil Erosion	CalFIRE 2019
Potential Sea Level Rise	National Oceanic and Atmospheric Administration (NOAA)
Tsunami	California Department of Conservation 2009
Fire Hazard Severity Zones	CalFIRE 2019
Responsibility Area	CalFIRE 2019
Vulnerable Populations	US Census Bureau estimates for 2018

4.3 Limitations

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and can arise from incomplete scientific knowledge concerning natural hazards and/or their effects on the built environment.

4.3.1 HAZUS-MH Limitations

The earthquake risk assessment HAZUS provides a default inventory of critical facilities and infrastructure. These facilities can be augmented with additional inventory. However, the program requires detailed information about the structure to predict how the facility will behave during a hazard event. Therefore, the HAZUS dataset analysis is not as comprehensive as the critical facilities dataset used for GIS assessed hazards because detailed information and economic values were not available for all OCTA structures.

5 Earthquake

5.1 General Background

The Earth's crust is comprised of tectonic plates, constantly moving at a prolonged rate (United States Geological Survey, 2016). Occasionally, the plates get stuck as they push against each other. Friction builds up between the plates when the plates do not move freely. Earthquakes result from friction released as energy that travels in waves through the ground, causing shaking on the surface (United States Geological Survey, n.d.). Surface shaking can be as short as a few seconds or start with one event followed by several more minor earthquakes over several days, known as tremors. These smaller seismic events that follow a more significant initial earthquake are called aftershocks.

Most seismic hazards occur on well-known active faults (Bolt, Earthquake, 2020). However, determining if a fault is active or potentially active depends on geologic evidence, which may or may not be available. Earthquakes are more likely to occur on faults with these conditions (Bolt, Earthquake, 2020):

- Pressure builds up more rapidly
- There were recent earthquakes
- Past earthquakes caused more significant displacements
- Faults are between plates and can relieve accumulated tectonic stresses

The fault types listed above are typically well documented. Depending on the proximity and depth of the earthquake's epicenter, ground shaking can still feel strong. In contrast, large regional faults can generate moderate magnitudes that result in only moderate shaking because of the epicenter's distance and depth. Lesser-known faults are challenging to predict since there is no historic geological data to inform predictions.

5.1.1 Potential Impacts from Earthquakes

Earthquakes can result in changes to the ground surface structure and placement. Ground shaking and displacement from an earthquake can lead to secondary impacts like mass earth movements and cascading effects, such as injuries and death and structural damage

DEFINITIONS

Aftershock – Lower-magnitude earthquakes that follow an initial primary earthquake.

Earthquake – A sudden shaking of the ground caused by seismic waves traveling through the earth.

Earthquake Magnitude – The seismic wave/amplitude measured and recorded by seismographs from an earthquake's epicenter. Magnitude is represented by a class name and numerical value from 3 to 8.

Epicenter (seismology) – The point on the ground's surface directly above the focus point where the fault ruptures.

Fault – A fracture in the Earth's crust where compression or tension pressure on causes displacement of soil and rock on the opposite side of the fracture.

Liquefaction – A loss of soil strength or cohesion that results in the soil behaving like a thick liquid (e.g., quicksand).

Modified Mercalli Scale – A measurement of the level of intensity felt on the ground's surface in populated areas, represented by a Roman numeral from I to X.

Surface Rupture – An area of the ground that is offset (raised, lowered, tilted) when a fault rupture reaches the surface of the ground.

to buildings and infrastructure. Earthquakes can disrupt communications and damage utilities such as electricity, gas, sewer, and water lines. Older facilities and infrastructure built before stringent earthquake codes are particularly vulnerable. After an earthquake, entities must check their structures and utility lines for damage (Committee on Consumers and the Public Interest, 2019). Secondary and cascading impacts from earthquakes are addressed further in Section 5.3.

5.2 Orange County Transportation Authority Planning Area Hazard Profile

The California Earthquake Authority (CEA) provides earthquake data and statistics based on California counties. The Southern California Coast region is at risk from the San Andreas Fault and more than 100 minor active faults in the area (California Earthquake Authority, n.d.). Although the San Andreas Fault only reaches the northern edge of the OCTA planning area, a large earthquake on the fault line would radiate from the epicenter and likely significantly impact the entire planning area.

The CEA's analysis indicates a 75 percent likelihood the Southern California Coast will experience a 7.5 magnitude or greater earthquake on the San Andreas Fault-line before 2044 (California Earthquake Authority, 2020). After the San Andreas Fault, the next most significant fault affecting the planning area is the Newport-Inglewood fault. The Newport-Inglewood fault is 47 miles long; it starts at Culver City in Los Angeles County, goes through the City of Inglewood, continues through the City of Newport beach in Orange County, and becomes the Rose Canyon fault in San Diego County (California Earthquake Authority, 2020). Locations where earthquakes might occur within the planning area, are discussed in Section 5.2.3.

5.2.1 Hazard Ranking

The Planning Team completed a hazard ranking survey during the OCTA 2022 HMP development process and assessed hazard-related factors based on worst case and most likely scenarios. Hazard definitions and ranking factors are in Appendix G, Table G-1. Survey results were prioritized and ranked based on their averaged score. The variables of severity, magnitude, frequency, onset, and duration are scored one to five, where one is the lowest and five is the highest. Compared to the other hazards in the survey, earthquakes are the second worst-case scenario and the second most likely scenario.

Table 5-1 – OCTA Earthquake Hazard Ranking

Severity	Magnitude	Frequency	Onset	Duration	Average	Rank
Worst-Case Scenario						
4.09	4.18	2.82	5.00	2.27	3.67	2
Most Likely Scenario						
3.09	3.82	3.09	4.82	1.91	3.35	2

5.2.2 Past Events

Table 5-2 below includes a few significant earthquakes that affected the Orange County region and OCTA's planning area. Magnitude definitions are in Table 5-3, and modified Mercalli definitions are in Table 5-4.

Table 5-2 – Historical Earthquakes that Affected the Planning Area (Federal Emergency Management Agency, 2020) (Southern California Earthquake Data Center, n.d.) (Scharer)

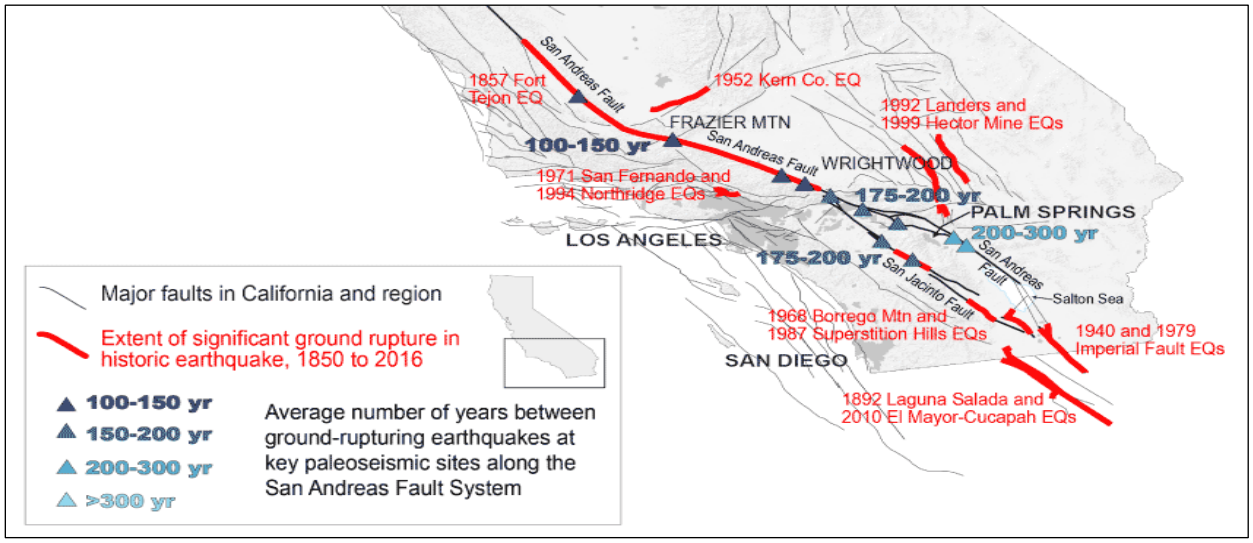
Date	Event Name/Location	Maximum Mercalli Scale Recorded	Magnitude Class	FEMA Disaster Declaration ID
10/1/1987	Whittier Narrows	VIII (severe)	5.9	DR-799-CA
11/23/1987	Superstition Hills Events 1 & 2	VIII (severe)	6.2 & 6.6	-
1/17/1994	Northridge/Reseda	IX (violent)	6.7	DR-1008-CA
4/4/2010	El Mayor-Cucapah	IX (violent)	7.2	DR-1911-CA
7/4/2019	Ridgecrest	IX (violent)	7.1	EM-3415-CA

5.2.3 Locations Where Earthquakes Appear

5.2.3.1 Southern California Earthquake Zones

The fault map in Figure 5-1 shows the fault lines that can impact the OCTA planning area. The San Andreas Fault runs through the planning area, with multiple smaller active faults cutting vertically and horizontally across the entire planning area. Figure 5-1 also shows major faults in Southern California that can, and have, affected the planning area as indicated by the events in Table 5-2.

Figure 5-1 – Major Faults in Southern California (US Geological Survey Department of the Interior/USGS) (Scharer)



5.2.3.2 San Andreas Fault Zone

In the OCTA planning area, the most hazardous and well-known fault line is the San Andreas Fault. This fault occurs where the Pacific Plate and North American Plate meet. This entire San Andreas Fault system is more than 800 miles long and, in some areas, as deep as ten miles. The southern end of the fault runs right through the planning area (Schulz & Wallace, 1992). Significant offshoots that can also impact OCTA's planning area include the Garlock and Owens Valley faults north of the planning area and the Banning and San Jacinto faults that stretch through the planning area from north to south.

The San Andreas Fault generates micro earthquakes daily and triggers major earthquakes after decades of pressure buildup (United States Geological Survey, n.d.). The San Andreas Fault and its off-shoot faults have triggered events felt in the planning area. The 2010 El Mayor-Cucapah earthquake is the most recent

event included in Figure 5-1; it measured a 7.1 magnitude with a modified Mercalli scale of IX (violent) and impacted all three counties in the planning area.

5.2.4 Frequency

In the last 50 years, the OCTA planning area has experienced ten earthquakes registering from a 6.2 magnitude in Coalinga to the 7.2 magnitude earthquake that struck Baja California and was felt throughout the planning area (United States Geological Survey). Table 5-2 details these past earthquakes. Based on these events, OCTA's planning area is affected by a moderate to a major earthquake on average once every 6.8 years.

Potentially major (magnitude 7-7.9) or great (magnitude eight or higher) earthquakes on the San Andreas Fault are challenging to predict. The entire fault has numerous segments and offshoots with variable past events, most with decades or hundreds of years between major earthquakes. As shown in Figure 5-1, there were only two historical major earthquakes on the southern end of the fault line, one in 1812 and the other in 1852 (Wald, Scharer, & Prentice, 2017). The USGS and CEA warn the San Andreas section running through the planning area is past due for a major earthquake (California Earthquake Authority, 2020).

5.2.5 Severity

The southern end of the San Andreas Fault runs through the planning area. The fault could rupture and generate a powerful earthquake that would devastate the planning area (California Earthquake Authority, 2020). Scientists and planners use different scales to communicate about earthquake power. The audience receiving the information about earthquake risk and hazard determines which scale is used (i.e., scientists or the general public). The most common earthquake measurement scales for hazard mitigation are the Richter Scale and the Modified Mercalli Intensity (MMI) Scale.

Richter magnitude is recorded on a scale of 1 through 9 (Table 5-3). The Richter magnitude is measured by recording the ground vibrations emanating from the source, or epicenter, of an earthquake on a seismograph. The Richter magnitude is an absolute scale, meaning that it will not change with distance from the earthquake epicenter. In recent years, the Richter Scale has been replaced with the Moment Magnitude (M_w) scale. The M_w scale is a more effective method for measuring earthquakes at larger distances from the epicenter than the Richter Scale. While the Richter Scale is becoming less used, measured Moment Magnitude values are still converted to values comparable to the Richter Scale to determine the earthquake risk.

Table 5-3 – Richter Earthquake Magnitude Classes (United States Geological Survey)

Magnitude Class	Magnitude Range (in numerical value)
Great	M > 8
Major	7 ≤ M < 7.9
Strong	6 ≤ M < 6.9
Moderate	5 ≤ M < 5.9
Light	4 ≤ M < 4.9
Minor	3 ≤ M < 3.9
Micro	M < 3

The MMI scale is an intensity scale ranging from I to X, where X is the most intense earthquake. The MMI scale measures the damage from earthquake shaking in a particular location. The MMI scale is subjective because it is based solely on observable data rather than measurements (Table 5-4). However, the MMI scale may be more effective when using it as a tool to communicate risk and hazard (USGS 2021).

The 2019 Ridgecrest events were the most recent large earthquakes to strike the OCTA planning area. The Ridgecrest earthquakes occurred on July 4 and 5, 2019 and consisted of three initial shocks of M_w magnitudes 6.4, 5.4, and 7.1 and several aftershocks. The shaking was felt by millions of people from as far north as San Francisco to as far south as Tijuana, Mexico (Byrd, 2019).

Table 5-4 – Modified Mercalli Earthquake Scale and Descriptions (United States Geological Survey)

Intensity	Shaking	Damage Description
I	Not Felt	Felt by very few under the right conditions.
II	Weakest	Felt by a few people at rest, most likely on upper floors of buildings.
III	Weak	Noticeably felt by people indoors, especially on upper floors. However, people may not recognize it as an earthquake. Stopped cars may rock slightly. It would feel like a large truck passing.
IV	Light	Many people would feel shaking indoors and could wake people up at night. Loose items could move or fall, like vases or pictures. It might feel like a heavy truck hitting the building. Stopped cars would noticeably rock.
V	Moderate	Nearly everyone would feel this and would wake up many people at night. Items could break like windows and dishes falling out of cabinets. Light and unsecured objects will overturn, like small furniture and bookcases.
VI	Strong	Everyone will feel this. It can move heavy furniture. Older structures can have fallen plaster or masonry.
VII	Very Strong	Newer structures built with high seismic standards and basic building standards will have negligible damage. While older or poorly built structures can have considerable damage.
VIII	Severe	Slight damage to newer structures with high seismic standards. Considerable damage to structures with basic building standards and possible partial collapse. Chimneys, factory stacks, columns, monuments, and walls can fall. Heavy furniture can overturn.
IX	Violent	Newer structures with high seismic standards can have considerable damage. New structures with basic building standards can substantially damage, partial collapse, and/or shift off foundations. Older buildings can be destroyed.
X	Extreme	Some newer, well-built wood structures will be destroyed. Most older buildings with masonry and frame structures will be destroyed. Foundations can be damaged and rails bent.

5.2.6 Warning Time

Earthquakes generally occur with little warning time. However, the CalOES managed Earthquake Warning California provides Californians with seconds to tens of seconds of warning before an earthquake is felt, enabling people to prepare (California Governor's Office of Emergency Services, n.d.). The warning system combines the MyShake smartphone app, the Android Earthquake Alerts system, and the national Wireless Emergency Alert to reach as many Californians as possible. The early warning system uses a network of ground motion sensors located across the state to detect an earthquake's first wave and the hazard (California Office of Emergency Management).

5.3 Secondary Hazards and Cascading Impacts

5.3.1 Secondary Hazards

Earthquakes may cause the following secondary hazards (Bolt, Earthquake: Geology, 2020):

- Surface ruptures (e.g., rising, tilting, dropping)
- Liquefaction
- Mass earth movements (e.g., landslides, rockslides, debris flows, mudflows)
- Dam and levee failure
- Tsunamis and seiches

5.3.1.1 Surface ruptures

Surface ruptures can alter the ground by pushing the ground up, dropping the ground, and tilting the surface's angle. Ruptures vary dramatically in size and depth. There are records of fault displacements ranging from one mile to 200 miles in length; typically, surface ruptures are found between six feet to 1,000 feet from the fault line (United States Geological Survey). Surface ruptures can damage anything on the impacted area before an earthquake changed the ground's shape.

5.3.1.2 Liquefaction

Liquefaction occurs when soils lose their shear strength and flow or turn the ground into a pudding-like liquid. Liquefaction can cause buildings and road foundations to lose load-bearing strength, resulting in structures and infrastructure sinking into quicksand-like soil where it was previously solid ground. To determine an area's soil structure and susceptibility to seismic hazards, the US Department of Agriculture, Natural Resources Conservation Service (NRCS) provides a Web Soil Survey library. The NRCS states this library is the single authoritative source for soil information in the US; it contains soil maps and data for more than 95 percent of US counties (United States Department of Agriculture Natural Resources Conservation Service, 2019).

Once the soil composition is determined, the National Earthquake Hazard Reduction Program (NEHRP) soil classification system explains an earthquake's amplifying effect on soft soils. This amplification is the average shear-wave velocity on the upper 100 feet of soil compared to the shaking amplification at the ground's surface (Palmer, et al., 2007). Seismic activity typically does not amplify or reduce B soils. However, earthquakes more easily alter increasingly softer C, D, and E soils. E soils are the most susceptible to liquefaction from seismic activity (Palmer, et al., 2007). Table 5-5 is the NEHRP system.

Table 5-5 – NEHRP Soil Classification System (Williams, Stephenson, Odum, & Worley, 1997)

NEHRP Soil Type	Description	Mean Shear Velocity to 30 m (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils)	

5.3.1.3 Mass Earth Movements

An earthquake can cause a mass earth movement, such as a debris flow, landslide, rockslide, or mudslide. When the ground shakes, it can shift the earth causing the ground's surface to become unstable and fall or flow. The most common earthquake-caused landslides are rockfalls (United States Geological Survey). The extent of a mass earth movement is dependent on several factors, including the earthquake's magnitude, the focal depth of the epicenter, soil or ground composition, and duration of the shaking (United States Geological Survey). Mass earth movements and their risk to the planning area are covered more in Section 8.

5.3.1.4 Dam and Levee Failure

An earthquake may result in dam and levee failure. Historically, solid dams made from materials like concrete are minimally affected by earthquakes (Hiner, 2020). However, earthen dams and levees are highly susceptible to a mass earth movement caused by a seismic event. Several earthen dams and levees could impact OCTA's planning area if they were damaged or failed. Examples include, but are not limited to the following (Enjoy OC):

- **The Santiago Dam** – Made from excavated dirt and rock that contains a 25,000 acre-feet reservoir
- **Villa Park Dam** – An earthen flood control dam downstream from the Santiago Dam
- **Walnut Canyon Reservoir** – An earth-filled and asphalt-lined structure with a water storage capacity of about 197 acre-feet, used by the City of Anaheim for potable water
- **Sulphur Creek Dam** – A dam made of dirt fill with a capacity of 382 acre-feet and owned by Orange County
- **Peters Canyon Dam** – An earth-filled dam with a capacity of 626 acre-feet depending on seasonal rainfall and owned by Orange County
- **Prado Dam** – An earth-filled dam with water storage capacity of 2,255 square feet located in Riverside County, providing flood control and water conservation storage for Orange County

At the time of writing this plan, dam vulnerability data had been deemed not available for public use given its sensitive nature and therefore was not included in this study. Additionally, flood control systems can extend beyond the geographic footprint of the county and ownership ranges from federal, state, local, and private facilities.

5.3.1.5 Tsunamis and Seiches

Depending on the location, earthquakes can also trigger tsunamis and seiches. Seismic seiches are waves generated by an earthquake on lakes, reservoirs, ponds, and rivers (United States Geological Survey). A seismic seiche impact is limited to the area around the water body; although, the waves can cause erosion, flooding, and damage or destroy earthen dams and levees. Shallow marine thrust earthquakes that displace the seafloor are the most likely combination of factors to cause a tsunami; however, major strike-slip earthquakes have occasionally triggered small tsunamis (United States Geological Survey). Tsunamis and their potential impact on the OCTA planning area are discussed further in Section 10. OCTA planning area risks from flooding, erosion and sea level rise are in Section 6.

5.3.2 Cascading impacts

The earthquake itself and the earthquake's secondary hazards can also cause cascading impacts. The shaking ground from a seismic event can directly damage and/or destroy structures and infrastructure with the movement. Horizontal seismic motion generally causes more damage to structures than vertical

movement (United States Geological Survey). Surface ruptures, mass earth movements, and liquefaction can all directly cause structural damage to anything directly over or very near the ground displacement or liquefaction.

Continuing cascading impacts come from the structural damage caused by earthquakes and their secondary impacts. One, or a combination of, these impacts pose a risk of injury or death to people. These issues can include, but are not limited to:

- **Utility failures or outages** – electricity, sewer, stormwater, transportation routes, systems, etc.
- **Hazardous materials spill** – from storage facilities, along transportation routes, etc.
- **Fires** – caused by broken gas and/or power lines (especially if broken water lines feed hydrants)

All earthquake impacts could affect OCTA staff, customers, and the community. Cascading effects can also, directly, and indirectly, impact OCTA's planning area, facilities, structures, and infrastructure.

5.4 Potential Impacts from Future Climate Conditions

The impacts of climate change on earthquake probability are unknown; however, secondary impacts from earthquakes can be magnified or more possible due to climate change factors (Mauger, Lee, & Won, 2018). For example, earthquakes can instigate fires, as indicated in the section above; this could lead to a significant wildfire event if it is compounded by climate change-influenced droughts. In addition, after an earthquake, mass earth movements may be more likely due to climate change, with increasing factors such as (Mauger, Lee, & Won, 2018):

- Increased wildfires depleting hillside vegetation
- Soil saturation from unusually high precipitation level
- Changes in river hydrology from more frequent and/or intense severe weather
- Weakened coastal slope stability due to SLR

5.5 Exposure and Vulnerability

For the hazard exposure and vulnerability analysis, OCTA used HAZUS-MH to evaluate a magnitude 8.2 earthquake scenario on the San Andreas Fault. This earthquake hazard scenario encompasses the entire planning area, and shaking is anticipated to be strong to very strong. The HAZUS-HM description and process are in Section 4.2.2 of this plan. Figure 5-2 shows the planning area exposed to earthquakes.

5.5.1 Population

5.5.1.1 Exposure

The entire population within the planning area is exposed to earthquakes, including the magnitude 8.2 San Andreas Fault scenario used for HAZUS-MH. The HAZUS-MH scenario intersected geospatial hazard data, and 2018 US Census Bureau estimates to assess population exposure and vulnerability in the planning area, covering almost 800 square miles, 582 census tracts, and nearly three million residents.

5.5.1.2 Vulnerability

The entire vulnerable population within the planning area is exposed to earthquakes. As discussed in Section 3.1.3, higher-risk vulnerable populations consist of low-income households, senior citizens, disenfranchised minorities, those that speak English as a second language or not at all, and children (FEMA, 2009). Vulnerable population demographic estimates:

- **Persons over 65 years old** – 11.4 percent of the population
- **Persons under 19** – 26.0 percent of the population
- **Hispanic or Latino** – 34.2 percent of the population
- **Black, American Eskimos, or Hawaiian/Pacific Islanders** – Less than one percent of the population
- **Asian** – 17.7 percent of the population
- **Persons that speak a language other than English at home** – 44.5 percent of the population
- **Persons living below the poverty level** – 13.0 percent of the population

The entire vulnerable population within the planning area is exposed to liquefaction. Figure 5-3 shows the planning area exposed to liquefaction. Vulnerable population demographic estimates:

- **Persons over 65 years old** – 5.8 percent of the population
- **Persons under 19** – 26 percent of the population
- **Hispanic or Latino** – 18.8 percent of the population
- **Black, American Eskimos, or Hawaiian/Pacific Islanders** – 1.6 percent of the population
- **Asian** – 11.7 percent of the population
- **Persons that speak a language other than English at home** – 26.2 percent of the population
- **Persons living below the poverty level** – 7.2 percent of the population

5.5.1.3 Property

All OCTA-owned and operated properties are exposed to earthquake hazards. However, only some of the OCTA-owned and operated properties are exposed to liquefaction. Reference Table 5-15 and 5-16 for specifics on Liquefaction.

5.5.1.4 Vulnerability

Older structures are more vulnerable to damage from seismic activity due to the adequacy of building codes. Table 5-6 lists building code milestones within the planning area, which can inform future property vulnerability analysis.

Table 5-6 – Age of Structures and Building Codes in Orange County (Wiley, 2020)

Date(s)	Significance of Time Frame
Pre-1925	Before 1925, there were no precise earthquake building code requirements in California.
1925-1933	The City of Santa Barbara was the first local government to adopt seismic reduction building codes in 1925.
1933-1960	After the 1933 Long Beach earthquake, the State realized earthquakes in California were not rare or one-time hazards, and the State rapidly enacted earthquake-resistant building codes.
1960-1972	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1972-1973	The 1971 San Fernando Valley earthquake inspired legislatures to propose 35 pieces of legislation, with more than five of these significant seismic safety acts passed in 1972.
1974-2000	California established the Joint Committee on Seismic Safety in 1974. In 1975, lateral force requirements made significant improvements. From 1974 to 2000, legislatures approved approximately 190 pieces of legislation on earthquake safety.
1990	The Seismic Mapping Act was passed in 1990 and addressed earthquake hazards associated with non-surface fault ruptures, liquefaction, and landslides (County of Orange and Orange County Fire Authority, 2015).

Date(s)	Significance of Time Frame
1994	In 1994, the Uniform Building Code (International Conference of Building Officials, 1994) was amended to include seismic safety provisions.
2000-Present	Seismic codes are enforced through building permits. The Seismic Safety Commission continues to inform and recommend seismic safety projects and renovations for buildings and infrastructure (Alquist, 2019).

5.5.1.5 Damage Estimates

Damage estimates for OCTA-owned and operated properties within the planning area were generated using HAZUS-MH for the San Andreas 8.2 magnitude scenario, the results of which are listed in Tables 5-7 to 5-10. The results include property loss for OCTA-owned and operated facilities, the types and counts of facilities impacted by strong shaking, the average probability of structure damage, and the anticipated average probability of full functionality in days after the earthquake scenario.

Table 5-7 – OCTA Facility Value Losses for the HAZUS-MH Scenario

Facility Type	Facility Loss Value (*in thousands $*)	Content Loss (*in thousands $*)	Economic Loss (*in thousands $*)
Administrative Facility	$3,522	$50,550	$704
91 Express Lanes	$216,954	$8,775	$51,528
Metrolink Expansion	$18,312	$0	$5,465
Pacific Electric ROW	$54,757	$0	$10,444
Park-and-Ride Facility	$5,232	$51	$1,263
Santa Fe Rail ROW	$112,249	$0	$34,070
Transit Base Facilities & Vehicles	$186,567	$368,715	$5,708
Transit Center Facility	$15,575	$100	$1,304
Transportation Security Operations Center	$4,013	$0	$154
Unused Land/Property	$13,089	$0	$2,358
Total	**$803,946.00**	**$428,735.00**	**$129,376.00**

Table 5-8 – OCTA Facilities Impacted by Strong Shaking in the HAZUS Scenario

Facility Type	Strong Shaking
Administrative Facility	2
91 Express Lanes	2
Metrolink Expansion	1
Pacific Electric ROW	1
Park-and-Ride Facility	4
Santa Fe Rail ROW	1
Transit Center Facility	13
Unused Land/Property	2
Total	**65**

Table 5-9 – OCTA Facility Average Probability of Structural Damage in the HAZUS-MH Scenario

Facility Type	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Destruction
Administrative Facility	39%	29%	28%	4%	1%
91 Express Lanes	5%	57%	24%	10%	3%
Metrolink Expansion	4%	54%	26%	12%	4%
Pacific Electric ROW	10%	66%	17%	5%	1%
Park-and-Ride Facility	30%	38%	22%	7%	2%
Santa Fe Rail ROW	3%	53%	27%	13%	4%
Transit Center Facility	73%	19%	6%	2%	0%
Unused Land/Property	11%	67%	16%	5%	1%
Total	**67%**	**22%**	**8%**	**2%**	**1%**

Table 5-10 – OCTA Facility Average Probability of Full Functionality After the HAZUS-MH Scenario

Facility Type	Day 1	Day 3	Day 7	Day 14	Day 30	Day 90
Administrative Facility	39%	40%	67%	67%	95%	99%
91 Express Lanes	5%	8%	62%	62%	87%	97%
Metrolink Expansion	4%	6%	57%	57%	84%	96%
Pacific Electric ROW	10%	13%	76%	76%	93%	99%
Park-and-Ride Facility	30%	32%	69%	69%	91%	98%
Santa Fe Rail ROW	3%	6%	56%	56%	83%	96%
Transit Base Facility	82%	83%	96%	96%	100%	100%
Transit Center Facility	73%	73%	92%	92%	98%	99%
Transportation Security Operations Center	81%	81%	94%	94%	100%	100%
Unused Land/Property	11%	15%	78%	78%	94%	99%
Total	**67%**	**68%**	**89%**	**89%**	**97%**	**99%**

5.5.2 Critical Facilities and Infrastructures

Damage estimates for OCTA-owned and operated critical facilities and infrastructures within the planning area were generated using HAZUS-MH for the San Andreas 8.2 magnitude scenario, the results of which are listed in Tables 5-11 to 5-14. The results include property loss for OCTA-owned and operated facilities, the types and counts of facilities impacted by strong shaking, the average probability of structure damage, and the anticipated average probability of full functionality in days after the earthquake scenario.

Table 5-11 – OCTA Critical Facility Value Losses from the HAZUS-MH Earthquake Scenario

Critical Facility Type	Facility Loss (*in thousands $*)	Content Loss (*in thousands $*)	Economic Loss (*in thousands $*)
Transportation Security Operations Center	$4,013	$0	$154
Transit Base Facilities and Vehicles	$186,567	$368,715	$708
Total	**$190,580**	**$368,715**	**$862**

Table 5-12 – OCTA Critical Facilities Impacted by Strong Shaking in the HAZUS Scenario

Critical Facility Type	No. Buildings of Experiencing Strong Shaking
Transportation Security Operations Center	1
Transit Base Facilities	35
Total	**36**

Table 5-13 – OCTA Critical Facility Average Probability of Structural Damage in the HAZUS-MH Scenario

Critical Facility Type	None	Slight	Moderate	Extensive	Destruction
Transportation Security Operations Center	81%	13%	5%	0%	0%
Transit Base Facilities	82%	14%	4%	0%	0%

Table 5-14 – OCTA Critical Facility Average Probability of Full Functionality After the HAZUS-MH Scenario

Critical Facility Type	Day 1	Day 3	Day 7	Day 14	Day 30	Day 90
Transportation Security Operations Center	81%	81%	94%	94%	100%	100%
Transit Base Facilities	81%	81%	94%	94%	100%	100%

Table 5-15 – OCTA Ownership of Environmental Parcels in Liquefaction.

Parcel Type	Acres
Pacific Horizon (proximal to Laguna Beach)	1.74
Trabuco Rose (proximal to Trabuco Canyon)	0.78
Wren's View (proximal to Trabuco Canyon)	2.33
Total	**4.85**

Table 5-16 – OCTA Infrastructure and Related Operations in Liquefaction.

Type	Miles
Bus Route	699.41
I-405 Freeway	71.23
SR-91 Freeway	45.219
Other Freeway	191.87
Metrolink Rail	37.54
Pacific Electric ROW	11.79
Streetcar Route	2.55
Total	**1059.609**

5.6 Development Trends

Earthquakes are one of the most likely and geographically extensive hazards within the planning area. OCTA understands these risks and will continue to consider seismic hazards in their new and future projects. Building development in earthquake zones is also highly regulated through State and local plans, laws, and building codes. OCTA's Heath, Safety, and Environmental Compliance Department ensure all projects and operations comply with applicable health, safety, and environmental standards, codes, and regulations (Orange County Transportation Authority, 2014).

California Legislature Sec. 65302 Government Code

General plans must identify and protect the community from any unreasonable risks associated with seismic hazards; these risks include earthquakes, tsunamis, mass earth movements, and any other seismic hazards (California Legislative Information, 2018).

The Orange County General Plan directs overall land use, addresses growth management, and establishes standards and regulations to protect the community from hazards (Orange County). Chapter XI Growth Management Element incorporates OCTA in the transportation development sections and includes plans and policies for traffic and public facility improvements to adjust for population increases (Orange County, 2020). The General Plan Chapter IX Safety Element provides building codes and standards to minimize exposure from all identified hazards. This section incorporates County emergency management, law enforcement, and fire management plans (Orange County, 2013).

Development plans include risk reduction measures, and growth management plans specific to transportation. The County states that it may not be responsible for some transportation projects but supports the transportation agencies leading these projects. Land-use planning and growth management are well managed by the County and designed to reduce seismic hazard risks.

5.7 Issues

Earthquake considerations in the OCTA planning area (Orange County Transportation Authority, 2020):

- Earthquakes could trigger secondary hazard events such as levee failures, landslides, or damage, potentially impacting the OCTA's customers, structures, infrastructure, and operations.
- New or renovated OCTA structures should include appropriate seismic building standards.
- Transportation routes may need to be altered immediately after an earthquake based on damage to infrastructure and OCTA's structures.
- Vulnerable populations may need additional transportation services after an earthquake.
- There could be considerable debris to clean up and possibly hazardous materials mixed, depending on the earthquake's magnitude and areas affected.

5.8 Hazard Maps

The maps of earthquake risks and liquefaction impacting the planning area is on the next page.

Figure 5-2 – OCTA HAZUS Earthquake Scenario Map

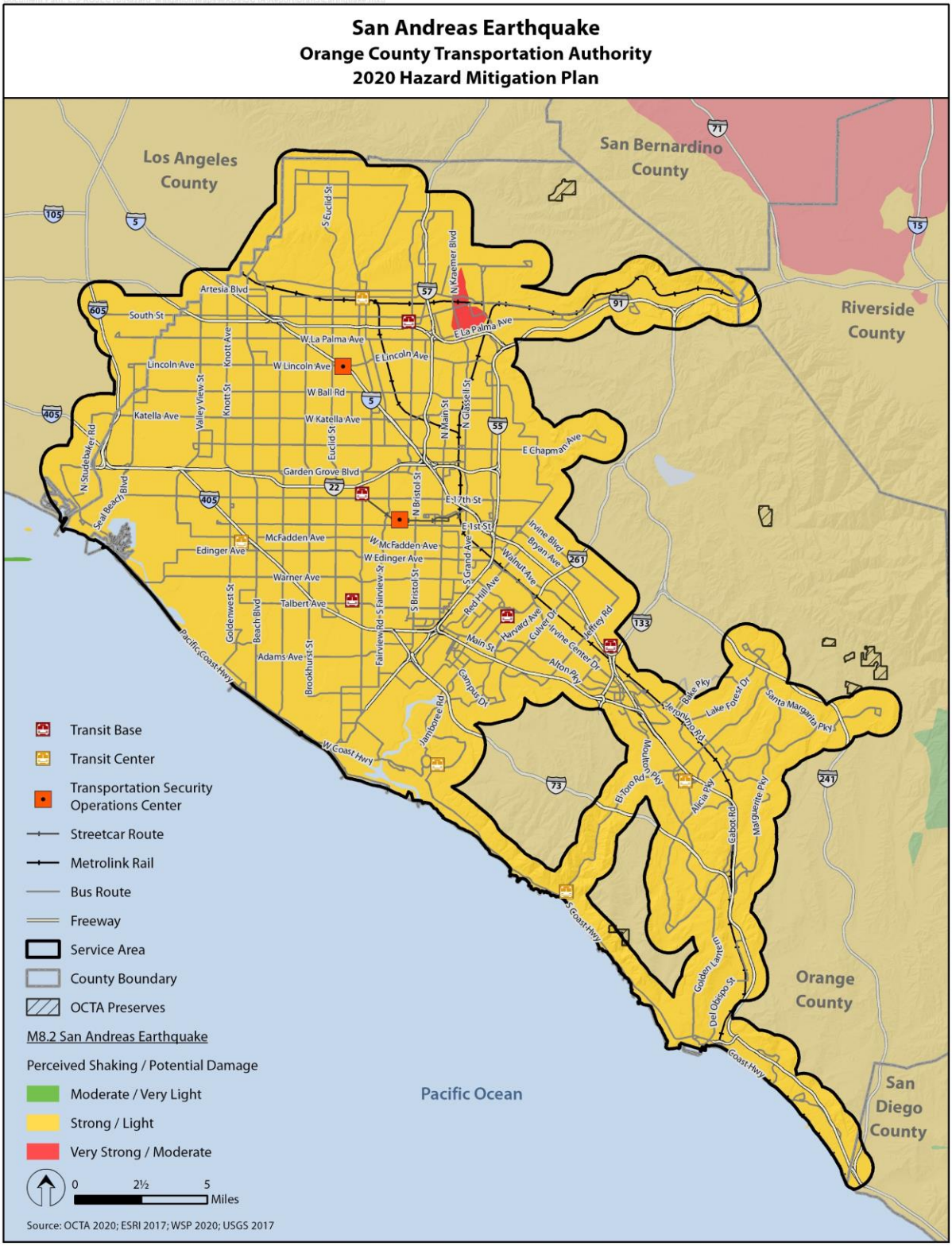
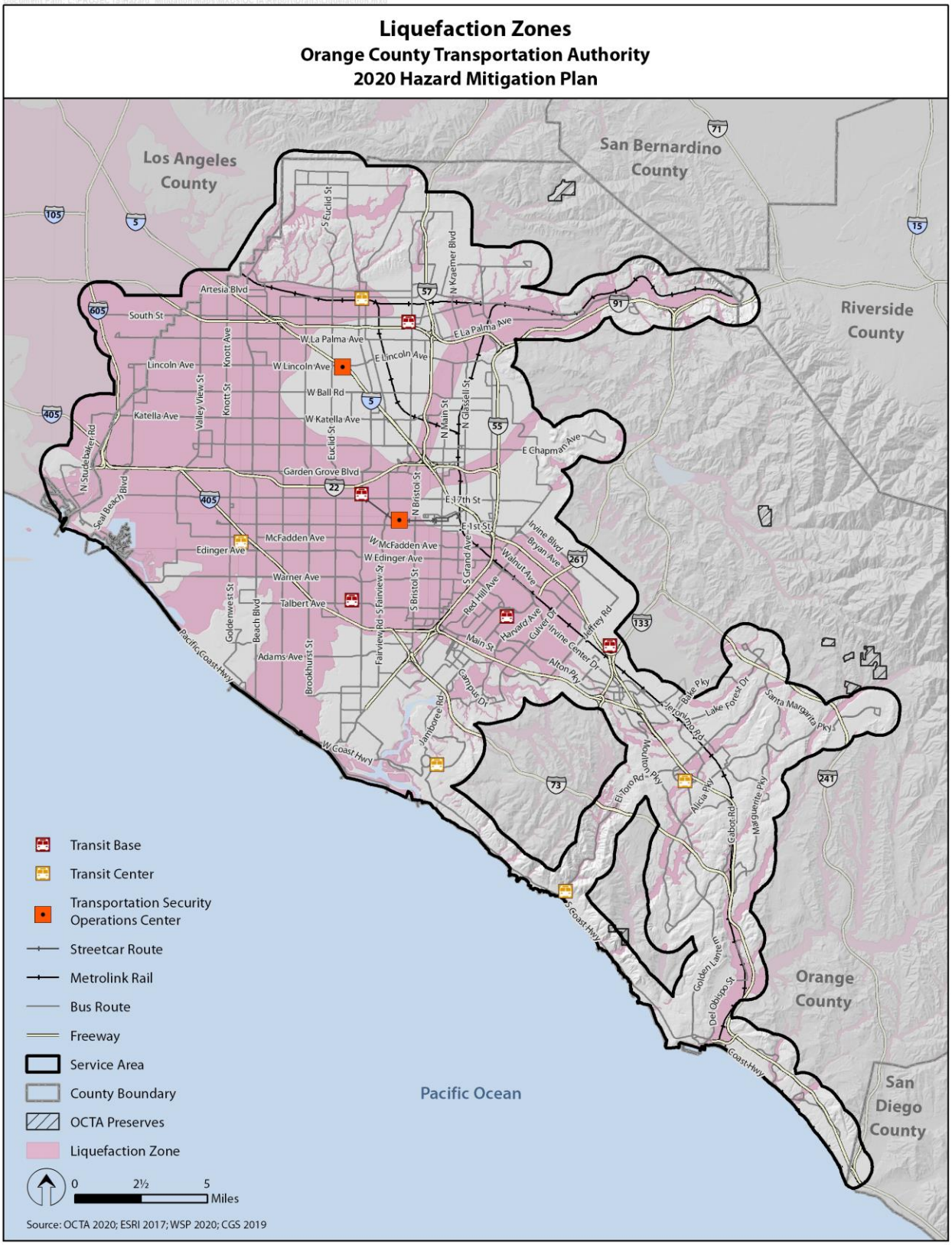


Figure 5-3 – OCTA Liquefaction Scenario Map



6 Epidemic/Pandemic

6.1 General Background

In the US, infectious diseases are a significant contributor to illness, disability, and death (Office of Disease Prevention and Health Promotion, 2020). Over the last few decades, outbreaks, epidemics, and pandemic events have increased, spreading faster and farther; this includes re-emerging diseases and recently discovered diseases (World Health Organization, 2018). An epidemic is a significant and unexpected increase in disease cases. An outbreak is like an epidemic, but it is limited to a geographic area or group of people. Pandemics occur when a disease crosses multiple countries and infects a large number of people. For example, COVID-19 started in China in 2019 and spread rapidly across the world, resulting in a global pandemic in 2020 (Centers for Disease Control and Prevention, 2020).

Infectious disease-causing agents can be viruses, bacteria, parasites, fungi, or parasites (Mayo Clinic Staff, 2019). Communicable diseases can be spread by direct contact from animal to person or person to person, indirect contact by touching a contaminated surface or object, insect bites, contaminated food or water, or inadequate medical sanitation (Mayo Clinic Staff, 2019). Chemicals or toxins can also cause outbreaks, such as "Jamaican ginger paralysis," and on occasion, the cause of a disease is unknown (World Health Organization).

An individual can be at risk from an infectious disease or chemical/toxic agent from ingestion, inhalation, or direct skin contact; radiation is the only exposure that can be external, traveling to the individual (Agency for Toxic Substances and Disease Registry, 2005). Some agents have multiple means of spreading, others only by bodily fluids.

Infectious diseases can be seasonal, such as influenza. In contrast, others may be rare but have a high mortality rate, like Ebola and hemorrhagic fevers (Cole, 2014). Some diseases occur after a disaster due to contaminated food and water, such as E. coli (Centers for Disease Control, 2019). Unfortunately, it is rare to eradicate diseases, and new ones are continually discovered (World Health Organization, 2018).

DEFINITIONS

Communicable Disease – an illness transmitted from an infected agent to an animal or individual through direct or indirect contact.

Disease Vector – an agent that carries and transmits infectious diseases, such as an insect, fungus, or animal.

Epidemic – happens when there is a significant and unexpected increase in disease cases.

Essential Workers – individuals that work in roles that are critical to infrastructure operations.

Herd Immunity – when enough of the population becomes resistant to a disease by recovering from the illness or vaccination.

Infectious Diseases – medical conditions/illnesses caused by organisms like bacteria, viruses, fungi, or parasites.

Mortality Rate – a mathematical measure of the frequency that individuals die in a defined population during a specific period of time.

Outbreak – similar to an epidemic but limited to a specific geographic area or group of people.

Pandemic – occur when a disease crosses multiple countries and infects a large number of people.

6.1.1 Potential Damage from Epidemics

Epidemics and pandemics can significantly impact mortality rates, social and mental health, the economy, and disrupt travel operations (Madhav, et al., 2017). Diseases and mortality rates can disproportionally affect vulnerable populations. These populations can include younger people who have not built up immunity, older individuals and people with underlying health conditions that lower their immune systems, and low-income or non-citizens who do not have access to affordable medical care (Madhav, et al., 2017). The disproportional impact can exacerbate the over-taxed emergency response and healthcare communities. A single outbreak can overrun a local emergency response and healthcare systems' resources and staff. Additionally, overwhelmed medical facilities reduce non-infectious disease medical and mental care (Bloom, Cadarette, & Sevilla, 2018).

An infectious disease event can have societal impacts that affect individuals and the economy. Infection control measures can lead to a temporary closure of schools and businesses and reduce transportation and public services (Bloom, Cadarette, & Sevilla, 2018). These measures and infectious diseases can cause general stress to an affected community and more severe mental health issues for some individuals. The stress can trigger concerns about a person or loved one's health, changes in sleep and eating, difficulty sleeping or concentrating, chronic medical and/or mental health problems increasing, and increased use of mood-altering substances (e.g., tobacco, alcohol, illegal drugs) (Centers for Disease Control, 2020).

6.2 Orange County Transportation Authority Hazard Profile

Epidemics and pandemics do not need to start in the OCTA planning area to impact OCTA's customers, staff, and operations. Transit operations, by virtue, are an essential service and does not allow the same protections as stay-at-home or remote work positions. The entire OCTA planning area is at risk from known-preventable diseases and newly introduced or reemergent diseases that do not have vaccines yet. Childhood vaccination percentages are a strong indicator of community resilience to known-preventable diseases and a cost-effective method for preventing these dangerous diseases (Office of Disease Prevention and Health Promotion, 2020). Orange County's childhood vaccination statistics are a good representation of vaccine percentages in the planning area.

There are 28 school districts in Orange County. The districts' 2016 records for kindergarteners showed the percentage of students with the required immunizations ranged between 86.3 percent and 98.2 percent (Orange County's Healthier Together, 2016). Orange County's vaccination percentages are high and a positive indication of vaccination levels in bordering counties. Therefore, the OCTA planning area has a low risk of an outbreak or epidemic from vaccine-preventable diseases. However, unvaccinated visitors and new residents can bring new or variant infectious diseases to the area, as revealed during the COVID-19 pandemic.

OCTA 2020 COVID-19 Pandemic Narrative

March 2020-current, OCTA responded to the COVID-19 Pandemic. Strategies taken included specific task forces to address ongoing items (Return to work, local infection rate monitoring, vaccinations, and others), as well as enhanced communications and partnerships with relevant stakeholders in the community. OCTA was asked to assist in transporting medical providers to specific community clinics, as well as partner with other trusted community transportation organizations to get members of the underserved communities to/from vaccination clinics.

6.2.1 Hazard Ranking

The Planning Team completed a hazard ranking survey during the OCTA 2022 HMP development process and assessed hazard-related factors based on worst case and most likely scenarios. Hazard definitions and ranking factors are in Appendix G, Table G-1. Survey results were prioritized and ranked based on their averaged score. The variables of severity, magnitude, frequency, onset, and duration are scored one to five, where one is the lowest and five is the highest. Compared to the other hazards in the survey, epidemics/pandemics were ranked third for the worst-case and the most likely scenarios.

Table 6-1 – OCTA Epidemic/Pandemic Hazard Ranking

Severity	Magnitude	Frequency	Onset	Duration	Average	Rank
Worst-Case Scenario						
4.18	4.27	1.55	2.91	4.18	3.42	3
Most Likely Scenario						
4.00	4.00	1.18	3.00	4.09	3.25	3

6.2.2 Past Events

The OCTA planning area was directly affected by two pandemic events in the last decade, H1N1 and COVID-19. In 2009, a pandemic of H1N1 influenza, popularly known as swine flu, resulted in many hospitalizations and deaths. In Orange County, there were 226 cases of severe illness and 57 deaths associated with H1N1 through August 9, 2010 (Orange County Mosquito and Vector Control District, 2020). In Appendix G Table G-6 lists diseases and rates for Orange County.

Throughout 2020 and the development of this plan, OCTA and the world responded to the COVID-19 pandemic. This virus had an unprecedented effect globally and directly influenced transportation operations. On May 4th, 2021, the COVID-19 rates for Orange County there are 270,345 infection cases and 4,969 deaths. (Orange County Health Care Agency, 2021)

HMP Planning During COVID-19

This plan was developed during the 2019 COVID-19 pandemic. A more in-depth review of COVID-19 and its effects will be in the 2026 HMP update.

6.2.3 Location

While it is difficult to anticipate where an epidemic or pandemic may spread, contact tracing is helpful for mapping out the locations and persons infected with a contagious disease. During an epidemic or pandemic, OCTA can support the Centers for Disease Control (CDC) and local public health efforts by preparing OCTA's staff and their operations and providing contact trancing information.

6.2.4 Frequency

Historical events indicate that epidemics and pandemics are happening more frequently and spreading farther over the past century. This increase is likely due to multiple factors, such as increased global travel, economic globalization, urbanization, and increased population growth in natural environment areas (Madhav, et al., 2017). Orange County shows a rise from 2015 to 2019 in certain infectious diseases:

Table 6-2 – Increasing Rates of Infectious Diseases in Orange County from 2015-2019 (Orange County Health Care Agency, 2019)

Disease Name	Agent	Vector	2015	2016	2017	2018	2019
Campylobacteriosis	Bacteria	Flies	398	488	544	575	651
Coccidioidomycosis "Valley Fever"	Fungus	Mosquitos	186	116	211	242	320
Shigellosis	Bacteria	Flies	69	71	96	178	176

6.2.5 Severity

The severity of an epidemic or pandemic varies for numerous reasons, such as how it is transmitted (e.g., airborne or skin-to-skin contact), how contagious the disease is, how long it can live on surfaces, and how long an individual is contagious before showing symptoms. The CDC's Pandemic Severity Index describes loss of life in five categories:

- **Category 1**: less than 90,000
- **Category 2**: 90,000 < 450,000
- **Category 3**: 450,000 < 900,000
- **Category 4**: 900,000 < 1.8 million
- **Category 5**: > 1.8 million

Figure 6-1 – CDC Workplace and Community Recommendations by Pandemic Severity Category (Centers for Disease Control)

	Pandemic Severity Index		
Interventions by Setting	**1**	**2 and 3**	**4 and 5**
Workplace/Community Adult social distancing			
–decrease number of social contacts (e.g., encourage teleconferences, alternatives to face-to-face meetings)	Generally not recommended	Consider	Recommend
–increase distance between persons (e.g., reduce density in public transit, workplace)	Generally not recommended	Consider	Recommend
–modify, postpone, or cancel selected public gatherings to promote social distance (e.g., stadium events, theater performances)	Generally not recommended	Consider	Recommend
–modify workplace schedules and practices (e.g., telework, staggered shifts)	Generally not recommended	Consider	Recommend

The CDC has provided category-specific strategies to mitigate the severity of a pandemic/epidemic (Figure 6-1). Additionally, the CDC developed a Pandemic Severity Assessment Framework (PSAF) for public health officials to determine the seriousness of an infectious disease (Centers for Disease Control, 2016). There are two steps for health officials to follow, an initial assessment early on during a pandemic and a refined evaluation that happens when more information becomes available (Centers for Disease Control, 2016). The federal, state, and local public health agencies will provide instructions to all organizations and individuals based on the severity of a pandemic and the infectious diseases' transmission methods.

6.2.6 Warning Time

Warning time for an epidemic or pandemic varies between a few hours to a few months, depending on the disease type, OCTA's proximity to the outbreak's origin, and the disease's contagious properties. The CDC explains that an outbreak will often start in countries with little medical resources. From there, highly contagious diseases can spread from remote communities to major urban areas around the globe in as little as 36 hours, growing from a localized outbreak to a pandemic (Centers for Disease Control, 2020). To manage potential pandemics in the initial phase, the CDC operates the Health Alert Network (HAN) to share public health information. The network is accessible to government and tribal organizations and furnishes critical data to plan and respond to public health issues (Centers for Disease Control, 2020).

The CDC sends and receives vital epidemic/pandemic data from state and local public health departments. Orange County Public Health administers the Communicable Disease (CD) Health Alert system. Any organization can subscribe to this system and receive immediate public health issues (Orange County Public Health, 2020). Infectious disease alerts and warnings give OCTA up-to-date information to support a timely response to an epidemic or pandemic, mitigating the severity and spread as much as possible. Table 6-3 below lists the CDC's HAN levels, also used in the planning area.

Table 6-3 – Epidemic/Pandemic Alert Levels (Centers for Disease Control, 2014)

Level	Description
Alert	The highest level of notification and requires immediate action or attention
Advisory	Provides significant information about a specific event or situation, may not need immediate action
Update	Provides new information regarding an incident or situation, unlikely to need immediate action
Info Service	General information that is not necessarily an emergency at the time it is reported

6.3 Secondary Hazards and Cascading Impacts

6.3.1 Secondary Hazards

There are no apparent secondary hazards that an epidemic or pandemic could cause. However, epidemic/pandemics can interfere with mitigation strategies for other risks. For example, organizations may prioritize prevention methods and emergency response strategies during a concurrent natural hazard or natural hazard season (Quigley, Attanayake, King, & Prideaux, 2020). Organizations may need to balance difficult decisions between pandemic control and protective measures and natural hazard prevention, such as clearing dry vegetation for wildfire fuel management. For example, an epidemic/pandemic can challenge fuel load management to mitigate wildfires due to reduced on-site staff capacity.

6.3.2 Cascading Impacts

An epidemic or pandemic may force transportation agencies to cancel and/or reduce the frequency at which routes are serviced due to diminished staff capacity from having contracted the virus and being unable to work. Transportation agencies may anticipate staffing shortages and proactively cancel or reduce the frequency of service, or they may seek to accept staffing shortages and subsequent service delays as they occur.

6.4 Potential Impacts from Future Climate Conditions

Climate and land use are significant factors influencing where disease-carrying insects live (Centers for Disease Control, 2020). Even slight temperature differences affect where insect populations live and what diseases they carry. Insects such as fleas, ticks, and mosquitoes can carry diseases like Lyme, West Nile, malaria, Zika, etc. Temperature increases predicted for the planning area are in Section 9.

As temperatures in the OCTA planning area rise, these insects carrying diseases will likely migrate in increasing numbers. There are also ideal temperatures where certain diseases spread the most effectively; malaria spreads best at 78 degrees and Zika at 84 degrees (Jordan, 2019). The World Health Organization (WHO) identified potential climate change factors that would increase the number of infectious disease outbreaks and types of diseases that could occur in the planning area (World Health Organization, 2020):

- Increased use of dams, canals, and irrigation to manage water flow changes can increase the risk of schistosomiasis, malaria, and helminthiasis
- As annual average temperatures change, new agricultural areas can succumb to infestation, increasing the risk of malaria and Venezuelan hemorrhagic fever
- Deforestation and populations spreading into wildland interurban areas can cause a rise in insect populations bringing malaria, oropouche, and visceral leishmaniasis
- Conversely, reforestation to combat tree loss can increase the risk of Lyme disease

6.5 Exposure & Vulnerability

6.5.1 Population

All OCTA customers and staff could be at risk from an infectious disease affecting the area. An epidemic or pandemic typically affects vulnerable populations disproportionately, including those with compromised immune systems, pre-existing medical conditions, individuals over the age of 65, and individuals with limited access to adequate health care.

6.5.2 Property

Epidemics and pandemics do not typically impact property directly. However, secondary impacts on the economy and persons can influence property management and operations, such as epidemics/pandemics, making hazard prevention methods more challenging, as discussed in Section 6.3.1. Adjustments can be made to existing buildings and new projects, such as improving heating, ventilation, and air conditioning systems. This includes improving ventilation; improving air filtration; increasing cleaning and sanitizing procedures and frequency; allowing more space for social distancing; and delaying construction projects (Megahed & Ghoneim, 2020). Additionally, OCTA can consider situational adjustments for concurrent natural hazard prevention with epidemic/pandemic safety procedures.

6.5.3 Critical Facilities

During the COVID-19 pandemic, OCTA implemented safety accommodations to reduce exposure and spread risks at their critical facilities. The mitigation measures did not require significant changes to the structures, and diseases cannot directly damage the facilities. OCTA can consider building these epidemic and pandemic safety measures into future developments where applicable.

6.6 Development Trends

To accommodate the expected development in the planning area, OCTA has undertaken many developments and renovation projects; then, COVID-19 swept through the planning area. OCTA adapted to the pandemic and adjusted projects as needed to continue development and renovations safely. OCTA also communicated all updates through its website, blog, and social media, keeping the public informed (Orange County Transportation Authority, 2020). These adjustments and procedures can inform planning area development in future epidemic/pandemic incidents. Epidemics and pandemics can significantly impact development and community growth, although the impacts are likely temporary, lasting only as long as the infectious disease continues to spread (Derven, 2020). Long-term growth in the Planning Area is still expected (United States Census Bureau, 2019).

6.7 Issues

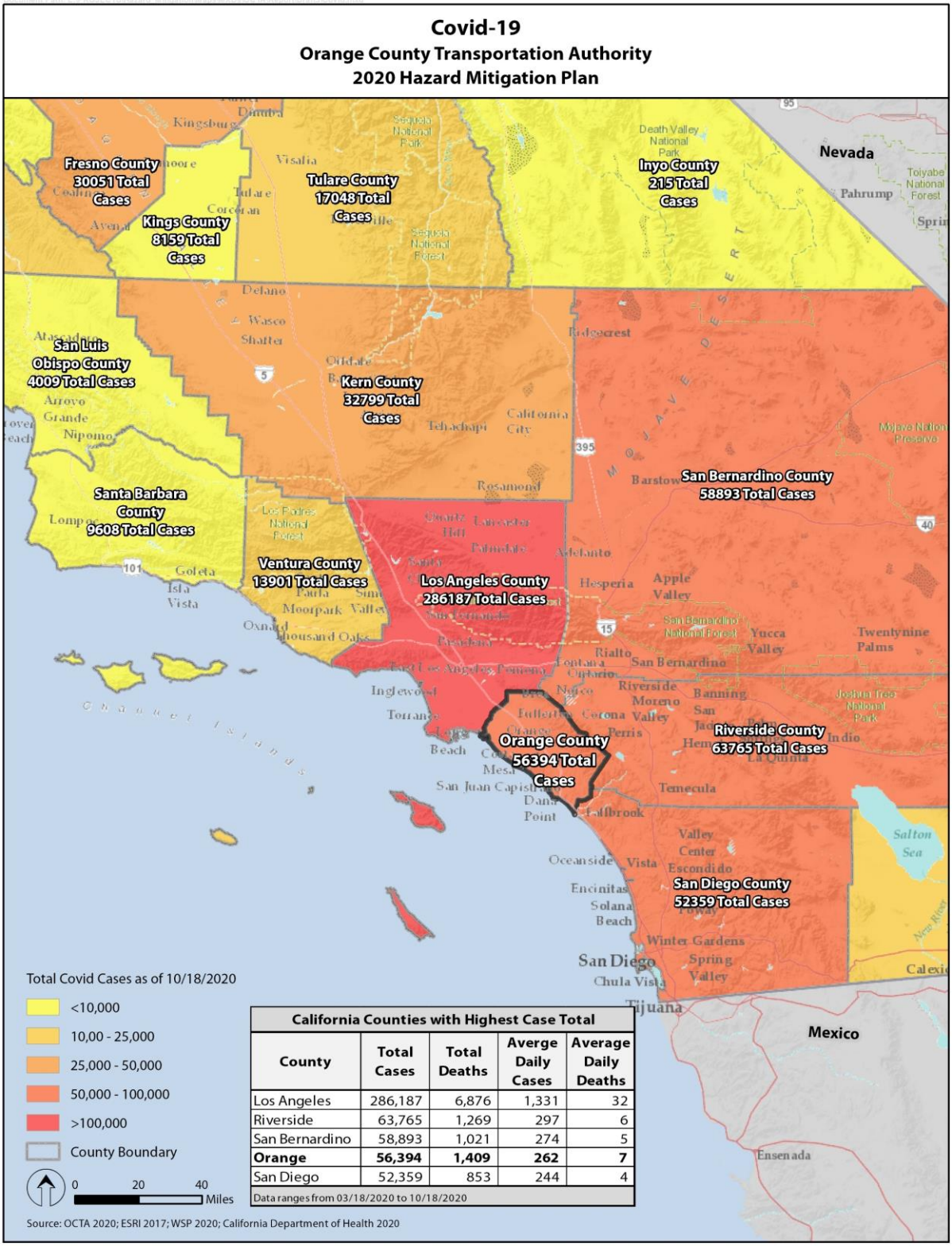
Pandemic/Epidemic considerations in the planning area (Orange County Transportation Authority, 2020):

- A sharp decline in ridership can mean revenue loss and temporary service changes.
- Safety and operations during an outbreak can require enhanced cleaning, processes, policies and procedures, and health-messaging solid campaigns (e.g., wearing masks and personal protective equipment for employees).
- Transit agencies must continue to provide critical route services, including carrying health care workers and other essential workers to their jobs and customers to medical services.
- While everyone can use public transportation, low-income and elderly populations typically depend on it as their primary form of transport.

6.8 Hazard Maps

The hazard map for COVID-19 cases in the planning area is on the next page.

Figure 6-2 – OCTA 2020 COVID-19 Hazard Map



7 Flood, Sea-Level Rise, and Cliff Erosion

7.1 General Background

Floods are the most common hazard in the US, occurring when water overflows onto naturally or altered dry lands (Ready.gov, 2020). Climate change is the primary cause of Sea Level Rise. Erosion is the natural process of removing surface ground material (soil, sand, rocks, etc.) from one area and transferring the material to another location, usually by wind or water (Editors of the Encyclopedia Britannica, 2020).

Rain, snow, coastal storms, storm surges, damaged dams and levees, or other damaged water control systems can all cause floods (Ready.gov, 2020). A flood can develop over time, such as during an unusually stormy season, or occur rapidly with little warning, like when a levee breaks and releases all the stored water at once. Depending on the extent of the event that triggers a flood, effects can be localized to a single neighborhood or block or extend as far as an entire region affecting multiple states. Riverine flooding and urban drainage can cause flash floods, depending on the geography and the event triggering the flood. It is the most dangerous type of flood due to the high-water flow velocity and large debris the water can carry (Federal Emergency Management Agency). Flooding categories (Federal Emergency Management Agency):

- **Riverine Flooding** – happens when water overtops the banks of a river, lake, or stream and spills onto the adjacent land and is the most common type of flooding. Typically caused by excessive or prolonged rains and can include flash floods, dam and levee failures, and alluvial fan flooding.
- **Urban Drainage** – "stormwater management" is physical and natural systems used by people in developed areas to eliminate surface water and stormwater runoff as quickly as possible by directing it into closed water management systems. Flooding can happen when these

DEFINITIONS

100-Year Floodplain – an area inundated by a flood with a one percent chance of being equal or greater each year.

500-year Floodplain – an area inundated by floodwaters that has a 0.2 percent chance of being equal or greater each year.

Alluvial Fans – are found in dry mountainous regions where rock and soil erode from mountainsides and built up on valley floors in a fan shape.

Coastal Flood – occur by seawater and coastlines, often due to severe weather events and cause coastline erosion.

Flash Flood – a rapid rise in water with a high flow velocity that carries debris. Flash floods have enough force to pull up and carry significant amounts of large debris (e.g., cars and trees).

Floodplain – an area of land neighboring a waterway or waterbody that is known to be flood prone.

Stormwater Management – physical and natural systems used by people to control and regulate the flow of surface and stormwater runoff.

Storm Surge – when a coastal flood happens at the same time as a high-tide, causing the coastal flood to reach father and bring more water than it would during a lower tide.

systems back up or when the incoming water exceeds the system's capacity.

- **Coastal Flooding and Cliff Erosion** – are floods that occur by seawater and coastlines, often caused by severe weather events. When a coastal flood coincides with a high tide, it is called a storm surge. Strong waves from storms can significantly increase the rate of cliff erosion.
- **Ground Failures –** subsidence and liquefaction can cause flooding in the immediate area, while mass earth movements can release or carry water with a mudslide, mudflow, or debris flow. These mass earth movements with flooding can be exceptionally damaging due to the water and ground material's force and the debris they can carry.
- **Fluctuating Lake Levels –** can be a seasonal process with standard weather patterns or can be caused by unusual heavy rainfalls.

SLR is affected by melting ice sheets and glaciers and average annual temperatures increasing brings an influx of water into the oceans, raising seawater levels (Administration, 2020). As sea levels rise, extreme coastal events (e.g., storm surges) can become more frequent and severe (Pörtner, et al., 2019). Additionally, as SLR continues, water that connects to the oceans spreads farther inland, resulting in expanded fluvial flooding (Pörtner, et al., 2019).

Erosion occurs when the movement of water removes the ground and carries it to another location. Water can erode coastlines, bluffs, cliffs above a waterway or body, along rivers and creeks, and anywhere the water movement can remove and transport loose material. The motion and force of sea waves along a coast can significantly alter the shore's shape (Editors of the Encyclopedia Britannica, 2020). Flooding can cause unexpected or increased erosion due to the force of the water's flow and water in unusual locations. Wind erosion is most common in deserts and arid lands where the wind picks up and moves loose ground material (Editors of the Encyclopedia Britannica, 2020).

7.1.1 Potential Damage from Floods, Sea Level Rise, and Cliff Erosion

Several factors influence the type and severity of damage from a flood, such as a floodwater's depth, length of time an area or a structure remains inundated, contents carried in the floodwater, and how rapidly the water moves (Federal Emergency Management Agency). Flood severity is discussed further in Section 7.2.5. Structures often suffer compounding damage the longer they are in the water; wood and carpet are especially susceptible. Structures in standing water can grow mold and fungi quickly and attract insects. These growths and insects can carry infectious diseases, which are covered more in Section 7.3.1. It can also be difficult to tell how deep the flood water is; cars can be submerged even by slow-moving water when it washes away the road or ground beneath, and a driver tried to continue through a flooded roadway.

On the other hand, rapidly moving water carries momentum and force that can damage structures, infrastructure, and injure or cause loss of life from the water impact or the debris carried in the water. Even six inches of fast-moving water can knock a person down, and a foot of water can move a car (Ready.gov, 2020). Erosion and flooding can impact waterways, causing higher than normal water levels for extended periods, harming people, structures, and infrastructure.

7.2 Orange County Transportation Authority Hazard Profile

Flooding, SLR, and cliff erosion can significantly impact OCTA's planning area, structures, and infrastructure. The map in Figures 7-2 displays areas exposed to 100-year and 500-year floods. The

primary source of riverine flooding in the planning area is the Santa Ana River and the extended network of channels and flood control systems associated with the river (Orange County Public Works).

To manage and mitigate all sources of flood risks in Orange County, the Public Works Department oversees 350 miles of flood control facilities designed to direct water flow from storm drains and runoff into the bay and ocean (Orange County Public Works). These systems include structures such as dams, levees, drains, and underground pipes.

Despite the mass amount of flood control systems, severe weather can overwhelm them, such as when flash floods damage the systems from the force of the water or debris impact. When water management systems overflow or collapse, they can inundate areas around the systems. Orange County Public Works warns that the East Garden Grove-Wintersburg Channel and Ocean View Channel cannot contain a 100-year flood as water has overtopped several spots already (Orange County Public Works). Areas near Santiago Creek and Collins Channel and unincorporated Orange County sections are also prone to flooding (Orange County Public Works).

Coastal flooding can occur when severe weather causes high waves or storm surges and sea level rise increases,leading to increased cliff erosion. Therefore, almost all OCTA's coastline rail system is subject to storm surges, coastal flooding, cliff erosion, and sea level rise. Figures 7-3 show the planning area coastline at risk from 100-year storm surges, and Figure 7-4 estimates sea level rise at 1, 2, and 3 feet.

7.2.1 Hazard Ranking

The Planning Team completed a hazard ranking survey during the OCTA 2022 HMP development process and assessed hazard-related factors based on worst case and most likely scenarios. Hazard definitions and ranking factors are in Appendix G, Table G-1. Survey results were prioritized and ranked based on their averaged score. The variables of severity, magnitude, frequency, onset, and duration are scored one to five, where one is the lowest and five is the highest. Compared to the other hazards in the survey, floods are the fifth worst-case and most likely scenario.

Table 7-1 – OCTA Flood, Sea Level Rise, and Erosion Hazard Ranking

Severity	Magnitude	Frequency	Onset	Duration	Average	Rank
Worst-Case Scenario						
2.85	2.97	3.18	2.61	3.18	2.96	5
Most Likely Scenario						
2.64	2.48	3.00	2.39	3.24	2.75	5

7.2.2 Past Events

Since 1969, there have been 15 flood events that have resulted in FEMA disaster declarations in the planning area (Federal Emergency Management Agency, 2020). Between 1956 and 2020, NOAA recorded 23 flash floods in the planning area, resulting in nine deaths and four injuries. A comprehensive list of disaster declarations is in Appendix G, Table G-4. NOAA records that resulted in an injury, death, or cost equal to or above $25,000 in property damage for both counties are in Table G-5 (National Oceanic and Atmospheric Administration). A few of the most consequential flood events recorded by NOAA or resulting in a disaster declaration since 2000 are in Table 7-2 below.

Table 7-2 – Significant Flood Events in the Planning Area (National Oceanic and Atmospheric Administration) (Federal Emergency Management Agency, 2020)

Date	Severe Weather Type	Deaths/ Injuries	Property Damage	FEMA Declaration
2/10/2000	Heavy Rain	1 death 4 injuries	$300,000	
1/11/2001	Flash Flood	0	$1,000,000	
1/7/2005	Heavy Rain	0	$5,000,000	
1/7/2005	Heavy Rain	0	$15,000,000	
2/18/2005	Heavy Rain	0	$20,000,000	
2/20/2005	Flash Flood	0	$1,000,000	
4/14/2005	Severe storms, flooding, landslides, debris/ mudflows			DR-1585-CA
12/15/2008	Heavy Rain	14 injuries	$250,000	
3/8/2010	Severe winter storms, flooding, debris/mudflows			DR-1884-CA
12/19/2010	Flood	0	$36,000,000	
12/22/2010	Flash Flood	0	$12,300,000	
1/26/2011	Winter storms, flooding, debris/mudflows			DR-1952-CA
3/16/2017	Severe winter storms, flooding, mudslides			DR-4305-CA
1/2/2018	Wildfires, flooding, debris/mudflows			DR-4353-CA

7.2.3 Location

Figures 7-2 to 7-4 are maps of the OCTA planning area exposed to a 100-year and 500-year flood, a 100-year storm surge, and SLR inundation from a 1, 2, and 3-foot increase. The planning area's entire coastline is at risk from coastal flooding, SLR, and cliff erosion. OCTA's critical facilities, structures, parcels, and infrastructure prone to these hazards are in Tables 7-7 through 7-13. Additionally, OCTA identified specific sections of rail exposed to these risks, including:

- Segments of rail in Mission Viejo near where the rail is in the trench
- Downstream of Oso Creek, where it flows into a channel – vertical banks on the west side have experienced erosion, although not infringing on the rail line
- The approximately seven-mile coastal rail section

7.2.4 Frequency

The OCTA planning area is susceptible to seasonal rainfalls and unpredictable severe weather events leading to flooding. Between 1969 and 2010, 17 disaster declarations were for flood events in the planning area (Federal Emergency Management Agency, 2020). The average number of disasters declared flooding events in OCTA's planning area is approximately 2.6 per year. However, FEMA's list in Table G-4 does not indicate flood declarations are happening more frequently (Federal Emergency Management Agency, 2020).

NOAA recorded seven flooding events and 24 flash floods that caused a person's injury or death or cost $25,000 or more in property damage (National Oceanic and Atmospheric Administration). Six of the NOAA

flood records happen in the last 20 years, and only one occurred in the 44 years prior (National Oceanic and Atmospheric Administration). Many factors could have influenced this significant increase in significant flood events from 2000, such as climate change, growing populations in flood zones, or more structures built in flood zones after 2000.

The NOAA flood reports indicate that flood frequency has increased over time, even though they have not increased disaster declarations. NOAA first recorded flash flood events in 1997; since then, flash floods in OCTA's planning area have occurred on average once every six months (National Oceanic and Atmospheric Administration). Increased populations and new infrastructure and structures that altered water's natural flow could attribute to this rise in records. Development trends are discussed more in Section 7.6.

So far, NOAA only reported one significant coastal flood event in 2005 and two storm surges in 1997 and 2001 (National Oceanic and Atmospheric Administration). SLR predictions for the planning area are in Figure 7-4. Twenty-five years of data from European and National Aeronautics and Space Administration (NASA) satellites revealed that SLR is accelerating faster than expected (Weeman & Lynch, 2018). Currently, NASA estimates SLR could double what it would be if the levels were rising at a constant rate (Weeman & Lynch, 2018).

NOAA's list includes numerous instances of high surf, which can increase coastline flooding and shoreline erosion. OCTA's coastline is likely to be increasingly affected by SLR and erosion as it continues to accumulate, causing more coastal flooding, high surf, and storm surges. Based on National Aeronautical and Space Administration (NASA) data, climate change significantly accelerated SLR's natural increased rate, which will lead to more frequent and severe SLR events, coastal flooding, and coastline erosion in OCTA's planning area. The effects of climate change, detailed in Section 7.4.

7.2.5 Severity

The severity of a flood is dependent on the amount, velocity, and area covered. One of the most significant flood threats in Orange County is from the Santa Ana River and the extensive network of the river's connecting flood management systems (Orange County Public Works). FEMA states that rivers are the most common source and often costliest type of flooding (Federal Emergency Management Agency). The Santa Ana River extends from the San Bernardino Mountains out to the Pacific Coast through Orange County. Heavy rains can build up vast amounts of water in the mountains and pick up incredible velocity down the steep mountainside (Federal Emergency Management Agency). This rapid influx of water can result in dangerous flash floods and debris/mudflows. As indicated in Section 7.2, although extensive flood control measures are in place, areas connected to the Santa Ana River are also at risk from flooding.

7.2.6 Warning Time

Flooding events can occur quickly or over days to weeks. The cause of the flood typically dictates the length of warning time. For example, there is minimal warning time for flash floods, but slow-moving rainstorms can build up surface water over days and weeks, eventually resulting in flooding (Ready.gov, 2020). Alternatively, SLR and cliff erosion take years to accumulate significant impacts.

The Orange County Public Works department maintains and monitors an advanced flood warning system called ALERT (Automated Local Evaluation in Real-Time), a rainfall and water level sensor network that enables real-time storm tracking.

The ALERT system details (Orange County Public Works):

- **Applies** – 130 sensors in more than 80 locations
- **Measures** – precipitation, the water level in regional flood control channels, temperature, barometric pressure, wind velocity and direction, relative humidity, and snow
- **Updates** – information is sent out every eight minutes during storm events and strategically deploys resources to critical locations

For the planning area, the NWS San Diego Office assesses potential weather and flood event factors to determine when to send emergency notifications and what level of warning to set. The NWS San Diego Office lists ten types of warnings and information text notifications they can issue (National Weather Service San Diego, 2020):

- **Flash Flood Warning** – there is an immediate risk to life and property from rapidly moving floodwater
- **Flash Flood Statement** – additional information to the flash flood warning
- **Flood Warning** – sent when floodwaters will affect life and property
- **Flood Statement** – additional information on flooding streams and rivers, risks to urban areas, and updates or cancelation of the flood warning
- **Flood Watch** – when there is a potential for flooding
- **Hydrologic Outlook** – long-range predictions and information on the current conditions
- **River and Lake Summary** – daily observations and predictions for river and lake conditions
- **Hydrologic Summary –** daily observed conditions
- **Hydrologic Statement** – additional forecasts and information
- **Drought Information Statement** – drought information

There are no emergency alert notifications for SLR or cliff erosion. However, OCTA is in the process of developing a rail infrastructure study Defense Against Climate Change Plan that considers OCTA's planning area exposure to flood, SLR, and erosion to mitigate these hazards before becoming an emergency. The planning area counties also have risk assessments and adaptation strategies for flood, SLR, and erosion (County of Orange and Orange County Fire Authority, 2015) (Hazen, 2019).

7.3 Secondary Hazards and Cascading Impacts

7.3.1 Secondary Hazards

Flooding, SLR, and cliff erosion can cause secondary hazards. Slopes destabilized by water inundation can erode and result in mass earth movements (e.g., landslides, mudslides, and debris flow), particularly on steep slopes and in areas with less vegetation after a wildfire. Mass earth movements are discussed further in Section 8 of this plan. Structures exposed to water for a length of time can be prone to growing mold, fungi, and attract insect populations. An outbreak or epidemic can occur due to infectious disease-carrying agents in contaminated water or food, increased insect populations that breed in waterways like creeks and ponds, and mold growing in damp structures. Epidemics and Pandemics are in Section 6.

7.3.2 Cascading Impacts

Flooding can damage infrastructure, resulting in communications, transportation, and utility disruptions. OCTA's structures, land parcels, and infrastructure exposed to 100-year and 500-year floods, 100-year storm surges, and 1, 2, and 3 feet of SLR are in Tables 7-7 to 7-13. These disruptions can directly damage OCTA's structures and infrastructure, challenging operations. Disruptions can also indirectly impact operations through downed communications and services, structures, or infrastructure that OCTA relies

on for continuity. SLR and erosion are slower moving hazards yet can result in infrastructure disruptions. OCTA conducts a rail infrastructure defense against climate change plan to understand better where and how these hazards can impact the planning area. According to the plan, the approximately seven-mile rail segment along the coast is at the highest risk from SLR and cliff erosion.

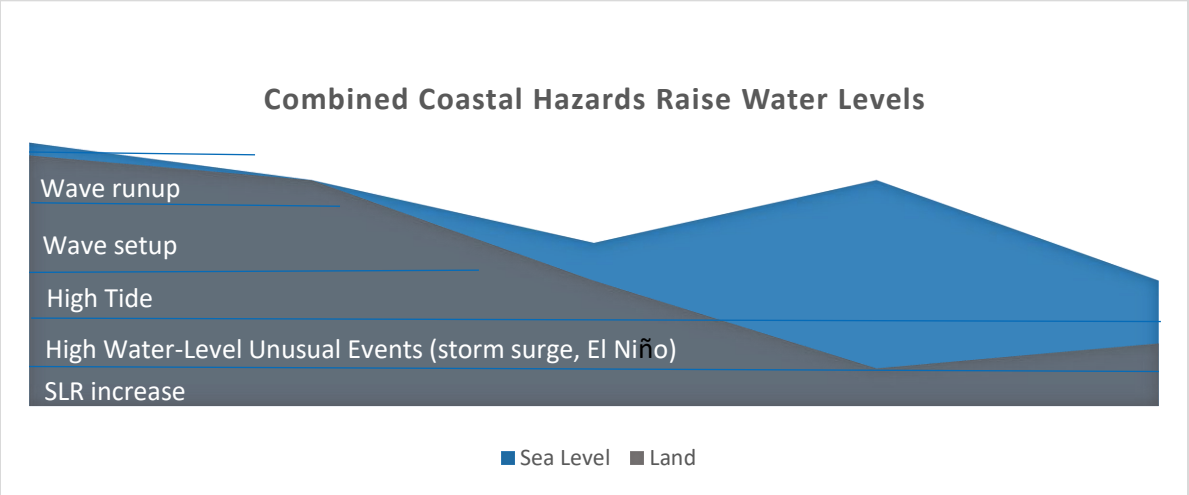
7.4 Potential Impacts from Future Climate Conditions

Climate change's influence will likely increase OCTA's planning area's flood risks, including storm intensity and frequency that will expand flooding areas and depths (Hazen, 2019). More frequent and severe storms will also increase the risk of river flooding and associated secondary hazards in the planning area. Additionally, climate change affected storms and SLR interconnect to increase coastal risks from flooding and erosion. The 2018 California Fourth Climate Change Assessment report stated that out of the five coastal counties in Southern California, the three counties that overlap the OCTA planning area are the most vulnerable to climate change impacts on the coast (Erikson, et al., 2018). These effects include coastal flooding, SLR, and severe coastal weather that can increase storm surges and erosion.

NASA's 2018 research study conservatively predicts that by 2100, sea levels will increase by 26 inches due to climate change (Weeman & Lynch, 2018). On the other hand, SLR predictions vary even between government agencies depending on the climate modeling technology and data sets they use. Although the exact amount of SLR by year is impossible to predict, even a one-foot increase by 2100 will impact OCTA's planning area, as shown in Figure 7-4. A two to three-foot increase is more significant.

Any SLR caused by climate change will permanently expand coastal lines and flooding boundaries, and further erode land along the coast. OCTA's rail infrastructure defense against climate change plan assesses the potential impacts to the planning area coastline. The Rail Infrastructure Defense Against Climate Change Study (completed January 2021) emphasizes the risk of combined coastal hazards influenced by climate change. For example, the Pacific Ocean can produce significantly high waves during storms; in conjunction with SLR and/or heavy precipitation, storms can easily lead to 100-year storm surge inundation levels. An example of combined water-level events is in Figure 7-1 below.

Figure 7-1 – Example of Water-Levels with Combined Coastal Hazards



7.5 Exposure

7.5.1 Population

Intersecting OCTA bus stop ridership and US Census planning area data with geospatial hazard data for flooding (100- and 500-year flood events) and SLR (1, 2, and 3 feet) indicate population exposure to each hazard type and socially vulnerable subgroups. Table 7-3 shows that up to nearly 1.8 million boardings could be impacted by 100-year flood events and more than 16 million for a 500-year flood event.

Table 7-3 – Bus Stop Ridership Exposed to 100 and 500-Year Flood Zones

Ridership	100-Year Flood Zone	500-Year Flood Zone
Total	1,797,145	16,422,896

Table 7-4 – Populations at Risk to 100 and 500-Year Flood Zones

Population	100-Year	500-Year
Black	2,649	27,258
American Eskimo	1,089	8,522
Asian	42,168	261,822
Hawaiian/Pacific Islander	728	5,379
Hispanic	60,025	484,041
Multiple Races	7,694	48,113
Children up to 19 Years Old	49,310	325,854
65 Years and Older	24,265	126,092
Below the Poverty Level	25,967	184,110

Table 7-5 projects that nearly 9,000 OCTA bus stop boardings may be impacted by one foot of SLR, while nearly ten times that amount may be impacted by three feet of SLR. There are nearly 1.7 million minority and mixed-race individuals at risk at one-foot SLR, approximately 757 thousand individuals aged 19 and below, over 332 thousand seniors, and over 375 thousand low-income households. As sea level rises to above two and three feet, these population numbers also increase.

Table 7-5 – Bus Stop Ridership Exposed to Sea Level Rise at 1, 2, and 3 Feet

Ridership	1 Foot SLR	2 Feet SLR	3 Feet SLR
Total	8,808	25,029	82,835

Table 7-6 – Populations Totals Vulnerable to Sea Level Rise at 1, 2, and 3 Feet

Population Type	Above 1 Foot SLR	Above 2 Feet SLR	Above 3 Feet SLR
Black	620	1,356	2,651
American Eskimo	400	618	1,072
Asian	6,000	15,894	24,957
Hawaiian/Pacific Islander	124	191	398
Hispanic	19,877	34,638	59,981

Population Type	Above 1 Foot SLR	Above 2 Feet SLR	Above 3 Feet SLR
Multiple Races	2,171	4,460	7,926
Age 0-19	15,140	29,115	49,580
Age 65 and Over	5,720	11,063	22,622
Below the Poverty Level	8,750	15,438	25,091

7.5.2 Property

GIS analysis indicates five OCTA structures are in the 100-year floodplain, and 14 structures are in the 500-year floodplain, shown in Tables 7-7 and 7-8. Table 7-9 shows OCTA's land-use parcels and acreage within 100-year and 500-year floodplains, while tables 7-10 and 7-11 indicate types and counts of infrastructure in those floodplains. Facilities exposed to sea level rise from 1 ft, 2 ft, and 3 ft increase are shown in tables 7-12 and 7-13.

National Flood Insurance Program

Special districts, like OCTA, are not eligible to participate in the National Flood Insurance Program.

Table 7-7 – OCTA Buildings Exposed to 100-Year Floodplain

Building Type	Number of Buildings	Building Value	Contents Value
Fullerton Park and Ride	3	$4,236	$43
Brea Park and Ride	1	$996	$8
Garden Grove Transit Base	1	$25,819	$88,226
Total	**5**	**$31,051.00**	**$88,277.00**

Table 7-8 – OCTA Buildings Exposed to 500-Year Floodplain

Building Type	Number of Buildings	Building Value	Contents Value
Fullerton Park and Ride	3	$4,236	$43
Brea Park and Ride	1	$996	$8
Garden Grove Transit Base	3	$77,701	$178,988
Anaheim Transit Base	7	$30,633	$61,116
Total	**14**	**$113,566**	**$240,155**

Table 7-9 – OCTA Ownership of Environmental Parcels in 100-Year Floodplain

Parcel Type	Acres
Eagle Ridge (proximal to City of Brea)	1.77
Trabuco Rose (proximal to Trabuco Canyon)	5.52
Wren's View (proximal to Trabuco Canyon)	0.27
Total	**7.55**

Table 7-10 – OCTA Ownership of Environmental Parcels in 500-Year Floodplain

Parcel Type	Acres
Eagle Ridge (proximal to City of Brea)	3.47
Pacific Horizon (proximal to Laguna Beach)	0.06
Trabuco Rose (proximal to Trabuco Canyon)	5.52
Wren's View (proximal to Trabuco Canyon)	0.27
Total	**9.31**

Table 7-11 – OCTA Infrastructure and Related Operations in 100-Year Floodplain

Type	Miles
Bus Route	62.24
I-405 Freeway	4.011
SR-91 Freeway	0.815
Other Freeway	18.176
Metrolink Rail	4.36
Pacific Electric ROW	1.48
Streetcar Route	0.47
Total	**91.552**

Table 7-12 – OCTA Infrastructure and Related Operations in 500-Year Floodplain

Type	Miles
Bus Route	435.88
I-405 Freeway	24.058
SR-91 Freeway	35.600
Other Freeway	121.220
Metrolink Rail	26.33
Pacific Electric ROW	9.69
Streetcar Route	1.72
Total	**654.498**

Table 7-13 – OCTA Infrastructure/Operations Vulnerable to a 1-3 Foot Sea Level Rise in Miles

Type	1 Foot SLR	2 Foot SLR	3 Foot SLR
Bus Route	1.55	4.32	10.99
Other Freeway	0.12	0.14	0.22
Total	**1.67**	**4.46**	**11.21**

7.5.2.1 Vulnerability

A GIS analysis estimated which structures would be affected by flooding, looking at flooding depth and the type of structure. The analysis is summarized in Tables 7-7 and 7-8 for the 100-year and 500-year flood events, respectively.

7.5.3 Critical Facilities

There are no critical facilities or infrastructures in the 100-year floodplain, however there is one critical facility in the 500-year floodplain shown in Table 7-14.

Table 7-14 – OCTA Critical Facilities Within OCTA's 500-Year Floodplain

Critical Facility Type	Number
Transportation Security Operations Center	1
Total	**1**

7.5.3.1 Vulnerability

A GIS analysis estimated the flood loss potential to critical facilities exposed to the flood risk. The facilities exposed are in Section 7.5.3 above, and the resulting map in Figure 7-2.

7.5.4 Environment

Environmental changes can be natural or human-made and can shift the frequency, location, and severity of flooding, sea level rise, and cliff erosion. Environmental influences on these hazards can affect the OCTA planning area in the short and long term, especially structures and infrastructure in the hazards' immediate area. An impaired or modified environment, including land development, can flood new or less common areas, increase coastal and bank erosion, and cause more severe flooding (City of Newport Beach, 2014). Flood control systems can increase stream bank erosion, causing rivers and streams to migrate and permanently change flood patterns.

7.6 Development Trends

As discussed in this section, multiple factors have also increased flooding, sea level rise, cliff erosion frequency and severity, and expanded flood zone boundaries in OCTA's planning area. The US Census Bureau predicts that Orange County's population will increase by 5.5 percent between 2010 and 2019 (United States Census Bureau, 2019). Therefore, regularly updated risk maps must inform development in an exposed area, particularly as climate change reshapes flood zones and coastlines (Federal Emergency Management Agency). OCTA will minimize flooding, sea level rise, and erosion risks to future projects in the planning area by following government regulations and incorporating mitigation measures into new and renovated developments.

OCTA's Long-Range Transportation Plan lists sea level rise, and associated cliff erosion is a significant hazard for transportation infrastructure. Structures and transportation infrastructure, designed to last for decades, make it vital to consider the long-term impacts of sea level rise and erosion, especially on the Pacific Coast Highway and rail sections along the coast (Orange County Transportation Authority, 2018). This HMP identifies and evaluates sea level rise and erosion risk methods to inform updates to other OCTA plans.OCTA will incorporate development and repair project mitigation strategies across organizational plans to avoid and minimize hazards where possible.

State and county land-use requirements guide OCTA's development projects in areas exposed to flooding. California Legislature Section 65302 of the Government Code states that general plans must include land-use elements that identify and annually review planning areas vulnerable to flooding, using FEMA's and/or the Department of Water Resources floodplain mapping (California Legislative Information, 2018). In the Orange County Code of Ordinances, Section 7-9-42: FP (Floodplain) Overlay District provides land-use regulations and maps to prevent and reduce the effects of flooding in known hazardous areas (Orange County, 2020).

Another development factor to consider, urban expansion in flood-prone areas increases the impervious surface area preventing water from being absorbed by the ground; this increases the likelihood of flood events and expands flood zones (Konrad, 2016). This condition is exacerbated by peak rain events when the ground around the impervious surfaces is quickly saturated, increasing the storm-runoff rate (Konrad, 2016).

7.7 Issues

Flood, sea level rise, and cliff erosion considerations in the OCTA planning area:

- Flood control systems will not prevent all flooding in the planning area.
- Continue climate change studies to understand future flood risks, especially new data and improved technology, to provide more accurate predictions.
- Educate customers on flood preparedness and transportation resources available during and after floods.
- Flood, sea level rise, and cliff erosion hazards overlap other hazards, such as mass earth movements, epidemics/pandemics, and severe weather. There is an opportunity to implement mitigation strategies that can reduce risks from multiple hazards.

7.8 Hazard Maps

The hazard maps for flood, storm surges, and sea level rise are in Figures 7-2 to 7-4, starting on the next page.

Figure 7-2 – OCTA Flood Zone Hazard Map

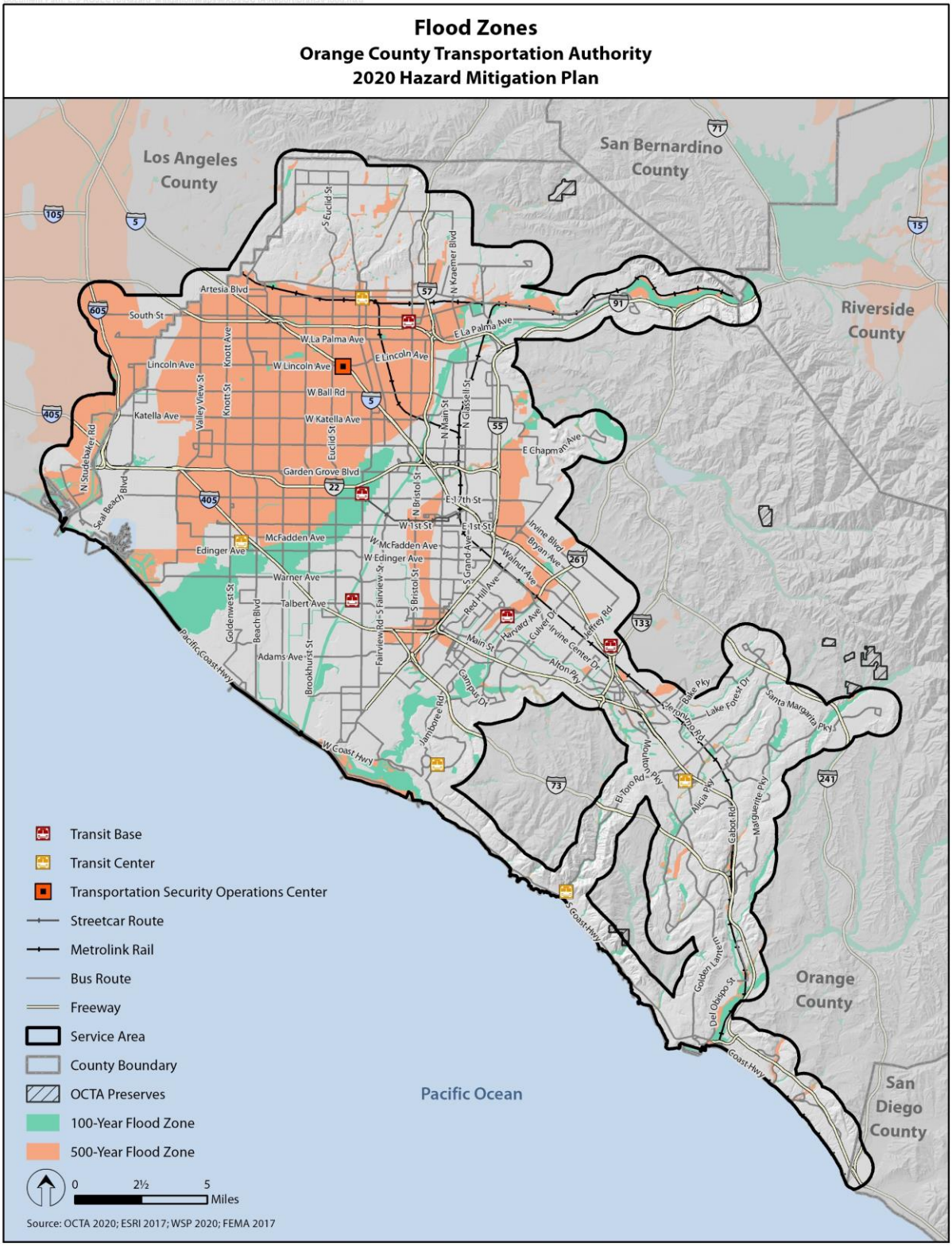


Figure 7-3 – OCTA 100-Year Storm Surge Hazard Map

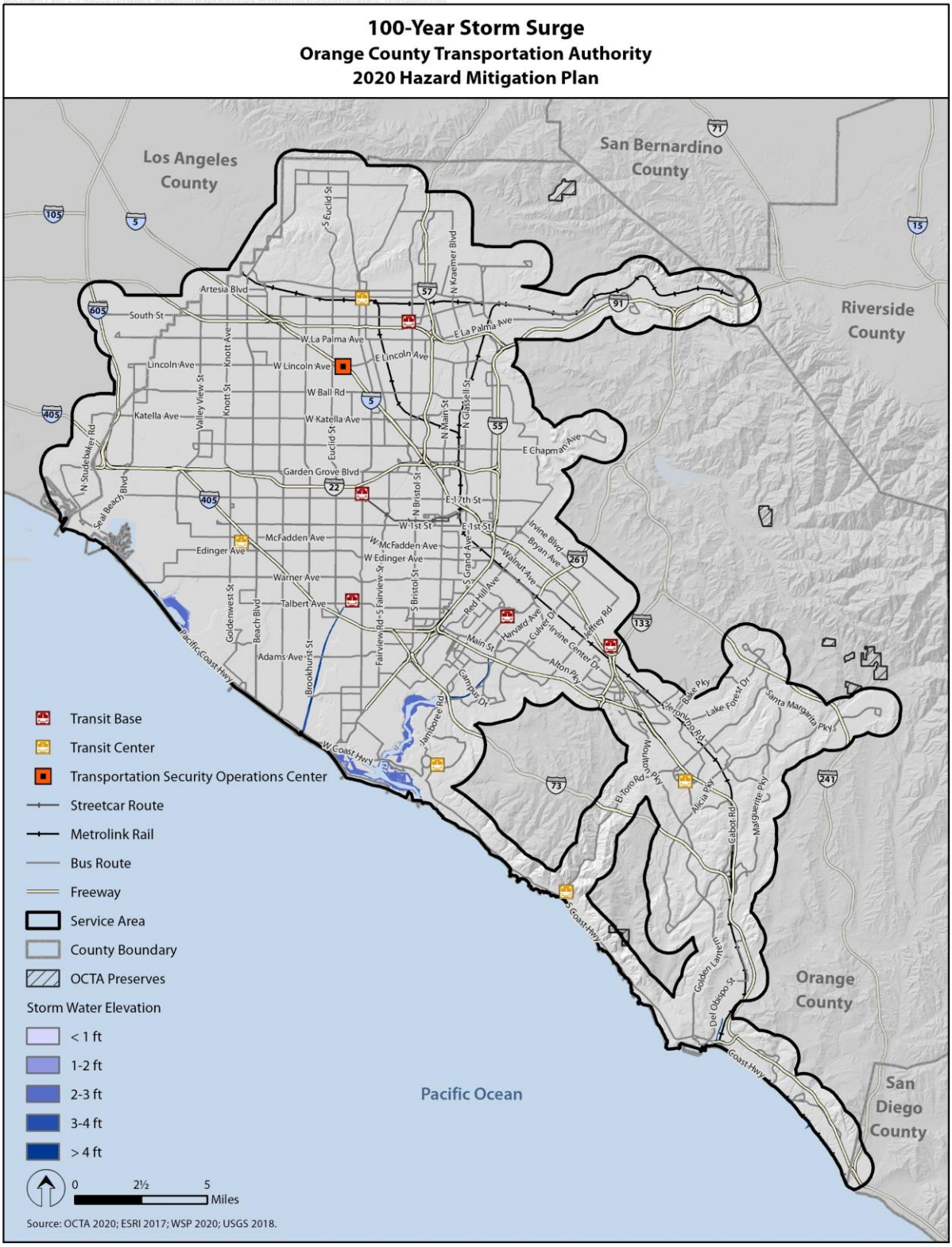
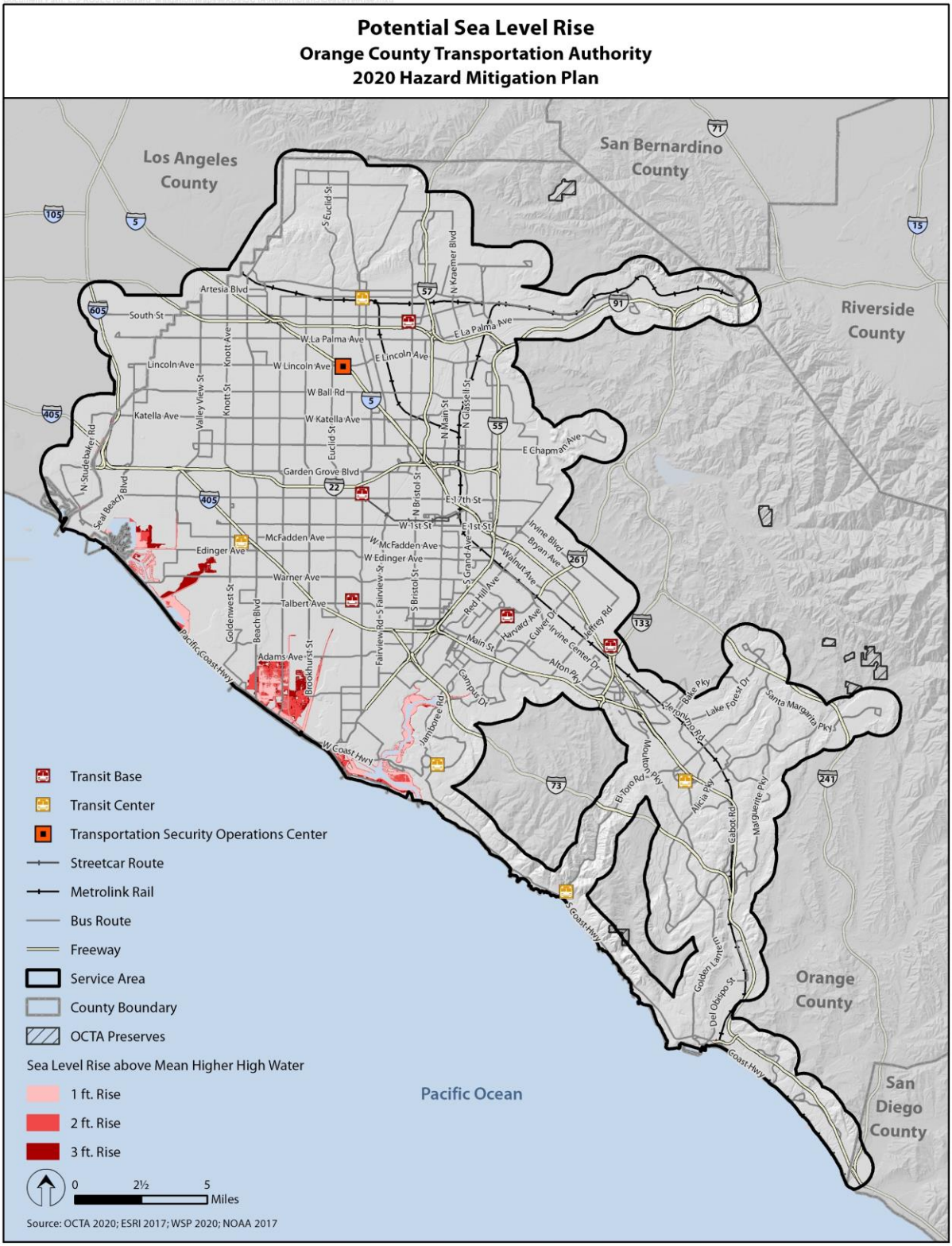


Figure 7-4 – OCTA Potential Sea Level Rise Hazard Map



8 Mass Earth Movements

8.1 General Background

A mass earth movement is defined as a landslide, mudslide, rockfall, sinkhole, or debris flow, and generally occurs for two reasons (United States Geological Survey):

- When up-slope ground material does not have the strength to overcome the downslope gravity pull
- When a force acts on the material (e.g., water, avalanche, earthquake), causing it to detach from the slope and move downhill

Several other hazards can trigger mass earth movements, such as severe weather, SLR, flooding, earthquakes, tsunamis, and wildfires (Editors of Encyclopedia Britannica, 2015). Natural changes to the environment can destabilize slopes and influence mass earth movements, such as surface water levels, stream erosion, groundwater movement, or any combination of these factors (United States Geological Survey). Humans can also generate mass earth movements by modifying the environment by removing vegetation and trees, destabilizing them.

There are three types of geologic materials, bedrock, debris and earth, and five forms of slope movements; examples of these forms are in Figure 8-1 (United States Geological Survey, 2004):

- **Flow** – Includes debris flows, debris avalanches, earth flows, mudflows, and creeps
- **Topples** – Characterized by a rotation of the materials around a pivot point as they move downward
- **Slides** – Refers to an area of weakness where the unstable layer separates from the stable underlying layer
- **Spreads** – Unique because the material moves laterally on gentle slopes or flat ground, caused by liquefaction
- **Fall** – An abrupt down-slope movement of large materials (e.g., rocks and boulders) off steep slopes or cliffs

DEFINITIONS

Debris Flow – A form of rapid mass movement in which loose soil, rock and sometimes organic matter combine with water to form a slurry that flows downslope.

Landslide – A large amount of rock, debris, or earth that travels down a slope.

Mass Movement – A collective term for landslides, debris flows, falls and sinkholes.

Mudslide (or Mudflow) – A river of rock, earth, organic matter, and other materials saturated with water.

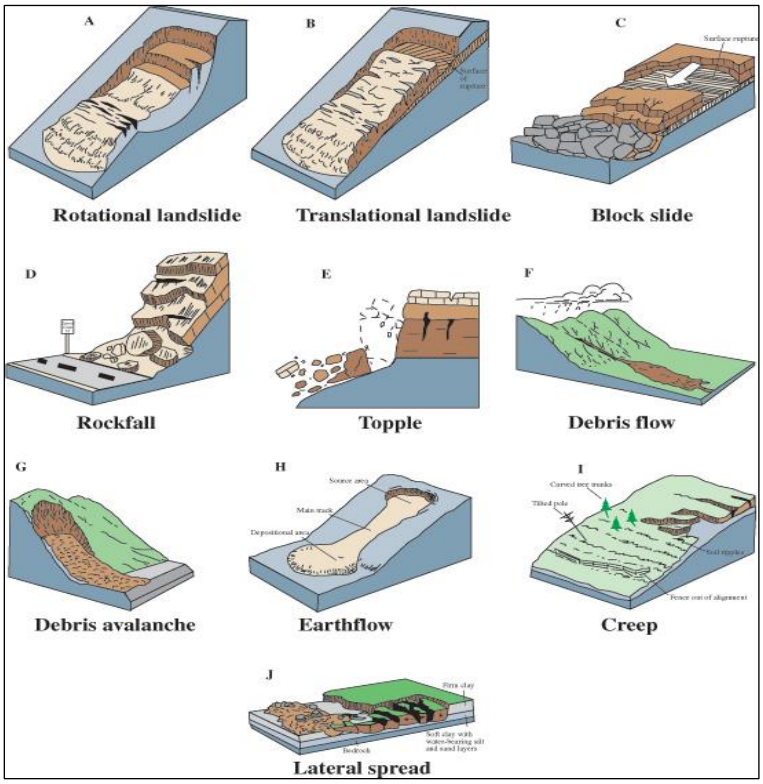
Sinkhole – A collapse depression in the ground with no visible outlet. Its drainage is subterranean. It is commonly vertical-sided or funnel-shaped.

Slope Failures – Occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.

8.1.1 Potential Damage from Mass Earth Movement

Mass earth movements can damage or destroy infrastructure, structures and cause human injury or loss of life. Mass movements that occur quickly and without warning are the most dangerous and deadly, as people do not have time to react or evacuate the hazard area (Ready.gov, 2020). They can travel several miles from the point of origin and grow as debris is collected and added to the mass movement (Ready.gov, 2020). Displaced ground material can dam waterways, such as rivers, and result in flooding. Blocked or broken roads will delay emergency responders and critical supply shipments. An event can occur with little to no warning, increasing the likelihood of damage from such an event.

Figure 8-1 – Diagrams of Mass Movement Forms (US Geological Survey Department of the Interior/USGS)



8.2 Orange County Transportation Authority Hazard Profile

OCTA's planning area is exposed to all types of mass earth movements (County of Orange and Orange County Fire Authority, 2015). Mapped landslide areas are in Figure 8-3. Deep-seated landslide susceptibility in the planning area is in Figure 8-4. Deep-seated slides are often more than ten to 15 feet deep and are instigated by deep infiltration of rainfall over weeks or months (United States Geological Survey). Planning areas at risk of soil erosion after a wildfire, shown on the map in Figure 8-5.

Orange County's emergency preparedness program ranks landslides as one of the County's top five hazards, stating the hazard frequently occurs in the area (Ready OC). The Orange County 2015 HMP emphasizes the serious role humans can play in escalating landslide risks through development (County of Orange and Orange County Fire Authority, 2015). In 2019, the California Department of Conservation conducted a landslide hazard mapping study by county and identified the following highway routes in Orange County are exposed – Routes 73, 241, and 246 (Wills, et al., 2019).

A mass movement on these highway routes could impact OCTA customers, staff, structures, and infrastructure or cause potential delays to services and supplies required for business operations. Common causes of movements that can impact the area include heavy or extended rain periods, slopes destabilized due to wildfire, and coastal slopes and cliffs affected by sea waves and erosion (United States Geological Survey). A landslide may take the form of a slide, fall, flow, or a combination of the three.

8.2.1 Hazard Ranking

The Planning Team completed a hazard ranking survey during the OCTA 2022 HMP development process and assessed hazard-related factors based on worst case and most likely scenarios. Hazard definitions and ranking factors are in Appendix G, Table G-1. Survey results were prioritized and ranked based on their averaged score. The variables of severity, magnitude, frequency, onset, and duration are scored one to five, where one is the lowest and five is the highest. Compared to the other hazards in the survey, mass earth movements were the seventh worst-case scenario and sixth most likely scenario.

Table 8-1 – OCTA Mass Earth Movement Hazard Ranking

Severity	Magnitude	Frequency	Onset	Duration	Average	Rank
Worst-Case Scenario						
2.55	2.45	1.91	3.73	1.82	2.49	7
Most Likely Scenario						
2.18	2.09	1.64	3.36	1.73	2.20	6

8.2.2 Past Events

In the planning area from 1969 to 2020, 15 FEMA disaster declarations involved mass earth movements (Federal Emergency Management Agency, 2020). Disaster declarations are in Appendix G, Table G-4. Table 8-2 shows some of the significant past landslides and their effects on the planning area.

Table 8-2 – Historic Planning Area Landslides (City of Newport Beach, 2014)

Year(s)	Event Name	Total Cost	Damage
1969	Glendora	$26.9 million	175 homes damaged
1977-1980	Monterey Park and Repetto Hills	$14.6 million	100 homes damaged
1979	Big Rock	$1.08 billion	Damage to Highway 1
1980	-	$1.1 billion	
1978-1980	120 slides reported	9 slides cost over $1 million	-
1983	San Clemente	$65 million	Damage to Highway 1
1983	Big Rock Mesa	$706 million	13 condemned houses, 300 houses threatened
2005	Blue Bird Canyon	Billions of dollars, a total number not available	17 homes destroyed, 11 homes damaged, 23 homes threatened

8.2.3 Location

OCTA's critical facilities, structures, parcels, and infrastructure prone to these hazards are in Tables 8-8 through 8-15. It is not always possible to remove the physical geology and natural hazards that instigate mass earth movements. However, quality research studies, effective engineering practices, and robust land-use and management regulations can minimize life, infrastructure, and property risks (United States Geological Survey).

8.2.4 Frequency

In the planning area there were 15 mass earth movement disaster declarations through FEMA over the last 30 years; approximately one event every two years. Natural hazards, such as earthquakes, heavy rain, floods, and vegetation loss after a recent wildfire often trigger these events. In general, the frequency of mass earth movement is related to the frequency of these other hazards, which may occur at any time of year.

8.2.5 Severity

Mass earth movements with little or no warning tend to be the most destructive, as it may not be possible to evacuate the area or brace for impact. Other factors contributing to the severity of mass earth movement events include a slope's steepness, which impacts the rate of travel, the amount and size of debris transported, and the development density of the area affected (Ready.gov, 2020). Debris flows are usually the most dangerous mass earth movement as they often start rapidly and may carry large objects like boulders, vehicles, homes, and trees (United States Geological Survey).

8.2.6 Warning Time

The warning time associated with mass earth movements depends on the rate of travel. As noted in the severity section above, the most dangerous movements have a rapid onset since there is little or no warning time. Heavy rains and recent wildfires that make slopes more prone to movement are strong indicators of a possible movement. Movements with the longest warning time happen over an extended period, such as creeps that can move in inches per year.

The San Diego NWS Office and the Operational Area EOC monitor mass earth movement conditions and send out watches, warnings, and evacuation notifications through the EAS when there is an immediate risk (Ready.gov, 2020). Upon receiving these notifications, OCTA strategies will range from evaluating the potential impact on OCTA operations and notifying relevant departments to mobilize assets to support evacuating communities if requested. Additionally, the Orange County Public Works Department provides information on mudflow predictions and protection, burned area reports, and burned area maps with recent fire damage to warn residents of potential mass earth movements after wildfires (Orange County Public Works). When received, this information can be used to adjust operations to protect OCTA assets proactively.

8.3 Secondary Hazards and Cascading Impacts

8.3.1 Secondary Hazards

Following a mass earth movement, the most common secondary hazard is flooding from fallen materials blocking waterways such as rivers (United States Geological Survey). Risks from flooding in OCTA's planning area, covered in Section 7, including the Santa Ana River and various water channels, which mass earth movements can block. Mass earth movement materials that get into drinking water supplies can reduce water quality.

8.3.2 Cascading Impacts

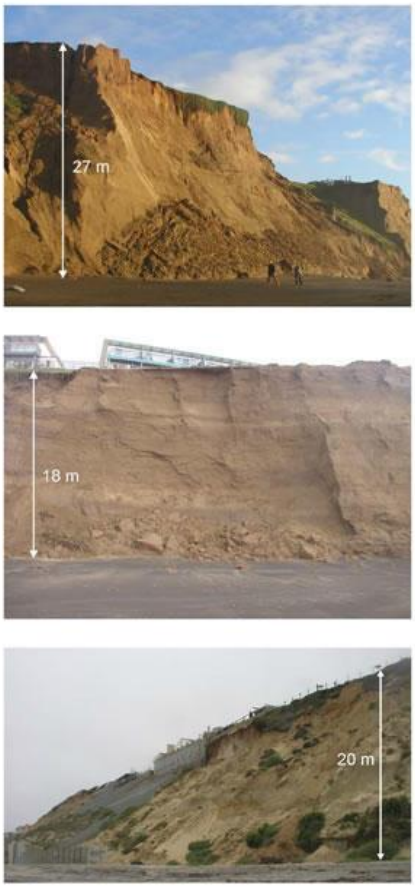
Mass earth movements can damage or destroy roads and other transportation infrastructure, utilities, and structures and cause injury or death. Blocked roads can disrupt OCTA's services and delay supplies or other business' services needed for operations. Utility damage or destruction can result in power and communication loss. Energized downed powerlines and broken gas lines can start fires and lead to injuries or death. Mass earth movements can carry large debris, even vehicles and buildings, which means

hazardous material inside, potentially releasing them into the environment. There is also a risk of destabilizing structural foundations, making it essential to have a qualified person inspect affected buildings before reentering (Ready.gov, 2020).

8.4 Potential Impacts from Future Climate Conditions

Climate change could cause more mass earth movements due to increased frequency and severity of storms, SLR, erosion, and wildfires, all of which raise the likelihood of mass earth movements (United States Geological Survey). Along the coastline, storms, SLR, and erosion can combine to put coastal cliffs at high risk for landslides. Unlike erosion, which happens slowly over time, these cliff mass movements can happen suddenly, releasing large amounts of ground material at once. Example images of three coastal landslides in southern California are in Figure 8-2.

Figure 8-2 – Coastal Cliff Landslides in Southern California (Collins, 2014)



Droughts may increase in occurrence and duration, increasing the chances for wildland fires, affecting vegetation that helps support steep slopes. Increased frequency and intensity of severe weather can inundate areas with more water than is typical, adding to the risk of slides from water-saturated soils. These factors are projected to increase the probability of a mass earth movement within the OCTA planning area (County of Orange and Orange County Fire Authority, 2015).

8.5 Exposure

8.5.1 Population

Intersecting OCTA bus stop ridership and US Census planning area data with geospatial hazard data for deep-seated landslides and post-fire soil erosion shows population exposure to each hazard type. Post-fire soil erosion classifications delineate the level of risk for a post-fire debris flow, ranked from class one to three. Populations at risk from post-fire landslide susceptibility with soil class one to three (one is the lower risk and three is the highest), in Table 8-6; ridership exposed to post-fire landslides are in Table 8-3.

The soil class map data comes from CalFIRE. Their soil analysis represents soil loss averaged over time in the total area using the Revised Universal Soil Loss Equation best estimate in a post-wildfire environment. There are nearly 600,000 individuals at risk from class one post-fire soil erosion and over 45,000 in a class three soil area. 2019 ridership in all three classes of post-fire land susceptibility areas was over 41,000 boardings combined.

Mapped landslide exposure is in areas that have known and mapped landslide features. Mapped landslides in the planning area are in Figure 8-3. These features include deposits, sources, and other mapped signs of landslide risk. Deposits indicate where previous slides left debris at the end of the flow. Landslide sources and other signs are data layers that show where previous landslides came from or started (United States Geological Survey). There were approximately 8.5 thousand boardings in 2019 in areas with mapped landslide features.

Susceptibility to deep-seated landslides was also measured. The levels range from one to ten, where one is the lowest likelihood of sliding and ten is the highest risk. These estimates are based on regional rock strength and slope steepness (California Department of Conservation). Table 8-4 indicates bus ridership susceptibility to landslides from levels three to ten. There were no values for levels one and two. In the level four landslide susceptibility area, there were over 523 thousand boardings in 2019.

Table 8-3 – Bus Stop Ridership Exposed to Mapped and Post-Fire Landslide Susceptibility

Ridership	Post-Fire Landslide Susceptibility	Mapped Landslides
Total	41,911	8,518

Table 8-4 – Bus Stop Ridership Exposed to Landslide Susceptibility from Level 3 to 10

Ridership	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10
Total	193	523,415	500	409,996	190,200	59,614	193	19,016

8.5.1.1 Vulnerability

Populations within the OCTA planning area at risk from mapped mass earth movements are in Table 8-5 below. The results show the highest exposure is to "other landslide features." In this category, minority and mixed-race individuals in the zone total almost 200,000; 86,000 individuals are 19 years old or younger; nearly 44,000 are seniors; and over 37,000 living below the poverty level.

Table 8-5 – Populations at Risk from Mapped Landslides

Populations	Other Landslide Feature	Landslide Deposits	Landslide Source
Black	7,319	332	162
American Eskimo	1,827	144	78
Asian	77,883	2,773	2,279
Hawaiian/Pacific Islander	1,137	97	49
Hispanic	94,187	4,361	2,247
Multiple Races	14,133	1,460	813
Children up to 19 Years Old	86,001	6,970	3,772
65 Years and Older	43,911	5,152	4,323
Below the Poverty Level	37,187	2,529	1,365

Populations at risk from post-fire landslide susceptibility with soil class one to three (with one as the lower risk and three as the highest risk) are in Table 8-6; soil class one has the highest population.

Table 8-6 – Populations at Risk from Post-Fire Landslides Soil Types 1 to 3

Populations	Soil Class 1	Soil Class 2	Soil Class 3
Black	10,799	7,825	503
American Eskimo	4,100	2,983	183
Asian	102,979	80,205	6,516
Hawaiian/Pacific Islander	2,215	1,695	125

Populations	Soil Class 1	Soil Class 2	Soil Class 3
Hispanic	232,631	174,958	6,741
Multiple Races	24,244	17,998	1,904
Children up to 19 Years Old	161,899	118,323	9,776
65 Years and Older	63,914	52,051	6,441
Below the Poverty Level	90,511	59,165	3,382

Populations at risk from landslide susceptibility levels three and five to ten (with one as the lowest risk and ten as the highest) are in Table 8-7; there is no class one, two, or four population exposure in the planning area. At the highest level of risk, level ten, the vulnerable population numbers are the greatest.

Table 8-7 – Populations at Risk from Landslide Susceptibility Level 3, and 5 to 10

Populations	Level 3	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10
Black	3,133	7,417	1,148	12,391	7,825	6,904	5,501
American Eskimo	958	2,580	330	3,804	2,192	2,500	2,240
Asian	25,615	69,280	15,480	119,406	60,268	61,216	68,357
Hawaiian/Pacific Islander	540	1,432	256	2,177	1,157	1,409	1,007
Hispanic	59,031	132,170	18,886	227,713	123,905	140,513	123,468
Multiple Races	5,680	16,500	2,834	27,003	14,349	16,421	14,727
Children up to 19 Years Old	38,262	101,872	16,697	170,318	91,951	105,133	99,131
65 Years and Older	11,743	46,102	6,107	72,777	43,078	48,899	44,142
Below the Poverty Level	19,922	50,491	8,360	87,328	47,452	45,494	383,905

8.5.2 Property

There are no OCTA-owned buildings exposed to mapped landslide hazards by building type. The planning risk areas are displayed in Figure 8-3. Table 8-8 and 8-9 lists Authority parcels and infrastructure exposed to mapped landslides. Tables 8-10 to 8-11 lists areas vulnerable to a landslide after a wildfire.

The GIS dataset used for the landslide susceptibility combines several layers, including landslide inventory, geology, rock strength, and slope, to generate susceptibility classes from zero at the lowest to ten at the highest (California Department of Conservation, 2018). Tables 8-13 to 8-15 show levels of susceptibility to landslides in the planning area. Landslide susceptibility ranges from levels 3 to 10. OCTA buildings are found in levels 5 and 7.

Table 8-8 – OCTA Owned Environmental Parcels Exposed to Mapped Landslides

Parcel Type	Acres
Eagle Ridge (proximal to the City of Brea)	81.53
Live Oak Creek (proximal to the City of Lake Forest)	8.83
Pacific Horizon (proximal to the City of Laguna Beach)	62.90
Silverado Chaparral (proximal to Silverado Canyon)	49.32
Trabuco Rose (proximal to Trabuco Canyon)	20.95

Parcel Type	Acres
Wren's View (proximal to Trabuco Canyon)	0.21
Total	**223.74**

Table 8-9 – OCTA Infrastructure and Related Operations Exposed to Mapped Landslides

Infrastructure Type	Miles
Bus Route	5.73
Other Freeway	20.25
Metrolink Rail	0.38
Total	**26.36**

Table 8-10 – OCTA Property Exposed to Landslides After a Wildfire with Soil Classes 1-3

Building Type	Soil Class 1	Soil Class 2	Soil Class 3
Park and Ride	1	0	0
Total	**1**	**0**	**0**

Table 8-11 – OCTA Owned Environmental Parcels in Acres Exposed to Landslides After a Wildfire Soil Classes 1-3

Land Use	Soil Class 1	Soil Class 2	Soil Class 3
Bobcat Ridge (proximal to the City of Lake Forest)	4.83	33.36	
Eagle Ridge (proximal to the City of Brea)	38.04	174.10	68.97
Live Oak Creek (proximal to the City of Lake Forest)	12.52	57.85	5.28
Pacific Horizon (proximal to the City of Laguna Beach)	5.80	63.30	66.10
Silverado Chaparral (proximal to Silverado Canyon)	26.84	98.60	77.64
Trabuco Rose (proximal to Trabuco Canyon)	103.65	282.10	7.85
Wren's View (proximal to Trabuco Canyon)	27.21	89.76	
Total	**218.88**	**799.94**	**225.80**

Table 8-12 – OCTA Infrastructure and Related Operations in Miles Exposed to Landslides After a Wildfire

Infrastructure Type	Soil Class 1	Soil Class 2	Soil Class 3
Bus Route	14.31	2.72	0.28
I-405 Freeway	2.293	0	0
SR-91 Freeway	1.764	0	0
Other Freeway	30.451	22.738	1.574
Metrolink Rail	2.293	0	0
Total	**51.111**	**25.458**	**1.854**

Table 8-13 – OCTA Buildings Landslide Susceptibility Class 3 to 10

Building Type	Class 5	Class 7
Brea Park and Ride	1	
Transit Center		1
Total	**1**	**1**

Table 8-14 – OCTA Environmental Areas (Acres) Landslide Susceptibility Class 3 to 10

Land Use Type	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10
Bobcat Ridge (proximal to the City of Lake Forest)	0	7.01	0	0.77	8.33	31.58	0	0.23
Eagle Ridge (proximal to the City of Brea)	0	14.30	0	3.42	19.60	157.80	0	97.95
Live Oak Creek (proximal to the City of Lake Forest)	0	6.50	0	2.85	8.50	49.37	0	14.46
Pacific Horizon (proximal to the City of Laguna Beach)	0	8.23	0	0.64	13.01	63.26	0	66.22
Silverado Chaparral (proximal to Silverado Canyon	2.65	11.30	5.24	18.32	30.26	112.63	2.65	21.71
Trabuco Rose (proximal to Trabuco Canyon)	52.70	18.30	59.78	65.54	40.45	88.40	52.70	35.34
Wren's View (proximal to Trabuco Canyon)	0.08	16.92	0.09	1.70	22.78	73.51	0.08	0.94
Total	**55.43**	**82.56**	**65.11**	**93.24**	**142.93**	**576.55**	**55.43**	**236.85**

Table 8-15 – OCTA Infrastructure in Miles with Landslide Susceptibility Class 3 to 10

Infrastructure Type	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10
Bus Route	0.62	63.08	0.30	91.73	18.11	25.14	0.62	208.30
Freeway	5.24	37.84	4.59	75.78	17.71	36.88	5.24	203.96
Metrolink Rail	0.01	2.82	0.01	6.72	0.72	1.59	0.01	13.07
Pacific Electric ROW	0	0	0	0.20	0	0	0	0.21
Streetcar Route	0	0	0	0.01	0	0	0	0.01
Total	**5.87**	**103.74**	**4.9**	**174.44**	**36.54**	**63.61**	**5.87**	**425.55**

8.5.2.1 Vulnerability

The definition of exposure and vulnerability in the GIS data includes buildings and critical infrastructure within even a moderate landslide hazard zone.

8.5.3 Environment

Specific environmental impact from mass earth movements within the OCTA planning area is challenging to predict. In general, earth movements can alter the surface topography, smother vegetation underwater

or ground materials, and carry new materials into an ecosystem. Mass earth movements that dump materials into rivers can block water flow, causing the flow to reroute or flood the area. Soil and exposed hazardous materials can accumulate downslope, potentially contaminating drinking water supplies (World Health Organization). OCTA's planning area is prone to the risks resulting from a mass earth movement, including flooding, altered waterways, and contaminated water.

8.6 Development Trends

The Orange County Resources and Development Management Department consistently monitors and assesses mass earth movement potential. The Orange County Resources and Development Management Department also evaluates the work consultants do on construction projects, including grading plans and soil reports, and corrective measures to mitigate geologic hazards (e.g., landslides and liquefaction) (Orange County).

The State, California Legislature Section 65302 of the Government Code requires general plans to include land-use elements that identify and protect the community from any unreasonable risks associated with slope instability that could lead to mass earth movements (California Legislative Information, 2018). Orange County Ordinance NO.15-006, Section 7-10-30 (a) Setback and Slopes address landslide hazards (Orange County, 2020). This regulation states development must have an acceptable way for water to flow across and away from the site. Any long-term water retention must meet Building Official approval to reduce risks from mass earth movements (Orange County, 2020).

8.7 Issues

Mass earth movement considerations in the OCTA planning area:

- As new data, technology, and science become available, update maps and mass earth movement hazard assessments
- Climate change could increase these trigger events, escalating the likelihood and extent of mass earth movements
- Potential cascading impacts, such as ruptured gas lines, and potential for secondary hazards, such as fires

8.8 Hazard Map

The hazard maps for deep-seated landslide susceptibility and post-fire soil erosion risks in the planning area start on the next page.

Figure 8-3 – OCTA Mapped Landslide Features

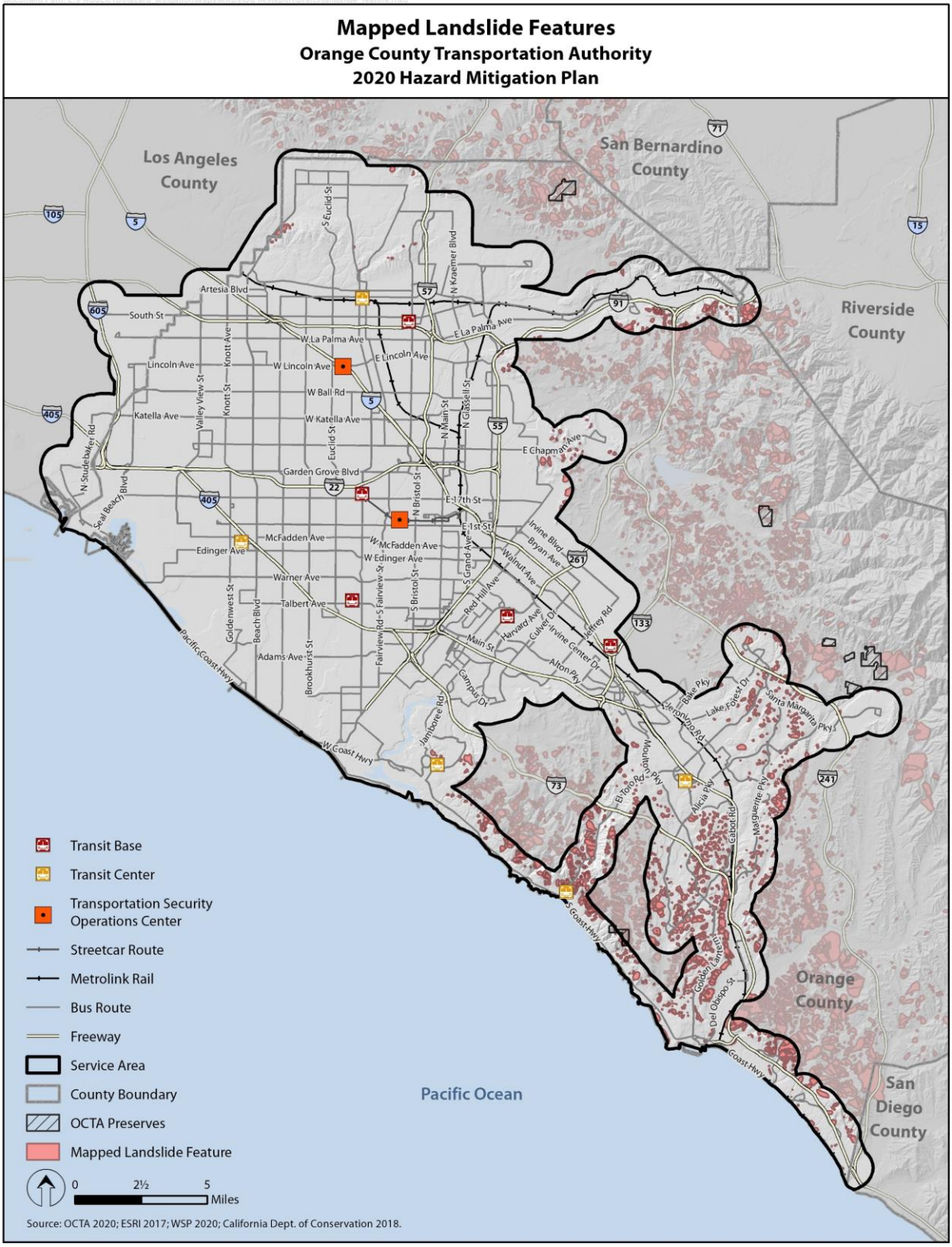


Figure 8-4 – OCTA Deep-Seated Landslide Susceptibility Area Hazard Map

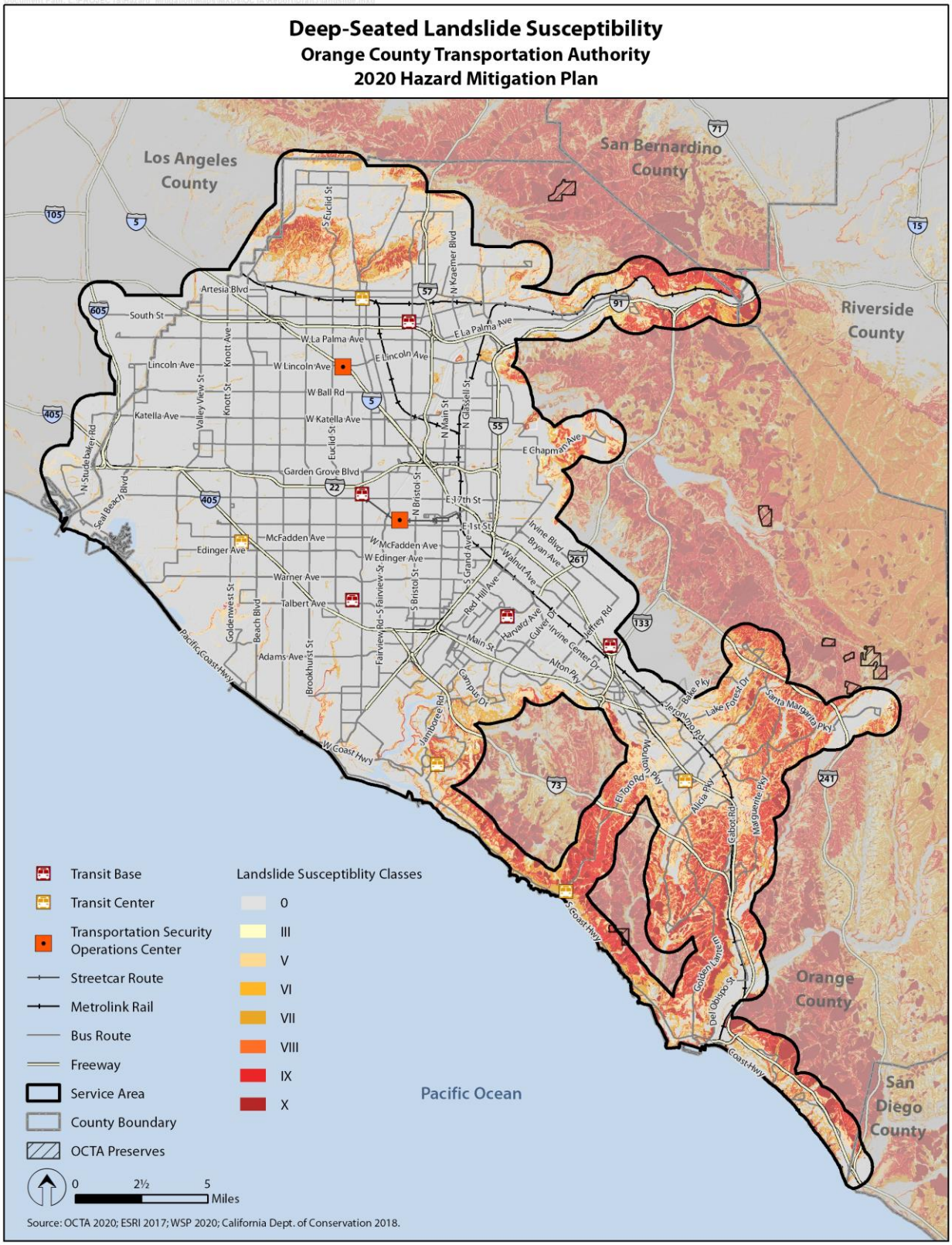
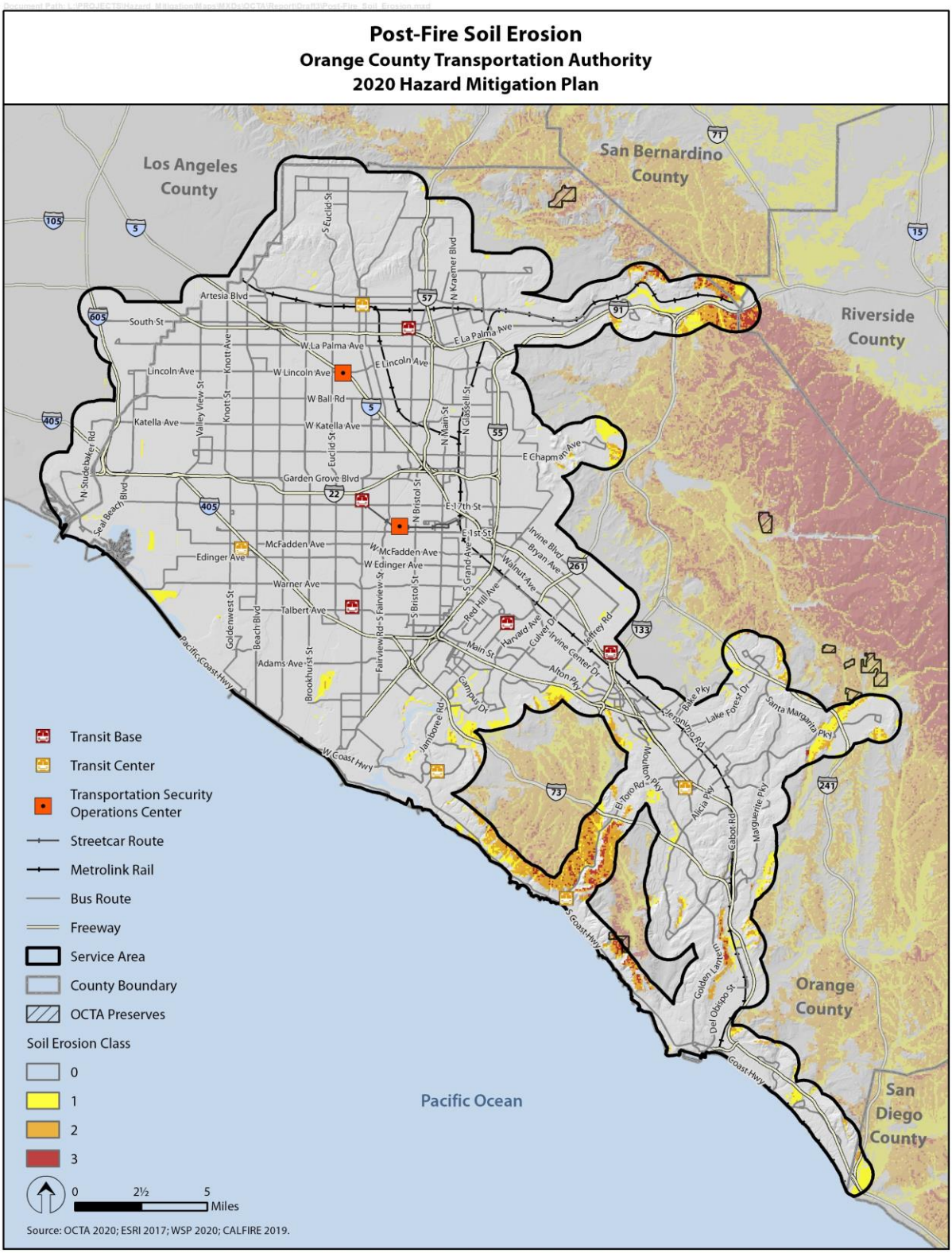


Figure 8-5 – OCTA Post-Fire Soil Erosion Hazard Map



9 Severe Weather Events

9.1 General Background

Severe weather occurs all over the US and can take multiple forms, such as thunderstorms, drought, heatwaves, tornadoes, flash floods, and winter storms (Ready.gov, 2020). These varying types of storms can occur at any time of day or night and throughout the year. Severe weather events can damage or destroy structures, infrastructure, and the environment and result in injuries or loss of life. Severe weather events may be categorized into two groups (World Meteorological Organization, 2004):

- **General Severe Weather** – systems that form over broad geographic areas that can cross regional and jurisdictional boundaries
- **Localized Severe Weather** – storms in a limited geographic area

It is essential to note the distinction between extreme weather and severe weather. The most intense and rare weather events at a particular place and/or time are considered extreme weather; in contrast, common forms of storms that cause significantly more damage than usual are severe weather events (National Academy of Sciences, 2008). For example, in an area that experiences annual windstorms, when one storm is more violent than normal, it is severe weather.

Severe weather can trigger flooding, flash floods, storm surges, and erosion; these flood-related hazards are in Section 7 of this plan. Severe weather identified as a hazard in this plan (National Weather Service, 2009):

- **Thunderstorms** – a local storm with thunder and lightning, can cause tornadoes, heavy rain, flash floods, hail, and high winds
- **Tornadoes** – a destructive rotating column of wind generated by a thunderstorm, shaped in a funnel that reaches the ground
- **Droughts** – extended periods of deficient rainfall and snowpack leading to serious groundwater shortages impacting people, animals, and the environment

DEFINITIONS

Derecho – a widespread and long-lived windstorm associated with thunderstorms that can cause damage similar to a tornado.

Droughts – extended periods of extremely low rainfall and snowpack that lead to groundwater shortages impacting a large area of people, animals, and the environment.

Excessive/Extreme Heat – a combination of high temperatures and humidity, where the human body cannot maintain internal temperatures and can cause heat stroke.

General Severe Weather – systems that form over broad geographic areas that can cross regional and jurisdictional boundaries.

Localized Severe Weather – damaging storms in a limited geographic area, can include all types of severe weather.

Thunderstorm – a local storm with thunder and lightning, can cause tornadoes, heavy rain, flash floods, hail, and high winds.

Tornadoes – a destructive rotating column of wind generated by a thunderstorm, shaped in a funnel that reaches the ground.

Winter Storm – a cold event with significant precipitation in the form of snow, ice, freezing rain, sleet, etc. Higher elevations get more precipitation.

- **Excessive/Extreme Heat** – a combination of high temperatures and humidity, where the human body cannot maintain internal temperatures and can cause heat-stroke

9.1.1 Potential Damage from Weather Events

There are multiple forms of severe weather and a variety of potential damages. Thunderstorms can produce heavy rains, tornadoes, hail, lightning, and high winds. Heavy rains can lead to several secondary hazards, such as flooding, flash floods, mass earth movements, and coastal erosion; secondary hazards are in Section 9.3. Tornadoes are the most violent type of storm (National Weather Service), which can quickly destroy structures, infrastructure, the environment and result in injuries or the loss of life.

Hail is balls of ice that form inside thunderstorms (The National Severe Storms Laboratory). Hail size depends on how long the ice stays in the thundercloud and continues to add layers. Eventually, the weight is too much for the storm to hold, and the hail drops to the ground. The largest hail size recorded had a circumference of 18.62 inches, and it weighed one pound, 15 ounces (The National Severe Storms Laboratory). Hail can significantly damage vehicles, break windows, and cause human injury or death.

If lightning hits a person, it can cause injury or loss of life. The high electrical current running through a body can damage the central nervous system, heart, lungs, and other vital organs (Krider). Lightning striking a building or power line can cause major electrical problems, including power outages, blown breaker boxes, blown transformers, and sometimes electrical fires (Krider). Under certain conditions, lightning-initiated fires can grow into wildfires.

Thunderstorms can bring high winds, sometimes called “straight-line” winds, to distinguish them from circular moving wind resulting in a tornado (The National Severe Storms Laboratory). High winds can reach up to 100 miles per hour and leave a destructive path that can extend hundreds of miles (The National Severe Storms Laboratory). These winds can directly damage structures and infrastructure and indirectly injure people struck by flying objects or cause loss of life.

Droughts are defined by their effects on people, animals, and the environment, which means the impacts determine when a weather event constitutes a drought (National Centers for Environmental Information). Droughts can have significant impacts on agricultural land and economies, animals, and human health. Droughts can also trigger several secondary hazards and cascading impacts; discussed in section 9.3

Excessive or extreme heat can affect every living thing, including humans, animals, and plants. Humans can experience heat-related illnesses such as heat stress, heat exhaustion, heatstroke, and in some cases, lead to loss of life (Centers for Disease Control, 2020). Extreme heat is a combination of temperatures above 90 degrees with high humidity over at least two days (Ready.gov, 2021). Warmer temperatures can reduce air quality and increase ozone levels (Centers for Disease Control, 2020). Excessive heat can lead to secondary hazards like wildfires and cascading impacts like rolling power blackouts, discussed in Section 9.3.

9.2 Orange County Transportation Authority Hazard Profile

The entire OCTA planning area is at risk from severe weather of varying types. In Appendix G Table G-5 lists the severe weather events that caused more than $25,000 in damages or resulted in human injury or death in the planning area; they include tornadoes, heavy rain, lightning, thunderstorms, dust storms, heat, hail, and strong wind (National Oceanic and Atmospheric Administration). Storms coming off the Pacific Ocean are hazardous when combined with an El Niño wet season or a warm phase of the Pacific

Decadal Oscillation (California Coastal Commission). An El Niño occurs when the ocean and atmospheric system are disrupted, bringing heavy rains along the coast (County of Orange and Orange County Fire Authority, 2015). These conditions often last one to two years.

Figure 9-2 for the year 2035 and Figure 9-3 for the year 2070 show the predicted average temperature increases in three zones throughout the planning area.

By 2035, the zone increases are predicted to be (in °F):

- **Zone 1** – degrees of warming 1.5-2
- **Zone 2** – degrees of warming 2-2.5
- **Zone 3** – degrees of warming 2.5-3

By 2070 the zones are expected to be (in °F):

- **Zone 1** – degrees of warming 2-2.5
- **Zone 2** – degrees of warming 2.5-3
- **Zone 3** – degrees of warming 3-3.5

Rising temperatures will mean more extended droughts and more extreme heat events. The planning area regularly experiences periods of drought. The last few were from 2006-2009, 2011-2014, and 2016-2017; although 2018-2019 brought more rain, parts of the planning area were still at a moderate drought level (UCLA Institute of the Environment & Sustainability, 2019). Drought-level explanations are in Section 9.2.5.

OCTA 2010 Severe Weather Narrative

December 2010, Orange County experiences severe weather resulting in several road closures, Metrolink train disruptions, and public evacuations. Multiple regular service routes were detoured due to flooding or accidents, with the City of Laguna Beach being significantly impacted requiring OCTA services to be dramatically detoured. Metrolink services were interrupted in the Laguna Nigel region, and OCTA provided vital bus bridges involving seven busses and 15 staff, resulting in the transportation of 122 citizens. Santiago Canyon experienced an evacuation due to debris flow and OCTA provided four busses and 13 staff to evacuate 49 citizens and two dogs.

While average temperatures have gone up, so have record high temperatures in the planning area. During extreme drought events in the area, heatwave incidents also increased from four to six times per year, indicating a correlation between droughts and heatwaves (Hulley, Dousset, & Kahn, 2020). These severe weather events and factors demonstrate the hazard exposure to the entire planning area. Table 9-1 below illustrates the 2020 average weather conditions in the planning area.

Table 9-1 – Normal Temperatures in °F and Precipitation in Inches Recorded at the San Diego Miramar NAS Weather Station (National Centers for Environmental Information, 2020)

Season	Max Temperature	Minimum Temperature	Average Temperature	Precipitation
Annual	73.4	55.1	64.2	11.48
Winter	67.1	47.1	57.1	6.95
Spring	69.9	52.9	61.4	2.70
Summer	79.3	63.1	71.2	0.19
Autumn	77.1	57.2	67.2	1.64

9.2.1 Hazard Ranking

The Planning Team completed a hazard ranking survey during the OCTA 2022 HMP development process and assessed hazard-related factors based on worst case and most likely scenarios. Hazard definitions and ranking factors are in Appendix G, Table G-1. Survey results were prioritized and ranked based on their averaged score. The variables of severity, magnitude, frequency, onset, and duration are scored one to five, where one is the lowest and five is the highest. Compared to the other hazards in the survey, severe weather events were the fourth worst-case and most likely scenario.

Table 9-2 – OCTA Severe Weather, Storm Surge, Drought, and Extreme Heat Event Hazard Ranking

Severity	Magnitude	Frequency	Onset	Duration	Average	Rank
Worst-Case Scenario						
3.05	3.09	3.50	2.57	3.02	3.05	4
Most Likely Scenario						
2.59	2.75	3.39	2.61	3.05	2.88	4

9.2.2 Past Events

Severe weather and flooding in 1997-1998 impacted Orange County, damaging facilities infrastructure, costing approximately $50 million (County of Orange and Orange County Fire Authority, 2015). In Appendix G Table G-4 lists 15 severe weather events in the planning area that resulted in a FEMA disaster declaration between 1969 and 2020 (Federal Emergency Management Agency, 2020). Table G-5 summarizes the severe weather events in the planning area that resulted in deaths, injuries, and/or more than $25,000 in damages. Since 1956, NOAA has recorded 133 of these weather events (National Oceanic and Atmospheric Administration). A few of the most notable events are in Table 9-3.

Table 9-3 – Significant Past Severe Weather Events in the Planning Area (Federal Emergency Management Agency, 2020) (National Oceanic and Atmospheric Administration)

Date	Severe Weather Type	Deaths/Injuries	Property Damage	FEMA Declaration or Scale
2/10/2000	Heavy Rain	1 death 4 injuries	$300,000	
3/6/2000	Hail	1 death	$75,000	
11/12/2003	Hail	0	$3,500,000	
1/7/2005	Heavy Rain	0	$5,000,000	DR-1577-CA
1/7/2005	Heavy Rain	0	$15,000,000	DR-1577-CA
2/18/2005	Heavy Rain	0	$20,000,000	
4/14/2005	Severe storms, flooding, debris/mudflows			DR-1577-CA
3/13/2007	Severe freeze			DR-1689-CA
9/3/2007	Excessive Heat	8 deaths	$0	
1/19/2010	Tornado	0	$500,000	EF-1
3/8/2010	Severe winter storms, flooding, debris/mudflows			DR-1884-CA

Date	Severe Weather Type	Deaths/Injuries	Property Damage	FEMA Declaration or Scale
1/26/2011	Winter storms, flooding, debris/mudflows			DR-1952-CA
3/16/2017	Severe winter storms, flooding, mudslides			DR-4305-CA

9.2.3 Location

The entire OCTA planning area has experienced damage from severe weather, as shown by the emergency declarations and storm database tables in Appendix G. However, the most significant thunderstorms typically occur where the Pacific Ocean's cooler air meets warmer air from the San Gabriel Mountains or farther south of Mexico (Meier & Thompson). These thunderstorms can bring heavy rains, hail, high winds, and lightning to the Santa Anna Mountains and the valleys and plains below. However, the planning area coastline is most at risk from storms coming off the Pacific to bring storm surges and high waves.

Temperature predictions show an increase over the next few decades, overlapping the planning area in three zones. Figures 9-2 and 9-3 show the distribution of predicted temperature increases over OCTA's planning area. These increased temperatures expand the entire planning area's exposure to extreme heat and drought events. Additionally, as indicated in the past events section, severe drought conditions in Southern California have crossed the entire planning area (UCLA Institute of the Environment & Sustainability, 2019).

9.2.4 Frequency

On average, OCTA can expect impacts from severe weather at least once a year, as indicated by Tables G-4 and G-5. Severe weather can strike anywhere at any time of day or year; however, certain types of storms happen more often in particular seasons, such as extremely high temperatures and droughts in the summer. The NOAA database shows the types of severe weather events that can happen more often, such as heavy rains and thunderstorms, while hail is uncommon in the planning area.

Droughts are not uncommon in the OCTA planning area, and their frequency will increase in the future. planning area drought events are happening more often and lasting longer (UCLA Institute of the Environment & Sustainability, 2019). Higher temperatures and heat waves affect the frequency of droughts and extreme heat events. A report shared by the NASA Earth Observatory states that heatwaves have also increased in frequency, duration, and intensity over the last few decades throughout Southern California, including in the OCTA planning area (Hulley, Dousset, & Kahn, 2020).

9.2.5 Severity

The OCTA planning area can experience damage from all types of severe weather, including thunderstorms, tornados, droughts, and excessive heat. The severity level varies for each type of event. Table 9-4 describes the severe thunderstorm categories. Tornado ratings are in Table 9-5. In the drought severity section is a list of the five drought levels. The Heat-Index risk level is in Figure 9-1.

9.2.5.1 Severe Storms and Thunderstorms

Heavy rain and hail resulted in the loss of life and injuries in the planning area. Heavy rain, hail, and a tornado also caused significant property damage costs, shown in Table 9-3. Orange County experienced the highest damage cost at $20 million after heavy rain in 2005. NWS has five severity categories:

Table 9-4 – NWS Severe Thunderstorm Risk Categories (National Weather Service)

Risk Severity	Label	Impacts
None	Thunderstorms (no official label)	Severe thunderstorm not expected, winds up to 40 mph, and small hail Lightning and floods can still occur
1	Marginal (MRGL)	Limited duration and/or intensity isolated severe thunderstorms possible Winds 40-60 mph Low tornado risk
2	Slight (SLGT)	Short term and/or not widespread, scattered severe thunderstorms and isolated intense storms possible Strong wind damage reports, one or two tornadoes Hail 1-inch diameter, and in isolated areas 2 inches
3	Enhanced (ENH)	Persistent and/or widespread, numerous severe thunderstorms possible Several strong wind damage reports with a few tornadoes Damaging hail 1-2-inch diameter
4	Moderate (MDT)	Longer widespread and intense thunderstorms likely Widespread wind damage and strong tornadoes possible Destructive hail of 2-inch diameter or more
5	High (HIGH)	Longer, very widespread, and especially intense thunderstorms expected Tornado outbreak Derecho

Table 9-5 – Enhanced Fujita Scale for Tornadoes (National Weather Service)

EF Rating	3 Second Gust (in mph)
0	65-85
1	86-110
2	111-135
3	136-165
4	166-200
5	Over 200

9.2.5.2Tornadoes

In the US, tornado intensity measurements are based on the Enhanced Fujita Scale (EF Scale). This scale defines a tornado's severity by the estimated wind speed and damages it causes, as shown in Table 9-5. Previous tornado events in the planning area fell within an EF-0 to EF-3 range (National Oceanic and Atmospheric Administration).

9.2.5.3Drought

Drought severity depends on several factors, including duration, intensity, geographic extent, and water supply needs in the planning area. The measure of drought magnitude is in length of time and the water deficit severity. Environmental factors can amplify droughts, such as prolonged high winds and wildfires. The US National Integrated Drought Information System measures conditions in five levels related to the OCTA planning area.

Table 9-6 – Drought Information System Measurements (National Integrated Drought Information System, 2021)

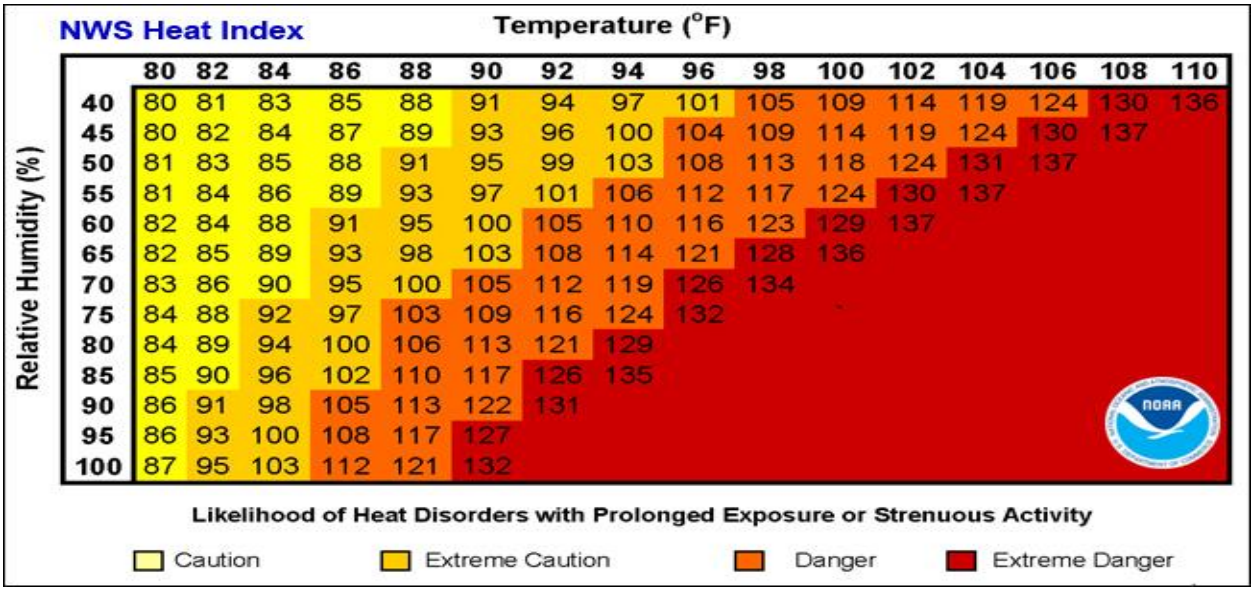
Drought Level	Drought Description
D0 **Abnormally Dry**	- Dry soil, deliver irrigation early - Active fire season begins
D1 **Moderate Drought**	- Dryland pasture growth student, supplemental feed for cattle - Landscaping and gardens need irrigation earlier - Stock ponds and creeks are lower than normal

Drought Level	Drought Description
D2 **Severe Drought**	- Fire season is longer with high burn intensity, dry fuels, and a larger coverage area - More fire crews on staff
D3 **Extreme Drought**	- Federal water is not adequate for irrigation contracts, and extracting extra groundwater is expensive
D4 **Exceptional Drought**	- Many crop yields are low, affecting economies and households with possible food shortages - Fire season is costly and extensive, with numerous fires and large areas burned - Many recreational activities are affected

9.2.5.4 Extreme Heat

Extreme heat events in the planning area are already occurring and expected to become more common, more severe, and longer lasting as our climate changes (Environmental Defense Fund). The relationship between high temperatures and high humidity determines the extreme heat severity level. NOAA's table in Figure 9-1 illustrates the relationship between temperatures and relative humidity to provide the Heat-Index output level (National Oceanic and Atmospheric Administration). When the combined heat index reaches 90˚F, many people are at serious risk.

Figure 9-1 – NOAA Heat Index (Leahy, 2019)



9.2.6 Warning Time

Meteorologists can often predict the likelihood of a severe storm, providing several days of advanced warning. For example, the NWS Climate Prediction Center issues long-range forecasts, with eight to 14 day, monthly, and seasonal outlooks (National Weather Service) (National Oceanic and Atmospheric Administration and National Weather Service, 2021). However, specific aspects of a storm can be challenging to determine, such as where lightning will strike or how large hail will be (The National Severe Storms Laboratory). Numerous scientific factors inform predictions. However, with so many factors to account for, forecasts are not always correct or exact.

9.2.6.1 Thunderstorm and Tornadoes

The NWS San Diego office assesses potential weather and flood event factors to determine when to send emergency notifications and what warning level to set. The office also provides up-to-the-minute watches, warnings, and advisories for four categories of severe weather, listed in the table below.

Table 9-7 – NWS Warnings and Advisories List (National Weather Service, 2021)

Convective/Tropical	Flooding	Winter Weather	Non-Precipitation
Tornado Watch	Flash Flood Watch	Winter Storm Watch	High Wind Warning
Tornado Warning	Flash Flood Warning	Winter Storm Warning	High Wind Advisory
Severe Thunderstorm Watch	Coastal/Flood Watch	Freezing Rain Advisory	
Severe Thunderstorm Warning	Coastal/Flood Warning	Ice Storm Warning	
Hurricane Watch	Small Stream Flood Advisory	Winter Weather Advisory	
Hurricane Warning			
Tropical Storm Watch			
Tropical Storm Warning			

9.2.6.2 Drought

The Drought Early Warning System (DEWS) uses climate and drought science to predict future drought conditions, making the data accessible and valuable for decision-makers (National Integrated Drought Information System, 2020). The DEWS goal is to provide as much forewarning as possible to improve stakeholders' capacity to monitor, forecast, plan for, and cope with drought impacts (National Integrated Drought Information System, 2020).

9.2.6.3 Extreme Heat

When temperatures spike in the summer months, there is a surge of energy use when residents return home from work and turn on appliances, air conditioners, and other cooling devices (California Independent System Operator). Orange County employs a “Flex Alert” (California Independent System Operator) when the grid is taxed or close to maxed out. The alert requests customers to reduce their energy usage during peak energy times and high temperatures.

9.3 Secondary Hazards and Cascading Impacts

9.3.1 Secondary Hazards

Severe weather can trigger several secondary hazards, such as flooding (Ready.gov, 2020), storm surge, and increase coastal erosion; flooding and erosion hazards are in Section 7 of this plan. Heavy rains can also destabilize slopes, resulting in mass earth movements (United States Geological Survey). Drier soil during a drought means less vegetation, increasing the risk of mass earth movements without the vegetation to stabilize slopes and surface erosion due to lose dry soil; Mass earth movements are in Section 8. Lightning strikes, droughts, and heatwaves increase wildfire risks (National Centers for Environmental Information); Section 11 discusses wildfires further.

9.3.2 Cascading Impacts

Cascading impacts from severe weather include damaged or destroyed infrastructure and utilities. Heavy rain, lightning, and tornadoes can knock out power, roads, communications and disrupt water

management systems. Damaged or flooded roads can disrupt OCTA's transportation services. High winds can topple trees, communication towers, and power lines. Downed power and broken gas lines can start fires. During heatwaves, people use more electricity when they are at home, especially running air cooling units, which can overwhelm the electrical grid and cause rolling brown or blackouts. Brownouts are when power is still transmitted but at a diminished capacity, while blackouts are a complete shutdown of affected power stations/substations (California Independent System Operator).

9.4 Potential Impacts from Future Climate Conditions

Severe weather will occur more often and be more intense as climate change worsens (Environmental Protection Agency), resulting in more frequent and severe extreme heat days and heatwaves, more droughts, and storms. As a result, the planning area could see more extremely wet winters and springs at the current global carbon emissions rate. These extreme events could increase as much as 50 percent by the 2070s, compared to the increase between 1850 to the present (Constible, 2019). Additionally, higher temperatures for more extended periods in OCTA's planning area mean more moisture evaporated into the atmosphere, amplifying rainfall, and creating a cycle of extreme weather (Environmental Defense Fund).

The planning area saw three years of continuous drought conditions from 2011-2014 (UCLA Institute of the Environment & Sustainability, 2019). Higher annual average temperatures contribute to drier conditions. The annual increase includes warmer weather in the winter with more precipitation in the mountains falling as rain instead of snow, resulting in less snowmelt in the summer to provide water in the drier summer months. Climate change factors have already increased temperatures and resulted in prolonged dry periods and severe drought conditions. These temperatures will continue to rise in the future, exacerbating already dry periods. Tables 78 to 83 list OCTA's structures, infrastructure, and land-use parcels with the predicted temperature increases due to climate change.

9.5 Exposure

9.5.1 Population

Intersecting OCTA bus stop ridership and US Census planning area data with geospatial hazard data for severe weather events shows population exposure to stormwater inundation and temperature increases. OCTA ridership exposed to stormwater inundation for a 100-year storm is in Table 9-8 below, with a total of 19,672 boardings in areas at risk from the inundation zone. Ridership exposed to predicted temperature increase in the planning area is in Tables 9-9 and 9-10. Ridership in areas predicted to increase by 1.5-2 degrees was over 4 million boardings in 2019 alone.

Table 9-8 – Summary of Ridership at Bus Stops Exposed to 100-year Stormwater Inundation Zone

Ridership at Bus Stops	Within 100-year Zone
Total	19,672

Table 9-9 – Bus Stop Ridership at Risk from Predicted Temperature Increases up to Year 2035

Ridership	1.5-2 Degrees	2-2.5 Degrees	2.5-3 Degrees
Total	4,149,156	14,930	31,278,952

Table 9-10 – Bus Stop Ridership at Risk from Predicted Temperature Increases up to Year 2070

Ridership	2-2.5 Degrees	2.5-3 Degrees	3-3.5 Degrees
Total	27,079,210	824,321	7,539,507

9.5.1.1 Vulnerability

Vulnerable populations are especially at risk and may require support to evacuate during a 100-year storm inundation event. Individuals with medical conditions or autoimmune deficiencies will be more affected by poor air quality or increased infectious diseases (United States Global Change Research Program, 2016). Although droughts may not directly impact individuals in the planning area, droughts can reduce food and water supplies, raising prices, and disproportionately affecting low-income households (Constible, 2019).

Intersecting OCTA bus stop ridership and US Census planning area data with geospatial hazard data for populations at risk from a 100-year stormwater inundation event are in Table 9-11. As the results show, there are nearly 30,000 households below the poverty level; this group is especially at risk as they may not have the funds to prepare their residences and/or may need assistance with transportation during an evacuation.

Table 9-11 – Vulnerable Populations at Risk from 100-Year Stormwater Inundation

Populations	100-Year Storm Inundation Zone
Black	2,949
American Eskimo	1,166
Asian	21,846
Hawaiian/Pacific Islander	457
Hispanic	76,521
Multiple Races	8,027
Children up to 19 Years Old	52,663
65 Years and Older	20,706
Below the Poverty Level	29,054

Extreme heat exposure is calculated by the length of time people spend in high temperatures (National Integrated Heat Health Information System, 2020). Groups vulnerable to extreme heat exposure include children, emergency responders, the elderly, outdoor workers, athletes, and individuals with existing medical conditions exacerbated by heat. For example, elderly persons that rely on OCTA services for transportation are at higher risk for heat-related illnesses while waiting outside for the transportation to arrive. Additionally, children often rely on adults to identify extreme heat events and take precautions like drinking plenty of water.

Outdoor workers on OCTA projects may have layers of protective clothing and/or need to carry heavy gear, which can escalate their susceptibility to heat illnesses. Additionally, the urban heat island effect can raise temperatures between 18 to 27 degrees during the day in densely populated areas with less vegetation and more asphalt (National Integrated Heat Health Information System, 2018). This heat island effect can impact the densely populated planning area (Orange County Transportation Authority, 2018).

The highest number of populations at risk in Table 9-12 are in the 2-2.5 temperature increase range by 2035. Over one million minority and mixed-race individuals are in areas predicted to warm 2-2.5 degrees by 2035. Table 9-13 shows warming up to the year 2070 and the populations that could be impacted, with nearly 1.3 million minority and mixed-race people at risk from 2.5-3 degree increase by 2070. Additionally, many low-income households are at risk from a 2.5-3 degree warming at 238,447 households.

Table 9-12 – Vulnerable Populations Exposed to Predicted Temperature Increases up to the Year 2035

Populations	1.5-2 Degrees	2-2.5 Degrees	2.5-3 Degrees
Black	20,707	32,515	784
American Eskimo	5,972	11,677	343
Asian	215,163	304,672	4,839
Hawaiian/Pacific Islander	3,475	5,916	126
Hispanic	305,062	692,038	17,502
Multiple Races	52,844	64,529	2,506
Children up to 19 Years Old	304,764	451,273	16,078
65 Years and Older	162,725	167,926	7,555
Below the Poverty Level	139,266	238,447	6,158

Table 9-13 – Vulnerable Populations Exposed to Predicted Temperature Increases up to the Year 2070

Populations	2-2.5 Degrees	2.5-3 Degrees	3-3.5 Degrees
Black	9,333	40,535	4,137
American Eskimo	3,041	13,396	1,555
Asian	137,848	359,480	27,347
Hawaiian/Pacific Islander	1,657	7,247	613
Hispanic	157,486	783,609	73,506
Multiple Races	29,675	79,554	10,650
Children up to 19 Years Old	170,529	535,549	66,307
65 Years and Older	83,233	220,904	34,070
Below the Poverty Level	85,995	272,800	25,076

9.5.2 Property

Table 9-14 shows OCTA's infrastructure vulnerable to a 100-year storm. Tables 9-15 to 9-17 are OCTA's buildings, land parcels, and infrastructure exposed to predicted temperature increases for the year 2035. Tables 9-18 to 9-20 show the areas affected with predicted temperature increases for 2070.

Table 9-14 – OCTA Infrastructure and Related Operations Exposed to Stormwater Inundation in a 100-Year Storm

Land Type	Miles
Bus Route	2.80
I-405 Freeway	0.230
Other Freeway	0.285

Land Type	Miles
Metrolink Rail	0.01
Total	**3.325**

Table 9-15 – OCTA Buildings Exposed to Predicted Temperature Increases to the Year 2035

Building Type	1.5-2 Degrees	2-2.5 Degrees	2.5-3 Degrees
Bus Stops	1242	4236	4
Fullerton Park-and-Ride	0	1	0
Brea Park-and-Ride	0	1	0
Streetcar Stop	0	13	0
Garden Grove Transit Base	0	5	0
Total	**1,242**	**4,256**	**4**

Table 9-16 – OCTA Environmental Areas Exposed to Predicted Temperature Increases to the Year 2035

Land Use Type	1.5-2 Degrees	2-2.5 Degrees	2.5-3 Degrees
Bobcat Ridge (proximal to the City of Lake Forest)	0	48.90	0
Eagle Ridge (proximal to the City of Brea)	0	0	296.90
Live Oak Creek (proximal to the City of Lake Forest)	0	82.54	0
Pacific Horizon (proximal to the City of Laguna Beach)	152.71	0	0
Silverado Chaparral (proximal to Silverado Canyon)	0	204.59	0
Trabuco Rose (proximal to Trabuco Canyon)	0	400.58	0
Wren's View (proximal to Trabuco Canyon)	0	116.96	0
Total	**152.71**	**853.57**	**296.9**

Table 9-17 – OCTA Infrastructure in Miles Exposed to Predicted Temperature Increases to the Year 2035

Infrastructure Type	1.5-2 Degrees	2-2.5 Degrees	2.5-3 Degrees
Bus Route	339.20	1009.59	1.06
I-405 Freeway	19.139	69.314	0
SR-91 Freeway	0	66.538	0
Other Freeway	159.095	375.994	2.206
Metrolink Rail	19.16	44.06	4.17
Pacific Electric ROW	0	11.79	0
Streetcar Route	0	5.05	0
Total	**536.594**	**1582.336**	**7.436**

Table 9-18 – OCTA Buildings Exposed to Predicted Temperature Increases to the Year 2070

Building Type	2-2.5 Degrees	2.5-3 Degrees	3-3.5 Degrees
Fullerton Park and Ride	0	0	1
Brea Park and Ride	0	0	1
Streetcar Stop	0	13	0
Garden Grove Transit Base	0	4	1
Total	**0**	**7**	**3**

Table 9-19 – OCTA Environmental Areas in Acres Exposed to Predicted Temperature Increases to the Year 2070

Land Use Type	2-2.5 Degrees	2.5-3 Degrees	3-3.5 Degrees
Bobcat Ridge (proximal to the City of Lake Forest)	0	48.90	0
Eagle Ridge (proximal to the City of Brea)	0	0	296.90
Live Oak Creek (proximal to the City of Lake Forest)	0	82.54	0
Pacific Horizon (proximal to the City of Laguna Beach)	152.71	0	0
Silverado Chaparral (proximal to Silverado Canyon)	0	33.24	171.35
Trabuco Rose (proximal to Trabuco Canyon)	0	400.58	0
Wren's View (proximal to Trabuco Canyon)	0	116.96	0
Total	**152.71**	**682.22**	**468.25**

Table 9-20 – OCTA Infrastructure in Miles Exposed to Predicted Temperature Increases to the Year 2070

Infrastructure Type	2-2.5 Degrees	2.5-3 Degrees	3-3.5 Degrees
Bus Route	83.36	1023.55	242.95
I-405 Freeway	33.07	501.24	157.97
SR-91 Freeway	0	88.452	0
Other Freeway	0	8.090	58.448
Metrolink Rail	4.30	34.88	28.20
Pacific Electric ROW	0	11.79	0
Streetcar Route	0	5.052	0
Total	**120.73**	**2745.754**	**856.658**

9.5.3 Critical Facilities

Critical facilities vulnerable to temperature increases are in Tables 9-21 and 9-22.

Table 9-21 – OCTA Critical Facilities Exposed to Predicted Temperature Increases to the Year 2035

Building Name	1.5-2 Degrees	2-2.5 Degrees	2.5-3 Degrees
Transportation Security Operations Center			1
Total	**0**	**0**	**1**

Table 9-22 – OCTA Critical Facilities Exposed to Predicted Temperature Increases to the Year 2070

Building Name	2.5-3 Degrees	2-2.5 Degrees	3-3.5 Degrees
Transportation Security Operations Center			1
Total	**1**	**0**	**1**

9.5.4 Environment

Severe storm and drought events can radically affect the physical environment, altering surface geography and temporarily altering waterways. Some severe weather types can influence the environment significantly in a short time, such as highly destructive tornadoes. Other severe weather forms can have slower harmful impacts, like prolonged heavy rain and more frequent and intense heatwaves. Higher temperatures and prolonged droughts reduce air quality and can be detrimental to vegetation. Secondary hazards such as flooding, coastal erosion, mass earth movements, and wildfires can change the ground's surface, contaminate drinking water, change floodplains and waterways, and reduce vegetation. Cascading issues like downed powerlines can instigate wildfires, damaging the environment. These environmental impacts can impair or destroy OCTA's buildings, infrastructure, alter their land, and adversely affect customers and staff health.

9.6 Development Trends

All future development is at risk of severe weather hazards. Primary hazards from thunderstorms can have immediate effects on OCTA's development projects, such as destructive tornadoes, direct lightning strikes, and large hail; unfortunately, it is impossible to predict precisely when and where these risks will occur. OCTA can mitigate the impacts on development projects by receiving local weather alerts and warnings and following the recommended strategies.

OCTA regularly has new projects in development and updating or renovation projects to improve existing development. The planning area expects future population growth (United States Census Bureau, 2018). To manage growth and minimize the risk of these hazards, OCTA consistently develops and updates development plans with the best available data and science. These plans include:

- The 2014-2019 Strategic Plan
- 2018 Transit Vision Final Report
- The OC Rail Climate Defense Plan, in progress
- 2018 Long-Range Transportation Plan
- 2019 Capital Programming Policies

9.7 Issues

Issues associated with severe weather in the OCTA planning area:

- The older structures are especially vulnerable to severe weather events.
- Extended droughts and more frequent and intense heatwaves can extend project timelines with heat-illness prevention measures.
- Modern/current building codes, stormwater management, and electrical systems can minimize the risks associated with lightning, high winds, heavy rains, and hail.

9.8 Hazard Maps

The hazard maps for predicated temperature increases in the planning area start on the next page.

Figure 9-2 – OCTA Average Maximum Temperature Increase: Baseline to the Year 2035

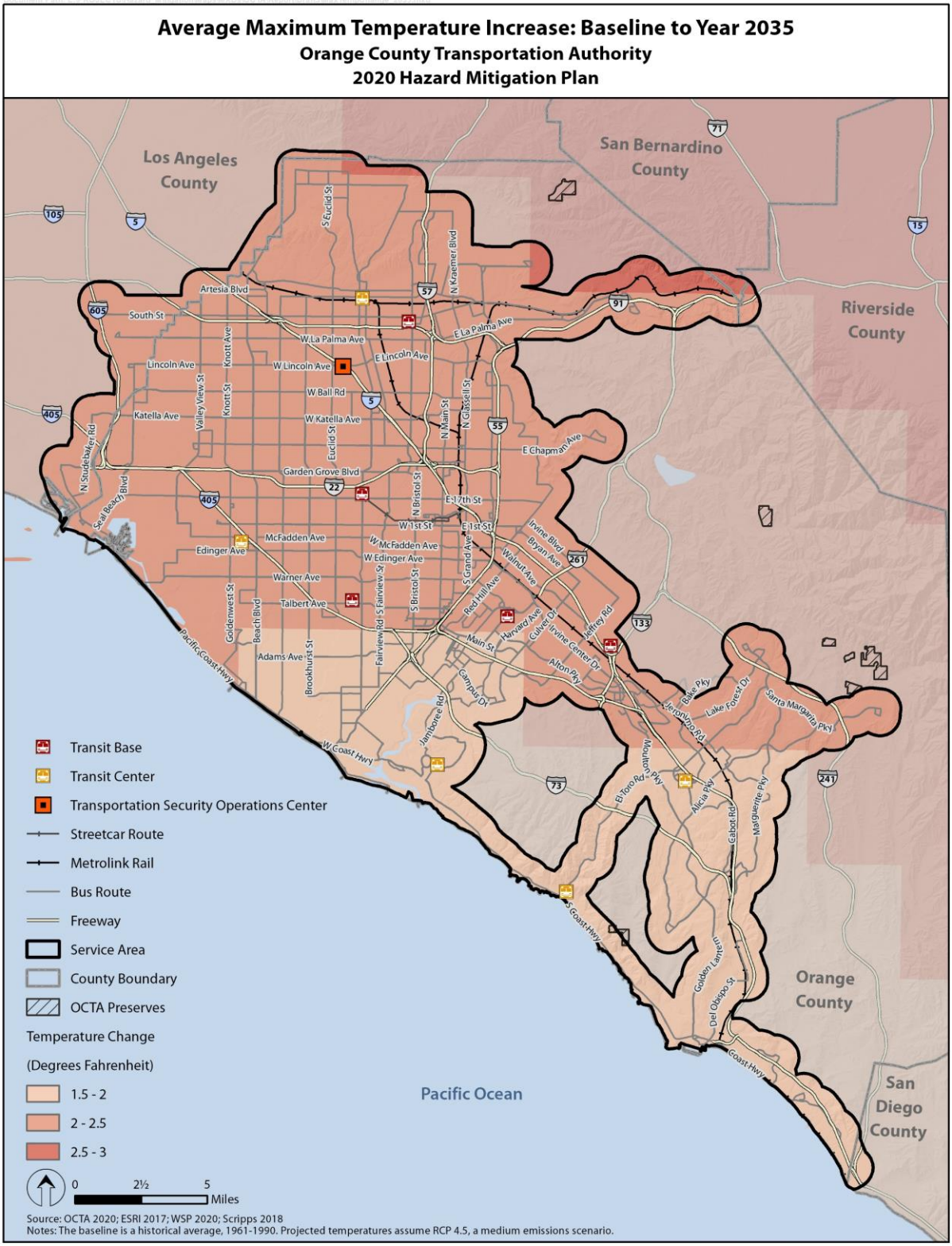
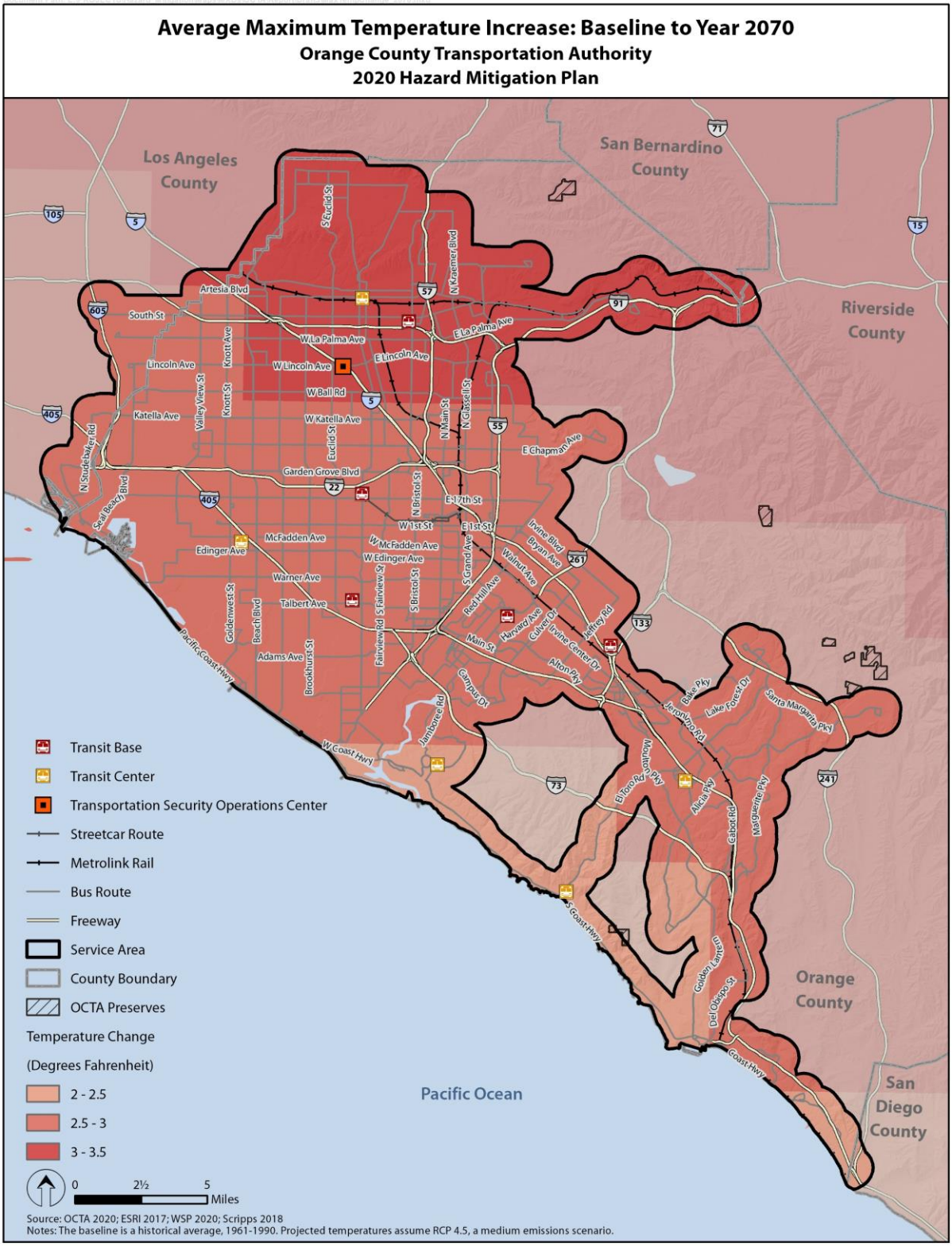


Figure 9-3 – OCTA Average Maximum Temperature Increase: Baseline to the Year 2070

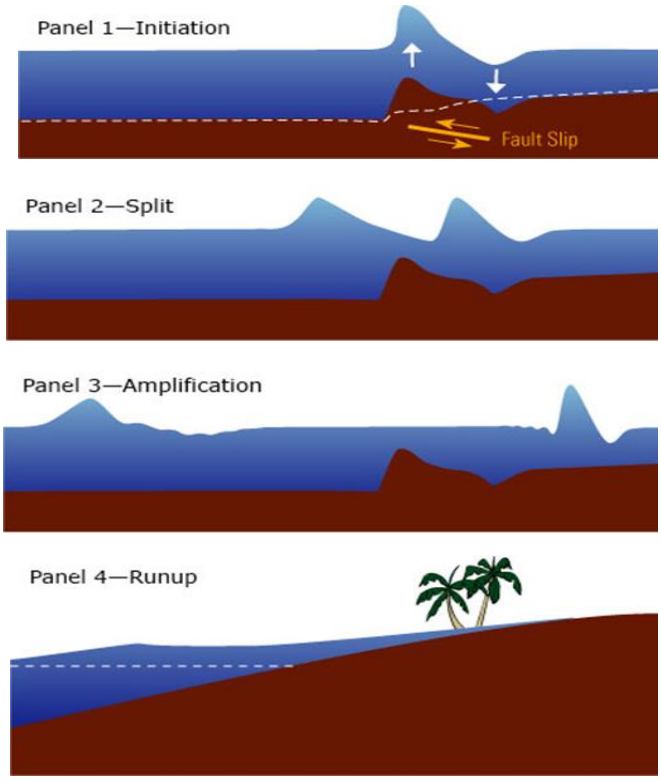


10 Tsunami

10.1 General Background

Tsunamis are sizable waves caused by earthquakes, volcanic eruptions, landslides under the sea that impact coastlines, or major landslides from the shore that drop significant amounts of debris into water bodies (National Oceanic and Atmospheric Administration, 2019). As waves travel inland, they build to higher heights as the ocean's depth decreases (National Oceanic and Atmospheric Administration, 2019). Figure 37 shows how a water body is affected by an earthquake along a fault, generating a tsunami that inundates the coastline.

Figure 10-1 – Earthquake Triggered Tsunami Process (United States Geological Survey, 2006)



DEFINITIONS

Runup – a measurement of the height of the water onshore observed above a reference sea level.

Tsunami – comes from the Japanese words for *harbor* ("tsu") and *wave* ("nami"); a long high sea wave caused by an earthquake, submarine landslide, or other disturbance.

Tsunami from a large undersea earthquake – the earthquake must cause significant vertical deformation on the seafloor for a tsunami to occur.

Tsunami Advisory – issued when strong currents and dangerous waves of one to three feet are expected.

Tsunami Warning – issued by PTWC when a potential tsunami with significant widespread inundation is imminent or expected.

Tsunami Watch – issued when an event may later impact the watch area; may be upgraded to tsunami warning.

Seiches – a standing wave/oscillation in an enclosed or partially enclosed body of water that varies in a period from a few minutes to several hours.

Tsunami-generated waves can reach heights of over 100 feet and travel at speeds over 500 miles per hour, the same speed as a commercial jet plane (National Oceanic and Atmospheric Administration and National Weather Service, 2018). If a tsunami is close to the coastline, populations may only have minutes to prepare (United States Geological Survey). Major tsunamis occur globally about once per decade; 59 percent of the world's tsunamis occur in the Pacific Ocean, 25 percent in the Mediterranean Sea, 12 percent in the Atlantic Ocean, and four percent in the Indian Ocean (National Oceanic and Atmospheric Administration and National Weather Service, 2020).

10.1.1 Potential Damage from Tsunamis

Areas most at risk are near the coastline and waterways connected to the ocean, such as beaches, bays, lagoons, harbors, river mouths, and areas along rivers and streams. The coastline is where the water surges the highest and with the most force. Tsunamis also increase currents near the coastal waterline, damaging boats in the area and pulling people in the water farther out to sea. Destruction can occur inland as tsunamis carry large amounts of water and debris into coastal waterways and land. As the water surge recedes to the shore, it can also drag debris and people into the water body.

NOAA explains, even six inches of rapidly flowing water can push an adult over, while 12 inches of fast-moving water can carry larger objects like cars, trees, and small boats (National Oceanic and Atmospheric Administration, 2018). The influx of quickly flowing water and everything the water carries can impact anything in its path, including ships, harbors, buildings, infrastructure, natural and cultural resources, and people. Although tsunami waves are known to cause damage, there are other hazards associated with tsunamis, such as land erosion and flooding. Flooding, SLR, and Erosion are in Section 7.

10.2 Orange County Transportation Authority Hazard Profile

The Orange County coastline is the most at risk of severe damage due to tsunamis; however, tsunamis can also push large amounts of water up waterways and flood areas around ocean-connected channels. Figure 10-3 shows land within the planning area that is exposed to a tsunami and associated flood zones.

OCTA 2011 Tsunami Narrative

In March 2011, a massive earthquake occurred off of Japan in the Pacific Ocean. This event devastated the Japanese coastline and sent a significant tsunami across the Pacific to the west coast of the US. OCTA activated its Emergency Operation Center and began pre-planning for the wave's arrival. Coastal bus routes were reviewed and detours implemented; Metrolink operations were consulted and placed on standby; and busses were readied to assist with evacuations if needed. At approximately 1300 on March 11th, all beaches were opened and OCTA operations returned to normal.

After the 1864 magnitude 9.2 earthquake in Alaska, there were tidal surges in Huntington Harbor that reached four to five feet (County of Orange and Orange County Fire Authority, 2015). A more recent tsunami in 2010 produced three-foot waves in Orange County, causing officials to close almost every beach and pier in the County (County of Orange and Orange County Fire Authority, 2015). For the same tsunami, the City of Newport Beach sent out automated alerts warning residents to avoid the beaches, and parts of Dana Point Harbor were closed. These events show a precedent for tsunamis in the planning area and examples of how they can impact staff, customers, residents, and visitors.

Earthquakes are the primary cause of tsunamis, and there are hundreds of earthquake zones and active faults in and around the OCTA planning area. These fault zones and seismic hazards are detailed in Section 5 of this plan. Past earthquakes that reached a "great" magnitude class (M > 8) in other regions of the world resulted in tsunamis that struck OCTA's coastline.

10.2.1 Hazard Ranking

The Planning Team completed a hazard ranking survey during the OCTA 2022 HMP development process and assessed hazard-related factors based on worst case and most likely scenarios. Hazard definitions and ranking factors are in Appendix G, Table G-1. The variables of severity, magnitude, frequency, onset, and duration are scored one to five, with one as the lowest and five as the highest. Survey results were

prioritized and ranked based on their average score. Compared to the other hazards in the survey, tsunamis were the sixth worst-case scenario and the seventh most likely scenario.

Table 10-1 – OCTA Tsunami Hazard Ranking

Severity	Magnitude	Frequency	Onset	Duration	Average	Rank
Worst-Case Scenario						
3.73	3.00	1.45	4.18	1.82	2.84	6
Most Likely Scenario						
2.18	2.18	1.09	3.45	2.00	2.18	7

10.2.2 Past Events

Table 10-2 lists seismic-triggered tsunami events that impacted the planning area between 1900 to 2019 and the damage these events caused.

Table 10-2 – History of Tsunami Events in OCTA's Planning Area (Uslu, Eble, Titov, & Bernard, 2010) (Los Angeles County Office of Emergency Management, 2019) (County of Orange and Orange County Fire Authority, 2015)

Date	Source	Magnitude	Damage/Effect
1922	Chile	8.3	Strong currents all along the coast of CA.
1946	Aleutian Islands	8.8	Broke ships from their moorings and had beach run-up heights from 1-6 feet in Catalina Island, Los Angeles, and Long Beach.
1952	Kamchatka	9.0	Beach run-up heights of 1-2 feet in Santa Monica, Los Angeles, and Long Beach.
1957	Aleutian Islands	8.3-8.6	San Diego had damage to ships and docks, run-up from 1-2 feet in Santa Monica, Los Angeles, and Long Beach.
1960	Chile	9.5	Beach run-ups were 2-5 feet in Catalina Island, Los Angeles, Long Beach, and Santa Monica. One death, 800 small marine craft unmoored, 200 boats damaged, and 40 boats sunk.
1964	Alaska	9.2	Beach run-ups were 2-3 feet in Catalina Island, Los Angeles, Long Beach, and Santa Monica. One death, 100 boats unmoored, and 7 boats sunk – approximately $350 thousand in damages.
2010	Chile	8.8	Run-up heights of 1-3 feet in Catalina Island, Los Angeles, Long Beach, and Santa Monica. Minor damage to docks and boats. Orange County closed most beaches. Newport Beach recommended residents avoid the beach. Dana Point Harbor's bait barge was broken into two pieces.
2011	Japan	9.0	Beach run-up of 2-3 feet in Catalina Island, Los Angeles, Long Beach, Redondo Beach, and Santa Monica. Damage to docks and boats.

10.2.3 Location

There are two types of seismic tsunami triggers along the California coast, local sources, and distance sources (California Department of Conservation). Local sources of seismic activity are more likely to generate a tsunami affecting the California coast (California Department of Conservation). The 1964 Alaska earthquake is an example of a local seismic tsunami trigger that significantly impacted the California coastline. In contrast, seismic triggers with a high magnitude farther out in the Pacific generally

caused smaller tsunamis and less damage to the state (Uslu, Eble, Titov, & Bernard, 2010). The OCTA planning area most susceptible to damage from a tsunami hazard is on the coast, shown in Figure 10-3.

10.2.4 Frequency

As described in Section 10.1, tsunamis occur due to significant water displacement from events such as earthquakes, volcanic eruptions, and landslides; therefore, the frequency of tsunamis is relative to the frequency of events that cause them. OCTA has experienced tsunamis across the planning area. These events listed in Table 10-2 reveal the risks to the planning area; unfortunately, it is difficult to predict how often or exactly when the next tsunami will happen.

10.2.5 Severity

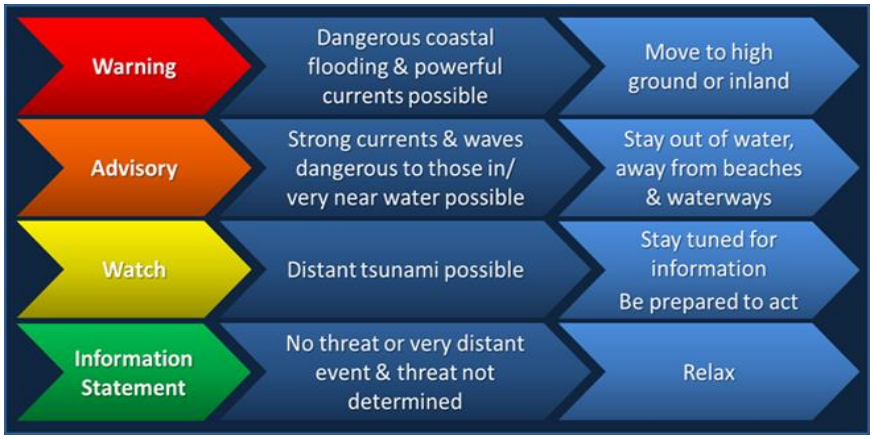
Tsunami severity depends on three factors: the trigger site's location relative to the impact area, magnitude or size of the triggering event, and depth of the trigger event. Most earthquake-generated tsunamis come from magnitudes 7.0 and greater in shallower water, less than 62 miles below the surface (National Oceanic and Atmospheric Administration). The earthquake must be large enough and close enough to the water surface to generate a significant wave or series of waves classified as a tsunami. A tsunami's height and impacts are influenced by local water depth, seafloor or ground topography, and the direction the tsunami comes from (National Weather Service). The damage from a tsunami can range from minimal to substantial, depending on the tsunami's severity. Even a six-foot tsunami can bring powerful currents that can knock a person over and carry them away (United States Geological Survey).

10.2.6 Warning Time

The time before a tsunami hits can vary from minutes to hours. However, not every event will produce a tsunami. To produce more accurate predictions, the NOAA tsunami warning centers use a vast network of sensors to determine which events will most likely result in a tsunami; when a tsunami is predicted, the centers then issue warnings to the appropriate locations (National Oceanic and Atmospheric Administration, 2018). There are four tsunami alert types defined by the NWS, listed in Figure 10-2. There are also natural signals before a tsunami arrives, such as (National Oceanic and Atmospheric Administration and National Weather Service, 2020):

- Severe ground shaking from local earthquakes
- Water receding from the coast and exposing the ocean floor, reefs, and fish, and abnormal ocean activity
- A wall of water creating a loud roaring sound like a train or jet aircraft

Figure 10-2 – NWS Tsunami Notification Levels (National Weather Service)



10.3 Secondary Hazards and Cascading Impacts

10.3.1 Secondary Hazards

After the initial wave hitting the coastline, tsunamis can generate several secondary hazards. The most common secondary hazard is flooding. High wave action and strong currents can significantly speed up natural erosion along the coast and connected waterways. Flooding, sea level rise, and erosion hazards to the planning area are addressed in Section 7. Water-saturated coastal cliffs can have mass earth movements.This hazard is described in Section 8. The extent of these risks depends on the severity of the tsunami and the amount of land inundated.

10.3.2 Cascading Impacts

Tsunamis can carry tons of debris, which endangers human life, and OCTA's property and infrastructure. Damage or destruction of transportation infrastructure can affect OCTA's services, economy, suppliers, businesses, and customers who rely on their services. The seriousness of the impact varies depending on the specific critical structures, infrastructure, and/or hazardous materials in the waves' path. Coastal structures such as breakwaters, piers, port facilities, and public utilities may get swept away by the water or collapse from the foundation, eroding after the water recedes. Ships moored in marinas or harbors may be destroyed or washed up onto the shore. Impacted vessels and coastal facilities can release hazardous materials into the environment. Harmful materials can be structure debris itself or anything hazardous the facilities and vessels contained. These materials could contaminate the floodwater and potentially drinking water.

10.4 Potential Impacts from Future Climate Conditions

Future climate conditions have no known effect on earthquakes that may cause tsunamis (Buis, 2019). However, as sea level rise increases, so do the tsunami hazard zone; the extent depends on the height of the sea level rise.

10.5 Exposure

10.5.1 Population

The 2015 Orange County HMP states the County's entire coastline could be impacted, and approximately 80,000 residents would have to be evacuated (County of Orange and Orange County Fire Authority, 2015). This number does not reflect population growth since 2015 or visitors to the area. Orange County alone had more than 50 million visitors in 2018 (De Nova, 2019). Visitors are more vulnerable since they do not know the tsunami hazards or evacuation routes or do not receive alert notifications.

Intersecting OCTA bus stop ridership and US Census planning area data with geospatial hazard data for tsunamis show population exposure and social vulnerability. Table 10-3 shows the OCTA bus ridership exposed to a tsunami, a quarter of a million boardings in 2019.

Table 10-3 – Bus Stop Ridership Exposed to the Tsunami Inundation Area

Ridership	Tsunami Exposure
Total	274,235

10.5.1.1 Vulnerability

The CDC defines three types of human health risks from a tsunami: immediate secondary, and long-lasting (Center for Disease Control, 2013). In the immediate aftermath of a tsunami, people can be trapped by debris or water. The secondary tsunami concern is food and potable water contamination and requires temporary shelter for displaced people.

Direct impacts to OCTA customers could mean adjusting transportation routes to support displaced residents. Secondary problems can include disease and illness spread from contaminated food and drinking water and dead remains of animals or humans before removing or inadequate sanitation in shelters and temporary living situations. Standing floodwater can also cause insect population growth, spreading disease, or consuming food supplies. Epidemic/Pandemic hazards are in Section 6.

Table 10-4 shows the populations at risk from tsunamis, with children, seniors, and those below the poverty level, especially at risk. They may need more assistance with transportation during evacuations.

Table 10-4 – Populations at Risk from Tsunamis

Populations	Tsunami Exposure
Black	3,651
American Eskimo	1,413
Asian	29,826
Hawaiian/Pacific Islander	558
Hispanic	86,939
Multiple Races	10,269
Children up to 19 Years Old	65,208
65 Years and Older	31,284
Below the Poverty Level	34,328

10.5.2 Property

A tsunami on the coastline is likely to significantly impact OCTA property in these inundation zones. The inundation line shows where the water will surge inland along smaller waterways.

Table 10-5 – OCTA Infrastructure Exposed to Tsunami Inundation Zones

Infrastructure Type	Miles
Bus Route	39.95
Other Freeway	0.12
Metrolink Rail	3.20
Total	**43.27**

10.5.2.1 Vulnerability

All structures and property located along tsunami inundation areas would be vulnerable, especially during events with little to no warning time.

10.5.3 Environment

A tsunami can change the surface of the land above and below the water. In some areas, the tsunami can push the ground farther up it, and in other areas, the water can erode the ground, lowering the surface. If the tsunami pushes water up waterways, it can expose new areas to flooding. Tsunami debris can clog waterways and leave a path of wreckage on the land when the water recedes. Depending on the severity of the tsunami, environmental changes can include permanent modifications to beaches and coastal features, and freshwater sources can be contaminated by saltwater or hazardous materials released by the tsunami. These environmental impacts can affect OCTA customers and the planning area with changes to the land, flood zones, debris damage, and public health issues.

10.6 Development Trends

In the Orange County General Plan, Chapter X Housing Element estimates future population numbers, characteristics, and housing needs. The plan's housing element was most recently updated in 2013, where expected growth from 2000-2012 was 7.4 percent (Orange County, 2013). As indicated in Figure 10-3, the OCTA planning area with the highest risk of tsunami damage is the coastline and coastal waterways.

The Orange County *Local Hazard Mitigation Plan* (LHMP) addresses tsunami risks in the planning area (County of Orange and Orange County Fire Authority, 2015). The LHMPs identify the hazard causes, probability, and potential damage. The Orange General Plan directs land use, addresses growth management, and establishes standards and plans to protect the community from hazards (Orange County). Development is safely regulated through building standards and performance measures to reduce risk. OCTA will continue to follow development codes, regulations, and laws to minimize or remove tsunami risks on renovations and new projects.

10.7 Issues

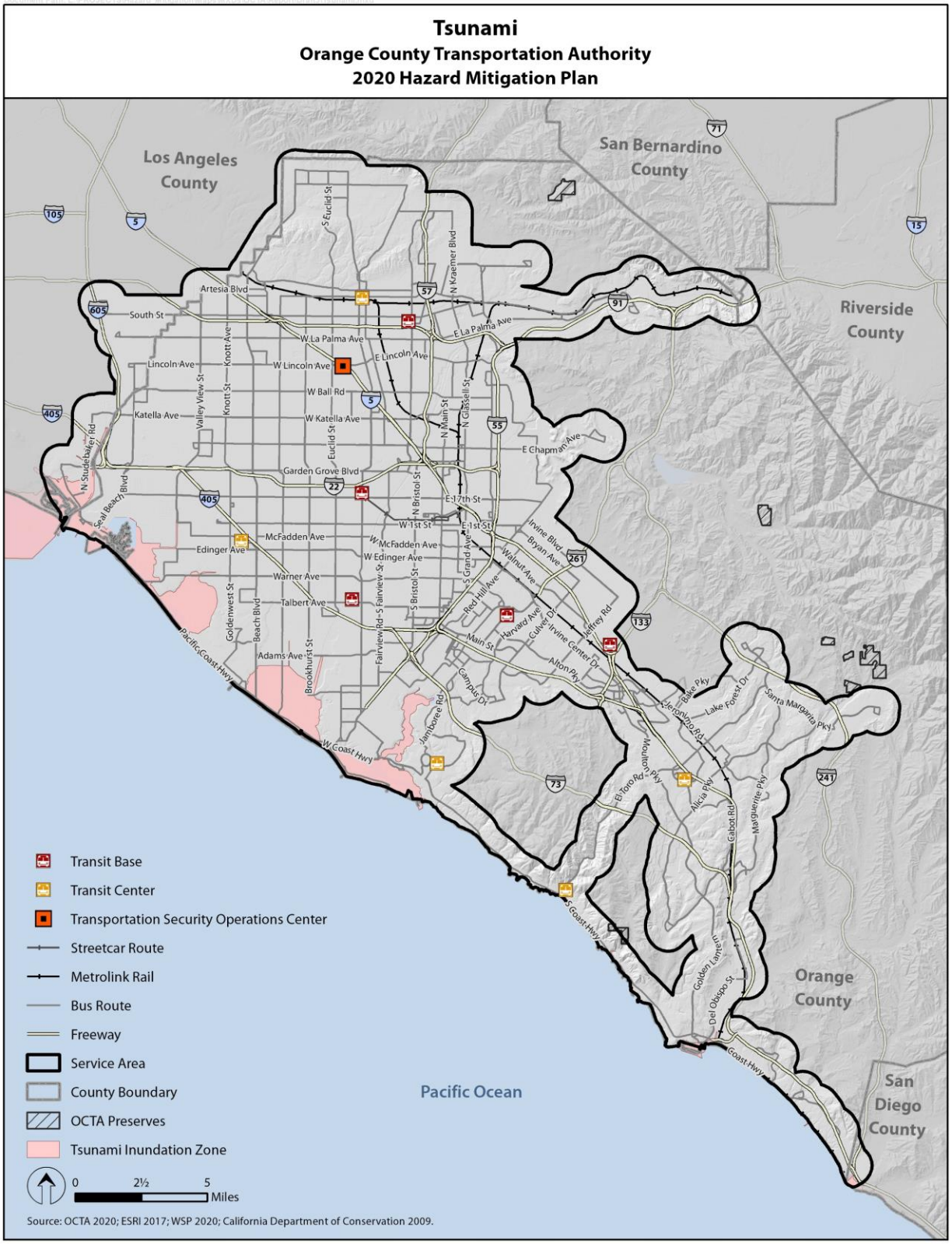
Issues associated with severe weather in the OCTA planning area:

- Tsunami science and technology are continually evolving. Therefore, hazard maps should be regularly reviewed and updated.
- Monitor tsunami warning systems and update as new versions or technologies are released.
- Continue to assess SLR's potential impacts on tsunamis as new data and models update predictions.

10.8 Hazard Map

The hazard map for tsunami risks in the planning area is on the next page.

Figure 10-3 – OCTA Tsunami Hazard Map

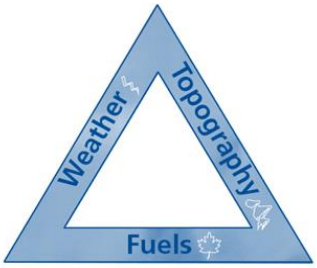


11 Wildfires

11.1 General Background

A wildfire, or wildland fire, is an unplanned fire that burns uncontrolled in forests, grasslands, brushlands, or croplands (Editors of Encyclopedia Britannica, 2020). The name refers to the fire's characteristics and region (Editors of Encyclopedia Britannica, 2020). There are two types of wildfires, ground, and surface. Ground fires burn underground into the vegetation's roots; this is most common when a thick layer of flammable organic matter is in the soil's top layer (National Geographic Society, 2019). Surface fires burn vegetation above the soil. A wildfire fire's behavior depends on three key factors, weather, topography, and fuel, in Figure 11-1.

Figure 11-1 – Wildfire Behavior Triangle (National Park Service, 2017)



Wildfires can occur year-round due to natural and human-caused ignitions. The most common natural cause of wildfires is lightning, although volcanoes and meteors can also generate wildfires (United States Department of the Interior Indian Affairs). These natural hazards can ignite fires; however, nearly 85 percent of wildfires in the US are caused by human activity (e.g., campfires and arson) (National Park Service, 2018).

Massive wildfires are more common during droughts and warmer seasons due to drier vegetation and soil, lower groundwater levels, and less precipitation. High winds can exacerbate warm, dry conditions, and spread wildfires considerably further. The US Forest Service Southern Research Station administered a report that studied the conceptual model that shows the relationship between ignition types, prevention methods, and extent factors in Figure 11-2 (Prestemon, et al., 2013). This model demonstrates the complicated nature of wildfire causes, severity, spread, and management. It can assist organizations in understanding all aspects of wildfire risks and develop effective mitigation strategies.

DEFINITIONS

Crown Fire – a type of fire that burnt through the top layer of trees, called the canopy. They are the most intense and difficult to contain.

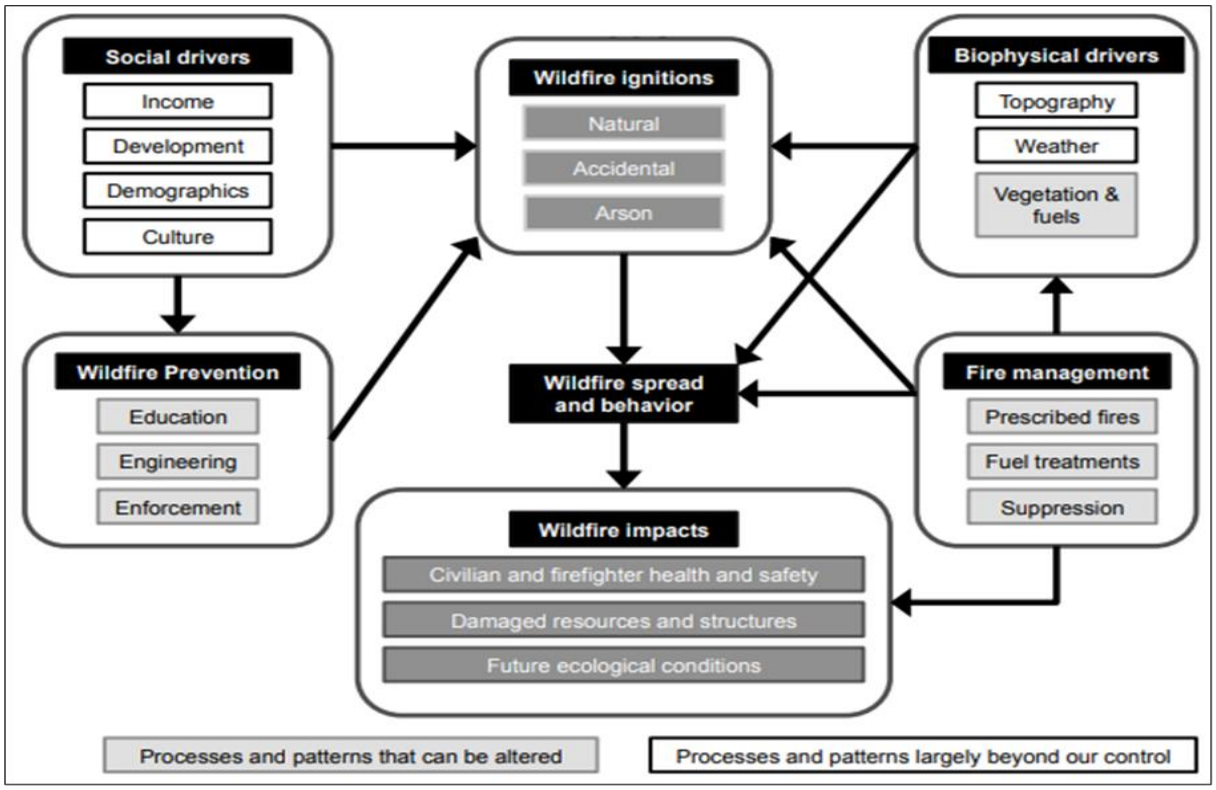
Fuels – materials that burn in a fire, such as paper products, flammable gases or chemicals, or wood products. The material composition determines how flammable it is, based on moisture level, chemical makeup, and material density. The less moisture and lower density, the faster and hotter it burns.

Terrain/Topography – the ground's slope can help or halt the spread of a wildfire. Large gaps in vegetation or waterways such as rivers and creeks can stop a wildfire from spreading. Fires also move faster upslope than down due to elevation changes and warm air rising.

Wildland Urban Interface Area – an area susceptible to wildfires and where wildland vegetation and urban or suburban development occur together. An example would be smaller urban areas and dispersed rural housing in forested areas.

Wildfire – fires that result in uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas. Because of their distance from firefighting resources, they can be difficult to contain and cause a great deal of destruction.

Figure 11-2 – Cohesive Strategy Wildfire Ignitions and Prevention Conceptual Model (Prestemon, et al., 2013)



11.1.1 Potential Damage from Wildfire

Wildfires pose a considerable risk to property, human life, and economies, as shown below (Western Forestry Leadership Coalition, 2010):

Buildings:	**People:**	**Economies:**
Insured and uninsured property loss	Loss of income	Lost revenues
Secondary hazards	Healthcare expenses	Infrastructure disruptions:
	Injuries or fatalities	Communications
	Evacuation displacement	Transportation
	Reduced air and water quality	Utilities

Wildfires can scorch vast areas of land, timber, and wildlife habitats (United States Forest Service). Fires can reduce the quality of drinking water and the air (World Health Organization). Additional health effects can be injuries, smoke irritation, and exacerbated medical conditions. They can also lead to cascading impacts, such as local businesses closing, hurting the area's economy. Wildfires can be extremely costly for government agencies, public and private businesses, and individuals. US wildfire loss costs from 2010-2019 ranged between a couple of million dollars to $24 billion, with the worst years in 2017 and 2018 by far (Insurance Information Institute, 2020). Hazardous materials can be released into the environment by damage to transportation and buildings that contain the materials. Secondary hazards and cascading impacts are in Section 11.3.

11.2 Orange County Transportation Authority Hazard Profile

Wildfires regularly occur within the planning area on an almost yearly basis. Tables 11-2 and 11-3 list some significant events that occurred in the past, which show how wildfires pose a substantial threat to life and property. Additionally, wildfires can damage or destroy infrastructure, utilities, and transportation services. Figure 11-4 displays those areas exposed to three different wildfire risk zones within the planning area, while Figure 11-5 indicates the Wildland Urban Interface Zones exposed to wildfire risks. The Orange County HMP identifies the WUI as the highest risk from wildfire damage (County of Orange and Orange County Fire Authority, 2015).

The following issues are substantial fire protection challenges in the urban area (County of Orange and Orange County Fire Authority, 2015):

- Multiple story high-density wood frame developments
- Large areas with developments close to each other that have combustible roofing materials
- Transportation of hazardous materials via air, rail, road, water, and pipeline
- Natural disasters that ignite wildfires and can make them more frequent and severe

The summer Santa Ana winds have a significant effect, spreading wildfires in the area. These high winds coming from inland and moving towards the coast spread fires farther, add oxygen to the fires, and the warm temperatures make ignition easier (County of Orange and Orange County Fire Authority, 2015).

11.2.1 Hazard Ranking

The Planning Team completed a hazard ranking survey during the OCTA 2022 HMP development process. The hazard factors are based on the worst-case and most likely scenarios. Definitions of the hazard ranking factors are in Appendix G, Table G-1. The survey results for each hazard were averaged to generate a score and rank, prioritizing the hazards. The variables of severity, magnitude, frequency, onset, and duration are scored one to five, where one is the lowest and five is the highest. When compared against the

OCTA Wildfire Narrative

2020 Bond Fire: Resulted in the evacuation of several WUI communities. This event moved near OCTA's Irvine Sand Canyon Bus Base, which housed paratransit operations. The base and its assets were evacuated for three days as a protective measure. Previous planning efforts meant operations were maintained during the relocation with no disruptions. The fire did not reach the base due to successful firefighting.

2017 Canyon 2 Fire: The fire started in Coal Canyon, spreading rapidly. It impacted several communities and the Operational Area (OA) EOC, triggering multiple city and counties to also activate EOCs. The OC Sheriff requested four cutaway busses to transport responders from Great Park to the OA EOC due to limited parking. Also, there were 40 OCTA busses on standby for evacuations. Bus routes in affected areas were rerouted.

2008 Lake Forest Value Inn Fire: OCTA was requested to transport 14 residents of the Americas Best Value Inn to a local reception site at El Toro High School.

2008 Freeway Complex Fire: OCTA was requested to be on stand by for evacuation support of communities. OCTA responded with 4 vehicles, 15 staff and logged 120.25 staff hours of involvement for the event.

2007 Santiago Fire: OCTA was asked to support emergency worker transportation and James A. Musick detention facility evacuation. Additionally, OCTA provided "bus bridge" services for Metrolink passengers, as rail lines were damaged and unusable. During this event, OCTA applied 695 hours and transported 1264 passengers.

other hazards included in the hazard ranking survey, wildfires were the first worst-case scenario and the first most likely scenario.

Table 11-1 – OCTA Wildfire Hazard Ranking Output

Severity	Magnitude	Frequency	Onset	Duration	Average	Rank
Worst-Case Scenario						
3.82	4.18	4.55	4.18	2.91	3.93	1
Most Likely Scenario						
3.73	3.64	4.45	4.00	3.55	3.87	1

11.2.2 Past Events

In Section 11.1.1, there were several wildfires damage categories identified. OCTA and its customers may experience direct wildfire damage to structures and infrastructure or indirect results across the entire area, such as health risks. Some of the most significant fires that affected the planning area. These two counties experienced wildfires that made the top twenty list of largest, most destructive, and deadliest fires, shown in Table 11-2.

Table 11-2 – California's 20 Largest, Most Destructive, and Deadliest Wildfires in the Planning Area (CalFIRE, 2021)

Category	Date	Acres	Structures	Deaths
Deadliest	October 1933	47	0	29
Deadliest	October 1943	13,145	0	11
Deadliest	September 1955	1,150	0	6
Deadliest	November 1956	43,904	0	11
Deadliest	November 1966	2,028	0	12
Deadliest	August 1968	22,197	0	8
Largest	September 1970	175,425	382	5
Deadliest, Most Destructive, and Largest	10/2003	273,246	2,820	15
Deadliest, Most Destructive, and Largest	10/2007	197,990	1,650	2

A comprehensive list of wildfire events between 1969 and 2010 in the planning area, resulting in a disaster declaration is in Appendix G, Table G-4. Table 11-3 below shows the 12 wildfire events recorded by NOAA in both counties that resulted in deaths, injuries, and or over $25,000 in damages.

Table 11-3 – Historic Severe Wildfire Events in the Planning Area (National Oceanic and Atmospheric Administration)

Date of Event	Deaths/Injuries	Property Damage Value Above $25,000
10/21/1996	16 injuries	$1,500,000
10/21/1996	0	$3,000,000
8/2/2000	0	$100,000
9/11/2000	2 injuries	-
1/23/2002	1 injury	-

Date of Event	Deaths/Injuries	Property Damage Value Above $25,000
2/9/2002	0	$1,200,000
5/13/2002	0	$250,000
9/1/2002	14 injuries	$12,700,000
1/23/2002	1 injury	-
9/22/2002	14 injuries	$15,300,000
11/20/2002	2 injuries	-
2/6/2006	8 injuries	-

11.2.3 Location

Figure 11-4 shows fire hazard severity zones from moderate to very high within the planning area. Figure 11-5 displays the WIU in the OCTA planning area. Cal FIRE also maps California areas with significant fire hazards by weighting fuels, terrain, and weather factors (California State Geoportal, 2020). These areas are divided into three Fire Hazard Safety Zones – moderate, high, and very high (California State Geoportal, 2020). In the planning area, WUI areas are often classed as a Very High Fire Hazard Severity Zone, as there are additional risks to people and structures (Orange County, 2017) (California State Geoportal, 2020). The WUI mixed developed land and wildland makes it problematic to predict precisely where and how the fire will spread (Department of Homeland Security Science and Technology, United States Fire Administration, and Federal Emergency Management Agency, 2019).

There are 23 Nationally Recognized Communities at Risk and five communities the Orange County Fire Authority (OCFA) identified as also at risk, in Table 11-4 below.

Table 11-4 – Orange County Communities at Risk from Wildfires (Orange County, 2017)

Nationally Recognized Communities at Risk				
Aliso Viejo	Anaheim	Brea	Costa de Caza	Trabuco Canyon
Cowan Heights	Dana Point	Fullerton	Irvine	Trabuco Highlands
Laguna Beach	Laguna Hills	Laguna Niguel	Laguna Woods	Villa Park
Mission Viejo	Modjeska	Newport Beach	City of Orange	Yorba Linda
Rancho Santa Margarita	San Clemente	San Juan Capistrano	Silverado	
Additional Orange County Fire Authority Recognized Communities at Risk				
Emerald Bay	Lake Forest	Lemon Heights/North Tustin	Santiago Canyon	Tustin Heights

11.2.4 Frequency

Since 1978, Orange County has experienced over 20 wildfires that exceeded 2,000 acres (County of Orange and Orange County Fire Authority, 2015). Approximately one FEMA declared wildfire disaster occurs in and around OCTA's planning area per year (Federal Emergency Management Agency, 2020). Contrary to historical events, current data shows wildfires can happen any time of year, especially in an unusually warm and dry winter. Climate change effects on snowpack levels in the mountain ranges to the east, precipitation patterns across the State, and high winds coming down from the mountains will contribute to more frequent and severe fires. Based on the risk factors presented and past occurrences,

it is likely that wildland fires will continue to significantly affect the OCTA planning area, caused by natural events and humans.

11.2.5 Severity

In OCTA's planning area, wildfires have caused injuries and death, destroyed, and damaged or destroyed structures and infrastructure. The past events in Tables 11-2 and 11-3 detail some significant wildfire events in the planning area. However, the largest fires are not always the most destructive fires. There are no injuries or deaths in some instances, but the value of property damage is in the millions of dollars; in other events, the cost is below the $25,000 threshold but injured several people. The severity and extent of a wildfire are influenced by the following factors (National Park Service, 2017):

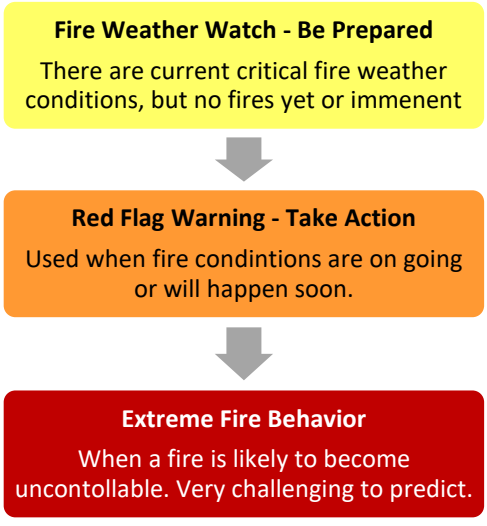
- **Fuel** – Materials that burn in a fire, such as paper products, flammable gases or chemicals, or wood products. The material composition determines how flammable it is, based on moisture level, chemical makeup, and material density. The less moisture and lower density, the faster and hotter it burns. Additionally, some plants have oils or resin that burn more easily, quickly, and/or intensely.
- **Weather** – Fires spread faster in hot, dry, windy weather. Less humidity and precipitation with warmer temperatures make fires easier to ignite. Strong wind adds lots of oxygen to the fire and carries embers, spreading the fires farther. Any combination of these factors makes wildfires more extensive and more severe.
- **Terrain/Topography** – The ground's slope can help or halt the spread of a wildfire. Significant gaps in vegetation or waterways such as rivers and creeks can stop a wildfire from spreading by removing the fuel to feed the fire or making the vegetation too wet to burn. Fires move faster upslope than down due to elevation changes and warm air rising.
- **Populated Areas** – The largest fires are not always the most destructive. While only a portion of the 30,202-acre Freeway Complex Fire in 2008 burned into the incorporated cities, it was in the cities where most of the structural damage occurred. In moderate and densely populated areas, the effects can be more severe for human injuries, loss of life, and/or property damage values.

11.2.6 Warning Time

Since humans cause most wildfires, there is no way to predict every ignition (National Park Service, 2018). However, weather factors that can lead to fire ignition or increase the spread and severity are more predictable, allowing for one to several days of warning time for current wildfire risks (United States Department of the Interior Indian Affairs). Additionally, organizations such as NOAA and the NWS use climate models to predict the next year's wildfire risk level. Past wildfire and weather data are fed into the models along with current conditions, like droughts. Unfortunately, climate change factors alter these models in unpredictable ways, making the annual prediction results less accurate in recent years (Mulkern, 2020).

To estimate wildfire risks for the next 12 to 72 hours, the NWS monitors weather conditions and issue notifications

Figure 11-3 – NWS Wildfire Notification Levels (National Weather Service)



from local NWS offices (CalFire). The NWS San Diego Office covers OCTA's planning area. This office will send out three wildfire notifications depending on the risk level; these levels are described in Figure 11-3. Extreme fire behavior is the most dangerous alert and only happens when one or more of the following conditions exist – spreading fast, significant crowning and/or spotting, there are fire whirls, or there is a strong convection column.

The OCTA planning area can also be at risk from wildfire smoke. The Interagency Wildland Fire Air Quality Response Program, led by the USFS, provides air quality information and maps (United States Forest Service). The program and its prediction models rely on subject matter experts (Air Resource Advisors), air quality monitoring equipment, smoke concentration and dispersion modeling, and coordination with agency partners (United States Forest Service). Predictions and warnings are provided to the public through the EPA's AirNow website.

11.3 Secondary Hazards and Cascading Impacts

11.3.1 Secondary Hazards

Wildland fires can contribute to several secondary hazards such as flooding, mass earth movements, and coastal erosion. Most wildland fires burn hot and long baking soils, especially those high in clay content, increasing the impervious ground area. Impenetrable ground means less water absorbed into the soil, increasing rain and stormwater runoff and raising flood risks (CalFire, 2020).

Vegetation removed by fires increases the risk of flooding frequency and severity. Flooding hazards in the planning area are discussed in Section 7. Less vegetation along slopes also exposes the ground to more water runoff, which increases the potential for mass earth movements and coastal slope erosion. Erosion is addressed more in Section 7. Mass earth movements can even occur several years after a fire before the vegetation has had a chance to extend roots deep into the soil and stabilize the slope. Mass earth movements are covered in Section 8.

11.3.2 Cascading Impacts

Wildland fires can cause cascading impacts such as hazardous materials releases, utility disruptions, higher taxes and utility/infrastructure fees to recoup losses, loss of structures and infrastructure, and water contamination. Hazardous materials can be released when fires spread to buildings, storage areas, or vehicles containing these materials. Depending on the material's reaction to fire, they can be explosive, flammable, release toxic gas or fumes, or contaminate the environment. Wildfires can impair or demolish utilities resulting in cascading impacts such as power outages, broken water lines, natural gas line leaks, structure fires, or communication issues (Sathaye, Dale, Larsen, & Gary, 2011). Ravaged infrastructure can include road and rail transportation systems, earthen dams and levees, water and wastewater systems (Department of Homeland Security, 2016). Damage to public utilities, structures, and infrastructure can raise rates and taxes (California Legislature's Nonpartisan Fiscal and Policy Advisor, 2019).

11.4 Potential Impacts from Future Climate Conditions

Climate change has already made the planning area more prone to wildfires (National Geographic Society, 2019). Historically, fire seasons in the planning area were from May and September, with the highest number of events between June to October (Kelly). However, wildfire trends have changed over the past 15 years as climate change variables have altered wildfire behavior (Orange County, 2017). Some predictions indicated that the area burned by wildfires could increase by 77 percent by 2100 (Bedsworth,

Cayan, & Franco, 2018) and that wildfire-related insurance costs will rise by an estimated 18 percent price rise by 2055 (Bedsworth, Cayan, & Franco, 2018).

More extreme heat days, higher average annual temperatures, and extended periods of drought will lead to more dry vegetation to fuel fires; weather hazards are discussed in Section 9. Climate change factors such as less rainfall and snowpack can also lower reservoirs and water tables, making it harder to fight wildfires (County of Orange and Orange County Fire Authority, 2015).

11.5 Exposure

11.5.1 Population

Intersecting OCTA bus stop ridership and US Census planning area data with geospatial hazard data for wildfire hazard zones and the WUI shows population exposure and social vulnerability. Specific sections of the planning area will also have a higher risk of secondary hazards such as increased flooding or mass earth movements, shown in the maps in Section 7 for floods and 8 for mass earth movements. Additionally, the entire planning area can be susceptible to cascading impacts of wildfires, such as poor air quality (World Health Organization).

Table 11-5 below shows the 2019 OCTA ridership exposed to wildfire hazards and boardings in the WUI area. There was significant ridership in the WUI through the year, at over a half-million boardings.

Table 11-5 – Bus Stop Ridership Exposed to Wildfires and in the Wildland Urban Interface

Ridership	Wildfire Exposure	WUI
Total	120,016	525,277

11.5.1.1 Vulnerability

Smoke and air pollution from fires can be a health hazard, especially for children, the elderly, and those with respiratory and cardiovascular diseases. Other symptoms can include:

Table 11-6 – Vulnerable Population Health Risks from Wildfires (World Health Organization)

Irritation	Worsen Cardiovascular Diseases	Lung Conditions	Lung Diseases
Eyes	Heart Failure	Coughing	Pulmonary inflammation
Nose		Wheezing	Bronchitis
Lungs		Sore Throat	Exacerbated Asthma

Vulnerable populations at risk from wildfire hazards are in Table 11-7. The majority of the population falls in the very high-risk zone; nearly 800 thousand minority and mixed-race individuals are in this zone. Additionally, 187,237 households in the very high exposure area are low-income, making them especially vulnerable to fire risks. They may not have the funds for insurance or structural protection methods.

Table 11-7 – Populations Exposed to Wildfire Risks Moderate, High, and Very High

Populations	Moderate	High	Very High
Black	37	1,172	18,395
American Eskimo	11	474	8,135
Asian	149	12,858	232,129

Populations	Moderate	High	Very High
Hawaiian/Pacific Islander	4	233	4,212
Hispanic	365	22,795	483,002
Multiple Races	79	2,672	50,986
Children up to 19 Years Old	571	16,227	339,748
65 Years and Older	260	6,177	141,475
Below the Poverty Level	167	7,382	187,237

The interface is where settled areas run up against wildland vegetation, while the intermix is where the settled land is directly mixed with the vegetation (Radeloff, et al., 2018). Table 11-8 shows the highest population numbers are in the interface.

Table 11-8 – Populations in the Wildland Urban Interface

Populations	Influence Zone	Interface	Intermix
Black	15,102	17,427	4,775
American Eskimo	5,165	5,630	1,824
Asian	153,705	179,101	46,592
Hawaiian/Pacific Islander	2,758	3,200	981
Hispanic	296,164	315,396	117,854
Multiple Races	35,238	36,434	10,862
Children up to 19 Years Old	231,115	234,202	74,724
65 Years and Older	105,969	94,930	27,789
Below the Poverty Level	113,504	116,934	42,675

11.5.2 Property

11.5.2.1 Exposure and Vulnerability

Intersecting OCTA facilities with geospatial hazard data for wildfire hazard zones and the WUI indicates exposure to this hazard. Property damage from wildland fires can be severe and significantly alter entire communities and transportation infrastructure. Tables 11-9 to 11-14 display OCTA's buildings, land use, and infrastructure exposed to wildfire hazard zones, their risk level, and those in the WUI zone.

Table 11-9 – OCTA Buildings Exposed to a Very High Risk of Least Moderate Wildland Fire Hazards

Building Type	Number of Buildings Exposed
Transit Center	1
Total	**1**

Table 11-10 – OCTA Environmental Areas Exposed to at Least Moderate Wildland Fire Hazards

Land Use Type	Acres
Bobcat Ridge (proximal to the City of Lake Forest)	48.90
Eagle Ridge (proximal to the City of Brea)	296.90

Land Use Type	Acres
Live Oak Creek (proximal to the City of Lake Forest)	82.54
Pacific Horizon (proximal to the City of Laguna Beach)	152.63
Silverado Chaparral (proximal to Silverado Canyon)	204.59
Trabuco Rose (proximal to Trabuco Canyon)	400.58
Wren's View (proximal to Trabuco Canyon)	116.96
Total	**1303.1**

Table 11-11 – OCTA Infrastructure and Related Operations Exposed to a Risk of Wildland Fire Hazards

Infrastructure Type	Moderate	High	Very High
Bus Route	0	0.05	24.42
SR-91 Freeway	0	0	9.461
Other Freeway	4.736	0.020	92.941
Metrolink Rail	0	0.21	3.90
Total	**4.736**	**0.28**	**130.722**

Table 11-12 – OCTA Buildings in the WUI Fire Hazard Zone

Building Type	In the Influence Zone	In the Interface Zone	In the Intermix Zone
Brea Park and Ride	0	1	0
Transit Center	0	1	0
Total	**0**	**2**	**0**

Table 11-13 – OCTA Environmental Areas in the WUI Fire Hazard Zone

Land Use Type	Influence Zone	Interface Zone	Intermix Zone
Bobcat Ridge (proximal to the City of Lake Forest)	48.77	0	0.13
Eagle Ridge (proximal to the City of Brea)	295.84	1.02	0
Live Oak Creek (proximal to the city of Lake Forest)	82.41	0	0.13
Pacific Horizon (proximal to the City of Laguna Beach)	152.27	0	0
Silverado Chaparral (proximal to Silverado Canyon)	204.23	0	0
Trabuco Rose (proximal to Trabuco Canyon)	398.59	0.45	0
Wren's View (proximal to Trabuco Canyon)	115.68	0	0.52
Total	**1297.79**	**1.47**	**0.78**

Table 11-14 – OCTA Infrastructure in Miles and Related Operations in the WUI Fire Hazard Zone

Infrastructure Type	In the Influence Zone	In the Interface Zone	In the Intermix Zone
Bus Route	9.39	103.62	1.98
I-405 Freeway	1.653	9.266	
SR-91 Freeway	0.490	2.114	2.124

Infrastructure Type	In the Influence Zone	In the Interface Zone	In the Intermix Zone
Other Freeway	27.139	67.748	8.588
Metrolink Rail	3.55	5.20	0.07
Total	**42.222**	**187.948**	**10.782**

11.5.3 Environment

Wildfires are a natural process in forest ecosystems; however, massive events can have adverse environmental impacts that may affect the OCTA planning area. Wildlife habitats can be destroyed, and occasionally wild animals might migrate outside of their normal environment and into more urban areas (Kenney, 2019). When fires burn, they release carbon dioxide into the atmosphere, and this greenhouse gas is hazardous to humans and animals that inhale it (United States Forest Service). A massive wildfire release of carbon dioxide can affect the weather and climate (World Health Organization).

11.6 Development Trends

OCTA's planning area is one of California's most rapidly growing regions; this area continues to experience residential, employment, and economic growth, including increasing growth into the WUI (County of Orange and Orange County Fire Authority, 2015). Every year the growing county and city boundaries expand into the hills, mountains, and forest lands. The growing interaction between urban/suburban areas and natural growth areas results in a significant wildfire risk for life and property.

The Orange County LHMP addresses wildfire risks in the planning area (County of Orange and Orange County Fire Authority, 2015). The LHMP identifies the hazard causes, probability, and potential damage. Additionally, the Orange County General Plan directs land use, addresses growth management, and establishes standards and plans to protect the community from hazards (Orange County).

Fire prevention methods are utilized to reduce the level of risk to structures to prevent the spread of wildfire embers and radiant heat (County of Orange and Orange County Fire Authority, 2015). Additionally, OCFA reviews all land use proposals and site development permits to ensure proper design and build. OCTA will continue to follow State and County regulations and permit requirements in all new developments in the planning area.

11.7 Issues

Issues associated with severe weather in the OCTA planning area (Orange County) (Orange County, 2017):

- Continue to properly manage hazardous materials in transportation and/or facility sites.
- Consider response times for emergency equipment and first responder personnel, especially during a hazardous material release incident.
- Emergency response services require the use of transportation infrastructure that could override OCTA's transportation services.

11.8 Hazard Map

The hazard maps of wildfire hazard severity zones and WUI in the planning area start on the next page.

Figure 11-4 – OCTA Fire Hazard Severity Zones Hazard Map

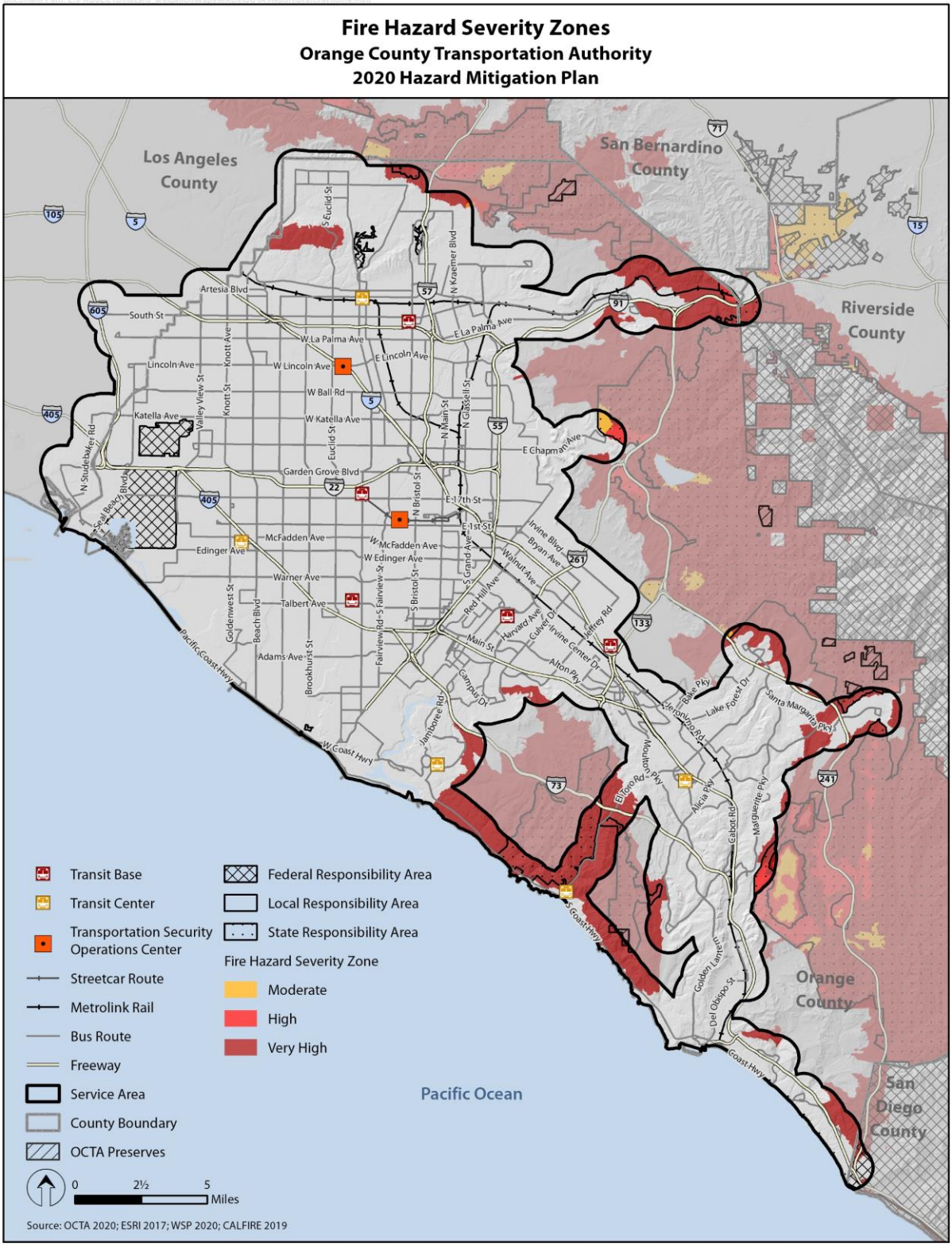
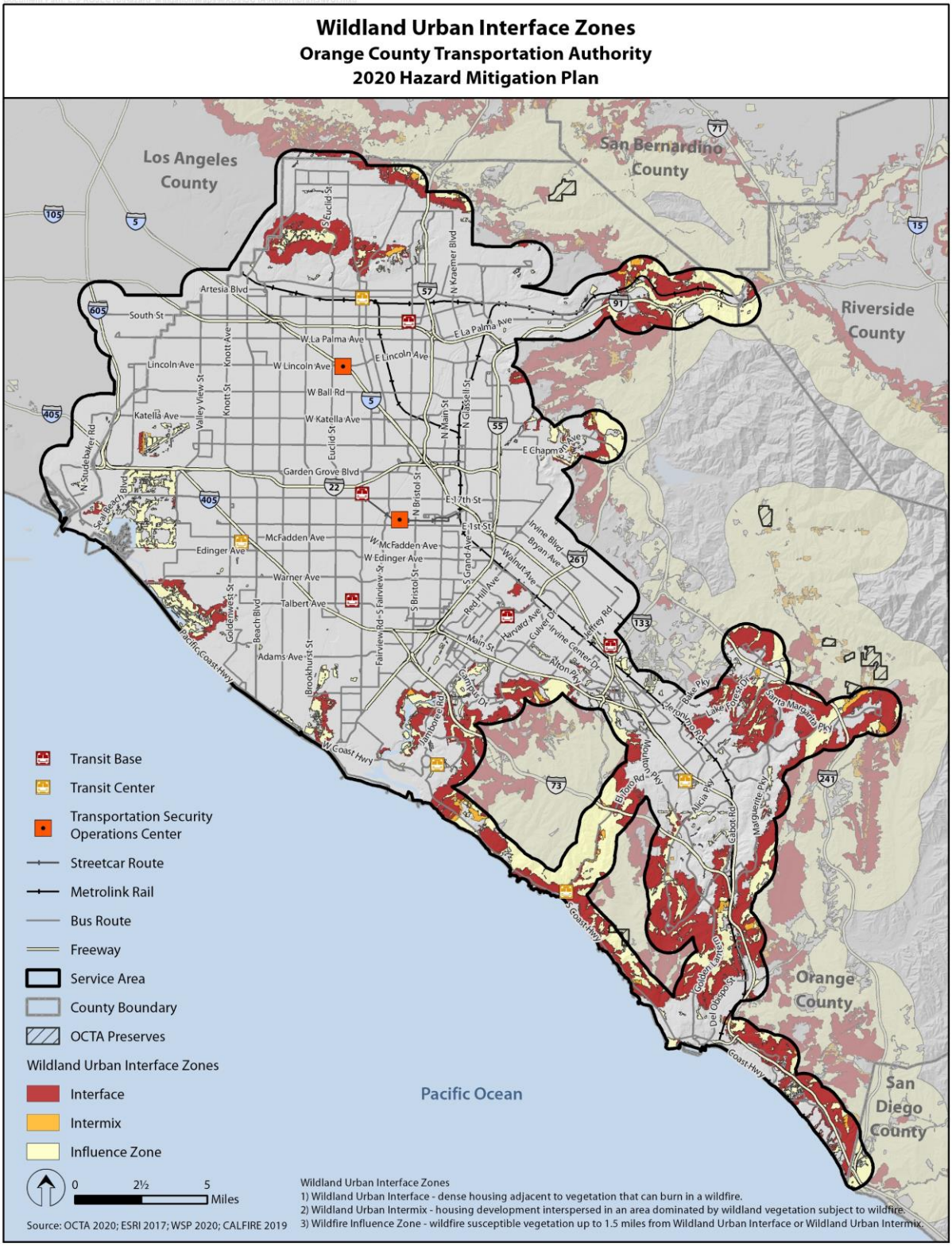


Figure 11-5 – OCTA Wildland Urban Interface Zones



OCTA 2022 Hazard Mitigation Plan

Part 3: Mitigation Strategy

12 Mitigation Strategy

12.1 Orange County Transportation Authority 2022 Hazard Mitigation Goals

44 CFR Section 201.6(c)(3)(i)

States that hazard mitigation plans (HMPs) shall describe mitigation goals to reduce or avoid long-term vulnerabilities to identified hazards.

Below are the four goals developed and adopted by the OCTA 2022 Steering Committee. Achievement of these goals defines the effectiveness of a mitigation strategy. The goals are used to help establish mitigation strategy priorities.

1. Support OCTA policies, plans, people, and programs to maintain a community transportation system that reduces risk and is resilient now and long term.
2. Minimize vulnerabilities to protect people, property, the natural environment, and keep Orange County moving.
3. Ensure resilience-oriented decisions are made through regional collaboration and enhanced partnerships.
4. Promote community engagement through transparent public outreach that is equitable and accessible to everyone in the community.

12.1.1 Strategies

The following table includes hazard mitigation strategies for OCTA as informed by the risk and capability assessments, including recommendations for prioritization for implementation and funding mechanisms. Through collaboration, these projects will positively benefit OCTA, the public, and the environment in Orange County. Those hazards consolidated into Severe Weather and Flooding do not have their own mitigation strategies as they did not score in the top one-third of the survey results and are therefore not high-priority hazards on their own; see Appendix D and G for unconsolidated Hazard Ranking Survey Results.

Table 12-1 – OCTA Mitigation Strategies

ID	Description	Status (New, Existing, Complete)	Goals Supported	Hazards Addressed	Lead Entity	Support Entity	Implementation Timeline + Anticipated Cost + Funding Source	STAPLEE + Mitigation Score	Priority: High, Med, Low
1	Increase public education and outreach by creating a new dedicated hazard webpage to share climate information changed and OCTA mitigation/preparedness measures.	New	1, 4	All Hazards	OCTA	-	- Less than 1 year - <$50,000 - Yes: existing budget	23 7	Low
2	Contribute to internal and regional after-action reports for the COVID-19 pandemic to identify critical strategies that need to be completed to reduce risks to the community from future pandemics. These recommendations should be included in future updates of the HMP.	New	1, 2, 3	Pandemic	OCTA	County and local governments	- < 1 year - < $50,000 - Yes: existing budget	34 10	High
3	Partner with other agencies to implement additional measures to protect coast rail infrastructure as appropriate in southern Orange County. See OC Rail Defense Against Climate Change for specific examples.	New	1, 2, 3	Flood, SLR, and Erosion	OC Parks, OC Public Works, OCTA	OCTA, Metrolink, Amtrak, LOSSAN	- 3-5 years (ongoing) -< $100,000,000 - Unknown: grants, existing budget	34 8	High
4	Partner with other agencies to study potential erosion control and stormwater measures.	New	1, 2	Flood, SLR, and Erosion	OC Public Works	OCTA, Metrolink, and Amtrak, LOSSAN, USACE, local jurisdictions	- 1 – 3 years < $100,000,000- - Unknown: grants, existing budget	41 8	High
5	Regularly obtain the most recent recommended future heavy precipitation and flow estimates and compare these to the current 100-year high confidence heavy precipitation and flow estimates used for infrastructure design. Determine which estimates should be used to minimize risks to infrastructure over the lifecycle. (Aligns with *OC Rail Defense Against Climate Change Plan*)	New	1, 2	Flood, SLR, and Erosion	OCTA	OC Public Works	- < 1 year (ongoing) - <$50,000 - Yes: existing budget	32 6	Med

ID	Description	Status (New, Existing, Complete)	Goals Supported	Hazards Addressed	Lead Entity	Support Entity	Implementation Timeline + Anticipated Cost + Funding Source	STAPLEE + Mitigation Score	Priority: High, Med, Low
6	Regularly review and update the data used to calculate the rail zero-stress temperature to account for current and projected climate change and stress newly installed and existing rail based on this information. (Aligns with *OC Rail Defense Against Climate Change Plan*)	New	1, 2	Severe Weather	OCTA	Metrolink	- <1 year (ongoing) - <$50,000 - Yes: existing budget	36 7	Med
7	Evaluate and develop recommendations to retrofit OCTA critical facilities to address seismic risks.	New	2	Earthquake	OCTA		- 3-5 years -< $100,000,000 - Unknown: grants, existing budget	28 7	Med
8	Assess and implement engineering options at OCTA bus bases for hardening fuel storage and fueling facilities against seismic and other hazards.	New	2	Earthquake, Flood/SLR/ Erosion, Wildfires, Tsunami	OCTA	-	- 3-5 years - < $100,000,000 - Unknown: grant, existing budget	34 7	Med
9	Develop site-specific response plans and structures for worksites using Standardized Emergency Management / National Incident Management principles.	New	1	All Hazards	OCTA	State, county, local government	- Less than 1 year - < $10,000 - Yes: existing budget	35 10	High
10	Continue OCTA vulnerability assessments for all hazards.	New	1, 2	All Hazards	OCTA	-	- < 1 year (ongoing) - $3.5 billion (2021 dollars) - Anticipated: grant	39 8	High
11	Share vulnerability assessment data with partner Agencies. Encourage train station amenities to help riders during extreme heat and other severe weather events, including additional shaded or covered areas and seating, restrooms, and cooling mechanisms. Provide accurate information on train schedules to minimize waiting times. (Aligns with *OC Rail Defense Against Climate Change Plan*)	New	1, 2, 4	Severe Weather	Cities, Metrolink Amtrak, LOSSAN Agency	OCTA	- Less than 1 year - < $100,000,000 (estimated $5,555,000) - - Unknown: grants, existing budget	31 8	High
12	Expand internal communications and preparedness education about potential hazards, including what to do during and after a hazard event.	New	1, 2	All Hazards	OCTA	-	- Less than 1 year - < $50,000 - Anticipated: existing budget	37 10	High

ID	Description	Status (New, Existing, Complete)	Goals Supported	Hazards Addressed	Lead Entity	Support Entity	Implementation Timeline + Anticipated Cost + Funding Source	STAPLEE + Mitigation Score	Priority: High, Med, Low
13	Perform fuel modifications on OCTA conservation properties to provide proper clearance near habitable structures per local fire authority standards. Assess opportunities to replace invasive species and plant fire-adapted native plants to prevent invasive species from becoming re-established, minimizing the risk of wildfires.	New	2	Wildfires	OCTA	County and local governments	- 1-3 years - < $500,000 - Unknown: grants, existing budget	43 9	High
14	Evaluate stormwater runoff systems at critical OCTA facilities and infrastructure. As appropriate, upgrade stormwater runoff management at OCTA critical facilities and infrastructure.	New and Existing	2	Flood/SLR/Erosion, Severe Weather	OCTA	Orange County Public Works, local governments	- 3-5 years - < $100,000,000 - - Unknown: grants, existing budget	39 7	High
15	Continue to use the most current GIS data layers in the hazard reduction decision-making processes.	Existing	1, 2	All Hazards	OCTA	Federal and state governments	- < 1 year (ongoing) - < $50,000 - Yes: existing budget	41 8	High
16	Regularly assess the planning area's evacuation routes and pickup points. Coordinate with the County Emergency Management Division and cities to provide the most efficient and effective evacuation transportation support.	Existing	1, 3	Flood/SLR/Erosion, Mass Earth Movements, Severe Weather, Tsunamis, Wildfires	OCTA	County and local governments (OCSD EMD, City Emergency Managers)	- < 1 year (ongoing) - < $50,000 - Yes: existing budget	37 9	High
17	Support cities and the county in the planning area with evacuation education and public outreach related to OCTA.	New	1, 3, 4	Earthquake, Flood/SLR/Erosion, Mass Earth Movements, Tsunami, Wildfires	OCTA	County governments	- <1 year - < $50,000 - Yes: existing budget	39 8	High
18	Evaluate transit options for providing transit service during a disaster event. (Aligned with *OC Transit Vision*)	New	1, 3	Earthquake, Epidemic/ Pandemic, Flood/SLR/Erosion, Tsunami	OCTA	OCTA Contracted Services	- 1-3 years -$50,000 - Yes: existing budget	37 7	High

ID	Description	Status (New, Existing, Complete)	Goals Supported	Hazards Addressed	Lead Entity	Support Entity	Implementation Timeline + Anticipated Cost + Funding Source	STAPLEE + Mitigation Score	Priority: High, Med, Low
19	Promote the use of new technology in hazard mitigation and emergency preparedness.	New	1, 2	All Hazards	OCTA	OCTA IS Department	- < 1 year (ongoing) - < $50,000 - Yes: existing budget	24 6	Med
20	Continue to develop new and evaluate existing climate change goals and policies as new scientific data and models become available.	Existing	1, 2, 3	Flood/SLR/Erosion, Mass Earth Movements, Severe Weather, Wildfires	OCTA	Federal and state governments	- < 1 year (ongoing) - < $50,000 - Yes: existing budget	31 6	Low
21	Incorporate data from the 2022 OCTA HMP, mitigation strategies, and risk reduction principles into future updates of agency plans related to hazard mitigation.	New	1, 2	All Hazards	OCTA	-	- < 1 year (ongoing) - < $50,000 - Unknown: grants, existing budget	33 7	Med
22	Develop and improve communication redundancies to ensure effective internal and external communication in a hazard event.	New and Existing	1, 2, 4	All Hazards	OCTA	-	- 3-5 years - $50,000 - Unknown: grants, existing budget	36 8	Low
23	Prepare and implement fire management plans, invasive species control, public education and awareness, and enhanced security measures to mitigate the potential for wildfire on conservation properties. Consider closure of conservation properties during times of high fire risk. (Aligned with resource management plans.)	New	1, 2, 4	Wildfires	OCTA	OCFA, OCSD	- 1-3 years - <$100,000 - Unknown: grants, existing budget	42 6	High
24	Monitor and address adverse effects from properties adjacent to conservation properties. (Aligned with resource management plans.)	New	1, 2, 4	Wildfires	OCTA	-	- 1-3 years - <$100,000 - Unknown: grants, existing budget	42 6	Low

12.2 Action Plan

44 CFR Section 201.7(c)(3)(iii)

Requires a description of how the strategies will be prioritized, implemented, and administered by the Government Agency.

All strategies listed above include an action plan of prioritized initiatives to mitigate natural hazards. The Steering Committee was asked to weigh the estimated benefits against the estimated costs of a project to establish a parameter to be used in prioritization. This benefit-cost review was qualitative and did not include the level of detail required under specific FEMA grant programs. This qualitative approach was used because projects may not be implemented for up to ten years, and the associated costs and benefits could change dramatically in that time. Each project was assessed by estimating the total cost of the initiative and assigning subjective ratings (high, medium, and low) to benefits, as described in the sections below.

12.2.1 Cost

Participants were given a dollar range to choose from to estimate the cost of the proposed initiative:

- < $50,000
- < $100,000
- < $500,000
- < $1,000,000
- >$1,000,000

For many of the initiatives identified, OCTA may seek financial assistance under FEMA's hazard mitigation grant programs and other federal grant programs, including:

- BRIC Program
- Hazard Mitigation Grant Program
- Flood Mitigation Assistance grant program
- Repetitive Flood Claims grant program
- Emergency Management Performance Grant program
- Severe Repetitive Loss grant program
- California Coastal Conservancy – Forest Health and Wildfire Resilience Program
- California Coastal Conservancy – Climate Ready Program
- California Department of Water Resource – Floodplain Management Protection and Risk Awareness Program
- California Natural Resources Agency – Urban Flood Protection Program
- Cal Fire – Fire Prevention Grants Program

12.2.2 Benefit

The Steering Committee evaluated each action using STAPLEE and Mitigation Effectiveness criteria, as described in Tables 12-2 and 12-3. Evaluators were asked to rate each STAPLEE and Mitigation Effectiveness criteria to develop a total score that determined each action's relative suitability and potential effectiveness.

Table 12-2 – STAPLEE Criteria

STAPLEE Criteria	Evaluation Rating
S: Is it Socially acceptable?	Strongly Agree = 5 Agree = 4 Neutral = 3 Disagree = 2 Strongly Disagree = 1
T: Is it Technically feasible and potentially successful?	
A: Does the responsible city agency/department have the Administrative capacity to execute this action?	
P: Is it Politically acceptable?	
L: Is there Legal authority to implement?	
E: Is it Economically beneficial?	
E: Will the project have a positive impact on the natural environment?	
Will historic structures or key cultural resources be saved or protected?	
Could it be implemented quickly?	

Table 12-3 – Mitigation Effectiveness Criteria

Mitigation Effectiveness Criteria	Evaluation Rating
Will the implemented action result in lives saved?	Strongly Agree = 5 Agree = 4 Neutral = 3 Disagree = 2 Strongly Disagree = 1
Could it be implemented quickly?	

STAPLEE scores can range from a low of nine to a high of 45. Mitigation effectiveness scores can run from a low of two to a high of ten. When these scores are combined, mitigation strategies can score within a range of 11 to 55 points. Strategies were ranked as low benefit if the total score was between zero and 17, medium benefit if the score was between 18 and 35, and high benefit if the score was 36 to 55.

12.2.3 Benefit-Cost Review

Most of the mitigation strategies will require a detailed Benefit-Cost Analysis (BCA) as part of the grant application process if the OCTA pursues grant funding. Analyses are performed using the FEMA or other applicable model process when preparing funding applications. OCTA commits to implementing mitigation strategies with benefits that exceed their costs. For projects that do not need grant funding that requires a BCA, OCTA reserves the right to define benefits that meet their needs and the goals and objectives of this plan.

12.3 Plan Adoption

OCTA will submit the final HMP to CalOES and FEMA Region IX for official approval prior to formal adoption of the plan by OCTA's Board. A copy of the adoption resolution will be included in Appendix F. OCTA will also comply with all applicable federal statutes and regulations in effect with respect to the periods for which it receives grant funding, including 2 CFR Parts 200 and 3002, and will amend its plan during regular plan updates to reflect changes in federal laws and statutes.

12.4 Plan Implementation and Maintenance Strategy

This section details the formal plan implementation and maintenance strategy to ensure that the OCTA's HMP remains an active and relevant document and supports eligibility for relevant funding sources. The plan maintenance process includes monitoring and evaluating the plan annually and submitting an updated plan to CalOES and FEMA for approval every five years. This section also describes how participation from customers and community members will continue to be a part of the plan maintenance and implementation process. The HMP's format allows sections to be reviewed and updated when new data becomes available, ensuring the plan stays current and relevant.

44 CFR Section 201.6(d)(3)

Entities are required to review and update their hazard mitigation plans where there are development changes, priority changes, and progress in local mitigation efforts. Plan updates must be resubmitted to the state and FEMA every five years to continue to be eligible for mitigation project grant funding.

12.4.1 Plan Implementation

The effectiveness of the HMP depends on the implementation of the plan through the initiatives identified in the action plan and the incorporation of mitigation principles and strategies into other OCTA and partner plans, policies, and programs. The HMP includes a range of strategies that, if implemented, would reduce losses from hazard events in the OCTA planning area. The Steering Committee has established plan goals that will be implemented through the development of new plans and incorporation into existing plans, policies, and programs.

The Security and Emergency Preparedness Manager under the OCTA Chief Executive Office will assume lead responsibility for planning and facilitating implementation and maintenance meetings. OCTA's Security and Emergency Preparedness Manager will serve as OCTA's point-of-contact for this plan. Although the Security and Emergency Preparedness Manager will have primary responsibility for convening these meetings, plan implementation and maintenance will be a shared responsibility among all OCTA departments identified as leads in the mitigation action plan.

12.4.2 Steering Committee

The Steering Committee is made up of staff from departments all across OCTA. This committee's purpose was to oversee the plan's development and make recommendations on key elements, including the maintenance strategy. The Steering Committee's position was that a similar oversight committee should have an active role in maintaining this plan. Therefore, it is recommended that the Steering Committee remain a viable body involved in the key elements of the plan maintenance strategy.

Each year, the OCTA Chief Executive Office will appoint a Steering Committee Chair to lead annual progress reporting. The Chair will be responsible for ensuring that the plan is reviewed and evaluated annually. The Security and Emergency Preparedness Manager will be responsible for facilitating annual progress review workshops.

The Steering Committee should include OCTA staff and representatives of key planning partners and stakeholders. The Steering Committee will convene to complete annual reviews at a place and time to be determined. The membership of this committee can be dynamic, which will allow for the representation of different points of view and allow a broad range of participants to have a say in the implementation of the plan. Individuals involved in the plan development process will be contacted and given the option to remain involved in plan implementation.

12.4.3 Annual Progress Report

The minimum task of the Steering Committee will be the evaluation of the progress of the plan during annual reviews. This evaluation will include the following:

- Summary of any hazard events that occurred during the prior year and their impact on the planning area
- A review of successful mitigation initiatives identified in the plan
- A brief discussion about why targeted mitigation strategies were not completed, including if planning goals and priorities have changed relative to the targeted action
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term project because of funding availability)
- Recommendations for new projects
- Changes in or potential for new funding options (grant opportunities)
- Impact of any other OCTA or partner planning programs or initiatives that involve hazard mitigation

To support the annual evaluation of the HMP and track progress in implementing individual strategies, lead entities listed in the action plan will complete an annual progress report using the Mitigation Strategy Evaluation and Mitigation Action Evaluation forms provided in Appendix C. The Steering Committee will complete, review, and approve progress reports, which will be the foundation of the formal annual progress of the plan. This report will be used made available as follows:

- Posted to the OCTA 2022 HMP webpage
- Provided to the local media through a press release
- Presented to the Board and Executive Office

12.4.4 Plan Updates

The OCTA intends to update the plan on a five-year cycle from the date of initial plan adoption. This cycle may be accelerated to less than five years based on the following triggers:

A Presidential Disaster Declaration that impacts the planning area
A hazard event that causes loss of life

It will not be the intent of this update process to start from scratch and develop a new HMP for OCTA. Based on needs identified by the Steering Committee, plan updates will, at a minimum, include the elements below:

- The Steering Committee will convene the update process.
- The hazard risk assessment will be reviewed and updated as needed using the best available information and technologies.
- The action plan will be reviewed and revised to account for any initiatives completed, dropped, or changed and to account for changes in the risk assessment or changes in planning goals or priorities identified by the Steering Committee or under another planning mechanism, as appropriate (such as OCTA strategic plans).
- The draft HMP will be sent to appropriate partner agencies and organizations for comment.

- Customers and community members will be given opportunities to comment on the update before adoption.
- The Board will approve a new resolution to adopt the updated plan.

12.4.5 Continuing Patron and Community Member Involvement

OCTA customers and community members will be updated on HMP status through the OCTA.net/HMP web page. Copies of the HMP annual progress reports will be distributed to stakeholders and the media, where appropriate.

Additionally, a new community engagement strategy will be initiated based on guidance from the Steering Committee each time the plan is updated. This strategy will be based on the needs and capabilities of OCTA during the plan update. At a minimum, the strategy will provide multiple opportunities for OCTA customers and community members to comment on the draft plan update online or other methods.

12.4.6 Integration with Other Planning Mechanisms

The information on hazards, risks, vulnerability, and mitigation strategies in this HMP is based on the best science and technology currently available. This information can be invaluable in informing decisions made under other planning efforts, such as OCTA's strategic and facilities planning. OCTA will use information from this plan as the best available science and data on natural hazards impacting OCTA's service area. As information becomes available from other agency planning efforts to enhance this plan, it will be incorporated in the HMP during the update process.

OCTA 2022 Hazard Mitigation Plan

Appendices

Appendix A. Acronyms and Definitions

Acronyms

Acronym	Definition
ALERT	Automated Local Evaluation in Real Time
BCA	Benefit-Cost Analysis
BCAR	FEMA's Benefit-Cost Analysis Tool
CAHAN	California Health Alert Network
CD	Communicable Disease
CDC	Centers for Disease Control
CEA	California Earthquake Authority
CEO	Chief Executive Officer
CERT	Community Emergency Response Team
CFR	Code of Federal Regulations
CIP	Capital Improvements Plan
COOP	Continuity of Operations Plan
COVID-19	Coronavirus
DEWS	Drought Early Warning System
DHS	Department of Homeland Security
DMA	Disaster Mitigation Act
EAP	Emergency Action Plan
EAS	National Emergency Alert System
EF Scale	Enhanced Fujita Scale
EOP	Emergency Operations Plan
EPA	US Environmental Protection Agency
FCD	Flood Control District
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FP	Floodplain
GIS	Geographic Information System
HAN	CDC Health Alert Network
HAZUS-MH	Hazards United States-Multi Hazard
HHSA	Health and Human Services Agency
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HVAC	Heating, Ventilation, and Air Conditioning
ID	Identification
LHMP	Local Hazard Mitigation Plan

Acronym	Definition
LOC	Location
NASA	National Aeronautics and Space Administration
NCDC	National Climatic Data Center
NEHRP	National Earthquake Hazards Reduction Program
NIMS	National Incident Management System
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
OC	Orange County
OCFA	Orange County Fire Authority
OES	Office of Emergency Services
OSHA	US Occupational Safety and Health Administration
PPE	Personal Protective Equipment
PSAF	Pandemic Severity Assessment Framework
RDMD	Orange County Resources and Development Management Department
SEMS	Standardized Emergency Management System
SFHA	Special Flood Hazard Area
SLR	Sea Level Rise
STAPLEE	Social, Technical, Administrative, Political, legal Economic, and Environmental
THIRA	Threat and Hazard Identification Risk Assessment
UCLA	University California, Los Angeles
US	United States
USFS	US Forest Service
USGS	US Geological Survey
WEA	Wireless Emergency Alert
WHO	World Health Organization
WUI	Wildland Urban Interface

Definitions

100-Year Floodplain – An area inundated by a flood with a one percent chance of being equal or greater each year.

500-year Floodplain – An area inundated by floodwaters with a 0.2 percent chance of being equal or greater each year.

Aftershock – Lower-magnitude earthquakes that follow an initial primary earthquake**.**

Alluvial Fans – Found in dry mountainous regions where rock and soil erode from mountainsides and build up on valley floors in a fan shape.

Asset – Any human-made or natural feature that has value, including, but not limited to, people, buildings, infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Benefit/Cost Analysis – A systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost-effectiveness.

Benefit – A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For benefit-cost analysis mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reducing expected property losses (buildings, contents, and functions) and protecting human life.

Building – A building is defined as a walled and roofed structure, principally above-ground and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment – A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an Authority's mission, programs, policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process. A community's strategy to reduce losses is identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment: legal and regulatory capability, administrative and technical capability, and fiscal capability.

Coastal Flood – Occur by seawater and coastlines, often due to severe weather events and cause coastline erosion.

Communicable Disease – An illness transmitted from an infected agent to an animal or individual through direct or indirect contact.

Critical Area – An area defined by state or local regulations as deserving special protection because of unique natural features or its value as a habitat for a wide range of flora and fauna species. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility – Those facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs. For this plan, critical facilities include the following:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials
- Public and private utilities, facilities, and infrastructure are vital to maintaining or restoring standard services to areas damaged by hazard events
- Government facilities

Crown Fire – A type of fire that burns through the top layer of trees, called the canopy. They are the most intense and difficult to contain.

Dam – Any artificial barrier and/or any controlling works, together with appurtenant works, can or do impound or divert water.

Dam Failure – An uncontrolled release of impounded water due to structural deficiencies in the water barrier.

Debris Flow – A form of a rapid mass movement in which loose soil, rock, and sometimes organic matter combine with water to form a slurry that flows downslope.

Derecho – A widespread and long-lived windstorm associated with thunderstorms that can cause damage similar to a tornado.

Disaster Mitigation Act of 2000 (DMA) – A Public Law 106-390 that is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. The DMA established a pre-disaster hazard mitigation program and new requirements for the national post-disaster (HMGP).

Disease Vector – an agent that carries and transmits infectious diseases, such as an insect, fungus, or animal.

Drainage Basin – The area within which all surface water (whether from rainfall, snowmelt, springs, or other sources) flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains, and ridges. Drainage basins are also referred to as watersheds or basins.

Droughts – Extended periods of extremely low rainfall and snowpack lead to groundwater shortages impacting a large area of people, animals, and the environment.

Earthquake Magnitude – The seismic wave/amplitude measured and recorded by seismographs from an earthquake's epicenter. Magnitude is represented by a class name and numerical value from 3 to 8.

Emergency Operations Plan (EOP) – A formal document that provides an entity's emergency response procedures, structure, and authorities.

Epicenter (seismology) – The point on the ground's surface directly above the focus point where the fault ruptures.

Epidemic – Happens when there is a significant and unexpected increase in disease cases.

Essential Workers – Individuals that work in roles that are critical to infrastructure operations.

Excessive/Extreme Heat – A combination of high temperatures and humidity, where the human body cannot maintain internal temperatures and cause heat-stroke.

Fault – A fracture in the Earth's crust where compression or tension pressure causes displacement of soil and rock on the opposite side of the fracture.

Flash Flood – A rapid rise in water with a high flow velocity that carries debris. Flash floods have enough force to pull up and carry significant amounts of large debris (e.g., cars and trees).

Flood – Inundation of ordinarily dry land resulting from rising and overflowing of a body of water.

Flood Insurance Rate Map (FIRM) – The official maps on which FEMA has delineated the Special Flood Hazard Area (SFHA).

Floodplain – An area of land neighboring a waterway or waterbody that is known to be flood-prone.

Focal Depth – The depth from the earth's surface to the hypocenter.

Fuels – Materials that burn in a fire, such as paper products, flammable gases or chemicals, or wood products. The material composition determines how flammable it is, based on moisture level, chemical makeup, and material density. The less moisture and lower density, the faster and hotter it burns.

General Severe Weather – Systems that form over broad geographic areas that can cross regional and jurisdictional boundaries.

Hazard Mitigation Grant Program (HMGP) – Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA. The Act provides grant information to states, tribes, and local governments.

Hazardous Material – Any biological agent and disease-causing material that has the reasonable potential to cause death, disease, behavioral changes, cancer, genetic mutation, psychological problems, or physical deformations to an exposed person or their unborn children.

Hazards US Multi-Hazard (HAZUS-MH) Loss Estimation Program – A GIS-based program to support the development of risk assessments required under the DMA. The HAZUS-MH software program quantitatively estimates damages and losses associated with natural hazards. HAZUS-MH is FEMA's nationally applicable, standardized methodology and software program. It contains modules for estimating potential losses from hazards.

Herd Immunity – when enough of the population becomes resistant to a disease by recovering from the illness or vaccination.

Hypocenter – The region underground where an earthquake's energy originates.

Infectious Diseases – Medical conditions/illnesses caused by organisms like bacteria, viruses, fungi, or parasites.

Inundation Area – The area of land that would be flooded following a dam failure.

Landslide – A large amount of rock, debris, or earth that travels down a slope.

Liquefaction – A loss of soil strength or cohesion results in the soil behaving like a thick liquid (e.g., quicksand).

Local Government – Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, a council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government. Any Indian tribe or authorized tribal organization, or Alaska Native village or organization. Any rural community, unincorporated town or village, or other public entity.

Localized Severe Weather – Damaging storms in a limited geographic area can include severe weather types.

Mass Movement – A collective term for landslides, debris flows, falls, and sinkholes.

Mitigation – A preventive action that can be taken to reduce or eliminate the risk to life or property in advance of an event.

Mitigation Actions – Specific actions to achieve goals and objectives that minimize the effects of a disaster and reduce life and property loss.

Modified Mercalli Scale – A measurement of the level of intensity felt on the ground's surface in populated areas, represented by a Roman numeral from I to X.

Mortality Rate – A mathematical measure of the frequency that individuals die in a defined population during a specific period.

Mudslide (or Mudflow) – A river of rock, earth, organic matter, and other water-saturated materials.

Objective – For this plan's purposes, an objective is defined as a short-term aim that forms a strategy or course of action to meet a goal when combined with other objectives. Unlike goals, objectives are specific and measurable.

Outbreak – Similar to an epidemic but limited to a specific geographic area or group of people.

Pandemic – Occur when a disease crosses multiple countries and infects a large number of people.

Preparedness – Actions that strengthen an entity's capability to respond to disasters and support their community.

Presidential Disaster Declaration – These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A presidential disaster declaration puts into motion long-term federal recovery programs, some of which are matched by state programs designed to help disaster victims, businesses, and public entities.

Risk – The estimated impact of a hazard on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms, such as a high, moderate, or low likelihood of sustaining damage above a determined threshold due to the occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses from the hazard.

Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) – Public Law 100-107 signed on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially for FEMA and its programs.

Runup – A measurement of the height of the water onshore observed above a reference sea level.

Seiches – A standing wave/oscillation in an enclosed or partially enclosed body of water varies in a period from a few minutes to several hours.

Severe Local Storm – Small atmospheric systems, including tornadoes, thunderstorms, and windstorms. Typically, significant impacts from a severe storm are on transportation infrastructure and utilities. These storms may cause many destructions and even death, but the impact is generally confined to a small area.

Sinkhole – A collapse depression in the ground with no visible outlet and underground drainage.

Slope Failures – Occur when the soils' strength forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.

Stakeholder – Individuals and organizations with a vested interest in a project and/or plan, such as business leaders, civic groups, academia, non-profit organizations, major employers, critical facilities managers, farmers, developers, special purpose districts, etc.

Steering Committee – The group that oversaw all phases of the HMP's development. Committee members included key stakeholders and community members in the planning area.

Stormwater Management – Physical and natural systems used by people to control and regulate surface and stormwater runoff flow.

Storm Surge – When a coastal flood happens simultaneously as a high tide, causing the coastal flood to reach farther and bring more water than it would during a lower tide.

Surface Rupture – An area of the ground that is offset (raised, lowered, tilted) when a fault rupture reaches the ground's surface.

Terrain/Topography – The ground's slope can help or halt the spread of a wildfire. For example, significant gaps in vegetation or waterways such as rivers and creeks can stop a wildfire from spreading. Fires also move faster upslope than down due to elevation changes and warm air rising.

Thunderstorm – A local storm with thunder and lightning can cause tornadoes, heavy rain, flash floods, hail, and high winds.

Tornadoes – A destructive rotating column of wind generated by a thunderstorm, shaped in a funnel that reaches the ground.

Tsunami – Comes from the Japanese words for *harbor* ("tsu") and *wave* ("nami"). A long high sea wave caused by an earthquake, submarine landslide, or other disturbance.

Tsunami from a large undersea earthquake – The earthquake must cause significant vertical deformation on the seafloor to generate a tsunami.

Tsunami Advisory – Issued when strong currents and dangerous waves of one to three feet are expected.

Tsunami Warning – Issued by PTWC when a potential tsunami with significant widespread inundation is imminent or expected.

Tsunami Watch – Issued when an event may later impact the watch area; can be upgraded to a tsunami warning.

Vulnerability – A description of how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. The vulnerability of a

community is often related to another's nearby community's vulnerability. Also, indirect effects can be much more widespread and damaging than direct effects.

Watershed – An area that drains downgradient from areas of higher land to lower land areas to the lowest point, a common drainage basin.

Wildland Urban Interface Area (WUI) – An area susceptible to wildfires and wildland vegetation and urban or suburban development occur together. An example would be smaller urban areas and dispersed rural housing in forested areas.

Wildfire – Fires result in uncontrolled destruction of forests, brush, field crops, grasslands, and personal property in non-urban areas. Because of their distance from firefighting resources, they can be difficult to contain and cause a great deal of destruction.

Windstorm – A storm featuring violent winds. Southwesterly winds are associated with intense storms moving onto the coast from the Pacific Ocean. Southern winds parallel to the coastal mountains are the strongest and most destructive winds. In addition, windstorms tend to damage ridgelines facing the wind.

Winter Storm – A cold event with significant precipitation in snow, ice, freezing rain, sleet, etc. Higher elevations get more precipitation.

Appendix B. Hazard Mitigation Plan Annual Progress Report

Annual Hazard Mitigation Progress Reporting Form

OCTA Department: _____

Prepared By: _____ Title: _____

For the 12-month period ending: _____ Date: _____

Instructions: Complete this form for each entity. Check the box beside the Yes or No options. Complete descriptions for each question to which a Yes response applies, inserting additional lines as needed.

Please answer the following questions to the best of your knowledge for the preceding 12 months:

1. Did OCTA experience any hazard events resulting in losses?

☐ No ☐ Yes – Describe (e.g., deaths, injuries, property damage, and indirect impacts such as loss of use, economic or environmental impacts, if a damage assessment was conducted, emergency or disaster declaration):

2. Have there been any observed impacts, physical changes, or new studies that materially affected the hazards analysis?

☐ No ☐ Yes – Describe:

3. Have any additional mitigation initiatives been identified that were not previously addressed in the Hazard Mitigation Plan?

☐ No ☐ Yes – For each new initiative, complete a Mitigation Action Evaluation Form.

4. Have any identified mitigation initiatives been completed and successful?

☐ No ☐ Yes – Review:

5. Were there targeted strategies in the past year that did not get completed?

☐ No ☐ Yes – Discuss:

6. Do any mitigation strategies in the current plan need timeline amendments (such as changing a long-term project to a short-term project due to funding)?

☐ No ☐ Yes – Describe:

7. Have there been any changes in potential or new funding options, including grant opportunities?

☐ No ☐ Yes – Describe:

8. Were there any other planning programs or initiatives that involved hazard mitigation? If so, what was their impact?

☐ No ☐ Yes – Describe:

9. Has public awareness of hazards improved?

☐ No ☐ Yes – Describe:

Appendix C. Mitigation Action Evaluation Forms

The OCTA Hazard Mitigation Plan Steering Committee will review the status of hazard mitigation strategies using this form,
informing the Annual Progress Report.

Mitigation Action Evaluation

Project ID: _____ Project Name: _____

1. Project Description:

2. Affected Entity: _____

3. Lead Entity: _____

4. Status and Priority Level: _____

5. Anticipated Completion Timeframe: _____

6. Actual Timeframe Completed: _____

7. Anticipated Cost: _____

8. Actual Cost to Complete: _____

9. Funding Source(s):

10. Anticipated Benefit vs. Cost – (For those projects with a measurable benefit in terms of future loss reduction, please quantify. For projects less easily quantified, please provide a qualitative assessment of the benefit to the cost):

11. Other Comments:

Prepared By: _____ Date: _____

Appendix D. Planning Process and Public Outreach

This appendix includes materials from workshops 1-4, the OCTA Customer Open House, and the Public Risk Assessment Survey. Workshop materials include (1) agenda, (2) PowerPoint, (3) sign-in sheet, and (4) summary notes. The unconsolidated version of the Hazard Identification and Ranking Survey completed by the Steering Committee follows Workshop 2 – Risk Assessment.

Appendix E. FEMA Region IX Local Hazard Mitigation Plan Review Tool

The *Local Hazard Mitigation Plan Review Tool* demonstrates how the Local Hazard Mitigation Plan meets the regulation in 44 CFR §201.6 and offers State and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The **Regulation Checklist** provides a summary of FEMA's evaluation of whether the plan has addressed all requirements.
- The **Plan Assessment** identifies the plan's strengths as well as documents areas for future improvement. This section also includes a list of resources for implementation of the plan.
- The **Multi-Jurisdiction Summary Sheet** is a mandatory worksheet for multi-jurisdictional plans that is used to document which jurisdictions are eligible to adopt the plan.
- The **Hazard Identification and Risk Assessment Matrix** is a tool for plan reviewers to identify if all components of Element B are met.

Jurisdiction: Orange County Transportation Authority (OCTA)	**Title of Plan:** Orange County Transportation Authority 2021 Hazard Mitigation Plan	**Date of Plan:** 2021
Local Point of Contact: Matt Ankley		**Address:** 550 S Main Street, Orange, CA 92868
Title: Emergency Management Specialist		
Agency: OCTA		
Phone Number: (714) 560-5961		**E-Mail:** mankley@octa.net

State Reviewer:	**Title:**	**Date:**
Phillip J. Labra	Sr. Local Mitigation Planner	1-18-2022
Tina Phan Tina.Phan@caloes.ca.gov (916) 539-1625	Lead Reviewer	3-23-2022
Date Received at State Agency	12-15-2021, 3-24-2022	
Date Sent to FEMA		

FEMA Reviewer:	**Title:**	**Date:**
Kathryn Strelevitz	Hazard Mitigation Planner (CERC)	4-15-2022
Xing Liu	Sr. Community Planner	4-18-2022
Date Received in FEMA Region IX	3-24-2022	
Date Not Approved		
Date Approvable Pending Adoption	4-27-2022	
Date Approved		

SECTION 1:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the plan by element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in the *Local Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)		**Location in Plan** **(section and/or page number)**	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS				
A1. Does the plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	a. Does the plan provide documentation of how the plan was prepared? This documentation must include the schedule or timeframe and activities that made up the plan's development as well as who was involved.	Part 1, Section 2: Plan Methodology (pp. 13-20) Appendix D: Planning Process and Public Outreach	X	
	b. Does the plan list the jurisdiction(s) participating in the plan that are seeking approval?	Part 1, Section 1: The Authority's Response to the 2000 Disaster Mitigation Act (p. 10)	X	
	c. Does the plan identify who represented each jurisdiction? (At a minimum, it must identify the jurisdiction represented and the person's position or title and agency within the jurisdiction.)	Part 1, Section 2.2: Formation of the Project Team (p. 13) Part 1, Section 2.3: Formation of the Steering Committee (pp. 13-14)	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)		**Location in Plan** **(section and/or page number)**	**Met**	**Not Met**
A2. Does the plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	a. Does the plan document an opportunity for neighboring communities, local, and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development, as well as other interested parties to be involved in the planning process?	Part 1, Section 2.3: Formation of the Steering Committee (pp. 13-14) Part 1, Section 2.5: Community Engagement (pp. 16-18) Part 1, Section 2.6: Coordination with Other Agencies (pp. 18-20) Appendix D: Planning Process and Public Outreach	X	
	b. Does the plan identify how the stakeholders were invited to participate in the process?	Part 1, Section 2.3: Formation of the Steering Committee (pp. 13-14) Part 1, Section 2.5: Community Engagement (pp. 16-18) Part 1, Section 2.6: Coordination with Other Agencies (pp. 18-20) Appendix D: Planning Process and Public Outreach	X	
A3. Does the plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	a. Does the plan document how the public was given the opportunity to be involved in the planning process?	Part 1, Section 2.5: Community Engagement (pp. 16-18) Part 1, Section 2.6: Coordination with Other Agencies (pp. 18-20) Part 1, Section 3.4.2: Public Participation and Committees (p. 25) Appendix D: Planning Process and Public Outreach	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)		**Location in Plan** **(section and/or page number)**	**Met**	**Not Met**
	b. Does the plan document how the public's feedback was incorporated into the plan?	Part 1, Section 2.5: Community Engagement (pp. 16-18) Part 1, Section 2.7: Plan Development Chronology and Milestones Appendix D: Planning Process and Public Outreach	X	
A4. Does the plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))		Part 1, Section 2.6: Coordination with Other Agencies (pp. 18-20) Part 1, Section 3.5.1: Planning and Regulatory (pp. 26-28) Appendix H. References	X	
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))		Part 3, Section 12.4.3: Annual Progress Report (p. 133) Part 3, Section 12.4.5: Continuing Patron and Community Member Involvement (pg. 134)	X	
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating, and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	a. Does the plan identify how, when, and by whom the plan will be **monitored** (how will implementation be tracked) over time?	Part 3, Section 12.4.1: Plan Implementation (p. 132) Part 3, Section 12.4.2: Steering Committee (p. 132) Part 3, Section 12.4.3: Annual Progress Report (p. 133) Appendix B: Hazard Mitigation Plan Annual Progress Report Appendix C: Mitigation Action Evaluation Forms	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)		**Location in Plan** **(section and/or page number)**	**Met**	**Not Met**
	b. Does the plan identify how, when, and by whom the plan will be **evaluated** (assessing the effectiveness of the plan at achieving stated purpose and goals) over time?	Part 3, Section 12.4.2: Steering Committee (p. 132) Part 3, Section 12.4.3: Annual Progress Report (p. 133) Part 3, Section 12.4.4: Plan Updates (pp. 133-134) Appendix B: Hazard Mitigation Plan Annual Progress Report Appendix C: Mitigation Action Evaluation Forms	X	
	c. Does the plan identify how, when, and by whom the plan will be **updated** during the 5-year cycle?	Part 3, Section 12.4.2: Steering Committee (p. 132) Part 3, Section 12.4.4: Plan Updates (pp. 133-134)	X	
ELEMENT A: REQUIRED REVISIONS				
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT (Reviewer: See Section 4 for assistance with Element B)				

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)		**Location in Plan** **(section and/or page number)**	**Met**	**Not Met**
B1. Does the plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	a. Does the plan include a general **description** of all natural hazards that can affect each jurisdiction?	Part 2, Section 5: Earthquake (pp. 38-45, 49-50) Part 2, Section 6: Epidemic/ Pandemic (pp. 51-55, 56-57) Part 2, Section 7: Flood, Sea-Level Rise, and Cliff Erosion (pp. 58-64, 69-72) Part 2, Section 8: Mass Earth Movements (pp. 73-77, 82-85) Part 2, Section 9: Severe Weather Events (pp. 86-94, 99-101) Part 2, Section 10: Tsunami (pp. 102-106, 108-109) Part 2, Section 11: Wildfires (pp. 110-116, 120-122)	X	
	b. Does the plan provide rationale for the **omission** of any natural hazards that are commonly recognized to affect the jurisdiction(s) in the planning area?	Executive Summary: Identifying + Assessing Natural Hazard Risks in the Planning Area (p. 4) *Clarifies that no hazards were omitted*	X	
	c. Does the plan include a description of the **type** of all natural hazards that can affect each jurisdiction?	Part 2, Section 4.2.1: Qualitative Methods – Identifying and Prioritizing Hazards of Concern (pp. 33-35) Appendix G: Hazards	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)		**Location in Plan** **(section and/or page number)**	**Met**	**Not Met**
	d. Does the plan include a description of the **location** for all natural hazards that can affect each jurisdiction?	Part 2, Section 5: Earthquake (pp. 40-41, 49-50) Part 2, Section 6: Epidemic/ Pandemic (pp. 53, 56-57) Part 2, Section 7: Flood, Sea-Level Rise, and Cliff Erosion (pp. 61, 69-72) Part 2, Section 8: Mass Earth Movements (pp. 82-85) Part 2, Section 9: Severe Weather Events (pp. 90, 99-101) Part 2, Section 10: Tsunami (pp. 104-105, 108-109) Part 2, Section 11: Wildfires (pp. 114, 120-122)	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)		Location in Plan (section and/or page number)	Met	Not Met
	e. Does the plan include a description of the **extent** for all natural hazards that can affect each jurisdiction?	Part 2, Section 4.2.1: Qualitative Methods – Identifying and Prioritizing Hazards of Concern (pp. 33-35) Part 2, Section 5: Earthquake (pp. 39-40, 41-45, 49-50) Part 2, Section 6: Epidemic/ Pandemic (pp. 54-55, 56-57) Part 2, Section 7: Flood, Sea-Level Rise, and Cliff Erosion (pp. 69-72) Part 2, Section 8: Mass Earth Movements (pp. 74, 76, 83) Part 2, Section 9: Severe Weather Events (pp. 90-93) Part 2, Section 10: Tsunami (pp. 102-105, 108-109) Part 2, Section 11: Wildfires (pp. 113, 115-116)	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)		**Location in Plan** **(section and/or page number)**	**Met**	**Not Met**
B2. Does the plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	a. Does the plan include information on **previous occurrences** of hazard events for each jurisdiction?	Part 2, Section 5: Earthquake (pp. 39-40) Part 2, Section 6: Epidemic/ Pandemic (p. 53) Part 2, Section 7: Flood, Sea-Level Rise, and Cliff Erosion (pp. 60-61) Part 2, Section 8: Mass Earth Movements (pp. 75, 83) Part 2, Section 9: Severe Weather Events (pp. 89-90) Part 2, Section 10: Tsunami (pp. 103-104) Part 2, Section 11: Wildfires (pp. 112-114) Appendix G: Hazards	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)		**Location in Plan** **(section and/or page number)**	**Met**	**Not Met**
	b. Does the plan include information on the **probability** of future hazard events for each jurisdiction?	Part 2, Section 4.2.1: Qualitative Methods – Identifying and Prioritizing Hazards of Concern (pp. 33-35) Part 2, Section 5: Earthquake (p. 39) Part 2, Section 6: Epidemic/ Pandemic (pp. 52-53, 55) Part 2, Section 7: Flood, Sea-Level Rise, and Cliff Erosion (pp. 60, 64, 68-72) Part 2, Section 8: Mass Earth Movements (pp. 74-77, 84) Part 2, Section 9: Severe Weather Events (pp.88-90, 94) Part 2, Section 10: Tsunami (pp. 103-105) Part 2, Section 11: Wildfires (pp. 112-115, 116-117)	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)		**Location in Plan** **(section and/or page number)**	**Met**	**Not Met**
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	a. Is there a description of each hazard's **impacts** on each jurisdiction (what happens to structures, infrastructure, people, environment, etc.)?	Part 2, Section 5: Earthquake (pp. 39, 44, 45-49) Part 2, Section 6: Epidemic/ Pandemic (pp. 52-53, 55-56) Part 2, Section 7: Flood, Sea-Level Rise, and Cliff Erosion (pp. 60-68) Part 2, Section 8: Mass Earth Movements (pp. 74-82) Part 2, Section 9: Severe Weather Events (pp. 88-99) Part 2, Section 10: Tsunami (pp. 103-104, 106-108) Part 2, Section 11: Wildfires (pp. 112-114, 116-120) Appendix G: Hazards	X	
	b. Is there a description of each identified hazard's overall **vulnerability** (structures, systems, populations, or other community assets defined by the community that are identified as being susceptible to damage and loss from hazard events) for each jurisdiction?	Part 2, Section 5: Earthquake (pp. 39, 44-50) Part 2, Section 6: Epidemic/ Pandemic (pp. 52-53, 55-56) Part 2, Section 7: Flood, Sea-Level Rise, and Cliff Erosion (pp. 60, 64-72) Part 2, Section 8: Mass Earth Movements (pp. 75, 77-84) Part 2, Section 9: Severe Weather Events (pp. 89, 94-101) Part 2, Section 10: Tsunami (pp. 103-104, 106-109) Part 2, Section 11: Wildfires (pp. 112-113, 117-122)	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)		**Location in Plan** **(section and/or page number)**	**Met**	**Not Met**
B4. Does the plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))		Part 1, Section 3.5: Hazard Mitigation Capabilities and Capacity Assessment (p. 28) *Clarifies that OCTA does not participate in the NFIP due to ineligibility*	X	
ELEMENT B: REQUIRED REVISIONS				
ELEMENT C. MITIGATION STRATEGY				
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	a. Does the plan document each jurisdiction's existing authorities, policies, programs and resources?	Part 1, Section 2.6.1: Review of Policies, Plans, and Programs (pp. 19-20) Part 1, Section 3.5: Hazard Mitigation Capabilities and Capacity Assessment (pp. 25-31)	X	
	b. Does the plan document each jurisdiction's ability to expand on and improve these existing policies and programs?	Part 1, Section 3.5: Hazard Mitigation Capabilities and Capacity Assessment (pp. 25-31) Part 3, Section 12.2: Action Plan (p. 130) Part 3, Section 12.4: Plan Implementation and Maintenance Strategy (pp. 132-134)	X	
C2. Does the plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))		Part 1, Section 3.5: Hazard Mitigation Capabilities and Capacity Assessment (p. 28) *Clarifies that OCTA does not participate in the NFIP due to ineligibility*	X	
C3. Does the plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))		Part 3, Section 12.1: Orange County Transportation Authority 2022 Hazard Mitigation Goals (p. 124)	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)		**Location in Plan** (section and/or page number)	**Met**	**Not Met**
C4. Does the plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	a. Does the plan identify and analyze a comprehensive range of specific mitigation actions and projects to reduce the impacts from hazards?	Part 3, Section 12.1.1: Actions (pp. 124-129) Part 3, Section 12.2: Action Plan (pp. 130-131)	X	
	b. Does the plan identify mitigation actions for every hazard posing a threat to each participating jurisdiction?	Part 3, Section 12.1.1: Actions (pp. 124-129)	X	
	c. Do the identified mitigation actions and projects have an emphasis on new and existing buildings and infrastructure?	Part 3, Section 12.1.1: Actions (pp. 124-129)	X	
C5. Does the plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	a. Does the plan explain how the mitigation actions will be prioritized (including cost benefit review)?	Part 3, Section 12.2: Action Plan (pp. 130-131)	X	
	b. Does the plan identify the position, office, department, or agency responsible for implementing and administering the action, potential funding sources and expected timeframes for completion?	Part 3, Section 12.1.1: Actions (pp. 124-129) Part 3, Section 12.2.1: Cost (p. 130)	X	
C6. Does the plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	a. Does the plan identify the local planning mechanisms where hazard mitigation information and/or actions may be incorporated?	Part 1, Section 3.5.1: Planning and Regulatory (pp. 26-28) Part 3, Section 12.1.1: Actions (pp. 124-129)	X	
	b. Does the plan describe each community's process to integrate the data, information, and hazard mitigation goals and actions into other planning mechanisms?	Part 1, Section 3.5.1: Planning and Regulatory (pp. 26-28) Part 3, Section 12.4.6: Integration with Other Planning Mechanisms (p. 134)	X	
	c. The updated plan must explain how the jurisdiction(s) incorporated the mitigation plan, when appropriate, into other planning mechanisms as a demonstration of progress in local hazard mitigation efforts.	*N/A: This is OCTA's initial HMP, not an update.* *The sections identified in C6-a and C6-b describe how OCTA's HMP will be integrated into other planning mechanisms.*	N/A	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** **(section and/or page number)**	**Met**	**Not Met**
ELEMENT C: REQUIRED REVISIONS			
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (Applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	*N/A: This is OCTA's initial HMP, not an update. The following sections describe recent development trends.* Part 2, Section 5: Earthquake (p. 49) Part 2, Section 6: Epidemic/ Pandemic (p. 56) Part 2, Section 7: Flood, Sea-Level Rise, and Cliff Erosion (pp. 68-69) Part 2, Section 8: Mass Earth Movements (p. 82) Part 2, Section 9: Severe Weather Events (p. 99) Part 2, Section 10: Tsunami (p. 108) Part 2, Section 11: Wildfires (p. 120)	N/A	
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	*N/A: This is OCTA's initial HMP, not an update. The following sections describe the planned revision process.* Part 3, Section 12.4.3: Annual Progress Report (p. 133) Part 3, Section 12.4.4: Plan Updates (pp. 133-134)	N/A	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** **(section and/or page number)**	**Met**	**Not Met**
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	*N/A: This is OCTA's initial HMP, not an update. The following sections describe the planned revision process.* Part 3, Section 12.4.3: Annual Progress Report (p. 133) Part 3, Section 12.4.4: Plan Updates (pp. 133-134)	N/A	
ELEMENT D: REQUIRED REVISIONS			
ELEMENT E. PLAN ADOPTION			
E1. Does the plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))	Not yet. See *Appendix F: Plan Adoption and Resolution* for adoption resolution language		X
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))	N/A	N/A	
ELEMENT E: REQUIRED REVISIONS **E1.** FEMA will issue formal approval upon receipt of adoption documentation.			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (Optional for State Reviewers only; not to be completed by FEMA)			
F1.			
F2.			
ELEMENT F: REQUIRED REVISIONS			

SECTION 2:
PLAN ASSESSMENT

INSTRUCTIONS: The purpose of this Plan Assessment is to offer the local community more comprehensiv feedback to the community on the quality and utility of the plan in a narrative format. FEM must complete the Plan Assessment.

The Assessment is an opportunity for FEMA to provide feedback and information to the community on:1) suggested improvements to the plan; 2) specific sections in the plan where the community has gone above and beyond minimum requirements; 3) recommendations for plan implementation; and 4) ongoing

partnership(s) and information on other FEMA programs, specifically Risk MAP and Hazard Mitigation Assistance programs.

The Plan Assessment is divided into two sections:

1) Plan Strengths and Opportunities for Improvement
2) Resources for Implementing Your Approved Plan

Plan Strengths and Opportunities for Improvement is organized according to the plan elements listed in the Regulation Checklist. Each element includes a series of italicized bulleted items that are suggested topics for consideration while evaluating plans, but it is not intended to be a comprehensive list. FEMA Mitigation Planners are not required to answer each bullet item, and should use them as a guide to paraphrase their own written assessment (2-3 sentences) of each element.

The Plan Assessment must not reiterate the required revisions from the Regulation Checklist or be regulatory in nature, and should be open-ended and to provide the community with suggestions for improvements or recommended revisions. The recommended revisions are suggestions for improvement and are not required to be made for the plan to meet Federal regulatory requirements. The italicized text should be deleted once FEMA has added comments regarding strengths of the plan and potential improvements for future plan revisions. It is recommended that the Plan Assessment be a short synopsis of the overall strengths and weaknesses of the Plan (no longer than two pages), rather than a complete recap section by section.

Resources for Implementing Your Approved Plan provides a place for FEMA to offer information, data sources and general suggestions on the overall plan implementation and maintenance process. Information on other sources of assistance including, but not limited to, existing publications, grant funding or training opportunities, can be provided. States may add state and local resources, if available.

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

Strengths:

1) The plan documents a broad community engagement plan. It includes many methods of, and chances for, public engagement. OCTA translated materials into several languages to best engage their constituents.

2) *Appendix D: Planning Process and Public Outreach* includes comprehensive planning materials, meeting minutes and public outreach items. These materials are very helpful to understand OCTA's planning process.

3) Tables 2-1 and 2-2 summarize key information about the planning process for easy reference.

Opportunities for Improvement:

1) Along with survey results, detail what public comments, if any, you received through the open house and comment period. Also, describe how you incorporated public feedback (e.g., informing hazard prioritization, vulnerability assessment, or mitigation actions).

Element B: Hazard Identification and Risk Assessment

Strengths:

1) The hazard description sections use a consistent format. This makes it very easy to find and compare information.

2) The plan describes potential impacts of climate change for each hazard. This is critical in developing long term mitigation activities.

3) Each section includes graphics. Some include narrative supplements, all of which help understand risk, impact, and vulnerability in OCTA's service area.

Opportunities for Improvement:

1) Include Table G-1 in *Section 4.2: Risk Assessment Methodology*. This will give the reader additional important context for Tables 4-2 and 4-3, as well as those referenced in each scenario-specific chapter.

2) Detail how you determined severity, magnitude, frequency, onset, and duration scores. To describe the process as "qualitative" is helpful, but the scores referenced (e.g., 3.02, 1.91) are specific.

3) Include additional metrics of extent where data is available. For example, stream height and flow are often used to describe flood intensity.

Element C: Mitigation Strategy

Strengths:

1) Mitigation actions cover a broad range of activities. They include continuous data acquisition and review, infrastructure upgrades, and enhancing internal communication.

2) The table in *Section 3.5.1: Hazard Mitigation Capabilities and Capacity Assessment, Planning and Regulatory* is a useful overview of current authorities that informed the plan and how they will be used to implement it.

Opportunities for Improvement:

1) Integrate other priorities into the mitigation action prioritization process. For example, if OCTA seeks to advance equity or clean energy, it may assign points to actions that further those goals.

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

Strengths:

1) The plan proposes a robust process for monitoring and evaluation. It includes details about roles and responsibilities, opportunities for continued public engagement, and outlines for an Annual Progress Report and Mitigation Action Evaluations.

Opportunities for Improvement:

1) N/A

Appendix F. Hazards

Definitions of Hazard Ranking Factors

Table G-1 – Definitions of Hazard Ranking Factors

Rank	Severity	Magnitude	Frequency	Onset	Duration
1	No injuries or deaths expected – minimal damage or impacts on natural systems.	A single or limited number of properties impacted	Less than every 25 years	Greater than 30 days of warning	Only brief moments
2	Between 1 and 5 injuries or deaths. Minimal to moderate damage or impacts on natural systems.	Neighborhood or small community impacted	10–25 years	5–30 days of warning	1–24 hours
3	Between 5 and 25 injuries or deaths. Moderate damage or impacts on natural systems.	City or town impacted	5–10 years	1–5 days of warning	Days to weeks
4	Between 25 and 50 injuries or deaths. Extensive damage or impacts on natural systems.	Entire county impacted	1–5 years	1–10 hours of warning	Weeks to months
5	Greater than 50 injuries or deaths. Catastrophic damage or impacts on natural systems.	State and/or region impacted	Once per year	No warning	Months to years

Original Hazard Identification and Raking Results

Original 12 hazards and output tables, later condensed into the seven hazards profiles in this. The scores were measured with one is the lowest and five is the highest.

Table G-2 – Original OCTA Hazard Ranking Worst-Case Scenario

	Severity	Magnitude	Frequency	Onset	Duration	Average Score	Rank
Wildfire	3.82	4.18	4.55	4.18	2.91	3.93	1
Earthquake	4.09	4.18	2.82	5.00	2.27	3.67	2
Pandemic	4.18	4.27	1.55	2.91	4.18	3.42	3
Severe Weather	3.27	3.18	3.73	3.18	2.55	3.18	4
Flooding	2.85	3.18	3.36	3.36	2.64	3.08	5
Sea Level Rise	3.00	3.36	3.45	1.55	4.18	3.11	6
Storm Surge	3.18	2.73	3.64	3.45	2.18	3.04	7
Extreme Heat	3.18	3.45	3.36	2.18	3.00	3.04	8
Drought	2.55	3.00	3.27	1.45	4.36	2.93	9
Tsunami	3.73	3.00	1.45	4.18	1.82	2.84	10

	Severity	Magnitude	Frequency	Onset	Duration	Average Score	Rank
Cliff Erosion	2.45	2.36	2.73	2.91	2.73	2.64	11
Earth Movement	2.55	2.45	1.91	3.73	1.82	2.49	12

Table G-3 – OCTA Original Hazard Ranking Most-Likely Scenario

	Severity	Magnitude	Frequency	Onset	Duration	Average Score	Rank
Wildfire	3.73	3.64	4.45	4.00	3.55	3.87	1
Earthquake	3.09	3.82	3.09	4.82	1.91	3.35	2
Pandemic	4.00	4.00	1.18	3.00	4.09	3.25	3
Severe Weather	2.55	3.27	3.36	3.09	2.73	3.00	4
Extreme Heat	3.00	2.82	3.64	2.45	2.91	2.96	5
Sea Level Rise	2.82	3.00	2.91	1.55	4.36	2.93	6
Storm Surge	2.55	2.36	3.36	3.55	2.18	2.80	7
Flooding	2.73	2.45	3.36	2.82	2.45	2.76	8
Drought	2.27	2.55	3.18	1.36	4.36	2.75	9
Cliff Erosion	2.36	2.00	2.73	2.82	2.91	2.56	10
Earth Movement	2.18	2.09	1.64	3.36	1.73	2.20	11
Tsunami	2.18	2.18	1.09	3.45	2.00	2.18	12

Comprehensive List of FEMA Disaster Declarations

Table G-4 – FEMA Disaster Declarations for the Planning Area (Federal Emergency Management Agency, 2020)

Type of Incident	Date	Event Effects	Disaster ID
Severe Weather and Flood	1/26/1969	Severe storms and flooding	DR-253-CA
Wildfire	9/29/1970	Brush fires	DR-295-CA
Earthquake	2/9/1971	San Fernando	DR-299-CA
Severe Weather, Flood, Mass Earth Movement	2/15/1978	Coastal storms, mudslides, and flooding	DR-547-CA
Mass Earth Movement	10/9/1978	Landslides	DR-566-CA
Wildfire	10/29/1978	Brush fires	EM-3067-CA
Severe Weather, Flood, Mass Earth Movement	2/21/1980	Severe storms, mudslides, and flooding	DR-615-CA
Wildfire	11/27/1980	Brush and timber fires	DR-635-CA
Fire	4/24/1982	Urban fire	DR-657-CA

Type of Incident	Date	Event Effects	Disaster ID
Severe Weather, Flood, Mass Earth Movement	2/9/1983	Coastal storms, floods, slides, tornadoes	DR-677-CA
Earthquake	10/7/1987	Whittier Narrows	DR-799-CA
Severe Weather, Storm Surge, Flood	2/5/1988	Severe storms, high tides, flooding	DR-812-CA
Wildfire	6/30/1990	Fires	DR-872-CA
Severe Weather	2/11/1991	Severe freeze	DR-894-CA
Severe Weather, Flood, Mass Earth Movement	2/25/1992	Snowstorm, heavy rain, high winds, flooding, mudslide	DR-935-CA
Severe Weather, Flood, Mass Earth Movement	2/3/1993	Severe storm, winter storm, mud and landslides, and flooding	DR-979-CA
Wildfire, Mass Earth Movement, Erosion, Flood	10/28/1993	Fires, mud and landslides, soil erosion, and flooding	DR-1005-CA
Earthquake	1/17/1994	Northridge	DR-1008-CA
Severe Weather, Flood, Mass Earth Movement	1/10/1995	Severe winter storm, flooding, landslides, mudflows	DR-1044-CA
Severe Weather, Mass Earth Movement, Flood	3/12/1995	Severe winter storms, flooding, landslides, mudflows	DR-1046-CA
Wildfire	10/23/1996	Severe fires	EM-3120-CA
Severe Weather and Flood	2/9/1998	Severe winter storms and flooding	DR-1203-CA
Wildfire	5/14/2002	Antonio fire	FSA-2405-CA
Wildfire	6/6/2002	Copper fire	FSA-2417-CA
Wildfire	9/4/2002	Leona fire	FSA-2462-CA
Wildfire	9/24/2002	Williams fire	FSA-2464-CA
Wildfire	1/7/2003	Pacific fire	FM-2466-CA
Wildfire	10/24/2003	Verdale fire	FM-2502-CA
Wildfire	10/27/2003	Wildfires	DR-1498-CA
Wildfire	7/12/2004	Pine fire	FM-2528-CA
Wildfire	7/18/2004	Foothill fire	FM-2534-CA
Wildfire	7/21/2004	Crown fire	FM-2535-CA
Severe Weather, Flooding, Mass Earth Movements	2/4/2005	Severe storms, flooding, debris flows, and mudslides	DR-1577-CA
Severe Weather, Flooding, Mass Earth Movements	4/14/2005	Severe storms, flooding, landslides, mud, and debris flows	DR-1585-CA
Wildfire	9/28/2005	Topanga fire	FM-2583-CA
Wildfire	2/6/2006	Sierra fire	FM-2630-CA
Wildfire	3/11/2007	241 fire	FM-2683-CA
Severe Weather	3/13/2007	Severe freeze	DR-1689-CA
Wildfire	5/9/2007	Griffith Park fire	FM-2691-CA
Wildfire	5/10/2007	Island fire	FM-2694-CA

Type of Incident	Date	Event Effects	Disaster ID
Wildfire	7/8/2007	Canyon fire	FM-2708-CA
Wildfire	10/21/2007	Canyon fire	FM-2732-CA
Wildfire	10/21/2007	Buckweed fire	FM-2733-CA
Wildfire	10/22/2007	Santiago fire	FM-2737-CA
Wildfire	10/22/2007	Ranch fire	FM-2736-CA
Wildfire	10/23/2007	Wildfires	EM-3279-CA
Wildfire	10/24/2007	Wildfires	DR-1731-CA
Wildfire	4/27/2008	Santa Anita fire	FM-2763-CA
Wildfire	10/12/2008	Mareck fire	FM-2788-CA
Wildfire	10/13/2008	Sesnon fire	FM-2789-CA
Wildfire	11/15/2008	Sayre fire	FM-2791-CA
Wildfire	11/15/2008	Freeway complex fire	FM-2792-CA
Wildfire	11/18/2008	Wildfires	DR-1810-CA
Wildfire	8/27/2009	PV fire	FM-2828-CA
Wildfire	8/28/2009	Station fire	FM-2830-CA
Severe Weather, Flood, Mass Earth Movement	3/8/2010	Severe winter storms, flooding, and debris and mudflows	DR-1884-CA
Severe Weather, Flood, Mass Earth Movement	1/26/2011	Winter storms, flooding, and debris and mudflows	DR-1952-CA
Wildfire	6/2/2013	Power House fire	FM-5025-CA
Wildfire	1/16/2014	Colby fire	FM-5051-CA
Earthquake	8/24/2014	South Napa	DR-4193-CA
Wildfire	6/5/2016	Old fire	FM-5124-CA
Wildfire	6/21/2016	Fish fire	FM-5129-CA
Wildfire	7/9/2016	Sage fire	FM-5132-CA
Wildfire	7/23/2016	Sand fire	FM-5135-CA
Severe Weather, Flood, Mass Earth Movement	3/16/2017	Severe winter storms, flooding, and mudslides	DR-4305-CA
Wildfire	9/2/2017	La Tuna fire	FM-5201-CA
Wildfire	9/26/2017	Canyon fire	FM-5213-CA
Wildfire	10/9/2017	Canyon 2 fire	FM-5223-CA
Wildfire	10/10/2017	Wildfires	DR-4344-CA
Wildfire	12/5/2017	Creek fire	FM-5225-CA
Wildfire	12/5/2017	Rye fire	FM-5226-CA
Wildfire	12/6/2017	Skirball fire	FM-5227-CA
Wildfire	12/8/2017	Wildfires	EM-3396-CA
Wildfires, Flood, Mass Earth Movements	1/2/2018	Wildfires, flooding, and mud and debris flows	DR-4353-CA

Type of Incident	Date	Event Effects	Disaster ID
Wildfire	11/9/2018	Wildfires	EM-3409-CA
Wildfire	11/12/2018	Wildfires	DR-4407-CA
Wildfire	10/11/2019	Saddleridge fire	FM-5293-CA
Wildfire	10/24/2019	Tick fire	FM-5296-CA
Pandemic	3/13/2020	COVID-19	EM-3428-CA
Pandemic	3/22/2020	COVID-19	DR-4482-CA

Comprehensive List of Severe Weather Events

Table 0-5 – Severe Weather Events in the Planning Area Resulting in Deaths, Injuries, or Costs Equal or Greater Than $25,000 (National Oceanic and Atmospheric Administration)

Date	Severe Weather Type	Deaths/Injuries	Property Damage Value
5/9/1956	Tornado	1 injury	$25,000
5/14/1962	Tornado	0	$25,000
11/7/1966	Tornado	10 injuries	$250,000
3/16/1977	Tornado	4 injuries	$2,500,000
5/8/1977	Tornado	0	$2,500,000
2/9/1977	Tornado	6 injuries	$2,500,000
11/9/1982	Tornado	0	$2,500,000
3/1/1983	Tornado	30 injuries	$25,000,000
9/30/1983	Tornado	0	$250,000
10/1/1983	Tornado	3 injuries	$2,500
3/16/1986	Tornado	0	$2,500,000
6/5/1987	Tornado	0	$25,000,000
1/18/1988	Tornado	0	$25,000
12/7/1992	Tornado	0	$250,000
1/14/1993	Tornado	0	$500,000
1/17/1993	Tornado	0	$50,000
1/17/1993	Tornado	1 injury	$5,000,000
1/18/1993	Tornado	0	$50,000
2/8/1993	Tornado	0	$50,000
2/23/1993	Thunderstorm	0	$50,000
11/11/1993	Tornado	2 injuries	$1,000
2/7/1994	Tornado	0	$50,000
2/7/1994	Tornado	0	$500,000
10/21/1996	Wildfire	16 injuries	$1,500,000
10/21/1996	Wildfire	0	$3,000,000
1/1/1997	Storm Surge/Tide	27 injuries	$0

Date	Severe Weather Type	Deaths/Injuries	Property Damage Value
1/20/1997	Heavy Rain	4 injuries	$0
8/5/1997	Rip Current	1 death/3 injuries	$0
9/14/1997	High Surf	4 injuries	$0
12/6/1997	Flash Flood	0	$17,700,000
1/9/1998	Tornado	1 injury	$0
2/6/1998	Flood	0	$4,290,000
2/6/1998	Flash Flood	0	$880,000
2/7/1998	Flash Flood	1 death/2 injuries	$0
2/9/1998	Flash Flood	1 death	$0
2/23/1998	Flash Flood	3 deaths	$0
2/23/1998	Flash Flood	2 deaths/2 injuries	$29,700,000
5/2/1998	High Surf	1 death	$0
7/20/1998	Lightning	1 injury	$0
12/1/1998	Heavy Rain	0	$140,000
12/6/1998	Thunderstorm	0	$450,000
12/9/1998	High Wind	0	$50,000
12/9/1998	Wildfire	0	$25,000
2/9/1999	Dust Storm	1 injury	$0
2/20/1999	High Surf	1 death/3 injuries	$0
4/9/1999	High Wind	1 injury	$0
5/26/1999	Lightning	1 death	$0
6/23/1999	High Surf	3 injuries	$250,000
6/18/1999	Rip Current	1 death	$0
7/13/1999	Lightning	1 injury	$0
12/27/1999	Wildfire	1 injury	$0
2/10/2000	Heavy Rain	1 death/4 injuries	$300,000
2/23/2000	Thunderstorm	1 injury	$0
3/3/2000	Lightning	0	$50,000
3/5/2000	Thunderstorm	0	$100,000
3/6/2000	Hail	1 death	$75,000
4/17/2000	Rip Current	1 death	$0
5/18/2000	Rip Current	1 death	$0
5/27/2000	Rip Current	2 injuries	$0
6/4/2000	Rip Current	1 death	$0
8/1/2000	Rip Current	2 injuries	$0
8/17/2000	Rip Current	1 death	$0
8/2/2000	Wildfire	0	$100,000

Date	Severe Weather Type	Deaths/Injuries	Property Damage Value
9/11/2000	Wildfire	2 injuries	$0
10/27/2000	Flood	0	$30,000
1/9/2001	Storm Surge/Tide	0	$240,000
1/10/2001	Flood	3 injuries	$0
1/11/2001	Flash Flood	0	$1,000,000
2/11/2001	Heavy Rain	0	$250,000
2/12/2001	Flood	0	$60,000
2/13/2001	Thunderstorm	0	$25,000
2/24/2001	Dense Fog	1 injury	$0
2/24/2001	Tornado	0	$50,000
4/20/2001	Thunderstorm	1 injury	$0
5/12/2001	Rip Current	1 death	$0
9/16/2001	Rip Current	1 injury	$0
9/19/2001	Rip Current	1 death	$0
12/7/2001	Rip Current	1 death/1 injury	$0
1/23/2002	Wildfire	1 injury	$0
2/9/2002	Wildfire	0	$1,200,000
5/13/2002	Wildfire	0	$250,000
9/1/2002	Wildfire	14 injuries	$12,700,000
9/1/2002	Heat	1 death	$0
9/22/2002	Wildfire	14 injuries	$15,300,000
11/03/2002	Dense Fog	41 injuries	$0
11/7/2002	Rip Current	1 death	$0
11/8/2002	Flood	0	$150,000
11/20/2002	Wildfire	2 injuries	$0
12/15/2002	Rip Current	5 injuries	$0
12/16/2002	Flood	0	$150,000
2/25/2003	Heavy Rain	1 injury	$150,000
6/26/2003	Rip Current	1 death	$0
7/1/2003	Rip Current	1 injury	$0
7/21/203	Rip Current	1 death	$0
7/24/2003	Rip Current	1 death	$0
7/28/2003	Lightning	1 injury	$0
11/12/2003	Flash Flood	0	$35,000
11/12/2003	Hail	0	$3,500,000
2/2/2004	Flash Flood	0	$75,000
2/26/2004	Flash Flood	0	$25,000

Date	Severe Weather Type	Deaths/Injuries	Property Damage Value
2/26/2004	Flash Flood	0	$30,000
10/20/2004	Flash Flood	1 death	$0
11/27/2004	Strong Wind	1 death/1 injury	$0
12/28/2004	Thunderstorm	0	$30,000
1/7/2005	Heavy Rain	0	$5,000,000
1/7/2005	Heavy Rain	0	$15,000,000
1/9/2005	Flash Flood	0	$300,000
1/9/2005	Flash Flood	0	$50,000
1/9/2005	Flash Flood	1 death	$0
1/9/2005	Flash Flood	0	$500,000
2/18/2005	Heavy Rain	0	$20,000,000
2/19/2005	Thunderstorm	0	
2/20/2005	Flash Flood	0	$1,000,000
2/20/2005	Debris Flow	1 death	$300,000
2/21/2005	Flash Flood	0	$100,000
2/22/2005	Flash Flood	0	$30,000
4/28/2005	Thunderstorm	0	$45,000
12/21/2005	Coastal Flood	1 injury	$0
2/6/2006	Wildfire	8 injuries	$0
4/10/2007	High Surf	2 deaths	$0
9/3/2007	Excessive Heat	8 deaths	$0
9/22/2007	Flash Flood	0	$300,000
1/6/2008	Flash Flood	0	$40,000
5/22/2008	Flash Flood	0	$500,000
5/22/2008	Flash Flood	0	$150,000
12/15/2008	Heavy Rain	14 injuries	$250,000
1/18/2010	Heavy Rain	0	$100,000
1/19/2010	Tornado	0	$500,000
1/19/2010	Thunderstorm	0	$350,000
1/19/2010	Thunderstorm	0	$25,000
1/20/2010	Heavy Rain	0	$50,000
12/19/2010	Flood	0	$36,000,000
12/22/2010	Flash Flood	0	$12,300,000

Reportable Diseases and Rates

Table 0-6 – Orange County 2019 Reportable Diseases and Rates (Orange County Health Care Agency, 2019)

Diseases/ Conditions	Common Name	2015	2016	2017	2018	2019
Amebiasis	Amoebic Dysentery	13	14	11	7	12
Botulism		3	3	3	0	0
Brucellosis		5	2	2	2	1
Campylobacteriosis		398	488	544	575	651
Chlamydial Infection		11459	12837	13997	17277	14139
Coccidioidomycosis	Valley Fever	186	116	211	242	320
Chikungunya	CHIKV	24	2	2	0	2
Creutzfeldt-Jakob Disease	CJD	4	1	1	4	2
Cryptosporidiosis	Crypto	27	26	35	26	43
Cysticercosis	Pork Tapeworm	4	4	5	2	0
Dengue	Dengue Fever	12	12	10	12	19
E. coli, Shiga Toxin-Producing	STEC E. coli	52	50	45	105	140
Encephalitis		17	15	16	9	12
Giardiasis		126	177	126	134	163
Gonococcal Infection	Gonorrhea	2317	3060	3511	3887	3873
Haemophiles influenza, Invasive Disease	Hib	2	1	7	0	6
Hansen's Disease	Leprosy	2	1	0	0	1
Hemolytic Uremic Syndrome	HUS	0	1	0	0	0
Hepatitis A, Acute	HAV	17	26	19	10	18
Hepatitis B, Acute Non-Perinatal	HBV	10	5	13	10	7
Hepatitis B, Perinatal		2	1	4	0	-
Hepatitis C, Acute		5	6	10	5	1
Hepatitis D	HDV	0	1	0	0	2
Hepatitis E	HEV	0	3	1	0	0
Legionellosis	Legionnaires' Disease	33	57	69	40	72
Listeriosis		12	5	16	9	7
Malaria		9	9	3	4	5
Meningitis		281	234	199	172	132
Meningococcal Infections		2	11	2	2	1
Mumps		5	5	27	13	31
Pertussis	Whooping Cough	138	65	182	141	159
Q-Fever		1	0	0	2	2
Respiratory Syncytial virus	RVS	0	1	1	2	0
Rocky Mountain Spotted Fever		2	0	0	0	2

Diseases/ Conditions	Common Name	2015	2016	2017	2018	2019
Salmonellosis	Salmonella	489	359	366	437	428
Shigellosis		69	71	96	178	176
Syphilis		742	904	1130	1221	1437
Typhoid Fever, Case		2	4	7	3	7
Typhus & Other Non-Spotted Fever Rickettsioses		17	15	13	18	18
Varicella Hospitalization	Chickenpox	8	5	7	3	8
Vibrio Infections (non-Cholera)		29	12	19	31	24
West Nile Virus Infections		97	36	38	13	7
Yersiniosis		14	24	14	13	32
Zika Virus Infection		0	30	12	1	2

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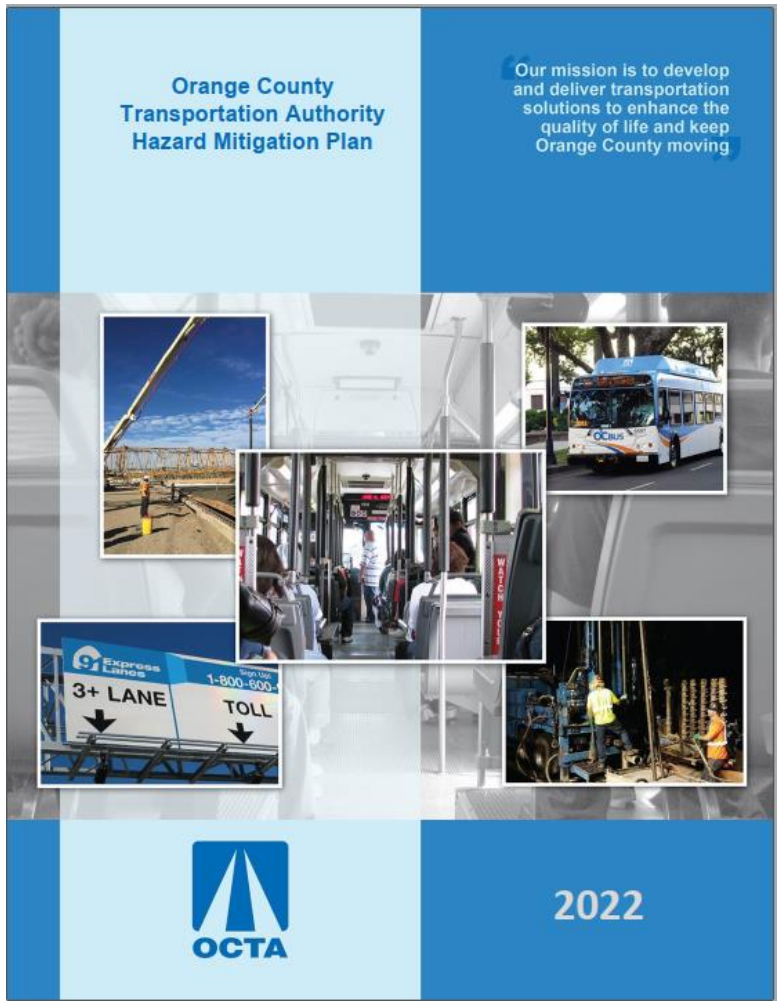
Orange County Transportation Authority

Natural Hazard Mitigation Plan



Goals of the OCTA NHMP

- Support OCTA people, policies, plans, and programs to maintain a community transportation system that reduces risk and is resilient now and long term
- Minimize vulnerabilities to protect people, property, the natural environment, and keep Orange County moving
- Ensure resilience-oriented decisions are made through regional collaboration and enhanced partnerships
- Promote community engagement through transparent public outreach that is equitable and accessible to everyone in the community

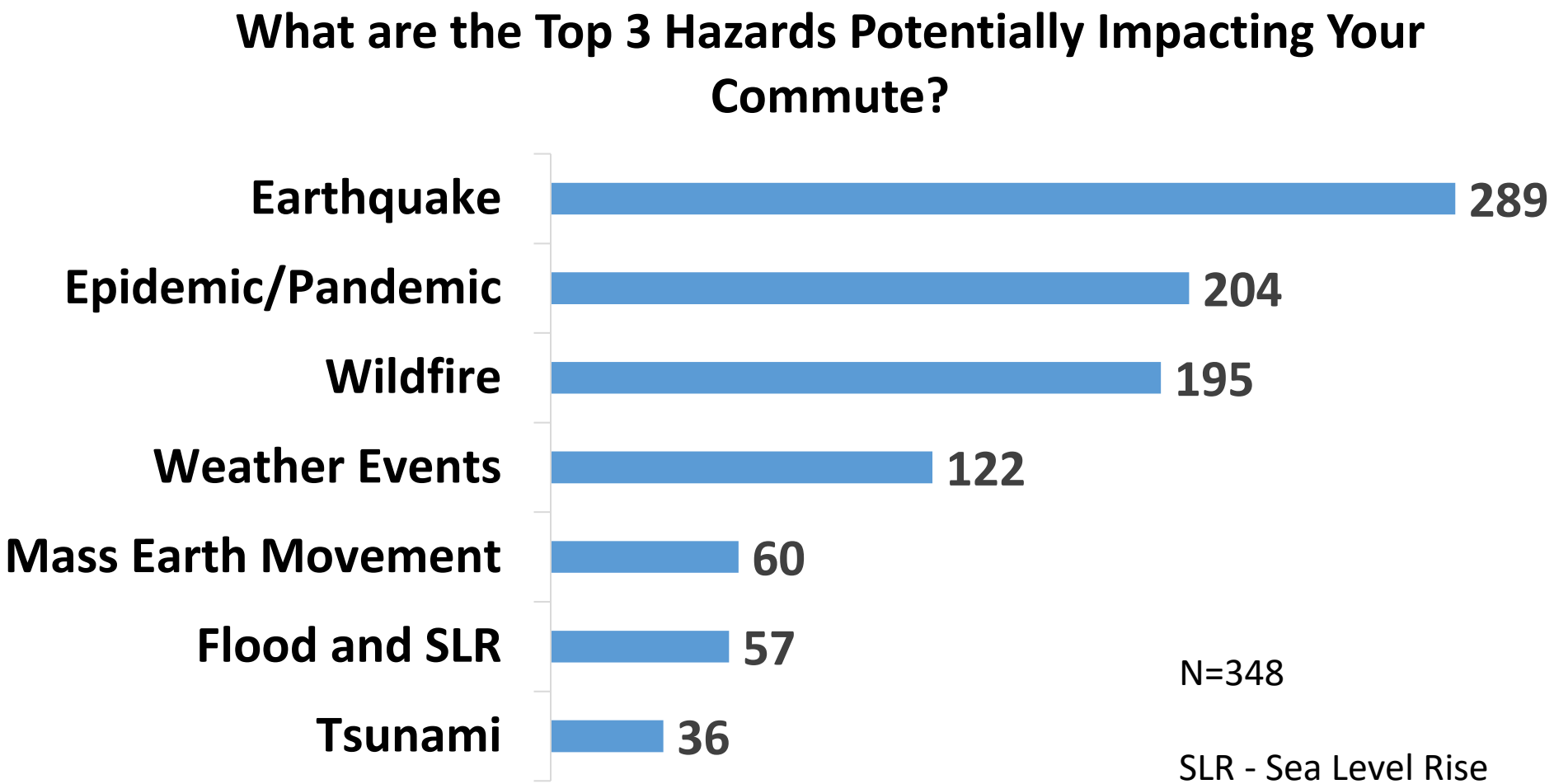
Hazard Identification: OCTA NHMP Steering Committee

	Severity	Magnitude	Frequency	Onset	Duration	Average Score	Rank
Wildfire	3.82	4.18	4.55	4.18	2.91	3.93	1
Earthquake	4.09	4.18	2.82	5.00	2.27	3.67	2
Pandemic	4.18	4.27	1.55	2.91	4.18	3.42	3
Severe Weather	3.27	3.18	3.73	3.18	2.55	3.18	4
Flooding	2.85	3.18	3.36	3.36	2.64	3.08	5
Sea Level Rise	3.00	3.36	3.45	1.55	4.18	3.11	6
Storm Surge	3.18	2.73	3.64	3.45	2.18	3.04	7
Extreme Heat	3.18	3.45	3.36	2.18	3.00	3.04	8
Drought	2.55	3.00	3.27	1.45	4.36	2.93	9
Tsunami	3.73	3.00	1.45	4.18	1.82	2.84	10

Risk Assessment: OCTA NHMP Steering Committee

Top-Ranked Natural Hazard Scenarios		
	Average Score	Rank
Wildfire	3.93	1
Earthquake	3.67	2
Pandemic	3.42	3
Severe Weather	3.18	4

Risk Assessment: OCTA NHMP Customers



OCTA NHMP Strategies

- 24 strategies were recommended that span OCTA's responsibilities to staff, facilities, ridership, communities, and the environment
- Examples include wildfire mitigation, facility infrastructure protection, and coordination of community evacuation procedures
- Due to the wide geographic area, some strategies suggest partnerships with local departments, jurisdictions, and agencies
- Strategies were constrained to OCTA assets directly owned and did not "predict" future ownership or values

Benefits Of The OCTA NHMP

- An OCTA Board-approved plan opens up previously unrealized grant funding opportunities
- Provides a specific assessment of potential hazard impacts on OCTA assets using qualitative and quantitative methods and multiple sources of data
- Informs and or compliments other OCTA planning efforts
- Suggests strategies to further reduce risks to OCTA and the community

October 3, 2022

To: Executive Committee

From: Darrell E. Johnson, Chief Executive Officer

Subject: Measure M2 Streets and Roads Program Milestone

Overview

Approximately one-third (32 percent) of the voter-approved Measure M2 local transportation sales tax revenue is dedicated to maintaining streets, synchronizing traffic signals, and improving local streets and roads to deliver a safer, more efficient roadway network. In September 2022, the Measure M2 Streets and Roads program surpassed $1 billion in funding allocations and distributions. This report commemorates this achievement and highlights the related accomplishments and benefits.

Recommendation

Receive and file as an information item.

Background

On November 7, 2006, Orange County voters, by nearly 70 percent, approved the Renewed Measure M Transportation Investment Plan (Plan) for the Measure M2 (M2) one half-cent sales tax for transportation improvements. The Plan provides a 30-year local revenue stream for a broad range of transportation and environmental initiatives. In accordance with Ordinance No. 3 (M2 Ordinance), the Orange County Transportation Authority (OCTA) directs approximately one-third (32 percent) of net local transportation sales tax proceeds to enable local jurisdictions to maintain streets, synchronize traffic signals, and improve the local streets and roads system to make it safer and more efficient. Orange County's network of local streets and roads is a critical component of connecting our communities to employment, social and health services, educational opportunities, and recreational activities; it is essential to maintain, enhance, and improve this system to sustain present and future quality of life.

Since 2011, OCTA has administered M2 funds through three streets and roads programs.

Local Fair Share (LFS)

The LFS is a formula-based program that provides flexible funding directly to local jurisdictions as gap funding needed for maintaining and repairing the aging street system as well as supporting local transportation priorities. The program is intended to augment, rather than replace, existing transportation expenditures. The M2 Ordinance specifies that 18 percent of net M2 revenues be allocated for this purpose. Funds are distributed via formula on a bimonthly basis based on population, street mileage, and the amount of sales tax collected in each jurisdiction.

Regional Capacity Program (RCP)

The RCP provides funding opportunities for improvements to the Master Plan of Arterial Highways, which is the backbone of Orange County's arterial street network. The program consists of three individual program categories: arterial capacity enhancements (ACE), intersection capacity enhancements (ICE), and freeway arterial/streets transitions (FAST). The M2 Ordinance specifies that ten percent of net M2 revenues are to be allocated for the RCP, through a competitive process to ensure critical project needs are addressed.

Regional Traffic Signal Synchronization Program (RTSSP)

The RTSSP provides funding opportunities and assistance to implement multi-agency synchronization projects that improve traffic flow by coordinating traffic lights across jurisdictional boundaries and maintaining coordination through freeway interchanges, where possible. The M2 Ordinance set the target of the program to regularly coordinate 2,000 signals along 750 miles of roadway. It also specifies that four percent of net M2 revenues to be allocated for RTSSP, under a competitive program which OCTA makes available through annual calls for projects (call).

In September 2022, these programs collectively surpassed $1 billion of M2 funding investments and commitments through annual competitive grants and flexible formula funding to local jurisdictions. This funding helped improve the Orange County's streets and roads network, as well as support local transportation priorities.

Discussion

The Plan was developed in anticipation of Orange County's needs over 30 years. Continued investments in the transportation system are necessary to manage traffic congestion, strengthen the local economy, and improve quality of life. Regardless of the mode of transportation (by foot, bicycle, bus, rail, truck, automobile, etc.), nearly every trip is connected to the street network, emphasizing the need to maintain Orange County's local streets and roads network.

Since 2011, Orange County's population has grown by over four percent to nearly 3.2 million residents; jobs have increased by 14 percent; housing has increased by approximately six percent; and travel on arterials and local roads has seen an increase of over six percent, yet the performance of the transportation system has remained at or above normal service levels. The M2 Streets and Roads program has provided a reliable source of funding to sustain Orange County's streets and roads through LFS, RCP, and RTSSP. Status of the three programs is provided below. Details on the $1 billion breakdown of allocations and distributions for each program are included in Attachment A.

LFS

As of September 2022, OCTA has provided $598 million of M2 funds directly to local jurisdictions through LFS. Staff's analysis of local jurisdictions' annual expenditure reports submitted to OCTA from fiscal year (FY) 2010-11 through FY 2020-21 reflects that over 85 percent of funds have been expended on maintenance of streets and roads. The remainder is comprised of new construction, right-of-way, administration, and other transportation priorities.

RCP

Through 12 calls to date, OCTA has allocated $283.4 million of M2 revenues for 191 RCP project phases (includes planning, environmental and engineering, right-of-way, and construction) for the ACE, ICE, and FAST categories. In the three most recent calls, 92 percent of project applications submitted received funding. RCP funding guidelines are regularly revisited in coordination with local jurisdiction representatives to align with current project needs. In addition, the project selection process relies on an open evaluation process based on objective criteria such as traffic and congestion levels, cost effectiveness, and project readiness, to ensure transparency and effectiveness. More importantly, 140 of the 191 project phases allocated are open to traffic, demonstrating the strong partnership between OCTA and local jurisdictions to ensure timely implementation for the public's benefit.

RTSSP

Through 12 calls to date, OCTA has allocated $119.6 million of M2 revenues for 109 synchronization projects. In the three most recent calls, 79 percent of project applications submitted received funding. RTSSP funding guidelines are also updated on a periodic basis in coordination with local jurisdictions. Modifications to the project selection criteria considers transportation significance, cost effectiveness, number of participating jurisdictions, and project readiness. Of the 109 projects funded under this program, 81 have been completed. This has resulted in traffic lights being synchronized at over 2,300 intersections along more than 621 miles of streets. The completed projects have improved travel times by 12 percent, reduced delays and congestion by 13 percent in increased average speed and increased the number of successive green lights drivers experience in their daily commutes with a reduction of 27 percent in stops.

Through LFS, RCP, and RTSSP, local jurisdictions have also been able to use M2 funds to repair sidewalks, enhance crosswalks, and add bicycle lanes as part of their awarded streets and roads projects. In addition, as appropriate, the local agencies have been able to upgrade pedestrian amenities with Americans with Disabilities Act features such as curb ramps and audible or visual signals, and other signage and flashing beacons to better connect the community and make every trip, regardless of mode, safer and more accessible.

Safeguards

M2 funds are intended to augment, rather than replace, existing transportation expenditures. The M2 Ordinance includes many taxpayer safeguards to ensure that revenues are spent accordingly, and programs are carried out as promised to voters. One of the most important safeguards is the M2 Taxpayer Oversight Committee (TOC), an 11-member independent body formed to monitor OCTA's use of M2 funds, approve changes to the Plan, and hold annual public hearings on expenditures. In addition, with the support of the TOC Annual Eligibility Review Subcommittee, the OCTA Board of Directors determines annually whether local jurisdictions remain eligible to receive M2 net revenue. Details about these requirements are included in Attachment B.

Additional Investments

The $1 billion of M2 investment does not include supplemental and leveraged external funding, the OC Bridges program (Attachment C), or local jurisdictions' matching funds. OCTA remains diligent in tracking and applying for external funding opportunities to expedite local improvements and ensure the availability of M2 funds for future projects. Since 2011, OCTA has also leveraged over $103.2 million in state and federal funding to expedite and extend the reach of improvements on the local streets and roads network.

OCTA also successfully leveraged significant funding for the OC Bridges program. Included in the M2 Ordinance for the RCP is an element for construction of railroad over- or underpass grade separations where high-volume streets are impacted by freight trains along the BNSF Railway in northern Orange County. The OC Bridges program grade separated seven streets and rail crossings in the cities of Anaheim, Fullerton, and Placentia. The new crossings have all been opened to traffic since 2017. M2 provided $152.6 million, a portion of the $666.5 million total program, leveraging the majority of the funds ($513.9 million) from local, state, and federal sources.

A table summarizing local streets and roads investments is shown below.

Local Streets and Roads Investments	Funding (in millions)
LFS	$ 598.0
RCP	$ 283.4
RTSSP	$ 119.6
Subtotal for M2 Streets and Roads Programs	$1,001.0
OC Bridges Program – M2 Funds	$ 152.6
External Funding	
Streets and Roads Projects	$ 103.2
OC Bridges Program	$ 513.9
Total Investments	$1,770.7

Summary

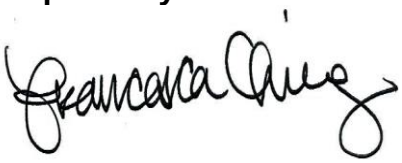
M2 dedicates approximately one-third (32 percent) of net local transportation sales tax proceeds to enable Orange County cities and the County of Orange to maintain streets, synchronize traffic signals, and improve the local streets and roads system to make it safer and more efficient. This element of M2 provides a balanced approach to streets and roads improvements by encouraging cooperative and collaborative regional planning while also allowing flexibility. As Orange County has grown over the years, local streets and roads have been able to accommodate more throughput, generally improve level of service, and also maintain the standing of having best pavement conditions in the state with an average weighted pavement condition index score of 79; where the average for the state is 66. Additionally, OCTA's diligence in seeking and leveraging external funding has helped extend the reach of these investments.

In partnership with the 35 local jurisdictions, a significant milestone in the M2 Streets and Roads program was reached as funding allocation and distributions surpassed $1 billion. M2 will continue to be a reliable revenue source through 2041 that maintains funding control at the local level. This allows for investments to be tailored to reflect the varied interests and priorities inherent in the diverse communities of Orange County – maintaining quality of life and keeping us moving.

Attachments

A. Breakdown of $1 Billion Streets and Roads Program Milestone
B. Measure M2 Eligibility Requirements Excerpt
C. External Funding for Streets and Roads Improvements

Prepared by:



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ATTACHMENT A

Breakdown of $1 Billion
Streets and Roads Program Milestone

Project O - Regional Capacity Program

Local Jurisdiction	Project No.	Project Name	Project	Program	Phase	M2 Allocation
Anaheim	11-ANAH-ACE-3502	Brookhurst St Widening (Ball Rd to Katella Ave)	O	ACE	C	$ 2,963,135
Anaheim	11-ANAH-ACE-3503	Brookhurst St Widening (I-5 to SR-91)	O	ACE	E	$ 981,907
Anaheim	11-ANAH-ACE-3504	Euclid St Widening (Crescent Ave to Westmont Dr)	O	ACE	--	$ 852,500
Anaheim	11-ANAH-FST-9000	Katella Ave (Manchester Ave to Anaheim Way)	O	FAST	--	$ 1,699,910
Anaheim	11-ANAH-ICE-3500	Ball Road and Anaheim Boulevard Intersection	O	ICE	E	$ 334,750
Anaheim	11-ANAH-ICE-3501	Ball Road and Sunkist Street Intersection	O	ICE	E	$ 383,547
Anaheim	11-ANAH-ICE-3506	Knott St and Lincoln Ave Intersection	O	ICE	--	$ 88,423
Anaheim	11-ANAH-ICE-3507	State College Boulevard and La Palma Avenue Intersection	O	ICE	E	$ 301,477
Anaheim	11-ANAH-ICE-3508	Tustin Ave/La Palma Ave Intersection Widening	O	ICE	C	$ 1,689,000
Anaheim	13-ANAH-ACE-3650	Brookhurst Street Widening (Interstate 5 to State Route 91)	O	ACE	R	$ 10,563,632
Anaheim	14-ANAH-ACE-3711	Brookhurst Street Widening (Interstate 5 to State Route 91)	O	ACE	C	$ 4,754,131
Anaheim	14-ANAH-ICE-3712	State College Boulevard and La Palma Avenue Intersection	O	ICE	R	$ 345,666
Anaheim	14-ANAH-ICE-3713	Ball Road and Anaheim Boulevard Intersection	O	ICE	R	$ 441,780
Anaheim	14-ANAH-ICE-3714	Ball Road and Sunkist Street Intersection	O	ICE	R	$ 727,921
Anaheim	15-ANAH-ACE-3760	Lincoln Avenue from Harbor Blvd. to West Street	O	ACE	E	$ 590,494
Anaheim	15-ANAH-ACE-3761	Lincoln Avenue Widening (East Street to Evergreen Street)	O	ACE	E	$ 762,904
Anaheim	15-ANAH-ICE-3762	State College Boulevard and La Palma Avenue Intersection	O	ICE	C	$ 2,189,239
Anaheim	15-ANAH-ICE-3763	Ball Road and Sunkist Street Intersection	O	ICE	C	$ 2,556,802
Anaheim	15-ANAH-ICE-3764	Ball Road and Anaheim Boulevard Intersection	O	ICE	C	$ 3,613,005
Anaheim	17-ANAH-ACE-3860	Lincoln Avenue from East Street to Evergreen Street	O	ACE	R	$ 1,147,669
Anaheim	22-ANAH-ACE-4014	Lincoln Widening Avenue (East Street to Evergreen Street)	O	ACE	C	$ 5,341,867
Anaheim	22-ANAH-ICE-4013	Lincoln Avenue and Harbor Boulevard Intersection Improvements	O	ICE	E	$ 78,750
Brea	11-BREA-FST-3509	SR-57 & Lambert Road Interchange Improvements Project	O	FAST	E	$ 927,000
Brea	16-BREA-FST-3802	SR-57 & Lambert Road Interchange Improvements Project	O	FAST	R	$ 5,212,800
Brea	18-BREA-FAST-3895	SR-57 & Lambert Road Interchange Improvements	O	FAST	C	$ 13,114,578
Brea	22-BREA-FAST-4015	SR-90 at SR-57 Southbound On-Ramp Project	O	FAST	E	$ 476,150
Buena Park	11-BPRK-FST-3510	SR-91/Beach Blvd WB Ramp	O	FAST	E	$ 308,000
Buena Park	13-BPRK-FST-3651	SR-91/Beach Blvd Westbound Ramp Widening	O	FAST	--	$ 1,474,370
Costa Mesa	11-CMSA-ACE-3518	Harbor Boulevard Widening (South Coast Drive to Sunflower Avenue)	O	ACE	--	$ 1,019,737
Costa Mesa	11-CMSA-ICE-3511	Baker St/Bear St	O	ICE	C	$ 181,500
Costa Mesa	11-CMSA-ICE-3512	Bristol St/Baker St	O	ICE	E	$ 66,260
Costa Mesa	11-CMSA-ICE-3513	Fairview Rd/Wilson St Intersection Widening	O	ICE	E	$ 92,429
Costa Mesa	11-CMSA-ICE-3515	Harbor Blvd/Gisler Ave Intersection Widening	O	ICE	E	$ 85,027
Costa Mesa	11-CMSA-ICE-3516	Harbor Blvd/Victoria St Intersection Widening	O	ICE	E	$ 48,750
Costa Mesa	11-CMSA-ICE-3517	Harbor Blvd/Wilson St Intersection Widening	O	ICE	C	$ 260,357
Costa Mesa	11-CMSA-ICE-9001	Harbor Blvd/Adams Ave	O	ICE	--	$ 1,687,168
Costa Mesa	15-CMSA-ACE-3766	West 17th Street Widening Project	O	ACE	E	$ 176,820
Costa Mesa	15-CMSA-ICE-3767	Harbor Boulevard at Gisler Avenue Intersection Improvement	O	ICE	C	$ 489,808
Costa Mesa	15-CMSA-ICE-3768	Hyland Avenue at MacArthur Boulevard Intersection Improvements	O	ICE	E	$ 37,500
Costa Mesa	16-CMSA-ACE-3803	Newport Boulevard Widening from 19th St to Superior Ave	O	ACE	E	$ 281,250
Costa Mesa	17-CMSA-ICE-3861	Hyland Avenue at MacArthur Boulevard Intersection Improvements	O	ICE	--	$ 251,735
County of Orange	11-ORCO-ACE-3519	Cow Camp Rd (Antonio Pkwy to I St, Segment 1)	O	ACE	--	$ 5,031,176
County of Orange	11-ORCO-ACE-3520	Edinger Ave Bridge Widening at Santa Ana River	O	ACE	E	$ 548,731
County of Orange	11-ORCO-ACE-3521	La Pata Ave Ext (Ortega Hwy/Calle Saluda/Del Rio)	O	ACE	E	$ 2,250,000
County of Orange	12-ORCO-ACE-3596	La Pata Ave Phase I (Prima Deshecha Landfill to Calle Saluda)	O	ACE	--	$ 5,110,000
County of Orange	13-ORCO-ACE-3655	La Pata Ave Phase II (Ortega Hwy/Prima Deshecha Landfill)	O	ACE	C	$ 8,550,866
County of Orange	14-ORCO-ACE-3727	Brea Boulevard and Brea Canyon Road Widening Improvements	O	ACE	E	$ 2,308,500
County of Orange	15-ORCO-ACE-3779	Cow Camp Road - Segment 2 (Engineering Phase)	O	ACE	E	$ 2,750,000
County of Orange	16-ORCO-ICE-3805	Oso/Antonio Parkway Intersection Improvements	O	ICE	C	$ 792,669
County of Orange	17-ORCO-ACE-3867	Ortega Highway Widening Improvements (PA&ED Phase)	O	ACE	E	$ 1,950,000
County of Orange	17-ORCO-ACE-3868	Cow Camp Road Segment 2A & 2B Construction	O	ACE	C	$ 14,778,770
County of Orange	21-ORCO-ACE-3991	Los Patrones Parkway Extension	O	ACE	E	$ 1,875,000
Cypress	11-CYPR-ACE-3522	Cerritos Ave (East) Widening at Walker St	O	ACE	E	$ 27,398
Fullerton	11-FULL-ACE-3523	Bastanchury Rd (Harbor Blvd to Fairway Isles Dr)	O	ACE	--	$ 376,300
Fullerton	11-FULL-ACE-3524	Chapman Ave at SR-57 Interchange	O	ACE	C	$ 151,073

Project O - Regional Capacity Program

Local Jurisdiction	Project No.	Project Name	Project	Program	Phase	M2 Allocation
Garden Grove	17-GGRV-ICE-3862	Euclid Street and Westminster Avenue Intersection Improvement	O	ICE	R	$ 517,646
Garden Grove	21-GGRV-ICE-3992	Euclid-Westminster Intersection Improvement Project - Construction Phase	O	ICE	C	$ 1,022,531
Garden Grove	22-GGRV-ICE-4016	Harbor-Garden Grove Intersection Improvement Project - Engineering Phase	O	ICE	E	$ 97,500
Huntington Beach	11-HBCH-ICE-3525	Beach Blvd/Warner Ave	O	ICE	E	$ 53,951
Huntington Beach	11-HBCH-ICE-3526	Brookhurst St/Adams Ave Intersection Widening	O	ICE	E	$ 176,345
Huntington Beach	12-HBCH-ACE-3597	Beach Blvd 4th NB Thru Lane	O	ACE	--	$ 266,906
Huntington Beach	15-HBCH-ACE-3770	Atlanta Avenue Widening	O	ACE	C	$ 1,200,000
Irvine	11-IRVN-ACE-3527	Culver Dr (Scottsdale to I-5)	O	ACE	--	$ 811,703
Irvine	11-IRVN-FST-3529	Jamboree Rd/I-405 SB Ramp Interchange	O	FAST	E	$ 64,340
Irvine	11-IRVN-ICE-3528	Jamboree Rd/Barranca Pkwy Intersection Widening	O	ICE	E	$ 46,206
Irvine	11-IRVN-ICE-3530	Jamboree Rd/Main St	O	ICE	E	$ 87,057
Irvine	13-IRVN-ACE-3653	University Dr Widening (MacArthur Blvd to Campus Dr)	O	ACE	E	$ 910,000
Irvine	14-IRVN-ICE-3715	University Dr/Ridgeline Dr/Rosa Drew Ln	O	ICE	E	$ 321,960
Irvine	15-IRVN-ACE-3771	University Drive (MacArthur to Campus) Widening	O	ACE	R	$ 147,640
Irvine	16-IRVN-ACE-3806	University Drive Widening (MacArthur to Campus)	O	ACE	C	$ 4,016,606
Irvine	16-IRVN-ACE-3807	Jamboree Road Widening (600 feet north of Main to Barranca)	O	ACE	E	$ 361,771
Irvine	16-IRVN-ICE-3808	University Dr/Ridgeline Dr/Rosa Drew Ln Intersection Improvements	O	ICE	R	$ 9,165
Irvine	17-IRVN-ICE-3863	University/Ridgeline Intersection Improvement	O	ICE	C	$ 1,724,024
Irvine	18-IRVN-ACE-3898	University Drive Widening from Ridgeline Drive to Interstate-405	O	ACE	E	$ 327,262
Irvine	18-IRVN-ICE-3899	Harvard Avenue at Michelson Drive Intersection Improvements	O	ICE	E	$ 54,420
Irvine	18-IRVN-ICE-3900	Culver Drive at Alton Parkway Intersection Improvements	O	ICE	E	$ 194,047
Irvine	20-IRVN-ACE-3964	University Drive Widening from Ridgeline Drive to Interstate 405	O	ACE	C	$ 1,833,901
Irvine	21-IRVN-ICE-3993	Jeffrey Road at Barranca Parkway Intersection Improvements	O	ICE	E	$ 187,500
Irvine	22-IRVN-ICE-4017	Culver Drive at Alton Parkway Intersection Improvements	O	ICE	C	$ 2,236,846
Irvine	22-IRVN-ICE-4018	Harvard Avenue at Michelson Drive Intersection Improvements	O	ICE	C	$ 306,311
La Habra	11-LHAB-ICE-3531	Whittier Blvd. and Hacienda Rd. Intersection Improvements	O	ICE	E	$ 172,777
La Habra	14-LHAB-ICE-3717	Whittier Blvd and Beach Blvd Intersection Improvements	O	ICE	C	$ 1,106,563
La Habra	14-LHAB-ICE-3718	Harbor Blvd at Lambert Rd Intersection Improvement	O	ICE	C	$ 573,028
La Habra	15-LHAB-ICE-3772	Whittier Blvd. and Hacienda Rd. Intersection Improvements	O	ICE	R	$ 624,067
La Habra	16-LHAB-ICE-3809	Whittier Blvd and Hacienda Rd Intersection Improvements	O	ICE	C	$ 1,230,548
La Palma	16-LPMA-ACE-3810	La Palma Ave / Del Amo Blvd over Coyote Creek Bridge Replacement Project	O	ACE	--	$ 975,000
Laguna Beach	11-LBCH-ICE-3532	South Coast Hwy/Broadway (SR-1/SR-133)	O	ICE	E	$ 47,300
Laguna Hills	11-LHLL-ACE-3533	Paseo De Valencia (Kennington Dr to Laguna Hills Dr)	O	ACE	E	$ 266,873
Laguna Niguel	11-LNIG-ACE-3534	Crown Valley Pkwy Widening (Cabot Rd to Forbes Rd)	O	ACE	C	$ 1,278,907
Laguna Niguel	15-LNIG-ACE-3775	Crown Valley Parkway Westbound Widening I-5 to Oso Creek Project	O	ACE	E	$ 922,000
Lake Forest	11-LFOR-ACE-9002	Rancho Parkway - Hermana Cr to Portola Pkwy	O	ACE	C	$ 1,231,444
Lake Forest	15-LFOR-ACE-3776	Portola Parkway Widening Improvements	O	ACE	C	$ 179,276
Mission Viejo	11-MVJO-ACE-3536	La Paz Bridge/Rd Widening (Muirlands Blvd to Chrisanta Dr)	O	ACE	R	$ 193,446
Mission Viejo	11-MVJO-ACE-3537	Oso Pkwy (I-5 to Country Club Dr)	O	ACE	C	$ 2,655,618
Mission Viejo	16-MVJO-ICE-3811	Alicia Parkway and Marguerite Parkway Intersection Capacity Enhancement	O	ICE	--	$ 271,989
Mission Viejo	16-MVJO-ICE-3812	Marguerite Parkway and Santa Margarita Parkway	O	ICE	--	$ 143,298
Mission Viejo	17-MVJO-ICE-3864	Los Alisos Boulevard and Santa Margarita Parkway	O	ICE	--	$ 205,559
Mission Viejo	18-MVJO-ACE-3904	La Paz Bridge and Road Widening from Muirlands to Chrisanta	O	ACE	C	$ 3,300,843
Mission Viejo	20-MVJO-ICE-3965	Marguerite Parkway & Jeronimo Road Intersection Capacity Enhancement Project	O	ICE	--	$ 481,749
Newport Beach	11-NBCH-ACE-3538	Newport Blvd Widening (Via Lido to 30th St)	O	ACE	E	$ 225,000
Newport Beach	12-NBCH-ACE-3598	West Coast Hwy Widening (Hoag Dr to Riverside Ave)	O	ACE	E	$ 270,000
Newport Beach	13-NBCH-ACE-3654	Newport Blvd Widening (Via Lido to 30th St)	O	ACE	R	$ 3,048,413
Newport Beach	14-NBCH-ACE-3720	Newport Blvd Widening (Via Lido to 30th St)	O	ACE	C	$ 1,194,000
Newport Beach	20-NBCH-ICE-3966	West Coast Highway and Superior Avenue/Balboa Boulevard Intersection Improvements (Phase 2)	O	ICE	E	$ 780,000
Orange	11-ORNG-FST-3540	Meats Ave at SR-55 Interchange	O	FAST	E	$ 728,722
Orange	11-ORNG-ICE-3539	Katella Ave/Wanda St Intersection Widening	O	ICE	E	$ 37,809
Orange	13-ORNG-ICE-3656	Lincoln Ave/Tustin St Intersection Widening	O	ICE	E	$ 80,714
Orange	14-ORNG-ICE-3721	Lincoln Avenue and Tustin Street Intersection Widening	O	ICE	--	$ 389,692
Orange	14-ORNG-ICE-3722	Katella Avenue and Wanda Road intersection widening	O	ICE	--	$ 703,680
Orange	15-ORNG-ICE-3780	Tustin Street and Chapman Avenue Intersection Widening	O	ICE	--	$ 243,750

Project O - Regional Capacity Program

Local Jurisdiction	Project No.	Project Name	Project	Program	Phase	M2 Allocation
Orange	15-ORNG-ICE-3781	Tustin Street and Katella Avenue Critical Intersection Widening	O	ICE	E	$ 56,114
Orange	15-ORNG-ICE-3782	Tustin/Meats Intersection Right Turn Lane Addition	O	ICE	E	$ 85,757
Orange	16-ORNG-ICE-3813	Tustin/Meats Intersection Right Turn Lane Addition	O	ICE	R	$ 1,206,634
Orange	17-ORNG-ICE-3865	Tustin/Meats Intersection Right Turn Lane Addition	O	ICE	C	$ 719,625
Orange	17-ORNG-ICE-3866	Tustin Street and Chapman Avenue Intersection Widening	O	ICE	C	$ 375,000
Orange	18-ORNG-ICE-3906	Cannon Street at Serrano Avenue Intersection Widening	O	ICE	E	$ 108,750
Orange	21-ORNG-ACE-3994	Cannon Street Widening - Santiago Canyon Road to Serrano Avenue	O	ACE	E	$ 618,750
Orange	22-ORNG-ICE-4019	Cannon Street at Serrano Avenue Intersection Widening	O	ICE	C	$ 631,814
San Juan Capistrano	15-SJCP-ACE-3784	Del Obispo Street Widening	O	ACE	--	$ 865,930
San Juan Capistrano	20-SJCP-ACE-3967	Ortega Highway Widening Improvements Project (PS&E Phase)	O	ACE	E	$ 5,250,000
Santa Ana	11-SNTA-ACE-3542	Bristol St (Washington Ave to 17th St)	O	ACE	E	$ 119,208
Santa Ana	11-SNTA-ACE-3543	Grand Ave Widening (1st St to 4th St)	O	ACE	C	$ 1,040,000
Santa Ana	11-SNTA-ACE-9003	Bristol St (3rd St to Civic Center Dr)	O	ACE	--	$ 1,873,587
Santa Ana	12-SNTA-ACE-3599	Bristol St Widening (Washington Ave to 17th St)	O	ACE	--	$ 13,769,007
Santa Ana	12-SNTA-ACE-3600	Grand Ave Widening (4th St to 17th St)	O	ACE	E	$ 244,141
Santa Ana	13-SNTA-ACE-3658	Warner Avenue Widening (Main Street to Oak Street)	O	ACE	E	$ 323,775
Santa Ana	14-SNTA-ACE-3724	Bristol Street Widening - Civic Center Drive to Washington Avenue	O	ACE	R	$ 6,656,000
Santa Ana	14-SNTA-ACE-3725	Bristol Street Widening - Warner Avenue to St. Andrew Place	O	ACE	R	$ 9,468,000
Santa Ana	15-SNTA-ACE-3785	Fairview Street Street Widening	O	ACE	E	$ 185,100
Santa Ana	16-SNTA-ACE-3814	Warner Ave Improvements and Widening (Main St to Oak St)	O	ACE	R	$ 5,200,000
Santa Ana	16-SNTA-ICE-3815	Bristol Street and Memory Lane Intersection Widening	O	ICE	E	$ 67,500
Santa Ana	16-SNTA-ICE-3816	Warner Avenue and Flower Street Intersection Improvements	O	ICE	E	$ 6,737
Santa Ana	17-SNTA-ACE-3869	Warner Avenue Improvements - Oak Street to Grand Avenue	O	ACE	E	$ 811,125
Santa Ana	17-SNTA-ACE-3870	Warner Avenue Improvements from Main St to Orange Avenue	O	ACE	R	$ 8,586,900
Santa Ana	17-SNTA-ICE-3871	Bristol Street and Memory Lane Intersection Improvements	O	ICE	R	$ 1,167,244
Santa Ana	17-SNTA-ICE-3872	Warner Avenue and Flower Street Intersection Improvements	O	ICE	C	$ 59,524
Santa Ana	18-SNTA-ACE-3907	Warner Avenue Improvements - (Standard Avenue to Grand Avenue)	O	ACE	R	$ 3,066,000
Santa Ana	18-SNTA-ACE-3908	Warner Avenue Improvements from Main St to Oak Street	O	ACE	C	$ 4,629,750
Santa Ana	18-SNTA-ACE-3909	Warner Avenue Improvements - (Oak Street to Standard Avenue)	O	ACE	R	$ 7,494,000
Santa Ana	20-SNTA-ACE-3968	Bristol Street Improvements Phase 3A - Civic Center Drive to Washington Avenue	O	ACE	C	$ 3,273,573
Santa Ana	20-SNTA-ACE-3969	Bristol Street Improvements Phase 4 - Warner Avenue to St. Andrew Place	O	ACE	C	$ 7,501,206
Santa Ana	21-SNTA-ACE-3996	Fairview Street Improvements from 9th St. to 16th St.	O	ACE	--	$ 5,658,840
Santa Ana	21-SNTA-ACE-3997	Warner Avenue Improvements- (Oak Street to Grand Avenue)	O	ACE	C	$ 9,076,305
Santa Ana	21-SNTA-ICE-3995	Bristol St. and Memory Ln. Intersection Improvements	O	ICE	C	$ 1,012,500
Santa Ana	22-SNTA-ACE-4020	Fairview St. Improvements (Monte Carlo Drive to Trask Street)	O	ACE	E	$ 825,000
Tustin	12-TUST-ACE-9004	Tustin Ranch Rd Ext (Walnut Ave to Warner Ave)	O	ACE	C	$ 4,510,035
Tustin	13-TUST-ACE-3659	Warner Ave Extension (Red Hill Ave to Tustin Ranch Rd)	O	ACE	C	$ 5,400,000
Tustin	16-TUST-ACE-3817	Red Hill Ave Widening and Raised Median Construction (Dyer Rd/Barranca Pkwy to Edinger Ave)	O	ACE	C	$ 6,000,000
Tustin	16-TUST-ICE-3819	El Camino Real/Jamboree Rd Modification	O	ICE	--	$ 71,093
Westminster	12-WEST-ACE-3602	Bolsa Chica Rd (Duncannon Ave to Old Bolsa Chica Rd)	O	ACE	--	$ 708,028
Westminster	14-WEST-ICE-3726	Magnolia Avenue and Bolsa Avenue Intersection Capacity Enhancements	O	ICE	--	$ 898,799
Yorba Linda	11-YLND-ACE-3544	Bastanchury Rd (Lakeview Ave to Eureka Ave)	O	ACE	--	$ 2,165,700
Yorba Linda	15-YLND-ACE-3789	Bastanchury Rd Improvements (Prospect Ave to Imperial Hwy)	O	ACE	C	$ 382,676
Yorba Linda	18-YLND-ACE-3910	Yorba Linda Boulevard Widening	O	ACE	E	$ 375,000
Yorba Linda	20-YLND-ACE-3970	Bastanchury Road Improvements	O	ACE	C	$ 2,651,605
Yorba Linda	20-YLND-ACE-3971	Yorba Linda Boulevard Widening	O	ACE	E	$ 1,636,500
Yorba Linda	21-YLND-ACE-3998	Lakeview Avenue Widening from Bastanchury Road to Oriente Drive	O	ACE	C	$ 479,462
Yorba Linda	21-YLND-ICE-3999	Yorba Linda Boulevard Widening Project Between Imperial Highway and Lakeview Avenue	O	ICE	E	$ 229,378
Yorba Linda	22-YLND-ICE-4021	Savi Ranch Parkway Widening	O	ICE	E	$ 227,624
					TOTAL	$ 283,407,231

Project P - Regional Traffic Signal Synchronization Program

City	Project No.	Project Name	Project	Program	Phase	M2 Allocation
Aliso Viejo	12-OCTA-TSP-3616	Pacific Park/Oso Pkwy Signal Sync (Aliso Viejo Pkwy to SR-241)/LHLL	P	RTSSP*	--	$ 137,262
Aliso Viejo	14-OCTA-TSP-3709	La Paz Rd Signal Sync (Olympiad Rd to Crown Valley Pkwy)	P	RTSSP*	--	$ 42,665
Aliso Viejo	15-OCTA-TSP-3774	Alicia Parkway Traffic Signal Synchronization Project	P	RTSSP*	--	$ 138,540
Aliso Viejo	18-OCTA-TSP-3905	Los Alisos Boulevard Route Project	P	RTSSP*	--	$ 51,410
Aliso Viejo	19-OCTA-TSP-3941	Aliso Creek Road TSSP	P	RTSSP*	--	$ 895,287
Anaheim	11-ANAH-TSP-3545	Lincoln Avenue Signal Synchronization (Knott Avenue to Imperial Highway)	P	RTSSP	--	$ 581,650
Anaheim	11-OCTA-TSP-3557	Tustin Ave/Rose Dr Signal Sync (1st St to Yorba Linda Blvd)/SNTA	P	RTSSP*	--	$ 111,219
Anaheim	12-OCTA-TSP-3603	Ball Rd Signal Sync (Holder St to Tustin St)/ANAH	P	RTSSP*	--	$ 594,067
Anaheim	13-ANAH-TSP-3660	Harbor Blvd Signal Sync (Romneya Dr to Shopping Ctr)	P	RTSSP	--	$ 731,867
Anaheim	13-OCTA-TSP-3666	Kraemer Boulevard Signal Synchronization	P	RTSSP*	--	$ 316,358
Anaheim	13-OCTA-TSP-3670	State College Boulevard Signal Synchronization (Via Burton to Garden Grove Boulevard)	P	RTSSP*	--	$ 541,518
Anaheim	14-ANAH-TSP-3701	Anaheim Boulevard Traffic Signal Synchronization	P	RTSSP	--	$ 787,940
Anaheim	14-ANAH-TSP-3705	Orangewood Avenue Signal Synchronization (Harbor Boulevard to Batavia Street)	P	RTSSP	--	$ 683,328
Anaheim	15-ANAH-TSP-3765	La Palma Avenue Signal Synchronization (Woodland Drive to Chrisden Street)	P	RTSSP	--	$ 2,518,146
Anaheim	16-OCTA-TSP-3794	Brookhurst St TSS (Commonwealth to Pacific Coast Hwy)	P	RTSSP*	--	$ 649,077
Anaheim	16-OCTA-TSP-3795	Magnolia Ave TSS (Commonwealth to Banning)	P	RTSSP*	--	$ 488,105
Anaheim	18-OCTA-TSP-3894	Katella Avenue / Villa Park Road / Santiago Canyon Road RTSSP	P	RTSSP*	--	$ 460,967
Brea	13-OCTA-TSP-3666	Kraemer Boulevard Signal Synchronization	P	RTSSP*	--	$ 243,352
Brea	14-BREA-TSP-3702	Birch Street/Rose Drive Corridor Regional Traffic Signal Synchronization	P	RTSSP	--	$ 661,235
Buena Park	11-BPRK-TSP-3546	Valley View St Signal Sync	P	RTSSP	--	$ 271,019
Buena Park	12-BPRK-TSP-3604	Knott Ave Signal Sync (Artesia Blvd to Garden Grove Blvd)	P	RTSSP	--	$ 426,388
Buena Park	12-OCTA-TSP-3603	Ball Rd Signal Sync (Holder St to Tustin St)/ANAH	P	RTSSP*	--	$ 22,002
Buena Park	14-BPRK-TSP-3703	Artesia Blvd Signal Sync (Valley View Ave to Dale St)	P	RTSSP	--	$ 372,859
Costa Mesa	11-CMSA-TSP-3547	Fairview Signal Sync (SR-55 to SR-22)	P	RTSSP	--	$ 591,067
Costa Mesa	12-CMSA-TSP-3605	17th St Signal Sync (Whittier to Dover)	P	RTSSP	PI	$ 199,121
Costa Mesa	12-CMSA-TSP-3606	Baker Placentia Signal Sync (Mesa Verde East to Airway Ave)	P	RTSSP	--	$ 446,046
Costa Mesa	12-CMSA-TSP-3607	Victoria Signal Sync (Santa Ana River to Irvine Ave)	P	RTSSP	PI	$ 190,050
Costa Mesa	13-OCTA-TSP-3663	Adams Avenue Signal Synchronization (Lake Street to Fairview Road)	P	RTSSP*	--	$ 309,115
Costa Mesa	13-OCTA-TSP-3668	Newport Boulevard Signal Synchronization (South)	P	RTSSP*	--	$ 913,217
Costa Mesa	14-CMSA-TSP-3706	Sunflower Avenue Signal Synchronization Project	P	RTSSP	--	$ 485,304
Costa Mesa	14-OCTA-TSP-3704	Bristol Street Traffic Signal Synchronization Project	P	RTSSP*	--	$ 584,232
Costa Mesa	16-CMSA-TSP-3790	Fairview Road Signal Synchronization	P	RTSSP	--	$ 1,695,150
Costa Mesa	17-CMSA-TSP-3873	Bear Street Signal Synchronization	P	RTSSP	--	$ 494,752
Costa Mesa	20-CMSA-TSP-3972	Baker/Victoria/19th TSSP	P	RTSSP	--	$ 1,772,956
County of Orange	11-OCTA-TSP-3553	Crown Valley Pkwy Signal Sync (PCH to Antonio Pkwy)/MVJO	P	RTSSP*	--	$ 47,736
County of Orange	12-OCTA-TSP-3616	Pacific Park/Oso Pkwy Signal Sync (Aliso Viejo Pkwy to SR-241)/LHLL	P	RTSSP*	--	$ 107,849
County of Orange	12-OCTA-TSP-3626	First St/Bolsa Ave Signal Sync (Edwards St to Newport Ave)	P	RTSSP*	--	$ 19,600
County of Orange	13-OCTA-TSP-3664	Antonio Parkway Signal Synchronization (Ortega Highway to Santa Margarita Parkway)	P	RTSSP*	--	$ 438,491
County of Orange	13-OCTA-TSP-3667	Newport Avenue and Newport Boulevard Signal Synchronization (North)	P	RTSSP*	--	$ 200,707
County of Orange	15-OCTA-TSP-3786	Westminster Avenue/ 17th Street Corridor Traffic Signal Synchronization	P	RTSSP*	--	$ 268,581
County of Orange	16-OCTA-TSP-3796	El Toro Road Traffic Signal Synchronization Project	P	RTSSP*	--	$ 55,622
County of Orange	18-OCTA-TSP-3894	Katella Avenue / Villa Park Road / Santiago Canyon Road RTSSP	P	RTSSP*	--	$ 41,906
County of Orange	19-OCTA-TSP-3939	Red Hill Avenue Corridor RTSSP	P	RTSSP*	--	$ 239,439
County of Orange	21-OCTA-TSP-4002	First Street/ Bolsa Avenue Regional Traffic Signal Synchronization	P	RTSSP*	--	$ 140,796
County of Orange	22-OCTA-TSP-4024	Crown Valley Parkway Regional Traffic Signal Synchronization Program Project	P	RTSSP*	--	$ 313,236
Cypress	18-OCTA-TSP-3894	Katella Avenue / Villa Park Road / Santiago Canyon Road RTSSP	P	RTSSP*	--	$ 188,577
Dana Point	11-OCTA-TSP-3553	Crown Valley Pkwy Signal Sync (PCH to Antonio Pkwy)/MVJO	P	RTSSP*	--	$ 22,032
Dana Point	22-OCTA-TSP-4024	Crown Valley Parkway Regional Traffic Signal Synchronization Program Project	P	RTSSP*	--	$ 156,618
Dana Point	22-OCTA-TSP-4025	Moulton Parkway/Golden Lantern Regional Traffic Signal Synchronization Program Project	P	RTSSP*	--	$ 467,939
Fountain Valley	11-OCTA-TSP-3555	MacArthur Blvd/Talbert Ave Signal Sync (SR-55 to Shopping Ctr)/SNTA	P	RTSSP*	--	$ 105,909
Fountain Valley	11-OCTA-TSP-3558	Warner Ave Signal Sync (PCH to Red Hill Ave)/FVLY	P	RTSSP*	--	$ 113,048
Fountain Valley	12-OCTA-TSP-3625	Edinger Ave Signal Sync (Bolsa Chica St to SR-55)	P	RTSSP*	--	$ 99,184
Fountain Valley	16-OCTA-TSP-3794	Brookhurst St TSS (Commonwealth to Pacific Coast Hwy)	P	RTSSP*	--	$ 499,290
Fountain Valley	16-OCTA-TSP-3795	Magnolia Ave TSS (Commonwealth to Banning)	P	RTSSP*	--	$ 325,403
Fullerton	11-FULL-TSP-3549	Bastanchury Rd Signal Sync (Malvern Ave to Valley View Ave)	P	RTSSP	--	$ 495,777
Fullerton	11-FULL-TSP-3550	Euclid St Signal Sync (La Habra Blvd to Ellis Ave)	P	RTSSP	--	$ 984,871
Fullerton	12-FULL-TSP-3608	Brea Boulevard Signal Synchronization	P	RTSSP	--	$ 311,696

Project P - Regional Traffic Signal Synchronization Program

City	Project No.	Project Name	Project	Program	Phase	M2 Allocation
Fullerton	12-FULL-TSP-3609	Commonwealth Avenue Signal Synchronization	P	RTSSP	--	$ 543,389
Fullerton	12-FULL-TSP-3610	Lemon St/Anaheim Blvd Signal Sync (Berkeley Ave to La Palma Ave)	P	RTSSP	--	$ 250,008
Fullerton	12-FULL-TSP-3611	Placentia Ave Signal Sync (Bastanchury Rd to State College Blvd)	P	RTSSP	--	$ 335,522
Fullerton	15-FULL-TSP-3769	Malvern Avenue/Chapman Avenue Corridor RTSSP	P	RTSSP	--	$ 2,202,304
Fullerton	16-OCTA-TSP-3794	Brookhurst St TSS (Commonwealth to Pacific Coast Hwy)	P	RTSSP*	--	$ 299,574
Fullerton	16-OCTA-TSP-3795	Magnolia Ave TSS (Commonwealth to Banning)	P	RTSSP*	--	$ 379,637
Fullerton	17-FULL-TSP-3874	Gilbert Street / Idaho Street Corridor RTSSP	P	RTSSP	--	$ 917,280
Fullerton	18-FULL-TSP-3896	Orangethorpe Avenue/Esperanza Road Corridor RTSSP	P	RTSSP	--	$ 3,577,668
Fullerton	19-FULL-TSP-3936	Harbor Boulevard Corridor	P	RTSSP	--	$ 2,174,995
Garden Grove	15-OCTA-TSP-3783	Chapman Avenue Corridor Traffic Signal Synchronization Project	P	RTSSP*	--	$ 1,065,475
Garden Grove	15-OCTA-TSP-3786	Westminster Avenue/ 17th Street Corridor Traffic Signal Synchronization	P	RTSSP*	--	$ 402,872
Garden Grove	16-OCTA-TSP-3794	Brookhurst St TSS (Commonwealth to Pacific Coast Hwy)	P	RTSSP*	--	$ 748,936
Garden Grove	16-OCTA-TSP-3795	Magnolia Ave TSS (Commonwealth to Banning)	P	RTSSP*	--	$ 488,105
Garden Grove	18-OCTA-TSP-3894	Katella Avenue / Villa Park Road / Santiago Canyon Road RTSSP	P	RTSSP*	--	$ 41,906
Garden Grove	18-OCTA-TSP-3897	Garden Grove Boulevard TSSP (Valley View St. - Bristol St.)	P	RTSSP*	--	$ 536,949
Huntington Beach	11-OCTA-TSP-3554	Goldenwest St Signal Sync (SR-22 to PCH)/HBCH	P	RTSSP*	--	$ 190,400
Huntington Beach	11-OCTA-TSP-3555	MacArthur Blvd/Talbert Ave Signal Sync (SR-55 to Shopping Ctr)/SNTA	P	RTSSP*	--	$ 31,380
Huntington Beach	11-OCTA-TSP-3558	Warner Ave Signal Sync (PCH to Red Hill Ave)/FVLY	P	RTSSP*	--	$ 230,084
Huntington Beach	12-OCTA-TSP-3625	Edinger Ave Signal Sync (Bolsa Chica St to SR-55)	P	RTSSP*	--	$ 238,042
Huntington Beach	13-OCTA-TSP-3663	Adams Avenue Signal Synchronization (Lake Street to Fairview Road)	P	RTSSP*	--	$ 444,823
Huntington Beach	16-OCTA-TSP-3794	Brookhurst St TSS (Commonwealth to Pacific Coast Hwy)	P	RTSSP*	--	$ 499,290
Huntington Beach	16-OCTA-TSP-3795	Magnolia Ave TSS (Commonwealth to Banning)	P	RTSSP*	--	$ 488,105
Huntington Beach	20-HBCH-TSP-3973	BOLSA CHICA STREET TSSP (CHAPMAN AVENUE TO WARNER AVENUE)	P	RTSSP	--	$ 1,488,480
Huntington Beach	21-OCTA-TSP-4002	First Street/ Bolsa Avenue Regional Traffic Signal Synchronization	P	RTSSP*	--	$ 281,592
Irvine	11-IRVN-TSP-3551	Jamboree Rd Signal Sync (Portola Pkwy to MacArthur Blvd)	P	RTSSP	--	$ 201,845
Irvine	12-IRVN-TSP-3612	Culver Dr Signal Sync (Portola Pkwy to Jamboree Rd)	P	RTSSP	--	$ 491,851
Irvine	12-IRVN-TSP-3613	Jeffrey Rd Signal Sync (Portola Pkwy to Jamboree Rd)	P	RTSSP	--	$ 299,004
Irvine	12-OCTA-TSP-3615	Lake Forest Dr Signal Sync (Laguna Canyon Rd to Rockfield Blvd)/LHLL	P	RTSSP*	--	$ 35,904
Irvine	13-IRVN-TSP-3661	Alton Pkwy Signal Sync (Red Hill Ave to Portola Pkwy)	P	RTSSP	--	$ 1,061,775
Irvine	13-IRVN-TSP-3662	Barranca Pkwy Signal Sync (Red Hill to Robin Cir)	P	RTSSP	--	$ 1,553,088
Irvine	13-OCTA-TSP-3665	Bake Parkway Signal Synchronization (Irvine Center Drive to Portola Parkway)	P	RTSSP*	--	$ 282,280
Irvine	16-IRVN-TSP-3791	Irvine Center Drive / Edinger Avenue Signal Synchronization Project	P	RTSSP	--	$ 1,545,946
Irvine	16-IRVN-TSP-3792	Von Karman Avenue/Tustin Ranch Road Signal Synchronization Project	P	RTSSP	--	$ 1,320,271
Irvine	17-IRVN-TSP-3875	Irvine Boulevard Signal Synchronization Project	P	RTSSP	--	$ 364,169
Irvine	18-IRVN-TSP-3902	Culver Drive / Bonita Canyon Drive / Ford Road RTSSP	P	RTSSP	--	$ 1,139,728
Irvine	18-OCTA-TSP-3901	Main Street RTSSP	P	RTSSP*	--	$ 315,541
Irvine	19-IRVN-TSP-3937	MacArthur Boulevard Corridor RTSSP	P	RTSSP	--	$ 1,258,440
Irvine	19-OCTA-TSP-3939	Red Hill Avenue Corridor RTSSP	P	RTSSP*	--	$ 419,018
Irvine	19-OCTA-TSP-3940	Lake Forest Drive Traffic Signal Synchronization Project	P	RTSSP*	--	$ 106,788
Irvine	20-IRVN-TSP-3974	Barranca Parkway Traffic Signal Synchronization Project	P	RTSSP	--	$ 3,740,268
Irvine	21-OCTA-TSP-4000	Alton Parkway RTSSP	P	RTSSP*	--	$ 2,552,113
Irvine	22-OCTA-TSP-4022	Bake Parkway and Rockfield Boulevard RTSSP Project	P	RTSSP*	--	$ 1,063,465
La Habra	11-LHAB-TSP-3552	Lambert Rd Signal Sync (Olinda Pl to Martinez Dr)	P	RTSSP	--	$ 509,636
La Habra	12-LHAB-TSP-3614	La Habra Blvd/Central Ave/State College Blvd Corridor	P	RTSSP	--	$ 420,019
La Habra	15-LHAB-TSP-3773	Imperial Highway/SR-90 Corridor	P	RTSSP	--	$ 2,760,001
La Habra	20-LHAB-TSP-3975	Lambert Road Corridor	P	RTSSP	--	$ 1,873,074
La Habra	22-LHAB-TSP-4023	Euclid Street Corridor	P	RTSSP	--	$ 4,961,013
Laguna Hills	12-LHLL-TSP-3617	Paseo de Valencia Signal Sync	P	RTSSP	--	$ 181,255
Laguna Hills	12-OCTA-TSP-3615	Lake Forest Dr Signal Sync (Laguna Canyon Rd to Rockfield Blvd)/LHLL	P	RTSSP*	--	$ 59,840
Laguna Hills	12-OCTA-TSP-3616	Pacific Park/Oso Pkwy Signal Sync (Aliso Viejo Pkwy to SR-241)/LHLL	P	RTSSP*	--	$ 78,436
Laguna Hills	12-OCTA-TSP-3618	Los Alisos Blvd Signal Sync (Paseo de Valencia to Altisima)	P	RTSSP*	--	$ 33,262
Laguna Hills	14-OCTA-TSP-3709	La Paz Rd Signal Sync (Olympiad Rd to Crown Valley Pkwy)	P	RTSSP*	--	$ 72,202
Laguna Hills	15-OCTA-TSP-3774	Alicia Parkway Traffic Signal Synchronization Project	P	RTSSP*	--	$ 415,620
Laguna Hills	18-OCTA-TSP-3905	Los Alisos Boulevard Route Project	P	RTSSP*	--	$ 137,093
Laguna Hills	19-OCTA-TSP-3940	Lake Forest Drive Traffic Signal Synchronization Project	P	RTSSP*	--	$ 213,577
Laguna Hills	22-OCTA-TSP-4025	Moulton Parkway/Golden Lantern Regional Traffic Signal Synchronization Program Project	P	RTSSP*	--	$ 623,918
Laguna Niguel	11-OCTA-TSP-3553	Crown Valley Pkwy Signal Sync (PCH to Antonio Pkwy)/MVJO	P	RTSSP*	--	$ 190,944

Project P - Regional Traffic Signal Synchronization Program

City	Project No.	Project Name	Project	Program	Phase	M2 Allocation
Laguna Niguel	14-OCTA-TSP-3709	La Paz Rd Signal Sync (Olympiad Rd to Crown Valley Pkwy)	P	RTSSP*	--	$ 72,202
Laguna Niguel	15-OCTA-TSP-3774	Alicia Parkway Traffic Signal Synchronization Project	P	RTSSP*	--	$ 554,160
Laguna Niguel	19-OCTA-TSP-3941	Aliso Creek Road TSSP	P	RTSSP*	--	$ 248,691
Laguna Niguel	22-OCTA-TSP-4024	Crown Valley Parkway Regional Traffic Signal Synchronization Program Project	P	RTSSP*	--	$ 1,252,946
Laguna Niguel	22-OCTA-TSP-4025	Moulton Parkway/Golden Lantern Regional Traffic Signal Synchronization Program Project	P	RTSSP*	--	$ 1,559,796
Laguna Woods	14-LWDS-TSP-3707	El Toro Road Regional Traffic Signal Synchronization	P	RTSSP	--	$ 422,112
Laguna Woods	14-LWDS-TSP-3708	Moulton Parkway Regional Traffic Signal Synchronization	P	RTSSP	--	$ 443,758
Lake Forest	12-OCTA-TSP-3615	Lake Forest Dr Signal Sync (Laguna Canyon Rd to Rockfield Blvd)/LHLL	P	RTSSP*	--	$ 23,936
Lake Forest	12-OCTA-TSP-3618	Los Alisos Blvd Signal Sync (Paseo de Valencia to Altisima)	P	RTSSP*	--	$ 16,631
Lake Forest	12-OCTA-TSP-3622	Santa Margarita Pkwy Signal Sync (El Toro Rd to Plano Trabuco Rd)	P	RTSSP*	--	$ 14,178
Lake Forest	13-OCTA-TSP-3665	Bake Parkway Signal Synchronization (Irvine Center Drive to Portola Parkway)	P	RTSSP*	--	$ 250,323
Lake Forest	13-OCTA-TSP-3669	Jeronimo Road Signal Synchronization (Lake Forest Drive to Olympiad Road)	P	RTSSP*	--	$ 61,688
Lake Forest	13-OCTA-TSP-3671	Trabuco Road Signal Synchronization (Paseo Sombra to Marguerite Parkway)	P	RTSSP*	--	$ 112,954
Lake Forest	16-OCTA-TSP-3796	El Toro Road Traffic Signal Synchronization Project	P	RTSSP*	--	$ 834,335
Lake Forest	18-OCTA-TSP-3905	Los Alisos Boulevard Route Project	P	RTSSP*	--	$ 17,137
Lake Forest	19-OCTA-TSP-3940	Lake Forest Drive Traffic Signal Synchronization Project	P	RTSSP*	--	$ 1,121,278
Lake Forest	21-OCTA-TSP-4000	Alton Parkway RTSSP	P	RTSSP*	--	$ 486,117
Lake Forest	21-OCTA-TSP-4001	Portola Parkway/Santa Margarita Parkway TSSP	P	RTSSP*	--	$ 891,173
Lake Forest	22-OCTA-TSP-4022	Bake Parkway and Rockfield Boulevard RTSSP Project	P	RTSSP*	--	$ 1,443,275
Los Alamitos	18-OCTA-TSP-3894	Katella Avenue / Villa Park Road / Santiago Canyon Road RTSSP	P	RTSSP*	--	$ 209,530
Mission Viejo	11-OCTA-TSP-3553	Crown Valley Pkwy Signal Sync (PCH to Antonio Pkwy)/MVJO	P	RTSSP*	--	$ 106,488
Mission Viejo	11-OCTA-TSP-3556	Marguerite Pkwy Signal Sync (El Toro Rd to Via Escolar)/MVJO	P	RTSSP*	--	$ 313,364
Mission Viejo	12-OCTA-TSP-3616	Pacific Park/Oso Pkwy Signal Sync (Aliso Viejo Pkwy to SR-241)/LHLL	P	RTSSP*	--	$ 166,675
Mission Viejo	12-OCTA-TSP-3618	Los Alisos Blvd Signal Sync (Paseo de Valencia to Altisima)	P	RTSSP*	--	$ 236,158
Mission Viejo	12-OCTA-TSP-3622	Santa Margarita Pkwy Signal Sync (El Toro Rd to Plano Trabuco Rd)	P	RTSSP*	--	$ 70,889
Mission Viejo	13-OCTA-TSP-3669	Jeronimo Road Signal Synchronization (Lake Forest Drive to Olympiad Road)	P	RTSSP*	--	$ 137,305
Mission Viejo	13-OCTA-TSP-3671	Trabuco Road Signal Synchronization (Paseo Sombra to Marguerite Parkway)	P	RTSSP*	--	$ 85,211
Mission Viejo	14-OCTA-TSP-3709	La Paz Rd Signal Sync (Olympiad Rd to Crown Valley Pkwy)	P	RTSSP*	--	$ 141,123
Mission Viejo	15-OCTA-TSP-3774	Alicia Parkway Traffic Signal Synchronization Project	P	RTSSP*	--	$ 738,880
Mission Viejo	16-MVJO-TSP-3793	Marguerite Parkway Corridor	P	RTSSP	--	$ 759,232
Mission Viejo	16-OCTA-TSP-3796	El Toro Road Traffic Signal Synchronization Project	P	RTSSP*	--	$ 222,489
Mission Viejo	17-MVJO-TSP-3876	Olympia Road - Felipe Road Traffic Signal Synchronization	P	RTSSP	--	$ 447,136
Mission Viejo	18-OCTA-TSP-3905	Los Alisos Boulevard Route Project	P	RTSSP*	--	$ 377,007
Mission Viejo	21-OCTA-TSP-4001	Portola Parkway/Santa Margarita Parkway TSSP	P	RTSSP*	--	$ 371,322
Mission Viejo	22-OCTA-TSP-4024	Crown Valley Parkway Regional Traffic Signal Synchronization Program Project	P	RTSSP*	--	$ 626,473
Newport Beach	12-NBCH-TSP-3619	Newport Coast Dr Signal Sync (PCH to Bonita Canyon)	P	RTSSP	--	$ 240,146
Newport Beach	12-NBCH-TSP-3620	San Joaquin Hills Rd Signal Sync (Jamboree Rd to Newport Coast Dr)	P	RTSSP	--	$ 220,000
Newport Beach	13-OCTA-TSP-3668	Newport Boulevard Signal Synchronization (South)	P	RTSSP*	--	$ 391,379
Newport Beach	14-OCTA-TSP-3704	Bristol Street Traffic Signal Synchronization Project	P	RTSSP*	--	$ 339,232
Newport Beach	15-OCTA-TSP-3778	Coast Highway Traffic Signal Synchronization Project	P	RTSSP*	--	$ 1,799,210
Orange	11-OCTA-TSP-3557	Tustin Ave/Rose Dr Signal Sync (1st St to Yorba Linda Blvd)/SNTA	P	RTSSP*	--	$ 349,544
Orange	12-OCTA-TSP-3603	Ball Rd Signal Sync (Holder St to Tustin St)/ANAH	P	RTSSP*	--	$ 117,347
Orange	13-OCTA-TSP-3666	Kraemer Boulevard Signal Synchronization	P	RTSSP*	--	$ 608,380
Orange	13-OCTA-TSP-3667	Newport Avenue and Newport Boulevard Signal Synchronization (North)	P	RTSSP*	--	$ 117,656
Orange	13-OCTA-TSP-3670	State College Boulevard Signal Synchronization (Via Burton to Garden Grove Boulevard)	P	RTSSP*	--	$ 243,290
Orange	15-OCTA-TSP-3783	Chapman Avenue Corridor Traffic Signal Synchronization Project	P	RTSSP*	--	$ 1,235,950
Orange	18-OCTA-TSP-3894	Katella Avenue / Villa Park Road / Santiago Canyon Road RTSSP	P	RTSSP*	--	$ 440,014
Orange	18-OCTA-TSP-3897	Garden Grove Boulevard TSSP (Valley View St. - Bristol St.)	P	RTSSP*	--	$ 23,346
Orange	18-OCTA-TSP-3901	Main Street RTSSP	P	RTSSP*	--	$ 210,361
Orange	20-ORNG-TSP-3976	Tustin Avenue - Rose Drive RTSSP	P	RTSSP	--	$ 2,766,833
Placentia	11-OCTA-TSP-3557	Tustin Ave/Rose Dr Signal Sync (1st St to Yorba Linda Blvd)/SNTA	P	RTSSP*	--	$ 111,219
Placentia	13-OCTA-TSP-3666	Kraemer Boulevard Signal Synchronization	P	RTSSP*	--	$ 389,363
Rancho Santa Margarita	12-OCTA-TSP-3618	Los Alisos Blvd Signal Sync (Paseo de Valencia to Altisima)	P	RTSSP*	--	$ 46,566
Rancho Santa Margarita	12-OCTA-TSP-3622	Santa Margarita Pkwy Signal Sync (El Toro Rd to Plano Trabuco Rd)	P	RTSSP*	--	$ 226,845
Rancho Santa Margarita	13-OCTA-TSP-3664	Antonio Parkway Signal Synchronization (Ortega Highway to Santa Margarita Parkway)	P	RTSSP*	--	$ 404,760
Rancho Santa Margarita	18-OCTA-TSP-3905	Los Alisos Boulevard Route Project	P	RTSSP*	--	$ 102,820
Rancho Santa Margarita	21-OCTA-TSP-4001	Portola Parkway/Santa Margarita Parkway TSSP	P	RTSSP*	--	$ 1,039,702

Project P - Regional Traffic Signal Synchronization Program

City	Project No.	Project Name	Project	Program	Phase	M2 Allocation
San Clemente	11-SCLM-TSP-3559	Avenida Pico Signal Sync (El Camino Real to Camino Celosia)	P	RTSSP	--	$ 383,163
San Clemente	11-SCLM-TSP-3560	El Camino Real Signal Sync (Camino Capistrano to Avenida San Luis Rey)	P	RTSSP	--	$ 333,473
San Clemente	12-SCLM-TSP-3623	Avenida Vista Hermosa Signal Sync (East/West Avenida Pico)	P	RTSSP	--	$ 274,612
San Clemente	12-SCLM-TSP-3624	Camino De Los Mares Signal Sync (Camino Mira Costa to Camino Vera Cruz)	P	RTSSP	--	$ 219,345
San Clemente	17-SCLM-TSP-3877	Camino Vera Cruz	P	RTSSP	--	$ 192,686
San Juan Capistrano	11-OCTA-TSP-3556	Marguerite Pkwy Signal Sync (El Toro Rd to Via Escolar)/MVJO	P	RTSSP*	--	$ 9,692
San Juan Capistrano	11-SJCP-TSP-3561	Del Obispo St Signal Sync (Ortega Hwy to PCH)	P	RTSSP	--	$ 106,608
Santa Ana	11-OCTA-TSP-3555	MacArthur Blvd/Talbert Ave Signal Sync (SR-55 to Shopping Ctr)/SNTA	P	RTSSP*	--	$ 207,399
Santa Ana	11-OCTA-TSP-3557	Tustin Ave/Rose Dr Signal Sync (1st St to Yorba Linda Blvd)/SNTA	P	RTSSP*	--	$ 95,330
Santa Ana	11-OCTA-TSP-3558	Warner Ave Signal Sync (PCH to Red Hill Ave)/FVLY	P	RTSSP*	--	$ 261,176
Santa Ana	12-OCTA-TSP-3625	Edinger Ave Signal Sync (Bolsa Chica St to SR-55)	P	RTSSP*	--	$ 396,737
Santa Ana	12-OCTA-TSP-3626	First St/Bolsa Ave Signal Sync (Edwards St to Newport Ave)	P	RTSSP*	--	$ 499,800
Santa Ana	13-OCTA-TSP-3666	Kraemer Boulevard Signal Synchronization	P	RTSSP*	--	$ 876,067
Santa Ana	14-OCTA-TSP-3704	Bristol Street Traffic Signal Synchronization Project	P	RTSSP*	--	$ 961,156
Santa Ana	14-SNTA-TSP-3710	Harbor Boulevard Corridor Signal Synchronization	P	RTSSP	--	$ 1,852,080
Santa Ana	15-OCTA-TSP-3786	Westminster Avenue/ 17th Street Corridor Traffic Signal Synchronization	P	RTSSP*	--	$ 1,074,325
Santa Ana	18-OCTA-TSP-3897	Garden Grove Boulevard TSSP (Valley View St. - Bristol St.)	P	RTSSP*	--	$ 23,346
Santa Ana	18-OCTA-TSP-3901	Main Street RTSSP	P	RTSSP*	--	$ 648,612
Santa Ana	21-OCTA-TSP-4002	First Street/ Bolsa Avenue Regional Traffic Signal Synchronization	P	RTSSP*	--	$ 1,407,960
Seal Beach	13-SBCH-TSP-3673	Seal Beach TMC Relocation and Fiber Optic Bridge Gap	P	RTSSP	--	$ 541,327
Seal Beach	15-OCTA-TSP-3786	Westminster Avenue/ 17th Street Corridor Traffic Signal Synchronization	P	RTSSP*	--	$ 179,054
Seal Beach	20-SBCH-TSP-3977	Seal Beach Boulevard Signal Synchronizations and ATC Controller upgrades	P	RTSSP	--	$ 546,750
Stanton	15-OCTA-TSP-3783	Chapman Avenue Corridor Traffic Signal Synchronization Project	P	RTSSP*	--	$ 42,619
Stanton	16-OCTA-TSP-3795	Magnolia Ave TSS (Commonwealth to Banning)	P	RTSSP*	--	$ 216,936
Stanton	18-OCTA-TSP-3894	Katella Avenue / Villa Park Road / Santiago Canyon Road RTSSP	P	RTSSP*	--	$ 104,765
Tustin	11-OCTA-TSP-3557	Tustin Ave/Rose Dr Signal Sync (1st St to Yorba Linda Blvd)/SNTA	P	RTSSP*	--	$ 15,888
Tustin	11-OCTA-TSP-3558	Warner Ave Signal Sync (PCH to Red Hill Ave)/FVLY	P	RTSSP*	--	$ 12,437
Tustin	12-OCTA-TSP-3626	First St/Bolsa Ave Signal Sync (Edwards St to Newport Ave)	P	RTSSP*	--	$ 137,200
Tustin	13-OCTA-TSP-3667	Newport Avenue and Newport Boulevard Signal Synchronization (North)	P	RTSSP*	--	$ 373,731
Tustin	15-OCTA-TSP-3786	Westminster Avenue/ 17th Street Corridor Traffic Signal Synchronization	P	RTSSP*	--	$ 179,054
Tustin	19-OCTA-TSP-3939	Red Hill Avenue Corridor RTSSP	P	RTSSP*	--	$ 1,017,615
Tustin	21-OCTA-TSP-4002	First Street/ Bolsa Avenue Regional Traffic Signal Synchronization	P	RTSSP*	--	$ 394,229
Villa Park	18-OCTA-TSP-3894	Katella Avenue / Villa Park Road / Santiago Canyon Road RTSSP	P	RTSSP*	--	$ 41,906
Westminster	11-OCTA-TSP-3554	Goldenwest St Signal Sync (SR-22 to PCH)/HBCH	P	RTSSP*	--	$ 190,400
Westminster	12-OCTA-TSP-3625	Edinger Ave Signal Sync (Bolsa Chica St to SR-55)	P	RTSSP*	--	$ 19,837
Westminster	12-OCTA-TSP-3626	First St/Bolsa Ave Signal Sync (Edwards St to Newport Ave)	P	RTSSP*	--	$ 323,400
Westminster	15-OCTA-TSP-3786	Westminster Avenue/ 17th Street Corridor Traffic Signal Synchronization	P	RTSSP*	--	$ 716,216
Westminster	16-OCTA-TSP-3794	Brookhurst St TSS (Commonwealth to Pacific Coast Hwy)	P	RTSSP*	--	$ 199,716
Westminster	16-OCTA-TSP-3795	Magnolia Ave TSS (Commonwealth to Banning)	P	RTSSP*	--	$ 325,403
Westminster	18-OCTA-TSP-3897	Garden Grove Boulevard TSSP (Valley View St. - Bristol St.)	P	RTSSP*	--	$ 210,111
Westminster	21-OCTA-TSP-4002	First Street/ Bolsa Avenue Regional Traffic Signal Synchronization	P	RTSSP*	--	$ 872,935
Yorba Linda	22-YLND-TSP-4026	Yorba Linda Boulevard / Weir Canyon Road Corridor RTSSP	P	RTSSP	--	$ 3,697,453
				TOTAL		$ 119,632,264

Project Q - Local Fair Share Program

Local Jurisdiction	Total
Aliso Viejo	$ 7,461,806.59
Anaheim	$ 62,167,831.51
Brea	$ 10,713,887.10
Buena Park	$ 16,655,961.63
Costa Mesa	$ 27,359,810.37
Cypress	$ 9,871,831.93
Dana Point	$ 6,276,663.46
Fountain Valley	$ 11,624,315.68
Fullerton	$ 24,447,554.41
Garden Grove	$ 27,959,827.78
Huntington Beach	$ 36,576,442.52
Irvine	$ 51,679,058.75
Laguna Beach	$ 4,749,370.23
Laguna Hills	$ 6,371,153.36
Laguna Niguel	$ 12,489,147.85
Laguna Woods	$ 2,386,352.22
La Habra	$ 9,944,215.13
Lake Forest	$ 14,980,279.28
La Palma	$ 2,973,540.60
Los Alamitos	$ 2,432,386.84
Mission Viejo	$ 17,428,126.52
Newport Beach	$ 20,632,060.27
Orange	$ 31,074,971.37
Placentia	$ 8,592,086.85
Rancho Santa Margarita	$ 7,948,983.58
San Clemente	$ 10,643,959.78
San Juan Capistrano	$ 7,144,965.23
Santa Ana	$ 52,154,373.62
Seal Beach	$ 4,637,601.42
Stanton	$ 5,615,864.47
Tustin	$ 16,910,011.60
Villa Park	$ 979,416.87
Westminster	$ 16,003,689.61
Yorba Linda	$ 11,344,062.44
County of Orange	$ 37,718,685.61
Total	**$ 597,950,296.48**

KEY:

Program / Phase
ACE - Arterial Capacity Enhancements
C - Construction
E - Engineering
FAST - Freeway Arterial / Streets Transitions
I-5 - Interstate 5
I-405 - Interstate 405
ICE - Intersection Capacity Enhancements
PI - Primary Implementation
R - Right-of-Way
RTSSP - Regional Traffic Signal Synchronization Program
RTSSP* - OCTA-led Regional Traffic Signal Synchronization Program
SR-1 - State Route 1 (Pacific Coast Highway)
SR-22 - State Route 22
SR-55 - State Route 55
SR-57 - State Route 57
SR-90 - State Route 90 (Imperial Highway)
SR-91 - State Route 91
SR-133 - State Route 133
SR-241 - State Route 241
-- - Multiple Phases

ATTACHMENT B

Measure M2 Eligibility Requirements Excerpt

III. REQUIREMENTS FOR ELIGIBLE JURISDICTIONS.

A. In order to be eligible to receive Net Revenues, a jurisdiction shall satisfy and continue to satisfy the following requirements.

1. Congestion Management Program. Comply with the conditions and requirements of the Orange County Congestion Management Program (CMP) pursuant to the provisions of Government Code Section 65089.

2. Mitigation Fee Program. Assess traffic impacts of new development and require new development to pay a fair share of necessary transportation improvements attributable to the new development.

3. Circulation Element. Adopt and maintain a Circulation Element of the jurisdiction's General Plan consistent with the MPAH.

4. Capital Improvement Program. Adopt and update biennially a six-year Capital Improvement Program (CIP). The CIP shall include all capital transportation projects, including projects funded by Net Revenues, and shall include transportation projects required to demonstrate compliance with signal synchronization and pavement management requirements.

5. Traffic Forums.

Participate in Traffic Forums to facilitate the planning of traffic signal synchronization programs and projects. Eligible Jurisdictions and Caltrans, in participation with the County of Orange and the Orange County Division of League of Cities, will establish the boundaries for Traffic Forums. The following will be considered when establishing boundaries:

a. Regional traffic routes and traffic patterns;

b. Inter-jurisdictional coordination efforts; and

c. Total number of Traffic Forums.

6. Local Traffic Signal Synchronization Plan. Adopt and maintain a Local Traffic Signal Synchronization Plan which shall identify traffic signal synchronization street routes and traffic signals; include a three-year plan showing costs, available funding

and phasing of capital, operations and maintenance of the street routes and traffic signals; and include information on how the street routes and traffic signals may be synchronized with traffic signals on the street routes in adjoining jurisdictions. The Local Traffic Signal Synchronization Plan shall be consistent with the Traffic Signal Synchronization Master Plan.

7. Pavement Management Plan. Adopt and update biennially a Pavement Management Plan, and issue, using a common format approved by the Authority, a report every two years regarding the status of road pavement conditions and implementation of the Pavement Management Plan.

a. Authority, in consultation with the Eligible Jurisdictions, shall define a countywide management method to inventory, analyze and evaluate road pavement conditions, and a common method to measure improvement of road pavement conditions.

b. The Pavement Management Plan shall be based on: either the Authority's countywide pavement management method or a comparable management method approved by the Authority, and the Authority's method to measure improvement of road pavement conditions.

c. The Pavement Management Plan shall include:

(i) Current status of pavement on roads;

(ii) A six-year plan for road maintenance and rehabilitation, including projects and funding;

(iii) The projected road pavement conditions resulting from the maintenance and rehabilitation plan; and

(iv) Alternative strategies and costs necessary to improve road pavement conditions.

8. Expenditure Report. Adopt an annual Expenditure Report to account for Net Revenues, developer/traffic impact fees, and funds expended by the Eligible Jurisdiction which satisfy the Maintenance of Effort requirements. The Expenditure

Report shall be submitted by the end of six (6) months following the end of the jurisdiction's fiscal year and include the following:

a. All Net Revenue fund balances and interest earned.

b. Expenditures identified by type (i.e., capital, operations, administration, etc.), and program or project .

9. Project Final Report. Provide Authority with a Project Final Report within six months following completion of a project funded with Net Revenues.

10. Time Limits for Use of Net Revenues.

a. Agree that Net Revenues for Regional Capacity Program projects and Regional Traffic Signal Synchronization Program projects shall be expended or encumbered no later than the end of the fiscal year for which the Net Revenues are programmed. A request for extension of the encumbrance deadline for no more than twenty-four months may be submitted to the Authority no less than ninety days prior to the deadline. The Authority may approve one or more requests for extension of the encumbrance deadline.

b. Agree that Net Revenues allocated for any program or project, other than a Regional Capacity Program project or a Regional Traffic Signal Synchronization Program project, shall be expended or encumbered within three years of receipt. The Authority may grant an extension to the three-year limit, but extensions shall not be granted beyond a total of five years from the date of the initial funding allocation.

c. In the event the time limits for use of Net Revenues are not satisfied then any retained Net Revenues that were allocated to an Eligible Jurisdiction and interest earned thereon shall be returned to the Authority and these Net Revenues and interest earned thereon shall be available for allocation to any project within the same source program.

11. Maintenance of Effort. Annual certification that the Maintenance of Effort requirements of Section 6 of the Ordinance have been satisfied.

12. No Supplanting of Funds. Agree that Net Revenues shall not be

used to supplant developer funding which has been or will be committed for any transportation project.

13. Consider, as part of the Eligible Jurisdiction's General Plan, land use planning strategies that accommodate transit and non-motorized transportation.

B. Determination of Non-Eligibility

A determination of non-eligibility of a jurisdiction shall be made only after a hearing has been conducted and a determination has been made by the Authority's Board of Directors that the jurisdiction is not an Eligible Jurisdiction as provided hereinabove.

IV. ALLOCATION OF NET REVENUES; GENERAL PROVISIONS.

A. Subject to the provisions of the Ordinance, including Section II above, use of the Revenues shall be as follows:

1. First, the Authority shall pay the State Board of Equalization for the services and functions;

2. Second, the Authority shall pay the administration expenses of the Authority;

3. Third, the Authority shall satisfy the annual allocation requirement of two percent (2%) of Revenues for Environmental Cleanup; and

4. Fourth, the Authority shall satisfy the debt service requirements of all bonds issued pursuant to the Ordinance that are not satisfied out of separate allocations.

B. After providing for the use of Revenues described in Section A above, and subject to the averaging provisions of Section D below, the Authority shall allocate the Net Revenues as follows:

1. Forty-three percent (43%) for Freeway Projects;

2. Thirty-two percent (32%) for Street and Road Projects; and

3. Twenty-five percent (25%) for Transit Projects.

C. The allocation of thirty-two percent (32%) of the Net Revenues for

External Funding for Streets and Roads Improvements

Leveraged through M2 Calls		
M2 Program	**Funding**	**Amount**
RCP	Proposition 1B - SLPP	$ 23,396,003
RTSSP	Mobile Source Air Pollution Reduction Review Committee	$ 1,250,000
RTSSP	SB 1 - Local Partnership Program	$ 6,693,813
	Subtotal	$ 31,339,816

Other External Funding		
M2 Program	**Funding**	**Amount**
RTSSP	Proposition 1B - Traffic Light Synchronization Program	$ 3,817,662
RTSSP	Congestion Mitigation and Air Quality	$ 1,773,863
RTSSP	SB 1 - Solutions for Congested Corridors Program	$ 12,000,001
	Subtotal	$ 17,591,526

Supplemental Non-M2 Calls		
	Funding	**Amount**
	Proposition 1B - SLPP	$ 24,528,000
	Regional Surface Transportation Program - Arterial Pavement Management Program	$ 19,864,978
	Coronavirus Response and Relief Supplemental Appropriations - Pavement Management Relief Funding	$ 9,920,921
	Subtotal	$ 54,313,899

Total External Funding	**$ 103,245,241**

OC Bridges Program	M2	State/Federal/Other	Project Total
State College Boulevard Undercrossing Project	$ 15,460,000	$ 83,920,000	$ 99,380,000
Raymond Avenue Undercrossing Project	$ 22,373,000	$ 103,046,000	$ 125,419,000
Placentia Avenue Undercrossing Project	$ 27,453,000	$ 37,086,000	$ 64,539,000
Kraemer Boulevard Undercrossing Project	$ 22,981,000	$ 40,849,000	$ 63,830,000
Orangethorpe Avenue Overcrossing Project	$ 16,182,000	$ 89,861,000	$ 106,043,000
Tustin Avenue/Rose Avenue Overcrossing Project	$ 26,384,000	$ 70,254,000	$ 96,638,000
Lakeview Avenue Overcrossing Project	$ 21,792,000	$ 88,910,000	$ 110,702,000
	$ 152,625,000	**$ 513,926,000**	**$ 666,551,000**

Acronyms
M2 - Measure M2
RCP - Regional Capacity Program
RTSSP - Regional Traffic Signal Synchronization Program
SB 1 - SB 1 (Chapter 5, Statutes of 2017)
SLPP - State Local Partnership Program

Measure M2
Streets and Roads Program Milestone

Measure M2 (M2) Commitment

OCGO Local Tax Dollars at Work

- **Fix potholes and resurface streets**
- **Synchronize traffic lights in every community**
- Expand Metrolink rail and connect it to local communities
- Relieve congestion on freeways
- Provide transit services, at reduced rates, for seniors and people with disabilities
- Reduce air and water pollution and protect local beaches by cleaning up oil runoff from roadways

ENVIRONMENTAL

A total of 5% of OC Go Freeway Program funds is allocated to the Freeway Environmental Mitigation Program

A total of 2% of the overall OC Go Program funds is allocated to the Environmental Cleanup Program

M2 Streets and Roads Programs

Regional Capacity Program

(Project O)

Provides competitive funding to improve busy streets and intersections on Orange County's Master Plan of Arterial Highways.

Regional Traffic Signal Synchronization Program

(Project P)

Provides competitive funding to support projects across city boundaries that synchronize traffic signals to ensure drivers hit the most green lights during peak traffic hours.

Local Fair Share

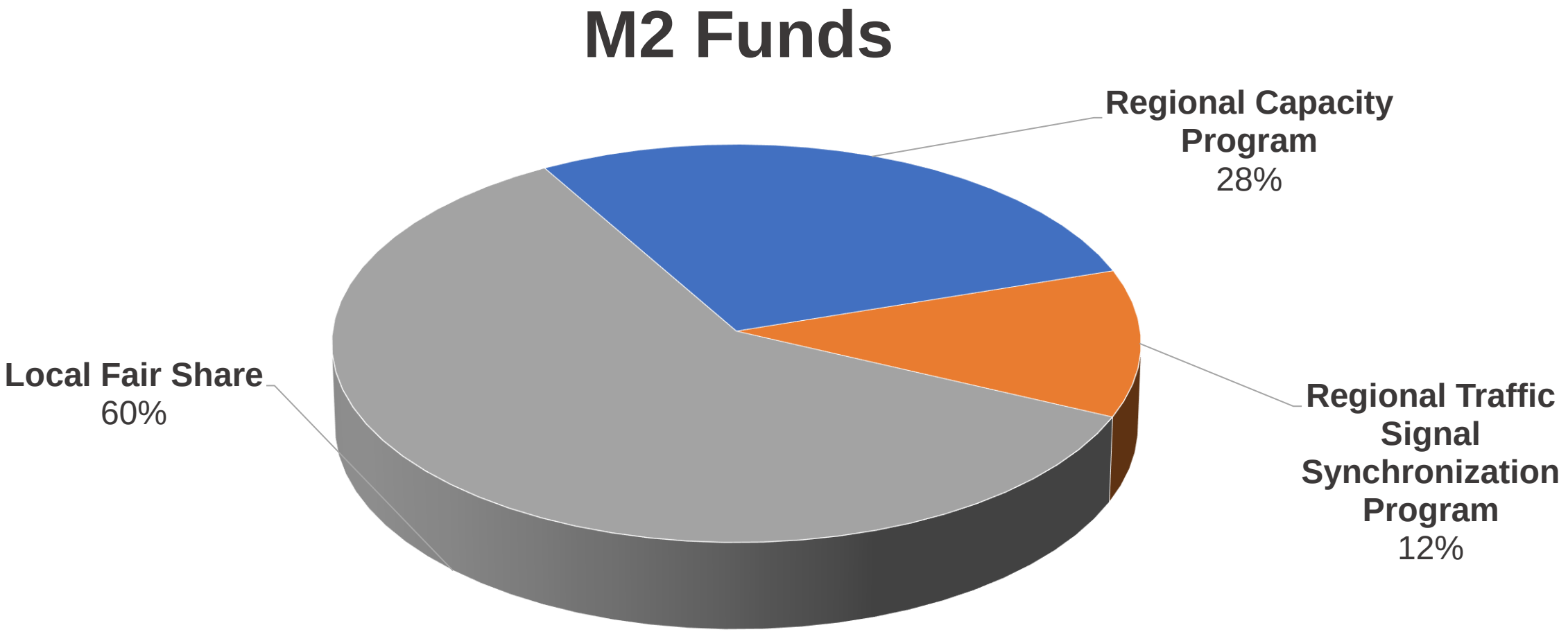
(Project Q)

Provides formula-based funds to preserve existing streets and roads and provide other transportation improvements based on the priorities and needs of local agencies.

M2 $1 Billion Milestone

- **From 2011 to 2022, over $1 billion in M2 funds have been invested locally in streets and roads.**
- The funding has:
  - Allowed Orange County to keep up with population growth and economic activities
  - Lead to a more complete roadway network
  - Provided safety enhancements: repaired sidewalks, upgraded pedestrian amenities with American with Disabilities Act features, added bike lanes, signage, etc.
  - Improved congestion, lessening stop-and-go traffic and benefitting the environment
  - Maintained Orange County's standing as having the best pavement conditions in the state

$1 Billion Investment by the Numbers



Regional Capacity Program

OCGO Local Tax Dollars at Work

- Closes gaps in the local road network
- Improves intersections to enhance street operations
- Provides better interfaces with the highway system
- Investment to date: $283.4 million

Project Examples

Newport Boulevard Improvements
City of Newport Beach

Bristol Street Improvements
City of Santa Ana

Regional Traffic Signal Synchronization

OCGO Local Tax Dollars at Work

- 2,300 intersections coordinated across 621 miles of street
- Invests in future-proofing the system
- Improves traffic flow and makes the system more efficient
- Investment to date: $119.6 million

Project Examples

Irvine Center Drive / Edinger Avenue
City of Irvine

Marguerite Parkway
City of Mission Viejo

Local Fair Share

- Pavement improvements repair aging streets for smoother, safer travel
- Supplements roadway maintenance funds to fix potholes
- Flexibility for local transportation priorities
- Investment to date: $598.0 million

Project Examples

Bristol Street
City of Costa Mesa

Laguna Beach Trolley
City of Laguna Beach

M2 Safeguards

- Specific eligibility requirements
- Supplement, rather than supplant, existing investments
- Prioritize regional projects based on objective criteria
- Formula funding balances miles, population and sales tax generation
- Ongoing monitoring by independent Taxpayer Oversight Committee

Additional Investments

- Leveraging of external funds
  - State and federal
  - Local matching dollars
- Special grants preserve roadway conditions
- OC Bridges program

OC Bridges

Key Takeaways

- M2 has invested $1 billion in local streets and roads to improve the quality of life in Orange County, whether you drive, cycle, walk, vanpool or take OC Bus
- Provides reliable and flexible funding source for cities and the County
- The investment has helped connect communities and make the streets and roads system work better and last longer
- Examples of local agency projects are highlighted at: www.ocgo.com/streets

October 3, 2022

To: Executive Committee

From: Darrell E. Johnson, Chief Executive Officer

Subject: Measure M2 Next 10 Delivery Plan: Market Conditions Key Indicators Analysis and Forecast

Overview

At the direction of the Board of Directors, the Orange County Transportation Authority monitors construction market conditions. Annually, a report on Market Conditions Key Indicators Analysis and Forecast is presented to the Board of Directors to provide insight into potential project delivery cost drivers that could affect the Measure M2 Next 10 Delivery Plan. The last effort was presented to the Board of Directors on October 11, 2021. An updated forecast has been prepared and a presentation on the results of this effort is provided.

Recommendation

Continue to monitor market conditions key indicators and provide updates to the Board of Directors as appropriate.

Background

On November 7, 2006, Orange County voters approved the renewal of Measure M, the one-half-cent sales tax for transportation improvements. The Orange County Transportation Authority (OCTA) Board of Directors (Board) continues to advance the implementation of Renewed Measure M (M2) commitments by adopting delivery plans. The delivery plans are designed to validate the ability to implement all projects and programs through 2041 as promised to the voters, ensure fiscal sustainability, and implement projects and programs effectively and expeditiously.

In 2016, the Board directed staff to acquire better insight into the construction market outlook. The intent was to provide an analysis of trends for near-term construction market conditions in tandem with the annual sales tax revenue update to assist with prudent project delivery decisions.

OCTA retained the Orange County Business Council (OCBC), led by Dr. Wallace Walrod, Chief Economic Advisor to OCBC, and Dr. Marlon Boarnet, Professor and Chair of the Department of Urban Planning and Spatial Analysis at the University of Southern California to provide this analysis.

The results of the initial analysis were presented to the Board in September 2017. The report identified several near-term cost indicators that could influence the construction market and, by extension, M2 project delivery. These included the pace of transportation construction programs in the neighboring counties (resulting in the strained supply of materials and construction labor), construction wage pressures, sustained low statewide unemployment, and residential construction demand. Overall, OCBC's analysis identified a strong potential that OCTA could experience an increasing cost environment in the near term.

Following this presentation, the Board directed staff to continue to work with OCBC to monitor and track the indicators and provide the Board with updates to cost risk factors for project delivery. In response, OCBC spent early 2018 analyzing trends and creating an Infrastructure Construction Cost Pressure Index (ICCPI) model. On September 10, 2018, OCBC presented its ICCPI model, and its forecast for 2018, 2019, and 2020 cost fluctuation ranges, to the Board.

Discussion

OCBC continues to monitor trends in material costs, labor costs, and general economic conditions. Relevant data for each model component is analyzed to determine a range of potential cost impacts to update the forecast biannually. The fall 2022 update provides a three-year forecast through 2025. Attachment A summarizes the fall 2022 forecast and also includes prior forecasts for reference. The full report on the ICCPI model update is included in Attachment B.

The ICCPI model is a forecasting tool, with scores indicating a forecast of fluctuations in public construction costs expressed in ranges. Index scores of two and three indicate somewhat low to normal inflationary environments in the range of one to four percent. Conversely, a score of four is a high inflation environment in the range of six to 11 percent. Extreme index values of zero and five correspond to the unusual conditions observed in Orange County immediately before and during the Great Recession and the high-cost inflation environment that occurred in the building boom years of the early 2000s.

Using the ICCPI model, OCBC forecasts a score of four in 2023 and 2024, which represents a potential range of higher cost fluctuation of six to 11 percent. The forecast for 2025 drops to a score of two, which anticipates a tempering of economic conditions.

OCBC Orange County Transportation ICCPI Score, 2023-2025		
Year	Index Score	Range of Cost Fluctuation
2023	4	Six percent to 11 percent
2024	4	Six percent to 11 percent
2025	2	One percent to two percent

The fall update predicts continued volatile market conditions forecasted in spring 2022 as cost pressures remain high. Major drivers include low unemployment rates coupled with high inflation rates, which could result in rising labor and material prices. Despite the Federal Reserve raising interest rates to curb inflation, the national and regional labor market remains strong. Additionally, some material prices saw large increases, specifically, Portland Cement Concrete pavement, aggregate base, and steel bar. Since full 2022 data is not yet available, the percentages calculated in the report are subject to change. As in prior forecasts, OCBC indicates that OCTA will also need to be aware and ready to respond to cost pressures that cannot be modeled. Examples of such forces include:

- Pace of Federal Reserve interest rate hikes largely unknown and subject to rapid changes,
- Lingering impacts of the pandemic, zero-tolerance policy in China, and
- General political uncertainty both domestically and internationally.

Overall, OCBC's analysis identifies a potential that in 2023 and 2024, OCTA may experience a high inflationary cost environment. To mitigate potential cost pressures, OCTA's Project Controls department monitors and adjusts project cost escalation assumptions according to market trends. Project Controls' cost estimating process uses historical information, as well as current trends in the market, and follows a consistent and defined process. Looking back at the last 20 years, OCTA's cost estimates have included a three percent escalation, which, on average during this timeframe, provided the appropriate escalation to deliver projects successfully. Currently, using 3.5 percent for construction escalation, as well as incorporating contingency based on the project type and complexity, is staff's preferred approach to cost estimating. Given the continued high market fluctuations in the current year, staff recommends continuing this effort to monitor key indicators to inform OCTA's delivery plans.

Summary

OCBC has prepared an update on construction market conditions to help OCTA with M2 project delivery planning. The update considers fluctuations in material costs, labor costs, and general economic conditions and trends. The Market Conditions Key Indicators Analysis and Forecast conclude that OCTA may experience a high inflationary cost environment in 2023 and 2024, with a tempering of cost pressures in 2025.

Attachments

A. Orange County Business Council, Orange County Transportation ICCPI Score, Fall 2018 through Fall 2022 Forecasts
B. Orange County Business Council, Orange County Transportation Infrastructure Construction Cost Pressure Index, Fall 2022, Prepared for the Orange County Transportation Authority

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ATTACHMENT A

Orange County Business Council
Orange County Transportation ICCPI Score
Fall 2018 through Fall 2022 Forecasts

Orange County Business Council Orange County Transportation ICCPI Score									
Year	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020	Spring 2021	Fall 2021	Spring 2022	Fall 2022
2018	4								
2019	3	4							
2020	3	3	3	3	0				
2021		3	3	2	1	1	5		
2022			3	2	1	2	4	5	5
2023					3	4	4	4	4
2024							4	4	4
2025									2

Range of Cost Fluctuations by Index Score			
Index Score	Low	Midpoint	High
0	-17%	-9.5%	-2%
1	-2%	-0.5%	1%
2	1%	1.5%	2%
3	2%	4%	6%
4	6%	8.5%	11%
5	11%	25.5%	40%

ICCPI – Infrastructure Construction Cost Pressure Index

ATTACHMENT B

Orange County Business Council
Orange County Transportation Infrastructure Construction Cost Pressure Index
Fall 2022
Prepared for the Orange County Transportation Authority

OCBC Research Team

Dr. Wallace Walrod – Chief Economic Advisor, Orange County Business Council
Dr. Marlon Boarnet – Professor and Chair, Department of Urban Planning and Spatial Analysis, USC

Background and Purpose

As a supplementary examination to the Next 10 Delivery Plan: Market Conditions Forecast and Risk Analysis study delivered by Orange County Business Council (OCBC) in September 2017, the Orange County Transportation Authority (OCTA) Board of Directors (Board) requested further study and exploration of potential cost fluctuations beyond existing cost analysis from the California Department of Transportation's (Caltrans) Construction Cost Index (CCI) and internal OCTA analysis. The OCTA Board requested an ongoing analysis of construction cost factors, with periodic updates. In response, the OCBC team developed the Orange County Transportation Infrastructure Construction Cost Pressure Index (ICCPI), which is updated every six months.

To develop the cost pressure index, the OCBC team analyzed annual trends in material costs, labor costs and general economic conditions to determine a range of potential cost increases with a time horizon that is typically three years into the future. The index updates begin by collecting relevant market data and indicators and then performing data analytics on to assess current cost pressure and forecast future cost pressure. In doing so, and providing these findings to OCTA's Board, more accurate budgets can be determined reducing the potential risk of cost pressure and project delivery slowdowns due to financial constraints. This September 2022 memo updates the March 2022 forecast of the Orange County Transportation ICCPI and provides annual cost pressure index forecasts for the remainder of 2022 and for 2023, 2024, and 2025.

Findings and Discussion

The most recent available input data were gathered to update the ICCPI. That includes first quarter 2022 data for the following index components: California's unemployment rate, California building permits, Caltrans index data on infrastructure construction materials costs as well as 4th quarter data on Orange County and Southern California construction industry wages. 2022 values for building permits and unemployment rates were estimated from changes from first quarter 2021 to first quarter 2022 and construction wages from fourth quarter 2020 to fourth quarter 2021.

Orange County Business Council
Orange County Transportation Infrastructure Construction Cost Pressure Index
Fall 2021
Prepared for the Orange County Transportation Authority

Following the trend established in the last update, wages continue to climb while the inflation rate remains stubbornly high, leading to elevated material and labor prices. Despite recent Fed actions in raising interest rates in an effort to mitigate the high inflationary environment, the labor market remains strong, suggesting that additional interest rate increases are likely to occur in the near future.

In the March 2022 update, the OCTA Construction Cost Pressure Index jumped to a reading of 5 for 2022, the highest inflation environment observed during the benchmark 1994-2017 time period, before dropping to an index of 4 in 2023 and 2024. Six months prior to that, the year-ago September 2021 Construction Cost Pressure Index predicted a high-inflation cost change environment in 2021 (index value of 5), declining slightly in 2022 and 2023 (to index values of 4).

The new estimate for September 2022 is an index value of 5 for the remainder of 2022, dropping to an index of 4 in both 2023 and 2024, before declining to an index of 2 in 2025. This update highlights the continued expected high-inflation environment first seen in September 2021 while also forecasting a light at the end of the tunnel, with a clear signal that inflationary pressures may begin to recede by 2025.

Table 1: September 2022 Update to Three-Year Orange County Transportation Infrastructure Construction Cost Pressure Index, with comparison to March 2022, September 2021, March 2021, and September 2020 index estimates

Year	Index (September 2022) with annual cost increase range	Index (March 2022) with annual cost increase range	Index (September 2021) with annual cost increase range	Index (March 2021) with annual cost increase range	Index (September. 2020) with annual cost increase range
2020	Not Estimated	Not Estimated	Not Estimated	Not Estimated	0 (-17% to -2%)
2021	Not Estimated	Not Estimated	5 (11% to 40%)	1 (-2% to 1%)	1 (-2% to 1%)
2022	5 (11% to 40%)	5 (11% to 40%)	4 (6% to 11%)	2 (1% to 2%)	1 (-2% to 1%)
2023	4 (6% to 11%)	4 (6% to 11%)	4 (6% to 11%)	4 (6% to 11%)	3 (2% to 6%)
2024	4 (6% to 11%)	4 (6% to 11%)	4 (6% to 11%)	Not Estimated	Not Estimated
2025	2 (1% to 2%)	Not Estimated	Not Estimated	Not Estimated	Not Estimated

The index values correspond to ranges of forecast annual infrastructure construction cost increases shown in Table 2.

Orange County Business Council
Orange County Transportation Infrastructure Construction Cost Pressure Index
Fall 2022
Prepared for the Orange County Transportation Authority

Forecasting Method

OCBC used a series of regression analyses and forward-looking projections to create the ICCPI. The ICCPI provides a ranking from 0 to 5, with each rank corresponding to a range of percent changes in overall construction costs. These ranges are built to be forecasting tools, with scores indicating public construction forecast cost increase. Values of 2 and 3 indicate somewhat normal inflationary environments. A value of 4 is a high inflation environment. A value of 1 is a low inflation/deflationary environment. Values of 0 and 5 correspond to the most extreme conditions observed in Orange County over the past three decades, and hence the ranges for those values are wide due to the unusual nature of the highly deflationary environment that occurred immediately prior to and during the Great Recession and the high-cost inflation environment that occurred in the building boom years of the early 2000s.

Table 2 below highlights each ICCPI ranking and the proposed range of cost fluctuations which have been provided on a low, midpoint, and high scale.

Table 2: OCBC Orange County Transportation ICCPI Scores

Index Value	Projected Annual Cost Increase, Low	Projected Annual Cost Increase, Midpoint	Projected Annual Cost Increase, High
0	-17%	-9.5%	-2%
1	-2%	-0.5%	1%
2	1%	1.5%	2%
3	2%	4%	6%
4	6%	8.5%	11%
5	11%	25.5%	40%

Orange County Business Council
Orange County Transportation Infrastructure Construction Cost Pressure Index
Fall 2022
Prepared for the Orange County Transportation Authority

Methodology

To determine the Transportation ICCPI, the OCBC team started by aggregating several datasets, measures, and indicators on an annual basis as far back as 1972.

The index was built with the following key data inputs:

- California's unemployment rate,
- Building permits in California,
- Selected construction materials costs for California, from Caltrans, and
- Orange County construction labor costs.

The OCBC team examined how the various measures and indicators of construction costs varied with changes and recent past trends in construction inflation. Using statistical analyses, the research team has built a forecasting model that projects forward cost increases and predicted cost increases are grouped into the categorical ranges shown in Table 2.

Recent Data Trends

Table 3 shows the recent pattern for three key components of the construction cost pressure index. While building permits in California declined from 2018 to 2020, they jumped by 12.2 percent in 2021 and are expected to decline slightly by 3.4 percent in 2022. (The 2022 estimate is based on the change in permits from first quarter 2021 to first quarter 2022.) This decline in building permits is most likely tied to the recent slowdown in the housing market. Rising interest rate and record home prices in Southern California have resulted in an increasingly smaller pool of residents able to afford the purchase of a home. These trends serve to reduce overall demand and slow the pace of new home developments. Despite recent interest rate increases by the Federal designed to rein in inflation, the national and regional labor markets remain strong, and wages continue to trend upward. The estimated change in Orange County construction salaries for 2021 is based in the change from fourth quarter 2020 to fourth quarter 2021.

Orange County Business Council
Orange County Transportation Infrastructure Construction Cost Pressure Index
Fall 2022
Prepared for the Orange County Transportation Authority

Table 3: Infrastructure Cost Correlates, Annual Percentage Changes, 2016-2022

Year	California Building Permits	% Change year-on-year	California Unemployment Rate	% Change year-on-year	OC Construction Labor Costs (avgerage annual wage)	% Change year-on-year
2016	102,350	4.2%	5.5%	-11.6%	$67,179	3.8%
2017	114,780	12.1%	4.8%	-12.9%	$71,474	6.4%
2018	113,502	-1.1%	4.2%	-12.0%	$74,669	4.5%
2019	109,904	-3.2%	4.1%	-3.4%	$77,288	3.5%
2020	104,544	-4.9%	10.3%	153%	$81,460	5.4%
2021	117,291	12.2%	7.3%	-28.9%	$84,040**	3.2%
2022	113,360*	-3.4%	4.0*	-44.9%	-	-

* Estimated from Quarter 1 (Q1) change, 2022 to 2021, converted to an annualized estimate
**Estimated from Quarter 4 (Q4) change, 2020 to 2021, converted to an annualized estimate

The appendix shows annual changes in materials costs in recent years. The 2022 values are the percent change from Q1 2021 to Q1 2022, and hence represent an estimate that will be revised in the next six-month update. Portland Cement Concrete (PCC) pavement costs saw the largest increase, 105 percent, with aggregate Base costs rising by 38.4 percent. Steel bar costs rose by 24.4 percent. Note that all of these are percent increases based on the change from Q1 2021 to Q1 2022, converted to an annual value for 2022 that is then compared to 2021 annual. The large increases in PCC pavement, aggregate base, and steel bar costs reflect changes from Q1 2021 to Q1 2022 that might be revised downward when full 2022 data are available. With an economic downturn expected in late 2022 or early 2023, prices are expected to continue to shift.

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Orange County Transportation Infrastructure Construction Cost Pressure Index
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Appendix: Changes in Infrastructure Materials Costs 2016-2022 (all values are percent year-on-year changes, 2022 values forecast from first quarter changes, 2021 to 2022)

Year	Aggregate	PCC Pavement	PCC Structure	Steel Structure	Steel Bar
2016	9.4%	8.6%	7.7%	35.0%	26.3%
2017	24.2%	106.8%	26.8%	-21.0%	-51.0%
2018	18.9%	25.9%	17.2%	9.4%	-58.8%
2019	4.6%	-11.1%	-4.2%	53.6%	0.8%
2020	14.9%	-20.5%	10.0%	-9.3%	-36.2%
2021	-27.5%	-19.8%	23.5%	5.0%	6.6%
2022*	38.4%	105.1%	-2.2%	-3.0%	24.4%

*The annual 2022 change in value represents the change between Q1 2021 and Q1 2022.

Orange County Transportation Infrastructure Construction Cost Pressure Index, Fall 2022

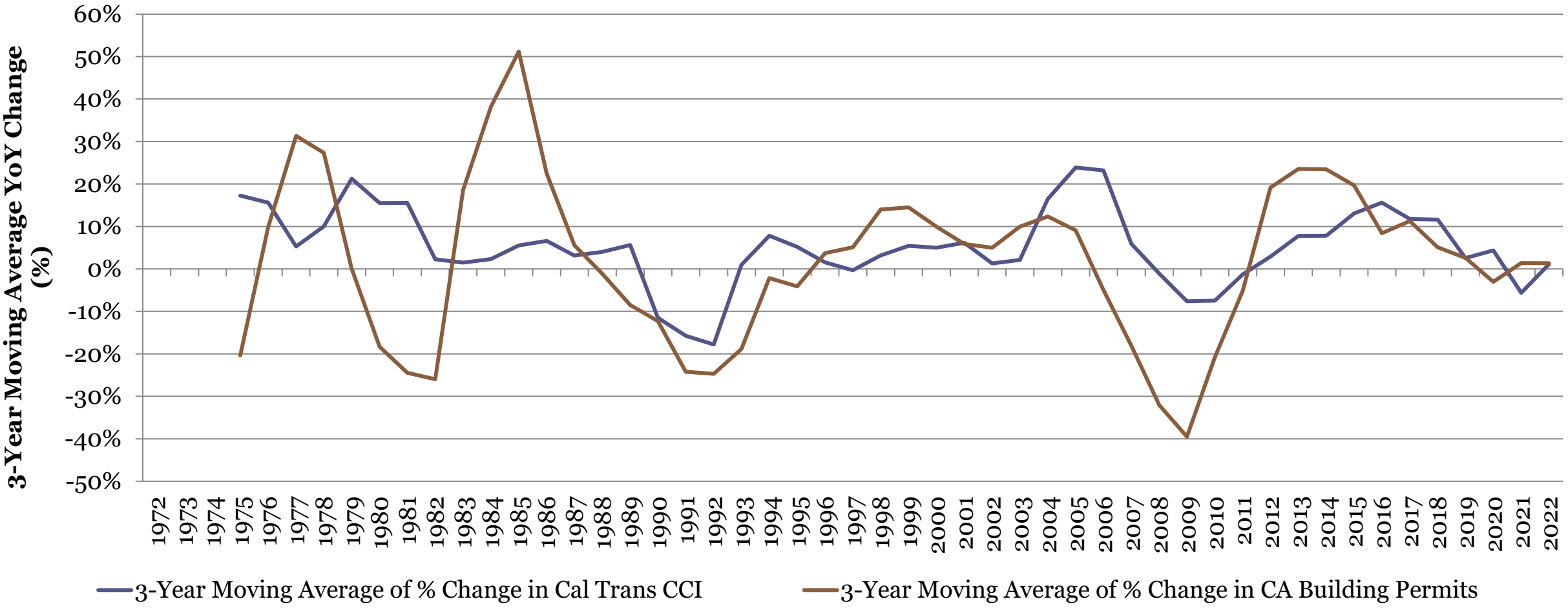
Orange County Business Council

September 2022

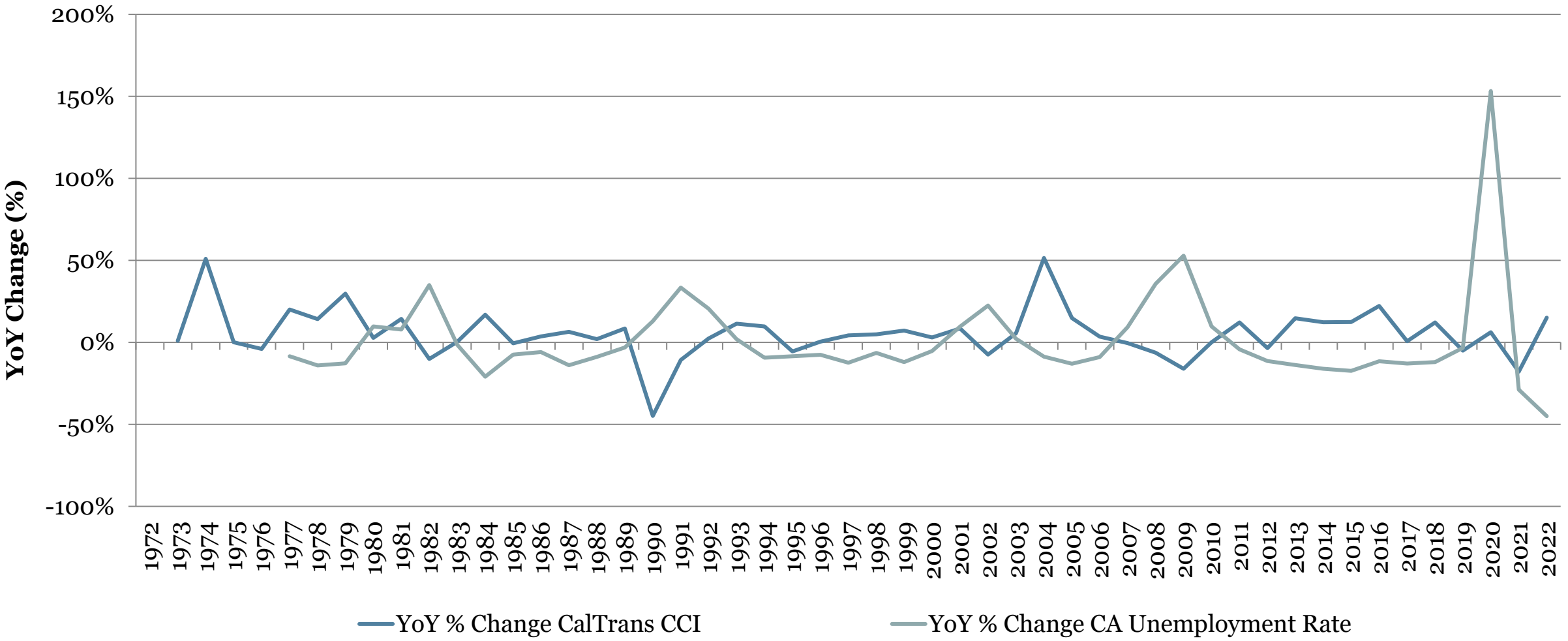
Orange County Transportation Infrastructure Construction Cost Pressure Index Model Components

- Economic Trends – State-level building permits and unemployment rate (Census and California Employment Development Department (EDD));
- Material Costs – Construction Aggregate, PCC Pavement, PCC Structural Concrete, Structural Steel and Bar Steel (Caltrans).
- Labor Costs – Localized construction wages of NAICS defined sectors provided by Bureau of Labor Statistics (BLS).
- Economic Conditions – Tight economy in 2002-2005 and slack economy in 2007-2011.

3-Year Moving Average of Year-Over-Year Percent Change in Caltrans CCI and Building Permits



Year-Over-Year Percent Change in Caltrans CCI and CA Unemployment Rates



Forecast and Range of Orange County Transportation Infrastructure Cost Increases by Index Value

- 2022 – Forecasted Index Value: 5
- 2023 – Forecasted Index Value: 4
- 2024 – Forecasted Index Value: 4
- 2025 – Forecasted Index Value: 2

Range of Cost Fluctuations by Index Score			
Index	Low	Medium	High
0	-17%	-9.5%	-2%
1	-2%	-0.5%	1%
2	1%	1.5%	2%
3	2%	4%	6%
4	6%	8.5%	11%
5	11%	25.5%	40%

Recovery from the Pandemic Begins

- Building activity begins to slow as record prices and interest rate increases reduces affordability;
- Despite uncertain economic outlook, the labor market remains strong and surprisingly tight;
- Wages continue to tick higher thanks to a tight labor market but largely offset by inflation;
- Building materials costs (PCC Structure, Steel Structure) showed small declines (-2 to -3%) outweighed by increases in Aggregate base, PCC Pavement, and Steel Bar (24% to 105%).

Year-over-Year Changes in California Building Permits, California Unemployment Rate and Orange County Construction Labor Costs, 2016-2022

Year	California Building Permits	% change year-on-year	California Unemployment Rate	% change year-on-year	OC Construction Labor Costs (avg. annual wage)	% change year-on-year
2016	102,350	4.2%	5.5%	-11.6%	$67,179	3.8%
2017	114,780	12.1%	4.8%	-12.9%	$71,474	6.4%
2018	113,502	-1.1%	4.2%	-12.0%	$74,669	4.5%
2019	109,904	-3.2%	4.1%	-3.4%	$77,289	3.5%
2020	104,554	-4.9%	10.3%	+153%	$81,460	5.4%
2021	117,291	12.2%	7.3%	-28.9%	$84,040**	3.2%
2022*	113,360	-3.4%	4.0%	-44.9%	-	-

*2022 values projected from year-on-year changes in quarterly data, 1st quarter 2021 to 1st quarter 2022.
** 2021 values projected form year-on-year changes in quarterly data, 4th quarter 2020 to 4th quarter 2021.

OCBC Infrastructure Construction Cost Forecast

- Systematic Risks – Supply chain disruptions, Russia-Ukraine War
  - While supply chain is improving, continued disruptions expected abroad.
  - Despite Fed intervention, inflation remains stubbornly high.

OCBC OC Transportation Infrastructure Construction Cost Index Score, 2022-2025		
Year	Index Score	Range of Cost Fluctuation
2022	5	11% to 40%
2023	4	6% to 11%
2024	4	6% to 11%
2025	2	1% to 2%

- Idiosyncratic Risks – not predictable and therefore not in model
  - Pace of Fed interest rate hikes largely unknown, subject to rapid changes.
  - Lingering impacts of pandemic, zero tolerance policy in China (Shenzhen).
  - General political uncertainty both domestically and internationally.

Questions

DIRECTIONS 2045

LONG RANGE TRANSPORTATION PLAN

Board of Directors Workshop Preview

Sustainable, equitable, and innovative transportation solutions.

OCTA

Key Challenges

- Growing travel demand and built-out roadway system
- Evolving travel trends
- Increasing climate-related risks
- Changing funding outlook
- Diversity, equity, and inclusion

Goals

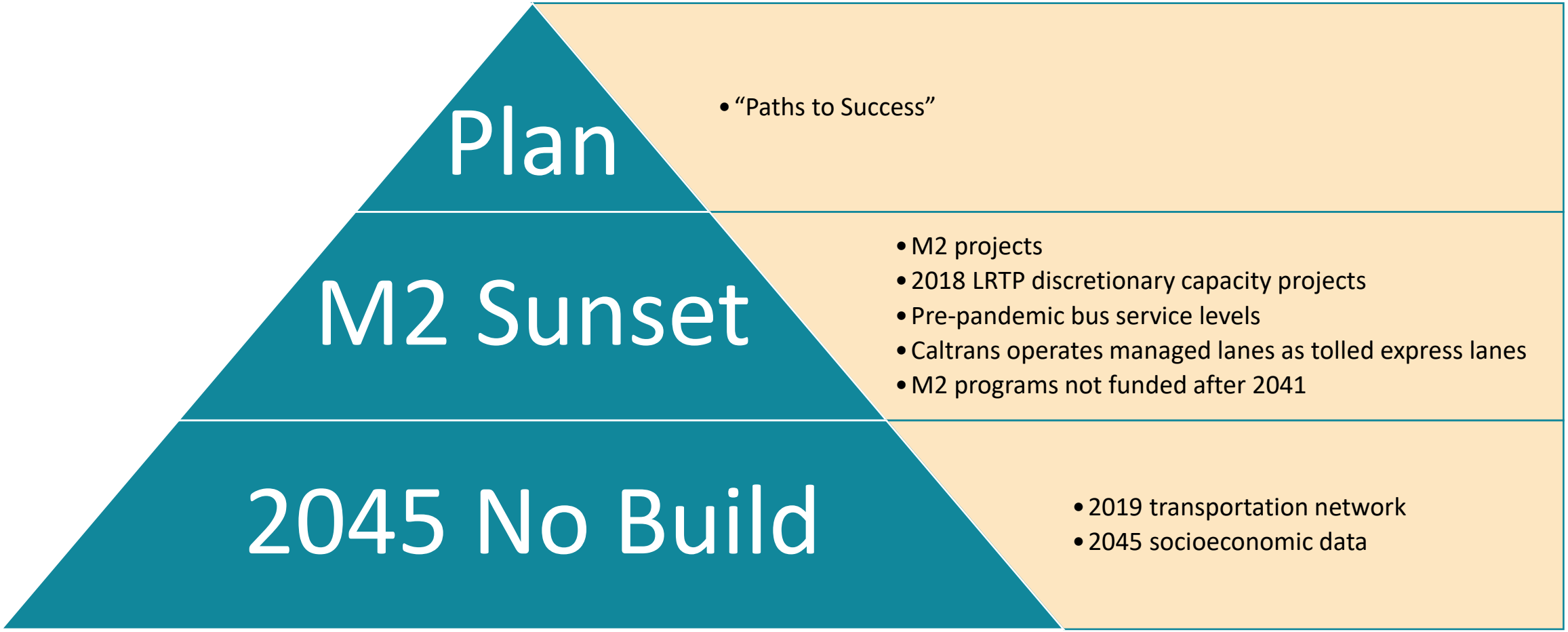
Deliver on Commitments

Improve System Performance

Expand System Choices

Support Sustainability

2045 Scenarios



Caltrans – California Department of Transportation
LRTP – Long-Range Transportation Plan
M2 – Measure M2

LRTP: Paths to Success

DIRECTIONS 2045

LONG RANGE TRANSPORTATION PLAN

Sustainable, equitable, and innovative transportation solutions.

1. Extend or modify select M2 programs
2. Expand transit services
3. Enhance active transportation
4. Explore mobility integration
5. Eliminate freeway chokepoints
6. Embrace technology
7. Elevate maintenance and resilience priorities

THANK YOU

DIRECTIONS 2045 LONG RANGE TRANSPORTATION PLAN

OCTA