

2025

California Earthquake Early Warning Business Plan Update

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Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES



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1. Introduction

This is an update to the California Earthquake Early Warning (CEEW) Business Plan. This update includes the following statutory report elements:

- The overall progress of the implementation of the EEW System.
- An update on funding acquired and expended.
- An update on contracts and requests for proposals.
- A summary of recommendations made by the CEEW Advisory Board to the Governor's Office of Emergency Services (Cal OES).

California's statewide EEW Program began in 2013 with Senate Bill 135 (Chapter 342, Statutes of 2013), which requires Cal OES to implement a comprehensive system within California in collaboration with other stakeholders. Since that time, Cal OES has formed numerous partnerships, which include the following: the California Institute of Technology (Caltech), the California Geological Survey (CGS), the University of California (UC), the United States Geological Survey (USGS), and the Alfred E. Alquist Seismic Safety Commission.

Cal OES worked with these and other partners to create a robust program aimed at educating and preparing Californians for earthquakes and providing alerts of incoming shaking. As of May 5, 2025, Cal OES and its partners have funded a network of 1,115 seismic stations, which are 94 percent complete (Cal OES-funded stations are 99 percent complete). Cal OES and its partners advanced multiple pathways to distribute EEW alerts, including the free MyShake app, downloaded over 4.0 million times and now available on Chromebooks and MacBooks, and industry-specific implementation that alerts major public and private sectors such as hospitals, schools, and fire stations. Major upcoming initiatives include an influencer campaign and media, such as success story videos to increase public awareness, finalizing research to explore offshore detection capability, expanding delivery through public television broadcasts, and continuing the uptake and use of EEW in critical infrastructure sectors.

The EEW Program's success in providing critical seconds to perform lifesaving actions was clearly demonstrated in 2024 during the M4.5+ earthquakes, including those in Lamont, Malibu, Highland Park, Cape Mendocino, El Centro, Barstow, Stovepipe, and Parker Butte, Nevada. With these real-world experiences, awareness among the public that the use of the California Earthquake Early Warning System (CEEWS)¹ is a viable life-safety tool.

¹ CEEWS is the California portion of the national ShakeAlert system currently operating in California, Oregon, and Washington.

Cal OES continues efforts to increase the opportunity for California businesses and services to implement automated protective actions using EEW technology. Through targeted pilot programs, Cal OES seeks various sector-specific implementations and encourages ShakeAlert Pilot License Agreements (PLA) and License to Operate (LtO) vendors to reach critical infrastructure. These are vital steps and partnerships required to make EEW ubiquitous in California.

2. Progress of Earthquake Early Warning in California

California has made significant progress in the implementation and expansion of CEEWS. This system delivers EEW alerts statewide to the public through three cellphone-based pathways — the Cal OES-sponsored MyShake app, Wireless Emergency Alerts (WEA), and smartphone-enabled devices—and is now working on integration with Chromebook and MacBook computers. Cal OES has completed work with California Public Television stations and USGS to outfit all 11 public television stations with the ability to broadcast EEW alerts, becoming a source of redundancy in public notifications and providing alerts to hard-to-reach areas.

Engaging Industry for Implementation and Automated Protective Actions

Cal OES continues to encourage multiple sectors to implement automated protective actions that have demonstrated the ability to save lives and property in an earthquake.

Several studies have demonstrated the high benefit-cost ratio for EEW automated actions. In “Benefits and Costs of Earthquake Early Warning” (Strauss and Allen, 2016), researchers at the Berkeley Seismological Laboratory concluded that EEW could prevent \$1-1.5 billion in damage and other costs in earthquakes like the 1989 Loma Prieta Earthquake. Researchers estimated that EEW technology and automated actions could prevent half of all injuries, abate millions of dollars in losses to the technology industry, avert train derailments, and prevent many deadly fires that commonly follow earthquakes. The potential for automated protective actions is a core component of the success of the EEW Program. The ability to prevent train derailment and signal hospitals and schools that an earthquake is about to strike is vital for the protection of Californians against earthquakes. Cal OES has recently embarked on another benefit-cost analysis with the plan to learn more about EEW implementation in sectors like mass transit, public announcement systems in schools, smartphone alerts, and elevators.

Pilot projects are an important component in the EEW Program's intention to advance the implementation of the technology across various sectors. Current expansion efforts involve funding provided by Cal OES, such as a contract that

created a partnership with the California State Transportation Agency (CalSTA) and UC Berkeley's Resilient and Innovative Mobility Initiative (RIMI) to study the integration of EEW technology and automated actions within California airports. Technology and automated actions being assessed include alerting individuals to take action to protect themselves with *Drop, Cover, and Hold On* and activating or ceasing critical processes before shaking starts, such as alerting air traffic control to ground planes and keeping them from landing, shutting off valves, de-energizing control panels, and starting backup generators. This contract was extended in 2024 and completed in April 2025. Additionally, the EEW Program funded a grant to implement EEW systems and automated actions within local fire stations, such as automatically opening bay doors to promote injury avoidance, reduce response impediments, and quicken overall response time; and automatically triggering safety measures like audio and visual alarms to enhance situational awareness for firefighters. The grant awarded three fire districts with funding to implement EEW technology into their stations and support the maintenance for up to five years. These partnerships will be crucial in developing additional projects to expand the usage of EEW technology and automated actions throughout California.

In partnership with UC Berkeley, Cal OES has expanded the potential reach of EEW alerts by extending the availability of the MyShake app to be downloaded by Chromebooks and MacBooks. Cal OES is also working with UC Berkeley to extend the alerting mechanism to desktop computers through a non-app-based browser extension. This project aims to target critical sectors with MyShake availability on desktops, providing redundancy and allowing an alerting system to be in place where smartphones may not be available. The MyShake app for computers will provide access to life-saving alerts in schools and work settings, offering users an additional alerting option that can be shared at home and with others.

The Los Angeles Unified School District, the largest school district in the state, adopted EEW procedures for its facilities in 2024. This, in addition to the MyShake app on Chromebooks, advances alerts in the public school sector. Chromebooks are commonly used throughout California public schools and are issued to 5.8 million students. With this in mind, in 2024, Cal OES began discussions with various California school districts, including Oakland Unified School District (OUSD), to explore the implementation of EEW via the MyShake app on Chromebooks in classrooms and is supporting the development of educational material in coordination with the Berkeley Seismology Lab. This aims to expand a life-saving tool into all classrooms someday soon and, with it, increase important preparedness.

As a major effort in 2024, Cal OES leveraged its existing connections to target various public and private sectors across the state, recruiting new users and

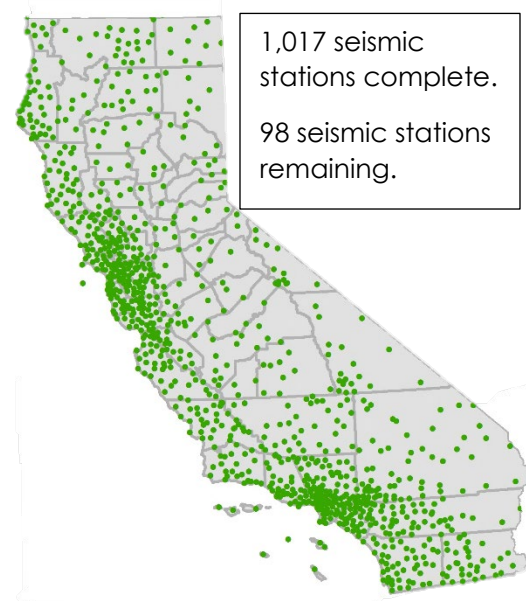
implementing automated actions. In the past year, approximately 480 new ShakeAlert implementations have occurred. In order to continue this implementation, Cal OES worked with USGS to rapidly move newly recruited users through the ShakeAlert LtO process to increase the pace and scale of use. The recruitment of users provides additional projects and funding that support the development of the system.

Additionally, the CEEW Program continues to work with Cal OES's Hazard Mitigation Assistance Program to support outreach, review, and approval of EEW projects that are eligible for the Hazard Mitigation Grant Program (HMGP) offered by the Federal Emergency Management Agency (FEMA).

System Operations

All 1,115 planned seismic stations are now funded, and 94 percent are built; operations and maintenance are now the major focus.

CEEWS, comprising seismic stations, communication equipment, and processing centers, is part of the national ShakeAlert network, managed by the USGS. The EEW Program works with the California Integrated Seismic Network (CISN)² and Cal OES Public Safety Communications to maintain equipment and the network to ensure system functionality for constant monitoring and distribution of earthquake data. Cal OES has committed to funding 702 of a total of 1,115 stations, and of those, 699 are completely built (99% of 1,115 stations). Following this accomplishment, Cal OES has transitioned its focus from the build-out phase to regular maintenance and refurbishment of existing stations and software. Ongoing funding will sustain equipment and staff to perform preventative and routine maintenance for effective operation. Seismic stations, especially free-standing field ground stations, are susceptible to damage and deterioration due to weather, pests, natural disasters (e.g., fires), and vandalism. On average, about thirty percent of these stations require maintenance each month. This maintenance ranges from minor fixes, such as software updates and telemetry checks, to more extensive repairs, such as the replacement of severed cables or solar



² The California Integrated Seismic Network (CISN) is a collaboration between Cal OES and the system operations partners, monitors earthquakes and collects data to support improvements to earthquake resilience. www.cisn.org.

panels. Further, logistical challenges to deliver, install, and maintain equipment in difficult-to-reach areas continue to exist statewide.

Cal OES continues to work with its partners to connect many of its stations to the California Public Safety Network (CAPSNET) for the use of its integrated microwave signal. This signal can be used for telemetry transport to CISM data processing centers. This networking process creates redundancy in data collection and transfer but also utilizes one of the fastest signals already available in California.

Research and Development

Research continues with the aim to create new pathways for delivering alerts beyond internet and cellular networks, and to test new methods of detecting earthquakes.

Cal OES targets various new alerting pathways to help provide a more robust system with greater capabilities and redundancy in the alerting network. Datacasting through television and radio signals provides dedicated bandwidth for emergency use that can send low-latency signals to datacasting-enabled devices in hospitals, schools, homes, businesses, government buildings, and other critical service facilities. These low latency signals provide resiliency during natural disasters and have the capability to execute automated actions such as opening gates, shutting off gas valves, and sending out auditory and visual alarms. A signal can reach receivers up to 150 miles away and provide critical alerts to rural areas where cellular and internet signals are not available. Additionally, television station towers are weather-hardened and can also be supported by diesel generators, giving three to four days of functional usage even after losing power from an electrical grid.

With proof of concept from the test of the Phase I implementation during the Ferndale earthquake, Cal OES granted funds to America's Public Television Stations (APTS) and California Public Television (CPT) to support Phase II of the pilot project, which brought datacasting capabilities to five additional CPT stations in Eureka, Redding, Rohnert Park, Los Angeles, and Reno, Nevada—which supports hard-to-reach areas of Eastern California. With the completion of Phase II at the end of 2024, all areas of California served by public television stations can receive datacast alerts. These 11 stations reach 88 percent of California's population. Phase III, in 2025, will distribute commercial and consumer receivers to public safety end users to receive a datacast signal. This critical infrastructure will allow earthquake alerts to be received by county and city emergency operations centers (EOCs) and fire departments in rural areas, which is especially important for areas with limited cell service.

Currently, few nearshore CEEWS stations exist, which limits the detection capabilities of earthquakes originating from faults off the coast. Seventy percent of false and missed alerts are related to events occurring in the Mendocino Triple Junction, which is the main seismically active nearshore area in northern California. The Palos Verdes fault zone in Southern California is also a very active nearshore seismic area, where Cal OES has limited earthquake detection. Cal OES continues to fund projects with its partners to discover ways to reduce latency and address the lack of reliable monitoring in these and other coastal areas through the continued support of nearshore seismic sensors such as those seen on the Farallon Islands and advanced technology like Distributed Acoustic Sensing (DAS).

With funding from Cal OES, UC Berkeley and Caltech continue to research DAS by utilizing existing fiber optic cables and developing algorithms that analyze the massive amounts of data collected from these cables. These analyses provide Cal OES with a closeout report illustrating its benefits. The BSL is analyzing collected data from the Monterey Accelerated Research System (MARS), a 52-km long submarine cable in a dense seismic array. This cable runs over the San Gregoria and San Andreas faults. Caltech utilizes three fiber optic cables in Southern California, including a submarine communication cable from Long Beach to Santa Barbara. The success of these projects could lead to significant advancements in the coverage of on- and off-shore areas for seismic activity. Cal OES expects to receive a report of findings and recommendations from its DAS partners in 2025.

The advancement of this technology aims to improve real-time earthquake location and magnitude estimates using DAS data by focusing on:

- Fine-tuning DAS configuration parameters to optimize the signal-to-noise ratio.
- Calibrating all the cable measurement points.
- De-noising signals through time-space filtering.
- Optimizing the P-wave picking algorithms.
- Adjusting EEW algorithm filters to accommodate DAS data.

In collaboration with Caltech and the University of California Los Angeles and with funding from Cal OES, CGS has leveraged research and development investment in the Community Seismic Network, which utilizes an accelerometer and computer to detect and process motion. This technology has the capability to detect severe shaking and structural damage in buildings. It tracks time using Network Time Protocol (NTP) instead of Global Positioning System (GPS), allowing it to function indoors and provide widespread use. Cal OES has previously funded the development of this technology to detect shaking and damage to homes and businesses but is now also directing these efforts toward stadiums

given the large sporting events coming to California in the near future (e.g., Superbowl, World Cup, Olympics, Paralympics). By utilizing this technology in large event spaces like stadiums, the EEW Program will be able to provide critical monitoring capabilities to areas with tens of thousands of people. This fine level of detail of infrastructure will offer essential information to improve response activities during disasters.

Public Education & Outreach

The ongoing EEW public education and outreach campaign expanded efforts include reaching socially vulnerable populations via community-based organizations.

Cal OES continues its comprehensive public awareness campaign to educate all California residents and visitors about the state's EEW system. As part of the campaign, ongoing, strategic efforts are made to educate key user groups such as local governments, first responders, medical and health care providers, businesses, the education sector, telecommunications providers, critical infrastructure providers, and non-profit organizations.



Leveraging local events has produced positive results, including news coverage, partner engagement, and website traffic. In 2024, Cal OES visited San Diego, Los Angeles, Berkeley, and Sacramento to raise awareness of earthquake preparedness and to acknowledge the 35th anniversary of the Loma Prieta earthquake. This tour leveraged the Great California ShakeOut and other local preparedness events, resulting in over 24,000 MyShake downloads and over 225 shake simulator experiences. The CEEWS was featured in over 197 media mentions, 39 interviews conducted in English and Spanish and received over \$2.0 million in ad equivalency. These shared efforts encouraged residents, businesses, and critical infrastructure industries to take the necessary steps to prepare for an earthquake and learn more about EEW and the state's EEW resources.

In August and September of 2024, the Los Angeles area experienced three earthquakes that resulted in shaking throughout the region. These showcased the importance of earthquake preparedness, given the distribution of over 1.3 million MyShake alerts and over 11 million Android alerts. Cal OES responded with rapid response protocols, which led to media interviews and outreach to

local communities. These earthquakes, which did little to no damage and affected large-scale areas, allowed Cal OES and the people in California to safely practice earthquake response. These events also served as an ideal time to remind people how to be prepared when a severe earthquake hits. The following table details notable earthquakes from 2024 and related CEEWS statistics.

2024 Earthquakes					
Date	Location	Magnitude	MyShake Downloads*	MyShake Alerts	Android Alerts**
February 2	El Centro	M4.8	20,807	79,327	1.1M
July 29	Barstow	M4.9	1,557	23,633	311K
August 6	Lamont	M5.2	137,664	517,354	4.9M
August 12	Highland Park	M4.4	164,431	381,255	3.0M
September 12	Malibu	M4.7	26,282	425,217	3.5M
December 9	Parker Butte, NV	M5.7	3,407	150,279	1.6M
December 5	Cape Mendocino	M7.0	20,379	468,247	4.5M
April 14	Julian, CA	M5.2	27,000	693,044	6.8M

*approximate number of downloads to the MyShake app within 48 hours of the shaking.

**approximate number of devices alerted. K indicates thousands, M indicated millions.

Cal OES continues to conduct outreach through strategic partnerships. In 2022, Cal OES partnered with United Way to fund outreach focused on earthquake preparedness and the MyShake app. The funding for this grant concluded at the end of 2024, and all subrecipients met their requirements and goals. In 2024, Cal OES partnered with Listos California, Cal OES's community-focused emergency preparedness program, to promote EEW throughout California. This outreach targeted the Inland Empire, Los Angeles, Sonoma County, and the central coast. It aimed to reach low-income, difficult-to-reach, and non-English speaking communities through community-based organizations (CBOs). Outreach has been presented in various languages and will continue to be presented until the end of 2025. These connections will provide opportunities to present information regarding the MyShake app and the resources available to prepare for an earthquake. California EEW Program will continue to utilize Listos California's broad resources to connect to impactful community-based organizations, as well as the assistance of Listos' multi-faceted and experienced team.

Cal OES will continue to connect and engage with disaster-vulnerable and underserved communities by working with the Cal OES Office of Diversity, Equity,

and Inclusion and the Office of Access and Functional Needs to ensure EEW is fully accessible to all communities. Additionally, the program is launching a new public awareness campaign that will utilize known and diverse social media influencers, who have the ability to disseminate information about EEW and individual earthquake preparedness to their social media followers.

As a part of its outreach campaign, the California EEW Program is pursuing education outreach in various public and private sectors through webinars and meetings with industry leaders. The program has provided material and presentations to fire officials describing the importance of EEW and the many ways to implement the technology into their fire stations. The EEW Program has also discussed EEW implementation strategies with operations managers of commercial airlines, aiming to develop a robust understanding of implementation in an airport terminal. The program presented on EEW to over 100 representatives at the California Hospital Association and the University of California Emergency Management and Business Continuity conferences. Goals for 2025 include continuing public and private sector outreach through meetings, conferences, and other opportunities to showcase the potential safety benefits of EEW.

Another core goal across all public awareness efforts is to increase the number of Californians who opt-in to receive an EEW alert. The MyShake app has been downloaded over 4.0 million times thanks to the combined public awareness efforts.

Public Alerting for EEW

Three cellphone-based alerting pathways now enable millions of Californians to receive EEW alerts.

Each second that can be removed from the EEW signaling process provides vital time to *Drop, Cover, and Hold On*. A focus for improvement is to decrease the latency of alerts by reducing the detection time of an earthquake. The initial shaking, the P-wave, comes before the substantial shaking, the S-wave. Sensors collect data from the P-wave and send the information to processing centers. From there, signals are delivered to



end users in shards to prevent system overload. Current research focuses on decreasing the latency of this transition to provide extra life-saving seconds by exploring how multiple algorithms can aggregate ground motion data and process location and intensity estimates faster.

MyShake delivers alerts within a second or two after ShakeAlert processes an earthquake. The location of the earthquake, the density of sensors, and the complexities of the geology where an earthquake strikes all affect latency. For example, when an earthquake occurs off-shore, a delay in detection by the seismic station network occurs until a P-wave reaches land. Whereas latency on land has proven effective in its delivery, shown in real-world examples such as the Highland Park earthquake on August 12, 2024, initial messages were delivered in under six seconds from the earthquake's origin (four-and-a-half seconds for detection and processing and one second for delivery).

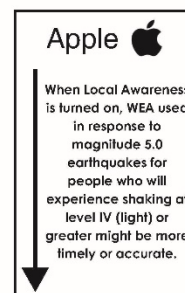
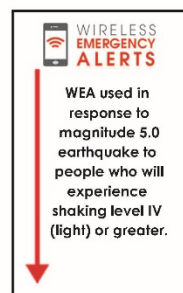
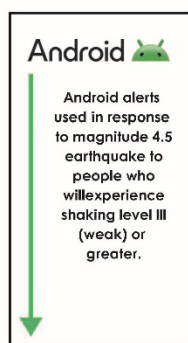
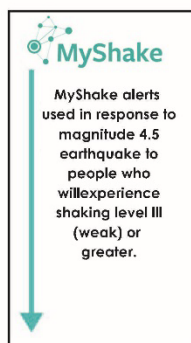
The MyShake alert is available in English, Spanish, Korean, Vietnamese, Chinese, and Tagalog. The notification system adapts to smartphone settings to provide alerts in the selected language. Information regarding this valuable tool is made available through Listos California and other public awareness campaigns as a means to achieve the shared goal of providing information to as many users as possible.

To ensure the successful delivery of alerts, Google has partnered with ShakeAlert and Cal OES to ensure all Android smartphones have EEW built into the operating system, which automatically alerts users with information to prepare them for what is to come. Like MyShake, Android alerts are delivered for earthquakes Magnitude 4.5 or greater to phones in the areas of weak to severe shaking. Apple has added an enhancement, "Local Awareness" to the iOS operating system (iOS) to pick up and improve the delivery of any governmental alerts, including WEA earthquake alerts, to iPhones. The WEA settings are set higher at M5.0 with light or higher shaking intensity. Alerts are not intended for all felt events—only those estimated to cause injury or damage. The following chart shows the threshold at which an alert is triggered for each alerting pathway.

ALERTING THRESHOLDS



INTENSITY	SHAKING
I	Not felt
II	Weak
III	Weak
IV	Light
V	Moderate
VI	Strong
VII	Very Strong
VIII	Severe
IX	Violent
X	Extreme



Google has recently released an additional component to their service to provide alerts across the country. This technology has already been used in other countries but is now offered throughout the United States. This new EEW implementation will not impact California, Oregon, or Washington State, as the Android alerting system in those states will still rely on the California Earthquake Early Warning System powered by ShakeAlert. Even with the expansion of Android alerting and Apple enhancements, the EEW Program still encourages Californians to download the MyShake app on all available platforms to receive EEW alerts and other earthquake preparedness information.

Update on Ongoing Funding Needs

Base funding has remained consistent since Fiscal Year (FY) 2021-22.

During the transition from build-out to system operation and maintenance, actual system maintenance costs are assessed annually. The balance of funding is divided between outreach and education and research and development based on existing or intended projects. The following is a breakdown for FY 2024-25:

Table 1: 2025 Spending Plan

EEW Stations (including but not limited to equipment and labor to maintain seismic and GPS stations, network infrastructure, and data processing) and MyShake app	\$ 9,855,619
Telemetry	\$ 3,700,000

Outreach and Education	\$ 1,950,000
Research and Development	\$ 1,150,000
Program Management	\$ 430,381
Total	\$17,086,000

3. Funding

FY 2016-17 Funding

Cal OES received an initial \$10 million one-time appropriation from the General Fund to contract for sensor installation, social science research, education and outreach efforts; research to improve telemetry and mass alert distribution; and consultation on the original Business Plan. The details about this funding and associated contracts are included in Appendix A.

FY 2018-19 Funding

Cal OES received a \$15 million one-time General Fund allocation for seismic station build-out. The details about this funding and associated contracts are included in Appendix B. Cal OES also began receiving a \$750,000 ongoing General Fund appropriation for California EEW Program staffing.

FY 2019-20 Funding

Cal OES received a \$16.3 million one-time General Fund for seismic station installations, continued telemetry improvements, and launching a statewide education and outreach campaign. The details about this funding and associated contracts are included in Appendix C.

FY 2020-21 Funding

Cal OES received a loan of \$17.3 million to the California Earthquake Safety Fund from the California School Land Bank Fund to support the California EEW System until a continuous funding stream could be established. The details about this funding and associated contracts are included in Appendix D.

FY 2021-22 Funding

Cal OES received a \$17.3 million one-time General Fund appropriation to complete seismic station installation and to support the continuation of operations and maintenance. Cal OES entered into several contracts and agreements with system partners to encumber the funding. The details of the funding and these contracts are included in Appendix E.

FY 2022-23 Funding

Cal OES received \$17.1 million in an ongoing General Fund appropriation to support education and outreach, system operations, and research and development of CEEWS. This funding has allowed the state to increase its earthquake sensor density in the rural parts of northern California and the Sierra Nevada Microwave Telemetry project. It has supported operations and maintenance of the seismic network stations, enabled grants to community-based organizations to educate hard-to-reach and other underserved communities, resulted in strategic partnerships to implement EEW technologies in critical sectors, and helped make progress on installing EEW infrastructure in the remaining public television stations. The details of this funding are included in Appendix F.

FY 2023-24 Funding

Cal OES received \$17.1 million in an ongoing General Fund appropriation for the operation and maintenance of the seismic network, an outreach campaign that continues to target underserved and hard-to-reach communities, research and development projects, and an implementation pilot project that will integrate EEW technology into approximately 20 fire stations throughout the state. In addition to the ongoing General Fund appropriation, the 2023 Budget Act (AB 102, Ting, Chapter 38, Statutes of 2023), provided a one-time allocation of \$500,000 to purchase and distribute datacasting receivers. The details of this funding and these contracts are included in Appendix G.

FY 2024-25 Funding

Cal OES continues to receive \$17.1 million in an ongoing General Fund appropriation for the operation and maintenance of the seismic network, research and development projects, telemetry costs, and outreach projects targeting underserved and hard-to-reach areas.

4. Contracts and Requests for Proposals

In FY 2024 and 2025, as in past fiscal years, Cal OES entered into inter-agency agreements and non-competitive bids with system operations partners for the continued development, operations, and maintenance of the statewide seismic network infrastructure and processing centers. Additionally, Cal OES continues to support application updates and increase capacity for the MyShake app while exploring an Application Programming Interface (API) for Chromebook and MacBook computers.

Implementation of the EEW system in existing critical infrastructure systems remains a priority. Cal OES is driving a strategic sector-based approach to expand the usage of the system through select pilot projects. In FY 2022-23, Cal OES entered an Inter-Agency Agreement with the UC RIMI team to complete an Airport Feasibility Study. With the near completion of the study, Cal OES aims to leverage the findings to encourage the implementation of EEW technology throughout airports. In 2024, Cal OES partnered with three (3) fire districts to fund the installation of EEW technology and automated actions. The fire districts were selected based on their location in a community with a Centers for Disease Control Social Vulnerability Index (SVI) of 0.6 and above, housing Cal OES fire apparatus, and a history of significant seismic events. This funding provides these fire districts with the opportunity to install EEW technology in their facilities and maintain the system for a five-year period.

Cal OES supports research and development through Inter-Agency Agreements and contracts to expand EEW technologies. Current efforts include:

- Studying the feasibility of DAS technology for EEW with additional funding allocated to Caltech and UC Berkeley. Cal OES supports research on using existing fiber optic infrastructure for earthquake monitoring to increase sensor density.
- Completing Phase III of the datacasting pilot project, with Cal OES grant funds to provide EOCs and volunteer fire stations with enterprise receivers, enabling an alert to come through a broadcast signal to provide capabilities for coordinated automated actions.

Cal OES continues education and outreach efforts through a public relations contract and staff efforts aimed at increasing user participation and educating Californians about EEW and how to receive alerts. Cal OES combines this effort with Listos California to leverage connections with CBOs to educate vulnerable communities. The EEW Program continues to target potential industry and local government partners to implement automated actions from EEW alerts.

5. California Earthquake Early Warning Advisory Board

The California Earthquake Early Warning Advisory Board advises the director of Cal OES on all aspects of the program, including system operations, research and development, and outreach and education. The Board members consist of the following industry experts and leaders:

- The Secretary of the Natural Resources Agency, or designee.
- The Secretary of California Health and Human Services, or designee.

- The Secretary of California State Transportation Agency, or designee.
- The Secretary of Business, Consumer Services, and Housing, or designee.
- One member who is appointed by, and serves at the pleasure of, the Speaker of the Assembly and represents the interests of private businesses.
- One member who is appointed by, and serves at the pleasure of, the Governor and represents the utilities industry.
- One member who is appointed by, and serves at the pleasure of, the Senate Committee on Rules and represents county government.
- The Chancellor of the California State University, or designee, serves as a non-voting member of the board.
- The President of the University of California, or designee, may serve as a non-voting member of the board.

The Advisory Board held its 2024 meeting on the following date:

- September 11, 2024

The next Advisory Board meeting is scheduled for June 2025.

Advisory Board members made the following recommendations about the development of the EEW program during the September 2024 meeting:

Device Technology: Members of the Advisory Board recommended analyzing the different distribution systems (MyShake and Android) to determine success rates, accuracy, etc.

Response: Cal OES is exploring comparative analyses of the different systems.

Other Ways of Implementing EEW: Members of the Advisory Board recommend exploring other pathways for implementing EEW outside of electronic devices. For example, datacasting or partnering with automakers or vehicle fleets.

Response: Cal OES has completed Phase II of a datacasting pilot project by APTS and CPT, which added the remaining six (6) public television stations to the current datacasting network. Phase III of the project has begun and will provide EOCs and fire stations with a receiver box to receive emergency alerts from the datacast infrastructure. No discussions have occurred yet with automakers or vehicle fleets.

Government Facilities: Members of the Advisory Board recommend implementing EEW in high-profile buildings.

Response: Cal OES is using a risk-informed methodology to explore EEW implementation in high-profile buildings across the state. EEW has worked with Regatta Seaside Residences to implement EEW across the building complex. Cal OES continues its outreach efforts with other building owners and organizations to implement EEW.

Visuals: Members of the Advisory Board recommend providing success stories and visuals that show what EEW implementation looks like.

Response: Cal OES is developing video success stories and working with partners on toolkits and visuals to illustrate the implementation of EEW in various public and private sectors.

Testing: Members of the Advisory Board recommend testing EEW with other systems currently in place, such as fire systems.

Response: Cal OES conducted initial discussions with the Office of the State Fire Marshal to explore considerations related to EEW and existing building safety systems and regulations.

6. Conclusion

Now in its sixth year, EEW has proven to be vital in providing critical seconds for Californians to take life-saving actions. The seismic network developed by system partners, in part with California funding, successfully sent alerts to millions of smartphone-enabled devices through the MyShake app, Android alerts, and Wireless Emergency Alert pathways. As the system's build-out approaches completion, the focus has shifted to finding additional ways to enhance and diversify alert delivery methods, decrease alert latency, implement automated protective actions, and increase public awareness.

With the progress made and advancements planned for the near future, EEW will continue to ensure the safety of everyone who lives, works, and visits California.

Appendix A. FY 2016-17 Spending Allocations

Contractor	Description	Funding Allocation
Seismic Station Installation and Maintenance		Total: \$6,484,000
California Geological Survey	70 strong motion station upgrades	\$250,000
California Institute of Technology	10 new broadband stations	\$527,000
United States Geological Survey	70 new strong motion stations	\$3,145,000
University of California, Berkeley	33 new broadband stations	\$2,562,000
Education and Training		Total: \$2,261,000
National Broadcasters Association	Public awareness campaign	\$2,138,000
California Geological Survey	Outreach to science teachers to assist in warning development	\$40,000
Cal OES Office of Public Information	Communication equipment	\$45,000
California State University, Fullerton	Research by Dr. Michele Wood to identify research gaps	\$38,000
Research and Development		Total: \$670,000
American Public Television Stations	Purchase and install equipment to attach to PBS stations to test datacasting capabilities with EEW	\$170,000
Cal OES Public Safety Communications	Demonstration project to connect stations to seismic laboratories over the state microwave network in northern and southern California	\$500,000
Finance / Business Plan		Total: \$250,000
Blue Sky Consulting	Research and production of the original Business Plan	\$250,000
Administration (6 months)		Total: \$335,000
FY 2016-17 State General Fund Budget Allocation		Total: \$10,000,000

Appendix B. FY 2018-19 Spending Allocations

Contractor	Description	Funding Allocation
Seismic Station Installation and Maintenance		Total: \$7,895,000
California Geological Survey	8 new strong motion seismic stations and 24 upgraded strong motion seismic stations	\$1,380,000
California Department of Water Resources	11 new or upgraded strong motion seismic stations and 13 new or upgraded combination strong motion and broadband stations	\$1,000,000
University of California, Berkeley	55 new combination broadband and strong motion seismic stations and 5 upgraded combination broadband and strong motion seismic stations	\$5,500,000
Department of General Services Permitting Fee	Fund additional workload capacity to review land use permit applications	\$15,000
Statewide Telemetry Plan		Total: \$5,895,000
Cal OES Public Safety Communications Division	Connect up to 25% (280) of EEWS seismic stations to the state microwave network	\$5,895,000
Research and Development		Total: \$1,210,000
University of California, Berkeley	Expand the use of the MyShake app to deliver EEW alerts to the public. Cell phones will also be used to use to crowd-source seismic event data. This data can potentially help reduce alert latency	\$1,210,000
FY 2018-19 State General Fund Budget Allocation		Total: \$15,000,000

Appendix C. FY 2019-20 Spending Allocations

Contractor	Description	Funding Allocation
Seismic Station Installation and Maintenance		Total: \$7,900,000
California Geological Survey	Establish Real-Time Data System at CGS and an interactive map of seismic activity for emergency response, upgrade 40 or more strong motions seismic stations, and install and conduct training on Earthworm algorithm software training to create redundant EEW data processing capability within the state	\$1,600,000
University of California, Berkeley	EEW State Microwave Project – Install microwave link to Warren Hall and connect 50 EEW remote seismic sites to microwave telemetry, 18 New and Upgraded Broadband/Geodetic stations, and EEW datacenter upgrades including 7 servers, microwave connection equipment, and VPN routers	\$3,200,000
California Institute of Technology	EEW State Microwave Project – Connect 100 EEW remote seismic sites to the State Microwave, 20 New or Upgraded Stations Broadband or Geodetic Stations, and EEW data center upgrades including 4 servers and routers.	\$3,100,000
Education and Training		Total: \$6,900,000
Pulsar Advertising	Statewide public awareness and education campaign	\$6,900,000
Research and Development		Total: \$1,500,000
University of California, Berkeley	Continue to support and enhance MyShake for statewide mobile earthquake notification	\$800,000
California Geological Survey	Update the existing CISN display (maintaining priority for emergency responders and creating a new public web application that will utilize ShakeAlert products	\$400,000
University of California, Berkeley	Conduct research to enhance alerting abilities by reducing latency, alerting during aftershock sequences, and reducing no-warning zones	\$300,000
FY 2019-20 State General Fund Budget Allocation		Total: \$16,300,000

Appendix D. FY 2020-21 Spending Allocations

Contractor	Description	Funding Allocation
Seismic Station Installation and Maintenance		Total: \$9,232,210
California Geological Survey	Continue with the establishment of a real-time data system at CGS for emergency response, upgrade 50 strong motions seismic stations	\$1,200,000
United States Geological Survey	Purchase updated equipment for 41 strong motion and broadband stations, construct three new telemetry interconnects, and communication costs	\$1,832,210
University of California, Berkeley	Install 30 new and upgraded broadband/geodetic stations, EEW data center upgrades, microwave EEW connections, and machine learning research and development	\$3,700,000
California Institute of Technology	Install 11 new broadband stations, upgraded 60 dataloggers, EEW datacenter upgrades, and machine learning research and development	\$2,500,000
Statewide Telemetry Plan		Total: \$2,300,790
Public Safety Communications	Connect 70 more EEW stations and annual reoccurring microwave leases and circuit cost	\$2,300,790
Education and Training		Total: \$3,500,000
United Way	Public awareness and education campaign	\$2,500,000
Imprenta	Graphic design and public relations services	\$1,000,000
Research and Development		Total: \$2,030,000
University of California, Berkeley	Continue to support and enhance MyShake for statewide mobile earthquake notification	\$1,400,000
California Geological Survey	Update the existing CISN display (maintaining priority for emergency responders and creating a new public web application, both will be mobile friendly	\$130,000
University of California, Berkeley, and California Institute of Technology	Conduct research to enhance alerting abilities by incorporating machine learning to reducing latency, alerting during aftershock sequences, and making EEW alerting more accurate	\$500,000
Administration		Total: \$220,000
FY 2020-21 California Earthquake Safety Fund Loan Allocation		Total: \$17,283,000

Appendix E. FY 2021-22 Spending Allocations

Contractor		Description	Funding Allocation
Seismic Station Installation and Maintenance			Total: \$10,205,000
California Geological Survey		Enhance real-time data center for structural monitoring, update 40 existing seismic stations to provide real-time data	\$2,010,000
United States Geological Survey		Purchase equipment to instrument 41 new or updated EEW seismic stations with dataloggers and sensors, equipment to update 6 EEW seismic stations, and continue FirstNet pilot project	\$850,000
University of California, Berkeley		Support operation and maintenance through equipment purchases and ongoing network improvement, increase staff, add 12 new and update 3 broadband stations, and modernize software for improved network data monitoring, alerting, and maintenance prioritization	\$4,645,000
California Institute of Technology		Rebuild and instrument 12 existing EEW seismic stations, update 20 stations with new dataloggers and sensors, update telemetry equipment, and continue support of operation and maintenance with upgrades for enhanced data quality and network monitoring	\$2,700,000
Statewide Telemetry Plan			Total: \$2,192,000
Public Safety Communications		Microwave leases and circuit costs for up to 350 stations and high-altitude antennas	\$2,192,000
Education and Training			Total: \$2,618,000
CEEWS Campaign		Public relations services for statewide education and outreach	\$2,618,000
Research and Development			Total: \$2,050,000
University of California, Berkeley		Continue support of MyShake app platform development and the development of metrics and tools to improve operation and maintenance decision-making process	\$1,600,000
University of California, Berkeley, and California Institute of Technology		Conduct research utilizing distributed acoustic sensing (DAS) and already existing fiber optic infrastructure for earthquake monitoring to increase sensor density particularly offshore	\$450,000
Administration			Total: \$218,000
FY 2021-22 State General Fund Budget Allocation			Total: \$17,283,000

Appendix F. FY 2022-23 Spending Allocations

Contractor	Description	Funding Allocation
Seismic Station Installation and Maintenance		Total: \$9,945,000
California Geological Survey	Support EEW and Real-time Data Center operations and maintenance through equipment purchases and ongoing network improvement	\$1,490,000
United States Geological Survey	Support operations and maintenance through equipment purchases, upgrades of aging infrastructure, and ongoing network and telemetry improvement. Continue FirstNet pilot project and ongoing communication costs	\$455,000
University of California, Berkeley	Support operations and maintenance through equipment purchases and ongoing network improvement. Fund expanded field team staff, engineering, and IT positions	\$3,500,000
California Institute of Technology	Support operation and maintenance through positions, equipment purchases, and upgrades of aging infrastructure for enhanced data quality, and network monitoring	\$2,500,000
University of California, Berkeley	Support MyShake app, including updates and additional storage to increase capacity	\$2,000,000
Statewide Telemetry Plan		Total: \$4,060,619
Public Safety Communications	One-time equipment and personnel costs to complete the PSC EEW Telemetry Project and PSC EEW annual maintenance	\$4,060,619
Education and Training		Total: \$650,000
Community Outreach Grants	Fund community-based outreach through Inland SoCal United Way and United Way Bay Area	\$350,000
EEW Benefit Cost Analysis	Utilize an Interagency Agreement to select a contractor to develop a Benefit Cost Analysis of the EEW program	\$300,000
Research and Development		Total: \$2,000,000
University of California, Berkeley, and California Institute of Technology	Conduct research utilizing distributed acoustic sensing (DAS) and already existing fiber optic infrastructure for earthquake monitoring to increase sensor density particularly offshore where the network is sparse and prone to errors	\$800,000

University of California, Berkeley	Conduct a feasibility study to understand EEW implementation costs and considerations for scale in airports.	\$400,000
America's Public Television Stations	Support the implementation of datacasting technology within remaining public broadcasting stations for statewide coverage	\$500,000
California Geological Survey	Continue the Community Seismic Network (CSN) pilot project for structure health monitoring for EEW alerting and emergency response.	\$300,000
Administration		Total: \$430,381
FY 2022-23 State General Fund Budget Allocation		Total: \$17,086,000

Appendix G. FY 2023-2024 Spending Allocations

Contractor	Description	Funding Allocation
Seismic Station Installation and Maintenance		Total: \$9,890,000
California Geological Survey	Support EEW and Real-time Data Center operations and maintenance through equipment purchases and ongoing network improvement	\$1,390,000
United States Geological Survey	Support operations and maintenance through equipment purchases, upgrades of aging infrastructure, and ongoing network and telemetry improvement. Continue FirstNet pilot project and ongoing communication costs	\$500,000
University of California, Berkeley	Support operations and maintenance through equipment purchases and ongoing network improvement. Fund expanded field team staff, engineering, and IT positions	\$3,500,000
California Institute of Technology	Support operation and maintenance through positions, equipment purchases, and upgrades of aging infrastructure for enhanced data quality, and network monitoring	\$2,550,000
University of California, Berkeley	Support MyShake app, including updates and additional storage to increase capacity	\$1,950,000
Statewide Telemetry Plan		Total: \$2,800,000
Public Safety Communications	One-time equipment and personnel costs to complete the PSC EEW Telemetry Project and PSC EEW annual maintenance	\$2,800,000
Education and Training		Total: \$2,560,000
Community Outreach Grants	Fund community-based outreach through Inland SoCal United Way and United Way Bay Area	\$1,140,000
CEEWS Campaign	One-year extension of PR services for statewide education and outreach and \$.5M for Rapid Response.	\$1,420,000
Research and Development		Total: \$1,848,000
Fire Stations Pilot Project	Provide funding for EEW implementation within fire stations in the San Bernardino Fire District, Los Angeles Fire District, and Morongo Reservations.	\$498,000
Community Seismic Network	CGS will continue the pilot project for structure health monitoring for EEW alerting and emergency response. Working with Caltech and UC Los	\$300,000

	Angeles, CGS to install 20 CSN instrument packages to collect and provide required strong motion data from the CSN to evaluate the CSN performance for EEW, ShakeMap, and engineering applications.	
Distributed Acoustic Sensing	UCB and CalTech will continue research using Distributed Acoustic Sensing and already existing fiberoptic infrastructure for earthquake monitoring to increase sensor density, particularly offshore (at urban centers) where the network is sparse and prone to errors, as well as enhancements to EPIC.	\$550,000
Datacasting (One time)	One-time funding: Per AB 102, Budget Act of 2023 EEW received a one-time allocation from the Governor's Budget to purchase and distribute Datacasting receivers throughout the State in coordination with the American Public Television Station.	\$500,000
Administration		Total: \$430,381
FY 2023-24 State General Fund Budget Allocation		Total: \$17,528,381

Appendix H. FY 2024-2025 Spending Allocations

Contractor	Description	Funding Allocation
Seismic Station Installation and Maintenance		Total: \$9,855,619
California Geological Survey	Support EEW and Real-time Data Center operations and maintenance through equipment purchases and ongoing network improvement	\$1,390,000
United States Geological Survey	Support operations and maintenance through equipment purchases, upgrades of aging infrastructure, and ongoing network and telemetry improvement. Continue FirstNet pilot project and ongoing communication costs	\$465,619
University of California, Berkeley	Support operations and maintenance through equipment purchases and ongoing network improvement. Fund expanded field team staff, engineering, and IT positions	\$3,500,000
California Institute of Technology	Support operation and maintenance through positions, equipment purchases, and upgrades of aging infrastructure for enhanced data quality, and network monitoring	\$2,550,000
University of California, Berkeley	Support MyShake app, including updates and additional storage to increase capacity	\$1,950,000
Statewide Telemetry Plan		Total: \$3,700,000
Public Safety Communications	One-time equipment and personnel costs to complete the PSC EEW Telemetry Project and PSC EEW annual maintenance	\$3,700,000
Education and Training		Total: \$1,950,000
CEEWS Campaign	One-year extension of PR services for statewide education and outreach and \$.5M for Rapid Response.	\$1,950,000
Research and Development		Total: \$1,150,000
Instrumentation of Stadiums (CGS)	Installation of real-time seismic stations within a large public venue to support rapid response to a seismic event.	\$50,000
Distributed Acoustic Sensing	UCB and CalTech will continue research using Distributed Acoustic Sensing and already existing fiber optic infrastructure for earthquake monitoring to increase sensor density, particularly offshore (at urban centers) where the network is sparse and prone to errors, as well as enhancements to EPIC.	\$300,000

Implementation Project Reserve Fund	Contingent upon the completion of EEW-based studies and reports, including the Airport Feasibility Study (2025), Benefit-Cost Assessment of the California Earthquake Early Warning System (2025), and the Closeout DAS Recommendation Report (2027). Program will propose implementation projects based on the report and study outcomes.	\$800,000
Administration		Total: \$430,381
FY 2024-25 State General Fund Budget Allocation		Total: \$17,086,000