

**Ferndale Earthquake Sequence:
Understanding Impediments to Local Recovery
in Rio Dell, California**



**CALIFORNIA SEISMIC SAFETY COMMISSION
SSC No. 24-02**

April 11, 2024



111 Faces Off the 101, Rio Dell (portion of mural), Julia Fordyce, Artist

Acknowledgments

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Ferndale Earthquake Sequence

Understanding Impediments to Local Recovery

in Rio Dell, California

Executive Summary

In the early morning hours of December 20, 2022, a magnitude (M)6.4 earthquake occurred near the small city of Ferndale in Humboldt County, a seismically active region along the far-northern coast of California. Just 12 days later, on January 1, 2023, a M5.4 earthquake occurred in the same area, beginning a year-long sequence of almost 500 aftershocks of magnitude 1.0 or greater. Aftershocks continued into 2024.

Although the Ferndale Earthquake Sequence was felt widely across Humboldt County, the community of Rio Dell, a small city of some 3,400 residents, sustained the most significant physical damage from the earthquake event and has suffered the greatest long-term economic and societal effects of the event. By the end of 2023, total damage in Humboldt County was approximately \$40 million, with \$32 million of that damage in Rio Dell.

Within hours of the initial mainshock, Humboldt County proclaimed a Local Emergency. A Local Assistance Center (LAC) was established in Rio Dell within 10 days, which brought together various organizations to aid in the aftermath. The Federal Emergency Management Agency's (FEMA) disaster Public Assistance and Individual Assistance funding were unavailable because the level of damage did not meet FEMA's minimum thresholds for California.

On May 23, 2023, the Seismic Safety Commission (SSC) held a hearing in Rio Dell on the impacts and lessons learned from the sequence of earthquakes. The SSC heard testimony from approximately 25 individuals including local, state, and federal representatives and members of the public. Several potential policy considerations and lessons learned emerged from the hearing and follow-up interviews, particularly highlighting the challenges faced by small, rural communities in the aftermath of disasters.

While this report reflects findings and recommendations similar to those in prior SSC post-event reports, it is focused, intentionally, on insights and recommendations unique to the Ferndale Earthquake Sequence. Further, the purpose of this report is not to develop a compendium of all information known about the sequence of earthquakes but, rather, to identify and focus on priority findings and recommended actions that should be considered, particularly in support of small, rural communities that experience vulnerability in disasters and recovery.

Priority Recommendations

After analyzing the information received both during the hearing and from follow-up interviews, the SSC formulated a series of recommendations to improve the disaster preparedness, mitigation, response, and recovery efforts of local governments. A number of the recommendations are a priority.

Develop or update a local emergency operations plan (EOP) in coordination with the local operational area or county. Ensure the plan includes low-tech communication alternatives in case power, cellular, and/or internet capabilities become unavailable. Regularly review and practice the plan.

Educate local residents and businesses on the value of and funding sources for seismic retrofits and other earthquake mitigation activities and how to protect property and reduce economic losses. Focus outreach efforts on housing, particularly older single-family homes and mobile homes.

Identify local Non-Governmental Organizations (NGO) and Community-Based Organizations (CBO) and establish a post-disaster plan with these organizations. NGO and CBO partners are essential to long-term recovery.

Working through the State, with the California State Association of Counties, the League of California Cities, the California Special Districts Association, and with federal representatives, encourage FEMA to update its eligibility criteria for federal assistance programs so small, rural communities that experience social vulnerability and/or economic disadvantage have equitable access to federal disaster-assistance funding.

As a stop-gap to the unavailability of federal assistance, work with the State to add an individual assistance funding program. Be prepared to demonstrate how communities that experience social vulnerability and/or economic disadvantage fall further behind when federal assistance is unavailable for individual community members.

Support long-term disaster recovery and resilience by having a plan to address the post-disaster social and mental health needs of all community members.

Introduction

The Ferndale Earthquake Sequence struck Humboldt County on December 20, 2022, and January 1, 2023. Registering M6.4 and M5.4, respectively, the mainshock and aftershock caused 17 injuries. Although two deaths were initially attributed to the earthquakes, it was later determined that the deaths were caused by medical emergencies that occurred around the same time as the earthquakes.

Although the Ferndale Earthquake Sequence was felt widely across Humboldt County, the community of Rio Dell (City) – a small city located along the Eel River and about 14 miles from the Pacific coast – sustained the major physical damage of the earthquakes and has suffered the long-term economic and societal effects of the event. Numerous homes and businesses sustained damage or were deemed uninhabitable, gas leaks and power outages occurred, internet, and cellular communications were unavailable for several days. In addition, the elementary school was damaged and Rio Dell's water and wastewater systems sustained significant damage. The Fernbridge, which leads to Ferndale, also was damaged. Initially, damage in Rio Dell was estimated at \$22 million; by the end of 2023, the level of damage was estimated at \$32 million with total damage in Humboldt County estimated at \$40 million.

Rio Dell was established in the 1840s as a lumber town and was incorporated as a city in 1965. The small city has about 3,400 residents. The area is considered severely disadvantaged economically with a median household income (MHI) of about \$37,000 per year, in comparison to the statewide average MHI of \$84,097. The local municipal government has 24 employees, including a 9-officer police department, a public works staff of 8, and a volunteer fire department. The local business community boasts about 100 small businesses, but only about 25 are storefront businesses, most of which belong to the Chamber of Commerce. Several businesses were shuttered due to the COVID-19 pandemic. The community has no major industry.

Humboldt County proclaimed a Local Emergency within hours of the December 20, 2022 mainshock. A Local Assistance Center (LAC) was established in Rio Dell within 10 days. The LAC brought together organizations that aided in the aftermath, including the Small Business Administration (SBA), the California Department of Insurance, city and county agencies, and numerous social service agencies.

Despite the significant level of damage for a small community like Rio Dell, a Presidential Disaster Declaration (PDD) was not requested by the State because the level of damage did not meet FEMA's minimum thresholds or indicators for California. In addition, California could not demonstrate that its resources were

overwhelmed. (See pages 14-17.) Some federal funding from the SBA and U.S. Department of Agriculture was made available after the earthquakes and the City coordinated with the County of Humboldt to utilize Community Development Block Grant (CDBG)¹ Owner-Occupied Rehabilitation program funds to assist citizens with repairs.

On May 23, 2023, the Seismic Safety Commission (SSC) convened a hearing in Rio Dell to hear testimony about and gather information on the Ferndale Earthquake Sequence and what can be learned for the future. The hearing was held at Rio Dell's City Hall and featured testimony from 25 individuals representing local, state, and the federal government; residents and businesses impacted by the earthquakes, and other organizations.

During the hearing, public testimony focused on the earthquakes' impacts to infrastructure, lessons learned from first responders, and ongoing recovery efforts. The stories of personal experiences were enlightening and made it clear the Rio Dell community came together to support one another both during and after the earthquakes. The testimony demonstrated that Rio Dell has a culture of self-sufficiency and resiliency—lessons that can serve as a guide to local governments that must be prepared to manage earthquakes and other disasters.

Many of the findings and recommendations in this report are similar to those identified by the SSC following the 2014 Napa and 2019 Ridgecrest earthquakes. In particular, earthquake recovery in both Ridgecrest and Rio Dell was hampered by the same challenge: the unavailability of federal disaster funding assistance for small, rural communities in economically strong states like California. (Note: Unlike Rio Dell, Ridgecrest is located near a major military installation (China Lake Naval Air Weapons Station) and was able to capitalize on the indirect economic benefits of the federal government's required post-earthquake infrastructure work).

The Ferndale Earthquake Sequence

The Ferndale Earthquake Sequence was a series of almost 500 earthquakes that occurred near Ferndale, California, a small community near the coast of Humboldt County in northern California. The earthquakes began in December 2022 and January 2023 and continued through 2023 and into 2024.

The mainshock, a M6.4 earthquake, struck on December 20, 2022, at 2:34 a.m. Pacific Standard Time with its hypocenter about 10 miles (15 kilometers) southwest of Ferndale, at a depth of 11 miles (18 kilometers) (Figure 1). At 1.458g (gravity), the M6.4 earthquake unleashed one of the strongest accelerations ever measured in

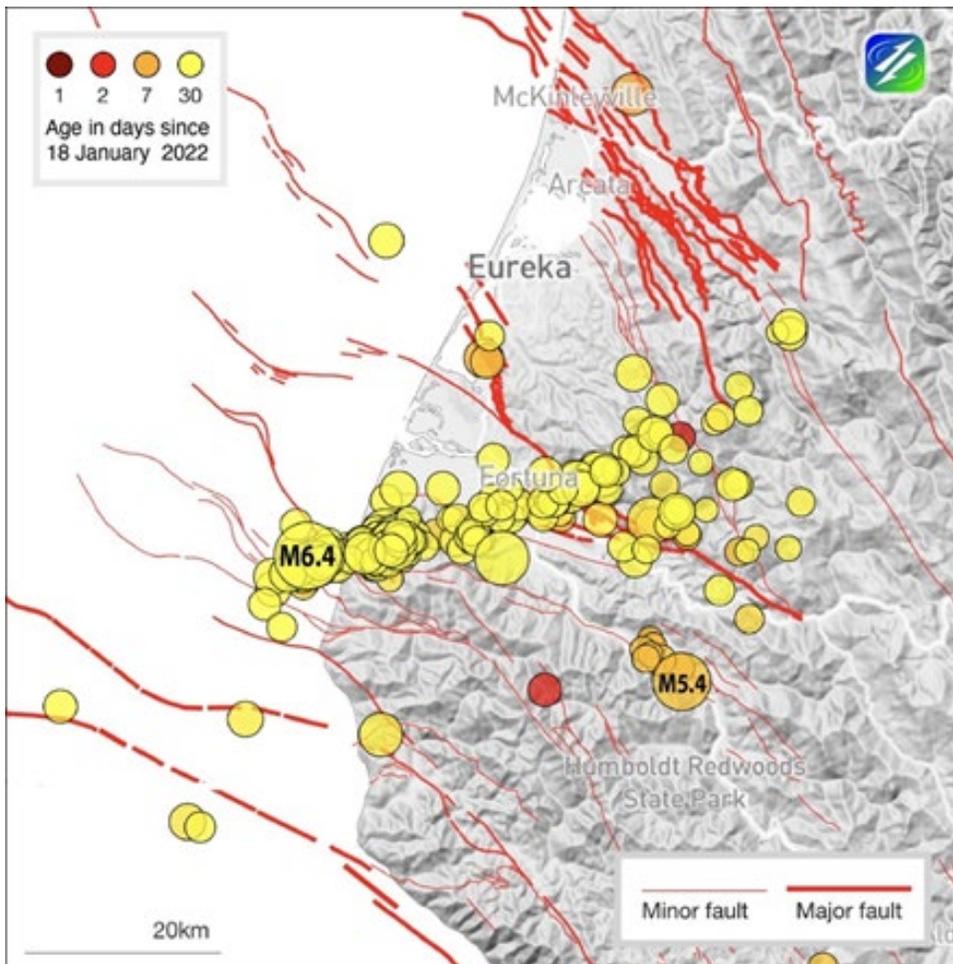
¹ [News Flash • April 6, 2023 | Humboldt County Earthquake Reco \(humboldt.gov.org\)](#)

California. Because the earthquake struck in a rural part of California, the damage, even with such strong accelerations, was relatively minimal. In all likelihood, damage would have been much more severe if an earthquake with similar acceleration had occurred in a densely populated area.

The December mainshock was followed by a sequence of aftershocks, including the largest at M5.4 on January 1, 2023. Over the ensuing 12 months, the area experienced nearly 500 recorded aftershocks of M1.0 or greater, including 5 aftershocks in the range of M4.0 to M4.9. Aftershocks have continued. As shown by the yellow dots in Figure 1, the aftershocks have occurred along a previously unknown subsurface fault that trends northeast from the Humboldt County coast.

This information will help scientists to better assess the seismic hazards of this region.

Figure 1: Map of M.6.4 and M5.4 Earthquakes & Aftershocks

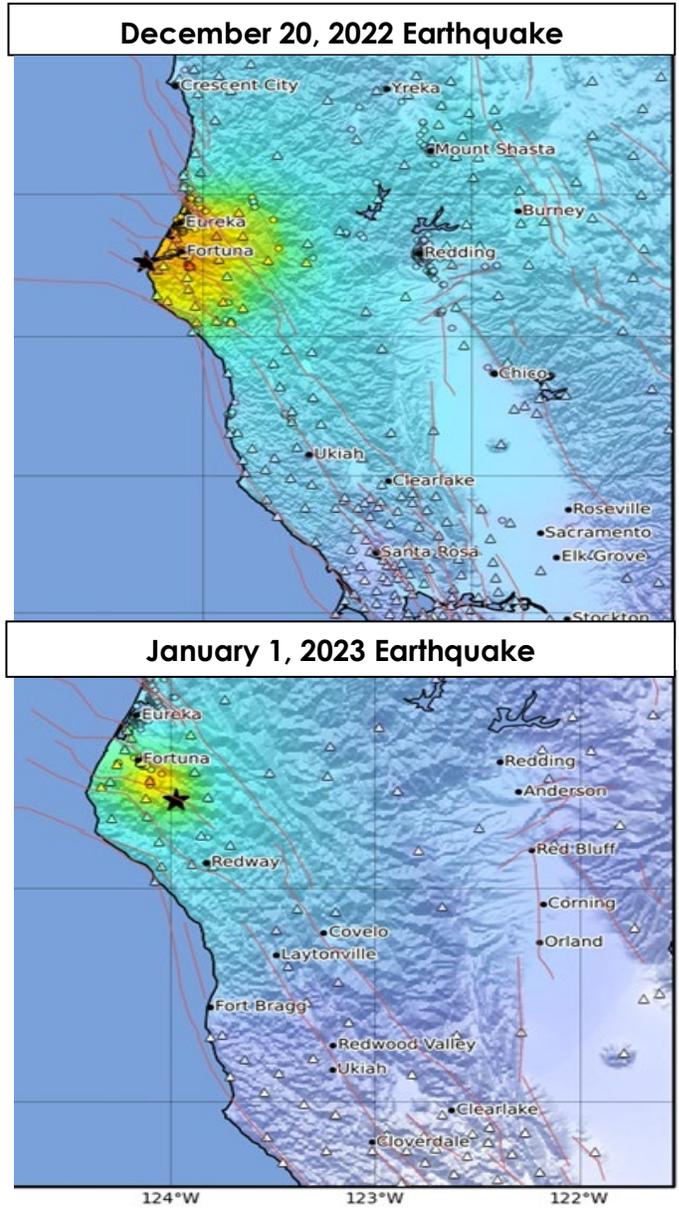


Source: Stein, R. S., Toda, S., Rollins, C., and Sevilgen, V., 2023, December 2022 California earthquake ruptured unknown fault: an analysis, *Temblor*²

² <https://temblor.net/earthquake-insights/dec-2022-california-earthquake-unknown-fault-analysis-14867/>

The United States Geological Survey (USGS) ShakeMaps in the next figure illustrate the intensity of shaking for the December mainshock and the January aftershock (Figure 2).

Figure 2: December 20, 2022 & January 1, 2023 ShakeMaps



SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
PGA(%g)	<0.0464	0.297	2.76	6.2	11.5	21.5	40.1	74.7	>139
PGV(cm/s)	<0.0215	0.135	1.41	4.65	9.64	20	41.4	85.8	>178
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based on Worden et al. (2012)

Version 6: Processed 2023-01-02T00:37:27Z

△ Seismic Instrument ○ Reported Intensity

★ Epicenter

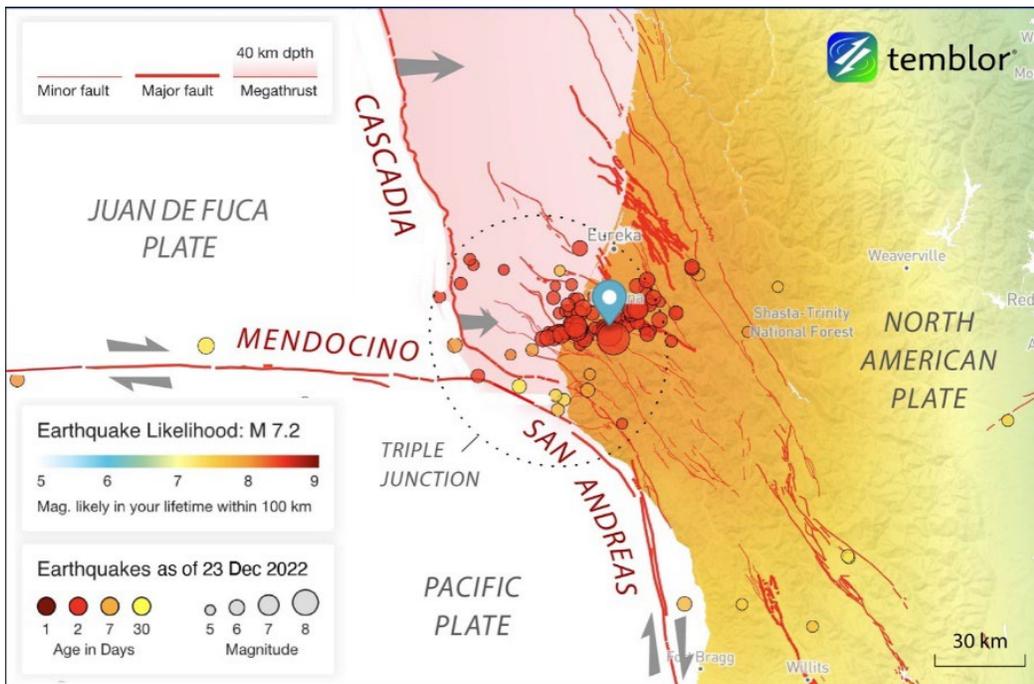
Ferndale Earthquake Sequence and Rio Dell

Located about 14 miles from the coast and about 10 miles southeast of Ferndale, Rio Dell is situated on the Mendocino Triple Junction, one of the most seismically active areas of California. As shown in Figure 3, the Mendocino Triple Junction is formed by the meeting of three tectonic plates—the North American, the Juan de Fuca, and the Pacific.

Because of this tectonic setting, the region – including Rio Dell – can experience large earthquakes. In fact, over the last 90 years, the region has experienced 20 earthquakes with a M6.4 or higher, and 5 of these events were recorded at M7.0 to M7.2. A previous sequence of large earthquakes began a year earlier on December 20, 2021.

The Ferndale Earthquake Sequence and the resulting damage to Rio Dell are a direct result of the tectonic interaction within the Mendocino Triple Junction.

Figure 3: Mendocino Triple Junction Map



The magnitude-6.4 quake (not shown) struck within the Mendocino Triple Junction, where three tectonic plates meet. Because the junction is distorted and compressed, deformation is distributed across a network of faults, one of which ruptured on Dec. 20, 2022. Historically, the junction has been extremely seismically active. The arrows give the sense of motion of the faults. The color ramp gives the magnitude (within 100 kilometers) that's likely in a lifetime. Note that likely maximum magnitude within 100 kilometers of the Mendocino region in a lifetime is magnitude 7.2.²

Ferndale Earthquake Sequence: Triggered Earthquakes?

In recent years, seismic interest has begun to focus on the phenomena of earthquake sequences that involve at least two large-magnitude events within a short period of time. Some of these sequences—which have occurred in different parts of the world—have been described as “triggered” events because the subsequent earthquake has occurred on a different (but near) fault that scientists believe was triggered by the release of energy from the earlier event.

As an example, the February 2023 Türkiye earthquake sequence was likely a triggered sequence, as it involved two mainshocks, an initial M7.8 mainshock that likely triggered the subsequent M7.5 mainshock. Extensive casualties and building collapse resulted from the two mainshocks as well as several large-magnitude aftershocks between and following the two mainshocks. Many of the buildings that survived the M7.8 mainshock collapsed during the M7.5 event.

In the U.S., the 2019 Ridgecrest earthquake sequence also was characterized by mainshocks that occurred on more than one fault.

The consequences of the Ferndale Earthquake Sequence are clear: The M6.4 and M5.4 earthquakes both caused significant and compounding damage. However, scientists have determined that the Ferndale Earthquake Sequence was not a triggered event.

Appendix A provides information on post-event structural damage assessments in Rio Dell.

To date, little research is available on how buildings and infrastructure withstand a sequence of strong earthquakes. The SSC has recently begun research on the cumulative effects of strong earthquake sequences.

Economics of Disasters for Underserved Communities

The ability of a community to effectively prepare for and respond to a natural disaster is often dependent on resources, particularly financial resources. This is uniquely true for small, underserved communities like Rio Dell, where local financial resources may be limited and state and/or federal assistance can be constrained.

Rio Dell's Economic Topography

Rio Dell is a rural community located in the Eel River Valley in Northern California's Humboldt County. Established in the 1840s as a center for the local lumber industry, Rio Dell—like many rural communities—has suffered with the decline of its primary industry.

Today, the State of California classifies Rio Dell as an economically disadvantaged community.

- Rio Dell's Median Household Income (MHI) is about \$37,000³, approximately 45 percent of the statewide MHI (\$84,097).
- With an average per capita income in Rio Dell of \$24,700, some 38 percent⁴ of Rio Dell's residents are living below poverty and nearly 43 percent receive some form of public assistance⁵.
- Rio Dell experiences a high level of social vulnerability (0.8278)⁶ and also has an “unhealthy places” designation⁴, which is a determinant that contributes to lower life expectancy.
- Rio Dell's population is primarily White (Non-Hispanic) with English as the self-reported language spoken in the home³.

Federal Disaster Assistance

Federal disaster assistance is critical to local communities. When a natural disaster strikes and the damage exceeds the capabilities of state or local government to respond, a state may ask the federal government to declare a disaster, which “unlocks” a variety of federal aid programs, including funding from the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA).

³ <https://datausa.io/profile/geo/rio-dell-ca/>

⁴ <https://map.healthyplacesindex.org/?view=7be44f16-734b-4c6a-919b-303133117e49>

⁵ <https://headwaterseconomics.org/apps/economic-profile-system/600060900>

⁶ https://www.atsdr.cdc.gov/placeandhealth/svi/interactive_map.html

FEMA offers two disaster assistance programs,⁷ both of which can be used for immediate relief and long-term recovery, and one program for mitigation projects.

- Public Assistance (PA) for infrastructure such as roads, bridges, and community facilities
- Individual Assistance (IA) for individual community members
- Hazard Mitigation Grant Program (HMGP) for mitigation projects

FEMA has a separate process for determining if assistance will be provided. For public infrastructure, FEMA considers, primarily, the severity of damage and an applicant's capabilities. For individual assistance, FEMA primarily looks at total uninsured homes and personal property losses.

Significantly, FEMA has established a minimum damage threshold for each state that is based on state-level metrics. The estimated value of damage from a local event must exceed the state-level minimum threshold to qualify for federal assistance.

Currently, California's minimum per-event threshold is \$72,750,330. The California threshold is exceedingly high because of the high economic value of the Los Angeles and San Francisco Bay Area regions and of the State's tech industry. As a result, small and/or rural communities in other areas of California that experience economic disadvantage or social vulnerability are unable to qualify for federal assistance and are deprived of an equitable opportunity for recovery.

For the Ferndale Earthquake Sequence, the level of damage did not meet the federal minimum threshold requirement. Although about 25 percent of Rio Dell's housing was damaged and there was significant damage to the local water and wastewater systems, neither FEMA's Public Assistance nor Individual Assistance funding programs were available.

Other federal programs for individuals and businesses are available for mitigation and/or post-disaster recovery activities. The United States Department of Agriculture (USDA) offers two grant programs: one that may assist homeowners with mitigating post-and-pier foundation concerns and the other for repairs following a disaster. The SBA may also issue a disaster declaration allowing homeowners and businesses to seek loans after a disaster. See Appendices C and D.

⁷ <https://www.govinfo.gov/content/pkg/COMPS-2977/pdf/COMPS-2977.pdf>

State Disaster Assistance for Local Governments

The State of California assists local governments with disaster response and recovery efforts through California Disaster Assistance Act (CDAA) funding and technical assistance by Cal OES.

Funding Support

Local governments may request CDAA funding with or without a federal disaster declaration. Through this program, the State may provide funding to cover public infrastructure costs incurred from a disaster; the State may also provide funds to meet the matching requirements under federal programs. Through CDAA, the State may provide funding at a minimum level of 75 percent of eligible costs; however, in certain cases, the State may authorize CDAA to cover up to 100 percent of the repair costs⁸. Even with 75 percent coverage from CDAA, the remaining 25 percent local cost share for communities experiencing social vulnerability and/or economic disadvantage can be challenging. The 100 percent CDAA coverage is retroactive, granted on a project-by-project basis and is not guaranteed. Given the scale of public infrastructure damage in Rio Dell and as projects may take years to complete, the City may face fiscal uncertainty for years to come.

Following the Ferndale sequence, six local government entities, including three cities, have successfully tapped into CDAA funding to support local disaster response efforts. As of February 2024, \$2.1 million in assistance funding for 13 projects ranging from emergency response activities and sheltering to debris removal and public infrastructure repair has been approved. An additional \$1.4 million in assistance for 3 projects has been approved, but not yet paid (funding is provided when projects have been completed), and more than 60 projects are still being scoped and/or reviewed for approval. See Appendix B for CDAA-approved projects.

Rio Dell may ask the State to adjust its local cost share for CDAA-submitted projects because they are AB 2140 compliant. However, the City has yet to ask the State for an adjustment. More detail on AB 2140 is in Appendix D.

CDAA funds are not available for individual assistance.

The California Residential Mitigation Program (CRMP), a joint powers authority between Cal OES and the California Earthquake Authority, offers a homeowner

⁸ Jurisdictions may not receive from the State more than 75% of the state's cost share on eligible CDAA funded projects unless they are AB 2140 compliant. AB 2140 authorizes cities and counties to adopt within the safety element of its general plan a federally specified local hazard mitigation plan (LHMP) that includes specified elements. Therefore, complying with AB 2140 may also significantly reduce the local cost share for both federal and CDAA-only funded projects.

grant program, Earthquake Brace + Bolt (EBB), to help retrofit raised-foundation homes. This program also can help homeowners retrofit post-and-pier houses with continuous perimeter foundation upgrades.

Cal OES Programmatic Recovery Assistance

To bolster local recovery efforts, Cal OES offers a range of specialized technical assistance and support services to help local communities transition from response to recovery. The Cal OES support personnel can help identify alternative funding for housing, health, and social services; community planning and capacity building; infrastructure systems; and natural and cultural resources.

Cal OES also manages the Safety Assessment Program (SAP), which utilizes volunteers and mutual aid resources to provide professional engineers, architects, and certified building inspectors, to help local communities conduct building safety evaluations after a disaster.

For the Ferndale earthquake response and recovery effort, a Cal OES Recovery Support Team worked locally for three months to aid with:

- Safety assessments and evaluations for damaged property
- Sheltering assistance
- Identification of low-interest home rehabilitation loans through sources such as CalHome and U.S. Housing and Urban Development's Community Development Block Grant (CDBG) funding

As of early February 2024, three USDA disaster grants for \$40,675 have been funded. See Appendices C and D for information on the USDA programs.

Improvements Needed for Individual Assistance

The absence of FEMA and CDAA funds for individual assistance disproportionately hinders recovery in communities experiencing disadvantage and underservice that are already struggling financially.

Although FEMA has recently improved⁹ the Individual Assistance Program (i.e., quicker access to funds, expanded eligibility for property and home repairs, simplified application process), the changes do not address the disparity that occurs in a state like California where the minimum-threshold requirement limits the availability of funds.

⁹ <https://www.fema.gov/press-release/20240119/biden-harris-administration-reforms-disaster-assistance-program-help>

To better avail small communities that experience disadvantage with equitable federal aid after disasters, FEMA should consider expanding the eligibility criteria to include factors such as poverty level and community vulnerability and evaluate impacts on a regional basis as an alternative to statewide thresholds that unfairly penalize residents of large and diverse states, such as California.

Further, because communities like Rio Dell face post-disaster financial challenges both at an individual and community level, the State should consider establishing a program like CDAA that provides individual assistance to disaster victims.

Findings and Recommendations

Based on the May 23, 2023 hearing, follow-up interviews, and subsequent research and data-gathering efforts, the SSC used the findings and lessons learned to formulate recommendations that, if implemented, will likely improve the disaster preparedness, mitigation, response, and recovery efforts of local governments.

This report first presents the findings from the local experience during and following the Ferndale Earthquake Sequence. The report then organizes recommendations within the four pillars of emergency management.

- **Preparedness** increases a community's ability to respond to a disaster through a continuous cycle of planning, training, and exercising.
- **Mitigation** involves hazard assessments and actions that will reduce the impact and consequences of a disaster and build community resilience.
- **Response** focuses on the event-initiated mobilization of resources and expertise to save lives and minimize damage.
- **Recovery** is a long-term process that begins during the response phase and extends far beyond the immediate aftermath of a disaster.

Findings

Emergency operations infrastructure, plans, and supplies

The apparatus bay doors at the Rio Dell Fire Department collapsed and came off the tracks, which caused a delay of 20 minutes to get an engine to respond. The fire department has received a grant through the Humboldt Area Foundation to replace the doors.

The Rio Dell fire station lost power following the earthquake and had no automatic transfer of emergency power. In addition, automated testing for the fire station's generator had not been installed. The Fire District is researching how it might purchase and install it in the future and plans to institute automated generator testing.

Some emergency supplies were not readily available or maintained. For example, first responders had to work in the dark because flashlight batteries were dead, some equipment was not charged, and vehicles were low on fuel.

Public safety radio system

The repeater for Rio Dell's police radio system lost power. Rio Dell officers initially used the fire channel to listen to calls and, eventually, switched to the City of Fortuna's repeater to facilitate communication. Although the Fortuna repeater was

better than nothing, the connection was not clear.

Immediately after the earthquake, police officers were only able to communicate face-to-face.

Power

Following the earthquakes, more than 70,000 were without power; most of the electric power outages were restored within 48 hours. Almost all of the power outage was not from infrastructure damage but, rather, from automatic shutoffs triggered by ground shaking and from phase-to-phase and phase-to-ground faults caused by wire swaying in 12 kV, 60 kV, and 115 kV systems. Subsequent assessments found no damage for 98 percent of these types of faults.

Pacific Gas & Electric (PG&E) completed 13,000 post-event natural gas assessments and found just 78 gas leaks. Only 12 leaks were caused by earth movement; most of the leaks occurred in customer distribution lines that were corroded or brittle and susceptible to earthquake damage. One leak in Rio Dell reportedly led to a structure fire.

Public communications

Cell phone and landline facilities were damaged.

With power, internet, and cellphone services mostly out, communications with the public and between public safety officials were nearly impossible.

To distribute information to community members, Rio Dell used Nixle, an opt-in mass-notification cellphone-based application. Unfortunately, only about 300 individuals out of a population of 3,400 had subscribed to the app and with most cellphone services out, information dissemination was limited.

Other than Nixle, Rio Dell had no other way to easily and consistently disseminate information and no way to reach community members who did not have cell phones.

Emergency responders posted information on an A-frame board near the fire station. Rio Dell was unable to utilize their electronic message board because power was unavailable. The Fire District has since purchased a portable message display sign.

Rio Dell conducted a press conference in English with Spanish and Mandarin translators. Humboldt County officials took efforts to ensure information disseminated was provided in English and Spanish but noted that translation into other languages may have been needed.

Emergency responders

Staff to handle emergencies is limited. Rio Dell has a small city staff of 9 police officers and 8 staff members responsible for public works, water, and wastewater. The City also relies on an all-volunteer fire department.

At the time of the Ferndale earthquakes, Rio Dell did not have trained Community Emergency Response Teams (CERT). Other communities have experienced the invaluable neighborhood-level support from these volunteers.

There were challenges with the collection of data from applicants for disaster aid as well as volunteers for recording service hours.

Some City staff, including first responders, had significant damage to their residences and personal property. With their continued support for the community, they were unable to address the needed repairs for their property.

Shelters and displaced persons

Immediately following the disaster, Rio Dell's designated shelter locations could not be used. The primary shelter location—a local elementary school—incurred damage and could not be used until the structure was evaluated. The secondary shelter site was under renovation, and there was not an identified third backup shelter site. Once it was determined there was not a third site, the Red Cross provided a shelter site in Fortuna.

Immediately following the earthquake, people congregated at the fire station, which overwhelmed the station and its staff. Fortunately, the number of medical emergencies was not so high as to negatively impact the ability of emergency responders to provide services.

Most people who had been displaced were able to shelter with family and friends.

Those individuals who could not shelter with family or friends were directed to the shelter in Fortuna. This was problematic for some residents who were concerned about sheltering with individuals of special circumstances/requirements (e.g., sex offender status). Later and only for a brief period, the shelter was moved to a school in Rio Dell after it was identified as safe. Had the school been the initial shelter location and given State law, sex offenders would not have been allowed to shelter there. The County partnered with the American Red Cross to assist several individuals with special circumstances in accordance with standard sheltering practices, but immediately following the earthquake the City was unsure of where and how these individuals would be sheltered.

While the initial shelter sites were not designated to help residents with pets,

coordination with a local animal shelter helped address pet sheltering needs.

After the American Red Cross shelter closed, non-congregate housing, serving almost 100 displaced households, was coordinated by the Humboldt County Emergency Operations Center (EOC) and was available for almost four months. EOC staff coordinated directly with non-congregate shelter clients to identify short and long-term sheltering options, and assisted clients in returning to their pre-disaster residence when possible. Humboldt County allocated \$1 million to fund an Earthquake Recovery & Assistance Program to assist Humboldt County and Rio Dell residents experiencing earthquake-related displacement.

Distribution of emergency food and supplies

There were challenges with distributing food and supplies to non-congregate shelter locations. Initially, deliveries of water, food, and clothing went to the Rio Dell fire station, which became overwhelmed until other locations were identified. Later, providing meals and other wrap-around services to individuals without access to transportation and with multiple non-congregate sites was difficult. Also, with the power outage, keeping medication refrigerated (e.g., insulin) was an issue for individuals. Rio Dell is seeking a grant to establish a community resilience center that address some of these issues.

NGOs and CBOs

Non-Governmental Organizations (NGO) and Community-Based Organizations (CBO) were valuable in providing immediate assistance to people and supporting long-term recovery. Agencies such as World Central Kitchen, Humboldt Made, and Food for People (Humboldt County's Food Bank) were pivotal in finding and distributing food, water, and clothing to affected residents and businesses. Food for People set up multiple food pantries throughout the community. Humboldt Made provided free hot meals every day until January 13, 2023. Later, Habitat for Humanity helped repair homes.

Beyond the immediate aftermath of the disaster, Habitat for Humanity, Catholic Charities and Hope Crisis Response Network—which have extensive long-term recovery experience—were instrumental in helping to form a Long-Term Recovery Group for Humboldt County. These organizations held in-person meetings to share education on the recovery process.

Humboldt County formed a Long-Term Recovery Group¹⁰ and hired a recovery officer to assist with the post-disaster needs of individual community members, including non-congregant housing. To ensure an individual's eligibility, Disaster Case

¹⁰ <https://humboldtrecovery.org/>

Management¹¹ protocols needed to be established. According to local officials, it is the centerpiece of long-term recovery efforts. It should be noted that pre-disaster needs are not considered unmet post-disaster needs.

Public education

Rio Dell is not unlike other local communities, in that residents and business owners are unaware of programs for mitigating disasters and post-disaster assistance, and greater public education is needed. Local building owners and homeowners reported being unaware of programs that will help them retrofit their homes and businesses (e.g., Earthquake Brace + Bolt program (EBB)). They also were unaware of grant and loan programs (See Appendices C and D) that may support seismic retrofits and repairs, such as:

- USDA's Single-Family Housing Repair Loans & Grants Program (Section 504 Home Repair program);
- USDA's Rural Disaster Housing Repair Grant program; and
- Small Business Administration's low-interest loan programs that help businesses and homeowners.

Federal and state financial assistance and cost-sharing requirements

Rio Dell, Humboldt County, and other local cities and special districts in the region sustained significant and costly damage both to public infrastructure and privately owned homes and businesses. About 25 percent of the housing stock of Rio Dell was damaged—a proportionately significant number for a remote community that is experiencing social vulnerability and underservice.

As explained on pages 14-17, because the total damages within California from the earthquake sequence did not meet the FEMA minimum threshold for federal assistance, the State did not request a Presidential Disaster Declaration and, therefore, FEMA did not provide federal aid for either public assistance or individual assistance. In addition, other State assistance can be limited and may take extended periods of time to receive. The FEMA financial assistance threshold can unintentionally disenfranchise small, rural communities that experience social vulnerability and underservice. A more equitable approach is needed.

In general, community leaders, residents, and business owners were unaware of the constraints of FEMA's requirements for providing federal aid. Most people believed

¹¹ Disaster Case Management (DCM) is a time-limited collaboration between a trained case manager and a disaster survivor involving the development of a disaster recovery plan and a mutual effort to meet those disaster-caused unmet needs described in the plan. Source: <https://www.fema.gov/emergency-managers/practitioners/recovery-resilience-resource-library/disaster-case-management>

federal funding would be forthcoming.

Earthquake insurance is expensive, particularly for low-income families. Residents told officials the cost of premiums and high deductibles were reasons why they did not have earthquake insurance. In California, the percentage of homeowners and renters with earthquake insurance is low, with an average uptake of 13 percent statewide. In low-income areas, the percentage is generally much lower. The number of Rio Dell households with earthquake insurance is disproportionately low.

More than a year later, many residents and businesses are still struggling, because they do not qualify for financial assistance to repair earthquake damage.

Some businesses and homeowners complain that loan assistance from the SBA has been delayed and that the application process is complicated and difficult to navigate.

Smaller community service districts and water districts have found it difficult to fund infrastructure that will improve seismic resiliency. Cal OES assisted with expediting an existing \$12,862,989 State Water Resources Control Board (SWRCB) grant opportunity, which had been in the works for several years, for the replacement of a water storage tank, various water mains, pipes, fire hydrants, service meters, and more to update Rio Dell's water system. While the initial SWRCB grant project scope would have replaced vulnerable sections of the system in advance of the earthquakes, it is now helping to remedy the damage incurred following the Ferndale Earthquake Sequence.

Residential property damage and repairs

About 25 percent of Rio Dell residential buildings sustained significant damage (defined by the residence receiving a yellow or red tag). Some yellow-tagged houses were re-evaluated after the second earthquake and were then red-tagged (see Appendix A). Even some green-tagged (safe to occupy) residences sustained damage that required repairs.

Repairs have been slow and, as of early 2024, many residents have found alternative permanent or long-term housing because they have been unable to return to their pre-disaster residences.

Rio Dell reports show that 30 of the original 60 red-tagged homes have completed repairs and/or closed out the pulled building permit (see Appendix A).

Both the age and type of housing stock and tenancy have been factors in the amount of damage and the recovery.

Age and type of housing: As can be expected, most damage occurred in¹²:

- Older homes with raised-floor foundations that lacked bracing or bolting
- Homes built with post-and-pier construction
- Pre-1994 mobile homes that sit on simple vertical supports and/or lack tie-downs

In contrast, most newer site-built homes—particularly homes with slab-on-grade construction (i.e., no “cripple walls”)—experienced little earthquake damage. The mobile homes in Rio Dell’s newer park had little to no damage because they had tie-downs or seismic bracing systems. (Note: The Housing and Urban Development (HUD) mobile home bracing code only addresses wind, not earthquakes. The efficacy of this code has not been tested by a strong earthquake in California.)

Tenancy: Almost 40 percent of Rio Dell’s housing is rented¹³. Because most funding for residential retrofit programs is designated for owner-occupied dwellings, rental residences are less likely to be retrofitted and, consequently, are more likely to be damaged in an earthquake. In addition, property owners can find it more difficult to secure funding assistance to repair damaged rental units, delaying repairs.

Mental health assistance

Disasters can have a profound and lasting impact on the emotional well-being of a community.

In January 2023, and following the earthquake sequence, the CAL FIRE Trauma Team led a training effort for the community on how to manage post-traumatic stress disorder (PTSD) after an earthquake event and how to identify the signs of PTSD in others.

The issuance of a Presidential Disaster Declaration can offer a community a sense of hope and support because it acknowledges the magnitude of the disaster and shows the government’s commitment to supporting recovery. Conversely, the lack of a declaration can have a long-term psychological impact on a community.

¹² <https://www.cityofriodell.ca.gov/home/news/damage-rio-dell-ferndale-earthquakes-20-december-2022-and-1-january-2023>

¹³ https://affordablehousingonline.com/housing-search/California/Rio-Dell#google_vignette

Recommendations

Preparedness Recommendations

Local Governments should:

- Establish a Local Emergency Operations Plan and drill. Equipment also should be routinely checked in advance in case of an emergency.
- Participate (especially cities) in operational area coordination meetings, trainings, and exercises.
- Designate location(s) within the community where emergency responders can access medical/emergency supplies, communicate with residents, conduct meetings, etc., to avoid emergency response structures, such as the local fire station, from being overwhelmed during disaster.
- Pre-select multiple shelter locations (congregate and non-congregate) that are accessible and emergency command center sites including pre-planning of grounds and facilities within those sites for respective purposes.
- In case of large events, prepare for extended power outages.
- Ensure emergency responders have multiple communication methods available for emergency alerts and public information. This includes making improvements to existing public safety communications systems and having low-tech methods for communicating with the public.
- As part of disaster planning, establish and integrate a network of Non-Governmental Organization (NGO) and Community-Based Organization (CBO) partners into the planning process. Include organizations located outside the community to ensure resources are available in the event a future disaster is community/county-wide.
- Set up a community resilience center (i.e., a non-shelter facility with a kitchen, refrigeration, and storage capacity for food and medications as well as space for meetings).
- Ensure emergency personnel will be able to operate for up to 72 hours without outside support (e.g., supplies of food, water, medicine, and first aid supplies; electrical power; refrigeration for medication).
- Continue to improve the delivery of mental health services to both emergency responders and the public at large after future disasters. Create partnerships before disaster strikes so post-disaster support is immediately available.
- Ensure culturally responsive services (including language) from local and state resources are available to all community members impacted by a disaster.
- Recruit and train CERT volunteers.

Mitigation Recommendations

- Regularly provide the community with information on how to retrofit homes and buildings and how to protect property from seismic damage. Include information on auto-gas-shut-off valves. Include information on funding opportunities and the realities of post-disaster assistance. Don't wait for post-event funding opportunities.
- Local governments should ensure communities with current FEMA-approved Local Hazard Mitigation Plans are adopted into the safety element of their general plan pursuant to AB 2140¹⁴ to ensure eligibility for future post-event local-share match-funding opportunities.
- Homeowners should consider seismic auto-gas-shut-off valves to reduce fire following earthquake risks.
- When developing long-term capital improvement plans, cities, counties, and special districts should consider their aging infrastructure and the risk of catastrophic loss as a prioritization factor.

Response Recommendations

Local Governments should:

- Provide multiple adequate and accessible post-event sheltering options in communities, to address special circumstances/requirements.
- Encourage Safety Assessment Program (SAP) Evaluator and Coordinator training, especially in rural regions of California. The earthquakes occurred during the winter holiday season in a remote area that experiences winter weather that could impede the arrival of assistance from outside of the area.
- Train appropriately qualified local government personnel to conduct rapid safety assessments of all potentially damaged residences and shelter locations. Each local government should have at least one trained SAP Coordinator on staff.
- Establish a consistent and shareable digital data format for assistance programs to collect disaster survivors' data and a system to document volunteer hours, which are used in offsetting local cost share. This will help minimize duplication of data entry across programs and forms.

¹⁴ <https://www.caloes.ca.gov/wp-content/uploads/Hazard-Mitigation/Documents/AB-2140-fact-sheet-11.7.2023.pdf>

Recovery Recommendations

- The State, in cooperation with the California State Association of Counties, the League of California Cities, and the California Special Districts Association, and with federal representatives, should encourage FEMA to update its eligibility criteria for federal assistance programs so small, rural communities that experience social vulnerability and/or economic disadvantage have equitable access to federal disaster-assistance funding. This includes consideration of regional-based threshold metrics so that residents of large states like California are not unfairly penalized. There may be an opportunity to address this disconnect in building resilience through federal initiatives such as Justice 40,¹⁵ which focuses on Climate and Economic Justice and defines Rio Dell's tract as overburdened and underserved.
- The State of California should consider the implementation of a State Level Individual Assistance Program that can make financial assistance available directly to survivors and individual households when federal aid is not available.
- The State of California and local governments should set expectations ahead of time on what local/state/federal assistance will provide in emergencies. Proactive communication about the criteria for aid are needed to facilitate understanding of why a community may not receive state or federal aid.
- Local governments should identify and contract with key partners that focus on recovery and revitalization specific to the community's needs.
- Local governments should consider implementation of a program/service to assist first responders in addressing damage/repairs to their homes while they are supporting their communities.

¹⁵ <https://www.whitehouse.gov/environmentaljustice/justice40/>

Conclusion

The Ferndale Earthquake Sequence that began in late December 2022 substantially impacted the City of Rio Dell. Significant damages were incurred by the community and challenges were faced in the response and ongoing recovery efforts. The region is likely to experience another significant event because it is within the area of the Mendocino Triple Junction, one of the most seismically active in the state.

Recommendations in this report aim to bolster the preparedness, mitigation, response, and recovery capabilities of Rio Dell and similar communities facing seismic risks. Establishing local emergency action plans and enhancing mental health support services will help communities build resilience and ensure equitable recovery. Proactive measures such as seismic retrofits and community partnerships, will help mitigate the impact of future disasters. A reassessment of eligibility criteria for federal assistance and the creation of a state assistance program that provides individual assistance directly to survivors will better address the post-disaster response and recovery needs of communities experiencing social vulnerability and underservice.

Moving forward, partners at all levels—local, state, and federal—should collaborate effectively and prioritize investments in disaster preparedness and resilience. Heeding the lessons learned from the Ferndale Earthquake Sequence, communities like Rio Dell may better withstand future seismic events and facilitate a more equitable and sustainable recovery process.

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Appendix A: Rio Dell Structural Damage by Damage Type

The four images on the following pages, data provided by the City of Rio Dell Building Division and the Cal OES Safety Assessment Program (SAP), show the number of Rio Dell buildings that were yellow-and red-tagged following the mainshock and subsequent aftershock and the status of repairs.

Image 1: Following the December 20, 2022 mainshock, 117 structures were found damaged.

- 23 buildings were deemed unsafe (red-tagged)
- 94 buildings were mandated restricted use (yellow-tagged)

Image 2: Following the January 1, 2023 aftershock, buildings that were not previously red-tagged were re-examined, including buildings that had been previously yellow-tagged. The total number of damaged buildings nearly tripled to 292.

- 37 red-tagged buildings
- 255 yellow-tagged buildings

Image 3: The total number of tagged structures after the mainshock and aftershock was 409.

- 60 red-tagged buildings
- 349 yellow-tagged buildings

Image 4: As of February 15, 2024, some 14 months after the initial M6.4 earthquake, repairs had been completed and permits closed out on 30 of the 60 red-tagged buildings.

Image 1: Safety Assessment Program Inspections—December 2022

Ferndale EQ (12.20.2022): SAP Inspections

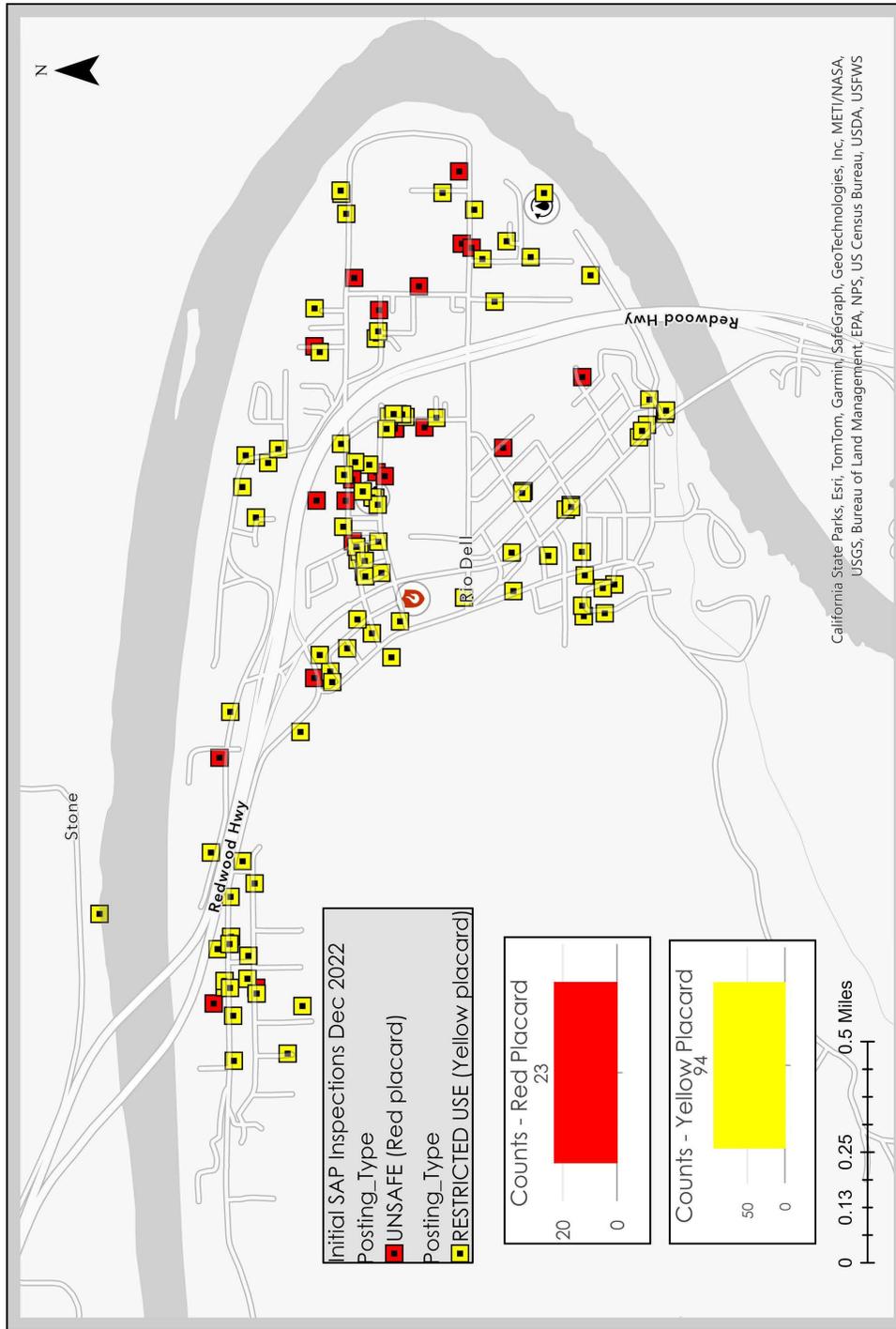


Image 2: Safety Assessment Program Inspections—January 2023

Rio Dell EQ (01.01.2023): SAP Inspections

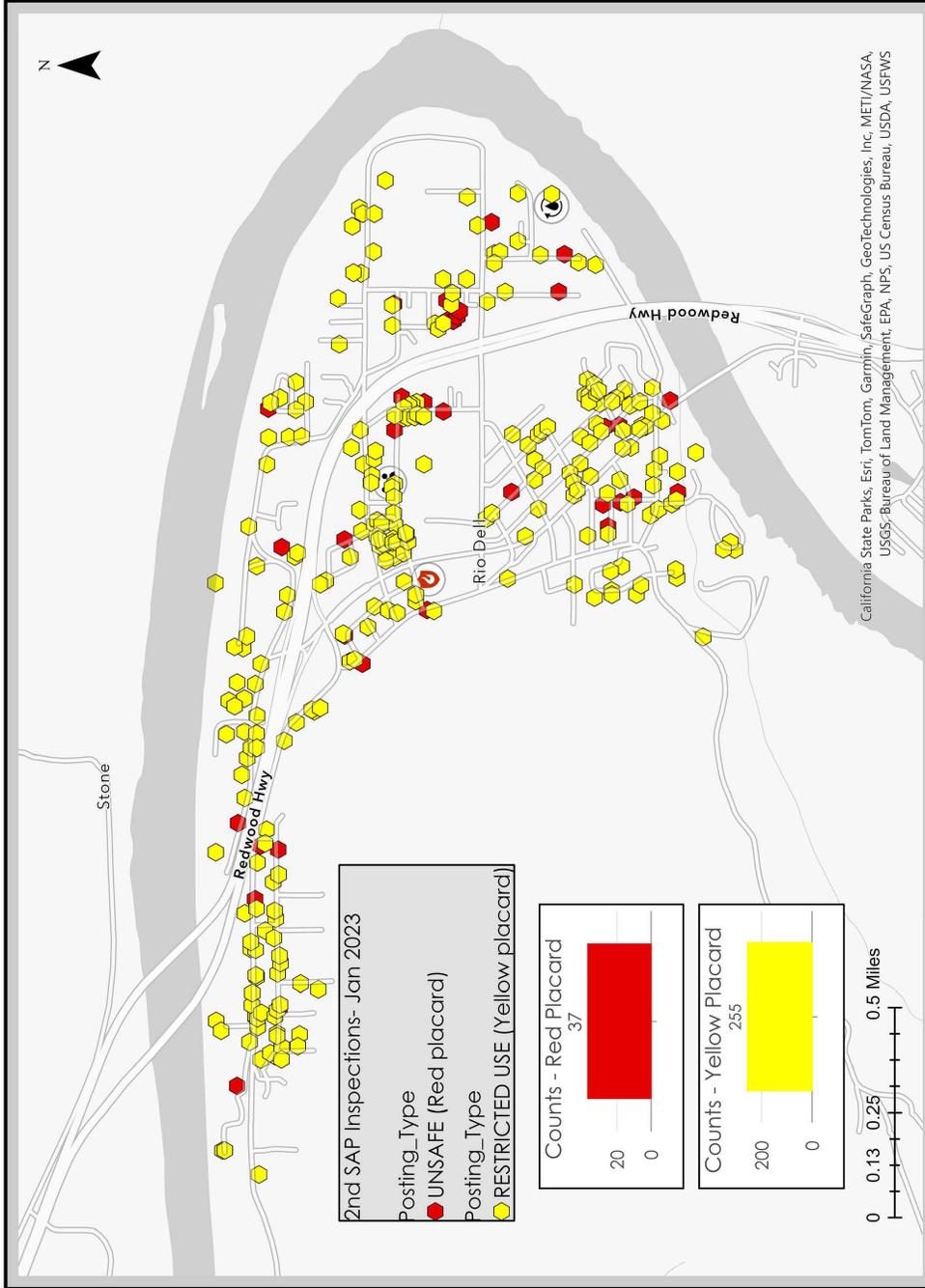


Image 3: Combined SAP Inspections

SAP Inspections for Main shock and Aftershock

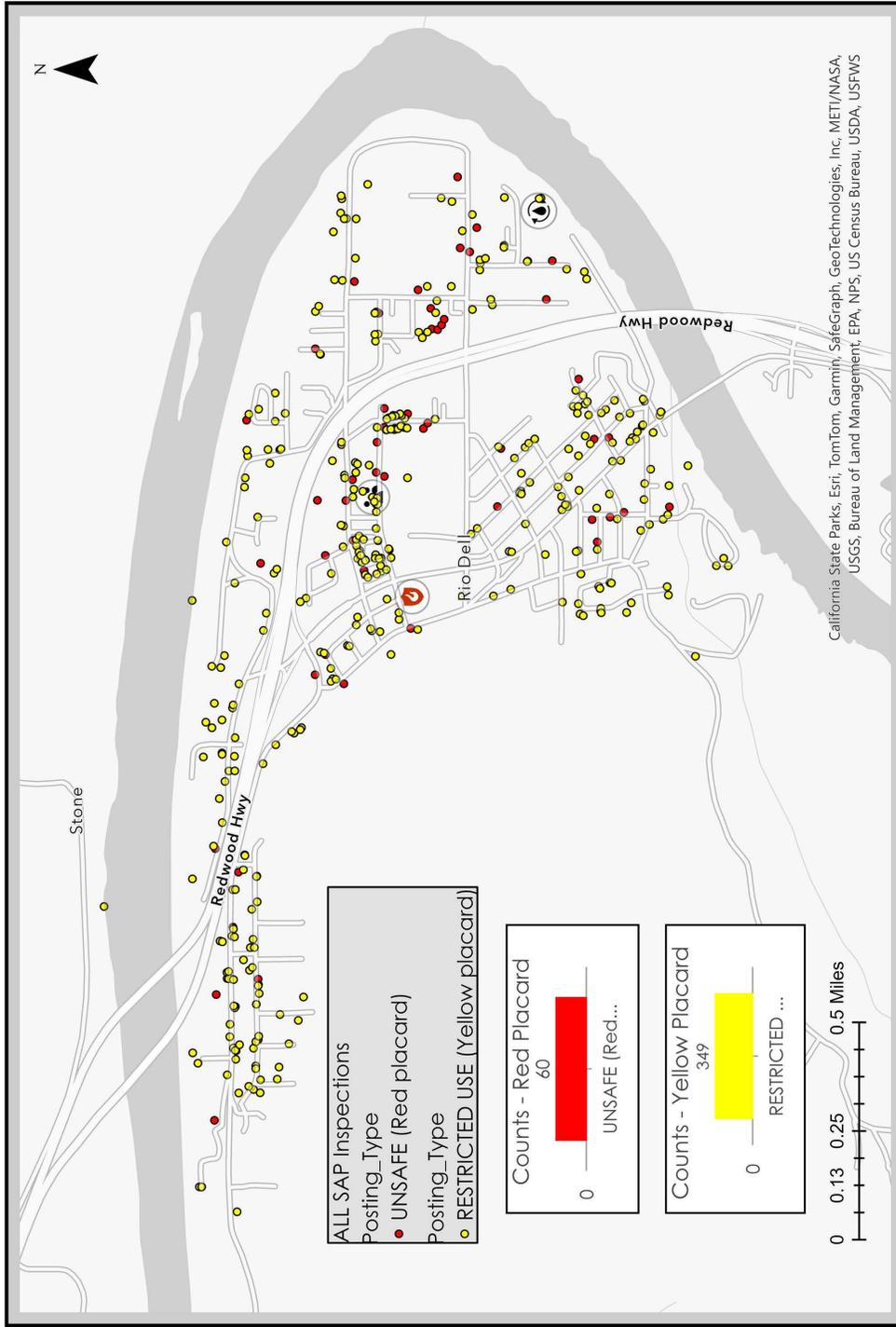
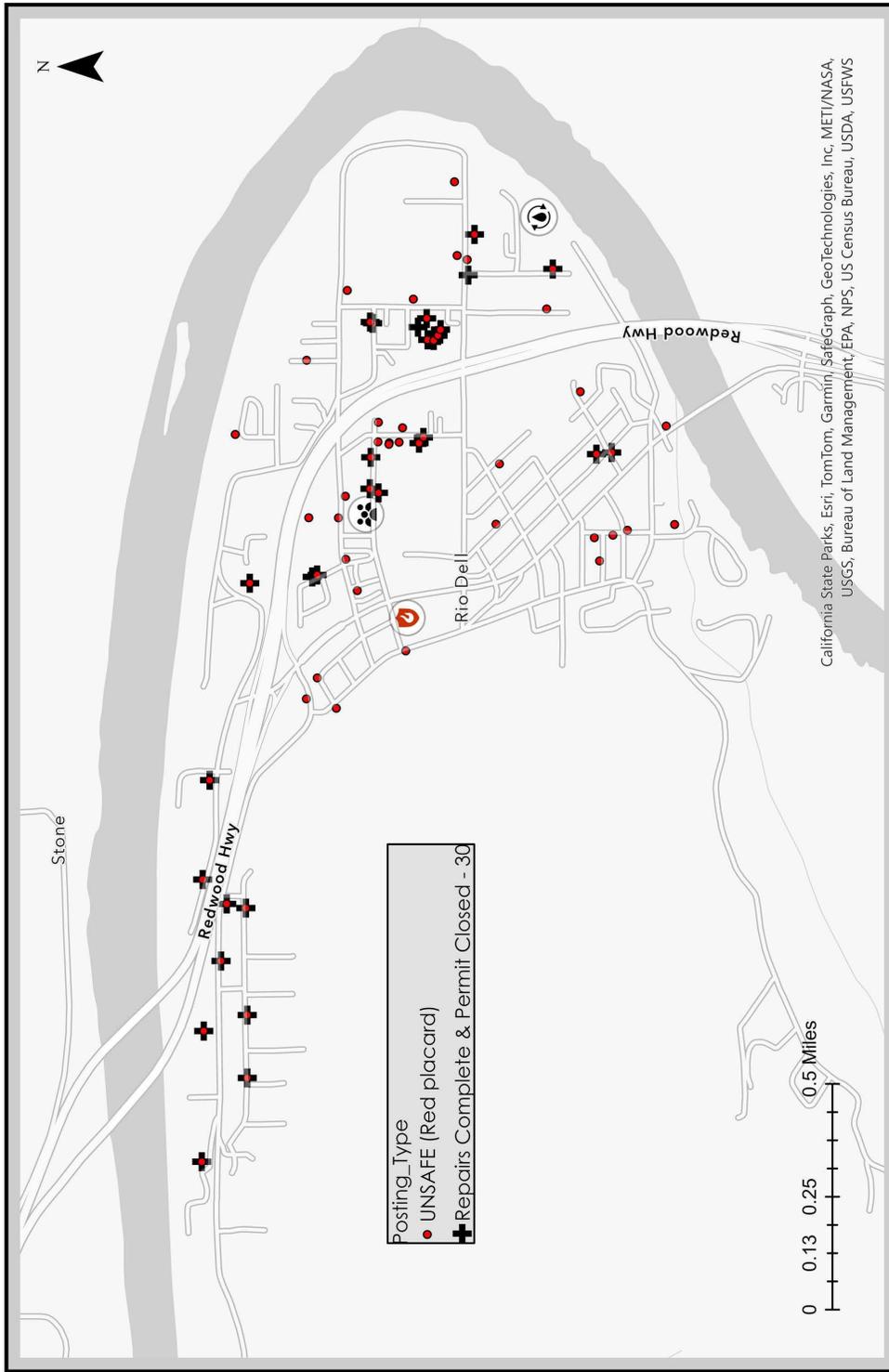


Image 4: Repaired Red-Tagged Buildings as of February 15, 2024

Repaired Red-Tagged Buildings as of 02.15.2024



Please note: This map shows only Red placard tagged buildings (60) where repairs have been completed and permit has been closed (30) for address per Rio Dell Building Division report as of February 15, 2024.

Appendix B: California Disaster Assistance Act Funded Projects

As of February 2024, more than \$3.5 million CDAA Projects had been approved with approximately \$2.1 million funded. More than 60 additional projects including projects from 5 additional applicants were under review.

Applicant	Damage Survey Reports (DSR) Description	DSR Amount	Date Approved
Humboldt County Services District	Emergency Protective Measures	\$33,000	03/23/23
	Damage Investigation	\$ 2,413	04/21/23
City of Ferndale	Community Center Ceiling Tile Replacement	\$52,500	04/06/23
City of Rio Dell	Bottled Water-Toilets-Washing Stations-Shower Trailer & Water Truck	\$ 126,856	03/23/23
	Overtime - Applicant Owned and Operated Equipment - Contract Dumpsters for Debris Removal	\$ 73,126	04/06/23
	Generator Fuel & Contract for Vac Trucks for Sewer Overflow	\$ 15,692	04/06/23
	Building Inspections	\$ 13,311	10/23/23
Humboldt County Sheriff's Office of Emergency Services	Sheltering - Phase I - pending Supplemental DSR	\$ 314,621	06/06/23
	Sheltering Phase II: Supplemental DSR to DSR #4149	\$ 62,476	01/04/24
	Patrol Operations	\$ 18,692	08/22/23
City of Eureka	Lloyd Building (219 5th St, Eureka, CA) Demolition	\$ 1,351,000	10/20/23
Westhaven Community Services District	Water Main Repairs	\$ 6,345	11/06/23
	Emergency Service Road Repair & Donated Resources	\$ 1,915	11/06/23
Total Paid DSRs		\$ 2,071,947	

Appendix C: USDA Rural Disaster Housing Repair Grant

USDA Rural Disaster Housing Repair Grants and Loans



Assistance for Humboldt County,
City of Rio Dell Residents with home damage
as a result of one of the below disasters.



What are USDA Rural Disaster Housing Repair Grants and Loans?

The Rural Development has resources to help rural homeowners affected by 2022 Ferndale Earthquake and/or the 2022/2023 Winter Storms make vital repairs to their homes.

See Website For More Details:
<https://www.rd.usda.gov/programs-services/single-family-housing-programs/single-family-housing-repair-loans-grants/ca>

Disaster Impacted By	Age Restriction	Income Restriction	Relief Amount
Ferndale EQ (Pilot Program FY23)	18+ Years Old	Very Low Income 1-4 Persons \$41,250 5-8 Persons \$54,450	\$40,675 grant + \$40,000 loan
Winter Storms (CY 22 DR4683/EM-3592)	No Age Restriction	Low income 1-4 Persons \$66,000 5-8 Persons \$87,100	\$40,675 grant + \$40,000 loan
Non-Disaster Related 504 Housing Repair	62+ Years Old	Very Low Income 1-4 Persons \$41,250 5-8 Persons \$54,450	\$10,000 grant + \$40,000 loan

*Programs can be combined and applied for simultaneously and combined

Interested homeowners should contact one of the approved packagers below, their case manager, or Rural Development to learn more.

APPROVED PACKAGERS LIST - CA

Habitat for Humanity Yuba/Sutter
familyservices@yubasutterhabitat.org
 530-742-2727, x5
 POC: Patricia Archuleta, Kimberly Eberhardt

Veronica Barrigan
veronica@veronicab.net
 559-351-7646

Imperial Valley Economic Development Corporation (IVEDC)
admin@ivbrc.org
 760-353-8332
 POC: Jaime Robles, Alessandra Muse, Alma Silva

Velma Hernandez
Vhernandez2491@gmail.com
 209-535-0043

Gloria Orta
gloriaorta117@gmail.com
 831-801-1825

Madrid's Team Realty
madridsteam@gmail.com
 559-331-0809 or 559-688-1800
 POC: Amanda Fuentes, Linsey Ledezma, Brandon Madrid or Elizabeth Madrid

Disaster Case Management
707-382-5890

Appendix D: Resources for Communities

1. **World Central Kitchen:** provider of meals in response to humanitarian, climate, and community crises.

https://wck.org/?gad_source=1&gclid=CjwKCAiA+5euBhB9EiwAdkXWO5G7UOwAUC1VPV6VKpsdYBY_6ABx82csj79TW7N9yHWiAcSwkflIRxoCdd4QAvD_BwE

2. **USDA:** The 2023 Consolidated Appropriations Act authorized the USDA Rural Disaster Housing Repair Grant program to provide resources to make essential repairs and improvements to rural homes located in Presidentially declared disaster areas that occurred in calendar year 2022. Even though the Ferndale Earthquake Sequence was not Presidentially declared, eligibility was extended to Humboldt County residents (see Appendix C).

3. **USDA:** Single Family Housing Repair Loans & Grants (Section 504) provides loans to very-low-income homeowners to repair, improve, or modernize their homes or grants to elderly very-low-income homeowners to remove health and safety hazards. This program is open year-round, and eligibility is not related to damage sustained from a disaster.

<https://www.rd.usda.gov/programs-services/single-family-housing-programs/single-family-housing-repair-loans-grants/ca>

4. **Earthquake Brace + Bolt (EBB):** EBB is a grant program designed to help homeowners to seismically retrofit their homes.

<https://www.earthquakebracebolt.com/>

5. **AB 2140:** Authorizes a city, county, or a city and county to adopt within the safety element of its general plan a federally specified local hazard mitigation plan (LHMP) that includes specified elements. Jurisdictions that have not adopted an LMHP as part of its safety element may not receive from the State more than 75 percent of the state's cost share of an eligible California Disaster Assistance Act (CDAA) funded project.

<https://www.caloes.ca.gov/wp-content/uploads/Hazard-Mitigation/Documents/AB-2140-fact-sheet-11.7.2023.pdf>

6. **U.S. Small Business Administration (SBA):** Provides low-interest loans to help businesses and homeowners recover from declared disasters.

<https://www.sba.gov/funding-programs/disaster-assistance>

7. **Community Development Block Grant (CDBG):** The program supports community development activities to build stronger and more resilient communities.

<https://www.hudexchange.info/programs/cdbg/>