3. Coastal Communities

Because the coast will suffer the worst consequences of this inevitable Pacific Northwest catastrophe, we emphasize the following main actions in the next 50 years:

- Protecting lives requires consistent and relentless education and outreach based on up-to-date physical and social science.
- Investing in hazard mitigation is necessary to reduce, relocate, and avoid exposure of vital community assets to tsunami devastation.
- Strengthening of critical facilities in the earthquake-only zone must occur so that they will be available when communities need them most.
- Planning for reconstruction and recovery must be done now to provide a strategic vision for restoring the economy and livability of the Oregon coast.

Introduction

Of the Oregon Resilience Plan's eight task groups, the Coastal Task Group was the only one focused geographically on a single sub-region of the state. This group looked at the resilience of the coastal counties in the face of both the Cascadia earthquake and the resulting tsunami. To facilitate this assessment, the group divided the coastal area into the tsunami zone and the remaining earthquake-only zone. The group also recognized that almost all coastal communities have a necessary relationship with the Pacific Ocean or a connected marine environment, such as a bay or estuary. This proximity not only defines these communities, but is the basis of much of their economies, whether they are dependent on a port, recreation, or tourism. Tourism has the additional effect of bringing large numbers of second-homeowners and visitors to the coast, which means that coastal areas have a variable daily population that equals or exceeds the resident population.

The coastal region's built environment, including roads, bridges, and ports, is nestled into the coastline's natural environments of estuaries, wetlands, headlands, mountains, and beaches. It is this dependent relationship with the Pacific Ocean that creates so much of the inherent vulnerability that we now face with a Cascadia earthquake and tsunami (see Figure 3.1).

All of these communities will be affected by the earthquake. The vulnerabilities of these communities to the tsunami vary, with the northern coastal communities of Cannon Beach, Seaside, and Warrenton having the most concentrated exposure to inundation. The Coastal Task Group focused its attention on land use planning and other social factors and relied on the results and conclusions of the other task groups, which were sector based.

The tsunami creates a greater challenge for coastal communities. It is both more destructive than the earthquake and will make mitigation and reconstruction efforts more difficult. Achieving (within a 50 year timeframe) the goal of restoring 90 percent of service within two to four weeks of the earthquake and tsunami will be a greater challenge for the coast than it will be for the rest of the state.

Figure 3.1: Tsunami Vulnerability: City of Seaside with 83% of its population, 89% of its employees and almost 100% of its critical facilities in the tsunami inundation zone. (Source: Horning Geosciences)

Earthquake and Tsunami Zones

The coastal area covers the majority of the seven coastal counties of Clatsop, Tillamook, Lincoln, Lane, Douglas, Coos, and Curry, reaching up to the summit of the Coast Range. The Coastal Task Group divided the coastal area into two zones: the tsunami inundation zone and the earthquake-only zone. The relationship between these two zones will define the local and regional capacity for resilience in the context of the Cascadia event. The post-disaster welfare of the earthquake-only zone of each community is dependent on which critical and essential facilities are located inside the tsunami inundation zone. Each coastal community's capacity to respond, direct relief efforts, and begin recovery will depend on how much it relies on its tsunami-affected area (see Figure 3.2). Communities that have not successfully relocated or created redundancies for important facilities, such as emergency service facilities, energy and water facilities, and vital businesses, will have a severely diminished response and recovery capacity.

TSUNAMI ZONE

The tsunami zone is defined by inundation mapping, which was produced by the Oregon Department of Geology and Mineral Industries (DOGAMI), primarily based on the earlier mapping defining the state's tsunami inundation line and established by Senate Bill 379 in 1995. DOGAMI is currently finishing up a more accurate tsunami inundation mapping study that will be finished in 2014. Due to its proximity to the fault, the tsunami zone will be subject to among the strongest earthquake motions to be generated during a Cascadia subduction event. It will then be subject to multiple tsunami inundations generated by the earthquake, inundations which will continue for up to 24 hours after the earthquake. The tsunami will further damage buildings, bridges, roads, and utility infrastructure, and will obliterate nearly all wood frame buildings. Even steel and reinforced concrete buildings that survive the earthquake and tsunami may be damaged beyond repair. The existing utilities will be severely damaged or destroyed. The tsunami zone will also have areas of coastal subsidence—places that had been dry land above the tidal zone before the earthquake, but that, having sunk three to six feet during the earthquake, are afterwards inundated daily during high tides or seasonally by variable high tides.

The vulnerability of coastal communities to tsunami hazards varies, with the most concentrated exposure being on the northern Oregon coast (as indicated in Figure 3.3). Within the tsunami inundation zone, practically all of the 22,000 permanent residents—along with an equal or greater number of second-homeowners—who survive the tsunami will be instantly displaced (Wood, 2007). The visitor population presents a great challenge, because visitors tend to congregate in the tsunami inundation zone and have the least knowledge of where and how to evacuate. Moreover, those that survive will put extreme pressure on local relief efforts, which must provide for their initial welfare.

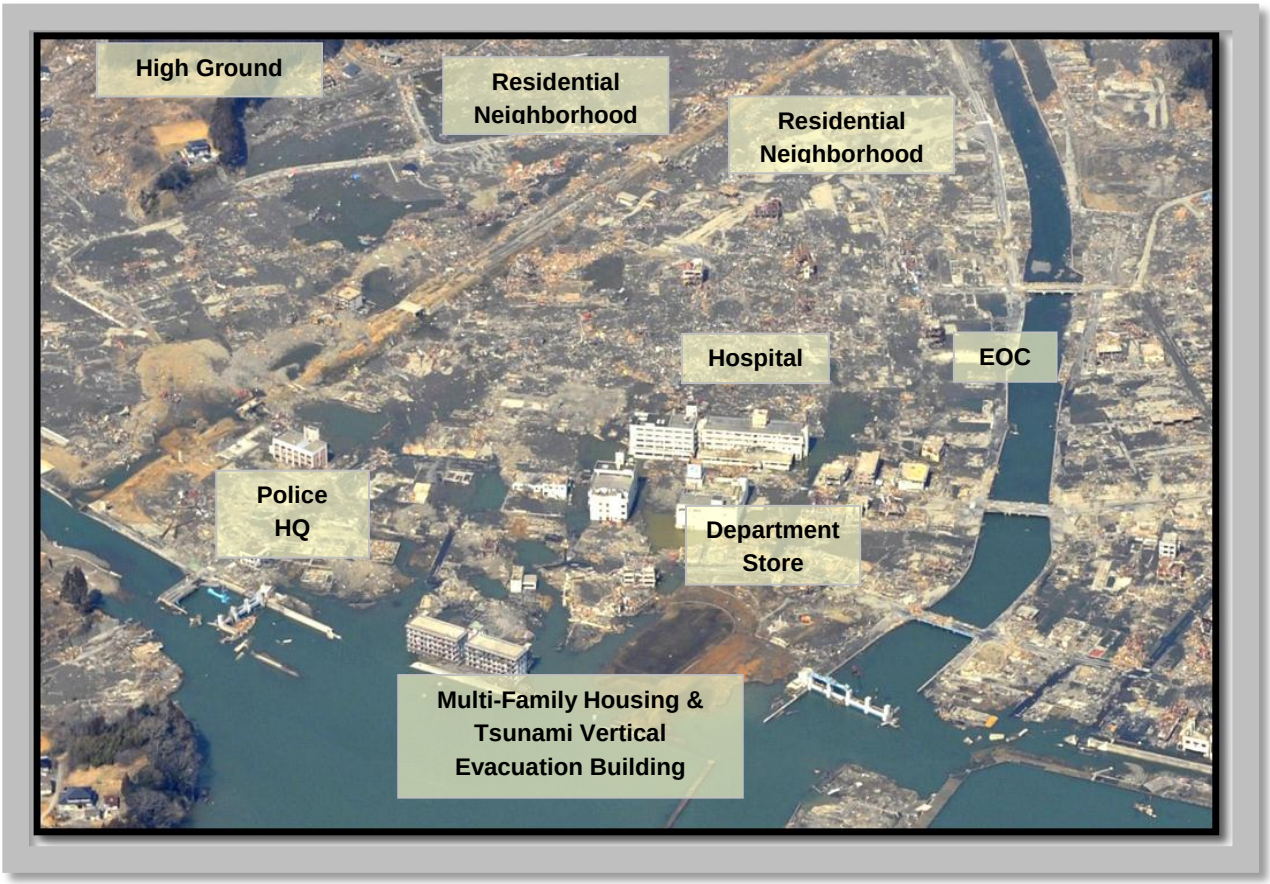
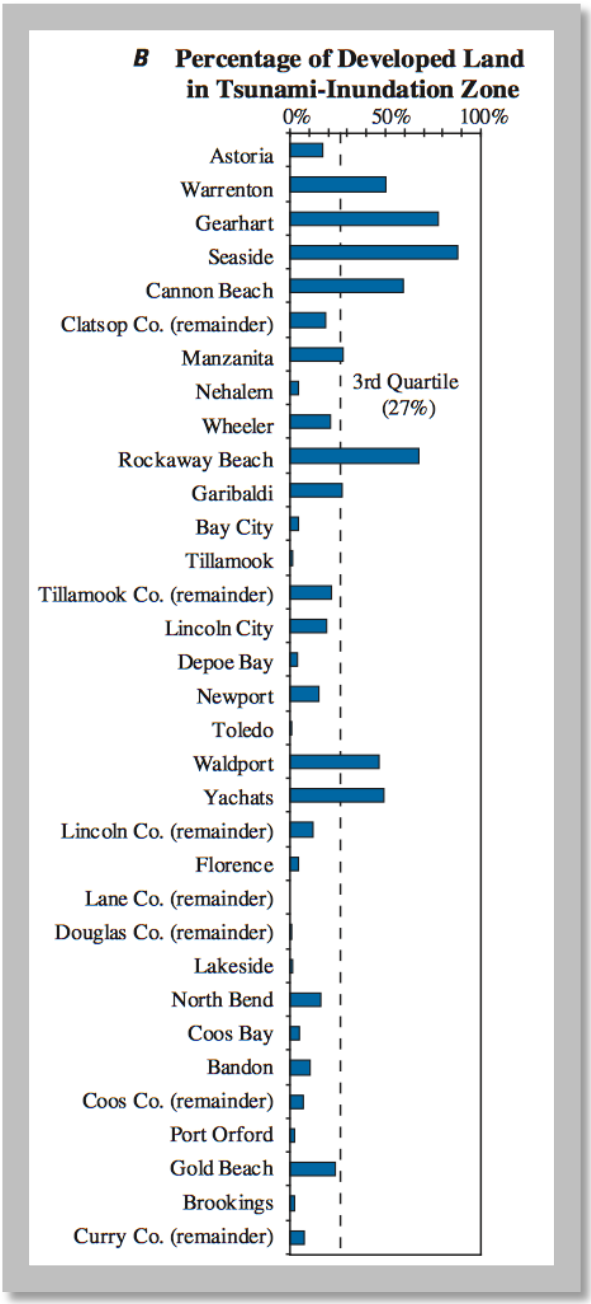


Figure 3.2: Critical Facilities in the Tsunami Zone – Minamisanriku, March 14, 2011. Because their hospital, emergency operation center, and other government and community service facilities were located in the tsunami inundation zone, the surviving community lost nearly all of its capacity to respond and implement recovery efforts. (Source: Asia Air Survey Co., Ltd.)



Numbers in Tsunami Inundation Zone

Residents	22,000
Households	10,000
Percent of coastal counties	4%
Employees	14,800
Businesses	1,800
Percent of coastal counties	6%
Oregon State Parks – Coastal (Annual average daily attendance)	53,700

Figure and numbers from Nate Wood Variations in City Exposure and Sensitivity to Tsunami Hazards in Oregon, USGS 2007

Figure 3.3: Oregon Coast Tsunami Exposure of People and Places. Wood, Nathan: 2007, Variations in City Exposure and Sensitivity to Tsunami Hazards in Oregon. (Source: US Geological Survey)

EARTHQUAKE-ONLY ZONE

The earthquake-only zone is the area outside of the tsunami zone. It includes portions of communities that will have tsunami inundations in their lowland areas, and communities that are completely outside of the inundation zone. Again, the proximity to the fault means that damage to roads and infrastructure from the magnitude 9.0 earthquake scenario will be greater here than in the valley. Minutes of strong ground shaking will concentrate damage in areas subject to ground failures such as liquefaction, lateral spreading, differential settlement, and landslides. The coast and Coast Range are particularly at risk from these effects of the earthquake.

Well-built wood frame buildings will withstand the shaking fairly well. Unreinforced masonry (URM) and under-reinforced concrete buildings will suffer significant damage. Unfortunately, this includes a number of government buildings and essential facilities in the coastal zone. Because subduction zone earthquakes generate long-period seismic waves and because the duration of the shaking is so long, certain structures, such as bridges, may resonate, amplifying shaking impacts.

Following the Cascadia Event

Following the Cascadia event, the coastal communities will be cut off from the rest of state and from each other. The coastal area's transportation system, electrical power transmission and distribution grid, and natural gas service will be fragmented and offline, with long-term setbacks to water and wastewater services. Reliable communications will be similarly affected. Because so many of these connecting systems are single lines with little or no redundancy, any break or damage requiring repair or replacement will compromise the service capacity of the entire line.

The loss of roads and bridges that run north and south will make travel up and down the coast and into the valley difficult, if not impossible, due to the lack of alternate routes in many areas. Reestablishing the roads and utility infrastructure will be a challenge, and the difficulties will be exacerbated in the tsunami inundation area by its more complete destruction. Even businesses outside of the tsunami inundation may not recover from the likely collapse of a tourist-based economy during the phased and complicated recovery and reconstruction period.

Based on the resilience targets provided by the Transportation, Energy, Communications, and Water/Wastewater task groups, current timelines for the restoration of services to 90-percent-operational levels will take a minimum of one to three years, and often over three years in the earthquake-only zone. Restoration in the tsunami zone will take even longer than that (see Figure 3.4). The most critical infrastructure is the road and highway system. Without functioning road systems, none of the infrastructure can be accessed to begin repairs.

The tsunami will also create an enormous amount of debris that needs to be gathered, sorted, and managed. The recent experience of Japan, with a similar mountainous coastline, has shown that debris management competes with shelter and reconstruction needs for the same flat land that is often in the inundation zone.

Figure 3.4: Hurricane Katrina Storm Surge – Electric Facility. Replacement of coastal power infrastructure based on 2012 capabilities may take one to three years for the Earthquake-only zone. (Source: FEMA.gov)

PREPAREDNESS AND POST DISASTER RELIEF

Emergency preparedness education and training helps people react appropriately during a disaster. Preparedness can also provide the foundation for initial disaster relief efforts at the personal, household, and community levels. Surviving the earthquake and then evacuating the tsunami zone is just the beginning of achieving life safety in the following hours, days, and even weeks (see Figure 3.5). Properly anticipating and managing relief efforts will have a significant impact on resilience.

Relief efforts need to consider other populations in addition to residents. The coast attracts a large number of second-homeowners and visitors. Data from the 2007 United States Geological Survey (USGS) study by Wood (2007) showed that the resident population in the coast's tsunami inundation area numbered around 22,000. Not included in this count was the population of second-homeowners and visitors, which in many coastal communities equals or exceeds the number of full-time residents. To arrive at a general estimate of the number of visitors to the coast, Wood looked at the number of visitors to Oregon's coastal state parks and found that the annual average daily attendance is 53,700 people. This is more than double the number of permanent residents at risk, and it does not include hotel visitors. The visiting population is generally located in the tsunami inundation zone and typically has low levels of knowledge about tsunami hazards and evacuation routes. The large population of visitors will also be difficult to house and feed adequately following the earthquake and tsunami. An essential task during the relief period will be transporting these people from the coastal areas to their own homes or to shelters further inland. Reducing the loss of life among residents and visitors is critical to insuring that people will come back to help with reconstruction and recovery.

Recommendations

► **Improve earthquake/tsunami education efforts.**

- Teach an earthquake/tsunami curriculum to Oregon's school children.
- Provide information about Cascadia earthquakes and tsunami in all hotels, motels, and short-term rentals. This should include information about tsunami evacuation routes.
- Require that all businesses over a certain size and located in tsunami inundation zones have tsunami evacuation plans.

► **Improve tsunami evacuation efforts.**

- Create tsunami evacuation modeling for each coastal community as a base level to estimate the likely fatality level. Models can be used to test improvements in evacuation measures and determine whether the improvements will reduce fatality levels.
- Improve tsunami evacuation measures by further developing existing evacuation routes, creating new evacuation routes, bettering education and signage about evacuation routes, and creating vertical evacuation structures or buildings.

► **Improve relief efforts to account for residents in the tsunami inundation areas and the visitor population.**

- Develop plans to provide shelter, water, and food for residents and visitors.
- Develop plans for getting visitors back to their own homes.

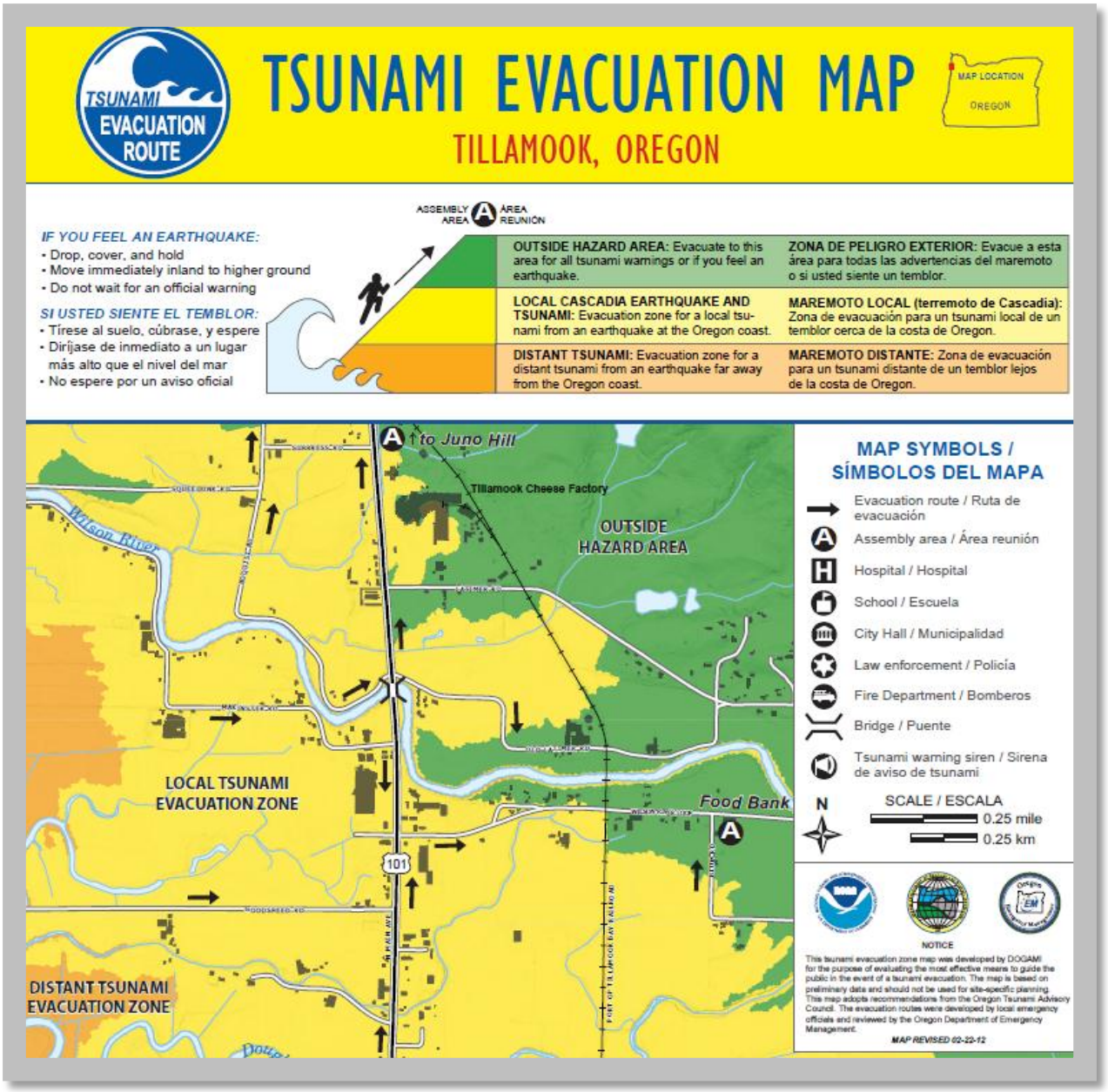


Figure 3.5: Tsunami Evacuation Map for the City of Tillamook, Oregon. (Source: Oregon Department of Geology and Mineral Industries, 2012)

Coastal Zone Targets

The goal for the coastal zone—like that of the other zones of the state—is 90-percent recovery in a two- to four-week period. This goal is based on the amount of stress businesses can take before they go out of business or relocate. While this goal should be the target for all of Oregon, it will be difficult to achieve in both the tsunami zone and the earthquake-only zone of the coast, with the tsunami zone presenting particularly significant obstacles. Consequently, it will likely either take longer to achieve this goal on the coast than it will in the other regions of the state, or it will require the application of substantial resources. Some coastal communities will have to reconstruct their economic districts—either substantially or completely. Alternate strategies need to be considered, and the expectations of coastal residents and businesses must be addressed with the realities of the state of preparedness.

PROTECTING BUILDINGS AND INFRASTRUCTURE

The first obstacle is the anticipated level of destruction of buildings and infrastructure within the tsunami zone. The solutions to protecting them include:

- Creating tsunami resistant seawalls. This solution has been tried in Japan, and it works provided that the wall is designed for the earthquake/tsunami that actually occurs. The failure of these structures in the 2011 Tohoku earthquake and tsunami was primarily due to their having been designed for a smaller event. They are very costly and would cut off the communities from the ocean, disrupting the main economic basis of many coastal communities. Moreover, this solution does not address such things as port facilities, which need direct access to the ocean.
- Constructing tsunami resistant buildings and infrastructure. This type of solution is typically used for port facilities, roads and bridges, and other essential buildings or infrastructure. It is very expensive and would be done in critical cases where other options do not exist. This solution does not address existing buildings and infrastructure.
- Relocating. While it is theoretically possible to relocate communities, in reality this rarely happens, even following major earthquakes and tsunamis. A more likely scenario is relocating essential buildings and functions outside of the tsunami zone as a mitigation strategy. In this way, police stations, fire stations, government offices, hospitals, public works, and similar critical facilities can, over time, be shifted outside of the tsunami zone. In addition, some thought can be given to the relocation of businesses and residences.

As Wood's study shows, the vulnerabilities of communities within the tsunami zone vary, so the solutions must vary accordingly (Wood 2007). Mitigation proposals should be developed that include actual mitigation projects—such as relocation—as well as more land-use related solutions that look at rebuilding communities after the earthquake and tsunami so that they are tsunami-ready for future events.

The target goal in earthquake-only areas of the coast also presents challenges. First, much of the essential infrastructure runs through both the tsunami zone and the non-tsunami earthquake zone.

Second, the geology of the coast means that there will be high levels of damage to these systems. Because these areas are lightly populated compared to the urban areas of the valley, strengthening them will tend to be a lower priority (from an economic standpoint) than projects that target the valley.

Recommendations

- **Use relocation strategies to meet target goals on a community basis as part of overall mitigation planning.**
- **Use tsunami resistant buildings as vertical evacuation structures to insure the safety of people in the inundation zone where other options are limited.**
- **Use tsunami resistant infrastructure for critical transportation, port facilities, and utilities.**
- **Ensure that critical transportation links to the valley and along the coast survive the earthquake so that coastal communities are not cut off from relief and recovery efforts.**

Government/Essential Facility Continuity

Given the high level of destruction in the tsunami zone, it is important that government buildings, essential facilities, and schools continue in operation following the earthquake and tsunami. Experience from the Tohoku earthquake/tsunami in Japan and other natural disasters in the U.S. and other countries has shown that where government continuity has been disrupted, post-disaster recovery times have been greatly increased. In addition to continuity of governments within the coastal zones, the capacity to communicate with state government offices must be firmly established.

Recommendations

- **Upgrade, or replace with buildings that meet or exceed current seismic codes, all government buildings, schools, and essential facilities located in the earthquake-only zone.**
- **Make all government buildings, schools, and essential facilities located within tsunami zones more resilient by adopting one of the following strategies:**
  - Relocate the facility outside of the tsunami zone.
  - Build the facility with reinforced concrete to resist tsunami loads. (If such a strategy is adopted, consider using the facility as a tsunami vertical evacuation refuge (TVER).

- Upgrade the facility to meet seismic life-safety standards, and create a backup facility outside of the tsunami zone.

Land Use

This resilience planning effort encourages a comprehensive, risk-based approach to reducing exposure and vulnerability to all natural hazards that potentially affect our coastal communities. Options and recommendations within this section should be helpful in assisting communities move forward in these important efforts. However, if a community needs to relocate a specific facility (for example, a hospital, fire station, police station, emergency response center, or school) in the short term to reduce tsunami risk, then utilizing a more strategic approach may be necessary and appropriate.

The need for pre-disaster relocation of government buildings, schools, and essential facilities has the potential to raise land-use issues. In some communities, such as Cannon Beach and Seaside, existing business areas may become part of new tidal zones after a Cascadia subduction earthquake as a result of subsidence. In some situations, such as the Seaside School District's relocation effort, sufficient existing land is not available inside the urban growth boundary for relocation, so it is necessary to collaborate with stakeholders to look at other appropriate sites. In other cases, such as the Waldport High School project, relocation can be accommodated within the existing urban growth boundary. In the Waldport case, it was necessary to maintain the vacated site as open space due to the requirements of FEMA funding, which assisted substantially in the relocation effort. FEMA funding can be very helpful in the development and implementation of community relocation strategies; however, there are situations in which these funds are not available or maintaining vacated sites as open space is not workable for a community. In these cases, transitioning to a more resilient community may dictate that the vacated site not be removed from the community's tax base, but instead be considered for (and used to help fund) the development of low-risk uses or uses which include appropriate and adequate protection or mitigation for seismic and tsunami risks.

The economies of most coastal communities are based on their proximity to the ocean. Ports, by their very nature, will always be in tsunami zones. Similarly, towns such as Cannon Beach and Seaside exist due to their close proximity to the ocean. Rethinking how ports can return and tourism can rebound following a Cascadia event will require an inspired strategy on the part of coastal communities and the state. (It should be noted that Oregon's coastal ports were built to support fishing and logging, and in many places, these industries are no longer the economic motors they were when the port facilities were built.) In addition, future development within the tsunami zone should seek to reduce risk. One hopeful sign is that 50 percent of growth since 2000 and 2010 census in coastal communities has been outside the tsunami zone (Personal communication with Wood, 2012).

SENATE BILL 379 TSUNAMI INUNDATION ZONE

In the mid 1990's, Senate Bill 379 directed the Department of Geology and Mineral Industries (DOGAMI) and its board to adopt a tsunami inundation line, and established requirements and restrictions for

certain development within the identified inundation zone. These requirements are found within ORS 455.446-447 and are administered within the Oregon Building Code. DOGAMI is currently remapping the Oregon coast for tsunami hazards. This new analysis is more comprehensive and uses updated methodology developed as a result of analysis of recent tsunami events and further Cascadia earthquake and tsunami research. The DOGAMI Board will soon review this new work to determine how this information should be used for purposes of administering the development restrictions of ORS 455.446-447. This updated mapping, and associated requirements as indicated, will be important considerations for local governments' comprehensive planning efforts and the development of implementation measures as required by Oregon Statewide Planning Goal 7, 17 and 18 (see http://www.oregon.gov/lcd/pages/goals.aspx for details).

OREGON DEPARTMENT OF LAND CONSERVATION AND DEVELOPMENT (DLCD) AND ITS COASTAL MANAGEMENT PROGRAM (OCMP)

Statewide Planning Goal 7 requires local governments to adopt comprehensive plans (inventories, policies, and implementing measures) to reduce risk to people and property from natural hazards and to address concerns about life safety, lifelines, economic viability, and infrastructure. Natural hazards include earthquakes and related hazards, tsunamis, and coastal erosion. DLCD is the agency charged with the responsibility of assisting local governments and local communities in addressing and planning for these hazards.

DLCD is charged with working with DOGAMI and local governments to address the implications of the updated tsunami inundation zone mapping for community development and comprehensive planning. This includes assisting local governments to develop adequate adaptation planning responses in anticipation of a major tsunami event. As part of this effort, DLCD has clarified specific policies that identify the tools that communities can use when adjustments to urban growth boundaries are required, or comprehensive long-term resilience planning is needed. These include:

- Urban growth boundary adjustments to address tsunami risk. Urban growth boundary expansions may be needed to allow for relocation of some community facilities due to tsunami hazard risks—if land is not suitable within the boundary. These would be strategic measures for a single purpose and would be subject to existing urban growth boundary requirements.
- Urban reserves. Communities may use a more comprehensive risk-based approach to reducing exposure and vulnerability to all natural hazards that may affect a community. This approach would be a longer-term effort and would help in situations where land-use zones would no longer be tenable or desirable following the event. Urban reserve work could include planning areas outside the urban growth boundary in preparation for pre- and post-disaster land-use efforts. This comprehensive approach could also help define what associated rezoning efforts would be needed inside the urban growth boundary.
- Community land use tsunami preparation. DLCD has placed a priority on supporting community land use tsunami preparation and on providing tools to help communities become more

resilient to this catastrophic hazard. In order to provide this assistance, the DLCD will partner with a qualified consultant to develop an array of best practices and tools which are tailored to the comprehensive plans of coastal local governments and statewide planning goals. This work will require comprehensive research, creative thinking, and compilation of an extensive set of resilience options, including a range of both land use incentive and regulation tools. This effort anticipates the development of a set of comprehensive tsunami resilience tools, which include such things as a tsunami hazard overlay zone and other land use related tsunami resilience provisions.

Recommendations

- **Encourage coastal communities to adopt the latest version of tsunami maps and analysis and to include these within local comprehensive plans.**
- **Work with local communities to develop comprehensive plans and policies related to becoming more resilient to tsunamis; such plans and polices should direct and authorize associated implementation actions.**
- **Encourage communities to develop a tsunami hazard overlay zone and other tsunami resilience provisions related to land use, which could be adopted and used within local land use codes.**
  - The code language could include options for incentives, requirements, and best practices for assisting communities to become more resilient to tsunamis.
  - Guidance materials could include options such as incentives and regulations related to allowed uses in inundation zone areas, tsunami evacuation route requirements, use requirements for vacated areas, and mitigation measures for development within inundation areas.
- **Support local government consideration of ORS 455.446-447 requirements (as potentially amended) for minimum requirements within local comprehensive plans and implementing ordinances.**
- **Support local government efforts to apply best practices and the tools developed by the Oregon Department of Land Conservation and Development (DLCD), when revising coastal communities' comprehensive plans to increase resilience to Cascadia type events.**
- **Support local governments as they review their respective urban growth boundaries to identify key community facilities which may need to be relocated to address substantial tsunami risk. Work with communities to develop local land use policies and strategies to address future relocation of these facilities.**
- **Encourage communities to consider strategies to increase the tsunami resilience of those parts of the community that cannot be relocated.**

- These strategies could include such things as the development of structures of such size and bulk that, if appropriate for the area, a vertical evacuation structure could be included as the top component.
- These strategies may need to include revision of zoning codes to allow suitable building height provisions for these structures.

Reconstruction

LARGE-SCALE DEBRIS REMOVAL

Requirements and plans for the removal of debris must be developed on a county and community level per discussion with U.S. Army Corps of Engineers before the Cascadia event. Given the terrain of the Oregon coast, available land for such purposes will be at a premium, and the need to dispose of debris may conflict with other vital needs during relief and recovery efforts. Moreover, both the debris and its removal will have long-lasting environmental impacts. Planning for recycling and reuse of this debris must be put into place before the event to reduce landfill and environmental impacts.

The U.S. Army Corps of Engineers has indicated that local governments should identify land for response and recovery efforts as part of their planning work *before* a Cascadia subduction zone event. This essential planning will expedite debris removal activities after the earthquake and tsunami. In addition, a viable transportation system must be put in place in order for the Corps of Engineers to get the necessary heavy equipment into place. Local jurisdictions can facilitate this effort by making arrangements in advance with existing local heavy equipment operators. These plans need to include both staging areas for the heavy equipment and areas for collection and sorting of the debris.

It should be noted that there are no landfill areas on the coast, and the local transfer station areas will be quickly overloaded following the event.

Recommendations

- ► **Develop and implement debris management programs for the recovery period following a Cascadia subduction zone earthquake and tsunami.**
- ► **Look at alternative strategies to reduce environmental impacts of debris for coastal communities.**
- ► **Develop a tool box of creative methods to recycle and reuse debris.**

COASTAL ECONOMIC RESILIENCE

Tourism

The impact of the earthquake and tsunami on coastal businesses will be severe and long-lasting. The impact on tourism will be felt with the loss of substantial numbers of buildings and businesses. Even those that remain will not have basic services, and the road system will be down, so that even if these services could be provided locally, there would be no way for visitors to travel into the area. The state park system will be damaged, and there will be changes in the beaches and estuaries as the tides re-equilibrate to the subsidence along the coast. Recreational opportunities will become limited. In addition, the positive image that people have of the Oregon coast will be damaged if there are widespread fatalities.

Plans should be developed for reestablishing tourism following the disaster (Figure 3.6). These arrangements should include coordinated recovery plans to provide an adequate workforce so that the number of visitors will not put a strain on the surviving infrastructure. Following the disaster, visitors must be protected and provided for in such a way that they understand that the coastal communities did all they could to assist them and that this understanding leads visitors to feel an attachment to the coastal communities and a desire to help them rebuild.

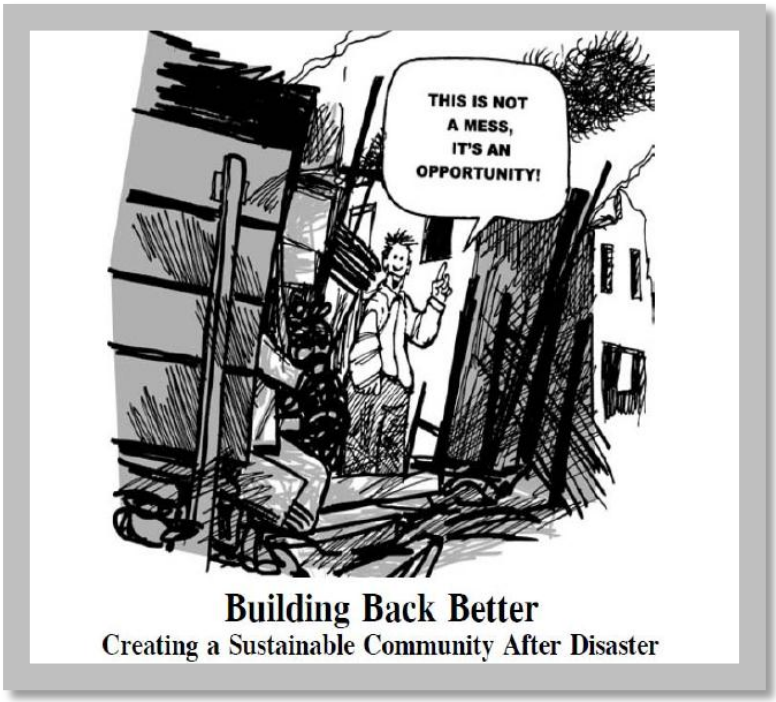


Figure 3.6: Building Back Better
(Source: www.colorado.edu/hazards)

Other Industries

- The logging industry will sustain major damage to its logging road system and will have difficulty transporting its products to market.
- The ports will sustain major damage so that goods and services will not be able to enter or leave until the ports are repaired.
- The fishing fleets may be severely damaged if they are in port when the tsunami arrives.

The Local Population

Even businesses that are not involved in tourism will be impacted by the loss of residents from the tsunami zones; and residents in earthquake-only zones will be forced to leave the area due to loss of jobs and loss of access to schools and medical facilities (see Figure 3.7). Many of the retirees who bring substantial money into the coastal communities may opt to relocate out of the area, putting further strain on coastal communities. The loss of the workforce will make it difficult for the businesses that remain to find sufficient help. For governments seeking to replace damaged infrastructure, the resulting reduction in the tax base will make recovery efforts more difficult. This problem will also hamper the efforts of the utilities providers, as demand for services will substantially decrease.

Recommendations

- ► **Require the state to do an assessment to determine an accurate level of coastal business operation following the Cascadia subduction zone event as a base case for recovery efforts.**
- ► **Require the Oregon Tourism Commission to work with the coastal hospitality industry and communities to develop plans for taking care of visitors following the Cascadia event and plan strategies for rebuilding the tourism industry after the event.**
- ► **Modify the use of room taxes to develop funding for mitigation efforts directly related to the evacuation of visitors to high ground, the provision of relief for visitors, and the development of mitigation and post-disaster recovery efforts. This could also include the creation of emergency funds.**
- ► **Develop economic incentives for recycling/reuse of post-disaster debris.**
- ► **Develop re-insurance or group insurance for the coastal zone to provide lower cost insurance to help with recovery efforts.**

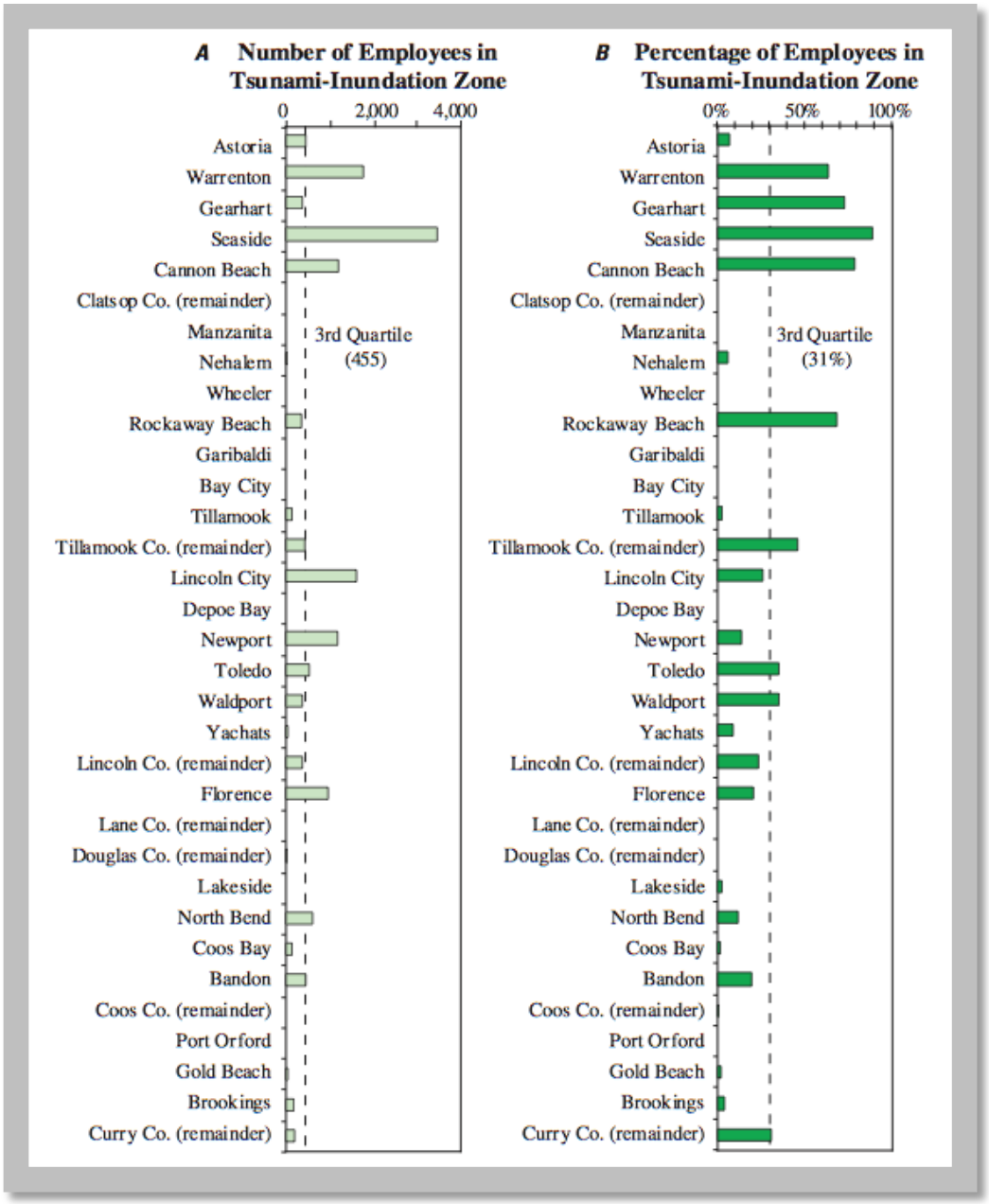


Figure 3.7: Number and Percentage of Employees in the Tsunami Inundation Zone. Wood, Nathan: 2007, Variations in City Exposure and Sensitivity to Tsunami Hazards in Oregon. (Source: US Geological Survey)

Disaster Resilience and Sustainability

Mitigation will be a primary tool in the creation of disaster resilience within Oregon's coastal areas. Solutions that are currently thought of as *sustainable development* should be studied as part of these mitigation and post-disaster recovery plans (see Figure 3.8). One of the main reasons that Japan and Chile got back up and running from their most recent earthquakes (i.e., the 2010 M8.8 Maule Earthquake and the 2011 M9.0 Tohoku Earthquake) was that they have redundant service systems. Sustainable solutions can help provide this redundancy. Given the expected problems of energy delivery following a Cascadia event, coastal communities should explore alternatives to the statewide utility grid and, to the extent possible, work towards greater self-sufficiency. Current localized energy generation options include:

- Wave, wind, and solar as models for economic growth, improved emergency self-reliance, and less dependency on a tourism-based economy.
- The proposed energy generation plant, if it is accepted, for a Coos Bay LNG facility. This plant could have value after a Cascadia subduction zone event if it is located outside of the tsunami zone.
- Investment early in infrastructure redundancy and alternative local sources of energy for areas that will someday need to be rebuilt and relocated due to catastrophic earthquake and tsunami damage. Such investment can have dual benefits: minimizing disaster-related downtime and encouraging sustainable community development. *(Example:* The Smart Grid concept http://www.smartgrid.gov/ to invest in alternative local/regional electricity generation and distribution.)

Figure 3.8: Disaster Resilience is a Critical Component of Community Sustainability. (Source: Public Entity Risk Institute)

HAZARD MITIGATION: PRE-DISASTER RISK REDUCTION

Natural hazard mitigation plans are required at the state, county, and city levels in order for these jurisdictions to be eligible for post-disaster FEMA grants. These plans acknowledge local and regional natural hazards and assess the related vulnerability of the community to determine the community's acceptable level of risk.

A tiered approach to mitigation should be developed:

- Top tier mitigation efforts should prioritize strengthening life-safety capacity during a worst-case-scenario event. Examples include finishing all mapping, hardening evacuation routes, increasing capacity to aid visitors, improving consistent signage, designating earthquake-resistant shelters, and stocking community emergency provisions sufficient to last for one month. This would also include strengthening existing critical facilities that are already outside of the tsunami zone.
- Tier two mitigation efforts should be to relocate critical infrastructure outside of the tsunami zone so that it is operational or repairable immediately following a Cascadia subduction zone event and is therefore able to provide emergency services (rather than being destroyed, abandoned, and useless).

Coastal hazard mitigation plans should have action items that are specific to a Cascadia subduction zone event. Such action items should call for prioritized mitigation projects to improve life safety and avoid damage or reduce exposure from the tsunami and earthquake.

PLANNING FOR RECONSTRUCTION AND RECOVERY

For legacy facilities that are too problematic to relocate, such as electric substations or wastewater treatment plants, pre-disaster recovery planning will allow community decision makers to outline goals, objectives, and strategies for realizing the more resilient and sustainable public and private sector arrangements that are to be implemented during post-disaster long-term recovery. There has been some concern expressed by utility providers about how these improvements will impact ratepayers.

Economic resilience must really address the number of local businesses that are located in the tsunami zone and the extent to which these businesses depend on services that are in (or move through) the tsunami zone. The tourism-based businesses that survive may have reduced demand following the Cascadia subduction zone event, but lodging, food, and commercial businesses can provide invaluable benefits to their communities by maintaining the capacity to operate.

Example: Timebank Concept from Lyttelton, New Zealand. *This isolated coastal community is using a concept they started called Timebank as a way to barter professional, skilled, and volunteer services to do earthquake recovery for community projects. This is a great model (at the small-community scale) for sharing the community's internal resources and a very practical model for Oregon's highly self-reliant coastal communities, especially those with a strong sense of place. (http://www.lyttelton.net.nz/earthquake/lyttelton-timebank)*

Recovery planning now is really about rebuilding for the *subsequent* Cascadia subduction zone event. While it may not provide any risk-reduction benefits now, it will substantially minimize uncertainty, deliberation, conflict, and delay by getting a very complicated and bureaucratic process moving forward in accordance with whatever vision the community adopts. The great importance of this recovery visioning process was revealed during a tsunami recovery workshop at Cannon Beach in 2006 (see http://csc.uoregon.edu/opdr/recovery/cannonbeachpilot). Coos, Curry, Douglas and Lane counties have already participated in a recovery planning process for southwestern Oregon. This process was facilitated by the Oregon Partnership for Disaster Resilience and funded by FEMA.

Having witnessed other subduction zone events during the past eight years (2004 Indian Ocean, 2009 American Samoa, 2010 Chile, and 2011 Japan)—events that are similar to what is expected from a Cascadia subduction zone earthquake and tsunami—Oregon's coastal communities are taking stronger steps towards planning for this inevitability. With the imperative of the Oregon Resilience Plan, it is critical that limited federal, state, and local capital be wisely invested in a manner that looks forward to sustainable objectives, with an emphasis on local resources, rather than doubling down on older systems that have heavy dependencies on services delivered from out of the area.

Relief and Resilience Ratings

The initial analysis of the current state of preparedness that was done to establish baselines for resilience targets has confirmed that our levels of preparedness are low (see Figure 3.9). This analysis has also revealed the timeframes within which people in Oregon can expect relief efforts to reach them following a Cascadia subduction zone earthquake and tsunami. Relief efforts of any size will clearly need to come from outside of the area, but the transportation systems—whether travel is by highway, air, or sea—are expected to be severely impacted. The difficulties associated with delivering aid are most acute for the coastal zone, but they could also be an issue for rural areas in the valley.

Information about the likely timeframes involved in delivering aid should be disseminated to citizens and communities to allow them to plan accordingly. The standard recommendation is for people to prepare to be self-sufficient for 72 hours following a natural disaster of this kind. This standard should be raised (see Figures 3.10 and 3.11). In the tsunami zone, preparation involves evacuating to high ground. Because homes and businesses will be lost, the preparation of residents also needs to include survival kits containing some sort of shelter (protection from the elements), food and water, and any other items that the individual will need while living in temporary shelters, whether located on the coast or in other areas). Visitors in the tsunami zone will not have made these preparations and will be relying on the help of residents and communities. People in the earthquake-only zone are expected to fare better, because they will likely still have their homes—although a certain percentage of those homes will be so damaged by the earthquake that they can no longer be occupied.

Coastal communities are beginning to make preparations. For example, several communities are creating stockpiles of emergency supplies outside of the tsunami zone. Communities and citizens need

some level of transparency in order to keep track of their own level of preparation for emergency response and progress towards achieving resilience.

Recommendations

► **Adopt a two-tiered rating system that gives (1) the number of hours/days that a citizen in a community can expect to wait before major relief arrives and (2) the number of days/months that a citizen can expect to wait before the community itself achieves 90-percent restoration of roads and services.**

- The rating system should adopt the zones established by the resilience report: tsunami zone, coastal earthquake-only zone, valley zone, and eastern zone.
- Standards and methodology must be developed to ensure that the rating system is consistent.
- Communities and counties should use these standards and methodology to develop standards for cities and unincorporated areas.

The goal of this two-tiered rating system is to provide information at any given time about what citizens should expect, and to serve both as the basis for a community's resilience targets and as a means of measuring how close the community is to meeting them. Because the resilience report sets a 50-year target for achieving statewide resilience, a mechanism is needed to track progress and provide pressure to meet the target.

	RELIEF	RESILIENCE
Eastern	72 hours	1 to 3 years
Valley	72 hours	1 to 3 years
Coast (Earthquake Only)	1-2 Weeks	3 years +
Tsunami Zone	1-2 Weeks	3 years +

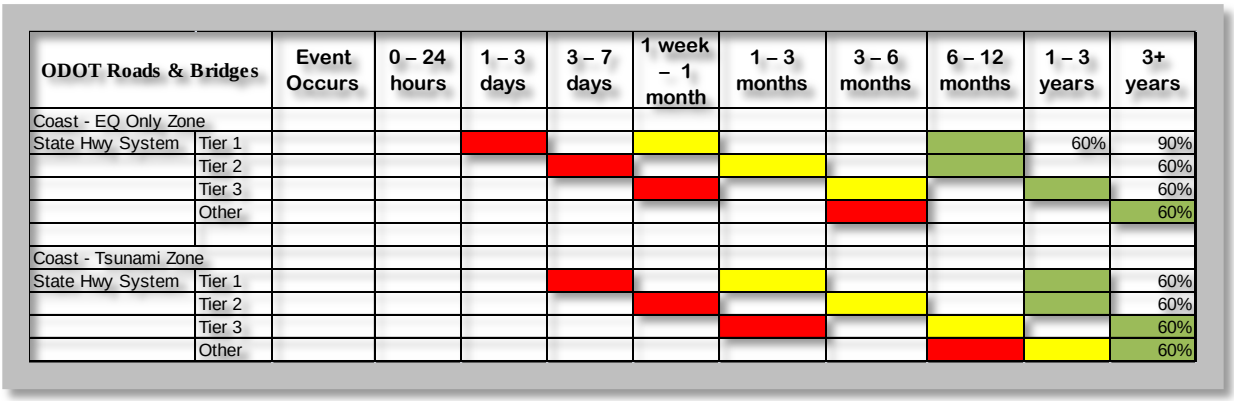
Figure 3.9: Existing Relief/Resilience Ratings

	RELIEF	RESILIENCE
Eastern	72 hours	2 weeks
Valley	72 hours	2 to 4 weeks
Coast (Earthquake Only)	72 hours	2 to 4 weeks
Tsunami Zone	72 hours	2-4 weeks

Figure 3.10: 50-Year Target Relief/Resilience Ratings

Coastal Service Restoration

50-Year Estimates for Roads/Bridges and Critical Facilities



50 Year Targets

Minimal: (A minimum level of service is restored, primarily for the use of emergency responders, repair crews, and vehicles transporting food and other critical supplies.)

Functional: (Although service is not yet restored to full capacity, it is sufficient to get the economy moving again—e.g. some truck/freight traffic can be accommodated. There may be fewer lanes in use, some weight restrictions, and lower speed limits.)

Operational: (Restoration is up to 90% of capacity: A full level of service has been restored and is sufficient to allow people to commute to school and to work.)

60% - ESTIMATED TIME FOR RECOVERY TO 60% OPERATIONAL

90% - ESTIMATED TIME FOR RECOVERY TO 90% OPERATIONAL

Figure 3.11: 50-Year Estimates for Roads/Bridges and Critical Facilities

Current 2012 Conditions for Critical Facilities in the Earthquake-Only Zone

Critical Facilities	Event Occurs	Phase 1 (hours)			Phase 2 (Days)		Phase 3 (Months)		
		4	24	72	30	60	4	18	36+
Coast - EQ Only Zone									
Emergency Operation Centers								X	
Police Stations									X
Fire Stations									X
Healthcare Facilities								X	X*
Primary Schools K-8								X	
Secondary/High Schools								X	
Emergency Shelters								X	
	Target in 50 Years								
X	Current Capability								

Figure 3.12: Current Conditions for Critical Facilities in the Earthquake-Only Zone

Disaster Resilience in Action:

- Waldport High School is the first FEMA tsunami acquisition project in the country. Lincoln County School District secured a bond to rebuild a new high school on the hill above the city.
- As of December 19, 2012, the Seaside School Board approved a resolution to authorize the superintendent to hire an architect to begin designing a new school campus, which would be constructed above the tsunami inundation zone. A long-anticipated bond measure to support this effort is expected to be on the ballot in May 2013.
- As of December 12, 2012, the Cannon Beach City Council agreed to acquire 55 acres to expand the city limits for a new school site above the tsunami inundation zone.

References

1. Wood, N. (2007). *Variations in City Exposure and Sensitivity to Tsunami Hazards in Oregon. US Geological Survey Scientific Investigations Report 2007-5283.*

2. Wood. N. (2012). Personal Communications