Unit 3

Defining Tsunamis

Facts about tsunamis

Defining a tsunami

Tsunami's natural warning signs

Key points to remember

Online learning resources

Facts About Tsunamis

In Washington, earthquakes and landslides are the most likely sources of a tsunami.

Tsunamis are a series of waves.

The first wave is not always the largest wave – tsunami waves can last for hours.

Do not return to the tsunami hazard zone until local authorities give the "All Clear."

When you are in a tsunami hazard zone, know the tsunami natural warning signs.

NATURAL WARNING SIGNS:
If you notice changes in the sea level or hear a loud roar –
TAKE ACTION
HEAD TO HIGH GROUND IMMEDIATELY
or
If you are on the shore or at the coast and feel the ground shake –
TAKE ACTION
"DROP, COVER, AND HOLD."

WHEN THE SHAKING STOPS,
HEAD TO HIGH GROUND IMMEDIATELY

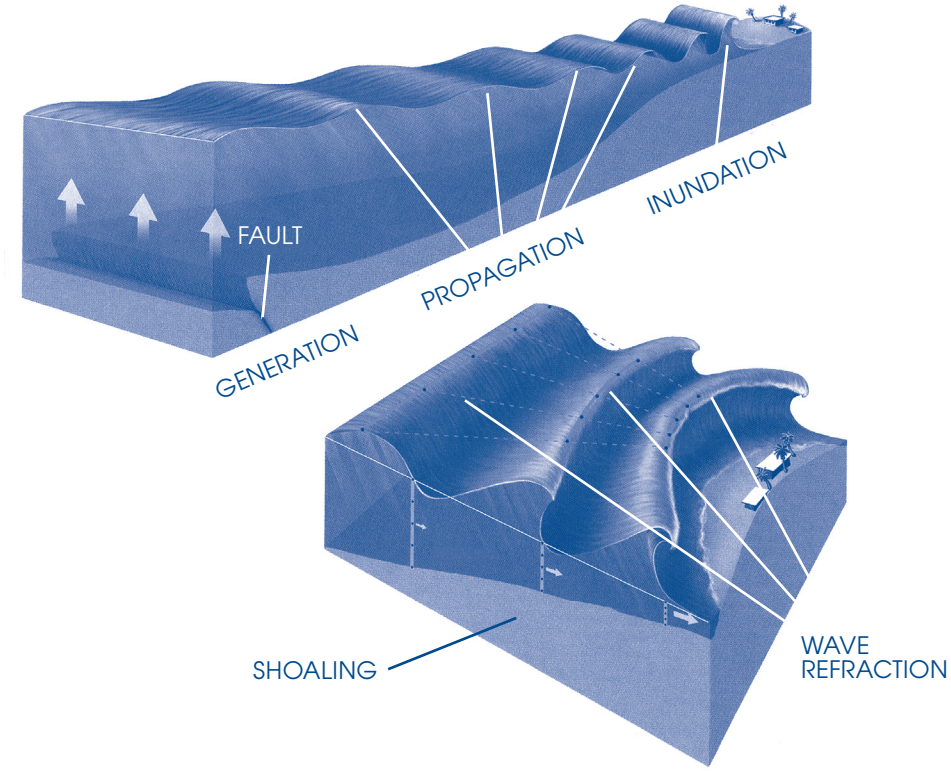
Defining a Tsunami

"Tsunami" is a Japanese word. Tsu means "harbor" and nami means "wave."

A tsunami is a series of giant waves produced by underwater movement due to a variety of natural events, such as earthquakes, volcanic eruptions, landslides and meteorites. In Washington, earthquake and landslides are the most likely sources of a tsunami.

In deep water of the open ocean, tsunamis cause no damage and are hardly noticed, even though they can travel as fast as an airplane. As the tsunami wave approaches shore from the open ocean the wave slows down and can grow as high as 100 feet. A person cannot out run a tsunami. Tsunamis can flow inland for tens of minutes while wind waves flow inland for tens of seconds. Tsunamis can create strong currents. Therefore, even a small tsunami can be dangerous.

Illustraion 7. Tsunami source



For example, the first tsunami wave arrivals in Thailand during the 2004 Indian Ocean Tsunami were a thunderous wall of water that immediately flooded inland. The wave forces and currents were so strong and turbid that people were easily swept off their feet where they drowned or were thrown against buildings or trees and lost consciousness. As successive waves entered a city or village, streets became river channels of floating debris

.

Tsunami's natural warning signs

For local tsunami events, a tsunami can strike our coastline before you receive an official tsunami warning to give sufficient time to get to high ground. Therefore, for local events, natural warning signs will be your warning notification.

Know these natural signs:

■ Earthquakes genereated from the Cascadia Subduction Zone can last up to several minutes.

■ Unusual ocean activity, especially if the ocean recedes seaward exposing the sea bottom, rocks and fish, or the ocean rapidly rises in elevation looking like a wall of water

■ Loud roaring sounds from the ocean, like an approaching airplane or train.

These are the natural warnings and mean a tsunami is on its way. You should go to high ground immediately.

TEACHER: Show the video "*Tsunami Basics.*"

Key Points to Remember

When you are in a tsunami hazard zone, know the tsunami natural warning signs.

IF YOU NOTICE CHANGES IN THE SEA LEVEL OR HEAR A LOUD ROAR –

TAKE ACTION:

HEAD TO HIGH GROUND IMMEDIATELY.

OR

IF YOU ARE ON THE SHORELINE OF THE BEACH AND FEEL THE GROUND SHAKE –

TAKE ACTION

"DROP, COVER, AND HOLD."

WHEN THE SHAKING STOPS,
IMMEDIATELY
HEAD TO HIGH GROUND.

Online learning resources

International Tsunami Information Center

Two videos available, each with multiple tsunami sections. These videos can be used for educational purposes. Contact VideoLab, 401 Kamakee St., 3rd Floor, Honolulu, HI 96814. Phone 808-593-0400, Fax 808-593-1841. Cost is $15.00, plus Blue Label shipping, approx. $15.00.

National Tsunami Hazard Mitigation Program

http://nthmp.tsunami.gov/

State of Washington

www.emd.wa.gov

TsunamiTeacher - Tsunami Basics

http://www.tsunami.noaa.gov/

Unit 4

Pacific-Wide Tsunamis

Facts about Pacific-wide tsunamis

The 1960 Chilean tsunami

The Great Alaskan earthquake and tsunami of 1964

The 2009 Samoa earthquake

The 2010 Chile earthquake

The 2011 Japan earthquake

Key points to remember

Online learning resources

Facts About Pacific-Wide Tsunamis

Just in the past three years, the Pacific Rim has experienced three destructive tsunamis: the 2010 Chile Tsunami killed 156; the 2009 Samoa Tsunami killed 192 people; and the 2011 Japan Tsunami killed 15,840 people.

Communities that have active tsunami preparedness programs can reduce their loss of life and damage from tsunami hazards.

A tsunami can originate at a local place near home, and can originate at a distant place far away from home.

Tsunamis can happen any time of the day.

Pacific-Wide Tsunamis

The Pacific Rim countries have a history of damaging tsunamis caused by both distant and local earthquakes. Earthquakes have caused 98% of the world's tsunamis with over 73% of these being observed along the Pacific "Ring of Fire". For this reason, communities in low-lying coastal areas around the Pacific Rim are among the most at risk to tsunami damages generated from both local and distant sources that can strike within minutes to many hours. Just in the past 3 years, the Pacific Rim has experienced and responded to 3 destructive tsunamis: the 27 February 2010 Chile Tsunami that killed 156 in Chile; the 2009 Samoa Tsunami that killed 192 in Samoa, America Samoa and Tonga; and the 11 March 2011 Japan Tsunami that killed 15,840, plus 4,000 missing and presumed dead. It is critical that our coastal communities learn from these past events and take action to be prepared and know the appropriate actions to take when it occurs.

Below are some of the past destructive tsunamis since 1960 that have impacted Pacific Rim coastal communities.

The 1960 Chilean Tsunami

The earthquake and tsunami approximately killed 1,655, injured 3,000, left 2,000,000 homeless, and caused $550 million damage in southern Chile; tsunami caused 61 deaths, $75 million damage in Hawaii; 138 deaths and $50 million damage in Japan; 32 dead and missing in the Philippines; and $500,000 damage to the west coast of the United States.

There was plenty of time for evacuation in Hilo, Hawaii, on May 22, 1960, as the tsunami was racing across the Pacific Ocean. An official warning was issued at 6:47 pm (local time) that waves would hit Hilo sometime around midnight. That evening coastal sirens sounded in Hilo starting at 8:35 pm and continued to sound every 20 minutes.

The first wave that hit Hilo was almost 5 feet high, but the third and largest wave arrived one hour later towering over 20 feet high and flooding 0.5 miles inland. Destructive high waves continued to come ashore for hours. Hundreds of people had failed to heed the warning and remained in their homes. Those that had left thought the danger was over after the initial wave and returned home. The tsunami waves killed 61 people and badly injured 282. Runups of more than 10 feet were measured on all Hawaiian Islands, with a maximum of 35 feet in Hilo, Hawaii.

When the Chilean earthquake occurred in 1960, seismographs recorded seismic waves that traveled all around the Earth. These seismic waves shook the entire Earth for many days. This phenomenon is called the free oscillation of the Earth.

Earthquake Facts, USGS

Talcahuano, Chile, February 2010. The tsunami tossed fishing boats and cargo containers about, leaving them strewn floating in the harbor or aground.

Credit / Rodrigo Nunez, ITIC

The US warning system for Hawaii, put in place after the 1946 Aleutian islands tsunami, provided good warnings for Pacific-wide tsunamis that hit Hawaii in 1952 and 1957. However, in 1960 because of the 15-hour long wait for the tsunami to hit Hawaii, many people were still unclear about the warning system, and interpreted the warnings in different ways. One must always remember that a tsunami is a series of waves that can be dangerous for many hours. Everyone should play it safe even if warnings seem ambiguous or you think the danger has passed, always choose to err on the side of safety.

In Oregon the tsunami caused damage to boats and mooring facilities and docks at Seaside and at Gold Beach. At Seaside the tsunami height was 4.5 feet. Along the Washington coast there was no damage, but runups were measured at Grays Harbor (small waves), Tokeland (two feet), Ilwaco (two feet), Neah Bay (1.2 feet), and Friday Harbor (0.3 feet).

The Great Alaskan Earthquake and Tsunami of 1964

The Great Alaskan Earthquake that occurred on March 28, 1964, was the second largest earthquake since 1900. The earthquake was a magnitude 9.2 and affected an area almost 1,000 miles long and more than 200 miles wide.

The earthquake generated a tsunami, which was extremely damaging. The area of damage extended from Alaska, along Vancouver Island, and in Northern California and Hawaii. In Crescent City, California 10 people were killed by the tsunami. Wave heights were reported between 7 and 21 feet. At Santa Cruz Harbor, the tsunami wave reached as high as 11 feet. The damage in San Francisco Bay was largely to pleasure boats. Damage also occurred in Los Angeles and Long Beach Harbors. Damage in California was between $1.5 and $2.3 million while in Crescent City the damage was estimated at $7.4 million.

In Crescent City the first of the four tsunami waves caused no significant damage other than flooding. The second and third waves were very similar to the first. It was the fourth wave that was the largest. The fourth wave was preceded by a withdrawal of water, leaving the harbor almost entirely dry. Finally, the fourth wave hit the city damaging piers, fishing boats and pleasure boats. Approximately 30 blocks of Crescent City was destroyed. Automobiles, lumber and other objects were carried away by waves that destroyed a good portion of the buildings in the area.

In Washington, tsunami wave heights varied on the south coast from the north coast; additionally, the tsunami was recorded inland in the Strait of Juan de Fuca (Friday Harbor), Puget Sound (Seattle), and the Columbia River (Vancouver). Observations were made of the tsunami in Grays Harbor County at Westport, Joe Creek, Pacific Beach, Copalis, Grays Harbor City, and Boone Creek.

Damages included debris deposits throughout the region, minor damage in Ilwaco, damage to two bridges on State Highway 109, a house and smaller buildings being lifted off foundations in Pacific Beach (the house was a total loss), and damage to the Highway 101 bridge over the Bone River near Bay Center when the Moore cannery building washed against its pilings.

Pago Pago Harbor, American Samoa, February 2009. The tsunami in Samoa pushed boats into the tops of coconut trees and roofs of office buildings.
Credit / Richard Madsen, ITIC

The 2009 Samoa Earthquake

The Samoa tsunami occurred early in the morning of September 29, 2009, as families were just waking, and children were preparing to go to school. The tsunami was generated by a magnitude 7.9 earthquake that occurred about 118 miles southeast of Samoa causing 149 deaths in Samoa, 34 in American Samoa, and 9 in Tonga, and damage in Wallis and Futuna. The earthquake caused strong ground shaking to be felt for over 60 seconds with some witnesses reporting it lasted more than two minutes.

The tsunami arrived in Samoa 10-20 minutes after ground shaking stopped. Maximum runup was measured between 45-60 feet in all three countries causing extensive coastal damage to structures and marine and coral reef, and lagoon ecosystems.

Pago Pago Harbor, American Samoa, February 2009. An overturned car and large boulders are shown caught in turbulent, swiftly-moving tsunami wave.
Credit / Richard Madsen, ITIC

The Pacific Tsunami Warning Center transmitted its first messages (preliminary earthquake observatory message) 11 minutes after the earthquake and an official warning 16 minutes after the earthquake. Fortunately through intergovernmental tsunami preparedness advocacy developed over the last decade in addition to workshops and trainings by the International Tsunami Information Center and Pacific countries, people had been educated about the tsunami hazard, the importance of pre-event preparedness and, for local tsunamis, the heeding of natural warnings. In other words, no one should wait for an official alert to evacuate. Rather, if you are living near the coast and a big earthquake occurs, unusual or abnormal sea level activities are seen, or you hear a loud roar, you should go to higher ground or inland immediately! This was clearly demonstrated in American Samoa and Samoa, where both countries had saved lives because they were actively engaged in pre-event awareness and education.

Factors which helped to reduce vulnerability for this event were the time of day (many were already awake, but not on the road because the work day had not started), generally limited earthquake damage which reduced injuries and damage to transportation infrastructure, relative closeness and availability of high ground, pre-event plans (such as school evacuation plans in American Samoa) and school and community drills (National Drill in 2007 and 2008 in Samoa). The 2004 Indian Ocean tsunami, and more recently, the March 19, 2009, earthquake off Tonga, also served as reminders of what tsunamis can do, and how warning and response agencies need to coordinate and respond.

Today, the countries are working on recovery issues, and improving their early warning and alert systems, especially in hardening the communications infrastructures critical for providing information on warning and evacuation. Both traditional methods of alerting (bells), and modern media (sirens, mobile phone alerting, radio/TV broadcast), are being strengthened. In addition, at the community and village levels, education and preparedness continues, such as the development and clarification of evacuation maps and routes to safe areas.

The 2010 Chile Earthquake

The 27 February 2010 magnitude 8.8 earthquake generated a tsunami that caused 156 tsunami-related deaths locally. Additionally, in spite of the great size of the earthquake, only a relatively small amount of earthquake damage occurred – this is generally attributed to the strong earthquake building code which structures have been built to over the decades since the 1960 magnitude 9.5 Chilean earthquake.

Similarly for the tsunami, while coastal residential dwellings were destroyed from tsunami waves, very few people lost their lives (compared to the potential vulnerable population, perhaps 100,000+ people) – this is largely attributed to pre-event preparedness, awareness, and education. Elders who lived through the 1960 tsunami passed on their experience and wise advice to their children and grandchildren, and the 2004 Indian Ocean tsunami and more recent earthquakes reminded everyone of the need to be aware and prepare. The Chile Navy's Hydrographic Service, Chile disaster management agency, and universities and community organizations led these efforts; inundation maps, hazard and evacuation signage, and awareness and education materials were distributed along the coasts. Without these efforts for the decades before, it is sure that many more would have perished.

Dichato, Chile, February 2010. This tsunami reduced homes made of wood and towns to rubble. Credit: Marcelo Lagos, ITIC

Factors that helped reduce vulnerability for this event were generally limited earthquake damage due to well-engineered structures, tsunami signage, tsunami-prepared police and fire responders who assisted in warning and evacuation, and a prepared and educated coastal public who also received training in schools and through in-community practice drills.

Factors that unfortunately increased the vulnerability were the time of day (many were sleeping so that the earthquake was their early warning), no or little tsunami hazard information at visitor facilities (such as campgrounds) to help uninformed/unaware tourists and workers, and the long duration of destructive tsunami waves (several to 4 hrs so people returned too early). In the town of Constitucion, where 45 died, inopportune timing was the principal cause of death, as many were camping on an island at the river mouth with no evacuation method, and the tsunami hit the night after a summer-ending fireworks celebration.

Today, like in the South Pacific, Chile is working to strengthen their early warning systems, especially in hardening the communications infrastructures critical for providing information on warning and evacuation, and in improving the earthquake and tsunami detection networks to more quickly assess tsunami threat to their coasts. Many are aware that the next tsunami will probably be to the north where there is already a long history of destructive tsunamis. Awareness and outreach campaigns in this region aim to further strengthen community preparedness. Again, the emphasis for local tsunamis is to ensure that everyone knows a tsunami's natural warning signs and then knows to immediately take action since the tsunami may attack coasts within 10-30 minutes after the earthquake.

The 2011 Japan earthquake

The March 11, 2011, M9.0 earthquake generated a devastating local tsunami that struck the Pacific coast of Honshu within about 20 minutes. On January 12, 2012, the Japan National Police Agency reported 13,895 persons killed and 13,864 persons missing from the earthquake and tsunami. 141,343 residents are still staying at evacuation shelters. The 2011 Japan Earthquake Tsunami Joint Survey Group (http://www.coastal.jp/tsunami2011/) reports tsunami runup heights up to 100 feet with a maximum of nearly 130 feet. The 11 March 2011 Japanese tsunami was the first to cause deaths since the 1993 Sea of Japan magnitude 7.7 earthquake caused 23 deaths and generated a tsunami that caused an additional 208, and the most fatal tsunami globally since the 2004 Indian Ocean tsunami generated off Sumatra, Indonesia that killed nearly 230,000 across the Indian Ocean.

Onagawa, Japan, March 2011. During the tsunami, cars were deposited on the fourth floor roof of building.
Credit / Laura Kong, ITIC

The Japan Meteorological Agency's national tsunami warning center issued a tsunami warning 3 minutes after the earthquake triggering the alerting process that immediately broadcasted by mass media and locally activated sirens and other mitigation countermeasures such as water gate closures. Live video of the advancing tsunami waves and their impact on structures at the coast was aired live by Japan NHK television and seen at the same time globally.

Despite Japan's sustained and globally recognized excellence in tsunami preparedness, many casualties resulted and again reminded us of the swiftness and destructive power of tsunamis. Waves overtopped tsunami walls and destroyed many structures, especially wooden homes. Nonetheless, some tall reinforced concrete buildings and evacuation platforms did survive and allowed citizens to shelter in place by vertically evacuating. Tsunami waves also caused huge infrastructure damage to the Fukushima Nuclear Power Plant, resulting in the meltdown of core reactors and local emission of dangerous radiation.

Like the previous tsunamis, drowning was the main cause of death, with casualties greatest in the elderly. The tsunami also propagated across the entire Pacific Ocean, with runups up 15 feet and $30 million in damage to harbors and homes in Hawaii 7 hours later, up to 9 feet and $50 million in damage in California 12 hours later, and up to 9 feet heights and more than $4 million in damage 22 hours later in Chile. Outside of Japan, 1 person died in California, USA, and 1 person died in Papua, Indonesia.

Taro, Japan, March 2011. Taro was well-known as a tsunami-prepared town in Japan. After the 1896 and 1933 tsunamis, as well as the 1960 tsunami, sea walls were built, evacuation maps and signage developed, and exercises conducted. Yet, all this was not enough when waves overtopped the walls, leaving only remnants such as this closed water gate standing. The hotel in the background was flooded to the third floor, but remained standing, as did the tower where the sirens sounded evacuation warnings. Seen at the right back, a gently winding road uphill offered an easy evacuation route to high ground for fleeing citizens.

Credit / Laura Kong, ITIC

Minamisanriku, Japan, March 2011. In many coastal towns, concrete, reinforced tall buildings designated as tsunami evacuation shelters withstood the tsunami waves, though the first few floors had been flooded.

Credit: Laura Kong, ITIC

Key Points to Remember

Know the appropriate actions to take for an earthquake and tsunami, and be prepared to take action at all times wherever you are.

Actively participate in community and school preparedness drills, and attend neighborhood and community preparedness meetings.

Local Tsunami Event – know the natural warning signs and take immediate action to get to high ground.

Distant Tsunami Event – Stay informed and follow directions from local authorities. Be prepared to evacuate, if required.

Know tsunami evacuation routes from your home, where you work, or frequently visited places.

Know the community tsunami warning system.

Should a tsunami occur in your area, head for high ground and do not enter the tsunami hazard zone until local authorities give the "All Clear" signal.

Online learning resources

International Tsunami Information Center
http://www.nws.noaa.gov/pr/itic/

U.S. Geological Survey
http://www.usgs.gov/

West Coast and Alaska Tsunami Warning Center - NOAA
wcatwc.arh.noaa.gov/

Unit 5

Tsunami Warning System in Washington State

Facts about tsunami warning system

Tsunami warning in Washington

Tsunami alerts

How the public receives tsunami warnings

Tsunami warning flow chart

Know the difference between "Cancellation" and "All Clear"

Key points to remember

Online learning resources

Facts About the Tsunami Warning System in Washington

Washington receives official tsunami warning messages from the West Coast/Alaska Tsunami Warning Center, then notifies the public through state and local emergency management officials.

There are four primary messages:

1. Warning (Danger; follow emergency instructions);
2. Advisory (Be prepared to take action);
3. Watch (Be alert, listen to your radio); and
4. Information Statement (For information only).

A NOAA Weather Radio provides complete information about hazard events and can be customized for your local area.

The Tsunami Warning in Washington

The United States has two Tsunami Warning Centers, the West Coast/Alaska Tsunami Warning Center located in Palmer, Alaska from which Washington receives its tsunami warning and information, and the Pacific Tsunami Warning Center located near Honolulu, Hawaii. The centers monitor earthquakes 24 hours a day, 7 days a week looking for large, shallow, undersea earthquakes. When one occurs they do an earthquake analysis and check sea levels to confirm whether a tsunami has been generated and if the waves are destructive or small. When this scientific data confirms that a tsunami is possible, the tsunami warning centers provide state and local authorities a tsunami alert as quickly as possible by a variety of communication methods (see *www.emd.wa.gov/hazards/prog_ahab.shtml* for details). The centers have a defined set of tsunami alerts (see image below) that can be sent out based on the current tsunami threat.

Illustration 8. Tsunami Alert Messages

The graph on the left shows the four types of tsunami alerts that can be received by the Alaska Tsunami Warning Center and the appropriate action steps that will be taken.

The West Coast and Alaska Tsunami Warning Center during the 2011 Japanese tsunami incident.

How the public receives tsunami warnings

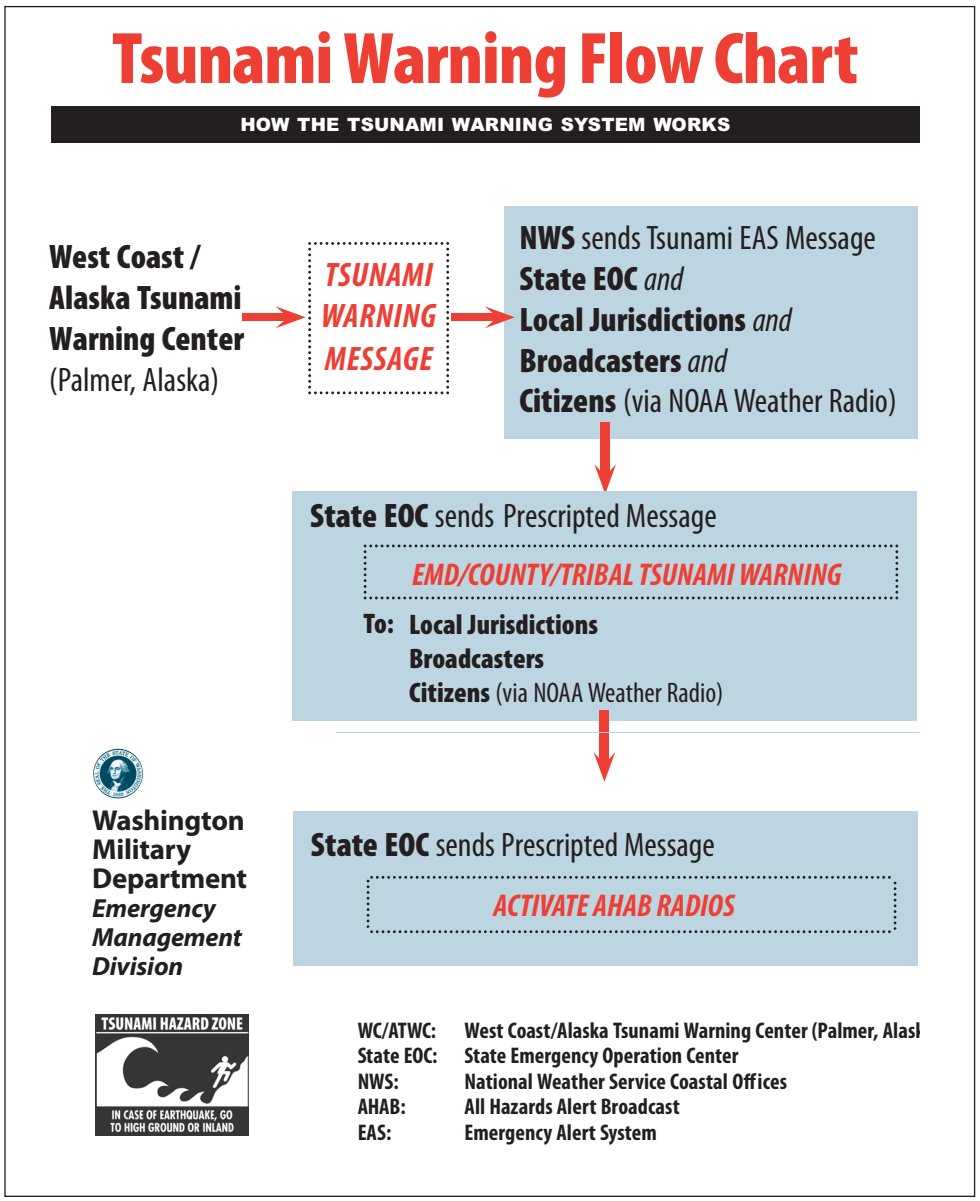
The Emergency Alert System (EAS) is a national public warning system that uses TV and radio broadcasters, cable television systems, and other communication providers to transmit emergency information. State and local authorities who deliver important emergency information, such as tsunami evacuation and other critical tsunami information, also can use the system.

The public is encouraged have a NOAA Weather Radio as an effective all-hazard alert and notification system. They can warn listeners about a tsunami before the mass media and community alert systems can do so, giving people additional time to react before a tsunami hits their area. Remember tsunamis can attack shores quickly, every minute counts and communities should have a goal to have NOAA Weather Radios become as common as smoke detectors in homes and businesses as these will help to save lives from natural and technological hazards. Each community's tsunami brochure lists the frequencies for receiving emergency information for that area.

Many coastal communities have an All Hazard Alert Broadcasting (AHAB) System that provides a tone to alert the public, and a voice message instructing them on specific action to take for a hazard. AHAB System uses satellites to monitor system health on a 24x7 basis and to activate the system, while also retaining the option for the state, county, local jurisdiction to activate from its emergency operations centers or remotely using handheld equipment. The AHABs are tested the first Monday of each month at noon. This system is for outside use only and not to be heard indoors. The NOAA Weather Radio and the siren system should be used together to ensure tsunami warnings would be received.

Finally, there are many other ways communities can receive tsunami warning and information. They range from a Telephonic Warning System, local responders using emergency vehicle sirens and public address systems to knocking on doors. Remember, that a local tsunami can strike before you receive official tsunami warning. Know the natural warning signs and take immediate action to head inland and to high ground.

Illustration 9



Knowing the difference between a "Cancellation" and an "All Clear" could save your life

A "**Cancellation**" is issued when a tsunami warning center(s) judges that destructive tsunami waves are below warning threshold limits in areas being notified. For instance, the Alaska Tsunami Warning Center sends out a Cancellation message that cancels previous Tsunami Warnings, Advisories and Watches that have been issued by them. It does not mean it is safe for the public to go back into the Tsunami Hazard Zone. Fires, downed utility lines, unsafe buildings, and other public safety issues may still exist that emergency response personnel are addressing.

An "**All Clear**" is issued once it is safe for the public to re-enter the tsunami hazard zone. Only your local authority can issue an "All Clear" for your community. The March 11, 2011, Great East Japan (Tohoku) Earthquake and Tsunami is a good example and reminder that the inundation area may not be accessible for weeks or months.

Key Points to Remember

Always follow the actions required for a tsunami Warning, Advisory or Watch messages.

Know the local warning and communication systems in your community – they relay critical tsunami alert messages.

Know the difference between a Tsunami Cancellation Message and an All Clear Message from authorities.

Remember:
A "Cancellation" is NOT an "All Clear"

Cancellation message means destructive tsunami waves are below warning thresholds – however, tsunami waves can continue for days. Stay out of the Tsunami Hazard Zone until you hear an "All Clear" message by local authorities.

Online learning resources

NOAA Weather Radio

http://www.nws.noaa.gov/com/weatherreadynation/

Washington Emergency Management Office, All-Hazard Alert Broadcast (AHAB) Siren

http://www.emd.wa.gov/hazards/prog_ahab.shtml

West Coast and Alaska Tsunami Warning Center - NOAA

wcatwc.arh.noaa.gov/

Unit 6

Earthquake and Tsunami Preparedness

Facts about earthquake and tsunami preparedness

Plan ahead for earthquakes and tsunamis

Community plans

Three day supply kit

Evaucation signs and what they mean

Tsunami! Move to high ground

What to do after a tsunami

Key points to remember

Online learning resources

Facts About Tsunamis Preparedness

Use these steps to develop your Action Plan:

Contact your local emergency management office for information about local tsunami hazards.

Develop a family action plan for home, school and work.

Include all household members in the planning process.

Learn evacuation routes and practice using them.

Practice your Action Plan.

Evaluate and update your Action Plan at least once a year.

Plan ahead for earthquakes and tsunamis

■ Make disaster plans before a disaster strikes. Be prepared to be on your own, without outside assistance, for at least three days. Discuss the earthquake hazard in your community and have a plan ahead of the earthquake. Contact your local emergency management office to find out what areas are in the tsunami hazard zone and designated evacuation routes and assembly areas. Ask for a Tsunami Brochure with evacuation map and go over the contents – it is critical everyone understands what are the appropriate actions they need to take when there is a tsunami threat. Keep it in a safe place that allows easy access to it for an emergency.

■ Create a family disaster plan. Meet with your family and discuss why you need to prepare for disaster. Discuss the dangers of an earthquake and tsunami. Learn earthquake safety procedures, especially the "Drop, Cover and Hold" procedure. Discuss the approved evacuation route for your area. Establish an out-of-area phone contact, and don't forget to make plans for your pets, because they are family, too! Discuss and know the natural warning signs of a tsunami and walk the evacuation route from home, work, or places most frequently visited to make sure you can reach high ground within 15 to 20 minutes. If that can't be done, look for tall structures that could be used for vertical evacuation.

■ Put your plan into action. Take a first aid class. Prepare your disaster supply kit. Have a kit available in your car, at home and at work. Your kit should include a portable radio with extra batteries, water (1 gallon per person per day), first aid supplies, flashlight, with extra batteries, non-perishable food, your prescription medications, copies of your insurance papers, a small amount of cash, extra clothing, heavy duty gloves, heavy shoes, sanitation supplies, and tools, such as a non-electric can opener and utensils.

■ Practice and maintain your plan. Review your plan every six months. Conduct drills with your family on a regular basis. Replace water and food in your disaster kit every six-months.

Community plans

Every attempt has been made by local Emergency Management offices to locate evacuation routes and public congregation areas that are safe, within a reasonable distance for foot or vehicle traffic, and accessible within a short period of time. These are difficult criteria to meet in some geographic areas, primarily as a result of private property issues. For that reason, residents who may be impacted by tsunami activity, but do not have an "official" route or congregation area within a reasonable distance, are urged to work together to develop an evacuation plan within their neighborhood or community. A plan should address property access issues, evacuation routes, and what might be expected in terms of numbers of people needing to access a locally organized congregation area. Talk to your local emergency manager about the program "Map Your Neighborhood" that can help you develop this planning effort.

BE PREPARED

Three Day Supply Kit

Assemble a 3-day minimum supply for your home. Include food, medications, and critical supplies for people with special needs. Modify this list for for your car and office.

Medical and special needs equipment

- First aid handbook
- First aid kit: gauze, bandages, aspirin, tape, scissors, disinfectants, antiseptics, and non-prescription medications
- Prescription medications for at least 7 days and glasses
- Personal hygiene supplies
- Plastic zip-close bags, chlorine

Household inventory and important documents

- Copies of important documents
- Household inventory, pictures of contents
- List of credit cards and account numbers
- Banking information
- Wills, durable power of attorney, legal documents
- Copy of driver's licenses
- Photos of household members
- School emergency information

Food and water

- Non-perishable food for 3 days
- Infant formula and medications
- Special dietary needs
- 1 gallon of water per person per day for at least three days
- Manual can opener
- Cooking utensils

Safety equipment

- Fire extinguisher
- Smoke detectors and fire alarm
- Whistle
- Tools

Special equipment

- Dust masks and eye protection
- Masking tape to seal areas
- Plastic wrap to protect equipment
- Battery-powered or hand crank radio and a NOAA Weather Radio with tone alert and extra batteries for both
- Extra batteries
- Flashlights
- Cleaning supplies
- Small amount of cash including coins for pay phones
- Quiet games and activities for children

Miscellaneous

- Tent and waterproof tarp
- Extra blankets
- Warm clothing
- Sturdy shoes
- Work gloves
- Infant specialty items
- Items for the elderly
- Pet items — medicines, food and water

Evacuation signs, what they mean

Tsunami evacuation routes were developed to assist coastal residents and visitors find safer locations in case of an earthquake and tsunami. Evacuation signs have been placed along roadways to indicate the direction inland to higher ground. In some places, there may be more than one direction available to reach safer areas. These routes may be marked with several signs showing additional options for evacuation. You will need to know the evacuation routes for your area and places frequently visited.

Tsunami! Move to High Ground! Life Saving Knowledge

Washington's coast is certainly vulnerable to tsunamis but they are infrequent. It is important to understand the hazard and learn how to protect yourself. But don't let the threat of tsunamis ruin your enjoyment of the beach.

- If you feel the ground shake under your feet, or see a change in sea level, or hear a loud roar, tell those around you and head to high ground immediately.
- When you feel an earthquake, always "Drop, cover, and hold" until the shaking stops and it is safe to get up.
- If the earthquake has damaged roads and power lines and resulted in significant debris, do not try to follow the evacuation routes out.
- If you can't evacuate inland and to high ground consider vertical evacuation.
- Listen to your radio for information from the emergency authorities. Use a NOAA Weather Radio with a tone-alert feature to keep you informed of tsunami warnings, advisories, and watches. The tone alert feature will warn you of potential danger even if you are not currently listening to local radio or television stations.
- If you are at home and hear a tsunami warning, make sure your entire family is aware of the warning.

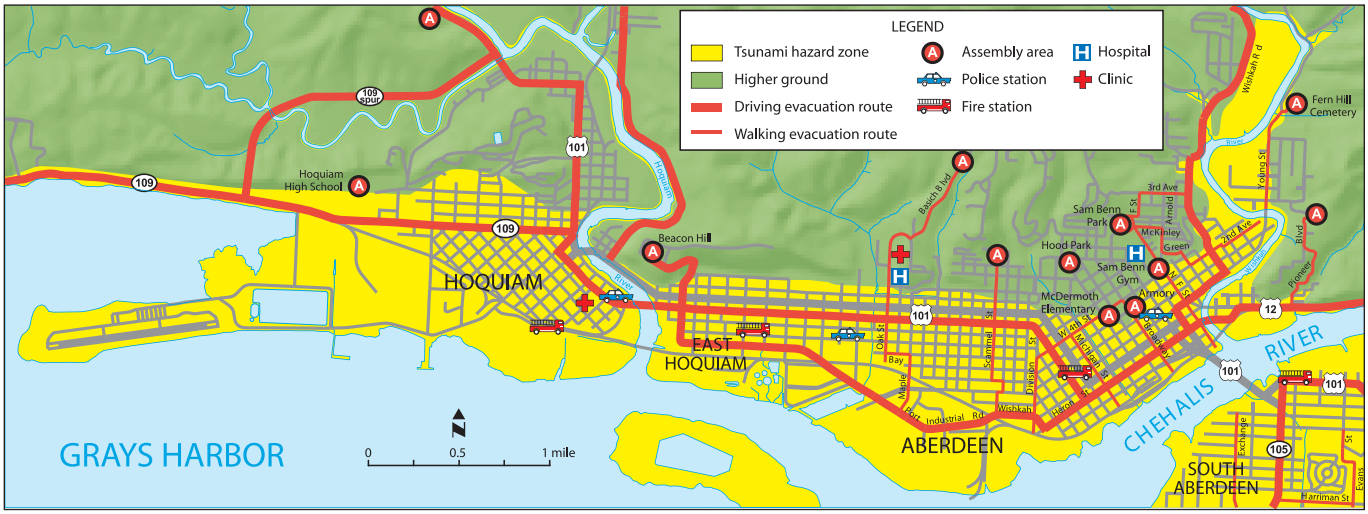


Illustration 10. Tsunami evacuation map for Hoquiam and Aberdeen in Grays Harbor County. The map provides a legend, evacuation routes and assembly areas are clearly marked with evacuation route signs. These maps can be found in Tsunami Evacuation Brochures for communities located in the tsunami hazard zone.

■ Never go back to the tsunami hazard zone until told to do so by local authority. An official "all clear" message will be disseminated when it's safe to return.

■ Tsunamis consist of a series of waves. Often the first wave is not the largest and can last for many hours after the arrival of the first wave.

Tsunamis can occur at any time, day or night. The following are preparedness facts that everyone should know.

If you are at school

Schools in Washington State have emergency evacuation plans. If you are at school and hear there is a tsunami warning, follow the advice of teachers and other school personnel. You will be directed to a place of safety.

If you are at home

If you are at home and hear a tsunami warning, make sure your entire family is aware of the warning. Follow instructions given by local authority and evacuate your house if you live in a tsunami hazard zone. Move in an orderly, calm and safe manner to the tsunami evacuation assembly area or to any place outside of the tsunami hazard zone.

If you are at the beach

If you are at the beach or near the ocean and you feel the earth shake, notice changes in sea level, or a loud roar, move immediately to higher ground. DO NOT wait for an official tsunami warning to be announced, the natural cues are your only warning. Stay away from rivers and streams that lead to the ocean. If you can't evacuate inland and to high ground before the tsunami arrives consider vertical evacuation. If there are no high concrete reinforced steel structures nearby, then you should find the tallest, sturdy structure and climb up and cling to it until the wave passes. In some cases, this might only be a strong tree or utility pole. If you're swept up by a tsunami, look for something to help you stay afloat, and to protect you from dangerous floating debris like houses, cars, and trees. If you are on the beach and unable to get to high ground or vertical evacuate, go inland away from the beach as far as you can.

If you are on a ship or boat

Since tsunami wave activity is unnoticeable in the open ocean, do not return to port if you are at sea and a tsunami warning or tsunami advisory has been issued for your area. However, shallow waters closer to shore will experience the effects of tsunami waves.

What to do after a tsunami

■ Listen to a NOAA Weather Radio, Coast Guard emergency frequency station, or other reliable sources for emergency information. **Do not enter the tsunami hazard zone until you are given the "All-Clear" by local authorities.**

■ Help a neighbor who may require special assistance — infants, elderly people, and people with disabilities. People who care for them or who have large families may need additional assistance in emergency situations.

■ Use the telephone only for emergency calls. Telephone lines are frequently overwhelmed in disaster situations. They need to be clear for emergency calls to go through.

■ Stay out of buildings if water surrounds them. Tsunami waters, like flood waters, can undermine foundations, causing buildings to sink, floors to crack, or walls to collapse.

■ Wear sturdy shoes. The most common injury following a disaster is cut feet.

■ Only use battery-powered lanterns or flashlights when examining buildings. Battery-powered lighting is the safest and easiest, and do not present fire hazards.

■ Look for fire hazards, such as broken or leaking gas lines, flooded electrical circuits, or submerged furnaces or electrical appliances. Flammable or explosive materials may come from upstream.

■ Check for gas leaks. If you smell gas or hear a blowing or hissing noise, open a window and quickly leave the building. Turn off the gas using the outside main valve if you can. If you turn off the gas for any reason, a professional must turn it back on.

■ Look for electrical system damage. If you see sparks or broken or frayed wires, or if you smell burning insulation, turn off the electricity at the main fuse box or circuit breaker. If you have to step in water to get to the fuse box or circuit breaker, call an electrician first for advice. Electrical equipment should be checked and dried before being returned to service.

■ Check for sewage and water line damage. If you suspect sewage lines are damaged, avoid using the toilets and call a plumber. If water pipes are damaged, contact the water company and avoid using water from the tap. You can obtain safe water from undamaged water heaters or by melting ice cubes. Use tap water if local health officials advise it is safe.

■ Watch out for animals. Use a stick to poke through debris. Tsunami floodwaters flush snakes and animals out of their homes.

Key Points to Remember

If you are at the beach or near the ocean and you feel the earth shake, notice changes in sea level, or hear a loud roar, move immediately to higher ground. DO NOT wait for an official tsunami warning to be announced.

If you are at school and hear there is a tsunami warning, follow the advice of teachers and other school personnel.

If you are at home and hear a tsunami warning, make sure your entire family is aware of the warning. Evacuate your house immediately and head for high ground.

Follow instructions given by local authorities.

Online learning resources

Great Washington Shakeout
www.shakeout.org/washington

Home Preparedness
www.emd.wa.gov/preparedness/prep_home.shtml

International Tsunami Information Center
http://itic.ioc-unesco.org

Map Your Neighborhood
www.emd.wa.gov/myn/index.shtml

Pet Preparedness
www.emd.wa.gov/preparedness/prep_pets.shtml

Preparing Your Emergency Evacuation Kit (Video)
www.emd.wa.gov/hazards/haz_video_emergency_kit.shtml

Preparing Your Evacuation Routes (Video)
www.emd.wa.gov/hazards/haz_video_evacuation_routes.shtml

Tsunami and Earthquake Preparedness
http://www.emd.wa.gov/preparedness/prep_index.shtml

Usapdin, T.P., A. Soemantri, and V. Agustin, The story that saved the lives of the people of Simeuleu, Indonesia, December 19, 2005
www.ifrc.org/docs/News/05/05121901/index.aspUsapdin, T.P., A. Soemantri, and V. Agustin, The story that saved the lives of the people of Simeuleu, Indonesia, December 19, 2005

Washington State Department of Natural Resources
Interactive maps of tsunami evacuation zones in both Oregon and Washington are available online and as a smartphone app (TsunamiEvac-NW).
http://www.dnr.wa.gov/ResearchScience/News/Pages/2012_03_20_tsunami_maps_nr.aspx

The online portal can be found on the web at:
http://www.nanoos.org/nvs/nvs.php?section=NVS-Products-Tsunamis-Evacuation

iPhone:
http://itunes.apple.com/us/app/tsunamievac-nw/id478984841?mt=8

Android:
https://play.google.com/store/apps/details?id=org.nanoos.tsunami&hl=en