Appendix 1: Tsunami Alerting Information

Alert Dissemination Responsibilities

NOAA is the authorized agency solely responsible for determining a region's appropriate tsunami alert level based on historical and preliminary earthquake event data, as well as preparing and issuing tsunami bulletins in which the alert level information is included. Tsunami alerts and event information for WA are disseminated by the NTWC, NWS, USCG, FEMA, WA SEOC, Tribes, and local jurisdictions through the methods outlined below. Tsunami alerts require immediate response due to the urgent nature of the event so the more alert methods you are signed up for, the better your chance of receiving a tsunami alert in a timely manner.

NTWC

The NTWC disseminates tsunami alerts within 5 minutes of a potential tsunamigenic earthquake which could impact the US and Canadian coastlines or the British Virgin Islands via the following methods to the following stakeholders (see figure 3):

- Via the NWS Gateway and NWS Chat (internal NWS chatroom) to the WFOs.
- Via FEMA IPAWS as WEA to the public.
- Via the National Warning System (NAWAS), email, and OMNIXX to state EOCs.
- Via NAWAS and OMNIXX to the USCG and Navy.
- Via www.tsunami.gov and the NTWC Facebook page and Twitter feed (@NWS_NTWC) to the public.
- Via iNWS to tribal and local emergency managers/officials.

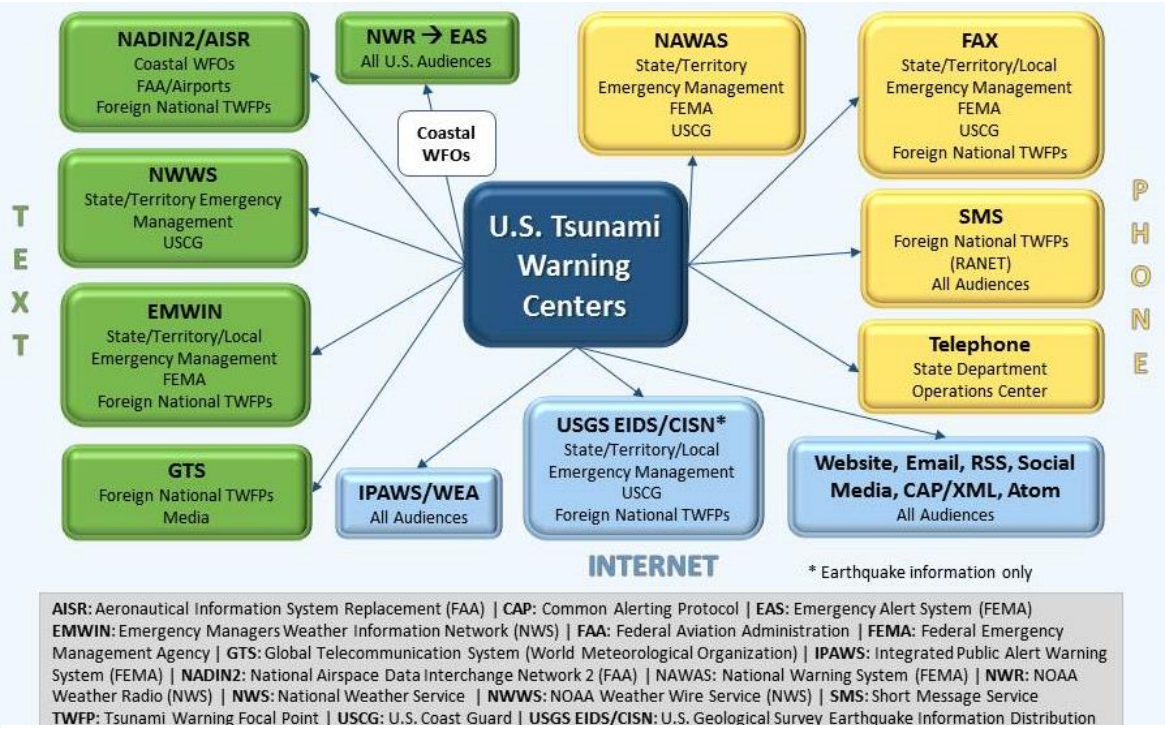

Figure 1: A diagram showing where and how the NTWC disseminates its tsunami alerts.

Tsunami alerts for Washington begin when Earthquakes that activate the NTWC's alarm system initiate an earthquake and tsunami investigation which includes the following four basic steps: automatic locating and characterizing the earthquake; earthquake analysis and review; sea level data analysis and tsunami forecasting; and disseminating information to the appropriate emergency management officials.

Tsunami bulletins are initially issued based solely on seismic data. Data from approximately 1,000 seismic monitoring stations are recorded at the NTWC. Seismic networks which provide the data are operated and funded by many different agencies, including the United States Geological Survey (USGS), the Global Seismic Network, NOAA, various universities throughout the country, and foreign governments. Access to data is provided through dedicated circuits, private satellite networks, and the internet. Once a significant earthquake has occurred, the nearest sea level gauges are monitored to confirm the existence or nonexistence of a tsunami, and its degree of severity. If a tsunami has been generated, the sea level data are critical for use in calibrating forecast models. The Center has access to approximately 1,000 tide gauge sites and 50 deep ocean tsunami detectors (DARTs). Many of these sites are maintained by NOAA's National Ocean Survey (NOS). In addition to the NOS sites, other international agencies provide sea level information to the Center. The NTWC also operates several gauges in Alaska.

The Center's initial response is issued very quickly and is based on seismic analysis and well-defined, preset criteria. Whether a Tsunami Warning, Watch, Advisory, or Information Statement is issued is based on these criteria and the initial seismic analysis. Following the first message, the tsunami is analyzed using observed sea level data, forecast models, historic data, and further seismic processing. Based on this analysis, supplemental messages are issued as necessary. Areas with forecasted waves that are 3.3 feet high or greater trigger a tsunami Warning, areas with forecasted waves that are 1 to 3.3 feet high trigger a tsunami Advisory, and waves less than 1 feet high trigger a cancellation if a Warning, Advisory, and/or Watch were previously issued. Historic events have shown that tsunamis can cause damage due to strong currents when amplitudes reach 1 foot or greater.

Tsunami Alert Messages

NTWC issues tsunami Warnings, Advisories, Watches, and Information Statements. Each has a distinct meaning relating to local emergency response. In summary:

Warning	**Inundating wave possible**	**Full Evacuation Suggested**
Advisory	**Strong currents likely**	**Stay away from the shore**
Watch	**Danger level not yet known**	**Get ready to take action**
Information	**Minor waves at most**	**No action suggested**

Table 1: Official tsunami alert levels, associated effects, and protective actions to be taken

Based on seismic data analysis or forecasted amplitude (which is dependent on whether the Center has obtained sea level data), NTWC will issue the appropriate alert. Warnings and Advisories recommend that protective action be taken. Watches are issued to areas that are far away from the earthquake that could be impacted by a tsunami in order to give people a heads up to get prepared to act. Once the danger level is determined, the watch is upgraded to a warning or advisory, or canceled. The full definition of each message is given below:

- Tsunami Warning - A tsunami Warning is issued when a tsunami with the potential to generate widespread inundation is expected, imminent, or occurring. Warnings alert the public that dangerous coastal flooding accompanied by powerful currents is possible and may continue for several hours after initial arrival. Warnings alert emergency management officials to take action for the entire tsunami hazard zone. Appropriate actions to be taken by local officials may include the evacuation of low-lying coastal areas, and the repositioning of ships to deep waters when there is time to safely do so. Warnings may be updated, adjusted geographically, downgraded, or canceled. To provide the earliest possible alert, initial warnings are normally based only on seismic information.
- Tsunami Advisory - A tsunami advisory is issued when a tsunami with the potential to generate strong currents or waves dangerous to those in or very near the water is expected, imminent, or occurring. The threat may continue for several hours after initial arrival, but significant inundation is not expected for areas under an advisory. Appropriate actions to be taken by local officials may include closing beaches, evacuating harbors and marinas, and the repositioning of ships to deep waters when there is time to safely do so. Advisories are normally updated to continue the advisory, expand/contract affected areas, upgrade to a Warning, or cancel the Advisory.
- Tsunami Watch - A tsunami watch is issued to alert emergency management officials and the public of an event which may later impact the watch area. The watch area may be upgraded to a Warning or Advisory - or canceled - based on updated information and analysis. Therefore, emergency management officials and the public should prepare to take action. Watches are normally issued based on seismic information without confirmation that a destructive tsunami is underway.
- Tsunami Information Statement - A tsunami information statement is issued to inform that an earthquake has occurred, or that a tsunami Warning, Advisory, or Watch has been issued for another section of the ocean. In most cases, Information Statements are issued to indicate there is no threat of a destructive basin wide tsunami and to prevent unnecessary evacuations as the earthquake may have been felt in coastal areas. Information Statements may indicate for distant regions that a large event is being evaluated and could be upgraded to a Warning, Advisory, or Watch.

Receiving Alerts

NTWC alerts can be received in several different ways. Tsunami.gov is a website run by NOAA that shows recent earthquakes on a world map and a list of the last 40 alert messages that have been issued as well as a database of all messages issued in the past. While this website is a useful tool, it can suffer issues during high traffic times, such as during an event. However, there are other ways to have tsunami alert messages delivered to you as they are released by the NTWC. Keep in mind that some forms of receiving alerts may not work when at sea or in remote locations. For this reason, vessel owners should be sure their vessel is equipped with a marine radio as well as a NOAA weather radio to ensure a viable form of receiving alerts even while at sea. Some options for receiving alerts are:

Syndication

The warning centers have Atom feeds available that can be monitored for product updates.

- NTWC ATOM Feed - www.tsunami.gov/events/xml/PAAQAtom.xml
- PTWC ATOM Feed - www.tsunami.gov/events/xml/PHEBAtom.xml

Text Messages [Short Messaging System (SMS)]

As of April 2020, the NTWC no longer relays tsunami alerts through Twitter's Tweet-to-SMS because this service was discontinued by Twitter.

To continue receiving notifications when a tweet from @NWS_NTWC or @NWS_PTWC is sent, you must choose to be notified within the Twitter app on your mobile device and/or through the twitter.com website. Your personal account settings may affect your ability to be notified in this way.

For more on how to set up tweet notifications (push notifications) to your device, head to https://help.twitter.com/en/managing-your-account/notifications-on-mobile-devices and choose Apple or Android.

You may find additional information here: https://help.twitter.com/en/managing-your-account/enabling-web-and-browser-notifications

Facebook

- NTWC Facebook Page
- PTWC Facebook Page

Email

The UNESCO/IOC service will provide NTWC bulletins for seismic events greater than magnitude 6.5. Other tsunami warning centers provide information to this list also.

- UNESCO/IOC Email Service
- Additional Third Party Email Options - NWS Subscriptions

Common Alerting Protocol

The warning centers generate Common Alerting Protocol (CAP) documents for events.

- NTWC CAP document - https://www.tsunami.gov/events/xml/PAAQCAP.xml
- PTWC CAP document - https://www.tsunami.gov/events/xml/PHEBCAP.xml

The CAP tsunami profile (CAP-TSU), is documented at: https://www.tsunami.gov/?page=cap

NOAA Weather Radio (NWR)

NOAA Weather Radio All Hazards (NWR) is a nationwide network of radio stations broadcasting continuous weather information directly from the nearest NWS office. NWR broadcasts official Weather Service warnings, watches, forecasts, and other hazard information 24 hours a day, 7 days a week. Working with the Federal Communication Commission's (FCC) Emergency Alert System, NWR is an "All Hazards" radio network, making it your single source for comprehensive weather and emergency information. NWR also broadcasts warning and post-event information for all types of hazards – including natural, environmental, and public safety. NWS will send a 1050 Hz tone alarm before broadcasting most warnings and many watch messages. The alarm will activate all the receivers equipped to receive it, even if the audio is turned off.

Tsunami alerts above an information statement will be broadcast over NOAA Weather Radio by the NWS.

NWR includes more than 1,000 transmitters, covering all 50 states, adjacent coastal waters, Puerto Rico, the U.S. Virgin Islands, and the U.S. Pacific Territories. NWR requires a special radio receiver or scanner capable of picking up the signal; the broadcasts cannot be heard on a simple AM/FM radio receiver. There are many receiver options, however, ranging from handheld portable units that just pick up Weather Radio broadcasts, to desktop and console models which receive Weather Radio as well as other broadcasts. Many newer models also include a feature which allows the radio to silently monitor for alerts, much like a smoke detector, and only sound an alarm for a warning.

A list of all NWR transmitters in WA can be found at the NWR County Coverage Listing for Washington. Broadcasts are found in the VHF public service band at these 7 frequencies (MHz):

162.400	162.425	162.450	162.475	162.500	162.525	162.550

Marine Radio

A marine radio is required for all commercial vessels as well as any recreational vessel over 65.6 feet in length. While a marine radio is not required for recreational vessels under 65.6 feet,

marine VHF radios are relatively inexpensive and should be considered an essential safety item for any boater. In the event of an emergency the USCG will utilize channel 16 (the designated emergency channel) to send alerts to all vessels in the area. Additionally, a marine radio can act as an essential means of communication during an emergency to alert fellow mariners, receive instructions from local authorities and receive information and instruction regarding the ability to return to local ports and harbors when at sea. Many marine radios also double as NOAA weather radio receivers, acting as both a means of communication and a means to receive emergency alerts. The USCG will be broadcasting tsunami warnings directly from the NTWC to boaters on marine radio channel 16 (156.800 MHz). Be sure to check if your radio can receive these alerts and is programmed with the correct local frequency for your area.

Vessel Traffic Service (VTS)

The Vessel Traffic Center is located at Pier 36 in Seattle and monitors the Strait of Juan de Fuca, Rosario Strait, Admiralty Inlet, and Puget Sound south as far as Olympia. Since 1979, the U.S. Coast Guard has worked cooperatively with the Canadian Coast Guard in managing vessel traffic in adjacent waters. Through the Cooperative Vessel Traffic Service (CVTS), two Canadian Vessel Traffic Centers work hand in hand with Puget Sound Vessel Traffic Service. Prince Rupert MCTS (Marine Communications and Traffic Services) manages the area west of the Strait of Juan de Fuca. North of the Strait of Juan de Fuca, through Haro Strait, to Vancouver, B.C. is managed by VICTORIA MCTS. The three Vessel Traffic Centers communicate via a computer link and dedicated telephone lines to advise each other of vessels passing between their respective zones.

Puget Sound *Seattle Traffic* 156.700 MHz (Ch 14): The waters of Puget Sound, Hood Canal and adjacent waters south of a line connecting Marrowstone Point and Lagoon Point in Admiralty Inlet and south of a line drawn due east from the southernmost tip of Possession Point on Whidbey Island to the shoreline

Puget Sound *Seattle Traffic* 156.250 MHz (Ch 5A): The waters of the Strait of Juan de Fuca east of 124°40' W. excluding the waters in the central portion of the Strait of Juan de Fuca north and east of Race Rocks; the navigable waters of the Strait of Georgia east of 122°52' W.; the San Juan Island Archipelago, Rosario Strait, Bellingham Bay; Admiralty Inlet north of a line connecting Marrowstone Point and Lagoon Point and all waters east of Whidbey Island North of a line drawn due east from the southernmost tip of Possession Point on Whidbey Island to the shoreline.

VTS Puget Sound, or Seattle Traffic, has two frequency areas, Ch. 5A and 14. The Channel 5A (156.250 MHz) service area is used in the northern portion of the VTS Area and is situated between Prince Rupert and Victoria's service areas. The Seattle Traffic Ch. 5A area has an exchange line with Prince Rupert and Victoria defined as a line drawn north from the Olympic Peninsula at 124°40'W Longitude to the Coast of Vancouver Island, thence eastward along the coast of Vancouver Island (including all the inlets and ports, i.e. Port Renfrew, and Sooke Inlet) to Church Point. From Church Point the line connects to Race Rocks Light, then due easterly to the intersection of the U.S./Canadian border at 48°17'53.0"N/ 123°14'06.0"W, north-easterly to

Hein Bank in position 48°21’05.62”N/123°02’45.72”W, northerly to Cattle Point Light on San Juan Island, along the shoreline to Lime Kiln Light, to Kellett Bluff Light on Henry Island, along the shoreline to the tip of McCracken Point at the northernmost point of Henry Island, to the southernmost point on Stuart Island in position 48°39’28”N/ 123°11’05”W, along the shoreline to Turn Point Light, to Sandy Point on Waldron Island, along the shoreline to Point Hammond, to Patos Island Light, to Alden Bank in position 48°50’23.39”N/ 122°52’13.67”W, then due north to Boundary Bay in position 49°00’07.5”N/ 122°52’13.67”W, then due east along the international boundary to the shoreline in Semiahmoo Bay. The Channel 14 (156.700 MHz) service area is all navigable waters south of a line from Nodule Point to Bush Point in Admiralty Inlet, and south of a line drawn eastward from Possession Point on Whidbey Island to the shoreline on the mainland.

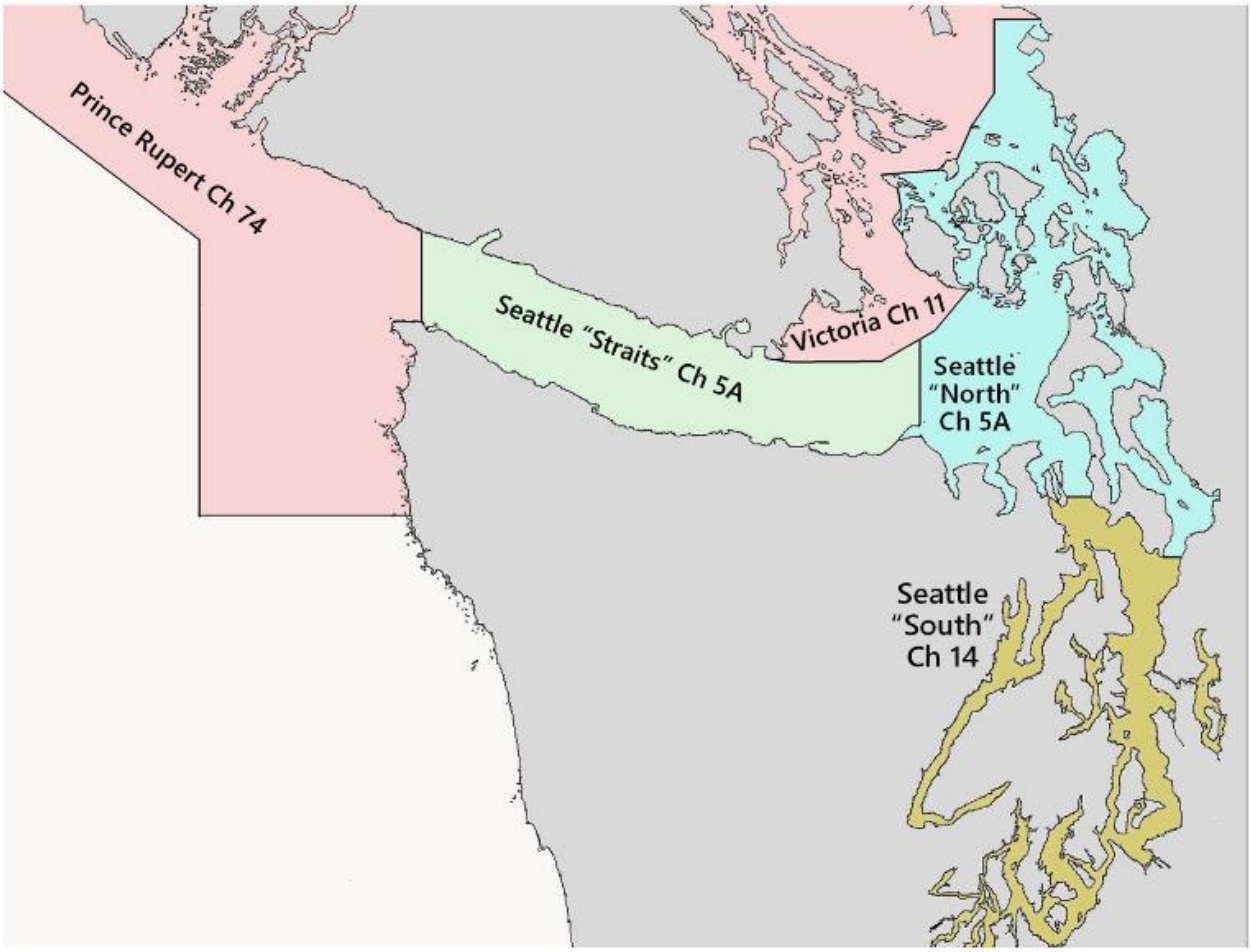

Figure 2: Map showing VTS channel locations.

Interactive NWS (iNWS)

The NWS also provides InteractiveNWS (iNWS) which is an application suite able to send NWS products to local partners in multiple ways, including as texts. Visit https://inws.ncep.noaa.gov/ to learn more or to register and sign up for the service. Once your registration has been accepted you can go onto the site and set up text and email alerts.

National Weather Service Systems

- NOAA Weather Wire Service
- NOAA Weather Radio (NWR)
- Emergency Managers Weather Information Network (EMWIN)
- The NOAAPORT broadcast system

Other Federal Systems

- Emergency Alert System (EAS)
- U.S. Coast Guard
- Wireless Emergency Alerts

AHAB Sirens

Washington has 120 All Hazard Alert Broadcast (AHAB) tsunami sirens installed in locations determined to be at high-risk from a tsunami. AHAB tsunami sirens are intended to act as an **outdoor** tsunami warning system using a 360-degree speaker with an effective audible range of 1 mile depending on weather, topography, and other factors. The sirens are equipped with a blue flashing light to alert the hearing impaired. The sirens are **not** designed or intended to warn people who are inside homes, cars, or buildings. The sirens can be activated by state officials by satellite, as well as by local authorities by radio. The connectivity of the entire network of sirens is tested daily in what is referred to as a 'silent test' to ensure that the sirens are operable. The sirens are sound tested on the first Monday of every month at 12:00 noon; the test consists of the siren playing the Westminster Chimes followed by a verbal test message in English and Spanish.

The Voice Test Message: *"The following is a test of the siren warning system. This is only a test of the siren warning system. Had this been a real emergency you should have moved to higher ground or inland before tuning to your local media sources for further instructions. This was only a test."*

The AHAB tsunami sirens are also tested annually during The Great Washington ShakeOut on the third Thursday in October. During the Great Washington ShakeOut, the sirens play the actual tsunami warning wail sound, followed by a voice message in English and Spanish.

Shakeout Voice Test Message: *"This is a test of the siren alert system. If you are in a low coastal area, test your evacuation route. If this had been a real emergency, you should follow evacuation routes, move to higher ground inland, now. Do not delay. Do not return until directed to do so. Tune into your local media sources for further instructions. This was only a test."*

Upon issuance of a **Tsunami Warning** from the NTWC, the Washington State Alert and Warning Center will activate the AHAB tsunami sirens. When activated the blue strobe light will flash and the siren will sound a long **wail tone** and a voice message will follow first in English, and then in Spanish. This message will repeat every 20 minutes for 4 hours or until the siren is deactivated, a cancellation is issued, or the batteries die.

The Voice Warning Message: *"The National Weather Service has issued a tsunami Warning. A tsunami can create strong waves, dangerous flooding, and powerful currents. If you are in a coastal area you are at risk and must move to higher ground or inland now. Do not return until directed to do so. Tune to local media for additional information after you move to higher ground or inland."*

If a tsunami warning is cancelled by the NTWC the Voice Warning Message will cease and the sirens will play a cancellation message to inform of the change.

The Cancellation Message: *"The tsunami Warning has been Cancelled. The tsunami Warning has been Cancelled. The tsunami Warning has been Cancelled. Tune to your local media sources for additional information."*