



Service Assessment

South Pacific Basin Tsunami – September 29-30, 2009



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service
Silver Spring, Maryland

Cover Photographs:

Photographs of the damage incurred on the island of American Samoa as a result of the September 29 tsunami.

Photos courtesy of the Associated Press (top left) and Gordon Yamasaki, NOAA National Marine Fisheries Service, Pago Pago



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May 2010

National Weather Service
John L. Hayes
Assistant Administrator for Weather Services

Preface

A magnitude 8.0 earthquake occurred on September 29, 2009, 120 miles southwest of American Samoa. This major earthquake generated a tsunami that took many lives and caused significant destruction to neighboring islands in the Pacific Ocean. With only 17 minutes between the beginning of the earthquake and the arrival of the first waves in American Samoa, preparedness efforts and rapid warnings were critical for residents to protect themselves. Although reduced in size, the tsunami generated by this earthquake reached the Hawaiian Islands and eventually the West Coast of the continental United States. There were no major impacts in Hawaii or along the West Coast.

The mission of the National Oceanic and Atmospheric Administration's National Weather Service is to provide weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters, and ocean areas for the protection of life and property and the enhancement of the national economy. This mission includes warnings for tsunami events. The National Weather Service chartered a team to assess the performance of our offices and the effectiveness of our services as they related to this tsunami event. The team focused on tsunami-affected areas served by the National Weather Service in American Samoa and Hawaii. The goal of this report is to share best practices and challenges with all our offices in order to continuously improve services.

Without a doubt, strong tsunami outreach and education efforts by the International Tsunami Information Center, the Pacific Tsunami Warning Center, the Weather Service Office in Pago Pago, American Samoa officials, and National Oceanic and Atmospheric Administration partners saved numerous lives. In fact, because of public tsunami education and outreach, people knew what actions to take based on the earthquake duration, magnitude, and the receding of the ocean. However, challenges were identified in the areas of internal and external communication and warning systems during this major disaster. These are further detailed in this report.



John L. Hayes
Assistant Administrator
for Weather Services

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Service Assessment Team

The following members were on the team:

Kenneth Graham	Team Leader , Meteorologist-in-Charge, National Weather Service (NWS) New Orleans/Baton Rouge, LA
Allison Allen	Oceanographer, Coastal Program Manager, Center for Operational Oceanographic Products and Services, National Ocean Service, Silver Spring, MD
Cheryl Anderson	Social Scientist, Director of the Hazards, Climate & Environment Program in the Social Science Research Institute, University of Hawaii, Honolulu, HI
Christa von Hillebrand-Andrade	Geologist, Director and Researcher, Puerto Rico Seismic Network, Department of Geology, University of Puerto Rico, Mayagüez, PR
Melinda Bailey	Meteorologist, Marine and Public Services Program Manager, NWS Southern Region Headquarters, Fort Worth, TX
Susan Buchanan	Public Affairs Specialist, National Oceanic and Atmospheric Administration, Silver Spring, MD
Michael Caropolo	Meteorologist-in-Charge, NWS Wilmington, NC
Jeff Lorens	Meteorologist, Marine and Warning Coordination Program Manager, NWS Western Region Headquarters, Salt Lake City, UT
Bruce Turner	Geophysicist, Science Officer (Ret.), NWS West Coast and Alaska Tsunami Warning Center, Palmer, AK
Bill Ward	Meteorologist, Chief Environmental Sciences and Services Division, NWS Pacific Region Headquarters, Honolulu, HI
Tyree Wilde	Warning Coordination Meteorologist, NWS Portland, OR

Other valuable contributors:

David Caldwell	Meteorologist, Director Office of Climate, Water, and Weather Services (OCWWS), NWS Headquarters Silver Spring, MD
Jenifer Rhoades	NOAA Tsunami Program Coordinator/National Tsunami Hazard Mitigation Program Administrator, OCWWS, NWS Headquarters Silver Spring, MD
Laura Kong, PhD	Director, International Tsunami Information Center, Honolulu, HI
Vasily Titov, PhD	Chief Scientist, NOAA Center for Tsunami Research, Seattle, WA
Paul Whitmore	Geophysicist, Director, West Coast and Alaska Tsunami Warning Center, Palmer, AK
Douglas Young	Chief, OCWWS Performance Branch
Sal Romano	Service Assessment Program Manager, OCWWS Performance Branch
Melody Magnus	Technical Editor, Earth Resources Technology Inc., OCWWS

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Executive Summary

A magnitude 8.0 earthquake, as measured by the U.S. Geological Survey, occurred on September 29, 2009, at 17:48 Coordinated Universal Time (6:48 a.m. local time). This major earthquake generated a destructive, basin-wide tsunami, which resulted in approximately 190 fatalities in American Samoa, Western Samoa, and Tonga. The tsunami prompted a large-scale response by the National Oceanic and Atmospheric Administration's National Weather Service (NWS), Emergency Managers, state and local governments, and coastal communities.

This event revealed weaknesses in the existing Pago Pago Weather Service Office (WSO) infrastructure and tsunami warning protocols. The public and local authorities expressed confusion during and following the event. Officials in American Samoa stated if this event had occurred during the night, the casualties would likely have been significantly higher. In addition, the Pacific Tsunami Warning Center did not include dissemination of local warning products for American Samoa in its mission, nor is there sufficient seismic and sea level instrumentation in the region to support local warning capabilities. Due to the short time between the earthquake and the tsunami impact, WSO Pago Pago was solely responsible for issuing a tsunami warning in American Samoa. Recent enhancements to the local Emergency Alert System (EAS) and the creation of an EAS Committee, driven by local warning focal points, American Samoa government officials, and the WSO over the past 3 years allowed for dissemination of critical information during this event.

Recent NWS tsunami outreach efforts in Western and American Samoa by the International Tsunami Information Center, Pacific Tsunami Warning Center (PTWC), and WSO Pago Pago, in recognition of the region's vulnerability to a potential local tsunami and in accordance with the mitigation strategy for local tsunamis practiced elsewhere in the world proved to be a tremendous success in triggering effective local response. Before official warning products were disseminated, emergency responders, local government officials, and the public were able to respond to natural warning signs because they understood the tsunami threat. This was due to education and outreach efforts such as seminars, meetings, and workshops held over the summer of 2009. In addition, many schools, businesses, and other major population centers had developed tsunami evacuation plans, which they implemented with success during this event. There is, however, a need for continued and expanded outreach and education in American Samoa and the surrounding area to sustain and build on these successful efforts and address any challenges.

In Hawaii and along the West Coast, NWS tsunami response and products were very effective. Hawaii's government avoided issuing an evacuation order due to information from the Pacific Tsunami Warning Center. Modifications to the tsunami advisory for Hawaii were used successfully. New numerical tsunami models were used in a major event for the first time and added significant value. Both Tsunami Warning Centers held a number of conference calls with state EMs to disseminate information for timely decision making.

The September 29 event revealed successes and needs for improvement in NWS response to tsunami events in the Pacific Basin. There has not been a destructive tsunami in this area of the Pacific since 1917. This event provides an opportunity to enhance infrastructure and streamline dissemination to prepare for future events. Specific recommendations addressing these and other concerns are detailed in the following report.

Without a doubt, several best practices helped save numerous lives. The following best practices should be highlighted:

- 1) Aggressive outreach taught officials and the public to take life-saving actions based upon natural warning signs such as “stronger earthquake than usual” and the sea receding. Every school on American Samoa has a Tsunami Evacuation Plan. Several schools were destroyed; however, previous outreach and training efforts resulted in successful evacuation of students and staff with minimal loss of life. Based on training, the police sounded car sirens and used public address systems to instruct the public to evacuate to higher ground. Tsunami outreach in the Pacific Basin should not only continue but should be institutionalized as part of an effective strategy to help prevent future loss of life.
- 2) EAS portable radios on American Samoa allowed officials to communicate despite jammed phone lines. The EAS system allowed the Meteorologist-in-Charge, at WSO Pago Pago, to radio Department of Homeland Security staff, who in turn asked the Local Primary 1 radio station to activate Vertical Evacuation Plans prior to the tsunami. Having an EAS Committee and plan for American Samoa allowed NWS to send critical information to the public quickly, thus saving lives.
- 3) Hawaii has been designated as TsunamiReady[®]. Based on preplanned actions, PTWC’s bulletins prompted swift action by the Waikiki Police Department, lifeguards, and hotel staff. Police officers walked the beaches asking people to leave. Lifeguards from the Ocean Safety Group used watercraft to urge people to get out of the water. Hotel staff told people to stay away from beaches.
- 4) The Short-term Inundation and Forecasting for Tsunamis model provided critical decision support information to Hawaii. Having Pacific Marine Environmental Laboratory modelers at PTWC during the event was beneficial for the Short-term Inundation and Forecasting for Tsunamis program. Modelers were able to see how the data are used and how they could improve the program.
- 5) Observing systems and monitoring networks are critical infrastructure to a successful tsunami warning system. Deep-Ocean Assessment and Reporting of Tsunamis[®] buoys, or tsunameters, NOS tide gauges, and seismometers are all critical to detecting and responding to local, short-fused, events in the Pacific. In fact, the California Integrated Seismic Network display at WSO Pago Pago allowed the office to see initial earthquake readings that exceeded known thresholds for tsunami genesis.

Despite these best practices, this report details significant areas needing improvement. The following summarizes some of the challenges:

- 1) Interviews in American Samoa showed strong support from EMs and the media for the TsunamiReady program. Other U.S. Territories should be encouraged to become TsunamiReady. In addition, other countries should be encouraged to adopt similar programs to improve tsunami preparedness, outreach and education, and mitigation.
- 2) The NWR Interalia system must be improved or replaced. The system requires users to complete dozens of steps to issue a tsunami warning. This complexity led to the accidental issuance of a Required Weekly Test and repetitive issuances and EAS activations during the tsunami. The tsunami warning was issued on NOAA Weather Radio after the event was over. Since Weather Radio is the primary input to EAS, this problem must be fixed without delay.
- 3) As during many major events, phone lines were jammed. Hotlines are urgently needed to ensure communication between Pacific WSOs, PTWC, the West Coast/ Alaska Tsunami Warning Center, Pacific Region Headquarters, and other national and international partners. Also, dedicated telephone lines would help facilitate media calls by differentiating them as partner contacts.
- 4) Local, short-fused warnings for communities outside of Hawaii were not part of PTWC's mission for this tsunami. PTWC's mission should be changed to ensure it develops domestic warning products in conjunction with WSOs, Weather Forecast Offices, and local EMs.
- 5) Bandwidth and outdated technology have been challenges at PTWC and WSO Pago Pago. Efforts should be taken to replace outdated equipment and to include these Websites in the NWS Web farm, which offers more bandwidth.
- 6) Immediate efforts should be taken to ensure PTWC has an Event Coordinator and has better control of building security and operations area access. The onslaught of people in the operations area during the event affected PTWC's ability to focus on mission delivery. A NOAA-wide Quick Response Team should be created to respond rapidly to tsunami events.

WSO Pago Pago does not have the Advanced Weather Interactive Processing System, Console Replacement System, or the staffing of a typical NWS Forecast Office; however, it is expected to perform similar mission duties. The team encourages technology upgrades for this and other WSOs.

Best practices must continue to be shared between the Tsunami Warning Centers. Vast differences in how each center operates impacts how critical services are provided to Forecast Offices, WSOs, media, EMs, and foreign nations.

This report identifies 12 best practices and 54 recommendations based on the team's findings. The NWS definitions of facts, findings, recommendations, and best practices can be found in **Appendix A**. A full list of best practices, findings, and recommendations from this report can be found in **Appendix B**.

1. Introduction

1.1. Pacific Tsunami Warning Center, West Coast and Alaska Tsunami Warning Center, and National Weather Service Mission

Tsunamis are high-impact, low frequency natural hazards. Since 1900, more than 200 tsunami events, mostly earthquake-generated, have affected the coasts of the United States and its territories, causing more than 500 deaths. The mission of the NOAA Tsunami Program is to provide reliable tsunami forecasts and warnings, and to promote community resilience. The mission of NOAA's Tsunami Warning Centers (TWC) is to protect lives and property from tsunami hazards by providing timely, accurate, reliable, and effective tsunami information to coastal populations and emergency management within their areas of responsibility, and by advancing other aspects of tsunami hazard mitigation such as community preparedness and public education. The primary operational warning system objectives for carrying out this mission are as follows:

- Rapidly locate, size, and otherwise characterize major earthquakes
- Determine their tsunamigenic potential
- Predict tsunami arrival times
- Predict coastal run-up when possible
- Disseminate appropriate warning and informational products

The PTWC, located at Ewa Beach, Hawaii, is responsible for preparing and disseminating tsunami watches, warnings, advisories and information bulletins to Hawaii, most countries in the Pacific Basin and all other U.S. interests in the Pacific Basin outside of Alaska, Canada, and the U.S. West Coast. The PTWC Area of Responsibility (AOR) also includes the countries of the Indian Ocean, South China Sea, and Caribbean Sea. PTWC's international responsibilities are determined by agreement and coordination with the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Intergovernmental Oceanographic Commission (IOC). The West Coast/Alaska Tsunami Warning Center (WC/ATWC) in Palmer, Alaska, is responsible for issuing tsunami warnings, watches, advisories, and information statements for Alaska; the West, East, and Gulf of Mexico Coasts of the United States; Canada; Puerto Rico; and the Virgin Islands. Each center's AOR is depicted in **Figure 1**.

Both TWCs detect, respond to, and evaluate earthquakes that have the potential to produce a tsunami in either center's AOR. The two centers coordinate the information in their products. Each center also backs up the other, as needed, to maintain continuous observation and warning capability.



Figure 1. PTWC and WC/ATWC Areas of Responsibility (Blue star represents WSO Pago Pago)

The Tsunami Warning and Education Act, which authorized the strengthening of the U.S. tsunami program, was signed into Public Law (P.L. 109-424) on December 20, 2006. This Act authorized NOAA to conduct a Tsunami Warning and Education Program, which included operating TWCs 24/7 and increasing education, outreach, and other mitigation activities. NWS was able to increase TWC staffing and to support 24/7 operations through 2005 Congressional Emergency Appropriations.

1.2. Purpose of Assessment Report

This Service Assessment focused primarily on operations, products, and services at the PTWC, WC/ATWC, WSO Pago Pago in American Samoa and the Weather Forecast Office (WFO) in Honolulu. Education and outreach relating to tsunamis proved to be a primary component in saving lives in American Samoa. Opportunities for improvement were found in PTWC and WSO Pago Pago operations, as well as in dissemination and coordination. The final outcomes are shared to ensure the NWS provides the best decision support services.

1.3. Methodology

The Service Assessment Team was chartered on October 16, 2009. The goal of the team was to assess NWS performance before, during, and after the tsunami event to identify best practices and challenges. The team deployed to American Samoa and Hawaii and conducted interviews with NWS personnel, Emergency Managers (EMs), residents, and others to explore all aspects of tsunami warning services provided on September 29, 2009.

2. Summary of Earthquake and Resultant Tsunami Event

The earthquake was centered about 193 km (120) miles southwest of American Samoa. Moderate to strong ground shaking—up to Intensity VI on the Modified Mercalli Scale¹—lasting up to 3 minutes—was reported from American Samoa. The earthquake occurred near the northern end of a 3000 km (1864 mi) long segment of the Pacific/Australia plate boundary, one of the most active earthquake regions in the world, with most earthquakes occurring on the thrust zone where the Pacific plate subducts beneath the Australia plate. It was initially inferred by the U.S. Geological Survey (USGS) that the earthquake occurred as a normal fault rupture on or near the outer rise of the Pacific plate where it flexes before subducting. Post-earthquake investigations suggested the fault rupture was more complicated, with multiple segments and different directions of motions. The average run-up heights² in American Samoa were 2 meters (6½ ft.), but run-up heights of up to 17 meters (56 ft.) were reported by post-event survey teams. Real-time observing systems during the event, operational forecast models, and post-event surveys have been critical in understanding the propagation and impact of this event. Real-time observations include those from seismic sensors, coastal sea level stations, and tsunameter buoys, including Deep-Ocean Assessment and Reporting of Tsunamis (DART) buoys.

The proximity of American Samoa, Western Samoa, and Tonga to the seismically active Tonga Trench makes this area extremely vulnerable to local, short-fused tsunami events. Approximately 17 minutes elapsed between the start of the earthquake and the arrival of the first wave at American Samoa. The PTWC issued a warning to the region in 16 minutes. The delay was partially due to the relatively low density of seismic sensors in this region. Disseminating tsunami warnings in this area can be further complicated by the presence of multiple governance structures, national languages, and cultural diversity. This event highlights the need to implement local tsunami warning capabilities throughout the Pacific basin and to streamline communication and product dissemination mechanisms to ensure efficient, swift delivery of warning services.

3. Best Practices, Facts, Findings, and Recommendations

3.1. PTWC Operations, Products, and Services

The earthquake occurred just before the scheduled shift-change [8 a.m., Hawaiian Standard Time (HST)] at PTWC. Operational duty staff was notified of the event via a phone call from WSO Pago Pago. The initial seismic data began arriving as staff took the call, and alarms sounded shortly after. (Refer to the detailed timeline in **Appendix E** for more

¹ Intensity scales consist of a series of certain responses as effects of an earthquake on the Earth's surface. The intensity scale currently used in the United States is the Modified Mercalli Intensity Scale. (<http://earthquake.usgs.gov/learn/topics/mercalli.php>)

² Tsunami run-up occurs when a peak in the tsunami wave travels from the near-shore region onto shore. Run-up is defined by the USGS as “a measurement of the height of the water onshore observed above a reference level.” (<http://walrus.wr.usgs.gov/tsunami/basics.html>)

information on the timing of specific events.) As PTWC received additional seismic information, it determined the earthquake location, depth, and magnitude and revised its initial magnitude from 7.1 to 7.9. Coordination with WC/ATWC via phone, per standard procedures, was efficient and effective.

No deficiencies were noted with regard to PTWC's hardware or software; however, there were differences between PTWC and WC/ATWC initial analysis of the event in terms of computational speed, accuracy, and seismic alarm functions. These differences contributed to the TWCs receiving initial earthquake determinations at different times and rating the earthquake at different magnitudes.

Best Practice 1—Coordination between the centers during a tsunami event allows the offices to quickly share information.

Best Practice 2—A “personnel exchange program” facilitates direct interchange of ideas and information between the TWCs, contributing to continuous improvements in real-time coordination during tsunami events and effectiveness of mutual service backup operations when needed.

Fact—WC/ATWC issued its initial Tsunami Information Statement approximately 2 minutes sooner than PTWC's initial Tsunami Bulletin.

Fact—WC/ATWC and PTWC arrived at their respective initial earthquake parameter assessments in different time frames and with different degrees of accuracy.

Finding 1—There is a low density of seismic sensors in the Samoa region, contributing to the delay in warning issuance when compared to other domestic regions.

Recommendation 1—NWS should collaborate with USGS and international partners to increase the density of seismic sensors in the southwestern Pacific basin.

Finding 2— PTWC operates different seismic analysis software than WC/ATWC. This difference, coupled with bandwidth limitations, may have contributed to a delay of up to 2 minutes in locating the earthquake position and depth and assigning an accurate preliminary magnitude.

Recommendation 2—Conduct an analysis of the WC/ATWC and PTWC seismic processing systems and alarm algorithms, and ensure the systems are aligned.

Fact—PTWC relies on NOAANet for transmission of critical seismic and water level data.

Fact—There is no redundancy system in place to back up NOAANet.

Finding 3—Currently available bandwidth allows PTWC to monitor only a limited number of seismic stations. This may have contributed to delays in locating and sizing the earthquake that produced the tsunami.

Recommendation 3—Increase the bandwidth and provide a backup system for NOAA Net.

The PTWC operations area became increasingly chaotic, due to continuous phone calls, the presence of a police officer, several members of the media, additional PTWC staff who arrived to help, three Short-term Inundation and Forecasting for Tsunamis (SIFT) model experts from Pacific Marine Environmental Laboratory (PMEL), and Pacific Region Headquarters (PRH) personnel. Additionally, the PTWC lead watchstander lacked an efficient means to collect and share vital decision support information with high priority users.

Fact—Soon after the earthquake occurred operations became negatively affected when additional people gathered in the operations area. Additional PTWC staff arrived shortly after being paged, adding to the total number of people present; media representatives also interacted with operational staff. This number of people resulted in too many concurrent conversations by those present and on the five phone lines, which were being used continuously.

Finding 4a—Extra staff members who arrived at PTWC to assist with the event were not assigned to fulfill specific functions, such as answering phones outside of the operation area and coordinating with media representatives.

Finding 4b—PTWC staff do not have a formal system for getting media representatives the information they need without affecting operations.

Finding 4c—Staff at PTWC lack training in media and crisis communications.

Recommendation 4a—PTWC should develop procedures to designate an Event Coordinator for all major events. The office should also include procedures in its Operations Manual for assigning a Media Liaison and initiating a Crisis Communications Plan.

Recommendation 4b—PTWC staff should receive professional media training that includes crisis planning, communicating during a crisis, delivering short sound bites, and organizing press conferences. Training should be ongoing with refresher courses at least every 2 years.

Recommendation 4c—PTWC should implement tighter physical controls for entry into its facility.

Fact—PTWC did not have staff members properly assigned to efficiently handle this event.

Fact—NWS communications resources in Hawaii were not leveraged during this tsunami event.

Finding 5—Two PRH staff members arrived at PTWC but were not used to resolve operational efficiency issues.

Recommendation 5—PRH should set up a Quick Response Team (QRT) for PTWC that would include all available NOAA communications assets in Hawaii [PRH Public Affairs Officer, WFO Warning Coordination Meteorologist (WCM), and Regional WCM, for example]. The QRT would be activated during high impact events to assist with media and public communications at PTWC. The team should meet regularly and create a Significant Event Crisis Communications Plan.

Finding 6—Space at PTWC is inadequate for media operations during high impact events.

Recommendation 6—PTWC should establish a media pool agreement with media outlets.

Fact—The heavy volume of incoming calls to PTWC compromised the operational environment and interfered with the staff’s ability to deliver timely decision support information. The telephone system at PTWC is not able to identify incoming callers (e.g., general public, media, public safety officials, State/County Civil Defense).

Finding 7—The limitations imposed by PTWC’s telephone system interfered with the staff’s ability to quickly respond to high priority calls from public safety and Emergency Management (EM) officials and the media. The high volume of incoming calls also hindered the center’s ability to make outgoing high priority calls. Because of the inability to differentiate incoming calls during this crucial time, PTWC was unable to prioritize calls. NWS Headquarters, WSO Pago Pago, WFO Honolulu, and Hawaii Civil Defense reported difficulty in reaching PTWC via phone.

Recommendation 7a—Increase the use of the Hawaii Warning System (HAWAS) for direct communication between NWS offices and key users/partners within the state of Hawaii.

Recommendation 7b—PRH should work with the Federal Emergency Management Agency (FEMA) to develop a hotline or equivalent capability-for other locales (e.g., Guam, American Samoa) in PTWC’s area of responsibility that require instantaneous and frequent communication with PTWC.

Fact—The telephone system at PTWC does not have an automated message capability for tsunami event information. Recordings are placed manually on the phone system during tsunami watch/warning/advisory situations. The general public is one of the primary users of this service.

Finding 8—Because of the time required for manual recording and the frantic atmosphere in PTWC’s operations area, no outgoing telephone message was provided during this event.

Recommendation 8—PTWC should implement an automated recording capability for tsunami watches, warnings, advisories, and other critical tsunami event information, and develop procedures to allow these functions to be performed by the QRT if necessary.

Fact—PTWC’s Website experienced a major slow-down at approximately 8:30 a.m., HST. As a result, many users were unable to obtain critical Web-based information for at least 3½ hours.

Finding 9—PTWC’s Website slow-downs are an ongoing problem. The near-failure of the Website in this event inhibited users’ abilities to receive timely, specific information, including details regarding tsunami watches, warnings, and advisories for Hawaii and the entire Pacific. The Website deficiencies added to an already heavy telephone call load at PTWC.

Recommendation 9a—The PTWC Website should be hosted on the consolidated Web farm to improve reliability and allow backup capability.

Recommendation 9b—Continue, and accelerate if possible, development of the NWS Tsunami Portal, which is planned to replace both TWC’s Websites as the primary site for all tsunami information.

During this event, scientists from the PMEL were visiting PTWC to provide training on the initial version of the SIFT model for TWC operations. These scientists ran the SIFT model in real time for the event, producing a valuable SIFT forecast for Hawaii as well as experiencing firsthand the difficulties running the current version of SIFT in crisis mode.

Best Practice 3—The SIFT forecasts provided PTWC with vital information indicating the tsunami would not be destructive for Hawaii. Despite the need for necessary enhancements, the SIFT, Alaska Tsunami Forecast Model (ATFM), and Real-time Inundation Forecasting for Tsunamis (RIFT) forecast models, along with the seismic and historical data, provided PTWC operations staff sufficient confidence to replace the tsunami watch with a tsunami advisory for Hawaii. This action prevented an unnecessary evacuation, while still providing an alert about the potential hazards from strong currents and sea level changes on beaches and in harbors.

Fact—As a result of PMEL interactions with the PTWC operations staff and PMEL’s observations of the SIFT model in an actual major tsunami situation, PMEL gained invaluable knowledge regarding the strengths and limitations of SIFT.

Finding 10a—PTWC had been using SIFT on an experimental/research basis. The current version of the SIFT model, however, is not sufficiently streamlined for real-time use in an operational environment. Given other high priority tasks operational staff are responsible for during events, it is difficult to manage and integrate the high volume of SIFT data output.

Finding 10b—The current version of SIFT does not include output for American Samoa. Additionally, SIFT is designed to provide output for specific points along a coast, not large-scale areas, where a Standby Inundation Model (SIM) has not been constructed.

Recommendation 10a—SIFT should be streamlined to include better information management capabilities.

Recommendation 10b—Modify SIFT to do the following:

- Increase the number and type of data sources for which it accounts.
- Add a capability to input other types of solutions not already included in the precomputed source information.
- Provide an accurate general forecast for coastlines not covered by SIMs.

Fact—The SIFT model provides critical tsunami inundation forecast information to assist TWC operational staff with tsunami watch/warning/advisory decisions; however, the model’s value is confined to a limited set of forecast output points, though the ATFM has additional output points, and was also used during the event. **Figure 2 in Appendix D** provides an example of output from the ATFM. The value of developing a more geographically extensive coastal inundation forecast model was illustrated during this event at Keahou Bay, a small inlet on the western coast of the island of Hawaii, which was not an output point on either operational forecast model, as shown in **Figure 3 of Appendix D**.

Fact—The ATFM provides quick coastal forecasts for the North American and Hawaiian coasts.

Finding 11—ATFM energy maps provided important information during the event, but the coastal forecast output file was corrupted and not used by either center.

Recommendation 11—The ATFM output files must be checked to ensure that forecasts for all precomputed sources are immediately available during events at both centers.

Fact—During the event, the water level rose 3 feet at Keahou Bay, a value higher than expected. Although there were no major impacts reported, the water level was high enough to cover docks and the parking lot at an adjacent boat ramp. In addition, there were indications of strong currents caused by the tsunami.

Finding 12—SIFT provides forecasts of water level only at a limited number of geographical points; Keahou Bay is not one of these points. PTWC cannot produce a coastal tsunami model that provides large scale, detailed forecasts of water levels for extended portions of the coast between or outside of the points provided by SIFT and ATFM. Had such a modeling capability existed, PWTC could have provided improved water level forecasts for the larger scale, i.e., coastal areas of Hawaii in between SIFT forecast points, American Samoa, and other international coasts for which PTWC has warning responsibility.

Recommendation 12—The large scale, coastal forecast ability of the ATFM should be expanded to include international areas and additional domestic areas (e.g., Hawaii).

The DART buoys, or tsunameters, and coastal sea level stations (tide gauges) proved extremely valuable to both TWCs. As the tsunami propagated, the water level data provided by the DART buoys and water level stations were critical to TWC operational staff issuing and updating tsunami watches, warnings, and advisories. Additionally, the DART data were used by officials in Hawaii to support their decision making processes.

Fact—There are 32 DART buoys in the Pacific Ocean as shown by **Figure 4 in Appendix D**. On September 29, 2009, 81 percent (26 of the 32 DART buoys) in the Pacific Ocean were operating. **Figure 5 in Appendix D** shows a sample of DART buoy output from DART 51425.

Fact—On September 29, 2009, 18 DARTs were triggered. Of these, six were triggered by the seismic signal; 12 of the DARTs were command-triggered by the TWCs.

Fact— DART 51426 near Tonga and DART 51425 near Samoa were the first two DART stations triggered by the event, setting off pagers at PTWC at 1754 UTC.

Fact—The National Ocean Service (NOS) coastal water level station at Pago Pago, American Samoa, provided the first measurement of the tsunami wave at the coast. (See **Figure 6, Appendix D**.) All NOS sea level stations in the Pacific were operational during this event.

Finding 13—Sea level data was crucial during the event, not only for PTWC and WC/ATWC tsunami forecasting, but also to EMs in Hawaii.

Recommendation 13—The National Data Buoy Center (NDBC) and NOS should be given resources to ensure they can promptly repair and maintain DART buoys and coastal water level stations.

Fact—In the past, NWS Pacific Region has participated in Tsunami Technical Review Committee meetings with PTWC and the Hawaii State and County Civil Defense. A primary purpose of these meetings was coordinating tsunami event procedures and related information. Key partners found these meetings to be extremely valuable.

Finding 14—There have been no meetings of the Tsunami Technical Review Committee for the past 2 years.

Recommendation 14—Tsunami Technical Review Committee meetings should be reinstated as soon as possible and PRH should help the Pacific Island territories establish similar review committees.

3.2. WSO Pago Pago Operations, Products, and Services

WSO Pago Pago, in conjunction with the PTWC, is responsible for providing tsunami watches and warnings for American Samoa. The infrequency of strong earthquakes and damaging tsunamis, and the short-fused nature of these events, coupled with the current staffing arrangement at the WSO can create a chaotic situation. WSO employees tried to get the information out to partners but significant challenges existed. (Refer to the detailed timeline in **Appendix E** for more information on the timing of specific events mentioned in the following section.) The WSO in Pago Pago does not have the Advanced Weather Interactive Processing System (AWIPS), Console Replacement System (CRS), or the staffing profile of WFOs. Despite

these deficiencies, the office is required to provide similar mission services to its area of responsibility as offices that have these technologies.

Best Practice 4—Personnel from the NOAA International Tsunami Information Centre (ITIC) connected WSO Pago Pago to the California Integrated Seismic Network (CISN) Display. The ability to access CISN seismic data to confirm the natural warning signs of an earthquake and a potential tsunami gave WSO staff the confidence to request activation of the EAS. While, ultimately, the WSO staff should have formally issued the initial warning, the ability to react to the situation before receiving official word from PTWC of tsunami generation was critical.

Best Practice 5—EAS radios were distributed by the Department of Homeland Security (DHS) to the Local Primary 1 (LP) and LP2 EAS stations, WSO Pago Pago, police, and other entities listed as critical for emergency response. EAS radios on American Samoa allowed officials to communicate during the tsunami, despite jammed phone lines. The system allowed the Meteorologist-in-Charge (MIC) at WSO Pago Pago to radio DHS, which in turn asked the LP1 radio station to activate vertical evacuation plans prior to the tsunami. Having an EAS Committee and plan for American Samoa created the framework to get critical information to the public quickly, thus saving lives.

Fact—WSO Pago Pago did not follow office procedures regarding issuance and dissemination of the Tsunami Warning. After the earthquake, staff made procedural errors with the initial Tsunami Warning, hindering dissemination through EAS.

Fact—Quick reference sheets and office log sheets to record the events, products, and phone calls were available, but were not used.

Finding 15—In the tsunami section of the office Station Duty Manual (SDM), the page regarding local policy and procedures for tsunami related products was missing.

Recommendation 15—The MIC must ensure that SDM chapters are updated and current. Staff should be required to use office logs, event logs, and reference sheets during any event. PRH should look into implementing electronic logs at WSOs. All staff must be familiar with, and adhere to, the policies and procedures regarding tsunami warnings and should read and sign off on the SDM content annually.

Fact—PTWC and WC/ATWC issued observatory messages at 6:56 a.m. and 6:57 a.m., local time, respectively, based on preliminary measurements of earthquake magnitude prior to the arrival of the tsunami at American Samoa. The 7.1 magnitude noted in the PTWC message was below the local American Samoa threshold for a tsunami event, while the 7.9 magnitude noted in the WC/ATWC's message was above the threshold for tsunami generation potential. American Samoa's threshold for a tsunami warning was 7.5. This information was first relayed to Pago Pago through the CISN Display.

Finding 16—After the WSO staff noted an earthquake magnitude greater than 7.5 on CISN, they started to issue a tsunami warning over NOAA Weather Radio (NWR) and EAS using Interalia equipment. However, the WSO did not send an official product until 7:17 a.m., local time, 29 minutes after the earthquake, and 12 minutes after the first tsunami wave arrived in Pago Harbor.

Recommendation 16—WSO Pago Pago must establish a protocol for sending an official tsunami warning within minutes of the office determining a tsunami is imminent.

Fact—WSO Pago Pago received the first official PTWC Tsunami Bulletin at 7:04 a.m., local time. WSO Pago Pago is responsible for relaying this message through local communication channels (LP1 and LP2) using NWR and EAS and to local government officials and emergency responders. The WSO inadvertently issued a Tsunami Warning at 7:10 a.m. as a Required Weekly Test (RWT) rather than an actual warning. The RWT was inadvertently repeated at least seven times over a nine minute period resulting in a total of eight times, reactivating EAS each time.

Finding 17—Messages released as RWTs activate EAS only as a test message. The RWT event code will not scroll the EAS message stating a tsunami warning is in effect, thus it will not interrupt broadcasts to relay critical information. This function is critical in American Samoa where none of the radio or television stations are staffed 24/7, though most broadcast all night.

Recommendation 17—All WSO Pago Pago forecasters must be trained to correctly operate NWR and EAS equipment to minimize transmission and coding errors and repeat messages.

Fact—The WSO uses the Interlalia system for NWR broadcasts, including EAS activations. A personal computer (PC) in conjunction with the Interlalia system is used to process data before transmitting over NWR.

Finding 18a—In order to process an emergency message on the Interlalia system, all existing messages must be cleared. The PC allows the staff to immediately clear out the message queue. Office personnel were unsure whether the software could issue the 1050 hertz tone, eliminating numerous manual steps. The manufacturer did not provide training on the system so the staff had to train themselves by reading the manual.

Finding 18b—Emergency messages must be deleted manually to prevent multiple EAS activations, which potentially block out a radio station's ability to verbally communicate emergency instructions.

Finding 18c—Issuing a product on NWR during a high impact event involves numerous manual entries via a numeric keypad, increasing the chance of errors.

Recommendation 18—The WSO should contact the Interlalia manufacturer to determine whether the software is capable of enhanced PC functions, determine if there have been software upgrades, and ask about training. If these actions do not resolve the problem, the WSO should request that the system be replaced with more efficient equipment to simplify the process and minimize human errors.

Fact—Due to heavy phone traffic during the event, no phone lines were available to transmit critical tsunami warnings from the PC to the Interlalia system.

Finding 19—The WSO compensated for the jammed lines by connecting to a Federal Aviation Administration line used at the old airport tower location.

Recommendation 19—The PC should be hardwired to the Interalia or a dedicated line installed.

Fact—The first tsunami waves were observed in Pago Harbor at 7:05 a.m., local time, 17 minutes after the earthquake. A magnitude 5.6 aftershock was recorded at 7:08 a.m., local time.

Fact: PTWC cancelled the Tsunami Warning for American Samoa at 10:35 a.m., local time.

Finding 20a—The staff correctly issued the Tsunami Warning using the tsunami warning event code (TSW) over NWR at approximately 7:19 a.m., local time, but the tsunami had already struck the island. Because a large aftershock had also occurred by this time, the TSW created confusion and panic. People thought a second tsunami had been generated by the aftershock.

Finding 20b—The TSW and RWT remained in the NWR broadcast cycle and played 21 times (TSW was broadcast eight times and RWT was broadcast 13 times), with an EAS activation each time per the EAS log and media interviews.

Finding 20c—WSO Pago Pago never relayed or broadcast the cancellation of the Tsunami Warning, though the office inadvertently extended the warning to 7:00 p.m. shortly before PTWC canceled the warning for American Samoa.

Recommendation 20—The WSO must implement a protocol for relaying all TWC messages and products through local communication pathways.

Fact—NWR is not effective for communication during a tsunami event in the western portion of American Samoa because residents cannot receive the signal in many parts of the island.

Fact—The WSO staff has not been officially trained on how to program the NWR receivers. At the time of the tsunami, NWR receivers were not sold by retailers on the island.

Finding 21—NWR receivers were provided to all schools by DHS, however, school staff did not receive assistance with programming the units. Several schools returned the NWRs to DHS because the units were difficult to program or did not receive a signal.

Recommendation 21a—WSO personnel should help residents program NWR receivers and explain the value of NWR and how it can be used to receive critical information.

Recommendation 21b—The WSO should relocate the existing NWR transmitter tower to a higher elevation (Mount Olotele) to provide NWR coverage over the entire island. Completing this recommendation was in progress.

Fact—Currently, a meteorologist is on shift 10 hours per day, while the HydroMeteorological Technician (HMT) staff works 24/7. The HMT staff is responsible for a suite of public products, and in the absence of a meteorologist, is responsible for issuing all watch, warning, and advisory products.

Fact—Office policy states that when no meteorologist is on shift during a significant event, the HMT is to call a meteorologist to get permission to issue a watch, warning, or advisory.

Finding 22—The HMT staff has not received sufficient training to issue public watch, warning or advisory products.

Recommendation 22—The WSO should be staffed 24/7 by a meteorologist trained to perform all mission functions.

Fact—The WSO Pago Pago uses antiquated computer systems that negatively impact its operations. Staff does not automatically archive data.

Fact—According to the WSO Pago Pago SDM, data must be archived after a high-impact event.

Finding 23a—The WSO’s PC hardware configurations are below operational standards. These computers take an inordinate amount of time to boot up. The field laptop is heavy, bulky, and antiquated.

Finding 23b—The WSO personnel did not digitally archive the products for this event, though they maintained hard copies. Local broadcast stations maintained digital and hard copy EAS logs.

Recommendation 23a—PRH should ensure the installation of an updated operational computer network that ties all of the systems together, including NWR, for quicker dissemination of all products. The system must be able to archive at least 30 days of time-stamped products.

Recommendation 23b—The WSO should implement additional detailed instructions in its SDM on how and when to archive data relating to a high impact event and should train staff on these procedures.

Fact—WSO Pago Pago relies on existing hardware within the office, including the fax machine, to transmit its products to customers and partners.

Finding 24—When the staff was having difficulty issuing products via the Interalia system, the fax machine was not used to transmit emergency information to the EAS community.

Recommendation 24—PRH should upgrade some of the office equipment, specifically the WSO needs computer facsimile hardware and software and a copier with facsimile capabilities to provide a dedicated backup dissemination method.

Fact—During the time following the earthquake, the WSO was able to contact the PTWC only three times because phone circuits became overwhelmed.

Finding 25—Unreliable communication with PTWC hampered the WSO’s efforts to get accurate, timely information on the Tsunami Warning.

Recommendation 25—PRH should work with the MIC and the local telecommunication company to install a hotline (or equivalent capability) to PTWC, WFO Honolulu, and PRH.

Fact—DHS could not reach the WSO on the handheld EAS radio kept in the operations area at the WSO.

Finding 26—The portable EAS radio was not charged at the time. Once plugged into the charger, the WSO was able to use the radio immediately to contact DHS and the LP1 radio station.

Recommendation 26—The WSO should procure a backup portable EAS radio. Staff should ensure at least one radio is always operable in the operations area and make sure it is charged. Also, staff should take part in DHS radio checks.

3.3. American Samoa External Response

"There was no time... Even another 5 minutes would have been great. It was just very quick, very sudden." Joey Cummings, KKJH, American Samoa (source: CBS News)

The proximity of American Samoa to a tectonically active plate boundary makes it vulnerable to tsunami events with limited warning time. WSO Pago Pago is the primary local authority for tsunami warnings and must act on the information it has, regardless of whether an official PTWC warning product has been issued. The response to the earthquake on September 29 highlighted challenges in several key areas with respect to external response in American Samoa, and how NWS information is being disseminated, understood, and acted upon. There was significant confusion during the tsunami regarding from whom official notice should come, particularly when the WSO could not be reached. Consequently, both the WSO and the local radio station (LP1) activated EAS, resulting in conflicting information.

Best Practice 6—A local EAS Committee created an EAS plan for American Samoa following the 2006 Tonga tsunami. It was utilized during the event.

Best Practice 7—The EAS was the most effective warning component in this event. EAS handheld radios allowed warnings to be received even when phone lines were jammed.

Fact—The American Samoa population received no official NWS tsunami warning product prior to the arrival of the first wave. Residents reacted to natural indicators such as the strength of the earthquake and receding of the sea, coupled with knowledge gained through NWS outreach efforts.

Finding 27a—The LP1 radio station issued an Earthquake Warning via EAS based on the duration and strength of the earthquake. Other radio stations received and broadcast the information, but no tsunami warning was issued prior to the arrival of the first wave.

Fact—Ten minutes after the earthquake, the MIC at WSO Pago Pago called DHS via the portable EAS radio requesting EAS be activated to initiate tsunami evacuation plans. DHS then directed the LP1 station to issue a tsunami warning over EAS.

Finding 27b—There is no record of the language used in the message; however, the LP1 radio station reports it included in the message the fact that no “official” tsunami warning had been issued. This message was initially conveyed by the WSO to indicate that no official tsunami

product had been received from PTWC confirming a tsunami warning but may have been interpreted by the public as the absence of a tsunami threat.

Finding 27c—The LP1 station recorded this tsunami message prior to losing power upon arrival of the tsunami, but the EAS logs at the LP2 do not reflect this message, indicating there may have been a transmission error. Therefore, the last thing many people heard over the radio before the tsunami waves struck Pago Harbor was the official message that “there is no official Tsunami Warning.”

Finding 27d—Most people knew how to respond to a tsunami, but many were confused because no official warning was in effect.

Recommendation 27—WSO Pago Pago must have adequate infrastructure and communication protocols to effectively issue or convey official tsunami warnings.

Fact—WSO Pago Pago is the local authority responsible for issuing weather and natural hazard warnings for American Samoa.

Fact—It was very difficult to reach the WSO during the event due to jammed phone lines, and the information on the WSO Website was not frequently updated.

Finding 28—The inability of DHS and other members of the EAS community to reach the WSO caused a great deal of confusion regarding who should issue warnings.

Recommendation 28a—WSO Pago Pago should work with the American Samoa government to clearly identify roles and responsibilities for EAS activation. The WSO should consider a scenario-based approach to train for potential contingencies. It is critical that information gets out through the correct channels by an authoritative agency, as quickly and concisely as possible.

Recommendation 28b—The WSO should continue to work with the EAS Committee, in particular the LP1 and LP2 stations, on improving critical communications.

In American Samoa, the media, especially frequency modulation (FM) radio broadcasts, play a large role in disseminating warning information, along with the American Samoa DHS and emergency responders (police, EMT, and fire). There is a very active local EAS committee of which the WSO must ensure it is an integral part. Current WSO protocols regarding interfacing with the EAS community during an event are lacking, though the basis of these protocols was established in the 2006 EAS Plan.

Fact—On the morning of September 29, the WSO fielded a telephone call from one radio station, issued a verbal tsunami warning, and advised a vertical evacuation over live radio. This was not on an LP1 or LP2 station.

Finding 29—The radio station over which WSO advised a vertical evacuation, Showers of Blessings, did not have input to EAS and had not broadcast the earlier earthquake EAS alert. This was the only radio station on which staff members from WSO Pago Pago went live.

Recommendation 29—The EAS protocol must be followed to allow the WSO to effectively communicate an official warning to the media during an event. LP1 and LP2 stations should be

called first via the EAS radio during a crisis and should automatically receive critical information via NWR.

Fact—FM radio is the primary source of information for the general population on American Samoa. Most radio stations broadcast 24/7 and have EAS capabilities but are not staffed 24/7. The radio stations operate in an unattended mode outside normal business hours.

Fact—American Samoa has most of the components in place for a functional EAS through the local efforts of an EAS committee. The EAS project, funded by FEMA through DHS for American Samoa, was never completed, even though a Memorandum of Agreement was signed in 2003.

Finding 30—At this time, there are missing components of the EAS and gaps in its functionality. Additionally, not all critical personnel have input to EAS.

Recommendation 30—WSO staff should help the DHS to complete and maintain EAS. The WSO should participate in EAS committee meetings and updates to the EAS plan.

Even a fully functional EAS would need to be adapted for American Samoa's infrastructure, culture, and language. For example, during the September 29 tsunami, a number of people reported not having felt the earthquake from their cars because roads were bumpy or vehicle suspension absorbed the shake. Others reported information broadcast on the FM radio station was not heard or understood by individuals who do not speak English or Samoan. In addition, public buses typically play loud music from CDs so riders do not hear radio warnings.

Fact—Many people who received a warning for this event were reached through FM radio, particularly from the LP1 station. They heard the earthquake warning EAS activation from the radio station and verbal reports of waves in Pago Harbor.

Finding 31a—Not everyone was listening to the radio on the morning of the tsunami, and very few people on American Samoa have or use a NWR receiver; therefore, it is critical to explore redundant means of communication.

Finding 31b—Most people, regardless of age, have cellular phones on American Samoa.

Recommendation 31a—NOAA should partner with DHS to install a siren system on American Samoa and clearly define protocols and responsibilities involved with activation of those sirens.

Recommendation 31b—NWS should explore usage of short message service (SMS) text warnings to cell phones similar to the system used on Western Samoa.

3.4. WFO Honolulu Operations, Products and Services

A tsunami is a high-impact, rare event that requires WFO forecasters to respond immediately to disseminate life-threatening information to the public. WFO Honolulu handled this event very well by using existing procedures to disseminate tsunami watch information in

Hawaii, and adapting quickly when the tsunami advisory was issued using a new definition. WFO Honolulu forecasters manually broadcast the tsunami messages over NWR and activated the EAS for the tsunami watch. They also headlined the tsunami hazard in the zone and state forecasts products and the coastal waters forecast. Additionally, the WFO issued a marine weather statement to inform mariners to expect strong currents in harbors and bays. WFO Honolulu also conducted 120 outreach events over the past year; many of these included a tsunami readiness component.

Fact—PTWC issued a Tsunami Watch for Hawaii. WFO Honolulu issued an EAS Alert for the Tsunami Watch via NWR at 8:13, HST, or approximately 8 minutes after the Tsunami Watch was issued.

Fact—WFO Honolulu performed a manual recording on NWR using predefined templates.

Finding 32—No text-to-speech formatter exists to automatically relay currently formatted tsunami messages to the NWR broadcast cycle. This deficiency increases the time required to disseminate potentially life-threatening information.

Recommendation 32—NWS should develop an NWR formatter for tsunami products that will decrease EAS activation times by eliminating human intervention.

During the event, PTWC held two conference calls with Hawaii Civil Defense authorities to brief them on the situation, including expected wave arrival time and potential impacts to Hawaii. Although these conference calls provided critical decision assistance information to state and local authorities, WFO Honolulu staff did not know about a critical decision regarding the tsunami advisory made during the conference call because they were not invited to participate.

Fact—The teleconference calls between PTWC and State and local Civil Defense did not include WFO Honolulu.

Fact—WFO Honolulu is an integral partner in the warning process.

Finding 33—WFO Honolulu was not invited to be on the coordination calls and thus was not aware the tsunami watch would be converted to a tsunami advisory until the WFO received the PTWC advisory message.

Recommendation 33—PTWC and State Civil Defense must include WFO Honolulu on tsunami coordination calls.

Approximately 1½ hours into the event, PTWC staff determined the tsunami would not be destructive for Hawaii but did expect a low-level impact event for the Hawaiian Islands. During the second conference call, the PTWC Director agreed to a request by Civil Defense to replace the tsunami watch with a tsunami advisory for Hawaii and use the new definition of the tsunami advisory that defines an advisory as a lower-level impact. This definition was crafted by the National Tsunami Hazard Mitigation Program (NTHMP) Warning Coordination Subcommittee in 2008 after the revised definition's successful use in 2007. The new advisory

definition was accepted by states within the WC/ATWC AOR, but had not yet been accepted by Hawaii Civil Defense staff, who preferred the information just be included in a cancellation.

Fact—PTWC implemented the alternate definition of the tsunami advisory for its Hawaii products (domestic) on an ad hoc basis during the Samoa event. This change was coordinated with Hawaii Civil Defense during a conference call and subsequently accepted to avoid issues involved with using the definition on an ad hoc basis.

Fact—At the time of this event, the official PTWC definition of the tsunami advisory differed from the corresponding definition in the WC/ATWC AOR. PTWC defined an advisory as posing no danger to the area. The alternate definition, implemented in 2008, meant strong currents could be expected along the beaches, harbors, and bays—a low impact hazard.

Finding 34a—The WFO Honolulu staff did not know a tsunami advisory was issued for Hawaii using the new WC/ATWC definition.

Finding 34b—WFO Honolulu received a few calls from the public and media outlets who were confused about what the tsunami advisory meant for Hawaii. The PTWC Website stated the tsunami advisory means: “The tsunami poses no danger to the area,” while the PTWC tsunami advisory statement stated: “Strong currents may occur along the coast which could be a hazard to swimmers, boaters, and beaches.” The Website was modified to use the new definition during the event.

Recommendation 34—PTWC should formally adopt the WC/ATWC tsunami advisory definition for its domestic AOR (Hawaii) as quickly as possible and update its Webpage with the new definition. PTWC is in the process of implementing this recommendation. Additional outreach and education are required.

3.5. Hawaii External Response

Hawaii State and local Civil Defense officials received the tsunami watch and advisory messages through several communication sources, including HAWAS, NWR, media outlets and direct contact with PTWC. State and local Civil Defense agencies participated in two teleconferences with PTWC during the event, which provided vital decision assistance information.

Fact—Hawaii State Civil Defense and/or PTWC initiated and held teleconference calls between PTWC and Civil Defense agencies to provide information on tsunami events, including timelines and potential impact areas.

Fact—Hawaii State Civil Defense agencies need 3 hours to effectively evacuate people in or near the inundation areas. Thus 10:00 a.m., HST, (approximately) on September 29, was a critical time in determining whether the tsunami watch was going to be upgraded to a tsunami warning, since the initial wave arrival time was expected around 1:00 p.m., HST.

Best Practice 8—Holding teleconferences throughout the event provided outstanding Decision Support Services to the state, county, and local Civil Defense Agencies.

“The teleconference between PTWC and Civil Defense Authorities around 9:30 am HST provided critical decision assistance information regarding an evacuation order. The information conveyed by PTWC that the tsunami was not going to be destructive for Hawaii saved an unnecessary evacuation. In the past, an evacuation for a Tsunami Warning in Hawaii has incurred a cost of about \$100M. The decision to cancel the Tsunami Watch and issue a Tsunami Advisory averted siren activation and doing unnecessary evacuations along the coastal areas of all the islands.”

Ed Teixeira, Vice Director, Hawaii State Civil Defense

Hawaii State Civil Defense authorities also helped disseminate the tsunami message through other jurisdictions, including fire and police, via facsimile and high frequency radio. Upon receipt of the tsunami advisory, the Waikiki Police Department notified the Ocean Safety Group (lifeguards) and local hotels. Police officers walked the entire beach to inform people of the hazard (advisory) and asked people to leave the beach. The lifeguards from the Ocean Safety Group also mounted their personal watercraft and asked people to get out of the water. Police representatives said most people heeded advice to get out of the water and leave the beach.

City and county EMs from Oahu, Maui, and Hawaii were able to clear the beaches shortly after the tsunami advisory was issued.

Fact—In Hawaii, the first waves from the tsunami were expected to begin around 1:00 p.m., HST.

Fact—When the tsunami advisory was issued, officials from local jurisdictions informed people on the beach of the tsunami advisory and dangers associated with it. Many people got out of the water and left the beach.

Fact—Most wave activity in Hawaii occurred between 3:00 p.m. and 7:00 p.m., HST.

Finding 35—People started to filter back onto the beach between 2:00 p.m. and 3:00 p.m., HST, after no wave activity had been observed on the beaches.

Recommendation 35a—Public education should be continued on tsunami danger, specifically the fact that there is often more than one wave, resulting in several hours of danger.

Recommendation 35b—To fulfill its tsunami warning responsibility to the state of Hawaii, PTWC must frequently update products to keep the public, EM, and media informed in accordance with prescribed instructions.

3.6. Dissemination

NWS Directive (NWSI 10-701) states that frequent updates of PTWC warning products during an event are necessary to meet users' needs for information to support decision-making processes. This mandate requires PTWC to issue updated products hourly at a minimum; however, during this event, PTWC issued updated bulletins at intervals up to nearly 1½ hours apart. At times, operational staff were waiting for additional data (e.g., DART and/or sea level station information), to better refine and potentially adjust tsunami watches, warnings, and/or advisories, resulting in users waiting long periods of time for critical information.

Fact—PTWC tsunami watch/warning bulletins for the Pacific (WEPA40 PHEB) were not consistently issued at least hourly, as required by NWSI 10-701. These bulletins contain a standard statement: “*Bulletins will be issued hourly or sooner if conditions warrant.*” The elapsed time between bulletins #2 and #3 and between bulletins #3 and #4 was 1 hour 26 minutes and 1 hour 14 minutes, respectively.

Finding 36—Users of this product had to wait significantly longer than the specified 1 hour for updates as indicated in the bulletins. As a result, several people said there were information voids during the event.

Recommendation 36a—PTWC must issue updates at least hourly as directed by NWSI 10-701, even if no new information is available.

Recommendation 36b—WFOs and WSOs in PTWC's AOR should develop procedures to issue local statements (e.g., using the special weather statement, marine weather statement, and/or creation of a new dedicated product, such as a “tsunami local statement”) to supplement PTWC watches, warnings, and advisories. Such statements should contain specific, local information if available, and not contradict official PTWC information.

Fact—PTWC Tsunami Watch/Warning message #1 (WEPA40 PHEB, issued at 1804 UTC) was not transmitted over NOAA Weather Wire Service (NWWS) or Aeronautical Fixed Telecommunications Network (AFTN) circuits. PTWC staff was made aware of this fact by a call from WC/ATWC.

Fact—PTWC staff has a checklist to follow during events, which includes ensuring dissemination of its products. There is also an electronic output when they send out a product listing all pathways through which the product was disseminated.

Finding 37—Users who depend solely on NWWS or AFTN for tsunami watch/warning/advisory information from PTWC did not receive the initial watch/warning message.

Recommendation 37—To the greatest extent possible, PTWC must ensure successful transmission and receipt of all products over required circuits and other designated dissemination media.

The Valid Time Event Code (VTEC) is a relatively recent addition to TWC tsunami bulletins. VTEC is included in the bulletins to allow users to obtain tsunami watch/warning/advisory information in an automated fashion. PTWC includes VTEC information in its tsunami messages for Hawaii (domestic product).

Fact—When the tsunami watch was cancelled for Hawaii, the PTWC Bulletin indicated in the headline that the tsunami watch was cancelled and a tsunami advisory was in effect; however, the VTEC line only indicated the tsunami watch had been cancelled. There was no separate VTEC line to indicate the tsunami advisory had been simultaneously issued.

Finding 38—As a result of the missing VTEC line between the Hawaii state messages #3 and #4, the Web-based NWS watch/warning/advisory maps showed no tsunami advisory for nearly 6 hours, even though the tsunami advisory was in effect. Furthermore, national vendors and commercial companies who use VTEC for automated dissemination did not receive accurate information during this timeframe.

Recommendation 38—PTWC must ensure that correct VTEC lines are included in all domestic (Hawaii) products for tsunami watches, warnings, and advisories. PTWC operational staff must ensure their messaging software correctly and automatically produces all necessary VTEC coding.

In addition to the tsunami watch/warning message for international areas, PTWC issues separate watch/warning messages for the state of Hawaii, known as the “domestic product.” Tsunami messages for Hawaii are designed to meet the needs of state and local officials, including Hawaii State Civil Defense. No other domestic products have been added for U.S. Territories in the Pacific. Such localized tsunami bulletins would fill other localized needs to formally convey official PTWC tsunami information, including tsunami watches, warnings, and advisories.

Fact—PTWC issues both a domestic product for Hawaii and an international product for the rest of PTWC’s area of responsibility. American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI) are included in PTWC’s international products.

Finding 39—During a visit by the PTWC Director to WSO Pago Pago, the Director and MIC verbally agreed to develop a domestic tsunami watch/warning/ advisory product for American Samoa; however, this product has yet to be implemented at PTWC.

Recommendation 39—PTWC should include American Samoa, Guam, and CNMI in its domestic product(s), either in a single segmented product or individual products, as appropriate.

PTWC and WC/ATWC have tsunami watch/warning/advisory responsibility for geographically separate, but adjacent, AORs (see **Figure 1**). Users around the world have ready access to both TWCs' products, especially via the Internet; however, users of these bulletins may not always be aware of these AOR differences, or more specifically, the status of tsunami watches, warnings, and/or advisories in each TWC's respective AOR.

Fact—WC/ATWC and PTWC products include a short statement regarding the status of the other TWC's tsunami warnings/watches/advisories.

Finding 40—WC/ATWC's information regarding the status of PTWC's tsunami watches/warnings/advisories was inaccurate at times. As a result, WC/ATWC's bulletins did not consistently convey the correct status of PTWC's tsunami watches/warnings/advisories.

Recommendation 40—PTWC and WC/ATWC watch/warning/advisory bulletins should include a brief, but accurate, generalized statement regarding the other TWC's watch/warning/advisory status, including a reference to the appropriate TWC Website for the latest information and additional detail.

PTWC's bulletins contained a list of "estimated initial tsunami wave arrival times." As the tsunami expanded across the Pacific, the list of arrival times continued to grow as PTWC added new locations; however, locations for which the initial wave had already passed were not eliminated from the list in later bulletins, resulting in increasingly lengthy products and confusion. Such lengthy bulletins made it more difficult for users to quickly obtain the specific information they need.

Fact—Each of the PTWC's Pacific watch/warning messages (WEPA40 PHEB) included "estimated initial tsunami wave arrival times" (except message #4, Warning and Watch Cancellation), even after the initial tsunami wave had passed.

Finding 41—Including locations where the initial wave had already passed in tsunami watch/warning bulletins resulted in unnecessarily long messages and, in some cases, obsolete information.

Recommendation 41—PTWC's message generation software should be modified to include only those points where the initial tsunami wave has not yet passed.

3.7. Social Science

Nearshore earthquakes often do not leave enough time for people to receive official tsunami warnings before taking action. The majority of people interviewed in American Samoa indicated that after the earthquake, they started observing the ocean to see if there were any changes. Because people were looking for natural warning signs of a tsunami, they were able to quickly move inland and uphill when they saw the ocean recede. Knowing that a strong earthquake can trigger a tsunami was critical during this event. The fact that the majority of

people interviewed during the assessment referenced natural indicators of a tsunami and understood the need to move uphill means that preparedness efforts and public education programs have been successful. PTWC and ITIC participated extensively in providing public awareness, training, and education used by the local WSO, DHS, and the Department of Education (DOE).

In one example of lessons learned from preparedness activities, the school principal of Taputapu Elementary School in Poloa, in southwest American Samoa, called the school immediately after the earthquake. The children were just sitting down to eat breakfast at the school when they felt the earthquake and went outside. The principal instructed everyone to leave everything and run to higher ground, in accordance with pre-established tsunami evacuation plans. This order to evacuate to higher ground saved the lives of the 103 enrolled students and 11 staff, who barely made it to safety. Several of the children were trapped in the water when the first wave arrived and had to be pulled to safety. Despite the coastal location of the school, and the 37-foot high waves in Poloa, all of the children and staff were safely evacuated and survived.

The school, which was rebuilt after Hurricane Heta (2004), incorporated mitigation features to secure roofing. The location was elevated at least 12 feet above sea level with a rock wall at the shoreline. Despite implementation of these hazard mitigation features, the entire building failed structurally, with significant cracks in the roof and vertical support beams. The successful evacuation of all students and staff from this school, especially considering they had to leave the village on a steep mountain road, is compelling evidence of the importance of education and outreach in saving lives.

In American Samoa, gender, culture, and social structure were all factors in tsunami preparedness and response. Of the casualties in American Samoa, over 75 percent (25 people) were female, 39 percent were over the age of 60, and 15 percent were of Asian ancestry. In Western Samoa, the majority of the 149 victims (with 7 additional missing) were female, young, or elderly. Understanding these demographics of the tsunami victims can help in targeting policies and plans to reduce risks in vulnerable coastal areas.

Fact—Complex social relationships exist in American Samoa and employees of the WSO are embedded in this cultural hierarchy.

Finding 42—The culture requires preparedness and warning information to come from an authoritative source such as a chief, high chief, or official government office, such as NWS.

Recommendation 42—Individual outreach efforts in local communities should be encouraged, supported, and recorded as an essential part of the WSO employees' jobs. This will increase the level of trust in WSO information.

Fact—Out of the 35 deaths in American Samoa (including 33 confirmed deaths and two missing persons), 13 were over the age of 60 and 3 were under the age of 10. At least 5 did not speak English.

Finding 43—All education programs and radio public service announcements have been conducted in English, with some education and outreach in Samoan.

Recommendation 43a—Education and public awareness materials should be developed for children, elderly, and other special needs groups. Evacuation routes should be identified that are accessible to these groups, with a plan for assisting those with mobility problems.

Recommendation 43b—Informational materials about disasters must be developed for those speaking English as a Second Language (ESL).

Recommendation 43c—Official warnings and general information need to be tailored to local areas and conditions to be recognized, understood, and used. New technologies should be investigated, e.g., multilingual NWR receivers. Once the technologies are identified, NWS should then work with the private sector to implement appropriate improvements.

Fact—In 2008, the Pacific Wave Workshop and Exercises run by PTWC and NOAA focused on the village of Tula, at the east end of the island. As a result of this exercise, evacuation plans were developed and the public was informed about tsunami hazards.

Finding 44—Tula was destroyed during this tsunami event, but everyone was safely evacuated because they knew where to go and had practiced evacuating.

Recommendation 44a—Continue public education, outreach, and training programs; integrate information on evacuation routes and clear, easily understandable warning signals when warnings are issued.

Recommendation 44b—The WSO should work with DHS and DOE to ensure schools promptly receive warnings and implement evacuation plans.

Fact—Pago Harbor was severely impacted by the tsunami. Significant economic and livelihood assets and resources are located near the harbor, including a power plant and canneries.

Fact—The canneries and fisheries are the biggest contributors to the economy with approximately \$265 million in exports for the StarKist cannery alone. The canneries employ roughly 40 percent of the local population.

Finding 45—Employees at the cannery and power plant participated in disaster evacuation exercises prior to this tsunami event and continue to work closely with the local EM officials. These efforts significantly contributed to a safe evacuation of all employees from the facilities following the earthquake.

Recommendation 45—The private sector must be included in local EM efforts, including public awareness and training activities, to protect lives and sensitive assets located in nearshore areas.

3.8. Outreach

Education and outreach must be primary elements within the NWS tsunami program for any tsunami warning system to be effective. It is vital that the necessary precautions be taken to ensure coastal communities are prepared in the event of a tsunami. NWS offices work with their partners in Federal, state, and local EM to build awareness and preparedness for this hazard through the TsunamiReady program, as well as routine interaction on all hazards preparedness activities. Tsunami education, outreach, preparedness, and awareness played a key role in this event.

In particular, recent outreach efforts undertaken by ITIC, WSO Pago Pago, PTWC, and DHS in American Samoa have been credited with saving lives during this event. During an outreach trip in July 2009 to Western and American Samoa, meetings and seminars were held for a wide range of audiences, from the public to EMs, focusing on tsunami preparedness and response.

Best Practice 9—Aggressive outreach taught officials and the public to take life-saving actions based upon natural warning signs, such as “stronger earthquake than usual” and “the receding of the sea.” Every school along the coast in American Samoa has a Tsunami Evacuation Plan. Several schools were destroyed; however, thanks to preparedness campaigns, there was no loss of life at schools that properly activated their Tsunami Evacuation Plans. Based on the training police officers received, they sounded car sirens and used their public address systems to instruct the public to get to higher ground immediately. Tsunami outreach in the Pacific should not only continue, but should be institutionalized as an integral part of an effective mitigation strategy to help prevent future loss of life.

Fact—Recent tsunami outreach efforts in American Samoa and Western Samoa by the ITIC, WSO Pago Pago, American Samoa government, and the PTWC proved to be tremendously successful in ensuring local response to this event. This education allowed for fast recognition of the natural warning signs, which prompted the evacuation of residents and tourists to higher ground.

Finding 46—People understood the need to evacuate to higher ground when they felt a strong earthquake, but were not clear on what routes to follow, what form of transportation to use, how far to go, or how long to stay there.

Recommendation 46—Improvements should be made to existing tsunami signage to clarify tsunami evacuation routes and protocols.

Finding 47—This event tested the plans that had been developed and provides an opportunity to assess and refine those plans and protocols before the next event.

Recommendation 47a—NOAA should continue to fund and strengthen tsunami education and training efforts for the public, government, and elected officials through the National Tsunami Hazard Mitigation Program (NTHMP).

Recommendation 47b—Tsunami outreach on American Samoa should be institutionalized through continued involvement in the TsunamiReady Program, with supporting funds, as needed via TsunamiReady and NTHMP grant funding programs, pending availability of funds.

Fact—Tsunami awareness education was an integral part of the National Preparedness Month education topics during September 2009.

Finding 48—WSO Pago Pago and ITIC’s participation in National Preparedness Month and their role in tsunami outreach helped save lives in American Samoa.

Recommendation 48—NOAA should continue to participate in National Preparedness Month and advocate tsunami topics as part of this and similar awareness campaigns, such as a National Tsunami Awareness Week, to generate local media interest.

NWS Websites are also a key source of information during potentially hazardous events when the public needs to respond quickly. There was confusion among the media and the public as to where to find accurate and timely information during the tsunami warning.

Fact—PTWC does not have a staff member designated to handle outreach and other coordination duties.

Finding 49—Although PTWC conducted some outreach, it does not have the resources to provide effective outreach to all its customers.

Recommendation 49—PTWC should leverage all existing NOAA resources (PRH, ITIC) and key partners (DHS, EMs) to increase the capacity for local, regional, national, and international outreach activities.

3.9. TsunamiReady Program

A cornerstone for NWS tsunami hazard preparedness and awareness activities is the TsunamiReady program. TsunamiReady promotes tsunami hazard readiness as an active collaboration among Federal, state and local EM agencies, the public, and the NWS Tsunami Warning System. TsunamiReady helps community leaders and EMs strengthen their local operations. TsunamiReady communities are better prepared to save lives thanks to proactive planning, education, and awareness. The program’s main goal is improvement of public safety during tsunami emergencies. More information on TsunamiReady can be found at: <http://www.tsunamiready.noaa.gov>

The NTHMP is a state/Federal working group founded by the U.S. Congress in 1995 to reduce the impact of tsunamis through hazard assessment, warning guidance, and mitigation. The TsunamiReady program is supported by the NTHMP and NOAA’s tsunami program as an important component of state mitigation and preparedness activities.

According to the Hawaii Civil Defense Agency, TsunamiReady and NTHMP programs have greatly improved the level of preparedness and the capabilities of Civil Defense and the

general public. The programs will support continued outreach and education efforts on the Hawaiian Islands. Mel Kaku, Oahu Director of Emergency Management, commented, “*One of the biggest challenges on the island is complacency and the TsunamiReady Program can counteract this attitude.*”

Best Practice 10—When the tsunami advisory was issued for Hawaii, the Ocean Safety Group deployed its lifeguards on jet skis and asked people to get out of the water. Waikiki Police officers walked the entire beach to inform people of the hazard (advisory) and asked people to leave the beach. Lifeguards and hotel staff helped disseminate the message. The TsunamiReady program helped facilitate this type of response.

Fact—Every county in Hawaii is TsunamiReady.

Fact—The Honolulu Police Department received the tsunami watch and advisory via fax from Civil Defense and disseminated the messages to its officers via fax and High Frequency radio. The police also notified the Ocean Safety Group and local hotels about the tsunami watch and advisory.

Finding 50—City and county officials were able to quickly clear many people from the beaches when the tsunami advisory was issued because clear protocols for tsunami response had been developed through the TsunamiReady certification process.

Recommendation 50—Continue maintaining and improving the TsunamiReady program in Hawaii to ensure tsunami awareness education is provided to residents and visitors of Hawaii.

Tsunami education and outreach activities in American Samoa resulted in an elevated awareness regarding the tsunami hazard among the residents. This awareness ultimately saved lives when the tsunami struck American Samoa because people knew how to recognize the natural warning signs and took immediate action. The TsunamiReady program can provide a framework for communities in American Samoa to maintain a state of readiness through continued education and outreach, ensuring communication systems are in place to receive and send urgent messages.

Fact—American Samoa has not been designated as TsunamiReady.

Finding 51—American Samoa has completed many of the necessary requirements to become designated as TsunamiReady.

Recommendation 51—WSO Pago Pago and PRH should continue to work with local officials to complete the TsunamiReady requirements for American Samoa.

3.10. WC/ATWC Operations, Products, and Services

WC/ATWC also issued products for its area of responsibility for this event and was in close contact with PTWC during the entire event. The most important product was the tsunami

advisory issued for the California and Oregon coastal areas. The tsunami advisory proved to be a very appropriate product for the situation; however, tsunami breakpoints and marine zone boundaries on the West Coast are not collocated in all areas, including near the Oregon-Washington border. This difference led to confusion on the part of local EM officials in southwestern Washington.

The WC/ATWC conference calls with the WFOs and State Warning Centers successfully communicated vital information during the event. WC/ATWC used its Website more for this event than in previous events and added information specifically to assist PTWC. This extra information was well received and will continue to be upgraded based on customer feedback.

Fact—Some residents in Pacific County, Washington (southern Washington coast) were confused about their watch/warning/advisory status during this event. The adjacent marine zone (PZZ250) was included in the tsunami advisory, according to current WC/ATWC procedures, and it was highlighted on the Web-based NWS watch/warning/advisory maps.

Finding 52—The affected marine zone (PZZ250) extends across the established breakpoint at the Oregon-Washington border, mouth of the Columbia River, from the northern Oregon coast to the southern Washington coast. As a result, many users viewing the Web-based NWS watch/warning/advisory maps thought southern Washington was included in the tsunami advisory, even though it was not. The coastal public (land-based) zones were all correctly displayed in the Web-based maps.

Recommendation 52—WC/ATWC should develop a solution, e.g., remove marine zones from tsunami bulletin products, to minimize confusion on the location of hazard areas on maps.

3.11. International Services

The tsunami affected other countries in the South Pacific. Although casualties were only recorded in Western Samoa, American Samoa, and Tonga, a number of other countries observed noticeable sea level changes: Fortuna, French Polynesia, Rarotonga, and the Cook Islands. Many national TWCs activated their tsunami warning emergency procedures for the event.

Best Practice 11—The continuous activation of sirens, church, and school bells by villages are signals that warn everyone to evacuate to designated evacuation sites.

Best Practice 12—Eyewitness accounts indicated many people in villages felt the strong earthquake, recognized the tsunami, and knew to immediately head inland and to higher ground. This knowledge saved many lives.

Fact—Communication lines for the public and between responding agencies were jammed.

Finding 53—Reports from the national and international media provided important information for the public, but the information was at times conflicting and confusing.

Recommendation 53—NWS, ITIC, and NOAA’s International Tsunami Program Team should work with local government agencies to provide tsunami education and training to the international media outlets.

International tsunami activities in the Pacific Basin are coordinated through the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS), overseen by UNESCO’s Intergovernmental Oceanographic Commission. The ICG/PTWS last met in February 2009 in Apia, Western Samoa. At that meeting the focus was on effectively mitigating local and regional tsunamis when only minutes elapse between the earthquake and the tsunami arriving. Recognizing the deadliness of this hazard, the ICG/PTWS has had a working group for the Southwest Pacific since 2003. With support from ITIC, the ICG/PTWS has worked closely with the Pacific Islands Applied Geoscience Commission (SOPAC) in tsunami disaster risk reduction. For the past few years, through heightened awareness and working partnerships, there have been a number of meetings and coordinated initiatives to strengthen tsunami warnings in this region.

The responsible organization for tsunami warning and emergency response in Western Samoa is the Samoa Meteorology Division (SMD). Currently, the division is heavily dependent on reports from a single seismic station, Afiamalu, to calculate the magnitude and location of earthquakes. This dependence becomes a problem when Internet connection is interrupted or electricity is down. Presently, there exists no international seismic network for the Pacific; however, establishment of a network using funds provided by China is underway. An upgrade to the Afiamalu Global Seismographic Network and International Monitoring System (GSN/IMS) station is planned by the USGS and the Comprehensive Test Ban Treaty Organization (CTBTO).

Fact—In Western Samoa, the SMD has primary responsibility for issuing warnings for local, short-fused, tsunami events. For distant tsunamis, SMD relays PTWC warnings. SMD typically coordinates with WSO Pago Pago on product dissemination for a consistent message.

Finding 54—The hotline between WSO Pago Pago and the SMD was inoperable during the tsunami, preventing information exchange and coordination on product and message dissemination.

Recommendation 54—WSO Pago Pago should work with local DHS officials and PRH to reconnect the hotline between WSO Pago Pago and the SMD, and develop procedures for communications tests and outage repairs. Additionally, a backup communication mechanism between the American and Western Samoa weather offices should be established.

Fact—Over the past several years, Western Samoa has conducted several tsunami awareness and preparedness activities, but these efforts are only first steps.

Fact—National Tsunami Warning exercises in 2007 and 2008 helped increase preparedness and readiness.

With the introduction of the Global System for Mobile communications (GSM) in Western Samoa in 2005, a new Tsunami Early Warning System was designed and tested in October 2007 and again in November 2008. The system involves informing the public of an approaching

tsunami using SMS sent to selected village and national level representatives such as mayors, government representatives, church ministers, schoolteachers, Cabinet Ministers, heads of all government ministries and corporations, non-governmental organizations, and the private sector.

Fact—PTWC messages are received via SMS, fax, email, and the Emergency Managers Weather Information Network (EMWIN) system.

Fact—Sending text messages is fully supported by local mobile service providers free of charge.

Fact—If the text message is a tsunami watch, the protocol is for all selected village and national level representatives to use word of mouth to inform their families, friends, and other contacts.

Fact—If the text message is a tsunami warning, church ministers and school teachers are responsible for ringing church bells for at least 10 minutes. This differs slightly from American Samoa's policy, where the bells are rung 4 times, wait 4 seconds, then another 4 times, repeatedly, to indicate a tsunami.

The Fire and Emergency Services, Samoa Airport Authority and Samoa Ports Authority are responsible for activating siren systems. These sirens continue until the threat is over. The sirens and church/school bells are warning signals for everyone to evacuate. The response agencies have plans they will activate once the text messages are received through their selected representatives. The response agency plans set out, in detail, functions and tasks to facilitate response during a tsunami event.

4. Summary

The proximity of the September 29, 2009, earthquake to islands such as American Samoa, Western Samoa, and Tonga left little time for residents to take action. Many on the team equated the urgency of getting the tsunami warning out to NWS partners and the public to a tornado warning based on the fast response required and the potential of loss of life and property. This report detailed several factors that saved many lives and places where the tsunami warning process should be improved. The recommendations of this report, in combination with the Tsunami Strategic Plan, will support continued growth of the Tsunami Warning program in the Pacific and beyond.

Appendices

Appendix A: Definitions

Best Practice—An activity or procedure that has produced outstanding results during a particular situation that could be used to improve effectiveness and/or efficiency throughout the organization in similar situations. No action is required.

Fact—A statement that describes something important learned from the assessment for which no action is necessary. Facts are not numbered, but often lead to recommendations.

Finding—A statement that describes something important learned from the assessment for which an action may be necessary. Findings are numbered in ascending order and are associated with a specific recommendation or action.

Recommendation—A specific course of action, which should improve NWS operations and services, based on an associated finding. Not all recommendations may be achievable, but it is important to document them. If the affected office(s) and OCWWS determine a recommendation will improve NWS operations and/or services, and it is achievable, the recommendation will likely become an action. Recommendations should be clear, specific, and measurable.

Appendix B: Appendix B: Findings, Recommendations, and Best Practices

Best Practices

Best Practice 1—Coordination between the centers during a tsunami event allows the offices to quickly share information.

Best Practice 2—A “personnel exchange program” facilitates direct interchange of ideas and information between the TWCs, contributing to continuous improvements in real-time coordination during tsunami events and effectiveness of mutual service backup operations when needed.

Best Practice 3—The SIFT forecasts provided PTWC with vital information indicating the tsunami would not be destructive for Hawaii. Despite the need for necessary enhancements, the SIFT, Alaska Tsunami Forecast Model (ATFM), and Real-time Inundation Forecasting for Tsunamis (RIFT) forecast models, along with the seismic and historical data, provided PTWC operations staff sufficient confidence to replace the tsunami watch with a tsunami advisory for Hawaii. This action prevented an unnecessary evacuation, while still providing an alert about the potential hazards from strong currents and sea level changes on beaches and in harbors.

Best Practice 4—Personnel from the NOAA International Tsunami Information Centre (ITIC) connected WSO Pago Pago to the California Integrated Seismic Network (CISN) Display. The ability to access CISN seismic data to confirm the natural warning signs of an earthquake and a potential tsunami gave WSO staff the confidence to request activation of the Emergency Alert System (EAS). While, ultimately, the WSO staff should have formally issued the initial warning, the ability to react to the situation before receiving official word from PTWC of tsunami generation was critical.

Best Practice 5—EAS radios were distributed by the Department of Homeland Security (DHS) to the Local Primary 1 (LP) and LP2 EAS stations, WSO Pago Pago, police, and other entities listed as critical for emergency response. EAS radios on American Samoa allowed officials to communicate during the tsunami, despite jammed phone lines. The system allowed the Meteorologist-in-Charge (MIC) at WSO Pago Pago to radio DHS, which in turn asked the LP1 radio station to activate vertical evacuation plans prior to the tsunami. Having an EAS Committee and plan for American Samoa created the framework to get critical information to the public quickly, thus saving lives.

Best Practice 6—A local EAS Committee created an EAS plan for American Samoa following the 2006 Tonga tsunami. It was utilized during the event.

Best Practice 7—The EAS was the most effective warning component in this event. EAS handheld radios allowed warnings to be received even when phone lines were jammed.

Best Practice 8—Holding teleconferences throughout the event provided outstanding Decision Support Services to the state, county, and local Civil Defense Agencies.

Best Practice 9—Aggressive outreach taught officials and the public to take life-saving actions based upon natural warning signs, such as “stronger earthquake than usual” and “the receding of the sea.” Every school along the coast in American Samoa has a Tsunami Evacuation Plan. Several schools were destroyed; however, thanks to preparedness campaigns, there was no loss of life at schools that properly activated their Tsunami Evacuation Plans. Based on the training police officers received, they sounded car sirens and used their public address systems to instruct the public to get to higher ground immediately. Tsunami outreach in the Pacific should not only continue, but should be institutionalized as an integral part of an effective mitigation strategy to help prevent future loss of life.

Best Practice 10—When the tsunami advisory was issued for Hawaii, the Ocean Safety Group deployed its lifeguards on jet skis and asked people to get out of the water. Waikiki Police officers walked the entire beach to inform people of the hazard (advisory) and asked people to leave the beach. Lifeguards and hotel staff helped disseminate the message. The TsunamiReady program helped facilitate this type of response.

Best Practice 11—The continuous activation of sirens, church, and school bells by villages are signals that warn everyone to evacuate to designated evacuation sites.

Best Practice 12—Eyewitness accounts indicated many people in villages felt the strong earthquake, recognized the tsunami, and knew to immediately head inland and to higher ground. This knowledge saved many lives.

Findings and Recommendations

Finding 1—There is a low density of seismic sensors in the Samoa region, contributing to the delay in warning issuance when compared to other domestic regions.

Recommendation 1—NWS should collaborate with USGS and international partners to increase the density of seismic sensors in the southwestern Pacific basin.

Finding 2—PTWC operates different seismic analysis software than WC/ATWC. This difference, coupled with bandwidth limitations, may have contributed to a delay of up to 2 minutes in locating the earthquake position and depth and assigning an accurate preliminary magnitude.

Recommendation 2—Conduct an analysis of the WC/ATWC and PTWC seismic processing systems and alarm algorithms, and ensure the systems are aligned.

Finding 3—Currently available bandwidth allows PTWC to monitor only a limited number of seismic stations. This may have contributed to delays in locating and sizing the earthquake that produced the tsunami.

Recommendation 3—Increase the bandwidth and provide a backup system for NOAA Net.

Finding 4a—Extra staff members who arrived at PTWC to assist with the event were not assigned to fulfill specific functions, such as answering phones outside of the operation area and coordinating with media representatives.

Finding 4b—PTWC staff do not have a formal system for getting media representatives the information they need without affecting operations.

Finding 4c—Staff at PTWC lack training in media and crisis communications.

Recommendation 4a—PTWC should develop procedures to designate an Event Coordinator for all major events. The office should also include procedures in its Operations Manual for assigning a Media Liaison and initiating a Crisis Communications Plan.

Recommendation 4b—PTWC staff should receive professional media training that includes crisis planning, communicating during a crisis, delivering short sound bites, and organizing press conferences. Training should be ongoing with refresher courses at least every 2 years.

Recommendation 4c—PTWC should implement tighter physical controls for entry into its facility.

Finding 5—Two PRH staff members arrived at PTWC but were not used to resolve operational efficiency issues.

Recommendation 5—PRH should set up a Quick Response Team (QRT) for PTWC that would include all available NOAA communications assets in Hawaii [PRH Public Affairs Officer, WFO Warning Coordination Meteorologist (WCM), and Regional WCM, for example]. The QRT would be activated during high impact events to assist with media and public communications at PTWC. The team should meet regularly and create a Significant Event Crisis Communications Plan.

Finding 6—Space at PTWC is inadequate for media operations during high impact events.

Recommendation 6—PTWC should establish a media pool agreement with media outlets.

Finding 7—The limitations imposed by PTWC's telephone system interfered with the staff's ability to quickly respond to high priority calls from public safety and EM officials and the media. The high volume of incoming calls also hindered the center's ability to make outgoing high priority calls. Because of the inability to differentiate incoming calls during this crucial

time, PTWC was unable to prioritize calls. NWS Headquarters, WSO Pago Pago, WFO Honolulu, and Hawaii Civil Defense reported difficulty in reaching PTWC via phone.

Recommendation 7a—Increase the use of the Hawaii Warning System (HAWAS) for direct communication between NWS offices and key users/partners within the state of Hawaii.

Recommendation 7b—PRH should work with the Federal Emergency Management Agency

Finding 8—Because of the time required for manual recording and the frantic atmosphere in PTWC’s operations area, no outgoing telephone message was provided during this event.

Recommendation 8—PTWC should implement an automated recording capability for tsunami watches, warnings, advisories, and other critical tsunami event information, and develop procedures to allow these functions to be performed by the QRT if necessary.

Finding 9—PTWC’s Website slow-downs are an ongoing problem. The near-failure of the Website in this event inhibited users’ abilities to receive timely, specific information, including details regarding tsunami watches, warnings, and advisories for Hawaii and the entire Pacific. The Website deficiencies added to an already heavy telephone call load at PTWC.

Recommendation 9a—The PTWC Website should be hosted on the consolidated Web farm to improve reliability and allow backup capability.

Recommendation 9b—Continue, and accelerate if possible, development of the NWS Tsunami Portal, which is planned to replace both TWC’s Websites as the primary site for all tsunami information.

Finding 10a—PTWC had been using SIFT on an experimental/research basis. The current version of the SIFT model, however, is not sufficiently streamlined for real-time use in an operational environment. Given other high priority tasks operational staff are responsible for during events, it is difficult to manage and integrate the high volume of SIFT data output.

Finding 10b—The current version of SIFT does not include output for American Samoa. Additionally, SIFT is designed to provide output for specific points along a coast, not large-scale areas, where a Standby Inundation Model (SIM) has not been constructed.

Recommendation 10a—SIFT should be streamlined to include better information management capabilities.

Recommendation 10b—Modify SIFT to do the following:

- Increase the number and type of data sources for which it accounts
- Add a capability to input other types of solutions not already included in the pre-computed source information
- Provide an accurate general forecast for coastlines not covered by SIMs.

Finding 11—ATFM energy maps provided important information during the event, but the coastal forecast output file was corrupted and not used by either center.

Recommendation 11—The ATFM output files must be checked to ensure that forecasts for all precomputed sources are immediately available during events at both centers.

Finding 12—SIFT provides forecasts of water level only at a limited number of geographical points; Keahou Bay is not one of these points. PTWC cannot produce a coastal tsunami model that provides large scale, detailed forecasts of water levels for extended portions of the coast between or outside of the points provided by SIFT and ATFM. Had such a modeling capability existed, PWTC could have provided improved water level forecasts for the larger scale, i.e., coastal areas of Hawaii in between SIFT forecast points, American Samoa, and other international coasts for which PTWC has warning responsibility.

Recommendation 12—The large scale, coastal forecast ability of the ATFM should be expanded to include international areas and additional domestic areas (e.g., Hawaii).

Finding 13—Sea level data was crucial during the event, not only for PTWC and WC/ATWC tsunami forecasting, but also to EMs in Hawaii during the event.

Recommendation 13—The National Data Buoy Center (NDBC) and NOS should be given resources to ensure it can promptly repair and maintain DART buoys and coastal water level stations.

Finding 14—There have been no meetings of the Tsunami Technical Review Committee for the past 2 years.

Recommendation 14—Tsunami Technical Review Committee meetings should be reinstated as soon as possible and PRH should help the Pacific Island territories establish similar review committees.

Finding 15—In the tsunami section of the office Station Duty Manual (SDM), the page regarding local policy and procedures for tsunami related products was missing.

Recommendation 15—The MIC must ensure that SDM chapters are updated and current. Staff should be required to use office logs, event logs and reference sheets during any event. PRH should look into implementing electronic logs at WSOs. All staff must be familiar with, and adhere to, the policies and procedures regarding tsunami warnings and should read and sign off on the SDM content annually.

Finding 16—The WSO started to issue a tsunami warning over NOAA Weather Radio (NWR) and EAS using Interalia equipment when staff noted an earthquake magnitude greater than 7.5 on CISM; however, the WSO did not send an official product until 7:17 a.m., local time, 29 minutes after the earthquake, and 12 minutes after the first tsunami wave arrived in Pago Harbor.

Recommendation 16— WSO Pago Pago must establish a protocol for sending an official tsunami warning within minutes of the office determining a tsunami is imminent.

Finding 17—Messages released as RWTs activate EAS only as a test message. The RWT event code will not scroll the EAS message stating a tsunami warning is in effect, thus it will not interrupt broadcasts to relay critical information. This function is critical in American Samoa where none of the radio or television stations are staffed 24/7 though most broadcast all night.

Recommendation 17—All WSO Pago Pago forecasters must be trained to correctly operate NWR and EAS equipment to minimize transmission and coding errors and repeat messages.

Finding 18a—In order to process an emergency message on the Interlalia system, all existing messages must be cleared. The PC allows the staff to immediately clear out the message queue. Office personnel were unsure whether the software could issue the 1050 hertz tone eliminating numerous manual steps. The manufacturer did not provide training on the system so the staff had to train themselves by reading the manual.

Finding 18b—Emergency messages must be deleted manually to prevent multiple EAS activations, which potentially block out a radio station's ability to verbally communicate emergency instructions.

Finding 18c—Issuing a product on NWR during a high impact event involves numerous manual entries via a numeric keypad, increasing the chance of errors.

Recommendation 18—The WSO should contact the Interlalia manufacturer to determine whether the software is capable of enhanced PC functions, determine if there have been software upgrades, and ask about training. If these actions do not resolve the problem, the WSO should request that the system be replaced with more efficient equipment to simplify the process and minimize human errors.

Finding 19—The WSO compensated for the jammed lines by connecting to a Federal Aviation Administration line used at the old airport tower location.

Recommendation 19—The PC should be hardwired to the Interlalia or a dedicated line installed.

Finding 20a—The staff correctly issued the Tsunami Warning using the tsunami warning event code (TSW) over NWR at approximately 7:19 a.m., local time, but the tsunami had already struck the island. Because a large aftershock had also occurred by this time, the TSW created confusion and panic. People thought a second tsunami had been generated by the aftershock.

Finding 20b—The TSW and RWT remained in the NWR broadcast cycle and played 21 times, with an EAS activation each time per the EAS log and media interviews.

Finding 20c—WSO Pago Pago never relayed or broadcast the cancellation of the Tsunami Warning, though the office inadvertently extended the warning to 7:00 p.m. shortly before PTWC canceled the warning for American Samoa.

Recommendation 20—The WSO must implement a protocol for relaying all TWC messages and products through local communication pathways.

Finding 21—NWR receivers were provided to all schools by DHS, however, school staff did not receive assistance with programming the units. Several schools returned the NWRs to DHS because the units were difficult to program or did not receive a signal.

Recommendation 21a—WSO personnel should help residents program NWR receivers and explain the value of NWR, and how it can be used to receive critical information.

Recommendation 21b—The WSO should relocate the existing NWR transmitter tower to a higher elevation (Mount Olotele) to provide NWR coverage over the entire island. Completing this recommendation was in progress.

Finding 22—The HMT staff has not received complete training to issue public watch, warning or advisory products.

Recommendation 22—The WSO should be staffed 24/7 by a meteorologist trained to perform all mission functions.

Finding 23a—The WSO's PC hardware configurations are below operational standards. These computers take an inordinate amount of time to boot up. The field laptop is heavy, bulky, and antiquated.

Finding 23b—The WSO personnel did not digitally archive the products for this event, though they maintained hard copies. Local broadcast stations maintained digital and hard copy EAS logs.

Recommendation 23a—PRH should ensure the installation of an updated operational computer network that ties all of the systems together, including NWR, for quicker dissemination of all products. The system must be able to archive at least 30 days of time-stamped products.

Recommendation 23b—The WSO should implement additional detailed instructions in its SDM on how and when to archive data relating to a high impact event and should train staff on these procedures.

Finding 24—When the staff was having difficulty issuing products via the Interalia system, the fax machine was not used to transmit emergency information to the EAS community.

Recommendation 24—PRH should upgrade some of the office equipment, specifically the WSO needs computer facsimile hardware and software and a copier with facsimile capabilities to provide a dedicated backup dissemination method.

Finding 25—Unreliable communication with PTWC hampered the WSO's efforts to get accurate, timely information on the Tsunami Warning.

Recommendation 25—PRH should work with the MIC and the local telecommunication company to install a hotline (or equivalent capability) to PTWC, WFO Honolulu, and PRH.

Finding 26—The portable EAS radio was not charged at the time. Once plugged into the charger, the WSO was able to use the radio immediately to contact DHS and the LP1 radio station.

Recommendation 26—The WSO should procure a backup portable EAS radio. Staff should ensure at least one radio is always operable in the operations area and make sure it is charged. Also, staff should take part in DHS radio checks.

Finding 27a—The LP1 radio station issued an Earthquake Warning via EAS based on the duration and strength of the earthquake. Other radio stations received and broadcast the information, but no tsunami warning was issued prior to the arrival of the first wave.

Finding 27b—There is no record of the language used in the message; however, the LP1 radio station reports it included in the message the fact that no “official” tsunami warning had been issued. This message was initially conveyed by the WSO to indicate that no official tsunami product had been received from PTWC confirming a tsunami warning but may have been interpreted by the public as the absence of a tsunami threat.

Finding 27c—The LP1 station recorded this tsunami message prior to losing power upon arrival of the tsunami, but the EAS logs at the LP2 do not reflect this message, indicating there may have been a transmission error. Therefore, the last thing many people heard over the radio before the tsunami waves struck Pago Harbor was the official message that “there is no official Tsunami Warning.”

Finding 27d—Most people knew how to respond to a tsunami, but many were confused because no official warning was in effect.

Recommendation 27—WSO Pago Pago must have adequate infrastructure and communication protocols to effectively issue or convey official tsunami warnings.

Finding 28—The inability of DHS and other members of the EAS community to reach the WSO caused a great deal of confusion regarding who should issue warnings.

Recommendation 28a—WSO Pago Pago should work with the American Samoa government to clearly identify roles and responsibilities for EAS activation. The WSO should consider a scenario-based approach to train for potential contingencies. It is critical that information gets out through the correct channels by an authoritative agency, as quickly and concisely as possible.

Recommendation 28b—The WSO should continue to work with the EAS Committee, in particular the LP1 and LP2 stations, on improving critical communications.

Finding 29—The radio station over which WSO advised a vertical evacuation, Showers of Blessings, did not have input to EAS and had not broadcast the earlier earthquake EAS alert. This was the only radio station on which staff members from WSO Pago Pago went live.

Recommendation 29—The EAS protocol must be followed to allow the WSO to effectively communicate an official warning to the media during an event. LP1 and LP2 stations should be

called first via the EAS radio during a crisis and should automatically receive critical information via NWR.

Finding 30—At this time, there are missing components of the EAS and gaps in its functionality. Additionally, not all critical personnel have input to EAS.

Recommendation 30—WSO staff should help the DHS to complete and maintain EAS. The WSO should participate in EAS committee meetings and updates to the EAS plan.

Finding 31a—Not everyone was listening to the radio on the morning of the tsunami, and very few people on American Samoa have or use a NWR receiver; therefore, it is critical to explore redundant means of communication.

Finding 31b—Most people, regardless of age, have cellular phones on American Samoa.

Recommendation 31a—NOAA should partner with DHS to install a siren system on American Samoa and clearly define protocols and responsibilities involved with activation of those sirens.

Recommendation 31b—NWS should explore usage of short message service (SMS) text warnings to cell phones similar to the system used on Western Samoa.

Finding 32—No text-to-speech formatter exists to automatically relay currently formatted tsunami messages to the NWR broadcast cycle. This deficiency increases the time required to disseminate potentially life-threatening information.

Recommendation 32—NWS should develop an NWR formatter for tsunami products that will decrease EAS activation times by eliminating human intervention.

Finding 33—WFO Honolulu was not invited to be on the coordination calls and thus was not aware the tsunami watch would be converted to a tsunami advisory until the WFO received the PTWC advisory message.

Recommendation 33—PTWC and State Civil Defense must include WFO Honolulu on tsunami coordination calls.

Finding 34a—The WFO Honolulu staff did not know a tsunami advisory was issued for Hawaii using the new WC/ATWC definition.

Finding 34b—WFO Honolulu received a few calls from the public and media outlets who were confused about what the tsunami advisory meant for Hawaii. The PTWC Website stated the tsunami advisory means: “The tsunami poses no danger to the area,” while the PTWC tsunami advisory statement stated: “Strong currents may occur along the coast which could be a hazard to swimmers, boaters, and beaches.” The Website was modified to use the new definition during the event.

Recommendation 34—PTWC should formally adopt the WC/ATWC tsunami advisory definition for its domestic AOR (Hawaii) as quickly as possible and update its Webpage with the new definition. PTWC is in the process of implementing this recommendation. Additional outreach and education are required.

Finding 35—People started to filter back onto the beach between 2:00 p.m. and 3:00 p.m., HST, after no wave activity had been observed on the beaches.

Recommendation 35a—Public education should be continued on tsunami danger, specifically the fact that there is often more than one wave resulting in several hours of danger.

Recommendation 35b—To fulfill its tsunami warning responsibility to the state of Hawaii, PTWC must frequently update products to keep the public, EM, and media informed in accordance with prescribed instructions.

Finding 36—Users of this product had to wait significantly longer than the specified 1 hour for updates as indicated in the bulletins. As a result, several people said there were information voids during the event.

Recommendation 36a—PTWC must issue updates at least hourly as directed by NWSI 10-701, even if no new information is available.

Recommendation 36b—WFOs and WSOs in PTWC’s AOR should develop procedures to issue local statements (e.g., using the special weather statement, marine weather statement, and/or creation of a new dedicated product, such as a “tsunami local statement”) to supplement PTWC watches, warnings, and advisories. Such statements should contain specific, local information if available, and not contradict official PTWC information.

Finding 37—Users who depend solely on NWS or AFTN for tsunami watch/warning/advisory information from PTWC did not receive the initial watch/warning message.

Recommendation 37—To the greatest extent possible, PTWC must ensure successful transmission and receipt of all products over required circuits and other designated dissemination media.

Finding 38—As a result of the missing VTEC line between the Hawaii state messages #3 and #4, the Web-based NWS watch/warning/advisory maps showed no tsunami advisory for nearly 6 hours, even though the tsunami advisory was in effect. Furthermore, national vendors and commercial companies who use VTEC for automated dissemination did not receive accurate information during this timeframe.

Recommendation 38—PTWC must ensure that correct VTEC lines are included in all domestic (Hawaii) products for tsunami watches, warnings, and advisories. PTWC operational staff must ensure their messaging software correctly and automatically produces all necessary VTEC coding.

Finding 39—During a visit by the PTWC Director to WSO Pago Pago, the Director and MIC verbally agreed to develop a domestic tsunami watch/warning/ advisory product for American Samoa; however, this product has yet to be implemented at PTWC.

Recommendation 39—PTWC should include American Samoa, Guam, and CNMI in its domestic product(s), either in a single segmented product or individual products, as appropriate.

Finding 40—WC/ATWC’s information regarding the status of PTWC’s tsunami watches/warnings/advisories was inaccurate at times. As a result, WC/ATWC’s bulletins did not consistently convey the correct status of PTWC’s tsunami watches/warnings/advisories.

Recommendation 40—PTWC and WC/ATWC watch/warning/advisory bulletins should include a brief, but accurate, generalized statement regarding the other TWC’s watch/warning/advisory status, including a reference to the appropriate TWC Website for the latest information and additional detail.

Finding 41—Including locations where the initial wave had already passed in tsunami watch/warning bulletins resulted in unnecessarily long messages and, in some cases, obsolete information.

Recommendation 41—PTWC’s message generation software should be modified to include only those points where the initial tsunami wave has not yet passed.

Finding 42—The culture requires preparedness and warning information to come from an authoritative source such as a chief, high chief, or official government office, such as NWS.

Recommendation 42—Individual outreach efforts in local communities should be encouraged, supported, and recorded as an essential part of the WSO employees’ jobs. This will increase the level of trust in WSO information.

Finding 43—All education programs and radio public service announcements have been conducted in English, with some education and outreach in Samoan.

Recommendation 43a—Education and public awareness materials should be developed for children, elderly, and other special needs groups. Evacuation routes should be identified that are accessible to these groups, with a plan for assisting those with mobility problems.

Recommendation 43b—Informational materials about disasters must be developed for those speaking English as a Second Language (ESL).

Recommendation 43c—Official warnings and general information need to be tailored to local areas and conditions to be recognized, understood, and used. New technologies should be investigated, e.g., multi-lingual NWR receivers. Once the technologies are identified, NWS should then work with the private sector to implement appropriate improvements.

Finding 44—Tula was destroyed during this tsunami event, but everyone was safely evacuated because they knew where to go and had practiced evacuating.

Recommendation 44a—Continue public education, outreach, and training programs; integrate information on evacuation routes and clear, easily understandable warning signals when warnings are issued.

Recommendation 44b—The WSO should work with DHS and DOE to ensure schools promptly receive warnings and implement evacuation plans.

Finding 45—Employees at the cannery and powerplant participated in disaster evacuation exercises prior to this tsunami event and continue to work closely with the local EM officials. These efforts significantly contributed to a safe evacuation of all employees from the facilities following the earthquake.

Recommendation 45—The private sector must be included in local EM efforts, including public awareness and training activities, to protect lives and sensitive assets located in nearshore areas.

Finding 46—People understood the need to evacuate to higher ground when they felt a strong earthquake, but were not clear on what routes to follow, what form of transportation to use, how far to go, or how long to stay there.

Recommendation 46—Improvements should be made to existing tsunami signage to clarify tsunami evacuation routes and protocols.

Finding 47—This event tested the plans that had been developed and provides an opportunity to assess and refine those plans and protocols before the next event.

Recommendation 47a—NOAA should continue to fund and strengthen tsunami education and training efforts for the public, government and elected officials through the National Tsunami Hazard Mitigation Program (NTHMP).

Recommendation 47b—Tsunami outreach on American Samoa should be institutionalized through continued involvement in the TsunamiReady Program, with supporting funds, as needed via TsunamiReady and NTHMP grant funding programs, pending availability of funds.

Finding 48—WSO Pago Pago and ITIC’s participation in National Preparedness Month and their role in tsunami outreach helped save lives in American Samoa.

Recommendation 48—NOAA should continue to participate in National Preparedness Month and advocate tsunami topics as part of this and similar awareness campaigns, such as a National Tsunami Awareness Week, to generate local media interest.

Finding 49—Although PTWC conducted some outreach, it does not have the resources to provide effective outreach to all its customers.

Recommendation 49—PTWC should leverage all existing NOAA resources (PRH, ITIC) and key partners (DHS, EMs) to increase the capacity for local, regional, national, and international outreach activities.

Finding 50—City and county officials were able to quickly clear many people from the beaches when the tsunami advisory was issued because clear protocols for tsunami response had been developed through the TsunamiReady certification process.

Recommendation 50—Continue maintaining and improving the TsunamiReady program in Hawaii to ensure tsunami awareness education is provided to residents and visitors of Hawaii.

Finding 51—American Samoa has completed many of the necessary requirements to become designated as TsunamiReady.

Recommendation 51—WSO Pago Pago and PRH should continue to work with local officials to complete the TsunamiReady requirements for American Samoa.

Finding 52—The affected marine zone (PZZ250) extends across the established breakpoint at the Oregon-Washington border, mouth of the Columbia River, from the northern Oregon coast to the southern Washington coast. As a result, many users viewing the Web-based NWS watch/warning/advisory maps thought southern Washington was included in the tsunami advisory, even though it was not. The coastal public (land-based) zones were all correctly displayed in the Web-based maps.

Recommendation 52—WC/ATWC should develop a solution, e.g., remove marine zones from tsunami bulletin products, to minimize confusion on the location of hazard areas on maps.

Finding 53—Reports from the national and international media provided important information for the public, but the information was at times conflicting and confusing.

Recommendation 53—NWS, ITIC, and NOAA’s International Tsunami Program Team should work with local government agencies to provide tsunami education and training to the international media outlets.

Finding 54—The hotline between WSO Pago Pago and the SMD was inoperable during the tsunami, preventing information exchange and coordination on product and message dissemination.

Recommendation 54—WSO Pago Pago should work with local DHS officials and PRH to re-connect the hotline between WSO Pago Pago and SMD, and develop procedures for communications tests and outage repairs. Additionally, a backup communication mechanism between the American and Western Samoa weather offices should be established.

Appendix C: Acronyms

AFTN	Aeronautical Fixed Telecommunications Network
AKDT	Alaska Daylight Time
ATFM	Alaska Tsunami Forecast Model
AOR	Area of Responsibility
AWIPS	Advanced Weather Interactive Processing System
CA	California
CISN	California Integrated Seismic Network
CNMI	Commonwealth of the Northern Mariana Islands
CRS	Console Replacement System (NOAA Weather Radio)
CTBTO	Comprehensive Test Ban Treaty Organization
DART	Deep-ocean Assessment and Reporting of Tsunamis
DHS	Department of Homeland Security
DOE	Department of Education
EAS	Emergency Alert System
EM	Emergency Management/Manager
EOC	Emergency Operations Center
ESL	English as a Second Language
FEMA	Federal Emergency Management Agency
FM	Frequency Modulation
GIC	Geophysicist in Charge
GSM	Global System for Mobile communications
GSN/IMS	Global Seismographic Network and International Monitoring System
HAWAS	Hawaii Warning System
HI	Hawaii
HMT	HydroMeteorological Technician
HST	Hawaiian Standard Time
ICG/PTWS	Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System
ITIC	International Tsunami Information Center
IOC	Intergovernmental Oceanographic Commission
LP1	Local Primary 1 (broadcast station for EAS)
LP2	Local Primary 2 (broadcast station for EAS)
MIC	Meteorologist-in-Charge
NDBC	National Data Buoy Center
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NTHMP	National Tsunami Hazard Mitigation Program
NWR	NOAA Weather Radio All Hazards
NWS	National Weather Service
NWSI	National Weather Service Instruction
NWWS	NOAA Weather Wire Service

OR	Oregon
PC	Personal Computer
PDT	Pacific Daylight Time
PL	Public Law
PMEL	Pacific Marine Environmental Laboratory
PRH	Pacific Region Headquarters
PTWC	Pacific Tsunami Warning Center
QRT	Quick Response Team
RIFT	Real-time Inundation Forecasting for Tsunamis
RWT	Required Weekly Test
SDM	Station Duty Manual
SIFT	Short-term Inundation Forecast for Tsunamis
SIM	Standby Inundation Model
SMD	Samoa Meteorology Division
SMS	Short Message Service
SOPAC	Pacific Islands Applied Geoscience Commission
SST	Samoa Standard Time
TSW	Tsunami Warning Event Code
TWC	Tsunami Warning Center
UNESCO	United Nations Educational, Scientific and Cultural Organization
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UTC	Universal Coordinated Time
VTEC	Valid Time Event Code
WA	Washington
WC/ATWC	West Coast/Alaska Tsunami Warning Center
WCM	Warning Coordination Meteorologist
WFO	Weather Forecast Office
WSO	Weather Service Office

Appendix D: Sea Level Observations and Model Output

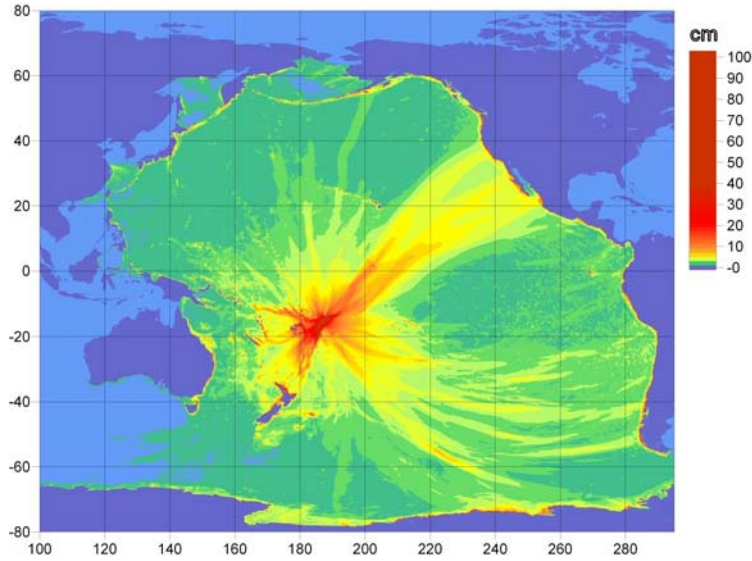


Figure 2. Tsunami Maximum Wave Amplitude Graph (Source: WC/ATWC; Model: Alaska Tsunami Forecast Model)

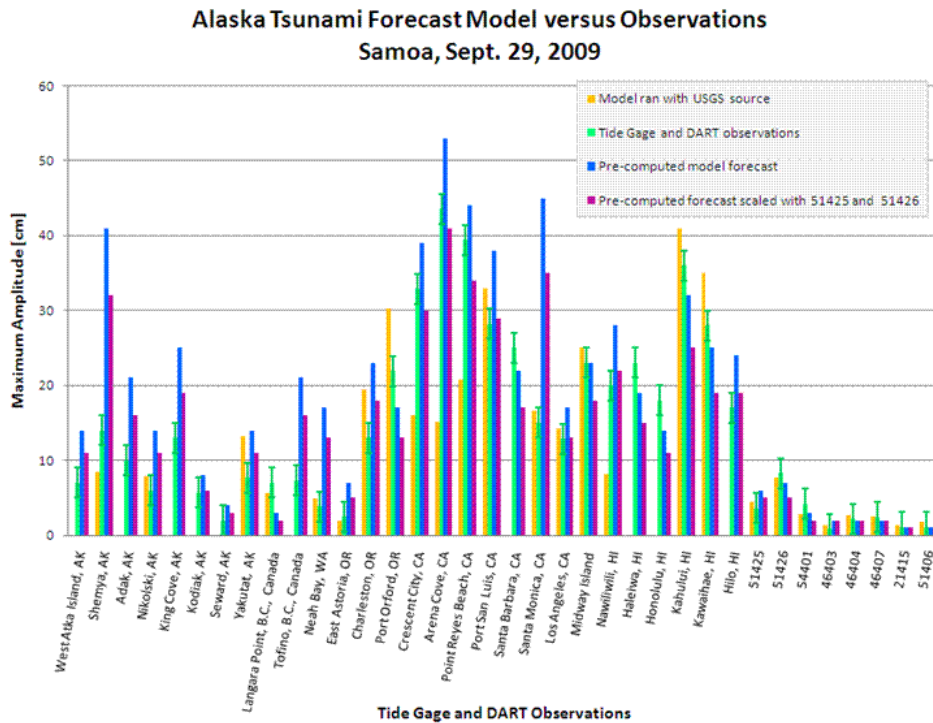


Figure 3. Comparison of observed versus forecasted amplitudes using the ATFM.

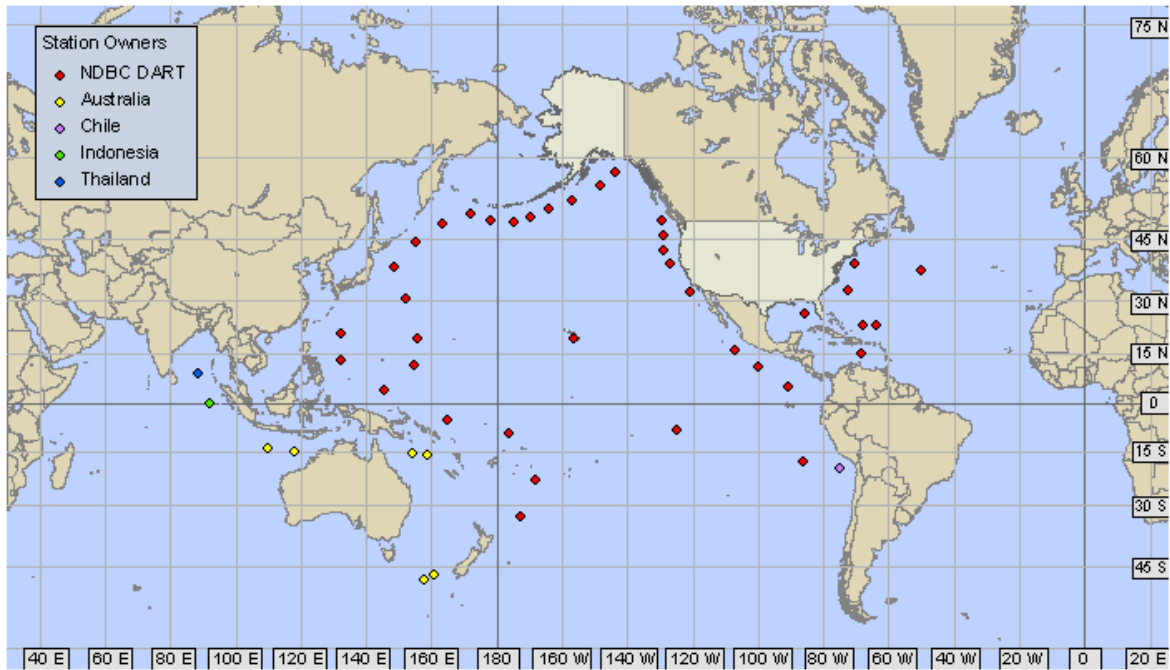


Figure 4. DART Buoy Network (Source: NOAA National Data Buoy Center)

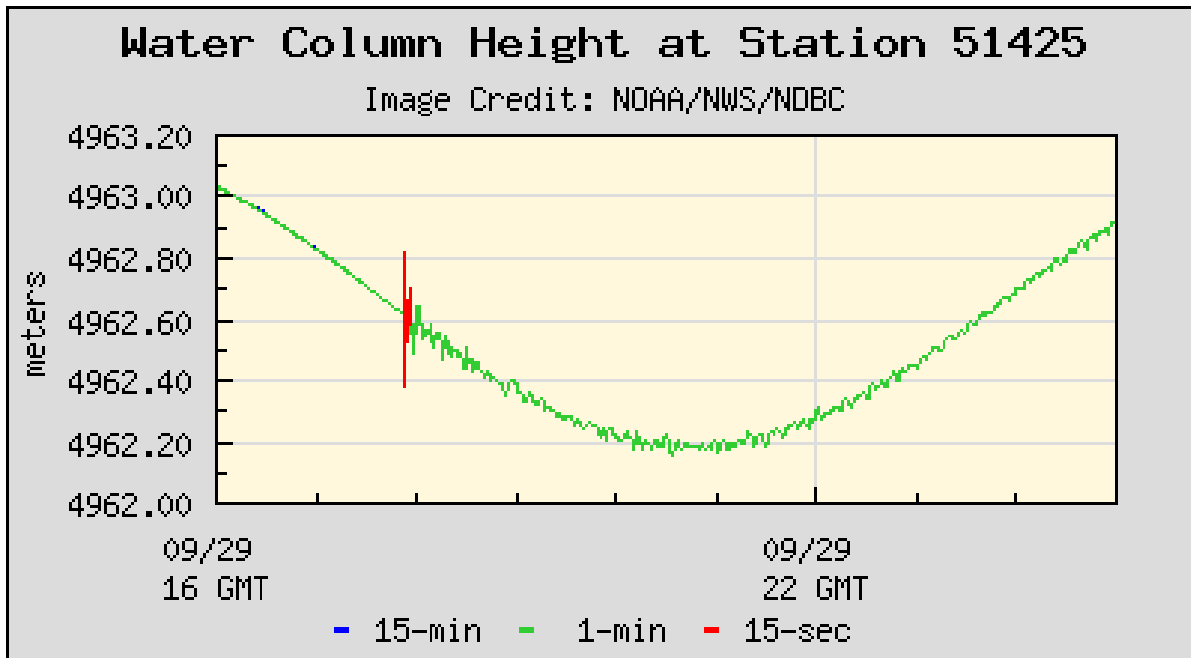


Figure 5. Tsunami Record at Buoy 51425 (Source: NOAA National Data Buoy Center)

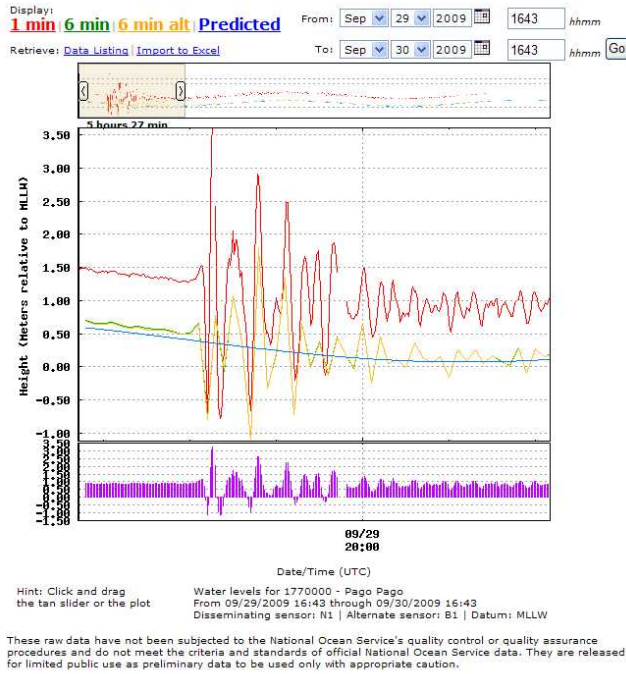


Figure 6. Water Level Record at Pago Pago, American Samoa, September 29, 2009 (Source: NOAA National Ocean Service, Center for Operational Oceanographic Products and Services)

Appendix E: Chronology of Events and Products September 29-30, 2009

Detailed Event Timeline

Time					Location:	Location:	Location:
UTC	SST	HST	AKDT	PDT	Pacific Islands	Hawaiian Islands	Alaska/West Coast
17:48	06:48	07:48	09:48	10:48	Earthquake Origin Time (Mag 8.0, Location 15.3°S, 171.0°W- 122 mi SW of American Samoa)		
17:48	06:48	07:48	09:48	10:48	<ul style="list-style-type: none"> • Strong earthquake felt in American Samoa. Shaking lasted 1-3 minutes (actual time unconfirmed). • DHS and NWS personnel begin mobilizing to EOC and WSO. DHS requested staff located nearby on Western side of the island to report to the EOC. 		
17:49	06:49	07:49	09:49	10:49	<ul style="list-style-type: none"> • Two landslides reported to American Samoa Police. 		
17:50	06:50	07:50	09:50	10:50	<ul style="list-style-type: none"> • WSO Pago Pago calls PTWC for more information. • American Samoa Emergency Operations Center (EOC) begins gathering information online and monitoring handheld radios for communication. 	<ul style="list-style-type: none"> • PTWC alerted to tsunami by phone call from WSO. 	<ul style="list-style-type: none"> • WC/ATWC's initial seismic alarm sounds.

					<ul style="list-style-type: none"> • WSO phones start ringing. • KKHJ (LP1) issues EAS Alert: Earthquake Warning before earthquake is over (between 6:50-6:51 a.m.). Message states that there has been an earthquake but no official tsunami warning. This message was approximately 2 minutes long and focused on earthquake safety information. 		
17:52	06:52	07:52	09:52	10:52	<ul style="list-style-type: none"> • LP1 calls DHS/EOC for more information and is put on hold for several minutes. • DART 51425 is auto-triggered (10 more triggered over next 24 mins) 		<ul style="list-style-type: none"> • WC/ATWC receives initial auto-location.
17:54	06:54	07:54	09:54	10:54		<ul style="list-style-type: none"> • Alarm sounds at PTWC and watchstanders paged based on two DART triggers and an automatic earthquake solution. 	
17:55	06:55	07:55	09:55	10:55	<ul style="list-style-type: none"> • Samoa Meteorology Division advised cell providers to send a warning based on the earthquake magnitude. 		
17:56	06:56	07:56	09:56	10:56		<ul style="list-style-type: none"> • PTWC Observatory Message sent with a preliminary magnitude of 7.1. 	<ul style="list-style-type: none"> • WC/ATWC determines initial magnitude of 7.9.
17:57	06:57	07:57	09:57	10:57	<ul style="list-style-type: none"> • Preliminary seismic data received by WSO Pago Pago via USGS CISN Display indicating a preliminary EQ location and magnitude of 15.3°S, 171.0°W, 7.9. 	<ul style="list-style-type: none"> • PTWC determines magnitude of 7.5 from additional data. 	<ul style="list-style-type: none"> • WC/ATWC Observatory Message sent with a preliminary magnitude of 7.9.
17:58	06:58	07:58	09:58	10:58		<ul style="list-style-type: none"> • PTWC computes magnitude 7.9 from additional seismic 	

						<ul style="list-style-type: none"> data. N. Becker is running messaging software and related algorithms. 	
17:59	06:59	07:59	09:59	10:59	<ul style="list-style-type: none"> WSO calls PTWC again for information. 	<ul style="list-style-type: none"> PTWC updates WSO on the 7.9 earthquake magnitude. 	
18:00	07:00	08:00	10:00	11:00	<ul style="list-style-type: none"> MIC arrives at WSO Pago Pago and starts gathering information. DHS Deputy Director and additional personnel arrive at EOC and unsuccessfully attempt to call WSO and DHS Director via telephone. Large waves and more landslides reported to police. 	<ul style="list-style-type: none"> PTWC and ATWC exchange seismic information (phone). 	
18:01	07:01	08:01	10:01	11:01	<ul style="list-style-type: none"> MIC calls DHS and tells Deputy Director to verbally activate EAS, with the message that a Tsunami Warning is in effect for American Samoa and that Tsunami Warning evacuation plans should be activated. DHS/EOC contacted LP1 via handheld EAS radio and issued an oral warning to activate EAS based on WSO confirmation. KKHJ (LP1) records approximately a 40 second message in English and Samoan relaying a warning to get to high ground. This message stated that there was no official tsunami warning. 		
18:02	07:02	08:02	10:02	11:02	<ul style="list-style-type: none"> MIC goes live on "Showers of Blessings" radio station, informing the public that American Samoa is now under a tsunami warning and that people need to move inland/to high ground immediately. 		<ul style="list-style-type: none"> WEPA43 TIS – Bulletin 1

					<ul style="list-style-type: none"> Samoa Meteorology Division receives PTWC earthquake observatory message via EMWIN. 		
18:03	07:03	08:03	10:03	11:03	<ul style="list-style-type: none"> Director DHS calls police to tell them they were assessing information and would keep police posted. WSO receives call from public (SE American Samoa) reporting seeing the ocean recede. WSO advises caller to get to high ground immediately. 		
18:04	07:04	08:04	10:04	11:04	<ul style="list-style-type: none"> WSO receives call from public (E. American Samoa) reporting seeing the ocean recede. WSO advises caller to get to high ground immediately. EOC maintains communication over EAS handheld radio with LP1 and LP2. DHS staff searching for information online: PTWC, USGS, and FEMA Region WatchCenter. 	<ul style="list-style-type: none"> PTWC issues WEPA40 Tsunami Bulletin Number 001, Expanding Regional Warning. 	
18:05	07:05	08:05	10:05	11:05	<ul style="list-style-type: none"> KKHJ Radio reports waves coming in to Pago Harbor via EAS handheld radios and over FM Broadcast. EOC and WSO receive WEPA40 Tsunami Bulletin Number 001. 	<ul style="list-style-type: none"> PTWC issues Bulletin Tsunami Message Number 1 to Civil Defense on the State of Tsunami (Tsunami Watch). 	
18:08	07:08	08:08	10:08	11:08	<ul style="list-style-type: none"> Water level at NOS Pago Pago sea level station begins to drop. 		
18:08	07:08	08:08	10:08	11:08	Aftershock: Earthquake Origin Time (Mag 5.6, Location 15.5°S, 172.0°W- 125 mi SW of American Samoa)		
18:09	07:09	08:09	10:09	11:09	<ul style="list-style-type: none"> Samoa Meteorology Division advises telephone companies to issue SMS text message warnings. 		

18:10	07:10	08:10	10:10	11:10	<ul style="list-style-type: none"> • WSO Pago Pago issues a Tsunami Warning with EAS alert using the Required Weekly Test event code. Message repeats 8 times over 9 minutes. • Arrival of tsunami recorded on NOS Pago Pago sea level station. 		
18:11	07:11	08:11	10:11	11:11	<ul style="list-style-type: none"> • Police headquarters receive reports of people seeing the ocean floor from SE American Samoa. People are advised to leave their vehicles and move up hill. 		
18:12	07:12	08:12	10:12	11:12		<ul style="list-style-type: none"> • PTWC issues a verbal message via HAWAS to State Civil Defense providing EQ time, location, depth, and preliminary magnitude. State Civil Defense acknowledged the message and made roll-call confirmation with all stations. • A hard copy of the message was received by Civil Defense from PTWC; roll call was conducted. • County administrators and PTWC were advised to come up to the conference bridge in 10 minutes. 	
18:13	07:13	08:13	10:13	11:13	<ul style="list-style-type: none"> • Police headquarters is flooded at the patrol section and main entrance. Building is evacuated. 	<ul style="list-style-type: none"> • WFO Honolulu recorded a message on the tsunami watch on CRS, with EAS tones and land zones only. 	

18:14	07:14	08:14	10:14	11:14	<ul style="list-style-type: none"> DHS/EOC contacts Director DHS. 		
18:15	07:15	08:15	10:15	11:15	<ul style="list-style-type: none"> Police receive notification of a Tsunami Alert. All police units are radioed to warn the public. Police units use loudspeakers to warn people to evacuate. Tsunami recorded on Apia sea level station (peak to peak amplitude 0.75 m) 		
18:16	07:16	08:16	10:16	11:16	<ul style="list-style-type: none"> Maximum wave height of 4.6 meters (peak to peak) recorded at Pago Pago sea level station. Police receive phone calls from FEMA with 7.9 earthquake magnitude noting that a Tsunami Warning is in effect. 		
18:17	07:17	08:17	10:17	11:17	<ul style="list-style-type: none"> WSO Pago Pago issues the first official Tsunami Warning with EAS alert using the TSW event code. KKHJ's Tsunami Warning EAS alert is sent 3 seconds after WSO's RWT is switched to an official warning.³ 		
18:19	07:19	08:19	10:19	11:19	<ul style="list-style-type: none"> WSO Tsunami Warning EAS Alert is repeated, followed by another Required Weekly Test message over EAS. 		
18:20	07:20	08:20	10:20	11:20	<ul style="list-style-type: none"> WSO Official Tsunami Warning EAS Alert repeats again and is reported to have been heard. DHS staff report waves in Pago Harbor 		
18:21	07:21	08:21	10:21	11:21	<ul style="list-style-type: none"> The first wave is reported in Western Samoa at Fagalii Bridge. 		
18:23	07:23	08:23	10:23	11:23	<ul style="list-style-type: none"> EOC calls Police about the Tsunami Warning. 		

³ The timing of this EAS alert was not confirmed due to a discrepancy in the EAS logs. The message may have been transmitted as early as 7:06 a.m. local time.

					<ul style="list-style-type: none"> • NOAA Fisheries calls Police to confirm three waves have hit Tutuila Islands. 		
18:24	07:24	08:24	10:24	11:24	<ul style="list-style-type: none"> • Police begin receiving reports of traffic jams, injuries, fatalities, damage, and missing persons. 		
18:27	07:27	08:27	10:27	11:27		<ul style="list-style-type: none"> • WFO Honolulu called Data Collection Offices about the tsunami watch. Both offices had received the information. Lihue was receiving many calls but Hilo was not. • Hilo DCO put the watch on the radio. 	
18:29	07:29	08:29	10:29	11:29	<ul style="list-style-type: none"> • DHS reports damage in Pago Harbor. 		
18:31	07:31	08:31	10:31	11:31	<ul style="list-style-type: none"> • EOC loses Internet connection. • WSO MIC reports to DHS that wave action will continue. 	<ul style="list-style-type: none"> • WFO HNL updated the ZFP, SFP, CWF, and generalized CWF with tsunami watch headlines. They also updated the Hazards grids and sent it to the Web. 	
18:34	07:34	08:34	10:34	11:34	<ul style="list-style-type: none"> • WSO Pago Pago completes activation of NWR Tsunami Warning. The office puts out a short narrative on the location of the earthquake and the details of the Tsunami Warning. 		
18:35	07:35	08:35	10:35	11:35	<ul style="list-style-type: none"> • WSO Pago Pago has a caller ask if he should take his child to school. WSO advises the child stay home. 		
18:45	07:45	08:45	10:45	11:45	<ul style="list-style-type: none"> • Another wave reported in Pago Harbor. 		
18:54	07:54	08:54	10:54	11:54		<ul style="list-style-type: none"> • PTWC issues WEPA40 Tsunami Bulletin. 	

						Number 002, Expanding Regional Warning— Supplement.	
18:55	07:55	08:55	10:55	11:55	<ul style="list-style-type: none"> • DARTs 5124 and 51426 register tsunami. 		
18:56	07:56	08:56	10:56	11:56		<ul style="list-style-type: none"> • PTWC issues WEHW40 Bulletin Tsunami Message Number 2, Watch Supplement, to Civil Defense in the state of Hawaii. 	
18:59	7:59	8:59	10:59	11:59			<ul style="list-style-type: none"> • ATWC issues WEPA43 TIS —Bulletin 2
19:00	08:00	09:00	11:00	12:00	<ul style="list-style-type: none"> • WSO confirms Tsunami Warning to police. 		
19:01	08:01	09:01	11:01	12:01	<ul style="list-style-type: none"> • Police commander advises public to stay off the road, park vehicles, and walk to higher ground. 		
19:02	08:02	09:02	11:02	12:02		<ul style="list-style-type: none"> • State Civil Defense conducts roll call for receipt of verbal and hard copy watch Supplement message. 	
19:04	08:04	09:04	11:04	12:04		<ul style="list-style-type: none"> • WFO HNL called Midway Airport to make sure staff knew it was under a tsunami watch. Midway had already heard from US Fish and Wildlife Service (USFWS). WFO briefed staff on the estimated arrival time. 	
19:05	08:05	09:05	11:05	12:05	<ul style="list-style-type: none"> • MIC goes live on the air with Showers of Blessings. 		

19:06	08:06	09:06	11:06	12:06		<ul style="list-style-type: none"> Began SIFT forecasting. Began inversion. Initial inversion completed by 1916 UTC. 	
19:07	08:07	09:07	11:07	12:07	<ul style="list-style-type: none"> Eastern American Samoa continues to report large waves. 	<ul style="list-style-type: none"> Hilo DCO called WFO HNL. Both offices are monitoring information and updating phone messages as new information comes out. 	
19:08	08:08	09:08	11:08	12:08	<ul style="list-style-type: none"> WFO HNL personal correspondence: report of two waves flooding the first floor of the Federal building in Western Samoa. 	<ul style="list-style-type: none"> WFO HNL tries to contact PTWC twice over HAWAS unsuccessfully. 	
19:10	08:10	09:10	11:10	12:10	<ul style="list-style-type: none"> DHS communicating with LP1 on wave action in Pago Harbor. DHS tries to reach ITIC for monitoring support. 		
19:15	08:15	09:15	11:15	12:15		<ul style="list-style-type: none"> PTWC provided information from water level gauges near Tonga and Samoa over HAWAS and confirmed its ability to conduct conference bridge in 10 minutes with State Civil Defense. 	
19:17	08:17	09:17	11:17	12:17			<ul style="list-style-type: none"> ATWC conducted dozens of phone interviews throughout event.
19:18	08:18	09:18	11:18	12:18		<ul style="list-style-type: none"> SIFT forecasting continues. SIM forecasts begun. First 12 sites completed 2024 UTC. 	
19:20	08:20	09:20	11:20	12:20	<ul style="list-style-type: none"> MIC continues to do interviews: Fox News, University of Hawaii, etc. PRH contacts WSO and make sure staff is accounted for. 		
19:22	08:22	09:22	11:22	12:22	<ul style="list-style-type: none"> PRH contacts Western Samoa Office. The 		

					staff is working on an FTR. Western Samoa is evacuating.		
19:30	08:30	09:30	11:30	12:30	<ul style="list-style-type: none"> • WSO receives a call from Showers of Blessings to talk about the event on air. • Tsunami Warning still in effect. • WSO tries to call Western Samoa; gets no answer. 		
19:33	08:33	09:33	11:33	12:33	<ul style="list-style-type: none"> • PRH receives notice from Western Samoa of 3 meter waves. 		
19:34	08:34	09:34	11:34	12:34	<ul style="list-style-type: none"> • EOC contacts police. Police transport Lt. Governor to EOC. • Police continue to advise people to seek high ground. 		
19:40	08:40	09:40	11:40	12:40	<ul style="list-style-type: none"> • MIC calls PTWC and reports five tsunami waves just hit shore. PTWC says the warning is continued. 		
19:46	08:46	09:46	11:46	12:46			<ul style="list-style-type: none"> • WFO HNL contacts WFO Monterey. Monterey staff is installing AWIPS build and are being backed up. Will be back up in 30 min-1 hour.
19:47	08:47	09:47	11:47	12:47		<ul style="list-style-type: none"> • WFO HNL contacts back-up capabilities (WFO Monterey, AWC, NHC, OPC) to let staff know about the tsunami watch and advise need for possible backup if tsunami reaches PTWC. 	
19:50	08:50	09:50	11:50	12:50		<ul style="list-style-type: none"> • WFO HNL cannot get to PR data directory, PTWC Website, WFO HNL site, etc. 	

19:51	08:51	09:51	11:51	12:51			<ul style="list-style-type: none"> WFO San Francisco reports they cannot get access to WFO HNL Website. WFO HNL faxed watch/warning to them.
20:00	09:00	10:00	12:00	13:00	<ul style="list-style-type: none"> Showers of Blessings called WSO for status update on the Tsunami Warning. WSO reports warning is still in effect. WSO calls NWS HQ to report that all WSO staff is accounted for. 		
20:02	09:02	10:02	12:02	13:02		<ul style="list-style-type: none"> Tonga military joins State Civil Defense call to get information on the earthquake. SWP will send any Tsunami Bulletins for the Tonga area to the email address provided. 	
20:20	09:20	10:20	12:20	13:20		<ul style="list-style-type: none"> TWCs confer on SIFT model inversion results. 	
20:22	09:22	10:22	12:22	13:22		<ul style="list-style-type: none"> PTWC issues WEPA40 Tsunami Bulletin Number 003, Expanding Regional Warning Supplement. Hawaii removed from watch. 	
20:23	09:23	10:23	12:23	13:23		<ul style="list-style-type: none"> PTWC issues Bulletin Tsunami Message Number 3 to Civil Defense in the State of Hawaii. PTWC cancels tsunami watch for the State of Hawaii because a destructive tsunami is not expected. A 	

						tsunami advisory is in effect until 7:00 p.m., HST. Message issued over HAWAS.	
20:30	09:30	10:30	12:30	13:30	<ul style="list-style-type: none"> Police Chief comes to WSO to pick up a tsunami statement and is briefed on the situation. 		<ul style="list-style-type: none"> California OES sponsors telcon with WC/ATWC and key OES tsunami response personnel. WC/ATWC provides initial impact estimates for California.
20:38	09:38	10:38	12:38	13:38	<ul style="list-style-type: none"> EOC contacts WSO for updates. MIC recommends communication on satellite phone. WSO informs EOC that the Tsunami Warning has not yet been lifted. 		
20:43	09:43	10:43	12:43	13:43		<ul style="list-style-type: none"> KHON-2 (Fox) calls WFO Honolulu to ask about the tsunami advisory. WFO HNL updates SFP, ZFP, CWP, and HI1 to remove tsunami watch and sends grids to Web. 	
20:45	09:45	10:45	12:45	13:45	<ul style="list-style-type: none"> WSO talks to PRH. 		
20:50	09:50	10:50	12:50	13:50		<ul style="list-style-type: none"> PTWC Website out of date. Still shows message Number 2 from 8:57 a.m. 10:20 bulletin not up. 	
20:54	09:54	10:54	12:54	13:54		<ul style="list-style-type: none"> Honolulu Advisor contacts WFO Honolulu to get clarification on the tsunami watch and advisory status. 	

20:55	09:55	10:55	12:55	13:55	<ul style="list-style-type: none"> Police continue to secure schools and transport students. 	<ul style="list-style-type: none"> PRH contacts WFO HNL regarding the tsunami advisory for Hawaii and the definition of tsunami advisory. WFO HNL records Tsunami Watch Cancellation message on CRS, no tones, land zones only, at 10:30 a.m., HST. Also rerecorded telephone message to include watch cancellation. 	
21:00	10:00	11:00	13:00	14:00	<ul style="list-style-type: none"> WSO calls PTWC for a status update on the Tsunami Warning. 		<ul style="list-style-type: none"> Decision to upgrade to an advisory for California and Oregon based on SIFT forecasts, AK propagation forecasts, historic information, and severity of local tsunami.
21:01	10:01	11:01	13:01	14:01	<ul style="list-style-type: none"> USCG contacts DHS for information. DHS contacts WSO for update. WSO informs DHS that the Tsunami Warning has not yet been lifted, and that it would likely be at least another hour. 		
21:03	10:03	11:03	13:03	14:03			<ul style="list-style-type: none"> ATWC Conference call notice sent.
21:05	10:05	11:05	13:05	14:05	<ul style="list-style-type: none"> ABC News contacted DHS for an interview about the tsunami. 		
21:15	10:15	11:15	13:15	14:15			<ul style="list-style-type: none"> ATWC Conference call confirmation received.
21:23	10:23	11:23	13:23	14:23		<ul style="list-style-type: none"> PTWC Website has been updated to include 10:23 a.m. bulletin, but the 	

						headline says "No current Watch, Warning, or Advisory is in effect."	
21:25	10:25	11:25	13:25	14:25	<ul style="list-style-type: none"> DHS contacts PTWC. Geophysicist says that the Tsunami Warning is still in effect. 		
21:30	10:30	11:30	13:30	14:30			<ul style="list-style-type: none"> West Coast conference call #1- WC/ATWC advised participants that information-only status would be upgraded to advisory for CA and OR at 2200 UTC. WC/ATWC provided forecasts for approximately a dozen sites on the West Coast.
21:36	10:36	11:36	13:36	14:36	<ul style="list-style-type: none"> Tsunami Warning cancelled for American Samoa. WSO Pago Pago is notified. 	<ul style="list-style-type: none"> PTWC issues Tsunami Bulletin Number 004, Expanding Regional Warning Cancellation. 	
21:42	10:42	11:42	13:42	14:42	<ul style="list-style-type: none"> WSO Pago Pago extends Tsunami Warning via EAS Alert to 7:01 p.m. Message repeated over EAS by KNWJ. 		
21:45	10:45	11:45	13:45	14:45	<ul style="list-style-type: none"> Tsunami Bulletin 004 (PTWC) sent to Tonga via email by HI State Civil Defense. 	<ul style="list-style-type: none"> Phone call between TWCS- WCATWC notifies PTWC they will advise CA/OR. 	
21:50	10:50	11:50	13:50	14:50	<ul style="list-style-type: none"> WSO Pago Pago calls police to cancel Tsunami Warning for American Samoa. Police inform all units, who inform the public. 		<ul style="list-style-type: none"> WC/ATWC notifies NOAA HQ that an advisory will be issued.

21:56	10:56	11:56	13:56	14:56	<ul style="list-style-type: none"> WSO MIC contacts DHS/EOC to issue the "All Clear." 		
22:02	11:02	12:02	14:02	15:02			<ul style="list-style-type: none"> WC/ATWC issues WEPA41 Tsunami Advisory CA/Mex to OR/WA border, Bulletin 3.
22:10	11:10	12:10	14:10	15:10	<ul style="list-style-type: none"> WFO HNL calls Fiji at the request of ITIC to determine tsunami impact. Fiji weather office reports no impact. WFO reports this response to ITIC. 		<ul style="list-style-type: none"> ATWC posts Web page with tsunami forecast information and observations, including marigrams.
22:12	11:12	12:12	14:12	15:12	<ul style="list-style-type: none"> EOC conducts a radio check with Police. Police report all clear. 		
22:25	11:25	12:25	14:25	15:25		<ul style="list-style-type: none"> Red Flag Warning issued. WFO HNL updates grids, FWF, notifies state warning point. 	
22:35	11:35	12:35	14:35	15:35	<ul style="list-style-type: none"> Police continue to receive reports of looting, more damage, and injuries. 		
23:14	12:14	13:14	15:14	16:14			<ul style="list-style-type: none"> WC/ATWC issues WEPA41 Tsunami Advisory CA/Mex to OR/WA border, Bulletin 4.
23:32	12:32	13:32	15:32	16:32	<ul style="list-style-type: none"> Police begin marine searches. Waves are rough. 		
00:00	13:00	14:00	16:00	17:00			<ul style="list-style-type: none"> West Coast Conference Call #2, WC/ATWC provides latest observations and forecasts.
00:04	13:04	14:04	16:04	17:04	<ul style="list-style-type: none"> WC/ATWC Tsunami Advisory #4 sent to 		

					Tonga by HI State Civil Defense.		
00:21	13:21	14:21	16:21	17:21			<ul style="list-style-type: none"> • WCATWC issues WEPA41 Tsunami Advisory CA/Mex to OR/WA border, Bulletin 5
00:24	13:24	14:24	16:24	17:24		<ul style="list-style-type: none"> • USCG notified Hilo EOC regarding unusual wave activity in Kailua Bay. Over 25 minutes, five waves surged into the bay, the largest, 3 feet in amplitude. Water receded rapidly. No damage reported. 	
00:40	13:40	14:40	16:40	17:40		TWCs manually trigger several distant DARTs over the next few hours.	
9/30 01:15	14:15	15:15	17:15	18:15		<ul style="list-style-type: none"> • State Civil Defense receives a fax from USCG advising that the tsunami watch has been cancelled but that caution should be exercised from 12 p.m. -8 p.m. HST. 	
9/30 01:58	14:58	15:58	17:58	18:58		<ul style="list-style-type: none"> • PTWC issues Tsunami Message Number 4 to Civil Defense in the State of Hawaii. 	
9/30 02:00	15:00	16:00	18:00	19:00			<ul style="list-style-type: none"> • West Coast Conference Call #3, WC/ATWC provided information on HI impacts and information that indicated forecasts might

							be too high.
9/30 02:01	15:01	16:01	18:01	19:01			<ul style="list-style-type: none"> ATWC receives SIM computational model results at Honolulu and Hilo with source data.
9/30 02:12	15:12	16:12	18:12	19:12		<ul style="list-style-type: none"> PTWC issues WEHW40 Tsunami Advisory Continuation for HI, Bulletin 4, indicates possibility for strong currents. 	
9/30 02:23	15:23	16:23	18:23	19:23	<ul style="list-style-type: none"> Reports that villages of Fagalii, Poloa, Amanave, and Leone are all "totally damaged." 		
9/30 02:24	15:24	16:24	18:24	19:24			<ul style="list-style-type: none"> WC/ATWC issues WEPA41 Tsunami Advisory Continuation, Bulletin 6.
9/30 03:00	16:00	17:00	19:00	20:00	<ul style="list-style-type: none"> Calls continue to WSO Pago Pago all day (estimated 30-40 calls). People ask whether there is another warning. WSO instructs people the warning was lifted about 10 a.m. local time. 		
9/30 03:03	16:03	17:03	19:03	20:03		<ul style="list-style-type: none"> PTWC issues WEHW40 Tsunami Advisory Continuation for HI, Bulletin 5, indicates possibility for strong currents. PTWC issues Tsunami Message Number 5 to Civil Defense in the State of Hawaii; message indicates possibility of strong currents. 	

9/30 03:07	16:07	17:07	19:07	20:07		<ul style="list-style-type: none"> • State Civil Defense reviews Tsunami Advisory Supplement, Message Number 5. Haleiwa has the largest measured wave amplitude at 1.5 feet. • PTWC will be issuing hourly messages. 	
9/30 03:57	16:57	17:57	19:57	20:57		<ul style="list-style-type: none"> • PTWC issues WEHW40 Tsunami Advisory Continuation for HI, Bulletin 6, indicating possibility for strong currents. • PTWC issues Tsunami Message Number 6 to Civil Defense in the State of Hawaii. 	
9/30 04:00	17:00	18:00	20:00	21:00			<ul style="list-style-type: none"> • WC/ATWC calls West Coast WFOs to provide the latest information and inquire about response local agencies have taken.
9/30 04:28	17:28	18:28	20:28	21:28			<ul style="list-style-type: none"> • WC/ATWC issues WEPA41 Tsunami Advisory Continuation, Bulletin 7 (bulletin notes amplitudes along the West Coast).
9/30 05:01	18:01	19:01	21:01	22:01		<ul style="list-style-type: none"> • PTWC issues final WEHW40 Tsunami Advisory for HI, Bulletin 7. Advisory ends, though possibility of strong 	

						<p>currents continues.</p> <ul style="list-style-type: none"> • PTWC issues Tsunami Message Number 7 to Civil Defense in the State of Hawaii. • Tsunami Advisory is ended for the State of Hawaii. 	
9/30 05:30	18:30	19:30	21:30	22:30			<ul style="list-style-type: none"> • WC/ATWC conducts West Coast Conference Call #4; provides present sea level records and expectations for the next hour.
9/30 06:00	19:00	20:00	22:00	23:00		<ul style="list-style-type: none"> • HI State Civil Defense receives call from a citizen concerned about the Hawaii Police Department on Waikiki Beach, noting that non-English-speaking tourists had a difficult time understanding these messages. 	<ul style="list-style-type: none"> • WC/ATWC updates Website with tsunami observations and graphs, including wave heights.
9/30 06:30	19:30	20:30	22:30	23:30			<ul style="list-style-type: none"> • WC/ATWC issues WEPA41 Tsunami Advisory Continuation, Bulletin 8. Message indicates tsunami has reached its maximum and will be waning.
9/30 07:30	20:30	21:30	23:30	00:30			<ul style="list-style-type: none"> • WC/ATWC conducts West Coast Conference Call #5; provides information that it will be cancelling all advisories

							within the next hour. Participants indicated no known impacts from the tsunami.
9/30 08:28	21:28	22:28	00:28	01:28			<ul style="list-style-type: none"> • WC/ATWC issues WEPA41 Cancellation Tsunami Advisory, Bulletin 9. Wave heights reported.

Appendix F: Tsunami Warning Center Messages

PTWC Tsunami Messages – 29 September 2009

FROM PACIFIC TSUNAMI WARNING CENTER

THIS IS PRELIMINARY DATA, NOT FOR PUBLIC DISSEMINATION.
COMPLETE INFORMATION CAN BE OBTAINED FROM THE USGS/NEIC
TELEPHONE (303) 273-8500.

H 17:48:11Z SEP 29 09 LAT 15.3S LONG 171.5W MWP 7.1 (4 STATIONS) SAMOA ISLANDS
REGION
KNTN P 175105.7 RAR P 175108.4 OUZ P 175322.2 CTZ P 175405.3
KHZ P 175417.0

TSUNAMI BULLETIN NUMBER 001

PACIFIC TSUNAMI WARNING CENTER/NOAA/NWS

ISSUED AT 1804Z 29 SEP 2009

THIS BULLETIN APPLIES TO AREAS WITHIN AND BORDERING THE PACIFIC OCEAN AND
ADJACENT SEAS...EXCEPT ALASKA...BRITISH COLUMBIA...WASHINGTON...OREGON AND
CALIFORNIA.

... A TSUNAMI WARNING AND WATCH ARE IN EFFECT ...

A TSUNAMI WARNING IS IN EFFECT FOR

AMERICAN SAMOA / SAMOA / NIUE / WALLIS-FUTUNA / TOKELAU /
COOK ISLANDS / TONGA / TUVALU / KIRIBATI / KERMADEC IS / FIJI /
HOWLAND-BAKER / JARVIS IS. / NEW ZEALAND / FR. POLYNESIA /
PALMYRA IS.

A TSUNAMI WATCH IS IN EFFECT FOR

VANUATU / NAURU / MARSHALL IS. / SOLOMON IS. / JOHNSTON IS. /
NEW CALEDONIA / KOSRAE / PAPUA NEW GUINEA / HAWAII / POHNPEI /
WAKE IS. / PITCAIRN / MIDWAY IS.

FOR ALL OTHER AREAS COVERED BY THIS BULLETIN... IT IS FOR
INFORMATION ONLY AT THIS TIME.

THIS BULLETIN IS ISSUED AS ADVICE TO GOVERNMENT AGENCIES. ONLY NATIONAL AND LOCAL GOVERNMENT AGENCIES HAVE THE AUTHORITY TO MAKE DECISIONS REGARDING THE OFFICIAL STATE OF ALERT IN THEIR AREA AND ANY ACTIONS TO BE TAKEN IN RESPONSE.

AN EARTHQUAKE HAS OCCURRED WITH THESE PRELIMINARY PARAMETERS

ORIGIN TIME - 1748Z 29 SEP 2009
COORDINATES - 15.3 SOUTH 171.0 WEST
DEPTH - SHALLOWER THAN 100 KM
LOCATION - SAMOA ISLANDS REGION
MAGNITUDE - 7.9

EVALUATION

IT IS NOT KNOWN THAT A TSUNAMI WAS GENERATED. THIS WARNING IS BASED ONLY ON THE EARTHQUAKE EVALUATION. AN EARTHQUAKE OF THIS SIZE HAS THE POTENTIAL TO GENERATE A DESTRUCTIVE TSUNAMI THAT CAN STRIKE COASTLINES NEAR THE EPICENTER WITHIN MINUTES AND MORE DISTANT COASTLINES WITHIN HOURS. AUTHORITIES SHOULD TAKE APPROPRIATE ACTION IN RESPONSE TO THIS POSSIBILITY. THIS CENTER WILL MONITOR SEA LEVEL DATA FROM GAUGES NEAR THE EARTHQUAKE TO DETERMINE IF A TSUNAMI WAS GENERATED AND ESTIMATE THE SEVERITY OF THE THREAT.

ESTIMATED INITIAL TSUNAMI WAVE ARRIVAL TIMES AT FORECAST POINTS WITHIN THE WARNING AND WATCH AREAS ARE GIVEN BELOW. ACTUAL ARRIVAL TIMES MAY DIFFER AND THE INITIAL WAVE MAY NOT BE THE LARGEST. A TSUNAMI IS A SERIES OF WAVES AND THE TIME BETWEEN SUCCESSIVE WAVES CAN BE FIVE MINUTES TO ONE HOUR.

LOCATION	FORECAST POINT	COORDINATES	ARRIVAL TIME
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AMERICAN SAMOA    PAGO PAGO          14.3S 170.7W      1759Z 29 SEP
SAMOA             APIA               13.8S 171.8W      1810Z 29 SEP
NIUE              NIUE IS.          19.0S 170.0W      1822Z 29 SEP
WALLIS-FUTUNA    WALLIS IS.        13.2S 176.2W      1835Z 29 SEP
TOKELAU          NUKUNONU IS.      9.2S 171.8W       1844Z 29 SEP
COOK ISLANDS     PUKAPUKA IS.     10.8S 165.9W      1846Z 29 SEP
                 RAROTONGA         21.2S 159.8W      1929Z 29 SEP
                 PENRYN IS.        8.9S 157.8W       1954Z 29 SEP
TONGA            NUKUALOFA         21.0S 175.2W      1851Z 29 SEP
TUVALU           FUNAFUTI IS.      7.9S 178.5E       1932Z 29 SEP
KIRIBATI         KANTON IS.        2.8S 171.7W       1935Z 29 SEP
                 FLINT IS.         11.4S 151.8W      2025Z 29 SEP
                 MALDEN IS.        3.9S 154.9W       2037Z 29 SEP
                 CHRISTMAS IS.     2.0N 157.5W       2100Z 29 SEP
                 TARAWA IS.        1.5N 173.0E       2104Z 29 SEP
KERMADEC IS     RAOUL IS.         29.2S 177.9W      1938Z 29 SEP
FIJI             SUVA              18.1S 178.4E      2003Z 29 SEP
HOWLAND-BAKER   HOWLAND IS.       0.6N 176.6W       2008Z 29 SEP
JARVIS IS.      JARVIS IS.        0.4S 160.1W       2028Z 29 SEP
NEW ZEALAND     EAST CAPE         37.7S 178.5E      2044Z 29 SEP
                 GISBORNE          38.7S 178.0E      2100Z 29 SEP
                 NORTH CAPE       34.4S 173.3E      2112Z 29 SEP
                 NAPIER           39.5S 176.9E      2140Z 29 SEP
                 WELLINGTON       41.3S 174.8E      2150Z 29 SEP
                 AUCKLAND (E)    36.7S 175.0E      2212Z 29 SEP
                 AUCKLAND (W)    37.1S 174.2E      2239Z 29 SEP
                 LYTTELTON       43.6S 172.7E      2255Z 29 SEP
                 NEW PLYMOUTH     39.1S 174.1E      2317Z 29 SEP
                 NELSON           41.3S 173.3E      2323Z 29 SEP
                 DUNEDIN         45.9S 170.5E      2331Z 29 SEP
                 MILFORD SOUND    44.6S 167.9E      2358Z 29 SEP

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	WESTPORT	41.8S 171.6E	2359Z 29 SEP
FR. POLYNESIA	PAPEETE	17.5S 149.6W	2045Z 29 SEP
	HIVA OA	10.0S 139.0W	2214Z 29 SEP
	RIKITEA	23.1S 135.0W	2247Z 29 SEP
PALMYRA IS.	PALMYRA IS.	6.3N 162.4W	2102Z 29 SEP
VANUATU	ANATOM IS.	20.2S 169.9E	2117Z 29 SEP
	ESPERITU SANTO	15.1S 167.3E	2123Z 29 SEP
NAURU	NAURU	0.5S 166.9E	2138Z 29 SEP
MARSHALL IS.	MAJURO	7.1N 171.4E	2147Z 29 SEP
	KWAJALEIN	8.7N 167.7E	2220Z 29 SEP
	ENIWETOK	11.4N 162.3E	2309Z 29 SEP
SOLOMON IS.	KIRAKIRA	10.4S 161.9E	2155Z 29 SEP
	GHATERE	7.8S 159.2E	2227Z 29 SEP
	AUKI	8.8S 160.6E	2244Z 29 SEP
	HONIARA	9.3S 160.0E	2244Z 29 SEP
	PANGGOE	6.9S 157.2E	2245Z 29 SEP
	MUNDA	8.4S 157.2E	2248Z 29 SEP
	FALAMAE	7.4S 155.6E	2304Z 29 SEP
JOHNSTON IS.	JOHNSTON IS.	16.7N 169.5W	2212Z 29 SEP
NEW CALEDONIA	NOUMEA	22.3S 166.5E	2216Z 29 SEP
KOSRAE	KOSRAE IS.	5.5N 163.0E	2233Z 29 SEP
PAPUA NEW GUINE	KIETA	6.1S 155.6E	2303Z 29 SEP
	AMUN	6.0S 154.7E	2323Z 29 SEP
	RABAU	4.2S 152.3E	2349Z 29 SEP
HAWAII	NAWILIWILI	22.0N 159.4W	2311Z 29 SEP
	HILO	19.7N 155.1W	2314Z 29 SEP
	HONOLULU	21.3N 157.9W	2315Z 29 SEP
POHNPEI	POHNPEI IS.	7.0N 158.2E	2318Z 29 SEP
WAKE IS.	WAKE IS.	19.3N 166.6E	2322Z 29 SEP
PITCAIRN	PITCAIRN IS.	25.1S 130.1W	2329Z 29 SEP
MIDWAY IS.	MIDWAY IS.	28.2N 177.4W	2349Z 29 SEP

BULLETINS WILL BE ISSUED HOURLY OR SOONER IF CONDITIONS WARRANT.
THE TSUNAMI WARNING AND WATCH WILL REMAIN IN EFFECT UNTIL
FURTHER NOTICE.

THE WEST COAST/ALASKA TSUNAMI WARNING CENTER WILL ISSUE PRODUCTS
FOR ALASKA...BRITISH COLUMBIA...WASHINGTON...OREGON...CALIFORNIA.

TSUNAMI BULLETIN NUMBER 002

PACIFIC TSUNAMI WARNING CENTER/NOAA/NWS

ISSUED AT 1856Z 29 SEP 2009

THIS BULLETIN APPLIES TO AREAS WITHIN AND BORDERING THE PACIFIC OCEAN AND ADJACENT SEAS...EXCEPT ALASKA...BRITISH COLUMBIA...WASHINGTON...OREGON AND CALIFORNIA.

... A TSUNAMI WARNING AND WATCH ARE IN EFFECT ...

A TSUNAMI WARNING IS IN EFFECT FOR

AMERICAN SAMOA / SAMOA / NIUE / WALLIS-FUTUNA / TOKELAU /
COOK ISLANDS / TONGA / TUVALU / KIRIBATI / KERMADEC IS / FIJI /
HOWLAND-BAKER / JARVIS IS. / NEW ZEALAND / FR. POLYNESIA /
PALMYRA IS. / VANUATU / NAURU / MARSHALL IS. / SOLOMON IS.

A TSUNAMI WATCH IS IN EFFECT FOR

JOHNSTON IS. / NEW CALEDONIA / KOSRAE / PAPUA NEW GUINEA /
HAWAII / POHNPEI / WAKE IS. / PITCAIRN / MIDWAY IS. / CHUUK /
AUSTRALIA

FOR ALL OTHER AREAS COVERED BY THIS BULLETIN... IT IS FOR
INFORMATION ONLY AT THIS TIME.

THIS BULLETIN IS ISSUED AS ADVICE TO GOVERNMENT AGENCIES. ONLY
NATIONAL AND LOCAL GOVERNMENT AGENCIES HAVE THE AUTHORITY TO MAKE
DECISIONS REGARDING THE OFFICIAL STATE OF ALERT IN THEIR AREA AND
ANY ACTIONS TO BE TAKEN IN RESPONSE.

AN EARTHQUAKE HAS OCCURRED WITH THESE PRELIMINARY PARAMETERS
NOTE THE MAGNITUDE UPGRADE TO 8.3

ORIGIN TIME - 1748Z 29 SEP 2009

COORDINATES - 15.3 SOUTH 171.0 WEST
 DEPTH - 33 KM
 LOCATION - SAMOA ISLANDS REGION
 MAGNITUDE - 8.3

MEASUREMENTS OR REPORTS OF TSUNAMI WAVE ACTIVITY

GAUGE LOCATION	LAT	LON	TIME	AMPL	PER
APIA UPOLU WS	13.8S	171.8W	1832Z	0.70M / 2.3FT	08MIN
PAGO PAGO AS	14.3S	170.7W	1812Z	1.57M / 5.1FT	04MIN

LAT - LATITUDE (N-NORTH, S-SOUTH)
 LON - LONGITUDE (E-EAST, W-WEST)
 TIME - TIME OF THE MEASUREMENT (Z IS UTC IS GREENWICH TIME)
 AMPL - TSUNAMI AMPLITUDE MEASURED RELATIVE TO NORMAL SEA LEVEL.
 IT IS ...NOT... CREST-TO-TROUGH WAVE HEIGHT.
 VALUES ARE GIVEN IN BOTH METERS (M) AND FEET (FT) .
 PER - PERIOD OF TIME IN MINUTES (MIN) FROM ONE WAVE TO THE NEXT.

EVALUATION

SEA LEVEL READINGS INDICATE A TSUNAMI WAS GENERATED. IT MAY HAVE BEEN DESTRUCTIVE ALONG COASTS NEAR THE EARTHQUAKE EPICENTER AND COULD ALSO BE A THREAT TO MORE DISTANT COASTS. AUTHORITIES SHOULD TAKE APPROPRIATE ACTION IN RESPONSE TO THIS POSSIBILITY. THIS CENTER WILL CONTINUE TO MONITOR SEA LEVEL DATA TO DETERMINE THE EXTENT AND SEVERITY OF THE THREAT.

FOR ALL AREAS - WHEN NO MAJOR WAVES ARE OBSERVED FOR TWO HOURS AFTER THE ESTIMATED TIME OF ARRIVAL OR DAMAGING WAVES HAVE NOT OCCURRED FOR AT LEAST TWO HOURS THEN LOCAL AUTHORITIES CAN ASSUME

THE THREAT IS PASSED. DANGER TO BOATS AND COASTAL STRUCTURES CAN CONTINUE FOR SEVERAL HOURS DUE TO RAPID CURRENTS. AS LOCAL CONDITIONS CAN CAUSE A WIDE VARIATION IN TSUNAMI WAVE ACTION THE ALL CLEAR DETERMINATION MUST BE MADE BY LOCAL AUTHORITIES.

ESTIMATED INITIAL TSUNAMI WAVE ARRIVAL TIMES AT FORECAST POINTS WITHIN THE WARNING AND WATCH AREAS ARE GIVEN BELOW. ACTUAL ARRIVAL TIMES MAY DIFFER AND THE INITIAL WAVE MAY NOT BE THE LARGEST. A TSUNAMI IS A SERIES OF WAVES AND THE TIME BETWEEN SUCCESSIVE WAVES CAN BE FIVE MINUTES TO ONE HOUR.

LOCATION	FORECAST POINT	COORDINATES	ARRIVAL TIME
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AMERICAN SAMOA	PAGO PAGO	14.3S 170.7W	1759Z 29 SEP
SAMOA	APIA	13.8S 171.8W	1810Z 29 SEP
NIUE	NIUE IS.	19.0S 170.0W	1822Z 29 SEP
WALLIS-FUTUNA	WALLIS IS.	13.2S 176.2W	1835Z 29 SEP
TOKELAU	NUKUNONU IS.	9.2S 171.8W	1844Z 29 SEP
COOK ISLANDS	PUKAPUKA IS.	10.8S 165.9W	1846Z 29 SEP
	RAROTONGA	21.2S 159.8W	1929Z 29 SEP
	PENRYN IS.	8.9S 157.8W	1954Z 29 SEP
TONGA	NUKUALOFA	21.0S 175.2W	1851Z 29 SEP
TUVALU	FUNAFUTI IS.	7.9S 178.5E	1932Z 29 SEP
KIRIBATI	KANTON IS.	2.8S 171.7W	1935Z 29 SEP
	FLINT IS.	11.4S 151.8W	2025Z 29 SEP
	MALDEN IS.	3.9S 154.9W	2037Z 29 SEP
	CHRISTMAS IS.	2.0N 157.5W	2100Z 29 SEP
	TARAWA IS.	1.5N 173.0E	2104Z 29 SEP
KERMADEC IS	RAOUL IS.	29.2S 177.9W	1938Z 29 SEP
FIJI	SUVA	18.1S 178.4E	2003Z 29 SEP
HOWLAND-BAKER	HOWLAND IS.	0.6N 176.6W	2008Z 29 SEP
JARVIS IS.	JARVIS IS.	0.4S 160.1W	2028Z 29 SEP

NEW ZEALAND	EAST CAPE	37.7S 178.5E	2044Z 29 SEP
	GISBORNE	38.7S 178.0E	2100Z 29 SEP
	NORTH CAPE	34.4S 173.3E	2112Z 29 SEP
	NAPIER	39.5S 176.9E	2140Z 29 SEP
	WELLINGTON	41.3S 174.8E	2150Z 29 SEP
	AUCKLAND (E)	36.7S 175.0E	2212Z 29 SEP
	AUCKLAND (W)	37.1S 174.2E	2239Z 29 SEP
	LYTTELTON	43.6S 172.7E	2255Z 29 SEP
	NEW PLYMOUTH	39.1S 174.1E	2317Z 29 SEP
	NELSON	41.3S 173.3E	2323Z 29 SEP
	DUNEDIN	45.9S 170.5E	2331Z 29 SEP
	MILFORD SOUND	44.6S 167.9E	2358Z 29 SEP
	WESTPORT	41.8S 171.6E	2359Z 29 SEP
	BLUFF	46.6S 168.3E	0044Z 30 SEP
FR. POLYNESIA	PAPEETE	17.5S 149.6W	2045Z 29 SEP
	HIVA OA	10.0S 139.0W	2214Z 29 SEP
	RIKITEA	23.1S 135.0W	2247Z 29 SEP
PALMYRA IS.	PALMYRA IS.	6.3N 162.4W	2102Z 29 SEP
VANUATU	ANATOM IS.	20.2S 169.9E	2117Z 29 SEP
	ESPERITU SANTO	15.1S 167.3E	2123Z 29 SEP
NAURU	NAURU	0.5S 166.9E	2138Z 29 SEP
MARSHALL IS.	MAJURO	7.1N 171.4E	2147Z 29 SEP
	KWAJALEIN	8.7N 167.7E	2220Z 29 SEP
	ENIWETOK	11.4N 162.3E	2309Z 29 SEP
SOLOMON IS.	KIRAKIRA	10.4S 161.9E	2155Z 29 SEP
	GHATERE	7.8S 159.2E	2227Z 29 SEP
	AUKI	8.8S 160.6E	2244Z 29 SEP
	HONIARA	9.3S 160.0E	2244Z 29 SEP
	PANGGOE	6.9S 157.2E	2245Z 29 SEP
	MUNDA	8.4S 157.2E	2248Z 29 SEP
	FALAMAE	7.4S 155.6E	2304Z 29 SEP
JOHNSTON IS.	JOHNSTON IS.	16.7N 169.5W	2212Z 29 SEP

NEW CALEDONIA	NOUMEA	22.3S 166.5E	2216Z 29 SEP
KOSRAE	KOSRAE IS.	5.5N 163.0E	2233Z 29 SEP
PAPUA NEW GUINEA	KIETA	6.1S 155.6E	2303Z 29 SEP
	AMUN	6.0S 154.7E	2323Z 29 SEP
	RABAUL	4.2S 152.3E	2349Z 29 SEP
	LAE	6.8S 147.0E	0015Z 30 SEP
	KAVIENG	2.5S 150.7E	0016Z 30 SEP
	PORT MORESBY	9.3S 146.9E	0039Z 30 SEP
	MADANG	5.2S 145.8E	0041Z 30 SEP
	MANUS IS.	2.0S 147.5E	0050Z 30 SEP
HAWAII	NAWILIWILI	22.0N 159.4W	2311Z 29 SEP
	HILO	19.7N 155.1W	2314Z 29 SEP
	HONOLULU	21.3N 157.9W	2315Z 29 SEP
POHNPEI	POHNPEI IS.	7.0N 158.2E	2318Z 29 SEP
WAKE IS.	WAKE IS.	19.3N 166.6E	2322Z 29 SEP
PITCAIRN	PITCAIRN IS.	25.1S 130.1W	2329Z 29 SEP
MIDWAY IS.	MIDWAY IS.	28.2N 177.4W	2349Z 29 SEP
CHUUK	CHUUK IS.	7.4N 151.8E	0020Z 30 SEP
AUSTRALIA	BRISBANE	27.2S 153.3E	0036Z 30 SEP
	SYDNEY	33.9S 151.4E	0038Z 30 SEP

BULLETINS WILL BE ISSUED HOURLY OR SOONER IF CONDITIONS WARRANT.
 THE TSUNAMI WARNING AND WATCH WILL REMAIN IN EFFECT UNTIL
 FURTHER NOTICE.

THE WEST COAST/ALASKA TSUNAMI WARNING CENTER WILL ISSUE PRODUCTS
 FOR ALASKA...BRITISH COLUMBIA...WASHINGTON...OREGON...CALIFORNIA.

TSUNAMI BULLETIN NUMBER 003

PACIFIC TSUNAMI WARNING CENTER/NOAA/NWS

ISSUED AT 2022Z 29 SEP 2009

THIS BULLETIN APPLIES TO AREAS WITHIN AND BORDERING THE PACIFIC OCEAN AND ADJACENT SEAS...EXCEPT ALASKA...BRITISH COLUMBIA...WASHINGTON...OREGON AND CALIFORNIA.

... A TSUNAMI WARNING AND WATCH ARE IN EFFECT ...

A TSUNAMI WARNING IS IN EFFECT FOR

AMERICAN SAMOA / SAMOA / NIUE / WALLIS-FUTUNA / TOKELAU /
COOK ISLANDS / TONGA / TUVALU / KIRIBATI / KERMADEC IS / FIJI /
HOWLAND-BAKER / JARVIS IS. / NEW ZEALAND / FR. POLYNESIA /
PALMYRA IS. / VANUATU / NAURU / MARSHALL IS. / SOLOMON IS. /
JOHNSTON IS. / NEW CALEDONIA / KOSRAE / PAPUA NEW GUINEA /
POHNPEI / WAKE IS.

A TSUNAMI WATCH IS IN EFFECT FOR

PITCAIRN / MIDWAY IS. / CHUUK / AUSTRALIA / MARCUS IS. /
N. MARIANAS / GUAM / INDONESIA / ANTARCTICA / YAP

FOR ALL OTHER AREAS COVERED BY THIS BULLETIN... IT IS FOR
INFORMATION ONLY AT THIS TIME.

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NATIONAL AND LOCAL GOVERNMENT AGENCIES HAVE THE AUTHORITY TO MAKE
DECISIONS REGARDING THE OFFICIAL STATE OF ALERT IN THEIR AREA AND
ANY ACTIONS TO BE TAKEN IN RESPONSE.

AN EARTHQUAKE HAS OCCURRED WITH THESE PRELIMINARY PARAMETERS

ORIGIN TIME - 1748Z 29 SEP 2009

COORDINATES - 15.3 SOUTH 171.0 WEST
 DEPTH - 33 KM
 LOCATION - SAMOA ISLANDS REGION
 MAGNITUDE - 8.3

MEASUREMENTS OR REPORTS OF TSUNAMI WAVE ACTIVITY

GAUGE LOCATION	LAT	LON	TIME	AMPL	PER
RAROTONGA CK	21.2S	159.8W	1951Z	0.47M / 1.5FT	08MIN
APIA UPOLU WS	13.8S	171.8W	1832Z	0.70M / 2.3FT	08MIN
PAGO PAGO AS	14.3S	170.7W	1812Z	1.57M / 5.1FT	04MIN

LAT - LATITUDE (N-NORTH, S-SOUTH)

LON - LONGITUDE (E-EAST, W-WEST)

TIME - TIME OF THE MEASUREMENT (Z IS UTC IS GREENWICH TIME)

AMPL - TSUNAMI AMPLITUDE MEASURED RELATIVE TO NORMAL SEA LEVEL.

IT IS ...NOT... CREST-TO-TROUGH WAVE HEIGHT.

VALUES ARE GIVEN IN BOTH METERS (M) AND FEET (FT) .

PER - PERIOD OF TIME IN MINUTES (MIN) FROM ONE WAVE TO THE NEXT.

EVALUATION

SEA LEVEL READINGS INDICATE A TSUNAMI WAS GENERATED. IT MAY HAVE BEEN DESTRUCTIVE ALONG COASTS NEAR THE EARTHQUAKE EPICENTER AND COULD ALSO BE A THREAT TO MORE DISTANT COASTS. AUTHORITIES SHOULD TAKE APPROPRIATE ACTION IN RESPONSE TO THIS POSSIBILITY. THIS CENTER WILL CONTINUE TO MONITOR SEA LEVEL DATA TO DETERMINE THE EXTENT AND SEVERITY OF THE THREAT.

FOR ALL AREAS - WHEN NO MAJOR WAVES ARE OBSERVED FOR TWO HOURS AFTER THE ESTIMATED TIME OF ARRIVAL OR DAMAGING WAVES HAVE NOT

OCCURRED FOR AT LEAST TWO HOURS THEN LOCAL AUTHORITIES CAN ASSUME THE THREAT IS PASSED. DANGER TO BOATS AND COASTAL STRUCTURES CAN CONTINUE FOR SEVERAL HOURS DUE TO RAPID CURRENTS. AS LOCAL CONDITIONS CAN CAUSE A WIDE VARIATION IN TSUNAMI WAVE ACTION THE ALL CLEAR DETERMINATION MUST BE MADE BY LOCAL AUTHORITIES.

ESTIMATED INITIAL TSUNAMI WAVE ARRIVAL TIMES AT FORECAST POINTS WITHIN THE WARNING AND WATCH AREAS ARE GIVEN BELOW. ACTUAL ARRIVAL TIMES MAY DIFFER AND THE INITIAL WAVE MAY NOT BE THE LARGEST. A TSUNAMI IS A SERIES OF WAVES AND THE TIME BETWEEN SUCCESSIVE WAVES CAN BE FIVE MINUTES TO ONE HOUR.

LOCATION	FORECAST POINT	COORDINATES	ARRIVAL TIME
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AMERICAN SAMOA	PAGO PAGO	14.3S 170.7W	1759Z 29 SEP
SAMOA	APIA	13.8S 171.8W	1810Z 29 SEP
NIUE	NIUE IS.	19.0S 170.0W	1822Z 29 SEP
WALLIS-FUTUNA	WALLIS IS.	13.2S 176.2W	1835Z 29 SEP
TOKELAU	NUKUNONU IS.	9.2S 171.8W	1844Z 29 SEP
COOK ISLANDS	PUKAPUKA IS.	10.8S 165.9W	1846Z 29 SEP
	RAROTONGA	21.2S 159.8W	1929Z 29 SEP
	PENRYN IS.	8.9S 157.8W	1954Z 29 SEP
TONGA	NUKUALOFA	21.0S 175.2W	1851Z 29 SEP
TUVALU	FUNAFUTI IS.	7.9S 178.5E	1932Z 29 SEP
KIRIBATI	KANTON IS.	2.8S 171.7W	1935Z 29 SEP
	FLINT IS.	11.4S 151.8W	2025Z 29 SEP
	MALDEN IS.	3.9S 154.9W	2037Z 29 SEP
	CHRISTMAS IS.	2.0N 157.5W	2100Z 29 SEP
	TARAWA IS.	1.5N 173.0E	2104Z 29 SEP
KERMADEC IS	RAOUL IS.	29.2S 177.9W	1938Z 29 SEP
FIJI	SUVA	18.1S 178.4E	2003Z 29 SEP
HOWLAND-BAKER	HOWLAND IS.	0.6N 176.6W	2008Z 29 SEP

JARVIS IS.	JARVIS IS.	0.4S 160.1W	2028Z 29 SEP
NEW ZEALAND	EAST CAPE	37.7S 178.5E	2044Z 29 SEP
	GISBORNE	38.7S 178.0E	2100Z 29 SEP
	NORTH CAPE	34.4S 173.3E	2112Z 29 SEP
	NAPIER	39.5S 176.9E	2140Z 29 SEP
	WELLINGTON	41.3S 174.8E	2150Z 29 SEP
	AUCKLAND (E)	36.7S 175.0E	2212Z 29 SEP
	AUCKLAND (W)	37.1S 174.2E	2239Z 29 SEP
	LYTTELTON	43.6S 172.7E	2255Z 29 SEP
	NEW PLYMOUTH	39.1S 174.1E	2317Z 29 SEP
	NELSON	41.3S 173.3E	2323Z 29 SEP
	DUNEDIN	45.9S 170.5E	2331Z 29 SEP
	MILFORD SOUND	44.6S 167.9E	2358Z 29 SEP
	WESTPORT	41.8S 171.6E	2359Z 29 SEP
	BLUFF	46.6S 168.3E	0044Z 30 SEP
FR. POLYNESIA	PAPEETE	17.5S 149.6W	2045Z 29 SEP
	HIVA OA	10.0S 139.0W	2214Z 29 SEP
	RIKITEA	23.1S 135.0W	2247Z 29 SEP
PALMYRA IS.	PALMYRA IS.	6.3N 162.4W	2102Z 29 SEP
VANUATU	ANATOM IS.	20.2S 169.9E	2117Z 29 SEP
	ESPERITU SANTO	15.1S 167.3E	2123Z 29 SEP
NAURU	NAURU	0.5S 166.9E	2138Z 29 SEP
MARSHALL IS.	MAJURO	7.1N 171.4E	2147Z 29 SEP
	KWAJALEIN	8.7N 167.7E	2220Z 29 SEP
	ENIWETOK	11.4N 162.3E	2309Z 29 SEP
SOLOMON IS.	KIRAKIRA	10.4S 161.9E	2155Z 29 SEP
	GHATERE	7.8S 159.2E	2227Z 29 SEP
	AUKI	8.8S 160.6E	2244Z 29 SEP
	HONIARA	9.3S 160.0E	2244Z 29 SEP
	PANGGOE	6.9S 157.2E	2245Z 29 SEP
	MUNDA	8.4S 157.2E	2248Z 29 SEP
	FALAMAE	7.4S 155.6E	2304Z 29 SEP

JOHNSTON IS.	JOHNSTON IS.	16.7N 169.5W	2212Z 29 SEP
NEW CALEDONIA	NOUMEA	22.3S 166.5E	2216Z 29 SEP
KOSRAE	KOSRAE IS.	5.5N 163.0E	2233Z 29 SEP
PAPUA NEW GUINE	KIETA	6.1S 155.6E	2303Z 29 SEP
	AMUN	6.0S 154.7E	2323Z 29 SEP
	RABAUL	4.2S 152.3E	2349Z 29 SEP
	LAE	6.8S 147.0E	0015Z 30 SEP
	KAVIENG	2.5S 150.7E	0016Z 30 SEP
	PORT MORESBY	9.3S 146.9E	0039Z 30 SEP
	MADANG	5.2S 145.8E	0041Z 30 SEP
	MANUS IS.	2.0S 147.5E	0050Z 30 SEP
	WEWAK	3.5S 143.6E	0124Z 30 SEP
	VANIMO	2.6S 141.3E	0134Z 30 SEP
POHNPEI	POHNPEI IS.	7.0N 158.2E	2318Z 29 SEP
WAKE IS.	WAKE IS.	19.3N 166.6E	2322Z 29 SEP
PITCAIRN	PITCAIRN IS.	25.1S 130.1W	2329Z 29 SEP
MIDWAY IS.	MIDWAY IS.	28.2N 177.4W	2349Z 29 SEP
CHUUK	CHUUK IS.	7.4N 151.8E	0020Z 30 SEP
AUSTRALIA	BRISBANE	27.2S 153.3E	0036Z 30 SEP
	SYDNEY	33.9S 151.4E	0038Z 30 SEP
	HOBART	43.3S 147.6E	0120Z 30 SEP
	CAIRNS	16.7S 145.8E	0123Z 30 SEP
	GLADSTONE	23.8S 151.4E	0212Z 30 SEP
MARCUS IS.	MARCUS IS.	24.3N 154.0E	0058Z 30 SEP
N. MARIANAS	SAIPAN	15.3N 145.8E	0110Z 30 SEP
GUAM	GUAM	13.4N 144.7E	0118Z 30 SEP
INDONESIA	JAYAPURA	2.4S 140.8E	0138Z 30 SEP
	WARSA	0.6S 135.8E	0221Z 30 SEP
ANTARCTICA	CAPE ADARE	71.0S 170.0E	0149Z 30 SEP
YAP	YAP IS.	9.5N 138.1E	0159Z 30 SEP

BULLETINS WILL BE ISSUED HOURLY OR SOONER IF CONDITIONS WARRANT.

THE TSUNAMI WARNING AND WATCH WILL REMAIN IN EFFECT UNTIL
FURTHER NOTICE.

THE WEST COAST/ALASKA TSUNAMI WARNING CENTER WILL ISSUE PRODUCTS
FOR ALASKA...BRITISH COLUMBIA...WASHINGTON...OREGON...CALIFORNIA.

TSUNAMI BULLETIN NUMBER 004

PACIFIC TSUNAMI WARNING CENTER/NOAA/NWS

ISSUED AT 2136Z 29 SEP 2009

THIS BULLETIN APPLIES TO AREAS WITHIN AND BORDERING THE PACIFIC OCEAN AND ADJACENT SEAS...EXCEPT ALASKA...BRITISH COLUMBIA...WASHINGTON...OREGON AND CALIFORNIA.

... TSUNAMI WARNING AND WATCH CANCELLATION ...

THE TSUNAMI WARNING AND/OR WATCH ISSUED BY THE PACIFIC TSUNAMI WARNING CENTER IS NOW CANCELLED FOR

AMERICAN SAMOA / SAMOA / NIUE / WALLIS-FUTUNA / TOKELAU /
COOK ISLANDS / TONGA / TUVALU / KIRIBATI / KERMADEC IS / FIJI /
HOWLAND-BAKER / JARVIS IS. / NEW ZEALAND / FR. POLYNESIA /
PALMYRA IS. / VANUATU / NAURU / MARSHALL IS. / SOLOMON IS. /
JOHNSTON IS. / NEW CALEDONIA / KOSRAE / PAPUA NEW GUINEA /
HAWAII / POHNPEI / WAKE IS. / PITCAIRN / MIDWAY IS. / CHUUK /
AUSTRALIA / MARCUS IS. / N. MARIANAS / GUAM / INDONESIA /
ANTARCTICA / YAP

THIS BULLETIN IS ISSUED AS ADVICE TO GOVERNMENT AGENCIES. ONLY NATIONAL AND LOCAL GOVERNMENT AGENCIES HAVE THE AUTHORITY TO MAKE DECISIONS REGARDING THE OFFICIAL STATE OF ALERT IN THEIR AREA AND ANY ACTIONS TO BE TAKEN IN RESPONSE.

AN EARTHQUAKE HAS OCCURRED WITH THESE PRELIMINARY PARAMETERS

ORIGIN TIME - 1748Z 29 SEP 2009
COORDINATES - 15.3 SOUTH 171.0 WEST
DEPTH - 33 KM
LOCATION - SAMOA ISLANDS REGION
MAGNITUDE - 8.3

MEASUREMENTS OR REPORTS OF TSUNAMI WAVE ACTIVITY

GAUGE LOCATION	LAT	LON	TIME	AMPL	PER
PAPEETE TAHITI	17.5S	149.6W	2123Z	0.11M / 0.4FT	10MIN
NUKUALOFA TO	21.1S	175.2W	2007Z	0.14M / 0.5FT	14MIN
PENRHYN CK	9.0S	158.1W	2102Z	0.08M / 0.3FT	04MIN
RAROTONGA CK	21.2S	159.8W	1951Z	0.47M / 1.5FT	08MIN
APIA UPOLU WS	13.8S	171.8W	1832Z	0.70M / 2.3FT	08MIN
PAGO PAGO AS	14.3S	170.7W	1812Z	1.57M / 5.1FT	04MIN

LAT - LATITUDE (N-NORTH, S-SOUTH)

LON - LONGITUDE (E-EAST, W-WEST)

TIME - TIME OF THE MEASUREMENT (Z IS UTC IS GREENWICH TIME)

AMPL - TSUNAMI AMPLITUDE MEASURED RELATIVE TO NORMAL SEA LEVEL.

IT IS ...NOT... CREST-TO-TROUGH WAVE HEIGHT.

VALUES ARE GIVEN IN BOTH METERS (M) AND FEET (FT) .

PER - PERIOD OF TIME IN MINUTES (MIN) FROM ONE WAVE TO THE NEXT.

EVALUATION

SEA LEVEL READINGS INDICATE A TSUNAMI WAS GENERATED. IT MAY HAVE BEEN DESTRUCTIVE ALONG COASTS NEAR THE EARTHQUAKE EPICENTER. FOR THOSE AREAS - WHEN NO MAJOR WAVES ARE OBSERVED FOR TWO HOURS AFTER THE ESTIMATED TIME OF ARRIVAL OR DAMAGING WAVES HAVE NOT OCCURRED FOR AT LEAST TWO HOURS THEN LOCAL AUTHORITIES CAN ASSUME THE THREAT IS PASSED. DANGER TO BOATS AND COASTAL STRUCTURES CAN CONTINUE FOR SEVERAL HOURS DUE TO RAPID CURRENTS. AS LOCAL CONDITIONS CAN CAUSE A WIDE VARIATION IN TSUNAMI WAVE ACTION THE ALL CLEAR DETERMINATION MUST BE MADE BY LOCAL AUTHORITIES.

NO TSUNAMI THREAT EXISTS FOR OTHER COASTAL AREAS ALTHOUGH SOME
MAY EXPERIENCE SMALL SEA LEVEL CHANGES. FOR ALL AREAS COVERED BY
THIS CENTER...THE TSUNAMI WARNING AND WATCH ARE CANCELLED.

THIS WILL BE THE FINAL BULLETIN ISSUED FOR THIS EVENT UNLESS
ADDITIONAL INFORMATION BECOMES AVAILABLE.

THE WEST COAST/ALASKA TSUNAMI WARNING CENTER WILL ISSUE PRODUCTS
FOR ALASKA...BRITISH COLUMBIA...WASHINGTON...OREGON...CALIFORNIA.

WC/ATWC Tsunami Messages – 29 September 2009

OBSERVATORY MESSAGE
QUAKE OF SEP 29

PRELIMINARY EARTHQUAKE PARAMETERS - 23 STATIONS IN SOLUTION
MAGNITUDE - M_wp 7.9 - 4 STATION AVERAGE
TIME - 0948 AKDT SEP 29 2009
 1048 PDT SEP 29 2009
 1748 UTC SEP 29 2009
LOCATION - 15.7 SOUTH 171.8 WEST
 - SAMOA ISLANDS REGION
DEPTH - 21 MILES/33 KM

THE LOCATION/MAGNITUDE AND TYPE OF MAGNITUDE (MB MS ML MW)
MAY CHANGE AS MORE DATA BECOMES AVAILABLE. THE LOCATION AND
MAGNITUDE ARE BASED ON PRELIMINARY INFORMATION.
FURTHER INFORMATION WILL BE ISSUED BY THE UNITED STATES
GEOLOGICAL SURVEY - EARTHQUAKE.USGS.GOV - OR THE APPROPRIATE
REGIONAL SEISMIC NETWORK.

WEPA43 PAAQ 291802

TIBWCA

TSUNAMI INFORMATION STATEMENT NUMBER 1

NWS WEST COAST/ALASKA TSUNAMI WARNING CENTER PALMER AK

1102 AM PDT TUE SEP 29 2009

...THIS TSUNAMI INFORMATION STATEMENT IS FOR ALASKA/ BRITISH COLUMBIA/
WASHINGTON/ OREGON AND CALIFORNIA ONLY...

NO WARNING... NO WATCH AND NO ADVISORY IS IN EFFECT FOR
THE STATES AND PROVINCES LISTED ABOVE.

EVALUATION

BASED ON MAGNITUDE... LOCATION AND HISTORIC TSUNAMI RECORDS THE
EARTHQUAKE WAS NOT SUFFICIENT TO GENERATE A TSUNAMI DAMAGING TO
CALIFORNIA/ OREGON/ WASHINGTON/ BRITISH COLUMBIA OR ALASKA. IN
COASTAL AREAS OF INTENSE SHAKING LOCALLY GENERATED TSUNAMIS CAN
BE TRIGGERED BY UNDERWATER LANDSLIDES.

PRELIMINARY EARTHQUAKE PARAMETERS

MAGNITUDE - 7.9

TIME - 0948 AKDT SEP 29 2009

1048 PDT SEP 29 2009

1748 UTC SEP 29 2009

LOCATION - 15.4 SOUTH 171.6 WEST

- SAMOA ISLANDS REGION

DEPTH - 21 MILES/33 KM

THE PACIFIC TSUNAMI WARNING CENTER IN EWA BEACH HAWAII WILL ISSUE
A TSUNAMI WARNING FOR REGIONS NEAR THE EPICENTER.

THIS WILL BE THE ONLY STATEMENT ISSUED FOR THIS EVENT BY THE
WEST COAST/ALASKA TSUNAMI WARNING CENTER UNLESS ADDITIONAL
INFORMATION BECOMES AVAILABLE. REFER TO THE INTERNET SITE
WCATWC.ARH.NOAA.GOV FOR MORE INFORMATION.

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WEPA43 PAAQ 291859

TIBWCA

TSUNAMI INFORMATION STATEMENT NUMBER 2

NWS WEST COAST/ALASKA TSUNAMI WARNING CENTER PALMER AK

1159 AM PDT TUE SEP 29 2009

...THIS TSUNAMI INFORMATION STATEMENT IS FOR ALASKA/ BRITISH COLUMBIA/
WASHINGTON/ OREGON AND CALIFORNIA ONLY...

NO WARNING... NO WATCH AND NO ADVISORY IS IN EFFECT FOR THE STATES AND
PROVINCES LISTED ABOVE.

EVALUATION

SEA LEVEL READINGS INDICATE A TSUNAMI WAS GENERATED WHICH MAY HAVE
BEEN DESTRUCTIVE ALONG COASTS NEAR THE EARTHQUAKE EPICENTER.

A DAMAGING TSUNAMI IS NOT EXPECTED ALONG THE CALIFORNIA/ OREGON/
WASHINGTON/ BRITISH COLUMBIA AND ALASKA COASTS ALTHOUGH
SOME OF THESE AREAS MAY EXPERIENCE NON-DAMAGING SEA LEVEL CHANGES.

A TSUNAMI HAS BEEN OBSERVED AT THE FOLLOWING SITES

LOCATION	LAT	LON	TIME	AMPL
-----	-----	-----	-----	-----
APIA WEST SAMOA	13.8S	171.8W	1832UTC	0.70M/2.3FT
PAGO PAGO AMER. SAMOA	14.3S	170.7W	1825UTC	1.57M/5.1FT

TIME - TIME OF MEASUREMENT

AMPL - TSUNAMI AMPLITUDES ARE MEASURED RELATIVE TO NORMAL SEA LEVEL.

IT IS ...NOT... CREST-TO-TROUGH WAVE HEIGHT.

VALUES ARE GIVEN IN BOTH METERS (M) AND FEET (FT) .

PRELIMINARY EARTHQUAKE PARAMETERS

MAGNITUDE - 8.3
TIME - 0948 AKDT SEP 29 2009
1048 PDT SEP 29 2009
1748 UTC SEP 29 2009
LOCATION - 15.3 SOUTH 171.0 WEST
- SAMOA ISLANDS REGION
DEPTH - 21 MILES/33 KM

THE PACIFIC TSUNAMI WARNING CENTER IN EWA BEACH HAWAII WILL ISSUE
MESSAGES FOR HAWAII AND OTHER AREAS OF THE PACIFIC.

THIS WILL BE THE FINAL STATEMENT ISSUED FOR THIS EVENT BY THE
WEST COAST/ALASKA TSUNAMI WARNING CENTER UNLESS ADDITIONAL
INFORMATION BECOMES AVAILABLE. REFER TO THE INTERNET SITE
WCATWC.ARH.NOAA.GOV FOR MORE INFORMATION.

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WEPA41 PAAQ 292202

TSUWCA

BULLETIN

TSUNAMI MESSAGE NUMBER 3

NWS WEST COAST/ALASKA TSUNAMI WARNING CENTER PALMER AK

302 PM PDT TUE SEP 29 2009

...A TSUNAMI ADVISORY IS IN EFFECT WHICH INCLUDES THE COASTAL AREAS OF CALIFORNIA AND OREGON FROM THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER...

...THIS MESSAGE IS INFORMATION ONLY FOR COASTAL AREAS OF WASHINGTON - BRITISH COLUMBIA AND ALASKA FROM THE OREGON-WASHINGTON BORDER TO ATTU ALASKA...

RECOMMENDED ACTIONS

A TSUNAMI HAS BEEN GENERATED WHICH COULD CAUSE DAMAGE TO THE ADVISORY REGIONS LISTED IN THE HEADLINE. PERSONS IN LOW-LYING COASTAL AREAS SHOULD BE ALERT TO INSTRUCTIONS FROM

THEIR LOCAL EMERGENCY OFFICIALS. EVACUATIONS ARE ONLY ORDERED BY EMERGENCY RESPONSE AGENCIES.

- PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

THIS MESSAGE IS BASED ON EARTHQUAKE DATA... OBSERVED TSUNAMI AMPLITUDES... HISTORICAL INFORMATION AND FORECAST MODELS.

A TSUNAMI HAS BEEN OBSERVED AT THE FOLLOWING SITES

LOCATION	LAT	LON	TIME	AMPL
-----	-----	-----	-----	-----
APIA WEST SAMOA	13.8S	171.8W	1832UTC	0.70M/2.3FT
PAGO PAGO AMER. SAMOA	14.3S	170.7W	1825UTC	1.57M/5.1FT
RAROTONGA COOK IS. (NZ	21.2S	159.8E	1950UTC	0.54M/1.8FT

FORECASTS INDICATE THAT A TSUNAMI WITH AMPLITUDES IN THE RANGE OF 20 TO 65CM IS EXPECTED ALONG THE CALIFORNIA AND OREGON COAST. TSUNAMIS OF THIS AMPLITUDE CAN GENERATE STRONG CURRENTS DANGEROUS

TO THOSE VERY NEAR OR IN THE OCEAN. THE TSUNAMI IS EXPECTED TO BUILD AND REACH ITS MAXIMUM APPROXIMATELY ONE AND A HALF HOURS AFTER THE INITIAL ARRIVAL. FURTHER ARRIVAL TIMES AND OTHER INFORMATION IS LISTED IN THE WEB SITE BELOW.

TIME - TIME OF MEASUREMENT

AMPL - TSUNAMI AMPLITUDES ARE MEASURED RELATIVE TO NORMAL SEA LEVEL.

IT IS ...NOT... CREST-TO-TROUGH WAVE HEIGHT.

VALUES ARE GIVEN IN BOTH METERS (M) AND FEET (FT) .

PRELIMINARY EARTHQUAKE PARAMETERS

MAGNITUDE - 8.0

TIME - 0948 AKDT SEP 29 2009

1048 PDT SEP 29 2009

1748 UTC SEP 29 2009

LOCATION - 15.3 SOUTH 171.0 WEST

- SAMOA ISLANDS REGION

DEPTH - 21 MILES/33 KM

THE PACIFIC TSUNAMI WARNING CENTER IN EWA BEACH HAWAII HAS CANCELLED THE WARNING FOR COUNTRIES IN THE SAMOA REGION.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR THE WATER IS IMMINENT OR EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION IS NOT EXPECTED FOR AREAS UNDER AN ADVISORY. CURRENTS MAY BE HAZARDOUS TO SWIMMERS... BOATS... AND COASTAL STRUCTURES AND MAY CONTINUE FOR SEVERAL HOURS AFTER THE INITIAL WAVE ARRIVAL.

THIS MESSAGE WILL BE UPDATED IN 60 MINUTES OR SOONER IF THE SITUATION WARRANTS. THE TSUNAMI MESSAGE WILL REMAIN IN EFFECT UNTIL FURTHER NOTICE. REFER TO THE INTERNET SITE

WCATWC.ARH.NOAA.GOV FOR MORE INFORMATION.

PZZ750-655-650-673-670-565-535-530-545-560-455-540-450-356-
353-350-255-250-CAZ039>046-087-034-035-515-006-506-508-509-
514-505-002-001-ORZ022-002-021-001-292302-
/O.NEW.PAAQ.TS.Y.0008.090929T2202Z-000000T0000Z/
COASTAL AREAS BETWEEN AND INCLUDING THE CALIFORNIA-MEXICO
BORDER TO THE OREGON-WASHINGTON BORDER
302 PM PDT TUE SEP 29 2009

...A TSUNAMI ADVISORY IS IN EFFECT WHICH INCLUDES THE
COASTAL AREAS OF CALIFORNIA AND OREGON FROM THE
CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER...

PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE
WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING
STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR
WATER IS IMMINENT OR EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION
IS NOT EXPECTED FOR AREAS IN AN ADVISORY. TSUNAMIS ARE A SERIES OF
WAVES POTENTIALLY DANGEROUS SEVERAL HOURS AFTER INITIAL ARRIVAL
TIME. ESTIMATED TIMES OF INITIAL WAVE ARRIVAL FOR SELECTED
SITES IN THE ADVISORY ARE PROVIDED BELOW.

SANTA BARBARA-CA	2103	PDT SEP 29	SAN FRANCISCO-CA	2125	PDT SEP 29
LA JOLLA-CA	2107	PDT SEP 29	CHARLESTON-OR	2128	PDT SEP 29
CRESCENT CITY-CA	2116	PDT SEP 29	SEASIDE-OR	2201	PDT SEP 29

FOR ARRIVAL TIMES AT ADDITIONAL LOCATIONS SEE
WCATWC.ARH.NOAA.GOV

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WEPA41 PAAQ 292314

TSUWCA

BULLETIN

TSUNAMI MESSAGE NUMBER 4

NWS WEST COAST/ALASKA TSUNAMI WARNING CENTER PALMER AK

414 PM PDT TUE SEP 29 2009

...A TSUNAMI ADVISORY IS IN EFFECT WHICH INCLUDES THE COASTAL AREAS OF CALIFORNIA AND OREGON FROM THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER...

...THIS MESSAGE IS INFORMATION ONLY FOR COASTAL AREAS OF WASHINGTON - BRITISH COLUMBIA AND ALASKA FROM THE OREGON-WASHINGTON BORDER TO ATTU ALASKA...

RECOMMENDED ACTIONS

A TSUNAMI HAS BEEN GENERATED WHICH COULD CAUSE DAMAGE TO THE ADVISORY REGIONS LISTED IN THE HEADLINE. PERSONS IN LOW-LYING COASTAL AREAS SHOULD BE ALERT TO INSTRUCTIONS FROM THEIR LOCAL EMERGENCY OFFICIALS. EVACUATIONS ARE ONLY ORDERED BY EMERGENCY RESPONSE AGENCIES.

- PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

THIS MESSAGE IS BASED ON EARTHQUAKE DATA... OBSERVED TSUNAMI AMPLITUDES... HISTORICAL INFORMATION AND FORECAST MODELS.

A TSUNAMI HAS BEEN OBSERVED AT THE FOLLOWING SITES

LOCATION	LAT	LON	TIME	AMPL
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APIA WEST SAMOA	13.8S	171.8W	1832UTC	0.70M/2.3FT
PAGO PAGO AMER. SAMOA	14.3S	170.7W	1825UTC	1.57M/5.1FT
RAROTONGA COOK IS. (NZ	21.2S	159.8E	1950UTC	0.54M/1.8FT

LAUTOKA	FIJI	17.6S	177.4E	2136UTC	0.05M/0.2FT
OWENGA	CHATHAM NZ	44.0S	176.4W	2248UTC	0.08M/0.3FT
PAPEETE	FR. POLYNESIA	17.5S	149.6W	2137UTC	0.14M/0.5FT
PENRHYN	COOK IS. NZ	9.0S	158.0W	2103UTC	0.08M/0.3FT
PORT VILA	VANUATU	17.8S	168.3E	2239UTC	0.18M/0.6FT

FORECASTS INDICATE THAT A TSUNAMI WITH AMPLITUDES IN THE RANGE OF 20 TO 65CM IS EXPECTED ALONG THE CALIFORNIA AND OREGON COAST. TSUNAMIS OF THIS AMPLITUDE CAN GENERATE STRONG CURRENTS DANGEROUS TO THOSE VERY NEAR OR IN THE OCEAN. THE TSUNAMI IS EXPECTED TO BUILD AND REACH ITS MAXIMUM APPROXIMATELY ONE AND A HALF HOURS AFTER THE INITIAL ARRIVAL. TSUNAMI ARRIVAL TIMES AND OTHER AMPLITUDE FORECASTS ARE LISTED IN THE WEB SITE BELOW.

TIME - TIME OF MEASUREMENT

AMPL - TSUNAMI AMPLITUDES ARE MEASURED RELATIVE TO NORMAL SEA LEVEL.

IT IS ...NOT... CREST-TO-TROUGH WAVE HEIGHT.

VALUES ARE GIVEN IN BOTH METERS (M) AND FEET (FT).

PRELIMINARY EARTHQUAKE PARAMETERS

MAGNITUDE - 8.0

TIME - 0948 AKDT SEP 29 2009

1048 PDT SEP 29 2009

1748 UTC SEP 29 2009

LOCATION - 15.6 SOUTH 172.0 WEST

- SAMOA ISLANDS REGION

DEPTH - 21 MILES/33 KM

THE PACIFIC TSUNAMI WARNING CENTER IN EWA BEACH HAWAII WILL ISSUE MESSAGES FOR HAWAII AND OTHER AREAS OF THE PACIFIC OUTSIDE THE STATES AND PROVINCES LISTED ABOVE.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING

STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR THE WATER IS IMMINENT OR EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION IS NOT EXPECTED FOR AREAS UNDER AN ADVISORY. CURRENTS MAY BE HAZARDOUS TO SWIMMERS... BOATS... AND COASTAL STRUCTURES AND MAY CONTINUE FOR SEVERAL HOURS AFTER THE INITIAL WAVE ARRIVAL.

THIS MESSAGE WILL BE UPDATED IN 90 MINUTES OR SOONER IF THE SITUATION WARRANTS. THE TSUNAMI MESSAGE WILL REMAIN IN EFFECT UNTIL FURTHER NOTICE. REFER TO THE INTERNET SITE WCATWC.ARH.NOAA.GOV FOR MORE INFORMATION.

PZZ750-655-650-673-670-565-535-530-545-560-455-540-450-356-353-350-255-250-CAZ039>046-087-034-035-515-006-506-508-509-514-505-002-001-ORZ022-002-021-001-300014-

/O.CON.PAAQ.TS.Y.0008.000000T0000Z-000000T0000Z/

COASTAL AREAS BETWEEN AND INCLUDING THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER

414 PM PDT TUE SEP 29 2009

...A TSUNAMI ADVISORY IS IN EFFECT WHICH INCLUDES THE COASTAL AREAS OF CALIFORNIA AND OREGON FROM THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER...

PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR WATER IS IMMINENT OF EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION IS NOT EXPECTED FOR AREAS IN AN ADVISORY. TSUNAMIS ARE A SERIES OF WAVES POTENTIALLY DANGEROUS SEVERAL HOURS AFTER INITIAL ARRIVAL TIME. ESTIMATED TIMES OF INITIAL WAVE ARRIVAL FOR SELECTED

SITES IN THE ADVISORY ARE PROVIDED BELOW.

SANTA BARBARA-CA	2111	PDT	SEP	29	SAN FRANCISCO-CA	2131	PDT	SEP	29
LA JOLLA-CA	2116	PDT	SEP	29	CHARLESTON-OR	2132	PDT	SEP	29
CRESCENT CITY-CA	2120	PDT	SEP	29	SEASIDE-OR	2205	PDT	SEP	29

FOR ARRIVAL TIMES AT ADDITIONAL LOCATIONS SEE
WCATWC.ARH.NOAA.GOV

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WEPA41 PAAQ 300021

TSUWCA

BULLETIN

TSUNAMI MESSAGE NUMBER 5

NWS WEST COAST/ALASKA TSUNAMI WARNING CENTER PALMER AK

521 PM PDT TUE SEP 29 2009

...A TSUNAMI ADVISORY IS IN EFFECT WHICH INCLUDES THE
COASTAL AREAS OF CALIFORNIA AND OREGON FROM THE
CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER...

...THIS MESSAGE IS INFORMATION ONLY FOR COASTAL AREAS OF
WASHINGTON - BRITISH COLUMBIA AND ALASKA FROM THE
OREGON-WASHINGTON BORDER TO ATTU ALASKA...

RECOMMENDED ACTIONS

A TSUNAMI HAS BEEN GENERATED WHICH COULD IMPACT THE
ADVISORY REGIONS LISTED IN THE HEADLINE. PERSONS
IN LOW-LYING COASTAL AREAS SHOULD BE ALERT TO INSTRUCTIONS FROM
THEIR LOCAL EMERGENCY OFFICIALS. EVACUATIONS ARE ONLY ORDERED BY
EMERGENCY RESPONSE AGENCIES.

- PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE
WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

THIS MESSAGE IS BASED ON EARTHQUAKE DATA... OBSERVED TSUNAMI
AMPLITUDES... HISTORICAL INFORMATION AND FORECAST MODELS.

A TSUNAMI HAS BEEN OBSERVED AT THE FOLLOWING SITES

LOCATION	LAT	LON	TIME	AMPL
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APIA WEST SAMOA	13.8S	171.8W	1832UTC	0.70M/2.3FT
PAGO PAGO AMER. SAMOA	14.3S	170.7W	1825UTC	1.57M/5.1FT
RAROTONGA COOK IS. (NZ	21.2S	159.8E	1950UTC	0.54M/1.8FT
PAPEETE FR. POLYNESIA	17.5S	149.6W	2137UTC	0.14M/0.5FT
PENRHYN COOK IS. NZ	9.0S	158.0W	2103UTC	0.08M/0.3FT
PORT VILA VANUATU	17.8S	168.3E	2239UTC	0.18M/0.6FT
NAWILIWILI KAUAI HI	22.0N	159.4W	0011UTC	0.16M/0.5FT
KAWAIHAE HI	20.0N	155.8W	0013UTC	0.18M/0.6FT

FORECASTS INDICATE THAT A TSUNAMI WITH AMPLITUDES IN THE RANGE OF 20 TO 65CM IS EXPECTED ALONG THE CALIFORNIA AND OREGON COAST. TSUNAMIS OF THIS AMPLITUDE CAN GENERATE STRONG CURRENTS DANGEROUS TO THOSE VERY NEAR OR IN THE OCEAN. THE TSUNAMI IS EXPECTED TO BUILD AND REACH ITS MAXIMUM APPROXIMATELY ONE AND A HALF HOURS AFTER THE INITIAL ARRIVAL. TSUNAMI ARRIVAL TIMES AND OTHER AMPLITUDE FORECASTS ARE LISTED IN THE WEB SITE BELOW.

TIME - TIME OF MEASUREMENT

AMPL - TSUNAMI AMPLITUDES ARE MEASURED RELATIVE TO NORMAL SEA LEVEL.

IT IS ...NOT... CREST-TO-TROUGH WAVE HEIGHT.

VALUES ARE GIVEN IN BOTH METERS (M) AND FEET (FT).

PRELIMINARY EARTHQUAKE PARAMETERS

MAGNITUDE - 8.0

TIME - 0948 AKDT SEP 29 2009

1048 PDT SEP 29 2009

1748 UTC SEP 29 2009

LOCATION - 15.6 SOUTH 172.0 WEST

- SAMOA ISLANDS REGION

DEPTH - 21 MILES/33 KM

THE PACIFIC TSUNAMI WARNING CENTER HAS CANCELLED THEIR WARNING FOR COUNTRIES AROUND SAMOA AND CONTINUED THE ADVISORY FOR

HAWAII.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR THE WATER IS IMMINENT OR EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION IS NOT EXPECTED FOR AREAS UNDER AN ADVISORY. CURRENTS MAY BE HAZARDOUS TO SWIMMERS... BOATS... AND COASTAL STRUCTURES AND MAY CONTINUE FOR SEVERAL HOURS AFTER THE INITIAL WAVE ARRIVAL.

THIS MESSAGE WILL BE UPDATED IN 120 MINUTES OR SOONER IF THE SITUATION WARRANTS. THE TSUNAMI MESSAGE WILL REMAIN IN EFFECT UNTIL FURTHER NOTICE. REFER TO THE INTERNET SITE WCATWC.ARH.NOAA.GOV FOR MORE INFORMATION.

PZZ750-655-650-673-670-565-535-530-545-560-455-540-450-356-353-350-255-250-CAZ039>046-087-034-035-515-006-506-508-509-514-505-002-001-ORZ022-002-021-001-300251-
/O.CON.PAAQ.TS.Y.0008.000000T0000Z-000000T0000Z/

COASTAL AREAS BETWEEN AND INCLUDING THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER
521 PM PDT TUE SEP 29 2009

...A TSUNAMI ADVISORY IS IN EFFECT WHICH INCLUDES THE COASTAL AREAS OF CALIFORNIA AND OREGON FROM THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER...

PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR WATER IS IMMINENT OF EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION

IS NOT EXPECTED FOR AREAS IN AN ADVISORY. TSUNAMIS ARE A SERIES OF WAVES POTENTIALLY DANGEROUS SEVERAL HOURS AFTER INITIAL ARRIVAL TIME. ESTIMATED TIMES OF INITIAL WAVE ARRIVAL FOR SELECTED SITES IN THE ADVISORY ARE PROVIDED BELOW.

SANTA BARBARA-CA	2111	PDT	SEP	29	SAN FRANCISCO-CA	2131	PDT	SEP	29
LA JOLLA-CA	2116	PDT	SEP	29	CHARLESTON-OR	2132	PDT	SEP	29
CRESCENT CITY-CA	2120	PDT	SEP	29	SEASIDE-OR	2205	PDT	SEP	29

FOR ARRIVAL TIMES AT ADDITIONAL LOCATIONS SEE

WCATWC.ARH.NOAA.GOV

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WEPA41 PAAQ 300224

TSUWCA

BULLETIN

TSUNAMI MESSAGE NUMBER 6

NWS WEST COAST/ALASKA TSUNAMI WARNING CENTER PALMER AK

724 PM PDT TUE SEP 29 2009

...A TSUNAMI ADVISORY IS IN EFFECT WHICH INCLUDES THE COASTAL AREAS OF CALIFORNIA AND OREGON FROM THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER...

...THIS MESSAGE IS INFORMATION ONLY FOR COASTAL AREAS OF WASHINGTON - BRITISH COLUMBIA AND ALASKA FROM THE OREGON-WASHINGTON BORDER TO ATTU ALASKA...

RECOMMENDED ACTIONS

A TSUNAMI HAS BEEN GENERATED WHICH COULD IMPACT THE ADVISORY REGION LISTED IN THE HEADLINE. PERSONS IN LOW-LYING COASTAL AREAS SHOULD BE ALERT TO INSTRUCTIONS FROM THEIR LOCAL EMERGENCY OFFICIALS. EVACUATIONS ARE ONLY ORDERED BY EMERGENCY RESPONSE AGENCIES.

- PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

THIS MESSAGE IS BASED ON EARTHQUAKE DATA... OBSERVED TSUNAMI AMPLITUDES... HISTORICAL INFORMATION AND FORECAST MODELS.

A TSUNAMI HAS BEEN OBSERVED AT THE FOLLOWING SITES

LOCATION	LAT	LON	TIME	AMPL
APIA WEST SAMOA	13.8S	171.8W	1829UTC	0.70M/2.3FT
PAGO PAGO AMER. SAMOA	14.3S	170.7W	1825UTC	1.57M/5.1FT

RAROTONGA	COOK IS. (NZ	21.2S	159.8E	1950UTC	0.54M/1.8FT
PAPEETE	FR. POLYNESIA	17.5S	149.6W	2137UTC	0.14M/0.5FT
PORT VILA	VANUATU	17.8S	168.3E	2239UTC	0.18M/0.6FT
NAWILIWILI	KAUAI HI	22.0N	159.4W	0015UTC	0.20M/0.7FT
KAWAIHAE	HI	20.0N	155.8W	0009UTC	0.14M/0.7FT
HONOLULU	OAHU HI	21.3N	157.9W	0031UTC	0.16M/0.5FT
KAHULUI	MAUI HI	20.9N	156.5W	0113UTC	0.36M/1.2FT

THE PEAK TSUNAMI AMPLITUDES HAVE PASSED IN HAWAII. THE MAXIMUM AMPLITUDE WAS RECORDED AT THE TIDE GAGE IN KAHULUI. OBSERVATIONS IN HAWAII SUPPORT FORECASTS OF 10 TO 60CM ALONG THE CALIFORNIA AND OREGON COASTS. TSUNAMIS OF 50CM AMPLITUDE CAN GENERATE STRONG CURRENTS DANGEROUS TO THOSE VERY NEAR OR IN THE OCEAN. THE TSUNAMI IS EXPECTED TO BUILD AND REACH ITS MAXIMUM APPROXIMATELY ONE AND A HALF HOURS AFTER THE INITIAL ARRIVAL. TSUNAMI ARRIVAL TIMES AND OTHER AMPLITUDE FORECASTS ARE LISTED IN THE WEB SITE BELOW.

TIME - TIME OF MEASUREMENT

AMPL - TSUNAMI AMPLITUDES ARE MEASURED RELATIVE TO NORMAL SEA LEVEL.

IT IS ...NOT... CREST-TO-TROUGH WAVE HEIGHT.

VALUES ARE GIVEN IN BOTH METERS (M) AND FEET (FT) .

PRELIMINARY EARTHQUAKE PARAMETERS

MAGNITUDE - 8.0

TIME - 0948 AKDT SEP 29 2009

1048 PDT SEP 29 2009

1748 UTC SEP 29 2009

LOCATION - 15.6 SOUTH 172.0 WEST

- SAMOA ISLANDS REGION

DEPTH - 21 MILES/33 KM

THE PACIFIC TSUNAMI WARNING CENTER IN EWA BEACH HAWAII WILL

ISSUE MESSAGES FOR HAWAII AND OTHER AREAS OF THE PACIFIC
OUTSIDE THE STATES AND PROVINCES LISTED ABOVE.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING
STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR THE
WATER IS IMMINENT OR EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION
IS NOT EXPECTED FOR AREAS UNDER AN ADVISORY. CURRENTS MAY BE
HAZARDOUS TO SWIMMERS... BOATS... AND COASTAL STRUCTURES AND MAY
CONTINUE FOR SEVERAL HOURS AFTER THE INITIAL WAVE ARRIVAL.

THIS MESSAGE WILL BE UPDATED IN 120 MINUTES OR SOONER IF
THE SITUATION WARRANTS. THE TSUNAMI MESSAGE WILL REMAIN IN EFFECT
UNTIL FURTHER NOTICE. REFER TO THE INTERNET SITE
WCATWC.ARH.NOAA.GOV FOR MORE INFORMATION.

PZZ750-655-650-673-670-565-535-530-545-560-455-540-450-356-
775-353-350-255-250-CAZ039>046-087-034-035-515-006-506-508-
509-514-505-002-001-ORZ022-002-021-001-300454-
/O.CON.PAAQ.TS.Y.0008.000000T0000Z-000000T0000Z/

COASTAL AREAS BETWEEN AND INCLUDING THE CALIFORNIA-MEXICO
BORDER TO THE OREGON-WASHINGTON BORDER

724 PM PDT TUE SEP 29 2009

...A TSUNAMI ADVISORY IS IN EFFECT WHICH INCLUDES THE
COASTAL AREAS OF CALIFORNIA AND OREGON FROM THE
CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER...

PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE
WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING
STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR

WATER IS IMMINENT OF EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION IS NOT EXPECTED FOR AREAS IN AN ADVISORY. TSUNAMIS ARE A SERIES OF WAVES POTENTIALLY DANGEROUS SEVERAL HOURS AFTER INITIAL ARRIVAL TIME. ESTIMATED TIMES OF INITIAL WAVE ARRIVAL FOR SELECTED SITES IN THE ADVISORY ARE PROVIDED BELOW.

SANTA BARBARA-CA	2111	PDT	SEP	29	SAN FRANCISCO-CA	2131	PDT	SEP	29
LA JOLLA-CA	2116	PDT	SEP	29	CHARLESTON-OR	2132	PDT	SEP	29
CRESCENT CITY-CA	2120	PDT	SEP	29	SEASIDE-OR	2205	PDT	SEP	29

FOR ARRIVAL TIMES AT ADDITIONAL LOCATIONS SEE
WCATWC.ARH.NOAA.GOV

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WEPA41 PAAQ 300428

TSUWCA

BULLETIN

TSUNAMI MESSAGE NUMBER 7

NWS WEST COAST/ALASKA TSUNAMI WARNING CENTER PALMER AK

928 PM PDT TUE SEP 29 2009

...A TSUNAMI ADVISORY IS IN EFFECT WHICH INCLUDES THE COASTAL AREAS OF CALIFORNIA AND OREGON FROM THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER...

...THIS MESSAGE IS INFORMATION ONLY FOR COASTAL AREAS OF WASHINGTON - BRITISH COLUMBIA AND ALASKA FROM THE OREGON-WASHINGTON BORDER TO ATTU ALASKA...

RECOMMENDED ACTIONS

A TSUNAMI HAS BEEN GENERATED WHICH COULD IMPACT THE ADVISORY REGION LISTED IN THE HEADLINE. PERSONS IN LOW-LYING COASTAL AREAS SHOULD BE ALERT TO INSTRUCTIONS FROM THEIR LOCAL EMERGENCY OFFICIALS. EVACUATIONS ARE ONLY ORDERED BY EMERGENCY RESPONSE AGENCIES.

- PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

THIS MESSAGE IS BASED ON EARTHQUAKE DATA... OBSERVED TSUNAMI AMPLITUDES... HISTORICAL INFORMATION AND FORECAST MODELS.

A TSUNAMI HAS BEEN OBSERVED AT THE FOLLOWING SITES

LOCATION	LAT	LON	TIME	AMPL
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APIA WEST SAMOA	13.8S	171.8W	1829UTC	0.70M/2.3FT
PAGO PAGO AMER. SAMOA	14.3S	170.7W	1825UTC	1.57M/5.1FT
RAROTONGA COOK IS. (NZ	21.2S	159.8E	1950UTC	0.54M/1.8FT

PORT VILA	VANUATU	17.8S	168.3E	2239UTC	0.18M/0.6FT
NAWILIWILI	KAUAI HI	22.0N	159.4W	0015UTC	0.20M/0.7FT
KAWAIHAE	HI	20.0N	155.8W	0009UTC	0.14M/0.7FT
HONOLULU	OAHU HI	21.3N	157.9W	0031UTC	0.16M/0.5FT
KAHULUI	MAUI HI	20.9N	156.5W	0113UTC	0.36M/1.2FT
EASTER ISLAND	CHILE	27.1S	109.3W	0342UTC	0.25M/0.8FT

THE TSUNAMI IS PRESENTLY REACHING ITS ARRIVAL TIME ALONG THE WEST COAST. AT PRESENT SMALL WAVE AMPLITUDES ARE BEING RECORDED WITH THE EXPECTATION TO GROW TO APPROXIMATELY 60CM ALONG THE CA AND OR COASTS. TSUNAMIS OF 50CM AMPLITUDE CAN GENERATE STRONG CURRENTS DANGEROUS TO THOSE VERY NEAR OR IN THE OCEAN. THE TSUNAMI IS EXPECTED TO BUILD AND REACH ITS MAXIMUM APPROXIMATELY ONE AND A HALF HOURS AFTER THE INITIAL ARRIVAL. TSUNAMI ARRIVAL TIMES AND OTHER AMPLITUDE FORECASTS ARE LISTED IN THE WEB SITE BELOW.

TIME - TIME OF MEASUREMENT

AMPL - TSUNAMI AMPLITUDES ARE MEASURED RELATIVE TO NORMAL SEA LEVEL.

IT IS ...NOT... CREST-TO-TROUGH WAVE HEIGHT.

VALUES ARE GIVEN IN BOTH METERS (M) AND FEET (FT).

PRELIMINARY EARTHQUAKE PARAMETERS

MAGNITUDE - 8.0

TIME - 0948 AKDT SEP 29 2009

1048 PDT SEP 29 2009

1748 UTC SEP 29 2009

LOCATION - 15.6 SOUTH 172.0 WEST

- SAMOA ISLANDS REGION

DEPTH - 21 MILES/33 KM

THE PACIFIC TSUNAMI WARNING CENTER IN EWA BEACH HAWAII CONTINUES ITS ADVISORY FOR HAWAII.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR THE WATER IS IMMINENT OR EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION IS NOT EXPECTED FOR AREAS UNDER AN ADVISORY. CURRENTS MAY BE HAZARDOUS TO SWIMMERS... BOATS... AND COASTAL STRUCTURES AND MAY CONTINUE FOR SEVERAL HOURS AFTER THE INITIAL WAVE ARRIVAL.

THIS MESSAGE WILL BE UPDATED IN 120 MINUTES OR SOONER IF THE SITUATION WARRANTS. THE TSUNAMI MESSAGE WILL REMAIN IN EFFECT UNTIL FURTHER NOTICE. REFER TO THE INTERNET SITE WCATWC.ARH.NOAA.GOV FOR MORE INFORMATION.

PZZ750-655-650-673-670-565-535-530-545-560-455-540-450-356-775-353-350-255-250-CAZ039>046-087-034-035-515-006-506-508-509-514-505-002-001-ORZ022-002-021-001-300658-
/O.CON.PAAQ.TS.Y.0008.000000T0000Z-000000T0000Z/

COASTAL AREAS BETWEEN AND INCLUDING THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER

928 PM PDT TUE SEP 29 2009

...A TSUNAMI ADVISORY IS IN EFFECT WHICH INCLUDES THE COASTAL AREAS OF CALIFORNIA AND OREGON FROM THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER...

PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR WATER IS IMMINENT OF EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION IS NOT EXPECTED FOR AREAS IN AN ADVISORY. TSUNAMIS ARE A SERIES OF

WAVES POTENTIALLY DANGEROUS SEVERAL HOURS AFTER INITIAL ARRIVAL
TIME. ESTIMATED TIMES OF INITIAL WAVE ARRIVAL FOR SELECTED
SITES IN THE ADVISORY ARE PROVIDED BELOW.

SANTA BARBARA-CA	2111	PDT	SEP	29	SAN FRANCISCO-CA	2131	PDT	SEP	29
LA JOLLA-CA	2116	PDT	SEP	29	CHARLESTON-OR	2132	PDT	SEP	29
CRESCENT CITY-CA	2120	PDT	SEP	29	SEASIDE-OR	2205	PDT	SEP	29

FOR ARRIVAL TIMES AT ADDITIONAL LOCATIONS SEE
WCATWC.ARH.NOAA.GOV

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WEPA41 PAAQ 300630

TSUWCA

BULLETIN

TSUNAMI MESSAGE NUMBER 8

NWS WEST COAST/ALASKA TSUNAMI WARNING CENTER PALMER AK

1130 PM PDT TUE SEP 29 2009

...A TSUNAMI ADVISORY IS IN EFFECT WHICH INCLUDES THE COASTAL AREAS OF CALIFORNIA AND OREGON FROM THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER...

...THIS MESSAGE IS INFORMATION ONLY FOR COASTAL AREAS OF WASHINGTON - BRITISH COLUMBIA AND ALASKA FROM THE OREGON-WASHINGTON BORDER TO ATTU ALASKA...

RECOMMENDED ACTIONS

A TSUNAMI HAS BEEN GENERATED WHICH COULD IMPACT THE ADVISORY REGIONs LISTED IN THE HEADLINE. PERSONS IN LOW-LYING COASTAL AREAS SHOULD BE ALERT TO INSTRUCTIONS FROM THEIR LOCAL EMERGENCY OFFICIALS. EVACUATIONS ARE ONLY ORDERED BY EMERGENCY RESPONSE AGENCIES.

- PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

THIS MESSAGE IS BASED ON EARTHQUAKE DATA... OBSERVED TSUNAMI AMPLITUDES... HISTORICAL INFORMATION AND FORECAST MODELS.

A TSUNAMI HAS BEEN OBSERVED AT THE FOLLOWING SITES

LOCATION	LAT	LON	TIME	AMPL
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EASTER ISLAND CHILE	27.1S	109.3W	0342UTC	0.25M/0.8FT
CHARLESTON OR	43.3N	124.3W	0528UTC	0.13M/0.4FT
PORT ORFORD OR	42.7N	124.5W	0509UTC	0.17M/0.6FT

SOUTH BEACH	OR	44.6N	124.0W	0545UTC	0.09M/0.3FT
SHEMYA	AK	52.7N	174.1E	0456UTC	0.10M/0.3FT
CRESCENT CITY	CA	41.7N	124.2W	0605UTC	0.21M/0.7FT
ARENA COVE	CA	38.9N	123.7W	0459UTC	0.33M/1.1FT
PORT SAN LUIS	CA	35.2N	120.8W	0531UTC	0.30M/1.0FT

THE TSUNAMI IS REACHING ITS MAXIMUM AMPLITUDE AT MANY LOCATIONS ALONG THE WEST COAST. EXPECTATIONS ARE FOR THE AMPLITUDE TO DECREASE OVER THE NEXT FEW HOURS. THE CENTER WILL CONTINUE TO MONITOR THIS EVENT UNTIL ALL POTENTIAL DANGER IS PASSED.

TIME - TIME OF MEASUREMENT

AMPL - TSUNAMI AMPLITUDES ARE MEASURED RELATIVE TO NORMAL SEA LEVEL.

IT IS ...NOT... CREST-TO-TROUGH WAVE HEIGHT.

VALUES ARE GIVEN IN BOTH METERS (M) AND FEET (FT).

PRELIMINARY EARTHQUAKE PARAMETERS

MAGNITUDE - 8.0

TIME - 0948 AKDT SEP 29 2009

1048 PDT SEP 29 2009

1748 UTC SEP 29 2009

LOCATION - 15.6 SOUTH 172.0 WEST

- SAMOA ISLANDS REGION

DEPTH - 21 MILES/33 KM

THE PACIFIC TSUNAMI WARNING CENTER IN EWA BEACH HAWAII WILL ISSUE MESSAGES FOR HAWAII AND OTHER AREAS OF THE PACIFIC OUTSIDE THE STATES AND PROVINCES LISTED ABOVE.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR THE WATER IS IMMINENT OR EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION IS NOT EXPECTED FOR AREAS UNDER AN ADVISORY. CURRENTS MAY BE

HAZARDOUS TO SWIMMERS... BOATS... AND COASTAL STRUCTURES AND MAY CONTINUE FOR SEVERAL HOURS AFTER THE INITIAL WAVE ARRIVAL.

THIS MESSAGE WILL BE UPDATED IN 120 MINUTES OR SOONER IF THE SITUATION WARRANTS. THE TSUNAMI MESSAGE WILL REMAIN IN EFFECT UNTIL FURTHER NOTICE. REFER TO THE INTERNET SITE WCATWC.ARH.NOAA.GOV FOR MORE INFORMATION.

PZZ750-655-650-673-670-565-535-530-545-560-455-540-450-356-775-353-350-255-250-CAZ039>046-087-034-035-515-006-506-508-509-514-505-002-001-ORZ022-002-021-001-300900-
/O.CON.PAAQ.TS.Y.0008.000000T0000Z-000000T0000Z/
COASTAL AREAS BETWEEN AND INCLUDING THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER
1130 PM PDT TUE SEP 29 2009

...A TSUNAMI ADVISORY IS IN EFFECT WHICH INCLUDES THE COASTAL AREAS OF CALIFORNIA AND OREGON FROM THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER...

PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR WATER IS IMMINENT OR EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION IS NOT EXPECTED FOR AREAS IN AN ADVISORY. TSUNAMIS ARE A SERIES OF WAVES POTENTIALLY DANGEROUS SEVERAL HOURS AFTER INITIAL ARRIVAL TIME.

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WEPA41 PAAQ 300828

TSUWCA

BULLETIN

TSUNAMI MESSAGE NUMBER 9

NWS WEST COAST/ALASKA TSUNAMI WARNING CENTER PALMER AK

128 AM PDT WED SEP 30 2009

...THE TSUNAMI ADVISORY IS CANCELED FOR THE COASTAL AREAS OF CALIFORNIA AND OREGON FROM THE CALIFORNIA-MEXICO BORDER TO THE OREGON-WASHINGTON BORDER...

EVALUATION

NO DESTRUCTIVE TSUNAMI THREAT EXISTS FOR ALASKA/ BRITISH COLUMBIA/
WASHINGTON/ OREGON OR CALIFORNIA. HOWEVER SOME AREAS MAY
EXPERIENCE NON-DAMAGING SEA LEVEL CHANGES. AS LOCAL CONDITIONS
CAN CAUSE A WIDE VARIATION IN TSUNAMI WAVE ACTION THE ALL
CLEAR DETERMINATIONS MUST BE MADE BY LOCAL AUTHORITIES.

A TSUNAMI HAS BEEN OBSERVED AT THE FOLLOWING SITES

LOCATION	LAT	LON	TIME	AMPL
-----	-----	-----	-----	-----
EASTER ISLAND CHILE	27.1S	109.3W	0342UTC	0.25M/0.8FT
CHARLESTON OR	43.3N	124.3W	0528UTC	0.13M/0.4FT
PORT ORFORD OR	42.7N	124.5W	0509UTC	0.17M/0.6FT
SOUTH BEACH OR	44.6N	124.0W	0545UTC	0.09M/0.3FT
SHEMYA AK	52.7N	174.1E	0456UTC	0.10M/0.3FT
CRESCENT CITY CA	41.7N	124.2W	0613UTC	0.21M/0.7FT
ARENA COVE CA	38.9N	123.7W	0459UTC	0.33M/1.1FT
PORT SAN LUIS CA	35.2N	120.8W	0531UTC	0.30M/1.0FT
SAN FRANCISCO CA	37.8N	122.5W	0529UTC	0.08M/0.3FT
MONTEREY HARBOR CA	36.6N	121.9W	0525UTC	0.15M/0.5FT

TIME - TIME OF MEASUREMENT

AMPL - TSUNAMI AMPLITUDES ARE MEASURED RELATIVE TO NORMAL SEA LEVEL.

IT IS ...NOT... CREST-TO-TROUGH WAVE HEIGHT.

VALUES ARE GIVEN IN BOTH METERS (M) AND FEET (FT) .

PRELIMINARY EARTHQUAKE PARAMETERS

MAGNITUDE - 8.0

TIME - 0948 AKDT SEP 29 2009

1048 PDT SEP 29 2009

1748 UTC SEP 29 2009

LOCATION - 15.6 SOUTH 172.0 WEST

- SAMOA ISLANDS REGION

DEPTH - 21 MILES/33 KM

THIS WILL BE THE LAST WEST COAST/ALASKA TSUNAMI WARNING
CENTER MESSAGE ISSUED FOR THIS EVENT.

THIS INFORMATION IS ALSO POSTED AT WCATWC.ARH.NOAA.GOV.

PZZ750-655-650-673-670-565-535-530-545-560-455-540-450-356-
775-353-350-255-250-CAZ039>046-087-034-035-515-006-506-508-
509-514-505-002-001-ORZ022-002-021-001-301028-
/O.CAN.PAAQ.TS.Y.0008.000000T0000Z-000000T0000Z/

COASTAL AREAS BETWEEN AND INCLUDING THE CALIFORNIA-MEXICO
BORDER TO THE OREGON-WASHINGTON BORDER

128 AM PDT WED SEP 30 2009

...THE TSUNAMI ADVISORY IS CANCELED FOR THE COASTAL AREAS
OF CALIFORNIA AND OREGON FROM THE CALIFORNIA-MEXICO BORDER
TO THE OREGON-WASHINGTON BORDER...\$\$