

California Tsunami Evacuation Playbook

City of San Clemente - Orange County

Playbook No. 2018-OC-06

DURING AN EMERGENCY, USE THE “QUICK REFERENCE” SHEET ON THE BACK PAGE (PAGE 18).

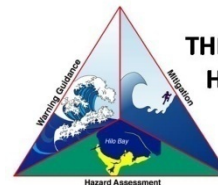
(For the expanded playbook analysis, use directions on Page 4)



California Tsunami Evacuation Playbook No. 2018-OC-06

California Geological Survey
California Governor's Office of Emergency Services
National Oceanic and Atmospheric Administration

Funded by the National Tsunami Hazard Mitigation Program



**THE NATIONAL TSUNAMI
HAZARD MITIGATION
PROGRAM (U.S.)**

DISCLAIMER: The State of California and its partners make no representation or warranties regarding the accuracy of this document and the maps within nor the data from which the maps were derived. Neither the State of California nor its partners shall be liable under any circumstances for any direct, indirect, special, incidental or consequential damages with respect to any claim by any user or any third party on account of or arising from the use of this document and its maps. In addition, the community is not responsible for the contents of this document.

Table of Contents – Tsunami Response Plan Playbooks

Page 2: Purpose and use of tsunami playbooks, and tsunami alert bulletins

Page 3: Tsunami alert bulletins and FASTER reference information

Page 4: Expanded real-time response reference page

Page 5: Tsunami evacuation/response “decision tree”

Page 6: Tsunami elevation-based evacuation playbook information

Page 7: Tsunami scenario-based evacuation playbook information

Pages 8-15: Tsunami elevation-based evacuation playbook plans and maps pages

Page 16-17: Notable historical tsunamis and state tsunami program modeling results

Page 18: APPENDIX – QUICK REFERENCE PAGE for real-time response activities

DURING AN EMERGENCY, USE THE “QUICK REFERENCE” ON PAGE 18 FOR GATHERING INFORMATION FOR RESPONSE ACTIVITIES.

PURPOSE: NOTE: Emergency managers should become familiar with this Playbook plan prior to use. The ultimate decision and responsibility for tsunami evacuation/response activities is up to community-level officials. A significant issue for emergency managers is that existing tsunami evacuation plans call for evacuation of the predetermined tsunami evacuation zone (typically at a 30- to 50-foot elevation) during a “Warning” level event; the alternative is to not call an evacuation at all. A solution to provide more detailed information has been the development of tsunami evacuation “Playbooks” to plan for tsunami scenarios of various sizes and source locations. NOAA-issued Tsunami Alert Bulletins received in advance of a distant event will contain a tsunami alert level, forecasted tsunami amplitude (or wave height) and arrival time for a number of locations along the coastline. Elevation-based “playbook” evacuation lines/zones can be useful for partial tsunami evacuations when information about forecasted tsunami amplitudes and arrival times is available to coastal communities and there is sufficient time to implement a partial evacuation. Provision for multiple elevation-based evacuation lines and response plans for those lines enables planning for different evacuation scenarios based on the forecast tsunami amplitude, potentially alleviating the need for an “all or nothing” decision with regard to evacuation.

USE: This playbook is designed to help the emergency managers with tsunami evacuation and response activities. First, it requires that the emergency manager become familiar with the information herein, especially the “Tsunami Response Decision Tree” (Page 5), the overall Playbook approach, and FASTER calculation (Page 3). When a distant-source tsunami is occurring, **fill out the information on Page 4 regarding the earthquake (magnitude, location) and tsunami (alert level, forecasted amplitude and arrival time).** Keep in mind that this information can change during the first hour or two after the earthquake occurs.

Use this information to determine which branch of the decision tree applies to the event. Refer to information on Pages 6 and 7 regarding the “Elevation-Based Evacuation Playbook,” the “Scenario-Based Evacuation Playbook,” and the FASTER calculation value. If there is sufficient time, FASTER will be calculated and provided to each community by the state, county or regional NOAA Weather Forecast Office. If there is sufficient time, the state or NOAA will also provide a recommendation on which tsunami “playbook” phase plan for each community to use. Each scenario-based Playbook will be accompanied by a digital file identifying the full evacuation zone for a community. This file should be referenced and used during an event. Communities may wish to use these maps to establish “reverse 911” calling areas.

Tsunami Alert Bulletins: During the typical tsunami alert, the Warning Center provides information about the tsunami in “bulletins” to the state and local jurisdictions. There are four levels of “alert” that can be sent by the NTWC (from least to greatest significance):

Tsunami Information Statement - Issued to inform and update emergency managers and the public that an earthquake has occurred, or that a tsunami Watch, Advisory or Warning has been issued elsewhere in the ocean.

Tsunami Watch - Issued to alert emergency managers and the public of an event which may later impact the Watch area. May be upgraded to an Advisory or Warning - or canceled - based on updated information and analysis.

Tsunami Advisory - Issued due to the threat of a tsunami which may produce strong currents or waves dangerous to those in or near the water; typically called when forecasted tsunami amplitudes are between 0.3m and 1m (1ft and 3ft) above existing tidal conditions are expected. Coastal communities are advised that beach and harbor areas could expect rapid, moderate tidal changes and strong currents.

Tsunami Warning - Issued when a tsunami with significant widespread inundation is imminent or expected; typically called when forecasted tsunami amplitudes are equal to or greater than 1m (3ft). Coastal communities are advised to evacuate people from low-lying areas identified as vulnerable to tsunamis.

FASTER Analytical Tool: To determine the full impact of the tsunami, other variables such as tidal and storm conditions must be considered. An analytical method has been created which incorporates important variables that will impact the ultimate tsunami flood level. The FASTER calculation will be made by the regional NOAA NWS Weather Forecast Office for each community during a tsunami event; it is used to help determine which “phase” evacuation/response playbook plan should be used. **NOAA and/or the state will recommend which particular phase evacuation plan should be used by each community, and transmit that information to the communities prior to the tsunami’s arrival.** Communities themselves can also use the FASTER value to match which phase playbook plan to use. The simplified components of the calculation are shown to the right.

**Working example: Formula for determining
playbook evacuation line to use (FA-S-T-E-R):**

$$\begin{aligned} & \text{FA: } \underline{\text{Forecasted Amplitude (Wave Height)}} \text{ from} \\ & \qquad \qquad \qquad \text{Warning Center} \\ & \qquad \qquad \qquad + \\ & \text{S: } \underline{\text{Storm}} \text{ surge or existing ocean conditions} \\ & \qquad \qquad \qquad + \\ & \text{T: Maximum } \underline{\text{tidal}} \text{ height (first 5 hours of tsunami)} \\ & \qquad \qquad \qquad + \\ & \text{E: Forecast } \underline{\text{error}} \text{ potential (30\%; analysis of 2010-11 events)} \\ & \qquad \qquad \qquad + \\ & \text{R: Site amplified } \underline{\text{run-up}} \text{ potential (from existing modeling,} \\ & \qquad \qquad \qquad \text{unique to each location; applied if inundation expected)} \\ & \qquad \qquad \qquad \text{-----} \\ & = \text{ Maximum tsunami run-up height} \\ & \qquad \qquad \qquad = \text{ Playbook elevation line} \end{aligned}$$

Expanded and Enhanced Reference Information for Determining Real-Time Tsunami Response Activities

NOTE: Tsunami response activities are the responsibility of the coastal community. It is important to review all sections of this Playbook prior to using it during a tsunami emergency. When a tsunami alert is issued by the National Tsunami Warning Center, fill out the Expanded Reference page below under Step 1 and follow steps on the right side of the page to determine response activities. If there is sufficient time, to help reduce confusion the state/NOAA will provide information on recommended “Phase” evacuation and response plans to use based on the FASTER tsunami flood level value calculated for each community.

Step 1: Obtain information about earthquake and tsunami from National Tsunami Warning Center in Alaska, regional NOAA-Weather Forecast Office, and/or county emergency manager. The explanation of the FASTER calculation is provided on Page 3. **FASTER value will be calculated and provided to the emergency manager;** it is used to determine which Playbook scenario to use.

Earthquake location _____

Earthquake magnitude _____

Tsunami Alert level (circle one) WATCH ADVISORY WARNING

Forecasted tsunami amplitude/wave height _____

Forecasted tsunami arrival time _____

Calculate/obtain FASTER tsunami run-up value in first 5 hours: _____

Calculate/obtain FASTER tsunami run-up value at highest tide _____

Other general information regarding tidal, storm, and other ambient conditions: _____

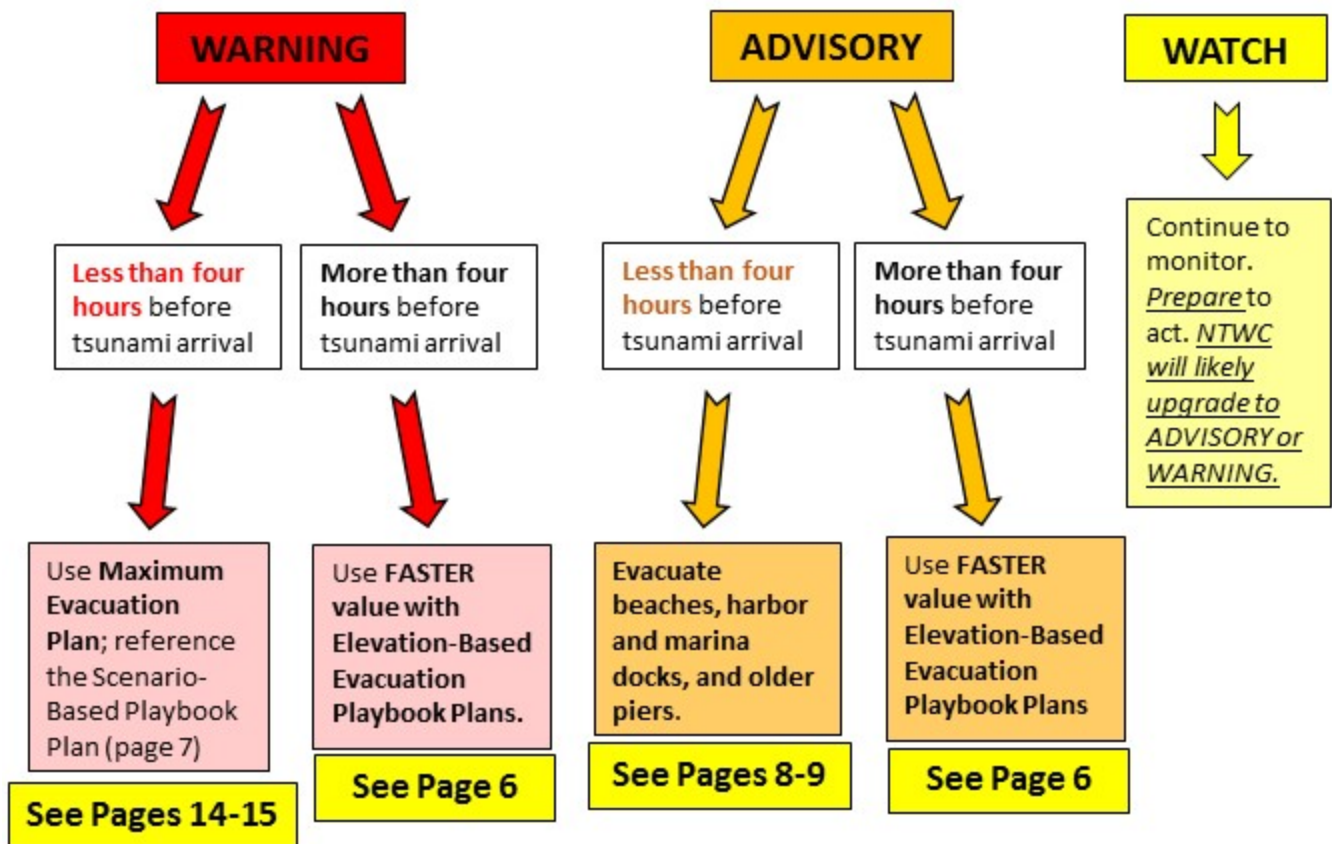
Step 2: Compare the information from Step 1 to the **Tsunami Response Decision Tree** on the right. Select the decision tree branch that best fits the forecast tsunami information.

Step 3: Go to Page 6 or 7 “Playbook” reference pages and utilize the appropriate Playbook or strategy for evacuation and response. Refer to the table on Page 6 to see which pages to related to a particular tsunami “phase” evacuation and response. The particular “phase” plan will be provided as a recommendation by the state/NOAA when a tsunami Advisory or Warning is issued.

A set of digital evacuation maps and response instructions will accompany each of the Elevation-based Evacuation Playbook plans. These files can be used to develop “reverse 911” calling areas prior to the event.

Tsunami Response Decision Tree

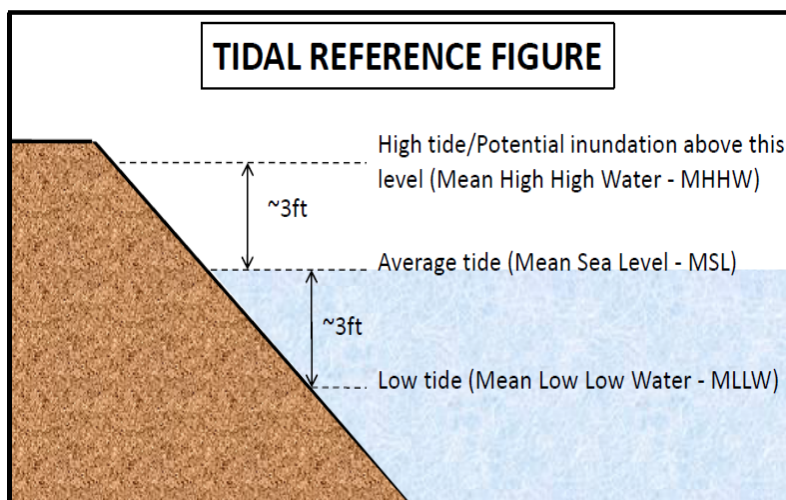
Users should reference information from Step 1 on page 4 regarding the potential tsunami event, including source location, magnitude, FASTER tsunami height number, arrival time, and Alert Level as listed. The following decision tree is guidance for community evacuation planning. Ultimately, each community is responsible for determining and carrying out the appropriate tsunami response activities.



Elevation-Based Evacuation Playbook

NOTE: The ultimate decision and responsibility for tsunami evacuation/ response activities is the community emergency manager. The table below shows the appropriate tsunami elevation-based evacuation playbook response plan for the resulting FASTER tsunami flood level number. **Once the FASTER value is calculated for each community, it will be used by the state and NOAA to recommend a specific playbook phase plan to use.** For example, if the FASTER number is 1.3m, the state/NOAA will recommend as an option that the community could use the Phase 2 Evacuation Plan provided on pages 10-11.

Evacuation Playbook Reference Pages	Recommended Community Action	Associated FASTER Tsunami Flood Level Number (in METERS above Mean Sea Level)	Associated FASTER Tsunami Flood Level Number (in FEET above Mean Sea Level)	Anticipated Associated NOAA Tsunami Alert Level	Tsunami height compared to other tidal reference points (see TIDAL REFERENCE FIGURE)	
					Tsunami flood level above high tide line - MHHW (flow depth above low-lying dry land)	Tsunami flood level above low tide conditions (Mean Low Low Water - MLLW)
Pages 8-9	Phase 1 Evacuation	less than 1.00m	less than 3.3ft	Advisory	none (less than 0 ft)	0 ft to 6ft
Pages 10-11	Phase 2 Evacuation	1.00m to 1.50m	3.3ft to 5.0ft	Advisory or Warning	0 ft to 1.7ft	6ft to 7.7ft
Pages 12-13	Phase 3 Evacuation	1.50m to 2.50m	5.0ft to 8.2ft	Warning	1.7ft to 5.0ft	7.7ft to 11.0ft
Pages 14-15	Maximum Evacuation Phase	more than 2.50m	more than 8.2ft	Warning	more than 5.0ft	more than 11.0ft



NOTE FOR TABLE ABOVE: Use only locally enhanced FASTER numbers coming from the state or your regional NWS office to implement actions on this page. The NTWC forecast amplitude/wave height should not be referenced here as it does not include tides, storms, or other factors contributing to flood potential.

Scenario-Based Evacuation Playbook

NOTE: The ultimate decision and responsibility for tsunami evacuation/ response activities is the community emergency manager. Scenario-based tsunami playbooks and guidance have been developed for maximum local and distant tsunamis, and for tsunamis coming from the Cascadia Subduction Zone toward central and southern California. Scenario playbook information about the expected tsunami amplitude, tsunami travel time, and map of source regions is available from the numerical modeling results for these sources (Page 17). These are important scenarios for emergency managers to prepare for as there could only be tens of minutes to evacuate or just a few hours to conduct response or evacuation activities before the tsunami arrives. Because of the short time for making response decisions, the following evacuation and response plans are recommended for all of Orange County:

Scenarios with short tsunami arrival times	Shortest tsunami travel time to Orange County after earthquake	Suggested Scenerio Playbook Response Plan
Local coastal earthquake >M6.5	10-15 minutes	Maximum Phase Evacuation
Cascadia subuduction zone >M8.5	2 hours	Phase 2 Elevation Playbook
Alaska or Aleutians subduction zone >M8.5	6 hours	Maximum Phase Evacuation

Phase 1 Evacuation Plan

Background Information:

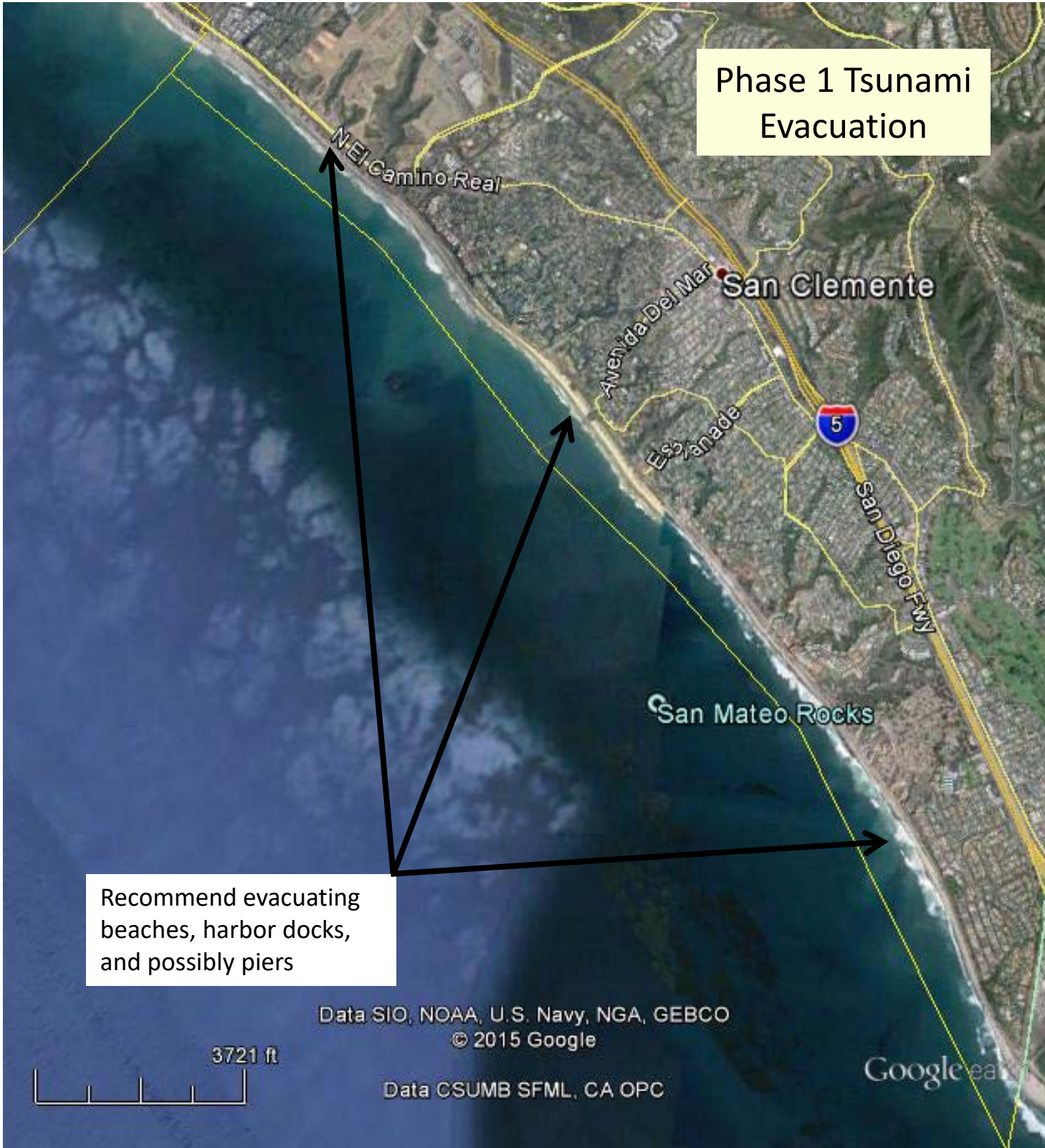
Alert level = Advisory

FASTER tsunami value = less than 1.0m (3.3 ft)

Specific Instructions:

- Follow general guidance for Advisory-level tsunamis (Page 3)
- Evacuate beaches, harbor docks and boats, and possibly piers (depending on the stability and age of the pier). Strong currents and potential scour may be expected in harbors.
- A digital file showing evacuation maps and response instructions is available for use.
- Specific evacuation and response instructions..... (completed with the community input)

Phase 1 Tsunami Evacuation



Recommend evacuating beaches, harbor docks, and possibly piers

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2015 Google

Data CSUMB SFML, CA OPC

Google Earth

Phase 2 Evacuation Plan

Background Information:

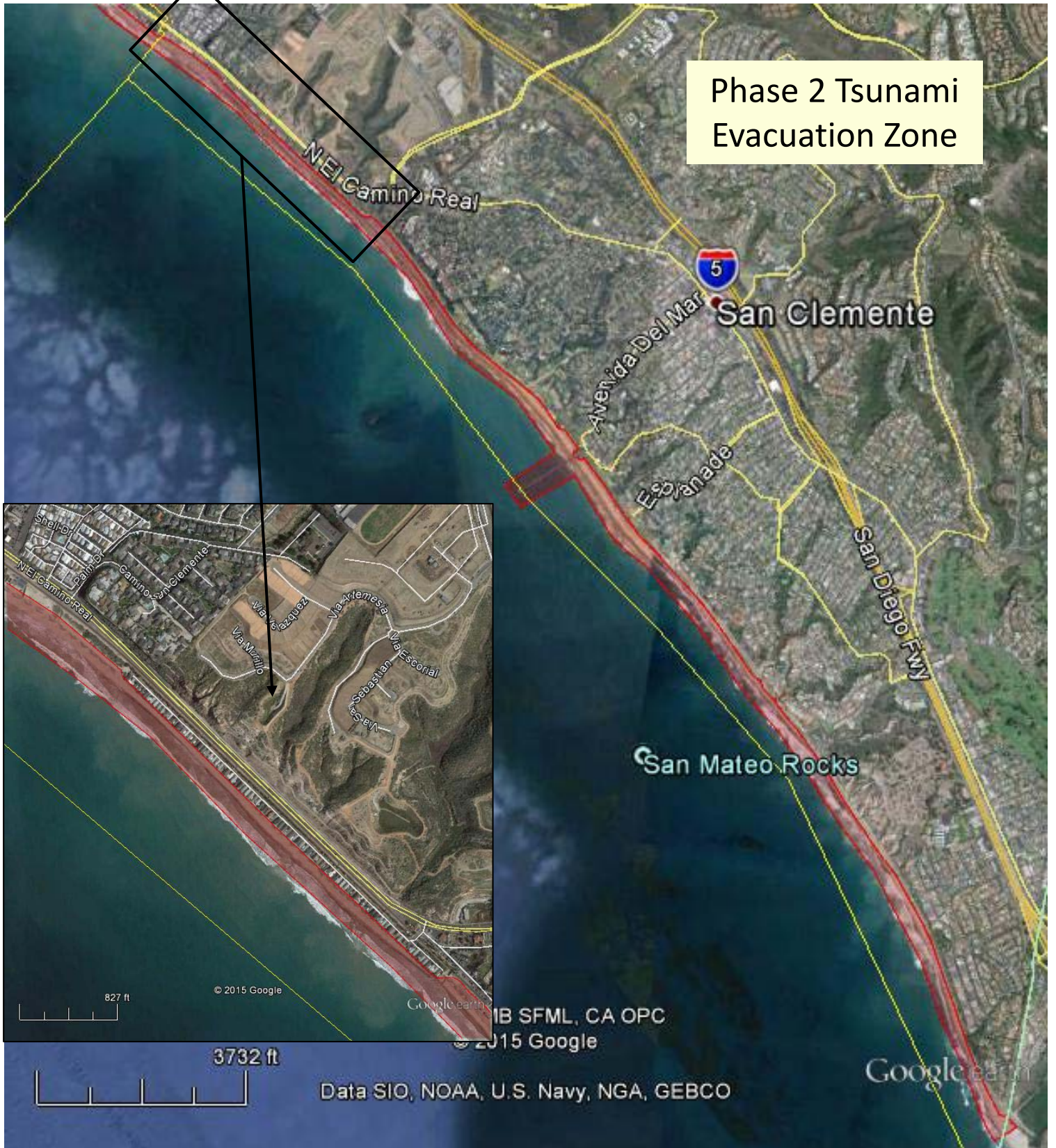
Alert level = Warning

FASTER tsunami value = between 1.0m (3.3 ft) and 1.5m (5.0ft)

Specific Instructions:

- Follow general guidance for Warning-level tsunamis (Page 3)
- Evacuate areas outlined by the red line, including beaches, piers, and harbor docks and boats. Strong currents and potential scour may be expected in harbors.
- A digital file showing evacuation maps and response instructions is available for use.
- Specific evacuation and response instructions..... (completed with the community input)

Phase 2 Tsunami Evacuation Zone



Phase 3 Evacuation Plan

Background Information:

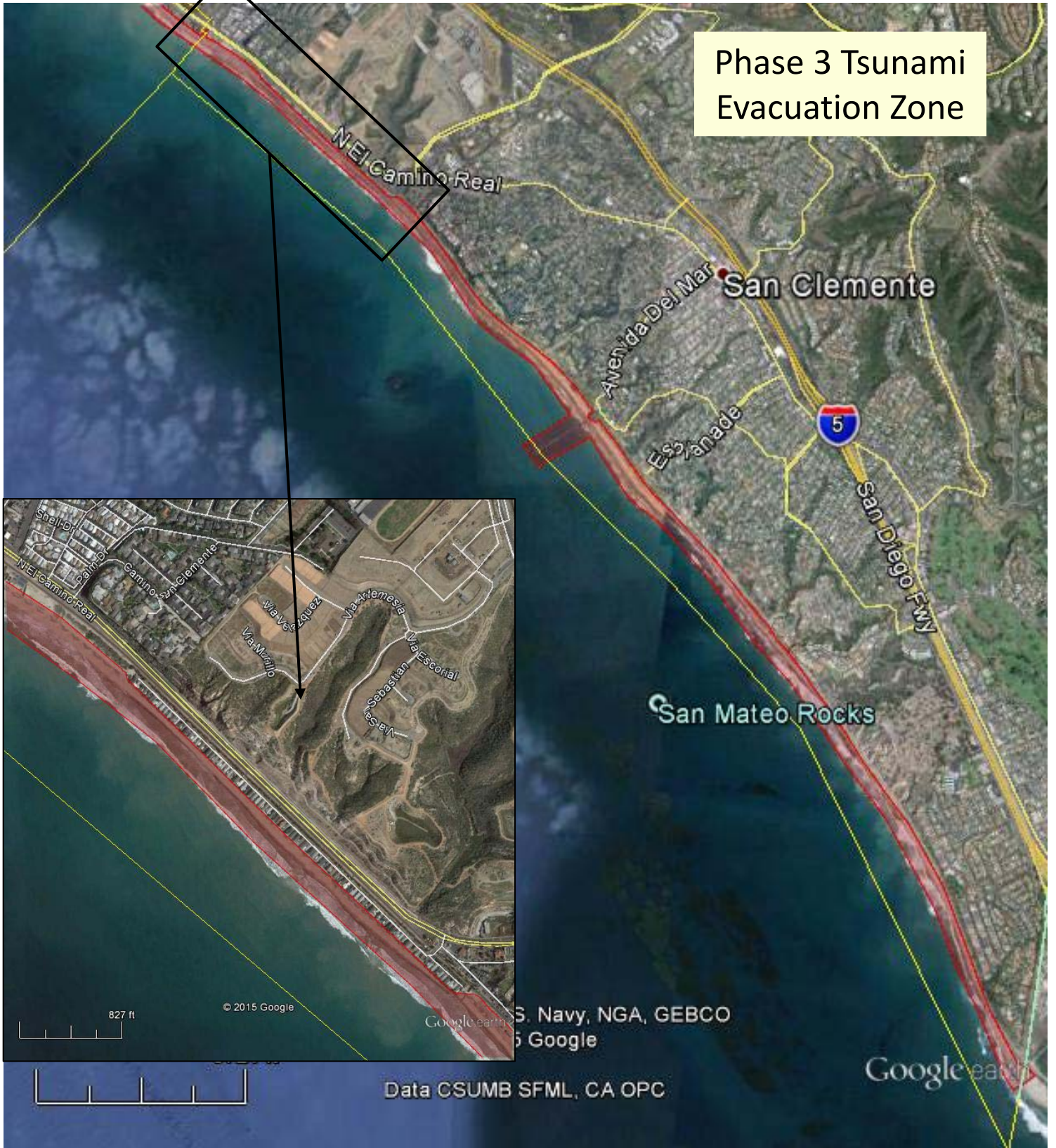
Alert level = Warning

FASTER tsunami value = between 1.5m (5.0ft) and 2.5m (8.2ft)

Specific Instructions:

- Follow general guidance for Warning-level tsunamis (Page 3)
- Evacuate areas outlined by the red line, including beaches, piers, and harbor docks and boats. Strong currents and potential scour may be expected in harbors.
- A digital file showing evacuation maps and response instructions is available for use.
- Specific evacuation and response instructions..... (completed with the community input)

Phase 3 Tsunami Evacuation Zone



Maximum Phase Evacuation

Background Information:

Alert level = Warning

FASTER tsunami value = greater than 2.5m (8.2ft)

Specific Instructions:

- Follow general guidance for Warning-level tsunamis (Page 3)
- Evacuate areas outlined by the red line (the maximum tsunami evacuation zone), including beaches, piers, and harbor docks and boats. Strong currents and potential scour may be expected in harbors.
- A digital file showing evacuation maps and response instructions is available for use.
- Specific evacuation and response instructions..... (completed with the community input)



Notable Historical Tsunamis: The following table provides very basic information about historical tsunami events; not all tsunamis are represented, especially minor or small tsunamis. Note that the largest, most damaging tsunamis in Orange County history have come from large earthquakes in the Alaska-Aleutian Islands and Chile regions as distant tsunami sources and potential offshore faults or submarine landslide as local sources. Although the potential for local tsunamis exists, they are much less frequent than distant source tsunamis.

Notable Historical Tsunamis in Orange County

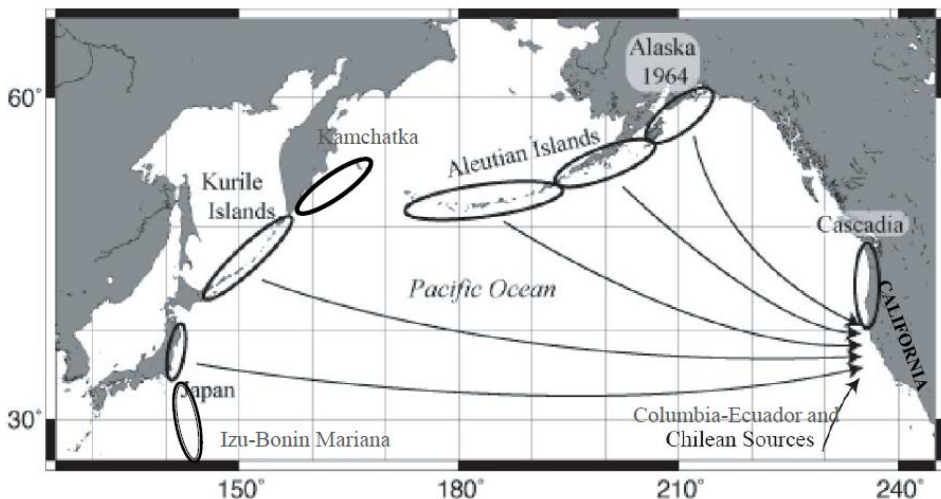
Run-up amplitude, in feet, above normal tide conditions

OBS = observed tsunami activity
NR = No damage or severe conditions reported

- Distant Source -
Tsunamis without felt earthquakes

- Local Source -
Earthquake and tsunami together

Date	Magnitude-Source area	Tsunami location	Run-Up/Amp	Remarks
7/10/1855	multiple local earthquakes	Dana Point	OBS	"...considerable commotion in the water, attended by a strong rushing sound..."
4/1/1946	M8.8 – Aleutian Islands	Newport Beach	1 ft	"...furious eddy between Balboa and Little Island..."
3/9/1957	M8.6 - Aleutian Islands	Newport Beach	1 ft	NR
5/22/1960	M9.5 - Chile	Alamitos Bay	2 ft	NR
		Dana Point	3 ft	cabin cruiser sunk
3/28/1964	M9.2 – Alaska	Alamitos Bay	1 ft	NR
		Newport Beach	1 ft	NR
2/27/2010	M8.8 – Chile	Huntington Beach	2 ft	NR
		Newport Beach	2 ft	NR
		Dana Point	2 ft	Bait barge severed
3/11/2011	M9.0 - Japan	Huntington Beach	2 ft	Boat pulled off mooring
		Newport Beach	1 ft	NR
		Dana Point	2 ft	Pylon damaged when hit by boat

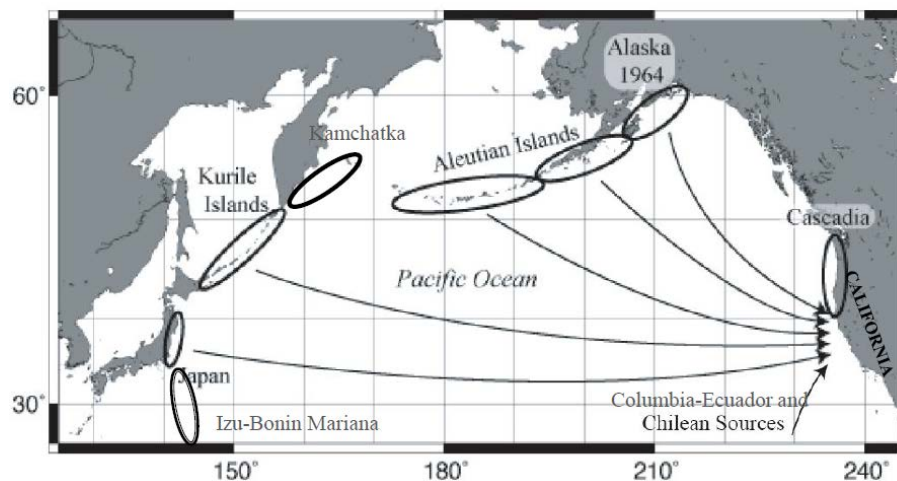


Modeled Tsunami Scenarios: Because very large tsunamis are infrequent and the likelihood that the largest potential tsunamis have not yet occurred in Orange County, the state tsunami program developed a suite of maximum credible tsunami scenarios as part of their tsunami inundation mapping project for local evacuation planning. The general tsunami wave height for key locations from these scenarios are provided below. As identified in the historical tsunami table, the largest tsunamis could occur from large earthquakes in the Alaska-Aleutian Islands or Chile regions, or from a large offshore fault or submarine landslide.

Tsunami Source Scenario Model Results for Orange County

Near shore tsunami heights (flow depths) for both local and distant source scenarios, in FEET above Mean Sea Level. NOTE: The projections do not include any adjustments for ambient conditions, such as storm surge and tidal fluctuations, and model error (it is very important to note this difference, as those numbers can increase the projected water height during an event).

	Tsunami Sources	Approximate Travel Time	Seal Beach	Seal B. Naval Harbor	Sunset Beach	Hunt Beach	Newport Beach	Crystal Cove	Laguna Beach	Aliso Beach	Dana Point	San Clemente
Local Sources	M7 Newport-Inglewood Fault	10-15min	2	3	3	2	2	2				
	M7.1 San Mateo Thrust Fault	10-15min								7	13	16
	M7.1 Oceanside Thrust Fault	15-20min								6	4	
	Palos Verdes Landslide 1	15-20min	5	5	10	10	3	3				
	Palos Verdes Landslide 2	15-20min	5	5	13	11	3	3	3	3		
	M7.7 Catalina Fault	20-30min	8	8	7	11	13	11	10	7	7	7
Distant Sources	M9 Cascadia-full rupture	2hr	4	4	3	3				3	3	3
	M9.2 Alaska 1964 EQ	6hr	10	6	6	6	3	4	4	4	6	5
	M8.9 Central Aleutians I	6hr	5	5	4	4				3	4	4
	M8.9 Central Aleutians II	6hr	3	3	3	3				3	3	3
	M9.2 Central Aleutians III	6hr	14	10	9	9	6	6	6	7	8	6
	M9 Kamchatka 1952 EQ	9hr								3		3
	M8.8 Kuril Islands II	10hr	2	3	2	2				2	3	2
	M8.8 Kuril Islands III	10hr	2	3	2	2				2	3	2
	M8.8 Kuril Islands IV	10hr	3	3	2	2				2	3	2
	M8.8 Japan II	11hr	3	3	3	2				2	3	2
	M9.5 Chile 1960 EQ	13hr	10	5	5	5	3	3	3	3	4	4
	M9.4 Chile North	13hr	10	6	7	8	4	4	4	4	4	4
	Maximum Runup - Local Source		9	9	14	12	14	12	11	8	15	17
	Maximum Runup - Distant Source		15	11	10	10	7	7	7	8	10	8



APPENDIX

Quick Reference Page for Determining Real-Time Tsunami Response Activities

Step 1: Obtain basic information about the earthquake and tsunami from National Tsunami Warning Center in Alaska, regional National Weather Service office, and/or county emergency manager. **NOTE: Tsunami Alert Level may change in first 2 to 3 hours after the earthquake; WATCH may be upgraded to ADVISORY or WARNING.**

Earthquake location _____

Earthquake magnitude _____

Tsunami Alert level (circle one) WATCH ADVISORY WARNING

Closest forecasted tsunami amplitude/wave height _____

Forecasted tsunami arrival time _____

Recommended community playbook evacuation zone phase plan _____

Calculated FASTER tsunami flood level number (if needed) _____

Step 2: Tsunami evacuation and response will depend on the amount of time before the tsunami arrival. Four (4) hours is considered the threshold time needed for evacuation. As a quick reference, we offer the following guidance:

1) If less than four hours before tsunami arrival, we recommend the following:

- ADVISORY – evacuate beaches, harbor docks, and piers
- WARNING – evacuate entire maximum evacuation zone

2) If greater than four hours before tsunami arrival, and your community has fully developed its tsunami playbooks plans, communities can utilize the tsunami elevation-based evacuation playbook “phase” plan recommended by the state and/or NOAA given sufficient time for them to provide this information. Use the table on the right to identify the page numbers for the appropriate phase plan.

Evacuation Playbook Reference Pages	Recommended Community Action
Pages 8-9	Phase 1 Evacuation
Pages 10-11	Phase 2 Evacuation
Pages 12-13	Phase 3 Evacuation
Pages 14-15	Maximum Evacuation Phase