Rational Evacuation Planning
For a
Near-source tsunami
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Figure 1. Map of fault uplift and subsidence showing Scenario 1A and Scenario 1A with 4.5-meter Washington asperity added. Scenario 1A shows time histories of modeled waves at various locations along the coast.

Figure 2. (next three pages) Time histories of the modeled waves at twelve localities immediately offshore of key communities, identified by community name and map number (in circle). These time histories give the change in water surface elevation with time for 6 hours of modeling.
Note the long peninsulas or spits of low-lying ground. Ocean Shores peninsula is 7 miles long and Long Beach peninsula is 20 miles long with little or no high ground over those distances.
A typical time history of the modeled tsunami for the Washington coast. Note that significant flooding is expected within 30 minutes of earthquake.
1 m/sec ~ 2 mph
WHAT IS A TSUNAMI?
A tsunami is a series of waves most commonly caused by an earthquake beneath the sea floor. As tsunamis enter shallow water near land, they increase in height and can cause great loss of life and property damage where they come ashore.
Recent research suggests that tsunamis may strike the Washington coast on a regular basis. They can occur at any time of the day or night, under any and all weather conditions, and in all seasons. Beaches open to the ocean, bay entrances, tidal flats, and coastal rivers are especially vulnerable to tsunamis.

WHAT IS THE DIFFERENCE BETWEEN A ‘DISTANT’ AND A ‘LOCAL’ TSUNAMI?
When a tsunami has been generated by a distant earthquake, it will not reach the Washington coast for several hours, and there is time to issue a warning. When a tsunami is generated by a strong offshore earthquake, its first waves would reach the outer coast minutes after the ground stops shaking. Feeling an earthquake could be your only warning!

WHAT CAN I DO TO PROTECT MYSELF FROM A TSUNAMI?
- Develop a family disaster plan. Everyone needs to know what to do on their own to protect themselves in case of disaster.
- Be familiar with local earthquake and tsunami plans. Know where to go to survive a tsunami. Identify an evacuation site within 15 minutes walking distance of home or work.
- Prepare three-day emergency kits for your home, automobile, and work.
- Take a first aid course and learn survival skills. Knowledge is your greatest defense against potential disaster.

HOW DO I KNOW WHEN TO EVACUATE?
If you feel the ground shake, evacuate inland or to high ground immediately! A wave as high as 30 feet could reach the Ocean Park area within 30 minutes of the quake. The first wave is often not the largest; successive waves may be spaced many minutes apart and continue to arrive for several hours. Return only after emergency officials say it is safe.
Isolated areas may not receive official warning of distant tsunamis. If you notice a sudden drop or rise in sea level, move to high ground or inland immediately.

WHERE DO I EVACUATE TO?
The map shows tsunami hazard areas (yellow) and areas of higher ground (green). Go to the nearest high ground—at least 50 feet above sea level, if possible. If you don’t have time to travel to high ground, but are in a multi-story building, go to an upper level.
If you are on the beach and unable to get to high ground, go inland as far as you can.

WHAT DO THE EVACUATION SIGNS MEAN?
Tsunami evacuation routes were developed to guide coastal residents and visitors to safer locations when car evacuation is possible. Evacuation signs have been placed along the main roads to direct motorists to higher ground. In some places, there may be more than one way to reach safer areas. These routes are marked with multiple signs showing additional options for evacuation. You will need to know the evacuation routes for your area.
WHAT IS A TSUNAMI?
A tsunami is a series of waves most commonly caused by an earthquake beneath the sea floor. As tsunamis enter shallow water near land, they increase in height and can cause great local inland damage.

WHAT TO DO TO PREVENT DAMAGE:
- Build tsunami-resistant structures.
- Avoid areas with lowlying terrain.
- Stay away from coastal areas.
- Use high ground.
- Evacuate tsunami zones.

WHAT TO DO IF A TSUNAMI OCCURS:
- Listen to public announcements.
- Evacuate immediately.
- Go to high ground or strong shelter.
- Do not return home until you are told it is safe.

WHERE TO GO?
- The nearest high ground or strong shelter.
- The nearest higher ground.
- The nearest strong building.

THE RIGHT WAY TO RUN:
- Do not run towards the sea.
- Do not run into buildings.
- Do not run onto roads.
- Do not run into water.

LEGEND
- Tsunami hazard zone—greatest risk
- Tsunami hazard zone—marginal risk
- Higher ground
- Evacuation route
- Assembly area
Initially, the city of Aberdeen laid out vehicle evacuation routes and assembly areas only.
After exercising the plan, they realized that for many people, particularly school children, only a foot evacuation is feasible.
SJDF propagation (1:00)
SJDF propagation (1:30)
SJDF propagation (2:00)
SJDF propagation (2:30)
SJDF propagation (3:00)
SJDF propagation (3:30)
SJDF propagation (4:00)
Tsunami hazard map for the Bellingham area
This map shows expected PGA from the soil type B-C interface from a M9.1 Cascadia subduction zone earthquake (from Mark Peterson, U.S.G.S.). This was the ground motion input for the CREW Hazus scenario.
Significant damage to roads, bridges and Cascade passes from Northern California to Northern Vancouver Island

Each blue dot represents a bridge that is out of service three days after the earthquake. This is only one possible outcome, not a listing of all bridges that will be damaged. The effects of liquefaction or tsunamis, either of which could create more damage at a specific site, were not included. Segments shown in green would likely be functional.

The importance of the map is in recognizing the pattern of widespread damage along the major transportation corridors of Hwy 101, I-5, Hwy 99, and across the Coast Range. This pattern can be applied to other types of structures in those areas. Including tall buildings and long power lines and pipelines.
Whatcom County proposed evacuation routes and assembly areas by vehicle over circuitous routes more than three miles long and over areas of liquefiable soils and steep slopes, even though such routes are unlikely to be available after a great earthquake.
Proposed Solution

We have proposed, and the governor has included it in her proposed budget for the next several years, that we produce detailed maps of earthquake-induced ground failures in tsunami inundation zones to force rational planning for earthquake collateral damage in tsunami evacuation planning.