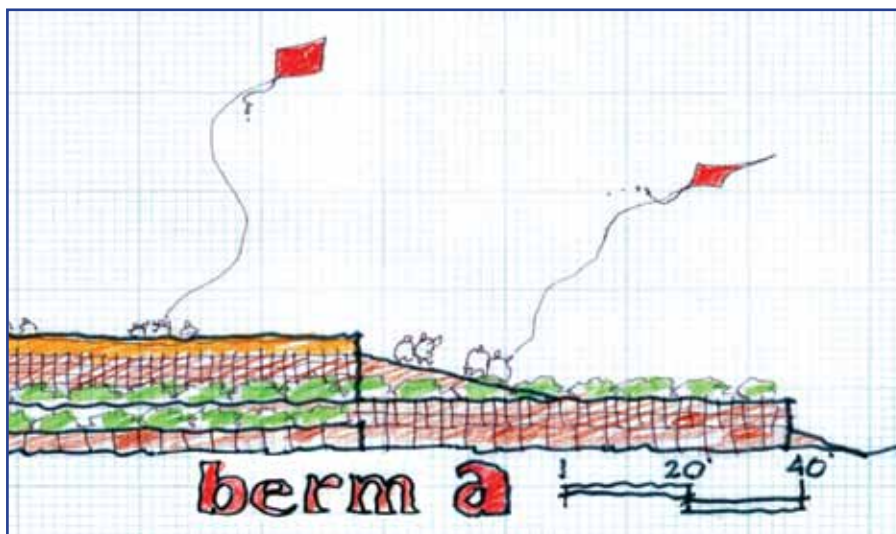
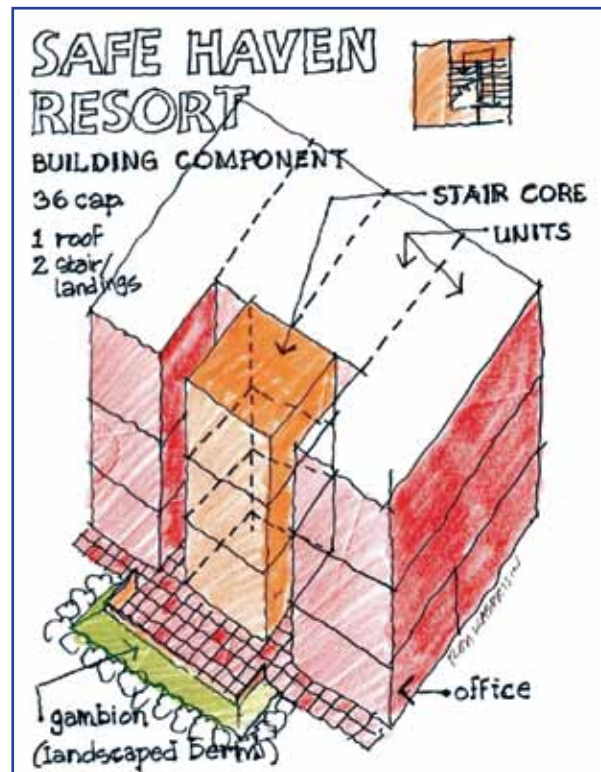
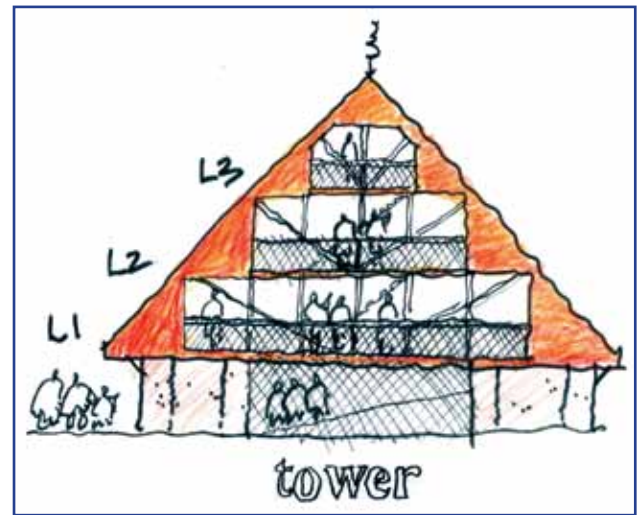
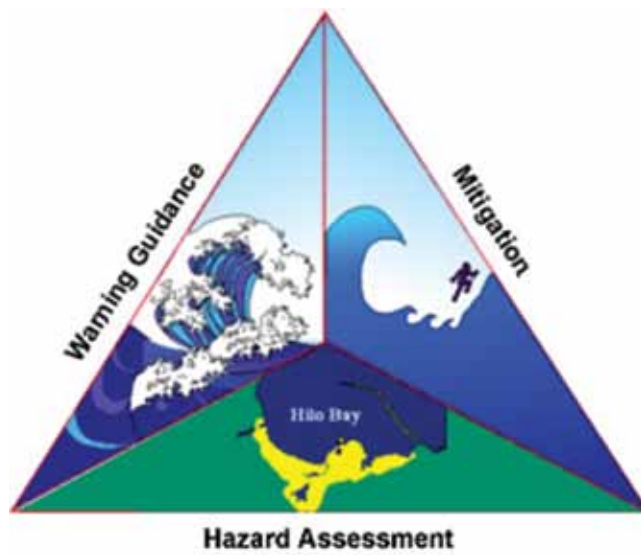


PROJECT SAFE HAVEN:

TSUNAMI VERTICAL EVACUATION ON THE WASHINGTON COAST



*Pacific
County*



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THE NATIONAL TSUNAMI HAZARD MITIGATION PROGRAM**

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1. EXECUTIVE SUMMARY

A magnitude 9+ Cascadia earthquake and tsunami — last experienced in 1700 AD — will endanger the low-lying communities along the Washington coast. The Long Beach and Tokeland peninsulas' vulnerability to a tsunami combined with the difficulty of typical horizontal evacuation spurred interest in alternative evacuation methods. Students from the University of Washington, with support from county and state emergency management officials, created a community-driven process to identify potential locations for vertical evacuation. This project addressed four coastal communities in Pacific County: Long Beach, Ilwaco/Seaview, Ocean Park, and Tokeland/North Cove. In the future, the project team will work with additional Washington coastal counties.

This report outlines the process, strategies, and scientific data used by the team for the project.

Project Safe Haven, a grassroots process to develop ideas and strategies about vertical evacuation, is the first of its kind. The project team adopted a six-phase methodology to accomplish its task.

1. A Steering Committee composed of local and state officials, emergency managers, and scientists was created to guide the project.
2. A team site visit to each community helped to identify opportunities for, and barriers to, potential vertical evacuation projects.
3. Community ideas and comments were solicited at the first public meeting, using World Café methodology. Community members were encouraged to discuss the possible strengths and weaknesses of the three vertical evacuation options: berms, towers, and buildings. Meeting participants used interactive hazard maps to discuss conceptual locations for the structures, and the pros and cons of each structure type.
4. The project team translated community members' ideas into three alternatives. At a second meeting, these were presented back to the participants, using maps and text. The strengths and weaknesses of each alternative were discussed. Ultimately, a preferred strategy emerged for each community.
5. Once each community developed a preferred strategy, the fifth phase was to conduct two communitywide meetings, one in Tokeland and one in Seaview, to present the final strategy. Each meeting was widely publicized and open to the public. The meetings allowed community members one more chance to reassess the final strategies. At each meeting, all four local strategies were presented to allow review for comprehensiveness, redundancy, and coordination of efforts.
6. A design team was introduced to the local communities to conduct intensive design charrettes to identify opportunities presented by the proposed vertical evacuation strategy. Identification of specific structure locations and how the structures will best fit into the contexts of the communities were discussed. Potential day-to-day uses for each vertical evacuation structure at each proposed site were incorporated into the overall vertical evacuation strategy and presented back to the community as hand-drawn conceptual designs.
7. The final version of the Pacific County preferred strategy includes:
 - 13 berms
 - 5 towers
 - 2 parking garages
 - 6 identified areas of high ground
 - 10 existing Pacific County assembly areas.
8. Construction costs for 20 facilities offering tsunami safe havens for 6,300 residents through the construction of 13 berms, 5 towers, and 2 buildings could be in the neighborhood of \$11 million.

2. PROJECT SAFE HAVEN: PACIFIC COUNTY

The Long Beach Peninsula and Tokeland Peninsula communities on the Washington coast lack natural high ground and sit within close proximity to the Cascadia subduction zone. This makes the communities vulnerable to significant damage from a tsunami triggered by a Cascadia subduction zone earthquake (see Figure 1). The goal of Project Safe Haven is to determine vertical evacuation options for the coastal communities of Pacific County through a grassroots, public process. Vertical evacuation allows residents and visitors to move upwards to safety and is particularly important on the peninsulas where traditional evacuation measures are not feasible. This report documents the methodology and results from the project's work within Long Beach, Ilwaco/Seaview, Ocean Park, and Tokeland/North Cove. In the sections below, the report provides a profile of the hazard, an overview of the four communities, the process to develop and refine vertical evacuation strategies for Pacific County, conceptual designs of vertical evacuation structures and descriptions and assessments of the preferred strategies.



Figure 1: Pacific County context map

3. BACKGROUND

A. HAZARD PROFILE AND MODELED SCENARIO

A tsunami is a series of sea waves, commonly caused by an undersea earthquake. Pacific County is vulnerable to two types of tsunamis:

- Those created by a *distant* seismic event (such as an earthquake near Japan).
- Those created by a *local*, offshore earthquake.

After a *distant* earthquake, Pacific County may be far enough from the epicenter so that there is no damage to evacuation infrastructure, such as roadways. A distant tsunami will not reach Pacific County for several hours. Residents will have time to receive warning from the AHAB (all-hazards alert broadcast) system and evacuate by car, using standard tsunami evacuation routes to Pacific County assembly areas.

A *local* earthquake, however, will cause tremendous destruction and leave little time for people to evacuate to high ground before the subsequent tsunami waves arrive. This short timeframe and lack of natural high ground requires the development of a vertical evacuation strategy; constructed areas of high ground, whether made of soil or using buildings, give people a place for evacuation. These areas should be easily accessible on foot within fifteen minutes after a near earthquake event.

To analyze the effects of a worst-case scenario tsunami, Project Safe Haven used a modeled subduction zone earthquake hazard scenario (developed in part by Priest and others, 1997; and Walsh and others, 2000). Additional information from by the Cascade Region Earthquake Workgroup (CREW, 2005) was combined with the model.

The referenced scenario is a local Cascadia subduction zone magnitude 9.1 earthquake (see Figure 2). An earthquake of this size occurs off the Washington coast every

300-500 years, on average. The last one took place in January 1700 AD. Evidence for the magnitude of the 1700 AD event is found in historic and geologic records of a tsunami that struck Japan following the earthquake (Satake and others, 2003; Atwater and others, 2005; CREW, 2005). A local subduction zone earthquake will:

- Originate approximately 80 miles off of the Pacific Northwest coast.
- Likely cause six feet of land subsidence along the coast.
- Last five to six minutes.
- Create a tsunami that will reach the Pacific County coast approximately 40 minutes after shaking stops.

Though the model suggests about half an hour is available for evacuation, only 25 minutes of that time can be expected to remain after people reorient themselves following the earthquake and prepare to evacuate. The earthquake will cause extensive destruction to local infrastructure and buildings and result in tremendous debris on roadways and other property. People at most

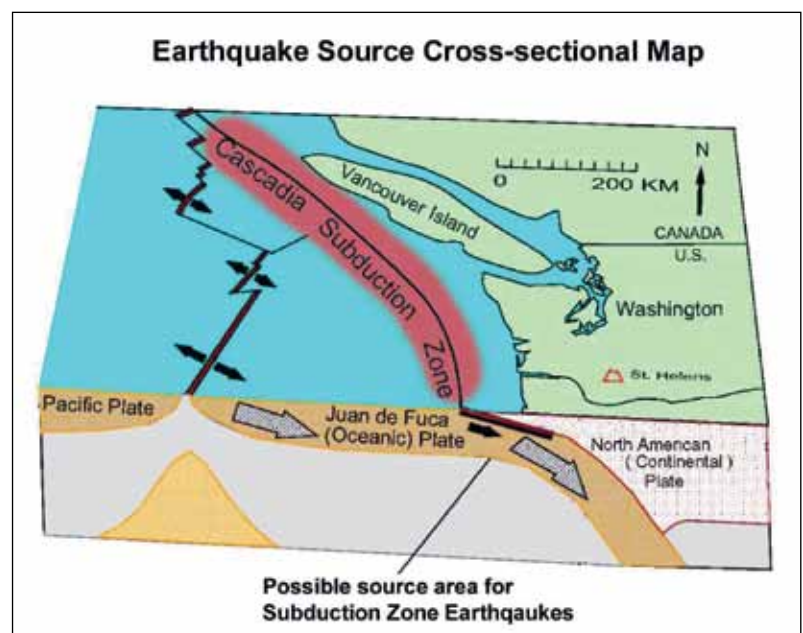


Figure 2: Subduction zone earthquake source
The Washington Coast can be affected by local or distant earthquakes and tsunamis.

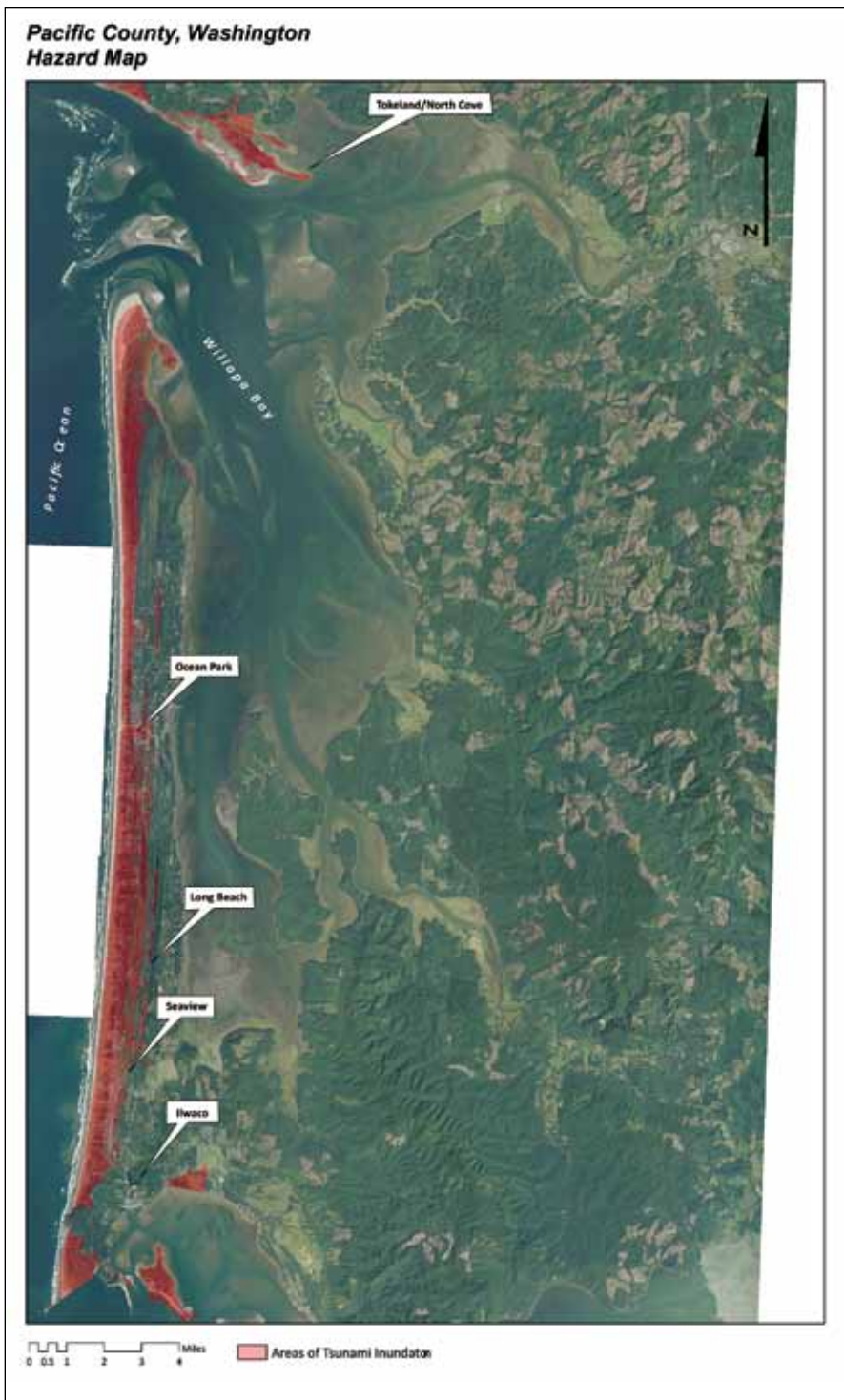


Figure 3: Pacific County hazard map.

locations on the Long Beach peninsula and the Tokeland peninsula will only be able to evacuate on foot. As an additional margin of safety, the estimated on-foot evacuation time was reduced to 15 minutes, to take into account the physical and emotional turmoil people experience during and after a major earthquake.

According to the model, the primary tsunami wave will have a wave-height of approximately 22 feet (National Geodetic Vertical Datum — NGVD) at the western shore, with some variation depending upon localized bathymetry and topography. Several other abnormally large waves will likely follow the initial wave, and the danger of recurring waves will persist throughout one entire tide cycle, 12 hours, after the earthquake. The 2010 Chilean earthquake (magnitude 8.8) produced at least three consecutive local waves. Of the three, the third wave was the largest and most destructive (Warren and Vergara, 2010). Vertical evacuation options need to be feasible for up to 24 hours after the earthquake in order to provide safety from multiple tsunami waves.

Currently, the scenario model does not include wave height information for the interior of Willapa Bay, the interior of Baker Bay near Ilwaco, and the easternmost part of the Tokeland peninsula.

B. COMMUNITY PROFILES

LONG BEACH PENINSULA

The long, narrow, and flat Long Beach Peninsula is located in the southwestern corner of Washington in Pacific County. The peninsula has two incorporated cities: Long Beach and Ilwaco. In addition, many small unincorporated communities line the peninsula: Seaview, Nahcotta, Oysterville, Ocean Park, and Klipsan Beach.

The peninsula is nationally recognized as having the longest continuous beach in the United States, 28 miles in length. There is very little natural high ground on the peninsula. Despite several Pacific County designated assembly areas located on the eastside and southern tip of the peninsula, the majority of residents do not live within reasonable walking distance to these locations or other areas of natural high ground. Most residents and visitors are not within a 15-minute walking distance to natural high ground.

Project Safe Haven has emphasized the consideration of capabilities and limitations of the peninsula’s aging population. A large percentage of peninsula residents are over the age of 50 and many will likely require ramps to access the vertical evacuation structures.

Permanent residents on the peninsula are familiar with the threat of a tsunami. Multiple tsunami evacuation signs are located along major arterials and thoroughfares directing people to one of several Pacific County designated assembly areas. Local businesses have embraced the tsunami hazard in their products and logos. The Corral Drive-in offers a “Grand Tsunami Burger.” The Long Beach Coffee Roasters sign depicts a tsunami of coffee leaping out a coffee cup. Additionally, public awareness efforts organized by Pacific County Emergency Management and publicized on their Facebook and Twitter pages elevate public awareness and education levels. The residents’ awareness of tsunamis has further improved after education and preparedness programs by the Weather Forecast Office (WFO) of Portland (Oregon), Washington Emergency Management, and Pacific County.

The Long Beach peninsula experiences substantial seasonal population fluxes because of its reputation for enchanting coastal vacations. During the seasonal peaks, thousands of visitors flock to the peninsula to attend festivals or to stay in one of the many vacation homes that dot the area. Local tourism efforts, such as the Long Beach Visitors Bureau (www.funbeach.com), promote the region

as a place where “Discovery awaits!” In addition to significantly contributing to the population numbers, seasonal visitors are often not aware of the tsunami hazard.

CITY OF LONG BEACH

Long Beach is well known for its festivals and attractions such as the annual International Kite Festival and “one of America’s best boardwalks.” (See Appendix A for the Long Beach context map.) The majority of Long Beach’s populated areas are not within a 15-minute walking distance to existing high ground. The annual population of Long Beach fluctuates considerably from 1,400 during the off-season to 4,000 to 5,000 during the peak season (see Table 1). The housing stock reflects this. Only 57% of the housing stock is inhabited year round, and vacation rentals comprise 43% of the housing. The city contains 147 recreational vehicle (R. V.) parking spaces, 700+ hotel rooms, and 20 bed and breakfasts to accommodate seasonal tourists and visitors.

Table 1: Long Beach demographics

| LONG BEACH | |
|---------------------------|-------------------|
| AGE | PERCENTAGE |
| < 24 | 23% |
| 25 – 44 | 23% |
| 45 – 64 | 29% |
| > 65 | 25% |
| 47 | Median age |
| Source: U.S. Census, 2000 | |

Project Safe Haven began in the city of Long Beach in response to its nearly complete lack of high ground and because Long Beach is the most densely populated location on the peninsula.

OCEAN PARK

Ocean Park is an unincorporated community located near the northern end of the Long Beach Peninsula. Ocean Park’s general topography is low; however, there are a number of high, naturally occurring dunes that run north-south on both the west side and the east side of the peninsula.

Ocean Park was settled in the late 1800s when the co-founder of nearby Oysterville fled to the area to establish it as a religious community. The area remains grounded in its past, with two bible camps and multiple churches. A significant number of seasonal tourists come to Ocean Park for annual festivals and beautiful beaches. Some major annual events are: The Northwest Garlic Festival (June), Fourth of July Parade (July), and the Rod Run to the End of the World (September).

The permanent population of the Ocean Park area is approximately 1,500 (see Table 2).

Table 2: Ocean Park demographics

| OCEAN PARK | |
|---------------------------|------------|
| AGE | PERCENTAGE |
| < 24 | 22% |
| 25 – 44 | 19% |
| 45 – 64 | 29% |
| > 65 | 31% |
| 52 | Median age |
| Source: U.S. Census, 2000 | |

Only 47% of the housing stock is occupied year round, meaning that about half of the housing stock is used as second homes or vacation rentals or are otherwise vacant. (See Appendix A for the Ocean Park Context Map.)

ILWACO/SEAVIEW

ILWACO

Ilwaco, an incorporated city located at the southern end of the Long Beach Peninsula, is often referred to as a “working fishing village.” Ilwaco’s topography is diverse. Three bodies of water surround Ilwaco: Baker Bay, the Columbia River, and the Pacific Ocean. The downtown area’s elevation is very low, but the surrounding areas to the west, north, and east have areas of easily accessible natural high ground. Ilwaco is home to the Lewis and Clark National and State Historic Park, Cape Disappointment State Park (the largest state park in Washington), ample beaches,

multiple campgrounds, and a seasonal downtown Saturday Market. The fishing industry provided the early economy of Ilwaco and the Port of Ilwaco still serves as a fishing destination for sea life ranging from sturgeon to crab. Founded in 1848, Ilwaco was incorporated and established as a community in 1890. The City of Ilwaco, in collaboration with local businesses, holds many popular events throughout the year including: The Blessing of the Fleet (May), Art Walks (June-September), Independence Day fireworks (July), and the Ilwaco Blues & Seafood Festival (August).

Approximately 950 people live in the City of Ilwaco (see Table 3).

Table 3: Ilwaco demographics

| ILWACO | |
|---------------------------|------------|
| AGE | PERCENTAGE |
| < 24 | 29% |
| 25 – 44 | 24% |
| 45 – 64 | 27% |
| > 65 | 20% |
| 43 | Median age |
| Source: U.S. Census, 2000 | |

Of the 524 housing units, 79% are occupied year round. Unlike other peninsula communities such as Long Beach and Ocean Park, Ilwaco has a larger percentage of year round residents than of vacation or second homes. (See Appendix A for the Ilwaco/Seaview Context Map.)

SEAVIEW

Seaview is an unincorporated area south of Long Beach and north of Ilwaco. Geographically, Seaview is very flat with little to no natural high ground. Seaview originally developed in the 1880s as a getaway for the socialites of Portland, Oregon. It was a stop on the original clamshell railroad that served the peninsula from 1889 to 1930. Today, many of the Victorian homes, a tree-lined streetscape, and the train depot still exist.

The permanent population of Seaview is approximately 516 (see Table 4).

Table 4: Seaview demographics

| SEAVIEW | |
|---------------------------|-------------------|
| AGE | PERCENTAGE |
| < 24 | 24% |
| 25 – 44 | 24% |
| 45 – 64 | 31% |
| > 65 | 22% |
| 46 | Median age |
| Source: U.S. Census, 2000 | |

Of the 398 housing units, 63% are occupied year round, leaving a noteworthy percentage of the housing stock most likely used as vacation rentals or second homes.

TOKELAND/NORTH COVE

The Tokeland peninsula area is named after Chief Toke, a Chinook/Chehalis native, and is home to the historic Tokeland Hotel, Shoalwater Bay Tribe, and Washaway Beach. Geographically, the Tokeland peninsula is narrow, less than three miles long and bordered by Willapa Bay and the Pacific Ocean. Just north of the peninsula, inland, is the Shoalwater Bay Tribal Reservation, Tribal Complex (Tribal Headquarters, Health Clinic, and Library), and Casino. Due west of tribal lands is the area referred to as North Cove. Washaway Beach is located in North Cove and is currently experiencing erosion at a rate of 100 feet per year over the last century. Washaway Beach has the most rapid rate of erosion anywhere on the west coast of the US.

Table 5: Tokeland/North Cove demographics

| TOKELAND/NORTH COVE | |
|----------------------------|-------------------|
| AGE | PERCENTAGE |
| < 24 | 27% |
| 25 – 44 | 20% |
| 45 – 64 | 30% |
| > 65 | 23% |
| 47 | Median age |
| Source: U.S. Census, 2000 | |

The permanent population of Tokeland/North Cove is approximately 435 (see Table 5).

Of the 403 housing units, 46% are occupied year round. As a result, a significant percentage of the housing stock is most likely utilized as vacation rentals or second homes. (See Appendix A for the Tokeland/North Cove Context Map.)

C. VERTICAL EVACUATION

After a tsunami warning, residents of the affected area typically evacuate horizontally, either by car or on foot. A *horizontal* evacuation strategy is appropriate when communities have natural high ground that is easily accessible. The traditional advice is, “go uphill or inland.”

However, if a community has little or no natural high ground, horizontal evacuation may not be an option. A different strategy is necessary. A *vertical* evacuation strategy provides artificial high ground in communities that lack natural high ground.

STRUCTURE TYPES

In order to accommodate vertical evacuation, the project team evaluated three potential options defined in *FEMA P646: Guidelines for Design of Structures for Vertical Evacuation from Tsunamis*. These options are berms, towers, and buildings. The minimum space for each is based on allotting every person ten square feet of space.

The conceptual designs for the structures, explained below, are intended as generalized designs to work under most conditions. These designs take into consideration the forces of both the earthquake vibration (anticipated to reach up to 1g, defined as 100% of the force of gravity) and the immense lateral forces of a tsunami. All conceptual designs reference and rely on design considerations for vertical evacuation structures found in *FEMA P646*.

COST

The cost of a vertical evacuation structure is a function of structure type, required safe haven area, and required structure height. The required height of the structure includes:



Figure 4: Constructed berm with stair access

- The height required at each location in order to meet the wave height projections
- Consideration of post-event subsidence
- A factor of safety

The required safe floor area is ten times the number of estimated evacuees for each structure (based on a 10 square feet per person standard).

The costs include design, construction, and materials. Land cost is not included in these estimations.* (See Appendix M for a summary of Pacific County costs.)

BERM

Berms are artificial high ground created from soil.

*See supplementary Safe Haven Vertical Evacuation Structures Conceptual Cost Analysis report for detailed cost estimates for four proposed vertical evacuation structures.

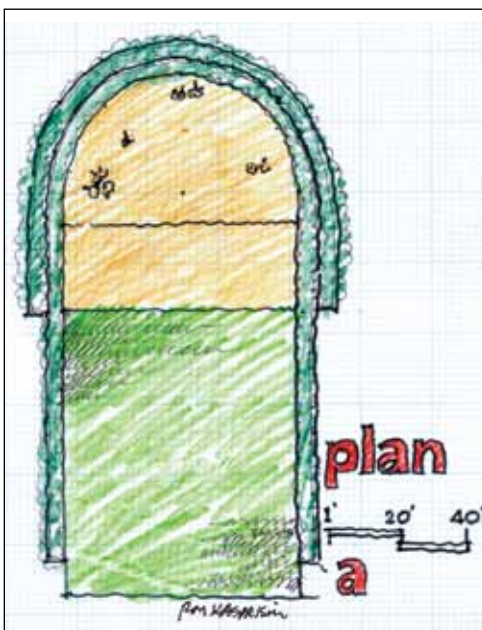


Figure 5: Basic berm conceptual designs
Front view (left) and side view (above)

They typically have ramps at a 1:4 slope providing access from the ground to the elevated surface. Berms have a large footprint on the landscape, giving the appearance of an engineered and designed hill (see Figure 4). A berm can range in size from 1,000 square feet for 100 people up to 100,000 square feet for 10,000 people.

The conceptual design for berms was based on the guidelines provided in FEMA P646. A berm has three component parts: a rounded front portion and gabion mound, the elevated safe haven area, and the access ramp (see Figure 5).

In order to reinforce the earthen mound from the forces of tsunami impact and scour, the entire berm will be surrounded by sheet metal or concrete. Sheet piling or concrete walls also add additional strength. The gabion mounds in front of the berm are intended to break the oncoming tsunami impact force. The access ramp is at a 1:4 slope to allow limited mobility individuals to have access.

Advantages:

- Easy access for many people including limited mobility
- Allow people to follow natural instinct to evacuate to high ground
- Eliminates fear of entering a structure that may not be safe
- Multifunctional

TOWER

A tsunami evacuation tower can take the form of a simple elevated platform above the projected tsunami wave height, or a form such as a lighthouse, that has a ramp or stairs leading to an elevation above projected wave height (see Figure 6). A 500 square foot tower can accommodate 50 people and a 1,000 square foot tower can accommodate 100 people. The conceptual design for vertical evacuation towers was modeled after a bird watching tower from Holland (see Figure 7).

The design consists of a four-legged base with a driven pile foundation stabilized by grade beams. This type of foundation is necessary to ensure that the structure remains safe for occupation while still being able to withstand the immense lateral forces from the tsunami.

An enclosed superstructure is made primarily of wood. The superstructure can be sized in order to provide the required safe haven area. Two access options are available; the first is a breakaway stair system designed for daily use and for use to access the safe haven area following a major earthquake. In the case of a tsunami, however, the stair system will breakaway freely from the structure. Following the tsunami event evacuees would use a



Figure 6: Basic tower
This metal tower is used in Japan.

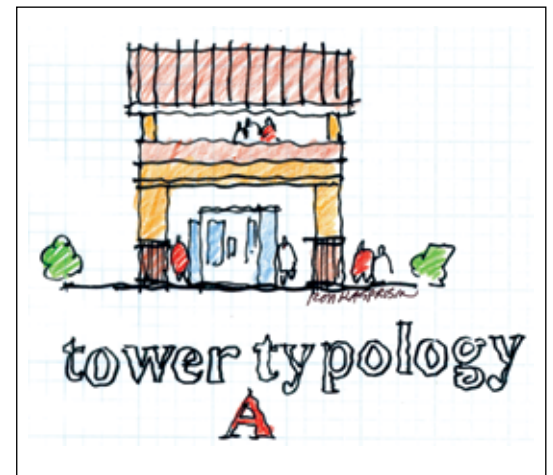


Figure 7: Tower typology A
Towers have many advantages as tsunami safe havens

retractable staircase to leave the tower.

Advantages:

- Economical
- Small footprint
- Due to lower cost, more towers could be distributed throughout the affected areas to increase accessibility and availability
- Multifunctional.

BUILDING

A building used as a tsunami evacuation structure has several lower levels that allow the tsunami wave to flow through it or the building is faced in a manner that the structural integrity of the building will support the force of the wave. Tsunami refugees seek safety in the upper floors of the building. Typical tsunami evacuation buildings are hotels or parking structures (see Figure 8).

A variety of building types can be used for vertical evacuation. A vertical evacuation building will likely be constructed with reinforced concrete. This material has proven to be strong against both earthquake and tsunami forces. In order to increase the likelihood of withstanding a tsunami, the first level is considered "transparent," having little surface area to create resistance against the force of the tsunami (see Figure 9).



Figure 8: Building for vertical evacuation.
Buildings can be used for other functions when not needed for evacuation.

Advantages:

- Lower levels of a building can be designed as “open space,” allowing the water to flow through without compromising the engineering
- Multifunctional
- Top level of a parking structure could provide a helicopter landing pad after the event to deliver much needed supplies
- Buildings have the potential to generate money through other, non-tsunami uses.

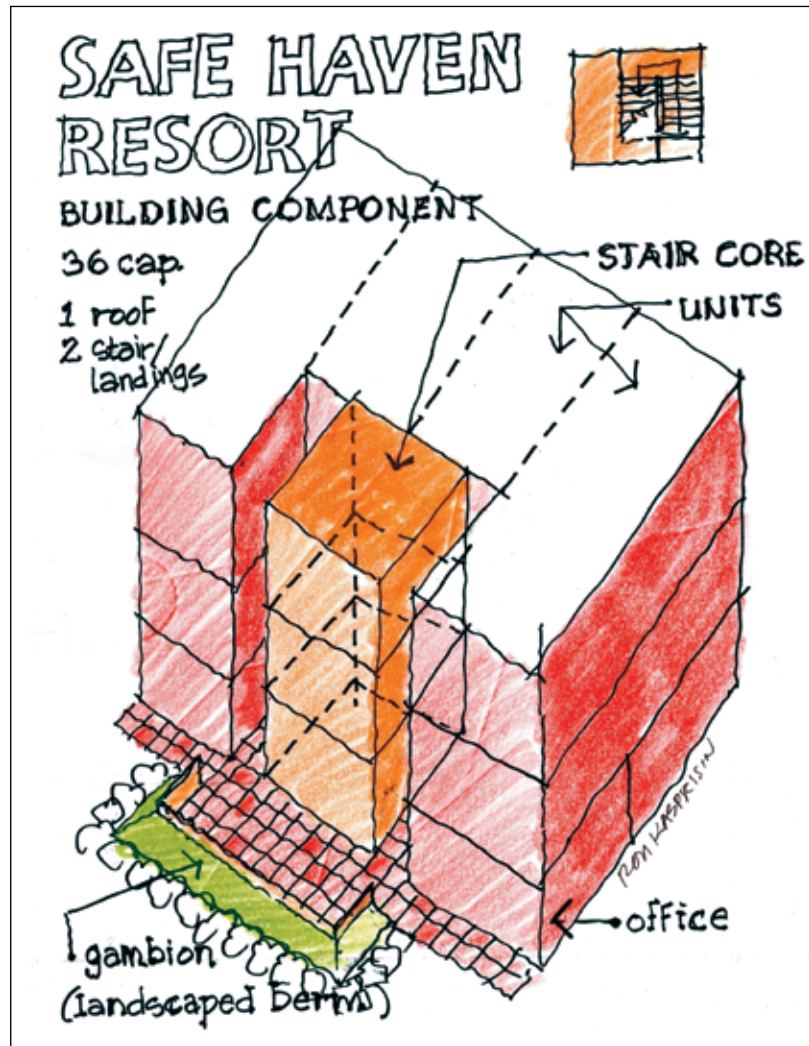


Figure 9: Conceptual design
Potential building with tsunami vertical evacuation capability.

4. METHODOLOGY AND RESULTS

Project Safe Haven used a six-phased methodology to assess the vertical evacuation needs in each of the four Pacific County communities. The six phases included selection of steering committee and communities, site survey and development of approach, identification of alternatives and preferred strategies, community mulling and acceptance of preferred strategy, reassessment of preferred strategy, and community design charrettes.

A. SELECTION OF THE STEERING COMMITTEE AND COMMUNITIES

Project Safe Haven is the result of concern arising from the 2004 Indonesian tsunami. Tragic lessons were learned about the difficulty that communities with little or no high ground have of evacuating after a local, offshore earthquake. The southwestern coast of Washington fits this definition. In 2008, FEMA and NOAA released guidance on vertical evacuation (FEMA P646: Guidelines for Design of Structures for Vertical Evacuation from Tsunamis). Several at-risk Pacific Coast communities began efforts to apply the FEMA guidance locally. For example, the city of Cannon Beach in Oregon held a workshop on the feasibility of building an elevated city hall that would serve as a tsunami safe haven and has since moved forward with their plans to complete the structure. In Pacific County, Washington, local officials documented their tsunami risk and identified the potential for future vertical evacuation structures in the Pacific County Hazard Mitigation Plan.

Under the direction of the state Earthquake and Tsunami Program, Pacific County's Emergency Manager, and the University of Washington Institute for Hazards Mitigation Planning and Research, Pacific County was selected as the pilot community to conduct the first safe haven identification project.

A Steering Committee was selected to provide oversight, with members ranging from local officials to emergency managers and scientists. Frequent conference calls were conducted to discuss

relevant, new, and changing information about the project. The Steering Committee, advising faculty, and project team agreed upon the potential implementation of berms, towers, and/or buildings with guidance from FEMA P646 and fully supported incorporation of a community-driven process.

Four Pacific County communities — Long Beach, Ocean Park, Ilwaco/Seaview, and Tokeland/North Cove — were selected as the project's focus and as locations to hold community meetings. The communities were selected during a meeting with the project team and steering committee, with direction from Pacific County Emergency Management and Washington Department of Emergency Management. The purpose of the project was to take a unique approach to vertical evacuation planning — one with greater community involvement and input.

The City of Long Beach was selected as the first community because of its vulnerability to the tsunami hazard and interest expressed by its elected officials. Following Long Beach, the project team moved north to the Ocean Park area, south to the Ilwaco/Seaview area, and lastly, just north of the Long Beach peninsula to the Tokeland/North Cove area in north Pacific County.

B. SITE SURVEY AND DEVELOPMENT OF APPROACH

LONG BEACH

In January 2010 the project team visited Long Beach for a site survey. The project team toured the peninsula, met with city officials, and visited the local elementary school. Geographical attributes were noted: low elevation, general lack of physical features, and dune cuts near the center of town. Additionally, vacant parcels were noted as potential locations for vertical evacuation structures. On the second day of the visit, the project team met with Long Beach City Administrator Gene Miles. Miles explained the future 67th Place assembly area. It may eventually house a warehouse stocked with

emergency supplies when complete. In the event of a distant tsunami, a two to three hour warning will allow residents to drive to 67th Place. However, in the event of a near tsunami, most residents cannot walk there within 15 minutes.

OCEAN PARK

The project team visited Ocean Park and the north peninsula area in April 2010. The team toured the northern end of the peninsula, noting significant differences from Long Beach, such as various high ridges within walking distance for many residents. Numerous house foundations cut into the dune system were also noted. Dune cuts reduce the effectiveness of the dune's natural defense against tsunamis. A system of pedestrian and automobile bridges in the north peninsula area of Surfside Estates is vulnerable to failure during an intense earthquake event. This is critical because most natural high ground is eastward. The bridges provide the majority of access in the near vicinity for tsunami evacuation.

ILWACO/SEAVIEW

The project team visited the Ilwaco and Seaview communities in May 2010. The team toured the area, noting the distinctive geographical attributes of each community. Several parcels without buildings were noted; however, most parcels are located on the east side of the highway and are currently being used for cranberry production.

Ilwaco has significant high ground within the Cape Disappointment State Park area near the ocean, as well as several high hills to the north and east of downtown. To the east, the area called Vandalia, with little to no elevation, is located adjacent to the river and recognized as a flood zone

The entire community of Seaview lies on low ground, in stark contrast to Ilwaco. The community is located between Highway 103 and the beach in a very low-lying area with marshes and cranberry bogs to the east. After the earthquake and subsidence of six feet the marshy areas as well as roads may experience mild flooding and would hinder all forms of evacuation, even on foot evacuation.

TOKELAND/NORTH COVE

The project team visited the Tokeland and North Cove communities in June 2010. The team noted the low lying Tokeland peninsula and the large bodies of water surrounding it. Further inland, in the vicinity of the Shoalwater Bay Casino on Hwy 105, accessible high ground was observed. Tokeland has two designated assembly areas located north of Highway 105: Annex Road and Eagle Hill Road. One is located west of the Casino and the other is located east of the Casino. The assembly areas are not within a fifteen-minute walking distance for the residents of the Tokeland peninsula.

One major area of concern for this area is Washaway Beach located in North Cove. The beach and shoreline have been drastically eroding over the past 100 years at a rate of 100 feet per year.

C. IDENTIFICATION OF ALTERNATIVES, ASSESSMENT OF ALTERNATIVES, AND DEVELOPMENT OF PREFERRED STRATEGIES

COMMUNITY MEETINGS

A series of meetings was conducted in each of the four communities to develop a vertical evacuation strategy. The first meeting used the World Café meeting process to identify and discuss the concept of vertical evacuation, various structure types, and conceptual site locations. In the second community meeting the project team presented the alternatives that had been synthesized from the first meeting and conducted discussions about the strengths and weaknesses of each alternative and conceptual vertical evacuation structure location. Two countywide meetings were held in Seaview and Tokeland at the end of the project to confirm the final preferred strategies and to receive further feedback. Lastly, two intensive, community design charrettes were led by an accomplished urban designer from the University of Washington to identify everyday uses for the proposed structures in the vertical evacuation strategies.

MEETING 1: WORLD CAFÉ

The World Café process is a "café style"

conversation to facilitate small group brainstorming. It is commonly referred to as encouraging “conversations that matter.” Participants discussed key issues at one of three stations, with one participant at each station facilitating the discussion and taking notes.

Before the meetings, project team members prepared for the role of facilitator by taking small group dynamics training. They were facilitators, not leaders, of discussion. They took notes throughout the rounds to record participant’s comments.

Each station represented a different type of vertical evacuation structure: berm, tower, or building. Each station used large table maps of the community, in combination with walking circles and Lego models of vertical evacuation structures, to determine ideal placement locations. When the allotted time ended, station participants rotated to another station, leaving one member behind to facilitate and share notes with the incoming group. This process typically continued until every participant had a turn at each station.

MEETING 2: DISCUSSION OF STRENGTHS AND WEAKNESSES

The purpose of the second meeting was to present results from the first meeting and to discuss the strengths and weaknesses of each conceptual site and vertical evacuation type. The project team presented the alternatives derived from the first meeting using maps and graphics. Next, the team facilitated a large group brainstorming session regarding the strengths and weaknesses of each alternative using SWOT analysis techniques. The goal of the meeting was to build consensus among those present and to develop a preferred strategy. *(See Appendix B for a complete description of SWOT analysis.)*

COUNTYWIDE MEETINGS

The final preferred strategies and the accompanying maps for each community were presented at the countywide, open house meetings. The project team encouraged verbal and written comments. Additional information about estimated costs,

community processes and the tsunami hazard was presented. Attendees were asked to vote for their favorite or most important proposed vertical evacuation location.

COMMUNITY DESIGN CHARRETTES

A design team, led by an urban designer from the University of Washington, joined Project Safe Haven after the countywide meetings to look at alternative community uses for the proposed vertical evacuation structures. The design team conducted two intensive, community design charrettes in Pacific County to encourage local residents to consider how the proposed vertical evacuation structures might fit into the context of the existing built environment and how the proposed structures could contribute to and even enhance the communities.

D. LONG BEACH

LONG BEACH MEETING 1: WORLD CAFÉ

The first Long Beach meeting was held on February 11, 2010. The City Administrator invited twelve people representing public, business, and nonprofit sectors to the meeting. Seven community invitees attended the meeting and were assigned to one of three groups. Five county and state invitees also attended the meeting and participated in the discussion, and four UW students assisted in the World Café process.

The students introduced the assumption that despite a warning time of approximately 40 minutes for a local tsunami, the expected earthquake shaking, road/sidewalk conditions, and general confusion would reduce the amount of time a person had to evacuate to 15 minutes. Each station was given a table-sized hazard map of Long Beach and was asked to examine one of the three types of vertical structures (berm, tower, and building). The purpose of the stations was to propose and discuss possible sites and sizes for the structures. Each station was given foam board cutouts representing the footprints of their assigned structure type. Station participants were also given two walking circles to determine how many people

each proposed structure will serve based on walking speeds (from Kaeser and Laplante, 2007):

- One circle represented a radius of 3,600 feet, the distance a person at average walking speed can cover in 15 minutes (four feet per second, 3,600 feet in 15 minutes)
- One circle represented a radius of 2,700 feet, the distance a person at below average walking speed can cover in 15 minutes (three feet per second, 2,700 feet in 15 minutes).

The participants moved the walking circles to different places on the map to analyze the accessibility of different locations for berms, towers, and buildings.

Participants at the first station were allotted 25 minutes to discuss structure placement alternatives. The second session lasted 20 minutes, and the third session lasted 10 minutes. After completing three rounds, the meeting participants reconvened to discuss the outcomes of each of the stations to inform the next step, assessment of alternative.

Comments recorded during the rounds were:

- Additional street names on maps would be helpful
- Chopsticks showing water direction (dune cuts) are useful
- Participants seemed very engaged working with the maps
- World Café process/intention during the second round needs to be better introduced by the facilitator
- Better explanation of wave height gradient would be helpful
- Using red to show tsunami inundation levels is confusing since water is usually colored blue on maps
- At least five minutes were needed for explanation of what was discussed during the first round
- More pictorial examples of potential structures need to be provided.

The World Café process allowed meeting participants to provide the project team with an abundance of local knowledge about Long Beach. Participants recorded their input and suggestions on the table maps by drawing arrows, identifying areas with a higher density of senior citizens, and correcting and adding labels to better identify important areas for consideration. The large maps at each table facilitated participation by providing a way for people to actively manipulate the building footprint cutouts and walking circles. After completing three rounds, the meeting participants reconvened to discuss the outcomes of each of the stations. Students recorded the information and input from this meeting to inform the next step, assessment of alternatives for vertical evacuation.

Note about process: Throughout the series of community meetings, the meeting process morphed as strengths and weaknesses about the process were identified. The noted strengths and weaknesses of the World Café process were: good brainstorming, good quantity of ideas, consensus reached, more people would have been better, and some people were confused as to what the maps portrayed. The adjustments made were: revision of maps (easier to understand), increased guided discussion at each table group, and encouraged map revisions and map notes to be written on the map itself. Participants provided feedback about the project itself and the idea of vertical evacuation both verbally and in writing. The World Café approach facilitated increased feedback in the sense that those attending were given multiple types and levels of opportunities to participate.

THREE ALTERNATIVES

The Project Safe Haven team developed three alternatives from the World Café meeting results.

1. Five berms located along the eastern boundary of the city
2. Four berms located along the eastern boundary of the city and one public building
3. Five berms and three potential hotel developments or redevelopments.

LONG BEACH MEETING 2: EVALUATION OF ALTERNATIVES

After generating three alternatives during meeting 1, a second meeting was held on February 25th, 2010 with the same set of meeting participants. Students presented and explained the alternatives, and then asked the participants to conduct a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis of the three alternatives. When used as a planning tool, a SWOT analysis can help identify supporting and unfavorable internal and external factors of a project. Students gave participants a SWOT matrix worksheet to facilitate group brainstorming and evaluation. Participants noted the strengths and weaknesses of the alternatives; they came to a consensus that alternatives one and two offered more benefits than alternative three. They proposed merging the first and second alternative into a single preferred strategy. (See Appendix C for complete comments.)

LONG BEACH: DESCRIPTION OF PREFERRED STRATEGY

The second community meeting produced a preferred strategy (see Table 6) with the following components:

- One large, multi-purpose berm located behind the elementary school. The berm will either be used as bleachers, with ball game spectators sitting on the grassy slope leading to the top of the berm, or as a playfield, with the grassy area on top of the berm serving as a sports field. The berm will accommodate approximately 1,000

evacuees and will be prioritized for construction since it will provide refuge for children.

- To provide evacuation for the general population, four smaller berms will be constructed along the east side of the community. Each berm will accommodate approximately 500 evacuees and will be built after the large berm near the school is constructed.
- Additionally, an elevated city hall is desired. The city will pursue this element as money becomes available from federal, state, or other funds.
- The 67th Place assembly area will serve as a site for long-term evacuation and provide access to emergency supplies.

E. OCEAN PARK

OCEAN PARK AREA MEETING 1: WORLD CAFÉ

The first Ocean Park/North Peninsula World Café meeting was held on April 22nd, 2010. The meeting took place at the Pacific County Fire Department meeting room in Ocean Park. Pacific County Emergency Management provided the list of people to invite. Twenty-four people attended.

The meeting began with a 30-minute risk overview by Tim Walsh, State of Washington Department of Natural Resources, followed by a question and answer session. The World Café process was explained, then attendees were divided into four groups of six. Each of the four table groups began the first round looking at the Ocean Park

hazard map and only one vertical evacuation structure type. As the groups moved to rounds two and three all of the structure(s) from previous rounds were brought into the discussion. During the last round, each table group considered all structure types rather than just focusing on each one independently.

At the World Café meeting, local knowledge about Ocean

Table 6: Preferred strategy for Long Beach

| LONG BEACH | |
|--|------------------------------|
| CONCEPTUAL LOCATIONS | SAFE HAVEN TYPE |
| N Place & 41st Place | Berm |
| Washington Avenue South & 5th Street South | Berm |
| Washington Avenue South & 2nd Street South | Berm |
| Washington Avenue & 13th Street South | Berm |
| Q Street & 26th Street North | Berm |
| 67th Place (west) | Pacific County Assembly Area |
| 67th Place (east) | Pacific County Assembly Area |

Park's natural lines of defense and key locations with high population densities was collected. After the meeting, the project team incorporated this local knowledge into their analysis of potential vertical evacuation strategies. They also discussed how best to incorporate areas of natural high ground into the process of identifying conceptual vertical evacuation sites. The project team agreed to include discussion about natural lines of defense into the discussion of the strengths and weaknesses of the strategy in Ocean Park due to the higher than average local knowledge available. Ultimately, a strategy emerged using collected local knowledge and input regarding potential vertical evacuation sites.

Note about process: The Ocean Park World Café meeting was conducted somewhat differently from the Long Beach World Café due to an increase in participation. Tim Walsh conducted a tsunami risk presentation at the beginning of the meeting. The number of tables used in the World Café process increased from three to four to accommodate increased participation. The World Café process was adjusted to gradually include consideration of all vertical evacuation structure types together rather than continue separate analysis.

OCEAN PARK AREA MEETING 2: EVALUATION OF ALTERNATIVES

The Ocean Park/North Peninsula evaluation of alternatives meeting was held on May 3rd, 2010. The meeting again took place at the Ocean Park Fire Department meeting room in Ocean Park and a total of 10 people attended. The purpose of the meeting was to present the strategy derived from the World Café meeting and to evaluate it in terms of strengths and weaknesses. The meeting began with a welcome and a segment regarding the hazard and scenario assumptions. (See Appendix D for project assumptions.)

The Ocean Park area geography includes more natural lines of defense than Long Beach. In fact, the entire northern peninsula has a multitude of natural ridges that run north and south and are a short walking distance from where people live.

Natural lines of defense were discussed before discussion of the strategy strengths and weaknesses. (See Appendix E for lines of defense.)

Strengths of the natural environment discussed were:

- Continuous primary dune
- Stable secondary dunes
- Various areas of natural high ground
- Deep beach.

Weaknesses of the natural environment discussed were:

- Near-shore erosion
- Interruption in dunes – focusing energy
- De-vegetation of dunes.

The Ocean Park area encompasses nearly the entire northern half of the peninsula. Therefore, in order to better analyze the results from the first meeting the project team divided Ocean Park into five strategy areas: Area A, Area B, Area CD, and Area E. Each area map represented information about current assembly areas, conceptual berm locations, and various geographic concerns. (See Appendix F for Ocean Park area maps.)

For analysis of the five areas, the project team conducted a large group discussion about the strengths and weaknesses of the conceptual strategies in each area. In addition to the large group discussion, each meeting attendee was provided with a packet for taking hand-written notes about each area's strengths and weaknesses that was submitted to the project team at the conclusion of the meeting. The strengths of each subarea consisted of issues such as proximity of proposed locations to the general public, natural lines of defense, and location to vacationers. The weaknesses of each subarea consisted of issues such as wetlands, lakes, car and pedestrian bridges, and dune stability. (See Appendix G for complete comments.)

OCEAN PARK AREA: DESCRIPTION OF PREFERRED STRATEGY

Derived from resident input at meeting 2, the preferred strategy for the Ocean Park/North

Table 7: Preferred strategy for Ocean Park

| OCEAN PARK | |
|--|-----------------------------------|
| CONCEPTUAL LOCATIONS | SAFE HAVEN TYPE |
| J Place & 315th Street (Surfside Inn parking lot) | Pacific County assembly area |
| Douglas Dr & Crellin Dr | Pacific County assembly area |
| Joe Johns Road & K Lane | High Ground |
| Joe Johns Road & X Lane | High Ground |
| U Street & 260th Street | Pacific County assembly area/berm |
| U Street & 227th Place | Berm |
| Z Street & 270th Place | High Ground |
| K Place & 271st Place | High Ground |
| SR 103 & 210th Place | Berm |
| SR 103 & 188th Place | Berm |
| SR 103 & 162nd Lane | Berm |
| SR 103 & Cranberry Road | Berm |
| Cranberry Road (between Birch Street & Sandridge Road) | High Ground |

Peninsula area includes a series of berms, existing assembly areas, and identified natural high ground (see Table 7).

F. ILWACO/SEAVIEW

ILWACO/SEAVIEW MEETING 1: WORLD CAFÉ

The first Ilwaco/Seaview meeting was held on May 17th, 2010. The meeting took place at the Ilwaco Community Center. Pacific County Emergency Management provided a list of individuals to invite to the meeting. Seven people attended.

The meeting was conducted using the World Café method. Prior to the World Café segment, a presentation about the hazard was given. In addition, a short presentation about the project/scenario assumptions was given to inform the attendees about the assumptions that the project team has used.

In response to the limited number of attendees, the project team divided the residents into two groups to conduct the World Café discussion. The residents self-selected to group themselves by their residence in either Ilwaco or Seaview.

Each table group looked at the Ilwaco/Seaview hazard map and potential sites for berms, towers, or buildings. After the first round, the table groups switched tables and discussed potential sites and structure types in the opposite community. For this meeting there were only two, rather than three, World Café rounds.

After the World Café rounds the project team came together as a large group and everyone shared their ideas, concerns, and suggestions based on local knowledge of the study area. Some of the comments are as follows:

ILWACO/SEAVIEW MEETING 1: WORLD CAFÉ

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about the assumptions that the project team has used.

In response to the limited number of attendees, the project team divided the residents into two groups to conduct the World Café discussion. The residents self-selected to group themselves by their residence in either Ilwaco or Seaview.

After the World Café rounds, the project team came together as a large group and everyone shared their ideas, concerns, and suggestions based on local knowledge of the study area. Some of the comments are as follows:

ILWACO

- Community center as gathering point; middle school/high school as gathering point
- Old high school has some Red Cross medical supplies — use it as gathering point?
- Vandalia area has the airstrip — cannot build within two miles
 - Evacuate Vandalia residents to China Hill (long distance)
 - Stringtown Road — reinforce to stand after quake and tsunami
- CapeDisappointmentStatePark(campground)
 - Small tower or berm to hold 100-200 people or designate a trail to high ground

SEAVIEW

- Long Beach 41st Place proposed site will cover most of Seaview’s population
- Overall Seaview vulnerability

ILWACO/SEAVIEW MEETING 2: STRENGTHS AND WEAKNESSES EVALUATION

The second Ilwaco/Seaview meeting was held on June 8th, 2010 at the Ilwaco Community Center. The residents invited to the first meeting were also invited to attend the second meeting. Three people attended.

The agenda for the meeting began with a welcome, introduction, and a discussion of the hazard and scenario threats and opportunities. Natural lines of defense, such as areas of natural high ground, were presented and discussed. Ilwaco was divided into three areas in order to better analyze the strengths and weaknesses of the proposed sites derived from the first meeting. The residents provided local knowledge as they discussed the strengths and weaknesses of each strategy area.

Consideration of the Vandalia population, wetland prominence in the Seaview area, and campground sites in Cape Disappointment State park was given throughout the discussion. Meeting participants suggested consulting wetland specialists and local officials as to how to address potential vertical evacuation sites in wetland areas. Ultimately, a preferred strategy for Ilwaco/Seaview emerged at the conclusion of the meeting.

ILWACO/SEAVIEW: DESCRIPTION OF PREFERRED STRATEGY

Derived from resident input at meeting 2, the preferred strategy for the Ilwaco/Seaview area includes a series of berms, predetermined Pacific

Table 8: Preferred strategy for Ilwaco/Seaview

| ILWACO/SEAVIEW | |
|---|------------------------------|
| CONCEPTUAL LOCATIONS | SAFE HAVEN TYPE |
| SR Loop 100 (see Pacific County Assembly Area map) | Pacific County Assembly Area |
| SR Loop 100 (see Pacific County Assembly Area map) | Pacific County Assembly Area |
| SR Loop 100 (see Pacific County Assembly Area map) | Pacific County Assembly Area |
| Brumbach Avenue NE & Provo Street NE (Ilwaco High School) | Pacific County Assembly Area |
| McKenzie Head Trail (Fort Canby Park Road) | High Ground |
| Ortelius Drive & Scarboro Lane North | Berm |
| N Place & 37th Place | Berm |

Table 9: Preferred strategy for Tokeland/North Cove

| TOKELAND/NORTH COVE | |
|----------------------------------|------------------------------|
| LOCATION | SAFE HAVEN TYPE |
| Eagle Hill Road | Pacific County assembly area |
| Annex Drive | Pacific County assembly area |
| Shoalwater Bay Casino | Parking structure |
| Shoalwater Bay Tribal Complex | Parking structure |
| Kindred Avenue (Nelson Crab) | Tower |
| Tokeland Road & Evergreen Street | Tower |
| Tokeland Road & Pine Lane | Tower |
| SR 105 & Whipple Avenue | Tower |
| SR 105 & Warrenton Cannery Road | Tower |

County assembly areas and highlighted natural high ground (see Table 8).

G. TOKELAND/NORTH COVE

TOKELAND/NORTH COVE MEETING 1: GROUP DISCUSSION AND LOCAL KNOWLEDGE

The first Tokeland/North Cove meeting was held on June 22nd, 2010 at the North Willapa Harbor Grange Hall. The project team was provided with a list of contacts from the Pacific County Emergency Management Coordinator. From the list of Tokeland/North Cove contacts three residents attended. Due to the limited number of attendees the project team changed the format of the meeting from a World Café format to a group discussion format. The meeting began with a presentation about the hazard by Tim Walsh. The meeting continued with a discussion of the Tokeland hazard map and potential berm, tower, and/or building locations. Two of the three meeting attendees were representatives from the local Shoalwater Bay Tribe. One was the tribal chairwoman and the other was the tribe’s emergency manager. The tribal representatives were very familiar with the hazard and have already worked on tribal plans to build a parking structure for the casino that could also serve as a vertical evacuation structure.

The comments and suggestions received:

- Tokeland’s winter population is 250 – 300

- Tokeland’s summer population is about 500
- Future parking garage at casino
- Mobility issues: use smaller walking circles exclusively
- Towers could be dual use: bird watching, view, etc.
- What about a rope to access steep hill near Annex Road assembly area?
- Tribe is the largest employer in Pacific County
- Easternmost tower needs to hold 250 people.

Ultimately, a preliminary strategy emerged using towers and parking structures. Towers were a popular vertical evacuation type due to the small footprint and limited open space on the Tokeland Peninsula. The participants used the smaller walking circles exclusively due to the high percentage of the population with walking limitations.

TOKELAND/NORTH COVE MEETING 2: WORLD CAFÉ AND STRENGTHS AND WEAKNESSES EVALUATION

The second Tokeland/North Cove meeting was held on July 13th, 2010 at the Shoalwater Bay Tribal Complex in Tokeland. The location was changed in order to increase participation among local residents. The project team opened the meeting to the general public using local media outlets to advertise the meeting. The attempts to increase participation and interest in the project were successful as more than 25 local residents attended the

meeting. Since the World Café was not possible at the first meeting, the project team took advantage of the larger number at the second meeting and conducted the World Café during the first part of the meeting. The participants were divided into four smaller groups. Two of the groups represented Tokeland residents and two of the groups represented North Cove residents. Those attending the meeting represented Tokeland and North Cove evenly.

The area of Tokeland/North Cove was divided into two areas for mapping purposes: Tokeland and North Cove. Each table group focused their efforts on thinking about potential berms, towers, and/or buildings in one of the two locations. Rather than rotating tables, like other World Café processes, the small groups only rotated once to the second table looking at the same community. Therefore, residents of North Cove only looked at North Cove and the same for Tokeland. The project team attempted to accomplish a combination of meeting 1 and meeting 2 in only one meeting. Ultimately, at the end of the second round consensus building was attempted and an analysis of the strengths and weaknesses of the consensus results was conducted in the second half of the meeting.

TOKELAND/NORTH COVE: DESCRIPTION OF PREFERRED STRATEGY

Derived from resident input at meeting 2, the preferred strategy for Tokeland/North Cove includes a series of towers, existing assembly areas, and potential future parking garages (see Table 9).

H. COMMUNITY MULLING AND ACCEPTANCE OF PREFERRED STRATEGY

After the series of initial community meetings were complete, the project team allowed time for the community to mull over and accept the preferred community strategies. This period lasted from July to November. The mulling process provided opportunities for both formal and informal community discussions about the preferred strategies. On September 25, 2010 the project team occupied

a booth at the Emergency Preparedness Fair that was held in Ocean Park. Preliminary strategies were presented to the general public in the form of brochures and community profiles. The preliminary findings contributed to the community mulling process because it served as an educational component for residents who were unaware of the safe haven project

PACIFIC COUNTY GROUND-TRUTHING TRIP

Over the summer, one project team member traveled to the study area in Pacific County to perform ground-truth research at the site level for each proposed vertical evacuation site. Additionally, walking volunteers were solicited to confirm the walking speed assumptions used throughout the project.

Information about the project and walking volunteer opportunities was disseminated with the help of a local writer for the *Chinook Observer*. The team member had met with the local writer to discuss the project and the need for walking volunteers and a newspaper article emerged from the conservation and was published in the *Chinook Observer*. (See Appendix H for newspaper article.) Volunteers from all four communities participated in the study by walking from their home to the nearest proposed berm, tower, or buildings or assembly location and recording the time, distance, walking path, age, and any potential obstructions. This particular component of the project was essential in encouraging discussion, acceptance and excitement about the project. Additionally, volunteers were encouraged to think about the limitations, reality, and necessity of evacuation on foot in the event of a near tsunami.

SITE GROUND-TRUTHING: BERM/TOWER/BUILDING, ASSEMBLY AREA, AND HIGH GROUND INSPECTIONS

Overall, there were 36 sites to inspect in four communities. Each site was photo documented as well as significant attributes noted. Additionally, seemingly safe routes to natural high ground were noted throughout the area and mapped. It is

Table 10: Complete list of preferred strategy conceptual sites

| TYPE* | COMMUNITY | SITE | STRUCTURE HEIGHT (FEET) | CAPACITY (# OF PEOPLE) |
|---|------------|---|-------------------------|------------------------|
| B1 | Long Beach | N Place & 41st Place | 13 | 480 |
| B2 | Long Beach | Washington Avenue South & 5th Street South | 10 | 800 |
| B3 | Long Beach | Washington Avenue South & 2nd Street South | 13 | 320 |
| B4 | Long Beach | 13th Street South & Washington Avenue | 10 | 560 |
| B5 | Long Beach | NE 26th and Washington | 10 | 400 |
| B6 | Ocean Park | U Street & 227th Place | 10 | 480 |
| B7 | Ocean Park | SR 103 & 210th Place | 13 | 160 |
| B8 | Ocean Park | SR 103 & 188th Place | 17 | 160 |
| B9 | Ocean Park | SR 103 & 162nd Lane | 26 | 120 |
| B10 | Ocean Park | SR 103 & Cranberry Road | 10 | 320 |
| B11 | Ocean Park | U Street & 260th Street | 17 | 320 |
| B12 | Seaview | N Place & 37th Place | 13 | 320 |
| B13 | Ilwaco | Ortelius Drive & Scarboro Lane North | 17 | 240 |
| T1 | Tokeland | Kindred Avenue (Nelson Crab) | 20 | 80 |
| T2 | Tokeland | Tokeland Road & Evergreen Street | 20 | 120 |
| T3 | Tokeland | Tokeland Road & Pine Lane | 20 | 60 |
| T4 | North Cove | SR 105 & Whipple Avenue | 22 | 80 |
| T5 | North Cove | SR 105 & Warrenton Cannery Road | 24 | 80 |
| PK1 | Tokeland | Shoalwater Bay Casino | 26 | 800 |
| PK2 | Tokeland | Shoalwater Bay Tribal Complex | 20 | 400 |
| | | | LIDAR ELEVATION | |
| HG1 | Ocean Park | Joe Johns Road & K Lane | 52.49 | |
| HG2 | Ocean Park | Joe Johns Road & X Lane | 31.17 | |
| HG3 | Ocean Park | Z Street & 270th Place | 22.97 | |
| HG4 | Ocean Park | K Place & 271st Place | 55.77 | |
| HG5 | Ocean Park | Cranberry Road (between Birch Street & Sandridge Road) | 22.97 | |
| HG6 | Ilwaco | McKenzie Head Trail (Fort Canby Park Road) | 183.73 | |
| A1 | Ilwaco | SR Loop 100 (see Pacific County Assembly Area map) | 127.95 | |
| A2 | Ilwaco | SR Loop 100 (see Pacific County Assembly Area map) | 187.01 | |
| A3 | Ilwaco | SR Loop 100 (see Pacific County Assembly Area map) | 95.14 | |
| A4 | Ilwaco | Brumbach Avenue NE & Provo Street NE (Ilwaco High School) | 49.21 | |
| A5 | Long Beach | 67th Place (west) | 101.71 | |
| A6 | Long Beach | 67th Place (east) | 45.93 | |
| A7 | Ocean Park | J Place & 315th Street (Surfside Inn parking lot) | 42.65 | |
| A8 | Ocean Park | Douglas Dr & Crellin Dr | 24.61 | |
| A9 | Tokeland | Eagle Hill Road | 111.55 | |
| A10 | Tokeland | Annex Drive | 32.81 | |
| * B = BERM T = TOWER PK = PARKING GARAGE HG = HIGH GROUND A = ASSEMBLY AREA | | | | |

important to note that these sites are conceptual locations only, not proposed locations. Particular parcels have not been selected as of yet. The preference is to find publicly owned parcels; however if not available, then potential willing property owners will be identified. If private parcels were used, the process would include assembling multiple parcels and negotiating with property owners. (See Appendix I for complete site analysis.)

Community volunteers were solicited to assist with confirmation of the assumed walking speeds of an average pedestrian speed and a below average pedestrian speed. Volunteers walked from either their home or workplace to the nearest proposed vertical evacuation structure or designated high ground to confirm walking times and to identify potential barriers. Walking worksheets were filled out by each volunteer and submitted to the Project team for analysis. Resident walking volunteers along with a couple of Project team members successfully confirmed the assumed walking speeds based on walking ability: 3,600 feet per 15 minutes and 2,700 feet per 15 minutes. (See Appendix J for walking volunteer results.)

After the ground-truthing trip was completed and the community given time to mull, the project team reconvened to analyze data and create the final strategy to be presented at the countywide meetings. In order to create the final strategy, the team utilized new LiDAR elevation data in combination with wave height data for each conceptual site. Each conceptual site was designated berm, tower, parking structure, high ground, or assembly area. Some proposed berm locations were changed to high ground to reflect the LiDAR elevation data. In conclusion, based on the LiDAR and wave height data the team's final strategy included final conceptual sites.

FINAL CONCEPTUAL SITES

The final conceptual sites were derived from the community participation processes with guidance from the project team (see Table 10). The sites and strategies were confirmed during the community mulling process and ground-truthing trip (see

Figures 10 through 14). The maps were presented at the countywide meetings along with estimated capacities for each vertical evacuation site or structure. (See Appendix N for structure calculations.)

I. REASSESSMENT OF PREFERRED STRATEGY: COUNTYWIDE MEETINGS

Two countywide meetings were held during November 2010. Both meetings were open to the general public, including those who were not familiar with Project Safe Haven. One meeting was held in Tokeland for the Tokeland/North Cove area residents. One meeting was held in Seaview for the Long Beach peninsula residents. The purpose of the countywide meetings was to present information about the community's preferred strategies, further educate residents about the hazard, and present information about vertical evacuation structure estimated costs. Additionally, we asked meeting attendees to fill out a survey to indicate their level of knowledge about tsunamis in general and to provide the project team with feedback about the meeting itself.

The meetings operated in an open house style with four stations: Tsunami Hazard, Vertical Evacuation, Community Strategies, and Community Design. The meeting did not have an official opening or closing. Rather, meeting attendees were allowed to come and go at any point during the two-hour allotted meeting time. Each station used a combination of maps to display the community strategies or tsunami hazard and educational brochures to represent the process of the project in Pacific County and to inform residents about vertical evacuation. Project team members were located at all four stations and interacted with local residents throughout the open house by answering questions and explaining the process and purpose of Project Safe Haven. As the residents left the meeting they were asked to fill out a survey about the meeting and their overall understanding of the tsunami risk. Additionally, they were asked to vote for their top two conceptual locations to prioritize for future planning efforts, those locations that are most needed or most important in their opinion.

**Long Beach Peninsula, Washington
Conceptual Vertical Evacuation Locations**

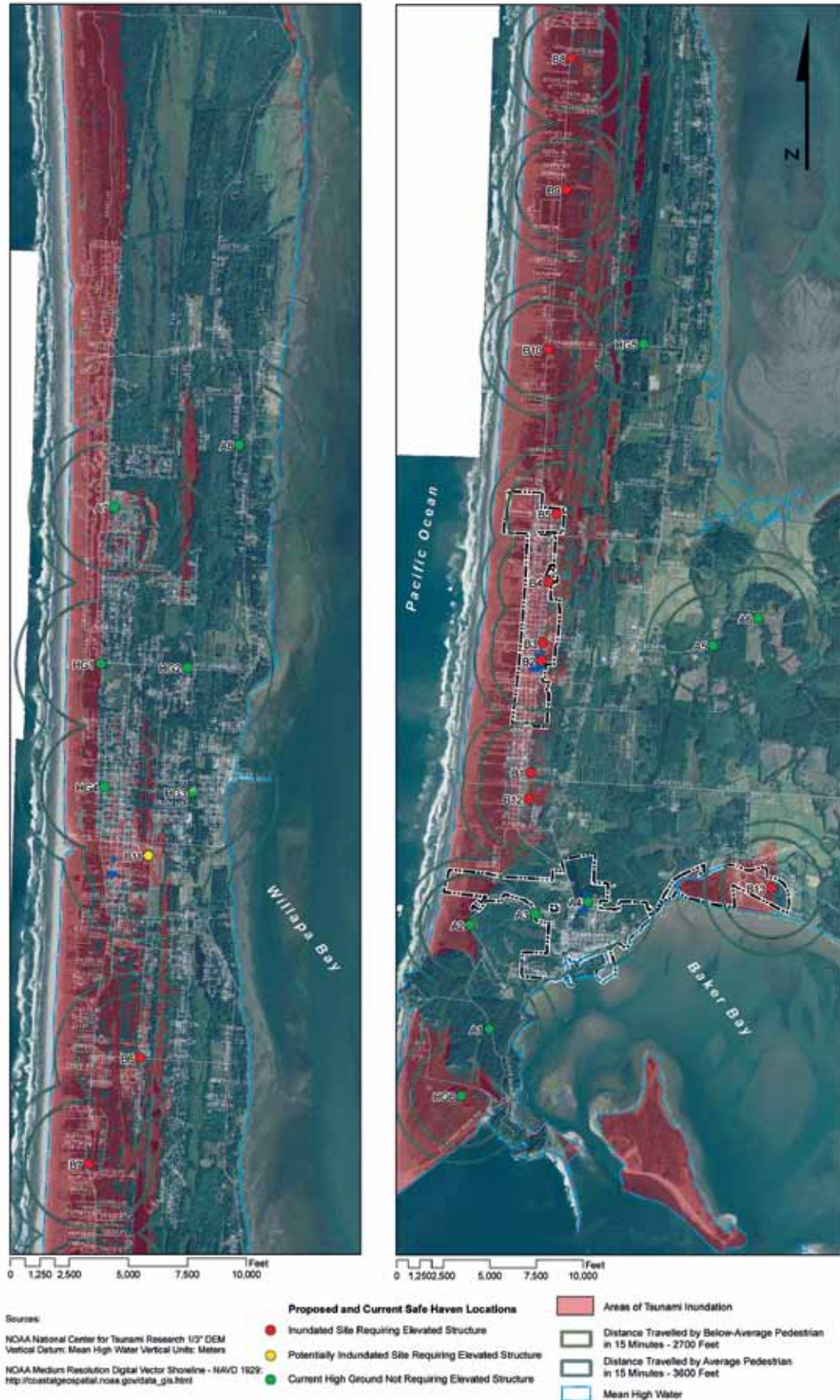


Figure 10: Long Beach Peninsula strategy map

**Long Beach, Washington
Conceptual Vertical Evacuation Locations**

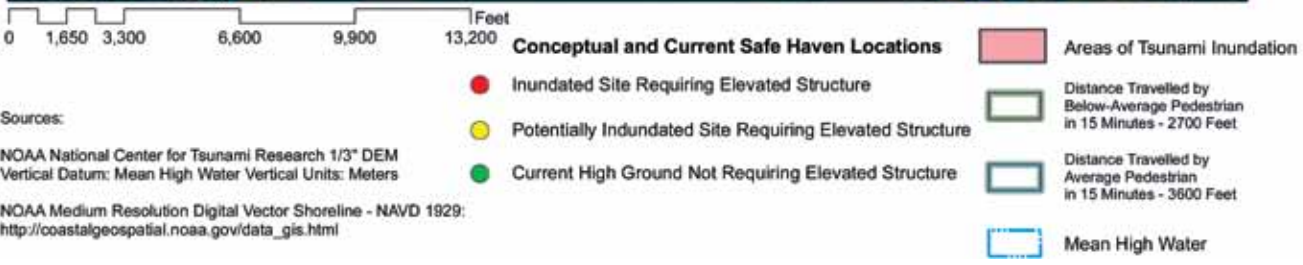
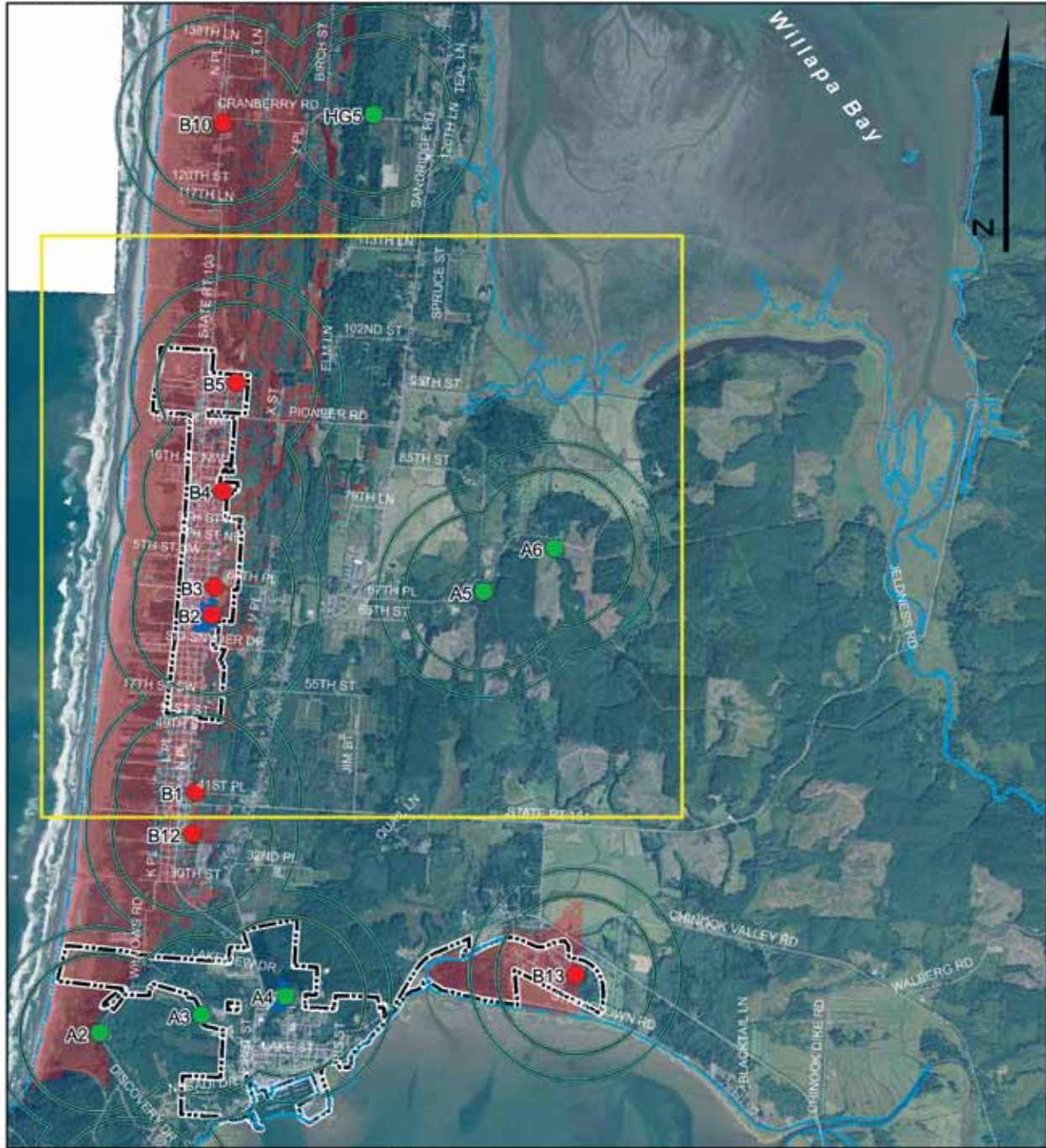


Figure 11: Long Beach strategy map

**Ocean Park area, Washington
Conceptual Vertical Evacuation Locations**



Conceptual and Current Safe Haven Locations

- Inundated Site Requiring Elevated Structure
- Potentially inundated Site Requiring Elevated Structure
- Current High Ground Not Requiring Elevated Structure

Areas of Tsunami Inundation
 Distance Traveled by Below-Average Pedestrian in 15 Minutes - 2700 Feet
 Distance Traveled by Average Pedestrian in 15 Minutes - 3600 Feet
 Mean High Water

Sources:
 NOAA National Center for Tsunami Research 1/3" DEM
 Vertical Datum: Mean High Water Vertical Units: Meters
 NOAA Medium Resolution Digital Vector Shoreline - NAVD 1988
http://coastalgis.noaa.gov/data_gs.html

Figure 12: Ocean Park strategy map

**Ilwaco/Seaview, Washington
Conceptual Vertical Evacuation Locations**

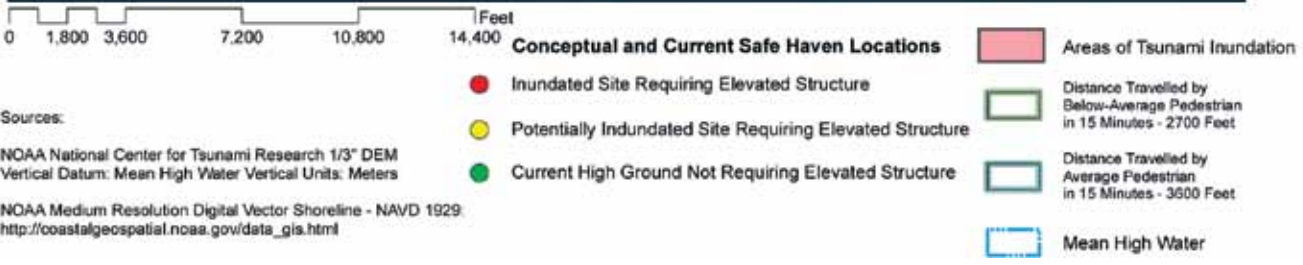


Figure 13: Ilwaco/Seaview strategy map

Tokeland/North Cove, Washington
Conceptual Vertical Evacuation Locations

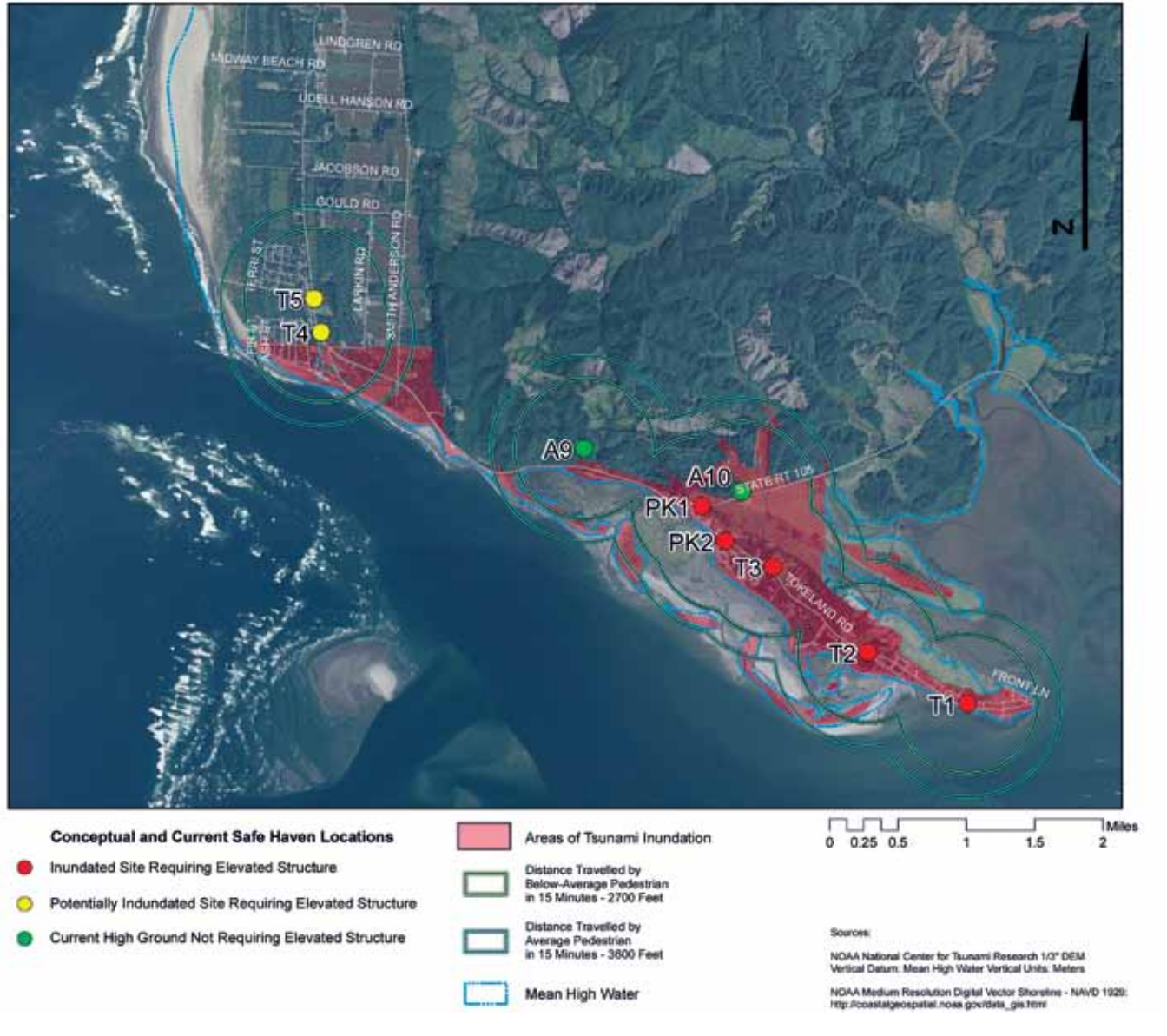


Figure 14: Tokeland/North Cove strategy map

RESULTS

The results from the two countywide meetings took the form of survey responses, voting for top two preferred vertical evacuation sites and general impressions of the successes and potential shortcomings of the meetings.

SURVEY RESPONSES

Participants were asked to fill out a survey at each countywide meeting to provide feedback to the project team about the meeting itself, participant's knowledge of tsunamis, final strategy and conceptual sites, and likelihood of implementation. Overall, most of the respondents had an average knowledge of tsunamis before attending the meeting and recorded an increase in knowledge as they exited. Almost all respondents appreciated the format of the meeting using thematic stations but only about half agreed fully with the proposed strategy. (See Appendix K for complete survey responses.)

SITE VOTING RESULTS

The project team requested meeting attendees to vote, with sticky dots, for their top two favorite or deemed most important vertical evacuation structure locations. The voting only took place at the Seaview meeting on the Long Beach Peninsula. The results reflect the interests of the attendees. In the future, decision makers will take their preferences into consideration as well as consider which conceptual vertical evacuation locations are the best for the community. (See Appendix L for voting results.)

SUCCESSES AND SHORTCOMINGS

The open house meeting method was selected for the countywide meetings because it creates a casual, non-threatening, atmosphere and facilitates discussion amongst all participants. Although a good deal of discussion took place, the meeting may have been too casual for some participants, without enough structure. This potential shortcoming was recognized at the first countywide meeting in Tokeland. As a result, the project team adjusted the meeting structure for the second

countywide meeting in Seaview. The purpose and format of the meeting was better communicated to meeting participants through the use of an agenda that explained the general idea of each station. Another adjustment was to decrease the number of handouts at each station. At the Tokeland meeting the number of handouts at each station ranged from one to three. At the Seaview meeting the number of handouts at each station was limited to one and in some cases two.

J. COMMUNITY DESIGN CHARRETTE

During phase six, community members worked hand-in-hand with urban design faculty and students from the University of Washington, Department of Urban Design and Planning, to determine options for integration of pioneering vertical evacuation structures into the communities' existing and new built form. Community members assisted the team in generating ideas for alternative community-benefit uses as well as designs for the vertical evacuation structures that fit the needs and desire of the local community; while providing a safe and effective haven for tsunami vertical evacuation.

The design process builds upon the vertical evacuation strategies developed in previous meetings. General locations and structure types were determined based on an interactive community process. The preferred strategy represents selected sites, necessary site capacities, recommended minimum vertical heights to avoid inundation, and structure type preferences.

SAFE HAVEN DESIGN CHARRETTE PROCESS

A charrette is a product driven intensive design process guided by community input on vertical evacuation structure design and alternative uses. Through a series of exercises, design team interpretations and explorations, and discussions, community members guide and critique the design process. Their ideas are interpreted and illustrated by urban designers from the University of Washington and cycled back to the community for approval and modification. The products of the

safe haven charrette include design drawings such as plans, site sections, axonometric drawings, perspective drawings and three-dimensional models. These can be used as a basis for future detailed structure design.

The charrette process is designed to help foster creative and innovative thinking that is grounded within the feasible limits of community resources. The charrette phase addressed both the initially preferred structures, berms in the case of Long Beach and towers in Tokeland, identified in phase one; and explored hybrids and combinations as each specific site was assessed.

Tasks accomplished during the community design process:

- Refinement of site
- Refinement of structure type
- Determination of alternative uses
- Design of the form
- Discussion of access, amenities, facilities.

Preliminary potential sites were chosen for the charrette process based on an assessment of site conditions, populations served, and structure typologies. The charrette provided feedback regarding the strengths and weaknesses of these sites and offered opportunities for detailed site refinement. In addition, topics such as community amenities, emergency provisions, and methods of access to the structures were discussed.

Two charrettes took place in January 2011: one on the Long Beach peninsula and the second on the Tokeland peninsula. This report summarizes the

findings and recommendations of those charrettes, including site-specific designs and typologies that have transferability to other sites and communities.

CHARRETTE PROCESS AND LAYOUT

In order to orient community members at the charrette site, a number of peninsula-wide reference maps were made available that summarized risk, preferred strategy locations, site selection criteria such as land ownership and critical areas. For each site, a series of context maps depicted information such as the selected sites, current and surrounding land use, and community facilities. Site level maps were used as the base map for key information gathering exercises. A number of materials were prepared to aid the visualization process including sketches of example structures, 3D models, and site photos (see Table 11) .

On the first day of the charrette community members in both communities had an opportunity to attend a lunch orientation session. They viewed examples of typologies and provided feedback on the preliminary site selection and site analysis. They identified attributes of the sites such as access points and currents use; provided feedback on missing or incorrect information.

During the first evening session, the first design exercise was conducted, asking community members to experiment with structure footprints and access routes using pre-sized papers (tower and berm footprints) and colored yarn (access and trail routes). This exercise assisted community members in better understanding the issues of structure-site relationships.

Table 11: Schedule for charrette process

| ITINERARY FOR COMMUNITY DESIGN CHARRETTE | |
|---|--|
| Day 1 | <p>Early Afternoon: Community review of site analysis and feedback on site selection Urban design team revises the site choice and sites analysis</p> <p>Evening: Community interactive design project 1, structure footprints</p> |
| Day 2 | <p>Urban design team interprets and draws community designs</p> <p>Evening: Community critique of initial interpretation, revision of design</p> |
| Day 3 | <p>Urban design team updates and community designs based on feedback</p> <p>Evening: Community review and final feedback on design, determination of design details such as facilities and amenities, community prioritization</p> |

From the Day 1 footprint designs and community feedback, the design team interpreted the comments into design concepts, visualizing them in hand-drawn graphics for further presentation and discussion during the Day 2 events: further refinement of design ideas, site visits, additional community interviews and an additional evening community discussion.

Day 3 provided community members a final opportunity to express preferences and ideas regarding the designs that they considered the most useful and appropriate for their neighborhoods. The University of Washington design team returned to Seattle to make final modifications and adjustments to the charrette process designs based on that community input.

THE ROLE OF URBAN DESIGN IN PROJECT SAFE HAVEN

Safe haven structures are engineered towers, berms or buildings. Their footprints, or space occupied within the community built form, can be substantial, i.e., at ten square feet per person, a 100 person tower plus stairs or ramps can exceed 1,000 square feet in area, the size of a modest house. A proposed berm in the City of Long Beach, Washington has a capacity for 1,000 persons with an approximate safe zone area of 10,000 square feet not including access facilities. The physical impacts of the structures on the communities could have both negative and positive impacts on the tourist-oriented communities and economies.

The University of Washington Urban Design Team explored means and methods to embed the tsunami vertical evacuation structures into the existing and emerging built form with reduced

negative physical impacts on neighborhoods, schools, commercial districts, parks and open space, etc. The urban design mission had three key objectives:

1. To assess each site and surrounding area for constraints and opportunities regarding the location of the safe haven structure, including related impacts on natural features and existing and future development patterns
2. To identify alternative community-benefit uses for the safe haven structures
3. To incorporate or embed the safe haven structures into the community built form in a compatible manner, supporting local uses and physical context.

In some situations, the safe haven structures can be simple towers or berms with minimal design enhancement. Other structure impacts can be visually modified and integrated or embedded into multiple use community forms and facilities. The final design concepts are guidelines for the community to follow during the implementation stages.

STRUCTURE TYPOLOGIES

In preparation for the design charrettes, the design team developed a number of exploratory structure typologies to begin the community dialogue. The exploratory typologies were intended to further develop community preferences regarding the appearance of vertical evacuation structures within their communities and neighborhoods. The initial preferred typologies were based on community ideas and feedback during prior community meetings (see Table 12).

Table 12: Typologies of potential safe haven structures

| EXAMPLE TYPOLOGIES | | |
|-----------------------------------|-----------------------------------|--------------------------------|
| BERM | TOWER | COMBINATION |
| A. Single berm | A. Single tower | A. Berm-Tower Combinations |
| B. Segmented or clustered berm(s) | B. Segmented / clustered tower(s) | B. Berm-Building Combinations |
| | C. Tiered tower | C. Tower-Building Combinations |
| | D. Tower bridge | |

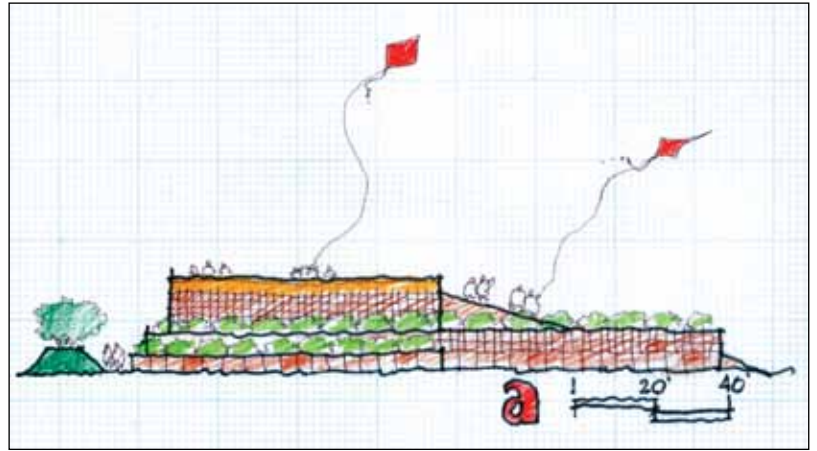
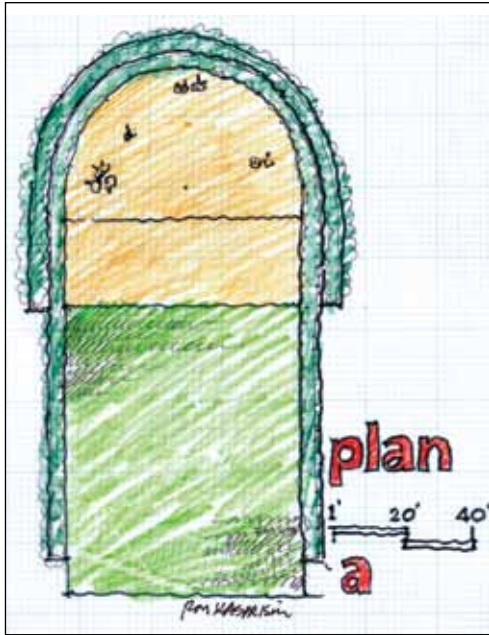


Figure 15: Basic berm structure
 The basic berm structure is a mounded buttress composed of a hardened front façade (rock, steel and/or concrete) and rear sloping access ramp. These basic berms are suitable for areas that have minimal urban form features to protect or enhance

BERM

Berms are engineered mounds comprised of earth, rock and steel components engineered to withstand both earthquake and tsunami wave forces. The berm safe zones are the areas above the inundation elevation. Berms are generally accessed by means of a slope or ramp incorporated into the berm. The berms can be entirely hardened as safe zones; or, they can have sacrificial components surrounding the safe zone that can be subject to damage during an emergency event. Berms can be used, for example, as viewing areas for athletic

fields, as play areas and parks, as visitor attractions and event facilities or as noise barriers near airports and industrial areas. Due to the sloping conditions of all or part of the berms, the actually footprint can be double or triple the size of the safe zone. The footprints for the larger berms can have a significant negative impact on the built form of smaller communities and areas of limited land availability. These factors were considered in more detail during the design charrette (see Figure 15).

Shelters, non-motorized winches, and other climate protection features are optional components

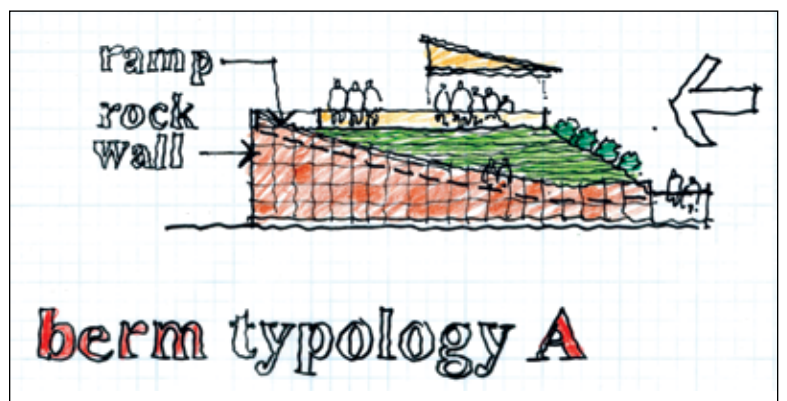
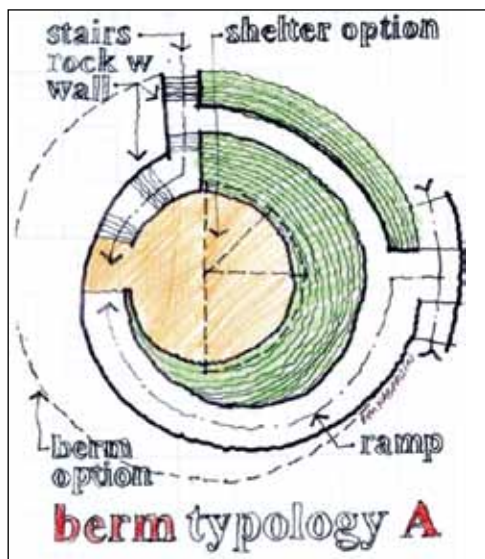


Figure 16: Modified basic berm structure
 The basic berm structure can be modified to enhance its visual appearance and use. There are many variations based on local need and budgets that can add recreational facilities, landscaping and weather protection.

and can serve as community amenities for everyday use. Bathroom facilities and storage facilities for basic supplies such as water, medical supplies, and tarps are additional options to be considered (see Figure 16).

BERM TYPOLOGY A: SINGLE BERM

Single berms have one primary safe zone at the top elevation with access provided by ramps, landscaped slopes and/or stairs. Alternate uses vary according to location and context. Single berms can be more effective in reducing negative visual urban design impacts when sufficient land area is provided for the base footprint. They are less suited for smaller built-up urban sites. The design of individual berms can incorporate numerous features to improve compatibility with the surrounding area including landscape features and natural features such as wetlands, ponds, etc.; and formal forms as sculpted mounds or pyramids.

BERM TYPOLOGY B: SEGMENTED/CLUSTERED BERM(S)

Segmented berms are separated berms, possibly clustered, that disperse safe zones within a given site to reduce the size of the berm-form footprint; or to adapt to site-specific form-functions. Segmented berm safe zones can be connected via pedestrian bridges, ramps, stairs, and safe haven towers. These berms are best suited for larger open space areas such as athletic facilities, farms, golf courses and undeveloped open space.

TOWERS

Towers are elevated safe zone platforms supported by vertical structural members. The platforms can be freestanding in geometries such as a square, rectangle, circle, and other geometric shapes depending upon local use and context. They generally have open ground level areas, uncovered or covered platforms with safety fencing. Towers can be used for a variety of functions including visitor centers, in which the at-grade level acts as sacrificial office, display areas or viewing platforms for scenic and/or wildlife areas, in conjunction with community water towers (see Figure 17).

Towers have a smaller footprint than berms for the same number of people. Access to tower structures can be restrictive to physically challenged and aged people if ramps are not included. A berm/tower combination typology has been developed to address limited mobility concerns. The provision of shelters and emergency facilities are optional.

TOWER TYPOLOGY A: SINGLE TOWER

Single towers may be the most appropriate structure for less costly safe havens where alternative uses are not feasible and/or land is limited. Alternative uses for towers and at-grade floor area can be accommodated as open space or with sacrificial uses such as shops, information booths, storage areas, etc. Towers can be accessed by stairs, ramps, and mechanical vertical assists in non-emergency

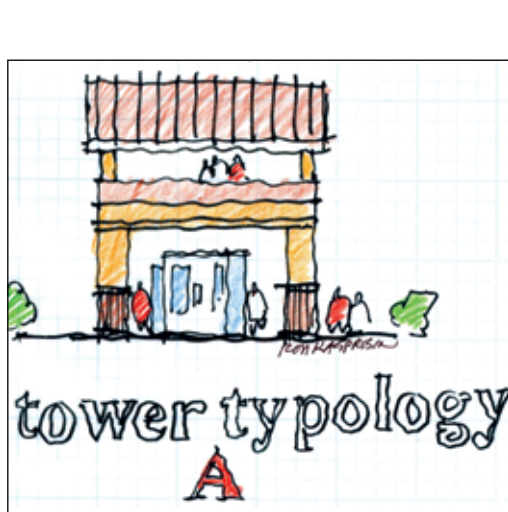


Figure 17: Basic tower structure A basic tower structure is a horizontal platform elevated above inundation levels by vertical supports. The at-grade level is open and can have additional rock or concrete barriers to break up wave-born debris. A “bare-bones” tower, essentially 40 feet square (200 person capacity) for example is a steel structure with a footprint of approximately 1,600 sf minimum.

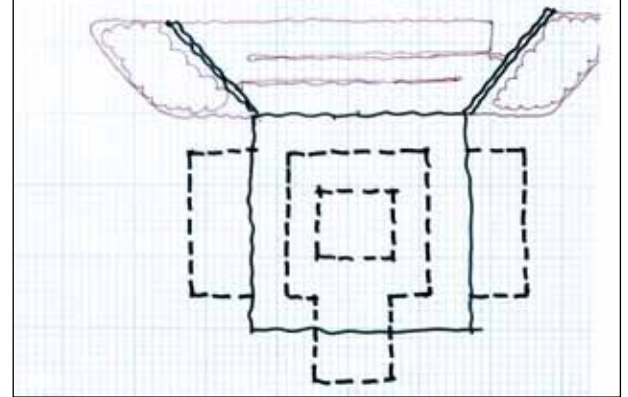
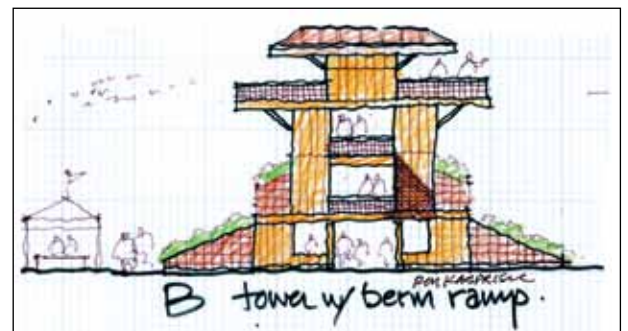
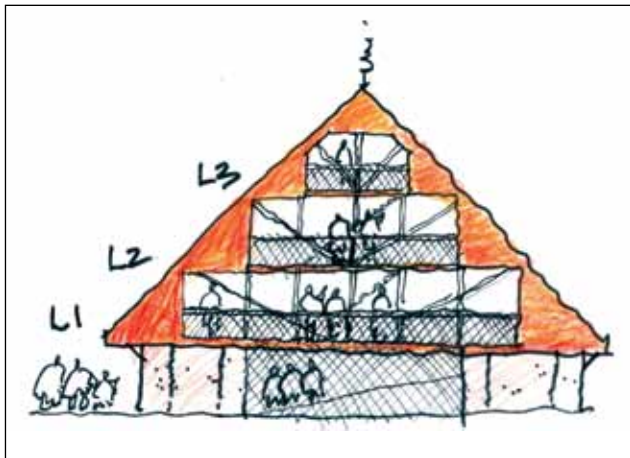
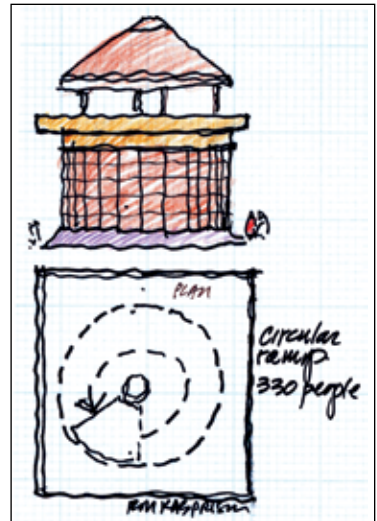
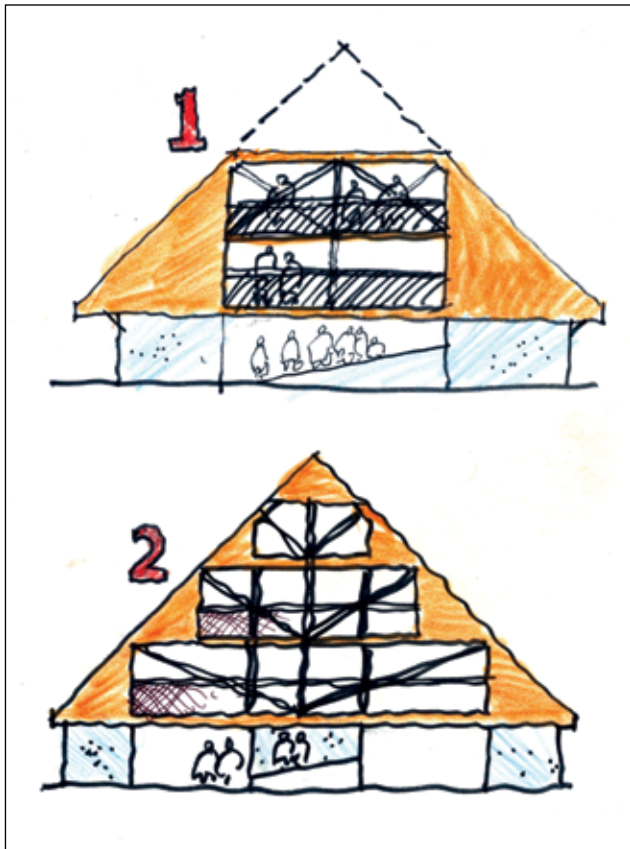


Figure 18: Modified basic tower structures
 Basic design improvements can add temporary activities on the ground level (example: information booth), landscaping, cladding materials for appearance, and a roof covering. Additional adaptations can include a berm-tower combination to improve access for physically challenged persons and reduce the industrial appearance of the tower structure with landscaped berm areas.

situations; and, manual vertical assists (winches, etc.), for emergency events (Figure 18).

TOWER TYPOLOGY B: MODULAR TOWER

Modular towers break the estimated tower size into smaller components. These towers are ideal for phased construction or to spread out the austere impacts of larger towers; and are appropriate where small pockets of land are available as scattered parcels throughout a community or where access within the walking radius is restricted due to physical barriers. They can either be segmented or clustered and contain multiple safe haven platforms within a given project site. In order to enhance integration into the desired built form the tower levels can be at varying heights, separate or connected by pedestrian bridges for shared access facilities. Where appropriate they can also be incorporated into or surrounding existing buildings.

TOWER TYPOLOGY C: CLUSTERED TOWERS

Similar to segmented towers, clustered towers allow for many freestanding smaller platforms scattered across a number of sites within a given area. Clustered towers reduce the impact of large safe haven areas on a small-scale urban form. This type of tower may be appropriate where only small pockets of land are available as scattered parcels throughout a community or where access within the walking circle is restricted due to barriers.

TOWER TYPOLOGY D: TIERED TOWERS

Tiered towers can reduce the size of the safe zone imprint on smaller site areas by stacking safe zones vertically on a number of levels. The lowest platform level exceeds the minimum inundation elevation. Upper tiers can be available for physically able persons accessed by stairs or ladders.

TOWER TYPOLOGY E: TOWER BRIDGE

A tower bridge structure connects two or more areas that may or may not be safe zones (such as play berms). These areas can include, for example, two or more safe havens, as in the segmented berm

or segmented towers, as a pedestrian overpass in congested areas, as water course crossings, or as a connection between free-standing building connections. The tower bridge can either be affixed to two structures designed to withstand earthquake and tsunami forces or can have an independent support structure.

COMBINATIONS

There are a number of design alternatives that offer hybridized combinations of towers and berms. The combinations offer an opportunity to capitalize on the best components of each structure type within the given physical context. For example, ramp-berms can provide access to tower structures if space permits, increasing access capabilities for physically challenged persons.

BERM-TOWER COMBINATIONS

Berm-tower combinations present opportunities to reduce the physical and visual impacts of larger tower structures with partial or complete sacrificial berm amendments. They also can reduce the overall footprint for a large berm structure.

BERM-BUILDING COMBINATIONS

Berms can be combined with new building structures in certain situations. The berm acts to provide a design element that can soften or reduce building mass and provide sloped access to building roofs and other safe zones. Examples include parking garages, industrial buildings, pedestrian overpasses, etc.

TOWER-BUILDING COMBINATIONS

Tower structures can be incorporated into new building structures to provide safe zones and reduce the construction costs of safe-zone-hardening the entire building. Examples include entryways-lobby areas, stair towers, office components, etc.

K. DESIGN CHARRETTES: PROCESS AND RESULTS

SITE-SPECIFIC AND MULTIPLE USE DESIGN CONCEPTS

LONG BEACH PENINSULA

LONG BEACH DESIGN CHARRETTE

The University of Washington, Department of Urban Design and Planning, College of Built Environments, Seattle, Washington, conducted a three day design charrette in Long Beach, Washington in January 2011. The design team consisted of an architect/urban planner faculty member and two graduate students, augmented by staff from the State of Washington Emergency Management Division and local emergency managers from Pacific County.

SELECTED SITES AND COMMUNITY TYPOLOGY PREFERENCE

The Long Beach peninsula community and the UW Project Safe Haven team selected fourteen sites for vertical evacuation structures (see Figures 11 through 14). The overall community preference is for berm structures.

The following sites were selected for conceptual design explorations, beginning from the northern end of the peninsula to the south:

DESIGN CONCEPTS BY SELECTED SITES

SITE B11: OCEAN PARK

U STREET AND 260TH STREET VICINITY

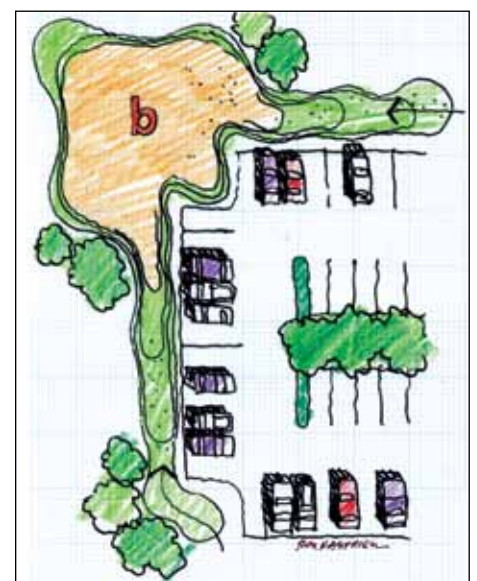
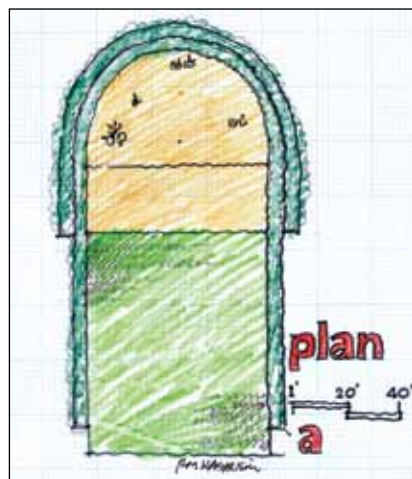
- Minimum height of safe zone floor: 17 feet
- Capacity: 320 people
- Safe Zone area: 3,200 square feet minimum

The Ocean Park Berm 11 site area has numerous location options: a new Methodist Church in planning stage, a fraternal lodge, and Sheldon Field—an athletic field/play area across Pacific Street from a school with 235 students. Safe haven recommendations for more open land such as the church property include a basic berm structure with ancillary and sacrificial landscape treatment such as stepped planting boxes around a curved front (wave face) that can also serve as a wave/debris brake; and expanded sloping areas that can serve as play areas for families and children at the church site. The church site berm can also be used to buffer parking lots from street view with an elongated sloping access berm(s) leading up to a linear 3,200 square feet safe zone for 320 people (see Figure 19).

The Sheldon Field site in Ocean Park is limited in area due to the extent of the athletic field/play area. A safe haven tower can be constructed as an elevated platform over a passive play area. Similar structures, without the tsunami wave engineering, are utilized in locales with significant inclement weather such as Ketchikan, Alaska and other southeast Alaska communities for outdoor playground protection. The Ocean Park structure example is a simple steel frame/platform construction with exterior stairs. Ramp-berms are an option given the availability of land (Figure 20).

Figure 19: Berm 11 Religious/fraternal lodge sites (a) and (b)

A basic berm with minimal landscaping to “soften” the wave-face façade (a) can provide basic protection with modest visual impacts on larger sites with significant open space. An elongated berm can be integrated into parking areas and play areas for religious and educational sites as in (b).



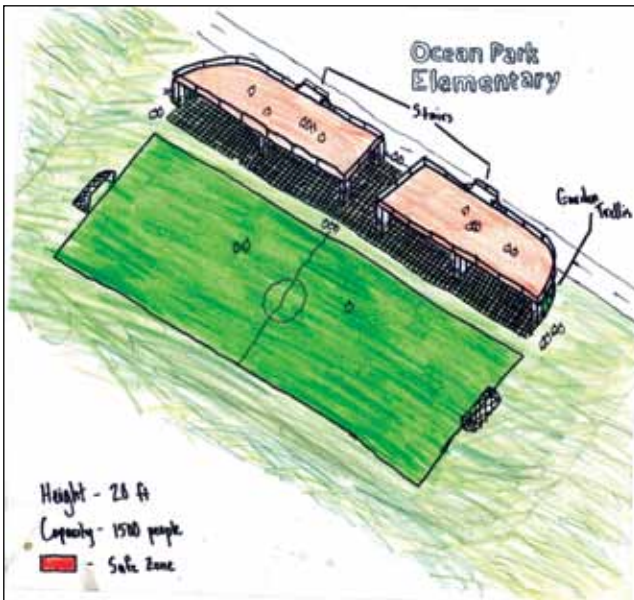


Figure 20: Additional safe haven: Sheldon Field platform Basic platform along the edge of the athletic field area can provide sheltered play areas with above grade passive play and observation area with a safe zone for 750 people for each elevated platform.

SITE B7 AND B8: SR 103 & 210 LANE/SR 103 & 188TH PLACE

- Minimum height of safe zone floor: 10 feet (B7) and 17 feet (B8)
- Capacity: 160 people each
- Safe Zone area: 1,600 sf minimum

Basic berms and buffer berms, as described above, are sufficient in locations with church sites, senior centers, and other semi-public facilities if land is available. Both sites, B7 and B8, are close to the inland lake and slough waterway in the interior of the peninsula. Structures could be incorporated into a Long Beach Peninsula Inland Park or Trail Network connecting to other parks such as the City of Long Beach Discovery Trail. Vertical evacuation structures can be phased in and used in various combinations to provide pedestrian viewing areas within the park network or pedestrian bridges crossing the waterway. The following illustrations depict various options and opportunities to combine safe haven structures with a peninsula wide park and trail network in close proximity to access roads (see Figures 21 and 22)..

SITE B5: WASHINGTON AVENUE & 26TH STREET N.

GOLF COURSE SITE

- Minimum Height of Safe Zone Floor: 13 feet
- Capacity: 400 people
- Safe Zone area: 4,000 sf minimum

Sites with expansive recreational uses such as golf courses can provide multiple (Figure 23) safe haven structure opportunities (S) within and as a part of their landforms. Examples include buffer berms for putting greens, tee-mounds (given the ten foot height) (T), 18th hole bleachers and clubhouse platforms. Golf course sites can also accommodate segmented or clustered berms to reduce the size of one large safe zone (4,000 square feet).

SITE B2-3: ELEMENTARY SCHOOL SITE

VICINITY

WASHINGTON AVENUE & 5TH STREET SOUTH

- Minimum Height of Safe Zone Floor: 10 feet
- Capacity: 800 people
- Safe Zone area: 8,000 sf minimum

The elementary school site represents an ideal location because school facilities and accompanying athletic fields and playgrounds provide an opportunity for large capacity berms integrated with school facilities. The school’s open space can accommodate berms that serve as play areas, seating areas for recreational events, kite flying mounds, viewing areas, children’s forts, etc. The berm is integrated with a peninsula-wide park and trail network, Discovery Trail, athletic fields and a small pond into a unique landscape feature for public use. In berm typology (a), a segmented berm provides two safe zone elevations with access ramp-slopes; a connecting tower that can be either a sacrificial bridge or safe zone tower structure; surrounding a play area with sand base and small stage area; and seating for athletic facilities. In (b), the berm is a single structure with larger safe zone area connected to the Pacific County Parks and Trails Network portage trails system (see Figure 24).



Figure 21: Long Beach Peninsula Inland Park and Trail Network tower-bridge
 The illustration, conceptualized during the charrette event, depicts multiple opportunities for safe haven structures within the park network: a viewing tower in close proximity to local access road; one safe haven tower in association with a pedestrian bridge and additional access tower (both can be sacrificed); or, combinations of all three serving as safe haven towers.

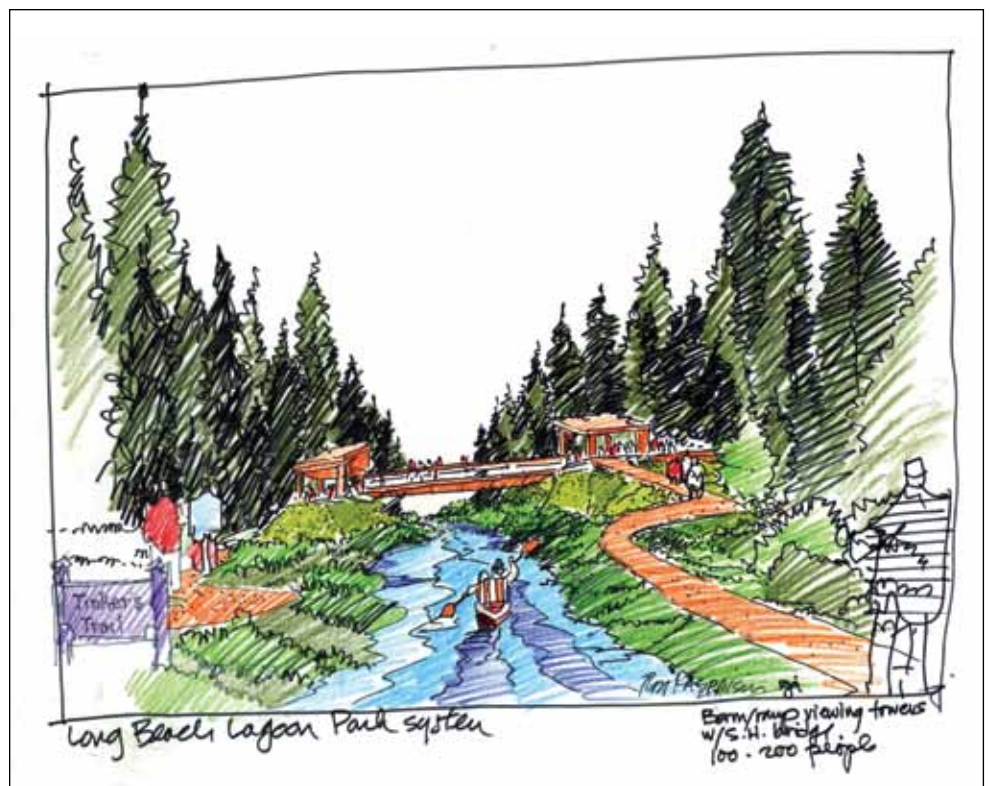


Figure 22: Long Beach Peninsula Inland Park and Trail Network berm-bridge
 As in the previous illustration, a safe haven can be located near an access road along the Inland Park Network using a combination of structure types. In this example, berms are used as land forms to access safe zone towers and bridges (optional) that cross the slough and lake network.

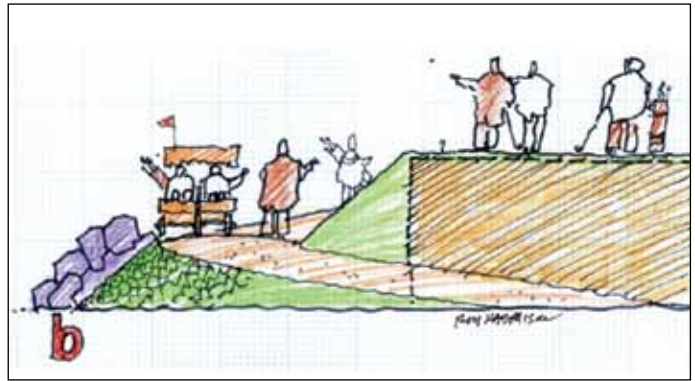
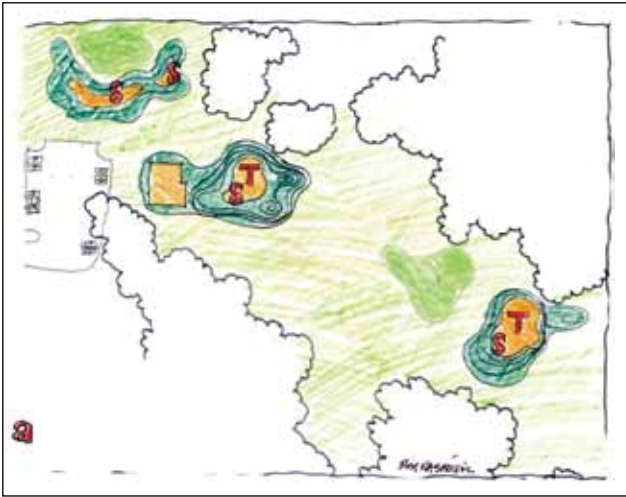


Figure 23: Golf course

Golf courses can accommodate berm structures into their land forms as putting green areas, tee-off areas, sand trap edges, seating and viewing areas, etc. Golf course layouts increase the opportunity to disperse berms throughout the site, reducing the size of large berm footprints. The illustration depicts berms used as bleacher areas (18th hole), tee-off areas and green buffers, (a) and (b).

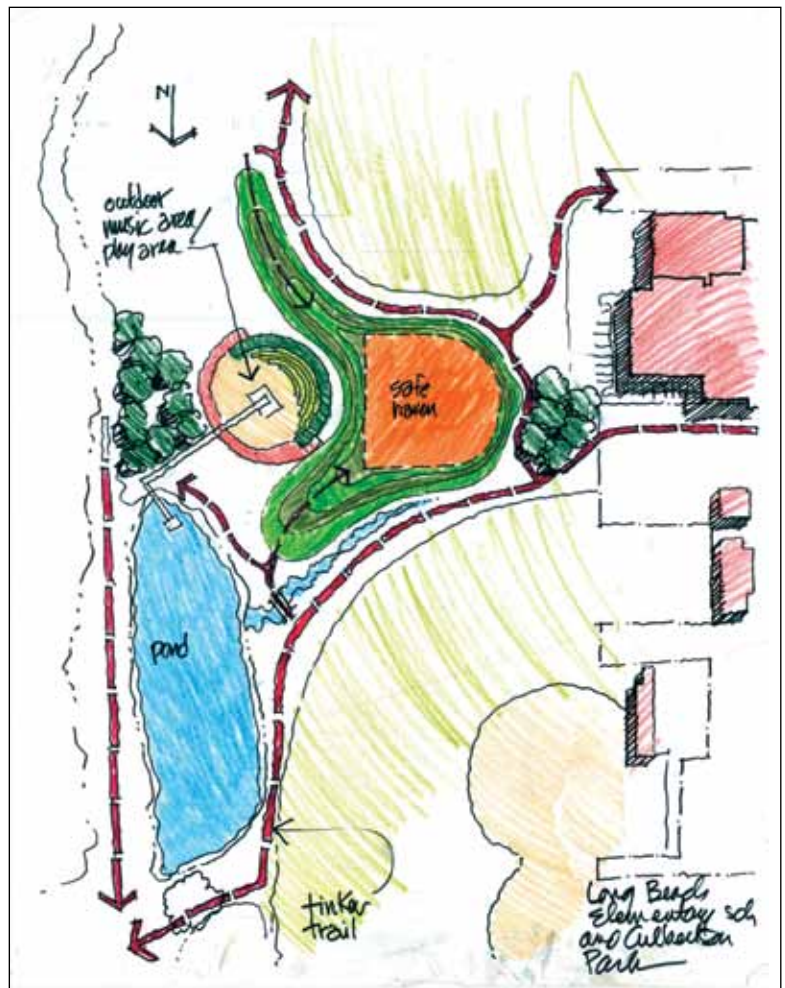
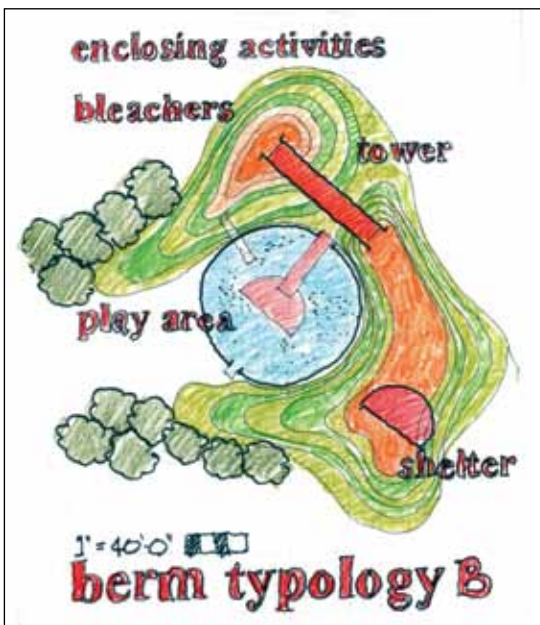


Figure 24: Elementary School site berm (a) and (b)

The orange dashed area highlights the safe zone embedded into the school berm. Play areas and events facilities can also be incorporated into and surrounding the berm structure.

SITE B1: N PLACE AND 41ST PLACE

- Minimum Height of Safe Zone Floor: 13 feet
- Capacity: 480 people
- Safe Zone area: 4,800 sf minimum

Berm 1 has a high capacity requirement for 480 people. A tower structure can be overpowering for the area even if placed at a site on 101st Street overlooking the cranberry fields, occupying approximately a 70 feet square structure, or a 24 feet by 200 square feet rectangular shape. A second option is a tower-berm combination with a smaller tower on 101st Street (a), approximately 30 square feet serving as a cranberry field viewing tower, with an alternate location (a), connected to an elongated berm (b) running south along the cranberry bogs to the Seaview Fire District Station, undulating vertically as a recreational land form with safe zone nodes along its length. An alternate can consist of safe nodes placed within the buffer berm, all connected by the sacrificial linear berm-ramp (see Figure 25).

SITE B12: N PLACE & 37TH PLACE SEAVIEW FIRE DISTRICT SITE

- Minimum Height of Safe Zone Floor: 13 feet
- Capacity: 320 people
- Safe Zone area: 3,200 sf minimum

The fire district site, overlooking the slough and cranberry bogs, offers two options for tsunami structures: one, a tiered tower; and, two, an extension of the B1 elongated berm trail system with or without a tower combination (see Figure 26).

SITE B13: AIRPORT VICINITY ORTELIUS DRIVE & SCARBORO LANE N.

- Minimum Height of Safe Zone Floor: 17 feet
- Capacity: 240 people
- Safe Zone area: 2,400 sf minimum

The airport vicinity and adjacent residential neighborhoods provide alternate or multiple sites for tsunami structures: a noise barrier-berm at the airport perimeter; and, a cluster of berms (or one elongated berm with varying vertical safe zones) within the public or community open space in the center of the neighborhood (see Figure 27).



*Figure 25: Berm 1, tower-elongated berm combination
The elongated berm connects viewing areas for the cranberry fields along the north-south slough water feature, with options of pedestrian crossings of the slough. The viewing tower structure can be located either east or west of the slough depending on soil conditions. This buffer berm can also be incorporated into a larger and more extensive “dune-park” series of visitor attractions and structures, mimicking the natural land forms.*

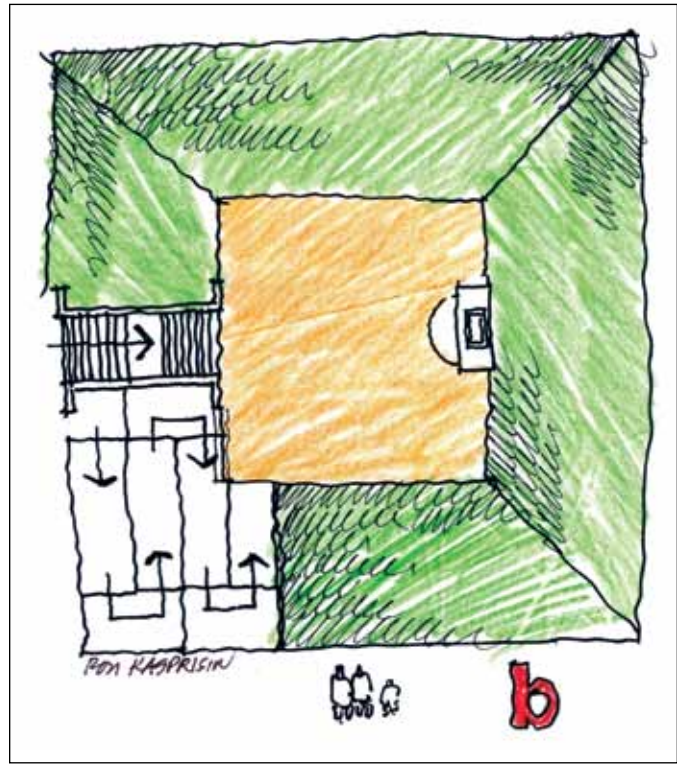
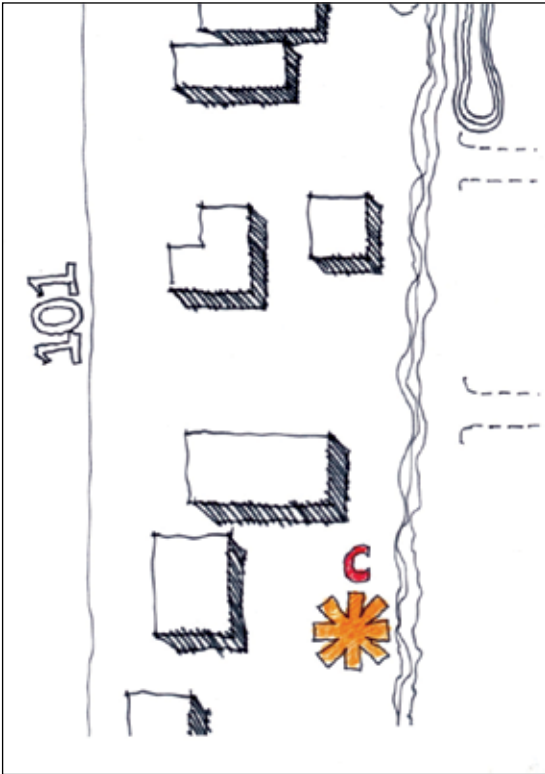


Figure 26: Seaview Fire District site

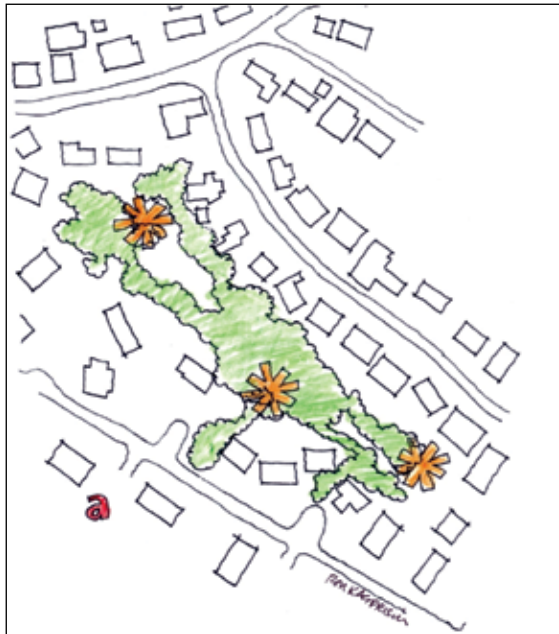


Figure 27: Ortelius/Scarboro neighborhood

A public open space/forested wetland area is framed by residential buildings. The area is suitable for a cluster of berm structures, each approximating 800 square feet or 28 feet square to reduce the size of a larger single berm that may have negative impacts on natural features and adjacent residences. The plan sketch (a) (above left) indicates a dispersed mound or berm formation, depending upon soil conditions and habitat features; and sketch (b) (top right) visualizes a number of berm concepts for play areas, habitat areas (bird nesting areas) (c) (above right), community picnic areas, etc.

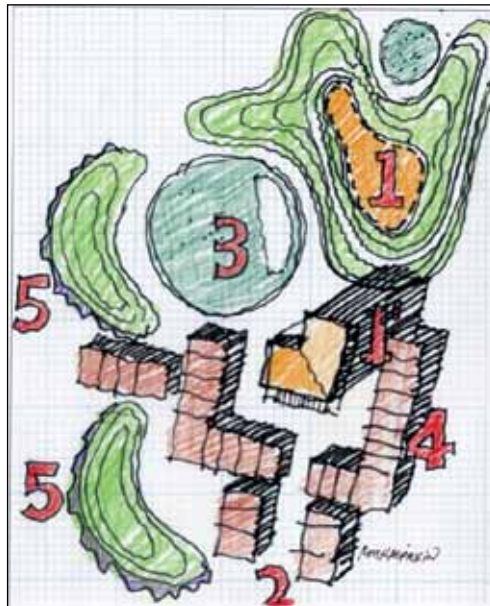
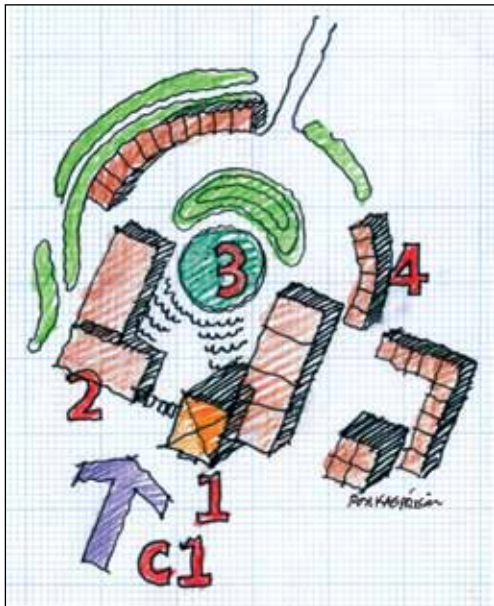
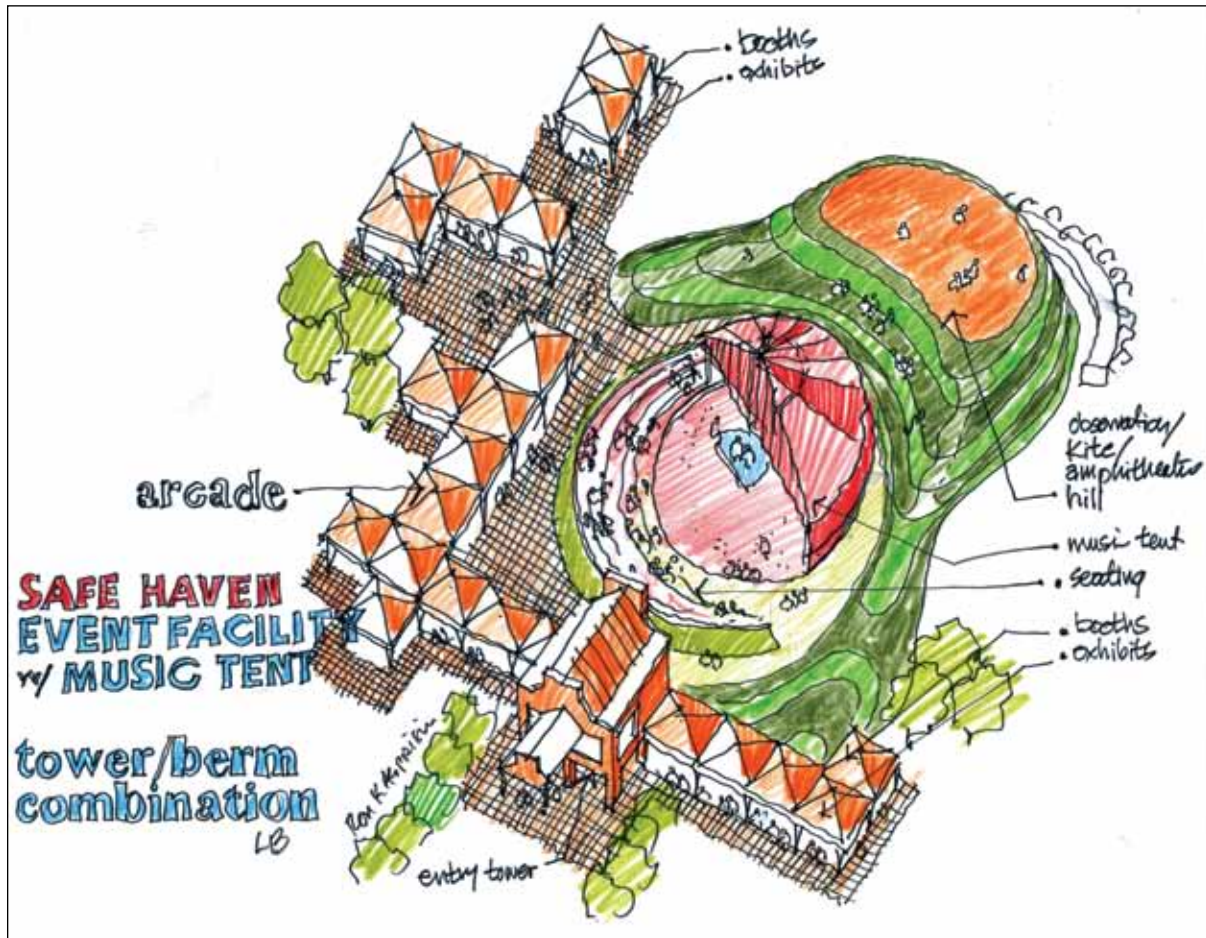


Figure 28: Festival event facilities, peninsula-wide and local (c1 and c2)

Festival events are an important part of the Long Beach tourism economy with numerous groups sponsoring and hosting music, arts and crafts festivals and farmers' markets at diverse sites along the peninsula. Regardless of their individual sizes, combinations of berm and tower structures can be incorporated into the event facility design; providing safe zones and tourism facilities during peak use. Larger or peninsula-wide facilities are depicted, with music tents, viewing tower/entry tower ticket booth tsunami structures and safe haven berms all integrated into the complex. Smaller event facilities (c1) and (c2) can include a few hardened structures either as towers or as berms with all other elements consisting of temporary and seasonal tents, booths, food vendor areas, etc.

SITE VARIABLE: FESTIVAL EVENT FACILITIES

- Minimum Height of Safe Zone Floor: 10 – 30 feet
- Capacity: 100 to 800 people
- Safe Zone area: 1,000 to 8,000 sf

Numerous festival events occur within the Long Beach peninsula area on multiple sites depending upon the sponsoring organizations and local communities. There is significant opportunity to incorporate safe haven vertical evacuation structures into these event facilities as towers and as berms; and, at different scales—from a large peninsula-wide event site similar to a county fair, to smaller venues dispersed throughout the length of the peninsula (see Figure 28).

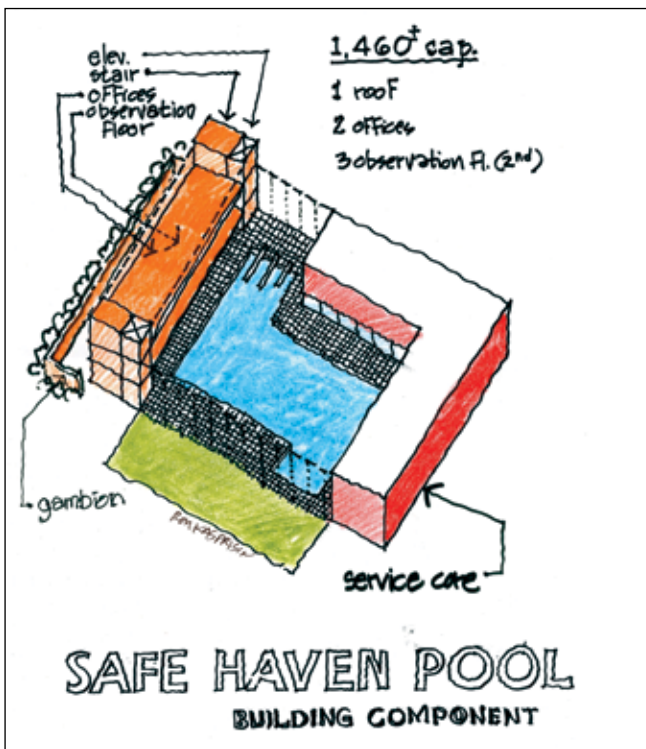


Figure 29: Safe haven building components, swimming pool example

The illustration portrays an enclosed Olympic size swimming pool with related locker room facilities, entry level, office level(s), observation balcony and vertical access tower. Various portions of the larger building can be hardened as safe zones, such as stair towers, office core, observation balconies. Elevators and emergency stair vertical assists are available depending upon the nature of the emergency (tsunami with localized earthquake and without).

The examples that follow represent a typology that can be increased or decreased in scale to fit local needs. The two main safe haven components include: berm structures to organize and assemble festival activities with seating and play areas; and, tower structures that serve as entry booths, information areas, restroom facilities, offices, observation towers etc.

SITE VARIABLE: COMMUNITY SWIMMING POOL/COMMUNITY CENTER FACILITIES

- Minimum Height of Safe Zone Floor: 20 feet minimum
- Capacity: variable
- Safe Zone area: variable

A community swimming pool is under consideration in the Long Beach area, site yet to be determined. The pool building and other similar community buildings such as civic buildings, community centers, and other indoor athletic structures and buildings can provide safe zone components as a part of the larger structure, without hardening the entire structure as safe havens, significantly reducing costs; enabling additional safe haven building components to be incorporated into more buildings, covering a larger area (see Figures 29 and 30).

SITE VARIABLE: ENVIRONMENTAL ART DUNES

- Minimum Height of Safe Zone Floor: variable (approximately 20 feet in examples)
- Capacity: variable

The Long Beach peninsula is characterized by sand dunes, particularly in the middle to northern sectors. The concept of the dune pattern can be used as a typology for a large environmental art and park project. The Environmental Art Dunes or Long Beach Dunes Park, connected to the Inland Park and Trail Network, can consist of clustered berms with tower-bridges connecting berms on both sides of the highway. This is an extensive facility with hardened and sacrificial components that is inspired by both the natural features of the peninsula and its tourism economy. The Dunes can consist of large and small hardened “dunes”

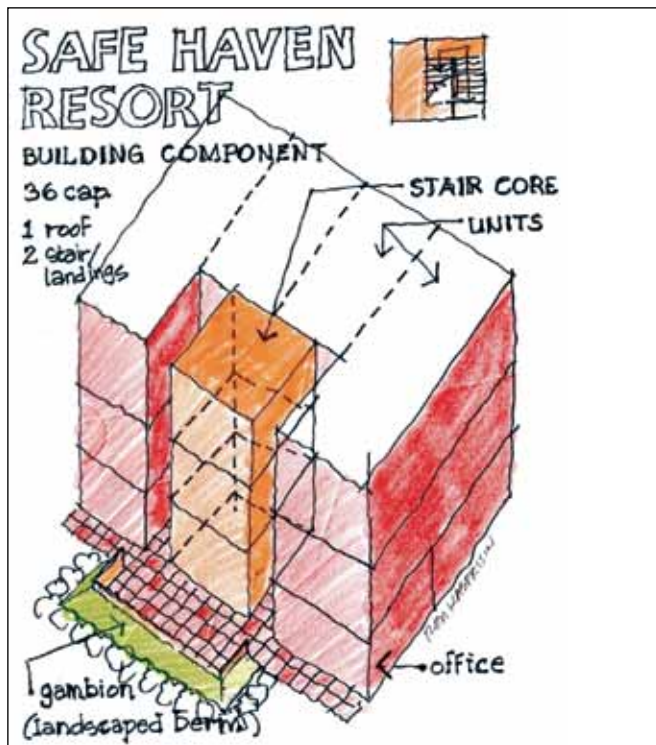


Figure 30: Safe haven building components
 The safe haven building component (hotels, resorts, multiple family residences) principle applies to private buildings such as hotels, resorts, etc. In the illustration, an enlarged stair tower is the hardened safe zone that can accommodate thirty or more people depending on the size of the overall structure. In this case, the building is a three story multiple family residential/hotel type building that accommodates 36 plus people.

consisting of viewing areas, kite flying nodes, picnic areas, etc. all connected by a trail network that may include pedestrian bridges at key points (see Figure 31).

TOKELAND PENINSULA

TOKELAND/NORTH COVE DESIGN CHARRETTE

The University of Washington, Department of Urban Design and Planning, College of Built Environments, Seattle, Washington, conducted a three day design charrette in the Tokeland/North Cove, Washington area. The design team consisted of an architect/urban planner faculty member and two graduate students, augmented by staff from the State of Washington Emergency Management Division and local emergency managers from Pacific County.

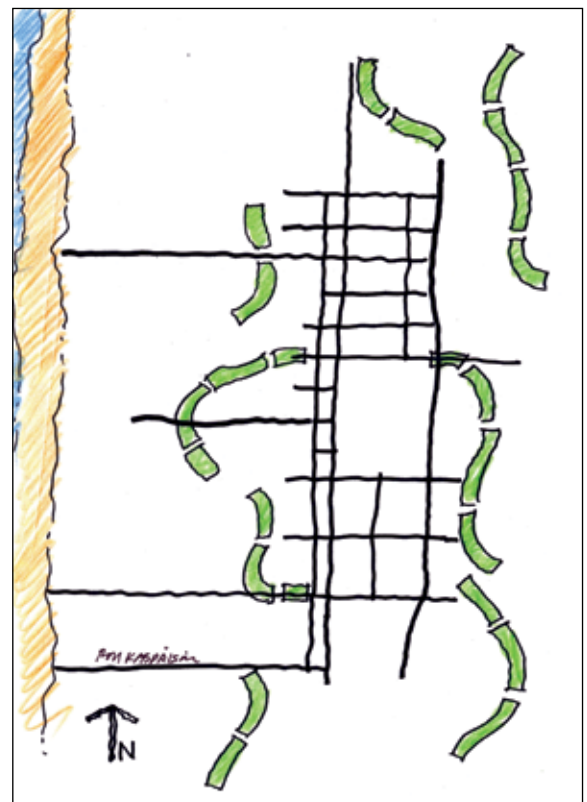


Figure 31: Environmental Art Dunes Park (Long Beach Dunes Park)

This illustration is conceptual, diagrammatic and not site specific. The dashed lines indicate a concept for dispersed elevated manufactured “dunes” or “dune-parks” that contain passive recreational uses and hardened safe zone sites. The “dunes” are connected with a pedestrian sidewalk, trail network with appropriate signage. Widths will vary as well as heights (higher points for safe zone nodes and lower points for general recreation uses). The “dunes” can be integrated into both private and public developments as visitor attractions, community activity areas, buffers from road noise, and protections for critical natural and habitat areas.

SELECTED SITES AND COMMUNITY TYPOLOGY PREFERENCE

The Project Safe Haven planning team and meeting participants selected five sites to discuss further for potential tower-type vertical evacuation facilities (Figure 32).

These include:

- PK1: Shoalwater Bay Casino Site
- T2: Tokeland Road and Evergreen Street
- T1: Nelson Crab Site and/or Tokeland Marina Area
- T5: SR 105 and Warrenton Cannery Road
- T4: SR 105 and Whipple Avenue

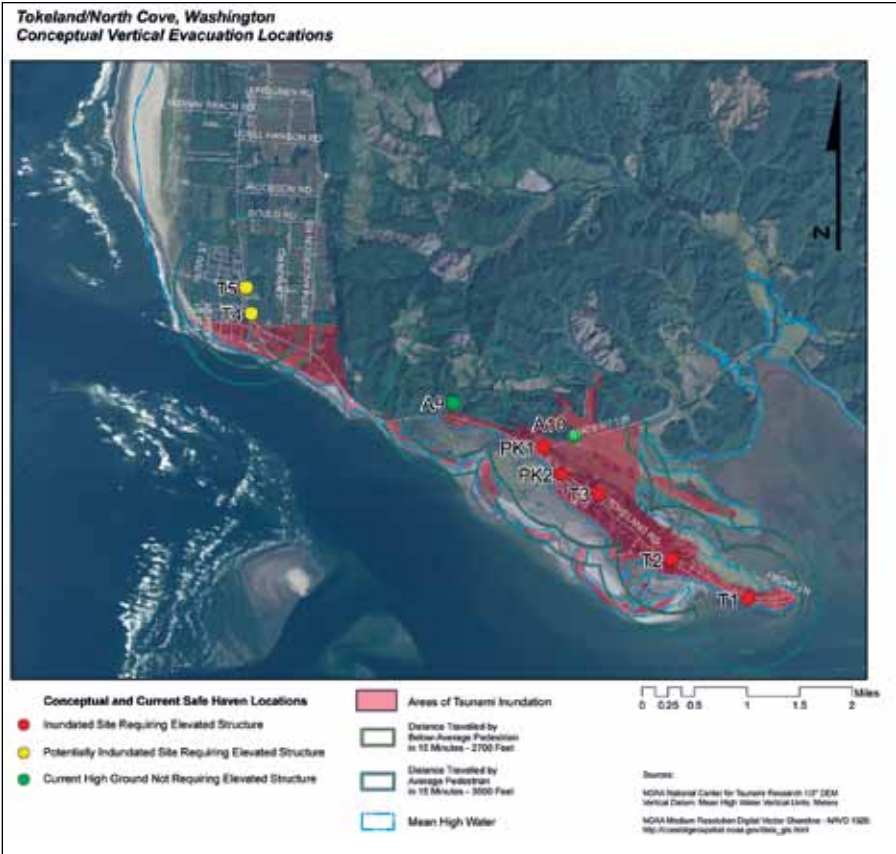


Figure 32: Tokeland/North Cove tsunami structure locations
The map portrays the selected locations of the tsunami vertical evacuation structures in the Tokeland area.

SITE: PK1: SHOALWATER BAY CASINO SITE PARKING STRUCTURE

- Minimum Height of Safe Zone Floor: 26 feet
- Capacity: 800 people
- Safe Zone area: 8,000 sf minimum

The Shoalwater Bay Casino is located on the north side of Highway SR 105 at the Tokeland Road entrance to the Tokeland Peninsula. The complex consists of a casino building with surface parking, and scattered accessory/residential buildings to the west. The site borders a wooded depression on the north side that separates the casino from safe higher ground to the north.

Expansion of the existing casino building is currently underway (Winter 2011) to add a single story restaurant and support facilities on the north side of the building. There is no public access from the north side of the new addition to the exterior spaces.

SHOALWATER BAY CASINO SITE PROJECTED IMPROVEMENTS

The Shoalwater Tribe anticipates future

development on this site, including further expansion of the existing casino, a new hotel and conference center, and a parking garage. A Coastal Walkway Retail Village is a concept contemplated by the tribe for the area north of the Shoalwater Bay service station south of Highway SR 105 at the entrance to the peninsula. A gift and information center with ocean viewing tower are possible uses within the village (Figure 33 and 34).

The tsunami vertical evacuation facility design concepts for the Shoalwater Bay complex explore various locations and tower typologies that can be incorporated into future development projects; and are illustrated and described in the following design concept drawings resulting from the Tokeland Design Charrette. They include: a new parking structure; hotel building components; and waterfront viewing tower as a part of the Coastal Walkway Village. The master plan for future development is an on-going process and these concepts do not represent a final vision. In addition, a number of options were explored by the design team to demonstrate the flexibility in

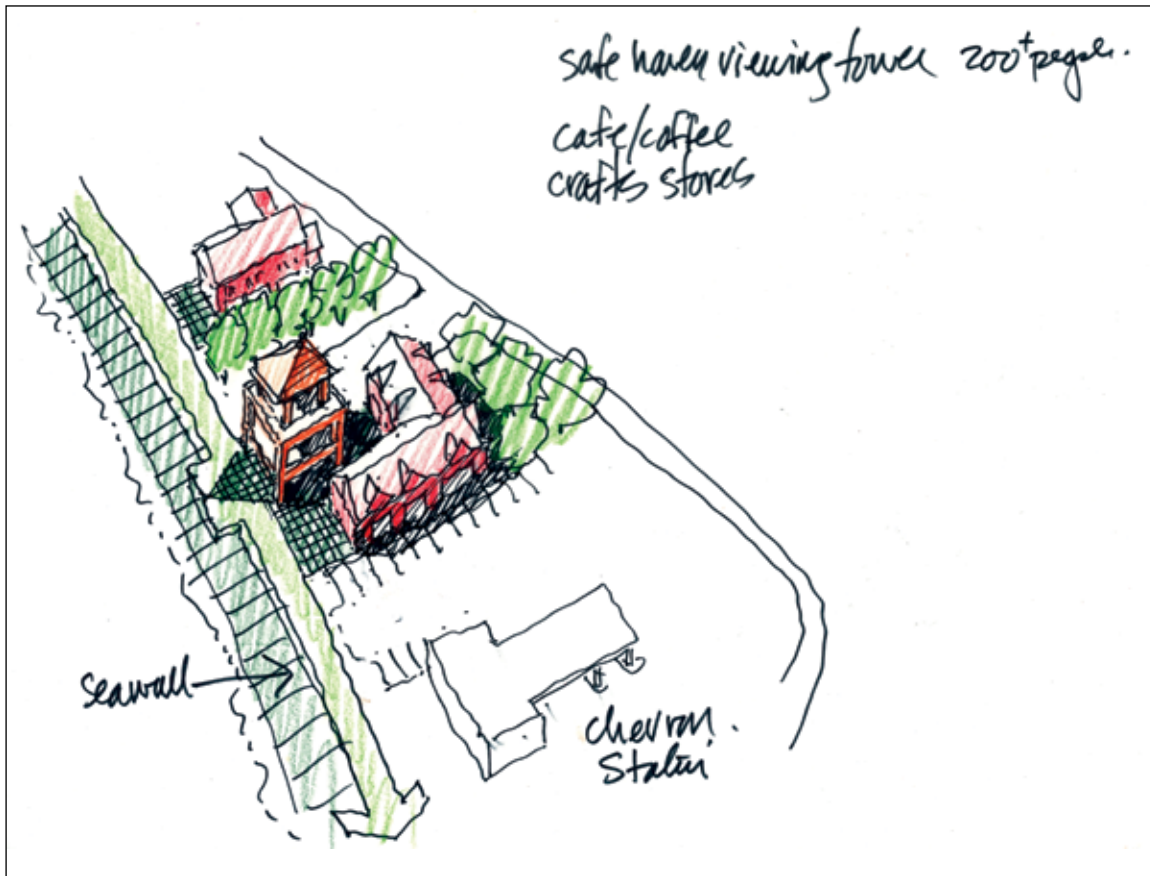


Figure 33: Tokeland safe haven and viewing tower concept

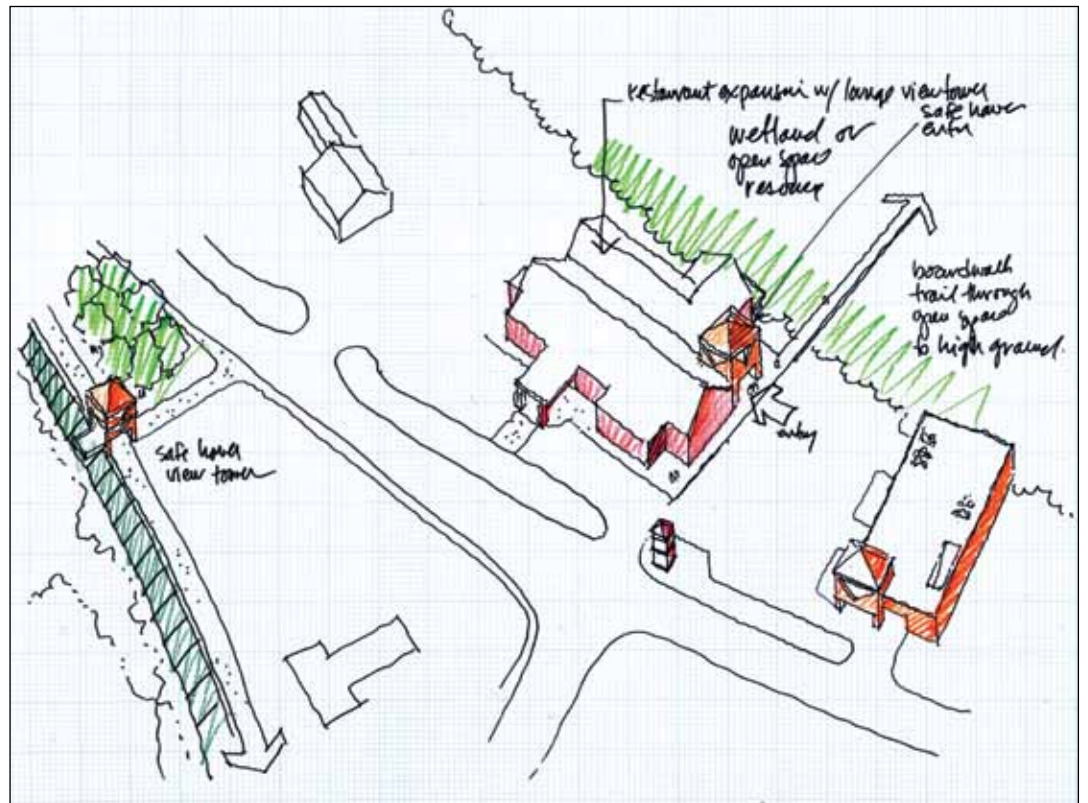


Figure 34: Potential Shoalwater restaurant expansion

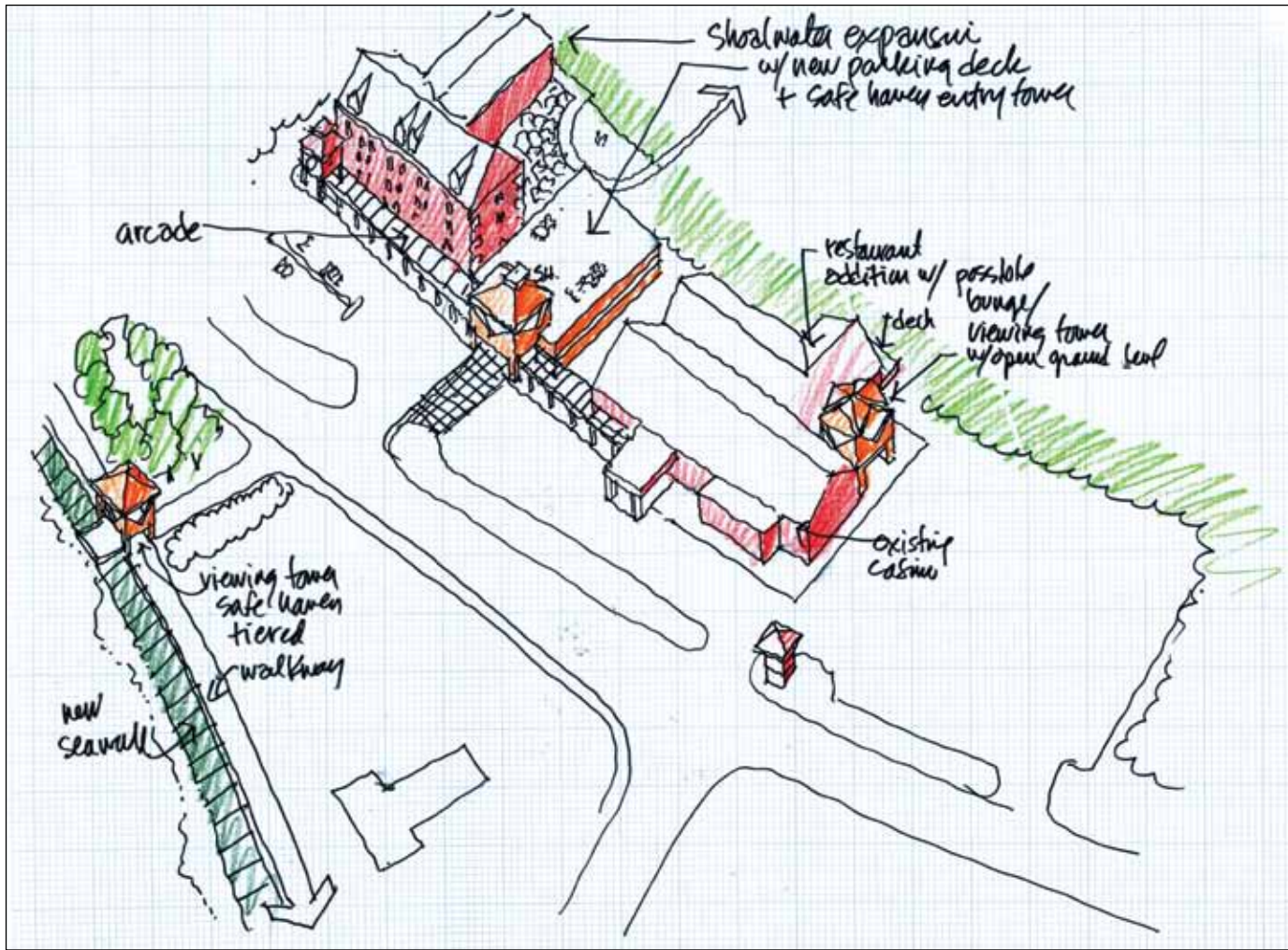


Figure 35: Shoalwater Bay charrette option

This concept was explored during the Tokeland Charrette, portraying a parking garage (D) located to the east of the existing casino building (A) and allocating space for casino eastward expansion (B), incorporating a tower facility into new construction. A pedestrian walkway/boardwalk loop (C) connects the casino complex with high ground to the north, returning via another walkway/boardwalk further west. These provide at least two potential high ground pedestrian facilities given a destructive earthquake. A new hotel and conference center (G) is located west of the existing casino. South of Highway SR 105, a vertical evacuation tower serves as a viewing tower (E) along the water edge and a coastal walkway (F).

locating vertical evacuation facilities within new building construction.

Shoalwater Bay charrette option

Following the charrette and based upon additional community input during the final charrette meeting, two additional development options were identified and are described below (see Figure 35).

Shoalwater Bay Casino option one

Figure 36 is a conceptual drawings for option one.

Shoalwater Bay Casino option two

Figure 37 is a conceptual drawing of option two.

All Shoalwater Bay Casino options incorporate a boardwalk loop from the casino facilities into and through the forested depression north of the complex. This loop connects the casino properties to high ground, hiking and other outdoor activities.

SITE: T2: TOKELAND ROAD AND EVERGREEN STREET

- Minimum Height of Safe Zone Floor: 20 feet
- Capacity: 120 people
- Safe Zone area: 1,200 sf minimum

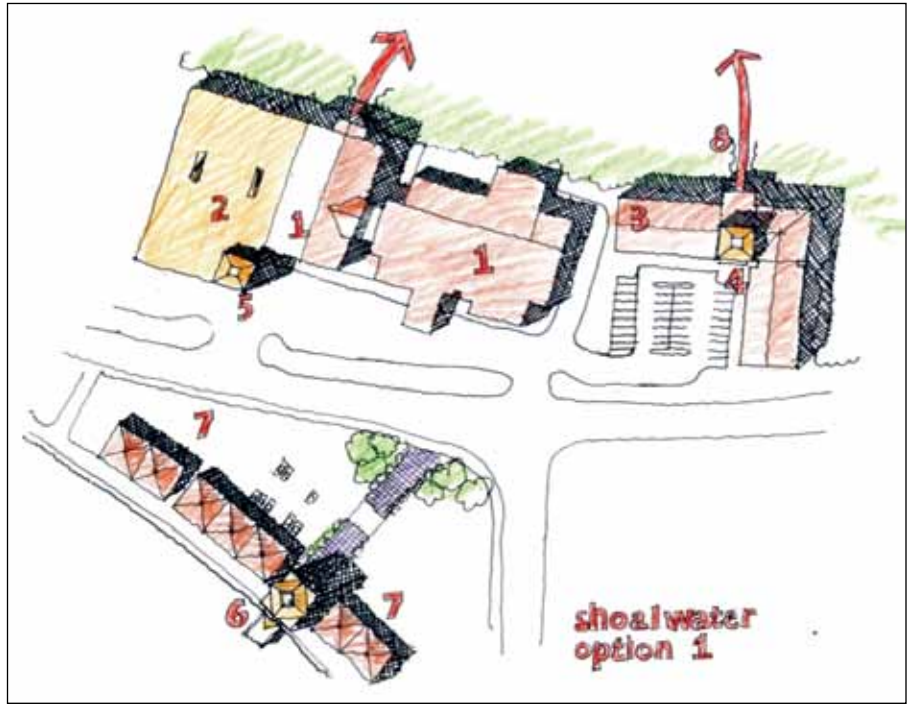


Figure 36: Option one

This consists of a new hotel and conference center, casino expansion, parking garage, and Coastal Walkway Retail Village. Elements include the existing casino (1) with current expansion on north side; (1a) future casino expansion; (2) future parking garage with vertical evacuation facility (5) incorporated into and higher than the parking structure entry given a two only a story parking deck; (3) future hotel structure with potential vertical evacuation tower(4) incorporated into hotel entry and lobby area; (6) vertical evacuation tower/viewing platform with waterfront access incorporated into a Coast Walkway Arts and Crafts village with small shops and waterfront access (7); and a walkway/boardwalk loop (8) that connects the casino complex to high ground to the north, augmented by additional tourism facilities and trails.

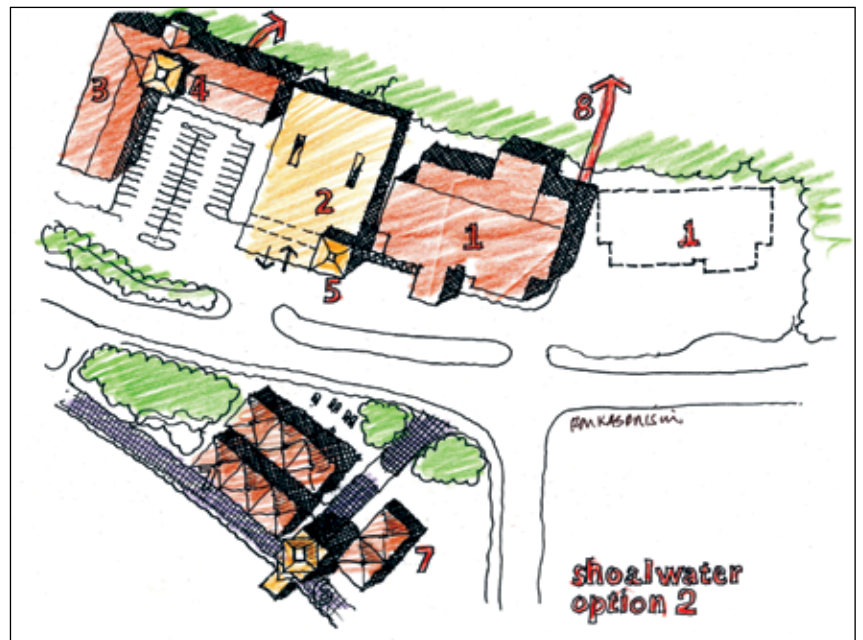


Figure 37: Option two

This option contains the same elements as Option One, in a different configuration. Elements include the existing casino (1) with current expansion on north side; (1a) future casino expansion to the east; (2) future parking garage with vertical evacuation facility entry structure (5) incorporated into and higher than the upper parking deck if needed; (3) future hotel structure with potential vertical evacuation tower(4) incorporated into hotel entry and lobby area; (6) vertical evacuation tower/viewing platform with waterfront access incorporated into a Coast Walkway Arts and Crafts village (7) south of the highway with a visible pedestrian concourse connecting the viewing platform and pedestrian crossing for the highway; and a pedestrian walkway/boardwalk loop connecting the casino complex with high ground to the north.

Figure 38: Tokeland Road and Evergreen Street Park
 The berm can be incorporated into a surface water detention facility with park and viewing facilities including a new habitat area.

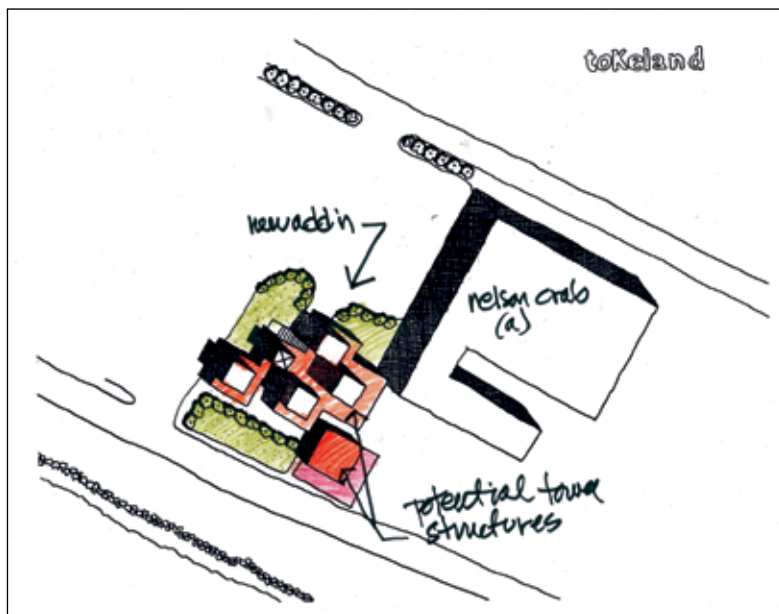
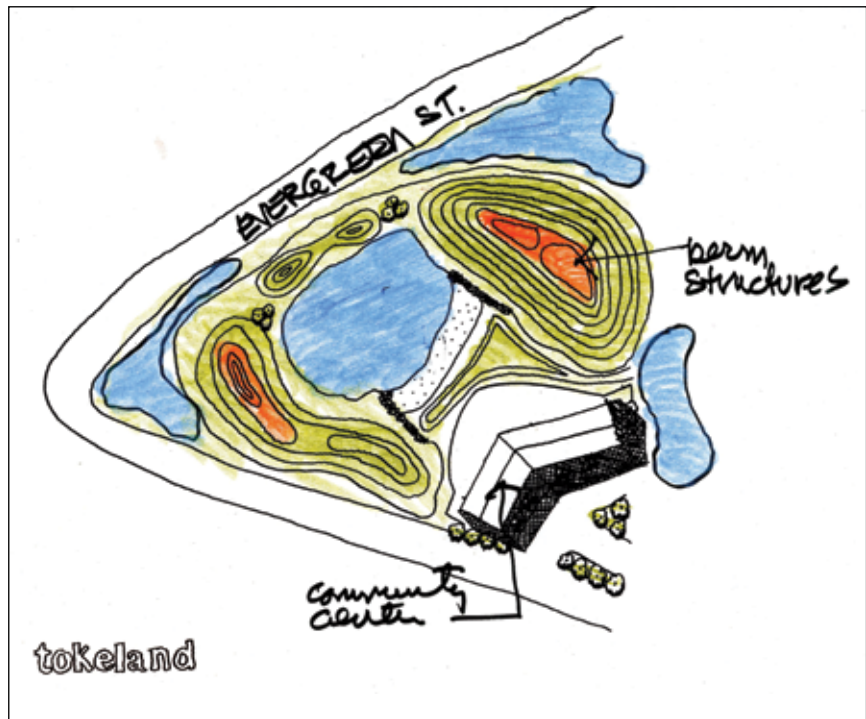
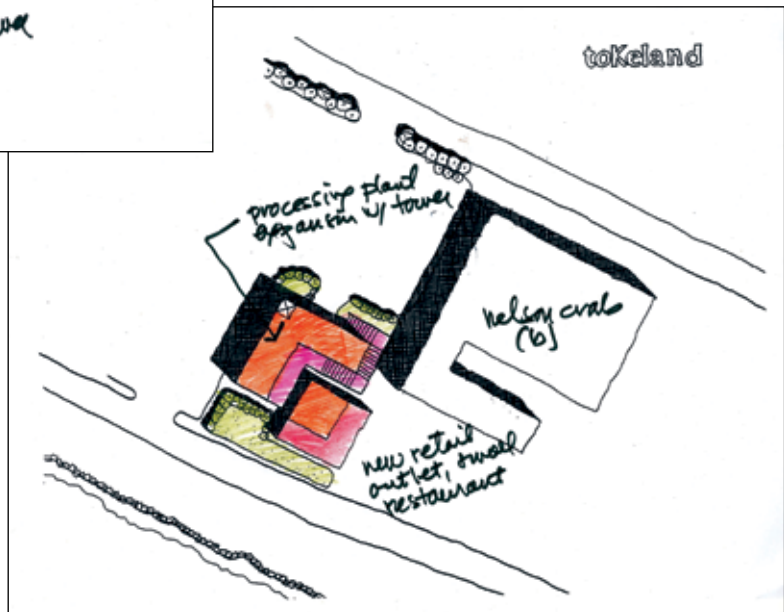


Figure 39: Nelson Crab expansion facilities
 In option (a), a vertical evacuation structure (orange area) is incorporated as an upper level in an expansion of office and processing space, including a new retail outlet. In option (b), a vertical evacuation tower is incorporated into a new office, processing and visitor area. The tower serves as a view platform for the surrounding waterfront; and the new visitor uses can include indoor and outdoor seafood dining facilities.



The vicinity for Tower 2 is along Evergreen Street east of the Shoalwater Bay housing development nearing completion (Winter 2011). Vacant land to the north and northeast is projected to be a mixed-use development with potential hotel, community center, housing, golf course expansion and other resort-type uses. Immediately east at the end of Evergreen Street is a ranch complex (see Figure 38).

The Evergreen Street site consists of a larger land area that can be suitable for a tower or a berm vertical evacuation facility, integrated into a larger master plan for future development. Interim surface water issues from surrounding construction uses and weather conditions affect the site. These water issues provide an opportunity to combine a berm-type evacuation facility with a surface water detention/infiltration facility and potential community center to form a park resource. The berm can serve as a passive recreation facility, neighborhood park, and viewing platform. A basic tower facility is an option for this open space site area.

SITE: T1: NELSON SEAFOOD PROCESSING SITE VICINITY

- Minimum Height of Safe Zone Floor: 20 feet
- Capacity: 80 people
- Safe Zone area: 800 sf minimum

The Nelson Seafood processing complex is located on Tokeland Road facing west toward the Pacific Ocean. The site contains processing plant and ancillary uses, a small retail outlet and office area, and vacant land to the north. The site is surrounded by residential uses to the north, east and south. The site provides an opportunity for private sector participation in the tsunami vertical evacuation facility implementation.

Economic incentives such as tax credits and/or governmental funding assistance may be available to the current property owners. The owners could incorporate a vertical evacuation facility into new construction in a number of ways: as a component of an expanded processing facility; as a component of a new retail, office and visitor center with dining

facilities (indoor/outdoor seafood bar); and, as a free-standing tower facility (see Figure 39).

SITE: TOKELAND MARINA MARKET SQUARE

- Minimum Height of Safe Zone Floor: 20 feet
- Capacity: 80 people
- Safe Zone area: 800 sf minimum

Sustainable Tokeland, a local community group, has proposed various improvements for the peninsula to improve both the level and type of community facilities and visitor attractions. Among their recommendations are: improved beach access, a boardwalk at key sites in marina area, an educational center, observation towers for bird watching and other wildlife activities, local seafood market and restaurant/coffee shop, a community center and/or museum, an interpretive center, public restrooms at the marina, community garden, and playground areas (see Figures 40 through 43).

Many of these ideas can incorporate a vertical evacuation structure(s) into a marina uplands master plan, providing additional sources of potential implementation funds.

An alternate site for a vertical evacuation tower, or additional tower facility, is situated on Tokeland Marina uplands on the southern tip of the Tokeland Peninsula. Sustainable Tokeland envisions an open-air market and festival space on the marina uplands with a small complex of permanent buildings surrounded by temporary festival booths for seasonal events. New buildings (and/or conversions of existing buildings) can contain a community center, museum and/or interpretive center, restaurant or coffee shop, and public restrooms as a part of the building complex to improve security. The marina uplands is presently occupied by one industrial building, a Nelson Seafood industrial facility on the water edge, and surface parking for commercial and sports fishing vehicles also on a seasonal basis.

Based on community input during the Tokeland Charrette, a vertical evacuation tower structure is recommended as a key feature in a number of design options for the Market Square proposal,

with improved public waterfront access. Final design will be determined by funding and final community input. The options presented here reflect the community's preferences for a market festival facility as of Winter 2011 and will be used as a basis of continuing community dialogue.

SITE: T5: NORTH COVE SR 105 & WARRENTON CANNERY ROAD

- Minimum Height of Safe Zone Floor: 24 feet
- Capacity: 80 people

- Safe Zone area: 800 sf minimum

Waterfront lands to the west of SR 105 are rapidly eroding, threatening existing residential areas and infrastructure. Construction of a basic tower along the east side of SR 105 is a straightforward approach for the vacant lands along the highway. This structure is perceived as a basic tower platform set back from the road at the rear parcel lines of selected properties.

Figure 40: Tokeland Market Square Option One

This concept plan utilizes land along the eastern edge of the Tokeland Marina properties for a market festival facility. The plan consists of two permanent structures—a vertical evacuation tower as a central focal point and a community building—plus temporary festival booths. Shoreline/waterfront is to the northeast and southeast (to the right and bottom in diagram).

Components include (1) a

vertical evacuation facility viewing tower for bird habitat areas (views north, west and east), with a usable ground level visitor information booth and display area with stair access to upper viewing and safe zone levels; (2) a community building with small meeting room, offices for Chamber of Commerce and other local organizations, and restroom facilities within the building with exterior secured entry for security, as a minimum footprint; (3) play and exhibit area with stage for musical events, shelter optional, with rock rubble wall on south and west faces, all oriented toward the key entry point into the marina area; (4) staff/community building parking (seven spaces minimum); (5) relocated drain field; (6) temporary festival booths, approximately ten feet square (seasonal); (7) existing port building; (8) ground level viewing shelter on waterfront; (9) small waterfront park area for bird watching with benches and basic landscaping; (10) parking and staging area for fishing activities; (11) bird habitat area and larger water environment (bay and ocean) views. Additional building structures are possible on the site including a restaurant or coffee shop, an interpretive center, etc. a vertical evacuation structure can also be incorporated into one of the new port buildings, mentioned above. Specifically, a hardened building component with a flat roof (at 23 feet minimum height) can be incorporated into either a three story building or a two story building with a tower component (stair tower, mechanical core, etc.) to achieve a 23-24 feet height.

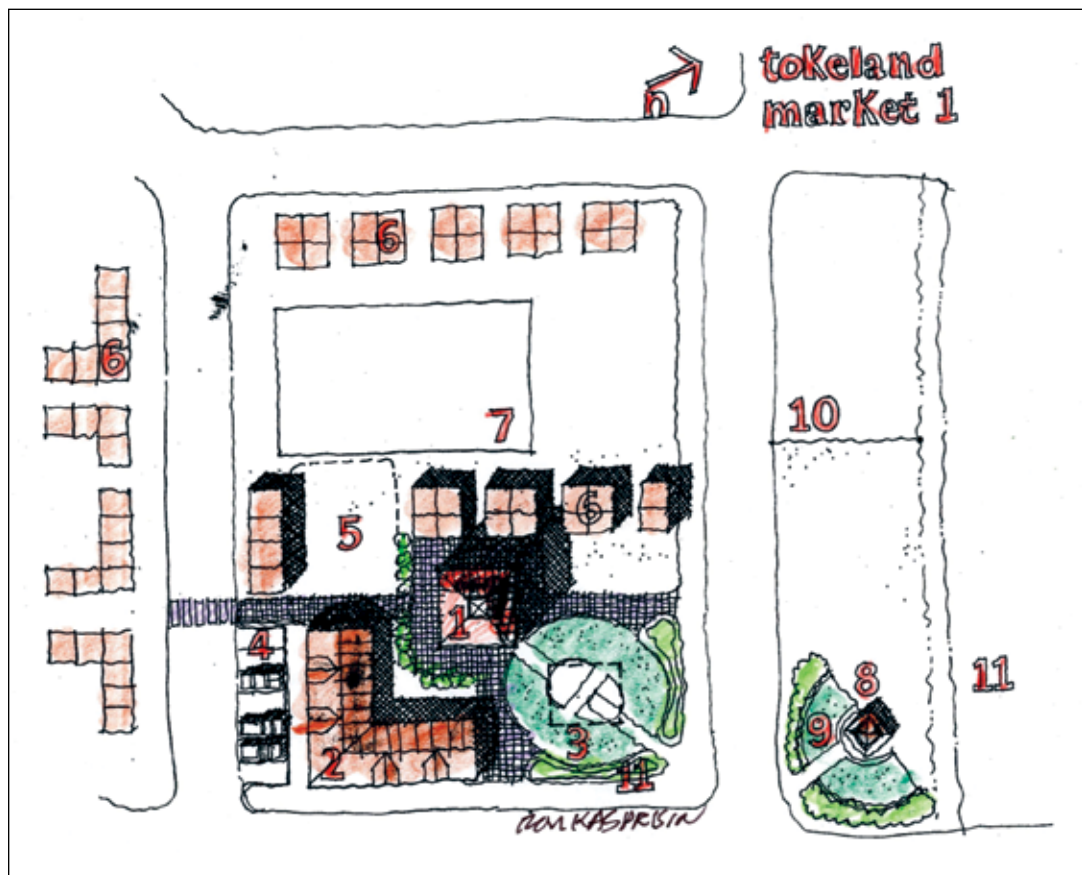


Figure 41: Tokeland Market Square Option Two
 This incorporates the vertical evacuation facility into a new community building. Components consist of a vertical evacuation facility (1) incorporated into a community building with information center and waterfront interpretive center on ground floor of the tower with a marquee for weather protection, and external stair access to upper viewing levels and safe zones; (2) community building with meeting room, Chamber of Commerce office, public restrooms; (3) common area with music stage, grassy berm for informal seating, general play area; (4) staff/community building parking (seven spaces minimum); (5) relocated drain field; (6) temporary festival booths, approximately ten feet square; (7) existing port building; (8) ground level viewing shelter on waterfront; (9) small waterfront park area for bird watching with benches and basic landscaping; (10) parking and staging area for fisherman; (11) rock rubble wall facing west and south; (12) bird habitat area and water environment.

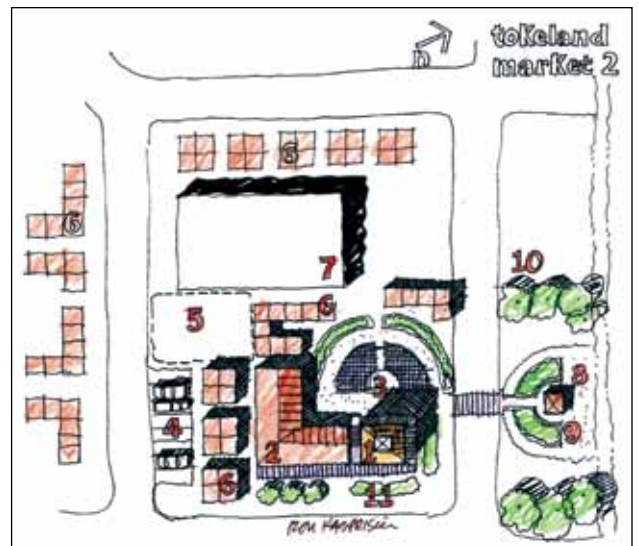
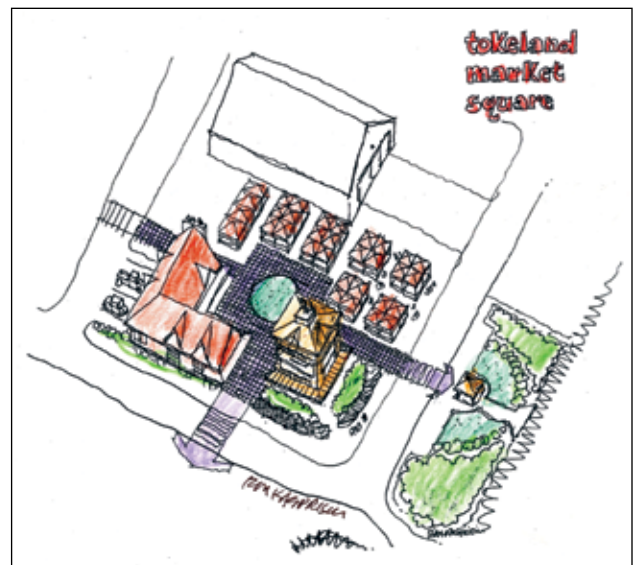


Figure 42: Tokeland Market Square Option Three
 Option 3 establishes a more formal community square with permanent and temporary facilities. Option 3 consists of (1) vertical evacuation facility viewing tower for bird habitat areas (views all directions with optional ground level tourism uses such as information center, display area; (2) community building with small meeting room, offices for Chamber of Commerce and other local organizations, and restroom facilities within building for security; (3) play and exhibit area with stage for musical events, with rock rubble wall on south and west faces; (4) staff/community building parking (seven spaces minimum); (5) relocated drain field; (6) temporary festival booths (seasonal); (7) existing port building; (8) ground level viewing shelter on waterfront; (9) small waterfront park area for bird watching; (10) parking and staging area for fisherman; (11) bird habitat area and water environment.



Figure 43: Tokeland Market Square axonometric diagram
 The axonometric drawing portrays a three dimensional view of the Tokeland Market Square concept with integrated vertical evacuation tower.



TOWER DESIGN CONCEPTS

Vertical evacuation towers for the Tokeland Peninsula sites have both generic and site specific design characteristics. The following illustrations describe both characteristics and are intended as a guide for site-specific applications, not as models for universal embedding in other communities. The tower designs continue to evolve as each charrette community explores the various ways to embed the tower structures into their community form.

General tower characteristics include:

- Square, triangular or rectangular footprints
- Tower footprints occupy less land area on average than berm-type facilities
- Access to safe zones is via stairways, presenting potential barriers for physically challenged citizens
- Roof and wind coverings are optional

Ramp facilities and sloping berms provide additional access for more citizens and are incorporated into site-specific designs as land area permits.

Site-specific characteristics, described in the following section, include:

- Serving as viewing towers with partial or full upper enclosures
- Ground level uses for tourism including information booths, community displays, food service
- Storage bunkers
- Industrial facilities
- Building components
- Park and open space features

Vertical evacuation towers present an urban design challenge in that they are bulky (1,000 square feet footprint per 100 persons) and are industrial in nature, making them less appealing for residential areas. A part of the challenge in tower design is to reduce this bulky appearance to reduce visual impacts in low-scale locations.

SHOALWATER BAY COMPLEX TOWER DESIGN OPPORTUNITIES

The Shoalwater Bay Tribe currently has several plans for future construction/improvement projects in the works. The design team worked with the Tribe to identify potential multi-use facilities to be integrated into future construction projects that could also serve as vertical evacuation structures.

Tower as building component

If new building construction is planned for the Shoalwater Tribal complex, vertical evacuation facilities as towers can be incorporated into portions of new structures as opposed to an entire structure. This can reduce construction costs and provide additional architectural features to new structures.

Tower and parking garage

A parking structure less than three levels may not be sufficient to provide a safe zone height of twenty-three feet. To augment the tsunami-hardened parking structure, a tower assembly may be necessary as an upper addition at a corner of the parking structure; as an entry structure; or, viewing tower to add a safe zone level as a part of the larger building structure. Refer to the Shoalwater concept plans for more detail.

Tower as tourism viewing platform/waterfront amenity

A new waterfront Coastal Walkway Crafts Village is a potential addition to the Shoalwater tribal complex, south of Highway SR 105 at the entrance to the Tokeland Peninsula. A vertical evacuation tower is incorporated into the coastal walkway and as a part of a new retail village of small shops, connected to controlled crosswalks at Highway SR 105 and Tokeland Road (see Figure 44).

Additional tower design explorations are included for continuing dialogue. Towers can resemble building structures, be semi-enclosed, contain circular ramp facilities, and sloping berms. The design of the tower structure is a continuing process (see Figure 45).

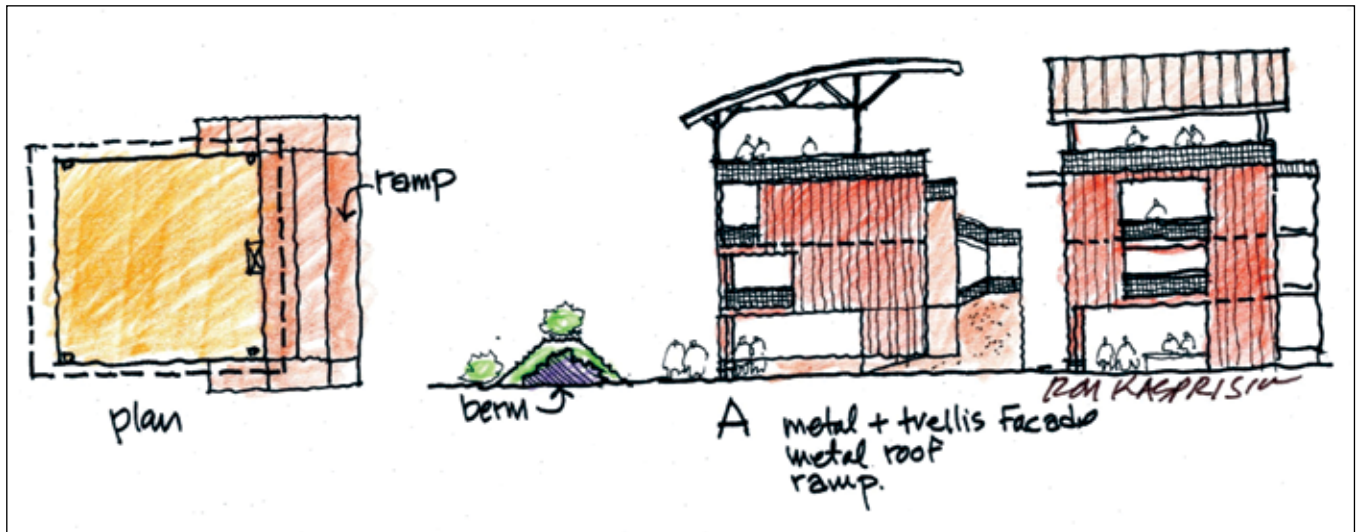


Figure 44: Coastal Walkway Arts and Crafts Village viewing tower.

The viewing tower can incorporate additional design features to reflect its prominent location along the waterfront and walkway; as a component of a retail village; and, as a new architectural element representing the Shoalwater tribal culture. The tower is 19 feet high at the safe zone with lower intermediate viewing levels with a capacity of 500 people. It has a covered upper level with an optional three sided galvanized metal core enclosure for wind and weather protection. The example sketch in no way represents a final architectural statement for the Shoalwater culture.

L. CONCEPTUAL COST ESTIMATES

Detailed cost estimates for four representative structures were developed. These estimates are included in the *Safe Haven Vertical Evacuation Structures Conceptual Cost Analysis*. (See Appendix M.) Because of site differences, facility height, and design it is difficult to offer an accurate total costs for all safe haven facilities. However, having said this, the residents of Pacific County

have suggested 20 facilities offering tsunami safe havens for 6,300 residents through the construction of 13 berms, 5 towers, and 2 buildings. If construction costs for all facilities are representative of those per person capacity estimates that have been developed, the total cost for the 20 safe haven facilities could be in the neighborhood of \$11 million.

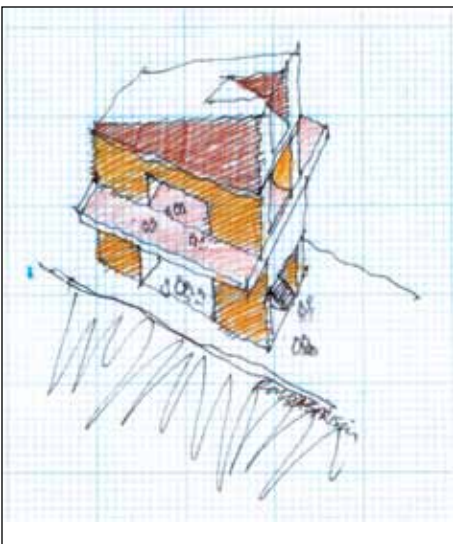
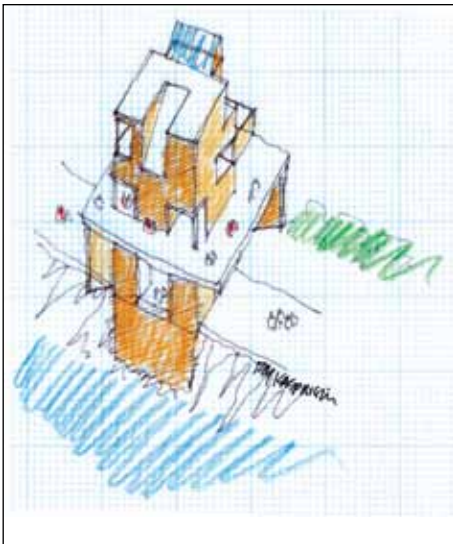
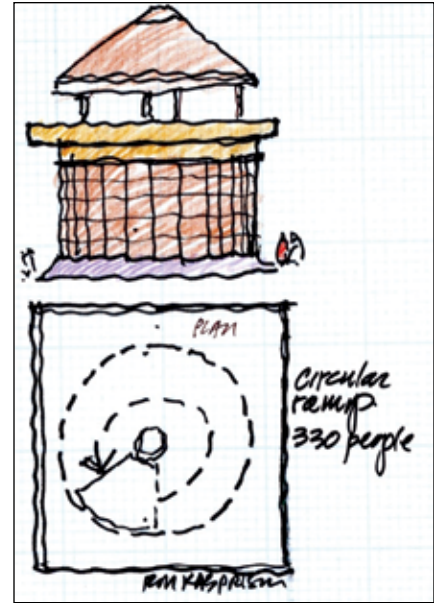
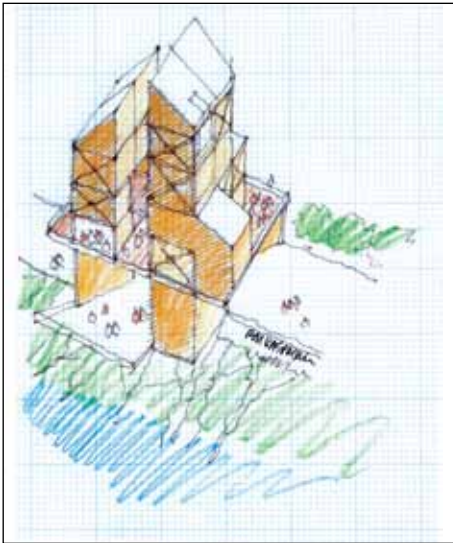
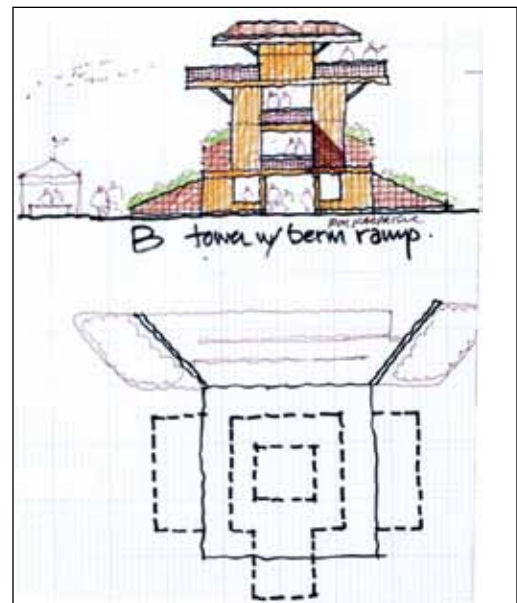


Figure 45: Additional tower explorations.

There are many adaptations of towers for the coastal communities. The examples that follow reflect comments and explorations of tower designs that can have multiple uses. A design challenge in tower design is the large footprint of the safe zone and how that large footprint is reduced in appearance. Some explorations used cantilevered platforms and others are more building type in nature. They are guides for further experimentation. Example (a) portrays a multi-level viewing tower; (b) explores a circular ramp structure providing improved access; and (c) experiments with festival or tourism facilities incorporated into a berm-tower combination with ramp access.



5. CONCLUSIONS AND NEXT STEPS

Pacific County has high risk/low frequency tsunamis triggered by magnitude 9+ Cascadia subduction zone earthquakes. The last Cascadia earthquake to trigger such a tsunami was recorded in 1700 AD. The rate of occurrence is every 400 years. As a result, the concept of vertical evacuation as a strategy to provide refuge and high ground for evacuation along Washington's coast could not be timelier. The preferred strategies developed for the four Pacific County communities reduce their vulnerability by proposing vertical refuges that are accessible to a significant amount of the population, both resident and tourist populations. The strategy was created through a process that builds upon the community's strengths and minimizes its weaknesses, to make the communities safer and more prepared. In the future, the preferred strategies may be revisited and modified as needed. Funding opportunities will be researched and solicited in order to implement the preferred strategies with local government coordination. Implementation will take place at a local level with possible state assistance, based on community needs, preferences and response to public input gathered during the duration of Project Safe Haven.

RECENT INTERNATIONAL EARTHQUAKE AND TSUNAMI EVENTS

The Pacific County Project Safe Haven report was in the process of being developed at the time of the February 27th, 2010 Chilean earthquake and tsunami. The March 11th, 2011 earthquake and tsunami in Japan took place during the same evening of a Project Safe Haven workshop in Grays Harbor County. As a result, the processes and report development has been influenced by both international earthquake and tsunami events.

Both events in Chile and Japan teach us the importance of tsunami preparedness and mitigation. Several of the structures in Japan, intended for vertical evacuation, saved lives while some did not function as well because of prior assumptions about the size of the event. Therefore, it is

imperative that the assumptions in these reports are dutifully revisited following any significant earthquake and/or tsunami to ensure that they remain valid and the conclusions reached in the reports are still applicable. Some of the items that may be revisited are: pedestrian travel times, engineering assumptions, subsidence, i.e.. On a related note, it is important to note that both reports are based on either existing tsunami inundation modeling and/or interpolation of existing modeling by technical experts.

Prior to construction of any proposed vertical evacuation refuge, additional and/or comprehensive tsunami inundation modeling is required. The approach recommended by this study is to use what is known as an ensemble modeling approach, which uses multiple tsunami inundation models and sources to determine the amount of flooding and the velocities of currents from a Cascadia event. The existing models, while good for traditional evacuation planning purposes, are not recommended for determining the final necessary height or elevation of a life-safety structure, such as a vertical evacuation refuge.

TSUNAMI VERTICAL EVACUATION REFUGES

It is important to communicate that the proposed vertical evacuation structures are "refuges" and not "shelters." According to FEMA P646, vertical evacuation refuges are not necessarily required to meet ADA requirements when they operate as a refuge. However, for day-to-day uses, vertical evacuation refuges should consider the needs of disabled occupants to the extent possible and the extent required by law, in the event of an emergency evacuation. During a tsunami evacuation, following a near-source earthquake, disabled evacuees may need additional assistance accessing refuge areas in vertical evacuation structures.

Throughout the public process of Project Safe Haven it has been the sincerest desire of the communities to incorporate accessibility features into the refuges to the greatest extent possible. For example, a hybrid tower-berm vertical evacuation

structure typology was developed to specifically address the needs of those with limited mobility as the berm portion of the structure includes ramps for wheelchair access. All drawings included in this report are conceptual in nature and as a result no engineered drawings for permitting have been developed. In later stages of vertical evacuation structure development additional accessibility features may be incorporated into the existing conceptual designs. Ultimately, compliance with ADA may vary by structure type, function and whether or not the detailed building plans call for long-term sheltering options as opposed to a short-term safe area for refuge.

FUTURE SOCIAL SCIENCE RESEARCH

Additional social science research is necessary before implementation takes place. The research should look at how the proposed vertical evacuation refuges will be phased in over a number of years and how the refuges should be incorporated into existing evacuation planning and messaging. A strategy and methodology for how to conduct public education about evacuation to vertical evacuation refuges needs to be created with updated, accompanying evacuation maps.

IMPLEMENTATION AND FUNDING OPPORTUNITIES FOR VERTICAL EVACUATION REFUGES

Tsunami vertical evacuation refuges have been developed over the course of decades in countries like Japan that historically had many significant tsunami incidents. Elsewhere, in countries that have also been recently impacted by devastating tsunamis, like Indonesia, tsunami vertical evacuation refuges are currently in the process of being implemented through the development of outdoor elevated parks. Funding for these projects has largely come from government or private sources. Intentionally designing any type of structure to serve as a tsunami safe haven is a relatively new concept for the United States and no official guidance for engineers or planners existed until late 2008. Traditional funding sources for structural mitigation activities, such as FEMA's Hazard Mitigation Grant Program (HMGP) and Pre-Disaster

Mitigation (PDM), do not yet consider tsunami vertical evacuation refuges eligible projects; however, Washington Emergency Management is currently working with FEMA and other stakeholders regarding this issue. It is likely that funding for implementation of this plan will require a combination of federal, state, local, private, and/or non-profit sources to realize full implementation in a timely manner. A variety of incentives may also be considered in order to leverage privately funded development projects. Therefore, project team members and local residents have begun to identify viable options to bring tsunami vertical evacuation to fruition in vulnerable communities along the coast. These funding options currently include, but are not limited to, the following:

Public:

- Federal and State financial assistance with grants
- Local Improvement Districts
- Incorporation of safe haven structures or components thereof into new public works facilities
- Incorporation of safe haven structures or components thereof into new civic and recreational facilities

Private:

- Internal Revenue Service tax credits similar to Historic and/or Architecturally Significant tax credits
- Business improvement areas
- Local and state tax credits
- Zoning incentives in permitting, site requirements and building program (density, parking, square feet, building heights)
- Private donations

CONCLUSION

In conclusion, it is important to note and remember that Project Safe Haven is merely a starting point. A collective community vision has been facilitated, recorded and presented. This report will serve as a guide and tool for how tsunami vertical evacuation may be incorporated into the community over a prolonged period of time with continued community support and direction.

APPENDIX A: COMMUNITY CONTEXT MAPS



Figure 46: Long Beach community context map

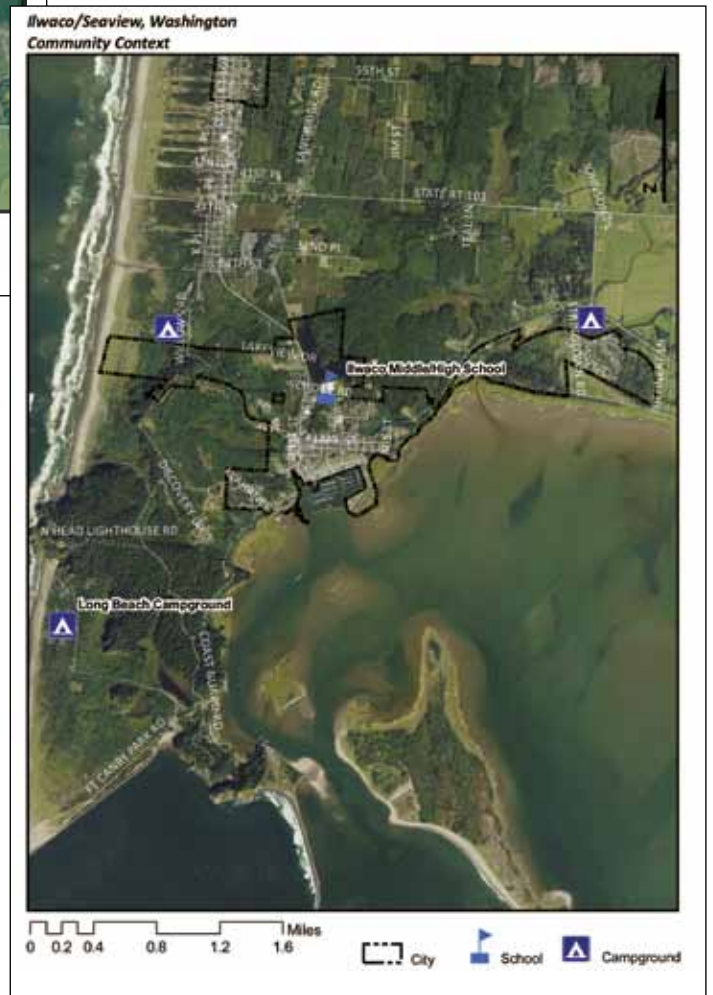


Figure 47: Ilwaco/Seaview community context map



Figure 48: Ocean Park community context map



Figure 49: Tokeland/North Cove community context map

APPENDIX B: SWOT ANALYSIS DESCRIPTION

SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. The project team used SWOT analysis to identify the features of the preferred alternative that address underlying characteristics of the community. The SWOT analysis helps demonstrate that the preferred alternative builds on the community's strengths, overcomes weaknesses, takes advantage of opportunities, and minimizes threats. A version of the SWOT analysis was carried out during the second community meeting in an annotated form of strengths and weaknesses evaluation. Meeting participants were given strengths and weaknesses forms to fill out for each conceptual vertical evacuation site. The following represents the underlying assumptions and definitions of each: strengths, weaknesses, opportunities, and threats:

STRENGTHS ARE CAPABILITIES

They are internal to the community and represent items to build upon. Categories of strengths include: financial; mobility; preparedness and awareness; and built and natural environment. The preferred alternative builds on the community's strengths.

WEAKNESSES ARE IMPACTS, EXPOSURES, OR VULNERABILITIES

They are internal to the community and represent items to overcome. Categories of weaknesses include: financial; mobility; preparedness and awareness; and built and natural environment. The preferred alternative helps overcome the community's weaknesses.

OPPORTUNITIES ARE CAPABILITIES

They are external to the community and represent items to exploit or enhance. Categories of opportunities include: business and economic; human and social capacity; natural and environmental; and built environment. The preferred alternative exploits opportunities available to the community.

THREATS ARE HAZARDS

They are external and generally out of the community's control. Categories of threats relate to geography, built environment, and demographics. The preferred alternative helps minimize the threat presented by a tsunami.

APPENDIX C: LONG BEACH SWOT ANALYSIS COMMENTS

Table 13: Long Beach SWOT comments (SWOT Explained in Appendix B)

| STRENGTHS AND WEAKNESSES COMMENTS | | |
|--|---|---------------------------------------|
| ALTERNATIVE ONE | ALTERNATIVE TWO | ALTERNATIVE THREE |
| Multi-functional | Public use | Blocks views |
| Potentially ADA accessible | Close to the beach (and thus the tsunami) | Privately owned vs. public building |
| Inexpensive construction costs | Not easily accessible for seniors (stairs only) | Close to beach (and thus the tsunami) |
| | Public building | Expensive |
| | Encourage tourism | |

APPENDIX D: PROJECT ASSUMPTIONS

To carry out the vertical evacuation community analysis, the project team made assumptions about the tsunami hazard, berm construction and design, and capabilities of the Pacific County population.

ASSUMPTIONS ABOUT THE TSUNAMI HAZARD

1. The scenario event will be a 9.1 magnitude subduction zone earthquake approximately 80 miles off the coast of the Long Beach peninsula.
2. The earthquake will last five to six minutes and will create a tsunami.
3. Six feet of subsidence is expected.
4. The modeled tsunami will have a wave-height of approximately 22 feet (NGVD) at the peninsula's western shore, depending upon localized bathymetry, topography and the built environment.
5. The warning before the tsunami will be the earthquake.
6. There will be about 40 minutes between the cessation of shaking and arrival of the first tsunami wave.
7. Although subduction zone earthquake models propose a tsunami warning time of 40 minutes, the creation of the preferred strategies are based on a 15 minute warning time. This reduced warning time takes into account delayed response time of citizens, poor road and sidewalk conditions resulting from the earthquake, as well as possible panic among citizens. Additionally, evacuees will need 5 to 10 minutes to reorient themselves after the earthquake and will ultimately have 15 minutes to walk to a safe haven.
8. Several other tsunami waves will likely follow the initial wave, and there will be danger of recurring waves throughout the entire post-event tide cycle.

9. Tsunami refugees will remain on the structure for two full tide cycles, or up to 24 hours.
10. Routes to vertical evacuation structures will be available and discernible after the earthquake.
11. Those evacuating will walk to the vertical evacuation structures — travel by car will not be possible.
12. Communication will be limited to voice.
13. There are natural lines of defense.
14. Some natural lines of defense have been destroyed.
15. Lines of defense that have been removed can be restored.

ASSUMPTIONS ABOUT THE CAPABILITIES OF THE LONG BEACH POPULATION

1. The majority of the Long Beach population is physically mobile and can walk to the proposed tsunami evacuation sites.
2. An average walking speed individual can walk 3,600 feet in 15 minutes and a slower walking speed individual can walk 2,700 feet in 15 minutes.
3. People on the beach have average to high physical mobility.
4. There is an awareness of tsunami risk in Pacific County.

ASSUMPTIONS ABOUT THE BERM CONSTRUCTION AND DESIGN

1. Safe havens can be provided.
2. The margin of safety (distance between the height of the tsunami and the floor of the berm) is factored to be 10 feet [Height above inundation level (4 feet) plus margin of safety (3 feet) plus allowance for climate change (3 feet)].

3. If the vertical evacuation structures are constructed on sites where wetlands are compromised, new wetlands will be developed or the compromised wetland will be mitigated in another way.
4. Each vertical evacuation structure will provide ten square feet of space per person.

APPENDIX E: LINES OF DEFENSE

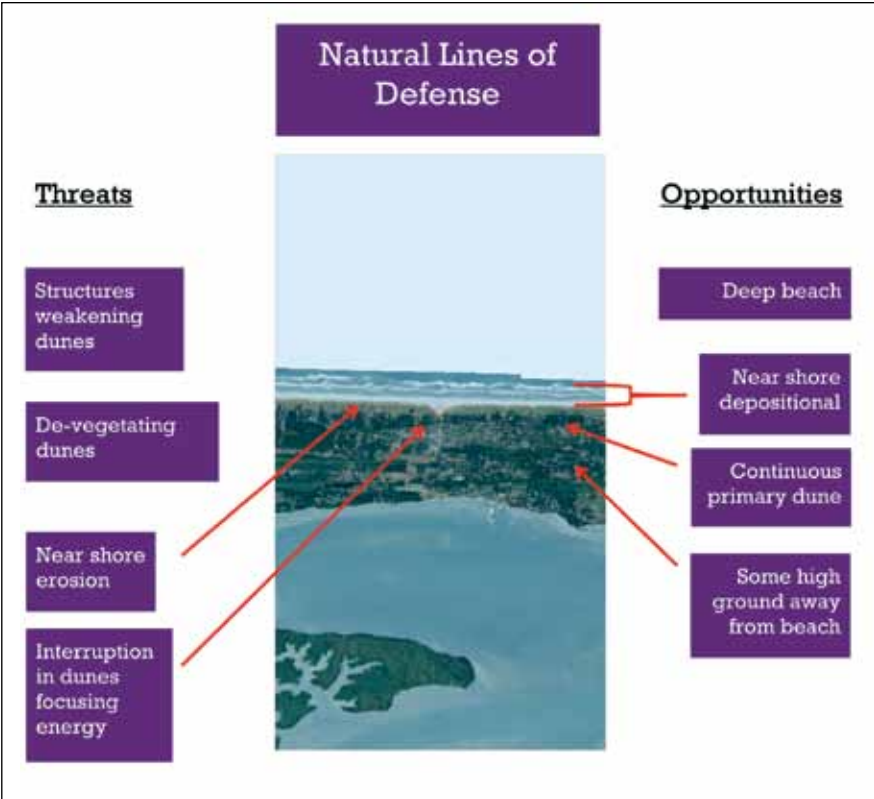


Figure 50: Natural lines of defense in Pacific County

KEY ASSUMPTIONS

- The scenario event will be a 9.1 subduction zone earthquake.
- Ground shaking will provide ample warning.
- The wave height will be approximately 22 feet at western shore.
- Safe havens will include 10 feet margin of safety.
- There will be up to 40 minutes before arrival of the first tsunami wave.
- Evacuees will need 5-10 minutes to reorient themselves after the earthquake and will have 15 minutes to walk to a safe haven.
- Average-walking speed person can walk 3,600 feet in 15 minutes and slower-walking person can walk 2,700 feet.
- Evacuees will have to remain on safe havens through one complete tide cycle.
- Routes to safe havens will be available and discernible after the earthquake.
- Those evacuating will walk to safe have. Vehicular travel will not be available.
- Communication will be limited to voice and radio.

APPENDIX F: OCEAN PARK AREA MAPS

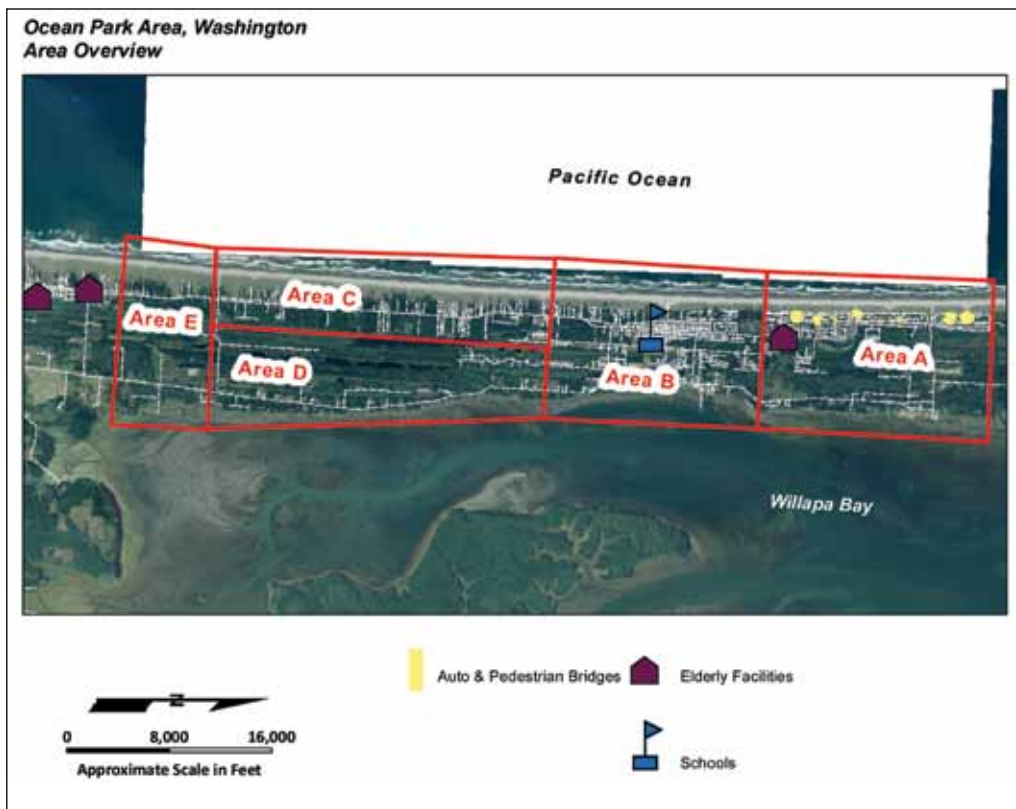


Figure 51: Ocean Park area overview

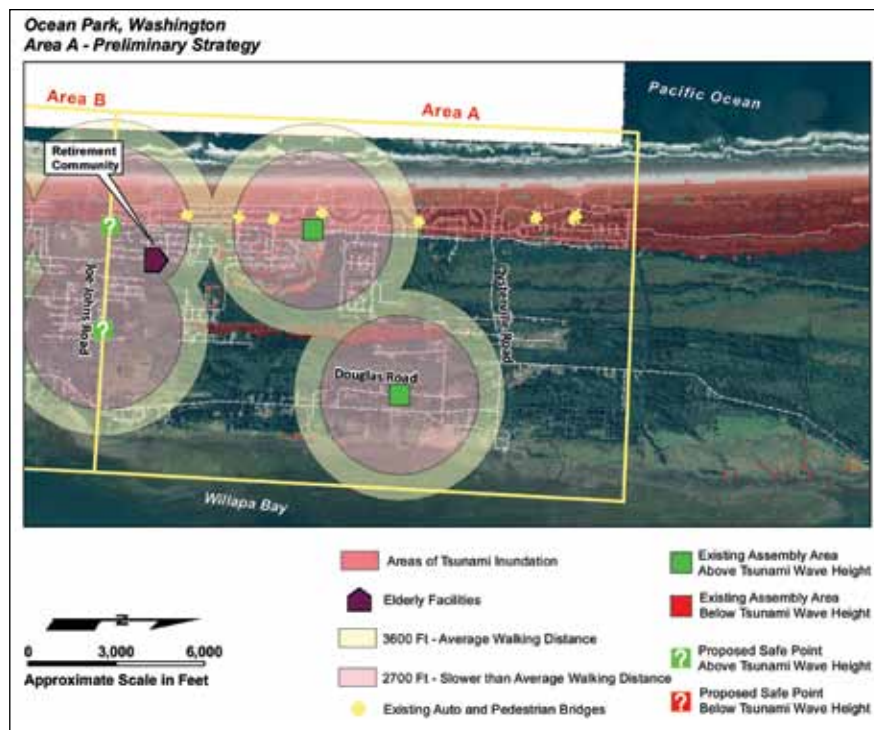


Figure 52: Ocean Park area A

Figure 53: Ocean Park area B

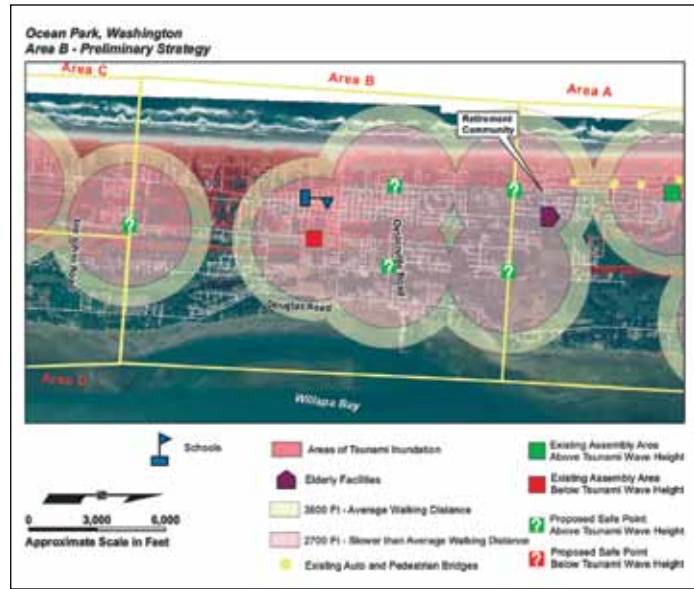


Figure 54: Ocean Park areas CD

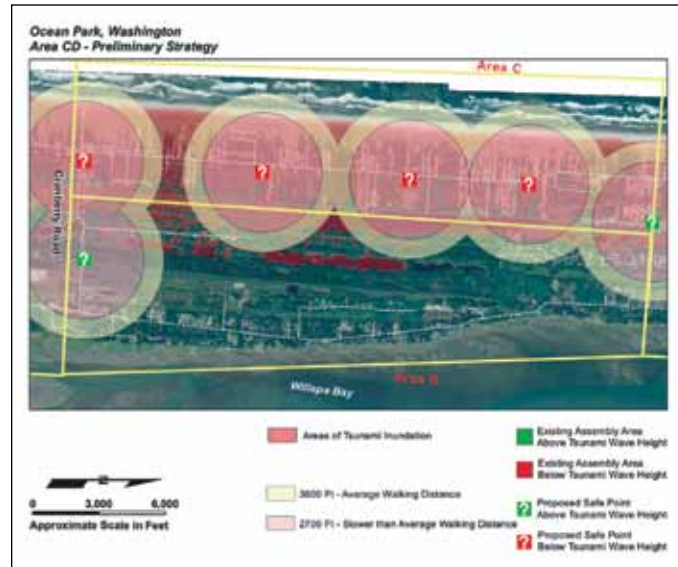
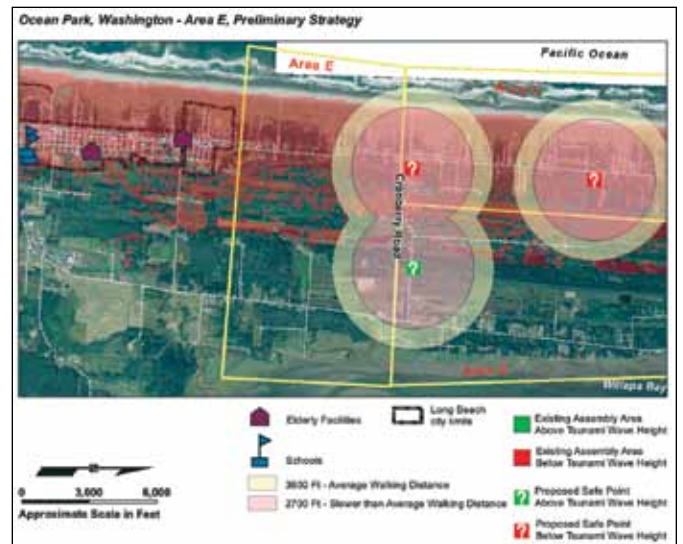


Figure 55: Ocean Park area E



APPENDIX G: OCEAN PARK SWOT ANALYSIS COMMENTS

Table 14: Area A SWOT comments (SWOT explained in Appendix B)

| OCEAN PARK STRENGTHS AND WEAKNESSES COMMENTS: AREA A | |
|---|--|
| STRENGTHS | Reasonable coverage area for all conceptual assembly areas |
| WEAKNESSES | Surfside's foot and auto bridges |
| | Dune stability |
| | Post-storm debris: Joe Johns Road |
| GENERAL COMMENTS | Pacific County frequently flooded areas |
| | Surfside Tsunami Committee? |
| | Night? Lights? Where could people find safe havens walking if lost? |
| | Density and population counts needed |
| | Communication: Let people know if their location is at risk and who could stay put if no major earthquake damage |

Table 15: Area B SWOT comments (SWOT explained in Appendix B)

| OCEAN PARK STRENGTHS AND WEAKNESSES COMMENTS: AREA B | |
|---|---|
| STRENGTHS | (None given) |
| WEAKNESSES | Many small lakes running north and south – will be even bigger lakes after subsidence |
| | Not sure the safe identified areas are high enough without augmentation |
| GENERAL COMMENTS | Use smaller walking circle for assembly area near school |

Table 16: Area CD SWOT comments (SWOT explained in Appendix B)

| OCEAN PARK STRENGTHS AND WEAKNESSES COMMENTS: AREA CD | |
|--|---|
| STRENGTHS | (None given) |
| WEAKNESSES | Sunset Sands – only one way out (one road) |
| GENERAL COMMENTS | U Street right-of-way extension between 227th and Cranberry on Birch Lane |
| | Sunset Sands (400+ residents) exit to 227th |
| | Golden Sands & Senior Center: Structure for both of these? |
| | Move Klipsan Airstrip location north |
| | Identify walking routes on conservation land |
| | New housing development: Mill Lane |

Table 17: Area E SWOT comments (SWOT explained in Appendix B)

| OCEAN PARK STRENGTHS AND WEAKNESSES COMMENTS: AREA E | |
|---|--|
| STRENGTHS | (None given) |
| WEAKNESSES | Wetlands |
| GENERAL COMMENTS | What about hotels on the Willapa Bay side? |
| | R-3 zoning: future development |

APPENDIX H: CHINOOK OBSERVER ARTICLE

CHINOOK OBSERVER

LONG BEACH, WASHINGTON

JULY 27, 2010

WALK 15 MINUTES TO HELP INCREASE SURVIVAL DURING EARTHQUAKE, TSUNAMI

BY KEVIN HEIMBIGNER

LONG BEACH - Most of us have thought about what we would do if and when "The Big One" hits like the 9.1 earthquake and 22-foot high series of tsunami waves that struck the Peninsula in 1700, and now each of us can actually do something about improving chances of surviving such an event off our coast. And all you have to do is walk for 15 minutes and then report your age and how far you went.

Jeana Wiser, a University of Washington graduate student is doing research that may some day lead to building reinforced berms or parking garage-like structures or buildings that could safely accommodate people during the 24 hours it would take to withstand another "worst-case scenario" like what happened in 1700.

Wiser and her husband Jeff came to the Peninsula last week to encourage people to determine their circle of life, how far they could walk in 15 minutes, should a destructive earthquake and subsequent tsunami strike off our coast. They also went to several places where sophisticated light detection and ranging (LiDAR) equipment had determined were high enough to be safe during "The Big One."

Wiser is working with Chris Scott, UW faculty advisor Bob Freitag, and a hazard mitigation instructor in a first of its kind project to provide elevated places to go for those in low-lying areas during a tsunami. Wiser visited Ocean Park, Long Beach, Ilwaco and Tokeland in April to discuss her project. "Our purpose of those meetings was to gain local knowledge and to make sure the plan would be community driven."

She says, "We wanted to get people's ideas and

suggestions about what if a tsunami hit here. We wanted them to tell us where natural barriers such as marshes or sloughs might be." Wiser adds, "The amount of interest was encouraging. Every community wanted a high point near the schools as a priority."

The Federal Emergency Management Administration (FEMA) has proposed plans for building structures one can go to in order to survive the ravages of an earthquake and resulting tsunami in Document P646. In each of the models they are working on designs that will withstand a 9.1 earthquake. Wiser relates, "Information from Japan determined that here in 1700 the waves reached a height of 22 feet. The ground also sank six feet and FEMA is suggesting a six-foot margin of safety so the structures would be about 34 feet above sea level."

There are places on the Peninsula that would likely be above water should a 9.1 earthquake hit off the coast, but many are accessible from the most populous areas only by automobile. Some of the high spots are behind gated entrances. It is likely roads would be blocked with fallen trees and debris and in some cases destroyed by the quake.

By far the least expensive type of structure to build would be reinforced berms. "Depending upon when a quake hits during the tide cycle it is estimated that the longest it would take for water levels to go back to normal would be 24 hours," Wiser explains. The structures would be designed to keep people above a catastrophic series of waves that typically travel over 500 miles per hour and also the deadly surge of water later receding back to the ocean.

“The berms could be used for many other things such as ball fields or places for recreation,” Wisner relates. “We just need to make sure when they are created that people can get to them within 15 minutes and that’s where our current research comes in.”

And that’s where anyone willing to help with the project enters the picture. Just report your age, record your starting and ending points, your general rate of walking, and determine the distance you walk in 15 minutes. An automobile’s odometer with tenths of a mile reading can be helpful. Please call the Pacific County Emergency Management

office at 642-9340 by the Aug. 15 deadline with any questions.

“We will have a meeting in early October to discuss the final draft from our study,” Wisner says. The study is funded by Washington State Emergency Management under the direction of John Schelling. Eventual implementation of the plan is likely years away, but for sure the North American and Juan de Fuca subduction zone just off our coastline is something to do more than just think about.

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APPENDIX I: SITE ANALYSIS

Table 18: Ocean Park site analysis comments

| OCEAN PARK SITE ANALYSIS | |
|---|--|
| LOCATION | SITE COMMENTS |
| 1. High Ground: 270th and Park Avenue | A very small vacancy on the NE corner of the intersection |
| | Highly vegetated |
| | No light to support night-time evacuation |
| 2. Berm 7: 210th and SR 103 | Large vacant area on the NE corner of the intersection |
| | Highly vegetated |
| | There is a sign that I am not sure if it is an ownership or Ad sign |
| | High trees might fall and block road during evacuation (mainly on east side of SR 103) |
| 3. Berm 8: 188th and SR 103 | No light to support night-time evacuation |
| | Large vacant area on the east side of SR 103 |
| | Highly vegetated |
| | High trees and transmission lines might fall and block road during evacuation |
| 4. Berm 9: 162nd and SR 103 | No light to support night-time evacuation |
| | The vacant areas are at SE and SW corners of the intersection |
| | Highly vegetated |
| | High trees and transmission lines might fall and block road during evacuation |
| 5. Berm 10: Cranberry Rd and SR 103 | No light to support night-time evacuation |
| | There is a major dune cut, but dunes in that area are not very high (about 2 meters [6 feet] high) |
| | East part of the dune cut has trees on both sides. |
| | Very close to beach (you can see it), people will fear staying there waiting for the wave |
| | Vacancy is on the SW corner of the intersection |
| | Highly vegetated |
| 6. High Ground: Joe Johns Road and K Lane | No light to support night-time evacuation |
| | There is a vacant parcel, not at the intersection, but about the 3rd parcel on K Lane and it is higher than surrounding ground |
| | Highly vegetated |
| 7. High Ground: Pacific Pines State Park | No light to support night-time evacuation |
| | If this park is above wave height, it can shelter <i>[meaning hold-ed. note]</i> a large number of people |
| | Dense trees surrounding the park will make accessibility to it difficult |
| | There seems to be access to the park close to Joe Johns Rd & M Lane, but it has a sign that says private! |
| | You can access the park from 274th Pl and K Lane, but this part of the park might not be high enough (check elevation) |
| | At this access point, you can also store medical materials and water |
| | It is close to beach so people will not feel safe seeing the beach |
| | There is no light in the park |
| Most of the high ground is vegetated (but not with trees) | |



Figure 56: Site 6, Ocean Park



Figure 58: Site 9, Surfside Estates



Figure 57: Site 8, Surfside Estates



Figure 59: Site 10, Surfside Estates

| OCEAN PARK SITE ANALYSIS (CONTINUED) | |
|---|---|
| LOCATION | SITE COMMENTS |
| 8. High Ground: Surfside Estates | Parking lot next to Surfside Inn is excellent for evacuation |
| | The parking has large area and is protected from waves because the ridge at this point is like a wall |
| | Cannot be accessed from east because it is very steep |
| | Limited high trees that can fall and block roads during evacuation |
| | It has few access points (mainly at roads). It is very steep for access otherwise |
| | There are a couple of stair-access points right next to each other but useless because they have no ramps for disabled, and go through private land |
| | No light to support night-time evacuation |
| PEDESTRIAN/ AUTO BRIDGES | SURFSIDE ESTATES |
| 9. Bridge 1: 1st and 344th | Wooden structure system with metal bracing below the deck. It does not look like it will withstand an 8 earthquake |
| | Bridge supports do not have much space to move laterally or longitudinally |
| | No light to support night-time evacuation |
| 10. Bridge 2: 35003 G Lane | Same as above |
| | It is not serving many people |



Figure 60: Site 2, Long Beach



Figure 61: Site 3, Long Beach

Table 19: Long Beach site analysis comments

| LONG BEACH | |
|-----------------------------------|--|
| LOCATION | SITE COMMENTS |
| 1. Berm 1: 41st and N Street | Vacant parcel on 41st (east of N and south of 41st) |
| 2. Berm 2: 5th and Washington | Ocean Park Elementary & school district building |
| 3. Berm 3: NE 2nd and Washington | Potential viewing bleachers built into berm @ Culbertson Park? |
| 4. Berm 4: NE 13th and Washington | Empty parcel across from LDS church? |
| 5. Berm 5: NE 26th and Washington | No visible vacant parcels |
| | Maybe vacant – west of 210 NE 26th? |



Figure 62: Site 1, Ilwaco



Figure 63: Site 3, Ilwaco

Table 20: Ilwaco/Seaview site analysis comments

| ILWACO/SEAVIEW | |
|---|---|
| LOCATION | SITE COMMENTS |
| 1. Berm 13: Vandalia (Ortelius Drive and Scarboro Lane) | There is a vacancy at the intersection between Capt. Gray Drive and Ortelius Drive |
| | The grass is cut, so is it really vacant? |
| | No light to support night-time evacuation |
| | Few trees that can fall and block evacuation |
| | To reach that parcel from the highway, the road does not have a curb and not even a shoulder for the pedestrians to walk on |
| | There is a much larger vacant area on the other side of Stringtown Road |
| 2. High Ground: Cooks Hill Road | The intersection of Cooks Hill Rd and US 101 has very steep slopes (you pass by this intersection to reach this place) |
| 3. High Ground: McKenzie Head | The trail to McKenzie Head and Ft. Canby: both are very steep so you can have land slides and trees will fall and block way |
| | The trail to McKenzie Head is extremely steep and does not support ADA. But why do we need it? It is very high. I think lower ground should still be OK |

Figure 64: Site 1, Tokeland



Figure 67: Site 5, Tokeland

Figure 65: Site 3, Tokeland



Figure 68: Site 6, Tokeland

Figure 66: Site 4, Tokeland



Table 21: Tokeland site analysis comments

| TOKELAND | |
|---|--|
| LOCATION | SITE COMMENTS |
| 1. Parking Structure 1: Shoalwater Bay Casino | Large parking lot on either side of the casino – easy access off of SR 105 |
| 2. Parking Structure 2: Shoalwater Bay Tribal Complex | Located on Tokeland Road near the SR 105 intersection |
| 3. Tower 1: Kindred Avenue/ Nelson Crab Company | Medium sized empty lots on either side of the storefront |
| | May want to adjust the site to move the tower closer to the marina due to future development |
| 4. Tower 2: Tokeland Road and Evergreen Street | This is where the new tribal housing development is being constructed |
| | The location is good due to future development and population density increase |
| 5. Tower 3: Tokeland Road and Pine Lane | Very vegetated – not sure if the lot on north side of road is vacant? |
| 6. Tower 4: Whipple Avenue and SR 105 | This site is very close to Washaway Beach |
| | This site may be moved to the north as suggested at the final meeting |
| 7. Tower 5: Warrenton Cannery Road and SR 105 | This tentative site was confirmed by the residents at the final meeting |
| | Near the Tokeland Market/Store – various vacant lots - confirm |

APPENDIX J: WALKING VOLUNTEER RESULTS

Table 22: Results of volunteers who walked various routes

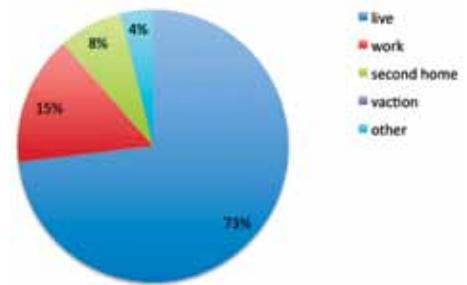
| NAME | NEIGHBORHOOD | STARTING POINT | ENDING POINT | AGE | WALKING SPEED | TIME OF WALK | DISTANCE |
|------------------|--------------|--------------------------|--|-----|---------------------|---------------|----------|
| Laurie Anderson | Seaview | 3101 K Place | Seaview Fire Dept. (N Street & 37th) | 58 | Faster than Average | 6 minutes | 0.4 |
| Jackie Sheldon | Long Beach | 207 5th Street NW | Culbertson Field (NE 2nd & Washington) | 55 | Faster than Average | 7 minutes | 0.3 |
| Dominic Vargas | Long Beach | 207 5th Street NW | Culbertson Field (NE 2nd & Washington) | 15 | Faster than Average | 5 minutes | 0.3 |
| Victoria Edwards | Long Beach | 104 11th Street South | Long Beach Elem. (5th Street S & Washington) | 10 | Faster than Average | 5 minutes | 0.3 |
| Victoria Edwards | Long Beach | 207 5th Street NW | Culbertson Field (NE 2nd & Washington) | 10 | Faster than Average | 5 minutes | 0.3 |
| Jackie Sheldon | Long Beach | 104 11th Street South | Long Beach Elem. (5th Street S & Washington) | 55 | Faster than Average | 6 minutes | 0.3 |
| Megan Aragon | Long Beach | 207 5th Street NW | Culbertson Field (NE 2nd & Washington) | 12 | Faster than Average | 5 minutes | 0.3 |
| Dominic Vargas | Long Beach | 104 11th Street South | Long Beach Elem. (5th Street S & Washington) | 15 | Average | 7 minutes | 0.3 |
| Megan Aragon | Long Beach | 104 11th Street South | Long Beach Elem. (5th Street S & Washington) | 12 | Faster than Average | 5 minutes | 0.3 |
| Kathleen Sayce | Ilwaco | 203 Howerton Way SE | Ilwaco Jr / Sr High | 50 | Average | 8 minutes | 0.4 |
| Richard Lemke | Ocean Park | 24619 J Place | Ocean Park Elementary | 71 | Faster than Average | 13 minutes | 0.8 |
| Richard Lemke | Ocean Park | 24619 J Place | 227th & U | 71 | Faster than Average | 26 minutes | 1.8 |
| Richard Lemke | Ocean Park | 24619 J Place | High Dune between L&K and 246th & 249th | 71 | Faster than Average | 2 1/2 minutes | 0.1 |
| Rose Power | Long Beach | 1300 W 143rd Place | Washington & 26th North | 67 | Average | 44 minutes | 2.6 |
| Rose Power | Ocean Park | 1300 W 143rd Place | Cranberry & Hwy 103 | 67 | Average | 14 minutes | 0.7 |
| Jeana Wiser | Tokeland | Nelson Lane & Front Lane | Nelson Crab | 25 | Faster than Average | 10 minutes | 0.6 |
| Jeana Wiser | Ocean Park | Park & 270th | Bay & OP Beach Approach | 25 | Faster than Average | 12 minutes | 0.6 |
| Jeana Wiser | Ocean Park | 306th & G Street | Surfside Inn | 25 | Faster than Average | 11 minutes | 0.6 |
| Jeana Wiser | Ocean Park | Surfside Inn | G Street & G Place | 25 | Faster than Average | 10 minutes | 0.5 |

| NAME | NEIGHBORHOOD | STARTING POINT | ENDING POINT | AGE | WALKING SPEED | TIME OF WALK | DISTANCE |
|-------------------------|--------------|---|---------------------------------|-----|---------------------|---------------|----------|
| Jeana Wiser | Ocean Park | G Place & G Street | 306th & G Street | 25 | Faster than Average | 17 minutes | 0.8 |
| Jeana Wiser | Ocean Park | 295th & H | Joe Johns & K Lane | 25 | Faster than Average | 7 minutes | 0.3 |
| Jeana Wiser | Ocean Park | Joe Johns & K Lane | K Place & 295th | 25 | Faster than Average | 10 minutes | 0.6 |
| Jeana Wiser | Nahcotta | Bailey's Café | 270th & Z | 25 | Faster than Average | 5 minutes | 0.3 |
| Jeana Wiser | Nahcotta | 270th & Z | Z & Bay | 25 | Faster than Average | 8 minutes | 0.4 |
| Jeana Wiser | Nahcotta | Z & Bay | Bailey's Café | 25 | Faster than Average | 13 minutes | 0.6 |
| Jeana Wiser | Ocean Park | Bay & SR 103 | Park & 270th | 25 | Faster than Average | 11 minutes | 0.6 |
| Kathy Fauver | Long Beach | 2611 Pacific Avenue North | Washington & 26th North | 52 | Slower than Average | 7 minutes | 0.1 |
| Clay Nichols | Ocean Park | 3501 281st Street | 270th & Z | 65+ | Faster than Average | 16 minutes | 0.9 |
| Lynn Lary | Ocean Park | 1109 196th Street | 188th & Hwy 103 | 58 | Average | 12 minutes | 0.5 |
| Lynn Lary | Ocean Park | 1109 196th Street | 210th & Hwy 103 | 58 | Average | 19 minutes | 0.9 |
| Barbara Norcross-Renner | Oysterville | 3012 Oysterville Road (Oysterville Post Office) | Douglas Drive & Crellin Drive | 65+ | Average | 15 minutes | 1.7 |
| Barbara Norcross-Renner | Oysterville | Douglas Drive & Crellin Drive | 30909 Sandridge Road | 65+ | Average | 20 minutes | 0.9 |
| Jon Ducharme | Oysterville | 33811 Territory Road | Douglas Drive & Crellin Drive | 55 | Average | 18 minutes | 0.8 |
| Margie Cochran | Nahcotta | 3501 281st | 270th & Z | 86 | Average | 18 minutes | 0.8 |
| LoAnne Moore | Tokeland | 4605 2nd Street | Nelson Crab | 74 | Average | 2 1/2 minutes | 0.3 |
| Charles Moore | Tokeland | 4605 2nd Street | Nelson Crab | 75 | Slower than Average | 3 minutes | 0.3 |
| Michael Moore | Tokeland | 4605 2nd Street | Nelson Crab | 54 | Average | 2 minutes | 0.3 |
| Keith Schwartz | Long Beach | 1519 SR 103 | Washington & 13th | 66 | Faster than Average | 4 1/2 minutes | 0.2 |
| Roger Holeman | Ilwaco | 6804 Chattam place | Ortelius & Scarboro | 60 | Average | 6 minutes | 0.4 |
| Lynn Johnson | North Cove | 3431 Ricki Street | Warrenton Cannery Road & SR 105 | 60 | Faster than Average | 11 minutes | 0.6 |

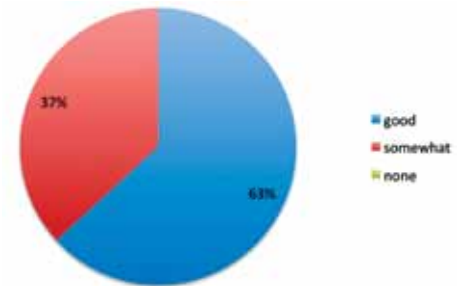
APPENDIX K: SURVEY RESPONSES

SEAVIEW SURVEY RESULTS

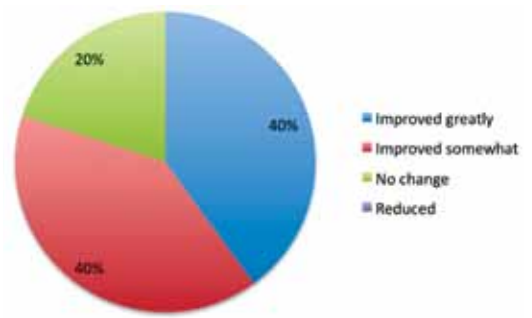
1. Do you: (Circle all that apply)
- A. Live full time in the Long Beach/North Beach Peninsula area
 - B. Work in the Long Beach/North Beach Peninsula area
 - C. Have a second home in the Long Beach/North Beach Peninsula area
 - D. Visit or vacation in the Long Beach/North Beach Peninsula area
 - E. Other



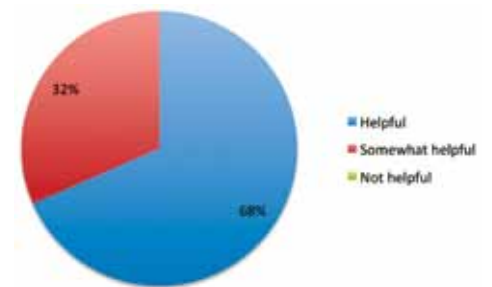
2. Prior to this Open House, what was your understanding of your tsunami risk? (Circle one)
- A. Good understanding
 - B. Some understanding
 - C. No understanding or unaware of tsunami risk



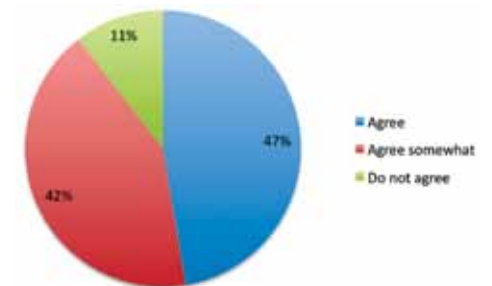
3. After this Open House, how has your understanding of your tsunami risk changed? (Circle one)
- A. Improved greatly
 - B. Improved somewhat
 - C. No change
 - D. Reduced



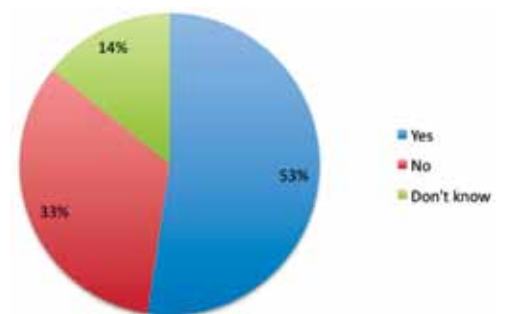
4. How helpful were the four stations at the Open House? (Circle one)
- E. Helpful
 - F. Somewhat helpful
 - G. Not helpful. I would have organized the Open House differently



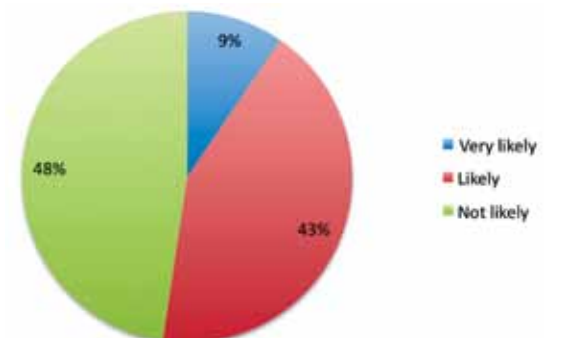
5. A vertical evacuation strategy was present at this Open House. Do you: (Circle one)
- A. Agree with the strategy presented
 - B. Agree somewhat with the strategy
 - C. Do not agree



6. If an earthquake created a tsunami that would flood the Long Beach/North Beach Peninsula, do you think you could make it to a safe place before the waves arrived? (Circle one)
- A. Yes
 - B. No
 - C. Don't know



7. How likely is it that a Safe Haven will be built in the Long Beach/North Beach Peninsula area? (Circle one)
- A. Very likely
 - B. Likely
 - C. Not likely



APPENDIX L: COUNTYWIDE MEETING VOTING RESULTS

Table 23: Results from community voting on potential sites

| LONG BEACH PENINSULA RESULTS | |
|-------------------------------------|--------------|
| SITE | VOTES |
| B1 | 2 |
| B6 | 2 |
| B7 | 5 |
| B8 | 5 |
| B9 | 1 |
| B11 | 1 |
| B12 | 2 |

APPENDIX M: SUMMARY OF COST ESTIMATES

SAFE HAVEN VERTICAL EVACUATION STRUCTURE COST ANALYSIS: PACIFIC COUNTY

(Excerpt from the Safe Haven Vertical Evacuation Structures Conceptual Cost Analysis report, available as a separate report)

EXECUTIVE SUMMARY

Detailed within this report [the *Safe Haven Vertical Evacuation Structures Conceptual Cost Analysis* report] are the construction cost estimates for select vertical evacuation structures designed for the Project Safe Haven: Pacific County. The purpose of the estimates was to start developing further information into the economic feasibility of constructing tsunami safe haven structures for various local communities at the Washington State coast that could withstand the forces of a magnitude 9.1 Cascadia Subduction Zone earthquake, and the resulting tsunami inundation. Two different structures sited in Pacific County were estimated: one berm and one tower. These structures not only will act as safe havens during the tsunami event but will also be active facilities that serve their local communities on a daily basis.

The first safe haven is a berm that will be located at the elementary school site at Washington Avenue and 5th Street S in the city of Long Beach. The berm is located next to accompanying athletic fields and playground, and will provide an opportunity for large-capacity safe haven space integrated with school facilities. The site open space can accommodate a berm structure that serves as a play area, seating area for recreation events, kite-flying mounds, and viewing area that is accessible from a sloped earth ramp. The cost estimated for this structure came to a total of \$839,708 with the majority of the costs involving earthwork and concrete placement.

The second safe haven is the Tokeland Farmers Market Tower. It is a basic tower with two platforms that will also serve the community as a covered market area. The top platform will be the safe haven space and will be accessible by a ramp on

the backside of the building. The estimated cost for this structure is \$385,319 with the majority of the costs involved in the foundation, structural system and the access ramp.

CONCEPTUAL COST ESTIMATES

For each site, certain challenges showed up that affect the estimated costs of the safe haven structures. The challenges typical to each site are due to the remote location of the Washington Coast and more limited options in material supply and builder competition. Listed below are the individual cost estimates for the two Pacific County safe havens.

The total cost for the Long Beach Elementary School berm structure is \$839,708 with the majority of the costs associated with the earthwork and concrete placement. While the costs to place earthwork materials in 18" lifts, wrapped in stabilization fabric, are significant, the haul distance to the site almost effectively triples the cost of fill materials. The remaining costs of the project activities are within an 8% range, higher or lower, of what is historically found on most construction projects based on RSMeans construction costs reference manuals (see Table 24).

The total cost of the Tokeland Farmers Market tower is \$385,319 with the majority of the costs being associated with the foundation and structure. This is a result of the tower being built on battered piles and having a heavily reinforced concrete structure supporting the safe zone platform. The costs of having ramp access to the two platforms does account for a larger portion of the project costs but the lack of significant earthwork for this project does not affect the overall estimated price as it does on other projects listed in this report (see Table 25).

Table 24: Long Beach berm cost estimate

| LONG BEACH BERM | |
|-----------------------------------|------------------|
| SCOPE | COST |
| Site utilities | \$49,814 |
| Excavation-backfill | \$289,512 |
| Concrete | \$153,951 |
| Landscaping | \$74,094 |
| CONSTRUCTION TOTAL | \$567,370 |
| Design Fees (8%) | \$45,390 |
| General conditions (10%) | \$56,737 |
| Contractor fees, O & P (15%) | \$85,106 |
| Construction contingency (5%) | \$28,369 |
| Estimate/design contingency (10%) | \$56,737 |
| PROJECT TOTAL | \$839,708 |

Table 25: Tokeland Farmers Market tower cost estimate

| TOKELAND FARMERS MARKET TOWER | |
|--------------------------------------|------------------|
| SCOPE | COST |
| Site utilities | \$15,257 |
| Excavation-backfill | \$13,034 |
| Foundation | \$66,757 |
| Structure | \$78,835 |
| Roofing | \$20,540 |
| Stairs/Ramps/Guardrails | \$55,734 |
| Fire protection | \$10,195 |
| TOTAL | \$260,351 |
| Design Fees (8%) | \$20,828 |
| General conditions (10%) | \$26,035 |
| Contractor fees, O & P (15%) | \$39,053 |
| Construction contingency (5%) | \$13,018 |
| Estimate/design contingency (10%) | \$26,035 |
| PROJECT TOTAL | \$385,319 |

APPENDIX N: STRUCTURE CALCULATION FORMULA TABLES

Table 26: Calculations for Long Beach

| MAP NUMBER | COMMUNITY | TYPE | LOCATION | EXISTING SITE ELEVATION | WAVE INUNDATION DEPTH AT SITE | MARGIN OF SAFETY | EXISTING ELEVATION + WAVE INUNDATION + MARGIN OF SAFETY | SAFE ZONE FLOOR HEIGHT | MINIMUM STRUCTURE HEIGHT (ROUNDED UP) | STRUCTURE CAPACITY |
|------------|------------|------|-----------------------------|-------------------------|-------------------------------|------------------|---|------------------------|---------------------------------------|--------------------|
| B1 | Long Beach | Berm | N place and 41st Place | 16.40 | 3.28 | 10 | 29.68 | 13.28 | 13 feet | 480 |
| B2 | Long Beach | Berm | 5th Street S and Washington | 16.40 | 0.00 | 10 | 26.40 | 10.00 | 10 feet | 800 |
| B3 | Long Beach | Berm | NE 2nd and Washington | 16.40 | 3.28 | 10 | 29.68 | 13.28 | 13 feet | 320 |
| B4 | Long Beach | Berm | NE 13th and Washington | 16.40 | 0.00 | 10 | 26.40 | 10.00 | 10 feet | 560 |
| B5 | Long Beach | Berm | NE 26th and Washington | 16.40 | 0.00 | 10 | 26.40 | 10.00 | 10 feet | 400 |

Table 27: Calculations for Ocean Shores

| MAP NUMBER | COMMUNITY | TYPE | LOCATION | EXISTING SITE ELEVATION | WAVE INUNDATION DEPTH AT SITE | MARGIN OF SAFETY | EXISTING ELEVATION + WAVE INUNDATION + MARGIN OF SAFETY | SAFE ZONE FLOOR HEIGHT | MINIMUM STRUCTURE HEIGHT (ROUNDED UP) | STRUCTURE CAPACITY |
|------------|------------|------|-------------------------|-------------------------|-------------------------------|------------------|---|------------------------|---------------------------------------|--------------------|
| B6 | Ocean Park | Berm | 227th and U Street | 16.40 | 0.00 | 10 | 26.40 | 10.00 | 10 feet | 480 |
| B7 | Ocean Park | Berm | 210th and SR 103 | 32.81 | 3.28 | 10 | 46.09 | 13.28 | 13 feet | 160 |
| B8 | Ocean Park | Berm | 188th and SR 103 | 22.97 | 6.56 | 10 | 39.53 | 16.56 | 17 feet | 160 |
| B9 | Ocean Park | Berm | 162nd Ln and SR 103 | 16.40 | 16.40 | 10 | 42.81 | 26.40 | 26 feet | 120 |
| B10 | Ocean Park | Berm | Cranberry and SR 103 | 26.25 | 0.00 | 10 | 36.25 | 10.00 | 10 feet | 320 |
| B11 | Ocean Park | Berm | U Street & 260th Street | 19.68 | 6.56 | 10 | 36.25 | 16.56 | 17 feet | 320 |

Table 28: Calculations for Ilwaco/Seaview

| MAP NUMBER | COMMUNITY | TYPE | LOCATION | EXISTING SITE ELEVATION | WAVE INUNDATION DEPTH AT SITE | MARGIN OF SAFETY | EXISTING ELEVATION + WAVE INUNDATION + MARGIN OF SAFETY | SAFE ZONE FLOOR HEIGHT | MINIMUM STRUCTURE HEIGHT (ROUNDED UP) | STRUCTURE CAPACITY |
|------------|-----------|------|--|-------------------------|-------------------------------|------------------|---|------------------------|---------------------------------------|--------------------|
| B12 | Ilwaco | Berm | Fire Dept. (N Street and 37th St) | 16.40 | 3.28 | 10 | 29.68 | 13.28 | 13 feet | 320 |
| B13 | Ilwaco | Berm | Vandalia (Ortelius Dr and Scarboro Ln) | 6.56 | 6.56 | 10 | 23.12 | 16.56 | 17 feet | 240 |

Table 29: Calculations for Tokeland/North Cove

| MAP NUMBER | COMMUNITY | TYPE | LOCATION | EXISTING SITE ELEVATION | WAVE INUNDATION DEPTH AT SITE | MARGIN OF SAFETY | EXISTING ELEVATION + WAVE INUNDATION + MARGIN OF SAFETY | SAFE ZONE FLOOR HEIGHT | MINIMUM STRUCTURE HEIGHT (ROUNDED UP) | STRUCTURE CAPACITY |
|------------|-----------|----------|---------------------------------|-------------------------|-------------------------------|------------------|---|------------------------|---------------------------------------|--------------------|
| PK1 | Tokeland | Building | Shoalwater Bay Casino | 9.84 | 16.40 | 10 | 36.25 | 26.40 | 26 feet | 800 |
| PK2 | Tokeland | Building | Shoalwater Bay Tribal Complex | 11.48 | 9.84 | 10 | 31.33 | 19.84 | 20 feet | 400 |
| T1 | Tokeland | Tower | 3088 Kindred Avenue | 9.84 | 9.84 | 10 | 29.68 | 19.84 | 20 feet | 80 |
| T2 | Tokeland | Tower | Tokeland Rd and Evergreen St | 9.84 | 9.84 | 10 | 29.68 | 19.84 | 20 feet | 120 |
| T3 | Tokeland | Tower | Tokeland Rd and Pine Ln | 9.84 | 9.84 | 10 | 29.68 | 19.84 | 20 feet | 60 |
| T4 | Tokeland | Tower | Wipple Ave and SR 105 | 18.04 | n/d | 10 | | | *22 feet | 80 |
| T5 | Tokeland | Tower | Warrenton Cannery Rd and SR 105 | 19.68 | n/d | 10 | | | *24 feet | 80 |
| | | | | | | | | | *Estimated height | |

APPENDIX O: PROJECT SAFE HAVEN SUBMITTED BIOGRAPHIES

COLLEGE OF BUILT ENVIRONMENTS, UNIVERSITY OF WASHINGTON

OVERSIGHT TEAM:

BOB FREITAG CFM:

Bob Freitag is Director of the Institute for Hazards Mitigation Planning and Research, and Affiliate Faculty at the University of Washington. The Institute promotes hazards mitigation principles through courses, student intern opportunities and research. Freitag is currently serving on the Board of Directors for the Association of State Floodplain Managers (ASFPM) and was past Director of the Cascadia Region Earthquake Workgroup (CREW). He is coauthor of “Floodplain Management: A new approach for a new era” (Island Press 2009). In coming to the University, he left a 25-year career with the Federal Emergency Management Agency (FEMA) serving as Federal Coordinating Officer (FCO); Public Assistance, Mitigation and Education Officer. Before coming to FEMA, he was employed by several private architectural and engineering firms in Hawaii and Australia, and taught science as a Peace Corps Volunteer in the Philippines. Freitag received his Master of Urban Planning degree from the University of Washington.

JEANA C. WISER:

Jeana C. Wiser is a research assistant at the Institute for Hazards Mitigation Planning and Research at the University of Washington. She is the Planning and Outreach Project Lead for Project Safe Haven. Jeana has specialized experience in the following areas: hazard mitigation planning, historic preservation, adaptive re-use, community outreach and project management. She recently graduated in June 2011 from the University of Washington with a Master’s of Urban Planning. In addition to the master’s degree, Jeana also earned a Certificate of Historic Preservation. Her thesis research addressed the integration of Historic Preservation and Hazard Mitigation especially regarding

Seattle’s unreinforced masonry buildings. Jeana also has two Bachelors’ of Science degrees in Ethnic Studies and Liberal Studies from Oregon State University.

AMANDA ENGSTFELD:

Amanda Engstfeld is a graduate of the Institute for Hazards Mitigation Planning and Research and holds a Masters Degree in Urban Planning, with a focus on hazard mitigation planning and land use from the University of Washington. Amanda is currently a Risk Analyst in the Mitigation Division for FEMA Region X. Prior to working for FEMA, Amanda worked as an Emergency Planner for the City of Redmond, Washington.

KATHERINE KILLEBREW:

Katherine Killebrew received her Master of Urban Planning and Master of Public Administration from the University of Washington in 2010. She now works as a policy analyst for the U.S. Government Accountability Office in the agency’s Seattle field office.

CHRISTOPHER A. SCOTT:

Christopher Scott is a Master of Urban Planning student at the University of Washington, studying natural hazard and environmental resource planning. He holds a Bachelor of Arts in environmental studies from the University of Washington Bothell, where he focused on natural hazards and restoration ecology. Before continuing his education, Christopher was employed by several private environmental and geotechnical engineering firms where he served as a GIS and CAD specialist.

URBAN DESIGN TEAM:

RON KASPRISIN AIA/APA:

Ron Kasprisin is a Professor in Urban Design and Planning, College of Built Environments, University of Washington, Seattle WA. Ron is an architect, urban planner and watercolor artist who is the principal designer on the Tsunami Vertical Evacuation Structures Charrette team. Ron is also a principal

in Kasprisin Pettinari Design, Langley WA, since 1975. He has authored four books including: *Urban Design—the composition of complexity*, Routledge Press UK 2011; *Design Media*, John Wiley & Sons NY 1999; *Visual Thinking for Architects and Designers* with Professor James Pettinari UO, John Wiley & Sons NY 1995; and, *Watercolor in Architectural Design*, Van Nostrand Reinhold NY 1989.

TRICIA DEMARCO:

Tricia DeMarco has recently graduated from the University of Washington with a Master in Urban Planning and a Master in Civil Engineering. Her specialization is in building the connection between engineering projects and their community context. Past projects include brownfield redevelopment, transportation impact reduction, and small town systems planning primarily in developing countries throughout South America, Asia, and Eastern Europe. DeMarco is a LEED A.P. and E.I.T. She now works for Magnusson Klemencic in Seattle, WA as a site designer.

COST ESTIMATING TEAM:

DR. OMAR EL-ANWAR:

Dr. El-Anwar is an assistant professor in the Department of Construction Management at the University of Washington. He earned his Ph.D. in civil engineering from the University of Illinois at Urbana-Champaign, and both his M.Sc. in structural engineering and B.Sc. in civil engineering from Cairo University. Dr. El-Anwar's general area of research is to develop of robust IT-based decision support systems for increasing the sustainability and resiliency of civil infrastructure systems and building, with specific focus on quantifying and optimizing the social, economic, safety, and environmental impacts of planning for post-disaster housing and tsunami vertical evacuation. This research resulted in eight peer-reviewed journal publications in *Disasters*, *Journal of Earthquake Engineering*, *Journal of Automation in Construction*, as well as the ASCE Journals of *Infrastructure Systems*, *Computing in Civil Engineering*,

and *Construction Engineering and Management*. Moreover, the findings of this research were incorporated in the development of two temporary housing decision-making modules, which are integrated in MAEviz software.

KIRK HOCHSTATTER:

Kirk is a graduate student at the University of Washington pursuing his Masters of Science in Construction Management. Before attending UW he worked for General Contractors in Seattle and the San Francisco Bay Area. His main expertise comes in healthcare, commercial and biopharmaceutical projects and he is LEED-AP. He is also and volunteer leader with Seattle Inner City Outings, which takes youth from low-income school districts on outdoor activities throughout the Puget Sound region. Kirk and his wife Megan live in Seattle and just welcomed their brand new baby, Lucile, into this world in June.

WASHINGTON STATE EMERGENCY MANAGEMENT DIVISION (EMD)

JOHN D. SCHELLING:

John D. Schelling is the Earthquake/Tsunami Program Manager for Washington State Emergency Management Division. He is responsible for managing the seismic and natural hazard safety efforts in the state through the earthquake, tsunami, and volcano programs. He serves on the Washington State Seismic Safety Committee, Chairs the State/Local Tsunami Work Group, which coordinates efforts to improve tsunami preparedness and mitigation efforts in tsunami hazard zones, and is currently serving as the State Co-Chair of the National Tsunami Hazard Mitigation Program's Mitigation & Education Subcommittee. In addition to emergency management expertise, John has an extensive background in state and local government with an emphasis on policy analysis, land use planning, and implementation of smart growth management strategies. John received his Bachelor of Science degree from the University of West Florida and Master's Degree from the University of South Florida.

JAMIE MOONEY:

Jamie Mooney is the State Hazard Mitigation Strategist for Washington at the Emergency Management Division. Prior to this position, she was a NOAA Sea Grant Fellow at Emergency Management focusing on building community resilience to coastal hazards. Jamie received her Masters of Marine Affairs from the University of Washington's School of Marine Affairs.

WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES (DNR)

TIM WALSH:

Tim Walsh is a licensed engineering geologist and Geologic Hazards Program manager for the Washington Division of Geology and Earth Resources of the Department of Natural Resources. He has practiced geology in Washington for more than 30 years and taught at South Puget Sound Community College for 25 years. Tim has done extensive geologic mapping in all parts of the state and has done tsunami hazard mapping, active fault characterization, landslide, and abandoned coal mine hazard assessments. He has also directed and participated in a broad range of geologic hazard assessments and maps for land use and emergency management planning. Tim received Bachelor's and Masters degrees in geology from UCLA.

UNITED STATES GEOLOGICAL SURVEY (USGS)

NATHAN WOOD:

Nathan Wood is a research geographer at the U.S. Geological Survey Western Geographic Science Center. Dr. Wood earned a Ph.D. in geography from Oregon State University. His research focuses on characterizing and communicating societal vulnerability to natural hazards, with emphasis on tsunamis in the Pacific Northwest. He uses GIS software, collaborative community-based processes, and perception surveys to better understand how communities are vulnerable to tsunamis. He recently served on a National Research Council committee to evaluate the U.S.

tsunami warning system and national preparedness to tsunamis.

NATIONAL OCEANIC AND ATMOSPHERIC ASSOCIATION (NOAA)

FRANK I. GONZÁLEZ:

Dr. González served as Leader of the Tsunami Research Program at the Pacific Marine Environmental Laboratory of the National Oceanic and Atmospheric Administration from 1985 until 2006, and was the founding Director of the NOAA Center for Tsunami Research. His work focused on the development of the NOAA Tsunami Forecast System, which integrates deep-ocean measurement and tsunami modeling technologies to produce real-time forecasts of tsunami impact on coastal communities. He has participated in field surveys of three devastating tsunamis that occurred in Nicaragua (1992), Indonesia (1992) and Japan (1993). As an affiliate Professor at the University of Washington, he continues to focus on tsunami research and education.

TYREE WILDE:

Tyree Wilde is the Warning Coordination Meteorologist for the National Weather Service (NWS) in Portland, OR. He works toward enhancing the forecast and warning system by closely tying the agency's mission of protecting lives and property, and enhancing the region's economy, with its customers, such as emergency managers, the media, land and water managers, and the marine community. Tyree holds a Masters degree in Meteorology from the University of Utah and has been a professional meteorologist for 28 years. Prior to his present position in Portland, he served as the Warning Coordination Meteorologist in Flagstaff, AZ. He has also worked in weather stations in Omaha, NE, Phoenix, AZ, and Cape Canaveral, FL while serving as a Weather Officer in the US Air Force.

DEGENKOLB ENGINEERS

CALE ASH, PE, SE

Cale Ash is a Project Engineer with Degenkolb Engineers in Seattle and is a licensed Structural Engineer in Washington and California. He joined Degenkolb in 2003 after graduating with his BSCE and MSCE from the University of Illinois at Urbana-Champaign. His project experience at Degenkolb has focused on the seismic evaluation and rehabilitation of existing buildings. Cale is Vice President of the Cascadia Region Earthquake Workgroup (CREW) and chair of their Education & Outreach Committee. He is also a Board Member with the Seattle Chapter of the Structural Engineers Association of Washington (SEAW).

EDITOR

JULIE CLARK:

Julie Clark is a geologist and an author. With a BA degree in political science and an MS in geology, she has worked in areas that combine these disciplines. Past positions include working at the Oregon State Legislature and several state agencies, managing political campaigns, and serving as an elected school board member. She has written several publications on geologic hazards, including books and articles on earthquakes, tsunamis, and flooding.

PACIFIC COUNTY EMERGENCY MANAGEMENT AGENCY (PCEMA)

STEPHANIE K. FRITTS:

Stephanie K Fritts serves as the E911 and Emergency Management Director for Pacific County, Washington. Pacific County recognizes that it is day-to-day relationship building that assists our local communities and residents to prepare for emergencies and disasters.

She has developed tsunami evacuation plans, routes, and public education campaigns in regard to the tsunami hazard within the local community. Ms. Fritts has also worked with the county and

local cities to complete the criteria necessary for the county to be designated as a "TsunamiReady" community.

Ms. Fritts received her Bachelor of Arts Degree in Economics and Business Administration from Linfield College and worked several years for businesses such as the Dayton Hudson Corporation and May Company. After leaving the corporate environment, she worked in local emergency services since 1983 and for the Pacific County since 1997.

CITY OF LONG BEACH

GENE MILES:

Gene has served as a city manager or administrator in Washington, Oregon, California and Kansas. He spent ten years as an educator both at the high school and university level, plus he coached high school tennis and basketball. Gene has also served as an elected official on the local level, first as a city commissioner of public works in the "commission form" of government (the same form of government Portland, OR has today), and later as deputy mayor and council member in the "council/administrator form" of government. While in working in Oregon Gene was a member of the Oregon Seismic Safety Policy Advisory Commission, which works with the Governor, Legislature and State Government on Seismic issues. Gene's education includes a master degree in Secondary School Administration and a BA in Political Science plus numerous senior management courses and training. In addition Gene has attended and participated in many seminars on tsunamis and seismic issues. He is a Full Member of the International City Managers Association and a member of the Washington City-County Managers Association. He is also a member of the American Public Works Association. During his tenure as a city manager he has been a volunteer firefighter, emergency medical and rescue member. Gene is a Vietnam Veteran.

APPENDIX P: REFERENCES

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