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DRAFT TECHNICAL MEMORANDUM

DATE:	June 30, 2021
TO:	Gail Henrikson – Clatsop County
FROM:	Ryan Farncomb, Nadine Appenbrink, Jason Nolin – Parametrix; Kent Yu – SEFT Consulting
SUBJECT:	Technical Memo #4: Analysis of Evacuation Routes and Trail Options
CC:	Michael Duncan – ODOT
PROJECT NUMBER:	274-2395-111
PROJECT NAME:	Clatsop County TEFIP

INTRODUCTION

This memo identifies and evaluates potential tsunami evacuation facility improvements in Clatsop County, with a specific focus on improving existing trails to serve evacuation needs. The memo proposes three types of improvements – trails, assembly areas, and vertical evacuation structures – and describes potential amenities for each. Improvement options are listed and mapped in the memo and in the companion interactive map. The project team made an initial evaluation of the options based on the screening criteria developed for *Technical Memo #2: Evaluation Criteria.* This memo also includes a list of potential funding options that the County may use to implement improvements.

COMPANION MAP

An interactive map supplements this memorandum, and it provides more detail than the static maps Figure 2 through Figure 4. This study focuses on the evacuation and recreational needs of unincorporated Clatsop County, in coordination with the County's five incorporated cities.

The interactive map is available at:
https://parametrix.maps.arcgis.com/apps/webappviewer/index.html?id=e773d228d2d5437baa18080d1f47df1e

EVACUATION AND TRAIL FACILITIES

Trail Typology

Trails are classified into three types for the purposes of this memo:

- On street: a sidewalk or roadway that can provide pedestrian travel in case of an evacuation.
- Multi-use path (MUP): an off-street path that is highly developed, typically paved, and built to comply with Americans with Disabilities Act (ADA) guidelines.
- Recreational: a trail that is less developed, unpaved, and not built to comply with ADA guidelines. Recreational trails tend to be steeper and more challenging to traverse.

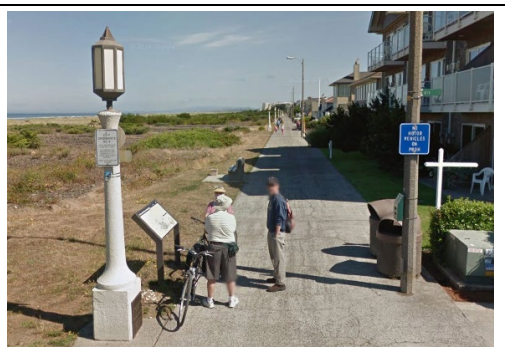
This planning effort prioritizes more developed trails for evacuation routes because they are easier to travel and are accessible to more people. However, less developed trails will still be considered in areas that lack other evacuation options.

Trail Amenities

Additional amenities can make trails more attractive for everyday use. Benches and seating, for example, provide opportunities for people to rest or stop and enjoy the scenery. Lighting can help make a trail feel safer in low light conditions. Some amenities can also be helpful after a seismic event. Shelters outside the inundation zone can be used for assembly areas. Wayfinding signs can point toward high ground and can include information about earthquake and tsunami resilience.

Potential trail amenities are listed in Table 1 along with considerations relevant to implementation and tsunami evacuation.

Table 1. Trail Amenities and Considerations

Amenity	Considerations	Example
Benches and seating	• Generally appropriate for heavily used trails. • Provides opportunities for resting for those with mobility impairments.	 *Seating options on the Seaside Promenade (source: Google Street View)*
Lighting	• Useful for trailheads and trails used at night. • Solar-powered lighting can be more seismically resilient than hard-wired, and it avoids the risk of fallen power lines in a seismic event. • Balance lighting provision with wildlife and light pollution impacts.	 *Pedestrian-scale lighting along the Seaside Promenade (source: Google Street View)*

Amenity	Considerations	Example
Fencing	• Useful for separating public right of way from private property. • Can impact accessibility of the evacuation route from adjacent areas.	 *Fence along the Fort to Sea Trail (source: Google Street View)*
Wayfinding and information signs	• Helpful for indicating evacuation route and direction and assembly areas or high ground. • Can increase tsunami awareness. • Can also include recreational wayfinding and information about the trail system.	 *Tsunami info sign on the Astoria Riverwalk (source: project team)*
Bicycle racks and fix-it stations	• Appropriate for trails with expected frequent use by people biking. • Consider overlap with or proximity to the Oregon Coast Bike Route.	 *Bike parking, fix it station, and solar charging at Hagg Lake (source: Washington County Parks)*

Amenity	Considerations	Example
Motor vehicle parking	• Requires space. • May be used as an assembly area if out of the inundation zone.	 *Trail head parking lot for Tillamook Head, Seaside (source: Google Street View)*
Restrooms and water fountains	• Toilets and water are practical for popular trails. • Providing toilets can help protect sensitive ecosystems. • Plumbing is vulnerable to a seismic event. • More substantial ongoing maintenance needs and costs.	 *Vault toilets at the Fort to Sea Trail trailhead (source: Google Street View)*
Shelters or pavilions	• Shelters can be practical amenities to protect trail users from rain or sun. • Shelters outside of the inundation zone may also be used for assembly areas. • Shelters within the assembly areas should include clear signage indicating the evacuation route.	 *Shelter along the Springwater Corridor in Gresham (source: Google Street View)*

Amenity	Considerations	Example
Viewpoints	• Unique viewpoints can draw people to a trail, which can increase awareness of it as a potential evacuation option. • Viewpoints can also be used to survey the area below after a seismic event.	 *View from the Neah-Kah-Nie Mountain Trail, Oswald West State Park (source: Google Street View)*

Assembly Areas

Assembly areas provide space on high ground outside the inundation area for people to gather temporarily during a tsunami. At minimum, they provide a clear and safe place for people to come together. This requires a plot of land outside the evacuation zone, effective wayfinding signs to get people there, and regular maintenance to keep it in good condition.

The Oregon Department of Geology and Mineral Industries (DOGAMI) has identified locations for assembly areas in coastal communities as part of their evacuation route mapping. This includes the populated communities of Clatsop County. But these assembly area locations primarily exist on maps and may not be clearly marked or signed for people trying to get to them. Assembly areas also may not be sized to accommodate their evacuation shed. Additional assembly areas will be needed as this TEFIP develops more evacuation route options. DOGAMI's identification of assembly area locations is a good starting point for further development. A thorough review of existing assembly areas is outside the scope of this project.

Location

Assembly areas should be located such that everyone in the inundation zone can reach an area within the time between an earthquake and subsequent tsunami. This amount of time varies greatly, depending on the epicenter of the earthquake and inland location. Generally, locations that are further inland have more time to evacuate. DOGAMI has modeled this to create their *Beat the Wave* evacuation maps. To simplify the planning effort, this TEFIP will use the Federal Emergency Management Agency (FEMA) evacuation time estimate of 15 minutes from their *Guidelines for Design of Structures for Vertical Evacuation from Tsunamis*.[1] This estimate is for people that are close to the water and for a tsunami caused by a local earthquake, the more conservative case with the shorter evacuation time. The distance that can be traveled depends on when a person leaves after the earthquake begins—a long-lasting earthquake will take several minutes, and then people will typically take time to gather themselves before evacuating—and the person's walking speed.

FEMA uses the following assumptions for tsunami evacuation:[1]

[1] April 2012. FEMA P-646: Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, Second Edition

- Time to evacuate: 15 minutes (the time between when a person leaves and when a local tsunami hits)
- Moderate walking speed: 4 miles per hour
- Mobility-impaired walking speed: 2 miles per hour
- Maximum travel distance: one-half mile

With a maximum travel distance of one-half mile, the maximum distance between assembly areas is 1 mile. This distance may be less in areas with terrain that is steep or difficult to traverse.

Siting an assembly area should consider other seismic risks. Is the land susceptible to liquefaction or landslide? Are there structures, trees, or utilities nearby that could pose a hazard after an earthquake? In the study area, there are a limited number of easily accessible areas outside of the inundation zone, so it is likely that assembly areas will need to be located in places with at least one potential hazard. These sites may require mitigation to minimize the risk.

In some locations, the nearest assembly areas are to the west — toward the incoming tsunami. This may be unintuitive for people and risks confusing evacuees. When possible, assembly areas and vertical structures should be located to the east of a community to take advantage of the instinct to run from the threat. Where this is not possible, the evacuation route must be made very clear.

Some existing and proposed assembly areas are on relatively small strips of ground that are expected to be surrounded by water in the XXL event. Additional amenities may be needed at these locations in case it takes emergency response longer to reach them.

Consider whether each assembly area should have motor vehicle access, and for those that will have access, consider how to manage it. Motor vehicle access can help with facility construction, amenity inventory, and upkeep. It can also help by allowing emergency responders easy access to evacuees.

Once located, the assembly area location must have clear indication for evacuees to recognize that they have reached a safe place. Signs and wayfinding ideally would include standard graphical icons that are used consistently in the county, state, and beyond. Additional information should be provided in common languages read by residents and visitors.

Size

Assembly areas need to be sized appropriately for the number of people they are likely to serve. Each assembly area should be analyzed to understand the number of residents and potential workers, students, and visitors who may use it. The assembly area—and amenities—need to be scaled to accommodate this total number of potential evacuees.

Amenities

Additional amenities can make assembly areas more comfortable. A covered area will help people stay dry in wet weather and provide shade in hot weather. Assembly areas can also hold stashes of food, water, blankets, first aid supplies, communication devices, and other emergency items as listed in Table 2. Which amenities and how much to provide depends on the evacuation shed that the assembly area serves, how many people are likely to assemble there, and whether those people are likely to need support. What to provide also depends on the context of the assembly area. An area that is geographically isolated will benefit more from amenities than an area with nearby resources.

Amenities will need storage space at the assembly area that is safe from the weather, pests, earthquake damage, and vandalism or theft, while also being easy to access during a seismic event. Perishable items (food, first aid supplies, water bottles, and batteries, for example) will need a plan to keep them fresh.

Table 2. Assembly Area Amenities

Amenity	Considerations
Shelter	• Evacuation shed (number of people expected to evacuate to this location) • Seismic stability
Food	• Storage space for longevity and to keep free of animals or pests • Evacuation shed
Drinking water	• System to maintain potability • Evacuation shed
First aid supplies	• Evacuation shed • Potential nearby hazards that may cause injuries to evacuees
Radio	• Power options
Communication devices	• Could include radio transmitters, walkie-talkies, and cell phones (though cell towers may not be operable after a seismic event)
Lighting	• Power options, solar chargeable batteries are a resilient option
Emergency power	• Could be used to charge communication devices • Options include solar power, batteries, and generators
Blankets	• Evacuation shed
Ponchos	• Evacuation shed

Vertical Evacuation Structures

In locations where natural high ground is not available or is not practical to reach in the time before the first tsunami wave arrives, vertical evacuation structures can be appropriately designed and constructed to serve as places of refuge where many people can evacuate and remain for up to 24 hours to escape the initial and subsequent tsunami waves.

Types of vertical evacuation structure include soil berms, towers, and buildings.

Vertical evacuation structures of all three types can be designed and built to serve recreational or other community functions, in addition to providing refuge in areas too far from natural high ground. Berms can be incorporated into parks and recreational areas; tower can make for an accessible viewpoint to take in the coastal

beauty of Clatsop County, and a rooftop evacuation platform could be located atop of a variety of multistory civic, commercial or residential buildings.

Table 3. Vertical Evacuation Structures

Structure Type	Considerations	Example
Soil berms	• Engineered earth mound created with soil or recycled construction materials • Can be integrated into parks and serve a recreational use • More cost effective than other types of vertical evacuation structures	 *A soil berm constructed in Tahara, Japan, in 2018 (Source: Disaster Prevention Bureau of Tahara, Japan)*
Evacuation towers	• Elevated platform, stairs, or ramps • Smaller physical footprint than berms • Space below platforms can serve multiple community uses • Consider equipping with amenities for communications and evacuees' immediate needs • Could be designed to serve recreational purposes, including a viewing platform; space below could be programmed for community events	 *Rendering of Tsunami Evacuation Tower in Tokeland, Washington (Source: Degenkolb Engineers)*
Buildings with rooftop refuge areas	• Multi-story building, typically with rooftop evacuation area • Can be integrated into buildings serving commercial or community uses • Lower levels typically designed with special features such as break-away walls	 *Ocosta Elementary School in Westport, Washington (Source: Degenkolb Engineers)*

FEMA has developed a valuable guideline document, known as FEMA P-646, to assist communities on the west coast to plan and develop tsunami vertical evacuation structures (FEMA 2019).

Soil Berms

Soil berms create high ground using soil or recycled construction materials such as concrete or masonry. They have a large footprint on the landscape and can be integrated with school playgrounds, parks, and other recreational facilities. In addition to stairs, access ramps can be installed on the berm to provide easy access for mobility impaired individuals to move from the ground to the elevated surface. Evacuating to berms allows people to follow their instinct to go to high ground and eliminates fear of entering a structure that they perceive may not be safe. Berms are immune to damage from large debris such as shipping containers, barges, and ships, making them suitable for locations near port facilities.

Evacuation Towers

A tsunami evacuation tower consists of elevated platforms and stairs and/or ramps to lead people to an elevation that is sufficiently above the projected inundation elevation. When not in use as a refuge, space below the platform can potentially serve other community functions to enhance the quality of life. Towers have a small footprint compared to soil berms and buildings, and therefore, can be more easily distributed throughout potentially affected areas to increase accessibility and availability. The Shoalwater Bay Indian Tribe tsunami evacuation tower in Tokeland, Washington, is an example of a recently designed tsunami evacuation tower that has two refuge levels with an occupancy capacity of approximately 400 evacuees. Two sets of stairs are provided for redundancy and are specially detailed to ensure their functionality immediately after an earthquake. The tower will be fed by commercial power for routine maintenance and by emergency power for radio communication and USB charging. Supplies (such as food, water, first aid kits, emergency radios, light sticks, tarps, and blankets) can be stored in benches installed at the refuge levels.

Buildings with Rooftop Refuge Area

In a building that is specifically designed as a tsunami evacuation structure, the roof level is often designated as the tsunami refuge area while the lower levels are designed with special features (such as break-away walls) that will allow the tsunami waves to flow through lower levels. Instead of being developed as a single-purpose tsunami evacuation structure, the tsunami refuge area is often integrated into buildings that already serve everyday commercial or community-based functions, including public office buildings, school facilities, multi-story parking garages, and multi-story residential facilities. As an example, the Ocosta Elementary School in Westport, Washington, (see Figure 3) was constructed in 2016 and included the first tsunami vertical evacuation structure in the continental United States. The rooftop of the gymnasium was designed to be 30 feet above grade to serve as a tsunami refuge for up to 1,000 students, staff, and nearby community members. This approach of leveraging ongoing community development (e.g., construction of schools) is a very cost-effective way to enhance tsunami evacuation capacity to protect local residents and tourists.

Spacing, Location, and Size Considerations

Vertical evacuation structures need to be strategically located to ensure that all persons designated to take refuge at a particular structure can reach it within the time available between the tsunami warning and tsunami inundation. In Oregon and Washington, coastal communities may rely on ground-shaking from an offshore Cascadia Subduction Zone earthquake as tsunami warning. After re-orienting from the physical and emotional turmoil experienced during an earthquake, residents and tourists in Clatsop County may only have as little as 15 minutes for evacuation on foot. Although an average healthy person can walk at approximately 4 mph, people with mobility challenges due to age, health, and disability may only be able to evacuate at 2 mph. This means that the maximum spacing for vertical evacuation structures or natural high ground is about one mile, but likely closer to 0.5 miles apart.

In addition to spacing, it is important to consider natural and learned behaviors of human beings when locating tsunami evacuation structures in a community. The natural tendency for evacuees will be moving away from the shore and seeking high ground. Figure 1 illustrates an example for possible arrangement of vertical evacuation structures based on travel distance and evacuation behavior (arrows show anticipated vertical evacuation routes). Once the location of a tsunami evacuation structure is selected, refuge capacity can be estimated based on the population density within its evacuation radius, and its size can be determined based on the recommendation of 10 square feet per occupant for a short-term vertical evacuation structure.

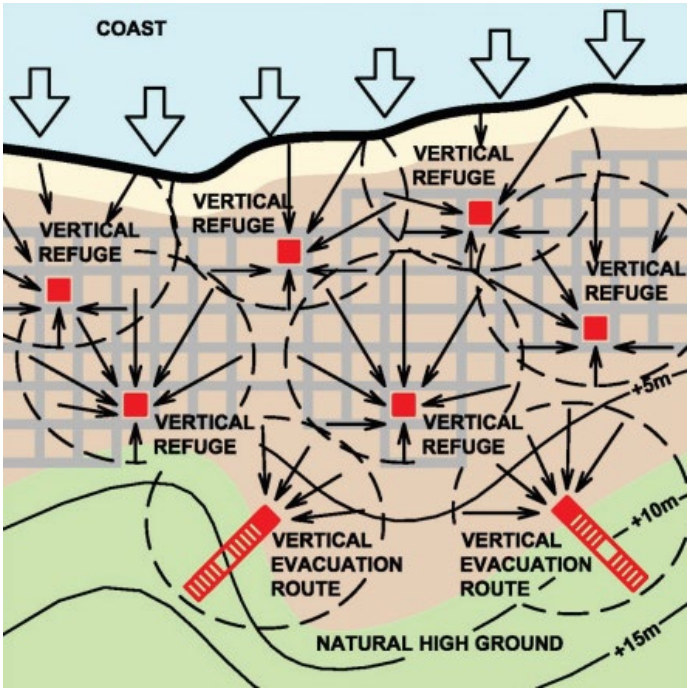


Figure 1. Spacing Diagram for Vertical Evacuation Structures

Example of Vertical Evacuation Refuge Locations and Anticipated Evacuation Routes (FEMA 2019)

Design Considerations

Vertical evacuation structures must be tall enough to ensure safety of those seeking refuge even if the tsunami exceeds the design tsunami event. Determination of elevation for tsunami refuge must consider the uncertainty inherent in the estimation of the tsunami runup elevation, possible splash-up during impact of tsunami waves, and the anxiety level of evacuees seeking refuge in the structure. The minimum refuge elevation recommended by the American Society of Civil Engineers in *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, ASCE 7-16 (ASCE 2017) is equal to the maximum anticipated tsunami inundation elevation, plus 30 percent, plus 10 feet or one story, whichever is greater.

In the Pacific Northwest, in addition to tsunami load effects, vertical evacuation structures must be designed to resist seismic loads from a Cascadia Subduction Zone earthquake, consider access issues including post-earthquake functionality of vertical circulation systems, and the availability of emergency power. Deep foundation systems are typically required to resist liquefaction and permanent ground deformation during a seismic event and significant scouring during a tsunami.

Cost Considerations

The type, height, and size of a tsunami evacuation structure are the main factors that impact the design and construction cost of a vertical evacuation structure. In many cases, tsunami evacuation structures may need to be constructed on a site with poor soil condition, where site-specific hazards such as liquefaction and lateral spreading can create design challenges and often require significant cost to improve ground conditions or construct robust deep foundation systems. Because tsunami evacuation structures are still relatively new in Oregon and Washington, the construction cost for a vertical tsunami refuge can range from $1 million to $5 million.

It requires resources and expertise to plan, design, and construct tsunami evacuation structures. Local governments can obtain funding through grants from different departments and agencies of the federal and state governments as well as from local funding sources discussed in the section Funding and Financing Options below.

Planning and Implementation in Washington

After the 2011 Tohoku Japan Earthquake and Tsunami, the Emergency Management Division of the State of Washington created Project Safe Haven to increase tsunami preparedness for coastal communities in three counties: Pacific, Grays Harbor, and Clallam. As the outcome of this project, over 43 structures located within a 15-minute walk of population centers have been proposed to provide safe haven for more than 18,450 people with high priority given to children, elderly, and people with disabilities. Project Safe Haven has resulted in planning, design, and construction of a number of tsunami evacuation structures including the completed Ocosta Elementary School, the Shoalwater Bay Indian Tribe tsunami evacuaton tower that is under construction, and design of a tsunami evacuation tower in the City of Westport, Washington.

Recommended Next Steps for Vertical Evacuation Structures

We recommend that Clatsop County build upon the success of Washington's Project Safe Haven. The County should leverage the work completed as part of this current TEFIP planning effort to develop a community enagement process and implementation strategy to determine the desired locations for vertical evacuation structures. The plan would develop initial tsunami vertical evacuation options and associated budgetary needs for planning, design, and construction.

With help from potential grants and funding from federal, state, and local partners, Clatsop County can take the important step of beginning to build the first vertical evacuation structure in the county and steadily increase the capability of its local govenrments and community champions to plan and implement additional future tsunami vertical evacuation structures. These vertical evacuation structures will save lives following a Cascadia Subduction Zone earthquake, enhance the tsunami resilience of the community, and by leveraging potential synergies between vertical evacuation structures and other community enhancements (e.g., parks, community centers, etc.), improve the everyday quality of life for Clatsop County residents and tourists.

FACILITY IMPROVEMENT OPTIONS

This memo proposes three types of evacuation facility improvements:

- Trail connections
- Assembly areas
- Vertical evacuation structures

Each improvement option is listed in Table 4. Options are mapped on Figure 2, Figure 3, and Figure 4 (included after Table 4), as well as on the interactive map at:
https://parametrix.maps.arcgis.com/apps/webappviewer/index.html?id=e773d228d2d5437baa18080d1f47df1e

Proposed amenities for each option are preliminary based on the geographic context of the option. Additional amenities should be coordinated through outreach with the neighboring community, landowners, and other stakeholders.

High level cost estimates have been developed for proposed trail facilities only. Assembly area costs will be determined by the level of amenities provided at each location. At the minimum, we recommend signage and wayfinding. Vertical evacuation structures vary in cost based on the type, and soil berms are the least-cost option. Costs for a vertical evacuation structure can range from $1 million to $5 million.

Cost ranges are estimated based on straight construction costs, and costs associated with design, construction management, permitting are not included. Costs are estimated using the following range for segment total cost.

- $ -- $0 to $50,000
- $$ -- $50,000 to $100,000
- $$$ -- $100,000 to $200,000
- $$$$ -- $200,000 to $500,000
- $$$$$ -- over $500,000

Table 4. Evacuation Facility Improvement Options

ID	Type	General Location	Description	Recommended Amenities or Features	Benefits or Constraints	Cost Estimate
Trails						
T-01	Trail connection (on street)	Arch Cape	Continue evacuation route outside of inundation zone from E Shingle Mill Lane, north on Fire Rock Road, and east to high ground.	• Wayfinding	• This is an existing evacuation route to serve the southern area of Arch Cape, but the route does not go far enough to escape the Cascadia "XXL" inundation zone.	$$$
T-02	Trail connection (MUP)	Arch Cape	Create a trail along Oceanview Lane right of way that leads to high ground.	• Wayfinding	• The County already has the right of way here, but it has not been built out. • US 101 has high cuts on either side. A pedestrian bridge over the highway could make an easier and more effective connection.	$$$$
T-03	Trail connection (on street)	Arch Cape	Create a trail at the south end of Carnahan Road that continues east past US 101 along Buena Vista Drive to high ground.	• Wayfinding	• Evaluate condition of existing US 101 pedestrian underpass at Carnahan Road.	$$$
T-04	Trail connection (MUP)	Arch Cape	Create a trail at the north end of Carnahan Road that continues north to high ground.	• Fencing to delineate trail right of way from private property	• Consider wooden steps for steep slope.	$
T-05	Trail connection (MUP)	South of Cannon Beach	Area has platted properties but is not yet developed. Consider placing trail(s) as conditions of development.	• Wayfinding		$

ID	Type	General Location	Description	Recommended Amenities or Features	Benefits or Constraints	Cost Estimate
T-06	Trail connection (recreational)	North of Gearhart	Create a trail to connect Shady Pine Road across Neacoxie Creek to higher ground to the west.	• Fencing to delineate trail right of way from private property	• Land appears to be privately owned. • If right of way for a trail cannot be obtained, consider a vertical evacuation structure in this area. • Requires bridge over Neacoxie Creek. • May require an elevated boardwalk to reduce impacts to wetland. • Will require environmental review.	$$$$$
T-07	Trail connection (recreational)	North of Gearhart	New trail to high ground from Cullaby Lake Lane.	• Wayfinding	• Current evacuation route ends within inundation zone. • Short trail segment needed to reach high ground. • Hillside appears steep. Trail likely to need switchbacks and may need retaining walls.	$$$
T-08	Trail connection (recreational)	South of Camp Rilea	Connect Fort to the Sea Trail to high ground with a trail spur at ridge.	• Fencing to delineate trail right of way from private property	• Existing trail stays in the inundation zone, while passing high ground. • Short trail segment needed to reach high ground. • The land above the inundation zone appears privately owned.	$
T-09	Trail connection (MUP)	South of Camp Rilea	Connect the neighborhood at Glenwood Village to high ground with trail to the east.	• Benches or seating for recreational use • Fencing to delineate trail right of way from private property	• Requires a bridge over the Skipanon River.	$$$$$

ID	Type	General Location	Description	Recommended Amenities or Features	Benefits or Constraints	Cost Estimate
T-10	Trail improvement (on street)	Camp Rilea	Improve Pacific Road to serve as an evacuation route.	• Wayfinding	• Needs to be coordinated with Camp Rilea.	$$$
T-11	Trail improvement (on street)	Camp Rilea	Improve Demo Road to serve as an evacuation route.	• Wayfinding	• Needs to be coordinated with Camp Rilea.	$$$
T-12	Trail connection (MUP)	Camp Rilea	Connect the residential area along Douglas Lane to high ground at Camp Rilea with a short trail to 2nd Causeway Road.	• Wayfinding	• Needs to be coordinated with private property owners and Camp Rilea.	$
T-13	Trail improvement (on street)	South of Warrenton	Delaura Beach Lane/SW 18th Street is an important connection from the beach to higher ground. Improve to be an effective evacuation route.	• Wayfinding	• Consider how a seismic event may affect the road. • Water is on both sides.	$$$
T-14	Trail improvement (MUP)	Fort Stevens	Improve existing trail to serve as evacuation route for people in park or at beach.	• Wayfinding	• Trail is oriented east-west and provides fairly direct route to high ground.	$$$
T-15	Trail connection (MUP)	Fort Stevens	New connection from existing trail to high ground.	• Wayfinding	• May be steep terrain.	$$
T-16	Trail connection (MUP)	Fort Stevens	New connection from existing Jetty Road parking area to high ground.	• Wayfinding	• May be steep terrain.	$

ID	Type	General Location	Description	Recommended Amenities or Features	Benefits or Constraints	Cost Estimate
Assembly Areas						
A-01	Assembly area	Arch Cape	Establish a formal assembly area at the end of the trail from Option T-01.	• Wayfinding	• An assembly area would indicate that evacuees have made it to a safe place.	--
A-02	Assembly area	Arch Cape	Establish a formal assembly area at the end of the trail from Option T-02.	• Wayfinding	• An assembly area would indicate that evacuees have made it to a safe place.	--
A-03	Assembly area	Arch Cape	Establish a formal assembly area at the end of the evacuation route on Buena Vista Drive from Option T-03.	• Wayfinding	• An assembly area would indicate that evacuees have made it to a safe place. • Area appears to be privately owned but undeveloped.	--
A-04	Assembly area	Arch Cape	Establish a formal assembly area at the end of the trail from Option T-04.	• Wayfinding	• An assembly area would indicate that evacuees have made it to a safe place. • Area appears to be privately owned but undeveloped.	--
A-05	Assembly area(s)	South of Cannon Beach	Area has platted properties but is not yet developed. Consider placing assembly area(s) as conditions of development.	• Wayfinding	• Future assembly areas can be created with future development.	--
A-06	Assembly area	South of Seaside	Establish a formal assembly area near Rippet Lane.	• Wayfinding	• Neighborhood adjacent to high ground, may be steep terrain.	--

ID	Type	General Location	Description	Recommended Amenities or Features	Benefits or Constraints	Cost Estimate
A-07	Assembly area	North of Gearhart	Establish one or multiple formal assembly areas along Polo Ridge Road.	• Wayfinding	• Polo Ridge Road is on a narrow ribbon of high ground above the inundation zone. This is the most accessible high ground for most of the Surf Pines community. • Multiple assembly areas spaced along the road to maximize accessibility is preferred. • Much of the property along the road is developed with homes.	--
A-08	Assembly area	North of Gearhart	Establish a formal assembly area at the end of the trail from Option T-06.	• Wayfinding	• Land appears to be privately owned but undeveloped.	--
A-09	Assembly area	North of Gearhart	Establish one or multiple formal assembly areas near West Lake Acres Road.	• Wayfinding	• Could co-locate with Gearhart Rural fire station. • Multiple assembly areas spaced along the road to maximize accessibility is preferred.	--
A-10	Assembly area	North of Gearhart	Establish a formal assembly area at the end of the trail from Option T-07.	• Wayfinding		--
A-11	Assembly area	South of Camp Rilea	Establish a formal assembly area at the end of the trail spur from Option T-08.	• Wayfinding	• Land appears to be privately owned but undeveloped.	--
A-12	Assembly area	South of Camp Rilea	Establish a formal assembly area at the end of the trail from Option T-09.	• Wayfinding	• Well connected with existing roads. Could serve as evacuation point for several neighborhoods (Glenwood Village Lane and Railroad Road).	--

ID	Type	General Location	Description	Recommended Amenities or Features	Benefits or Constraints	Cost Estimate
A-13	Assembly area	Camp Rilea	Establish a formal assembly area along Pacific Road in Camp Rilea. Connects with Option T-10.	• Shelter (can also serve as a feature of Camp Rilea) • Wayfinding	• Well connected with existing roads. • Needs to be coordinated with Camp Rilea.	--
A-14	Assembly area	Camp Riles	Establish a formal assembly area along Demo Road in Camp Rilea. Connects with Option T-11.	• Shelter (can also serve as a feature of Camp Rilea) • Wayfinding	• Well connected with existing roads. • Needs to be coordinated with Camp Rilea.	--
A-15	Assembly area	Camp Rilea	Establish a formal assembly area along 2nd Causeway Road near the south intersection with Cev Road in Camp Rilea.	• Shelter (can also serve as a feature of Camp Rilea) • Wayfinding	• Well connected with existing roads. • Needs to be coordinated with Camp Rilea.	--
A-16	Assembly area	Camp Rilea	Establish a formal assembly area for Option T-12 along 2nd Causeway Road near the north intersection with Cev Road in Camp Rilea.	• Shelter (can also serve as a feature of Camp Rilea) • Wayfinding	• Well connected with existing roads. • Needs to be coordinated with Camp Rilea.	--
A-17	Assembly area	North of Camp Rilea	Establish a formal assembly area at the south end of Smith Lake County Park to serve evacuees from the neighborhood on Smith Lake Road.	• Shelter (can also serve as a feature of Smith Lake County Park) • Wayfinding	• Can be co-located with Smith Lake County Park. • The south end of the neighborhood is roughly one-half mile from the proposed assembly area, consider a vertical evacuation structure to serve this area (V-03)	--
A-18	Assembly area	North of Camp Rilea	Establish a formal assembly area along Whiskey Road to serve neighbors on the northeast side of Smith Lake.	• Wayfinding	• Appears to be privately owned and developed. Coordinate with landowners. • Adjacent to Warrenton city limits. Coordinate with the City of Warrenton.	--

ID	Type	General Location	Description	Recommended Amenities or Features	Benefits or Constraints	Cost Estimate
A-19	Assembly area	Fort Stevens	Establish a formal assembly area on this ridge of high ground to serve the trails in Options T-14, T-15, and T-16.	• Shelter (can also serve as a feature of the park) • Wayfinding	• Evacuation shed may be large for this location when the park hosts many visitors.	--
Vertical Evacuation Structures						
V-01	Vertical structure	North of Gearhart	Area north of Gearhart is not well connected and requires traversing long distances to reach high ground.	• Wayfinding, solar charging, communications.	• Placement should be considered through community outreach.	--
V-02	Vertical structure	Camp Rilea	Beach area is nearly one-half mile to high ground.	• Wayfinding, solar charging, communications.	• Placement should be considered through community outreach and coordination with Camp Rilea.	--
V-03	Vertical structure	South of Warrenton	The community at the southwest end of Smith Lake is roughly one-half mile from high ground.	• Wayfinding, solar charging, communications.	• Placement should be considered through community outreach. • Option A-17 proposes an assembly area at the high ground on the north end of the community.	--
V-04	Vertical structure	Between Warrenton and Astoria	Area is surrounded by water and not well connected to high ground.	• Wayfinding, solar charging, communications.	• Placement should be considered through community outreach.	--
V-05	Vertical structure	Between Warrenton and Astoria	Area is surrounded by water and not well connected to high ground.	• Wayfinding, solar charging, communications.	• Placement should be considered through community outreach.	--

ID	Type	General Location	Description	Recommended Amenities or Features	Benefits or Constraints	Cost Estimate
V-06	Vertical structure	Clatsop Spit	The Clatsop Spit is long, flat, and vulnerable to a tsunami. It is also popular with visitors of Fort Stevens State Park.	• Wayfinding, solar charging, communications.	• Placement should be considered through community outreach and coordination with Fort Stevens State Park.	--
V-07	Vertical structure	North of Gearhart	Area is separated from high ground by Sunset Lake. Requires traveling long distances to evacuate the inundation zone. Consider vertical evacuation structures.	• Wayfinding, solar charging, communications.	• Placement should be considered through community outreach.	--

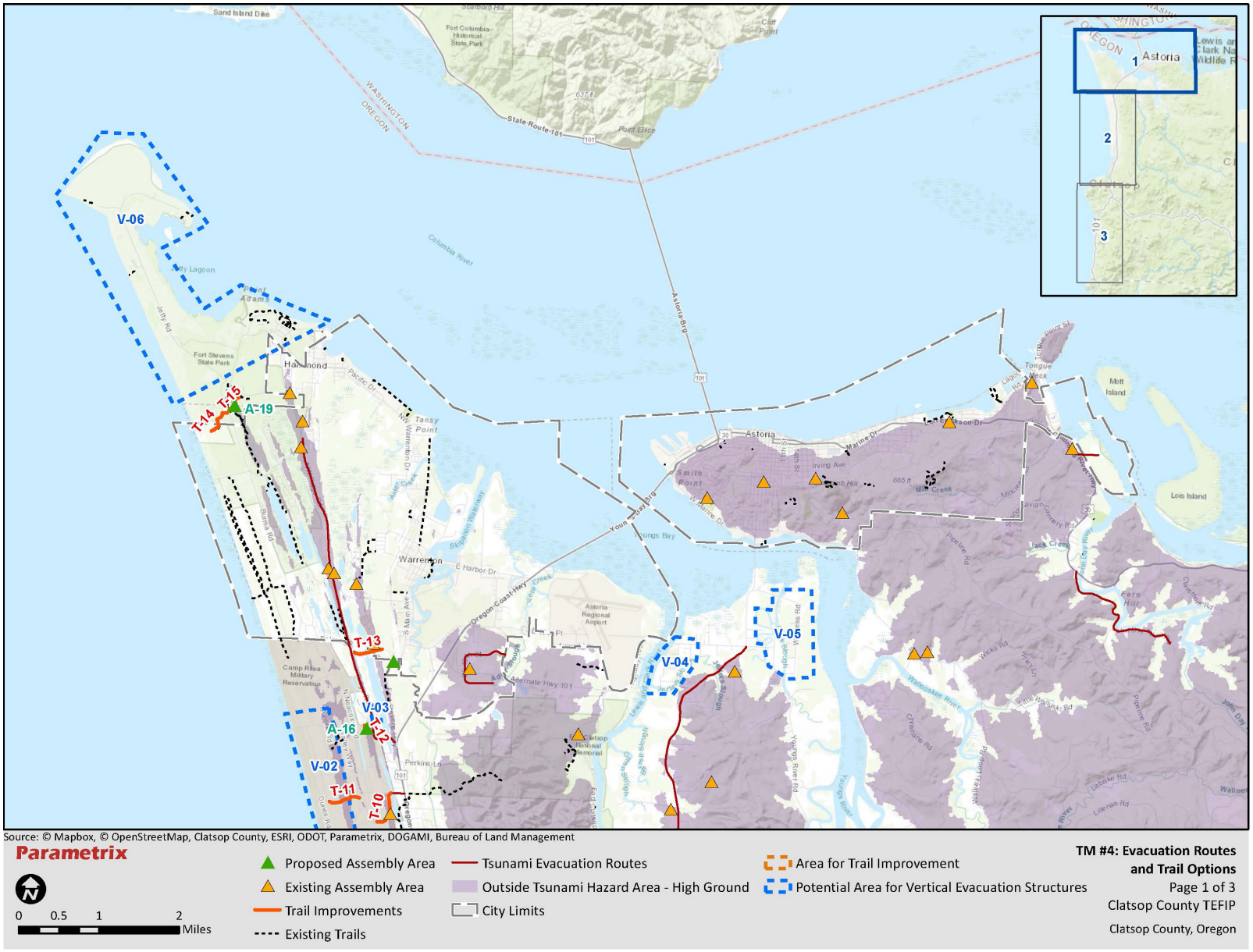


Figure 2. Evacuation Routes and Trail Options - North Area

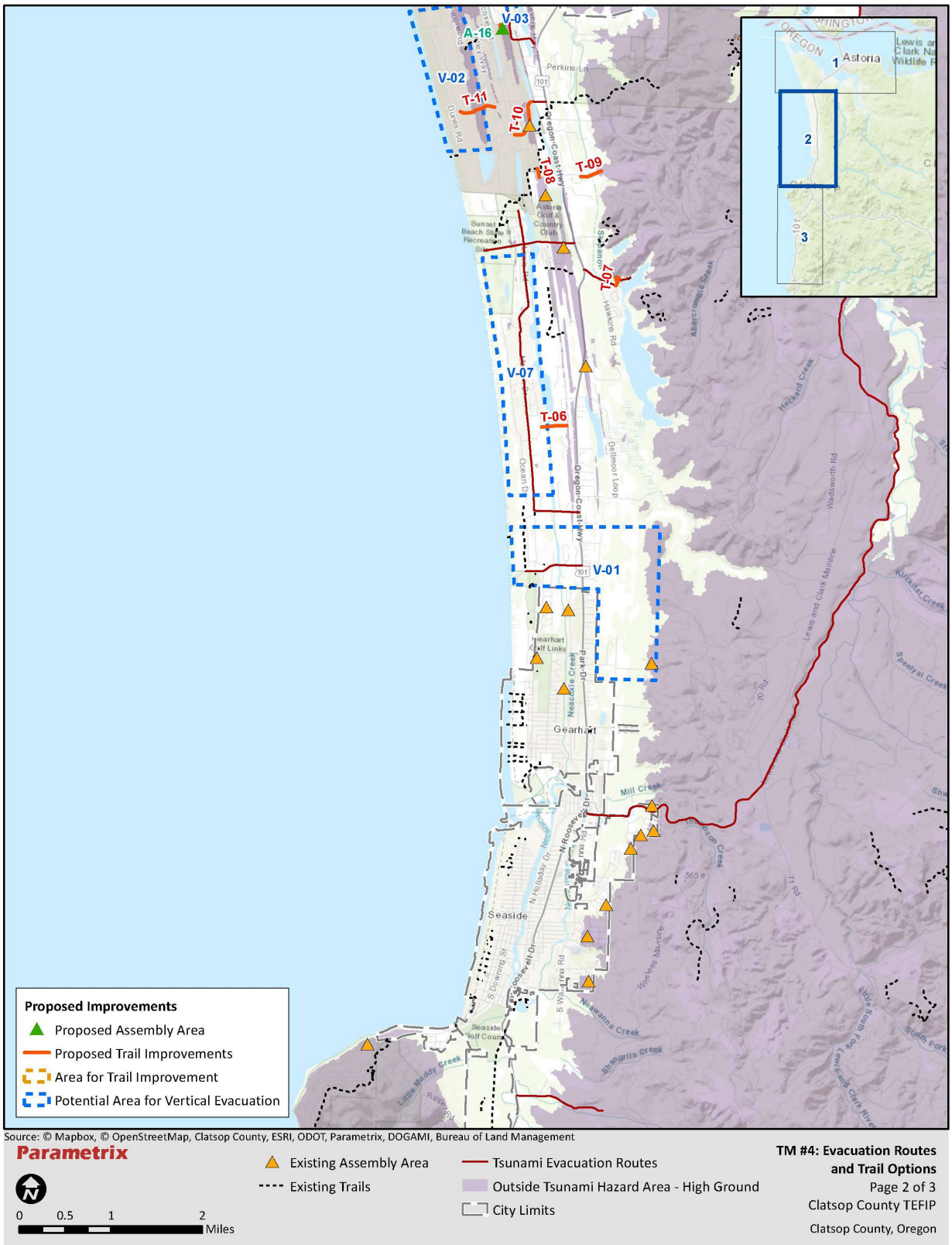


Figure 3. Evacuation Routes and Trail Options - Central Area

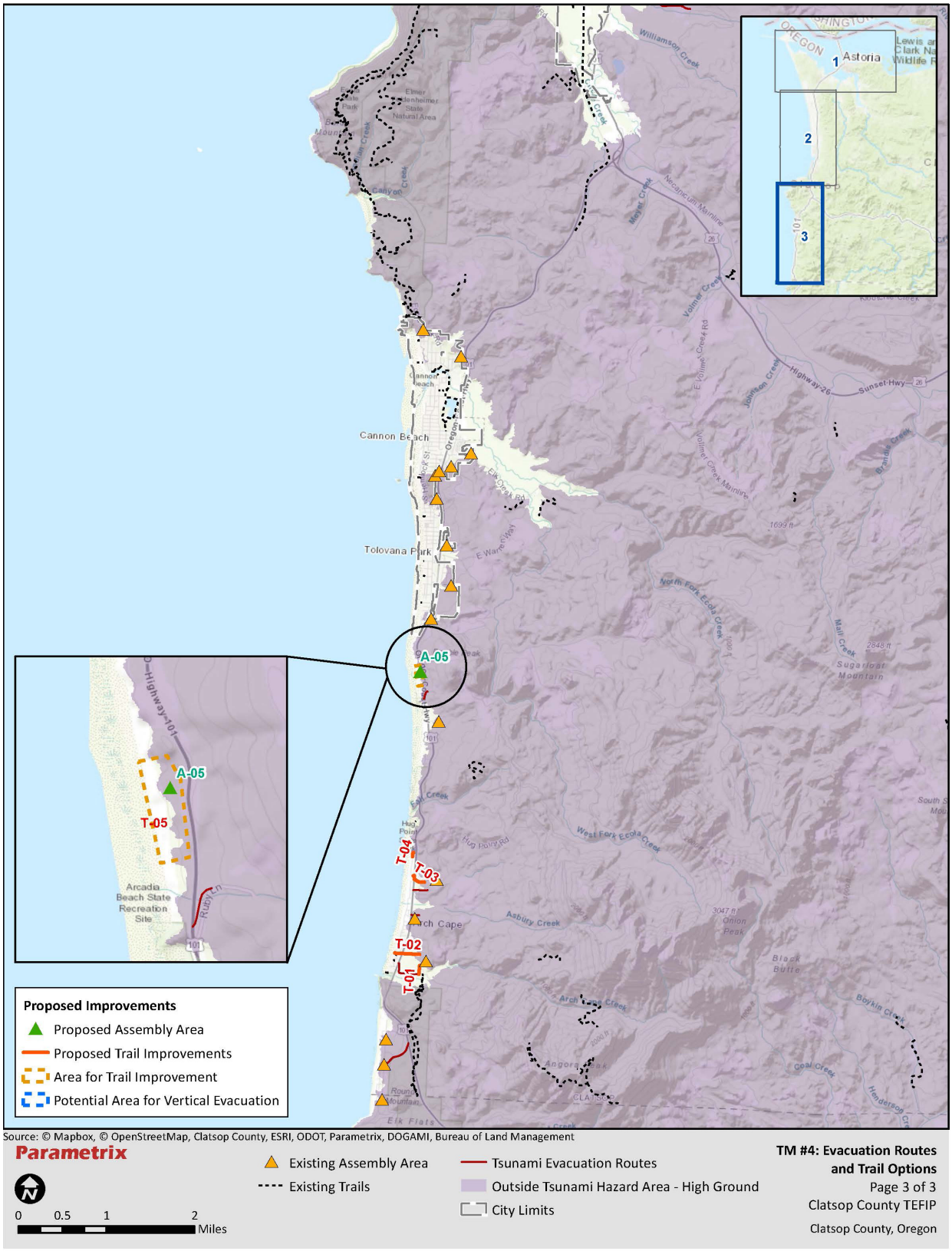


Figure 4. Evacuation Routes and Trail Options - South Area

ANALYSIS OF PROPOSED EVACUATION FACILITIES

Proposed evacuation facilities were assessed based on the screening criteria developed for *Technical Memo #2: Evaluation Criteria* and are listed in Table 5. Because specific locations were not identified for vertical evacuation structures, these were not screened.

Table 5. Screening Criteria

Subject	Criterion
User experience	Provides the most comfortable and enjoyable user experience
Safety and security	Provides a clear tsunami evacuation benefit
Multimodal connectivity	Increases connectivity of the multimodal network
Planning, land use, and regulatory impacts	Aligns with the existing County land use plans
Property ownership impacts	Minimizes impacts to private property owners
Directness of travel	Supports directness of evacuation routes
Cost and funding availability	Relative cost and likelihood of funding with grants
Infrastructure hardening	Increases the resiliency of the existing infrastructure system
Phasing opportunities	Project may be phased so as to facilitate incremental benefit
Accessibility	Facilitates connections for people with physical disabilities
Populations served	Enhances evacuation routes or connections for unincorporated communities
Existing infrastructure	Makes use of existing roadway, public trail, or evacuation route

The screening evaluation used a three-point scale as follows:

4 Concept meets or fully addresses the criterion (+1)

2 Concept partially meets or addresses the criterion, or is neutral with respect to the criterion (0)

0 Concept does not meet or negatively impacts the criterion (-1)

Table 6 shows how each proposed evacuation trail improvement scored against the evaluation criteria. The following evacuation facilities scored highest:

- T-01 – Trail connection. Arch Cape. Continue evacuation route outside of inundation zone from E Shingle Mill Lane along 3rd Road.
- T-02 – Trail connection. Arch Cape. Create a trail along Oceanview Lane right of way that leads to high ground.
- T-13 – Trail improvement (on-street). South of Warrenton. Delaura Beach Lane/SW 18th Street is an important connection from the beach to higher ground. Improve to be an effective evacuation route.

- T-14 – Trail improvement (MUP). Fort Stevens. Improve existing trail to serve as evacuation route for people in park or at beach.
- T-15 – Trail connection (MUP). Fort Stevens. New connection from existing trail to high ground.
- T-16 – Trail connection (MUP). Fort Stevens. New connection from existing Jetty Road parking area to high ground.

Table 6. Evaluation of Proposed Evacuation Facilities

ID	Description	Map sheet	User experience	Safety and security	Multimodal connectivity	Planning, land use, and regulatory impacts	Property ownership impacts	Directness of travel	Cost and funding availability	Infrastructure hardening	Phasing opportunities	Accessibility	Populations served	Uses existing infrastructure
T-01	Trail connection. Arch Cape. Continue evacuation route outside of inundation zone from E Shingle Mill Lane on Fire Rock Road.	South	4	4	2	2	4	4	4	4	2	4	4	4
T-02	Trail connection. Arch Cape. Create a trail along Oceanview Lane right of way that leads to high ground.	South	4	4	2	2	4	4	4	4	2	4	4	4
T-03	Trail connection. Arch Cape. Create a trail at the south end of Carnahan Road that continues east past US 101 along Buena Vista Drive to high ground.	South	4	4	2	2	2	4	4	4	2	4	4	4
T-04	Trail connection. Arch Cape. Create a trail at the south end of Carnahan Road that north to high ground.	South	4	4	2	2	2	4	4	4	2	4	4	0
T-05	Trail connection. South of Cannon Beach. Area has platted properties but is not yet developed. Consider placing trail(s) as conditions of development.	South	4	4	2	2	2	4	4	4	4	4	2	0
T-06	Trail connection. North of Gearhart. Create a trail to connect Shady Pine	Central	4	4	4	2	0	4	4	2	4	4	4	0

ID	Description	Map sheet	User experience	Safety and security	Multimodal connectivity	Planning, land use, and regulatory impacts	Property ownership impacts	Directness of travel	Cost and funding availability	Infrastructure hardening	Phasing opportunities	Accessibility	Populations served	Uses existing infrastructure
	Road across Neacoxie Creek to higher ground to the west.													
T-07	Trail connection. North of Gearhart. Continue trail to high ground from Cullaby Lake Lane.	Central	4	4	2	2	0	4	4	4	2	4	4	4
T-08	Trail connection (recreational). South of Camp Rilea. Connect Fort to the Sea Trail to high ground with a trail spur at ridge.	Central	4	4	2	2	0	4	4	2	2	0	2	2
T-09	Trail connection. South of Camp Rilea. Connect the neighborhood at Glenwood Village to high ground with trail to the east.	Central	4	4	2	2	0	4	4	4	2	4	4	4
T-10	Trail improvement (on-street). Camp Rilea. Improve Pacific Road to serve as an evacuation route.	Central	4	4	2	2	2	4	4	4	2	4	2	4
T-11	Trail improvement (on-street). Camp Rilea. Improve Demo Road to serve as an evacuation route.	Central	4	4	2	2	2	4	4	4	2	4	2	4
T-12	Trail connection. Camp Rilea. Connect the residential area along Douglas Lane to high ground at Camp Rilea with a short trail to 2nd Causeway Road.	North	4	4	2	2	0	4	4	4	2	4	4	4

ID	Description	Map sheet	User experience	Safety and security	Multimodal connectivity	Planning, land use, and regulatory impacts	Property ownership impacts	Directness of travel	Cost and funding availability	Infrastructure hardening	Phasing opportunities	Accessibility	Populations served	Uses existing infrastructure
T-13	Trail improvement (on-street). South of Warrenton. Delaura Beach Lane/ SW 18th Street is an important connection from the beach to higher ground. Improve to be an effective evacuation route.	North	4	4	2	2	4	4	2	4	2	4	4	4
T-14	Trail improvement (MUP). Fort Stevens. Improve existing trail to serve as evacuation route for people in park or at beach.	North	4	4	4	2	4	4	2	4	2	4	2	4
T-15	Trail connection (MUP). Fort Stevens. New connection from existing trail to high ground.	North	4	4	4	2	4	4	2	4	2	4	2	4
T-16	Trail connection (MUP). Fort Stevens. New connection from existing Jetty Road parking area to high ground.	North	4	4	4	2	4	4	2	4	2	4	2	4

Table 7 shows how each proposed assembly area scored against the evaluation criteria. The following assembly areas scored highest.

- A-17 – Establish a formal assembly area at the south end of Smith Lake County Park to serve evacuees from the neighborhood on Smith Lake Road.
- A-13 – Establish a formal assembly area along Pacific Road in Camp Rilea. Connects with Option T-10.
- A-14 – Establish a formal assembly area along Demo Road in Camp Rilea. Connects with Option T-11.
- A-15 – Establish a formal assembly area along 2nd Causeway Road near the south intersection with Cev Road in Camp Rilea.

- A-16 – Establish a formal assembly area for Option T-12 along 2nd Causeway Road near the north intersection with Cev Road in Camp Rilea.
- A-19 – Establish a formal assembly area on this ridge of high ground to serve the trails in Options T-14, T-15, and T-16.

Table 7. Assembly Area Concept Evaluation

ID	Description	Map sheet	User experience	Safety and security	Multimodal connectivity	Planning, land use, and regulatory impacts	Property ownership impacts	Directness of travel	Cost and funding availability	Infrastructure hardening	Phasing opportunities	Accessibility	Populations served	Uses existing infrastructure
A-01	Establish a formal assembly area at the end of the trail from Option T-01.	South	4	4	2	2	0	4	2	4	2	4	4	2
A-02	Establish a formal assembly area at the end of the trail from Option T-02.	South	4	4	2	2	0	4	2	4	2	4	4	2
A-03	Establish a formal assembly area at the end of the evacuation route on Buena Vista Drive from Option T-03.	South	4	4	2	2	0	4	2	4	2	4	4	2
A-04	Establish a formal assembly area at the end of the trail from Option T-04.	South	4	4	2	2	0	4	2	4	2	4	4	2
A-05	Area has platted properties but is not yet developed. Consider locating assembly area(s) as conditions of development.	South	4	4	2	2	2	4	2	4	4	4	2	0
A-06	Establish a formal assembly area near Rippet Lane.	South	4	4	2	2	0	4	2	4	2	4	4	2
A-07	Establish one or multiple formal assembly areas along Polo Ridge Road.	Central	4	4	2	2	0	4	2	4	2	4	4	2

ID	Description	Map sheet	User experience	Safety and security	Multimodal connectivity	Planning, land use, and regulatory impacts	Property ownership impacts	Directness of travel	Cost and funding availability	Infrastructure hardening	Phasing opportunities	Accessibility	Populations served	Uses existing infrastructure
A-08	Establish a formal assembly area at the end of the trail from Option T-06.	Central	4	4	2	2	0	4	2	4	2	4	4	2
A-09	Establish one or multiple formal assembly areas near West Lake Acres Road.	Central	4	4	2	2	0	4	2	4	2	4	4	2
A-10	Establish a formal assembly area at the end of the trail from Option T-07.	Central	4	4	2	2	0	4	2	4	2	4	4	0
A-11	Establish a formal assembly area at the end of the trail spur from Option T-08.	Central	4	4	2	2	0	4	2	4	2	4	4	0
A-12	Establish a formal assembly area at the end of the trail from Option T-09.	Central	4	4	2	2	0	4	2	4	2	4	4	0
A-13	Establish a formal assembly area along Pacific Road in Camp Rilea. Connects with Option T-10.	Central	4	4	2	2	2	4	2	4	2	4	4	2
A-14	Establish a formal assembly area along Demo Road in Camp Rilea. Connects with Option T-11.	Central	4	4	2	2	2	4	2	4	2	4	4	2
A-15	Establish a formal assembly area along 2nd Causeway Road near the south intersection with Cev Road in Camp Rilea.	North	4	4	2	2	2	4	2	4	2	4	4	2

ID	Description	Map sheet	User experience	Safety and security	Multimodal connectivity	Planning, land use, and regulatory impacts	Property ownership impacts	Directness of travel	Cost and funding availability	Infrastructure hardening	Phasing opportunities	Accessibility	Populations served	Uses existing infrastructure
A-16	Establish a formal assembly area for Option T-12 along 2nd Causeway Road near the north intersection with Cev Road in Camp Rilea.	North	4	4	2	2	2	4	2	4	2	4	4	2
A-17	Establish a formal assembly area at the south end of Smith Lake County Park to serve evacuees from the neighborhood on Smith Lake Road.	North	4	4	2	2	4	4	2	4	2	4	4	4
A-18	Establish a formal assembly area along Whiskey Road to serve neighbors on the northeast side of Smith Lake.	North	4	4	2	2	0	4	2	4	2	4	4	2
A-19	Establish a formal assembly area on this ridge of high ground to serve the trails in Options T-14, T-15, and T-16.	North	4	4	2	2	2	4	2	4	2	4	2	4

FUNDING AND FINANCING OPTIONS

The following funding sources should be considered for implementing evacuation trail improvements to provide a supplement to existing local funding. Tsunami evacuation planning completed for Washington's three southern-most counties has received substantial interest and support from FEMA, and there is a good opportunity for Oregon and Clatsop County to work with FEMA and others to identify and fund innovative tsunami evacuation facilities including trails, assembly areas, and vertical evacuation structures.

Federal Emergency Management Agency

One of the grant programs is FEMA's Building Resilient Infrastructure and Communities. It is a relatively new FEMA pre-disaster hazard mitigation program that replaced the former Pre-Disaster Mitigation Grant Program to support states, local communities, tribes, and territories through capability- and capacity-building to reduce the risks they face from disasters and natural hazards.

In 2016, the City of Newport, Oregon, partnered with FEMA and ODOT to develop Safe Haven Hill as a tsunami evacuation assembly area. In Washington, FEMA has funded the construction of the Shoalwater Bay Indian Tribe tsunami evacuation tower and provided grant assistance to develop the design of a tsunami evacuation platform in the City of Westport.

Oregon Community Paths Program

The Community Paths Program is a new funding program that ties together several pre-existing as well as new funding sources for trails and multimodal pathway improvements. The program is funded through both state and federal sources including funding from the new state bicycle excise tax as well as federal funding from the Transportation Alternatives pot of federal transportation monies. There are two main funding tracks with the Community Paths Program:

- Project refinement – Furthers planning, environmental or permitting work, and design on projects, but does not fund construction explicitly.
- Construction – Funding for final design and construction of trails projects. These can be state or federal funds.

In 2021, the Oregon Transportation Commission approved approximately $15 million in funding for projects across the state. To be competitive, projects need to be well defined, ideally link communities together, fill a critical missing link in a corridor, or serve as an element of the larger regional trail network. Clatsop County would be eligible to apply for both project refinement and construction funds.

More information: https://www.oregon.gov/odot/Programs/Pages/OCP.aspx

Rivers, Trails, and Conservation Assistance Grants from the National Park Service

The National Park Service (NPS) offers the Rivers, Trails and Conservation Assistance grant program for community-led natural resource conservation and outdoor recreation projects. Selection criteria favor projects with a near-term implementation schedule (within 5 years), clearly defined roles for project sponsors, evidence of broad community support, and project attributes that fit with the program's five focus areas, which are listed below. NPS will consider projects outside these focus areas as well.

- Build healthy communities.
- Conserve natural lands, rivers, and watersheds.
- Engage youth in outdoor recreation and stewardship.
- Strengthen organizational capacity of partners.
- Support NPS and community networks.

Oregon Recreational Trails Program

The Recreational Trails Program (RTP) is a federally funded grant program administrated by the Oregon Parks and Recreation Department. Since 1993, Oregon has funded over 500 projects with RTP funds to develop, improve, or expand motorized and non-motorized trails and their facilities. This annual grant program allocates approximately $1.5 million each year and prioritizes projects that are accessible for users of all ages and abilities. The RTP grants can be used for a variety of trails projects, including the following:

- New trail construction
- Heavy trail restoration
- Trail head facilities
- Purchase or lease of trail construction and maintenance equipment
- Land or easement acquisition for trail purposes
- Safety and education programs or materials
- Assessment of trail conditions for accessibility or maintenance
- Water trails

More information: http://www.oregon.gov/oprd/grants/Pages/trails.aspx.

Land and Water Conservation Fund

The Land and Water Conservation Fund State Grants program provides 50/50 matching grants to state and tribal governments for the acquisition and development of public parks and other outdoor recreation sites. Grants have funded projects in every county in the country—over 40,000 projects since 1965. Land and Water Conservation Fund monies are distributed to states based on population, and project selection for these funds is conducted at the state level. Selection criteria for the grants are aligned with Oregon's statewide recreation plan goals and priorities.

Department of Housing and Urban Development

Another federal grant program to consider is the Community Development Block Grant (CDBG) Program from the Department of Housing and Urban Development (HUD), which is a flexible program that provides communities with resources to address a wide range of unique community development needs. CDBG funding could be used to help build a vertical evacuation refuge structure if it is co-located with a qualifying asset, such as a community center.

More information: https://www.hud.gov/program_offices/comm_planning /communitydevelopment/programs

NEXT STEPS

The proposed trails and evacuation facilities identified in this memorandum will be shared with stakeholders and community members during the second outreach phase for their consideration and review. Their input and feedback, along with the project evaluation ring contained herein, will help the County to determine a set of preferred trail improvements and amenities.

REFERENCES

ASCE (American Society of Civil Engineers). 2017. Minimum Design Loads and Associated Criteria for Buildings and Other Structures, ASCE/SEI Standard 7-16, American Society of Civil Engineers, Reston, Virginia.

FEMA (Federal Emergency Management Agency). 2019. Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, FEMA P-646 (Third Edition), Prepared by the Applied Technology Council for the Federal Emergency Management Agency, Washington, D.C.