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May 13, 2020

Tim Bingham, timbingham@hotmail.com

Subject: **Engineering Geologic Hazard Report**
Proposed Deck Extension
79209 Ray Brown Road
Clatsop County Tax Lot 41031CBC1102
Cove Beach, Oregon

Dear Mr. Bingham:

As you requested, I am pleased to submit my engineering geologic hazard report for the subject project.

Introduction
This geologic hazard report has been prepared in general accordance with the requirements of Clatsop County GHO ordinance, Section 4.044 for properties in geologic hazard areas.

The engineering geologic conclusions and recommendations of this report are based site photographs, background information you provided about the deck foundation pier construction, my review of pertinent background geologic reports and literature, and my familiarity with general geologic hazard and soil and foundation construction conditions in the local area.

The scope of work for this project did not include advance geotechnical subsurface exploration or analyses of site-specific slope stability, ground motion response during a strong earthquake or other detailed geotechnical engineering analyses.

In preparing this report, available geologic hazard maps and reports, various site plans and available topographic data were reviewed for the site and local vicinity of the subject property. The following geologic reports, maps, aerial photographs and other information were reviewed and referenced:

- Environmental Geology of the Coastal Region of Tillamook and Clatsop Counties, Oregon, Oregon Department of Geology and Mineral Industries (DOGAMI), Bulletin 74, 1972.
- Digitized image of USGS 7.5 Minute Topographic Map of the Arch Cape Quadrangle, Provisional Edition, 1985 from National Geographic software TOPO! Mapping software.
- DOGAMI LIDAR Viewer, (http://www.oregongeology.org/sub/lidardataviewer/index.htm), accessed online May 12, 2020.
- United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), Web Soil Survey: http://websoilsurvey.nrcs.usda.gov/ accessed online May 12, 2020.

- Plan diagram of pier location, number and depth of embedment provided by Tim Durham, GeoHaz Post and Deck Plan.xlsx Excel file.
- Clatsop County Tax Lot Map 4N 10 31BC.
- Google Earth Aerial photographs of the Cove Beach, Oregon area, photo dates: September 3, 1994, July 29, 2000, June 15, 2003, June 29, 2005, December 12, 2005, August 1, 2011, July 6, 2012, July 30, 2014, August 23, 2016, and June 22, 2017.
- Clatsop County website, www.co.clatsop.or.us
- Clatsop County Land Use Ordinance Section 4.040 Geologic Hazards Overlay District (/GHO).

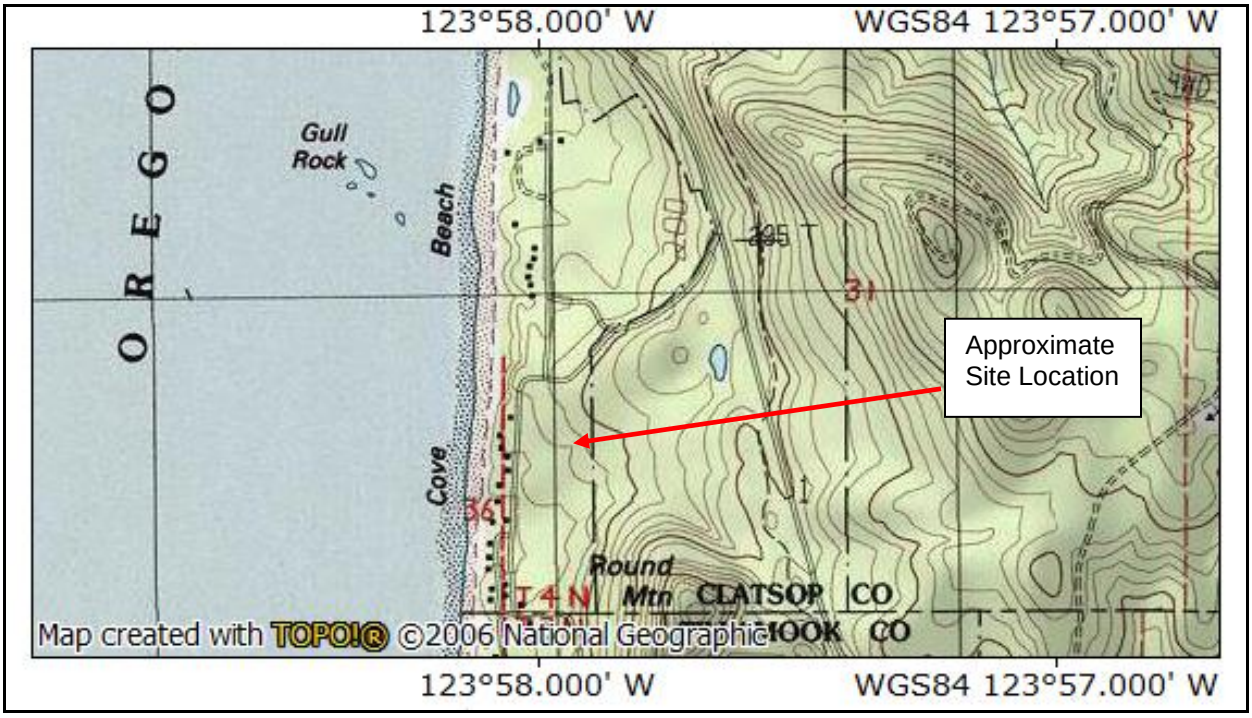

Figure 1- Site Location Plan

Site Description

The subject property is in the Cove Beach coastal residential area of southwestern Clatsop County, Oregon as shown in Figure 1. The property is designated as Clatsop County Tax Lot 1102, of Map 4N 10W 31CB, Figure 2. The parcel contains an existing home built in 1995 on a near level area of the lot with a gravel driveway leading to the front of the home, Photo 1. The home is has existing attached deck on the north and south sides. The proposed deck addition will be at the west side of the existing home where new posts will be supported on 16 recently constructed concrete foundation piers.

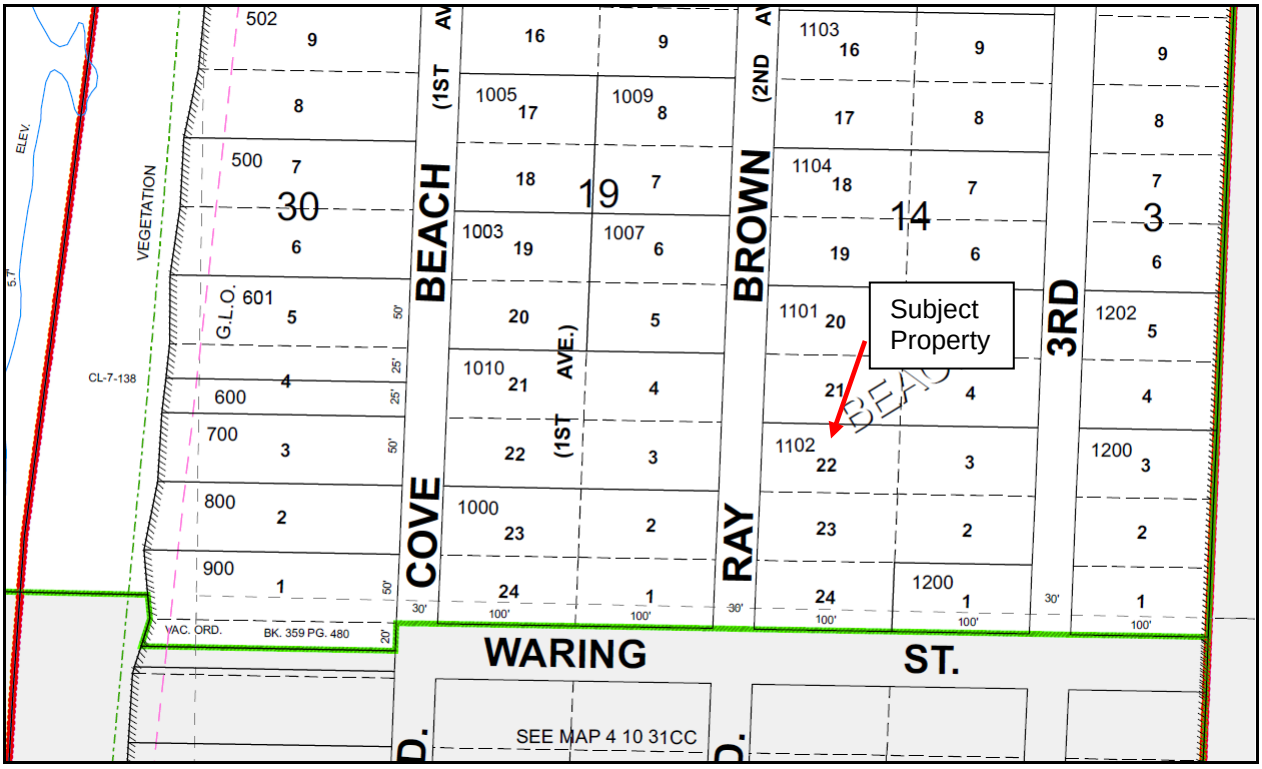

Figure 2- Portion of Clatsop County Tax Lot Map 4N 10 31CB.

Photo 1- West side of existing home where proposed deck addition is planned, Photo courtesy of Clatsop County.

Proposed Construction

The proposed deck extension on the west side of the home will be supported on 16 newly installed concrete foundation piers in the near-level gravel driveway area, as shown in red pier positions in Figure 3. It is my understanding that a one-man, trailer-mounted power auger was used to advance the pier holes to as much as 36 inches below ground surface. Piers 4 through 7 on the west side of the home were reportedly advanced to refusal on solid bedrock at 20 inches to 24 inches below the gravel surfaced driveway grade. I do not expect additional excavation or earthwork to be conducted as part of this deck addition project. No new cuts or fills or significant landscape modifications are proposed. There are no reported issues with settlement or cracking of existing foundations at this residence. Similarly, there are no reported soil erosion, drainage, or slope stability concerns for the subject property.

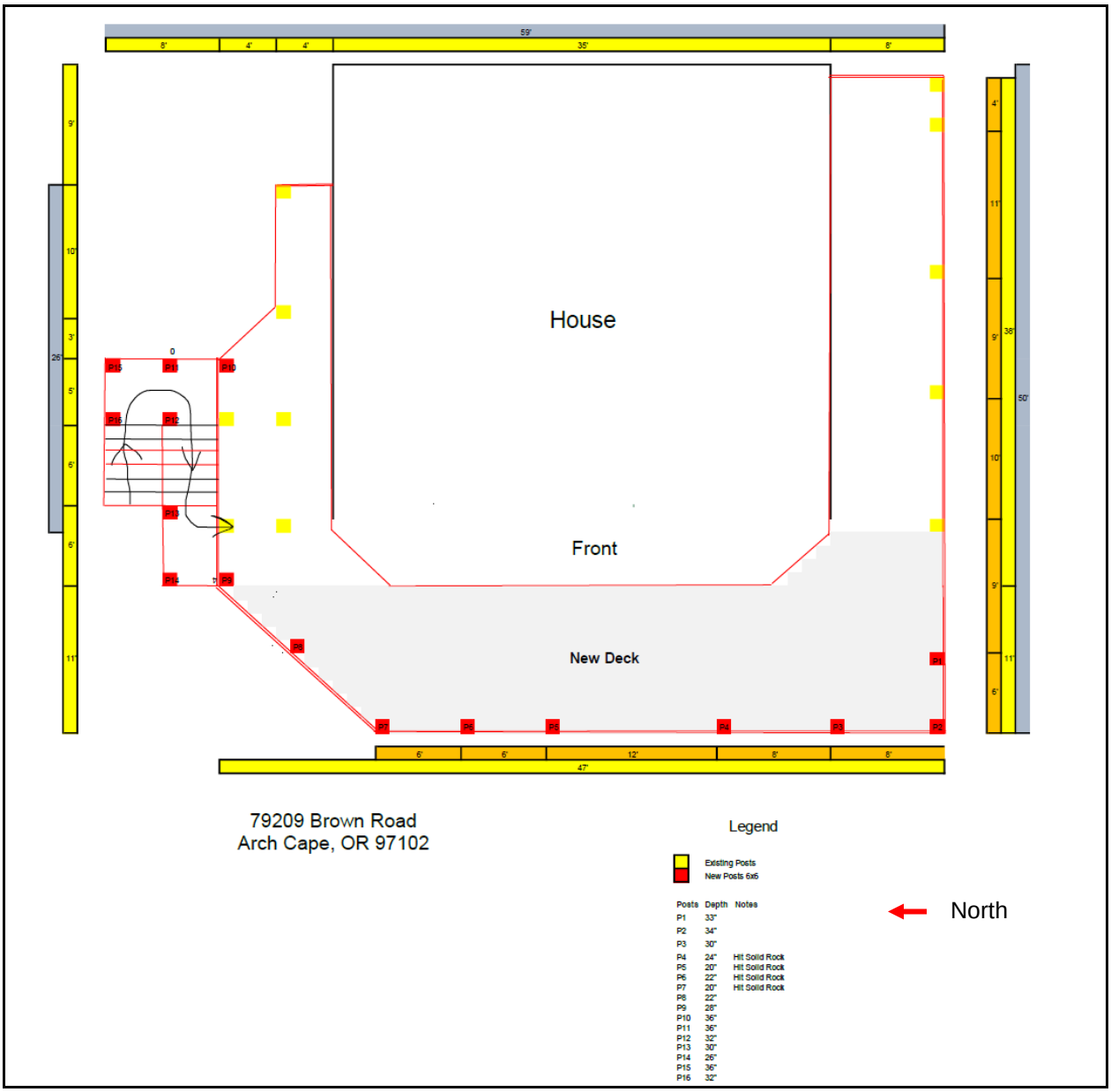

Figure 3 – Deck and Pier Plan provided by Tim Durham.

Soils and Geology Overview

Surface soils in the project area are mapped by the USDA NRCS Web Soil Survey of Tillamook County, Oregon as Walluski medial silt loam, 7 to 15 percent slopes. This relatively well drained medial silt loam to silty clay loam soil forms in mixed alluvium and/or fluvio-marine deposits derived from sedimentary bedrock. In this area the sedimentary bedrock source material is being mass-wasted and eroded from steep eastern uplands onto the isolated marine terrace.

DOGAMI Bulletin 74 includes geologic mapping at a scale of 1:24,000 for the Cove Beach area. The southwest corner of the geologic map of the Cannon Beach Quadrangle is shown in Figure 4. Mapped geologic units of the project area include Quaternary marine terrace (**Qmt**) deposits of Pleistocene age (last approximately 1.8 million years). This marine terrace deposit is described as consolidated to moderately consolidated gravel, beach and dune sand that locally contains minor clay-rich paleosol, colluvium, debris flows, and alluvial interbeds.

Landslide disturbed, decomposed, Tertiary age, Oligocene to Miocene marine siltstone and sandstone bedrock of the Astoria Formation (**Tma**) lies upslope to the east of the subject property. DOGAMI maps abundant landslides in the Astoria Formation, both active and ancient, inactive landslide topography. The mapped active and inactive landslides are identified by black curved lines with barbs or tick marks. The ancient landslide topography of the Astoria Formation is mapped with a blue stippled and triangular shaped overprint pattern.

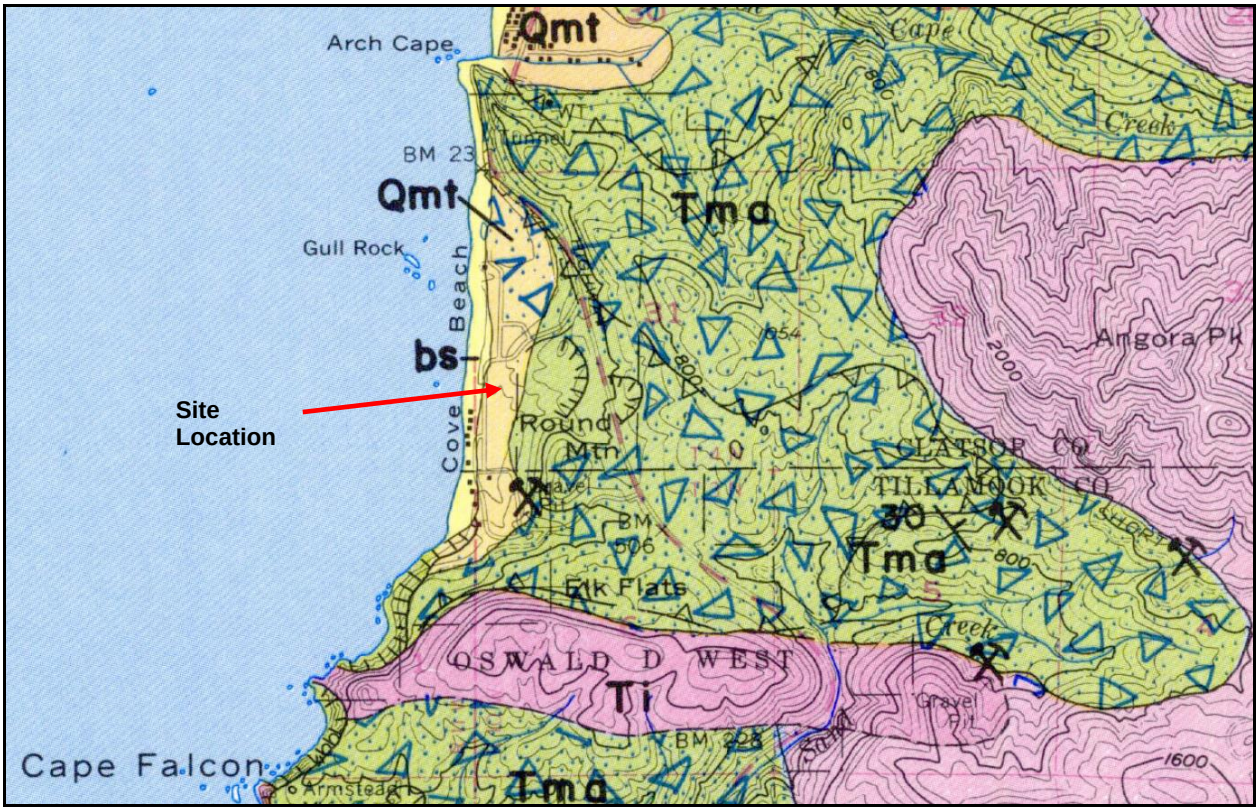

Figure 4- Portion of Geologic Map of Cannon Beach Quadrangle, DOGAMI Bulletin 74 (1972)

Because of the geologic history of active and inactive landslides, it is unlikely that intact sedimentary bedding of the Astoria Formation exists in this area. Mapped symbols for strike, dip, faults and folds and other deformation of primary sedimentary bedding are largely absent on this portion the geologic map, likely indicating that sufficiently intact sedimentary beds on which to obtain accurate strike and dip measurements were not found. The Quaternary Marine terrace geology of the Cove Beach area may be considered variably consolidated deposits of decomposed sedimentary rock in a matrix of silt and clay soil.

Cobble and boulder of basalt rock may have been encountered in the pier drilling. This rocky colluvium material likely was conveyed down slope from the east as colluvium from the Angora Peak Tertiary intrusive and volcanic rock (**Ti**) mapped on the peaks and ridges within about a mile to the east and south of the subject property.

Slopes and Topography

Surveyed or detailed topographic mapping was not available for the property. To evaluate geologic landslide and slope stability conditions at a neighborhood scale, I reviewed available Light Detection and Ranging (Lidar) topographic land surface images on the DOGAMI LIDAR Viewer website. A shaded relief topographic image of the bare earth surface is shown for the project area in Figure 5. The Lidar image shows cut and fill roadway grading and natural topographic features like creek drainage and eroded bluffs of the active ocean shoreline to the west. I do not interpret active landslide, slope failure geomorphology, or landslide deposits at or near the subject property in the Lidar image.

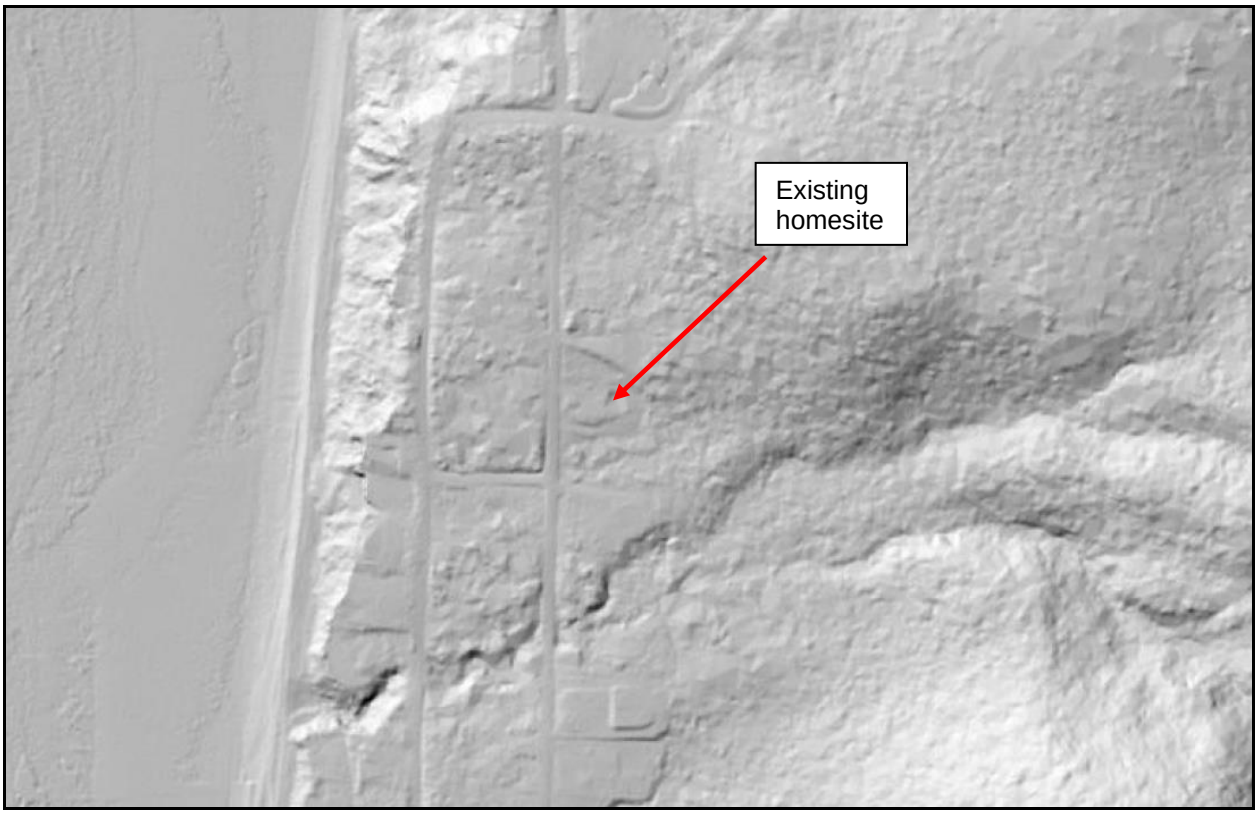

Figure 5- DOGAMI LIDAR viewer bare-earth shaded relief topographic image of project area.

Regional Seismic Hazard

The Pacific and Juan de Fuca tectonic plates that form the Pacific Ocean are converging eastward and are being compressed and pushed or subducted beneath the western edge of the North American continental tectonic plate. This zone of tectonic plate convergence is called the Cascadia Subduction Zone (CSZ) and is located about 50 to 60 miles off the northern Oregon coast. This compressive tectonic plate convergence takes the form of a global scale thrust or reverse fault that creates significant seismic hazard for much of the western Pacific Northwest region. This fault between the tectonic plates is considered locked up and building increasing pressure and strain. When this fault moves and simultaneously releases the accumulated energy a strong earthquake can result.

The CSZ can produce massive earthquakes that will cause violent ground shaking and destruction region wide. Geologic and geophysical research over the past few decades has established that the CSZ has repeatedly produced large earthquakes on an approximately 300-year to 700-year recurrence interval with possibly some greater time intervals. Historic Japanese tsunami records and modern tree ring dating techniques have been used to calculate that the most recent CSZ Zone earthquake occurred in January of 1700 AD. The next CSZ earthquake is widely expected to occur within many of our lifetimes.

Scientists and engineers generally agree that the potential intensity of the next CSZ earthquake could potentially exceed magnitude 8.5 to 9.5. The duration of strong ground shaking could exceed several minutes and may be followed by days or weeks of strong aftershocks.

During a CSZ earthquake, the project area will experience a few minutes of very intense ground shaking. The undersea, vertical thrust fault displacement will cause an ocean tsunami that will arrive at the Oregon coast about 15 to 20 minutes after the strong earthquake strikes. At about 120 feet in elevation above sea level, the home is above the estimated tsunami inundation zone that could result from a strong CSZ earthquake.

Other potential earthquake sources occur in this region. These include fault ruptures deep within the subducting oceanic plates and within the overlying continental crustal tectonic plate. However, the CSZ thrust fault earthquake mechanism is considered the greatest seismic hazard to the region and the seismic source which dictates minimum building code design requirements for permitted habitable structures.

Conclusions and Recommendations

My engineering geologic hazard review finds that the existing home and new deck piers are not in a known active landslide hazard area, or coastal erosion or tsunami inundation zone. It is my interpretation that the subject property has relatively high risk of earthquake ground shaking. The relatively high seismic risk is based on the proximity of the offshore CSZ fault and the expected severity and duration of seismic ground shaking. I do not interpret the existing home site to be situated in landslide or debris flow susceptible topography. Seismic slope instability risk would be greater in the steeper slopes to the east of the subject property, and in potential debris flow paths such as the creek channel a few hundred feet to the south of this property. The local roads and services may be cut off for extended period following a strong earthquake.

There may be no complete engineering mitigation available for seismic and landslide risk for this area. Relative seismic risk is considered no greater for this property than for many previously developed residential lots in this area. In my professional opinion, the foundation pier construction will not influence or increase geologic hazards on the subject site or on adjacent properties.

The foundation pier drilling reported firm soil or bedrock at shallow depth. I would not suspect disturbed, organic, expansive, or highly compressible soil in the existing graded building pad. In my opinion design and construction of the proposed deck foundation piers in accordance with Oregon Structural Specialty Code (OSSC) is considered appropriate.

Limitations

The engineering geologic services performed for this project have been conducted with that level of care and skill ordinarily exercised by members of the profession currently practicing in this discipline and area under similar budget, time, and work scope constraints. No warranty, expressed or implied, is made regarding the interpretations of site and subsurface conditions, recommendations, or conclusions of this report.

If you have any questions regarding the information presented in this report, please do not hesitate to contact me at 360-903-4861 or warrenkrager@gmail.com.

Sincerely,

R. Warren Krager, R.G., C.E.G.
Oregon Licensed Engineering Geologist E-957