

The Oregon Department of Geology and Mineral Industries (DOGAMI) has been identifying and mapping the tsunami inundation hazard along the Oregon coast since 1994. In Oregon, DOGAMI manages the National Tsunami Hazard Mitigation Program, which has been administered by the National Oceanic and Atmospheric Administration (NOAA) since 1995. DOGAMI's work is designed to help cities, counties, and other states in coastal areas reduce the potential for disastrous tsunami-related consequences by understanding and mitigating this geologic hazard. Using federal funding awarded by NOAA, DOGAMI has developed a new generation of tsunami inundation maps to help residents and visitors along the entire Oregon coast prepare for the next Cascadia Subduction Zone (CSZ) earthquake and tsunami, as well as for far-traveled, or "distant" tsunamis.

The Ring of Fire also called the Circum-Pacific belt, is the zone of earthquake activity surrounding the Pacific Ocean. It is an arc stretching from New Zealand, along the eastern edge of Asia, north across the Aleutian Islands of Alaska, and south along the coast of North and South America (Figure 1). The Ring of Fire is located at the borders of the Pacific Plate and other major tectonic plates. The Pacific Plate is colliding with and sliding underneath other plates creating subduction zones that eventually release energy in the form of an earthquake rupture. This rupture causes a vertical displacement of water that creates a tsunami. When these events occur around the Ring of Fire but not directly off the Oregon coast, they take more time to travel the Pacific Ocean and arrive onshore in Oregon (Figure 2). Distant earthquake/tsunami events have affected the Oregon coast: for example, offshore Alaska in 1964 and offshore Japan in March 2011.

Historically, about 68 distinct tsunamis have been documented by Oregon tide gauges since 1854. The most severe was generated by the 1964 M9.2 Prince William Sound earthquake in Alaska. Oregon was hit hard by the tsunami, which killed four people and caused an estimated 750,000 to 1 million dollars in damage to bridges, houses, cars, boats, and sea walls. The greatest tsunami damage in Oregon did not occur along the ocean front as one might expect, but in the estuary channels located further inland. Of the communities affected, Seaside was inundated by a 10 foot tsunami wave and was the hardest hit. Tsunami wave heights reached 10 to 11.5 feet in the Nehalem River, 10 to 11.5 feet at Depoe Bay, 11.5 feet at Newport, 10 to 11 feet at Florence, 11 feet at Reedsport, 11 feet at Brookings, and 14 feet at Coos Bay (Witter and others, 2011).

Alaska-Aleutian Model Specifications: DOGAMI model two distant tsunamigenic and tsunami scenarios involving M9.2 earthquakes originating near the Gulf of Alaska. The first scenario attempts to replicate the 1964 Prince William Sound event, and the second scenario represents a hypothetical maximum event. This maximum event is the same model used by the U.S. Geological Survey (USGS) in their 2006 tsunami hazard assessment of Seaside (TPSW, 2006). This model uses extreme fault model parameters that result in maximum seafloor uplift nearly twice as large as in the 1964 earthquake. The selected source area on the Aleutian chain of islands also shows higher energy release than the Oregon coast than other Alaska source locations. For these reasons the hypothetical "Alaska Maximum" scenario is selected as the worst case distant tsunami scenario for Oregon. Detailed information on fault geometries, subsidence, computer models, and the methodology used to create the tsunami scenarios presented on this map can be found in DOGAMI Special Paper 43 (Winter and others, 2011).

Figure 1: The "Ring of Fire" is a zone of active earthquakes and volcanoes that rings much of the Pacific Ocean, including the Oregon coast. Volcanoes and earthquakes on this ring are caused by the movements of tectonic plates. One type of movement is called subduction – when thin, oceanic plates, such as those that compose the rock beneath the Pacific Ocean, slide beneath thicker, lighter plates that make up continental plates. Earthquakes that occur as a result of subduction can trigger tsunamis.

Figure 2: This image depicts the actual initial tsunami arrival times, in hours, around the Pacific Rim from the 1964 Prince William Sound earthquake. This magnitude 9.2 earthquake and resulting tsunami caused 125 deaths and \$311 million in property loss, \$84 million and 106 deaths in Alaska (NGDC/WDC). The tsunami devastated many towns along the Gulf of Alaska, left serious damage in British Columbia, Hawaii, and along the west coast of the United States, and was recorded on tide gauges in Cuba and Puerto Rico.

	Entire Map Area	Unincorporated Areas
Total Buildings	199	199
Buildings within Tsunami Zones*		
Alaska M9.2 (1964)	0	0
Alaska Maximum	15	15
Percent of Buildings within Tsunami Zones		
Alaska M9.2 (1964)	0.0%	0.0%
Alaska Maximum	7.5%	7.5%

*Building counts shown are based on polygon centroids and are cumulative within the map area.

No Gauge Station for Map Extent

A UMPQUA BEACH A'

Elevation, feet (NAVD88)

Distance along Profile, miles

0 mi 0.25 mi 0.5 mi

0 ft 40 ft 80 ft 120 ft 160 ft 200 ft

Alaska M9.2 (1964)

Alaska Maximum

Rupture Plane

Distance to Rupture Plane

B SOUTH UMPQUA BEACH B'

Elevation, feet (NAVD88)

Distance along Profile, miles

0 mi 0.25 mi 0.5 mi

0 ft 40 ft 80 ft 120 ft 160 ft 200 ft

Alaska M9.2 (1964)

Alaska Maximum

Rupture Plane

Distance to Rupture Plane

Figure 5: These profiles depict the expected maximum tsunami wave elevation for the two Alaska tsunami scenarios along lines A-A' and B-B'. The tsunami scenarios are modeled to occur at a static (no flow) tide and equal to the Mean Higher High Water (MHHW) high tide.

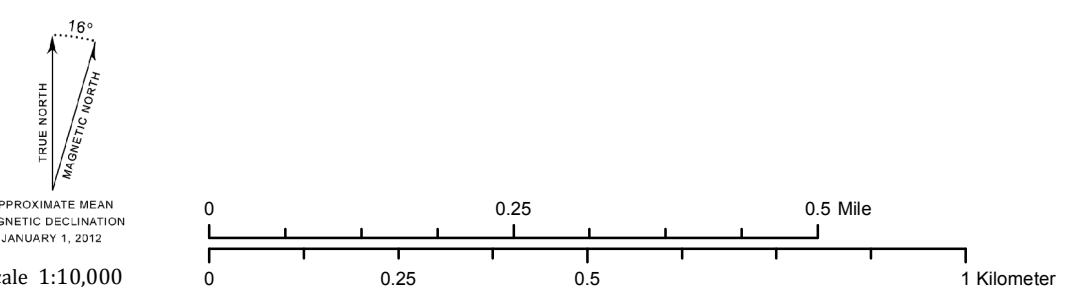


Figure 4: This chart depicts the tsunami waves as they arrive at the selected reference point (simulated gauge station). It shows the change in wave heights for the two Alaska tsunami scenarios over an 8-hour period. Wave heights vary through time, and the first wave will not necessarily be the largest as waves interfere and reflect off local topography and bathymetry. Any absence of data indicates periods for which tsunami inundation has not yet reached or has receded from the station location and dry land is exposed.

Earthquake Size	Slip / Deformation	Earthquake Magnitude
	Alaska M9-2 (1964)	Vertical seafloor deformation estimates.
	Alaska Maximum	Uniform slip on 12 subfaults with each assigned values ranging from 49 to 98 feet.
	Alaska Maximum Wet/Dry Zone	
	Urban Growth Boundary	Fire Station
	Building Footprint	Police Station
	Simulated Gauge Station	School
	Profile Location	Hospital/Urgent Care Clinic
	Senate Bill 379 Line	U.S. Highway
	State Park	State Highway
	Elevation Contour (25 ft intervals up to 200 ft)	Improved Road

The map displays the study area in Oregon, with nine numbered sites (01-09) marked. Site 09 is highlighted with a black border. The map includes labels for 'Lang Douglas' and 'Douglas Cove'. An inset map shows the location of the study area within the state of Oregon.

Site List:

- Dump 01 Silness Lake
- Dump 02 Tahkeneth Lake
- Dump 03 Gardiner
- Dump 04 Hoodport
- Dump 05 East Gortner
- Dump 06 Unquap River West
- Dump 07 Sulphur Springs
- Dump 08 Unquap River East
- Dump 09 Clear Lake

Source Data
 Source data for hydrodynamic transport models (Jorge Zhang, Oregon Health and Science University, Portland, OR, USA), and meteorological data (by T. Englund and G. R. Potter, Department of Geology, University of Colorado, Boulder, CO, USA).
 Hydrologic data (stream, critical facilities, and wetland footprints) were created by DOGAMI. Senate Bill 11, which requires that all waterways in the state be designated by DOGAMI. Smith and Biss (2009) provide a detailed description of the data.
 Urban growth boundaries (2011) were provided by the Oregon Department of Land Conservation and Development (2011).
 Transportation data (2012) provided by Douglas County were edited by DOGAMI to improve the spatial accuracy. The data were then extracted based on the raster in the original data layer.
 Lidar data were from DOGAMI. Lidar data Quadrangles (1:25000 scale) were obtained from the Oregon Department of Land Conservation and Development (2012).
 Lakeside, 1929–42–43–44–45–46–47–48–49–50–51–52–53–54–55–56–57–58–59–60–61–62–63–64–65–66–67–68–69–70–71–72–73–74–75–76–77–78–79–80–81–82–83–84–85–86–87–88–89–90–91–92–93–94–95–96–97–98–99–100–101–102–103–104–105–106–107–108–109–110–111–112–113–114–115–116–117–118–119–120–121–122–123–124–125–126–127–128–129–130–131–132–133–134–135–136–137–138–139–140–141–142–143–144–145–146–147–148–149–150–151–152–153–154–155–156–157–158–159–160–161–162–163–164–165–166–167–168–169–170–171–172–173–174–175–176–177–178–179–180–181–182–183–184–185–186–187–188–189–190–191–192–193–194–195–196–197–198–199–200–201–202–203–204–205–206–207–208–209–210–211–212–213–214–215–216–217–218–219–220–221–222–223–224–225–226–227–228–229–230–231–232–233–234–235–236–237–238–239–240–241–242–243–244–245–246–247–248–249–250–251–252–253–254–255–256–257–258–259–260–261–262–263–264–265–266–267–268–269–270–271–272–273–274–275–276–277–278–279–280–281–282–283–284–285–286–287–288–289–290–291–292–293–294–295–296–297–298–299–300–301–302–303–304–305–306–307–308–309–310–311–312–313–314–315–316–317–318–319–320–321–322–323–324–325–326–327–328–329–330–331–332–333–334–335–336–337–338–339–340–341–342–343–344–345–346–347–348–349–350–351–352–353–354–355–356–357–358–359–360–361–362–363–364–365–366–367–368–369–370–371–372–373–374–375–376–377–378–379–380–381–382–383–384–385–386–387–388–389–390–391–392–393–394–395–396–397–398–399–400–401–402–403–404–405–406–407–408–409–410–411–412–413–414–415–416–417–418–419–420–421–422–423–424–425–426–427–428–429–430–431–432–433–434–435–436–437–438–439–440–441–442–443–444–445–446–447–448–449–450–451–452–453–454–455–456–457–458–459–460–461–462–463–464–465–466–467–468–469–470–471–472–473–474–475–476–477–478–479–480–481–482–483–484–485–486–487–488–489–490–491–492–493–494–495–496–497–498–499–500–501–502–503–504–505–506–507–508–509–510–511–512–513–514–515–516–517–518–519–520–521–522–523–524–525–526–527–528–529–530–531–532–533–534–535–536–537–538–539–540–541–542–543–544–545–546–547–548–549–550–551–552–553–554–555–556–557–558–559–560–561–562–563–564–565–566–567–568–569–570–571–572–573–574–575–576–577–578–579–580–581–582–583–584–585–586–587–588–589–590–591–592–593–594–595–596–597–598–599–600–601–602–603–604–605–606–607–608–609–610–611–612–613–614–615–616–617–618–619–620–621–622–623–624–625–626–627–628–629–630–631–632–633–634–635–636–637–638–639–640–641–642–643–644–645–646–647–648–649–650–651–652–653–654–655–656–657–658–659–660–661–662–663–664–665–666–667–668–669–670–671–672–673–674–675–676–677–678–679–680–681–682–683–684–685–686–687–688–689–690–691–692–693–694–695–696–697–698–699–700–701–702–703–704–705–706–707–708–709–710–711–712–713–714–715–716–717–718–719–720–721–722–723–724–725–726–727–728–729–730–731–732–733–734–735–736–737–738–739–740–741–742–743–744–745–746–747–748–749–750–751–752–753–754–755–756–757–758–759–760–761–762–763–764–765–766–767–768–769–770–771–772–773–774–775–776–777–778–779–780–781–782–783–784–785–786–787–788–789–790–791–792–793–794–795–796–797–798–799–800–801–802–803–804–805–806–807–808–809–810–811–812–813–814–815–816–817–818–819–820–821–822–823–824–825–826–827–828–829–830–831–832–833–834–835–836–837–838–839–840–841–842–843–844–845–846–847–848–849–850–851–852–853–854–855–856–857–858–859–860–861–862–863–864–865–866–867–868–869–870–871–872–873–874–875–876–877–878–879–880–881–882–883–884–885–886–887–888–889–890–891–892–893–894–895–896–897–898–899–900–901–902–903–904–905–906–907–908–909–910–911–912–913–914–915–916–917–918–919–920–921–922–923–924–925–926–927–928–929–930–931–932–933–934–935–936–937–938–939–940–941–942–943–944–945–946–947–948–949–950–951–952–953–954–955–956–957–958–959–960–961–962–963–964–965–966–967–968–969–970–971–972–973–974–975–976–977–978–979–980–981–982–983–984–985–986–987–988–989–990–991–992–993–994–995–996–997–998–999–1000–1001–1002–1003–1004–1005–1006–1007–1008–1009–101



For copies of this publication contact:
Nature of the Northwest Information Center
800 NE Oregon Street, #28, Ste. 905
Portland, Oregon 97232
telephone (503) 675-2331