Background Report: Geologic and Seismic Characteristics of Trinidad, CA

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Introduction

The purpose of this report is to summarize the most recent geologic and seismic information available for the City of Trinidad and immediate surrounding areas. The information will be used to update the Conservation, Safety, and Open Space Elements of the City's General Plan.

Overview of Area Geology

The entire Trinidad area is underlain by a geologic unit commonly referred to as the Franciscan Formation, or Franciscan Complex. Franciscan rocks have their origins in the deep sea, where they were formed by turbidity currents that deposited sand, mud, gravel, and silica from the shells of marine creatures. These substances accumulated over tens of millions of years and hardened to form sandstone, shale, conglomerate, greenstone, and chert.[1] Geologists refer to this formation as a *mélange* because of its mixture of different rock types. Over time, these rocks have been uplifted by seismic activity to their present location above sea level. Seismic activity has also caused breakage and deformation of these rocks.[2] As a result, the Franciscan Formation consists of blocks of resistant sedimentary and metamorphic rock within a matrix of sheared, deformed, and highly erodible rock.[3]

Local topography is characterized by a series of marine terraces, which in cross-section have the appearance of wide stair-steps. These gently sloping surfaces were formed in the geologic past by wave erosion and deposition, and have been moved above sea level due to periodic sea-level changes and uplifting of the coastline.[4] The terrace surfaces range in elevation from about 140 feet at the western edge of town, to 600 feet at the eastern edge

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[1] Kilmer, Frank (c. 1975). Trinidad Beach Geology educational booklet.
[2] Kilmer, Frank (c. 1975)
[3] Rust, Derek (1982). Coastal Faulting and Erosion Hazards in Humboldt County, Northern California.
[4] Oscar Larson & Associates (1977). A Facilities Study of Subsurface Disposal Systems.

of the Trinidad area.[5] Most of the ground surface in Trinidad has a slope of 15% or less,[6] but steeper slopes are found at sea cliffs, stream banks, and the boundaries between marine terraces.

Alluvial deposits have accumulated on the terraces over time; they are typically composed of sand, silt, and gravel. These deposits range in thickness from a few inches to more than 100 feet.[7] Information on specific soil types will not be available until an official soil survey is completed for Humboldt County.

The entire northern coast of California is subject to seismic activity, due mainly to the proximity of the Cascadia Subduction Zone (CSZ). Multiple tectonic plates (pieces of the Earth's crust) collide off the coast of northern California and southern Oregon to form the CSZ, a 750-mile-long thrust fault.[8] The tectonic activity most relevant to Humboldt County is the movement of the Gorda and Juan de Fuca plates underneath the North American plate (Fig. 1). This movement causes the Earth's crust to compress and break, resulting in an extensive system of onshore faults and frequent offshore earthquakes.

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[5] Oscar Larson & Associates (1977)
[6] Dyett & Bhatia (2002). Humboldt 2025 General Plan Update: Natural Resources and Hazards.
[7] Oscar Larson & Associates (1977)
[8] Calif. Division of Mines and Geology (1995). Planning Scenario in Humboldt and Del Norte Counties, California, for a Great Earthquake on the Cascadia Subduction Zone.

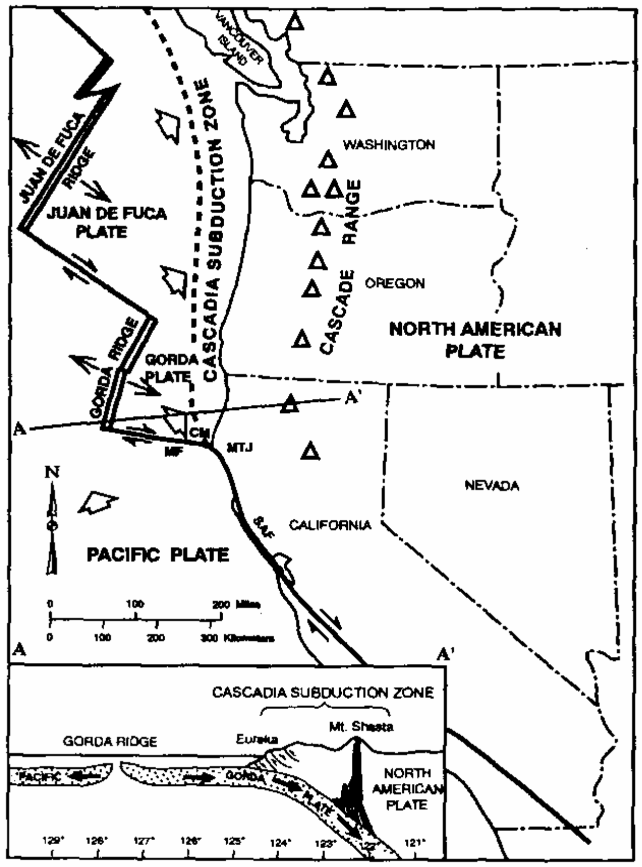

Fig. 1 Depiction of plate tectonics near the Cascadia Subduction Zone (source: Calif. Division of Mines and Geology [1995])

Within the City, the Trinidad Fault (part of the Mad River Fault Zone) has been designated under the Alquist-Priolo Act of 1972 (Fig. 2). The zone encompasses about 60 acres, or 19% of the land within City limits.[9] In this zone, any new development of structures for human occupancy would be required to undergo a geologic study before a building permit would be issued.[10]

9 City of Trinidad GIS
10 Calif. Division of Mines and Geology (1995)

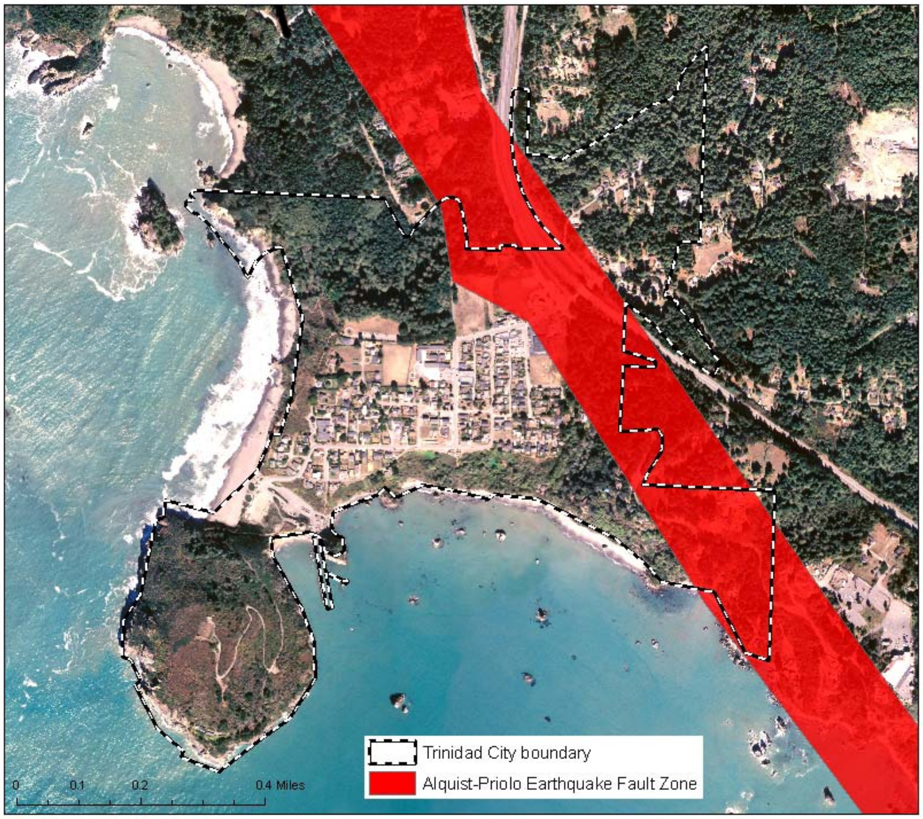

Fig. 2 Alquist-Priolo Zone designated for Trinidad Fault (source: City of Trinidad GIS; Humboldt County Community Development Services GIS)

Bedrock and Soils

Stability characteristics

As previously mentioned, the Franciscan bedrock that underlies Trinidad is composed of pieces of relatively resistant rock within a matrix of sheared, unstable material. Area geology is characterized by outcroppings of this material, especially at the coastline, and by the poorly consolidated alluvial deposits that cover the surfaces of the marine terraces. These different materials are subject to erosion and various types of slope failure.

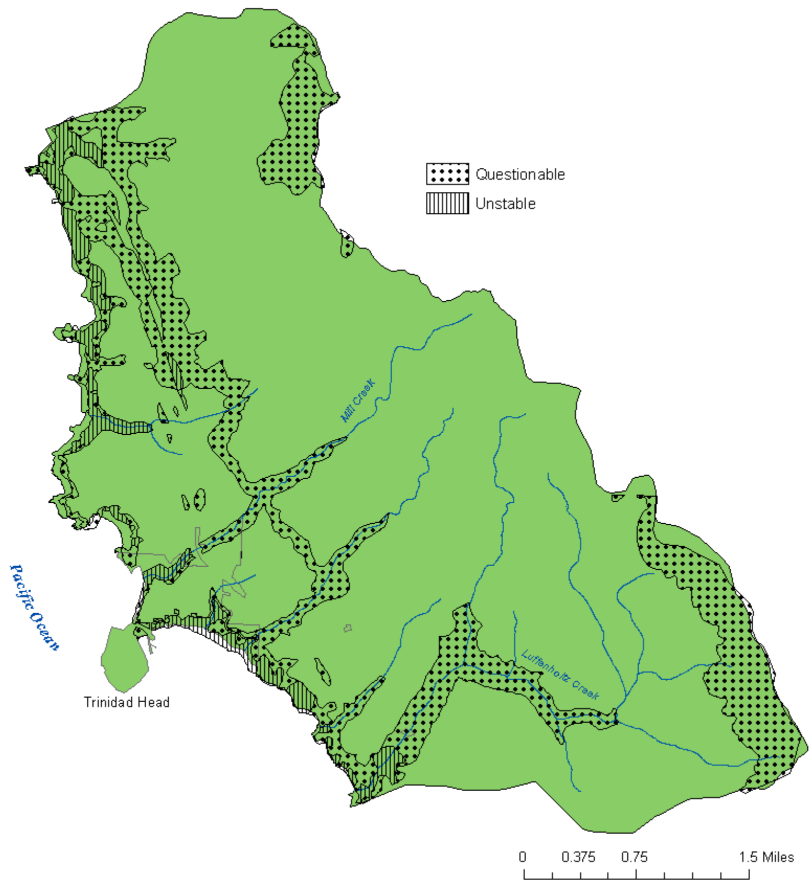

Fig. 3 Geologically questionable and unstable areas within Trinidad planning watershed (source: City of Trinidad GIS)

Erosion of coastal bluffs is a concern because the coastline is continuously attacked by ocean waves, particularly at high tide and during the winter storm season. In addition, sea level may be rising at an approximate rate of 1 mm per year, thus intensifying the effects of wave erosion.[11] Evidence of past cliff retreat is seen in areas such as College Cove (Fig. 4). This small bay was "carved" out of weak Franciscan matrix material, and according to aerial photographs, the shoreline retreated at a rate of 0.4 mm per year between 1942 and 1974.[12] Cliff retreat is also actively occurring at the Tsurai Village site located in the City of Trinidad[13] (Fig. 5).

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[11] Rust, Derek (1982)
[12] Rust, Derek (1982)
[13] LACO Associates (2004). Engineering Geologic Assessment of Tsurai Village.

Fig. 4 Evidence of past cliff retreat caused by wave erosion (source: City of Trinidad GIS)

Fig. 5 Active sea cliff erosion at Tsurai Village (source: City of Trinidad GIS)

Rates of cliff retreat vary along the coastline depending on local bedrock characteristics and degree of protection from waves. Coastal bedrock varies from sheared and fractured shales, which are highly erodible, to erosion-resistant diorite and greenstone (Fig. 6). Cliff retreat also occurs at different rates over time, as rates of sea level rise and geologic uplift change. Most of the Trinidad coast is approaching an equilibrium state, meaning that sea cliff erosion is more or less balanced by geologic uplift.[14] The rates of these processes, however, are not constant and cannot be predicted.

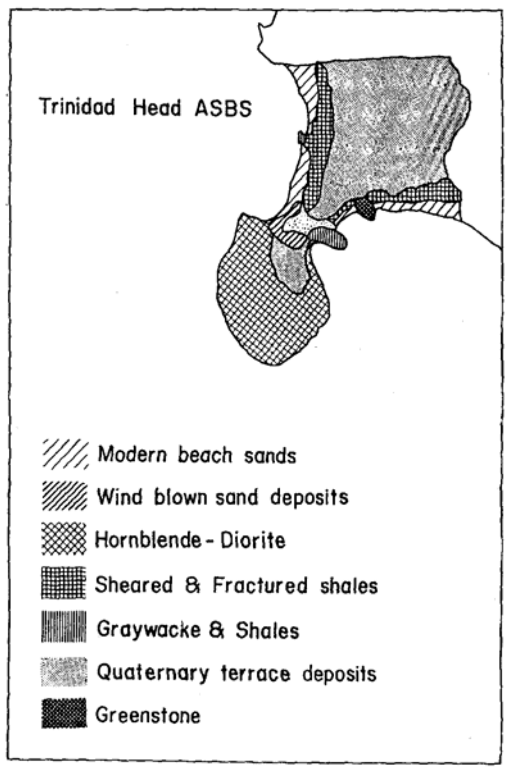

Fig. 6 Generalized rock types in Trinidad Head Area of Special Biological Significance (source: California State Water Resources Control Board [1979])

General slope instability is also a concern, particularly at the coastal bluffs. Several types of slope failure have the potential to occur in the Trinidad area. Earthflows and debris flows are the most common, and tend to happen on the clay-rich material of the Franciscan matrix.[15] This type of landslide poses a danger to structures because it often involves the movement of large blocks of material, such as the ones that come to rest on

[14] Rust, Derek (1982)
[15] Rust, Derek (1982)

Trinidad State Beach. Active flows are generally characterized by a “head” scarp at the upslope end and either a lumpy “toe” of debris or a cohesive block of material at the downslope end, so they can be recognized in the field. Currently there are no active landslides that may constrain development in the area (see below for a definition of *constraint*).[16]

Marine terrace deposits are also susceptible to rockfall. Rockfalls involve small pieces of material breaking off the edge of a slope and falling through the air, coming to rest in a pile at the bottom. This type of failure is common on deposits that overlie “sandy broken formation” rocks, the more resistant component of the Franciscan Formation according to Horan (1979).[17] Slopes that undergo rockfall are generally more stable than those that experience earthflow or debris flow, and structures built on sandy broken formation rocks are not expected to be in much danger.[18]

[16] Dyett & Bhatia (2002)
[17] Horan, Edwin P. III (1979). The Influence of Bedrock Composition and Structure on Coastal Slopes and Associated Types of Failure in Northern California.
[18] Horan, Edwin P. III (1979)

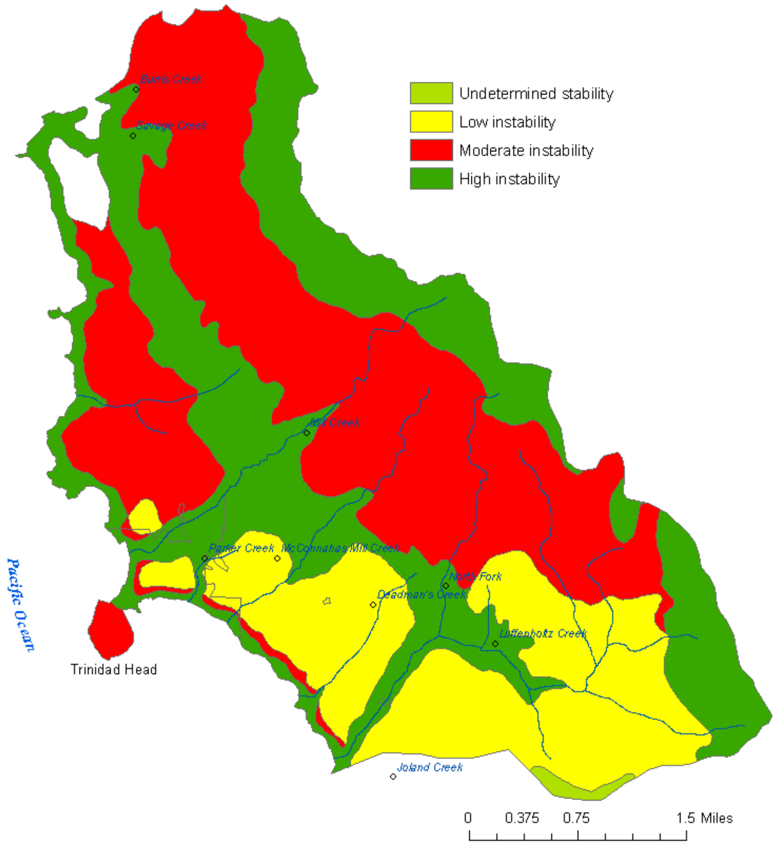

Fig. 7 Slope stability in Trinidad planning watershed (source: City of Trinidad GIS; Humboldt County Community Development Services GIS)

Dyett & Bhatia (2002) defined a Trinidad-Westhaven Community Planning Area (CPA) and a Trinidad Coastal Zone Planning Area (CZPA). The CPA has the Coastal Zone as its Western boundary, and is roughly 5 miles long by 1 mile wide. The CZPA encompasses most of the City and extends about 1 mile northward and 4 miles southward (Fig. 8). Between these two zones, a total of 116.2 acres are constrained by unstable slopes[19] (areas shaded pink in Fig. 8). In this context, a *constraint* implies that development should be prohibited completely, permitted on part of the land, or allowed with certain conditions and site plan review.

[19] Dyett & Bhatia (2002)

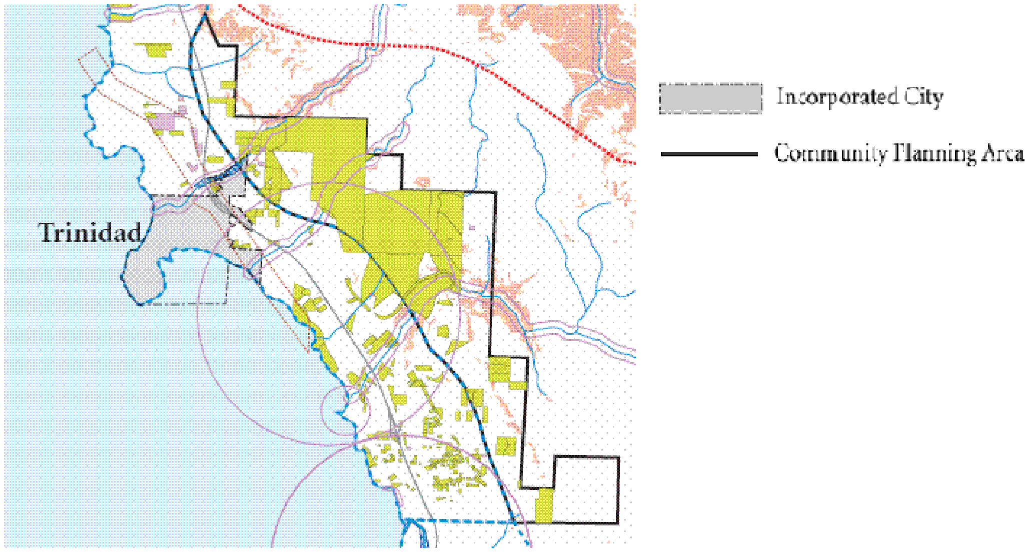

Fig. 8 Trinidad-Westhaven Community Planning Area (outlined in black) and Trinidad Coastal Zone Planning Area (delineated by dashed blue line) (source: Dyett & Bhatia [2002])

Permeability characteristics

Knowledge of the permeability of geologic material is essential for implementing septic systems. On-site waste disposal can work properly only if soils and bedrock are able to adequately transmit water and effluent. Generally, the best conditions for percolation are sandy-textured soils and/or highly fractured bedrock.

Soil and bedrock permeability vary throughout the Trinidad area. The soil in some areas is sandy enough to permit the functioning of septic systems. However, Franciscan bedrock and marine terrace deposits have generally low permeability. Franciscan bedrock has very low permeability due to tightly packed grains, and overall is not fractured enough to permit much water movement. Terrace deposits tend to be too fine-textured at the surface to be highly permeable, and at depth they contain layers of intermittent permeability. Furthermore, an impervious clay layer exists at the contact point between the bedrock and terrace deposits. When water, or effluent, flows along one of these impervious or less-permeable layers it may “daylight” where that layer intersects the ground surface.[20]

[20] Oscar Larson & Associates (1977)

The local position of the water table is also important for septic systems, as it influences the likelihood of groundwater contamination by sewage effluent. In the Trinidad area, groundwater tends to be shallow at sites where terrace deposits are thin and where large amounts of water infiltrate the soil due to rainfall or streamflow. Sites with these characteristics have a limited capacity to handle effluent from septic systems.[21]

A study by Moore & Taber (1977) summarized conditions in “sub-area I” (the town west of Highway 101) and “sub-area II” (east of Highway 101). In sub-area I, terrace deposits are thick and relatively permeable, and the water table is more than 20 feet below the surface. Terrace deposits are thinner in sub-area II, with an impervious zone near the surface, and groundwater is shallow year-round. Generally, sub-area I is better suited for septic systems than is sub-area II.

Soil types

The USDA Natural Resources Conservation Service is in the process of mapping Humboldt County soil types. When this information becomes available it can be used to identify further soils-related constraints on development in the Trinidad area.

Beach and offshore geology

The appearance of Trinidad’s coastline is variable because of the diversity of rock types present in the Franciscan Formation. Weaker rocks have been eroded by ocean waves, forming bays and exposing outcroppings of more-resistant rocks like the ones that comprise Trinidad Head and Pewetole Island. Additionally, this wave erosion has led to the creation of numerous sea stacks offshore.

In 2000, the sea stacks became part of a new California Coastal National Monument (CCNM). The CCNM is managed by the Bureau of Land Management (BLM) and

[21] Oscar Larson & Associates (1977)

includes all rocks, islands, and exposed reefs within 12 nautical miles of the shore.[22] The intent of the monument is to preserve the "critical resource values" of these rocks, particularly their value as habitat for marine mammals and birds.[23] Many offshore rocks in the greater Trinidad area provide nesting and roosting habitat for Leach's storm-petrel and the common murre, which may be disturbed by kayaking and climbing. Camel Rock (a.k.a. Little River Rock), for example, is home to storm-petrel nests that are burrowed into soft sediments. Climbers, who can access Camel Rock at low tide, may not recognize these nests while walking around.[24] Flatiron Rock and Green Rock are home to large nesting colonies of common murres, which may be disturbed by kayakers who approach too closely. (See Fig. 9 for rock locations.) Kayakers in Trinidad Bay also have the potential to disrupt marine mammals that use harbor rocks as haul-out areas.[25]

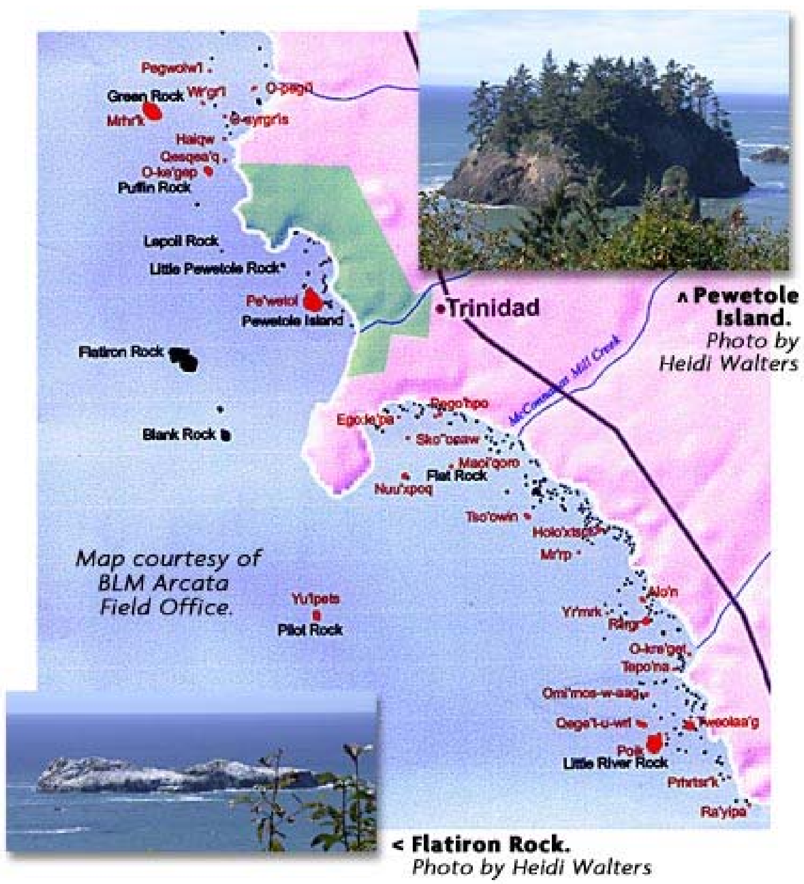

Fig. 9 Locations and names of Trinidad offshore rocks (source: *North Coast Journal* [2005])

[22] Hanks, Herrick E. (2003). Rocks, Buttons, Ecosystems, & Partnerships: Developing a Management Approach for the California Coastal National Monument.
[23] Wick, Robert (2007a). Personal communication.
[24] Wick, Robert (2007b). Personal communication.
[25] Wick, Robert (2007b)

Access to Trinidad's offshore rocks is not yet restricted, due to a lack of specific information about the impacts of human activities. The BLM has taken an adaptive-management approach to the CCNM and will not limit access to the rocks unless human activities are found to be detrimental.[26] Until the specific threats are understood, the BLM is focused on raising public awareness. Trinidad is considered a "gateway" to the Monument and is thus a major area of focus for interpretive activities and environmental education.[27] To this end, the BLM has established partnerships with the City, the Trinidad Rancheria, the Tsurai Ancestral Society, and state-level agencies. The partners are currently working on an informational kiosk to be placed near the harbor, as well as an interpretive brochure that will help visitors understand which areas of the coastline are sensitive to human impacts. Additionally, the local partners serve as "the eyes and ears" of the BLM and can report any activities that appear to be disturbing coastal resources.[28]

Summary of concerns

Steep slopes and unstable geologic material create erosion and landslide hazards in some of the Trinidad area. Coastal bluffs are especially subject to these hazards because of continuous wave erosion. Development should be located far enough from the edge of the bluffs so that structures are not in danger of being undercut by wave activity in the foreseeable future. Development should also be restricted in areas dominated by the clayey matrix component of the Franciscan Complex, as these materials are susceptible to earthflows and debris flows.

Land use policies should take into account human activities which, although they may not occur immediately adjacent to steep slopes, contribute to slope failure. (See Fig. 10 for location of parcels on unstable slopes.) LACO Associates (2004) have identified several land uses and activities that decrease slope stability at the Trinidad coastline. Runoff from impermeable ground surfaces (e.g. pavement), when not intercepted by drainage structures, may proceed downslope to unpaved areas and wash away topsoil. Excessive watering of landscapes and usage of undersized septic leachfields decrease water table

[26] Wick, Robert (2007a)
[27] Wick, Robert (2007b)
[28] Wick, Robert (2007b)

depth; as a result, the ground is closer to being fully saturated and is more prone to slope failure. Disposal of yard waste on slopes increases the amount of weight, and thus the amount of stress, affecting the slope. The latter problem can be mitigated by enforcing proper disposal of yard waste. Runoff problems can be mitigated by utilizing drainage collection structures and ensuring that discharge does not occur on slopes that are already prone to erosion. Another solution would be to implement Low Impact Development options, such as catchments and porous ground cover surfaces, which reduce runoff by capturing rainwater or allowing it to infiltrate the soil.[29]

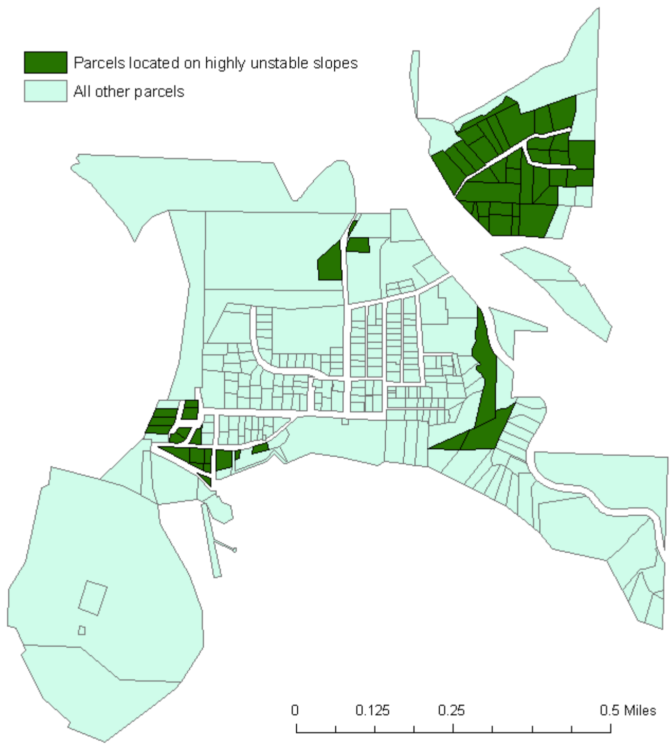

Fig. 10 City of Trinidad parcels located within areas of highly unstable slopes (source: City of Trinidad GIS; Humboldt County Community Development Services GIS)

The variable soil and geologic properties found in Trinidad have implications for the location of septic systems. Marine terrace deposits and Franciscan bedrock have generally low permeability and include intermittent impervious layers, which can cause effluent to emerge at the ground surface in some areas. High water tables also present an

[29] Barboza, Nina, *et al.* (2006). The Study of Impervious versus Pervious Surfaces, and Low Impact Development Designs Within the City of Trinidad.

obstacle to proper septic system functioning. Effluent is unable to percolate well through saturated soils, and groundwater may become contaminated. Before any new septic system is installed, or an existing one expanded, the proposed site should be evaluated for soil permeability, the possibility that effluent will seep to the ground surface at nearby locations, and local water table elevations (including seasonal variations).

Offshore rocks provide important habitat and resting areas for marine birds and mammals, and are under BLM jurisdiction as part of the California Coastal National Monument. The City should continue to work in cooperation with the BLM and other partners to increase public awareness of the Monument. Kayakers should be encouraged to maintain a respectful distance from rocks that are known roosting or nesting areas for birds. Rocks that are partially covered by soil, such as Camel Rock, should be considered likely nesting sites for Leach's storm-petrel. Climbers should be cautioned not to walk atop the soil in order to avoid disturbing these nests.

Seismicity

Earthquake history

The Humboldt County coast is well known for frequent earthquakes due to the proximity of the Cascadia Subduction Zone (see Overview of Area Geology). Between 1871 and 1980, the county was affected by 21 quakes of magnitude 6.0 or higher.[30] From 1980 to 1997 another six quakes of this magnitude or higher occurred, as well as five quakes that were near magnitude 7.0.[31] Most local earthquakes originate offshore, within tectonic plates rather than along plate boundaries. The Gorda plate is most susceptible to seismic activity because it undergoes a large amount of stress, and consequent fragmentation, as it is pushed beneath the North American plate[32] (see Fig. 1). Offshore quakes are less damaging to human communities than onshore quakes, but they can still be quite large, as evidenced by the magnitude 7.0 earthquake that occurred in November 1980.

[30] Rust, Derek (1982)
[31] Dengler, Lori (1997). Recent North Coast Earthquakes.
[32] Kilbourne, Richard T., and George J. Saucedo (1981). Gorda Basin Earthquake, Northwestern California.

Recent and potential faulting activity

There is evidence of active faulting in the Trinidad area, as described by Rust (1982). Ground surface along the Trinidad Fault has been offset by 5 m at Andersen Ranch (approx. 1 mile north of the City), and about 14 m at a site south of College Cove Creek. The average rate of slip along this fault is approx. 0.17 mm per year, and a single seismic event could result in ground displacement of 2 to 3 m. The fault is surrounded by a zone of deformed and stressed rocks, which creates further hazards related to ground shaking and breakage. Rust also found evidence of ground displacement on Trinidad Head, but because the Head is composed of sheared Franciscan material, it is difficult to determine whether this potential fault is a current hazard or was only active in the past.[33]

Earthquake risks

More quakes will certainly occur in Humboldt County in the foreseeable future. It is important to anticipate where they will be centered, how large they will be, and consequently what kinds of damage they are likely to cause. The type of quake most likely to occur is centered offshore and has a magnitude between 5.0 and 7.5.[34] Onshore earthquakes are less probable, having an average recurrence interval of 20 years. This type of quake could have a magnitude of 7.5 or higher; it would be more intense, and more damaging, than any historic quake.[35]

Although most earthquakes in the region originate offshore within the Gorda plate, they can also occur on the CSZ boundary. The magnitude 7.1 earthquake of April 1992 is thought to have occurred along that boundary, and was the first such occurrence in about 300 years. Evidence of prehistoric subduction zone earthquakes suggests that they could have magnitudes of 8.0 or greater.[36] Accordingly, the California Division of Mines and Geology (DMG) developed a planning scenario based on a "great earthquake" of

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[33] Dengler, Lori (2007). Personal communication.
[34] Dengler, Lori, and Kathy Moley (1995). On Shaky Ground.
[35] Dengler and Moley (1995)
[36] Dengler and Moley (1995)

magnitude 8.4, originating on the CSZ boundary.[37] The probability of this event is unknown, but local communities are urged to prepare for it.

The general risks associated with earthquakes in the Trinidad area are structural damage, slope failures, liquefaction, and tsunamis. With the exception of tsunamis, these risks tend to be greater in areas of unstable slopes, wet conditions, alluvial deposits, or fill material.

Structural damage results directly from fault rupture and associated ground shaking. Historically, this type of damage has not been extensive in Trinidad because of sparse development.[38] Within City limits there are few to no unreinforced masonry buildings, which are the structures likely to sustain the most damage in an earthquake.[39] Wood frame houses built prior to 1940 are also susceptible to damage, and a number of these are located in Trinidad.[40] In the "great earthquake" scenario previously mentioned, the City would experience shaking intensities of VII or VIII+ on the Mercalli scale.[41] The Mercalli intensity scale, as opposed to the Richter magnitude scale, describes the observable effects of an earthquake in a given location. Intensities of VII or VIII+, respectively, would result in "negligible damage in well-designed buildings" or "considerable damage in ordinary substantial buildings."[42] Thus, even well-constructed buildings could sustain damage or be weakened by ground shaking in a maximum probable earthquake scenario.

Slope failures triggered by ground shaking are likely to occur where the water table is high and where slopes are steep, such as along terrace margins (see Overview of Area Geology) and road cuts. Any of the landslide types described under "stability characteristics" (see Bedrock and Soils) can be caused or accelerated by seismic

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[37] Calif. Division of Mines and Geology (1995). Planning Scenario in Humboldt and Del Norte Counties, California, for a Great Earthquake on the Cascadia Subduction Zone.
[38] Rust, Derek (1982)
[39] Calif. Division of Mines and Geology (1995)
[40] Brown, Robert (2006). Rapid Assessment of Historic Structures Using Historic Aerial Photo Overlay/Analysis.
[41] Calif. Division of Mines and Geology (1995)
[42] Calif. Division of Mines and Geology (1995)

shaking.[43] According to the DMG report, which does not provide a detailed damage assessment for Trinidad, most of Highway 101 in Humboldt County would be closed for at least three days under a great earthquake scenario.[44] It is reasonable to assume that landslides would be responsible for closing the portion of highway that runs through Trinidad.

Liquefaction caused by seismic shaking has a low probability of occurrence in Trinidad. This phenomenon involves unconsolidated materials, such as sand, losing strength and becoming temporarily fluid; entire buildings can slide when the ground beneath them is liquefied.[45] A liquefaction potential map produced by DMG shows no potential for this occurring in the Trinidad area.[46] However, there was evidence that beach sands became liquefied at Big Lagoon (5 miles north of Trinidad) during the magnitude 7.0 quake of November 1980.[47] Trinidad beach sands could undergo some liquefaction in a large quake, but given the relatively small size of the beaches, this would not pose a hazard to structures or people.[48]

Tsunamis—seismically generated ocean waves—have hit Trinidad in the past and should be considered a future possibility. Predicted tsunami heights at Trinidad Bay are 3.1 m for an event occurring every 100 years, and 5.7 m for an event occurring every 500 years.[49] These waves could result from earthquakes occurring anywhere in the Pacific Ocean basin. For example, the 1964 Alaska earthquake caused a tsunami runup of 5.4 m in Trinidad.[50] Despite the substantial height of this wave, the docks in Trinidad Harbor were not damaged. The gently concave shape of Trinidad Bay does not concentrate the energy of waves approaching the coast, whereas a more enclosed bay (such as the one at Crescent City) would “funnel” wave energy toward the shore and result in a higher

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[43] Rust, Derek (1982)
[44] Calif. Division of Mines and Geology (1995)
[45] Taylor, Bruce, and Larry Parsons (1980). Big Lagoon’s Quake ‘Scars.’
[46] Calif. Division of Mines and Geology (1995)
[47] Taylor and Parsons (1980)
[48] Dengler, Lori (2007)
[49] Houston and Garcia (1978). Type 16 Flood Insurance Study: Tsunami Predictions for the West Coast of the Continental U.S. *in* Rust (1982)
[50] Lander, J.F., et al. (1993). Tsunamis Affecting the West Coast of the United States, 1806-1992.

runup.[51] The shape of the bay, coupled with the steepness of the Trinidad coast, means that the predicted tsunami heights are not expected to cause much structural damage. However, the predicted heights are based on distant-source earthquakes; a quake originating near the California coast could result in a larger tsunami,[52] or one that would arrive with little to no warning.[53] Tsunamis of all sizes pose a danger to Trinidad beachgoers, if not to structures.

Summary of concerns

The City of Trinidad is located in a seismically active region. Several damaging quakes have occurred locally in the past, and even larger ones are predicted for the future. The most damaging type of quake would be one that occurs on the Cascadia Subduction Zone boundary and results in onshore fault rupture. An earthquake on the CSZ could have a magnitude as high as 8.4 and result in greater damage than has ever been seen in Humboldt County. Although such a large event has a low probability of occurrence, earthquakes are generally unpredictable and worst-case scenarios should be anticipated.

The Trinidad Fault is the major active fault located in the Trinidad planning area. Development in the Trinidad Fault Zone is regulated by the Alquist-Priolo Act (Fig. 11). However, there is a possibility of ground shaking and breakage outside the Alquist-Priolo boundary. It may be helpful to designate a wider zone within which site studies would be required before development.[54]

[51] Dengler, Lori (2007)
[52] Dengler, Lori (2007)
[53] Calif. Division of Mines and Geology (1995)
[54] Rust, Derek (1982)

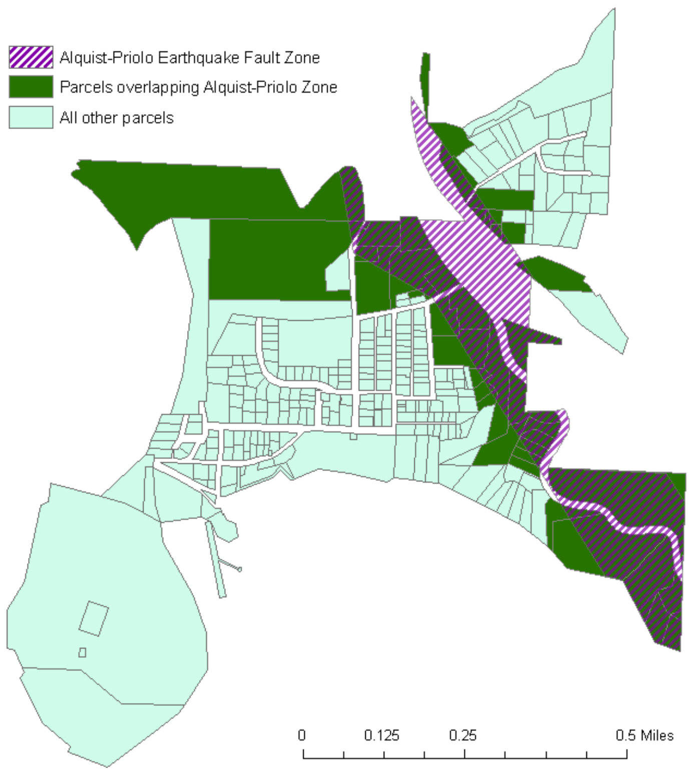

Fig. 11 City of Trinidad parcels located partially or wholly within Alquist-Priolo Earthquake Fault Zone (source: City of Trinidad GIS; Humboldt County Community Development Services GIS)

In case of an earthquake, the major hazards would be structural damage and slope failures. Pre-1940s buildings are especially prone to damage or weakening, and they should be inspected for their ability to withstand the ground shaking that would result from a maximum probable earthquake. Slope failures could result in road closures and damage to buildings. Unstable or steep slopes (see Figs. 7 and 10) in close proximity to roads, buildings, or other valuable resources should be evaluated for their potential to fail in a maximum probable earthquake, under both wet and dry conditions.

Tsunamis present another hazard. The potential inundation zone for the City should be mapped, and a tsunami-readiness plan should be prepared.

List of Recommendations

1. New development along the coast should be set back from bluffs at sufficient distance that structures are not in danger of being undercut by ocean waves in the foreseeable future. *Addressed in General Plan 2001 Administrative Draft, Policy OS-1*.
2. Development on clay-rich geologic material should be restricted pending geologic investigation to determine the probability of slope failure at the site.
3. The City should encourage the use of Low Impact Development options, such as pavers and rainwater catchments, at public facilities and private residences to reduce stormwater runoff.
4. Disposal of yard waste on steep or unstable slopes should be prohibited. *Addressed in GP 2001 Admin. Draft, Policy SAF-1.*
5. Before any new onsite wastewater treatment system is installed, or an existing one expanded, a geologist or engineer should evaluate the proposed site for soil permeability, the possibility that effluent will seep to the ground surface at nearby locations, and local water table elevations.
6. The City should continue to work with the Bureau of Land Management and other partners to implement the California Coastal National Monument Resource Management Plan, and to increase public awareness of the scenic and habitat values of offshore rocks and sea stacks.
7. The City should designate zones outside the Alquist-Priolo boundary in which there is a high probability of ground shaking and breakage during a maximum probable earthquake. Before development could occur in this zone, site studies would be required to determine the safety of the proposed structure(s).
8. Unstable or steep slopes in close proximity to roads, buildings, or other valuable resources should be evaluated for their potential to fail during a maximum probable earthquake, under both wet and dry conditions. The City should prepare an earthquake-readiness plan for any road, building, or other major resource that may be damaged or rendered unusable by seismically induced slope failures. *Addressed in GP 2001 Admin. Draft, Policy SAF-13.*

9. Structures built prior to 1940 should be inspected for their ability to withstand the ground shaking that would occur during a maximum probable earthquake. Any such structure that presents a safety risk during an earthquake should be required to undergo reinforcements, as determined by a building engineer. However, it is noted that current Building Code standards are stringent for this part of Humboldt County.
10. The predicted tsunami runup zone should be modeled for the Trinidad coast, and the potential for damage should be evaluated.

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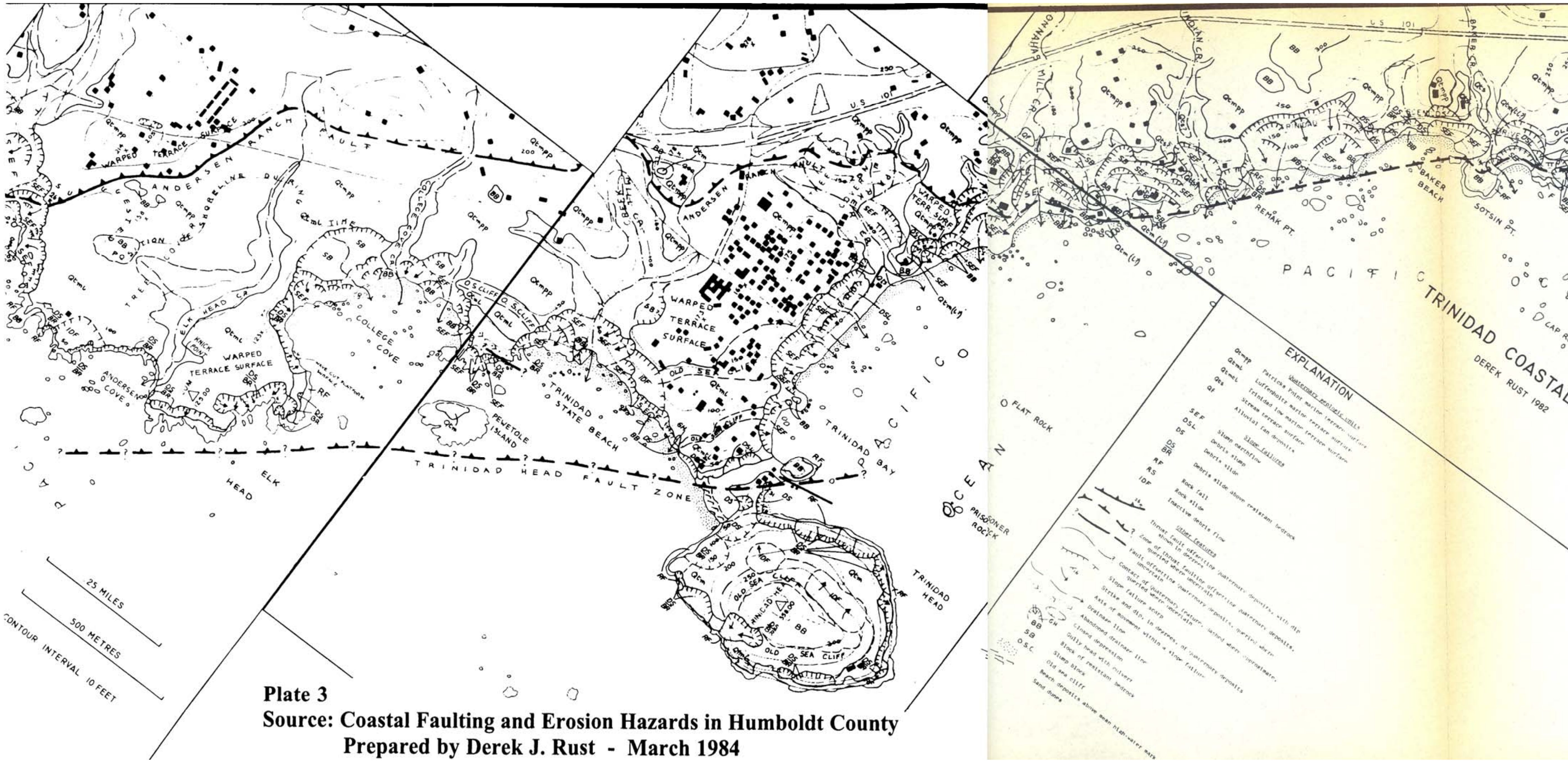
Appendix: Summary Geologic Map of Trinidad Area



Source: Rust, Derek (1982). Coastal Faulting and Erosion Hazards in Humboldt County, Northern California. Compiled by California Coastal Commission and Calif. Department of Fish and Game from a collection of papers presented at the Ocean Studies Symposium, November 7-10