North Coast Integrated Regional Water Management Plan

Proposition 84, Round 2 Implementation Grant

Attachment 3, Work Plan

APPENDIX A

Priority Project

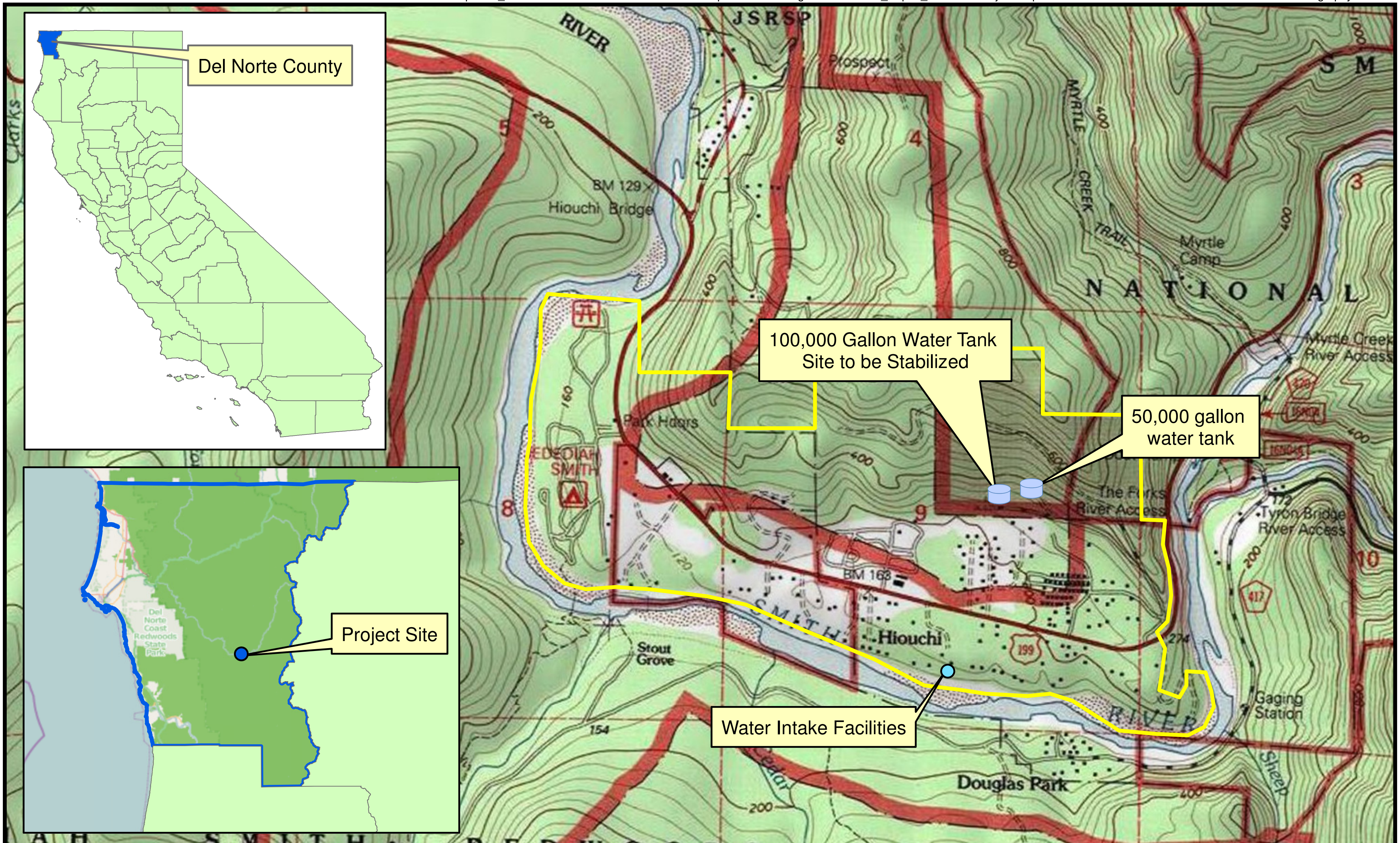
Plans, Specifications, Technical Studies and Scientific Data

North Coast Rivers Watershed Management Area

101 - Big Rock Community Services District, Stabilize Water Storage Tank

Big Rock CSD Technical and Scientific Documentation Table		
Technical and Scientific Document Name	**Document Description**	**Relevant page #**
GHD. Big Rock Community Services District Water Storage Tank Stabilization Project- Benefit Cost Analysis Support, 2012	Benefit Cost Analysis software, version 4.5.5.0, was used to find a benefit cost ratio for the Big Rock CDS project.	All
GHD. Big Rock Community Services District Water Tank Stabilization Project- Supporting Information for Environmental Checklist, 2012	The Supporting Environmental Information Checklist provides information on the relevant environmental factors. Some of these items will be addressed in more detail in Environmental Documentation to come.	All
GHD. Big Rock CSD Water Storage Tank Stabilization Project- Scope of Work, 2012	The Scope of Work (SOW) document describes the methodology of the project as well as specific items that are included in the scope of the project.	All
GHD. Project Location Map, 2012	Provides project location and vicinity of tank stabilization project.	N/A

M:\Proposals_Presentations\2011\PP 11000000-11005 Special District\BigRockCSD\Tank_Repair_PDM\GIS\Project Map.mxd - 10/14/2011 - 5:19:09 PM Cartography: RCH



Legend

Big Rock CSD Boundary

N

0 875 1,750 3,500 ft

1 inch = 1,720 feet printed at 8.5x11

Sources: USDA: Aerial NAIP 2009 1 meter resolution; Humboldt County GIS: Parcels, Blueline Streams.

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Figure 1
100,000 Gallon Water Tank Project Site Map

Stabilize Water Tank
Big Rock CSD

Big Rock Community Services District
Water Storage Tank Stabilization Project
Benefit Cost Analysis Support

Introduction

This document presents a discussion of the modeling approach and supporting data used to evaluate the benefits of retrofitting the Big Rock Community Services District (CSD) 100,000 gallon water tank and tank pad. Each benefit modeled is discussed as well as a summary of the final benefit-cost ratio.

BENEFIT ESTIMATION AND MODELING

To perform the BCA, and obtain a benefit cost ratio (BCR), the Benefit Cost Analysis software, version 4.5.5.0, was utilized. Within the BCA software, the *Big Rock CSD Water Tank* project was created. Within this project several, "structures" were created. Because the mitigation project has multiple benefits, the benefits were separated from the project cost. The structure "Big Rock CSD Tank Site Project" contains the project cost while the remaining structures were used to determine the project benefits. The result is a BCR for the project as a whole.

Earthquake Event Analysis Data is used as the basis of the model, and was developed for the project area based on data derived from the Crescent City/Del Norte County Hazard Mitigation Plan; Volume 1, Planning Area-Wide Elements, Chapter 12 Earthquakes (Included as Attachment 1) and the 2009 USGS Earthquake Probability Mapping for an exposure time of 50 years for the latitude longitude of the project site. Three different return events: the 45 year event, the 80 year event, and the 145 year event are included in the model. The corresponding approximate peak ground acceleration, annual probability, recurrence interval, Modified Mercalli Intensity, and earthquake magnitude are listed in Table 1. Each event is given a number for correlation to other tables.

Table 1: Earthquake Event Analysis

Earthquake Event	1	2	3
PGA (%g)[1]	0.05 - 0.1	0.1 - 0.34	0.1 - 0.65
Annual Probability[2]	0.8	0.5	0.3
Recurrence interval[3]	45	80	145
Approx Modified Mercalli Intensity Scale[1]	VI-VII	VII	VIII
Approx Magnitude[1]	>5.0	>5.5	>6.0

1) Data taken from Crescent City/Del Norte County Hazard Mitigation Plan; Volume 1, Planning Area-Wide Elements, Chapter 13 Earthquakes pages 12-4.
2) 2009 USGS Earthquake Probability Map for a exposure time of 50 years for the latitude longitude of the project site.
3) Per USGS Guidance on calculating earthquake recurrence intervals.

Economic benefits of this project were modeled for two different scenarios: (1) Potable Water Service Loss and (2) Loss of Life and Major Injury after an earthquake event. In all the model scenarios, accepted FEMA values were used unless otherwise noted. The next section presents information on how the values used in the Benefit Cost Analysis model were developed.

Description of Water Tank Site Failure

The Big Rock CSD's 100,000 gallon water tank is located on a steep hillside with grades of 35% near the toe of the hill north of town and upwards of 60% at and above the water tank. The tank was built in 1971 under the California Building Code at the time, for which seismic provisions were not mandatory. Construction of the tank, foundation, and pad were prior to both the 1975 lateral force requirement additions and the amendment of the Uniform Building Code in 1994 to include seismic safety provisions. The proposed project would be consistent with the current California Building Code at the time of construction which is based upon the International Building Code.

In addition to the reduced code standards the tank was built under, the tank site itself presents a serious hazard to the community. As discussed above, the hillside the tank is constructed on is very steep. To place the tank on level ground, it was constructed on a built up fill prism. This fill prism sits on top of approximately 10 – 15 feet of loosely consolidated material, which is underlain by bedrock. There are significant water seeps from the hillside above the tank that are eroding the soils around and under the tank foundation and setting up the fill prism to slide down the hillside in a serious land/ mudslide. The photos below show the slope above the tank with deep cuts through the loosely consolidated rock and soil.

Photos of Erosion Above the Existing 100,000 Gallon Water Tank

Information from the Crescent City/Del Norte County Hazard Mitigation Plan; Volume 1, Planning Area-Wide Elements, Chapter 12 Earthquakes was used to assist in determining at what threshold the tank would fail. Table 2 below is excerpted from the County Hazard Plan (page 12-3). As can be seen from the Table even a magnitude 5 earthquake is expected to cause significant damage to poorly built structures like the District's water tank and tank pad. Thus it is reasonable to estimate that a magnitude 6 earthquake or greater would take down the tank completely and cause the associated land slide. The Big Rock CSD has had several licensed engineers at the site who have confirmed the tank will fail during a moderate earthquake.

Table 2: Earth Quake Magnitude and Intensity			
Event	**Magnitude**	**Modified Mercalli Intensity Index**	**Description**
1	5.0	VI – VII	Damage considerable in poorly built or badly designed structures.
2	5.5	VII	Damage considerable in poorly built or badly designed structures.
3	6.0	VIII	Considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures.

The sections below present the information used in the Benefit Cost Analysis model to estimate benefits of the project.

(1) Potable Water Service Loss for the Big Rock CSD

If the existing pipes connecting the 100,000 gallon water tank to the system break or if the water tank fails completely and slides down the hillside into the community there will be no potable water supply for customers of the Big Rock CSD. While the District does have a second 50,000 gallon tank, it is currently reliant on water service to the 100,000 gallon tank and a 5 HP transfer pump to be filled. The 50,000 gallon tank serves approximately 1/3 of the system at a different pressure. When the 100,000 gallon tank goes down the District will have difficulty rigging a temporary system that can fill the 50,000 gallon tank and serve both pressure zones. With complete failure of the 100,000 gallon tank, major portions of the distribution system will be torn out, that will prevent any temporary system from being put in place for approximately 4 months due to difficulty accessing the tank site, need to rebuild the supply system, and difficulty getting materials to the remote Big Rock CSD area. Table 3 below summarizes the loss of service for each modeled earthquake event.

As seen in Table 3, a 145 recurrence seismic event is anticipated to result in a complete loss of the tank and tank site and major damage to the distribution system, and therefore, the tank would need to be replaced. The Loss of Function Time values were determined from discussions with experienced civil engineers and the Big Rock CSD staff. The Loss of Function Time included in the model is conservative for a complete replacement, especially when considering the other emergency repair needs that may arise from such an event.

The mitigation project has a high level of effectiveness and is anticipated to reduce loss of function time to zero for all three modeled events. This is because the mitigation project will be built to current building code standards, including modern seismic design provisions. The connection of the pipe to the new tank will include modern seismic couplers, to prevent loss of water from potential breaks in the distribution system. The proposed project design will prevent sliding of the tank and it's foundation off the fill prism it was constructed on and allow movement of the connecting pipes during an earthquake event. Further discussion of the mitigation project is presented at the end of this report. The population justification is attached separately directly in the Benefit Cost Model.

Table 3: Loss of Service Modeled Values		
Event	**Description of Damage**	**Loss of Service Estimate**
1	The connections to the water tank would break. The District would be required to dig up the line, find the break, and install a new section of pipe. This would be complicated during wet weather by limited access to the site.	It is estimated that the CSD customers would be out of service for **1 day** under this type of damage event.
2	In addition to the damage that would occur under event 1, additional damage would be anticipated, including potential foundation shift and warping of the steel bands that hold the redwood tank boards together which would prevent the tank from holding water thus leaving the system without water storage. The system pumping system relies on overnight filling of the water tanks to maintain supply. Thus, there would not be enough water to meet demands	For the purpose of the BCA model it was assumed only 50% of customers would be without water service, but for a total length of time of 30 days. The value entered into the model was **15 days** to account for some customers having water service.
3	Under this event the entire tank site is expected to fail. The tank, foundation, and fill prism would initiate a land slide that would reach into the community approximately 500 feet destroying 19 homes and taking out major sections of the distribution system.	For the purposes of the BCA model, it was assumed that all customers would be out of service for at least **4 months**. This is a conservative estimate given the remote nature of the facility in the State, and the significant damage expected.

(2) Loss of Life and Major Injury after an Earthquake Event

As discussed above, complete tank site failure will result in a landslide due to weaking of site from long-term erosion of soils surrounding the tank pad and failure of the fill prism under the tank pad. Based visual inspections of the site, drainage and erosion patterns, and topography, there are 19 homes that lay in the path of the earthquake induced landslide. These homes on Jedediah Smith Way and Hiouchi Drive are listed in Table 4, including home owner name and water account #. A door to door survey of these homes conducted by Big Rock CSD staff found there are 62 people living in these 19 homes. Figure A attached to this report shows the area of impact of the landslide. For the homes closest to the tank and the first impacted by the landslide, it is assumed there would be no survivors. The homes would be buried under tens of feet of mud, rock and water. Those further away would experience a combination of major injury and minor injuries. Table 5 shows the estimated break out of injuries for those 62 people living within the impact area.

Table 4: Residences Destroyed/ Damaged When the Big Rock CSD's 100,000 Gallon Tank and pad fail and slides down Hiouchi Mountain						
Jedediah Smith Way House #	**Owner**	**Water Account #**		**Hiouchi Drive House #**	**Owner**	**Water Account #**
165	Linda Norbury	114		161	Vincent Danna	72
185	Rob Jacob	100		185	Kassandra Mattz	120
205	Patrick Finley	64		201	Michael Sullivan	121
215	John Walczak	65		210	(Family is using a well)	N/A
200	M. Sperling/L. Conley	97		211	F. E. Finley	67
160	John Aflague	113		220	Kevin Osborne	68
110	Mary Faulkenberry	91		221	Shannon Aten	66
				200	Tom Hutzell	123
				190	Rena Tyron	81
				170	Lillian Norris	79
				160	Jack Owen	78
				140	Bill Patterson	74

Table 5: Loss of Life Values			
Category	FEMA Standard Value	People	Avoided Loss of Life Value
Death	$5,800,000	31	$179,800,000
Major Injury	$1,483,000	19	$28,177,000
Minor injury	$12,000	12	$144,000

Fire Damage for Del Norte County After Earthquake Event When Loss of Water Service Occurs Concurrently with an Earthquake

If the tank site failure occurs concurrently with a fire event, then additional loss of property is expected. Data was not available to model this scenario, thus no calculated benefits are included in the model. However in addition to supplying water for fighting fires in Big Rock CSD, the District's water storage tank provides water for wildland fire fighting, in previous years multiple state and federal agencies have relied on the District's water supply to fight fires. The loss of the water tank could potentially result in significant structure damage as well as long-term damage to nearby Jedediah Smith State & Federal Park forestland and other forest lands.

Effectiveness of Mitigation Project

The mitigation project has a high level of effectiveness and is anticipated to reduce loss of function time and loss of life to zero for the two modeled events. The proposed project would not be subject to the same vulnerabilities as the existing tank. The tank pad would be cut into the bedrock beneath the Franciscan Formation and appropriately anchored in the bedrock. The new mitigation project will be built to current building code standards, including modern seismic design provisions. The connection of the pipe to the new tank will include modern seismic couplers. The proposed project design will prevent sliding of the tank and its foundation off the fill prism it was constructed on and allows movement of the connecting pipes during an earthquake event.

Since the tank pad will need to be completely re-built, the tank must also be moved. The existing redwood tank would need to be disassembled and re-assembled on the new pad. However, based on the District's understanding of service providers, there are no companies that still perform this work. There are very few redwood tanks still in use, and the demand for these services has dropped to such a level that service providers have gone out of business. Thus, to retain the 100,000 gallons of storage that the mitigation project is addressing, a replacement tank must be installed. In addition, even if a service provider could be found, the existing tank has been in service for 40 years and is at the end of its useful life. If it was taken apart and re-constructed the mitigation project would only have a useful life of 10 years. Significant funds would have been spent to relocate the tank, without a long-term benefit to the District or for the use of Federal funds. Thus, the District's mitigation project proposes a replacement bolted steel tank, which can more easily be installed at the site, and will have a useful life of 50 years or more.

Conclusion

The Benefit Cost Ratio generated by the modeling effort is presented in Table 4. The resulting project BCR is 1.74.

Table 4: Summary of Benefits and Costs

Description of Possible Loss	**Expected Avoided Damages After Mitigation (Benefits)**
(1) Potable Water Service Loss for Big Rock CSD	$ 829,549
(2) Loss of Life for Big Rock CSD	$ 19,808,156
Total	*$20,637,705*
Total Project Cost (Including present value of maintenance costs)	*$1,551,525*
Benefit to Cost Ratio	**13.3**

ATTACHMENT 1
Crescent City/Del Norte County Hazard Mitigation Plan;
Volume 1, Planning Area-Wide Elements,
Chapter 12 Earthquakes

CHAPTER 12.
EARTHQUAKE

12.1 EARTHQUAKE DEFINED

The following definition applies in the discussion of earthquake hazards:

- **Earthquake**—An earthquake is the shaking of the ground caused by an abrupt shift of rock along a fracture in the earth such as a fault or a contact zone between tectonic plates. Earthquakes are typically measured in both magnitude and intensity.

12.2 GENERAL BACKGROUND

California is seismically active because it sits on the boundary between three of the earth's tectonic plates. Most of the state - everything east of the San Andreas Fault - is on the North American Plate. Monterey, Santa Barbara, Los Angeles, and San Diego are on the Pacific Plate, which trends offshore at Cape Mendocino. North of Cape Mendocino, the offshore subducting Gorda Plate strongly influences seismicity of Humboldt and Del Norte counties. The relative movement between the Pacific and North American plates is primarily a strike-slip movement, whereas the movement between the Gorda and North American plates is primarily a thrust subduction. The area where the three tectonic plates intersect is known as the Mendocino Triple Junction.

The constant motion of the plates causes stress in the brittle upper crust of the earth. These tectonic stresses build as the rocks are gradually deformed. The rock deformation, or strain, is stored in the rocks as elastic strain energy. When the strength of the rock is exceeded, rupture occurs along a fault. The rocks on opposite sides of the fault slide past each other as they spring back into a relaxed position. The strain energy is released partly as heat and partly as elastic waves called seismic waves. The passage of these seismic waves produces the ground shaking in earthquakes.

California has thousands of recognized faults, hundreds of which have names, but only some are known to be active and pose significant hazards. The motion between the Pacific and North American plates occurs primarily on the faults of the San Andreas system and the eastern California shear zone. North of Cape Mendocino, the Little Salmon and the Mad River fault zones are seismically important.

Faults are more likely to have future earthquakes on them if they have more rapid rates of movement, have had recent earthquakes along them, experience greater total displacements, and are aligned so that movement can relieve the accumulating tectonic stresses. Geologists classify faults by their relative hazards. "Active" faults, which represent the highest hazard, are those that have ruptured to the ground surface during the Holocene period (about the last 11,000 years). "Potentially active" faults are those that displaced layers of rock from the Quaternary period (the last 1,800,000 years). Determining if a fault is "active" or "potentially active" depends on geologic evidence, which may not be available for every fault. Although there are probably still some unrecognized active faults, nearly all the movement between the two plates, and therefore the majority of the seismic hazards, are on the well-known active faults.

Earthquakes can last from a few seconds to over five minutes; they may also occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris, because the shocks shake, damage, or demolish buildings and other structures. Disruption of communications, electrical power supplies and gas, sewer and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides or releases of hazardous material, compounding their disastrous effects.

A direct relationship exists between a fault's length and location and its ability to generate damaging ground motion at a given site. In some areas, smaller, local faults produce lower magnitude quakes, but ground shaking can be strong, and damage can be significant as a result of the fault's proximity to the area. In contrast, large regional faults can generate great magnitudes but, because of their distance and depth, may result in only moderate shaking in the area.

Earthquakes are classified according to the amount of energy released as measured by magnitude or intensity scales. While several scales have been defined, currently the most commonly used are the moment magnitude (Mw), and the modified Mercalli intensity. Estimates of moment magnitude roughly agree with estimates using other scales, such as the local magnitude scale (ML) commonly called the Richter magnitude scale. One advantage of the moment magnitude scale is that, unlike other magnitude scales, it does not saturate at the upper end. That is, there is no particular value beyond which all large earthquakes have about the same magnitude. For this reason, moment magnitude is now the most often used estimate of large earthquake magnitudes. Table 12-1 presents a classification of earthquakes according to their magnitude. Table 12-2 compares the moment magnitude scale to the modified Mercalli intensity scale.

Another element of earthquake hazard assessment is the calculation of expected ground motion values. This involves determining the annual probability that certain ground motion accelerations will be exceeded, then summing the annual probabilities over the time period of interest. The most commonly mapped ground motion parameters are the horizontal and vertical ***peak ground accelerations*** (***PGA***) for a given site classification (soil or rock type). Maps of PGA values form the basis of seismic zone maps that are included in building codes, including the International Building Code (IBC) and its predecessor the Uniform Building Code.

Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short period structures" (i.e. single-family dwellings, the most common structures in Del Norte County). Maps of longer period spectral response components may also need to be developed to determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 12-3 illustrates the damage potential by PGA factors as compared to the Mercalli scale.

**TABLE 12-1.
MAGNITUDE CLASSES**

Magnitude Class	Magnitude Range (M = magnitude)
Great	M > 8
Major	7 <= M < 7.9
Strong	6 <= M < 6.9
Moderate	5 <= M < 5.9
Light	4 <= M < 4.9
Minor	3 <= M < 3.9
Micro	M < 3

TABLE 12.2.
EARTHQUAKE MAGNITUDE AND INTENSITY

Magnitude (Mw)	Intensity (Modified Mercalli)	Description
1.0 – 3.0	I	I. Not felt except by a very few under especially favorable conditions
3.0 – 3.9	II – III	II. Felt only by a few persons at rest, especially on upper floors of buildings. III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it is an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
4.0 – 4.9	IV – V	IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rocked noticeably.
5.0 – 5.9	VI – VII	VI. Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight. VII. Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken.
6.0 – 6.9	VII – IX	VIII. Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
7.0 and higher	VIII and higher	X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent. XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly. XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

**TABLE 12-3.
MERCALLI SCALE AND PEAK GROUND ACCELERATION COMPARISON**

MM	Potential Damage	Estimated PGA
I	None	0.017
II-III	None	0.017
IV	None	0.014-0.039
V	Very Light	0.039-0.092
VI	None to Slight; USGS-Light	0.02-0.05
	Unreinforced Masonry-Stair Step Cracks; Damage to Chimneys; Threshold of Damage	0.04-0.08 0.06-0.07 0.06-0.13 0.092-0.18
VII	Slight-Moderate; USGS-Moderate	0.05-0.10
	Unreinforced Masonry-Significant; Cracking of parapets	0.08-0.16 0.10-0.15
	Masonry may fail; Threshold of Structural Damage	0.1 0.18-0.34
VIII	Moderate-Extensive; USGS: Moderate-Heavy	0.10-0.20
	Unreinforced Masonry-Extensive Cracking; fall of parapets and gable ends	0.16-0.32 0.25-0.30 0.13-0.25 0.2 0.35-0.65
IX	Extensive-Complete; USGS-Heavy	0.20-0.50
	Structural collapse of some un-reinforced masonry buildings; walls out of plane. Damage to seismically designed structures	0.32-0.55 0.50-0.55 0.26-0.44 0.3 0.65-1.24
X	Complete ground failures; USGS- Very Heavy (X+); Structural collapse of most un-reinforced masonry buildings; notable damage to seismically designed structures; ground failure	0.50-1.00

The impact of an earthquake on structures and infrastructure is largely a function of ground shaking, liquefaction and distance from the source of the quake. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics so that locations potentially subject to liquefaction may be identified. Table 12-4 summarizes NEHRP soil classifications.

TABLE 12-4.
NEHRP SOIL CLASSIFICATION SYSTEM

NEHRP Soil Type	Description	Mean Shear Velocity to 30 m (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	

12.3 HAZARD PROFILE

Del Norte County is located within the two highest of five seismic risk zones specified by the Uniform Building Code, and offshore Cape Mendocino has the highest concentration of earthquake events anywhere in the continental United States. Nine quaternary faults have been identified in the region that could impact the planning area.

The subducting Gorda Plate and the Juan de Fuca Plate form the "Cascadia Subduction Zone," which runs north offshore of Humboldt and Del Norte Counties, Oregon, and Washington. Recent investigations have shown that this system has moved in unison in a series of great earthquakes (magnitude 8 to 9) over the last 20,000 years, most recently about 300 years ago, with events occurring at 300- to 500-year intervals. The seismic setting has the potential to cause significant ground shaking, leading to the following hazards:

- A serious liquefaction and subsidence hazard, particularly around the muds and sands of Crescent City
- A near-shore tsunami striking the coast within 15 minutes of ground-shaking
- A significant landslide hazard countywide
- Surface fault rupture along the San Andreas, and possibly along the Little Salmon and Mad River fault zones, and other active or potentially active faults in the county.

12.3.1 Past Events

According to the California State Hazard Mitigation Plan, Del Norte County has been impacted by at least one recorded earthquake between 1950 and 2003 that caused sufficient damage for the state to proclaim a state of emergency: the Cape Mendocino Earthquake on April 25, 1992, which also warranted a Presidential disaster declaration (DR-943). Table 12-5 illustrates seismic events with a magnitude of 5.0 or larger that were felt within the planning area since 2000.

TABLE 12-5.
RECENT EARTHQUAKES MAGNITUDE 5.0 OR LARGER FELT WITHIN DEL NORTE COUNTY

		Epicenter Location		
Date	Magnitude	Distance	Direction	Nearest City
February 26,2007	5.4	51 km	W	Ferndale, CA
July 16, 2006	5.0	6 km	WNW	Punta Gorda, CA
March 25, 2006	5.0	3 km	WNW	Punta Gorda, CA
June 14, 2005	7.2	156 km	W	Trinidad, CA
August 15, 2003	5.3	121 km	WNW	Ferndale, CA
June 17, 2002	5.27	37 km	W	Eureka, CA
September 20, 2001	5.10	80 km	WNW	Punta Gorda, CA
January 13, 2001	5.19	92 km	WNW	Ferndale, CA
March 16, 2000	5.59	N/A	N/A	Offshore Punta Gorda, Point Mendocino

Source: Earthquake Catalogs, Northern California Earthquake Data Center, 2007

12.3.2 Location

The impact of an earthquake is largely a function of the following components:

- Ground shaking (ground motion accelerations)
- Liquefaction (soil stability)
- Distance from the source (both horizontally and vertically)

To map the extent and location of areas within Del Norte County considered vulnerable to seismic risk, the planning team utilized two principle tools: Probabilistic “Shake Maps” showing predicted ground motion, and soils mapping that shows the stability of soils in response to seismic events.

Shake Maps

Earthquake shaking is measured by instruments called accelerographs that are triggered by the onset of shaking and record levels of ground motion at stations throughout a region. These readings are recorded by state and federal agencies tasked with monitoring and predicting seismic activity. A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree could occur. It is probabilistic in the sense that the analysis takes into consideration the uncertainties in the size and location of earthquakes and the resulting ground motions that can affect a particular site.

The maps are expressed in terms of probability of exceeding a certain ground motion, such as the 10-percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas. Figure 12-1 illustrates the estimated ground motion for a 100-year probabilistic earthquake, and Figure 12-2 illustrates the estimated ground motion for a 500-year probabilistic earthquake.

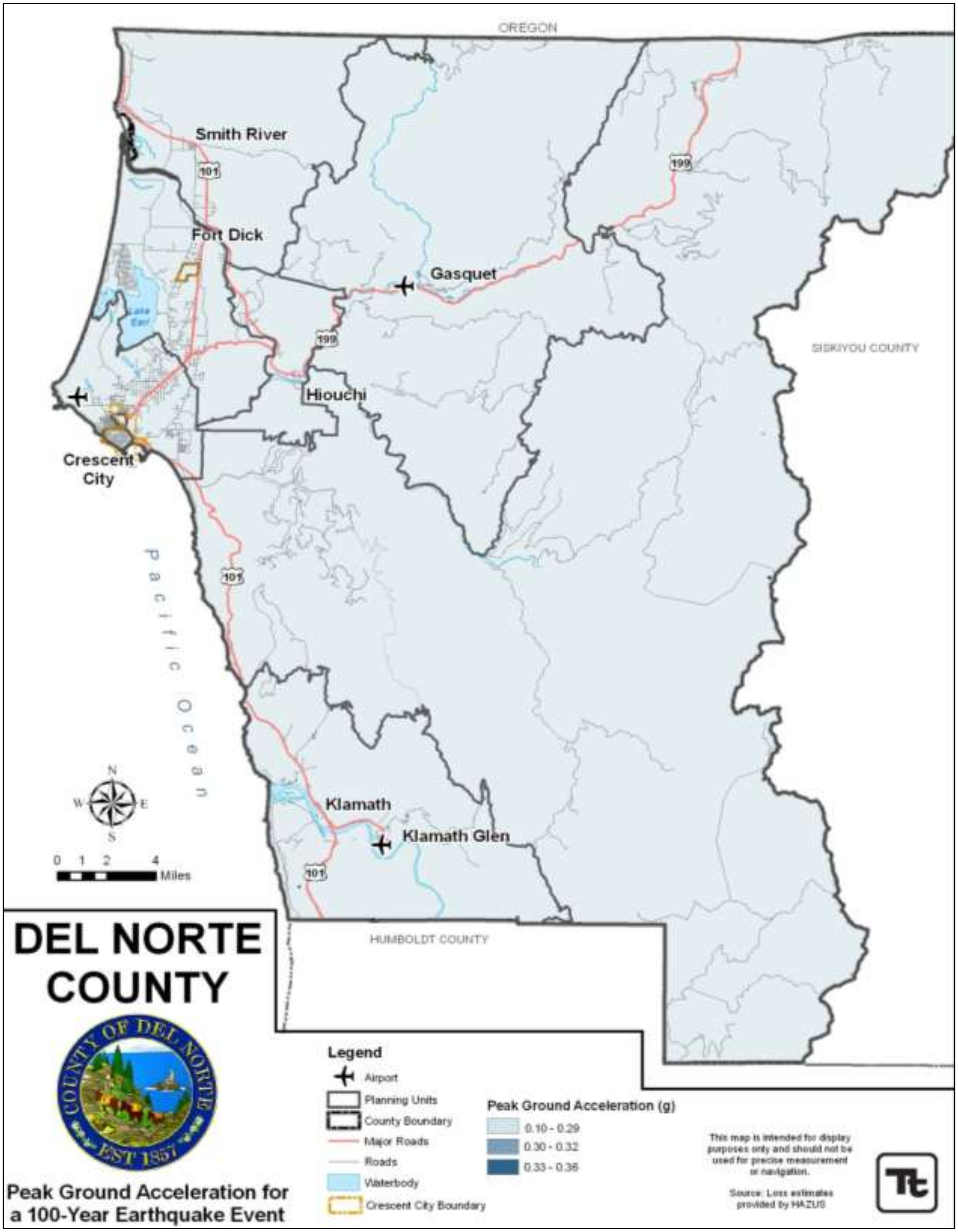

Figure 12-1. 100-Year Probabilistic Ground Motion Map for Del Norte County

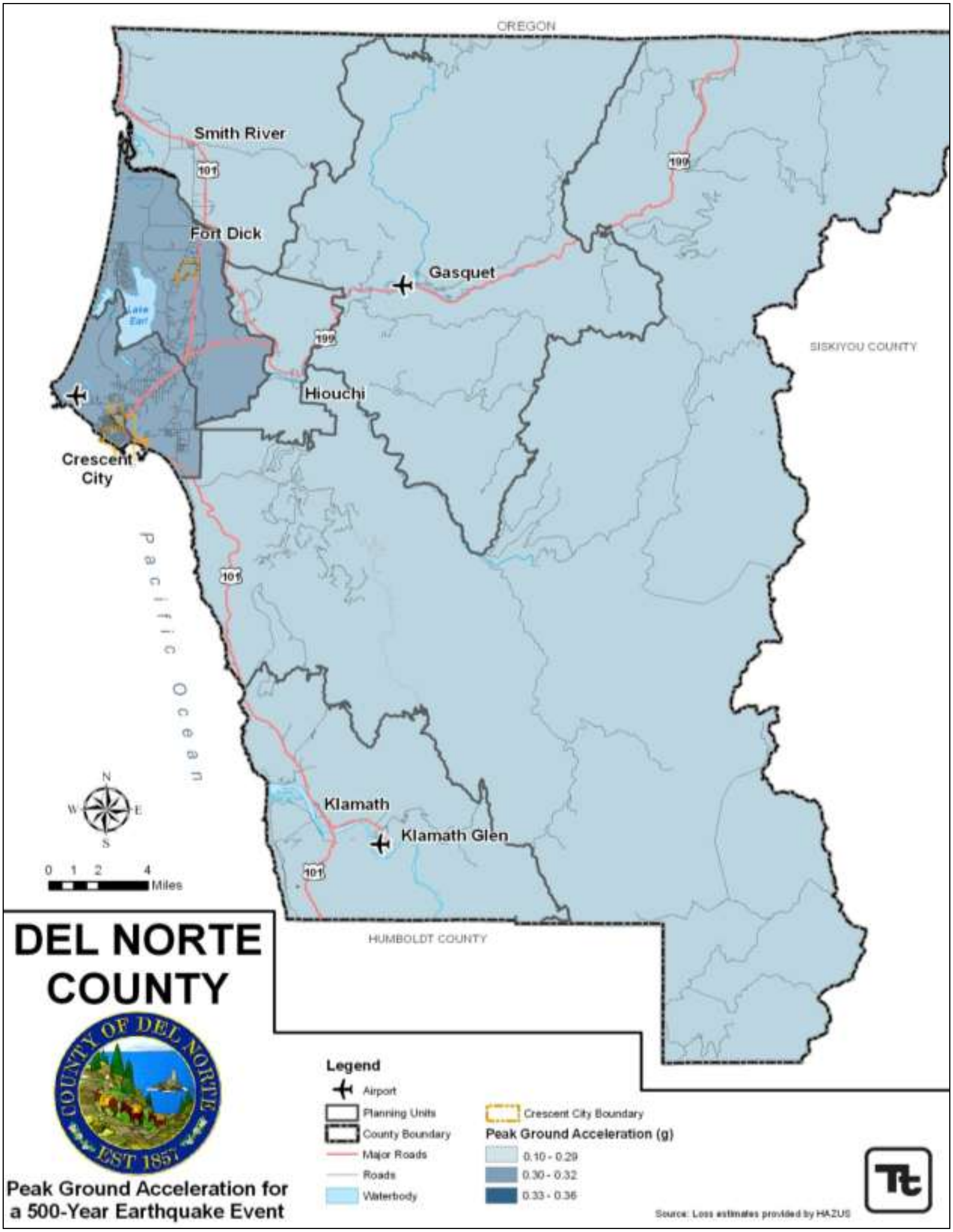

Figure 12-2. 500-Year Probabilistic Ground Motion Map for Del Norte County

NEHRP Soils

NEHRP soil types define the locations in the county that will be significantly impacted by an earthquake. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E and F. In general these areas are also most susceptible to ***liquefaction,*** a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Figure 12-3 shows NEHRP soil classifications throughout the county.

12.3.3 Frequency

Del Norte County is susceptible to regular earthquake activity, as evidenced by the nine seismic events with a magnitude of 5.0 or higher experienced from 2000 through 2007 (see Table 12-5) The USGS has created a probabilistic hazard map based on peak ground acceleration that takes into account new information on several fault zones. The northern California area, including Del Norte County, is in a moderate-risk area, with a 10-percent probability in a 50-year period of ground shaking from a seismic event exceeding 20 percent of gravity. Figure 12-4 shows the expected peak horizontal ground motions for this probability (USGS Website, 2007).

12.3.4 Severity

The severity of an earthquake can be expressed in terms of both intensity and magnitude. Intensity is based on the observed effects of ground shaking on people, buildings, and natural features. It varies from place to place within the disturbed region depending on the location of the observer with respect to the earthquake epicenter. Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments, which have a common calibration. Magnitude is thus represented by a single, instrumentally determined value

Past events suggest that earthquakes typical for Del Norte County would cause light to moderate damage. However, severity can increase based on proximity to the hypocenter of the event, and the surrounding soil type. There are soft soils within Del Norte County that have a high degree of vulnerability to earthquakes. The USGS estimates that there is at least a 0.5-percent probability of an earthquake with a magnitude of 7.0 or greater occurring within 50 km of the planning area within the next five years (Figure 12-5). This probability of occurrence mixed with potentially unstable soils could lead to a scenario of an earthquake event causing severe damage in the planning area.

12.3.5 Warning Time

Earthquake early warning systems are designed to provide a few seconds warning prior to damaging ground shaking in an earthquake. The further the earthquake is from a region, the more warning time there will be. There is presently no current method to accurately determine when and where an earthquake may occur.

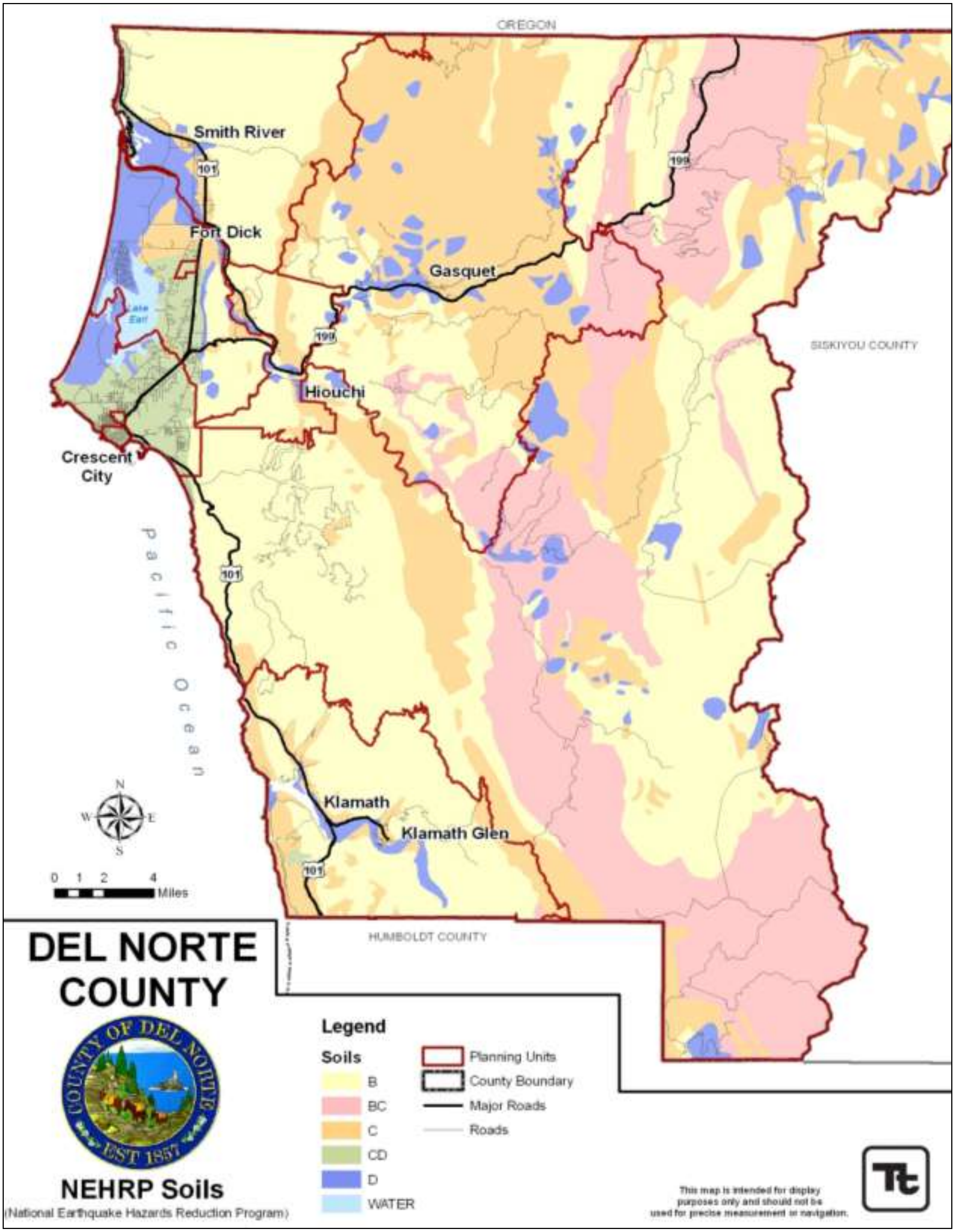

Figure 12-3. NEHRP Soil Classifications in Del Norte County

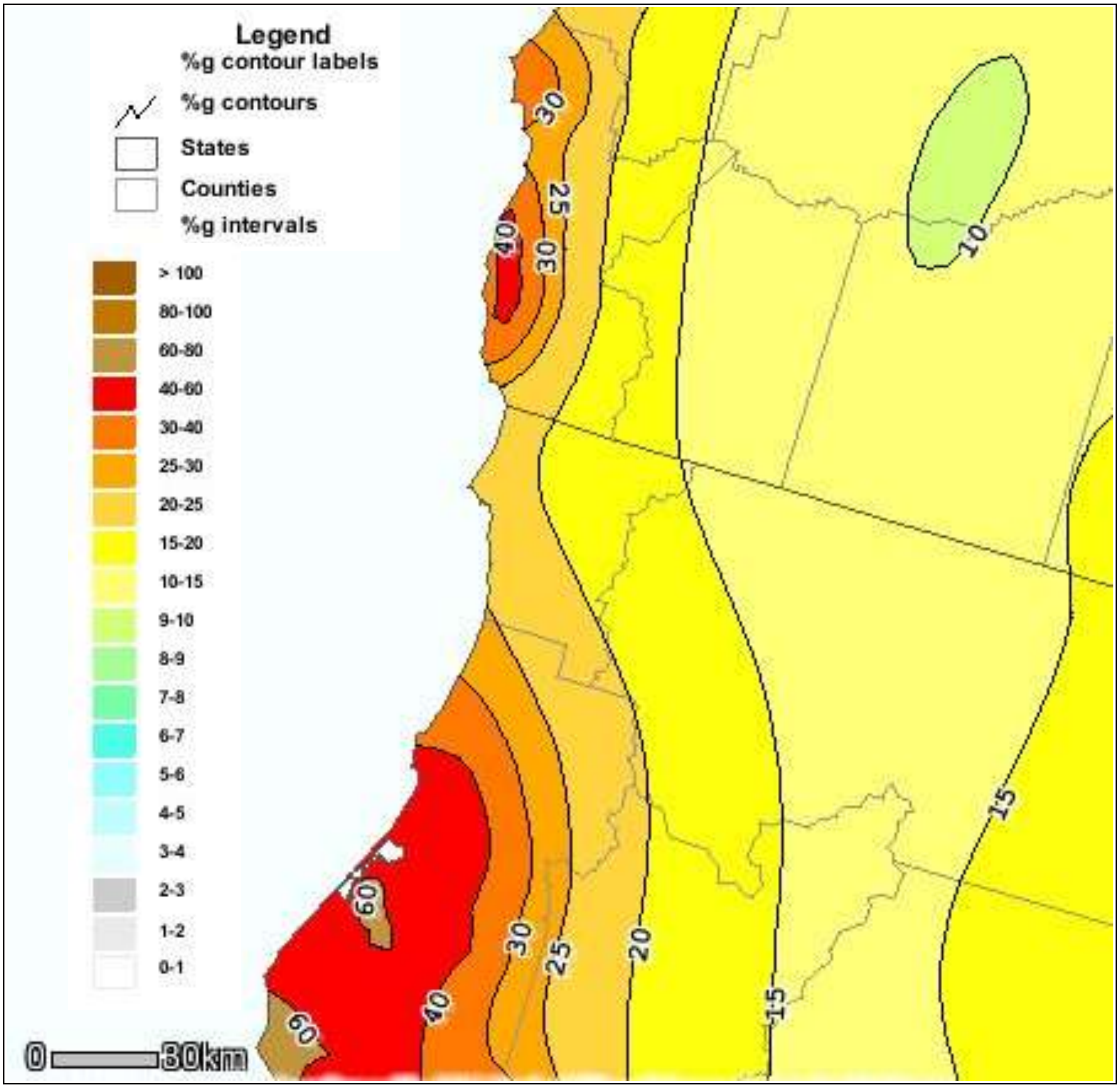

Figure 12-4. Peak Horizontal Acceleration with 10% Probability of Exceedance in 50 Years

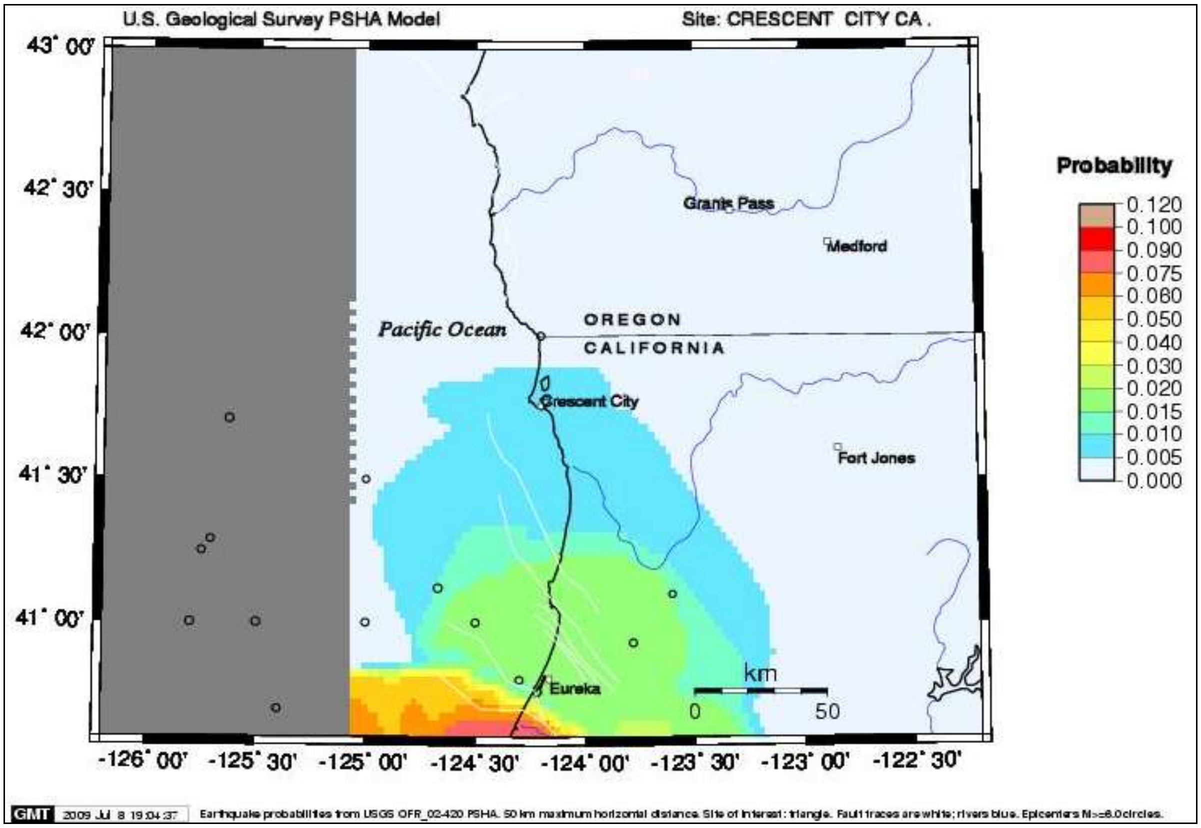

Figure 12-5. Probability of Earthquake with M > 7 Within 5 Years and 50 Kilometers

12.4 SECONDARY HAZARDS

Earthquakes can cause several secondary effects. They can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and “float” freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink quicksand-like into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risk exposure to earthquakes. Also, within the Del Norte County planning area, tsunamis can be considered secondary hazards to earthquake events.

12.5 CLIMATE CHANGE IMPACTS

The general perception in the emergency management community is that the impacts of global climate change on earthquake probability are unknown. Some scientists say melting glaciers could induce tectonic activity. As ice melts and waters runs off, tremendous amounts of weight are lifted off of Earth’s crust. As the newly freed crust settles back to its original, pre-glacier shape, it can cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. In a new study, NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA, 2004).

The secondary impacts of earthquakes could be significantly enhanced due to the impacts of climate change. Soils saturated from repetitive, isolated storms could fail prematurely during seismic activity due to this increased saturation. Dams, storing increased volumes of water due to changes in the hydrograph triggered by climate change could fail during seismic events. Wildland fire risks associated with earthquakes could be significantly enhanced by drought conditions triggered by climate change. There are currently no models available to estimate these impacts. Therefore, local governments are forced to utilize the best data available at the time of the preparation of these plans.

12.6 EXPOSURE

The data in this section was generated using the HAZUS-MH program for earthquakes, which uses mathematical formulas and information about building stock, local geology and the location and size of potential earthquakes, economic data, and other information to estimate potential losses. Once the location and size of a hypothetical earthquake are identified, HAZUS-MH estimates the violence of the ground shaking, the number of buildings damaged, the number of casualties, and the amount of damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

12.6.1 Population

The entire population of Del Norte County is potentially exposed to earthquakes.

12.6.2 Property

According to the Del Norte County Assessor, there are approximately 11,708 buildings within the census tracts that define the planning area. The majority of these buildings are residential use. All of these buildings are considered to be exposed to the earthquake hazard.

12.6.3 Critical Facilities and Infrastructure

Since the entire Del Norte County planning area has exposure to the earth quake hazard, all 194 critical facilities and infrastructure components are exposed to the earthquake hazard. The breakdown of the numbers and types of facilities is illustrated in Tables 12-6 and 12-7.

TABLE 12-6.
CRITICAL FACILITIES WITHIN DEL NORTE COUNTY

Planning unit	Medical & Health Services	Government Function	Protective Function	Schools	Societal Function	Hazmat	Other Critical Function	**Total**
Crescent City	1	12	4	2	8	1	0	**28**
Crescent City UGA	3	8	2	5	7	1	1	**27**
Fort Dick	0	0	2	2	2	0	0	**6**
Gasquet	0	0	1	1	1	0	1	**4**
Hiouchi	0	0	0	0	0	0	0	**0**
Klamath	0	0	1	1	2	0	3	**7**
Smith River	0	0	1	1	3	0	1	**6**
Other County	0	1	0	0	0	0	0	**1**
Total	**4**	**21**	**11**	**12**	**23**	**2**	**6**	**79**

**TABLE 12-7.
CRITICAL INFRASTRUCTURE WITHIN DEL NORTE COUNTY**

Planning unit	Water Supply	Waste Water	Power	Fuel storage	Communications	Bridges	**Total**
Crescent City	1	2	2	1	2	0	**8**
Crescent City UGA	3	0	3	2	12	3	**23**
Fort Dick	5	0	1	0	2	5	**13**
Gasquet	1	0	0	0	2	17	**20**
Hiouchi	2	0	0	0	0	7	**9**
Klamath	2	4	0	0	2	15	**23**
Smith River	1	0	2	0	0	6	**9**
Other County	0	0	0	0	0	10	**10**
Total	**15**	**6**	**8**	**3**	**20**	**63**	**115**

Hazardous Materials

Hazardous material releases from fixed facilities and transportation-related releases can occur during an earthquake event. Vital transit corridors such as U.S. Highways 101 and 199 and the Northwestern Pacific River Railroad can be disrupted during an earthquake, which can result in the release of hazardous materials that are being transported along these corridors to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of populations surrounding them. There are two facilities in the planning area that handle materials considered to be hazardous. During an earthquake event, structures storing these materials could rupture and leak into the surrounding area, or river, having a disastrous effect on the environment.

Roads

There are many roads that cross earthquake-prone soils in the county. These soils have the potential to be significantly damaged during an earthquake event. Access to major roads is crucial to life and safety after a disaster event as well as to response and recovery operations.

Bridges

Earthquake events can significantly impact bridges. These are important because they often provide the only access to certain neighborhoods. Since the HAZUS-MH analysis identified soft soil regions that follow floodplain boundaries, bridges that cross water courses should be considered vulnerable. Since most of the bridges provide access across water courses, most are at least somewhat vulnerable to earthquakes. A key factor in the degree of vulnerability is the age of the facility and the type of construction, which help indicate the standards to which the facility was built.

Water and Sewer Infrastructure

Water and sewer infrastructure would likely suffer considerable damage in the event of an earthquake. This is hard to analyze due to the amount of infrastructure and the fact that water and sewer infrastructure are usually linear easements, which are difficult to inventory in a GIS environment. Without further analysis of individual components of the system, it should be assumed that these systems are exposed to potential breakage and failure.

12.6.4 Environment

Environmental problems as a result of an earthquake can be numerous. Secondary hazards will likely have the some of the most damaging effects on the environment. Earthquake-induced landslides in landslide prone areas can significantly impact surrounding habitat. It is also possible for streams to be rerouted after an earthquake. This can change the water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater wells drying up because of changes in underlying geology.

12.7 VULNERABILITY

12.7.1 Population

A geographic analysis of demographics was performed using the HAZUS-MH model. The inventoried data included total population, age, gender, and race distribution and other data obtained from the U.S. Census Bureau and Dun & Bradstreet. The demographics for this analysis were aggregated at the Census block level. The vulnerable populations are those living in economically disadvantaged households, those over 65 and those under 16.

Although the vulnerability is low, towns are more at risk than rural areas due to higher density. Towns are also more vulnerable because they are typically located in small valleys alongside streams, which typically have softer soils. Many of these towns also have buildings that were built during the beginning of the 20th century and were not subject to the building codes implemented over the last 30 years, which require that structures be able to withstand earthquakes. Ornamentation (such as parapets) and chimneys may be shaken loose and fall on people walking below.

12.7.2 Property

Age of Structures

The California Multi-Hazard Mitigation Plan identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development. Using these time periods, the Planning team inventoried the structures within the planning area by age of structure as summarized in Table 12-8. Only 1.30 percent of the planning area’s structures were constructed since the Uniform Building Code was amended in 1994 to include seismic safety provisions. Approximately 7.17 percent of the planning area’s structures were built before 1940 when there were no building permits, inspections or seismic standards.

Loss Potential

Loss estimates for the planning area were generated for the 100-year and 500-year earthquake events through a Level 1 analysis using HAZUS-MH. The results of this analysis are summarized in Table 12-9. The data are segregated into structural and non-structural categories. The structural values represent damage estimates to individual structures. The non-structural values represent cost estimates for contents, inventory, relocation, income loss, rental loss, and wage loss. It is estimated that there would be $61 million of damage potential during a 100-year earthquake event. This represents approximately 2.4 percent of the total assessed value for improvements to land in the planning area. For a 500-year earthquake the estimated damage potential is $596.3 million, or 23.9 percent of the total assessed value for the planning area.

TABLE 12-8.
AGE OF STRUCTURES IN DEL NORTE COUNTY

Time Period	Number of Structures Built in Del Norte County	% of Total Structures	Significance of Time Frame
Pre-1940	840	7.17%	Before 1940, there were no explicit requirements for earthquakes in building codes. State law did not require local governments to have building officials or issue building permits. In 1940, the first strong motion recording was made in El Centro.
1941-1960	2,355	20.11%	In 1960, the Structural Engineers Association of California reached the first statewide consensus on recommended earthquake provisions and published the guidelines.
1961-1979	3,937	33.63%	In 1975, significant improvements were made to lateral force requirements that were then enforced throughout the state.
1979-1994	4,424	37.79%	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1994 to present	152	1.30%	Seismic code is currently enforced.
Total	**11,708**	**100%**	

TABLE 12-9.
EARTHQUAKE BUILDING LOSS POTENTIAL

	Estimated Earthquake Losses by Occupancy Class					
	100- Year Probabilistic Earthquake			500- Year Probabilistic Earthquake		
Planning Unit	Structural	Non-Structural	**Total**	Structural	Non-Structural	**Total**
Crescent City	$721,903	$4,517,708	**$5,239,611**	$8,510,554	$47,962,928	**$56,473,482**
Crescent City UGA	$2,519,084	$15,764,561	**$18,283,645**	$29,599,970	$166,816,554	**$196,416,524**
Fort Dick	$566,516	$3,545,289	**$4,111,805**	$6,807,510	$38,365,085	**$45,172,595**
Gasquet	$165,525	$1,035,866	**$1,201,391**	$1,174,025	$6,616,452	**$7,790,477**
Hiouchi	$162,761	$1,018,568	**$1,181,329**	$1,154,421	$6,505,968	**$7,660,388**
Klamath	$166,885	$1,044,360	**$1,211,245**	$1,779,276	$10,027,468	**$11,806,744**
Smith River	$531,575	$3,326,624	**$3,858,199**	$3,770,314	$21,248,361	**$25,018,676**
Other County	$3,572,035	$22,353,614	**$25,925,649**	$37,062,594	$208,873,667	**$245,936,260**
Total	**$8,406,284**	**$52,606,590**	**$61,012,874**	**$89,858,664**	**$506,416,482**	**$596,275,146**

Other potential losses estimated by HAZUS-MH include the following:

- A 100-year event could create as much as 10,920 tons of debris to be removed, and a 500-year event could create as much as 120,000 tons of debris.
- For a 100-year event, as many as 12 households would be displaced, with 10 households needing short term shelter. For a 500-year event, there would be as many as 306 households displaced, with 256 households needing short-term shelter.

12.7.3 Critical Facilities

Level of Damage

The inventory of critical facilities as defined by the steering committee was entered into HAZUS-MH to determine the vulnerability of these facilities to earthquake damage. Critical facilities were categorized into the following levels of vulnerability: no damage, slight damage, moderate damage, extensive damage, or complete damage. HAZUS-MH calculated the probability of damage under each of these categories for the 100-year and 500-year events. The results are summarized in Tables 12-10 and 12-11.

TABLE 12-10.
VULNERABILITY OF CRITICAL FACILITIES FROM A 100-YEAR EARTHQUAKE EVENT

Category	No Damage	Slight Damage	Moderate Damage	Extensive damage	Complete damage	**Total**
Medical and Health	0	4	0	0	0	**4**
Government Functions	1	18	2	0	0	**21**
Protective Functions	2	8	1	0	0	**11**
Schools	0	12	0	0	0	**12**
Societal Functions	3	16	4	0	0	**23**
Hazmat	0	2	0	0	0	**2**
Other Critical Functions	1	3	2	0	0	**6**
Total	**7**	**63**	**9**	**0**	**0**	**79**

TABLE 12-11.
VULNERABILITY OF CRITICAL FACILITIES FROM A 500-YEAR EARTHQUAKE EVENT

Category	No Damage	Slight Damage	Moderate Damage	Extensive damage	Complete damage	**Total**
Medical and Health	0	0	0	1	3	**4**
Government Functions	0	0	1	4	16	**21**
Protective Functions	0	1	2	4	4	**11**
Schools	0	1	1	1	9	**12**
Societal Functions	0	0	0	3	20	**23**
Hazmat	0	0	0	1	1	**2**
Other Critical Functions	0	0	1	1	4	**6**
Total	**0**	**2**	**5**	**15**	**57**	**79**

Time to Return to Functionality

Another analysis of critical facilities performed by HAZUS deals with the estimated time to restore critical facilities to full functional use. HAZUS reflects this data in the form of percent probability of being functional at specified time increments post-event: 1, 3, 7, 14, 30 and 90 days after the event occurs. For example, HAZUS may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. The functionality analysis was performed for all critical facilities and infrastructure components in the planning area for both the 100-year and 500-year earthquake events. Results are summarized in Tables 12-12 and 12-13.

TABLE 12-12.
FUNCTIONALITY OF CRITICAL FACILITIES, 100-YEAR EARTHQUAKE

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Crescent City	36	10	11	75	76	93	96
Crescent City UGA	50	10	11	75	76	93	96
Fort Dick	19	11	13	76	79	95	97
Gasquet	24	5	7	62	64	87	92
Hiouchi	9	6	8	65	68	90	94
Klamath	30	6	8	65	66	85	91
Smith River	15	11	13	75	77	93	96
Other County	11	20	23	87	88	97	98
Total/Average	**194**	**9.88**	**11.75**	**72.5**	**74.3**	**91.63**	**95**

TABLE 12-13.
FUNCTIONALITY OF CRITICAL FACILITIES, 500-YEAR EARTHQUAKE

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Crescent City	36	0	0	6	6	22	37
Crescent City UGA	50	0	0	6	6	22	37
Fort Dick	19	0	0	10	10	33	47
Gasquet	24	0	0	6	7	24	38
Hiouchi	9	0	0	8	9	26	39
Klamath	30	0	0	4	4	17	30
Smith River	15	0	0	8	8	29	45
Other County	11	1	2	28	29	60	70
Total/Average	**194**	**0.13**	**0.25**	**9.5**	**9.88**	**29.13**	**42.88**

12.7.4 Environment

The environment vulnerable to earthquake hazard is the same as the environment exposed to the hazard.

12.8 FUTURE TRENDS IN DEVELOPMENT

It is assumed that development and redevelopment trends in Del Norte County are not such that there is major concern about development in identified seismic risk areas. To meet the intent of California state mandates (AB 2140 and Executive Order S-13-08), Crescent City, Del Norte County and all of their planning partners are committed to ensuring that future growth and development in the planning area take seismic risk into account, along with all of the hazards of concern addressed by this plan.

12.9 SCENARIO

Based on history and geology, the Del Norte County planning area will be frequently impacted by earthquakes. The degree and magnitude of these impacts are difficult to predict, since there are many factors to determining net impact. The worst-case scenario is a higher-magnitude event (5.0 or higher) with an epicenter within 50 miles of Del Norte County.

It is safe to assume that the damage potential from earthquakes is greater in areas with softer soils. It is also safe to assume that the older building stock in the planning area is at higher risk. Therefore, the highest degree of damage would be to older structures located on soft soils. Bridges and utilities that cross poor soils would likely fail, causing loss of critical infrastructure and utilities. River valley and coastal hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction would occur in water-saturated sands, silts or gravelly soils. Building and road foundations would lose load-bearing strength. Injuries could occur from debris, such as parapets and chimneys that could topple or be shaken loose and fall on those walking or driving below. An earthquake may also cause minor landslides along unstable slopes, which put at risk major roads and highways that act as sole evacuation routes. This would be even more likely if the earthquake occurred during the winter or early spring. Isolation due to the loss of critical infrastructure is an important concern.

12.10 ISSUES

Important issues associated with an earthquake in Del Norte County include but are not limited to the following:

- Isolation of neighborhoods and communities. Several vulnerable populations are on NEHRP C, CD and D soils.
- Conflagration of wooden homes, collapse of essential buildings such as fire stations, dam failure and isolation due to bridge collapse.
- Sixty-one percent of the planning area’s building stock was build prior to 1975, when seismic provisions became uniformly applied through building code applications.
- Landslides and tsunamis are major natural secondary hazards that could have a widespread effect on the county.
- There is concern about major infrastructure such as roads, bridges and railroads that cross vulnerable soils.
- With only two principal highways in and out of the county (Highway 101 and Highway 199), isolation due to severe road damage to either of these facilities is a huge concern, especially in light of the remote nature of many towns in the planning area.
- A high number of critical facilities in the planning area are at risk and would have a significant amount of functional downtime post-event. This creates a need for mitigation and for continuity of operations planning to develop procedures for providing services without access to essential facilities.

ATTACHMENT 2
Tank Failure Map

M:\Proposals_Presentations\2011\PP 11000000-11005 Special District\BigRockCSD\Tank_Repair_PDM\GIS\Project_details_map.mxd - 10/16/2011 - 5:10:03 PM Cartography: RCH

Legend

Big Rock CSD Boundary

N

0 365 730 1,460 ft

1 inch = 715 feet printed at 8.5x11

Sources: USDA: Aerial NAIP 2009 1 meter resolution; Humboldt County GIS: Parcels, Blueline Streams.

WINZLER & KELLY
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Figure A
Damage Extent of 100,000 Gallon Tank Failure

Stabilize Water Tank
Big Rock CSD

Big Rock CSD
Water Storage Tank Stabilization Project
Scope of Work

INTRODUCTION

This document describes the Big Rock Community Services District's (BRCSD) Water Storage Tank Stabilization Project. The BRCSD includes the town of Hiouchi and the Jedediah Smith Redwoods State and National Park. The BRCSD is located along the Smith River off Highway 199 in Del Norte County approximately 10 miles inland from the coastal community of Crescent City.

The BRCSD withdraws water from the Smith River. There is a well head located close to the River with two pump houses for water transmission. The system serves approximately 100 residential and commercial meters. The system includes 2.5 miles of pipe, 15 fire hydrants, two emergency generators, a SCADA system, and two redwood storage tanks. The tanks are located on Hiouchi Mountain and include a 100,000 gallon tank which serves a majority of the town and a 50,000 gallon tank at a higher elevation that serves a second smaller pressure zone.

The 100,000 gallon tank, built in 1971, is located on an earthen pedestal, created by cutting the hillside and filling the slope to create a level pad. This earthen pedestal is eroding due to significant water run-off from the mountain above. The Special District has been warned by two credible engineering firms that a moderate earthquake in the wintertime when water erosion is at its worst would send the tank, the concrete pad upon which it sits, and the earthen pedestal down the side of the mountain onto homes and neighborhoods. That kind of event would cause possible loss of life, loss of private property, and destroy the township's municipal water system, which would require one to three years to replace. A separate benefit cost analysis describes the potential damage in more detail.

BRCSD is proposing a seismic retrofit project that includes constructing a new tank pedestal anchored into the granite bedrock, improved drainage structures, and a replacement 100,000 gallon bolted steel water tank. The general project methodology is presented first, followed by the scope of work.

GENERAL METHODOLOGY

The first part of the project will be to acquire property rights for one acre on the north side of the existing water storage tank and yet another acre on the downhill (southeast) section of the project where drainage features for surface-water runoff can be constructed. While the total land acquisition needed is estimated at 2 acres, the actual area of disturbance will be less than one acre. The District has started discussions with the County to acquire land that is currently part of a conservation easement. According to the Community Development Department Director, County of Del Norte, at least a majority vote of the Del Norte County Board of Supervisors is necessary to purchase the property after the matter successfully passes through the County's Planning Commission. Preliminary discussions with the Community Development Department indicate that the process would be a formality, for local officials strongly support this project which protects public health.

The access road to the storage tank area will need to be improved. The BRCSD already has an easement for this access, but the road must be improved to allow construction equipment to access the site. This is anticipated to include minor grading and placement of compacted aggregate base on the road surface.

Before construction can start the site must be prepared. This includes removing the cyclone fencing and razor wire surrounding the tank site and storage for reinstallation; protecting the existing generator and pump house, which serves the 50,000 gallon tank, which must remain in service; and installing temporary water storage/pipelines/valves on the southeast. The temporary system must maintain a minimum pressure of 20 psi in the municipal system to meet water code requirements. As water supply will be reduced during construction of the new tank, temporary water conservation measures will be enacted throughout the BRCSD's jurisdiction and fire suppression agencies will be notified to find water elsewhere. Before earthwork can begin, the existing redwood tank must be disassembled and disposed of.

Once site preparations have been made as described above the earthwork can begin. This includes excavation of approximately 3,000 cubic yards of material to reveal the granite bedrock for anchoring the new tank. This excavated material will be disposed of off-site. A new retaining wall, designed to meet the requirements identified in the site geotechnical report will be installed to prevent the hill slope above from failing. Next the tank foundation and footings will be installed. Site piping and valves to connect the new tank to the water system will be installed, including a seismic shut off valve in case there is a pipe break in the distribution system the tank will not be drained. New electrical and telecommunications conduits will be run for site lighting and to connect the tank level monitor to the existing SCADA system. Safety and security lighting will be installed at the site. The total ground disturbance area is estimated to be approximately 0.9 acres.

Site drainage features will be installed to prevent the type of erosion that undermined the existing tank. Features will also be designed and constructed to prevent damage to properties below the tank site.

The replacement tank will be installed at the site, which will include tank erection, installation of tank safety features, cathodic protection system, and tank disinfection and water quality testing. Once this is complete the new tank can be put on line, and temporary storage taken off line. All systems will be tested, including the valving and connections to the existing 50,000 gallon upper tank. The BRCSD considered re-constructing the redwood tank on the new tank site. However, the tank is over 40 years old and much less durable than the proposed bolted steel replacement tank. Also the company that has always maintained the tank (Bellagio) has gone out of business, leaving the District without a means to maintain the tank even if it could be re-built. Thus, this project proposes a replacement 100,000 gallon bolted steel tank, which offers at least a 50-year life span and can be maintained.

An access road and parking area around the tank will be installed for District vehicles and includes minor grading and placement of compacted aggregate base. New fence posts will be installed so the existing cyclone fence can be re-installed. Damage to private property from construction staging will be restored to pre-project conditions. The contractor can then demobilize from the site including site cleanup and removal of all construction equipment and debris, and the project will be ready for a final inspection.

SCOPE OF WORK
This section presents a detailed description of the tasks necessary to complete the proposed flood protection project.

Environmental Permitting: Complete appropriate CEQA and NEPA documents and other environmental permits. The BRCSD will be the lead agency for the preparation of the California Environmental Quality Act (CEQA) document. For this scope of work, it is assumed that a Mitigated Negative Declaration will be the appropriate type of CEQA document, and it will be prepared per CEQA guidelines Article 6 (Sections 15070 through 15075). The Notice of Intent to Adopt and Proposed Negative Declaration will be circulated per CEQA Guidelines Section 15073 including a public Notice of Availability. After circulation, a response to comments will be prepared and Proposed Negative Declaration finalized. The Lead Agency will then consider for adoption the Proposed Negative Declaration per CEQA Guidelines Section 15074, and Prepare a Mitigation Reporting and Monitoring Program per CEQA Guidelines 15097.

A NEPA Environmental Assessment will be completed at the same time as CEQA in close coordination with Federal Agencies. The NEPA document will also be circulated for public review, followed by a response to the public and finalization of the document. Finally it is anticipated that a Findings of No Significant Impacts (FONSI) will be prepared and filed.

This task begins with collecting site resource data for preparation of the environmental documents. An archeological records search will be conducted by a qualified archeologist to verify no resources exist at the site. AS Preconstruction nesting bird survey and summary of findings will be completed, and concurrence from US Fish and Wildife obtained.

Preliminary Engineering: This task includes surveying, a geotechnical report, hydrologic evaluation, and basis of design report. First a geotechnical evaluation will be completed which will include evaluation of depth to bedrock, soil/geological stability, and soil pore pressure to assure appropriate parameters are used in the design of the new tank foundation. Construction requirements resulting from the geotechnical investigation will be included on the plans and specifications. A survey of the tank location will be conducted to update topographic data necessary for design. The final deliverable will be a site topographic map.

A hydrologic evaluation of the area for designing drainage structure to move water away from the tank foundation and reduce erosion will be conducted. A basis of design report will be completed to finalize the overall project concept that will be the basis for the final design, plans, and specifications.

Design: Plans and specifications will be developed for the 30% design submittal, 90% design submittal, and final plans and specifications. Based on the data collected in the above tasks, a predesign concept at the 30 percent level of completion will be developed. This submittal will include preliminary earthwork calculations and preliminary design details for the tank foundation, drainage and structure. The 90 % submittal is nearly a complete bid package and opinion of costs, and generally only lacks finalization of some of the design details and finalizing the specifications. The BRCSD as well as the designer’s in-house quality control will review the 90% plans and specifications. Taking input from the project reviews and quality control review, the 100% plans and specifications and contract documents will be finalized for bidding. An

Opinion of Probable Cost for the 100% design submittal will also be prepared identifying quantities, unit costs, and total construction costs. The opinion shall be based on the final Bid Schedule and Measurement and Payment sections of the specifications. All labor costs estimated shall be based upon Federal prevailing wage rates or State prevailing wage rates, whichever is higher.

Bid Period Services: This task includes placing a public notice in local paper as well as distributing bid packages to up to four Builder's Exchanges so they can have them publicly available to contractors to view. Copies of the bid package will also be distributed to interested contractors. Bid packages will be sold at cost and a bidders list will be maintained. One pre-bid walk through with contractors will be scheduled and meeting minutes and written responses to questions prepared. Project addenda to clarify the intent of the plans and specifications will be prepared and distributed. The task includes the bid opening. The bids will be summarized and the apparent low bidders' bonds and insurance will be reviewed. A Notice of Award, Contract, and Notice to proceed will be prepared for the General Manager's review, approval, and execution.

Construction: This task encompasses the actual construction of the project including the tank site, tank foundation, site drainage improvements, and replacement storage tank. The contractor will be responsible for ordering all equipment per the project specifications. Construction materials and methods will be included in the final plans and specifications.

Construction Observation: Construction observation includes construction engineering, observation, and management consisting of documenting preconstruction conditions, conducting the preconstruction conference, addressing contractor questions raised during construction, conducting periodic site inspections, maintaining a construction diary, reviewing progress pay requests, preparing change orders, and other services as needed during construction.

Qualified construction observers and managers will be used to ensure that the construction project runs smoothly, the client is properly represented in the field and that the work is constructed as intended. A full time engineering construction observer will be on site for the duration of the project. The construction observer will review and update as necessary project schedule, contractor payment requests, contractor log submittals, and payroll and manpower utilization reports. They will also track and monitor the review process, preparing any recommended change orders, and maintaining accounts of commitments, expenditures, and forecasts of cash flows and costs to complete. The construction inspector will be supported by office staff for submittal review, project management, and document filing. The contractor will be notified of work not acceptable that must be corrected.

Construction Project Closeout: During the close out phase, the construction observer will establish that all work is substantially complete and prepare a list of any unfinished work. Operations testing will be performed on the new pipeline. Copies of the record drawings and any other accumulated records and reports will be turned over to the City. A notice of completion would be prepared and recorded with the County Clerk, and recommendations concerning final payments to contractors and the release of retained percentages will be prepared.

Project Administration: Throughout the project the project manager will keep in close coordination all people working on the project. This task includes grant management such as required reporting, and reimbursement requests. An effective project manage assures the project will be implemented on schedule and within budget.

Big Rock Community Services District
Water Tank Stabilization Project
Supporting Information for Environmental Checklist

NATIONAL HISTORIC PRESERVATION ACT

The structure involved is a 1971 Redwood Water Tank. These types of tanks are routinely replaced throughout California, and are not considered historic structures eligible for listing.

ARCHEOLOGICAL & HISTORICAL PRESERVATION ACT

The project includes ground disturbance to excavate a new tank pad. Excavation is estimated to include 24 horizontal feet into the hillside and will top out at 42 feet along a 60 degree slope. The excavation will be approximately 60 feet long, which results in 3,000 cubic yards of excavated material. The site was previously disturbed when the original tank was installed in 1971. A mitigation measure in case of accidental discovery of archeological remains is included below.

MITIGATION MEASURE: The purpose of this provision is to avoid creating a significant impact in the event of accidental discovery of previously unidentified and unknown cultural resources or human remains during construction. Construction personnel will be notified of, and required to monitor for, signs of potential undiscovered historical, archaeological, ethnic, religious, or paleontological resources. In the event that such materials are encountered during construction, ground-disturbing work will be halted in that area until a qualified cultural resources specialist evaluates the situation and recommends an appropriate course of action. Project personnel may not collect cultural resources. Examples of prehistoric resources include obsidian or chert flakes and/or tools, projectile points, heat-affected rock, locally darkened midden soils, ground stone artifacts, deposits of shell, dietary bone, and human burials. Historic resources include stone foundations or walls, structures and remains with square nails, and refuse deposits found often in old wells and privies. If human remains are discovered, the County Coroner must be contacted. Required procedures to be followed in the event of accidental discovery of cultural materials or human remains are described in sections 15064.5(e) and 15064.5(f) of the State CEQA Guidelines (California Code of Regulations, Title 14, Sec. 15000-15387).

ENDANGERED SPECIES ACT AND FISH AND WILDLIFE COORDINATION ACT

A DFG California Natural Diversity Data Base (CNDDB) List for a 9 quad areas surrounding Hiouchi, Del Norte County is attached. There are no endangered plants or animals in the area. There are two candidate species in the project vicinity, the Pacific Fisher, a member of the weasel family, and the Mardon Skipper, a type of butterfly. An additional search through the California Native Plant Society also showed no special status plants in the project area.

Formal consultation with the California Department of Fish and Game (CDFG) and the US Fish and Wildlife service has not been conducted. It is anticipated that a no permit required letter will be obtained from CDFG and a letter of concurrence will be requested from the United States Fish & Wildlife Service (FWS) that the project is not likely to impact any endangered, threatened, or special status species.
(Electronic File Name “CNDDB_ListsHiouchiQuad.pdf”)

FARMLANDS PROTECTION POLICY ACT

The proposed project site is located on the steep slope of Hiouchi Mountain surrounded by a public conservation easement. The land is not zoned for agriculture and is mostly zoned residential or state and federal lands. The soils at the site are Jayel-Walnett-Oragran and are extremely stony. This type of soil is not classified as prime farmland. Based on this information, there are no defined prime or unique farmland present at the project site.

CLEAN AIR ACT

The project will result in minor increases in air emission during construction. The following mitigation measure or similar will be included in the proposed project environmental documents (CEQA/ NEPA).

MITIGATION MEASURE: The applicant, at all times, shall comply with the California Air Resources Board guidelines. This shall require implementation of Best Management Practices (BMPs) such as, but not limited to: (1) covering open bodied trucks when used for transporting materials likely to give rise to airborne dust; (2) covering of all soil stock piles with tarps; (3) watering all exposed surfaces and haul roads three times daily for control of dust in construction operations, grading of roads, or land clearing; (4) the use of aqueous diesel fuel by construction equipment; and (5) the use of diesel particulate filters in construction equipment.

CLEAN WATER ACT (Section 404) RIVERS AND HARBORS ACT (Section 10) and E.O. 11990 – WETLANDS

The National Wetlands Inventory produced by the US Fish and Wildlife service was reviewed for the proposed project. There are no wetlands identified near the proposed project site. This is consistent with the vegetation and soils at the project site as well.

WILD AND SCENIC RIVERS ACT

There are no segments of designated wild and scenic river in Del Norte County.

WILDERNESS ACT

There is no land designed as a wilderness area located at or near the project site.

E.O. 11988 – FLOODPLAINS

The proposed project is not located within the 100-year flood plain.
(Electronic File Name “FloodPlain_Map.pdf”)

E.O. 11990 – WETLANDS

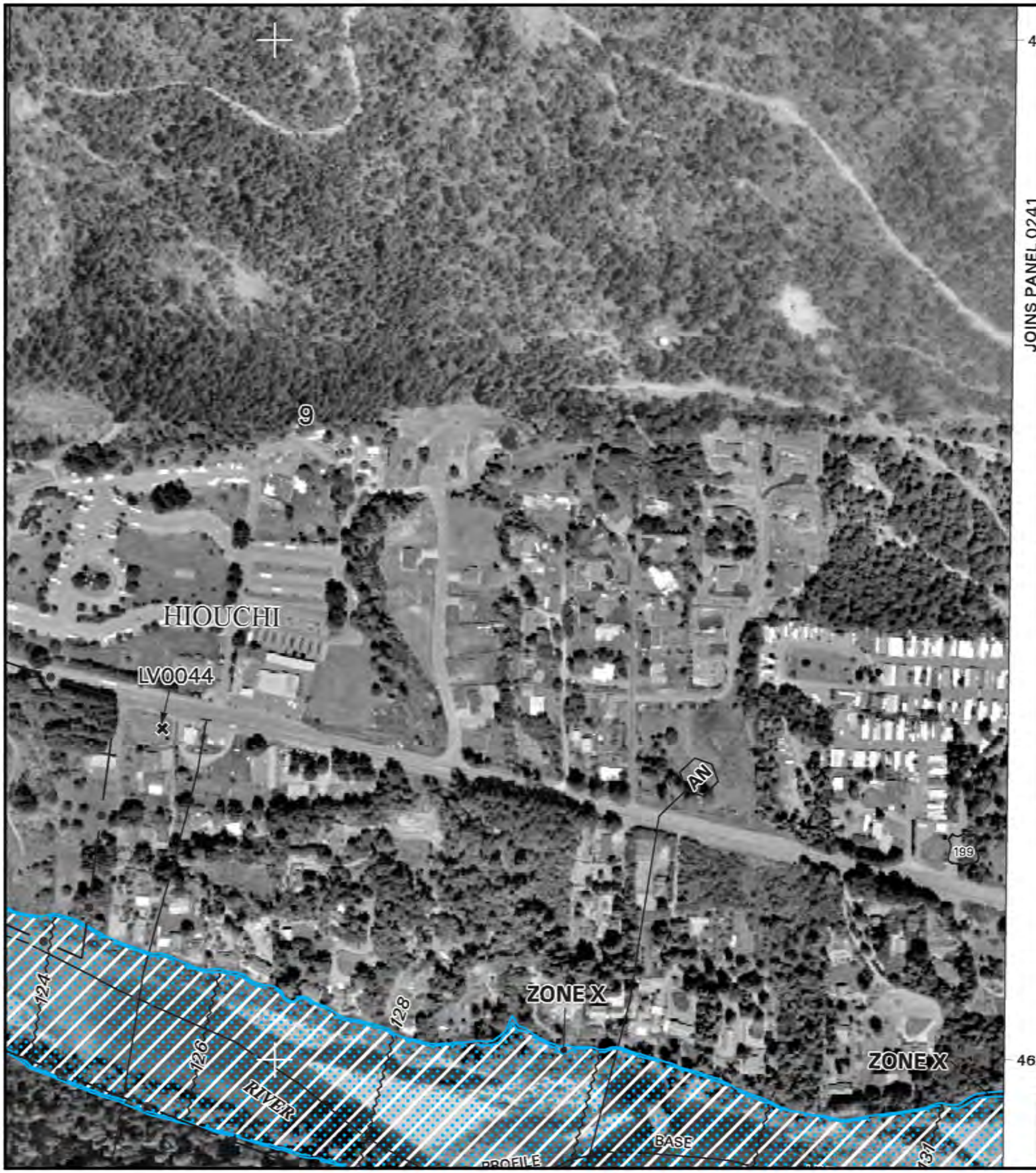
The project is depicted on a NWI map. The mapping shows no wetlands near the project site.
(Electronic File Name “NWI_Hiouchi.pdf”)

E.O. 12898 – ENVIRONMENTAL JUSTICE

The proposed project would protect the Big Rock CSD and its residents from catastrophic failure of the water tank and earthen pad. Big Rock CSD is a diverse community with many low income residents. The town of Hiouchi, in which the Big Rock CSD is located, has an annual Median household income of $48,063 according to the Census American Community Survey (2006-2010). This is less than 80% of the Statewide MHI for the same period, which qualified Hiouchi as disadvantaged under numerous funding programs. The District Board of Directors has increased water rates to the residents and commercial consumers to the microeconomics extreme of price elasticity. In other words, the price of water has increased to a barely tolerable level. Wildfire disasters, unfunded State and Federal Mandates, rising operations expenses, the California Legislature's recent diversion of property tax revenue, and local emergency measures generated by constant diesel and gasoline spills along the river miles above Hiouchi have combined to keep the Big Rock CSD's capital reserve at dangerously low levels even with significant rate increases. This project would protect the disadvantaged community of Hiouchi, thereby promoting environmental justice by protection the disadvantaged population within the town.

California Natural Diversity Database Search Results for the 9 Quad Area Surrounding Hiouchi, CA (August 2012)

Record	QUADNAME	ELMCODE	SCINAME	COMNAME	FEDSTATUS	CALSTATUS	DFGSTATUS	CNPSLIST
1	Hiouchi	AAAAD12050	Plethodon elongatus	Del Norte salamander	None	None	SSC	
2	Hiouchi	AAAAJ01020	Rhyacotriton variegatus	southern torrent salamander	None	None	SSC	
3	Hiouchi	AAABA01010	Ascaphus truei	Pacific tailed frog	None	None	SSC	
4	Hiouchi	AAABH01021	Rana aurora	northern red-legged frog	None	None	SSC	
5	Hiouchi	AAABH01050	Rana boylii	foothill yellow-legged frog	None	None	SSC	
6	Hiouchi	ABNUA01010	Cypseloides niger	black swift	None	None	SSC	
7	Hiouchi	AFCHA0208A	Oncorhynchus clarkii clarkii	coast cutthroat trout	None	None	SSC	
8	Hiouchi	AFCHA0213B	Oncorhynchus mykiss irideus	summer-run steelhead trout	None	None	SSC	
9	Hiouchi	AMACC01020	Myotis yumanensis	Yuma myotis	None	None		
10	Hiouchi	AMACC02010	Lasionycteris noctivagans	silver-haired bat	None	None		
11	Hiouchi	AMAJF01021	Martes pennanti (pacifica) DPS	Pacific fisher	Candidate	None	SSC	
12	Hiouchi	IILEP66030	Polites mardon	mardon skipper	Candidate	None		
13	Hiouchi	NBMUS2W0U0	Fissidens pauperculus	minute pocket moss	None	None		1B.2
14	Hiouchi	NLLEC5P420	Usnea longissima	long-beard lichen	None	None		
15	Hiouchi	PDAST8H0H1	Packera bolanderi var. bolanderi	seacoast ragwort	None	None		2.2
16	Hiouchi	PDASTDT0F4	Pyrrocoma racemosa var. congesta	Del Norte pyrrocoma	None	None		2.3
17	Hiouchi	PDBRA060Z0	Boechera koehleri	Koehler's rockcress	None	None		1B.3
18	Hiouchi	PDBRA0K0R3	Cardamine nuttallii var. gemmata	yellow-tubered toothwort	None	None		3.3
19	Hiouchi	PDCAR0G0F0	Minuartia howellii	Howell's sandwort	None	None		1B.3
20	Hiouchi	PDCAR0U2B0	Silene serpentinicola	serpentine catchfly	None	None		1B.2
21	Hiouchi	PDCON04012	Calystegia atriplicifolia ssp. buttensis	Butte County morning-glory	None	None		4.2
22	Hiouchi	PDLNT01040	Pinguicula macroceras	horned butterwort	None	None		2.2
23	Hiouchi	PDMON03030	Monotropa uniflora	ghost-pipe	None	None		2.2
24	Hiouchi	PDPLM040B6	Gilia capitata ssp. pacifica	Pacific gilia	None	None		1B.2
25	Hiouchi	PDPOR040B0	Lewisia oppositifolia	opposite-leaved lewisia	None	None		2.2
26	Hiouchi	PDRAN0A020	Coptis laciniata	Oregon goldthread	None	None		2.2
27	Hiouchi	PDSAX0U160	Cascadia nuttallii	Nuttall's saxifrage	None	None		2.1
28	Hiouchi	PDSCR0D213	Castilleja miniata ssp. elata	Siskiyou paintbrush	None	None		2.2
29	Hiouchi	PMCYP03KM0	Carex serpenticola	serpentine sedge	None	None		2.3
30	Hiouchi	PMLIL0U070	Erythronium hendersonii	Henderson's fawn lily	None	None		2.3
31	Hiouchi	PMLIL0U080	Erythronium howellii	Howell's fawn lily	None	None		1B.3
32	Hiouchi	PPASP021K2	Asplenium trichomanes ssp. trichomanes	maidenhair spleenwort	None	None		2.3



ne if flood insurance is available in this community, co
l the National Flood Insurance Program at (800) 638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FT

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0237E

FIRM
FLOOD INSURANCE RATE MAP

DEL NORTE COUNTY,
CALIFORNIA
INCORPORATED AREAS

PANEL 237 OF 675

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DEL NORTE COUNTY, UNINCORPORATED AREAS	060025	0237	E

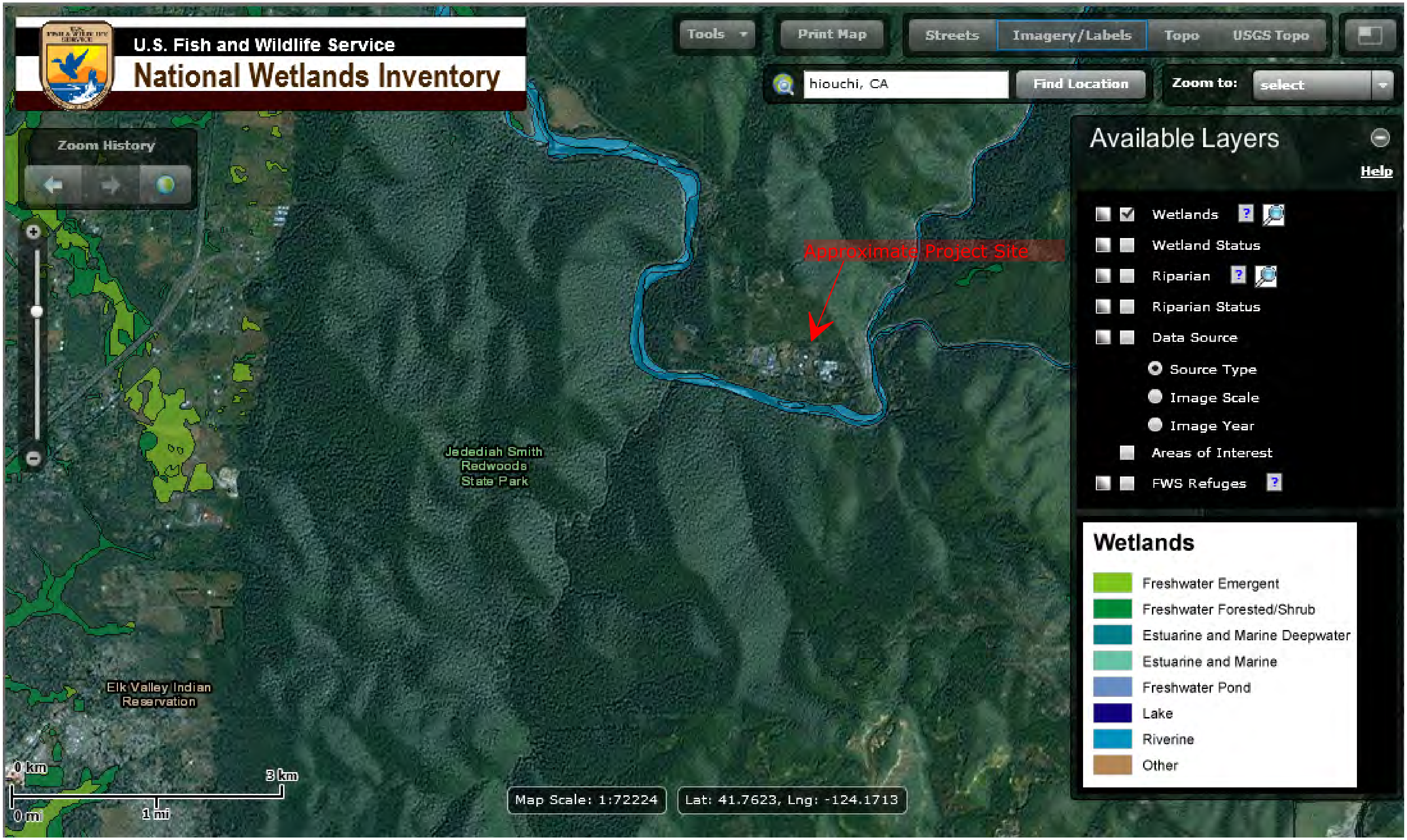
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06015C0237E

EFFECTIVE DATE:
SEPTEMBER 26, 2008

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov


U.S. Fish and Wildlife Service
National Wetlands Inventory
Tools
Print Map
Streets
Imagery/Labels
Topo
USGS Topo
hiouchi, CA
Find Location
Zoom to:
select
Zoom History
Available Layers
Help
Wetlands
Wetland Status
Riparian
Riparian Status
Data Source
Source Type
Image Scale
Image Year
Areas of Interest
FWS Refuges
Approximate Project Site
Jedediah Smith Redwoods State Park
Elk Valley Indian Reservation
Wetlands
Freshwater Emergent
Freshwater Forested/Shrub
Estuarine and Marine Deepwater
Estuarine and Marine
Freshwater Pond
Lake
Riverine
Other
0 km
3 km
0 mi
1 mi
Map Scale: 1:72224
Lat: 41.7623, Lng: -124.1713