THE PERCEPTION OF EARTHQUAKE HAZARD
AT TEHACHAPI, CALIFORNIA

A thesis submitted in partial satisfaction of the requirements for the Master of Arts in Geography
by
Richard Burrill Pond

June, 1969
The thesis of Richard Burrill Pond is approved:

Committee Chairman

San Fernando Valley State College
June, 1969
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THE PERCEPTION OF EARTHQUAKE HAZARD

AT TEHACHAPI, CALIFORNIA

by

Richard Burrill Pond

Master of Arts in Geography

June, 1969

This thesis attempts to answer the following question concerning the perception of the natural hazard of earthquakes by the people of Tehachapi, California:

What is the difference between the real landscape of seismic activity and the perceptual landscape of the people exposed to this hazard?

Investigation of this question is an attempt to provide information on the relations between man and one of the hazardous aspects of his natural environment. The decision process as it relates to man's settlement patterns is not well understood and it is hoped this research will help to illuminate this aspect of geography.

Two methods of investigation were used in this study: a questionnaire field survey to establish the perceptual landscape, and library research to establish the real landscape.

With respect to the real seismic landscape, the combination of the thick alluvium upon which Tehachapi is
situated, the number of major and minor faults that frac­
ture the mountains which surround the alluvium, and the
established tectonic pressure being exerted in this area
produce a substantial earthquake hazard at Tehachapi. The
destruction in Tehachapi on July 21, 1952 is evidence of
this high hazard level.

The perception of the earthquake hazard by the people
of Tehachapi is quite low. A marginal level of conceptual
awareness of the hazard was identified but is due largely
to the fact that forty percent of the inhabitants experi­
ence a major earthquake while living in Tehachapi. But
they have little knowledge of the mechanisms and frequen­
cies of earthquakes, and safety and preventive measures
which might be taken to relieve damage due to an earth­
quake. The conceptual awareness is not supported by a
rational interpretation of the possible future occurrence
of an earthquake.

Further, it was found that various primary earthquake
information sources do not disseminate their information
voluntarily, thus compounding the hazard.

Conclusions are drawn and recommendations are made
suggesting possible legislative adjustment.
CHAPTER I
INTRODUCTION

The majority of modern geographic research is directed toward gaining an understanding of material phenomena, both physical and cultural. But the ways in which man perceives the various aspects of his geographic setting can be, and thus far has been found to be, quite different from the real setting. Only recently have geographers applied their research efforts to the task of gaining a better understanding of man's perception of his relationship with the physical and cultural environment. The research which is presented in this thesis has as its objective the development of a better understanding of man's environmental perception.

The past decade has seen the accumulation of a considerable body of knowledge concerning the perception of natural hazard.\(^1\) Direct interview data are available for residents of hazardous flood, storm, drought, tsunami, snow, and tornado areas; no data are available on the perception of earthquake hazard. This thesis presents and analyzes data gathered in an area subjected to a high degree of earthquake hazard and gives an indication of how man perceives this hazard.

It should be pointed out that the data presented here were collected in November and December of 1968, and therefore, the level of perception indicated by the people was...
not affected by the recent "California earthquake scare." This scare was initiated by soothsayers' predictions that California would suffer a colossal earthquake in April 1969 and precipitated great attention and volumes of publicity concerning earthquakes. It would be an interesting and valuable extension of this study to conduct another survey to measure the effect this attention has had upon people's awareness and knowledge of the hazard.

1.1 Statement of the Problem

I propose to answer the following question regarding the perception of the natural hazard of earthquakes by the people of a city:

What is the difference between the real landscape of seismic activity and the perceptual landscape of the people exposed to this hazard?

The real seismic landscape can be defined in terms of: (1) the historical record of earthquakes in the region, and (2) the geologic setting. The perceptual seismic landscape can be defined through the awareness and knowledge of the people exposed to the earthquake hazard.

The following hypotheses were formulated and tested: (1) The real landscape of seismic activity and the perceptual landscape of the inhabitants differ considerably.
(2) The environmental hazard of earthquakes plays little role in the people's process of settlement decision.

(3) The higher the socio-economic class level of the inhabitant, the higher his level of awareness and knowledge of earthquakes.

(4) The majority of the inhabitants:

(a) have little accurate technical knowledge about earthquakes.

(b) appear overly optimistic.

(c) feel they and their dwellings would escape damage in the event a major earthquake did occur.

(d) while expressing some knowledge of the world wide effects of earthquakes, do not relate earthquake effects to their local environment.

(e) have little, if any, knowledge of protective measures that can be taken before and during an earthquake to reduce damage and death.

This investigation is an attempt to provide information on the relations between man and one of the hazardous aspects of his natural environment. This information can perhaps guide us in understanding settlement patterns. The decision process as it relates to man's settlement patterns is not well understood and it is hoped that this research will help to illuminate this aspect of geography.

This research is patterned after research carried on by several geographers which relates to perception in resource management (section 1.4 contains a review of the
literature). Most of these studies have approached the problem of people's perception of natural hazard through the study of flood plain occupancy; however, research has been conducted in snow, drought, tsunami and coastal storm hazard zones. The seismic activity, real and potential, to which approximately twenty million people of the United States are subject lends itself to a study of environmental perception.

1.2 The Study Area

For purposes of this research an area was chosen which had:

1. been exposed to the effects of a major earthquake.
2. a small size and population, yet a relatively diverse economy making it an area where a feasible, meaningful statistical sample could be taken.
3. a convenient location.
4. a geologic setting which was similar to that of a great many population centers in California, thus giving the results of the research more general applicability.

The study area selected was Tehachapi in Kern County, California, a city having a population of 3838 persons in 1965 and covering 2427 acres. It is situated in the Tehachapi Mountains at an elevation of 4000 feet, and is 120 miles northwest of Los Angeles and 350 miles southeast of San Francisco (see Figure 1). It is located on the
Shaded area represents the location of the larger map.

FIGURE 1
inland railroad line connecting Los Angeles and San Francisco. On July 21, 1952 the city was heavily damaged by earthquake and twelve persons lost their lives.

1.2.1 The Physical Setting

Tehachapi is situated on thick alluvium in the central part of Tehachapi Valley, an intermontane valley of thirty-six square miles that lies between the Tehachapi Mountains and the southern end of the Sierra Nevada. The valley is surrounded by hills of granitic and metamorphic rock and is filled with unconsolidated alluvium derived from gently sloping, coalescing alluvial fans. The unconsolidated sediments consist of boulders and coarse gravel in the upper parts of the alluvial fans and fine gravel, sand, silt and clay at lower elevations.\(^4\)

In the northern part of Tehachapi, 800 feet north of the Southern Pacific Railroad track, the alluvium consists of two to three feet of light olive-gray, calcareous, sandy, clayey silt that overlies about four feet of greenish-white calcareous, sandy clay, as revealed by field observations. Both the silt and the underlying clay are plastic when wetted, the clay becoming more plastic than the silt. Directly below Tehachapi, it is believed that sandy clay and gravel beds underlie the greenish-white clay. The water table is a considerable distance below the surface, according to Don Simpson, Tehachapi City Engineer.
1.2.2 The Cultural Setting

Although traces of mining operations believed left by Spanish and Mexican prospectors indicate prior temporary settlement, the John M. Brite family became the first known permanent settlers in Tehachapi Valley when they homesteaded land in 1854. In 1859, Brite moved to a nearby valley, later called Brite's Valley, where they founded Old Town. By 1867 this town was a thriving village of 200 people, and was a trading center for the stockmen of Tehachapi, Brite's, Cummings, and Bear Valleys, and for the miners washing gold from the sand and gravel on China Hill. The economy of the locale depended primarily upon cattle, a marble quarry, and the salt recovery operations of the John Narbee Company.

With the anticipated arrival of the railroad, many residents of Old Town established a new settlement about a mile west of the present site of Tehachapi and called it Greenwich. When the Southern Pacific Railroad finally conquered Tehachapi Pass in 1876, it bypassed both Old Town and Greenwich and established its depot at Summit Station. The new settlement, soon to be renamed Tehachapi—the name given to the area by its early Indian inhabitants meaning "land of plenty acorns and good water"—became a rival of the two towns to the west. Greenwich soon moved to the new townsite, and about 1883, Old Town moved the three miles to Tehachapi. Tehachapi was incorporated as a city in 1909.
Mining has always been an important economic function for the town. It was in the 1870's that rich deposits of lime were discovered in the mountains that rim the north-eastern portion of the valley. By 1883 a sizeable lime mining operation had been established. The Tehachapi Lime Company began operations in 1887.

In 1919, the Monolith Portland Cement Company acquired the cement plant which had been established by the City of Los Angeles in 1910 to construct the Los Angeles Aqueduct. This industrial plant located in the Tehachapi Valley to the east of Tehachapi stimulated the growth of the town and has continued to be important.

Today the economy of the city is based on four primary activities. Two large cement plants, Monolith Portland Cement Company and California Portland Cement Company annually employ approximately 550 persons. Agriculture including the production of pears, apples, peaches, alfalfa, oats, hay, barley, wheat, potatoes and nursery flowers, employs 300 persons. Retail services account for the employment of approximately 200 persons. Although the railroad has been the primary factor in facilitating the growth of Tehachapi, now it employs only about thirty residents. Light industry has been an increasingly important employer since 1960 and is expected to grow rapidly in the near future with the completion of a new freeway through Tehachapi and the Feather River Water
Project which will eliminate a seasonal water problem.

Population and structural growth figures indicate that Tehachapi has experienced a moderate growth rate since 1940 with two periods of accelerated growth rate from 1950 to 1955 and from 1960 to 1965 (see Table 1).

Mr. H. Tracy Wardell, a sales representative for the Carroll Development Company, the primary real estate and land development company in Tehachapi, indicated on December 6, 1969 that approximately 40 percent of the currently occupied dwellings in the city have been constructed since 1950 and that the "boom" period of 1950 to 1955 was produced by the reconstruction of the town following its destruction by the 1952 Tehachapi-Arvin earthquake. The Carroll Development Company and the Pacific Cascade Land Development Company opened large parcels of pasture land to industrial and residential development in 1966 and 1967 and new construction was evident in 1968.

TABLE 1
POPULATION AND STRUCTURAL GROWTH AND TRENDS - TEHACHAPI, CALIFORNIA -

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Occupied Dwellings</th>
<th>Water Meters</th>
<th>Telephone Accounts</th>
<th>Electric Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1940</td>
<td>1,264</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1950</td>
<td>1,685</td>
<td>-</td>
<td>800</td>
<td>750</td>
<td>-</td>
</tr>
<tr>
<td>1956</td>
<td>2,550</td>
<td>800</td>
<td>794</td>
<td>935</td>
<td>987</td>
</tr>
<tr>
<td>1958</td>
<td>2,947</td>
<td>860</td>
<td>987</td>
<td>987</td>
<td>1,161</td>
</tr>
<tr>
<td>1965</td>
<td>3,838</td>
<td>1,256</td>
<td>1,226</td>
<td>2,541</td>
<td>177</td>
</tr>
</tbody>
</table>

Source: Kern County Standard Industrial Survey Summary Report - Tehachapi
1.3 Methodology

Two methods of investigation were used in this study: a questionnaire field survey to establish the perceptual landscape and library research to establish the real landscape. The real landscape was established from the abundant available data on earthquakes in California.

The primary research method, questionnaire survey, upon which the validity of this research depends, involved a 10 percent stratified random sample of the adult population of Tehachapi. A questionnaire designed to identify individual hazard perception was administered through personal interview. All respondents were potentially subject to the same degree of hazard. The sampling technique and questionnaire design are fully explained in Chapter 3.

Earthquake information availability in the town of Tehachapi was determined through personal interviews with Dr. Mryl C. Rupel, Superintendent of the Tehachapi Unified School District, Mr. H. Tracy Wardell, sales representative for the Carroll Development Company, and Mr. W. Metts, Tehachapi City Building Inspector.

This research is presented in three basic divisions in addition to this introductory chapter. The first of these, Chapter 2, is a discussion of the "Real Seismic Landscape" of Tehachapi. This real seismic landscape is based on a scholarly review of our present knowledge of seismic potential for the general and specific area of Tehachapi. The second division, Chapter 3, is a discussion
of the results of interviews conducted in Tehachapi. These results represent the first record of earthquake hazard zone resident perception of the natural hazard which they face. The third division, Chapter 4, compares the real and perceptual landscapes of earthquakes in Tehachapi, examines the validity of the original hypotheses, and presents recommendations in light of these findings.

1.4 Literature Survey

Studies of environmental perception can be found in many disciplines, and they seem to be increasing. Several examples of this interest in perception and man-milieu relationships can be pointed out in other social and behavioral sciences.

In anthropology, current works include Bronislaw Malinowski's The Coral Gardens and Their Magic and Evon Vogt's Modern Homesteaders: The Life of a Twentieth Century Frontier Community; the latter is a geographically excellent report on the effect of different value systems on adaptation to an arid environment. Jerome Bruner in Social Psychology and Perception points out that "contemporary social psychology is much concerned, indeed even preoccupied, with problems of perception."

In psychoanalysis a shift from the genetic and biological framework to ego psychology with its emphasis on social character as formed by interaction between man and
his environment is exemplified by E. Erikson's *Childhood and Society*. J. McVickers Hunt, in *Intelligence and Experience*, points out that in the field of developmental psychology the heredity versus environment controversy has moved from ideas of fixed intelligence and predetermined development to emphasis on interaction between the individual and his environment.

The field of philosophy has been permeated with questions and writings revolving around the basic theme of "how man views his material world and how the material world changes man's views," an example of which is Don Locke's *Perception and Our Knowledge of the External World*. Kevin Lynch's *The Image of the City*, in which he applies new techniques for investigating the imagability of the city and the elements used by people in orienting themselves in an urban area, is an example of a specific environmental perception and adaptation study from another field.

There are many other examples of interest and research in environmental perception in fields other than geography. Perception study is not unique to geographic research, but is a significant area of inquiry in a number of fields. Nevertheless, several general statements on the study of perception in geography deserve mention for their illumination of the direction which the field is taking, or suggestions of directions it should take.
Yi Fu Tuan in his papers "Attitudes Toward Environment: Thèmes and Approaches" and "Topophilia of Sudden Encounter with the Landscape" points out that geographers have taken one of five basic approaches to the theme of environmental perception, but that not enough attention has been given environmental perception other than by resource geographers; all geographers he feels should aim at more perceptive, sensitive portrayals of the earth.

David Lowenthal's review article, "Geography, Experience and Imagination: Towards a Geographical Epistemology" shows how images and ideas of the world are derived from experience, memory and imagination. He points out the differences between the world outside and the world inside our heads and how this varies among humans and other animals. He further applies this theme of research in collaboration with Hugh C. Prince in "English Landscape Tastes" to show the contrast between the urban-bound English citizen's perceived environment and his real environment (as perceived by Lowenthal and Prince). Lowenthal has also edited a book titled Environmental Perception and Behavior, which contains five papers presented at the sixty-first meeting of the Association of American Geographers representing significant research efforts in environmental perception. Alexander Spoehr illustrates how closely perception of resources and cultural appraisal of resources relates in his article entitled, "Cultural
Differences in the Interpretation of Natural Resources,"^20

Peter Gould points out, in "On Mental Maps," a further
application of perception research in his effort to de-
lineate mental images of boundaries. Hans Meihoef er in
"The Use of the Circle in Thematic Maps; A Study in Visual
Perception of a Cartographic Symbol,"^21 proves the prac-
ticality of perception research in demonstrating the de-
ficiencies of cartographic symbols.

These citations illustrate the range of perception
literature in geography; however, the greatest volume of
perception research has focused on questions concerning
resources management, with particular emphasis placed upon
human perception of the more hazardous aspects of the
natural environment. The attitudes of flood plain resi-
dents have been a primary concern and the primary tech-
nique of research has been that of personal interview with
hazard zone occupants (see Table 2). However, as Table 2
shows, other hazard zone occupancy types have been studied
and various research techniques, not new in themselves,
but not previously employed extensively in geographical
research have been adopted. These include the use of
structured and unstructured interviews,^22,31,33 benefit/
cost analysis,^26,27 thematic aperception tests,^31 models
of decision making,^25 content analysis of news media,^32
and extended uses of probability theory.^26

Several other approaches to research on perception in
resource management can be cited. Robert C. Lucas has
<table>
<thead>
<tr>
<th>Hazard Type</th>
<th>Date</th>
<th>Investigator(s)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood</td>
<td>1960</td>
<td>Roder (22)*</td>
<td>Topeka, Kansas</td>
</tr>
<tr>
<td></td>
<td>1960</td>
<td>Burton (23)</td>
<td>Hammond, Munster, Indiana</td>
</tr>
<tr>
<td></td>
<td>1960</td>
<td>Burton (24)</td>
<td>Rural areas in 12 states</td>
</tr>
<tr>
<td></td>
<td>1961</td>
<td>Kates, White (25, 26)</td>
<td>Tenn., Calif., Wisc., N.Y., Ohio</td>
</tr>
<tr>
<td></td>
<td>1963</td>
<td>Burton (27)</td>
<td>Belleville, Ontario</td>
</tr>
<tr>
<td></td>
<td>1963</td>
<td>Kates (28)</td>
<td>Connecticut</td>
</tr>
<tr>
<td></td>
<td>1963</td>
<td>Sewell (29)</td>
<td>Fraser Valley, B.C.</td>
</tr>
<tr>
<td></td>
<td>1966</td>
<td>Czamanske (30)</td>
<td>Ga., Ill., Pa., La., N.J., W.Va., N.C.</td>
</tr>
<tr>
<td>Drought</td>
<td>1965</td>
<td>Saarinen (31)</td>
<td>Great Plains</td>
</tr>
<tr>
<td>Coastal Storm</td>
<td>1964</td>
<td>Burton, Kates, Nather, Snead (33)</td>
<td>East coast of U.S., Maine to N.Car.</td>
</tr>
<tr>
<td>Tsunami</td>
<td>1966</td>
<td>Havighurst (34)</td>
<td>Oahu, Hawaii</td>
</tr>
</tbody>
</table>

*Figures in parenthesis refer to published works cited in references.
worked with people's perception of the wilderness area in a national park zone. J. Blaunt has identified the Jamaican farmers' perception of the process of soil erosion. L. Schuyler Fonaroff has examined the impact of culture on resource perception and management among Navaho people.

This thesis is part of the long-term inquiry into the relationship between man and the more hazardous aspects of the natural environment. However, the majority of the previous research carried on by geographers has focused on the implications that human perception of the hazardous aspects has upon resource management. This work looks at human perception of an uncontrollable natural hazard, and is not immediately applicable to resource management. Its purpose is to identify the perception level of a population to a very real but unpredictable natural hazard and, thereby, to determine to what degree that natural hazard plays a part in determining settlement patterns. It identifies attitudes and knowledge about the hazard of earthquakes in an attempt to draw conclusions as to the degree to which a population is educated to, and prepared for, an environmental hazard.
References


2. Ibid.


6. Ibid.

7. Ibid.


CHAPTER 2
THE REAL SEISMIC LANDSCAPE

2.1 The Complex Nature of Earthquake Hazard

Earthquakes are vibrations transmitted as waves in the materials of the earth. They result from release of stress accumulated within the outer 400 mile shell of the earth. The origins of these stresses are still obscure, both in terms of the source of energy and in terms of the mechanisms by which this energy is converted to seismic kinetics. The energy source is generally assumed to be of thermal origin, although other sources such as gravitational forces may also be active.¹

The mechanisms which have been suggested for transferring thermal energy into mechanical energy or elastic strain are convection currents, change of phase or state, diffusion process, expansion, or contraction.² Gravitational return to equilibrium from disturbances produced in the past may also play a role. However, these mechanisms are generally looked upon by geologists and seismologists to be inadequate to explain all the known observations, so that other as yet unknown sources may also be active.

Even though the fundamental causes of accumulation of stresses are not thoroughly understood, these stresses are known to occur at the unstable margins of continental platforms and ocean deeps. The number of variables involved, the lack of long-recorded data, and incomplete
measurements of all observed phenomena preclude any further positive conclusions about the causes of earthquakes or predictions of specific earthquakes in time and place.

In accordance with the complexity of earthquakes, the hazard posed to humans by the occurrence of earthquakes is just as complex. The hazard's complexity is brought about by the nature of events: the extensiveness of areas of high seismic potential yet low frequency of occurrence at any one point, the release of monumental amounts of energy without warning, and the complex nature of direct (tectonic movements) and induced (landslide, tsunami, fire) earthquake hazard. 3

Our lack of knowledge concerning the causes of earthquakes and our inability to predict earthquakes or even calculate probability distributions for estimating their chance of occurrence at a specific site further complicates the hazard. Finally, in the United States, the complexity of the hazard is compounded by the people's lack of experience with major earthquakes and, therefore, the lack of national policies and legislation designed to reduce the hazard.

Five principal elements influence damage to man-made structures:

(1) Strength of the earthquake waves reaching the surface. An earthquake with magnitude 4.5 or greater, originating from a depth of some ten miles (where most
California earthquakes originate) usually results in maximum intensities of VI, VII, or VIII, which can include substantial building damage.

(2) Length of the earthquake motion. Very rarely will an earthquake shock be felt as a single pulse; it is usually a fluctuating series of tremors that last from ten seconds to a minute. The cumulative effect of this motion on structural walls is the usual cause of collapse.

(3) Proximity to the fault. This is important only as a general concept. Obviously, a house five miles from a fault that causes an earthquake is in more danger than a house 100 miles away. However, there is not necessarily a direct relationship between distance and damage received. Unless you live right on top of a fault zone, proximity (within ten or twenty miles) is much less important than the construction of a home and the geologic foundation under it.

(4) Geologic foundation. To many engineers and insurance experts, this is perhaps the most important factor in building damage. Earthquake studies have almost invariably shown that the intensity of a shock is directly related to the type of ground material supporting the building. Structures built on solid rock near the epicenter of an earthquake frequently fare better than more distant buildings on soft ground. A great deal of evidence has been accumulated to
substantiate a general theory that structural damage is greatest in areas underlain by thick, unconsolidated sediments and least in areas underlain by rock. Thick, unconsolidated sediments underlain and/or surrounded by rock which is shaking act as does liquid in a bowl when the bowl is vibrated; wave motion is initiated and structures built on these sediments receive much more shaking than do structures built on the rock foundation.

Fill, especially when watersoaked, transmits much greater intensity of motion than nearby rock outcroppings. Loose, water-charged natural ground is also dangerous. Even worse than building on soft ground is locating a structure partly on rock or hard ground and partly on soft ground. Differential settlements can impose tremendous stress on the structure that may prove disastrous during an earthquake.

(5) Building design. Architects and engineers have declared for years that any building can be designed to be earthquake resistant, provided its site is suitable. The object is to insure that the structure will overcome inertia and move with the earth as a unit, not as an unrelated assembly of parts. The basic essential is strength, obtained by adequate bracing and structural continuity, with secure anchoring and bonding of all elements. Investigations of structural damage,
which include the one conducted at Tehachapi following the 1952 disaster, have revealed the following about building design:

(a) Steel buildings such as gas stations are generally left undamaged.

(b) Reinforced-concrete buildings usually are left structurally undamaged. Large sheets of glass, as in department stores, usually shatter and parapets will be dislodged.

(c) Reinforced-concrete block usually suffers minor damage.

(d) Reinforced brick suffers light damage; unreinforced brick suffers total collapse in most cases.

(e) Wood frame construction has a high degree of quake resistance, provided workmanship is sound, bracing is adequate and the frame is well tied to sound reinforced foundation.

(f) Unreinforced concrete suffers severe damage and usually collapses.

(g) Adobe is the worst construction material commonly used in an earthquake zone; buildings made with it will collapse.

2.2 Tehachapi's Position in the World Distribution of Earthquakes

No part of the surface of the earth is free from earthquakes, but even the short period of seismograph
records (about fifty years) has been long enough to show that certain areas of the earth's surface have many times more earthquakes than others. These areas of greatest earthquake frequency are the regions of high, actively building mountain ranges, steep continental slopes, and deep ocean belts. One such belt rims the entire Pacific ocean (the circum-Pacific belt) and the other extends discontinuously from west to east through the West Indies, Mediterranean sea, and Himalaya mountains and turns southeastward to join the Pacific belt in the East Indies (the Alpide belt).

For purposes of this thesis the Tehachapi area is defined as an area of 9000 square miles between latitude 34°45' and 35°45' North and longitude 118°00' and 120°00' West (see Figure 5). A series of earthquakes was initiated in this area by the severe Arvin-Tehachapi earthquake of July 21, 1952. It was part of the continuing evidence of the position of California in a seismically active belt of geologically young, developing, mountain ranges, valleys and abrupt continental margins that rim the Pacific ocean.

Interpretation of seismograph records suggest that deep-focus earthquakes originate at depths as great as 400 miles, shocks of intermediate originate at depths of 27 to 150 miles, and shallow earthquake at depths of less than 27 miles. The large majority of earthquakes fall into the last category. As shown by Figure 2, California
Figure 2. THE CIRCUM-PACIFIC EARTHQUAKE BELT (Shaded area represents the belt.)

is part of the circum-Pacific seismic belt that is responsible for about 80 percent of the shallow focus earthquakes, 90 percent of the intermediate origin shocks, and nearly all of the deeper ones.\(^6\)

California and Nevada have accounted for about 75 percent of the earthquakes in the United States.\(^7\) Earthquakes of destructive magnitude have occurred in California on an average of once a year for the past fifty years.

The remainder of this chapter presents the real and potential seismic landscape of the Tehachapi area within the limitations imposed by our present understanding of the situation.

2.3 \textbf{California's Fault System}

Since nearly all destructive earthquakes are thought to result from movements along faults, the locations and characteristics of faults in an earthquake belt are of particular interest. This is especially true of active faults, that is, those that have either an historical record of earthquake foci along their courses or show evidence of Holocene movement.

California is interlaced with hundreds of faults the most important of which are shown in Figure 3. Ten of these faults have either made significant contributions to the visible landforms of the state, or have caused major earthquakes during recorded history.\(^8\)

(1) San Andreas fault is the most publicized rift in California. It is by far the longest in the state,
GEOLOGIC MAP OF CALIFORNIA
SHOWING
PRINCIPAL FAULTS
IN RELATION TO
GEOMORPHIC PROVINCES

- Geomorphologic province boundary
- Fault
- Blocked area represents the Tehachapi area
  and is enlarged as Figure 5

Source: Geomorphic provinces and fault lines generalized from Jenkins, O., 1938, Geomorphic Map of California 1:2,000,000.
and it annually produces dozens of earthquakes. But despite its importance, the role of the San Andreas is often exaggerated; it is frequently blamed for every earthquake in California, and many people believe that once they move away from this great fault, they no longer need to fear earthquakes. This is a dangerous fallacy.

(2) Hayward fault, despite its distinctive name, is really a branch of the San Andreas zone. The fault has played a significant role in the geologic development of the San Francisco Bay area, and it has also given birth to several large tremors.

(3) Sierra Nevada fault movements have created the magnificent escarpment that forms the eastern edge of the Sierra. The Owens Valley branch of the system was responsible for the 1872 earthquake - the largest in California's recorded history.

(4) White Wolf fault is a short left lateral reverse fault near the juncture of the Garlock and San Andreas faults. Existence of the White Wolf fault has been known by geologists for many years; its general trace was plotted on a geological map as early as 1906. Prior to 1952, when it generated the largest earthquake since 1906, it had not been considered active in the sense of constituting an earthquake threat. Unimpressive size and apparent inactivity are deceiving.
(5) Garlock fault is the second largest fault in the state, and has made several contributions to the landscape, including the mountain ranges that form the northern edge of the Mojave Desert. However, not a single great earthquake during recorded history can be blamed on this huge fracture.

(6) San Jacinto fault is part of the San Andreas zone, indeed, it may be the most active branch. It has long been the source of many important earthquakes, and the landforms along its route give mute testimony to its long-term impact upon the state topography.

(7) Elsinore fault has been instrumental in the development of many mountain ranges and valleys near the southern coast. However, earthquake activity associated with this fault during the past 150 years has been insignificant.

(8) Imperial fault is another branch of the San Andreas zone. Exact route of the fault was not exposed until the 1940 earthquake ruptured the surface on both sides of the United States-Mexico border.

(9) Newport-Inglewood fault was unknown until 1920, when a small earthquake told seismologists that there was an active break along the coast. Any doubts about activity were dispelled in 1933, when the disastrous Long Beach quake rattled the coast.

(10) Santa Ynez fault is the largest of a group of related breaks that form a large seismic area around
the Santa Barbara channel. The most spectacular earthquake in this region was the 1925 Santa Barbara shock.

While all the faults in California may be considered as parts of the same general system, the circum-Pacific belt, there are distinct variations in direction and movement. The San Andreas and related faults are arranged in a southeast-northwest direction, while another group, dominated by the Garlock fault, runs predominantly southwest-northeast.

The effect of the faults on California becomes readily apparent on a relief map of the state. The Mojave Desert, for example, is clearly limited on the south and west by great faults, and development of the San Francisco Bay area has been substantially influenced by the movements along branches of the San Andreas system. Figure 3, which shows California's major faults in relation to its geomorphic provinces, shows the importance faults have had in defining these geologically different zones.

Each of the major faults shown on the map consists of several interwoven branches that together make up a definable fault zone. Almost all of the surface details that can be traced today are located along the branches that have experienced the most recent movements. Historical records indicate that, in most cases, the next shift within any given fault zone can be expected along the same
active branch where the last movement occurred.

2.4 California's Seismic History

The records of California earthquakes started in 1769, when the expedition of Gaspar de Portola was violently shaken by an earthquake while camped on the Santa Ana River near the present town of Olive. In the 200 years since then about 5000 perceivable quakes have occurred each year in the California-Nevada area, or about 2.5 percent of those felt in the entire world and about 90 percent of those felt in the United States.\textsuperscript{9,10,11} Twelve-hundred are felt per year in southern California, or about one-half of one percent of the world's quakes. This means that there is an earthquake of sufficient intensity to be felt by a person somewhere in the California-Nevada area every hour and forty-five minutes, on an average, year in and year out. But of the approximately 920,000 perceivable earthquakes since the first record, only 43 can be classified as major shocks on any of the intensity or magnitude scales. (These earthquakes are described in Appendix A. Distinction between intensity and magnitude of an earthquake is also explained there. In addition, the Rossi-Forel, Modified Mercalli, and Richter scales are presented.)

Major shocks occur only once every 4.6 years, which may offer comfort. Of these 43 earthquakes only one (San Francisco, 1906) has resulted in a substantial loss of
life (approximately 1000 lives) which, when compared to
the earthquake of 1920 at Kansou, China (approximately
180,000 lives lost), seems small. At first glance it does
appear that California's earthquake hazard is over-rated;
however, a closer look reveals that Californians have
been extremely fortunate. Most high magnitude earthquakes
have struck in unpopulated or slightly populated areas and,
therefore, are not recognized by most inhabitants of
California as having potentially devastating effects.
The summary presented as appendix A points out that in
every instance, where a major earthquake has originated
near a heavily populated area, the results have been dis­
astrous (San Francisco, 1906 and Long Beach, 1933).
Even in these cases the loss of life was not as great as
it might have been. One can only speculate about the
loss of property and life a major earthquake might inflict
in the Los Angeles or San Francisco area today.

A further apparent conclusion that can be drawn from
the history of earthquakes in California is that when the
epicenters of the major earthquakes, summarized in appen­
dix A, are plotted on the fault map of California there
seems to be a relationship between the location of the
epicenters and faults (see Figure 4).

2.5 Tectonics and Major Faults of the Tehachapi Area

The tectonic movements in the Tehachapi area are
the result of constant regional strain in this part of
CALIFORNIA'S HISTORIC EARTHQUAKES
SHOWN IN RELATION TO PRINCIPAL FAULTS

- Represents one earthquake of intensity VIII to IX on modified Mercalli scale.
- Represents one earthquake of intensity X to XII on modified Mercalli scale.

Blocked area represents the Tehachapi area and is enlarged as Figure 5.

Source: Robert Iaccopi, Earthquake Country, (Lane Books: Menlo Park, California) p.10
the earth's crust. The area blocked out in Figure 4 and shown in detail in Figure 5 lies at the juncture of five of California's physiographic provinces: the Sierra Nevada, Great Valley, Coast Ranges, Transverse Ranges, and Mojave Desert provinces. It comprises the southeast corner of the Great Valley province, the north-central portion of the adjacent Transverse Range province to the south, and the southerly end of the Sierra Nevada province to the east and northeast. Each one of these physiographic provinces is also a tectonic province, characterized by a well defined strain pattern.

The Great Valley province is an elongated basin with a northwest-southeast trend filled with sediments of Tertiary and Quaternary age. The surficial deposits are gravels, sands, silts and clays of fluvial origin and are relatively unconsolidated. This large, rigid segment of the earth's crust has resisted tectonic movements; only in the extreme southern portion, where tectonic movements have been severe, has it yielded to faulting. The Transverse Range province south of the San Joaquin Valley is composed of a thick section of Cenozoic sediments, and is made up of acid intrusives and schists of earlier age. A pronounced east-west structural trend is apparent in this province. The Sierra Nevada province is a great tilted fault block having a core of granitics and other acid intrusives. This fault block is uplifted on the east side, and on the southerly end it is terminated by
the Garlock fault which forms the north boundary of the Mojave Desert province. The southern Sierra Nevada, bounded on the east by the Sierra Nevada normal fault zone, is partly broken into two major north-trending blocks by the normal Kern Canyon fault zone.

The Tehachapi area then, is a major focal point of crustal stress in California. This stress has resulted in the production of several major faults and subsequent earthquakes. The fault system is shown on the map of the Tehachapi area (Figure 5). Several of these faults will be discussed in relation to the tectonics of the area.

The mountainous area in which Tehachapi is located is undergoing active uplift. This rising of the earth's crust has been caused by constant, deep seated compressive and shear movements active throughout the Quarternary on the San Andreas, Garlock and related faults. Earthquake producing displacements have occurred on these faults several times in this century.

The southern Sierra Nevada foothills and eastern San Joaquin Valley northward from the White Wolf fault are cut by many parallel faults in a broad, arcuate pattern. South of the Kern River the faults trend generally northwest, and north of the river they tend to swing north. The great majority of these faults are of normal type, although some are probably vertical or even steep reverse faults. These faults are of the same type as the major faults of the Sierra Nevada and displacements are largely
Figure 5.
FAULT MAP OF THE TEHACHAPI AREA SHOWING EPICENTER LOCATIONS OF EARTHQUAKES OCCURRING IN THE REGION FROM 1934 TO 1952.
- Represents one earthquake.
* Marks epicenter of earthquake of July 21, 1952.
- Known fault location.
- - - Suspected fault location.

Source: Bulletin 171, State of California, Department of Natural Resources, Division of Mines, Figure 1, Section 3, Part II.
vertical, with some evidence of lateral movement.\textsuperscript{13}

The southern Sierra Nevada is broken by only two widely spaced major normal faults, the Sierra Nevada and Kern Canyon; the adjoining foothill area is broken by moderately spaced normal faults, the largest being the Kern River or Gorge fault.

The extreme southeastern portion of the Sierra Nevada-San Joaquin Valley provinces was elevated as a block on the northeast-trending White Wolf fault to form the Bear Mountain-Tejon Hills uplift.\textsuperscript{14} The Tehachapi Mountains are in part a compressive uplift formed against the northeast trending Garlock fault, a master shear zone separating the Sierra Nevada from the Mojave Desert province to the southeast. Nearly all of the movement on the Garlock fault has been left lateral, along which the Mojave Desert block has moved relatively northeastward. This indicates a great northeast-southwest counterclockwise torsional stress.\textsuperscript{15} The Garlock and the White Wolf fault have taken up all of this stress as indicated by their left lateral movement.

The area between the White Wolf fault and Garlock fault is under a north-south compressive stress as indicated by the northerly movement of Bear Mountain in the earthquake generated on July 21, 1952 by the White Wolf fault and by the compressive uplift of the Tehachapi Mountains against the Garlock shear zone.\textsuperscript{16}
The extreme southeastern portion of the Sierra Nevada-Great Valley provinces are thus affected by two compressive stresses: northeast-southwest and north-south.

Tectonic implications and relationships of the San Andreas, Garlock and other major strike-slip faults and related structures are discussed by Hill and Dibblee (1953). They suggest that these faults are genetically related and resulted from an overall single regional north-south stress. They conclude that the White Wolf fault is genetically related to the Pleito and Garlock faults and possibly in part to the San Andreas fault, but not to any of the faults to the north. Both the Garlock and Pleito faults are in part the result of compressive stresses developed along both the Garlock and San Andreas shear zones. The White Wolf fault is believed to be closely related to the Garlock fault, as indicated by its northeast trend parallel to it and southeast dip toward it, and by evidence of left lateral movement on both. The bending of the great San Andreas shear zone at both points where it is, or may be, intersected by the Garlock and White Wolf faults implies that both these northeast-trending faults are deep seated zones of weakness along which the rigid Sierra Nevada-Great Valley block is being pushed southwestward relative to the Mojave Desert block.

2.6 **Seismic History of the Tehachapi Area**

The southeastern San Joaquin Valley has been shaken
in the past by earthquakes about as violently and frequently as any section of California. A great deal of this shaking has been attributed to the larger faults marginal to the area—the San Andreas, Garlock and Sierra Nevada faults. Instrumental records since 1932, in this area, as in others, show that minor shocks originate at points generally peppered over the map and only the larger ones can be taken as related to the principal faults (Figure 5). Imperfect historical records and geologic field evidence indicate that no great earthquake has originated on the western part of the Garlock fault in historical time.

Table 3 lists the non-instrumentally recorded earthquakes which affected the Tehachapi area prior to 1927, and Table 4 lists instrumentally-recorded quakes from 1932 to 1952 except 1933. These tables were taken from a bulletin on local earthquakes in southern California which was prepared at the Seismological Laboratory at California Technical Institute, Pasadena. The epicenters listed on Table 4 are plotted in Figure 5.

Table 5 lists those shocks which occurred in the Tehachapi area during what is commonly called the Kern County series of 1952-1953. Most of these occurred within fifty miles of Tehachapi, and were aftershocks resulted from adjustment movement along the White Wolf fault after the major shock of July 21, 1952.
Table 3. Non-instrumentally recorded earthquakes which affected the Tehachapi area prior to 1927.

<table>
<thead>
<tr>
<th>Date</th>
<th>Intensity (Rossi-Forel)</th>
<th>Area and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1857-Jan.9</td>
<td>R-F IX-X.</td>
<td>Fort Tejon. (see appendix A for description)</td>
</tr>
<tr>
<td>1868-Sept.4</td>
<td>R-F IX.</td>
<td>Headwaters of the Kern River, Inyo County. (see appendix A for description)</td>
</tr>
<tr>
<td>1890-Feb.13</td>
<td>R-F ?</td>
<td>Three light shocks at Tehachapi.</td>
</tr>
<tr>
<td>Jul.24</td>
<td>R-F ?</td>
<td>Severe shock at Bakersfield.</td>
</tr>
<tr>
<td>1903-Jan.7</td>
<td>R-F ?</td>
<td>Light shock at Bakersfield.</td>
</tr>
<tr>
<td>1905-Jan.5</td>
<td>R-F ?</td>
<td>Strong shock at Tehachapi and Bakersfield.</td>
</tr>
<tr>
<td>Mar.18</td>
<td>R-F ?</td>
<td>Severe shock at Tehachapi and Bakersfield.</td>
</tr>
<tr>
<td>Dec.23</td>
<td>R-F ?</td>
<td>Severe shock causing considerable damage at Bakersfield.</td>
</tr>
<tr>
<td>1906-Apr.18</td>
<td>R-F ?</td>
<td>&quot;San Francisco earthquake&quot; felt lightly at Bakersfield.</td>
</tr>
<tr>
<td>1908-Nov.4</td>
<td>R-F ?</td>
<td>Strong shock causing damage at Tehachapi.</td>
</tr>
<tr>
<td>1921-Nov.15</td>
<td>R-F ?</td>
<td>Slight shock at Bakersfield.</td>
</tr>
<tr>
<td>1922-Mar.10</td>
<td>R-F ?</td>
<td>Strong shock felt throughout the area and centering on the San Andreas fault near Fort Tejon.</td>
</tr>
<tr>
<td>1926-Jun.30</td>
<td>R-F ?</td>
<td>Strong shock centering in Kern Canyon and felt strongly at Tehachapi and Bakersfield.</td>
</tr>
<tr>
<td>1927-Jul.8</td>
<td>R-F ?</td>
<td>Moderate shock at Bakersfield. No damage.</td>
</tr>
</tbody>
</table>
Table 4. Listing of instrumentally located epicenters (plotted in Figure 5) 1932 to 1952 except 1933. Limits: Latitude 34°45' to 35°45'N, Longitude 118°15' to 120°00'W.

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<thead>
<tr>
<th>Date</th>
<th>Mag.*</th>
<th>Date</th>
<th>Mag.*</th>
<th>Date</th>
<th>Mag.*</th>
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Table 5. Number of aftershocks occurring in the Kern County, California active area. (A 900 square mile area limited by Latitude 34°45'N to 35°45'N and Longitude 118°15'W to 120°00'W.

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2.7 Effects of Earthquakes on Tehachapi

Although the town of Tehachapi has been damaged lightly by earthquakes on several occasions since its founding in 1876, the effects of one earthquake originating on July 21, 1952 at 4:52 A.M. overshadow the effects of the others. Other shocks which have caused damage occurred on January 5, 1905; November 4, 1908; October 22, 1916; June 30, 1926; February 23, 1939; May 7, 1939; September 21, 1941; June 5, 1946.

The July 21st shock, now called the Arvin-Tehachapi earthquake, was assigned a magnitude of 7.7 on the Richter scale, making it the largest with an epicenter in California since 1906. The epicenter of this shock was placed on the southwest end of the White Wolf fault at 35°00'N, 119°02'W. It was assigned an intensity of VII to IX on the modified Mercalli scale in the southeastern San Joaquin Valley. The shock was felt over 160,000 square miles and produced minor building damage as far away as San Diego, San Francisco, and Las Vegas. Twelve people were killed and total damage to man-made structures reached $48,650,000 in Kern and Los Angeles Counties. The generally low population density of the area and the early hour of the shock are responsible for this surprisingly small mortality.

The localized effects at Tehachapi were devastating. Eleven of the twelve people who were killed as a result
of the earthquake died in Tehachapi, the result of failure of the weakest type of outdated masonry. Tehachapi was an old town and many of the structures on the main street were of this character and consequently approximately 80 percent of the business district was destroyed.

There is a distorted impression that, because of the high concentration of death and destruction at Tehachapi, the earthquake reached its highest intensity there. This impression is untrue and was largely due to popular misinformation. In actuality, local intensity at Tehachapi on the modified Mercalli scale was between VI and VII.\textsuperscript{19} When Tehachapi is analyzed with respect to the five damage factors presented earlier (section 2.1), the causes of the high degree of destruction in 1952 and the potential for further damage in future earthquake become evident.

The shock of 4:52 A.M., July 21, 1952, as stated earlier, had a magnitude of 7.7 measured on the Richter scale and developed a local intensity at Tehachapi of VI or VII. In general, poorly designed or built structures were leveled. Since the relatively small White Wolf fault, thought to be "inactive", was responsible for this shock, conceivably Tehachapi could be subjected to a shock of similar or greater magnitude and intensity in the future by movements along the "inactive" Garlock fault or the San Andreas fault. Although proximity to a fault is not a major factor in determining damage to structures,
Tehachapi certainly would be damaged by an earthquake with epicenter seven miles to the south along the Garlock fault or eleven miles to the northwest along the White Wolf fault. Tehachapi is literally surrounded by faults, two of them being the primary faults in California.

Perhaps the second greatest factor contributing to the destruction of Tehachapi in 1952 was the town's geologic foundation of deep alluvium surrounded by hills of granitic and metamorphic rock. Deep alluvium tends to lengthen and intensify earthquake motion. Consequently, even though the shock reached only an intensity of VI to VII on the modified Mercalli scale, the alluvium in Tehachapi Valley shook like a bowl full of jelly, thus causing greater damage. Because of the limited distribution of strong-motion accelerographs, no record was obtained of the stronger ground motions in the actual area of the July 21st earthquake. But, due to the alluvium foundation the motion duration at Tehachapi probably was great and future earthquakes of similar magnitude will also be of long duration. There is a greater potential for destruction in Tehachapi or any other alluvium filled valley than there is in areas of more solid geologic foundation.

As mentioned earlier, Tehachapi was an old town at the time of the 1952 earthquake. The majority of its central business district was made up of unreinforced
brick buildings constructed before 1930. This was the primary factor for the high degree of structural damage and resultant loss of life at Tehachapi. Figure 6 shows the severe damage Tehachapi's central district suffered in 1952.

An engineering study by Steinbrugge and Moran dealing in part with structural damage at Tehachapi, 20 found that steel and properly reinforced concrete or concrete block structures erected on thick alluvium in Tehachapi Valley withstood the 1952 shock with little or no damage. Brick buildings, with some exceptions, and unreinforced or inadequately reinforced concrete buildings on alluvium were severely damaged by the earthquake. Most wood-frame buildings in good structural condition withstood earthquake shocks with very little damage, regardless of the foundation material on which they were built. Stone masonry and adobe buildings built on rock or on a very small amount of natural or artificial fill overlying rock were undamaged or only slightly damaged by earthquake shocks; the extent of damage for those built on fill overlying rock varied with the thickness of the fill, the damage increasing with increasing depth of fill. Adobe buildings on thick alluvium were badly damaged or destroyed.

Hopefully, the buildings in Tehachapi will never be as susceptible to damage from earthquakes as they were
Figure 6

in 1952. According to the city building inspector, William Metts, when the town was re-built between 1952 and 1955 contractors were required to follow a new building code which conformed with the earthquake provisions of the Uniform Building Code of 1952. However, building codes set minimum standards, so a building which meets the requirements may actually verge on being unsafe.

The inherent potential for earthquake damage at Tehachapi is not known nor feasible to determine. But all indications are that it is quite high. Figures 7 and 8 illustrate buildings in Tehachapi which must certainly be considered subject to damage in the event of earthquake.

2.8 Summary

Analysis of the fault systems and history of earthquakes in California establishes that Tehachapi is in an area of considerable seismic activity and potential. The Tehachapi area is a major focal point of crustal stress in California. The two primary faults in California, the San Andreas and the Garlock, and several other large faults fracture the mountains which surround the Tehachapi area. The Tehachapi mountains are a tectonically active uplift block formed against the northeast-trending Garlock fault and under considerable north-south and northeast-southwest compressive stress. A review of the seismicity of the Tehachapi area historically supports the conclusion that the region is one of considerable stress and movement.
Fi gure 7
Unreinforced brick buildings in Tehachapi's business district. November 1968
Figure 8

The "new" and the "old". Upper photo points out prevalent use of brick for facing and chimneys in new housing tract. Lower photo shows older brick house with wood frame addition.
Tehachapi is situated on thick alluvium in the central part of Tehachapi Valley, an intermontane valley of thirty-six square miles that lies between the Tehachapi Mountains and the southern end of the Sierra Nevada. The combination of this thick alluvium, which is highly conducive to high localized earthquake shock intensities, and the number of major and minor faults that fracture the mountains which surround the alluvium, and the established tectonic pressure being exerted in this area produce a substantial earthquake hazard at Tehachapi. The destruction in Tehachapi on July 21, 1952 is evidence of this high hazard level.

Although the distribution of seismicity in coastal and southern California is such that risk can be considered relatively uniform over the area, certain sections can be identified as having a greater hazard. Increased risk is a function of decreasing rigidity of ground materials upon which structures are built. Thus, Tehachapi or any other town which is established on unconsolidated material in a seismically active region, incurs a greater risk of damage than a town which is built on bedrock.
References


2. Ibid.


14. Ibid.


16. Ibid.


CHAPTER 3
THE PERCEPTUAL SEISMIC LANDSCAPE

3.1 The Field Research Design

The field survey was designed to probe by questionnaire into the individual hazard perception of a ten percent stratified random sample of the adult population of Tehachapi. The following is a detailed explanation of the questionnaire and the sampling technique.

3.1.1 The Questionnaire

The interview questionnaire is reproduced as appendix B. The questionnaire was designed to determine the perception of earthquake hazard in Tehachapi. Each of twenty-seven questions was designated into one of six groups. These groups probe the following aspects of individual perception.

The first group determined reference information about the respondent in the categories of:

1) Age
2) Sex
3) Education Level
4) Occupation
5) Income
6) Length of residence in the study area
7) Length of residence in California

The reference information serves to characterize the population of the sample. Through characterization it was possible to relate trends in answers to socio-economic class. Through residence history it was possible to relate degree of perception to hazard exposure.
The second group sought to find out what, if any, natural hazards the respondent perceived within his environment which he felt might affect him while living in Tehachapi. The purpose of securing this information was to ascertain to what degree the inhabitants of Tehachapi were aware of the hazard of earthquakes.

The third group sought to elicit the attitudes of the inhabitants toward the future possible occurrence of earthquakes in the study area.

The fourth group was designed to determine the degree of knowledge of past seismic activity in the study area and surrounding areas. The purpose of this questioning was to rate the inhabitants historical knowledge of his seismic environment.

The fifth group determined the inhabitants amount of knowledge concerning the causes, effects, and frequencies of earthquakes. It was the purpose of these questions to find out to what degree individuals were informed of the more technical aspects of earthquakes in an area of extreme susceptibility. Ratings were made of the amount of accurate knowledge and number of false impressions about earthquakes.

The sixth group determined the inhabitants knowledge of the protective and preventive measures which might be taken to reduce damage to property or lives either before or during an earthquake. This information provided another indicator of the respondent's degree of awareness of this
environmental hazard and his ability to recognize the danger as a real part of his life.

Both "fixed alternative" and "open ended" questions were used in the questionnaire and in several questions both methods of questions were combined. After careful preparation and revision the questionnaire was given an initial pre-test in nineteen interviews, or a one percent sample of the adult population of Tehachapi. Following this pre-test the questionnaire was revised to its final form.

All interviews were conducted by one person to increase comparability and to assure conscientious effort. Each respondent was interviewed at his home or business. Each respondent was approached with the same introduction and where necessary, explanations of questions were identical. Generally, the respondents showed a willingness to answer the questionnaire; only 3 percent of the 198 prospective interviewees refused to respond.

3.1.2 The Sample

A stratified random method of sampling was used to assure that the sample be well distributed. Only adults, over 21 years old, were surveyed. The Kern County Standard Industrial Survey Summary Report for Tehachapi listed the population in 1965 as 3838, of which 1693 were registered school pupils and, therefore, not adults. Mary L. Madding, Tehachapi City Clerk, said the town had an
additional 250 to 350 people under 21 years of age. Hence, the universe of the sample consisted of between 1800 and 1900 adults.

It was desired that the error due to sampling not exceed 3 percent in 95 out of 100 samples. Therefore, a 95 percent confidence level was set with a desired reliability of ±3 percent. Within these tolerances the sample size has to consist of 185 interviews for a population of 2000. Coincidentally, 185 is slightly less than 10 percent of 1900 and to save figuring the exact sample size to give a ±3 percent reliability for a population which is only approximated anyway, 185 interviews were taken.

On a city map of Tehachapi showing individual lot locations obtained from the city clerk (reproduced here as Figure 9), 14 groups of 100 lots each were plotted and numbered 1 through 100. Using a table of random sampling numbers, 13 primary and 5 alternate lot locations were selected for interviews within each of the 14 whole blocks of 100 lots. In the fifteenth block of 40 lot locations, 3 primary interviews were selected to bring the total of primary interview locations to 185. The pool of 5 alternative locations was to be drawn from if: 1) the primary location had no dwelling or business upon it, 2) the primary location dwelling was vacant, 3) the residents of the dwelling at a primary location were not
Figure 9
Photograph of the city map of Tehachapi, California
home on three interview attempts or, 4) the resident refused to respond. Every effort was made to gain an interview from an adult resident at each of the 185 primary locations.

One-hundred and nine interviews were conducted on Saturdays and Sundays between 10 A.M. and 9 P.M. thus assuring that a number of male head-of-households were interviewed. Forty-seven interviews were conducted on Friday evenings between 7 P.M. and 10 P.M. and 29 interviews were conducted on weekdays between 8 A.M. and 5 P.M. One adult was interviewed per location.

When the interviews were coded, socio-economic classification was keyed to the income, occupational and educational status of each head-of-household.

Two possibilities for bias are noted: 1) The ratio of new to old homes in the town was not maintained in the sample. In the older sections of the city a lot sometimes held more than one resident; then a flip of the coin was used to pick one for the interview. However, a substantial portion of the older residents have moved to newer sections of town, leaving the older sections open for younger residents. 2) A small section of houses off Dennison Road (see Figure 9), not physically within the city limits but serviced by city facilities, was included in the sample area. Thus the results do not apply solely to residents within the city limits.
3.2 Sample Characteristics

This analysis of the data will isolate the significant implications of the survey. The data is presented in the groups previously described in section 3.1.1. The questions comprising each group are stated in the order and form they appeared in the questionnaire.

3.2.1 Reference Information

(1) How long have you lived in this town?
   if "all my life": How long has your family lived in this town?
   if a newcomer: Where did you live previously?

The results of this question established that 78 respondents (42%) lived in Tehachapi in 1952. The remaining 107 (58%) had moved to Tehachapi since 1952 and thus had not experienced a major earthquake there. Of these 107 "newcomers," 81 (76%) came from an area of the same relative seismic potential and only 26 (24%) came from an area of less seismic potential.

These figures establish that the overwhelming majority (85%) of the sampled population has been living in a seismically dangerous area for many years and at least 42 percent had seen the effects of a major earthquake.

(2) How long have you lived in California?
   if not "all my life": Where did you live previous to the time you moved to California?

Answers to this question revealed 31 years as the
average length of residence in California; 34 respondents (18%) had migrated to California from areas of less seismic potential (less than coastal and southern California) and only 3 (2%) from areas of the same seismic potential. The results of this question further establish that the majority of the sample has been associated, at least physically, if not mentally, with an area of high seismic activity and potential.

(3) How old are you?

The purpose of the third question was simply to determine if the respondent met the arbitrary age of 21 years old which qualified him as an adult. The data derived from this question is later used to compare attitudes toward the possibility of future earthquakes of different age groups.

(4) What is your occupation?

(5) How many years of school did you complete?

(6) What is your approximate gross income?

A simple socio-economic index was constructed from the information secured by the three above questions. Criteria used for assigning respondents to social classes are presented in Table 6. The samples distribution and the comparative distribution of the United States 1965 urban population into the classes is presented as the bottom two lines of the table. The criteria refer to the characteristics of the head-of-household and were chosen
in such a way as to make each class as large as possible. No significance is attached to this index beyond the purpose it has served in this study. Respondents were placed in the class for which at least two of their measured characteristics fit. Those who exhibited abnormal characteristics were placed in a reasonable class.

As shown by the last two lines of Table 6, the socio-economic structure of the Tehachapi sample is very similar to that for the urban population of the United States in 1965. While Tehachapi is a rural community its population has urban attributes, and the results of this study should be applicable to cities in general.

(7) Do you own or rent your home (business place)?

The results of this question indicated that the majority of the respondents (154 or 83%) were buying or owned their home or business place and, therefore, should have a vested interest in whether it stood or fell in an earthquake. The remainder of the respondents (31 or 17%) rented home or business place.

3.2.2 Hazard Awareness

(8) What are the main advantages of living in Tehachapi?

(9) What natural hazards do you think might directly affect you here in Tehachapi?

(10) What natural hazards do you think might directly affect you here in California that might not
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td>Occupation</td>
<td>unskilled</td>
</tr>
<tr>
<td></td>
<td>semi-skilled</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>under $4,500</td>
</tr>
<tr>
<td>Education</td>
<td>less than 12th grade</td>
</tr>
<tr>
<td></td>
<td>(did not finish high school)</td>
</tr>
<tr>
<td>Total no. of respondents (%)</td>
<td>82 (44%)</td>
</tr>
<tr>
<td>U.S., 1965</td>
<td>(43%)</td>
</tr>
</tbody>
</table>
affect you as much in other parts of the United States?

(11) Do you think earthquakes are a natural hazard which might affect you here in Tehachapi?

(12) Do you think earthquakes are a natural hazard which might affect you here in California more than they would affect you in most other parts of the United States?

The five above stated questions were directed toward establishing the degree to which a respondent was aware of the hazard. The eighth question was intended to determine how many respondents, on their own volition, identified high seismic danger as a disadvantage of living in Tehachapi. Most respondents (134 or 73%) emphasized advantages of the town—good climate, lack of congestion, and lack of smog. Only 32 (17%) emphasized disadvantages of Tehachapi—high volume of train traffic and noise, lack of entertainment facilities, and variable weather. Nineteen (10%) gave a balanced treatment of both advantages and disadvantages of the area. Only 29 respondents (16%) mentioned the earthquake hazard as a disadvantage of living in Tehachapi.

Question nine was intended to find out if the respondent, with no priming, perceived earthquakes as a natural hazard. Only 54 (29%) mentioned the earthquake hazard while 131 (71%) did not mention it.
Question 10 was still more directed than question 9, but less than half of the sample indicated an awareness of the potential earthquake hazard in California. Earthquakes were mentioned by 86 respondents (47%) and not by 99 (53%).

Questions 11 and 12 were asked of those respondents who did not mention earthquakes when answering questions 9 and 10 respectively. These pointed questions were intended to further establish the degree of awareness to the hazard of earthquakes. Those respondents who did not indicate an awareness of the hazard after being asked question 11 or 12 can be classified as having absolutely no awareness of the earthquake hazard posed to California or Tehachapi. Only 49 (37%) of the 131 asked question 11 felt that earthquakes were a hazard which might affect Tehachapi while 66 (51%) felt the opposite way and 16 (12%) were uncertain. Of the 99 respondents asked question 12, 52 felt earthquakes might affect California more than other areas of the United States while 38 felt the opposite and 9 were uncertain.

Results of questions 9 through 12 show that, even though the respondents live in Tehachapi, they were more aware of the threat posed to California than to Tehachapi by earthquakes. Thus, a high percentage of the people who acknowledge awareness of the general danger to California do not relate this danger to themselves. This
is brought out by the fact that in total, 82 respondents (44%) gave no expression of awareness to the earthquake hazard posed to Tehachapi.

A three-level awareness scale was constructed utilizing the results of questions 9 through 12. Forty-seven respondents (25%) expressed no awareness of the hazard posed to Tehachapi or California. Seventy-seven (42%) expressed some awareness of the hazard posed either to Tehachapi or California, but not both. Sixty-one (33%) showed considerable awareness of the hazard posed to both Tehachapi and California.

The classification system is perhaps biased toward the aware side of the scale. A great number of those respondents classified as being "considerably aware" or having "some awareness" expressed "no awareness" of the hazard until asked the direct questions (11 and 12) which mentioned earthquakes as a possible hazard.

3.2.3 Future Expectations

The following questions sought to elicit attitudes toward the future.

(13) Do you think that you will have, or there will be, a bad earthquake while you are living (in business) here?

(14) Do you think your house (business) might suffer damage?
Understandably, very few people answered the first question with a flat "yes" (33 respondents or 18%) while 106 (57%) said "no". The remainder of the sample (46 respondents or 25%) were uncertain of the future. After giving his answer, the respondent was asked to explain why he did or did not expect an earthquake. This answer was first evaluated for the quality of reasoning used by the respondent in discussing his expectations and, second, for optimism or pessimism in the answer. The majority of the sample (146 respondents or 79%) was optimistic while only 9 respondents (5%) displayed a pessimistic attitude. The remaining 30 respondents (26%) were neutral. A good number of the respondents (71 or 38%) used no reasoning at all in answering the probe while an additional 65 (35%) used poor reasoning. Only 49 respondents (27%) used good reasoning in explaining their answer.

Even fewer people (13 respondents or 7%) answered question 14 with a "yes" while 138 respondents (75%) answered "no." The remainder (34 respondents or 18%) were uncertain whether their house might suffer damage. Here again the respondent was asked to explain why he answered the question the way he did, and his answer was evaluated for quality of reasoning. Seventy-three respondents (39%) used no reasoning, 85 (46%) used poor reasoning, and only 27 (15%) used good reasoning.

A sharp increase in hostility and reluctance to answer the question was apparent when these questions
about future seismic activity were introduced. Perhaps this uneasiness was caused by the unpleasant thoughts raised by the question.

Analysis of the data derived from the questions on future expectations reveals an important point. Despite the fact that 138 respondents (75%) had "some" or "considerable" awareness of earthquake hazard and that 78 (42%) had been associated with, and had seen the effects of a major earthquake occurring near their town, only 33 respondents (18%) expected earthquakes in the future and less expected damage to their homes or businesses due to an earthquake. Apparently expectations of future outcomes cannot be understood solely on the basis of awareness of the past or of the potential; such expectations arise out of the mental process of interpretation. Our knowledge and experience of real events in the world is personalized and distorted by preconceived concepts of uniqueness and repetitiveness.

These "probing" questions were expected to provide clues about resident concepts of the natural environmental phenomena in question. Analysis of the answers to these questions suggest two approaches.

(a) The majority of the respondents who did not think that they would experience an earthquake while living in Tehachapi reasoned that the town had been affected in the recent past and therefore was not likely
to have another earthquake for a good number of years. Each respondent who reasoned in this manner had a different theory on the number of years which will elapse before Tehachapi suffers the effects of another earthquake. The important point is that these respondents were attempting to order the repetitiveness of earthquakes.

(b) Respondents reacted to the uncertainty of the randomly ordered phenomena of earthquakes in fundamentally different ways. Some simply see earthquakes as unique and unpredictable and therefore refuse to recognize them as a phenomenon with which to be concerned. The majority, however, reacted by finding order where no order exists, identifying cycles on the basis of the most sketchy knowledge or folk insight, and in general, striving to reduce uncertainty associated with the hazard. The former respondents, who denied all knowledge of earthquakes, usually assigned their fates to a "higher power" and gave the impression that they had given up worrying about such things.

The attitudes identified in the respondents' answers also appeared to be influenced little by the degree of awareness or knowledge of seismicity in the environment, or by what is heard or read. These attitudes appeared to be derived from basic factors in the personality. Thus, there may be a tendency to interpret all new knowledge in the already established personality pattern.
without changing basic outlook. The majority of the respondents who felt the 1952 earthquake was a freak or extraordinary occurrence that could not happen again, or that felt "the good Lord will not permit it to repeat itself" were given an optimistic score. These were the most common optimistic answers. The majority of the pessimistic scores were achieved by respondents who gave fatalistic replies.

Additional measures of optimism were derived from two main findings. First, a large number of respondents (94 or 51%) indicated an awareness of the earthquake hazard in Tehachapi but felt they would not experience a major earthquake while living in the town. Second, a number of respondents indicated that they felt they might experience an earthquake in the future and yet felt their house or business would not suffer damage. Only 20 respondents (11%) expressed these attitudes but these 20 constitute 61 percent of the 33 respondents who felt the town might experience another major earthquake.

3.2.4 Historical Knowledge

(15) Have you ever heard of, or experienced, any earthquake affecting this town?

(16) Have you ever heard of, or experienced, any earthquake affecting the southeastern San Joaquin Valley?
(17) Have you ever heard of, or experienced, any earthquake affecting California?

(18) Can you recall any major earthquakes in the world which have caused death and destruction?

The questions stated above were to provide an understanding of the respondents' knowledge and possible experiences of past earthquakes in: (1) Tehachapi, (2) the southeastern San Joaquin Valley, (3) California and (4) the world. These questions were all similarly designed and, therefore, will be treated as a unit. In all of the questions, those respondents who answered that they had heard of, or experienced, an earthquake in the area of question were subjected to a structured probe to determine the degree of knowledge of earthquakes in that area.

In scoring the respondents' answers a very liberal method was used, whereby, if the respondent answered "yes" to the question and could, in the probe, demonstrate even the slightest factual knowledge of past seismic activity, he was rated as being "knowledgeable." If he answered "no" or gave a "yes" answer and could not, in the probe, give evidence to validate his claim the respondent was given a "no knowledge" rating.

The results of these questions are presented in Table 7. The figures show a general increase in knowledge with increase in the size of the area in question. This trend points again to the tendency of persons to be
more aware and knowledgeable of major earthquakes occurring in areas other than their own immediate locale. Perhaps the reason for this macro-awareness is the more complete news coverage at the world level. However, the striking point of these figures is that, although 78 respondents (42%) have experienced a major earthquake while living in Tehachapi and 81 more (44%) moved to Tehachapi from an area of the same seismic potential (usually from some place in southern California), 63 respondents (34%) were classified as having "no knowledge" of a history of earthquakes in Tehachapi. (Even those who answered "yes" to question 15 but could not verify their answer in the probe were given a "knowledgeable" rating.)

TABLE 7
HISTORICAL KNOWLEDGE OF EARTHQUAKES DEMONSTRATED BY 185 RESPONDENTS

<table>
<thead>
<tr>
<th>Knowledge of history of earthquakes in:</th>
<th>Tehachapi</th>
<th>S.E. San Joaquin Valley</th>
<th>California</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number (%) KNOWLEDGEABLE</td>
<td>122 (66%)</td>
<td>129 (70%)</td>
<td>143 (77%)</td>
<td>147 (80%)</td>
</tr>
</tbody>
</table>

Thirty-seven percent of the respondents indicated that they had experienced at least one earthquake at Tehachapi while 49 percent said they had experienced an earthquake in the southeastern San Joaquin Valley (usually former residents of Bakersfield) and 53 percent said that they had experienced an earthquake while living in California.
3.2.5 Technical Information

The questions stated below were designed to determine the respondent's basic technical knowledge of the causes and frequencies of earthquakes and his knowledge of sources of potential earthquake information.

(19) From what sources do you think that you could gain knowledge about earthquakes?

(20) What is the most basic cause of earthquakes?

(21) How many earth tremors or earthquakes do you think might occur on the face of the earth in one year?

The results of question 19 points to the serious lack of knowledge on the availability of information about earthquakes. Seventy-three respondents (39%) gave no answer to the question, while an additional 91 (49%) identified the newspaper as their only source of information and were given a "poor knowledge" rating. (The newspaper has been identified by many prominent authorities on earthquakes as the major promoter of false impressions and knowledge regarding earthquakes. Therefore, respondents who stated only this source of information were given a "poor knowledge" rating.) The remainder of the respondents (21 or 12%) who gave any logical source in addition to the newspaper were given a "good knowledge" rating. The information is available for those who care to look for it; however, the public as represented
by the people of Tehachapi neither knows where to look
nor is interested in finding out where to locate such
information.

The results of question 20 indicate a very low
knowledge of earthquakes. The majority of respondents
(125 or 68%) showed that they possessed either "poor" or
"no" knowledge of the basic causes of earthquakes. The
majority of these people gave an "I don't know" reply.
A good number (41 or 22%) felt that "God causes earth-
quakes." The 41 respondents (22%) who felt faults caused
earthquakes were given an "adequate knowledge" rating
because they at least associated earthquakes with a move-
ment of the earth's crust. When these 41 respondents
were asked whether there were any faults nearby, only 8
displayed a good knowledge, 13 had a vague idea of where
the San Andreas fault was, and 21 could not identify any.
Nineteen respondents (10%) were rated as having "excellent
knowledge" because they identified the basic cause of
earthquakes to be crustal stress generated by a variety
of stated internal mechanisms. They knew the role of
faults in an earthquake, and they were familiar with a
good number of them. These people did not necessarily
identify the specific cause of earthquake; however, they
were educated to possible causes which have been thus far
identified scientifically.
The results of question 21 further point to a very low knowledge of earthquakes. One-hundred and sixty-eight respondents (91%) had no conception of the amount of crustal movement taking place on the earth. The majority of persons gave an answer within the range of 5 to 10. Anyone who gave an answer of over 500, which is still very low, was placed in the "knowledgeable" category (17 respondents or 9%).

3.2.6 Protective and Preventive Measures

(22) Where do you think it is safe to live in an area which is susceptible to earthquakes?
(a) valley bottom* (b) on the side of a gentle hill (c) doesn't make any difference.

(23) Which is the safer type of building to be in during an earthquake? (a) brick or adobe (b) wood frame (c) doesn't make any difference (d) don't know.

(24) If you were inside a building in an earthquake, which would you consider the safer thing to do? (a) remain inside the building (b) run outside the building (c) remain inside the building but move under a door frame or desk, etc. (d) don't know.

*This alternative originally read "in an alluvium filled valley bottom" when the questionnaire was tested, but 18 of the 19 trial respondents did not know the meaning of the word "alluvium" so that word was dropped. However, this omission should not affect the findings.
The above questions were designed to measure the respondents' knowledge of safety measures that can be taken prior to and during an earthquake. Safety measures usually must be taken before the occurrence of the shock. These include selecting the proper type of ground material on which to build a house and selecting a house constructed of materials which are resistant to structural strain. Therefore, the first two questions were designed to test the respondents' knowledge of the advantages and disadvantages of selected ground and building materials. The last question of the series was designed to determine peoples' understanding of a precaution that can be observed during an earthquake. The precaution is that of remaining inside a building during an earthquake and taking shelter under a door frame, desk, or other stable, covering object. It is generally accepted that a large number of deaths attributed to the shaking of an earthquake are caused by panic-stricken people running outside of a building only to be crushed by an outside wall or some other falling object.

The results showed a lack of knowledge of safety and preventive measures. In question 22, 88 respondents (48%) chose the "valley bottom" alternative, 57 (31%) thought it did not make any difference where one lives in an earthquake prone area, and 13 (7%) made no response. Only 27 respondents (14%) chose the alternative of "on the side of a gentle hill" thus showing some knowledge of the disadvantages of living on a valley bottom. In answering
question 23 the majority of respondents (57 or 31%) chose the "brick or adobe" alternative, 49 (26%) said they did not know, and 61 (33%) did not feel the construction material made any difference. Only 18 respondents (10%) selected the better alternative of "wood frame." In response to question 24 only 26 persons (14%) chose the correct answer of "remaining inside and taking cover" and an additional 17 (9%) chose the partially correct answer of "remaining inside the building." The majority of the respondents (97 or 52%) said they did not know while an additional 45 (25%) said they would "run outside of the building."

The irony of the responses to these questions is that, even though the greatest contributing factors in Tehachapi's destruction and subsequent loss of life in 1952 were the alluvium upon which the town sits and its poorly constructed brick buildings, the respondents showed no understanding of the influence of ground and building materials on damage during an earthquake.

Using the results of these three questions, a three-level scale of "knowledge of safety and preventive measures" was established. One-hundred and three respondents (56%) were classified as having "no knowledge" because they failed to answer any of the three questions with the best possible answer. Fifty-three (29%) were classified as having "poor knowledge" because
they answered only one of the three questions with the best answer. Twenty-nine (15%) were classified as having "good knowledge" because they answered two of the three questions with the best answer.

(25) Do you carry earthquake insurance?

(26) Do you feel there is anything that can be done by individuals or by governments before or during an earthquake to reduce damage and death?

Question 25 was designed to find out how many people carried insurance which covered losses caused by earthquakes. It was felt that this would provide a further measure of earthquake awareness manifested in rational, calculated action. A person who carries insurance is assumed to be more highly aware of the hazard and cognizant of its effects than one who does not. Answers suggest that the level of awareness, which would cause a resident to take precautionary measures in the form of insurance, has not been reached. Only seven respondents (4%) carried insurance, while 142 (77%) did not and 36 (19%) were uncertain. The 142 persons who said they did not carry insurance were asked if they had looked into the availability of such insurance. One-hundred and thirty-nine had not, which suggests that even if the cost of such insurance was lowered, thereby making it more available to the general public, it is highly doubtful many more persons would carry it.
Question 26 established that the majority of the respondents (91 or 49%) are uncertain that there is anything which can be done by individuals, or by governments, before or during an earthquake, to reduce damage and death. Seventy-one (38%) felt there is nothing which can be done. The remainder (23 respondents or 13%) felt there is something which can be done. When asked to specify, these persons gave answers related to proper ground and housing material selection and tighter building code restrictions. The high number of apathetic persons, who were uncertain if anything could be done, implies that people accept earthquake damage without giving thought to the possibility of action being taken to reduce it. Those who felt that nothing could be done simply resigned themselves to their "fate."

(27) Did you know anything about earthquakes and their affects on this town when you decided to move (stay) here?

if yes: Did it influence your decision to move here?

if no: Knowing what you now know about earthquakes and their affects on this area of the country, would you locate here again?

This final question of the interview was directed toward finding out what impact earthquake hazard has on
settlement decision. The results indicate that knowledge of earthquakes and of their effects upon a respondent's environment has had little impact upon: (1) the decision to locate in Tehachapi and (2) the desire to remain there. Ninety-two respondents (50%) indicated that they knew something about earthquakes and their effects upon Tehachapi when they decided to move there (stay there in the case of those growing up in Tehachapi). The majority of these respondents (85) further indicated that their knowledge of earthquakes did not influence the decision to settle in Tehachapi. Ninety-three respondents (50%) said they knew nothing of the earthquake hazard when they decided to settle in Tehachapi. Seventy-nine of them said that knowing what they now know about the earthquake hazard would not deter them from again locating in the town.

3.3 Further Analysis

Tables 8, 9, and 10 were constructed using the data described in the last section. Each questionnaire was reviewed, after initial tabulations, and selected information was plotted into categories on each table. These tables were designed to further refine the data in an effort to draw further conclusions and perhaps to explain some of the trends in the data.

Part I of Table 8 shows that over three-quarters of the respondents have lived in a seismically dangerous
# Table 8

<table>
<thead>
<tr>
<th>I. NUMBER OF YEARS IN A SEISMICALLY HAZARDOUS AREA</th>
<th>NUMBER OF RESPONDENTS (%)</th>
<th>NUMBER OF YEARS IN TEHACHAPI</th>
<th>MOVED TO TEHACHAPI PRIOR TO 1952</th>
<th>MOVED TO TEHACHAPI SINCE 1952 FROM AREA OF SAME SEISMIC POTENTIAL</th>
<th>MOVED TO TEHACHAPI SINCE 1952 FROM AREA OF LESS SEISMIC POTENTIAL</th>
<th>EXPECTATIONS OF FUTURE EARTHQUAKES AND DAMAGE</th>
<th>NO EARTHQUAKES OR DAMAGE EXPECTED</th>
<th>EARTHQUAKES AND DAMAGE UNCERTAIN</th>
<th>EARTHQUAKES EXPECTED BUT NO OR UNCERTAIN DAMAGE EXPECTED</th>
<th>EARTHQUAKES AND DAMAGE EXPECTED</th>
<th>EARTHQUAKES UNCERTAIN BUT NO DAMAGE EXPECTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>5 (2.2)</td>
<td>4 (2.2)</td>
<td>3 (1.6)</td>
<td>12 (6.5)</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>6-10</td>
<td>18 (9.3)</td>
<td>7 (3.8)</td>
<td>2 (1.1)</td>
<td>27 (14.5)</td>
<td></td>
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<td></td>
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<tr>
<td>11-20</td>
<td>12 (6.5)</td>
<td>24 (12.6)</td>
<td>4 (2.1)</td>
<td>40 (21.6)</td>
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</tr>
<tr>
<td>21-30</td>
<td>10 (5.4)</td>
<td>34 (18.3)</td>
<td>15 (8.2)</td>
<td>59 (31.9)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>31 OR MORE</td>
<td>2 (1.1)</td>
<td>8 (4.3)</td>
<td>37 (20.0)</td>
<td>47 (25.4)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

| II. NUMBER OF YEARS IN TEHACHAPI                  |                           |                             |                                 |                                                               |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| MOVED TO TEHACHAPI PRIOR TO 1952                 | 4 (2.2)                   | 31 (16.7)                   | 43 (23.2)                       | 78 (42.1)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| MOVED TO TEHACHAPI SINCE 1952 FROM AREA OF SAME SEISMIC POTENTIAL | 23 (12.4)                  | 42 (22.7)                   | 16 (8.7)                        | 81 (43.8)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| MOVED TO TEHACHAPI SINCE 1952 FROM AREA OF LESS SEISMIC POTENTIAL | 20 (10.8)                  | 4 (2.2)                     | 2 (1.1)                         | 26 (14.1)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |

| III. EXPECTATIONS OF FUTURE EARTHQUAKES AND DAMAGE |                           |                             |                                 |                                                               |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| NO EARTHQUAKES OR DAMAGE EXPECTED                 | 42 (22.7)                 | 46 (24.9)                   | 18 (9.7)                        | 106 (57.3)                                                   |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| EARTHQUAKES AND DAMAGE UNCERTAIN                  | 2 (1.1)                   | 16 (8.6)                    | 13 (7.1)                        | 31 (16.8)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| EARTHQUAKES EXPECTED BUT NO OR UNCERTAIN DAMAGE EXPECTED | 0                          | 8 (4.3)                     | 12 (6.5)                        | 20 (10.8)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| EARTHQUAKES AND DAMAGE EXPECTED                    | 0                          | 2 (1.1)                     | 11 (5.9)                        | 13 (7.0)                                                     |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| EARTHQUAKES UNCERTAIN BUT NO DAMAGE EXPECTED       | 3 (1.6)                   | 5 (2.7)                     | 7 (3.8)                         | 15 (8.1)                                                     |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |

| IV. SOCIO-ECONOMIC CLASS                          |                           |                             |                                 |                                                               |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| LOWER                                            | 29 (15.7)                 | 47 (25.4)                   | 6 (3.2)                         | 71 (44.1)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| MIDDLE                                           | 16 (8.6)                  | 27 (14.6)                   | 36 (19.5)                       | 79 (47.7)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| UPPER                                            | 2 (1.1)                   | 3 (1.6)                     | 19 (10.3)                       | 24 (13.0)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |

| V. PERCEPTION OF ADVANTAGES AND DISADVANTAGES OF LIVING IN TEHACHAPI |                           |                             |                                 |                                                               |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| EMPHASIZED ADVANTAGES OF TEHACHAPI                | 38 (20.5)                 | 63 (34.1)                   | 33 (17.8)                       | 134 (72.4)                                                   |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| EMPHASIZED DISADVANTAGES OF TEHACHAPI             | 7 (3.8)                   | 8 (4.3)                     | 17 (9.2)                        | 32 (17.3)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| GAVE BALANCED TREATMENT OF ADVANTAGES AND DISADVANTAGES | 2 (1.1)                   | 6 (3.2)                     | 11 (6.0)                        | 19 (10.3)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |

| VI. KNOWLEDGE OF BASIC CAUSES AND MECHANICS OF EARTHQUAKES |                           |                             |                                 |                                                               |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| EXCELLENT                                         | 0                          | 2 (1.1)                     | 16 (8.7)                        | 19 (10.3)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| ADEQUATE                                          | 6 (3.2)                   | 11 (6.0)                    | 24 (13.0)                       | 41 (22.2)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| POOR OR NO                                        | 47 (25.4)                 | 63 (34.0)                   | 21 (11.3)                       | 125 (67.5)                                                   |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |

| VII. EARTHQUAKE INSURANCE                         |                           |                             |                                 |                                                               |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| OWN HOME AND CARRY INSURANCE                      | 0                          | 2 (1.1)                     | 5 (2.7)                         | 7 (3.8)                                                      |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| OWN HOME AND DON'T CARRY INSURANCE                | 19 (10.3)                 | 45 (24.3)                   | 47 (25.4)                       | 111 (60.0)                                                   |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| OWN HOME AND UNCERTAIN OF COVERAGE FOR EARTHQUAKE DAMAGE | 16 (8.7)                  | 13 (7.0)                    | 2 (1.1)                         | 31 (16.8)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
| RENT HOME                                         | 12 (6.4)                  | 17 (9.2)                    | 7 (3.8)                         | 36 (19.4)                                                    |                                                               |                                                             |                                      |                               |                                          |                                          |                                          |
## TABLE 9

### KNOWLEDGE OF PREVENTIVE AND SAFETY MEASURES

<table>
<thead>
<tr>
<th></th>
<th>KNOWLEDGE OF PREVENTIVE AND SAFETY MEASURES</th>
<th>NUMBER OF RESPONDENTS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO KNOWLEDGE</td>
<td>POOR KNOWLEDGE</td>
</tr>
<tr>
<td>I. NUMBER OF YEARS IN A SEISMICALLY HAZARDOUS AREA</td>
<td>TOTAL: 103 (55.7%)</td>
<td>TOTAL: 53 (26.8%)</td>
</tr>
<tr>
<td>1-5</td>
<td>9 (4.8)</td>
<td>2 (1.1)</td>
</tr>
<tr>
<td>6-10</td>
<td>19 (10.4)</td>
<td>5 (2.7)</td>
</tr>
<tr>
<td>11-20</td>
<td>23 (12.4)</td>
<td>10 (5.4)</td>
</tr>
<tr>
<td>21-30</td>
<td>31 (16.8)</td>
<td>20 (10.3)</td>
</tr>
<tr>
<td>31 OR MORE</td>
<td>21 (11.3)</td>
<td>16 (8.7)</td>
</tr>
<tr>
<td>II. NUMBER OF YEARS IN TEHACHAPI</td>
<td>TOTAL: 17 (9.2%)</td>
<td>TOTAL: 44 (23.3%)</td>
</tr>
<tr>
<td>MOVED TO TEHACHAPI PRIOR TO 1952</td>
<td>17 (9.2)</td>
<td>44 (23.3)</td>
</tr>
<tr>
<td>MOVED TO TEHACHAPI SINCE 1952 FROM AREA OF SAME SEISMIC POTENTIAL</td>
<td>65 (35.1)</td>
<td>7 (3.8)</td>
</tr>
<tr>
<td>MOVED TO TEHACHAPI SINCE 1952 FROM AREA OF LESS SEISMIC POTENTIAL</td>
<td>21 (11.4)</td>
<td>2 (1.1)</td>
</tr>
<tr>
<td>III. EXPECTATIONS OF FUTURE EARTHQUAKES AND DAMAGE</td>
<td>TOTAL: 74 (40.0%)</td>
<td>TOTAL: 32 (17.3%)</td>
</tr>
<tr>
<td>NO EARTHQUAKES OR DAMAGE EXPECTED</td>
<td>74 (40.0)</td>
<td>32 (17.3)</td>
</tr>
<tr>
<td>EARTHQUAKES AND DAMAGE UNCERTAIN</td>
<td>16 (8.7)</td>
<td>9 (4.9)</td>
</tr>
<tr>
<td>EARTHQUAKES EXPECTED BUT NO OR UNCERTAIN DAMAGE EXPECTED</td>
<td>3 (1.6)</td>
<td>8 (4.3)</td>
</tr>
<tr>
<td>EARTHQUAKES AND DAMAGE EXPECTED</td>
<td>9 (-)</td>
<td>3 (1.6)</td>
</tr>
<tr>
<td>EARTHQUAKES UNCERTAIN BUT NO DAMAGE EXPECTED</td>
<td>10 (5.4)</td>
<td>3 (1.6)</td>
</tr>
<tr>
<td>IV. SOCIO ECONOMIC CLASS</td>
<td>TOTAL: 57 (30.8%)</td>
<td>TOTAL: 21 (11.4%)</td>
</tr>
<tr>
<td>LOWER</td>
<td>57 (30.8)</td>
<td>21 (11.4)</td>
</tr>
<tr>
<td>MIDDLE</td>
<td>44 (23.8)</td>
<td>24 (13.0)</td>
</tr>
<tr>
<td>UPPER</td>
<td>2 (1.1)</td>
<td>8 (4.3)</td>
</tr>
<tr>
<td>V. EARTHQUAKE HAZARD AWARENESS</td>
<td>TOTAL: 34 (18.4%)</td>
<td>TOTAL: 9 (4.9%)</td>
</tr>
<tr>
<td>NO AWARENESS</td>
<td>34 (18.4)</td>
<td>9 (4.9)</td>
</tr>
<tr>
<td>SOME AWARENESS</td>
<td>45 (24.4)</td>
<td>25 (13.5)</td>
</tr>
<tr>
<td>CONSIDERABLE AWARENESS</td>
<td>24 (12.9)</td>
<td>19 (10.3)</td>
</tr>
</tbody>
</table>
## Table 10.

### Attitudes Toward Future Earthquakes

<table>
<thead>
<tr>
<th></th>
<th>Number of Respondents (%)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pessimistic</td>
<td>Neutral</td>
<td>Optimistic</td>
<td>Total: 9 (4.9%)</td>
<td>Total: 30 (16.2%)</td>
</tr>
<tr>
<td><strong>Socio-Economic Class</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td>8 (4.3)</td>
<td>15 (8.2)</td>
<td>59 (31.8)</td>
<td>82 (44.3)</td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td>1 (0.6)</td>
<td>4 (2.1)</td>
<td>74 (40.0)</td>
<td>79 (42.7)</td>
<td></td>
</tr>
<tr>
<td>Upper</td>
<td>0 -</td>
<td>11 (5.9)</td>
<td>13 (7.1)</td>
<td>24 (13.0)</td>
<td></td>
</tr>
<tr>
<td><strong>Age Groups</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-30 Years</td>
<td>2 (1.1)</td>
<td>7 (3.8)</td>
<td>23 (12.4)</td>
<td>32 (17.3)</td>
<td></td>
</tr>
<tr>
<td>31-40 Years</td>
<td>0 -</td>
<td>13 (7.0)</td>
<td>36 (19.5)</td>
<td>49 (26.5)</td>
<td></td>
</tr>
<tr>
<td>41-50 Years</td>
<td>0 -</td>
<td>5 (2.7)</td>
<td>40 (21.6)</td>
<td>45 (24.3)</td>
<td></td>
</tr>
<tr>
<td>51-60 Years</td>
<td>2 (1.1)</td>
<td>3 (1.6)</td>
<td>33 (17.8)</td>
<td>38 (20.5)</td>
<td></td>
</tr>
<tr>
<td>Over 60 Years</td>
<td>5 (2.7)</td>
<td>2 (1.1)</td>
<td>14 (7.6)</td>
<td>21 (11.4)</td>
<td></td>
</tr>
</tbody>
</table>
area for 11 years or more and that a similar number have at least "some awareness" of this danger. (The "earthquake hazard awareness scale" is given on page 69.) Hazard awareness increases steadily with the length of residence in the hazardous environment. However, this awareness accumulates very slowly: the vast majority of those who had resided in a seismically dangerous area between 21 and 30 years (largest single group) displayed only "some awareness" of the hazard. Considering the liberal fashion in which respondents were accorded as having "some" or "considerable" awareness, the awareness displayed by a sample which has lived in a potential earthquake area for such a long time is surprisingly low. Exposure to the environment does increase the level of awareness but only over a long period of time, even when a great number of the people have been exposed to the effects of a major earthquake.

Part I of Table 9 shows that length of residence in a seismically dangerous area has little effect upon the respondents' knowledge of safety and preventive measures which can be taken to prevent damage or injury during an earthquake. (The scale of "knowledge of safety and preventive measures" is given on page 80.) An increase in knowledge with an increase in length of exposure is shown, but the overall percentage of those having "good knowledge" is far overshadowed by those having "no" or "poor" knowledge.
A comparison of parts I of Tables 8 and 9 shows that awareness of the hazard increases, at a very slow rate, with increased exposure to the environment, but knowledge of how to prepare for, and cope with, the hazard does not show this same increase.

Part II of Table 8 shows the influence experience and exposure has upon awareness. Those people who lived in Tehachapi at the time of the 1952 earthquake showed a great deal more awareness of the hazard than did people who moved to Tehachapi since 1952. Similarly, those people who moved to Tehachapi since 1952 from areas of the same seismic potential as Tehachapi, and who have had indirect contact with minor earthquakes, showed a greater awareness than did those who came from areas of less seismic potential. Experience of the hazard breeds the highest degree of awareness, while indirect contact breeds awareness at a much lower level.

Part II of Table 9 shows that, to a limited extent, experience and exposure also increases knowledge of safety and preventive measures. People who lived in Tehachapi since 1952 have at least a "poor knowledge" while the majority of those who moved there after 1952 displayed "no knowledge" of safety measures. Similarly, those respondents who have had contact with, but no experience in, areas of high seismic danger are no further advanced in their knowledge of safety measures than are
persons who came from areas of less seismic danger.

Again, comparing parts II of Tables 8 and 9 shows that hazard awareness increases with increased exposure but the knowledge of how to cope with the hazard does not increase at the same rate; in fact it does not increase at all unless the respondent has first hand experience with the hazard.

Part III of Table 8 shows that awareness of earthquake hazard does not carry over into a realistic assessment of the future. Although 75 percent of the respondents displayed at least some awareness of the hazard, only 18 percent expected earthquakes to occur in the future and only 7 percent of these people expected future earthquakes to damage their belongings. However, higher awareness seems to carry with it a more realistic assessment of the future: only 30 percent of those who displayed "considerable awareness" of the hazard were naive enough not to expect, or to be uncertain about, future earthquakes.

Part III of Table 9 further establishes the concept that increased information about a hazard promotes a more realistic assessment of the future concerning the occurrence of that hazard. No one who displayed a good knowledge of safety and preventive measures that can be taken before or during an earthquake expected immunity from future earthquakes and damage.
Parts IV of Tables 8 and 9 show that awareness of earthquake hazard and knowledge of safety and preventive measures increased with socio-economic class. Lack of information in the lowest class is not surprising since educational attainment is one of the measures creating the classes, as discussed on page 64.

No significant difference between social classes can be detected with respect to attitude toward future earthquakes (see Table 10, Part I). (The scale of "Future Attitudes" is presented on page 70.) The lowest class seems slightly more pessimistic than the upper most class, but this observation is not conclusive because very few pessimists were identified.

Likewise, a very weak association was found (Table 10, Part II) between increased age and increased pessimism regarding the future occurrence of earthquakes. The association may be the result of past experience but also may be part of a generally more pessimistic attitude on the part of older people.

Part V of Table 8 shows weak association between higher levels of earthquake awareness and greater recognition of the disadvantages of Tehachapi. However, most persons classified as being considerably aware of the hazard emphasized advantages rather than disadvantages of living in Tehachapi. Only a small percentage of those persons who emphasized disadvantages mentioned earthquakes as one of them.
Part V of Table 9 emphasizes that earthquake hazard awareness far surpasses knowledge of safety and preventive measures which might be observed in order to minimize damage during an earthquake. A slight increase in the knowledge level with increased awareness of the hazard is suggested. However, the highest number of "considerably aware" respondents indicated "no knowledge" of safety and preventive measures. Hence, the general knowledge level of the people concerning these safety measures does not increase at a rate commensurate with the increase in levels of hazard awareness.

In cross-examining awareness and knowledge of basic causes and mechanics of earthquakes, the same conclusion is reached as was reached in analysis of Table 9, Part V (see Table 8, Part VI). Knowledge is far below what it should be considering the degree of awareness.

Part VII of Table 8 makes it clear that greater earthquake awareness makes no difference in the decision of whether or not to carry earthquake insurance. Almost no one carries it, whether he is, or is not aware. Five of the seven who indicated that they carry insurance were business proprietors.

3.4 Earthquake Information Availability

Three preliminary conclusions have been reached through analysis of the data:

(1) The earthquake hazard awareness of 70 percent of the
respondents appeared to be developed through either informal discussion between inhabitants or personal experience, and was accumulated during many years of residence in the hazard zone.

(2) Although the historical knowledge of earthquakes in the immediate vicinity was adequate, the knowledge of what caused earthquakes, their mechanics, and what might be done for protection in the event a quake occurred was very slight.

(3) Most respondents were unjustifiably optimistic that they would suffer no future earthquakes or damage while living in Tehachapi.

These conclusions raise a very important question: To what degree is information concerning seismology in general, and local seismicity in particular, made available to the residents of Tehachapi by public and private officials of the town?

In an effort to answer this question several interviews were conducted with persons who represented potential primary sources of information.

Dr. Mryl C. Rupel, Superintendent of the Tehachapi Unified School District, was asked about the school district's earthquake education program. Dr. Rupel said, "There is no formalized structure of education directed toward giving the student an understanding of earthquakes." He "presumed" that the topic was covered by the high
school science teacher (who could not be reached to verify this presumption). Dr. Rupel further believed that students acquired knowledge about the effects of local earthquakes in a course on Kern County history. He also stated that the school system observed earthquake drill sessions in compliance with state laws and that all school buildings were approved by the State Architectural Board in accordance with sections 19 and 21 of the building code.

Dr. Rupel mentioned that when trying to hire teaching personnel, he does not point out the earthquake history or potential earthquake hazards in Tehachapi and Kern County. In his opinion, too much attention is paid to the effects of the 1952 earthquake upon Tehachapi and not enough to its effects upon Bakersfield or Arvin. (This is true, probably because more lives were lost at Tehachapi than at Bakersfield or Arvin; however, Tehachapi will continue to draw the interest of seismologists because it is in an area of extremely high seismic activity and potential activity.) Mr. Rupel's attitude was summed up by his statement, "We may get shaken again but people won't be hurt by it."

Mr. H. Tracy Wardell, sales representative for the Carroll Development Company, the largest builder and real estate brokerage firm in the town, laughed at first when asked if prospective buyers are informed of Tehachapi's
geologic situation within the faults which surround it, and of the town's earthquake history. His formal reply was, "No they are not informed unless they ask about it." The percentage of prospective buyers who ask about earthquakes, he said, "is very small, perhaps less than five percent." He further indicated that those prospective buyers who did know of the hazard, did not seem to consider it in deciding whether to settle in Tehachapi.

Most of the company's customers come from the Los Angeles area, he said, and their primary reasons for selecting Tehachapi as a town in which to settle are climate, lack of smog, and lack of congestion. He did not know specifically, what safety measures his company builds into a home to reduce structural damage from earthquakes. He knew only that his company follows the Tehachapi city building code, which is a duplicate of the Bakersfield code.

Mr. W. Metts, Tehachapi City Building Inspector stated that the current Tehachapi mechanical, structural, electrical and plumbing codes have followed the California Uniform Building code word for word since 1955, before which the town maintained its own code. The existing structural code has additions to foundation and chimney requirements specifically designed to reduce damage due to shaking.

The town library has only one book dealing with
earthquakes and their effects on Tehachapi: Robert Iacopi's Earthquake Country.5

A statement concerning the coverage of earthquakes and publication of information related to earthquakes in the town newspaper was sought but not secured. However, a review of issues dating back to 1953 showed that virtually no information is printed. One article dated July 26, 1962, commemorated the tenth anniversary of the 1952 earthquake and commended the success and growth of the town since 1952. No mention was made of the possibility of future earthquakes or precautions which have been taken to prevent another disaster.

These interviews and investigations suggest that earthquake hazard information is suppressed in both the public and private sectors. A small but influential group of people in Tehachapi (school officials, builders, real estate brokers and government officials and employees) possess considerable knowledge of local earthquake hazards but do not disseminate it voluntarily.

3.5 Summary

The perceptual seismic landscape has been established by 185 respondents:

(1) Awareness of the earthquake hazard as identified by the degree to which they identify the hazard as part of their physical environment.

(2) Attitudes toward the possibility of a future earthquake and its associated damage while living in
(3) Knowledge of past earthquakes which have occurred in their specific and generalized environments.

(4) Knowledge of the causes and mechanics of earthquakes.

(5) Knowledge of safety and preventive measures which might be taken to reduce damage to property or lives, either before or during an earthquake.

In analysis of the measurements which were made using a personally administered questionnaire the following conclusions were drawn:

(1) The majority of the adult population (75%) had at least some awareness of the earthquake hazard posed to Tehachapi. However, the majority of these people expressed this awareness only after being asked specifically if they thought earthquakes were a potential hazard. The hazard was not prominent enough in their minds to be identified when asked what natural hazards might affect them in Tehachapi.

(2) A high percentage of the people who expressed awareness of the earthquake hazard in California failed to relate that hazard to themselves at Tehachapi.

(3) The awareness displayed was accumulated over a long period of years of residence in a high risk area and usually through two sources, either informal discussion between inhabitants or experience. Experience seems to be a prime factor in creating awareness while
simple contact with a high risk area does not seem to breed as much awareness.

(4) The earthquake hazard is not considered a primary disadvantage of living in Tehachapi by its inhabitants. The majority of the adult population does not include it when considering the disadvantages of life in Tehachapi. However, a weak association was found between higher levels of earthquake awareness and greater recognition of the disadvantages of living in Tehachapi.

(5) Awareness of the earthquake hazard does not carry over into a realistic assessment of the future. The vast majority of the people do not anticipate any future earthquakes in Tehachapi; moreover, they do not anticipate any future damage if an earthquake does strike. However, an association was found between higher levels of hazard awareness and a more realistic assessment of the future.

(6) Generally, members of higher socio-economic class have a greater awareness of earthquake hazard.

(7) Increased levels of knowledge concerning safety measures that can be taken before and during an earthquake, and the causes and mechanics of an earthquake are associated with increased awareness of the hazard. However, this level of knowledge does not increase at the same rate as awareness increases.
(8) The majority of the adult population displayed optimism that major earthquakes would not affect Tehachapi in the future. The same optimism was displayed in the expectation of no future earthquake-caused damages. These optimistic attitudes were usually based upon little or no reasoning. There was a noticeable tendency to establish order and predictability where no ordering or predictive capabilities now exist.

(9) The pessimistic or optimistic attitudes identified in the people seemed little influenced by their degree of awareness or knowledge of seismicity in their environment. Instead, these attitudes appear to reflect basic personality differences.

(10) The vast majority of the adult population has no knowledge of safety and preventive measures which might be taken before or during an earthquake to prevent damage or injury. They do not know that different ground materials are affected differently by earthquakes or that certain house building materials are better than others in zones of high earthquake risk. They do not know how to protect themselves during an earthquake.

(11) The majority of the adult population has no idea of the causes and mechanisms of an earthquake and they have no concept of the frequency of earthquakes on
the face of the earth. Virtually no one knew of the fault system surrounding Tehachapi.

(12) The historical knowledge of earthquakes was far better than the knowledge of earthquakes themselves. There was a tendency for people to be more knowledgeable of major earthquakes occurring in areas other than their own. More people knew about the major earthquakes of the world than about those of California, or the southeastern San Joaquin Valley.

(13) There is a very great difference between the level of awareness regarding the earthquake hazard and knowledge of earthquakes. While only one-quarter of the sample was classified as not being aware of the hazard over one-half was classified as having no knowledge of ways to cope with the hazard.

(14) Little information is readily available on earthquakes in Tehachapi; few know of such information elsewhere.

(15) The increase in the number of years of exposure to high earthquake risk has a very slight influence upon the increase in knowledge concerning earthquakes. Respondents who had lived in a seismically dangerous area longest displayed more knowledge, but even this was slight considering they experienced the 1952 earthquake.

(16) Increased levels of knowledge of earthquake is associated with a more realistic assessment of their possible future occurrences.
(17) There is a weak association between increased age and increased pessimism displayed toward the future occurrence of earthquakes. However, the cause of this pessimism may come from a variety of factors other than experience with earthquakes.

(18) No substantial difference is displayed in attitudes towards future earthquakes by different socio-economic classes, although the lower class seems to be more pessimistic.

(19) In the majority of cases, the higher the socio-economic class of a respondent the higher was his knowledge of safety and preventive measures.

(20) Apparently, high levels of awareness and knowledge of earthquakes does not prompt people to take the rational, calculated action of insuring against earthquake damage. The majority of the people have not even investigated the availability of insurance.

The overall perception of the earthquake hazard by the people of Tehachapi as measured by the stated criteria appears to be quite low. A marginal level of conceptual awareness of the hazard is due largely to the fact that forty percent of the inhabitants experienced a major earthquake while living in Tehachapi. But they have a very little knowledge of the mechanisms and frequencies of earthquakes, and of safety and preventive measures which might be taken to relieve damage due to
an earthquake. The conceptual awareness is not supported by a rational interpretation of the future. The unpredictable event of a natural hazard occurring is somehow ordered in the minds of those subjected to that hazard and the possibility of its occurrence in the future is negated by this ordering.
References


CHAPTER 4
CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The hypotheses stated in the first chapter will now be reviewed in light of the findings of this study:

(1) Although we can only make a subjective assessment, it appears that there is a negative association between the real landscape of seismic activity in Tehachapi and the perceptual landscape of the people regarding seismic activity. Tehachapi is situated on a highly flexible geologic foundation of alluvium which is surrounded by fault-fractured mountains. The region within which Tehachapi is located is tectonically active and has a documented record of earthquakes. Tehachapi has been shaken by numerous earthquakes and was nearly destroyed by one just seventeen years ago. Yet the adult population of Tehachapi shows only a vague conceptual awareness of the hazard and a very poor knowledge of the actual hazard potential. The data supports the conclusion that the people remarkably underestimate the hazard.

(2) The data collected support the hypothesis that the higher the socio-economic class level of the respondent, the higher his level of awareness and knowledge of earthquakes. The lower class is least informed and the upper class is best informed but the difference is small.
(3) The data collected support the hypothesis that the majority of the respondents have very little knowledge of earthquakes. Even though the standards used to judge the respondents' knowledge were very modest, the majority of the respondents could not meet them.

(4) The data demonstrate that the majority of persons were optimistic that no major earthquake would hit Tehachapi. In most cases the people did not even consider the chance. It was further demonstrated that these optimistic attitudes are not based on sound reasoning.

(5) The hypothesis that the majority of people would not expect their dwelling to incur damage in any future earthquakes was strongly supported; even more so, in fact, than the hypothesis that they did not expect future earthquakes.

(6) The data collected in both the questionnaire survey and from interviews with real estate representatives in Tehachapi support the hypothesis that the environmental hazard of earthquakes plays little role in influencing people's decisions about where they will settle. However, this conclusion is applicable only for the decisions of people moving to Tehachapi. Only comparative studies of other cities could support or refute this hypothesis.

(7) The hypothesis that the majority of people, while having a fair knowledge of the world-wide effects of earthquakes, fail to relate earthquakes' effects to their
own local environments, was only partially substantiated. The majority of people had knowledge of the history of earthquakes in both their own, and other environments. However, there was a tendency for more people to be knowledgeable of the occurrence of earthquakes on a world scale than on a local scale.

(8) The hypothesis that the residents who moved to Tehachapi since 1952 would have little awareness of the potential of earthquakes in Tehachapi and that for these residents the settlement decision was little affected by the presence of the natural hazard was only partially substantiated. Although the people who lived in Tehachapi at the time of the 1952 earthquake showed a greater awareness of the hazard than did people who moved there since 1952, the more recent arrivals did show some awareness. Awareness of the hazard is highest in those who have experienced, and seen the effects of a major earthquake but contact with an area of high potential does seem to improve awareness.

(9) The hypothesis was firmly established that the majority of people have little, if any, knowledge of protective measures that can be taken before or during an earthquake to reduce damage and death.

The findings of this study concur with other hazard perception studies and support the observation that human response to environmental hazard is largely
irrational. It points out that in his mind, man evaluates the unpredictable but inevitable occurrence of a hazard by distorting factual human experience in such a way as to best fit his needs. Order is established where none exists in an effort to reduce the uncertainty of the threat of hazard, or conversely, all knowledge is denied and facts are assigned to remote causes.

In various ways, man rationalizes his sub-optimal behavior. He may choose to remain ignorant of the sub-optimal nature of his environment, he may claim knowledge that the scientific community has yet to secure, or he may place all his reliance in, and assign his fate to, government projects designed to reduce rather than negate hazard. Thus man relieves himself of the more difficult task of seeking positive solutions to environmental hazard. This sub-optimal course continually sets the stage for another "unavoidable" natural disaster.

4.2 Observations

The following observations were made during this study: Although man's decision as to where he will live is extremely complex and individualistic, certain factors seem to dominate in the final decision. Climate was found to be the dominant factor in this study. This author speculates that climate is one of the most dominant factors in settlement decisions. Aesthetic values, such as
a nice view or less urban congestion, real and potential economic gain, availability of recreational facilities, and convenience factors such as transportation facilities and shopping centers were found to be important influencing factors in the decision to settle in Tehachapi. However, in this and other studies, it was found that the hazards of the natural environment have very little, if any, influence upon the final outcome in the decision of where to settle.

Further research is needed in this aspect of geography to substantiate these observations. Similar situations appear to exist at other locations. One such example is found at Desert Hot Springs, California. People have settled in this community for the primary reasons of the town having a warm, dry climate and a hot spring. Nevertheless, the town is built on an alluvial fan below a large canyon which, during a heavy rain, produces flood conditions at its mouth. The community has been flooded once. In addition to the flood hazard, the community is subject to earthquake hazard. It is built on alluvium which is very near an active fault zone.

4.3 Recommendations

This study was begun with the intention of conducting similar surveys in two towns with the same degree of earthquake hazard, but only one of which had experienced a major earthquake. Comparison of the two surveys would
point out the differences and similarities of perception of the danger. The hypothesis of this approach was that a high level of perception of the hazard would be expected in Tehachapi and a low level of perception in the town which had not experienced an earthquake. If validated this assumption would show that experience breeds awareness and knowledge and that, perhaps, rather than waiting for the hazard to occur to foster the awareness and preparedness, we should shorten the cycle and educate the people and local governments about the hazard and methods to cope with it.

However, the second survey was not necessary. The adult residents of Tehachapi, just seventeen years after their town was demolished by earthquake, showed a low level of perception of the danger. Hence, the citizens of any town equally exposed to the hazard but which has not witnessed its effects would express even less perception of the hazard.

So what is to be done? It is quite evident that it is illogical, unfeasible, and unconstitutional to force people out of an area of high risk. However, the state is responsible for the welfare of its people and, with respect to protection from damage and injury by natural hazard, it is not doing its job. This is pointed out very clearly by the findings of this study. Any guilt for past death, and future death, due to earthquake
clearly lies with the state. What is needed is a positive and aggressive assignment of responsibility to the state to see that people are informed of the total natural hazard environment and that suppression of this information is outlawed. Only when the state accepts this responsibility and applies its powers to the job will it be relinquished of its guilt. The responsibility for disaster then falls upon the people and they have only themselves to question.

First, the state must assume the responsibility of enforcing the administration of "regionalized environmental education." This education would not attempt to scare people away from potentially hazardous areas, but only give them a clear picture of the situation and what has been done, and can be done, to cope with the hazards. The citizen, enlightened with this information, would be better equipped to make an intelligent, calculated settlement decision. If he chooses to settle, or remain in an area of high risk, he does so with full knowledge of the situation and, thereby, assumes all responsibility.

This "regionalized environmental education" could be given in three ways:

(1) The schools should be required, by law, to address the hazard specifically, by offering an environmental education program which gives a true picture of the situation.
(2) Real estate brokers, by law, should be educated to the environmental hazards of the area in which their business is conducted and then be required to inform all prospective buyers of all natural hazards which exist. This should be enforced with the threat of loss of license and criminal charges for noncompliance.

(3) City and county governments should be required to make available to the public all sources of information regarding the environmental hazards of an area.

When this educational program has been instituted, and the hazard does occur, and a town suffers damage and death due to factors which are controllable by man, such as buildings being poorly built or built too tall, then the people have no recourse but to bury their dead and move out or rebuild at their own cost. The government has fulfilled its obligation of educating the people to the regional environment and, therefore, has no obligation to bear the cost of ignorance.

Second, the state must initiate and enforce building codes which will guarantee maximum safety to the people. Structural engineers have a good knowledge of building types, materials, and construction methods which will insure minimum damage in an earthquake. This knowledge is available not only for public dwellings, but for all man made features. We cannot afford to tolerate incompetent construction methods in the urbanization of hazardous
earthquake zones. An unprecedented disaster is due in the Los Angeles area, and its primary cause will be unmanaged, unrestricted, and generally poor construction methods—not the earthquake itself. All we must do is look to our hillside development or to our freeway interchange systems to envision the extent of this inevitable disaster. The technology is available to build safely—it is the state's responsibility to enforce laws to assure that that technology is utilized.

Third, the state must, without further delay, institute a comprehensive earthquake disaster program. To date, if a major earthquake strikes a major urban area anywhere in the country and particularly in California, the resulting disaster will be amplified many times what it should be simply because there is no large scale plan for emergency procedures.
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APPENDIX A

A HISTORIC SUMMARY: EARTHQUAKES IN CALIFORNIA

This summary is prefaced with a brief explanation of the major earthquake intensity and magnitude rating scales.

**Intensity**

Seismic intensity is a term intended to refer to the level of violence of shaking at any given place and, as such, it can have a precise scientific meaning. Unfortunately, when the term first began to be used, instrumental techniques capable of accurate measurement were not yet developed. The early seismologists, consequently, established a substitute in the form of a scale based on a set of arbitrarily chosen effects resulting from the shaking. The first such attempt in 1878 was known as the Rossi-Forel scale after its authors, M.D. DeRossi and F.A. Forel. This was later modified by G. Mercalli and finally in 1931 by H.O. Wood and F. Neumann. The scale now generally used is the Mercalli scale as modified by Wood and Neumann. It should be kept in mind that the measurements used in these scales are relative and approximate. An abridged form of the modified Mercalli scale is as follows, the corresponding Rossi-Forel scale numbers being (approximately) indicated in brackets.

I. Not felt except by a few under especially favorable circumstances. (R.F., I.)
II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (R.F., I-II.)

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. (R.F., III.)

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed, walls make creaking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably. (R.F., IV-V.)

V. Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (R.F., V-VI.)

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (R.F., VI-VII.)

VII. Everybody runs outdoors. Damage negligible in building of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars. (R.F., VIII-.)
VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected from ground in small amounts. Changes in well water. Disturbs persons driving motor cars. (R.F., VIII+ to IX−.)

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shift off foundations. Ground cracked conspicuously. Underground pipes broken. (R.F., IX+.)

X. Some well built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed over river banks. (R.F., X−)

XI. Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipe line completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly. (R.F., X+)

XII. Damages total. Waves seen on the ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air. (R.R., X+)
From a precise scientific point of view, the magnitude scale has very serious limitations as a means for determining the energy of earthquakes. Crude as it is, however, it represents a great advance over preceding methods of rating the size of earthquakes.

The only precise way in which the size of an earthquake can be accurately specified is by the energy released as seismic waves. In order to provide a quick and easy means of classifying earthquakes as to relative size, Charles F. Richter, in 1935, devised a magnitude scale based on the maximum tract amplitude of a seismograph written by a horizontal pendulum seismograph of 0.8 second period and magnification of 2,800. He chose as a standard earthquake one providing a maximum trace amplitude of one micron on this instrument at a distance of 100km. (62mi.). He then defined magnitude as the logarithm to the base ten of the ratio of the amplitude of any earthquake at the standard distance to that of the standard earthquake.

The Richter scale does not have grades like the intensity scales. It is numerical, with the numbers related in a fast mounting way to the energy. Each number on the scale stands for 62 times as much energy as the previous one. Thus an earthquake of magnitude 7 would be 62 times as strong as one rated at 6.
List of Major Earthquakes, 1769-1952*

1769. July 28, Los Angeles region. Four violent shocks felt by an expedition camped on the Santa Ana River. R-F intensity VI to VIII.

1790. R-F intensity X. Region of the Owens Valley.

1800. October 11-31. R-F VIII or IX. San Juan Bautista. Up to six shocks a day. Every building in the area was fully destroyed.

1812. May to December. R-F IX-X. Several major earthquakes occurred in an east-west belt affecting Santa Barbara, Ventura, and northern Los Angeles counties.

1836. June 9 or 10. R-F VIII to X. San Francisco Bay Region. Possible origin along Hayward fault.


November 9. R-F VIII to X. Region of Fort Yuma along the Colorado River.

*All reports were taken from one of the following sources: H.O. Wood and N.H. Heck, Earthquake History of the United States. Part II - California and Nevada; and S.D. Townley and M.W. Allen, "Descriptive Catalogue of Earthquakes of the Pacific Coast of the U.S., 1769 to 1928," Bulletin of the Seismological Society of America, vol. 29, no. 1, Jan. 1939.
1852. November 27 to 30. R-F IX or X. Continued shocks distributed over an area of over 300 square miles extending from San Luis Obispo to the Colorado River.

December 17. R-F IX. San Luis Obispo. Structural damage.

1853. October 23. R-F VIII. Humboldt Bay. Three heavy shocks. Structural damage.

1855. July 10 or 11. R-F IX or X. Los Angeles County.

Severe structural damage to the town of Los Angeles. Submarine origin suggested.

1857. January 8 to 9. R-F IX-X. Fort Tejon. One of the three or four greatest shocks in California since the advent of the white settler. The origin of this shock was along the San Andreas fault perhaps in the vicinity of the Carrizo Plain with the Elkhorn scarp as the surface evidence remaining. A fissure twenty feet wide and forty miles long appeared, but closed with such force that a ridge ten feet long and several feet high was formed. This ridge still exists at the head of Terwilliger Valley in Los Angeles County. Among the many things done by the shock were: reversed the flow (temporarily) of the Kern River, threw the Los Angeles River out of its bed, changed part of the course of the San Gabriel River and destroyed every building at Fort Tejon.

1858. November 26. R-F VII to IX. San Jose - San Francisco. Considerable damage to structures in San Jose,
somewhat less in San Francisco.

A quake of large magnitude but with epicenter in sparsely populated area, hence no report of damage.

1865. October 1. R-F IX. Eureka and Fort Humbolt.
October 8. R-F IX. San Francisco - Santa Cruz.
Epicenters probably on San Andreas rift.


1871. March 2. R-F VII. Humbolt County. Duration twenty seconds. Severe structural damage.

Commonly regarded as the greatest earthquake in California in historic time. Lone Pine destroyed with 27 fatalities. Ground disturbed for the 70 miles from Hailwee to Bishop along the Owen Valley fault system. Maximum movements: horizontal, twenty feet; vertical twenty-three feet. Shock felt sharply over 125,000 square mile area.

1873. November 22. R-F VII to X. Del Norte County and Southern Oregon. Severe damage to Crescent City.
1885. April 11. R-F VIII or higher. Central coast ranges.
Felt from Marysville to Ventura with probable epicenter on San Andreas rift between Cholame and San Benito. A large quake but with small damage owing to unpopulated area of highest intensity.

1890. February 9. R-F VIII. Southern California. Quake of large magnitude originating in San Jacinto Mountains but having no devastating effects to populated area.

April 19-21. R-F IX to X. Solano County. Extreme damage to Vacaville and Winters.

1898. April 14. R-F IX or X. Mendocino County coast.

1899. December 25. R-F IX or X. San Jacinto. A large magnitude quake felt over an area of 100,000 square miles. Six people killed in San Jacinto and Hemet.

1901. March 2. R-F IX. Stone Canyon, Monterey County.
Felt over area of 40,000 square miles. Epicenter probably on San Andreas fault northwest of Cholame Valley.

1903. January 23. R-F X? (VI at San Diego) Imperial Valley. This shock was recorded by seismographs all over the world and was no doubt of great intensity at its epicentral area, the uninhabited area south of Imperial Valley in Baja California.

1906. April 18. R-F X. Central California coast. "The San Francisco Earthquake." The most documented of the three great shocks of California history. Duration forty seconds in San Francisco. Maximum horizontal displacement twenty-one feet at Olema. Small vertical displacement. Felt over 375,000 square mile area. Total damage estimated at between 350 million and 1 billion dollars. Total casualties in San Francisco 750 to 1000; 300 outside the city. This earthquake was not as strong as a good number of previous and past earthquakes in California, but since the epicenter was near a densely inhabited area, it was therefore of great concern to a great many people.


1915. June 22. R-F IX. Imperial Valley. Affected area of over 50,000 square miles in southern California, western Arizona and northwestern Mexico. Greatest
damage ($900,000) in El Centro, Calexico and Mexicali with six deaths in the latter town. Epicenter along San Jacinto fault.

October 2. R-F VI in northeastern California, R-F X at Pleasant Valley, Nevada. A huge earthquake of high intensity and magnitude. Intensely felt from Washington to the Mexican border and from the Pacific ocean shore to the Rocky mountains or over a 500,000 square mile area. Epicenter along great scarp which suddenly appeared at western pediment of the Sonoma Range south of Battle Mountain. Damage slight due to low population density.


1922. January 31. R-F X. Submarine, northwest of Cape Mendocino. Seismograph records indicate area shaken to be 400,000 square miles. Magnitude probably as great as the shock of April 18, 1906.

March 10. R-F VIII. Cholame Valley, Monterey, and San Luip Obispo Counties. Shaken area: 100,000 square miles.


1925. June 29. R-F IX-X. Santa Barbara and westward. Destroyed central business district of Santa
Barbara. Affected 100,000 square miles. Possible epicenters along Mesa or Santa Ynez faults. Not a great shock, but of high intensity at a thickly populated area, resulting in several deaths.

1927. November 4. R-F IX-X. Submarine, west of Pt. Arguello, Santa Barbara County. Recorded over the world as a stronger shock than the Santa Barbara quake of 1925.

1933. March 10. R-F IX. Long Beach and vicinity. Not a great shock, but since it occurred in a region of dense settlement with many buildings of poor construction, it ranks only second to the San Francisco quake of 1906 in destructive effect. Over 100 lives lost and monetary damage reached an estimated forty million dollars. Felt over 100,000 square mile area with epicenter along the Inglewood-Newport fault.

1940. May 18. R-F X. Imperial Valley. Six million dollars worth of damage. Eight deaths. Felt over area of 60,000 square miles.

APPENDIX B

QUESTIONNAIRE - NATURAL HAZARD PERCEPTION

A. Reference Information

1. How long have you lived in this town? ____ years
   if "all my life": How long has your family lived in this town? ____ years
   if a newcomer: Where did you live previously?

   _______________________________________________________
   ___ same seismic potential
   ___ less seismic potential
   ___ greater seismic potential

2. How long have you lived in California? ____ years
   if not "all my life": Where did you live previous to the time you moved to California? _____________

   _______________________________________________________
   ___ same seismic potential
   ___ less seismic potential
   ___ greater seismic potential

3. How old are you? ____ years

4. What is your occupation? ____________________________

5. How many years of school did you complete? ____
   ___ 8th grade or less    ___ 1-3 years college
   ___ 9-11 years          ___ college graduate
   ___ 12 years-high       ___ post graduate
   ___ technical training  ___ not applicable
6. What is your approximate gross income? $

- $50-2499
- 2500-4999
- 5000-9999
- 10,000-19,999
- 20,000-39,999
- 40,000 and over

7. Do you own or rent your home (business place)?

- own
- rent

B. Hazard Awareness

8. What are the main advantages or disadvantages of living in Tehachapi?

- Emphasizes advantages
- Emphasizes disadvantages
- Balanced treatment

List: Advantages Disadvantages

9. What natural hazards do you think might directly affect you here in Tehachapi? 

- Expression of awareness of earthquakes
- No expression of awareness of earthquakes

List of hazards stated:
10. What natural hazards do you think might directly affect you here in California that might not affect you so much in other parts of the United States?

___ Expression of awareness of earthquakes
___ No expression of awareness of earthquakes

List of hazards stated:

If reference is made to earthquakes in question 9 skip to question 12.

11. Do you think earthquakes are a natural hazard which might affect you here in Tehachapi?
Yes No Uncertain

If reference is made to earthquakes in question 10 skip to question 13.

12. Do you think earthquakes are a natural hazard which might affect you here in California more than they would affect you in most other parts of the United States?
Yes No Uncertain

C. Future Expectations

13. Do you think that you will have, or there will be, a bad earthquake while you are living (in business) here?
Yes No Uncertain
Probe: Why? Determine motives or reasons for answer. Determine degree of optimism or pessimism in answer.

14. Do you think your house (business) might suffer damage?

Yes       No       Uncertain

Probe: Why? Good reasoning

Poor reasoning

D. Historical Knowledge

15. Have you ever heard of, or experienced, any earthquake affecting this town?

Yes       No       Uncertain

if yes:   a. Approximately how many?

   ___ 1-5 earthquakes
   ___ 6-10 earthquakes
   ___ 11-15 earthquakes
   ___ 16-20 earthquakes
   ___ 21-25 earthquakes
   ___ no answer

b. Were any of these earthquakes severe enough to cause damage?

Yes       No       Uncertain

C. Do you recall when the most severe earthquake struck? Yes  No

Approximate date__________
16. Have you ever heard of, or experienced, any earthquakes affecting the southern San Joaquin Valley?

Yes    No    Uncertain

if yes: a. Approximately how many?

   ___1-5 earthquakes  ___16-20
   ___6-10             ___21-25
   ___11-15            ___no answer

b. Were any of these earthquakes severe enough to cause damage?

   Yes    No    Uncertain

c. Do you recall when the most severe earthquake struck? Yes  No

   Approximate date:

17. Have you ever heard of, or experienced, any earthquakes affecting California?

Yes    No    Uncertain

if yes: a. Approximately how many?

   ___1-5 earthquakes  ___16-20
   ___6-10             ___21-25
   ___11-15            ___no answer

b. Were any of these earthquakes severe enough to cause damage?

   Yes    No    Uncertain
c. Do you recall when the most severe earthquake struck? Yes No
Approximate date:

18. Can you recall any major earthquakes in the world which have caused death and destruction?
   Yes No
   ___ Excellent knowledge ___ Poor knowledge
   ___ Good knowledge ___ No knowledge
List of recollections:

E. Technical Information

19. From what sources do you think that you could gain knowledge about earthquakes?
   ___ Good answer ___ Poor answer ___ No answer
   ___ Source books (encyclopedias, etc)
   ___ Call authorities
   ___ Newspapers
   ___ Magazines
   ___ Journals
   ___ Other-list

20. What is the most basic cause of earthquake?
Stated alternatives: ___ Faults
                   ___ Weather conditions
                   ___ Supernatural causes
Stress put upon the crust or outer shell of the earth, probably thermal in nature.

Probe and rate on ability to answer

____Excellent knowledge
____Adequate knowledge
____Poor or no knowledge

Causes as stated:

21. How many earth tremors or earthquakes do you think might occur on the face of the earth in one year?

____________________

Rating:  ____Has knowledge of the amount of crustal movement on earth
____Has no knowledge

F. Protective and Preventive Measures

22. Where do you think it is safe to live in an area which is susceptible to earthquakes?

____Valley bottom
____On the side of a gentle hill
____No response
____Doesn't make any difference
23. Which is the safer type of building to be in during an earthquake?

___ brick or adobe
___ wood frame
___ doesn't make any difference
___ don't know

24. If you were inside a building in an earthquake, which would you consider the safer thing to do?

___ remain inside the building
___ run outside of the building
___ remain inside the building but move under a door frame or desk etc.
___ don't know

25. Do you carry earthquake insurance?

Yes  No  Uncertain

If no, have you looked into the availability and possibility of getting earthquake insurance?

Yes  No

26. Do you feel there is anything that can be done by individuals or by governments before or during an earthquake to reduce damage and death?

Yes  No  Uncertain

If yes: Probe - What? list
27. Did you know anything about earthquakes and their affects on this town when you decided to move (stay) here?

Yes

No

If yes: Did it influence your decision to move here?

If no: Knowing what you now know about earthquakes and their effects upon this area of the country, would you (move) (start) locate here again? Yes No Uncertain

INTERVIEWER COMMENTS

Respondents sex: male female

Respondents address:

Comments: