has a responsibility to determine what is appropriate and necessary in each case, and so does the professional who reviews each report.

Many active faults are complex, consisting of multiple breaks. Yet the evidence for identifying active fault traces is generally subtle or obscure and the distinction between recently active and long-inactive faults may be difficult to make. Because of the complexity of evaluating surface and near-surface faults and because of the infinite variety of site conditions, no single investigative method will be the best at every site; indeed, the most useful technique at one site may be inappropriate for another site.

Geologic reports prepared using these guidelines would be expected to be done by or under the direct supervision of registered geologists. Clear descriptions of work and unambiguous presentations of results are encouraged. If the report falls within the scope of the Geologist and Geophysicist Act (Business and Professions Code, Chapter 12.5), the report must be signed by the responsible professional(s). It is important that reports that present conclusions or recommendations based in part on field sampling or field or laboratory testing of samples include the test results with adequate descriptions of the methods employed, and with specific reference to standard sampling and testing methods, where appropriate. Where necessary, technical terms (such as active fault, maximum earthquake, etc.) will need to be defined.

The following is a suggested guide or format for earthquake and fault hazard reports. These reports may be prepared for projects ranging in size from a single lot to a master plan for large acreage, in scope from a single family residence to large engineered structures, and from sites located on an active fault to sites a substantial distance from the nearest known active fault. Because of this wide variation, flexibility in the order, format, and scope of the reports will allow tailoring to the seismic and geologic conditions and intended use of the site. The format is intended to be relatively complete, and not all items will be applicable to small projects or low risk sites. In addition, some items may be covered in separate reports by geotechnical engineers, geophysicists, or structural engineers.

II. REPORT CONTENTS

A. Purpose and Scope of the Investigation

Includes a brief description of proposed or existing site use; may also include a description of limitations of the work and authorization to perform the work. The design lifespan of the proposed project should be implicitly stated.

B. Regional Geologic Setting

May include reference to geologic province and location with respect to major structural features.

C. Site Description and Conditions

Includes information on geologic units, landforms, graded and filled areas, vegetation, existing structures, etc., that may affect the choice of investigative methods and the interpretation of data.

D. Description of the Investigation

1. Review of the region's seismic or earthquake history, based primarily on existing maps and technical literature.

   a. Significant earthquakes during historic time and epicenter locations and magnitudes in the vicinity of the site.

   b. Location of fault traces that may affect the site, including maps of fault breaks and a discussion of the tectonics and other relationships of significance to the proposed construction.

   c. Location and chronology of other earthquake-induced features such as landsliding, lurching, settlement and liquefaction, accompanied by:

      (1) Map showing the location of these features relative to the proposed project.

      (2) Description of the disturbed zone for each feature.

      (3) Estimate of the amount of disturbance relative to bedrock and surficial materials.

2. Interpretation of aerial photographs and other remotely sensed images relative to fault-related topography, vegetation, and soil contrasts, and other lineaments of possible fault origin.

3. Surface investigation.

   a. Mapping of geologic units and structures, topographic features, deformation of man made structures, etc., both on and beyond the site (sag ponds, spring alignments, offset bedding and man made features, disrupted drainage systems, offset ridges, faceted spurs, dissected alluvial fans, scarps, landslide alignments, vegetation patterns).

   b. Review of local groundwater data (water-level fluctuations, groundwater impediments, water quality variations, or anomalies indicating possible faults).

   c. Description of the distribution, depth, thickness, and nature of the various earth materials, including subsurface water, which may affect the seismic response and damage potential at the site.

4. Subsurface investigation.

a. Trenching and any other excavation (with appropriate logging and documentation, including method of cleaning wall) to permit the detailed and direct observation of continuously exposed geologic units and features. This would include trenching done across any known active faults and suspicious zones to determine the location and recency of movement, the width of disturbance, the physical condition of fault zone materials, the type of displacement, the geometry of fault features, and recurrence interval, if known.

b. Borings drilled and test pits excavated to permit the collection of data needed to evaluate the depth and types of materials and groundwater and to verify fault-plane geometry. Data points sufficient in number and adequately spaced will permit valid correlations and interpretations.

c. Geophysical surveys conducted to facilitate the evaluation of the types of site materials and their physical properties, groundwater conditions, and fault displacements, including a description of the types of equipment and techniques used, such a seismic refraction, magnetic, electrical resistivity, seismic refraction, magnetic, electrical resistivity, seismic reflection, and gravity.

5. Other special methods (used when special conditions permit or critical structures demand a more intensive investigation).

a. Aerial reconnaissance overflights, including special photography.

b. Geodetic and strain measurements, microseismicity monitoring, or other monitoring techniques.

c. Radiometric analysis (e.g., C14, K-Ar), stratigraphic correlation (fossils, mineralogy), soil profile development, paleomagnetism, or other age-dating techniques to identify the age of faulted or unfaulted units or surfaces.

E. <u>Conclusions</u>

1. Regarding areas of high risk and potential hazards relative to the intended land use or development (made in conjunction with the geotechncial engineering study) and a statement of the degree of confidence in, and limitations of, the data and conclusions.

a. Presence or absence (including location and age) of active or potentially active faults on or adjacent to the site or in the region of the site if they could affect it (through ground shaking).

b. Types and probability of, or relative potential for, future surface displacement within or immediately adjacent to the site, including the direction of relative displacement and the maximum possible displacement.

c. Secondary effects, such as: liquefaction of sediments and soils, shallow ground rupture, settlement of soils, earthquake-induced landslides, and lurching.

d. Estimates of maximum earthquake, upper bound earthquake, or other definitions of earthquakes if required by statute or regulation for the specific type of project.

F. Recommendations

1. Mitigative measures that provide appropriate protection of the health, safety and welfare of the public.

2. Effect of fault locations on proposed structures at the site. Federal, state and local law may dictate minimum standards.

3. Risk evaluations, if appropriate, relative to the proposed development.

4. Other recommendations as appropriate for the proposed project.

G. References

1. Literature and records cited and reviewed.

2. Aerial photographs or images interpreted, listing the type, scale, source, index numbers, etc.

3. Compiled data, maps, or plates included or referenced.

4. Other sources of information, including well records, personal communications, or other data sources.

H. Illustrations

1. Location map to identify the site locality, significant faults, fault strain and/or creep, geographic features, seismic epicenters, and other pertinent data.

2. Site development map, at an appropriate scale, to show the site boundaries, existing and proposed structures, graded areas, streets, exploratory trenches, borings, geophysical traverses, and other data.

3. Geologic map to show the distribution of geologic units (if more than one), faults and other structures, geomorphic features, aerial photo lineaments, and springs. The geologic map may be combined with the location and site development maps. A clear distinction should be made on the map and within the report between observed and inferred geologic features and relationships.

4. Geologic cross-sections illustrating displacement and/or rupture, if needed to

provide a three-dimensional picture.

5. Logs of exploratory trenches and borings to show the details of observed features and conditions.

6. Geophysical data and the geologic interpretations of those data.

I. Supporting data not already provided

1. Water well data.

J. Signature and registration number of the responsible professional(s)

1. Registered Geologist, Certified Engineering Geologist.

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(Rev. 7/98)