

FINAL TECHNICAL REPORT

**DEVELOPMENT AND EVALUATION OF
INNOVATIVE COMPOSITE AND INTERPRETIVE DAMAGE POTENTIAL MAPS
FOR GROUND SHAKING INTENSITY AND OTHER EARTHQUAKE HAZARDS –
SAN FRANCISCO BAY AREA
1434-HQ-96-GR-02723**

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Program Element -- IV

Research supported by the U.S. Geological Survey (USGS), Department of the Interior, under USGS award number **1434-HQ-96-GR-02723**. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

Abstract

The Association of Bay Area Governments (ABAG), the regional planning agency for the San Francisco Bay Area, was funded to produce creative and innovative maps and map products which incorporate ground shaking and other hazard information.

We created five new types of maps and map-based reports in this effort. These new products include:

1. Maps showing composite risk to a type of facility based on combining ground shaking damage potential with damage potential from other direct and indirect hazards. Other direct hazards include liquefaction, landslides and fault surface rupture. Other indirect hazards included building damage, water pipeline breaks, major gas pipeline breaks, hazmat releases, and freeway structure hazard.
2. Maps showing fire, police and hospitals facilities on top of maps showing some form of damage prediction.
3. Educational materials for the ABAG Internet site and for inclusion with the sale of individual city maps.
4. Intensity maps for two additional earthquake scenarios.
5. Additional information on the relative activity of Bay Area faults.

Our efforts were guided by a ABAG's Earthquake Mapping Review Committee.

In addition, we have published the data in hard copy and on ABAG's Web site. We successfully publicized the availability of the new maps and information. Finally, we have evaluated their use, and misuse.

Description of New Products and Their Status

ABAG has created five new types of maps and map-based reports in this effort to provide creative and useful shaking hazard maps and materials.

1. Maps showing composite risk to a type of facility based on combining ground shaking damage potential with damage potential from other direct and indirect hazards. Other direct hazards include liquefaction, landslides and fault surface rupture. Other indirect hazards included building damage, water pipeline breaks, major gas pipeline breaks, hazmat releases, and freeway structure hazard.

STATUS = Maps were developed for transportation disruption and published October 15, 1997 in *Riding Out Future Quakes* (Perkins and others, 1997). Maps and partial documentation are available on ABAG's Web site at:

<http://www.abag.ca.gov/bayarea/eqmaps/eqtrans/eqtrans.html>

2. Maps showing fire, police and hospitals facilities on top of maps showing some form of damage prediction.

STATUS = Maps were developed for transportation disruption and published October 15, 1997. Maps are available on ABAG's Web site at:

<http://www.abag.ca.gov/bayarea/eqmaps/eqtrans/eqtrans.html>

3. Educational materials for the ABAG Internet site and for inclusion with the sale of individual city maps.

STATUS = The following materials were published in the *On Shaky Ground – Supplement*, as well as on ABAG's Web site. In addition, the summary table and building information is now included with the sale of individual city maps. The materials detail the damage and disruption likely to be associated with each intensity level based on ABAG's recent work on housing and transportation, as well as on additional available data from Loma Prieta and Northridge earthquakes. This product includes:

- ◆ Summary table
- ◆ Detailed information on ten building types (including mobile homes, unreinforced masonry residential buildings, wood-frame single family homes both pre- and post-1940s, wood-frame apartments pre- and post-1940s, other apartment buildings, unreinforced masonry commercial buildings and concrete commercial buildings), including photographs of the typical types of damage
- ◆ Ground failure data, including liquefaction and landsliding
- ◆ Engineering parameters (that is, correlations of shaking intensity with other measures of shaking severity)
- ◆ Case studies of users of ABAG shaking maps – the City of Berkeley, the East Bay Municipal Utility District, and JCP Geologists, Inc. (a real estate disclosure company)

The materials were developed and published September 24, 1998 in the *On Shaky Ground – Supplement* (Perkins, 1998). The materials are available on ABAG's Web site at:

<http://www.abag.ca.gov/bayarea/eqmaps/doc/1998contents.html#1998>

Links from other parts of our Web site to this information should clarify the “meaning” of intensity.

4. Intensity maps for two additional earthquake scenarios.

STATUS = First, shaking intensity maps were generated for a magnitude 7.3 earthquake on the Peninsula-Golden Gate segment of the San Andreas (versus a 7.1 earthquake on the Peninsula segment produced in 1995) as an example of the effect of segmenting faults on overall earthquake risk. This map was supplemented with additional information on estimates of uninhabitable housing units and road closures. Second, a shaking intensity map was generated for a magnitude 6.7 earthquake on the Monte Vista thrust fault in the Santa Clara Valley as an example of the effects of a relatively short thrust fault in a highly urban area. The maps and explanatory materials were developed and published September 24, 1998 in the *On Shaky Ground – Supplement* (Perkins, 1998). The maps are available on ABAG's Web site at:

<http://www.abag.ca.gov/bayarea/eqmaps/pickfault.html>

5. Additional information on the relative activity of Bay Area faults.

STATUS = composite maps were intentionally not developed at this time due to the concern of other earthquake researchers, both within and outside of USGS, that the release of these maps which require the incorporation of earthquake probability information prior to the release of revised probabilities in 1999 would be confusing to the public and need to be redone (as out of date) in 1999. The most promising composite risk map showing risk of damage over time versus benefits of earthquake retrofitting appears to be one for owners of wood-frame homes built prior to the 1940s. Instead, a revised table and map showing Bay Area faults and the current probability information (using a combination of data from the reports of the Working Group on California Earthquake Probabilities (1990) and the Working Group on Northern California Earthquake Potential (1996) were developed and published September 24, 1998 in the *On Shaky Ground – Supplement* (Perkins, 1998).

Use of ABAG’s Earthquake Mapping Review Committee

ABAG used an advisory committee to review the products of this effort, the Earthquake Mapping Review Committee. This committee is chaired by a local elected official and contains both technical representatives and representatives of key users. The committee is currently composed of the following individuals:

- Bill Ward – Committee Chair – Councilmember, City of Hayward
- Catherine Bauman – Planner, City Planning Department, San Francisco
- Edward Bortugno/Scott McAffie – Earthquake Prog., Calif. Office of Emergency Services
- Arrieta Chakos – Office of the City Manager, Berkeley
- Tom Holzer/Mike Bennett – Geologists, U.S. Geological Survey
- Keith Knudsen/William Lettis – Geologists, William Lettis & Associates
- Dale Markum – Geologist, Cotton, Shires and Associates
- Carl Mortensen – Geophysicist, U.S. Geological Survey
- Carol Prentice – Geologist, U.S. Geological Survey
- Doug Sandy – Assistant Director, American Red Cross - Bay Area
- Richard Scott – Principal Engineering Technician, City of Novato
- Michael Shimamoto – Geologist, Public Works Department, City of San José
- William Schock – Building Official, Development Services, City of San Leandro
- Stephan Keifer – Building Official, City of Dublin

Other earthquake researchers at both the U.S. Geological Survey and the California Division of Mines and Geology were also asked to review drafts of the reports.

Publication and Distribution of Maps and Map Products

Two separate open houses were held by ABAG. In both cases, a flier was prepared and mailed to approximately 1500 people in various user groups in the Bay Area, including:

- ◆ local, state and federal government planners, building inspectors, emergency responders;
- ◆ private engineering, safety and emergency response consultants;
- ◆ risk and safety professionals with major corporations; and
- ◆ Red Cross and other emergency relief professionals.

The new transportation hazard map products were released at an open house on October 15, 1997, while the shaking maps were released at an open house on September 24, 1998. ABAG

staff prepared multiple press releases publicizing the new hazard map products. The press releases were mailed to Bay Area print, radio and television media. Both open houses were covered by all four major Bay Area television stations and numerous major and local newspapers and radio stations.

The ABAG Web site had an increase of approximately 15,000 hits on October 16, 1997, due to people viewing maps and related earthquake information. Similarly, the Web site had an increase of over 20,000 hits on September 25, 1998.

The lead articles of both ABAG's November 1997 and November 1998 newsletters is on these maps. This newsletter is mailed to approximately 2000 individuals, including the more than 700 elected officials (mayors, city councilmembers, and county supervisors) in the Bay Area.

Evaluation of Use of Maps and Map Products

The transportation information is not necessarily being used appropriately, however. People visiting our Web site have been confused by the "disruption density" nature of these maps. They also have been frustrated because we do not pinpoint individual roads that will be closed. (This was necessary, from a technical standpoint, because the maps are based on statistical probabilities.)

On the other hand, the additional information in the *On Shaky Ground – Supplement* appears to be encouraging more appropriate use of the maps by those who purchase the reports and maps, or who view the data on our Web site.

Unfortunately, while most news media appreciated that the two new scenarios were intended to be in addition to those already in existence, some assumed that there was a "new" San Andreas scenario that was "replacing" the 1995 version. This problem is typical of difficulties involved in trying to communicate uncertainty to the media. The media also completely ignored our efforts to try to communicate the meaning of intensity. However, individuals who purchase the maps or view our Web site get improved information.

Reports Published

Perkins, J.B., Chuaqui, B., and Wyatt, E., 1997, *Riding Out Future Quakes – Pre-Earthquake Planning for Post Earthquake Transportation System Recovery in the San Francisco Bay Region*. ABAG: Oakland, CA, 198 pp.

Perkins, J.B., 1998, *On Shaky Ground – Supplement – A Guide to Assessing Impacts of Future Earthquakes Using Ground Shaking Hazard Maps for the San Francisco Bay Area*. ABAG: Oakland, CA, 28 pp.

References

Working Group on Northern California Earthquake Potential, 1996. *Database of Potential Sources for Earthquakes Larger Than Magnitude 6 in Northern California*. U.S. Geological Survey Open-File Report 96-705, 53 pp.

Working Group on California Earthquake Probabilities, 1990. *Probabilities of Large Earthquakes in the San Francisco Bay Region, California*. U.S. Geological Survey Circular 1053, 51 pp.