Elements of an Effective Geologic Hazard Mitigation Program

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SUMMARY Effective geologic hazard mitigation requires evaluation, education and enforcement. Evaluation requires geologic hazard mapping to determine the location, and seriousness of the hazards and a hazard investigation prior to land use changes or construction. In developed areas investigations should be undertaken at the first indication of a problem. These should be conducted by qualified private consultants or government staffs. If by consultants they should be subject to governmental review. Publication and availability of results furthers the education element. Education informs decision makers and the general public as to the character and extent of the geologic hazards and the consequences if ignored. Decision makers include regulatory government officials, landowners, industry and financiers. Educational efforts should include graphically illustrated talks, publications and the media. Reports must interest and inform the layman and be scientifically credible. Enforcement must ensure that information gained by evaluation guides land use decision-making and construction location and design. Enforcement can be hazard zoning, grading codes, subdivision regulation, and building codes, as well as economic decisions by enlightened developers or investors. Enforcement must utilize geological review of land use changes and construction sites by competent geologic staff of a governmental agency free from political and economic pressures.

1. INTRODUCTION

Throughout the world society has struggled to mitigate the serious economic, safety, health and social impacts of geologic hazards. Long-term consideration of this problem by the staff of the Colorado Geological Survey and our experience leads to the conclusion that an effective geologic hazard mitigation program must utilize three interrelated elements. They consist of evaluation, education and enforcement. Like the three-legged stool, the program will fail if any of the legs or elements are missing or deficient.

The Colorado Survey's involvement with geologic hazard mitigation began with its reestablishment in 1969. Two of its major statutory charges were: "to delineate areas of natural geologic hazards that would affect the safety of or cause economic loss to the citizens" and "to provide advice and counsel to all agencies of state and local government on geologic problems". At that time the burgeoning spread of Front Range metropolitan urbanization onto geologically less favorable sites and the exploding alpine recreational developments caused major problems for government agencies. The impact of geologic hazards on these developments certainly caused economic loss to and affected the safety of our citizens. Therefore the fledgling Survey began a long-range program to evaluate the seriousness of the problem, educate public and private decision makers to the character and magnitude of geologic hazards and to provide a mechanism for enforcement of the consideration of geologic hazards information in public and private construction or major changes of land use.

2. EVALUATION

The evaluation element consists of two phases. The first must be a determination of the overall magnitude, character and seriousness of the hazards to be mitigated. This step forms the critical basis of and provides the information for the educational element. Conduct of the evaluation must be credible to be accepted by government officials, private decision makers and the general public. In Colorado we utilized previous work of the U.S. Geological Survey, academicians, consultants and investigations by our own small staff. Particularly in the early stages we drew heavily on examples from areas such as California.

Even in areas where little or no geologic mapping has been done, a review of historical records and analogies drawn from areas of similar geologic environments will satisfy many of the requirements of this first phase of evaluation.

The second phase of the evaluation element consists of detailed site investigations prior to significant land use changes or construction. As such it provides the information to be used by decision makers or by regulators in the enforcement element. Colorado adopted the philosophy that site investigations for the second evaluation phase would be conducted by consultants and that the costs therefore, would be borne by the development applicant. The consultant's work then would be reviewed by the Colorado Geological Survey who made recommendations for approval, denial or modification to the regulatory agency in the enforcement element. This process provided considerable additional work for geological consultants, validated high quality work, screened out the shoddy work and provided state wide objective uniformity of evaluation. As an agency with total responsibility to the public rather than to any specific client, we were able with careful quality control to establish the necessary strong credibility with the regulatory agencies, development applicants and the public.

3. EDUCATION

The critical education element follows and utilizes information derived from the first phase of the evaluation element. The education process must provide the evidence and justification for the second evaluation phase and for the establishment of an enforcement element. It must inform decision makers and the general public as to the character, severity and extent of the geologic hazard and the consequences to be suffered if the hazard is ignored. In Colorado the education element was enhanced immeasurably by the dedicated work of many members of the local sections of the American Institute of Professional Geologists (AIPG) and the Association of Engineering Geologists (AEG). Their cooperative efforts in hosting five Governor's Conferences on environmental geology helped to educate geologists, planners, legislators and the public. Road shows with accompanying field trips over wide areas of the state helped to educate local government staffs, elected officials and influential citizens. The careful tutoring and education of several newspaper and television reporters aided them in providing accurate and extensive media coverage of current newsworthy hazard events. We found that colored-slide, illustrated talks presented to legislative hearings, service clubs, geological societies and any other interested audiences throughout the state were extremely effective. The Colorado Survey's early successful involvement in several high visibility, controversial projects increased the public's sensitivity to the problem.

Early on we established a policy that geologic hazard publications especially should be timely, accurate and understandable to the non-geologist. Publications such as Special Publication 12, Nature's Building Codes - Geology and Construction in Colorado; Special Publication 6 - Guidelines and Criteria for Identification and Land Use Controls of Geological Hazards and Mineral Resource Areas; Special Publication 11 - Home Construction on Shrinking and Swelling Soils; Special Publication 14 - Home Landscaping and Maintenance on Swelling Soils; and Special Publication 26 - Subsidence Above Inactive Coal Mines - Information For the Home Owner, have been widely accepted and widely distributed. They are effective educational tools for geologists, engineers, architects, lawyers, planners, builders and private citizens.

4. ENFORCEMENT

Even after massive and successful efforts at education and evaluation, the hard facts in many situations require strict enforcement with statutory backup. Though many development proponents and regulatory agencies can be persuaded by the merits of a geological review of a project, sometimes the bottom line must be a legal requirement that an evaluation must be conducted, and that the consideration of the results of that evaluation must be part of the decision making process.

A successful enforcement mechanism to ensure that the hazard knowledge gained by the evaluation element can only be set in place after a successful education effort. The enforcement element must ensure that the information gained by the evaluation phase guides land use decision making and construction site location and design. The enforcement mechanism may be by hazard zoning, grading codes, subdivision regulations, building codes, deed restrictions, easements or covenants. In Colorado the legislature has maintained that all land use controls shall be at the local government level. The enforcement authority therefore resides with county commissions and town councils. The function of statewide evaluation, review, recommendations and technical advice by the Colorado Survey to the regulatory bodies is mandated by the statues.

The enforcement mechanism in Colorado actually began with the Colorado Geological Survey's enabling statute (34-1-101 CRS 1973) which required the Survey to advise and counsel governmental agencies and to delineate natural hazardous areas. Importantly the laws gave the Colorado Survey no regulatory authority but required it to give advice, counsel and recommendations to those that had that authority.

One of the strongest portions of Colorado's enforcement strategy is its statewide subdivision law, Senate Bill (SB)-35 (30-28-101 and 113 et seq. CRS 1973). SB-35 requires the developer of a subdivision which is outside city limits to conduct an investigation of the "geological characteristics of the area significantly affecting the land use and the impacts of such characteristics on the proposed subdivision. Evidence to show that the areas of subdivision which involve soil or topographic conditions presenting hazards or requiring special precautions have been identified and that proposed uses of such areas are compatible with such conditions." (Subdivision was defined as breaking land into two or more parcels, one of which was less than 35 acres).

As part of the subdivision approval process, counties are required to submit a geologic report provided by the developer's consultants and the subdivision plan "to the Colorado Geological Survey for an evaluation of those factors which would have a significant impact on the proposed use of the land". The Colorado Survey must make its recommendation to the county commissioners within 35 days.

The geological portion of this subdivision law has been the most successful part of the evaluation and enforcement framework. Most subdividers now realize that the cost of an adequate subdivision geological investigation is an investment in their project's success, rather than an unnecessary expense. Most consulting geologists are now conducting adequate subdivision investigations. Most county commissioners and planning commissions and staff now realize that geologic factors can be a critical part of their land use decisions.

Success of the program is validated by the fact that since 1973 over 12,000 subdivisions have been reviewed. Except for swelling soil problems, we are not aware of any serious geologic problems which have occurred when the geologic recommendations of the consultant and our staff were followed.

In 1973 House Bill (HB)-1574 (34-1-201 and 202 CRS 1973) was passed. It defined geological practice and required that geologic work be done by a legally defined

professional geologist. That statute does not require licensing or registration and has no enforcement clause but it has improved the stature of the geological profession and has essentially kept non-geologists from making geological reports.

In 1974 HB-1034 (29-20-101 CRS 1973) specifically gave local governments the power to "plan for and regulate the use of land by regulating developments and activities in hazardous areas". This gave broad powers, but did not require cities, towns and counties to address and mitigate geologic hazards in a broad variety of land use cases.

Also in 1974 HB-1041 (24-65.1-101 CRS 1973) specifically defined geologic hazards and those geologic conditions which could constitute a geologic hazard. It gave local governments the power for, but did not require the identification, official designation, and administration of hazard areas. It also required the Colorado Survey to promulgate a model geologic hazard area control regulation (Rogers 1974). Most local governments with potential hazard problems used the Colorado Survey or consultants to map and identify potential geologic hazard areas within their jurisdiction. This evaluation work provided immense amounts of hazard information and increased local governments' awareness of their geologic hazard problems. Although most governments utilize this information in their planning, zoning, and land use decisions, none have carried out their full authority to formally designate and manage geologic hazard areas. Political and philosophical controversies over the non-geologic portions of this broad land use control act caused it to fall in disrepute and prevented its full implementation. However, the widespread hazard identification studies and legal definition of geologic hazards and hazard areas served to institutionalize the rational concern for the geologic impacts on future developments.

In 1984 concerns for extensive swelling soil damage to residential construction in several Denver suburbs spurred the passage of SB-13 (6-6.5-101 CRS 1973). With the title of Soil and Hazard Analysis of Residential Construction, that statute requires "that very builder shall provide the purchaser of a new home with a copy of a summary report of the analysis and the site recommendations. For sites in which significant potential for expansive soils is recognized, the builder shall supply each buyer with a copy of a publication detailing the problems associated with such soils, the building methods to address these problems during construction and suggestions for care and maintenance to address such problems". Not coincidentally the Colorado Survey's SP-14, Home Landscaping and Maintenance on Swelling Soils fit that description and is now widely and routinely distributed by builders to home buyers. The statute served to educate and raise the consciousness of all home builders, government agencies and home buyers to the serious swelling soil problems.

Also in 1984 HB-1045 (22-32-124 CRS 1973) required the Colorado Survey to "determine the geologic suitability" of new school construction or school site acquisitions. This requires a geologic review of school construction sites and forces the consideration of geologic problems that could be encountered.

5. CONCLUSIONS

Colorado has over the years devised a workable though imperfect set of procedures to: educate the public and decision makers; evaluate or review with Colorado Geological Survey's staff most development activities before they are approved or become certain and most importantly the enforcement through a statutory framework which requires geological hazard information to be acquired, reviewed and addressed for most development projects.

The education effort, though extensive and fairly successful, has been seriously hampered by the lack of funding. Many worthwhile projects to provide hazard information have had to be shelved.

The first phase of the evaluation element has essentially been terminated. Although we have learned to identify potential hazard areas, considerable research into the causal mechanisms and the temporal predictability of geologic hazards needs to be conducted. Fortunately the second phase of the evaluation element has been included in and interwoven with the enforcement strategy.

The enforcement or statutory framework for geologic hazard mitigation has been relatively successful. Statutes now require all subdivisions in the state's unincorporated areas to undergo geological investigations, state Survey review, and consideration of those results by planning commissions and county commissioners. Both cities and towns have broad powers to consider geologic hazard information and most require geologic investigations and review of suspected problem areas. The National Environmental Policy Act, the Environmental Impact Statement process, the old federal A-95 process and the state Joint Review Process ensure the geological investigation and review for major projects and those which require federal decisions or federal funding. School sites now require geological investigations. Homes built on suspected swelling soils require an evaluation, analysis and disclosure of mitigation methods to the home buyers. A strong network of local government staff, geologists and informed citizens throughout the state bring the Survey into the picture on many controversial or geologically suspect projects even though geological review may not be legally required.

One must realize that an enforcement program does not consist of simply passing a law. Regulators must have ready access to and utilize competent, objective, credible geologic advice. The source of that advice should be as free as possible from political and economic pressures. The objective evaluation of controversial or politically sensitive developments or projects is fraught with difficulty. Reviewers soon learn that a person's mettle is forged in the crucible of controversy.

Last year Governor Romer signed an executive order establishing a Colorado Natural Hazard Mitigation Council. The Council's charge is to manage the mitigation of natural hazards such as floods, wild fires, earth-

quakes, drought, avalanches, and landslides. It should assess the vulnerability of those situations, evaluate and prioritize mitigation options, seek funding for the most immediate needs and coordinate all levels of government and private sector in effective responses to such hazards. The council is made up of 25 official and 27 ex-officio positions representing the legislature, the governor's office, the affected departments of state government, local governments, the universities, and professional societies. The Hazard Mitigation Council should serve to institutionalize concerns for mitigating geological hazards. Hopefully it will carry forward the three key elements of a hazard mitigation program.

The Colorado system is far from perfect and could stand considerable improvement, but it has worked remarkably well in mitigating the impacts of geologic hazards. We firmly believe that a program of evaluating the seriousness of a geologic hazard, educating the decision makers to its seriousness and a statutory enforcement mechanism could mitigate geological hazards any place in the world.

6. REFERENCES

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