HOMER ADVISORY PLANNING COMMISSION
491 E PIONEER AVENUE
HOMER, ALASKA

January 17, 2018
6:30 PM WEDNESDAY
COWLES COUNCIL CHAMBERS

REGULAR MEETING AGENDA

1. Call to Order

2. Approval of Agenda

3. Public Comment
The public may speak to the Commission regarding matters on the agenda that are not scheduled for public hearing or plat consideration. (3 minute time limit).

4. Reconsiderations

5. Adoption of Consent Agenda
All items on the consent agenda are considered routine and non-controversial by the Planning Commission and are approved in one motion. There will be no separate discussion of these items unless requested by a Planning Commissioner or someone from the public, in which case the item will be moved to the regular agenda.

A. Approval of minutes of January 3, 2018 **p. 1**

6. Presentations

7. Reports

A. Staff Report 18-05, City Planner's Report **p. 9**

8. Public Hearings
Testimony limited to 3 minutes per speaker. The Commission conducts Public Hearings by hearing a staff report, presentation by the applicant, hearing public testimony and then acting on the Public Hearing items. The Commission may question the public. Once the public hearing is closed the Commission cannot hear additional comments on the topic. The applicant is not held to the 3 minute time limit.

A. Staff Report 17-91, Ordinance to add Retail Marijuana Facilities as a permitted use in the Marine Commercial District under Homer City Code 21.28.020 **p. 11**

9. Plat Consideration

10. Pending Business

A. Staff Report 18-06, Natural Hazards Planning **p. 47**

11. New Business

12. Informational Materials

A. City Manager's Reports for the January 8, 2018 City Council Meeting **p. 173**

13. Comments of the Audience
Members of the audience may address the Commission on any subject. (3 min limit)

14. Comments of Staff

15. Comments of the Commission

16. Adjournment
The next regular meeting is scheduled for Wednesday February 7, 2018. Meetings will adjourn promptly at 9:30 p.m. An extension is allowed by a vote of the Commission.

Session 18-01, a Regular Meeting of the Homer Advisory Planning Commission was called to order by Chair Don Stead at 6:30 p.m. on January 3, 2018 at the City Hall Cowles Council Chambers located at 491 E. Pioneer Avenue, Homer, Alaska.

PRESENT: COMMISSIONERS HIGHLAND, BENTZ, BERNARD, BOS, STEAD, VENUTI AND BANKS

STAFF: CITY PLANNER ABBOUD
DEPUTY CITY CLERK KRAUSE

Approval of the Agenda

Chair Stead called for a motion to approve the agenda.

HIGHLAND/BENTZ SO MOVED.

There was no discussion.

VOTE. NON-OBJECTION. UNANIMOUS CONSENT.

Motion carried.

Public Comment
The public may speak to the Planning Commission regarding matters on the agenda that are not scheduled for public hearing or plat consideration. (3 minute time limit).

Reconsideration

Adoption of Consent Agenda
All items on the consent agenda are considered routine and non-controversial by the Planning Commission and are approved in one motion. There will be no separate discussion of these items unless requested by a Planning Commissioner or someone from the public, in which case the item will be moved to the regular agenda and considered in normal sequence.

A. Approval of minutes of December 6, 2017

Chair Stead requested a motion to approve the consent agenda.

HIGHLAND/ BENTZ– SO MOVED.

There was no discussion.

VOTE. NON-OBJECTION. UNANIMOUS CONSENT.

Motion carried.

PRESENTATIONS

REPORTS

A. Staff Report 18-01, City Planner's report

City Planner Abboud reviewed the staff report. He requested volunteers for the City Council meetings in January and February.

January 8, 2018	Commissioner Highland
January 22, 2018	Commissioner Bos
February 12, 2018	Commissioner Bernard

Commissioner Bos congratulated the Planning Director on processing $35 million dollars in permits in 2017.

PUBLIC HEARINGS

PLAT CONSIDERATION

A. Staff Report 18-02, Tsunami View No. 2 Preliminary Plat

Chair Stead requested City Planner Abboud to present his report to the Commission.

Gary Nelson, property owner and applicant, provided a brief history on the platting of this parcel and the previous platting attempt in 2015-2016.
Mr. Nelson read into the record a letter addressed to the City Manager copied to Public Works Director Carey Meyer dated January 3, 2018 regarding Trespass by the City of Homer Mid Hill PRV Access Stairway and Roadway on Parcel #17504016 152 Dehel Avenue Homer, Alaska 99603

Chair Stead opened the floor for Public Comment. Having no one in the public come forward he closed the public comment period noting that the Commission could ask questions of the staff present and applicant.

The commission requested clarification and commented on the following:

- Steepness of the parcel in question.
- Area where the parcel is flat
- Previous presentation presented to the commission
- Any requirements for the property owner to provide an easement to the City
- Modification of the recommendation to remove a comment
- Road Construction requirements
- Encroachment in relation to the easement
- City water and sewer services

The commission requested information from Public Works Director Meyer on the construction of the access outside the existing easement.

Chair Stead recommended that the commission discontinue the line of questioning and discussion relevant to comment number six and decide to include the comment in their recommendation to approve.

BOS/HIGHLAND – MOVED TO RECOMMEND ADOPTION OF STAFF REPORT 18-02 AND APPROVAL OF THE PRELIMINARY PLAT FOR TSUNAMI VIEW NO. 2 PRELIMINARY PLAT WITH COMMENTS 1-6

The commission discussed an amendment to comment #6, and City Planner Abboud reviewed the Preliminary Plat and noted changes that have been made since it was presented the first time and highlighted the requirements under City Code versus any agreements between the city and the property developer.

BANKS/BERNARD – MOVED TO AMEND THE MOTION TO DELETE COMMENT NUMBER SIX.

Discussion by the commission on comment number six ensued.

VOTE. YES. BANKS, BERNARD.
VOTE. NO. VENUTI, STEAD, BOS, BENTZ, HIGHLAND.

Motion to amend failed.

VOTE. (Main) NON-OBJECTION. UNANIMOUS CONSENT.

Motion carried.

B. Staff Report 18-03, J. Waddell Survey Dierich Addition Lot 4B-3A 2018 Replat Preliminary Plat

City Planner Abboud provided a summary of his report to the commission.

There was no applicant present.

There was no public present for public comment on the action.

The commission

VENUTI/BOS – MOVED TO ADOPT STAFF REPORT 18-03 AND APPROVE THE PRELIMINARY PLAT FOR J. WADDELL SURVEY DIERICH ADDITION, LOT 4B-3A 2018 REPLAT PRELIMINARY PLAT WITH COMMENTS 1 AND 2.

There was no discussion.

VOTE. NON-OBJECTION. UNANIMOUS CONSENT.

Motion carried.

PENDING BUSINESS

NEW BUSINESS
A. Staff Report 18-04, Election of Officers

The commission decided to vote by voice vote and if more than one person then ballot.

Chair Stead opened the floor for nominations of Vice Chair.

There was a brief discussion on the process to nominate and vote on the Vice Chair then the Chair and how long the current Chair and Vice Chair have held their positions.

Commissioner Highland nominated Commissioner Bos. Commissioner Venuti seconded the nomination.

Commissioner Banks nominated Commissioner Bentz. Commissioner Bernard seconded the nomination.

Commissioner Highland inquired about the ability of Commissioner Bentz to fill the office with her responsibilities of the Borough Planning Commission. Commissioner Bentz assured her there would be no issues.

Chair Stead closed the floor for nominations.

Commissioner Venuti questioned if each candidate wanted to serve in the role of Vice Chair.

Commissioner Bos and Bentz responded that they did. Commissioner Venuti recommended voting by ballot.

Deputy City Clerk Krause distributed ballots to the commissioners. Upon completion of voting she collected and tallied the votes. The results were as follows:
Commissioner Bentz – 4 votes Commissioner Bos – 3 votes

Chair Stead congratulated Commissioner Bentz and passed the gavel over.

Vice Chair Bentz opened the floor for nominations of Chair.

Commissioner Bos nominated Commissioner Stead stating his reasons for the nomination. Commissioner Highland seconded the nomination.

Commissioner Stead stated he was willing to serve as Chair.

Commissioner Bernard nominated Commissioner Banks. Commissioner Banks stated he was not willing.

Vice Chair Bentz closed the floor for nominations calling for the vote in the manner previously decided.

Deputy City Clerk Krause collected and tallied votes. The results were as followed:

Commissioner Stead – 5 votes Commissioner Banks - 1 vote Write in – 1 vote

Commissioner Bos asked if the Clerk was going to shake up the seating.

Ms. Krause responded that if the Commissioners desired to relocate she would accommodate.

Commissioner Highland indicated that she had a preference not to move her seat.

B. Staff Report 18-05, Natural Hazards Planning

City Planner Abboud reviewed the materials included in the packet and a presented a preliminary plan to investigate other communities and their development plans, building codes, mitigation of possible scenarios.

Commissioners commented and discussed that there may not be a reasonable solution for this problem, and coming up with a recommendation other than not to allow building in areas such as this one of Mt. Augustine was the likely outcome; the commission noted the issues with water and sewer services for the properties also.

The commission agreed by consensus that any zoning regulations that are developed should apply to all similar areas of the city not just the Baycrest Subdivision.

City Planner Abboud noted that several worksessions will be conducted on this subject; and Geotechnical information is necessary.

Further discussion ensued on the extent of the specific issues; how the steep slope section in city code would apply; the buyer beware principle; what the responsibility and possible liability of the city; preventive versus remediation; and that hazards planning will take several meetings before completion.

C. 2018 Draft Land Allocation Plan - Memo from Julie Engebretsen, Deputy City Planner

City Planner Abboud reviewed the process for the commission and commented on some of the lease or properties available for lease.

A discussion on prior recommendations for certain parcels in the plan; if the land would ever be offered for sale that is currently leased; clarification on what would happen if the spit was private instead of public land; the aspects of having a working harbor; difference in actual value versus assessed value of city owned land.

Chair Stead read the requested action from the commission.

HIGHLAND/VENUTI MOVED TO RECOMMEND CITY COUNCIL DESIGNATE THE PARCELS #17717706 AND #17717707 ON PAGE C-15 OF THE PLAN AS OPEN SPACE.

A brief discussion ensued on prior recommendations, better to get off the city's responsibility.

VOTE. YES. HIGHLAND, BENTZ, BERNARD, STEAD, VENUTI, BANKS
VOTE. NO. BOS

Motion carried.

BOS/BENTZ MOVED TO RECOMMEND COUNCIL GIFT THE PARCELS #17715402 AND 17715403 TO THE PROPERTY OWNER TO THE SOUTH TO GET THEM BACK ON THE TAX ROLLS.

There was no discussion.

VOTE. NON-OBJECTION. UNANIMOUS CONSENT.

Motion carried.

HIGHLAND/ BOS - MOVED TO SUPPORT THE LEASE COMMITTEE RECOMMENDATIONS TO MAKE LOT 11 AVAILABLE FOR LEASE AND INCLUDE THE FOLLOWING INFORMATION ON EACH APPLICABLE LOT, "PRIOR TO A LONG TERM LEASE THE SITE IS APPRAISED. THE APPRAISED LEASE RATES FOR UPLANDS IS APPROXIMATELY $0.90 PER SQUARE PER ANNUM. LEASE RATES VARY CONTACT THE HARBOR OFFICE AT 907-235-3160".

There was no discussion.

VOTE. NON-OBJECTION. UNANIMOUS CONSENT.

Motion carried.

INFORMATIONAL MATERIALS
A. City Manager's Reports for the December 11, 2017 City Council Meeting

Commissioner Highland inquired about the subdivision agreement and connecting to services.

City Planner Abboud provided clarification and that if left vacant they do not have to hook up but if improved they do.

COMMENTS OF THE AUDIENCE

COMMENTS OF THE STAFF

COMMENTS OF THE COMMISSION

Commissioner Highland commented that she likes to see the contour lines on the preliminary plat to show steepness.

City Planner Abboud explained when those were used and that they are not shown on the final, public works reviews these. But it would be noted on the plat.

Commissioner Highland also inquired about operating drones in city limits and noted that aircraft is supposed to be over 1000 feet above the city.

City Planner Abboud responded that she needed to check with the FAA regarding the regulations but he knew that you were required to have a license to operate a drone within a certain distance of airports.

Commissioner Bentz inquired about the status of the Draft Comprehensive Plan.

City Planner Abboud responded that they will see the draft at the January 17, 2018 regular meeting. There are still some formatting issues he is working out and some sections are being finalized by the Planning department and Borough getting some reciprocal outreach. They will be scheduling an Open House and as many opportunities for public input on the city's comprehensive plan.

Commissioner Bentz provided information on the release of the Borough Comprehensive Plan and expressed dismay at not getting input on the Planning Commission level. She recommended to the Borough that they attend the Council meeting so that it is advertised on the radio for the community. Commissioner Bentz she wanted this commission aware of the roll out plan for the Comp Plan.

City Planner Abboud informed the commission on some items from the last time the plan was reviewed.

Commissioner Bentz also announced the March Science conference and that there will be a panel on science and policy.

Commissioner Bernard asked if they will get to see the comp plan before release to the public.

City Planner Abboud responded that they will see the final draft and make a recommendation to council when finalized.

Commissioner Bos stated it was a great meeting, congratulated the new officers and Happy New Year.

Commissioner Venuti had no comments.

Commissioner Banks commented it was nice to see a full commission and echoed some of Commissioner Highland's desire in showing the average slopes put on the lots, as that is what triggers the steep slopes applicability.

Chair Stead stated it was good meeting and it will be a fun when they start getting into these natural disaster things.

ADJOURN
There being no further business to come before the Commission, the meeting adjourned at 9:29 p.m. The next regular meeting is scheduled for Wednesday, JANUARY 17, 2018 at 6:30 p.m. in the City Hall Cowles Council Chambers. There is a worksession scheduled at 5:30 p.m. prior to the meeting.

_____
RENEE KRAUSE, CMC, DEPUTY CITY CLERK I

Approved: _____

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TO: Homer Advisory Planning Commission
FROM: Rick Abboud, City Planner
DATE: January 17, 2018
SUBJECT: City Planner's Report PL 18-05

City Council - 1.8.18
The worksession had the PARCAC and the Council discuss the future of the HERC building

Ordinance 18-04, An Ordinance of the City Council of Homer, Alaska, Amending Homer City Code Chapter 21.03.040 to Define "Employee-Occupied Recreational Vehicles"; Title 21.54 to add 21.54.325, Permitting Employee-Occupied Recreational Vehicles in the Marine Commercial and Marine Industrial Zoning Districts; and Amending 21.54.200 and 21.54.210 to Reflect the Newly Permitted Use in these Districts. Smith. Recommended dates: Introduction January 8, 2018, Public Hearing and Second Reading January 22, 2018.

Comprehensive Plan
We have been working diligently to create the Public Draft version. This is a considerable undertaking. We are creating a uniform document and double checking for consistency in format and still cleaning up some references to items that have been removed or moved to a different location in the document. With something this large, I seem to continually find things that could be improved upon from the latest version. I believe that we will have a suitable draft during the week of the meeting. Then the fun begins as we solicit comments.

I will send out links to the document once we have it posted and also provide paper copies. I imagine it would be beneficial for all the commissioners to have one for reference and mark-up.

Planning Commission report schedule for City Council meetings
January 22: Tom
February 11: Mandy
February 26: ???
March 12:
March **27**:

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Staff Report PL 17-91

TO: Homer Advisory Planning Commission
FROM: Rick Abboud, City Planner
DATE: December 6, 2017
SUBJECT: Retail marijuana in the Marine Commercial District

Introduction
This subject is back to the Planning Commission after a request made by the Cannabis Advisory Commission (CAC) for the City Council to reconsider the decision to add a provision for retail marijuana operations in the Marine Commercial District.

Analysis
The Port and Harbor Commission reviewed the request and support the allowance of Retail Marijuana in the Marine Commercial District. I have provided backup of the discussion that lead to the negative recommendation for marijuana business on the spit last year. Basically, the votes were split on both the Planning Commission and City Council.

My review of any ordinance involving the addition of an activity to a district includes how the change is aligned with the purpose of the district and relevant information found in the comprehensive plan.

Marine Commercial District

> *The purpose of the Marine Commercial District is primarily for water-related and water-dependent uses and the business and commercial uses that serve and support them, including but not limited to fishing, marine transportation, off-shore energy development, recreation and tourism. It is recognized that unique natural features of Homer's marine environment contribute significantly to the economic and social environments; therefore, performance standards are required to minimize the impact of development on the natural features on which they depend.*

A retail marijuana facility in this district does not necessarily enhance or support water-dependent use. The use would have to be found to fit into the 'tourism' aspect. Justifying this business in the Marine Commercial District depends on how the community feels that this activity supports tourism. I am sure that we will enter into a debate about how this use will benefit or harm existing businesses on the spit. I am providing the thought I have 'through the

planning lens', in the end, it is for the community to provide guidance and determine community standards.

The support for this activity seems to revolve around the concept that it should be allowed to prosper and contribute to the economic benefit of the city. Like most other retail business, retail marijuana is confined to business districts. Marijuana business in the Marine Commercial district is unique in that much of the land is owned by the city and leased. Attached is a map of the district indicating the private property that will likely be the only opportunity for the use, as the City has taken the position that we will not allow the operation of an activity that conflicts with federal law on City owned land.

Comprehensive Plan
In consideration of the Marine Commercial District and the Spit Plan, I am not finding any direct support. It may be found to be supported in aspects of the Economic Vitality Chapter. The benefits to the community are debatable. It would have to be construed to be an amenity that enhances the tourism industry such as the selling of arts and crafts or curios, currently permitted uses.

Staff Recommendation
Hold a public hearing, discuss the merits of the proposal and make recommendation to the City Council.

Attachments
Draft Ordinance
Memorandum PL 17-07
November 15, 2017 Marine Commercial Properties Map
August 28, 2017 Memo of the Cannabis Advisory Commission
October 10, 2017 Memo from the City Planner to Port and Harbor Commission
October 25, 2017 Port and Harbor Commission Meeting Minutes
September 6, 2017 Letter from Jeremiah Emmerson to City Council
January 25, 2016 City Council Minutes - Discussion of Retail Marijuana in Marine Commercial
January 14, 2016 Memorandum 16-017 from the City Planner to City Council
Nov. 4, Oct. 21, Oct. 7, 2015 HAPC Meeting Minutes
Public Comments

CITY OF HOMER
HOMER, ALASKA

Planning Commission

ORDINANCE 18-___

AN ORDINANCE OF THE CITY COUNCIL OF HOMER, ALASKA, AMENDING HOMER CITY CODE 21.28.020, PERMITTED USES AND STRUCTURES; ADDING MARIJUANA RETAIL FACILITIES IN THE MARINE COMMERCIAL DISTRICT.

WHEREAS**,** it is in the City's best interest to draft comprehensive regulations regarding the use of property within the City to cultivate, manufacturer marijuana or to operate a retail store selling marijuana; and

WHEREAS, the City is dedicated to drafting regulations that prevent the distribution of marijuana to minors; prevents revenue from the sale of marijuana from going to criminal enterprises, gangs, and cartels; prevents the diversion of marijuana from states where it is legal under state law in some form to other states; prevents state-authorized marijuana activity from being used as a cover or pretext for the trafficking of other illegal drugs or other illegal activity; prevents violence and the use of firearms in the cultivation and distribution of marijuana; prevents drugged driving and the exacerbation of other adverse public health consequences associated with marijuana use; prevents the growing of marijuana on public lands and the attendant public safety and environmental dangers posed by marijuana production on public land; and prevents marijuana possession or use on federal property.

THE CITY OF HOMER ORDAINS:

Section 1. Homer City Code Chapter 21.28 is amended as follows:

Section 21.28.020 Permitted uses and structures.

The following uses are permitted outright in the Marine Commercial District, except when such use requires a conditional use permit by reason of size, traffic volumes, or other reasons set forth in this chapter:

a. Offices for tourism-related charter and tour businesses, such as fishing, flightseeing, day excursions and boat charters and tours;

b. Marine equipment sales, rentals, service, repair and storage;

c. Retail stores limited to the sale of seafood products, sporting goods, curios, and arts and crafts;

d. Business offices for water-dependent and water-related activities such as fish brokers, off-shore oil and gas service companies, and stevedores;

e. Customary accessory uses that are clearly subordinate to the main use of the lot or building such as piers or wharves; provided, that separate permits shall not be issued for the construction of an accessory structure prior to that of the main structure;

f. Mobile food services;

g. Itinerant merchants, provided all activities shall be limited to uses permitted outright under this zoning district;

h. Recreational vehicle parks, provided they shall conform to the standards in Chapter 21.54 HCC;

i. Restaurants;

j. Cold storage facilities;

k. Campgrounds;

l. Manufacturing, processing, cooking, and packing of seafood products;

m. Parks;

n. Boat launching or moorage facilities, marinas;

o. Caretaker, business owner or employee housing as an accessory use to a primary use, and limited to no more than 50 percent of the floor area of a building and for use by an occupant for more than 30 consecutive days;

p. Lodging as an accessory use, limited to no more than 50 percent of the floor area of a building;

q. As an accessory use, one small wind energy system per lot;

r. Marijuana retail facilities as defined by state law.

Section 2. This ordinance shall take effect upon its adoption by the Homer City Council.

Section 3. This ordinance is of a permanent and general character and shall be included in the City code.

ENACTED BY THE CITY COUNCIL OF THE CITY OF HOMER, ALASKA, this _____ day of _____ 2018.

CITY OF HOMER

_____
BRYAN ZAC, MAYOR

ATTEST:

_____
MELISSA JACOBSON, MMC, CITY CLERK

AYES:
NOES:
ABSTAIN:
ABSENT:

First Reading:
Public Reading:
Second Reading:
Effective Date:

Reviewed and approved as to form:

_____ _____
Kate Koester, City Manager City Attorney

Date: _____ Date: _____

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Memorandum PL 17-07

TO: Homer Advisory Planning Commission
FROM: Rick Abboud, City Planner
DATE: November 28, 2017
SUBJECT: Planning Staff review of Retail Marijuana in the Marine Commercial District

Planning Staff review per 21.95.040

21.95.040 Planning Department review of code amendment. The Planning Department shall evaluate each amendment to this title that is initiated in accordance with HCC 21.95.010 and qualified under HCC 21.95.030, and may recommend approval of the amendment only if it finds that the amendment:

A. Is consistent with the comprehensive plan and will further specific goals and objectives of the plan.

1. *Staff response:* This proposal to varying degrees supports the goals and objectives listed below.
    a. 2008 Comprehensive Plan Chapter 8, Economic Vitality Goal 1, Define and encourage economic development that meets the desires and interests of Homer residents and positively supports the unique character of the community.
    b. 2008 Comprehensive Plan Chapter 8, Economic Vitality Goal 1, Define and encourage economic development that meets the desires and interests of Homer residents and positively supports the unique character of the community, economic development strategies;
        1. #2, Encouraging the production or sales of goods and services to better serve the local economy.
        2. #3, Amend land use and taxation regulations to encourage production of custom or unique products to sell locally and outside the community; such as art, technology, or value added seafood products.
        3. #4, Encourage “import substitution;” i.e., leakage control by producing locally what is otherwise imported. An example is the local farmer’s market, which provides produce which would otherwise be trucked into the community with profits leaving the community
    c. 2008 Comprehensive Plan Chapter 8, Economic Vitality Goal 2, Encourage the creation of more year-round, higher wage jobs, implementation strategies;

i. #3, Ensure that zoning and land use regulations do not unduly restrict entrepreneurial development and new business formation. Also ensure that the value of adjacent property is not degraded through noise, odor or similarly negative impacts.

ii. #6, Promote and enable small-scale employers who may have different land use and infrastructure needs than one or two-person sole proprietorships.

iii. #10 Establish and maintain consistent municipal standards and policies relating to the establishment and/or expansion of business activities on private and municipal lands.

iv. #13 Examine and replicate appropriate regional successes.

B. Will be reasonable to implement and enforce.

Staff response: Working in conjunction with state officials in the highly regulated industry, the addition of the use will be reasonable to implement and enforce.

C. Will promote the present and future public health, safety and welfare.

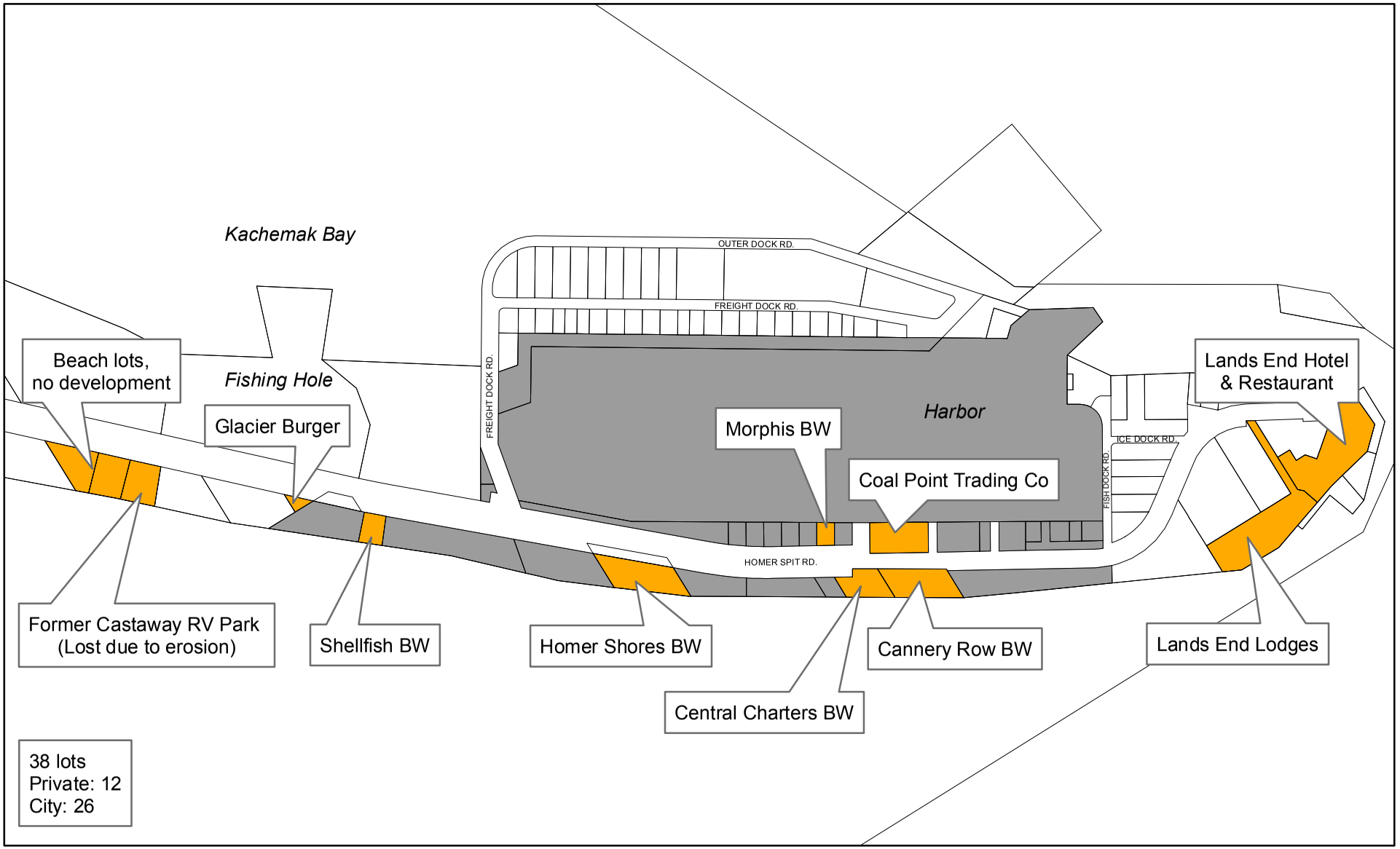
Staff response: This amendment promotes health, safety and welfare by locating the industry in a commercial area that is regulated in order to limit incompatible uses.

D. Is consistent with the intent and wording of the other provisions of this title.

Staff response: This amendment has been reviewed by the City Attorney and is consistent with the intent, wording and purpose of HCC Title 21.

STAFF COMMENTS/RECOMMENDATIONS:

Planning staff has reviewed the ordinance per 21.95.040 and recommends the Planning Commission conduct a public hearing, and make a recommendation to the City Council.



Legend

Owner

- Private
- City

Disclaimer:
It is expressly understood the City of Homer, its council, board, departments, employees and agents are not responsible for any errors or omissions contained herein, or deductions, interpretations or conclusions drawn therefrom.

Marine Commercial Properties on the Homer Spit

November 15, 2017

Feet
0 250 500 1,000

City of Homer
Planning and Zoning Department

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MEMORANDUM

TO: CITY COUNCIL AND MAYOR ZAK

FROM: CANNABIS ADVISORY COMMISSION

THRU: RENEE KRAUSE, CMC, DEPUTY CITY CLERK

DATE: AUGUST 28, 2017

SUBJECT: RECOMMENDATION TO AMEND ZONING ON THE HOMER SPIT TO ALLOW CANNABIS

At the regular meeting of the Cannabis Advisory Board the following recommendation was discussed and passed regarding forwarding a request to Council to consider amending the zoning on the Homer Spit to allow commercial cannabis. Following is the excerpt from the minutes of that meeting reflecting the discussion and subsequent motion:

NEW BUSINESS
B. Cannabis on the Spit – Recommendation to Council to Amend the Regulations to allow Cannabis Operations on the Spit

City Planner Abboud briefly clarified that the memorandum in the packet was referring to city owned land when saying that the city would not approve cannabis related businesses and that was advice received from the City Attorney. Private owners are allowed.

Additional discussion on the lack of support from the current City Council a recommendation to reconsider zoning for cannabis on the spit might receive and the responsibility and job of this commission ensued.

HARRIS/LEWIS - MOVED TO FORWARD A RECOMMENDATION IN SUPPORT OF CANNABIS BUSINESSES ON THE SPIT AND THAT CITY COUNCIL REVIEW HOMER CITY CODE TOWARDS THAT GOAL.

Discussion ensued on reasons for prohibiting businesses on the spit, it is not the City's responsibility to govern how, when or what the public does with the merchandise as long as it was purchased legally; it was noted that the US Coast Guard still enforces the regulations against marijuana on vessels and if there was a business in town a passenger could purchase it there and they would have no control over what happened after that it was further noted that there were private property owners on the spit that were interested but were unable to have commercial cannabis since it is not zoned.

VOTE. NON-OBJECTION. UNANIMOUS CONSENT.

Motion carried.

City of Homer
www.cityofhomer-ak.gov

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Memorandum

TO: PORT AND HARBOR COMMISSION

FROM: RICK ABBOUD, CITY PLANNER

DATE: October 10, 2017

SUBJECT: Retail sales of marijuana in the Marine Commercial District

At the August 28th meeting of the Cannabis Advisory Commission a motion was made for the City Council to support an allowance for marijuana businesses to be located in the Marine Commercial District.

The Planning Commission last had a discussion about the allowance of retail marijuana facilities in the Marine Commercial District in November of 2015. Several members of the public, including the owners of a boardwalk, testified against the provision. The motion for allowing the activity failed for lack of a majority, ending in a 3-3 vote.

At this time, the city has been advised against supporting marijuana businesses on city property in order to not aggravate the city's relationship with the federal government. Practically, this activity would be a consideration for only privately owned property at this time, although the provision would comprise the entire Marine Commercial District.

In consideration of the purpose of the Marine Commercial District, I believe it would be best to only consider a provision for the retail sales as manufacturing, testing, and cultivation is best addressed in districts where there is not so much emphasis on water dependent activities.

The Port and Harbor Commission is asked whether or not if it supports retail marijuana businesses in the Marine Commercial District. The recommendation will be forwarded to the Planning Commission and then the City Council for consideration.

Att.

CC Memo from CAC

- Stall Retention is higher than previous years and the Harbor desperately needs new stalls to lower the stall retention.
- Fished the LED project with Puffin Electric and have seen some good results
- Small Boat Harbor Potable Water , Fish cleaning Stations, and the ECO barge have all been shut down and winterized
- The Deep water Dock inside berth fender attachment points are breaking off. Repairs are being made, but some bigger repairs will need to be made in the near future to keep this from happening.
- AAHPA has two Resolutions that they would like the City of Homer to Support.
- Harbor Facility Grant Program was used to replace the Floats in the City of Homer Harbor. This is the only funding that the State provides that goes directly to the Harbor.
- Agenda was included for the AAHPA Conference in Petersburg, Alaska

Harbor Master Hawkins stated that if anyone has questions about the AAHPA Conference or the Agenda to contact him at a later time to discuss it.

PUBLIC HEARING

PENDING BUSINESS

NEW BUSINESS

A. Marijuana Zoning on the Spit

I. Memo from Planning Commission To Port and Harbor Advisory Commission Re: Retail of marijuana in the Marine Commercial District

II. Memo from the Cannabis Advisory Commission to City Council Re: Recommendation to Amend Zoning on the Homer Spit to Allow Cannabis

Commissioner Zimmerman stated that in the past the Port and Harbor Commission had made a recommendation to City Council to allow marijuana on the Spit. However, he could not recall that the recommendation went forward to City Council and asked if anyone on the Commission remembered if the recommendation was heard. Harbor Master Hawkins replied that he believe the recommendation did go before City Council and that City Council voted against the Port and Harbors recommendation.

The Commission discussed the Memorandum from the City Planner and clarified that the recommendation would only be for privately owned property at this time.

Commissioner Zieset stated that since the Federal level has not yet recognized marijuana usage, that it may be wise for the City to restrict the use to privately owned property only.

Commissioner Hartley asked if the US Coast Guard still enforced the regulations against marijuana on vessels. Commissioner Stockburger clarified that the US Coast Guard, the FAA, and the DOT all enforce regulations against the use of marijuana in any kind of transportation.

STOCKBURGER/ ZIESET- MOVED TO FORWARD A RECCOMENDATION TO THE PLANNING COMMISSION AND TO CITY COUNCIL IN SUPPORT OF MARIJUANA RETAIL ON PRIVATELY OWNED SPIT PROPERTY.

Commissioner Zieset echoed his earlier comment. He believes it is wise to keep marijuana retail off of the City leased properties until there is a general idea of how everything will be run.

VOTE: 4 YES 0 NO. UNANIMOUS CONSENT.

Motion Carried

B. Purchase of Lot 42 on Homer Spit

I. Memo from City Manager to Port and Harbor Commission Re: Purchase of Lot 42 on Homer Spit.

II. Draft Ordinance from City Manager Koester and Exhibit A map Overlay Sketch from TLO

Commissioner Stockburger asked Bryan how the City got into this mess with the Mental Health Land Trust to begin with.

Harbor Master Hawkins replied with a brief history between the Mental Health Land Trust and the City of Homer on Lot 42. In 1964 there was a different plat in place that was obliterated due to the 1964 Earthquake. The City re-platted that section of the Spit and gave notice to the State that the previous plat was void. Two years later the Borough became the Platting authority and also recognized the City's re-plat of the Spit. Now, the Mental Health Land Trust is stating that some of the previous plat still applies and was never voided. The City was served with a trespass notice, and since then has been in discussion with the Mental Health Land Trust. There was a special meeting held between the City of Homer and the Mental Health Land Trust with attorneys present, and the outcome was the compromise brought forth now. The City of Homer is not admitting that the Mental Health Land Trust owns Lot 42, but has taken the attorney's fees and everything else at risk into consideration. Ultimately, the City feels that buying Lot 42 would be the wisest and cheapest option moving forward.

The Commission clarified the property line of Lot 42 and had a small discussion about Mental Health Land Trust relinquishing their rights to the other Lots, along with the City purchasing Lot 42 for $550,600.

Harbor Master Hawkins stated he looked at the business opportunity like this; "if I were looking back on this deal 10 years from now, would I see it as a bad deal?" He believes this deal is one that will benefit the City and the Harbor for years to come, so he doesn't think this is a "bad deal".

Commissioner Zimmerman expressed that his only issue with this deal is that the City is taking the money out of the General Fund, which in return the Harbor has to pay back plus interest. The City should pay for Lot 42 and not make the Harbor pay back interest, because it's in the best interest for the entire City, not just the Harbor.

Harbor Master Hawkins explained that this is the agreement that he and the City Manager has come up with, the other option would be for the Harbor to pay for the Lot out of their reserve fund, which they did not see feasible.

From: Jeremiah Emmerson
To: Department Clerk
Subject: Cannabis Advisory Commission Recommendations
Date: Wednesday, September 06, 2017 12:50:07 PM

City clerk,

Please send this to all council members or add this to the next agenda packet. Thank you.

--

Dear Council,

As you all are probably aware, the Cannabis Advisory Commission has made a recommendation to you to make a zoning change and allow cannabis retail establishments to operate on the spit.

I fully support their recommendation and believe it would be an acceptable way to bring more jobs and revenue to the City of Homer. It seems many always ask and consider, how do we bring jobs and new revenue to Homer?

First of all you need a retail outlet in town for this to happen. We have one retail license in limbo right now on Ocean Drive and my guess is they will be approved as this isn't their first rodeo with the state. This will be their second establishment.

I would have prefered that it be a Homer resident or local, but this will do for now and opens up the door for other local cultivators (such as myself) to have an incentive to start a cultivation and extraction facility. I know of several others who have expressed the same desire to go to a local outlet.

I do not want to license and then have to drive 2+ hours one way to deliver products. I would much rather retail at my local Homer retailer and service local residents within the legal market.

I know of at least 3 Homer locals who had plans to build a retail establishment on the spit last year before zoning pushed them out. Their plans were crushed by the council last year. One of them had to sell his building he had purchased to start a retail establishment. Others were simply hosed out of an opportunity that many in the rest of the state were able to take advantage of.

I've said it before and I will say it again; Homer is losing out on new revenues while other port cities, including Juneau, Sitka, and Valdez all have retail establishments and aren't having the issues that some folks predicted would happen.

I've heard just about every single concern folks have about spit retail and I will try to provide my opinion on the matter and hope that you will not only consider it, but actually listen..and do the right thing for Homer.

#1- Drugged Driving; You DO NOT have to approve licenses that have an onsite consumption endorsement. The city needs to be aware that they can reject these types of establishments. If

the city wanted to take a small step and just open spit retail up (with no onsite consumption) they can do so. If you do decide to go that route please consider that there will be people (tourists) smoking in their vehicles or hotels or on the beach as they may not have anywhere to go (except for their RV which would be acceptable and outside of a public place).

The city could do a conditional use permit for onsite consumption with stipulations that the establishment provide an operating plan that highlights HOW the establishment will take steps to keep people from leaving their establishment while stoned. If they can provide an acceptable plan and follow through with it, I don't see where there would be a problem.

#2- Cannabis on Boats or Planes; Cannabis is already on boats and planes and there has been 0 federal interference thus far. It flies in and out of Juneau and Sitka regularly. How else would these folks be able to move their product back and forth to the testing lab or to other establishments?

Every business also has their own policies and as an employee in the charter industry I can tell you that our business doesn't accept it on the boat and each time we brief our passengers we inform them that their is no tolerance for cannabis or other drugs on the boat and we have posted signs on the boat. From there, the customer makes their own choice and are liable to be kicked off the boat if they bring it on. This mostly has to do with the Coast Guard regulations and something already being dealt with.

#3- Law enforcement concerns; Mark Robl has made the statement that he is worried about second hand inhalation when entering a cannabis establishment with onsite consumption. These are actually valid concerns, however, it is much harder to obtain a contact high or test positive for cannabis from second hand smoke than most believe. Studies have been done to show that the likelihood of this occurring is low. If the police department wanted to purchase "gas masks" or filter masks that can filter out the smoke, that would be acceptable and an understandable expense.

I urge the city council to have an open mind about this issue. You told us that if the zoning was too strict you would loosen things up. Here is your opportunity to fix the wrongs of the past. There are more improvements to be made, however, this would be a big step and a boon to our economy and tourism offerings.

People have asked numerous times, where do I go to get it? We need to be able to answer that question and provide our guests with an outlet or they will spend their money in Anchorage, Kenai, or Sterling on the way in or out.

Warm Regards,

Jeremiah Emmerson

Memorandum 16-017 from City Planner as backup.

Mayor Wythe called for a motion for the adoption of Ordinance 16-04 for introduction and first reading by reading of title only.

LEWIS/REYNOLDS – SO MOVED.

REYNOLDS/LEWIS - MOVED TO AMEND TO STRIKE SECOND READING ON FEBRUARY 8TH AND HAVE A PUBLIC HEARING ON FEBRUARY 8TH AND A SECOND PUBLIC HEARING AND FINAL READING ON FEBRUARY 22ND.

Mayor Wythe and Council expressed the need for an additional public hearing for people that are concerned or interested in the ordinance. Council may have changes to the ordinance also.

VOTE: (amendment) YES. NON OBJECTION. UNANIMOUS CONSENT.

Motion carried.

LEWIS/REYNOLDS – MOVED TO AMEND THE CENTRAL BUSINESS DISTRICT (CBD) WHICH IS CUP (CONDITIONAL USE PERMIT) ONLY TO HAVE IT TO WHERE IT IS PERMITTED OUTRIGHT.

The amendment would require complaints to be presented at the state level instead of litigation against the city.

Asked about the liability of the CUP process, City Attorney Wells advised the CUP process has criteria with substantially related terms and wiggle room that creates vulnerability for legal challenges. Communities are putting a moratorium on the CUP process while others are using CUPs. It comes with legal costs that cannot be predicted. We will have a better understanding once the industry gets going in communities that are using CUPs.

Councilmember Lewis reminded Council the City has had a lot of litigation on CUPs and zoning issues. He would just as soon pass that cost off to the State instead of us bearing that cost.

VOTE: (amendment) YES. LEWIS, SMITH, ADERHOLD, REYNOLDS, ZAK, VAN DYKE

Motion carried.

Councilmember Van Dyke commented on Marine Commercial. The Homer Spit draws people from all over the state with families. There is the Homer Ice Rink, Nick Dudiak Fishing Lagoon, and parks and campgrounds up and down the Spit. Each one has tons of families and children. He would like to see no cannabis activity on the Spit.

VAN DYKE/SMITH– MOVED THAT MARINE COMMERCIAL BE A NO SALE ZONE.

Councilmember Lewis questioned the depiction of the Spit as a great, wholesome place with Salty Dawg Saloon, other bars and liquor stores, and five or six guys sitting out at night after a day's charter pounding down beers. It's not a good analogy to restrict the cannabis business there. On his visit to Denver he did not see derelicts hanging outside. There are laws on advertising.

Councilmember Smith asked what the economic benefit is that we are projecting versus the social costs.

Councilmember Lewis answered the problems are already there; we aren't going to bring anything new. The product and alcohol are there and some will use both. Those that want to use one or the other will use one or the other. It will not create more smoking and driving. Those that are going to do it will regardless if it is legal or not.

Mayor Wythe commented the majority of properties on the Spit are City of Homer properties. In complying with the eight guiding principles to keep us out of the federal target zone, one of those is growing marijuana on public lands and the public safety and environmental dangers posed by marijuana production. Although there wouldn't be marijuana growing on the Spit, people could not lease city properties to sell marijuana. We can start smaller and if it makes sense we can grow.

VOTE: (amendment) YES. ADERHOLD, ZAK, SMITH, VAN DYKE
VOTE: NO. REYNOLDS, LEWIS

Motion carried.

ZAK/VAN DYKE – MOVED TO AMEND TO MAKE THE HOMER SPIT A BUFFER ZONE.

City Planner Abboud advised no buffer is needed if Marine Commercial is a no sale zone. Adding a buffer to the Spit could be decided by the Planning Commission at a later date.

VOTE: (amendment) YES. VAN DYKE, ZAK, SMITH
VOTE: NO. REYNOLDS, ADERHOLD, LEWIS

Mayor Wythe broke the tie with a NO vote.

Motion failed.

ADERHOLD/LEWIS - MOVED TO AMEND LINE 20 to CHANGE the WORD "MANUFACTURER" TO "MANUFACTURE."

There was no discussion.

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Memorandum 16-017

TO: MAYOR WYTHE AND HOMER CITY COUNCIL
THROUGH: KATIE KOESTER, CITY MANAGER
FROM: RICK ABBOUD, CITY PLANNER
DATE: JANUARY 14, 2016
SUBJECT: DRAFT ORDINANCE PROPOSING TO ZONE MARIJUANA RELATED ACTIVITIES WITHIN THE CITY OF HOMER

The Planning Commission has been working on this item since August. It has been an agenda item at six meetings, two of which have been public hearings. This proposed ordinance deals specifically with zoning regulations for the four activities defined by the state: Cultivation; Limited (small - under 500 square feet) and Standard (large - more than 5000 square feet), Manufacturing, Retail, and Testing. The best way to express this is the table below and the map attached. At this point, there is no distinction for zoning purposes between limited and standard cultivation operations.

Our goal with this ordinance is to provide a place to start with the regulation of the industry and to have some options available prior to the date when the state is scheduled to accept applications, February 24th. This will allow the City Council to introduce and hold two public hearing prior to this date. The Planning Commission wants to allow the industry to start in a somewhat limited area until we gain more experience, with the thought it would be much easier to loosen rules in the future rather than try to ratchet it back later and leave nonconformities behind. If the Council recommends something that needs to be review by the Planning Commission, I recommend passing the parts of the ordinance that are acceptable to the Council, so that entrepreneurs have reasonable options to apply for a license February 24th. If no ordinance is adopted, commercial marijuana will be an unlisted use, meaning every application will be a conditional use with a fairly high threshold for approval. This is an unreasonable expectation.

It is important to consider the regulation that is proposed by the state when considering the regulations proposed by the city. We may not propose anything that is more liberal than what the state proposes. A brief summary of the state regulation is provided and attached is the regulation proposed at the time of this report.

A = Allowed (reviewed by the Planning Office). C = Conditional Use Permit needed (hearing before the Planning Commission required).

Table 1. Cannabis Activity by Zoning District

	District						
Activity	CBD	GC1	GC2	EEMU	MC		
Retail	C	A	A	A	C		
MFG	C	A	A	A			
Testing	A	A	A	A			
Cultivation							
small	C	A	A	A			
large	C	A	A	A			

The Planning Commission also proposes some buffer distances in addition to the state provisions. These buffers are based on the federal governments' double penalty zone as defined in US Code. This includes 1000 feet buffers from the two colleges, the Alaska Bible Institute and the Kenai Peninsula College. 1000 feet buffers from Karen Hornaday, Jack Gist, Bayview, and Ben Walters Parks are also recommended. Another recommendation is a 200 foot buffer from the library. The language used by the state and the federal government does not describe a library, but after a request from the Library Advisory Board, the commission did recommend a 200 foot buffer. This buffer with the buffer extended from the college and consideration of the uses and ownership of nearby properties realistically ensures that operations will not be proposed anywhere in close proximity to the library. The combination of the library and college buffers, and existing land uses and land ownership (post office, banks) realistically ensures that operations will not be proposed anywhere close to the library.

You will surely be made aware of a petition that proposes that limited cultivation be allowed outright in the Rural Residential District and that marijuana activities be allowed outright in the Central Business District. Both of these subjects have been discussed at length by the Planning Commission. The commission believes that the limited cultivation in the Rural Residential District is too commercial to meet the purpose of the district. A limited cultivation operation is required by the state to have exterior lighting to facilitate surveillance (including within 20 feet of each entrance), a security alarm on all windows and doors, and continuous video monitoring. Approval for a commercial business from the Fire Marshal is required. All persons dealing with the product must have a marijuana handler permit. There must be a plan for odor control to ensure that it is not detectable off the premises. This is just a sampling of the many requirements of the state licensing requirements found in the final regulations through 12-1-15. Another concern about limited cultivation in the Rural Residential District is density. Because of the city regulations for lot size, many lots that have access to water and sewer are small. In any event, the commission would not entertain commercial activities on lots less than 20,000 square feet (about half an acre). In addition, there was discussion about the minimum distance between a commercial grow operation, and the adjoining property. In the end, commercial cultivation was not recommended for the district.

The Commission also thought that cannabis activities in the Central Business District would be best with additional review of the Planning Commission and an opportunity for neighbors to be noticed and participate in the hearing.

State of Alaska

While the City is looking at regulating relatively small aspects of the industry, the meat of requirements are found in the proposed regulations of the state. These regulations are quite extensive. There are requirements (Article 7) that apply to all of the activities along with more specific requirements that address each of the 4 individual licensing areas individually. One really needs to understand the state regulations to get an accurate picture of what these businesses may look like when approved. There are 127 pages that compose articles 1-9 of the proposed state regulations. I have highlighted some of these below, and draw particular attention to those that are a relevant consideration for zoning.

Many aspects of marijuana businesses are regulated by the state including:

- All waste disposal
- Transportation of the product
- Signage and advertising
- Inventory tracking
- No odor may be detectable off site

- None of the product may be consumed in any licensed facility (with the exception of the newly proposed consumption component of the retail license-more rules to come)
- No facilities may reduce or expand without board approval
- No delivery off-site
- No operation between the hours of 5 am and 8 am
- All business activities must be secured. This means that cameras and lighting needs to be adequate to identify those inside the facility and anyone within 20 feet of the outside entrances.
- Commercial grade locks will need to be installed.
- State application procedures require announcement in the newspaper for 3 consecutive weeks and announcements on the radio twice a week for 3 consecutive weeks, as well as on-site and nearby postings.

The state has proposed buffers such as:

- 500 feet from a school, a recreation or youth center, a building which religious services are regularly conducted, or a correctional facility.

Other aspects of the industry not addressed

During our conversation with the commission we received testimony and talked about other aspects of the industry not related to zoning such as; public consumption, driving under the influence, and a host of other concerns related to consumption. These items are for the police. Another item that came up frequently is the cannabis club or cafe. I put this in two categories.

I consider the cannabis club as a fraternal organization of sorts. This is not open to the general public in the sense that you have to be a member to enter, think ELKs. In this case, I would treat this use as the 'run-of-the-mill' fraternal assembly. The fraternal assembly may do anything that is not against the law. If they break the law, it would be the business of law enforcement to address.

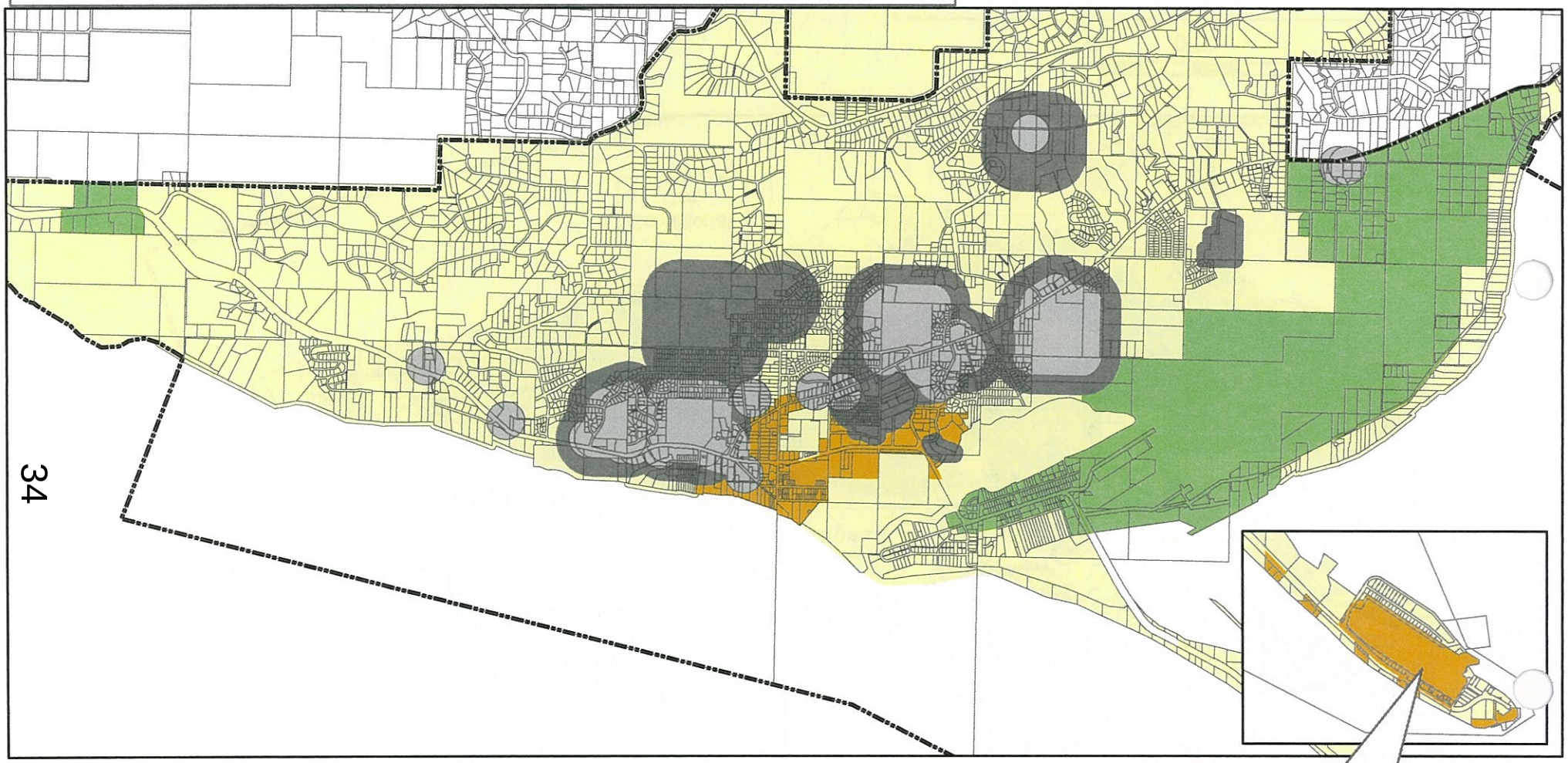
I would describe a cannabis café as a place open to the general public where sales and consumption take place. The state is working on an allowance for a retail marijuana store to have a place for consumption. We do not have the specifics of this yet, but it is in the realm of a state licensed activity. I will not propose provision in city code for an activity that is not recognized by the state. If the state rules change in the future, the City can address it at that time.

Att.

1. Ordinance 16-04
2. Commercial Cannabis Cultivation Map 1/25/16
3. Commercial Cannabis Retail and Manufacturing Map, 1/25/16
4. State Regulations

January 6, 2016 Public Hearing Version Homer Advisory Planning Commission
2016 Commercial Cannabis Retail and Manufacturing Map.
Testing is allowed outright in the green areas, and in downtown Homer.

Questions? Contact City Planner Rick Abboud



Legend

- City Limits
- State Buffers
- Additional City Buffers

Commercial Cannabis Activites

- Retail by Conditional Use Permit
- Retail allowed outright, Manufacturing by CUP
- No Commercial Cannabis Businesses

Proposed state regulations call for buffers to be measured between the public entrance of the cannabis business, and the public entrances of churches and jails. Distances for schools and youth/rec centers are measured from the boundaries to the front door of the cannabis business. All distances are measured by the shortest pedestrian route.

Presentations

Reports

A. Staff Report PL 15-74, City Planner's Report

City Planner Abboud reviewed his staff report.

Public Hearings

Testimony limited to 3 minutes per speaker. The Commission conducts Public Hearings by hearing a staff report, presentation by the applicant, hearing public testimony and then acting on the Public Hearing items. The Commission may question the public. Once the public hearing is closed the Commission cannot hear additional comments on the topic. The applicant is not held to the 3 minute time limit.

A. Staff Report PL 15-75 Zoning for Marijuana

City Planner Abboud reviewed the staff report.

Chair Stead opened the public hearing.

Jackie Dentz, city resident, commented in opposition to allowing retail sales on the spit because it's a recreational area. She owns Frosty Bear Ice Cream parlor which draws kids, families, and elderly visitors. She also noted visitors from cruise ships are not allowed to bring marijuana on the ship. She doesn't think a retail establishment for marijuana belongs on the spit. She is fine if locals want to buy it and if it's done safely, but encouraged the Commission to think about where they recommend putting retail.

Crisi Mathews, city resident, owns a boardwalk on the spit and real estate in town with her husband Chad. She commented that a CUP is warranted for any grow or retail facility in a residential area, she thinks they will hurt residential property values. She also expressed opposition to allowing retail for marijuana on the spit. She noted several recreational venues that draw youth and families throughout the summer including Islands and Ocean, Alaska Coastal Studies, and HOWL which conduct many of their outings on the beaches, trails, docks, and campgrounds, as well as the Kevin Bell arena in the winter. She added that if retail is allowed and is available year round, there will be minimal oversite as a majority of the area shuts down off season. With a business in Homer and rental cabins in Anchor Point, as well as raising four children here, they have a lot of vested interest in seeing this continue to be a family community.

Chad Mathews, city resident, added that there are buildings on their boardwalk. The way it is worded now, the people who own those buildings, don't have to their permission as the boardwalk owner, to open a dispensary. He encouraged that be readdressed. He thinks with the amount of accidents and almost accidents they see on the spit and impaired drivers could be an issue, as well as the potation for increased break in attempts.

Garth Bradshaw had a business on the spit for many years and his preference is no sales at all within the community, as other communities in Alaska have done. He encourages them to follow suit. That being said, if they allow one person to sell it, how will they restrict others? He suspects there will need

to be limits on licenses, like with alcohol. He supports not selling it in Homer at all, his adult kids and his grandchildren are here and he doesn't like the exposure, and doesn't think it's the thing to do to our community.

Megan Murphy attempted to comment regarding the Waddell Park 2016 Replat Preliminary Plat. It was explained that topic would be addressed under Plat Consideration and if she was unable to stay, she could contact the planning staff for more information regarding the preliminary plat.

Shlomo Gherman commented that if the recreational sale of marijuana in town is done right it could be really effective, specifically bringing in more taxable revenue to the city. We could have a PFD type situation for many of the people living here. Colorado school district received $6 million in additional funding from sales. No matter where you place a dispensary, once it's known the town has one, there is no stopping purchasing it. Whether it's on the spit or in town, it won't really make a difference, the real concern is managing how it's sold and who is able to purchase. It's very accessible now. If the issue is stoned people on the spit, they are already there.

There were no further public comments.

City Planner Abboud said limiting the number of establishments will be in the code under licensing and not zoning. He will have something on the next agenda for the Commission to make a recommendation.

VENUTI/STROOZAS MOVED THAT EAST END MIXED USE AREA BE ALLOWED TO HAVE SMALL VOLUME CULTIVATION.

There was brief discussion to clarify small grow operations would be allowed anywhere in the district with this motion. Other comments were that this should be more restrictive to begin with.

VOTE: YES: STEAD, VENUTI, STROOZAS, BRADLEY
NO: HIGHLAND, ERICKSON

Motion carried.

HIGHLAND/VENUTI MOVED TO ADD A CUP FOR ALL SMALL CULTIVATION IN RURAL RESIDENTIAL.

Commissioner Highland commented that rural residential is the largest district, it is family oriented, and there are a lot of lots over 40,000 square feet. Allowing it outright doesn't give the residents the opportunity to speak about small grow operations in their neighborhood. Lighting is also an issue, as well as security, in rural residential.

It was noted that currently no small cultivation is allowed on lots under 20,000, and this motion allows it in all of rural residential with a CUP. It would include the smaller lots if approved as presented.

ERICKSON/HIGHLAND MOVED TO AMEND THAT A CUP BE REQUIRED ON LOTS OVER 20,000 SQUARE FEET.

There was brief discussion.

VOTE (Amendment): NON OBJECTION: UNANIMOUS CONSENT.

Motion carried.

There was brief discussion.

VOTE (Main motion as amended): NON OBJECTION: UNANIMOUS CONSENT.

Motion carried.

There was discussion about buffers that are outlined by the state. City Planner Abboud said he would bring that back with information along with the license restrictions.

Discussion ensued regarding allowing retail on the spit and the comments from the public tonight.

HIGHLAND/ERICKSON MOVED TO DISALLOW RETAIL FOR MARIJUANA IN MARINE COMMERCIAL.

Commissioner Highland said tonight's public comments included good reasons to be concerned about retail sales out there.

Commissioner Venuti noted there are bars and liquor stores on the spit now that sell cheap liquor which he thinks is more dangerous.

Commissioner Erickson agrees with the public comments about not allowing retail in marine commercial.

Commissioner Bradley commented that a CUP is required for retail in marine commercial which is fairly restrictive.

Commissioner Stroozas expressed his thought that the fishing hole is a recreational facility for families with kids and youth based fishing events that are held there. Based on state buffers, that could justify disallowing retail on the spit. If the CUP remains in place, then an applicant complies with all the regulations, the Commission would have to allow it.

VOTE: YES: ERICKSON, STROOZAS, HIGHLAND
NO: STEAD, BRADLEY, VENUTI

Motion failed for lack of a majority.

No further amendments were proposed and another public hearing is scheduled for December 2nd.

Plat Consideration

and applicants have 90 days to act up on the license. He noted retail places won't likely have product to sell right away because cultivators would have to have a license before they could grow. He predicts the scenario would likely be the end of summer at best before product would be available.

He is working on a manageable schedule for the Comp Plan review.

Comments of the Commission

Commissioner Highland and Erickson had no comment.

Commissioner Bradley commented she is looking forward to speaking at the city council meeting on the 23rd and will be getting ahold of the City Planner for assistance with talking points. She thought the comments tonight were interesting.

Commissioner Stroozas said he expected standing room only tonight for the public hearing. It's nice to get done early. It was a well conducted meeting and thanked Chair Stead for moving things along.

Commissioner Venuti agreed it was interesting discussion tonight. He thinks that for what it will cost to get licensed and into operation on the spit for a three month season, doesn't make economic sense. He doesn't think there will be a lot of people jumping at that opportunity. Regarding commissioner comments at council meetings he encouraged that speakers work with staff to get a script or talking points to ensure they aren't giving personal feedback.

Chair Stead said he thinks they did good tonight.

Adjourn

There being no further business to come before the Commission, the meeting adjourned at 8:01 p.m. The next regular meeting is scheduled for December 2, 2015 at 6:30 p.m. in the City Hall Cowles Council Chambers. A worksession will be held at 5:30 p.m.

_____
MELISSA JACOBSEN, CMC, DEPUTY CITY CLERK

Approved: _____

It was suggested this is a good place to start, and they will have the opportunity to add CBD later if it seems reasonable.

VOTE (Amendment): YES: BOS, ERICKSON, HIGHLAND
NO: VENUTI, BRADLEY, STEAD, STROOZAS

Motion failed.

Commissioner Erickson feels there are people who will be very offended by these activities.

VOTE (Main motion): YES: STROOZAS, VENUTI, BRADLEY, STEAD
NO: ERICKSON, BOS, HIGHLAND

Motion carried.

HIGHLAND/STROOZAS MOVED TO ALLOW RETAIL IN COMMERCIAL AND INDUSTRIAL WITH A CUP.

There was brief discussion.

HIGHLAND/BOS MOVED TO EXTEND THE MEETING ADJOURNMENT 15 MINUTES UNTIL 9:45 P.M.

There was no discussion.

VOTE: NON OBJECTION: UNANIMOUS CONSENT

Motion carried.

BOS/HIGHLAND MOVED TO AMEND TO INCLUDE MARINE COMMERCIAL AS CUP.

There was brief discussion recognizing that it will be important to get public input for these activities. It was noted that they recommended testing be allowed outright with the understanding that it will be a laboratory environment.

VOTE (Amendment): NON OBJECTION: UNANIMOUS CONSENT

There was no further discussion on the main motion as amended.

VOTE: NON OBJECTION: UNANIMOUS CONSENT

Motion carried.

City Planner Abboud expressed his frustration with having to take these recommendations to the Cannabis Advisory Commission.

Commissioner Bos reiterated that this is a good place to start and there may be some changes here and there after they get public testimony.

Commissioner Highland commented that residential is mixed in most of the districts and there are ramifications of marijuana related activities that warrant something keeping it more restrictive in the beginning. If it is less restrictive and down the road we want to change regulation, we are left dealing with nonconforming uses.

Deputy City Planner Engebretsen confirmed for the next meeting staff will bring back two options to consider for rural residential, one not at all and two by CUP with rigorous standards like minimum lot size and separation distances to establish grounds to allow or deny.

There was general discussion about the lengthy process of getting licensed for an operation, and the stringent regulations for the marijuana related activities once they are licensed.

Under the manufacturing table it was suggested to eliminate CBD and include GC1 and GC2 as a CUP. Lot sizes in the CBD are too small and flammable materials are used at times in the process. Exclude Town Center and Gateway Business and Marine districts as well.

No changes were suggested for the table under testing.

Regarding retail, there was discussion of the notion of limiting the number of retail operations. Deputy City Planner Engebretsen explained that in staff's discussion, these stores can't sell other things. It raises the question how many can the community really support? The spit has a short retail season and there are a lot of hurdles to get a license from the state. It's questionable if it will be worth doing it out there. No changes were suggested.

Deputy City Planner Engebretsen said they will bring back a draft ordinance for the Commission to review.

B. Staff Report PL 15-71 Transportation Recommendations

Deputy City Planner Engebretsen reviewed the staff report.

BOS/HIGHLAND MOVED TO FORWARD THE TRANSPORTATION RECOMMENDATIONS TO COUNCIL.

There was brief discussion in support of the recommendations.

VOTE: NON OBJECTION: UNANIMOUS CONSENT

Motion carried.

Informational Materials

A. City Manager's Report September 28, 2015
B. Town Hall Potential Revenue Solutions Pros/Cons

Comments of the Audience
Members of the audience may address the Commission on any subject. (3 minute time limit)

Diamond Ridge Art Studio

November 4, 2015

City of Homer

Planning Commission

491 E. Pioneer Avenue

Homer, AK 99603

RE: Cannabis Advisory/Oversight Committee Proposed Spheres

Dear Commission Members:

In May of 2014, I opened Diamond Ridge Art Studio at 4025 Homer Spit Road, #17. My decision to locate my business there was based primarily on the nature of the prospective clientele that visits the area. The Homer Spit attracts large numbers of vacationing families, tourists, fishermen and boaters. Between May 4th and Labor Day of this year, I logged over 5,000 visitors to my gallery. Many of these visitors were families with children of all ages. Also, many were residents of Homer. I organized painting demonstrations that were attended by both children and adults, both from Homer and elsewhere. In addition, I carry art items that are appropriate for families.

The proposed city ordinance permits the retail sale of marijuana on the Spit. I would ask the Commission to consider establishing a buffer zone due to its proximity to the Nick Dudiak Lagoon, adjacent campgrounds (which serve as temporary residences) and the small boat harbor.

The Homer Spit is a seasonal retail environment. Virtually all of the businesses close for the winter. A police presence is a challenge to the city to maintain during the busy summer season and would need to become a greater presence during the winter should marijuana sales be conducted there.

I know that there are several families who would no longer come to my business for any reason if there is an establishment selling marijuana nearby. As a small business owner, I strive to attract every potential customer by providing an environment that is family-friendly and wholesome.

Homer has demonstrated its commitment to promoting tourism. The city, the Chamber of Commerce, and the business community have successfully collaborated to attract tourists and to grow the cruise

Olga Amaral, Owner
#17 Homer Spit Road
Homer, AK 99603
(907)299-7750
Diamond.ridge.art@gmail.com

ship business. Much of that is centered on the Spit. The retail sale of marijuana and cannabis products does not seem to me to be consistent with the promotion of a family-centered vacation destination.

I would welcome the opportunity to discuss this further with you and can be reached at the number listed below.

Sincerely,

Olga Amaral

Olga Amaral, Owner
#17 Homer Spit Road
Homer, AK 99603
(907)299-7750
Diamond.ridge.art@gmail.com

Dotti Harness

From: Crisi Matthews <broker@cmreagent.com>
Sent: Wednesday, December 02, 2015 3:28 PM
To: Department Planning
Subject: Public Comment for Planning Commission Meeting Tonight

I find it rather disappointing that members of the community came forward in support of limiting cannabis sales here in Homer from recreational areas such as the Spit and resulted in such minute support from the Commission. This conversation is not about alcohol on the Spit as was Council's statement in opposition of our request for restrictions to sales on the Spit. As a governing body, one member went on to read the definition of the City Code for recreation and it's facilities as they exist in Homer. In addition, the General Plan also designates OSR zones on Homer Spit and therefore it seems natural that RECREATION as defined by your code should have the same buffer zone as the 'Park' does. Children congregate in these zones while visiting Homer more than any other Zone in our City. I'm still not clear how the Council who has defined Recreation and it's Zones so clearly isn't placing any protection on them now. Buffer Zones for the zones of OSR need to be identified also as there won't be specific designations addressed in the state code such as these nor on marine OSR zones as this designation pertains to Homer not the state at large. The code limits construction so as to preserve them and their use a buffer zone here seems only logical.

To date, the state committee is still answering public questions on these same texts and they haven't completed the adoption of their guidelines as they apply to Alaska. It also states at this time that the local jurisdiction must approve a license request before the state will issue it once these guidelines are in place, so I'm not sure why there is such haste in generating Homer's guidelines ahead of the state. If ANYTHING it would seem prudent to allow them to lead not to supersede local recommendations ahead of theirs. The idea that we need to have our doors open first is extremely liberal and not reflective of the overall populous of Homer. As shown in the last public hearing the opponents far outweighed those in support and none from the Cannabis committee even attended.

According to the 2010 Census nearly 25% of Homer's population is under 19. In addition, a call to the Chamber of Commerce identified that 11,600+ visitors came into the Chamber not including the City of Homer in general from May 1 to August 31 and 9 cruise ships distributing 4500 visitor guides to these. Big draws like the Birding Week and Salmon Derby are big draws here also. It seems pretty obvious to me, a business owner in town and to the others that spoke last month requesting your expressed protection of the Spit that the Planning Commission HAS the authority and the obligation to protect the OSR Zones they've created for outdoor use. The families that live here came for all that is Homer; a safe community to raise healthy families. The residents and the visitors came for every reason OTHER than access to Cannabis Sales. Tourism is the heart of Homer's summer revenue as a City and for small time business owners that depend on the summer commerce, not a hope for retail tax from these proposed businesses.

We ask that you revisit the OSR and place a buffer zone on them just the same as you have identified for the Hornaday Park.

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Loyally,
Crisi Matthews, Broker
c: 907-299-8700
f: 888-552-2805
www.CMREagent.com

Dotti Harness

Subject: FW: Comments for public hearing December 2nd planning commission

From: Chad Matthews <info@ofishial.com>
Date: December 2, 2015 at 3:59:47 PM AKST
To: planning@ci.homer.ak.us
Subject: Comments for public hearing December 2nd planning commission

I apologize ahead of time for being a terrible pubic speaker and my wife and I can't be there tonight but ask that you be patient for a couple of serious points not only on the Cannabis subject but how I have witnessed it address by this board. Neither point will mean anything unless you know my background. So please humor me for a minute down a quick blink of my life which I promise is all relevant to this town that I/We call home. I was born and raised in San Jose California more specifically the East side "the wrong side of town". It was ridden by drugs and gangs and my father and I were only there to grant my grandmother's dying wish to live out her years in the house that my grandfather built. As much as I loved my grandmother we said every year that this would be grandma's last Christmas living in what became one of the top rated ghettos in the lower 48. My grandfather's hand built home was built in the middle of an almond orchard that in 40 years became the festering grounds for gang activity, drug trafficking and violence. There I both witnessed and was a victim of violence based on drug trade both from gang selling and at the hands of the childhood product of druged out parenting. I went to school everyday sick to my stomach about about what would happen before the day was out. To save you the long "opera' moment I have been beaten to an inch of the end of my life more than once. Many of these kids who were violent in the name of gang involvement began their drugged lives at the hand of marijuana. It was a gateway drug for them. My rear neighbors who were 5th graders had access to marijuana and sold it within the neighborhood. How is that related to the pot here, in Homer I am sure you ask as well as this is not a forum to discuss the legality legalizing it since that has already been done.

I offer further evidence of the effects of it and ask what basis anyone in this room has to offer to the affects on this town? The Cannabis of the 70s when pot was a fraction of the potency and was a part of a free loving era that was the platform of counter capitalism has evolved. Those who believe the legality is just are ignoring that it is a controlled substance and it has become a more potent, more marketed, more effectively and illegally grown product that has lead to continual growth and profitability of major gangs and cartels that have changed everything from those fun loving hippy days. My story does not end there, at 13; the year before my grandmother passed and I had an out to get out of the ghetto based on my parents' divorce. I moved with my mother to a small dairy town in the Central Valley of California. This is the town that shaped me but I've been told by the teachers there that we were the last good class to come through a long history of a good wholesome town. Even my younger brother was on the wrong path. He harmlessly thought smoking pot was a good idea in contrast to myself who saw the devastating effects as a kid in the ghetto. I have not spoken to him in 10 years. He now sells marijanua through California's medical marijuana laws, he has multiple convictions of driving under the influence and theft still living with our mother at nearly 30 years old. I watched his demise which started with pot.

As an adult man legally hunting pigs in the mountains of California, I've been shot at by those growing illegally on forestry land. The crime report we produced for this board a month ago regarding the effects of legalization in Colorado, who read it? Was it a priority to look at those unbiased statistics before making decisions on how it will be implemented here before THE STATE OF ALASKA has even completed it's editing process of this document to serve as our template here in Homer?

Back to this board their basis for addressing this issue. In the first meeting I addressed specific questions that were brought up but not addressed in discussion since they clearly did not conform to what apprearded to be personal agenda. Only one proponent without a logical presentation showed up

to the meeting to state 'it's already here' in our town yet the appeal by business owners who are the lifeline of the City's revenue was largely ignored. 44% of the City's Budgeted Revenue is generated by taxes; sales and property therefore, why would the Plannign Commission ignore that this is largely based on the series Homer currently offers; safety, community, clean wholesome family activities and tourism of this town? When only 2 of the board both Roberta and Shelia tried to address questions by the people they were shut down or it was likened to rot gut sales on the Spit which has nothing to do with this issue nor minimized in light of alcohol a legalized and VERY REGULATED industry. How is it that in representing the people, their comments are ignored? What experience (like mine in seeing direct result of loose oversight of controlled substances) does the rest of the board have in this matter? I'm not sure why in Homer there is the need to be the trendsetter with this legislation in rushing to approval ahead of the state? I don't see more advocates for looser restrictions appearing than the opposite asking for more restriction. I'm a staunch advocate of the exact draw there is for people to Homer—1. tourism, 2. family based community 3. small town and low crime rates
The mission statement of Homer is:

The City of Homer Community Recreation will promote community involvement and life-long learning through educational and recreational opportunities for people of all ages. This will be accomplished through maximizing usage of all community facilities and resources, while utilizing, expanding and uniting local business and school resources and expertise. Our program shall be designed to recognize cultural diversity and to address social and community concerns.

Is your direction to allow pot retail in nearly all parts of Homer a reflection of that?
Do you see the need for liberal Cannabis legislation to be paramount to building our community and the families here? You've outlined Recreation should have a buffer and in the General Plan there are numerous OPEN SPACE RECREATION areas and you further defined those at the last meeting per the City Code yet no consideration is being given to a buffer zone for those even at the request of those who conduct business there. I'm a little frustrated as I have seen first hand the effects of liberalization and left behind all of that for a place to conduct a family-run business and a community like many here to raise our family.

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O'Fish'ial Charters of Alaska
Capt. Chad Matthews
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Staff Report PL 18-06

TO: Homer Advisory Planning Commission
FROM: Rick Abboud, City Planner
DATE: January 17, 2018
SUBJECT: Natural Hazards Planning

Introduction

Last meeting I provided a few chapters in a PAS report to better familiarize you with landslides and mitigation for events. Right now, I wish to provide you with more information and an update on proposed activities.

Analysis

After learning more about landslides and actions that may be taken to mitigate dangers, I have concluded that we will need more information about the specific conditions before we might develop any additional regulations.

I see the issues in the Mount Augustine areas breaking down into two categories, mitigation and zoning. Mitigation activities would be those that might physically affect current development. Some mitigation activities might include relocation or infrastructure improvements to address hazards. Zoning actions focus on regulating future development. The Commission was asked to respond with zoning recommendations.

I have contacted the state and expressed my desire to seek funding for both types of activities. The state is partnered with federal agencies to provide support on multi-hazard mitigation efforts that could potentially help us address our concerns. On the mitigation side, I am looking for programs that might provide funding to address opportunities for buyout. For zoning and planning for the future, I am seeking out funds to help us better define and map our geologic hazards. I believe that mapping and better understanding the hazard will help us with both zoning and in consideration of mitigation. I should receive some preliminary feedback in the next few weeks.

I have found more information on landslides through the USGS at https://landslides.usgs.gov/learn/ls101.php. Links on the bottom of the page lead to The Landslide Handbook and A Homeowner's Guide to Landslides for Washington and Oregon. The handbook covers much of the material that I provided last week and depicts many of the physical strategies for dealing with landslides. It didn't take long for me to see that Earth slope

stabilization/mitigation efforts are generally major projects with significant costs. After input from a geotech specialist, the most appropriate methods may be determined. If you would like to have a printed version of these resources please let us know.

The rest of the PAS report included in the packet is a collection of case studies. These studies show past responses to landslide hazards. You will quickly see that responses rely on interpretation of highly scientific data. It seems our work is cut out for us at this time. First we need to inventory the data available to us, determine what additional data is needed, get additional data (if needed), and then get someone to evaluate the data and make recommendations.

Staff Recommendation
Review information.

Attachments

1. Schwab, Gori, and Jeer (2005). *Landslide Hazards and Planning* (Chapters 4-7). Chicago, IL: American Planning Association.

CHAPTER 4

Geologic Hazard Abatement Districts (GHADs)

This chapter is contains two articles. The first, by Daniel J. Curtin, Jr., and Shawn J. Zovod, describes what a GHAD is, how California has employed them, and how they might be improved. The second part, by Sanjay Jeer, discusses how practitioners need to weigh the risk transfer aspects of GHADs.

CALIFORNIA'S EXPERIENCE WITH HAZARD MITIGATION THROUGH GEOLOGIC HAZARD ABATEMENT DISTRICTS

By Daniel J. Curtin, Jr. and Shawn J. Zovod

Daniel J. Curtin, Jr., a member of the firm of Bingham McCutchen LLP in the Walnut Creek, California, office, concentrates his practice on local government and land-use law representing both private and public-sector clients. He is the author of numerous publications on California land-use and subdivision law, including *Curtin's California Land Use & Planning Law*.

Shawn Zovod is counsel to the firm of Ebbin Moser + Skaggs, LLP, specializing in land-use and natural resources law. She counsels numerous private property developers and public agencies. Her practice focuses on various aspects of the development process, including the preparation and processing of environmental documents under the California Environmental Quality Act and compliance with state and federal endangered species and clean water laws.

California's Geologic Hazard Abatement Districts—commonly referred to as GHADs (pronounced "gads")—are governmental districts formed to prevent, mitigate, abate, or control landslides, land subsidence, soil erosion, coastal erosion, and similar geologic hazards. GHADs provide a regulatory mechanism to finance and implement long-term abatement and maintenance of properties potentially susceptible to geologic hazards. Abatement may include, for instance, shoring up the bottom of a hill to prevent the slope from sliding. Maintenance may include the routine monitoring and draining of water from hillsides. Unlike special assessment or local administrative districts, GHADs are political subdivisions of the state and have unique authority that overlaps public and traditionally private responsibilities.

In recent years, GHADs have become a popular local planning tool and are now used across California to mitigate site-specific hazards in both existing and new development. Northern California has about 15 GHADs, and a few more exist in coastal communities in central and southern California. Some communities require GHADs as a condition of development approvals. Although planners in other states also have considered GHAD-like legislation to address geologic hazards, only California has adopted a law authorizing GHADs. Despite its many benefits, the GHAD law is complicated and must be fully understood by local planners and their governing bodies so that a GHAD does not fall short of their expectations.

History of GHADs

In 1979, in the aftermath of the Portuguese Bend landslides in the Palos Verdes area of Los Angeles County, California adopted its GHAD law (California Public Resources Code, Sections 26500—26654; all following section references are to the California Public Resources Code unless otherwise noted). The law, authored by Senator Robert Beverly, gave local agencies the authority to form special districts that could speedily address "an actual or threatened landslide, land subsidence, soil erosion, earthquake, or any other natural or unnatural movement of land or earth" (Section 26507). It was a legislative response to the difficulty many California residents experienced while obtaining insurance in geologic hazard areas. Likewise, the law aimed to reduce the high costs and long delays associated with litigation after damage by geologic hazards. The first GHAD was established in 1981 in the Portuguese Bend area to arrest a slide and to save several houses from toppling into the Pacific Ocean. Since then, numerous GHADs have been established throughout the state to reduce the risk of, and when necessary to abate damage caused by, geologic hazards.

GHAD Powers

A GHAD is empowered to acquire, construct, operate, manage, or maintain improvements on public or private lands. "Improvement" is defined to mean any activity necessary or incidental to the prevention, mitigation, abatement, or control of a geologic hazard, including, but not limited to, all of the following:

a. Acquisition of property or any interest therein

b. Construction

c. Maintenance, repair, or operation of any improvement

d. Preparation of geologic reports required . . . for multiple projects within an earthquake fault zone or zones

e. Issuance and servicing of bonds, notes, or debentures issued to finance the costs of the improvements specified in subdivisions (a), (b), (c), and (d)(Section 26505; www.consrv.ca.gov/cgs/rghm/GHAD_law.htm)

Improvements can be made with the consent of any property owner within the GHAD's boundaries, or the GHAD may exercise the power of eminent domain (Section 26576). Also, the GHAD may accept improvements undertaken by others (Section 26580).

A GHAD may include lands in more than one local government jurisdiction, and the lands may be publicly or privately owned (Sections 26531–26532). The lands comprising a GHAD do not have to be contiguous, but the district cannot divide the boundaries of a parcel (Sections 26530, 26533). The law requires only that proposed improvements specially benefit all of the lands within the district (Sections 26530, 26534).

A GHAD's primary source of funding is landowner assessments (Section 26650). These assessments, which attach as liens on property, may be collected at the same time and in the same manner as general taxes on real property (Section 26654). A GHAD also is authorized to finance improvements through California's Improvement Act of 1911, the Municipal Improvement Act of 1913, and the Improvement Bond Act of 1915 (Section 26587). The Improvement Act of 1911 and the Municipal Improvement Act of 1913 let local agencies and special districts levy assessments for a variety of public improvements (California Streets and Highway Code, Sections 5000 et seq., Sections 10000 et seq.). The Improvement Bond Act of 1915 allows local agencies and special districts to issue assessment bonds and bond anticipation notes (California Streets and Highway Code, Sections 8500 et seq.). In addition, a GHAD may accept financial or other assistance from any public or private source (Section 26591) and may borrow funds from the local, state, and federal government (Section 26593).

Forming a GHAD

The GHAD law specifies a routine procedure for formation (Sections 26525–26567.3) as well as an emergency formation procedure that allows a local government to form a GHAD to prevent, mitigate, or control an imminent geologic hazard with shortened notice to affected property owners (Sections 26568–26569.4). The basic steps for routine formation follow.

Before forming its first GHAD, the legislative body of the local government must adopt a resolution declaring that it will be subject to the statutory provisions for initiating formation proceedings. It must also forward a copy of this resolution to the State Controller (Section 26550). This resolution needs to be adopted only once, whether at the time the first GHAD is formed or in advance of the first formation.

Proceedings for formation can be initiated either by a petition signed by the owners of at least 10 percent of the real property to be included within the district, or by resolution of the legislative body (Section 26550.5). The legislative body must formally accept the petition at a noticed public hearing. If the proposed GHAD is located in more than one local government jurisdiction, the local government with jurisdiction over that portion of the proposed GHAD with the greater assessed real property valuation will initiate and conduct the formation proceedings.

A plan of control must be attached to the formation petition (or prepared by the legislative body if it initiates the formation) so that the plan is before the public and the legislative body throughout the petition, protest, hearing, and decision-making stages. The plan of control, prepared by a certified engineering geologist, describes geologic hazards, their location, the affected areas, and a plan for prevention, mitigation, abatement, and

CALIFORNIA PUBLIC RESOURCES CODE

Division 17: Geologic Hazard Abatement Districts (excerpts)

Chapter 2: District Formation

Article 1. Purpose

26525. A geologic hazard abatement district may be formed pursuant to this division for the following purposes:

(a) Prevention, mitigation, abatement, or control of a geologic hazard.

(b) Mitigation or abatement of structural hazards that are partly or wholly caused by geologic hazards.

Article 2. Lands Included

26530. The lands included within a district may be contiguous or noncontiguous.

26531. The lands included within a district may be situated in more than one local agency.

26532. The lands included within a district may be publicly or privately owned.

26533. No parcel of real property shall be divided by the boundaries of the proposed district.

26534. All lands included within a district shall be specially benefited by construction proposed in a plan of control approved by the legislative body.

Chapter 3. Nature and Powers of the District

Article 1. Nature of the District

26570. A district is a political subdivision of the state. A district is not an agency or instrumentality of a local agency.

26571. A district is comprised of an area specially benefited by and subject to special assessment to pay the cost of an improvement. While a district performs certain governmental and proprietary functions as a political subdivision of the state, it is not a special district within the meaning of Section 56036 of the Government Code.

26573. The powers of a district are vested in the board of directors.

Article 2. Powers of a District

26574. A district may do all of the following:

(a) Sue and be sued.

(b) Make, amend, and repeal bylaws.

(c) Have a seal.

(d) Exercise all powers necessary or incidental to carry out the purposes of this division.

26575. A district may obtain, hire, purchase, or rent office space and equipment.

26576. Within the territorial limits of the district, or for the purposes set forth in this division, a district may acquire real property or any interest therein by eminent domain.

26577. A district may purchase, lease, obtain an option upon, acquire by gift, grant, bequest, or devise, or otherwise acquire any property or any interest in property.

26578. A district may sell, lease, exchange, assign, encumber, or otherwise dispose of property or any interest in property.

26579. The district may enter into contracts and agreements with the United States, any state or local unit of government, public agency, including any other geologic hazard abatement district or public district, private organization, or any person in furtherance of the purposes of the division.

26580. The district may:

(a) Acquire, construct, operate, manage, or maintain improvements on public or private lands. Such improvements shall be with the consent of the owner, unless effected by the exercise of eminent domain pursuant to Section 26576.

(b) Accept such improvements undertaken by anyone. 26580.1. The district may make improvements to existing public or private structures where the board of directors determines that it is in the public interest to do so.

(continued)

CALIFORNIA PUBLIC RESOURCES CODE *(continued)*

26581. At any time following the adoption of the resolution pursuant to Section 26567, the board of directors may proceed to annex territory to the district. The proceedings for annexation shall follow the procedure contained in Article 3 (commencing with Section 26550) and Article 4 (commencing with Section 26561) of Chapter 2 of this division. In such instance, the board of directors shall assume the responsibilities of the legislative body. Annexation of territory to a district shall be subject to the approval of the legislative body which ordered formation of the district. Such approval shall be given by resolution, following the order by the board of directors for annexation of territory to the district.

Chapter 6. Maintenance

26650. A district may levy and collect assessments pursuant to this chapter to pay for the cost and expenses of the maintenance and operation of any improvements acquired or constructed pursuant to this division.

26651. The board of directors shall adopt a resolution declaring its intention to order that the cost and expenses of maintaining and operating an improvement acquired or constructed pursuant to this division shall be assessed against the property within the district benefited thereby. The resolution shall contain both of the following:

(a) A report prepared by an officer of the district which sets forth the yearly estimated budget, the proposed estimated assessments to be levied each year against each parcel of property, and a description of the method used in formulating the estimated assessments.

(b) The time, date, and place for the hearing of protests to the proposed assessments.

26652. The board of directors shall cause a notice of the adoption of the resolution described in Section 26651 to be mailed by first class mail to each owner of real property within the district as shown on the last equalized assessment roll of the county. The notice shall be mailed not less than 14 days prior to the date set for the hearing and shall contain all of the following:

(a) A statement that the board of directors has adopted the resolution.

(b) The time, date, and place set forth in the resolution for the hearing of protests on the proposed assessments.

(c) A statement of the total yearly estimated budget for the maintenance and operation of the improvements.

(d) A statement that the report described in Section 26651 is available for inspection at the office of the district.

(e) The name and telephone number of a person designated by the board of directors to answer inquiries regarding the proposed assessment.

26653. At the hearing, the board of directors shall hear and consider all protests. At the conclusion of the hearing, the board of directors may adopt, revise, change, reduce, or modify any assessment and shall make its determination upon each assessment described in the report. Thereafter, by resolution, the board of directors may confirm the assessments and order the levy and collection thereof.

26653.5. If assessments are proposed to increase from the maximum amount levied in any previous year, the board of directors shall comply with the notice, protest, and hearing procedures in Section 53753 of the Government Code with respect to that increase.

26654. Following the order by resolution of the levy and collection of assessments by the board of directors, the clerk shall cause to be recorded a notice of assessment, as provided for in Section 3114 of the Streets and Highways Code, whereupon the assessment shall attach as a lien upon the property, as provided in Section 3115 of the Streets and Highways Code. Thereafter, the clerk shall collect the assessments as directed by the board of directors, or, in lieu of collection by the clerk, the board of directors may provide that the assessments are payable at the same time and in the same manner as general taxes on real property are payable. A district board of directors shall reimburse the city or county, as the case may be, for any cost incurred pursuant to this section.

control of these hazards (Section 26509). The plan of control therefore serves as a "constitution" for the GHAD and describes the GHAD's ongoing activities, including the monitoring of geologic conditions, identification of geologic hazards, and construction of needed improvements as well as the maintenance, repair, and replacement of facilities (Section 26509).

The plan of control therefore serves as a "constitution" for the GHAD and describes the GHAD's ongoing activities, including the monitoring of geologic conditions, identification of geologic hazards, and construction of needed improvements as well as the maintenance, repair, and replacement of facilities.

At a noticed public hearing, the legislative body considers whether to form the GHAD. The date for this hearing is generally set when the legislative body accepts the petition for formation. Property owners within the proposed GHAD may object to formation, and if owners of more than 50 percent of the assessed valuation of real property in the GHAD area object, the legislative body must abandon the formation proceedings (Sections 26564, 26566).

The legislative body is required to decide within 60 days of the close of this hearing whether to order formation of the GHAD. If the legislative body approves formation, it does so by adoption of a resolution (Section 26567). The legislative body must then select an initial board of directors for the GHAD. The legislative body may either select five landowners from the GHAD area to serve on the initial GHAD board or appoint itself to act as the board of directors. If the legislative body acts as the board of directors, the GHAD has access to the local agency's resources, including technical, legal, and administrative expertise on geologic issues. If the legislative body selects five landowners to act as the GHAD board, their initial term is four years; after that, the landowner GHAD board is elected from the district (Sections 26567, 26583).

These are the exclusive procedures for GHAD formation (Section 26560). Therefore, the formation of a GHAD does not need approval by the Local Agency Formation Commission (see *Las Tunas Beach Geologic Hazard Abatement District v. Superior Court*, 45 Cal. Rptr.2d 529 (1995)) or environmental review under the California Environmental Quality Act (CEQA) (Section 26559). Also, improvements by the GHAD and all activities in furtherance of, or in connection with, the GHAD are exempt from environmental review under CEQA (Section 26601).

After a GHAD is formed, it must take a number of steps before it becomes operational, including: passing a budget; appointing a clerk, treasurer, and other officers; and levying assessments.

Making a GHAD Operational: Post-Formation Procedures

After a GHAD is formed, it must take a number of steps before it becomes operational, including: passing a budget; appointing a clerk, treasurer, and other officers; and levying assessments (Sections 26584–26586). Determining an appropriate budget for the GHAD, like preparing the plan of control, is critical to the long-term success of the GHAD. The GHAD's board of directors should realize that the amount of money needed to accumulate an adequate reserve fund to address probable future geologic events varies. Likewise, Proposition 218—a constitutional amendment that requires voter approval of assessments (California Constitution, Article XIIIC, XIIID)—makes levying assessments in California time consuming and procedurally complex. These potential problems amplify the importance of carefully determining how much money the GHAD will need in the future.

Procedure for Levying Assessments

The special benefit to each of the properties within the GHAD is calculated by an engineer and set forth in a detailed engineering report. Enacted in 1996, Proposition 218 requires that votes on assessments be apportioned according to financial obligations. In accordance with Proposition 218, the amount of the assessment levied on each property must also be proportionate to the special benefit to the property (see *Not About Water Committee v. Solano County Board of Supervisors*, 116 Cal. Rptr.2d 536 (2002)).

Before assessments can be levied, the GHAD board must calculate the assessment, adopt a resolution of intention to order the assessment, hold a public hearing on the proposed assessment with notice to all property owners within the district, and allow the affected property owners to vote on the proposed assessment. At the public hearing, all protests against the assessment are to be considered. Ballots are tabulated at, or after, the hearing (Sections 26650–26654). Property owners' votes are weighted according to the proportional financial obligation of each affected property owner. If there is a majority protest—which exists if the weight of the votes submitted in opposition to the assessment exceeds the weight of the votes submitted in its favor—the GHAD board cannot impose the assessment (California Constitution, Article XIIID, Section 4).

Annexing Land to an Existing GHAD

Land may be annexed to an existing GHAD through the same procedure used for formation of a GHAD, except the existing GHAD's board of directors acts in place of the local government's legislative body (Section 26581). The legislative body that ordered the formation of the GHAD, however, must also approve the annexation (Section 26581). This procedure allows both existing and new development to take advantage of existing funds, procedures, and improvements already committed to managing geologic hazards.

Dissolving a GHAD

The GHAD law has its own dissolution procedure (Sections 26567.1–26567.3). The legislative body of the local government that formed the GHAD may order its dissolution only if it makes certain findings:

- The GHAD has not been active.
- The GHAD has not levied or collected any assessments.
- The GHAD has not substantially complied with a material condition of the resolution of its formation.

Dissolution of the GHAD has been called for by unanimous vote of the board of directors, or by the owners of more than 50 percent of the assessed valuation of real property in the district (Section 26567.1(a)). Any liquid assets of the GHAD are returned to the landowners and local governments in the same proportion they have contributed to the revenue of the district. Capital improvements and other assets are distributed by resolution; any property owner within the district, however, may offer an alternative distribution plan. The board must adopt the alternative plan if it is approved by the owners of more than 50 percent of the assessed valuation of real property in the district (Section 26567.3).

The Advantages of Forming a GHAD

GHADs operate locally for the sole purpose of addressing geologic hazards and related concerns. As such, they offer several advantages:

Focus on prevention. Through the development and implementation of a plan of control, a GHAD acts to prevent damage resulting from earth movement by identifying and monitoring potential geologic hazards and undertaking improvements as appropriate.

Ability to respond to unforeseen events. When unforeseen hazards arise, GHADs, as existing agencies, are in place with the technical and organizational resources and funding capability needed to respond quickly and effectively. In contrast, homeowners associations generally

lack GHADs' expertise and authority, which hampers the associations' ability to react to hazards.

Improved method of collecting assessments. GHADs are authorized to collect assessments at the same time the local government collects general property taxes. This combined procedure eliminates separate collection by a private entity, such as a homeowners' association.

Concerns over liability less likely to discourage needed actions. GHADs enjoy limited liability for their actions (California Government Code, Sections 865 et seq.). The state legislature intended that these provisions encourage local agencies to take remedial action to abate earth movement. In addition, the Tort Claims Act (California Government Code, Sections 810 et seq.) provides the same immunities to GHADs as it does to other local public agencies.

California's Experience with the GHAD Law—and How It Can Be Improved

Today, cities and counties throughout California realize the benefits GHADs provide. Moreover, many local governments recognize the value of requiring the developer to form and fund a GHAD before a project is constructed. Generally, if a GHAD is formed by the developer, the property can be assessed with minimal controversy before homes are built and sold to the public. Because of the complicated notice and voting procedures required under Proposition 218, local governments find it easier to levy assessments at the development stage, when the developer is the only property owner. When the formation of a GHAD is a condition of project approval, the developer—as the sole property owner—prepares a plan of control and submits the petition for formation. Local agencies also have required the developer to provide seed money for the GHAD—often $50,000 or more—and to finance GHAD activities for several years, until an adequate reserve fund has been generated.

The developer can also draw benefits from preparing the plan of control. The developer likely has contacts with a number of different agencies involved with the project and may be able to identify geologic hazards the local government would overlook. For example, a state or federal resource agency may require wildlife mitigation, such as the creation of new wetlands. Wetlands, if functioning improperly, could result in slope failures. The developer's plan of control can therefore be used to identify and formulate ways to abate such potential geologic hazards.

Despite these advantages, developer-created GHADs have an important drawback. Conditions requiring the developer to form a GHAD often stop at formation and do not ensure that assessments will be levied. As a result, some developers have created GHADs but have objected to assessments. To avoid this potential trap, local agencies should impose conditions on developers that specifically require both forming a GHAD and levying assessments. A condition of approval requiring the assessments to be levied can save both the developer and the local government time and money.

Planners need to be conversant in the law and be able to draft conditions that attain their governments' goal of establishing a district that is financially and technically capable of addressing geologic hazards. When used properly, California's GHAD law allows development in areas that cities and counties once viewed as too vulnerable to geologic hazards.

WEIGHING THE BENEFITS OF GHADS

By Sanjay P. Jeer, AICP

Sanjay Jeer, AICP, was formerly a senior research associate for APA focusing in areas of land-use planning, environmental regulation, and computer applications for planning and research. He served as the principal investigator for the Land-Based Classification Standards (LBCS) project.

Hazard mitigation can take one or more of three forms: risk identification, risk reduction, and risk transfer. With respect to landslide hazards, risk identification is carried out through mapping, surveying, testing soil stability, and similar tasks. Risk reduction can include either hard mitigation techniques (e.g., engineering solutions, such as constructing retaining walls, drilling bores to drain excess water, and reshaping terrain for erosion and stormwater control) or soft mitigation techniques (e.g., planning, zoning, and other regulatory techniques) to keep development out of harm's way. Risk transfer techniques minimize losses by spreading the burden of risk through such programs as insurance, disaster relief, and disclosure laws. These risk transfer mechanisms do not directly reduce the hazard but protect against financial losses, provide relief in the aftermath of a disaster, and allow buyers and sellers to make investment decisions with full knowledge of the risk they incur. Most mitigation strategies comprise elements of all three techniques, but their emphasis may favor one over the other. GHADs are no exception.

GHADs Function as Risk Transfer Mechanisms

California's GHAD legislation emphasizes risk reduction through risk transfer. A GHAD is set up as a political subdivision of the state and is thus, in contrast to a traditional zoning district or homeowners association, a separate legal entity. Through special assessments and other powers to raise funds, a GHAD operates as a risk transfer mechanism whereby a group of property owners (public and private) takes responsibility for funding and maintaining geologic hazard abatement measures. Because mitigation measures are traditionally implemented by local government, shifting this responsibility to a GHAD requires careful consideration.

GHADs can finance their activities by exercising a broad set of powers: levying assessments, issuing bonds, borrowing money, and accepting grants from public and private sources. Though a GHAD can only implement what has been approved in the plan of control submitted as part of the petition for its formation, the district also has the power of eminent domain and annexation. GHADs may share some of the same responsibilities as homeowners associations in long-term maintenance of such hillside drainage features as pipes, culverts, ditches, and drop inlets. But GHADs' responsibilities extend beyond the property maintenance functions of homeowners associations, albeit for the sole purpose of geologic hazard mitigation. Many communities, in evaluating petitions to form GHADs, also have had to contend with the fact that such districts are exempt from California's Environmental Quality Act and may be exempt from some local permitting requirements.

Having Control vs. Avoiding Liability

To get around concerns that GHADs could interfere with the jurisdiction's authority, the government's legislative body may appoint itself as the GHAD's board of directors and assign specific roles in administering the district to local government staff. For example, in San Leandro, the city council formed a GHAD to stabilize a landslide hazard area. The city council serves as the GHAD's board of directors, the city clerk as the district secretary, the city's finance director as the district's treasurer, the city's attorney as the district's general counsel, the city engineer as the district engineer, and the city manager as the district manager. However, many GHADs in the state—including the first one, formed in Palos Verdes in 1981—operate independently with a separate board, staff, and budget. These independent GHADs typically include property owners.

Another approach that addresses concerns about GHADs being exempt from local permitting requirements has been to impose limitations in the plan of control that require compliance with permitting requirements and any other parts of the local government's code. These limitations may help ease the local government's review and adoption of the plan of control because the limitations allow local government to exert control over the GHAD. But what happens if the area's geologic factors change? If measures envisioned in the GHAD's original plan of control are no longer effective, the plan will need to be changed to address those changes, and it is not clear what recourse the GHAD has if the proposed solutions conflict with the local government's plans.

What is also not clear is the potential liability of the local government. Under what circumstances would the local government be held responsible for a GHAD's liabilities? If the GHAD is independent—that is, it has a property-owner board of directors and staff (or consultants) who are not employees of the local government—the local government's chances of being held responsible for GHAD's liabilities are not as high as if the GHAD's board of directors and staff are from the local government. But this situation has not been fully tested in the courts. GHADs enjoy broad immunities under the California Tort Claims Act. While it can be argued that the overall liability for a local government will not increase due to a GHAD, it is clear that GHADs are not a solution if the local government's main concern is to avoid liability. In any case, liability issues figure prominently in most GHAD formations and may affect how local governments choose to develop a comprehensive strategy to address geologic hazards.

What is also not clear is the potential liability of the local government. Under what circumstances would the local government be held responsible for a GHAD's liabilities?

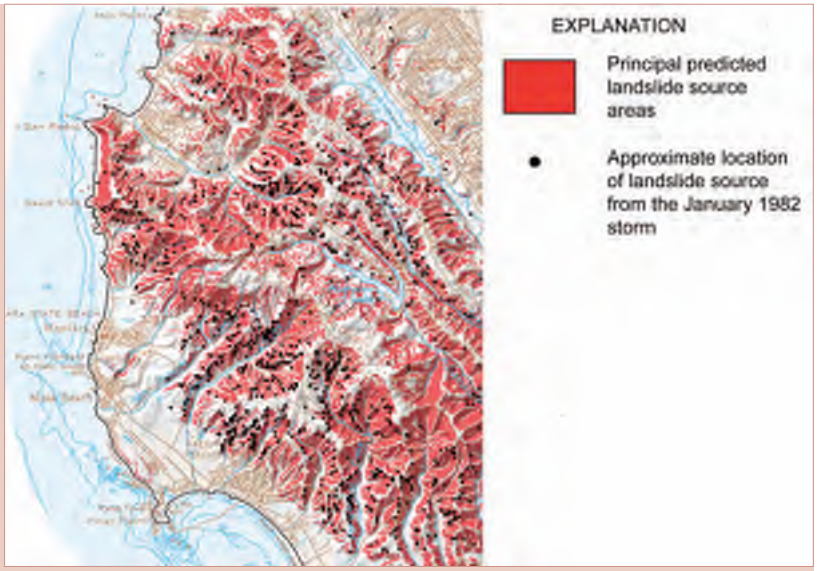
For GHADs formed as a condition of approval for new developments, local governments rely on indemnity and insurance as additional precautions against future liability. A plan of control can include provisions to indemnify, defend, and hold the local government harmless for liability associated with the GHAD. Such an indemnity, of course, would be meaningless if the GHAD does not have enough funds or if the liability claims arise after the completion of a project. This raises two questions: a) What constitutes an acceptable duration for an indemnity obligation? and b) How is indemnity performance secured after the project is complete and the developer has left? Similar questions apply to insurance. No insurance requirements currently exist for GHADs. One local government approved a plan of control on condition that the GHAD carry insurance for unforeseen or catastrophic events for the duration of its existence. Even if insurance were to be readily available, however, concerns remain about determining an adequate amount. Given the uncertainties in estimating losses for damages from landslides, there is no easy way to establish a limit for future potential losses.

While the full effect of GHAD enabling statutes has yet to be construed judicially, the general statutory scheme appears to afford local governments considerable discretion in identifying and implementing landslide hazard mitigation through GHADs. But with this level of flexibility comes significant responsibility. Current mechanisms to overcome potential limitations concerning liability and insurance may not increase a local government's financial liabilities, but they also do not insulate the local government.

Representation

GHAD legislation provides landowner participation in different ways at the petition and formation stages. If landowners initiate the petition to form a GHAD, owners of at least 10 percent of the assessed valuation of real property in the proposed district must sign the petition. At the formation stage, however, if owners of more than 50 percent of the assessed valu-

SAN MATEO COUNTY, CALIFORNIA



Detail from map showing slope stability during earthquakes in San Mateo County, California.

Landslides in San Mateo County have frequently occurred as a result of intense rainfall. Winter storms in 1969, 1972-73, 1982, and 1997-98 caused widespread damage throughout the 10-county San Francisco Bay region. The 1972-73 and 1997-98 storms coincided with the warm phase of the El Niño Southern Oscillation. However, in the San Francisco Bay area, some the most damaging storms (e.g., 1969 and 1982) in terms of direct costs resulting from landslides occurred during non-El Niño winters (Godt et al. 1999). Landslides were triggered throughout coastal regions of California in 1969 and resulted in about $155 million (in 1998 $) in direct economic losses in the San Francisco Bay area alone. The storm in January 1982 was particularly devastating to the region. Flooding and debris flows claimed 25 lives in the San Francisco area and damaged or destroyed more than 100 homes. One person was killed by a landslide in San Mateo County. The storm and resulting landslides required the evacuation of homes and the closing of the main coastal transportation route, Highway 1 (Cannon et al. 1985). Sections of the highway were washed away when drainage works were overwhelmed.

The El Niño storms of 1997–98 were damaging to both public and private property in the San Francisco Bay region. Direct costs associated with landslides were estimated to be more than $150 million. San Mateo County was particularly hard hit; the only fatality resulting from landslides occurred there when a debris flow destroyed a home near Loma Mar on February 7. Damage resulting from landslides was estimated to be more than $55 million, about half of which was to public property (Jayko et al. 1999). On February 9, President Clinton declared all 10 counties in the region eligible for much-needed federal assistance.

The county had adopted a geologic hazards zoning district in April 1982, just before that year's storms, and amended it in 1999 with new requirements for review and disclosure. Building permit approvals in the hazard district now require a review by the county geologist, and property deeds must be recorded with the location identified as a geologic hazard district (San Mateo County Zoning Code, Chapter 19.5, Section 6295.4). Landslide susceptibility maps serve a vital role in the county's long-range planning strategy. The county's general plan uses the geotechnical hazard area designation for susceptible areas (Section 15.9), and it also contains specific development policies that regulate density limits, building on steep slopes, geotechnical investigations, and hazard abatement alternatives for these areas.

ation of real property in the proposed district object, the local government cannot form a GHAD. With GHADs, a majority is determined by the value of the property, a condition unique to planning. A local government can also participate in this vote as an owner if the GHAD is to include local government lands and facilities. Coastal communities, for example, that own public parks and beach facilities potentially subject to landslides due to coastal erosion find it expedient to include as many of those parks and facilities as possible in a GHAD, which increases their influence over the formation of the district. Such a voting scheme, however, falls short of representation as commonly understood.

Valuation-based criteria can also undermine the rationale for justifying the boundaries of a GHAD. Rather than being shaped by a geotechnical hazard, a GHAD's boundaries can be decided by the willingness of property

Rather than being shaped by a geotechnical hazard, a GHAD's boundaries can be decided by the willingness of property owners to participate in the GHAD.

owners to participate in the GHAD. Such boundaries lead to uneven treatment of a hazard, with dissimilar risk reduction measures being applied to areas with similar risks. For instance, after a 1998 landslide in San Leandro, the city anticipated a GHAD for a large area encompassing several hundred houses. The area included lands well beyond the immediate area of the landslide, with its boundaries based on landslide susceptibility as determined by geotechnical studies. But after the city sensed a lack of support among property owners in the area, it reduced the area of the proposed GHAD to only those properties in the immediate vicinity of the landslide.

The GHAD may be hindered because its power of eminent domain can only be executed within district boundaries, and adjacent property owners are likely to be uncooperative. . . .

Although actions like San Leandro's may be politically expedient in creating a GHAD, the GHAD that results may do little to mitigate the hazard. A jurisdiction may subsequently find that it needs to make improvements outside district boundaries to control the landslide for which the GHAD was created or to prevent damage to district properties from landslides on adjacent lands. In such cases, the GHAD may be hindered because its power of eminent domain can only be executed within district boundaries, and adjacent property owners are likely to be uncooperative—just as they were prior to the GHAD's formation, which is why their property was not included in the district's original boundaries. A GHAD might resolve such a limitation by annexing the necessary adjacent area, but it would have to go through the formation process again and would almost certainly be faced with a majority protest. Jurisdictions must be careful to balance political expediency and mitigation needs: setting GHAD boundaries that disregard geotechnical findings in favor of short-term political gain will often result in uneven success in mitigating landslide hazards.

Ideal Circumstances for a GHAD

GHADs as allowed by California law can be a useful tool in hazard mitigation for landslide areas in special circumstances. These special circumstances can be characterized by a combination of geologic and geographic conditions, local development patterns, and the type of development affected. Affected areas include areas in the vicinity with similar geologic conditions that can lead to landslides. The ideal circumstances for a GHAD in these areas are described here:

- The affected areas should comprise a small portion of the local jurisdiction. If the conditions of the affected areas extend to vast sections of the community, a more comprehensive funding and maintenance regime is required.
- The mitigation actions primarily should protect existing development and public infrastructure. Applying GHADs to make a hazardous area suitable for new development is fraught with many geologic, financial, and legal unknowns. Perpetual protection of developments from catastrophic events, or of local governments from liability, is not feasible.
- The affected areas should be isolated from the rest of the community. Isolation ensures that any future catastrophic event in the GHAD does not affect public infrastructure relied on by other parts of the community. A GHAD would not be appropriate if major lifelines—such as major trunk lines for water, sewer, and other utilities, and main access routes—traverse the affected areas and are at risk of being disrupted.
- Land uses adjacent to affected areas should remain compatible. Future incompatible land uses and construction practices (grading, landscaping, etc.) adjacent to affected areas could undermine a GHAD's mitigation measures. Minimizing such incompatible uses and construction practices will ensure a GHAD's success.

- There should not be a litigious environment in the community. Litigation is not conducive to a successful GHAD. Besides affected property owners, adjacent property owners and the community as a whole should buy into the concept of special assessments and sharing local governmental powers with an agency of the state.
- The overall cost of repairs and maintenance should be a reasonable fraction of assessed property values. If the abatement costs far exceed the assessed valuation of real property in the district, or the ability of property owners to pay assessments, then no matter how sound the solution, the GHAD cannot stay financially solvent.

While the GHAD is a useful tool, its applicability has to be weighed against long-term solutions. Such solutions entail dealing with geologic hazards at the planning stages, with a clear public policy about development in hazardous areas. This policy should reflect consideration of which land uses are compatible with hazardous areas and what changes in building and construction regulations are necessary to ensure compatibility. Public investment in infrastructure should take into account risks of geologic hazards, and the capital improvements program ought to incorporate risk-based analysis when prioritizing projects. Dealing with a geologic hazard at the site plan or post-construction stage will have a limited focus and cannot, as a policy, sustain the long-term effectiveness of both public and private mitigation efforts. GHADs cannot substitute for a comprehensive approach to dealing with geologic hazards.

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CHAPTER 5

Technical Tools to Assist Planners in Combating Landslide Hazards

The two papers in this chapter describe innovative technical tools that will help planners improve their chances of more effectively counteracting the deleterious effects of landslides. In the first article, William Haneberg describes four types of quantitative models now in use to assess the level of hazard from landslides in an area. In the second article, Mike Price describes how geographic information systems (GIS) have been used to map and model the geologic hazards in the Moab-Spanish Valley area in Grand County, Utah. A partnership between the American Planning Association, ESRI (formerly the Environmental Sciences Research Institute), and the National Fire Protection Association (NFPA) was the foundation for the development of these tools and a training exercise that contributed to the case study.

NEW QUANTITATIVE LANDSLIDE HAZARD ASSESSMENT TOOLS FOR PLANNERS

By William C. Haneberg

William C. Haneberg is an internationally recognized consulting geologist whose specialties include landslide hazard mapping, slope stability modeling, and LiDAR (Light Detetection and Ranging) data enhancement.

Recent advances in the capability of landslide modeling tools offer planners better hazard information. Reaching beyond basic maps of slope and soil characteristics, these new research tools incorporate many additional quantitative measurements derived from the location and frequency of landslides and the mechanical properties of slopes that affect stability. Although they have yet to gain widespread acceptance in planning applications, they hold great promise.

TRADITIONAL QUALITATIVE METHODS

A traditional qualitative assessment of landslide hazards typically makes use of two types of maps: landslide inventory maps and landslide hazard maps (Soeters and van Westen 1996). Both are based on aerial photographs and field surveys of geologic features, but each provides slightly different information. A landslide inventory map shows only the location of known landslides, whether those landslides are currently moving or are inferred to have moved in the past. A landslide hazard map likewise shows known landslides, but it also contains a subjective component: an interpretation of land stability. This interpretation might distinguish between stable and potentially unstable ground based on the following characteristics:

- Inferred age of the slide (active, dormant, prehistoric)
- Type of slide (translational vs. rotational, deep vs. shallow)
- Features such as persistently wet areas or open cracks
- Presence or absence of bedrock types linked to landslide problems

Ideally, inventory and hazard maps would accurately reflect the distribution of landslide hazards in an area. But in practice, these maps are prone to error. They can miss dormant landslides with no pronounced topography or those obscured by heavy vegetation. Different geologists can also come up with different inventory or hazard maps for the same area (Ardizzone et al. 2002; Wills and McCrink 2002).

One way to minimize such differences is to use a three-tiered approach in which the hazard map is built on an inventory map that is in turn built on a standard geologic map. At each of the three tiers, the maps can incorporate an increasing degree of subjective professional judgment (see Haneberg et al. 1992, Haneberg et al. 2002).

NEW QUANTITATIVE METHODS

There are four types of quantitative methods that can be used in geologic hazard assessment:

1. Empirical
2. Rational
3. Deterministic
4. Probabilistic

Empirical methods are those based on observational data, such as the location of existing landslides.

Rational methods, on the other hand, are based on physical principles, such as the forces acting on a slope.

Deterministic methods assume a direct cause-and-effect relationship: if *x*, then *y*. For example, if a slope is greater than 20 percent, then a landslide

will occur. These methods must be used with caution, however. This yes-or-no approach may provide straightforward answers, but in a complicated real-world planning situation these answers are often wrong.

Probabilistic methods, on the other hand, incorporate a degree of uncertainty in the cause and effect relationship: if something like *x*, then perhaps *y* (expressed as a degree of certainty). For instance, if the slope is greater than 20 percent, then there is a 75 percent chance of a landslide at some point in time. Probabilistic landslide models are thus similar to weather forecasts or stock market predictions.

Probabilistic landslide models are thus similar to weather forecasts or stock market predictions.

These qualitative methods have been made possible by recent advances in GIS, GPS (Global Positioning Systems), satellite data, real-time monitoring of slopes, and related technologies. Whereas qualitative methods depend only on inventory maps, quantitative methods require accurate, high-quality data. For instance, a database that contains information about landslides only in developed areas or in areas with damages to structures should be used with caution. Areas that were not developed when data were collected could be assigned a low hazard rating simply because damage had not been reported. Planning decisions based on incomplete or biased data can be dangerously incorrect.

Rational methods try to compensate for possible data shortcomings like these. But these methods can be hampered by two different kinds of errors: model error and parameter error. Model error refers to the inability within rational methods to incorporate all the necessary details of a complicated geological process. Parameter error refers to the difficulty of establishing the limits within which the model's results remain valid.

FOUR CATEGORIES OF QUANTITATIVE MODELS

There are four categories of quantitative models used in geologic hazard assessment based on the methods described above (Haneberg 2000a):

1. Empirical deterministic
2. Empirical probabilistic
3. Rational deterministic
4. Rational probabilistic

Empirical Deterministic

A slope angle or grade map is the simplest empirical deterministic model. This type of model assumes a link between slope steepness and landslide hazard (or susceptibility). This relationship is fuzzy, but useful in some circumstances. Preparing such models requires elevation data for the study area. The common source for this data is a United States Geological Survey (USGS) Digital Elevation Model (DEM). But for many areas DEM resolution is no finer than 30 meters (90 feet), and important topographic features can be obscured. Newer DEMs, some with 10-meter and even two-meter resolutions, can overcome these limitations.

Slope data from DEMs can also be refined. One model called SMORPH, short for surface morphology, incorporates both the slope angle and curvature of the land surface derived from DEMs. SMORPH is based on an algorithm developed by the state of Washington to assist in watershed assessments (Shaw and Vaugeois 1999). The model weights slope angles according to surface curvature—convex, nearly planar, or concave—so as to identify low, medium, and high landslide hazards (Figure 5-1). In SMORPH, the thresholds for these hazard categories can be set through either an inventory map or a calculation of slope stability. This flexibility makes this model applicable to both empirical and rational deterministic modeling.

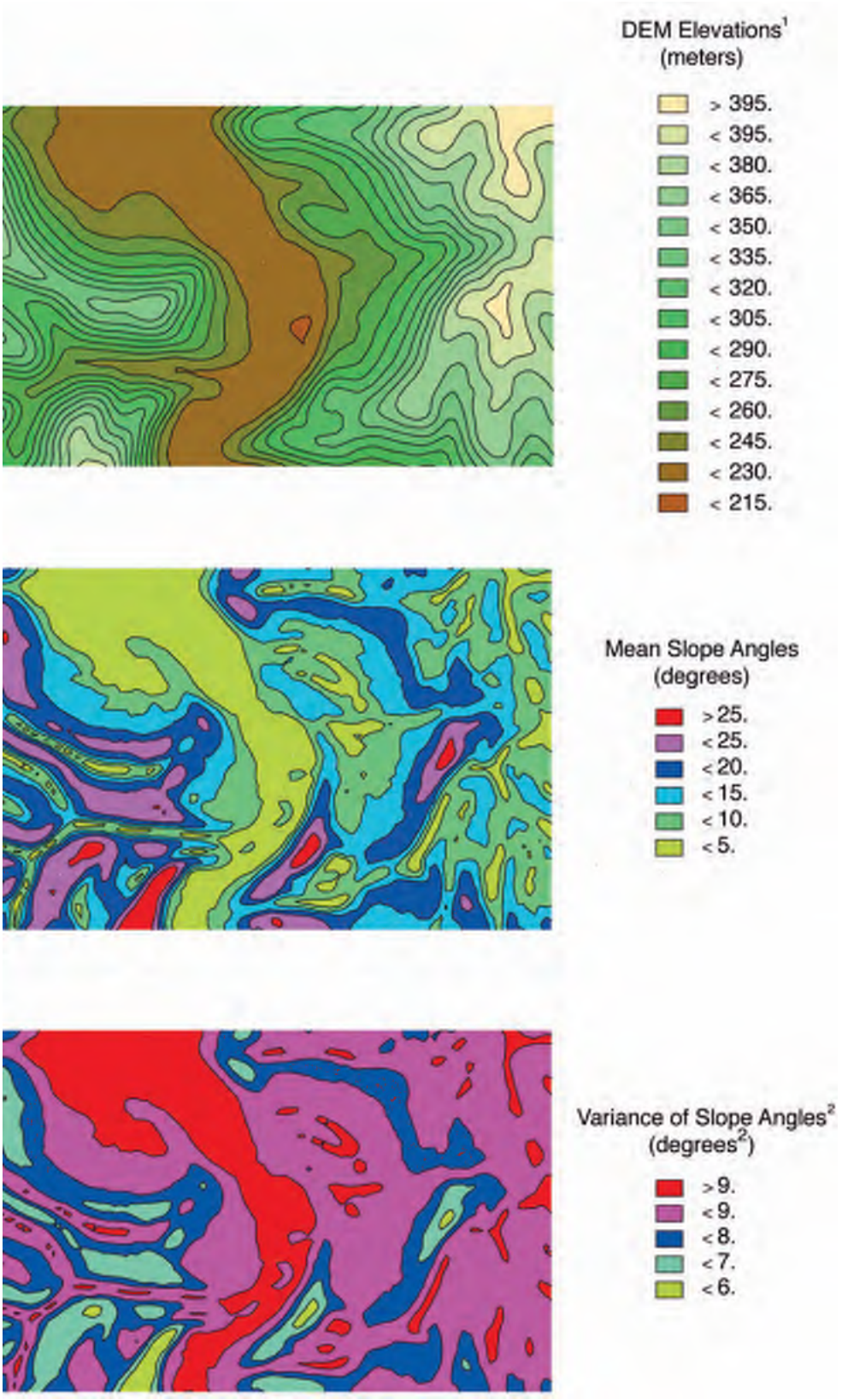


Figure 5-1. *Topographic and slope angle maps for a 1,500-acre site near Wheeling, West Virginia.*

1. Data derived from USGS UN-OH Quadrangle 30-meter DEM.

2. Figure show the calentated uncertainty for associating with the slop angles valves.

SMORPH and other models that use calculations based on slope-angle maps have limitations. DEM data may not be accurate or may be outdated. Calculation of the slope-angle thresholds that separate areas of high, medium, and low landslide hazard can also be difficult because thresholds change as land-use and other local environmental conditions change. Likewise, the effects of extreme events, such as large storms or major earthquakes, cannot be easily incorporated. Despite these shortcoming, SMORPH is a valuable quantitative tool, and its usefulness has been tested in several parts of the country, including Washington and Wheeling, West Virginia. Figure 5-2 illustrates the SMORPH hazard matrix and results for a test area near Wheeling.

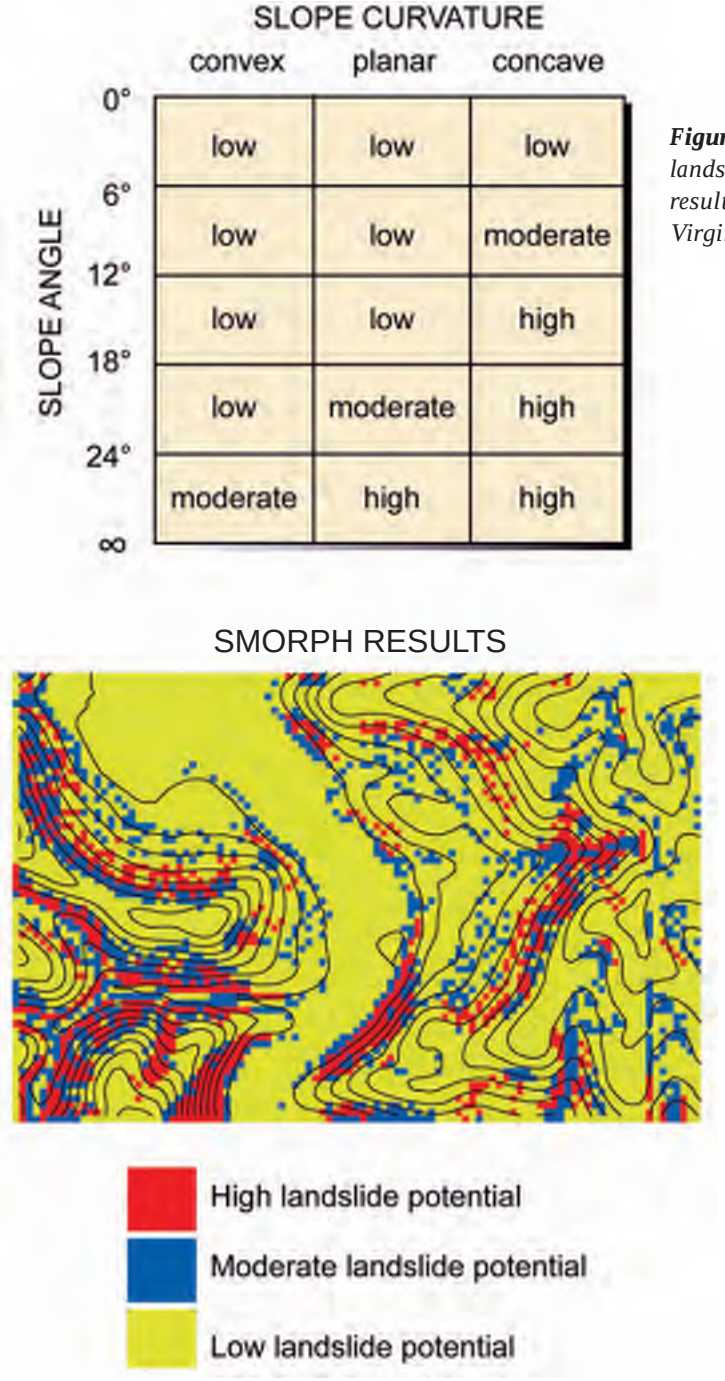


Figure 5-2. *SMORPH landslide potential matrix with results for Wheeling, West Virgina, test area*

Empirical Probabilistic

Empirical probabilistic models also depend on data about existing landslides, but they include an uncertainty component to reflect real world complexity (Haneberg 2000a). By using standard statistical methods, patterns of seemingly random occurrences can be analyzed to predict the probability of hazard events. These types of models require a variety of information, including location of landslides, slope angle, soil shear strength, existing development, types of construction in the area, and so on. By analyzing these factors, empirical probabilistic models produce a range of likelihood for future landslides. But, like all quantitative models, the precision of these models depends on the thoroughness and accuracy of the information used.

Applications of empirical probabilistic models have produced useful results in many cases. For a study in the Cincinnati, Ohio, area (Bernknopf et al. 1988), a probabilistic model analyzed different landslide damage avoidance strategies by comparing the costs and benefits of the strategies. The model used a series of logistic regression analyses applied to a grid of the area in which each grid cell was a discrete unit of analysis. The model drew on a number of factors to calculate the potential costs of the landslide mitigation plans, including the probability of sliding under each plan, the potential reduction in property losses, the time value of money, the capital investment costs for mitigation, and other expected benefits. The model also analyzed the cost of collecting regional geologic information. This study found that incorporation of geologic information into a mitigation strategy yields economic benefits that far exceed the cost of data acquisition. Mitigation strategies involving site investigation yielded a net annualized benefit of $1.7 million compared to $8,000 for strategies using just the slope angle.

Applications of empirical probabilistic models have produced useful results in many cases.

Jäger and Wieczorek (1994) used a similar logistic regression approach to analyze landslide susceptibility in Tully Valley, New York. This model incorporated slope angle, soil type, and location of ice-age shorelines to calculate landslide probability values along a continuous scale. These values were then grouped into low-, medium-, and high-hazard categories, which were then used to generate landslide hazard maps.

Coe et al. (2000) used an extensive landslide database for Seattle, Washington, to estimate the number of landslides likely to occur over a specified period of time throughout the city, a measure known as the landslide recurrence rate (see also Crovelli 2000). These researchers used the Poisson probability model, which is common in earthquake hazard studies, to estimate the probability that one or more landslides would occur in each grid cell during periods ranging from one to 100 years. One unique aspect of this study was the extent of data used: Seattle maintains a database of landslides that goes back to 1897. Still, some parts of the city appeared to have low landslide recurrence rates simply because they were undeveloped and no landslides had been reported. Unlike a simple grid analysis, this study used 10-acre circles centered on 25-meter-square grids to calculate a landslide recurrence rate over periods of one, five, 10, 25, and 100 years. The result was a map showing the contours of these estimated recurrence rates. When properly interpreted, such maps can be invaluable to long-range planning.

Models based on linear regression fare better than those based on simple observation of landslide locations. Chung and Fabbri (1999) compared five empirical probabilistic methods and found that direct estimation of future landslide hazard events fails when it is based on only information about the location of past events; that is, where landslides have occurred in the past has little correlation to where they might occur in future. The study area was in Colombia's Rio Chincina watershed. The researchers used a

1960 landslide inventory map and compared the actual location of landslide events since then to the predicted locations under each of the five methods. Methods that used linear regression and those that also incorporated knowledge from local experts both fared better than models based solely on the locations of previous landslides.

Rational Deterministic

Rational deterministic models incorporate the underlying physics and mechanics of landslides, not the location or distribution of past landslides. Most of these models assume that the slip surface of the slide is parallel to the ground and then calculate the stability of the slope using slope angles from DEMs. Results are given in terms of a factor of safety, which takes into account the balance for forces acting within the slope. Values greater than 1 indicate stability and less than 1 indicate instability.

Methods that used linear regression and those that also incorporated knowledge from local experts both fared better than models based solely on the locations of previous landslides.

Rational models can simulate unique events, an advantage over empirical models. The effects of major land-use changes or first-time disasters cannot be accurately predicted using empirical models because changes of that magnitude may have occurred rarely, if at all, in the past.

The biggest disadvantage of deterministic models is that there is rarely enough data available to obtain accurate results. Oreskes et al. (1994) provide a discussion of the problems inherent in model calibration, validation, and verification.

SHALSTAB and SINMAP are two GIS-based rational deterministic slope stability models that take into account water pressure and its effect on slope stability. SHALSTAB (Montgomery and Dietrich 1994; Montgomery et al. 2001; Dietrich et al. 2001) and SINMAP (Pack et al. 1999) come as extensions to the ArcView GIS software. SINMAP produces a stability index map, and SHALSTAB calculates the steady precipitation rates necessary to trigger landslides. When SHALSTAB was used for a study of the Seattle metropolitan area, it showed landslide location was a function more of slope angle than where groundwater accumulated (Montgomery et al. 2001). This Seattle study also shows that grid spacing of the underlying DEM is an important factor in model accuracy. Morrissey et al. (2001) used SINMAP as one of three approaches to assess shallow landslide and debris-flow hazards in Madison County, Virginia. They concluded that it was the only method that could easily be translated into a hazard map useful for planners.

Rational models can simulate unique events, an advantage over empirical models.

Both SHALSTAB and SINMAP have limitations when it comes to predicting storm-triggered landslides, especially since both assume that rainfall is gentle and steady. Two other models, DSLAM (Wu and Sidle 1995) and TRIGRS (Baum et al. 2002) incorporate unsteady groundwater flow-models for better simulation of individual storms. DSLAM also incorporates time-sensitive factors, such as decay of tree root strength after logging.

Rational deterministic models have also been used for studying earthquake-triggered landslides. These models were used in Oakland (Miles and Keefer 2000), Los Angeles (Jibson et al. 1998), and Seattle (McCalpin 1997). These models calculate the critical seismic acceleration necessary to initiate movement and then estimate the total displacement for a given earthquake. If the total displacement is large enough (generally greater than 10 centimeters or so), then sliding is inferred. The main product of these types of studies is a map showing the potential distribution of earthquake-induced landslides in a given area, which can be employed in a number of planning applications. These models also typically produce a static (e.g., not earthquake-caused) landslide hazard map. After the 1994 Northridge earthquake in California, Jibson et al. (1998) compared the model's results to the landslide distribution map and developed a hybrid set of results that linked seismic factor of safety to probability of sliding.

Rational Probabilistic

Rational probabilistic models also incorporate the underlying physics and mechanics of landslides. But unlike deterministic models, in which the variables are fixed numbers, probabilistic models treat variables as a set of ranges or probabilities. Depending on the variable, probability values can take a normal bell-shaped distribution, a flat uniform distribution, or a more complicated distribution. Probability implies uncertainty, and uncertainty carries over to the results as well. The results of rational probabilistic models can be given as the mean and standard deviation of the factor of safety, the probability of landsliding (or stability), or a slope reliability index (Figure 5-3).

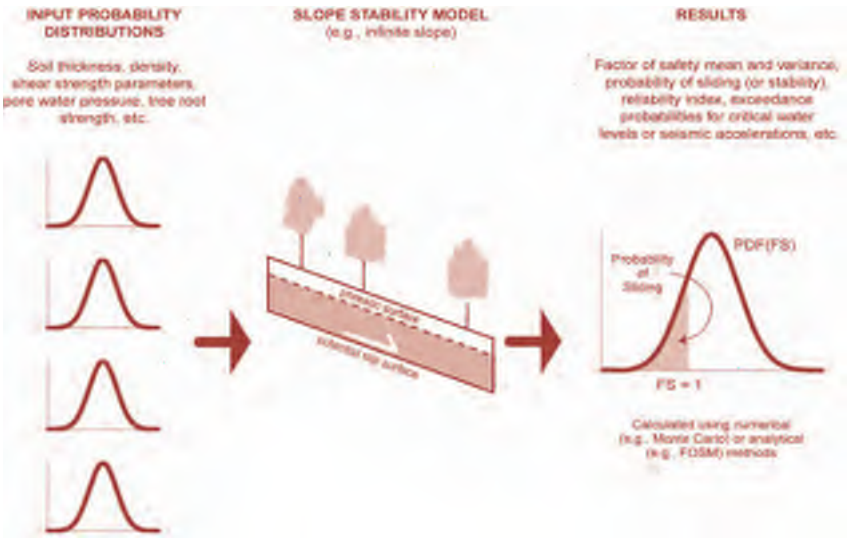


Figure 5-3. *Results of a rational probabilistic slope stability model.*

The advantage of rational probabilistic methods is their ability to deal with uncertainty, which can reflect real-world conditions. This ability, however, comes with a price.

Rational probabilistic models use two main approaches to incorporate uncertainty: algebraic equations or randomly computed variables. By contrast, when a computer is used to randomize the variables, model simulations are run hundreds of times to generate an ensemble of results. In either case, the end products of the model are the mean and standard deviation of the factor of safety or the probability of sliding for each model cell or grid point.

The advantage of rational probabilistic methods is their ability to deal with uncertainty, which can reflect real-world conditions. This ability, however, comes with a price. The results are not simple yes-or-no options. They require expert geologic and engineering interpretation before planners can use them. For example, it may not be easy to define the threshold probability of sliding or to calculate a reliability index that should be used to delineate hazardous and nonhazardous areas. Another drawback to existing rational probabilistic models is that they have not yet been integrated with groundwater flow models. It is therefore difficult to evaluate the effects of specific rainstorms, although it is computationally possible to do so.

Though experimental, examples of rational probabilistic models exist. Manizales et al. (1996) calculated both a mean and a standard deviation for the factor of safety against sliding in each cell, which in turn enabled them to calculate probabilities of sliding. Mankelow and Murphy (1998) used this same approach to simulate earthquake-

triggered landslides in southern California. Haneberg (2000b, 2001) developed a more general method and tested it near Wheeling, West Virginia, to produce contour maps that identified safety factors and levels of landslide probability. The maps also established a slope reliability index for the area (Figure 5-4).

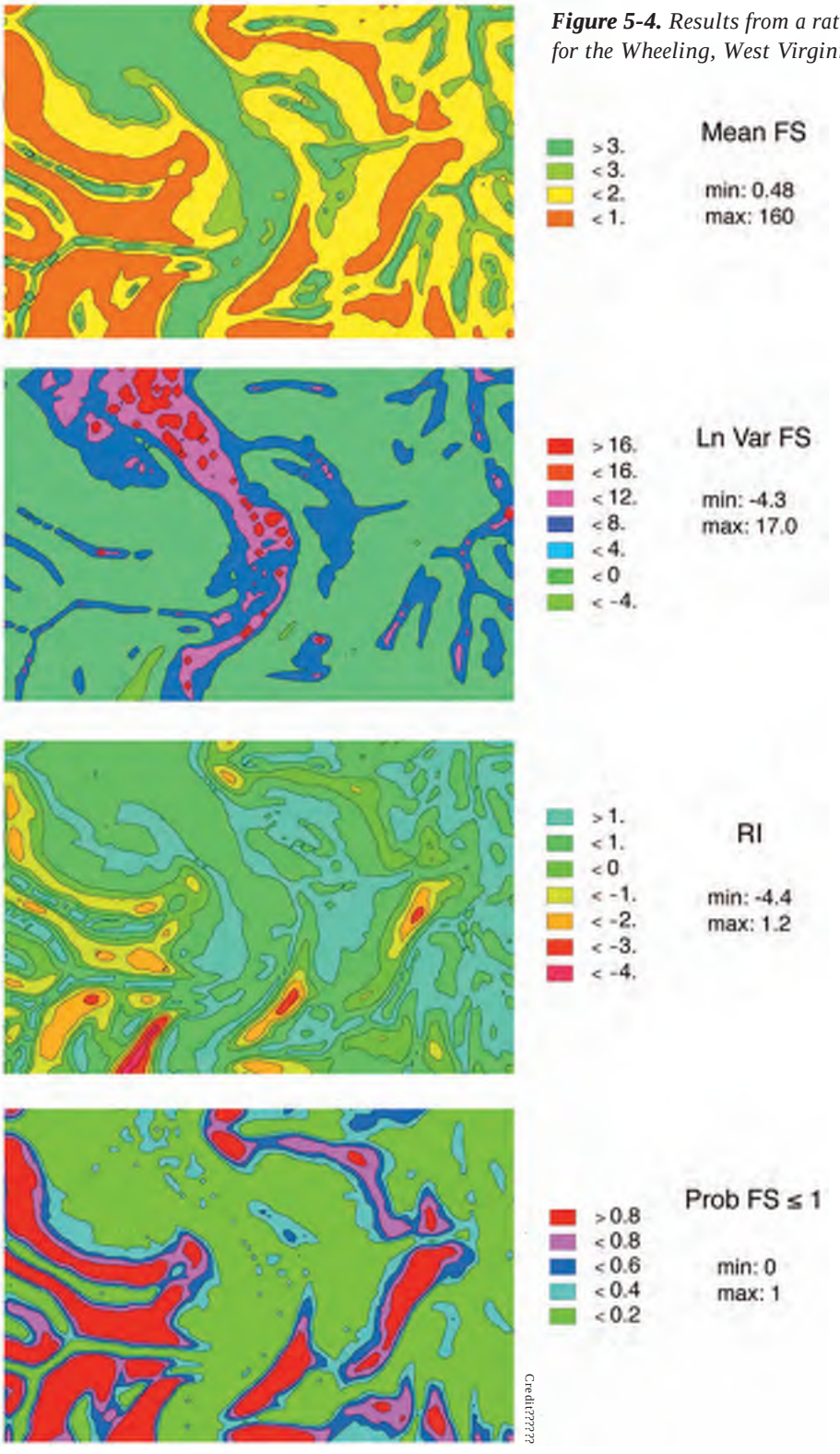


Figure 5-4. *Results from a rational probabilistic slope model for the Wheeling, West Virginia, test area.*

Map 1. Mean factor of safety against sliding (FS > 1 indicates sliding occurs).

Map 2. Results showing the highest uncertainty associated with the flattest areas.

Map 3. The reliability index. Large positive values indicate reliably stable slopes; large negative values indicate reliably unstable slopes; small values indicate unreliably stable or unstable slopes (that is, their stability is in question).

Map 4. The probability of sliding if the factor of safety is assumed to be log-normally distributed.

The U.S. Forest Service makes use of computer-based, numerical methods for its LISA (Level I Stability Analysis) program to generate hazard levels for forest watersheds (Hammond et al. 1992; Koler 1998). LISA was also one of the models tested for a debris-flow hazard study in Madison County, Virginia, by Morrissey et al. (2001). Although LISA's results cannot be easily adapted to a GIS-based analysis, the underlying techniques have much to offer. The LISA manual, which is a valuable reference for slope stability analysis, provides examples of how different geomorphologic or engineering geologic map units can be analyzed for using this kind of modeling technique.

The best approach using currently available and evolving tools is a multitiered strategy in which landslide inventory data are compared to deterministic model results.

THE BOTTOM LINE

No universal solution exists for modeling landslide hazards. The most effective method for a given area will depend on geologic conditions and land use. It will also depend on the availability of data about past landslides, detailed geologic maps, geotechnical information, and computational and financial resources available to the planning agency. In an ideal case, the planning agency will have extensive and detailed historical landslide inventories, exhaustive geotechnical soils data, the ability to run sophisticated GIS-based landslide hazard models (most of which are still in the research stage), and geologic expertise necessary to interpret the results.

The best approach using currently available and evolving tools is a multitiered strategy in which landslide inventory data are compared to deterministic model results. Areas predicted to be unstable by a deterministic computer model, but which have no historical record of landslides, should be targeted for detailed geotechnical investigations before development is approved. Known landslides not identified by a deterministic model should be tested for stability for both present and future land uses. The value of observational and model information can therefore be maximized in order to minimize the risks of developing in potentially unstable slopes.

GROWTH, GEOLOGY, AND GIS: MAPPING, MODELING, AND LIVING WITH GEOLOGIC HAZARDS IN MOAB-SPANISH VALLEY, GRAND COUNTY, UTAH

By Mike Price

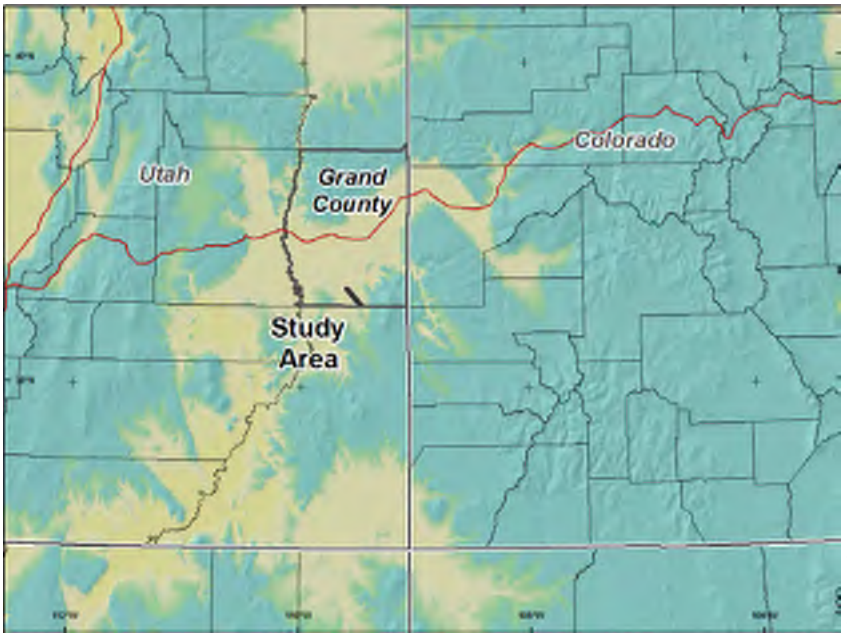
Mike Price is the principal of Entrada / San Juan, Inc., based in Moab, Utah. He specializes in natural resources and public safety / emergency management mapping.

As planners continue to adopt and apply GIS technology, APA recognizes the need to develop and deploy comprehensive GIS training curricula. APA, in partnership with ESRI and the NFPA, has developed a real-world training set that includes Utah Geological Survey (UGS) hazard mapping, combined with spatial data from local, state, and federal data providers. This article presents an overview of the Moab-Spanish Valley training model, including an introduction to Moab area geology, hazards, GIS data sources, and observed growth trends.

RESIDENTIAL GROWTH IN A RECREATIONAL AREA

Moab, Utah, is recognized as a premier destination for high-energy outdoor recreation. Vacationers from across the world come to Moab to experience mountain biking, jeeping, rafting, hiking, and more. Some visitors, enchanted by Moab's rugged terrain and opportunities for desert recreation, solitude, and more, decide to remain, becoming seasonal or permanent residents. Between 1990 and 2000, the population of Grand County, and Moab, its county seat, increased nearly 30 percent, growing from 6,620 year-round residents to nearly 8,500. Since 2000, the observed growth in southern Grand County and neighboring San Juan County has exceeded the pace measured by Census 2000.

From 1979 to the mid 1990s, residential construction in Moab and Grand County had almost stopped. Since 1995, new and long-time residents have built high-value homes, often in areas away from the town, in areas close to the canyons and desert they have come to appreciate. New dwellings are sited in areas near cliffs, canyons, mountain, and streams, where geologic hazards expose homeowners to significant risk.



Utah Gdological Survey

Figure 5-5. *The four corners area with study area shown.*

UGS recently mapped the geology and geologic hazards in Moab-Spanish Valley and in neighboring Castle Valley. UGS geologists recognize that when development occurs in geologically hazardous areas, early identification and analysis of hazards is crucial. The UGS has published comprehensive geologic and hazard maps of Moab and southern Grand County, including Special Study 107, *Geologic Hazards of Moab-Spanish Valley, Grand County, Utah*. They have also developed GIS data layers for hazards iden-

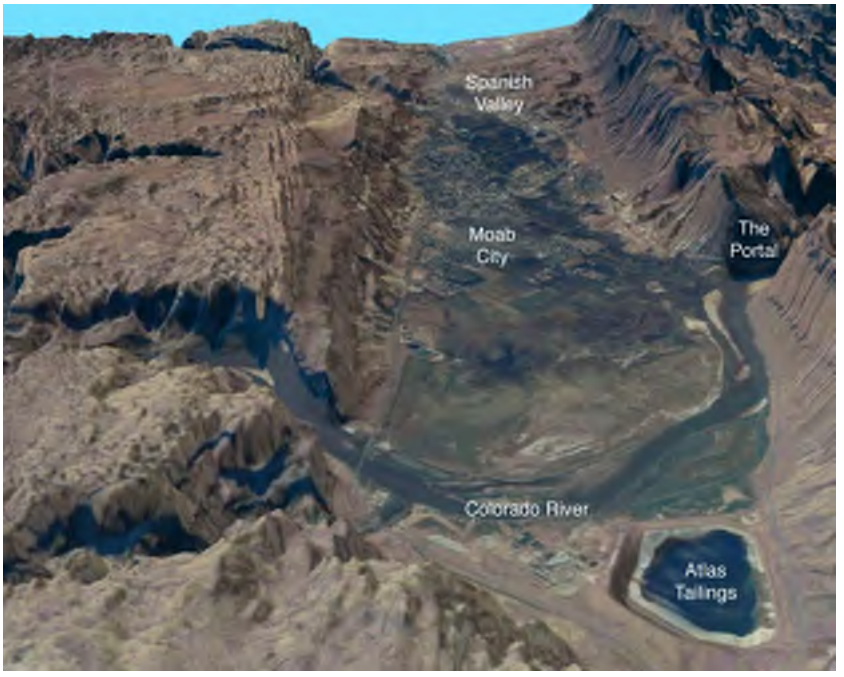
tified in selected areas, including Moab-Spanish Valley. Castle Valley hazards are described in UGS Open-File Report 238, *Geologic Hazards of Castle Valley, Grand County, Utah.*

CANYON COUNTRY GEOLOGY

Moab-Spanish Valley is in the Colorado Plateau physiographic province, in a subregion called the Paradox Basin. Approximately 300 million years ago, an inland sea formed and then evaporated in what is now southeastern Utah and southwestern Colorado. Eroding mountains east of the sea quickly covered thick layers of seafloor salt and gypsum with thousands of feet of sandstone, limestone, and shale. The weight of overlying sediments caused the salt to deform and move. The plastic salt thickened in the cores of parallel northwest-trending folds called anticlines. Over time, salt was dissolved and removed from the anticline cores and the overlying sediments collapsed back into the center of the structures, creating today's cliffs and canyons. The Colorado River traverses the Paradox Basin, crossing many of the major salt anticlines (Figure 5-6), including Moab-Spanish Valley.

Canyon Country scenery consists of landforms characterized by erosion-resistant, near-vertical sandstone cliffs separating gentle to moderate slopes made of less resistant siltstones, thin sandstones, and shales. The mix of hard sandstone and softer shale, uplifted and incised over time by the Colorado River, creates the classic stair-stepped canyon wall topography.

Steep sandstone cliffs defining faulted valley margins are continually subjected to chemical and mechanical weathering. Natural processes loosen large sandstone blocks which tumble to the valley floor without warning. A thin veneer of sandstone debris barely protects soft sediment slopes below the cliffs from the erosional energy of summer thunderstorms. In addition, gypsum and clay minerals weather and decompose as shales and evaporites erode.

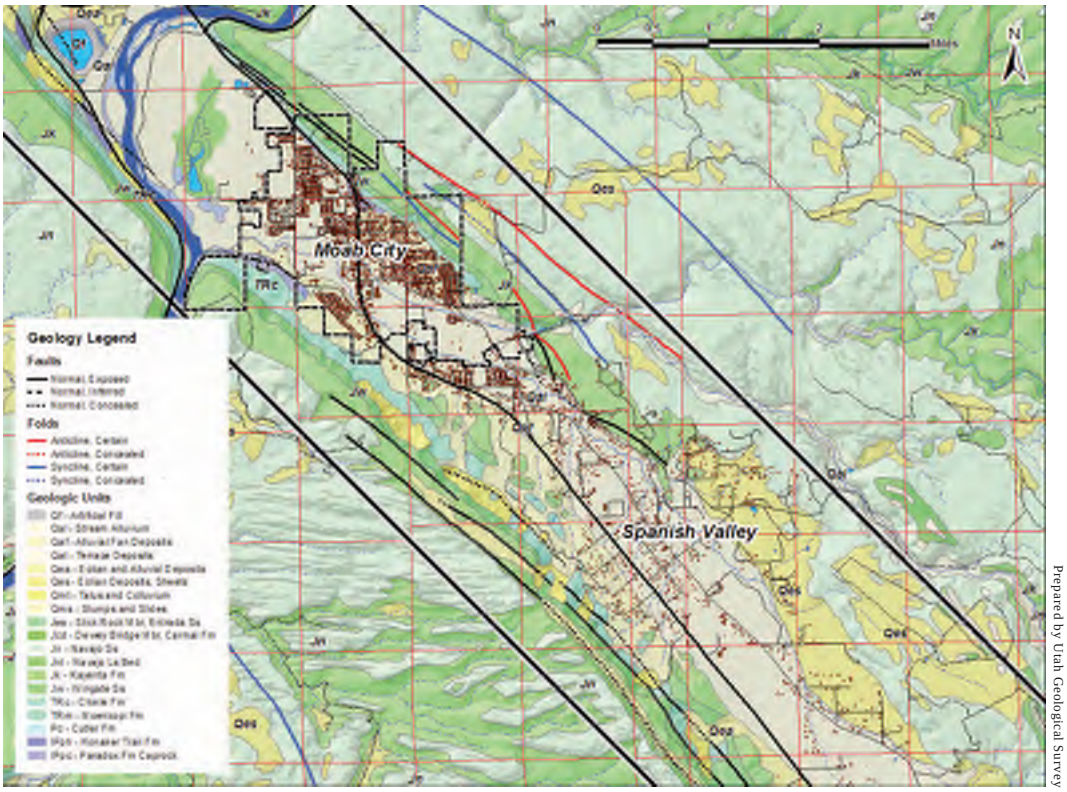


Utah Gdological Survey

Figure 5-6. *Three-dimensional computer model of Moab-Spanish Valley.*

Doelling et al. (2002) and Hylland and Mulvey (2003) provide excellent detailed descriptions of Moab area geology, with extensive information

describing the hazards presented in this report. Figure 5-7 shows the bedrock portions of the Moab and Rill Creek 7.5' quadrangles, mapped by Doelling and UGS staff.



Prepared by Utah Geological Survey

Figure 5-7. *Map of Moab-Spanish Valley showing geologic units, fold acres, and faults.*

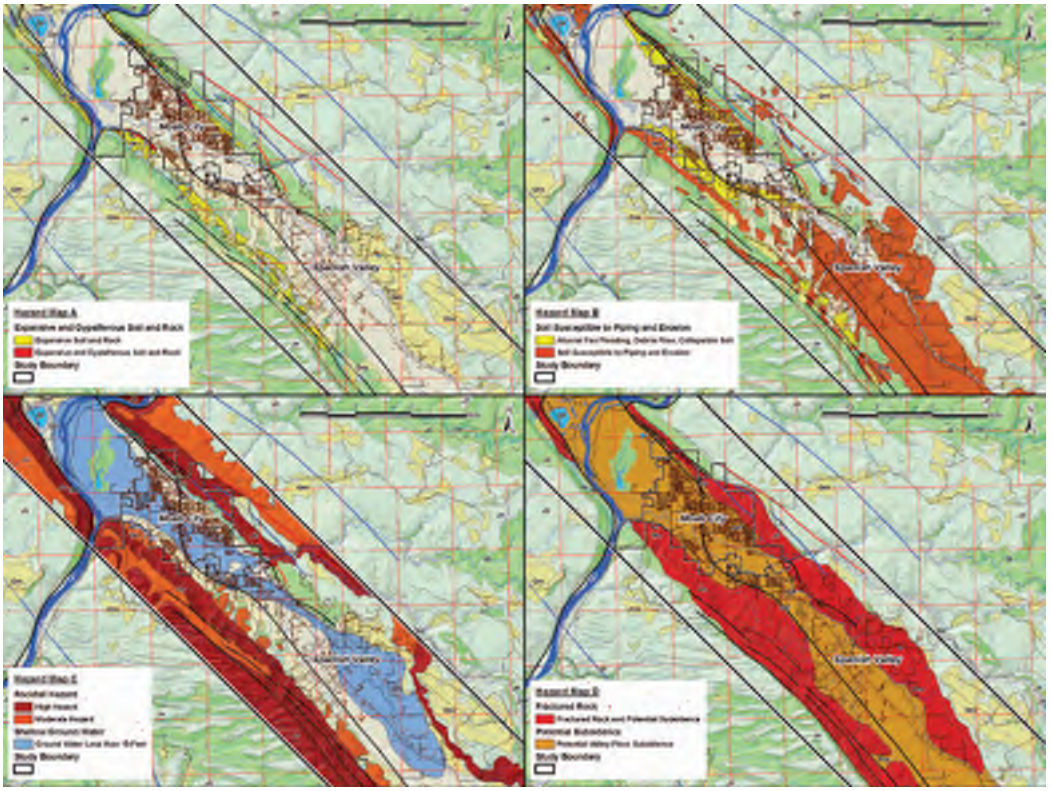
GEOLOGIC HAZARDS

UGS geologists have mapped and analyzed many geologic hazards in Moab-Spanish Valley. Several of the most common hazards are described below and shown in the maps in Figure 5-8. Also below are suggestions for mitigation or avoidance. For detailed analysis of these hazards in Moab-Spanish Valley, refer to UGS Special Study 107.

Expansive and Gypsiferous Soil and Rock (Hazard Map A)

Several formations exposed along the base of cliffs on both sides of Moab-Spanish Valley contain clay minerals that may absorb large quantities of water. (See Figure 5-9.) Repeated wetting and drying of the weathered rock and soil may cause significant change in soil volume. The repeated volumetric change can damage structural foundations, road base, runways, buried utilities, and residential septic drain fields. Paradox Formation mudstones and swelling clays near the base of the Chinle Formation are both problematic. Fortunately, the clay content of the Chinle in Moab-Spanish Valley is atypically low and problems associated with expansive soils are not as great as in other southern Utah communities. The Brushy Basin Member of the Morrison Formation also contains water-reactive clays. The Brushy Basin is not present in Moab-Spanish Valley, although it is well exposed several miles south of Moab in San Juan County and on several mesas on the La Sal Mountains, east of the valley.

Gypsiferous rock and soils, outcropping northeast of The Portal, in low hills on the northeast side of town, create a localized hazard in the valley. Gypsum rock has a very low load-bearing strength; it is often subject to dissolution, subsidence, and collapse. Gypsum in concrete aggregate re-



Prepared by Utah Geological Survey

Figure 5-8. *Geologic hazards in Moab-Spanish Valley.*

duces the strength and durability of the material. Gypsiferous soils in contact with clean concrete present a moderate concrete corrosion potential.

Expansive and gypsiferous soil and rock provide highly undesirable building substrate; they are often best left undisturbed. If construction is necessary, extensive sub-grade preparation, strengthened foundations, storm water diversions, and deep piling may help reduce structural damage over time. Gypsiferous soils may be removed from around a new foundation and replaced with inert materials. Impermeable membranes or coatings may provide some protection to concrete at or below grade.

Potential alluvial-fan flooding and debris flows are best identified before construction and avoided.

Stream Flooding, Alluvial-Fan Flooding, and Debris Flows (Hazard Map B)

Summer thunderstorms produce intense surface runoff events that may overtop local drainage systems throughout the valley. Cloudburst events, common in late summer, may flow excessive water and can transport large clastic material down intermittent and perennial streams through Moab. These streams occasionally top their normal banks and their hydraulic energy and sediment load may damage low-lying structures. Bridges, crossings, and bikeways have all been damaged by these brief intense storms.

Alluvial-fan flooding and debris flows also occur during thunderstorm events. These phenomena dislodge and transport unconsolidated alluvial fan materials and cause high sediment loading of local streams and washes. Overly steep, unconsolidated, and water-saturated slopes are vulnerable, especially near canyon mouths. (See Figure 5-10.)

Mitigation measures for stream flooding include building away from recognized flood areas, channel and bank stabilization, dike construction, and channeling. Channeled drainages are problematic because they must be periodically cleaned of undesirable vegetation, debris, and accumulated large sediment. Potential alluvial-fan flooding and debris flows are best identified before construction and avoided. A surface drainage plan may divert surface flow away from potential areas of concern.

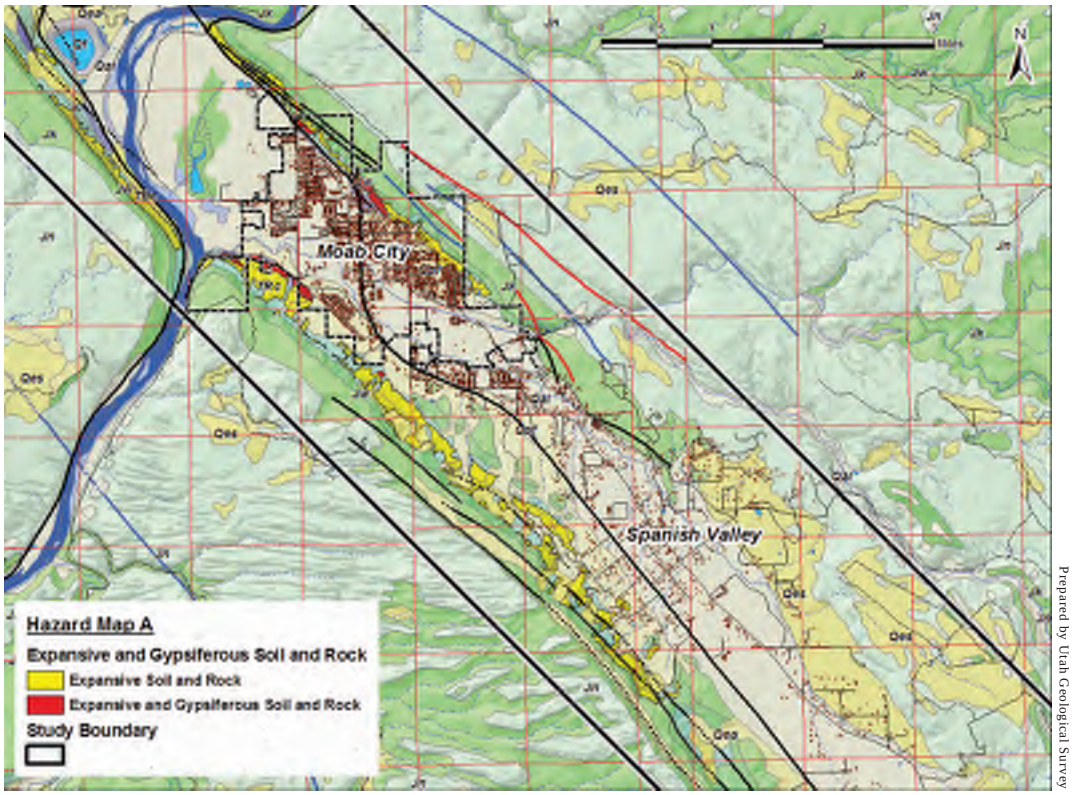


Figure 5-9. *Hazard Map A: Expansive and gypsiferous soil and rock.s*

Collapsible Soils (Hazard Map B)

Collapsible soils typically occur in fine-grained alluvial fan deposits and wind-deposited loess, containing small fractions (generally less than 12 percent) of clay. (See Figure 5-10.) Collapse occurs when loose, dry, low-

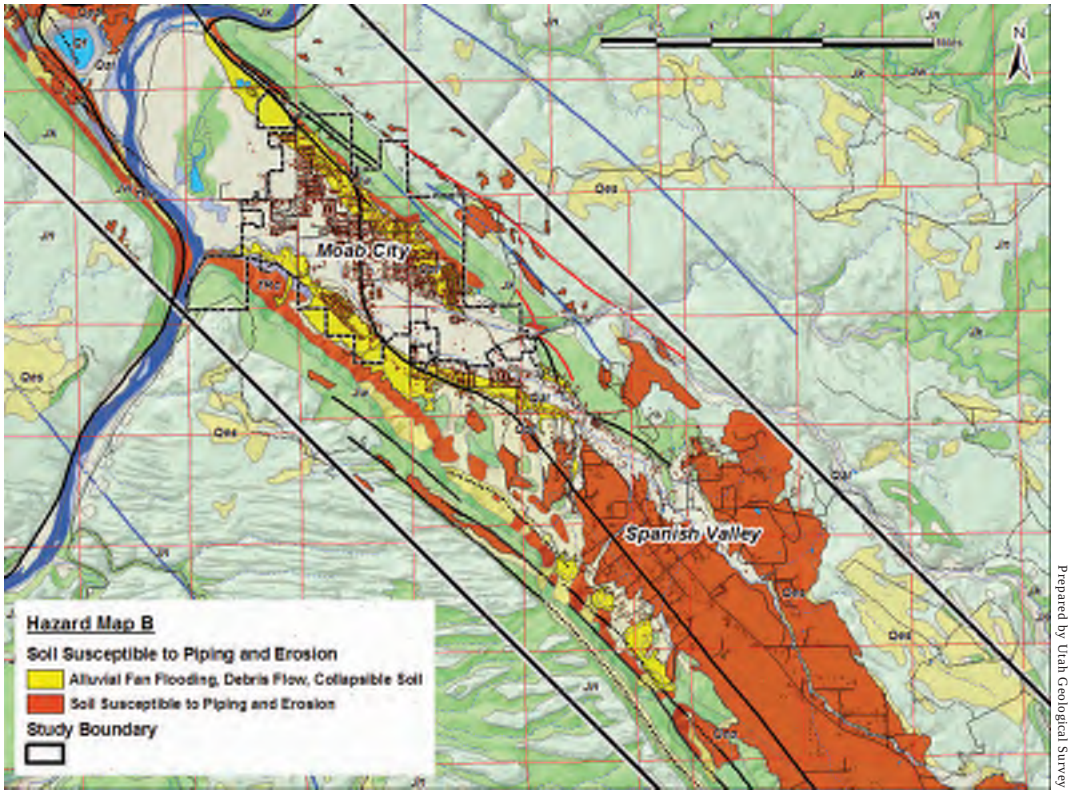


Figure 5-10. *Hazard Map B: Soil susceptible to piping and erosion.*

density deposits are wetted soon after initial deposition. The resulting loss of soil volume may damage foundations and structures. Collapsible soils in southern Utah are associated with young sediments derived from the Paradox, Moenkopi, and Chinle Formations. In the Moab-Spanish Valley area, they form on the downstream or distal margins of alluvial fans.

Collapsible soils are typically mitigated by identification, followed by removal, replacement, and compaction. A well-designed drainage system and surface treatments may also help.

Soil Susceptible to Piping and Erosion (Hazard Map B)

Piping is a subsurface erosion phenomenon common in arid environments. (See Figure 10.) Small volumes of water flowing through poorly sorted, unconsolidated sediments may transport fine sediment particles downward through an alluvial fan or stream bank. If the transported sediments reach the face of an incised drainage, they move into the drainage and the "tunnel" is enlarged. Piping features often grow during summer thunderstorms when inter-rill surface flow encounters fractures or animal burrows near deep washes. As a pipe grows, it may enlarge to create a sinkhole and if completely breached at the surface, it will form a deep gully.

Certain soft formations, notably the Chinle Formation, are very susceptible to surface erosion and gully formation. Piping occurs in poorly sorted, unconsolidated alluvium and fan debris near incised drainages. Piping and erosion are best minimized through a well-designed drainage plan. Constructed lined drainages, riprap placement, landscaping, artificial surface covers, and restricting surface disturbance may help.

Rock Fall (Hazard Map C)

Rock fall is possibly the most spectacular geologic hazard observed and mapped in Moab-Spanish Valley. (See Figure 5-11.) It is also the primary mass-movement hazard in the valley. Sheer sandstone cliffs undergo subtle, continuous chemical and mechanical weathering. As rocks loosen from their footing, gravity draws them toward the valley floor. In thick units, such as the Wingate Sandstone, dislodged rock may fall several hundred feet before striking an underlying talus slope. Once the falling rock reaches the talus, it continues to bounce, roll, and slide until it reaches the flattened lower slopes. Studies indicate that rock fall will continue to move at high velocity on slopes with average slope greater than 28 degrees.

Rock fall is a short-duration-proximity hazard. Avoidance by distance and decreased slope is a primary mitigation technique. Constructed barriers, catch berms, and deflection structures may slow or redirect rolling or sliding material. Stabilizing or removing fractured rock may also help. Formations prone to rock fall include the major cliff-forming sandstones of the Wingate, Navajo, and Entrada Sandstones.

Shallow Ground Water (Hazard Map C)

Shallow groundwater, at depths of 10 feet or less, is present in unconsolidated valley fill beginning near the San Juan County line and continuing northwest to the Colorado River. (See Figure 5-11.) The near-surface aquifer recharges from snowmelt and storm runoff flowing down Pack and Mill Creeks. The USG uses well logs and observed surface flow to map the extent of shallow groundwater. Seasonal variation and recent drought cause the water table to fluctuate significantly.

Shallow groundwater can cause flooding of basements, utility lines, and septic drain fields. It may also contribute to corrosion and failure of concrete walls and slabs, and damage to building foundations. Shallow ground water may also contribute to erratic behavior of swelling clays, collapsible soils, and pip-

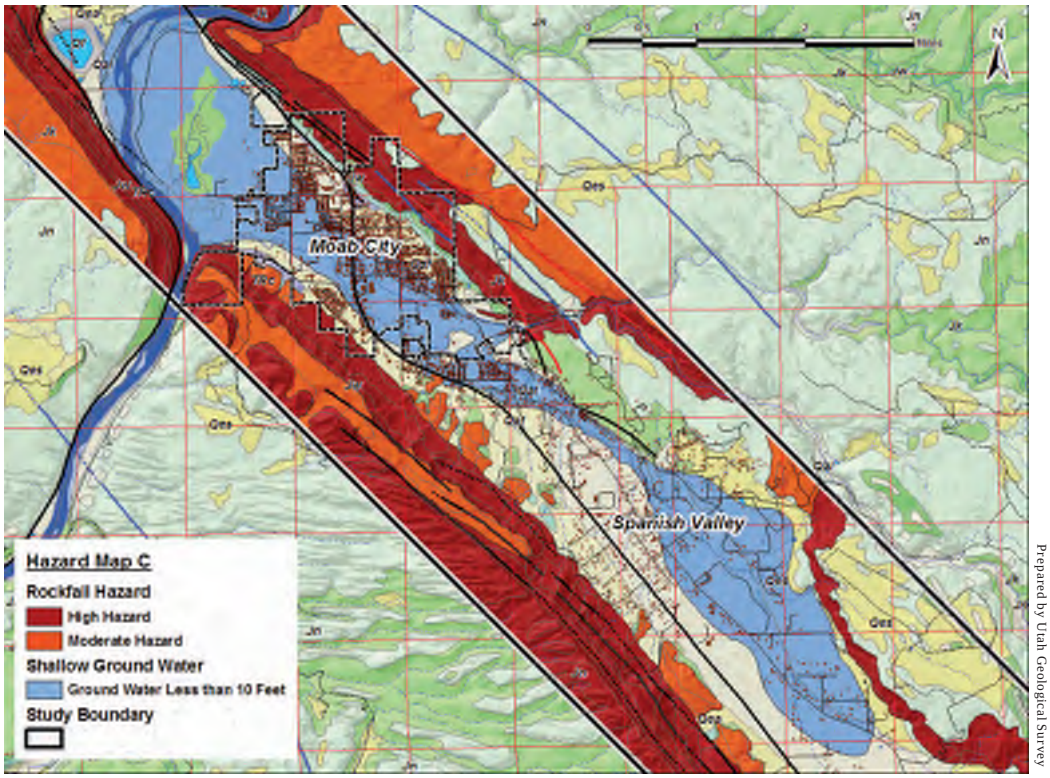


Figure 5-11. *Hazard Map C: Rockfall hazard and shallow groundwater.*

ing. Effects of shallow groundwater are first observed near the Mill and Pack Creek channels and are more problematic during wetter climatic periods.

Shallow groundwater should be identified prior to development. If present, building techniques and dewatering may minimize its effects.

Fractured Rock (Hazard Map D)

Moab-Spanish Valley formed primarily by dissolution and remobilization of soluble salt below an unconsolidated valley floor. (See Figure 5-12.) Collapse of overlying rock on both sides of the valley is an ongoing process, as fractured and faulted rocks along both sides of the valley continue to deform and settle. Fracturing weakens the bearing strength of the rock and increases its permeability. Deep-seated fractures may act as rapid downward conduits for residential sewage, allowing effluent to reach the culinary water table without filtering and adequate biotic remediation. Building foundations placed on fractured rock are susceptible to settling and constructed trenches are susceptible to collapse.

Fractured rock also contributes to increased slope instability and rock fall potential. This hazard should be identified prior to construction and structure placement should consider areas of unstable, fractured rock.

Shallow groundwater should be identified prior to development. If present, building techniques and dewatering may minimize its effects.

Valley Floor Subsidence (Hazard Map D)

Valley floor subsidence is closely related to fractured rock, although this hazard is most evident away from the bedrock margins and is present throughout lower areas of the valley. (See Figure 5-12.) Breccia pipes and collapse features of unknown origin have been mapped on the northeast valley margin, especially in southern valley areas.

Valley floor subsidence is a slow, continuous, widespread phenomenon. The UGS concludes that valley floor subsidence is an ongoing process that should be studied further. Foundations with adequate reinforcement and horizontal integrity will minimize structural damage, allowing the building to slowly settle as a homogeneous unit.

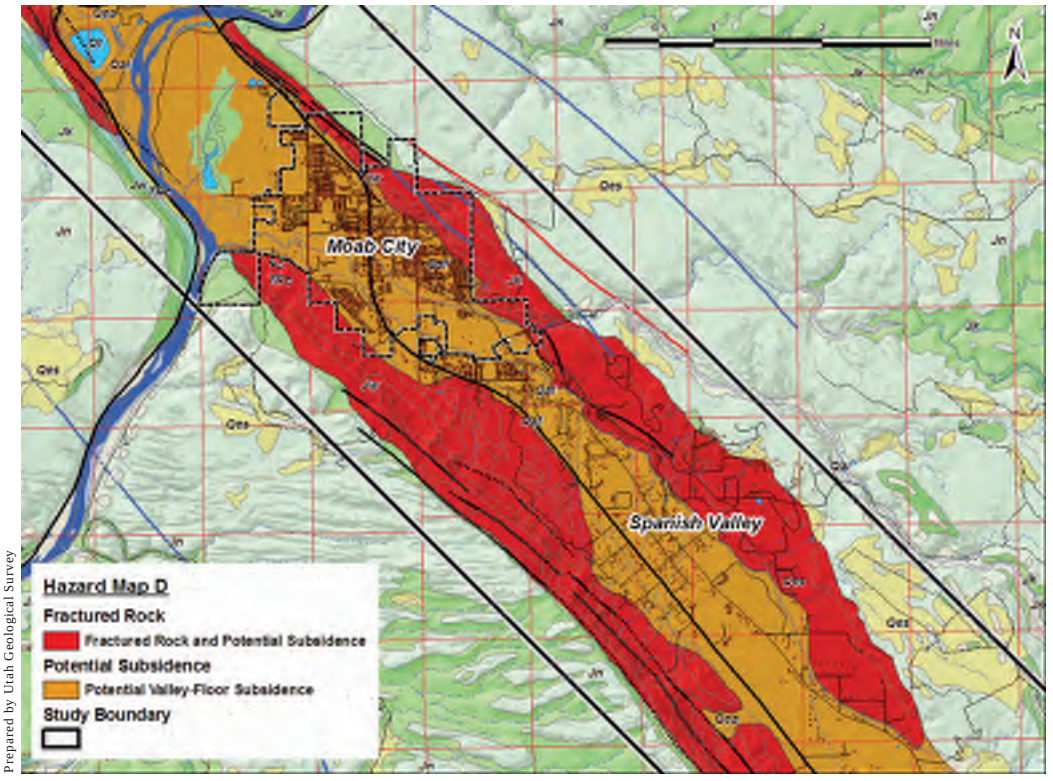


Figure 5-12. *Hazard Map D: Fractured rock and potential subsidence.*

The UGS concludes that valley floor subsidence is an ongoing process that should be studied further. Foundations with adequate reinforcement and horizontal integrity will minimize structural damage, allowing the building to slowly settle as a homogeneous unit.

GEOGRAPHIC INFORMATION SYSTEMS (GIS) MODELING

To model the geologic hazards of Moab-Spanish Valley, many GIS methods and processes may be applied. Table 5-1 summarizes the hazards mapped in Figure 5-8 and shows primary and secondary GIS processes applied to define and analyze the hazard. Several additional unmapped hazards are also listed. Core GIS processes of proximity and overlay define and assess all hazards. Digital terrain supports all analyses and is essential for most. Networks and steepest paths support stream flooding and rock-fall models. Volumetric determination is important for hazards such as expansive soils, debris flows, and erosion. Layered raster analysis, especially in vertical space, is applied for groundwater assessment and for unstable soils.

TABLE 5-1: GIS METHODS AND PROCEDURES APPLIED TO MAP GEOLOGIC HAZARDS IN MOAB–SPANISH VALLEY, UTAH

Hazard Analysis with GIS	Terrain Analysis	Slope, Aspect Modeling	Proximity Analysis	Overlay, Theme-on-Theme	Networks, Steepest Path	Volumes, Cut-Fill Analysis	Raster, Vertical Analysis
Mapped Hazards							
Expansive and Gypsiferous Rock and Soil	2	2	A	A		1	1
Stream Flooding, Alluvial Fan Flooding	1	2	A	A	1	2	
Debris Flow, Landslides	1	1	A	A	1	1	
Collapsible Soils	1	2	A	A		1	1
Piping, Erosion	1	1	A	A	1	2	
Rock Fall	1	1	A	A	1		
Shallow Ground Water	1	2	A	A			1
Fractured Rock	1	1	A	A			
Other Hazards							
Earthquakes	2		A	A			
Subsidence	1	2	A	A			
Indoor Radon	2		A	A			

Code	Description
A	GIS Process or Concept Applies to all Hazards
1	Primary GIS Process or Spatial Concept
2	Secondary GIS Process or Spatial Concept

Data mapped in Moab-Spanish Valley were obtained from many sources, shown in Table 5-2. Most data were obtained from the State of Utah, Grand County, and local providers. Table 5-2 also lists national sources where similar data may be obtained for hazard assessments in other areas.

TABLE 5-2. DATA SOURCES FOR MOAB–SPANISH VALLEY GEOLOGIC HAZARDS MODEL, WITH SUGGESTED SOURCES FOR SIMILIAR DATA IN OTHER LOCATIONS

Framework Data			
	Moab-Spanish Valley Model	**Nationally Available Data**	**National Data Web Site**
Elevation	UT AGRC	GOS - USGS Seamless	www.geodata.gov/gos, seamless.usgs.gov
Hydrography	UT AGRC	GOS - NHD	www.geodata.gov/gos
Geodetic Control	USBLM	GOS - NGS	www.ngs.noaa.gov/
Cadastral Information	UT AGRC, USBLM	GOS - USBLM	www.geodata.gov/gos
Governmental Units	Grand County, UT AGRC	GOS – US Census	www.geodata.gov/gos
Transportation	Grand County, UT AGRC	GOS – USDOT BTS	www.geodata.gov/gos
Orthoimagery	Commercial, USBLM, Grand County	GOS - USGS	www.geodata.gov/gos
Hazards and Values Data			
Data Type	**Moab-Spanish Valley Model**	**Nationally Available Data**	**National Data Web Site**
Geology	UGS	USGS, State Sources	www.usgs.gov
Geologic Hazards	UGS	USGS, State Sources	www.usgs.gov
Flood Hazard	Grand County, US FEMA	US FEMA HAZUS	www.fema.gov/hazus
Electrical, Gas Utilities	UT AGRC, Grand County	US FEMA HAZUS	www.fema.gov/hazus
Water, Wastewater	Grand County, Moab City	US FEMA HAZUS	www.fema.gov/hazus
Building Stock	Grand County, Moab City	US FEMA HAZUS	www.fema.gov/hazus
Essential Facilities	Grand County, Moab City	US FEMA HAZUS	www.fema.gov/hazus
Demography	US Census, TIGER	US Census, TIGER	www.census.gov/geo/www/tiger
Land Use/Land Cover	UT AGRC	USGS Seamless	seamless.usgs.gov
Planning and Zoning	Grand County	Local Sources	
Agency Acronyms			
Agency	**Full Name**		
FEMA HAZUS	Federal Emergency Management Agency Hazards-US		
GOS	Geospatial One Stop		
NED	National Elevation Dataset		
NGS	National Geodetic Survey		
NHD	National Hydrologic Database		
TIGER	US Census Topologically Integrated Geographic Encoding and Referencing system		
UGS	Utah Geological Survey		
US FEMA	US Federal Emergency Management Agency		
USBLM	US Bureau of Land Management		
USDOT BTS	US Department of Transportation, Bureau of Transportation Statistics		
USGS	US Geological Survey		
UT AGRC	Utah Automated Geographic Reference Center		

The Utah Automated Geographic Reference Center (AGRC) was an excellent source for much of the framework data. UGS mapped and compiled geology, geologic structure, and all hazard layers. County and Special District agencies provided infrastructure, values at risk, and planning information.

RED ROCK RANCHOS: THE APA GEOLOGIC HAZARDS GIS TRAINING MODEL

State Trust Lands managed by Utah School and Institutional Trust Lands Administration (SITLA) are occasionally leased or sold to successful bidders for development. Trust Lands on Johnson's Up on Top, a high mesa between Mill Creek and Pack Creek above southeastern Spanish Valley, are candidates for future residential development. Desirable state tracts are east of developed Spanish Valley in areas zoned for grazing and large lot, dispersed residential development. (See Figure 5-13.) They also occur largely within the area mapped by the UGS.

THE RED ROCK RULES

- Development shall occur only on selected, transferred State Trust Land
- All development shall occur only in Grand County Zone G–1 (Grazing)
- Archaeological surveys will be performed on all selected lands and any identified sites will be properly mitigated
- Access roads shall be constructed to Grand County Class B standards, will have no slopes exceeding 6 percent, and will have minimum curve radii of 100 feet
- Only 25,000 feet of hard surfaced perimeter road is allowed within the development, excluding access, and shall provide continuous, looped access throughout the development
- All development is limited to within 500 feet of center line of hard-surfaced perimeter road
- All structural placements shall be confined to slopes of less than 15 percent
- Lot setback shall be 50 feet from outward-facing lot line
- Forty percent of residential development may be clustered on 10 percent of available land
- Disperse residential development shall be limited to 2.5-acre minimum lots
- Culinary water will be provided by developer and will be adequate to meet emergency needs
- Sanitary sewer will be provided by developer and all sewage will be transported offsite; refuse collection will be mandated
- Grading plan and erosion control measures will address geologic hazards, especially rock fall, unstable soils and disturbed soils, windblown particles, and vegetative ground cover
- Vegetation plan will favor xeric landscaping, designed to minimize wind and water erosion
- Public safety plan will address and mitigate geologic hazards, ingress-egress limitations, fire suppression water supply, and Wildland / Urban Interface concerns
- Surface water plan will mitigate surface runoff by confinement and infiltration

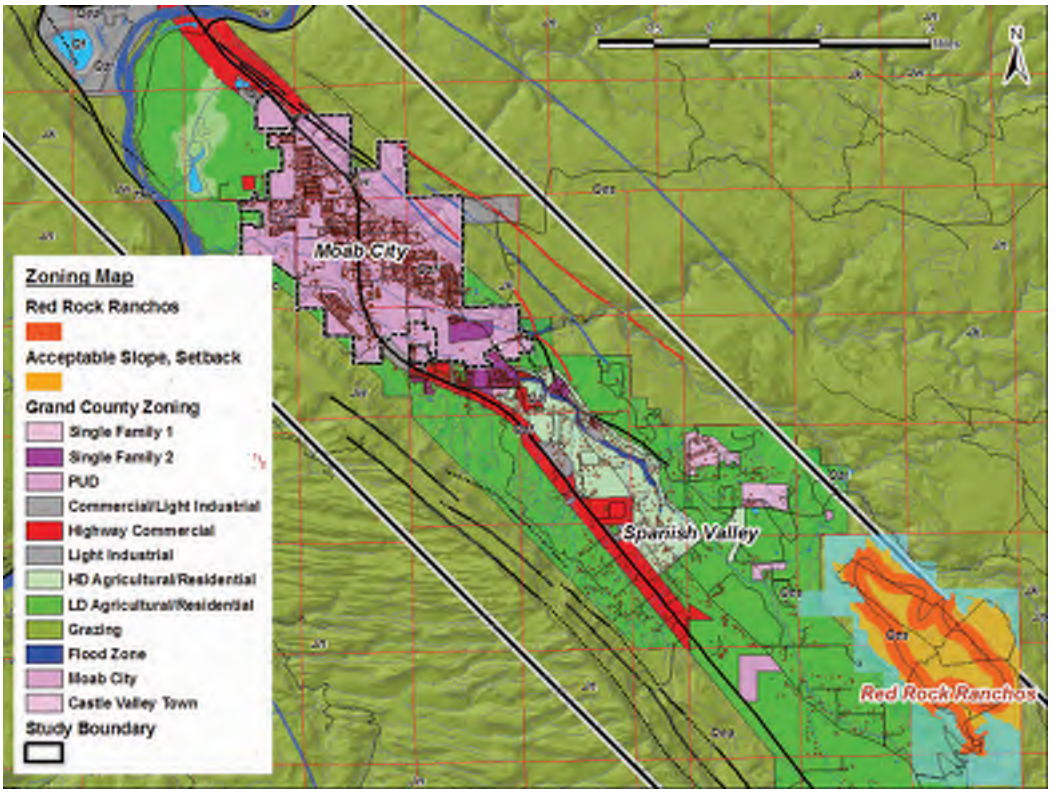


Figure 5-13. *Zoning map.*

The Moab-Spanish Valley area . . . provides an exceptional virtual and hands-on classroom to identify, map, and analyze geologic hazards in high-relief sedimentary terrain.

To provide planners with a real-world training set for mapping and understanding geologic hazards, APA and ESRI have developed a training model focusing on state trust lands. It considers zoning, access, visibility, aesthetics, and more. A summary of the model's land selection and development rules and constraints is provided in the sidebar.

SUMMARY

The Moab-Spanish Valley area of southern Grand County, Utah, provides an exceptional virtual and hands-on classroom to identify, map, and analyze geologic hazards in high-relief sedimentary terrain. Extensive, high-quality data sets are available from federal, state, and local providers. The UGS has mapped major geologic hazards throughout the valley. Grand County's recent history has been rapid residential spread into the remote cliffs and canyons surrounding Moab.

The APA / ESRI training model provides planners with opportunities to experiment with GIS and learn to apply valid GIS processes to identify, understand, and resolve real-world planning issues related to dispersed growth, rugged terrain, and geologic hazards.

CHAPTER 6

Case Studies: How Local Governments Respond to the Challenge of Planning for Landslide Hazards

Four case studies of local government efforts to successfully respond to the difficulties of allowing appropriate development in landslide-prone areas make up this chapter. The jurisdictions covered in the papers by various authors include Portola Valley, a small northern California town, 30 miles south of San Francisco in San Mateo County; Kelso, Washington; Pittsburgh, Ohio; and Jefferson County, Colorado.

A MODEL OF EFFECTIVE USE OF GEOLOGY IN PLANNING, PORTOLA VALLEY, CALIFORNIA

By George Mader, *FAICP*

Mr. Mader is president of Spangle Associates, a planning firm in Menlo Park, California. He has served as consulting town planner since 1965. Among other activities, he has been chairman of the California Seismic Safety Commission and taught in the School of Earth Sciences at Standford University for 30 years.

Portola Valley, a small northern California town, has demonstrated for more than 30 years how geology can be effectively used in shaping land-use decisions. While this case study is based on a single community, the components of Portola Valley's integrated geologic hazards mitigation program, including geologic mapping, retaining a geologist, a general plan with geology components, and regulations that take geology into consideration when making land-use decisions, can be adapted to other communities.

Setting

The town of Portola Valley, located about 30 miles south of San Francisco in San Mateo County, is located in hilly land on the eastern flanks of the Santa Cruz Mountains (Figure 6-1). Covering an area of approximately nine square miles (5,750 acres), the town is in a valley with steep and rugged tree-covered mountains on the west, and lower, gently rolling grass and oak-covered hills on the east. The San Andreas Fault zone passes through the floor of the valley. West of the fault, steep slopes rise 1,600 feet to the crest of the Santa Cruz Mountains; east of the fault, the less precipitous rolling hills rise 400 feet. Landslides are widespread west of the fault but virtually nonexistent to the east.

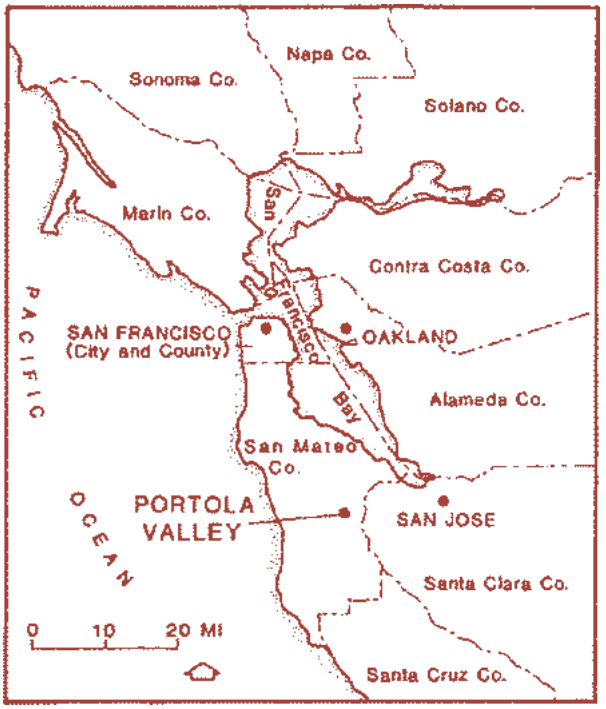


Figure 6-1. *Location of Portola Valley.*

Preservation of the town's natural setting and views was one reason residents voted to incorporate in 1964. Today, Portola Valley is a residential community of about 4,400 people. Most development consists of homes built on lots of 1/2.5 acres. The natural characteristics of the town and its separation from the more urbanized areas of the peninsula make it an attractive place to live. Residents work primarily on the peninsula or in San Francisco.

From the 1960s, development in the town had been concentrated in the geologically stable lands lying east of the San Andreas Fault. In recent years, however, development pressures have been sufficient to encourage developers to undertake projects in the less stable lands to

the west of the fault. Conscious of the fact that ongoing landslides are a constant concern and that massive earthquakes like that in 1906—when horizontal movement along the fault was about eight feet—are certain to recur, Portola Valley has come to realize the extent to which geologically hazardous conditions exist in the region. The town has thus taken a conservative standpoint toward the level of geologic hazard risk it considers acceptable.

Overview of Geologic Hazards Mitigation Program

The major parts of the integrated geologic hazards mitigation program in Portola Valley were put in place between 1967 and 1979. Since 1979, the program has been fine-tuned based on the town's experience. Each of the program elements has been tested and improved, where necessary. Today, the town's long familiarity with the program guarantees automatic and comprehensive consideration of geologic concerns during review of development proposals.

The general plan, zoning regulations, subdivision regulations, site development and grading regulations, and building code contain the major elements of the hazards mitigation program. Each plays a significant role in ensuring safe development. The relationship between the plan and regulations is illustrated in Figure 6-2.

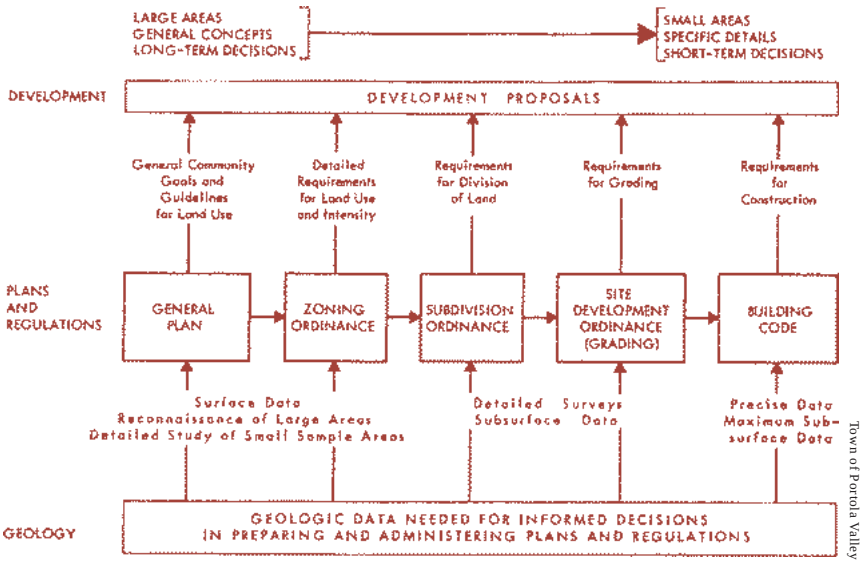


Figure 6-2. *Planning-regulation-development process. Increasing detailed geology needed as concern progresses from the general plan to building.*

The most general hazards policies are found in the general plan. The geologic input required by the general plan is broadly defined, but the regulations that implement the general plan demand increasingly more detailed information as development projects are designed and progress through reviews and construction. The intent of the general plan and the regulations is to generate a level of geologic detail appropriate for the town to assess as accurately as possible the risk associated with development and then require decisions by the planning commission and town council that minimize those risks.

Portola Valley's general plan specifies that unstable lands, such as faults and landslides, are to be kept free of all buildings for human occupancy and of most improvements. These hazards are identified on two maps maintained by the town, one that describes the area's geologic features—especially the San Andreas Fault and landslides—and another that specifies potential ground movement. Thus, the plan sets the policies that essentially prevent development of hazardous lands.

The zoning ordinance contains two specific references to geology. First, it includes a map of the San Andreas Fault that establishes required setbacks from the fault as well as locations that require investigation. Second, the ordinance includes by reference the map, *Movement Potential of Undisturbed Ground*, which is the basis for the ordinance's guidelines for permitted development.

When an application for development is submitted, it is first reviewed against the fault map, the movement potential map, and other relevant zoning maps. The maps and related text describe:

- types and amounts of uses permitted on the land;
- parcels where building sites are restricted or prohibited because of geologic or flood hazards; and
- procedures that must be followed to attempt to overcome identified hazards.

Portola Valley's subdivision ordinance, required under state law, regulates the conditions and procedures under which land may be subdivided. An approved subdivision is required before existing property can legally be divided into two or more new parcels for sale, lease, or financing. The subdivision ordinance specifies the information that a prospective subdivider must submit to the town. The ordinance further requires that the town find that a subdivision is in conformity with the general plan and zoning ordinance before it can be approved. A Subdivision Committee is authorized to review subdivision maps and report its findings to the planning commission. The committee includes the town geologist, town planner, town engineer, building inspector, fire chief, health officer, and designated members from the Architectural and Site Control Commission, Conservation Committee, and Trails Committee.

When an application for development is submitted, it is first reviewed against the fault map, the movement potential map, and other relevant zoning maps.

The site development ordinance, enacted to implement the general plan—specifically its open space, conservation, seismic safety, and safety elements—regulates grading, removal of vegetation, and construction of site improvements such as driveways. This ordinance requires detailed reports on soil and geologic conditions, grading specifications, drainage calculations, and landscape plans. No significant grading or vegetation removal may begin until a site development permit has been issued.

The building codes require a building permit prior to construction of any new structure or significant modification of an existing structure. The town's geologist reviews all permit applications for development in potentially unstable areas, as defined on the movement potential map. Sometimes, more detailed geologic studies indicate that geologic conditions are not as bad as shown on the town's generalized geologic map and development is permitted. In other instances changes in location of a building to a stable location on a parcel can solve the problem. In extreme cases the permit is not allowed, but the applicant can appeal the decision of the geologist to the planning commission and ultimately the town council, something that has seldom occurred. In many instances, a person considering building on a vacant parcel upon seeing the town's map will decide not to pursue the project. In other instances, he/she may elect to pursue a detailed geologic investigation. In virtually all instances, when the town geologist and the applicant's geologist have the same and detailed information, there is a meeting of the minds and the project either does or does not proceed.

Under the California Environmental Quality Act (CEQA) and its guidelines, the town is responsible for determining the environmental

impact of any land-use proposal it approves. Through these guidelines, Portola Valley has integrated environmental review procedures that include close attention to geologic conditions into day-to-day planning.

In 1970, the town passed an ordinance, pursuant to state law, requiring that a Residential Data Report be provided, either by the owner or realtor, prior to the resale of a home. The report contains information about occupancy, zoning classification, and any potential hazards, such as landslides and flooding shown on town maps. A reference to the geologic report, if one has been prepared, must be included in the data report.

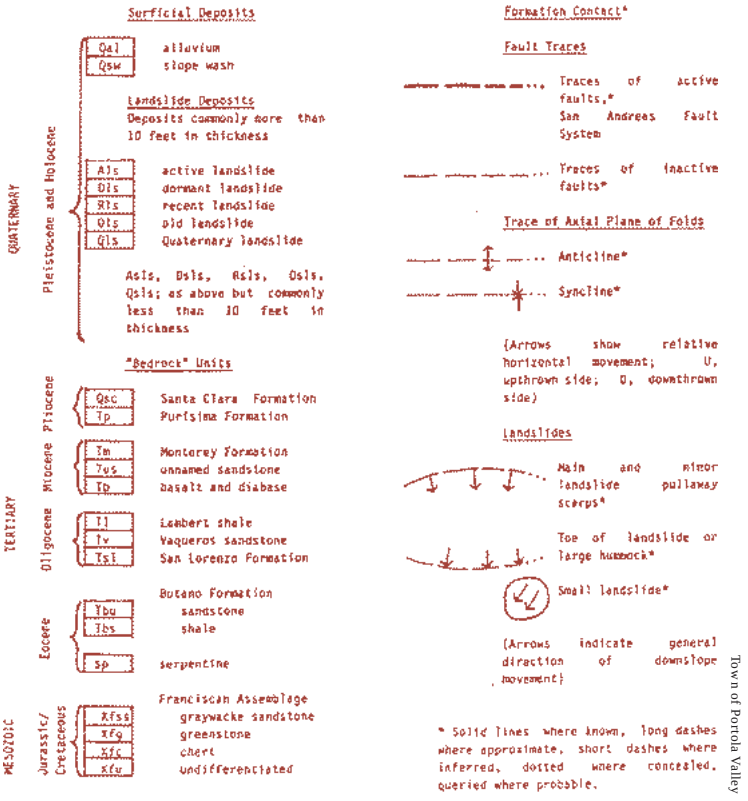
Mapping

In 1970 Portola Valley authorized the start of geologic mapping. The mapping, in addition to providing information to the town, was intended to provide a context for site investigations made by geologists and engineers. Working under the direction of the town geologist, graduate students in geology at Stanford University completed a geologic map of Portola Valley in 1974.

The map depicts primarily the surficial geology of the area. This information is particularly important to engineering geology studies since it describes the stability of soils and the bedrock at and immediately below the earth's surface. The students used extensive fieldwork and aerial photographs to gather this information; they also drew on the few subsurface studies then available. Considered a reconnaissance map to be refined as more data was gathered, the map is nonetheless quite detailed, showing individual parcels and buildings at a scale of 1"=500' (Figure 6-3). The legend for the map appears in Figure 6-4.

Because this geologic map was intended for use by geologists and other professionals, it resulted in a highly technical document that residents and public officials found difficult to understand. Thus the town translated it into a map, illustrated in Figure 6-5 on page 92, that used terminology easily understood by nongeologists to describe the ground's potential for movement. The map's most important features are the 11 categories of land stability

Figure 6-3 *(above). A portion of the town's Geologic Map;*
Figure 6-4 *(below). Legend for the town's Geologic Map.*



(shown on Figure 6-7). The 11 categories are listed in descending degree of stability and come under the following four general categories:

- Relatively Stable Ground
- Areas with Significant Potential for Downslope Movement of Ground
- Areas with Potential for Surface Rupturing and Related Ground Displacements Associated with Active Faulting
- Unstable Ground Characterized by Seasonally Active Downslope Movement.

Figure 6-5. *A protion of the town's interpretive map "Movement Potential of Undisturbed Ground." See legend on Figure 6-7.*

The map carries the following note:

> This is an interpretive map derived both from the town's Geologic Map and additional field observations and geological experience in the Portola Valley region. It illustrates the relative stability or movement potential of ground in its natural state. Works of man (grading, construction, irrigation, disposal of waste water, etc.), earthquakes, and unusually heavy or prolonged rainfall may seriously alter the natural stability of the ground.

Through the mapping program, residents began to understand the complexities and problems of local geology. The mapping revealed that lands east of the San Andreas Fault were generally quite stable, but that much of the land west of the fault, called the western hillsides, consisted of old, dormant, and

active landslides (Figure 6-6). With this information, the town had to make difficult decisions on development proposals. It accordingly directed that any proposals for development of potentially unstable lands be referred by planning staff to the town geologist and if necessary to the planning commission for consideration. Even with this procedure, however, the town had difficulty in dealing consistently with applications since the town had not yet developed a standard review process. Each one was being considered separately.

The geologic and potential movement maps developed in the early 1970s are still used in Portola Valley today. But a critical part of the town's mapping program is that it is open to challenge and improvement. A note on the town's first geologic map encouraged users to notify the town of any errors or omissions. Knowing that site-specific geologic investigations may provide new information, the town allows geologists working for clients to submit new data that the town then considers. If approved by the town, the new data is used to update the town's maps. This approach is essential to preserving the integrity of the mapping program.

George Moder

Figure 6-6. *View looking across fault- formed valley to the largely unstable western hillsides.*

Defining Acceptable Risk

In 1973 Portola Valley's town council decided to adopt a five-month moratorium, later extended, on the processing of subdivision and building applications for lands identified on its geologic map as active, dormant, recent, old, and quaternary landslides. The town geologist played a central role in helping the council reach this decision. During council meeting, she pointed out the likelihood of landslides and ground failure in an earthquake, the effect of grading on stability, the problems of drainfields, the potential for public hazard or life loss, and the liability of the town. The council's approval of the moratorium, according to one council member, was therefore intended as a first step toward establishing stricter, more standardized guidelines for local development.

The council also established an ad hoc geologic committee at the time it adopted the moratorium. The committee was made responsible for developing recommendations for legislation that defined the level of risk from geologic hazards the city was willing to accept when it approved development. The committee, chaired by the town geologist, included the geologist who prepared the geologic and movement potential maps, a consulting geologist, a civil engineer, two geologists from the U.S. Geological Survey, an attorney, and the town planner.

The first task the committee undertook was to correlate acceptable uses of land with the stability categories shown on the movement potential map. To facilitate this task, each member was asked to fill out a matrix in which basic land uses were rated for levels of acceptability in each land movement category. Prior to making the ratings, committee members agreed that the town could not afford a slope failure involving substantial damage to residences, roads, or similar improvements and that, therefore, the ratings should be approached from a conservative viewpoint that minimized the risk the town would be willing to accept. The geologist who prepared the town's maps also pointed out that the maps reflected a bias toward safety and that more detailed studies might even reduce the extent of areas considered unstable. When committee members' ratings were compared at a subsequent meeting, there was—despite the widely varying backgrounds of the committee members—virtual unanimity of opinion.

After nine months of study, the committee recommended that the town adopt a resolution designating the geologic and movement potential maps as the official geologic maps of the town and affirming the matrix correlating land uses with the land movement potential categories as town policy. The committee suggested that, by adopting these provisions by resolution rather than as an ordinance, the maps could be more easily modified in the future as more detailed geologic information became available. The resolution, Resolution 500-1974, adopted by town council on May 8, 1975, included the rating matrix shown in Figure 6-7.

Figure 6-7. *Matrix adopted by the town that correlates land uses with stability ratings shown on the Movement Potential of Undisturbed Groun map.*

CRITERIA FOR PERMISSIBLE LAND USE IN PORTOLA VALLEY

	Land Stability Symbol	Roads		Houses (parcel acreage)			Utilities	Water Tanks
		Public	Private	¼-Ac	1-Ac	3-Ac		
MOST STABLE	Sbr	Y	Y	Y	Y	Y	Y	Y
	Sun	Y	Y	Y	Y	Y	Y	Y
	Sex	[Y]	Y	[Y]	Y	Y	Y	[Y]
	Sls	[Y]	[Y]	[N]	[Y]	[Y]	[Y]	[N]
	Ps	[Y]	[Y]	[N]	[Y]	[Y]	[Y]	[N]
	Pmw	[N]	[N]	[N]	[N]	[N]	[N]	[N]
	Ms	[N]	[N]	N	N	N	N	N
	Pd	N	[N]	N	N	N	N	N
	Psc	N	N	N	N	N	N	N
	Md	N	N	N	N	N	N	N
LEAST STABLE	Pf	[Y]	[Y]	(Covered by zoning ordinance)			[N]	[N]

LEGEND:

- Y Yes (construction permitted)
- [Y] Normally permitted, given favorable geologic data and/or engineering solutions
- N No (construction *not* permitted)
- [N] Normally *not* permitted, unless geologic data and/or engineering solutions favorable

LAND STABILITY SYMBOLS: (as used on geologic hazards map)

- S Stable
- P Potential movement
- M Moving
- br bedrock within three feet of surface
- d deep landsliding
- ex expansive shale interbedded with sandstone
- f permanent ground displacement within 100 feet of active fault zone
- ls ancient landslide debris
- mw mass wasting on steep slopes, rockfalls and slumping
- s shallow landsliding or slumping
- sc movement along scarps of bedrock landslides
- un unconsolidated material on gentle slope

Town of Portola Valley

In addition, the committee recommended that the town consider incorporating some geologic limitations directly in the zoning ordinance. Specifically, it suggested that the permitted density of development be reduced by a factor that took into account the geologic hazards identified on the movement potential map. Finally, the committee recommended that information from that map also be considered during preparation of the seismic safety element and review of the land-use element of the general plan.

The Role of the Town Geologist

A few matters of definition will help create a better understanding of the following paragraphs. First, terms used for those professionals investigating soil and geologic problems can be confusing. As used in this PAS Report, the term "geotechnical consultant" refers to both an "engineering geologist" and a "geotechnical engineer." In California, professionals must be certified by the state in order to use either of these titles. In general, an engineering geologist is a geologist who specializes in interpreting geology in relation to engineering problems. A geotechnical engineer, by contrast, is an engineer who specializes in engineering solutions for soils and geologic problems. Also, as used in this report, "geotechnical" refers to investigations and recommendations from geotechnical (soils) engineers and engineering geologists.

The town geologist also provides critical geologic and geotechnical services, participates directly in the planning-regulation-development process, and educates residents and public officials about geologic hazards in the town.

Portola Valley's geologist is charged with ensuring that all new development conforms to local requirements regarding geologic hazards. The town geologist also provides critical geologic and geotechnical services, participates directly in the planning-regulation-development process, and educates residents and public officials about geologic hazards in the town. These services not only help safeguard the community as a whole, but also protect the individual landowner from the risks of development in potentially hazardous areas. Combining a broad knowledge of the ongoing evolution of landforms with a keen awareness of the town's active seismic setting, the town geologist is uniquely qualified to identify local geologic hazards and to define appropriate levels of site-specific geotechnical investigation.

The town currently employs a private consulting firm as town geologist. A senior staff member, an engineering geologist, is responsible for most of the position's work. The firm has experience in dealing with the types of geologic problems indigenous to the area as well as with local government policy-making and development regulations. It also has expertise in engineering geology, geotechnical engineering, hydrogeology, and geophysics.

The town geologist is under contract to the town to provide specified services, summarized as follows:

Retainer service. Under the retainer, the geologist agrees to keep abreast of new geologic information, advise how geologic conditions affect land-use planning developments in the town, attend meetings of town bodies, and respond, in a timely fashion, to town requests. Additionally, the town geologist agrees to provide the town with records of time spent on projects for use in billing permit and other planning applicants.

Professional services. These are geotechnical services provided by the town geologist and compensated for by a deposit required with each planning application. The services include:

- review of subdivision, site development, and building permit applications;
- definition of site conditions and recommendations on the scope of geotechnical investigations;
- review of engineering geologic and soils reports submitted in support of applications;

- preparation of written evaluation reports, including recommendations to the building inspector, planning staff, planning commission and town council. attendance at specific town meetings.

Availability for special projects. The town geologist agrees to be available to the town for special assistance and for emergency projects, as authorized by the town administrator. For time spent on such projects, the geologist is compensated at an hourly rate.

Movement potential map. The town geologist is responsible for updating this map whenever changes occur. Each request for a map change made by a private applicant is required to include a deposit for the amount of time the town geologist spends on the update.

The town geologist bills the town for geotechnical services in accordance with the firm's standard schedule of charges. Since the amount of time required by the geologist may exceed application deposits, applicants are notified that additional funds may be necessary and that any unused portion of the deposits will be refunded once the application process is completed.

Geologic Review Procedure

Arguably, the most important event during the review process is the town geologist's visit to the development site. While there, the geologist identifies the site's conditions and problems, and then requests the applicant's consultant to react to his concerns. When an application is referred to the town geologist for normal geologic review, whether it is pursuant to the zoning, subdivision, site development, or building code, the geologist conducts the following investigative tasks:

Background research. The first step the town geologist takes in a review is to examine the town's geologic and movement potential maps. The geologist also gathers previously prepared technical maps and reports pertinent to the geologic and geotechnical conditions of the subject site.

Field inspection. Once background materials have been reviewed, the town geologist inspects the project site. An inspection may not be necessary for routine applications if the site has been visited by the town geologist during the previous year. The main purpose of the inspection is to characterize current site conditions and identify any existing or potential geologic and geotechnical hazards. The field inspection routinely includes photographing pertinent aspects of the site and preparing a preliminary field map showing:

- cultural features, including existing structures, utilities, and foundation distress;
- natural and artificial topographic features ;
- drainage patterns and features, including gullies, streams, groundwater seeps, residential drainage, and leachfields; and
- distribution of such earth materials as artificial fills, soil and colluvium, bedrock, landslide deposits, and geologic contacts (e.g., faults).

Geologic/Geotechnical evaluation. After background research and field inspection, the town geologist evaluates the site with regard to the proposed development application. If the site evaluation indicates no problems are present, the applicant may not need to provide additional information. If, however, problems are identified or site conditions cannot be clearly defined, the applicant is required to retain a geologic / geotechnical firm to perform detailed investigations. When the investigations are completed, the town geologist evaluates the adequacy of the geotechnical data

(i.e., mapping, subsurface sampling, and laboratory testing) and the appropriateness of the geotechnical recommendations for the proposed development. A Standard of Care adopted by the town establishes general guidelines for geotechnical consultants who provide services within Portola Valley. The intent of the document is to shorten the review process by explaining to consultants, in advance, the stages in the application process and the minimum standards expected in their reports.

Preparation of town geologist letter report. After the town geologist completes his evaluation, he prepares a letter report for the town. The letter report summarizes: a) the type of development proposed; b) the plans and maps used in the review process; c) the general geologic and geotechnical conditions of the site; d) any potential and existing constraints posed by the site conditions; and e) the town geologist's recommendations for proceeding to the next phase of the application process.

Applicant's submission of letter report for final approval. After the project construction inspections and testing have been completed, the applicant's geologic / geotechnical consultant is required to submit to the town and the town engineer, who then has the responsibility for final approval, a letter report that describes the as-built conditions of the project. This letter must be approved prior to final project approval.

Impact on General Plan

The general plan for Portola Valley was prepared in 1965. The plan employed slope-density standards for the large undeveloped land of the steep western hillsides. The density ranges for these areas ranged from one to nine acres per dwelling unit. The plan diagram showed a clustering of development on the ridges, with the intervening canyons left as open space. A simplified version of the 1965 plan showing these cluster provisions is shown in Figure 6-8. The holding capacity of this plan was calculated to be approximately 2,400 dwelling units with a population of 8,000 to 9,000.

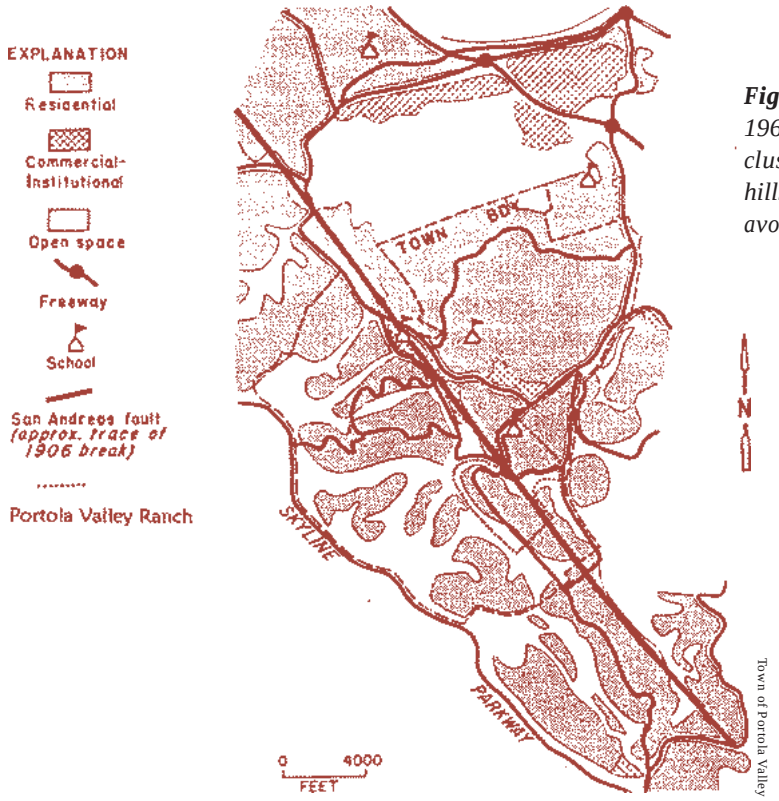


Figure 6-8. *Simplified version of 1965 general plan that shows clustering of houses on the western hillsides on ridges and largely avoiding steep canyons.*

This plan served the town well in the early years after incorporation in 1964. As concern developed over the unstable geology of the western hillsides, however, some of the features of the plan came into question. After the town had established in 1974 the level of risk that it deemed acceptable, as previously described, the plan for the western hillsides was reevaluated. When the movement potential map was overlaid on the general plan, it was discovered that significant portions of the land designated for residential use in the western hillsides were classified as unstable since they were shown as:

- moving shallow landsliding or slumping (Ms);
- moving deep landsliding (Md);
- potential deep landsliding (Pd);
- potential permanent ground displacement within 100 feet of active fault zone (Pf);
- potential mass wasting on steep slopes, rockfalls and slumping (Pmw); and
- potential movement along scarps of bedrock landslides (Psc).

Also, all slopes greater than 50 percent were determined to be susceptible to landslides and were thus considered virtually impossible to develop safely. Therefore, unstable and steep slopes were removed from the general plan as potential residential areas. At the same time, the town determined that the slope density standards needed to be revised to further limit development in the western hillsides. These revisions were completed in 1982.

The result of these revisions, which were based primarily on the town's geologic and potential movement maps and its new policy outlining acceptable risk in unstable areas, was to reduce the housing capacity for the entire town from 2,400 housing units and 8,000 to 9,000 in population to 1,950 housing units and a population of 6,800. These revisions further reduced the cluster areas in the western hillsides as shown on Figure 6-9.

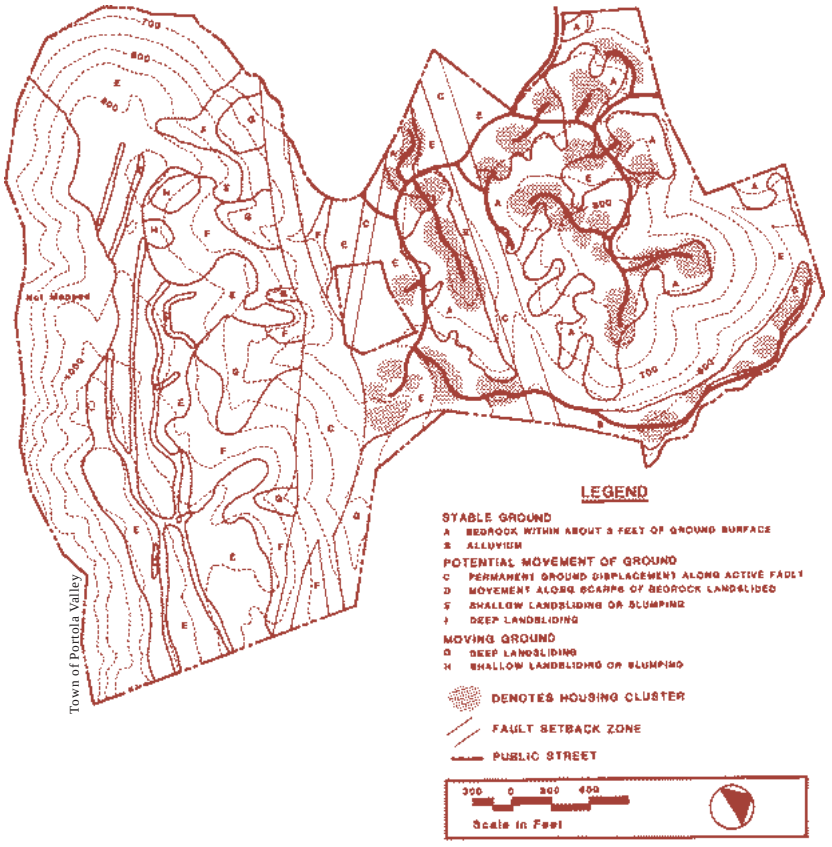


Figure 6-9. *Portola Valley Ranch general development plan and geology.*

Revising the Zoning Ordinance

After making these revisions, Portola Valley's planning commission and town council debated at length what the density of unstable lands in the zoning ordinance should be. Both agreed that no development should be permitted that was not in compliance with the rating matrix adopted as part of Resolution 500-1974. But questions arose over how to treat parcels that were located in both stable and unstable categories. There were two points of view. One position was that the acreage of unstable lands should be deducted from the total parcel area and the density calculated only on the remaining stable acreage. The other position was

that some increase in density on the stable portions of a parcel should be permitted to encourage property owners to retain the hazardous lands as open space. If no density credit were allowed, proponents of this second position argued, a developer would be encouraged to sell the land to another party rather than to retain the land as open space encumbered with an appropriate open space easement.

After considerable debate, the planning commission and the town council agreed on the second position. The permitted density of the unstable portion of a parcel would be calculated as if it were stable. Then, 10 percent of that density could be added to the permitted density of the stable portion of the parcel. The zoning ordinance was amended in 1979 to allow this 10 percent density transfer from lands classified as Ms, Md, Pd, Pf, Pmw, and Psc, as shown on the movement potential map. This transfer was made possible by the cluster provisions of the zoning ordinance. These provisions were critical to the flexibility Portola Valley needed when planning for areas with unstable lands or other features to be left in their natural condition. The ten percent density transfer also allowed the town to fulfill its objectives of preserving open space and natural features.

Town of Portola Valley

Figure 6-10. *This aerial photo shows the clustering arrangement used in the Portola Valley Ranch subdivision. All of the open space is held in common by the homeowners. That open space is encumbered by easements. The design was driven by the site's geology.*

Application of Geology to Subdivisions: An Example

In 1973, a developer proposed the Portola Valley Ranch Subdivision, a residential development on a 453-acre parcel. The town's movement potential map indicated that the western portion of the property would be subject to numerous landslides. The town's subdivision ordinance required that the developer make a detailed study of the geology of the parcel. The town geologist reviewed the resultant map and established an agreement with the geologist serving the subdivider on which parts of the parcel were unstable. The western 200 acres of the property were so constrained by unstable geology that the subdivider's land planner recommended that all of the potential development on the property be clustered on the eastern portion of the parcel, thus avoiding construction in very difficult terrain and at great cost.

Working within the limitations imposed by zoning regulations and geologic and topographical conditions, the developer was able to design the subdivision with minimum disturbance to the natural landscape and that was consistent with the town's general plan. As submitted in 1973, the general development plan indicated the location of housing clusters and roads in relation to the geology of the site. Of the 453 acres, 395 acres would be left as open space, 205 houses would occupy about 43 acres in small clusters separated by open space, and an additional 15 acres would be devoted to park and recreation uses.

The plan that resulted is shown in Figure 6-10, an aerial photo of the development. The houses in the subdivision are clustered on lots of ap-

proximately 20,000 square feet. These lots are long and narrow, thus allowing homes to be clustered tightly along roads that are largely located on ridges. All of the open space is held in common by the homeowners. The open space, which is traversed by public and private trails, is encumbered by open space easements held by the town.

To ensure safe construction of this project, the applicant's geotechnical consultants were required to review and supervise phases of the grading, roadway pavement design, and residential foundation design. In addition, geotechnical reports submitted to the town for review and approval by the town geologist and the town engineer were required at all stages of development.

In this example, the subdivision was not penalized for including large areas in a landslide and earthquake fault zone. All of the density from the unstable land was transferred to the stable portion of the parcel.

All in all, the design of the subdivision was driven by the site's geology. Prior to incorporation of the town, a preliminary subdivision map that had been presented to the county showed the entire property covered by roads and lots, all designed with almost no regard for geologic features. At that time, the county did not have geologic expertise available. In all likelihood, the project would have been approved and built, with major landslide problems for homeowners the likely result. The owner at that time decided not to pursue the development. By the mid 1970s, however, Portola Valley had its hazards mitigation program in place, which required the consideration of geologic information during the development review process. As a result, the subdivision was designed in a geologically responsible manner.

In this example, the subdivision was not penalized for including large areas in a landslide and earthquake fault zone. All of the density from the unstable land was transferred to the stable portion of the parcel. Several years after the development was approved, the town decided that when properties have serious limitations on building, only partial density credit should be given for hazardous areas, as explained above.

To ensure that this project was constructed safely, the applicant's geotechnical consultants were required to review and supervise phases of the grading, roadway pavement design, and residential foundation design. In addition, geotechnical reports submitted to the town for review and approval by the town geologist and the town engineer were required at all stages of development.

Applicability to Other Jurisdictions

After more than 30 years of experience with Portola Valley's integrated geologic hazards mitigation program, the author of this case study makes three specific recommendations for those jurisdictions just beginning to grapple with the problems of geologic instabilities.

Hire a geologist. The most important recommendation is that a jurisdiction secure the assistance of a qualified geologist. This person can do much to educate planning and engineering staffs and elected and appointed officials. This education process can in turn build momentum toward the creation of a formal hazards mitigation program. It may be possible to interest a faculty member of a nearby educational institution to become involved in this program on a pro bono basis, but, once the program is fully developed, the jurisdiction should seek paid assistance from a professional geologist. All too often cities do not have in-house or consulting geologic capabilities. Sometimes they rely on a civil engineer to perform this function, but a civil engineer is normally not qualified to review the work of consulting geologists serving an applicant. Even if a jurisdiction does not have a geologic map of the area, a geologist working for a community can provide advice as to when geologic studies are required prior to approving developments.

Often cities and counties take the position that, because a geologist for an applicant is a qualified professional, there is no need for equal review capabilities on the part of the jurisdiction. Yet this approach fails to protect the city or county and future property owners. Just as a jurisdiction employs an attorney to review legal documents from an applicant, so too should a jurisdiction employ a geologist to review geological and geotechnical data. In both contexts, the need for unbiased review is equally great.

Include geology in plans and regulations. A jurisdiction should include geologic goals and policies in its general plan and local planning regulations. These regulations should incorporate detailed requirements and must specify the jurisdiction's right to require geologic reports when appropriate, whether because of the advice of a geologist or as dictated by a map that shows areas of suspected geologic instability.

Developing a matrix clearly indicating the amount of acceptable risk and basing it on the geologic and movement potential maps as the official geologic maps of the town and correlating land uses with the land movement potential categories is an excellent idea. A matrix should be responsive to local needs and most importantly reflect the level of risk the community is willing to accept. The matrix adopted by Portola Valley has few land-use designations since the range of land uses permitted in the town is relatively limited. In other jurisdictions that have adopted similar matrices, the list of land uses and of geologic conditions is much longer. Also, in some jurisdictions, the matrix is used as a guide for planning staff rather than as a regulation that determines when specific geologic investigations are needed. In other jurisdictions, the matrix lists not only land uses but correlates the land uses with structural types.

Map the geology. A jurisdiction should use whatever means are possible to obtain or develop maps showing local geologic conditions. Even if the maps are very general, they can provide the context for reviews and serve as the basis for more detailed geologic maps in the future. Whatever the level of detail in these maps, however, jurisdictions should be careful always to create a provision for improvement of the maps as more information becomes available. It would be a serious error for a community to adopt maps but to not recognize that they will likely need to be changed as further development and hazard events occur in the area.

It would be a serious error for a community to adopt maps but to not recognize that they will likely need to be changed as further development and hazard events occur in the area.

These three recommendations highlight the most important features of the hazards mitigation program adopted by Portola Valley. But, as this chapter has made clear, the town's program has developed over a number of years and includes numerous integrated elements. A full program should include all of the ingredients described in this paper, although it is recognized that, as with any model, Portola Valley's program will not be appropriate for all jurisdictions. Variations in the size of a community, community objectives, staff capabilities, presence of geologic hazards, experience with geologic hazards, and many other factors will determine the best program for a community. Nonetheless, it is suggested that a complete program address the following elements.

Public Agency Geologist

- A jurisdiction must have access to a professional geologist with experience in dealing with geologic hazards and land-use regulations for a successful mitigation program. Ideally, an engineering geologist should be retained who works with or has access to a geotechnical engineer. A jurisdiction can gain access to a geologist in several ways, including: 1) a consultant hired on a part-time basis, 2) a full-time professional staff member, or 3) a contract with a larger public jurisdiction for geologic services.

- The geologist should be experienced, well-qualified, and familiar with local geologic conditions.
- The role of the geologist should be well-defined and the geologist's review responsibilities clear, with established standards of performance.
- The review process should be clearly defined for the applicant and the geologist hired by the applicant.
- The jurisdiction's geologic database should be maintained and regularly updated by its geologist.
- The geologist should play a crucial role in educating government officials and the community at large about the jurisdiction's geologic hazards.

Geologic Mapping

- Geologic maps are the foundation of any geologic hazards program and provide a basis for developing land-use criteria.
- The scale of a jurisdiction's areawide maps and their level of detail should be satisfactory for preliminary site-specific evaluation. (As described above, Portola Valley uses mapping at a scale of 1"=500'.) But mapping at a smaller scale—for example, 1"=2,000'—can be used as a general indicator of geologic hazards that triggers requirements for more specific studies prior to development.
- Site-specific mapping must be done at a large scale, for example from 1" = 20' to 1" = 100'and in high detail prior to any development approval.
- Maps must be updated to incorporate current information obtained from site investigations. Procedures and budgets should be established to update the maps on a regular basis.
- Because maps will be used on a daily basis by administrators, developers, and consultants, they must be as clear and as easy to use as possible. Like Portola Valley's movement potential map, interpretive maps that are adapted from technical geologic information can be more easily understood by nongeologists than the maps typically used by professional geologists.
- Ordinances should require interpretive maps to be used as official guides to development decisions.

General Plan

- The general plan should reflect the geology of a jurisdiction and be amended as new geologic information becomes available.
- Hazardous areas that cannot be safely developed can be designated as open space on the land-use diagram. Doing so can help the community to achieve its objectives for public safety, environmental protection, and open space preservation. Combining objectives like these with the reduction of geologic hazard risk can help the adoption of geologic regulations, especially when geologic hazards are a low priority item on a jurisdiction's agenda or budget.
- Geologic maps should be part of or referenced in the general plan if the plan's land-use designations are based on geologic conditions. If these maps are small-scale, the plan can recommend that additional mapping and study be performed at a site before development.

- The general plan should specify those land-use regulations and procedures to be adopted to implement geologic policies.

Zoning Regulations

- Zoning regulations can reduce the impact of geologic hazards by reducing the amount of development in hazardous areas. Development can be limited through provisions such as the prohibition of building on unstable lands, fault setbacks, and slope-density regulations.
- Zoning regulations that allow for cluster development allow creative development of properties that include both hazardous and nonhazardous areas. Safe development combined with valuable open space can result.
- Zoning regulations should require submission of geologic information when projects are in areas with suspected geologic hazards.

Subdivision Regulations

- In any areas suspected of geologic hazards, all subdivision applications should include soil engineering and geotechnical reports.
- The geologist serving the public agency should review all geologic and geotechnical reports submitted with project applications. In consultation with a geotechnical engineer, he or she should recommend conditions for approval that must be satisfied before an application is approved or at a subsequent point in the development process. (Recommendation of conditions pertains to applications under zoning, site development and grading, and building regulations as well.)
- Geologic problems can be most effectively dealt with if they are discovered early in the subdivision process. After lots are created and the positions of roads and utilities are established, options for dealing with hazards become significantly reduced. Therefore, subdivision regulations should require that applicants submit specific geologic information for review at an early stage.
- Fees for geologic review by a city or a county should be included in the application fee for any action, whether the review is done by an outside consultant or a geotechnical engineer on the jurisdiction's staff. (This requirement also pertains to applications under zoning, site development and grading, and building regulations.)

Site Development and Grading Regulations

- Strict control of grading is necessary for safe and attractive development of both stable and unstable hillsides.
- An application for a grading permit should include site-specific geotechnical reports prepared by qualified consultants. The reports should be reviewed by the geologist for the jurisdiction as well as a geotechnical engineer, and their recommendations should be incorporated into grading specifications.
- The geotechnical consultant for the applicant should monitor soils testing and submit a report to the jurisdiction.
- Actual grading should be inspected at several points by the city or county engineer.

Building Codes

- Building codes should require soils reports to be submitted with most building permit applications for new construction unless waived by a qualified professional, such as the jurisdiction's geologist.
- Building codes should include design standards for construction in areas with specific geologic hazards.
- Building officials must be well-qualified and trained to check plans for compliance with local codes.
- Inspections and monitoring during construction are necessary to ensure that all work is done according to the approved plans.
- An as-built inspection and sign-off by the building official should be required before a certificate of occupancy is issued.

THE KELSO, WASHINGTON, ALDERCREST-BANYON LANDSLIDE

By Jane Preuss, Kenneth Buss, and Lois Lopez

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Kenneth Buss, at the time of his untimely death, had 35 years of experience as a geotechnical engineer in Washington, Oregon, and the eastern United States. He was a principal with GeoEngineers, Inc. His experience included many projects involving evaluation of slope stability, drainage, and erosion. These projects frequently required development of innovative solutions that included combinations of drainage, structural mitigation, and vegetation to restore stability of slopes in areas with critical constraints.

Lois Lopez has been a mitigation specialist in emergency management for nine years and is currently employed with the Federal Emergency Management Agency at Bothell, Washington. She worked as an independent contractor for the City of Kelso, developing and managing the grants and the subsequent acquisition project that arose from the Aldercrest Landslide Disaster.

A 1998 landslide in Kelso, Washington, is the second most destructive landslide to occur in the United States. The widespread disruption affected residents of the subdivision and those living adjacent the active landslide area. The ensuing effects of this disruption soon spread across the community. In the immediate vicinity of the slide, roads, utilities, and other public infrastructure were destroyed, homes evacuated, and the full effects of the slide will not be known until many more years, as the slide has not stopped moving. The site is now a designated an open space reserve per the conditions of using federal disaster-related funds to buy-out the properties at risk. The region continues to endure the economic ripples of this disaster. Property values in and around the surrounding areas have gone down and so did the overall economic strength of the local business district.

Kelso, Washington, is a city of 12,000 located in southwestern Washington, about 50 miles north of Portland, Oregon. Coping with disasters is not new for the people of this region, which is about 35 miles from Mount St. Helens. The mountain erupted in 1980 and became active again in 2004. In many respects, the city has yet to fully recover from the economic aftereffects of the 1980 eruption, which were compounded by declines in the timber and fishing industries.

The 1998 landslide was in the Aldercrest subdivision, which was a very desirable neighborhood because of the sweeping views it offered and the promise of a close-knit community. Houses in this neighborhood were among the city's highest valued. Loss of so many homes was devastating from an economic and community standpoint.

The Landslide

The first signs of a slide came in February 1998 when the city's Public Works Department staff inspected a sewer line break. At that time no slope movement was observed. A month later homeowners began to experience jammed doors and to notice cracks in foundations and driveway slabs. Then in April, a landslide scarp developed; an offset of more than 18 inches split right through the foundation of one house. This dramatic land movement prompted the city to hire a technical team of engineering geologists and geotechnical engineers to investigate the conditions. The technical team conducted field reconnaissance, inspected numerous residences, and reviewed historical documents and references related to geological problems in the area. What the geologists found in the area was a deep-seated landslide that had been inactive for many hundreds or thousands of years. Subsequent analysis of the slide area and laboratory testing results indicated that the movement had been triggered by moisture saturation on the slopes. The area had experienced three years of above-average rain, which was as much as 60 percent above the 75-year average.

The investigation concluded that, in the area where the primary slide occurred, the movement was generally a translational movement of the old slide debris on the surface of a stiff clay layer, also known as the Cowlitz Formation. As the movement increased, it took other forms including debris-flow, block-glide, and near-fluid flows in some areas. Rotational landslides also occurred in the area of the ancient landslide's headscarp as the old slide debris moved down the slope. The landslide movement was continuous, but not rapid. Over a nine-month period, April 1998 to January 1999, the scarp expanded to about 3,000 feet in length and displaced about 100 feet vertically.

Planning for Recovery

The city issued an "Emergency Declaration" on May 19, 1998. It requested assistance from Cowlitz County to respond to the landslide. The county in turn declared an emergency two weeks later and then requested the State of Washington and the federal government to recognize the area as a major national disaster. On October 16, 1998, the Aldercrest subdivision was formally designated a "major disaster area."

Delineation of declaration area. For any disaster assistance, it is necessary to define three parameters:

- When the landslide started
- When the landslide would stop
- What are the geographic limits of the event

With disasters such as fire or flood, the start and end of the disaster is short and definite, whereas landslides, especially the slow-moving kind, develop over several months and years.

As for when the landslide started, the city, the technical team, and FEMA representatives agreed that the ruptured sewer line in February 1998, when the city's Public Works Department was first notified, should mark the start of the event.

The first challenge was delineating the disaster area. Delineation at this stage was difficult because the slide continued to move and it was impossible to define the full area that would eventually sustain damages. With disasters such as fire or flood, the start and end of the disaster is short and definite, whereas landslides, especially the slow-moving kind, develop over several months and years. The technical team could see that the movement would continue for some time, but there was no way to precisely set limits on when the movement would stop. For administrative purposes the team suggested a period of five years. The technical team subsequently used the five-year limit to estimate where the area of active sliding could extend within five years.

As the engineers and geologists attempted to delineate the slide boundaries under the criteria established, they examined homes in both the actively moving main landslide area and those located above the headscarp. Patterns of damage suggested a separate earth movement distinct from the main landslide mass, now called Aldercrest-Banyon Landslide Complex. The technical team completed a detailed reconnaissance of the area around Davis Terrace and the Aldercrest subdivision in January 1999 that showed slope movement on the North Slope of Davis Terrace, distinct from the Aldercrest landslide complex. Now called the North Slope Landslide Complex, this new area had also moved recently, but there was no evidence of rapid movements. These observations were critical to delineating the disaster area.

To delineate, the technical team categorized the observed limits of active sliding into three subzones (Table 6-1):

Active Landslide Area:
: Zone of visible ground movement extending from the top of the headscarp to the lower limit of the run-out zone. Within this active area, essentially all the public facilities and all the residences were severely damaged or totally destroyed.

Headscarp Expansion Area:
: Zone where upslope growth of the headscarp can be expected.

Landslide Damage Influence Area:
: Zone where damage to public and private facilities is occurring and is related to the landslide activity. However, the character of ground movement is of a relatively low magnitude and distinctly different from the other two areas.

TABLE 6-1: ZONATION OF A LANDSLIDE AND THE HAZARDS ASSOCIATED WITH EACH

AREA	PROCESS	POTENTIAL IMPACTS
LANDSLIDE DEPOSITS	Localized landsliding and settlement of soil within ancient landslide debris.	Localized damage to streets, utilities, and structures from small-scale slides, including localized destruction of residences and other facilities.
	Massive, large-scale translational movements and earthflows resulting from reactivation of ancient landslide masses.	Catastrophic damage to most, if not all, streets, utilities and structures from large-scale re-activation of landslide deposits.
UPLAND—POTENTIAL LANDSLIDE EXPANSION AREA	Possible headward expansion of ancient landslide scarps into areas that have not previously experienced landsliding.	Possible catastrophic damage in areas where landslides enlarge and expand headward.
	Localized sloughing of scarp faces, resulting in gradual reduction of slope steepness.	Localized catastrophic damage at locations of scarp failures.
		Isolation from access and utility service from landslide activity in areas surrounding the upland.
UPLAND—POTENTIAL LANDSLIDE INFLUENCE AREA	Landslide-related ground movement.	Gradual damage to structures and utilities from ground movement in areas upslope of active landslide movements. Cumulative damage may be irreparable.
UPLAND—INFERRED STABLE	N/A	Isolation from access and utility service from landslide activity in areas surrounding the upland.
EROSION SWALES AND VALLEYS	Localized slope failures within the approximate limits of the erosional swale or valley	

The engineers and the city then defined the boundaries of the disaster area in relation to the underlying subdivision boundaries. When clear topographic boundaries to the subdivision existed, topography was used as the boundary of the disaster area. In the remaining areas streets were used to define the edges of the disaster area.

SAGis Projects/9/9813001

***Figure 6-11**. Adlercrest Landslide.*

Although they did not expect upslope migration of the active landslide zone to be uniform along the length of the mainscarp, the engineers plotted the migration zone as a line around both of the slide complexes. (See Figure 6-11.) The mainscarp is the steep surface on undisturbed ground at the upper edge of a landslide caused by movement of displaced material away from undisturbed ground; it is the visible part of surface rupture (Cruden and Varnes 1996).

Though the active landslide zone of the North Slope Complex was undeveloped, the engineers indicated the possibility that larger failure zones could materialize, especially if wetter than average weather patterns continue. Expansion of the failure zone would jeopardize the houses that bordered the North Slope Complex along the northwest and north margins of Banyon Drive. This area, designated as the Upland Potential landslide expansion area (i.e., the area to which the slide could extend within five years), was also included within the declared disaster area. Now the boundaries of the declared disaster area was about 100 acres and contained 137 houses, of which an estimated 61 were directly destroyed by the slide, and another 76 were in the moving slide area.

Selecting a mitigation strategy. Central to any mitigation strategy was an understanding of the limits of disaster recovery programs. They are designed to assist victims and to repair structures, not address losses to property or diminution of the value of a site for development. They function similar to mortgage and flood insurance policies that do not cover damage to the site. FEMA's programs are no exception.

FEMA has three disaster funding programs: the Individual Family Grant Program (IFG), the Public Assistance Program (PA), and the Hazard Mitigation Grant Program (HMGP). Each responds to the agency's mandate to help disaster victims and rebuild publicly owned infrastructure.

The IFG program provides immediate assistance to help pay for home repairs, storage and relocation costs, and temporary housing. Under this program, in the first six weeks after the Presidential Declaration, more than $600,000 was granted to homeowners for immediate housing needs.

The PA Program provides up to 75 percent of the costs for permanent repair and restoration of publicly owned infrastructure. The repair cost to the city-owned infrastructure within the declared disaster area was estimated by FEMA to be about $4.2 million.

HMGP funds projects that reduce or eliminate the risks from future disasters. Eligible projects include: acquisitions and elevations, seismic or flood-related retrofitting, drainage improvement projects, and construction activities that will result in protection from hazards. Under this program currently, a community receives up to 7.5 percent of FEMA's total expenditures for the disaster. At the time of this disaster, the calculation was at 15 percent. That amounted to $1 million of HMGP funds.

Preventing reoccurrence at the site scale. Beginning in May 1998, after the area was first declared a local disaster, the city held public meetings to discuss potential solutions for the landslide area. The meetings, which continued through spring 1999, relied on an Aldercrest Task Force that included residents of the affected subdivision, representatives from the city council, the city staff, and local businesses.

By June 1998, it was apparent from the results of the studies by the technical team that repair or mitigation of the Aldercrest-Banyon Landslide Complex was not feasible. This decision was based on the following factors:

- The slide was moving fairly rapidly, as much as one to two feet per day, which would result in complex and extremely expensive construction methods.

- The zone of movement extended down to a depth of approximately 40 feet, which would also require complex and expensive construction methods.
- The fine-grained soils in the landslide would not respond readily to dewatering techniques.
- The variety of types of movement occurring within the slide mass would require extremely complex structural solutions to ensure success. Preliminary estimates indicated that such solutions would cost far more than the property values, making them unaffordable.

When it became evident that stopping or restraining the landslide was not financially feasible, the task force considered several alternatives from which it ultimately selected an acquisition project. It was the consensus of the Aldercrest Task Force that an acquisition project was the most appropriate use of available funds. Designated as the Alternate Project, the task force combined the various grants to fund an acquisition project using the HMGP's conditions for acquisitions, which stipulate that:

- jurisdictions must agree to dedicate and use the property as open space in perpetuity;
- property owners must agree to be bought out (condemnation is forbidden in FEMA-funded acquisitions); and
- should there be another landslide in the area, those residents whose homes were not destroyed and chose not to sell would not receive any assistance from FEMA, which is prohibited from providing disaster assistance funding twice to the same federal disaster area.

The Alternate Project called for combining funds that the city would have received to repair the infrastructure under FEMA's PA Program with HMGP funds to acquire 121 houses in the disaster area. Also unique was the pooling of more funds from HUD's Disaster Recovery Initiative program, called Unmet Needs, that provided an additional $4.2 million. Total funding reached about $9.5 million for implementing the project.

TABLE 6-2: NUMBER OF RESIDENCES AFFECTED IN DECLARED DISASTER AREA

Homes destroyed	61
Homes within potential slide area	76
Total homes in Declared disaster area	137
Homes acquired	123

Once the Aldercrest Task Force agreed on an acquisition project, it had to develop a method to determine fair market value of properties so as to proportion the pooled funds. Establishing the fair market value was complicated as 61 houses were already destroyed and not available to be appraised by commercial appraisers, so an alternate methodology had to be developed so that all participants would be treated and valued alike. It was a contentious issue, as the available grant funds would defray only a fraction of the value of the properties. Estimated fair market values totaled $26 million, while the grant funds available were about $10 million, which meant that owners would be awarded only about one-third of their market value. The total number of homes affected and acquired is shown in Table 6-2.

Eleven owners chose not to sell, and three homes were foreclosed upon shortly after the landslide.

The city hired a consultant to develop and manage this large acquisition project through the management of four grants (PA, HMGP, Unmet Needs, and a Community Development Block Grant). To streamline the closing of the transactions, several escrow offices participated in a negotiated settlement for fees (for escrow and title search).

Five years later, the disaster area is an open space reserve, although 11 homes of the nonparticipants remain occupied.

A major challenge not addressed in policy or law, and unexpected by the agencies, was resolving homeowners' existing mortgages. Many mortgages exceeded the amount homeowners would receive. Some homeowners were able to negotiate with their mortgagors, but many found themselves unable to negotiate for reasons such as: (1) still too emotionally fragile from the disaster; (2) lack of knowledge of the project parameters and funding programs' scopes; and (3) not feeling confident that any money would come or the project would ever take place. Without the help of the city-hired consultant, who negotiated with banks on behalf of the homeowners to reduce mortgage balances so they could participate in the acquisition, this would have remained a major obstacle to implementing the Alternate Project.

Five years later, the disaster area is an open space reserve, although 11 homes of the nonparticipants remain occupied. This 100-acre area along with an adjacent 120-acre area, donated by the Jacobson Land Trust to the Department of Natural Resources, now forms a contiguous 200-acre reserve.

The Local Planning Process: Community Scale

Local development in Kelso is regulated under a regulatory framework established by the state. It consists of two acts adopted by the state of Washington:

- The 1990 Growth Management Act (GMA)
- The 1971 State Environmental Policy Act (SEPA)

GMA requires all communities to identify critical areas, defined to include: geologically hazardous areas, frequently flooded areas, critical aquifer recharge areas, wildlife habitat areas, and wetlands. Geologically hazardous areas include those susceptible to one or more of the following hazards: (i) erosion; (ii) landslide; (iii) seismic; or (iv) areas subject to other geological events, such as coal mine hazards and volcanic hazards.

GMA mandates all communities identify critical areas using Best Available Science (BAS). The BAS does not require communities to collect detailed new information; rather it permits them to use data that is currently available. Since no money is provided by the state for compliance communities either must rely on available data or pay to undertake the necessary studies. Kelso and other small communities typically do not have the funds for such geological investigations and thus tend to rely on available information (which may be spotty or dated).

SEPA ensures state and local agencies consider environmental values during decision making. Modeled after the National Environmental Policy Act, SEPA requires the identification and evaluation of probable impacts to significant elements of the built and natural environment. SEPA provides a tool to identify probable environmental impacts of governmental decisions, such as issuing permits for private projects, constructing public facilities, or adopting regulations, policies or plans. Information generated during the SEPA process can help decision makers, applicants, and the public understand how a proposal may affect the environment. This information can be

used to change a proposal to reduce likely impacts or to condition or deny a proposal when adverse environmental impacts are identified.

Kelso's planning process. To comply with GMA, Kelso adopted a Critical Areas Ordinance in 1997 (Kelso Municipal Code Ordinance 18.20). It contains provisions for geotechnical hazards, floodplains, and critical aquifers. The Kelso Critical Areas Ordinance (CAO) states that the critical area inventory maps are based on available map sources that are adopted by reference as BAS; these information sources are listed here.

Five classification areas were delineated based on geologic factors and relative slope stability.

- Allen J. Fiksdal, "Slope Stability of Longview-Kelso Urban Area, Cowlitz County," Department of Natural Resources, 1973
- Geologic Hazard Map of Cowlitz County, Cowlitz-Wahiakum Council of Governments, 1993
- Soil Conservation Service, Cowlitz Soil Survey, February 1974
- Washington Department of Natural Resources, Soils Based Slope Stability Map

For Kelso, the maps were based primarily on studies conducted by the State Department of Natural Resources (1973) prepared at 1:24,000 scale. Research for the maps was based on a three-part process: (1) examination of published and unpublished information; (2) interpretation of air-photos and field investigations; and (3) analysis. Landslides were identified on 1968 aerial photos using typical landslide features such as scarps, hummocky surfaces, flow features, disruption of drainage, and surface scars. These maps were intended to be used only as general guidance documents. Five classification areas were delineated based on geologic factors and relative slope stability:

- Class 1: Believed to be stable
- Class 2: Probably stable under normal conditions but may become unstable if modified by man's activities
- Class 3: Poor natural stability
- Class 4: Ancient landslide debris, with slope stability similar to Class 2
- Class 5: Historical or recently active landslides.

The report accompanying the map noted that the mapping was general and that accuracy was no better than 200 to 300 feet resolution. At this level of accuracy, the report noted that the boundaries between classifications are very rough. Map users are cautioned that field investigation and analysis by a qualified expert may be necessary to confirm the presence of a critical area. The map had the following caution as well:

> Locally there are quite stable areas that are included in the potential problem areas but that are too small to be shown on the map. This is also true of the areas indicated as stable; locally there may be small isolated areas that are indicated as stable; locally there may be small isolated areas that are unstable and unsuitable for building. For this reason, each proposed construction site should be considered separately as to its stability and potential landslide hazard. . . .

The maps designated portions of the Aldercrest subdivision Class 1 (areas believed to be stable) and the rest as Class 3 (areas of poor natural stability). The ordinance designated the entire area of the subdivision as within the geologic hazard area, which means a geologic study was required to confirm the presence or absence of probable landslide conditions.

Expert review and decision making. Hillside development in Kelso under the CAO requires submittal of an assessment by a qualified expert who is a licensed geotechnical engineer or a licensed engineering geologist. (See the sample checklist in Figure 6-12.) It also requires that the proposal coordinate the requirements of the Uniform Building Code. As required by the CAO, if geotechnical assessment indicates that the site cannot accommodate the proposed development without special measures or precautions as determined by a qualified expert, the city's planning department may require a geotechnical report.

Figure 6-12. *Geotechnical Report Checklist*

GEOTECHNICAL REPORT CHECKLIST

Project Name:_____ Date:_____

Application No.: _____Geotechnical Engineer:_____

Professional Liability Insurance Certificate on File: _____

Circled items need to be addressed. Checked items are OK.

RETURN ALL REVIEW MARK-UPs AND CHECKLIST WITH RESUBMITTAL

Items 1 through 31 are the minimum requirements to be addressed by the geotechnical engineer. All remaining items are required to be completed by the applicant or their agents prior to permit approval.

1. _____ Report stamped and signed by P.E.
2. _____ Contour map of area, showing existing contours, at a maximum scale of 1"=20' and with two-inch contour intervals.
3. _____ Delineation of 15 to 39 percent slopes on maps with the report.
4. _____ Delineation of slopes greater than 40 percent on maps with the report.
5. _____ Boring or test pit logs included. (Septic test pits are not acceptable.)
6. _____ Exploration methods described and justified.
7. _____ Soil and / or rock stratigraphy described.
8. _____ Ground water levels and estimated or measured seasonal variations.
9. _____ Description of any prior site grading.
10. _____ Description of any on and near site soil instability.
11. _____ Description of any on and near site slope failure.
12. _____ Submittal of data concerning the vulnerability of the site to seismic events.
13. _____ Slope stability studies and opinion of slope stability both in static and seismic events.
14. _____ Proposed angles of cut and fill.
15. _____ Site grading requirements.
16. _____ Structural foundation requirements.
17. _____ Estimated foundation settlement.
18. _____ Soil compaction criteria.
19. _____ Proposed surface water drainage.
20. _____ Proposed subsurface water drainage.
21. _____ Lateral earth pressures.
22. _____ Vulnerability of the site to erosion.
23. _____ Suitability of on-site soil for fill.
24. _____ Specifications for import fills.
25. _____ Lab data and soil index properties.
26. _____ Building limitations.
27. _____ Discussion on whether or not wet weather construction is feasible.
28. _____ Report is less than five years old for the site.
29. _____ Required buffer and setback from toe: _____ Feet.
30. _____ Required buffer and setback from top: _____ Feet.
31. _____ Required buffer and setback from flank: _____ Feet.

Since small jurisdictions in Washington are too small to have specialized geotechnical staff, they normally do not have the necessary in-house expertise to conduct such reviews. Some communities, like Kelso, have received funds from the Washington Cities Insurance Authority (WCIA) that maintains a pool of money for the state's local communities to retain technical experts to help with local geotechnical reviews. Funding from this program is only available to communities that have had problems in the past; it is not proactive.

GEOTECHNICAL REPORT CHECKLIST *(continued)*

NARRATIVE ADDRESSING THE FOLLOWING ISSUES:

1. _____ Is the development located to minimize disturbance and removal of vegetation?
2. _____ Are structures clustered (where possible) to reduce disturbance and maintain natural topographic character?
3. _____ Development conforms to the natural contours.
4. _____ Foundations tiered (where possible) to conform to existing topography.
5. _____ Development designed to minimize building footprint and disturbed area.
6. _____ Development designed to minimize impervious surface coverage.
7. _____ Roads, walks and parking designed to parallel natural contours.
8. _____ Access located on least sensitive area of site.

NOTIFICATION REQUIREMENTS:

1. _____ Buffer placed in a critical area tract, protective easement, land trust dedication or other Department approved mechanism.

2. _____ Letter from engineer stating that the edge of the buffer(s) and setback(s) have been clearly staked, flagged and fenced (see attached detail) prior to any site clearing or construction.

3. _____ Title notification recorded for landslide and / or erosion and / or seismic hazard area.

EROSION HAZARD AREA REQUIREMENTS:

1. _____ Erosion hazard is present if site has a USDA designation of: moderate-severe, severe or very severe SCS soil type _____ SCS hazard designation
2. _____ Abbreviated Erosion / Sediment Control plan needed.
3. _____ Full Erosion / Sediment Control plan needed.

STORM DRAINAGE REQUIREMENTS:

1. _____ Abbreviated Drainage plan meeting geotechnical recommendations.
2. _____ Full Drainage plan meeting geotechnical recommendations.
3. _____ Letter from engineer stating that drainage plan meets geotechnical recommendations.

PRIVATE INSPECTION:

1. _____ Letter of inspection by the geotechnical engineer verifying compliance with the approved report prior to footing and / or foundation inspection approval.
2. _____ Letter of inspection by the geotechnical engineer verifying installation of erosion control facilities.
3. _____ Storm drainage certification letter by the civil engineer prior to final building inspection approval.

Source: State of Washington Department of Community Trade and Economic Development, *Model Critical Areas Ordinances, Appendix E.*

Since the 1998 slide, the city has adopted additional requirements and developed alternate funding mechanisms for geological reviews. One solution the city now uses is an escrow fund for SEPA-required reviews. The city uses the SEPA's authority to make a determination of probable significant impact and to require developers to contribute to an escrow fund for SEPA reviews. This mechanism permits the city to pass the costs of reviews to the applicant without relying on the WCIA pool. The escrow fund allows the city to retain outside technical assistance before a project is approved. It also gives the city control over the quality of geotechnical reviews, which is especially important since the underlying CAO maps are generalized.

The city's zoning ordinance, in effect since 1989, consolidated all single-family residential zones into a single district with a minimum lot size of 6,000 square feet. In revisions to the ordinance, as submitted to the planning commission in May 2002, four new residential single-family zones have been proposed with different lot size requirements in critical areas. The minimum lot size was increased to 15,000 square feet and the maximum density for Class 3, 4, or 5 areas to two dwelling units per acre (Table 6-3). All critical areas in the city are now zoned RSF15 or RSF-E and all structures require an engineered foundation. The city derived the zoning from reviewing critical areas, which is an important distinction because normally critical area designations are superimposed onto existing zoning designations. An important change in the new code is the two-tier geotechnical review for all areas in the city. Tier one is a geotechnical assessment. Tier two is a detailed geotechnical report if warranted by the assessment.

TABLE 6-3: COMPARISON 1997 AND 2002 VERSIONS OF THE KELSO ZONING CODE FOR HILLSIDE AREAS

Zone	Min. Area (sq. ft.)	Max Density (units/acre)	Lot Width	Lot Depth	Minimum Yards		
					Front	Side	Rear
R-1 (Repealed)	6,000						
RSF-15	15,000	2 du/acre	80	100	20	5	10
RSF-E	110,000	.4 du/acre	110		20	5	10

Source: City of Kelso Zoning Code 1989 as amended in 1993, 1997, and 2003.

Revisions to the zoning code downzoned hillsides from 6,000 square feet minimum lot size to a range between 15,000 square feet to 2.5 acres. Permitted uses in the RSF zone are single-family dwellings built to current building code standards. Exceptions to lot size requirements state:

> At the time of passage of the ordinance codified in this title, if a property has an area or dimension that does not meet the lot size requirements of the district in which the property is located, the property may be occupied by a use permitted in the district, subject to the other requirements of the district.

If there is an existing legal lot and the owner can find a qualified professional (with liability insurance) to prepare a geotechnical report, it is technically possible that the applicant will be allowed to build.

To keep the political process from interfering in the technical reviews, the CAO now includes an option for appeal to a hearing examiner. The system allows for an optional process for development reviews but has yet to be used. Moreover, the hearing examiner position, a part-time appointment, is yet to be funded by the city.

Secondary "Ripple" Effects of the Slide

Among the most devastating effects mentioned to the authors by city staff is that banks and realtors appear to have redlined the entire city. Bankers are reluctant to lend, and people believe it is unsafe to build. Values have decreased throughout the city; the assessor has decreased values outside of the declared area by approximately 25 percent (based on oral estimates from city staff). Kelso was economically affected by the Mount St. Helens eruption in 1980. It has also suffered economically because of reductions in forest product manufacturing and losses in the fishing industry. Thus whether Kelso has in fact been redlined or is perceived to be so is difficult to verify. The bottom line is that property values are low and business has declined.

Among the most devastating effects mentioned to the authors by city staff is that banks and realtors appear to have redlined the entire city. Bankers are reluctant to lend, and people believe it is unsafe to build.

The landslide caused a federal disaster declaration, made the public acquire destroyed properties, and forced the city to make changes to the zoning code. Current and former city staff indicate that the long-term effects will linger. The economic impacts have been felt in both residential and commercial sectors of the local economy.

City staff must implement policies that reduce densities in the areas that potentially would support businesses in Kelso's central business district. In addition, the large open space created on the hillside essentially creates a donut configuration in the middle of the small town. In general these policies have resulted in the perception that reduction of vulnerability to future landslides has resulted in adoption of land-use polices counter to policies adopted under growth management in the comprehensive plan which, is intended to concentrate development.

Many of the residents of houses adjacent to slide area but outside of the designated disaster area have also relocated for a number of reasons. Some are concerned for their safety and property values because the slide may still be moving. Others have moved because the neighborhood character and desirability has changed. Owners adjacent to the slide were not eligible to participate in the acquisition because they were outside the declared area. Anecdotal reports to the authors were that these homes were converted to rentals. Other houses are for sale at significantly reduced prices.

LESSONS FROM KELSO

What can Kelso's experience offer to planners?

Identify landslide hazards before a disaster strikes. Before new plans are approved, local governments need information about landslide hazards. For this, a general assessment of the risk of landslides needs to be prepared for all areas of a jurisdiction subject to growth. Frequently, the main stumbling block for preparing such assessments is funding. Small communities cannot afford to perform such predevelopment studies unless a regional, state, or federal funding mechanism can be developed. Even for areas where landslide reports exist, as in the case of Kelso, which had a study report from 1973, the analyses typically were based on a large area evaluation. As such, they were not intended to serve as site-specific studies for development decisions. Preparing site-specific reports with current methods can help avoid misinterpreting unstable areas as stable (as has happened for the Aldercrest subdivision area). Preparing landslide hazard studies will also give local planners the ability to develop compatible uses around highly unstable areas, avoid planning for land uses that put vulnerable populations in harm's way, and improve the overall quality of local land-use decision making.

Establish sound local development review processes. For large developments, such as Aldercrest, in small communities without adequate qualified staff, establishing rigorous development review processes is essential

to avoiding risky development proposals. The processes should also ensure that qualified and certified professionals advise the city at key stages of the development process in matters about risk, hazards, and long-term effects. State laws may provide the necessary enabling legislation to implement procedures, standards, and funding mechanisms for development reviews, but small communities need assistance, such as guidance on independent reviews, fee structure, sharing technical resources with other communities, and relying on state and regional staff for assistance. The process should be spelled out in existing codes, and it has to follow a consistent path and establish expectations at each step in the process. It should match the complexity of the development. It should have a quick screening method, a method to determine when to require a detailed investigation, and adequate peer review of technical findings. Peer review must be independent even if qualified professionals serve the developer. For such independence, the process requires a financing mechanism for the local government to hire experts.

Enforce geologic hazard mitigation at all stages of the development process. Local government staff should have the authority and responsibility for enforcing regulations. The hearing examiner option the city adopted as part of its changes to regulations may help in some of the problems created by competing technical merits. Communities must use the predevelopment planning phases to influence the development, rather than relying on mitigation at the construction stages.

Review by experts is essential. Experts are needed at three main stages: in the identification of landslide hazards, in the review of geotechnical assessments and reports, and in adjudicating competing technical merits. The process has to include a mechanism to pay for specialists independent of the developer or property owner.

Responding to landslides requires creative responses. Disaster declaration for landslide hazards needs to be adapted to address long-term consequences, such as moving boundaries of the landslide area. Most natural disasters, such as fire, earthquake, or flood, have a clear point in time between the event and the end point at which recovery and rebuilding can occur; the fire is contained, the floodwaters have crested, an earthquake is over. For a landslide, the ground movement may continue for many years, causing damages long after the disaster.

POLICY TOOLS FOR ADDRESSING LANDSLIDE HAZARDS IN PITTSBURGH, PENNSYLVANIA

By David A. Hart, AICP

David Hart is the Geographic Information Systems (GIS) Specialist at the Aquatic Sciences Center at the University of Wisconsin-Madison. Through this position, he works to support sustainable management of the Great Lakes through research and outreach associated with the application of GIS to coastal issues.

The City of Pittsburgh has an innovative, planning-based program to address landslide hazards, which are common in the city and the surrounding southwestern Pennsylvania region (Figure 6-13). The program coordinates several city functions, spread among various city departments, such as zoning, parks and open space, property management, and economic development, to tackle landslide and related hazards. The uniqueness of the program is in its implementation, where each department has internal processes that come to bear in the development process to minimize development in landslide-prone areas. This level of coordination is a reflection of the city's long history of dealing with landslides and ground failures, coupled with several economic factors in favor of public acquisition of marginal lands.

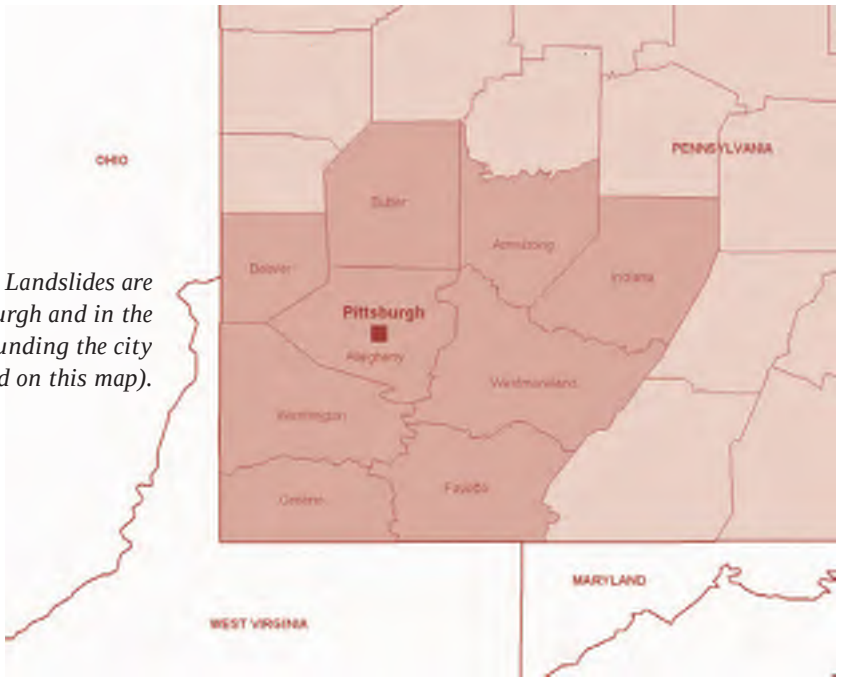

Figure 6-13. *Landslides are common in Pittsburgh and in the counties surrounding the city (shown as shaded on this map).*

Geologic Conditions and Landslides in the Pittsburgh Area

Southwestern Pennsylvania is a region known for its hilly terrain. The geology of the area, which includes the counties of Alleghany, Armstrong, Beaver, Butler, Fayette, Indiana, Westmoreland, Greene, and Washington, consists of flat-lying sedimentary rocks and clay-rich colluvial soils where slumps, landslides, and debris flows are common (Delano and Wilshusen 2001). The geologic layers in the Pittsburgh area consist of clay stones, silt stones, sandstones, limestones, and coal beds (Pomeroy 1974). Coal mining in this region has also left a legacy of mine-related slumps and subsidence.

A distinctive geologic feature in the region is a 20-foot-thick layer of mudstone called the "Pittsburgh redbeds" (Pomeroy 1974). Other redbeds in proximity to the Pittsburgh redbeds, such as the Schenley and Connellsville redbeds, are less significant but still problematic. These redbeds, like clay stones or shales, can be relatively stable under natural conditions, but they weather easily when exposed, which results in very slide-prone soils. In contrast, some areas with limestones and sandstones in the region weather at a much slower rate when exposed and can often be seen as ledges on steep hillsides or cliffs. The hills have slopes generally exceeding 25 per-

cent. Within Pittsburgh, such steep hillsides make up nearly 7,000 acres, which is about 20 percent of the city area (Smuts 1982). Approximately 60 percent of all city lands have slopes in excess of 15 percent, and 11 percent of all city lands have slopes in excess of 40 percent.

Landslides are not new to the region. They were well known to the Native Americans in the region (Heyman and Craft 1977). Monongahela, one of the primary rivers in this region, gets its name from the meaning "river with the sliding banks" or "high banks, which break off and fall down" (Espenshade 1925). Geologic studies of the area have noted thousands of prehistoric and hundreds of more recent landslides (Delano and Wilshusen 2001). The frequency of landslides intensified since the mid-1900s when these hazardous areas began to be developed (Heyman and Craft 1977). Early development patterns in the region followed low-lying areas of the river valleys. But the pattern since the end of World War II has favored residential construction on hilltops, with major transportation corridors and other urban infrastructure at the bottom of hills.

Construction on or at the crest of steep slopes, grading the base of steep slopes, and placing fill on slopes have all caused landslide damages ranging from "backyard slumps" to collapse of entire buildings and destruction of roads.

As human activities increased in vulnerable areas, so have landslides. Construction on or at the crest of steep slopes, grading the base of steep slopes, and placing fill on slopes have all caused landslide damages ranging from "backyard slumps" to collapse of entire buildings and destruction of roads. Though injuries or human toll due to landslides are not as common as in other parts of country, catastrophic landslides did occur. Examples include:

- a 1942 rockslide involving a bus that killed 22;
- a 1951 landslide that destroyed six houses and disrupted a streetcar line and utilities;
- a 1983 rockslide that killed two in a car that was waiting at a traffic light; and
- a 1990 landslide that caused spill into a major river from a broken petroleum pipeline, affecting public water supplies and costing $12 million in cleanup and fines (Hopey 2001; Delano and Wilshusen 2001, 27).

Tools for Addressing Landslide Hazards

For landslides and related earth failures, the main regulatory tools the city uses are zoning regulations, mainly as standards for grading and other land disturbances, and a greenways program to convert landslide-susceptible vacant hillside parcels into public open spaces. For mining-related hazards, the state runs a mine subsidence insurance program to financially assist property owners.

Zoning regulations. Pittsburgh's zoning contains two overlay districts and two special purpose districts to address landslide hazards. The overlay districts, Landslide-Prone Overlay and Undermined Area Overlay, serve to reduce the risk of hazards from development through overlay regulations specific to the hazard where the underlying zoning district regulates uses and other aspects of development in hazardous areas. The special purpose districts, Parks and Open Space and Hillside, serve for parks and special requirements of uses in hazardous areas.

The Landslide-Prone Overlay zoning district requires two additional steps for any development in the overlay district: (1) compliance with the Hillside Development Standards of the subdivision regulations, and (2) completion of a field investigation by a geotechnical expert. The Hillside Development Standards require a development plan and the field investigation report must show evidence that the proposed development, including any fill, excavation, or vegetation removal as part of the development

of the site will not contribute to landslides or soil erosion. The zoning administrator reviews both of these requirements before issuing development permits and occupancy permits. For grading (including any land operations) and building permits, the construction plans must also be reviewed and approved by the chief of the bureau of building inspections. The overlays function as check points in the development process for known or suspect areas for landslide and other related hazards that have already been mapped and identified by the city.

The Undermined Area Overlay zoning district applies to areas with underground mines, which can cause land subsidence, to reduce the risk of property damage and danger to life. District regulations specify that (1) subsurface conditions in undermined areas be investigated, (2) development in such areas be restricted, and (3) special construction techniques be used in mine hazard areas. Though mine areas are mapped, such maps do not necessarily reveal all mines and the delineations of particular mines on the map may be incomplete. The city assumes anything underlain by the Pittsburgh Coal Seam has been mined unless evidence is presented to prove otherwise. Though not completely prohibited, development in mined areas requires review by qualified experts; the city's review process merely ensures that development applicants recognize their exposure to this hazard. The city's review process also requires that applicants submit the necessary technical information, especially the physical characteristics of the mine and the likelihood of land subsidence; such information may be available from other government sources (e.g., the Pennsylvania Department of Environmental Protection).

The overlays function as check points in the development process for known or suspect areas for landslide and other related hazards that have already been mapped and identified by the city.

For single-unit residential dwellings, the overlay regulations specify that there be no history of subsidence in the area and that there be more than 100 feet of "overburden," which is the soil and rock between the top of the mine ceiling and the ground surface. Development is prohibited under any other conditions until the applicant submits evidence that the site is safe, including for structures proposed for land with less than 100 feet of overburden, in areas of subsidence, and for any other use. If a site investigation recommends special construction techniques, building or land operations permits must be first approved by the city's building inspection bureau. Construction plans must be approved by a "geotechnical consultant with appropriate professional insurance certification and the appropriate academic credentials and professional association" hired by the applicant.

The Parks and Open Space district is used mainly for the park and recreation facilities the city operates and cemeteries. In terms of recreation, the district includes both active and passive recreation uses and can include structures associated with recreation or community centers.

The Hillside Zoning District applies to areas where it is difficult for the city to provide services, in places with rich scenic resources, and other similar areas not suitable for intensive development. The district promotes environmental preservation and fiscal responsibility, while allowing for reasonable use and development of property. Single-unit residential is the only use allowed by right in this district. Other uses allowed as either a special or conditional use include group homes, communication towers, parks and recreation facilities, and transit facilities.

Development applications in this district go through the same reviews as those required for the overlay district, including geotechnical reviews, construction plans, etc. The city recently drafted site development standards for this district. The standards require that developers:

- build structures to fit into a hillside;
- develop in the least sensitive portion of the hillside;

- avoid developing in the brow of the hillside;
- limit impervious areas;
- promote natural drainage of the hillside;
- replant vegetation compatible with the hillside;
- match the type of development with soil conditions; and
- avoid straight and unnatural slopes when grading.

The new guidelines also address aesthetics and design, landscape preservation, compatibility in scale and character between the development, the surrounding terrain, and adjacent neighborhoods, and view preservation.

One important change the greenways program brought was putting a stop to re-selling tax delinquent hillside properties. Re-selling hillside properties merely encouraged more development in hazardous areas and, in times of disaster, put people at risk.

Other Regulations

Greenways for Pittsburgh Program. The Greenways for Pittsburgh Program started in 1982 as an outgrowth of a Vacant / Sensitive Land Management Study conducted in late 1970s by the Pittsburgh Department of City Planning and Urban Development Consultants, Inc. The study's main concern was the fragmented ownership and management of hillsides. At the time of the study, many hillsides in Pittsburgh were a patchwork of public and private lands, including tax delinquent parcels and streets that were mapped but either abandoned or never built. The city also was concerned about the costs of providing city infrastructure and services to parcels that were isolated or had landslide hazards. Furthermore, hillsides suffered from illegal dumping. The responsibility of managing these sensitive lands was spread among many city departments and not well coordinated.

One important change the greenways program brought was putting a stop to re-selling tax delinquent hillside properties. Re-selling hillside properties merely encouraged more development in hazardous areas and, in times of disaster, put people at risk. The city altered this counterproductive policy by designating such marginal properties for passive recreational uses. The city then consolidated and linked these open spaces into 50 clusters spread throughout the city. Hillsides with landslide problems became the target for consolidation. The city enlisted residents from adjacent neighborhoods and special interest groups to identify open spaces of interest to them. The city also promoted gifts of private property to consolidate sites. A single city agency was now assigned to acquiring and cleaning up sites. This greatly improved the previous fragmented approach to managing public lands. City plans now connect hillside sites with existing parks, emphasizing passive recreational uses.

The process of designating a site for the greenways program starts with a resolution by a neighborhood or special interest group. The group should endorse the greenway, assist the city in cleanup, and monitor the process of acquiring the site. If the city's planning commission agrees with the resolution and verifies that passive recreation use is highest and best use, it makes a recommendation to the city council. The city council then votes to relinquish back taxes and transfer the land to the city's parks and recreation department.

The program's effect on landslide mitigation has been significant. As of 2001, 480 acres in 9 greenways have been dedicated. Their sizes vary from 4 to 132 acres. The city has several thousand additional acres earmarked for potential designation in the future as part of this program. Besides benefiting neighborhoods adjacent these lands, the program has ensured improved maintenance of hillsides while avoiding the high cost of providing public infrastructure to isolated sites. As a consequence of the program, values of properties adjacent to the greenways have increased. The value of the overall citywide park system has also increased because of the trails and parks linking the city's greenways (Figure 6-14).

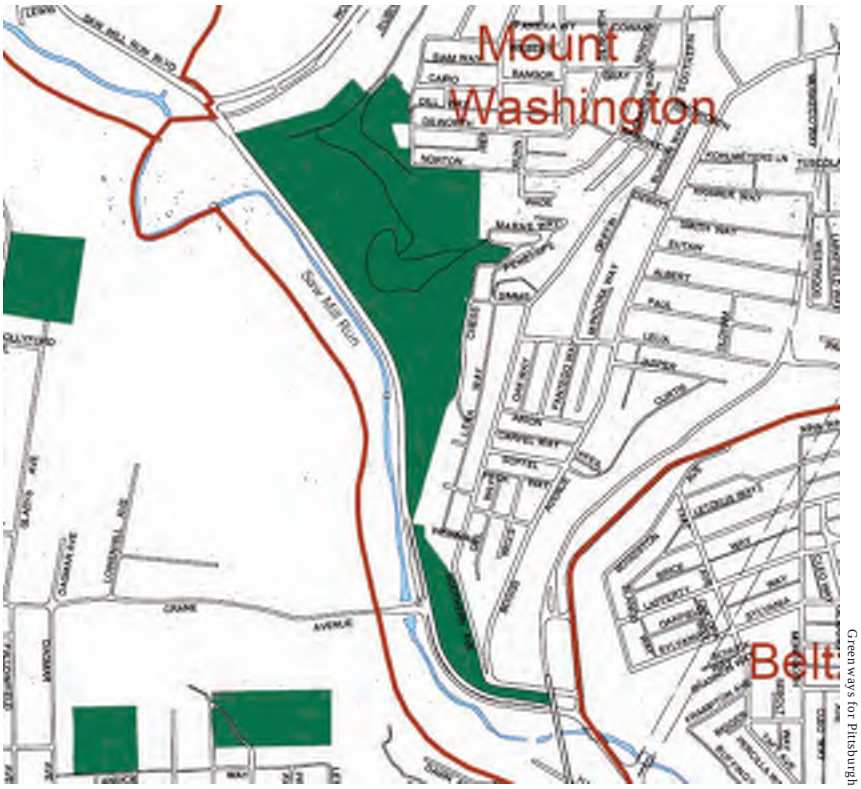

Figure 6-14. *The Greenways for the Pittsburgh program designated marginal hillside properties for passive uses and helped create a system of trails and parks linking the city's greenways (links shown in red).*

Mine subsidence insurance. For more than a century, coal and clay mining has been an important part of the history of Pittsburgh and southwestern Pennsylvania. Mines that no longer operate dot the entire region. Their locations are not always known. Many mined areas now stand developed with public and private investments in buildings, infrastructure, and important road and utility networks. Every year, lands subside in the region costing millions of dollars in damages. Damages can be from either sinkholes (common) or trough subsidence (rare). Sinkholes typically occur if the mine is near the surface, and their effect is local. They can cause extensive damage to properties. Trough subsidence, on the other hand, typically occurs were a remnant mine pillar collapses, leaving a large shallow depression. The area affected by trough subsidence often increases with the greater depth of the mine (Pennsylvania DEP 2002).

Due to repeated subsidence problems in western Pennsylvania, the state created an insurance fund in 1961 to alleviate the financial hardship to property owners. It provides coverage of up to $150,000 for residential properties and $250,000 for nonresidential structures (Pennsylvania DEP 2002). The Pennsylvania Department of Environmental Protection administers the Mine Subsidence Insurance Fund. Since many mines operating in the city were closed long before the city created any maps, the insurance fund, which is run as a nonprofit entity, provides relief to property owners who could not otherwise get regular homeowners insurance coverage for such events. As a result of numerous landslides in 2004-2005, several western Pennsylvania legislators are exploring the idea of developing a similar insurance program for landslide-prone areas.

Conclusion

Pittsburgh's strategy includes a combination of special purpose and overlay zoning districts supplemented by hillside development standards, a greenways program that encourages passive open space designation for

hillsides, and state-administered mine subsidence insurance. Zoning ensures risk reduction. Open space provisions serve many public purposes, including preserving views (including those from transportation corridors), linking recreational facilities, increasing property values, and reducing the need to provide expensive infrastructure to isolated sites. The techniques may not be new, but their combination is. Pittsburgh's success demonstrates that successful landslide hazard mitigation can be integrated into local and state regulatory frameworks while also advancing open space, recreation, and aesthetic goals.

Pittsburgh continues to refine its approach to landslide hazards. City planners have been working since 2002 with a committee of development and conservation interests to refine the program through regulation revisions, better stewardship and management of publicly held hillside lands, and refinements in the greenways program. The regulation revisions include the development of a point system that rates proposed hillside development in order to determine if permits should be granted for development to proceed. The rating system addresses features such as slope, percent of parcel disturbed by development, soils, geology, proximity to infrastructure and existing development, design issues, and vegetation (control of invasives, preservation of existing quality vegetation, and provision of new vegetation). The ultimate goal of this effort is to ensure responsible development in appropriate locations, recognizing environmental and community character assets and limitations.

THE GREEN MOUNTAIN LANDSLIDE: A CASE HISTORY OF GEOLOGIC HAZARDS PLANNING IN COLORADO

By Karen A. Berry, AICP

Karen Berry, AICP, is a geological engineer and natural resource planner with more than 20 years experience in natural hazards planning. She was a member of the Jefferson County Engineering Advisory Board and the planning department at the time of the case study.

A landslide in 1998 in Jefferson County, Colorado, destroyed three houses and severely damaged two others in a new subdivision. It also damaged nearby roads and utilities. The ensuing disruption extended beyond the immediate area, which is known as Green Mountain. The subdivision is in an incorporated area of the county near the city of Lakewood. Both the city and the county are part of the rapidly urbanizing eight-county Denver metropolitan area (Figure 6-15). What followed after the initial rescue and recovery were several lawsuits, including one by the homeowners of those houses damaged or destroyed by the slide (*Brooks vs. Leprino* 1998).

Figure 6-15. *The eight-county Denver metropolitan area, which is urbanizing rapidly.*

The lawsuits, against the developer and other construction professionals, were settled out of court and the details of the settlement are sealed. A limited liability company, owned and managed by the original developer, however, spent about $1 million to remediate the slide with underground anchors and drains. The company also acquired and demolished three of the most severely damaged homes (*Quaker Court vs. The Jefferson Board of County Commissioners* 2004).

In an effort to recover losses, the company sought, but was denied, building permits to rebuild homes destroyed by the landslide. The company unsuccessfully challenged the county's decision on the grounds of inverse condemnation. Although Jefferson County has not been held not liable for the landslide, its actions and inactions in this case, more than any other party, became the focus of intense and critical media attention and public scrutiny.

TIMELINE

2002 Developer requests and is denied building permits to rebuild homes.

2002 Developer sues Jefferson County for a "takings" but claims later dismissed

2004 Developer appeals decision

2004 Court of Appeals upholds District Court decision and denies developer's "takings" claim

In the absence of uniform statewide requirements for considering hazards in local plans, Colorado cities and counties typically use subdivision regulations to mitigate landslide hazards.

The following sections describe in detail how such a failure of planning and development could happen. The case study offers insights into the shortcomings of Colorado's legislation governing landslide hazard area planning and regulation and the lessons that Jefferson County, in particular, learned.

A Brief History of Natural Hazards Planning in Colorado

Land-use planning in Colorado's enabling legislation first took shape in 1970 under the Colorado Land Use Act (Colorado Revised Statutes, Section 24-65-101). Amendments passed in 1974 defined geologic or natural hazards, such as landslides, as having a "state interest," thereby providing the basis for regulation at the state and local levels. This act encouraged local governments to designate hazard areas in their comprehensive plans and regulate hazards through local ordinances. Though not a mandate, this act also funded efforts by local governments to map geologic hazards, develop plans, and adopt regulations to address these hazards.

Local governments, however, resist using the "state interest" act because of its detailed statutory requirements that many feel give local land-use control to the state (Johnson and Himmelreich 1998). Hence, natural hazards in Colorado communities are not uniformly addressed in local plans. For larger communities, the 1999 Colorado Responsible Growth Initiative would have made a hazards element mandatory, but this ballot initiative was defeated. Subsequent amendments to the Colorado Land Use Act have made adoption of a master plan mandatory, but only recreation and tourism elements—not a hazards element—are required.

In the absence of uniform statewide requirements for considering hazards in local plans, Colorado cities and counties typically use subdivision regulations to mitigate landslide hazards. Under a 1972 law (Colorado Revised Statutes, Section 30-28-133), county subdivision regulations must include geologic hazard mitigation. Although this requirement is optional for municipalities, most counties and municipalities in the state use this law to manage hazards when reviewing subdivision proposals. Because reviews of hazards occur at this late stage in the development process, avoidance of geologic hazards through land-use planning is almost impossible. Instead, mitigation solutions tend to be structural (i.e., hard construction solutions such as retaining walls). But this 1972 law does not cover all subdivisions. It does not apply to two types of subdivisions: those platted before 1972, and those greater than 35 acres (called large lot subdivisions). Subdivisions platted before 1972 typically contain small lots on steep terrain in areas with numerous hazards. Hazard mitigation in these areas is a statewide issue and a recurring topic of debate for local governments and

state lawmakers. Some communities use a hazards overlay zoning district to review mitigation plans for new developments in older lots.

An additional law, a disclosure law for residential uses established under the state's consumer protection act (Colorado Revised Statutes, Section 6-6.5-101), requires that builders provide purchasers with a geotechnical report and site recommendations 14 days before closing. This statute was adopted in response to widespread damage to homes from expansive soils and is often interpreted to include landslide hazards (Johnson and Himmelreich 1998; *Brooks vs. Leprino* 1998).

Colorado communities currently have four planning tools available for landslide hazard mitigation: community plans, overlay zoning, subdivision regulations, and the "areas of state interest" designation. These tools, however, have brought only mixed success.

History of Geologic Hazard Planning in Jefferson County

Starting in 1976, Jefferson County began using geologic hazard overlay zoning to control potentially hazardous development in new subdivisions and in those exempt from the provisions of the 1972 subdivision law. Under this zoning, geologic hazard mitigation is a required first step for all applications for rezoning, subdividing, or building and grading permits. This requirement applied to all hazardous areas regardless of underlying zoning.

In terms of process, the county's Board of Adjustment reviews hazard mitigation plans for building and grading permits, and the county's commissioners approve mitigation plans, rezoning, and subdivisions. The commissioners can waive master plan policies and subdivisions regulations, and they can remove overlay zoning, but they cannot waive the requirements of the overlay zoning district. Passive and accessory uses, without occupied structures, are excluded from overlay zoning requirements or are administratively reviewed.

Jefferson County adopted the overlay district to minimize risks of development in geologic hazard areas and to reduce public expenditures, mainly on the construction and maintenance of roads and other utilities placed in hazard areas. Because of the extent of geologic hazards and the number of development applications in the overlay district, the county commissioners created an engineering geologist position in the planning department. Beyond reviewing geologic hazard plans, the engineering geologist's responsibilities include the administrative reviews required by the overlay district regulations.

Because of the extent of geologic hazards and the number of development applications in the overlay district, the county commissioners created an engineering geologist position in the planning department.

Colorado Geological Survey's Role in Hazards Planning

The Colorado Geological Survey (CGS) was created in 1967 and is part of the Colorado Department of Natural Resources. CGS assists local governments in identifying and mitigating geologic hazards, and it publishes guides and maps about geologic hazards for planners, builders, building officials, and homeowners. CGS has developed model regulations to help local governments implement geologic hazard land-use controls. As a state agency, CGS has no regulatory control over local land use; its role is to serve as an advisory body to local governments and citizens.

The Case of Green Mountain

Geologic hazard overlay zoning for the Green Mountain area kept development from landslide areas until 1990. Then, based on a developer's engineering reports that declared development in landslide areas would be safe (Anderson 1990), the county commissioners approved a large residential subdivision. The commissioners also re-

moved the proposed areas for development from the provisions of the overlay district. Houses, roads, and utilities were subsequently built over several years. But in 1998, following several years of above-average rainfall, a new landslide emerged from an older one. Three homes were destroyed; two others were severely damaged, and roads and utilities suffered significant damages. The homeowners, in a lawsuit filed against the county, developer, builders, and engineers, claimed that the mitigation plan submitted to the county used "unreasonable assumptions" and that construction did not follow the specifications in the approved plan. The suit also claimed that the county failed to enforce its own rules and regulations (*Brooks v. Leprino* 1998). The case showed that the county had adequate information about the hazard, adopted appropriate regulations, and informed developers at the appropriate stages; yet the process, the technology, and the general concern about hazards were not sufficient to prevent the disaster.

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The lawsuit, against the developer and other construction professionals, was settled out of court. The agreement requires that the details of settlement not be disclosed. In connection with the lawsuit, however, a limited liability company, owned and managed by the original developer, repurchased homes within and near the landslide. The company demolished three homes that were beyond repair and spent approximately $1 million to remediate the slide (*Quaker Court vs. The Board of County Commissioners* 2004). The court dismissed the homeowner's claims against Jefferson County officials.

A history of geologic hazards on Green Mountain. The 1998 landslide did not come without warning. In 1972, USGS maps first identified old landslides (not moving) and active landslides on large parts of Green Mountain (Figure 6-16). Because the active landslides identified on the maps had formed from older landslides, USGS also warned that the old landslides were not necessarily stable (Scott 1972). This information, however, did not translate into sound development practice: in 1973, while a lot in Lakewood was being graded, one of the old landslides reactivated. Removing debris from the slope stabilized it. Due to erosion of the exposed rocks and cut slopes, however, rockfall and excessive sedimentation over time affected homes and roads. The city and the county then funded a comprehensive study of Green Mountain for hazards. This 1978 study identified landslide, flooding, erosion, and expansive soil hazards, and evaluated land-use compatibility and the severity of geologic hazard risk (Schneider 1978).

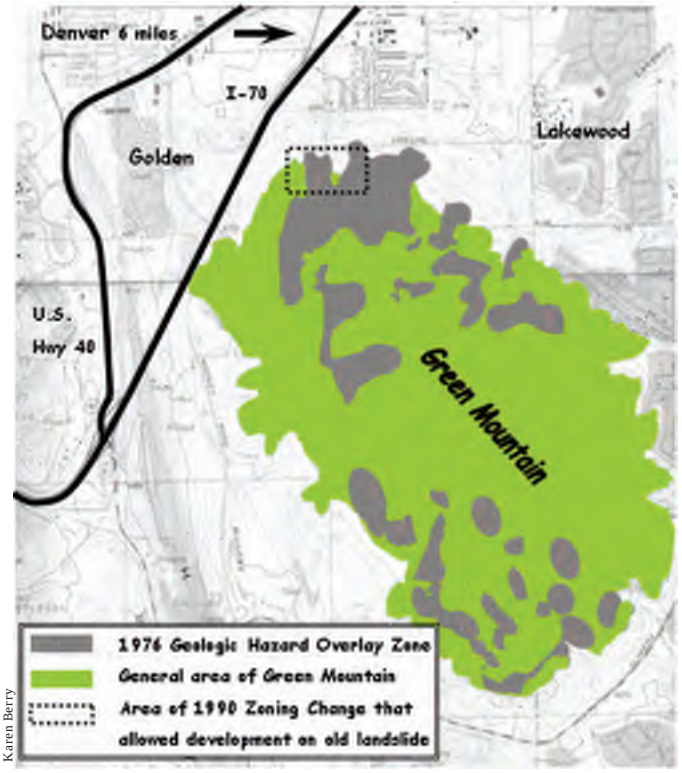

Figure 6-16. *The darker areas are old and active landslides mapped by USGS. USGS mapped most of the lighter areas as "potentially unstable" where development could cause slope failure.*

In the study, hazard areas were grouped into high, moderate, and low risk (Figure 6-17). Passive uses were recommended for high-hazard areas. The study also stressed that "development or severe natural events may reactivate slope movement" on areas with a moderate-hazard rating (Schneider 1978, plate 7).

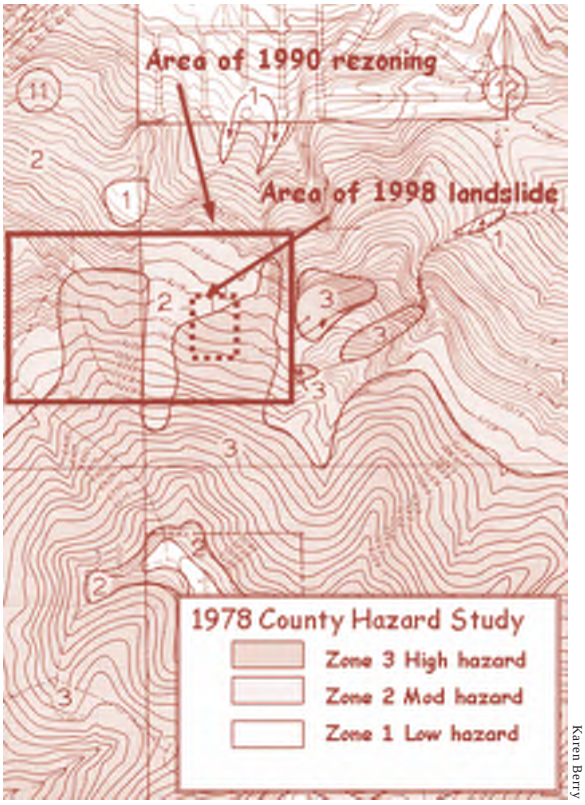

Figure 6-17. *This map shows the severity of hazards. High hazard ratings were mainly given to landslide prone areas where development was strongly discouraged. A 1980 PUD showed high-hazard areas as "preservation areas" and moderate-hazard areas as "sensitive development overlay areas." A 1990 PUD amendment allowed development in the preservation areas.*

From no development to development. The county's overlay zoning district prohibited the kind of intense development that contributed to the 1998 landslide. This zoning district was intended to ensure a certain level of safety by keeping inappropriate uses from hazard areas. But the shift from regulations that allowed no development to approval of development shows how local review processes can undercut sound technical information about a hazard.

The shift from regulations that allowed no development to approval of development shows how local review processes can undercut sound technical information about a hazard.

From 1976 to 1990, the overlay district effectively kept development away from known high-hazard areas, largely due to the 1978 study. Shortly after this 1978 study was completed, the first development proposal was a planned unit development (PUD). The developer closely followed the study's recommendations for avoiding and mitigating hazards. The plan delineated two types of areas: sensitive areas and preservation areas. Sensitive areas were earmarked for development under careful planning and construction standards. Preservation areas were identified as being extremely risky for development. When compared to the 1978 study, the sensitive areas in the PUD were roughly the areas identified as having moderate hazards, and the preservation areas were those with an extreme risk of sliding. Of note is this warning in the plan's geotechnical report:

> Extensive cuts in SDO [Sensitive Development Overlay] could induce upslope instability on Green Mountain wherever thick sequences of slope materials are encountered. . . . This condition will not preclude development within SDO, but will require careful planning and controlled construction to minimize the potential for inducing hazardous slope conditions. (Florquist 1978)

When the county approved the PUD in 1980, it included restrictions on construction practices in sensitive development areas, as recommended by the planning staff and CGS. But with that approval, the stage was set for the expansion of development into riskier areas that were hitherto restricted. During the following decade, escalating land values throughout the region made marginal areas valuable and put increasing development pressure on the slopes of Green Mountain. By 1990, landslide and potentially unstable areas began to be cited by the developer as desirable residential locations because of the commanding views from high on the mountain.

The county amended the 1980 PUD in 1990 to allow development in preservation areas, which had previously by definition precluded any development (Figure 6-18). Moreover, the geologic overlay zoning district restrictions also constrained developing preservation areas. Through rezoning, the county removed both of these restrictions on about 24 acres, clearing the way for a 118-acre plat with 275 single-family houses. Along with the rezoning, the developer, in the application, requested a waiver of grading restrictions for the cut and fill of slopes, drainage, and the amount of area to be graded. A geotechnical report submitted with this request proposed using retaining structures, engineered fill, and drain systems instead (Anderson 1990).

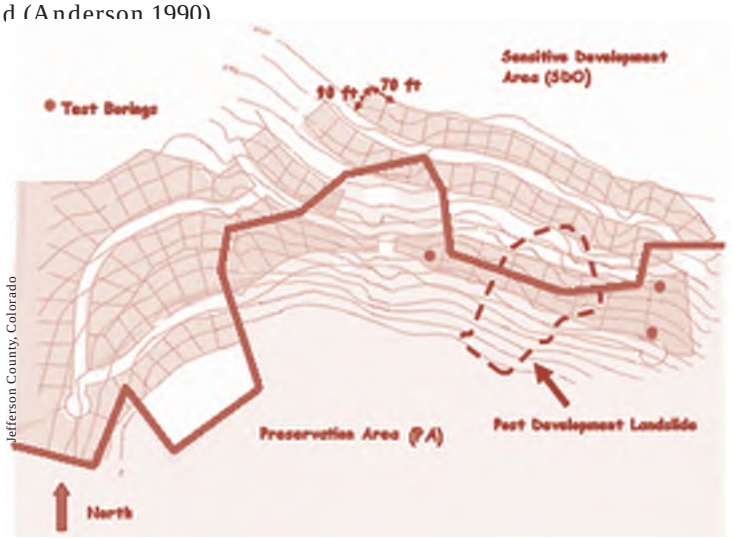

Figure 6-18. *Map showing development expansion into Preservation Area, an area where development had been prohibited. The map also illustrates errors in the developer's 1990 PUD engineering report. The nearest test borings to the 1998 landslide encountered stable bedrock. Subsequent testing revealed thick, unstable soil between the original borings that resulted in an underestimation of landslide risk.*

County planning staff recommended that the request be denied. But the county commissioners approved it, although they reduced the number of houses that could be built in the preservation area and required some additional mitigation measures. Over the next several years, the development proceeded with significant private investment. So did public investments, with the expansion of utilities, gas, and water lines in sensitive and preservation areas.

This development pushed forward because each step up the mountain carried higher land values, higher development pressure, and greater hazard potential as shown on the geologic maps. Each step also depended more heavily on engineering mitigation of marginal lands. Prior to 1980 there had been no development in moderate- and high-risk areas. In 1980 development began in moderate-risk areas. In 1990, high-risk areas were developed while at the same time developers and local government ignored required mitigation in medium-risk areas (Able, May 7, 1998). Then in 1998 came the culmination: a landslide that destroyed part of the 118-acre plat approved for development in 1990, which had been marked as high risk as early as 1972.

Waiting for a trigger. By 1998, as development of this hazardous area of Green Mountain continued, all components for major losses were present: a known hazard, private investment, and public infrastructure. All that was remaining was a trigger. Soon after construction of Sixth Avenue West Estates was completed, homeowners and maintenance crews began to notice damages to homes and roads but were unsure of the cause (Able, May 1, 1988). Beginning in 1998, after several years of above-average precipitation, the slope moved at a noticeable rate and, within six weeks, a large depression formed in a public road. As the slide continued to move, it damaged three homes, which were eventually demolished. One of the two access roads to the subdivision was also closed. A large water main, an important source of fire protection for several hundred homes, was shut down. Due to safety concerns a regional high-pressure natural gas pipeline was temporarily relocated (Figure 6-19). By now the impacts extended to areas beyond the slide area.

Figure 6-19. *Landslide rupture (within the white line) can be seen in pavements and open space areas. The main water line for fire hydrants was located in the head of the slide and a regional high-pressure gas main, serving the western half of the county, was located near the toe of the slide. Three homes, within the white line, were severly damaged and torn down. Two damaged homes located at the toe of the slide were repaired.*

Errors compounded. But knowledge of the factors triggering this landslide can be traced back to a 1990 geotechnical report that argued for the safety of houses in the preservation area. But that report, which helped secure the amendments to the 1980 PUD, was based on incorrect engineering assumptions (*Brooks v. Leprino* 1998). It underestimated the thickness of slope (old landslide) deposits and overestimated soil strength. Part of the problem can be traced to test boring locations that missed thick slope (old landslide) deposits. These test results indicated higher soil strength values than were actually present, which resulted in an inaccurate assessment of landslide risks. This error was discovered much later, during soil testing for landslide remediation (Thompson 1998).

The study found that, contrary to the findings made by the engineer hired by the contractor and submitted to the county, the grading did not meet the requirements of the PUD and approved plats.

Furthermore, compounding these errors in soil conditions analysis, the extent of site development exceeded what was approved as part of the 1990 PUD amendments. Slight modifications to natural slopes can result in development-caused instability. The stability model used in 1990 was based upon maximum cut and fill heights. But actual site grading for cuts and fills exceeded the heights used by the geotechnical engineer, whose model had placed the site close to the edge of acceptable engineering risk. Even had the actual site grading complied with the recommended maximum cuts and fills, however, the fact that the stability of the soil had been overestimated would have made the hazard risk unacceptable (Thompson 1990 and Anderson 1990).

Before assuming maintenance responsibility for public roads, the county received a grading report only for areas within public right-of-way. But the county did not regulate grading permits outside of the right-of-way, and extensive grading occurred without county oversight. An engineer hired by the developer's contractor certified that grading complied with PUD and plat requirements. This arrangement was atypical, however: grading evaluations for large hillside grading projects are usually based on extensive observation and testing by an independent engineer rather than an engineer working directly for the contractor (Colby 1992).During a typical soil investigation for a house foundation, a geotechnical engineer, hired by a builder, raised concerns about improper compaction of fill. The builder had the geotechnical engineer conduct a detailed engineering study to evaluate the grading done by the developer. The study found that, contrary to the findings made by the engineer hired by the contractor and submitted to the county, the grading did not meet the requirements of the PUD and approved plats. The homebuilder's study also found that underground drains, an important mitigation element, had not been installed (Colby 1992). Though a report prepared by a builder would not be routinely submitted to the county, these deficiencies came to light when a remediation study carried out after the 1998 landslide showed that the slope would not have been stable without an extensive underground drain system (Thompson 1998).

Procedural gaps. Site plans for each lot in the preservation area of the PUD required a stability study that analyzed the cumulative effects of grading on regional slope stability. The developer's study, at the rezoning and platting stages of the development process, considered only impacts from roads. Other aspects of development that can induce a slope failure, such as grading for driveways and building pads and irrigation of landscaping, were left for analysis at the building permit stage. Reviews this late in the development process shifted the burden of addressing the cumulative impact—and, more importantly, the mitigation responsibilities—to lot owners.

To make matters worse, the county issued building permits without checking if stability reports were submitted as part of the application. Though the requirement for a stability report is noted on the plat, it was not widely known: engineers who designed house foundations, homeowners, and builders said they did not know of such a requirement. One county official explained: "There are two responsibilities involved. One is the responsibility of the builder to comply with all the regulations, the other is that we [the county] are supposed to make sure that they have done that…and it appears all of the information required…may not have been submitted" (Able, May 7, 1998). After the 1998 landslide, the requirement verification mechanisms within the zoning and platting processes were found to be inadequate (Brindle 1998).

Post-landslide analysis also found that, while the PUD restricted development in the preservation area to only 10 houses, 15 were in fact built—an increase that was not accounted for in any stability study. More houses were built than was safe even if all the mitigation measures had been followed (*Brooks vs. Leprino* 1998).

While development and natural conditions triggered the slide, the county's procedural gaps, errors, and lack of oversight during permitting and construction prevented timely intervention. Having acknowledged these failures, the county has since improved its development review and construction oversight process (Able 1998; Brindle 1998).

Post-landslide analysis also found that, while the PUD restricted development in the preservation area to only 10 houses, 15 were in fact built—an increase that was not accounted for in any stability study.

Disclosure to purchasers. Plat notes and warnings in public records are often ineffective or insufficient in conveying hazards risk to buyers. Though plat restrictions, included as notes on the plat, warn about possible hazards, Colorado title companies reference but rarely list such plat notes on policies. Such was the case at Green Mountain: in a lawsuit filed by homeowners, they alleged that the developer "failed to supply material information concerning the stability of that land, and failed to provide complete information regarding the plat restrictions, thereby misleading these prospective purchasers . . ." (*Brooks v. Leprino* 1998). Public records held in county offices represent another way prospective homebuyers can learn about hazard threats to property. These threats are described in hazard warnings and special conditions on hazard overlay maps, PUD documents, and subdivision plats.

Another opportunity for disclosure in Colorado is a soils report. Builders have to share this report with homebuyers as required under state law (Colorado Revised Statutes, Section 6-6.5-101). But in the landslide area, homeowners said they did not receive soil reports containing landslide mitigation recommendations on landscaping, drainage, and grading (*Brooks v. Leprino* 1998). Moreover, the homeowners association required irrigation of landscaping in covenants, contrary to safe practices in landslide areas. Some homeowners also constructed large retaining walls, imported fill, and installed extensive landscaping and irrigation contrary to engineering recommendations, zoning, and platting restrictions.

Steps taken by Jefferson County to improve the planning and construction process. Prior to and in the aftermath of the 1998 landslide, Jefferson County made several changes to its development regulations and approval process. The county's subdivision regulations, for example, have been amended to include overlot grading specifications. These specifications require full-time engineering inspections and mandate testing methods and testing frequency. They also require that a professional engineer certify as-built grading. The subdivision regulations also now include standards for the design of subsurface drainage systems so that the systems will function properly and can be maintained by homeowners associations and water and sewer districts.

The county also requires that the county clerk make public records, such as easements and drainage system plans, available for review. Developers record subsurface drainage plans and easements with the plat and can be viewed at the county clerk's office or online. The county's development approval process has likewise been altered to require:

- grading permits for most grading projects;
- geologic hazard areas shown on plat and zoning documents; and
- review of building permit applications by a senior staff member to verify compliance with zoning and plat requirements (Brindle 1998).

Once construction begins, the county building department must verify that builders are following hazard mitigation measures contained in geotechnical investigations through foundation inspections or engineering certifications.

Conclusion: The Challenge of Risk

The litigation that followed the 1998 Green Mountain landslide suggests that there was a failure by all parties to understand fully the level of risk incurred by development. Developing landslide-prone areas always involves some level of risk, depending on the engineering assumptions, construction activities, and dynamic natural conditions of the area during development. Only a thorough analysis can determine the level of landslide risk at a site.

There are a number of important factors that contribute to the level of risk: a prominent geotechnical engineer, for example, argues that possibly the most important factor affecting the ability to predict whether a slide will start is whether we are in an old slide area (Peck 1967). Yet landslides are complex processes that can be difficult for geologists and engineers to model and predict. As nonspecialists, elected officials often struggle to understand the uncertainty and degree of risk that comes with landslide hazards. When asked how they could have approved such a development in a known landslide area, the county commissioners said that, because they are not experts, they relied on the developer's engineering reports (Able, July 12, 1998). But the commissioners also believed geologic engineering was more of an exact science (Able, July 12, 1998).

What the development review process for the Green Mountain project did not adequately convey, therefore, was the level of risk being taken by all parties involved: the developer, local government, and homeowners.

Likewise, at Green Mountain—as at all development sites in landslide-prone areas—mitigation of that risk was driven by project economics. Because elimination of all risk was physically and fiscally impossible, the developer was forced to balance expected revenues with mitigation costs in such a way that left the subdivision exposed to some risk.

What the development review process for the Green Mountain project did not adequately convey, therefore, was the level of risk being taken by all parties involved: the developer, local government, and homeowners.

Developers and public officials often have two choices when faced with development in hazard areas: hard mitigation options or no development at all. Development in a landslide-prone area is not risk free and carries no guarantee for perpetual safety. Whereas developers balance projected revenues with mitigation costs, public officials must account for public safety and public liability.

Evaluating landslide risks requires complex geologic and geotechnical mapping, testing, and modeling. Planners and public officials cannot be expected to have the technical expertise to understand and evaluate fully such risks. Establishing independent technical review panels to help officials sort through complex engineering reports can help local governments. Such panels can also serve as an independent body to review differing opinions from engineers, planning staff, and other technical experts (Jefferson County 2004).

Complex specifications for installation and maintenance of landslide mitigation measures require special expertise unfamiliar to most developers, builders, engineers, and public works inspectors. Quality control of construction and maintenance are critical to reducing landslide hazards. Compounding this problem, homeowners, real estate agents, and homeowners' associations are also often unaware of the "do's and don'ts" of living in landslide areas.

Local governments must ensure that they have the necessary staff, such as geologists and geotechnical engineers, and that the appropriate regulations and procedures are in place—and enforced—when approving landslide mitigation plans. As one Jefferson County commissioner stated after the 1998 slide, "This [landslide] makes me realize people's lives are in my hands . . . and every decision we make becomes more important and more difficult" (Able, July 12, 1998).

CHAPTER 7

State and Federal Roles in Landslide Hazard Planning and Mitigation

The three papers in this chapter address the roles that state and federal agencies play in landslide hazard planning and mitigation. Charles Real describes California's 1990 Seismic Hazards Mapping Act and its implementation in detail. Jerome DeGraff describes how the United States Forest Service manages threats to the nearly 191 million acres of lands it manages. And, finally, Paula Gori and Lynn Highland document the role of government, especially federal agencies, in dealing with the physical, social, and economic impact of landslides in the United States.

CALIFORNIA'S SEISMIC HAZARDS MAPPING ACT: A STATEWIDE APPROACH TO LANDSLIDE HAZARD MITIGATION

By Charles R. Real

Charles Real is a registered geophysicist in California and has worked in the field of earthquake hazards for more than 30 years. He helped to establish and currently manages the California Geological Survey's Seismic Hazard Mapping Program.

California implemented the nation's toughest grading codes in 1952 after heavy damages in built areas due to severe winter storms. When repeated winter storms in Southern California affected the Los Angeles Basin, which had seen rapid post-World-War II development spread to the hillsides, the grading codes underwent further refinements. In 1962, the state amended the codes to require, for the first time, site-specific slope investigations by qualified geologists or engineers (Scullin 1990). Even with such measures, "engineered slopes" continued to fail, especially after harsh events (Figures 1 and 2).

More recently, slope failures triggered by earthquakes, such as the 1971 San Fernando, the 1989 Loma Prieta, and the 1994 Northridge, focused attention on the need to consider earthquake forces when assessing slope stability for construction projects. Extensive losses caused by numerous landslides in the Santa Cruz Mountains and the widespread settlement of loose, saturated ground due to liquefaction along the shores of San Francisco Bay prompted the California Legislature to enact the Seismic Hazards Mapping Act (SMHA) of 1990 (California Public Resources Code, Sections 2690 et seq.; California Code of Regulations, Title 14, Div. 2, Chapter 8, Sections 3270 et seq.).

As a result of this Act, landslide hazard assessments in general are improving because evaluating slopes under earthquake loading must still consider gravity forces. The quality and reliability of slope stability investigations, including methods of analysis, field practice, and laboratory testing of earth materials have improved considerably due to the implementation of this Act. While the implementation of the Act is still in progress, it has already established more uniform and better quality standards in site investigation, design, and construction in hillside areas.

The Act functions within a larger policy framework, supported by state and local laws that establish standards, processes, and responsibilities for state agencies, local governments, developers, and property owners (Real 2002). Understanding this framework is essential to recognizing the spe-

City of Laguna Niguel

Figure 7-1. *Aerial view of landslide triggered by El Nino winter storms of 1997-1998 in the city of Laguna Niguel. This slide occurred in an existing hillside development, within engineered slopes, destroying over a dozen homes.*

Siang Tan

Figure 7-2. *Street view of damage caused by the Laguna Niguel landslide. Such occurrences have been the driving force for the development and evolution of grading codes in California.*

cific improvements to landslide hazard mitigation brought about by the Act. Transferring such a regulatory mechanism to places outside California requires an understanding of the context in which the interdependent regulations and development practices function in mitigating landslide hazards.

POLICY FRAMEWORK

California delegates the power to protect life and property to its city and county governments. Under the Reserved Powers Doctrine of the U.S. Constitution, this power rests with the state government, which is in turn delegated to local governments. Local governments in the state are, then, solely responsible for landslide hazard mitigation. The state government, however, plays an important role in shaping local policies, including land use and development in landslide hazard areas. It does so by establishing a policy framework under which local governments have choices in executing and implementing statewide policies. Two main policies drive SHMA:

1. Disclosure of geological hazards (where the intent is to publicize the hazard so it can either be avoided or mitigated)
2. Mitigation of geological hazards (in which the local governments choose the most appropriate mitigation for a given site based on site-specific geotechnical investigations)

California's Natural Hazards Disclosure laws ensure that hazard information is provided to buyers, sellers, and local governments. As for mitigation, it depends on a detailed, site-specific geotechnical study.

California's Natural Hazards Disclosure laws ensure that hazard information is provided to buyers, sellers, and local governments. As for mitigation, it depends on a detailed, site-specific geotechnical study. But when to require a geotechnical study requires some knowledge of the hazard, though such information will not be available until after a study is completed. The Act addresses this problem in a two-step process: a regional hazard assessment followed by a more detailed local assessment. This two-step method was first introduced in 1972 in the Alquist-Priolo (A-P) Earthquake Fault Zoning Act (California Public Resources Code Sections 2621 et seq.) that regulates construction in active fault areas. Implementation of the A-P Act served as a model for SHMA (Holden and Real 1990; Real and Holden 1991).

In step one, the state's California Geological Survey (CGS) delineates potentially hazardous areas on maps based on a regional assessment. Marked as "zones of required investigation" under SHMA's Seismic Hazard Zone Maps, these areas serve as a first-order check. These maps are provided to local governments along with advice on what they mean and how to use them. Because of their widespread distribution, these maps have become the main policy instrument of the Act. In step two, local governments require local development proposals in these zones to prepare a detailed study of the hazard, taking into consideration variations in site-specific soil and geologic conditions.

PLANNING LAW

Local governments incorporate these hazard maps in the safety element of the general plan. California's planning laws require all cities and counties to prepare and adopt a general plan. The general plan must include the safety element, in which the community identifies man-made and natural hazards, including wildfires, floods, earthquakes, and landslides (California Government Code, Section 65302 (g)). By including these hazards in the safety element, the intent is to promote safe land-use and development policies that minimize exposure to risk. SHMA also requires that cities and counties take into account the information contained in the seismic hazard

zone maps when adopting or revising land-use and permitting ordinances. Through the safety element, SHMA maps showing landslide hazards become available early in the development process, unlike geotechnical reports that become available at later stages of site plan review or building permit. In addition, statutes also require that, when land undergoes subdivision prior to construction, a soil report be prepared to identify potential hazards that could weaken proposed structures (Subdivision Map Act, California Government Code Sections 66410 et seq.). The soil report provides the first glimpse of geotechnical hazards that could adversely impact development of the site.

Protecting the "buyer's right to know," California law requires the seller (or seller's agent) of real property to disclose whether it is located in a landslide hazard zone prior to sale.

BUILDING STANDARDS LAW

California Building Standards Code (CBSC) (Title 24, California Code of Regulations) provides general guidance for hillside development and sets standards for grading. It also requires a soils report and an engineering geology report. Defined by local agencies and industry practice, these reports must recommend mitigation for sites with geotechnical problems. CBSC also mandates that any mitigation approved must become a part of the construction plan before local government can issue a construction permit. This ensures that the construction proceeds according to the mitigation plan. CBSC, which has been adopted by the state after making appropriate amendments to the triennial edition of the model Uniform Building Code (ICBO 1997), serves as the default code for all jurisdictions in the state. Local agencies can adopt a more restrictive form of CBSC to meet the needs of specific local conditions (California Health and Safety Code, Sections 17957-17958 and Sections 18930-18934.8). Although building codes throughout the state have a common basis, industry practice, field performance, review, and acceptance by local governments have led to local standards that can vary from one jurisdiction to another in the state.

NATURAL HAZARDS DISCLOSURE

Protecting the "buyer's right to know," California law requires the seller (or seller's agent) of real property to disclose whether it is located in a landslide hazard zone prior to sale (California Civil Code, Sections 1103-1103.14). This policy affords the buyer the opportunity to make a more informed decision, potentially avoiding future financial loss or personal injury. Natural hazards disclosure also includes fire, flood, dam inundation, and the earthquake hazards of liquefaction and fault rupture. Failure to disclose a property's location with regard to these natural hazard zones can render a seller liable for losses should a damaging event occur in the future. Disclosure laws are an important component of the process because designation of natural hazard zones provides information as to what could happen in an area far enough in advance that precautionary measures can be undertaken to protect life and property.

REGISTRATION OF GEOLOGISTS AND GEOPHYSICISTS

California laws require that geologic plans, specifications, reports, or documents must be prepared under the direction of a Registered Geologist (California Business and Professions Code, Sections 7800 et seq.). A Certified Engineering Geologist must be registered as a geologist, have suitable engineering geology experience, and must have successfully completed a certification exam. SHMA mandates that geotechnical site investigation, report, and review be done by, or under the direction of, a Registered Civil Engineer or a Certified Engineering Geologist. For endorsing hazard investigations, SHMA requires these certified professionals also have expe-

rience in seismic hazard evaluation and mitigation to ensure the validity and reliability of their technical expertise.

THE SEISMIC HAZARDS MAPPING ACT

SHMA requires site-specific geotechnical hazards investigations to determine the potential for seismically induced landslides, liquefaction, and other ground failures. Unlike building codes and planning laws, the geotechnical report is required only for buildings designed for human occupancy (which is defined as 2,000 person-hours per year) located in the seismic hazard zones. Under SHMA, the local government's lead agency can decide if the recommended mitigation is required as a condition for issuing a construction permit. In this way SHMA can induce mitigation because knowledge of hazards and risk and responsibility for taking action are transferred from the state to the local government to the property owner or developer.

The State Mining and Geology Board, whose members are appointed by the governor, serves as a policy advisory body for SHMA. An advisory committee comprised of technical experts from outside the state staff serves as a technical advisory body for SHMA. The State Geologist prepares and distributes the hazard maps delineating susceptible landslides and liquefaction areas based on a regional hazard analysis (Figure 7-3). Then the cities and counties require geotechnical reports before issuing construction permits in the delineated areas. The process does two things: forces the development process to be concerned about the hazard and makes mitigation measures part of the construction plan.

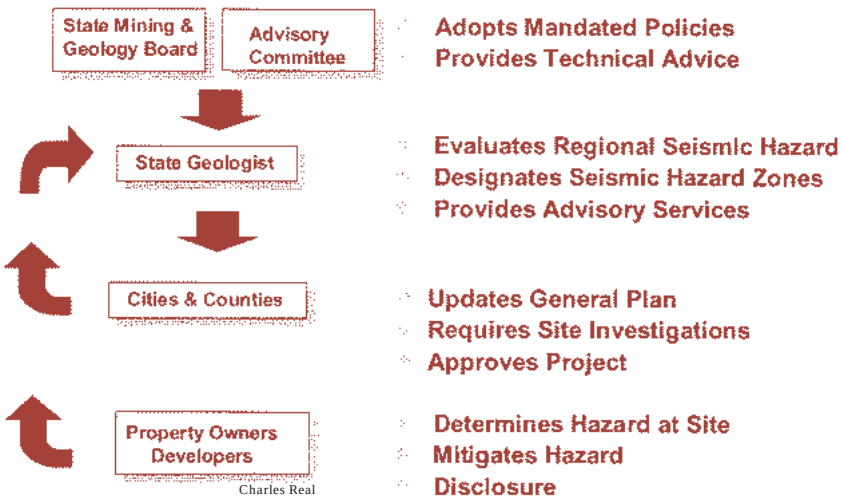

Figure 7-3. *Responsibilities of the state, cities, counties, and owner/developers under the Seismic Hazards Mapping Act of 1990.*

It also ensures that the burden of proof that the mitigation works is placed on the developer.

The maps provided by the state delineate both landslide and liquefaction zones on a single sheet. Each zone is the result of a regional analysis that takes into account topography, groundwater saturation, and rock and soil characteristics. Each map is at 1:24,000 scale, covering a standard USGS 7.5-minute quadrangle that encompasses about 60 square miles (Figure 7-4). A hazard report for each map area includes a detailed inventory of existing landslides, related geological and geotechnical data, and a summary evaluation of the hazard in the region based on criteria established by the technical advisory committee (CDMG 1999). The maps, reports, and criteria are made available in hard copy and online, including an interactive map feature (go to http://gmw.consrv.ca.gov/shmp/).

California Geological Survey

Figure 7-4. *Portion of Official Seismic Hazard Zone Map for the San Jose East Quadrangle showing zones of required investigation for landslides (blue) and liquefaction (green).*

Funding for the mapping program comes from a levy on local building permit fees paid by developers and property owners. The SHMA process ensures that the hazard assessment occurs uniformly at the regional scale using public funding mechanisms. Requiring detailed geotechnical studies at the site-specific scale at the time of development ensures that the hazard and its mitigation options reflect current existing conditions, both in geological and financial terms. Otherwise, preparing detailed maps ahead of any development proposal would not only be prohibitively expensive, but also offer no guarantees that the geologic conditions would remain the same at the time of construction. Then there is the question of who pays for such studies. But by requiring detailed studies at the time of development proposals, the costs are entirely borne by the immediate beneficiaries (i.e., the market value of the completed project will reflect the costs incurred to mitigate the hazard).

Implementation Process

CGS administers SMHA. With an extensive outreach program for local building and planning departments, CGS also manages the education and public information aspects of the program. When delineating seismic hazard zones in a community, CGS meets with local planning and building officials to convey the requirements of the Act and to obtain local geotechnical information. These meetings help ease tensions about the financial costs of complying with the Act because local governments see the requirement as an unfunded state mandate. The meetings also help facilitate the local implementation process (for amending local regulations) while preparation of the hazard maps is underway.

During the mapping process, CGS meets with local agencies as questions about policy, reporting, disclosure requirements, etc., arise. CGS prepares and releases the maps so entire communities can be completed in a timely manner. When completed, CGS issues the preliminary map for a 90-day review and comment period that includes a public hearing. This review period gives local agencies the opportunity to identify mistakes and provide additional data to improve the accuracy and reliability of the hazard zones. CGS then revises the maps within the next 90 days to produce the final maps, completing the process.

Local Adoption

The first step local governments take is to revise local plans and ordinances as required under SHMA.

The first step local governments take is to revise local plans and ordinances as required under SHMA. This is typically undertaken by local building and planning departments. For small cities with no local staff, the county government may coordinate this aspect of the process. For instance, Los Angeles County has served as the permitting agency for several dozen jurisdictions within the county. CGS coordinates with such lead agencies to help revise local review procedures and to set the standards for when to require site investigations, their scope, and other changes in the land-use and construction permitting process. The revisions also include setting the quality and safety standards for geotechnical investigations using technical guidelines provided by CGS (California Division of Mines and Geology 1997). Technical guidelines merely offer options for best practices; they do not prescribe the standards. Local governments have the flexibility to set their own standards based on community objectives and perceptions of acceptable risk. Providing such flexibility to local governments was instrumental in getting support for California's adoption of SHMA.

When fully adopted, SHMA enhances the information available for decision making during each step of the land-use and construction process in California (Figure 7-5). Mandated reports for the safety element of general plans, the Subdivision Map Act, and the local building code are supplemented by more detailed geotechnical hazard reporting required by SHMA.

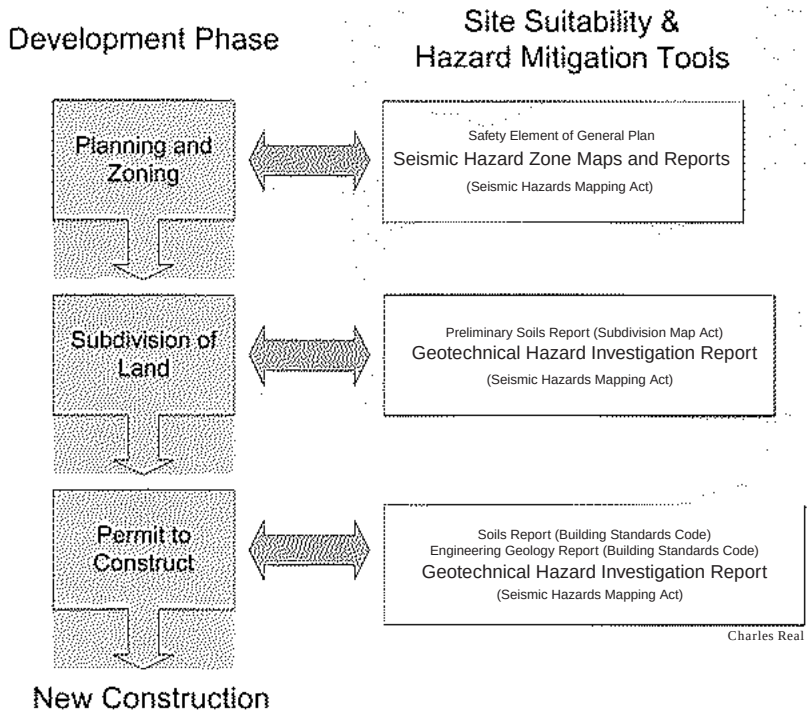

Figure 7-5. *Relationship between planning law, building standards code, and the Seismic Hazards Mapping Act in the development process.*

Similar flexibility applies to building codes governing foundation design and slope stability analysis. Communities have the option of adopting the state standard, which is to protect life, or of creating a more stringent one protecting property and avoiding personal injury. The level of risk a community takes is for the local government to decide (Figure 7-6). SHMA ensures minimum standards. All building code changes ultimately have to be approved by the local legislative body (city council, board of supervisors, etc.).

Getting local geotechnical information has been a major problem for CGS in its preparation of hazard zone maps. While such information is considered "public" if used in a local permitting application, many reports reside in geotechnical firms.

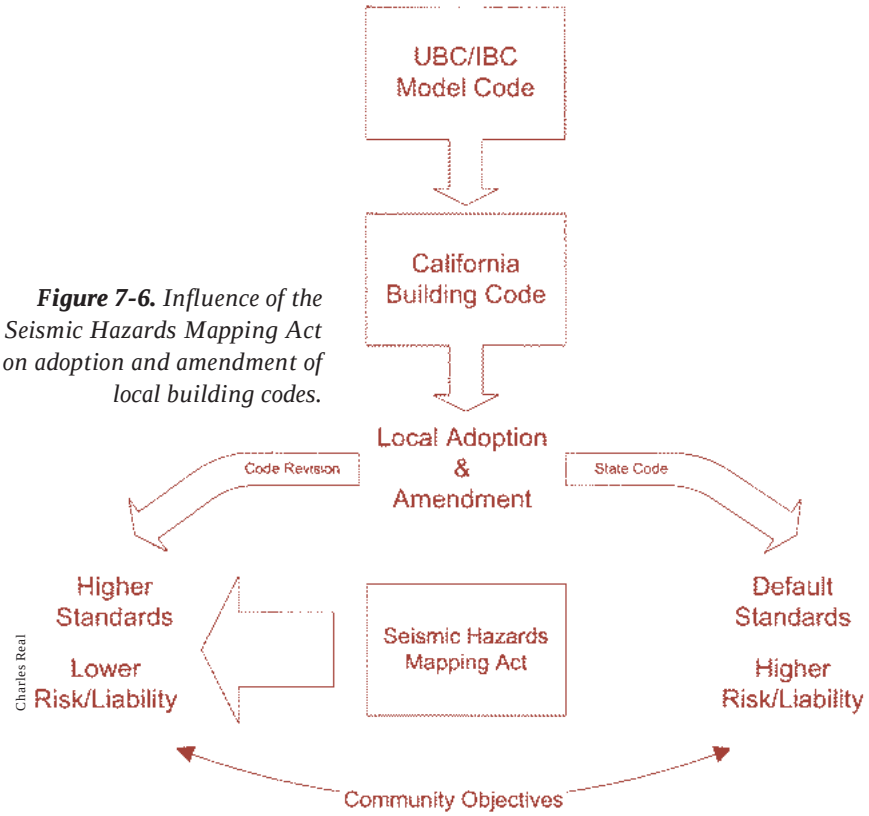

Figure 7-6. *Influence of the Seismic Hazards Mapping Act on adoption and amendment of local building codes.*

Barriers to Implementation

Getting local geotechnical information has been a major problem for CGS in its preparation of hazard zone maps. While such information is considered "public" if used in a local permitting application, many reports reside in geotechnical firms. Such reports, having never been submitted for a public review, are not accessible since they are protected under proprietary and copyright laws. Consequently, CGS relies on other public agencies, such as local building departments and local and state transportation departments. Further compounding this problem of access to geotechnical reports is the recent practice of private consulting firms protecting reports submitted to public agencies through copyrights. Consequently, some local governments have stopped sharing such reports with CGS because of concerns over liability for possible copyright infringement.

CGS also encounters resistance from local agencies due to concerns about cost of implementation because modifying procedures, using hazard maps, and educating everyone involved in the SHMA provisions requires resources. The SHMA local funding provision, which is 5 percent of the local revenue generated by building permit fees, can be retained by the lead agency to help administer local responsibilities of the Act, which has generally eased local concerns. Eventually, as the full benefit of the Act becomes better understood during implementation, most of the concerns disappear.

Another common reaction is fear of a reduction in property values and potential backlash from homeowners to the natural hazards disclosure requirements. Whereas geotechnical hazard investigations apply only to new construction, natural hazards disclosure requirements apply to all existing buildings located in a landslide hazard zone. Putting restrictions on future developable areas also raises concerns about affordable housing and economic development. Although studies have shown such an effect is marginal compared to potential losses suffered in a disaster, the perception of loss of economic value is real (Palm 1981). To address some of these perception problems, CGS uses the "zones of required investigation" (see, for example, Figure 7-4 above) designation instead of "hazard zone." This also helps emphasize the fact that hazards do not exist everywhere inside a zone.

Putting restrictions on future developable areas also raises concerns about affordable housing and economic development. Although studies have shown such an effect is marginal compared to potential losses suffered in a disaster, the perception of loss of economic value is real.

One Southern California community recently attempted to amend the Act to exclude existing hillside developments from the landslide hazard zone designation since the developments had been properly engineered according to codes in effect at the time of construction. If such an amendment had passed, the new law would also have exempted areas with landslide mitigation from being included in a hazard zone. However, the community's efforts failed when a legislative committee reviewing the bill recognized that mitigation is a site-specific engineering solution, and, without a detailed site-specific analysis, the state cannot certify against the risk of failure. Moreover, a detailed site-specific analysis would be inconsistent with the regional approach from which the hazard zones were derived. Under SHMA, any detailed site-specific analysis is a local government responsibility. Furthermore, it was the inadequacy of codes when older subdivisions were constructed that has led to strengthening of the codes through SHMA. To assuage the community's concerns, CGS added language on the maps to the effect that some areas within hazard zones may not be hazardous or may have been mitigated to local safety standards.

Expert Committees

The Act spurred enormous interest among geological and geotechnical experts. The City and County of Los Angeles jointly formed "blue ribbon" expert committees to help implement the Act. Under the auspices of the Southern California Earthquake Center, the American Society of Civil Engineers, and the Association of Engineering Geologists, two committees were formed, one each for liquefaction and landslide hazards. Committee members consisted of geotechnical consultants, university researchers, and geologists representing all six counties in the southern California region. Their work is having two effects: bringing uniformity to the practice, and improving the quality of geotechnical practice throughout southern California.

The committees provided procedural details on how to conduct geotechnical hazard evaluations by specifying standards of practice (Blake et al. 2002; Martin et al. 1999). Standards cover field investigations, collection of samples, and determining strength of various soil types, saturation levels, and loading conditions (under both gravity and earthquake conditions). The committees were also able to strike a balance between sophisticated state-of-the-art techniques and practical application. For example, they offered a procedure to screen sites that do not warrant more detailed investigations. Due to research and technical advancements in earth sciences, building codes can also be adjusted, further raising the geotechnical industry's standards of practice. The committees took it upon themselves to provide a road map for practitioners to incrementally improve their practices to meet the new state guidelines. Their guiding principle was based on the fact that current technologies allow the profession to move beyond

gross conservatism and almost purely judgment-based design to a quantitative engineering approach. While such professional practices take time to be assimilated, the benefits of relying on such committees are expected to pay off in the long run in terms of both safety and economy.

Education

Education through training courses has been a key to SHMA's implementation. CGS presented recommendations from the expert committees to regulators and consultants in well-organized workshops. CGS has also provided a three-day short course on "Seismic Hazard Evaluation and Mitigation" in southern and northern California in partnership with the University of California at Berkeley. Instructors for these courses came from both academia and industry. The course syllabus covers the requirements of the Act, soil behavior, and methods of evaluating ground motion, liquefaction, and landslides.

Lessons from California show that regulations do not just mean mapping, but a whole series of interrelated components.

TRANSFERRING THE LESSONS FROM CALIFORNIA

So far the Act is working as intended. Feedback from a survey of local building and planning departments in communities where SHMA has been implemented indicates:

- the quality of geotechnical hazard evaluations improved significantly;
- mitigation solutions have also improved;
- site investigation reports have improved in quality;
- problems at the construction stages are being dealt with more effectively;
- communities for which maps have yet to be completed have become aware of the increasing standards and are now requesting that their areas be covered next; and
- the value and benefits the Act provides are finally being realized.

Lessons from California show that regulations do not just mean mapping, but a whole series of interrelated components. Any successful implementation of a statewide program must contain the following elements:

- "Zones of required investigation" that screen those sites where further geotechnical investigations are warranted
- A scientifically sound basis for delineating these zones
- An expert technical advisory committee
- A requirement for local government to use the zones and resulting information from geotechnical site investigations in the construction permitting process
- Local control over setting of standards for review and mitigation
- Shared findings of geotechnical investigations with a state agency for future updates to the hazard maps
- A simple and direct funding mechanism

The Act cannot be as successfully implemented without supporting laws and regulations. Key to California's SHMA implementation were:

- professional licensing requirements (many states have this, but may not include all the necessary professions);
- natural hazards disclosure laws (to apply to all types of uses and not just residential uses, as some states currently do);

- a safety element (of the general or comprehensive plan; not all states require such elements and those that do might make it an optional component); and
- building and site development standards (to reflect modern engineering and technical standards).

For implementation, the key components are:

- a strong outreach program to connect with local government, the real estate industry, and the geotechnical industry;
- a strong education program in partnership with universities and professional organizations;
- a continuing application development program to improve the seismic zoning process as science and technology improves and our concerns about risks and hazards change; and
- a geographic information system-based mapping and online dissemination of products to facilitate access and use by stakeholders.

LANDSLIDE HAZARDS AND FEDERAL LANDS: THE UNITED STATES DEPARTMENT OF AGRICULTURE FOREST SERVICE EXPERIENCE

By Jerome V. DeGraff

Jerome DeGraff is currently the Province Geologist for the Southern Sierra Province consisting of the Sierra, Stanislaus, and Sequoia National Forests in California. During his more than 25 years in the USDA Forest Service, he has served as an environmental or engineering geologist in National Forests in Utah and California. In these capacities, Jerry defined landslide-hazard issues for land and resource planning and identified their impact to projects such as timber harvesting, road construction, and similar resource development activities.

Federal agencies, especially those that manage significant amounts of land, deal with landslide hazards in a variety of ways. Depending on the agency's mission and planning processes in place, landslide hazards shape not just immediate development needs or emergency response, but also long-range planning aspects of land management. Unlike local and state governments, where the focus is on adopting regulations and enforcing them, federal agencies with land and resource management functions go further by putting regulations into practice by their own staff. Plans for development, resource protection, or any of the other activities commonly associated with stewardship of land have to take into account all such agency-specific regulations. In this respect, planning functions in a federal agency mirror the land management functions of large private properties. However, like other local or state government process, federal planning processes also undergo public scrutiny for various aspects: complying with federal and state environmental regulations, meeting agency goals and objectives, implementing congressional mandates, and using best available science.

The following article is a summary of the planning process and incorporates information about landslide hazards at one agency: the Forest Service. The Forest Service is an agency of the Department of Agriculture, and it manages public lands in national forests and grasslands for renewable resources, such as water, forage, wildlife, wood, and recreation. It also is known worldwide for its research in forestry-related topics.

NATIONAL FOREST SYSTEM LANDS

It was the 1897 Organic Act that first created forest reserves on federal land in the West to protect and enhance water supplies, reduce flooding, secure favorable conditions of water flow, protect the forest from fires and depredations, and provide a continuous supply of timber. The National Forest System came into existence along with the Forest Service following the 1905 transfer of forest reserves from the Department of Interior to the Department of Agriculture. Conservation principles in forest management took on new emphasis after President Theodore Roosevelt took office and Gifford Pinchot became the first chief of the Forest Service. Principles established then govern most Forest Service initiatives, including planning and development. Incorporating landslide hazards into this process is a logical extension of these long-held principles.

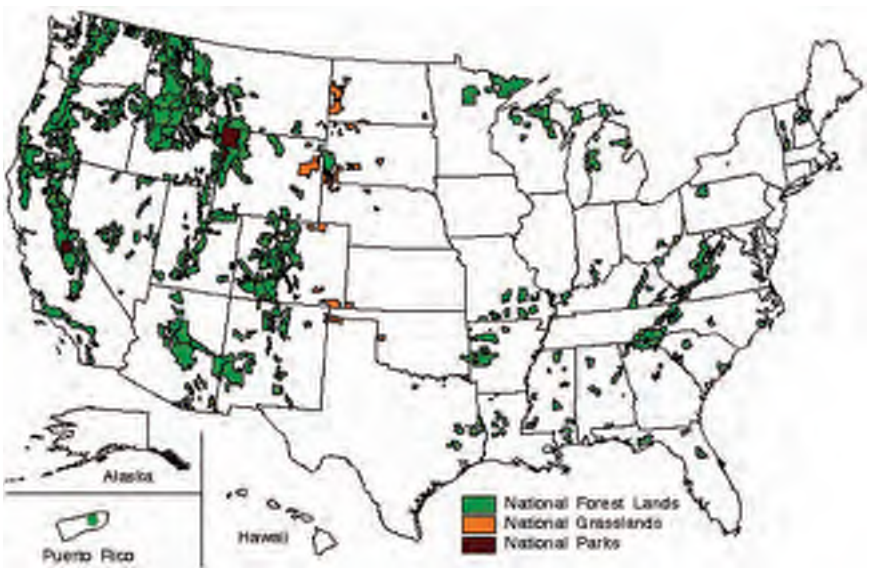

Figure 7-7. *Map showing the general locations of National Forests, National Grasslands, and other units comprising the National Forest System.*

Forests and grasslands managed by the Forest Service constitute about 191 million acres of land (an area the size of Texas), distributed across 44 states, Puerto Rico, and the Virgin Islands. They make up the National Forest System (NFS) and constitute 155 National Forests, 19 National Grasslands, and 18 Land Utilization Projects, most of which are in the western United States. NFS serves multiple purposes: grazing, wood products, recreation, fisheries, mineral extraction, and development of energy. Planning for any of these purposes includes activities for environmental and hazard issues, such as watershed protection, wildlife habitat protection, and landslide hazards. Landslide disasters have affected NFS lands in a variety of ways. Forests are not just virgin terrain with vegetation, but include a whole host of activities, some of which entail building and construction. It is protecting these investments from natural and man-made hazards that underlie the basis for sound planning in national forests.

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THREE LEVELS OF PLANNING

Landslide hazards as a planning issue enter into the planning process at several stages. The process that the Forest Service currently employs has been shaped by several acts passed by Congress since 1905. Of relevance to this discussion are the following key acts that define multiple use, sustained yield, and management:

- The 1960 Multiple-Use Sustained-Yield Act
- The 1974 Forest and Rangeland Renewable Resource Planning Act (RPA)
- The 1976 National Forest Management Act (NFMA).

All of these acts either broadened the scope or extended the provisions of the 1897 Organic Act. The multiple-use concept as enacted in 1960 is the management of all the renewable surface resources to meet the continuing needs of the public. It directs the administration of renewable surface resources for multiple use and sustained yield. Outdoor recreation, range, timber, watershed protection, and fish and wildlife are some of the multiple uses specified in this act. Besides multiple-use provisions, the other conceptual change has been the emphasis on sustained yield without impairing the land's productive capacity. The 1974 and 1976 acts provided the framework for implementing management objectives through the land-planning process. They established resource management practices and levels of resource production and management, and defined availability and suitability of lands for resource management.

The Forest Service uses three levels of planning (Table 7-1):

- A Regional Guide (one for each region of the NFS)
- A Land and Resource Management Plan (one for each forest or grassland)
- An Implementation Plan (usually site-specific)

TABLE 7-1: THE THREE LEVELS OF PLANNING USED BY THE U.S. FOREST SERVICE

Type of Plan	Geographic Area Affected	Purpose
Regional Guide	Forest Service Region[1]	Address the major issues that need to be considered at the regional level to facilitate planning
Land and Resource Management Plan "Forest Plan"	National Forest	Develop multiple use goals and objectives; identify the quantities of goods and services to be produced, subject to minimum management requirements for protection of wildlife habitat, soil and water quality. Address local issues and develop alternatives showing minimum resource development and maximum biological potential, with costs and benefits. Towards these purposes, allocate land among different management emphases, set standards and guidelines for management.
Implementation Plan	Part of National Forest[2]	Propose actions to achieve goals of plan, assess site-specific effects, estimate budgets needed and outputs that will result. Mitigate adverse environmental effects.

USDA Forest Service

Notes:

1 Typically, one or more states or part of states.

2. May apply to an entire forest or ranger district within a forest, buy typically applies to a part of a forest or district.

At the broadest planning level is the Guide, which sets the RPA goals for each region. Each region may encompass several National Forests or Grasslands. Guides also establish regionwide standards and guidelines for addressing regional issues, such as specific strategies for wide-ranging species and appropriate forestry method practices.

The second level of land planning is the Land and Resource Management Plan or "Forest Plan." Forest Plans, one for each of the National Forests and Grasslands within the NFS, are periodically revised and amended, and incorporate multiple-use goals and objectives. These goals and objectives help Forest Service planners identify the quantities of goods and services to be produced. The plans also set the standards and guidelines for land management applicable to an entire plan area, specific management areas, or specific activities or forestry practices.

Landslides in NFS lands have caused significant loss of life and property. Economic impacts have extended beyond the boundaries of NFS lands.

The third level is project implementation, which means implementing specific activities as set forth in the management goals and objectives of the Forest Plan. Projects at this stage are usually site-specific, involving activities within one or more watersheds. Annual appropriations from Congress determine project funding and priorities. Typical projects entail fuels reduction work, timber sales, campground construction, landslide repairs, and wildfire restoration.

Implementation planning also encompasses reviewing and approving development decisions undertaken by entities besides the Forest Service. For instance, mining, hydroelectric facilities, building of ski resorts, access roads, etc., require a permitting process in which these projects are evaluated against the broad principles set forth in various acts governing the Forest Service. At the implementation level, any of these projects initiated outside the Forest Plan process prompt additional plan reviews.

THE NATIONAL ENVIRONMENTAL POLICY ACT AND THE NATIONAL FOREST SYSTEM

The 1969 National Environmental Policy Act (NEPA) has a significant role in the Forest Service's activities and a direct bearing on Forest Service plans when it comes to landslide hazards. Federal projects must comply with NEPA standards. Such projects include those discussed above under the three levels of planning. To comply, procedures require preparing environmental documents, assessing the effects of a project, evaluating alternative plans, balancing short-term gains with long-term effects, and assessing any irreversible or irretrievable commitments of resources. Each of these compliance components may involve landslide hazard assessment.

Integrating landslide hazards as NEPA requires comes at two stages of the planning process: detailed, site-specific analyses during the Forest Plan or Implementation Plan stages (levels two and three). NFMA specifically requires preparing environmental impact statements during the development of regional guides and forest plans (levels one and two). In short, incorporating landslide hazards in planning at the Forest Service permeates all three levels of planning.

LANDSLIDE DAMAGES IN NATIONAL FORESTS

Landslides in NFS lands have caused significant loss of life and property. Economic impacts have extended beyond the boundaries of NFS lands. For example, a slow-moving landslide in the Manti-LaSal National Forest in Central Utah threatened the water supply of the city of Manti. Even though this landslide was more than four miles from the nearest permanent dwelling, it resulted in more than $2 million in damages and repairs to Manti's water and hydroelectric system (Fleming and Taylor 1980, 20).

It is not just the magnitude of direct costs. Losses can be significant in indirect costs as well. Take for instance the large landslide in 1983 that blocked U.S. Highway 50 in the Eldorado National Forest in California. It severed the transportation link between South Lake Tahoe and Placerville, California, for 75 days. Local businesses estimated losses of about $20 million in South Lake Tahoe and $2 million in Placerville (Kuehn and Bedrossian 1987, 247). That same landslide also dammed the South Fork American River and cost a public utility company that operates a canal for water transport more than $11 million (at the rate of $30,000 per day during the 392 days it was out of service). Though some indirect costs can be easily estimated when it comes to infrastructure repairs (e.g., electrical transmission lines and pipelines delivering gas, oil, or water), many more aspects of indirect costs, including the cost of disruption to service, remain hidden or unknown.

Even minor damages from small landslides can cumulate into significant costs. For example, the Federal Highway Administration allotted emergency funds of $2,225,600 in 1982 and $1,138,900 in 1983 for six National Forests in the Sierra Nevada to restore forest roads affected by landslides (DeGraff 1987, 4). Of this funding, nearly $1.3 million in direct costs were incurred to repair 17 small landslides along a major timber haul road in the Sierra National Forest (Figure 7-8).

USDA Forest Service

Figure 7-8. *Landslide damage to Stump Springs Road on the Sierra National Forest, California. Note large rocks from rockslide onto the road in the background. This is one of thirteen damaging landslides from precipitation events affecting the Sierra Nevada in 1982 and 1983.*

These examples illustrate some of the direct and indirect costs of dealing with landslides. Direct costs include repair to public roads, water systems, and similar infrastructure. Indirect costs, often more difficult to quantify, could exceed direct costs. What these examples also point to are that damages can be as significant for several small landslides in a single geographic location as they are for one large one.

GEOGRAPHIC AND GEOLOGIC CONDITIONS OF NFS LANDS

Most of the landslide susceptible regions of the country, the Pacific Coast, the Rocky Mountains, and the Appalachian Mountains (Schuster 1996, 15), contain most of the NFS lands (Figures 7-7 and 7-9). The physical characteristics that make it suitable for NFS lands are also those that are most susceptible to landslides. Steep slopes and landslide-susceptible soil and bedrock are dominant features of these areas. Any of the common landslide triggers—rapid snowmelt, volcanic eruption, or earthquake—can cause widespread landslides (Wieczorek 1996, 76).

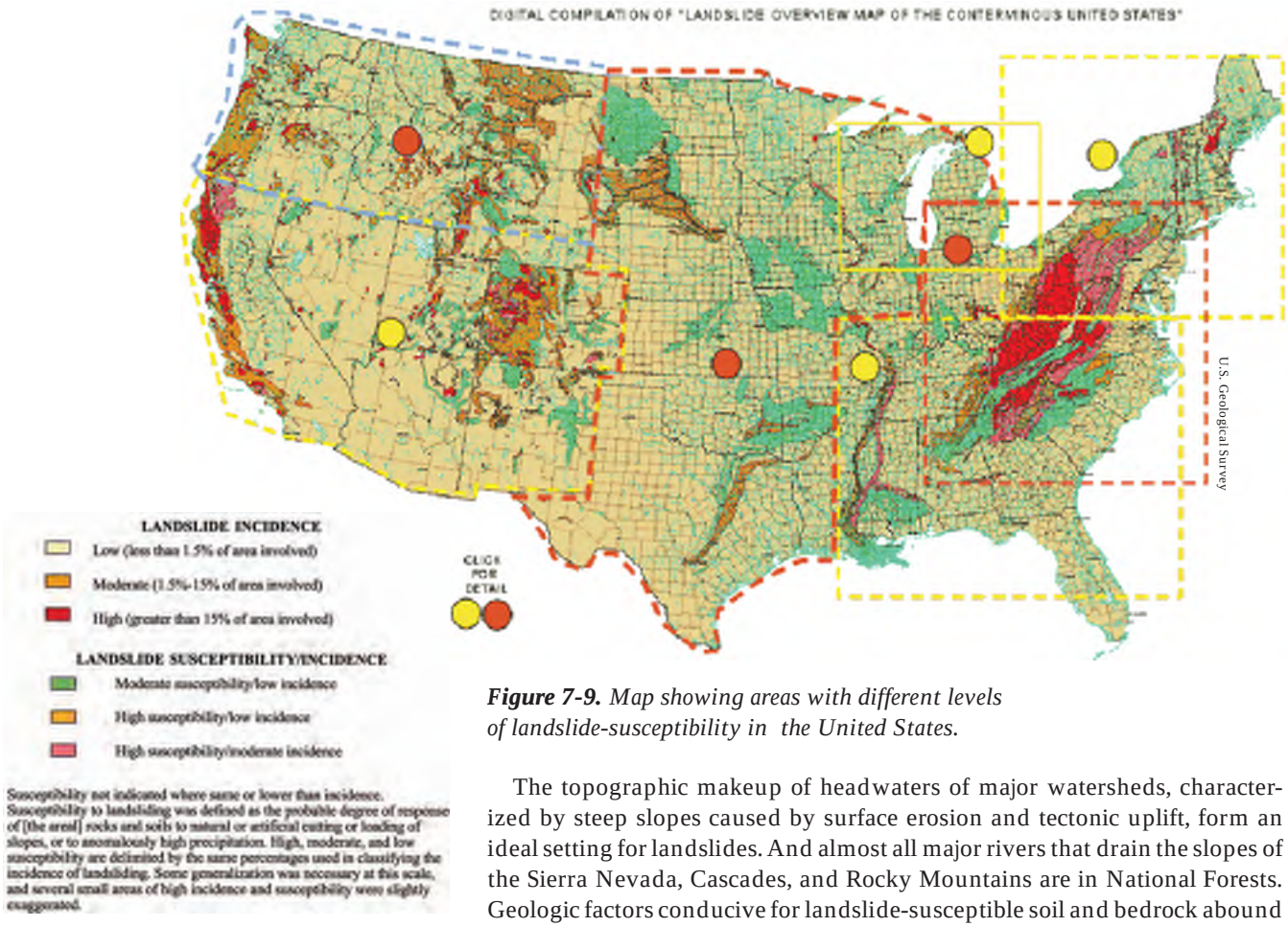


Figure 7-9. *Map showing areas with different levels of landslide-susceptibility in the United States.*

The topographic makeup of headwaters of major watersheds, characterized by steep slopes caused by surface erosion and tectonic uplift, form an ideal setting for landslides. And almost all major rivers that drain the slopes of the Sierra Nevada, Cascades, and Rocky Mountains are in National Forests. Geologic factors conducive for landslide-susceptible soil and bedrock abound in mountainous areas (Sidle, Pearce, and O'Loughlin 1985, 36). Tectonically active mountain ranges like the Wasatch Range in Utah and the Coast Ranges of California contain highly faulted and sheared bedrock. Even when not tectonically active, mountain ranges such as the Appalachians have bedding planes, folds, and other rock structures with characteristics suitable for slope movement. Volcanic mountains like the Cascades are accumulated piles of volcanic materials with varying strengths, including materials affected by hydrothermal alteration, that make them susceptible for landslides.

Intense rainfalls have triggered numerous shallow landslides in a short period. One storm in November 1977 triggered many shallow landslides in the Pisgah National Forest in western North Carolina (Neary et al. 1986, 465). Intense rainfall (as much as 340 millimeters in 48 hours) from Hurricane Hugo triggered more than 400 landslides in and around the 11,300-hectare Caribbean National Forest in Puerto Rico. An intense summer thunderstorm triggered a small debris flow in John Muir Wilderness in the southern Sierra Nevada, California, in July 2001, damaging hiking trails. A thunderstorm in 1976 caused the Big Thompson Canyon flood in Colorado's Roosevelt-Arapahoe National Forest. While most of the damage and loss of life was attributable to the flash flood, landslides and rockslides on the steep canyon slopes triggered by the floods blocked Colorado Highway 34, a major transportation route in the region.

Rapid snowmelt triggered debris flows in 1983 and 1984 along Utah's Wasatch Front (Wieczorek, Lips, and Ellen 1989, 191). Rainfall on the warm snow packs of the Cascade Range and Sierra Nevada produce similar debris flows. The 1997 New Year's storm in California's Central Valley, which delivered 7.9 inches of rainfall in a 24-hour period, caused flooding and landslides at the nearby Sierra Nevada mountains and caused major debris flow within the Stanislaus National Forest (DeGraff 2002, 22). (See Figure 7-10.)

USDA Forest Service

Figure 7-10. *Aerial view of upper part of the Sourgrass debris flow in the central Sierra Nevada. This 1997 event affected U.S. Highway 4 where it crosses the Stanislaus National Forest, California.*

Volcanic eruption and earthquake shaking have triggered landslides in NFS lands. The eruption of Washington's Mount St. Helens in the Gifford Pinchot National Forest caused large-scale landslides. The 1995 Northridge, California, earthquake triggered more than 11,000 landslides (Harp and Jibson 1995, 1). Most of these were in the Santa Susana Mountains, including some parts of the Los Padres National Forest. This 6.7-magnitude Northridge earthquake also triggered landslides in the San Gabriel Mountains of the Angeles National Forest. A sequence of 6.0-magnitude earthquakes in May 1980 caused many rock falls and slides within the Inyo National Forest on the eastern slopes of the Sierra Nevada (Harp, Tanaka, Sarmiento, and Keefer 1984). The 1959 Hebgen landslide in the Gallatin National Forest, Montana, is another well-known earthquake-induced landslide. Triggered by the 7.5-magnitude Hebgen Lake earthquake, 80 million tons of rock came to rest at the bottom of Madison Canyon, damming the Madison River to create Earthquake Lake.

THE RELATIONSHIP BETWEEN NFS ACTIVITIES AND LANDSLIDE HAZARDS

The most common activity for the Forest Service in NFS lands is vegetation management, and the most common method employed is timber harvest. Forestry practices for timber harvest vary from selective cutting of individual or small groups of trees to clear cutting 10- to 40-acre patches. Logging may include helicopter, cable, and tractor systems. Clear cutting is clearly recognized as increasing slope instability. For example, an extended study of debris avalanches on the Suislaw National Forest in Oregon found a significantly increased occurrence during the 10- to 20-year period after cutting (Swanson, Swanson, and Woods 1981, 73).

Managing vegetation also means controlling wildfires by minimizing the "fuels" or vegetation load. As population and urbanization encroaches on rural fringes of National Forests and Grasslands, fuels management becomes a matter of safety and protection of lives. Fuels management focuses on reducing the likelihood of large, catastrophic fires, which can engulf lives and property on adjacent NFS lands. Techniques for fuel reduction include burning under controlled conditions, mechanical or hand removal or thinning of brush, and removing trees—all activities that can affect slope stability.

Certain wildlife habitat improvements also entail vegetation management that involves techniques similar to fuels reduction. The objectives may vary from increasing grass for grazing species to maintaining a sufficient number of snags needed for birds to nest or roost. Though most wildlife projects involve small areas compared to the size of areas for timber harvest and fuels management, they nevertheless can affect slope stability in landslide susceptible areas.

Removal of vegetation means a certain amount of water previously removed by transpiration now enters the soil. In certain soils, this additional moisture may increase pore pressures and result in slope movement.

Vegetation's role in slope stability was not widely recognized until recently. Vegetation exerts both mechanical and hydrologic forces on slopes (Gray and Leiser 1982, 37). The mechanical effects of vegetation vary; roots of woody species can reinforce the soil to give it greater strength, thereby increasing slope stability. Deeper roots can act as buttresses for the soil, resisting slope movements. Roots can also wedge into cracks and fissures within bedrock, which can in turn affect slope stability. It may increase or decrease slope stability. In certain instance, the weight of trees on slopes may increase or decrease stability. All of these mechanical factors have to be considered in assessing the risk of landslides.

Vegetation alters the rate and quantity of water that seeps into the surface soil (Greenway 1987, 191). Root decay can create macropores in the soil that may cause rapid saturation on parts of a slope. Removal of vegetation means a certain amount of water previously removed by transpiration now enters the soil. In certain soils, this additional moisture may increase pore pressures and result in slope movement. Vegetation acts to regulate the infiltration of water into soil and rock. For example, rain or snow intercepted on leaves and stems lessens the rate at which precipitation reaches the ground surface and more precipitation enters the soil, rather than becoming potentially erosive surface runoff. Vegetation creates surface roughness that slows surface runoff and promotes greater infiltration into the soil.

In central Utah's Fishlake National Forest, one study examined whether converting the vegetative regime from tree to grass cover can increase surface water in watersheds. Subsequent increases in landslide activity showed that this form of vegetative manipulation does affect slope stability (DeGraff 1979, 426). In Southern California's NFS lands, burning brush-covered slopes to contain fuels was shown to increase susceptibility to landslides after rainstorms (Rice, Corbett, and Bailey 1969, 647).

Wildfires in NFS lands can have the same effect as large-scale clear cutting of vegetation, thereby destabilizing both hydrologic and mechanical forces on slopes (Wells III 1987, 105). Landslides after a wildfire are common to NFS lands as well. It is for this reason, as part of the Burned Area Emergency Rehabilitation (BAER) assessments, which are done after a wildfire, the Forest Service requires evaluating landslide potential (DeGraff and Lewis 1989).

Building roads and routine maintenance also affect slope stability. With about 380,000 miles of roads in NFS lands, most of which has been built in the last 50 years, landslides are a common threat. Roads with cuts and fills can alter slope stability by adding weight, by altering slope steepness, and by interfering with subsurface water flow (Sidle, Pearce, and O'Loughlin 1985, 79). In the western Cascades, one study found roads were the leading cause of landslides (Swanson and Dryness 1975, 393). A more recent study, in Clearwater National Forest in Idaho found that half the landslides triggered by major storms in November-December 1995 and February 1996 resulted from Forest Service roads.

Road construction standards also have an effect on slope stability. One study found that roads constructed to standards designed to maintain post-construction slope stability had lower failure rates than those that did not.

Most of the roads built after 1970 conform to these higher standards (McClelland, et al 1997, 12, 20).

Facilities built on NFS lands to support functions, such as mining, ski resorts, administration buildings, etc., can be vulnerable to landslides as well. The Forest Service regulates them through a permitting process that includes review of geotechnical and geologic investigations.

NFS lands host a vast network of transportation and utility corridors. Steep terrain limits the number of routes feasible for roads, pipelines, railways, and long-distance electrical transmission lines. A landslide along any of these networks can have disruptive effects across an entire region. For instance, a 1994 debris flow from Storm King Mountain in the White River National Forest, near Glenwood Springs, Colorado, trapped 30 cars on the highway and swept two people to death in the Colorado River down below (Kirkham, Parise, and Cannon 2000, 1).

Requiring a hazard assessment must be based on sound evidence because something as complex as landslide hazards cannot be reduced to a checklist of factors.

ASSESSING LANDSLIDE HAZARDS IN THE PLANNING PROCESS

Since landslide hazards do not affect all areas uniformly, the question of assessing the hazard revolves around where (in which parts of NFS lands) to require a study. When to require a study is well established in the procedures and regulatory requirements. However, requiring a hazard assessment must be based on sound evidence because something as complex as landslide hazards cannot be reduced to a checklist of factors. Only information about local conditions (i.e., whether geologic, geomorphic, or past landslides in the area) can help in establishing the initial need for a landslide hazard assessment. Each National Forest's geologists, geotechnical engineers, and earth scientists on staff maintain such information. They have procedures that establish when such determinations may be necessary. While these procedures vary within NFS lands, the overall approach or steps for an assessment remain uniform. These steps can be characterized as follows:

Step 1: Define the extent of the area to be assessed (Keaton and DeGraff 1996, 179). The two factors that determine the area are: the type of activity proposed and location of known landslides. The type of activity is known from the development proposal. The Forest Service's earth scientists provide the location of landslide hazards (gathered from published and unpublished sources) in and around the proposed development area. Depending on past experience with landslides, this information may be available in map form as well. This will establish the vulnerability of the proposed activity.

Step 2: Examine aerial photography and existing topographic maps to define the area to be assessed (Keaton and DeGraff 1996, 181). In the absence of a map of landslides for the assessment area, aerial photographs and topographic maps are used to develop a landslide map.

Step 3: Perform field investigation through reconnaissance and mapping of both natural slopes and existing landslides (Keaton and DeGraff 1996, 198).

Step 4: Analyze the field data by interpreting the hazard from landslides and the proposed activity, presenting the discussions in a report that will also contain recommendations.

The objectives of landslide hazard assessments are to:

- ensure public safety;
- avoid damage to existing facilities or property; and
- minimize damage to natural resources.

Minimizing damage to natural resources means trying to prevent excessive stream sedimentation, loss of habitats for fish, loss of productive soil, and impediments to reforestation. Local regulations besides those man-

dated by the Forest Service can also set standards for acceptable levels of damage or impacts. For example, the Clean Water Act specifies levels of sediment allowed for water quality, and the Threatened and Endangered Species Act sets the minimum standards for habitat protection.

DEVELOPING SITE-SPECIFIC STRATEGIES

The Forest Service's planning approach can adapt to specific local conditions based on site characteristics. As site-specific information becomes more precise, either through additional studies or mapping projects, local guidelines for managing Forest Service activities may be altered accordingly.

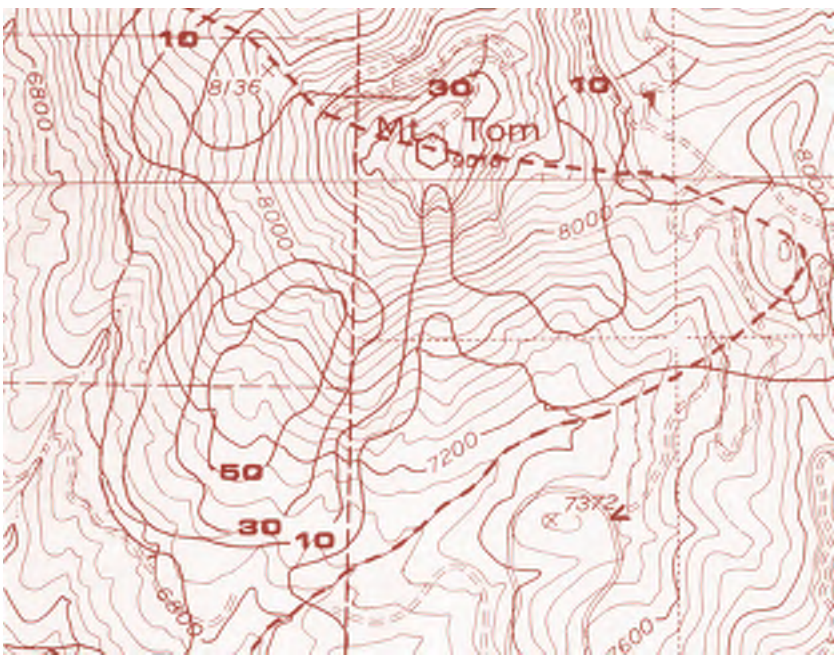
As site-specific information becomes more precise, either through additional studies or mapping projects, local guidelines for managing Forest Service activities may be altered accordingly.

Take, for instance, the landslide maps prepared for California's Sierra National Forest where one study undertook an analysis of how trees affect slope stability. Based on maps prepared for this study, landslide hazards were ranked on a scale with negligible, low, moderate, high, very high, and extreme categories. About 8,100 acres (equal to 2 percent of areas planned for logging) were classified as unsuitable for commercial logging in high-risk areas. In another 16,200 acres, logging was restricted to special conditions to avoid triggering landslides. When developing production levels in the Forest Plan, subsequent analyses will take this landslide inventory and analysis into consideration.

In a similar case in the Olympic National Forest in Washington, landslide maps at the project review stage helped avoid harvesting timber on landslide-susceptible areas. The maps were originally prepared to address erosion problems, which on examination also led to specific guidance on road construction around landslides (Koler and Neal 1978, 935). Without such detailed mapping to show vulnerable zones, it would not have been possible to develop detailed recommendations at the project review stage.

OTHER STRATEGIES

Site-specific analyses as described above may not always be possible or economically viable. Where the risks are more general, generic techniques can help in deciding where to focus site-specific studies. Many techniques have been developed outside the Forest Service, such as in academic institutions and geological surveys at the state and national level. One of these is isopleth mapping that shows frequency of landslides (Figure 7-11). Un-



USDA Forest Service

Figure 7-11. *Isopleth map for the Kaiser Timber Sale (sale boundary indicated by bold dashed line). Isopleths indicate landslide-susceptibility ranging from negligible (<1%) to very high (50% to 70%).*

like a simple map of landslides, isopleth maps show contour lines that connect areas with a similar frequency of landslides. Frequency of landslides is sometimes established by studying the characteristics of landslide deposits. In the absence of information about specific landslide events, isopleth maps can help identify areas of high landslide susceptibility. By using a simple susceptibility scale (see Table 7-2) for large areas, it would be possible to easily administer such large-scale activities as logging. In the Sierra National Forest example described above, isopleth maps were used to delineate areas with high landslide risk and subsequently restrict timber sales (DeGraff 1985, 450).

TABLE 7-2: LANDSLIDE SUSCEPTIBILITY SCALE

Landslide Susceptibility Categories	Area Underlain by Landslide Deposits (in percent)	Generalized Management Guidelines
Negligible	< 1	Landslides pose no concern to proposed land use.
Low	1 - 10	Landslides may require geologic review to identify criteria for design modifications
Moderate	10 -- 30	Landslides will require geologic study to determine mitigation potential and to develop design requirements.
High	30 - 50	Landslides will require geologic investigation to establish degree of hazard and feasibility of mitigation methods.
Very High	50 - 70	Landslides will require detailed geologic investigation to determine degree of hazard and vulnerability to specific risk.
Extreme	70 - 100	Landslides will require extensive geologic investigation to address degree of total risk.

USDA Forest Service

Researchers at the Forest Service have also developed computer models to establish ratings for slope stability (Hammond et al. 1992). The models use site-specific data, such as soil characteristics, slope angles, and other related mechanical and geophysical conditions, along with information about previous landslides in the area to develop a probability scale. Using this scale, Forest Service planners can assign different hazard ratings. For instance, in Washington's Wenatchee National Forest, where these models were employed for a wildfire study, a 25 percent probability rating got a medium-hazard rating and a 50 percent probability rating got a high-hazard rating (Koler 1998, 191). Such ratings serve not just land-use and Forest Service activities, but also assist in preparing for future landslides.

The techniques the models employ to translate existing conditions and probability of landslides into a rating scheme follow well-established scientific methods. Though complex and technical, these models, when applied by qualified geologists and geotechnical engineers with the help of local information about landslides, either through maps, aerial photography, or GIS, can provide advance information useful to all three levels of planning.

NEW TECHNIQUES

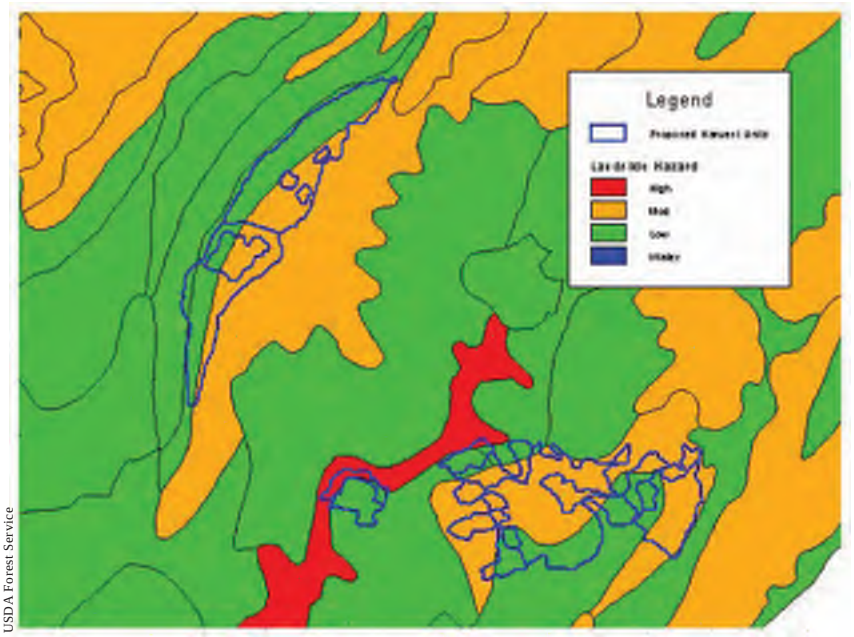
Of all the advances in research at the Forest Service, two of them in particular show promise for reducing losses from landslides. One is the widespread adoption of GIS and data standards for mapping. The other is a uniform method for tabulating land characteristics, such as soils, geology, geomorphology, vegetation, and so forth, that are essential to understanding landslide hazards.

GIS is already widely employed throughout the Forest Service for day-to-day operations. But with recent advances in federal data standards, es-

Of all the advances in research at the Forest Service, two of them in particular show promise for reducing losses from landslides. One is the widespread adoption of GIS and data standards for mapping. The other is a uniform method for tabulating land characteristics. . . .

pecially those developed through a consortium of federal agencies under the Federal Geographic Data Committee, Forest Service map data should solve the problems of incompatibilities (which costs time and effort in data conversion), thereby opening the way to uniformly develop landslide hazard assessments across all geographic units of the agency. Readily available maps will also help in rapid deployment of resources in times of landslide disaster.

The data layers that make up the GIS come from a variety of disciplines. Soils, geology, geomorphology, and vegetation are just a few of these. Each of these disciplines employs its own units of measurement for inventory and analysis. But as part of the Natural Resource Information System, these units are now being standardized to what is commonly referred to as a "terrestrial ecological unit inventory" or TEUI for short. TEUI will ensure consistency in analyses for land capability, suitability, and other measures necessary for assessing landslide hazards and plans that address them. In one recent example, the Sammy Vegetation Management Project in California's Stanislaus National Forest, TEUI was used for assessing both landslide hazards and the watershed in an integrated approach that would not have been possible if not for the standard (Figure 7-12).



USDA Forest Service

Figure 7-12. *Part of the landslide hazard map for the Sammy project. It shows units where activity is planned in relation to areas with low, moderate, and high landslide hazard. The different levels of landslide hazard are based on management interpretation of geomorphic map units from the Terrestrial Ecological Unit Mapping (TEUI) using the NRIS database and geographic information system map layers for the Stanislaus National Forest.*

As more uses permeate through National Forests, such integrated approaches will become indispensable to managing human activities in forests. As more human activities encroach along the boundaries of forests, the complexity and interdisciplinary aspects of analyses magnify. Employing integrated tools and techniques, such as GIS and TEUI, will become indispensable to all three levels of planning at the Forest Service.

THE ROLE OF GOVERNMENT IN LANDSLIDE HAZARDS LOSS REDUCTION WITH A DISCUSSION OF THE ROLE OF THE UNITED STATES GEOLOGICAL SURVEY AND OTHER FEDERAL AGENCIES

By Paula Gori and Lynn Highland

Paula Gori is the Associate Coordinator of the Landslide Hazard Program at the U.S. Geological Survey. Her primary mission with USGS is to encourage other federal agencies, state and local governments, and the private sector to use geologic hazards information to reduce losses through informed natural hazard management.

Lynn Highland is a geographer with the U.S. Geological Survey in Golden, Colorado. She maintains the outreach arm of the USGS Landslide Program and is coordinator of the USGS National Landslide Information Center.

Much of the information contained in this article appeared originally in a USGS Circular 1244, "National Landslide hazards Mitigation Strategy: A Framework for Loss Reduction," by Elliott Spiker and Paula Gori (2003).

THE ROLE OF FEDERAL AGENCIES

As in other natural hazards where events are infrequent and costs high (see Chapter 1 of this PAS Report and Schuster (1996)), the federal role is primarily focused on training, information dissemination, regional assessments, and warning and prediction. Many federal agencies share responsibilities and work closely with other local, regional, and state agencies along with the private sector. The following paragraphs provide an overview of the roles federal agencies play. Subsections in this article describe those roles in more detail.

The federal role in hazard reduction originates in the Organic Act of 1879, which created the United States Geological Survey (USGS). Subsequent legislation, mainly the Dam Inspection Act of 1972 and the 1974 Disaster Relief Act (Stafford Act), formalized this role.

The responsibility for providing credible, impartial earth science information to those charged with making public policy is central to the mission of USGS. USGS is the recognized authority on landslide hazards in the United States and a long-time leader in this branch of geological science. USGS derives its leadership role in landslide hazard work from the Stafford Act, which delegated to the USGS Director the responsibility of issuing disaster warnings for an earthquake, volcanic eruption, landslide, or other geologic catastrophe consistent with the Stafford Act.

The USGS Landslide Hazard Program, which is the only congressionally authorized program in the United States dedicated to landslide hazards, conducts research, assessment, and mapping of landslide hazards, and provides technical assistance during disasters for response and recovery. Through the National Landslide Information Center in Golden, Colorado, the program also serves the public by responding to inquiries, maintaining databases and web sites, and disseminating information about the latest in research, assessment, and mapping of landslide hazards.

The National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA) fund landslide hazard research mainly through universities. The National Oceanic and Atmospheric Administration's National Weather Service provides weather forecasts and assists in emergency response activities. Other federal agencies, whose stewardship includes large land holdings or infrastructure, such as the U.S. Army Corps of Engineers, the Bureau of Land Management (BLM), the U.S. Forest Service (see the article above by Jerome DeGraff), the National Park Service, the Office of Surface Mining Reclamation and Enforcement, the Department of Transportation (especially the Federal Highway Administration (FHWA)), and the Bureau of Reclamation have landslide hazard experts on staff and programs that currently assess landslide hazards.

The Federal Emergency Management Agency (FEMA) is responsible for both emergency management and long-term mitigation of natural hazards, including landslides. FEMA coordinates emergency response, disaster relief funding, and hazard mitigation efforts. FEMA's Federal Insurance Administration and Mitigation Administration provides insurance coverage for flood damages, including mudslides. Because of the absence of both an accepted technical definition of "mudslide" and a uniformly accepted methodology for delineating mudslide hazard areas, implementation of the insurance program has been difficult.

THE ROLE OF STATE AND LOCAL GOVERNMENT AGENCIES

While the federal government plays a lead role in: (1) funding and conducting landslide research, (2) developing landslide mapping and moni-

toring techniques, and (3) landslide hazard management on federal lands, the reduction of losses due to landslides on nonfederal land is primarily a state and local responsibility. State agencies, commissions, and councils have responsibility for landslide hazards, including those with oversight of natural resources, transportation, geology, hazards, emergency services, or land uses.

State agencies, commissions, and councils have responsibility for landslide hazards, including those with oversight of natural resources, transportation, geology, hazards, emergency services, or land uses.

States vary in their approach to managing landslide hazards. Only a few states have regulatory authority for landslide hazards or provide sufficient enabling authority for local governments to adequately address such hazards. Some produce inventories of landslides and maps of landslide-prone areas. Local governments in such states rely on these maps for local plans. Private property owners and developers also depend on such maps and inventories when the scale and detail of such data are adequate for parcel-level analysis. Such maps in practice, however, may not always follow widely accepted standards of accuracy, scale, and format. Some states also monitor landslide-prone areas and support research or detailed geological studies. Most states provide support and expertise for response and recovery activities to local communities.

The reduction of landslide losses through land-use planning and building, grading, and zoning codes is currently a local government responsibility. Regulatory approaches vary widely from extensive local review to none. In times of disaster, local governments usually have the responsibility for issuing warnings of imminent landslides and managing emergency operations after a landslide, unless the disaster is of a great enough scale for a state or presidential declaration, in which case state emergency management departments and FEMA respond.

Landslide hazards traditionally occupy a relatively modest position among the variety of concerns in public policy, embodied mainly in zoning, legal liability, insurance, building codes, land-use practices, and environmental reviews. Maps of landslides and areas susceptible to landslides have been used primarily for zoning (mainly setback requirements from coastal or riverine bluffs), siting for critical facilities (e.g., nuclear reactors), and for disclosures for platting or realty sales. Some localities use building codes for construction on steep and unstable slopes. Many localities do not have adequate technical information to incorporate landslide hazard information in their plans, much less to evaluate policy options and to adopt sound development policies. Systematic policy implementation to address landslide hazards is rare in local governments.

THE ROLE OF THE PRIVATE, ACADEMIC, AND OTHER SECTORS

Private-sector geologists, planners, engineers, and others in building professions work mainly as consultants for both local governments and private property owners, although some may work in cooperation with state and federal entities and research agencies. They primarily investigate landslide hazard areas and recommend measures of hazard reduction. Their recommendations are then either implemented by the property owner and/or the local government. Consultants are increasingly being hired by lending and financial institutions, such as banks, insurance underwriters, and others, primarily to assess risk of financial exposure due to hazards.

Faculty and researchers at major universities conduct research on landslide processes, develop monitoring and mitigation techniques, and advance scientific methods to understand the hazard. Professional societies (e.g., the American Society of Civil Engineers (ASCE), the Association of Engineering Geologists (AEG), and the American Planning Association (APA)) serve as conduits of information between researchers and practitioners in both the public and private sectors. Professional societies also

promote best practices, model codes, guidebooks, and training for their professional membership.

THE SPECIFIC ROLE OF VARIOUS FEDERAL AGENCIES

The following sections offer more detailed descriptions of the roles of various federal agencies in landslide hazard reduction. Each description was based on a contribution from an agency representative whose name you will find listed among the acknowledgments to this PAS Report. Federal agencies can generally be divided into two types—those providing or supporting technical expertise and those engaging in land-management. USGS, FEMA, and NOAA provide technical expertise especially in times of emergency response. The Bureau of Land Management (BLM), the National Park Service (NPS), and the U.S. Forest Service (USFS) have responsibility for the lands they manage. The U.S. Army Corps of Engineers (the Corps) and the U.S. Department of Transportation (DOT) provide both technical expertise and are responsible for various facilities.

Federal agencies can generally be divided into two types—those providing or supporting technical expertise and those engaging in land-management.

The United States Geological Survey, Department of the Interior

USGS funds and maintains landslide hazard expertise in several of its programs. These programs direct research and assessment of landslides, debris flows, and lahars caused by storm, earthquakes, volcanoes, submarine landslides, and riverine and coastal erosion. Below is a more detailed description of some of these efforts.

The Landslide Hazards Program. The landslides hazards program supports:

1) hazard investigations and assessments;
2) research on monitoring and forecasting landslides;
3) response to landslide emergencies; and
4) the National Landslide Information Center.

The program supports research and assessment that may lead to implementation of mitigation strategies for federal, state, and local land-management and emergency-response agencies. Its research and assessments provide a basis for land-use planning, emergency planning, and private decision making, including insurance and financial incentives. Much of this program's current research and assessment activities are located in California, the Pacific Northwest, and the Blue Ridge Mountains in the East.

The program also supports monitoring of active landslides. Real-time monitoring sites are currently in Washington, California, New Mexico, and Colorado. In times of national and international landslide disasters, the program staff assists federal, state, and local agencies in evaluating landslide hazards, which includes strategies for mitigation. The program may at times cooperate with cities, states, or other local entities for the implementation of pilot projects and for modeling new research techniques in discrete areas. Such cooperation is facilitated through formal cooperatives, memos of understanding, or through other agencies (e.g., FEMA). Most data from these projects is in the public domain, and developed methodologies can be applied in other geographic locations as designated.

The National Landslide Information Center. The Center provides information and literature about landslide hazards to anyone, including lay public, researchers, planners, and local, state, and federal agencies through a dedicated web site and toll free telephone access. The Center is also a repository of publications about landslides. It maintains several databases

about landslides and informs the public and media (press) in landslide hazard emergencies.

THE USGS NATIONAL LANDSLIDE INFORMATION CENTER (NLIC)

1711 Illinois St.
Golden, Colorado, 80401, USA

Mailing Address:
U.S. Geological Survey, MS 966, Box 25046
Denver Federal Center
Denver, CO 80225

Phone:
303-273-8588
800-654-4966 (toll free)
303-273-8600 (fax)

email:
highland@usgs.gove

website:
http:/ /landslides@usgs.gov

Landslide Materials Available from NLIC

- Some landslide publications are available in digital formats from the website http://landslides.usgs.gov
- Landslide fact sheets are free from the center

The Earthquake Hazards Program. Ground failures and landslides caused by earthquakes are studied through the earthquake hazards program. The program also supports monitoring active landslides through seismic instrumentation.

The Volcano Hazards Program. USGS currently supports five volcano observatories in the United States. The primary research in debris-flow and lahars is conducted through the volcano hazards program at the Cascades Volcano Observatory. The program funds the experimental debris-flow flume in the Willamette National Forest, Oregon, and conducts field investigations at Mount St. Helens and Mount Rainier, Washington. The program also provides assistance internationally through its Volcano Disaster Assessment Program, which is funded primarily by the U.S. Office of Foreign Disaster Assistance, Agency for International Development.

The Coastal and Marine Geology Program. The Coastal and Marine Geology Program funds and conducts coastal and submarine landslide studies in California, Washington, Alaska, Hawaii, and Lake Michigan. It also conducts subsidence studies in Louisiana.

The National Geologic Cooperative Mapping Program. The National Geologic Cooperative Mapping Program supports mapping of landslides by USGS scientists and provides matching funds for geologic mapping as a basis for landslide hazard assessment through its grants program to states.

The Water Resources Discipline Program. The Water Resources Discipline Program conducts research on landslides, debris flows, subsid-

ence, and riverine and coastal flooding, and on erosion through its National Research Program and its district offices located throughout the United States.

The Federal Emergency Management Agency

The Federal Emergency Management Agency (FEMA), at this writing a part of the Department of Homeland Security, is responsible for emergency response, disaster assistance, and promotion of landslide hazard mitigation.

FEMA implements the federal response plan for landslides when they occur as the result of earthquakes, hurricanes, and volcanoes. The agency provides financial assistance to state and local governments for repair of public facilities damaged during these disasters, including replacement of lost fill and construction of fill-retaining devices (e.g., gabions and rock toes). The agency also supports post-disaster mitigation measures (e.g., drainage ditches to direct flow away from the landslide areas).

FEMA provides relief to individuals whose property was damaged by mudslides and who are insured by the National Flood Insurance Program (NFIP). However, the distinctions that the agency makes between landslides and mudslides have been a source of controversy, as the agency provides only limited damage coverage. Also encouraging mitigation measures in tandem with insurance coverage, which is a cornerstone of the flood insurance program, has been impossible because, to date, there are no maps that delineate mudslide zones and no standards governing development in mudslide-prone areas.

FEMA promotes landslide hazard mitigation by developing state and national guidebooks for landslide loss reduction, including a prototype mitigation plan that can be incorporated into existing hazard mitigation plans. Through FEMA's Pre-Disaster Mitigation Program (originally called Project Impact), the agency assists local jurisdictions to implement mitigation programs that reduce landslides along with other hazards. For instance, the Seattle Project Impact includes landslide hazard mapping as a major part of the community's pre-disaster mitigation effort.

The Federal Emergency Management Agency (FEMA), at this writing a part of the Department of Homeland Security, is responsible for emergency response, disaster assistance, and promotion of landslide hazard mitigation.

The National Oceanic and Atmospheric Administration (NOAA), United States Department of Commerce

NOAA's National Weather Service (NWS) provides forecasts of hydrologic and meteorological conditions for landslide forecasts and mitigation efforts. Through the Federal Response Plan, NWS assists other federal, state, and local agencies in landslide mitigation. NWS provides on-scene meteorological personnel to assist in emergency response activities at some landslides. Through NOAA Weather Radio and other NWS dissemination systems, landslide warnings as "Civil Emergency Messages" are broadcast.

The National Park Service, United States Department of the Interior

On federal lands, including national parks, federal agencies are responsible for mitigating landslide hazards. NPS handles the many geologically active national parks. Because they are the result of a natural process, landslides are left unimpeded in national parks unless safety is a concern. But such natural processes, including slope failures, mudflows, and rock falls, can cause deaths and injuries, closing roads and trails, and damaging lifelines and infrastructure. Recent examples include:

- several rockfalls in Yosemite Valley, Yosemite National Park, California, each with one fatality;
- damaging landslides in Shenandoah National Park, Virginia, triggered by torrential rains;

- repeated slope failures fed by artificial aquifers at Hagerman Fossil Beds National Monument, Idaho;
- landslides that closed roads in Zion National Park, Utah, and in Wyoming's Yellowstone National Park; and
- the threat of large debris flows at Mt. Rainier in Washington.

Where humans destabilized landscape through logging, mining, or road building, NPS restores, where practical, to predisturbance condition.

Park officials deal with several hazard-related tasks. They incorporate information from hazard assessments and maps into decisions about appropriate sites for facilities (e.g., campgrounds, visitor centers, and concession areas). Park planners make difficult choices as they attempt to reduce risk while also providing safe public access to popular but potentially hazardous areas. When a landslide occurs, park officials quickly rescue people, stabilize structures, and clear debris from roads and other public areas. They also work with experts to assess the nature and extent of the event, and the risk of reoccurrence. When deciding whether and when to reopen affected areas, park officials rely on short-term studies. For long-term solutions, including deciding on future uses, park officials embark on detailed research, planning, and analysis of risks not just in the affected areas, but also in other areas that may face similar hazards.

Park officials also offer programs to inform visitors about key resources and issues, which can help the public to better understand geologic hazards. Nature walks and campfire presentations, as well as exhibits in visitor centers, and in some cases books and videos sold by park cooperating associations and concessionaires, educate the public about geology and hazards. NPS is increasingly reaching out to a broader audience (many of whom may not have the opportunity to visit parks) through school programs, websites, and other methods. Park officials work in partnership with the scientific community to ensure that complex information is conveyed accurately and in a form comprehensible and relevant to nonspecialists.

Office of Surface Mining, Reclamation, and Enforcement, The United States Department of the Interior

The Office of Surface Mining's (OSM) role in landslide hazard mitigation is confined to landslides related to past coal mining activity as authorized by the Surface Mining Control and Reclamation Act. For example, a coal mining technique in the Appalachians involving mountaintop removal and valley filling is monitored by OSM to prevent serious landslides. OSM also provides grants to states and Native-American tribes for land reclamation of abandoned mines. If a state or tribe does not have a reclamation program, OSM, through its Federal Reclamation Program, has responsibility for land reclamation.

OSM or state / tribe emergency programs take abatement actions when occupants are in immediate danger because of a landslide. Otherwise, landslide problem areas that endanger human health, safety, and general welfare are assigned priorities, and mitigation actions are taken based on the highest priority. Reclamation records, maintained in OSM's Abandoned Mine Land Inventory System, indicate that OSM and the states / tribes have completed reclamation on 3,367 acres of dangerous slides at a cost of more than $125 million. Also, reclamation of 651 acres is designated as a high priority, and mitigation efforts for that reclamation, which have been funded but had not at time of this writing been completed, have been estimated to cost $30.69 million. An additional 2,276 acres are slated for reclamation at an estimated cost of $73.77 million, but these efforts are currently unfunded.

The United States Forest Service, Department of Agriculture

[Please see the article by Jerome DeGraff above in this chapter.]

The United States Bureau of Land Management

BLM manages multiple uses on approximately 264 million surface acres of public land located primarily in 12 western states. A relatively small portion of this land is located in steep mountainous terrain with geologic and climatic conditions resulting in high landslide hazards in western Oregon, northern California, and northern Idaho.

Many landslides on public land are a result of natural disturbance events, but land management activities (e.g, road building, timber harvest, historic mining, and water impoundments) can also contribute to their occurrence. BLM does not have an agencywide landslide hazards program or specialized personnel. The bureau's local field office landslide hazards prevention activities include identification of unstable slopes using aerial photo interpretation, landslide hazards guides, onsite indicators, predictive models, and limited inventory and monitoring of landslides.

Prevention and mitigation of landslides are accomplished using a variety of methods. Existing roads may be closed and obliterated, rerouted, or kept open and stabilized with additional runoff-control structures, subsurface drainage control, or other techniques. Routine road maintenance is an important factor in helping to reduce landslide hazards. Prudent route analysis and design to minimize landslide hazard are employed for new roads in landslide-prone areas. Hazardous fuels management can reduce the risk of catastrophic wildfires that would increase landslide hazards. Timber management practices are employed to maintain root strength where needed for slope stability. Existing slide areas threaten human health and safety, roads and recreational facilities, water quality, fisheries and aquatic habitat. Other resource values are stabilized, and sediment is controlled with revegetation and structural controls.

Cooperative efforts in landslide hazard assessment, prevention mitigation, restoration, and public awareness would immeasurably assist bureau efforts to protect public health and safety and to sustain the health, diversity, and productivity of the public lands.

Routine road maintenance is an important factor in helping to reduce landslide hazards. Prudent route analysis and design to minimize landslide hazard are employed for new roads in landslide-prone areas.

The United States Army Corps of Engineers, Department of Defense

The mission of Army Corp of Engineers (the Corps) includes planning, design, building, and operating water resources and civil projects in the areas of flood control, navigation, environmental quality, coastal protection, and disaster response, as well as the design and construction of facilities for the Army, Air Force, and other federal agencies. The Corps has addressed a full range of technical challenges associated with landslides and ground failure. Corps engineering geologists, geotechnical engineers, and geophysicists have been involved in the assessment, monitoring, analysis, and mitigation of landslides in locations around the world.

Corps scientists and engineers have investigated landslides of various mechanisms and scales along navigable waterways, such as the Mississippi and Ohio Rivers, which result in serious navigation hazards and threatening or loss of flood protection works. Landslides also play an important role in the erosion of the nation's shoreline and the protection of shoreline is a major responsibility of the Corps. Corps scientists and engineers investigate dam sites, identifying and assessing past and potential landslides.

Corps engineering geologists, geotechnical engineers, and geophysicists monitor active landslides and ground failure in both natural and engineered soils and earth materials. Landslide monitoring focuses on identifying tem-

poral and spatial variability of earth movements and the causes of those movements. Engineers and scientists use monitoring data, along with detailed site information, to analyze the stability of the landslide for initial movements, present conditions, and conditions after mitigation actions.

FHWA recognizes a need for consistent understanding and application of soil and rock slope stability analysis and mitigation for highway projects across the United States.

As an engineering agency, the Corps plays a significant role in the planning, design, and construction of landslide mitigation measures associated with the protection of its civil and military projects. Corps engineers develop and implement specific methods for reducing landslide hazards and increasing slope stability at sites around the world. The Corps' critical role in landslide projects, through the process of initial engineering geological investigation, engineering analysis, remedial design, implementation, construction, and post-project monitoring, is of great value to the United States and the international community.

The Corps is also involved in disaster response. The Corps responds to landslides, especially those that result from floods, hurricanes, volcanic eruptions, and earthquakes. In assistance to FEMA, Corps personnel have provided emergency assessments and immediate mitigation of past and potential landslides. Additionally, the Corps conducted recent landslide assessments, analysis, and mitigation in Venezuela, Honduras, Nicaragua, Colombia, Peru, Haiti, Puerto Rico, South Korea, and the Philippines.

Researchers at the Corps Engineering Research and Development Center develop and test analytical tools and assessment methods and approaches for landslide mitigation. Basic research in soil and rock mechanics, geomorphology, hydrogeology, remote sensing, geophysics, and engineering geology has resulted in advancements in the understanding of the causative factors and mechanics of landslides and ground failures.

The Federal Highway Administration, United States Department of Transportation

FHWA is a part of the U.S. DOT and is headquartered in Washington, D.C., with field offices across the United States. FHWA performs its mission through two main programs.

First, the Federal-Aid Highway Program provides federal financial assistance to state DOTs to construct and improve the national highway system, urban and rural roads, and bridges. The program provides funds for general improvements and development of safe highways and roads.

Second, the Federal Lands Highway Program provides access to and within national forests, national parks, Native-American reservations, and other public lands by preparing plans, letting contracts, supervising construction facilities, and conducting bridge inspections and surveys.

FHWA recognizes a need for consistent understanding and application of soil and rock slope stability analysis and mitigation for highway projects across the United States. These analyses are generally carried out throughout the life of most highway projects during planning, design, construction, improvement, rehabilitation, and maintenance. Planners, engineers, geologists, contractors, technicians, and maintenance workers become involved in the process.

To this end, the FHWA geotechnical engineering program continues to develop and support the development of training courses, design manuals, demonstration projects, and geotechnical software. The program maintains an ongoing dialog and exchange of information with and among state DOTs through the annual Regional Geotechnical Meetings, training courses, and technical assistance provided through the FHWA Resource Centers.

The Federal Railroad Administration, United States Department of Transportation

The Federal Railroad Administration's (FRA) primary mission is to promote and regulate railroad safety. FRA sponsors research in techniques for advancing railroad safety, operations, and maintenance practices.

Landslides threaten the safety of railroad operations as they would any other form of surface transportation. But mitigating landslides when it comes to railroads differs in many respects, dictated mainly by these three characteristics:

1. Trains need advance warnings, sometimes one to two miles from the site of a landslide, so they can stop.
2. Trains cannot steer around a landslide or even a small obstruction.
3. Finding alternate routes for trains can mean significant detours, especially in western states where they can add hundreds of miles and cause significant disruption in the rail network.

Landslide mitigation techniques for railroads share a similarity with those used for highways. Commonly used techniques are: slide fences; rock or slide sheds in areas of frequent, heavy slides; and anchoring or stabilizing unstable rock or soil slopes. Slide fences tie into rail signal systems, where any breaks in the fence wires near a slide area activate stop signals for trains along that segment of the track, serving as an early warning system helping railroads avoid major disasters. Though such efforts have minimized serious accidents, injuries, and fatalities, landslides cause disruptions and delays.

Further reducing disruptions and delays would require earlier warning systems. FRA sponsored two new techniques on this front. Both these techniques, currently being demonstrated in the rail corridor between Eugene, Oregon, and Vancouver, British Columbia, suggest the direction such warning systems might take. One technique, which uses cellular grills, is for stabilizing slopes particularly susceptible to weathering and erosion. The other is a technique to monitor levels for slope movement using liquid sensors. In addition, FRA is focusing on weather and weather events as landslide triggers mainly through research and education, such as the Enhanced Weather Information for Railroad Productivity and Safety Symposium in 2001 sponsored by the Association of American Railroads and the National Center for Atmospheric Research.

The National Science Foundation

NSF is an independent U.S. government agency responsible for promoting science and engineering. NSF provides funding for landslide and slope stability research through the Geotechnical and GeoHazards Program (GHS) of the Civil and Mechanical Systems Division in the Directorate for Engineering and the Hydrologic Science and the geology programs in the Geosciences Directorate (EAR / GEO).

The engineering directorate provides funding in response to peer-reviewed unsolicited proposals, support for workshops, and small grants for exploratory research. GHS supports:

- development of numerical analysis techniques for slope stability;
- landslide mitigation techniques;
- investigations of seismic slope stability;
- earthquake-induced submarine landslides;

- model development related to slope stability and mud and debris flows; and
- post-landslide reconnaissance.

Current GHS-funded research includes development of probabilistic methods of stability analysis and development of sensors for early warning of slope movement, evaluation of factors controlling seismic slope stability using GIS, and stabilization of slopes using in-situ reinforcement.

In the geosciences directorate, the hydrology program supports studies of landslide triggering caused by high-water contents in soils and lubricating slip planes between strata, and the geology program focuses on the role of landslides as a process of erosion and deposition reshaping the Earth's surface. Both programs interact with other earth science programs because they share an interest in projects that study the triggering of landslides by earthquakes or volcanic events. Because wet conditions and fluctuating pore pressures often exacerbate vulnerability to landslides, EAR has active studies on diffusive soil transport as a process in hillslope evolution and on reconstructing landslide history through destabilization caused by events generating high pore fluid pressures. NSF is also initiating a Science and Technology Center at the University of Minnesota on Earth Surface Dynamics where landslides are an important component process. The patterns of landslide spreading and buildup over sequential events are important components in defining and addressing heterogeneity in groundwater aquifers. The simulation of this process is receiving growing attention as a tool in mapping aquifer properties.

Government at the federal, state, and local levels provides landslide information in three basic categories: 1. landslide types and processes (often in the form of maps); 2. site-specific information; and 3. general mitigation information.

INFORMATION AND RESOURCES COMMON TO ALL LEVELS OF GOVERNMENT

Government at the federal, state, and local levels provides landslide information in three basic categories:

1. landslide types and processes (often in the form of maps),
2. site-specific information, and
3. general mitigation information.

Emergency response landslide information is a separate realm and will not be discussed here. Despite having many goals in common, emergency management and hazard mitigation activities have historically been carried out independently. The integration of these two efforts is most often demonstrated in the recovery phase following a disaster, when decisions about reconstruction and future land uses in the community are made.

The description of landslide processes and the identification of the types and causes of landslides may employ maps or remotely sensed imagery to show the distribution of landslides and area geology. Information may also include a databases documenting the historical occurrence of landslides in an area. Such information may include state-of-the-art engineering practices for general evaluation and application, and is usually highly technical and uses geotechnical and geological nomenclature and terms.

Site-specific information includes intensive analysis about a smaller site, such as an urban lot, city block, or other individual property. Information of this type incorporates local soil characteristics, topographical information, geology, weather, climate, and land-use. Site-specific information may include results of drilling below grade to evaluate soil and geologic characteristics, surveys to monitor movements, and data from instrumental monitoring.

General mitigation information concerns methods of mitigating land-

slide hazards, including engineering, site-plan restrictions, hazard avoidance strategies, and others. Much of this information is state-of-the-art engineering methodology that applies principles of geology, geomorphology, and soil mechanics, as well as instrumental monitoring techniques.

LANDSLIDE MAPPING

Local governments need to know a potential hazard exists in order to require a geologic study. For this, they use the best available geologic and hazard maps. Ideally the city or county adopts maps as part of an ordinance or resolution requiring geologic studies. Geologic hazard maps combine basic geology with other information to show areas subject to specific hazards. They show where the hazard exists, its relative severity at each location, and probability of occurrence. Landslide-susceptibility maps and liquefaction-potential maps show where landslides or liquefaction are likely to occur. Some recent examples of useable hazard maps published by and available from the U.S. Geological Survey are Coe et al. (2000), Morgan et al. (1999), and Jäger and Wieczorek (1994).

Local governments need to know a potential hazard exists in order to require a geologic study. For this, they use the best available geologic and hazard maps.

Large-scale hazards maps (maps that range in scale from 1:24,000 to 1:12,000, or greater) are the most useful because they show the most detail and allow geographical areas to be pinpointed more easily; for example, a hazard-prone area can be pinpointed by street address, creating awareness of hazards at the residential lot size. The cost of providing such detailed maps, however, prevents their widespread implementation. Small-scale maps can be used somewhat effectively, especially at the county level. For instance, Sonoma County, California, uses maps at a scale of 1:62,500 (1 inch = 5,280 feet). These maps, prepared by California's Division of Mines and Geology, focus on general areas where hazards are located. Napa County, California, has geologic hazard map overlays as part of a 26-map overlay system at the scale of 1:24,000, designed to fit over USGS 7.5-minute topographic quadrangle maps (Blair-Tyler 1994).

Small-scale maps can give misleading information about individual sites, particularly if the selected site is a single lot or small parcel that is not subdivided. A site may be shown on a small-scale map as hazard-free when, in fact, it may contain significant hazards. Conversely, a site shown in a generally hazardous zone may in fact be free of hazards. Consequently, users of small-scale maps are well advised to resist the temptation to enlarge such maps in order to see more details. The purpose of site-specific geologic studies is to provide the site-specific detail missing in small-scale hazards maps of large areas. Blair-Tyler (1994) has a detailed explanation of geologic mapping.

It must be noted that much of the United States and the world in general has not been mapped for landslide hazards. Landslide hazard mapping is expensive, and few geologists have the expertise to evaluate and/or delineate landslide hazards.

It must be noted that much of the United States and the world in general has not been mapped for landslide hazards. Landslide hazard mapping is expensive, and few geologists have the expertise to evaluate and / or delineate landslide hazards. Mapping landslide hazards can be politically unpopular because pinpointing hazards sometimes is perceived to reduce property values and increase liability. Debate may occur over how extensive or severe a hazard, once it is mapped, may actually be. Magnitudes and return periods of storms that might impact landslide-prone areas are unpredictable. Also, earthquake recurrence, in areas where earthquake-induced landslides may occur, is unpredictable. The insurance industry has been peripherally interested in rates of landslide occurrence for certain geographical areas but as of this writing has not collectively implemented insurance coverage for landslide damage. In summary, for reasons already stated, too little is known about the distribution and probability of landslides to insure against landslide losses.

LANDSLIDE SPECIALISTS

A **geologist** is a scientist who studies the dynamics and physical history of the earth, the rocks of which it is composed, and the physical, chemical, and biological changes the earth has undergone or is undergoing.

An **engineering geologist** is a geologist versed in the application of geologic knowledge and principles in the investigation and evaluation of naturally occurring rock and soil for use in the design of civil works (adapted from Uniform Building Code, 1991, Chapter 70, Sec. 7005). The State of California certifies engineering geologists who pass an examination given by the state.

A **geotechnical engineer** (also called a **soils engineer**) is a civil engineer versed in the application of the principles of soils mechanics in the investigation, evaluation, and design of civil works involving the use of earth materials and the inspection or testing of the construction thereof (adapted from Uniform Building Code, 1991, Chapter 70, Sec. 7005)

Geologists and **engineering geologists** both have degrees in geology. An engineering geologist has additional training in engineering. A geotechnical engineer has a degree in civil engineering with additional training in geology.

A **geotechnical** or **civil engineer** may recommend and approve mitigation measures such as special foundation designs, retaining walls, and/or drainage systems. These professionals must be registered and become licensed with state boards of examiners to practice in individual states. Several states also require registration and licensing for geologists or engineering geologists. It is advisable to check licensing requirements and qualifications for professionals as regulations vary from state to state.

Professional associations and societies can provide lists of licensed geologists, civil engineers, and geotechnical experts. The **Association for Engineering Geologists (AEG)** and the **American Society of Civil Engineering (ASCE)** are two organizations commonly consulted for lists of companies and/or individuals who are members in good standing.

FUTURE OF LANDSLIDE HAZARD LOSS REDUCTION

In response to the rising costs due to landslides, the U.S. Congress requested that USGS prepare a national strategy for reducing losses from landslides (House Report 106-222 accompanying the Interior Appropriations bill for FY 2000, which was incorporated in Public law 106-113). USGS outlined the requested strategy in "National Landslide Hazards Mitigation Strategy: A Framework for Loss Reduction" by Spiker and Gori (2003).

The strategy calls for a prominent role for the federal government, in partnership with state and local governments, in reducing losses from landslides. It includes developing new partnerships between all levels of government, academia, and the private sector, and expanding landslide research, mapping, assessment, real-time monitoring, forecasting, information management and dissemination, development of mitigation tools, and emergency preparedness and response. The strategy relies on new technological advances, enlists the expertise associated with other related hazards (e.g., floods, earthquakes and volcanic activity), and uses incentives for the adoption of loss reduction measures nationwide.

The National Research Council of the National Academy of Sciences endorsed the USGS recommended strategy in "Partnerships for Reducing Landslide Risk: Assessment of the National Landslide Hazards Mitigation Strategy" (National Research Council 2003).

The long-term mission of the strategy is to provide and encourage the use of scientific information, maps, methodology, and guidance for emergency management, land-use planning, and development and implementation of public and private policy to reduce losses from landslides and other ground failures nationwide. The 10-year goal is to substantially reduce the loss of life, injuries, economic costs, and destruction of natural and cultural resources that result from landslides and other ground-failure hazards.

The long-term mission of the strategy is to provide and encourage the use of scientific information, maps, methodology, and guidance for emergency management, land-use planning, and development and implementation of public and private policy to reduce losses from landslides and other ground failures nationwide.

The strategy employs a wide range of scientific, planning, and policy tools. It has nine major elements, spanning a continuum, from research to the formulation and implementation of policy and mitigation:

1) Research: Developing a predictive understanding of landslide processes and triggering mechanisms.
2) Hazard Mapping and Assessments: Delineating susceptible areas and different types of landslide hazards at a scale useful for planning and decision making.
3) Real-Time Monitoring: Monitoring active landslides that pose substantial risk.
4) Loss Assessment: Compiling and evaluating information on the economic impacts of landslide hazards.
5) Information Collection, Interpretation, and Dissemination: Establishing an effective system for information transfer.
6) Guidelines and Training: Developing guidelines and training for scientists, engineers, and decision makers.
7) Public Awareness and Education: Developing information and education for the user community.
8) Implementation of Loss Reduction Measures: Encouraging mitigation action.
9) Emergency Preparedness, Response, and Recovery: Building resilient communities.

CONCLUSION

Landslide hazards loss reduction requires increased capacity of all federal agencies, state and local governments, and the private sector. Landslide hazard mitigation also depends on active collaboration among academia, government, and the private sector. The education of land-use planners and the implementation of land-use policies that incorporate landslide hazards into the planning process at the local level and other levels of government will begin the process of reducing losses from landslides. The implementation of an effective national landslide hazards mitigation strategy would require additional investment in landslide hazard research, mapping, and monitoring, and mitigation activities at all levels of government.

An effective national landslide hazards mitigation strategy also depends on stronger partnerships among federal, state, and local governments and the private sector in the areas of hazard assessments, monitoring, and emergency response and recovery. The ultimate result of implementation of such a strategy will be to substantially reduce the risk of loss of life, injuries, economic costs, and destruction of natural and cultural resources that result from landslides within the United States.

APPENDIX A

A Glossary of Landslide-Related Terms

Citations at the end of the definition provide the source for the definition; consult Appendix B, the list of references, for full bibliographic information about the source. If no citation is provided, project manager Sanjay Jeer compiled a common definition based on several sources.

alluvial fan A generally planar surface in a larger valley downslope from the mouth of a canyon, consisting of materials deposited by flooding and debris flow (Wieczorek et al. 1995)

block slide (*see also* ***slide***) A translational slide in which the moving mass consists of a single unit or a few closely related units that move downslope as a single unit (Wold 1989)

bore hole A hole drilled into the earth for exploratory purposes (Nichols 1974)

check dams Concrete or masonry structures in canyons designed to retain debris flows and to stabilize channels (Wieczorek et al. 1995)

colluvium Loose and incoherent deposits of soil, rock fragments, or alluvium usually at the base of a slope brought there chiefly by gravity, mass-wasting, erosion, and runoff (Wieczorek et al. 1995)

concavity A topographic depression on a hillside, usually both across the slope horizontally and along the vertical profile, also referred to as a "hollow" or swale (Wieczorek et al. 1995)

creep The imperceptibly slow, steady downward movement of slope-forming soil or rock indicated by curved tree trunks, bent fences or retaining walls, tilte poles or fences, and small soil ripples or terracettes (Wold 1989)

debris avalanche *(see also* ***lahar****)* A variety of very rapid to extremely rapid debris flow (Wold 1989)

debris basin An earthen or concrete structure designed to retain debris flows, often equipped with spillways to pass more fluid portions of flow and slotted towers to drain water from deposits; requires occasional removal of deposits (Wieczorek et al. 1995)

debris flow A form of rapid mass movement in which soils, rocks, and organic matter combine with entrained air and water to form a slurry that then flows downslope. Debris-flow areas are usually associated with steep gullies. Individual debris-flow areas can usually be identified by the presence of debris fans at the termini of the drainage basins (Wold 1989).

delta-front landlsiding (*see also* ***rapid sedimentation***) Underwater landsliding along coastal and delta regions due to rapid sedimentation of loosely consolidated clay, which is low in strength and high in pore-water pressures

digital elevation model (DEM) A three-dimensional model of digital elevation data for cartographic representation. Digital terrain models (DTMs) are often displayed as a grid draped over topography maps to illustrate peaks and valleys. USGS has a DEM standard for exchange of spatial data that has elevations in it. USGS also provides DEM data in a variety of scales (7.5-minute DEM, 30-minute DEM, 1-degree DEM, etc.). Most GIS software packages have extensions that allow DEM data from USGS to be added to local maps.

drawdown Lowering of water levels in rivers, lakes, or underground aquifers. Any drawdown leaves unsupported banks or poorly packed earth that can cause landslides

Earth Science Information (ESI) Pertains to the land, its natural features, composition of materials, and processes affecting land and water. It is a combination of scientific information and interpretation from the science of soils, geology, and hydrology. It has been extended to include other sciences, such as biology, meteorology, and climatology. ESI in land-use planning aims to bring together techniques of scientific interpretation to bear on the planning process.

earthflow (*See also* ***mud flow, debris flow, lahar***) A bowl or depression forming at a head where unstable material collects and flows out. The central area is narrow and usually becomes wider as it reaches the valley floor. Flows generally occur in fine-grained materials or clay-bearing rocks on moderate slopes and with saturated conditions. Dry flows of granular material are also possible. Earthflows have a characteristic "hourglass" shape (Wold 1989).

epicenter The point on the earth's surface directly above the origin of an earthquake (Nichols 1974)

expansive soils Types of soils that shrink or swell as the moisture content decreases or increases

falls Abrupt movements of materials that become detached from steep slopes or cliffs, moving by free-fall, bounding, and rolling. Includes topples, slides, rotational landslides, and translational slides (Spiker and Gori 2003).

geodetic measurements Controls on location (vertical and horizontal) of positions on the earth's surface of a high order of accuracy, usually extended over large areas for surveying and mapping operations (Nichols 1974)

geologic map A geologic map is a graphical information display that uses a combination of colors, lines, and symbols to depict the composition and structure of geologic materials and their distribution across and beneath the landscape. The graphical display contains both *descriptive information* about geologic units and structures and an *interpretive model* of how they were formed. This combination of descriptive and interpretive geologic map information provides a conceptual framework that relates all the geologic elements of an area together so that the position, characteristics, and origin of each element are understood in relation to all other elements. Such a unique synthesis of descriptive and interpretive information makes the geologic map a powerful research tool for understanding the Earth's composition and structure, internal and external processes, and history.

The standard geologic map is a general purpose product; that is, it conveys essential information about many aspects of the geologic setting, not just one or a few aspects (Bernknopf et al. 1993).

geomorphological maps *(see also* ***landslide susceptibility*** maps) Maps showing surface features. They may or may not include landslide areas (risk or potential).

geophysical studies Studies in the changes in the Earth's electrical and gravitational fields to determine certain subsurface characteristics, such as the groundwater table, depth to bedrock, saturation zones, etc. Such studies may even employ sonar scans to measure acoustic reflections. These studies are often supplemented with other methods, such as drilling, aerial surveys, satellite imagery, and other remote-sensing techniques.

head of a fan The apex or upslope point where an alluvial fan intersects a channel emerging from a canyon (Wieczorek et al. 1995)

lahar (*see also* ***mud flows***) Mudflow or debris flow that originates on the slope of a volcano, usually triggered by heavy rainfall eroding volcanic deposits, sudden melting of snow and ice due to heat from volcanic vents, or the breakout of water from glaciers, crater lakes, or lakes dammed by volcanic eruptions (Spiker and Gori 2003)

landslide hazard map (*see also* ***landslide inventory map***) A map indicating the annual probability of landslide occurring throughout an area. An ideal landslide hazard map shows not only the chances that a landslide may form at a particular place but also the chances that a landslide from farther upslope may strike that place (Spiker and Gori 2003).

landslide inventory map (*see also* ***landslide susceptibility map***) A map showing the location and outlines of landslides using a data set that may represent a single event or multiple events. Small-scale maps may show only landslide locations whereas large-scale maps may distinguish landslide sources from deposits and classify different kinds of landslides and show other pertinent data (Spiker and Gori 2003).

landslide risk map (*see also* ***landslide hazard map; landslide susceptibility map***) A map showing the expected annual cost of landslide damage throughout an area, combining the probability information from a landslide hazard map with an analysis of all possible consequences (property damage, casualties, and loss of service) (Spiker and Gori 2003)

landslide susceptibility map (*see also* ***landslide hazard map***) A map ranking the slope stability of an area into categories that range from stable to unstable, showing where landslides may form. Many use a color scheme that relates warm colors (red, orange, and yellow) to unstable and marginally unstable areas and cool colors (blue and green) to more stable areas (Spiker and Gori 2003).

landslide Any movement of rock, earth, or debris on slopes due to gravity. Besides sliding, movement may also include falls, topples, spreads, or flows. Landslides can be caused by rains, floods, earthquakes, and other natural causes, as well as man-made causes, such as grading, terrain cutting and filling, and excessive or inappropriate developments. Landslides can occur in developed areas, undeveloped areas, or any area where the terrain was altered for roads, houses, utilities, and even lawns and yards of homes. Landslides go through various stages of activity: active, reactivated, suspended, or inactive (such as dormant, abandoned, stabilized, or relict).

lateral spreads (*see also* **liquefaction)** The result of the nearly horizontal movement of geologic materials, distinctive because they usually occur on very gentle slopes. The movement is caused by liquefaction triggered by rapid ground motion, such as that experienced during an earthquake or by slow chemical change in the pore water and mineral constituents of the ground (Wold 1989).

liquefaction (*see also* **lateral spreads)** The changing of soils from solid to a liquid state, commonly occurring during earthquakes

lithology The composition, fabric, texture, or other attributes that influence the physical or chemical behavior of rocks and engineering soils; important for determining characteristics of soil and rock materials, which in turn affect slope stability (Varnes 1984)

loess A type of soil deposit, primarily silt-size fine sand particles, coated by a clay binder. Relatively strong when dry but loses strength when wet and causes granular soil to resettle and consolidate. Nearly 7 percent of the soil deposits in the United States can be characterized as loess, mostly concentrated in the Midwest (extending along the Mississippi River from Minnesota to Louisiana), Alaska, Idaho, Oregon, and Washington.

mud flow An earthflow that consists of material wet enough to flow rapidly and containing at least 50 percent sand-, silt-, and clay-size particles (Wold 1989)

perched water table The level of water in a hillside over an impermeable, nonsaturated zone, generally temporarily created during heavy storms within shallow soils over less permeable bedrock (Wieczorek et al. 1995)

rapid sedimentation (*see also* **delta-front landsliding)** A phenomenon common to delta regions where rivers deposit large sediments along coastal areas

risk assessment A measurement of the probable degree of injury and property damage in a given area over a specific time interval (Godschalk et al. 1999)

rotational slide A landslide in which the surface of the rupture is curved concavely upward (spoon shaped) and the slide movement is more or less rotational about an axis parallel to the contour of the slope. A "slump" is an example of a rotational slide (Wold 1989).

sag pond Enclosed depression, generally occupied by water, formed when movement along a fault has disturbed the surface or subsurface continuity of drainage (Nichols 1974)

sand ridges Low ridges of sand extruded along fissures caused by ground cracking and expulsion of water and sand by liquefaction (Nichols 1974)

scarp A steep surface on the undisturbed ground around the periphery of a landslide caused by movement of slide material away from the undisturbed ground

sheetwash A thin sheet of flowing water on slope surfaces (usually colluvial or alluvial soil types) due to an intense rainstorm. The momentum in a sheetwash is sufficient to transport pebbles, sand, and mud, and cause significant surface erosion. Surface vegetation helps slow sheetwash momentum and reduce surface erosion.

slide (*see* landslide)

slurry A mixture of different size particles, from clay to boulder-size materials, mixed with water (Wieczorek et al. 1995)

soil slip A term used to describe a type of slope movement involving shallow sliding within a layer of soil, which can turn into debris flow with sufficient moisture (Wieczorek et al. 1995)

source area The hillside area where landslides are triggered and debris flows are initiated, most frequently topographic swales on hillsides filled with colluvial soils (Wieczorek et al. 1995)

Stafford Act The Robert T. Stafford Disaster Relief and Ermergency Assistance Act, PL 100-107, signed into law November 23, 1988; amended the Disaster Relief Act of 1974, PL 93-288. Section 404 authorizes the Hazard Mitigation Grant Program that provides funding for cost-effective hazard mitigation measures. Section 409 encourages identification and mitigation of hazards at all levels of government, requiring the identification and evaluation of mitigation opportunities as a condition for receiving federal disaster assistance (The Federal Emergency Management Agency).

structure The features of inhomogeneity and discontinuity in rocks or soils at scales larger than a hand specimen, including stratigraphic sequence, attitude of layering, gross changes in lithhology, bedding planes, joints, faults, and folds (Varnes 1984)

submarine and subaqueous landslide Landslides, including rotational and translational landslides, debris flows, and mud flows, and sand and silt liquefaction flows that occur principally or totally under water in lakes and reservoirs or in coastal and offshore marine areas. The failure of underwater slopes may result from rapid sedimentation, methane gas in sediments, storm waves, current scour, or earthquake stresses. These landslides pose problems for offshore and river engineering, jetties, piers, levees, offshore platforms and facilities, and pipelines and telecommunications cables (Spiker and Gori 2003).

subsidence The sinking or collapsing of the ground surface normally due to poorly compacted soils or withdrawal of groundwater, oil, or gas. Mining and natural caverns also cause subsidence.

swelling soils A major form of ground failure frequently encountered in arid regions in soil containing montmorillonite clay, the particles of which can absorb large quantities of water and in so doing expand, resulting in an uplift at ground surface (Spiker and Gori 2003)

technological hazards Hazards produced by human activity rather than by geophysical processes (Palm 1990)

toe of the slope The furthest and lowermost curved surface of displaced landslide materials pushed over on to the undisturbed slope; the downslope end of an alluvial fan.

topple A block of rock that tilts or rotates forward to fall, bounce, or roll down the slope (Spiker and Gori 2003)

translational landslide A landslide in which the mass of soil and rock moves out or down and outward with little rotational movement or backward tilting. Material from a translational landslide may range from loose unconsolidated soils to extensive slabs of rock and may progress over great distances if conditions are right (Spiker and Gori 2003).

vulnerability assessment An estimate of the property, critical facilities, and number of people exposed to a hazard (Godschalk et al. 1999)

zonation Division of the land surface into areas and the ranking of these areas according to degrees of actual or potential hazard from landslides or other mass movements on slopes (Varnes 1984)

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Memorandum

TO: Mayor Zak and Homer City Council

FROM: Katie Koester, City Manager

DATE: January 3, 2018

SUBJECT: January 8 City Manager Report

Battle Creek Project
The Battle Creek project is a 46 million dollar project to expand power generation capacity at Bradley Lake by diverting runoff from the Battle Glacier. The project is expected to begin this spring with completion in 2020. The Port of Homer is the most logical and cost effective way to handle the projects logistical needs and we expect to see increased traffic during all phases of construction.

Project Review of 2017 and what's ahead for 2018
Public Works complied a year in review for projects completed in 2017 (attached). The list includes the budget and actual for the projects and recent equipment purchases. In the case of each project/purchase, the unspent funds lapse back into the account they were appropriated from. For example, the used steamer truck purchased in 2013 came in $14,569 under budget. These funds then stay in the Public Works Fleet Reserve. Overall, the record demonstrates a track record of responsible project management. The write up also includes anticipated projects for 2018.

Governor's Budget
On December 15th Governor Walker released his Draft 2019 budget. The direct impacts to Homer remain fairly status quo, detailed below. However, it is important to remember that this is just the proposed budget, the power of the purse is held with the Legislature. The budget – and proposed revenue stream – will undergo intense scrutiny in the coming months.

1. The City participates in Alaska Land Mobile Radio (ALMR), a state wide radio communications system. To encourage participation in ALMR the state pays a maintenance fee for the equipment on behalf of municipalities. In the past the State has threatened to not fund this and shift the cost to participating municipalities. For Homer, that could mean opting out of ALMR. In Governor Walker's budget, the State will continue to fund ALMR.

2. The City has a contract with DOT to provide winter maintenance to Pioneer Avenue ($34,000). The City took over this responsibility years ago from the State as the businesses and residents demanded a higher level of service than DOT was able to provide (plowed sidewalks and removal of snow from the middle of the road, for example). The Governor's budget includes status quo funding for this contract.

3. Police Department. The Troopers have a contract with the City for occasional use of the Police station. This will remain in place in the proposed budget ($36,000). The Department of Corrections has a contract with the City to house state prisoners in the Homer Jail. This contract was cut by 40% in 2015, but will remain status quo ($424,000) in the proposed budget.

4. The City pays 22% of payroll for each employee in the Public Employees Retirement System (PERS). The State picks up anything over 22% per employee, as calculated by the actuaries. Some years this is a very high number, depending on the health of the fund and variables the actuaries use to determine the normal cost. Although the Governor's budget includes the full on behalf payment, in the past the Legislature has repeatedly threatened to increase the 22%. A 1% increase in PERS contribution rates represents approximately $60,000 for the City of Homer operating budget.

5. State wide, Community Assistance (formerly Revenue Sharing) will drop by 1/3, or $20 million state wide. This means the City of Homer would receive $136,731 this year in comparison to $205,118 in 2017. However, there has been talk of a the FY18 supplemental including a $30 million boost to the fund, so this is one we should also be watching.

Customer Comment Cards
The 4th quarter report for customer feedback comment cards is included in your packet. In summary, Five compliments received – two to Public Works for road and trail work; three to the Library. Five cards held suggestions for improving City services; these were shared with appropriate Department and follow-up completed with each customer offering a suggestion.

Police Station Worksession
An extended worksession (4-7) is scheduled for the police station project on January 29th. In order to prepare for the meeting and make sure it is a productive use of your time, I welcome any input you have on materials you would like to have available or any information that needs to be tracked down. I am hopeful that after the worksession legislation can be introduced at the February 12th Council meeting that confirms the direction the City Council would like to head in. Some talking points for the worksession pulled from previous Council discussion are listed below. Resolution 17-074(S)(A) directs existing police station project budget to be used to hire a local facilitator. I welcome any suggestions you have on facilitating the worksession.

1. Building location
2.Builidng cost
3.How to pay for it
4.Timing. Target date for construction?
4. Weather or not to maintain current design/build contract with Stantec

Kenai Peninsula Borough Comprehensive Plan Update
The Kenai Peninsula Borough is soliciting public comment on their draft 2018 Comprehensive Plan until January 31, 2018. The Planning Director has participated in the process and the Planning Commission will review the document. To review the Public Review Draft and comment, visit **http://kpbcompplan.com/**

Quiet Creek Park Subdivision (Phase I)

Councilmembers have asked for an update on the proposed Quit Creek Park Subdivision. Public works provided the December 2017 update below.

The Developer has executed a Construction Agreement that sets the conditions under which the City will accept ownership of the road, drainage, water and sewer improvements (and non-City-owned utilities) constructed by the Developer to serve the subdivision. The plat cannot be recorded or lots sold until all subdivision improvements has been constructed and accepted by the City. Plans have been submitted, reviewed and commented on. Final plan submittal for Phase I will be made once ADEC approval to construct has been obtained. Attached is a map showing the three phases. The road connection to Mountain View Drive is anticipated to be completed during Phase II.

The plans currently provide for gravel roads, piped water and sewer mains meeting City standards, and drainage improvements (including storm water detention basins – sized to detain runoff from a 10 year storm). The developer is not required to pave the roads, but has indicated that his intention is to pave after all phases are complete. No sidewalks are included in the project.

The Developer has paid an inspection fee. The Developer has submitted and Public Works has approved a Flushing/Testing plan for the water line installation, a Work Schedule, a Quality Control Plan, and Public Works has reviewed the SWPPP Plan and Corps wetlands permits.

Public Works has reviewed submittals from the Contractor, East Road Services, for all materials and equipment being used and approval has been issued with a few exceptions. Public Works has issued a Conditional Notice to Proceed for the construction of the above referenced subdivision improvements that covers approval to order drainage culvert and water main pipe, complete clearing and grubbing, culvert installation, and initial road excavation. No construction of any road improvements or water and sewer improvements is authorized until plans receive final approval.
Public Works expects that construction of the creek crossing culverts will be completed over the next few month; followed by installation of water and sewer mains. Road construction will start in early spring 2018 with substantial completion mid-summer.

At full build-out, anticipated annual road and drainage maintenance costs are $30,000. However, the increase in property tax revenue with full build out and occupancy should more than cover the anticipated expense.

Enc:
January Employee Anniversaries
Public Works 2017 Project Review
Resolution 17-074(S)(A)
APSC Stakeholder Academy Funding
4th Quarter Customer Comment Card Report