THE ENVIRONMENTAL HAZARDS
OF COLORADO SPRINGS

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SUMMARY

This paper evaluates the various risks posed by the many hazards affecting the area in and around Colorado Springs, Colorado. It is designed to be a working document for persons living in the area to aid them in determining the acceptability and suitability of a given location for a given use. In addition, it is also intended to be used as a guide by other geographers, planners, developers in preparing similar surveys of hazards impinging on other locations.

The paper includes discussions of the hazards posed by floods, various geological phenomena, weather anomalies, air pollution, and hazardous waste. Besides giving spatial and historical accounts of these hazards, existing and potential mitigation measures are also examined.

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PREFACE

This paper is one in a series on research in progress in the field of human adjustments to natural hazards. It is intended that these papers be used as working documents by those directly involved in hazard research, and as information papers by the larger circle of interested persons. The series was started with funds from the National Science Foundation to the University of Colorado and Clark University, but it is now on a self-supporting basis. Authorship of the papers is not necessarily confined to those working at these institutions.

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INTRODUCTION

Why This Study?

This paper has two objectives: to meet a local need and to set an example for geographers, graduate students, planners, or others who may wish to assemble a comprehensive set of information on hazardous locations in their own communities.

The population of Colorado Springs is rapidly growing. While the environment is not particularly more hazardous than that found in many other American cities, until this document was completed, there was no over-all assessment of the relative risks faced by the population. We set out to document potential hazards in several categories so that the information could be used by officials, homeowners, and potential home buyers. In addition, we felt that our work could serve as a model for other cities/regions wanting to conduct similar analyses. (Such projects do not necessarily require a major grant, but they might be very time consuming if Colorado Springs records are any indication of other communities' record keeping.)

Why had no one previously conducted an assessment of hazards in Colorado Springs? It isn't that Pikes Peak planners are not doing their jobs. Rather, it is that they are overwhelmed by the number of development proposals they must review, and that there has been little opportunity to assess comprehensively the cumulative impacts of proposed and approved developments. The planners are so busy responding to developers' requests that there is little time for or interest in stepping back from day to day decision making to devise a comprehensive land-use plan which takes hazards into account when analyzing sites for development. Many other sunbelt growth areas are probably experiencing a similar lack of planning. We do not argue that the lack of comprehensive planning is intentional. However, community leaders in a position to require more planning analysis from developers have not done so. The lack of comprehensive planning means that planners are issuing building permits based on inadequate information.

Two similar studies have been completed (Hewitt, 1971; Cooke, 1984). Both of these works point out that to date most research has examined single hazards. Hewitt called for more comprehensive ecological studies, but few planners, geographers, or students have undertaken them. He points out that a natural hazard of any sort is a function both of the physical event itself and the state of human society. This definition specifically includes the adjustments adopted to cope with the hazard as well as the state of preparedness of the population. The concept of a flood of a given magnitude or frequency causing a specific amount of damage is by itself misleading. Any volume of damage reported or expected is a function of both the natural event or physical cause and the prevailing or anticipated magnitude of the problem due to the state of the affected society (1975, p. 5).

Thus, from an ecological perspective it becomes clear that hazard and disaster potential relate as strongly to the normal activities of a community as to the particular nature of the extreme event. It follows that events for which there are no precedents in a population can create the greatest emergencies. In any given locality, a specific disaster can be so rare that it is difficult to persuade people, even on a nation-wide basis, that an accumulation of such unprecedented occurrences can represent an appreciable problem.

The mitigation of such rare but potentially devestating hazards is the ultimate goal of this study. If the report enlightens even a few prospective home buyers, planners, students, politicians, home builders, or teachers, we will have made at least a bit of difference.

The Origins of the Study

The Local Context. In the past, official policy has leaned toward *caveat emptor* (let the buyer beware) when possible hazards exist. For example, a home buyer would have to search through a variety of widely scattered documents in order to ascertain whether or not a prospective home was in an area of swelling soils or abandoned coal mines, as so many Colorado Springs houses are.

However, in 1983 a call for an assessment of the hazards of the city was included in the original Comprehensive Plan presented to City Council after a series of task forces developed the plan. The original plan called on the city to identify all natural hazards, such as steep slopes and dangerous soil conditions, and establish design guidelines for development in such areas. The plan also stated that channelization or similar modifications to watercourses should only be considered to ensure public safety or to avoid possible excessive costs of maintaining streams and drainageways in their natural state.

City Council revised the wording and intent of the above criteria in its final draft of the plan. These criteria were changed so that only a review of hazard areas is necessary with the *possibility* of requiring a land suitability study prior to the approval of development in an area of concern.

The Colorado Context. In Colorado a progressive law was passed to aid the battle against geologic hazards. House Bill 1041 provides for the identification and designation of geologic hazards and the adoption of guidelines at the county level to deal with these hazards. The bill provides local governments with needed information about the identification of the hazards themselves and the qualifications necessary for those workers determining the extent of hazard (Rogers *et al.*, 1974).

The Federal Context. Federal government agencies offer a wide range of programs to help local and regional officials deal with natural hazards. Within this paper, the federal response to the hazards facing Colorado Springs will be dealt with in the separate discussions of the various hazards.

The Myths About Natural Hazards in Colorado Springs

A helpful way to illustrate some of the problems in hazard management in Colorado Springs is to examine some of the prevailing beliefs or 'myths' held by people in the community. Most of these myths have little or no real basis when viewed in light of current hazard knowledge, local ordinances, and federal hazard policy.

"If we don't find out about dangers, there aren't any." The attitudes of some public officials in Colorado Springs are ambivalent at best. The prevailing philosophy appears to be that if an assessment of the hazards facing Colorado Springs is not available, then it follows that Colorado Springs has few natural or technological hazards to worry about.

"If we don't acknowledge hazards, we will not be liable for damages." This attitude assumes that the city is only liable for that about which it has knowledge. In light of past litigation, we doubt that this is the case for Colorado Springs or any other local government. In the national context, the issue of liablity does loom large. However, communities are finding that it is their responsibility 1) to enforce local hazard ordinances, 2) to have accurate maps of hazard areas, and, 3) to inform citizens about environmental risks.

"The government cannot tell land owners what they can and cannot do with their land." This argument is consistently raised by the city council, city planning office, and even by concerned, honest citizens. There is no basis to this argument for at least three reasons. First, landowners are constantly restricted. One cannot distill whiskey, operate a gambling casino, or place a steel fabrication plant in a residential neighborhood. Second, the assumption that someone who purchases land deserves to make a profit on that purchase is false. Land speculation is a risky business; in cases in which permits are granted for development on hazardous land, developers may make a fast profit, but after the hazard occurs, an individual or some government agency must bear the burden of recovery. Third, while many persons in Colorado Springs believe it is against the law to "take" property owners' rights by restricting land use through zoning or by refusing building permits, the courts consistently uphold a community's right to protect its citizens in spite of an individual landowner's interest. In fact, as reported by Kusler (1980), "No state supreme court has invalidated sensitive area regulations due to insufficient regulatory powers, and a successful challenge is unlikely in light of the array of general and specific enabling and home rule powers available in the states."

"It won't happen here." At the local level the odds seem rather small for a 1% or a 100-year magnitude hazard event. However, at the federal level, where all taxpayers are affected, hundreds of moderate to severe disasters occur annually, causing billions of dollars worth of damage and taking many lives. A community such such as Colorado Springs cannot afford to risk the lives and property of its citizens by relying on the blind notion that the community will not suffer significant hazard damages in the near future. Few local planners think that a disaster will happen in their town, but one will happen somewhere. The costs of preparation and wise hazard management may be perceived to be great, but they will pay for themselves many times over in reduced hazard damages when a major disaster does occur.

Uses of This Paper

The paper is divided according to hazard. It is intended to be a resource. Users should consult the references, ask questions of local officials, update the contents, refer to state and federal sources listed in the bibliography. The information is as accurate as is possible considering the scale of the maps used to analyze the hazards, the rapid annexation of additional land to the city, and the difficulty of accurately determining boundaries of hazard zones.

Mitigation of natural hazard phenomena is not an unwarranted expense; it is the most economically feasible approach to rational land-use policy. As Baker and McPhee (1975) have stated, there are several social benefits which derive from hazard mitigation. First is the substantial reduction of the risk to the population and to the economic investment in an area. Second is the reduction in public and private relief, evacuation and rehabilitation costs. Third is the reduction in expenditures on expensive protective structures. The long-term benefits of hazard mitigation pay off. This paper shows where mitigation measures are overdue and suggests practical and, in some cases, reasonable means for reducing losses.

FLOOD HAZARDS

> A fellow was building an apartment house in the flood plain. One day, while watching the construction, a geographer asked the builder whether he knew that the property where he was putting his new apartment house was in the flood plain. The builder answered, "Of course. In the 1894 flood, the water was ten feet deep right where we are standing." "Well then," asked the geographer, "aren't you worried about the long term value of your investment in the building?" "No," the builder replied. He only intended to own the building for six months, and the risk of a flood during that time was extremely small (White, 1975).

Floods pose the most severe potential hazard for Colorado Springs in terms of loss of property and loss of life. The main axis of the city runs along a usually placid stream called Monument Creek. Because of the semiarid climate in this part of Colorado, the creek normally has only a small quantity of water flowing within its banks. At times, however, intense thunderstorms or heavy and prolonged rain can cause the creek to flood severely--most recently in 1935 and 1965. During those devestating floods, millions of dollars of damage were incurred and many lives were lost.

Urbanization and Flood Plains

More than one-sixth of all urban land in the United States lies in the 1% flood plain (Goddard, 1976), and more than half this land was developed by 1974. Such development can effect changes in stream hydrology which in turn can cause severe increases in flood potential. Many researchers have documented the actual impacts that paving streets, lining drainage channels, and reducing permeable surfaces have on flood magnitude. These by-products of urbanization all shorten rainfall runoff time, resulting in earlier and higher concentrations of storm runoff in stream channels than would otherwise occur. Even small debris such as grass clippings or dumped garbage accumulating in an unmaintained channel can reduce channel capacity during high water and transform a small flood into a major one.

When a flood plain is developed, the value of the property which must be protected from floods increases. The greater the development, the better the cost/benefit ratio for a dam or other structural flood control device, and ironically, the sense that the dam protects developed property enhances future flood plain encroachment. Yet, many urban areas face severe flood hazards either because potential floods might exceed the design capability of structural flood control measures or because development is so extensive that spillways, essential for maintaining flood control, can no longer be used.

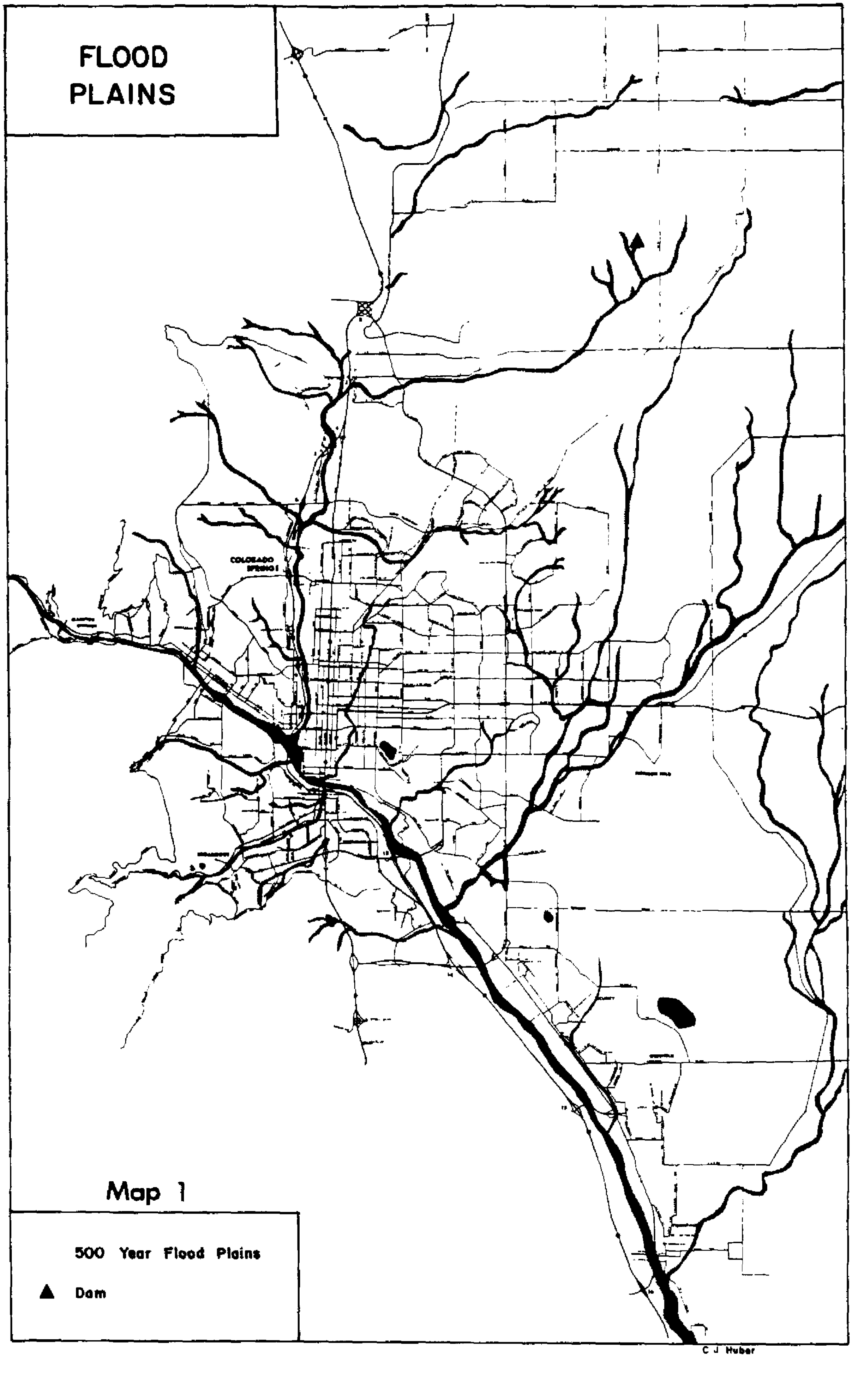
National Flood Insurance Program

The passage of the National Flood Insurance Act in 1973 enabled property owners in certain flood plain areas to purchase federally subsidized flood insurance. To avoid the possibility that the availability of flood insurance would lead to further development of flood plains, communities which participated in the program were required to pass flood plain regulations.

A flood plain ordinance was first passed in Colorado Springs in 1972. In 1985 Colorado Springs is expected to approve Flood Hazard Boundary Maps to assist in the enforcement of the flood plain ordinance and will thus enter the regular phase of the Flood Insurance Program (Map 1).

Urban Drainage and Flood Control

Regional flood plain management--i.e., basin-wide planning--is essential for successful flood mitigation. Floods and streams do not conform to political, jurisdictional boundaries, and flood plain managers must take into account the implications of upstream and downstream changes in the flood plain.


FLOOD
PLAINS
COLORADO
SPRINGS
Map 1
500 Year Flood Plains
Dam

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Thus, intergovernmental management allows communities to work together toward common goals such as region-wide warning systems or structural flood control works. For example, since 1969 Denver has had an active Urban Drainage and Flood Control District that manages the metropolitan area's flood control efforts, warning systems, and beautification projects. This agency has been instrumental in ameliorating severe flooding problems throughout the Denver Metro area. Smaller communities like Colorado Springs might also benefit from the development of similar districts which would coordinate flood hazard mitigation efforts.

Public Awareness

Civic groups, including the League of Women Voters of the Pikes Peak Region, have tried to increase public awareness of the flood hazard by conducting public forums and participating in decision-making processes leading to policy and structural changes in the flood plain. The League's 1984 consensus statement reads:

> In the future, only non-structural uses such as agriculture, recreation, open space or wildlife sanctuaries should be allowed in the 100-year floodplains. Parking lots are not considered acceptable uses in the floodplain. Similar restrictions are desirable in the 500-year floodplains. Channelization and other alterations of natural floodplains should be minimized. There should be strong regulatory city and county floodplain ordinances exceeding National Flood Insurance Program minimum standards. Ordinances should be strictly enforced with a minimum of variances. Provisions should be made for informing potential buyers that property is located in a floodplain. Cooperation in floodplain management among governmental bodies is essential. Mechanisms such as the National Flood Insurance Program, building codes, land use planning and the comprehensive plan should be used in such management where appropriate (Land Use Committee, LWPPR, 1983).

Flood Events

Colorado Springs and El Paso County have experienced several historical floods of significance. Some, as would be expected, affected more than one drainage area. In particular, the flood of May, 1935 was widespread and included Sand, Fountain, and Monument Creeks. The June, 1965 flood caused damage along both the Sand Creek and Fountain Creek drainages. Most of the flood-producing storms over the Monument Creek watershed occur during the summer months of May through August. In the immediate Colorado Springs area, floods are characterized by high peak flows, moderate volumes, and short durations.

Although the most recent flood in Colorado Springs occurred in 1965, the Big Thompson flood of 1976 was frightening to Colorado Springs residents even though it occurred about 130 miles northwest of the city. An unusual combination of conditions led to a flash flood which killed more that 140 people and caused more than $25 million in damages. A similar meteorlogical event is always a possibility in the Colorado Springs area and could be far more devastating than the Big Thompson flood since many more people and much more property are at risk in the Colorado Springs area.

Moreover, the potential for flood damage is on the increase. The rapidly increasing population is encroaching on many of the smaller intermittent feeder streams to Monument Creek as well as on Monument Creek itself. Fountain Creek, which flows through Ute Pass and Manitou Springs, also poses a very serious problem and has been called one of the two worst potential flood disasters in the state by FEMA officials (October, 1983, personal communication).

Sand Creek. Recorded flooding of Sand Creek spans a period of 55 years. In August, 1915, flooding resulted in considerable property damage and the loss of three lives. There was extensive damage during the May 30, 1935 flood as well. A new bridge was badly damaged, Galley Road (north of Highway 40) was nearly washed out, and another bridge was completely carried away. On

June 18, 1965, Sand Creek overflowed its banks one-half mile south of Fountain Boulevard. One bridge was washed out and another swept away. Drennan Road and the Bradley Road cutoff were also washed out, and agricultural land and stockwater dams were badly damaged. Extensive damage was again caused by the July 25, 1970 flood, during which 1.24 inches of rain fell in a two hour span. Resultant damages totalled approximately $50,000. Roads and bridges were badly damaged in the Kelker Road area, and the Aque land bridge was washed out. Powers Boulevard was also washed out, and Fountain Boulevard sustained shoulder damage. One life was lost (Soil Conservation Service, 1973).

Since 1962, gradual progress has been made in flood mitigation along Sand Creek. At that time, subdivisions were planned with specific allowance for greenbelts along the creek. In 1971, proposals were submitted for installation of storm sewers, extension of the length of bridge structures, and widening of the green belt, rip-rap, and concrete lining. In March of 1972, low-level aerial photography was used to gather additional flood hazard information. This data helped in the computation of water surface profiles and flood hazard area outlines (at a scale of 1:200 with four-foot contour intervals). An additional study of the Sand Creek area undertaken at the time analyzed hydrologic conditions. Both analyses used runoff computations based on existing land use as well as computations reflecting projected developments in 1990. Ten- to fifty-year floods were plotted as a result of this study. A further study conducted in 1973 showed that 82% of land in the area was open space, but projections for 1990 anticipated that 78% of the land would be residential with 56% of that in 5-acre tracts.

Fountain Creek. The first recorded major flooding on Fountain Creek occurred June 10, 1864, with a discharge estimated at 40,000 cubic feet per second. Another flood occurred on July 25, 1885, beginning with a cloud burst north of Colorado College and initial flooding in Monument Creek and Shooks Run. Flooding on June 3, 1921 seriously flooded the country surrounding Fountain while the town itself was spared. Severe damage occurred below the mouth of Spring Creek. On May 30, 1935, flooding again occurred, severely damaging the area along Monument Creek. All bridges were destroyed, and flood waters spread out and covered a mile wide area, leaving the town of Fountain without water. During the severe flood on June 17, 1965, water crested at eight feet on Sand Creek, putting a roller coaster bend in the bridge at the Sand-Fountain Creek confluence. Another wall of water completely washed out the bridge and filled Santa Fe Drive with turbulent muddy water, drowning several persons caught in their cars at the Harrison interchange. At the peak of the flood, the waters were 10 to 12 feet deep and a mile wide. (Corps of Engineers, 1984).

Flood hazard mitigation efforts for Fountain Creek have included placing a recording gauge just below the mouth of Little Fountain Creek in March of 1940 and monitoring it until 1952. In 1964, the recording gauge was located at Carson Boulevard bridge and Fountain Creek. In 1967, the Colorado Springs/El Paso County evacuation/operations plan was implemented along with a warning system to be used in case of heavy rainfall.

Monument Creek. Monument Creek also has a long history of flooding, including the June 10, 1864 flood which caused the loss of thirteen lives (discussed in the section on Fountain Creek). The flood of July 25, 1885 destroyed the Huerfano Street wagon bridge and Colorado bridge when flood water overflowed the tracks of the Denver and Rio Grande railroad. Some squatters' tents and cabins were also badly damaged. On August 2, 1886, intense rainfall in the Monument Creek and Templeton Gap drainage areas resulted in an estimated peak discharge of 40,000 cubic feet per second in Monument Creek. The area-wide flood of May 30, 1935 damaged property along Monument Creek severely. Excessive rainfall during a short period of time over an area of less than 100 square miles in the Monument Creek basin resulted in approximately $1,769,000 in damages that included destruction of all bridges with the exception of the Bijou Street viaduct. Eighteen lives were lost and many people were injured.

Following the 1935 flood, the city sponsored flood control work that included the construction of 2.6 miles of improved channel and guide levees on Monument Creek at the Templeton Gap outlet. The original design, planned in 1939, allowed for a peak flow of 50,000 cubic feet per second; however, this maximum has subsequently been reduced due to changes in the stream hydrology.

Small Drainages. In 1949, a concrete lining costing $1,172,000 was constructed at Templeton Gap. It is two miles long and was designed to handle a discharge of 14,000 cubic feet per second. In addition, a trapezoidal channel 10,590 feet long was built extending from Templeton Gap southwest to Monument Creek also with a capacity of 14,000 cubic feet per second.

At Peterson Field, stream water detention ponds were constructed at the air base to reduce peak flows from the upper 3.5 square miles of the drainageway. Other channelization has occurred in the area including the construction of concrete lined drainageways along sections of Bear Creek, Camp Creek, Douglas Creek North and South, Peterson Field drainage, Rockrimmon drainage, Sand Creek, South Shooks Run, and Spring Creek.

Dam Break Hazard

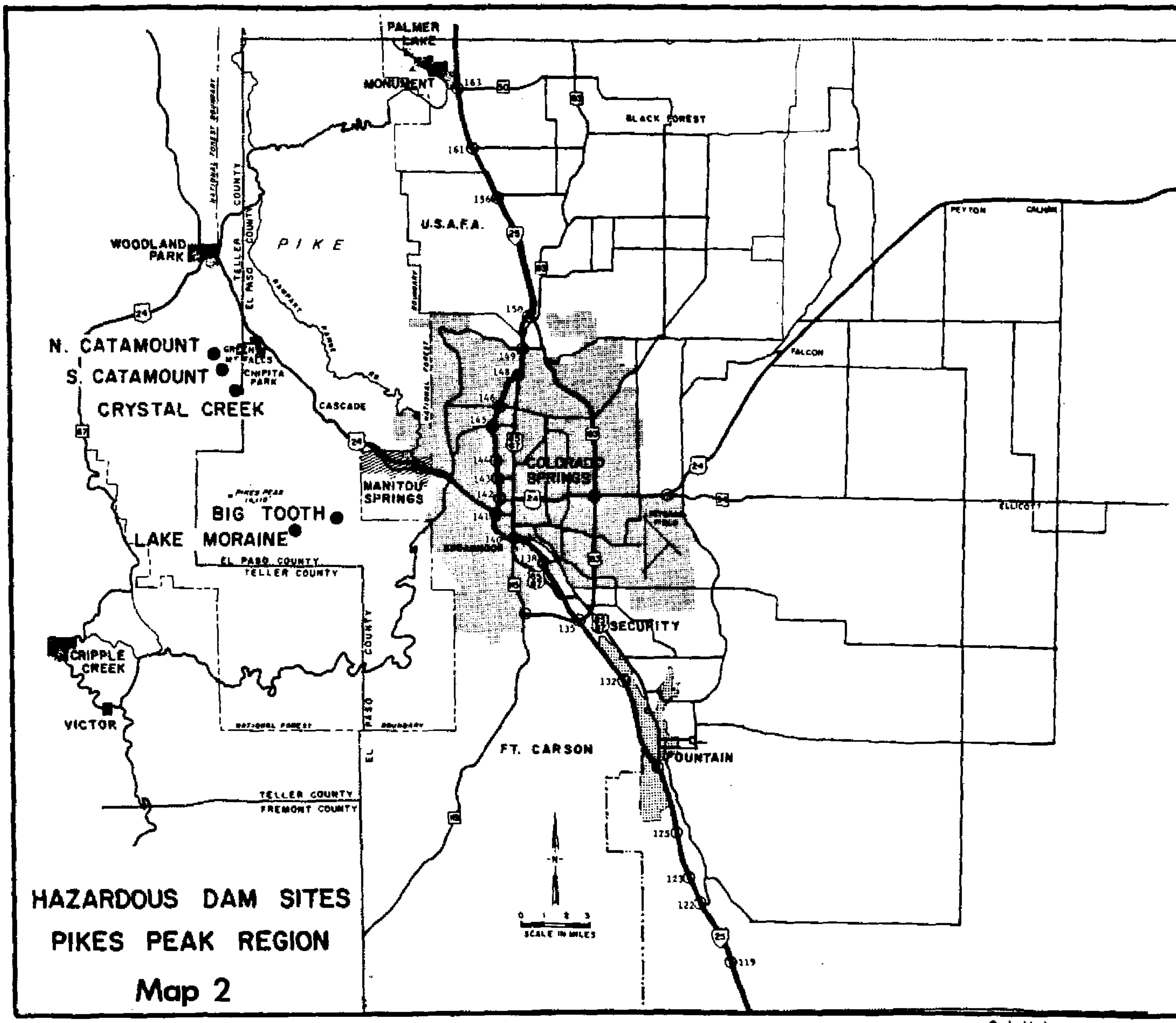
There are approximately 26 high and moderate hazard dams in El Paso County, and roughly 65% were built prior to the 1930s. The majority are earthen dams constructed entirely from mud, clay, and sand. These dams were built to supply water to Colorado Springs, not to control floods. Because the rains which cause most of the severe flooding in the region usually occur at a lower elevation than the dams, no protection should be expected from them.

Moreover, these dams age, becoming weak and cracked, and they are seldom repaired; dams in the state of Colorado are not officially inspected at any regular intervals. After the Big Thompson flood in 1976, the Colorado State Engineer's office began a state-wide inspection of all dams. However, this work has not been completed, and there are several dams in El Paso County that have not been inspected for more than twenty years.

High Risk Potential Dam Failure. Five dams (the South Catamount, North Catamount, Big Tooth, Lake Moraine, and Crystal Creek) pose a particularly severe hazard in El Paso County (Map 2). If these dams should completely fail, the maximum warning time for effected areas downstream would be 20 minutes; the minimum, only 2-3 minutes for people living below the Crystal Creek dam. These dams have been classified as high risk by the State Water Conservation Board because of the large populations and extensive property at risk below them.

Population at Risk. South Catamount dam is located 2 1/2 miles southwest of Green Mountain Falls, and it is anticipated that the peak discharge if it failed would be a minimum of 13,241 cubic feet per second. Fountain Creek would rise an estimated 10 to 15 feet above flood stage. Worse, should the South Catamount dam fail, the warning time to the public would be at best ten minutes.

Big Tooth and the Lake Moraine dams, located within five miles of the populated areas of Englemann Canyon, are approximately 1 1/2 miles apart, and both drain into Ruxton Creek. The peak discharge upon complete failure of


PALMER LAKE
MONUMENT
BLACK FOREST
U.S.A.F.A.
WOODLAND PARK
PIKE
TELLER COUNTY
EL PASO COUNTY
N. CATAMOUNT
S. CATAMOUNT
CRYSTAL CREEK
CASCADE
MANITOU SPRINGS
COLORADO SPRINGS
BIG TOOTH
LAKE MORAINE
EL PASO COUNTY
TELLER COUNTY
CRIPPLE CREEK
VICTOR
FALCON
PEYTON
CALHAN
ELLICOTT
SECURITY
FT. CARSON
FOUNTAIN
TELLER COUNTY
FREMONT COUNTY
SCALE IN MILES
HAZARDOUS DAM SITES
PIKES PEAK REGION
Map 2

C.J. Huber

either dam would be approximately 7,000 cubic feet per second. The Colorado Water Resources Department has added an additional warning for both dams. They "expect significant overbank flooding with overbank velocities in excess of eight to ten feet per second. Extensive property damage and potential loss of life expected."

Crystal Creek dam is located .9 miles south and slightly west of Green Mountain Falls. It drains into Crystal Creek. The town of Green Mountain Falls is directly in the path of any flood waters if this dam fails. The warning time to the town in the case of complete dam failure is only two to three minutes. The peak discharge would be approximately 22,000 cubic feet per second.

These five dams are owned by the City of Colorado Springs and are visually inspected daily by caretakers who live nearby.

Mitigation. El Paso County has a warning system in case of heavy rainfall, snowmelt, or dam weaknesses. The plan, thus far untested, specifies steps to be taken in case of failure of any one of the dams. Each plan outlines who is responsible for notifying the media, law enforcement agencies, and the general public but contains no plan for evacuation. If a dam should fail and the general public needs to be evacuated, confusion is likely to result.

Although dam failure so far has not been a major concern for the people of El Paso County, the dams are old, they remain uninspected, and they are being used for purposes for which they were not designed (McWilliams, 1984). As the population in the affected areas continues to grow, the potential for loss of life and property becomes even greater.