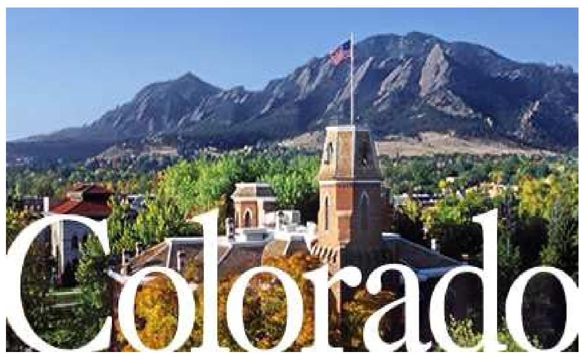
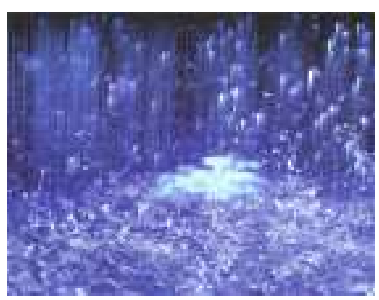
July, 2006

University of Colorado-Boulder Multi-Hazard Mitigation Disaster Resistant University Plan





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Multi-Hazard Mitigation DRU Plan
Executive Summary

The University of Colorado-Boulder (UCB) has prepared this Multi-Hazard Mitigation, Disaster Resistant University Plan (DRU Plan) pursuant to the requirements of the Disaster Mitigation Act of 2000, PL 106-390 390 and established regulations at 44 CFR Part 201.6 (hereafter referred to as DMA 2000). This plan documents the UCB DRU Planning Process, identifies natural hazards and associated risks of concern to UCB, and identifies UCB's hazard mitigation strategy to make UCB less vulnerable and more disaster resistant and sustainable. Information in the plan can also be used to help guide and coordinate mitigation activities, local policy decisions and the direction of future land use for the University.

Hazard Mitigation is defined as any sustained action taken to reduce or eliminate long-term risk to human life and property from hazards. Hazard Mitigation Planning is the process through which natural hazards that threaten communities are identified, likely impacts of those hazards are determined, mitigation goals are set, and appropriate strategies that would lessen the impacts are identified, prioritized, and implemented. Hazard Mitigation Planning is required for state and local governments to maintain their eligibility for FEMA Pre-Disaster Mitigation (PDM) and Hazard Mitigation Grant Programs (HMGP). More importantly, this plan and planning process lays out the strategy that will enable UCB to become less vulnerable to future disaster losses.

This Executive Summary provides an overview of the mitigation planning effort and is organized in the following sections:

1) Background, Methodology & Process
2) Risk Assessment Findings
3) Mitigation Strategy Action Plan
4) Plan Adoption and Implementation

BACKGROUND, METHODOLOGY & PROCESS

The Campus

UCB has grown from one building in 1876 into a teaching and research institution of national reputation. The UCB campus is located in the Rocky Mountain Front Range area in the City of Boulder, about 25 miles northwest of Denver. The UCB campus includes three proximate properties, all of which are located within the City of Boulder: the 306-acre Main Campus, the 197-acre East Campus, and 64 acres at Williams Village. In addition, the campus includes the undeveloped CU-Boulder South Campus, 308 acres just southeast of the City of Boulder, and the Mountain Research Station, 190 acres situated in the mountains west of Boulder between Nederland and Ward. All campus properties, except for the Mountain Research Station at an elevation of 9,400 feet, are located in the Boulder Valley at the base of the Rocky Mountain foothills at an elevation of 5,400 feet.

Scope

UCB's DRU Plan is a single jurisdictional plan that identifies goals, objectives, and measures for hazard mitigation and risk reduction of natural hazards. This plan covers the UCB campus, which includes Main campus, Williams Village, East Campus, South Campus, and the Mountain Research Station.

This plan follows DMA 2000 planning requirements and associated guidance for developing Local Hazard Mitigation Plans, including specific guidance for "Building a Disaster-Resistant University."

The Planning Process

UCB, Office of Emergency Management and Business Recovery Planning (UCB OEM) recognized the need and importance of this plan and was responsible for its initiation. The primary funding source for this planning assistance contract was obtained by the UCB OEM in the form of a FEMA grant. In addition, planning team members contributed in-kind services to this effort by attending meetings, collecting data, managing administrative details, and providing facilities for meetings.

UCB contracted with AMEC Earth & Environmental (AMEC) to facilitate and develop this DRU Plan. AMEC established the planning process utilizing DMA planning requirements and FEMA's associated guidance. This guidance is structured around a generalized four-phase process:

- Phase 1: Organize resources
- Phase 2: Assess hazards and risks
- Phase 3: Develop a mitigation plan
- Phase 4: Evaluate the work

Phase 1: Organize Resources

The first phase of the plan development process involved three steps:

- Build the planning team,
- Plan for public involvement,
- Coordinate with other departments and agencies

Build the Planning Team

Plan development began with the formation of a Hazard Mitigation Planning Committee (HMPC) comprised of key UCB representatives and other interested stakeholders from local city, county, and other governmental agencies. The HMPC met five times over an eight-month period. The list of participating HMPC members is provided below.

University Departments

- Emergency Management Operations
- UCB OEM
- Environmental Health & Safety
- Public Safety
- University Risk Management
- University Police
- Residential Housing
- Family Housing
- Athletics
- Facilities Management
- University Fire
- Mountain Research Station Manager
- Planning Departments
- ITS Department
- Faculty and Student Representatives
- Wardenburg Medical Clinic

Local Government/Agency Representatives

- City of Boulder Floodplain Manager
- Colorado Water Conservation Board
- Urban Drainage and Flood Control District

Plan for Public Involvement

At the kick-off meeting, the HMPC discussed options for public involvement. The HMPC's approach utilized established public information mechanisms and resources within the University. Public involvement activities included press releases, website postings and collection of public comments to the Draft Plan. Stakeholder and public comments are reflected in the preparation of the plan, including those sections addressing mitigation goals and action strategies.

Coordinate with other Departments and Agencies

Early on in the planning process, the HMPC determined that data collection, mitigation and action strategy development, and plan approval would be greatly enhanced by inviting other state and federal agencies to participate in the planning process. Based on their involvement in hazard mitigation planning, their landowner status in the county, and/or their interest as a neighboring jurisdiction, representatives from various UCB departments and key county, city, district and stakeholder representatives were invited to participate in the plan development process.

Development of the plan also included coordination with other University planning efforts. Integrating existing planning efforts and mitigation policies and action strategies into this DRU Plan establishes a credible and comprehensive plan that ties into and supports other university programs.

RISK ASSESSMENT FINDINGS

Phase 2: Assess Hazards and Risks

Risk from natural hazards is a combination of hazard, vulnerability and exposure. The risk assessment process measures the potential loss to a community, including loss of life, personal injury, property damage, and economic injury resulting from a hazard event. The risk assessment process allows a community to better understand their potential risk and associated vulnerability to natural hazards. This information provides the framework for a community to develop and prioritize mitigation strategies and projects to help reduce both the risk and vulnerability from future hazard events.

This risk assessment for UCB followed the methodology described in the FEMA publication 386-2 Understanding Your Risks – Identifying Hazards and Estimating Losses (FEMA, 2002) and was based on a four-step process:

- Identify Hazards
- Profile Hazard Events
- Inventory Assets
- Estimate Losses

Identify Hazards and Profile Hazard Events

The UCB HMPC conducted a Hazard Identification study to determine what hazards threaten the planning area. This section of the plan documents and profiles the possible natural hazards affecting UCB. It includes a description, by hazard, of previous occurrences and the likelihood of their recurrence. This hazard profile sets the stage for the next part of the risk assessment where the risk to UCB is quantified for each of the significant hazards.

The natural hazards identified and investigated for UCB's DRU Plan include:

- Avalanche
- Dam failure
- Drought
- Earthquakes

- Floods
- Landslides and Rockfalls
- Human health hazards
    - West Nile Virus
    - Pandemic Influenza
- Severe weather
    - Extreme temperatures
    - Hailstorm
    - Heavy rains/storms
    - Lightning
    - Tornadoes
    - Windstorms
    - Winter Storms
- Soil Hazards
    - Expansive soils
    - Land subsidence
- Volcano
- Wildfires

The frequency of past events is used in this section to gauge the likelihood of future occurrences. Based on historical data, the frequency of occurrence is categorized into one of the following classifications:

Highly Likely*: Near 100% chance of occurrence in next year, or happens every year.*

Likely*: Between 10 and 100% chance of occurrence in next year, or has a recurrence interval of 10 years or less.*

Occasional*: Between 1 and 10% chance of occurrence in the next year, or has a recurrence interval of 11 to 100 years.*

Unlikely*: Less than 1% chance of occurrence in next 100 years, or has a recurrence interval of greater than every 100 years.*

Inventory Assets and Estimate Losses

As the next part of the Risk Assessment process, the HMPC conducted a Vulnerability Assessment to describe the impact that each hazard identified in the preceding section would have upon the UCB Planning Area. This Vulnerability Assessment includes an inventory of assets at risk and an estimate of potential losses.

Vulnerability is measured in general, qualitative terms, and is a summary of the potential impact based on past occurrences, spatial extent, and damage and casualty potential:

Extremely Low: *The occurrence and potential cost of damage to life and property is very minimal to non-existent.*

Low*: Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.*

Medium*: Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.*

High*: Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread. Hazards in this category may have already occurred in the past.*

Extremely High: *Very widespread and catastrophic impact.*

The table below summarizes the results of the Risk Assessment. The table also includes an evaluation of whether a hazard was considered a Critical or Non-Critical hazard relative to the UCB Planning Area. Those hazards that are identified as Critical are addressed in the Mitigation Strategy portion of the Plan. Those that are identified as Non-Critical are tabled until evaluated again during the annual update process for this plan. The methodology for determining the Criticality of a hazard to UCB is described below.

Defining the criticality of a hazard to a community is based on a subjective analysis of several factors. This analysis is used to focus and prioritize mitigation measures for the plan. These factors include the following:

Past Occurrences: *Frequency, extent, and magnitude of historic hazard events.*

Likelihood of Future Occurrences: *Based on past hazard events.*

Ability to Reduce Losses through Implementation of Mitigation Measures*: Based on mitigation measures currently in place, consideration of both the ability to further mitigate the risk of future occurrences as well as the ability to further mitigate the vulnerability of a community to a given hazard event.*

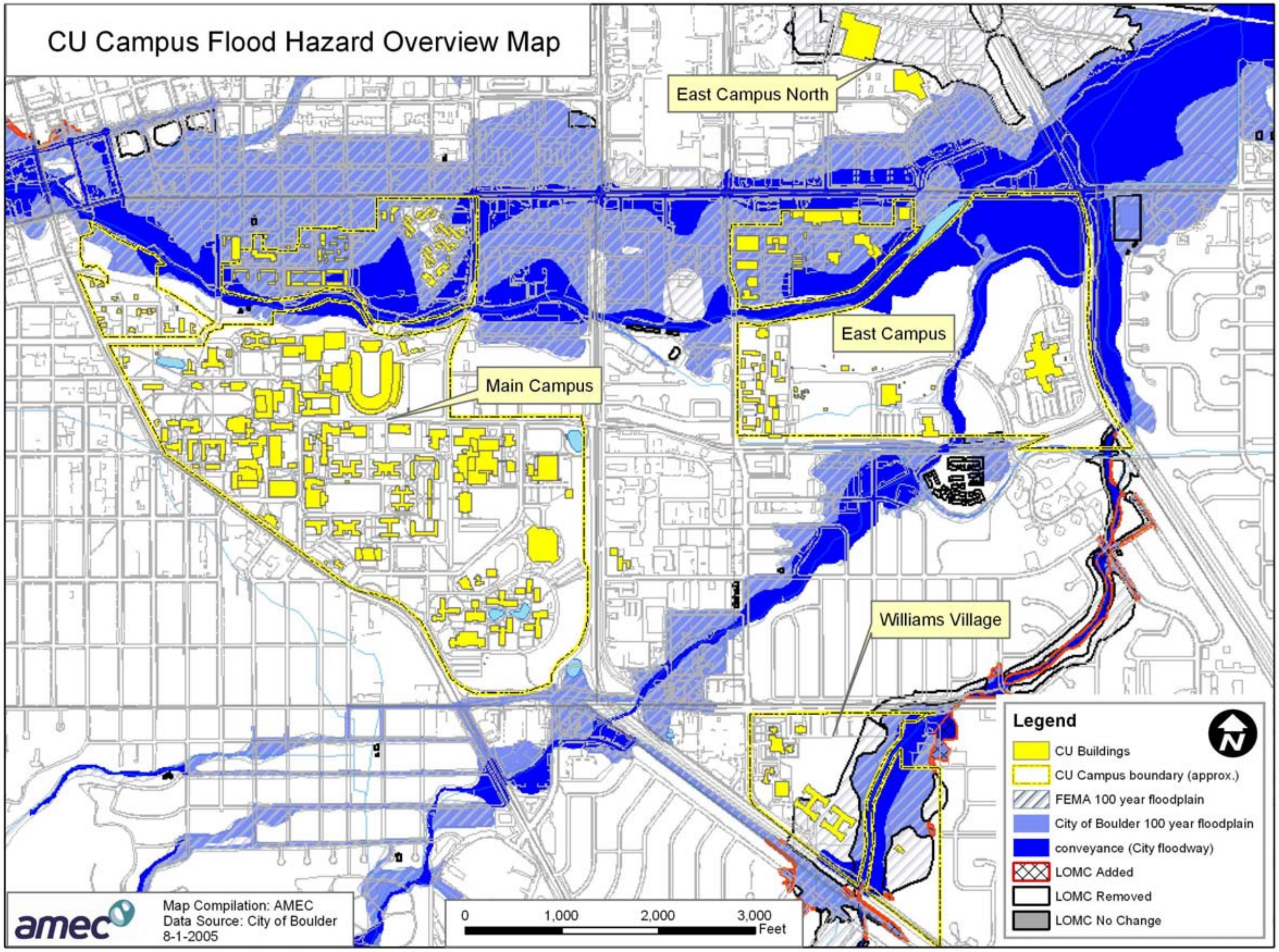
Risk Assessment Summary			
Hazard	**Risk Classification**	**Vulnerability Classification**	**Critical/ Non Critical Hazard**
Avalanche	Unlikely	Extremely Low	Non-Critical Hazard
Dam Failure	Unlikely	Extremely High	Non-Critical Hazard
Drought	Likely	Low	Non-Critical Hazard

Risk Assessment Summary			
Hazard	**Risk Classification**	**Vulnerability Classification**	**Critical/ Non Critical Hazard**
Earthquakes	Occasional	High	Non-Critical Hazard
Floods	Occasional	High	**Critical Hazard**
Landslides/ Rockfalls	Unlikely	Extremely Low	Non-Critical Hazard
Human Health Hazards: West Nile Virus	Occasional	Medium	**Critical Hazard**
Human Health Hazards: Pandemic Influenza	Occasional	High	**Critical Hazard**
Severe Weather: Extreme Temperatures	Highly Likely	Low	Non-Critical Hazard
Severe Weather: Hailstorm	Likely	Low	**Critical Hazard**
Severe Weather: Heavy rains/ thunderstorms	Highly Likely	Medium	**Critical Hazard**
Severe Weather: Lightning	Highly Likely	Medium	**Critical Hazard**
Severe Weather: Tornadoes	Likely	Low	Non-Critical Hazard
Severe Weather: Windstorms	Highly Likely	Medium	**Critical Hazard**
Severe Weather: Winter Storms	Highly Likely	Medium	**Critical Hazard**
Soil Hazards: Expansive Soils	Occasional	Low	Non-Critical Hazard
Soil Hazards: Land Subsidence	Occasional	Low	Non-Critical Hazard
Volcano	Unlikely	Low	Non-Critical Hazard
Wildfires	Likely	Medium	**Critical Hazard**

In evaluating the hazards affecting the University, the flood hazard is clearly the most significant in terms of risk of occurrence and potential losses. Therefore, the following sections expand on the Risk Assessment findings associated with the flood hazard.

The Flood Hazard

Flooding and floodplain management is a significant issue in Boulder County, the City of Boulder, and the UCB Planning Area. The risk potential or likelihood of a flood event occurring in the Planning Area increases with the annual onset of heavy rains from April through September and the snowmelt runoff during May through June. Much of the historical growth in Boulder and the UCB Planning Area occurred adjacent to streams. Should these streams overflow, flooding could cause damages to property, losses from disruption of community activities, and potential loss of life. Additional development occurring in the watersheds of these streams has the potential to affect both the frequency and duration of damaging floods through an increase in stormwater runoff. Other issues related to flooding include erosion, sedimentation, water quality degradation, loss of environmental resources, and certain health hazards. Also to be considered during a flood on the UCB campus is the possible isolation of the university from necessary response-type services such as hospital, police and fire. The figure that follows illustrates the flood hazard at UCB.


CU Campus Flood Hazard Overview Map
East Campus North
East Campus
Main Campus
Williams Village
Legend
CU Buildings
CU Campus boundary (approx.)
FEMA 100 year floodplain
City of Boulder 100 year floodplain
conveyance (City floodway)
LOMC Added
LOMC Removed
LOMC No Change
amec
Map Compilation: AMEC
Data Source: City of Boulder
8-1-2005
0
1,000
2,000
3,000
Feet

UCB maintains NFIP flood policies for all 58 improved parcels located in FEMA's 100-year floodplain. This includes 48 parcels located on Main Campus and 10 policies for parcels on East Campus. There have been no claims filed on the NFIP policies since coverage was purchased about four years ago. Additionally, prior to obtaining NFIP flood policies, there were no reported damages to structures within the 100-year flood plain as a result of flooding. The following tables summarize the analyses conducted on UCB assets and populations at risk within the 100-year floodplain.

UCB Flood Hazard
Assets and Values at Risk
Summary Table

Type of Building/Assets	Number of Buildings			Value of Properties and Assets		
	# on Campus	# in Hazard Area	% in Hazard Area	$ on Campus	$ in Hazard Area	% in Hazard Area
Classrooms	46	3	6.52%	$604,110,657	$23,368,720	3.87%
Common Areas/Auditoriums	4	0	0%	$85,471,130	$0	0%
Data Systems	3	0	0%	$6,351,000	$0	0%
Libraries/Museums	2	0	0%	$327,047,385	$0	0%
Medical Facilities	1	0	0%	$12,459,980	$0	0%
Offices	34	2	5.88%	$201,487,085	$535,490	0.27%
Recreation	10	0	0%	$135,928,400	0	0%
Research	23	6	26.09%	$333,358,090	$72,723,525	21.82%
Residential	41	16	39.02%	$360,480,980,	$90,916,250	25.22%
Storage/Parking	14	8	57.14%	$13,318,650	$561,200	4.21%
Utilities/ & Infrastructure	16	5	31.25%	$124,350,634	$5,922,800	4.76%
Totals	**194**	**40**	**20.62%**	**$2,204,363,991**	**$194,027,985**	**8.80%**

(Source: Risk Management Property Schedule; City/UCB GIS Flood Maps and Parcel Data)

UCB Populations at Risk to the Flood Hazard Summary Table						
Type of Building/Assets	**Number of Staff**			**Number of Students**		
	# on Campus	**# in Hazard Area**	**% in Hazard Area**	**# on Campus**	**# in Hazard Area**	**% in Hazard Area**
Classrooms	4123	133	3.23%	23,289	0	0%
Common Areas/Auditoriums	871	0	0%	189	0	0%
Data Systems	0	0	0%	0	0	0%
Libraries/Museums	760	0	0%	186	0	0%
Medical Facilities	234	0	0%	0	0	0%
Offices	2808	2	0.07%	466	0	0%
Recreation	505	0	0%	23	0	0%
Research	3198	967	30.24%	788	2	0.25%
Residential	1386	1	0.07%	6,949	1,022	14.7%
Storage/Parking	2	0	0%	0	0	0
Utilities/ & Infrastructure	113	45	39.8%	0	0	0
Totals	**14,000**	**1,148**	**8.2%**	**31,890**	**1,024**	**3.21%**

(Source: Risk Management, Family and Residential Housing, Planning, Budget & Analysis)

Key issues relative to the flood hazard at UCB are summarized below:

- 20.62% of the total number of UCB buildings are located in the flood hazard area. This includes 39% of UCB's residential housing and 26% of their research facilities.
- Looking at associated values, $194,027,985 or 8.8% of the total UCB values are located in the 100-year floodplain.
- It should be noted that included in the values at risk in the flood hazard area is $1,707,225 for research animals. This equates to 39.98% of all research animals at UCB being located within the flood hazard area.
- With respect to populations at risk in the flood hazard area, 8.2% of the staff and 3.21% of the student population are located within the 100-year floodplain. It is important to consider that the 1,022 students located within the flood hazard area are within the family housing area adjacent to Boulder Creek and reside there on a 24/7 basis.

- Critical Facilities: 21 Priority One Facilities out of a total of 77 for all campus properties (27.27%) are located within the 100-year floodplain; 2 Priority Two Facilities out of a total of 13 for all campus properties (15.38%) are also located in the flood hazard area.
- Identified as a critical facility, the Computing Center for the UCB campus is located in the 100-year floodplain, currently with no viable backup options.

Total Values at Risk and Floodproofing Analysis. With so many key assets at risk within the flood hazard area, the ability to determine cost effective solutions for reducing UCB vulnerability is critical. To assist in this effort, the HMPC reviewed a 2002 Floodproofing Analysis for the Boulder Creek floodplain that was prepared for the University by Love and Associates, Inc. This analysis identifies UCB buildings located within the 100-year floodplain along Boulder Creek, starting at 17th Street going easterly toward Folsom Street. As part of this study, a field survey was conducted to determine finished floor elevations to evaluate the potential exposure these buildings have to flooding from Boulder Creek. This was followed by an analysis of suitable floodproofing solutions. The floodproofing elevation was set to meet Urban Drainage and Flood Control District (UDFCD) criterion, which is one foot above the 100-year floodplain elevation.

Utilizing this data, the HMPC developed an initial starting point for a cost benefit analysis to be used to determine and support proposed floodproofing options on a building by building basis. Combining information from UCB's property schedule, this analysis presents the total values at risk and compares them to proposed floodproofing costs. Using total values for all buildings at risk, this equates to $87,370,100 at risk compared to a cost of $1,501,160 to $1,923,400 to floodproof these buildings, depending on the floodproofing option selected.

This comparison of values at risk to costs to mitigate the problem is somewhat misleading and can further be refined with additional analysis. This additional analysis recognizes that 100% of the building structure and contents will not be lost in a 100-year flood. To more accurately determine what is currently at risk to the 100-year flood, base flood elevation (BFE) data from the Love Study was used to determine likely percent of damage to the entire structures. Utilizing this data, the average BFE for all buildings in the study is 0.5 feet.

Using both FEMA's Flood Building and Content Loss Estimation Tables for Two Story No Basement Buildings: In a 100-year flood, flood depth ranging from -1/2 foot to 1/2 foot results in building and content damages averaged at 6.25%. This equates to $5,460,631.25 of the total $87,370,100 currently at risk to the 100-year flood compared to the $1.5 to 1.9 Million in costs to floodproof the structures.

This number could also be misleading due to many unknowns during a flood event. For example, the nature of any given flood event might change the degree of damages. If a flood event is greater than a 100-year flood, more damage should occur. Other factors to be considered include damages caused by upstream structures which have joined the floodwaters, increase in damages due to high velocity flood waters, whether any of the structures have basements, and the types of existing building construction, to name a few. **However, beyond looking at these variables in property damage, life safety considerations are paramount.** These structures at risk are used primarily for family housing. Access to high ground becomes a significant issue during any flood event.

In order to determine probable impacts during a given flood event, additional evaluation and a detailed cost benefit analysis is recommended on a structure by structure basis, factoring in both property damage and life safety considerations.

500-Year Floodplain Analysis. The previous analysis has focused on evaluating impacts to the university from a 100-year flood event. Also to be considered are potential damages associated with a 500-year flood. A 500-year flood would result in more widespread impact to UCB properties, both in terms of the number of structures inundated and in the depth of flooding. Using GIS to model the affects, 34 UCB properties, in addition to the properties impacted by the 100-year flood, would be impacted by the 500-year flood as illustrated in the following table.

UCB
500-Year Flood Hazard
Assets at Risk

CU Properties within the 500 year Floodplain, but outside of the 100 year floodplain	
Name	**Number of Structures**
Distribution center	1
Bear Creek Apartments	2
Center for Innovation & Creativity	1
Darley Towers	1
Lasp Space Tech Center	1
Newton Court	25
Presidents Residence	1
Unnamed	2
Total	**34**

With respect to UCB assets, a 500-year flood on Boulder Creek would have the greatest impacts, as opposed to the Skunk and Bear Canyon Creek drainages. As indicated above, not only does the 500-year flood damage 34 more structures than the 100-year flood, the damage to structures within the 100-year floodplain are greater due to the increased flood depth within the area of the 100-year floodplain. Other impacts would be increased displacement time for student residents and increased functional downtime of UCB facilities.

Assess Existing Mitigation Capabilities

Thus far, the planning process has identified the natural hazards posing a threat to the UCB Planning Area and described and quantified the vulnerability of UCB to these risks. A critical and final part of the risk assessment is to determine what loss prevention mechanisms are already in place. An evaluation of UCB's existing capabilities results in the identification of UCB's "net vulnerability" to natural disasters and more accurately focuses the goals, objectives and proposed actions of this plan designed to reduce the impacts of these risks. This part of the planning process is referred to as the "Capability Assessment."

The HMPC took two approaches in conducting this assessment. First, an inventory of existing policies and plans was made. These policy and planning documents were collected and reviewed to determine if they contributed to reducing hazard related losses, or if they inadvertently contributed to increasing such losses. The purpose for this effort was to identify activities and actions including existing policies, regulations and plans that were either in place, needed improvement, or could be undertaken, if deemed appropriate. Once complete, the HMPC was ready to develop the Mitigation Strategy portion of the Plan.

MITIGATION STRATEGY & ACTION PLAN

Phase 3: Develop a Mitigation Plan

This section describes the mitigation strategy process and mitigation action plan for UCB's DRU Plan. The development of the mitigation strategy and action plan follows Phase 3 of FEMA's 4 Phase guidance: "Developing the Mitigation Plan." and includes the following steps:

- Set Planning Goals
- Review Possible Activities
- Draft an Action Plan

Set Planning Goals

Up to this point in the planning process, the HMPC has organized resources, assessed natural hazards and risks, and documented mitigation capabilities within the County. A profile of UCB's vulnerability to natural hazards resulted from this effort, which is documented in the early chapters of this plan. The resulting goals, objectives, and mitigation actions were developed based on this profile. The HMPC developed this section of the plan with a series of meetings and exercises designed to achieve a collaborative mitigation planning effort.

During the initial goal setting meeting, the HMPC reviewed the results of the hazard identification, vulnerability assessment and capability assessment. This analysis of the risk assessment identified areas where improvements could be made, providing the framework for the HMPC to formulate planning goals, objectives and the ultimate mitigation strategy for the University.

Utilizing the risk assessment, the HMPC developed the following three goals with several objectives and associated mitigation measures. These goals and objectives provide the direction for reducing future hazard-related losses within UCB.

GOAL 1: Provide protection for people's lives from hazards

Objective 1.1: Inform and educate university residents, faculty, staff, students, visitors, regents, etc. about the types of hazards they are exposed to and where they occur, as well as recommended responses to identified hazards (create an outreach program, provide educational resources and training)

Objective 1.2 Identify and resolve impediments to implementation of recommended responses

Objective 1.3: Continue emergency planning, public education, and training for university, including early warning and detection (real-time), evacuation procedures, and related information for residents, faculty, students and visitors

GOAL 2: Improve University capabilities to mitigate losses

Objective 2.1: Provide protection for existing buildings to the extent possible

- 2.1.1 Provide/Improve flood protection
    - 2.1.1.1 Family Housing
    - 2.1.1.2 Computing Center
    - 2.1.1.3 Research Animals (Behavioral Genetics)
    - 2.1.1.4 As an annex to this Plan, develop a 10-year strategic flood mitigation plan identifying specific facilities to be mitigated and the cost and proposed schedule for mitigation
- 2.1.2 Maintain and improve the flood mitigation program to provide flood protection at a minimum to 100-year protection, with consideration of 500-year and worst case scenarios

2.1.3 Consider and incorporate mitigation activities for all natural hazards of concern to the university during any renovation activities

Objective 2.2: Provide protection for future development to the extent possible

2.2.1 Incorporate hazard mitigation for all natural hazards of concern to the university in future development and in long-range planning

2.2.2 Ensure that university is practicing sound floodplain management

2.2.2.1 Establish a floodplain manager for university

Objective 2.3: Provide protection for critical facilities and services

2.3.1 Identify and protect the most “critical” facilities

2.3.1.1 Essential facilities: Co-Gen, IT, Wardenburg, Research, etc

2.3.2 Protect hazardous materials locations

2.3.2.1 Science Buildings

2.3.2.2 EHSC

Objective 2.4: Promote improved internal and external University coordination

2.4.1 Assure coordination between other university plans and goals

2.4.2 Minimize losses by informing affected facilities/departments of issues/potential losses

2.4.3 Assure coordination with other departments, communities, agencies, etc.

2.4.4 Create tracking system and central repository for university documents

2.4.5 Identify and incorporate hazard mitigation “lessons-learned” and best practices from other universities into plan implementation

GOAL 3: Maintain/Provide for FEMA eligibility and work to position University for grant funding

Objective 3.1: Provide university departments with information regarding mitigation opportunities

Objective 3.2 As part of Plan implementation, review projects in this plan on an annual basis to be considered for annual FEMA PDM-C grant allocations or after a presidential disaster declaration in Colorado for HMGP funding

Review Possible Activities

Following the goal setting process, the HMPC analyzed a set of viable mitigation alternatives that would support identified goals and objectives. Each HMPC member was provided with the following list of categories of mitigation measures:

- Prevention,
- Property Protection,
- Structural Projects,
- Natural Resource Protection,
- Emergency Services, and
- Public Information.

The HMPC members were also provided with several lists of alternative multi-hazard mitigation actions for each of the above categories. A facilitated discussion then took place to examine and analyze the alternatives. With an understanding of the alternatives, a brainstorming session was conducted to generate a list of preferred mitigation actions to be recommended.

Once mitigation actions were identified, the HMPC members were provided with several sets of decision-making tools, including FEMA's recommended STAPLE/E set, Sustainable Disaster Recovery criteria, Smart Growth principles, and "Others" to assist in deciding why one recommended action might be more important, more effective, or more likely to be implemented then another. This effort led to a prioritization exercise of identified projects.

Recognizing the DMA regulatory requirement to prioritize by Benefit-Cost and the need for any publicly funded project to be cost-effective, the HMPC decided to pursue implementation according to when and where damages occur, available funding, individual department priority, and priorities identified in the State Mitigation Plan. This process drove the development of a prioritized action plan for UCB. Cost effectiveness will be considered in additional detail when seeking FEMA mitigation grant funding for eligible projects associated with this Plan.

Draft an Action Plan

The results of the planning process, the risk assessment, the goal setting, the identification of mitigation measures, and the hard work of the HMPC led to the Action Plan that follows. Taking all of the above into consideration the HMPC has developed this **overall mitigation strategy**:

- COMMUNICATE the hazard information collected and analyzed through this planning process so that the University community better understands what can happen where, and what they can do themselves to be better prepared. This also includes publicizing the "success stories" that are achieved through the HMPC's ongoing efforts.

- IMPLEMENT the Action Plan recommendations of this plan.

- UTILIZE existing rules, regulations, policies and procedures already in existence. Communities can reduce future losses not only by pursuing new programs and projects, but also by more stringent attention to what's already "on the books."

- MOM—ardently monitor "Multi-Objective Management" opportunities, so that funding opportunities may be shared and "packaged" and broader constituent support may be garnered.

This Action Plan presents the recommendations developed by the planning team for how UCB can lessen the vulnerability of people, property, infrastructure, and natural and cultural resources to future disaster losses. The Recommended Mitigation Actions that follow are organized by hazard and UCB department, as appropriate. Within each category, the projects are listed in order of relative priority as determined by the HMPC.

It is important to note that UCB has numerous existing, detailed project descriptions, including cost estimates and benefits, in the Campus Master Plan and associated Capital Improvement Reports. These projects are considered to be part of this plan and the details, to avoid duplication, should be referenced in their original source document. UCB also realizes that new project needs and priorities may arise as a result of a disaster or other circumstances, and reserves the right to support these projects, as necessary, as long as they conform to the overall goals of this plan.

Action Plan
The projects included in this DRU Action Plan are listed in the table that follows:

Mitigation Action Plan
Summary Table

Mitigation Type and Action #	Mitigation Action Title	Priority	Responsible Department
Flood Measures			
Action #1	Evaluate Flood Mitigation Options	High	Risk Management, Emergency Management, Facilities Management, Vice Chancellor of Administration, Housing and Dining Services/Family Housing
Action #2	Establish Floodplain Management Policy/Floodplain Manager	High	Facilities Management
Action #3	Relocate Campus Utilities that Cross Boulder Creek	High	Facilities Management Engineering

Mitigation Type and Action #	Mitigation Action Title	Priority	Responsible Department
Action #4	Evaluate Family Housing Buildings for Shelter in Place during Floods	Medium	Dining and Housing Services
Action #5	Implement Stormwater Projects Identified and Prioritized in the UCB Stormwater Drainage Master Plan Report	Medium	Facilities Management
Wildfire Measures			
Action #6	Install Automatic Fire Suppression Systems Throughout Family Housing	Medium	Department of Housing, Fire and Life-Safety Group
Action #7	Conduct Wildfire Mitigation of Mountain Research Station	Low	Facilities Management
Human Health Measures			
Action #8	Implement Mosquito-Borne Disease Controls	Low	Facilities Management Environmental Services – Environmental Operations
Action #9	Implement Avian Flu Planning and Mitigation	*	Environmental Health & Safety, Facilities Management-Environmental Services, EMOG
Emergency Management Measures			
Action #10	Evaluate Evacuation and Shelter-In-Place Planning and Conduct Evacuation Training and Drills	High	Police Department, Emergency Management, Housing and Dining Services/Family Housing
Action #11	Improve and Enhance Early Detection and Notification System	High	Police Department, Emergency Management, Facilities Management
Action #12	Conduct Additional Evaluation of Critical Facilities at Risk to All Hazards	Medium	Emergency Management, University Police, Facilities Management
Action #13	Conduct Table Top Exercises	Medium	Family Housing, Emergency Management, Environmental Health & Safety

Mitigation Type and Action #	Mitigation Action Title	Priority	Responsible Department
Action #14	Continue training in ICS/Emergency Response and Business Continuity Planning	Low	Emergency Management
Action #15	Human-Caused Hazards Annex to DRU Plan	Low	Emergency Management, Environmental Health & Safety

*No score indicates that Action Measure was developed after prioritization exercise.

PLAN ADOPTION & IMPLEMENTATION

Phase 4: Evaluate the Work

Once the Mitigation Action Plan has been developed, UCB is ready to formally endorse the plan through adoption by the UCB governing board and then to implement, evaluate and revise the plan as necessary. The development of the mitigation strategy and action plan follows Phase 4 of FEMA's 4 Phase guidance: "Evaluate the Work" and includes the following steps:

- Adopt the Plan
- Implement the Plan

Adopt the Plan

The purpose of formally adopting this plan is to secure buy-in from University leaders, to raise awareness of the plan, and to formalize the plan's implementation process. The UCB Board of Regents have adopted this DRU Plan by passing a resolution which is included in Appendix D.

Implement the Plan

Implementation and maintenance of the plan is critical to the overall success of hazard mitigation planning. Upon adoption, the plan faces the truest test of its worth: implementation. Implementation implies two concepts: action and priority. These are closely related.

While this plan puts forth many worthwhile and high priority recommendations, the decision about which action to undertake first will be the first task facing the HMPC. Fortunately, there are two factors that help make that decision. First, there are high priority items and second, funding is always an issue. Thus, often pursuing low or no-cost high-priority recommendations will have the greatest likelihood of success.

Another important implementation mechanism that is highly effective and low-cost, is to incorporate the DRU Plan recommendations and their underlying principles of this into other university plans and mechanisms, such as campus master planning and capital improvement budgeting. The University has and continues to implement policies and programs to reduce losses to life and property from natural hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs, and recommends implementing projects, where possible, through these other program mechanisms. **Mitigation is most successful when it is incorporated within the day-to-day functions and priorities of government and development**. This integration is accomplished by constant, pervasive and energetic efforts to network, identify and highlight the multi-objective, win-win benefits to each program, the university community, and its stakeholders. This effort is achieved through the routine actions of monitoring agendas, attending meetings, and promoting a safe, sustainable university community.

Simultaneous to these efforts, it is important to maintain a constant monitoring of funding opportunities that can be leveraged to implement some of the more costly recommended actions. This will include creating and maintaining a bank of ideas on how any required local match or participation requirement can be met. When funding does become available, the HMPC will be in a position to capitalize on the opportunity.

Additional mitigation strategies could include consistent and ongoing enforcement of existing policies, and vigilant review of university wide programs for coordination and multi-objective opportunities.

Plan maintenance implies an ongoing effort to monitor and evaluate plan implementation, and to update the plan as progress, roadblocks or changing circumstances are recognized. In order to track progress and update the mitigation strategies identified in the Action Plan, the University will revisit the DRU Plan annually, or after a hazard event. The UCB OEM is responsible for initiating this review and will consult with members of the HMPC. This monitoring and updating will take place through a semi-annual review by UCB OEM, an annual review through the HMPC, and a 5-year written update to be submitted to the state and FEMA Region VIII, unless disaster or other circumstances (e.g., changing regulations) lead to a different time frame.

Evaluation of progress can be achieved by monitoring changes in vulnerabilities identified in the Plan. Changes in vulnerability can be identified by noting:

- Lessened vulnerability as a result of implementing recommended actions,
- Increased vulnerability as a result of failed or ineffective mitigation actions, and/or
- Increased vulnerability as a result of new development (and/or annexation).

Updates to this plan will consider:

- Changes in vulnerability due to project implementation
- Document success stories where mitigation efforts have proven effective
- Document areas where mitigation actions were not effective
- Document any new hazards that may arise or were previously overlooked
- Incorporating new data or studies on hazards and risks
- Incorporate new capabilities or changes in capabilities
- Incorporate growth and development-related changes to UCB's inventory
- Incorporate new project recommendations or changes in project prioritization

Changes should be made to the plan to accommodate projects that have failed or are not considered feasible after a review for their consistency with established criteria, the time frame, the university's priorities, and funding resources. Priorities that were not ranked high, but identified as potential mitigation strategies, should be reviewed as well during the monitoring and update of this plan to determine feasibility of future implementation. Updating of the plan will be by written changes and submissions, as the HMPC deems appropriate and necessary, and as approved by the UCB Board of Regents.

The update process provides an opportunity to publicize success stories from the plan's implementation, and seek additional public comment. The plan maintenance and update process should include continued public and stakeholder involvement and input through available web-postings and press releases, and the final product adopted by the Board of Regents, appropriately.

Table of Contents

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Multi-Hazard Mitigation DRU Plan

1.0 Introduction

The University of Colorado-Boulder (UCB) has prepared this Multi-Hazard Mitigation, Disaster Resistant University Plan (DRU Plan) pursuant to the requirements of the Disaster Mitigation Act of 2000, PL 106-390 390 and established regulations at 44 CFR Part 201.6 (hereafter referred to as DMA 2000; see Appendix A for a list of acronyms used in this document). This plan documents the UCB DRU Planning Process, identifies natural hazards and associated risks of concern to UCB, and identifies UCB's hazard mitigation strategy to make UCB less vulnerable and more disaster resistant and sustainable. Information in the plan can also be used to help guide and coordinate mitigation activities and local policy decisions for future land use decisions.

Hazard Mitigation is defined as any sustained action taken to reduce or eliminate long-term risk to human life and property from hazards. Hazard Mitigation Planning is the process through which natural hazards that threaten communities are identified, likely impacts of those hazards are determined, mitigation goals are set, and appropriate strategies that would lessen the impacts are determined, prioritized, and implemented. Hazard Mitigation Planning is required for state and local governments to maintain their eligibility for certain federal disaster assistance and hazard mitigation funding programs.

This section of the plan describes the purpose and need for the plan, the scope of this effort and plan organization.

PURPOSE AND NEED

Each year, natural disasters in the United States kill hundreds of people and injure thousands more. Nationwide, taxpayers pay billions of dollars annually to help communities, organizations, businesses and individuals recover from disasters. These monies only partially reflect the true cost of disasters, because additional expenses to insurance companies and non-government organizations are not reimbursed by tax dollars. Additionally, many natural disasters are predictable, and, often with the same results. Many of the damages caused by these events can be alleviated or even eliminated.

FEMA, the Federal Emergency Management Agency, now a part of the Department of Homeland Security, has targeted reducing losses from natural disasters as one of its primary goals. Hazard mitigation planning and subsequent implementation of projects, measures, and policies developed through those plans are the primary mechanisms for achieving these goals. Success in reducing disaster damages has taken place as the result of mitigation projects implemented subsequent to mitigation planning.

DMA 2000 requires state and local governments to develop Hazard Mitigation Plans in order to maintain their eligibility for certain federal disaster assistance and hazard mitigation funding programs. Compliance with these requirements will maintain UCB's continued eligibility for certain FEMA Hazard Mitigation grant programs. Communities at risk from natural disasters can not afford to jeopardize this funding.

More importantly, proactive mitigation planning at the local level can help reduce the cost of disaster response and recovery to property owners and governments by protecting critical community facilities, reducing liability exposure, and minimizing overall community impacts and disruption. UCB has been affected by natural hazards in the past and is committed to reducing disaster impacts and maintaining eligibility for federal mitigation grant funding.

SCOPE

UCB's Multi-Hazard Mitigation DRU Plan is a single jurisdictional plan that identifies goals, objectives, and measures for hazard mitigation and risk reduction of natural hazards. This plan covers the UCB campus, which includes Main campus, Williams Village, East Campus, South Campus, and the Mountain Research Station.

This plan follows DMA 2000 planning requirements and associated guidance for developing Local Hazard Mitigation Plans, including specific guidance for "Building a Disaster-Resistant University". These guidelines set forth a generalized 4-task planning process: 1) Organize your Resources, 2) Assess Hazards and Risks, 3) Develop a Mitigation Plan, and 4) Evaluate your Work.

PLAN ORGANIZATION

UCB's Multi-Hazard Mitigation DRU Plan is organized as follows:

Executive Summary
1.0 Introduction
2.0 University Profile
3.0 Planning Process
4.0 Risk Assessment
5.0 Mitigation Strategy
6.0 Plan Adoption
7.0 Plan Implementation & Maintenance

Multi-Hazard Mitigation DRU Plan
2.0 University Profile

Location and Setting

The UCB campus is located in the Rocky Mountain Front Range area in the City of Boulder, about 25 miles northwest of Denver. The UCB campus includes three proximate properties, all of which are located within the City of Boulder: the 306-acre Main Campus, the 197-acre East Campus, and 64 acres at Williams Village. In addition, the campus includes the undeveloped CU-Boulder South Campus, 308 acres just southeast of the City of Boulder, and the Mountain Research Station, 190 acres situated in the mountains west of Boulder between Nederland and Ward. The map that follows shows the campus locations in Boulder (i.e., with the exception of the Mountain Research Station). A brief description of each of the campuses is provided in the following paragraphs.

Main Campus

The Main Campus area has grown from an original 44 acres of donated land in central Boulder to the current 306 acres. The campus has grown by acquiring houses and lots adjoining the Main Campus, plus the acquisition of a few larger tracts of land. The Main Campus is generally bordered by Broadway on the west, streets near Boulder Creek on the north, 28th Street on the east, and Baseline Road on the south. The 306 acres includes six acres of the 10-acre Grandview Terrace area, just north of University Avenue. All streets in Grandview are city streets. Additional acquisitions in this area are ongoing. Natural areas along Boulder Creek and student family housing north of the creek are also included in the Main Campus property.

The Main Campus houses academic programs with related research, cultural facilities, student services, some single student and family housing, and some indoor and outdoor athletics and recreation facilities.

East Campus

The East Campus is located two blocks east of the Main Campus, generally bordered by 30th Street on the west, Arapahoe Avenue on the north, Foothills Parkway on the east, and Colorado Avenue on the South. The East Campus was purchased in 1955 and is currently at 197 acres. Although still owned by the University, 4.3 acres east of Foothills Parkway was allocated by the University to the Boulder Open Space Program as a preserve.

The East Campus houses some research, support services, student housing, and athletics facilities. Occupying much of the East Campus is the UCB Research Park, a development of 96 buildable acres designed to enhance the university's research capabilities, to provide collaborative opportunities with government and business, and to increase technology transfer. Several corporations, including US West, Sybase, and others, have located research facilities in the Park. Key UCB research buildings on the East Campus include: the Laboratory for Atmospheric and Space Physics (LASP), the Center for Astrophysics and Space Astronomy (CASA), and the EPO Biology Greenhouse. An approximate 37 acres in the Research Park remain undeveloped.

Williams Village

Williams Village is located two blocks southeast of the Main Campus, near the end of the Boulder-Denver Turnpike, U.S. Highway 36, which serves as the southern boundary of the property. The Williams Village property is bordered by Williams Village Shopping Center on the west and single-family residential areas to the east and north.

The property consists of 64 acres deeded to UCB by the Williams Foundation in 1964 to be used for student housing and related activities. Some of the single student housing, recreation areas, parking lots, as well as the University Residence are housed on this property.

South Campus

The UCB South Campus is 308 acres of undeveloped land located in unincorporated Boulder County. The property is contiguous to the southeast boundary of the City of Boulder; Louisville, Lafayette, and Superior are located to the east. The property was acquired in 1997 as a strategic acquisition for the University as part of their long-range planning. The land has been reclaimed from previous gravel mining activities. It is currently undeveloped, except for one warehouse building with office space, a cross-country running course, and a public pedestrian and bicycle trail on the property. Several ponds were created temporarily by the previous owner during gravel mining operations.

Mountain Research Station

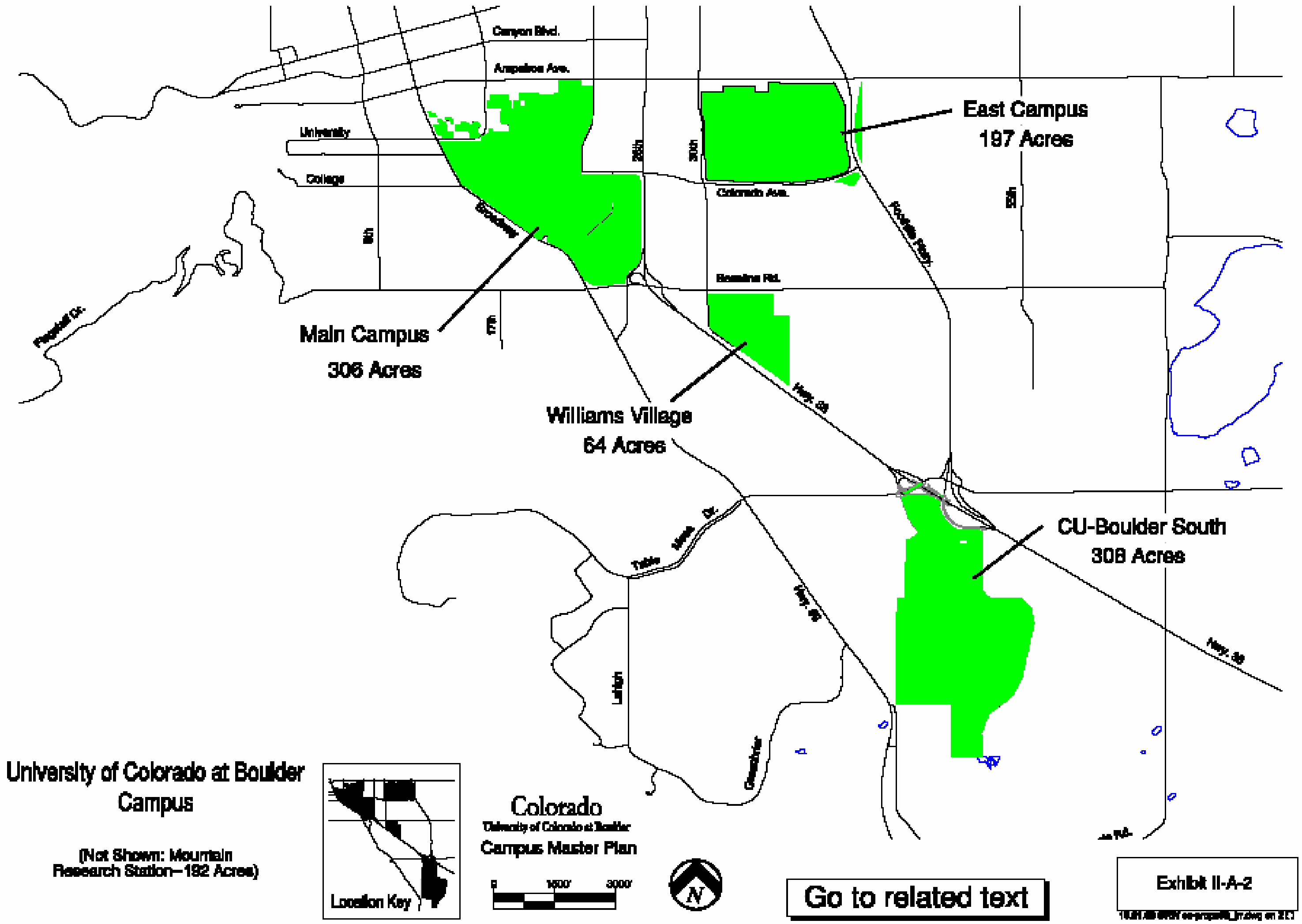
The Mountain Research Station is located at an elevation of 9,500 feet in the mountains west of Boulder, accessed by Boulder Canyon on Highway 7 and north along the Peak-to-Peak Highway, Highway 119. It is three miles east of the Continental Divide and six miles southwest of Ward, Colorado. The property is approximately 192 acres surrounded by the City of Boulder Watershed, Indian Peaks Wilderness Area, and Roosevelt National Forest. Existing development consists of approximately 65 buildings, most of a seasonal nature, used for laboratory, office, housing and dining uses. The Marr Alpine Laboratory at 6,000 square feet is the focal point of the property.

The Mountain Research Station began in 1914 as a recreational retreat for university faculty. Managed by the CU Institute of Arctic and Alpine Research (INSTAAR), it is now used as an interdisciplinary research facility devoted to the study of environmental science. Research is now conducted year round at the facility, with some of the research occurring on the adjoining Niwot Ridge, an alpine environment where atmospheric sampling and monitoring stations are located.

Other Properties

In addition to the five main properties described above, UCB also owns several miscellaneous properties in the Boulder area. These include:

- The UCB Distribution Center at 2000 Central Avenue, used as a warehouse for storage, shipping, receiving and surplus property disposition;
- A 3.7 acre Academy property located in the University Hill residential area, several blocks west of the Main Campus, at 10th Street between Aurora and Cascade Streets. This property was privately redeveloped under a long-term lease into a retirement community and is not currently available for University use.
- Miscellaneous properties purchased or leased by UCB and associated operations such as the CU system administration and CU Foundation. These include: lease of two privately owned office buildings located in the pearl Plaza office park along Pearl Parkway; University Management Systems (UMS), UCB's central administrative computing plaza, occupies 37,094 assignable square feet (ASF) in One Pearl Plaza; UCB's system administrative offices of the university controller, internal audit, and treasurer occupy 11,294 ASF in Two Pearl Plaza; and CU system administration leased space in the US West Building in the Research Park which houses administrative offices of the System Budget Office, University Risk Management, Associate Vice President for Academic Affairs and Federal Relations, Public Affairs, and Administrative Streamlining Project.


Canyon Blvd.
Arapahoe Ave.
University
College
Colorado Ave.
Baseline Rd.
Broadway
Foothills Pkwy.
Flagstaff Dr.
Table Mesa Dr.
Hwy. 36
Hwy. 93
Lehigh
Greenbriar
East Campus
197 Acres
Main Campus
306 Acres
Williams Village
64 Acres
CU-Boulder South
308 Acres
University of Colorado at Boulder Campus
(Not Shown: Mountain Research Station–192 Acres)
Location Key
Colorado
University of Colorado at Boulder
Campus Master Plan
0
1500'
3000'
N
Go to related text
Exhibit II-A-2

Natural Setting

All campus properties, except for the Mountain Research Station at an elevation of 9,400 feet, are located in the Boulder Valley at the base of the Rocky Mountain foothills at an elevation of 5,400 feet. The paragraphs below provide a brief description of the natural setting of UCB properties, including details on topography, subsurface soils, and drainages. The maps that follow illustrate the topography of UCB properties.

Main Campus

Most of the Main Campus is located on a mesa well above Boulder Creek. The Main Campus slopes gently to the north and east from the highest areas along Broadway near the University Memorial Center (UMC), down toward the bluff overlooking Boulder Creek. At this escarpment, the land drops sharply 70 feet to Boulder Creek. North of Boulder Creek, university property is in the relatively flat floodplain.

Besides the bluff along Boulder Creek, development is influenced topographically by Observatory Hill, with its slope rising approximately 40 feet from Regent Drive. This hill is located between Fiske Planetarium and 28th Street, and it is anchored at its east end by the Coors Events/Conference Center.

Subsurface conditions vary considerably on the Main Campus. In general, at shallow depths, weathered claystone and sandstone are present, with dense blue shale at varying depths below these layers. The shallow soils are not well suited for building foundations, while the blue shale found at greater depths provides good bearing capacity for drilled pier construction. The bluff rising immediately south of Boulder Creek has areas of unstable surface and subsurface conditions. These varying soil conditions on the Main Campus make it essential that soils be tested prior to building design and construction.

East Campus

The East Campus slopes very gently about 30 feet from the southwest corner to the northeast corner. Boulder Creek flows diagonally from the west to the northeast, dividing the East Campus into separated areas on the two sides of the creek. Two smaller creeks also flow through the East Campus. Skunk Creek, entering midway along the south property line, flows northeasterly to connect with Bear Canyon Creek, which flows through the portion of the East Campus located east of Foothills Parkway. During development of this area, the University re-established wetlands with native vegetation in flood areas through a Corps of Engineers permit.

Soil conditions on the East Campus vary throughout the property. A review of the available soils reports indicates that much of the central and western portions consists of a layer, up to 14 feet deep, of mixed sandy and silty clay over strata of water-bearing sandy gravel, over claystone bedrock. The subgrade condition along the south boundary appears to be a shale slope. Depending on core sample results, drilled pier and grade beam foundations have been required for multistory buildings in some portions of the East Campus, and basements are not recommended without detailed investigation.

Williams Village

The Williams Village property slopes very gently about 25 feet from higher areas on the southwest edge of the property to a low point at the northeast corner. Bear Canyon Creek flows through the property, entering midway along the southwest property line (U.S. 36 right-of-way), flowing across to the northeast corner.

The soils investigation conducted for construction of Stearns Towers, Darley Towers, and Darley Commons indicates 7 to 21 feet of sandy clay over weathered shale to hard blue shale at 27 feet, suggesting a high load-bearing capacity for multistory buildings. The material between this strong layer and the surface is poor material that may swell. This has been taken into account when constructing buildings and hard-surface facilities such as tennis courts, and it may prevent slab-on-grade construction.

South Campus

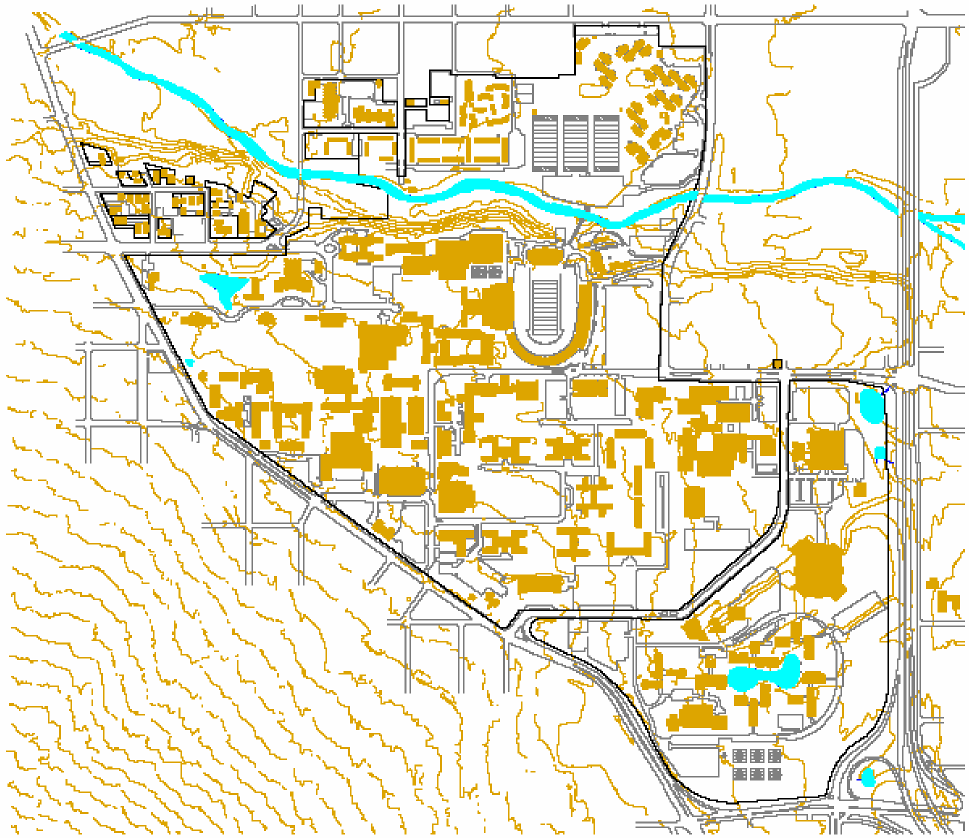
Most of the CU-Boulder South property also slopes very gently from the southwest to the northeast. The relatively flat area was excavated in recent years for gravel mining. Along the east and south borders is a berm near South Boulder Creek, reducing the flood hazard for the site and other properties. Along the western border, south of the Tantra neighborhood, the land rises more sharply toward houses to the west.

Insufficient information is available to assess subsurface soil conditions of the UCB South Campus property. It appears that surface mining removed much of the sandy gravel over the bedrock.

Mountain Research Station

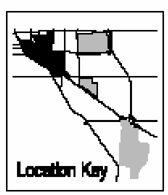
The Mountain Research Station sits on a heavily forested site just east of the Continental Divide. The developed portion sits on the steeply sloping face of a mountain ridge. The topography is a determining factor to development. Como Creek runs through the property. Much of the station and adjoining U.S. Forest Service lands are sensitive ecological areas, including steep slopes, wetlands, protected fish habitat, and alpine areas.

The subsurface conditions of the Mountain Research Station site vary greatly depending on location. The developed portion sits on glacial till brought down from the mountains during the last ice age. Recent excavation for a hostel revealed that this layer extended over 14 feet deep with only an occasional large rock. A large granite layer was discovered during the wastewater treatment plant design, requiring blasting, indicating the importance of investigation for each potential building.



Topographic Map
Main Campus

Ten Foot Contour Intervals Shown



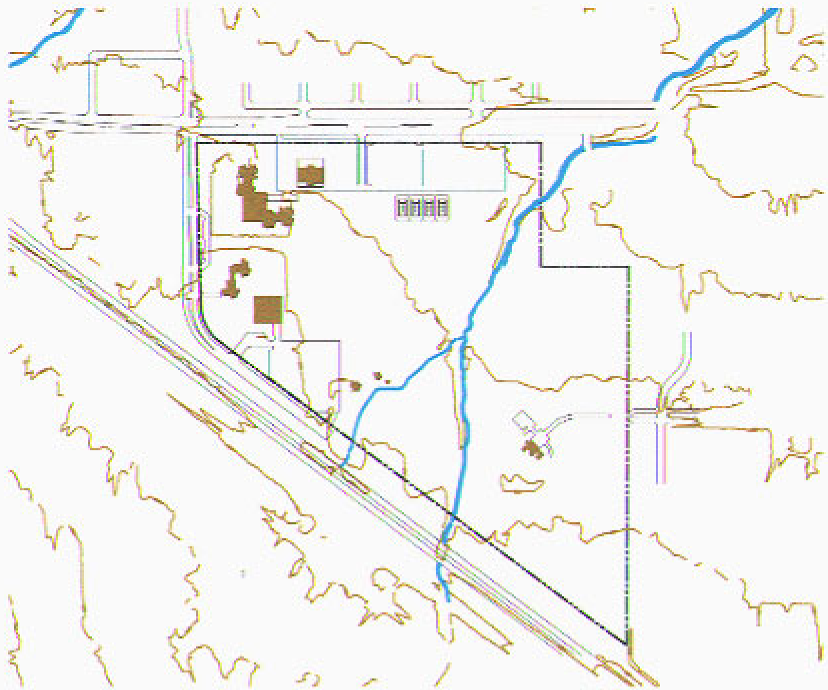
Colorado
University of Colorado at Boulder
Campus Master Plan

0 450' 900'

N

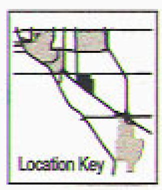
Go to related text

Exhibit II-C-1



Topographic Map
Williams Village

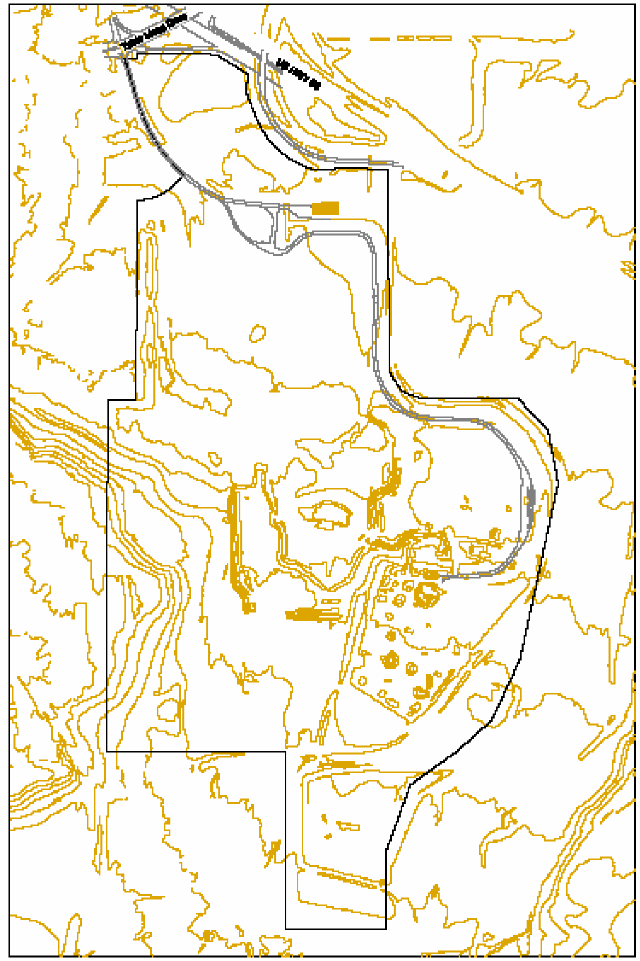
Ten Foot Contour Intervals Shown



Colorado
University of Colorado at Boulder
Campus Master Plan

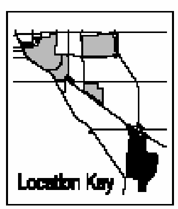
0 300' 600'

Exhibit II-C-3



Topographic Map
CU-Boulder South

Ten Foot Contour Intervals Shown

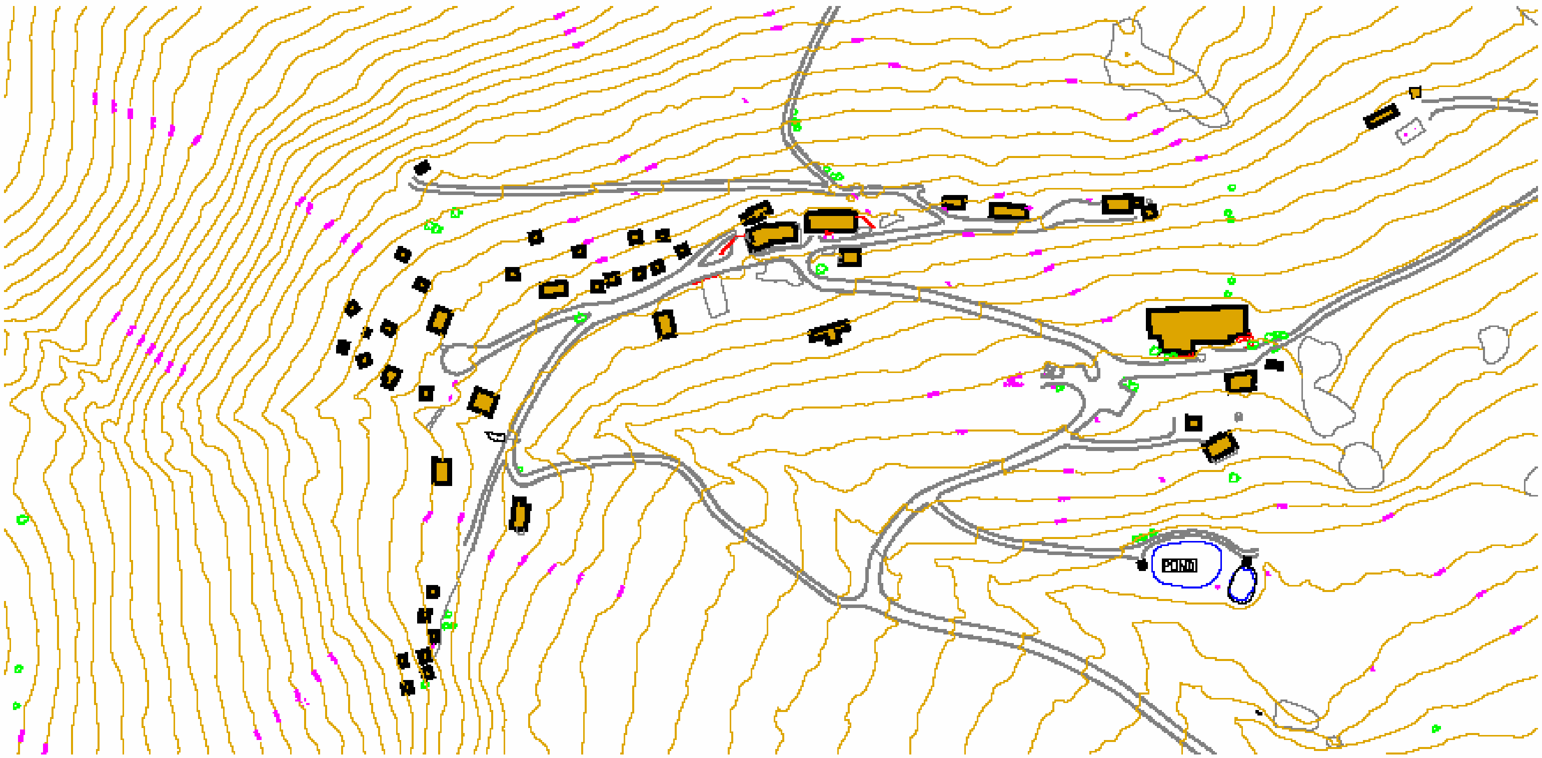


Colorado
University of Colorado at Boulder
Campus Master Plan

0 550' 1100'

Go to related text

Exhibit II-C-4



**Mountain Research Station
Topographic Map
(Developed Portion Only)**

Ten Foot Contour Intervals Shown

Colorado
University of Colorado at Boulder
Campus Master Plan

0 100' 200'

Go to related text

Exhibit II-C-5

History

The University of Colorado at Boulder has grown from one building in 1876 into a teaching and research institution of national reputation. The setting and uniform architectural style of Main Campus contributes to its reputation. According to Thomas Gaines, in the *Campus as a Work of Art*, 1991, the Main Campus has been ranked the fourth most beautiful in the country. The following paragraphs provide a brief summary of the history of the UCB Campus.

In 1872, Boulder was selected as the site of the State University. Old Main, located on Main Campus above Boulder Creek, was the first building constructed on land donated by three prominent citizens. Completed in 1876, it contained the living quarters for the president and his family, classrooms, library, laboratories, and rooms for the building custodian and his family. Eight years later, smaller buildings were added nearby, housing students and the university president. The expansion of a more formal campus occurred with the construction of Woodbury Men's Residence Hall in 1890 and Hale Science in 1892. Over the next 30 years (considered the Early years from 1875-1917), the University expanded around a large cruciform-shaped open space that became Norlin Quadrangle. Significant buildings in this area included, Buckingham Library (now University Theatre), Guggenheim Law (now Guggenheim Geography), Macky Auditorium, additions to Hale Science, and a Power House for steam generation. Landscaping was added at this time, and included the addition of large green lawns and many trees. During these early years, Campus buildings constructed prior to 1917 represent a variety of Gothic, Classical, and Victorian architectural styles.

In 1917, the Colorado General Assembly supported increasing UCB enrollment from 1,200 to 3,000 students. As a result, the Board of Regents directed President Livingston Farrand to hire an architectural firm to conduct development planning in order to improve the campus appearance. The Philadelphia firm of Day and Klauder was commissioned to do the work under the direction of George W. Norlin, who had become the interim university president. The ultimate style created used the locally quarried sandstone to produce architecture that would blend more harmoniously with the Boulder mountain backdrop. In 1919, the Board of Regents approved the resultant Campus Development Plan and accompanying scale model. Architectural historians categorize the style as Tuscan vernacular. It is characterized by multi-hued sandstone walls and tile roofs, off-whit limestone trim, and black metal accents.

From 1940 to 1960, World War II and the postwar period altered demands on university facilities. With the death of Klauder in 1938, design of new facilities continued to be designed according to his style but without the same creativity. UCB continued to grow rapidly postwar and in the 1950s and 1960s embarked on a more expansive land acquisition purchasing 220 acres of farmland, now known as the East Campus and the University Research park. It also accepted, with financial obligations, the Williams Village property as a location for housing students. During this period and into the 1960s, peripheral buildings, such as Litman Research Laboratory and Research Laboratories 2 and 3, were built that were not in the Tuscan vernacular style.

In the early 1960s, a new campus development plan was created by Sasaki, Walker and Associates. The plan sustained the Klauder design principles and materials, but allowed flexibility to incorporate new concepts and forms. Now, a variety of architects are commissioned to design campus facilities, with continuity ensured by campus staff and the University Design Review Board.

UCB grew rapidly in the 1960s, doubling campus building space. Significant additions included the Kittredge Complex for new student housing, the Engineering Center, Stearns and Darley towers at Williams Village, The Duane Physical Laboratories complex, and the Life Sciences Laboratories complex (Muenzinger Psychology and Porter Biosciences).

In 1971, the State Legislature established an enrollment limit of 20,000 full-time equivalent students for the Boulder campus, which was later removed. This resulted in an emphasis on renovating existing facilities and developing new space to support UCB's growing role as a major research institution. This change in focus continued into the 1980s and 1990s where older buildings, such as Old Main, Macky, Hale, the Power House, and the Women's Cottage, were rehabilitated.

Most recently, the challenge is to accommodate an increase in enrollment and continued support of the research objectives. In order to accommodate this growth, development will increasingly occur on East Campus, Williams Village, and the South Campus.

The UCB Campus

Founded in 1876 in Boulder, UCB is the original campus of the University of Colorado, system. Built in the shadow of the Flatirons, the Boulder campus is often recognized as one of the most beautiful campuses in the nation. With over 200 buildings and complexes located on five main campuses, totaling over 786 acres, UCB currently offers 3,400 courses in about 150 fields of study. 85 different majors are offered at the bachelor's level, 70 at the master's level and 50 at the doctoral level. UCB is also considered a major research university, committed to its mission to be a comprehensive university that leads in innovation, creativity, discovery, and dissemination of knowledge. UCB is further committed to providing a diverse campus. UCB population and demographic statistics for the 2004 year include:

- 31,943 total students were enrolled. Of these, 29,258 were regular on-campus, degree-seeking students. The other 2,685 included students on study abroad, faculty/staff on tuition waivers, non-degree seeking students, students enrolled in the evening program or in correspondence courses, and students from other CU campuses taking courses at UCB.
- Of the regular on-campus degree-seeking students, 84% (24,710) are undergraduates and 16% (4,548) are graduate students. Of these, 68% (19,884) are Colorado residents.
- Of the regular on-campus degree-seeking students, 47% (13,862) are women and 52% (15,396) are men. Of these, 13.8% (4,043) are minorities. Of these, 236 are Native American Indian, 1,672 Asian American, 448 African American, and 1,687 Hispanic/Latino.
- International student enrollment in fall 2004 was 1,086. UCB international students represent more than 100 countries.

Multi-Hazard Mitigation DRU Plan
3.0 Planning Process

44 CFR 201.6(b): "An open public involvement process is essential to the development of an effective plan".

UCB, Office of Emergency Management and Business Recovery Planning (UCB OEM) recognized the need and importance of this plan and was responsible for its initiation. The primary funding source for this planning assistance contract was obtained by the UCB OEM in the form of a FEMA grant. In addition, planning team members contributed in-kind services to this effort by attending meetings, collecting data, managing administrative details, and providing facilities for meetings.

UCB contracted with AMEC Earth & Environmental (AMEC) to facilitate and develop this Multi-Hazard Mitigation Disaster Resistant University (DRU) Plan. AMEC's role was to:

- Assist in establishing a Hazard Mitigation Planning Committee (HMPC) for UCB; as defined by DMA regulations;
- Meet the DMA/DRU requirements as established by federal regulations, following FEMA's planning guidance;
- Facilitate the entire planning process;
- Identify the data requirements that HMPC participants could provide, and conduct the research and documentation necessary to augment that data;
- Assist in facilitating the public input process;
- Produce the draft and final plan documents; and
- Coordinate the State OES and FEMA Region VIII reviews of this plan.

AMEC established the planning process utilizing DMA planning requirements and FEMA's associated guidance. This guidance is structured around a generalized four-phase process:

1) Organize resources,
2) Assess hazards and risks,
3) Develop a mitigation plan, and
4) Evaluate the work.

AMEC also integrated an older, more detailed 10-step planning process that was required, at the time this effort was initiated, for other FEMA mitigation plans such as for FEMA's CRS and Flood Mitigation Assistance (FMA) programs. Thus, AMEC formulated a single planning process to meld these two sets of planning requirements together and meet the requirements of five major programs: CRS, FMA, HMGP, FEMA's Pre-Disaster Mitigation program (PDM) and new flood control projects authorized by the U.S. Army Corps of Engineers (USACE). The graphics below show how the old 10-step process fits within the new 4-phase process.

The following table shows how the 10-step process fits within the four-phase process.

DMA/DRU/AMEC Planning Process	
DMA 4-Task Process (44 *CFR* 201.6)	**DRU/AMEC 10-Step Process**
Planning process	**Organize Resources**
201.6(c)(1)	1. Organize
201.6(b)(1)	2. Involve the public
201.6(b)(2) & (3)	3. Coordinate
Risk assessment	**Identify Hazards/Assess the Risks**
201.6(c)(2)(i)	4. Assess the hazard
201.6(c)(2)(ii) & (iii)	5. Assess the problem
Mitigation strategy	**Develop the Mitigation Plan**
201.6(c)(3)(i)	6. Set goals
201.6(c)(3)(ii)	7. Review possible activities
201.6(c)(3)(iii)	8. Draft an action plan
Plan maintenance	**Adopt and Implement the Plan**
201.6(c)(5)	9. Adopt the plan
201.6(c)(4)	10. Implement, evaluate, revise

LOCAL GOVERNMENT/UNIVERSITY PARTICIPATION

The DMA planning regulations and guidance stress an academic institution seeking the required FEMA approval of their mitigation plan must participate in the planning effort which is defined as meeting all of the following requirements:

1. Have an active role in the development of a plan (through meeting attendance, data input, plan review, etc.);
2. An assessment of the specific area describing any unique differences from the jurisdiction as a whole;
3. At least one specific action item developed for the Mitigation Strategy that will reduce the impact of future disasters on that entity. This action may be the same for the entire area included in the plan, unless unique circumstances suggest a different action would be more appropriate; and
4. Formal adoption or agreement by the entity to adhere to and implement the plan requirements.

THE 10-STEP PLANNING PROCESS

As described in the following sections, the planning process followed a 10-Step planning process:

Step 1: Get Organized – Building the Planning Team

With UCB's commitment to participate in the DMA/DRU planning process, AMEC worked with the UCB OEM to establish the framework and organization for development of the Plan. The Plan was developed by the HMPC led by AMEC and the UCB OEM, and was comprised of key UCB representatives and other interested stakeholders from local City, County, and other governmental agencies. The list of participating HMPC members is provided below.

University Departments

- Emergency Management Operations
    - ♦ UCB OEM, Sylvia Dane
    - ♦ Environmental Health & Safety, Darrell Droddy, Dave Vergin
    - ♦ Public Safety, Michell Irving
    - ♦ University Risk Management, Steven Harvath, Janese Carney
    - ♦ University Police, Michell Irving
    - ♦ Residential Housing, Sarah Bradford, Wendy Parker Nassmacher
    - ♦ Family Housing, Federika Martinez, Curt Huetson
    - ♦ Athletics, John Krueger
    - ♦ Facilities Management, John Bruning, Lisa Adair, John Morris, Ed Von Bleichert
    - ♦ University Fire, Mansour Alipour-Fard
- Mountain Research Station, John Bruning, Facilities Management
- Planning Departments, Robert Stubbs
- ITS Department, Ilene MacDonald, Dan Jones
- Faculty and Student Representatives, Jon Sawicki, Mark Dubin
- BP Center for Visualization, Mark Dubin, Christopher Philipp
- Wardenburg Medical Center

Local Government/Agency Representatives

- City of Boulder Floodplain Management, Alan Taylor
- Colorado Water Conservation Board, Bryan Hyde
- Urban Drainage and Flood Control District, Kevin Stewart
- Floodsafety.com, Marshall Frech

The planning process officially began on March 10, 2005 with a kick-off meeting at UCB. The meeting covered the scope of work and an introduction to the DMA/DRU 2000 requirements. Participants were provided with a Data Collection Guide that included worksheets to facilitate the collection of necessary information to support development of the plan. Utilizing FEMA guidance, worksheets were designed by AMEC to capture information on historic hazard events, identify hazards of concern to the UCB, quantify values at risk to identified hazards, and inventory existing capabilities. Participants were also provided a mitigation project worksheet to record ideas for possible projects identified during the planning process.

The HMPC communicated during the planning process with a combination of face to face meetings, by email and through the use of an FTP (file transfer protocol) site where draft documents were uploaded for review by team members. The HMPC met five times over an eight-month period.

HMPC Meeting	Meeting Topic	2005 Meeting Date
1	Kick Off meeting: Introduction to DMADRU 2000 and Introduction to the Planning Process and Hazard Identification	March 10
2	Hazard Identification Work Session and Introduction to Vulnerability and Capability Assessment	May 12
3	Vulnerability and Capability Assessment Overview/ Development of Mitigation Goals and Objectives	October 12
4a	Finalize Goals and Objectives/Review of Possible Mitigation Activities	November 10
4b	Developing and Prioritizing Mitigation Recommendations	November 15

Attendees and agendas for each of the HMPC meetings are on file with the UCB OEM.

Step 2: Plan for Public Involvement – Engaging the Public

At the kick-off meeting, the HMPC discussed options for public involvement. The HMPC's approach utilized established public information mechanisms and resources within the university. Public involvement activities included press releases, website postings and collection of public comments to the draft plan. Stakeholder and public comments are reflected in the preparation of the plan, including those sections addressing mitigation goals and action strategies. An example press release that was distributed early on in the planning process to the EMOG policy group at UCB is detailed below:

> **"DRU Kickoff**
>
> Dane noted that on March 10, a group of university experts as well as flood experts and city officials from around the state met with AMEC Earth & Environmental to begin the process of developing a Natural Hazards Mitigation Plan for the Boulder Campus. AMEC is the consultant hired to conduct the process from funds Dane obtained from the Federal Emergency Management Agency (FEMA) to help the Boulder Campus become a Disaster Resistant University (DRU).
>
> During that meeting, participants received an overview of the process required by FEMA to develop a plan and were asked to provide data regarding natural hazard risks, including what they thought were the greatest risks on the

> campus, whether they remembered any natural disasters that affected the campus, whether they knew of any resources where AMEC could obtain that data, and what their thoughts were about the project. The group will continue meeting for the next several months to work on the plan. EMOG members will have a chance to review the plan before it is submitted to the Chancellor and his Executive Committee for approval. Once that approval is obtained, the plan will then be submitted to FEMA for approval. Once FEMA approves the plan, the university is then eligible to apply for up to $3 Million to conduct hazard mitigation efforts."

Once an initial draft of the plan was complete, public comments were solicited and obtained from individuals in the local "hazard community", including from the Natural Hazards Center at UCB and from Gilbert White, a longtime, local flood expert. These comments were incorporated into the next draft of the plan. Upon completion of this next draft, the plan was placed on a public website for additional public review and comment prior to finalizing the plan for submittal to FEMA. Notice of the public review period for review of the draft plan was given through a Campus-wide Buff Bulletin e-mail that goes to all UCB faculty, staff and students and through an announcement on the CDEM (i.e., public state) website. A copy of the plan for public review was also place in Norlina, the main UCB library and in the downtown library for the City of Boulder. Additional comments on this draft were also solicited from the EMOG group during this process through an e-mail solicitation and placement as an agenda item during their June 21, 2006 EMOG meeting. The plan is currently online and available for viewing at http://www.dola.state.co.us/dem/mitigation/mitigation.htm. All press releases and website postings are on file with the UCB OEM.

Step 3: Coordinate with other Departments and Agencies

Early on in the planning process, the HMPC determined that data collection, mitigation and action strategy development, and plan approval, would be greatly enhanced by inviting other state and federal agencies to participate in the planning process. Based on their involvement in hazard mitigation planning, their landowner status in the county, and/or their interest as a neighboring jurisdiction, representatives from the following key agencies were invited to participate as members of the HMPC:

- Boulder County
- Boulder Valley School District
- City of Boulder
- Colorado Office of Emergency Management
- Colorado State Forest Service
- Colorado Water Conservation Board
- FEMA Region VIII
- Naropa University
- National Weather Service
- NOAA
- U. S. Forest Service

Invitations to these agencies were extended through a combination of e-mails, announcements at other interagency meetings (e.g., Multi-Agency Coordinating System [MACs] for Boulder County), and verbally through personal working relationships between individuals at UCB and these other agencies.

In addition to those agencies listed above, the HMPC utilized the resources of the agencies and groups listed below in the development of this plan. Specifically, technical data, reports and studies were obtained from those agencies and groups listed below as well as those identified above either through web-based resources or directly from agency resources.

- Boulder County Health Department
- Boulder County IT/GIS Department
- Boulder County Land Use Department
- Boulder County Nature Association
- Boulder County Parks and Open Space
- Boulder County Planning Department
- Boulder County Wildfire Mitigation Group
- Boulder Daily Camera
- Bureau of Land Management
- City of Boulder IT/GIS Department
- City of Boulder Open Space and Mountain Parks
- City of Boulder Parks & Recreation
- City of Boulder Planning Department
- City of Boulder Public Works
- Colorado Division of Wildlife
- Colorado Geological Survey
- Colorado State Forest Service
- Flood Safety.Com
- National Oceanic and Atmospheric Administration, National Climatic Data Center
- Natural Hazards Research and Applications Information Center
- NOAA-CIRES Climate Diagnostics Center
- State and Federal Historic Preservation Districts
- The Natural Resource Conservation Service and its predecessor, the Soil Conservation Service
- U.S. Fish & Wildlife
- U.S. Geological Survey
- UCB Academic Scheduling
- UCB Consultants
- Western Regional Climate Center

Other University/Community Planning Efforts and Hazard Mitigation Activities

Coordination with other university planning efforts is also paramount to the success of this plan. Hazard mitigation planning involves identifying existing policies, tools and actions that will reduce a community's risk and vulnerability from natural hazards. The University utilizes a variety of comprehensive planning mechanisms such as the Campus Master Plan, emergency response and business recovery plans, and university policies to guide and control university growth and development. Integrating existing planning efforts and mitigation policies and action strategies into this Multi-Hazard Mitigation DRU Plan establishes a credible and comprehensive plan that ties into and supports other university programs. The development of this plan utilized information included in the following key plans, studies, reports, and initiatives:

- Campus Master Plan
- Micro-master plans: UCB Boulder Research Park, Norlin Quadrangle Historic Area, Williams Village
- UCB Floodproofing Analysis for Family Housing area, Love and Associates, 2002
- Civil Utility Master Plan, Boyle Engineering Corporation, 2003
- Storm Water Drainage Master Plan Report, Boyle Engineering Corporation, 2004
- Emergency Management Plans
- Business Recovery Plans
- Flood Hazard Mitigation Plan for Colorado, Colorado Water Conservation Board, 2004
- State of Colorado, Natural Hazard Mitigation Plan, 2004

Many other documents were reviewed and considered, as appropriate, in Steps 4 and 5 during the collection of data to support the Risk Assessment phase.

Step 4: Hazard Identification and Step 5: Risk Assessment

AMEC led the HMPC in an exhaustive research effort to identify and document all natural hazards that have, or could, impact UCB. A Data Collection guide was developed and utilized in this effort to aid in determining hazards and vulnerabilities, and where the risk varies across the planning area. GIS was also used to display, analyze, and quantify hazards and vulnerabilities. Step 5 included a Capability Assessment which documents the participating jurisdiction's current capabilities to mitigate natural hazards. A more detailed description of the risk assessment process and the results are included in this plan as Section 4.0 – Risk Assessment. A copy of the Data Collection Guide is provided in Appendix B.

Step 6: Identifying Goals and Step 7: Review Possible Measures

AMEC facilitated brainstorming and discussion sessions with the HMPC that described the purpose and the process of developing planning goals and objectives, a comprehensive range of mitigation alternatives, and a method of selecting and defending recommended mitigation actions utilizing a series of selection criteria. This information is included in this plan as Section

5.0 – Mitigation Goals and Strategy. Additional planning process documentation of the goals and strategy development is provided in Appendix C.

Step 8: Draft the Mitigation Action Plan

AMEC developed several drafts of this plan for the HMPC. The first two drafts consisted of the Hazard Identification only and the Hazard Identification and Risk Assessment portion of the plan and was reviewed by members of the HMPC in advance of the mitigation planning goals and strategy meetings. AMEC received comments, made appropriate revisions at the direction of the HMPC, and developed a first complete draft of this plan, which included the HMPC's mitigation strategy and other required plan elements. This complete draft was posted for HMPC review and comment on an internal website. Other agencies and the public were invited to comment on this draft as well through posting on a public website. The comments and issues from the public and the additional internal review comments were then discussed with the HMPC, appropriate revisions were made, and a second draft of the plan was produced reflecting the public and technical input for CO OEM and FEMA review.

Step 9: Adopt the Plan

In order to secure buy-in and officially implement the plan, the plan was adopted by the UCB Board of Regents. A scanned version of the adoption resolution is included as part of Appendix D to this plan.

Planning Step 10: Implement the Plan

The true worth of this, and any mitigation plan, is its final step – implementation. To this point, all of the HMPC efforts have been directed at researching data, coordinating input from participating entities, and developing appropriate mitigation actions. Each recommended action includes key descriptors, such as a lead manager and possible funding sources, to help initiate implementation of the specific action. Beyond that, however, an overall implementation strategy is described in Section 7.0 – Implementation and Plan Maintenance.

Finally, there are numerous organizations within UCB whose goals and interests interface with hazard mitigation. Coordination with these other planning efforts is paramount to the ongoing success of this plan and mitigation at UCB and is addressed further in Section 7.0 A plan update and maintenance schedule and a strategy for continued public involvement is also documented in Section 7.0.

Multi-Hazard Mitigation DRU Plan

4.0 Risk Assessment

44 CFR 201.6(c)(2)(ii): "The risk assessment shall include…A description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community".

Risk from natural hazards is a combination of hazard, vulnerability and exposure. The risk assessment process measures the potential loss to a community, including loss of life, personal injury, property damage, and economic injury resulting from a hazard event. The risk assessment process allows a community to better understand their potential risk and associated vulnerability to natural hazards. This information provides the framework for a community to develop and prioritize mitigation strategies and plans to help reduce both the risk and vulnerability from future hazard events.

This risk assessment for UCB followed the methodology described in the FEMA publication 386-2 Understanding Your Risks – Identifying Hazards and Estimating Losses (FEMA, 2002) and was based on a four-step process: (1) Identify Hazards, (2) Profile Hazard Events, (3) Inventory Assets, and (4) Estimate Losses.

This risk assessment covers Planning Step 4: Identify the Hazards and Planning Step 5: Assess the Risks. It also includes a third component, Assessing Existing Mitigation Capabilities, in which the risk and vulnerability are analyzed in light of existing mitigation measures such as building codes, warning systems and floodplain development regulations.

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Multi-Hazard Mitigation DRU Plan
4.1 Hazard Identification

The UCB HMPC conducted a Hazard Identification study to determine what hazards threaten the planning area. This section of the plan documents the previous occurrence of natural hazards, those that might occur in the future, and the likelihood of their recurrence.

This section begins with an overview of the declared disasters in Boulder County and the UCB Planning Area and leads to a detailed hazard profile for the identified hazards. The purpose of this section is to profile all the natural hazards that affect, or could affect UCB. For each hazard, a generic description of the hazard and associated problems is provided, followed by details on the hazard specific to Boulder County and, to the extent data is available, the UCB Planning Area. Information on past occurrences, including the extent or location of the hazard within or near the University, and impacts, where known, are discussed here. Information provided by planning team members are integrated in this section with information from other data sources, such as National Weather Service databases.

The frequency of past events is used in this section to gauge the likelihood of future occurrences. Based on historical data, the frequency of occurrence is categorized into one of the following classifications:

Highly Likely: *Near 100% chance of occurrence in next year, or happens every year.*

Likely: *Between 10 and 100% chance of occurrence in next year, or has a recurrence interval of 10 years or less.*

Occasional: *Between 1 and 10% chance of occurrence in the next year, or has a recurrence interval of 11 to 100 years.*

Unlikely: *Less than 1% chance of occurrence in next 100 years, or has a recurrence interval of greater than every 100 years.*

The frequency, or chance of occurrence, was also calculated where possible based on existing data. Frequency was determined by dividing the number of events observed by the number of years and multiplying by 100. This gives the percent chance of the Event happening in any given year. An example would be three droughts occurring over a 30 year period, which equates to a 10% chance of that hazard occurring any given year.

Utilizing existing natural hazard data as well as input during planning meetings, the HMPC agreed upon a list of those natural hazards of concern to the UCB Planning Area. Hazard data from the Colorado Division of Emergency Management (CDEM), the

Natural Hazards Research and Applications Information Center at UCB, the National Oceanic and Atmospheric Administration (NOAA), and many other sources were examined to confirm the significance of these hazards to the Planning Area. Significance was measured in general terms, focusing on key criteria such as frequency and resulting damage, including deaths/injuries and property and economic damages to a community. The natural hazards evaluated as part of this plan include those that have either historically or have the future potential to cause significant human and/or monetary losses.

The natural hazards identified and investigated for UCB's Multi-Hazard Mitigation DRU Plan include:

- Avalanche
- Dam failure
- Drought
- Earthquakes
- Floods
- Human health hazards
  - West Nile Virus
  - Pandemic Influenza
- Landslides and Rockfalls
- Severe weather
  - Extreme temperatures
  - Fog
  - Hailstorm
  - Heavy rains/storms
  - Lightning
  - Tornadoes
  - Windstorms
  - Winter Storms
- Soil Hazards
  - Expansive soils
  - Land subsidence
- Volcanoes
- Wildfires

In order to assess the natural hazard history for UCB, the hazard history for Boulder County and the City of Boulder was evaluated in order to get a larger regional perspective on those hazards with a potential to adversely impact the UCB Planning Area. This information is provided in the following sections.

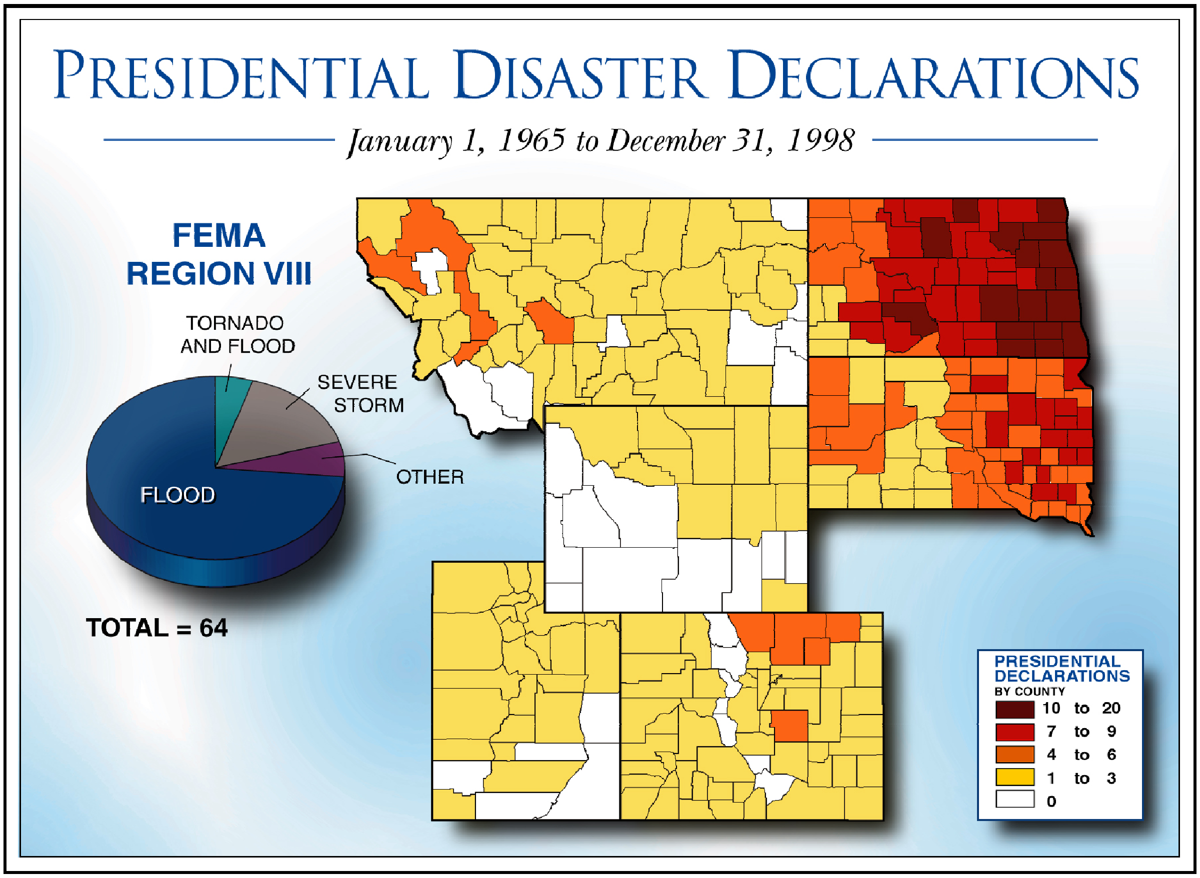
DISASTER DECLARATION/INSURANCE CLAIMS

This section provides information on the Disaster Declaration and Insurance History for the UCB Planning area.

Disaster Declarations

One method to identify hazards based upon past occurrence is to look at what events triggered federal and/or state disaster declarations within the Planning Area. Disaster declarations are granted when the severity and magnitude of the event's impact surpass the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. Should the disaster be so severe that both the local and state government's capacity is exceeded, a federal disaster declaration may be issued, allowing for the provision of federal disaster assistance.

From 1965 to 1998, FEMA Region VIII has experienced 64 Presidential Disaster Declarations. The State of Colorado experienced 14 Presidential Disaster Declarations from 1955 through 2005 and one Emergency Declaration. Within Boulder County, there have been two federal declarations from 1965 through 1998 as illustrated on the map and table that follow. The two most recent federal declarations that affected Boulder County were the Disaster Declaration associated with Wildfires occurring throughout the state in 2002 and the Emergency Declaration for the 2003 Blizzard.



According to the State of Colorado Natural Hazard Mitigation Plan, 2004, Boulder County's disaster declaration history is as follows:

Boulder County Disaster Declaration History		
Year	**Declaring Jurisdiction**	**Disaster Type**
1989	Local	Wildfire
1990	Local	Wildfire
1994	Local	Flooding
1995	State	Flooding
1998	Local	Wildfire
2000	USDA	Drought
2001	State	Severe Weather
2002	Presidential/Federal	Wildfire
2002	USDA	Drought
2003	Presidential/Federal Emergency Declaration	Snow

(Source: State of Colorado Natural Hazard Mitigation Plan (2004)

Insurance Claims

Another method for evaluating damages from natural disasters is to look at the types and amounts of insurance claims associated with these types of damages. UCB provided the property claims information as summarized in the table below for a period from 7/1/97 through 2/28/05. During that time there were 41 hazard events resulting in 43 insurance claims. Details on identified claims are provided in each of the hazard sections of this plan.

UCB Claim Data 7/1/97 – 2/28/05

Disaster Type	Number of Claims	$ Amount of Claims Paid*
High Winds	28	$331,653.69
Extreme Cold	6	$22,611.62
Heavy Rains	5	$19,159.60
Winter Storm	2	$15,190.31
Flood	1	$9,512.43
Lightning	1	$8,000
Totals	**43**	**$406,127.65**

*Note: In some instances, value of damages was more than amount of claim.

Based on this information, during the approximate seven year period, high wind events were the most frequent and costly to UCB. High winds accounted for 65% of the total claims made during that period and 82% of the total damages incurred for all claims.

Although not as detailed as the above insurance data, UCB provided additional claim information for the period from February 1989 to April 1997. For that time period, the data is summarized in the following table. This data is presented separately from the data above, as it is more difficult to definitively determine whether (or the extent to which) all of these claims (e.g., water damage claims) are associated with natural hazard events.

UCB Claim Data 2/6/89-4/24/97

Disaster Type	Number of Claims	$ Amount of Claims Paid*
Floods	2	$161,407.60
Freeze	6	$99,279.23
Lightning	7	$58,747.82
Mold	1	$32,877.00
Wind	6	$31,649.74
Water Damage	5	$23,538.30
Heavy Rains	3	$12,690.59
Snow	2	$3,538.21
Totals	**33**	**$391,728.49**

*Note: In some instances, there were no damages associated with an identified claim.

Looking at this approximately eight year period, it is interesting to note that the types of claims (i.e., disaster types) are similar, but associated damages are vastly different. The most damages were associated with localized sheet flow flooding occurring outside of the 100-year floodplain within the Main Campus area.

The following sections discuss the natural hazards evaluated in this plan.

AVALANCHE

Avalanche hazards occur predominantly in the mountainous regions of Colorado above 8,000 feet. The vast majority of avalanches occur during and shortly after winter storms. Avalanches occur when loading of new snow increases stress at a rate faster than strength develops, and the slope fails. Critical stresses develop more quickly on steeper slopes and where deposition of wind-transported snow is common. Historically in Colorado, avalanches have occurred during the months between November and April. The avalanche danger increases with major snowstorms and periods of thaw. About 2,300 avalanches are reported to the Colorado Avalanche Information Center (CAIC) in an average winter. More than 80% of these fall during or just after large snowstorms. The most avalanche-prone months are, in order, February, March, and January. Avalanches caused by thaw occur most often in April.

The combination of steep slopes, abundant snow, weather, snowpack, and an impetus to cause movement create an avalanching episode. According to the CAIC, about 90% of all avalanches start on slopes of 30-45 degrees; about 98% of all avalanches occur on slopes of 25-50 degrees. Avalanches release most often on slopes above timberline that face away from prevailing winds (leeward slopes collect snow blowing from the windward sides of ridges.) Avalanches can run, however, on small slopes well below timberline, such as gullies, road cuts, and small openings in trees. Very dense trees can anchor the snow to steep slopes and prevent avalanches from starting; however, avalanches can release and travel through a moderately dense forest. An average-sized avalanche travels around 80 mph; the typical range of impact pressure from an avalanche is from 0.5 to 5.0 ton/ft.

This hazard generally affects a small number of people, such as snowboarders, backcountry skiers, snowmobilers, and climbers who venture into backcountry areas during or after winter storms. Motorists along highways are also at risk of injury and death due to avalanches. Roads and highway closures, damaged structures, and destruction of forests are also a direct result of avalanches. Recognizing areas prone to avalanches is critical in determining the nature and type of development allowed in a given area.

Avalanche hazards exist in western Boulder County, where combinations of the above avalanche conditions occur.

Past Occurrences

Avalanches following significant snowstorms have resulted in fatalities within Boulder County. According to CAIC, between the winters of 1950/51 and 2003/04, five avalanche fatalities have occurred in Boulder County.

UCB Data

The only portion of the UCB Planning Area potentially at risk from avalanche hazards is the Mountain Research Station. There is no record of any avalanches occurring at this facility. According to the HMPC, given the topography of the property, the Mountain Research Station is not at risk to avalanches. However, some of the mountain research areas in the vicinity of the UCB property are likely located in avalanche risk areas. These research areas are owned by others (e.g., USFS) and are unlikely to adversely impact the UCB property. However, UCB staff and students conducting research in these nearby areas should be cognizant of possible avalanche hazards.

Likelihood of Future Occurrences

Unlikely: There is no recorded history of avalanches occurring on the Research Station property. The sloped areas within the property boundaries generally exceed a 1-to-8 slope (<11.25 degrees) which is well below the CAIC data that indicates that 98% of all avalanches occur on slopes of 25-50 degrees.

Given the topography and amount of snow falling on an annual basis in western Boulder County, avalanches will continue to occur. The loss of life due to an avalanche is usually due to people recreating in remote areas at the wrong time. Incidences of injury and loss of life will most likely continue if people continue to take risks in backcountry areas during the winter months. This would include researchers from the Mountain Research Station working in backcountry areas. The HMPC determined, however, that no properties within the UCB Planning Area are at risk to avalanches.

DAM FAILURE

Dams are human-made structures built for a variety of uses including flood protection, power, agriculture, water supply, and recreation. Overtopping is the primary cause of earthen dam failure. Failed dams can create floods that are catastrophic to life and property as a result of the tremendous energy of the released water. A catastrophic dam failure could challenge local response capabilities and require evacuations to save lives. Impacts to life safety will depend on the warning time available and the resources to notify and evacuate the public. Major loss of life could result as well as potentially catastrophic effects to roads, bridges and homes. Associated water quality and health concerns could also be an issue.

Dams typically are constructed of earth, rock, concrete, or mine tailings. Two factors that influence the potential severity of a full or partial dam failure include:

- The amount of water impounded, and
- The density, type, and value of development and infrastructure located downstream.

Dam failures can result from any one or a combination of the following causes:

- Prolonged periods of rainfall and flooding, resulting in overtopping,
- Earthquake,
- Inadequate spillway capacity, resulting in excess overtopping flows,
- Internal erosion caused by embankment or foundation leakage or piping, or rodent activity,
- Improper design,
- Improper maintenance,
- Negligent operation, and/or
- Failure of upstream dams on the same waterway.

Dams and reservoirs have been built throughout Boulder County. There are 24 Class I and 16 Class II dams. Class I dams are defined as those dams that would result in loss of life if they failed. Class II dams are defined as those dams that, following a failure, would result in significant damage, but not loss of human life. Boulder County Class I dams are listed below.

- Barker Meadow
- Baseline Reservoir
- Beaver Park Reservoir
- Boulder Reservoir
- Buttonrock Reservoir
- Clover Basin Reservoir
- Foothills Reservoir
- Gross Reservoir
- Harper Lake
- Hayden
- Ish Reservoir
- Jasper Lake
- Lagerman Reservoir
- Lefthand Park
- Lefthand Valley Reservoir
- Leggett & Hillcrest
- Marshall Lake
- McCall Lake
- Pleasant Valley (Terry Lake)
- Silver Lake
- Six Mile Reservoir
- Superior Reservoir
- Valmont "A"
- Waneka Reservoir

Past Occurrences

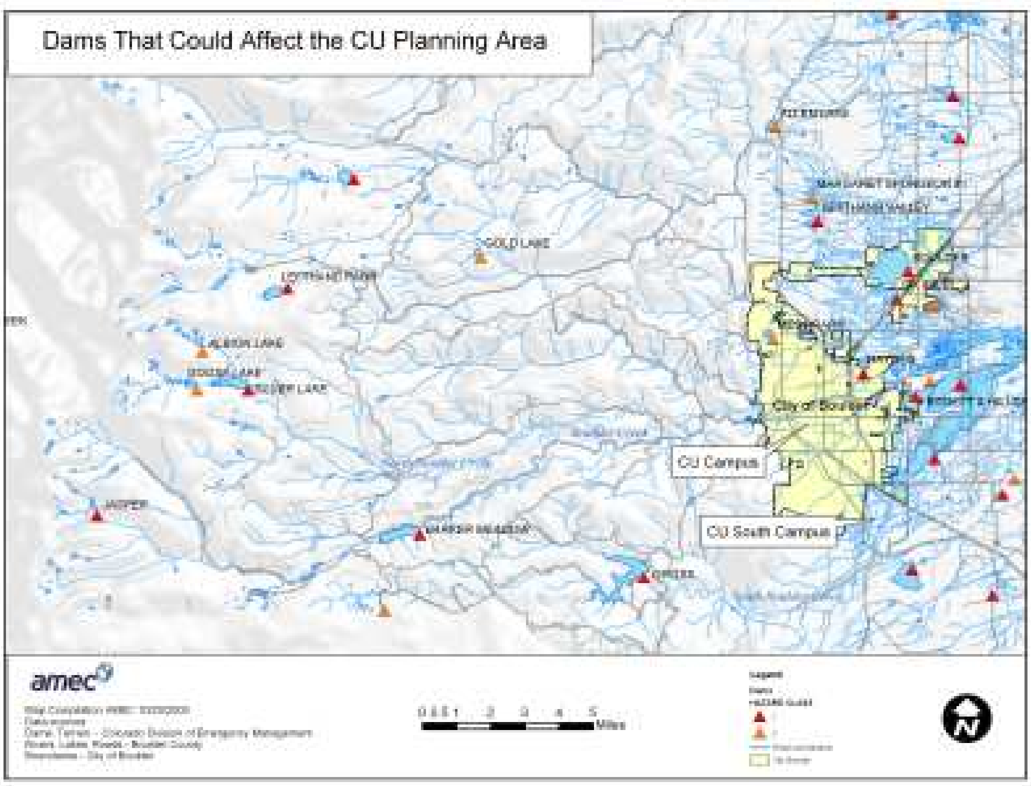
According to historical data, there have been no dam failures in Boulder County. Two dams in the past were listed as unsafe but conditions have since been corrected and the unsafe rating removed.

However, on July 15, 1982, the nearby Long Lake Dam in Rocky Mountain National Park above Estes Park failed and caused a flood that flowed directly through downtown Estes Park. Three people in campgrounds were killed in this flood.

UCB Data

The HMPC determined that in the event of a failure, six dams (see map below) threaten the UCB Planning Area:

- Albion Lake (Class II)
- Barker (Class I)
- Goose Lake (Class II)
- Gross (Class I)
- Jasper (Class I)
- Silver Lake (Class I)



Although, not a significant threat to UCB because of its size and location, according to the HMPC, Varsity Lake located on Main Campus is considered a state regulated Dam.

Likelihood of Future Occurrences

Unlikely: Based on historic data indicating that there have been no dam failures in the past that adversely impacted the UCB Planning Area, the risk of future occurrences is unlikely.

DROUGHT

Drought is a gradual phenomenon. Although droughts are sometimes characterized as emergencies, they differ from typical emergency events. Most natural disasters, such as floods or forest fires, occur relatively rapidly and afford little time for preparing for disaster response. Droughts occur slowly, over a multiyear period, and it is often not obvious (and difficult to quantify) when a drought begins or ends.

Drought impacts are wide-reaching and include economic, environmental and societal. The most significant impacts associated with drought in Colorado are those generally related to water intensive activities such as: agriculture, wildfire protection, municipal usage, commerce, tourism, recreation, and wildlife preservation. A reduction of electric power generation and water quality deterioration are also potential problems. Drought conditions can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding. An ongoing drought may also leave an area more prone to beetle kill and subsequent wildfires. Drought impacts increase with duration, as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline.

With its semiarid conditions, drought is an expected but unpredictable occurrence in Colorado. Drought is a complex issue involving many factors – it occurs when a normal amount of moisture is not available to satisfy an area's usual water-consuming activities. Drought can often be defined regionally based on its effects:

- Meteorological - this type of drought is usually defined by a period of below average water supply.

- Agricultural - this type of drought occurs when there is an inadequate water supply to meet the needs of the state's crops and other agricultural operations such as livestock.

- Hydrological - a hydrological drought is defined as deficiencies in surface and subsurface water supplies. It is generally measured as stream flow, snowpack, and as lake, reservoir and groundwater levels.

- Socioeconomic - a socioeconomic drought occurs when the results of drought impacts the health, well being, and quality of life, or when a drought starts to have an adverse economic impact on a region.

Due to natural variations in climate and precipitation sources, it is rare for all of Colorado to be deficient in moisture at the same time. However, single season droughts over some portion of the state are quite common. Defining when a drought begins is a function of drought impacts to water users. Hydrologic conditions constituting a drought for water users in one location may not constitute a drought for water users elsewhere, or for water users having a different water supply. Individual water suppliers may use criteria such as rainfall/runoff, amount of water in storage, or expected supply from a water wholesaler to define their water supply conditions. The drought issue is further compounded by water-rights specific to any state or region. Water is a commodity possessed under a variety of legal doctrines.

Past Occurrences

Historically, Colorado has experienced multiple severe drought conditions. According to The Colorado Drought Mitigation and Response Plan, since 1893 Colorado has experienced five multi-year droughts throughout the state as identified in the following table.

Colorado's Historical Wet and Dry Periods

DATE	DRY	WET	DURATION (Years)
1893-1905	X		12
1905-1931		X	26
1931-1941	X		10
1941-1951		X	10
1951-1957	X		6
1957-1959		X	2
1963-1965	X		2
1965-1975		X	10
1975-1978	X		3
1979-1996		X	17

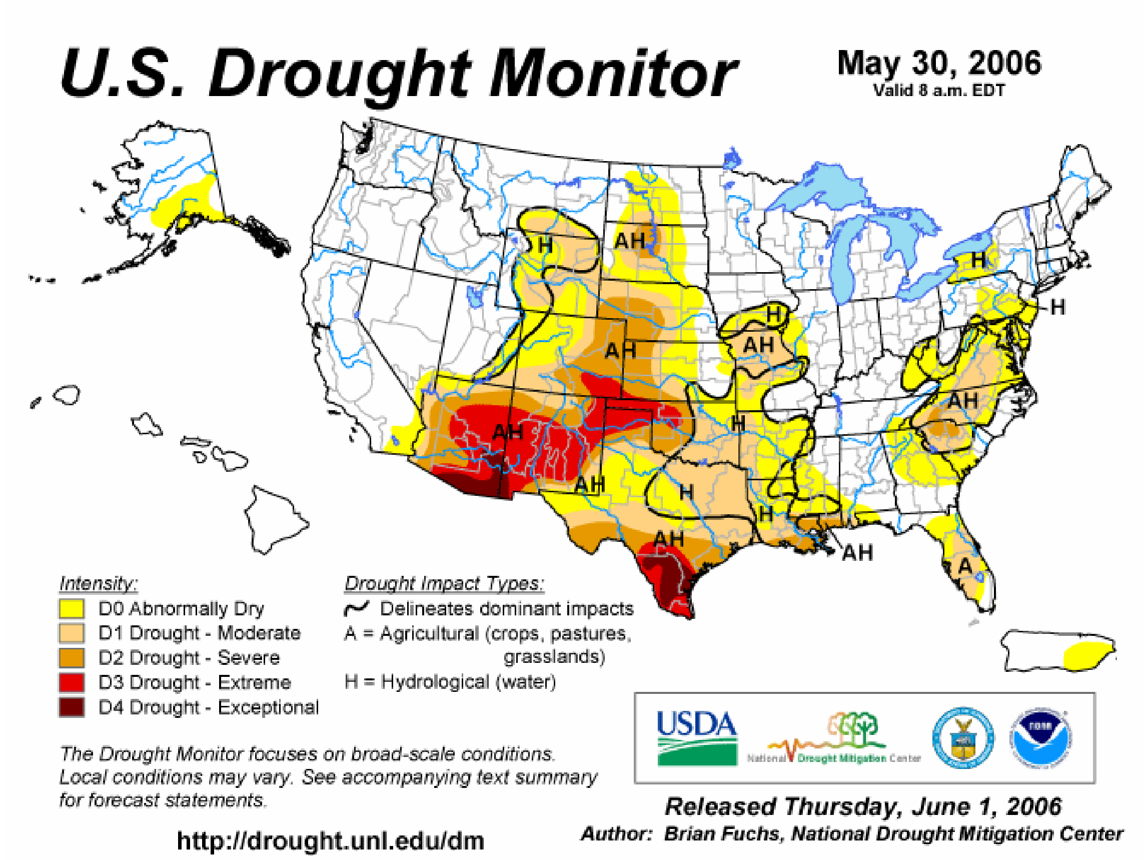
Source: McKee, Doesken and Kleist, 1999; Colorado Office of Emergency Management 2000.

With respect to Boulder County and the UCB Planning Area, the following drought events were identified by the HMPC:

- 1930-1937 – The drought of the 1930s had the greatest impact on the agricultural industry. Poor farming techniques, low market prices, and a depressed economy compounded the problem.

- 1951-1957 – Similar to the drought of the 1930s, the drought of the 1950s once again impacted the agricultural industry. Improvements in irrigation and farming techniques mitigated the effects.
- 1976-1977 – This drought was characterized as a winter event, limited in duration. It was the driest winter in recorded history for much of Colorado's high country and western slope, severely impacting the ski industry.
- 1980-1981 – This drought, beginning in the fall of 1980 and lasting until the summer of 1981, also generated costly impacts on the ski industry. According to the 2001 Colorado Drought Mitigation and Response Plan, this was considered the last severe and widespread drought to affect Colorado.
- 1994 – This drought was considered a growing season drought impacting northeast Colorado and identified as one of the driest years on record. Significant impacts reported included an increase in wildfires statewide, loss to the winter wheat crops, difficulties with livestock feeding, and impacts to the state's fisheries.
- 2000 – Strong La Nina conditions led the majority of months to be below average in precipitation and above average in temperature. Statewide, snowpack started out well below average but recovered to near average with March precipitation. However, with an early snowmelt resulting in low stream flows, by June drought conditions were beginning to affect most of the state. Most dry were the northeastern plains, the Rio Grande, and San Juan/Dolares basins. Wildfire conditions were extreme, contributing to several fires statewide. Agriculture also suffered, with dryland farming and ranching affected the most. By October 2000, 17 Colorado counties and 29 contiguous counties were eligible for assistance as a result of a USDA Secretarial Disaster Designation. Boulder County was eligible for aid as a contiguous county. Weather patterns eventually returned to near normal with average precipitation and below average temperatures.
- May 2002 – The Colorado Governor, for the first time in state history, asked the federal government to declare all of Colorado a drought disaster area. 2001, with an average temperature of 52.4 degrees, was the warmest year since 1986. The drought started in late 1999 and was compounded by scarce snowfall in 2001. 2002 was the driest year on record for the Denver region and much of the State. Total precipitation for 2002 was 7.48 inches; the average is 15.81 inches (NWS-Denver Office).

The map that follows provides a "snapshot in time" perspective of the current drought conditions as of May 2006. According to the U.S. Drought Monitor, Boulder County and the UCB Planning Area are currently experiencing Abnormally Dry to Moderate drought conditions. The Drought Monitor focuses on broad-scale conditions; local conditions may vary. This map considers several factors including the Palmer Drought Severity Index, Soil Moisture Models, USGS Weekly Streamflows, Standardized Precipitation Index, and Satellite Vegetation Health Index.



UCB Data

Regional drought events do have an adverse impact on the UCB Planning Area. Impacts include an increase in wildfire danger and impacts to campus landscapes. Although difficult to document, the HMPC identified the following suspected damages occurring as a result of an extended drought in 2003:

> Due to the extreme dry conditions, 12-13 mature spruce trees on campus shattered. Also attributed to the drought, 21 or 22 underground water main bursts occurred in one year. This was thought to be caused as the ground dried up.

Likelihood of Future Occurrences.

Likely**:** According to historic data, the UCB Planning Area has experienced seven periods of drought since 1930. This is an average of one drought every 10.86 years or a 9.21% chance of drought any given year.

Given the geographic location of the Planning Area, its semi-arid conditions, and historical drought cycles, there is always the potential for a drought to impact the UCB Planning Area.

EARTHQUAKE

Colorado is considered a region of minor earthquake activity. Geologic studies indicate there are about 90 potentially active faults in Colorado, with documented movement within the last 1.6 million years. "Active" faults, which represent the highest earthquake hazard, are those that have ruptured to the ground surface during the Holocene period (about the last 11,000 years).

An earthquake is caused by a sudden slip on a fault. Stresses in the earth's outer layer push the sides of the fault together. Stress builds up and the rocks slip suddenly, releasing energy in waves that travel through the earth's crust and cause the shaking that is felt during an earthquake. The amount of energy released during an earthquake is usually expressed as a magnitude and is measured directly from the earthquake as recorded on seismographs. Another measure of earthquake severity is intensity. Intensity is an expression of the amount of shaking at any given location on the ground surface. Seismic shaking is typically the greatest cause of losses to structures during earthquakes. Seismologists have developed two scales as seen on the following page to quantify the magnitude and shaking intensity of an earthquake's effects, which is measured by how an earthquake is felt by humans.

Earthquakes can cause structural damage, injury and loss of life, as well as damage to infrastructure networks such as water, power, communication, and transportation lines. Other damage-causing effects of earthquakes include surface rupture, fissuring, settlement, and permanent horizontal and vertical shifting of the ground. Secondary impacts can include landslides, seiches, liquefaction, wildfires and dam failure.

EARTHQUAKE INTENSITIES
WITH APPROXIMATE CORRESPONDING MAGNITUDES

Mercalli Intensity	Description	Richter Magnitude
I	*INSTRUMENTAL*: detected only by seismographs	3.5
II	*FEEBLE*: noticed only by sensitive people	4.2
III	*SLIGHT*: like the vibrations due to a passing train; felt by people at rest, especially on upper floors	4.3
IV	*MODERATE*: felt by people while walking; rocking of loose objects, including standing houses	4.8
V	*RATHER STRONG*: felt generally; most sleepers are awakened and bells ring	4.9 - 5.4
VI	*STRONG*: trees sway and all suspended objects swing; damage by overturning and falling of loose objects	5.5 - 6.0
VII	*VERY STRONG*: general alarm; walls crack; plaster falls	6.1
VIII	*DESTRUCTIVE*: car drivers seriously disturbed; masonry fissured; chimneys fall; poorly constructed buildings damaged	6.2
IX	*RUINOUS*: some houses collapse where ground begins to crack, and pipes break open	6.9
X	*DISASTROUS*: ground cracks badly; many buildings destroyed and railway lines bent; landslides on steep slopes	7.0 - 7.3
XI	*VERY DISASTROUS*: few buildings remain standing; bridges destroyed; all services (railways, pipes and cables) out of action; great landslides and floods	7.4 - 8.1
XII	*CATASTROPHIC*: total destruction; objects thrown into air; ground rises and falls in waves	> 8.1

(Source: Math/Science Nucleus.Org website)

Past Occurrences

According to the USGS, Eastern Colorado is nearly aseismic, with just a few epicenters in the Arkansas and Platte River Valleys. Most shocks in the history of this state have centered west of the Rocky Mountain Front Range. The first seismographs in Colorado of sufficient quality to monitor earthquake activity were installed in 1962. Until that time, newspaper accounts are the primary source of published data.

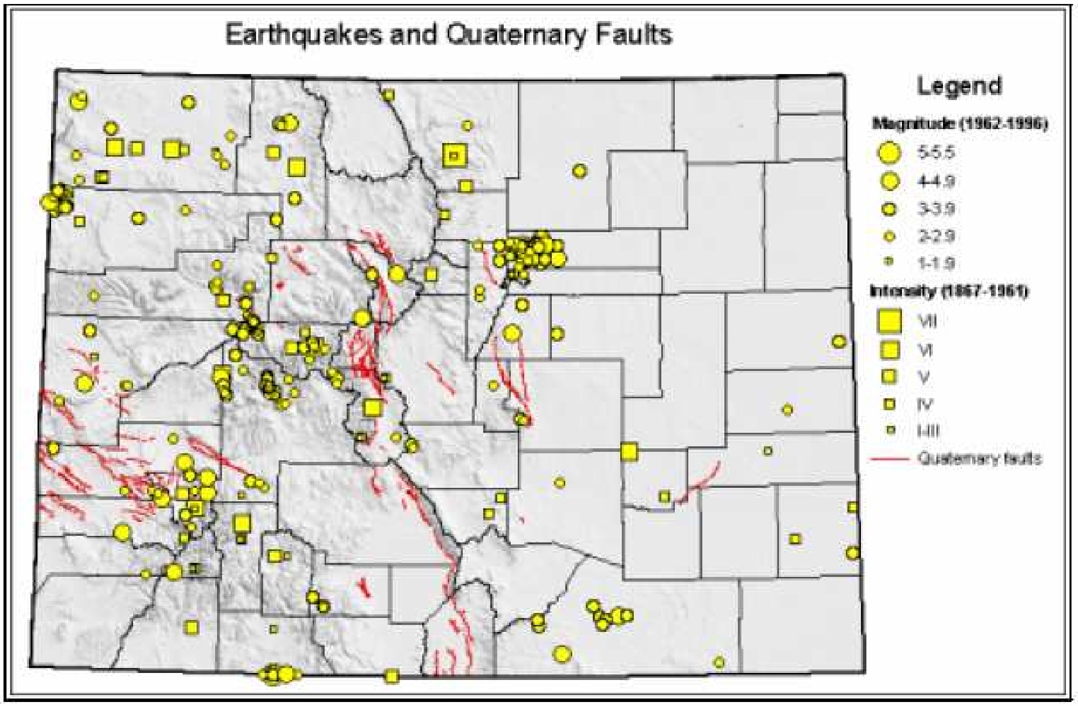
The following provides a summary of known earthquake activity in Colorado with a focus on the Boulder County region.

- **Since 1867 –** more than 400 earthquake tremors of magnitude 2.5 or greater have been recorded in Colorado.
- **November 7, 1882 –** the largest historical earthquake in the state and the first ever to cause damage in Denver. The epicenter is thought to be located in the Front Range near Rocky Mountain National Park; the magnitude was estimated to be about 6.2 on the Richter scale. In Boulder County the walls of "The Depot" cracked, and plaster fell from walls at the University at Colorado, Boulder. The quake was felt as far away as Salina, Kansas and Salt Lake City, Utah.
- **1962-1967 –** a series of earthquakes occurred in the Denver-Boulder area. The earthquakes were felt by cities and towns within a 100-mile radius of Denver. Some attribute this earthquake activity to deep-well injections conducted at the Rocky Mountain Arsenal starting in 1962. A few notable occurrences are detailed below.
    - ♦ **1965 -** Three shocks **–** February 16, September 29, and November 20 **–** caused intensity VI damage in Commerce City and area.
    - ♦ **January 4, 1966 –** located northeast of Denver, Magnitude 5.0, Intensity V.
    - ♦ **April 10, 1967 –** the largest earthquake since the series began in 1962 occurred; 118 windowpanes were broken in buildings at the Rocky Mountain Arsenal, a crack in an asphalt parking lot was noted in the Derby area, and schools were dismissed in Boulder, where walls sustained cracks. Legislators quickly moved from beneath chandeliers in the Denver Capitol Building, fearing they might fall. The Colorado School of Mines rated this tremblor magnitude 5.0.
    - ♦ **April 27, 1967 –** Boulder sustained minor damage to walls and acoustical tile ceilings as a result of this magnitude 4.4 earthquake.
    - ♦ **August 9, 1967 –** located northeast of Denver, this earthquake, with a recorded magnitude of 5.2 and intensity of VII, caused greater than $1 million in damages, and was considered the most economically damaging earthquake in Colorado history.

- ♦ **November 27, 1967 –** located northeast of Denver, Magnitude 5.1, Intensity VI.

- **Since 1971 –** there have been 12 to 15 earthquakes, located north and northeast of Denver, large enough to be felt in Boulder County and the UCB Planning Area.

A map from the State Natural Hazard Mitigation Plan detailing historic earthquakes and Quaternary Faults in Colorado is provided below.



(Source: State of Colorado Natural Hazard Mitigation Plan 2004)

UCB Data

As reported above, the 1882 earthquake caused plaster to fall off the walls in some of the buildings on campus. According to the HMPC, though not readily documented, it is thought that the 1967 earthquake also caused minor damage in some of the buildings on Campus.

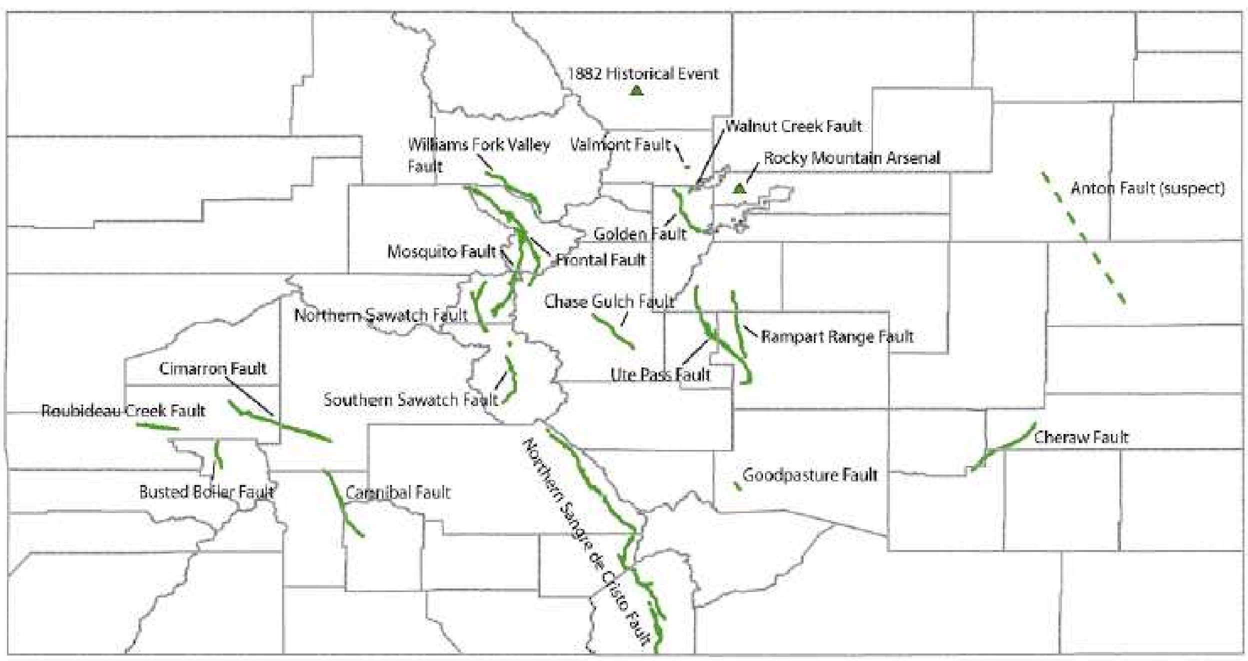
Likelihood of Future Earthquake Occurrences

Occasional: The ability to accurately estimate the timing, location, and severity of future earthquake activity in Colorado is limited due to the lack of good historic data and their relative infrequent occurrence. According to the State Hazard Mitigation Plan, of the 90 known active faults in Colorado, several of these are thought capable of causing earthquakes as large as magnitude 6.5 to 7.25.

The State, utilizing HAZUS, FEMA's loss estimation software, identified the following five most potentially damaging faults in Colorado: Rocky Mountain Arsenal, Golden, Rampart Range, Ute Pass, and Walnut Creek. Of these five faults, Rocky Mountain Arsenal, Golden, and Walnut Creek are within close proximity to Boulder County as seen in the below Fault Map. According to the City of Boulder, the only known "active" fault in Boulder County, located along North 75th street near Valmont Drive, has been quiet for over 10,000 years. However, the State Natural Hazard Mitigation Plan also identifies the Rock Creek fault in Boulder County. It appears that the Rock Creek fault is considered a Quaternary (Q) fault (and therefore may not be considered an "active" fault); while the Valmont fault is considered a Middle to Late Quaternary (MLQ) fault. Further, in estimating potential earthquake impacts within Boulder County, the State analyzed impacts associated with the faults listed below. Within the County, only the Valmont fault in Boulder County was analyzed along with six other faults located in other nearby counties:

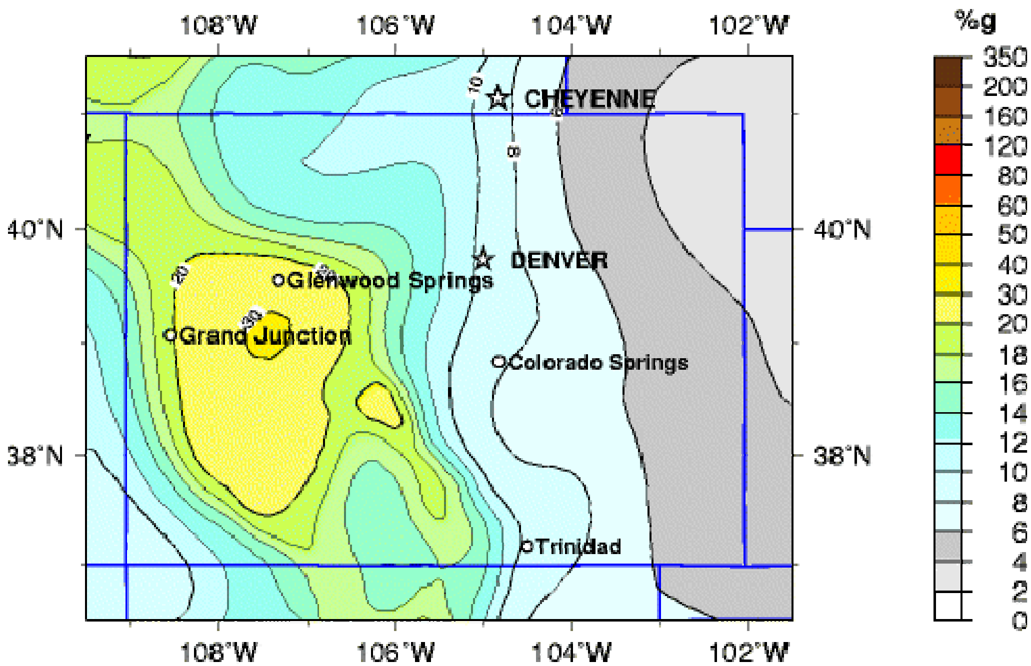
- Frontal
- Golden
- Mosquito
- Ute Pass
- Valmont
- Walnut Creek
- Williams Fork

Colorado Major Fault Map



(Source: State of Colorado Natural Hazard Mitigation Plan 2004)

Seismic hazard zone maps and earthquake fault zone maps are used to identify where such hazards are more likely to occur based on analyses of faults, soils, topography, groundwater, and the potential for earthquake shaking sufficiently strong to trigger landslide and liquefaction. The USGS's Probabilistic Seismic Hazard Map of Colorado below depicts the shaking level that has a two percent chance of being exceeded over a period of 50 years. CU (Boulder County) lies in the range of 10-12% peak acceleration.



Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years
site: NEHRP B-C boundary
National Seismic Hazard Mapping Project

(Source: http://neic.usgs.gov/neis/states/colorado/hazards.html)

FLOOD

Floods can be among the most frequent and costly natural disaster in terms of human hardship and economic loss, and can be caused by a number of different weather events. Floods can cause substantial damage to structures, landscapes, and utilities as well as life safety issues. Certain health hazards are also common to flood events. Standing water and wet materials in structures can become a breeding ground for microorganisms such as bacteria, mold, and viruses. This can cause disease, trigger allergic reactions, and damage materials long after the flood. When floodwaters contain sewage or decaying animal carcasses, infectious disease is of concern. Direct impacts such as drowning can be limited with adequate warning and public education about what to do during floods. Where flooding occurs in populated areas, warning and evacuation are paramount to reduce life and safety impacts. Boulder County and the UCB Planning Area are susceptible to various types of flood events as described below.

Riverine and Flash Flooding - is defined as when a watercourse exceeds its “bank-full” capacity and is usually the most common type of flood event. Riverine flooding generally occurs as a result of prolonged rainfall or rainfall that is combined with already saturated soils or overloaded drainage systems from previous rain events. The duration of riverine floods may vary from a few hours to several days. Factors that directly affect the amount of flood runoff include precipitation amount, intensity and distribution, the amount of soil moisture, seasonal variation in vegetation, snow depth, and water-resistance of the surface due to urbanization. Other factors such as debris blocking a waterway or channel can further aggravate a flood event. In Boulder, development has altered the natural environment, changing and interrupting some of the natural drainage ways. As a result, drainage systems can become overloaded more frequently.

The most serious overbank flooding occurs during intense rainstorm or in a dam failure, resulting in a flash flood. The term flash flood describes localized floods of great volume and short duration. In contrast to riverine flooding, this type of flood usually results from a heavy rainfall on a relatively small drainage area. Flash floods can occur very quickly.

Irrigation Ditches/Canals – The eastern portion of Boulder County has more than 100 irrigation ditches and canals used to convey water collected in the mountain reservoirs to downstream users. Ditches convey irrigation water along hillsides following contours, and, as a result, cut across the natural drainage pattern of stormwater runoff flowing down hillsides. Although efforts are made to separate stormwater runoff and irrigation water, excessive runoff can flow into an irrigation ditch, causing overbank flooding or a collapse of the ditch itself. As in flash floods, there is often little warning for these types of events.

Urban or Street Flood Events - This type of flooding results as land is converted from fields to roads and parking lots and loses its ability to absorb rainfall. Urbanization increases runoff two - six times over what would occur on natural terrain. Except at underpasses, street flooding and yard ponding usually do not get deeper than a foot or two and is often viewed more as a nuisance than a major hazard. However, during periods of urban flooding, high velocity flows can occur in streets, even in areas with only shallow flooding.

The area adjacent to a channel is the floodplain. Floodplains are illustrated on inundation maps, which show areas of potential flooding and water depths. In its common usage, the floodplain most often refers to that area that is inundated by the 100-year flood, the flood that has a one percent chance in any given year of being equaled or exceeded. The 100-year flood is the national minimum standard to which communities regulate their floodplains through the National Flood Insurance Program (NFIP). Boulder County and the City of Boulder where the UCB Planning Area is located participate in the NFIP.

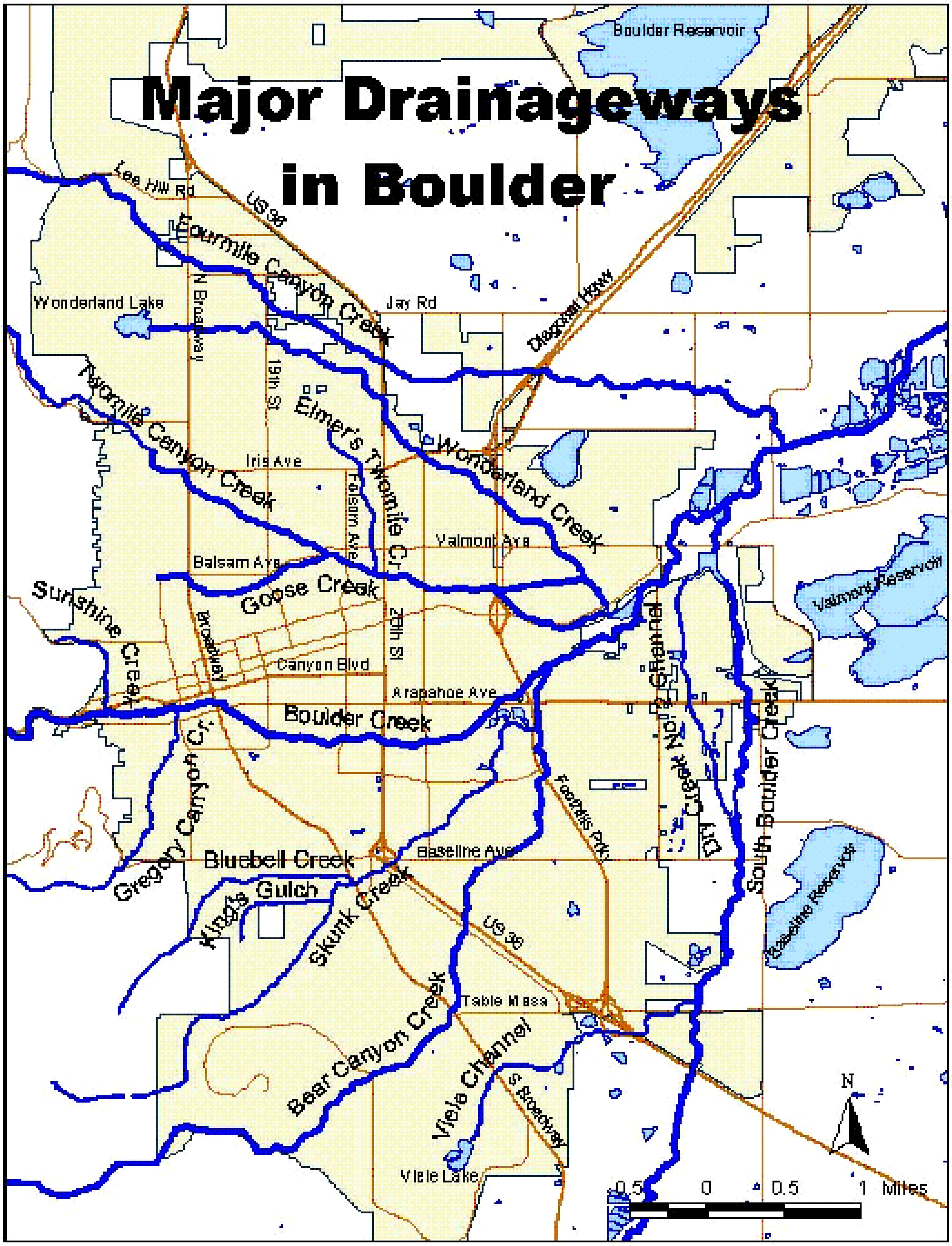
The potential for flooding can change and increase through various land use changes and changes to land surface, resulting in a change to the floodplain. A change in environment can create localized flooding problems in and outside of natural floodplains by altering or confining natural drainage channels. These changes are most often created by human activity.

Major Sources of Flooding

Boulder County encompasses multiple creeks, tributaries, and associated watersheds. The County is situated in a region that dramatically drops in elevation from the western foothills to the eastern plains, where excess rain or snow can contribute to downstream flooding. Boulder is crossed by 13 major drainageways, or creeks, and two major channels. All may be subject to periodic flooding and are ultimately tributary to Boulder Creek. The drainageways include:

- Boulder Creek
- Bear Canyon Creek
- Bluebell Creek
- Dry Creek Ditch No.2 Channel (part of the South Boulder Creek floodplain)
- Elmer's Twomile Creek
- Fourmile Canyon Creek
- Goose Creek
- Gregory Canyon Creek
- King's Gulch
- Skunk Creek
- South Boulder Creek
- Sunshine Canyon Creek
- Twomile Canyon Creek
- Viele Channel
- Wonderland Creek

The following map illustrates the major drainageways in Boulder.



(Source: http://www.ci.boulder.co.us/publicworks/depts/utilities/floodplain/drainage.htm)

According to the Boulder County website, a flood event would most likely result from a heavy rainstorm that stalls over any of the creek basins. It could rain for as little as three to four hours in the foothills before the water starts overflowing stream banks.

According to the HMPC, should flooding occur, the drainages most likely to impact the UCB Planning Area include:

- Boulder Creek
- Bear Canyon Creek
- Bluebell Creek
- Dry Creek
- Fourmile Creek
- Gregory Canyon Creek
- Skunk Creek
- South Boulder Creek
- Sunshine Canyon
- Viele Channel
- Como Creek

Past Occurrences

The flood season in Boulder County and the UCB Planning Area is April 1 through September 30, but floods can happen at any time. Historically, the most frequent flooding occurs in May and June, when snowmelt increases runoff. However, the most dangerous flooding in Boulder County seems to occur from mid-July through September due to heavy precipitation from thunderstorms. Creeks with mountainous, upstream watersheds are subject to flash floods. Colorado's worst flash flood occurred on July 31, 1976, in the Big Thompson Canyon, west of Loveland, claiming over 400 houses and 142 lives. The flood was caused when 12-14 inches of rain fell in the canyon along Highway 34. The flood resulted in $35.5 million in damages and changed the course of the river in 30 places. More recently, in 1997, the Fort Collins flood caused $200 million in damage and claimed five lives. The flood was caused by a storm that dumped 14.5 inches of rain.

Major flooding events recorded within Boulder County include the following flood events detailed by creek.

Boulder Creek

May 23, 1876 – General storm over the Boulder Creek basin created flooding on the plains of Boulder County up to 1.5 miles wide.

May 29 to June 2, 1894 – The flood, caused by a downpour, washed away much of Boulder's downtown. Records for a 96-hour period indicate 4.5 to 6 inches of precipitation. Mountain rainfall, combined with snowmelt runoff, produced the greatest flood known at Boulder and inundated the valley. Bridges, buildings, roads and railroads were washed away. Every bridge in Boulder Canyon was swept away, destroying the highway and railroads as far up the canyon as Four Mile Creek. Buildings were destroyed at Crisman, Sunset and Copper Creek. The town was isolated from other Colorado communities for five days. Only one person was killed. Records indicate that the floodplain was inundated by water over an area as much as one mile wide for several days. Floodwater covered the entire area between Canyon Boulevard (i.e., called Water Street at the time) and University Hill to depths as great as eight feet. Rainfall amount has been estimated at 5.5 inches. Computations made 18 years later produced estimates of the peak discharge ranging from 9,000 cfs to 13,600 cfs. This was considered a slow rising flood, and designated as a 100-year event. Agricultural damages included loss of livestock, crops, pastures, fences, roads and deposition of sand and silt on floodplain lands. Although damages were extensive, a dollar amount was not available.

(Source: http://www.ci.boulder.co.us/publicworks/depts/utilities/natural_hazards/history.html)

July 8, 1906 – Heavy rains, an estimated 2.8 inches Saturday night through Sunday, over Sunshine Canyon, led to extensive flooding. The water spread out at the point where the dry gulch comes into Pearl Street, rushed down through the corner of Third Street, through Pearl and down into Walnut and Railroad Street. Water stood two feet deep on the platform at the Colorado and Southern passenger depot, and the yards were so flooded that the tracks were invisible. By building a temporary wall at Third Street, they were able to direct the water in its natural channel across Pearl and down into Boulder Creek. The flooding did considerable damage to the Silver Lake Ditch, which broke and contributed a considerable quantity of water to the body of the flood, which affected the west part of town.

June 1-2, 1914 – The peak discharge was estimated at 5,000 cfs. Numerous bridges were washed out between Colburn Mill and Boulder Falls. A portion of the main line for Boulder's water system was destroyed.

June 2-7, 1921 – Rainfall totaled 3.36 inches in Boulder. A peak discharge of 2,500 cfs was recorded on June 6, 1921.

September 4, 1938 – A maximum discharge of 4,410 cfs occurred near the mouth of Boulder Creek. Numerous bridges were destroyed.

May 6-8, 1969 – This flood was the result of a combination of snowmelt in the mountains and four days of continuous rainfall. Total precipitation for the storm amounted to 7.60 inches at Boulder and 9.34 inches at the Hydroelectric Plant located in Boulder Canyon. Peak flooding occurred on May 7th in Boulder. Bear Canyon Creek, Skunk Creek, and Two Mile Creek overflowed their banks. Damages from this storm were estimated at $325,000. Schools were closed. The gauging records show that floods the size of the May 1969 flood occur on an average of about once every five years on

Boulder Creek. It is important to note that mitigation in the area has been done to reduce the damaging affects of later floods. The picture below shows the damage at Bear Creek.

(Source: http://www.ci.boulder.co.us/publicworks/depts/utilities/natural_hazards/history.html)

South Boulder Creek

September 1938 – in the mountains west of Eldorado Springs, six inches of rain fell resulting in flooding that destroyed many buildings in the Eldorado Springs community and exceeded previous flood records dating back to 1895. The Town of Eldorado Springs recorded 4.42 inches of rainfall. This resulted in a peak discharge of 7,390 cfs. This was the highest recorded flood on South Boulder Creek. The picture below shows the destroyed dancehall at the Eldorado Springs Resort.

(Source: http://www.ci.boulder.co.us/publicworks/depts/utilities/natural_hazards/history.html)

May 4-8, 1969 – Precipitation amounts totaled 8.11 inches at Eldorado Springs and 10.05 inches at Gross Reservoir. A peak discharge of 1,690 cfs occurred at Eldorado Springs. Peak flooding occurred on the 7th of May at Eldorado Springs. Analysis of gauging records show that floods the size of the 1969 storm occur on an average of about once every seven years on South Boulder Creek.

Boulder County also identifies the following flood events at South Boulder Creek with peak discharges in excess of 1,000 cfs:

- June 3, 1895 1,130 cfs
- May 9, 1900 1,100 cfs
- June 20, 1909 1,340 cfs
- May 24, 1914 1,240 cfs
- June 6, 1921 1,440 cfs
- June 21, 1947 1,290 cfs
- June 6, 1949 1,430 cfs
- June 18, 1951 2,370 cfs
- June 4, 1952 1,080 cfs

Four Mile Canyon Creek

Four Mile Creek experiences occasional flooding with notable events occurring in 1916, 1941, and 1951. Railroad bridges were washed out in 1916 and 1941. Localized flooding along the lower reaches of Four Mile Canyon Creek occurs frequently. Damages and losses have generally been low because the area is undeveloped.

July 23, 1909 – Heavy rains caused two injuries and two deaths as flash flooding occurred in Two Mile and Four Mile Creeks, northwest of Boulder. Damage to bridges and pipelines also resulted.

July 30, 1916 - Heavy rain (1-3 inches) centered over Four Mile Canyon caused a brief but strong flash flood which flooded farms and damaged roads, railroads, bridges, and irrigation ditches. Though the 26th Street bridge crossing *(now Folsom Street)* was covered with three feet of water, it was not damaged by the flood. The flood water was from 10 to 12 feet deep on the Terry Ranch. Damages were estimated at several thousand (1916) dollars.

July 2-7, 1921 – Flooding in Coal Creek and Four Mile Canyon occurred, destroying numerous structures, injuring and killing livestock and damaging bridges. The maximum recorded rainfall was 5.29 inches, and the greatest recorded rainfall intensity was 4.3 inches in six hours at Longmont. This flood was produced by a combination of rainfall and snowmelt.

Goose Creek

Significant flooding occurred in September 1951 and July 1954. The 1954 event damaged an addition to Boulder Community Hospital that was under construction.

Twomile Creek

The worst flood on Twomile Creek occurred in September 1933, while other flooding events occurred in: 1909 (see Four Mile event above), 1941, 1942, 1949, and 1965.

Lefthand Creek

Significant flooding on Lefthand Creek occurred in 1864, 1876, 1894, 1896, 1918, 1921, 1938, 1949, 1951, 1963, 1969, and 1973.

June 1894 – Heavy rains combined with high spring runoff caused extensive flooding throughout Boulder County. Damage was extensive along Lefthand Creek. Bridges and roads near Lefthand Creek were washed out. Buildings in Ward, Rowena, Glendale, and all the towns along James Creek sustained heavy damage or were swept away. Damage to nearby mines was also extensive. Trees were uprooted, roads and railroads were destroyed, and ten families lost houses. James Creek (a tributary of Lefthand Creek) grew to a width of 250 feet at some locations. From May 30 through June 1, 8.54 inches of rain was reported in Ward.

August 1913 – Jamestown also suffered extensive flood damage in August 1913. Flooding damaged or destroyed most of the houses along the creek. All wagon and footbridges were destroyed, and Jamestown was isolated for two weeks when the access road washed out.

June 2-6, 1921 – The maximum recorded rainfall was 5.29 inches and the greatest recorded rainfall intensity was 4.3 inches in six hours at Longmont. The storm lasted for five days. This flood was produced by a combination of rainfall and snowmelt. Although this storm caused overbank flooding, neither discharges nor damages were recorded.

September 3, 1938 – During this storm, showers were generally over the Lefthand Creek basin, accompanied by isolated cloud bursts along the foothills and the lower elevations. A maximum peak discharge of 812 cfs was recorded at US highway 287 near Longmont.

June 4, 1949 – Heavy and prolonged rainfall, accompanied by runoff from snowmelt, caused overbank flooding on Lefthand Creek during May and early June. The high flow caused minor damages to irrigation headworks, bridges, and farmlands. The peak discharge was 1,140 cfs.

August 3, 1951 – A heavy rainstorm occurred over the Front Range and foothills east of the Continental Divide from the vicinity of Boulder to near Ft. Collins, a distance of approximately 50 miles. One of the storm centers was on Lefthand Creek near the town of Niwot. At this storm center, total precipitation was unofficially reported to have been over 6 inches. Overbank flows occurred along most of the length of Lefthand Creek. Bridges, roads, crops, and irrigation structures were damaged.

May 1969 – Three days of heavy snow and rain, along with spring runoff, caused a flood that damaged houses and businesses in Jamestown and caused major erosion damage to roads and bridges along James Creek. Peak discharge measurement on James Creek was 1,970 cfs. Precipitation totals of approximately 8 inches were recorded in the James Creek Basin.

St. Vrain Creek

St. Vrain Creek flood history dates back to 1844. Flooding also occurred in 1864, 1876, 1894, 1914, 1919, 1921, 1938, 1941, 1949, 1951, 1957, 1969, 1973, and 1976. Over the course of 100 years, floods occurring along the St. Vrain Creek have destroyed farmland, roads, and bridges.

May 31, 1894 – All of the lower parts of Lyons were washed away and 20 houses were destroyed or ruined. The St. Vrain Valley looked like a lake three miles wide. Peak discharge was estimated at 9,800 cfs, which made it greater than a 50-year event.

August 2, 1919 – Bridges on the North St. Vrain for about five miles up and five miles downstream were destroyed. Longmont and Lyons water mains up the canyon were torn out in many places. People living on the lowlands along the banks of the St. Vrain were flooded out. Peak discharge was estimated at 9,400 cfs.

June 2, 1921 – North and south St. Vrain Creeks carried large volumes of water. Damage was done to bridges, sheds, and barns. The peak discharge at Lyons of 2,020 cfs was not indicative of conditions at Longmont because of heavy rain downstream from Lyons. Longmont recorded 5.87 inches. No estimate of the discharge at Longmont is available.

September 1-4, 1938 – Precipitation for the three day period totaled 4.54 inches at Longmont. The peak discharge at Lyons was only 1,650 cfs, while near the mouth of the St. Vrain Creek it was estimated to be 8,360 cfs. Highways were underwater, some bridges were washed out, and many residents near the creek were forced from their homes.

June 2, 1941 – Overbank flooding as a result of four inches of rain in the Longmont area caused damage or destruction of homes, businesses, bridges, roads, water lines, crops, livestock and irrigation structures. The peak discharge was 10,500 cfs.

June 4, 1949 – All bridges between Longmont and Lyons were impassable when the St. Vrain peaked at 6,700 cfs. A total of 16 bridges were damaged, with two completely destroyed. Irrigation headworks were extensively damaged. In Longmont 10 homes and five businesses were flooded.

August 3, 1951 – Lyons received 6.3 inches from a cloudburst and flooding resulted. The peak discharge at Lyons was 3,700 cfs and 6,200 cfs at a point seven miles east of Longmont. Railroad and highway bridges near Longmont were severely damaged.

May 1957 – Three to five inches of rain fell over the entire St. Vrain basin, peaking at 3,060 cfs in Lyons. Irrigation works and bridges between Lyons and Longmont were damaged or destroyed.

May 4-8, 1969 – Roads and bridges along streams were damaged, stream banks were eroded, and farmlands were flooded. The peak discharge at Lyons was 2,900 cfs on May 7 and 10,300 cfs on May 8.

Miscellaneous

May 30, 1896 – Flooding occurred in Marshall and Boulder County caused by locally heavy thunderstorms over the Longmont area. Estimated rainfall was at 4.62 inches. Large hail was also present during the storm.

August 19, 1896 – A storm tore up the road beyond Salina and made the passage of Four Mile impassable. Considerable damage was done to property in Salina. According to reports, "Boulder has not had such a dashing rain storm as that of yesterday afternoon for a long time." Lightning burned out the telephone of the Daily Camera office. The rise of the creek in the south part of town was so rapid and of such threatening proportions as to cause great anxiety for two or three hours to the people living in that section.

July 31, 1929 – 4.8 inches of rain fell, causing flooding in Four Mile Creek, Boulder Creek, and South Boulder Creek. Water ran in streams down Boulder streets and across University Hill lawns and sidewalks. Damages were estimated at $4,000 to roads, bridges and culverts in Boulder. Principal damage was on 10th St. from Chatauqua to University Avenue and from 12th Street from University Avenue to Arapahoe. A large section of the Armstrong Bridge in Gregory Canyon was washed out, and 150 feet of Baseline in front of the Chatauqua golf course was covered with rock and gravel. A cement sidewalk across Gregory Ditch on Marine was washed out.

June 22, 1941 – Heavy rains caused flooding in areas of Four Mile Creek, St. Vrain Creek, Two Mile Creek, and Boulder Creek. Flash floods swept a Longmont man to his death. The storm dropped one inch of rain in Boulder and more to the north and west. Roads, gullies, and some structures were damaged in several areas. Damage estimates were in the thousands (1941) of dollars. The storm was centered over Sugarloaf Mountain just west of Boulder and primarily affected Four Mile and St. Vrain Canyons. Numerous roads were partially or completely destroyed, most west and north of Boulder.

August 10, 1994 – Approximately three inches of rain fell in a period of 30 minutes in the Town of Lyons. An urban flash flood resulted when the drainage system was unable to manage the large amounts of water. Damage to streets alone was $65,000.

May of 1995 – Boulder received record rainfall (9.37 inches), and combined with above average snowfall in the mountains, caused flooding throughout Boulder County. St. Vrain Creek in Lyons and Longmont, as well as lesser streams throughout the County, overflowed. Boulder Creek ran at its highest level of the year, but did not overtop its banks within the City limits. The biggest threat was a related mudslide at the base of Flagstaff Road that threatened six homes.

According to the State Natural Hazard Mitigation Plan, information on losses and payments to each community participating in the NFIP provides some details on damages associated with flood events since the program's inception in 1978. From 1978 through 1999, unincorporated Boulder County had 47 losses totaling $58,039 and the City of Boulder had 72 losses totaling $147,299.

UCB Data

Other information provided by the HMPC identified the following claims associated with localized flooding at UCB:

June 1, 1991 – flood damage throughout campus: $153,394.10.

July 13,1993 – flood damage in Math building: $7,500.

1997 – extensive sheet flooding throughout campus. Some of the flooding was caused by a contractor working in the street on a steam line. He reportedly put up a dirt embankment to prevent runoff water from entering the opening in the street. When heavy rains started, the embankment diverted the water from its normal path along a new path directly into the window well drains of the Environmental Design and Telecommunications buildings. Heavy rain and hail also triggered a flash flood which sent a wall of water through the window of the financial aid office at UCB. In all, 10 buildings at UCB received water damage, causing an estimated $100,000 in damages.

August 5, 1999 – flood and water damage throughout campus: $9,512.43.

Likelihood of Future Occurrences

100-year flood – *Occasional*: the 100-year flood is the flood that has a one percent chance in any given year of being equaled or exceeded.

According to the Boulder County website, it only takes three inches of rain over a few hours to trigger a 100-year flood. A flash flood has never occurred in the City of Boulder, but because of its large population and location at the mouth of the narrow Boulder Canyon, **Boulder has the greatest potential for loss of life from a flash flood of any community in Colorado.** An estimated 6,000 people live and work in the floodplain of Boulder Creek, which runs through the heart of the city. Since Boulder County has a history of flooding, the potential exists for more flooding in the future.

LANDSLIDES AND ROCKFALLS

Landslides refer to a wide variety of processes that result in the perceptible downward and outward movement of soil, rock, and vegetation under gravitational influence. According to the Colorado Geological Survey, common names for landslide types include slump, rockslide, debris slide, lateral spreading, debris avalanche, earth flow, and soil creep. Although landslides are primarily associated with steep slopes, they may also occur in areas of generally low relief and occur as cut-and-fill failures, river bluff failures, lateral spreading landslides, collapse of waste piles, and failures associated with quarries and open-pit mines. Landslides may be triggered by both natural and human-induced changes in the environment, resulting in slope instability. Landslides can occur slowly or very suddenly and can damage and destroy structures, roads, utilities, forested areas and can cause injuries and death.

Rockfalls are considered the falling of newly detached rock masses from a cliff or down a very steep slope. Precipitation, topography, and geology affect landslides and rockfalls. Human activities such as mining, construction, and changes to surface drainage areas also affect the landslide potential. Landslides often accompany other natural hazard events, such as floods, wildfires, or earthquakes.

Past Occurrences

There has been no loss of life from landslides and rockfalls in Boulder County. However, damages to structures and highways have occurred. Development in areas vulnerable to landslides increases the potential for destructive landslides and rockfalls. Most historical landslides occurring in Boulder County were a secondary impact associated with wildfires and heavy rains. These include the following:

- The highway in Boulder Canyon below Sugarloaf Mountain was closed at least six times during the months following the Black Tiger Fire in July of 1989 after mud, boulders and other debris slid down onto the highway. One home was destroyed and two others were damaged.
- A mudslide occurred at the base of Flagstaff Road during a period of heavy rains in May and June of 1995. Approximately six homes were threatened by the slide.

UCB Data

According to the HMPC, there are no landslide and/or rockfall areas that would directly impact the UCB Planning Area. Depending on the circumstances, a severe landslide or rockfall could impact certain access routes to UCB facilities, such as the Mountain Research Station.

Likelihood of Future Occurrences

***Unlikely*:** Based on historic data, there are no documented landslide and/or rockfall events that have adversely impacted the UCB Planning Area.

The Colorado Landslide Hazard Mitigation Plan developed in 1988 identified 49 areas within Colorado as having the “most serious or immediate potential impact on communities, transportation corridors, lifelines, or the economy.” Boulder County was not identified in this Plan. Based on analysis conducted for the Colorado Natural Hazard Mitigation Plan using HAZUS-MH data, most of Boulder County was identified as low landslide potential with a few areas in the northeast corner and the far western portion of the County as moderate landslide potential. Minor landslides will likely continue in susceptible areas as a result of post-fire conditions or when heavy precipitation occurs, as they have in the past.

HUMAN HEALTH HAZARDS

The impact to human health that wildlife, and more notably, insects, can have upon an area can be substantial. The following section focuses on those naturally occurring human health hazards of potential concern to the UCB Planning Area.

West Nile Virus

A fairly recent natural hazard to affect Colorado is the West Nile Virus (WNV). Mosquitoes transmit this potentially deadly disease to livestock and humans alike. WNV first struck the northern hemisphere in Queens, N.Y., in 1999 and killed four people. In 2003, all 50 states warned of an outbreak from any of the 30 mosquito species known to carry it. From 62 severe cases in 1999, confirmed human cases of the virus spread to 39 states in 2002, and killed 284 people. As of May 2004, WNV has been documented in 47 states and the District of Columbia. Less than one percent of those infected develop severe illness. People over 50 years of age appear to be at high risk for the severe aspects of the disease.

Boulder County and the UCB Planning Area recognize the potential for WNV to occur within the County. A public outreach campaign is in place throughout the County with efforts on reducing the mosquito population and educating the public.

The County's mosquito abatement program consists of a multidisciplinary program with the following components:

- Identify mosquito sources
- Control mosquitoes
- Work with property owners to eliminate or reduce mosquito habitat
- Educate the community
- Conduct disease surveillance

The County maintains records with the dates and street addresses for all birds, mosquito pools, and sentinel chickens that are tested for WNV. It also receives the addresses and date of onset for the majority of the equine cases. This information is available on a need to know basis from the County Health Department. UCB also has a WNV surveillance and community outreach programs.

Past Occurrences

Information obtained from the Colorado Department of Health and Environment (CDPHE) indicated WNV was first detected Colorado in 2002. Although the virus was detected in Boulder County in 2002, the County did not have its first case of WNV in humans until 2003. A summary of historical information compiled by the CDPHE is provided below.

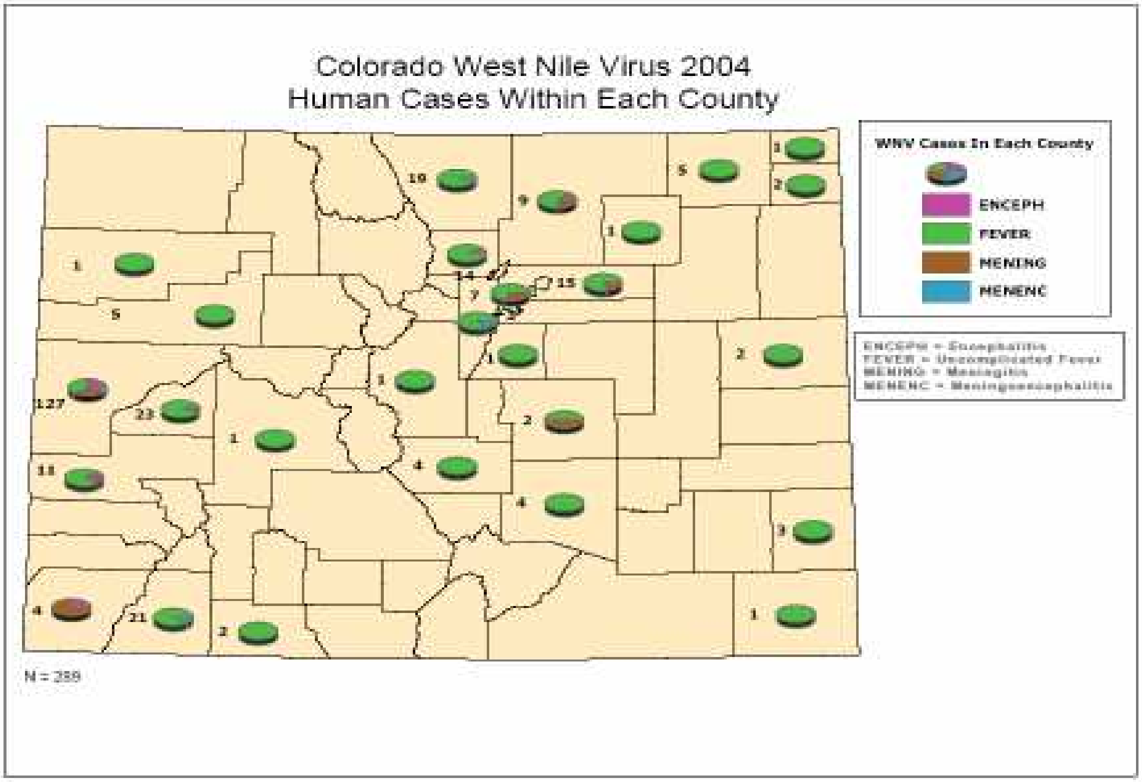
Summary of WNV in Colorado and Boulder County 2001 to 2004

Year/ Area	Humans		Birds		Mosquitoes		Veterinary		Sentinel Flock	
	CO	Boulder County	CO	Boulder County	CO	Boulder County	CO	Boulder County	CO	Boulder County
2001	0	0	0	0	0	0	0	0	0	0
2002	14	0	137	5	15	0	380	3	3	0
2003	2,947	421	766	50	639	118	393	18	213	22
2004	291	14	55	0	168	8	30	0	0	0
2005	106	5	40	1	122	0	13	0	-	0

The current WNV map for Colorado showing number of human cases by county is provided on the following page. Colorado had 291 cases in 2004; 14 of these were located within Boulder County. This was dramatically down from 2003, when 2,947 cases of WNV were confirmed in the state, with 421 cases in Boulder County. The cooler weather helped to keep the mosquito count low, which attributed to decreased incidence of the disease. Of the 14 positive cases, only one person had a severe case requiring hospitalization. There were no human deaths in 2004 compared to 2003 when seven Boulder County residents died.

In 2005, animal, mosquito, and human populations were less affected by WNV than in previous years. In the animal and mosquito populations, only one American Crow tested positive for WNV during the 2005 season.

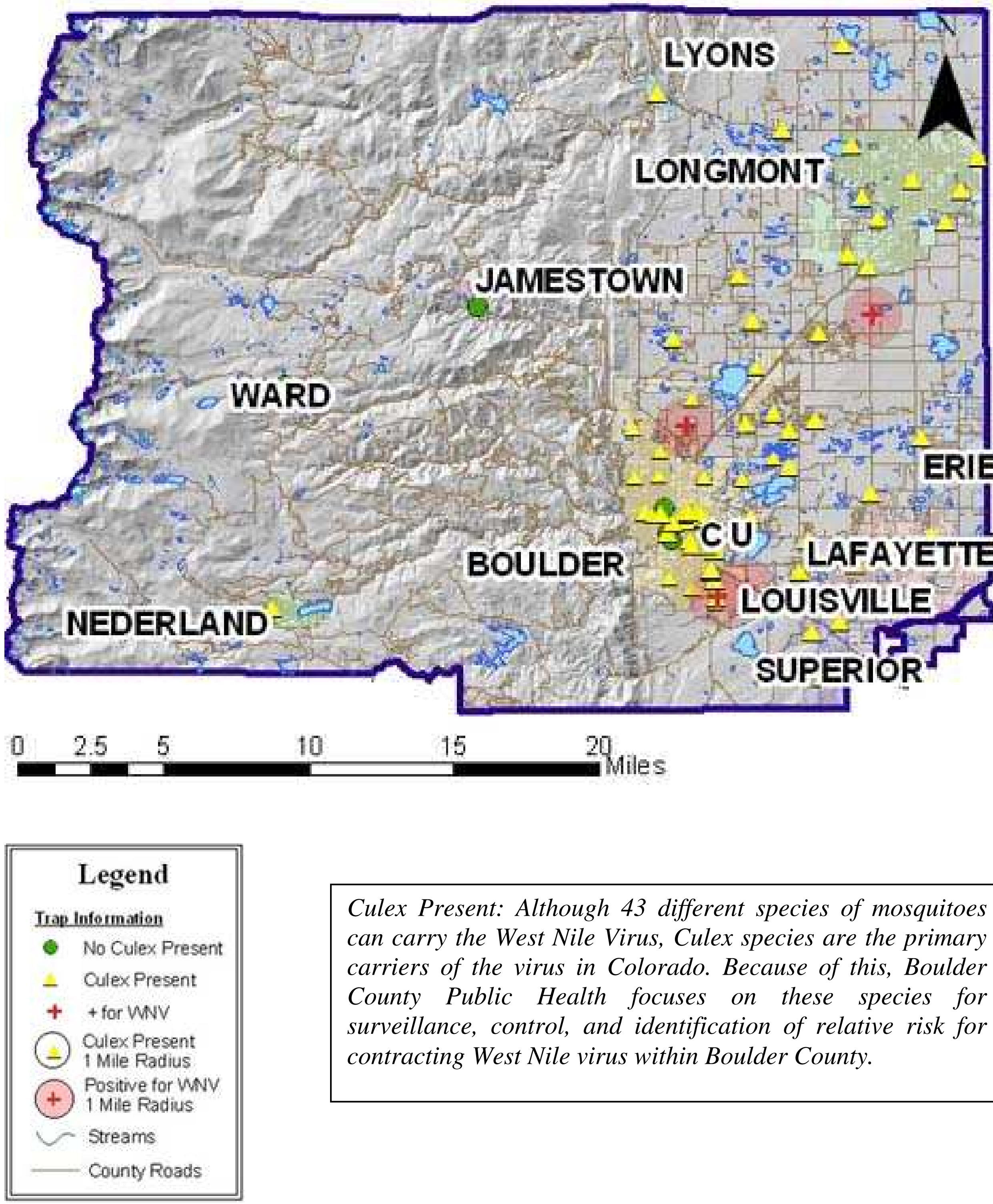
Despite significant testing of mosquito pools in Boulder County, none of the pools contained mosquitoes that tested positive for West Nile virus. Overall, five Boulder County residents tested positive for WNV in 2005, compared to 14 human cases in 2004. Of the five positive cases this year, one person did develop meningitis. There were no human deaths from West Nile virus in Boulder County during 2005 or 2004, unlike in 2003, when 7 county residents lost their lives to the virus.



(Source: http://www.cdphe.state.co.us/dc/zoonosis/wnv/images/wnvh_county_case_1.pdf)

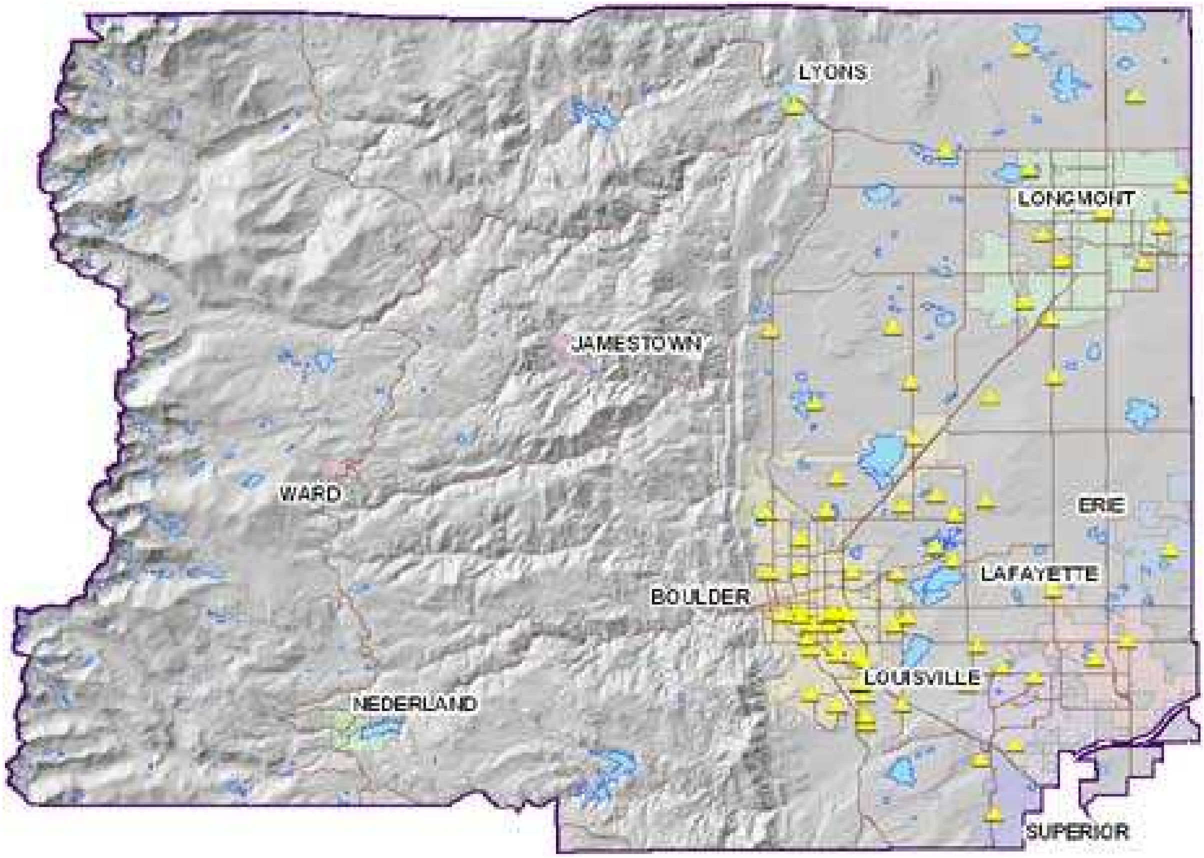
The following maps show the distribution of WNV for Boulder County (2003 and 2004) and the UCB Planning Area for 2004.

2004 Boulder County West Nile Map

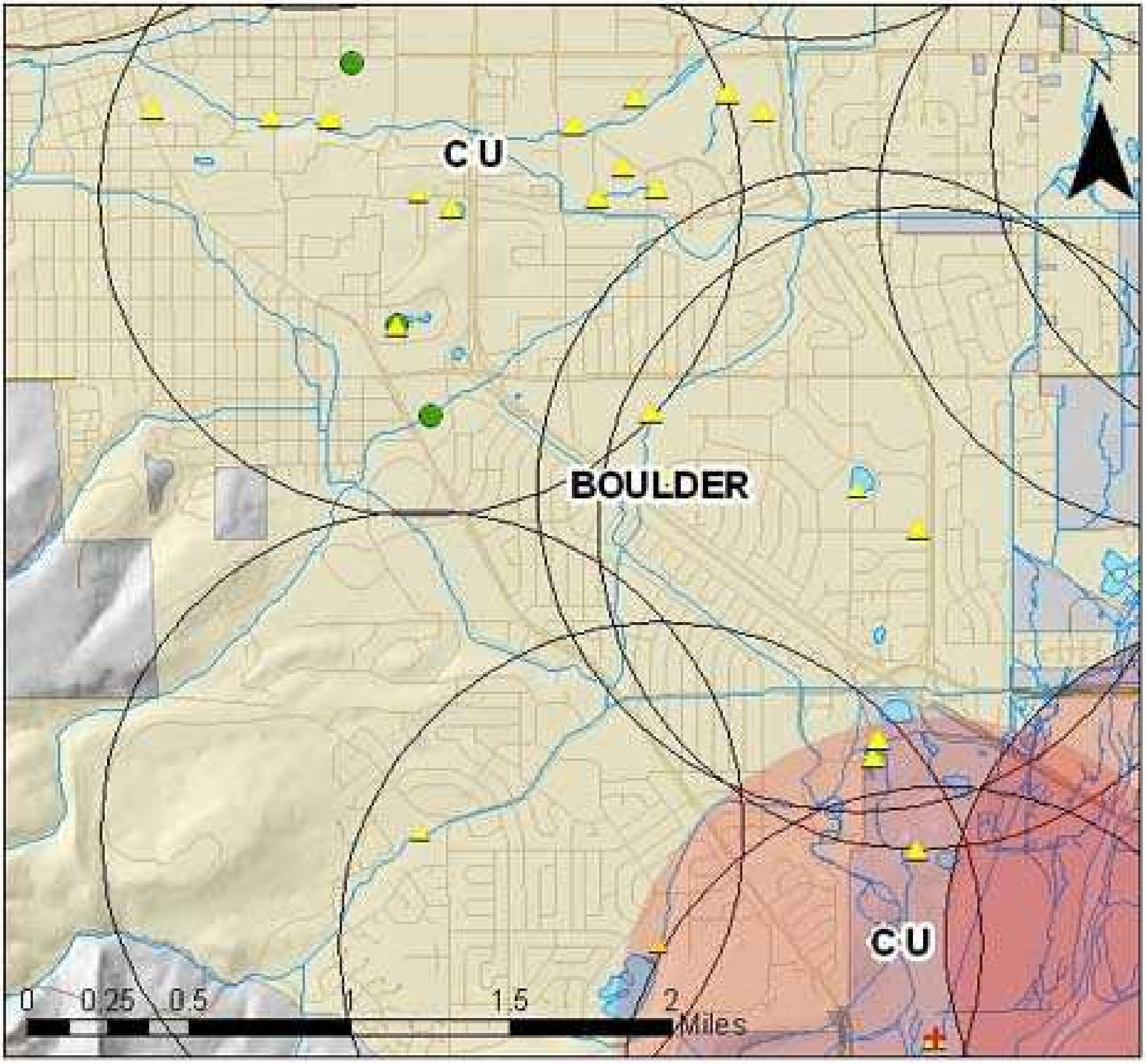


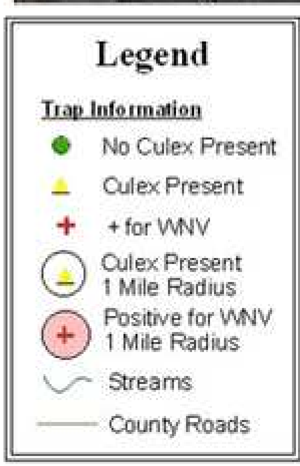
Culex Present: Although 43 different species of mosquitoes can carry the West Nile Virus, Culex species are the primary carriers of the virus in Colorado. Because of this, Boulder County Public Health focuses on these species for surveillance, control, and identification of relative risk for contracting West Nile virus within Boulder County.

2005 West Nile Map



2004 UCB West Nile Map





Culex Present: Although 43 different species of mosquitoes can carry the West Nile Virus, Culex species are the primary carriers of the virus in Colorado. Because of this, Boulder County Public Health focuses on these species for surveillance, control, and identification of relative risk for contracting West Nile virus within Boulder County.

UCB Data

Likelihood of Future Occurrences

***Occasional*:** Based on historic data indicating a significant downward trend in occurrences within Boulder County.

The state will continue surveillance for the disease in 2006. Based on nationwide trends, the second year is often more severe than the first year. This was certainly the case for Boulder County. According to the Boulder County Health Department, Boulder County and the UCB Planning Area will continue to be at future risk of WNV. However, the severity of the virus is expected to change from year to year, depending on variables such as weather patterns, the mosquito population, the bird population, as well as immunity in humans.

Pandemic Influenza

A pandemic is a global disease outbreak. A Pandemic flu is a virulent human flu that causes a global outbreak, or pandemic, of serious illness. A flu pandemic occurs when a new influenza virus emerges for which people have little or no immunity, and for which there is no vaccine. This disease spreads easily person-to-person, causes serious illness, and can sweep across the country and around the world in very short time. The U.S. Centers for Disease Control and Prevention (CDC) has been working closely with other countries and the World Health Organization (WHO) to strengthen systems to detect outbreaks of influenza that might cause a pandemic and to assist with pandemic planning and preparation.

Most recently, health professionals are concerned by the possibility of an Avian (or bird) flue pandemic associated with a highly pathogenic avian H5N1 virus. Since 2003, Avian Influenza has been spreading through Asia. A growing number of human H5N1 cases contracted directly from handling infected poultry have been reported in Asia, Europe, and Africa, and more than half the infected people have died. There has been no sustained human-to-human transmission of the disease, but the concern is that H5N1 will evolve into a virus capable of human-to-human transmission.

An especially sever influenza pandemic could lead to high levels of illness, death, social disruption, and economic loss. According to UCB's Draft 2006 Pandemic Response Plan, Impacts can range from school and business closings to the interruption of basic services such as public transportation and food delivery. For UCB, the most important issues will be the impacts of absenteeism and supply disruption on the campus.

Past Occurrences

Taken from the UCB Draft Pandemic Response Plan, there have been three acknowledged pandemics in the 20th century:

1918-19 Spanish Flu (H1N1). This flu is estimated to have sickened 20-40% of the world's population, and over 20 million people died. Between September 1918 and April 1919, 500,000 Americans died. It spread rapidly; many died within a few days of infection, others from secondary complications. The attack rate and mortality was highest among adults 20-50 years old, although the reasons for this are uncertain.

1957-58 Asian Flu (H2N2). This virus was quickly identified due to advances in technology, and a vaccine was produced. Infection rates were highest among school children, young adults, and pregnant women. The elderly had the highest rates of death. A second wave developed in 1958. In total, there were about 70,000 deaths in the United States. Worldwide deaths were estimated between 1-2,000,000.

1968-69 Hong Kong Flu (H3N2). This strain caused approximately 34,000 deaths in the U.S. and 700,000+ deaths worldwide. This virus was first detected in Hong Kong in early 1968 and spread to the United States later that year. Those over age 65 were most likely to die. This virus returned in 1970 and 1972 and still circulates today.

Likelihood of Future Occurrences

***Occasiona*l:** According to historic data, three influenza pandemics have occurred since 1918. This is an average of a pandemic every 29.34 years or a 3.41% chance of pandemic any given year.

Although scientists cannot predict when the next influenza pandemic will occur or how severe it will be. Wherever and whenever a pandemic starts, everyone around the world is at risk. If an influenza pandemic does occur, it is likely that many age groups would be seriously affected. The greatest risks of hospitalization and death—as seen during the last two pandemics in 1957 and 1968 as well as during annual outbreaks of influenza—will be to infants, the elderly, and those with underlying health conditions. However, in the 1918 pandemic, most deaths occurred in young adults. Few, if any, people would have immunity to the Avian Influenza virus.

SEVERE WEATHER

Severe weather conditions generally occur on an annual basis throughout Boulder County including the UCB Planning Area. A database maintained by the National Climatic Data Center (NCDC) identified 380 weather events occurring in Boulder County between January 1, 1950 and December 31, 2004. The NCDC data is summarized in the table that follows.

National Climatic Data Center, Boulder County Events
01/01/1950 to 12/31/2004

Type of Weather Event	Number of Occurrences
Blizzard	4
Drought	1
Dry Microburst	6
Flash Floods	4
Flooding	1
Funnel Cloud	3
Hail	141
Heavy Rain	1
Heavy Snow	44
High Winds	74
Lightning	34
Snow	1
Thunderstorm Wind	41
Tornado	10
Urban/Small Stream Flood	1
Winds	2
Winter Storm	12
Totals	**380**

For the 380 events listed above, there were seven deaths and 44 injuries, and property damages totaled $106,810 million. The majority of costs were associated with either blizzard or wind events. Sixty two million alone was attributed to the Blizzard of 2003 for all affected counties. Details on notable events identified in the table are included in the Plan sections that follow.

For this plan, severe weather is discussed in the following subsections:

- Extreme temperatures
- Fog
- Hailstorms
- Heavy rains/storms
- Lightning
- Tornadoes
- Windstorms
- Winter Storms

Weather conditions can vary greatly from the western portion to the eastern portion of Boulder County due to topographical changes and variance in elevation. With portions of the UCB campus in both the western and eastern portion of the County, the weather will be described in two distinct sections, as appropriate: western Boulder County, above an elevation of 8,240 feet above sea level, utilizing information from the Nederland weather station (which applies to the UCB Mountain Research Center); and the eastern portion of the County, which is around 5,440 feet above sea level, utilizing information from the Boulder weather station (which applies to most of the UCB Planning Area).

Extreme Temperatures

Extreme temperature events, both hot and cold, can have severe impacts on human health and mortality, natural ecosystems, agriculture and other economic sectors.

Extreme Heat

According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Heat kills by taxing the human body beyond its abilities. In a normal year, about 175 Americans succumb to the demands of summer heat. According to the National Weather Service (NWS), among natural hazards, only the cold of winter – not lightning, hurricanes, tornadoes, floods, or earthquakes – takes a greater toll. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the heat wave of 1980, more than 1,250 people died.

Heat disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating, or a chemical (salt) imbalance caused by too much sweating. When heat gain exceeds the level the body can remove, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise and heat-related illness may develop. Elderly persons, small children, invalids, those on certain medications or drugs, and persons with weight and alcohol problems are particularly susceptible to heat reactions, especially during heat waves in areas where moderate climate usually prevails. The following graphic illustrates the relationship of temperature and humidity to heat disorders.

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

(Source: National Weather Service, 2006)

The NWS has in place a system to initiate alert procedures (advisories or warnings) when the Heat Index (HI) is expected to have a significant impact on public safety. The expected severity of the heat determines whether advisories or warnings are issued. A common guideline for the issuance of excessive heat alerts is when the maximum daytime HI is expected to equal or exceed 105°F and a nighttime minimum HI of 80°F or above for two or more consecutive days.

Extreme Cold

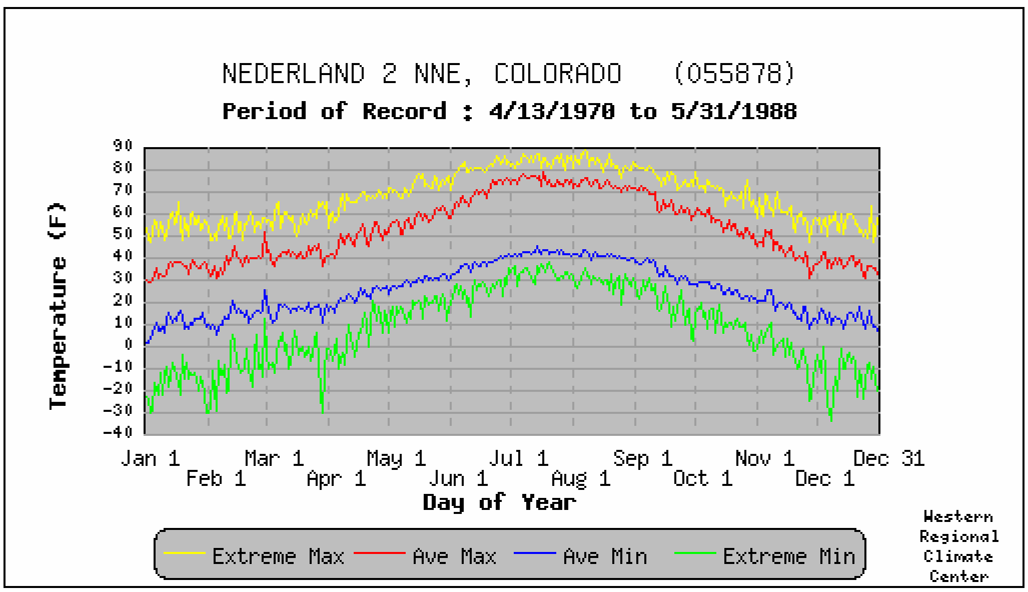
Extreme cold often accompanies a winter storm or is left in its wake. Prolonged exposure to the cold can cause frostbite or hypothermia and can become life-threatening. Infants and the elderly are most susceptible. Pipes may freeze and burst in homes or buildings that are poorly insulated or without heat.

In 2001, NWS implemented an updated Wind Chill Temperature (WTC) index. This index was developed by the NWS to describe the relative discomfort/danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

The NWS will issue a Wind Chill Advisory when wind and temperature combine to produce wind chill values of 18 degrees below zero to 25 degrees below zero. A wind chill warning is issued for wind chills of at least 25 degrees below zero on the plains and 35 degrees below zero in the mountains.

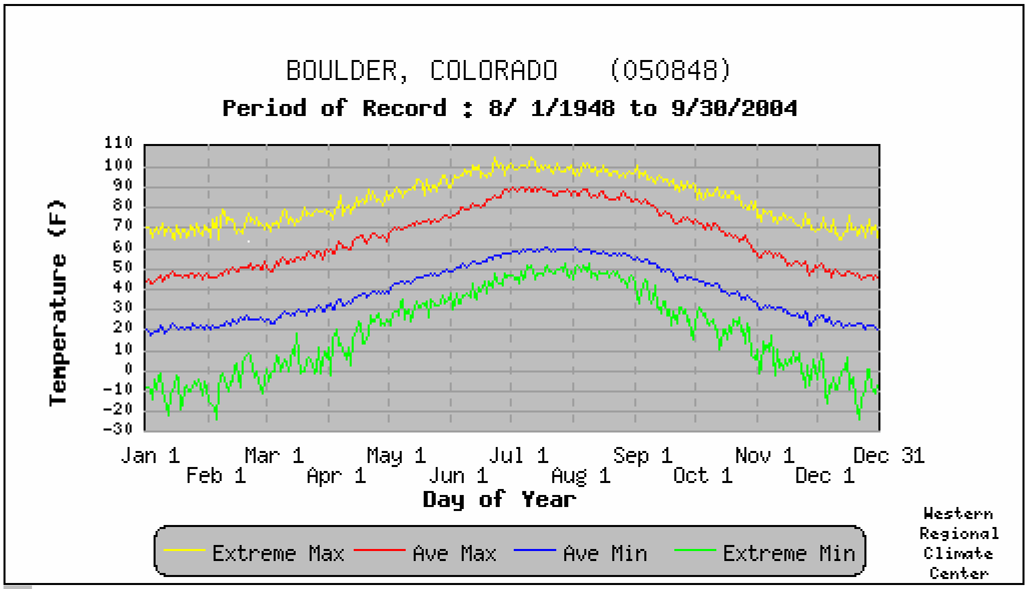
Past Occurrences

Western Boulder County (Nederland Weather Station-Period of Record 4/13/70 to 5/31/88). In western Boulder County, monthly average maximum temperatures in the warmest months (May through October) range from the mid 50s to the mid 70s. Monthly average minimum temperatures from November through April range from the low teens to the low 40s. The highest recorded daily extreme in western Boulder County is 89 degrees Fahrenheit (°F) on August 7, 1979. The lowest recorded daily extreme is -34°F on December 8, 1978, with several other days being recorded at -30°F. For the period of record (POR) for maximum temperature extremes (on an annual basis), no days exceeded 90°F and 46.3 days were less than 32°F. For the POR for minimum temperature extremes (on an annual basis), 242.1 days exceeded 32°F and 21.8 days were less than 0°F.



- Extreme Max. is the maximum of all daily maximum temperatures recorded for the day of the year.
- Ave. Max. is the average of all daily maximum temperatures recorded for the day of the year.
- Ave. Min. is the average of all daily minimum temperatures recorded for the day of the year.
- Extreme Min. is the minimum of all daily minimum temperatures recorded for the day of the year.

Eastern Boulder County (Boulder Weather Station-Period of Record 8/1/48 to 9/30/04). In eastern Boulder County, monthly average maximum temperatures in the warmest months (May through October) range from the high 60s to the high 80s. Monthly average minimum temperatures from November through April range from the low to high 20s. The highest recorded daily extreme in eastern Boulder County is 104°F occurring on both June 23, 1954 and July 11, 1954. The lowest recorded daily extreme is -24°F occurring on both December 12, 1963, and December 22, 1990. For the POR for maximum temperature extremes (on an annual basis), 31.6 days exceeded 90°F and 15.4 days were less than 32°F. For the POR for minimum temperature extremes (on an annual basis), 135.5 days exceeded 32°F, and 4.7 days were less than 0°F.



- Extreme Max. is the maximum of all daily maximum temperatures recorded for the day of the year.
- Ave. Max. is the average of all daily maximum temperatures recorded for the day of the year.
- Ave. Min. is the average of all daily minimum temperatures recorded for the day of the year.
- Extreme Min. is the minimum of all daily minimum temperatures recorded for the day of the year.

UCB Data

Other information provided by the HMPC indicated that during the period of 7/1/97 through 2/28/05, UCB filed six insurance claims for damages associated with extreme cold conditions in the amount of $22,611.62. The claims were primarily related to pipes, radiators, and coils freezing due to extreme cold temperatures. From the period of 1989 to 1997, one additional claim associated with freezing temperatures was made on 2/3/1996 in the amount of $3,000. This claim was the result of a frozen sprinkler.

Likelihood of Future Occurrences

Highly Likely: Given the history in Boulder County, extreme temperature events will continue to occur annually in the UCB Planning Area.

Fog

Another hazard is dense fog. Dense fog events can significantly reduce visibility. Fog results from air being cooled to the point where it can no longer hold all of the water vapor it contains. For example, rain can cool and moisten the air near the surface until fog forms. A cloud-free, humid air mass at night can lead to fog formation, when land and water surfaces that have warmed up during the summer are still evaporating a lot of water into the atmosphere—this is called 'radiation fog'. A warm moist air mass blowing over a cold surface can also cause fog to form—this is called 'advection fog'. Severe fog incidents can close roads, cause accidents, and impair the effectiveness of emergency responders.

Past Occurrences

The NCDC data shows no severe fog incidents for Boulder County. Other data sources consulted during this planning process did not identify any notable fog events for Boulder County and the UCB Planning Area.

Likelihood of Future Occurrences

***Unlikely*:** Given the lack of reportable fog history for the UCB Planning area, severe fog events are not of concern to UCB.

Hailstorm

Hail is formed when water droplets freeze and thaw as they are thrown high into the upper atmosphere by the violent internal forces of thunderstorms. Hail is usually associated with severe summer storms which occur throughout the spring, summer, and fall within the UCB planning area. Hailstorms generally occur more frequently during the late spring and early summer. Hailstones are usually less than 2 inches in diameter and can fall at speeds of 120 mph.

Hail, once thought to be primarily an agricultural problem, is a major cause of property damage in the plains just east of the Rockies. The past 30 years has brought one catastrophic hailstorm after another to the Front Range. One of the largest storms occurred on July 11, 1990 when Denver took a direct hit by hail during a severe thunderstorm. Damage totals close to $600 million were reported—the greatest property losses from hail ever reported from one storm up to that time, and one of the most expensive natural disasters to affect Colorado.

The NWS considers hailstones in excess of ¾ inch diameter as one criteria of a severe thunderstorm. Severe hailstorms can be quite destructive causing damage to roofs, buildings, automobiles, and vegetation. While minor injuries can also result during severe hailstorms, rarely do hailstorms result in loss of life. However, in 1979 a child was killed in Fort Collins after being struck in the head by a hailstone reported to be the size of a grapefruit. Livestock injuries and fatalities from hail can also occur.

Past Occurrences

A study conducted in 1994 by the State Climatologist looked at recorded hail statistics from 1973 to 1985 and from 1986 to 1993. The data used for this study is limited as systematic observations of hail are taken only at a small number of weather stations. Therefore, this study relied on point weather station data from a small number of sites in and near Colorado along with statewide data on severe hailstorms obtained from the national publication, *Storm Data*. Further, since hail occurs only briefly and tends to be very localized, many storms go undetected by these "official" weather stations. Regardless, by analyzing the existing data, this study provided the following statistics regarding hailstorms in Colorado:

- The hail season in Colorado begins in March and ends in October.
- There has been an average of more than 130 reported severe hailstorms each year since 1986.
- Overall, June has the highest frequency of days with hail, with slightly more than 10 days on average.
- Hail in Colorado is primarily an afternoon or evening phenomenon; 90% of all severe hailstorms reported from 1986 to1993 occurred between 1:00 and 9:00 pm.
- Hail usually only falls for a few minutes. Hail that continues for more than 15 minutes is unusual.
- A study of 60 Fort Collins hail events showed the median duration to be six minutes.
- The vast majority of hail stones that fall in Colorado are half inch diameter or smaller.
- The most common size range for damaging hail in Colorado is 1 to 1.5 inches in diameter and accounts for more than 13 of the severe hailstorm reports in this study.
- Six percent of the reported severe hailstorms had the maximum hail stone diameters of 2.5 inches or greater.
- The maximum hail stone size reported in this study was 4.5 inches.
- Hail frequency can be very variable. For example there were only 25 severe hail days in 1988 compared to 51 in 1993.
- Severe hail is not a statewide problem, but is limited to eastern Colorado beginning in the eastern foothills and extending across all the Eastern Plains.

Costly hailstorms in the Denver Front Range area identified by the CODEM include those listed below. The extent of damage in the Boulder and UCB Planning Area from these storms could not be determined from available data.

Denver Front Range Costly Hailstorms 1984-2004

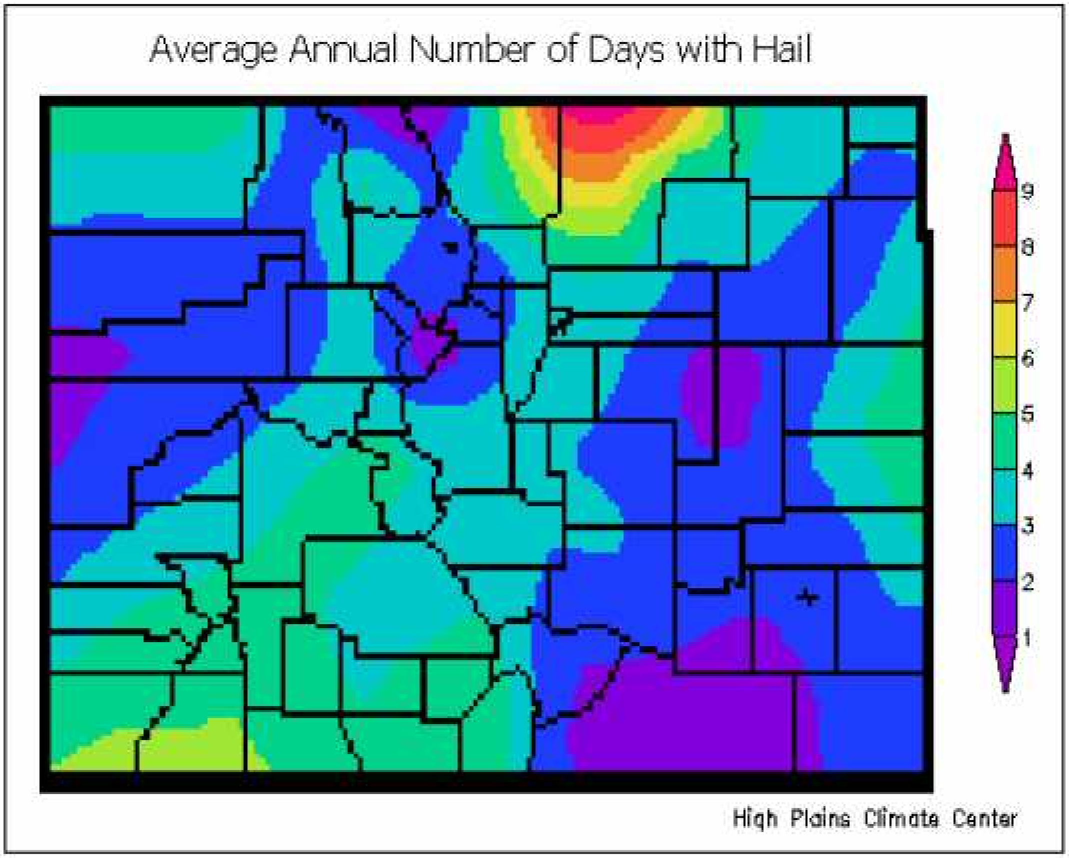
Date	Location	Cost of Damages
June 8-9, 2004	Golden/SW Denver	$100 Million +
October 15, 1998	Denver area	$87.8 Million
August 11, 1997	Denver area	$128 Million
June 21-22, 1996	Denver/Larimer County	$100 Million
May 22, 1996	Denver	$122 Million
October 1, 1994	Denver	$225 Million
July 11, 1990	Denver/Front Range	$626 Million
August 2, 1986	Denver/Fort Collins/Longmont	$145 Million
June 13-14, 1984	Denver/Arvada	$276.7 Million

Data obtained from the NCDC identified 140 hail events in Boulder County between 01/01/1950 and 12/31/2004, with hailstones exceeding three quarters inch diameter. Of these, the following four hail events as reported through NCDC resulted in damage to people or property:

- 08/02/1986 at 1635 hours – hailstones of 1.75 inches caused one injury.
- 08/02/1986 at 1650 hours – hailstones of 1.75 inches caused six injuries.
- 09/17/1993 at 1706 hours – hailstones of 0.75 inches (Lafayette) caused $5,000 in property damage.
- 07/12/1996 at 07:46 pm – hailstones of 1.25 inches (Broomfield) caused $1 million in property damage. Large hail, strong winds and heavy rain caused substantial damage to property in portions of Boulder and northern Jefferson Counties.

The Colorado State Multi-Hazard Mitigation Plan reports that Boulder County experienced 49 hailstorm events between 1/1/1993 and 1/31/2000, resulting in $1 Million in damages. This likely includes the events identified above.

The following map from the State of Colorado Hazard Mitigation Plan, originally created by the High Plains Climate Center and adapted to show just Colorado, depicts the average number of days per year with hail. The north-central area, specifically northeast Larimer and north Weld Counties, show the highest number of days in the state, with six or greater. Boulder County and the UCB Planning Area show three or more days.



Adapted from http://hpccsun.unl.edu/coop/atlas/hailann.gif

UCB Data

Insurance data provide by the HMPC did not specifically identify any claims associated with hail damage from July 1997 through February 2005. Although there were several claims for wind and heavy rain events.

Likelihood of Future Occurrences

Likely**:** Given the history of severe weather events in Boulder County, severe weather, including hailstorms, will continue to occur on an annual basis; however the extent of impact to UCB will vary depending on the location and severity of any given storm and associated hail event.

Heavy Rain/Thunderstorms

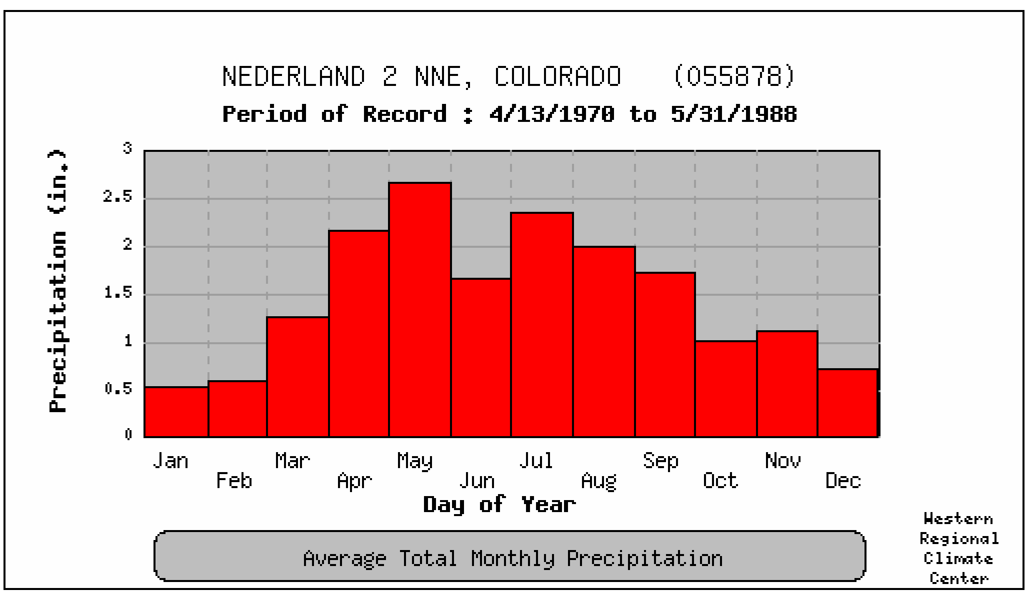
Thunderstorms are quite prevalent in the eastern plains and along the eastern slopes of the mountains during the spring and summer. Thunderstorms develop when cold upper air sinks and warm moist air rises. As the warm air rises, storm clouds (thunderheads) develop, resulting in a thunderstorm. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. They most often occur during the afternoon and evening hours. Severe storms/thunderstorms generally include heavy rains that are often accompanied by strong winds, lightning, and hail. Thunderstorms can produce a strong rush of wind known as a downburst or straight-line winds which may exceed 120 miles per hour. Tornadoes can also (but rarely in the Planning Area) occur during these big storms. Severe storms can overturn mobile homes, tear roofs off of houses and topple trees. Thunderstorms are also directly responsible for causing secondary hazards such as landslides, soil erosion, and flooding.

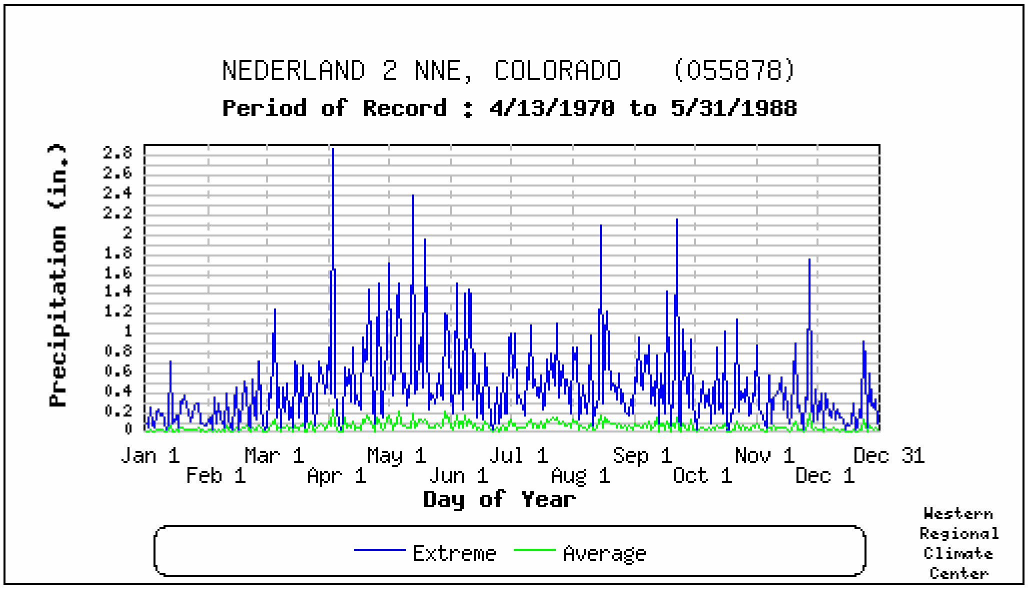
Approximately 10 percent of the thunderstorms that occur each year in the United States are classified as severe. A thunderstorm is classified as severe when it contains one or more of the following phenomena: (1) hail, three-quarters inch or greater; (2) winds gusting in excess of 50 knots (57.5 mph); or (3) a tornado.

Past Occurrences

Heavy rains and severe thunderstorms occur in Boulder County including the UCB Planning Area primarily during the spring, summer and early fall seasons. The bulk of the rain occurs during the months of March through September but can be quite variable, depending on different regions of the County. Due to the change in elevation from the western portion of Boulder County to the eastern limit (from approximately 5,440 feet to more than 8,240 feet above sea level), precipitation can vary greatly throughout the County.

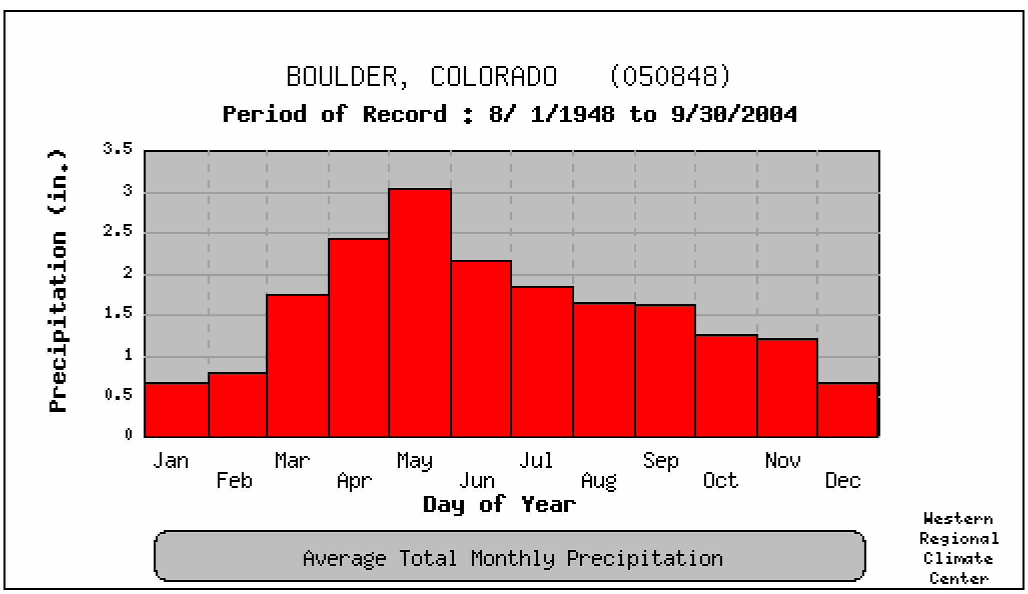
Western Boulder County (Nederland Weather Station-Period of Record 4/13/70 to 5/31/88). Average annual precipitation in western Boulder County for the POR is 17.97 inches per year. The highest recorded annual precipitation is 25.52 inches in 1983; the highest recorded precipitation for a 24-hour period is 2.85 inches on April 3, 1986. The lowest annual precipitation total is 13.11 inches in 1977.

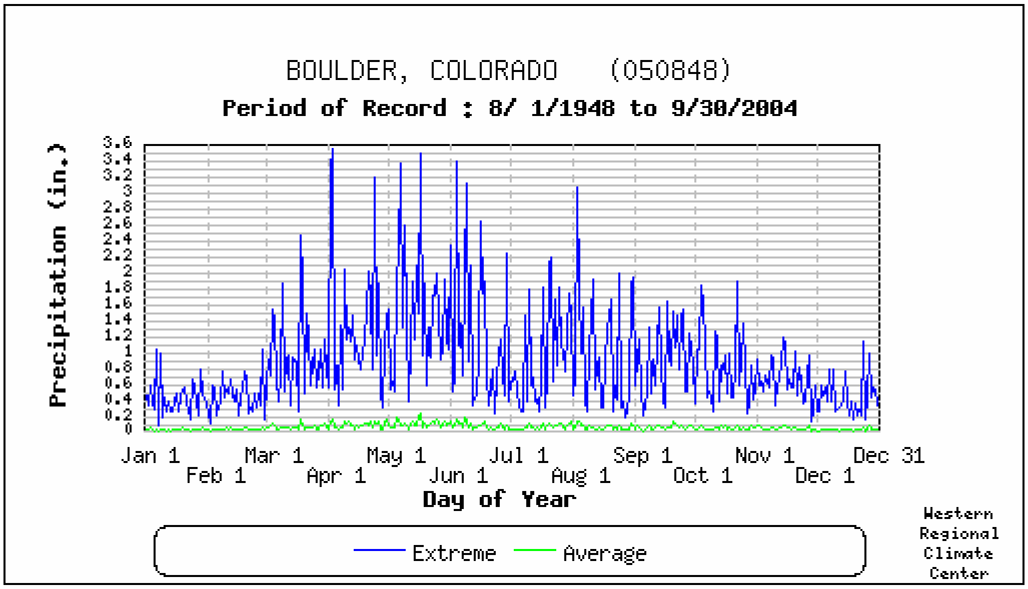




Eastern Boulder County (Boulder Weather Station-Period of Record 8/1/48 to 9/30/04).

Average annual precipitation in eastern Boulder County for the POR is 19.17 inches per year. The highest recorded annual precipitation is 29.43 inches in 1995; the highest recorded precipitation for a 24-hour period is 3.56 inches on April 3, 1986. The lowest annual precipitation total is 10.91 inches in 1954.





Severe thunderstorms on record with the County include those identified in the previous table summarizing NCDC climatic data on page 4-41 and include the following notable events obtained from the Boulder County website:

- **September 1989** – Two months following the Black Tiger Fire, heavy rain and hail caused a mudslide in Boulder Canyon. One home was destroyed. Lack of vegetation following the fire contributed to the flooding. Hail fell in the city of Boulder. Lightning caused a small forest fire in Coal Creek Canyon. Power outages occurred throughout the county.
- **July 11, 1990** - The hail storm initiating in the Town of Lyons in northern Boulder County tracked to the southeast along the foothills, catching the eastern portion of the City of Boulder. Hail was reported in the southeastern part of the county where Louisville experienced marble size hail. The storm path was five to 10 miles wide, continuing into the Denver area where the storm was the most severe.
- **July 20, 1990** - A thunderstorm caused localized flooding, in the City of Boulder. Bear Creek in the Table Mesa area overflowed its banks. Large rocks tumbled down on highway 119 at the mouth of Boulder Canyon.
- **September 1990** – Heavy rain and hail triggered mudslides in Boulder Canyon.
- **June 1993** – Heavy rain caused low-lying flooding and Boulder Creek overflowed its banks onto the Creek Path where it passes under Broadway. Heavy rain fell in the mountains near Ward and Nederland. Rockslides were reported on Flagstaff Road. The storm dumped 2 ½ inches in two days in Boulder County, setting records for rainfall and cool temperatures.
- **August 1994** – A severe thunderstorm accompanied with heavy rain caused street flooding in the cities of Boulder and Longmont. In Boulder, rivers of water more than a foot deep were reported along Canyon Boulevard, Valmont Road and

Folsom Street. On 17th Street between Canyon and Arapahoe the rushing water washed out part of the street creating a deep pit. The Town of Lyons was hit the hardest and suffered the most damage. A gas main burst when street flooding caused the road to collapse. Power outages occurred and many trees were blown down.

UCB Data

Other information provided by the HMPC indicated that during the period of 7/1/05 through 2/28/05, UCB filed five insurance claims for damages associated with heavy rains for a total of $19,159.60. The claims were predominantly for water damage during heavy rains caused by leaking buildings and drains backing up. From the period of 1989 to 1997, four claims associated with heavy rains for $12,690.59 and five claims associated with water damage for $23,538.30 were made.

Likelihood of Future Occurrences

Highly Likely: Given the history of severe weather events in Boulder County, severe weather, including thunderstorms and heavy rain, will continue to occur annually within Boulder County and the UCB Planning Area.

Lightning

Lightning is an electrical discharge between positive and negative regions of a thunderstorm. A lightning flash is composed of a series of strokes, with an average of about four. The length and duration of each lightning stroke vary, but typically average about 30 microseconds.

Lightning is one of the more dangerous weather hazards in the United States and in Colorado. Each year, lightning is responsible for deaths, injuries, and millions of dollars in property damage, including damage to buildings, communications systems, power lines, and electrical systems. Lightning also causes forest and brush fires and deaths and injuries to livestock and other animals. According to the National Lightning Safety Institute, lightning causes more than 26,000 fires annually in the United States. The Institute further estimates property damage, increased operating costs, production delays and lost revenue from lightning and secondary effects to be in excess of $6 billion per year. Lightning can kill or injure people and damage property by either direct or indirect means. People or objects can be directly struck or damage can occur indirectly when the current passes through or near them.

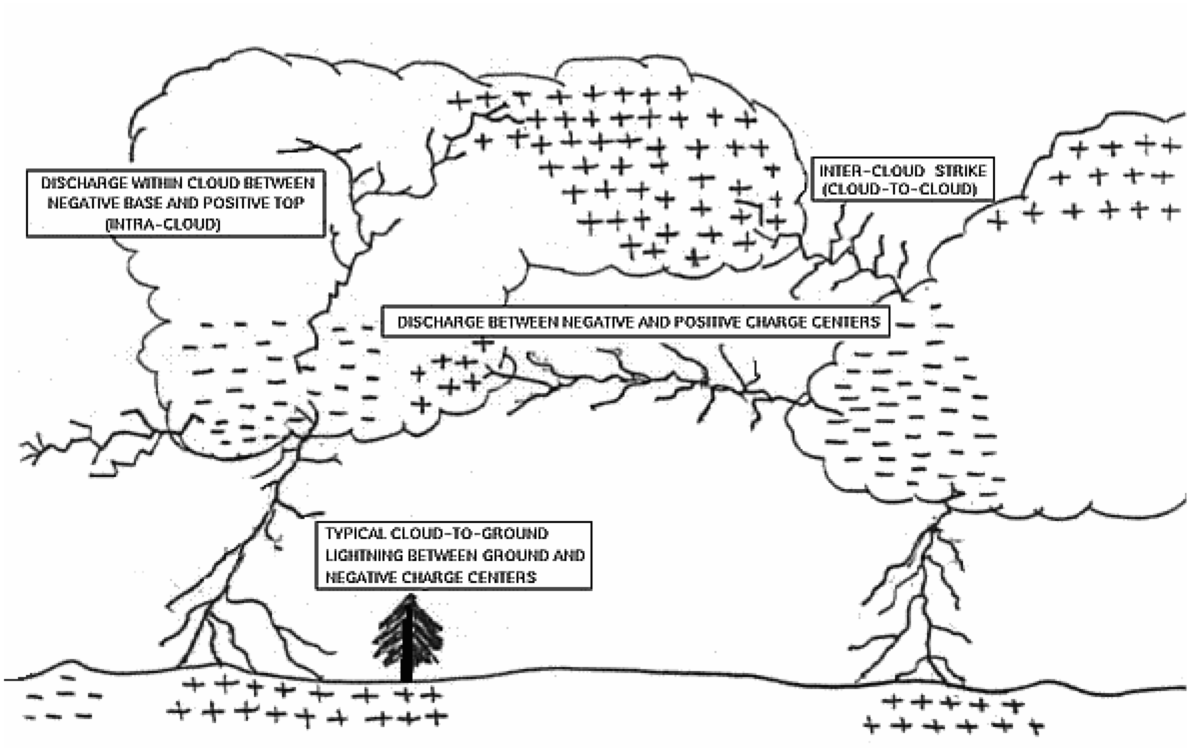
Intra-cloud lightning is the most common type of discharge. This occurs between oppositely charged centers within the same cloud. Usually the process takes place within the cloud and looks from the outside of the cloud like a diffuse brightening which flickers. However, the flash may exit the boundary of the cloud and a bright channel, similar to a cloud-to-ground flash, can be visible for many miles.

Although not as common, cloud-to-ground lightning is the most damaging and dangerous form of lightning. Most flashes originate near the lower-negative charge center and deliver negative charge to Earth. However, a large minority of flashes carry positive charge to Earth. These positive flashes often occur during the dissipating stage of a thunderstorm's life. Positive flashes are also more common as a percentage of total ground strikes during the winter months. This type of lightning is particularly dangerous for several reasons. It frequently strikes away from the rain core, either ahead or behind the thunderstorm. It can strike as far as five or 10 miles from the storm in areas that most people do not consider to be a threat. Positive lightning also has a longer duration, so fires are more easily ignited. And, when positive lightning strikes, it usually carries a high peak electrical current, potentially resulting in greater damage.

The ratio of cloud-to-ground and intra-cloud lightning can vary significantly from storm to storm. Depending upon cloud height above ground and changes in electric field strength between cloud and Earth, the discharge stays within the cloud or makes direct contact with the Earth. If the field strength is highest in the lower regions of the cloud a downward flash may occur from cloud to Earth. Utilizing a network of lightning detection systems, the United States monitors an average of 25 million strokes of lightning from the cloud to ground every year.

The lightning discharge process is illustrated in the following graphic.

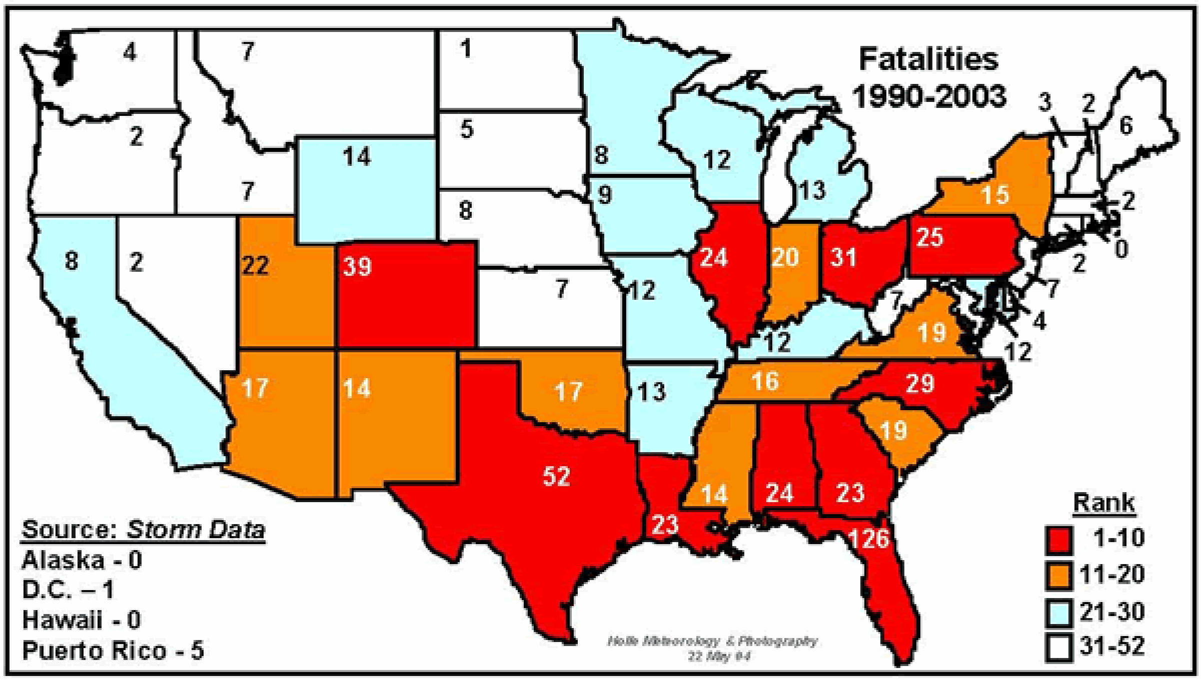
LIGHTNING DISCHARGE PROCESSES



The lower part of a thundercloud is usually negatively charged. The upward area is usually positively charged. Lightning from the negatively charged area of the cloud generally carries a negative charge to Earth and is called a negative flash. A discharge from a positively-charged area to Earth produces a positive flash.
(Source: http://thunder.msfc.nasa.gov/primer/primer3.html)

Past Occurrences

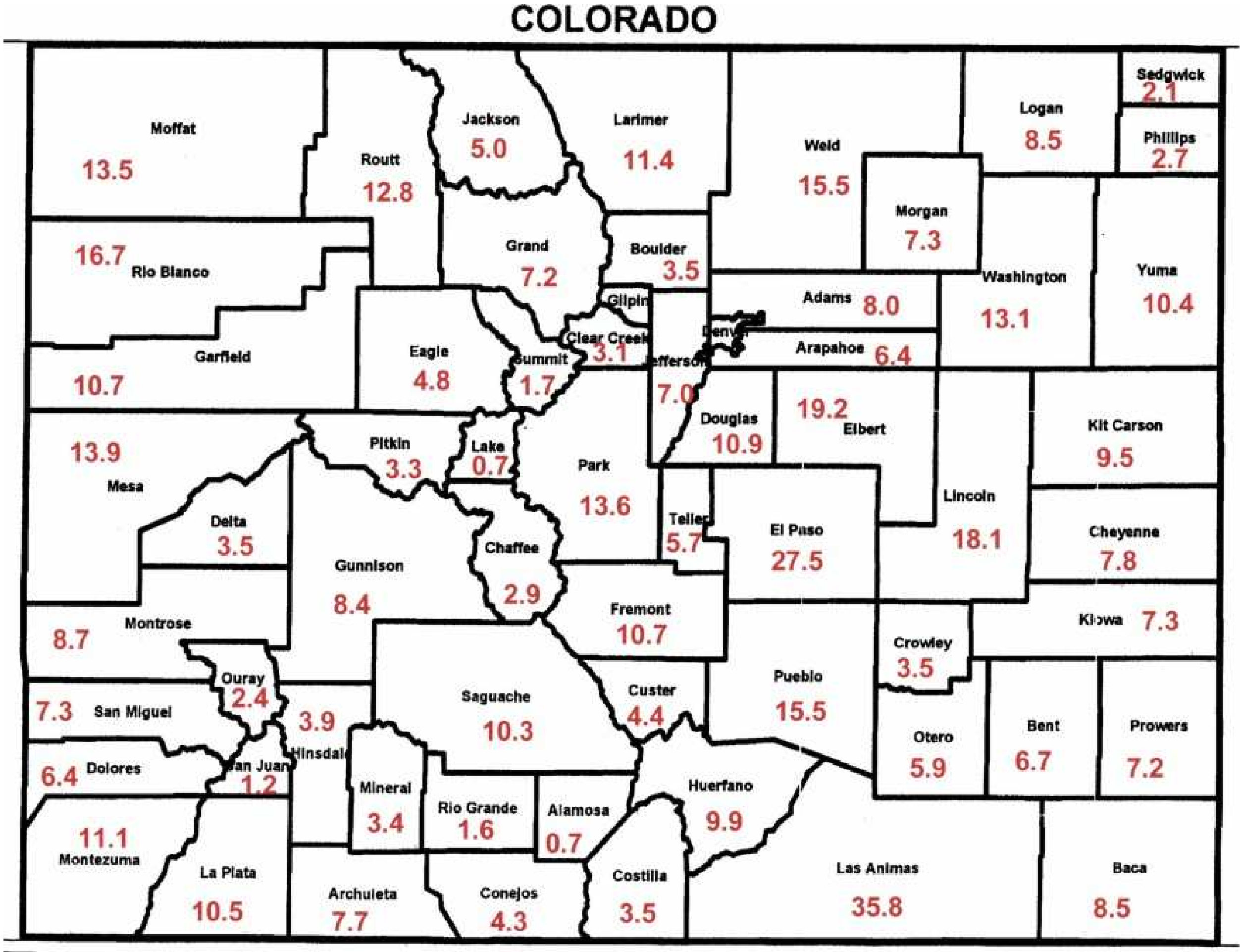
On average, 67 people are killed each year by lightning. Many more people are injured each year. USA lightning statistics compiled by National Oceanic and Atmospheric Administration (NOAA) between 1959 and 1994 indicate that most lightning incidents occur during the summer months of June, July, and August, and during the afternoon hours from 2:00 to 6:00 p.m. The following map shows state-by-state lightning deaths from 1990 to 2003 based on Storm Data compiled by the National Lightening Safety Institute. Colorado ranks third for the number of deaths at 39. Only two states were ahead of Colorado: Florida with 126 deaths and Texas with 52 deaths. Ohio followed up Colorado with 31 deaths.



(Source: National Lightning Safety Institute)

According to the NWS, Colorado ranks number 26th in the nation with respect to the amount of cloud to ground lightning, with an average amount of cloud to ground lightning at ~494,000 flashes per year. The following map of Colorado provides the estimated number of Cloud to Ground lightning flashes (in thousands) which occur in each county in Colorado per year. Boulder County is at 3.5 thousand flashes.

Cloud to Ground Lightning Flashes per Year (In Thousands)



(Source: National Weather Service)

According to the State of Colorado Hazard Mitigation Plan, in a study conducted for the Colorado area, it was determined one out of 52 lightning flashes results in an insurance claim.

Additional information obtained from the Lightning Safety Institute identified the following lightning casualties for Boulder County:

Boulder County Lightning Casualties 1980-2000

Date	Time	Killed	Injured
July 12, 2000	1400 mst	1	0
July 10, 2000	1540 mst	0	3
July 24, 2000	1500 mst	0	2
June 7, 1997	1200 mst	0	1
June 5, 1997	1400 mst	0	1

June 19, 1997	1404 mst	0	1
June 27, 1995	1530 mst	0	1
August 30, 1992	1130 mst	0	1
June 13, 1991	1400 mst	0	1
August 19, 1989	1235 mst	1	1
June 25, 1988	1530 mst	1	1
August 7, 1987	1930 mst	0	1
July 2, 1987	1734 mst	0	4
August 5, 1983	1700 mst	0	1
August 22, 1981	Morning	0	2
June 3, 1981	1200 mst	1	2
June 27, 1980	1412 mst	0	4
Totals		**4**	**27**

Data obtained from the NCDC identified 34 lightning events in Boulder County between 01/01/1950 and 12/31/2004. Of these, the following 16 lightning events resulted in damage to people or property:

- 05/15/1993 at 1600 hours **–** lightning resulted in property damage of $5,000.
- 05/27/1993 at 1455 hours **–** lightning (Lyons) resulted in property damage of $5,000.
- 05/31/1994 at 1800 hours **–** lightning (Louisville) resulted in property damage of $1,000.
- 07/27/1994 at 1600 hours **–** lightning resulted in property damage of $5 million. (The damage occurred when lightning struck a furniture store in Boulder, igniting a fire which caused major damage to the building and contents).
- 06/02/1995 at 1110 hours **–** lightning (Nederland) resulted in property damage of $5,000.
- 06/27/1995 at 1530 hours **–** lightning (Longmont) resulted in one injury.
- 09/14/1996 at 05:00 pm – lightning (West Longmont) resulted in property damage of $7,000.
- 06/05/1997 at 02:00 pm – lightning (Nederland) resulted in one injury.
- 06/07/1997 at 12:00 pm – lightning (Ward) resulted in one injury.
- 06/19/1997 at 02:04 pm – lightning (Broomfield) resulted in one injury.
- 06/02/1995 at 05:30 pm – lightning resulted in property damage of $20,000.
- 07/10/2000 at 03:40 pm – lightning resulted in three injuries.
- 07/12/2000 at 02:00 pm – lightning (Allens Park) resulted in one death**.** (A climber was struck and killed by lightning as he and a companion were ascending a sheer rock face, near the summit of Longs Peak).

- 07/24/2000 at 03:00 pm – lightning (Longmont) resulted in two injuries.
- 06/19/2002 at 05:30 pm – lightning resulted in property damage of $25,000.
- 08/05/2002 at 02:00 pm – lightning resulted in one injury.

UCB Data

Other information provided by the HMPC indicated that during the period of 7/1/05 through 2/28/05, UCB filed one insurance claim for damages associated with lightning for a total of $8,000. A lightning strike at Duane Physics damaged an electrical circuit board. From the period 1989 to 1997, seven claims for damages caused by lightning were made in the amount of $58,747.82. Most notable was a lightning strike September 7, 1991 at the Armory causing $47,229.94 in damages.

Likelihood of Future Occurrences

***Highly Likely*:** Given the history of lightning occurrences in Colorado and Boulder County, lightning is an annual occurrence and will continue to be a concern for the UCB Planning Area.

Tornadoes

Tornadoes are another weather-related event that sometimes affect Boulder County and the UCB Planning Area. Tornadoes form when cool, dry air sits on top of warm, moist air. In the plains areas of Colorado, this most often happens in the spring and early summer (i.e., May, June and July) when cool, dry mountain air rolls east over the warm, moist air of the plains. Tornadoes are rotating columns of air marked by a funnel-shaped downward extension of a cumulonimbus cloud whirling at destructive speeds of up to 300 mph, usually accompanying a thunderstorm. Tornadoes are the most powerful storms that exist. They can be composed of the same pressure differential that fuels 300-mile wide hurricanes across a path only 300 yards wide or less.

Tornado magnitude is ranked according to the Fujita scale listed below:

The Fujita Scale

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage Done
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage Done
			foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well constructed houses; trains overturned; most trees in fores uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-inforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Tornadoes can cause damage to property and loss of life. While most tornado damage is caused by violent winds, most injuries and deaths result from flying debris. Property damage can include damage to buildings; fallen trees and power lines; broken gas lines, broken sewer and water mains resulting from trees being uprooted; and the outbreak of fires. Agricultural crops and industries may also be damaged or destroyed. Access roads and streets may be blocked by debris, delaying necessary emergency response.

Past Occurrences

Colorado tornadoes tend to be small, short-lived and relatively weak as compared with the plains states tornadoes. Statistics indicate that Colorado tornadoes last only a few minutes, are generally only about 100 yards in diameter at the surface and have an average path length of 1 ½ miles. Wind speeds appear to average 100 mph or less. The following table shows the level of tornado activity in Colorado between 1975 and 2000 as reported by the National Severe Storm Forecasting Center:

Tornado Activity in Colorado
1975-2000

Category	**% Occurrence**	**Mean Path Length (Miles)**
F0	25.5	1.2
F1	37.3	2.6
F2	2.6	5.4
F3	9.3	10.0
F4	2.0	27.2
F5	0.3	35.5

According to data obtained by the HMPC, tornadoes are rare and usually only affect the lower elevations in the eastern portion of Boulder County. The NCDC documents 10 incidents of tornadoes in Boulder County. Information on these 10 events is detailed below:

- 09/17/1953 at 1500 hours – Magnitude F1, property damage of $3,000.
- 05/12/1955 at 1730 hours – Magnitude F1, property damage of $3,000.
- 05/17/1978 at 1545 hours – Magnitude F1, property damage of $3,000.
- 04/30/1980 at 1100 hours – Magnitude F1, property damage of $0.
- 10/15/1980 at 1822 hours – Magnitude F2, property damage of $25,000 (roof at Vo-Tech on East Arapahoe)
- 06/05/1988 at 1525 hours – Magnitude F2, property damage of $250,000.
- 06/01/1990 at 1703 hours – Magnitude F0, property damage of $0.
- 06/16/1996 at 04:15 pm – Magnitude F1 (Pinecliff), property damage of $0.

- 07/12/1996 at 07:40 pm – Magnitude F0 (Broomfield), property damage of $0.
- 06/06/1997 at 01:15 pm – Magnitude F1, property damage of $0. (Although other sources indicate a home was damaged in the vicinity of Baseline Reservoir during this event).

UCB Data

There are no documented incidents of tornadoes adversely impacting the UCB Planning Area.

Likelihood of Future Occurrences

Likely**:** Ten tornadoes in Boulder County occurred during a 54-year period of record keeping, which equates to one tornado every five years, on average, or an 18.5% chance of a tornado occurring in any given year. However, of the 10 tornadoes, none were known to impact the UCB Planning Area. Based on this data, tornadoes will continue to occur in Boulder County; the risk to the UCB Planning Area is dependant upon the nature and location of any given tornado.

Compared with other States, Colorado ranks ninth for frequency of tornadoes, 38th for number of deaths, 31st for injuries and 30th for cost of damages. When compared to other states by the frequency per square mile, Colorado ranks 28th for the frequency of tornadoes, 38th for fatalities, 37th for injuries per area and 37th for costs per area (based on data from 1950 – 1995).

Windstorms

High Winds are a frequent occurrence throughout Boulder County and the UCB Planning Area. High Winds can result in property damage and injury. Strong gusts can rip roofs from buildings, snap power lines, shatter windows, down trees, and sandblast paint from cars. Other associated hazards include utility outages, arcing power lines, debris blocking streets, dust storms, and an occasional structure fire from this natural hazard.

Boulder has some of the highest peak winds of any city in the US. The peak of the wind season is December and January, but downslope windstorms have been recorded in every month except July. Damage from Boulder's winds averages about a million dollars per year, with one exceptionally strong storm on January 17, 1982 resulting in more than $10 million worth of damage.

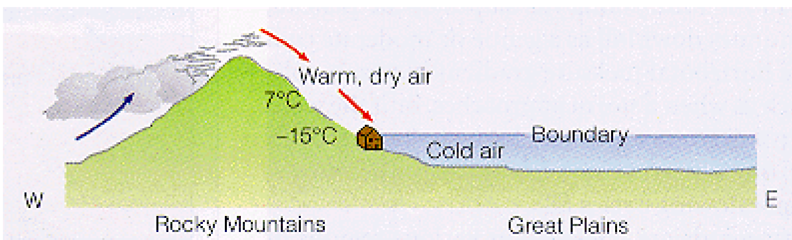
Chinook Winds

Boulder's often violent, downslope winds are referred to as Chinook winds, after Native Americans of the Pacific northwest, where the winds originate. These downslope winds, typically warm and dry, occur in areas where mountains stand in the path of strong air currents. In Boulder, these warm, downslope winds occur when the winds blow across the Continental Divide from the west and descend the foothills into Boulder. They are caused by high pressure west of Boulder, low pressure over or east of Boulder and strong westerly winds in the mountains. This is because it is the pressure difference across Colorado that moves the air, with the wind blowing from high to low pressure, and with the speed depending on the magnitude of the force that drives the wind. During these Chinooks, wind speeds can reach extreme values and do quite a bit of damage.

Bora Winds

Bora winds, downslope winds that replace relatively warm light wind conditions with cold temperatures and strong wind gusts, may also be observed in Boulder. Bora winds that strike Boulder blow from the west, are relatively dry, but are also cold. The arrival of a Bora in Boulder can be similar to the onset of a Chinook, with strong westerly, but colder and drier air, whereas a Chinook brings warmer and drier air. Boulder seems to gets its most extreme winds during Chinook events.

The first graphic below illustrates these typical wind patterns along the Front Range. The second graphic provides a scale describing the damaging effects of windspeed.



(Source: http://wxpaos09.colorado.edu/windstorms/windstorms.htm)

Beaufort Wind Scale

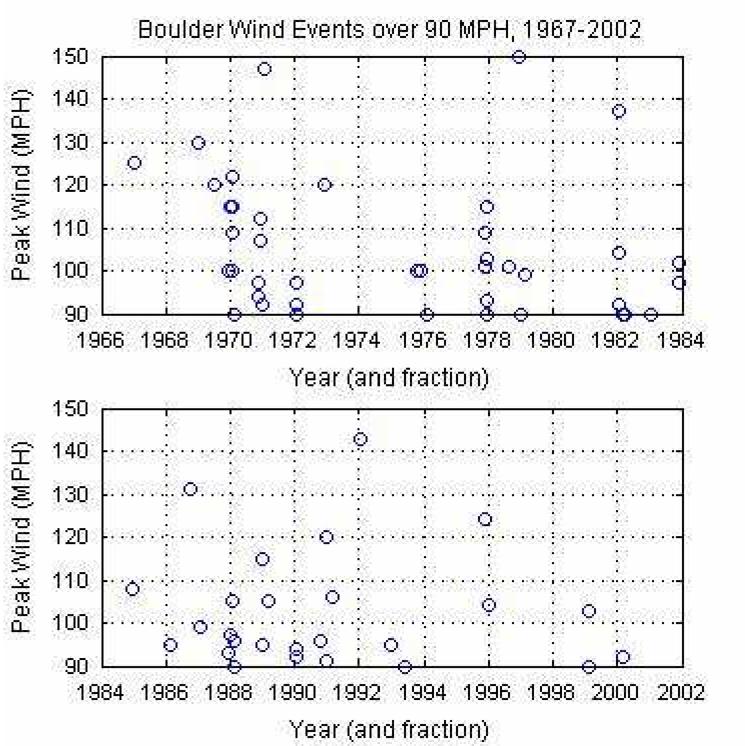
Windspeed in MPH	Description - Visible Condition
0	Calm smoke rises vertically
1 - 4	Light air direction of wind shown by smoke but not by wind vanes
4 - 7	Light breeze wind felt on face; leaves rustle; ordinary wind vane moved by wind
8 - 12	Gentle breeze leaves and small twigs in constant motion; wind extends light flag
13 - 18	Moderate breeze raises dust and loose paper; small branches are moved
19 - 24	Fresh breeze small trees in leaf begin to sway; crested wavelets form on inland water

Windspeed in MPH	Description - Visible Condition
25 - 31	Strong breeze large branches in motion; telephone wires whistle; umbrellas used with difficulty
32 - 38	Moderate gale whole trees in motion; inconvenience in walking against wind
39 - 46	Fresh gale breaks twigs off trees; generally impedes progress
47 - 54	Strong gale slight structural damage occurs; chimney pots and slates removed
55 - 63	Whole gale trees uprooted; considerable structural damage occurs
64 - 72	Storm very rarely experienced; accompanied by widespread damage
73+	Hurricane devastation occurs

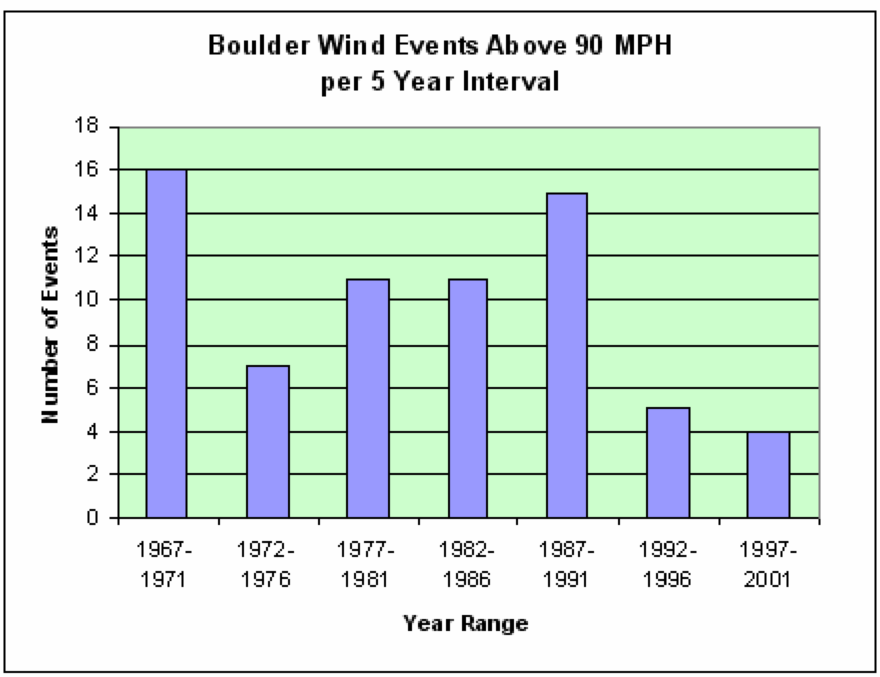
Past Occurrences

High wind events are one of the most notable natural hazards affecting Boulder County and the UCB Planning Area. At least one location in or near Boulder experiences wind gusts in excess of 100 mph almost every year. Gusts have been measured as high as 147 mph. The National Center for Atmospheric Research reports that a severe windstorm in January 1982, comparable to the landfall of a Category 2-3 hurricane, resulted in more than $10 million in damages, damaging nearly half of all buildings in Boulder.

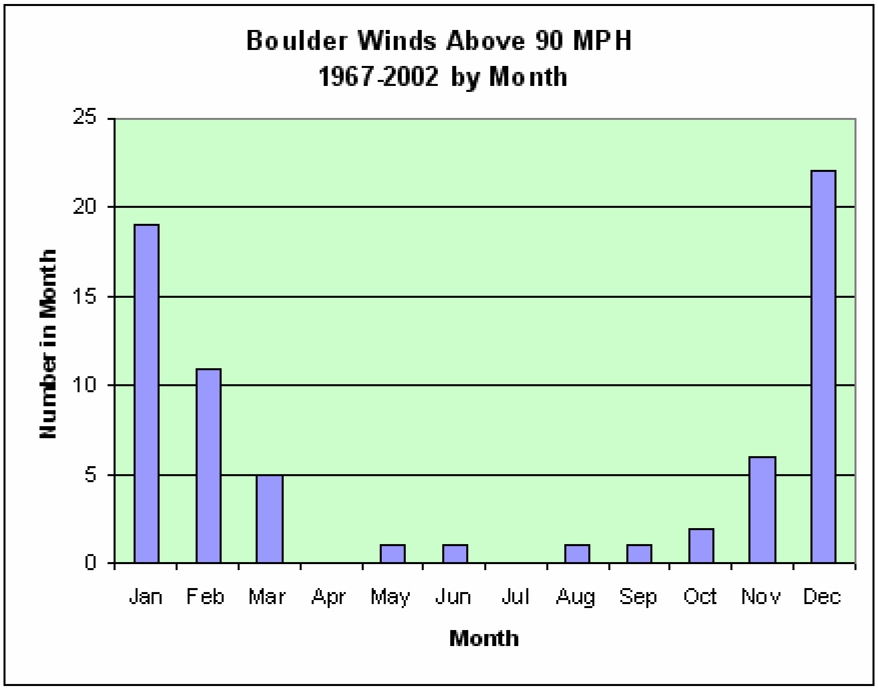
To define this hazard, information was extracted from NOAA's Climate Diagnostics Center Web Page. The information from NOAA describes notable Boulder wind events from 1967 through 2002. The data generally focuses on days in which wind gusts above 70 mph were reported somewhere in the area. Sometimes, the highest gust was reported at NCAR; other times Rocky Flats, Table Mesa, or sometimes not specified. Utilizing this information, Steve Jones with the *Boulder Daily Camera* newspaper extracted 69 wind events where gusts at or above 90 mph are indicated. The following figures provide a graphical overview of the frequency and intensity of these events. The first series of graphics shows the individual events over the whole time period.



The second graphic below shows the distribution over the year, broken into 5-year intervals. This graph shows that gusts over 90 mph have been less common in the last decade than earlier in the reporting period.



The third graph shows the distribution of events by month of the year, clearly demonstrating that the strongest winds usually occur in mid-winter.



Other historical windstorm events are summarized below:

- **Between 1950 and 2004,** the NCDC had record of 93 wind events exceeding 50 kts (57.6) mph.
- Of the 97 wind events identified by NCDC, 12 of them were associated with injuries and/or property damage. The specifics of these events are detailed below:
    - ♦ **02/24/1994** – high winds, 96kts (~110 mph); Property Damage of $500K. High winds buffeted much of the northern and central mountains east of the Continental Divide and portions of the front range. Wind speeds of 70 to 80 mph were common over much of the area. Significant wind gusts included 110 mph (96 kts) at the National Center for Atmospheric Research (NCAR) in west Boulder at 1630 MST and 95 mph (83 kts) in north Boulder at 1630 MST.
    - ♦ **03/23/1994** – high winds, 67kts (~80 mph); Property Damage of $5K.
    - ♦ 1**0/29/1996** – high winds, 88kts (~103 mph); One death, five injuries, property damage of $5.2 M. High winds gusting from 70 to around 100 mph blasted across much of Northeast Colorado. One man was killed when a strong wind gust overturned a popup camper on him as he tried to secure it. In addition, five people at the Rocky Flats Environmental Test Facility received minor injuries when several windshields were blown out, spraying glass onto them. Several trees and power lines were also downed.

- **02/02/1999** – high winds, 110kts (~127 mph); property damage of $3million. A powerful Chinook windstorm struck the Front Range Foothills and adjacent plains. Several locations registered peak wind gusts in excess of 100 mph. Other peak wind reports included: 97 mph (84 kts) at Boulder and 93 mph (81 kts) at the NCAR Mesa Lab. The damage associated with the windstorm was extensive. Thirty 70-ft tall power poles were damaged, including several that supported high voltage lines transmitting power directly from generating plants. The combination of downed power poles, power lines and trees resulted in outages for approximately 10,000 residents. The outages primarily affected residents in Boulder, Broomfield, Lafayette, Louisville and Fort Lupton. In addition to the outages, high winds ripped apart several roofs in Boulder, including the Boulder County Jail. Total damage estimates for the windstorm reached $3 million, making it the fourth costliest on record in Colorado.
- **04/08/1999** – high winds, 100kts (~115 mph); property damage of $7.2million. Another damaging windstorm ravaged much of northeast Colorado, costing $7.2 million, making it the third costliest storm to strike the region. Most of the damage to homes ($4.35 million) consisted of broken fences, awnings, doors and windows. Scores of automobiles ($2.85 million) suffered broken or cracked windshields and paint damage from flying debris. Multiple accidents were triggered as several tractor-trailer rigs were blown on their sides by strong cross-winds, causing many highways to close. Several trees, power poles and power lines were downed causing a number of outages throughout northeast Colorado as well as sparking a few small grass fires. Peak wind gusts reached or exceeded the century mark at several locations, including 100 mph (87 kts) at the NCAR Mesa Lab. Other peak wind reports included 96 mph (83 kts) at the Rocky Flats Environmental Test Facility and 80 mph (70 kts) at the CU Campus in Boulder.
- **04/09/1999** – high winds, 85kts (~98 mph); property damage of $13.8million. Another round of damaging winds buffeted eastern Colorado, in and near the foothills from Fort Collins south to Pueblo, as well as portions of the adjacent plains. Total damage estimates were at $13.8 million. Peak wind reports included: 92 mph (80 kts) at the CU Campus in Boulder and 91 mph (79 kts) at the NCAR Mesa Lab.
- **05/20/2001** – high winds, 72kts (~82 mph); six injuries, property damage of $3.4 million. Intense winds developed as a vigorous cold front, accompanied by a line of thunderstorms, spilled over the Cheyenne Ridge and moved rapidly across the Urban Corridor and Northeast Plains. Peak wind gusts to 83 mph (72 kts) downed trees and power lines. Approximately 32,000 Xcel customers in Weld and Boulder counties and in the cities of Lafayette, Littleton, central Denver and Aurora were without electricity for up to two hours. Zero visibilities were reported due to blowing dust, dirt and other flying debris. Temperatures in one hour dropped from the mid 70s into the mid 30s.

- **10/29/2003** – high winds, 70kts (~81 mph); property damage of $979 thousand. Strong Chinook winds developed in and near the Front Range Foothills. Several trees and power lines were downed in Boulder, causing damage and triggering scattered electrical outages. The combination of strong winds, very dry conditions and downed power lines sparked two large wildfires. The Overland Wildfire in Boulder County, near Jamestown, consumed nearly 3,900 acres and destroyed 12 structures, including homes, trailers and outbuildings. Preliminary damage estimates for the value of lost property was approximately $979,000.
- **12/20/2004** – high winds, 88kts (~102 mph); three injuries, property damage of $400 thousand. Damaging downslope winds developed along the Front Range and spread into the adjacent plains. Peak wind gusts approached 100 mph along the foothills of Boulder. Strong winds forced the closure of State Highway 93, between Golden and Boulder, for approximately two hours. Insurance agents estimated 650 to 850 homes suffered wind damage in the Boulder and Louisville areas. In addition, downed trees and power lines left approximately 10,000 residents, mainly in the Boulder area, without electricity. At least three people suffered minor injuries in the storm.

Other significant wind events identified by the HMPC include:

- **January 11, 1972** – Winds gusting to 97 mph damaged 40 trailers at Boulder Valley Village, including three that burned. Damage was estimated near $3 million.
- **January 17, 1982** – One of the most devastating windstorms in Boulder County, winds were clocked at 137 mph at NCAR. Twenty gusts in excess of 120 mph were measured during a 45 minute period. South Boulder was the hardest hit area of the county. At least 15 people were treated for cuts and bruises at Boulder Community Hospital after being struck with flying debris and glass. Trees were uprooted, power lines were toppled, roofs were blown off, houses were torn apart, and cars were damaged. Damages totaled approximately $17 million dollars.

Wind-related deaths in Boulder County include:

- March 18, 1920 – Three people were killed when a fire truck responding to a fire collided with a car.
- January 7, 1969 – One-half of all the houses in the city were damaged by wind. Winds clocked at 96 mph downtown and 130 mph at NCAR. One person died when he was blown off a Cherryvale Fire Department truck that was responding to a grass fire near the Boulder Airport.
- June 1969 – A UCB student died while sailing under a parachute in 80 mph winds.

- January 10, 1990 – One person was killed in a three-car accident on the Boulder Turnpike two miles west of Broomfield. Winds gusting to 107 mph caused poor visibility.
- October 29, 1996 – A Boulder County man died as he was trying to secure his pop-up camper trailer during winds in excess of 100 mph. The trailer blew over on top of him. Trees were downed and cars and property were damaged.
- February 3, 1999 – Downed power poles and tree limbs cut power to over 10,000 homes. The peak gust of 127 mph was recorded at Sugarloaf. Nederland had 80 mph, Boulder 98, Lafayette 120, Longmont 100, and Wondervu 119 mph. Nearly a dozen power poles went down between Baseline and Arapahoe on 95th Street near Lafayette. The roof of the Boulder County Jail sustained approximately $150,000 damage. Damage along the front range was close to $3 million.
- April 8-10, 1999 – High winds hit Boulder County on April 8, 1999 and then again on April 10 with winds recorded at 120 mph at Sugarloaf, near 100 mph in South Boulder and 90 mph in Longmont. Trees were uprooted and semi-trailers overturned.

Other significant storms with wind velocities above 85 mph include:

- October 1949 – 85 mph, 300 ton crane toppled at Xcels' Valmont Plant
- January 15, 1967 – 125 mph , NCAR
- June 25, 1969 – 123 mph, NCAR
- January 24, 1970 – 122 mph, NCAR
- January 25, 1971 – 147 mph, NCAR
- December 11, 1973 – 120 mph, Marshall Mesa
- November 26, 1977 – 119 mph, Davidson Mesa
- December 4, 1978 – 148 mph, one death
- January 24, 1982 – 140 mph, Wondervu
- December 25, 1984 – 112 mph, $100,000 damage
- September 24, 1986 – 131 mph, $100,000 damage
- January 23, 1988 – 90 mph, damaged bridge – Hwy 157
- February 9, 1988 – 96 mph, 1600 homes without power
- May 7, 1988 – 110 mph, 12,000 residents without power
- January 8, 1990 – 110 mph, minor damage
- December 14, 1990 – 120 mph – roof trees, cars damaged
- January 24, 1992 – 143 mph at NCAR, minor damage
- January 3, 1995 – 104 mph, Boulder Airport
- December 4 1995 – 95 mph at NCAR, minor damage
- November 13, 1995 – 124 mph at NCAR, power outages in Nederland, a downed power line started a wildfire in Pine Brook Hills

UCB Data

Other information provided by the HMPC indicated that during the period of 7/1/97 through 2/28/05, UCB filed 28 insurance claims for damages associated with high winds, for a total of $331,653.69. The claims ranged from tiles coming off roofs, to entire roofs coming off buildings, to UCB-owned boats flying into other boats. Many claims were small in dollar amounts. Seven claims accounted for 88% of the total amount of claims for wind damage. These included:

- February 3, 1999 – Claim for $10,224.12, high winds (in excess of 100 mph) blew clay tiles off the roofs of numerous buildings.
- November 18, 1999 – Claim for $10,019.5, high winds blew a section of the roof off.
- January 13, 2002 – Claim for $6,614.94, high winds blew open and damaged the frame of a French door.
- November 11, 2003 – Claim for $120,000 high winds blew down section of fence surrounding newly constructed tennis courts at the south campus.
- December 20, 2004 – Claim for $80,000, high winds blew solar panels off roof of engineering building; roof collapsed at math building.
- December 14, 2004 – Claim for $25,000, high winds blew roof off of IMIG, Hend and Law buildings.
- August 10, 2004 – Claim for $40,000, high winds blew an eight person crew boat from its stakes into a single boat owned by a Boulder Rowing Club member.

Other insurance data for the period 1989 to 1997 identified six wind events totaling $31,649.74 in damages.

Likelihood of Future Occurrences

Highly Likely: High Winds are a common event in the Boulder area. Given historical data, topography of the area, and weather patterns, high winds in Boulder County and the UCB Planning Area will continue to occur annually.

Winterstorms

Winterstorms can include heavy snow, ice, and blizzard conditions. Heavy snow can immobilize a region, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse roofs and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. The cost of snow removal, repairing damage, and loss of business can have a tremendous impact on cities and towns. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days until damages can be repaired. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians. Some winter storms are accompanied by strong winds, creating blizzard conditions with blinding wind-driven snow, severe drifting, and dangerous wind chills. Strong winds with these intense storms and cold fronts can knock down trees, utility poles and power lines. Blowing snow can reduce visibilities to only a few feet in areas where there are no trees or buildings. Serious vehicle accidents can result in injuries and deaths.

Winterstorms in Boulder County, including strong winds and blizzard conditions, can result in localized power and phone outages; closures of streets, highways, schools, business, and non-essential government operations. People can also become isolated from essential services in their homes and vehicles. A winter storm can escalate, creating life threatening situations when emergency response is limited by severe winter conditions. Other issues associated with severe winter weather include the threat of physical overexertion that may lead to heart attacks or strokes. Snow removal costs can also impact budgets significantly. Heavy snowfall during winter can also lead to flooding or landslides during the spring if the area snowpack melts too quickly, most often accompanied by rain.

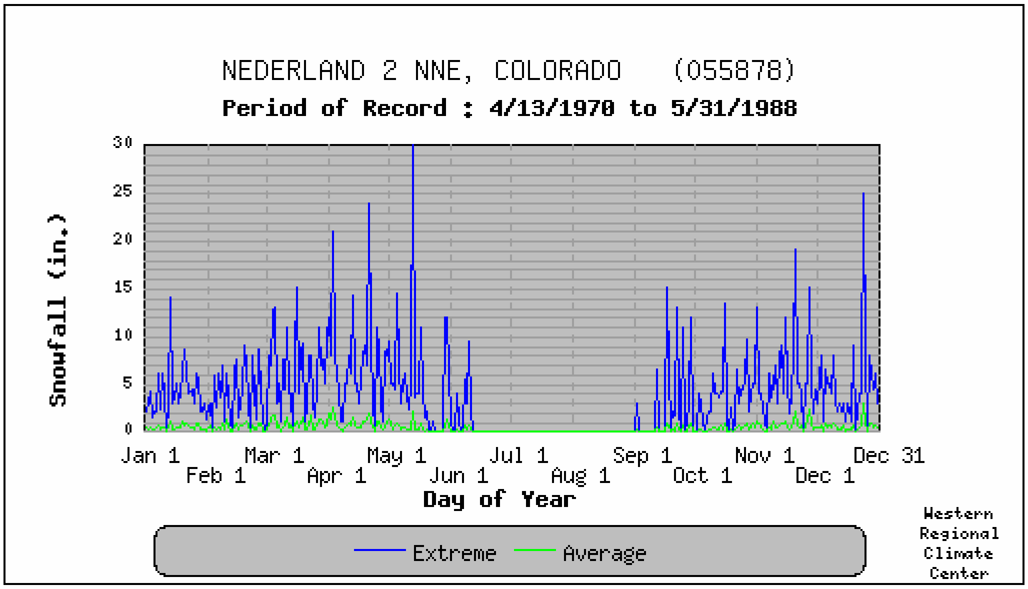
Past Occurrences

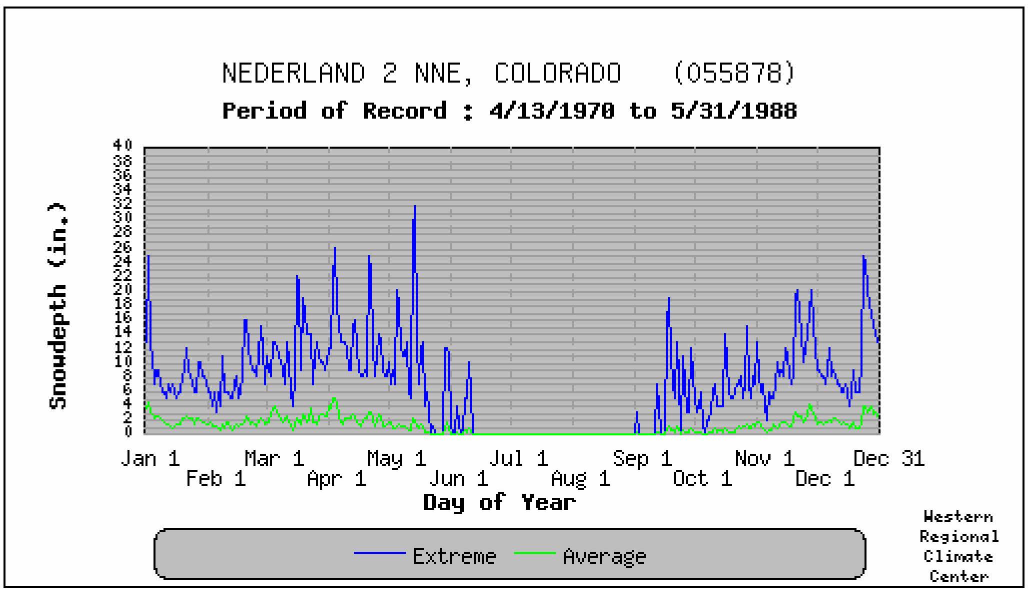
Both the western and eastern portions of Boulder County receive snowfall on a regular seasonal basis, predominantly from October through April; however, the western portion of the County receives substantially more snow than the eastern portion.

Western Boulder County (Nederland Weather Station-Period of Record 4/13/70 to 5/31/88).

The average annual total snowfall for the Nederland area is 139.0 inches. The two snowiest months are March and April, with 23.9 and 24.3 average inches of snow respectively. November is the next snowiest month with an average snowfall of 19.9 inches; December is next with an average snowfall of 16.1 inches. January at 13.3 and February at 13.1 are just above May with an average monthly snowfall of 12.2 inches. The highest recorded monthly snowfall for the POR is 52 inches for the month of March in 1983. The highest annual snowfall for the POR is 231 inches also in 1983. The most snowfall in a 24 hour period occurred in Boulder County in April 1921 at Silver Lake, when 76 inches was recorded.

The average snow depth ranges from 1-2 inches during these winter months; however, daily extremes include snow depths up to 32 inches.

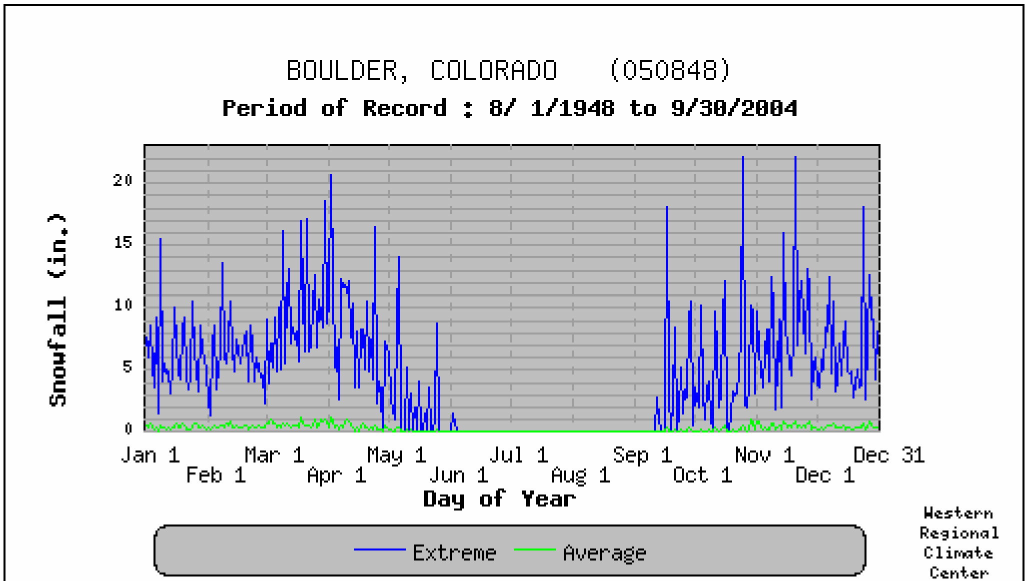


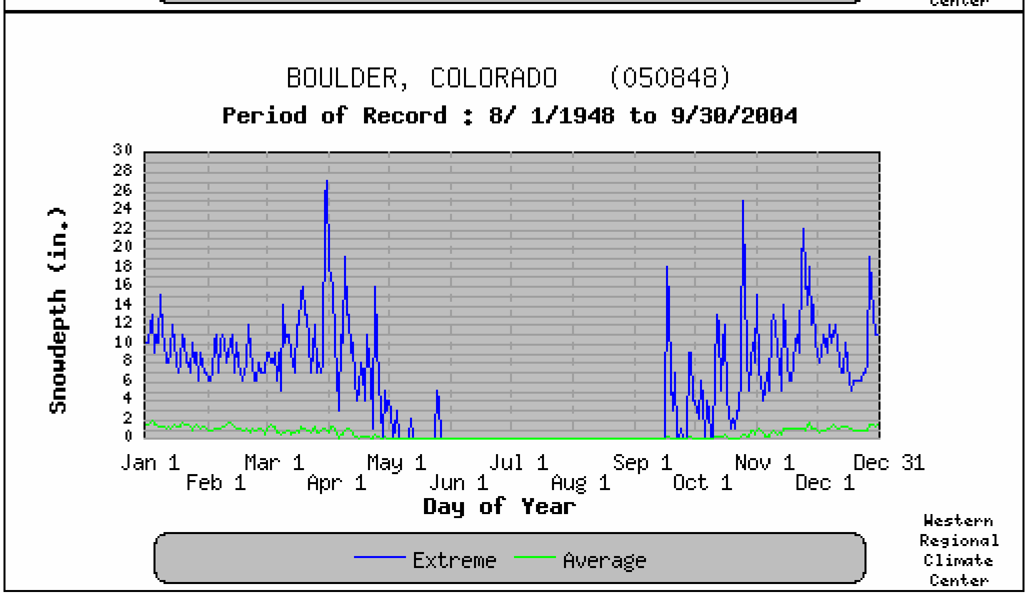


Eastern Boulder County (Boulder Weather Station-Period of Record 8/1/48 to 9/30/04).

The average annual total snowfall for the Boulder area is 83.1 inches. The two snowiest months are November and March, with 13.4 and 17.8 average inches of snow respectively. April is the next snowiest month, with an average snowfall of 11.5 inches; other snowy months include December with 10.4, January with 10.7, and February with 11.1, on average. October is next with 5.1 inches. And both May and September receive snowfall with a monthly average of 1.5 inches. The highest recorded monthly snowfall for the POR is 56.7 inches for the month of March in 1970. The highest annual snowfall for the POR is 125.4 inches in 1987.

The average snow depth ranges from 0-1 inches during these winter months; however, daily extremes include snow depths up to 27 inches.





Data from the NCDC identified the following 61 winterstorm events between 1950 and 2005: One snow, 44 heavy snow, 12 winterstorms, and four blizzards. Of these, the following events resulted in injuries and/or property damage:

- **02/11/1994 –** Heavy Snow, two injuries, property damage of $50 thousand. Moist upslope winds and an upper level system produced heavy snow over portions of the front range. Amounts ranged from 6 to 12 inches.
- **01/28/1995,** Heavy Snow, two deaths, property damage of $25 thousand. All mountains, N.E. Front Range: A strong, very moist and slow moving winter storm system took aim on Colorado. The mountains received the brunt of the storm where they measured the snow in feet. As for the high country, all mountain ranges received at least three feet of snow with some locations in the Elk Mountains, collecting six to eight feet (72 to 96 inches). Two people were killed

by avalanches during the week. Road closures were common in the high country due to poor visibilities and avalanches. In addition, Interstate 70 was closed on the 12th when an avalanche crossed the westbound lanes west of the Eisenhower Tunnel. At lower elevations, including the foothills and northern front range, the snow started falling the morning of the 10th. Most of the snow had fallen during the 24-hour period after the onset. Storm accumulation amounts varied. Locations in and near the foothills received the most snow, ranging between 10 and 15 inches. Golden and south sections of Boulder received 15 and 14 inches respectively.

- **02/08/1995** – Blizzard, property damage – $3.1million. The spring storm that moved into eastern Colorado developed into a blizzard across the Northeast Plains as an intense surface cyclone formed. The combination of freezing rain, followed by heavy snow and damaging winds, led to widespread electrical outages. Snowfall totals generally ranged from six to 18 inches. The heaviest snow occurred near the Front Range Foothills, the Palmer Divide, stretching from just south of Denver, then east and northeast into northern Lincoln and Washington Counties, and near the Nebraska state line. Sustained winds from 35 to 58 mph with gusts to around 75 mph were recorded. Denver International Airport was completely shut down for the first time in its brief six-year history. Power surges and outages constantly crippled the airport's massive computer system. The airport was closed at 5 am and did not reopen until mid-afternoon. Power outages affected nearly all of northeast Colorado. Some areas only had scattered outages for a few hours, while more remote areas were blacked out for over a week. The only businesses that remained open during the storm were those utilizing backup generators. As a result, most businesses were closed, and school classes were canceled. Overall, 220,000 Xcel Energy customers were affected, making it the worst outage in the company's history. Previously, the worst event occurred in September of 1995, when downed trees and branches from a snowstorm left 100,000 customers without electricity. Overall, at least 500 poles were downed or damaged during the storm. The company replaced 120 electrical poles, repaired 180 additional poles, and repaired or replaced another 400 cross-arms. Approximately $1.6 million was spent on repairs across northeastern Colorado.

- **1997 –** Blizzard, property damage of $10.5 million. This 1997 snowstorm was the second costliest on record.

- **03/17/2003**, Blizzard, property damage of $62 million. A very moist, intense and slow moving Pacific storm system made its way across the four corners area and into southeastern Colorado from March 17th to the 19th, allowing for a deep easterly upslope flow to form along the Front Range. The storm dumped 31.8 inches of snow at the former Stapleton International Airport, making it the second worst storm in Denver. The storm also managed to vault March 2003 into first place for the snowiest March in Denver history and fifth place for the wettest March on record. In addition, the storm allowed the month of March to break a streak of 19 consecutive months of below normal precipitation in Denver. The heavy wet snow caused roofs of homes and businesses to collapse across the urban corridor. The snow also downed trees, branches and power lines. Up to 135,000 people lost power at some point during the storm, and it took several days in some areas to restore power. Avalanches in the mountains and foothills closed many roadways, including Interstate 70 in both directions, stranding hundreds of skiers and travelers. Denver International Airport (D.I.A.) was also closed, stranding approximately 4,000 travelers. In all, the estimated cost of the damage to property alone (not including large commercial buildings) was $93 million, making it easily the costliest snowstorm ever in Colorado. The areas hardest hit by heavy snow were the northern mountains east of the Continental Divide, the Front Range Foothills and Palmer Divide, where snowfall totals ranged from 3 ft. to over 7 ft. In Boulder 22.5 inches fell.

Other winter storm events identified by the HMPC, include the following:

- **1912 -**
- **1978 -**
- **Christmas storm of 1982** – the storm began on Christmas Eve, lasting through Christmas Day. Winds created large drifts, closing roads and stranding travelers.
- **December 24-29, 1987** – 20 inches fell over a few day period. County-wide snow removal operations were estimated at $280,000.
- **March 6, 1990 –** More than two feet of wet snow dumped in the foothills, paralyzing traffic, stranding travelers, preventing mail delivery, and causing hundreds of accidents and power outages in Boulder County. Winds of 37 mph qualified the storm as a blizzard.
- **March 9, 1992** – 20 inches of snow fell in Boulder County. The storm began early in the afternoon with spring-like thunder and lightning and turned winter-like in about one hour. More than 25,000 residents were without electricity when wet, wind-driven snow toppled power lines. Many cars were stranded on Highway 36 between Boulder and Denver and on Highway 93 between Boulder and Golden.
- **April 24, 1997** – a snowstorm dumped over 16 inches of snow in Boulder; mountain areas received around 30 inches total. UCB lost 120 + trees as a result of this storm.
- **October 24, 1997** – During this “Blizzard of 1997”, Boulder received 30 inches of snow in 48 hours. A total of 51 inches fell in Coal Creek Canyon, just west and south of Boulder. Power outages were sporadic, and tree breakage was minimal. Areas south and east of Boulder County were impacted more by the storm than Boulder County due to high winds creating blizzard conditions. This storm was the largest October storm in Boulder history, ranking 4th largest on record. Snow totals made the 1997 calendar year the snowiest on record, with a total of approximately 130 inches. The storm resulted in five deaths, two injuries, and 1.2 million in property damages. Losses were estimated at $20 million for air carriers.

Other Boulder County storms with measurable snowfall include:

- December 4-5, 1913: 43 inches
- November 2-5, 1946: 31 inches
- January 23-27, 1948: 21 inches
- April 7-11, 1959: 26 inches
- March 29-31, 1970: 26 inches
- September 17-18, 1971: 21 inches
- May 5-6, 1978: 31 inches
- November 20, 1979: 22 inches
- November 26-27, 1983: 23 inches

UCB Data

Other information provided by the HMPC indicated that during the period of 7/1/05 through 2/28/05, UCB filed two insurance claims for damages associated with winterstorms for a total of $15,190.31. The claims were predominantly for damage to trees and buildings caused by the weight of ice and snow. From the period of 1989 to 1997, two claims for $3,538.21 as a result of heavy snow were filed for damages on Campus.

Although very infrequent, closure of the UCB campus has occurred as a result of blizzard conditions. Most recently was closure on March 18, 2003. According to the HMPC, two to three people were stranded at the Mountain Research Station for several days under seven to eight feet of snow.

Likelihood of Future Occurrences

Highly Likely**:** Based on historical data, winter storms are an annual occurrence within Boulder County and the UCB Planning Area. The potential exists for a severe winter storm to occur during any year in Boulder County due to its geographic location. The highest point in the County is 14,255 feet and the lowest 4,986 feet. Over 50% of the County is 6,000 feet or above in elevation.

SOIL HAZARDS

Expansive Soils

Expansive (swelling) soils or soft bedrock are those that increase in volume as they get wet and shrink as they dry. They are known as shrink-swell, bentonite, expansive, or montmorillinitic soils. Swelling soils contain high percentages of certain kinds of clay particles that are capable of absorbing large quantities of water, expanding up to 10% or more as the clay becomes wet. The force of expansion is capable of exerting pressures of 20,000 per square foot (psf) or greater on foundations, slabs, and other confining structures. In Colorado, swelling soils tend to be at a constant moisture content in their natural state and are usually relatively dry prior to any construction disturbance. Exposure to water sources (such as lawn watering) during or after development generally results in swelling.

Swelling soils are one of the nation's most prevalent causes of damage to buildings. According to the Colorado Natural Hazard Mitigation Plan, annual losses are estimated in the range of $2 billion. In Colorado, the cost is estimated at $16 million annually. Damages can include severe structural damage; cracked driveways, sidewalks, and basement floors; heaving of roads and highway structures; condemnation of buildings; and disruption of pipelines and other utilities. Destructive forces may be upward, horizontal, or both. Building in and on swelling soils can be done successfully, although more expensively, as long as appropriate construction design and mitigation measures are followed.

Past Occurrences

Colorado, with its arid or semi-arid areas with seasonal changes of soil moisture, experiences a much higher frequency of swelling problems than eastern states that have higher rainfall and more constant soil moisture. Rocks that contain swelling clay are generally softer and less resistant to weathering and erosion than other rocks and therefore, more often occur along the sides of mountain valleys and on the plains than in the mountains. Buildings designed with lightly loaded foundations and floor systems often incur the greatest damage and costly repairs from expansive soils. In 1972, a state college library in southern Colorado required $170,000 to repair swelling-clay damage. A six-year-old $2 million building on the same campus was closed pending repairs to structural components pulled apart by swelling clay. A college building in western Colorado was also included among other state buildings severely damaged by swelling clays. Also affected across the state are local school districts that have spent hundreds of thousands of dollars for repairs.

UCB Data

According to the HMPC, expansive soils have been an issue on the Main Campus. During construction of the Coors Events Center, expansive soils were encountered. Design and construction of the Events Center accounted for these soil conditions; however, the fill excavated from the site had no value for resale. As a result, excavated fill remained on Campus in an area adjacent to the Coors Events Center now known as "Observatory Hill".

Likelihood of Future Occurrences

Occasional: Given the geology within Boulder County and the historic discovery of expansive soils within the Main Campus, the potential exists for expansive soils to be a future issue to UCB.

Land Subsidence

The Colorado geological survey defines land subsidence as the sinking of the land over human-caused or natural underground voids. In Boulder County, the type of subsidence of greatest concern is the settling of the ground over abandoned mine workings. In Boulder County, past coal and clay mining activities have created surface subsidence in some areas and has created the potential for subsidence in other areas.

Subsidence can result in serious structural damage to buildings, roads, irrigation ditches, underground utilities and pipelines. It can disrupt and alter the flow of surface or underground water. Weight, including surface developments such as roads, reservoirs, and buildings, and human-caused vibrations from such activities as blasting, heavy truck or train traffic can accelerate the natural processes of subsidence. Fluctuations in the level of underground waters caused by pumping or by injecting fluids into the earth can initiate sinking to fill the empty space previously occupied by water or soluble minerals. The consequences of improper utilization of land subject to ground subsidence will generally consist of economic losses. This includes high repair and maintenance costs for buildings, irrigation works, highways, utilities and other structures. This results in direct economic losses to citizens and businesses, and indirect losses through increased taxes, decreased property values, and sales taxes from affected businesses.

Past Occurrences

Subsidence has occurred within Boulder County. Based on information included in the State Natural Hazard Mitigation Plan, a substantial area within Boulder County has been identified as a major mining district within Colorado and a smaller portion of the eastern county is considered a coal region of the state. Boulder County is second in the state for number of abandoned mines, with 183 abandoned coal mines and 3,600 abandoned mines of other types. In Lafayette in 1974, an abandoned coal mine created a sinkhole in a trailer park area that expanded to 25 feet deep and 25 feet in diameter in about a 24-hour period.

UCB Data

According to the HMPC, subsidence has been an issue in a couple of areas on main campus. Specifically, Clare Small Gym and Sommers-Bausch Observatory have had damages associated with land subsidence. Infilling and structural improvements have been completed to correct these issues; the amount of damages, insurance claims, and cost of mitigation is unknown.

Likelihood of Future Occurrences

Occasional: Given the history of mining activity and past subsidence issues within Boulder County and the University Main Campus, the potential exists for subsidence to continue to be an issue within the UCB Planning Area.

WILDFIRE

Wildfire and Urban Wildfire are ongoing concerns for Boulder County and the UCB Planning Area. Generally, the fire season extends from spring to late fall. Fire conditions arise from a combination of hot weather, an accumulation of vegetation, and low moisture content in air and fuel. These conditions, especially when combined with high winds and years of drought, increase the potential for wildfire to occur. While the wildfire risk is predominantly associated with Wildland-Urban Interface (WUI) areas, significant wildfires can also occur in heavily populated areas. WUI is a general term that applies to development interspersed or adjacent to landscapes that support wildland fire. A fire along this wildland/urban interface area can result in major losses of property and structures.

Potential losses from wildfire include: human life, structures and other improvements; natural and cultural resources; the quality and quantity of the water supply; other assets such as timber, range and crop land; recreational opportunities; and economic losses. Smoke and air pollution from wildfires can be a severe health hazard. In addition, catastrophic wildfire can lead to secondary impacts or losses such as future flooding, erosion, and landslides during heavy rains. Generally, there are three major factors that sustain wildfires and predict a given area's potential to burn. These factors are fuel, topography, and weather.

- **Fuel –** Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is generally classified by type and by volume. Fuel sources are diverse and include everything from dead tree needles and leaves, twigs, and branches to dead standing trees, live trees, brush, and cured grasses. Also to be considered as a fuel source are structures, such as homes, and other associated combustibles. The type of prevalent fuel directly influences the behavior of wildfire. Light fuels such as grasses burn quickly and serve as a catalyst for fire spread. In addition, "ladder fuels" can spread a ground fire up through brush and into trees, leading to a devastating crown fire, one that burns in the upper canopy and cannot be controlled. The volume of available fuel is described in terms of fuel loading. Certain areas in and surrounding Boulder County are extremely vulnerable to fires as a result of dense vegetation combined with a growing number of structures being built near and within rural lands. The presence of fine fuels, 1000 hour fuels and needle cast combined with the cumulative effects of previous drought years, vegetation mortality, tree mortality and blowdown across Boulder County has added to the fuel loading in the area. Fuel is the only factor that is under human control.

- **Topography -** An area's terrain and land slopes affect its susceptibility to wildfire spread. Both fire intensity and rate of spread increase as slope increases due to the tendency of heat from a fire to rise via convection. The arrangement of vegetation throughout a hillside can also contribute to increased fire activity on slopes.

- **Weather -** Weather components such as temperature, relative humidity, wind, and lightning also affect the potential for wildfire. High temperatures and low relative humidity dry out the fuels that feed the wildfire creating a situation where fuel will more readily ignite and burn more intensely. Wind is the most treacherous weather factor. The greater a wind, the faster a fire will spread, and the more intense it will be. Winds can be significant at times in Boulder County. In addition to wind speed, wind shifts can occur suddenly due to temperature changes or the interaction of wind with topographical features such as slopes or steep hillsides. Lightning also ignites wildfires, often in difficult-to reach terrain for firefighters. Related to weather is the issue of recent drought conditions contributing to concerns about wildfire vulnerability. During periods of drought, the threat of wildfire increases.

Rangeland and grassland fires also present greater risk in the eastern portion of Boulder County due to increased residential development in semi-urban and rural areas combined with continued drought conditions.

Past Occurrences

Wildfires are of significant concern throughout Colorado. According to the Colorado State Forest Service, vegetation fires occur on an annual basis; most are controlled and contained early with limited damages. For those ignitions that are not readily contained and become wildfires, damages can be extensive. There are many causes of wildfire from naturally caused lightning fires to human-caused fires linked to activities such as smoking, campfires, equipment use and arson.

The 2002 wildfire season was the worst in Colorado history. Recent wildfire history in Colorado is summarized in the following table.

Colorado Wildfire History

Year	# of Fires	# of Acres Burned
1990	1,474	9,825
1991	1,406	6,787
1992	1,020	4,135
1993	1,267	3,526
1994	3,190	52,184
1995	2,368	34,293
1996	2,499	49,498
1997	1,605	16,703
1998	1,349	10,282
1999	2,161	35,261
2000	3,698	249,976
2001	4,022	72,210
2002	4,612	619,030
2003	2,180	53,412
2004	899	17,263
Totals	**29,719**	**1,234,385**

Historically, Boulder County has experienced numerous wildfires dating back to June 29, 1916. Details are provided below.

June 29, 1916 – 1,000 acres burned around Bear Mountain.

July 5, 1924 – 1,600 acres burned near Nederland.

August 9, 1978 – Fire caused by lightning burned more than 1,000 acres in the northwestern portion of Boulder County in Rocky Mountain National Park.

October 6, 1980 – A fire caused by an arsonist burned 150 acres in the Pine Brook Hills Subdivision, destroying a $150,000 home.

September 1988 – The Lefthand Canyon Fire (1,500 acres) and Beaver Lake Fire (700 acres) occurred in the canyon above Buckingham Park and close to Beaver Lake near Ward. Houses were threatened, but no structures lost. They were thought to be human-caused fires.

July 9, 1989 – The Black Tiger Fire destroyed 44 homes on Sugar Loaf Mountain and burned over 2,100 acres. Hot temperatures, low humidity and gusty winds contributed to this human-caused fire. Costs were estimated at $10 million.

November 24, 1990 – Olde Stage Road Fire, considered the fourth major wildfire in Boulder County, started when a man threw a burning mattress out his front door. Wind gusts up to 80 mph fanned the fire out of control. Ten homes, five out-buildings and approximately 3,000 acres were burned in the fire.

September 15, 2000 – Walker Ranch/Eldorado Fire, likely a human-caused fire burned approximately 1,000 acres. No structures were lost: although over 250 homes were threatened. Firefighting costs were estimated at $1.5 million. A FEMA fire suppression declaration was made to help cover firefighting costs. This area had previously undergone fuels treatment, mitigating the severity of the fire.

Other notable fires (greater than 50 acres in size) in the Boulder area include:

- **11/1/1964:** Near Eldorado Springs (100 acres)
- **5/28/1974:** Near Gold Hill (160 acres)
- **6/1976:** Comforter Mountain (256 acres)
- **8/1979:** Coal Creek Canyon (50 acres)
- **9/21/1984:** United States Forest Service (USFS) Land near Lyons (60 acres)
- **8/1/1987:** Between Boulder and Lyons (50 acres)

- **11/4/1987:** Southwest of Highway 36 (100 acres)
- **2/21/1988:** Sunshine Canyon (200 acres)
- **9/7/1988**: North of Ward (160 acres)
- **7/15/1991:** West of Boulder Hills Subdivision, six miles North of Boulder (135 acres)
- **7/14/1994:** Near Ward (50 acres)
- **9/3/1996:** Rabbit Mountain-Lyons (50 acres)

UCB Data

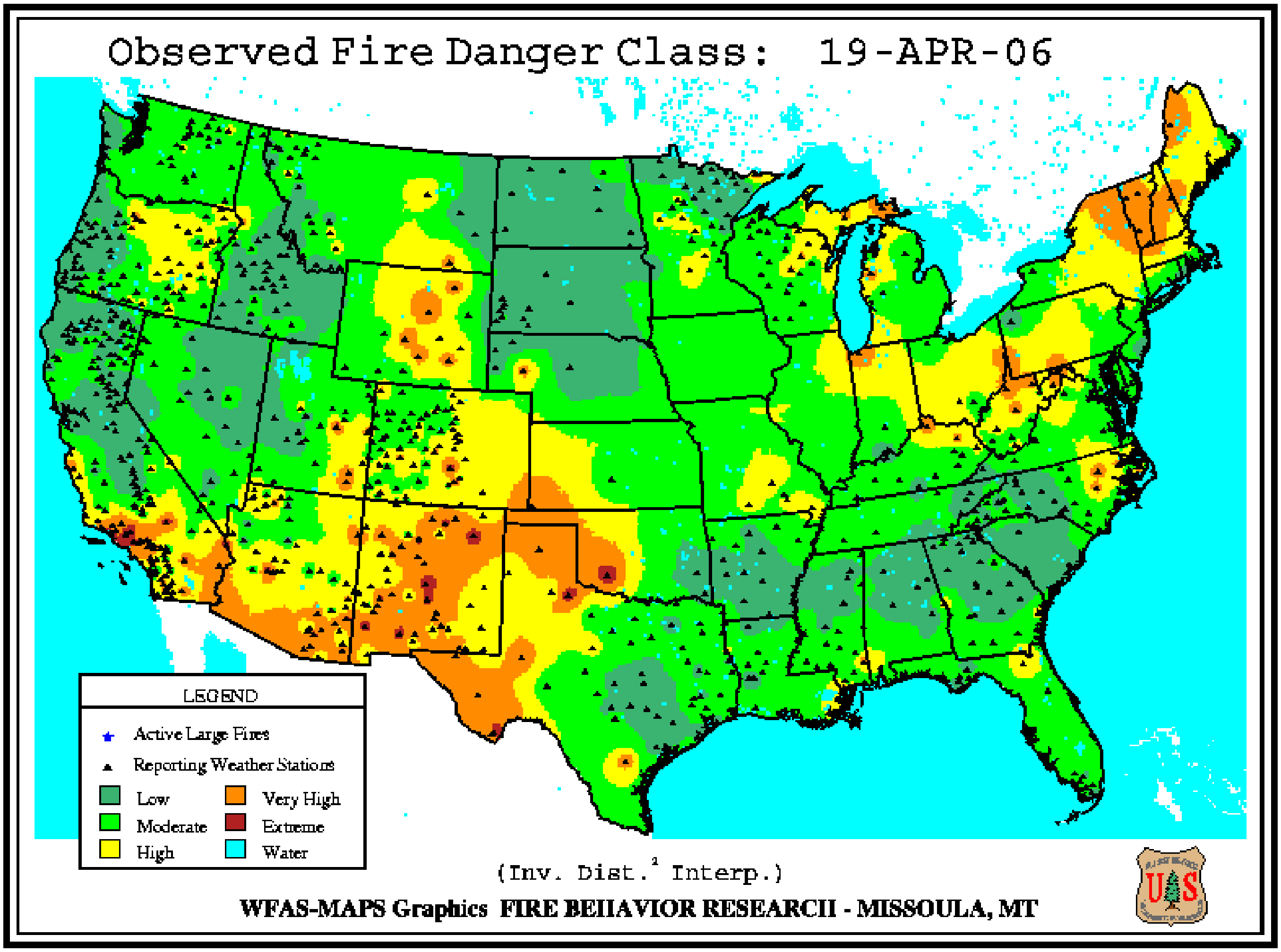
The HMPC had no information to indicate wildfires had directly impacted the UCB Planning Area. However, UCB's firefighting services can become taxed by supporting fire suppression efforts for large fires occurring throughout the region. For example, UCB provided staff and support services during the Hayman fire in 2002 and the Walker Ranch fire during 2000.

Likelihood of Future Occurrences

Likely: Based on historic data, Boulder County experienced at least 20 significant (>50 acres) fires since 1916. This is an average of one fire every 4.45 years, or a 22.47% chance of a fire any given year. Depending on the severity and location of a fire, the UCB Planning Area is potentially at risk to fires occurring within the county, especially in the forested areas in and around the Mountain Research Station.

From spring through fall each year, Boulder County faces a serious wildland fire threat. Much of the county is susceptible to wildland fires. According to the Colorado Natural Hazard Mitigation Plan, a century of aggressive fire suppression, combined with cycles of drought and changing land management practices, has left many of Colorado's forests unnaturally dense and ready to burn. Further, the threat of wildfire and potential losses are constantly increasing as human development and population increases and the Wildland-Urban Interface areas expand. Due to the existing fuel loads, semi-arid conditions, and continued development, Boulder County continues to be at risk from wildfire.

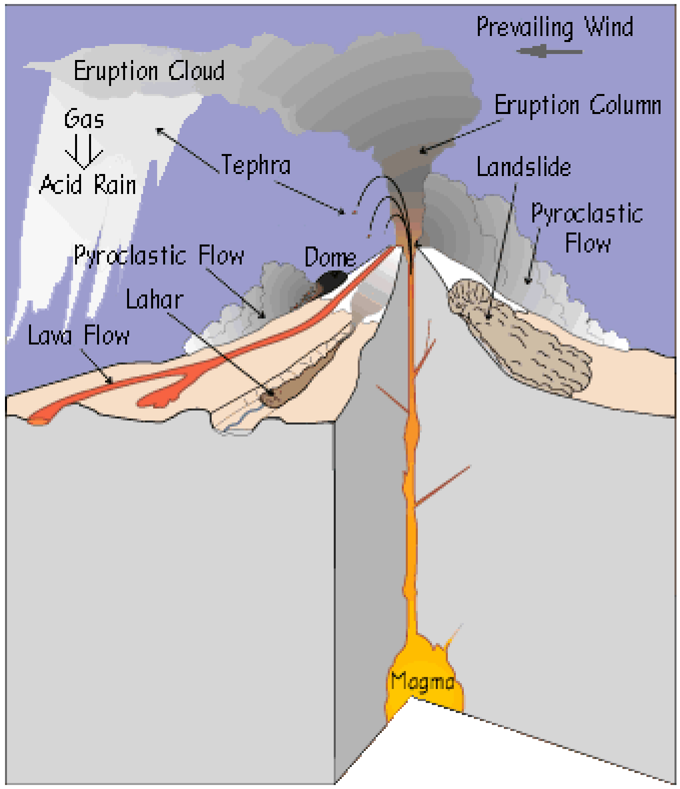
Further, early indicators of the 2006 wildfire season compiled by the Rocky Mountain Area (RMA) Predictive Services predicts an average potential for large fires over the Boulder portion of the RMA. The current observed Fire Danger Class prepared by the USFS shows Boulder County and the UCB Planning Area as of April 19, 2006 to be in an area of high danger as seen in the graphic that follows. However, this danger map changes weekly based on current conditions.



(Source: http://www.fs.fed.us/land/wfas/fd_class.gif)

VOLCANO

Of the almost 70 active and potentially active volcanoes in the U.Ss, more than 50 have erupted one or more times in the past 200 years. Volcano hazards are the greatest in five western states: Alaska, Hawaii, California, Oregon, and Washington. Volcanoes create a wide variety of hazards that can kill people and destroy property. Populations living near volcanoes are most vulnerable to volcanic eruptions and lava flows; although large explosive eruptions can endanger people and property hundreds of miles away and even affect global climate. Volcanic ash can also travel and affect populations many miles away. The ash from the 1980 eruption of Mount St. Helens in Washington fell over an area of 22,000 square miles in the Western U.S., including Boulder. Heavy ash fall can collapse buildings, and even minor ash fall can damage crops, electronics, and machinery. Some volcanic hazards, such as landslides, can occur even when a volcano is not erupting. The following depicts a volcano typical of those found in the Western U.S.



(Source: http://pubs.usgs.gov/fs/fs002-97/)

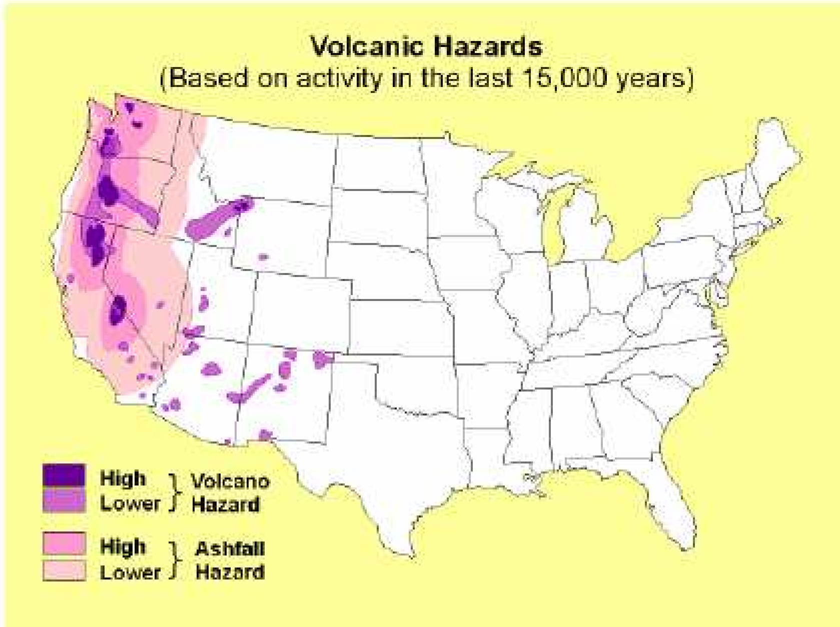
Past Occurrences

The HMPC was unable to find any evidence of volcanic activity within Boulder County and the UCB planning area.

Likelihood of Future Occurrences

Given its location to potentially active volcanoes in the U.S., Boulder County and the UCB Planning Area are not at great risk to volcanic hazards. Volcanic hazards would likely be limited to ash fall from a large eruption from volcanoes located in the western U.S. The map on the following page illustrates volcanic hazards based on activity in the last 15,000 years. Areas in blue or purple show regions at greater or lesser risk of local volcanic activity, including lava flows, ashfall, lahars (volcanic mudflows), and debris avalanches. Areas in pink show regions at risk of receiving five or more centimeters of ashfall from large or very large explosive eruptions, originating at the volcanic centers shown in blue. An eruption from potentially active volcanoes located in the western U.S. is not likely to adversely impact the UCB Planning Area.

VOLCANIC HAZARDS ASH DISPERSION MAP



(Source: http://www.usgs.gov/themes/map2.html)

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Multi-Hazard Mitigation DRU Plan
4.2 Vulnerability Assessment

As the second part of the Risk Assessment process, the HMPC conducted a Vulnerability Assessment to describe the impact that each hazard identified in the preceding section would have upon the UCB Planning Area. This Vulnerability Assessment includes an identification of assets at risk and an estimate of potential losses.

Vulnerability is measured in general, qualitative terms, and is a summary of the potential impact based on past occurrences, spatial extent, and damage and casualty potential:

Extremely Low: *The occurrence and potential cost of damage to life and property is very minimal to non-existent.*

Low*: Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.*

Medium*: Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.*

High*: Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread. Hazards in this category may have already occurred in the past.*

Extremely High: *Very widespread and catastrophic impact.*

An estimate of the vulnerability of UCB to each identified hazard, in addition to the estimate of risk or likelihood of future occurrence, is provided in each of the hazard-specific sections

The DMA regulations require that the HMPC evaluate the risks associated with each of the hazards identified as posing a threat to the UCB planning area.

The hazards identified in Section 4.1 are:

- Avalanche
- Dam failure
- Drought
- Earthquakes
- Floods
- Human health hazards
    - West Nile Virus
    - Pandemic Influenza

- Landslides and Rockfalls
- Severe weather
    - Extreme temperatures
    - Fog
    - Hailstorm
    - Heavy rains/storms
    - Lightning
    - Tornadoes
    - Windstorms
    - Winter Storms
- Soil Hazards
    - Expansive soils
    - Land subsidence
- Volcanoes
- Wildfires

The HMPC has determined that the risk of the following hazards occurring within the UCB Planning Area is minimal or non-existent, as described in Section 4.1, and they are no longer addressed in this plan until such time information becomes available that changes that assessment:

- Fog
- Volcanoes

TOTAL VULNERABILITY AND VALUES AT RISK

Risk – Unlikely; Vulnerability – Extremely High

As a starting point for analyzing the UCB Planning Area's vulnerability to identified hazards, the HMPC utilized a variety of data to define a baseline against which all disaster impacts could be compared. If a catastrophic disaster were to occur in the Planning Area, the following information describes significant assets at risk. Data used in this baseline assessment included:

- Total Values and Assets at Risk
- Critical Facility Inventory
- Cultural and Natural Resource Inventory
- Development Trends

Total Values and Assets at Risk

The UCB Office of Risk Management in conjunction with other university departments provided data to support an analysis of Total Values and Assets at Risk in the UCB Planning Area. This analysis is presented below.

Total Insurable Values

The following data obtained by the UCB office of Risk Management utilizes total insurable values for University infrastructure. A summary of the Total Insurable Values, which includes building, contents and other miscellaneous values for UCB infrastructure, is provided in the table below. In order to further analyze the data for purposes of this risk assessment, the Risk Management data was converted into an Access database and an additional data field (that assigns the building type) was added to the database based on the primary use of a building. The additional data field includes the following descriptions:

- Classroom
- Common Areas/Auditoriums
- Data Systems
- Libraries/Museums
- Medical Facilities
- Offices
- Recreation
- Research
- Residential
- Storage/Parking
- Utilities/Infrastructure

The data was then summarized below according to the primary use of a building.

UCB
Total Insurable Values

Type of Building/Assets	**Number of Structures & Assets**		**Value of Structures & Assets**				
	# on Campus	% on Campus	Building Value	Contents Value	Misc. Value*	Total Value	% of Total Value
Classrooms	46	23.71%	$393,506,880	$83,374,200	$127,229,577	$604,110,657	27.41%
Common Areas/Auditoriums	4	2.06%	$80,618,530	$4,277,400	$575,200	$85,471,130	3.88%
Data Systems	3	1.54%	$0	$6,351,000	$0	$6,351,000	.29%
Libraries/Museums	2	1.03%	$44,922,720	$2,239,000	$279,885,665	$327,047,385	14.84%
Medical Facilities	1	.52%	$10,259,980	$1,948,000	$252,000	$12,459,980	.57%
Offices	34	17.53%	$154,118,430	$38,915,555	$8,453,100	$201,487,085	9.14%
Recreation	10	5.15%	$127,711,000	$6,040,900	$2,176,500	$135,928,400	6.17%
Research	23	11.85%	$228,636,920	$92,973,400	$11,747,770	$333,358,090	15.12%
Residential	41	21.13%	$344,443,290	$15,452,890	$584,800	$360,480,980	16.35%
Storage/Parking	14	7.21%	$13,070,500	$230,400	$17,750	$13,318,650	.60%
Utilities/ Infrastructure	16	8.24%	$18,948,690	$103,663,944	$1,738,000	$124,350,634	5.64%
Totals	**194**	**100%**	**$1,416,236,940**	**$355,466,689**	**$432,660,362**	**$2,204,363,991**	**100%**

*Miscellaneous data includes values for: electronic data (EDP), library contents, valuable papers & rare materials, fine arts, and other values characterized as miscellaneous by UCB risk management, excluding research animals.

In addition to the inventory summarized above, there are a few additional buildings located on UCB campuses, but not included in the inventory. This includes the USW building located at 4001 Discovery Drive on the East campus, which is leased by UCB the Bear Creek Apartments on the Williams Village Campus which have recently been purchased by UCB, but were not included in UCB's current property schedule. Any values associated with these properties would be in addition to the values set forth above. This additional data was not available to the HMPC.

Business Income and Research Animal Values

Other factors to be considered in determining the total values at risk are the:

- Business Income Value
- Research Animal Value

The Business Income Value is calculated by UCB on an annual basis and considers gross income less deductions for providing supplies and services. The 2004-2005 Business Income for UCB is $122,229,582.

The Research Animal income for UCB is calculated at $4,270,570.00. This value **is included in** the above table and is primarily tied to two properties:

- Institute for Behavioral Genetics located on the East Campus: $1,707,225
- Molecular, Cellular and Developmental Biology located on the Main Campus: $2,563,345

Also considered a valuable asset at UCB are the students and staff that live and work on campus. The data for the number of staff was provided by the Office of Risk Management. The data for the number of students was provided by several sources: Family Housing, Department of Housing – Residential, Non-Family, and Department of Planning, Budget & Analysis. This data is a generalized estimate based on limitations in available data. Data limitations include:

- Departments do not always record the information consistently. For example, a department to which student workers are assigned may not be their actual work location, but the department will sometimes record their work location at the primary office. This data also excludes a small percentage of employees that are retirees that return to work with the University in a part-time capacity.
- Student population data was based on data originally created for calculating campus space use. Utilizing enrollment and scheduling information, this data provided a number for Total Reportable Student Credit Hours on a per building basis. In order to calculate an actual student headcount per building, the Reportable Credit Hours was divided by 15. In some cases certain assumptions were necessary to assign student populations to each building provided in UCB's master Property Schedule. For example, where information was not available as to the specific building, students were assumed to be associated with the Main Campus and assigned as a default to Hellums, a large-capacity classroom facility.
- In addition, since data were collected from different sources, there may be some double counting of those students that reside in Resident and Family Housing as they can not

accurately be accounted for and subtracted from the academic scheduling data. Additional double counting may also occur as some student workers are included in both the staff count and student count.

The following table summarizes these critical populations located within the UCB Planning Area that may be at risk to natural hazards. With the exception of estimates for residential buildings, all other estimates are based on assumed occupancies during weekdays from 8:00 am-5:00 pm during the primary school year of September to June. The student headcount for residential buildings are assumed to be on a 24/7 basis.

UCB
Critical Populations at Risk

Type of Building/Assets	**Populations at Risk**			
	# of Staff	% of Staff	# of Students	% of Students
Classrooms	4123	29.45%	23,289	73.03%
Common Areas/Auditoriums	871	6.22%	189	0.59%
Data Systems	0	0%	0	0%
Libraries/Museums	760	5.43%	186	0.58%
Medical Facilities	234	1.67%	0	0%
Offices	2808	20.06%	466	1.46%
Recreation	505	3.61%	23	0.07%
Research	3198	22.84%	788	2.47%
Residential	1386	9.90%	6,949	21.79%
Storage/Parking	2	0.01%	0	0%
Utilities/ Infrastructure	113	0.81%	0	0%
Totals	**14,000**	**100%**	**31,890**	**100%**

Critical Facility Inventory

Of significant concern with respect to any disaster event is the location of critical facilities at UCB. During Year 2000 (Y2K) Contingency Planning conducted by UCB, Facilities Management solicited the input of all departments to determine a building priorities list defining those facilities critical to the ongoing operations of UCB. Three levels of building priorities were established as described below. The final prioritization scheme was approved and endorsed by the Vice Chancellors for UCB. The priority scheme for establishing critical facilities for UCB are:

- "Priority One" facilities are those where, "a lack of utilities services to these buildings could pose a life or safety risk to the occupants or could pose a threat to the ability of the University to fulfill its mission." For Priority One facilities it is the primary goal of UCB to provide uninterrupted utility services.

- "Priority Two" facilities are not "mission critical" and are of secondary importance to UCB in maintaining or restoring utility services.
- "Priority Three" facilities are all remaining, non-mission critical facilities within UCB.

It is important to note that this prioritization scheme was based, in part, on the time of year and the level of activity on campus on January 1, 2000. Most residence halls were unoccupied during the winter break, but during the normal school year when the residence halls are occupied, they would all have been rated facility Priority One. In utilizing this scheme for DMA planning purposes, all residential facilities were reprioritized as a Priority One.

A summary table of critical facilities is included below. Note that the values associated with these critical facilities are also included in the overall Total Values at Risk.

UCB
Critical Facilities at Risk

Campus Property	Critical Facilities at Risk					
	# of Priority One	% of all Facilities	Total Value of Priority One	# of Priority Two	% of all Facilities	Total Value of Priority Two
Main	65	33.50%	$1,215,450,968	9	4.64%	$120,133,057
East	8	4.12%	$59,553,525	4	2.06%	$14,634,200
Williams Village	3	1.55%	$75,603,390	0	0	$0
South	0	0	$0	0	0	$0
Mountain Research Station	0	0	$0	0	0	$0
Other	1	0.52%	$86,600	0	0	$0
Totals	**77**	**39.69%**	**$1,350,694,483**	**13**	**6.70%**	**$134,767,257**

In addition to the prioritization of facilities described above, a list of mission critical departments was developed with assistance from the Vice Chancellors' offices. These departments include the following:

- Admissions
- Bursar and Accounting
- Environmental Health and Safety
- Facilities Management
- Financial Aid
- Housing
- Human Resources
- ITS/Telecommunications
- Mailing Services
- Planning, Budget, and Analysis
- Police Department

- Registrar
- Transportation
- Wardenburg

Cultural and Natural Resource Inventory

In evaluating the vulnerability of a given area to disaster, it is important to inventory the cultural and natural resources specific to that area. Cultural and Natural Resources are important to identify pre-disaster for four reasons:

- First, the University may decide that these areas are worthy of a greater degree of protection than currently exists, due to their unique and irreplaceable nature;

- Second, should these resources be impacted by a disaster, knowing so ahead of time allows for more prudent care in the immediate aftermath, when the potential for additional impacts are higher;

- Third, the rules for repair, reconstruction, restoration, rehabilitation and/or replacement usually differ from the norm; and

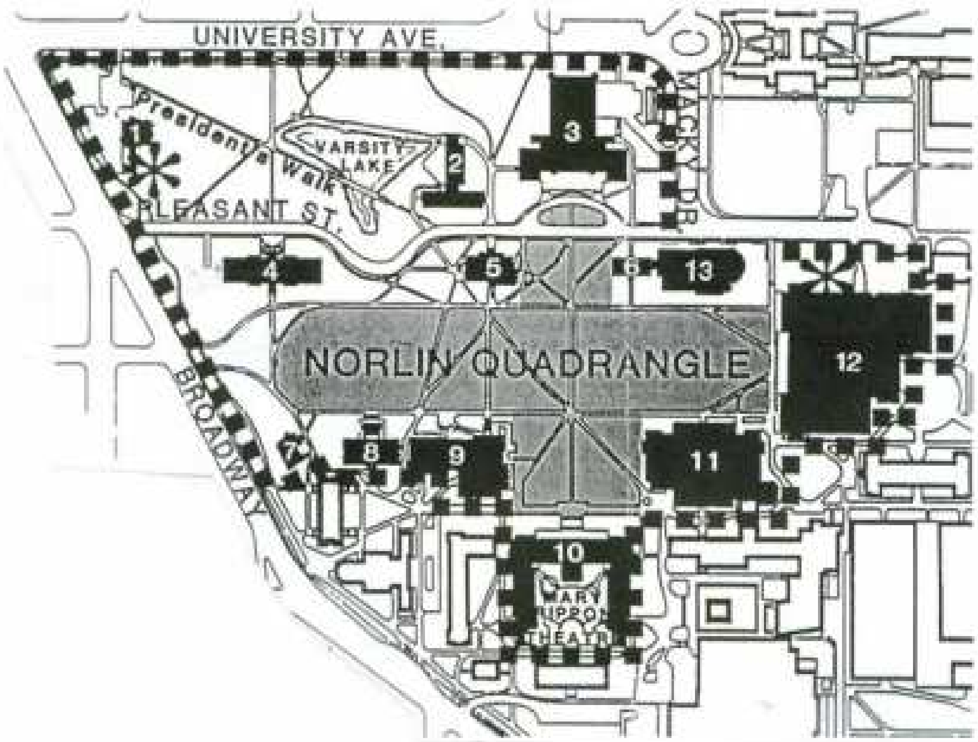
- Fourth, natural resources, such as wetlands and riparian habitat, can have beneficial functions that contribute to the reduction of flood levels and damage.

Cultural Resources

To inventory UCB's cultural resources, the HMPC collected information from the Colorado State Register of Historic Properties, which includes all properties designated under the Colorado State Register nomination process and all properties listed in the National Register of Historic Places. These registers include listings for buildings, structures, sites, objects, or districts. A district contains a group of related sites, buildings, structures, or objects. The elements within a district are united historically or aesthetically by plan or physical development. The directory of Colorado State Register Properties includes one historic listing associated with UCB. This listing from the state register is described as follows:

> Norlin Quadrangle Historic District, National Register 3/27/1980, 5BL.360: The district is comprised of twelve buildings which form the oldest part of the main campus of UCB. The buildings, constructed on land donated in 1872 by six leading Boulder residents, reflect a deliberate variety of architectural styles.

UCB's 1999 Micro Master Plan for the Norlin Quadrangle Historic Area identifies and maps 13 historic buildings located within the District. The Plan also includes a map of historic corridors within the District as well as a map describing typical historic features. This information is detailed in the maps that follow.



NOT TO SCALE

NORLIN QUADRANGLE HISTORIC DISTRICT

HISTORIC BUILDINGS:

1. KOENIG ALUMNI CENTER
2. McKENNA LANGUAGES
3. MACKY AUDITORIUM
4. HALE SCIENCE
5. OLD MAIN
6. WOODBURY ARTS & SCIENCES
7. HAZEL GATES WOODRUFF WOMEN'S STUDIES COTTAGE
8. GUGGENHEIM GEOGRAPHY
9. UNIVERSITY THEATRE
10. HELLEMS ARTS & SCIENCES
11. EKELEY CHEMISTRY
12. NORLIN LIBRARY
13. HUMANITIES

NORLIN QUADRANGLE

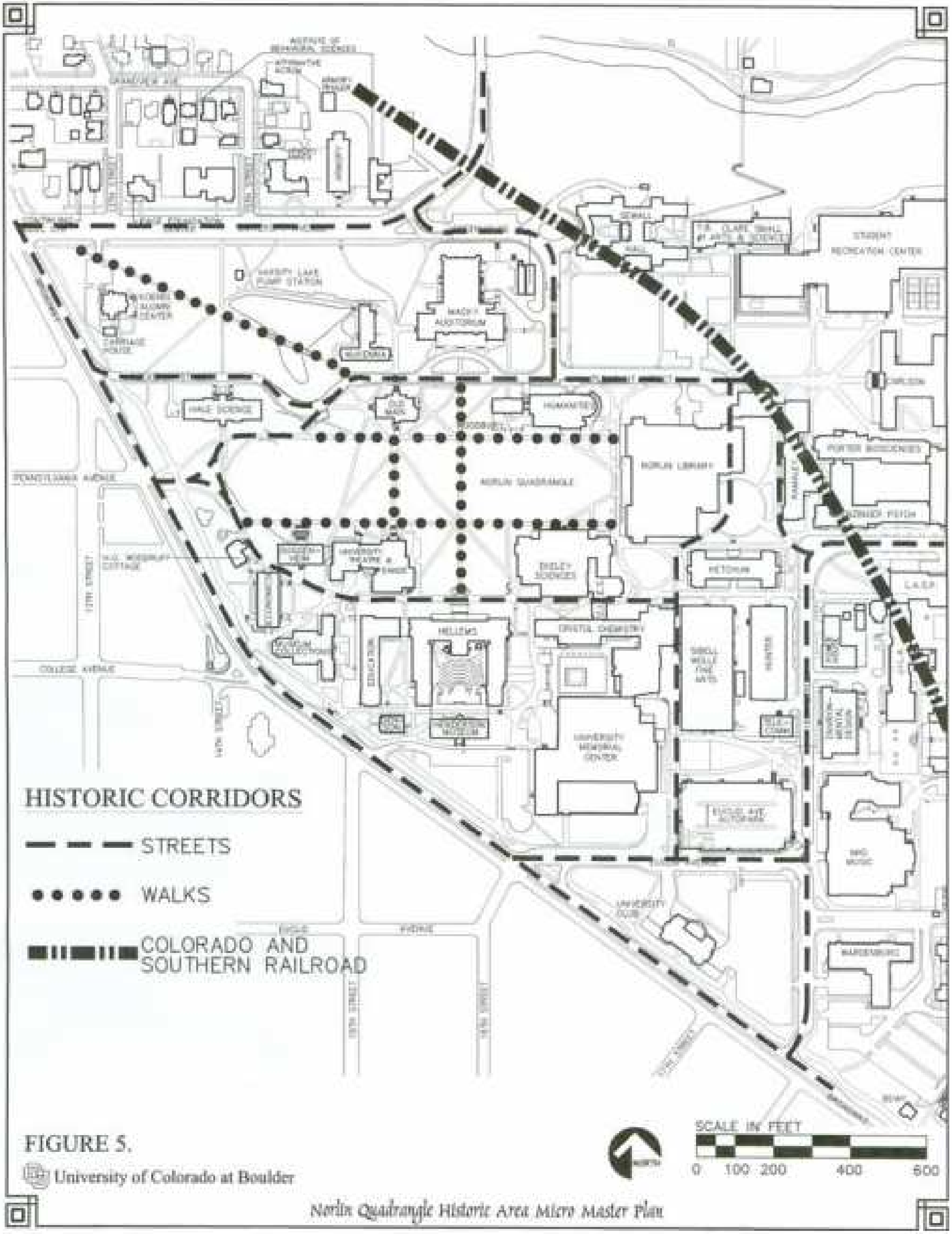
HISTORIC DISTRICT BOUNDARY

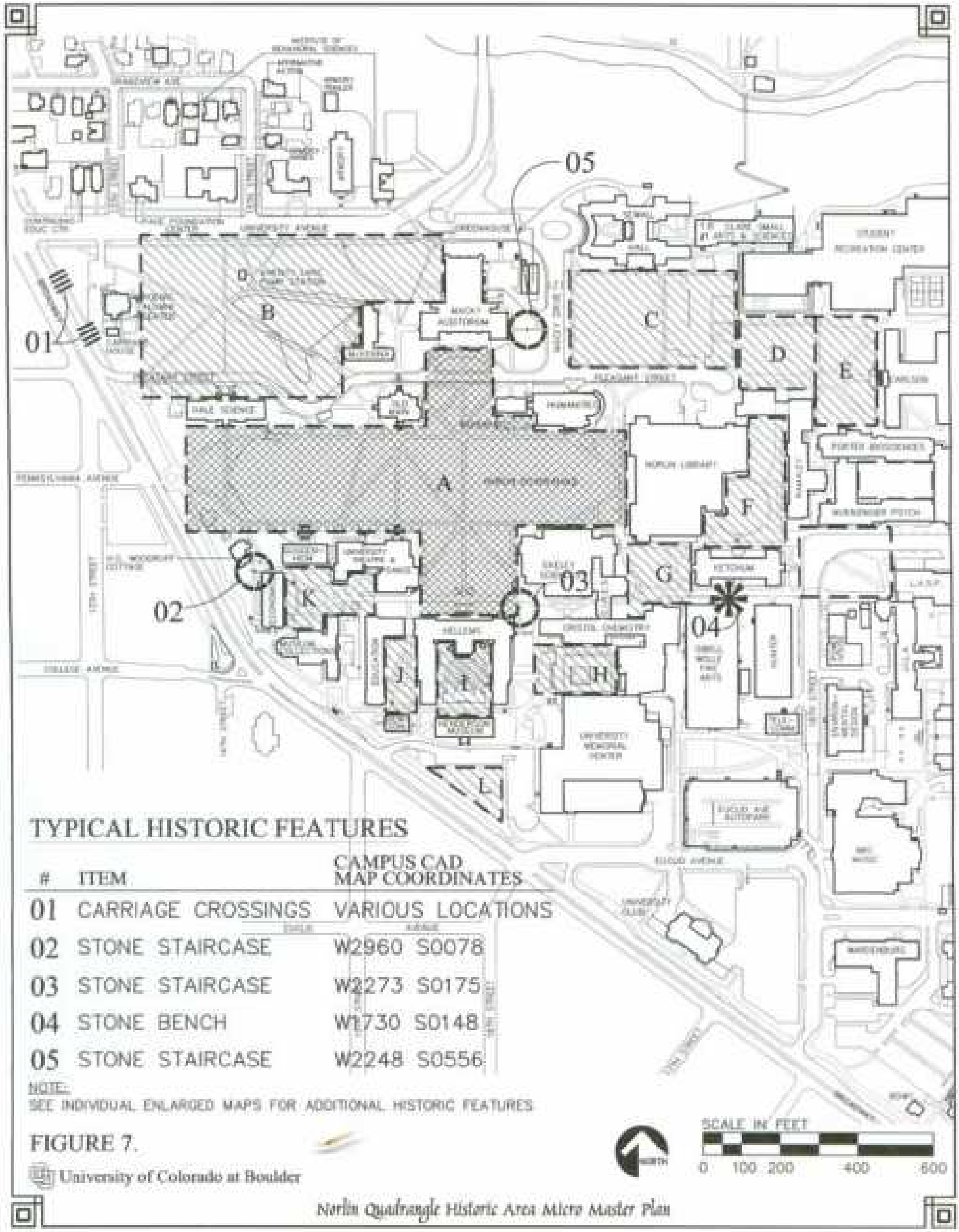
POTENTIAL BUILDING SITE

FIGURE 1.

University of Colorado at Boulder

Norlin Quadrangle Historic Area Micro Master Plan


HISTORIC CORRIDORS
STREETS
WALKS
COLORADO AND SOUTHERN RAILROAD
FIGURE 5.
University of Colorado at Boulder
Norlin Quadrangle Historic Area Micro Master Plan
SCALE IN FEET
0 100 200 400 600
MACKY AUDITORIUM
NORLIN QUADRANGLE
NORLIN LIBRARY
HALE SCIENCE
HELLEMS
UNIVERSITY MEMORIAL CENTER
STUDENT RECREATION CENTER
PENNSYLVANIA AVENUE
COLLEGE AVENUE


TYPICAL HISTORIC FEATURES
ITEM CAMPUS CAD MAP COORDINATES
01 CARRIAGE CROSSINGS VARIOUS LOCATIONS
02 STONE STAIRCASE W2960 S0078
03 STONE STAIRCASE W2273 S0175
04 STONE BENCH W1730 S0148
05 STONE STAIRCASE W2248 S0556
NOTE:
SEE INDIVIDUAL ENLARGED MAPS FOR ADDITIONAL HISTORIC FEATURES
SCALE IN FEET
0 100 200 400 600
A
B
C
D
E
F
G
H
I
J
K
L
01
02
03
04
05
NORLIN LIBRARY
MACKY AUDITORIUM
UNIVERSITY MEMORIAL CENTER
PLEASANT STREET
UNIVERSITY AVENUE
EUCLID AVENUE
COLLEGE AVENUE
PENNSYLVANIA AVENUE
HALE SCIENCE
HENDERSON MUSEUM
KETCHUM
PORTER BIOSCIENCES
STUDENT RECREATION CENTER
WARDENBURG
University of Colorado at Boulder
Norlin Quadrangle Historic Area Micro Master Plan
FIGURE 7.

Although not included on the federal or state historic register, several of the buildings described as "bungalows" within the Grandview area of the Main Campus are of historic significance. These buildings north of University Avenue and east of Broadway, considered Craftsman-style bungalows built in the first three decades of this century, housed many UCB faculty and staff members. The area has been distinguished as a solid example of the arts-and-crafts style of architecture of the 1920s and 1930s. It was named one of the most endangered historic places by the nonprofit Colorado Preservation Inc. in 1999. UCB owns most structures in the 12-acre neighborhood, starting with acquisitions in 1968. In recognition of historic preservation concerns, UCB, as part of its Memorandum of Agreement with the City of Boulder, created a covenant with the City to create a 25-year preserve for the bungalows it owns facing Grandview Avenue between 13th and 15th streets. Under the covenant, UCB will not demolish or relocate the bungalows within the preserve except as specified, during the term of the covenant. According to the Campus Master Plan, the bungalows may be used in a number of ways, including University academic/research uses and housing rentals.

Natural Resources

For purposes of this plan, natural resources primarily include threatened and endangered species and wetlands. Also of significant value to UCB, and identified below, are the water rights associated with various ditches in the area.

Threatened and Endangered Species

To further evaluate UCB's vulnerability in the event of a disaster, it is important to inventory key natural resources such as threatened and endangered species.

Endangered Species means any species of fish, plant life, or wildlife that is in danger of extinction throughout all or a significant part of its range and is protected by law.

Threatened Species means any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range and protected by law.

Special Concern means any species about which problems of status or distribution are suspected, but not documented. This is not considered a statutory category. However, many animal species listed as Special Concern can be protected under other state and federal laws addressing hunting, fishing, collecting, and harvesting.

Wildlife. The Colorado Division of Wildlife identifies the following numbers of state and federally listed endangered, threatened, and special concern wildlife in Colorado.

State and Federally Listed Endangered, Threatened, and Special Concern Wildlife of Colorado as of April, 2003

Designation	Totals
Federal and State-listed endangered	7
Federal and State-listed threatened	5
Federal-listed endangered and State-listed threatened	2
Federal-listed threatened and State-listed endangered	2
Federal-listed endangered	0

Designation	Totals
Federal-listed threatened	0
State-listed threatened	6
State-listed endangered	10
Species of special concern	42
Total for all categories	**74**

(Source: http://wildlife.state.co.us/species_cons/list.asp)

Boulder County also recognizes the potential for habitat to exist in the County for the 32 threatened and endangered species on either the federal or state list. Note that some of the species, such as the grizzly bear and wolverine, have been extirpated from Colorado, but suitable habitat remains. These 32 species are identified below:

Boulder County Website
Threatened and Endangered Species

Endangered	Threatened
Fish	**Fish**
Bonytail	Humpback Chub
Lake Chub	Colorado Pikeminnow
Plains Minnow	Greenback Cutthroat Trout
Razorback Sucker	Brassy Minnow
Rio Grande Sucker	Common Shiner
Suckermouth Minnow	Arkansas Darter
Northern Redbelly Dace	Southern Redbelly Dace
Amphibians	
Boreal Toad	
Birds	**Birds**
Whooping Crane	Piping Plover
Least Tern	Bald Eagle
Southwest Willow Flycatcher	Mexican Spotted Owl
Plains Sharp-Tailed Grouse	Burrowing Owl
	Lesser Prairie-Chicken
Mammals	
Gray Wolf	
Black-Footed Ferret	
Grizzly Bear	
Preble's Meadow Jumping Mouse	
Lynx	
Wolverine	
River Otter	
Kit Fox	

(Source: http://www.co.boulder.co.us/openspace/resources/wildlife/endangered.htm)

Many surveys and studies have been conducted to determine whether any of these species or suitable habitats are located within the UCB Planning area. According to the HMPC the following species and/or species habitat have been identified:

- Mt. Research Station – Gray Wolf, Grizzly Bear, Greenback Cutthroat Trout. Como Creek, which traverses the property, has one of nine original populations for the trout, which is listed as a threatened species.

Plant Species. In addition to endangered wildlife, many rare plant species of special concern exist within Colorado. Botanical research in the state of Colorado has identified 12 plant species that are listed by the U.S. Fish and Wildlife Service (USFWS) as threatened or endangered and an additional 388 plant species considered to be of special concern by the U.S. Forest Service (USFS), the Bureau of Land Management (BLM), the USFWS, and/or the Colorado Natural Heritage Program. The Boulder County Comprehensive Plan lists 40 plant species of special concern in Boulder County. The HMPC indicated that the following plant species have been identified within the UCB Planning Area:

- South Boulder Campus – Ute ladies' tresses orchid

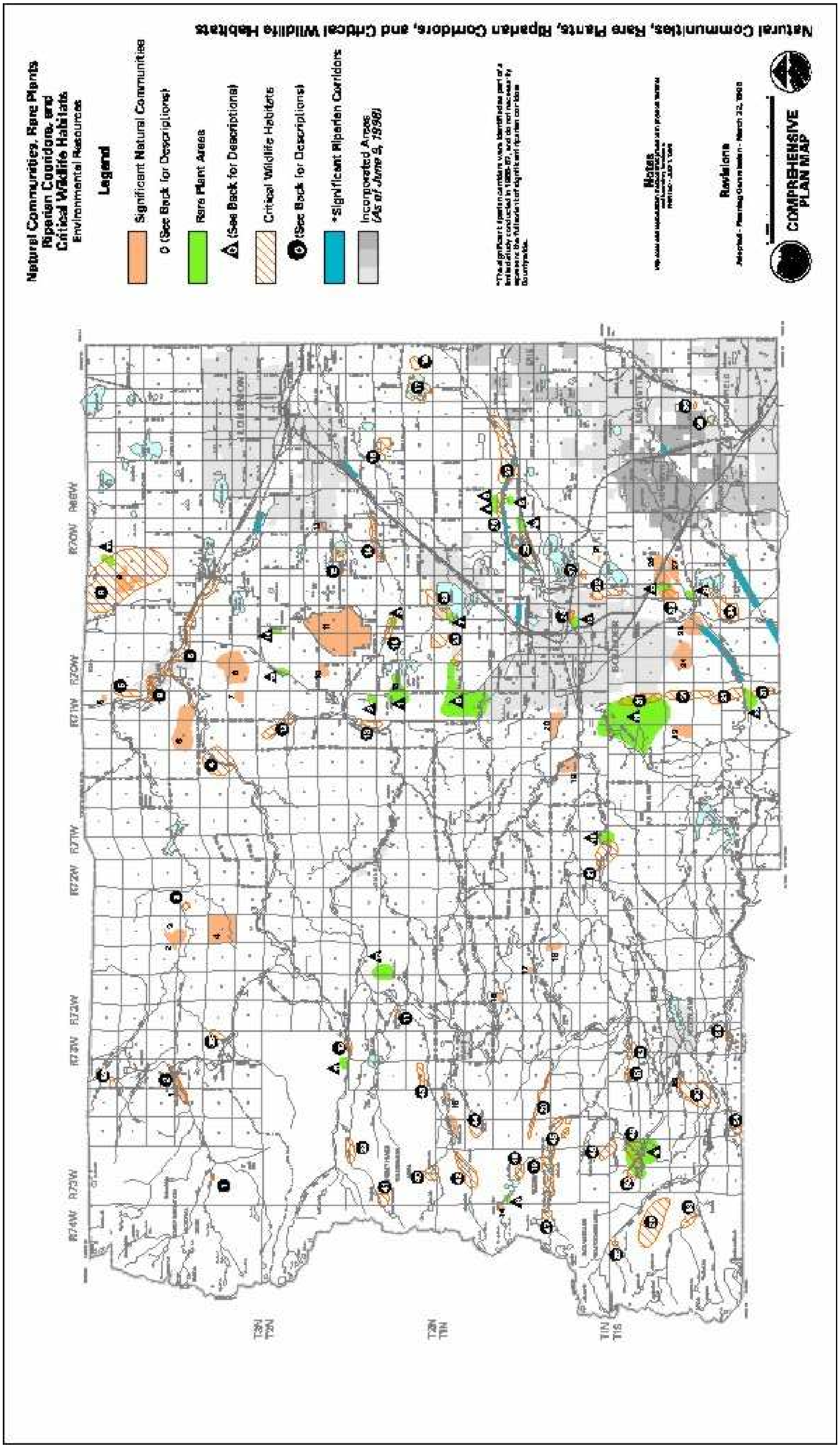
Wetlands

Wetlands are also an important and legally protected resource. Wetland communities play a vital role in groundwater recharge and water quality protection, as well as provide habitat for dependent plant and wildlife species. A variety of wetlands occur throughout Boulder County and the UCB Planning Area. This includes those wetlands meeting the regulatory definition of wetlands under Section 404 of the Federal Clean Water Act (CWA) as well as functional wetlands that provide substantial wetland habitat values or other ecological benefits. Activities that affect wetlands may require special permitting under Section 404 of the CWA.

As part of master planning for the campus, one of UCBs goals is to preserve riparian corridors and designated wetlands. The wetlands within the UCB Planning Area include both natural ones and those created by UCB as described below:

- Main Campus – The Main Campus includes a variety of areas designated as wetlands.
- East Campus – A series of ditches, ponds, and wetlands were created. In addition to their aesthetic and flood control value, they were designed to allow chemicals and oils to settle out before water is discharged into Boulder Creek.
- Williams Village – According to the Master Plan, no wetlands have been designated on the property.
- South Campus – Wetland areas located at the South Campus will be delineated as part of any future development.
- Mountain Research Station – Construction of experimental riparian wetlands are planned to filter water entering Como Creek. These wetlands are designed with a purpose of maintaining and improving the habitat for the Greenback trout.

With the goal of preserving or restoring natural resources in the area, Boulder County and the City of Boulder have many ongoing programs defining the protection and management of significant agricultural lands, wildlife and plant habitats, wetlands and natural areas. Many tools and products of these efforts were utilized by the HMPC to supplement their natural resource data. The following "Natural Communities, Rare Plants, Riparian Corridors and Critical Wildlife Habitats" map for Boulder County is one tool used for purposes of inventorying and protecting these assets. This map identifies these natural resource features located in the vicinity of the UCB Planning Area.


Natural Communities, Rare Plants, Riparian Corridors, and Critical Wildlife Habitats
Environmental Resources
Legend
Significant Natural Communities
Rare Plant Areas
Critical Wildlife Habitats
*Significant Riparian Corridors
Incorporated Areas (As of June 9, 1998)
Notes
Revisions
COMPREHENSIVE PLAN MAP
Natural Communities, Rare Plants, Riparian Corridors, and Critical Wildlife Habitats

Significant Natural Communities

1 Montane Willow Carr
2 Foothills Ponderosa Pine Scrub Woodland (Purshia)
3 Mixed Foothills Shrubland (Purshia)
4 Foothills Ponderosa Pine Savanna
5 Mixed Foothills Shrubland (Cercocarpus)
6 Xeric Tallgrass Prairie
7 Foothills Ponderosa Pine Scrub Woodland (Cercocarpus)
8 Foothills Ponderosa Pine Scrub Woodland (Cercocarpus)
9 Foothills Ponderosa Pine Scrub Woodland (Cercocarpus)
10 Great Plains Mixed Grass Prairie (Stipa comata)
11 Great Plains Mixed Grass Prairie (Stipa neomexicana)
12 Great Plains Salt Meadow
13 Great Plains mixed Grass Prairie (Stipa comata)
14 Alpine Wetlands
15 Montane Wet Willow Carr
16 Montane Grasslands
17 Foothills Ponderosa Pine Savanna
18 Montane Grasslands
19 Foothills Ponderosa Pine Savanna
20 Xeric Tallgrass Prairie
21 Great Plains Mixed Grass Prairie
22 Montane Willow Carr
23 Montane Grasslands
24 Wet Prairie
25 Wet Prairie
26 Wet Prairie
27 Xeric Tallgrass Prairie

Rare Plant Areas

1 *Physaria bellii*
2 *Physaria bellii*
3 *Physaria bellii*
4 *Aristida basiramea*
5 *Apios americana*
6 *Asplenium adiantum-nigrum*
7 *Physaria bellii*
8 *Physaria bellii*
9 *Phippsia algida*
10 *Physaria bellii*
11 *Listera convallarioides*
12 *Eustoma grandiflorum*
13 *Physaria bellii*
14 *Physaria bellii*
15 *Selaginella weatherbiana*
16 *Amorpha nana, Betula papyrifera, Carex saximontana, Listera convallarioides, Malaxis brachypoda, Pyrola picta, Selaginella weatherbiana*
17 *sensitive species*
18 *Eustoma grandiflorum*
19 *Botrychium echo, Botrychium hesperium, Botrychium lanceolatum, Botrychium pallidum, Listera convallarioides, Botrychium minganense*
20 *Selaginella weatherbiana*
21 *Amorpha nana*
22 *Amorpha nana*

Critical Wildlife Habitats

1 Ouzel Falls
2 Copeland Willow Carr (+wetlands)
3 South Sheep Mountain
4 Deadman Gulch and South St. Vrain
4 Steamboat Mountain
6 St. Vrain Creek (+wetlands)
7 St. Vrain Corridor (+wetlands)
8 Rabbit Mountain
9 Old Apple Valley
10 Middle St. Vrain Willow Carr (+wetlands)
11 Tumbleson Lake (+wetlands)
12 Mariette Canyon
13 Lefthand Palisades
14 Lefthand Creek Cottonwood Groves (+wetlands)
15 Lagerman Reservoir (+wetlands)
16 Gaynor Lakes (+wetlands)
17 Panama Reservoir (+wetlands)
18 B-J Acres Ranch
19 City of Boulder Watershed (Special Consideration)
20 Como Creek (Special Consideration)
21 Boulder Falls area
22 Boulder Valley Ranch (+wetlands)
23 Boulder Reservoir (+wetlands)
24 Cottonwood Grove on Boulder Creek (+wetlands)
25 Walden and Sawhill Ponds (+wetlands)
26 White Rocks (+wetlands)
27 Cottonwood Grove & Heron Rookery (+wetlands)
28 Diamond Lake Outlet
29 Chittenden Meadows (+wetlands)
30 Arapaho Ranch – Tucker Homestead (+wetlands)
31 Boulder Mountain Parks - Eldorado Mountain
32 South Boulder Creek (+wetlands)
33 Tallgrass Prairie
34 Marshall Mesa
35 Stearns Lake (+wetlands)
36 Carolyn Holmberg Preserve at Rock Creek Farm
37 Sombrero Marsh (+wetlands)
38 Lazy H. Ranch Willow Carr (+wetlands)
39 Coney Flats Willow Carr (+wetlands)
40 Mitchell Lake Willow Carr (+wetlands)
41 Coney Lake Willow Carr (+ wetlands)
42 Long Lake Willow Carr (+wetlands)
43 South St. Vrain Willow Carr (+wetlands)
44 Lefthand Reservoir Willow Carr (+wetlands)
45 Boulder Watershed Willow Carr (+wetlands)
46 Lake Albion Willow Carr (+wetlands)
47 Triple Lakes Willow Carr (+wetlands)
48 Horseshoe Creek Willow Carr (+wetlands)
49 Caribou Park Willow Carr (+wetlands)
50 Upper Caribou Park Willow Carr (+wetlands)
51 Dolonde Creek Willow Carr (+wetlands)
52 Caribou Ranch Willow Carr (+wetlands)
53 Woodland Flats Willow Carr (+wetlands)
54 Buckeye Basin Willow Carr (+wetlands)
55 Los Lagos Willow Carr (+wetlands)
56 Roaring Fork Willow Carr (+wetlands)
57 Peterson Lake (+wetlands)
58 Hunter's Creek

Development Trends

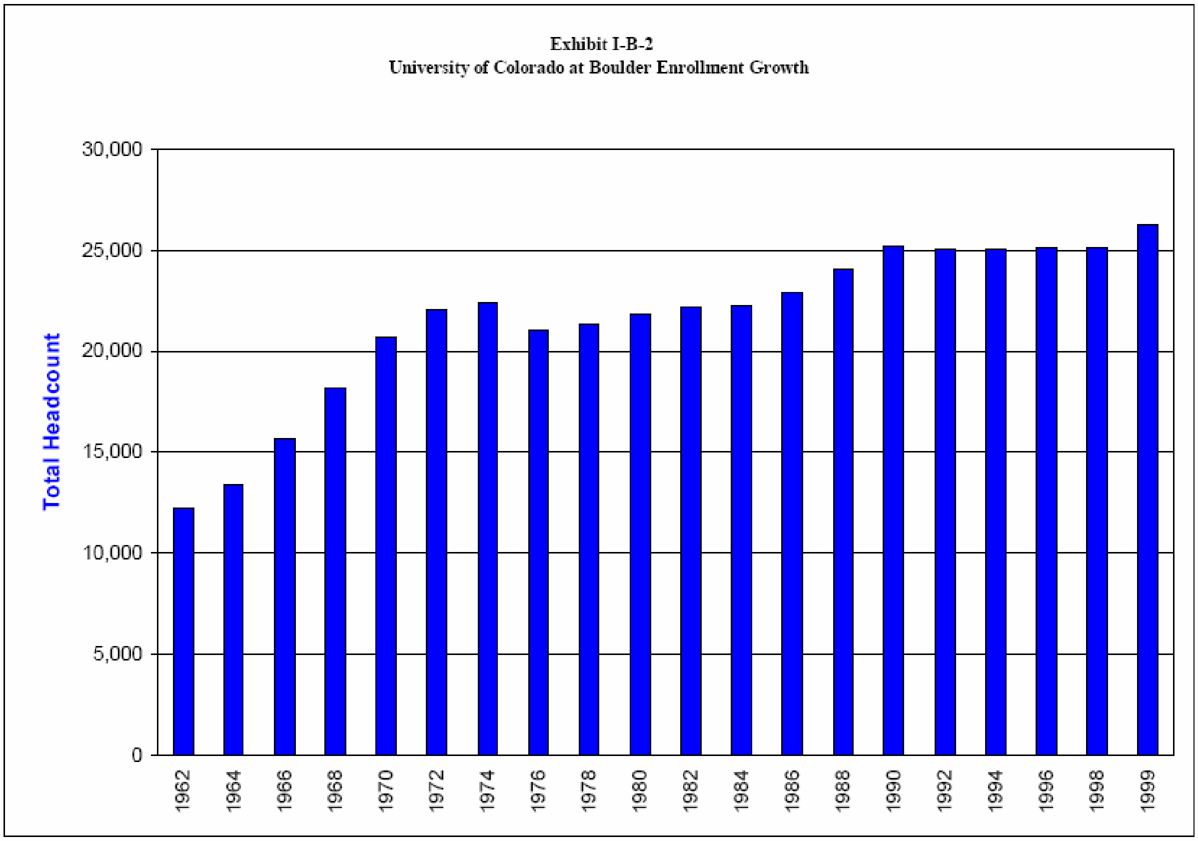
Campus planning includes updating existing buildings and constructing new buildings. In the current Campus Master Plan for UCB, the goals reflect a balance between preservation and growth. The purpose of a campus master plan is to periodically identify what is needed and to comprehensively plan development for the Campus to accommodate those needs. In 1959, long-term planning for the Campus was based on a projected student enrollment of 20,000; this number has long since been exceeded. The Campus has also grown to include several separate properties. According to the Master Plan, UCB needs to accommodate a modest increase in current enrollment, a larger increase in research, and additional space to better accommodate existing functions. The following information taken from the Master Plan addresses projected enrollment growth and associated infrastructure needs of the UCB Planning Area.

Overview of Projected Growth at UCB

Growth on the Main Campus is limited as the property is essentially fully developed. Any new use of a site displaces an existing use. The Campus Master Plan envisions some well-planned infill development to accommodate limited growth on the Main Campus. The East Campus, Williams Village, and South Campus have more vacant land to accommodate growth. As a result, non-academic functions, not critical to the Main Campus, are being located on these other properties. The primary timeframe of the Current Master Plan is through the 2008-2009 academic year. Understanding that growth will need to continue beyond this 10-year timeframe, the intent of the Plan was to "chart a course for a decade, but also to lay a foundation for many more years into the future."

Enrollment Growth

Student enrollment is projected at 27,000 students by the year 2008. The following figure from the Master Plan illustrates historic and projected growth of student population for the campus.



In determining these growth projections, UCB evaluated several growth scenarios as detailed on the following page:

Exhibit I-B-4
Projected Enrollment

Fall Headcount	1997*	1998	1999	2000	2001	2002	2003 . . .	2008
Midpoint estimate—Students								
Resident undergrad	13,842	14,045	14,221	14,446	14,601	14,739	14,872	15,082
NR undergrad	6,595	6,665	6,522	6,551	6,574	6,601	6,638	6,720
Total undergrad	20,437	20,711	20,743	20,997	21,175	21,340	21,510	21,802
Resident grad	3,396	3,325	3,375	3,425	3,475	3,525	3,575	3,675
NR grad	1,276	1,265	1,295	1,325	1,355	1,385	1,415	1,465
Total grad	4,672	4,590	4,670	4,750	4,830	4,910	4,990	5,140
Total	25,109	25,301	25,413	25,747	26,005	26,250	26,500	26,942
Freshmen	4,268	4,210	4,194	4,390	4,367	4,390	4,424	4,562
Percent resident	68.7%	68.7%	69.2%	69.4%	69.5%	69.6%	69.6%	69.6%
Low estimate								
Total	25,109	25,107	24,832	24,859	24,873	24,912	25,000	25,215
Percent resident	68.7%	69.2%	70.2%	70.5%	70.6%	70.6%	70.6%	70.6%
High estimate								
Total	25,109	25,392	25,766	26,322	26,757	27,148	27,500	28,654
Percent resident	68.7%	68.4%	68.8%	68.9%	69.0%	69.1%	69.1%	69.4%

* Actual figures are given for 1997. Figures for 1998 and beyond were estimated in fall 1997. Actual 1998 fall headcount (25, 125) was slightly under the midpoint estimate.
NR=nonresident

Actual enrollment will vary from the midpoint estimate, but the Master Plan estimates an overall growth trend of a 7.2% increase over the 10-year period.

Research Growth

Research is integral to UCB's mission as a comprehensive university. Contributions to the advancement of knowledge are made in both sponsored (externally funded) and unsponsored research programs. Growth in sponsored research needs to be considered in addition to growth in student enrollment to determine the overall growth of UCB. Sponsored research funding has been very successful at UCB. In 1988, sponsored research funding was $80.2 million, increasing to $181.7 million in fiscal year 1998. Preliminary 1999 figures (at the time the Master Plan was written) were $204 million. Adjusted for inflation, the increase has been about 4.6% per year annually. Growth projections through 2008 are expected to continue at a similar rate of 4.6%. At some point, a moderation of the rate of growth is inevitable.

Increases in sponsored research drive the need for new or renovated research laboratory and office space. The increase in research facilities space has not kept up with the need. Space requirements and building plans associated with growth projections for sponsored research is illustrated in the tables included in the Facilities Needs discussion below.

Employment Growth

To support more than 2,500 different courses in over 150 fields of study, UCB employs roughly 6,500 faculty and staff members. As research and other programs grow, so do the number of support staff. This growth further taxes the need for space. The number of faculty and staff has increased 13% since 1989. The following table outlines the level of employees projected to be employed on the Boulder Campus from 1999 to 2008. The projections include 929 additional employees by fall of 2008; a 14.4% increase since 1998. The large growth in employment projections is largely due to the predicted large increase in future sponsored research funding and staffing.

Exhibit I-D-2
Ten Year Projection of the Number of Employees (Fall Headcount)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Instructional	1,997	2,021	2,045	2,069	2,094	2,119	2,145	2,170	2,197	2,223
Non-Instructional / Research	1,510	1,552	1,596	1,641	1,687	1,734	1,782	1,832	1,884	1,936
Classified Staff	2,690	2,714	2,739	2,705	2,729	2,754	2,779	2,804	2,829	2,854
Unclassified Staff	366	368	371	371	374	376	379	381	384	387
Total	6,563	6,655	6,751	6,786	6,884	6,983	7,085	7,187	7,294	7,400

Land, Space and Facilities Needs

As previously described, UCB campus includes three proximate properties located within the City of Boulder

- Main Campus – 306 acres, predominantly developed
- East Campus – 197 acres, predominantly developed
- Williams Village – 64 acres, predominantly developed

The two additional Campuses are located within Boulder County

- South Boulder – 308 acres, predominantly undeveloped
- Mountain Research Station – 190 acres, moderately developed

There are 94 acres within the potential development areas on all three developed City of Boulder campuses: Main, East, and Williams Village. Overall, about half (49 acres) are earmarked for expansion of adjacent uses, with the other half (45 acres) for unspecified uses. With respect to the South Boulder property, land use planning is still in preliminary stages; and it is unknown which areas will be used for what land use and which portions may be left as natural areas. Further development of the Mountain Research Station is planned and will be discussed further in the paragraphs below, which focus on the development plans for each of the five main UCB properties.

During the preparation of the Campus Master Plan, there was a focus on those areas of the campus where the greatest changes are likely to occur and for which there was not a current area plan. These areas include:

- Grandview, part of the Main Campus, redeveloping from an area previously a mix of fraternities, sororities, and single-family homes, into academic land uses, including research units. A micro-master plan was prepared for this area.

- Williams Village, an area acquired for student housing. This property has been selected by the Board of Regents as the preferred site for new student housing. A micro-master plan was prepared by Design Workshop.

- CU-Boulder South, 308 undeveloped acres initially planned for use by Intercollegiate Athletics, Student Recreation, and other outdoor uses. A master plan for this property will include new hydrologic information currently being developed and will look at other facilities and appurtenances needed to provide mitigation of flood hazards in this area. During the current Master Plan period ending in 2008, the only infrastructure improvements that are planned relate to flood protection, drainage improvements, wetlands management, and development of athletics and recreation facilities.

- Mountain Research Station, an asset of CU-Boulder where unique scientific research takes place. A micro-master plan was prepared by the Facilities Planning Office. Development plans include six building sites for additional classrooms, computer labs, research facilities, housing, maintenance and support services, and an astronomical observatory. New development will recognize the sensitive nature of Como Creek. No new structures will be located within 50 feet of the creek and only limited improvements should be made to existing structures within this zone. Construction techniques must minimize soil erosion and prevent deterioration of stream quality.

The development potential of each of the five UCB properties are described more fully in the following paragraphs.

Main Campus

According to the Campus Master Plan, the most important functions—teaching and research—are best focused upon the Main Campus even though it is largely built out. This will require a more efficient and appropriate use of the Main Campus, giving priority to academic uses in this area. This includes implementing an expansion for academic use in the newly acquired and adjoining Grandview areas.

The Main Campus has no substantial undeveloped acreage remaining. The usable real estate has been developed with buildings, parking lots, and improved open space. However, the Master Plan envisions infill development to meet space needs, while continuing with development of infrastructure on other campus properties to meet overall growth objectives. Specifically, there are 37 acres on the Main Campus designated as developable areas. Several of these sites are currently surface parking lots. However, building on these sites will create a demand for new structured parking. About 18 acres of the potential development sites on Main Campus may be needed for expansion of adjoining uses. Several Main Campus "potential development areas" are better described as redevelopment sites where buildings may be removed for redevelopment in order to maximize the utilization of the land resource. Such sites include: The Hunter and Sibell Wolle Fine Arts buildings, the Grounds Building area, much of the Grandview area, Faculty/Staff Court, and Athens Court. Additional building sites on the natural areas (e.g., those prone to flooding, areas of steep slopes) or on the remaining recreational fields would be inappropriate, compromising both safety and campus qualities. The Campus Master Plan envisions a moderate increase in the Main Campus density, with higher density growth planned for the Grandview area.

East Campus
Although research activities are essential within the academic area of the Main Campus, some of the larger, space-consumptive research programs, such as space sciences, biological science greenhouses and animal colonies have been located on the East Campus where more land is available.

The East Campus has the largest remaining development potential of the three developed campuses. Several research park "pods" are available for development. In total, 30 acres are potential development sites, largely in the Research Park, with only three acres earmarked for expansion of existing uses. The goal set forth in the Research Park Master Site Development Plan was for a campus-like development with increased density. The increased density is not expected to require structured parking in the foreseeable future. Density north of Boulder Creek will increase somewhat when the consolidated facilities services development occurs.

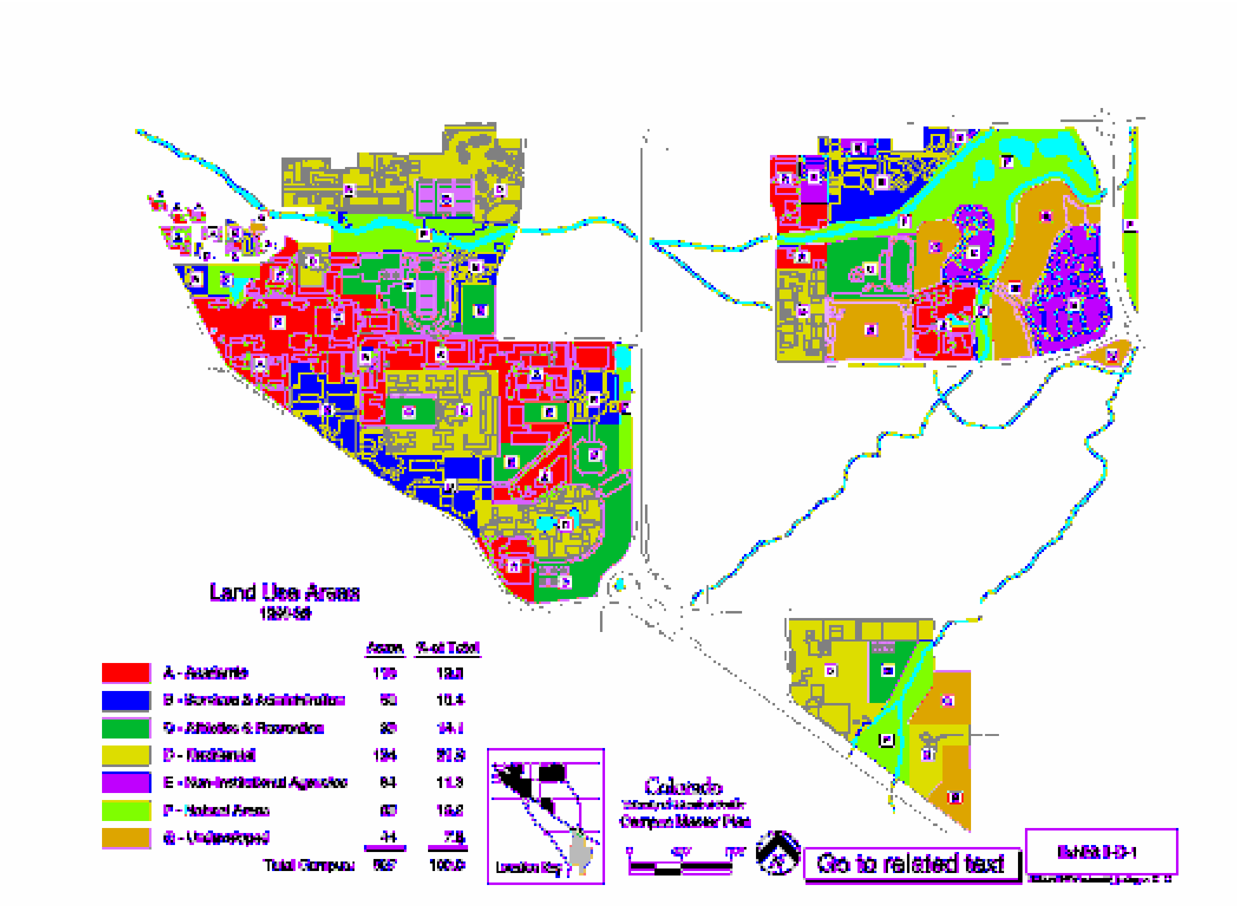
Williams Village
Williams Village is planned as the site for new housing and related development. Currently, there is substantial undeveloped or underdeveloped acreage at Williams Village. Even after accounting for the Bear Canyon Creek flood issues, approximately 27 acres have been designated for future development. Of these, 23 acres are west of Bear Canyon Creek and have been designated for expansion of student housing and related uses. A relatively compact village-like development is planned, facilitating walking, bicycling, and transit use. About four developable acres lie east of Bear Canyon Creek and might be used for faculty and staff housing. A large amount of acreage will be devoted to outdoor recreational areas and the Bear Canyon Creek Floodway. Some structured parking is also anticipated.

South Campus
At the time the Master Plan was written, initial planning studies for the South Campus property were underway. Land use considerations include strategically locating athletics and recreation fields as well as the limited infrastructure necessary to support the fields.

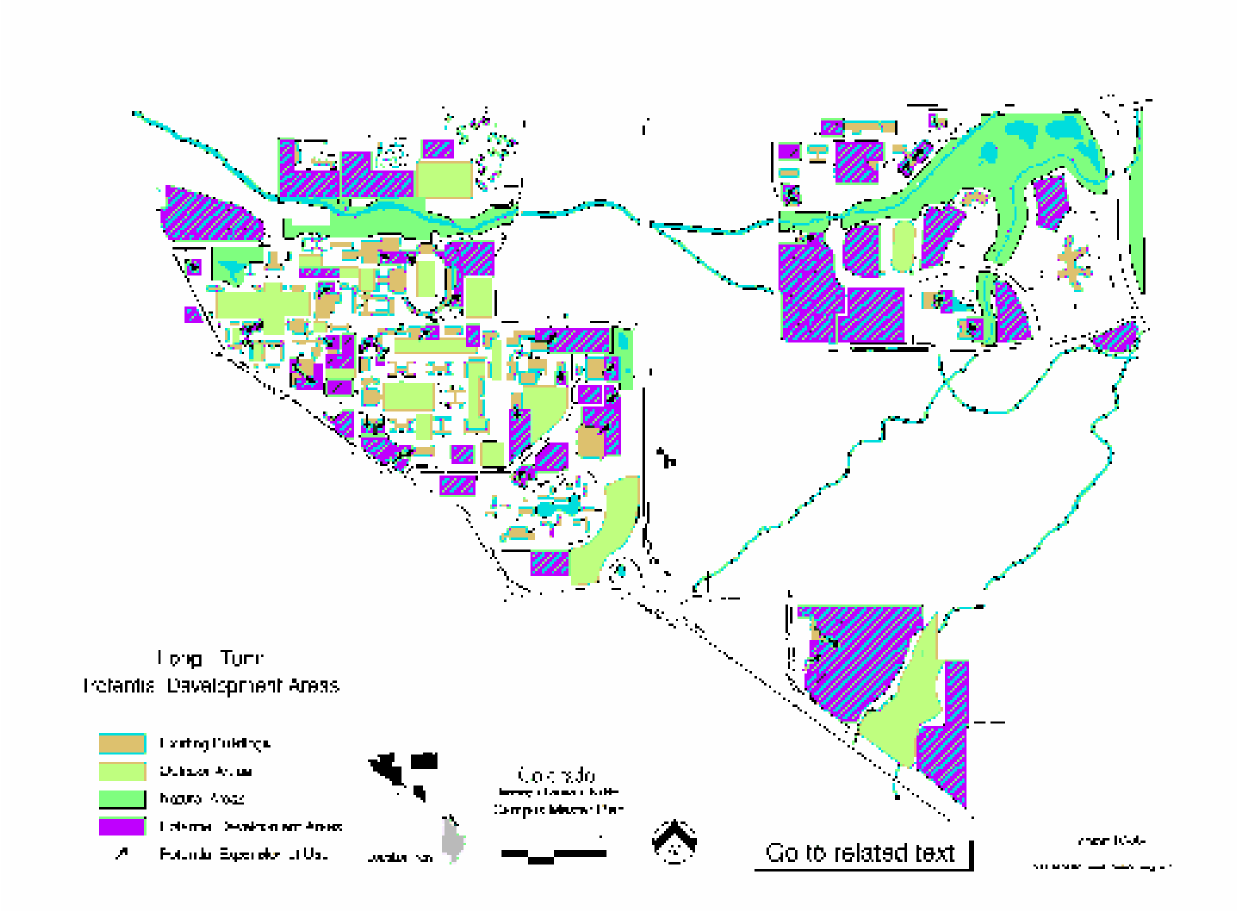
Mountain Research Station
Proposed development projects include completion of a hostel, winterization of additional buildings, additional lab space and possibly additional living and support spaces. The Mountain Research Station cluster of buildings is planned to infill modestly, likely facilitating increased winter use of the station.

The development potential for the three campus properties located within the City of Boulder is illustrated in the following figures taken from the Master Plan.

UCB Development Potential: Main, East, Williams Village Properties
Land Use Areas

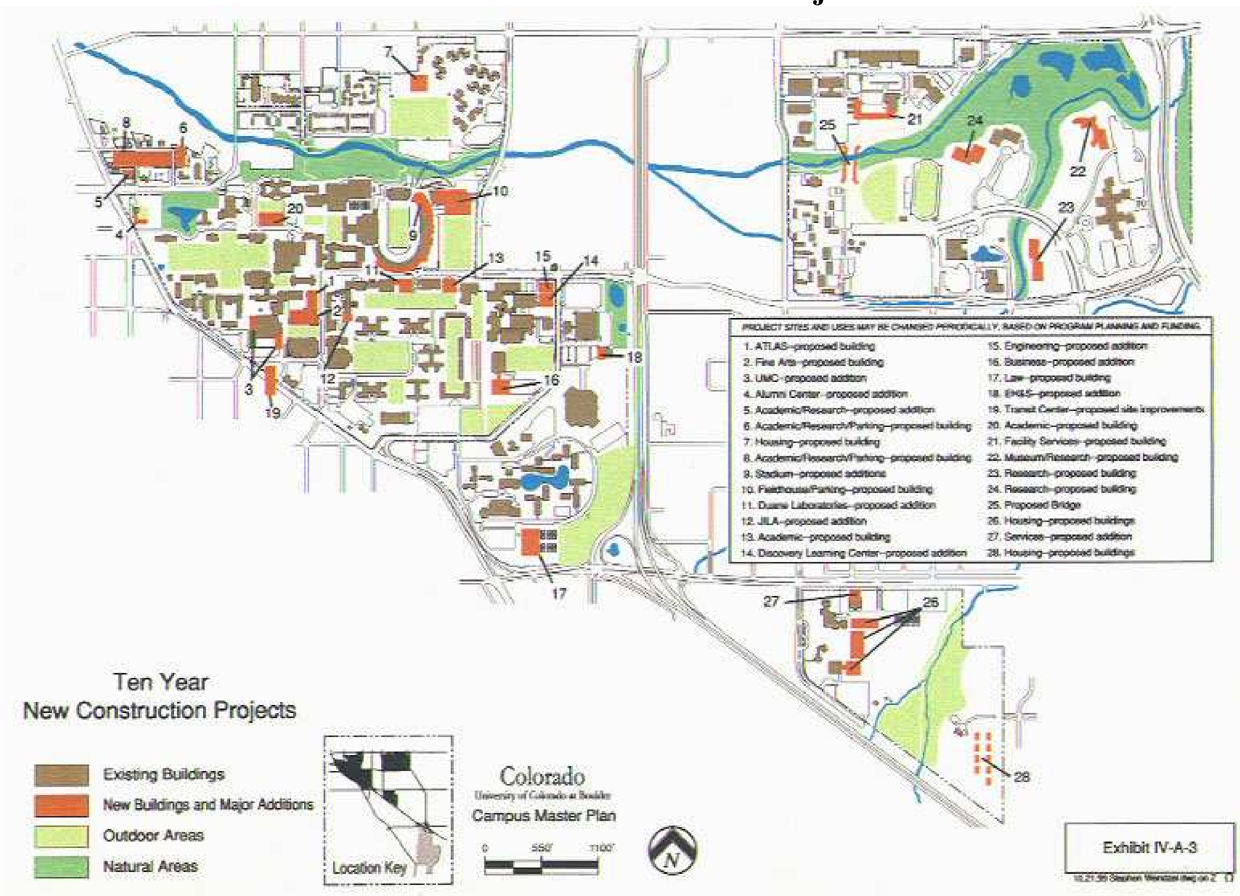


UCB
Main, East, Williams Village Properties
Long-Term Potential Development
Areas



The next figure maps new buildings and major additions planned through 2008 on the three adjoining campus properties.

UCB
Ten Year New Construction Projects



The next three figures provide additional detail of the development plans for the Grandview area, part of the Main Campus property, for the Williams Village property, and for the Mountain Research Station.

UCB
Grandview Area
Development and Preservation Areas

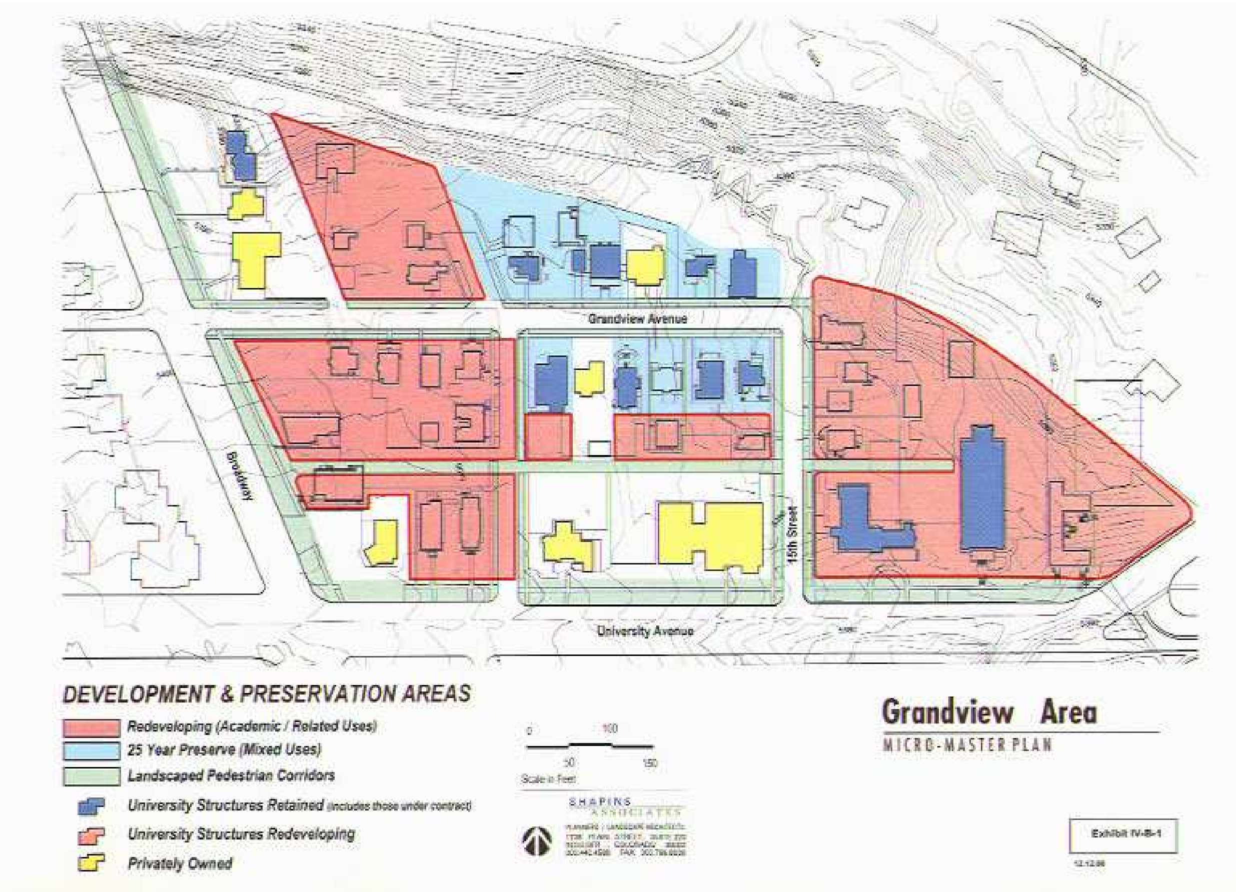
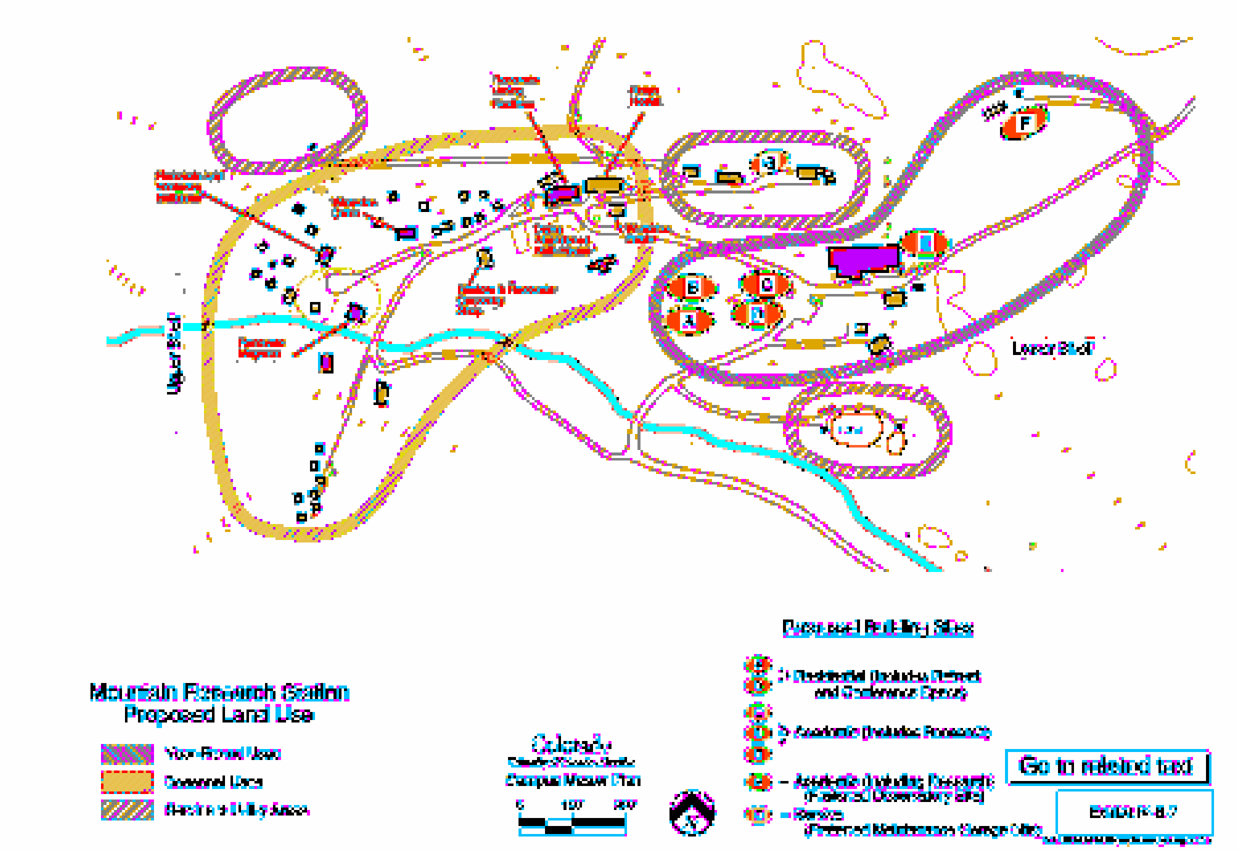


Exhibit IV-B-2
Williams Village Framework Diagram

UCB
Mountain Research Station
Proposed Land Use



Also to be considered for the UCB Planning Area are the University's goals for additional land acquisition. UCB's projected growth in student enrollments, research and support programs requires a long-term source of land to meet its goals, including the overall quality of life for the UCB community. Because development and expansion are likely to continue far into the future, some land must be acquired for its long-term value rather than for an immediate use. As a result, the Campus Master Plan defines UCB's acquisition priorities as further described:

- **North periphery of the Main Campus.** Land acquisitions continue to be ongoing in Grandview and for the Athens and Marine Street area north of Boulder Creek, as recommended in previous master plans and approved in a 1980 Program Plan. These areas are needed to meet long-term needs of instruction, research, services, parking, housing, conferences, cultural uses, and student recreation.

- **Properties between the Main Campus and the East Campus.** Strategically located properties between the Main Campus and the East Campus should be acquired in order to help achieve a physical connection and logistical cohesiveness. These properties could be used for transportation improvements, housing, research, or services. At the time this plan is written, UCB leases spaces in three of the buildings in this area for research and services. Public-private cooperation may be another option to acquire or control the land uses and building development within this corridor.

- **Large institutional properties close to campus.** Relatively large properties, such as public schools and housing complexes, are near the campus and would be useful to the university if their owners decide that these properties are surplus to their needs. Uses might include instruction, research, services, recreation, housing, or parking. Institutional scale of buildings and grounds would be more useful and relatively less expensive than smaller parcels.

- **Properties adjoining the Main Campus.** The university should consider acquisition of any property adjoining or in the immediate vicinity of the current Main Campus. A few acquisitions would make for a more cohesive campus and preclude incompatible land. Uses might include instruction, research, services, recreation, housing, or parking. Use of these properties would depend on the proximity to related Main Campus uses.

- **Properties around the East Campus and the Research Park.** These properties could be needed for expanding research, services, intercollegiate athletics and student recreational fields, and parking.

- **Remote Properties.** Properties not in the immediate vicinity of the current campus may be used as investments, to accommodate larger or specialized functions unavailable near the existing campus, or to help ensure the long-term viability of the campus by serving as "expansion" properties of the future.

- **Properties near the Mountain Research Station**. The Mountain Research Station maintains many cooperative agreements with adjacent landholders. The station has several research sites located on National Forest Service land. Conversely, the station allows trail access across portions of the university's property. The station has been approached about exchanging parcels of land so that major equipment sites are on university property. This may be desirable in the future as research grows and the need to consolidate operations increases.

As an alternative to land acquisition, UCB has also considered the following:

- Cooperative agreements with neighboring jurisdictions (e.g., City of Boulder, Boulder Valley School District)

- Leasing of properties for specific uses

VULNERABILITY OF UCB FROM SPECIFIC HAZARDS

Vulnerability can be quantified in those instances where there is a known, identified hazard area, such as a mapped floodplain. In these instances the numbers and types of buildings subject to the identified hazard can be counted and their values tabulated. Further, other information can be collected, such as the location of critical, historic structures, and valued natural resources that are within the specific hazard area. Together, this information portrays the impact, or *vulnerability*, of that area to that hazard.

It is important to note that these values can sometimes be refined one step further, with regard to the percent of probable impact. For example, when a flood occurs, seldom does the event cause the total destruction of an area. In fact, we know from NFIP insurance claims that a flood with an average depth of 2-feet above the ground is likely to cause approximately 20 percent damage to structures in the aggregate (those with basements, no basements, and second stories). Thus, if the 100-year flood were estimated to be two feet deep, a more accurate description of flood vulnerability would be a one percent annual chance of incurring a loss of 20 percent of the values tabulated in the 100-year floodplain – and this is without the additional impacts of damage to infrastructure and economic disruption. This allows a community to measure the cost-effectiveness of alternative mitigation projects under consideration. The benefits of a mitigation project are the future losses avoided – or, in this example, that portion of the value of the one percent annual chance of 20 percent damage that is protected by the project.

Identified Hazard Risk Areas: Floods, Wildfires

The HMPC identified two hazards within the UCB Planning Area where specific geographical hazard areas have been defined: floods and wildfires. For these two hazard areas, the HMPC has inventoried the following for the UCB Planning Area, to the extent feasible, as a means of quantifying the vulnerability within identified hazard areas:

- General hazard-related impacts, including impacts to life, safety and health;
- Values at risk (i.e., types, numbers, and value of land and improvements);
- Insurance coverage, claims paid, and repetitive losses;
- Identification of critical facilities at risk;
- Identification of cultural and natural resources at risk;
- Overall community impact; and
- Development trends within the identified hazard area.

The sections that follow present the vulnerability analysis for the UCB Planning Area to identified hazards.

VULNERABILITY TO FLOODS

Risk – Occasional; Vulnerability – High

Flooding and floodplain management is a significant issue in Boulder County, the City of Boulder, and the UCB Planning Area. The risk potential or likelihood of a flood event occurring in the Planning Area increases with the annual onset of heavy rains from April through September, combined with snowmelt runoff during May through June. Much of the historical growth in Boulder and the UCB Planning Area occurred adjacent to streams. Should these streams overflow, flooding could cause damages to property, losses from disruption of community activities, and potential loss of life. Additional development occurring in the watersheds of these streams has the potential to affect both the frequency and duration of damaging floods through an increase in stormwater runoff. Other problems connected with stormwater runoff include erosion, sedimentation, degradation of water quality, losses of environmental resources, and certain health hazards. Also to be considered during a flood on the UCB campus is the possible isolation of the university from necessary response-type services such as hospital, police and fire.

Taken from the Campus Master Plan, the flooding potential is further described by UCB property:

Main Campus

The potential for major (100-year) flooding on the Main Campus is generally limited to the areas adjacent to Boulder Creek, especially north of the creek. Most of the land from Boulder Creek to Arapahoe Avenue, between 17th Street and Folsom Street, is in the floodplain. CU has student family housing units in this area, and there is considerable privately-owned residential development in this 100-year floodplain as well.

Flood mapping and building elevation surveys were conducted as part of this master plan to assess the potential hazard in this housing area, since it is the area at greatest flood risk on the Boulder campus. Most of the campus housing buildings in the area are located within FEMA's 100-year floodplain.

The campus buildings that are at greatest risk are Faculty-Staff Court housing buildings. All seven buildings in this complex have first-floor elevations approximately three feet below the 100-year flood level. The first floor elevations of the nine buildings in Athens Court are nearly at, or slightly below, the 100-year flood level.

A small cluster of privately owned houses just east of 17th Street, on the north bank of Boulder Creek, compounds the flooding hazard. Also potentially restricting floodway conveyance are the bridges across the creek, including two CU footbridges and one CU vehicular/footbridge.

Outside of the 100-year floodplain, several basements of Main Campus buildings (Sibell Wolle Fine Arts, and Environmental Design, for example) tend to flood every few years, often following a thunderstorm. In recent years, substantial improvements have been made to the campus storm sewer system (and more are planned) in order to reduce instances of minor flooding.

East Campus

The East Campus is affected by flood flows from Boulder Creek, Skunk Creek, and Bear Canyon Creek. Most of the East Campus buildings located north of Boulder Creek are in the 100-year floodplain. Minor modifications to these buildings could help reduce flood damage. Newer buildings in this area, notably the Computing Center, the Housing System Service Center, the Marine Science Center, and the Transportation Center and Annex were elevated above the 100-year flood levels according to information available at the time of the construction of these buildings.

The Research Park lies south of Boulder Creek. Major regrading removed most of the building sites in the Research Park from the floodplain. In one of the largest such projects in the Boulder area, the university re-established wetlands and ponds with native vegetation in the flood areas. These wetlands were established through a Corps of Engineers permit. Access is limited in order to maintain the somewhat fragile environment. Public trails and a rest area are located nearby to permit enjoyment of the scenic resource.

The Skunk Creek floodplain on the East Campus was re-established into a channel, which emulates the natural meandering of a stream, in order to contain a 100-year flood event. Bear Canyon Creek may flood the dedicated open space area of East Campus that lies east of Foothills Parkway.

Williams Village

The Williams Village campus is bisected by the Bear Canyon Creek floodplain. Some reconfiguring of this floodplain was done to protect the University Residence east of the creek from flooding. Improvements also resulted in the Bear Creek Apartments (leased, not owned by UCB) being removed from the floodplain. No other properties are located within the floodplain on this property. Land uses in the floodplain area are open space; recreational facilities, including playfields and tennis courts; parking; and undeveloped property. No wetlands have been designated on the property.

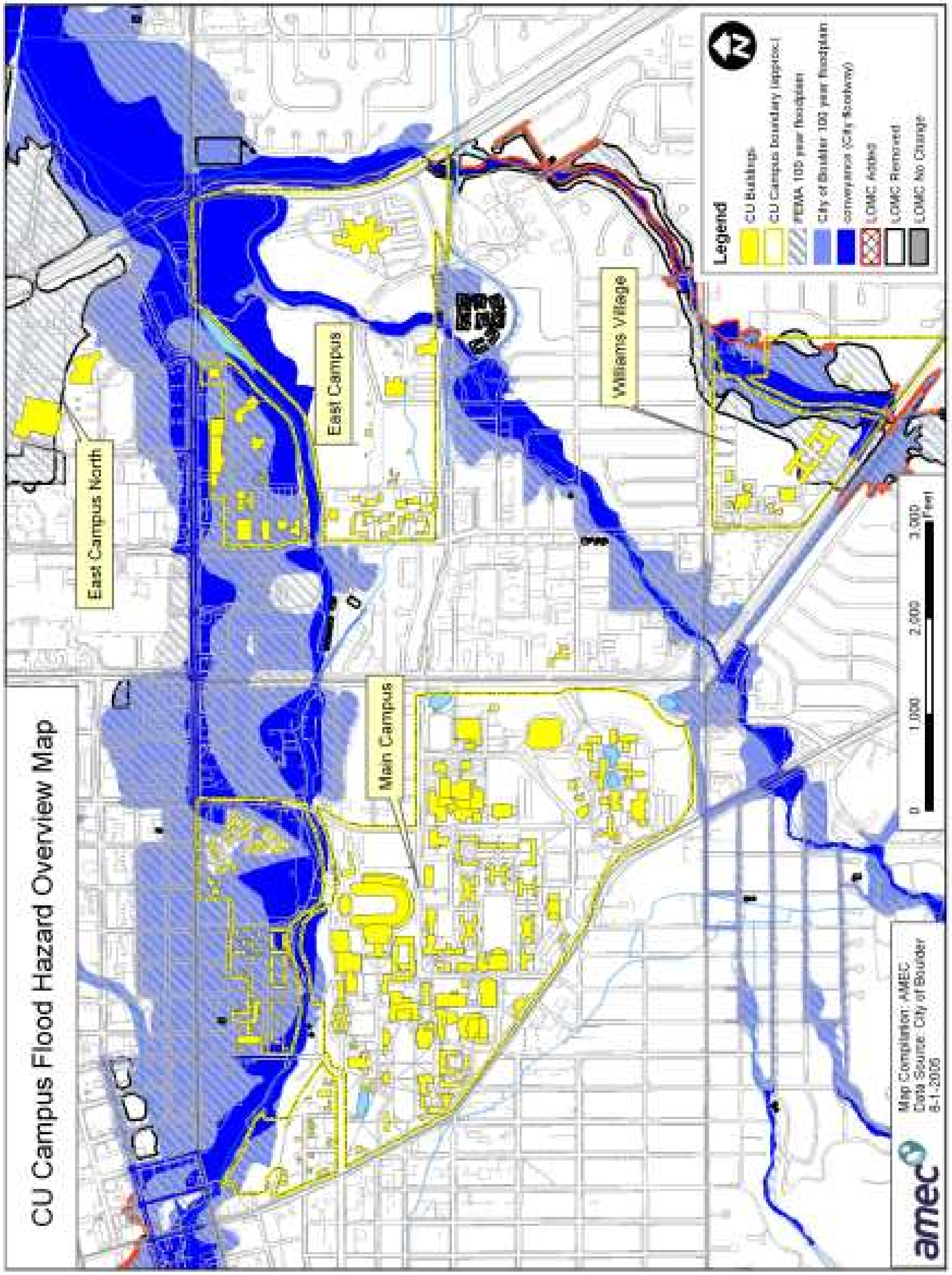
South Campus

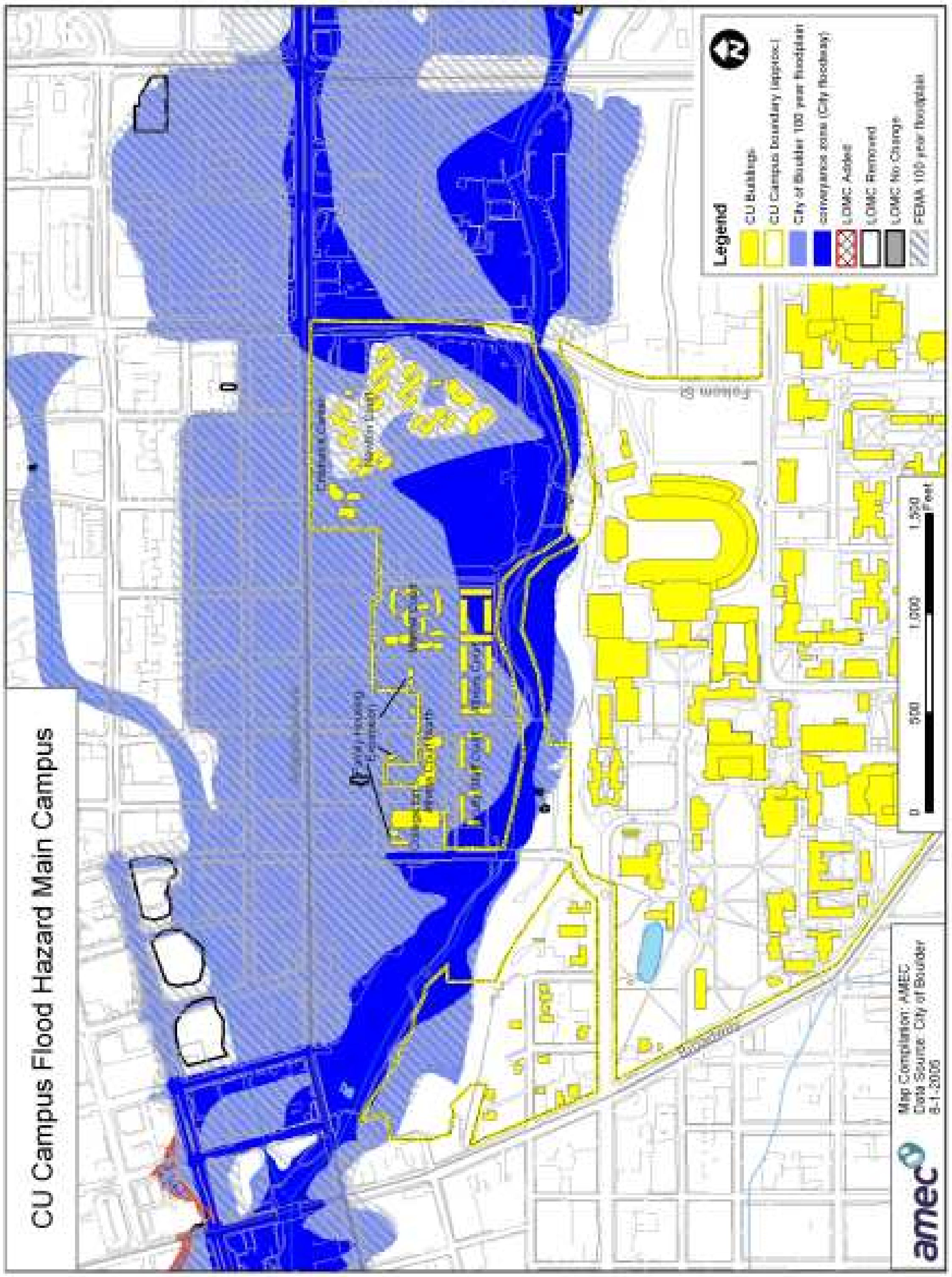
South Boulder Creek lies east of the CU-Boulder South property. A berm along the creek was installed when the property was mined for gravel and has recently been widened by the seller of this property. A study of flooding for this area is underway as this plan is being written, so there is insufficient information to fully assess the flood hazard at this time. One small storage building is located on the property in an area outside of the existing 100-year floodplain. A wetlands analysis will also be conducted for the property prior to development.

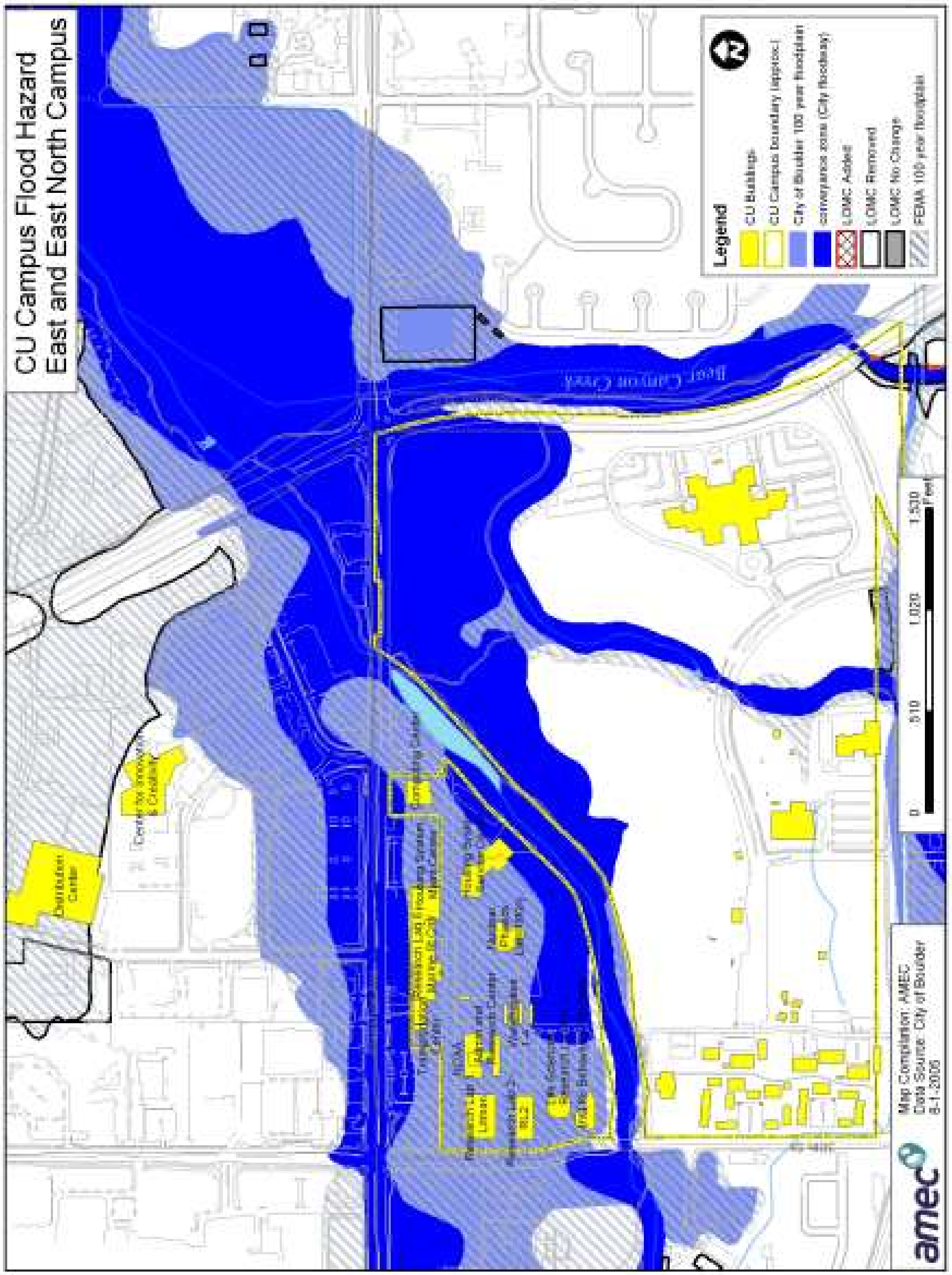
Mountain Research Station

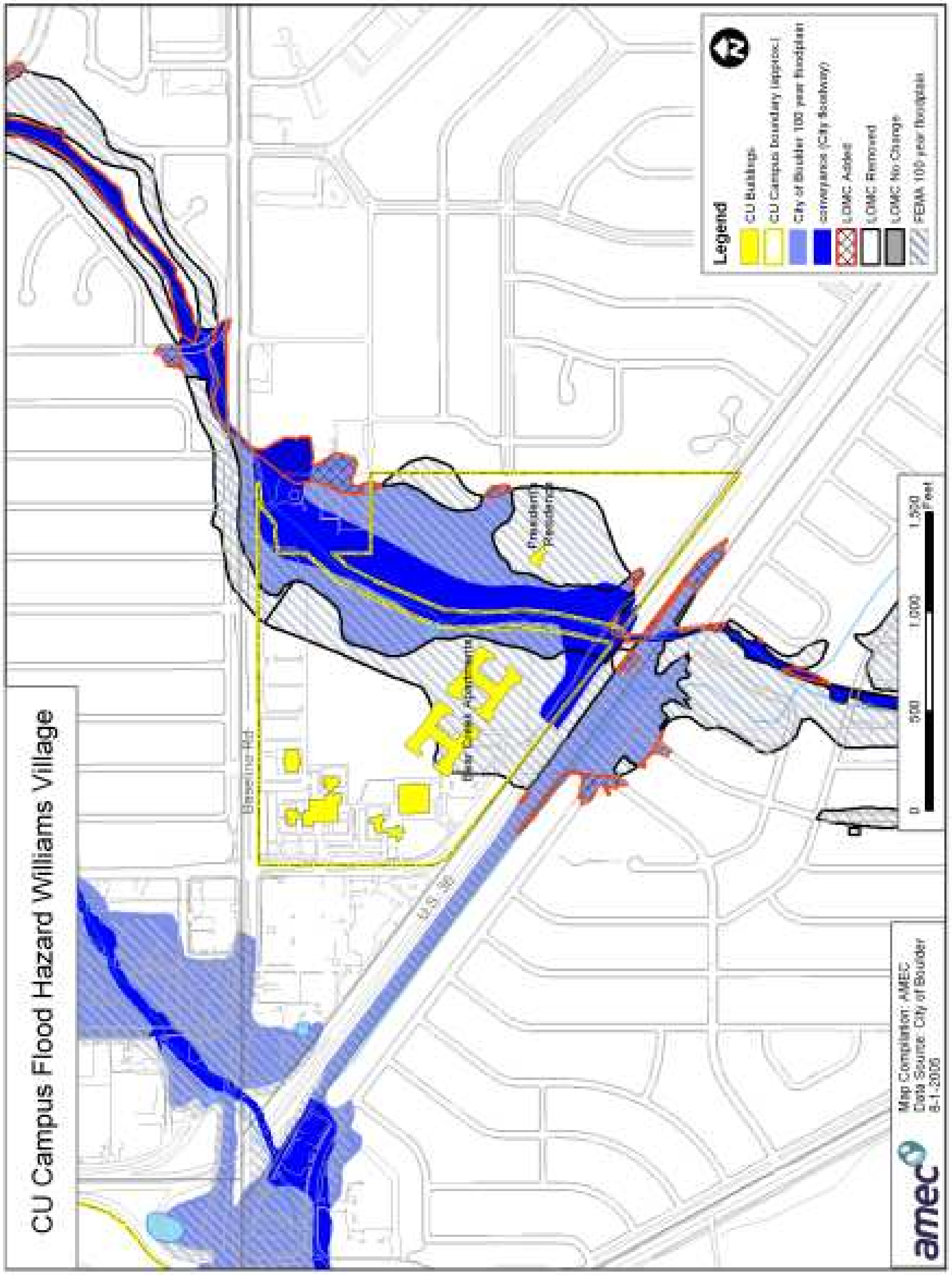
Como Creek runs through the Mountain Research Station. No floodplain or floodway has been identified. As in all mountain areas, there is the potential of flash flooding along the creek. However, only one small occupied structure is located near the creek. Access to the station crosses the creek and could be affected in the event of a significant flood. Much of the station and adjoining U.S. Forest Service lands are sensitive ecological areas, including steep slopes, wetlands, protected fish habitat, and alpine areas.

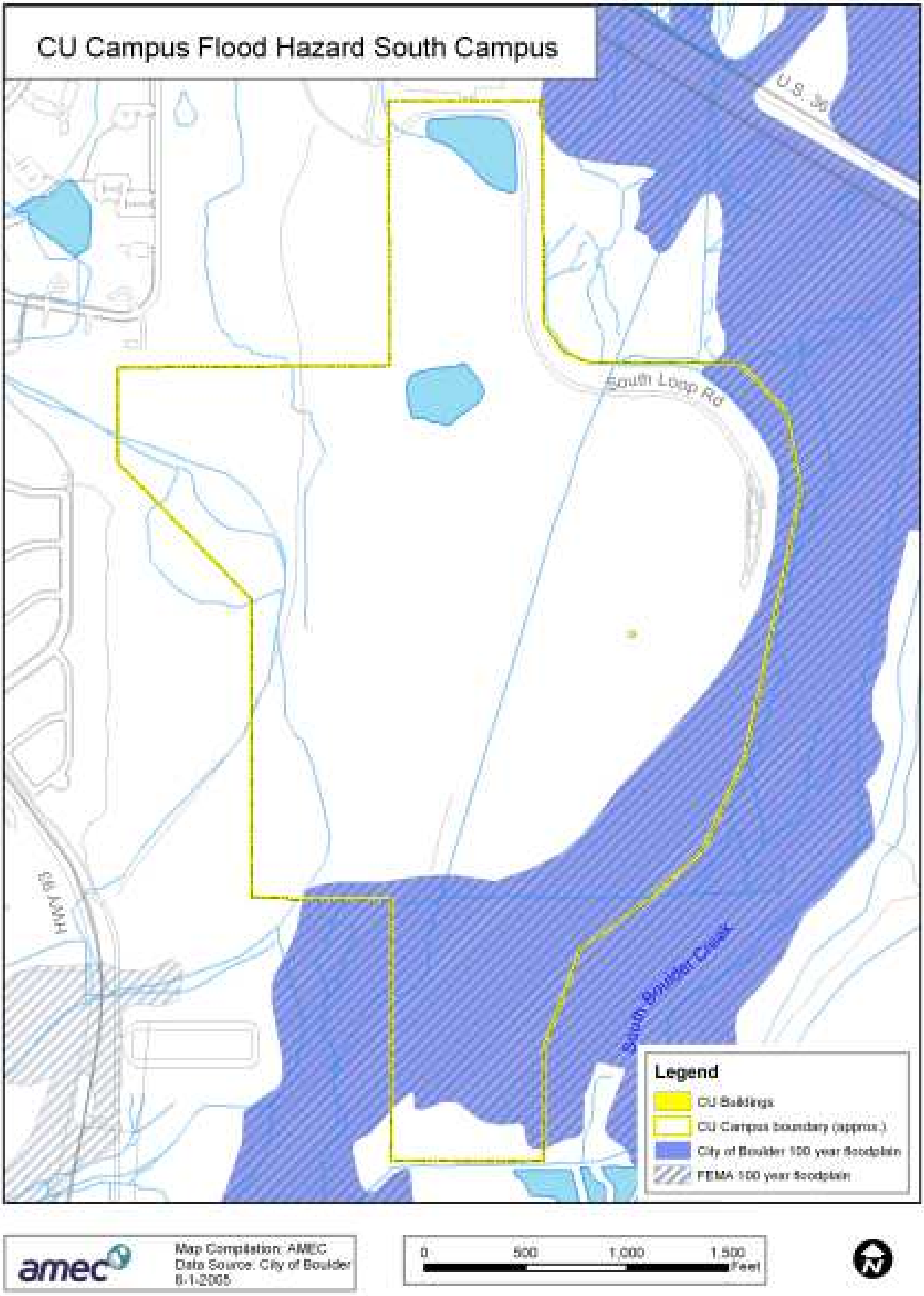
The following five figures illustrate the flood hazard at UCB properties. These figures show the original FEMA 100-year floodplain (based on Flood Insurance Rate Maps (FIRMs), the City of Boulder's 100-year Floodplain (which illustrates the current floodplain - that is the original FEMA floodplain as modified by Letter of Map Changes (LOMCs) that either removed areas or included new areas in the 100-year regulatory floodplain). These LOMCs are discussed further in this section. The maps also illustrate the City of Boulder Conveyance Zone, which are those portions of the floodplain required for the passage or conveyance of the 100-year flood, where the 100-year flood profile will be raised by six inches or more.


CU Campus Flood Hazard Overview Map
East Campus North
East Campus
Main Campus
Williams Village
Legend
CU Buildings
CU Campus boundary (approx)
FEMA 100 year floodplain
City of Boulder 100 year floodplain conveyance (City floodway)
LOMC Added
LOMC Removed
LOMC No Change
0
1,000
2,000
3,000
Feet
Map Compilation: AMEC
Data Source: City of Boulder


CU Campus Flood Hazard Main Campus
Legend
CU Buildings
CU Campus boundary (approx)
City of Boulder 100 year floodplain
conveyance zone (City floodway)
LDMC Added
LDMC Removed
LDMC No Change
FEMA 100 year floodplain
Folsom St
0
500
1,000
1,500
Feet
amec
Map Compilation: AMEC
Data Source: City of Boulder
8-1-2005


CU Campus Flood Hazard
East and East North Campus
Legend
CU Buildings
CU Campus boundary (approx)
City of Boulder 100 year floodplain
conveyance zone (City floodway)
LOMC Added
LOMC Removed
LOMC No Change
FEMA 100 year floodplain
0
510
1,020
1,530
Feet
Bear Canyon Creek
Distribution Center
Map Compilation: AMEC
Data Source: City of Boulder
8-1-2006
amec


CU Campus Flood Hazard Williams Village
Legend
CU Buildings
CU Campus boundary (approx)
City of Boulder 100 year floodplain
conveyance (City floodway)
LDMC Added
LDMC Removed
LDMC No Change
FEMA 100 year floodplain
Baseline Rd
U.S. 36
President's Residence
Bear Creek Apartments
0
500
1,000
1,500
Feet
Map Compilation: AMEC
Data Source: City of Boulder
8-1-2005
amec



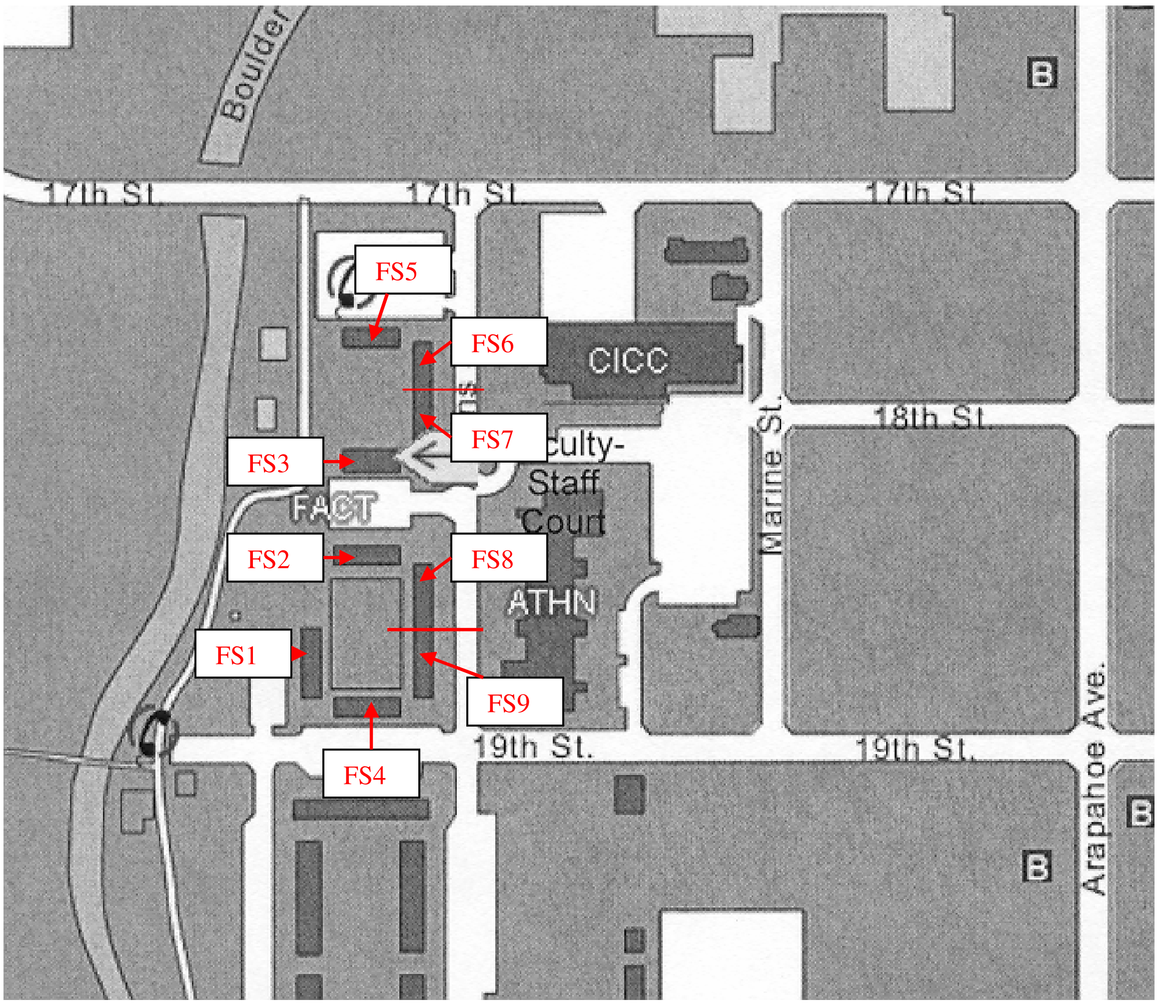
CU Campus Flood Hazard South Campus
U.S. 36
South Loop Rd
HWY 93
South Boulder Creek
Legend
CU Buildings
CU Campus boundary (approx.)
City of Boulder 100 year floodplain
FEMA 100 year floodplain
amec
Map Compilation: AMEC
Data Source: City of Boulder
8-1-2005
0
500
1,000
1,500
Feet

As previously mentioned, the Master Plan indicates that the most damaging major flood on campus likely would affect existing housing units in the floodway and floodplain north of Boulder Creek. This area is further detailed below in the following four schematics (provided by University Risk Management) that provide additional information on properties and structures located within the 100-year floodplain. Specifically, the four schematics provide details on the following areas within the Main Campus property:

- Faculty/Staff Apartments
- Marine Court Apartments
- Athens Court Apartments
- Newton Court Apartments

Faculty/Staff Apartments:

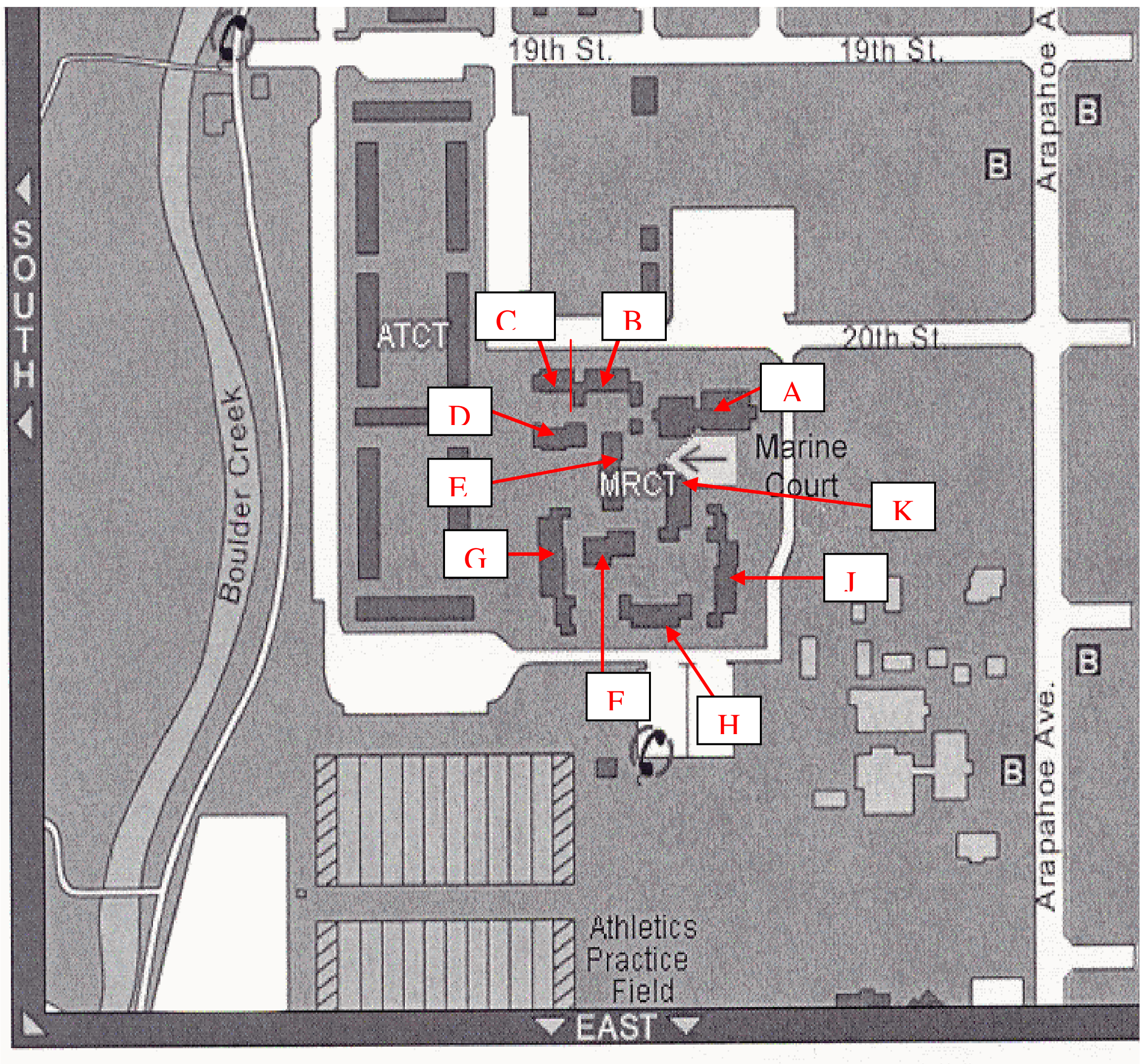
Building No.	# of stories	Street Address	Square Footage	NFIP Policies
FS1	2	1245 19th St.	3,621	FS1
FS2	2	1250 18th St.	3,621	FS2
FS3	2	1255 18th St.	2,904	FS3
FS4	2	1255 19th St.	3,621	FS4
FS5	2	1740 Athens Ct.	2,904	FS5
FS6/7	2	1750-1760 Athens Ct.	5,832	FS6/7
FS8/9	2	1850-1860 Athens Ct.	7,226	FS8/9



(Source: University Risk Management)

Marine Court Apartments
1350 20th St.

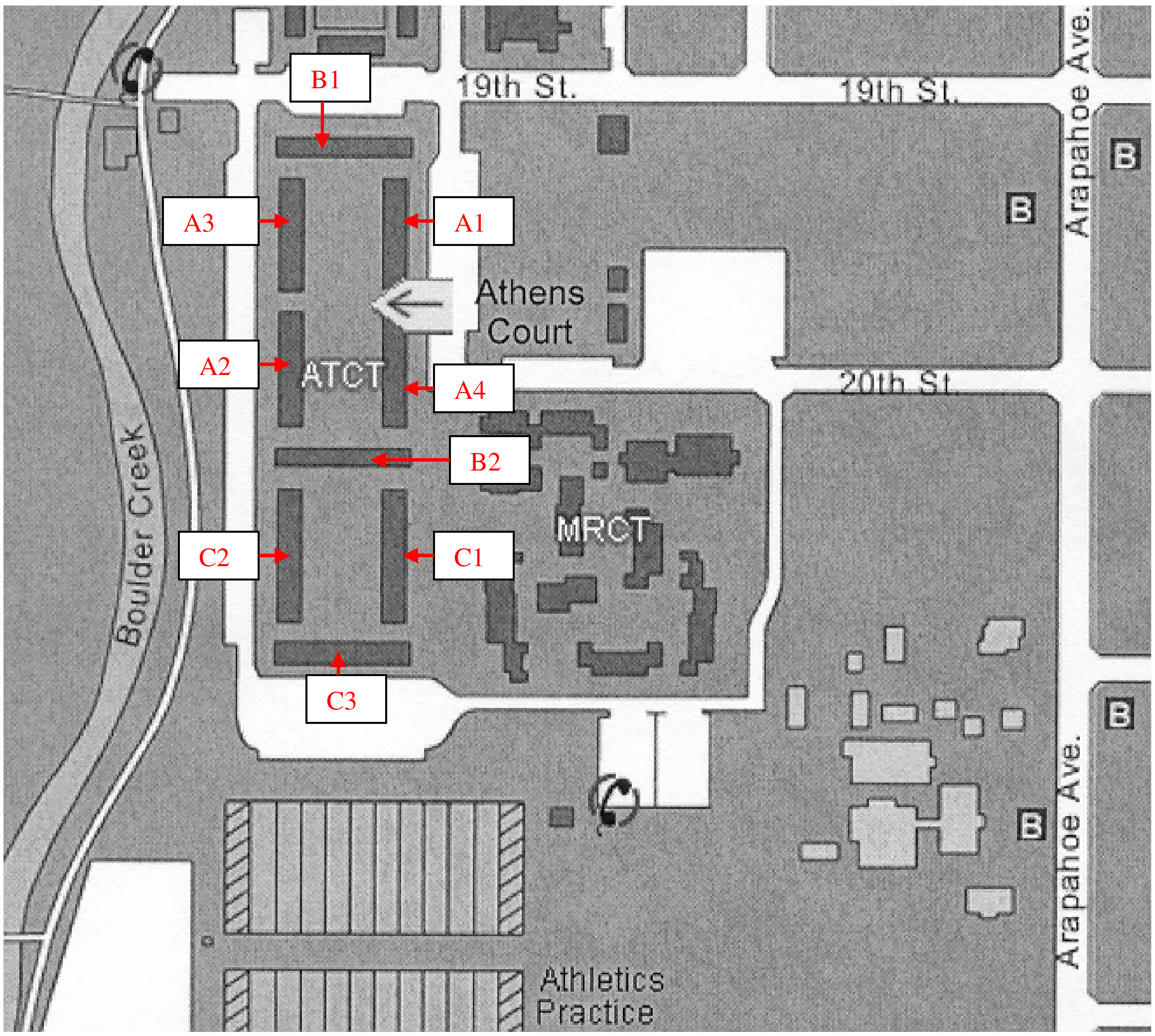
Building No.	# of stories	Square Footage	NFIP Policies
A	6	39,227	Building A
BC	4,2	14,261	Building BC
D	2	4,160	Building D
E	2	4,980	Building E
F	2	3,338	Building F
G	3	13,291	Building G
H	4	11,541	Building H
J	3	12,161	Building J



(Source: University Risk Management)

Athens Court Apartments:

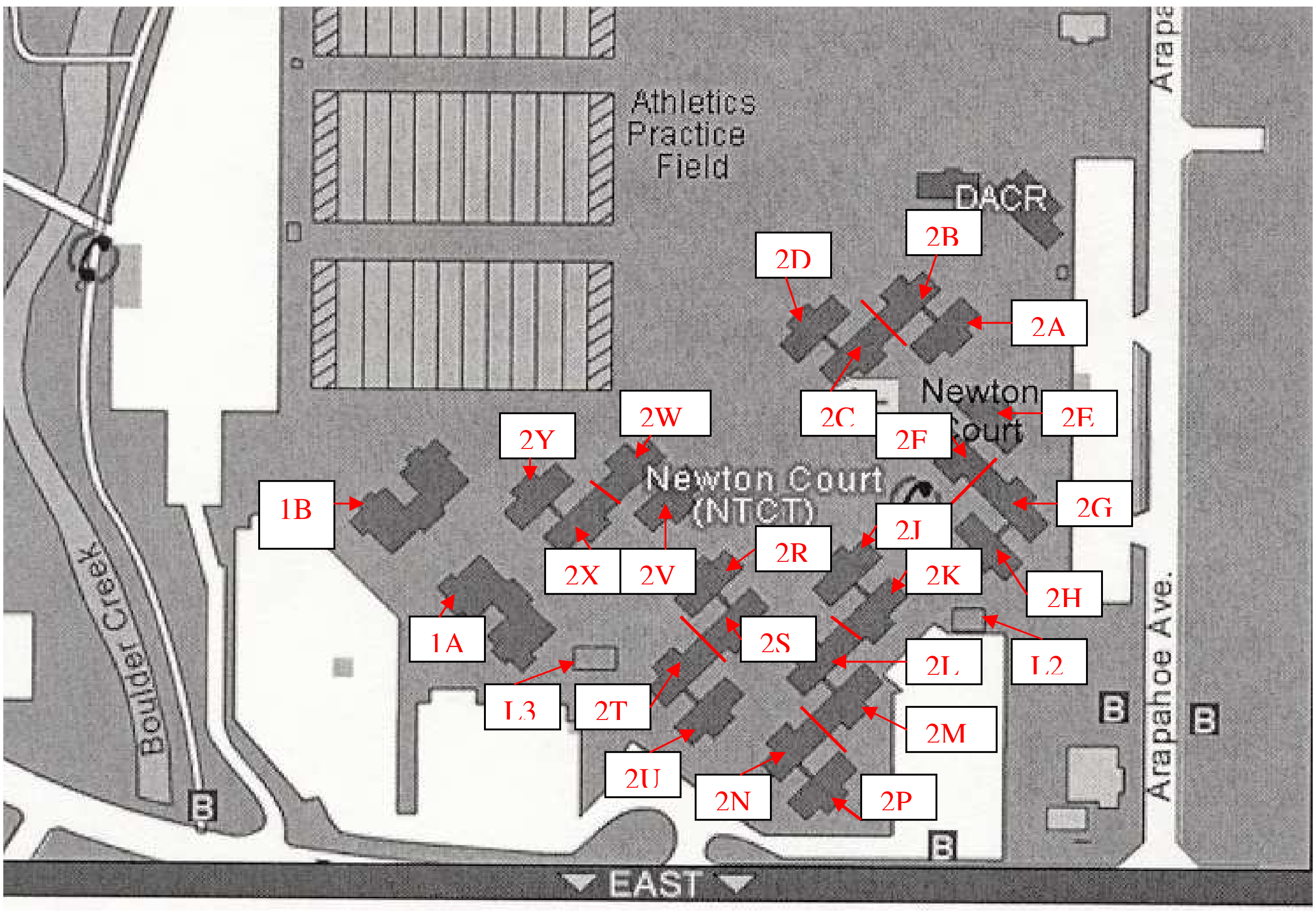
Building No.	# of stories	Street Address	Square Footage	NFIP Policies
A1	2	1930 Athens St.	6,294	A1
A2	2	1950 Athens St.	6,294	A2
A3	2	1931 Grandview Ave.	6,294	A3
A4	2	1951 Grandview Ave.	6,294	A4
B1	2	1910 Athens St.	7,494	B1
B2	2	2010 Athens St.	7,494	B2
B3	2	2050 Athens St.	7,494	B3
C1	2	2030 Athens St.	8,408	C1
C2	2	2031 Athens St.	8,408	C2



(Source: University Risk Management)

Newton Court Apartments:

Building No.	Square Footage	NFIP Policies		Building No.	Square Footage	NFIP Policies
2A	10,141	2A-2D		2R	10,141	2R-U
2B/2C	20,282	2A-2D		2S/2T	20,282	2R-U
2D	10,141	2A-2D		2U	10,141	2R-U
2E	10,141	2E-2H		2V	10,141	2V-Y
2F/2G	20,282	2E-2H		2X/2W	20,282	2V-Y
2H	10,141	2E-2H		2Y	10,141	2V-Y
2J	10,141	2J-P		1A	29,093	1A
2K/2L	20,282	2J-P		1B	29,097	1B
2M/N	20,282	2J-P		L2	975	L2
2P	10,141	2J-P		L3	1,318	L3



(Source: University Risk Management)

NFIP/CRS Program

UCB participates in the NFIP Program through their standing in the larger Boulder Community. Boulder County joined the NFIP on 02/01/1979 and entered the CRS program 10/1/1991. The current rating is a Class 8; last assigned on 10/01/1996. The Class 8 rating allows for a 10 percent discount on flood insurance for all improved parcels located within the 100-year mapped floodplain and a 5 percent discount for those improved parcels located outside of the mapped floodplain. The City of Boulder joined the NFIP on 07/17/1978 and entered the CRS program 10/01/1992. The current CRS rating for the City is also an 8 which provides the same levels of discounted flood insurance as the County. Several FIRMs exist for the incorporated and unincorporated areas of Boulder County. The following two FIRM maps for Boulder County (including incorporated areas) cover the developed portions of the UCB Planning Area:

Map Number	Effective Date	LOMCs[1] - #
0813C0395F	06/02/1995	45
08013C0410	06/02/1995	1

1LOMCs – defined as Letter of Map Changes and includes Letter of Map Amendments (LOMAs) and Letter of Map Revisions (LOMRs)

As of 06/02/2005 there have been 45 FEMA approved, Letters of Map Changes (LOMCs) for Map Number 08013C039F (ranging in dates from 1998-2005) and one approved LOMC for Map Number 08013C0410. These FEMA approved changes to the regulated 100-year floodplain have changed the originally mapped 100-year floodplain in relation to UCB properties. As a result, the flood analysis in this plan is based on the original FEMA 100-year floodplain mapping as modified through approved revisions (using the City of Boulder's GIS data which reflects the current 100-year floodplain.)

Insurance Coverage, Claims Paid, and Repetitive Losses

UCB maintains NFIP flood policies for all 58 improved parcels located in FEMA's 100-year floodplain. This includes 48 parcels located on Main Campus and 10 policies for parcels on East Campus as detailed in the table that follows. Note that in the following tables, depending on the data source and purpose, some parcels are separated into individual units while other times the units are rolled up into the larger residential complex.

There have been no claims filed on the NFIP policies since coverage was purchased about four years ago. Additionally, prior to obtaining NFIP flood policies, there were no reported damages to structures within the 100-year flood plain as a result of flooding.

2005-2006 UCB
NFIP Flood Policies
Zone AE

Campus	Address	Year Built	# of Stories	Postfirm/Prefirm	Elevation Cert	Basement Y/N	Building Limit	Replacement Cost	Contents Limit
East	#5 - 3100 Marine Street-Research Lab	1974	7	Prefirm	N	Y	$500,000.00	$27,436,600	$500,000
East	#8 - 3500 Marine Street-Housing Maintenance Center	1981	1	Postfirm	Y	N	$500,000.00	$4,380,100	$395,700
East	#10 - 1520 30th Street-Research Lab (Life Sciences Center	1988	2	Postfirm	Y	N	$500,000.00	$1,735,900	$500,000
East	#11 - 1560 30th Street-Litman Research Lab	1961	3	Prefirm	N	Y	$500,000.00	$8,838,500	$500,000
East	#12 - 1540 30th Street-Research Lab #2	1963	2	Prefirm	N	Y	$500,000.00	$12,351,800	$500,000
East	#39 - 3300 Marine St.-Warehouse #4	1974	1	Prefirm	N	N	$100,000.00	$64,600	$23,000
East	#40 - 3300 Marine St.-Warehouse #3	1974	1	Prefirm	N	N	$100,000.00	$64,600	$23,000
East	#41 - 3300 Marine St.-Warehouse #2	1974	1	Prefirm	N	N	$100,000.00	$64,600	$23,000
East	#42 - 3300 Marine St.-Warehouse #1	1974	1	Prefirm	N	N	$100,000.00	$64,600	$23,000
East	#43 - 3210 Marine St.-Electric Supply Bldg	1952	1	Prefirm	N	N	$91,700.00	$70,400	$47,700
East	#9 - 1480 30th Street-Institute for Behaviorial Genetics	1989	2	Postfirm	Y	N	$500,000.00	$2,731,200	$500,000
Main	#1 - 1729 Athens-College Inn Conference Center	1960	4	Prefirm	N	N	$500,000.00	$9,679,500	$447,500
Main	#7 - 3400 Marine Street-Nuclear Physics Lab *	1965	2	Prefirm	N	Y	$500,000.00	$5,566,400	$500,000
Main	#20 - 1712 Marine St. - Family Housing Expansion	1960	1	Prefirm	N	N	$128,000.00	$120,600	$1,000
Main	#21 - 1328 17th Street - Family Housing Expansion	1960	1	Prefirm	N	N	$250,000.00	$481,600	$2,000
Main	#22 - 1834 Marine Street - Family Housing Expansion	1945	1	Prefirm	N	N	$195,000.00	$194,900	$1,000
Main	#24 - 1860 Athens St. - Faculty-Staff Ct. Shed	1950	1	Prefirm	N	N	$40,400.00	$20,600	$2,000
Main	#19 - 1855 Athens Street - Athens North Ct.	1988	3	Postfirm	Y	N	$250,000.00	$5,700,000	N/A
Main	#25 - 1201 19th St - Steam Conversion Shed*	1950	1	Prefirm	N	N	$118,200.00	$68,700	$16,500
Main	#26 - 1320/1322 19th St. - Family Housing Expansion	1950	1	Prefirm	Y	N	$72,600.00	$75,500	$1,000
Main	#27 - 1330 19th St. - Family Housing Community Center	1940	1	Prefirm	N	N	$248,500.00	$244,600	$1,000
Main	#29 - 1324/1326 19th St. - Family Housing Expansion	1950	1	Prefirm	N	N	$117,400.00	$114,200	$1,000
Main	#30 - 1301 Folsom St.-Practice Football Fld Bldg	1950	1	Prefirm	N	N	$17,500.00	$19,900	$19,900
Main	#31 - 2202 Arapahoe Ave.-Childrens Center	1975	1	Prefirm	N	N	$500,000.00	$790,600	$43,400
Main	#13 - 1475 Folsom Street-Newton Court Pod 1	1975	2	Prefirm	N	N	$250,000.00	$38,402,500	$10,000
Main	#13A - 1475 Folsom Street-Newton Court Pod 2	1975	2	Prefirm	N	N	$250,000.00	Inc in L30	$10,000
Main	#13B - 1475 Folsom Street-Newton Court Pod 3	1975	2	Prefirm	N	N	$250,000.00	Inc in L30	$10,000
Main	#13C - 1475 Folsom Street-Newton Court Pod 4	1975	2	Prefirm	N	N	$250,000.00	Inc in L30	$10,000
Main	#13D - 1475 Folsom Street-Newton Court Pod 5	1975	2	Prefirm	N	N	$250,000.00	Inc in L30	$10,000
Main	#13E - 1475 Folsom Street-Newton Court Pod 6	1975	2	Prefirm	N	N	$250,000.00	Inc in L30	$10,000

Campus	Address	Year Built	# of Stories	Postfirm/Prefirm	Elevation Cert	Basement Y/N	Building Limit	Replacement Cost	Contents Limit
Main	#13F - 1475 Folsom Street-Newton Court Pod 7	1975	2	Prefirm	N	N	$250,000.00	Inc in L30	$10,000
Main	#13H - 1475 Folsom Street-Newton Court Laundry 1	1975	1	Prefirm	N	N	$150,000.00	Inc in L30	$20,000
Main	#13I - 1475 Folsom Street-Newton CourtLaundry 2	1975	1	Prefirm	N	N	$100,000.00	Inc in L30	$15,000
Main	1930 Athens, Bldg A1	1957	2	Prefirm	N	N	$250,000.00	$10,481,100	$15,000
Main	1950 Athens, Bldg A2	1957	2	Prefirm	N	N	$250,000.00	Inc in L38	$15,000
Main	1931 Grandview, Bldg. A3	1957	2	Prefirm	N	N	$250,000.00	Inc in L38	$15,000
Main	1951 Grandview, Bldg. A4	1957	2	Prefirm	N	N	$250,000.00	Inc in L38	$15,000
Main	1910 Grandview, Bldg. B1	1957	2	Prefirm	N	N	$250,000.00	Inc in L38	$15,000
Main	2010 Athens St., Bldg. B2	1957	2	Prefirm	N	N	$250,000.00	Inc in L38	$15,000
Main	2050 Athens St., Bldg. B3	1957	2	Prefirm	N	N	$250,000.00	Inc in L38	$15,000
Main	2030 Athens St., Bldg. C1	1957	2	Prefirm	N	N	$250,000.00	Inc in L38	$15,000
Main	2031 Athens St., Bldg. C2	1957	2	Prefirm	N	N	$250,000.00	Inc in L38	$15,000
Main	1245 19th St., Bldg. FS1	1954	2	Prefirm	N	N	$250,000.00	$3,464,700	$15,000
Main	1250 18th St., Bldg. FS2	1954	2	Prefirm	N	N	$250,000.00	Inc in L47	$15,000
Main	1255 18th St., Bldg. FS3	1954	2	Prefirm	N	N	$250,000.00	Inc in L47	$15,000
Main	1255 19th St., Bldg. FS4	1954	2	Prefirm	N	N	$250,000.00	Inc in L47	$15,000
Main	1740 Athens St., Bldg. FS5	1954	2	Prefirm	N	N	$250,000.00	Inc in L47	$15,000
Main	1750 Athens St., FS 6/7	1954	2	Prefirm	N	N	$250,000.00	Inc in L47	$15,000
Main	1850 Athens St., FS 8/9	1954	2	Prefirm	N	N	$250,000.00	Inc in L47	$15,000
Main	1350 20th St., Bldg. A (Marine Ct)	1965	3+	Prefirm	N	N	$250,000.00	$15,011,400	$15,000
Main	1350 20th St., Bldg. BC (Marine Ct)	1965	3+	Prefirm	N	N	$250,000.00	Inc in L54	$15,000
Main	1350 20th St., Bldg. D (Marine Ct)	1965	2	Prefirm	N	N	$250,000.00	Inc in L54	$15,000
Main	1350 20th St., Bldg. E (Marine Ct)	1965	2	Prefirm	N	N	$250,000.00	Inc in L54	$15,000
Main	1350 20th St., Bldg. F (Marine Ct)	1965	2	Prefirm	N	N	$250,000.00	Inc in L54	$15,000
Main	1350 20th St., Bldg. G (Marine Ct)	1965	3+	Prefirm	N	N	$250,000.00	Inc in L54	$15,000
Main	1350 20th St., Bldg. H (Marine Ct)	1965	3+	Prefirm	N	N	$250,000.00	Inc in L54	$15,000
Main	1350 20th St., Bldg. J (Marine Ct)	1965	3+	Prefirm	N	N	$250,000.00	Inc in L54	$15,000
Main	1350 20th St., Bldg. K (Marine Ct)	1965	3+	Prefirm	N	N	$250,000.00	Inc in L54	$15,000

(Source: University Risk Management)

Note: Replacement cost is often listed once for the entire complex and covers all units within that complex as indicated.

Values at Risk

The HMPC used data provided by UCB's Risk Management group to quantify the potential flood losses to UCB within the mapped floodplain areas.

Specifically, Computer-Aided Drafting and Design (CADD) and Geographical Information System (GIS) data provided by UCB, the City of Boulder, and Boulder County were used to determine the limits of the current 100-year floodplain. The GIS data were developed using FEMA Q3 flood data and updated with FEMA map revisions reflected in approved LOMCs. The maps developed for this effort appear above on pages 4-16 through 4-120. This information was compared with UCB's NFIP data. The number and location of UCB-owned properties within the floodplain were inventoried and evaluated based on data provided by University Risk Management. A list of properties within the 100-year floodplain was generated and is included in the table that follows. This data was supplemented with UCB's property schedule data to quantify the value of improved property that lies within the floodplain. The following tables provide the values of properties at risk for those properties located within the 100-year floodplain.

UCB
Flood Hazard
Assets and Values at Risk
Summary Table

Type of Building/Assets	Number of Buildings			Value of Properties and Assets		
	# on Campus	# in Hazard Area	% in Hazard Area	$ on Campus	$ in Hazard Area	% in Hazard Area
Classrooms	46	3	6.52%	$604,110,657	$23,368,720	3.87%
Common Areas/Auditoriums	4	0	0%	$85,471,130	$0	0%
Data Systems	3	0	0%	$6,351,000	$0	0%
Libraries/Museums	2	0	0%	$327,047,385	$0	0%
Medical Facilities	1	0	0%	$12,459,980	$0	0%
Offices	34	2	5.88%	$201,487,085	$535,490	0.27%
Recreation	10	0	0%	$135,928,400	0	0%
Research	23	6	26.09%	$333,358,090	$72,723,525	21.82%
Residential	41	16	39.02%	$360,480,980,	$90,916,250	25.22%
Storage/Parking	14	8	57.14%	$13,318,650	$561,200	4.21%
Utilities & Infrastructure	16	5	31.25%	$124,350,634	$5,922,800	4.76%
Totals	**194**	**40**	**20.62%**	**$2,204,363,991**	**$194,027,985**	**8.80%**

(Source: Risk Management Property Schedule)

UCB
Flood Hazard
Populations at Risk

Type of Building/Assets	Number of Staff			Number of Students		
	# on Campus	# in Hazard Area	% in Hazard Area	# on Campus	# in Hazard Area	% in Hazard Area
Classrooms	4123	133	3.23%	23,289	0	0%
Common Areas/Auditoriums	871	0	0%	189	0	0%
Data Systems	0	0	0%	0	0	0%
Libraries/Museums	760	0	0%	186	0	0%
Medical Facilities	234	0	0%	0	0	0%
Offices	2808	2	0.07%	466	0	0%
Recreation	505	0	0%	23	0	0%
Research	3198	967	30.24%	788	2	0.25%
Residential	1386	1	0.07%	6,949	1,022	14.7%
Storage/Parking	2	0	0%	0	0	0
Utilities & Infrastructure	113	45	39.8%	0	0	0
Totals	**14,000**	**1,148**	**8.2%**	**31,890**	**1,024**	**3.21%**

(Source: Risk Management, Family and Residential Housing, Planning, Budget & Analysis)

UCB
Flood Hazard
Detailed Table

Name or Description of Asset	Classrooms	Common	Data Systems	Libraries/Museums	Medical Facilities	Offices	Recreation	Research	Residential	Storage/Parking	Utilities/Infrastructure	Gross Sq. Footage (sq. ft.)	Replacement Value ($)	Contents Value ($)	Misc Value ($)	Total Value ($)	Critical Facility Priority
Computing Center) Incl C	X											28848	$3,684,000	$1,277,200	$3,012,000	$7,973,200	2
IBSI #9	X											7704	$998,820	$158,000	$34,000	$1,190,820	3
Nuclear Physics Lab	X											31241	$5,566,400	$8,158,300	$480,000	$14,204,700	3
IEC Classroom Annex						X						3098	$360,890	$8,000	$12,000	$380,890	3
Trans. Annex						X						1440	$88,600	$37,200	$28,800	$154,600	
Administrative & Research Center								X				191141	$27,436,600	$1,779,500	$616,700	$29,832,800	
Institute for Behavioral Genetics								X				17317	$2,731,200	$478,300.	$1,844,225	$5,053,725	1
Life Sciences Research Pl #4 Lab								X				11957	$1,735,900	$1,012,900	$41,000	$2,789,800	1
Litman Research Lab #1								X				54035	$8,838,500	$4,032,900	$1,118,200	$13,989,600	1
Marine Science Center (RL #6)								X				48593	$6,770,000	$110,300	$67,500	$6,947,800	3
Research Lab #2								X				77713	$12,351,800	$1,238,000	$520,000	$14,109,800	3
Athens Court Apartments									X			92752	$10,481,100	$85,000	$0.00	$10,566,100	1
Athens North									X			51885	$6,771,400	$0.00	$0.00	$6,771,400	1
Child Care Center (DACR)									X			6897	$790,600	$13,400	$10,000	$814,000	1
College Inn									X			74968	$9,679,500	$438,000	$9,500	$10,127,000	3
Faculty/Staff Apartments									X			29705	$3,464,700	$15,000	$0.00	$3,479,700	1
Family Housing Expansion									X			4250	$481,600	$2,000	$0.00	$483,600	1
Family Housing Expansion									X			660	$75,500	$1,000	$0.00	$76,500	1
Family Housing Expansion									X			1067	$114,200	$1,000	$0.00	$115,200	1
Family Housing Expansion									X			2259	$244,600	$1,000	$0.00	$245,600	1
Family Housing Expansion (T.B. 87)									X			1765	$194,900	$1,000	$0.00	$195,900	1
Family Housing Expansion (TB32)									X			1164	$120,600	$1,000	$0.00	$121,600	1
Housing System Service Center									X			39489	$2,789,200	$375,500	$9,500	$3,174,200	1
Marine Court Apartments									X			113699	$15,011,400	$925,100	$23,000	$15,959,500	1
Newton Court Apartments									X			283499	$38,402,500	$11,500	$0.00	$38,414,000	1
T.B. 1514 13th St. TB90									X			2092	$226,120	$1,000	$0.00	$227,120	1
T.B. 99									X			1394	$143,830	$1,000	$0.00	$144,830	1
Faculty/Staff Court Shed(T.B. 57)										X		576	$20,600	$2,000	$0.00	$22,600	3

Name or Description of Asset	Classrooms	Common	Data Systems	Libraries/Museums	Medical Facilities	Offices	Recreation	Research	Residential	Storage/Parking	Utilities/Infrastructure	Gross Sq. Footage (sq. ft.)	Replacement Value ($)	Contents Value ($)	Misc Value ($)	Total Value ($)	Critical Facility Priority
Hazardous Waste Material Storage										X		1339	$57,700	$28,900	$0.00	$86,600	1
Practice Football Field Bldg										X		289	$11,000	$2,600	$0.00	$13,600	3
T.B. 12 Steel Butler (NE of Stadium - Warehouse)										X		1635	$64,500	$23,500	$0.00	$88,000	3
T.B. 45 (Warehouse #1 N E)										X		2000	$64,600	$23,000	$0.00	$87,600	3
T.B. 46 (Warehouse #2 N Center)										X		2000	$64,600	$23,000	$0.00	$87,600	3
T.B. 47 (Warehouse #3 S Center)										X		2000	$64,600	$23,000	$0.00	$87,600	3
T.B. 48 (Warehouse #4 S E)										X		2000	$64,600	$23,000	$0.00	$87,600	3
Electric Supply Bldg.											X	1309	$70,400	$47,700	$0.00	$118,100	1
Housing System Maintenance Center											X	38559	$4,380,100	$355,200	$40,500	$4,775,800	2
Practice Football Field Pump Station											X	100	$8,900	$20,000	$0.00	$28,900	
Steam Conversion Shed											X	1688	$68,700	$16,500	$0.00	$85,200	1
Trans. Center (Trailer & Vehicles)											X	7467	$668,300	$246,500	$0.00	$914,800	3
									Totals:			**124,1594**	**$165,163,060**	**$20,998,000**	**$7,866,925**	**$194,027,985**	

(Source: Risk Management Property Schedule)

Summary of UCB Assets and Values at Risk Due to Flood Hazard

In analyzing this data, 20.62% of the total number of UCB buildings are located in the flood hazard area. This includes 39% of UCBs residential parcels and 26% of their research facilities.

Looking at associated values, $194,027,985 or 8.8% of the total UCB values are located in the 100-year floodplain. To be added to this number is the Business Income value. To do this, we took 8.8% of the total Business Income Value of $122,229,582 for $10,756,203 and added this sum to the $194,027,985 for total values at risk in the floodplain of $204,784,188. Also, it should be noted that included in the values at risk in the flood hazard area is $1,707,225 for research animals. This equates to 39.98% of all research animals at UCB being located within the flood hazard area.

With respect to populations at risk in the flood hazard area, 8.2% of the staff and 3.21% of the student population are located within the 100-year floodplain. It is important to note that the 1,022 students located within the flood hazard area are within the family housing area adjacent to Boulder Creek and reside there on a 24/7 basis. There is also a potential risk to identified populations while in transit between buildings and campuses.

Also to be considered as valuable assets to UCB are the other university areas not accounted for in the building valuation. These include areas adjacent to buildings such as transportation corridors, athletic fields, plazas, bike and pedestrian trails and paths, and other outside "common" areas. These areas can and do have a flood risk and are used to house and move people and goods throughout the UCB campus. Although there is no data to quantify the value of these assets, they should be considered as part of the overall UCB assets at risk to a flood event.

Total Values at Risk and Floodproofing Analysis

With so many key assets at risk within the flood hazard area, the ability to determine cost effective solutions for reducing UCB vulnerability is critical. To assist in this effort, the HMPC reviewed a 2002 Floodproofing Analysis for the Boulder Creek floodplain that was prepared for the University by Love and Associates, Inc. This analysis identifies UCB buildings located within the 100-year floodplain along Boulder Creek, starting at 17th Street and going easterly toward Folsom Street. A field survey was conducted to determine finished floor elevations and to determine the potential exposure identified buildings have to flooding from Boulder Creek. This was followed by an analysis of suitable floodproofing solutions. The floodproofing elevation was set to meet Urban Drainage and Flood Control District (UDFCD) criteria which include one foot above the 100-year floodplain elevation. For each structure evaluated, the following information was provided in the Love Study:

- Property Address
- Discussion of Property – Flood Impacts
- Floodproofing Requirements
    - ♦ One foot of freeboard was incorporated per UDFCD criteria. This is an additional

one foot above the resultant 100-year water surface elevation (e.g., 100-year water surface elevation is 5,300 – the freeboard would increase this elevation to 5,301.) This freeboard provides an allowance for wave action and any stacking up that occurs to flood water when it encounters obstructions.

- Estimate of Probable Floodproofing Costs
  - ♦ This utilized representative construction costs for the Denver Metropolitan area as of 2002. A 40% contingency factor was added to cover the cost of design and construction observation services and to allow for unknowns or cost increases if the work is completed in a year or more down the road, as the estimate was based upon preliminary engineering. Generally, two floodproofing options and costs were identified for each building.
- Priority of Floodproofing by Building:
  - ♦ ***High Priority***: This rating was given to those buildings which are located in close proximity to Boulder Creek with a finished floor elevation that is more than one foot below the floodproofing elevation of the structure. These buildings would have the greatest life-safety risk since the evacuation distance to get out of the floodplain is the greatest.
  - ♦ ***Medium Priority***. This rating was given to those buildings located a greater distance from Boulder Creek that have a finished floor elevation which is one foot or more below the floodproofing elevation or buildings close to Boulder Creek which have a finished floor elevation that is less than one foot below the floodproofing elevation. These buildings have a lesser life safety risk for the occupants.
  - ♦ ***Low Priority***. This rating is given to those buildings located near the edge of the 100-year floodplain, for which the life safety risk to the building occupants is the lowest.

Utilizing this data, the HMPC developed an initial starting point for a cost benefit analysis to be used to determine and support proposed floodproofing options on a building by building basis. Combining information from UCB's property schedule, this analysis presents the total values at risk and compares them to proposed floodproofing costs. Using total values for all buildings at risk, this equates to $87,370,100 at risk compared to between $1,501,160 to $1,923,400 to floodproof these buildings, depending on the option selected.

This comparison of values at risk to costs to mitigate the problem is somewhat misleading and can further be refined with additional analysis. This additional analysis recognizes that 100% of the building structure and contents will not be lost in a 100-year flood. To more accurately determine what is currently at risk to the 100-year flood, base flood elevation (BFE) data from the Love Study was used to determine likely percent of damage to the entire structures. Utilizing the Love data, the average BFE for all buildings in the study is .5 feet.

Using both FEMA's Flood Building and Content Loss Estimation Tables for Two Story No Basement Buildings: In a 100-year flood, flood depth ranging from -1/2 foot to 1/2 foot results in building and content damages averaged at 6.25%. This equates to $5,460,631.25 of the total $87,370,100 currently at risk to the 100-year flood compared to the $1.5 to 1.9 Million of costs to floodproof the structures.

This number could also be misleading due to many unknowns during a flood event. For example, the nature of any given flood event might change the degree of damages. If a flood event is greater than a 100-year flood, more damages should occur. Other factors to be considered include damages caused by upstream structures and other debris that have joined the floodwaters, increase in damages due to high velocity flood waters, whether any of the structures have basements, and the types of existing building construction, to name a few. **However, beyond looking at these variables in property damages, life safety considerations are paramount.** These structures at risk are used primarily for family housing. Access to high ground becomes a significant issue during any flood event.

In order to determine probable impacts during a given flood event, additional evaluation and a detailed cost benefit analysis is recommended on a structure by structure basis, factoring in both property damage and life safety considerations.

The following table summarizes the results of this analysis.

Floodproofing Analysis: Main Campus, Flood Zone AE

Love Study Priority	Category	Street Address	CU Identifier	Unit Name	Bldg Name	Total Value from UCB Prop. Schedule*	Elevation**	Mitigation Cost Option 1	Mitigation Cost Option 2	Comments
High	Residential	1930 Athens Street	A-1-Athens Ct		Athens Court Apartments	$10,566,100.00	-0.6	$44,700.00	$40,300.00	
High	Residential	1950 Athens Street	A-2-Athens Ct		Athens Court Apartments		-1.2	$45,700.00	$40,200.00	
High	Residential	1931 Grandview Avenue	A-3-Athens Ct		Athens Court Apartments		-1.5	$45,800.00	$40,300.00	
High	Residential	1951 Grandview Avenue	A-4 Athens Ct	ATCT 144	Athens Court Apartments		-1.9	$46,000.00	$40,600.00	
High	Residential	1910 Athens Street	B-1-Athens Ct		Athens Court Apartments		-0.1	$56,500.00	$36,200.00	
High	Residential	2010 Athens Street	B-2-Athens Ct		Athens Court Apartments		-0.3	$56,700.00	$36,400.00	
High	Residential	2050 Athens Street	B-3-Athens Ct		Athens Court Apartments		-1.9	$58,100.00	$57,400.00	
High	Residential	2030 Athens Street	C-1-Athens Ct		Athens Court Apartments		-0.3	$56,700.00	$45,600.00	
High	Residential	2031 Athens Street	C-2-Athens Ct		Athens Court Apartments		-1.3	$57,200.00	$46,200.00	
					Sub Total:	**$10,566,100.00**		**$467,400.00**	**$383,200.00**	
High	Residential	1729 Athens Street	College Inn	CICC 197	College Inn	$10,127,000.00	-1.6	$125,400.00	$0.00	
					Sub Total:	**$10,127,000.00**		**$125,400.00**	**$0.00**	
High	Residential	1330 19th Street	Family Housing Ctr	TB34 141	Family Housing Expansion	$245,600.00	-5.0	$18,000.00	$21,500.00	Basement; Option 3 =$76,440
					Sub Total:	**$245,600.00**		**$18,000.00**	**$21,500.00**	
High	Residential	1245 19th Street	FS-1			$1,739,850	-1.4	$179,400.00	$168,600.00	Option 1 & 2 is for FS1, 2, 4, 8 & 9 total
High	Residential	1250 18th Street	FS-2				-2.0	$179,400.00	$168,600.00	Option 1 & 2 is for FS1, 2, 4, 8 & 9 total

Love Study Priority	Category	Street Address	CU Identifier	Unit Name	Bldg Name	Total Value from UCB Prop. Schedule*	Elevation**	Mitigation Cost Option 1	Mitigation Cost Option 2	Comments
High	Residential	1255 19th Street	FS-4				-1.0	$179,400.00	$168,600.00	Option 1 & 2 is for FS1, 2, 4, 8 & 9 total
High	Residential	1850 Athens Street	FS-8				-1.7	$179,400.00	$168,600.00	Option 1 & 2 is for FS1, 2, 4, 8 & 9 total
High	Storage/ Parking	1860 Athens Street	FS-9	TB57 138	Faculty/Staff Court Shed(T.B. 57)	$22,600.00	-1.1	$179,400.00	$168,600.00	Option 1 & 2 is for FS1, 2, 4, 8 & 9 total
					Sub Total:	**$1,762,450.00**		**$179,400.00**	**$168,600.00**	
High	Residential	1255 18th Street	FS-3			$1,739,850	-2.1	$133,100.00	$169,400.00	Option 1 & 2 is for FS3, 5, 6, 7 total
High	Residential	1740 Athens Street	FS-5				-2.8	$133,100.00	$169,400.00	
High	Residential	1750 Athens Street	FS-6				-3.3	$133,100.00	$169,400.00	
High	Residential	1760 Athens Street	FS-7				-1.0	$133,100.00	$169,400.00	
					Sub Total:	**$1,739,850.00**		**$133,100.00**	**$169,400.00**	
			Total for Faculty/Staff Court:			**$3,502,300.00**		**$312,500.00**	**$338,000.00**	
Low	Residential	1855 Athens Street	Athens North	ATHN 131	Athens North	$6,771,400.00	-0.7	$41,960.00		
					Sub Total:	**$6,771,400.00**		**$41,960.00**		
Low	Residential	1350 20th St.	A-Marine Ct	MRCT 150	Marine Court Apartments	$15,959,500.00	-1.0	$291,400.00		Cost applies to overall complex remediation. (nine properties)
Low	Residential	1350 20th St.	B & C-Marine Ct	MRCT 150	Marine Court Apartments		-1.0	$291,400.00		Cost applies to overall complex remediation. (nine properties)

Love Study Priority	Category	Street Address	CU Identifier	Unit Name	Bldg Name	Total Value from UCB Prop. Schedule*	Elevation**	Mitigation Cost Option 1	Mitigation Cost Option 2	Comments
Low	Residential	1350 20th St.	D-Marine Ct	MRCT 150	Marine Court Apartments		-1.0	$291,400.00		Cost applies to overall complex remediation. (nine properties)
Low	Residential	1350 20th St.	E-Marine Ct	MRCT 150	Marine Court Apartments		-1.0	$291,400.00		Cost applies to overall complex remediation. (nine properties)
Low	Residential	1350 20th St.	F-Marine Ct	MRCT 150	Marine Court Apartments		-1.0	$291,400.00		Cost applies to overall complex remediation. (nine properties)
Low	Residential	1350 20th St.	G-Marine Ct	MRCT 150	Marine Court Apartments		-1.0	$291,400.00		Cost applies to overall complex remediation. (nine properties)
Low	Residential	1350 20th St.	H-Marine Ct	MRCT 150	Marine Court Apartments		-1.0	$291,400.00		Cost applies to overall complex remediation. (nine properties)
Low	Residential	1350 20th St.	J-Marine Ct	MRCT 150	Marine Court Apartments		-1.0	$291,400.00		Cost applies to overall complex remediation. (nine properties)
Low	Residential	1350 20th St.	K-Marine Ct	MRCT 150	Marine Court Apartments		-1.0	$291,400.00		Cost applies to overall complex remediation. (nine properties)
					Sub Total:	**$15,959,500.00**		**$291,400.00**		

Love Study Priority	Category	Street Address	CU Identifier	Unit Name	Bldg Name	Total Value from UCB Prop. Schedule*	Elevation**	Mitigation Cost Option 1	Mitigation Cost Option 2	Comments
Low	Residential	2202 Arapahoe Avenue	Children's Center	DACR 191	Child Care Center (DACR)	$814,000.00	-1.0	$37,800.00		Cost applies to remediating both structures
Low	Residential	2202 Arapahoe Avenue	Children's Center	DACR 191	Child Care Center (DACR)		-1.0	$37,800.00		Cost applies to remediating both structures
					Sub Total:	**$814,000.00**		**$37,800.00**		
Low	Residential	1320 & 1322 19th Street	Duplex	TB34 141	Family Housing Expansion	$76,500.00	-0.2	$0.00	$0.00	Candidate for structure replacement
Low	Residential	1324 & 1326 19th Street	Duplex	TB35 145	Family Housing Expansion	$115,200.00	0.0	$0.00	$0.00	Candidate for structure replacement
					Sub Total:	**$191,700.00**		**$0.00**		
Low	Residential	1834 Marine Street		TB87 134	Family Housing Expansion (T.B. 87)	$195,900.00	-0.2	$26,300.00	$61,900.00	
					Sub Total:	**$195,900.00**		**$26,300.00**	**$61,900.00**	
Low	Residential	1712 Marine Street		TB32 132	Family Housing Expansion (TB32)	$121,600.00	-0.8	$25,100.00	$50,300.00	
					Sub Total:	**$121,600.00**		**$25,100.00**	**$50,300.00**	
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	1A-Newton Ct	NTCT 170	Newton Court Apartments	$38,414,000.00	-2.4	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	1B-Newton Ct	NTCT 170	Newton Court Apartments		-1.4	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2A-Newton Ct	NTCT 170	Newton Court Apartments		-1.6	$108,900.00	$990,200.00	Cost applies to overall remediation

Love Study Priority	Category	Street Address	CU Identifier	Unit Name	Bldg Name	Total Value from UCB Prop. Schedule*	Elevation**	Mitigation Cost Option 1	Mitigation Cost Option 2	Comments
										in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2B &2C-Newton Ct	NTCT 170	Newton Court Apartments		-1.9	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2D-Newton Ct	NTCT 170	Newton Court Apartments		-1.7	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2E-Newton Ct	NTCT 170	Newton Court Apartments		-1.0	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2F &2G-Newton Ct	NTCT 170	Newton Court Apartments		-1.0	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2H-Newton Ct	NTCT 170	Newton Court Apartments		-1.0	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2J-Newton Ct	NTCT 170	Newton Court Apartments		-2.4	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2K &2L-Newton Ct	NTCT 170	Newton Court Apartments		-2.3	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2M &2N-Newton Ct	NTCT 170	Newton Court Apartments		-2.2	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2P-Newton Ct	NTCT 170	Newton Court Apartments		-1.0	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2R-Newton Ct	NTCT 170	Newton Court Apartments		-2.3	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.

Love Study Priority	Category	Street Address	CU Identifier	Unit Name	Bldg Name	Total Value from UCB Prop. Schedule*	Elevation**	Mitigation Cost Option 1	Mitigation Cost Option 2	Comments
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2S &2T-Newton Ct	NTCT 170	Newton Court Apartments		-2.4	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2U-Newton Ct	NTCT 170	Newton Court Apartments		-2.2	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2V-Newton Ct	NTCT 170	Newton Court Apartments		-1.3	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2W &2X-Newton Ct	NTCT 170	Newton Court Apartments		-1.4	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	2Y-Newton Ct	NTCT 170	Newton Court Apartments		-1.3	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	L2-Newton Ct	NTCT 170	Newton Court Apartments		-3.4	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
Medium	Residential	1475 Folsom & 2300 Arapahoe Ave	L3-Newton Ct	NTCT 170	Newton Court Apartments		-3.5	$108,900.00	$990,200.00	Cost applies to overall remediation in complex.
					Sub Total:	**$38,414,000.00**		**$108,900.00**	**$990,200.00**	
Medium	Residential	1328 17th Street		TB33 133	Family Housing Expansion	$483,600.00	-0.5	$46,400.00	$78,300.00	
					Sub Total:	**$483,600.00**		**$46,400.00**	**$78,300.00**	
Summary for 'Priority'= High (20 detailed records):										
					Sum:	**$24,441,000.00**		**$923,300.00**	**$742,700.00**	
					Standard:	**27.97%**		**61.51%**	**38.61%**	
Summary for 'Priority'= Medium (21 detailed records):										
					Sum:	**$38,897,600.00**		**$155,300.00**	**$1,068,500.00**	

Love Study Priority	Category	Street Address	CU Identifier	Unit Name	Bldg Name	Total Value from UCB Prop. Schedule*	Elevation**	Mitigation Cost Option 1	Mitigation Cost Option 2	Comments
					Standard:	44.51%		10.35%	55.55%	
					Summary for 'Priority'= Low (16 detailed records):					
					Sum:	$24,054,100.00		$422,560.00	$112,200.00	
					Standard:	27.52%		28.15%	5.83%	
					Grand Total:	$87,392,700.00		$1,501,160.00	$1,923,400.00	

*Note: Where only one value appears for a series of units comprising one complex, the value applies to all units within that complex.

**The elevation refers to the relationship of the finished floor to the floodproofing elevation which is BFE + 1.

Critical Facilities at Risk

As described earlier, critical facilities are located throughout the UCB Planning Area. UCB does not have a current mapped inventory of these facilities. However, utilizing the critical facility data previously described, the HMPC identified the following critical facilities located within the mapped floodplain areas.

- 21 Priority One Facilities out of a total of 77 for all campus properties (27.27%)
- Two Priority Two Facilities out of a total of 13 for all campus properties (15.38%)

Cultural and Natural Resources at Risk

Cultural and natural resources are located throughout Boulder County and the UCB Planning Area as previously described. Neither of the two areas identified as significant cultural resources, the Norlin Quadrangle Historic District and the Grandview Area Preserve bungalows, are located within the 100-year floodplain.

With respect to natural resources, UCB does not currently have this information developed sufficiently to support further analysis of natural resources located within the mapped floodplain areas.

Overall Community Impact

The overall impact to UCB from a devastating flood includes:

- Potential for loss of life and disruption of infrastructure;
- Structural damage;
- Damages to roads/bridges resulting in loss of mobility;
- Damages to utilities;
- Significant economic impact upon the university;
- Possible negative impact upon university enrollment;
- Significant disruption to students and teachers as temporary facilities and relocations would be likely; and
- Significant impact on the overall mental health of the university.

Development Trends

Reducing the likelihood of flood damage through appropriate land use planning, building siting and building design is an important component of campus master planning. The current campus policy is "not to construct new buildings or building additions that would be flooded in a 100-year event." Development trends relative to flood mitigation for the five areas of the UCB campus are described as follows:

Main Campus – Consideration is given to the purchase and removal of houses in the floodway east of 17th Street. Also considered is redevelopment of Faculty Staff Court and Athens Court to elevate units and provide improved student housing.

East Campus – As renovation and development occur in this area, improvements will be implemented to reduce the flooding potential.

Williams Village – Proposed residential development in the area will include regrading of the Bear Canyon Creek floodplain to accommodate housing sites, while maintaining flow capacity (i.e., volume velocity and storage).

South Campus - There has not been enough planning conducted to determine which sites will be used for which of the various land uses and which portions may be left as natural areas. Studies are on-going to ensure any development of the South Campus considers all potential flooding issues.

Mountain Research Station – Como Creek at the Research Station may also periodically flood, but the potential has not been studied. The measures adopted in the micro-master plan for the area include avoiding construction of new structures intended for human occupancy within a defined zone along the creek.

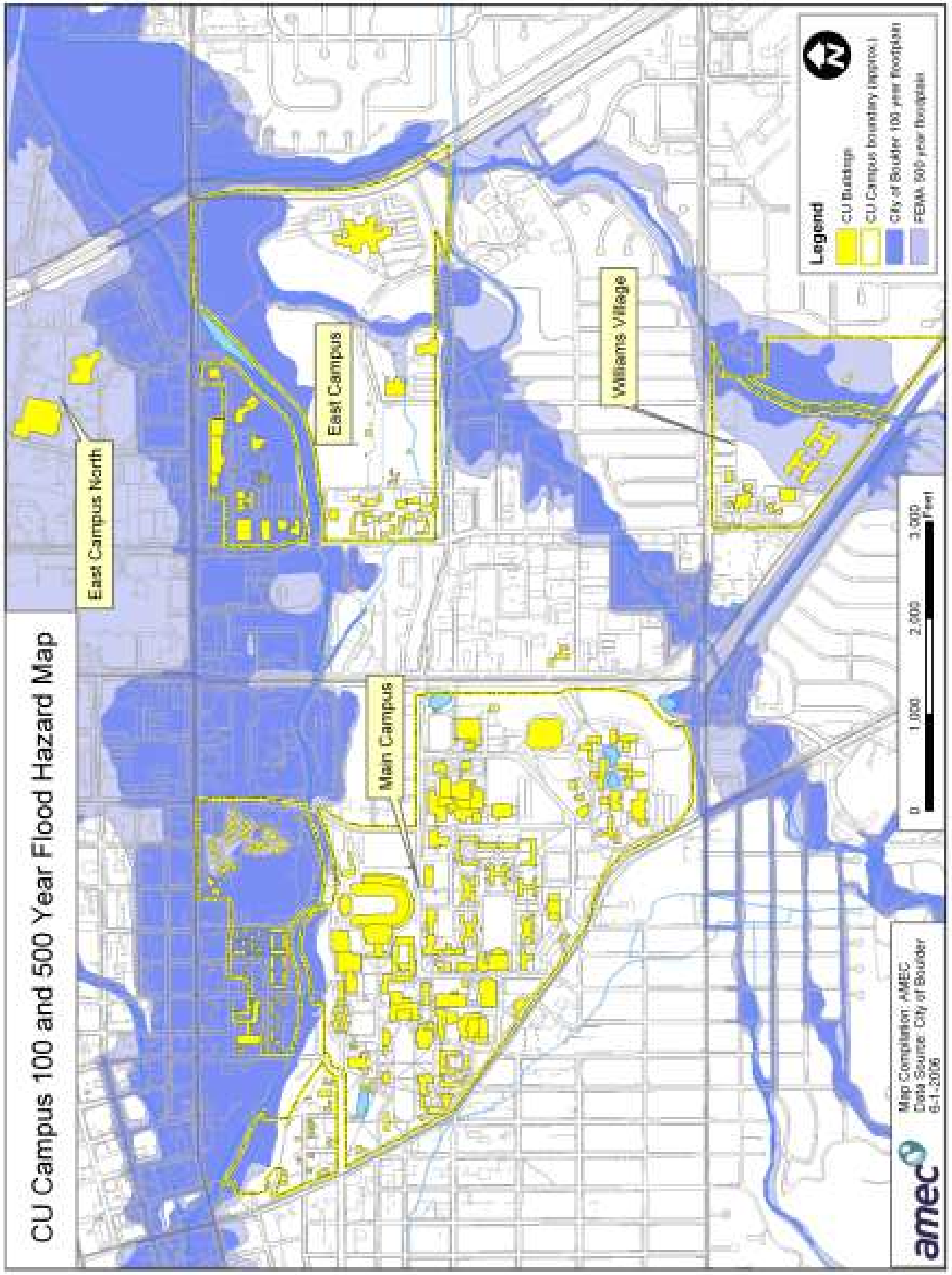
Also of concern for all properties is the smaller, more frequent floods that occur primarily as a result of local drainage issues. The design standard for a campus storm sewer and surface drainage systems is to accommodate a five-year flood, but storm sewers and surface drainage systems are not complete. Water from storms somewhat greater than a five-year storm may be accommodated within streets in many parts of campus. A few detention/retention sites are also available to manage stormwater runoff in existing and new development areas.

Taken from the Master Plan, UCB's current policy is to: Design new building development on all Campus properties to not flood in a 100-year flood. To meet this goal, several development guidelines have been established as described below:

- Do not develop buildings or parking lots in floodways;
- Elevate the first floor level of new buildings in floodplains above the 100-year flood level;
- Allow athletic playing fields and recreational facilities to be located in floodplains or floodways;
- Complete flood studies for South Campus to provide additional information needed for development; and
- Address localized flooding situations and continue to upgrade storm drainage systems.

500-Year Floodplain Analysis

The previous analysis has focused on evaluating impacts to the university from a 100-year flood event. Also to be considered are potential damages associated with a 500-year flood. A 500-year flood would result in more widespread impact to UCB properties, both in terms of the number of structures inundated and in the depth of flooding. Using GIS to model the affects, 34 UCB properties, in addition to the properties impacted by the 100-year flood, would be impacted by the 500-year flood. These properties are detailed in the map and table that follows.


CU Campus 100 and 500 Year Flood Hazard Map
East Campus North
East Campus
Main Campus
Williams Village
Legend
CU Buildings
CU Campus boundary (approx.)
City of Boulder 100 year floodplain
FEMA 500 year floodplain
0 1,000 2,000 3,000
Feet
amec
Map Compilation: AMEC
Data Source: City of Boulder
6-1-2006

UCB
500-Year Flood Hazard
Assets at Risk

CU Properties within the 500 year Floodplain, but outside of the 100 year floodplain	
Name	**Number of Structures**
Distribution center	1
Bear Creek Apartments	2
Center for Innovation & Creativity	1
Darley Towers	1
Lasp Space Tech Center	1
Newton Court	25
Presidents Residence	1
Unnamed	2
Total	**34**

With respect to UCB assets, a 500-year flood on Boulder Creek would have the greatest impacts, as opposed to the Skunk and Bear Canyon Creek drainages. As indicated above, not only does the 500-year flood damage 34 more structures than the 100-year flood, the damage to structures within the 100-year floodplain are greater due to the increased flood depth within the area of the 100-year floodplain. Other impacts would be increased displacement time for student residents and increased functional downtime of UCB facilities.

Big Thompson Scenario

Also of concern to UCB is a larger scale flood event occurring on Boulder Creek. Using information developed by the City and County of Boulder for their 2006 “Big Thompson” on Boulder Creek Flood Exercise, the HMPC analyzed the potential impacts to the university associated with this larger scale event. This “Big Thompson” scenario flood on Boulder Creek modeled the affects of a flood equal in magnitude as the Big Thompson Flood of 1976 on Boulder Creek under current 2006 conditions. This scenario is considered a probable, 1000 year event, based on actual parameters that occurred over Big Thompson Canyon.

Extracting data developed by the City and County of Boulder for their 2006 Emergency Response Flood Exercise, UCB would be impacted by such a scenario as follows:

- UCB Married Student Housing on Marine Street – 8 feet of flooding, structural failures and collapse, non-repairable.
- UCB Newton Court Student Housing – 4 feet of flooding, damage to main level units.
- UCB East Campus on Marine Street – 6 feet of flooding, significant structural and content losses.
- All north-south roadway crossings of Boulder Creek would be washed out with multiple bridge failures.

Also using this data, damage assessments for UCB are summarized in the following table.

Big Thompson on Boulder Creek Exercise – Realistic Damage Assessment
Using 2000 Census Data & Based on FEMA's Depth-Damage Curve

DEPTH	College Enrollment (population)	Building Value	Building Value Loss	Total Value	Building Contents Value	Building Contents Value Loss	Total Value Loss
< 2 Feet	201	$148,541	$20,796	$371,503	$222,962	$67,618	$67,618
2 - 4 Feet	1006	$1,087,078	$271,769	$2,718,226	$1,631,148	$875,294	$875,294
4 - 8 Feet	884	$2,177,888	$805,819	$5,445,115	$3,267,227	$2,635,466	$2,635,466
> 8 Feet	511	$2,227,492	$1,136,021	$5,569,155	$3,341,662	$3,508,601	$3,508,601
Totals	**2602**	**$5,641,000**	**$2,234,405**	**$14,103,999**	**$8,463,000**	**$7,086,979**	**$7,086,979**

VULNERABILITY TO WILDFIRES

Risk – Likely; Vulnerability –Medium

Given the predominantly urban setting of the UCB Planning Area, the risk and vulnerability from wildfires is of relatively limited concern. In the larger Boulder County area, high fuel loads, along with geographical and topographical features of the foothills areas, create the potential for both natural and human-caused fires resulting in loss of life and property. These factors, combined with natural weather conditions common to the area, including periods of drought, high temperatures, low relative humidity, and periodic high wind conditions, can result in frequent and sometimes catastrophic fires. Even the relatively flat, more populated portions of the county are not immune, with large areas of dry vegetation and the greater potential for human-caused ignitions. Any fire, once ignited, has the potential to quickly become a large, out-of-control fire.

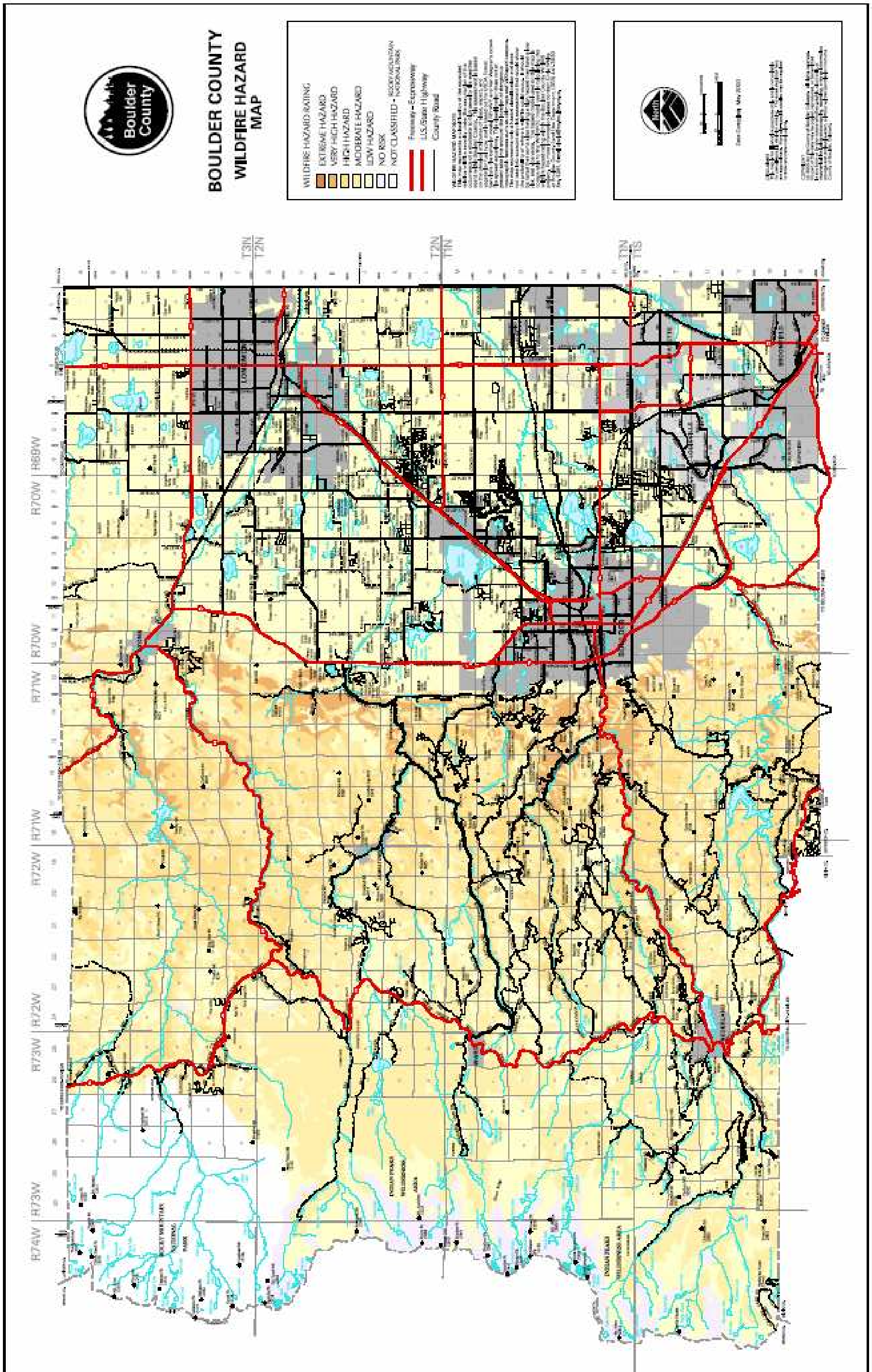
To evaluate the risk and vulnerability of the UCB Planning Area to wildfire, Boulder County's Wildfire Hazard Identification and Mitigation System (WHIMS) was used. WHIMS was a cooperative effort with the Colorado State Forest Service that began in 1992 to identify wildfire hazards and assess risks due to wildfires for the wildland urban interface (WUI) areas along Boulder County's front range. Using geographic data management and analysis modeling, the following maps were developed:

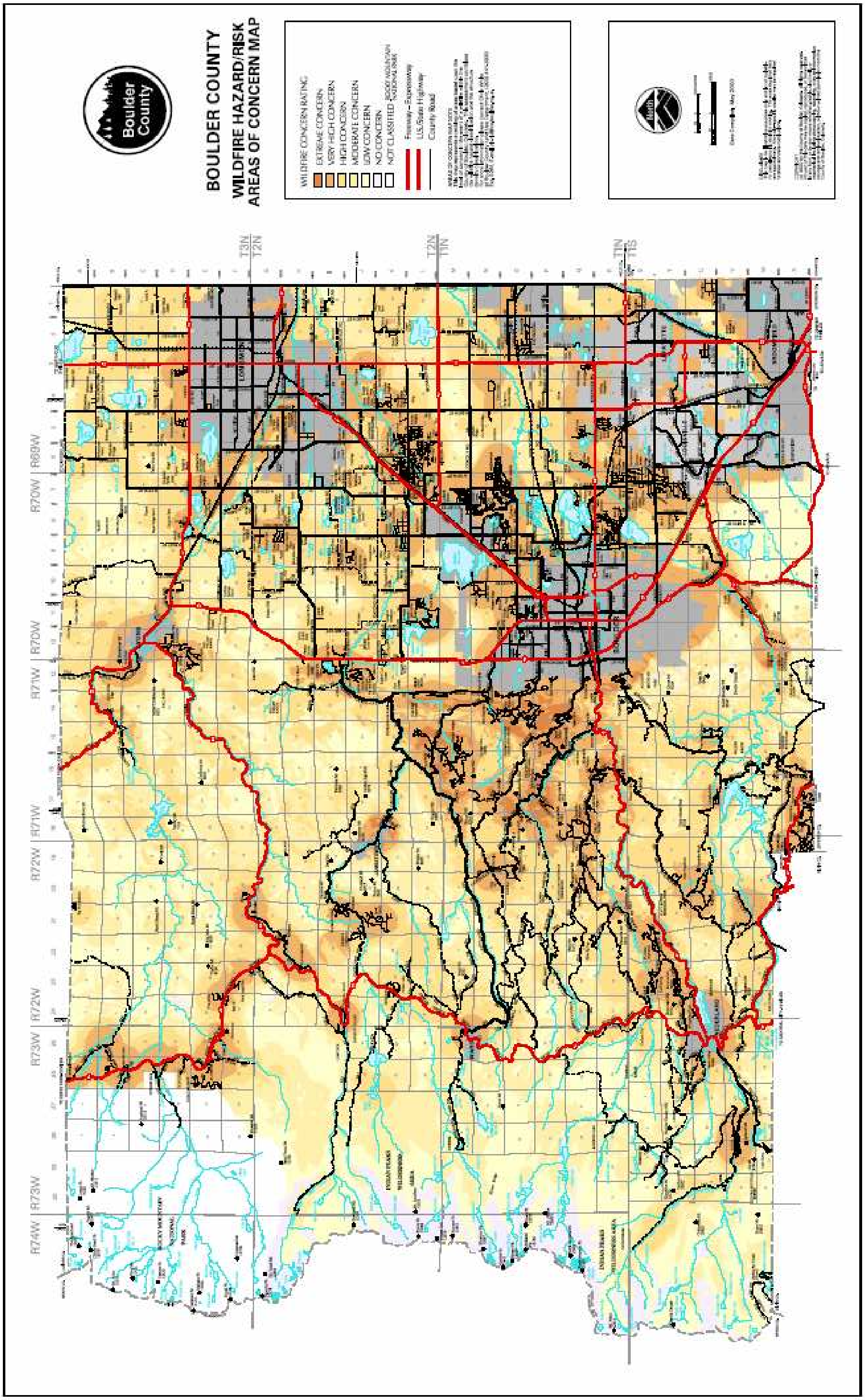
- a **Wildfire Hazard Map** that identifies the slope, aspect, elevation and vegetation fuel type along the interface;
- a **Structure Density Map** that shows the density of buildings, homes, and other physical structures in the study area; and,
- an **Area of Concerns Map** that shows the areas of high risk in the event of wildfire. This map is a result of combining the wildfire hazard and structure density maps.

Pictured below is the Wildfire Hazard Map, the Area of Concerns Map, and a flow diagram illustrating the WHIMS methodology. It is important to note that this data only covers the portions of UCB outside City of Boulder boundaries: the South Campus and the Mountain Research Station. Analyzing this information relative to the UCB Planning Area defines the risk and vulnerability of these Campus areas to wildfire:

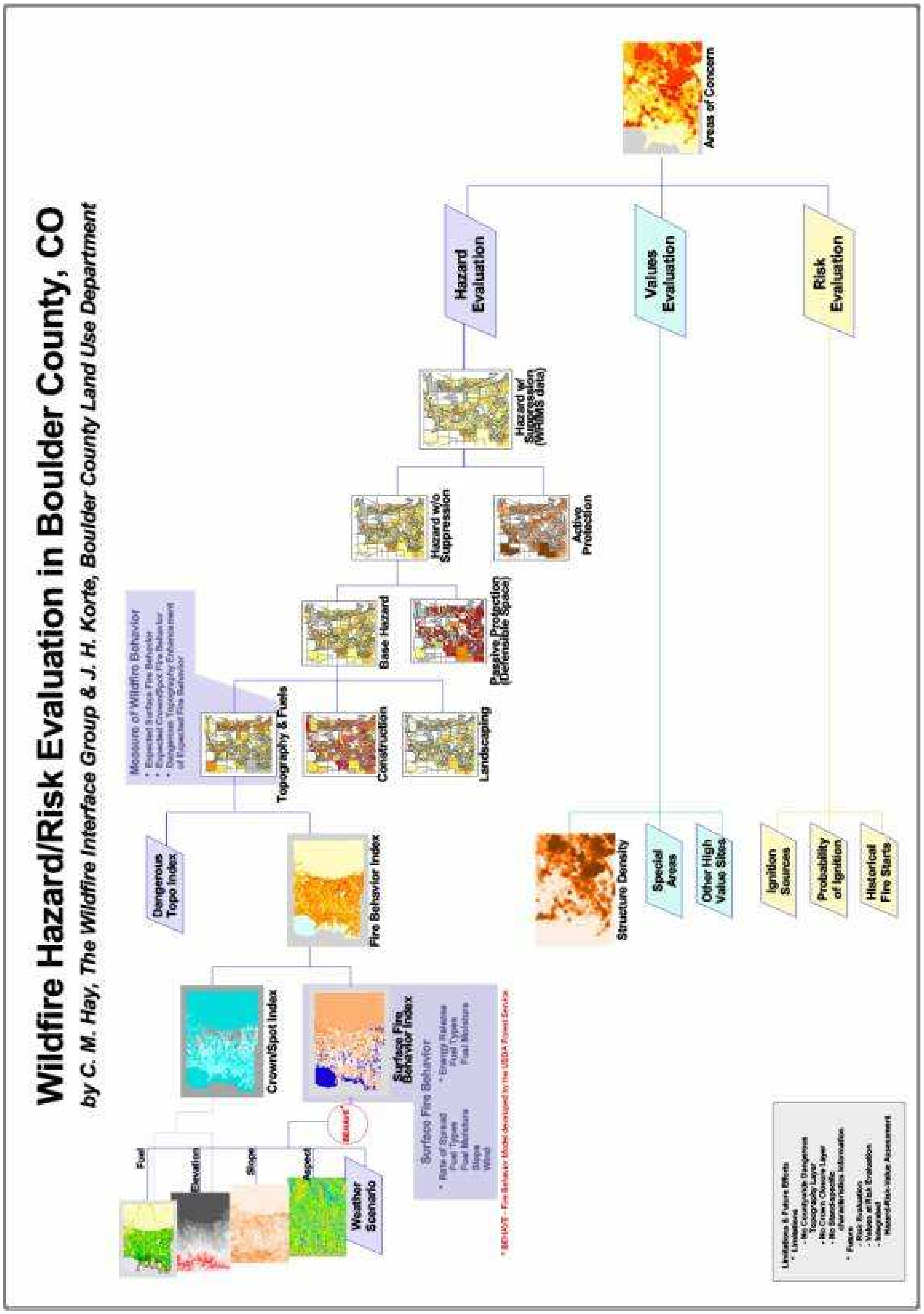
- **South Campus** – Looking at the Wildfire Hazard Map, the South Campus is located in an area of generally Low Hazard. A review of the Area of Concerns Map places the South Campus in an area of Very High Concern.

- **Mountain Research Station** – The Wildfire Hazard Map places the Mountain Research Station in an area of Moderate Hazard. The Area of Concerns Map locates the Research Station in an area of High Concern. The Campus Master Plan recognizes fire protection issues unique to this property that include the remote location, surrounded by forest, and with buildings constructed largely of wood.


Boulder County
BOULDER COUNTY
WILDFIRE HAZARD MAP
WILDFIRE HAZARD RATING
EXTREME HAZARD
VERY HIGH HAZARD
HIGH HAZARD
MODERATE HAZARD
LOW HAZARD
NO RISK
NOT CLASSIFIED - ROCKY MOUNTAIN NATIONAL PARK
Freeway - Expressway
U.S./State Highway
County Road
T3N
T2N
T1N
T1S
R74W
R73W
R72W
R71W
R70W
R69W



BOULDER COUNTY
WILDFIRE HAZARD/RISK
AREAS OF CONCERN MAP
WILDFIRE CONCERN RATING
EXTREME CONCERN
VERY HIGH CONCERN
HIGH CONCERN
MODERATE CONCERN
LOW CONCERN
NO CONCERN
NOT CLASSIFIED
ROCKY MOUNTAIN NATIONAL PARK
Freeway - Expressway
U.S./State Highway
County Road


Wildfire Hazard/Risk Evaluation in Boulder County, CO
by C. M. Hay, The Wildfire Interface Group & J. H. Korte, Boulder County Land Use Department
Fuel
Elevation
Slope
Aspect
Weather Scenario
Crown/Spot Index
Surface Fire Behavior Index
Surface Fire Behavior
Fire Behavior Index
Dangerous Topo Index
Measure of Wildfire Behavior
Topography & Fuels
Construction
Landscaping
Base Hazard
Passive Protection (Defensible Space)
Hazard w/o Suppression
Active Protection
Hazard w/ Suppression (WRMS data)
Hazard Evaluation
Values Evaluation
Risk Evaluation
Areas of Concern
Structure Density
Special Areas
Other High Value Sites
Ignition Sources
Probability of Ignition
Historical Fire Starts

Values at Risk

Using the Wildland Fire Risk Map and information provided by University Risk Management, the HMPC conducted additional analyses to determine values of identified parcels at risk. The analysis was conducted using the areas of concern map, which combines both the wildfire hazard elements with the structure density data. The results are included in the following table.

UCB Assets and Values at Risk
Wildfire Hazard

Campus Property	Number of Buildings			Value of Buildings and Assets		
	Total # of Buildings on Campus	# in Hazard Areas*	% of all UCB Buildings in Hazard Area	Total $ of Buildings on Campus	$ in Hazard Area	% of all UCB Buildings in Hazard Area
Main Campus	154	0	0%	$1,939,852,996	0	0%
East Campus	25	0	0%	$158,843,715	0	0%
Williams Village Campus	7	0	0%	$87,377,110	0	0%
South Campus: Warehouse	1	1	100%	$950,510	$950,510	0.043%
Mountain Research Station Campus, Other	2	2	100%	$3,976,700	$3,976,700	0.18%
Other	5	0	0%	$13,362,960	0	0%
Totals	**194**	**3**	**1.55%**	**$2,204,363,991**	**$4,927,210**	**0.22%**

*Includes campus properties identified in areas of both High and Very High Concern.

UCB
Populations at Risk
Wildfire Hazard

Campus Property	Number of Staff			Number of Students		
	Total # of Staff on Campus	# in Hazard Area	% of all UCB Staff in Hazard Area	Total # of Students on Campus	# in Hazard Area	% of all UCB Students in Hazard Area
Main Campus	12,601	0	0%	30,115	0	0%
East Campus	1360	0	0%	362	0	0%
Williams Village Campus	9	0	0%	1,413	0	0%
South Campus: Warehouse	0	0	0%	0	0	0%
Mountain Research Station Campus, Other	2	2	0%	0	0	0%
Other	28	0	0%	0	0	0%
Totals	**14,000**	**2**	**0.014%**	**31,890**	**0**	**0%**

*Includes campus properties identified in areas of both High and Very High Concern.

Summary of UCB Assets and Values at Risk in Wildfire Hazard Area
In analyzing this data, 1.55% of the total number of UCB buildings are located in the Wildfire Hazard area. This includes 100% of UCB's buildings located at the South Boulder and Mountain Research Station properties.

The above tables show $4,927,210 or 0.22% of the total UCB values to be located in an area of High or Very High Concern with respect to the Wildfire hazard. Also to be added to this value is the Business Income value. To do this, we took 0.22% of the total Business Income Value of $122,229,582 (for $268,905) added this sum to the $4,927,210, and came up with total values at risk in the High or Very High Wildfire Hazard of $5,196,115.

According to available data, only two of the 14,000 person staff and none of the students have work/school locations assigned to the two properties (i.e., Mt. Research Station and South Campus) located within the Wildfire Hazard Area. However, it must be recognized that some number of both staff and students frequent both the Mountain Research Station (which includes overnight accommodations) and South Campus properties, even if only on a transient basis.

Critical Facilities at Risk

Critical facilities at risk would include those associated with the South Campus and Mountain Research Station. According to available data, there are no Priority One or Priority Two critical facilities located at either the South Campus or Mountain Research Station properties.

Cultural and Natural Resources at Risk

There are no identified cultural resources associated with either the South Campus or Mountain Research Station Properties.

Natural resources at risk would include those Threatened and Endangered Species and wetlands associated with the South Campus and Mountain Research Station properties as listed below:

South Campus

- Ute ladies' tresses orchid
- A wetland delineation study will be conducted prior to additional site development

Mountain Research Station

- Greenback cutthroat trout
- Natural wetlands are present. Construction of experimental riparian wetlands are planned to filter water entering Como Creek in order to maintain and improve the habitat for the Greenback trout.

In addition to previously identified wetlands and threatened and endangered species, there are other natural resources at risk when wildland-urban interface fires occur. The first are the watershed and ecosystem losses that occur from wildland fires. The second are the forest and ground cover assets that make up the lifestyle aspects of living in the area. The last is the aesthetic value of the area. Major fires that result in visible damage detract from that value. Because the UCB Planning Area borders Arapahoe-Roosevelt National Forest, the issues of watershed, wildlife, and recreation tourism are all critical elements to UCB and surrounding areas and are all at risk from wildfire hazards. Further, the Mountain Research Station is considered one of the premier alpine research facilities in the world. Damage to the mountain ecosystem could certainly compromise ongoing research efforts at this facility.

Overall Community Impact

The overall impact to the community from a wildfire includes:

- Potential for injury and loss of life
- Structural damage
- Impact on the water quality of watersheds located within the county
- Impact to natural resource habitats and other resources
- Loss of water, power, roads, phones, and transportation could impact, strand and/or impair mobility for UCB staff and students
- Loss of structures and ecosystem associated with research studies and grants
- Disruption in university services
- Significant impact on the overall mental health of the university community
- Exacerbation of flood risk due to Increased runoff from watersheds post-fire also exacerbate the flood risk

Development Trends

UCB properties with available wildfire hazard data include the South Campus and Mountain Research Station. Development trends for these UCB properties are those previously described. These trends relative to the wildfire hazard are discussed further by property.

South Campus – Currently only one warehouse building is located on the property. Studies are on-going to ensure any development of the South Campus considers all land use issues. According to the Campus Master Plan, the conceptual land use assessment for the South Campus will identify site opportunities and constraints for the purpose of strategically locating athletics and recreation fields. During the short term, UCB expects to use the property for outdoor intercollegiate athletics facilities, recreational fields, pedestrian and bicycle trails, grazing, storage, and a cross-country running course. Outdoor research projects may also occur at the South Campus. Minor support and spectator facilities may also be included in future development.

Mountain Research Station – The developed portion of the property sits on a south-facing sub-ridge below Niwot Ridge. The site slopes steeply to the south. Many of the level areas are boggy and have springs. Future development will likely occur in areas with a slope. Six potential building sites are proposed within the year-round lower shelf area. In addition to the development of new structures, future plans include creating nature trails throughout the property and further development of utilities to support site activities, including a new wastewater treatment plant and improvements to existing utilities. New development of the area will utilize construction materials suitable for construction in areas of high fire hazard.

Other Identified Hazards: Avalanches, Dam Failure Drought, Earthquakes, Landslides and Rockfalls, Human-Health Hazards, Severe Weather, Soil Hazards, Volcanoes

For the other hazards identified in the Hazard Identification section of this Plan, information is available where the potential impacts can be developed or inferred, although it is not tied to a specific location. For these other identified hazards, the entire UCB Planning Area is potentially at risk. The following sections describe the vulnerability of UCB to these other hazards.

VULNERABILITY TO AVALANCHES

Risk – Unlikely; Vulnerability – Extremely Low

Avalanches following snowstorms often occur and have historically resulted in both injuries and fatalities. This hazard is primarily limited to the western portion of the UCB Planning Area in sloped areas in and around the Mountain Research Station property. This hazard generally affects only a small number of people - mostly recreational users of backcountry areas. There is no recorded history of avalanches occurring on the Research Station property and the sloped areas within the property boundaries generally exceed a 1-to-8 slope (<11.25°) which is well below the CAIC data that indicates that 98% of all avalanches occur on slopes of 25-50%. As such, Mountain Research Station structures, utilities, and people are not considered at risk within the property boundaries. It is possible, however, that researchers from the Mountain Research Station could be at risk in backcountry research areas with greater sloped areas.

VULNERABILITY TO DAM FAILURES

Risk – Unlikely; Vulnerability –High

Dam failure flooding can occur as the result of partial or complete collapse of an impoundment. Dam failures often result from prolonged rainfall and flooding. The primary danger associated with dam failure is the high velocity flooding of those properties downstream of the dam. Of the 24 Class I and 16 Class II dams identified, only six were identified by the HMPC with the potential to adversely impact the UCB Planning Area in the event of a failure:

- Class I: Barker, Gross, Jasper, and Silver Lake
- Class II: Albion and Goose Lake

The Division of Water Resources runs the Dam Safety Program in Colorado. According to the State Natural Hazard Mitigation Plan, Colorado has Emergency Action Plans for 95% of the state-regulated high- and significant-hazard potential dams. Inundation maps for some dams have also been developed. Of the six dams identified above, only Barker and Gross reservoirs have inundation maps. However, for homeland security purposes, the inundation maps for Barker and Gross and any associated analysis are not included in this plan.

Without available inundation maps for all dams that present a hazard to the UCB Planning Area and recognizing that a dam failure can range from a small, uncontrolled release to a catastrophic failure, no further analyses were done with respect to potential values and significant assets at risk in the inundation zones. However, based on this planning level analysis, the mapped inundation zones generally follow the existing streams and drainage areas, and areas subject to flooding from a dam failure would primarily be those located along streams and drainages.

The overall impact to the University community from a dam failure includes those previously identified for flood events. The biggest difference is that a catastrophic dam failure has the potential to result in a much greater loss of life and destruction to property and infrastructure due to the lack of early warning and potential speed of onset.

VULNERABILITY TO DROUGHT

Risk – Likely; Vulnerability –Low

Drought is different than many of the other natural hazards in that it is not a distinct event, and usually has a slow onset. Drought can severely impact a region both physically and economically. A drought's effects impact various sectors in different manners and with varying intensity. Adequate water is the most critical issue. As an area's population continues to grow, so will the demand for water.

Based on historic information, the occurrence of drought in Boulder County and the UCB Planning Area is cyclical, driven by weather patterns. Drought has occurred in the past and will continue to occur in the future. The periods of actual drought with adverse impacts can vary from short to long term; often the period between droughts is extended. Although an area may be under an extended dry period, defining when a drought occurs is a function of drought impacts to individual water users. Since 1893, Colorado has experienced five multi-year droughts throughout the state. The HMPC identified four drought events impacting the area since 1990. The vulnerability to the UCB Planning Area from drought is usually campus-wide, and depending on the area includes reduction in water supply and an increase in dry fuels and wildfire potential. Most of the campus is irrigated with raw water from senior water rights owned by the University, so impacts associated with a reduction in water supply is limited, depending on the length and severity of the drought. UCB's senior water rights are very high priority; only once, in 2002, were they called out of priority.

VULNERABILITY TO EARTHQUAKES

Risk – Occasional; Vulnerability –High

Earthquake vulnerability is primarily based upon population and the built environment. Urban areas in high hazard zones are the most vulnerable, while uninhabited areas are less vulnerable. The ability to accurately estimate the timing, location, and severity of future earthquake activity in Colorado is limited due to the lack of good historic data and the relative infrequent occurrence of earthquakes in Colorado.

Ground shaking, the principal cause of damage, is the major earthquake hazard. Many factors affect the potential damageability of structures and systems from earthquake-caused ground motions. Some of these factors include proximity to the fault and the direction of rupture, epicentral location and depth, magnitude, local geologic and soils conditions, types and quality of construction, building configurations and heights, and comparable factors that relate to utility, transportation, and other network systems. Ground motions become structurally damaging when average peak accelerations reach 10 to 15 percent of gravity, average peak velocities reach 8 to 12 centimeters per second, and when the Modified Mercalli Intensity Scale is about VII (PGA 18-34%).

> Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving cars. (Bolt, 2003)

The USGS's Probablistic Seismic Hazard Map of Colorado shown in Section 4.1 is a two percent probability over 50 years of shaking intensity. UCB (Boulder County) lies in the range of 10-12% acceleration. Shaking is measured in a variety of ways, including peak ground acceleration, peak ground velocity, and spectral acceleration. This map is spectral acceleration, at one second frequency. The reason for looking at different frequencies is due to building response. In general, taller buildings may experience more damage by energy released in longer waveforms due to the harmonics of building sway, and ground shaking. Natural or artificially filled areas tend to experience amplified motions, liquefaction, and associated ground failures that can cause extensive damage. Subsurface soils in the UCB Planning Area vary and are site-specific.

Fault rupture itself contributes very little to damage unless the structure or system element crosses the active fault. There are no known potentially active faults in the Planning Area. In general, newer construction is more earthquake resistant than older construction because of improved building codes and their enforcement. Manufactured housing is very susceptible to damage because rarely are their foundation systems braced for earthquake motions. Locally generated earthquake motions, even from very moderate events, tend to be more damaging to smaller buildings, especially those constructed of unreinforced masonry.

Common impacts from earthquakes include damages to infrastructure and buildings (e.g., crumbling of unreinforced masonry [brick], collapse of architectural facades; rupture of underground utilities; gas-fed fires; landslides and rock falls; and road closures). Earthquakes also frequently trigger secondary effects, such as dam failures, explosions, and fires that become disasters themselves.

HAZUS-MH Earthquake Scenarios

The State of Colorado in their Natural Hazard Mitigation Plan utilized HAZUS to model earthquake losses for Colorado's eastern plains, including Boulder County. The results of the HAZUS runs identified the following top five counties at the greatest risk (i.e., high monetary loss, casualties, and loss ratios) from an earthquake: El Paso, Jefferson, Denver, Summit, and Chaffee. Boulder County, while not on this list borders both Denver and Jefferson Counties.

The State run HAZUS results generated for Boulder County are detailed below. The results are reported in the following format:

HAZUS Risk:
N Sangre: M7.5 – 4 fatal, $152.7 Million (-8.0%).

- "N Sangre" is the name of the fault (North Sangre de Cristo fault)
- "M7.5" is the magnitude chosen for that scenario
- "4 fatal" is the number of deaths calculated in the casualty results. There are four levels of severity for casualties, with the highest being death.
- "$152.7 Million" is the total economic loss which includes direct and indirect.
- "(-8.0%)" is the loss ratio, which is the percentage of the total building stock value damaged. The higher this ratio, the more difficult it is to restore a community to viability.
- Fault names and information are from CGS Colorado Late Cenozoic Fault and Fold Internet Map Server: (http://geosurvey.state.co.us/CGS_Online/WEB/LoadMap.cfm)
- Time of most recent fault activity in parentheses after fault name: H = Holocene, LQ = Late Quaternary, MLQ = Middle to Late Quaternary, Q = Quaternary, LC = Late Cenozoic.
- Demographic data from 2000 Census and Northeastern Colorado Emergency Managers hazard analysis (www.ncem10.org/pdf/Local%20Hazards.pdf).

Boulder County HAZUS Scenarios

Boulder County:
Population: 291,288 Growth since 1990: 29.3%
County Size: 750 square miles Inventory: $23,607.40 million
Faults within County: Rock Creek (Q), Valmont (MLQ)
Historical Earthquakes: Oct. 12, 1916 Boulder (#29)
Faults analyzed for County: Frontal (LQ), Golden (Q), Mosquito (LQ), Ute Pass (MLQ), Valmont (MLQ), Walnut Creek (Q), Williams Fork (H)
Previous studies – perceived hazard: None

HAZUS Risk Based on Possible Source Faults:
Frontal: M7.0 – 0 fatal, $31.8 Million (-0.14%)
Golden: M6.5 Reverse WUS – 41 fatal, $1.44 Billion (-6.1%)
M6.0 Reverse WUS – 5 fatal, $467.5 Million (-2.0%)
M5.5 Reverse WUS – 1 fatal, $135 Million (-0.6%)
M5.0 Reverse WUS – 0 fatal, $33.5 Million (-0.14%)
Mosquito: M7.0 – 0 fatal, $31.7 Million (-0.13%)
Ute Pass: M7.0 – 0 fatal, $42.2 Million (-0.18%)
Valmont: M5.0 – 1 fatal, $256 Million (-1.1%)
Walnut Creek: M6.0 CEUS – 42 fatal, $2.14 Billion (-9.1%)
Williams Fork: M6.75 – 0 fatal, $29.3 Million (-0.12%)
M6.5 – 0 fatal, $18 Million (-0.08%)
M6.0 – 0 fatal, $4.8 Million (-0.02%)

M5.5 – 0 fatal, $0.2 Million (-0.00%)
1882 Earthquake: M6.2 – 0 fatal, $53.8 Million (-0.23%)

State HAZUS Results: Methodology and Interpretation
The results of the HAZUS runs are extremely detailed and only the summaries are presented here. The full reports are 20 pages each and include such things as casualties broken into several categories of severity and calculated at three different times of the day; building damage broken into categories; highway and utility damage; number of people needing shelter; hospitals able to function at 50% capacity one day after the earthquake, seven days after the earthquake, and two weeks after the earthquake; post earthquake fires, and volume of debris to clean up. Historical earthquake data is from CGS Colorado Earthquake Information database, soon to be published as an interactive internet map server. Event identification numbers can be found in an earthquake database table.

Inventory and HAZUS Risk are from scenarios performed in FEMA's Hazus-MH software. Deterministic scenarios were run for faults and counties to assess potential economic and social losses due to earthquake activity in Colorado. County inventories are the sum of building, transportation, and utility replacement default values in the HAZUS data tables.

Default attenuation functions for the Western United States (WUS) and the Central United States (CEUS) were used for each scenario. These functions are taken from the USGS National Seismic Hazard Maps. The attenuation, or decrease in height of seismic waves over time, is greater in the WUS region. Seismic waves travel farther in the WUS. The inverse is true for the CEUS; however, the frequency of ground motion is greater for a given moment magnitude. This means an Mw 6.5 earthquake will be more damaging in the CEUS than the WUS. The results commonly show significant differences in losses between CEUS and WUS attenuation factors. This emphasizes the importance of determining what the attenuation factor actually is in Colorado. Areas of Colorado fall in both the CEUS and WUS.

VULNERABILITY TO HUMAN HEALTH HAZARDS

West Nile Virus: Risk – Occasional; Vulnerability – Medium
Pandemic Influenza: Risk – Occasional; Vulnerability – High

West Nile Virus

Based on historic data, the risk to the UCB Planning area is occasional and the vulnerability is considered medium. The first appearance of WNV in North America occurred in 1999. As of May 2004, WNV has been documented in 47 states and the District of Columbia. In Boulder County, WNV was first detected in 2002.

In Colorado, the worst year on record was in 2003, where 2,947 cases of human WNV were confirmed, including 421 cases in Boulder County; seven people died. In 2004, Colorado only had 291 cases, with only 14 located within Boulder County. In 2005, Colorado was down to 106 human cases, with only five from Boulder County. There were no human deaths in 2004 or 2005.

Although the potential for exposure does exist in Boulder County and the UCB Planning Area, the risk should be considered in terms of adverse effects due to exposure. The county and UCB have an active vector control program in place for mosquitoes. And most important, protective measures to prevent exposure are relatively simple and cost effective. Given the nature of protective measures, such as wearing long-sleeved clothing and using bug spray, the responsibility for protection can and should be an individual responsibility. Boulder County's and UCB's public education programs for WNV should give the UCB community both the knowledge as well as access to resources to effectively counter the risk and impact from WNV.

Pandemic Influenza

Based on historic occurrences, the risk to the UCB Planning Area is occasional, but the vulnerability would be high. According to the CDC, the risk from avian influenza is generally low to most people, because the viruses do not usually affect humans. However, H5N1 is one of the few avian influenza viruses to have crossed the species barrier to infect humans, and it is the most deadly of those that have crossed the barrier. Most cases of H5N1 influenza infection in humans have resulted from contact with infected poultry. So far the spread of H5N1 from person to person has been limited and has not continued beyond one person. Nonetheless, because all influenza viruses have the ability to change, scientists are concerned that H5N1 virus one day could be able to infect humans and spread easily from one person to another. Because these viruses do not commonly infect humans, there is little or no immune protection against them in the human population. If H5N1 virus were to gain the capacity to spread easily from person to person, a pandemic could begin and everyone would be at risk.

VULNERABILITY TO LANDSLIDES AND ROCKFALLS

Risk – Unlikely; Vulnerability – Extremely Low

Historically landslides resulting in significant losses have been limited within Boulder County. Impacts from landslides primarily involve damage to infrastructure, utility systems, and roads. Landslides have not occurred within the UCB Planning Area. As a result, impacts to UCB from landslides occurring elsewhere in the county primarily involve road closures. Road closures could impact the ability to commute to and from campus properties and can impair emergency response efforts and interrupt school activities. Due to its location above Boulder Canyon, the Mountain Research Station is the UCB property that would most likely be affected by a road closure caused by a landslide.

VULNERABILITY TO SEVERE WEATHER

Extreme Temperatures: Risk – Highly Likely; Vulnerability – Low
Hailstorm: Risk – Likely; Vulnerability – Medium
Heavy Rains/Thunderstorms: Risk – Highly Likely; Vulnerability – Low
Lightning: Risk – Highly Likely; Vulnerability – Medium
Tornadoes: Risk – Likely; Vulnerability – Low
Windstorms: Risk – Highly Likely; Vulnerability – Medium

Looking at historical hazard data for Boulder County and the UCB Planning Area, severe weather is an annual occurrence; damages and disaster declarations related to severe weather events have occurred in the past and will continue to occur in the future. The severe weather evaluated as part of this risk assessment included: extreme temperatures, fog, hailstorms, heavy rains/thunderstorms, lightning, tornadoes, windstorms, and winterstorms. As previously indicated, due to the lack of historical occurrences and/or negligible damages, fog is not discussed further in this Risk Assessment. The historical damages associated with the primary effects of severe weather have been limited within the Planning Area and are discussed below. It is the secondary effects of weather such as flood and fire that have had the greatest potential impact to UCB. The risk and vulnerability associated with these secondary impacts are discussed in these other sections.

Extreme Temperatures

Extreme temperature events occur within the UCB Planning Area on an annual basis. The elevations of the various Campus properties should be a primary factor in determining the extent to which a given property is affected by temperature extremes. Those properties located within the lower elevation of Boulder Valley (i.e., Main Campus, East Campus, Williams Village, and South Campus) generally experience high temperature extremes during the summer months, while the higher Mountain Research Station Property experiences greater low temperature extremes during the winter months. However, in looking at UCB's insurance claim history, the only claims related to extreme temperatures were for damages associated with extreme cold conditions on properties located within the lower elevation of Boulder Valley. The claims were primarily for damages caused by freezing pipes, radiators, etc. This leads one to believe that while elevation should be a key factor in determining the vulnerability of UCB properties to extreme temperatures, the quantity, age, and construction of structures located at the lower elevation campus properties results in a greater net vulnerability in these areas.

Hailstorms

According to the State Natural Hazard Mitigation Plan, Boulder County experienced 49 hailstorm events between 1993 and 2000 resulting in $1 Million in damages. The HMPC did not identify any historic insurance claims for hail for UCB properties. However, given the magnitude of historic hail storms and associated losses in Boulder County and the Denver Front Range, the entire UCB Planning Area remains at risk and is vulnerable to future hailstorms.

Heavy Rains/Thunderstorms

Boulder County and the UCB Planning Area experience heavy rains and severe thunderstorms during the spring, summer, and early fall on an annual basis. Both global and regional climate patterns determine the potential severity of these storms from year to year. The entire planning area is equally at risk; it is often a matter of chance as to which drainage area a slow-moving storm might linger.. Based on historic information, the primary effect of these storms has not resulted in significant injury or damages to people or property. Direct damages incurred by UCB were predominantly for water damage during heavy rains caused by leaking buildings and drains backing up. Although UCB continues to make improvements to the area of stormwater drainage, such improvements can only provide a certain level of protection. In addition, future development occurring within and adjacent to UCB properties will continue to affect current stormwater drainage patterns and capacities. As such, the UCB Planning Area will continue to be vulnerable to the effects of heavy rains and thunderstorms. It is the secondary affect of flooding caused by heavy thunderstorms which results in the greatest vulnerability to UCB.

Lightning

With 39 fatalities, Colorado ranks only behind Florida and Texas for the number of lightning fatalities between 1990 and 2003. Information obtained from the Lightning Safety Institute identified 4 fatalities and 27 injuries occurring within Boulder County from 1980 through 2000. Cloud-to-ground lightning is the most dangerous form of lightning. Boulder averages 3.5 thousand cloud-to-ground flashes per year. Additional statistics for Colorado estimate that one out of 52 lightning flashes results in an insurance claim. UCB has had past damage claims from lightning damage. Given the lightning statistics for Colorado and Boulder County and the history of UCB claims, the entire UCB Planning Area remains at risk and is vulnerable to the effects of lightning.

Tornadoes

Based on data from 1950-1995, Colorado, when compared to other states by the frequency of tornadoes per square mile, ranks number 28 for the frequency of tornadoes, number 38 for fatalities, number 37 for injuries per area and number 37 for costs per area. During a 54-year period, 10 tornadoes occurred in Boulder County, equating to one tornado every five years, on average. Of these 10 occurrences, two tornadoes were magnitude F0 on the Fujita scale, six were F1, and two were F2. UCB had no record of damages associated with tornadoes. Further, tornadoes in Colorado tend to be small, short-lived, and relatively weak as compared with the plains states tornadoes. Given the frequency and nature of tornadoes in Colorado, the UCB properties (i.e., all but the Mountain Research Station) located in the Boulder Valley will continue to be at risk and are vulnerable to tornadoes.

Windstorms

Boulder has some of the highest peak winds of any city in the U.S. According to data compiled by University Corporation for Atmospheric Research (UCAR), damage from Boulder’s winds averages about a million dollars per year. One exceptionally strong storm in 1982 resulted in more than $10 million in damages. Since 1980, UCB has filed 34 claims for wind damage totaling over $360,000. The claims ranged from tiles coming off roofs, to entire roofs coming off buildings, to UCB-owned boats flying into other boats. As previously described, high winds are a common event in the Boulder area. Given historical data, topography of the area, and weather patterns, the entire UCB Planning Area will continue to be at risk and vulnerable to high wind events.

Winterstorms

Impacts to the UCB Planning Area as a result of winter snowstorms include damage to infrastructure, frozen pipes, utility outages, road closures, traffic accidents, and interruption in business and university activities. Delays in emergency response services can also be of significant concern. Further, there are economic impacts associated with areas prone to heavy snow. Depending on the nature of a given storm, the entire Planning Area is at risk to winterstorms. While the Mountain Research Station receives a greater amount of snowfall during the winter months and access to the property can be difficult, the overall vulnerability to UCB is low due to the limited number of assets located on the property. Severe winterstorms occurring in the Boulder Valley area have the potential to adversely impact the other four Campus Properties. Of these, activities and damages to Main Campus, East Campus and Williams Village would be the most significant given the number of buildings and the student and staff population in these areas.

Like most weather events, periods of heavy snow occur on an annual basis. University closures, when they do occur, are usually short-lived. Damages to infrastructure and landscaping (i.e., mostly trees in wet heavy snows) also occur. The economic impact for increased manpower and efforts for general snow-removal efforts is usually included in annual budgets.

VULNERABILITY TO SOIL HAZARDS

Expansive Soils: Risk – Occasional; Vulnerability – Low
Land Subsidence: Risk – Occasional; Vulnerability – Low

Expansive Soils

Expansive soils in Colorado are a common problem. UCB has experienced construction-related issues associated with expansive soils, specifically during construction of the Coors Event Center. However, with proper testing and mitigation during future construction projects, adverse impacts from expansive soils should be minimal.

Land Subsidence

Subsidence is a known occurrence in Boulder County. UCB has also experienced subsidence-related issues on a couple of their buildings (i.e., Clare Small Gym area), which have since been fixed and have experienced no additional problems. Since subsidence in the county is predominantly attributable to past mining activities, the risk to UCB is considered occasional and the vulnerability low.

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Multi-Hazard DRU Mitigation Plan
4.3 Capability Assessment

Thus far, the planning process has identified the natural hazards posing a threat to the UCB Planning Area and described and quantified the vulnerability of UCB to these risks. The next step is to assess what loss prevention mechanisms are already in place. Doing so provides UCB's "net vulnerability" to natural disasters and more accurately focuses the goals, objectives and proposed actions of this plan designed to reduce the impacts of these risks. This part of the planning process is referred to as the "Capability Assessment."

The HMPC took two approaches in conducting this assessment. First, an inventory of existing policies and plans was made. These policy and planning documents were collected and reviewed to determine if they contributed to reducing hazard related losses or if they inadvertently contributed to increasing such losses. The purpose of this effort was to identify activities and actions beyond policies, regulations and plans that were either in place, needed improvement, or could be undertaken, if deemed appropriate. A summary of each of these elements that contribute to the overall Hazard Mitigation framework at UCB follows.

UCB MASTER PLAN, UPDATED FEBRUARY 2000

The Campus Master Plan is considered a comprehensive and long-term (10-year) document that serves as the University's "constitution" for land use and future development. The Master Plan guides the use of the University's land between 1998 and 2008 and succeeds the Campus's 1990 Master Plan. Besides being essential for proper University physical development, a facilities master plan is required by the Colorado Commission on Higher Education (CCHE) and:

- Establishes overall goals, objectives, and design principles that serve as a framework for future physical development.
- Provides long range planning for architecture, land use, space use, landscape, transportation, parking, and utilities.

The Master Plan sets the stage in its first two sections, laying out UCB's setting and history as well as the campus's goals and projections for enrollment, sponsored research and employment. The next section, on Facilities Needs, examines the amount of space the campus will require in the next 10 years for academic and research uses, services and administration, intercollegiate athletics, recreation, and residential and conference facilities. The bulk of the document is found in the fourth section, The Land and Facilities, which contains chapters on buildings, outdoor areas, environmental management, transportation and utilities infrastructure. Noting that some of the campus's long-term development will occur on UCB's perimeter properties, the report also contains "micro-master" plans for: the Grandview neighborhood, Williams Village, CU-Boulder South, and the Mountain Research Station. Micro-master plans also exist for: Campus Lighting Plan, CU Boulder Research Park, Intercollegiate Athletics, East Area of Main Campus Land Use Evaluation, Norlin Quadrangle Historic Area, and 28th Street Landscape Master Plan.

Flood Considerations

According to the Master Plan, the flooding potential is one of the major influences on campus land use planning. Reducing the likelihood of flood damage through appropriate land use planning, building siting and building design is an important component of campus master planning. The Plan recognizes regulation of the 100-year flood event. Flood control issues and policies are identified in the Plan and include the following:

- Defines certain City of Boulder regulations for floodplain management indicating that while the University does not use the City of Boulder terminology or regulations, the information is considered in accordance with state Executive Order # 8504.
- Sets forth this goal: New building development on all campus properties should be designed to not flood in a 100-year flood. In order to achieve this goal, the following guidelines have been established in the plan:
  - ♦ Do not develop buildings or parking lots in floodways.
  - ♦ Elevate the first-floor level of new buildings in floodplains above the 100-year flood level.

- ♦ Design and locate athletics playing fields and other recreational facilities, (e.g., soccer fields) in floodplains or floodways.
- ♦ Complete flood studies for CU-Boulder South to provide additional information needed for development.
- ♦ Address localized flooding situations; continue to upgrade storm drainage systems.

- Existing housing units in the floodway and floodplain north of Boulder Creek are potentially the most vulnerable to a large, damaging flood. Flood-warning sirens have been placed to alert people along Boulder Creek of an impending flood. Planning is underway to mitigate the flood hazard for those existing campus residential units north of Boulder Creek. Options under consideration include:
  - ♦ Cooperate with the City of Boulder and the Urban Drainage and Flood Control District on their purchase and removal of the houses in the floodway east of 17th Street. Additional flood engineering studies will be needed to assess whether re-grading this property to increase flood conveyance might reduce the flood hazard for properties in the area.
  - ♦ When possible, replace the small campus bridges over Boulder Creek between 17th Street and Folsom Avenue with "breakaway bridges" as used elsewhere for pedestrian crossings of Boulder Creek. Utilities on the existing bridges ideally would be buried below the creek.
  - ♦ Consider redevelopment of Faculty Staff Court and Athens Court (perhaps in cooperation with a private developer) to elevate units and provide improved student housing.
  - ♦ Implement an evacuation plan.
- On the East Campus, most of the research and services buildings north of Boulder Creek are in a shallow floodplain of Boulder Creek. In the event of a 100-year flood, the flooding of this area would be relatively shallow according to the study prepared in March 1987 by consulting engineers titled "University of Colorado East Campus Flood-proofing Study." To mitigate potential flooding, improvements that had been recommended are being implemented when renovations occur in the area.
- The Bear Canyon Creek floodplain in Williams Village will require regrading in order to accommodate proposed residential development on that site. Flow capacity must be maintained (volume of water, velocity, and storage), but needed housing sites can be gained by regrading.
- The flooding potential of South Boulder Creek, on and around CU-Boulder South, is currently being studied as part of planning for use of the property.
- Como Creek at the Mountain Research Station may also periodically flood, but the potential has not been studied. The measures adopted in the micro-master plan for the

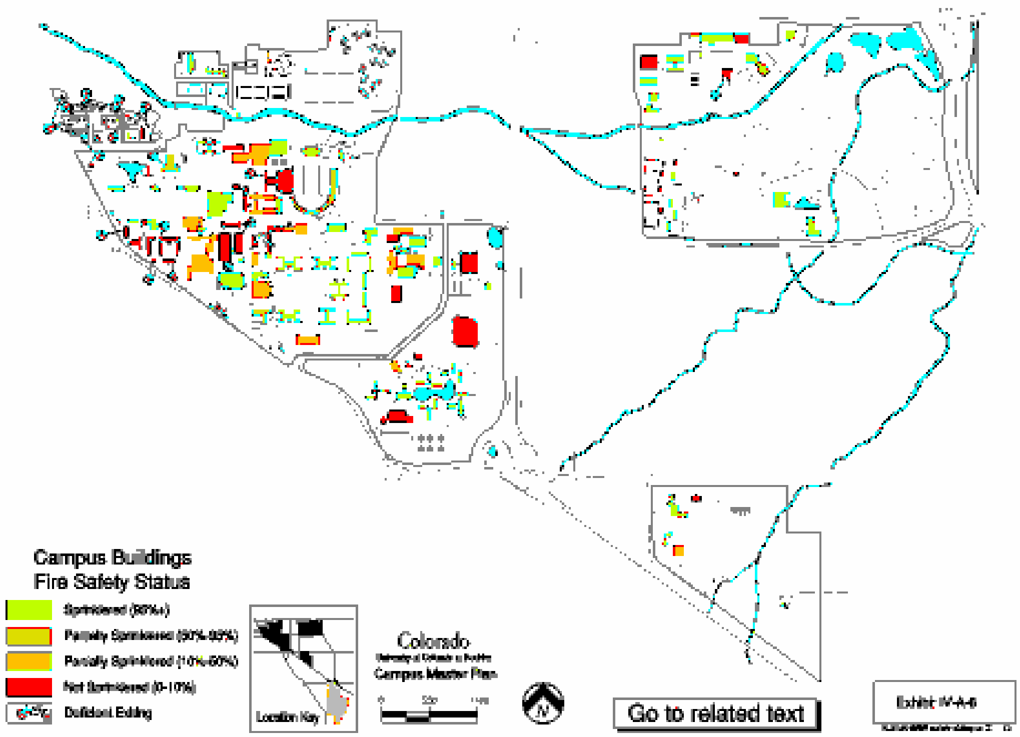
Mountain Research Station (in Section IV.B.2) include avoiding construction of new structures intended for human occupancy within a defined zone along the creek.

- On all properties, the smaller, more frequent floods are also of concern. The design standard for campus storm sewer and surface drainage systems is to accommodate a five-year flood, but storm sewers and surface drainage systems are not complete. Water from storms somewhat greater than a five-year storm may be accommodated within streets in many parts of campus. A few detention/retention areas are also available.

Fire and Life Safety Considerations

According to the Master Plan, safety is of paramount concern in future development of the campus. Increasing density increases the need for close attention to fire and life safety considerations. The level of life safety and fire protection of most UCB campus buildings is generally above normal for buildings of similar age, but below that of buildings built to current standards. The durable materials of campus buildings, including masonry walls and tile roofs, contribute to fire safety. But the wide range of building uses, including the widespread use of chemicals in research, inherently raises life safety and fire protection concerns. Fire Safety objectives include the protection of people, property and continuity of operations. According to the Master Plan, in order to meet these fire safety objectives, the fire safety features of many campus buildings should be upgraded. Specific policies and recommendations identified in the Master Plan include the following:

- Campus policies require inclusion of fire sprinklers for all new construction, renovation, and addition projects unless specifically waived by the Campus Fire Marshal. The fire safety status of UCB buildings, according to available records, is depicted in the figure that follows. The figure indicates the status of fire sprinkler protection in campus buildings and identifies those buildings in which inadequate emergency egress is an issue.



- The university as an entity of State government is not bound by local height restrictions. As such, the Campus Plan recommends providing built-in fire and life safety protection systems to the extent feasible in construction of high-rise university buildings, since the responding fire department may not have expertise and equipment for high-rise situations.

- Large building complexes such as the Engineering Center should be carefully evaluated for fire protection systems. The building size and complexities increase both the potential hazards and response time. Renovations or new construction should be arranged to minimize response times, and take advantage of modern fire detection and suppression technologies.

- Bridges between building and below grade spaces are also of concern as these building features have increasingly been used to increase campus density. There are two emergency access and fire protection issues with such features: (1) limitations on fire department access, and (2) potential fire spread from one building to another. To address fire and emergency access of these features, new construction should be designed such that there is always an alternative fire apparatus access route around a bridge or below-grade space. To address the potential fire spread potential, there should be fire separation walls and doors between buildings.

- A process is in place to ensure plan review and adherence to recommended fire protection measures. Architects and engineers submit written code reviews for construction projects. Campus authorities review construction documents and help ensure that code requirements are met. Compliance with code requirements includes the following:

- ♦ Interior building systems such as fire barriers, means of emergency escape, fire suppression, and fire detection.
- ♦ Exterior site requirements such as separation of buildings, emergency apparatus access, and water supply availability (in terms of water flows/pressure and with regard to hydrant location).
  - ▪ Adequate access by Fire Department vehicles is to be included during all phases of new construction and site development. It is the campus practice for the Boulder Fire Department to be invited to provide input for all site and building developments. Boulder Fire Department apparatus requirements with regard to width, height, and turning radius are to be addressed for necessary access in site and building designs.
- ♦ New buildings are required to be fully code compliant. Renovation and remodeling activities are to meet the same standards to the extent practicable.

- A comprehensive fire prevention program is being planned in order to reduce fire defense weaknesses attributable to misuse of the buildings and their systems, such as improper storage of combustibles or improper use of ignition sources. This program will also provide occupant training as well as notification of code violations.

Natural Resource Protection

Environmental Management Planning is an integral part of campus planning. The following goals and guidelines have been set forth in the Master Plan to ensure a safe, efficient and environmentally-friendly campus:

- Preserve riparian corridors and designated wetlands
- Preserve flora and fauna habitats
- Re-establish a sustainable drainage system will be reestablished
- Enhance detention/retention areas with appropriate landscaping
- Slope sites to drain away from buildings, sidewalks, and plazas
- Use landscaping to control soil erosion
- Use academic resources to study sustainable systems
- Use more drought-tolerant plantings, naturally grouped.

OTHER UCB PLANNING & POLICY DOCUMENTS & PROGRAMS

In addition to the Master Plan which governs future land use and development decisions at UCB, this section provides information on other UCB Planning and Policy Documents and established programs that contribute to the overall hazard mitigation framework, organized by Hazard Area.

Flood Considerations

Laws/Executive Orders

- Research conducted during the development of this DRU Plan determined that there is no record of, or mandate for, which set of rules UCB follows with respect to floodplain management. According to the HMPC, UCB has a record of adhering to the Urban Drainage and Flood Control District's regulations, policies, and guidelines.

- In general, the following set of laws and executive orders apply to state entities in the area of Floodplain Management:

  - ♦ Protection of Wetlands, 44 FR 47006, August 9, 1973
  - ♦ Flood Disaster Protection Act of 1973, 42 U.S.C. 4001, et. seq.
  - ♦ Executive Order #11988, Floodplain Management, May 24, 1977, 42 FR 26952, May 25, 1977
  - ♦ Executive Order 11990, Protection of Wetlands, May 24, 1977, 42 FR 26951, May 25, 1977
  - ♦ Colorado Executive Order #8491, Evaluation of Flood Hazards in Locating State Buildings, Roads and other Facilities, and in Reviewing and Approving Sewage and Water Facilities, and Subdivisions.
  - ♦ Colorado Executive Order #8504, Requirements and Criteria for State Participation in the National Flood Insurance Program.

These laws require that grantees review each project site to determine whether or not it is within the 100 year floodplain, or recognized wetland areas. CDBG funds should not be expended on projects in a floodplain, unless it has been determined that there is no practical alternative to such encroachment. Likewise, CDBG projects should, to the greatest extent possible, enhance, preserve, and protect wetland areas. If it appears that situating the project in a floodplain or wetland area cannot be avoided, the grantee must go through a specified public process to consider whether or not to proceed with the project. There is an eight-step process mandated by federal regulation which must be followed in these situations.

- UCB maintains flood insurance on all properties located within the 100-year floodplain.

Stormwater Program

- A stormwater study and master plan were developed in the mid-90s, and several phases of that master plan have been completed to enhance stormwater control on the main campus. In 1997, the stormwater main that runs along 18th Street and Colorado Avenue was enlarged, and several new drain inlets were installed. Subsequently, multiple phases have been completed on laterals attached to the main that "spider" across the main campus. This system has greatly improved both stormwater capacity and the number of inlets, thus significantly reducing the potential for street flooding. A second stormwater study was completed in 2004 that looks primarily at the southern part of the main campus and east campus improvements. Facilities Management is currently looking for funding to complete these stormwater control projects.
- The storm sewer system in the Research Park is owned and maintained by the City of Boulder and is adequate. As Grandview and other campus areas are developed, new storm sewer systems will also be integrated into those projects.
- It also appears that the federal government will increasingly regulate the quality of stormwater discharged into lakes and streams. The use of catch basins for sediment and the routing of stormwater through landscaped areas are being considered as local conditions warrant. The Research Park was built with such a system, assuring cleaner water returning to Boulder Creek without the oils and other water-borne additions typical of urban development.

Environmental Management

Environmental Health and Safety (EH&S) Department

The EH&S mission is to provide high quality/timely human health and safety services to the Boulder Campus community (students, faculty, staff and visitors). In addition, EH&S provides leadership in environmental stewardship and regulatory compliance assistance to the campus community. Effective fulfillment of this responsibility is made possible through the significant efforts of many individuals as well as our partnerships with various constituents of the campus community and regulatory agencies.

Environmental Management System (EMS)

An EMS has been established at UCB to provide a mechanism for environmental management of all areas and departments throughout the Boulder campus. The EMS enables UCB to initiate and maintain ongoing cycles of reviewing, planning, implementation and ultimately, the continual improvement of our environmental stewardship.

Emergency Management

Emergency Management and Business Recovery Planning

The campus Emergency Management and Planning Coordinator oversees emergency management and business continuity planning for UCB. Services include directing the Emergency Management Operations Group (EMOG):

- Offering emergency preparedness training
- Training EMOG members in the Incident Command System (ICS) and National Incident Management System (NIMS)
- Providing emergency, business continuity, and business recovery planning assistance
- Conducting and reviewing exercise guidance and review

Emergency Management and Operations Group (EMOG)

To manage emergency incidents, the University of Colorado at Boulder uses a Policy Group and an Emergency Management Operations Group (EMOG). The Policy Group serves as an advisory board for the Chancellor and provides strategic guidance during incidents. EMOG oversees operational emergency response and crisis event management. EMOG routinely meets and also participates in tabletop exercises. Typically, these exercises are attended by local city and county emergency management agencies.

- The **Policy Group** consists of the following:
    - ♦ Chancellor
    - ♦ Provost and Executive Vice Chancellor for Academic Affairs
    - ♦ Senior Vice Chancellor and Chief Financial Officer
    - ♦ Vice Chancellor for Administration (chair)
    - ♦ Vice Chancellor for Research
    - ♦ Vice Chancellor for Student Affairs
    - ♦ Associate Vice Chancellor for Academic and Campus Technology
    - ♦ Executive Director for University Communications
    - ♦ Managing Senior Associate, University Counsel
    - ♦ Executive Assistant to the Chancellor and Chief of Staff
- **EMOG** is drawn from organizations involved directly in managing emergencies or large scale events and includes representatives from the following agencies:

- ♦ Athletics
- ♦ Boulder Fire Department
- ♦ Boulder Office of Emergency Management
- ♦ Environmental Health & Safety (EH&S)
- ♦ Facilities Management
- ♦ Financial and Business Services
- ♦ Graduate School / Vice Chancellor for Research
- ♦ Housing and Family Housing
- ♦ Information Technology Services / Telecommunications
- ♦ Natural Hazards Center
- ♦ Public Safety
- ♦ Recreation Services
- ♦ Risk Management
- ♦ Red Cross
- ♦ University Communications
- ♦ University Libraries
- ♦ University Memorial Center
- ♦ Vice Chancellor for Academic Affairs
- ♦ Wardenburg Health Center

Other Emergency Management Program Components

Besides the Policy Group and EMOG, many other people and departments at the university are also involved in planning for and handling emergencies:

- Deans, Department Heads and Directors appoint emergency planners and oversee preparation of emergency preparedness and business continuity and recovery plans for all organizations within the university.
- The Registrar maintains emergency notification data for students and student's parents/family.

- Facilities Management and the Police Department, and EH&S serve as primary emergency response agencies for incidents on the CU-Boulder campus.

Key Emergency Management elements include:

- The campus emergency response protocol is outlined in its Ubrella Plan (http://ehs.colorado.edu/embr).

- The campus is integrated with the City and County multi-agency emergency management response, coordination and planning programs.

- The campus has two outdoor public warning systems (sirens and voice) in place that are located near Folsom Field on the main campus and in the flood zone on the east campus. These systems are tested once per month during the flood season. In addition, there is a weather station associated with the campus irrigation system that measures precipitation and temperature.

- The campus has reverse 911 capabilities.

- Evacuation maps are posted in each campus building.

- Temporary sheltering is available in the Coors Events Center, Balch Field House and Student Recreation Center. Food services are available from the Housing and Dining Services, UMC Food Services and Red Cross.

- Campus emergency communication systems exist, but are fragmented and lack inter-operability. A project is underway to investigate a campus-wide emergency communication system. The campus' phone and data communication systems are stand-alone and backed up with emergency generators and UPS.

- The campus has an EOC at the EH&S building and/or UCPD.

- Barricades are available to block streets and bridges.

- Electrical power can be shut off quickly, if needed.

- Representatives from UCB serve on the Boulder County Mass Casualty Task Force which was created by Boulder County hospitals. The group meets monthly.

- UCB has a 32 MW, dual-fueled cogeneration plant that provides steam, chilled water, compressed air and electricity. This enables the campus to disconnect from the public electrical grid and run isochronous, which has been used several times during times of unstable electrical service and/or during major weather events. The utility distribution system includes roughly four miles of tunnels in addition to direct buried utilities.

- Significant efforts have been made on developing emergency and contingency plans for utility system disruptions and outages, including load-shedding protocols. Roughly 24 campus buildings are also equipped with standby emergency generators that turn on automatically if the primary electrical service fails. A list of these buildings is available from Facilities Management. In addition, the campus has two mobile electrical generators that can be moved to the site to restore power to campus buildings, if needed.

- Emergency shelters are available and the Red Cross participates in EMOG.

- The campus does not currently have a Structural Engineer on staff, but these services are available locally and have been employed after emergencies to inspect the structural integrity of buildings.

- The campus has a well designed and implemented snow and ice removal plan that typically exceeds the City of Boulder in terms of clearance and response time. Snow plowing maps and routes are available from Facilities Management.

- UCB has an Emergency Plan designed to address readiness, response, and recovery and to deal with questions related to continuity of campus business.

  The Emergency Plan, which consists of an Umbrella Plan, outlines procedures for a major emergency and identifies departments responsible for planning, emergency response, business continuity and business recovery planning. Implementation of the plan is the responsibility of EMOG. Other Emergency Response Plans include:

  - ♦ Contingency Plan
  - ♦ Fire Plan
  - ♦ Storm Plan
  - ♦ Tornado Plan
  - ♦ Flood Plan
  - ♦ High Winds Plan
  - ♦ Pandemic Influenza Plan

- The campus engages in business continuity and recovery planning. These plans are available from EH&S. Each campus department is currently updating these emergency management plans on an improved format provided by URM and EH&S.

- The CU-Boulder campus operates under the ICS, which is used by the State Office of Emergency Management and by public safety departments throughout the nation for emergency response. A nationally recognized system, the Incident Command System creates an integrated organizational structure designed to meet the complexity and demands of whatever crisis occurs. The Incident Command System has proven effective in managing multiple agency and multiple jurisdiction incidents of any nature.

- The campus is also part of the Boulder Area Multiple Agency Coordination System (MACS) which is used by the City of Boulder, Boulder County, and other Boulder County municipalities to ensure that all the agencies coordinate their responses in the case of a major emergency event.

    - ♦ The MACS system assigns priority status to emergency events using a system of four modes with Mode 1 being the least severe and requiring the lowest level of response and coordination among agencies and Mode 4 being the highest level of emergency and requiring a high level of coordination among local, state, and national organizations.

- CU-Boulder's Police Department is staffed by commissioned police officers who undergo the same training that officers in Colorado's municipal and county law enforcement departments receive. The campus police department provides 24-hour/7-day coverage.

- As of reporting time, 50 campus employees have received 10 weeks of training to become members of campus/community response teams (CERTs). Training includes first aid, CPR, preparedness, search and rescue, fire safety, and disaster psychology.

Communications and Public Information

- The University's Public Relations Department takes the lead on all external communications, but there are other internal outreach initiatives related to safety and hazards issued from EH&S, University Risk Management, Department of Housing, Facilities Management and the Wardenburg Student Health Center.

- The University Police Department and Facilities Management have radio systems backed up by UPS. However, there is a need for a campus-wide communication system for integrated communications between campus emergency responders and administrators. Many departments recently purchased devices that provide wireless, digital two-way paging and cell communications into one device and provide connectivity between campus emergency responders and administration.

Natural Resource Protection

- Flood retention areas exist on the southern side of the Main Campus, Research Park and South Campus. The campus has many designated open spaces, some of which are wetlands and riparian areas. Care is taken to protect threatened/endangered species, while making the University properties available for recreational and aesthetic opportunities. Erosion and sediment control are consistently implemented during construction activities, and herbicides are used sparingly and discretely for weed control, particularly near standing water and streams to avoid runoff.

- The campus now has a fulltime landscape architect who oversees landscape design and collaborates with the Grounds and Irrigation Division on maintenance operations.

- UCB has a program to identify and implement institutional actions that help address air quality concerns.

- UCB has a program to maintain acceptable levels of water quality in campus discharges to storm sewer systems and to streams.

- The campus has a raw water irrigation system that covers approximately 75% of the main campus. The senior water rights that were obtained in the 1860s and used by the University are very high priority and have only once (2002) been called out of priority. Domestic water is provided by the city utility.

- Many undeveloped areas of University owned property are rough mowed to control weeds and mosquitoes. In addition, goats are brought in one or two times per year, and natural predators have been introduced to control weeds.

Design and Building Standards

Office of Facilities Planning

The Office of Facilities Planning manages and directs the planning and design of campus facilities and grounds under the direction of the Director of Planning, Design, and Construction, coordinated with the campus architect, and with the assistance of the campus planner, the campus landscape architect, and an administrative assistant with historic preservation expertise.

Facilities Master Plan

The campus has developed a Facilities Master Plan that is updated every 10 years or so. This plan articulates the campus' planning, zoning, open space preservation and land development. The plan also considers floodplain development regulations, emergency responder access and utilities.

Facilities and Capital Development Design and Planning

- Incoming architectural designers are not presented with set "design guidelines" for the Boulder campus. These do not exist, but there are key principles to follow. Any change to the physical appearance of campus buildings and grounds is monitored by the campus architect and facilities planning staff. This includes everything from curb cuts to whole buildings.

- The University has adopted IBC 2003 as the official building code, along with the latest associated international building codes for plumbing, mechanical, fire/life safety and electrical. In addition, the campus has developed campus design and construction standards which result in very robust, durable and sustainable facilities. These standards are available on the Facilities Management Design & Construction website. The campus architect is designated as the agency building official and "as built" inspections are conducted at each phase of construction.

- The University has flood zone maps, which are available from Facilities Management upon request, as are building footprint and construction plans for each building. In addition, the campus building space database is maintained by Facilities Management and lists the space category, use and occupancy for each room on campus.

- Approximately 75-80% of the campus buildings are fully sprinkled and fit with state of the art fire detection systems that are monitored 24/7 at the Facilities Management Service Center and University of Colorado Police Department Communications Center. Plans and diagrams of these systems are available from Facilities Management.

- Campus facilities have proven to be very resistant to high winds, as the campus standard roofing material is vitrified clay tile.

Sustainability

Sustainability is part of long-term campus planning. A generally accepted definition of sustainability is "providing for the needs of the present without detracting from the ability to fulfill the needs of the future." The concepts of sustainable design and use of "green" building materials apply at all stages of the design process (program plans, architect selection, design, construction, and closeout). Key program elements include:

- Adopt improved building industry practices for sustainability and the use of safe materials.

- Conserve energy to mitigate environmental impacts and to reduce costs.

- Limit environmental impacts and costs through water conservation.

- Reduce the waste for which the campus must pay removal costs.

University Risk Management

The University of Colorado and its System Campuses are exposed to risks of loss resulting from occurrences involving disappearance, damage, and destruction of its own property and property of others, injuries to employees or others, and dishonesty and unforeseen liabilities imposed by law or assumed by contract.

The philosophy of the CU System is oriented toward affirmative control and minimization of risk to the greatest extent practicable, retention of the remaining risk when within established guidelines, and protection against unpredictable loss by reasonable use of liability transference, including the use of available excess insurance and/or property funding when there is a significant possibility of loss in excess of the amount established as an acceptable self-retention. The University is self-insured and has a reinsurance policy above certain loss limits for property and boiler/machinery.

Of vital importance to the accomplishment of this objective is a centralized direction for a proactive Risk Management/Safety and Loss Prevention Program with uniformity for all campuses, implemented with consciousness and awareness on the part of all personnel at all levels. Recognizing the need for a systematic and coordinated approach to the handling of risk, the Board of Regents has established a Risk Management Policy.

UCB PROJECTS

Wildfire Mitigation Projects

Mountain Research Station. A wildfire mitigation survey was conducted several years ago at the Mountain Research Station, and subsequent improvements have been made and are continuing. This includes under story clearance, dead wood removal and thinning, use of spark arrestors, metal roofs on all the buildings, firewood storage areas, clearance around LP tanks, additional fire pumps and water storage, and evacuation planning and training for the staff and faculty. During the summer of 2005, defensible space and fire protection zones were created around each of the primary facilities by removing trees that are close to the buildings and "sculpting the tree canopy to taper away from the buildings."

Structural Projects

- A flood control levee exists on the South Campus that protects the property from flooding by South Boulder Creek. Annual inspections of the structure are conducted and actions are taken to protect the structure from erosion, noxious weed infestation and structural failure.

- Storm sewer projects as previously discussed in this section.

- As previously noted, three buildings (i.e., Clare Small Gym area) have experienced some subsidence and actions were taken to structurally brace the buildings or replace the damaged sidewalks.

EXTERNAL AGENCY DEPARTMENTS & PROGRAMS

Colorado Commission on Higher Education

The Colorado Commission on Higher Education (CCHE) provides coordination and policy direction with Colorado's 28 public colleges and universities and serves as a bridge between the Governor and the Colorado General Assembly and the institutions of higher learning within the State of Colorado. The Commission's overriding goal is to ensure high-quality, affordable, student-centered, and performance-based higher education for all Colorado citizens desiring to pursue higher education. The CCHE is the central policy and coordinating board for Colorado's public institutions of higher education and oversees the governing boards for Colorado's public institutions of higher education. The Board of Regents, whose members are elected, is the governing board for UCB.

Boulder County Wildfire Mitigation Group (BCWMG)

In the aftermath of the Black Tiger Fire in 1989, which burned 44 homes and blackened over 2,000 acres of forested land in the western part of the county, just five miles from the city of Boulder, the BCWMG was created. This group is chaired by staff in the County Land Use department and consists of members from the county Land Use and Sheriff Departments, the county's Fire Protection Districts, the Colorado State Forest Service, the City of Boulder Fire Department, the USDA Forest Service, the National Park Service, and private citizens. The group's mission is to discuss and coordinate actions that could help minimize loss of life and property from future wildfires. As part of their efforts, the GIS-based Wildfire Hazard Identification and Mitigation System (WHIMS) was developed to assess wildfire hazards using a hazard-rating model based upon wildfire behavior models and the expertise of wildfire behavior specialists.

City of Boulder Flood Program

The City of Boulder has taken many steps to reduce the threat of floods – all of which assist UCB in the management of their flood risk. The flood program was initiated in the decade following the 1969 flood. . During this time the City adopted its first floodplain ordinance and first drainageway master plan. The floodplain ordinance, by requiring flood proofing of new buildings, was designed to ensure that new flooding problems would not be created. The master plan proposed improvements that would address future development and remedy existing problems.

Also in 1969, Boulder County, with five other counties, joined the Urban Drainage and Flood Control District (UDFCD). The UDFCD was given the authority to plan, design, construct, and operate drainage facilities throughout the five-county area. It also assisted with implementation of early warning systems and in helping communities qualify for the NFIP.

Today, the City of Boulder is a participant in the NFIP. The City joined the NFIP on 07/17/1978 which allows private property owners in participating communities to purchase affordable flood insurance through the NFIP, while the community retains its eligibility to receive certain federally backed monies, and disaster relief funds.

The City also participates in the NFIP's Community Rating System (CRS). The CRS is a voluntary program for NFIP-participating communities that provide flood insurance discounts for policyholders in exchange for the community providing extra measures to provide protection from flooding, above the minimum NFIP requirements. The City of Boulder entered the CRS in 10/01/1992, and has a current CRS rating of Class 8. This rating provides a 10% discount for policyholders within a Special Flood Hazard Area (SFHA) and a 5% discount for those outside of a SFHA.

The City's flood management program addresses both small scale floods and larger, more catastrophic floods and works to reduce flood hazards, adopt floodplain policies, map floodplains, develop master plans for floodplains, regulate floodplain activities, prepare for flood events, educate the public on floods and floodplains, and mitigate flood potential.

The City's local guiding principles for flood management include:

1. **Preserve Floodplains -** where possible to recognize the beneficial functions of floodplains for hazard reduction, water quality enhancement, wetland protection, wildlife habitat, riparian corridors, recreation, alternate modes travel, environmental relief, aesthetics, greenway areas.
2. **Be Prepared for Floods** - by developing advanced floodplain mapping, detailed risk assessments, enhanced early warning systems, multiple emergency notification measures, understandable response plans, workable recovery plans, and ongoing storm monitoring.
3. **Help People Protect Themselves from Flood Hazards -** through public interaction and involvement, available flood information, community outreach and education, self-help measures, flood proofing options, affordable flood insurance, and emergency preparedness.
4. **Prevent Adverse Impacts and Unwise Uses in the Floodplain -** through appropriate regulation and land use, open land preservation and acquisition, multi-objective planning, relocation or elimination of high hazard structures, prohibiting unacceptable encroachments, and establishing ongoing maintenance practices that preserve and enhance environmental functions.
5. **Seek to Accommodate Floods, Not Control Them -** through planned and monitored system maintenance, nonstructural flood proofing, opening non-containment corridors, overbank land shaping to train flood waters, and limited structural (channelization) measures at constrained locations or where no alternatives are available.

Further, as stated in the Boulder Valley Comprehensive Plan, Policy 4.24, Larger Flooding Events, emphasizes the City's commitment to consider the impacts of floods larger than the 100-year flood. Policy 4.24 reads as follows:

> Flood management has historically focused on and primarily addresses the impacts of a 100-year flood event. The city recognizes that larger flooding events will occur resulting in greater risks and flood damage that will affect even improvements constructed with standard flood protection measures. The city will seek to better understand the impact of larger flood events and consider necessary floodplain management strategies.

Colorado Water Conservation Board (CWCB), Flood Protection Program

The Flood Protection Program is directed in Section 37-60-106(1) C.R.S (1990) to prevent flood damages, review and approve floodplain designations prior to adoption by local government entities, and provide local jurisdictions with technical assistance and floodplain information. In addition, an August 1, 1977 Executive Order requires the CWCB and Land Use Commission to provide assistance to entities in meeting the requirements of the National Flood Insurance Program. The Floodplain Management Section conducts the following activities: hazard identification, floodplain designations and regulations, community/basin planning, project implementation, preparedness/flood response, engineering/technical assistance, information management/education, and federal-state program coordination.

Urban Drainage and Flood Control District

The Urban Drainage and Flood Control District was established by the Colorado legislature in 1969, for the purpose of assisting local governments in the Denver metropolitan area with multi-jurisdictional drainage and flood control problems. The District covers an area of 1,608 square miles and includes Denver, as well as parts of 33 incorporated cities and towns. The district operates six programs that address: master planning, design and construction, maintenance, floodplain management, information services and flood warning, and the south platte river.

Non-University Emergency Service Providers

The Boulder Fire Department and the ambulance service provider currently under contract with Boulder County are primary emergency response agencies for incidents on campus. These agencies will respond to all fire and hazardous materials calls on campus. The Boulder Fire Department participates in EMOG.

- The Boulder Police Department and Boulder County Sheriff's Office support the CU Police Department in accordance with standard operating procedures.
- The Boulder office of the American Red Cross may be required to support shelter operations for the university. The American Red Cross participates in EMOG.
- The Boulder Office of Emergency Management is a principal assisting agency for the University in the event of major emergencies and the channel for requesting assistance from state agencies and the state or federal government. The Boulder Emergency Manager participates in EMOG.

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Multi-Hazard Mitigation DRU Plan
5.0 Mitigation Strategy

***44 CFR Requirement** 201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.*

This Section describes the mitigation strategy process and mitigation action plan for UCB's Multi-Hazard Mitigation DRU Plan. This Section describes how UCB accomplished Step 3 of FEMA's 4 Step guidance: "Developing the Mitigation Plan." and includes the following CRS steps from the older 10-step guidance:

Step 6 Set Planning Goals
Step 7 Review Possible Activities
Step 8 Draft an Action Plan

5.1 GOALS AND OBJECTIVES

Up to this point in the planning process, the HMPC has organized resources, assessed natural hazards and risks, and documented mitigation capabilities within the University. A profile of UCB's vulnerability to natural hazards resulted from this effort, which is documented in the preceding chapters of this plan. The resulting goals, objectives, and mitigation actions were developed based on this profile. The HMPC developed this section of the plan with a series of meetings and exercises designed to achieve a collaborative mitigation planning effort as described further in this section.

During the initial goal setting meeting, AMEC staff reviewed the results of the hazard identification, vulnerability assessment and capability assessment with the HMPC. This analysis of the Risk Assessment identified areas where improvements could be made, providing the framework for the HMPC to formulate planning goals objectives and the ultimate mitigation strategy for the University.

Goals were defined for the purpose of this mitigation plan as broad-based public policy statements that:

- *Represent basic desires of the community;*
- *Encompass all aspects of community, public and private;*
- *Are nonspecific, in that they refer to the quality (not the quantity) of the outcome;*
- *Are future-oriented, in that they are achievable in the future; and*
- *Are time-independent, in that they are not scheduled events.*

Goals are stated without regard for implementation, that is, implementation cost, schedule, and means are not considered. Goals are defined before considering how to accomplish them so that the goals are not dependent on the means of achievement. Goal statements form the basis for objectives and measures that will be used as means to achieve the goals. Objectives define strategies to attain the goals, and are more specific and measurable.

Team members were given a list of sample goals to consider. The HMPC members were instructed that they could use, combine or revise the statements they were provided or develop new ones on their own, keeping the risk assessment in mind. Team members were provided three index cards each and asked to write a goal statement on each card. Goal statements were collected and grouped into similar themes and pasted onto the wall of the meeting room. The goal statements were then attached to the meeting-room wall, and grouped into similar topics. New goals that represented the team's input were written until consensus was formed amongst the team. Some of the statements were determined to be better suited as objectives or actual mitigation projects, and were set aside for later use. Using this information, objectives were then developed, based on the team's input that summarizes strategies to achieve each goal. Initial mitigation recommendations that were developed by the HMPC are listed under the appropriate Goal and Objective. As part of the prioritization process described later in this section, prioritized mitigation measures were further developed into projects as part of the overall mitigation strategy for this plan.

Based upon the risk assessment review and goal setting process, the HMPC developed the following three goals with several objectives and associated mitigation measures. These goals and objectives provide the direction for reducing future hazard-related losses within UCB.

GOAL 1: Provide Protection for People's Lives from Hazards

Objective 1.1: Inform and educate university residents, faculty, staff, students, visitors, regents, etc. about the types of hazards they are exposed to, where they occur, and recommended responses to identified hazards (create an outreach program, provide educational resources and training)

Objective 1.2 Identify and resolve impediments to implementation of recommended responses

Objective 1.3: Continue emergency planning, public education, and training for University, including early warning and detection (real-time), evacuation procedures, and related information for residents, faculty, students and visitors

GOAL 2: Improve University Capabilities to Mitigate Losses

Objective 2.1: Provide protection for existing buildings to the extent possible

2.1.1 Provide/Improve flood protection
- 2.1.1.1 Family Housing
- 2.1.1.2 Computing center

2.1.1.3 Research animals (Behavioral Genetics)
2.1.1.4 As an annex to this Plan, develop a 10-year strategic flood mitigation plan identifying specific facilities to be mitigated and the cost and proposed schedule for mitigation

2.1.2 Maintain and improve the flood mitigation program to provide flood protection at a minimum to 100-year protection, with consideration of 500-year and worst case scenarios

2.1.3 Consider and incorporate mitigation activities for all natural hazards of concern to the university during any renovation activities

Objective 2.2: Provide protection for future development to the extent possible

2.2.1 Incorporate hazard mitigation for all natural hazards of concern to the university in future development and in long-range planning

2.2.2 Ensure that university is practicing sound floodplain management
2.2.2.1 Establish a floodplain manager for university

Objective 2.3: Provide protection for critical facilities and services

2.3.1 Identify and protect the most "critical" facilities
1.3.1.1 Essential facilities: Co-Gen, IT, Wardenburg, Research, etc

2.3.2 Protect hazardous materials locations
1.3.2.1 Science buildings
1.3.2.2 EHSC

Objective 2.4: Promote improved internal and external University coordination

2.4.1 Assure coordination between other university plans and goals

2.4.2 Minimize losses by informing affected facilities/departments of issues/potential losses

2.4.3 Assure coordination with other departments, communities, agencies, etc.

2.4.4 Create tracking system and central repository for university documents

2.4.5 Identify and incorporate hazard mitigation "lessons-learned" and best practices from other universities into plan implementation.

GOAL 3: Maintain/Provide for FEMA Eligibility and Work to Position University for Grant Funding

Objective 3.1: Provide university departments with information regarding mitigation opportunities

Objective 3.2 As part of Plan implementation, review projects in this plan on an annual basis to be considered for annual FEMA PDM-C grant allocations or after a presidential disaster declaration in Colorado for HMGP funding.

5. 2 IDENTIFIED MITIGATION MEASURES AND ALTERNATIVES

In order to identify and select mitigation measures to support the mitigation goals, each hazard identified in Section 4.1 was evaluated. Only those hazards that pose a significant threat to the university community were considered further in the development of hazard specific mitigation measures. These hazards include:

- Floods
- Wildfire
- Human Heath Hazards

The HMPC eliminated the hazards identified below from further consideration in the development of mitigation measures, either because the risk of the hazard occurring within the UCB Planning Area is unlikely or non-existent, or if they do occur, the vulnerability of the University is low or existing capability measures are currently in place to mitigate the affects of these hazards. The eliminated hazards include:

- Avalanche
- Dam Failure
- Drought
- Earthquakes
- Landslides and Rockfalls
- Severe Weather
    - ♦ Extreme Temperatures
    - ♦ Fog
    - ♦ Hailstorm
    - ♦ Heavy Rains/storms
    - ♦ Lightning
    - ♦ Tornadoes
    - ♦ Windstorms
    - ♦ Winterstorms
- Soil Hazards
- Volcanoes

It is important to note, however, that all above identified hazards are addressed to some extent in the Emergency Management Mitigation Measures.

Once it was determined which hazards warranted the development of specific mitigation measures, the HMPC analyzed a set of viable mitigation alternatives that would support identified goals and objectives. Each HMPC member was provided with the following list of categories of mitigation measures that are based on the six CRS categories:

- Prevention,
- Property Protection,
- Structural Projects,
- Natural Resource Protection,
- Emergency Services, and
- Public Information.

The HMPC members were also provided with several lists of alternative multi-hazard mitigation actions for each of the above categories. A facilitated discussion then took place to examine and analyze the alternatives. With an understanding of the alternatives, a brainstorming session was conducted to generate a list of preferred mitigation actions to be recommended.

Prioritization Process

Once the mitigation actions were identified, the HMPC members were provided with several sets of decision-making tools, including FEMA's recommended STAPLE/E set, Sustainable Disaster Recovery criteria, Smart Growth principles, and "Others" to assist in deciding why one recommended action might be more important, more effective, or more likely to be implemented then another. In accordance with the DMA requirements, an emphasis was placed on the importance of a cost-benefit analysis in determining project priority. The lists of mitigation categories, multi-hazard measures, and criteria sets are included in Appendix C.

With these criteria in mind team members were given a set of nine colored dots, three each of red, yellow, and blue. The dots were assigned red for High priority (3 points), blue for Medium priority (2 points), and green for Low priority (1 point). The team was asked to use the dots to prioritize projects with the above criteria in mind. This process provided both consensus and priority for the HMPC recommendations. The results of the prioritization exercise are included in the following table.

Mitigation Action Prioritization Results

Mitigation Type and Action #	Mitigation Action Title	Score	Priority
Flood Measures			
Action #1	Evaluate Flood Mitigation Options	39	High
Action #2	Establish Floodplain Management Policy/Floodplain	34	High

Mitigation Type and Action #	Mitigation Action Title	Score	Priority
	Manager		
Action #3	Relocate Campus Utilities that Cross Boulder Creek	27	High
Action #4	Evaluate Family Housing Buildings for Shelter in Place during Floods	24	Medium
Action #5	Implement Stormwater Projects Identified and Prioritized in the UCB Stormwater Drainage Master Plan Report	13	Medium
Wildfire Measures			
Action #6	Install Automatic Fire Suppression Systems Throughout Family Housing	18	Medium
Action #7	Conduct Wildfire Mitigation of Mountain Research Station	8	Low
Human Health Measures			
Action #8	Implement Mosquito-Borne Disease Controls	7	Low
Action #9	Implement Avian Flu Planning and Mitigation	*	*
Emergency Management Measures			
Action #10	Evaluate Evacuation and Shelter-In-Place Planning and Conduct Evacuation Training and Drills	36	High
Action #11	Improve and Enhance Early Detection and Notification System	32	High
Action #12	Conduct Additional Evaluation of Critical Facilities at Risk to All Hazards	19	Medium
Action #13	Conduct Table Top Exercises	11	Medium
Action #14	Continue training in ICS/Emergency Response and Business Continuity Planning	10	Low
Action #15	Human-Caused Hazards Annex to DRU Plan	7	Low

* No score indicates that Action Measure was developed after prioritization exercise.

After completing the prioritization exercise, some team members expressed concern that prioritizing all the projects as a group is not very effective since many of the projects are department-specific. However, the team agreed that prioritizing the projects collectively enabled the projects to be ranked in order of relative importance, and helped steer the development of additional projects that meet the more important objectives. The last two columns in the above table provides the results of the collective prioritization exercise. Point totals were converted to High, Medium and Low priorities using the following conversions: 1-10 points=Low; 11-25 points=Medium, and 26-39 points=High.

Recognizing the limitations in prioritizing projects from multiple departments and the DMA regulatory requirement to prioritize by Benefit-Cost as well as the need for any publicly funded project to be cost-effective, the HMPC decided to pursue implementation according to when and where damages occur, available funding, and individual department priority. This process drove the development of a prioritized action plan for UCB. Cost effectiveness will be considered in additional detail when seeking FEMA mitigation grant funding for eligible projects associated with this plan.

5.3 THE MITIGATION STRATEGY

The results of the planning process, the risk assessment, the goal setting, the identification of mitigation measures, and the hard work of the HMPC led to the Action Plan that follows. The process also helped the HMPC clearly comprehend and identify the overall mitigation strategy that will lead to the implementation of the Action Plan. Taking all of the above into consideration, the HMPC has developed this **overall mitigation strategy**:

- COMMUNICATE the hazard information collected and analyzed through this planning process so that the community better understands what can happen where, and what they can do themselves to be better prepared. Also, publicize the "success stories" that are achieved through the HMPC's ongoing efforts.

- IMPLEMENT the Action Plan recommendations of this plan.

- UTILIZE existing plans, programs, rules, regulations, policies and procedures already in existence. Communities can reduce future losses not only by pursuing new programs and projects, but also by more stringent attention to what's already "on the books".

- MOM - ardently monitor "Multi-Objective Management" opportunities, so that funding opportunities may be shared and "packaged" and broader constituent support may be garnered.

5.4 UCB MITIGATION ACTION PLAN

This Action Plan presents the recommendations developed by the HMPC for how UCB can lessen the vulnerability of people, property, infrastructure, and natural and cultural resources to future disaster losses. The recommended mitigation actions that follow are organized by hazard or mitigation type, in order of priority (or point total) as previously described above in the Prioritization Process. In addition, if different from the priority level assigned during the collective prioritization process, the priority level within the lead department is also provided. The Action Plan summarizes who is responsible for implementing each of the prioritized strategies, as well as when and how the actions will be implemented. Each recommendation also includes a discussion of the benefit-cost ratio to meet the regulatory requirements of DMA.

It is important to note that UCB has numerous existing, detailed project descriptions, including cost estimates and benefits, in the Campus Master Plan and associated Capital Improvement reports. These projects are considered to be part of this plan and the details, to avoid duplication, should be referenced in their original source document. UCB also realizes that new project needs and priorities may arise as a result of a disaster or other circumstances, and *reserves the right to support these projects, as necessary, as long as they conform to the overall goals of this plan.*

FLOOD MITIGATION MEASURES

ACTION #1: EVALUATE FLOOD MITIGATION OPTIONS

Issue/Background: The University should conduct a detailed evaluation of flood mitigation options for properties in or near the floodplain, particularly along Boulder Creek. Elevation, acquisition and relocation, constructing a floodwall, and other options should be considered.

Some work has already been completed in this area, but Family Housing is currently evaluating whether to retain several buildings in the floodplain or to tear them down. Constructing new buildings in a safer area should be carefully evaluated.

Other critical buildings on campus that are in the floodplain but not in an area of high risk like the Family Housing units, should also be evaluated.

Other Alternatives: No Action

Responsible Office: Risk Management, Emergency Management, Facilities Management, Vice Chancellor for Administration, Housing and Dining Services/Family Housing

Priority (High, Medium, Low): High

Cost Estimate: $100,000 to $500,000 for engineering design and analysis

Benefits (avoided Losses): Property damage, loss of life, injuries, business interruption

Potential funding: Staff time and UCB funds for analysis; PDM, HMGP, and FMA for design/construction

Schedule: 1-3 years

ACTION #2: ESTABLISH FLOODPLAIN MANAGEMENT POLICY/FLOODPLAIN MANAGER

Issue/Background: Currently, the university has a policy to follow the guidelines of the National Flood Insurance Program. However, there has not been an individual designated as the floodplain manager for the campus.

The university is in the process of hiring a Stormwater Engineer who will be responsible for floodplain management issues.

Other Alternatives: No Action

Responsible Office: Facilities Management

Priority (High, Medium, Low): High

Cost Estimate: Annual salary to be determined (1/2 Full Time Equivalent)

Benefits (avoided Losses): Property damage, loss of life, injuries, business interruption

Potential funding: UCB Funds

Schedule: Within 1 year

ACTION #3: RELOCATION OF CAMPUS UTILITIES THAT CROSS BOULDER CREEK

Issue/Background: The University evaluated options for utility relocation necessitated by the proposed replacement of existing bridges across Boulder Creek with new break-away bridges. The bridges are owned and being replaced by the City of Boulder. All three bridges are within the 100-year floodplain as well as within the high hazard area designation of that floodplain. UCB's utilities are currently attached to or supported by these existing bridges.

The university should relocate utilities to run under Boulder Creek in order to better protect them from flood damage. The firm of Martin/Martin has been retained by UCB to develop and cost alternatives for the relocation of these utilities.

Other Alternatives: No Action

Responsible Office: Facilities Management Engineering

Priority (High, Medium, Low): High, but contingent on City of Boulder priority.

Cost Estimate: $275,000 to $446,000

Benefits (avoided Losses): Limit damages to utilities and maintain utility services to large areas of campus during flood events.

Potential funding: PDM, HMGP, UCB in-kind services

Schedule: 1-3 years

ACTION #4: EVALUATION OF FAMILY HOUSING BUILDINGS FOR SHELTER IN PLACE DURING FLOODS

Issue/Background: The University of Colorado-Boulder's Family Housing properties are located along Boulder Creek in a high hazard area for flash floods. Because warning experts believe that we may have 30 minutes or less to issue a warning about a flash flood, officials have recommended that building occupants shelter in place and move to higher floors when a flash flood occurs.

However, the buildings have never been evaluated for their ability to withstand the force of a flash flood. A careful assessment needs to be done of the safety of these buildings and to identify measures that will approve their safety in such an event. This analysis is critical in evaluating the shelter in place option and should include at a minimum the structural integrity of structures during a 100-year and 500-year flood event.

Other Alternatives: Flood wall along Boulder Creek or other floodproofing measures

Responsible Office: Dining and Housing Services

Priority (High, Medium, Low): Medium; Lead Department Priority: High

Cost Estimate: $25,000 to $50,000

Benefits (avoided Losses): Avoid loss of life and property

Potential funding: UCB Funds and others to be determined

Schedule: 1-3 years

ACTION #5: IMPLEMENT STORMWATER PROJECTS IDENTIFIED AND PRIORITIZED IN THE UCB STORMWATER DRAINAGE MASTER PLAN REPORT

Issue/Background: When the UCB was first planned and the first buildings were constructed, there were no drainage master plans for the campuses. Most of the surface runoff was either intercepted by irrigation ditches or conveyed along streets or other natural topographic features. Runoff was generally directed across campus to Boulder Creek. Roof drains were connected to foundation drains, and foundation drains were connected to underground tunnel drainage systems. According to Facilities Management personnel, tunnel systems were frequently flooded. Over the years, minor systems were constructed to alleviate surface flooding, but these systems were constructed on an “as needed basis”, without consideration for future development.

In the past 10 years, many major drainage system improvements have been designed and constructed on both campuses, but were completed without the benefit of a master plan, and improvements were not well documented. As a result, it is difficult to determine what areas of campus have adequate stormwater infrastructure and what areas are deficient.

In order to determine the status of the existing stormwater infrastructure, the University, through Boyle Engineering Corporation, recently completed an evaluation of UCB’s stormwater drainage system. The findings, contained in the 2004 Storm Water Drainage Master Plan Report include prioritized recommendations for system improvements. The purpose of the study included:

- Compiling existing drainage information for the Main and East Campus,
- Performing a five-year design storm event hydrologic and hydraulic analysis of the existing storm sewer system mainlines serving the campuses utilizing data from previous studies,
- Identifying and evaluating drainage improvements, and
- Developing a comprehensive drainage master plan for a future build-out drainage system.

The report includes a prioritized list of projects recommended for system enhancement. In prioritizing the projects, several factors were considered including: potential threat to life, potential damage to property, and ease of constructability. A range of probable construction costs are also included. It is recommended that the projects identified in the report be implemented in order to reduce flood damage associated with localized stormwater drainage and to improve the capacity and effectiveness of the stormwater drainage system for both existing facilities and for new development.

Other Alternatives: Maintain the status quo

Responsible Office: Facilities Management

Priority (High, Medium, Low): Medium; Lead Department Priority: High

Cost Estimate: See report for listing of costs by project

Benefits (avoided Losses): Property damage, loss of life, injuries, business interruption

Potential funding: UCB funds, PDM, HMGP, FMA

Schedule: 1-10 years (Implementation should begin in 2006 and continue as funding allows)

WILDFIRE MITIGATION MEASURES

ACTION #6: AUTOMATIC FIRE SUPPRESSION SYSTEMS THROUGHOUT FAMILY HOUSING.

Issue/Background: Automatic fire sprinklers will help extinguish fires in their infancy and reduce the likelihood of large fires.

Other Alternatives: Provide standpipes instead of automatic sprinklers. This alternative requires the intervention by firefighters and cannot control or extinguish fires in their infancy.

Responsible Office: Department of Housing, Fire and Life-Safety Group.

Priority (High, Medium, Low): Medium; Lead Department Priority: High

Cost Estimate:
Newton Court: $2,693,250
Smiley Court: $845,500
TOTAL: $3,538,750

Benefits (avoided Losses): Automatic fire sprinklers will help extinguish fires in their infancy and reduce the likelihood of large fires that can happen during a flood.

Potential funding: UCB Funds, other to be determined

Schedule: 1-5 years.

ACTION #7: WILDFIRE MITIGATION OF MOUNTAIN RESEARCH STATION

Issue/Background: This program has been on-going since winter of 2000. The property was divided up into seven zones for ground fuel mitigation and forest canopy sculpting and thinning. Zones 1 and 2 were completed in 2001, Zone 3 completed in winter '00, Zones 4 and 5 completed in summer '02, and Zones 6 and 7 in summer of '03. All these zones were for control of ground fuels. Thinning and canopy sculpting of zoned areas started in the winter of 2003 and completion date is scheduled for the summer of 2007. See attached Zone Plan.

Ground fuels cleared to within 30 ft. of Marr/Kiowa labs; Trees thinned within 60 ft of buildings.

Other Alternatives: No Action

Responsible Office: Facilities Management, Physical Plant in coordination with the Nederland Fire Department.

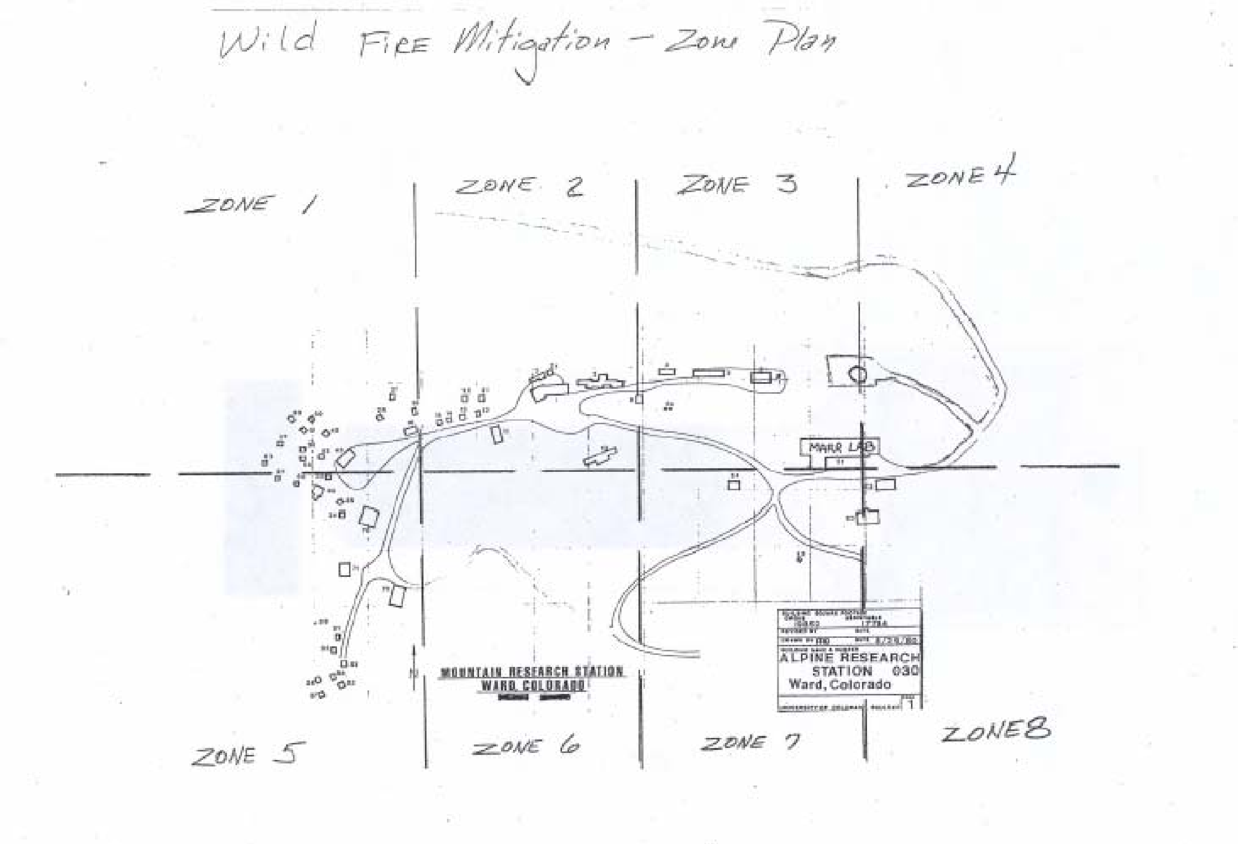
Priority (High, Medium, Low): Low; Lead Department Priority: High

Cost Estimate: To date the project costs approximately $ 32,000 per year.

Benefits (avoided Losses): Protection of structures in alpine setting at Mountain Research Station.

Potential funding: UCB funds, Boulder County, CFS, USFS, PDM, HMGP

Schedule: On-going.



HUMAN HEALTH MITIGATION MEASURES

ACTION #8: MOSQUITO-BORNE DISEASE CONTROL

Issue/Background: There are many mosquito-borne illnesses that affect both people and livestock. These include but are not limited to Eastern Equine Encephalitis, St. Louis Encephalitis, and West Nile virus. The Environmental Services division of Facilities Management has been actively controlling vector mosquito species since the summer of 2003. The program relies heavily on monitoring of all stages of the mosquito life cycle and the control of mosquito larvae. Traps are placed weekly for adult surveillance, while weekly inspections are made of known and potential breeding sites. This information allows for a direct and effective control program that aims to eliminate vector mosquitoes before they become reproducing adults. The program has been highly successful in part due to the use of student labor.

Other Alternatives: Other alternatives would most likely be more expensive and less effective. Larval control has been demonstrated to be the most effective control method. CU is particularly good at this form of control as the university setting does not have private land that presents access issues. Restricted access makes it difficult to monitor effectively. Should the program not be fully funded, the focus will be placed on areas known to breed significant numbers of vector mosquitoes, such as East campus.

Responsible Office: Facilities Management Environmental Services – Environmental Operations.

Priority (High, Medium, Low): Low; Lead Department Priority: Medium

Cost Estimate: Total of $25,000 per year, roughly $8,000 of which is recharge.

Benefits (avoided Losses): Protection of human life as well as livestock, pets, and wildlife.

Potential funding: UCB funds; Colorado Department of Public Health and Environment, Boulder County. Most funding sources are for educational materials or adulticiding, where the adult mosquito is targeted for eradication. The CU campus has not yet had a need for adulticiding and most of our educational materials are provided by the county.

Schedule: May 15th-Sept 30th annually

ACTION #9: AVIAN FLU PLANNING AND MITIGATION

Issue/Background: Avian Flu is a new strain of the influenza virus that was detected in birds in Southeast Asia several years ago. This strain is highly virulent and has the potential to infect many people. The concern is that the strain will mutate into a form of virus that will be able to jump directly from birds to humans. To date, the majority of humans infected with Avian Flu have been those involved in the slaughter and/or processing of infected birds. If the strain does in fact jump from birds to humans, the potential for a pandemic across many nations will be significant.

This is an issue that will require coordination amongst several groups on campus, including EH&S, Wardenburg, EMOG, Facilities Management and others. Planning measures should include emergency procedures for essential services coverage/disruption in work force, emergency closures, quarantine, disinfection protocol, medical advice, and general educational materials focusing on prevention.

Other Alternatives: Impacts are best mitigated though aggressive planning and prevention.

Responsible Office: Environmental Health & Safety, Facilities Management-Environmental Services, EMOG

Priority (High, Medium, Low): Lead Department Priority: High

Cost Estimate: $30,000

Benefits (avoided Losses): Avian Bird flu has the potential to reach pandemic proportions. Such a pandemic would result in significant loss of life, loss of workforce, and impacts to the regional and global economy.

Potential funding: UCB funds, Boulder County Public Health, Colorado Department of Public Health and Environment, US Department of Health and Human Services, Department of Homeland Security

Schedule: Ongoing. Planning has begun on the county, state and federal levels. Boulder County Public Health (BCPH) reps are meeting every other week with the state's Pandemic Response Plan team. Weekly updates on Avian influenza are being sent to BCPH disaster teams as well as other local public health and emergency response agencies. UCB representatives meet at least once a month with Boulder County Department of Health. Recently, UCB completed a draft Pandemic Response Plan.

EMERGENCY MANAGEMENT MITIGATION MEASURES

ACTION #10: EVALUATE EVACUATION AND SHELTER-IN-PLACE PLANNING AND CONDUCT EVACUATION TRAINING AND DRILLS

Issue/Background: One of the most difficult issues facing UCB during a flood is whether to have residents of its Family Housing buildings along Boulder Creek evacuate or shelter in place. Because most experts believe we may only have a warning time of 30 minutes, we are uncertain that we will have enough time to evacuate families to a safer location.

Methods for doing this could include evacuation modeling from a consultant and/or conducting training and a live exercise to time an evacuation. It is not known whether traffic would become delayed as everyone tried to leave the parking lots at once or whether there would be an orderly exit. Also, due to the short warning time, we would not be able to provide buses to move people from the area in time.

Other Alternatives: Continue with shelter in place planning for Family Housing

Responsible Office: Police Department, Emergency Management, and Housing and Dining Services/Family Housing

Priority (High, Medium, Low): High

Cost Estimate: To be determined.

Benefits (avoided Losses): Injuries and loss of life.

Potential funding: UCB funds, Training and educational programs of: UDFCD, CWCB, CDEM, FEMA Region XIII, FMA

Schedule: 1-3 years and ongoing

ACTION #11: IMPROVE AND ENHANCE EARLY DETECTION AND NOTIFICATION SYSTEM

Issue/Background: Residential buildings, research facilities, and operational buildings of UCB lie along the Boulder Creek floodplain, and many are in the high hazard area. Boulder Creek is designated as the number one flash flood risk in the state of Colorado, and many experts believe there may be only a 30 minute warning.

Because of this risk, the university must continue to improve its early detection of flash floods and work to increase the effectiveness of warning measures. This includes identifying and implementing new technologies; enhancing existing technologies; training staff, faculty, and students to take proper precautions when a flood watch is issued; and educating the public about where to obtain real-time weather and flood data.

Other Alternatives: Maintain status quo.

Responsible Office: Police Department, Emergency Management, Facilities Management

Priority (High, Medium, Low): High

Cost Estimate: To be determined.

Benefits (avoided Losses): Property damage, loss of life, and injuries

Potential funding: UCB funds, HMGP, UDFCD, USGS, NWS, City of Boulder, Department of Homeland Security

Schedule: On-going

ACTION #12: CONDUCT ADDITIONAL EVALUATION OF FACILITES AT RISK TO ALL HAZARDS

Issue/Background: Protecting critical facilities during any hazard event is vital. However, this protection can draw workers and resources away from protecting other areas or facilities. Identifying which facilities are vital to response and recovery during a hazard as well as those facilities with the potential of causing a secondary disaster if destroyed is critical to defining priorities for mitigation projects.

The existing critical facilities analysis and prioritization used in the development of this plan was initially conducted for purposes of Year 2000 Contingency Planning (Y2K), during which time the University was not in session. Additional analysis and/or refinement to this initial analysis should be performed in order to evaluate and define "critical facilities" in the context of natural hazards. This would provide the University with additional direction and prioritization for identifying mitigation projects protective of critical facilities at UCB. It would also assist the University in prioritizing response and recovery efforts during and after a natural disaster.

Other Alternatives: Continue to use the Y2K critical facilities analysis

Responsible Office: Emergency Management, University Police, Facilities Management

Priority (High, Medium, Low): Medium, Lead Department Priority: High

Cost Estimate: To be determined.

Benefits (avoided Losses): Property damage, life safety, business interruption

Potential funding: UCB funds

Schedule: 1-5 years

ACTION #13: TABLE TOP EXERCISES

Issue/Background: Campus officials and the wider university community must understand their roles when a flash flood occurs along Boulder Creek. UCB should conduct tabletop exercises on the flood risk periodically to ensure that occurs and to identify ways to improve public awareness about safe actions to take during a flood. UCB should conduct both internal campus flood exercises and continue to participate in the annual City of Boulder flood exercise.

Our Family Housing Department, which is located along Boulder Creek (the number one flood risk in the state), conducts an annual flood exercise to educate and better protect residents and staff in the event of a flood. They also stock and maintain supplies to support those in the buildings in the event of a flood and power failure. Supplies are checked during the exercise and rotated if necessary.

Other Alternatives: Have residents stay in the buildings and move to a higher floor.

Responsible Office: Family Housing, Emergency Management, and Environmental Health and Safety

Priority (High, Medium, Low): Medium, Lead Department Priority: High

Cost Estimate: $5,000-$10,000 annually

Benefits (avoided Losses): Injuries and loss of life.

Potential funding: UCB funds; Training and educational programs of: UDFCD, CWCB, CDEM, FEMA Region XIII, FMA

Schedule: On-going.

ACTION #14: ICS/EMERGENCY RESPONSE AND BUSINESS CONTINUITY PLANNING TRAINING

Issue/Background: Key personnel on the UCB campus must understand the Incident Command System and protocols for emergency response. The Emergency Management and Planning Coordinator will continue to train individuals and groups on campus regarding response issues and protocols. In addition, campus units will continue to provide input on improving response.

Departments on the UCB campus are encouraged to develop and practice detailed business continuity plans. Software (*LBL Contingency Planner*) is provided to departments that contain numerous templates to guide planning. In addition, the Emergency Management and Planning Coordinator provides training on the use of the software and assistance to departments in their planning efforts. Departments are encouraged to develop plans for events that are small, moderate, and most serious events. They are asked to identify office functions and rate them according to criticality and to develop detailed information about what equipment, information systems, and other items would be needed if it became necessary to relocate.

Other Alternatives: No Action

Responsible Office: Emergency Management

Priority (High, Medium, Low): Low, Lead Department Priority: High

Cost Estimate: $30,000 annually

Benefits (avoided Losses): Business interruption, tuition refunds, housing refunds, and reputation of the University.

Potential funding: UCB funds, Department of Homeland Security, Colorado Chapter of Association of Contingency Planners

Schedule: On-going.

ACTION #15: HUMAN-CAUSED HAZARDS ANNEX TO DRU PLAN

Issue/Background: The University of Colorado-Boulder employs an all-hazards approach to managing risks to the campus. However, human-caused events can create situations that may not occur during natural disasters, such as chemical leaks, release of toxic substances, and others.

The plan should be developed with the input of most operational departments on campus.

Other Alternatives: No Action

Responsible Office: Emergency Management, EH&S

Priority (High, Medium, Low): Low

Cost Estimate: $15,000 to $25,000

Benefits (avoided Losses): Possible early detection and improved response to such events.

Potential funding: UCB funds, PDM, HMGP, CDEM

Schedule: 5-10 years

Multi-Hazard Mitigation DRU Plan
6.0 Plan Adoption

44 CFR requirement 201.6(c)(5): "{The local hazard mitigation plan shall include} documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commissioner, Tribal Council)."

The purpose of formally adopting this plan is to secure buy-in from the participating jurisdiction, raise awareness of the plan, and formalize the Plan's implementation. The adoption of this plan completes Step 9 of the Plan Development Process: Formal Plan Adoption. The UCB Board of Regents have adopted the Multi-Hazard Mitigation DRU Plan by passing a resolution. A copy of the generic resolution and the executed copy is included in Appendix C.

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Multi-Hazard Mitigation DRU Plan

7.0 Plan Implementation and Maintenance

44 CFR Requirement 201.6(c)(4): "{The plan maintenance process shall include a} section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle."

Implementation and Maintenance of the Plan is critical to the overall success of Hazard Mitigation Planning. This is Step 10 of the Ten step Plan Development Process.

Implementation

Upon adoption, the plan faces the truest test of its worth: implementation. Implementation implies two concepts: action and priority. These are closely related. While this plan puts forth many worthwhile and high priority recommendations, the decision about which action to undertake first will be the first task facing the HMPC. Fortunately, there are two factors that help make that decision. First, there are high priority items, and second, funding is always an issue. Thus, pursuing low or no-cost high-priority recommendations will have the greatest likelihood of success.

Another important implementation mechanism that is highly effective and low-cost is to incorporate the Hazard Mitigation Plan recommendations and their underlying principles of this into other university plans and mechanisms, such as campus master planning and capital improvement budgeting. The University has and continues to implement policies and programs to reduce losses to life and property from natural hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs, and recommends implementing projects, where possible, through these other program mechanisms. **Mitigation is most successful when it is incorporated within the day-to-day functions and priorities of government and development.** This integration is accomplished by constant, pervasive and energetic efforts to network, identify and highlight the multi-objective, win-win benefits to each program, the university community, and its stakeholders. This effort is achieved through the routine actions of monitoring agendas, attending meetings, and promoting a safe, sustainable university community.

Simultaneous to these efforts, it is important to maintain a constant monitoring of funding opportunities that can be leveraged to implement some of the more costly recommended actions. This will include creating and maintaining a bank of ideas on how any required local match or participation requirements can be met. When funding does become available, the HMPC will be in a position to capitalize on the opportunity. Finding opportunities to be monitored include special pre- and post-disaster funds, special district budgeted funds, state or federal ear-marked funds, and grant programs including those that can serve or support multi-objective applications.

Additional mitigation strategies could include consistent and ongoing enforcement of existing policies, and vigilant review of university wide programs for coordination and multi-objective opportunities.

Mitigation Coordinating Committee (HMPC)

With adoption of this plan, the HMPC will be tasked with plan implementation and maintenance. This Mitigation Coordinating Committee (i.e., HMPC), led by the UCB Emergency Management and Planning Coordinator, and EMOG, agrees to:

- Act as a forum for hazard mitigation issues;
- Disseminate hazard mitigation ideas and activities to all participants;
- Pursue the implementation of high priority, low/no-cost recommended actions;
- Keep the concept of mitigation in the forefront of University decision-making by identifying plan recommendations when other University goals, plans and activities overlap, influence, or directly affect increased University vulnerability to disasters;
- Maintain a vigilant monitoring of multi-objective cost-share opportunities to assist the University in implementing the plan's recommended actions for which no current funding exists;
- Monitor and assist in implementation and update this plan;
- Report on plan progress and recommended changes to the Chancellors/Board of Regents; and
- Inform and solicit input from the public.

The Committee will not have any powers over UCB staff; it will be purely an advisory body. Its primary duty is to see the plan successfully carried out and to report to Chancellors/Board of Regents and the public on the status of plan implementation and mitigation opportunities for the University. Other duties include reviewing and promoting mitigation proposals, hearing stakeholder concerns about hazard mitigation, passing concerns on to appropriate entities, and posting relevant information on the University website.

Maintenance

Plan maintenance implies an ongoing effort to monitor and evaluate the plan implementation, and to update the plan as progress, roadblocks or changing circumstances are recognized.

Maintenance Schedule

In order to track progress and update the Mitigation Strategies identified in the Action Plan, the University will revisit this Multi Hazard Mitigation DRU Plan annually or after a hazard event. The UCB Emergency Management and Planning Coordinator is responsible for initiating this review and will consult with members of the HMPC. This monitoring and updating will take place through a semi-annual review by the UCB Emergency Management and Planning Coordinator, an annual review through the HMPC, and a five-year written update to be submitted to the state and FEMA Region VIII, unless disaster or other circumstances (e.g., changing regulations) lead to a different timeframe.

Maintenance Evaluation Process
Evaluation of progress towards plan implementation can be achieved by monitoring changes in vulnerabilities identified in the plan. Changes in vulnerability can be identified by noting:

- Lessened vulnerability as a result of implementing recommended actions,
- Increased vulnerability as a result of failed or ineffective mitigation actions, and/or
- Increased vulnerability as a result of new development (and/or annexation).

Updates to this plan will consider:

- Changes in vulnerability due to project implementation,
- Success stories where mitigation efforts have proven effective,
- Areas where mitigation actions were not effective,
- Any new hazards that may arise or were previously overlooked,
- New data or studies on hazards and risks,
- New capabilities or changes in capabilities,
- Growth and development-related changes to UCB's inventory, and
- New project recommendations or changes in project prioritization.

In order to best evaluate any changes in vulnerability as a result of plan implementation, the HMPC will follow the following process:

- A representative from the responsible office identified in each mitigation measure will be responsible for tracking and reporting on an annual basis to the HMPC on the status of a given project and provide input on whether the project as implemented meets the defined objectives and is likely to be successful in reducing vulnerabilities; and
- If the project does not meet identified objectives, the HMPC will determine what additional measures may be implemented and an assigned individual will be responsible for defining project scope, implementing project, monitoring success of project, and making any required modifications to the plan.

Changes should be made to the plan to accommodate projects that have failed or are not considered feasible after a review for their consistency with established criteria, the timeframe, the university's priorities, and funding resources. Priorities that were not ranked high, but identified as potential mitigation strategies, should be reviewed as well during the monitoring and update of this plan to determine feasibility of future implementation. Updating of the plan will be by written changes and submissions, as the HMPC deems appropriate and necessary, and as approved by the UCB Board of Regents.

Incorporation into Existing Planning Mechanisms
The Mitigation Strategy listed in Section 5.3 of this plan recommends utilizing existing plans and/or programs to implement hazard mitigation at the University, where possible. This point is also emphasized previously in this Implementation and Maintenance section. Based on this plan's capability assessment, the University has and continues to implement policies and

programs to reduce losses to life and property from natural hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs, and recommends implementing projects, where possible, through the following mechanisms:

- Campus Master Plan
- Micro-Master Plans
- Future Flood Studies and Projects
- Civil Utility Master Plan, 2003
- Storm Water Drainage Master Plan Report, 2004
- Emergency Management Plans
- Business Continuity and Recovery Plans
- Local Fire Plans
- Capital Improvement Programs and Budgets
- New Construction Design and Review Process
- Other plans, regulations, and practices outlined within the Capability Assessment section of this plan

In order to effectively utilize other UCB plans and programs for publicizing and implementing the mitigation strategy detailed in this plan, the UCB OEM is taking the lead in this effort. The UCB OEM is working closely with Facilities Management (i.e., the director and the newly established Floodplain Manager) and operational Vice Chancellor(s) to ensure that both short and long-range planning at all department levels are consistent with the goals, objectives and mitigation strategies set forth in this plan. These integration efforts will also be supported by the UCB OEM's continued involvement in the EMOG group. EMOG is made up of representatives from key university departments. As part of its mission, EMOG is tasked with educating and implementing, within other university departments, emergency management planning and preparedness efforts, including mitigation planning.

Continued Public Involvement

The update process provides an opportunity to publicize success stories from the plan's implementation and seek additional public comment. Public outreach to receive public comment on plan maintenance and updating will be held during the update period. When the HMPC reconvenes for the update(s), they will coordinate with all stakeholders participating in the planning process (or that have joined the Committee since inception of the planning process) to update and revise the plan. The plan maintenance and update process will include continued public and stakeholder involvement and input through attendance as desired at HMPC meetings, web-postings, press releases, and the final product adopted by the Board of Regents, appropriately.

Multi-Hazard Mitigation DRU Plan
Appendix A

Acronyms and Abbreviations Used in this Plan

BCPH	Boulder County Public Health
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
CADD	Computer-Applied Drafting and Design
CAIC	Colorado Avalanche Information Center
CCHE	Colorado Commission on Higher Education
CEUS	Central United States
CFS	Cubic Feet per Second
CDBG	Community Development Block Grants
CDC	U.S. Centers for Disease Control and Prevention
CDEM	Colorado Division of Emergency Management
CERT	Citizen Emergency Response Team
CRS	Community Rating System
CWA	Clean Water Act
CWCB	Colorado Water Conservation Board
DMA	Disaster Mitigation Act
DRU	Disaster Resistant University
EH&S	Environmental Health and Safety
EMOG	Emergency Management Operations Group
EMS	Environmental Management System

FEMA	Federal Emergency Management Agency (technically the Emergency Preparedness and Response Directorate (EP&R) within the Department of Homeland Security [DHS])
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study, the report providing the details to the local FIRM
FMA	Flood Mitigation Assistance
FTP	File Transfer Protocol
GIS	Geographical Information System
HI	Heat Index
HMGP	Hazard Mitigation Grant Program
HMPC	Hazard Mitigation Planning Committee
HUD	Housing and Urban Development (Department of)
ICS	Incident Command System
Km	Kilometer
LHMP	Local Hazard Mitigation Plan
LOMC	Letter of Map Change
LOMR	Letter of Map Revision (an administrative method of changing the mapped floodplain without having to actually re-map it)
MACS	Multiple Agency Coordination System
MMI	Modified Mercalli Intensity scale (one way of measuring earthquakes)
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NFIP	National Flood Insurance Program
NIMS	National Incident Management System

NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
OEM	Office of Emergency Management
PDM	Pre-Disaster Mitigation (Grant Program)
POR	Period of Record
SEMS	State Emergency Management System
UBC	Uniform Building Code
UCB	University of Colorado, Boulder
UCPD	University Campus Police Department
UDFCD	Urban Drainage and Flood Control District
UMC	University Memorial Center
URM	Unreinforced Masonry (e.g., brick buildings, most prone to earthquake damage)
USACE	United Sates Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WHIMS	Wildfire Hazard Identification and Mitigation System
WHO	World Health Organization
WUI	Wildland Urban Interface (That area where development and forest overlap).
WNV	West Nile Virus
WUS	Western United States

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Multi-Hazard Mitigation DRU Plan
Appendix B

Data Collection Guide

MULTI-HAZARD MITIGATION PLAN
DATA COLLECTION GUIDE

For

UNIVERSITY OF COLORADO, BOULDER CAMPUS
HAZARD MITIGATION PLANNING COMMITTEE
(HMPC)

Prepared by

AMEC Earth and Environmental, Inc.

March, 2005

OVERVIEW

The contents of this workbook have been designed to assist in collecting necessary background information to support the hazard mitigation planning process pursuant to the requirements of the University of Colorado, Boulder's (UCB) Disaster Resistant University (DRU) Grant and the Federal Disaster Mitigation Act (DMA) of 2000. This includes a hazard identification and risk assessment, an assessment of UCB's current hazard mitigation capabilities, and an identification of potential mitigation projects that, if undertaken, could prevent or reduce future losses.

The essential information needed to support the planning process includes background information about UCB; plans, technical studies, and data related to hazards and risks; current governing codes, ordinances, regulations, and procedures whose intent is to minimize future losses; and some indication of UCB's technical and organizational capabilities to perform hazard mitigation/loss prevention functions.

The planning process is heavily dependent on existing data to be supplied by each of the participants represented on the Hazard Mitigation Planning Committee (HMPC). The DMA plan development process does not require original research to be done to develop new data, but requires *existing data only*.

The information collected provides the basis for the action plan that contains goals for the future; identifies mitigation issues and actions that are important to each participant; and assigns priorities and responsibilities for their adoption and implementation. The goal of this process is to produce a hazard mitigation plan that meets UCB's needs, as well as the requirements for UCB's DRU initiative and DMA 2000 and that contains a list of projects that may be eligible for streamlined mitigation funding pre-or post-disaster.

UCB PARTICIPATION

The DMA planning regulations and guidance stress that each entity seeking the required FEMA approval of their mitigation plan must:

- Participate in the process,
- Detail areas within the planning area where the risk differs from that facing the entire area,
- Identify specific projects to be eligible for funding, and
- Have the governing board formally adopt the plan.

For UCB HMPC members, 'participation' means the planning committee representatives will:

- Attend and participate in HMPC meetings,
- Provide available data that is requested of the HMPC coordinator,
- Review and provide/coordinate comments on the draft plans,
- Advertise, coordinate and participate in the public input process, and
- Coordinate the formal adoption of the plan by the governing board.

DATA COLLECTION GUIDE

This guide contains an explanation of the types of hazard mitigation/loss prevention data that is needed for the hazard mitigation planning process. This guide identifies specific requirements for the Risk Assessment Process, which includes the Hazard Identification, Vulnerability, and Capability Assessments and requirements for development of the Mitigation Strategy

AMEC has learned some valuable lessons about how to make the data collection process well organized and effective. Some ways of organizing the data collection process include: (1) the "circuit riding" HMPC member who contacts everyone individually in his/her jurisdiction or area of expertise and assembles the information; (2) the committee approach wherein a "mini-HMPC" is formed within the jurisdiction to collectively compile the needed data; and (3) a "network" based on existing relationships is used to funnel data to the HMPC representative (seems especially useful for widely dispersed types of organizations that have common functions, such as school districts and fire districts). Regardless, it is important to contact and involve those persons whose responsibilities include activities for avoiding future losses.

Some lessons about effective data collection include: (1) being inclusive; that is, collecting all of the potentially useful information one time so time-consuming follow-up work is minimized, (2) following this guidance carefully, and (3) asking questions of the consultants before great effort is expended.

The worksheets at the end of this guide have been developed to assist with the data collection. These need to be completed by each participating entity and will serve two purposes:

1) they will help facilitate the collection of the necessary information, and
2) they will function as evidence of "participation" in the planning process.

The Risk Assessment Process

The risk assessment process includes three components: 1) Hazard Identification, 2) Vulnerability Assessment, and 3) Capability Assessment. Data needs for each of the plan components are described in the following pages.

Hazard Identification Data for the following hazards:

- Avalanche
- Dam failure
- Drought
- Earthquakes
- Floods
- Landslides

- Natural health hazards
    - ♦ West Nile Virus
    - ♦ Other?
- Severe weather
    - ♦ Dust storms
    - ♦ Extreme temperatures
    - ♦ Fog
    - ♦ Hailstorm
    - ♦ Heavy rains/storms
    - ♦ Lightning
    - ♦ Tornadoes
    - ♦ Windstorm
    - ♦ Winter Storms
- Soil Hazards
    - ♦ Land subsidence
    - ♦ Expansive soils
    - ♦ Erosion
    - ♦ Soil liquefaction
- Volcanoes
- Wildfires

Specifically, we need the following types of data to construct a good historical summary of each hazard as it impacts UCB:

- What type of hazard event?
- Brief description of the nature and magnitude of the event
- Where did the event occur?
    - ♦ County, City, University facilities affected, and physical location/boundaries on map
- When did it occur – date?
- Type of damage?
    - ♦ Personal injury/death
    - ♦ Damage to infrastructure/personal property
    - ♦ Damage to crops
    - ♦ Lost business or work
    - ♦ Road/School/other closures
- Approximate dollar amount of damage?
- Percentage of costs covered by insurance? Other?
- Opinion as to whether this is likely to occur again, either in the planning area in general and/or in the location of the previous occurrence.
- Dollars received from federal/state disaster declarations in each community

A summary Hazard Identification Worksheet (**Worksheet 1**) and Historic Hazard Event Data Collection Sheet (**Worksheet 2**) are included at the end of this workbook to help collect this information. It is also very useful to provide backup data that supports the information provided in the worksheets. Types of backup data include news articles and reports, interagency memos, and copies of pertinent information from technical reports, plans and studies.

Vulnerability Data

For each identified hazard, we need to determine the vulnerability of UCB as follows:

- Do any of the hazards occur repeatedly in a given area or areas to create a hazard map? Provide existing hazard map or identify hazard risk areas on a base map.
- Inventorying each mapped risk area (hazard by hazard, where different):
    - ♦ Total Values at Risk (i.e., types, numbers, and value of improvements)
    - ♦ Building Counts, by type of use, occupancy, construction
    - ♦ Estimated Values of those structures
    - ♦ Past Loss Data, as an indication of potential future losses
    - ♦ Insurance Data – coverage, claims paid, and repetitive losses
    - ♦ Identification of critical facilities at risk and estimated values (See list below)
    - ♦ Identification of natural resources at risk- wetlands, threatened & endangered species, others
    - ♦ Identification of cultural resources at risk – state and federal listed historic sites
    - ♦ Identification of impact to the community
    - ♦ Description of development trends within risk area
- Identify the above items for risk areas that can not be specifically mapped (likely a total listing of all above items on a community by community basis)
- County/University Abstract of assessed valuations or insured values
- Flood risk areas and floodplain inventory on a community by community basis (Number of buildings and Number of Repetitive Losses)
- National Flood Insurance Program (NFIP) insurance data (Number of policies, number/date/dollars of claims paid)
- Average depth of 100-year floodplain in communities

A critical facility is often defined as one that is essential in providing utility or direction either: 1) during the response to an emergency; or 2) during the recovery operation. Some critical facilities are likely located in identified risk areas of the county and communities, potentially rendering them inoperable in a flood emergency. Critical facilities can also include those facilities that may require additional attention during an emergency such as daycare centers and nursing homes. Examples of critical facilities include:

- Main county office building/municipal buildings
- Water pumping and disinfection stations
- Airports
- Wellheads and water towers/tanks
- Police stations
- Fire stations
- Emergency operations center(s)
- Key access roads
- Hospitals
- Schools

- Power substations
- Sewage lift stations
- Aboveground pipeline (gas) facilities
- Shelters
- Day Cares
- Nursing Homes

A Vulnerability Questionnaire (**Worksheet 3**) and three additional Vulnerability Worksheets (**Worksheets 4, 5, and 6**) are included at the end of this workbook.

Capability Data

This section describes the type of required information for documenting UCB's existing capabilities for reducing future disaster losses. A matrix (**Worksheet 7**), included at the end of this workbook, can be used as a checklist for collecting this information.

Capabilities are methods that the participating jurisdiction currently uses to reduce hazard impacts. A capability matrix is provided to help identify the usual methods that communities follow to mitigate hazards. Please err on the side of generosity so the planning team has the most complete relevant information available to it to support the planning process. Please complete the matrix and *provide supporting documentation* regarding:

- Identify existing or provide documentation/information regarding other programs/projects underway for hazard mitigation
- Identify and provide other community plans and goals
- Identify and provide existing policy/program guidance
    - ♦ General Plan/safety elements/natural environment elements
    - ♦ Zoning/floodplain management ordinances
    - ♦ Building codes (seismic, wildfire, etc.)
    - ♦ Existing emergency management (i.e., warning, evacuation, EOC, LEPC, utilities response plan)
- Other existing capabilities that mitigate the risk and vulnerability of a community to a given hazard?
- Listing of GIS data available for each community: floodplain maps, floodplain building/parcel inventory, building type critical facility inventory [police, fire, power, water, sewer, drainage pumps], repetitive loss *areas*, completed/underway mitigation project areas (elevation/acquisition), land use, building types (URM, manufactured housing parks), soils map, vegetation types, natural/cultural resource areas, dam-failure inundation maps, levee failure inundation maps, existing hazard maps)
- Response and evacuation plans for dams

The Mitigation Strategy

One of the planning process' last activities will be for HMPC members to prepare brief descriptions of proposed mitigation projects that would effectively reduce future disaster losses. It is very important that potential projects start being identified very early so the information needed to describe them and to assign priorities is developed during the entire process, leaving only “final tinkering” for the final phase of work.

This section provides guidance on the categories of mitigation measures to be considered along with a mitigation project outline with two example projects. Two Mitigation Worksheets (**Worksheets 8 and 9**) are included at the end of this workbook. **Worksheet 8** provides a form for brainstorming potential projects to address identified issues. **Worksheet 9** provides the format for writing up potential projects to be included in the mitigation strategy.

Categories of Mitigation Measures

PREVENTION: Preventive measures are designed to keep the problem from occurring or getting worse. Their objective is to ensure that future development is not exposed to damage and does not increase damage to other properties.

- Planning
- Zoning
- Open space preservation
- Land developmentrRegulations
    - ♦ Subdivision regulations
    - ♦ Building codes
    - ♦ Floodplain development regulations
    - ♦ Geologic hazard areas development regulations (for roads too!)
- Stormwater management
- Fuels management, Fire-breaks

EMERGENCY SERVICES measures protect people during and after a disaster. A good emergency services program addresses all hazards. Measures include:

- Warning (flooding, tornadoes, winter storms, geologic hazards, fire)
    - ♦ NOAA Weather Radio
    - ♦ Sirens
    - ♦ “Reverse 911” (Emergency Notification System)
- Emergency Response
    - ♦ Evacuation & Sheltering
    - ♦ Communications
    - ♦ Emergency Planning
        - ° Activating the EOC (emergency management)
        - ° Closing streets or bridges (police or public works)
        - ° Shutting off power to threatened areas (utility company)
        - ° Holding/releasing children at school (school district)
        - ° Passing out sand and sandbags (public works)
        - ° Ordering an evacuation (mayor)
        - ° Opening emergency shelters (Red Cross)
        - ° Monitoring water levels and flow rates(engineering)

        - Security and other protection measures (police)
        - Critical Facilities Protection (Buildings or locations vital to the response and recovery effort, such as police/fire stations, hospitals, sewage treatment plants/lift stations, power substations)
        - Buildings or locations that, if damaged, would create secondary disasters, such as hazardous materials facilities and nursing homes
        - Lifeline utilities protection
- Post-Disaster Mitigation
    - Building Inspections
    - Identify Mitigation opportunities and funding prior to reconstruction

PROPERTY PROTECTION: Property protection measures are used to modify buildings subject to damage rather than to keep the hazard away. A community may find these to be inexpensive measures because often they are implemented by or costs are shared with property owners. Many of the measures do not affect the appearance or use of a building, which makes them particularly appropriate for historical sites and landmarks.

- Retrofitting/disaster proofing
    - Floods
        - Wet/dry floodproofing (barriers, shields, backflow valves)
        - Relocating/Elevating
        - Acquiring properties at risk to floods and removing structures
        - Retrofitting
    - High Winds/Tornadoes
        - Building Safe rooms
        - Securing roofs and foundations with fasteners and tie-downs
        - Strengthening garage doors and other large openings
    - Winter Storms
        - Removing immediately snow/ice from roofs, tree limbs
        - Installing "Living" snow fences
    - Geologic Hazards (Landslides, earthquakes, sinkholes)
        - Anchoring, bracing, shear walls
        - Dewatering sites, agricultural practices
        - Constructing Catch basins
    - Drought
        - Improving water supply (transport/storage/conservation)
        - Removing moisture competitive plants (Tamarisk/Salt Cedar)
        - Implementing water restrictions/water saver sprinklers/appliances
        - Grazing on CRP lands (no overgrazing-see noxious weeds)
        - Creating incentives to consolidate/connect water services
        - Recycling wastewater on golf courses
    - Wildfire, Grassfires
        - Replacing building components with fireproof materials
            - Roofing, screening
        - Creating "defensible space"

        - Installing spark arrestors
        - Undertaking Fuels modification
    - ♦ Noxious Weeds/Insects
        - Mowing
        - Spraying
        - Planting replacement cover
        - Halting overgrazing
        - Introducing natural predators
- o Insurance

NATURAL RESOURCE PROTECTION: Natural resource protection activities are generally aimed at preserving (or in some cases restoring) natural areas. In so doing, these activities enable the naturally beneficial functions of floodplains and watersheds to be better realized. These natural and beneficial floodplain functions include the following:

- storage of floodwaters
- absorption of flood energy
- reduction in flood scour
- infiltration that absorbs overland flood flow
- groundwater recharge
- removal/filtering of excess nutrients, pollutants, and sediments from floodwaters
- preservation of habitat for flora and fauna
- support of recreational and aesthetic opportunities

Methods of protecting natural resources include:

- Wetlands Protection
- Riparian Area/Habitat Protection/Threatened-Endangered Species
- Erosion & Sediment Control
- Best Management Practices
    - ♦ Best management practices ("BMPs") are measures that reduce nonpoint source pollutants that enter the waterways. Nonpoint source pollutants come from non-specific locations. Examples of nonpoint source pollutants are lawn fertilizers, pesticides, and other farm chemicals, animal wastes, oils from street surfaces and industrial areas and sediment from agriculture, construction, mining and forestry. These pollutants are washed off the ground's surface by stormwater and flushed into receiving storm sewers, ditches and streams. BMPs can be implemented during construction and as part of a project's design to permanently address nonpoint source pollutants. There are three general categories of BMPs:
        1. Avoidance: setting construction projects back from the stream.
        2. Reduction: Preventing runoff that conveys sediment and other water-borne pollutants, such as planting proper vegetation and conservation tillage.

3. Cleanse: Stopping pollutants after they are en route to a stream, such as using grass drainageways that filter the water and retention and detention basins that let pollutants settle to the bottom before they are drained

- Dumping Regulations
- Set-back regulations/buffers
- Fuels Management
- Water Use Restrictions
- Landscape Management
- Weather Modification

STRUCTURAL PROJECTS have traditionally been used by communities to control flows and water surface elevations. Structural projects keep flood waters away from an area. They are usually designed by engineers and managed or maintained by public works staff. These measures are popular with many because they "stop" flooding problems. However, structural projects have several important shortcomings that need to be kept in mind when considering them for flood hazard mitigation:

- They are expensive, sometimes requiring capital bond issues and/or cost sharing with federal agencies, such as the U.S. Army Corps of Engineers or the Natural Resources Conservation Service.
- They disturb the land and disrupt natural water flows, often destroying habitats or requiring Environmental Assessments.
- They are built to a certain flood protection level that can be exceeded by a larger flood, causing extensive damage.
- They can create a false sense of security when people protected by a structure believe that no flood can ever reach them.
- They require regular maintenance to ensure that they continue to provide their design protection level.

Structural measures include:

- Detention/retention structures
- Erosion and sediment control
- Basins/low-head weirs
- Channel modifications
- Culvert resizing/replacement/maintenance
- Levees and floodwalls
- Anchoring, grading, debris basins (for landslides)
- Fencing (for snow, sand, wind)
- Drainage system maintenance
- Reservoirs(for flood control, water storage, recreation, agriculture)
- Diversions
- Storm sewers

PUBLIC INFORMATION: A successful hazard mitigation program involves both the public and private sectors. Public information activities advise property owners, renters, businesses, and local officials about hazards and ways to protect people and property from these hazards. These activities can motivate people to take protection

- Hazard maps and data
- Outreach rojects (mailings, media, web, speakers bureau, displays)
- Library resources
- Real estate disclosure
- Environmental education

Example Project Description

Each project description for each jurisdiction should conform to the following format:

TITLE
Issue/Background
Other Alternatives
Responsible Office
Priority (High ,Medium,Low)
Cost Estimate
Benefits
Potential funding
Schedule

This Mitigation Project Description Worksheet (**Worksheet 9**) is included at the end of this workbook to record potential projects during the planning process.

The following are two examples taken from other DMA 2000 qualifying plans.

Sample ACTION #12: ELEVATE REMAINING 95 HOMES IN THE DRY CREEK WATERSHED

Issue/Background: Historically, flooding in the Dry Creek watershed has been a major concern. The February 1986 flood caused widespread damage in most of the Dry Creek watershed. Nearly all bridges and culverts were overtopped, with 30 sustaining embankment damages and one crossing washing out; two bridges over Dry Creek were damaged, street cave-ins occurred at a number of locations, and over 125 homes flooded. Of the 145 homes subject to historical flooding within the Watershed, 95 structures remain non-elevated. Of these 95 remaining homes, 25-30 declined initial grant money for elevation, as did the three repetitive loss structures. Placer County is not only concerned with existing flooding problems, but with future problems resulting from increased growth and development in the area. According to the 1992 Dry Creek Watershed Flood Control Plan, substantial flood damages will occur with the 100-year flood under existing conditions. Areas with the most extensive and frequent damages include areas in the location of the 95 homes. The report indicates that some of these areas are susceptible to flooding from storms as frequent as the 10-year storm. Elevating the remaining 95 homes will reduce future flood-related losses.

Other Alternatives: No Action

Responsible Office: Placer County Flood Control and Water Conservation District, in conjunction with its member agencies including the cities of Rocklin, Loomis, and Roseville.

Priority (H, M, L): Medium

Cost Estimate: The cost to elevate is estimated at $40 per square foot. Homes need to be elevated anywhere from one to six feet. Of the 95 homes where elevating is feasible, it is estimated to cost $6 million or $50,000 to $60,000 per home.

Benefit: Life Safety; Reduction in Property Loss.

Potential Funding: HGMP, PDM, Dry Creek Trust Fund

Schedule: Within three years

Sample ACTION #4: TODD VALLEY SHADED FUEL BREAK

Issue/Background: Saving lives and property along with rapid containment of wildfires and structure fires are a high priority for the Foresthill Fire Protection District (FFPD) and Foresthill Fire Safe Council (FFSC). The Todd Valley Subdivision is a neighborhood of about 1,100 homes located southeast of Foresthill, CA in rural Placer County. It encompasses some 1,500 acres, and 45 miles of roadways, with only two main exits to Foresthill Rd. The southern boundary of the 25-year-old subdivision directly intersects the steep cliffs of the Middle Fork of the American River. To the 3,000 people who live there, Todd Valley appears to be an isolated enclave, sheltered by towering oaks and pine trees. Many homes are shielded from neighbor's views by a quarter-century accumulation of dense brush and impenetrable vegetation under story. The calculations for fire travel from the Middle Fork American River to this subdivision in the middle of summer on the right day is 15 minutes.

A Shaded Fuel Break at the top of the ridge of the Middle Fork American River Canyon would give firefighters a place to make a stand and allow an area for the fire to slow and drop to the ground where it can be managed. This would also give sheriffs and firefighters a better chance to evacuate the area.

Other Alternatives: If you look at the fire history on the Foresthill Divide, it is not a question of IF but WHEN will we have a devastating wildfire. To do nothing would leave the residents open to a devastating firestorm. The Chipper Program has been used very successfully in this area, but is still far from making a significant continuous connected Shaded Fuel Break. Continuous public education is also an alternative.

Responsible Office: Luana R. Dowling: FFSC Chairman

Priority (H, M, L): High

Cost Estimate: Approximately $1,200 per acre. 50/50 match with property owners and a federal grant. The property in the canyon is state recreation area owned by Bureau of Reclamation (BOR). This recreation area has been the area of several fire starts in the past.

Benefit: Benefit to the 3,000 residents of Todd Valley is their lives as well as their homes. At the current county median value per home of over $400,000 per home, the 1,100 homes in Todd Valley are valued at $440,000,000. Having a strategically planned shaded fuel break will not only save lives, but also assist firefighters in gaining timely access to protect homes.

Potential Funding: Grants, loans and subsidies available for such projects.

Schedule: Completed by the end of 2008

Worksheet 1

Hazard Identification Worksheet

Purpose: Use this worksheet to identify the possible hazards that may impact your jurisdiction. This worksheet will be used to support the hazard identification and risk assessment. Use the Hazard Event worksheet to provide evidence to justify your conclusions.

Hazard	**Frequency of Occurrence**	**Spatial Extent**	**Potential Magnitude**	**Significance**	**Risk Map Avail. Source/scale**	
					GIS	**Hard Copy**
Avalanch						
Dam Failure						
Drought						
Earthquake						
Flood						
Hail						
Heavy Rain/Lightning						
High Wind						
Landslide						
Natural Health Hazard						
Tornado						
Wildfire						
Winter Storm						

Guidelines

Frequency of Occurrence:
Highly Likely: Near 100% probability in next year.
Likely: Between 10 and 100% probability in next year, or at least one chance in 10 years.
Occasional: Between one and 10% probability in next year, or at least one chance in next 100 years.
Unlikely: Less than 1% or 1% probability in next 100 years.

Potential Magnitude
Catastrophic: More than 50% of area affected
Critical: 25 to 50%
Limited: 10 to 25%
Negligible: Less than 10%

Spatial Extent
Limited: Less than 10% of planning area
Significant: 10-50% of planning area
Extensive: 50-100% of planning area
Significance (Your subjective opinion)

Low, Medium, High

Contact information
Filled out by:
Address:
Phone:

Worksheet 2
Historic Hazard Event Data Collection Sheet

Instructions: Please fill out one sheet for each event with as much detail as possible. Attach supporting documentation, photocopies of newspaper articles or other original sources.

Type of natural hazard event	
Date of Event	
Description of the nature and magnitude of the event	
Location (community or description with map)	
Injuries	
Deaths	
Property damage	
Infrastructure damage	
Crop damage	
Business/economic impact	
Road/school/other closures	
Other damage	
Total damages	
Insured losses	
Fed/state disaster relief funding $	
Opinion on likelihood of occurring again	
Source of information	
Comments	

Contact information
Name of jurisdiction:
Filled out by:
Address:
Phone:

Worksheet 3
Vulnerability Questionnaire

1. Natural Hazard Type?

2. Do you know the frequency and magnitude of possible future hazard events?

3. Has the university/college ever been affected by this type of hazard event? If so, how? (may reference Hazard ID Worksheet).

4. Are some parts of the campus particularly vulnerable to damages, or is the entire area vulnerable?

5. Are some buildings particularly vulnerable to damages? If so, which buildings and to what extent?

6. What are the uses and occupancies of the vulnerable buildings?

7. What will the expected damages do—threaten life safety? Ruin buildings? Destroy equipment and computers? Disrupt work?

8. Are your utilities or other infrastructure (e.g. roads, bridges, other) vulnerable to damages? How?

9. What systems depend on either building functionality or utility functionality?

10. Are any Critical facilities vulnerable to damages? How?

11. Are any areas of historic or cultural significance vulnerable to damages? How?

12. Are any areas of environmental significance (e.g., threatened and endangered species, wetlands, others) vulnerable to damages? How?

13. Are any areas of historic or cultural significance vulnerable to damages? How?

14. Can you provide an estimate of the affected population? Include any special needs populations.

15. What could it cost to repair damages?

16. How long could it take?

17. How will teaching be affected?

18. How will research be affected?

19. How will students be affected on campus?

20. How will students be affected off campus?

21. Will employees who live in the area be able to get to work?

22. Will employees' homes be affected by the hazard event(s)?

23. Could the university or portions of the university be closed down for a significant period of time because of possible disaster losses?

24. Are there other anticipated impacts to the community?

25. Are there any identified development trends/constraints in the hazard area?

Contact information
Name of jurisdiction:
Filled out by:
Address:
Phone:

Worksheet 4
Vulnerability Assessment

What will be affected by the hazard event? √

Determine the proportion of buildings, the value of buildings, and the population on campus that are located in hazard areas.

Hazard____

Type of Building/Assets	**Number of Structures**			**Value of Structures**			**Number of People**		
	# on	# in Hazard	% in Hazard	$ on	$ in Hazard	% in Hazard	# on	# in Hazard	% in Hazard
	Campus	Area	Area	Campus	Area	Area	Campus	Area	Area
Residential									
Classroom Buildings									
Administration									
Research/labs									
Recreational use									
Libraries									
Medical facilities									
Dining facilities/auditoria									
Utilities and infrastructure									
Data systems									
Critical facilities									
Historical/cultural resources									
Environmental/ natural resources									

Contact information
Name of jurisdiction:
Filled out by:
Address:
Phone:

Worksheet 5
Vulnerability Assessment

What will be affected by the hazard event?

Compile a detailed inventory of what can be damaged by a hazard event.

Inventory the assets that are of highest priority to your institution's operations that can be damaged by a hazard event.

Hazard___________________________________

Name or description of asset	Sources of Information	Residential	Classroom buildings	Administration	Research/labs	Recreational use	Libraries	Medical facilities	Dining Facilities/auditoria	Utilities /infrastructure	Data systems	Critical facilities	Historical/cultural resources	Environ/natural resources	Size of building (sq ft)	Replace-ment value ($)	Contents value ($)	Function or use value ($)	Displace-ment cost ($ per day)	Occupancy or capacity *(#)*	Other hazard-specific information
		√	√	√	√	√	√	√	√	√	√	√	√	√							

Name or description of asset	Sources of Information	Residential	Classroom buildings	Administration	Research/labs	Recreational use	Libraries	Medical facilities	Dining Facilities/auditoria	Utilities /infrastructure	Data systems	Critical facilities	Historical/cultural resources	Environ/natural resources	Size of building (sq ft)	Replace-ment value ($)	Contents value ($)	Function or use value ($)	Displace-ment cost ($ per day)	Occupancy or capacity *(#)*	Other hazard-specific information
		√	√	√	√	√	√	√	√	√	√	√	√	√							

Contact information
Name of jurisdiction:
Filled out by:
Address:
Phone:

Worksheet 6
Vulnerability Assessment
(Estimate Losses)

Date: How will the hazard events affect you?

.

Hazard_______________________________________

Structure Loss **Contents Loss**

Name/description of structure	Structure replacement value ($)	X	Percent damage (%)	=	Loss to structure ($)	Replacement value of contents ($)	X	Percent damage (%)	=	Loss to contents ($)
		X		=			X		=	
		X		=			X		=	
		X		=			X		=	
		X		=			X		=	
		X		=			X		=	
		X		=			X		=	
		X		=			X		=	
		X		=			X		=	

Total Loss to Structure **Total Loss to Contents**

Structure Use and Function Loss

Name/description of structure	Average daily operating budget (functional use value)	X	Functional downtime (# of days)	+	Displacement cost per day ($)	X	Displacement time ($)	=	Structure use and function loss ($)		Structure loss + content loss + function loss
		X		+		X		=			
		X		+		X		=			
		X		+		X		=			
		X		+		X		=			
		X		+		X		=			
		X		+		X		=			
		X		+		X		=			
		X		+		X		=			

Total Loss to Structure Use and Function **Total Loss For Hazard Event**

Contact information
Name of jurisdiction:
Filled out by:
Address:
Phone:

Worksheet 7

Jurisdiction:	Y/N other	Comments
Comp plan/general plan		
Subdivision ordinance		
Zoning ordinance		
NFIP/FPM ordinance		
- Substantial damage language?		
- Administrator/certified floodplain manager?		
- Number of flood threatened buildings		
- Number of flood insurance policies		
- Number of repetitive losses?		
- Maintain elevation certificates?		
CRS rating, if applicable		
Stormwater program?		
Erosion or Sediment controls		
Number of URM buildings		
Hospitals built before 1973 (for HSSA)		
Building code version		
Full-time building official?		
Conduct "as-built" inspections?		
Local emergency operations plan		
Fire department ISO rating		
Fire safe programs		
Hazard mitigation plans		
Warning systems/services		
- Storm ready certified?		
- Weather radio reception?		
- Outdoor warning sirens?		
- Emergency notification (R-911)?		
- Other? (e.g., cable over-ride)		
GIS system?		
- Hazard data?		
- Building footprints?		
- Links to assessor data?		
- Land-use designations?		
Structural protection projects		
Property protection projects		
Critical facilities protected?		
Natural/cultural resources inventory?		
Public information program/outlet		
Environmental education program?		

EXPLANATION OF CAPABILITY ASSESSMENT MATRIX

The following definitions are designed to help each HMPC member complete an assessment of his or hers current capabilities. This list is not exhaustive, and the amount of information available locally can vary greatly between jurisdictions.

[Accompanying matrix entries: Y=yes, N=no, ? = uncertain or item unclear.]

Comprehensive, General, or Land Use Plan: Comprehensive (general, land use) long-term community growth management plan

Subdivision Ordinance: Dictates lot sizes, densities, set-backs, construction type.

Zoning Ordinance: Dictates type of use and occupancy; implements Land use plan.

NFIP & FPM Ordinances: National Flood Insurance Program (NFIP) and Floodplain Management ordinances (FPM): govern development in identified Flood Hazard Areas, and are required for participation in NFIP and Floodplain Mitigation programs. Do not need floodplain maps, but do need related recent (within last 10 years) documents, special studies, program summaries, etc.

Substantial Damage Language: FPM ordinance language on Substantial damage/improvements ("50% rule"). Copy needed if in place.

Administrator/Certified Floodplain Manager: Name and contact information needed for floodplain management administrator (someone with the responsibility of enforcing the ordinance and providing ancillary services (e.g., map reading, public education on floods, etc.).

Number of flood threatened buildings: Need total number of buildings by community that are in the floodplains.

Number of flood insurance policies: Need total number of buildings by community that are insured against floods through the NFIP.

Number of repetitive flood losses: Need number of repetitive losses properties (usually on a parcel basis); and for which NFIP/FEMA has paid more than $1,000 twice in the past 10 years.

Maintain Elevation Certificates: The Elevation Certificate documents the lowest floor elevation of any new building or substantial improvement built in the Special Flood Hazard Area. How does the jurisdiction maintain these?

Community Rating System (CRS) Rating: NFIP's: participation (yes or no); if yes, need the rating.

Stormwater program: Need documentation of any existing stormwater management programs.

Erosion or Sediment Controls: Need summary information for any projects or regulations.

Number of unreinforced masonry buildings: Need number of URMs and any mitigation plan or risk reduction program information.

Hospitals built before 1973 - Hospital Seismic Safety Act: Need number of hospital buildings governed by HSSA that were built prior to 1973 and which are governed by 1994 legislation that calls for their replacement or change of use.

Building Code Version: Need the date of most recent UBC adoption (do not need the code itself). Also need to know if the jurisdiction has a full-time inspector and if "as-built" inspections are conducted.

Local Emergency Operations Plan: Local Emergency Operations Plan (EOP; a disaster or multi-hazard functional response plan); and any directly related contingency plans (e.g., terrorism response, hazardous materials response, and dam failure evacuation and inundation maps.

Fire Department ISO Rating: Need at least the rating and date of it; and could use back-up documentation showing ratings of various items, especially fire prevention measures and programs, including date of most recent UFC adoption (do not need the code itself).

Fire Safe Programs: Need summary information about local fire-safe programs and extent of participation.

Hazard Mitigation Plans: Need existing Hazard Mitigation Plans that were for recent past disasters or that were prepared for other reasons. Also need related grant information: purpose of application (e.g., replace earthquake vulnerable communications center), amount requested, and whether approved or not.

Warning Systems/Services: Do not need technical information, but do need to know if communities have any types of systems, such as: "Storm Ready" Certification from the National Weather Service, NOAA's Weather Radio reception, sirens, cable (TV) override, "Reverse 911," etc.

GIS and HAZUS Capabilities: Geographic Information System capabilities and hazards layers and applications, including uses of federally-funded loss estimation software (HAZUS) for earthquakes, floods, and high winds. If yes, need summary information on hazards related layers (e.g., floodplains, ground motion contours) and how used (e.g., to estimate post-earthquake debris, zoning decisions).

Structural Protection Projects: Need summary information about proposed or planned projects (e.g., levees, drainage facilities, detention/retention basins, seismic retrofits).

Property Protection Projects: Need summary information about proposed or planned projects (e.g., buy-outs, elevation of structures, floodproofing, small "residential" levees or berms/floodwalls, non-structural measures for buildings).

Critical Facility Protection: Need summary information about proposed or planned projects (e.g., protection of power substations, sewage lift stations, water-supply sources, the EOC, police/fire stations, medical facilities) that are at risk from the area's hazards.

Natural and Cultural Inventories: Inventories of resources, maps, or special regulations within the community (e.g., wetlands, Native American sites, historic structures/districts, etc.); need only summary information.

Public Information and/or Environmental Education Program: Do not need documents; need only summary information about ongoing programs even if their primary foci are not hazards (e.g., "regular" flyers included in utility billings, a website, or environmental education programs in conjunction with parks and recreational activities).

Worksheet 8
Mitigation Strategy

Date: Identify Mitigation Actions

Instructions: For each type of loss identified on previous worksheets, determine possible actions. Record information below.

Hazard _______________________________

Priority	**Possible Actions** (include location)	**Sources of Information** (include sources you reference and documentation)	**Comments** (Note any initial issues you may want to discuss or research further)	**Planning Reference** (Determine into which pre-existing planning suggested projects can be integrated)

Contact information
Name of jurisdiction:
Filled out by:
Address:
Phone:

Worksheet 9
Mitigation Project Description Worksheet

Instructions: Use this guide to record potential mitigation projects (one or more pages per project) identified during the planning process. Provide as much detail as possible and use additional pages as necessary. These will be collected following HMPC meetings on mitigation goals and measures and included in the plan.

Jurisdiction:

Mitigation Project Title:

Issue/Background:

Other Alternatives:

Responsible Office:

Priority (High, Medium, Low):

Cost Estimate:

Benefits (avoided Losses):

Potential funding:

Schedule:

Worksheet Completed by
Name and Title:
Phone:

Multi-Hazard Mitigation DRU Plan

Appendix C

Mitigation Categories, Alternatives and Selection Criteria

(from CRS, with some multi-hazard examples added)

- Prevention
  - Planning and Zoning
  - Open space preservation
  - Land development regulations
  - Stormwater management
  - Fuels management

- Property Protection
  - Fire-Wise construction
  - Defensible space/fuels modification
  - Water supply
  - Flood protection

- Natural Resource Protection
  - Erosion and sediment control
  - Wetlands protection
  - Threatened and endangered species protection
  - Fuels management

- Emergency Services
  - Warning and evacuation
  - Communications
  - Critical facilities protection
  - Lifeline utilities protection
  - Health and safety maintenance

- Structural Projects
  - Detention/retention structures
  - Sediment basins/low-head weirs
  - Channel modifications
  - Culvert resizing/replacement/maintenance
  - Floodwalls

- Public Information
  - Hazard maps
  - Outreach programs (mailings, media, web, speakers bureau)
  - Education Program (Children/Adults)

ALTERNATIVE MITIGATION MEASURES BY CATEGORY

PREVENTION: Preventive measures are designed to keep the problem from occurring or getting worse. Their objective is to ensure that future development is not exposed to damage and does not increase damage to other properties.

- Planning
- Zoning
- Open space preservation
- Land developmentrRegulations
    - ♦ Subdivision regulations
    - ♦ Building codes
    - ♦ Floodplain development regulations
    - ♦ Geologic hazard areas development regulations (for roads too!)
- Stormwater management
- Fuels management, Fire-breaks

EMERGENCY SERVICES measures protect people during and after a disaster. A good emergency services program addresses all hazards. Measures include:

- Warning (flooding, tornadoes, winter storms, geologic hazards, fire)
    - ♦ NOAA Weather Radio
    - ♦ Sirens
    - ♦ "Reverse 911" (Emergency Notification System)
- Emergency Response
    - ♦ Evacuation & Sheltering
    - ♦ Communications
    - ♦ Emergency Planning
        - ° Activating the EOC (emergency management)
        - ° Closing streets or bridges (police or public works)
        - ° Shutting off power to threatened areas (utility company)
        - ° Holding/releasing children at school (school district)
        - ° Passing out sand and sandbags (public works)
        - ° Ordering an evacuation (mayor)
        - ° Opening emergency shelters (Red Cross)
        - ° Monitoring water levels and flow rates(engineering)
        - ° Security and other protection measures (police)
        - ° Critical Facilities Protection (Buildings or locations vital to the response and recovery effort, such as police/fire stations, hospitals, sewage treatment plants/lift stations, power substations)
        - ° Buildings or locations that, if damaged, would create secondary disasters, such as hazardous materials facilities and nursing homes
        - ° Lifeline utilities protection
- Post-Disaster Mitigation
    - ♦ Building Inspections
    - ♦ Identify Mitigation opportunities and funding prior to reconstruction

PROPERTY PROTECTION: Property protection measures are used to modify buildings subject to damage rather than to keep the hazard away. A community may find these to be inexpensive measures because often they are implemented by or costs are shared with property owners. Many of the measures do not affect the appearance or use of a building, which makes them particularly appropriate for historical sites and landmarks.

- Retrofitting/disaster proofing
  - Floods
    - Wet/dry floodproofing (barriers, shields, backflow valves)
    - Relocating/Elevating
    - Acquiring properties at risk to floods and removing structures
    - Retrofitting
  - High Winds/Tornadoes
    - Building Safe rooms
    - Securing roofs and foundations with fasteners and tie-downs
    - Strengthening garage doors and other large openings
  - Winter Storms
    - Removing immediately snow/ice from roofs, tree limbs
    - Installing "Living" snow fences
  - Geologic Hazards (Landslides, earthquakes, sinkholes)
    - Anchoring, bracing, shear walls
    - Dewatering sites, agricultural practices
    - Constructing Catch basins
  - Drought
    - Improving water supply (transport/storage/conservation)
    - Removing moisture competitive plants (Tamarisk/Salt Cedar)
    - Implementing water restrictions/water saver sprinklers/appliances
    - Grazing on CRP lands (no overgrazing-see noxious weeds)
    - Creating incentives to consolidate/connect water services
    - Recycling wastewater on golf courses
  - Wildfire, Grassfires
    - Replacing building components with fireproof materials
      - Roofing, screening
    - Creating "defensible space"
    - Installing spark arrestors
    - Undertaking Fuels modification
  - Noxious Weeds/Insects
    - Mowing
    - Spraying
    - Planting replacement cover
    - Halting overgrazing
    - Introducing natural predators
  - Insurance

NATURAL RESOURCE PROTECTION: Natural resource protection activities are generally aimed at preserving (or in some cases restoring) natural areas. In so doing, these activities enable the naturally beneficial functions of floodplains and watersheds to be better realized. These natural and beneficial floodplain functions include the following:

- storage of floodwaters
- absorption of flood energy
- reduction in flood scour
- infiltration that absorbs overland flood flow
- groundwater recharge
- removal/filtering of excess nutrients, pollutants, and sediments from floodwaters
- preservation of habitat for flora and fauna
- support of recreational and aesthetic opportunities

Methods of protecting natural resources include:

- Wetlands Protection
- Riparian Area/Habitat Protection/Threatened-Endangered Species
- Erosion & Sediment Control
- Best Management Practices
    - ♦ Best management practices ("BMPs") are measures that reduce nonpoint source pollutants that enter the waterways. Nonpoint source pollutants come from non-specific locations. Examples of nonpoint source pollutants are lawn fertilizers, pesticides, and other farm chemicals, animal wastes, oils from street surfaces and industrial areas and sediment from agriculture, construction, mining and forestry. These pollutants are washed off the ground's surface by stormwater and flushed into receiving storm sewers, ditches and streams. BMPs can be implemented during construction and as part of a project's design to permanently address nonpoint source pollutants. There are three general categories of BMPs:
        4. Avoidance: setting construction projects back from the stream.
        5. Reduction: Preventing runoff that conveys sediment and other water-borne pollutants, such as planting proper vegetation and conservation tillage.
        6. Cleanse: Stopping pollutants after they are en route to a stream, such as using grass drainageways that filter the water and retention and detention basins that let pollutants settle to the bottom before they are drained

- Dumping Regulations
- Set-back regulations/buffers
- Fuels Management
- Water Use Restrictions
- Landscape Management
- Weather Modification

STRUCTURAL PROJECTS have traditionally been used by communities to control flows and water surface elevations. Structural projects keep flood waters away from an area. They are usually designed by engineers and managed or maintained by public works staff. These measures are popular with many because they "stop" flooding problems. However, structural projects have several important shortcomings that need to be kept in mind when considering them for flood hazard mitigation:

- They are expensive, sometimes requiring capital bond issues and/or cost sharing with federal agencies, such as the U.S. Army Corps of Engineers or the Natural Resources Conservation Service.
- They disturb the land and disrupt natural water flows, often destroying habitats or requiring Environmental Assessments.
- They are built to a certain flood protection level that can be exceeded by a larger flood, causing extensive damage.
- They can create a false sense of security when people protected by a structure believe that no flood can ever reach them.
- They require regular maintenance to ensure that they continue to provide their design protection level.

Structural measures include:

- Detention/retention structures
- Erosion and sediment control
- Basins/low-head weirs
- Channel modifications
- Culvert resizing/replacement/maintenance
- Levees and floodwalls
- Anchoring, grading, debris basins (for landslides)
- Fencing (for snow, sand, wind)
- Drainage system maintenance
- Reservoirs(for flood control, water storage, recreation, agriculture)
- Diversions
- Storm sewers

PUBLIC INFORMATION: A successful hazard mitigation program involves both the public and private sectors. Public information activities advise property owners, renters, businesses, and local officials about hazards and ways to protect people and property from these hazards. These activities can motivate people to take protection

- Hazard maps and data
- Outreach rojects (mailings, media, web, speakers bureau, displays)
- Library resources
- Real estate disclosure
- Environmental education

MITIGATION ALTERNATIVE SELECTION CRITERIA
For use in selecting and prioritizing Proposed Mitigation Measures

1. **STAPLE**

Social:	Does the measure treat people fairly? (different groups, different generations)
Technical:	Will it work? (Does it solve the problem? Is it feasible?)
Administrative:	Do you have the capacity to implement and manage project?
Political:	Who are the stakeholders? Did they get to participate? Is there public's support? Is political leadership willing to support?
Legal:	Does your organization have the authority to implement? Is it legal? Are there liability implications?
Economic:	Is it cost-beneficial? Is there funding? Does it contribute to the local economy or economic development?
Environmental:	Does it comply with environmental regulations?

2. **SUSTAINABLE DISASTER RECOVERY**

- Quality of life
- Social equity
- Hazard mitigation
- Economic development
- Environmental protection/enhancement
- Community participation

3. SMART GROWTH PRINCIPLES

- Infill versus sprawl
- Efficient use of land resources
- Full use of urban resources
- Mixed uses of land
- Transportation options
- Detailed, human-scale design

4. OTHER

- Does measure address area with highest risk?
- Does measure protect:…
  - ♦ The largest number of people exposed to risk?
  - ♦ The largest number of buildings?
  - ♦ The largest number of jobs?
  - ♦ The largest tax income?
  - ♦ The largest average annual loss potential?
  - ♦ The area impacted most frequently?
  - ♦ Critical infrastructure (access, power, water, gas, telecommunications)
- Timing of available funding
- Visibility of project
- Community credibility

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Multi-Hazard Mitigation DRU Plan
Appendix D

University Adoption

Note to Reviewers: When this plan has been reviewed and approved pending adoption by FEMA Region VIII, the adoption resolution will be scanned and put on the document CD, which will contain the adoption, in this Appendix D. A model resolution is provided below:

Resolution # ______

Adopting the University of Colorado, Boulder

Multi-Hazard Mitigation Disaster Resistant University Plan

Whereas, ***(Name of Government/District/Organization seeking FEMA approval of Hazard Mitigation Plan)*** *recognizes the threat that natural hazards pose to people and property within our community; and*

Whereas, *undertaking hazard mitigation actions will reduce the potential for harm to people and property from future hazard occurrences; and*

Whereas, *an adopted Multi-Hazard Mitigation Plan is required as a condition of future funding for mitigation projects under multiple FEMA pre- and post-disaster mitigation grant programs; and*

Whereas, ***(Name of Government/District/Organization)*** *fully participated in the FEMA-prescribed mitigation planning process to prepare this Multi-Hazard Mitigation Plan; and*

Whereas, *the Colorado Division of Emergency Management and Federal Emergency Management Agency, Region VIII officials have reviewed the* "University of Colorado, Boulder Multi-Hazard Mitigation Disaster Resistant University Plan" *( ) and approved it ( ) contingent upon this official adoption of the participating governing body;*

Now, therefore, be it resolved, *that the* ***(Name of Government/District/Organization)*** *adopts the* "University of Colorado, Boulder Multi-Hazard Mitigation Disaster Resistant University Plan" *as an official plan; and*

Be it further resolved, ***(Name of Government/District/Organization)*** *will submit this Adoption Resolution to the Colorado Office of Emergency Management and Federal Emergency Management Agency, Region VIII officials to enable the Plan's final approval.*

Passed: ___(date)___

____

Certifying Official

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Multi-Hazard Mitigation DRU Plan
Appendix E

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