

Outline, Boulder County GIS and WHAMs Update, 3/14/91:

1. **GIS: ESRI ARC/INFO, PRIME, PCs. Mainframe, etc.** Interrelational data base, graphics and text data. Since '87. Parcel mapping, building permit records, monthly & annual reports, inspection tracking, mapping for long range planning projects. Both graphic and text data can be "attributes" of parcels. Attributes can be displayed either as text or graphically and can include such items as Assessor's data, zoning, floodplain, soils, building permit records, slope, comprehensive plan designations, etc. Display or plotting as shaded, patterned or colored overlays. Note that the minicomputer route was "state-of-the-art" in 1986, but today smaller, faster, more powerful work stations are the way to go in terms of doing actual mapping work. Minicomputer still does an excellent job in answering queries by multiple users, but slow when being used for intensive mapping tasks and queries, such as building permit functions, simultaneously.
2. **Other uses:** zoning and subdivision records, comprehensive plan designations, services, utilities, etc., entered or digitized for "automatic" recognition for any given parcel as opposed to manual data entry. This can all happen only after: 1) all parcel mapping is complete, and 2) all other data is entered or digitized. Analysis and reporting on attributes of parcels, permits and other records. Powerful sorting and reporting capabilities.
3. **WHAMs Update:**
 - a) Digitize existing hazards ratings and 30% slope contours for overlay on county parcel base at any scale from individual parcel to countywide.
 - b) Place overlays of hazard ratings plots over current aerial photography at same scale to check vegetation data. Also conduct field checks for current vegetation type and density. Update hazard ratings contours into GIS as necessary.
 - c) Use 3-dimensional slope/aspect capabilities of GIS software to check accuracy of existing slope/aspect data. Assessor will also use for property appraisals.
 - d) As better vegetation data becomes available from individual property hazard assessments or vegetation changes, **continually input new data into GIS to improve quality and accuracy of hazard mapping.**
4. **Use for Wildfire Hazard Mitigation Planning:**
 - a) Combine with other data, such as land use inventory, emergency response times, water supplies, etc., to prioritize areas of county with highest needs for mitigation.
 - b) Use for review and analysis of new development proposals.
 - c) Use for Pre-Fire planning.

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WHAT USES DO WE ANTICIPATE FOR UPDATED WILDFIRE HAZARD AREA MAPS(WHAMs)?

- 1) Classify relative degree of wildfire hazard for different areas of the county based upon commonly accepted standards, with contributing factors including slope, aspect(directional exposure of slope), ecosystem(vegetation) types, and vegetation cover.
- 2) Assess relative wildfire hazard risks for different areas of the county.
- 3) Establish priorities for wildfire hazard mitigation efforts based upon a combination of factors, including wildfire hazard ratings, location of housing, density of development, capabilities of local fire protection agencies, emergency response times, fire fighting water supplies, etc.
- 4) Continually update initial data with more detailed data as it becomes available.
- 5) Utilize as a basis for more detailed ratings of the defensibility of individual properties and structures.
- 6) Use for pre-fire planning by the County Sheriff's Department and county fire protection districts.
- 7) Use for review of future development proposals for wildfire concerns.
- 8) Use for comparison with other parcel attributes as they might relate to wildfire hazard ratings and mitigation efforts.

WHAT IS THE DESIRED PRODUCT?

- 1) WHAMs that relate to the county's parcel mapping base, section structure, etc. and can be used at any scale from an individual parcel to a countywide map.
- 2) Maps should be capable of identifying areas with 5 different hazard ratings(O,A,B,C,X) and 2 different slopes(under 30% and over 30%).
- 3) Maps should be able to be compared with other parcel attributes, including:
 - a) Assessor's data
 - b) Housing Locations
 - c) Development Densities
 - d) Parcel sizes
 - e) Fire Protection District boundaries
 - f) Road access, either by public road or by physically existing roads

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WORK PLAN, LISA TRIMARCO, 2/11/91

1. Transfer existing wildfire hazard categories for the Pinebrook Hills area from the existing Wildfire Hazard Area Maps(WHAMs) to the 1" = 200' parcel maps for the area(DONE).
2. Receive digitizing training sufficient to enable digitizing of the WHAMs hazard and slope ratings(TRAINING TENTATIVELY SCHEDULED FOR FRIDAY, FEBRUARY 15TH).
3. Digitize WHAMs ratings as attribute(s) of section maps for the Pinebrook Hills pilot project area(TO BE DONE AFTER RECEIVING TRAINING AND AFTER SET UP OF STRUCTURE TO DIGITIZE INTO BY GIS STAFF).
4. Work with GIS staff to plot display map of the pilot area showing wildfire hazard and slope information overlaid on top of parcel boundaries. IT WOULD BE GOOD TO HAVE THIS IN TIME FOR THE CSFS WILDFIRE MITIGATION TRAINING PROGRAM IN GOLDEN ON MARCH 14TH! Meeting with Dave Farmer to prepare for March 14th set for Wednesday, March 6th, 1:00 at Land Use Dept. Next BCFFA committee meeting is Thursday, 3/7, 6:00 at Fire Training Center.
5. Develop process for updating vegetation data. Most recent aerial photos at 1"=200' scale. Satellite imagery? Field checking? (Dave Farmer of CSFS can provide assistance in this part of the project.)
6. Assess accuracy of existing hazard ratings, based upon new vegetation data and more accurate slope and aspect information and other factors.
7. Update vegetation data and wildfire hazard ratings for Pinebrook Hills pilot area.
8. Collect land use information for Pine Brook Hills pilot area, including total number of platted acres, developed vs. undeveloped acres, number of developed lots/parcels vs. vacant lots/parcels, identifying individual lots with existing dwellings, driveway & house locations, etc(IN PROCESS). Occupied vs. vacant lots and other land use information may be able to be obtained from Assessor's data. In order to obtain lot areas, may need to use areas of polygons from GIS mapping text data. Total platted area acreage can be determined either by adding polygon areas and/or possibly from old subdivision review files for Pinebrook Hills 1-7. Use Assessor's data to obtain age of existing dwellings on lots and note this information on the larger-scale zoning maps or on the parcel maps.
9. Work with GIS staff to plot display map of pilot area with all hazard and land use information.

Lisa's Work Plan, 2/11/91, p. 2

10. Inventory other portions of the mountainous area of the county that have parcel mapping complete and available. Check with Ken Ziebarth and other GIS staff about which other areas of the mountainous portion of the county may have mapping completed before the end of the semester.
11. Work with WHAMs task force/subcommittee to prioritize other areas that have parcel maps available and have the greatest need for updated mapping.
12. Digitize existing WHAMs info onto other areas of county as selected.
13. Update vegetation data using methodology from pilot project.
14. Inventory and input land use data.
15. Plot display maps of completed areas.

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WILDFIRE HAZARD MAPPING PROJECT.

INTRODUCTION.

Fire is a cause for concern in the Boulder County Region. Causes of fire are numerous, with greatest responsibility given to human interaction, followed by that of lightning strikes. Other factors that affect likelihood of fire occurrence, fire intensity, and magnitude include; amount of oxygen, fuel available, moisture content, high temperatures, low humidity and solar heat.

Identification of the hazard areas is of great importance for present and future reference. Fire intensity potential is a function of four main factors:

1.DEGREE OF SLOPE : On land of more than 5 acres and greater than 30% slope fire intensity is doubled.(Fire intensity is quadrupled on slopes of more than 60% etc.)

2.ASPECT : The direction in which the slope faces. This is a function of sun exposure whereby the South and South-West contain drier fuels.

3.VEGETATION TYPES : Vegetation types determine fire type. Fire break potential and potential problem areas can be identified by investigation into bark type, crown density, growth rate and fire resistance. Age, history, tree type, and vegetation composition all are also important factors.

4,VEGETATION DENSITY/DENSITY OF CROWN COVERAGE: Such density measurements determine whether ground, surface, or crown fire predominate. Vegetation density serves as a parameter in the Wildfire Hazard Rating System. The primary criteria for determining Wildfire Hazard Areas consist of crown density and hazard class ratings.

Therefore, Wildfire Hazard Area Maps (WHAMS) are a composite of factors 1 -4 , including other factors such as, town areas, residential subdivisions, fuel sources and fire generators etc.

WILDFIRE HAZARD AREA RATINGS.

MINIMAL : Usually includes areas within the upper Sub-Alpine and Alpine Zones, Riparian areas, meadows, areas of deciduous vegetation and clear areas. DANGER LEVEL : QUITE SAFE.

LOW : Above 35% vegetation densities and away from human concentration. DANGER LEVEL :MINIMAL.

MEDIUM : Above 35% and below 55 % vegetation density. Quite high fire hazard potential becomes severe in the case of high winds, dry spells, poor forest health or beetle infestation. DANGER LEVEL : OF CONCERN.

HIGH : Greater than 55% vegetation density increases the probability of a crown fire, causing disastrous property and personal damage. DANGER LEVEL : SEVERE.

WILDFIRE HAZARD MITIGATION PLAN.

PINEBROOK HILLS PILOT PROJECT.

The area of Pinebrook Hills consists of a 410 acre low density development. Within the 410 acres there are approximately 411 lots, 311 of which are owner-occupied.

Within the region there is a land requirement forcing developers to set aside a 5%

tract of usable land for such purposes as preservation or school establishment.

FIRE DISTRICT AREA.

The Fire District Area Boundary has a general tendency to follow either the settlement subdivision demarcation, (e.g. to the South of the region) or else the natural forested boundary.(e.g. to the West of the region) Select housing found within the forested zone, and accessible from the Pinebrooks Area are also included within the district.

Where accessibility is poor, and hence response time in the event of fire is slow, the subdivision is cut-off and an alternative fire district is chosen to serve the area.

To the north, the district boundary follows the track of Wagonwheel Gap Road. To the Southern edge of the settlement, the fire district boundary follows the subdivision boundary, up to and including the intermix area. Forested area seen beneath the subdivision has poor access and contains public property, although properties are not always visible from the aerial photographs. Hence, inclusion into the fire district is necessary in this case.

The Eastern edge fire district boundary follows the natural topography, slope, and tree line, whereas the fire district boundary to the West, follows the half section line of the subdivision.

Various maps were compiled of the Pinebrook Hills area, each offering a different scale, perspective, and information format. A 1:1500 map of the area was taken, and the fire district boundary superimposed upon it to give a visual perspective. In addition, individual, (i.e. unspliced) 1:200 and 1:100 scale maps were taken and the Wildfire Hazard Areas were overlayed manually. Aerial photographs of 1:400 and 1:200 scales were also used to give a more distinct perspective of the area allowing greater visual identification and clarification.

A 1:1500 zoning map was taken, and manual overlay of the Wildfire Hazard Areas, and their respective levels of intensity, areas of above 30% slope, and finally all unoccupied lots were completed.

Wildfire Hazard Areas were found to be numerous, with levels B and C covering the settlement area, and level A covering land outside of the settlement area.

Slopes of greater than 30% were found to cover most of the region, especially the central most strip of the Pinebrook Hills Area. Within the Pinebrook Hills settlement, 311 out of 411

lots are owner-occupied, and therefore, unoccupied lots were shaded in on the 1:1500 scale map to improve clarity.

UNOCCUPIED LOT NUMBERS :12/31/90- MICRO ASSESSORS DATA FILES - (SOURCE).

2 8 9 11 17 21 23 24 26 28 43 49 61 68 88 91 103 106 109 116 117 18 122 127 129 133 135
135 136 137A 138A 138B 139 142 142 148A 149A 154 156 157 158 160 162 172 175 179 180
187 188 191 195 198 199 203 204 211 215 236 247 261 265 265 273 283 286 300 303 305 306
306 310 312 324-9 330 331-6 337 338-41 342 343 349 351 358 360 365 381 385 391 396 404
410

AVERAGE LOT SIZE = 1.0

MINIMUM = 0.17 acres (ALDER ROAD A REPLOT B)

MAXIMUM = 2.0 (LOTS 224 AND 225 CEDAR BROOK ROAD AND LOTS 342 AND 343 LINDEN DRIVE)

411 LOTS (INCLUDING REPLOTS AND SUB PLOTS e.g, 148A 148B= 2 LOTS)

100 UNOCCUPIED

311 OCCUPIED

THE NUMBER OF UNOCCUPIED LOTS WAS OF A SURPRISINGLY HIGH NUMBER. NO DEFINITE SOURCE OF INFORMATION CAN DETERMINE THE REASON FOR THIS RESULT.

A CROSS CHECK WAS DONE USING THE MOUNTAIN ADDRESSING BOOK AND PLOT MAPS. THE ADDRESS BOOK DATA WAS COMPILED IN 1986 AND THE PLOT MAPS DATE BACK TO 1963/4.THEREFORE THE 1990 MICRO ASSESSORS DATA IS BY FAR THE MOST ACCURATE AND UP TO DATE MEASUREMENT.

(1963/4 UNOCCUPIED LOTS FOR MEANS OF COMPARISON :

3 4 6 7 8 10 11 17 18 21 22 23 24 26 27 28 46 47 48 50 54 55 59 60 81 88 149a 149b 172
174 175 180 185 187 188 193 195 198 199 203 210 211 212 222 224 385 391 396 397 404.)

Unfortunately, no acreage data was available, and thus it was necessary to refer to the Pinebrook Hills subdivision files, in order to determine the total land area of Pinebrook Hills. Within the 410 acres of Pinebrook Hills,the average lot size is 2.5 acres and the minimum is 27,000 square feet- 1 acre.

Examples of randomly selected lot sizes :-

LOT # 86 109 110 = 5.7 ACRES.

LOT # 115 116 117 = 6.8 ACRES.

LOT # 334 345 346 347 348 365 366 =10.8 ACRES.

LOT # 135 =2.34 ACRES.

LOT # 230 =1.1 ACRES.

LOT # 231 =0.91 ACRES.

LOT # 295 =1.35 ACRES.

Having gathered all the previous information on the Pinebrook Hills area, it is therefore possible to incorporate the use of G.I.S. (Geographical Informations system) into the project. A map of the region is digitized into the G.I.S computer, followed by the hazard ratings and their distribution. Areas of above 30% slope and finally unoccupied/occupied lot numbers are then inputted into

the system.

Although each source map is of a different scale, the process of digitizing allows for the adjustment of each scale in order to fit the original scale of the area map.

GEOGRAPHICAL INFORMATION SYSTEM ANALYSIS.

DIGITIZING.

Using the original base area map, the first means of input is that of the section corners of the grid squares. This has the effect of registering the coverage area. Once this is completed, it is possible to input the first of the information assembled. Calling each line on the information map an arc, it is necessary to start digitizing the arc from the point of its origin, known as a node. The direction of the arc is carefully followed until a final node is reached. This process is repeated for all curves on the second and subsequent source maps. Once all arcs representing the same features are completed it is possible to label the arcs by means of a colour coding. Finally, it is also possible to label the polygons created in terms of area, perimeter etc.

Upon the completion of all the data input required, a computer representation of the area and the features mentioned will be accomplished. This therefore means that a Wildfire Hazard Area Map has been assembled, and due to the computer layout increased ease in map updating will be achieved.

Gary - You may already have a copy of this, but I thought it was interesting. May give us some new ideas. Jim

The Western Forest Fire Research (WESTFIRE) Center

I. Overview

The proposed Western Forest Fire Research (WESTFIRE) Center is an interdisciplinary, creative research consortium to be based at Colorado State University. The WESTFIRE Center will bring together researchers and land managers for the purpose of developing and applying technologies for managing forest fires before they occur. The proposed WESTFIRE Center will:

- o provide new visions for forest fire research/management: technology synthesis, information fusion, and timely dissemination;
- o integrate basic and applied research in forest fire science;
- o develop new theories and applications in forest protection science;
- o focus initially on developing computerized Early Warning Systems (short- and long-term) for low frequency, high intensity fire-prone ecosystems, e.g., Colorado Front Range

The WESTFIRE Center will fill a void in current fire management and research activities. The Center will not duplicate work ongoing elsewhere. For example, the Boise Interagency Fire Center is oriented primarily towards mobilizing personnel and equipment to respond to ongoing fire incidents, and does not conduct fire research. The U.S. Forest Service, while conducting basic fire research, is severely limited in its ability to respond to emerging fire problems (due to budget and personnel cutbacks). The National Park Service's fire management opportunities are limited due to its preoccupation with natural ecosystems.

The following summarizes activities proposed for the WESTFIRE Center, including justification of need, planned activities, and rationale for locating at Colorado State University. Key personnel and budget information are attached as appendices.

II. National and Regional Importance

The WESTFIRE Center will have national, regional, and statewide significance. Research designed to predict and prevent fires will result in substantial reduction in massive annual expenditures for fighting fires and rehabilitating damaged property. The need for the WESTFIRE Research Center is supported by noting the following statistics:

- o Annual national forest fires
 - 100,000 to 135,000 wildland fires
 - 4 to 7 million acres burned
 - \$1 billion suppression expenditures (average)
 - property and natural resource damages unknown

Recent disastrous fire years (e.g., Colorado 1990 and 1989; Yellowstone 1988; California 1990, 1987, and 1985; Oregon 1987) illustrate problems of increasing severity, complexity, and cost. The budgets and resources of local, state, and federal entities supporting firefighting efforts have been stretched to their limits. These same limits have left a federal fire research program funded at approximately one-third of what would be required to address emerging fire problems. Further, the dwindling federal commitment to fire research has handcuffed public agencies attempting to incorporate the latest technological advancements into pre-suppression management activities. In light of today's fiscal constraints, there is a critical need for cost-effective investments in fire management technologies.

A. The Situation in Colorado and the West

Colorado's wildfire problems result from unique interactions among physical and social forces. Physically, the wildland vegetation, continental climate, and steep topography produce a natural habitat for periodic fire outbreaks. Society impinges on the natural fire setting through land uses and management practices which unwittingly may increase fire hazards.

Wildfire problems are accentuated during prolonged droughts. Long, warm, dry summers dessicate wildland biomass, adding to fuel stockpiles which accumulate over time due to insect epidemics and other sources of tree mortality. High winds, widely recognized as the most dangerous problem in firefighting, routinely occur during each fire season.

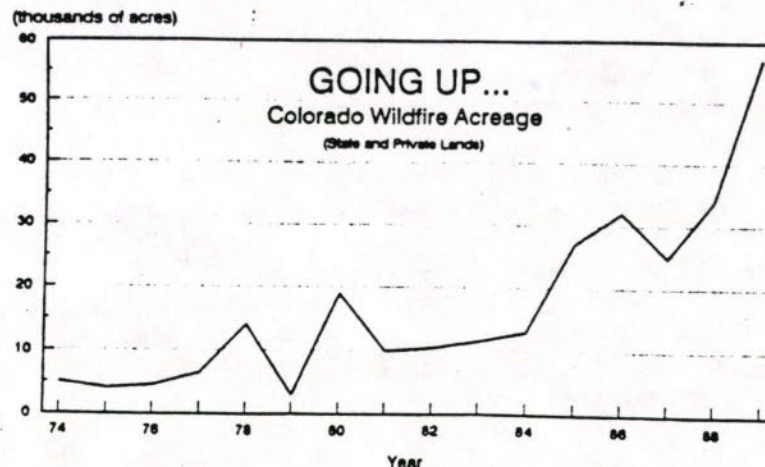
Human population pressures aggravate the fire situation. Recreationists, home owners, and land developers increase the likelihood of human-caused fire ignitions. Wildland residents and users are often ill-prepared for the inevitable fires and tragic loss of life and property.

The 1988 Yellowstone fires provide dramatic evidence of the flammability of Rocky Mountain forests following prolonged drought. Colorado's high elevation forests are remarkably similar to those in the Greater Yellowstone Area in terms of plant species composition, susceptibility to insects and pathogens, and incidence of dense dog-hair thickets on unmanaged public lands. Additionally, the State's mountain communities and recreational developments (such as ski areas and resorts) will be exposed to substantial risk in the event of large-scale forest fire episodes.

For example, during one afternoon in July, 1989 the Black Tiger fire in Colorado destroyed or damaged 66 homes near Boulder. This fire did not behave atypically as it spread over 2100 acres in a few short hours; rather, this fire is indicative of what will become increasingly commonplace as people continue to build homes in wildland areas. In fact, the 1990 Stagecoach Road fire was a virtual repeat episode of conditions which just one year earlier accompanied the Black Tiger fire.

Colorado and the West are especially susceptible to serious fire outbreaks, due to the continuing drought, hazardous forest fuels, and our annual lightning fire season (Figure 1). Although there is considerable uncertainty as to when future fire disasters will occur, it is only a matter of time before entire communities will be devastated by wildfire. Further, if current climate projections are correct, the continued warming of the earth's atmosphere portends significant increases in future wildfire activity.

Figure 1. Recent trends in Colorado wildfire acreage (state and private lands) indicate increasing fire loads.



The situation in Colorado is accentuated throughout the West. The entire region appears ripe for record fire years in upcoming years. The reasons include record western drought, population incursions into wildland areas, and unacceptable fuel situations created by human and natural disturbances.

California forests seem particularly vulnerable, given historic fire frequencies and the record low moisture levels during the past 5-7 years. The prolonged moisture deficit has given rise to massive insect epidemics throughout the central Sierra Nevada and southern Cascade mountains, as weakened trees become susceptible to attack. The wildfire outlook is bleak, especially due to the resultant increase in fuels from dead and dying trees.

The 1987 fire season in California and Oregon provides a grim reminder of potential consequences. In one 6-day period 12,000 cloud-ground lightning strikes ignited numerous fires throughout the central and northern Sierras. In response, 19,000 firefighters were mobilized. Ten lives were lost, suppression costs totalled \$200 million, and 64 homes were destroyed. An estimated 1.9 billion board feet of valuable timber was destroyed. Over 900,000 acres were burned in California and Oregon that year.

B. The Need for New Approaches

"Research designed to predict and prevent fires will result in substantial reduction in massive annual expenditures for fighting fires and rehabilitating damaged property. Nationally, the WESTFIRE Center will represent a unique, interdisciplinary opportunity for mitigating the effects of damaging forest fires, particularly those occurring in the western U.S. and the Rocky Mountain Region.

Currently, forest fire research is focused primarily in government laboratories. The USDA Forest Service Fire Laboratories in Missoula (MT), Riverside (CA), East Lansing (MI), and Macon (GA) focus exclusively on wildland fire investigations. However these facilities are restricted by budget and personnel cutbacks resulting from the shrinking federal commitment to forest fire research. Moreover, these research facilities are hampered by institutional boundaries to promoting integrative, interdisciplinary research. This provides a unique niche for the WESTFIRE Center at Colorado State University, especially since natural resource experts can join forces with support disciplines across the campus, such as atmospheric science, soil and water relations, remote sensing, ecology, political science, and sociology. This mix of University faculty expertise cannot be matched by any government fire research laboratory. In addition, Colorado State has unique advantages over other academic institutions because of its extensive network of computerized resources, including climate and weather models, fire behavior prediction systems, models for predicting fire effects on ecosystems, systems for analyzing and displaying satellite data, and geographic information systems (GIS) capabilities.

Formal coordination is lacking in terms of a multi-disciplinary, scientific approach to proactive management before wildfires occur. The need for such leadership is especially acute in the western U.S., where most wildfire problems are concentrated. New visions are needed for coordinating forest fire research and management, including synthesis of existing and new technologies, fusion of information from the myriad of fire intelligence sources, and timely dissemination to land managers and affected publics.

III. Planned Activities of the WESTFIRE Center

Technology Synthesis, Information Fusion, and Timely Dissemination

Recent advances in forest fire science include computerized fire spread and fire danger rating models, automated lightning detection systems, and geographic information systems (other examples are

included in Table 1). While extremely important, much of the recent research has not facilitated active intervention to prevent disastrous wildfire situations. Further, little effort has been directed at understanding and managing the social dimensions of wildfire problems, including human behavior and reaction to wildfire risk.

Table 1. Example research tools and studies to be augmented, synthesized, and/or developed further at the Western Forest Fire Research (WESTFIRE) Center

- Fire Behavior and Fire Danger Predictions Systems
- Weather and Climate models, particularly for wind and drought effects
- Automated Lightning Detection Systems
- Remote sensing/Geographic Information Systems
- Fire history studies
- Fire effects and ecosystem models
- Sociological and Human Behavior studies
- Models for Forest Fire Economics
- Studies of management impacts on fuels and forest fire behavior
- Smoke management studies (including effects on visibility and human health)

The objectives of the WESTFIRE Center include identification and assessment of important knowledge voids in two key areas:

- identifying the scope and magnitude of wildfire problems in the West, so that efforts can focus on high risk areas; and
- developing models and action plans which will mitigate threats should fires occur.

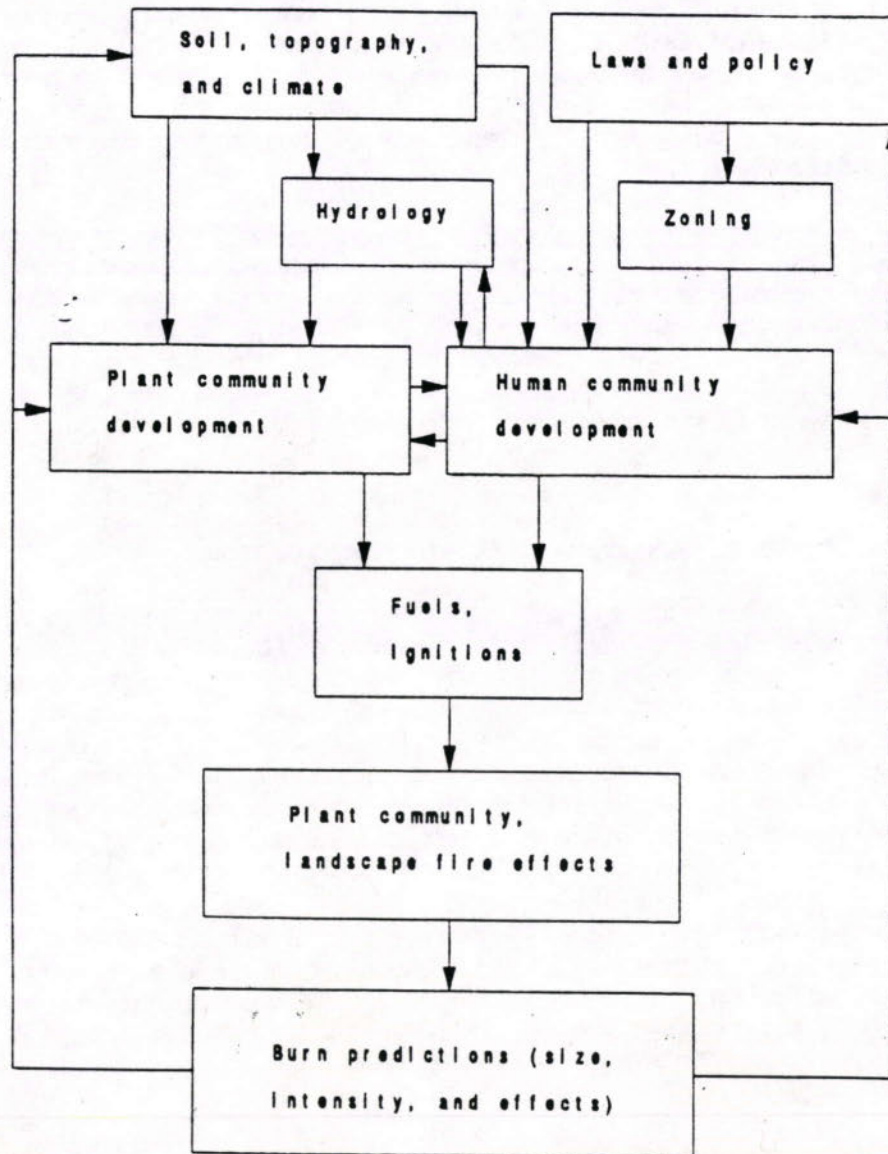
To sharpen this focus, the WESTFIRE Center will bring together scientists, practitioners, and private concerns to assist in prioritizing research and management needs. Once priorities are identified, faculty/student teams will be assembled to develop prototype models, collect data, and report on research results. Thus, the WESTFIRE Center will also serve as a clearing house for information dissemination to concerned publics, including those not commonly served by fire researchers and managers, such as local zoning boards and environmental groups.

Integration of Basic and Applied Research

Recent fire research (in subject areas such as those listed in Table 1) has increased understanding of forest fires. A significant volume of literature exists on the response to wildland fires of biotic and abiotic components of wildland ecosystems. However, a complete picture of fire effects on ecosystems is difficult to construct, since previous studies have been fragmented, dealing with perhaps one component of the ecosystem, and usually a limited range of fire intensities. Few studies have attempted to build a comprehensive view of fire in ecosystems, including the role of humans in managing and being affected by fires. The 1988 Yellowstone fires provided dramatic evidence that the size and scale of fire events must also be considered in modeling future fire outbreaks.

Figure 2 presents a simplified model which will be used initially to study and understand the scope and magnitude of problems associated with western wildfires. The figure shows parallel development of plant and human communities in wildland areas, both of which are influenced by site factors (soil, topography and climate) and resultant hydrologic characteristics. Local zoning regulations reflect law and policy, which also regulate human community development. Humans in turn affect plant

Figure 2. A simplified conceptual model showing important considerations in managing fire impacts in an area. The bottom box shows example outputs which can be used to develop strategies for mitigating undesirable fire impacts through management intervention.



communities and water relations, and also influence fuel levels and eventual fire ignitions. Upon ignition, plant community and landscape fire effects become important in defining the status of post-fire community development (plant and human), site, and legal responses. Each fire episode may evoke a variety of such responses, depending in large part on the magnitude and intensity of fire impacts.

In reality, each of the boxes in Figure 2 represents a complex set of relations or submodels, which faculty/student teams will need to develop carefully and in coordination with other investigative teams. For example, plant communities develop over time, in response to site and management factors that influence plant succession within an ecosystem. Resultant impacts on fuel profiles, fire behavior (spread, intensity, and size), and consequent plant community and landscape fire effects are not well-known for all ecosystems of interest.

The integration of subsystem models is the key to meeting WESTFIRE objectives, and represents one of the Center's unique contributions. The output from the integrated model will provide valuable information and insight to land management planners and decision-makers. Modeling provides a powerful thinking tool for synthesizing fragmented information, for understanding complex fire and human effects, and for assessing management options, such as fuels management or prescribed burning. Models representative of the interactions in Figure 2 will be used to identify and evaluate appropriate strategies for early management intervention. Potential payoffs and costs, wildfire risk, and priority areas for treatment consideration may also be assessed.

Develop New Theories and Applications in Forest Protection Science

The proposed research will be responsive to the future dramatic changes anticipated for western forests. Recent concerns for the environment, such as preservation of biological diversity, conservation biology, or global climate change, suggest the likelihood of dramatic emphasis shifts in fire and forest management. In brief, as greater emphasis is placed on reducing human impacts in wildland ecosystems, fuel profiles and consequent fire episodes will be affected. New paradigms in forest protection science will need development and study. Future fuel and fire scenarios will need to be constructed and analyzed, whether as the result of endangered species management or as outcomes from restrictions on traditional forest management activities, such as logging and road construction. Such analyses will be possible from the integrated modeling effort at the WESTFIRE Center.

Models (such as Figure 2) will be useful for developing and testing hypotheses about the consequences of alternative forest protection strategies. Natural resource managers and planners will need tools for identifying and comparing consequences of passive and active management, not only in terms of cost-effectiveness, but also relative to long-term societal needs. Such models will not only provide managers and planners with comprehensive pictures of potential changes expected, but also help restrict focus to critical questions.

Early Warning Systems

The model in Figure 2 will be developed in order to provide insights into the magnitude and extent of fire problems for an area. To facilitate model construction, faculty/student teams will be assembled to develop appropriate submodels in the following subject areas: 1) Climatology; 2) Soil and Water; 3) Plant Community and Landscape Effects; 4) Social responses; and 5) Fire activity and management. This structure encompasses the major relations embodied in Figure 2. In constituting faculty/student teams, special care will be exercised to make sure that the following themes can be addressed:

- o Climatological impacts (e.g. prolonged drought) on fuels, fire behavior, and fire season severity;

- Soil and water relations during drought and fire episodes;
- Plant and ecosystem responses to prolonged drought and subsequent fires;
- Social responses to fire episodes;
- Pre-suppression and prevention planning for extreme fire contingencies, including risk assessment.

The intent behind focusing on the above themes is to ensure that the model is not only responsive to fire events, but can also be used to develop early warning indicators of potential fire disasters. Initial efforts will be directed toward constructing submodels which can address the above themes for low frequency, high intensity fire-prone ecosystems along Colorado's Front Range. This initial study area has several desirable attributes, including a major national park, national and state forest lands, urban interface areas, mountain developments, major riparian zones, and considerable natural resource diversity. Based on initial results, an attempt will be made to generalize the approach for dealing with an analogous situation in California.

- While admittedly ambitious, these themes will be investigated at physical, ecological, and social levels necessary to allow management models and early mitigation plans to be developed. Thus, reliance will be on existing tools, empirical data, known relationships, and experience-based assumptions.

Administrative Organization

The proposed modeling themes may be subject to modification, based on discussions with the multi-agency steering group to be assembled for the WESTFIRE Center. This Executive Steering Group will consist of representatives from the public, private, and academic sectors, and will be responsible for overall guidance and policy development at WESTFIRE. In addition, a Technical Steering Committee, consisting of scientists and managers, will implement policy and oversee the faculty/student investigative teams. A preliminary list of key personnel is included in Appendix A.

The guiding organizational philosophy for the WESTFIRE Center will involve total quality management, in which client needs are assessed and continually serviced during the project's lifetime. This will require a commitment to quality among all participants, as well as a willingness to set and abide by measureable benchmarks of project progress.

Two additional practices will be institutionalized at the WESTFIRE Center: 1) research proposal generation; and 2) timely and effective dissemination of results. Additional research contracts and grants will be used to augment the funding base for WESTFIRE. Dissemination efforts will focus on providing information to scientific, managerial, and lay audiences.

Non-duplication of Effort

The multi-agency perspective of the Executive Steering Group will assure against duplication of efforts ongoing elsewhere. In fact, an attempt will be made to augment or supplement efforts at other fire centers. Thus existing relations will be strengthened with the USDA Forest Service centers (for research and management) and the Boise Interagency Fire Center. Examples of existing fire center technologies to be utilized include products developed by the Fire Behavior, Fire Effects, and Fire Chemistry work units (all at the USDA Forest Service--Intermountain Fire Sciences Lab); Fire Economics (USDA Forest Service--Riverside Lab) and Initial Attack Analysis (USDA Forest Service--Washington Office); Smoke Management (USDA Forest Service--Pacific Northwest Station); Fire Danger Rating Systems (USDA

Forest Service—Southern Fire Lab); Fire Weather Forecasting, Lightning Detection, and Daily Situation Fire Reports (Boise Interagency Fire Center).

The intent is to couple technologies and strengths developed elsewhere with those available at Colorado State University, in order to meet the objectives of WESTFIRE, i.e., to identify the scope of problems and set priorities for early intervention; and to develop models and action plans for mitigation. The WESTFIRE Center would thus serve as an information source for public and private agencies with land management responsibilities. Though advisory in nature, recommendations from WESTFIRE would assist these agencies in planning, implementing, and evaluating management schemes.

Schedule

Phase 1 (duration: 6 months): Project Planning and Initial Model Development

The first task facing WESTFIRE is to assemble the Executive Steering Group at Colorado State University to refine objectives and activities for the Center. At this time, the desired composition for the Technical Steering Group will be discussed, along with refinements to themes which will be addressed by faculty/student investigative teams. Consensus will be reached on key factors to be included in the project study plan, specific objectives, performance evaluation criteria, and preliminary model definitions.

Each participating faculty/student team will be responsible for developing an initial literature search to inform subsequent research efforts. Trips for discussion with subject matter experts will be scheduled. Available technologies and data sources will be identified. Each team will present its initial study plan to the Executive Steering Group (through the Technical Steering Committee). Based on review and comment, a final study plan will be prepared for distribution to subject matter experts and interested public and private audiences.

Initial model development will proceed as the study plan is reviewed. Faculty/student teams will operate in workshop fashion to specify important information linkages that address major project themes and facilitate communication among the teams. Outlines of potential publications and research proposals will be developed. Networked work-stations and software will be installed and/or expanded in laboratories within the participating colleges on the Colorado State University campus.

Phase 2 (duration: 12 months): Model development and generalization of applications

Faculty/student teams will complete construction of models so as to provide outputs relevant to major project themes, and for tabular and graphical display at networked work-stations on campus. Data from the initial study area (Colorado Front Range) will be collected and fed into models. As necessary, additional submodels will be conceptualized and developed in consultation with the Technical Steering Committee. The networked work-stations will facilitate iterative model runs and testing. When the models are in final form, they will be presented in seminar format to the Executive Steering Group (through the Technical Steering Committee) for review and comment. A progress report will be prepared, detailing description and analysis of the overall model and sub-models, and including a plan for dissemination of project results. The progress report will also include recommendations concerning fire mitigation measures. Each faculty/student team will prepare drafts of potential publications and research proposals. The Executive Steering Group will convene to evaluate progress to date, including areas requiring further investigation.

Phase 3 (duration: 18 months): Model refinement, testing in California, and dissemination

The overall model will be constructed so as to be applicable, with appropriate generalization, for testing in a similar mixed-conifer area in California. The area will include a similar mix of wilderness and multiple

use areas, as well as urban interface. During this latter phase, test data will be collected, fed into models, and analyzed in order to tune and evaluate performance. Preliminary management models and action plans will be suggested. A major workshop will be held at Colorado State University, in which progress to date will be summarized and participants will use the overall model in interactive sessions. In conjunction with the Technical Steering Committee and Executive Steering Group, sessions would be structured so as to facilitate refinements in preliminary management models and suggested action plans for the Colorado and California test areas. The final report will document the entire project, present model assumptions, uses, and outputs, and document management models and action plans.

IV. Rationale for locating WESTFIRE at Colorado State University

Colorado State University is uniquely positioned to support and carry out activities of the proposed Center. The WESTFIRE Center would greatly assist fire managers in anticipating and responding to emerging fire crises. The western U.S. is literally a powder-keg of wildfire problems waiting to happen. Urban encroachment, increasing utilization of forests for consumptive and non-consumptive uses, and natural susceptibility to fire ignitions complicate management alternatives, but do not negate the need for creative solutions. Consequences of alternative policy and management decisions can be examined through systematic investigation and computer simulation. Preventive measures and post-disaster remedial actions can be analyzed from ecological and socioeconomic perspectives.

Existing research laboratories are limited in their ability to carry out the activities of the proposed WESTFIRE Center. To their credit, existing laboratories have continued with basic fire behavior and fire effects research, in spite of budgetary and staffing cutbacks. However, these same cutbacks have severely restricted their capability to identify and address fully the complexity of biophysical and socioeconomic impacts from forest fires. In fact, WESTFIRE will focus on two research subjects which have been casualties of recent federal cutbacks: fuels management and fire prevention, previously housed in the Rocky Mountain and Pacific Southwest Forest and Range Experiment Stations, respectively. The proposed WESTFIRE Center will enable a concerted, cooperative attack on the West's forest fire problems, using sophisticated, computerized analysis techniques to identify and prioritize problem areas and evaluate the consequences of treatment alternatives.

Colorado State University Experience and Expertise

Colorado State University has the largest and strongest academic program in forest fire science in the U.S. During its relatively short life (15 years) over 50 Master's and Ph.D. degrees have been earned. Annually, 15 to 20 students earn the undergraduate degree in forestry with a concentration in forest fire science. Graduate and undergraduate alumni hold influential positions with natural resource management and research agencies worldwide.

In addition to forestry and natural resource experts in the College of Natural Resources, strong support disciplines exist across the campus, in related subjects such as atmospheric sciences, remote sensing, ecology, political science, and sociology. This mix of faculty expertise at the university is preferable to relying on the relatively narrow focus at government research laboratories. In addition, the campus supports an extensive network of existing computerized resources, including climate and weather models, fire behavior prediction systems, models for predicting fire effects on ecosystems, and systems for analyzing and displaying satellite data.

Existing support networks with research labs, public fire management agencies (USDA Forest Service, USDI-BLM, NPS, and FWS), and the Boise Interagency Fire Center will facilitate the work proposed. In addition, the university maintains active ties with other academic institutions and private organizations with wildland fire interests.

Colorado State University is the only land-grant institution in Colorado. The University is committed to teaching, research, and service to serve the needs of the people of the state and nation. Its goals include dedication to building and maintaining quality teaching and research programs. Evidence of the outstanding teaching and research in progress include:

- The Carnegie Foundation has designated Colorado State University as a Class I Carnegie Research Institution, a status accorded only 26 of the nation's land-grant universities, and only 30 of the nearly 3,500 higher education institutions in the United States;
- Federal grants have established national centers of excellence at the University in optoelectronics, geosciences, neurobiology, atmospheric sciences, water resources, and chemistry.

- Funded research at Colorado State University reached \$94 million in fiscal year 1989-90. This compares to \$60 million in 1983.

Finally, Colorado State University is uniquely situated in proximity to problems "waiting to happen": Urban interface, wilderness, and forest management areas. This mix of situations will provide tremendous opportunity for carrying out WESTFIRE study objectives, as well as for developing tools which can be used throughout the western states.

CONCLUSIONS

The WESTFIRE Center will establish an integrated, multi-disciplinary team of scientists from government, academic, and private sectors. WESTFIRE will provide valuable insights through basic data collection, monitoring of environmental change, assessment and modeling of fire effects, and evaluation of proposed mitigation treatments. For example, models of climate change and fire effects on multiple resources could be linked together to assess alternative management regimes. A series of "what-if" constructions (analyzed through computer models) would at least inform policy makers of potential consequences and relevant tradeoffs.

The WESTFIRE Center will fill a growing void in fire management and research. These deficiencies are recognized by public agencies with fire management responsibilities. Existing relations with fire management agencies will be strengthened through WESTFIRE, as creative solutions to wildland fire problems are developed and implemented.

In the absence of the proposed research effort, the nation's firefighters doubtless will continue to react to wildfires, using stressful and costly suppression activities. The consequences of this reactive response need to be compared against the benefits of preventive research and management, such as embodied in the WESTFIRE Center.

Appendix - Budget

Funding sources for the Center will be derived from federal, state, and extramural sources. The federal request is for \$1 million/year for three years. The remainder of funds will come from state funds, augmented by contract and grant activity.

	<u>1991-92</u>	<u>1992-93</u>	<u>1993-94</u>
Total Personnel (incl. fringe)	\$340,420	\$354,037	\$368,198
Administrative Costs	\$41,000	\$58,320	\$83,653
Office ¹			
Rent	\$33,000	\$34,320	\$35,693
Furnishings	\$12,000	\$12,480	\$12,979
Communications	\$6,000	\$6,240	\$6,490
Equipment ²			
Workstations	\$240,000		
Peripherals	\$20,000		
Non-capital equipment ³	\$120,000	\$100,000	\$40,000
Maintenance/repair contracts	\$5,500	\$5,720	\$5,949
Research Grants Program ⁴	\$10,000	\$20,000	\$30,000
Visiting Scholars Program ⁵	\$40,000	\$41,600	\$43,264
GRA Tuition ⁶	\$25,000	\$26,000	\$27,040
Indirect Costs ⁷	\$282,524	\$284,723	\$281,801
 TOTAL	 \$1,247,164	 \$1,017,987	 \$1,012,596
 CUMULATIVE			 \$3,227,747

Budget Notes

1. Office space to be rented on Colorado State University Advanced Technology Center (3000 sf @ \$11 psf); furnishings to be rented; communications include telephone line (2), fax transmission, and hook-ups with campus and remote centers (e.g. super-computer, weather forecasting, and fire data bases).

2. Each faculty-graduate student team, and the Research Associate will have access to one Sun SPARCSTATION II, with 19" color monitor, 16 MB memory, 700 MB hard-disk, and graphics accelerator. One work station will be dedicated to serving the WESTFIRE network (20,000 x 12); associated input/output peripherals include tape readers, CD-ROM storage device, laser printer, network hard-wires, and digitizer.

3. Year 1 software includes GIS processor, programming language compilers, spreadsheet, data base manager, and word processor for each work center (10,000 x 12). Year 2 expenditures are for hardware and software for developing data acquisition, geographic information display, and desktop publishing capabilities. Year 3 expenditures are for developing presentation graphics capability.

4. The Center will institute a mini-grants program to solicit seed-money proposals (e.g., \$5,000 max) from on-campus investigators.

5. The Center will initiate a Visiting Scholars program aimed at attracting collaboration from faculty or agency sabbatical participants. At least one Visiting Scholar will participate each year.

6. In-state tuition for 2 semesters plus summer (5,000 per year x 5).

7. 45% of all items, except capital equipment and tuition.

GUIDELINES AND CRITERIA

for

WILDFIRE HAZARD AREAS

Includes:

GUIDELINES FOR ADMINISTRATION

GUIDELINES FOR DESIGNATION

SAFETY GUIDELINES AND STANDARDS

MODEL WILDFIRE HAZARD AREA CONTROL REGULATIONS

September, 1974

Colorado State Forest Service
Colorado State University
Fort Collins, Colorado 80523

GUIDELINES AND CRITERIA

FOR

WILDFIRE HAZARD AREAS

PART I - INTRODUCTORY MATERIAL:

101 Purpose.

These guidelines have been formulated for use by counties, developers, the Colorado State Forest Service and others, public and private, involved in administering, reviewing, or developing lands within Colorado. The main objective is to provide for the long-term health, welfare, and safety of the public from destructive wildfire to life, property, and associated investments. Additional objectives include efficient use of public funds and resources of State and local governments.

102 Definitions.

As used in these guidelines, unless the context otherwise indicates:

- (1) "Aspect" means the cardinal direction that the land surface faces.
- (2) "Fire hazard rating" means a word, number, or letter used to describe or designate the wildfire hazard severity of an area.
- (3) "Fuel" means vegetation, debris, or other substances that will support combustion.
- (4) "Fuelbreak" means a strategically located strip of land, variable in width, on which the vegetation has been modified to reduce the rate of fire spread so that fire suppression forces can be utilized in relative safety to control a wildfire. The term may include provisions for all-wheel-drive access. Greenbelts, open space, forest openings, riding and hiking

trails, and underground utility easements may also be incorporated within fuelbreaks.

- (5) "Fuel modification" means manipulation or management of fuels to render them less hazardous when subjected to wildfires. The term usually embraces, but is not limited to, live, standing trees and/or brush.
- (6) "Fuel treatment" means manipulation or alteration of fuels to render them less hazardous when subjected to wildfires. The term usually embraces, but is not limited to, slash or dead fuels.
- (7) "Natural hazard" means a wildfire.
- (8) "Natural hazard area" means areas affected by wildfire, and usually contain a variable combination of fuels, topography, and weather that influence hazard and damage severity.
- (9) "Slash" means vegetative debris left after cutting or clearing operations in forest or brush areas and which requires treatment.
- (10) "Slope" means the gradient of the ground surface measured in percent.
- (11) "Spot fire" means a wildfire starting outside the main wildfire perimeter due to rolling, blowing, or falling firebrands from the main wildfire.
- (12) "Wildfire" means uncontrolled fire burning in vegetation, structures, or other improvements.
- (13) "Wildfire behavior" means the predictable action of a wildfire under given conditions of fuels, weather, and topography.
- (14) "Wildfire hazard" means a wildfire phenomenon which is so adverse to past, current or foreseeable construction or land

use as to constitute a significant hazard to public health and safety or to property. The term includes but is not limited to:

- (a) Slope and aspect;
- (b) Wildfire behavior characteristics;
- (c) Existing vegetation types.

(15) "Wildfire hazard area" means an area containing or directly affected by a wildfire hazard.

103 Elements of a wildfire.

Before a wildfire can occur, three basic ingredients must be present simultaneously and in the proper combination. These are oxygen, heat, and fuel. Oxygen is provided by the air, heat is provided by some hot (500 to 600 degrees F.) outside ignition source or from the fire itself, and fuel is provided by flammable organic matter, usually vegetation. The action needed for wildfire to start is ignition, either from purposeful or accidental man causes, or from nature's lightning.

In order to more easily understand the needs of wildfire, a triangle can be visualized with the three key ingredients as the legs of the triangle. When the "fire triangle" is complete, wildfire will occur. Remove or reduce any one or more of the triangle legs breaks the triangle and the wildfire is extinguished. The principle of breaking the fire triangle is used by fire-fighters the world over.

Since air is an everyday, abundant substance and forest-brush-grass areas are commonly available fuels, all that is needed to complete the triangle is heat from an ignition source. On-going fire prevention programs are planned to reduce the chances of ignition. Fire prevention

can never be 100 percent effective in outdoor areas, especially since lightning can still occur despite fire prevention efforts. The next obvious alternative for reduction of wildfires is to work on the fuel leg of the triangle either by fuel treatment or fuel modifications. Fuel is the constituent of wildfire that is most susceptible to effective manipulation by man.

104 Severity of the problem.

The severity of wildfire hazards is not equal for all areas. The severity can vary from "none" to "severe". The fire hazard severity ratings are to be based mainly on fuel and topographic factors and will necessarily change to reflect these variables.

Refer to Sections 302 through 306 for more complete descriptions of wildfire hazard severity categories and their wildfire behavior.

105 Consequences of Improper Use/Care.

Nearly all large or destructive wildfires can be expected to occur in the three highest severity categories of "moderate", "severe-trees", and "severe-brush". Because of the higher burning intensities, the increased violent wildfire behavior, the subsequent risks to public health, safety, and property, and the increased fire suppression difficulties, these categories warrant close scrutiny, analysis, and field inspection for any proposed developments or zoning. Damage, if not outright destruction, and high risk to human life will be greater than necessary if developments are permitted to proceed without review and proper mitigation practices.

No one can say for sure how much loss will occur in the future if

improper use/care is permitted to proceed in such natural hazard areas, but the potential will always exist from that time forward.

106 Knowledgeable Agencies.

The following is a list of agencies and individuals that are recognized to be knowledgeable in wildfires and their behavior in Colorado:

- (1) Colorado State Forest Service
Colorado State University
Fort Collins, Colorado 80521
Phone: 482-9512, 482-8185
- (2) Colorado State Forest Service
Various District Offices within Colorado
Contact reference 106 (1) for current addresses
and phone numbers.
- (3) U. S. Forest Service
State and Private Forestry
Cooperative Fire Programs
Building 85
Denver Federal Center
Denver, Colorado 80225
Phone: 234-4321
- (4) Bureau of Land Management
Division of Resource Management
Fire Control Specialist
1600 Broadway
Denver, Colorado 80202
Phone: 837-3414
- (5) Jack Barrows
College of Forestry and Natural Resources
Colorado State University
Fort Collins, Colorado 80521
Phone: 491-5502
- (6) U. S. Forest Service
Fire Research
Rocky Mountain Forest and Range Experiment Station
240 West Prospect Street
Fort Collins, Colorado 80521
Phone: 482-7332

107 Books, Periodicals and other References.

The literature is replete with references about wildfire. The following is a selected list of books and other references that are known to be helpful in learning about wildfires, its behavior, and control:

- (1) Barrows, Jack S., Fire Behavior In Northern Rocky Mountain Forests, USDA, Northern Rocky Mountain Forest and Range Experiment Station, Station Paper No. 29, May, 1951, 104 pages.
- (2) Beaufait, William R., Fire and Smoke In Montana Forests, Montana Forest and Conservation Experiment Station, Missoula, Montana, 1971, 23 pages.
- (3) Brackenbush, Arthur P., Fire In The Environment Symposium Proceedings, USDA, Forest Service as publisher, December, 1972, pages 143-144.
- (4) Brown, Arthur A. and Davis, Kenneth P., Forest Fire Control and Use, McGraw-Hill Book Co., New York, 1973, 686 pages.
- (5) Clar, C. Raymond and Chatten, Leonard R., Principles of Forest Fire Management, California State Board of Forestry, Sacramento, California, 1966, 274 pages.
- (6) Colorado State Forest Service, Subdivision Development Recommendations, illustrated binder of illustrations and recommendations given to Colorado Land Use Commission, December, 1971, 23 pages.
- (7) Colorado State Forest Service, Wildfire Hazards: Guidelines For Their Prevention In Subdivisions and Developments, Fort Collins, Colorado, April, 1973, 7 pages.
- (8) Countryman, Clive M., This Humidity Business: What It Is All About and It's Use In Fire Control, USDA, Pacific Southwest Forest and Range Experiment Station, Berkeley, California, 1971, 15 pages.
- (9) County Supervisors Association of California, Be Fire Safe!, Sacramento, California, March, 1965, 25 pages.
- (10) Fahnestock, George R., Fire Hazard From Precommercial Thinning of Ponderosa Pine, USDA, Pacific Northwest Forest and Range Experiment Station, Paper No. 57, 1968, 16 pages.
- (11) Fahnestock, George R., Unpublished report for the Colorado State Forest Service entitled "Rating Forest-Fire Hazard In Residential Developments In Colorado Forests," Fort Collins, Colorado, August, 1971, 29 pages.

- (12) Hulbert, James, "Fire Problems In Rural Suburbs", American Forests Magazine, Vol. 78, No. 2, February, 1972, pages 24-27.
- (13) Lynch, Dennis L. and Broome, Standish R., Mountain Land Planning, Colorado State University, Fort Collins, Colorado, 1973, pages 10-11.
- (14) National Fire Protection Association, Homes and Camps In Forest Areas, MFPA No. 224, Boston, Mass., 1972, 31 pages.
- (15) Oregon State Forestry Department, Fire Safety Considerations For Developments In Forested Areas, Salem, Oregon, 11 pages.
- (16) Schroeder, Mark J. and Buck, Charles C., Fire Weather, USDA, Forest Service, Agriculture Handbook 360, May, 1970, 229 pages.

108 Related Laws and Regulations.

Several existing State laws are related to wildfire protection and administering wildfire hazard areas. Laws include but are not limited to:

- Constitutional Article XVIII, Section 6 Preservation of forests
- 106-7-101 through 106-7-502 1974 Land Use Act
- 106-3-9 1974 Land Use Act
- 106-4-3 1974 Land Use Act
- 106-2-9 (3) 1972 Subdivision Act
- 106-2-9 (4) (a) 1972 Subdivision Act
- 106-2-34 (1) Subdivision regulations
- 106-2-34 (3) through 106-2-34 (8) Subdivision regulations
- 106-2-37 Referral and review requirements
- 112-7-14 Powers and duties of board of agriculture
- 112-7-15 Cooperation with governmental units
- 112-7-18 Employees and personnel
- 112-7-23 Cooperation by counties
- 112-7-26 Emergencies

All listed statutes are from the 1963 C.R.S. as ammended which should be employed as the official text.

PART II - IDENTIFICATION OF NATURAL HAZARDS:

201 Without Prior Knowledge.

If local governments have no prior knowledge, detailed maps, or other means approved by the Colorado State Forest Service for identifying wildfire hazard areas, such local governments may utilize the 1/2-inch = 1 mile maps entitled "Possible Wildfire Hazard Areas" on an interim basis until more complete information is available. The "Possible Wildfire Hazard Areas" maps were prepared by the Colorado State Forest Service and delivered to all counties (except Denver) in October, 1974 for such interim use until detailed mapping of wildfire areas can be completed.

202 With Prior Knowledge.

If local governments have prior knowledge that an area is known to contain wildfire hazard areas as delineated on maps entitled "Wildfire Hazard Area Map", with a scale of 1:24,000 (7 1/2-minute USGS quad), as furnished by the Colorado State Forest Service, or as later delineated by other methods that meet the minimum identification requirements as determined by the Colorado State Forest Service, then local governments should utilize such information and maps in designating and administering wildfire hazard areas.

203 General Criteria for Identification.

The general criteria and minimum procedures for identification of wildfire hazard areas are in a separate document to be written by the Colorado State Forest Service in late 1974 and entitled "Guidelines For Identification of Wildfire Hazard Areas." These guidelines compose the requirements, minimum standards and procedures to be used by

local governments or others in carrying out or contracting for identification work, see Section 201 above.

PART III - GUIDELINES FOR ADMINISTRATION:

301 Hazard Area Classifications.

Wildfire hazard area classifications should be made according to the Colorado State Forest Service "Guidelines For Identification of Wildfire Hazard Areas" as described in Section 203, and utilize at least three major criteria: fuels, slope, and aspect.

301.1 Fuels. Fuels should be delineated into five recognized types of "O", "A", "B", "C", and "X". Fuel considerations are described in Sections 302 through 306 for each respective type.

301.2 Slope. Slopes should be delineated into at least the two categories of 0-29.9 percent and 30 percent and over. Slope considerations should be in accordance with the Colorado State Forest Service Wildfire Hazard Area Map user guides.

301.3 Aspect. Aspect should be delineated into at least the eight categories of N, NE, E, SE, S, SW, W, and NW. Aspect considerations will be in accordance with the Colorado State Forest Service Wildfire Hazard Area Map user guides.

302 Fuel Type "O".

Fuel type "O" includes areas that presently have absolutely no wildfire hazard, and none is expected to develop in the foreseeable future.

302.1 Species and composition. Areas are devoid of fuels. Examples include but are not limited to lakes, glaciers, rock, sand, skree.

- 302.2 Burning characteristics. Wildfire will not occur in these areas.
- 302.3 Why the area is of state interest. These areas are not of state interest for wildfire hazards.
- 302.4 Resultant dangers. None from wildfire.
- 302.5 Coordinated developments advantages. None.
- 302.6 Mitigation procedures. None.
- (1) Avoidance: Not necessary.
 - (2) Nonconflicting uses: All uses will be non-conflicting for wildfire hazard.
 - (3) Modifications and treatments: None.
- 303 Fuel Type "A".
- Fuel type "A" includes areas that presently have fuels which support only low wildfire hazard severity. Fuels in this type may remain relatively unchanged or may change to "B" fuels in the foreseeable future.
- 303.1 Species and composition. Fuels are sparse to continuous, usually less than eighteen inches in height, can be fine in texture or heavy trees and shrubs if isolated or of low burning intensity when green. Examples include but are not limited to: grasses, low brush, alpine, deciduous trees, streamside, widely scattered conifer with high branches, bogs, dryland crops.
- 303.2 Burning characteristics. Fuels support low intensity fires, spot fires begin within short range, rates of spread may vary from slow to fast, flare-ups occur only occasionally, just-burned areas tenable within minutes. Fire spread easy to stop and flames easy to black out.

- 303.3 Why the area is of state interest. These areas are generally not of state interest unless accompanied by hazardous topographic influences on wildfire behavior. Humans can usually avoid burning areas with ease and fire-fighters can work easily and efficiently.
- 303.4 Resultant dangers. The dangers that can result from uncontrolled development of any such area will vary with the kind of fuels. Dangers can vary from nearly none, to scorch, to light burns, to heavy losses for property. Heavy damages will usually result when items are within the burning area without adequate fuel treatments, clearances, or protection. Danger to humans can vary from little to serious injury. Children, invalids, and the elderly can be seriously injured because of their lack of agility to move quickly.
- 303.5 Coordinated development advantages. This fuel type will safely accomodate the heaviest and widest range of developments with respect to wildfire hazards. With coordination, most developments can be guided into this fuel type and safely constructed and thereby avoid the higher wildfire hazards associated with types "B", "C", and "X".
- 303.6 Mitigation procedures. Little or no mitigation is necessary except as noted in (2) below. Fire protection is necessary since some "A" fuels ignite very easily and burn very rapidly. Consequently, numerous, large but low-intensity fires may occur in these areas.
- (1) Avoidance: Usually not necessary.
 - (2) Nonconflicting uses: Nearly all uses are compatible with this fuel type. Exceptions could be schools, hospitals,

nursing homes and other developments for children, invalids, or elderly if no other precautions are taken.

- (3) Modifications and treatments: Usually none. Developments for children, invalids or the elderly must be located in areas that are: (A) separated from natural fuels by roads, parking lots, playgrounds, watered grass or flowers, or (B) separated from natural fuels by elimination of the fuels in a 12-foot to 14-foot wide strip around the development through quarterly disking or use of soil sterilants, or (C) use of fire retardant chemicals on the fuels, or (D) prescribed burning the fuels, or (E) a combination of these methods.

304 Fuel Type "B".

Fuel type "B" includes areas that presently have fuels which support medium wildfire hazard severity. Fuels in this type may remain relatively unchanged or may change to "C" fuels in the foreseeable future. Modification and treatments can usually lower fire hazards.

304.1 Species and composition. Fuels are medium density conifer stands with or without small patches of conifer reproduction, deadwood, or brush. Tree crowns are close but usually not touching. Ground is not completely shaded at one time. Conifer species may be pure or in a mixture.

304.2 Burning characteristics. Fuels support medium intensity fires, spot fires common within short to medium ranges, rates of spread slow to fast, flare-ups occur intermittently, just-burned area tenable by humans within about 1/2 hour. Fires can be hot.

- 304.3 Why the area is of state interest. These areas are of state interest due to the associated Burning characteristics. Inexperienced people are usually afraid and can panic when these areas burn. They cannot be easily persuaded to move or travel toward or near such burning fuels.
- 304.4 Resultant dangers. The dangers that would result from uncontrolled development of any such area will vary from moderate to high. Property, real and personal, can sustain heavy losses due to the heavier burning intensities. For the same reasons, injuries to people can be expected to be higher than in "O" or "A" fuels. Because more solar heat reaches the forest floor than in "C" or "X" fuels, numerous fires can be expected to easily start, spread rapidly, and reach hot intensities. The higher fire incidence and moderate burning intensities make this fuel type more hazardous than one might at first suspect. Such dangers to developments are obvious.
- 304.5 Coordinated development advantages. Due to the Burning characteristics and Resultant dangers for fuel type "B", it will be advantageous to coordinate and regulate development in these areas. Development can only exist if fuel modifications and treatments are completed prior to completion of the development. Such treatments need not be for the entire area, but can be concentrated within and adjacent to the development itself. This reinforces the advantages to coordinated development.
- 304.6 Mitigation procedures. Mitigation should accompany development in fuel type "B". Good wildfire and structural fire protection

is needed in these fuels.

- (1) Avoidance: Whenever possible, "B" fuels should be avoided when "A" fuels are available and can accomodate the same development.
- (2) Nonconflicting uses: Without modification or treatment, nonconflicting uses include agriculture, mineral extraction, forestry, grazing, recreation hunting and hiking, picnicing, roads, energy transmissions, greenbelts, open space; with modification or treatment additional nonconflicting uses include camping, single family residential, small retail businesses, schools, nursing homes, hospitals, PUD.
- (3) Modifications and treatments: Fuel type "B" can usually be lowered to a hazard rating of "A" if modified correctly through thinning, pruning, grouping or fuelbreaks. On-the-ground prescriptions for modifications must be made and work approved by a graduate forester with at least two years fire experience in the Rocky Mountain area. Untreated slash will raise the hazard one complete step. Developments for children, invalids or the elderly must be in areas rated as "A" and treated as in Section 303.6 (3) (a).

305 Fuel Type "C".

Fuel type "C" includes areas that presently have fuels which support severe wildfire hazards. Fuels in this type will remain relatively unchanged for the foreseeable future until affected by cutting or wildfire, landslide, insect, disease, avalanche or other natural disturbance. Modifications and treatments may lower fire hazards if done carefully.

- 305.1 Species and composition. Fuels are mixed or pure high-density conifer stands, heavy slash, deadstanding or down trees, conifer species with heavy brush understory, vines, or other "ladder" fuels. Small patches of other fuel types may exist but are of minor occurrence. Tree crowns are usually touching. Nearly all of the ground is shaded throughout most of the day.
- 305.2 Burning characteristics. Fuels support high intensity, long-burning fires during critical fire weather, long-range spot fires of over 1/4 mile common, rate of spread slow to very fast, flare-ups higher than trees and are frequent to continuous, true crown fires possible, just-burned area is untenable by humans for an hour or more, the fire front is impassable. Fires are usually hot, but can also smolder if conditions are damp.
- 305.3 Why the area is of state interest. These areas are of state interest due to the associated Burning characteristics, the difficulty of fire protection and suppression, and the Resultant dangers to life and property. Inexperienced people and animals are afraid and exhibit panic when these areas burn hot. Experienced firefighters are most cautious in these fuel types and are ever fearful of the dreaded crown fires. Rescue of persons entrapped by hot wildfires in fuel type "C" is nearly impossible.
- 305.4 Resultant dangers. The dangers that result from uncontrolled development of any such area will be high to extreme. Property, real and personal, will face complete destruction during wildfires. Injuries will be serious and deaths may easily occur. Because of shading, less solar heat will reach the forest floor than in "A" or "B" fuels. Consequently, fewer fire starts can be expected,

but those that do start will result in more intense fires.

The dangers of intense, destructive wildfires, large and small, in coniferous fuels are greatest in "C" fuels. Homes or other parts of developments that can themselves burn also threaten the entire development because of the heavy surrounding fuels.

305.5 Coordinated development advantages. The Burning characteristics and Resultant dangers in fuel type "C" make it one in which close, coordinated and regulated development is advantageous to all interests, both public and private. At best, developments in these areas will only be marginal in safety and then only after modifications and treatments are completed prior to completion of the development itself. Such modifications will have to be made for much larger areas than in "A" or "B" fuels in order to effectively slow oncoming wildfires.

305.6 Mitigation procedures. Mitigation must be practiced for all developments in fuel type "C". Good wildfire and structural fire protection is a must for developments in these areas.

- (1) Avoidance: "C" fuels must be avoided in all but exceptional or absolutely necessary cases. Whenever "A" or "B" fuels are available and can safely accommodate the same development, they should be the preferred areas to develop. Goals should be to prevent conflicting developments in "C" areas.
- (2) Nonconflicting uses: Without modification or treatment, nonconflicting uses include agriculture, mineral extraction, forestry, grazing, recreational hunting and hiking, roads, energy transmission, open space; with modification or treatment, additional nonconflicting uses include camping, single

family residential on large lots, small isolated retail businesses, clustered multiple family dwellings or PUD.

- (3) Modifications and treatments: Fuel type "C" may be lowered to a hazard rating of "B" and rarely "A" if modified correctly through thinning, pruning, grouping or fuelbreaks. On-the-ground prescriptions for modifications must be made and work approved by a graduate forester with at least two years fire experience in the Rocky Mountain area. Untreated slash will compromise all modification work.

306 Fuel Type "X".

Fuel type "X" includes areas that presently have non-coniferous fuels which support high-to-severe wildfire hazards. Fuels in this type tend to change very slowly to "C" fuels or remain relatively unchanged for the foreseeable future. Although very similar to "C" fuels when subjected to wildfire, the "X" type is delineated separately from "C" fuels because of its different requirements for mitigation.

- 306.1 Species and composition. Fuels are dense, high brush 1 1/2 to 10 feet in height, dense conifer saplings over 1 foot in height. Small scattered patches of conifer or deciduous trees or scattered individual trees may also exist but are of minor effect and occurrence. The fuels are continuous or nearly so. Despite heavy shading, the ground is seldom damp. Flammability may vary markedly in the year due to changes in fuel moisture and leaf fall. Fire seldom kills these species. Many re-sprout after fires with more stems resulting in more numerous, thin-stemmed fuels than before. Brush fuels reach maturity sooner than forests and thereby can be expected to burn more frequently than forests.

306.2 Burning characteristics. Fuels become extra hazardous during special times of the year. The critical time of year varies with the species. For example, oakbrush is very difficult to burn when the leaves are green, but when its leaves are brown and still hanging on the branches, it becomes one of Colorado's most flammable fuels for 2 to 3 weeks in autumn. The "X" fuels support medium- to high-intensity fires, short-range spot fires are common, rate of spread is moderate to fast, flare-ups brief but common and hot, just-burned area is tenable by humans within about 1/4 hour, the fire front is impassable. Brush fires seldom burn throughout the night and into the next day if suppression action is made.

306.3 Why the area is of state interest. These areas are of state interest due to the associated Burning Characteristics, the difficulty of fire suppression, and the Resultant dangers to life and property during special times. By their very nature "X" fuels often create a false sense of security due to their lush greenness and sometimes non-flammable periods. Many people find it impossible to believe the potential flammability until they witness burning in critical periods. Fires in "X" fuels are difficult to control because their thin, tough, and numerous stems resist easy cutting, their strong root systems make them difficult to clear or grub out, and their rate of spread can be extremely fast. Using oakbrush again for example, it has been observed to stall D-7 sized crawler bulldozers trying to uproot it, and its rate of fire spread has been observed and timed to be an incredible 16 acres per minute, steady for three hours in

Colorado! Fast running mule deer have been found dead in oakbrush burns--unable to outrun the fire's spread. Brush fires are very sensitive to wind direction. Property and lives considered safe on a flank can be quickly threatened within minutes by a wind shift.

306.4 Resultant dangers. Even though the hazardous periods may be brief, the dangers that result from uncontrolled development of any such area will be intolerable due to the Burning characteristics. Property, real and personal, will face heavy damage and possibly complete destruction during wildfires. Injuries can be serious and deaths may easily occur due to entrapment. Homes or other parts of developments that can themselves burn also threaten the entire development because of the heavy surrounding fuels. "X" fuels have an additional danger not common to the other fuels in Colorado: many landowners believe in or have a long family tradition of willfully burning off the brush with little regard for impending weather changes or spread to the property of others. Also, hunting season often coincides with the flammable season of several brush species; several wildfires can be expected to result from unattended hunter warming fires.

306.5 Coordinated development advantages. The Burning characteristics and Resultant dangers in fuel type "X" make it one in which close, coordinated and regulated development is advantageous to all interests, both public and private. Developments in these areas may not be entirely fire safe despite fuel treatments and modifications. Encouraging developments into other areas and coordinating them so that "X" fuels can be avoided should be the goal.

306.6 Mitigation procedures. Mitigation by fuel modifications and treatments is nearly impossible. Avoidance and nonconflicting use are the best procedures until better techniques are found. Good fire protection is highly desirable but it may not be able to offer the protection that developments deserve in "X" fuels.

- (1) Avoidance: "X" fuels must be avoided for all conflicting uses. Whenever other fuel classes are available and can safely accomodate the same development, they must be the areas developed. The only sure way to reduce or eliminate losses in "X" fuels is to avoid them.
- (2) Nonconflicting uses: With partial treatment, nonconflicting uses include agriculture, grazing, roads, buried pipelines, open spaces, erosion control. With complete clearing of brush except for occasional, widely-spaced individual plants, all uses as outlined in Section 303.6 (2) will become non-conflicting, provided that the brush can be kept from returning and that water quality for surface run-off will sustain no adverse, marked change.
- (3) Modifications and treatments. Except for complete removal with heavy equipment, most "X" fuels cannot be easily modified or treated. Some species are resistant to normal herbicide treatments since such treatments may encourage increased fuel density by promoting a species' sprouting abilities. Repeated herbicide applications over several years may kill most of the brush, but environmental standards may not allow such a practice. Nearly all species respond

favorably to burning with vigorous new sprouts and re-growth. Pruning is possible but costly and may result in new sprouting. Reduction of fuels by grazing of domestic livestock is often questionable since at least one species (oakbrush) is toxic to animals at certain times of the year. Complete removal of roots and stems by heavy equipment will reduce the wildfire hazard, but in the process soils will be highly disturbed and exposed to erosion. Complete removal of the brush may also destroy the aesthetics and very reasons that prompted the development to be located there in the first place. Slightly lower wildfire hazards can be obtained if wide, grassy, inter-connected openings exist between clumps of brush and the openings can be kept free of invading brush. Partial modification of "X" fuels must be under the supervision of a graduate forester or range scientist with at least two years fire experience in the Rocky Mountain area.

PART IV - GUIDELINES FOR DESIGNATION AND IMPLEMENTATION:

401 Responsibility of Local Governments.

Each local government for a political unit in which wildfires can occur should:

- (1) Adopt control regulations and the necessary procedures, as outlined by the Colorado State Forest Service, which will be operative in the identified wildfire hazard areas.
- (2) Carry out wildfire identification in accordance with the minimum standards and procedures established by the Colorado

State Forest Service.

- (3) Commence and complete an identification program which identifies by the adoption of maps the lands in which appropriate wild-fire hazard protective regulations will be operative. Such identification programs may be achieved through county staff, private contract or consultant, or contract with the Colorado State Forest Service.
- (4) Designate appropriate wildfire hazard areas established or located in the identification program.
- (5) Administer designated wildfire hazard areas following the adopted control regulations and the model administrative guidelines set forth by the Colorado Land Use Commission and the Colorado State Forest Service.

402 Adoption of Regulations.

Each local government should adopt control regulations for wildfire areas following the outline set forth in the Model Wildfire Hazard Area Control Regulations.

402.1 Elements of control regulations. Wildfire hazard control regulations should contain the following elements:

- (1) Actions to be taken for areas of local concern and in which prudent men would be concerned about the possibilities of fire and would take the appropriate mitigation procedures where needed.
- (2) Actions to be taken for areas identified by experts as being one of State concern, and in which prudent men would not carry on development without first having undertaken the proper mitigation procedures.

- (3) Permit procedures whereby no development is permitted in either type of area without first identifying the type of area, and providing evidence that the development is in accordance with the appropriate mitigation procedures and practices.

403 Identification.

Identification of natural hazards should be completed for the local governmental political unit as soon as possible as in Section 401 (2-3), or by a permit system using qualified expert analysis for each area with the costs to be paid for by the party planning the activity in the area. All identification and analysis work to be in accordance with the minimum standards and procedures established by the Colorado State Forest Service. See Section 404.1 for identifications necessary for designation.

404 Designation of Wildfire Hazard Areas.

Each local government should designate wildfire hazard areas to be administered as areas of State concern. Such designation procedures shall conform to those provided for in statutes 106-7-401 through 106-7-407 inclusive, 1963 C.R.S. as ammended.

404.1 Identifications necessary for designation. Identification should accompany designation and may be one of several levels of intensity:

- (1) Identify and designate the entire political unit as an area of state concern.
- (2) Designate areas that contain possible wildfire hazards as outlined on the 1/2 inch= 1 mile maps provided by the Colorado State Forest Service in October, 1974.

- (3) Designate areas of wildfire hazard as identified from completed 1:24,000 Wildfire Hazard Area Maps.

Where both maps outlined in Sections 404.1 (2) and 404.1 (3) exist, the local government should utilize the identification level of Section 404.1 (3).

405 Administration of Wildfire Hazard Areas.

All wildfire hazard areas, whether designated as areas of State concern or not, should be administered by the appropriate local government following the Guidelines for Administration, Model Subdivision Regulations, and Model Building Code Standards as established by the Colorado State Forest Service.

405 Assistance.

Local governments needing or desiring assistance in implementing wildfire hazard area control programs should utilize the technical assistance available through the Colorado State Forest Service.

APPENDIX I

WILDFIRE SAFETY GUIDELINES AND STANDARDS

for

SUBDIVISIONS AND DEVELOPMENTS

September, 1974

Colorado State Forest Service

COLORADO STATE FOREST SERVICE
WILDFIRE SAFETY GUIDELINES AND STANDARDS
for
SUBDIVISIONS AND DEVELOPMENTS

In addition to Model Wildfire Hazard Area Control Regulations, Guidelines for Administration of Wildfire Hazard Areas, and Guidelines for Identification of Wildfire Hazard Areas, local governments should have safety guidelines and standards included in their Subdivision Regulations and Building Codes.

A. MODEL SUBDIVISION REGULATIONS.

The following are standards for Model Subdivisions Regulations which will help to reduce the exposure of developments to unnecessary hazards of wild-fire, and provide adequate roads and other means to enhance fire protection in developed areas.

1. Slope: Fire spread rates increase with slope. Due to this natural uphill phenomena, homes or homesites shall be restricted from vegetated hillsides that exceed 30 percent in slope over the length of the proposed developed hillside until evaluations and recommendations have been completed by the Colorado State Forest Service.
2. Hazardous Fire Areas: Lands containing "fire chimneys", excessive slope, heavy fuels or other hazardous wildfire components, as determined by the State Forester, shall be zoned to exclude development until such time the hazard can be overcome through modification.
3. Fuelbreaks: Practical fuelbreak systems shall be installed and approved as needed in strategic fire defense locations on lands dedicated or encumbered with easements for such purposes before final plat approval. The State Forester can assist in the determination of fuelbreak need, location, and design.
4. Fuel Modifications: Areas that have high fire hazard ratings, as determined by the State Forester, which can be reduced to lower hazard ratings through thinning, grouping or other such fuel modification, shall be so modified before the lot is sold by the developer.
5. Access: All subdivision filings shall be platted so as to provide

two or more dedicated access roads for separate, multiple ingress-egress. Loop drives with one entrance point do not satisfy this need.

6. Road Dedication: All subdivision roads and road easements including fire access lanes, but not including private driveways, shall be dedicated to the public in perpetuity. All subdivision lots shall abut onto a public road.
7. Road Grade: Grade of all dedicated roads shall be a maximum of 8 percent; all roads having centerline curves greater than 45 degrees in arc shall have a maximum of 6 percent grade along such curves. On straight line portions, variances to 10 percent grade will be allowed for a maximum of 200 feet in horizontal distance.
8. Road Curves: Radius of curvature on centerlines of all dedicated roads shall be a minimum of 100 feet. Variances down to 80 foot minimum radii can be made for extreme or severe topography.
9. Road Width: All dedicated roads shall have a minimum dedicated right-of-way of 60 feet, and a minimum all-weather gravel or paved roadbed of 34 feet. Cul-de-sac turn-around pads shall have a minimum right-of-way of a 45-foot radius and a minimum all-weather gravel or paved roadbed of a 30-foot radius.
10. Cul-de-sacs: Maximum length of cul-de-sac roads shall be 750 feet as measured on the centerline. Cul-de-sac roads shall not cross major draws, canyons or gullies conducive to fire spread, nor shall cul-de-sacs terminate in such draws, canyons or gullies.
11. Dead-end Streets (not cul-de-sacs): Dead-end streets shall not be permitted.

12. Road Intersections: Road and street intersections shall be as close to 90 degrees for at least 80 feet from intersection centerlines as terrain will permit. In no case will the angle of such road intersections be less than 45 degrees.
13. Stub Roads: All stub roads shall have a turn-around pad constructed at its end until such time the road is connected. Pad requirements shall be the same as for cul-de-sacs.
14. Road Right-of-way: All roads and streets shall have their right-of-ways cleared of all flammable materials, living or dead, on their entire dedicated width.
15. Road Slash: To avoid insects, diseases, and wildfire hazards all cut combustible materials, vegetative residues including fallen or cut trees and shrubs, pulled stumps, or other such flammable road-clearing debris shall be disposed of from subdivision roadside strips by either chipping or removal prior to approval of the final subdivision plat. Roadside strips are 100 foot wide areas that parallel each side of the road and are measured from the edge of the road right-of-way. Compacting of slash and debris into road fill areas shall not be permitted.
16. Road Names and Signs: Proposed road names shall not duplicate other existing or proposed road names within the county. Street and road signs of durable and permanent materials shall be installed at all intersections in the subdivision prior to final plat approval. The county commissioners shall have final approval in assigning road names. House or lot numbering systems should be plainly visible from the road.

17. Fire-fighting Water Supplies: Fire hydrant systems that meet the current NFPA standards shall be installed not more than 1,000 feet apart and fully charged with water prior to approval of the final plat. In the absence of a working hydrant system, water cisterns of good design, metal or concrete, shall be provided at strategic locations with a minimum capacity per cistern of 100 gallons per acre protected, or 500 gallons per dwelling unit, whichever is more, prior to approval of the final plat. Reduced cistern density on cluster developments with large open spaces may be allowed. It is further recommended that access to each cistern be provided and dedicated to the county for use by the local fire protection agencies. The developer should construct and maintain the cistern(s) for one year before acceptance. Thereafter, the local fire tax district or county should provide care and maintenance of the cistern(s). The State Forester can assist in the determination of cistern locations and design.
18. Fire Stations: Developments that are planned in excess of four (4) miles from the nearest presently available fire protection, as measured over local public roads, shall dedicate to the Colorado State Forest Service lands sufficient and suitable for fire department stations or substations, or, the developer shall escrow title of such lands in the name of the county.
19. Lot Size: Minimum lot size shall increase as slope and amount of vegetation increase:

% Slope	Minimum Lot Size (Acres)	
	Open Grass	Forest & Brush
0-9	1	2
10-19	2	3
20-29	3	4
30 & over *	5	5

* Minimums may be raised and other modifications required by the county if development is to be allowed on slopes of 30% or more. Alternative lot sizes in the form of "cluster" or "planned unit development", are urged whenever possible.

20. Driveways: The subdivider shall show on the preliminary plat that driveway access is available to all building sites within a maximum grade of 12%. Entrance of driveways on to public roads should be as close to 90 degrees in angle as possible in order to provide adequate access for emergency vehicles.
21. Final Plat: Copies of the final plat shall be sent to the local agencies or organizations responsible for fire control on the area. Included are the county sheriff, Colorado State Forest Service, and the local volunteer fire department or fire protection district, if any.

B. MODEL BUILDING CODE STANDARDS.

The following are Model Building Code Standards which, in addition to existing local building codes, will further help to reduce the risk of fire in buildings located in wildfire areas.

1. Slash Around Homes: To avoid insects, diseases, and wildfire hazards, all vegetative residue, slashings, branches, limbs, stumps, roots, or other such flammable lot-clearing debris shall be disposed of from around homesite areas by either chipping or removal prior to final building inspection approval. Homesite areas shall include all areas of the lot in which such materials are generated or deposited.
2. Stilt Homes: Houses or structures built upon a slope and employing wood, masonry, stone, or metal stilt foundations shall have such foundation areas entirely walled or enclosed.
3. House Numbers: House numbers or fire numbering systems shall be plainly visible and legible from the street or road.
4. Power for Pumps: Electrical service loops to buildings having individual water wells and pump pressure systems shall run first to the pump and be provided with adequate controls or switches such that fire in the building or its electrical systems will not impair or stop the operation of the pump pressure system.

APPENDIX II

MODEL WILDFIRE HAZARD AREA

CONTROL REGULATIONS

September, 1974

MODEL WILDFIRE HAZARD AREA
CONTROL REGULATIONS

WHEREAS, authority for the governing body of a municipality or a county to adopt, amend, repeal, enforce and otherwise administer under the police power reasonable Wildfire Hazard Area Land Use Control Regulations and orders pertaining to land use within the areas of its jurisdiction is contained in Section 1, Chapter 106, Article 7, C.R.S. 1963 as amended, and

WHEREAS, the uncontrolled use of lands within wildfire hazard areas within the jurisdiction's boundaries adversely affects the public health, safety and welfare of the citizens of the county (municipality), and

WHEREAS, the governing body of a municipality or county is empowered by Section 1, Chapter 106, Article 7, C.R.S. 1963 as amended, to designate and administer areas of state interest in a manner that will minimize significant hazards to public health and safety or to property due to a wildfire hazard, and

WHEREAS, wildfire hazards are declared to be matters of state interest and are defined by Chapter 106, Article 7, C.R.S. 1963 as amended, to include but is not limited to areas which have slope, aspect, wildfire behavior characteristics, and existing vegetation types and which create wildfire phenomenon;

WHEREAS, a public hearing on the Wildfire Hazard Area Control Regulations proposed by the county (municipality) has been held at which any person having an interest therein had an opportunity to be heard as required in Section 1, Chapter 106, Article 7, C.R.S. 1963 as amended;

WHEREAS, the Board of County Commissioners (Municipal Council) has with due consideration determined said Wildfire Hazard Area Control Regulations to be necessary to execute the legal duties imposed upon the county (municipality) by Section 1, Chapter 106, Article 7, C.R.S. 1963 as amended;

NOW, THEREFORE, BE IT RESOLVED that the Board of County Commissioners (Municipal County) does therefore adopt the following Wildfire Hazard Area Control Regulation:

SECTION 1.0 PURPOSES

To promote the public health, safety and general welfare, to minimize the effect of significant hazards to public health and safety or to property due to a wildfire hazard by the proper administration of all land use changes within such wildfire hazard areas, and to promote wise use of wildfire hazard areas. This Wildfire Hazard Area Control Regulation has been established with the following purposes intended:

1.1 To reduce the impact of wildfire hazards to life and property by:

- 1.11 Prohibiting certain land uses which are dangerous to life or property in wildfire hazard areas;
- 1.12 Restricting uses which would be hazardous to public health or property in wildfire hazard areas;

- 1.13 Restricting uses which are particularly vulnerable to wildfire hazard so as to alleviate hardship and eliminate the demands for public expenditures for relief and protection.
- 1.14 Requiring permitted wildfire hazard area land uses, including public facilities, which serve such uses to be protected from wildfire hazards by providing for wildfire hazard investigation and the avoidance of or mitigation of such hazard impacts at the time of initial construction.
- 1.15 Adoption of Building Code Amendments which require:
 - (a) The disposal of flammable lot clearing debris from homesite areas by chipping or removal.
 - (b) Homes built upon slopes to have fully enclosed foundation walls.
 - (c) Each house be identified by a visible and legible house number which can be plainly seen from the street or road.
 - (d) Development roads, both interior and service roads, to be adequate for use and service by fire trucks and other safety equipment.
- 1.2 To protect wildfire hazard area occupants or users from the impacts of wildfire hazards which may be caused by their own, or other, land use and which is or may be undertaken without full realization of the danger by:
 - 1.21 Regulating the area in which or the manner in which structures designed for human occupancy may be constructed so as to prevent danger to human life or property within such structures;
 - 1.22 Designating, delineating and describing areas that could be adversely affected by wildfire hazards so as to protect individuals from purchasing or improperly utilizing lands for purposes which are not in fact suitable.
- 1.3 To protect the public from the burden of excessive financial expenditures from the impacts of wildfire hazards and relief by:
 - 1.31 Regulating all land uses within wildfire hazard areas so as to produce a pattern of development or a soundly engineered manner of construction which will minimize the intensity and/or probability of damage to property and loss of life or injury to the inhabitants or the users of wildfire hazard areas.
 - 1.32 Regulating manmade changes which could initiate or intensify adverse conditions within wildfire hazard areas.
 - 1.33 Encouraging uses such as agriculture, forestry, grazing, open space and recreation within wildfire hazard areas.

SECTION 2.0 GENERAL PROVISIONS

- 2.1 Jurisdiction: The jurisdiction of this Regulation includes all lands within Designated Wildfire Hazard Areas within the county (municipality) as defined in the Definitions section of Section 1, Chapter 106, Article 7, C.R.S. 1963 as amended.

- 2.2 Boundaries: The boundaries of the Designated Wildfire Hazard Areas shall be delineated on Wildfire Hazard Areas. Maps kept on file with the County (Municipal) Planning Office and in the office of the Colorado State Forest Service, Fort Collins, Colorado. The boundary lines on the map shall be determined by the use of the scale appearing on the map. Where there is a conflict between the boundary lines illustrated on the map and actual field conditions, or where detailed investigations show that hazardous conditions are not significant throughout the entire designated area, the dispute shall be settled according to Section 5.5 "Mapping Disputes" of this Regulation.
- 2.3 Interpretation: In their interpretation and application, the provisions of this Regulation shall be held to be minimum requirements and shall be liberally construed in favor of the governing body, and shall not be deemed a limitation or repeal of any other powers granted by Colorado Statutes. Interpretations of this Regulation shall be consistent with GUIDELINES AND CRITERIA FOR WILDFIRE HAZARD AREAS prepared by the Colorado State Forest Service.
- 2.4 Warning and Disclaimer of Liability: The degree of protection from wildfire hazards intended to be provided by this Regulation is considered reasonable for regulatory purposes, and is based on accepted forestry and fire science methodology. This Regulation is intended to minimize the dangers, costs and impacts from wildfire hazards. Therefore, unforeseen or unknown wildfire conditions or natural or man-made changes in conditions such as climate, vegetation, fire breaks, fuel materials, fire suppression or protection devices, and ignition sources may contribute to future damages to structures and land uses even though properly permitted within Designated Wildfire Hazard Areas. This Regulation does not imply that areas outside Designated Wildfire Hazard Area boundaries or land uses permitted within such areas will always be totally free from the impact of wildfire hazards. This section shall not create a liability on the part of or be a cause of action against the county (municipality) or any officer or employee thereof, or the Colorado State Forest Service or any employee thereof for any personal or property damage that may result from reliance on this Regulation or from damages occurring in areas which for any reason have not been officially designated as Wildfire Hazard Areas.
- 2.5 Adoption of Official Maps: The location and boundaries of the Designated Wildfire Hazard Areas established by this Regulation are shown upon the Designated Wildfire Hazard Area Maps of the county (municipality) which are hereby incorporated into this Regulation. These maps together with everything shown thereon and all amendments thereto shall be as much a part of this Regulation as if fully set forth and described herein. Each change in the official maps shall be subject to the Amendment procedure as required in Section 5.5 "Map Disputes" and Section 7 "Amendments."

SECTION 3.0 NONCONFORMING USES

- 3.1 The existing lawful use of land, structures, or premises which is not in conformity with the provisions of this Regulation may be continued subject to the following conditions:
- 3.11 No such land use shall be changed, expanded or enlarged except in conformity with the provisions of this Regulation.

- 3.12 No structural alteration, addition or repair to any nonconforming structure over the life of the structure shall exceed fifty (50) percent of its assessed value at the time of its becoming a nonconforming use unless permanently changed to a conforming use.
- 3.13 If such use is discontinued for twelve (12) consecutive months, after adoption of these Regulations, any future use of the land, structures and premises shall conform to this Regulation.
- 3.14 Uses or adjuncts thereof which are nuisances or which significantly increase the severity of wildfire hazards and create an increasingly severe impact on current or proposed land use in or adjacent to a Designated Wildfire Hazard Area shall not be permitted to continue as nonconforming uses.
- 3.15 Any alteration, addition, or repair to any nonconforming structure or significant change in land use permitted pursuant to Section 3.12 of this Regulation shall be protected by measures designed to minimize, mitigate or avoid the significant adverse impact of wildfire hazards.

SECTION 4.0 DESIGNATED WILDFIRE HAZARD AREAS

- 4.1 Application: Provisions of this Regulation apply to all Wildfire Hazard Areas for which appropriate identification and evaluation have been made, which have been reviewed by the Colorado State Forest Service and which have been Designated by the Board of County Commissioners (Municipal Council)
- 4.2 Description of Designated Wildfire Hazard Areas: The Designated Wildfire Hazard Areas shall include the area delineated on the official maps which have been reviewed by the Colorado State Forest Service, adopted by the Board of County Commissioners (Municipal Council) and kept on file and available in the County (Municipal) Planning Office and the office of the Colorado State Forest Service.
- 4.3 Description of Permitted Uses: The following open uses shall be permitted within Designated Wildfire Hazard Areas to the extent that they are not prohibited in a particular area by any underlying county or city zoning ordinance or regulation.
 - 4.31 Agricultural Forestry and open space uses which do not require permanent structures for human habitation, which provide reasonable fire protection and suppression facilities, and which do not constitute a source of probable ignition of fires.
 - 4.32 Industrial-commercial uses which do not require permanent structures for habitation, which provide reasonable fire protection and suppression facilities, and which do not constitute a source of probable ignition of fires.
 - 4.33 Public and private recreational uses not requiring permanent structures designed for human habitation if such uses do not cause concentrations of people in areas during period of high hazard probability.

- 4.4 Description of Road Requirements: All development roads within a Designated Wildfire Hazard Area and roads which service and connect such development to main county roads shall meet the minimum standards set forth in the WILDFIRE SAFETY GUIDELINES AND STANDARDS FOR SUBDIVISIONS AND DEVELOPMENTS, Parts A-5 through A-16 inclusive and A-20 by the Colorado State Forest Service.
- 4.5 Description of Fire Protection and Suppression Requirements: All fire and suppression systems proposed within a Designated Wildfire Hazard Area shall meet the minimum standards set forth in the WILDFIRE SAFETY GUIDELINES AND STANDARDS FOR SUBDIVISIONS AND DEVELOPMENTS, Parts A-3, A-4, A-17, A-18, A-19 by the Colorado State Forest Service.

SECTION 5.0 ADMINISTRATION

- 5.1 Designated Wildfire Hazard Area Administrator: The County (Municipal) Administrator shall administer the provisions of this Regulation. When necessary, he shall call upon the Colorado State Forest Service to provide technical and scientific assistance in administering the provisions of this Regulation.
- 5.2 Application for Development Permit: Any person, company or corporation desiring to undertake development or to make significant land use changes with the County (Municipal) Planning Office. The application shall be filed on a form prescribed by the Colorado Land Use Commission. Reasonable fees for this permit shall be set sufficient to cover the cost of processing the application including the cost of holding the necessary hearings. Such fee shall be paid at the time of filing such application.
- 5.22 Application for Development Permit: An application for development permit shall include:
- (a) A map or maps showing location, nature and density of the proposed development or land use change. Such maps shall be on a scale sufficiently detailed to meet the objectives of this Regulation but, in no case, shall be less detailed than 1 inch = 500 feet. The applicant shall also explain in narrative, pictorial or graphic form, the nature, density, and intensity of the proposed development or land use change proposed.
 - (b) A map or maps portraying the existing wildfire conditions of the area with particular attention given to the Designated Hazard conditions and the slope, aspect, topographic and vegetation (living and dead) conditions. Such maps shall be on a scale sufficiently detailed to meet the objectives of this Regulation but, in no case, less detailed than 1 inch = 500 feet. If possible, the wildfire condition maps shall be at the same scale and format as the development plan maps. Such maps shall be signed by the professional forester preparing them.
 - (c) A map or maps and associated narrative showing
 - 1. The procedures proposed to reduce conditions of wildfire hazard,
 - 2. The fire protection plan for the proposed use,
 - 3. All fire suppression facilities which are necessary to meet the objectives of this regulation. The above maps may be produced in the form of overlays to be used in conjunction with the wildfire condition maps required in 5.22 (a).

- (d) A wildfire hazard report explaining the wildfire conditions and mitigating procedures shown on the above maps. This report shall also include an analysis of climatic conditions which may effect the intensity of the hazard or the season of hazard existence. Potential ignition sources on or adjacent to the area must be identified and analysis.
- (e) Other permit information required by the County (Municipal) Planning Office or Colorado Land Use Commission.
- (f) All maps and reports prepared under this Regulation shall be prepared by or under the direction of and signed by a professional forester. Such maps and reports will be accompanied by documents which attest to graduation of the forester from an accredited College of Forestry and verify a minimum of two consecutive years of fire suppression experience in the Rocky Mountain area.

5.23 Exemptions: This Regulation shall not apply to any development which meets any one of the following conditions as to the effective date of this Regulation:

- (a) The development or activity is covered by a current building permit issued by the appropriate local government; or
- (b) The development or activity has been approved by the electorate; or
- (c) The development or activity is to be on land:
 - (I) which as been conditionally or finally approved by the appropriate local government for planned unit development or for a use substantially the same as planned unit development; or
 - (II) which has been zoned by the appropriate local government for the use contemplated by such development or activity; or
 - (III) with respect to which a development plan has been conditionally or finally approved by the appropriate governmental authority.

5.3 Permit review:

- 5.31 Not later than 30 days after receipt of a completed application for a permit, notice of a public hearing on said application shall be published. Such publication shall be at least once in a newspaper of general circulation in the County (Municipal), not less than 30 or more than 60 days before the date set for hearing. Such notice shall also be given to the Colorado Land Use Commission.
- 5.32 Upon receipt of a complete application for development, the county (Municipality) shall forward a complete copy of such application together with maps and plans to the District Forester, Colorado State Forest Service, for the county. It shall also include such additional available information pertinent to the application. It shall notify the District Forester of the date of the proposed hearings on said application. The Colorado State Forest Service shall, on or before the date ten (10) days prior to the proposed hearing, review and make recommendations on subject application.

- 5.33 If a person proposes to undertake any development in a wildfire hazard area which has not been previously Designated and for which guidelines or regulations have not been adopted, the county (municipality) may hold one hearing for the determination of Designation and guidelines and the granting or denying of the permit.

5.4 Permit Approval or Denial:

- 5.41 Deliberations on the application shall include but not be limited to:
- (a) Objectives and definitions of Chapter 106, Article 7, C.R.S. 1963 as amended;
 - (b) Guidelines and criteria promulgated and distributed by the Colorado State Forest Service;
 - (c) The technical information presented by the applicant;
 - (d) The recommendations of the Colorado State Forest Service;
 - (e) Any other available technical information;
 - (f) The severity of the hazardous conditions and the probable effect of those conditions on the proposed development;
 - (g) The intensity and character of the proposed development and its probable effect on those hazardous conditions;
 - (h) Relationship between (f) and (g) above and the related potential impact upon future users of the subject and adjacent or affected lands.
 - (i) The provision of firebreaks and other means of reducing conditions conducive to fire.
- 5.42 A complete record of such proceedings shall be made and preserved.
- 5.43 The county may approve a permit to allow a development in a Designated Wildfire Hazard Area if the proposed development complies with the objectives of Chapter 106, Article 7, C.R.S. 1963 as amended, and with the guidelines and Regulations governing such Wildfire Hazard Areas. If the proposed development does not comply with the objectives of Chapter 106, Article 7, C.R.S. 1963 as amended, the guidelines and these Regulations, the permit shall be denied.
- 5.44 Within forty-five (45) days after conclusion of hearings on the Development Application Permit, the county (Municipality) shall render a decision as to approval or denial. It shall state in writing reasons for its decision and its findings and conclusions, and shall provide timely transmittal of its findings to the applicant, the Colorado Land Use Commission and the Colorado State Forest Service.
- 5.45 After the effective date of this Regulation, any person desiring to engage in a development in a Designated Wildfire Hazard Area who does not obtain a permit pursuant to this Regulation may be enjoined by the Colorado Land Use Commission or the appropriate local government from engaging in such development.
- 5.46 The denial of a permit by a local governmental agency shall be subject to judicial review in the district court for the judicial district in which the proposed development was to occur.

5.5 Mapping Disputes: The following procedure shall be used by the County Commissioners (Municipal Council) in deciding contested cases in which the boundary of a Designated Wildfire Hazard Area is disputed or in cases where because of local, detailed circumstances, the designated hazard condition does not present a significant hazard to public health, safety or to property at the specific location for the particular proposed land use.

5.51 In all cases, a person contesting the location of the district boundary or the severity of conditions at a specific location within the Designated Wildfire Hazard Area shall be given a reasonable opportunity to present his case to the Board (council) and shall submit technical and physical evidence to support such contest. The Board shall not allow deviations from the boundary line as mapped or non-permitted land uses within the boundary areas unless technical and physical evidence clearly and conclusively establishes that the map location of the line is incorrect, or that the Designated Hazard conditions do not present a significant hazard to public health, safety or to property at the specific location within the hazard area boundary for the particular proposed land use.

SECTION 6.0 ENFORCEMENT AND PENALTIES

6.1 Every structure, building, road, or residential activity which is placed, or maintained within any Designated Wildfire Hazard Area in violation of this Regulation is a public nuisance, and the creation thereof may be enjoined and maintenance thereof may be abated by action at suit of the City, Town, or County in which it is located or by the County Commissioners (Municipal Council) or any citizen thereof. Any person who places, constructs, or maintains any structure, building, road, or residential activity within any Wildfire Hazard Area in violation of this Regulation may be fined not more than \$500.00 for each offense. Each day during which such violation exists is a separate offense.

SECTION 7.0 AMENDMENTS

7.1 The Board of County Commissioners (Municipal Council) may from time to time alter, supplement or change the Designated Wildfire Hazard Area boundaries and the provisions contained in this Regulation in the manner provided by law.

7.11 Amendments to this Regulation may be made on petition of any interested party in accordance with the provisions of the Colorado Revised Statutes.

SECTION 8.0 DEFINITIONS

Definitions of terms utilized in this Regulation are as given in this Section. Other definitions can also be found in Chapter 106-7-102 and 103 C.R.S. 1963 as amended, and the Guidelines and Criteria For Wildfire Hazard Areas as promulgated by the Colorado State Forest Service.

- 8.1 "Aspect" means the cardinal direction the land surface faces.
- 8.2 "Firebreak (Fuelbreak)" means a strategically located strip of land, variable in width, on which the vegetation has been modified to reduce the rate of fire spread so that fire suppression forces can be utilized in relative safety to control a wildfire. The term may include provisions for all-wheel-drive access. Greenbelts, open space, forest openings, riding and hiking trails, and underground utility easements may also be incorporated within fuelbreaks.
- 8.3 "Fuel" means vegetation, debris, or other substances that will support combustion.
- 8.4 "Ignition Source" means any device or method which can ignite a fire.
- 8.5 "Slash" means vegetative debris left after cutting or clearing operations in forest or brush areas and which requires treatment.
- 8.6 "Slope" means the gradient of the ground surface measured in percent.
- 8.7 "Wildfire Behavior" means the predictable action of a wildfire under given conditions of fuels, weather and topography.
- 8.8 "Wildfire Hazard" means a wildfire phenomenon which is so adverse to past, current, or foreseeable construction or land use as to constitute a significant hazard to public health and safety or to property. The term includes but is not limited to:
- (a) Slope and aspect
 - (b) Wildfire behavior characteristics; and
 - (c) Existing vegetation types.
- 8.9 "Wildfire Hazard Area" means an area containing or directly affected by a wildfire hazard.

Wildfire Safety:

*Model Regulations for
Protecting People & Homes
in Subdivisions and Developments*

Revised April, 1988

WILDFIRE SAFETY:
MODEL REGULATIONS
FOR
PROTECTING PEOPLE AND HOMES
FROM WILDFIRE
IN
SUBDIVISIONS AND DEVELOPMENTS

by

Ronald J. Zeleny



CSFS #123-0588

FORWARD

April, 1988

These model regulations, or guidelines, have been formulated for use by counties, developers, the Colorado State Forest Service, and other public or private interests involved in designing, constructing, reviewing, or regulating subdivisions and improvement in rural or wildland areas of Colorado.

In drawing up these guidelines, the leading objective was to help provide for the long-term health, welfare, and safety of the public from destructive wildfires to life, property, and associated investments. Other objectives include efficient use of public funds and resources of the county and the state, as well as the interests of the private individual and developer. High standards are essential to produce and maintain quality, high-value accomplishments. Land development is no exception.

When differences exist between these guidelines and existing county standards, the county standards shall apply. When these guidelines are more stringent, they should be noted in writing to the county during plat reviews and when county standards are being revised.

While the focus is mainly upon the criteria for developing fire-safe areas, many paragraphs easily relate to the subjects of erosion control, forest insects and disease, tree vigor, and beauty on developed acreages. Additional guides and recommendations for these and other subjects are available upon request.

Additional information can be acquired by contacting any of the district offices listed within this publication or by contacting me directly.

James E. Hubbard
State Forester

COLORADO STATE FOREST SERVICE

A. MODEL SUBDIVISION REGULATIONS

Special Problems

1. Slope: Fire spread rates increase with slope. Due to this natural uphill phenomena, homes, or homesites shall be restricted from vegetated hillsides that exceed 30 percent in slope over the length of the proposed developed hillside until on-site evaluations and recommendations have been completed by the Colorado State Forest Service.
2. Hazardous Fire Areas: Lands containing "fire chimneys," excessive slope, heavy fuels or other hazardous wildfire components, as determined by the State Forester, shall be zoned to exclude development until such time the hazard can be overcome through modification.

Natural Fuels

1. Fuel Modifications: Areas that have high fire hazard ratings, as determined by the State Forester, which can be reduced to lower hazard ratings through thinning, grouping, or other such fuel modification, shall be so modified before the lot is sold by the developer. The booklet "Wildfire Safety Guidelines For Rural Homeowners" or the State Forester can help determine fuel hazards and modifications.

2. Fuelbreaks: Practical fuelbreak systems shall be installed as needed in recommended locations with final approvals by the State Forester prior to final plat approval. These strategic wildfire defense locations shall be situated on lands dedicated or encumbered with easements for such purposes. Fuelbreak locations may be included on road right-of-ways provided fuelbreak easements outside the right-of-way are included. Determination of fuelbreak need, location, and design can be obtained from the State Forester and from publication "Fuelbreak Guidelines for Forested Subdivisions."
3. Safety Zones: Wildfire safety zones are necessary for temporary public evacuation areas during fires. "Wildfire safety zones" shall be so indicated by permanent signs in such areas along public roads prior to lot sales. Such areas shall also be shown on the final plat. The State Forester can assist in locating wildfire safety zones.

Road Systems

1. General Access: All subdivision filings shall be platted so as to provide two or more dedicated access roads for widely separated ingress/egress. Loop drives with one entrance point or divided single entrances do not satisfy this need.
2. Lot Access: All subdivision lots must abut onto a public road. Private driveways do not satisfy public road or safety access requirements for more than one lot.

3. Road Dedication: All subdivision roads and road easements including fire access lanes, but not including private driveways, shall be dedicated to the public in perpetuity.
4. Road Width: All dedicated roads shall have a minimum dedicated right-of-way of 60 feet, and a minimum all-weather gravel or paved roadbed of 34 feet. Cul-de-sac turnaround pads shall have a minimum right-of-way of a 45-foot radius and a minimum all-weather gravel or paved roadbed of a 30-foot radius.
5. Road Grade: Grade of all dedicated roads shall be a maximum of 8 percent; all roads having centerline curves greater than 45 degrees in arc shall have a maximum of 6 percent grade along such curves. On straight line portions, variances to 10 percent grade will be allowed for a maximum of 200 feet in horizontal distance.
6. Road Curve: Radius of curvature on centerlines of all dedicated roads shall be a minimum of 100 feet. Variances down to 80-foot minimum radii can be made on case-by-case basis for extreme or severe topography.
7. Road Intersections: Road and street intersections shall be as close to 90 degrees for at least 80 feet from intersection centerlines as terrain will permit. In no case will the angle of such road intersections be less than 45 degrees.

8. Cul-de-sacs: Maximum length of cul-de-sac roads shall be 750 feet as measured on the centerline. Cul-de-sac roads shall not cross major draws, canyons, or gullies conducive to fire spread, nor shall cul-de-sacs terminate in such draws, canyons, or gullies. Special exemptions to the 750 foot maximum shall have one extra vehicular turnaround area for every 750 feet of cul-de-sac centerline installed between the road intersection and its terminus. Such turnaround areas shall be the same standard as cul-de-sac turnaround pads.
9. Dead-end Streets (not cul-de-sacs): Dead-end streets shall not be permitted.
10. Stub Roads: All stub roads shall have a turnaround pad constructed at its end until such time the road is connected. Pad requirements shall be the same as for cul-de-sacs.
11. Road Names and Signs: Proposed road names shall not duplicate other existing or proposed road names within the county. Street and road signs of durable and permanent materials shall be installed at all intersections in the subdivision prior to final plat approval. The Board of County Commissioners shall have final approval in assigning street and road names. House or lot numbering systems should be plainly visible from the public road.
12. Driveways: The subdivider shall show on the preliminary plat that driveway access within a maximum grade of 12 percent is available to all building sites. Driveways shall have their entrance on to public roads as close to 90 degrees in angle for at least 25 feet from the edge of the public road as terrain will permit,

have a minimum roadbed width of 16 feet, and contain no curves or turns greater than 90 degrees in order to provide adequate access for emergency vehicles.

Slash and Flammables

1. Road Right-of-way: All roads and streets shall have their rights-of-way cleared and maintained free from all flammable materials, living or dead, on their entire dedicated width.
2. Road Slash: To avoid insects, diseases, and wildfire hazards all cut combustible materials, vegetative residues including fallen or cut trees and shrubs, pulled stumps, or other such flammable road-clearing debris shall be disposed of from subdivision roadside strips by either chipping or removal prior to approval of the final subdivision plat. "Roadside strips" are 100-foot wide areas that parallel each side of the road and are measured outward from the edge of the road right-of-way.
3. Fills: Compacting of slash and debris into road fill areas shall not be permitted or approved.

Fire Protection

1. Fire Stations: Developments that are planned in excess of 4 miles from the nearest presently available fire protection, as measured over local public roads, shall dedicate lands sufficient and suitable for fire stations or substations in the name of the fire district or the county.

2. Fire Hydrants: Fire hydrant systems that meet current National Fire Protection Association standards shall be installed no more than 1,000 feet apart and fully charged with water and tested prior to approval of the final plat.
3. Cisterns: In the absence of hydrant systems, water cisterns of good design that meet current National Fire Protection Association standards shall be provided at strategic locations prior to approval of the final plat. Minimum capacity per cistern shall be 100 gallons per acre protected, or 1,000 gallons per dwelling unit, whichever is more. Reduced cistern density on cluster developments with large open spaces may be allowed. Access to each cistern shall be provided and dedicated to the county for use by the local fire protection agencies. The developer shall construct and maintain the cistern(s) for one year before acceptance. Thereafter, the local fire district or county shall provide care and maintenance of the cistern(s). The State Forester can assist in the determination of cistern locations.
4. Dry Hydrants: Dry hydrants that meet current National Fire Protection Association standards may be installed in lieu of cisterns where available fire suppression water supplies can meet or exceed those of proposed cisterns.

Subdivided Lots

1. Lot Size: Minimum lot size shall increase as slope and amount of vegetation increase:

<u>% Slope</u>	<u>Minimum Lot Size (Acres)</u>	
	<u>Open Grass</u>	<u>Forest & Brush</u>
0- 9	1	2
10-19	2	3
20-29	3	4
30 & over*	5	5

*Minimums may be raised and other modifications required by the county if development is to be allowed on slopes of 30 percent or more. Alternative lot size in the form of "cluster" or "planned unit development," are urged whenever possible.

2. Lot Splitting: Re-subdivision of existing lots shall meet the same wildfire safety standards as new lots.
3. Building Envelopes: A proposed building site or "envelope" will be shown for each lot that is to be occupied by a structure. Such envelopes shall not be located in gullies, fire chimneys, saddles or other terrain conducive to wildfire spread.

Platting

1. Plat Restrictions: Any restrictions or requirements imposed by the county for fire safety measures shall be shown on the final plat.

2. Final Plat: Copies of the final plat shall be sent to the local agencies or organizations responsible for fire protection of the area. Included are the county sheriff, Colorado State Forest Service, and the local fire department or fire protection district, if any.
3. Zoning: Wildfire safety requirements of subdivisions shall not be exempted or relaxed by zoning, or by rezoning to higher or lower land use intensities.

B. MODEL BUILDING CODES:

Natural Fuels

1. Fuel Modification: Fuel modifications necessary for wildfire hazard reduction is to be included as part of the building permit process.
2. Slash Around Homes: To avoid insects, diseases, and wildfire hazards, all vegetative residue, slashings, branches, limbs, stumps, roots, or other such flammable lot-clearing debris shall be disposed of from around homesite areas by either chipping or removal prior to final building inspection approval. Homesite areas shall include all areas of the lot in which such materials are generated or deposited.

Other

1. Stilt Homes: Houses or structures built upon a slope and employing wood, masonry, stone, or metal stilt foundations shall have such foundation areas fully walled or enclosed.
2. House Numbers: House numbers or fire numbering systems using 2-inch or larger letter shall be plainly visible and legible from the public street or road.

C. GLOSSARY:

1. Cul-de-sac -- a short street having one end open to traffic and being terminated at the other end by a vehicular turnaround area or pad.
2. Fire Hazard Areas -- wildland areas where the combination of fuels, topography, weather, and risk of fire ignition create threats to life and property.
3. Fire Hazard Rating -- a word, number, or letter used to describe or designate wildfire hazard severity of an area.
4. Fuel -- vegetation, debris, structure, or other substances, man made or natural, that will support burning combustion.
5. Fuelbreak -- a strategically located strip of land, varying in width, on which the vegetation has been modified to reduce the rate of fire spread so that firefighters can work in relative safety to control a wildfire. Fuelbreak effectiveness depends largely upon location and fuel treatments. Exact, advantageous locations and sizes must be made on an individual prescription basis to account for variations in fuels and topography. Fuelbreaks include provisions for all-wheel drive access. Public roads, greenbelts, open space, forest openings, riding and hiking trails, and underground utility easements may also be incorporated within fuelbreaks.
6. Wildfire -- uncontrolled fire burning in vegetation. Structures and other improvements may also be threatened or included.

7. Wildland -- uncultivated areas, hilly or flat, covered by timber, woodland, brush, and/or grass.

D. ADDITIONAL INFORMATION:

1. Suggested booklets available from the Colorado State Forest Service about wildfire safety:
 - "Your Forest Home--Protect if From Fire"
(a checklist)
 - "Wildfire Safety Guidelines For Rural Homeowners"
 - "Fuelbreak Guidelines For Forested Subdivisions"
 - "Landowner Guide to Thinning"
2. More information can be obtained from any of the following offices:

ALAMOSA DISTRICT

Colorado State Forest Service
P.O. Box 1137
610 State Street
Alamosa, CO 81101
(719) 589-2271

BOULDER DISTRICT

Colorado State Forest Service
936 Lefthand Canyon Drive
Boulder, CO 80302
(303) 442-0428

CANON CITY DISTRICT

Colorado State Forest Service
515 McDaniel Blvd.
Industrial Park
Canon City, CO 81212
(719) 275-6865

CASTLE ROCK DISTRICT

Colorado State Forest Service
355 S. Wilcox #111
Castle Rock, CO 80104
(303) 688-3096

DURANGO DISTRICT

Colorado State Forest Service
P.O. Box 7333
Fort Lewis College Campus
Durango, CO 81301
(303) 247-5250

FORT COLLINS DISTRICT

Colorado State Forest Service
Building #1052, Foothills Campus
Colorado State University
Fort Collins, CO 80523
(303) 491-8660

FORT MORGAN DISTRICT

Colorado State Forest Service
1117 E. Burlington
Fort Morgan, CO 80701
(303) 867-5610

GOLDEN DISTRICT

Colorado State Forest Service
1504 Quaker Street
Golden, CO 80401
(303) 279-9757

GRAND JUNCTION DISTRICT

Colorado State Forest Service
State Services Building
222 S. 6th Street, Room 416
Grand Junction, CO 81501
(303) 248-7325

HIGH COUNTRY DISTRICT

Colorado State Forest Service
P.O. Box 2189
Dillon, CO 80435
(303) 468-1667

LA JUNTA DISTRICT

Colorado State Forest Service
P.O. Box 977
Dalton & Highway 50 West
La Junta, CO 81050
(719) 384-9087

LA VETA DISTRICT

Colorado State Forest Service
P.O. Box 81
Moore & Poplar Streets
La Veta, CO 81055
(719) 742-3588

SALIDA DISTRICT

Colorado State Forest Service
7980 W. Highway 50
Salida, CO 81201
(719) 539-2579

STEAMBOAT SPRINGS DISTRICT

Colorado State Forest Service
P.O. Box 773657
401A Lincoln Avenue
Steamboat Springs, CO 80477
(303) 879-0475

WOODLAND PARK DISTRICT

Colorado State Forest Service
P.O. Box Y
113 South Boundary
Woodland Park, CO 80866
(719) 687-2921

STATE FORESTER

Colorado State Forest Service
Colorado State University
Fort Collins, CO 80523
(303) 491-6303