Development and Mapping Techniques for the Comprehensive Community Wildfire Protection Plan (CWPP) for Jefferson County, Colorado

Scot Fitzgerald

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Scot Fitzgerald
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Capstone Project
July 2011
Abstract

The Community Wildfire Protection Plan (CWPP) development process highlighted in this document was developed for multiple CWPP for Jefferson County, Colorado. Documents were created for three Fire Protection Districts, and a larger scale plan was developed to cover all of Jefferson County. The county-wide plan was developed combining existing fire protection district CWPP information, infrastructure data from the Jefferson County GIS department, and fuels and vegetation from LANDFIRE in order to create maps with which wildfire hazards and fuel mitigation recommendations could be identified. The final CWPP is a tool for communities and other local stakeholders to implement wildfire hazard reduction measures.
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Development of and Mapping Techniques for the Comprehensive Community Wildfire Protection Plan (CWPP) for Jefferson County

Introduction

Jefferson County Colorado, like all counties in Colorado, is mandated to have Community Wildfire Protection Plans (CWPP's) for wildfire mitigation, planning, and emergency response by the Senate Bill 09-001 of 2009 and the Healthy Forests Restoration Act of 2003 (Colorado State Forest Service Minimum standards for Developing Community Wildfire Protection Plans, per Colorado Senate Bill 09-001). Jefferson County (JeffCO) is topographically similar to other counties located on the Front Range of Colorado where the mountains and plains meet, in that there is a sharp contrast of flat land and the mountainous areas that continue west through the state.

A Wildland-Urban Interface (WUI) is an area where development of houses and living space interfaces with the open country and is relevant for the CWPP development because it is where people can be most affected by wildfire (Colorado State Forest Service 2011). Since this county has such a large population and many areas classified as Wildland-Urban Interface, it is important to develop plans as well as to plan for fire responses to minimize potential damage in case of large wildfire events. Defensible space zones around homes, structures, and selective cutting projects near populated areas can help to ensure that people can escape from these areas in the event of a wildfire. This could also provide areas in which firefighters can safely and effectively fight a fire. (Firewise Communities website, 2011). Road width analysis and fuels mitigation efforts have been made for many areas within Jefferson County. This is of particular concern because it enables residents to escape safely and firefighting operations within these often
remote areas. While defensible space is referenced in the CWPP’s, specific housing analysis is typically not done in fire protection district-wide or county-wide CWPP’s. They are meant to be a broad-based analysis of communities and regional hazards on a landscape scale. A community hazard analysis is performed by evaluating average defensible space, along with other factors that contribute to fire hazard. This information is combined to assign a hazard rating that can be addressed through recommended mitigation efforts. This information is tallied numerically and evaluated in the National Fire Protection Agency’s Wildfire Risk and Hazard Severity Form (1144 form, Appendix C).

These documents are commonly a broad-based set of maps and recommendations for a specific area such as a Fire Protection District area (FPD’s). Emergency personnel require documented strategies and data available prior to an event in order to: evaluate fire potential and spread in an active event; evaluate critical infrastructure; visualize areas for evacuation if necessary; and analyze human inhabitation. Ultimately the CWPP’s overall goal is to save lives, preserve infrastructure, and analyze fire potential to the landscape to promote improved response and land use.

Specific Goals

The specific goal of this CWPP development is to create an updatable document that contains areas of interest, areas of potential risk, and specific proposals for mitigation that can serve to meet the guidelines of Senate Bill 09-001, as well as the needs of the JeffCO firefighting community. This process of development will be highlighted in the CWPP and will give a basis of understanding that can be read to initiate any new team developing CWPP’s. Several previous CWPP’s were developed by Anchor Point (from
2004 - 2005) and Walsh Engineering (from 2006 - 2008), environmental consulting firms located in Boulder, Colorado. A plan was created for North Fork Fire Protection District and signed by the core team in February of 2011. The CWPP’s for Golden Gate and Elk Creek FPD’s have been completed as of August 2011. The requirement for the countywide plan will be completed and signed by the end of September 2011.

2.1 Project Objectives

This capstone project will deliver the following tasks:

- Gather data and develop relations necessary for CWPP creation
- Complete North Fork Fire Protection District CWPP, February 2011
- Complete Elk Creek Fire Protection District updated CWPP, June 2011
- Complete Golden Gate Fire Protection updated CWPP, August 2011
- Graduate from University of Denver, August 2011
- Complete the County Wide CWPP, September 2011

Benefits of Development and Research Questions

There are several main reasons for developing CWPP’s for Counties and their respective FPD’s. The first goal is to protect lives, preserve property and to maintain forests as a resource (HFRA 2003). This goal supports the most important component of WUI’s: to save lives in the wildfire events that occur throughout the state of Colorado and the western US. Protecting property, such as structures, homes and property, is an auxiliary goal. Property and structures will be protected, but not at the potential cost of lives of owners or firefighters. The most effective ways to protect these structures in the
WUI is to build using non-burnable materials and maintain defensible space surrounding the premises in the event of a grass fire. (Firewise Communities website, 2011)

The purpose of these plans for multiple FPDs is to provide a comprehensive County-wide wildfire protection plan for Jefferson County, Colorado. In the case of an emergency, strategies can be developed to help residents with egress, response ingress, or to provide a plan for the evacuation of entire communities (Colorado State Forest Service Minimum standards for Developing Community Wildfire Protection Plans, per Colorado Senate Bill 09-001, 2009).

There are various data that need to be gathered and taken into consideration when developing maps for CWPP's. Critical infrastructure such as roads, buildings/addresses, water features, and power lines are some initial data layers to include. Other data including wildland fuels, past burn areas, recommended areas for treatment, and treated areas such as re-vegetation areas or harvested regions (clear or selective) are important to further analysis. Some layers are easily created by symbolizing hazard or in various color ramps. Other layers, such as the FBFM TU5 and slope analysis, are created by querying and selective exporting to visualize a particular fuel model in the raster layer and slope greater than 20%.

One of the most important things to consider is how wildfire can affect people living in the region and the ability to evacuate in the event of catastrophic wildfire. This egress routing is evaluated through analysis of individual homes in communities throughout the particular FPD or county. In past CWPP's for Jefferson County the plans have given specific roads as evacuation routes in a wildfire event, but current thought on this subject has lead the team to believe that this could provide a false sense of security.
for people living in a specific area. It may be best to evacuate people in during an event and use reverse 911 to notify individuals of the current best way to evacuate their neighborhood. Then hazard ratings for communities are developed based on the National Fire Protection Agency (NFPA) Chart (Appendix A Form 1). Then the community as a whole is rated and generalized recommendations are made for the Community by our team developing the CWPP’s which consists of Rocco Snart, Robin Keith, and Scot Fitzgerald. These numbered hazard ratings are entered into a database that will be linked to the geography in the GIS (Appendix C Map 3: WUI). Defensible space for structures is not specifically addressed in the mapping process and is only generalized in the text of the CWPP documents. This is because this document is only a broad generalized guide of recommendations for communities and is looked at as a whole community and not as a plan for routing to and from single structures.

Literature Review

Basis for developing Community Wildfire Protection Plans (CWPP)

The Colorado Senate Bill 09-001 of 2009 mandates CWPP’s as recommended by the Healthy Forests Restoration Act of 2003 (HRFA, 2003). The HFRA, which was signed into law by the Bush administration on 2003, can expedite implementation of fuel reduction projects on lands managed by government agencies such as the United States Forest Service (USFS) and the Bureau of Land Management (BLM). The Colorado Senate Bill 09-001 of 2009 guidelines can be found here: (http://csfs.colostate.edu/pdfs/FINAL_Revised_CWPP_Minimum_Standards_111309.pdf, July 2011)
These guidelines are meant to build upon the general guidelines set forth in the HFRA of 2003 and are specific to Colorado. All CW PP’s in Colorado must first meet the minimum guidelines of HFRA 2003 first and Colorado’s minimum standards as well. (Colorado State Forest Service Minimum standards for Developing Community Wildfire Protection Plans, per Colorado Senate Bill 09-001. 2009)

Past CW PP development has been a standard best practice even before it was mandated in 2009 in Colorado because fire prone counties, such as Jefferson County, needed plans in place because of past major fires such as the Hi Meadow fire in 2000 and Hayman in 2002 that affected southern JeffCO in the North Fork Fire Protection District. These prior plans created by Anchor Point and Walsh Engineering, both located in Boulder CO, have set the standard in JeffCO for recommended mapping techniques as well as a standard format that serves the County fire professionals in a meaningful manner. These plans are meant to give the emergency mitigation teams the platform to design landscape-scale fuels reduction projects that could reduce the chances of human deaths and damage to property. These plans are not meant to be static products, but living documents that evolve over time with increasing populations, new mitigation efforts, as well as new developments in providing services. (Jefferson County Website, 2011)
W A L S H  E n g i n e e r i n g  B o u l d e r ,  C o l o r a d o .

W A L S H  E n g i n e e r i n g  h a s  d e v e l o p e d  s t r a t e g i e s  f o r  a n d  c o m p l e t e d  9  C W P P ' s  f o r  J e f f e r s o n  C o u n t y  f r o m  2 0 0 6 – 2 0 0 8 .  T h e s e  p l a n s  s e t  t h e  s t a g e  o f  w h a t  J e f f e r s o n  C o u n t y  i s  u s e  t o  s e e i n g  a n d  u s i n g  o n  a  c o n t i n u o u s  b a s i s .  T h e s e  i n c l u d e d  u s i n g  t h e  f o r m  e s t a b l i s h e d  b y  N F P A  u s i n g  t h e  1 1 4 4  F o r m  1 - ( A p p e n d i x  C )  C o m m u n i t y  H a z a r d  A s s e s s m e n t .  T h e y  a l s o  c r e a t e d  a  n u m b e r  o f  v a r i o u s  m a p s  s u c h  a s :  C o m m u n i t y  O v e r v i e w  ( W U I  m a p s ) ,  C o m m u n i t y  I n f r a s t r u c t u r e ,  F B F M ,  H i s t o r i c  F i r e s ,  F u e l s  T r e a t m e n t s  o r  a l s o  c a l l e d  F u e l s  M i t i g a t i o n  R e c o m m e n d a t i o n s ,  a n d  P u b l i c  L a n d s .  T h e r e  w e r e  a l s o  m a p s  t h a t  r e f e r r e d  t o  s y m b o l i z a t i o n  o f  o t h e r  L A N D I F R E  p r o d u c t s  s u c h  a s :  H i s t o r i c  F i r e  R e g i m e ,  P o t e n t i a l  N a t u r a l  V e g e t a t i o n ,  a n d  F i r e  R e g i m e  C o n d i t i o n  C l a s s .  W e  d e t e r m i n e d  t h e  p r o d u c t s  n e c e s s a r y  f o r  t h i s  c o a r s e  s c a l e  h a z a r d  a s s e s s m e n t  a n d  t h e s e  p r o d u c t s  w e r e  n o t  n e c e s s a r y .  A l l  o f  t h e  p r e v i o u s  C W P P ' s  a n d  m a p  d o c u m e n t s  c a n  b e  f o u n d  h e r e  ( h t t p : / / w w w . c o j e f f e r s o n . c o . u s / s h e r i f f / s h e r i f f _ T 6 2 _ R 1 9 3 . h t m ,  J u l y  2 0 1 1 )

D o u g l a s  C o u n t y  C W P P

D o u g l a s  C o u n t y  h a s  a l s o  b e e n  a c t i v e l y  i n v o l v e d  i n  d e v e l o p i n g  t h e i r  c o u n t y  w i d e  p l a n  f o r  t h e  p a s t  2  y e a r s .  T h e y  h a v e  d o n e  s i g n i f i c a n t  w o r k  w i t h  t h e  c o m m u n i t y  a n d  c o l l a b o r a t e d  o n  t h e  J e f f e r s o n  C o u n t y  N o r t h  F o r k  C W P P  d e v e l o p m e n t  a n d  o u r  C o r e  T e a m  f o r  t h a t  p r o j e c t .  A  c o r e  t e a m  f o r  C W P P  d e v e l o p m e n t  g e n e r a l l y  c o n s i s t s  o f  i n d i v i d u a l s  t h a t  m a y  h a v e  a  s t a k e  i n  t h e  C W P P  p r o d u c t  c r e a t e d .  I n  t h e  c a s e  o f  t h e  N o r t h  F o r k  C W P P ,  t h e  t e a m  i n c l u d e d  i n d i v i d u a l s  f r o m  t h e  U S F S ,  C S F S ,  J e f f e r s o n  C o u n t y ,  a n d  t h e  l o c a l  F i r e  o f f i c i a l s  w i t h i n  t h e  F P D .  J e f f e r s o n  C o u n t y  h a d  b e e n  w o r k i n g  o n  t h e  d i s t r i c t- w i d e  p l a n s  f i r s t  a n d  t h e n  w o r k i n g  u p  t o  t h e  C o u n t y w i d e  p l a n  w h e r e a s  D o u g l a s  C o u n t y  i s
focusing on the county-level planning first and then working to the more local regions. Douglas County has developed some useful information for community members, made all finalized maps available, as well as some very informative video vignettes all available on the County government website at (http://www.douglas.co.us/CWPP/index.html, July 2011).

**LANDFIRE and Fire modeling**

**LANDFIRE** (which stands for Landscape Fire and Resource Management Planning Tools) is vegetation fuels characteristics and fire mapping software program available for Windows XP. The data is 30 meter pixels and has been designed to be used on a landscape scale covering the entire United States. The data has been divided into regional zones that can be applied to smaller areas. Three regional LANDFIRE zones converge at the Jefferson, Douglas and Arapahoe county lines. For the project, this data has been acquired and mosaiced using ESRI's ArcGIS ArcToolbox. It was then exported to the boundary of a 5 mile buffer of Jefferson County so further analysis can be done to produce the 50th and 90th Percentile flame length maps. All data has been clipped to this 5 mile buffer so areas that could directly affect Jefferson County residents can be evaluated. These percentile maps are produced to give an idea of various weather conditions. The 50% would be an average day and the 90% would be a day in which the weather is extreme. These parameters can be created within FLAMMAP3. The FLAMMAP3 software application enables creation of static raster layer creations that are representative of specific characteristics at a static moment in time. Other programs such as Wildfire Decision Support System (WFDS) and FARSITE can be used to create
a real time estimation of fire spread and has a web interface, but these tools are not used in this scenario because modeling an active wildfire is not the goal in this project.

**Study Area**

The Study area covers the entire region of Jefferson County. JeffCO is approximately 773 square miles and has a population of about 545 thousand, of which roughly 190 thousand live in the 655 unincorporated square miles of this relatively large County (Jefferson County Website, 2011). There are a total of 18 Fire Protection Districts in JeffCO, but there are also regions colloquially referred to as “no man’s lands” that are not covered by a FPD. This is an issue that the County is addressing and these lands will eventually be incorporated into a FPD in which various FPD documents will need to be changed to reflect. Elk Creek and Golden Gate FPD’s are to the North Fork FPD in the very southern end of JeffCO and will be developed in conjunction with the County wide plan. The County wide CWPP will cover all of the FPD’s within the County with a broader perspective and recommended plan. There are also large urban areas of eastern JeffCO that are developed urban areas that will need to be discussed in the County Wide plan, but not necessarily incorporated into any given FPD. This is primarily because they do not meet the requirements of a Wildland-Urban Interface. A Wildland Urban Interface described by the Colorado State Forest Service is:

“... any area where man-made improvements are built close to, or within, natural terrain and flammable vegetation, and where high potential for wildland fire exists.”

(\texttt{http://csfs.colostate.edu/pages/w-f-wildland-map.htm}, July 2011)
Fires in the plains do stand some chance of meeting this definition, but with the development of these CWPP's, the areas described are woodland areas. Fires in these areas tend to be the most catastrophic fires to structures and property, and considering the density of houses within the mountainous areas of southern and western Jefferson County, this has driven the development of these particular documents as highlighted in this document.

See Appendix C for maps of Jefferson County. See Map 15 Elk Creek WUI overview

Data Retrieval and Sources

Much of the initial base data for the County is available through a networked Spatial Data Engine (SDE) geospatial database residing in the GIS department at the Jefferson County offices. These consist of many of the layers that are consistently updated by the GIS department of JeffCO. The GIS data is imported and maps made within ESRI's ArcGIS 9.3.1. The fire potential mapping was completed within the Fire Family plus software which includes: FLAMMAP3 (Anderson, P.L. 2009). The GIS data that was used consists of: address points, parcel, fire protection districts, fire stations, water features, roads of various detail, and other important base layers. Since the FPD of North Fork in southern JeffCO has been changed and now extends into Douglas County, that change is now reflected in the data used for analysis and maps. A data exchange was established and the data from Douglas, Clear Creek, and Park counties have been obtained so a perimeter of 5 miles outside the county can be observed. Boulder County makes much of their data available for downloading on their website so that has been
collected as well. See the Data Dictionary in Table 1 below for the full reference information for GIS data layers.

The Data in Table 1 is a list of the basic information necessary for this development of the needed CWPP’s for JeffCO. By looking at past CWPP creation from Walsh Engineering and analyzing the new 2009 standards, the current CWPP’s must meet these standards to be signed. (Colorado State Forest Service Minimum standards for Developing Community Wildfire Protection Plans, per Colorado Senate Bill 09-001, 2009).

**Table 1: Data Dictionary for JeffCo CWPP**

<table>
<thead>
<tr>
<th>Map Layers</th>
<th>Data Type</th>
<th>Source</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streams</td>
<td>polyline</td>
<td>JeffCO SDE</td>
<td>Critical overview information</td>
</tr>
<tr>
<td>Firefighting water sources</td>
<td>points</td>
<td>Walsh Chief's</td>
<td>Digitized or Geocoded for each region then merged</td>
</tr>
<tr>
<td>Airports</td>
<td>points</td>
<td>JeffCO SDE</td>
<td>Critical overview information</td>
</tr>
<tr>
<td>Roads</td>
<td>polyline</td>
<td>JeffCO SDE</td>
<td>Critical overview information</td>
</tr>
<tr>
<td>Fire Protection Districts</td>
<td>polygon</td>
<td>JeffCO SDE</td>
<td>Critical overview information</td>
</tr>
<tr>
<td>Fee Stations</td>
<td>points</td>
<td>JeffCO SDE</td>
<td>Critical overview information</td>
</tr>
<tr>
<td>Addresses: JeffCO</td>
<td>points</td>
<td>JeffCO SDE</td>
<td>Critical overview information</td>
</tr>
<tr>
<td>Addresses: Jefferson CO</td>
<td>points</td>
<td>JeffCO SDE</td>
<td>Critical overview information</td>
</tr>
<tr>
<td>Managed Land State</td>
<td>polygon</td>
<td>JeffCO</td>
<td>Keep separate due to wildly different attributes</td>
</tr>
<tr>
<td>Managed Land County</td>
<td>polygon</td>
<td>JeffCO</td>
<td>Keep separate due to widely different attributes</td>
</tr>
<tr>
<td>Documented Historic Fires</td>
<td>polygon</td>
<td>USGS and JeffCO</td>
<td>Merged and combined attribute tables</td>
</tr>
<tr>
<td>Wildfire Behavior Fuel Model</td>
<td>raster</td>
<td><a href="http://www.landfire.gov/">http://www.landfire.gov/</a></td>
<td>Symbolized and displayed</td>
</tr>
<tr>
<td>Specific Look at FBFM TU5</td>
<td>raster</td>
<td>JeffCO Fire Modeling/Rocco Snart</td>
<td>Incomplete: needed to visualize WF potential</td>
</tr>
<tr>
<td>Lightning Point Density</td>
<td>points</td>
<td>USGS Kernel Density of Point Data</td>
<td>Highlighting areas of high concentration</td>
</tr>
<tr>
<td>WUI - Wildland Urban Interface</td>
<td>polygon</td>
<td>Walsh CWPP’s and JCD (self digitizing)</td>
<td>Compiled from previous plans and current plans, all attribute tables and data are matched to plan attributes</td>
</tr>
</tbody>
</table>
Model Data and Research Methodology

The study area is Jefferson County with a 5 mile buffer extending beyond the county borders. This buffer amount was chosen so that areas within a range could be evaluated and weight given to areas that could affect locations within Jefferson County. Many of the layers in the Jefferson County GIS SDE are clipped to the Jefferson County boundary so those layers are displayed as such. The WUI boundaries, lightning point data, and the LANDFIRE fuels layer were cut to the 5 mile buffer so that these areas outside the county could be better analyzed.

Infrastructure Features

Infrastructure Overview: Appendix C Map 2
Water Features: Natural and Man Made: Appendix C Map 11
Historical Sites: Appendix C Map 13
Fire Facilities: Appendix C Map 11

These maps were created using information readily available in the Jefferson County maintained SDE. The features were imported and displayed using ArcGIS and then exported to jpegs. Each of these maps contains very important information for Fire responders, planning officials, and the general public alike. They provide access, road, natural water, historical sites, and fire facilities information for anyone who might be affected by a wildfire.

Other Essential Features

WUI Boundaries: Appendix C Map 3

The features existed in the previous CWPP projects, but before this project they had never been combined into comprehensive county wide feature sets. The man-made
water availability features had wildly different attributes. These were standardized based upon the available information and from past CWPP documents and then merged using the ArcToolbox tools. The WUI layers were combined similarly but the hazard attributes were retrieved from past CWPP documents and then merged. These were then displayed for the Countywide CWPP development process as seen in the maps in Appendix C.

**Lightning Potential Kernel Density: Appendix C Map 5**

This point vector data was made available as a joint effort between Douglas County, Jefferson County and the USGS. The data consists of about 225,000 points that represent the capture of latitude, longitude, and amplitude of cloud to ground strikes from 1990 – 2009. The ArcToolbox Spatial Analyst tool Kernel Density was then used to find the areas that had the highest concentrations of strikes over this 20 year period. This information is important because the resulting data can then be used to determine areas of high density and viewed in conjunction with other factors to determine areas of highest Fire Ignition Propensity.

**Elevation and Slope: Appendix C Maps 9 and 10**

For the mapping and analysis methodology, Digital Elevation Models (DEM’s) were used to create Aspect and Slope maps using the Spatial Analyst extension in ArcGIS 9. The SDE had a 10 Meter DEM, but it only extended to the Jefferson County boundary and a 30 Meter DEM was obtained from Douglas County and that was used instead. The 30 meter data extended beyond the Jefferson County boundary and is comparable to the LANDFIRE Data spatial accuracy of 30 Meter pixels. This is useful because the information that fire planning officials need extend beyond the county line.
Having this information can be beneficial to determine areas just to the west of Jefferson County that could have conditions that would allow for catastrophic wildfire spread into the county.

**Fuel Model TU 5 crown fire potential Kernel Density:** Appendix C map 7

Fuel models are of particular importance in establishing broad based analysis of catastrophic wildfire potential due to the fact that there are certain fuel models that can propagate ground fire to crown fire. Timber Understory 5 (TU5) is one of these fuel models that can be essential to these fires along the Front Range. Also slope angle or percentage can play a role in fire propagation. Starting with a DEM a slope percentage map was created. Then the TU5 fuel model was queried out selecting all pixels in the FBFM 40 raster layer. Those selected features were exported to their own raster. Then the Slope raster layer was queried for all slopes with greater than 20%. Those were exported as well. Then all pixels were selected that had the two features in common, TU5 and slope greater than 20%. These pixels in the raster were then exported to vector points. This layer was then analyzed using the Kernel Density tool in the Spatial Analyst extension in ArcGIS 9.3.1. The results were displayed with address locations from the Jefferson County GIS SDE.

**Fire Spread Potential:**

Fire Spread Potential analysis programs will be used to create fire analysis of the county, such as FLAMMAP3. These programs demonstrate the potential for fire given the fuels data as well as aspect, slope, elevation, fuel model, canopy cover, stand height, crown bulk density, and crown base height. Weather data is then added and can be given
a static weather condition or one that varies; file for input. These programs have the ability to analyze fire potential as well as possible rate of spread, but for the purpose of the CWPP, they will be used to create 50 and 90th percentile projections for moderate and worst case scenarios. These will be compared to known places of inhabitation in the WUI to visualize potential selective cutting recommendations for the neighborhoods in the future, but for now is another factor in determining areas that could be a problem in an active wildfire event.

Step 1: Import each of the needed Zones (27, 28, 33) for each file: DEM, fuel model, Canopy Cover, Stand Height, Crown Bulk Density, and Crown Base Height.

Step 2: Combine each of these Zones for each Raster File type and then export the Raster clipped to the 5 mile buffer of Jefferson County

Step 3: Convert each of the clipped Raster files to ASCII so that it can be used in FLAMMAP3
Step 4: Open FLAMMAP3 and create a landscape (.lcp) file importing each of the needed layers (see image below)

Figure 1. Step 4 in FLAMMAP3
Step 5: Save the landscape file and make sure all the settings are correct for units and options.

Figure 2. Step 5 in FLAMMAP3
Step 6: Import the Weather (.wtr), Wind (.wnd), and Fuel Moisture (.fms)

Note: Weather and Wind files are created to represent normal (50%) and extreme conditions (90%). The same fuel moisture file was used for both runs of 50th and 90th percentile.

Figure 3. Step 6 in FLAMMAP3
Step 7: Choose your Fire Behavior Outputs (rate of Spread, Flame Length, and Crown Fire Activity) and Crown Fire Calculation Method (Scott/Reinhardt 2001)

Figure 4. Step 7 in FLAMMAP3
Step 8: Results are then completed and the two different runs can be compared for each type of product produced. Each of these is color ramped based upon the default color ramp established in the FlamMap3 parameters for that particular file, this can be seen below in Figure 5. These layers can then be exported from FlamMap3 in ASCII format to ArcGIS 9.3.1 and re-symbolized.

Figure 5. Step 8 in FlamMap3

Field Data

Although for a project of this size, there can be a sizable amount of data gathering required, very little field data gathering has been necessary for this project. The major part has been traveling to the various communities within the fire protection district and evaluating the hazard rating for WUI boundaries based upon various requirements listed in the following section.
Much of the data has been available from Jefferson County, Past CWPP development efforts, and other County, State, and Federal Agencies. By networking with the various agencies, this data has been gathered and disseminated for useful information. This information has been included with the final countywide maps in Appendix C and be found on the Jefferson County website.

The wildland-urban interface boundaries are drawn to encompass as much of a community housing density as possible. These properties and buildings are evaluated based upon the descriptors in the NFPA 1144 form and given a rating. When mitigation projects start in a particular area (after the completion and not necessarily in conjunction with the CWPP development), ground-truthing recommended fuels treatments from the CWPP will be necessary. This will include such things as: generating community and landowner interest for the project, then determining if the topography is too appropriate for treatment using conventional methods such as hand cutting and mastication. If community interest is present then identification of proposed landowners will need to be compiled and site visits will be necessary to analyze the variables on the ground.

**Time Table**

The North Fork FPD CWPP was signed on March 8th, 2011 and the Elk Creek CWPP update was signed on June 21, 2011. The core team met and formalized the needed last changes prior to the final signing. The Golden Gate FPD update will be signed in August of 2011. Completion for the JeffCO CWPP is set for September 2011. Some basic maps of current and needed data have been plotted and modifications are taking place at the same time as the developments within the FPD are mentioned above.
The base of the needed mapping has been completed as of the end of June 2011. Fire potential mapping, in the form of Flame Length maps, will be developed using the program; FLAMMAP3 and should be completed sometime in early August 2011. These Flame Length maps will give a more broad view of areas within the county that could pose potential dangers in the event of fire on the landscape or when weather could enable a small fire to turn into something larger. Identifying these areas is essential to better understanding the landscape in which the officials in Jefferson County must serve its people.

Deliverables for Completion of the CWPP’s

North Fork CWPP

The North Fork Fire Protection District’s Community Wildfire Protection Plan has been completed and is a document of about 50 pages with corresponding overview maps of the entire area, as well as inset detailed maps of areas within the FPD. These communities consist of recommended fuel breaks to protect the populated areas from catastrophic wild fires. They also consist of: topographic information, basic infrastructure like roads and water features, as well as address points and larger planned fuel mitigation on USFS, CSFS, and Denver Water land. See Map 13 in Appendix C. The document can also be downloaded here.

Elk Creek and Golden Gate Updates

The Elk Creek updating of mapping began in February 2011 and was signed June 15th. Golden Gate preliminary mapping efforts have been completed and the CWPP
document is in production and in the final stages of completion as of July 2011. The preliminary expected document and mapping completion is the first week of July. These are updates to the past Anchorpoint documents and will be completed with the newest guidelines in mind. By updating these documents, the newest changes are reflecting population change as well as new roads and if there is a change in fuels due to mitigation. The newest data have been gathered and will be included with these new plans. New recommendations will be included in the plan as well as current employees of each FPD have been included in the process as much as possible to ensure that it is a usable document for local officials.

**County wide CWPP**

This document will be completed by September 2011. The necessary mapping is in full swing and many preliminary mapping products have been produced (See Map 1-10 in Appendix C). By compiling the various layers from all previous FPD CWPP's then the county wide layers are created for an efficient County wide CWPP that has the most up to date information and reflects the needs of County Officials. These layers will then be made available to the needed officials so that mitigation efforts can be made prior to a disaster and essential resources can be easily accessed during an event.
Conclusion

CWPP’s are intended to be living documents and maps that can be referenced for mitigation, and emergency response as mandated by the State of Colorado in Colorado Senate Bill 09-001 of 2009 and in conjunction with the HFRA of 2003. These maps developed by spatial analysis of relevant datasets along with suggested fuel breaks in the various neighborhoods will serve to better prepare the stakeholders within the respective FPD’s as well as with the Jefferson County Emergency Operations Center. The information contained within these maps and documents is meant to give a quick and accurate description of the various conditions in the areas highlighted as well as some basic fuel mitigation recommendations. These will serve as recommendations for Jefferson County and the WUI communities therein. They are available for any of the general public to view and generate discussion for project implementation at each community’s convenience. The main goal of these Community Wildfire Protection Plans are to have the basic building blocks in place for needed mitigation work as well as emergency response in worst case scenarios in order to protect life and property.
Cited


Douglas County CWPP website (date accessed: May 2011) <http://www.douglas.co.us/CWWPP/index.htm>

Firewise Communities (date accessed: May 2011) <http://www.firewise.org/>


HFRA (date accessed: May 2011) <Healthy Forests Restoration act (HFRA) of 2003>

JeffCO, Colorado CWPP link page, Last Modified, July 1 2010 <http://www.jeffco.us/sheriff/sheriff_T62_R193.htm>

JeffCO, Colorado Demographics Maps and Statistics, Last Updated April 15 2010 <http://www.co.jefferson.co.us/planning/planning_T59_R37.htm>


National Interagency Fuels, Fire, and Vegetation Technology Transfer (NIFFT)


http://www.orw.org/B&B_Complex/Policy/HFRA_2003/
http://www.azsf.az.gov/UserFiles/PDF/SitgreavesCWP.pdf
Appendix A: List of Terms and Abbreviations

CWPP – Community Wildfire Protection Plan
FPD – Fire Protection District
FBFM – Fire Behavior Fuel Model
WFDS – Wildland-Urban Interface Fire Dynamics Simulator
WFDSS – Wildland Fire Decision Support System
SDE – Spatial Database Engine
ESRI – Environmental Systems Research Institute
GIS – Geographic Information Systems
WUI – Wildland-Urban Interface
RAW S – Remote Automated Weather Stations
CUSP – Coalition for the Upper South Platte
JFSP – Joint Fire Sciences Program
USFS – United States Forest Service
CSFS – Colorado State Forest Service
USGS – United States Geologic Survey
JeffCO – Jefferson County
JCD – Jefferson Conservation District
Appendix B: Acknowledgements

Jefferson County Emergency Management
   Rocco Snart
   Carole Small
   Tim McSherry

Jefferson County GIS Department
   Barbara Morey
   Calli Broom e

Jefferson Conservation District
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   Joseph Hansen

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   Craig Barraclough

Douglas County GIS
   Jill Alexander
   Josh Keown
   Mark Rankin

University of Denver
   Heather Hicks
   Steve Hick

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   Matt Schweich
   Kevin Zimlinhaus
   Dennis W Cleary

Colorado State Forest Service
   Collin Wassink

United States Geological Survey/Rocky Mountain Geographic Science Center
   John D Guthrie
Map 2: Infrastructure Overview

Infrastructure Overview Map
Jefferson County, Colorado CWPP

Legend
- 5 Mile Buffer
- JeffCO Major Bridges
- JeffCO Railroad
- JeffCO Powerline
- JeffCO Major Streets
- Colorado County Boundary
- World Shaded Relief

Data Source:
Scott Fitzgerald

Data Details:
World Shaded Relief by ESRI
County Data from GIS Data Depot

Jefferson County SHERIFF
Emergency Management
Map 3: Wildland Urban Interface delineation Combined Base Map

Legend
Wildland Urban Interface Hazard Class
- Extreme
- High
- Moderate
- Low
- In Progress
- 5 Mile Buffer
- Colorado County Boundary
- World Shaded Relief

Map By: Scott Fitzgerald
Map Date: WUI data from past NLESH engineering plans and 2011 updates World Shaded Relief by ESRI archive County Data from GIS Data Depot
Map Details: NAV 52 13W 1:207,000 APR 2011
County: Wildfire CWPP project in conjunction with the Jefferson Conservation District and Jefferson County Emergency Management

All WUIs were combined from past Walsh plans as well as the North Fork plans and the Golden Gate and Elk Creek updates of 2011. The hazard ratings were all entered from the past plans and new hazards ratings following the terms, losses, and hazards.

Jefferson County SHERIFF
Emergency Management

1 in = 2 miles

Fitzgerald 34
Map 5: Lightning Point pattern analysis map

Lightning Base Map
Jefferson County, Colorado CWPP

Legend
Lightning Density, 1990 - 2009

- 0 - 30,000
- 30,000.00001 - 40,000
- 40,000.00001 - 50,000
- 50,000.00001 - 70,000
- 70,000.00001 - 98,024.27344
- 5 Mile Buffer
- Colorado County Boundary
- World Shaded Relief

Map By: Scott Fitzgerald
Map Data:
- Lightning Data provided by: John D. Gutknecht, USGS
- Jefferson County Data Center: GIS Center
- County Data from GIS Data Depot

Map Details:
- NAD 83 UTM
- June 2011
- Jefferson County CWPP project in cooperation with the Jefferson County Sheriff’s office and Jefferson County Emergency Management

Jefferson County Sheriff’s Office
Emergency Management

1 in = 2 miles

Fitzgerald 36
Map 7: Fuel Model TU5, Slope over 20%, and proximity to Address Points

Fuel Model TU5, Slope 20+, Address Points
Jefferson County, Colorado CWPP

Legend
- 5 Mile Buffer
- Colorado County Boundary

Fuel Model TU5 KD and Slope of 20+
Kernel Density
- 0 - 0.000006569
- 0.000006569 - 0.000003157
- 0.000003157 - 0.000001805
- 0.000001805 - 0.0000008275
- 0.0000008275 - 0.00000032844
- 0.00000032844 - 0.000000195442
- 0.000000195442 - 0.000000095918
- 0.000000095918 - 0.00000005255
- 0.00000005255 - 0.000000026275

- JEFFCO Master Address
- Clear Creek County Address
- Park County Address
- Douglas County Address
- Unknown Shaded Relief

Map Data:
- 2007 data from LandInfo
- Jefferson County address data from JEFFCO SIDC
- Clear Creek County address data from Clear Creek County GIS
- Park County address data from Park County GIS
- Douglas County address data from Douglas County GIS
- OTHER: County data from OGS Data Depot

Map Credits:
- NAD 83 129

Map created for the Jefferson County CWPP project in conjunction with the Jefferson County Commissioners and Jefferson County Emergency Management.

TU5 was exported out of NPSMID layer and then a steep cut was done to match the TU5 points that were 25-degree slope. A Kernel Density was then run on those points (after converting to points).
Map 12: Water features, natural and man made

Water Features Map
Jefferson County, Colorado CWPP

Legend
- Various Water Sources (man made)
  - JeffCO Hydrology
  - 5 Mile Buffer
  - Colorado County Boundary
  - JeffCO Lake
  - World Shaded Relief

Map By: Scott Fitzgerald
Map Data:
- All Natural Water Data from JeffCO GIS
- All Man Made water data from all combined CWPP's
- World Shaded Relief by DBR Images
- County Data from CG Data Depot

Map Details:
- NACO 5013
- June 2013
- County Wide CWPP project in conjunction with the Jefferson Conservation district and Jefferson County Emergency Management

1 in = 2 miles

Jefferson County SHERIFF
EMERGENCY MANAGEMENT
Map 15: Map created for Elk Creek CWPP which includes hazard ratings
Form 1 Community Hazard Assessments NFPA 1144
(Form from Current (2011) CWPP development for Jefferson County, by Robin Keith)

1144 Field Form Example (left blank):

<table>
<thead>
<tr>
<th>Community Name:</th>
<th>Overall Rating:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value Points Assigned</td>
</tr>
</tbody>
</table>

### A. Means of Access

<table>
<thead>
<tr>
<th>1. Ingress and Egress</th>
<th>Value Points Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 or more roads in &amp; out</td>
<td>0</td>
</tr>
<tr>
<td>One road in &amp; out</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Road Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 24 ft</td>
</tr>
<tr>
<td>≥ 20 - 24 ft</td>
</tr>
<tr>
<td>&lt; 20 ft</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. All-Season Road Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surfaced Road, grade &lt;5%</td>
</tr>
<tr>
<td>Surfaced Road, grade &gt;5%</td>
</tr>
<tr>
<td>Non-Surfaced Road, grade &lt;5%</td>
</tr>
<tr>
<td>Non-Surfaced Road, grade &gt;5%</td>
</tr>
<tr>
<td>Other than all-season</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Fire Service Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 300 ft with turnaround</td>
</tr>
<tr>
<td>&gt; 300 ft with turnaround</td>
</tr>
<tr>
<td>≤ 300 ft with no turnaround</td>
</tr>
<tr>
<td>&gt; 300 ft with no turnaround</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Street Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present (at least 4&quot; and reflective)</td>
</tr>
<tr>
<td>Present (small or non-reflective)</td>
</tr>
<tr>
<td>Not Present</td>
</tr>
</tbody>
</table>

### B. Vegetation (Fuel Models)

<table>
<thead>
<tr>
<th>1. Characteristics of predominant vegetation within 300 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light: 1, 2, 3</td>
</tr>
<tr>
<td>Medium: s, b., s, m</td>
</tr>
<tr>
<td>Heavy: 4, 10</td>
</tr>
<tr>
<td>Slash: 11, 12, 13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Defensible Space (vegetation treatment from the structure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 100 ft</td>
</tr>
<tr>
<td>1 - 100 ft</td>
</tr>
<tr>
<td>31 - 70 ft</td>
</tr>
<tr>
<td>≤ 30 ft</td>
</tr>
</tbody>
</table>

### C. Topography within 300 ft of Structures

<table>
<thead>
<tr>
<th>1. Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 9%</td>
</tr>
<tr>
<td>10 - 20%</td>
</tr>
<tr>
<td>21 - 30%</td>
</tr>
<tr>
<td>31 - 40%</td>
</tr>
<tr>
<td>&gt; 41%</td>
</tr>
</tbody>
</table>

### D. Additional Rating Factors (rate)
### Additional factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Points Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topographic features adversely affect fire behavior</td>
<td>0 - 5</td>
</tr>
<tr>
<td>Areas with a history of high fire occurrence (high ignition potential)</td>
<td>0 - 5</td>
</tr>
<tr>
<td>Severe fire weather potential</td>
<td>0 - 5</td>
</tr>
<tr>
<td>Separation of adjacent structures contributing to fire spread</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>

### E. Roofing Assembly

<table>
<thead>
<tr>
<th>Roofing Materials</th>
<th>Points Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A (asphalt, clay, concrete, slate, metal)</td>
<td>0</td>
</tr>
<tr>
<td>Class B (fire-resistance rating that indicates roofing materials are able to withstand moderate exposure to fire originating from sources outside the building)</td>
<td>3</td>
</tr>
<tr>
<td>Class C (fire-resistance rating that indicates roofing materials are able to withstand light exposure to fire originating from sources outside the building)</td>
<td>15</td>
</tr>
<tr>
<td>Nonrated</td>
<td>25</td>
</tr>
</tbody>
</table>

### F. Building Construction

1. **Materials**

   - Noncombustible/fire-resistant siding, eaves, and deck: 0
   - Noncombustible/fire-resistant siding only: 5
   - Combustible siding and deck: 10

2. **Building setback from slope of ≥30%**

   - ≥ 30 ft to slope: 1
   - < 30 ft to slope: 5

### G. Available Fire Protection

1. **Water Source Availability**

   - Pressurized hydrants
     - 500 gpm hydrants ≤1000 ft apart: 0
     - 250 gpm hydrants ≤1000 ft apart: 1
   - Nonpressurized water sources (off site)
     - ≥ 250 gpm continuous for 2 hours: 3
     - ≤ 250 gpm continuous for 2 hours: 5
   - Water Unavailable: 10

2. **Organized Response Resources**

   - Station 5 miles or less from structure: 1
   - Station > 5 miles from structure: 3

3. **Fixed Fire Protection**

   - NFPA 13, 13R, 13D sprinkler system: 0
   - None: 5

### H. Placement of Gas and Electric Utilities

1. aboveground/underground
   - Both underground: 0
   - One underground, one aboveground: 3
   - Both aboveground: 5

### I. Point total for home or subdivision

- <40 = LOW
- 40 = MODERATE
- 70 = HIGH
- >112 = EXTREME
(This particular NFPA 1144 was created by Robin Keith in the North Fork CWP for JeffCO Colorado), another similar form can be found here:
http://www.firescape.us/NFPA1144.pdf)
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