Guidelines for Fire Hazard Zoning Review and Validation

1. Background

CDF is legally mandated to periodically map Fire Hazard Severity Zones (FHSZ) Reference:D:\FHSZ\FHSZ_review_instructionsv1227.docon SRA lands, as well as recommend Very High Fire Hazard Severity Zones in LRA. New building code standards recently promulgated by the State Fire Marshall have established these maps as the basis for adoption of these new regulations. Under direction by the Director of CDF, the Fire and Resource Assessment Program (FRAP) has developed a statewide, consistent logic and science-based model for Fire Hazard Zoning to meet the needs of the adoption of these new building standards.

Ongoing information and support documents for the review can be found at www.frap.cdf.ca.gov/fhsz/review.html

2. Definitions

We follow definitions and terminology recently advanced for using classic quantified risk assessment techniques for use in wildland fire assessment as found in Bachmann and Algöwer 2000, and Scott 2006. Here, **hazard** refers to the physical conditions that can lead to damage, and **risk** is a quantified assessment of that potential damage. Wildfire hazard has two key components: probability, and fire behavior. The FHSZ modeling outlined here and employed in the maps uses these two components to describe hazard, but has no information regarding asset or resource characterization nor their relative vulnerability to damage as based on the hazard score. A good way of viewing this issue is to consider fire hazard to only be concerned with the nature of the fire itself: how often we believe an area will burn, and when it does burn, what kinds of potential ignition mechanisms will that fire create such that exposure to buildings may lead to to the structure being damaged/destroyed. Thus hazard does not equal risk, but is an important factor in determining risk. Ongoing work at true quantified risk assessment must include hazard, asset characterization, and response (damage) relationships of various assets to the mixture of fire behaviors it will be exposed (Scott, 2006)

The other key definitional element associated with this work concerns the term “zone”. We interpret wildfire hazard zones to be areas of relatively homogeneous burn probabilities and associated fire behavior mechanisms that drive structure ignitions. Consequently zones differ from highly resolved spatial characterization of fire behavior in that they are aggregated or averaged over space into zones of user-defined sizes. In the following FHSZ modeling, zones vary in sizes from 20 acre minimums in urbanized areas to 200 acre minimums in wildland areas.

In summary**, wildfire hazard zones represent *areas of variable size ranging from 20 acres in urbanized areas to at least 200 acres in wildland areas, with relatively homogeneous characteristics regarding expected burn probability and potential fire behavior attributes based on climax fuel conditions over a 30-50 year time horizon*.**

3. Model Construction

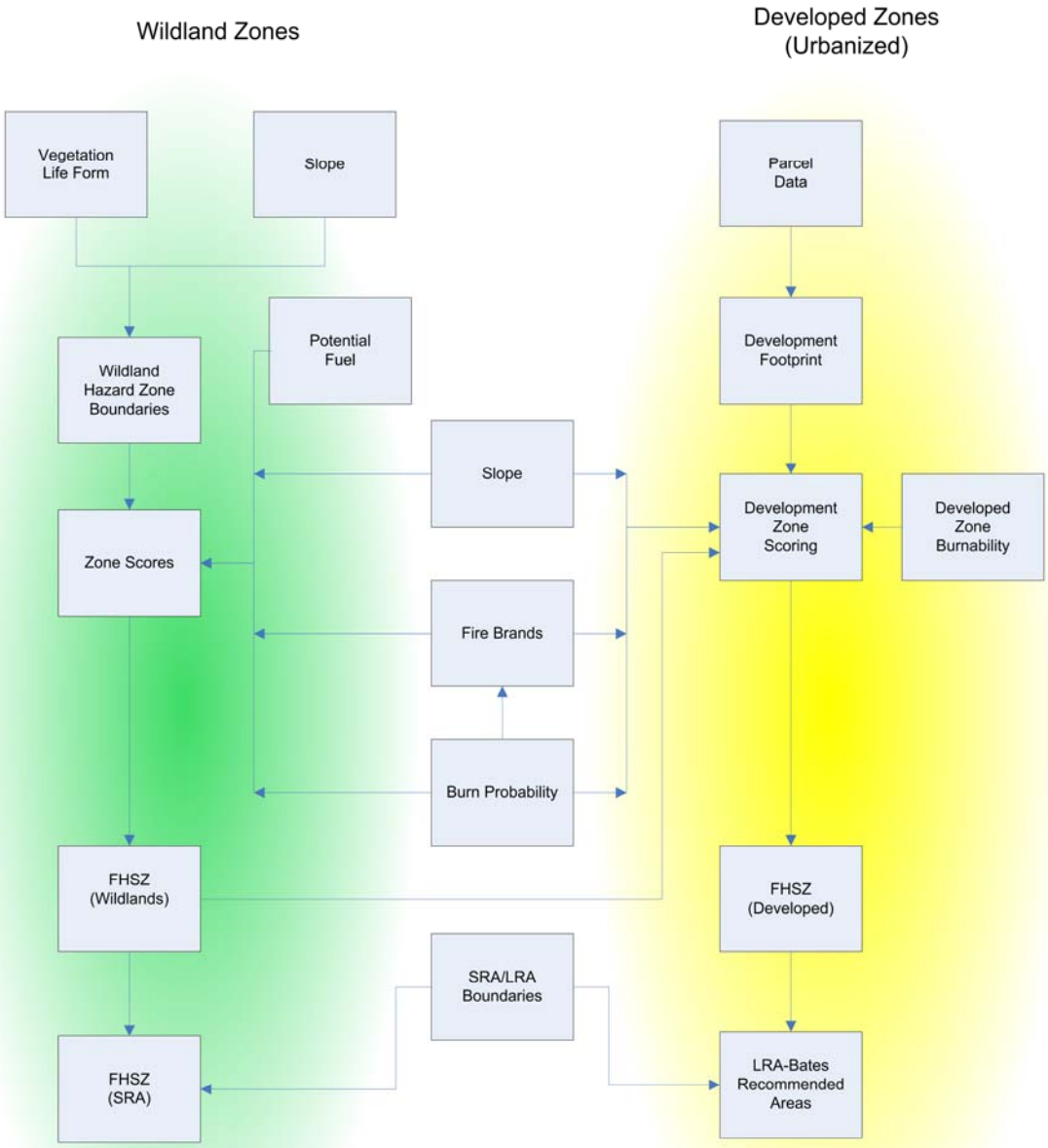
A simplified flow-chart of the principle steps in FHSZ mapping is shown in Figure 1. The basic procedure follows a zone creation-scoring-classification routine where zones are differentiated into wildland and urban/developed areas.

A) ZONING

Zoning is divided into urban/developed and wildland areas due to the unique characteristics of urbanized areas where classic wildland fire assessment tends to break down. In the wildland areas, expected fire behavior is a function of the typical fire intensity expected on a normally severe fire weather day, inclusive of expected firebrands landing in the zone, coupled with the expected likelihood that the zone will burn as based on a stratified calculation of burn probability calculated from the last 50 years of fire history. Wildland zones are aggregated into polygons with a minimum size of 200 acres based on general vegetation type and slope conditions.

Urban/Developed zones are based on parcel data (where available) in conjunction with 2000 census data and the existing urban footprint found in the most recent multi-source statewide vegetation map data available at FRAP. The criteria are based on concentrations of development where minimum size of area (20 acres) and maximum size of residential parcels (2 acres) is designed to find areas where significant changes in the drivers for hazard change as a reflection of urbanization: fuel discontinuity, non-wildland fuels, increased detection and suppression response, etc. The net effect is to define areas where existing modeling techniques designed for wildlands do not effectively work.

FIRE HAZARD SEVERITY ZONING
MODEL STRUCTURE



B) SCORING/CLASSIFICATION

The Fire Hazard Zone model uses expected potential fire behavior in conjunction with burn probability to assess hazard. Wildland Zones are relatively uniform areas regarding slope and potential fuel type that represents the maximal fire hazard. Assessment of fuel conditions for this process differ from many hazard assessments in that the model may differ from current conditions due to the desire to reflect hazard potential over a long (30-50 year) horizon. Consequently, fuel characterization uses a "climax fuel" construct, to reflect the maximal fire hazard the area might produce during this period. Burn probability acts as fire behavior multiplier and as such exerts strong influence on scoring. Cell-based fire behavior reflecting nearby radiation and flame-contact potential is based on expected flame length times burn probability that is then classified into three classes.

Firebrands are produced from sites based on surface fire or torching potential of forested fuel types and produce a halo of area where brands are received. Each cell in the data set is calculated for its sum of all brand scores received, which then forms the basis for the final brand 3-class data that together with flame class forms the basis of the final FHSZ class score.

In contrast, urban zones as classified based on the wildland hazard adjacent to the developed area, the vegetation density and fuel type in the developed area, and the likely zone of influence of firebrands coming from wildland and densely vegetated urban areas supporting woody vegetation. Both inputs to the model and the final product have been extensively cross-checked against recent (2005) full color aerial photography as a means of ground check. Analogous 3-class flame and brand class components are used for final FHSZ classification. Where counties have made parcel data available to CDF, final boundaries between rankings in wildland areas are adjusted to result in no parcels less than 5 acres having more than one ranking, and all rankings in developed areas are resolved at the individual parcel scale (i.e., no parcels are split amongst two or more hazard ranks). In cases where no parcel data is available, the maps have no rectification with parcel boundaries, and will require review and judgment regarding appropriate designation in cases where parcels are split.

4. Map Review

Map review can be conducted via either reviewing a paper map or by using the GIS data provided. In both instances, the design is to solicit areas where the existing daft map appears to be either wrong or confusing, highlight those areas, and provide a recommended score and justification for the change. The GIS option allows considerably more information to be assessed and consequently is the preferred method for developing field inputs into a final product. In both

cases, please use all available information, including the information provided in this document to make sound recommendations.

To assist in the review process please review the FHSZ class descriptions given in Appendix A. For each polygon, give both the current and recommended FHSZ classes (1,2,3). Other basic elements to consider include:

- Potential fuel type (brush, grass, woodland, conifer)
- Vegetation fuel density and continuity in developed zones
- Slope or key terrain features (e.g., chimneys)
- General pattern of fire occurrence in the area (low, medium, high)
- Distance to wildland fuel areas (if in developed zone)
- Distance to fuels capable of producing significant firebrands
- An accompanying photo highlighting fuel/terrain conditions
- Any other pertinent information you feel is relevant to the hazard classification

GIS-based map review procedures

We have provided a data system and ARCVIEW project to conduct GIS-review. Workshops will go over these procedures step-by-step, but we encourage an initial review of the procedure prior to the workshop if possible.

Copy the entire FHSZ directory to your root C: drive (or similar workspace).

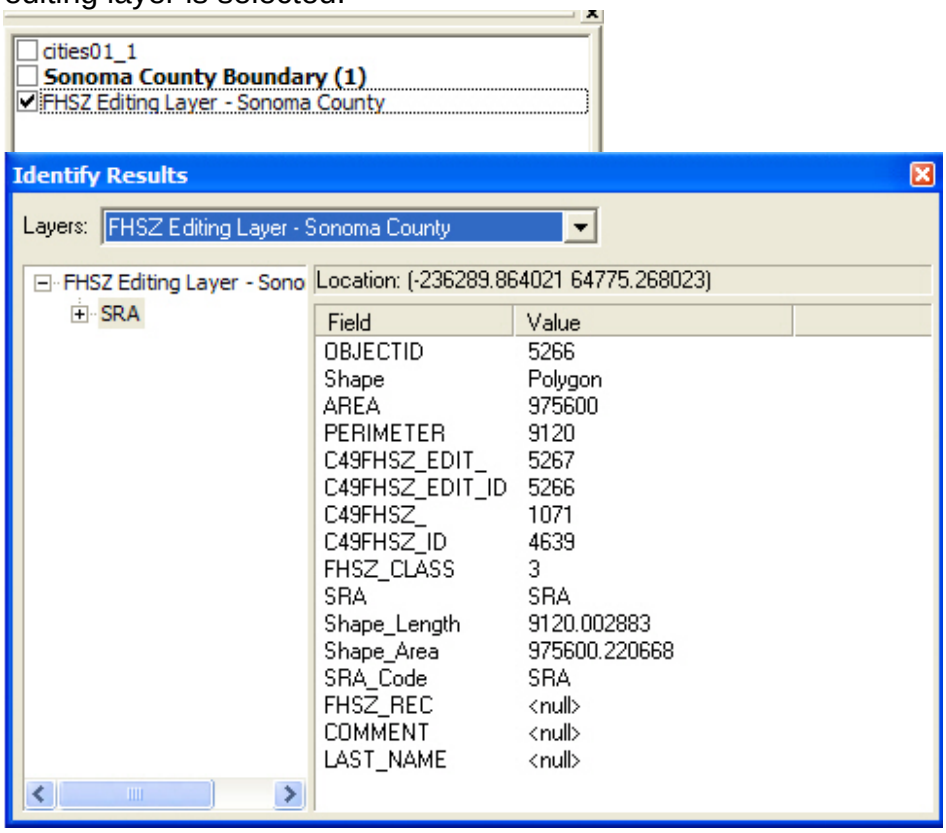
The directory structure contains the following:

Basedata – FIREPLAN shapefiles that may assist with review process
Documents – various documents related to the FHSZ process
Imagery – NAIP Mr. Sid format imagery
Intermediates – the intermediate FHSZ data products (most are GRID format)
Products – pdfs and jpgs of the FHSZ map
Projects – the basic FHSZ editing project
<unit_id>_fhsz.mdb – the fhsz editing geodatabase

Open the **<unit_id>_fhsz_review.mxd** project found under /FHSZ/<Unit_id>/Projects

Verify that your editor toolbar is turned on.

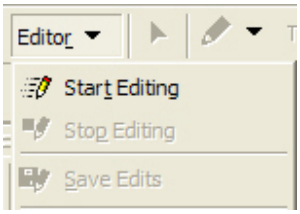
Switch over to the selection tab of your menu…… make sure only the FHSZ editing layer is selected.



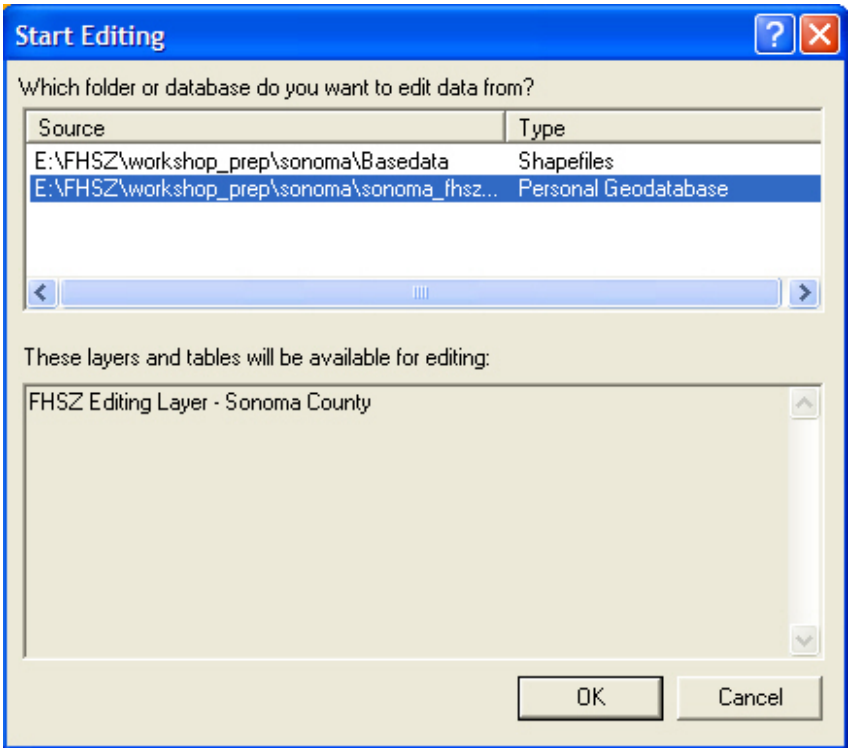
To identify a polygon and verify it's attributes…..

The identify tool 

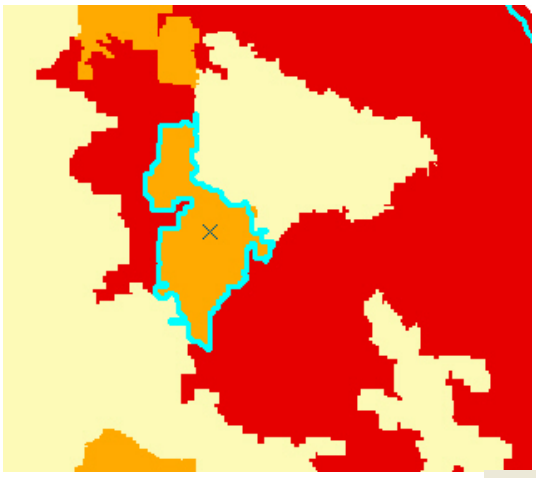
If there is a change that needs to be made to a polygon, start editing the layer.



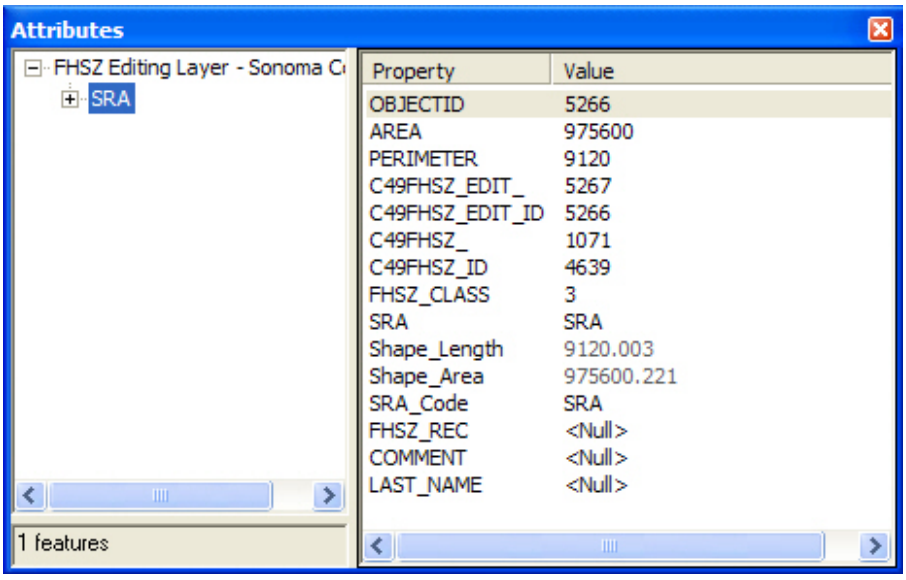
Select the FHSZ_edit geodatabase from the menu.



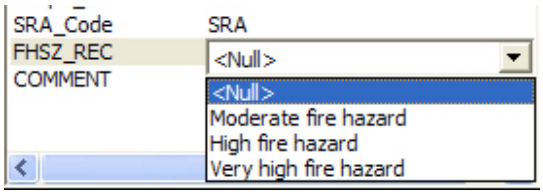
Use either the edit tool  or the selection arrow  to select a polygon of interest.



The edit attribute window button 

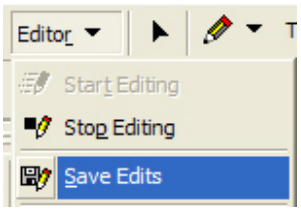


Select the Null field and a dropdown menu will open



For each FHSZ recommendation that you make, you must also include a brief comment and the last name of the person making the recommendation. These comments are designed to provide us with information justifying the change, and as such should reflect information on model building blocks like burn probability and fuel type. Please see the discussion above for more detail

Make sure to save your edits often!!!



Sub-polygon issues

If a particular area of concern encompasses only a portion of an existing edit polygon, we encourage you describe the area in the comment field or draw on a printout of the area, label the polygon for its UNIQUE_ID value, and write comments on the paper and submit with your package. We will attempt to resolve sub-polygon edits in compiling all the review data. Multiple issues with a

single polygons should precipitate interaction between reviewer and FRAP. Please include name and phone number in comment field so discussion can ensue.

Intermediate GIS Product List

The following datasets comprise the principle building blocks of the FHSZ zone model. In parenthesis following the data description is an index **(L = Low; M = Moderate; H = High; V = Variable)** indicating the relative strength of influence of this component on the the final FHSZ class shown in the map. Cell – based data exists for 30 meter raster data, sometimes grouped into zone polygons.

Brand_class (GRID) – Brand class scores – grouped from brand_recpt_p
A zone-based average classification of firebrands **(M).**

Brand_gen (GRID) – Brand codes from whrslope2, but only where the torch index (torch) is 1; these are cells that produce brands **(L)**

Brand_recpt (GRID) – Brand receptivity scores from circular kernel files and probability; an estimate of the relative number of brands likely to impinge on a individual 30 m cell **(L)**

Brand_recpt_p (GRID) – Zone polygons labeled for brand receptivity scores from circular kernel files -- aggregated average of brand_recpt for the entire zone polygon **(M)**

<county#>burnhw (GRID) – Urban footprint with burnability. 4 classes of vegetation density influencing both the relative porosity of fire from adjacent wildlands and the generation of firebrands within the urban footprint. **(V)**

F_prob1 (GRID) – County-wide fire rotation based fire probability layer from 2005 fire data. Estimate of annual probability of individual cell burning. Directly influences cell based hazard score through product with both fire behavior mechansisms (Flame length and brand generation) **(H)**

FR_2006 (GRID) Statewide fire probabilities. Required to understand effects of estimated burn probability, and associated comparisons between counties. As above, but shown for entire state **(H)**

Fbmatrix1 (GRID) – Combined xflame (flame classes) x brand_class for running through the ‘matrix’ fhsz gets calculated here. **(H)**

Fl (GRID) – Cell –based average flame length based on fuel and terrain conditions crossed against two weather scenarios: Flame score is a product of surface, fuel, crown fuel attributes (in fuel systems with trees), slope, and two weather scenarios (both hot and dry, with two wind speeds - 0 and 20 mph @ 20 ft) **(L)**

Flam_class (GRID) – Polygon based wildland flame class grouped from flam_score_p. Data goes into fbmatrix as the flame mechanism and drives the buffer routine into adjacent urban areas **(H)**

Flam_score (GRID) – Pixel based wildland fhsz scores from combined flame length (FL) and probability (f_prob1). A cell-based estimate of the combined flame and burn probability **(L)**

Flam_score_p (GRID) – Polygon based wildland FHSZ score (average per polygon) in raster format. Data is grouped into classes to form Flam_class **(M)**

Fmod (GRID) – Surface fuel model using the new Scott (2005) fuel model set. See the accompanying .chm help file for model descriptions and photos. **(M)**

Torch (GRID) – Areas that will torch trees and loft brands. A function of fire behavior modeling influenced by slope, surface, fuels, and estimated crown fuel characteristics **(M)**

Whrslope1 (GRID) – fe (fire environment) group (poly x slope class combined). Contains both slope and life-form data used to group wildlands into zones **(V)**

Xflame (GRID) – Merged flame_class and flam_urb1 to generate complete flame (surface) score prior to brand score, parcel snap and final eliminates **(H)**

<county#>fhsz (shapefile) – Polygon version of FHSZ – final snapped eliminated polygons with SRA coded. Classfieed FHSZ based on the combined influence of brand class and flame class. See class descriptions for general characteristics typical for each class in both wildland and urban areas **(Final Product)**

Fhsz_urb (shapefile)- FHSZ polygons clipped for urban areas only **(Subset of Final Product)**

Par<county#> (shapefile) – County parcel data **(L)**

4. WORKSHOP/VALIDATION SUBMITTAL

FRAP staff will also be available for one-day workshops to facilitate map review and answer questions about model development. It would be beneficial to have local review of maps by key operational personnel prior to the workshops to identify areas and/or issues of concern in the draft maps.

All comments for review via either map or GIS process are to be submitted to FRAP no later than **3 weeks after the workshop.** Digital data can be uploaded to ftp://frap.cdf.ca.gov/pub/incoming/fhsz_review.
Login ID is ftpuser,
password is frap.

Local Review

Government code authorized final adoption of LRA Bates areas with local political authority (City Council, county Board of Supervisors). We will make every attempt to assist in the resolution of a final product adopted at the local level, but there currently exists no state authority for upward reporting of the final maps adopted for LRA areas. We recommend a flexible process whereby willing and able counties maintain GIS data delivery via their own websites, and other counties desiring the FRAP to post the GIS data from its website inclusive of links to local delivery sites to make the most complete data portal possible. In cases where local agencies do not either report their final adopted maps back to FRAP nor make them available via an open website, map data will be in the form of paper maps at local building offices. We are currently exploring the development of a web-based data delivery system in conjunction with the UC Fire Center designed to not only provide a searchable map function, but also provide additional ancillary data to aid in local review and adoption, and final zone interpretation in the case of appeals. Appeals will be handled through the use of a decision key emulating the maps logic and may result in a modification of code requirements, but will not change the maps.

Questions and comments regarding model development and review and validation procedures can be directed to Dave Sapsis at:
dsapsis@ire.ca.gov
916.445.5369 (o)
916.801.3489 (c)
CDF Fire and Resource Assessment Program (FRAP)
PO Box 944246
Sacramento, CA 94244-2460

Literature Cited

Bachmann, Andreas, and B. Allgöwer. 2000 The need for a consistent wildfire risk terminology. Pages 67-77 In: Vol 1, Proceedings from: The Joint Fire Sciences Conference and Workshop, Boise ID June 15-17, 1999. L. F. Neuenschwander, K.C. Ryan, Tech. Eds. University of Idaho, Moscow ID. Scott

Scott, Joe H. 2006. An analytical framework for quantifying wildland fire risk and fuel treatment benefit. Pages 149-162 In: Fuels Management – How to measure success: Conference Proceedings. USDA, Forest Service Rocky Mountain Research Station Proceedings RMR-P_41. 809 p.

Scott, J.H, and R. E. Burgan 2005. Standard Fire behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model. USDA Forest Serivce Gen. Tech. Rep. RMRS-GTR-153. 72 p.

Appendix A.

FHSZ_class descriptions

Class levels are applied to both wildland and urban/developed areas:

Wildland zones are defined as relatively homogeneous areas 200 ac and larger dominated by native vegetation cover. They may include inholdings of non-burnable types including water, agricultural lands and barren/rock, but the majority of the landscape is covered by natural plant cover.

Developed/Urban zones are areas that have a strong influence of human development, and are characterized by parcel sizes 2 acres or smaller and/or intermingled commercial properties. Contiguous Zones are a minimum of 20 acres in total size, and wildland enclaves within urban areas are also a minimum of 20 acres.

FHSZ_class definitions

Value = 1
Label = Moderate

Either a) **Wildland** areas supporting areas of typically low fire frequency and relatively modest fire behavior. Contributing factors may include a relatively short active fire season and/or low frequency of severe fire weather conditions; modest slope; low incidence of past large and damaging fires; dominant climax fuel types supporting modest surface fire regimes with respect to fire intensity and minimal areas supporting crown fire and associated firebrand development and reception; nearby or interspersed areas supporting non-wildland fuels (agriculture lands, water, rock/barren) may also be present.

Or b) **developed/urbanized** areas with a very high density of non-burnable surfaces including roadways, irrigated lawn/parks, and low total vegetation cover (<30%) that is highly fragmented and low in flammability (e.g., irrigated, manicured, managed vegetation). These areas are classic high density urban residential areas or commercial properties where wildland areas are removed by a large distance (>.5 mile) or if closer, only present modest fire hazards ((see above). If fire was to spread through these zones it would either be isolated and contained due to incidence of firebrands, or resulting from house-to-house ignitions under the most extreme weather conditions.

Value = 2
Label = High

Either a) **wildland** areas supporting medium to high hazard fire behavior and roughly average burn probabilities. Typically characterized by climax fuels from

surface strata only with flat to steep slopes in conjunction with relatively rare fire occurrence influenced by short fire seasons and/or significant moderation of fire weather conditions (e.g. marine influence on fuel moistures), or lesser hazard fuels types subject to more prevalent burn frequencies. Nearby forested areas supporting crown fire are isolated or non-existent. Slopes vary from flat to steep, depending on fuel hazards and burn probabilities.

Or b) **developed/urbanized** areas with moderate vegetation cover and more limited non-burnable cover. Vegetation cover typically ranges from 30-50% and is only partially fragmented. Short-range lateral spotting may breech fuel discontinuities and allow for some areas to spread as a flame front. Areas supporting tree cover should not result in significant torching. Adjacent nearby wildlands (within ¼ mile) are typically High Hazard zones (see above) or if farther away, more typical of Very High Hazard zones (see below). These areas lie midway between classic urbanized areas dominated by homes, roadways, and low flammability vegetation cover, and those developed areas where both surface and crown fuels are dense and continuous.

Value = 3
Label = Very High

Either a) **wildland** areas supporting high-to extreme- fire behavior resulting from climax fuels typified by well developed surface fuel profiles (e.g., mature chaparral) or forested systems where crown fire is likely. Additional site elements include steep and mixed topography and climate/fire weather patterns that include seasonal extreme weather conditions of strong winds and dry fuel moistures. Burn frequency is typically high, and should be evidenced by numerous historical large fires in the area. Firebrands from both short- (<200 yards) and long-range sources are often abundant.

Or b) developed/urban areas typically with high vegetation density (>70% cover) and associated high fuel continuity, allowing for frontal flame spread over much of the area to progress impeded by only isolated non-burnable fractions. Often where tree cover is abundant, these areas look very similar to adjacent wildland areas. Developed areas may have less vegetation cover and still be in this class when in the immediate vicinity (1/4 mile) of wildland areas zoned as Very High (see above).

Value = -2
Label = Urban/non-zoned

Developed areas spatially removed from proximity to wildland fire areas. Urban centers such as city centers ranging from 200 ft to ¾ miles way from wildland zones, where the critical distance allowing for this classification is dependent on the nature of the fire hazards in those wildland areas.

Value = -1
Label = Non burnable open Space

Areas outside State Responsibility Areas (SRA) that are not classified as developed/urban or as a wildland zone, and are typically associated with non-flammable conditions: water, agricultural lands (excluding rangelands) and barren/rock areas. Similar areas within SRA are recoded to the Moderate class per state statute.