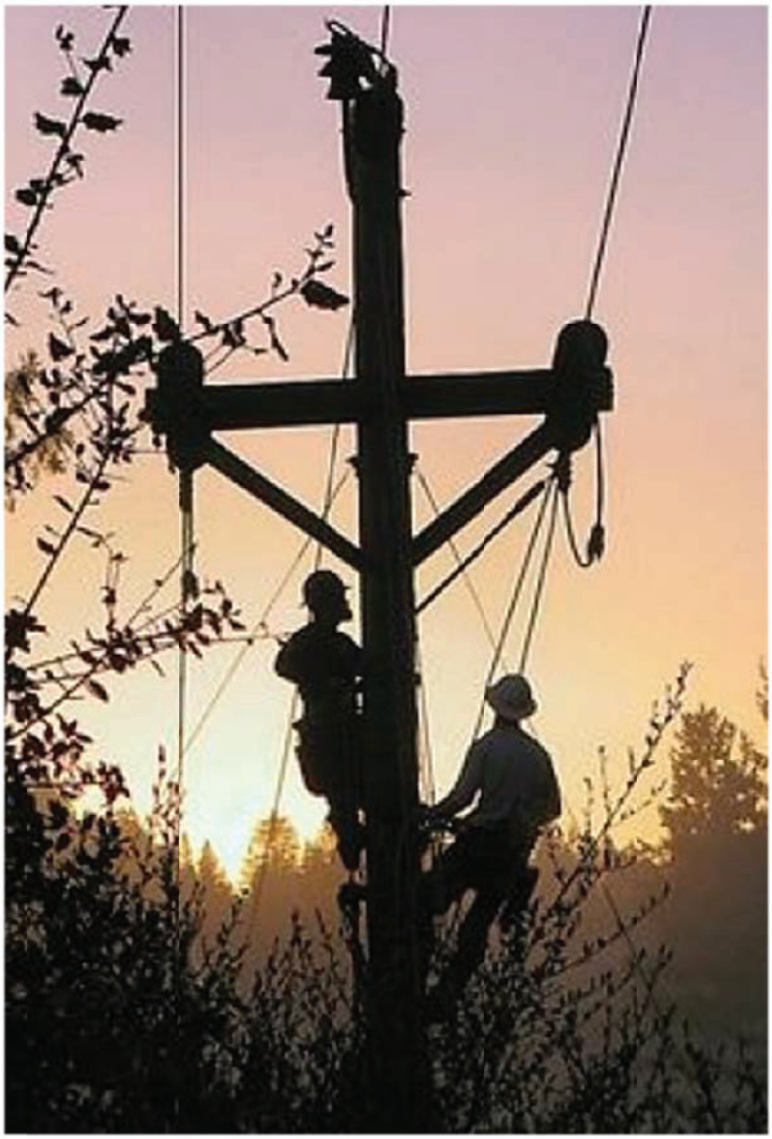

Independent Review Team Final Report on the Production of the California Public Utility Commission's Statewide Fire Map 2

MAP OF UTILITY-ASSOCIATED WILDLAND FIRE THREAT ACROSS CALIFORNIA

Independent Review Team | November 21, 2017

IRT Summary Report on Statewide Fire Map 2 Production
November 21, 2017
Prepared By
Independent Review Team (IRT)

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INTRODUCTION

In October 2007, wildfires driven by Santa Ana winds, burned hundreds of square miles in Southern California. Several of the worst wildfires were reportedly ignited by overhead utility power lines and aerial communication facilities near power lines. In response to these wildfires, the Commission initiated Rulemaking (R.) 08-11-005 to consider and adopt regulations to protect the public from potential fire hazards associated with overhead power-line facilities and nearby aerial communication facilities. The Commission issued several decisions in R.08-11-005 that together adopted dozens of new regulations.[1] Most of the new regulations consist of new or revised rules in General Order (GO) 95. Several of the new regulations rely on maps that designate areas where there is an elevated hazard for power-line fires to occur and spread rapidly (fire-threat maps).

The Commission in R.08-11-005 adopted three fire-threat maps on an interim basis for use in conjunction with the previously identified fire-safety regulations. Each map covers a different part of California. In Decision (D.) 12-01-032, the Commission concluded that it was in the public interest to (1) develop and adopt a permanent fire-threat map that covers the entire State; and (2) incorporate into GO 95 a new High Fire-Threat District based on the newly adopted fire-threat map; and (3) consider and adopt new fire-safety regulations for electric utility and CIP structures in the High Fire-Threat District. The Commission also determined that the first step towards the development of a permanent statewide fire-threat map would be the preparation of a work plan for completing this task.

In D.14-01-010, the Commission adopted a work plan for the funding, development, adoption, and implementation of a statewide fire-threat map. The adopted work plan specified a two-step process. The first step was to develop and adopt a scientifically based fire-threat map that depicts the physical and environmental conditions associated with an elevated potential for utility-associated wildfires (hereafter, “Fire Map 1”). The second step was to develop a statewide map that depicts utility fire-

[1] These decisions include Decision (D.) 09-08-029, D.12-01-032, D.14-02-015, and D.14-05-020.

threat zones where the fire-safety regulations adopted in R.08-11-005 for high fire-threat areas would apply (hereafter, "Fire Map 2").

Once Fire Map 1 was adopted, the Commission turned to the development of Fire Map 2 and revising GO 95 to incorporate a new High Fire-Threat District and fire-safety regulations for the new district. The California Department of Forestry and Fire Protection (CAL FIRE) agreed to take the lead role in the development of Fire Map 1. This required CAL FIRE to organize and lead a team with expertise in a range of disciplines, including wildland fuels and fire behavior; meteorology; and geographic information systems (GIS). CAL FIRE was also authorized by D.14-01-010 to identify, select, and oversee the internal and external experts and resources that it deemed necessary to develop Fire Map 1. D.14-01-010 approved a funding mechanism to pay for experts selected and overseen by CAL FIRE. After the Commission adopted Fire Map 1 in D.16-05-036. The same Decision directed the parties to immediately commence the preparation of a work plan for the development of Fire Map 2.

The purpose of Fire Map 2 was to designate areas where there is an elevated hazard of utility-associated wildfires to occur and spread rapidly, and where communities face an elevated risk of damage or harm from utility-associated wildfires. Conveyed by the boundaries identified in Fire Map 2, areas identified with elevated or extreme fire-threat would be where stricter fire safety regulations might apply. To create Fire Map 2, an interactive engagement process was used, where utility entities potentially affected by Commission regulations were provided an opportunity to review and submit input (e.g., map change proposals) on the interim wildfire threat map (Shape B1 Map) – which represented modeled utility-associated wildfire threat level of "elevated" across the state of California. An independent wildfire expert team (Independent Review Team), led by CAL FIRE, reviewed map changes proposed by utility entities. This report summarizes the process and approach that the Independent Review Team (IRT) used to evaluate map changes proposed by Territory Leads (TL) and the Peer Development Panel (PDP).

FIRE MAP 2 WORK PLAN

A prehearing conference (PHC) was held on June 22, 2016, and the Assigned Commissioner's Scoping Memo and Ruling (Scoping Memo) was issued on July 15, 2016. The Scoping Memo directed the Fire Safety Technical Panel (FSTP) to convene workshops to prepare a detailed work plan for the development, adoption, and implementation of Fire Map 2. Publicly noticed workshops were held in August - September 2016. The Workshop Report included a proposed work plan for the development of Fire Map 2 – that included a three-step process to develop and adopt Fire Map 2. Step 1 is the creation of a map known as Shape A, Step 2 is the creation of a map known as Shape B, and Step 3 is the creation of a final map known as Shape C.

Per the work plan, the first step in the development of Fire Map 2 was the creation of a preliminary statewide fire-threat map called Shape A. Shape B was to be a refinement of the CAL FIRE-approved Shape A. The refinements would be based on utilities' and other Stakeholders' knowledge of local conditions affecting utility-associated wildfire hazards and risks. Additionally, Shape B was to be subdivided geographically into fire-threat "Tiers" to delineate different levels of utility-associated wildfire hazards and risks. Shape B was developed by the PDP, as assigned territory-specific mapping roles to Territory Leads; and reviewed and approved by the IRT, led by CAL FIRE. Step 3 was the creation of a final map known as Shape C, which included an overhead utility infrastructure overlay component and final map fidelity work by the IRT. However, in June 2017 the Commission issued D.17-06-024, which eliminated the requirement to develop a Shape C map and revised the Fire Map 2 Work Plan to conclude the development of Fire Map 2 with the adoption of the IRT-approved final Shape B map.

IRT REVIEW PROCESS & WORKFLOW

The process for developing Fire Map 2 was initially mobilized in late December 2016, where CAL FIRE worked with Spatial Informatics Group (SIG) and Reax to plan project logistics prior to and per D.17-01-009 (January 19, 2017). During this time, CAL FIRE, SIG and Reax 1) identified likely project elements, 2) conducted outreach and gained initial commitment from potential IRT members, and 3) researched options that could be used to satisfy the Decisions requirement for an Integrated Project Management/Version Control Software (IPM/VC, "Ticketing System").

After the formal Decision was issued (January 20, 2017), a ticket system was selected in collaboration with the PDP, and proposed via filing per the February 20, 2017 Decision deadline. The ticketing system selected was Zendesk, which is an out-of-the-box costumer service ticketing system. The IRT adapted and customized this system in collaboration with the PDP (https://puc-map2.zendesk.com/hc/en-us), along with a custom-designed open-source web mapping platform (http://cpuc_firemap2.sig-gis.com/) used to post TL proposed map changes along with other data used to facilitate the review of Shape B1. Combined, these two sites satisfied the requirements of the Decision to use a version control and review system that is: 1) transparent and readable by all that are authenticated through web-based ticketing system, and 2) capable of capturing and archiving input and interactions/communications across different review groups (i.e., TL, PDP, and IRT) related to map change recommendations and approved map changes. Guidelines for using the ticketing system and map change proposal submission were prepared and posted as a link in the ticketing systems home page.

In late February and early March, members of the PDP and IRT met two times in San Diego, CA to: 1) test the ticketing system, 2) develop the wildland fire threat/risk rubric, and 3) develop Tier definitions.

Figure 1 shows an overview workflow process for moving proposed map changes to through the different groups for vetting. As indicated in Figure 2, multiple interactions across the different groups occurred as they were being considered, and before proposed changes were moved from one review group to another.

Shape A to Initial Shape B

As a starting point in March 2017, Shape A was refined to remove non-burnable landscapes (e.g., water bodies and densely populated area with substantial impervious cover), pursuant to direction given in D.17-01-009, instructing the PDP and IRT to reach agreement on an initial Shape B map (Shape B1). The resulting Shape B1 map was used as the basis for review by Stakeholders and Territory Leads.

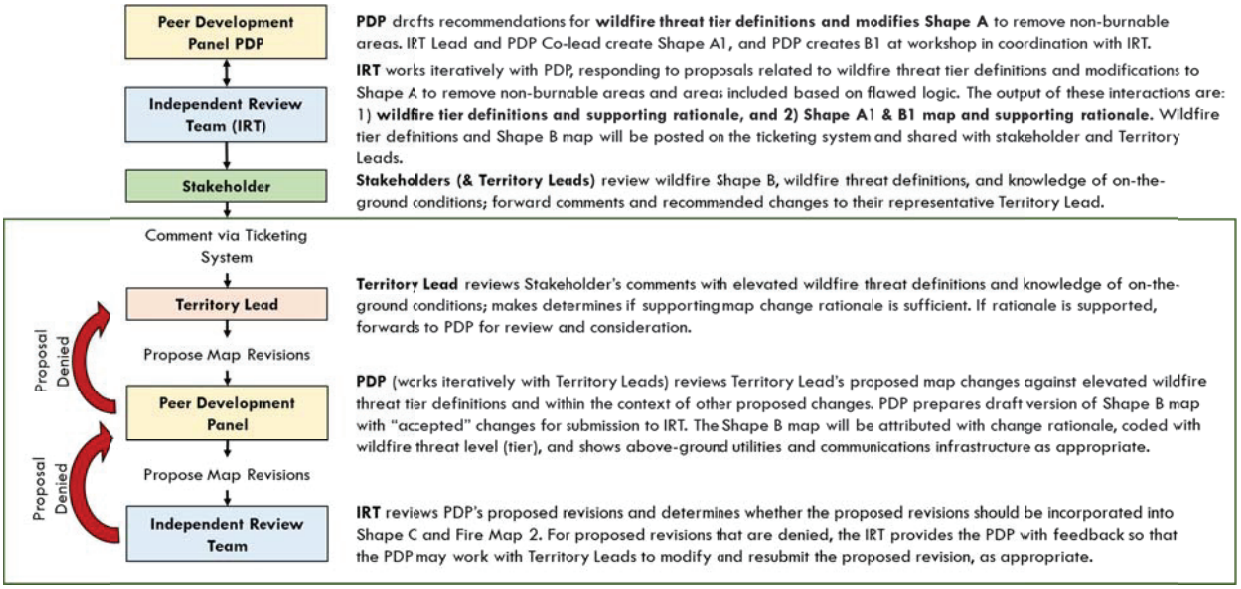

Figure 1. Generalized workflow for vetting and moving recommended map changes through the different identified groups and ticketing system. The green box in lower portion of figure represents the review and input phase provided through the ticketing system.

Wildland Fire Threat/Risk Rubric

Prior to the initiation of map change proposal submissions (in March 2017), the Peer Development Panel (PDP) and Independent Review Team (IRT) worked together developed a threat/risk assessment rubric/diagram (Figure 2) to guide Territory Lead's and PDP's development of map change proposals, as well as informing the IRT review of map change submissions. The wildfire threat rubric represented in Figure 2 was used to assist wildfire experts, utilities, and stakeholders with their assessment of risk and hazards (including likelihood of occurrence and impacts to societal values) from wildfires associated with overhead utility powerlines or overhead utility powerlines also supporting communication facilities. The figure shows three levels, or "Tiers" which correspond to locations in the state of California where enhanced utility regulations might be necessary to reduce the risk of utility caused wildland fire. Tier definitions and the factors used to determine axis values of "likelihood" and "impact" are simplified in the graphic for clarity, with the following summary narrative providing additional description of element represented on each axis in the graphic.[2]

[2] Complete definitions and descriptions may be found in filings supporting the CPUC Rulemaking to Develop and Adopt Fire-Threat Maps and Fire Safety Regulations (15-05-006).

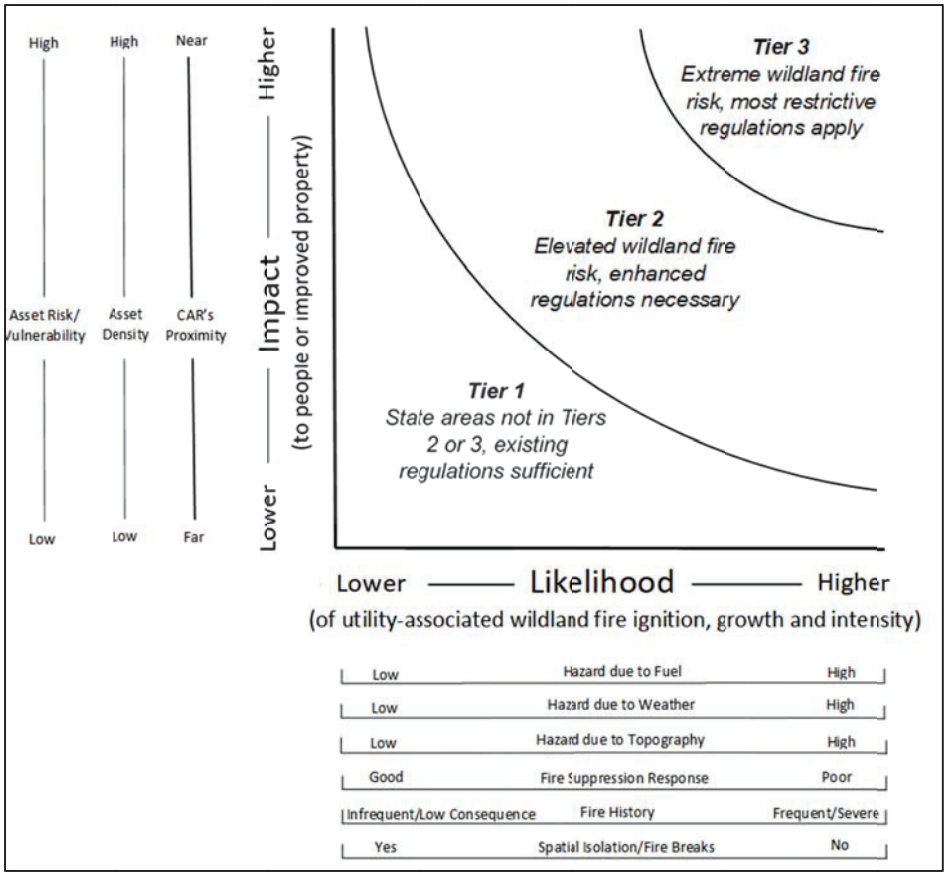

Figure 2. Wildfire Threat Rubric used as a general guide for Territory Leads, Peer Development Panel, and Independent Review Team for evaluating and supporting utility-associated wildfire threat across California.

Likelihood of Utility-associated Wildland Fire Ignition, Growth and Intensity Axis

Fuels and weather are captured in the Utility's Fire Map 1 and the Fire Threat Map. For the former, a severe fire weather analysis was performed using the composite Fosberg Fire Weather Index (FFWI) that combines winds, relative humidity and temperature data into a singular measure of fire weather that is related to fire behavior potential expressed at hourly intervals and resolved at 4 km^2 grid resolution for the state of California. The threshold record set was developed by ranking FFWI values and selecting the top 2% of daily maximum values for records where the temperature was > 50^{o}F, and results in 73 unique records representing the most severe fire weather days across the ten-year period for each cell. There are two main sub-components that are used to describe the sequence of events leading to large damaging fires:

1) An Ignition Potential Index that is used to assess an area's likelihood for producing a viable ignition point. The Ignition Potential Index couples two models: one describing wind forces, and the other being the widely-used Schroeder Ignition Probability measure (1969) for ember ignition on stylized natural vegetation fuel beds; and
2) A Fire Spread Index that is used to evaluate the subsequent potential of the ignition to result in a large fire. The Fire Spread Index sub-component was created using spatial fire behavior modeling in conjunction with the WRF threshold data, and a modified LANDFIRE fuels (vegetation characteristics related to combustion and propagation of wildfires) and terrain

information (elevation, slope, and aspect) collected from the public LANDFIRE website at 30-meter pixel resolution and overlaid on the 2 km WRF grid.

It was agreed that there were some systematic errors identified in LANDFIRE which led to use of the most current statewide vegetation data (CALVEG 2015) as a fuel system overlay onto LANDFIRE fuels for determination of mismatched fuel typing. CAL FIRE – Fire and Resources Assessment Program's (FRAP) Fire Threat Map, was also mapped using the same projection and extents as Fire Map 1, keeping its native 100m resolution. Fire Threat is classified as "high," "very high," or "extreme."

Topography: (elevation, slope, aspect) and fuels data (vegetation characteristics related to combustion and propagation of wildfires) were collected from the public LANDFIRE website at 30-meter resolution and overlaid on the 2km WRF grid.

Fire Suppression Response: Road density is relevant to fire risk assessment because with everything else equal, higher road density (miles of roads per square mile, mi/mi^2) corresponds to shorter response times and decreased probability of an initial attack fire becoming an extended attack fire. Particularly on campaign or Type 1 fires, existing roads are often used as control or firing lines because doing so is less resource intensive than building dozer or hand lines. Therefore, with everything else being equal, it was reasoned that a higher road density should correspond to a smaller fire size at containment. Other factors include terrain characteristics (slope and ruggedness), and distance from fire stations / air attack bases. CALFIRE maintains a GIS database of CALFIRE and Schedule A Contract fire suppression facilities. This dataset includes only CALFIRE facilities but does not include local or USFS facilities. However, local facilities are included in the USGS National Structures Dataset (NSD).

Fire History: FRAP fire perimeters (1960 – 2015) are used to assess fire history for a specific location. California Department of Forestry and Fire Protection, based on a statewide interagency wildfire geodatabase, includes prescribed burns and other fuel modification projects. The current fire perimeter layer developed by BLM, CAL FIRE, NPS and USFS is the most complete digital record of fire perimeters (greater than 300 acres) in California. However, some fires may be missing because historical records were lost or damaged, fires were too small for the minimum cutoffs, documentation was inadequate, or fire perimeters have not yet been incorporated into the database.

Spatial Isolation/Fire Breaks: The Decision Adopting the Work Plan for Fire Map 2 directed the PDP to carve out non-burnable areas from Fire Map 1 (Shape A Map), and was completed by deleting polygons at a 1,000-pixel threshold, i.e. non-burnable areas smaller than 0.9 km2 (222 acres) were carved out. Polygons with perimeter divided by area values greater than 20 km/km^2 were also deleted to remove long slender features (riverine, roads, etc.). Also removed were isolated 100 m pixels with a sieve function. Initial cut is done to remove groups of (four-connected) pixels smaller than 400 pixels, the size of 1 WRF cell. Retained were high fire-threat cells isolated spatially that may therefore represent a reduced risk of fire spread.

Impact to People and Improved Property Axis

Communities at Risk (CARs) Proximity: To help protect people and their property from potential catastrophic wildfire, the National Fire Plan directs funding to be provided for projects designed to reduce the fire risks to communities. A fundamental step in achieving this goal was the identification of communities that are at high risk of damage from wildfire. These high-risk communities fall within the wildland-urban interface, i.e., the area where homes and wildlands intermix plus a 1.5-mile buffer.

Asset Density: Population density (people/mi^2) and housing density (structures/mi2) may be calculated from 2010 US Census data for each of the 710,145 census blocks California by dividing the population or housing count for each census block by its area. While real estate (or county parcel) data is available to assist with valuation, these data sets are unwieldy and complicated by numerous factors, e.g., the division of value into land and improvements, market fluctuations, and complex bases for taxation and appraisals.

Asset Risk/Vulnerability: Within the context of wildland fire, both positive and negative outcomes can be realized from a given fire. A low-intensity fire occurring within the historic range of variability may provide a net benefit to the burned areas. While this may be true for some fires, it is usually not true for fires burning under extreme fire weather conditions (high wind, low humidity) in areas adapted to low intensity high frequency fire. It is also not likely true for fires burning through intermix or interface areas with structures. Consequences/impacts may incur negative impacts to structures and people, natural resources and critical infrastructure or other high-value assets. Community vulnerability may be assessed by proximity to wildland fuels, terrain, accessibility to fire suppression resources, configuration, newness of construction, etc. Timber may be used as a proxy for impact to natural resources where estimates of fire-induced tree mortality probability is based on species, diameter at breast height, and crown scorch fraction (which is related to fire-line intensity) and estimates of economic damages associated with timber loss can be estimated based on knowledge of timber prices, time remaining in the harvesting rotation, stand age when fire occurs, tree mortality coefficient, percentage of immature timber in the stand, and percentage of a stand affected by fire. Other high value assets, e.g., federal land, historical sites, cultural relics, etc. could be addressed by establishing valuations.

Tier Definitions

Following the coordinated development of the *Wildland Fire Threat/Risk Rubric, a*nd pursuant to direction given in D.17-01-009, the PDP and the IRT to worked together and reached agreement on tier definitions associated with map zones on March 24, 2017. The approved definitions are as follows:

Tier 1 - is [all] area in the state of California that is not in Tier 2 or Tier 3. An example of an areas approved as Tier 1 is shown in Figure 3 and 4.

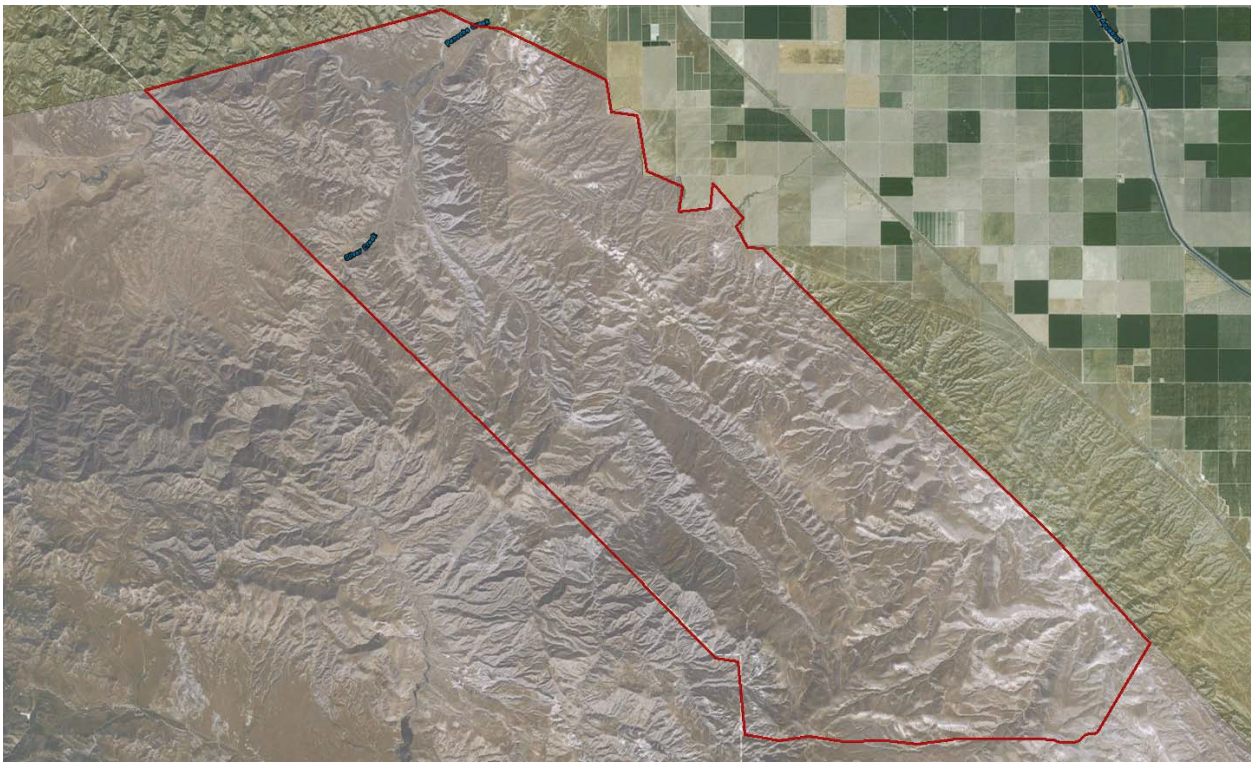

Figure 3. An example of an area (west side of the Central Valley near Silver Creek) approved by the IRT to be reclassified Tier 1 (red outline) from Shape B1 (grey zone) due to lack of risk to people or improved property.

Figure 4. An example of an area (Oakhurst) approved by the IRT to be reclassified Tier 1 (red outline) from Shape B1 (grey zone) due to lack of fuel continuity and impervious cover.

Tier 2 - is elevated risk (including likelihood and potential impacts of occurrence) from wildfires associated with overhead utility powerlines or overhead utility powerlines also supporting communication facilities, including impacts to people or improved property.

Figure 5. An example of an area (near McCoy Flat Reservoir to the west) approved by the IRT to be reclassified as Tier 2 (red outline) to Shape B1 (grey zone) due to small inholdings of improved property and increased fire hazard.

Tier 3 - is extreme risk (including likelihood and potential impacts of occurrence) from wildfires associated with overhead utility powerlines or overhead utility powerlines also supporting communication facilities, including impacts to people or improved property.

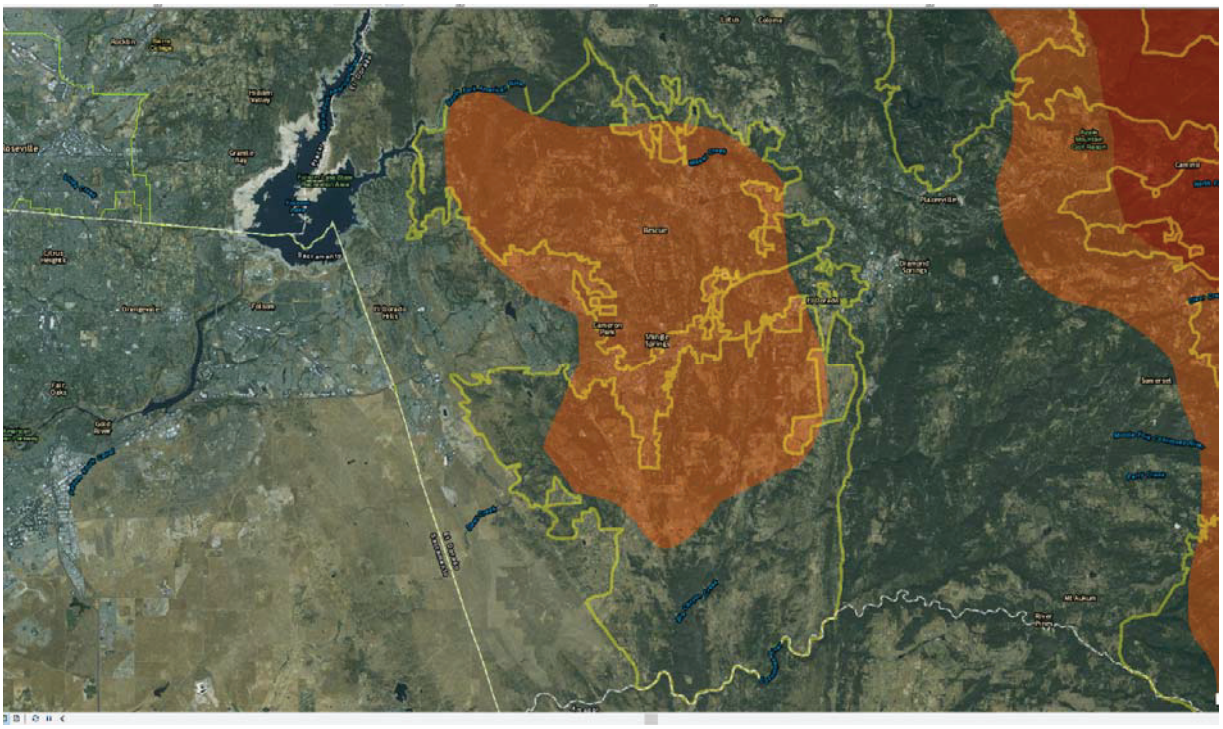

Figure 6. An example of an area (near Folsom Lake) approved by the IRT to be reclassified as Tier 3 (yellow outline) from Shape B1 due to high iUTI values (orange polygon representing areas greater than 85 percentile).

Guidance for identifying boundaries between Tiers

Tier 2 was distinguished from Tier 1 by having greater likelihood of fire initiation and growth that would impact people or property, from utility-associated wildfires, and where enhanced utility regulation could be expected to reduce utility-fire risk.

Tier 3 is distinguished from Tier 2 by having highest likelihood of fire initiation and growth that would impact people or property from utility-associated fires, and where the most restrictive utility regulations are necessary to reduce utility-fire risk. To aid in identifying areas of Tier 3, the IRT used the Integrated Utility Threat Index (iUTI) as a guide for identifying areas of possible Tier 3 status (see detailed description of iUTI in next section). Like the Fire Map 1 products, the iUTI is a coarse (2-km) raster built on broad-scale inputs; it was not meant to be used for drawing exact polygon boundaries, but instead for finding areas of California with similar values of integrated utility wildfire threat. By "integrated", the IRT meant the combination of both the likelihood of an escaped utility-associated wildfire and its harm/impacts to people and property if one should occur.

The IRT provided guidance to PDP and TL that areas with iUTI values below the 85th percentile are weaker candidates for Tier 3 status, but may be good candidate for Tier 2. However, the TL and PDP may use local knowledge of fuel, weather, terrain, and residential and commercial development vulnerability to request Tier 3 status even though iUTI values are below the 85th percentile. Areas between the 85th and 95th percentiles are strong candidates for Tier 3 status. Where iUTI values were above the 95th percentile, the IRT is expected Tier 3 status, unless there is strong evidence suggesting otherwise. In all

cases, the IRT provided guidance that local knowledge should be used (by the TLs and PDP) to draw specific polygon boundaries for both Tier 2 and Tier 3 designations.

Integrated Utility Threat Index (iUTI) Model

The IRT used the integrate Utility Thread Index (iUTI) spatial model that was developed by Joe Scott of the IRT to help identify Tier 3 utility wildfire threat/risk areas across California. The purpose of the model was to assess the "*Risk Associated with an Ignition Location*" (RAIL). The three main elements of such an analysis are provided by Scott and Thompson (2015; https://www.fs.fed.us/rm/pubs/rmrs_p073/ rmrs_p073_196_206.pdf), and include:

1) Ignition (or escaped-fire) likelihood (at a given location)
2) Fire growth potential (from that location)
3) Resource or asset (population) vulnerability (in the fire-plain around the location)

The Commission's Fire Map 2 utility wildfire threat project focuses on protecting people from utility-related wildfires, so the analysis/modeling focused specifically on population vulnerability; wildfire threat to any other resource or asset (e.g., environmentally sensitive areas) were not included. For the Ignition Likelihood component, the IRT used the Utility Threat Index (UTI, a Fire Map 1 input), which represents the potential for utility related ignition and subsequent escape (due to fire growth). For population vulnerability we used CAL FIRE's WUI-DEN4 dataset, which represents the relative exposure of people to wildfire across the state. This California-specific dataset was supplemented with similar data (Wildland Development Area [WDA]) for neighboring states so that a simulated wildfire originating in California could impact population in a neighboring state. The WDA dataset was matched to the density classes of the WUI-DEN4 dataset. Finally, for the Fire Growth Potential element the IRT used a 10,000-year simulated event set generated with the Fsim large fire simulator (Finney and others 2011).[3]

The Fsim large-fire event set for CA was generated by clipping results from CONUS Fsim modeling efforts conducted by Pyrologix on behalf of Dr. Karen Short at the Rocky Mountain Research Station. The CONUS Fsim modeling project divided CONUS into 128 pyromes developed by the Rocky Mountain Research Station (Short, personal communication). We gathered the Fsim fire-perimeter results for those pyromes, then removed fires that started outside of CA. The resulting large-fire event set for CA consists of 879,964 fires >100 ha. The density of starts was designed to follow the historical pattern. Areas void of large-fire ignitions include non-burnable land cover and areas where sparse fuel prevented fires from reaching at least 100 ha.

Fsim was calibrated for each pyrome based on the 24-year (1992-2015 inclusive) historical fire occurrence dataset (Short 2017, available https://www.fs.usda.gov/rds/archive/Product/RDS-2013-0009.4/). Using that dataset, we found the mean annual number of large fires and mean annual large-fire area burned (per million acres) for each pyrome. From those values, we calculated the mean large-fire size. We also generate bootstrapped 70 and 90% confidence intervals on the number of large fires and large-fire area burned. Finally, we plotted the simulated mean number and sizes of large fires. The IRT looked at the historical and simulated fire-size distributions on a log-log exceedance probability curve. We used charts to confirm, visually, that the fire-size distribution was reasonable with respect to historical fires.

[3] NOTE: The Fsim results have been used here with permission from Dr. Karen Short. They are not yet published.

The Fsim event set and population vulnerability datasets were combined by summing the population exposed to each simulated fire perimeter. This produced a measure of each fire's effect on people. We then assigned that population-exposed attribute to the ignition location of each fire in the event set, and generalized the resulting point-feature class using ESRI's Point Statistics tool (2-km cell size, 5-cell search radius; snapped to the Utility Threat Index raster). We then cut out non-burnable land cover from the resulting raster, using the same land cover dataset used by the PDP in doing the automate cutout from Shape A to Shape B1). This produced a Conditional Impact (CI) raster that represents the mean impact of escaped wildfires originating in each 2-km cell (given that a wildfire occurs there). The raw Conditional Impact results are relative, but otherwise dimensionless. About 42% of CA resulted in "zero" impact potential.

Finally, we calculated the Integrated Utility Threat Index (iUTI) as the product of UTI and CI. The iUTI map can be used to identify the areas of the state with the greatest utility wildfire threat. The Integrated Utility Threat Index incorporates measures of the likelihood of a utility-related wildfire occurring (IPI), the potential for escape due to 1-hr fire growth potential (FSP), the escaped-fire growth potential (Fsim event set) and the exposure of population to escaped wildfires (WUI-DEN4 + WDA).

We used a Lorenz curve to show the cumulative Utility Wildfire Threat as a function of landscape percentile. That is, the landscape is ranked from the least to most risky in terms of Integrated Utility Wildfire Threat (landscape percentile), and then we found how much cumulative threat was contained at or above each landscape percentile. For example, 89.4% of the cumulative Integrated Utility Wildfire Threat is found on 10.6% of the most vulnerable (wildfire threatened) landscape.

The IRT is used the Integrated Utility Threat Index (iUTI) as a guide for identifying areas of possible Tier 3 status. Like the Fire Map 1 products, the iUTI is a coarse (2-km) raster built on broad-scale inputs; it was not meant to be used for drawing exact polygon boundaries, but instead for finding areas of California with similar values of integrated utility wildfire threat. By "integrated", we mean the combination of both the likelihood of an escaped utility-associated wildfire and its harm/impacts to people and property if one should occur.

Again, the IRT provided guidance that areas with iUTI values below the 85th percentile are weaker candidates for Tier 3 status. However, the TL and PDP are directed use local knowledge of fuel, weather, terrain, and residential and commercial development vulnerability to request Tier 3 status even though iUTI values are below the 85th percentile. Areas between the 85th and 95th percentiles were strong candidates for Tier 3 status. Where iUTI values are above the 95th percentile, the IRT is expecting Tier 3 status, unless there is strong evidence suggesting otherwise.

Two versions of the iUTI map were posted to the CPUC Fire Map 2 web map to aid TLs and PDP delineation of Tier 3 areas: 1) a 2-km gridded version that shows iUTI values with 2% breaks above the 80^{th} percentile, and 2) a vector layer that show a smoothed contour representation of the iUTI, broken in percentile breaks from 1) 75^{th} to 84^{th} percentile, 2) 85^{th} to 94^{th} percentile, and 3) 95^{th} percentile and above. These data layers can be viewed at http://cpuc_firemap2.sig-gis.com/, select "Fire Threat Boundaries" in the left panel to drop down list of available layers, then select either "Integrated UTI (iUTI) 2% breakpoints" to show the 2-km gridded version of iUTI map, or "Integrated UTI 3x3 contours" to show smoothed contour representation of the iUTI. Map data were downloadable from the "Data" tab.

IRT Review Approach, Data and Decision Used to Evaluate Proposed Map Changes

Once a map change proposal (submitted by a TL) was reviewed and approved by the PDP, it was submitted through the ticketing system for review by the IRT. The IRT used a standardized review form to capture the nature of proposed map changes from the TL/PDP, and the rationale of the IRT review for approving or denying a map change proposal. The IRT review typically contained the following pieces of information:

- Map change proposal Submitter
- Data submitted by TL/PDP for IRT Review
- General summary of the nature of the proposed map change
- IRT Review of polygon-specific changes
- IRT responses to Review Questions/Criteria, including:
    - Map Products Clarity/Quality?
    - Map Change Summary?
    - Map Change Rationale?
    - Stakeholder Input Summary?
- IRT Summary Determination

In addition to data used by the PDP to formulate Shape B and map change proposals, the following data sources were available via the Fire Map 2 web map, and used by the IRT to evaluate map change proposal submitted by TL and PDP.

- Integrated Utility Threat Index (iUTI) 3x3 contours – vector smoothed iUTI product
- Integrated Utility Threat Index (iUTI) 2% breakpoints (raster) – raw, 2 km grid iUTI product
- Ignition Potential Index (from Map 1)
- Fire Spread Potential Index (from Map 1)
- Utility Threat Index (from Map 1)
- FRAP Fire Threat (2005)
- FRAP burn Probability (2015)
- LANDSCAN WUI DEN4 – housing density intersected with CAL FIRE Fire Hazard Severity Zones
- US Forest Service Aerial Survey - Dead Trees/Acre (1 - 250/acre)
- Shape A (from Decision)
- California Fire Perimeters (1878-2015)
- FVEG WHR Life Forms (2015)
- California Counties
- Incorporated Cities; Footprint
- State Responsibility Areas (2017)
- CA Electric Utility Service Area 2015

To maintain review consistency across IRT reviewers, the IRT created and kept a list of situations that arose during the review process that needed clarified (Table 1). For each listed situation, a standardized determination was articulated and applied to reviews.

Table 1. IRT decision rules governing situations that arose during the review of TL and PDP map change proposals.

Review Situation or, TL or PDP Reason for Removal	IRT Call on Decision
Wilderness Area Designation	Wilderness designation alone is not a supported reason for removing from Tier 2 (Shape B1). Fire severity, smoke, and other impacts in backcountry or wilderness areas may affect firefighter and community safety.
FRAP WUI Threat Layer	FRAP WUI DEN Threat layer is designed to show where wildfire damage could occur. FRAP WUI Threat should not alone be used to deny proposed map change. When deciding, use risk associated with ignition location (RAIL) and population vulnerable to wildfire.
FRAP Fire Threat Layer	Can be a resource for informing approval or denial of map change proposals, but not alone. Must also include vulnerability of population and development to wildfire (e.g., WUI DEN).
High-resolution imagery and street view (google)	Can be used to inform whether there is sufficient fuel breaks and fire suppression efficacy.
Fire History	Fire return interval/history is an important consideration for approving or denying proposed map changes. Historic fire activity (frequency, size, impact, etc.) indicates past fire threat, while fire return interval suggests fuel/weather interactions in the future. Using lack of fire history alone as a reason to demote to Tier 1 is not sufficient to approve the proposed map change; particularly for small areas/polygons.
Forest and Shrub Dominated Landscapes	Forested/shrub-dominated landscapes typically burn with higher severity than grasses, though threat to human communities also must be evaluated.
Margins of Shape B	Margin should coincide with fire history, fuel breaks, low fuels, assets of interest, and/or fire weather. Western margins in coastal areas, east/west boundary areas adjacent to Sacramento and San Joaquin Valleys, or Mojave Desert margins to Shape B may be candidates for removal. Suppression resources, SRA jurisdiction also must be considered.
Consequence to property or people.	Needs to be a consideration in approving or denying map change proposals - per the wildfire threat rubric.
Tier 3 Determinations	Notwithstanding modeling comparisons with historic fire perimeters (based on fuels, weather footprints, etc.), high-severity landscapes also may burn as cusp-catastrophes (i.e., jump from Tier 1 to Tier 3 unexpectedly). Because Tier 3 map change submissions, for the most part, were submitted after the submissions of Tier 1 and Tier 2 submissions, Tier 3 map changes shall supersede Tier 1 and Tier 2 when there overlap with previous submissions. When there is a conflict in Tiers, the higher Tier will supersede lower Tiers.
Coastline removals in southern California	In most instances, strands or slivers of coastline removals from Shape B1 (i.e., Tier 2 to Tier 1) in southern California are approvable due to their relative low wildfire risk resulting from moderating coastal climatic conditions.

Review Situation or, TL or PDP Reason for Removal	IRT Call on Decision
Filling Operational Holes – (e.g., Tier 1 to Tier 2)	In situation where there are patches of Tier 1 interspersed across a larger area of Tier 2, the IRT will support of the filling in and reclassification of holes to Tier 2 to improve implementation of regulations (i.e., management by local jurisdictions may dictate inclusion of fire-safe areas as Tier 2).
Conforming Local Fire Threat Boundaries with Shape B	Stakeholders (including local fire jurisdictions, public interest groups, etc.) are encouraged to inform Tier boundary decisions.
Non-burnable Lands	It is appropriate to classify non-burnable lands as Tier 1 as a sole reason for reclassification. Language used in the ticket could be something to the effect of - "*The areas were included in Shape A, but not in Shape B because the areas are shown as agriculture land cover, where a utility-related wildfire is not capable of igniting and spreading to vulnerable communities. Despite the surrounding population exposed to a potential utility-related wildfire, The IRT agrees with the TL or PDP Reviewer that Tier 1 designation is indicated due to non-burnability within the polygons themselves. Contrary to the TL notes for these polygons, "fuel density" is not high and access is not limited. Nonetheless, the IRT accepts the Territory Lead's request for Tier 2 designation "without prejudice", meaning that we reserve the right to approve requests for Tier 2 status in similar situations. The IRT approves the map change proposal for addition of Polygon X to Tier 2 "without prejudice."* OR "*IRT will defer to the PDP recommendation to include the designated polygon into Tier 2, but notes that neither the mapped fuels nor past fire occurrence warrant this promotion.*"
What should the IRT do with different map change proposals where the Territory Lead map change recommendation is different than the PDP Reviewer's recommendation	The IRT will go with the PDP Reviewer recommendation over the Territory Lead to improve consistency of the statewide map. IRT needs to note the differences in the IRT Review and the extent to which the PDP submission diverges from the Territory Lead's recommendations. The IRT has the final discretion on approval and denials of map changes.
Existing utility regulations as a reason to demote to Tier 1	Existing regulations have little if any bearing on the decision for approval or denial of a polygon
Evidence of stakeholder interactions and review of	The IRT will need to see a letter of support that the said stakeholder approved map change proposal. Otherwise, the IRT reviewer needs to note the depth of provided information. The IRT will capture the extent to which they felt the stakeholder were sufficiently characterized in the project summary.

Review Situation or, TL or PDP Reason for Removal	IRT Call on Decision
proposed map changes	
Use of the Integrated UTI Map Layer	The Integrated UTI integrates the Firemap1 UTI with the consequence to people of a wildfire. In general, Tier 2 is above 50% and Tier 3 is generally above the 84th percentile. However, the IRT need to take into other considerations, such as defensible space and population vulnerable to wildfire.
Utility Infrastructure	In instances where the boundary of two tiers coincides within 100m of utility infrastructure, the zone where the utilities exist will be included in the higher of the two Tiers.

Through the IRT review, each polygon was evaluated using a variety different sources of data, and assigned one of three general approval ratings, including 1) "*Approved*" – the polygon and associated Tier classification change was approved by the IRT for incorporation into Fire Map 2, 2) "*Denied*" – the polygon and associated Tier classification was rejected and thus should not be incorporated into Fire Map2, and 3) "*Denied, Pending Revision*" – the polygon and associated Tier classification should not be incorporated into Fire Map 2 until recommended revisions are approved by the IRT. In a few instances, an "*Approval (with recommended changes)"* determination was made, which can be interpreted to mean that the polygon, "as is," is approved by the IRT, however additional guidance was suggested to TL to modify the polygon to improve map fidelity. Following the initial IRT review – where polygons were denied by the IRT, the TL/PDP where provided an opportunity to revise their original proposal, and resubmit to the IRT for review through the ticketing system. The IRT reviewed revised submissions, and posted updated determination to the ticketing system.

Statewide Fire Map 2 Production and IRT Audit of PDP Tier 2 and Tier 3 Polygons

The IRT prepared and posted to the ticketing system homepage guidelines and recommendations for the final statewide Fire Map 2 production prior to its creation. After all map change proposals were reviewed and determined to be completed, the PDP merged all IRT approved Tier 2 and Tier 3 polygons and generated two map layers, one representing IRT approved Tier 2 areas and one representing IRT approved Tier 3 areas. Simultaneously, the IRT generated a comprehensive data layer representing submitted polygons and their respective IRT determination status (as approved, denied, denied, pending revision, withdrawn). To confirm accuracy of IRT determination status in the data layer, each record in the data layer's attribute table was compared to the IRT determination in the final IRT review (as recorded and posted to the ticketing system). The IRT data layer was then compared to the PDP prepared maps, where confirmation on polygon approval status was made through communication between the PDP and IRT. As a result of this process, about 130 map change proposals, representing approximately 1,400 polygons, were submitted to the Independent Review Team (IRT) for expert review and consideration for approval. At this time, the IRT has a comprehensive dataset that has tracked the processing of every submittal, which serves as a data process document for tracking the disposition of all map changes performed, should any question arise about how areas on the map were processed. .

The filename for this product is Uber_IRT_TICKETS_20171112_Sort.zip, and will be provided in the archive data package for this proceeding. Figure 7 illustrates the IRT audit process and the associated creation of the final comprehensive PDP tiered map.

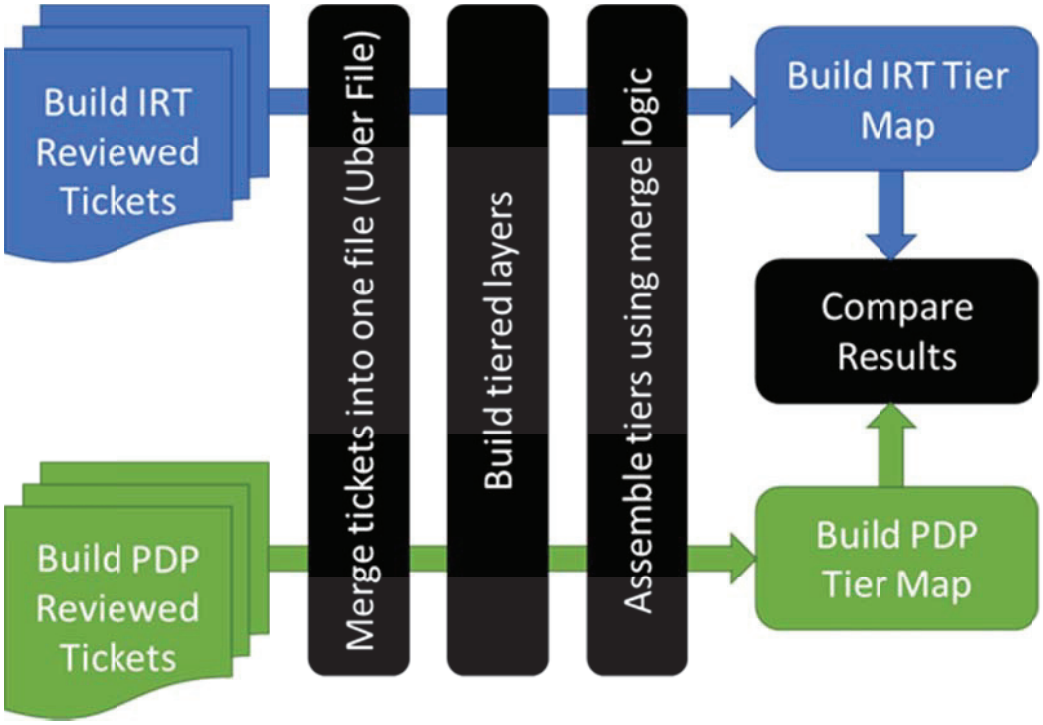

Figure 7. Schematic diagram for IRT Audit process

IRT Comments Fire Map 2 Implementation

The purpose of Map 2 is to serve as a means of implementing revised fire safety regulations produced concurrently with this map, and codified in a recent Proposed Decision Adopting Regulations to Enhance Fire Safety in the High Fire-Threat District. Implementing these regulations requires assigning overhead utility equipment, as based on their location, to the appropriate tier, including whether a subject piece of equipment is in the Fire-Threat district at all. This implementation process raises some issues related to Map 2 production regarding its fundamental accuracy and precision.

A number of the input data sets, including but not limited to the Original Shape A, and various change polygons received from Territory Leads, were created using "hand-drawn" techniques that used varying degrees of diligence and spatial precision to register tier boundaries. In many cases, areas of urban, or other types of land cover that were deemed to lack sufficient fire spread potential were excluded from Tier 2, but the precise line in the map describing that distinction is not uniformly depicted This is not surprising when mapping roughly many tens of millions of acres, and using a variety of techniques and input data to guide the process. Much of the "non-burnable" exclusion process to

the mapping was automated within GIS, and this too can result in spatial imprecision, but is due to intrinsic data limitations, and not hand drawn inference and the limits of digitization. In summary, the net boundaries as depicted on the map may vary in their true intended location by some distance, and it would seem prudent that the process for assigning equipment that is close to tier edges be assigned to the higher of the two tiers.

Below (Figure 8) is a graphic example is slightly misaligned polygon development showing the final boundary in Map 2 of an area with a Tier 1/Tier boundary. The presumed intent of the map would be to follow the NW road boundary, and all lands to the lower right of that road would be considered Tier 2.

Figure 8. An area showing modest edge precision error between Map 2 tiers 1 and 2.

A final concern regarding assignment of utility equipment to tiers involves the potential for lateral displacement of aerial equipment when it fails. Consider a hypothetical example of a pole on the west side of a road that travels north/south. The areas to the west are covered in row crop agriculture, and the areas to the east are dense wildland fuels. The boundary of Map 2 depicts the initiation of the High Fire-Threat district on the east side of the road. If only a direct spatial overlay of the pole onto the map were required for determining it's tier status, it would fail to address how the pole or conductors on the west side of the road could fail and contact the Fire Threat zone on the east side of the road. One convenient and effective process would be to buffer the pole/line a distance equal to or greater than the height of the component, thereby accounting for failure and 2-demensional displacement.

For the reasons outlined above, the IRT recommends a process for interpreting the Map's intent for fire safety, and requiring that utilities use due-diligence in assigning tier status to equipment that is in close proximity to boundaries found in Fire Map 2. A simple buffer routine applied to equipment, ensuring that equipment that poses real risks from wildfire, would be a simple and effective method for accomplishing this goal. The IRT is prepared to assist in this process if requested.

IRT Invoicing and Expenses

Table provides a summary of invoices submitted to PG&E through October 31, 2017. As of October 31, 2017, expenditures account for 66.2% of the allocated budget of $500,000.

Table 2. IRT billings through October 31, 2017.

Vendor	Billing Period	Invoice Date	Invoice #	Amount
Spatial Informatics Group	12/10/16 - 1/31/17	2/16/2017	1001	$14,325.50
Spatial Informatics Group	February 2017	3/14/2017	1002	$28,219.84
Spatial Informatics Group	March 2017	3/30/2017	1003	$31,915.92
Spatial Informatics Group	April 2017	5/1/2017	1004	$10,653.44
Spatial Informatics Group	May 2017	6/2/2017	1005	$16,692.83
Spatial Informatics Group	June 2017	7/5/2017	1006	$26,466.23
Spatial Informatics Group	July 2017	8/4/2017	1007	$25,891.25
Spatial Informatics	August 2017	8/31/2017	1008	$39,886.85

Group				
Spatial Informatics Group	September 2017	10/2/2017	1009	$97,321.88
Spatial Informatics Group	October 2017	10/31/2017	1010	$39,582.74
			TOTAL	**$330,956.48**