

## **Appendix B of Background Report No. 6 (Fire Management Background Report) – FARSITE Modeling**

FARSITE was used to test the efficacy of each strategy using the site-specific conditions, based on hypothetical scenarios where treatments are located, including: fuelbreak, defensible space, strategically placed area treatments (SPLATs) and combinations thereof. The results are measured in terms of acreage burned, burn severity and potential damage. Acreage burned is a direct output of FARSITE, burn severity is based on decision-rule based translation from fire behavior characteristics to burn severity, and potential damage is based on the value/acre for each land use type<sup>1</sup>.

FARSITE is a fire-growth simulator that can display where and how fast a fire can be expected to spread. Typical ignition locations, with near worst-case scenarios can highlight potential weaknesses in fuelbreak locations or widths and indicate possible expansion and/or other strategies for fuel treatment. FARSITE is particularly valuable in displaying potential fire spread pre-and post-fuel modification scenarios, thus illustrating the effect of treatments. FlamMap and FARSITE use the same data layers.

The FARSITE simulations for this analysis did not include fire suppression. The simulations ran only for 2 to 3 hours, which is approximately the time in which fire suppression would become effective because of the time it takes to reach the site and set up operations.

The effects on fire behavior and potential damage under the various scenarios are quantified in terms of acreage, fire severity, and/or potential damage (using an average cost/acre in various land uses, or other costs as advised by the District).

### **Weather Conditions**

Selecting the appropriate weather conditions under which the simulations should be conducted is an important element to fire behavior modeling. The weather data from the most representative remote automated weather stations will be collected for at least the most recent five years. Weather data will be sorted by percentiles, so that the 10 percent hottest, driest, days may be determined. The District staff could also wish to simulate weather conditions on the days the 2003 Southern California Firestorm occurred, or the 1997 Vision Fire, or another significantly hot, dry day that resonates with public memory of a “bad fire day”.

The following is a summary of weather observations from the nearest weather station for four of the ignition points. The Woodacre weather station is representative weather for Ignition points #1 – 4; the most extreme values (highlighted) were used for the analyses. In this general area, the value of 95 degrees F<sup>o</sup> is in the 99<sup>th</sup> percentile. Stated another way, only ~3 days a year are hotter than 95 degrees in the vicinity of the Woodacre weather station. Similarly, 99.5 percent of the days near Woodacre are not as dry as 15%

---

<sup>1</sup> *As of 2002, the average residence in Marin county was valued at \$600,000<sup>1</sup>*

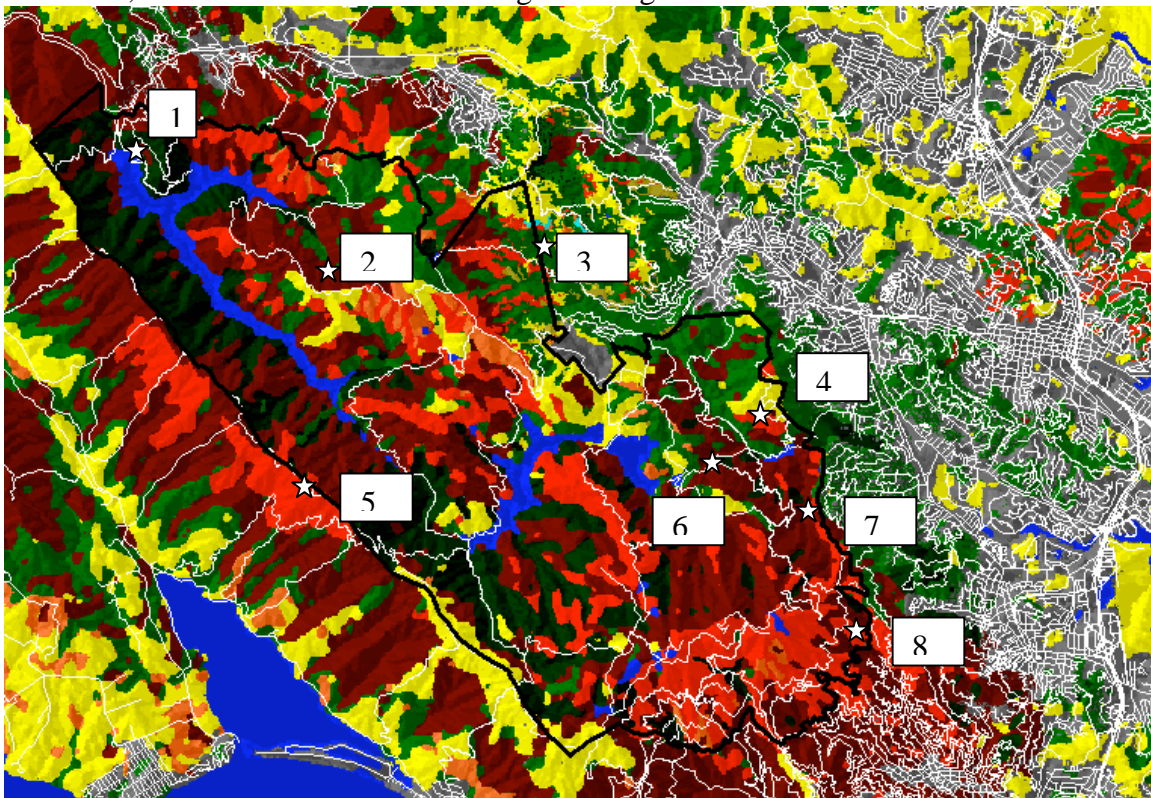
relative humidity. Winds stronger than 15 mph are rare in the area, occurring only slightly more than once a year.

Weather Station at Woodacre<sup>2</sup>

Weather Criteria	Days Met	Number of Observations	Observation Factor
95 Degrees	140	3161	.044
90 Degrees	473	3161	.150
80 Degrees	902	3161	.285
15 Percent	125	3153	.040
25 Percent	583	3153	.185
40 Percent	1694	3153	.537
15 mph	24	3161	.007
10 mph	232	3161	.073
8 mph	560	3161	.177

### Ignition Locations

Ignition locations were selected to test the fuelbreak’s effectiveness so that the anticipated fire spread patterns can be developed using FARSITE. The fuelbreak is not identified in the original fuel layer. However, the Primary and Secondary Containment lines were edited from the original fuel map. The treated areas were changed to a Fuel Model #8, the model with the most benign burning characteristics.



<sup>2</sup> From the Marin County Fire Department Fire Management Plan,

The following segments of the fuelbreak were tested comparing the fire growth with and without fuel management.

1. Peter's Dam
2. San Geronimo Ridge (N wind scenario)
3. N wind on Pam's Blue Ridge (ala Cascade Canyon)
4. Deer Park - Worn Springs to Baldy
5. Bolinas Ridge (possibly along the GGNRA Bolinas Ridge Fuelbreak, which is along road to be a control line for prescribed fires in the redwoods on top.
6. Treatment Plant (threatening treatment plan & water supply)
7. Bill Williams
8. Mill Valley

## RESULTS

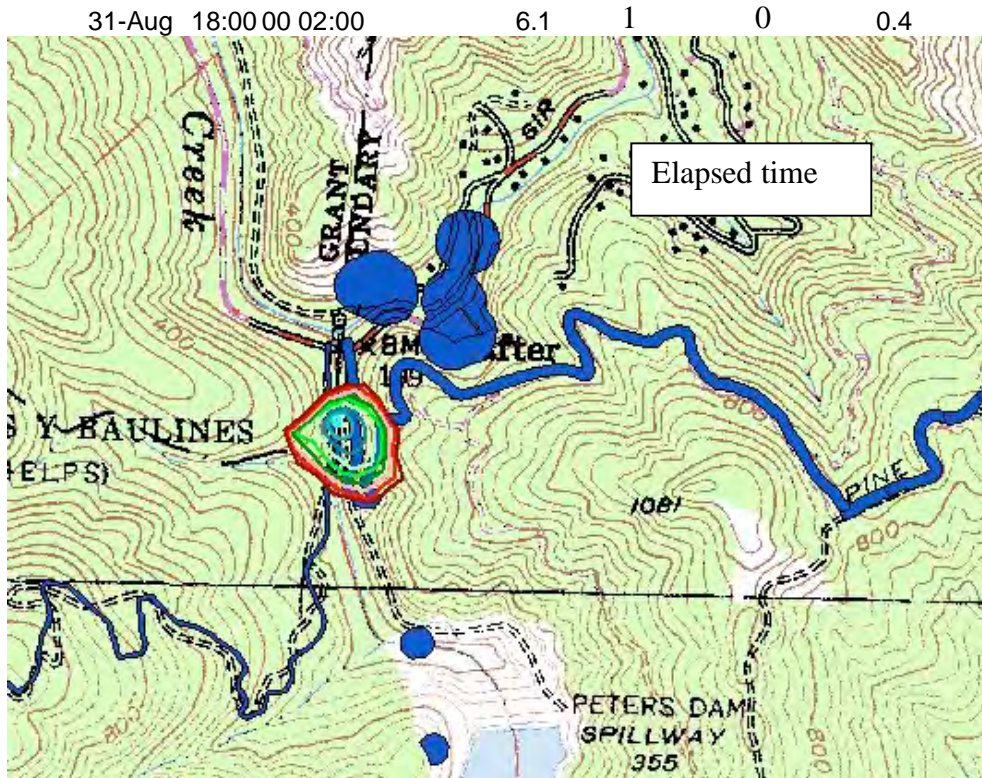
**1. Peter's Dam:** The difference from 10 to 6 acres shows the utility of fuel treatment to slow fire spread near the dam. The difference in fire size, intensity and acreage is not significant, however, the number of fires is the important, since with fuel treatment no torching is predicted to occur.

### Peters Dam no fuelbreak

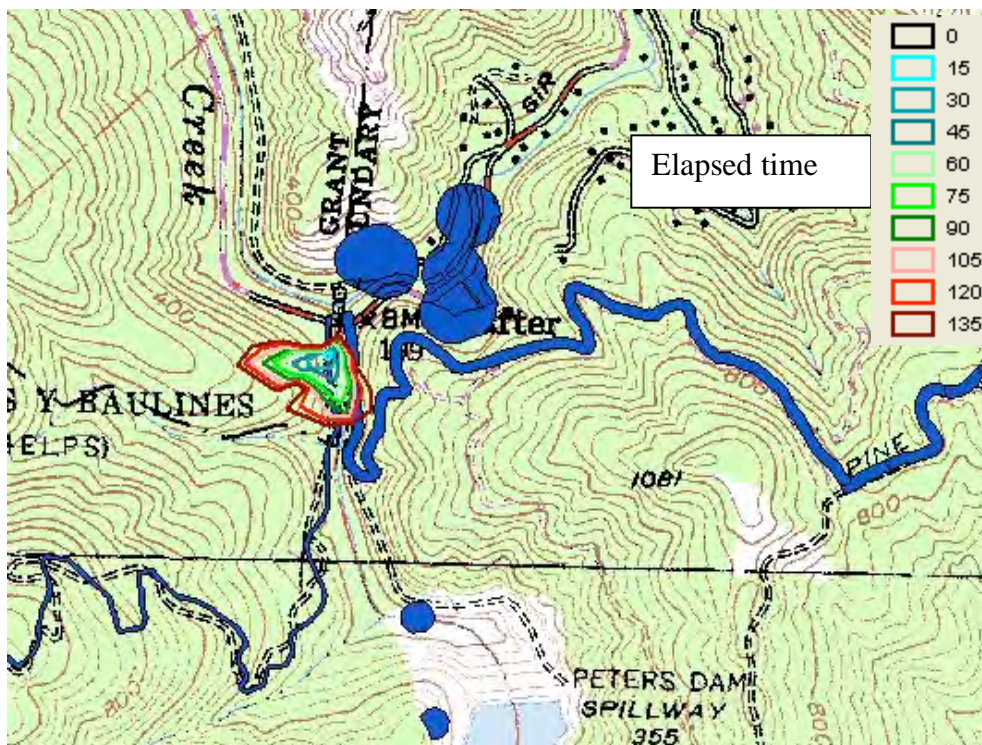
<i>Date</i>	<i>Time</i>	<i>Elapsed Time</i>	<i>Fire Area (acres)</i>	<i># of Fires</i>	<i>Spots</i>	<i>Perimeter (miles)</i>
31-Aug	16:00	00:00:00	0.0	4	3	0.0
31-Aug	16:15	00:00:15	0.1	4	3	0.0
31-Aug	16:30	00:00:30	0.6	2	1	0.1
31-Aug	16:45	00:00:45	1.7	1	0	0.2
31-Aug	17:00	00:01:00	3.3	1	0	0.2
31-Aug	17:15	00:01:15	5.2	1	0	0.3
31-Aug	17:30	00:01:30	6.9	1	0	0.4
31-Aug	17:45	00:01:45	8.4	1	0	0.4
31-Aug	18:00	00:02:00	10.1	1	0	0.4

### Peters Dam fuelbreak

<i>Date&amp;Time</i>	<i>Elapsed Time</i>	<i>Fire Area (acres)</i>	<i># of Fires</i>	<i>Spots</i>	<i>Perimeter (miles)</i>
31-Aug	16:00 00:00:00	0.0	1	0	0.0
31-Aug	16:15 00:00:15	0.0	1	0	0.0
31-Aug	16:30 00:00:30	0.4	1	0	0.1
31-Aug	16:45 00:00:45	1.0	1	0	0.2
31-Aug	17:00 00:01:00	1.7	1	0	0.2
31-Aug	17:15 00:01:15	2.5	1	0	0.3
31-Aug	17:30 00:01:30	3.6	1	0	0.3
31-Aug	17:45 00:01:45	4.6	1	0	0.4

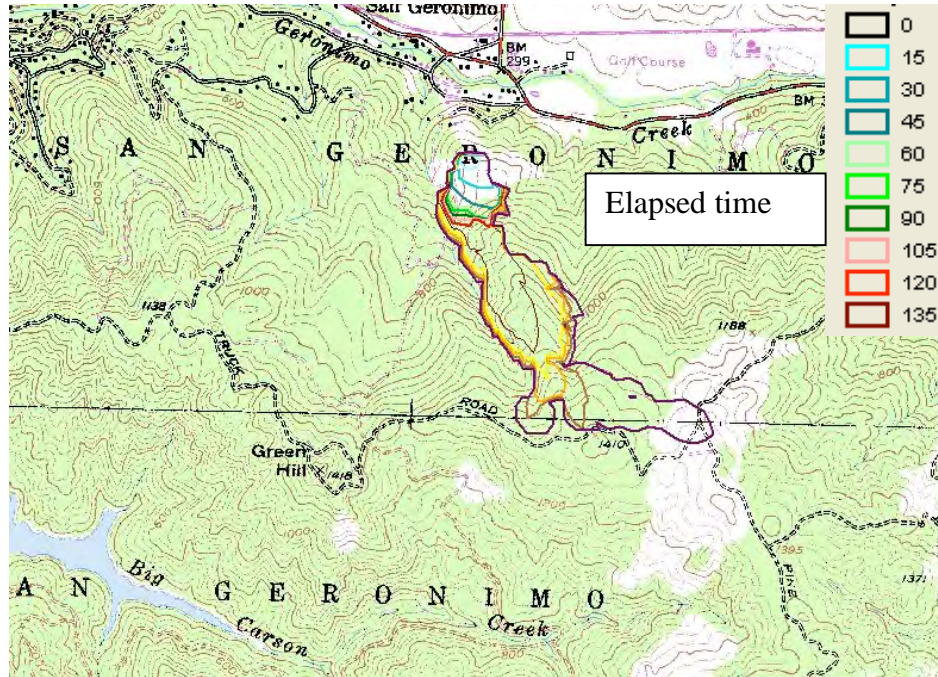


*Fire spread within two hours without the Secondary Containment Line. The line is shown only for orientation.*

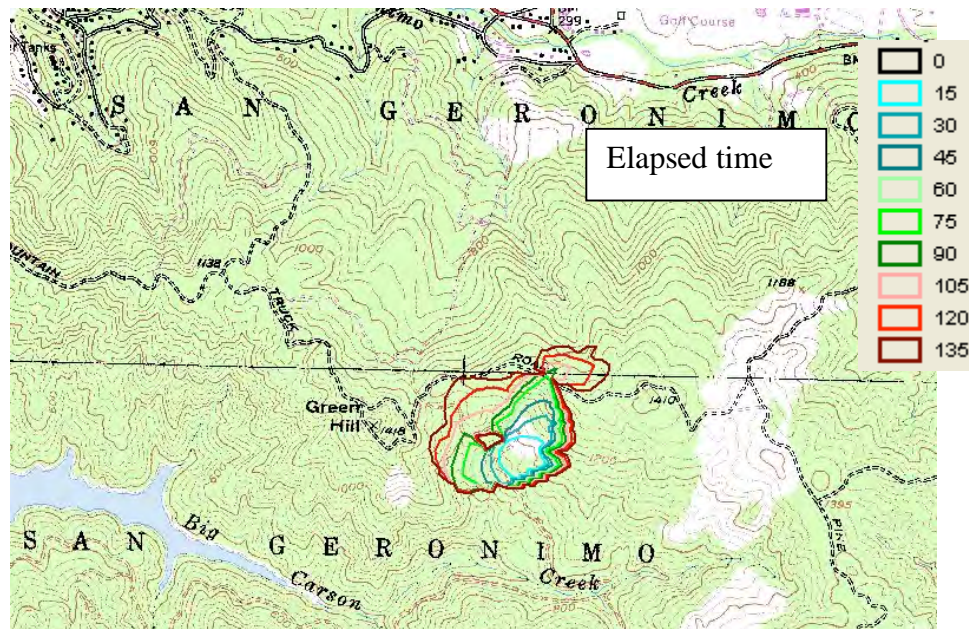


*Fire spread within two hours with the Secondary Containment Line.*

#2. San Geronimo Ridge. The first simulation shows the utility of the fuelbreak to contain a fire spread from the north (from a neighborhood), once initial attack is unsuccessful. If no containment location is available, fire spread through the chaparral above Kent Lake would be inevitable



*A hypothetical fire starting behind a yard in San Geronimo burns uphill through the chaparral to the District boundary and the Secondary Containment Line.*



A fire starting on the road down to Kent Lake jumps across the secondary containment line without suppression action. However, the fire spread is limited when it reaches the Containment line, indicating suppression action is more likely to be effective.

## San Geronimo Ridge FB

NW winds

<i>Date&amp;Time</i>	<i>Elapsed Time</i>	<i>Fire Area (acres)</i>	<i># of Fires</i>	<i>Spots</i>	<i>Perimeter (miles)</i>
29-Aug	13:30 00 00:00	0.0	12	1	0.0
29-Aug	13:45 00 00:15	0.9	1	0	0.1
29-Aug	14:00 00 00:30	4.0	1	0	0.3
29-Aug	14:15 00 00:45	8.0	4	3	0.4
29-Aug	14:30 00 01:00	10.4	1	0	0.5
29-Aug	14:45 00 01:15	11.1	1	0	0.5
29-Aug	15:00 00 01:30	11.9	1	0	0.5
29-Aug	15:15 00 01:45	12.8	1	0	0.6
29-Aug	15:30 00 02:00	14.0	20	19	0.6
29-Aug	15:45 00 02:15	33.0	15	14	1.4
29-Aug	16:00 00 02:30	48.9	4	3	1.6
29-Aug	16:15 00 02:45	58.0	10	9	1.9
29-Aug	16:30 00 03:00	68.3	56	55	2.2

## San Geronimo Ridge From Rd to Kent Lake

<i>Date&amp;Time</i>	<i>Elapsed Time</i>	<i>Fire Area (acres)</i>	<i># of Fires</i>	<i>Spots</i>	<i>Perimeter (miles)</i>
29-Aug	16:30 00 00:00	0.0	5	4	0.0
29-Aug	16:45 00 00:15	6.2	8	7	0.4
29-Aug	17:00 00 00:30	11.8	7	6	0.6
29-Aug	17:15 00 00:45	17.1	2	1	0.7
29-Aug	17:30 00 01:00	22.2	5	4	0.9
29-Aug	17:45 00 01:15	27.5	1	0	1.0
29-Aug	18:00 00 01:30	34.9	10	9	1.3
29-Aug	18:15 00 01:45	44.3	17	15	1.5
29-Aug	18:30 00 02:00	57.1	12	10	1.7

**#3. Pam's Blue Ridge.** These two simulations indicate that the fire is expected to spread through grass and chaparral under both a NW and NE wind direction. In neither case does the fire reach the access road. The access road is useful for staging equipment to get to the fire below. Burning characteristics are the same in both simulations; in both cases fire skirts around the woodland and forest fuel types, and burn through the grass and shrub-based fuels. The simulation illustrates that the overall fuel type is sometimes more important than the installation of fuelbreaks in determining overall spread pattern and fire size. This generality does not extend to potential damage, as fuelbreaks can help guide fire growth to avoid high-value locations in strategically important ways



*Fire growth with a northwest wind, burning almost the same area and location as with a different ignition location and wind direction.*

### **Pam's Blue Ridge NE Wind**

<b>Date</b>	<b>Elapsed Time</b>	<b>Fire Area (acres)</b>	<b># of Fires</b>	<b>Spots</b>	<b>Perimeter(miles)</b>
31-Aug 16:30	00:00	0.0	1	0	0.0
31-Aug 16:45	00:15	27.8	23	22	1.0
31-Aug 17:00	00:30	75.8	124	123	2.3
31-Aug 17:15	00:45	127.0	18	16	3.3
31-Aug 17:30	01:00	146.9	6	4	3.7
31-Aug 17:45	01:15	165.4	6	3	4.1
31-Aug 18:00	01:30	187.9	4	1	4.7
31-Aug 18:15	01:45	217.6	5	0	5.5
31-Aug 18:30	02:00	243.8	10	3	5.8
31-Aug 18:45	02:15	265.5	12	6	6.0
31-Aug 19:00	02:30	290.4	13	1	6.1
31-Aug 19:15	02:45	307.0	11	0	6.1
31-Aug 19:30	03:00	320.1	11	0	6.3

### **Pam's Blue Ridge NW wind**

<b>Date</b>	<b>Elapsed Time</b>	<b>Fire Area (acres)</b>	<b># of Fires</b>	<b>Spots</b>	<b>Perimeter(miles)</b>
29-Aug 14:30	00:00	0.0	1	0	0.0
29-Aug 14:45	00:15	4.8	4	3	0.3
29-Aug 15:00	00:30	14.3	29	28	0.6
29-Aug 15:15	00:45	32.5	28	27	1.1
29-Aug 15:30	01:00	50.1	10	9	1.4
29-Aug 15:45	01:15	66.5	3	2	1.9
29-Aug 16:00	01:30	81.8	3	2	2.4
29-Aug 16:15	01:45	129.7	17	15	3.4
29-Aug 16:30	02:00	160.7	12	10	3.8

#### **4. Deer Park – Worn Springs Road**

The simulations focus on the need for fuel management along the western border of MMWD. Surface fuels were modified to characterize the presence of French broom and occasional SOD in the understory. Individual 30-m pixels were changed from Fuel Model 8 (oak woodland) to Fuel Model 4 (Brush/Chaparral). In this worst-case scenario, winds blew from the northwest at 15-20 miles per hour.

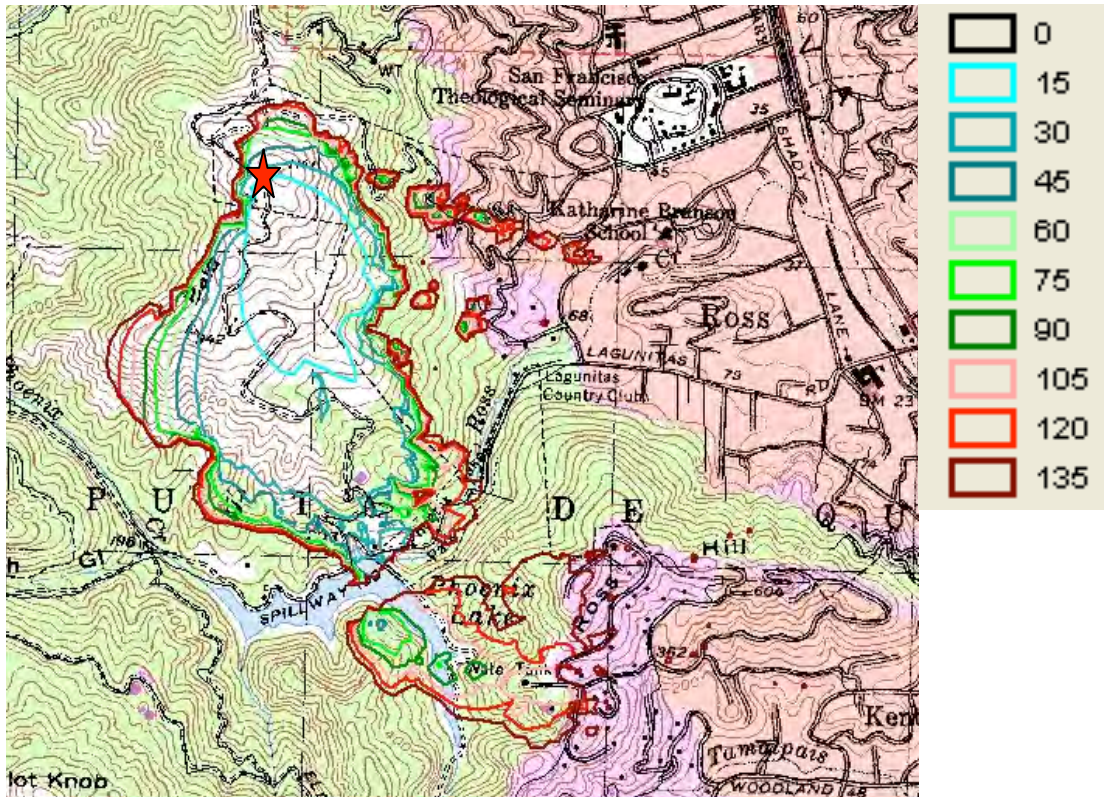
The fire continues to burn in the grass as a surface fire until it runs into the crowns of the hardwoods. The spotting that results challenges fire suppression efforts as it moves through the vegetation surrounding the residences on the western extent of Ross.

This highlights the importance of pruning along the outer edge of the woodland canopy. Fire behavior is expected to moderate once it spreads into the woodland, but the energy of the fire could easily allow the flames to climb into the tree crown, and thereby starting a chain of heat transfer that is difficult to stop. Performance standards along all fuelbreaks should include an emphasis of pruning lower tree limbs on the boundary between trees and shrubs, and trees and grass.

This scenario involves hundred of homes, with values far greater than the \$600,000 average value per structure in Marin. The combination of accumulated understory fuels and SOD jeopardize neighborhoods to the west of MMWD lands.

### **Worn Springs Road with Broom & SOD**

<i>Date</i>	<i>Time</i>	<i>Elapsed Time</i>	<i>Fire Area (acres)</i>	<i># of Fires</i>	<i>Spots</i>	<i>Perimeter (miles)</i>
29-Aug	12:00	0:00	0.0	1	0	0.0
29-Aug	12:15	0:15	52.7	44	43	0.7
29-Aug	12:30	0:30	143.9	66	116	2.4
29-Aug	12:45	0:45	176.1	65	25	3.6
29-Aug	13:00	1:00	194.2	55	8	4.8
29-Aug	13:15	1:15	211.2	60	40	6.4
29-Aug	13:30	1:30	231.0	172	103	8.1
29-Aug	13:45	1:45	265.7	204	32	8.8
29-Aug	14:00	2:00	301.0	192	208	9.4

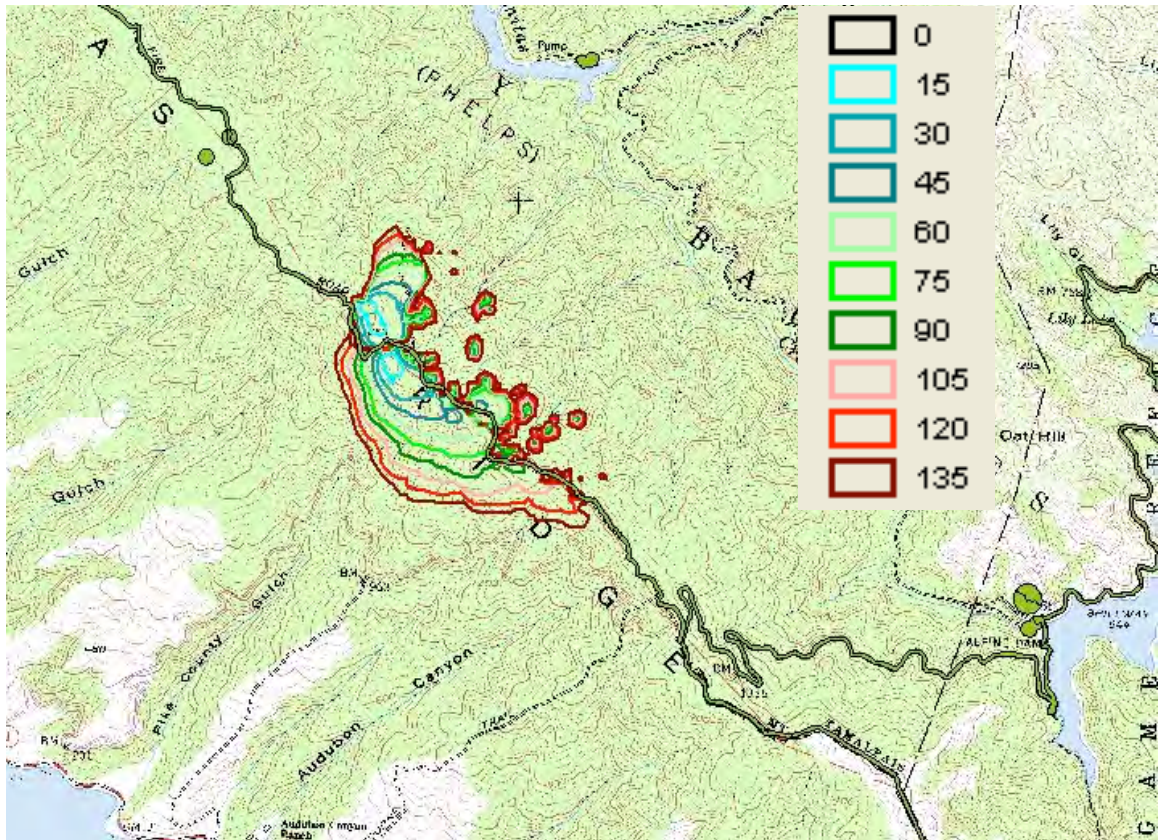


### 5. Bolinas Ridge

A fire burning with a westerly wind in chaparral off the Bolinas Ridge Fire Road quickly crosses the road and fuelbreak. With poor access, the ~75 acre fire will be a challenge to contain. There are no structures in the area, so even though the fire is large, damage is not as great as in any fire on the western border.

### Bolinas Ridge

Date	Time	Elapsed Time	Fire Area (acres)	# of Fires	Spots	Perimeter (miles)
29-Aug	17:30	0:00	0.0	23	22	0.0
29-Aug	17:45	0:15	1.9	44	21	1.0
29-Aug	18:00	0:30	8.1	35	11	2.0
29-Aug	18:15	0:45	14.1	47	17	3.4
29-Aug	18:30	1:00	22.9	59	17	4.9
29-Aug	18:45	1:15	31.3	75	22	6.2
29-Aug	19:00	1:30	40.5	90	31	7.9
29-Aug	19:15	1:45	52.5	102	27	9.2
29-Aug	19:30	2:00	64.9	86	7	10.8
29-Aug	19:45	2:15	76.9	57	1	11.4

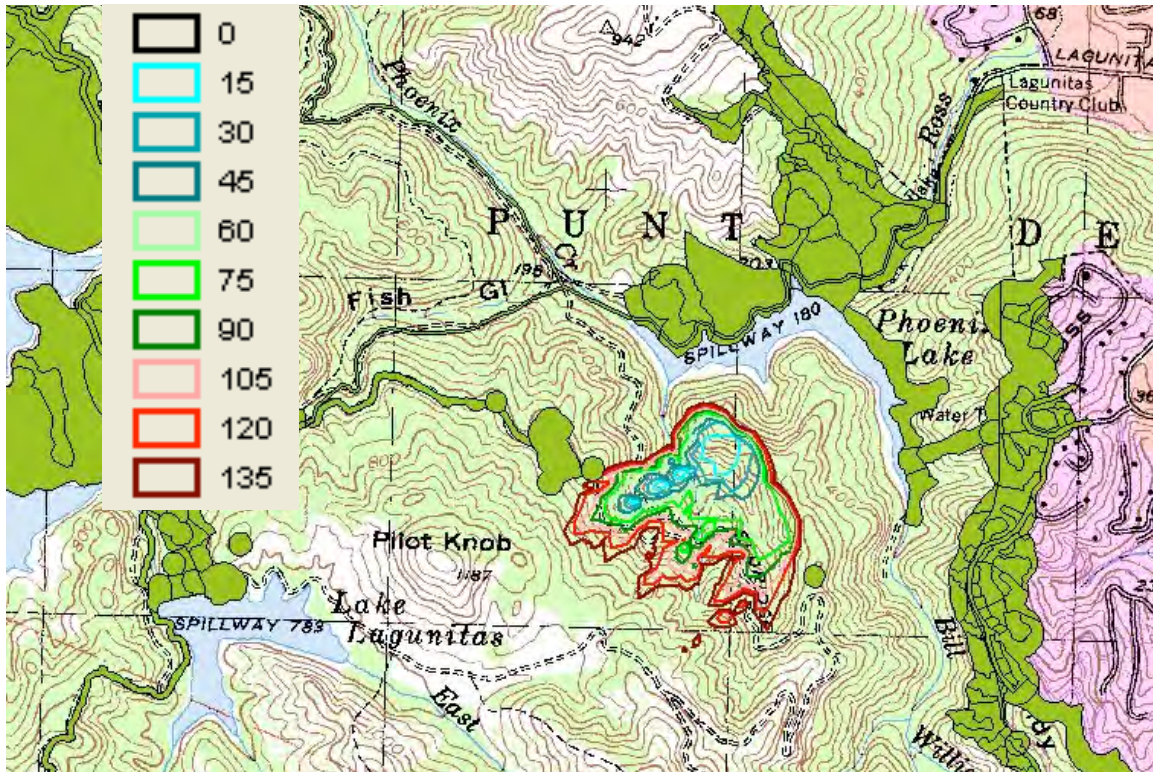


### 6. Treatment Plant (threatening treatment plan & water supply)

Fire burning under an easterly wind near the Treatment Plant spreads through the chaparral but decreases its speed through the woodland fuels. Treatments adjacent to the Treatment Plant help avoid direct spread to the facility.

### Treatment Plant

<i>Date</i>	<i>Time</i>	<i>Elapsed Time</i>	<i>Fire Area (acres)</i>	<i># of Fires</i>	<i>Spots</i>	<i>Perimeter (miles)</i>
31-Aug	17:30	0:00	0.0	31	30	0.1
31-Aug	17:45	0:15	1.4	33	2	1.0
31-Aug	18:00	0:30	3.5	26	8	1.4
31-Aug	18:15	0:45	6.1	17	2	2.0
31-Aug	18:30	1:00	9.5	14	1	2.6
31-Aug	18:45	1:15	12.7	11	1	2.8
31-Aug	19:00	1:30	16.1	8	1	3.2
31-Aug	19:15	1:45	19.8	8	1	3.7
31-Aug	19:30	2:00	24.1	9	1	4.1
31-Aug	19:45	2:15	28.7	9	0	4.1

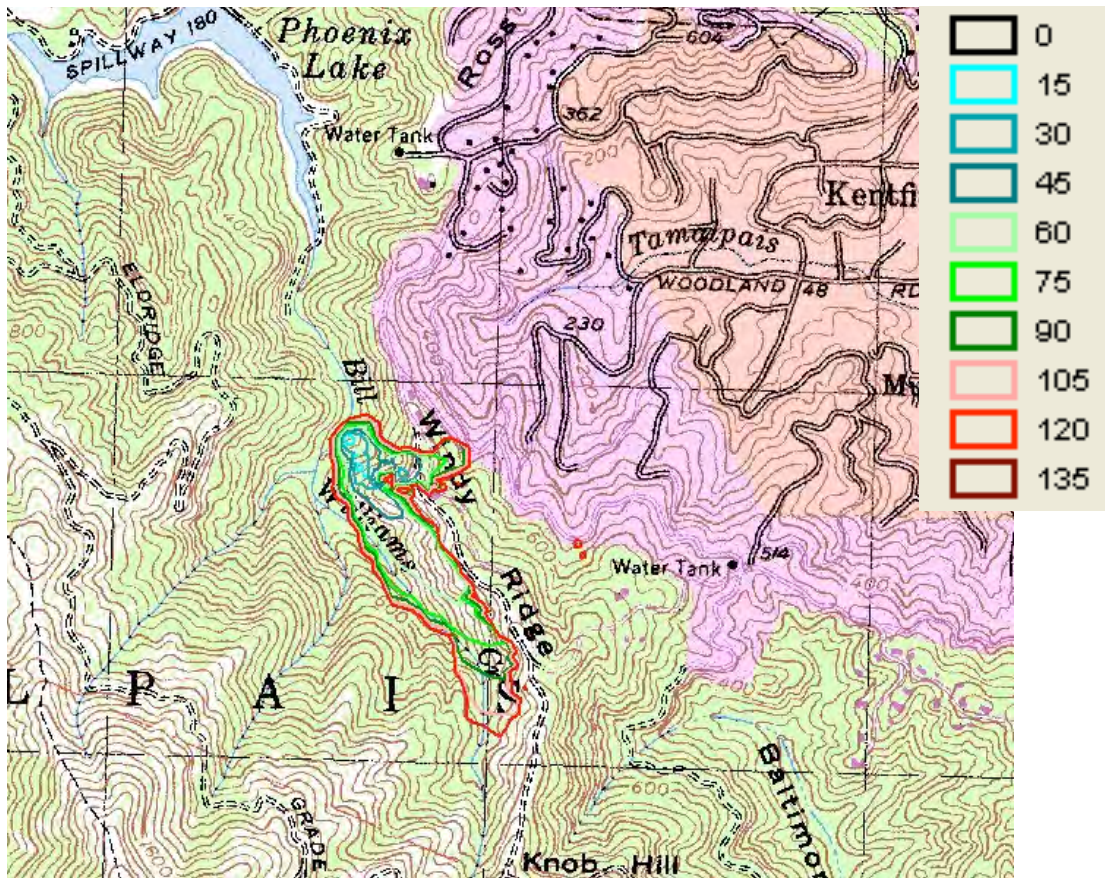


### 7. Bill Williams Gulch

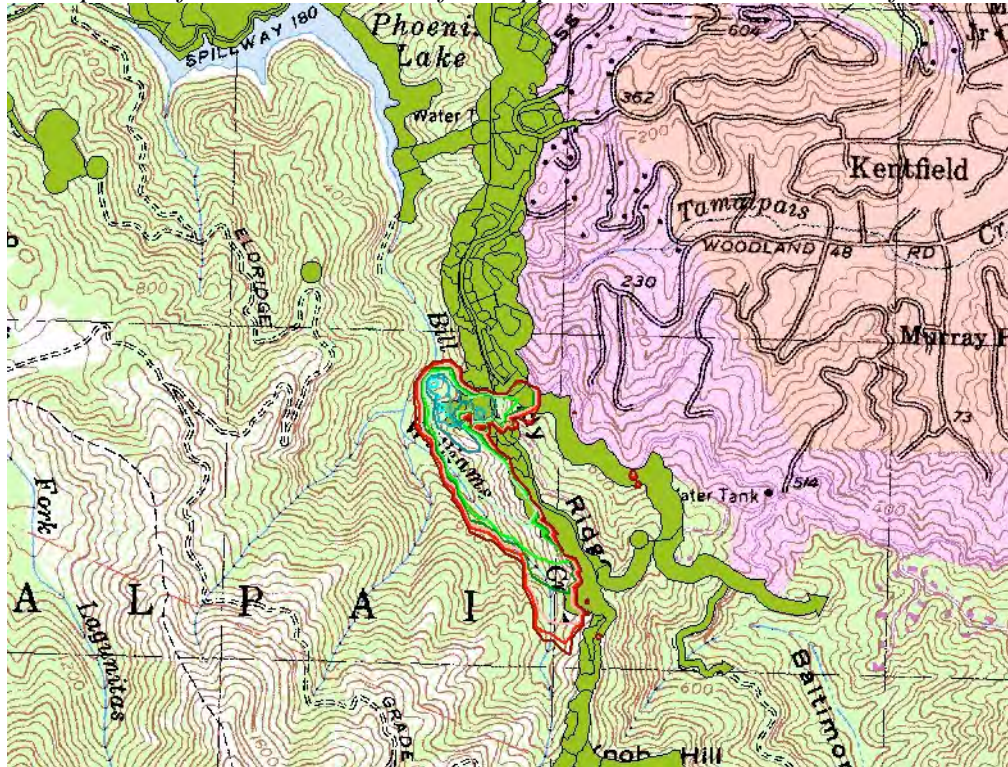
Fire spread accelerates only after 45 minutes, spreading up the chaparral-filled canyon. The western border largely follows the fuelbreak with a small stretch blowing across the saddle. The fuelbreak is largely effective. If fire does cross the MMWD border, the potential damage is newsworthy.

### Williams Gulch

Date	Time	Elapsed Time	Fire Area (acres)	# of Fires	Spots	Perimeter (miles)
29-Aug	12:30	0:00	0.0	6	5	0.0
29-Aug	12:45	0:15	0.2	14	8	0.1
29-Aug	13:00	0:30	1.7	20	7	0.4
29-Aug	13:15	0:45	5.3	17	3	0.7
29-Aug	13:30	1:00	14.7	14	1	1.1
29-Aug	13:45	1:15	22.7	8	0	1.4
29-Aug	14:00	1:30	29.4	10	1	1.6
29-Aug	14:15	1:45	35.6	10	3	1.8
29-Aug	14:30	2:00	40.2	11	1	1.9



*Fire spread after 2 hours with no fire suppression, but with installed fuelbreak.*



*Fire spread after 2 hours with fuelbreak displayed. No effective fire suppression.*

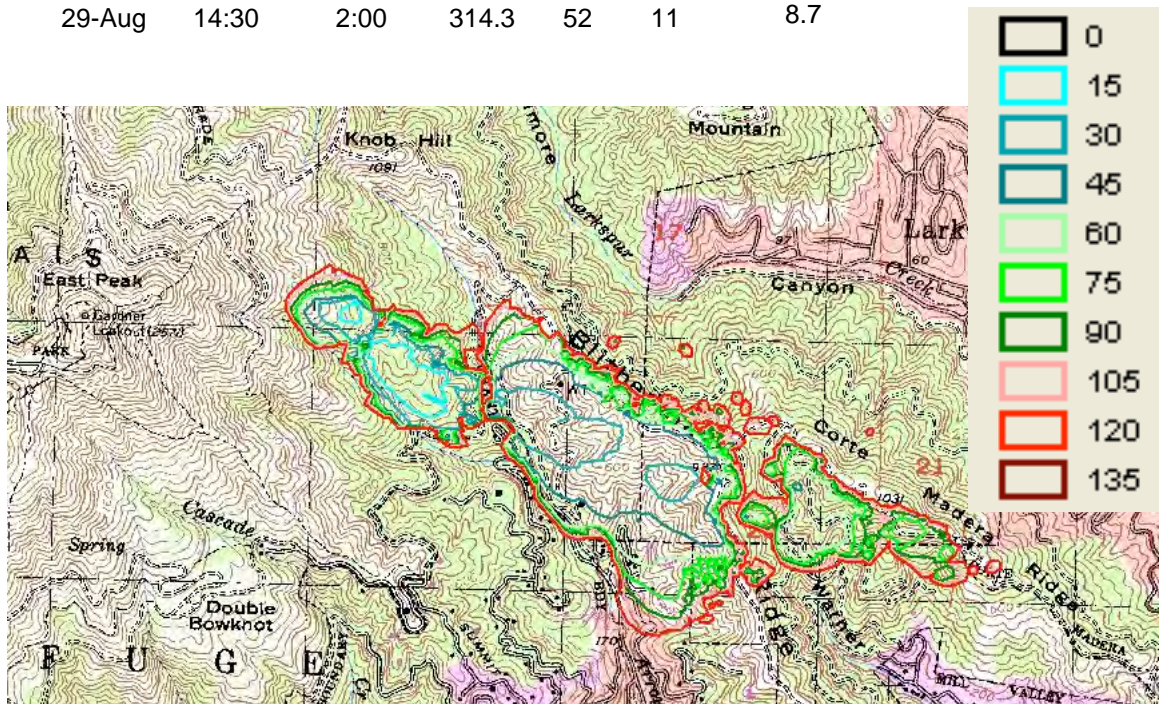
## 8. Mill Valley

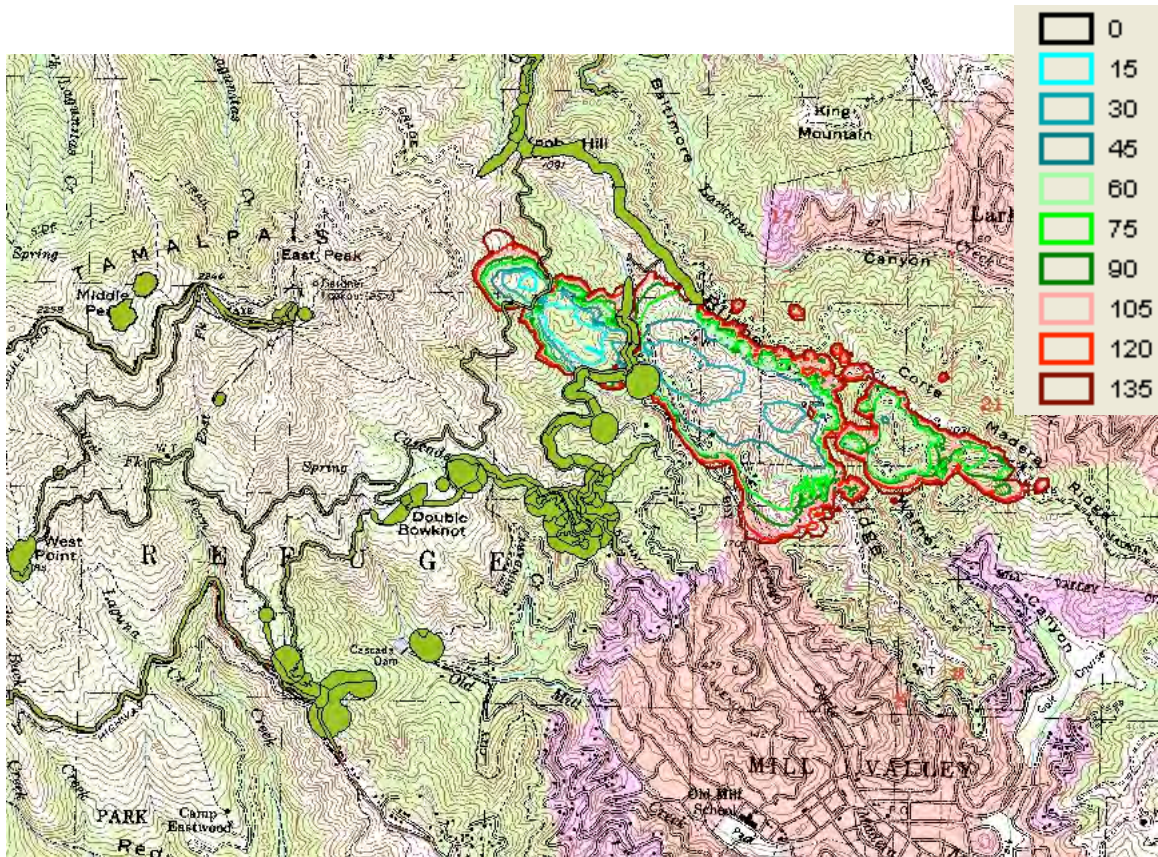
The ignition below East Peak simulates an ignition strike as it is not near a road but on a side ridge. Several other simultaneous ignition sites did not spread; the results of this particular ignition location were tracked to identify locations that have a potential for damage. Tracking the acreage and number of fires from multiple ignition sites gets very confusing.

The fire does jump the fuelbreak on the MMWD boundary after 30 minutes of fire spread, and Blithedale Ridge after 75 minutes of burning with no effective fire suppression. With rapid response and set-up, effective fire suppression could prevent fire spread from the two fuelbreaks in place. Other simulations consistently result in crossing the MMWD fuelbreak along its border within 30 minutes with no fire suppression. This illustrates the importance of early suppression actions, effective within 30 minutes.

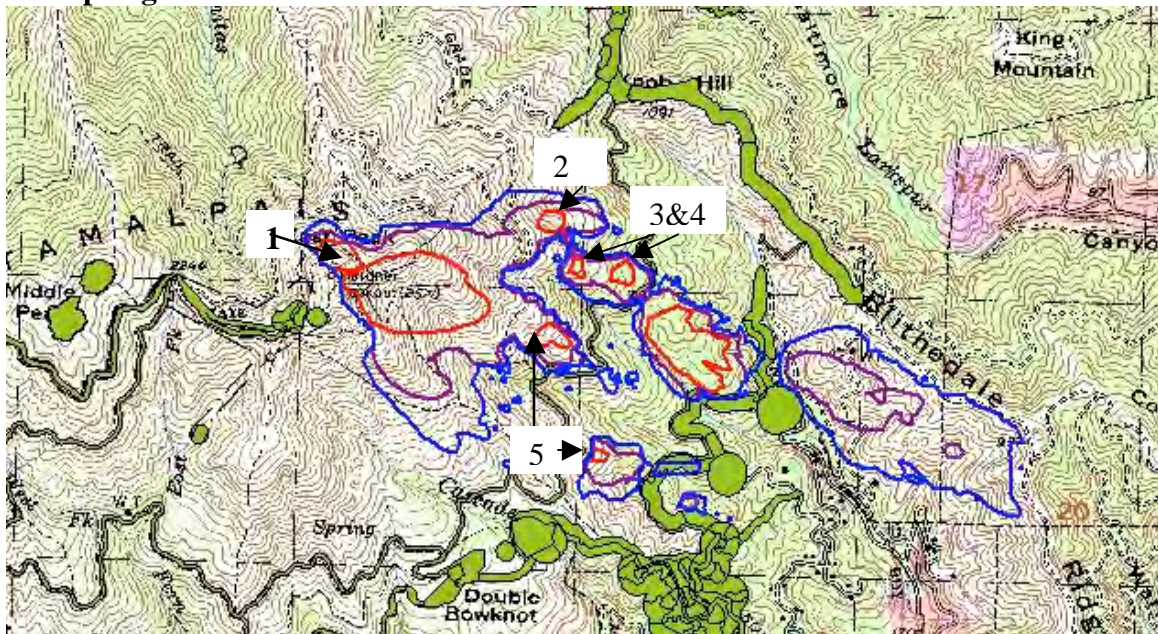
## Mill Valley

Date	Time	Elapsed Time	Fire Area (acres)	# of Fires	Spots	Perimeter (miles)
29-Aug	12:30	0:00	0.0	22	21	0.0
29-Aug	12:45	0:15	13.7	48	26	1.0
29-Aug	13:00	0:30	58.4	89	48	3.1
29-Aug	13:15	0:45	124.6	150	81	4.2
29-Aug	13:30	1:00	175.8	244	105	6.3
29-Aug	13:45	1:15	215.7	229	46	8.1
29-Aug	14:00	1:30	253.6	131	4	8.2
29-Aug	14:15	1:45	285.1	67	6	8.5
29-Aug	14:30	2:00	314.3	52	11	8.7





Multiple ignitions south side of East Peak



In this display the colors for the time sequences are: red = 15 minutes elapsed, purple = 45 minutes elapsed, blue = 1 hr elapsed.

Six simultaneous ignitions burn, after 1 hour one ignition site envelops the others. This illustrates the importance of the location of the ignition.