HYDROLOGY RESOURCE ASSESSMENT

Prepared by: Tracy Weddle – Hydrologist
Corrine Black - Hydrologist

Santiago Fire

November 9, 2007

Redacted Version Nov 28, 2007
This is a redacted version of this report. The treatment costs and addresses were removed from this report so bidding for any contracts for treatment implementation would not be influenced. The location of T & E species was removed to protect them from potential human disturbance.

Objectives

- Assess watershed changes caused by the fire, particularly those that pose substantial threats to human life and property.
- Assess potential downstream effects of severely burned areas.
- Identify values at risk downstream and down slope from the high and moderate severity burn areas.

Initial Concerns

- Threats to human life and property within and downstream of the burn area from flooding and debris slides.
- Threats to Water Quality downstream of the burn area.

Resource Setting

The majority of the burn area is located in the Lower Santa Ana Watershed, with some areas in the Aliso/Laguna and San Juan Creek Watersheds. Most of the area burned on NF drains into Irvine Lake (also known as Santiago Reservoir), with a few watersheds flowing into Trabuco Canyon. The mean annual rainfall is estimated at 24 inches and occurs primarily in the winter months. A USGS stream gauge is located along Santiago Creek at Modjeska. This gauge was installed in 1962 and has recorded peak flows in 1969 and 1998 exceeding 6200 cfs. Annual peak flows were as low as 3.4 and 5.6 (2002 and 1999 respectively).

The fire burned approximately 28,476 acres (6,701 acres occurred on the Trabuco Ranger District). This analysis includes all the watersheds that flow into Lake Irvine, some of which have little to no burn area but are included to assess the increase in sediment and overall discharge to the reservoir. Not included in this analysis are watersheds which are located entirely on private lands and which flow away from the reservoir. Because so much of the burn area is located upslope from the communities of Silverado, Modjeska, Williams and Trabuco, smaller subwatersheds were delineated to better assess the hazards to these communities. Figure 1 displays the watersheds delineated for this assessment.

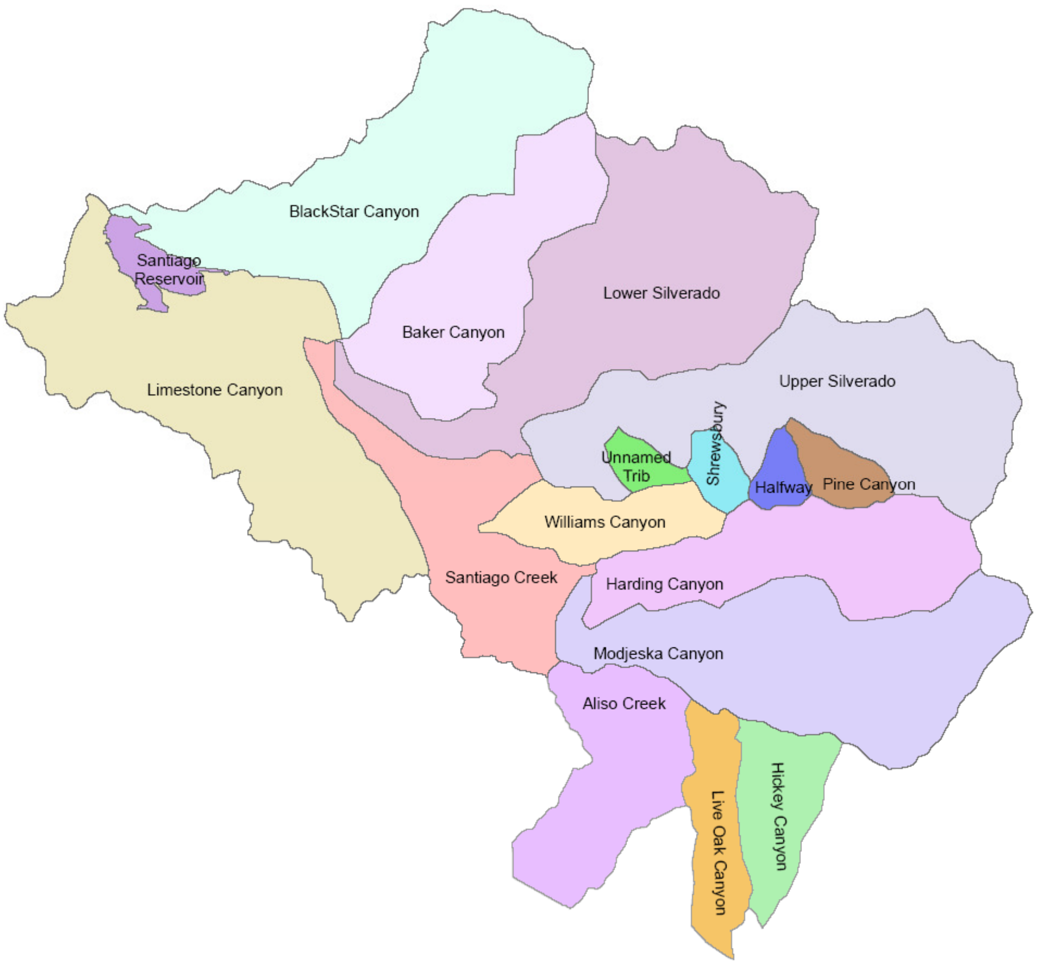


Figure 1 – Assessment Watersheds of the Santiago Fire

The BAER Team assessment found the overall burn severity summary for the 28,476 acre Santiago Fire was 1,799 acres High, 8,184 acres Moderate, and 18,314 acres Low and Unburned. Table 1 lists the acres burned by severity within the assessment watersheds.

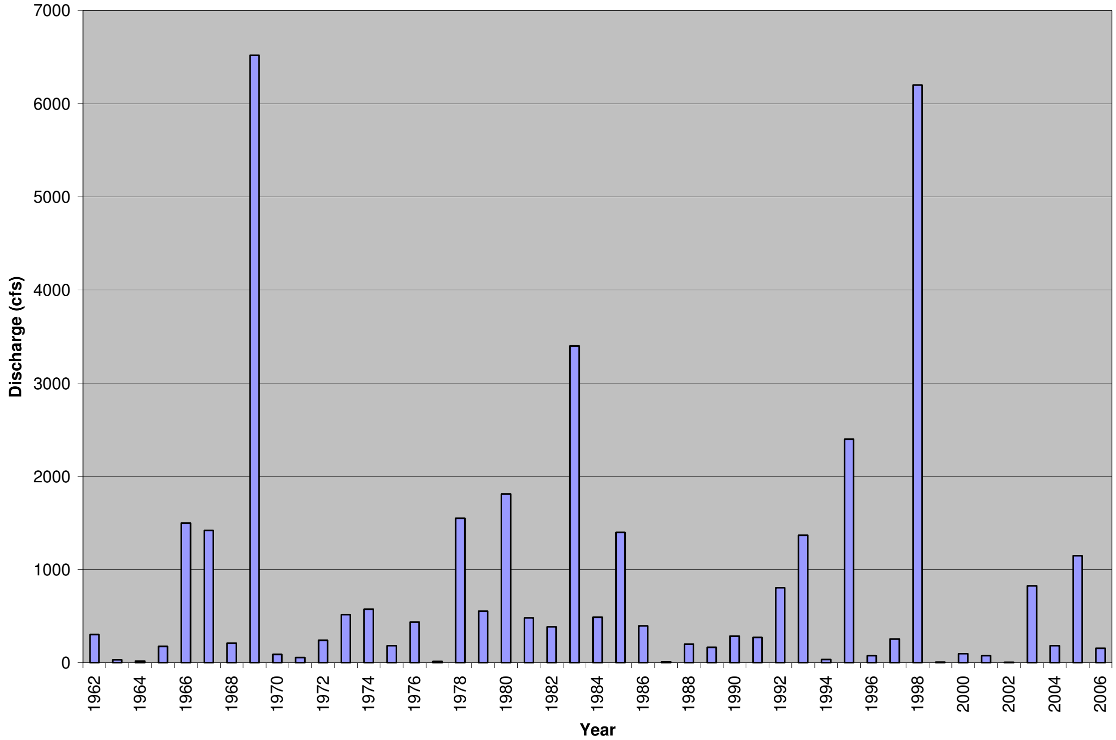
Table 1: Acres of burn severity by watershed within the Santiago Fire

Assessment Watersheds	High Burn Severity	Moderate Burn Severity	Low Burn Severity	Watershed Acres Not Burned	Total Watershed Acres	% of High & Moderate Burn Severity
Black Star Canyon	0	0	0	5,349	5,349	0%
Limestone Canyon	37	784	2,646	2,936	6,403	13%
Santiago above Reservoir	1,404	4,566	3,543	18,864	28,377	21%

Williams	34	636	222	366	1,258	53%
Silverado	218	741	388	11,602	12,949	7%
Lower Silverado	0	12	43	6,114	6,169	0.2%
Upper Silverado	218	729	345	5,488	6,780	14%
Assessment Watersheds	**High Burn Severity**	**Moderate Burn Severity**	**Low Burn Severity**	**Watershed Acres Not Burned**	**Total Watershed Acres**	**% of High & Moderate Burn Severity**
Pine Canyon	84	247	75	81	487	68%
Halfway Canyon	71	160	49	29	309	75%
Shrewsbury Spring	2	173	20	147	342	51%
Unnamed Trib	0	7	15	267	289	2%
Baker Canyon	0	0	0	3,450	3,450	0%
Santiago Upstream of Gauge	1,141	2,644	1,652	2,530	7,967	48%
Harding Canyon	721	1,244	741	373	3,079	64%
Modjeska Canyon	419	1,400	911	2,165	4,895	37%
Hickey Canyon	0	25	106	1,129	1,260	2%
Live Oak Canyon	2	120	172	839	1,133	11%
Aliso Canyon	19	421	387	1,639	2,466	18%

Discharge within the assessment watersheds is highly variable. Annual peak discharge data from 1962-2006 can be seen in Figure 1 for the USGS stream gauge along Santiago Creek at Modjeska.

Figure 1: Annual Peak Discharge: USGS Gauge 11075800, Santiago Creek at Modjeska CA



Observation and Findings from On-The-Ground Surveys

Threats to Life and Property

The BAER Team performed a rapid air reconnaissance of the burned area to validate the burn severity map.

The Team began a rapid ground reconnaissance BAER watershed survey on November 1, 2007 by investigating Modjeska Canyon area. Investigations were centered on identifying structures and facilities that could be at risk to flooding during high stream flows and potential debris flows. The Modjeska Reservoir located in Harding Canyon was completely filled with sediment after the 1969 flood event. The dam was built in 1919 and is approximately 45 feet high and about 120 feet wide. Sediment has built up behind the dam for about 1200 feet. The reservoir still serves as a groundwater source for local residents. Several homes are located immediately downstream of the dam. The community of Modjeska is located immediately adjacent to the stream channel in a narrow confined valley with very steep side slopes. The one lane road into Harding Canyon has several bridge crossings and some residents have lined the channel bottom and side slopes with concrete. One resident at the end of the road has placed small check dams in the channel bottom.

On November 2, the BAER Hydrologists and Soil Scientists continued investigations in the Williams, Modjeska, Upper Silverado, Pine and Halfway watersheds. We encountered similar values at risk as in Harding and Modjeska Canyons. Specifically, structures located immediately adjacent to the stream channel in narrow, confined valleys with steep side slopes directly below areas of high and moderate burn severity.

On November 3, BAER Hydrologists investigated the Shrewsbury Spring and Unnamed Tributary in the Upper Silverado watersheds. No structures appeared to be located in the floodplain of Shrewsbury Spring. In the Unnamed Tributary downstream of Shrewsbury Spring, several houses are immediately adjacent to the stream channel. The structures here had about a 6 foot retaining wall constructed on the channel banks to protect it from high stream flows. The Silverado School located on Santiago Canyon Road was not built adjacent to a stream channel and did not appear to be at risk to flooding. No evidence of previous debris flows were noted at the school.

Another air reconnaissance flight was taken November 5 with BAER Hydrologists and Soil Scientist. The objective for the flight was to validate the Burn Severity Map and identify values at risk. The recon was concentrated in Williams, Harding, Modjeska and Silverado watersheds.

A meeting was held with the Orange County Public Works dept on November 7 (Engineering and Hydrology subcommittee). BAER Hydrologists shared the predicted increases in flows and sediment draining from the burn area.

Threats to Water Quality downstream of the burn area

BAER Hydrologist mapped the area above Irvine Lake (Santiago Reservoir watershed) to assess the potential for increased sedimentation during storm events. The reservoir is located about 6.5 miles downstream from the confluence of Williams Canyon. Approximately 21% of the watershed was mapped as high and moderate burn severity. Post fire erosion rates are estimated to be 6 times more than background levels. The discharge of a 2-year return interval storm was estimated to be approximately 2.6 times larger than under pre-fire conditions. The Cal Fire BAER Team will contact Irvine Ranch Water District concerning the expected increases in stream flows and sedimentation to the reservoir.

BAER Hydrologists and Soil Scientist investigated the abandoned Blue Light Mine located in the Pine Canyon watershed to assess the potential for increased runoff to erode existing tailing piles in the mine processing area. The drainage directly above the mine tailings was not burned and was not considered to be at risk to increased flooding. A portion of the mine processing area (20-30 CY) is perched along the upper bank of Pine Creek and could be undermined and delivered to the channel during a large storm event.

Threats to public road access in the burn area

The access roads (County and Private) in the communities of Modjeska, Harding, Williams, and Silverado that are located in and adjacent to the channel are at risk of flooding; subsequent bridge failures may occur during some storm events.

Results of Hydrologic Modeling

Discharge

Three models were analyzed to determine pre and post-fire discharges in the assessment watersheds. The USGS PEAKFQ program (2006) uses USGS stream gauge data to determine pre-fire discharges at different recurrence intervals. USGS gauge 11075800 (Santiago Creek at Modjeska) was used for this analysis. Waananen and Crippen (1977) was also used to predict pre-fire discharges at different recurrence intervals. Rowe, Countryman and Storey (1949) provides data for pre- and post-fire discharges and erosion rates in southern California watersheds. The analysis table used for the Santiago Fire was “Santiago Creek Above Dam.” The Santiago fire was an unprecedented event and therefore there is uncertainty in discharge estimates. Therefore, all three models were used to determine the 2, 5, 10, 25, 50, and 100-year pre-fire discharges to show the range of potential outcomes. Due to variability in results, the results were recorded as ranges of likely discharges. In addition to the three models, the Orange County Flood Control District provided 100-year pre-fire discharge data derived from hydrographs for most of the watersheds analyzed (Orange County Hydrology Manual, 1986; Orange County Hydrology Report EO8-2 and EO8-2A). The Orange County data fell within the range of likely discharges at all watersheds except one. The 100-year discharge range for this watershed was expanded to include the Orange County value.

Of the three models, Rowe, Countryman and Storey is the only model which is capable of determining post-fire discharges. Post-fire discharges in the assessment watersheds were determined using this method. The ratio of increase in discharge was determined. This ratio was multiplied by the pre-fire discharge estimates determined by the other two models as well as the 100-year discharge for the Orange County model. For example, if Rowe, Countryman and Storey predicted that at Williams Canyon a 5-year recurrence interval discharge would be 3 times larger post-fire than pre-fire, then the pre-fire results of the other models would be multiplied by 3 to approximate post-fire conditions.

Rowe, Countryman and Storey, PEAKFQ, and Waananen and Crippen do not calculate bulked flow, which may occur following fire as a result of debris flows/torrents. Following the 2003 Cedar Fire on the Cleveland National Forest, non-bulked results calculated using Rowe, Countryman and Storey were compared to a modified rational equation model which considered bulked flow using the U.S. Army Corps of Engineers Los Angeles district method for prediction of debris yield (2000). This comparison found that predicted bulked flows were 2.14 times larger than unbulked flows. Because bulked flows were not available with the three models analyzed for the Santiago fire, post-fire flows were multiplied by 2.14 to approximate bulked flows. This value was used to accommodate the high risk of debris flows throughout the fire area.

Tables 2-7 show increases in discharge due to fire. The project file includes excel spreadsheets used to calculate the reported values.

Table 2: Range of Predicted Discharges for 2-year return interval storm

Watersheds	Pre-Fire Discharge (cfs)	Post-Fire Discharge (cfs)	Bulked Discharge (cfs)	Ratio of increase
Black Star Canyon	92-192	92-192	92-192	1.00
Limestone Canyon	110-229	167-348	248-516	2.25
Santiago Ck above Reservoir	488-1,016	896-1,868	1478-3,080	3.03
Baker Canyon	59-124	59-124	59-124	1.00
Williams Canyon	22-45	68-142	134-279	6.20
Silverado Canyon	223-464	289-602	383-799	1.72
Lower Silverado Canyon	106-221	107-223	108-225	1.02
Upper Silverado Canyon	117-243	182-379	275-574	2.36
Pine Canyon	8-17	31-64	63-131	7.49
Halfway Canyon	5-11	21-44	43-90	8.17
Shrewsbury Spring	6-12	18-36	34-71	5.79
Unnamed Tributary	5-10	7-15	11-22	2.11
Santiago Ck Upstream of Gauge	137-286	399-832	772-1,609	5.63
Harding Canyon	53-110	189-394	383-797	7.23
Modjeska Canyon	84-175	210-438	389-811	4.63
Hickey Canyon	22-45	29-61	40-83	1.83
Live Oak Canyon	19-41	28-57	39-81	2.01
Aliso Creek	42-88	73-152	116-242	2.74

Table 3: Range of Predicted Discharges for 5-year return interval storm

Watersheds	Pre-Fire Discharge (cfs)	Post-Fire Discharge (cfs)	Bulked Discharge (cfs)	Ratio of increase
Black Star Canyon	218-759	218-759	218-759	1.00
Limestone Canyon	257-908	383-1,353	564-1,993	2.19
Santiago Ck above Reservoir	1139-4,025	2,044-7,222	3,345-11,821	2.94
Baker Canyon	138-489	138-489	138-489	1.00
Williams Canyon	50-178	153-541	301-1,063	5.96
Silverado Canyon	520-1,837	667-2356	878-3,103	1.69
Lower Silverado Canyon	248-875	249-881	252-891	1.02
Upper Silverado Canyon	272-962	417-1,475	626-2,212	2.30
Pine Canyon	20-69	69-245	141-497	7.20
Halfway Canyon	12-44	47-167	97-344	7.84
Shrewsbury Spring	14-49	39-140	77-270	5.58
Unnamed Tributary	12-41	17-59	24-84	2.06
Santiago Ck Upstream of Gauge	320-1,131	900-3,181	1,735-6,131	5.42
Harding Canyon	124-437	425-1,501	858-3032	6.94

Modjeska Canyon	196-694	475-1,680	876-3,097	4.46
Hickey Canyon	51-179	67-237	91-320	1.79
Live Oak Canyon	45-161	63-224	89-315	1.96
Aliso Creek	99-350	166-588	263-930	2.66

Table 4: Range of Predicted Discharges for 10-year return interval storm

Watersheds	Pre-Fire Discharge (cfs)	Post-Fire Discharge (cfs)	Bulked Discharge (cfs)	Ratio of increase
Black Star Canyon	366-1,469	366-1,469	366-1,469	1.00
Limestone Canyon	433-1,759	579-2,354	810-3,291	1.87
Santiago Ck above Reservoir	1,917-7,793	2,971-12,077	4,627-18,809	2.41
Baker Canyon	233-948	233-948	233-948	1.00
Williams Canyon	85-345	205-832	393-1,596	4.62
Silverado Canyon	875-3,556	1,046-4,252	1,315-5,346	1.50
Lower Silverado Canyon	417-1,694	419-1,703	422-1,717	1.01
Upper Silverado Canyon	458-1,862	627-2,549	893-3,630	1.95
Pine Canyon	33-134	91-369	182-738	5.52
Halfway Canyon	21-85	61-250	125-509	5.99
Shrewsbury Spring	23-94	53-216	100-407	4.34
Unnamed Tributary	20-79	25-103	35-141	1.78
Santiago Ck Upstream of Gauge	539-2,190	1,215-4,937	2,277-9,254	4.23
Harding Canyon	208-846	559-2,272	1,110-4,513	5.34
Modjeska Canyon	331-1,344	656-2,665	1,166-4,739	3.53
Hickey Canyon	85-346	104-424	134-546	1.58
Live Oak Canyon	77-311	97-396	130-530	1.70
Aliso Creek	167-677	245-996	368-1,497	2.21

Table 5: Range of Predicted Discharges for 25-year return interval storm

Watersheds	Pre-Fire Discharge (cfs)	Post-Fire Discharge (cfs)	Bulked Discharge (cfs)	Ratio of increase
Black Star Canyon	655-2,845	655-2,845	655-2,845	1.00
Limestone Canyon	777-3,405	957-4,191	1,275-5,584	1.64
Santiago Ck above Reservoir	3,445-15,092	4,733-20,739	7,019-30,754	2.04
Baker Canyon	419-1,835	419-1,835	419-1,835	1.00
Williams Canyon	153-669	299-1,310	559-2,447	3.66
Silverado Canyon	1572-6,887	1,781-7,804	2,153-9,432	1.37
Lower Silverado Canyon	749-3,281	751-3,292	756-3,313	1.01
Upper Silverado Canyon	823-3,606	1,030-4,512	1,397-6,119	1.70
Pine Canyon	59-259	130-569	255-1,119	4.32
Halfway Canyon	38-164	87-382	175-767	4.67
Shrewsbury Spring	42-182	78-343	143-628	3.45
Unnamed Tributary	35-154	42-185	55-241	1.57
Santiago Ck Upstream of Gauge	968-4,241	1,794-7,862	3,260-14,285	3.37
Harding Canyon	374-1,638	803-3,517	1,564-6,852	4.18
Modjeska Canyon	594-2,603	991-4,344	1,696-7,430	2.85
Hickey Canyon	153-670	176-772	218-954	1.42
Live Oak Canyon	138-603	163-715	208-913	1.52

Aliso Creek	299-1,312	395-1,732	565-2,476	1.89

Table 6: Range of Predicted Discharges for 50-year return interval storm

Watersheds	Pre-Fire Discharge (cfs)	Post-Fire Discharge (cfs)	Bulked Discharge (cfs)	Ratio of increase
Black Star Canyon	839-4,260	839-4,260	839-4,260	1.00
Limestone Canyon	996-5,099	1,191-6,097	559-7,979	1.56
Santiago Ck above Reservoir	4,414-22,599	5,815-29,770	8,458-43,302	1.92
Baker Canyon	537-2,748	537-2,748	537-2,748	1.00
Williams Canyon	196-1,002	355-1,816	655-3,352	3.35
Silverado Canyon	2,014-10,313	2,242-11,478	2,671-13,676	1.33
Lower Silverado Canyon	960-4,913	963-4,928	968-4,955	1.01
Upper Silverado Canyon	1,055-5,400	1,279-6,550	1,704-8,721	1.62
Pine Canyon	76-388	153-781	298-1,524	3.93
Halfway Canyon	48-246	102-522	204-1,042	4.24
Shrewsbury Spring	53-272	93-476	168-862	3.16
Unnamed Tributary	45-230	53-270	68-346	1.50
Santiago Ck Upstream of Gauge	1,240-6,350	2,139-10,949	3,834-19,627	3.09
Harding Canyon	479-2,452	945-4,839	1,825-9,345	3.81
Modjeska Canyon	761-3,898	1,193-6,108	2,008-10,279	2.64
Hickey Canyon	196-1,003	221-1,133	269-1,379	1.37
Live Oak Canyon	176-902	204-1,044	256-1,313	1.45
Aliso Creek	384-1,964	488-2,497	684-3,508	1.78

Table 7: Range of Predicted Discharges for 100-year return interval storm

Watersheds	Pre-Fire Discharge (cfs)	Post-Fire Discharge (cfs)	Bulked Discharge (cfs)	Ratio of increase
Black Star Canyon	1,916-6032	1,916-6,032	1,916-6,032	1.00
Limestone Canyon	2,281-7221	2,533-8,017	3,153-9,980	1.38
Santiago Ck above Reservoir	10,109-32,003	11,917-37,724	16,374-51,835	1.62
Baker Canyon	1,229-3,891	1,229-3,891	1,229-3,891	1.00
Williams Canyon	448-1,419	653-2,068	1,159-3,670	2.59
Silverado Canyon	4,613-14,603	4,907-15,533	5,631-17,826	1.22
Lower Silverado Canyon	2,198-6,957	2,201-6,969	2,210-6,998	1.01
Upper Silverado Canyon	2,415-7,646	2,705-8,564	3,421-10,828	1.42
Pine Canyon	173-549	273-863	517-1,638	2.98
Halfway Canyon	110-348	180-569	351-1,111	3.19
Shrewsbury Spring	122-386	173-549	300-950	2.46
Unnamed Tributary	103-326	113-358	138-437	1.34
Santiago Ck Upstream of Gauge	2,841-8,993	4,000-12,662	6,859-21,712	2.41
Harding Canyon	1,097-3,950	1,699-6,117	3,183-11,461	2.90
Modjeska Canyon	1,744-5,520	2,301-7,284	3,675-11,633	2.11
Hickey Canyon	449-1,421	482-1,525	562-1,781	1.25
Live Oak Canyon	404-1,278	439-1,391	528-1,671	1.31
Aliso Creek	879-2,781	1,013-3,207	1,345-4,256	1.53

Erosion

Annual erosion rates following fire were also determined using Rowe, Countryman and Storey. Table 8 displays the estimated increase in erosion following the fire.

Table 8: Annual Erosion rates Following Burning

Watersheds	Pre-Fire Erosion (cubic yards)	Post-Fire Erosion (cubic yards)	Ratio of increase
Black Star Canyon	9,096	9,096	1.00
Limestone Canyon	10,005	47,078	4.71
Santiago Ck above Reservoir	44,339	310,851	7.01
Baker Canyon	5,391	5,391	1.00
Williams Canyon	1,966	32,220	16.39
Silverado Canyon	20,233	63,538	3.14
Lower Silverado Canyon	9,639	10,181	1.06
Upper Silverado Canyon	10,594	53,357	5.04
Pine Canyon	761	15,392	20.23
Halfway Canyon	483	10,733	22.23
Shrewsbury Spring	534	8,121	15.20
Unnamed Tributary	452	1,942	4.30
Santiago Ck Upstream of Gauge	12,459	183,376	14.72
Harding Canyon	4,811	93,543	19.44
Modjeska Canyon	7,648	89,788	11.74
Hickey Canyon	1,969	6,800	3.45
Live Oak Canyon	1,770	7,054	3.98
Aliso Creek	3,853	23,677	6.14

Emergency Determination

Threats to Human Life and Property

Peak flow increases for the 2-year and 5-year storm in the Santiago Upstream of Gauge Watershed (this includes Harding and Modjeska Canyon watersheds) are estimated to increase 5.6 and 5.4 times pre-fire flows. Erosion rates are predicted to increase 14.7 times pre-fire erosion rates. Based on these estimates there is an emergency threat to life and property.

Several high risk areas were identified by the BAER watershed assessment team and they include:

- Residents and structures in immediate proximity to streams in the Modjeska, Harding, Williams, Pine and Halfway Canyons face increased risk from flooding and debris flows during high intensity rainstorms.

- Debris flows in Modjeska, Harding, Williams, Pine and Halfway Canyons could potentially create temporary dams in drainage bottoms which, when filled with water and then breach, can cause dangerous flooding downstream.
- Access roads (County and Private) in the communities of Modjeska, Harding, Williams, and Silverado are at risk of flooding and subsequent bridge crossing failures.

Threats to Water Quality
Peak flow increases for the 2-year and 5-year storm in Pine Creek is estimated to be 7.49 and 7.20 times pre-fire flows. The processing area of the Blue Light Mine is perched above the stream channel. There are about 20-30 cubic yards of material that could be transported downstream during a high flow event.

There is a threat to water quality at Irvine Lake. Increased storm discharges are estimated to be 2.6 times larger than pre-fire discharges during the 2-year return interval storm. Erosion may be 6 times background levels.

Treatments to Mitigate the Emergency

Aerial Hydromulching

There is an opportunity to reduce the expected post-fire peak flow increases by hydromulching moderate and high intensity burn areas where slopes are less than 50 percent. There are approximately 1750 such treatable acres on National Forest land. This treatment would also be expected to reduce erosion and sedimentation.

Rowe, Countryman and Storey predict post-fire discharges at various years following fire to account for natural recovery and return to pre-fire conditions. The model assumes that it takes 70 years to return to pre-fire discharge rates. To determine the effectiveness of proposed treatments on reducing post-fire discharges, it was assumed that treatments which improve ground cover would reduce post-fire discharges to conditions which would be seen 30 years following fire. This would assume approximately 70% effectiveness of treatment. It was also assumed that while bulking would be reduced by treatment, it would not be eliminated. Therefore, a bulking factor of 1.5 was used for the treated areas. The reduction in discharge was also applied to the other two models. The likelihood of success of the treatment is estimated to be 70% for up to the 10-year return interval storm. According to Orange County precipitation data, the 10-year, 6-hour duration storm would produce approximately 3.9 inches of rain (Orange County, 2007). Tables 9-11 show percent reduction in discharge expected with the hydromulch treatment. Using Santiago Creek upstream of gauge as a representative site, flow reduction estimates range from 25-27%. It is unlikely that hydromulching would be effective at the 25, 50 or 100-year return intervals because the flow magnitudes are too great.

Table 9: Reduction in 2-year Return Interval Discharge Following Treatment

Watersheds	Pre-Fire Discharge (cfs)	Post-Fire Bulked Discharge (cfs)	Discharge Following Treatment (cfs)	Percent Reduction in Discharge
Black Star Canyon	92-192	92-192	92-192	0
Limestone Canyon	110-229	248-516	248-516	0
Santiago Ck above Reservoir	488-1,016	1478-3,080	1,211-2,752	18
Baker Canyon	59-124	59-124	59-124	0
Williams Canyon	22-45	134-279	104-216	22
Silverado Canyon	223-464	383-799	358-745	7
Lower Silverado Canyon	106-221	108-225	108-225	0
Upper Silverado Canyon	117-243	275-574	250-520	9
Pine Canyon	8-17	63-131	49-101	22
Halfway Canyon	5-11	43-90	35-72	19
Shrewsbury Spring	6-12	34-71	33-68	3
Unnamed Tributary	5-10	11-22	11-22	0
Santiago Ck Upstream of Gauge	137-286	772-1,609	561-1,170	27
Harding Canyon	53-110	383-797	291-607	24
Modjeska Canyon	84-175	389-811	270-562	31
Hickey Canyon	22-45	40-83	37-78	8
Live Oak Canyon	19-41	39-81	33-68	15
Aliso Creek	42-88	116-242	116-241	0

Table 10: Reduction in 5-year Return Interval Discharge Following Treatment

Watersheds	Pre-Fire Discharge (cfs)	Post-Fire Bulked Discharge (cfs)	Discharge Following Treatment (cfs)	Percent Reduction in Discharge
Black Star Canyon	218-759	218-759	218-759	0
Limestone Canyon	257-908	564-1,993	564-1,993	0
Santiago Ck above Reservoir	1139-4,025	3,345-11,821	2,752-9,723	18
Baker Canyon	138-489	138-489	138-489	0
Williams Canyon	50-178	301-1,063	233-824	23
Silverado Canyon	520-1,837	878-3,103	821-2,900	6
Lower Silverado Canyon	248-875	252-891	252-891	0
Upper Silverado Canyon	272-962	626-2,212	569-2,009	9
Pine Canyon	20-69	141-497	109-387	23
Halfway Canyon	12-44	97-344	78-276	20
Shrewsbury Spring	14-49	77-270	74-261	4
Unnamed Tributary	12-41	24-84	24-85	0
Santiago Ck Upstream of Gauge	320-1,131	1,735-6,131	1,267-4,476	27
Harding Canyon	124-437	858-3032	655-2,315	24
Modjeska Canyon	196-694	876-3,097	611-2,160	30
Hickey Canyon	51-179	91-320	85-301	7
Live Oak Canyon	45-161	89-315	75-264	16
Aliso Creek	99-350	263-930	263-928	0

Table 11: Reduction in 10-year Return Interval Discharge Following Treatment

Watersheds	Pre-Fire Discharge (cfs)	Post-Fire Bulked Discharge (cfs)	Discharge Following Treatment (cfs)	Percent Reduction in Discharge
Black Star Canyon	366-1469	366-1,469	366-1,469	0
Limestone Canyon	433-1759	810-3,291	810-3,291	0
Santiago Ck above Reservoir	1917-7,793	4,627-18,809	3,918-15,925	15
Baker Canyon	233-948	233-948	233-948	0
Williams Canyon	85-345	393-1,596	312-1267	21
Silverado Canyon	875-3,556	1,315-5,346	1246-5067	5
Lower Silverado Canyon	417-1,694	422-1,717	422-1,717	0
Upper Silverado Canyon	458-1,862	893-3,630	824-3350	8
Pine Canyon	33-134	182-738	144-587	21
Halfway Canyon	21-85	125-509	102-415	18
Shrewsbury Spring	23-94	100-407	97-394	3
Unnamed Tributary	20-79	35-141	35-141	0
Santiago Ck Upstream of Gauge	539-2,190	2,277-9,254	1,717-6,979	25
Harding Canyon	208-846	1,110-4,513	868-3,526	22
Modjeska Canyon	331-1,344	1,166-4,739	849-3,451	27
Hickey Canyon	85-346	134-546	128-520	4
Live Oak Canyon	77-311	130-530	113-460	13
Aliso Creek	167-677	368-1,497	368-1,495	0

Rowe, Countryman and Storey was used to determine the effectiveness of proposed treatments on reducing post-fire erosion. The model assumes that it takes 10 years to return to pre-fire erosion rates. It was assumed that hydromulch would reduce post-fire erosion in moderate and high burn severity areas to conditions which would be seen 3 years following fire. Table 12 displays the reduction in erosion from post-fire (no treatment) to post-treatment conditions.

Table 12: Reduction in Annual Erosion rates Following Treatment

Watersheds	Pre-Fire Erosion (cubic yards)	Post-Fire Erosion (cubic yards)	Erosion Following Treatment (cubic yards)	Percent Reduction in Erosion
Black Star Canyon	9,096	9,096	9,096	0
Limestone Canyon	10,005	47,078	47,078	0
Santiago Ck above Reservoir	44,339	310,851	249,781	20
Baker Canyon	5,391	5,391	5,391	0
Williams Canyon	1,966	32,220	25,254	22
Silverado Canyon	20,233	63,538	57,618	9
Lower Silverado Canyon	9,639	10,181	10,181	0
Upper Silverado Canyon	10,594	53,357	47,437	11
Pine Canyon	761	15,392	12,179	21
Halfway Canyon	483	10,733	8,748	19
Shrewsbury Spring	534	8,121	7,832	4
Unnamed Tributary	452	1,942	1,942	0
Santiago Ck Upstream of Gauge	12,459	183,376	135,191	26
Harding Canyon	4,811	93,543	72,645	22
Modjeska Canyon	7,648	89,788	62,501	30

Hickey Canyon	1,969	6,800	6,259	8
Live Oak Canyon	1,770	7,054	5,574	21
Aliso Creek	3,853	23,677	23,641	0

Mine Spoil Relocation

The Blue Light Mine is scheduled for reclamatin in the summer of 2008. Some reclamation work could begin immediately at the mine by excavating the section of the processing area that is protruding into the stream channel. There is a regional contract for hazmat projects, which the BAER implementation team must utilize to complete the emergency work. This treatment would include pulling back mine spoils from the stream and containing erosion by installing silt fencing or fiber rolls. Approximately 100 feet of the road needed to access the mine may need to be improved to allow equipment access. The On-Scene HazMat Coordinator, Jerry Degraff, estimates the cost to remove and stockpile 20-30 cubic yards of material would be about $XXXX. The Regional Hazardous Response Contract is the ONLY mechanism for implementation. The On-Scene Coordinator for this contract is Jerry Degraff (office phone 559-297-0706 ext. 4932 or cell phone (559-284-2230).

The CalFire BAER Team will coordinate with Irvine Ranch Water District to determine what treatment is needed to protect water quality at Irvine Lake.

References

Orange County Hydrology Report No EO8-2 and EO8-2A. Year unknown. Santiago Creek. From Villa Park Dam to Santiago Peak.

Orange County Hydrology Manual. 1986. Orange County Environmental Management Agency. 190 pp. http://www.ocflood.com/documents/OC_Hydrology_Manual.pdf

Orange County. 2007. Alert System – Orange County Point Precipitation Return Frequency Data. http://www.ocgov.com/pfrd/envres/Rainfall/alert_PPD.asp

Rowe, P.B., C.M. Countryman and H.C. Storey. 1949. Probable peak discharges and erosion rates from southern California watersheds as influenced by fire. U.S. Department of Agriculture, Forest Service. California Forest and Range Experiment Station.

U.S. Army Corps of Engineers. 2000. Los Angeles District Method for Prediction of Debris Yield. 166 pp. http://www.spl.usace.army.mil/resreg/htdocs/DebrisMethod.pdf

Waananen and Crippen USGS, 1977, USGS Water-Resources Investigations 77-21: Magnitude and Frequency of Flooding in California.