



# Hayden Pass Fire – Big Cottonwood Drainage Recovery Plan | 2018

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## *Hazard Characterization Report*

**Submitted to:**

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# EXECUTIVE SUMMARY

The Hayden Pass Fire and Flood Recovery Coalition (HPFFRC, or Coalition) with funding from the Colorado Water Conservation Board (CWCB) have conducted a hazard characterization map of the flood affected areas of the Hayden Pass Fire. This mapping was necessary to address current post-fire flood issues as well as potential risks of future flooding. All issues were identified during site visits, discussions with landowners, and hydraulic simulations. The issues identified in this report pose risks to life and property and are divided into the following categories:

- flooding (e.g. inundation, depth, and velocity)
- hazards (e.g. trees, road erosion, etc.)
- debris (e.g. likely to remobilize during flood events, debris jams, etc.)
- channel issues (e.g. deep incision, dangerous bank erosion, etc.).

Flood events were simulated with 10-, 25-, 50-, and 100-year return intervals using the model and post-fire hydrologic data reported in the previously submitted Hydrologic and Hydraulic Report. These simulations identified 19 homes that were at moderate and high risk due to flood depth and velocities.

Existing and potential hazards, debris, and channel issues were mapped using GIS software (ArcGIS Desktop, 10.4) and contain attributes of the issue's description and ranking (1: high risk, 2: moderate risk, 3: low risk). A total of 171 issues were identified and the map includes over 215 gps-tagged images (i.e. photo points) to reference.

The maps produced are intended to educate landowners on existing threats as well as has guide field crews remove such issues. To date, this map has helped field crews remove serveral hazards and debris and will continue to serve as a checklist for future projects as well as identify future recovery needs. In the event that issues are out of the scope of work and / or abilities of the Coalition, the Coalitions effectively communicates these issues to the Fremont County Engineer and Manager.

# 1. PURPOSE AND BACKGROUND

A floodplain hazard identification and assessment was requested to help guide work efforts and plan future recovery needs around the Hayden Pass fire and flood impacted areas. Please reference the Hayden Pass Fire – Big Cottonwood Drainage Recover Plan Hydrologic and Hydraulic Report (hereafter the H&H report) for a detailed background on the fire, subsequent flooding, and previous hydrologic and hydraulic work.

## 2. Methods

Field assessments to document current floodplain issues were completed from January to July, 2019. Issue identification included any risks to life and property that existed in the Big Cottonwood Creek drainages (including Bitter and Little Cottonwood creeks), Hayden Creek, and Sullivan Creek drainages (including Mosher and Oak creeks). Such issues were identified by: i) hydraulic simulations and ii) field visits. All issues and risks were divided into one of the following categories:

- Flooding (e.g. what return interval do houses become inundated and at what depth and velocity).
- Hazards (e.g. risk of falling trees near homes or that may divert flow toward homes or infrastructure).
- Debris (e.g. potential to mobilize and cause downstream issues, existing debris jams, and channel spanning trees capable of causing future debris jams).
- Channel issues (e.g. bank erosion near homes, significant channel incision that is dangerous or degrading to the land function).

Hydraulic simulations were conducted using the previously calibrated HEC-RAS 2d model and post-fire hydrologic data presented in the H&H report. Flood scenarios of 10-, 25-, 50-, and 100-year return intervals were conducted. While many outbuildings were observed to become inundated, only houses are marked and discussed. Flood conditions' depths and velocities were used to determine the level of risk the house likely faces during the different scenarios. High risk properties are those that are likely to flood under all scenarios and experience significant dangerous depths and velocities. Moderate risk properties are those that are likely to become inundated under less frequent events and /or experience moderate depths and velocities.

Hazards, debris, and channel issues are mapped and ranked according to perceived risk to life and property using a high, moderate, and low system. Most of these issues have gps-tagged images (i.e. photo-points) that were taken during field visits. All photo-points were integrated into GIS software to provide reference to the specific issues identified.

## 3. Results

All mapped GIS layers are available as shapefiles. The mapped area is broken into 15 reaches for viewing convenience (Figure 1). These reaches are designated as C (i.e. Cottonwood), H (i.e. Hayden), and S (i.e. Sullivan). Maps (Figures 2-15) are provided below and organized by reaches C1-9, H1-2, and S1-2. Reach LC (i.e. Little Cottonwood) is also included despite landowners refusing current assistance. In total, 171 issues were identified and 215 photo-points were captured. Each figure below is followed by a table that lists the issue identified, a description, and a risk ranking. Figures 16-23 provide a greater detail view of the 19 homes that are threatened by future flood events and Tables 13-20 provide the home address and associated risk.



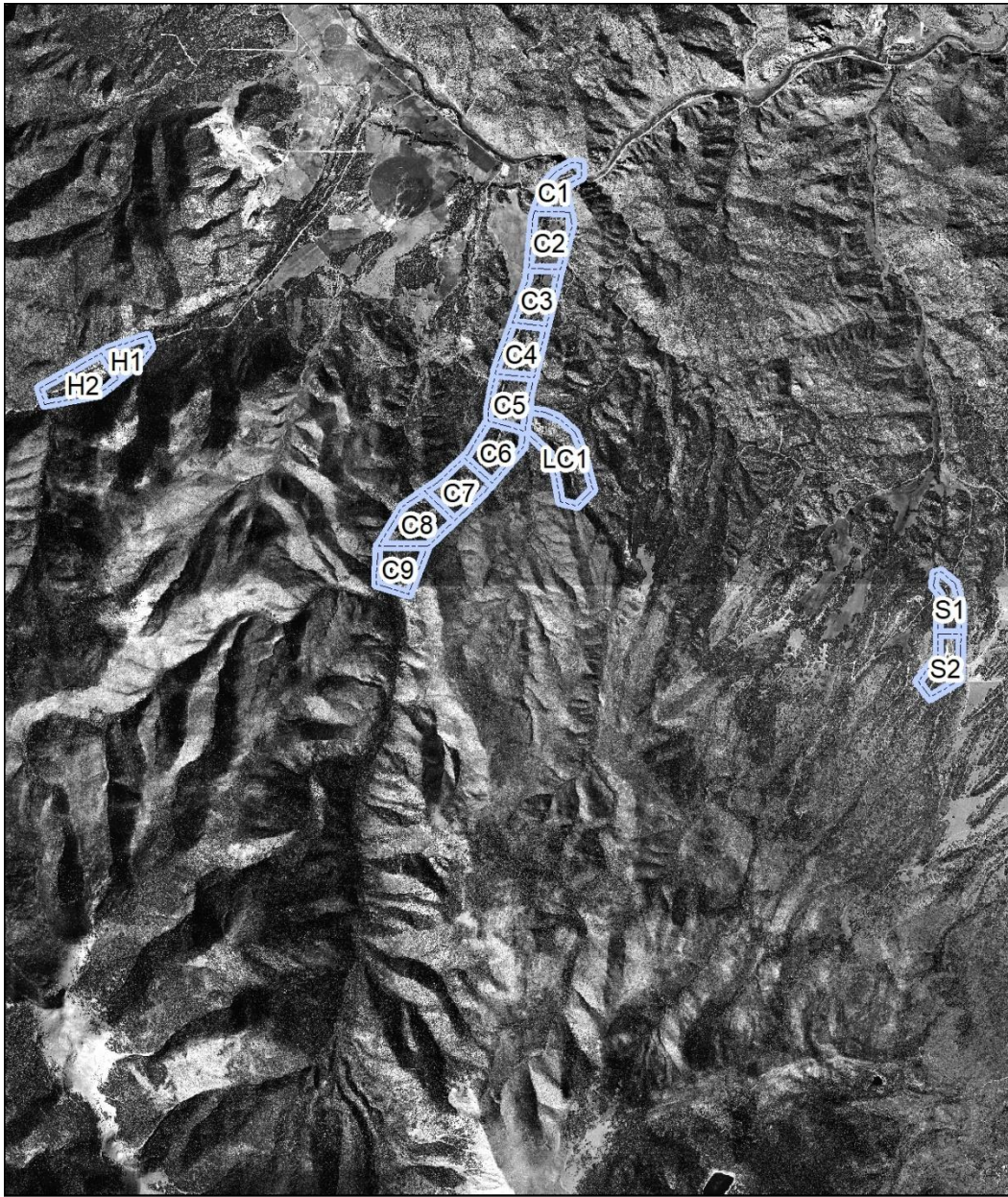
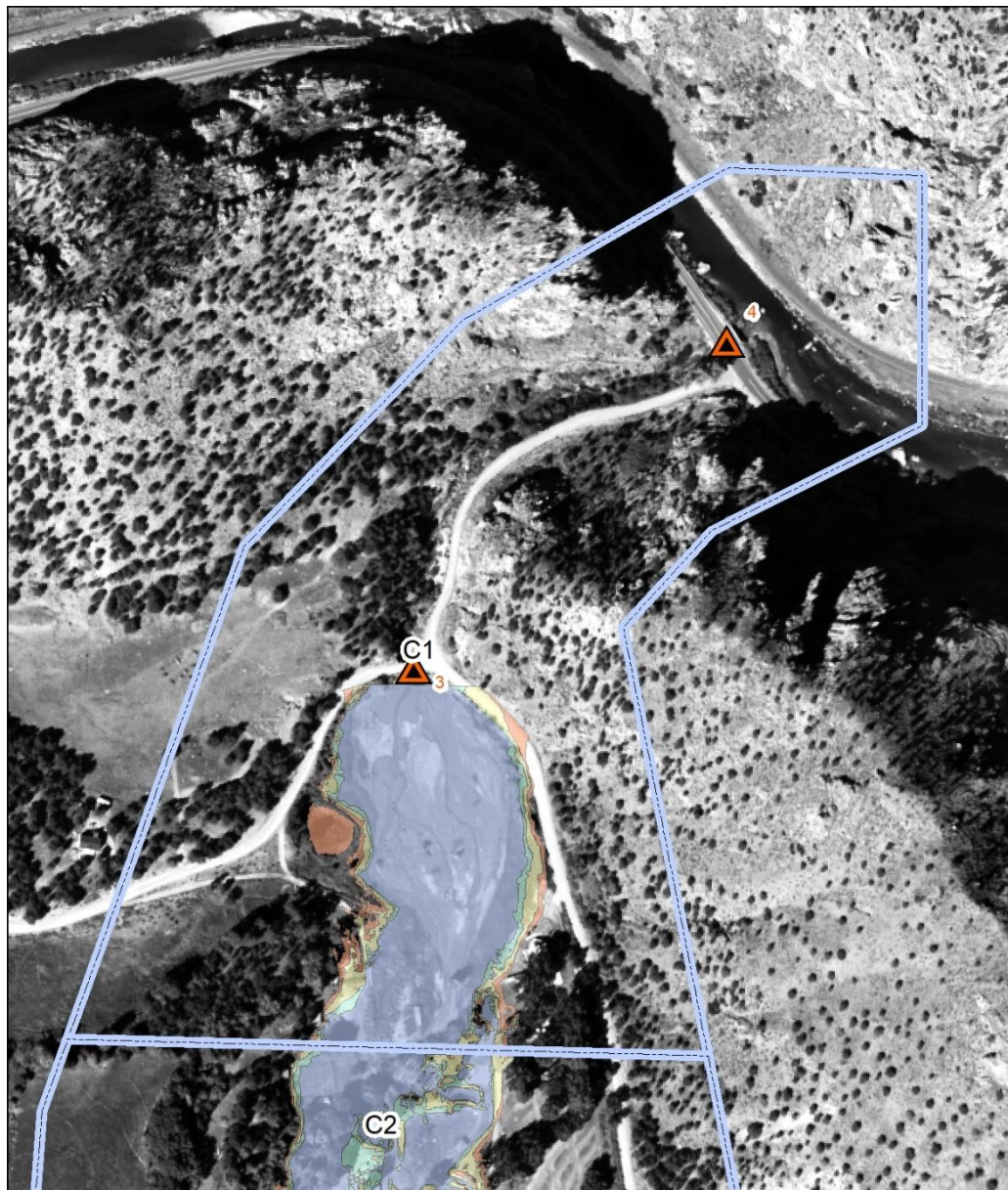


Figure 1: Layout of the 15 reaches referenced in Figures 2-16.





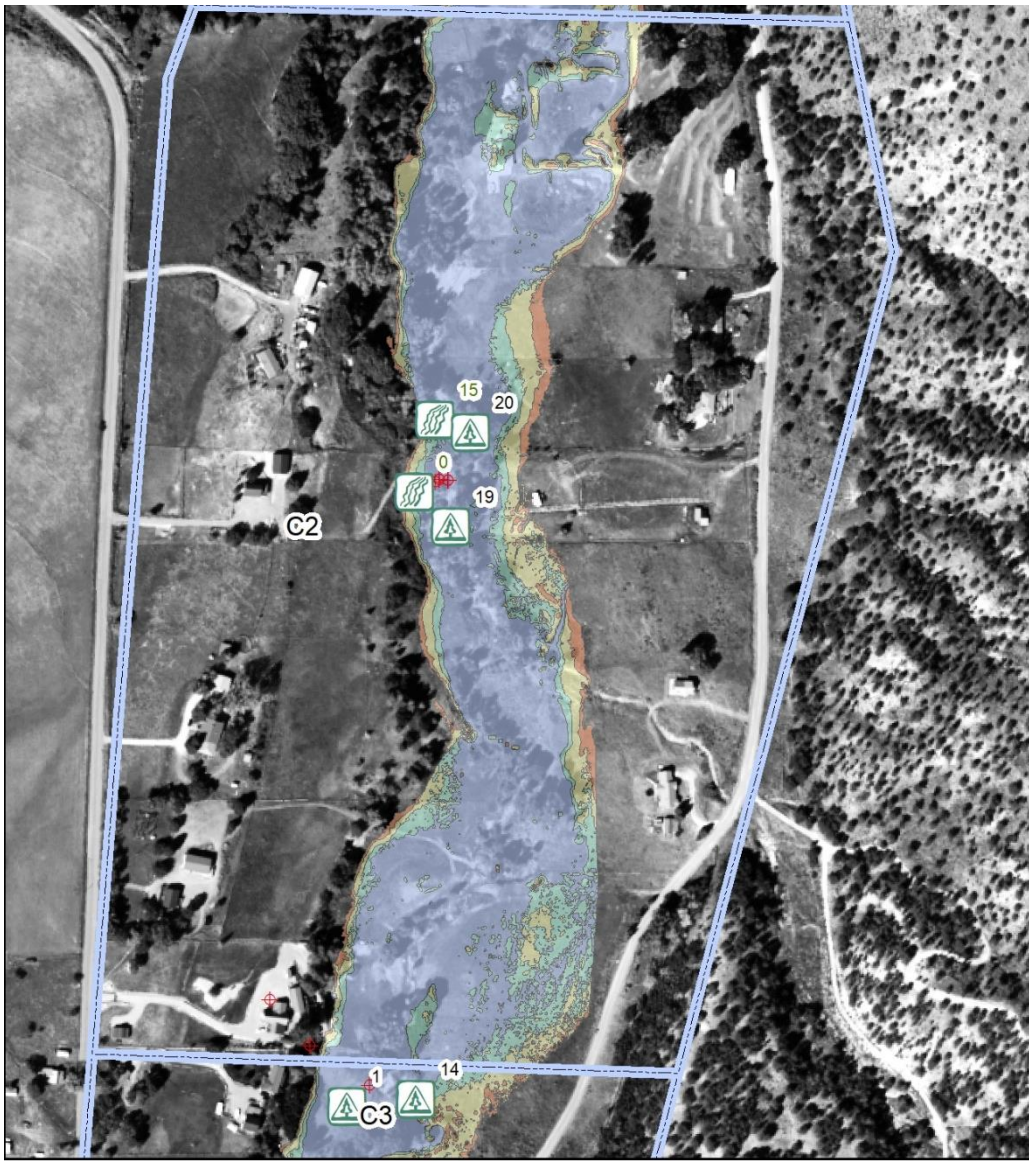
#### Legend



Figure 2: Hazard identification and prioritization for Reach C1 of Big Cottonwood Creek.

Table 1: Description and ranking of mapped dangers, debris, and channel issues in reach C1, Figure 2.

Id:	Description	Rank (1= high, 3 =low)
<b>Danger</b>		
3	Road overtopping. Potential to strand 5 landowners if CR39 is damaged.	2
4	Potential for clogging and overtopping. Several large boulders have come down during July 2018 flood. These cause concern for flow passage near bridge.	2



#### Legend

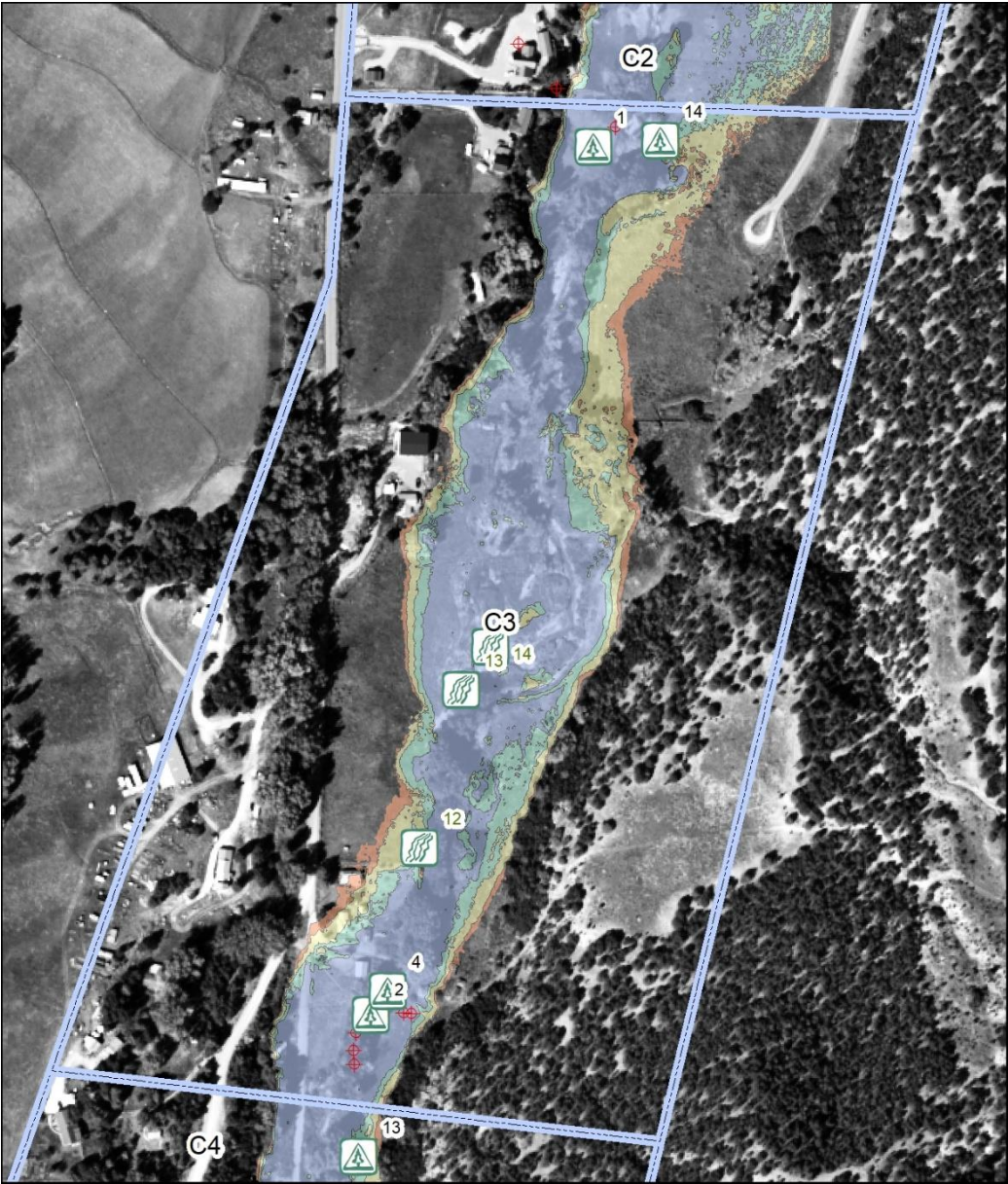


Figure 3: Hazard identification and prioritization for Reach C2 of Big Cottonwood Creek.

Table 2: Description and ranking of mapped dangers, debris, and channel issues in reach C2, Figure 3.

Id:	Description	Rank (1= high, 3 =low)
<b>Danger</b>		
19	Channel Spanning tree	2
20	Small to medium debris jam.	2
<b>Channel Issues</b>		
0	High bank erosion	3
15	Channel incision	3





Legend



Figure 4: Hazard identification and prioritization for Reach C3 of Big Cottonwood Creek.

Table 3: Description and ranking of mapped dangers, debris, and channel issues in reach C3, Figure 4.

Id:		Description	Rank (1= high, 3 =low)
Debris			
1		Very large tree. Owners want it gone. Neighbor afraid of it coming down on his property in next flood	3
2		Fallen/deposited tree spanning the creek with debris piling up. Removal of the left bank material so that it continues to act like a trash rack.	1
4		Owner wants to keep this tree and debris jam since they feel it protects their house downstream.	0
14		Juniper fallen in the creek. Possibly large enough to get caught in HWY 50 bridge	1
Channel			
12		Channel incision	3
13		Channel incision	3
14		Channel incision	3



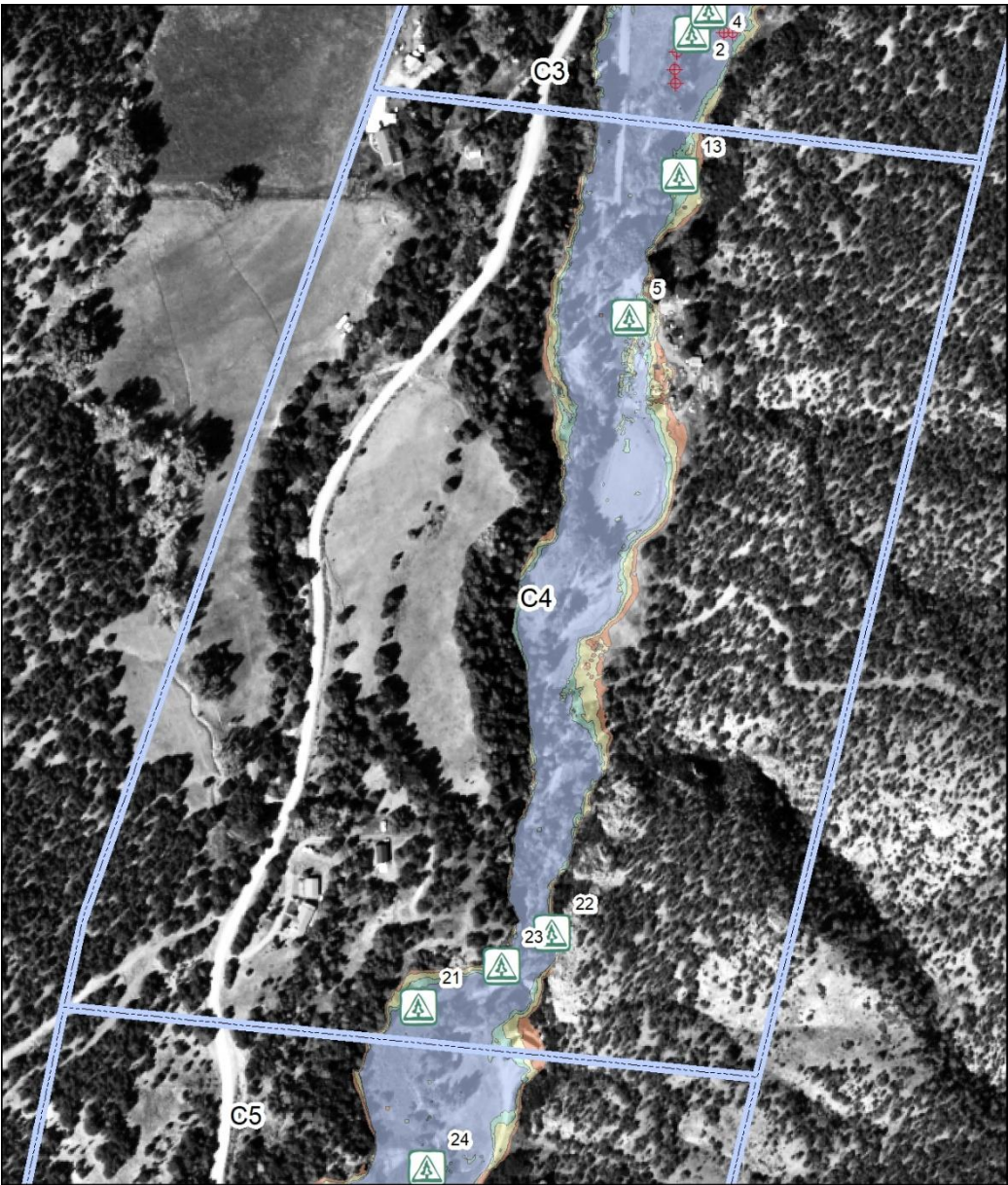


Figure 5: Hazard identification and prioritization for Reach C4 of Big Cottonwood Creek.

Table 4: Description and ranking of mapped dangers, debris, and channel issues in reach C4, Figure 5.

Id:	Description	Rank (1= high, 3 =low)
Debris		
5	Debris pile may still exist.	2
13	Some smaller debris piled in trees	3
21	Large debris deposits - likely to be re-mobilized and clog downstream bridges.	2
22	2 trees down and spanning the creek. Potential to cause debris dams.	1
23	Moderate debris jam in standing trees.	1



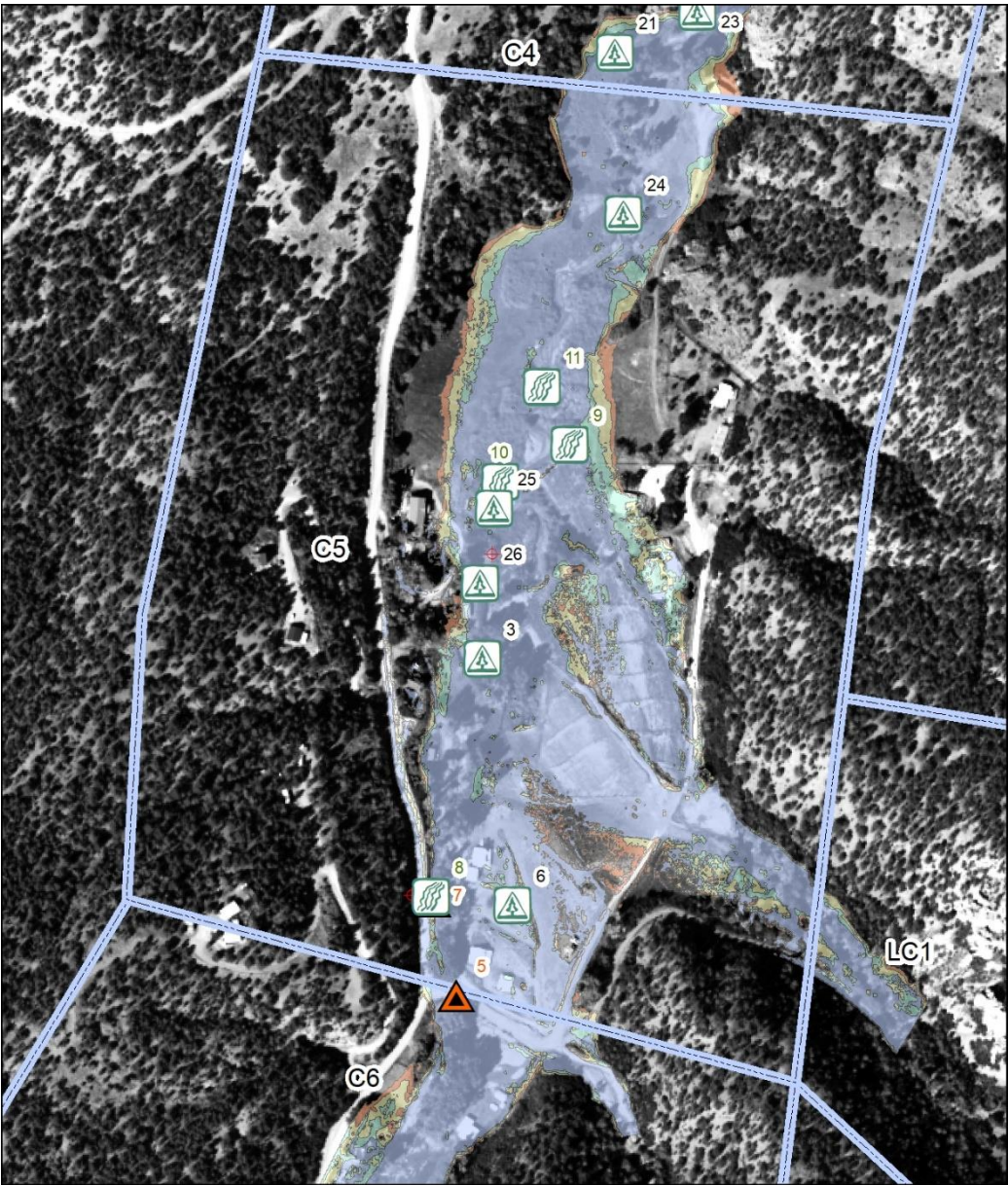
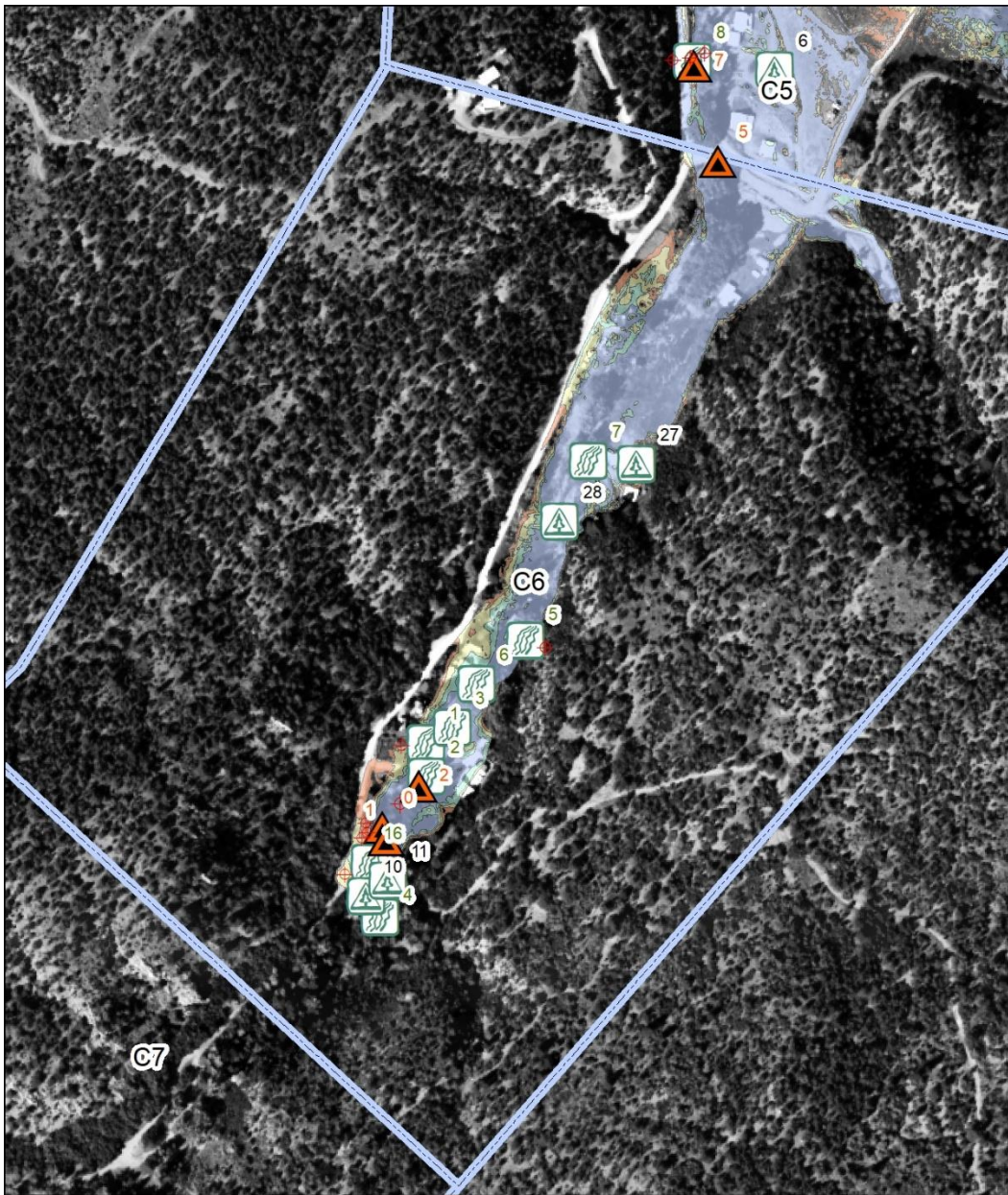


Figure 6: Hazard identification and prioritization for Reach C5 of Big Cottonwood Creek.

Table 5: Description and ranking of mapped dangers, debris, and channel issues in reach C5, Figure 6.

Id:	Description	Rank (1= high, 3 =low)
Danger		
7	Road erosion potential	1
Debris		
3	Large debris jam in tree	2
6	Debris pile may still exist.	2
24	Debris pile	2
25	Several smaller piles of deposited debris around this property that could be remobilized	3
26	Several smaller piles of deposited debris around this property that could be remobilized	3
Channel Issues		
8	Channel incision	3
9	Channel incision	3
10	Channel incision	3
11	Channel incision	3





### Legend

#### Hillslope Treatment Priorities

- 1 1
- 2 2
- 3 3

+ Photo Points



Debris



Dangers



Channel Issues



Reaches



Channel Grading



10 year flood inundation



25 year flood inundation



50 year flood inundation



100 year flood inundation

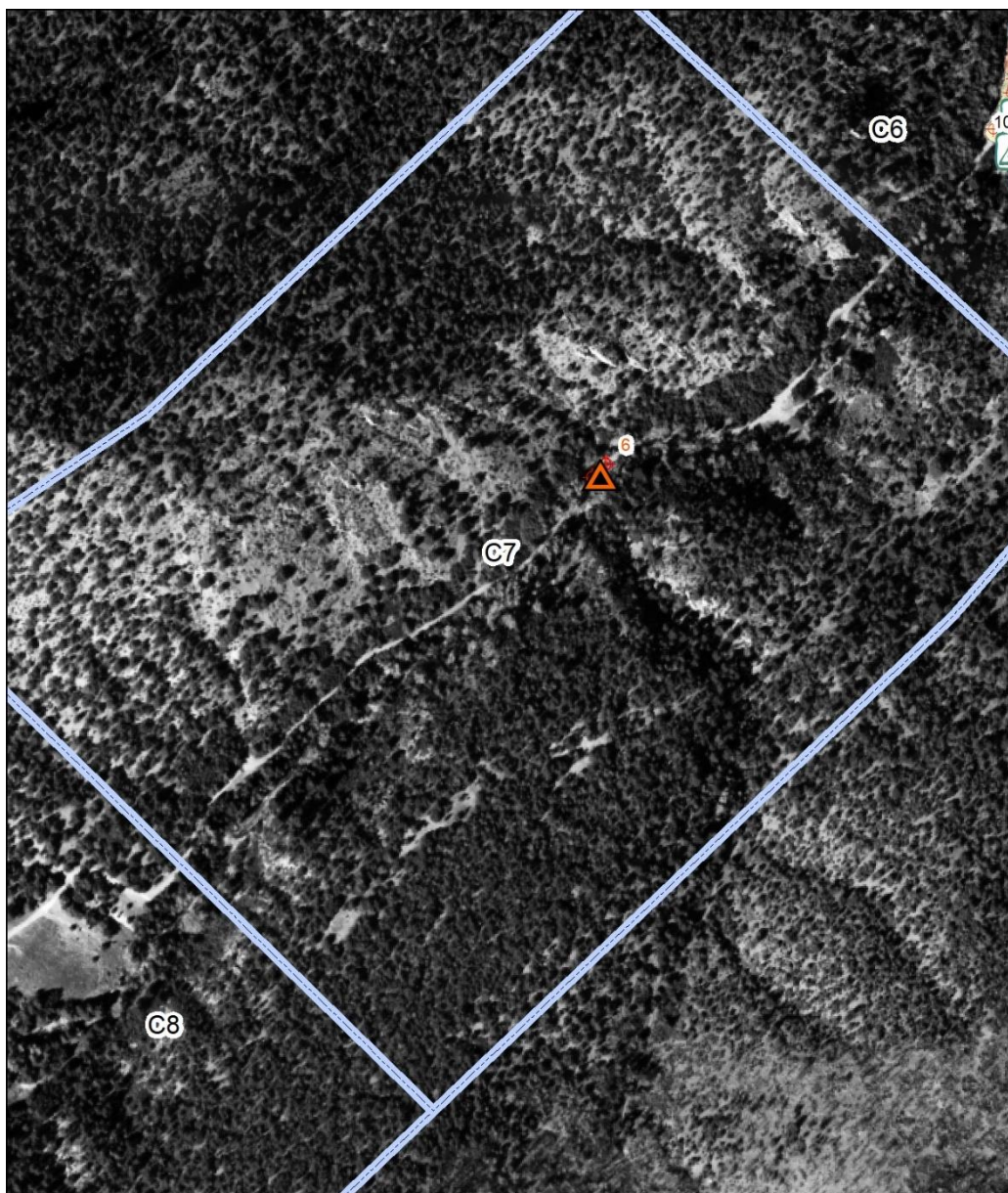
0 125 250 500  
Feet

Figure 7: Hazard identification and prioritization for Reach C6 of Big Cottonwood Creek.



Table 6: Description and ranking of mapped dangers, debris, and channel issues in reach C6, Figure 7.

<b>Id:</b>	<b>Description</b>	<b>Rank (1= high, 3 =low)</b>
<b>Danger</b>		
0	Bridge is not secure and its foundation is eroded.	1
1	Trees being undermined by bank erosion. Too close to houses to allow to fall in during an event.	1
2	Tree being undermined and it is likely to fall in creek near houses	1
5	Overtopping and potential failure in large events with debris flow.	1
<b>Debris</b>		
10	Small wood jam, but directly upstream of houses	1
11	Moderate amounts of wood to be cleared since it is upstream of houses	1
27	2 large piles of debris at fringe	2
28	Two small debris jams.	2
<b>Channel Issues</b>		
1	Channel incision / flow close to Bill Woods house. Bill banks to be graded. High priority, but may have too much liability?	3
2	Head cut	3
3	Channel incision	3
4	start of head cut	3
5	Channel incision / bank erosion	3
6	High priority, but expensive engineering solution. Danger to house. Narrow stream between hill and house. High priority, but an expensive engineering solution needed.	1
7	Channel incision	3
16	Channel incision	3



#### Legend



Figure 8: Hazard identification and prioritization for Reach C7 of Big Cottonwood Creek.

Table 7: Description and ranking of mapped dangers, debris, and channel issues in reach C7, Figure 8.

Id:	Description	Rank (1= high, 3 =low)
<b>Danger</b>		
6	USFS/BLM/State road being eroded. Also a few trees near here are already falling and others being undermined	3



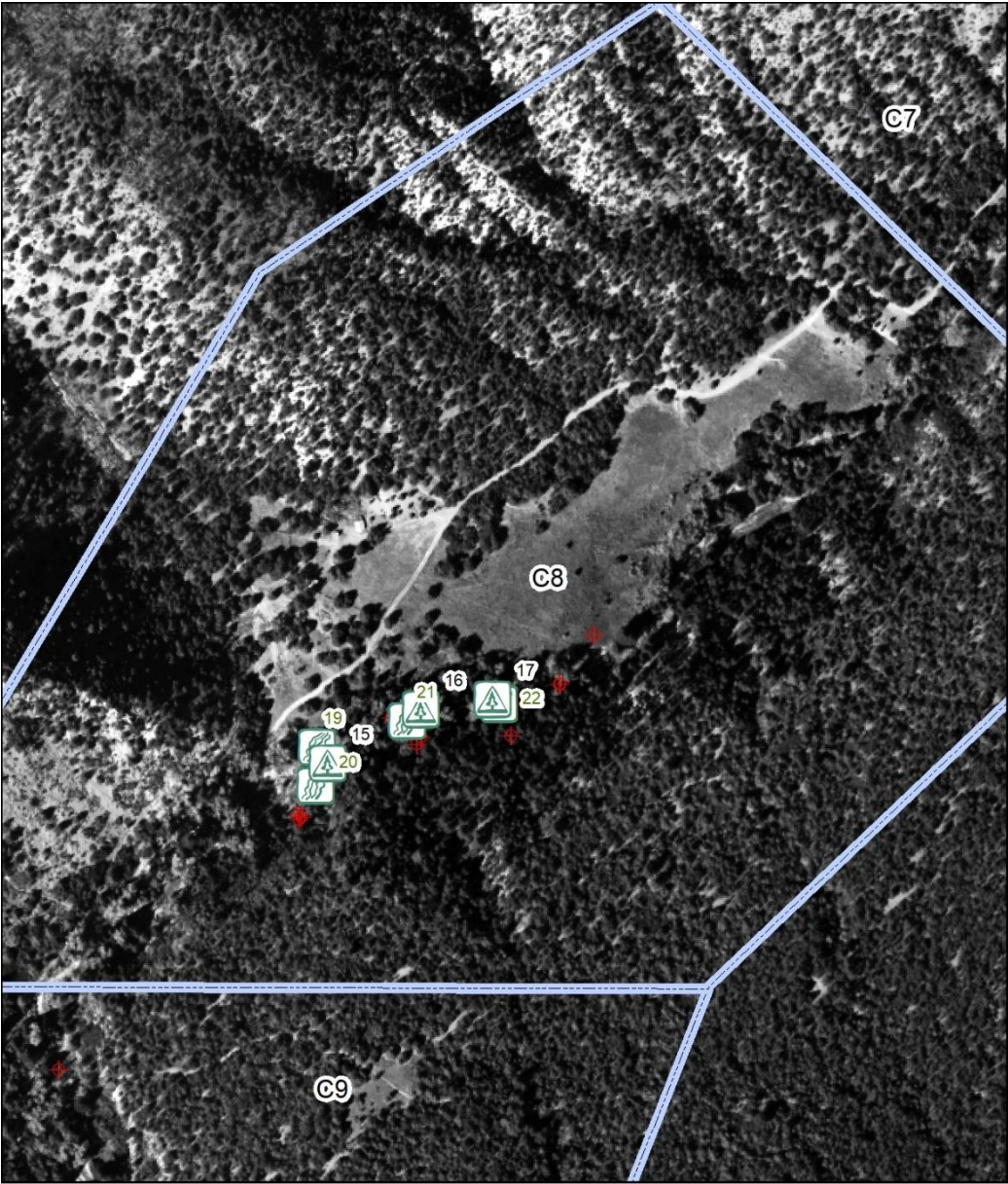
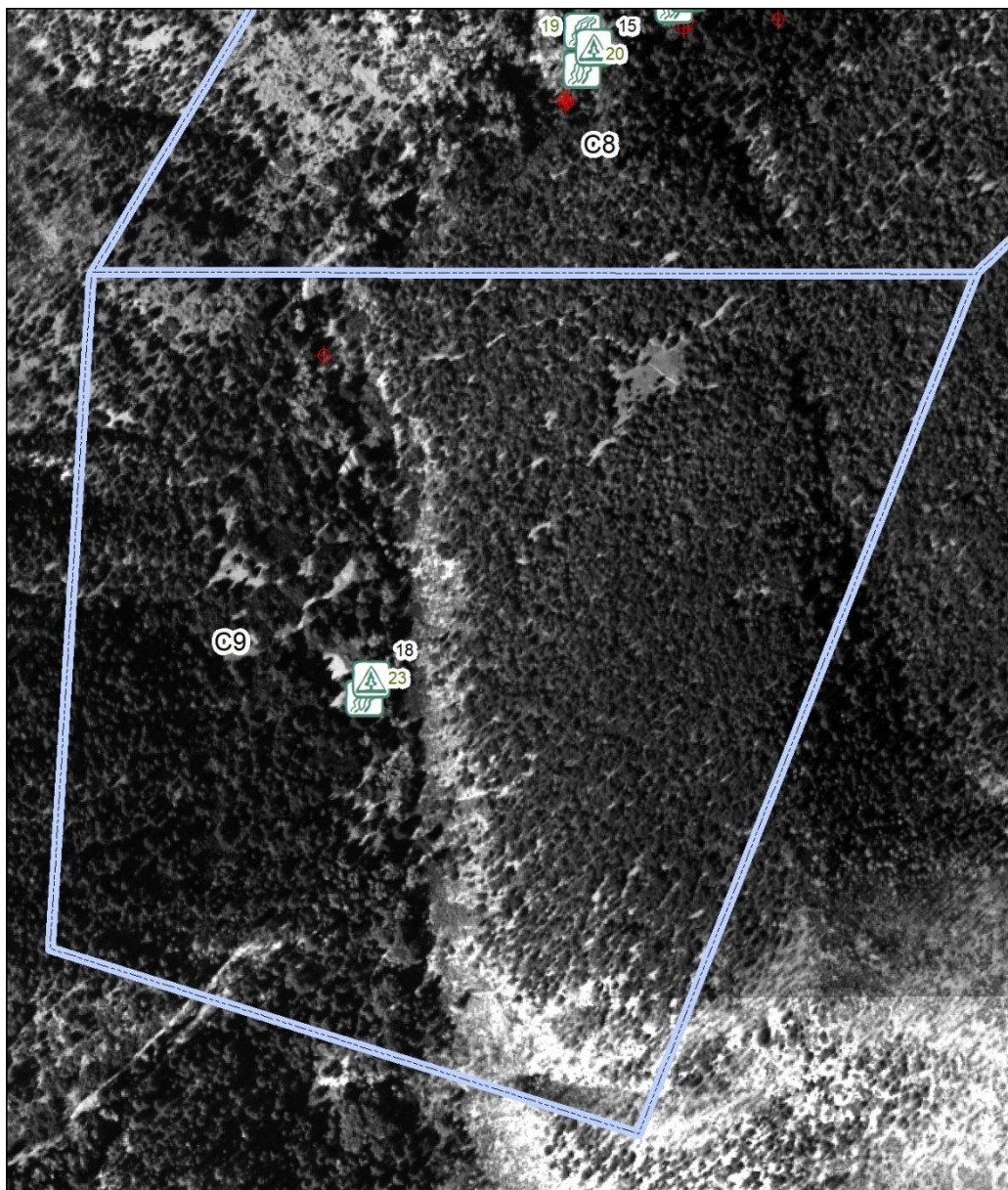


Figure 9: Hazard identification and prioritization for Reach C8 of Big Cottonwood Creek.

Table 8: Description and ranking of mapped dangers, debris, and channel issues in reach C8, Figure 9.

Id:	Description	Rank (1= high, 3 =low)
Debris		
15	Several fallen trees - on state land	2
16	Several fallen trees - on state land or USFS	2
17	Several fallen trees - on state land	2
Channel Issues		
19	Deep incision. Head cut was here, but moved upstream	3
20	Deep incision	3
21	Deep incision	3
22	Deep incision	3



**Legend**



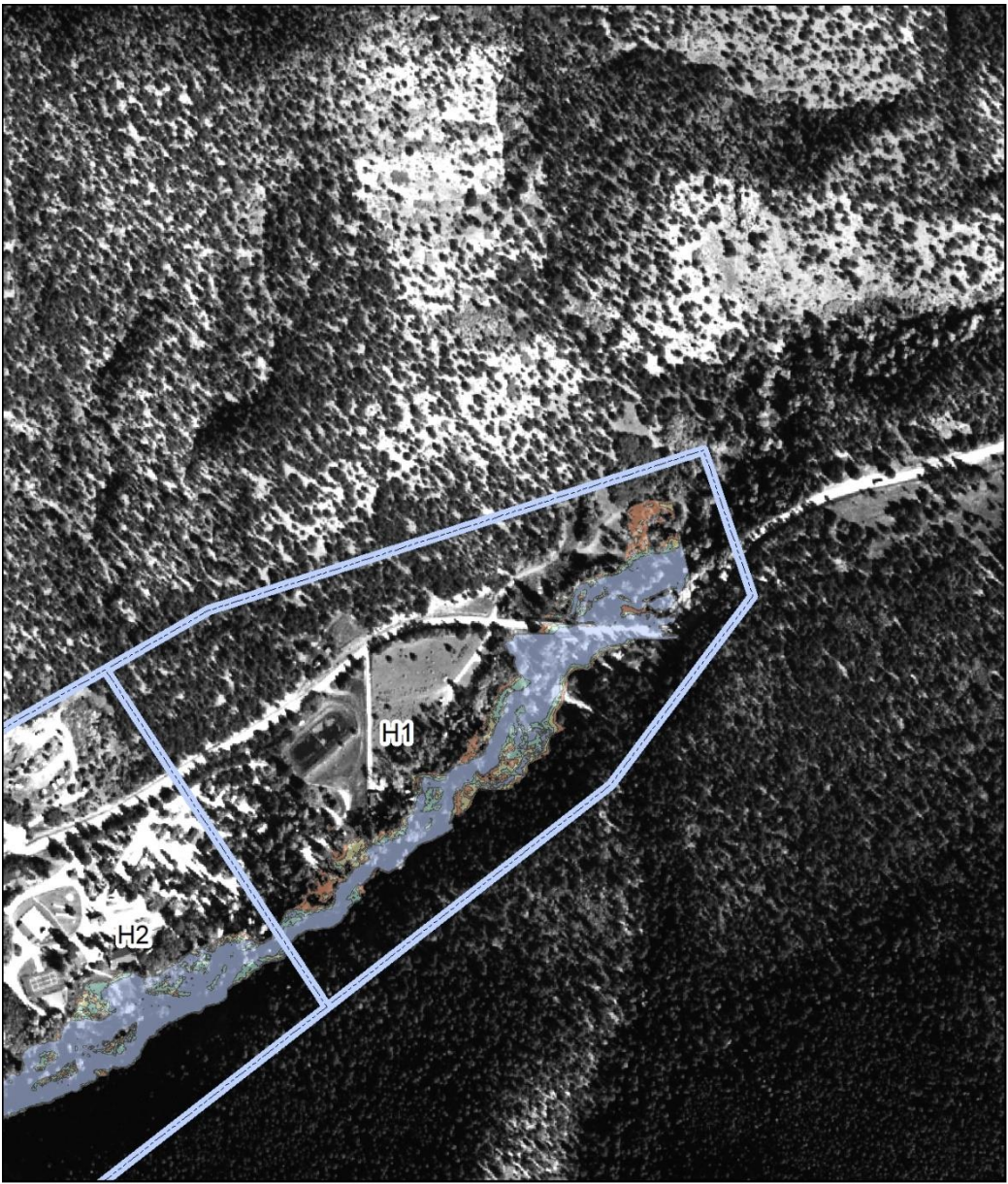
0 125 250 Feet

Figure 10: Hazard identification and prioritization for Reach C9 of Big Cottonwood Creek.

Table 9: Description and ranking of mapped dangers, debris, and channel issues in reach C9, Figure 10.

Id:	Description	Rank (1= high, 3 =low)
<b>Debris</b>		
18	Several trees about to fall in - USFS land	2
<b>Channel Issues</b>		
23	Deep incision on USFS land	3



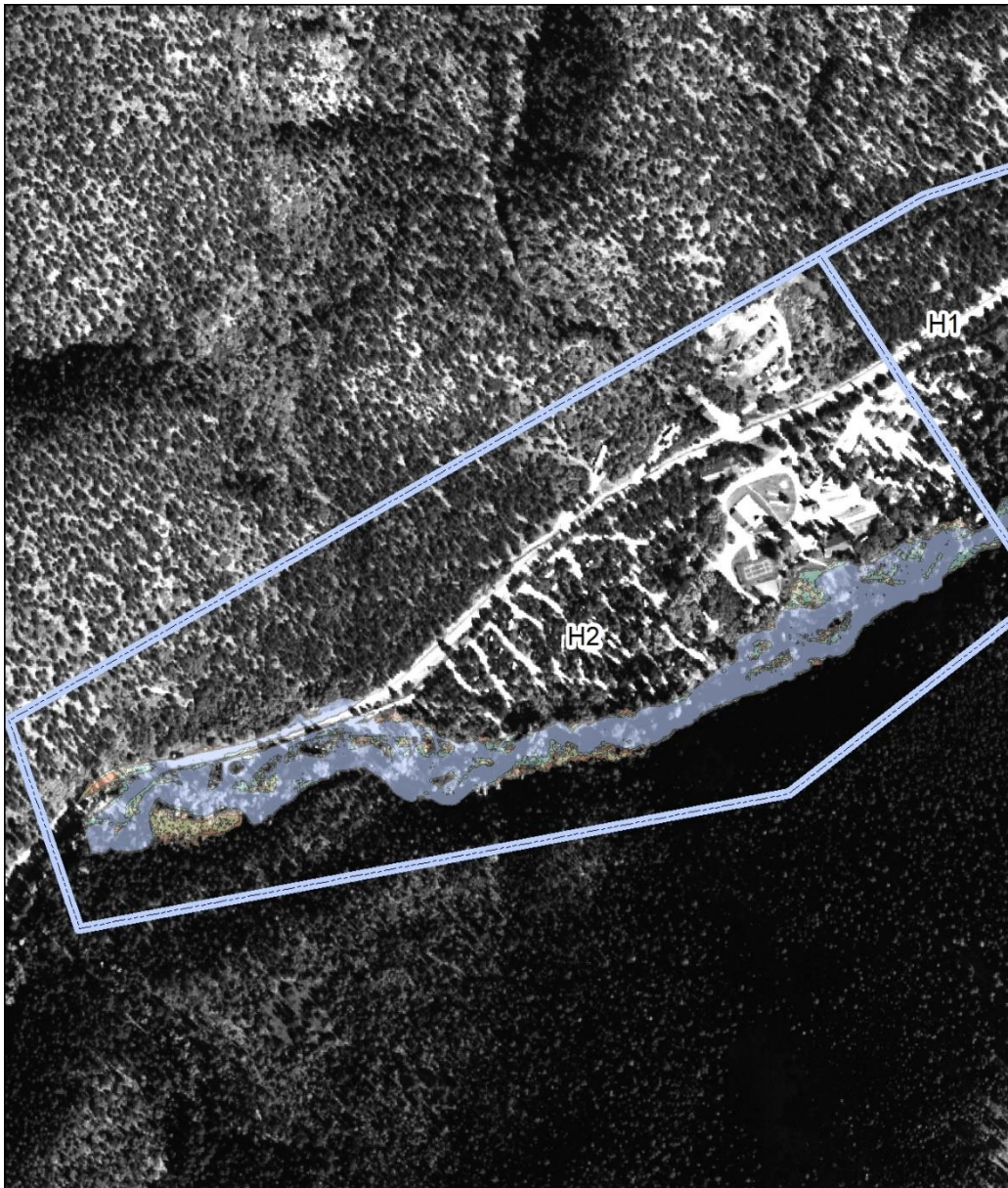


**Legend**



Figure A11: Hazard identification and prioritization for Reach H1 of Hayden Creek. Note: no debris, dangers, or channel issues determined in this reach.





# **Legend**



Figure A12: Hazard identification and prioritization for Reach H2 of Hayden Creek. Note: no debris, dangers, or channel issues determined in this reach.



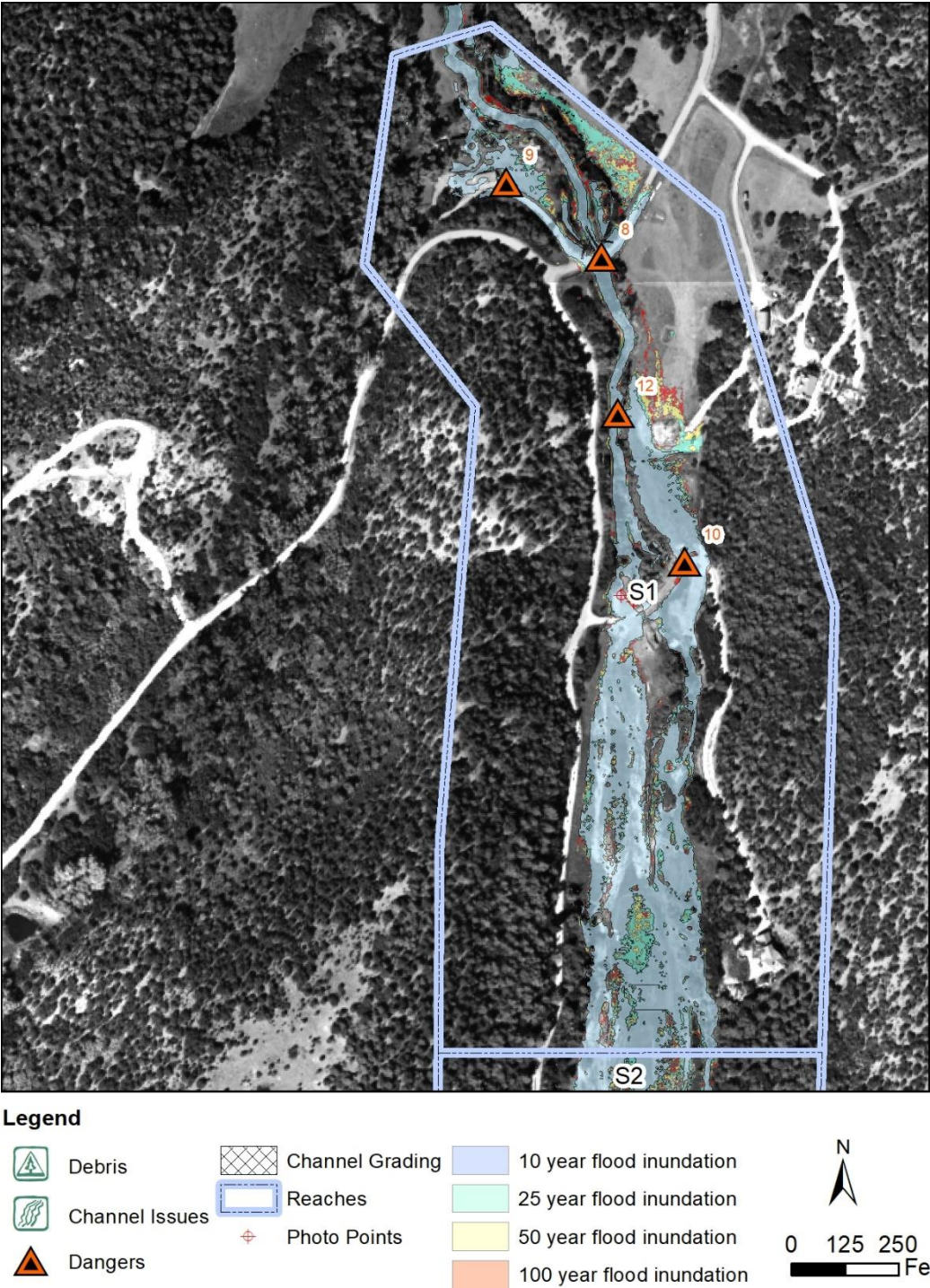


Figure 13: Hazard identification and prioritization for Reach S1 of Sullivan Creek.

Table 10: Description and ranking of mapped dangers, debris, and channel issues in reach S1, Figure 13.

Id:	Description	Rank (1= high, 3 =low)
Danger		
8	Road will easily overtop due to small culvert and low road elevation. Downstream side has large elevation drop, likely leading to a head cut and eroding the road. This is only exit for 5 landowners.	1
9	Small inundation near house during flood events. Flow goes down his driveway and may trap him.	3
10	Overtopping area during floods. This is just dirt, so highly likelihood of being eroded. This is only exit for 1 landowner and could cause him being trapped.	2
12	CR has steep banks to the creek. Overland flow leaving the upstream detention pond re-enters the creek here at an angle that may cause bank erosion. This area is heavily vegetated, so may not be a problem.	3



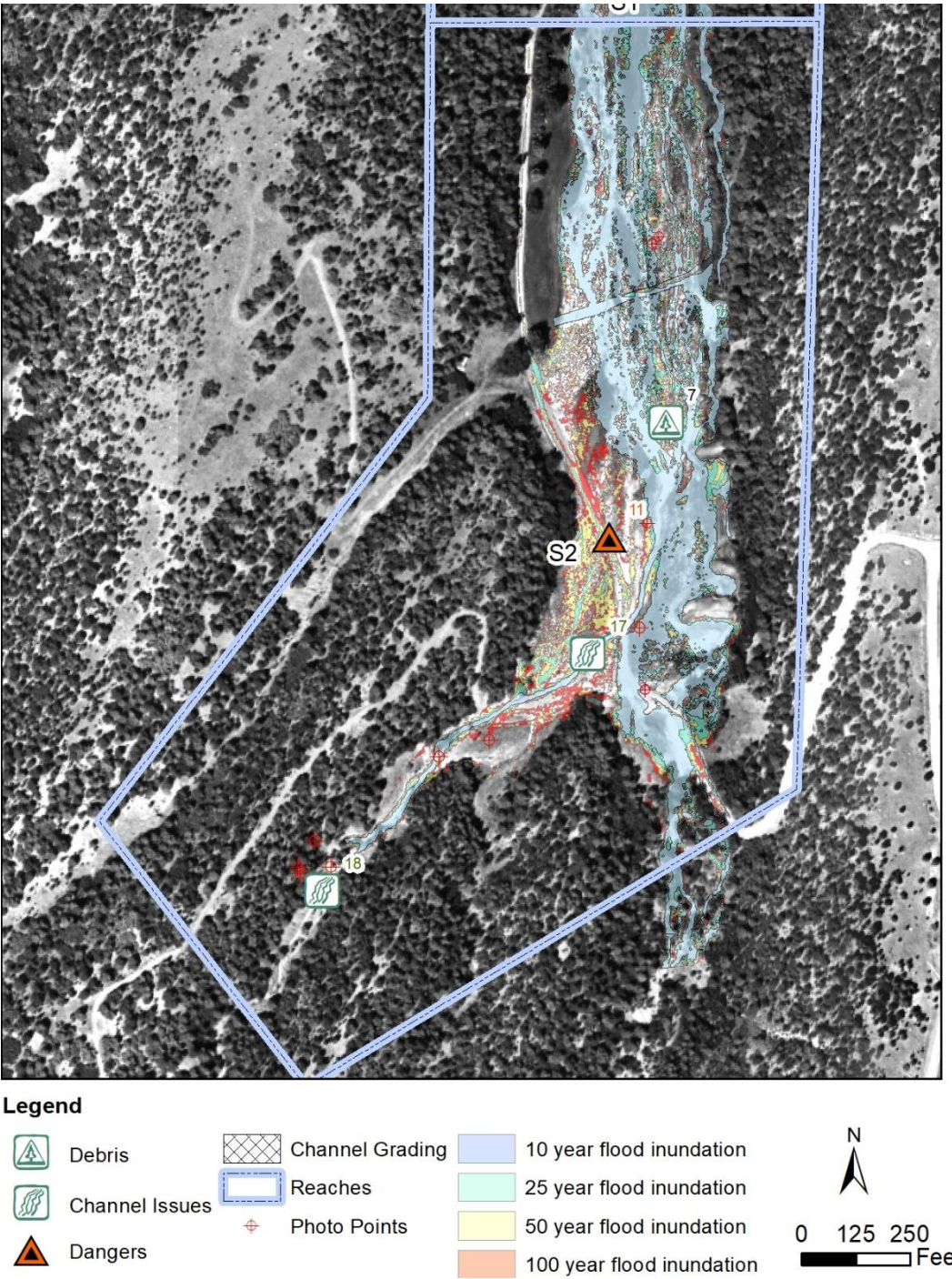
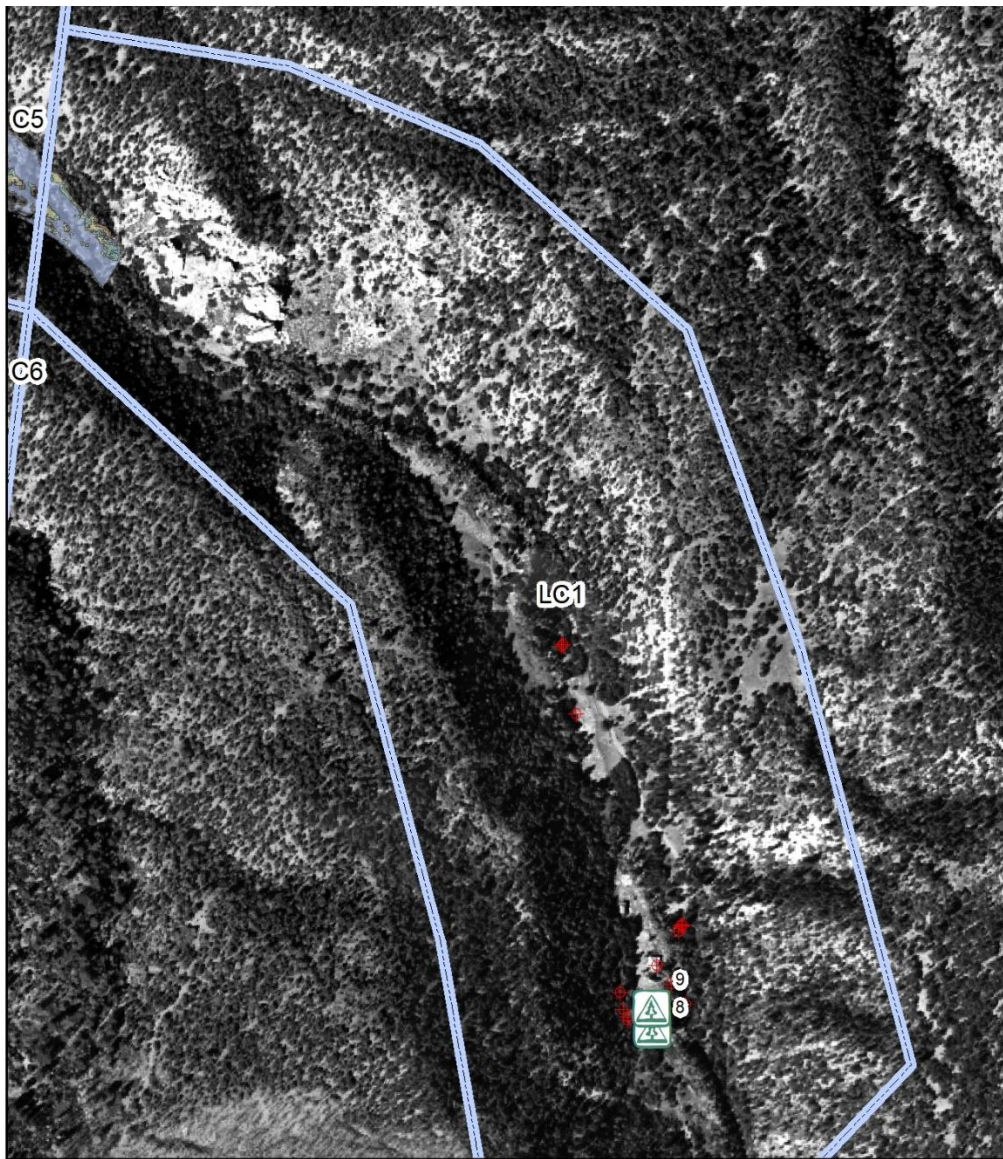


Figure 14: Hazard identification and prioritization for Reach S2 of Sullivan Creek.

Table 11: Description and ranking of mapped dangers, debris, and channel issues in reach S2, Figure 14.

Id:	Description	Rank (1= high, 3 =low)
Danger		
11	Road eroded. Cut power line.	3
Debris		
6	Debris pile may still exist.	2
Channel Issue		
17	Channel incision	3
18	Start of headcut	3





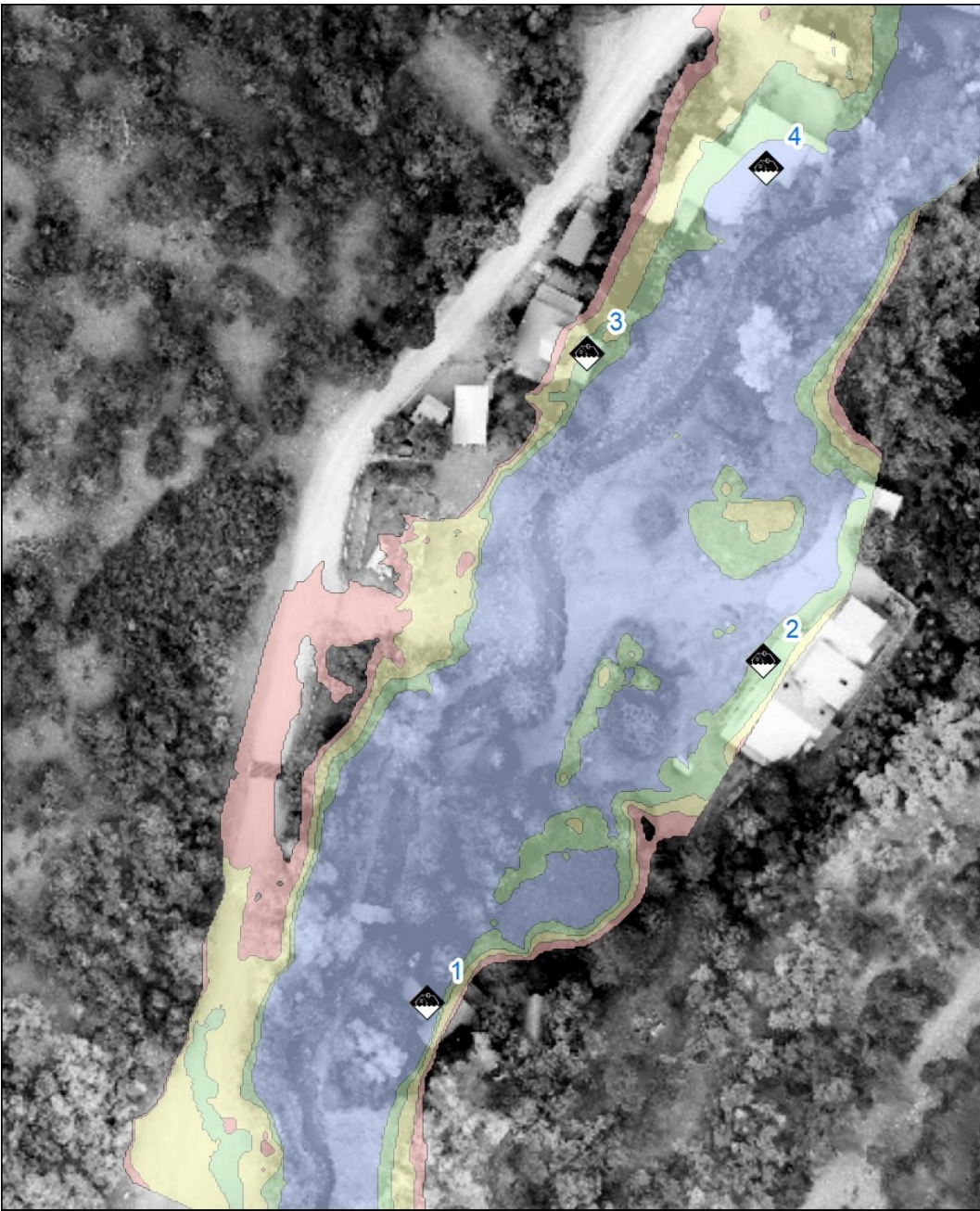
#### Legend



Figure 15: Hazard identification and prioritization for Reach LC1 of Little Cottonwood Creek. Note, landowners are not participating in any work with the Hayden Pass Fire and Flood Recovery Coalition, but we include this as information to be considered in the future.

Table 12: Description and ranking of mapped dangers, debris, and channel issues in reach LC1, Figure 15.

Id:	Description	Rank (1= high, 3 =low)
<b>Debris</b>		
8	Large amounts of wood jam around trees.	2
9	Large amounts of wood jam around trees.	2



Legend

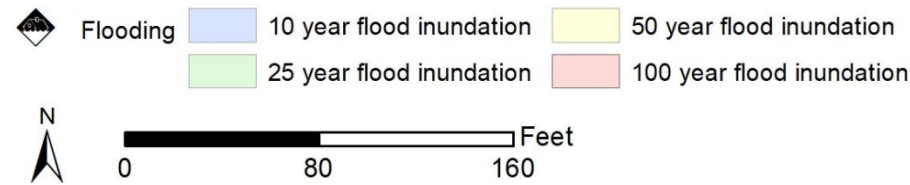
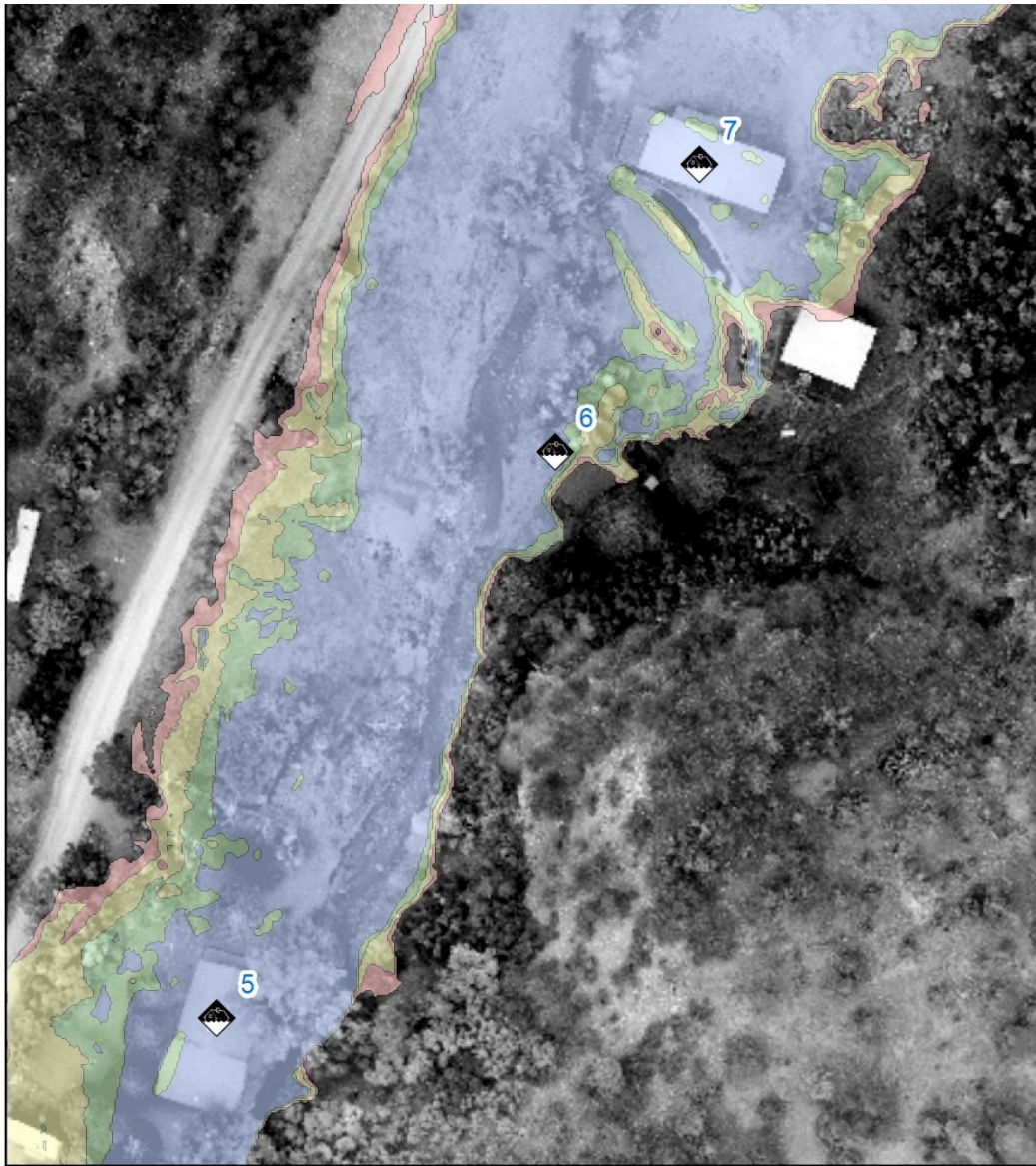


Figure 16: Identified properties that are at high and moderate risk for future flooding under 10, 25, 50, and 100-year flood events.

Table 13: Description and ranking of properties at risk of future flooding, Figure 16.

ID	Flood Risk	Description (Associated depths and velocities of the 10-, 25-, 50-, and 100-year floods, respectively)	Address
1	High	Depths: 1.8, 2.4, 3.9, and 5 ft; Velocity: 8, 13, 20, and 23 ft/s.	2192 CR 40
2	Moderate	Depths: 0, 1, 2.8, and 3.9 ft; Velocity: 0, 2.9, 3.2, and 4 ft/s.	2190 CR 40
3	Moderate	Depths: 0, 0.7, 1.8, and 2.3 ft; Velocity: 0, .2, 0.8, and 1.3 ft/s.	2118 CR 40
4	High	Depths: 3.6, 6.0, 9.8, and 12 ft; Velocity: 0, 0.3, 9, and 12 ft/s.	2110 CR 40





### Legend

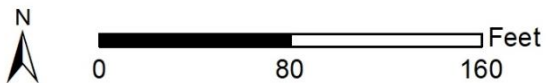
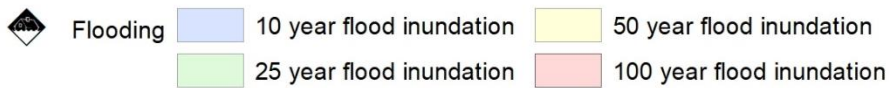
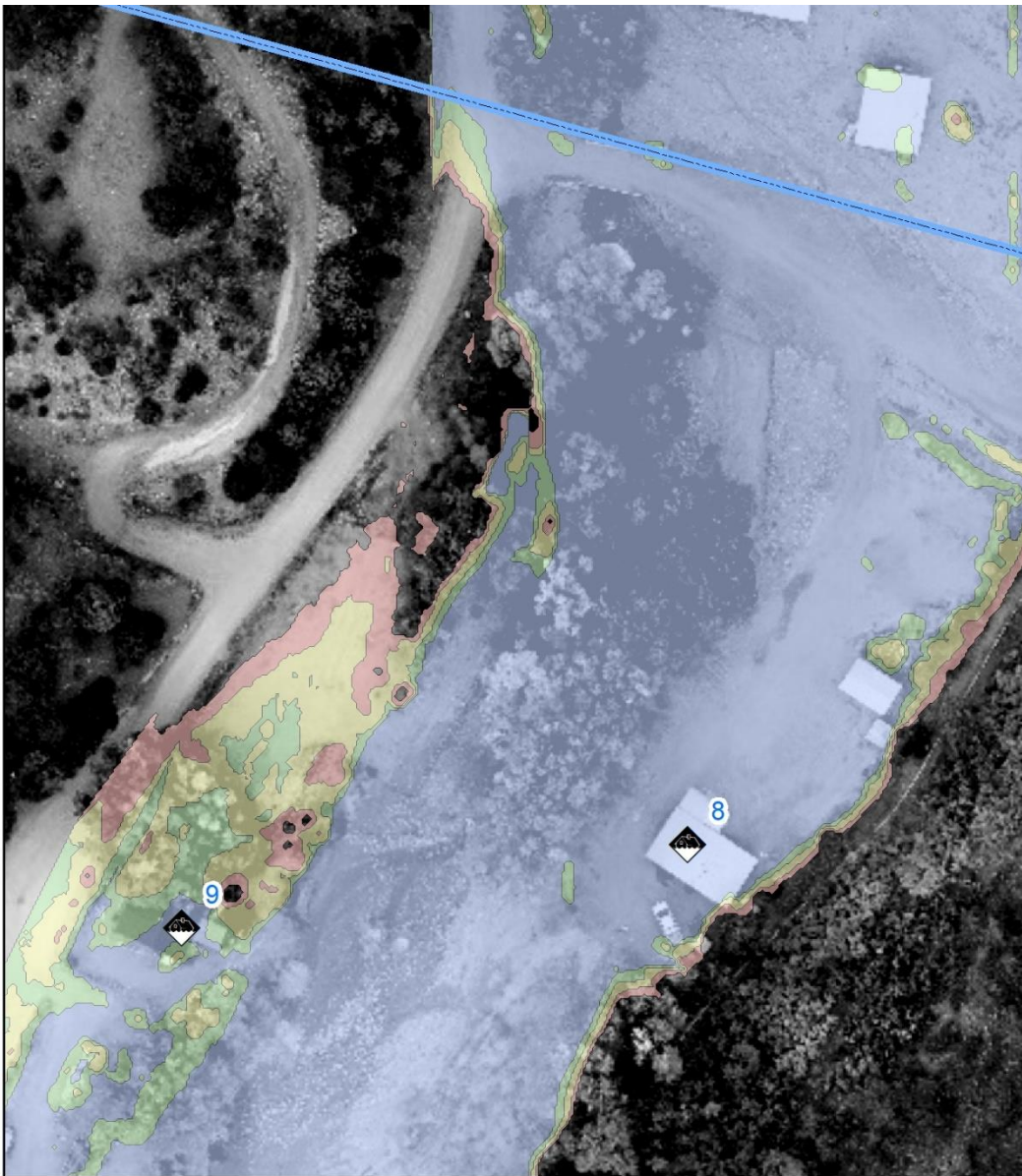


Figure 17: Identified properties that are at high and moderate risk for future flooding under 10, 25, 50, and 100-year flood events.

Table 14: Description and ranking of properties at risk of future flooding, Figure 17.

ID	Flood Risk	Description (Associated depths and velocities of the 10-, 25-, 50-, and 100-year floods, respectively)	Address
5	High	Depths: 2.0, 3.6, 6.5, and 8.4 ft; Velocity: 16, 20, 23 and 25 ft/s.	2054 CR 40
6	Moderate	Depths: 0, 0, 0, and 0.3 ft; Velocity: 0, 0, 0, and 7 ft/s.	2022 CR 40
7	High	Depths: 0, 0.5, 1.7, and 2.4 ft; Velocity: 0, 9, 15, and 20 ft/s.	2020 CR 40



### Legend

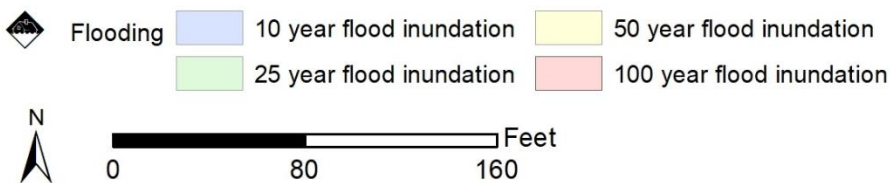
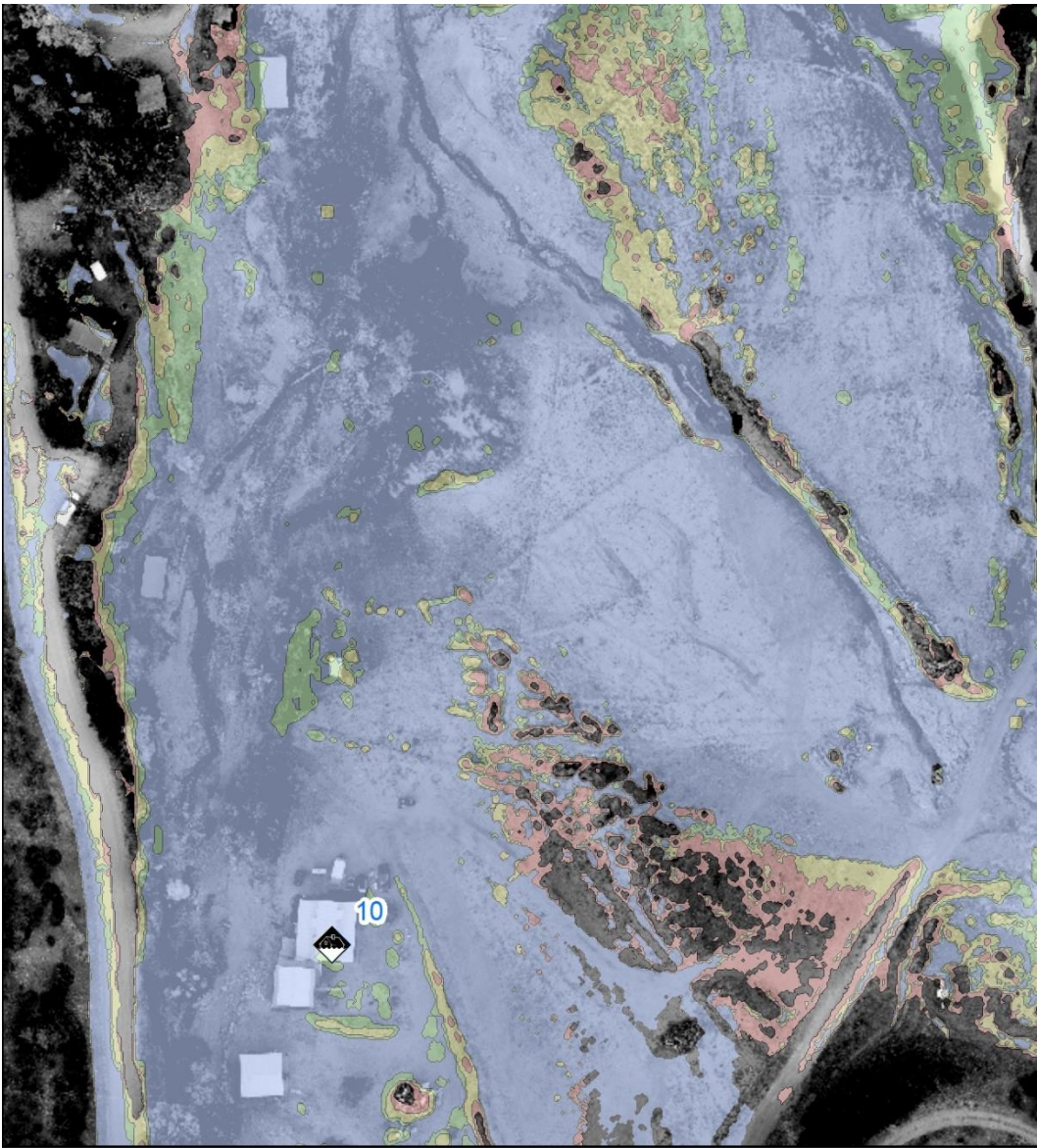


Figure 18: Identified properties that are at high and moderate risk for future flooding under 10, 25, 50, and 100-year flood events.

Table 15: Description and ranking of properties at risk of future flooding, Figure 18.

ID	Flood Risk	Description (Associated depths and velocities of the 10-, 25-, 50-, and 100-year floods, respectively)	Address
8	High	Depths: 1.4, 2.0, 3.2, and 4.2 ft; Velocity: 8, 12, 16 and 18 ft/s.	34 Dinkle Ditch
9	Moderate	Depths: 0, 0.2, 1.2, and 1.8 ft; Velocity: 0, 4, 8, and 11 ft/s.	1918 CR 40





**Legend**

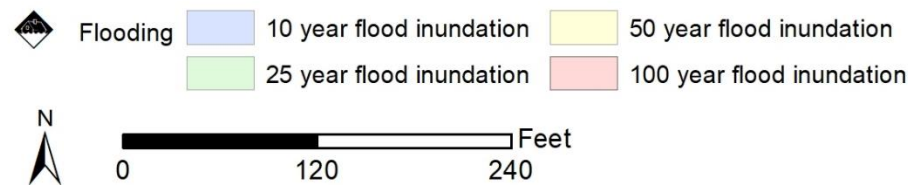
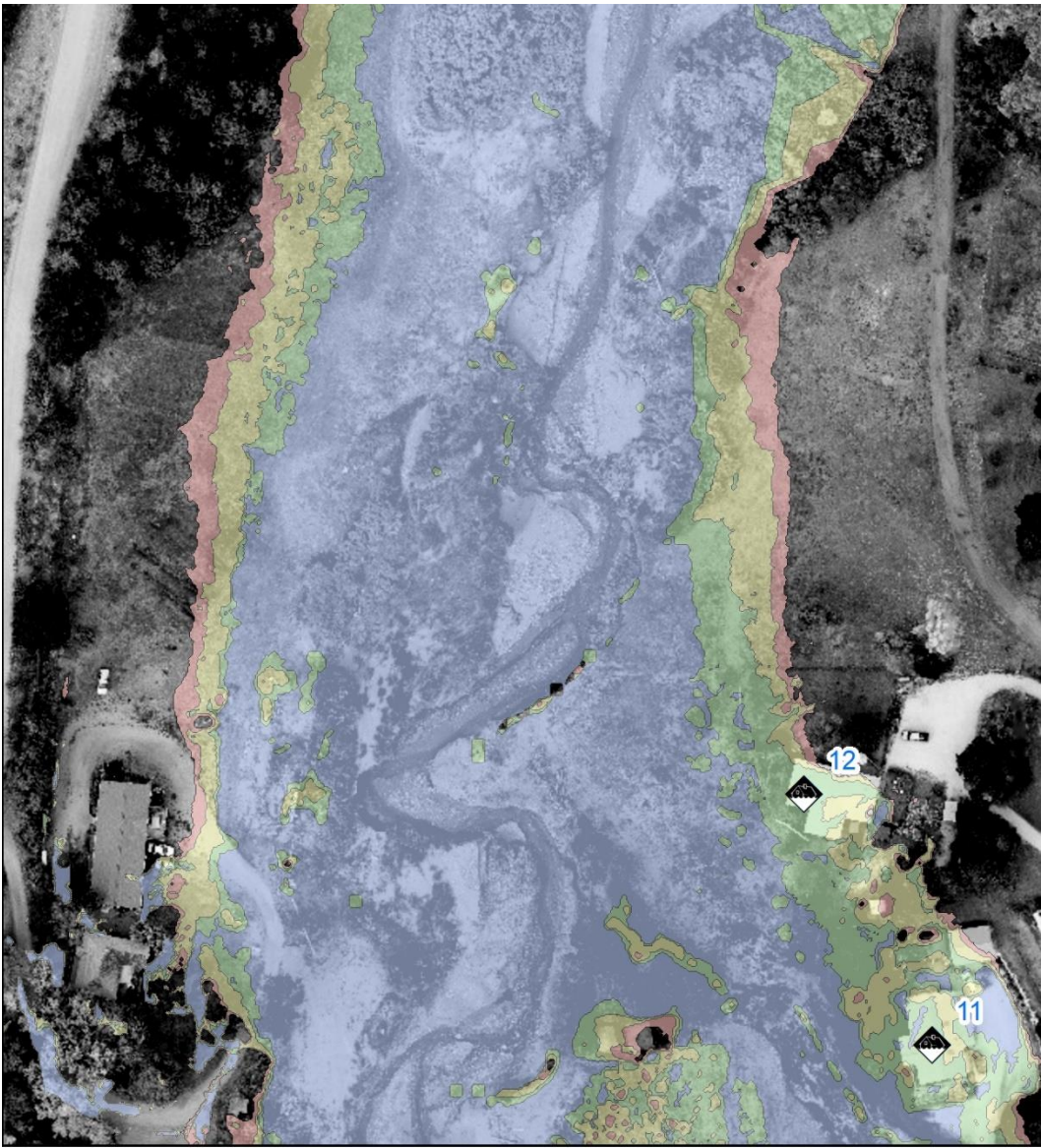


Figure 19: Identified properties that are at high and moderate risk for future flooding under 10, 25, 50, and 100 - year flood events.

Table 16: Description and ranking of properties at risk of future flooding, Figure 19.

ID	Flood Risk	Description (Associated depths and velocities of the 10-, 25-, 50-, and 100-year floods, respectively)	Address
10	High	Depths: 0.4, 1.2, 2.4, and 3.2 ft; Velocity: 4, 9, 15 and 19 ft/s.	47 Dinkle Ditch
11	Moderate	Depths: 0, 0.1, 0.5, and 0.8 ft; Velocity: 0, 2, 5, and 7 ft/s.	309 Dinkle Ditch



**Legend**

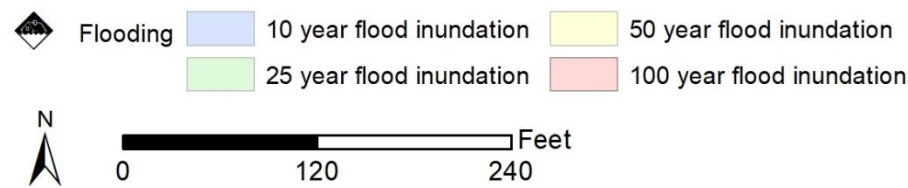
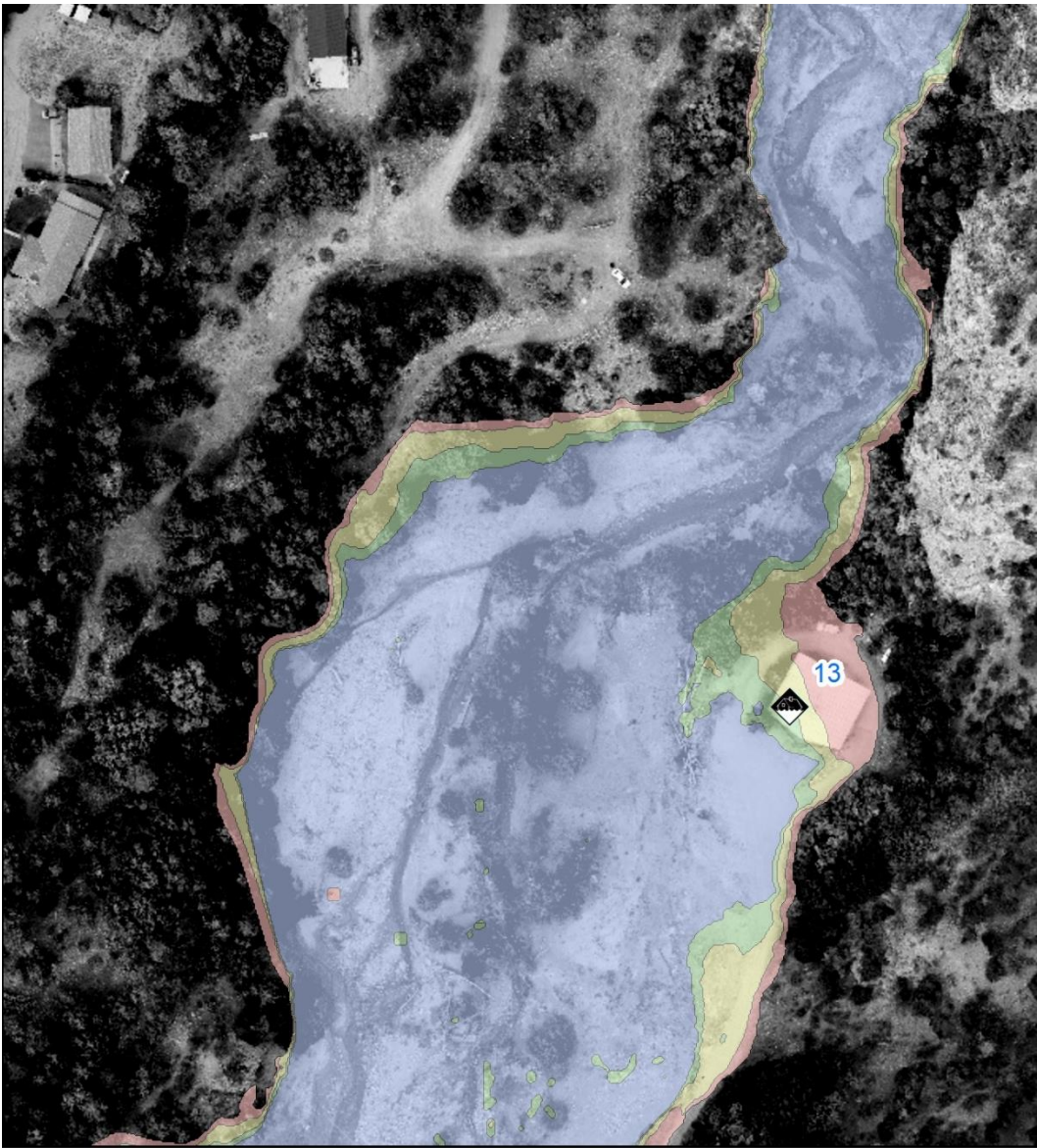


Figure 20: Identified properties that are at high and moderate risk for future flooding under 10, 25, 50, and 100-year flood events.

Table 17: Description and ranking of properties at risk of future flooding, Figure 20.

ID	Flood Risk	Description (Associated depths and velocities of the 10-, 25-, 50-, and 100-year floods, respectively)	Address
11	Moderate	Depths: 0, 0.1, 0.5, and 0.8 ft; Velocity: 0, 2, 5, and 7 ft/s.	309 Dinkle Ditch
12	Moderate	Depths: 0, 0.1, 0.8, and 1.2 ft; Velocity: 0, 3, 8 and 10 ft/s.	311 Dinkle Ditch





**Legend**

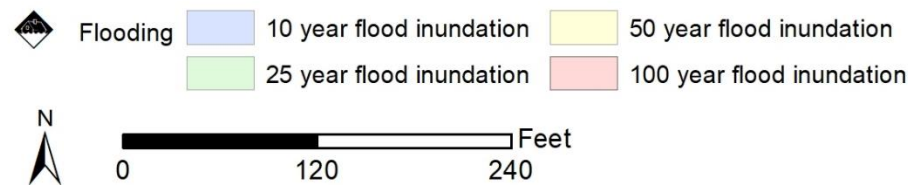
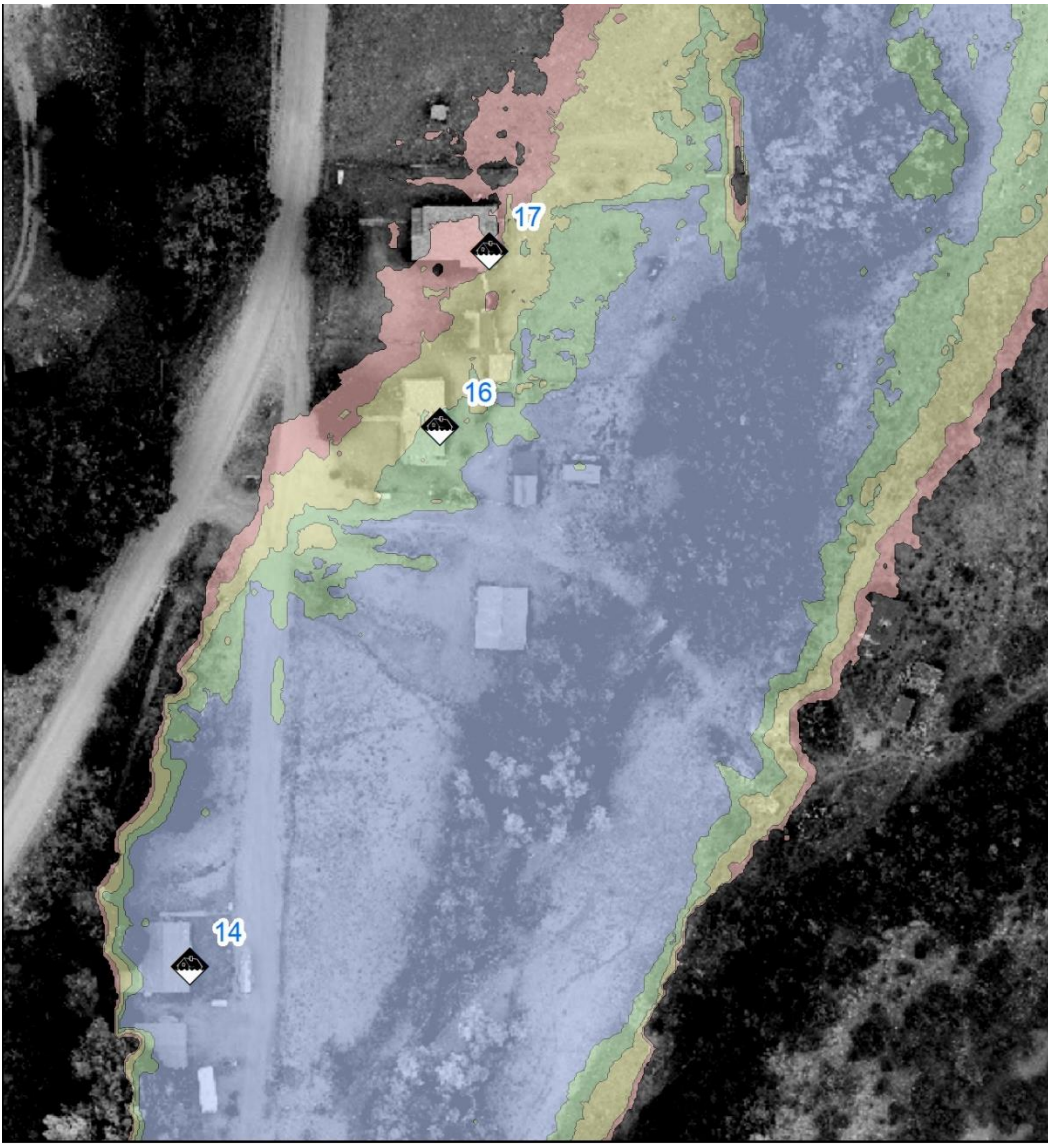


Figure 21: Identified properties that are at high and moderate risk for future flooding under 10, 25, 50, and 100-year flood events.

Table 18: Description and ranking of properties at risk of future flooding, Figure 21.

ID	Flood Risk	Description (Associated depths and velocities of the 10-, 25-, 50-, and 100-year floods, respectively)	Address
13	Moderate	Depths: 0, 1, 4.5, and 8 ft; Velocity: 0, 1.5, 5 and 7 ft/s.	403 Dinkle Ditch



**Legend**

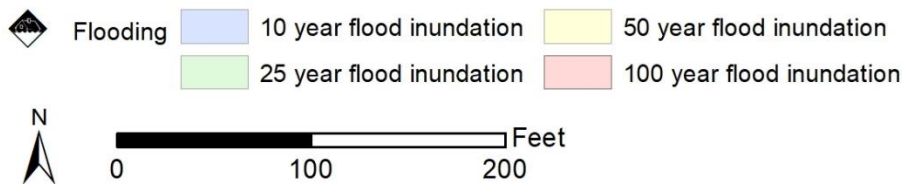
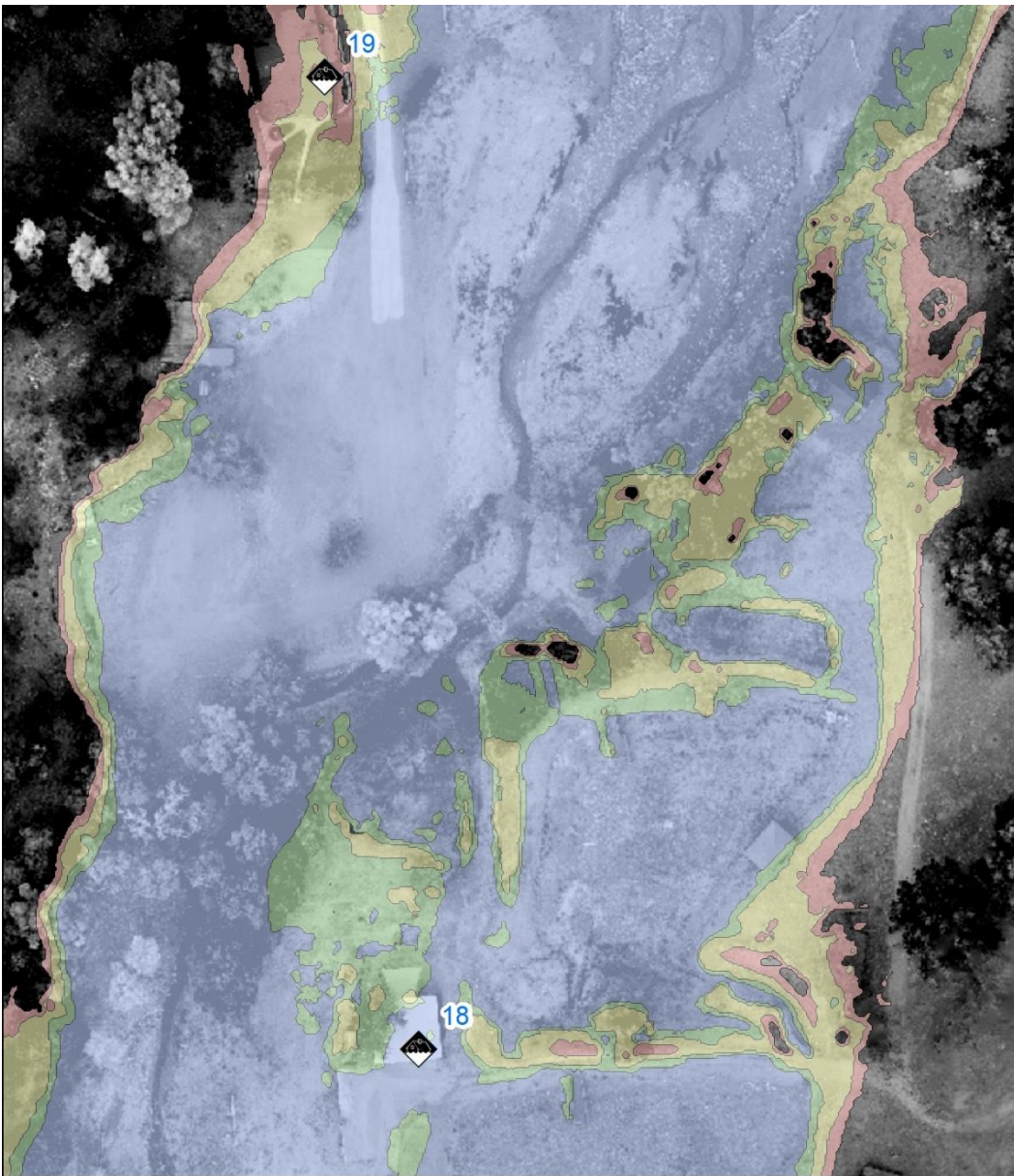


Figure 22: Identified properties that are at high and moderate risk for future flooding under 10, 25, 50, and 100-year flood events.

Table 19: Description and ranking of properties at risk of future flooding, Figure 22.

ID	Flood Risk	Description (Associated depths and velocities of the 10-, 25-, 50-, and 100-year floods, respectively)	Address
14	Moderate	Depths: 1.1, 1.9, 3.0, and 3.8 ft; Velocity: 5, 8, 11 and 12 ft/s.	920 CR 40
16	Moderate	Depths: 0, 0, 2.2, 3.9 and ft; Velocity: 0, 0, 13 and 16 ft/s.	910 CR 40
17	Moderate	Depths: 0, 0, 0, 0.7 and ft; Velocity: 0, 0, 0 and 7 ft/s.	910 CR 40





### Legend

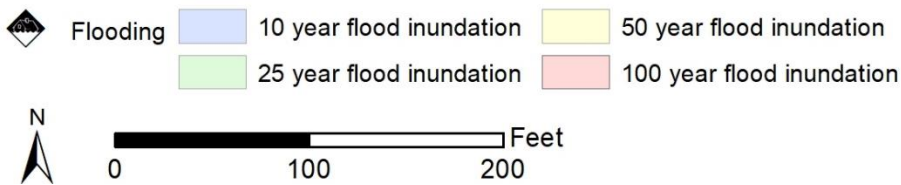


Figure 23: Identified properties that are at high and moderate risk for future flooding under 10, 25, 50, and 100-year flood events.

Table 20: Description and ranking of properties at risk of future flooding, Figure 23.

ID	Flood Risk	Description (Associated depths and velocities of the 10-, 25-, 50-, and 100-year floods, respectively)	Address
18	Moderate	Depths: 0, 0.5, 1.6, and 2.7 ft; Velocity: 0, 4, 9 and 11 ft/s.	340 Pole Mtn Lane
19	Moderate	Depths: 0, 0, 0, 1 and ft; Velocity: 0, 0, 0 and 7 ft/s.	376 CR 39

## 4. Discussion and Conclusions

Many of the identified issues pose immediate threats to life and property. Specifically, Hazard ids 0, 1, 2, 3, 4, 5, and 7 are of immediate concern. However, the bridge and road related issues are out of the budget and purpose of the Coalition, but all concerns have been effectively communicated the appropriate Fremont County personnel. Starting in July 2019, field crews have started to remove debris and cut down dangerous trees. To date, debris issues that have been resolved include:

- Debris id: 1, 14 (Figure 4)
- Debris id: 21, 22, 23 (Figure 5)
- Debris id: 10 and 11 (Figure 7)

Specific examples of this work have been documented. Figure 16 shows field crews removing two channel spanning junipers (Debris id: 22, Figure 5) that could have encouraged future debris jams. This was a high priority debris removal because it was upstream and in close proximity of a landowner's property access bridge. Figure 17 shows the removal of a very large cottonwood tree that caused neighbor disputes, and Figure 18 shows clearing the floodplain debris in the constricted upper reach of Big Cottonwood Creek where numerous homes are built within close proximity to the creek.



Figure 16: Debris jam (Debris id: 22, Figure 5) before removal (left); during removal with workforce crew, ARWC, and River Science (center); and after removal (right).





*Figure 17: Large cottonwood tree deposited during July, 2018 flood event (Debris id: 1, Figure 4) before removal (left), and after the majority of removal (right).*



*Figure 18: Field crews removing debris (Debris id: 10 and 11, Figure 7) during removal (left) and after removal (right).*

These projects have been well received and are highly appreciated by the landowners. Clean up efforts will continue during the remainder of the summer and likely into the fall. Further, any unresolved issues will be collated into the future Recovery Plan along with long-term issues (i.e. stream health, recreation, etc.), future recovery needs, and possible solutions.