Blue River Wildfire/Watershed Assessment

Prioritization of watershed-based risks to water supplies

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http://www.jw-associates.org/Projects/Blue_River/Blue_River.html

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INTRODUCTION

This watershed assessment is designed to identify and prioritize sixth-level watersheds based upon their hazards of generating flooding, debris flows and increased sediment yields following wildfires that could have impacts on water supplies. It is intended to expand upon current wildfire hazard reduction efforts by including water supply watersheds as a community value. The watershed assessment follows a procedure prescribed by the Colorado Watershed Protection Data Refinement Work Group (2009).

Following the prioritization of watersheds and identification of Zones of Concern, some basic information was analyzed within the Zones of Concern to complete an initial screening of potential opportunities for watershed protection. The results of the identification of potential opportunities is presented in the *Opportunities & Constraints* section of this report.

Another goal of this assessment is to gather the key water supply stakeholders to communicate the suggested process, listen to any suggested changes, and build collaborative support for the assessment. Four stakeholder meetings have created a diverse group of stakeholders (Appendix A) that have been engaged in the process.

WATERSHED DESCRIPTION

The Blue River watershed is a high Rocky Mountain headwaters watershed. The Blue River flows into the Colorado River when it emerges from this watershed. The Blue River watershed assessment is designed to assess hazards from forest wildfire to water supply. Therefore, the subwatersheds that are mostly or entirely outside of the forest were examined closely because they can skew the results of the assessment because they are relatively flat, have higher road densities and very different fire regimes.

The Blue River watershed is one fourth-level[1] (eight-digit) watershed (HUC 14010002) that is 436,970 acres in size and contains 25 sixth-level watersheds. For this watershed assessment, one sixth-level watershed was eliminated based upon its wildfire hazard, ruggedness, and an examination of how well it fit into this assessment. The Blue River watershed used in this analysis is 422,634 acres, contains six fifth-level watersheds and 24 sixth-level watersheds, which are the analysis units for this watershed assessment (Front Range Watershed Protection Data Refinement Work Group 2009). The Blue River watershed and its fifth-level and sixth-level watersheds are shown on Figure 1 and listed in Table 1.

View of Dillon Reservoir with the Meadow Creek Watershed in the background

[I] The watersheds that were used are part of the existing national network of delineated watersheds. Hydrologic Unit Codes (HUCs) are nested watersheds and are designated numerically by levels (Federal Geographic Data Committee 2004). Sixth-level HUCs or watersheds, use the 11th and 12th digits in the HUC code. Fifth-level HUCs use the ninth and 10th digits in the HUC code.

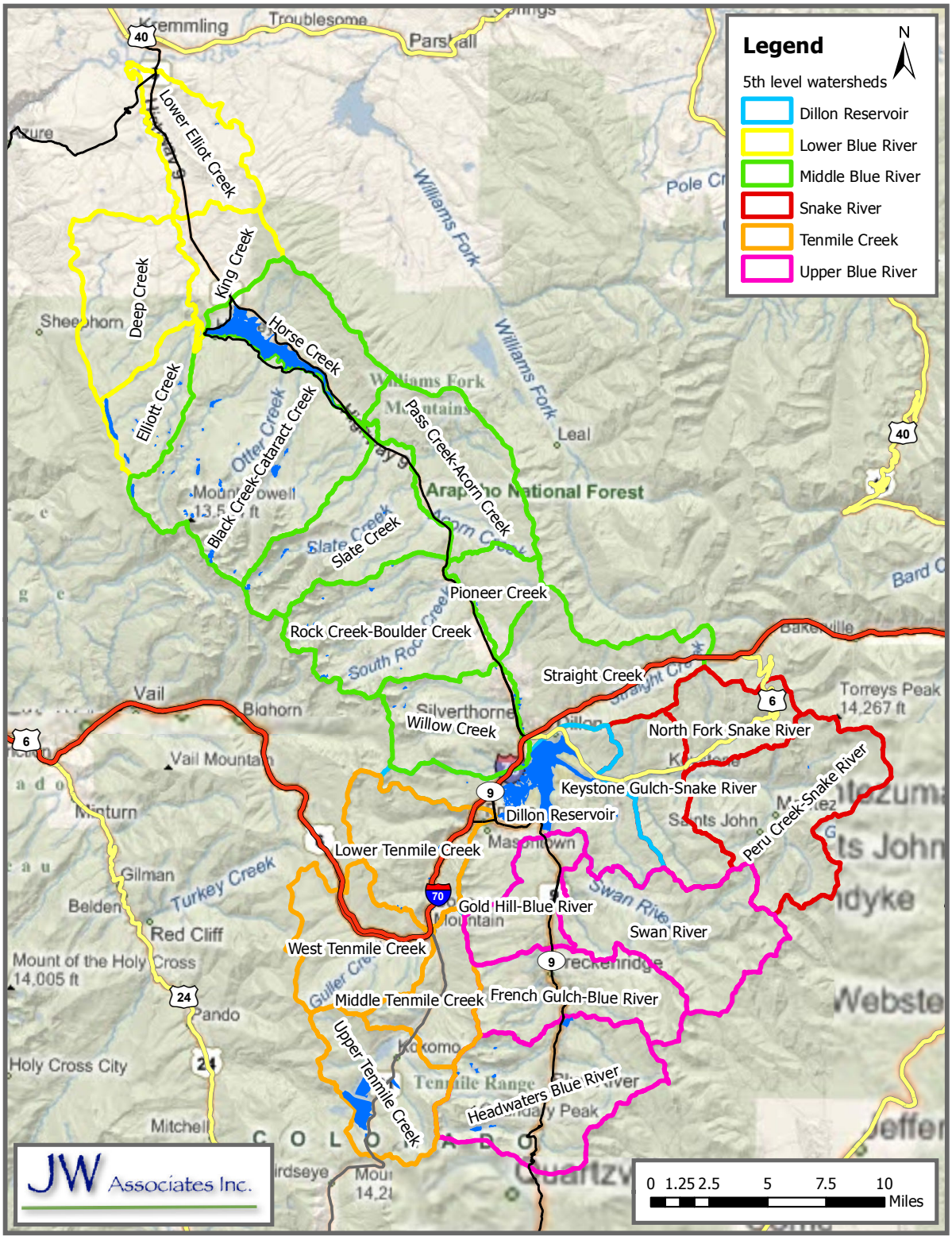

Figure 1. Blue River Watershed Analysis Area[2]

[2] The sixth-level watersheds are labeled and delineated in this figure.

Table 1. Fifth-level and Sixth-level Watersheds in Blue River Watershed

Fifth-level Watershed	Sixth-level Watershed	Watershed Area (acres)	Hydrologic Unit Code (HUC)	Map Number
Upper Blue River HUC 1401000201	Headwaters Blue River	27,034	140100020101	331
	French Gulch-Blue River	17,341	140100020102	333
	Swan River	24,059	140100020103	343
	Gold Hill-Blue River	10,424	140100020104	344
Snake River HUC 1401000202	North Fork Snake River	10,232	140100020201	342
	Peru Creek-Snake River	26,667	140100020202	341
	Keystone Gulch-Snake River	12,841	140100020203	338
Tenmile Creek HUC 1401000203	Upper Tenmile Creek	15,804	140100020301	335
	West Tenmile Creek	17,538	140100020302	334
	Middle Tenmile Creek	10,413	140100020303	339
	Lower Tenmile Creek	15,655	140100020304	345
Dillon Reservoir HUC 1401000204	Dillon Reservoir	25,623	140100020401	340
Middle Blue River HUC 1401000205	Straight Creek	20,818	140100020501	337
	Willow Creek	14,723	140100020501	351
	Pioneer Creek	6,651	140100020502	336
	Rock Creek-Boulder Creek	23,347	140100020502	350
	Pass Creek-Acorn Creek	19,242	140100020503	332
	Slate Creek	19,756	140100020503	349
	Black Creek-Cataract Creek	39,423	140100020504	329
	Horse Creek	14,983	140100020504	348
Lower Blue River HUC 1401000206	Elliot Creek	9,610	140100020601	328
	Deep Creek	19,142	140100020602	330
	King Creek	8,937	140100020602	347
	Lower Elliot Creek	12,372	140100020603	346
Total Area		422,634		

WATERSHED ASSESSMENT

The potential of a watershed to deliver sediments following wildfire depends on forest and soil conditions, the physical configuration of the watersheds, and the sequence and magnitude of rain falling on the burned area. High-severity fires can cause changes in watershed conditions that are capable of dramatically altering runoff and erosion processes in watersheds. Water and sediment yields may increase as more of the forest floor is affected by fire.

The Blue River Watershed Assessment considers four components that are integral in evaluating hazardous watershed conditions: wildfire hazard, flooding or debris flow hazard, soil erodibility and water supply. This section of the report presents the wildfire/watershed assessment analysis that results in prioritization of sixth-level watersheds. It also discusses the technical approach for each component and the process used to assemble the watershed ranking.

The Blue River Watershed Assessment was developed through a stakeholder review process. The stakeholder group included representatives from water providers; federal, state and local land management agencies; counties; towns and other interested groups (Appendix A). Four stakeholder meetings were conducted to get the groups involved in the process, provide some local expertise to check and adjust the draft results and to understand how the assessment can be useful to the various stakeholder organizations.

The results for each component are categorized into five categories that are used throughout the analysis. The categorization procedure is the one prescribed by the Colorado Watershed Protection Data Refinement Work Group (2009). The categories are used in this analysis for the purpose of comparing watersheds to each other within the Blue River Watershed. Comparisons with other watershed assessments are not valid because this approach prioritizes watersheds by comparing them to the other sixth-level watersheds only in this watershed assessment area.

The calculation of ranking for each sixth-level watershed is completed as follows:

1. Use the hazard based on the percentage of each sixth-level watershed (or other metrics).
2. Scale the results so that they fall within five equal categories.
3. Round the scaled result to the nearest whole number (retain the actual number for use in the Composite Hazard Ranking).
4. Create a map of the results using the following scheme:

    Category 1 – Lowest

    Category 2

    Category 3

    Category 4

    Category 5 – Highest

Component 1 - Wildfire Hazard

The forest conditions that are of concern for the assessments are the wildfire hazard based on existing forest conditions. The wildfire hazard (Flame Length) was determined using the Fire Behavior Assessment Tool (FBAT) (http://www.fire.org) which is an interface between ArcMap and FlamMap. The input spatial data were collected from LANDFIRE project (http://www.landfire.gov/).

After a mountain pine beetle outbreak there are substantial increases in the amount of fine dead fuels in the canopy. The majority of these fuels remain in the canopy for 2-3 years post outbreak (Knight 1987, Schmid and Amman 1992). Therefore, certain input spatial data sets were updated based on Mountain Pine Beetle (MPB) mortality conditions using USDA Forest Service, Rocky Mountain Region Aerial Detection Survey (ADS) Data from the years 2002-2007 (http://www.fs.fed.us/r2/resources/fhm/aerialsurvey/). The assumptions used in the FBAT model are presented in Appendix B.

The flame length results were divided into five categories of wildfire hazard ranging from lowest (Category 0) to highest (Category 4). The flame length categories that were used are;

Flame Length Category 0 - 0 meters

Flame Length Category 1 - 1 to 10 meters

Flame Length Category 2 - 11 to 25 meters

Flame Length Category 3 - 26 to 40 meters

Flame Length Category 4 - >40 meters

Figure 2 shows the results of the wildfire hazard modeling. The results were categorized by sixth-level watershed into five categories that are used throughout the analysis using the following formula.

Wildfire Hazard Ranking = (Percentage in Category 3 + Percentage in Category 4 * 2)

The categorized wildfire hazard by sixth-level watershed was mapped (Figure 3). The map shows that the highest hazards are in the following sixth-level watersheds: Elliot Creek, Swan River, Gold Hill-Blue River, Lower Tenmile Creek, Willow Creek, and Keystone Gulch-Blue River. Six watersheds were ranked as Category 4, which is the next highest category (Appendix C).

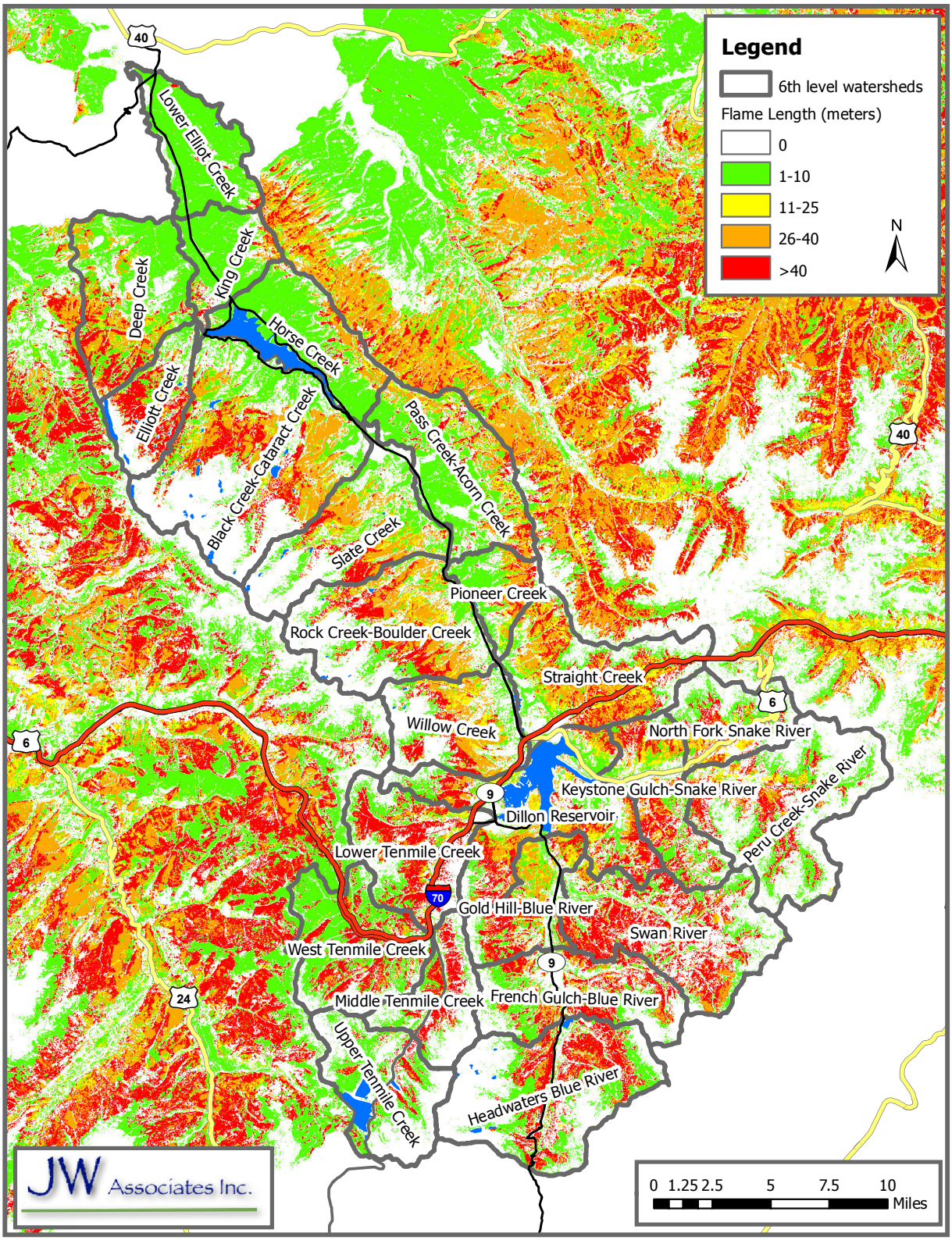

Figure 2. Blue River Watershed Wildfire Hazard Modeling Results

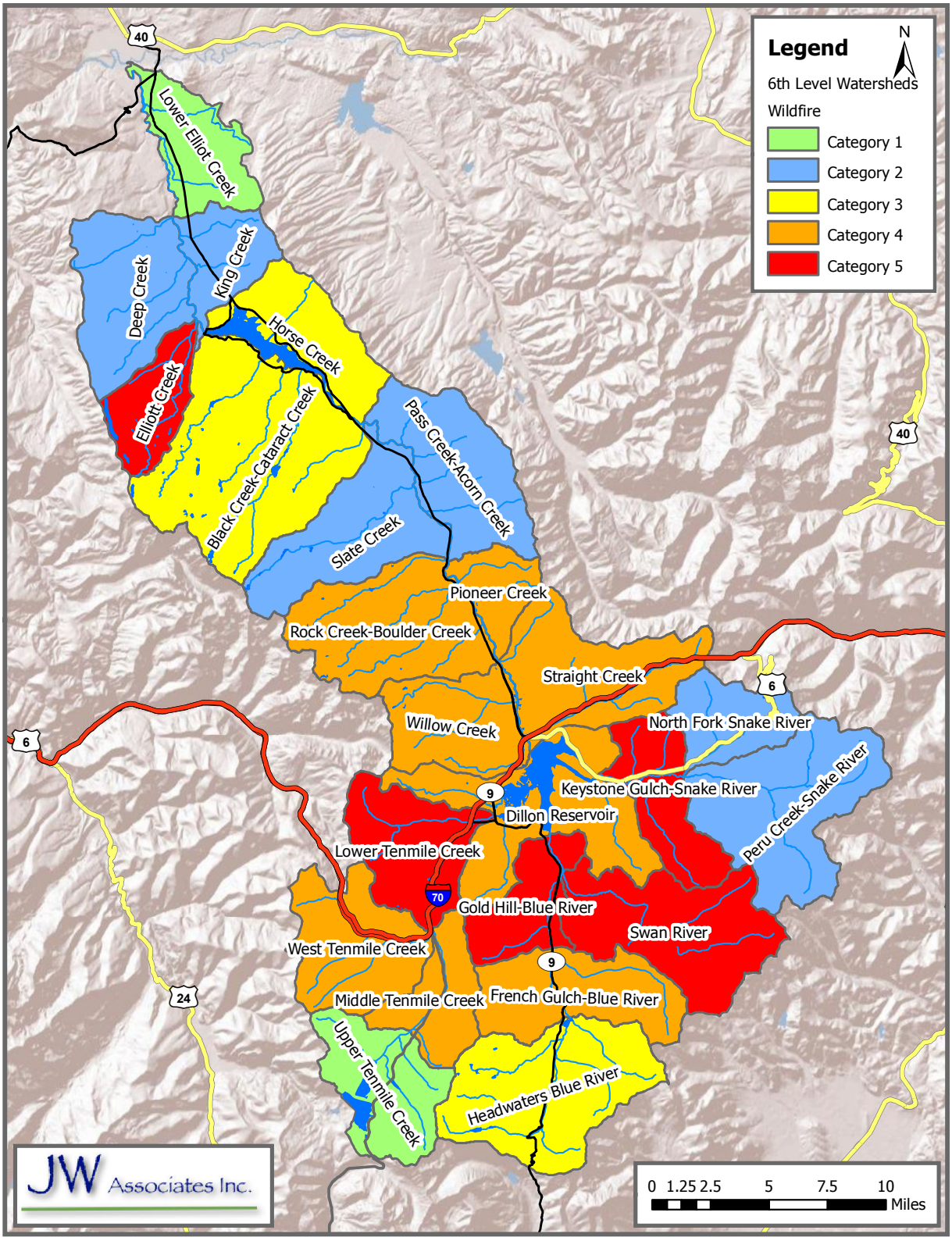

Figure 3. Blue River Watershed Wildfire Hazard Ranking

Component 2 - Flooding or Debris Flow Hazard

A combination of ruggedness and road density (miles of road per square mile of watershed area) was used to assess the flooding or debris flow hazard portion of the analysis. The two components, ruggedness and road density, are described below.

Ruggedness

Watershed steepness or ruggedness is an indicator of the relative sensitivity to debris flows following wildfires (Cannon and Reneau 2000). The more rugged the watershed, the higher its sensitivity to generating debris flows following wildfire (Melton 1957). The Melton ruggedness factor is basically a slope index.

Melton (1957) defines ruggedness, R, as;

$$R = H_b A_b^{-0.5}$$

Where A_b is basin area (square feet) and H_b is basin height (feet) measured from the point of highest elevation along the watershed divide to the outlet.

The ruggedness result in some watersheds was adjusted because they do not accurately reflect the slope in those watersheds. Those situations are most common in composite watersheds because they are disconnected from their headwaters. These watersheds can have a high hazard for debris flows because they contain a main stem of a creek or river with several steep first order streams as tributaries. In those situations, the ruggedness calculation was adjusted up by reducing the watershed area. These adjustments were completed on the following watersheds; Headwaters Blue River, French Gulch-Blue River, Swan River, North Fork Snake River, Peru Creek-Snake River, Keystone Gulch-Snake River, Upper Tenmile Creek, West Tenmile Creek, Lower Tenmile Creek, Straight Creek, Rock Creek-Boulder Creek, Pass Creek-Acorn Creek, Slate Creek, Black Creek-Cataract Creek, Horse Creek, and Deep Creek.

Figure 4 displays the categorized ruggedness for the Blue River Watershed. The tabular results are presented on Table C-2 in Appendix C. The map (Figure 4) shows that the most rugged sixth-level watersheds are Pioneer Creek, North Fork Snake River, Headwaters Blue River, Rock Creek-Boulder Creek, French Gulch-Blue River, Slate Creek, and Black Creek-Cataract Creek.

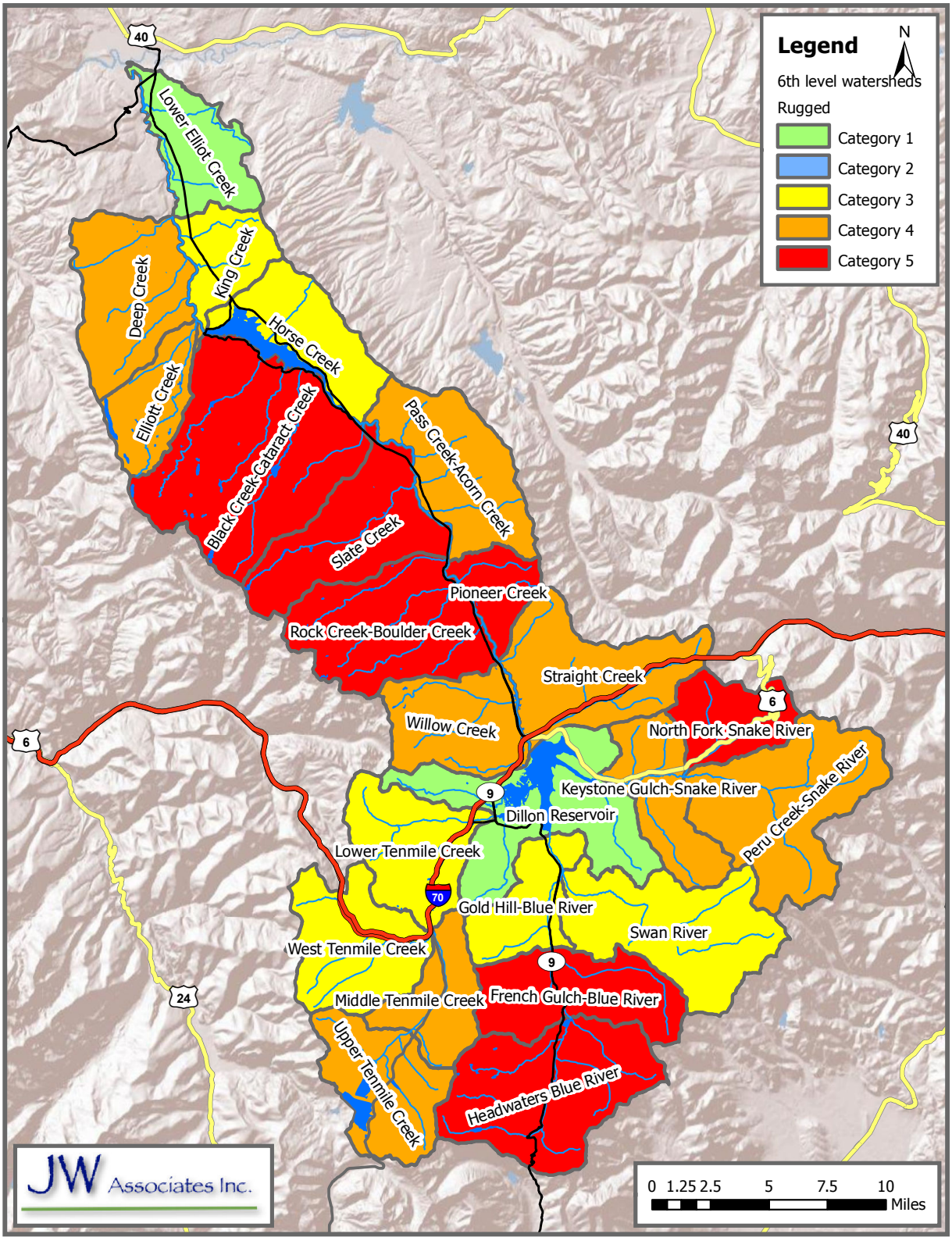

Figure 4. Blue River Watershed Ruggedness Ranking

Road Density

Roads can convert subsurface runoff to surface runoff and then route the surface runoff to stream channels, increasing peak flows (Megan and Kidd 1972, Ice 1985, and Swanson et al. 1987). Therefore, watersheds with higher road densities have a higher sensitivity to increases in peak flows following wildfires. Road density in miles of road per square mile of watershed area was used as an indicator of flooding hazard. The U.S. Forest Service roads data was used on National Forest System (NFS) lands because it is the most accurate roads data for those roads in the forest. On all other lands the U.S. Census Bureau's Tiger database was used because it is a consistent roads data layer (Figure 5).

Road densities were adjusted in some watersheds for two separate reasons. One reason for adjusting the road density was the situation where a watershed had a much higher road density than the next highest value, so that watershed was skewing the categorization. In that situation, the watershed was manually given a road density slightly higher than the next highest score.

The other situation where road density was adjusted is where some of the roads within a watershed were within towns, developed areas, or outside the forested areas of the watershed. The roads that are of interest in this analysis are those roads that would increase the risk of flooding or debris flows following wildfires in forested areas. The watersheds were all examined by looking at the roads data overlain on digital images and vegetation mapping. If it was found that there were significant lengths of road outside forested areas, the road density in those watersheds was adjusted down based on ocular estimates.

Road density in the French Gulch-Blue River, Swan River, Keystone Gulch-Snake River, and Dillon Reservoir watersheds were all adjusted down. The adjustments are displayed on Table C-3 in Appendix C.

Figure 6 displays the categorized road density for the Blue River Watershed and tabular results are presented in Appendix C (Table C-3). Figure 6 shows that the highest rankings are in French Gulch-Blue River, Gold Hill-Blue River, Willow Creek, and Upper Tenmile Creek.

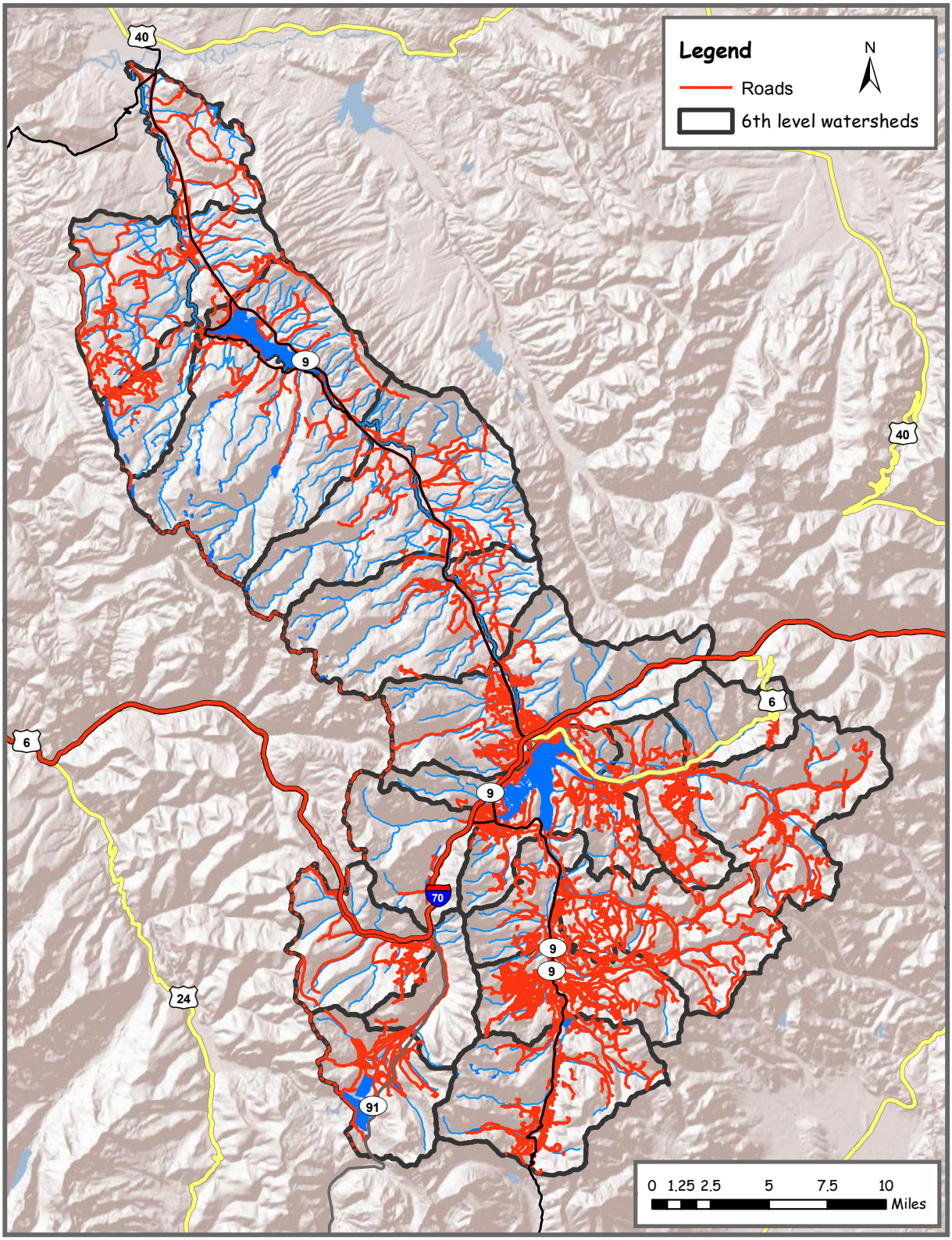

Figure 5. Blue River Watershed Roads Map

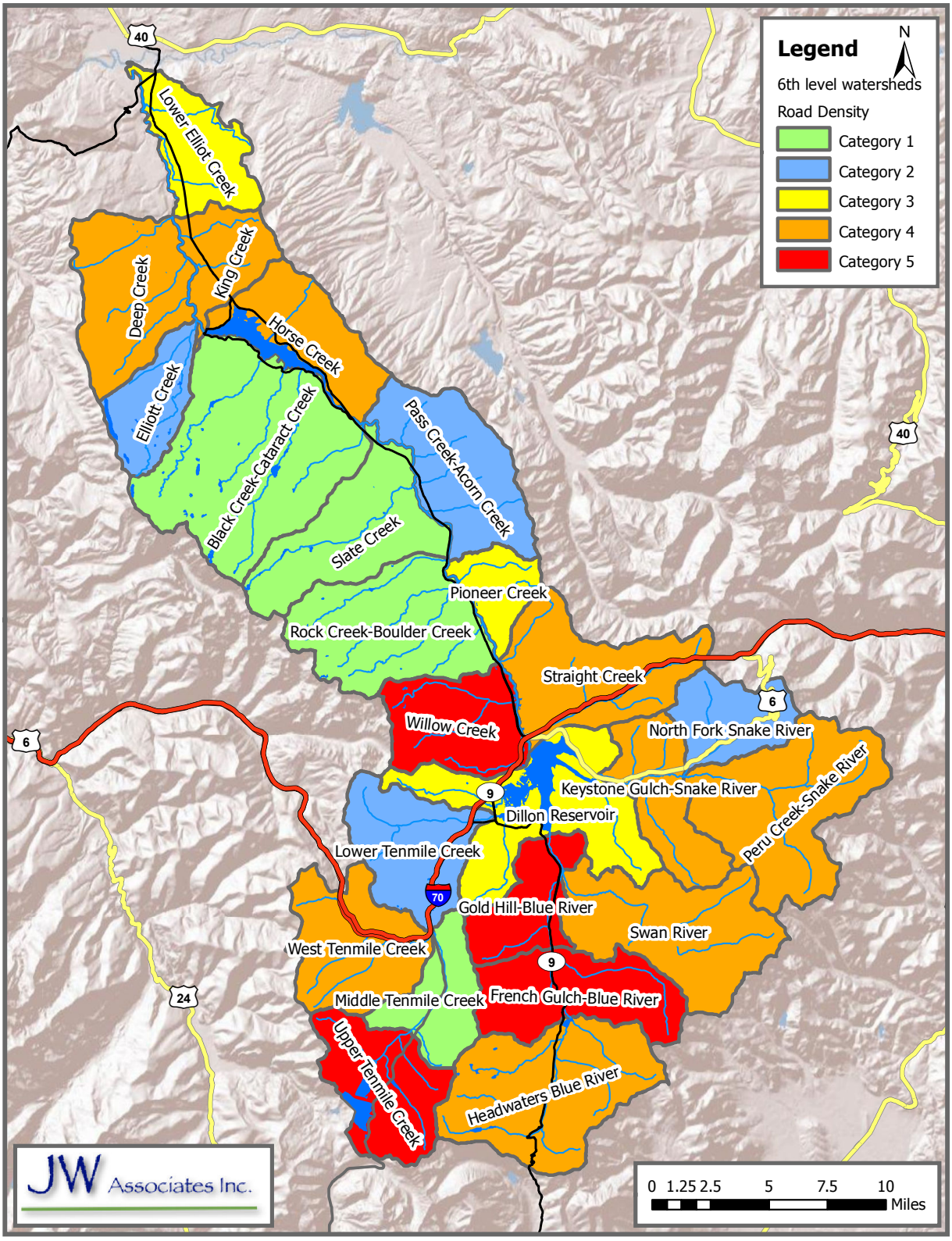

Figure 6. Blue River Watershed Road Density Ranking

Flooding or Debris Flow Hazard Ranking

The Flooding or Debris Flow Hazard is the combination of ruggedness and road density. The procedure from the Colorado Watershed Work Group (2009) assigned ruggedness a higher value than road density in this ranking. While ruggedness is the most important factor, an increase in road density will magnify the effects of ruggedness on the flooding/debris flow hazard. Accordingly, the analysis for flooding or debris flow hazard for the Blue River Watershed used the following formula. The results of this calculation were then re-categorized into five hazard rankings.

Flooding or Debris Flow Hazard Ranking = (Road Density Ranking + Ruggedness Ranking * 2)

Figure 7 shows that areas of the watershed with high road densities and high ruggedness rank high in this combined factor. The best way to look at this map is to look at a single watershed on the ruggedness and road density maps, noting the rankings on each. Then look at this map and see how they result in the final ranking for this component. The tabular results are presented in Table C-4 in Appendix C.

The highest ranked sixth-level watersheds are French Gulch-Blue River, Headwaters Blue River and Pioneer Creek. Dillon Reservoir and Lower Elliot Creek were skewing the categorization because of their low combined numeric scores for Flooding or Debris Flow Hazard Ranking. The combined numeric scores for Dillon Reservoir and Lower Elliot Creek watersheds was manually given a score slightly less than the next lowest score (Table C-4 in Appendix C).

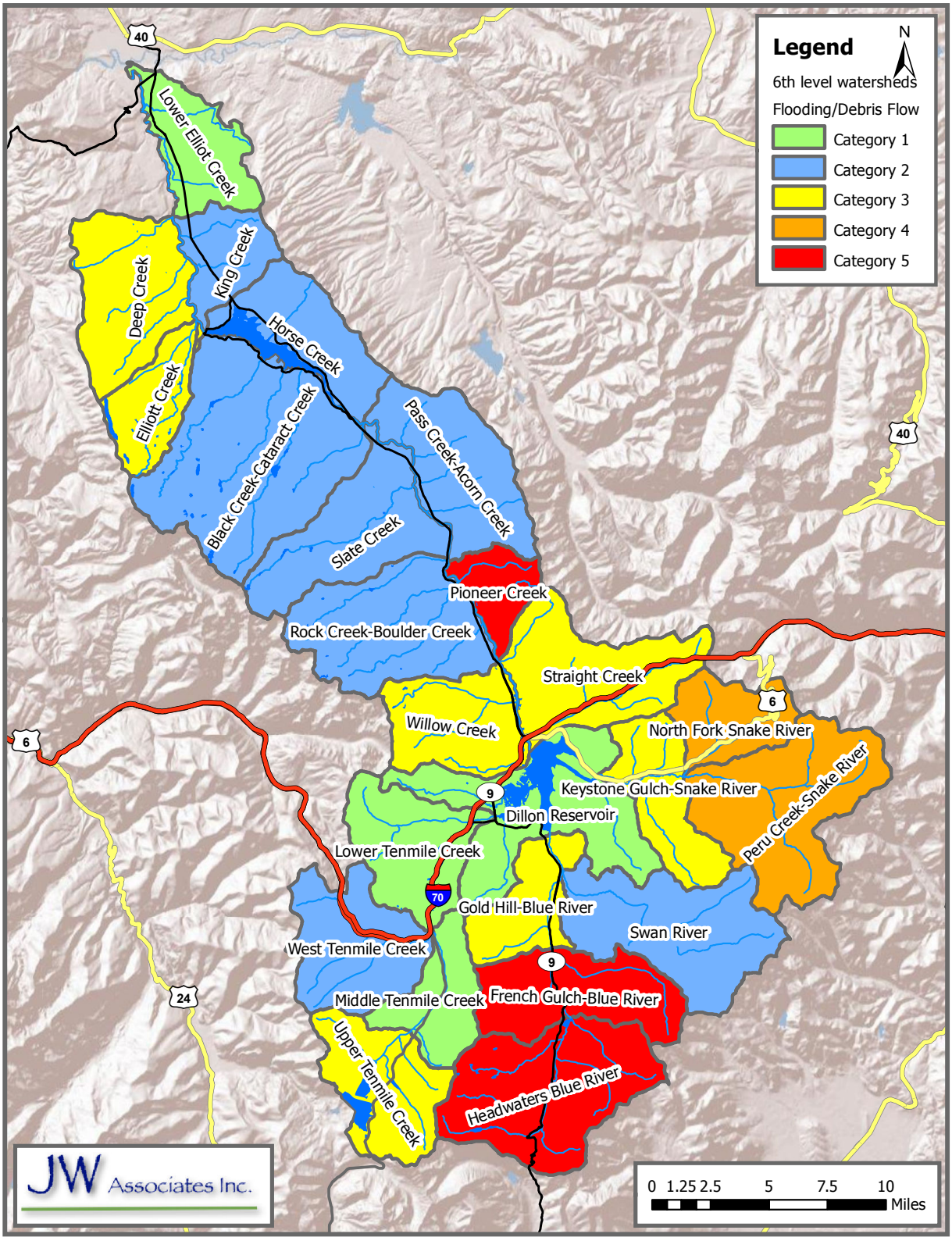

Figure 7. Blue River Watershed Flooding/Debris Flow Hazard Ranking

Component 3 - Soil Erodibility

High-severity fires can cause changes in watershed components that can dramatically change runoff and erosion processes in watersheds. Water and sediment yields may increase as more of the forest floor is consumed (Wells et al. 1979, Robichaud and Waldrop 1994, Soto et al. 1994, Neary et al. 2005, and Moody et al. 2008) and soil properties are altered by soil heating (Hungerford et al. 1991).

Two soils data sets were evaluated for use in this analysis. They were the U.S. Department of Agriculture - Natural Resources Conservation Service (NRCS) STATSGO and SSURGO soils data. STATSGO data are relatively coarse soils data, created at a scale of 1:250,000 and are available for the entire watershed assessment area. SSURGO soils data do not cover all the watershed assessment area, though efforts by the NRCS are currently under way to produce an updated soils data layer.

The data used in this analysis is the U.S. Department of Agriculture - Natural Resources Conservation Service (NRCS) SSURGO soils data combined with the U.S. Forest Service soils data. SSURGO data does not cover all the watershed but is available at a preferable scale (generally ranges from 1:12,000 to 1:63,360) than STATSGO data. The U.S. Forest Service soils data is comparable with the SSURGO data in scale and quality. Areas without SSURGO data were filled in with U.S. Forest Service soils data (Figure 8).

The soil erodibility analysis used a combination of two standard erodibility indicators: the inherent susceptibility of soil to erosion (K factor) and land slope derived from Unites States Geological Survey (USGS) 30-meter digital elevation models. The K factor data from the SSURGO spatial database was combined with a slope grid using NRCS (USDA NRCS 1997) slope-soil relationships (Table 2) to create a classification grid divided into slight, moderate, severe and very severe erosion hazard ratings.

Table 2. NRCS Criteria for Determining Potential Soil Erodibility

Percent Slope	K Factor <0.1	K Factor 0.1 to 0.19	K Factor 0.2 to 0.32	K Factor >0.32
0-14	Slight	Slight	Slight	Moderate
15-34	Slight	Slight	Moderate	Severe
35-50	Slight	Moderate	Severe	Very Severe
>50	Moderate	Severe	Very Severe	Very Severe

The potential soil erodibility hazard rankings are shown on Figure 9 and the tabular results are presented in Table C-5 in Appendix C. The map shows areas of high soil erodibility in the assessment area. The highest ranked sixth-level watersheds based on soil erodibility are Pioneer Creek, Middle Tenmile Creek, Keystone Gulch-Snake River, and Lower Tenmile Creek. The soil erodibility value for Straight Creek was adjusted up due to the presence of large quantities of highway sand that increase the concern for soil erosion. Middle Tenmile Creek and Pioneer Creek were skewing the categorization because of their high soil erodibility values and were manually given a score slightly more than the next highest score (Table C-5 in Appendix C).

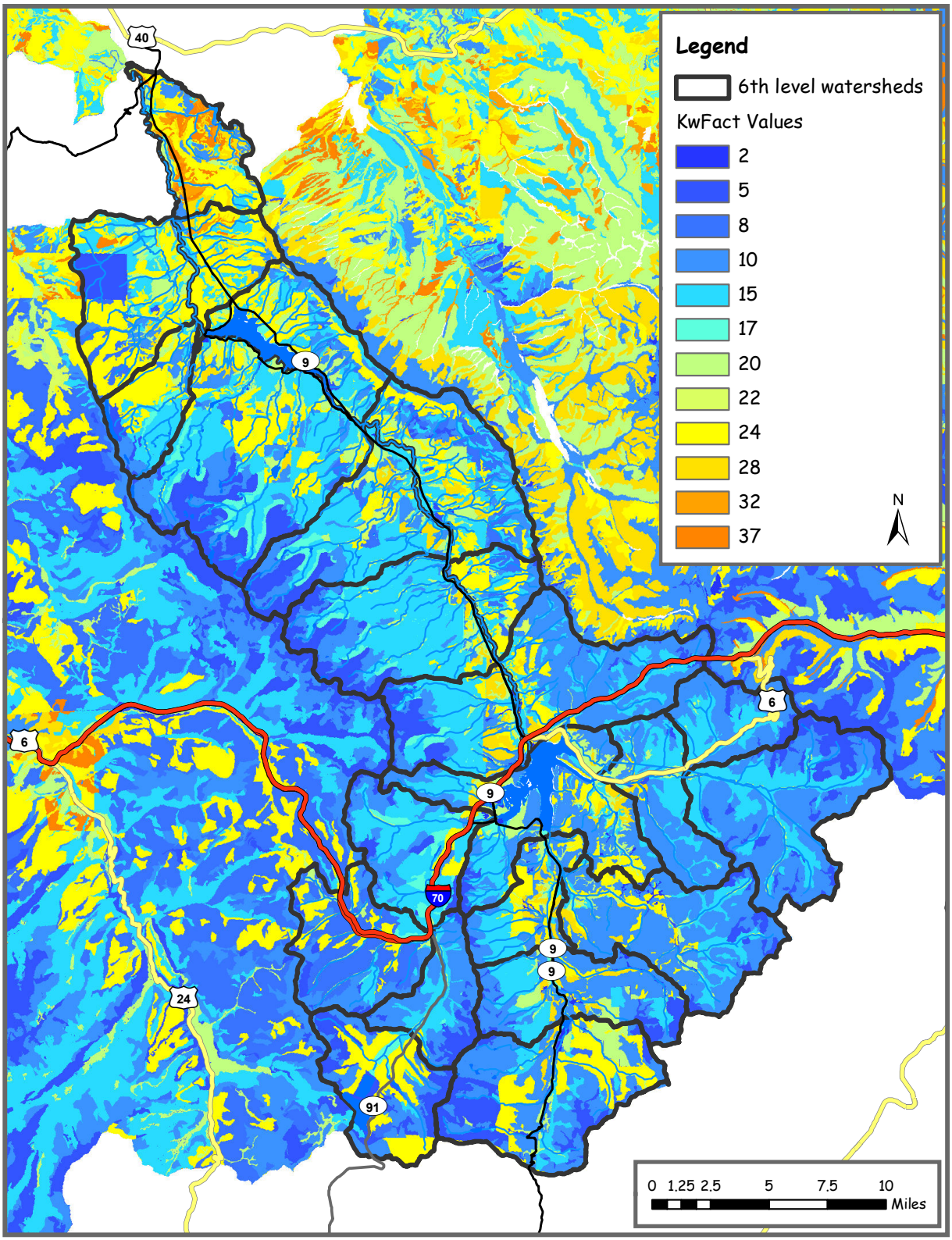

Figure 8. Blue River Watershed Soils K-Factor Map

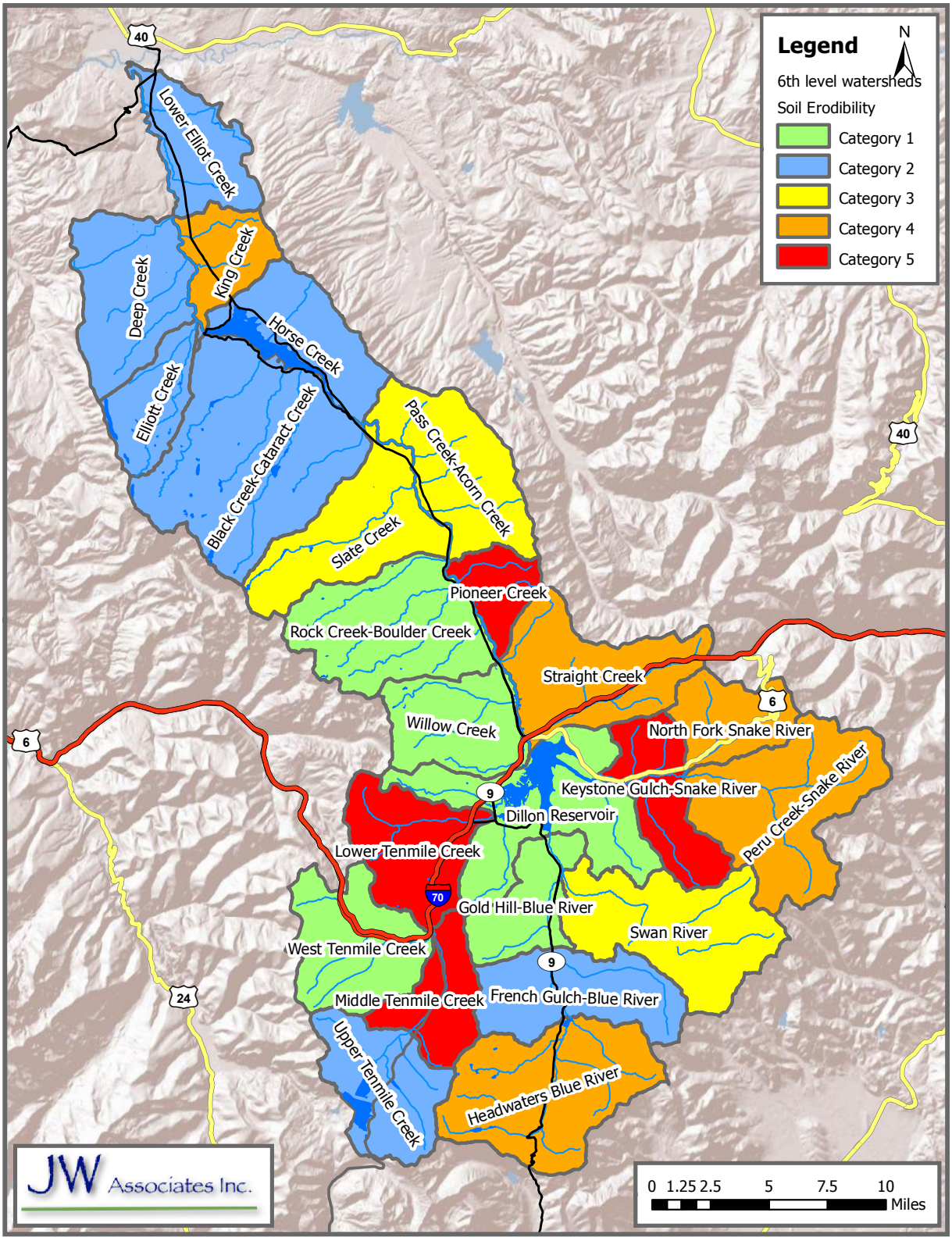

Figure 9. Blue River Watershed Potential Soil Erodibility Hazard Ranking

Composite Hazard Ranking

The Composite Hazard Ranking combines the first three components (Wildfire Hazard, Flooding/Debris Flow Hazard and Soil Erodibility) by numerically combining their rankings for each sixth-level watershed and then re-categorizing the results. The Composite Hazard Ranking map is useful in comparing relative watershed hazards based solely on environmental factors. Figure 10 shows the Composite Hazard Ranking for the Blue River Watershed. The tabular results that display the rankings for Wildfire Hazard, Flooding/Debris Flow Hazard and Soil Erodibility, as well as the composite rankings are presented in Table C-6 in Appendix C. The highest ranked sixth-level watersheds are Pioneer Creek, Keystone Gulch-Snake River, and Headwaters Blue River. Additionally, there are five watersheds in Category 4.

Lower Elliot Creek was skewing the categorization because of its low score for the Composite Numeric Rank. The Composite Numeric Rank for Lower Elliot Creek was manually given a score less than the next lowest score (Table C-6 in Appendix C).

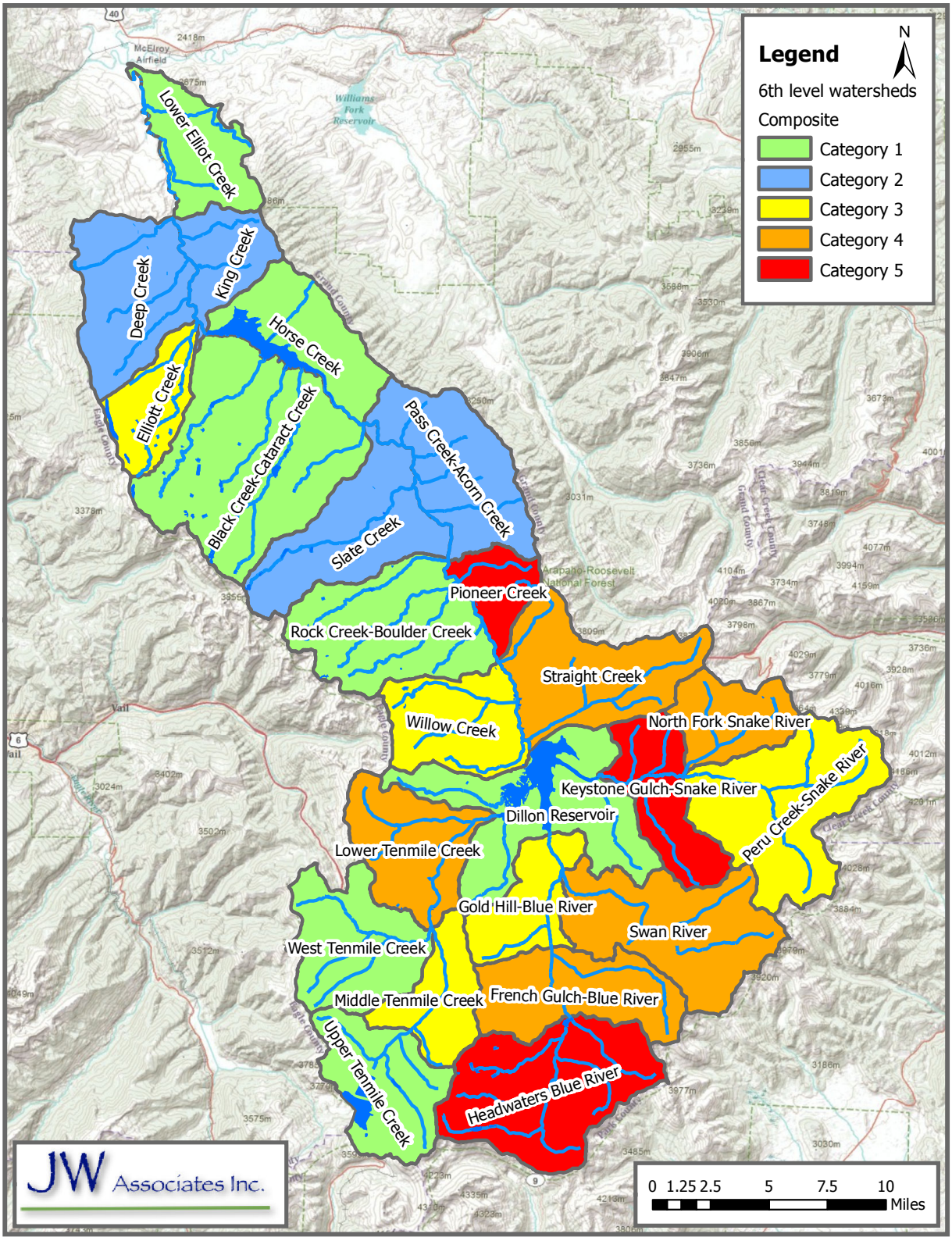

Figure 10. Blue River Watershed Composite Hazard Ranking

Component 4 - Water Supply Ranking

Surface water intakes, diversions, conveyance structures, storage reservoirs and streams are all susceptible to the effects of wildfires. The suggested approach from the procedure prescribed by the Colorado Watershed Protection Data Refinement Work Group (2009) is to first rank watersheds based upon the presence of water nodes.

Surface drinking water supply collection points from the Source Water Assessment and Protection (SWAP) Program (see http://www.cdphe.state.co.us/wq/sw/swaphom.html for basic information on the SWAP Program) were used to identify which sixth-level watersheds contain critical components of the public water supply infrastructure in Colorado. For this assessment, water nodes were defined as coordinate points corresponding to surface water intakes, upstream diversion points and classified drinking water reservoirs.

Water supply locations may not be identified in the state's database for some drinking water supply reservoirs that do not have associated direct surface water intakes. Also, some water supply reservoirs may not be identified in the SWAP database. The Water Supply map was modified to include these features by including all named reservoirs.

Figure 11 shows the sixth-level watersheds that have water supply locations in blue and those without water supply locations in green.

Final Priority

The Blue River Watershed Stakeholder Group decided to use the water supply nodes in the prioritization process. Those watersheds that have a water supply feature (diversion, reservoir or other) were given higher priority in the ranking scheme by increasing their priorities from the Composite Hazard map by one category. Those results were re-categorized and the result is the Final Priority map (Figure 12). The sixth-level watersheds that ranked highest in the Final Priority are Keystone Gulch-Snake River, Headwaters Blue River, Pioneer Creek, French Gulch-Blue River, Straight Creek, and North Fork Snake River.

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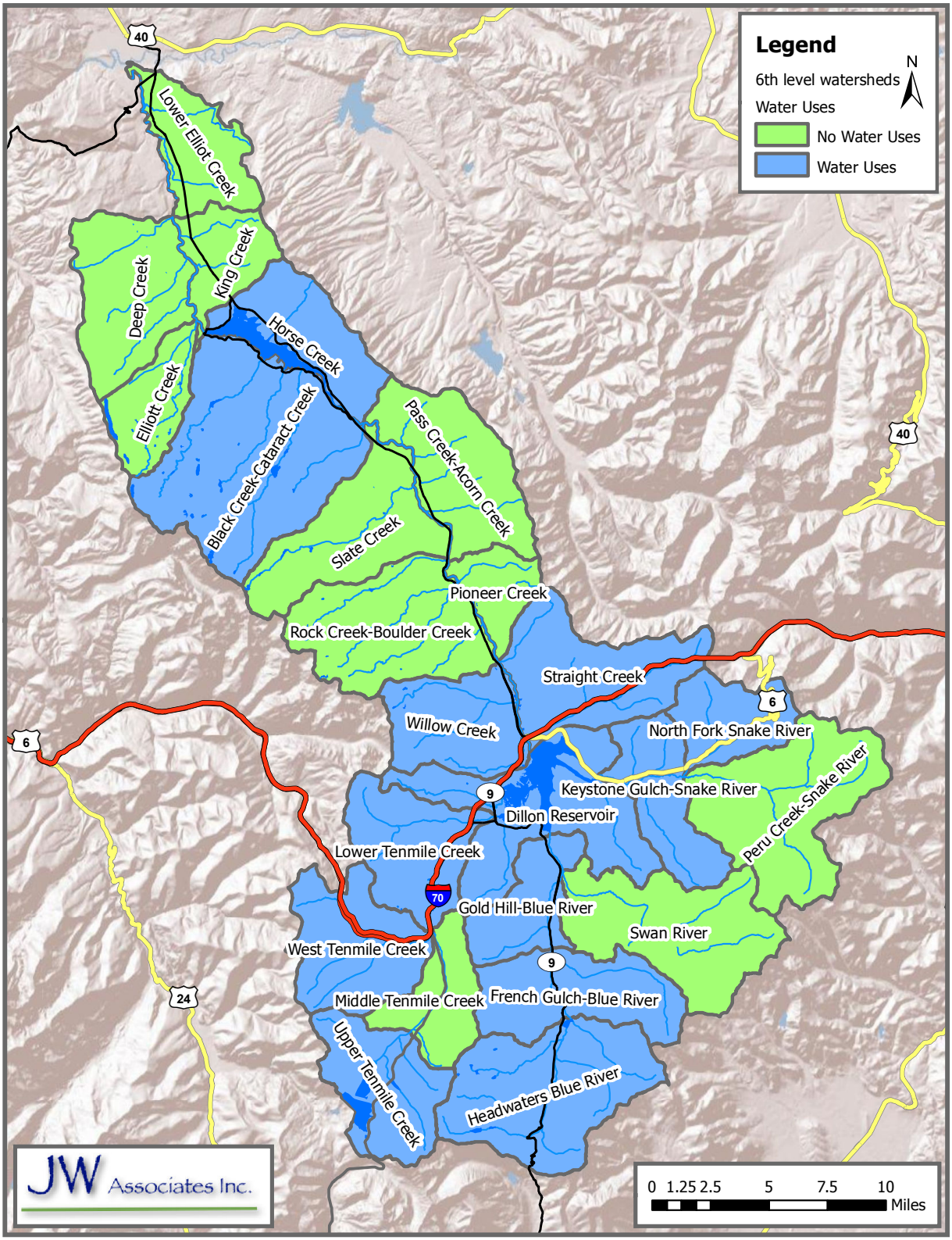

Figure 11. Blue River Watershed Water Supply Ranking

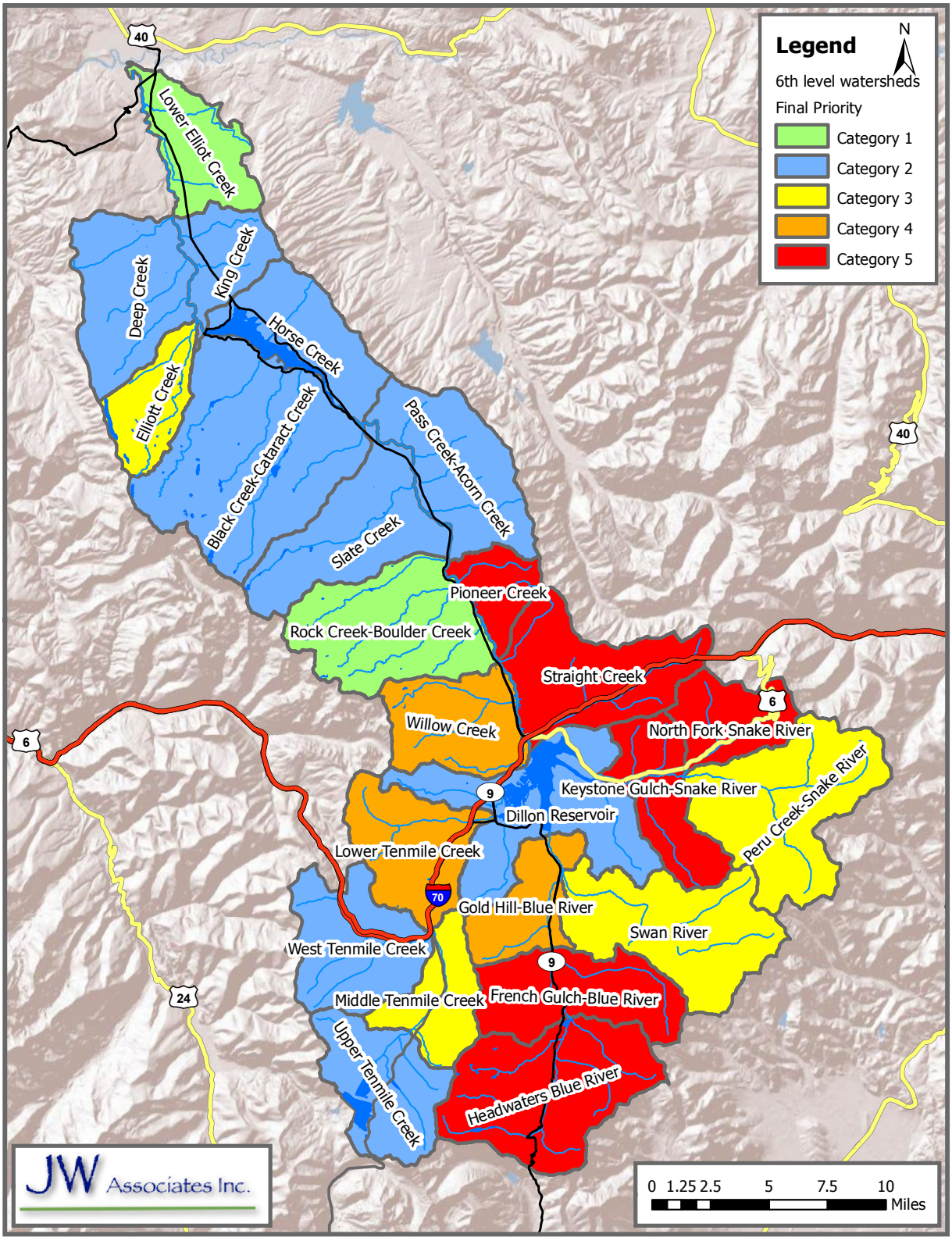

Figure 12. Blue River Watershed Final Priority

Zones of Concern

The Front Range Watershed Protection Data Refinement Work Group identified an important risk factor for water uses related to transport of debris and sediment from upstream source water areas. The source water areas (i.e. watershed areas) above important surface water intakes, upstream diversion points and drinking water supply reservoirs that have a higher potential for contributing significant sediment or debris are called Zones of Concern. These zones also can be used by stakeholders to further define project areas that focus on watershed protection actions.

There were several methods suggested by the Front Range Watershed Protection Data Refinement Work Group (2009) to define Zones of Concern. The Blue River Watershed Stakeholders agreed to use the five-mile upstream distance. This approach is based on Colorado State Statute 31-15-707 which allows municipal water providers to enact an ordinance to protect their water intakes within five miles upstream of their intakes. This municipal statute that has been in place since the late 1800's and has been tested in court several times and upheld.

Twenty-one Zones of Concern were delineated in the Blue River Watershed (Figure 13 and Table 3). The Zones of Concern were overlaid on the Final Priority map. More detailed maps of the ZoC are presented in the *Opportunities & Constraints* section below. The water supply agencies for each ZoC have also been identified in Table 3. Some of the ZoC overlap with others, or in other areas, the ZoC are close to overlapping other ZoC. In those situations, ZoC can be combined or viewed as one, combining several stakeholders into a larger ZoC.

Stakeholder groups may want to expand their Zones of Concern to include all the sixth-level watersheds that have any portion of those watersheds within their Zone of Concern. Erosion, flooding and debris flows can originate high in watersheds and travel long distances. The debris flow and flooding following the Buffalo Creek fire in the Upper South Platte watershed in 1996 traveled 11 miles down Spring Creek. Decisions of what areas to include would be made at the next level in planning (see *Recommendations* section below).

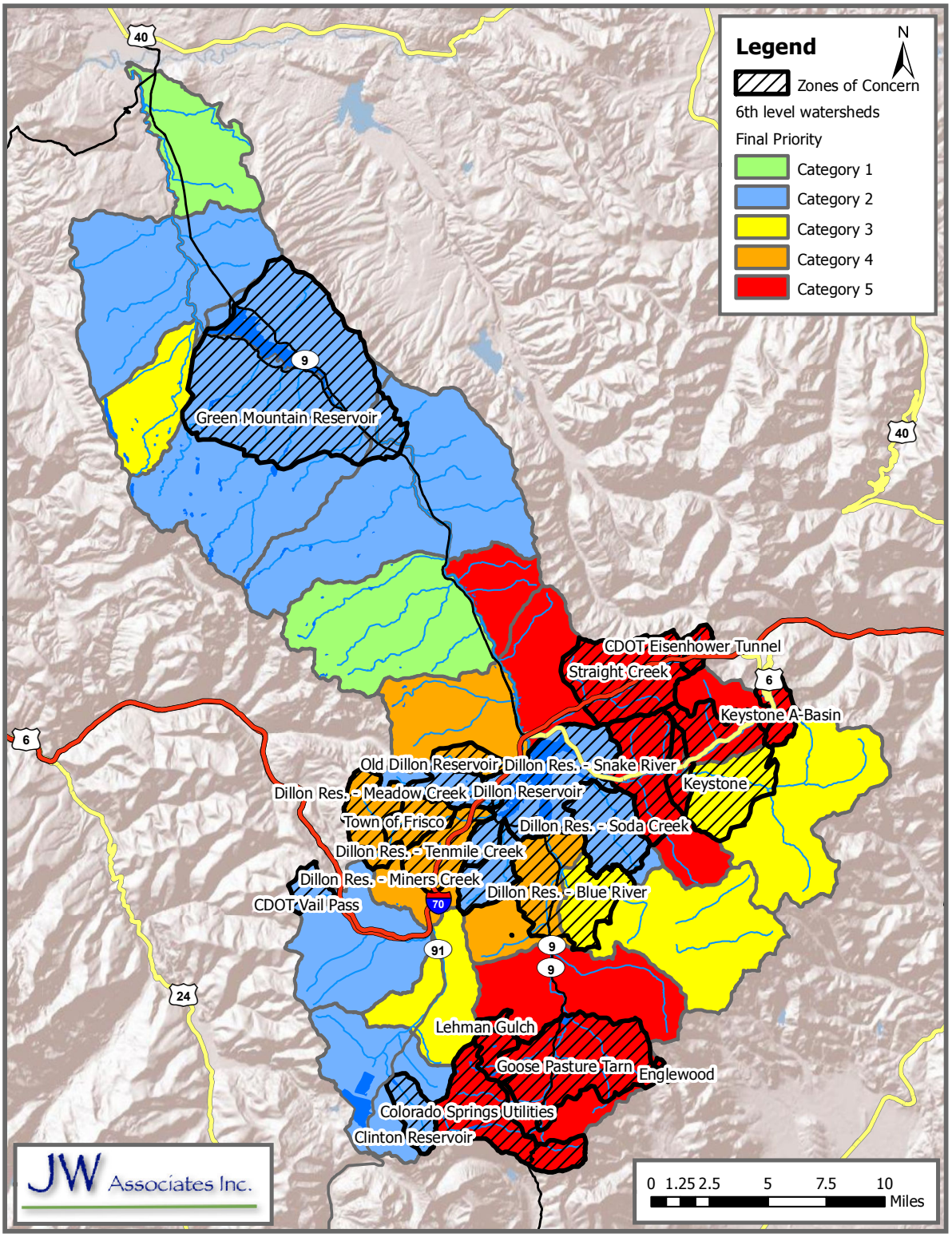

Figure 13. Blue River Watershed ZoC[3]

[3] The *Opportunities & Constraints* section below displays and identifies each ZoC at a better scale than Figure 13.

Table 3. Blue River Watershed Zones of Concern

Water Supply Name	ZoC Area (acres)	Owner/Operator
Colorado Springs Utilities	10,275	Colorado Springs Utilities
CDOT Eisenhower Tunnel	1,178	Colorado Department of Transportation
CDOT Vail Pass	1,623	Colorado Department of Transportation
Clinton Reservoir	2,703	Clinton Reservoir and Ditch Company
Englewood	264	Englewood
Goose Pasture Tarn	14,388	Town of Breckenridge
Green Mountain Reservoir	32,680	???
Keystone	12,796	Keystone - Summit Lodge
Keystone A-Basin	2,101	Keystone - Arapahoe Basin
Dillon Reservoir	11,948	Denver Water
Dillon Reservoir - Blue River	10,782	Denver Water
Dillon Reservoir - Meadow Creek	2,797	Denver Water
Dillon Reservoir - Miners Creek	3,365	Denver Water
Dillon Reservoir - Snake River	9,133	Denver Water
Dillon Reservoir - Soda Creek	5,818	Denver Water
Dillon Reservoir - Tenmile Creek	7,509	Denver Water
Lehman Gulch	410	Breckenridge Ski
Old Dillon Reservoir	2,015	Town of Dillon
South Barton Creek	626	Peak 7/Slope/Breckenridge
Straight Creek	9,744	Town of Dillon, Dillon Valley Municipal District
Town of Frisco	7,456	Town of Frisco
Totals	**149,611**	

RECOMMENDATIONS

This watershed assessment is a process that sets priorities, identifies stakeholders and ZoC. The next steps that are taken by stakeholders using the information presented in this report are essential to address the hazards identified through this process. Some potential opportunities are presented in the next section of this report. These recommendations are presented first to guide the reader through the *Opportunities & Constraints* section.

Hazard Reduction Strategies

Although there are other strategies that can be pursued, the reduction of wildfire severity is the main goal for minimizing adverse hydrologic responses following intense wildfires. Wildfire severity is the effect that the fire has on the ground. Vegetative forest treatments can be effective in reducing the threat of crown fire (Graham et al. 1999). Treatments that reduce density and change the composition of stands would reduce the probability of crown fire, decrease severity, and enhance fire-suppression effectiveness and safety (Oucalt and Wade 1999, and Pollet and Omi 2002). In forested stands that have developed without regular disturbance, combinations of mechanical harvest/thinning and prescribed fire are the most effective technique for altering the fuels matrix (Graham et al. 2004).

There are portions of watersheds that may not be available for vegetation treatments because they are economically or administratively inaccessible. Examples of economic inaccessibility include areas that are far from existing roads where it would be very costly to build new roads to provide access, or areas that are so steep that removal of logs by helicopter may be the only option. During follow-up planning efforts the costs of specific project alternatives should be carefully evaluated in light of fire probabilities and the potential costs of no action. An example of administrative inaccessibility would be areas designated by the US Forest Service as wilderness.

There are some prudent measures that can be taken in situations where critical watersheds are economically or administratively inaccessible including;

1. Managing wildland fires in certain places as a management tool that would allow wildfire to reduce wildland fuels under defined circumstances. The conditions would be monitored frequently to ensure that the fire stays within that management prescription or suppression efforts would be required.

2. Reduction of wildfire severity in surrounding areas within those watersheds to reduce the potential extent of high severity burn.

3. Pre-permitting sediment control structures downstream from high hazard watersheds. Following the Hayman Fire in 2002, Denver Water installed a sediment control structure in Turkey Creek above Cheesman Reservoir. It took more than one year to get all approvals and permits in place to construct that structure. The highest sediment yield from wildfires is usually in the first 2-3 years. Stakeholders can do much of the permitting work ahead of time, including planning with the appropriate government agencies and conceptual design.

4. Communicating with state and local leaders and other interested groups about the hazards that these watersheds pose. There may be other resources at risk below these watersheds that can be protected, such

as; houses in floodplains, important fisheries or riparian areas, and areas of mining tailings that could be a water quality risk if they are transported downstream.

Stakeholder Group Organization

The ZoC are natural project areas for stakeholders to start the next planning steps. In some cases several ZoC may be lumped together to form larger project areas. Stakeholder groups will, by definition, include the water providers and/or municipalities that own water rights and operate in those watersheds, but should also include the following;

1. U.S. Forest Service - Dillon Ranger District of the White River National Forest.
2. Colorado State Forest Service - Granby District
3. Summit County
4. Home owner associations
5. Other interested groups such as power companies

Stakeholders should review the *Opportunities & Constraints* section below to determine what watersheds/ZoC should be their priority. Some additional planning will be required to initiate watershed protection/hazard reduction projects within those ZoC. The discussion below presents some of the options.

There is a new planning process that is focused on watershed issues called Critical Community Watershed Wildfire Protection Plans (CWP)^2. The CWP^2 process (see http://www.jw-associates.org/Projects/Front_Range/Front_Range.html) is similar to the Community Wildfire Protection Plan (CWPP) process but expands to include watershed issues. Some existing CWPPs may cover portions of the watersheds/ZoC of interest. It may be more efficient to revise an existing CWPP by incorporating the watershed components from this assessment than to complete the CWP^2 process. Specific treatment areas and priorities identified in existing plans also should be reviewed for their contribution to the watershed protection efforts and incorporated into the expanded plan. Other efforts, such as source water protection plans, may also gain some efficiency and consistency by incorporating the results of this assessment.

National Environmental Policy Act (NEPA) planning efforts on federal lands may be able to be modified to incorporate watershed priorities. The NEPA analysis and decision-making process may also benefit from the technical support provided by this watershed assessment. Other existing land and vegetation management plans, fuels treatment plans, source water protection plans, watershed restoration plans or prescribed fire or fire-use plans may exist that cover portions of the critical watersheds.

This section of the assessment presents the first step in identifying opportunities and constraints within the ZoC. This analysis is intended to identify potential opportunities that will aid the stakeholders in deciding whether to pursue watershed protection/hazard reduction efforts, the overall scope that those efforts might involve, and identification of the key partners for those projects. This section is organized by general descriptions of the opportunities and constraints first and then presentation of potential opportunities for each ZoC that are shown on Figure 14.

General Opportunities & Constraints

The opportunities and constraints described below were applied to the ZoC as a series of filters and identifiers of potential opportunities.

Ownership

Major ownership classifications are Federal, State, Local Government and Private. Federal Lands include the NFS Lands, Bureau of Land Management (BLM), National Park Service, Department of Defense, and potentially other agencies and departments. State lands are typically those owned or managed by the State Land Board, the Colorado Division of Wildlife, or State Parks. However, there are other agencies or institutions, such as state universities, that also may own significant acreage.

Local Government lands typically include county, city or town-owned properties. County-owned lands are often managed as open space or park lands. City-owned lands are also often owned and managed for open space or parks, but also for watershed protection or other purposes.

The final category, Private Lands, is a catch-all that can include a myriad of other types of ownerships including special district lands, company or corporate-owned lands, privately-owned properties and more. These, too, can be of all sizes. Privately-owned parcels can be extremely complex, particularly where they are comprised of old mining claims.

Access

Access to and within a watershed or ZoC is a key factor in determining opportunities for mitigating wildfire hazards or the ability to install, operate and maintain erosion and sediment control structures following wildfires. The analysis often is limited by the data available in determining what roads exist within any given area. Normally, data layers available for the analysis usually show major roads and access routes, but often fail to include small, local roads and trails, particularly on non-federal lands. Such roads are very important for accessing backcountry areas for conducting mitigation activities. Experience has shown that old roads used for mining or logging that can be temporarily re-opened to conduct project work may not be shown on any maps. Another option is temporary roads that can be constructed and closed following treatment, but they add costs to projects and current policies on many federal lands make even use of temporary roads difficult.

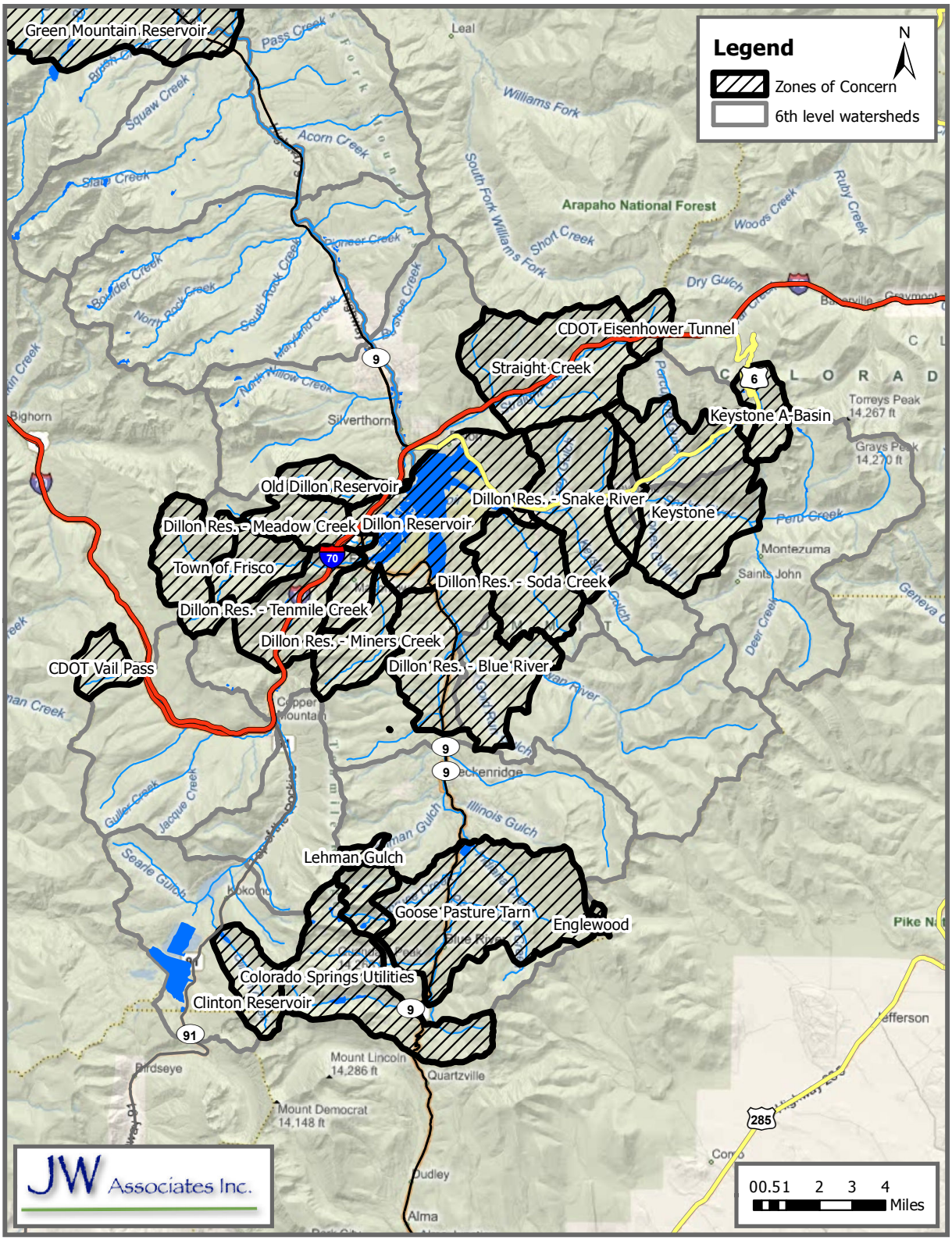

Figure 14. Blue River ZoC Base Map

When conducting traditional logging and thinning operations where products are removed from the forest, areas within ¼ to as much as ½ mile of roads can be addressed. Specialized logging equipment commonly referred to as "forwarders" can be used to move logs and other products to the road from as far away as 2 miles or more if terrain allows. If products do not have to be removed to meet fuel loading requirements and alternate treatment methods such as "mastication" or mulching can be used, equipment can be "walked" to treatment units as far from roads as terrain allows and it is practical to maintain and support the equipment.

Slopes

Land slope can be a major constraint when considering where and what treatments may be conducted to reduce wildfire hazards. Slope constraints are related directly to the typical harvesting or treatment systems and equipment employed and available within Colorado. Land management agency policies may also constrain the slopes upon which treatments may be conducted.

Slopes of 30 percent or less are the easiest to treat and the most traditional threshold for treatment given typical harvesting systems and equipment availability. Technological, power and other improvements now allow equipment to operate on slopes of 40 percent or perhaps even steeper ground. Experimental work conducted by the Colorado State Forest Service on Denver Water's lands in the Upper South Platte showed that tracked mastication equipment could work on slopes of up to 55 percent without causing erosion.

Quite recently in Colorado there have been several cable logging and even a few helicopter logging operations conducted. Slope is typically not an absolute constraint with these types of operations, but other factors such as the shape of the hillside (convex vs. concave), whether the project can be treated from above or below and others determine actual project feasibility.

The stakeholders decided to use a 40 percent slope as the upper limit of mechanical treatments. Potential opportunities were identified as greater on shallower slopes (less than 40 percent slope).

Wilderness Areas

Operations in designated wilderness areas are highly restricted by law and agency policies. Often the only treatments possible would be to plan for use of natural fire to reduce wildfire hazards.

Roadless Areas

Operations in designated roadless areas are restricted primarily by agency policies. Regulations allow construction of temporary roads, and their closure upon project completion, for the purpose of conducting harvests and wildfire hazard reduction treatments. Agency policy has caused treatments to focus on areas other than roadless whenever possible.

Colorado is one of two states that are attempting to develop rules for treatments within roadless areas. The Colorado Roadless Areas are currently under review by the US Secretary of Agriculture, but are operating under their proposed rules. This situation has resulted in roadless areas being divided into 2001 Roadless Rule (Federal) and Colorado Roadless Areas. Due to current legal actions, 2001 Roadless Rule areas are basically off limits to forest management. However, they should not be viewed as off limits to long-term watershed protection efforts.

The Colorado Roadless Areas have been reviewed and adjusted for actual conditions and therefore are likely more precise than the 2001 Roadless Rule areas. As currently proposed, treatments within Colorado Roadless Areas may be possible adjacent to at risk communities and for reducing wildfire hazards within watersheds. Areas within ½-mile of communities, and in some circumstances up to 1.5-miles from communities, may be treated to reduce wildfire hazards. Areas within watersheds may be treated if the USFS Regional Forester determines a significant risk of wildfire exists. All decisions about specific projects within roadless areas will be made by the USFS Regional Forester.

On April 15, 2011 changes to the Colorado Roadless Areas were published in the Federal Register (36 CFR Part 294, Vol. 76, No. 73). The major change was the addition of Upper Tier designations for specific Roadless Areas that further restricted activities allowed. The Upper Tier designation would not allow tree cutting and temporary road building for watershed protection. These Upper Tier areas are displayed on the maps for each ZoC below.

Vegetation

Vegetation is what fuels a wildfire. The vegetation type and its arrangement, size, density, and moisture content; the slope of ground and the aspect it is found on; whether it is dead or alive; the weather and season of the year, and more all dictate if and how intensely that fuel will burn.

The Colorado State Forest Service is developing a series of documents related to watersheds and their protection. The first document, tentatively titled, "A Comprehensive Strategy for the Management and protection of Colorado's Watersheds," will have a series of companion documents entitled, "Management and Protection Techniques for Colorado's Watersheds." The first companion document discusses management of ponderosa and lodgepole pines and uses numerous photographs to illustrate what these treatments might look like. (Additional species will be added to this series over time.)

In Colorado, lodgepole pine is also found in dense, continuous stands. It is difficult, within a short time period, to thin lodgepole pine sufficiently to develop diversity significant enough to reduce wildfire hazards. This much needed diversity must be developed by creating diversity at the stand and landscape levels by clearcutting, patch cutting, creating permanent openings, converting areas to aspen. Once management has begun for watershed protection, in some situations it may be advisable to utilize less traditional management techniques, such as thinning in young lodgepole pine stands, for long-term management (Colorado State Forest Service 2009).

Spruce/fir is a major component of the forest vegetation in the Blue River Watershed. This forest type is comprised of mixtures of Engelmann and Colorado blue spruce, subalpine fir and other minor species. It too, like lodgepole pine, is difficult, within a short time period, to thin it sufficiently to develop diversity significant enough to reduce wildfire hazards. This much needed diversity must be developed by creating varied conditions at the stand and landscape levels by group selection, small patch cutting, creating permanent openings, converting areas to aspen, and by other techniques. Once management has begun for watershed protection, in some situations it, too, may be advisable to utilize less traditional management techniques for long-term management.

The stakeholders decided to use lodgepole pine and spruce/fir at higher elevations as targets for vegetation treatments to reduce wildfire severity. Aspen was also added to the Opportunity maps.

Blue River Headwaters & Clinton Reservoir

This section discusses the Goose Pasture Tarn (Town of Breckenridge) and Colorado Springs Utilities ZoC because they overlap within the Headwaters Blue River watershed and the Clinton Reservoir ZoC because it is on the same map (Figure 15). Note that the ZoC are shown here in pink with crosshatching, but in the remaining figures the outlines appear as bold black lines with no crosshatching.

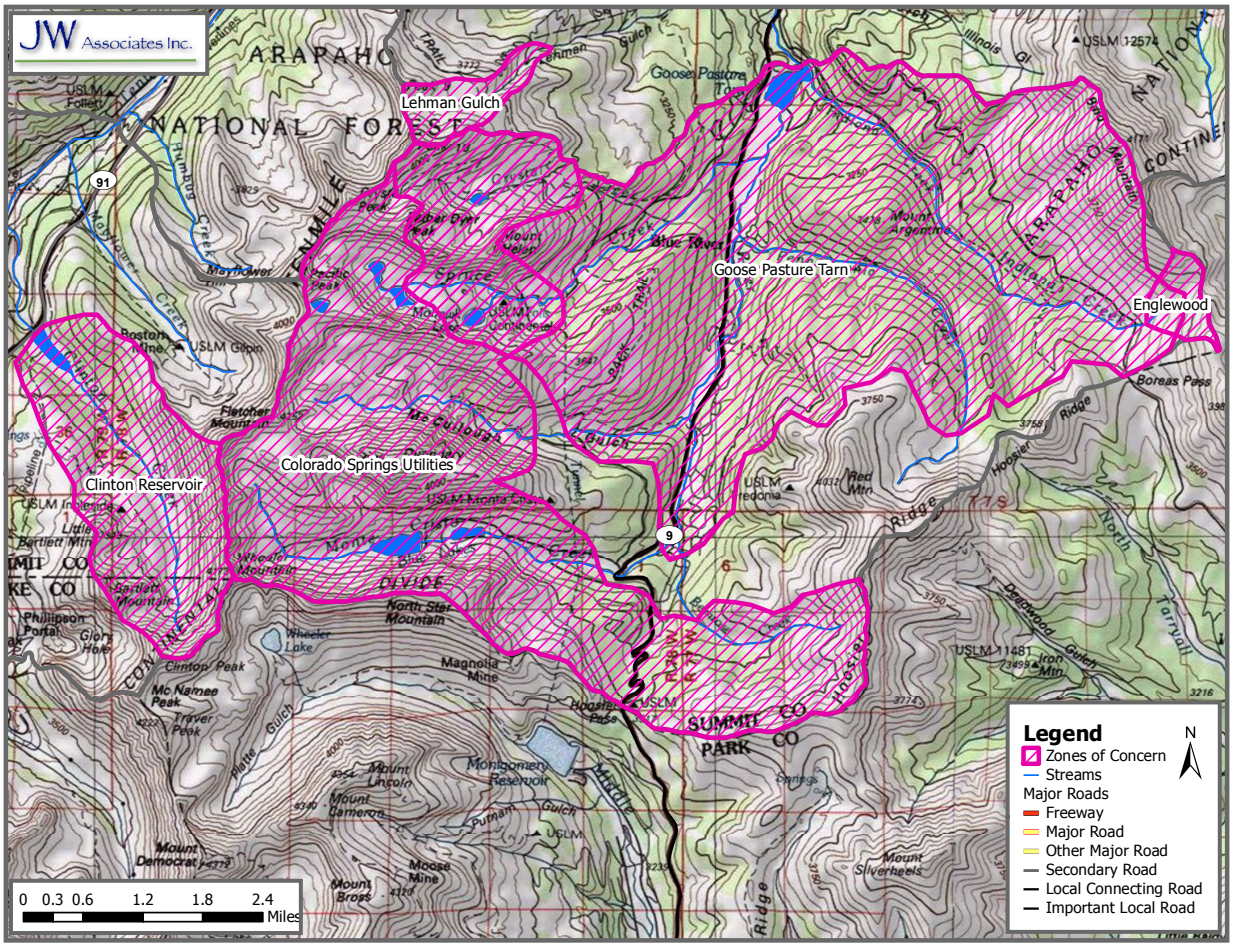

Figure 15. Blue River Headwaters & Clinton Reservoir ZoC Location

Blue River Headwaters Ownership

Both ZoCs are mostly National Forest System lands with scattered private mining claims. There is also a large area of private land along Highway 9 and partially up Indiana Creek (Figure 16).

Clinton Reservoir Ownership

Ownership is mostly National Forest System lands with some scattered mining claims north of Clinton Creek and all private lands south of the creek (Figure 16).

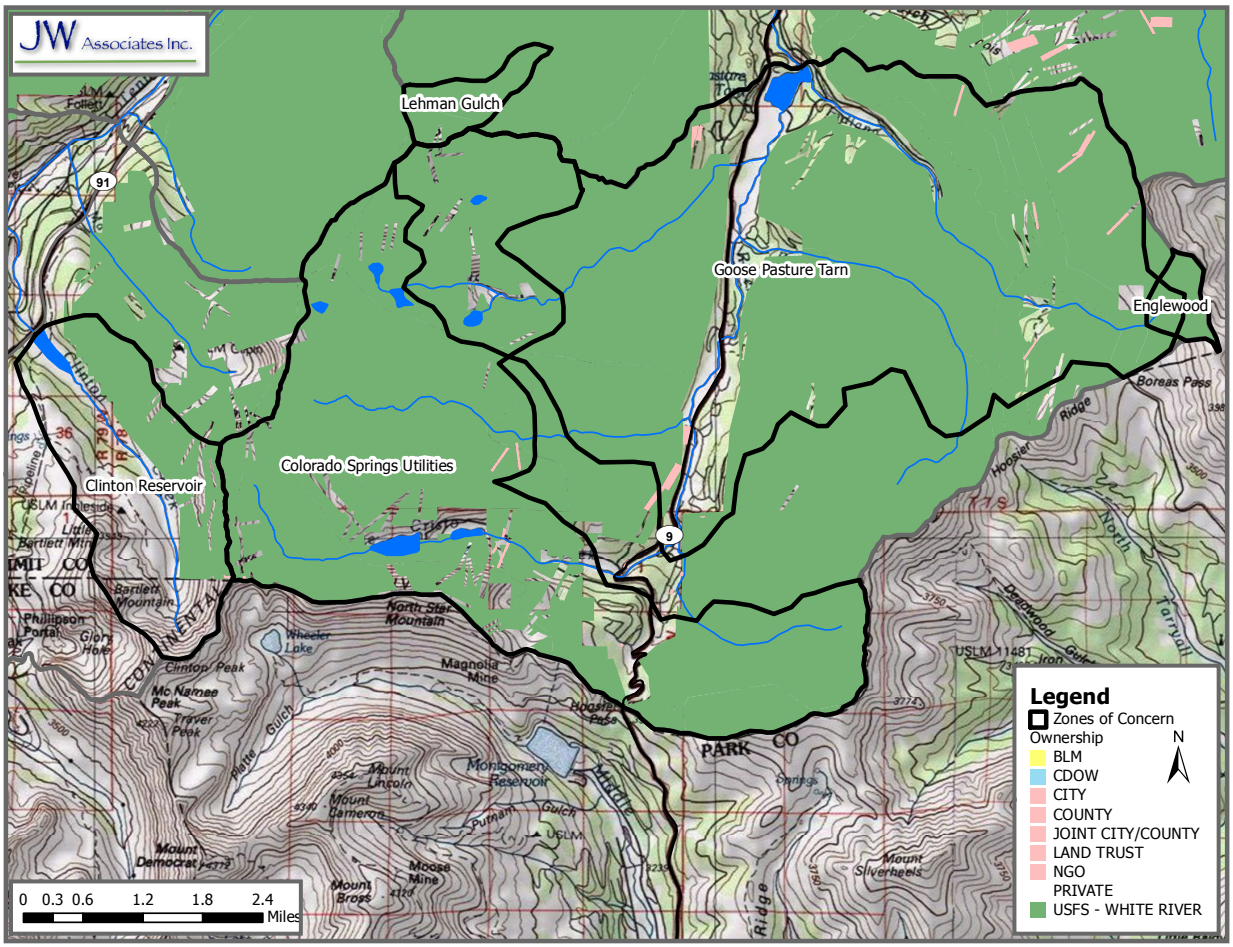

Figure 16. Blue River Headwaters & Clinton Reservoir ZoC Ownership

Blue River Headwaters Watershed Priority

The Headwaters of the Blue River watershed is ranked as Red (Category 5 - highest) overall. It is also ranked as Red (Category 5 - highest) for Flooding/Debris Flow and Composite Hazard. It ranked as Yellow (Category 3) in Wildfire Hazard and Orange (Category 4) in Soil Erodibility (Figure 17).

Clinton Reservoir Watershed Priority

The Upper Tenmile Creek watershed is Blue (Category 2) overall. It ranked as Green (Category 1 - lowest) in Wildfire Hazard and Composite Hazard. It ranked Yellow (Category 3) in Flooding/Debris Flow and Blue (Category 2) in Soil Erodibility (Figure 17).

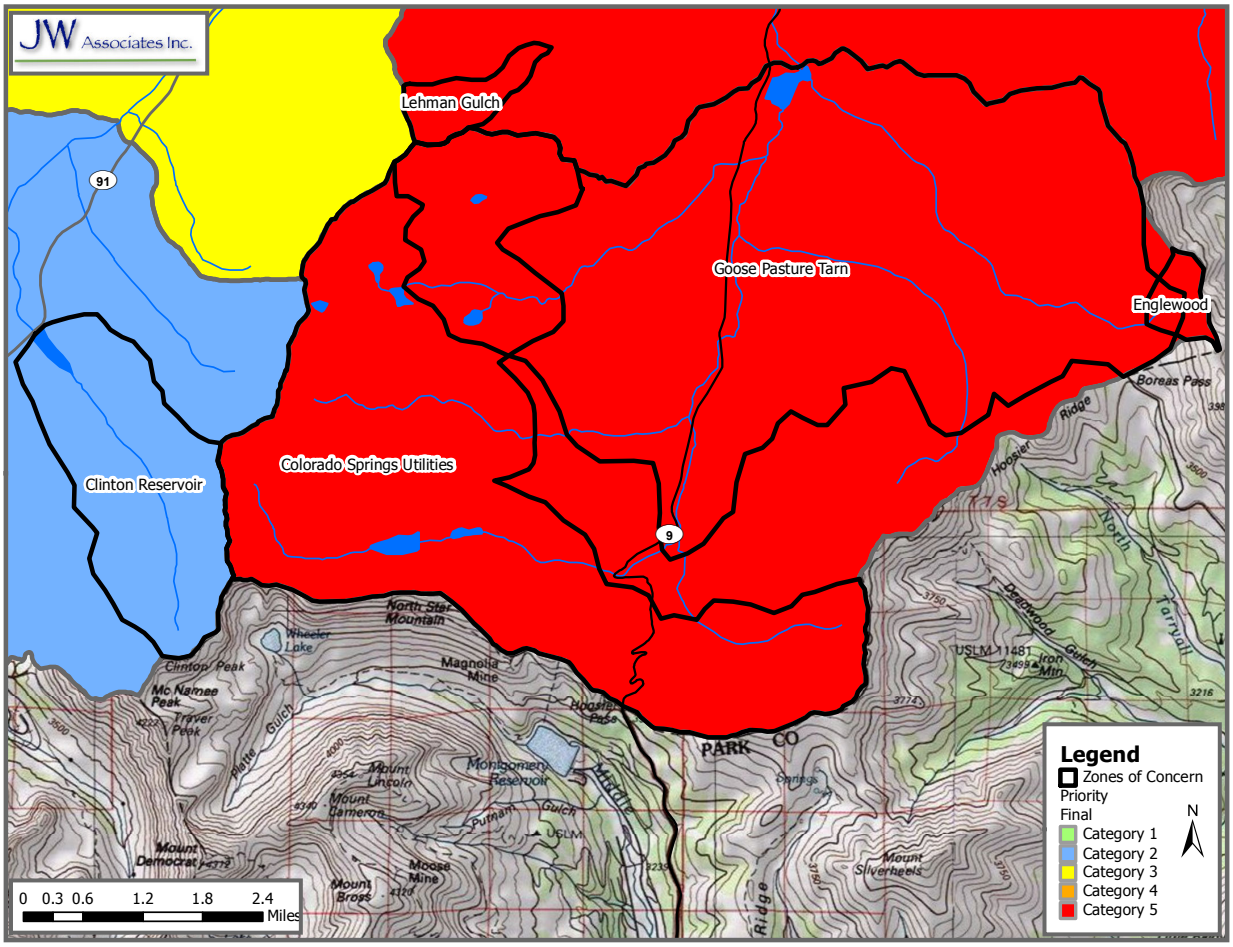

Figure 17. Blue River Headwaters & Clinton Reservoir ZoC Watershed Priority

Blue River Headwaters Slopes

There are substantial areas of steep slopes throughout this ZoC, primarily at higher elevations (Figure 18).

Clinton Reservoir Slopes

Steep slopes cover a large portion of the higher elevation areas. Shallower slopes are present around the reservoir and the lower portions of Clinton Creek (Figure 18).

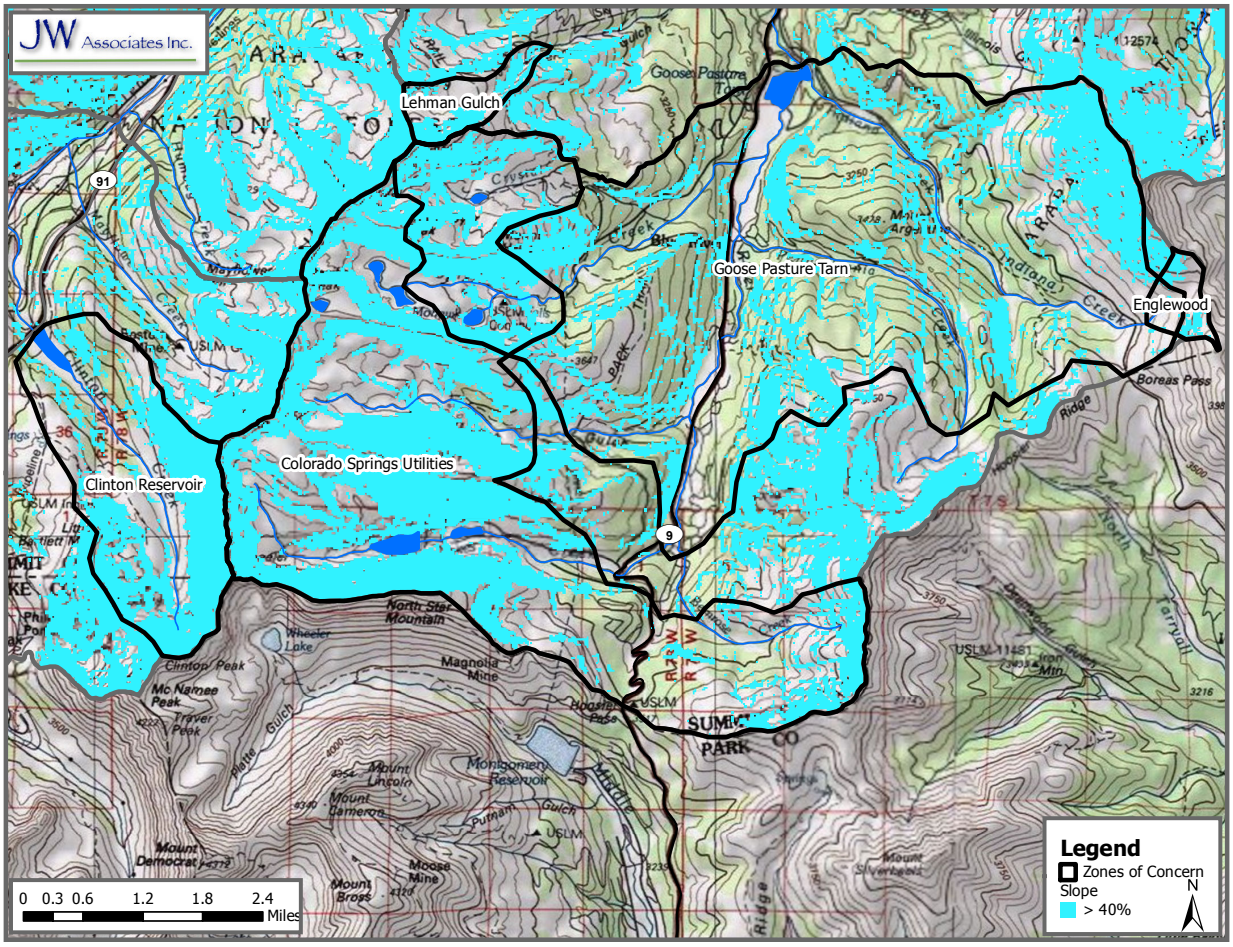

Figure 18. Blue River Headwaters & Clinton Reservoir ZoC Slope

Blue River Headwaters Special Areas (Wilderness/Roadless)

There are no wilderness areas in the ZoC (Figure 19). The Hoosier Ridge Roadless Area occupies a large area within the southeastern portion of the ZoC and is designated as Upper Tier. Fully explore and comprehensively plan treatment opportunities within Roadless Areas and capitalize on the extent of treatments that are allowed for Wildland-Urban Interface (WUI) and Watershed Protection areas within Roadless Areas. Where treatments are feasible, permission should be sought for the entire watershed ZoC as opposed to piecemeal permission for individual projects. In the remaining roadless areas, planning should be conducted to allow and maximize fire use opportunities to create diversity in these inaccessible areas.

Clinton Reservoir Special Areas (Wilderness/Roadless)

There are no wilderness or roadless areas in this ZoC (Figure 19).

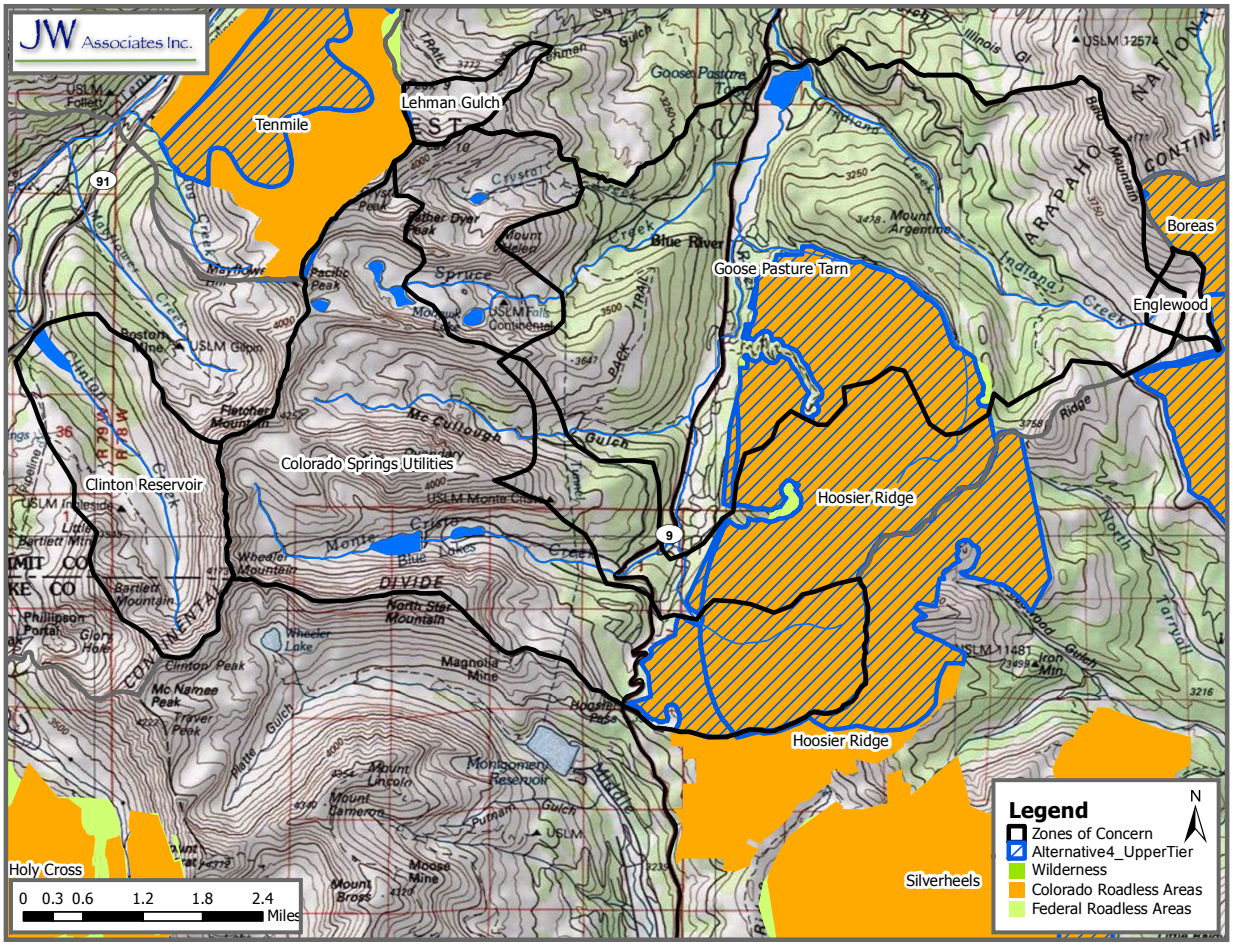

Figure 19. Blue River Headwaters & Clinton Reservoir ZoC Special Areas

Blue River Headwaters Vegetation

Lodgepole pine, riparian and aspen covers the valley, while extensive areas of spruce-fir are located above the lodgepole pine at higher elevations (Figure 20). Colorado has long-experienced the impacts of mountain pine beetles in lodgepole pine. Stakeholders should be aware that spruce beetles are becoming more prevalent in spruce/fir stands in many areas of the state and management needs of this species should not be ignored. The local situation should be monitored closely and adjustments made to treatment and protection plans as warranted. The highest elevations are alpine, barren and/or snow-ice fields.

Clinton Reservoir Vegetation

The vegetation is mostly spruce-fir surrounding the reservoir transitioning to alpine, tundra and snow/ice (Figure 20). Colorado has long-experienced the impacts of mountain pine beetles in lodgepole pine. Stakeholders should be aware that spruce beetles are becoming more prevalent in spruce/fir stands in many areas of the state and management needs of this species should not be ignored. The local situation should be monitored closely and adjustments made to treatment and protection plans as warranted.

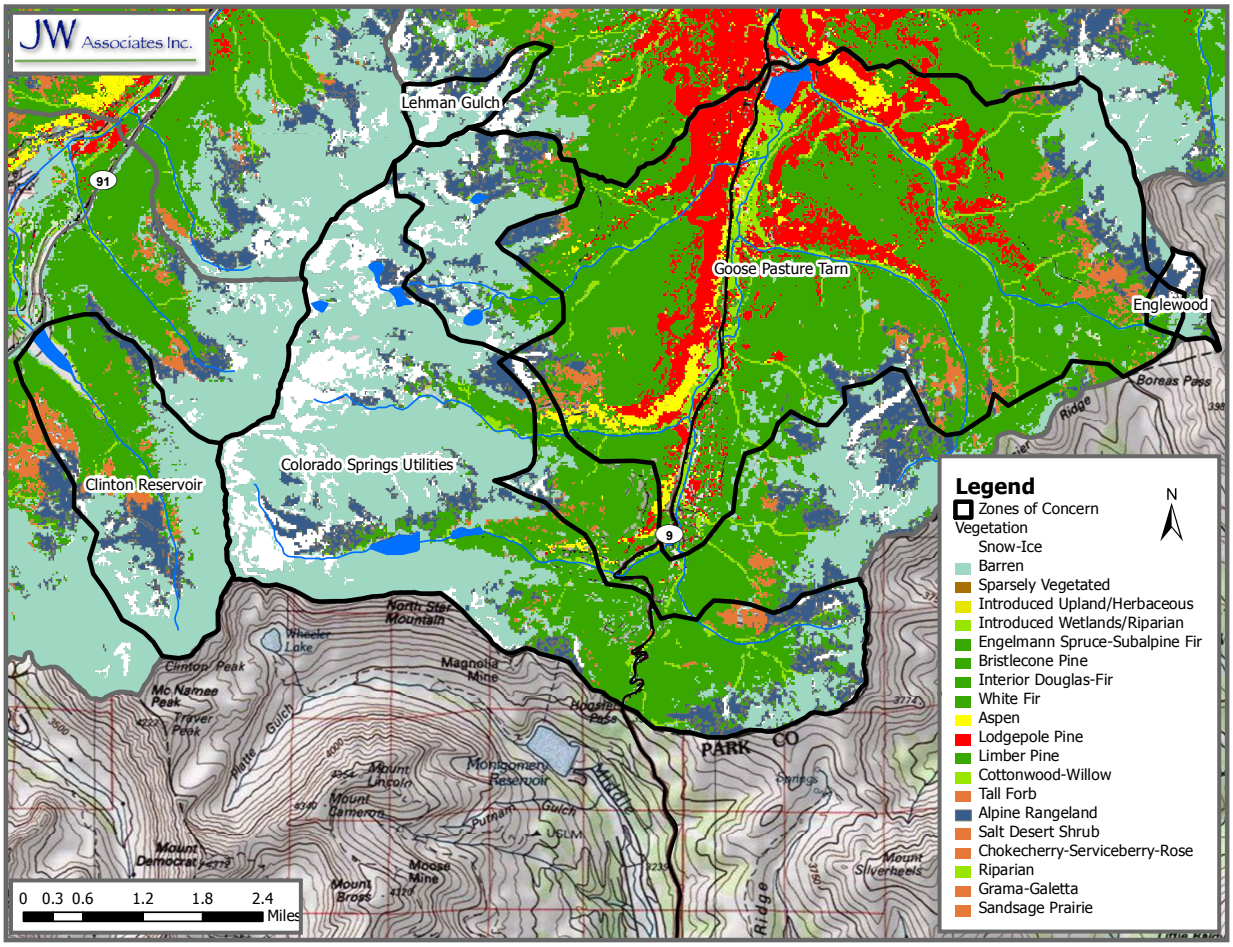

Figure 20. Blue River Headwaters & Clinton Reservoir ZoC Vegetation

Blue River Headwaters Access

The roads are mostly in valley bottoms with some roads running up some of the steams (Figure 21). Tributary streams that have some road access are Indiana and Pennsylvania Creeks, McCullough Gulch and Blue Lakes. In addition there are numerous old mining or logging roads throughout the area. Where roads exist, consider using them as 'jump-off points' for development of temporary roads or the use of forwarders, mastication or other alternative harvesting equipment to implement treatments where slopes allow.

Clinton Reservoir Access

There are no existing roads above the reservoir except for old logging or mining roads (Figure 21). These older roads provide good access to the timber stands south of the reservoir, as well as some of the stands in the upper basin, just below timberline. Consider development of temporary roads or the use of forwarders, mastication or other alternative harvesting equipment to implement treatments where slopes allow.

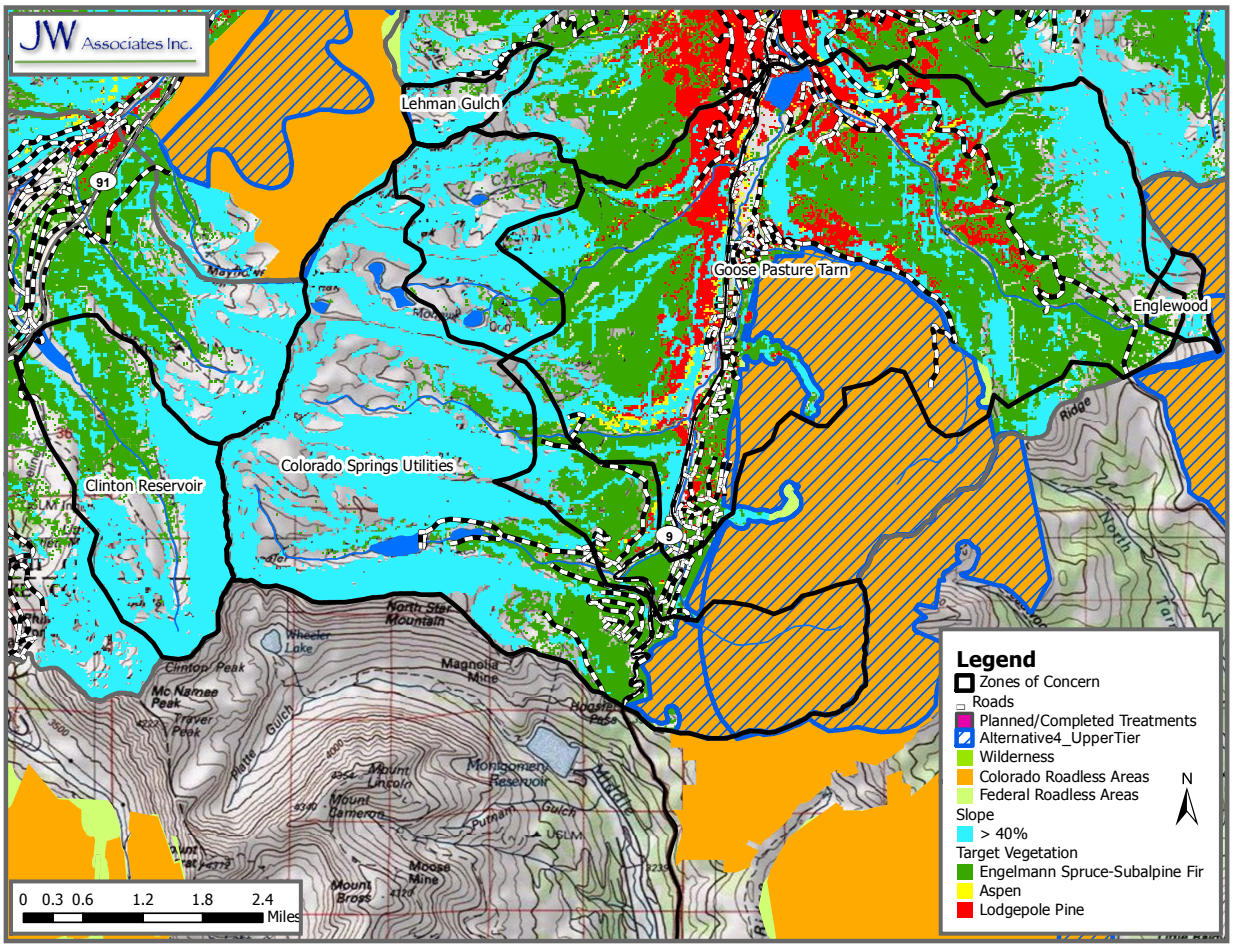

Figure 21. Blue River Headwaters & Clinton Reservoir ZoC Opportunities

Blue River Headwaters Opportunities

There are opportunities in this ZOC within the lodgepole pine and aspen, lower in the ZoC, and within the spruce-fir in Indiana and Pennsylvania Creeks (Figure 21). Operable areas are also located along Spruce Creek Road; consider developing a fuelbreak along this road. The lower portions of Lehman Gulch and Carter Creek have operable areas and a jeep trail traverses this area. Consider developing a fuelbreak along that road. The area west of Goose Pasture Tarn and west of the highway appear quite operable. The northerly aspects of Mount Argentine appear to be operable, particularly if forwarders are used. A fuelbreak could be developed along the ridges of Mount Argentine to serve as a defensive position for fires moving from the south. There are good, operable areas east of the highway in the Bemrose Creek area.

It appears there may have been some past harvesting activity along County Road 851, southeast of McCullough Gulch. The old harvesting roads could be easily reopened to re-treat this area.

Where bark beetles have heavily impacted lodgepole pine, explore opportunities to salvage or masticate dead trees to allow regeneration that will be relatively free from the heavy fuels that would normally build up following tree death and the resultant snag fall. Also look for opportunities to convert and maintain areas as open meadows or parks, thus creating much-needed diversity and areas that could be used as fuelbreaks or safety zones. Similarly, where aspen is a significant component of the stands, explore converting and maintaining these areas as aspen. Finally, where aspen stands currently exist, decide which stands contribute most to the landscape diversity and block the potential movement of fires. Manage these stands over the long term to maintain them as aspen, interrupting their normal succession to conifer stands.

The Summit County CWPP and any local CWPPs that might be developed in the future should be reviewed and updated as necessary to incorporate watershed protection as a value to be protected, along with specific treatment recommendations. Water providers should become active partners in these CWPPs to give them standing with other participants.

Given the amount of steep, inoperable terrain in the higher elevations, water providers should plan now for post-fire erosion events, focusing on development of sediment dams and/or other structures. There may be opportunity to partner with the County Emergency Services and down-stream subdivisions and communities to seek FEMA grants for fuels treatments, pre-flooding preparations and other activities.

Stakeholders include: Town of Breckenridge, Colorado Springs Utilities, US Forest Service, Colorado State Forest Service, Summit County, and private landowners.

Clinton Reservoir Opportunities

The few opportunities in this ZoC are in spruce-fir around the reservoir (Figure 21). However the Wildfire Hazard is ranked as Green (Category 1 - lowest) and these areas may be of lower priority compared to treatments elsewhere in this watershed or in other Blue River watersheds. In areas with steep slopes that cannot be managed, manage wildfires by developing fire use plans to help develop needed stand diversity over time.

The Summit County CWPP and any local CWPPs that might be developed in the future should be reviewed and updated as necessary to incorporate watershed protection as a value to be protected, along with specific treatment recommendations. Water providers should become active partners in these CWPPs to give them standing with other participants.

Water providers should plan now for post-fire erosion events, focusing on development of sediment dams and/or other structures. There may be opportunity to partner with the County Emergency Services and down-stream subdivisions and communities to seek FEMA grants for fuels treatments, pre-flooding preparations and other activities.

Stakeholders include: Clinton Reservoir and Ditch Company, US Forest Service, Colorado State Forest Service, and Summit County.

Old Dillon Reservoir and Dillon Reservoir-Meadow Creek ZoC

This section discusses the Old Dillon Reservoir and Dillon Reservoir-Meadow Creek ZoC because they are adjacent to each other (Figure 22). Note that the ZoC are shown here in pink with crosshatching, but in the remaining figures the outlines appear as bold black lines with no crosshatching.

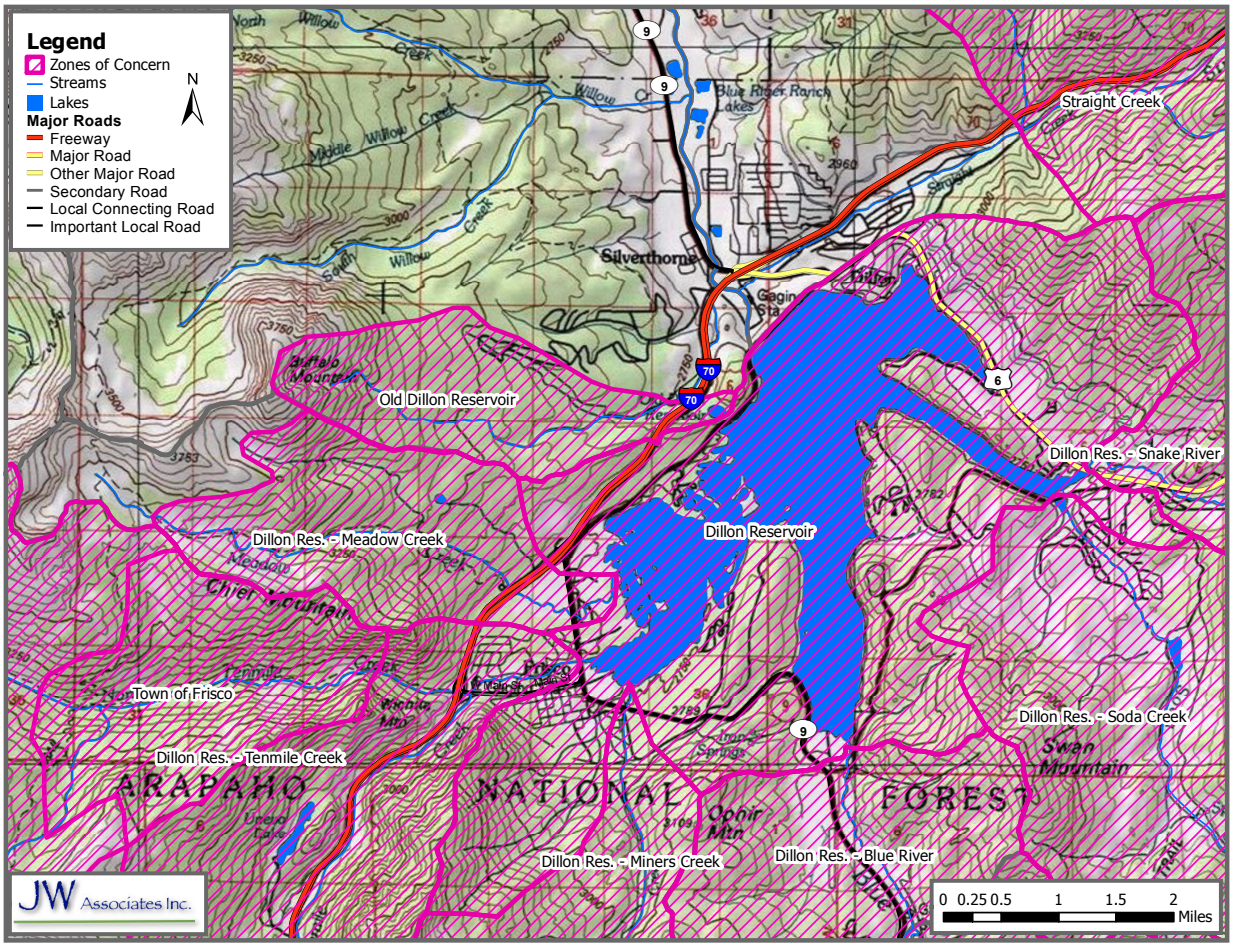

Figure 22. Old Dillon Reservoir and Dillon Reservoir-Meadow Creek ZoC Location

Old Dillon Ownership

This ZoC is dominated by National Forest System lands, with a small area of private lands (Figure 23).

Dillon Reservoir- Meadow Creek Ownership

This ZOC is dominated by National Forest System lands, with the lower portion of the ZoC in private lands (Figure 23).

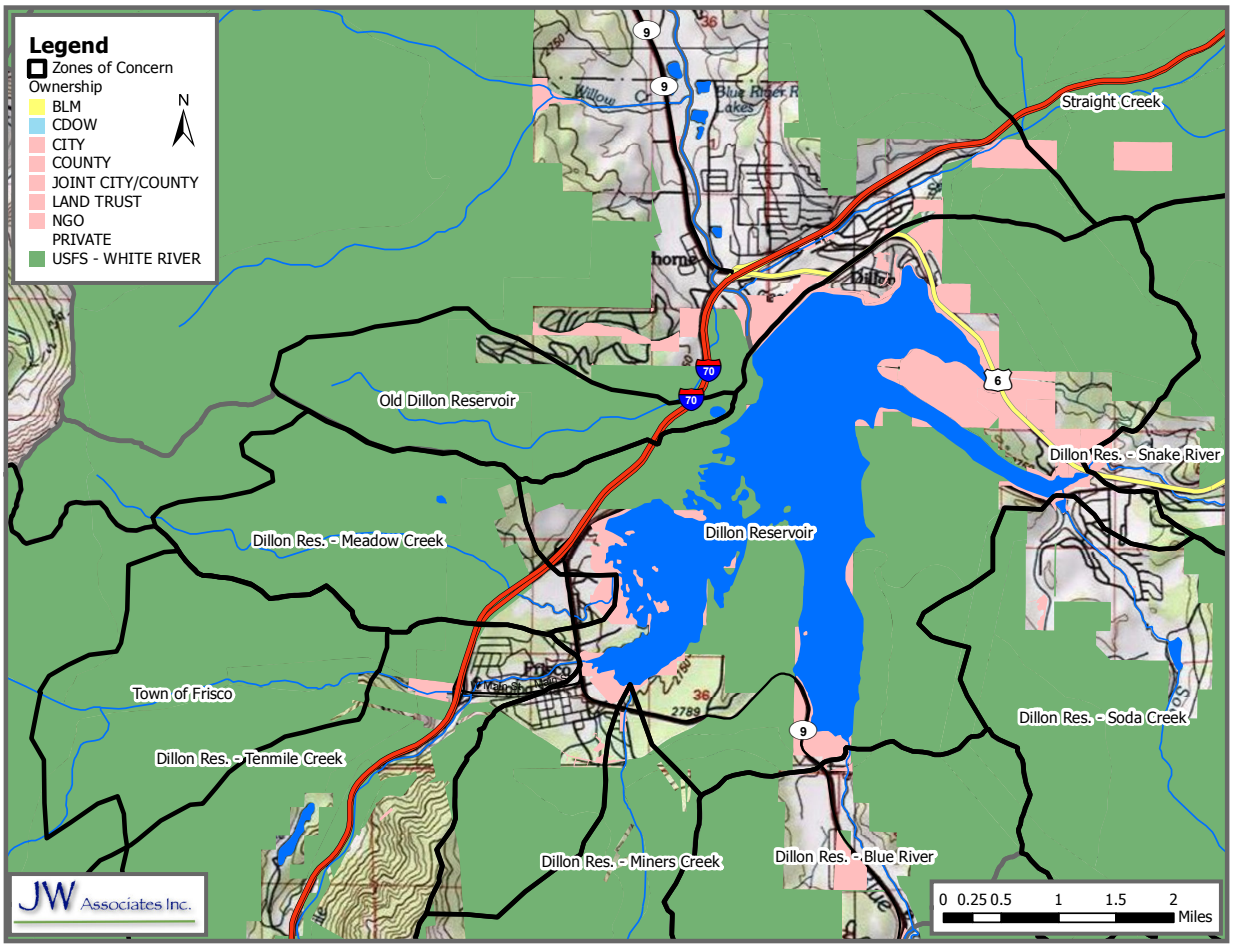

Figure 23. Old Dillon Reservoir and Dillon Reservoir-Meadow Creek ZoC Ownership

Old Dillon Watershed Priority

The Willow Creek watershed is Orange overall (Category 4) (Figure 24). Wildfire Hazard is also Orange (Category 4).

Dillon Reservoir- Meadow Creek Watershed Priority

The Dillon Reservoir watershed is ranked Blue overall (Category 2). The wildfire hazard was rated as Orange (Category 4) (Figure 24).

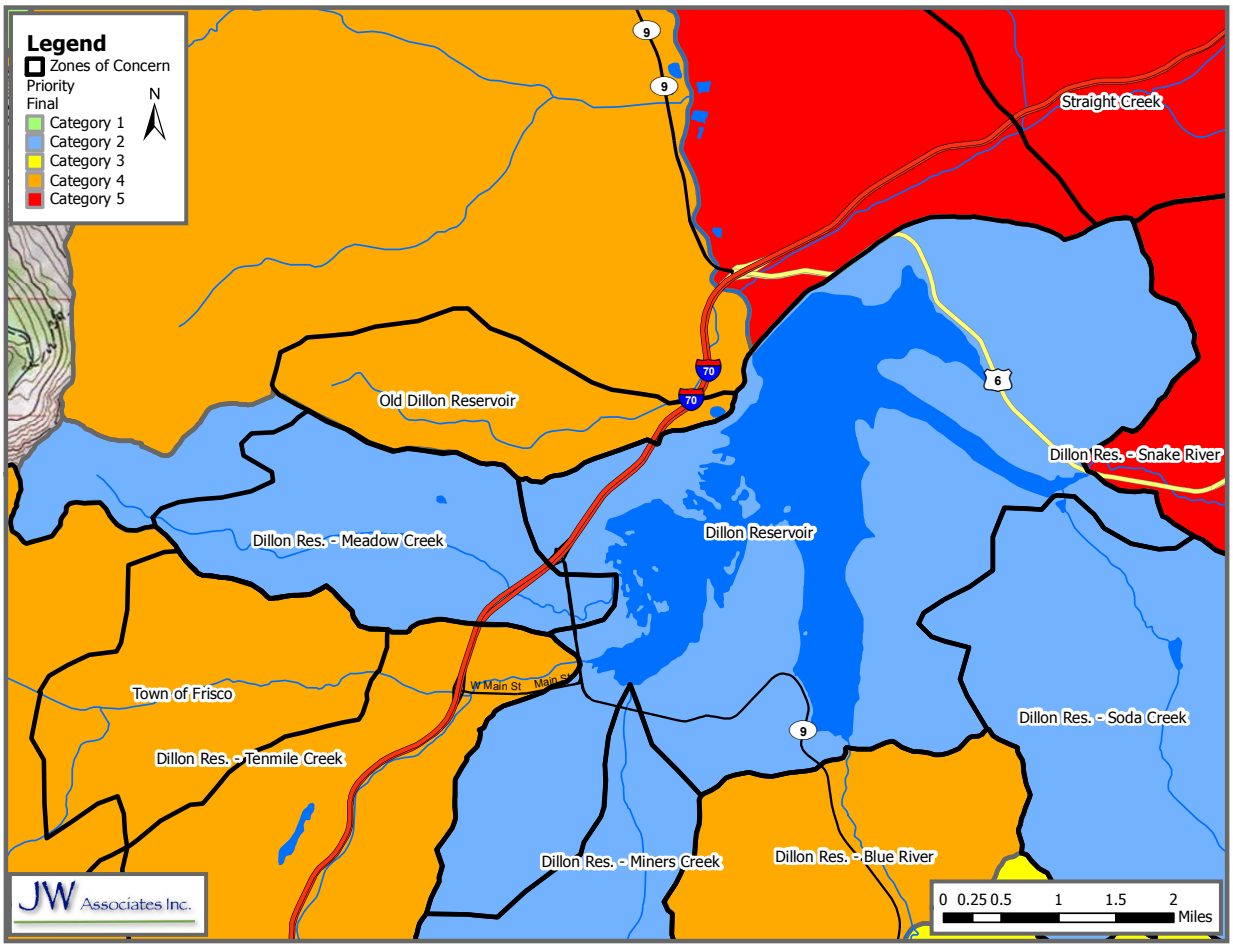

Figure 24. Old Dillon Reservoir and Dillon Reservoir-Meadow Creek ZoC Watershed Priority

Old Dillon Slopes

Steep slopes are present only at the highest elevations in this ZoC (Figure 25).

Dillon Reservoir- Meadow Creek Slopes

Steep slopes are present only in a small area of this ZoC (Figure 25).

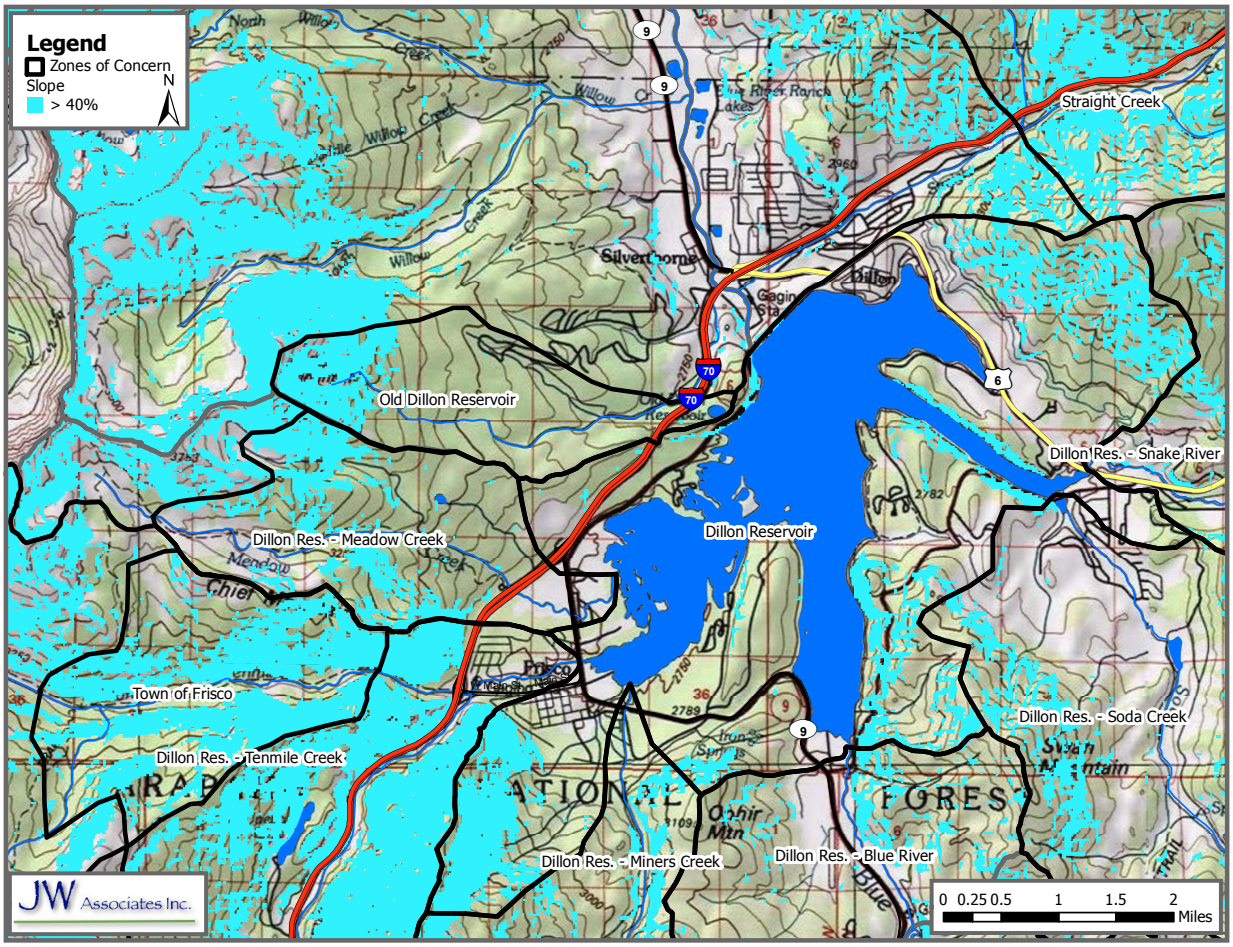

Figure 25. Old Dillon Reservoir and Dillon Reservoir-Meadow Creek ZoC Slope

Old Dillon Special Management Areas

The Eagles Nest Wilderness Area covers the majority of the upper portions of the ZoC. The Ryan Gulch roadless area covers some of the ZoC below the wilderness area (Figure 26).

Dillon Reservoir- Meadow Creek Special Management Areas

The Eagles Nest Wilderness Area covers the majority of the upper portions of the ZoC. The Ryan Gulch roadless area covers some of the ZoC below the wilderness area (Figure 26).

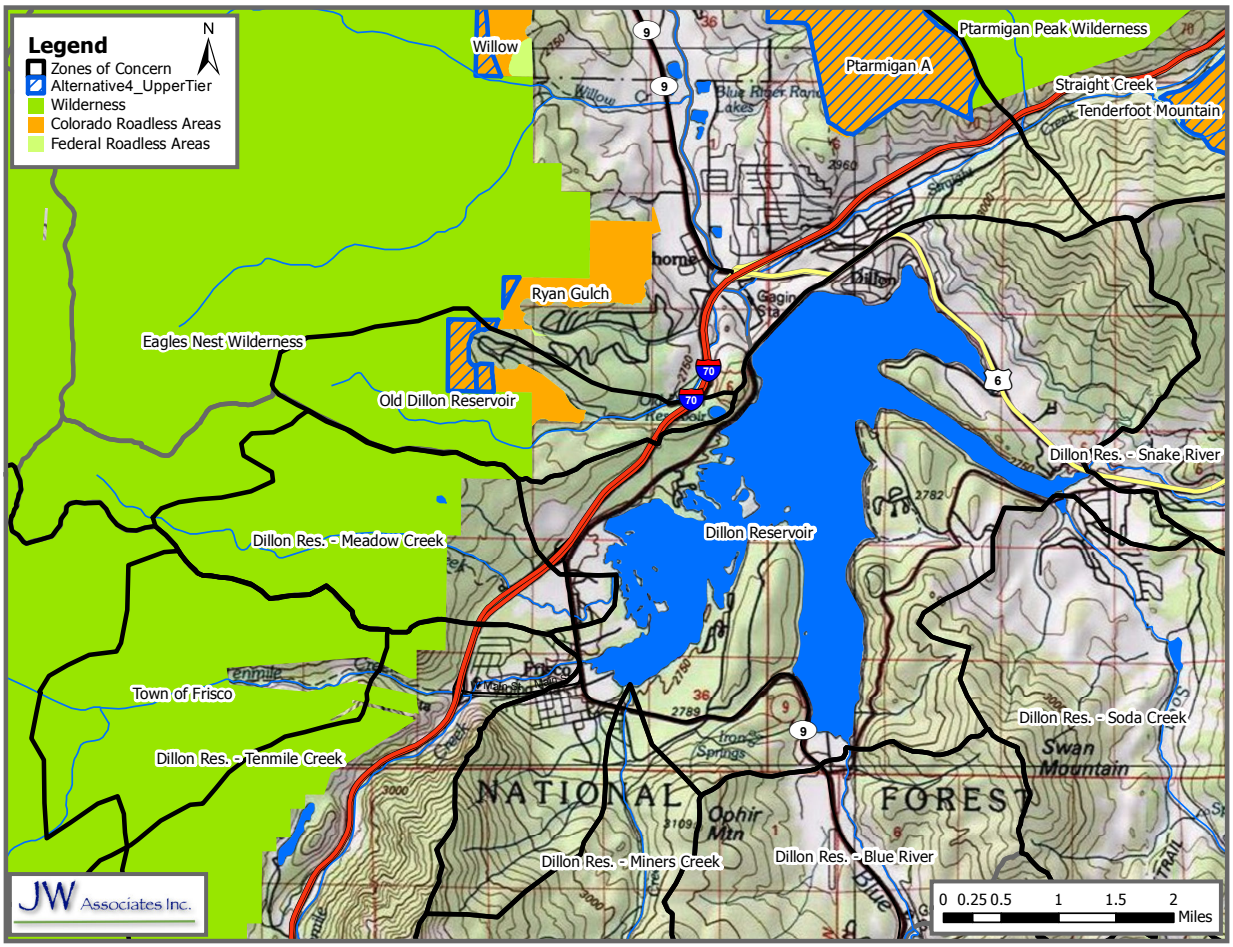

Figure 26. Old Dillon Reservoir and Dillon Reservoir-Meadow Creek ZoC Special Areas

Old Dillon Vegetation

The middle zones of the ZoC are dominated by lodgepole pine (Figure 27). There is some aspen lower in the ZoC and spruce-fir at the higher elevations. Colorado has long-experienced the impacts of mountain pine beetles in lodgepole pine. Stakeholders should be aware that spruce beetles are becoming more prevalent in spruce/fir stands in many areas of the state and management needs of this species should not be ignored. The local situation should be monitored closely and adjustments made to treatment and protection plans as warranted (Figure 27).

Dillon Reservoir- Meadow Creek Vegetation

There is a large area of aspen lower in the ZoC, transitioning to lodgepole pine and then spruce-fir at the higher elevations (Figure 27). Colorado has long-experienced the impacts of mountain pine beetles in lodgepole pine. Stakeholders should be aware that spruce beetles are becoming more prevalent in spruce/fir stands in many areas of the state and management needs of this species should not be ignored. The local situation should be monitored closely and adjustments made to treatment and protection plans as warranted (Figure 27).

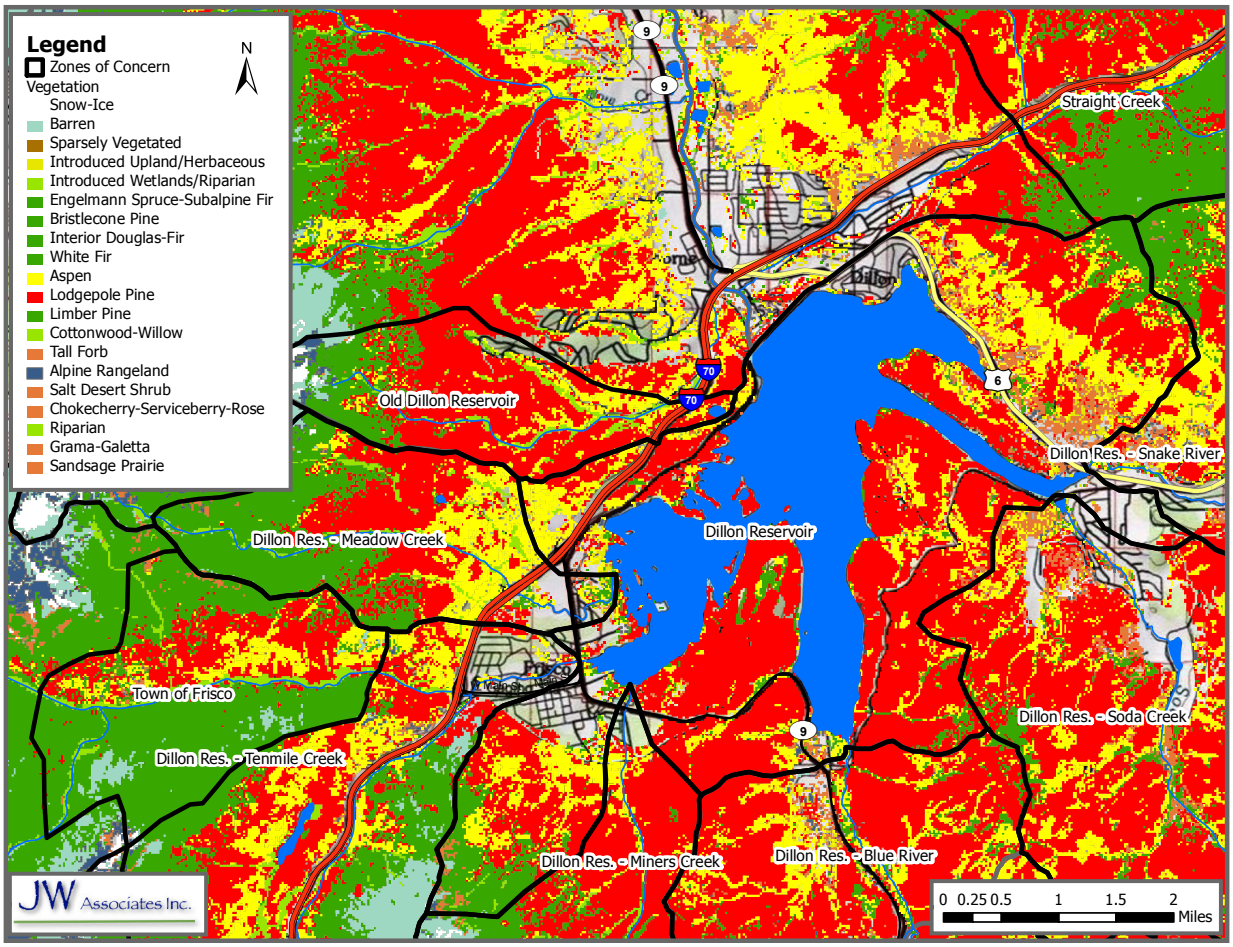

Figure 27. Old Dillon Reservoir and Dillon Reservoir-Meadow Creek ZoC Vegetation

Old Dillon Access

There are some roads located low in the ZoC and within the small area of private land (Figure 28). Where roads exist, consider using them as 'jump-off points' for development of temporary roads or the use of forwarders, mastication or other alternative harvesting equipment to implement treatments where slopes allow.

Dillon Reservoir-Meadow Creek Access

Existing road access is limited to the lower portions of the ZOC, although there are several old roads leading to mines northeast of Chief Mountain (Figure 28). Where roads exist, consider using them as 'jump-off points' for development of temporary roads or the use of forwarders, mastication or other alternative harvesting equipment to implement treatments where slopes allow.

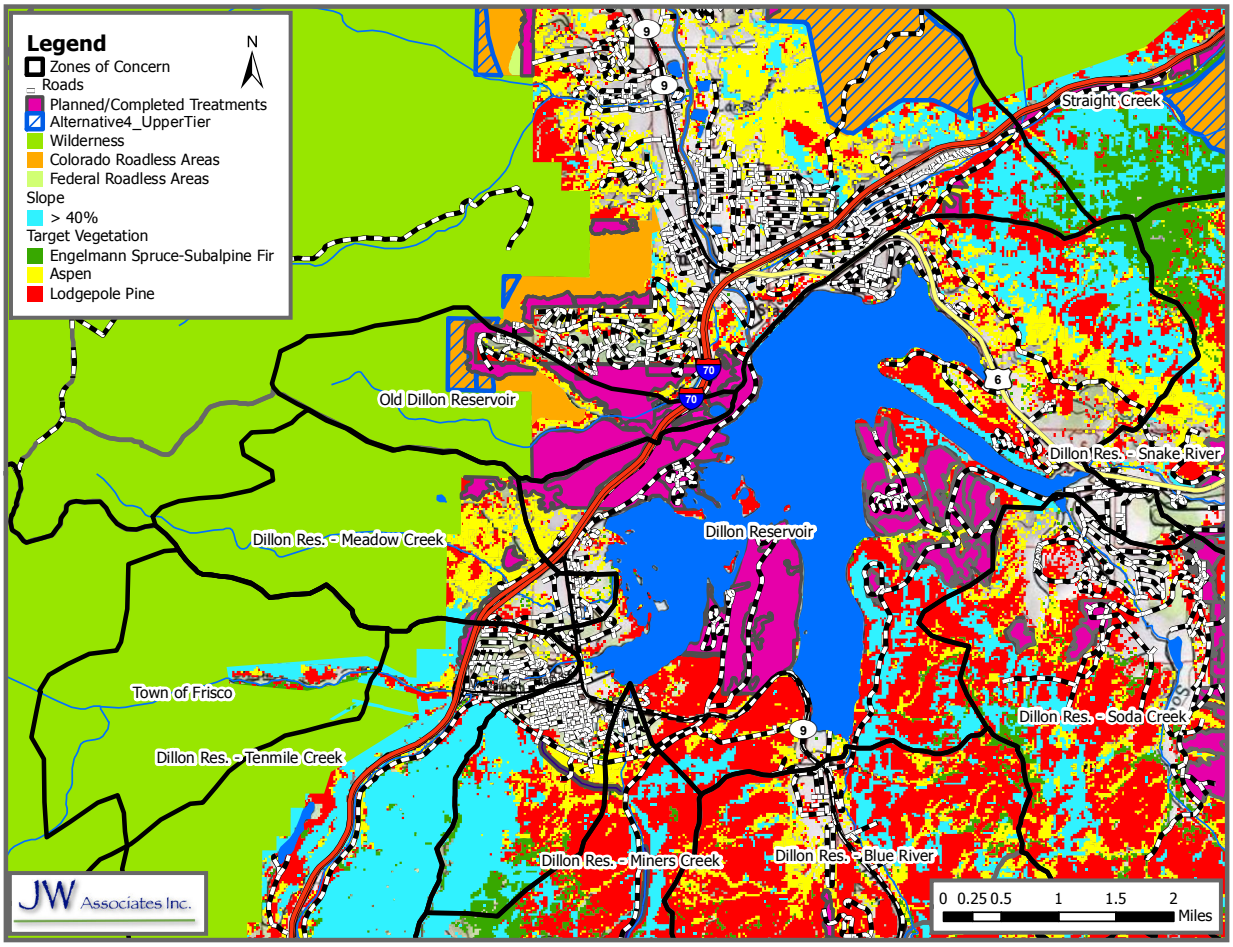

Figure 28. Old Dillon Reservoir and Dillon Reservoir-Meadow Creek ZoC Opportunities

Old Dillon Opportunities

There are a number of planned and completed treatments within this ZoC (Figure 28). There appear to be very few opportunities outside of roadless areas that have not been planned or treated. Accordingly, fully explore and comprehensively plan treatment opportunities within roadless areas and capitalize on the extent of treatments that are allowed for Wildland-Urban Interface (WUI) and Watershed Protection areas within roadless areas. Where treatments are feasible, permission should be sought for the entire watershed ZoC as opposed to piecemeal permission for individual projects. In the remaining wilderness and roadless areas, planning should be conducted to allow and maximize fire use opportunities to create diversity in these inaccessible areas.

Since much of the operable areas are already treated or have treatments planned, consider now future re-entries to these areas. Look for opportunities to convert and maintain areas as open meadows or parks, thus creating much-needed diversity and areas that could be used as fuelbreaks or safety zones. Such future treatments can be done relatively inexpensively where the resultant, smaller regeneration and sapling and small pole-sized trees only need be removed. Planned treatments may not have considered aspen as a target species. So similarly, where aspen is a significant component of the stands, explore converting and maintaining these areas as aspen. Finally, where aspen stands currently exist, decide which stands contribute most to the landscape diversity and block the potential movement of fires. Manage these stands over the long term to maintain them as aspen, interrupting their normal succession to conifer stands.

Water providers should plan now for post-fire erosion events in the inoperable and/or inaccessible steeper terrain high in the ZoC. Focus on the development of sediment dams and/or other structures lower in the ZoC where access is available to facilitate sediment removal. There may be opportunity to partner with the County Emergency Services and down-stream subdivisions and communities to seek FEMA grants for fuels treatments, pre-flooding preparations and other activities

The Summit County CWPP and any local CWPPs that might be developed in the future should be reviewed and updated as necessary to incorporate watershed protection as a value to be protected, along with specific treatment recommendations. Water providers should become active partners in these CWPPs to give them standing with other participants.

Stakeholders include: Denver Water, US Forest Service, Colorado State Forest Service, Summit County, and private landowners.

Dillon Reservoir- Meadow Creek Opportunities

There are some areas of opportunity lower in the watershed but they are mostly in aspen (Figure 28). Capitalize on the large amount of aspen in this ZoC. Consider aspen a target species to manage for and maintain these areas as aspen over time, interrupting their normal succession to conifer stands. Decide which stands contribute most to the landscape diversity and block the potential movement of fires. Focus management efforts in these stands.

Fully explore and comprehensively plan treatment opportunities within roadless areas and capitalize on the extent of treatments that are allowed for Wildland-Urban Interface (WUI) and Watershed Protection areas within roadless areas. Where treatments are feasible, permission should be sought for the entire watershed ZoC as opposed to piecemeal permission for individual projects. In the remaining wilderness and roadless

areas, planning should be conducted to allow and maximize fire use opportunities to create diversity in these inaccessible areas.

Where bark beetles have heavily impacted lodgepole pine, explore opportunities to salvage or masticate dead trees to allow regeneration that will be relatively free from the heavy fuels that would normally build up following tree death and the resultant snag fall. Also look for opportunities to convert and maintain areas as open meadows, parks or as “new” aspen stands, creating much-needed diversity and areas that could be used as fuelbreaks or safety zones.

The Summit County CWPP and any local CWPPs that might be developed in the future should be reviewed and updated as necessary to incorporate watershed protection as a value to be protected, along with specific treatment recommendations. Water providers should become active partners in these CWPPs to give them standing with other participants.

Water providers should plan now for post-fire erosion events, focusing on development of sediment dams and/or other structures that might be needed. There may be opportunity to partner with the County Emergency Services and down-stream subdivisions and communities and communities to seek FEMA grants for fuels treatments, pre-flooding preparations and other activities.

Stakeholders include: Denver Water, US Forest Service, Colorado State Forest Service, Summit County, and private landowners.

Town of Frisco and Dillon Reservoir-Tenmile Creek ZoC

The Town of Frisco and Dillon Reservoir-Tenmile Creek ZoC are combined in this section because they overlap within the Lower Tenmile Creek watershed (Figure 29). Note that the ZoC are shown here in pink with crosshatching, but in the remaining figures the outlines appear as bold black lines with no crosshatching.

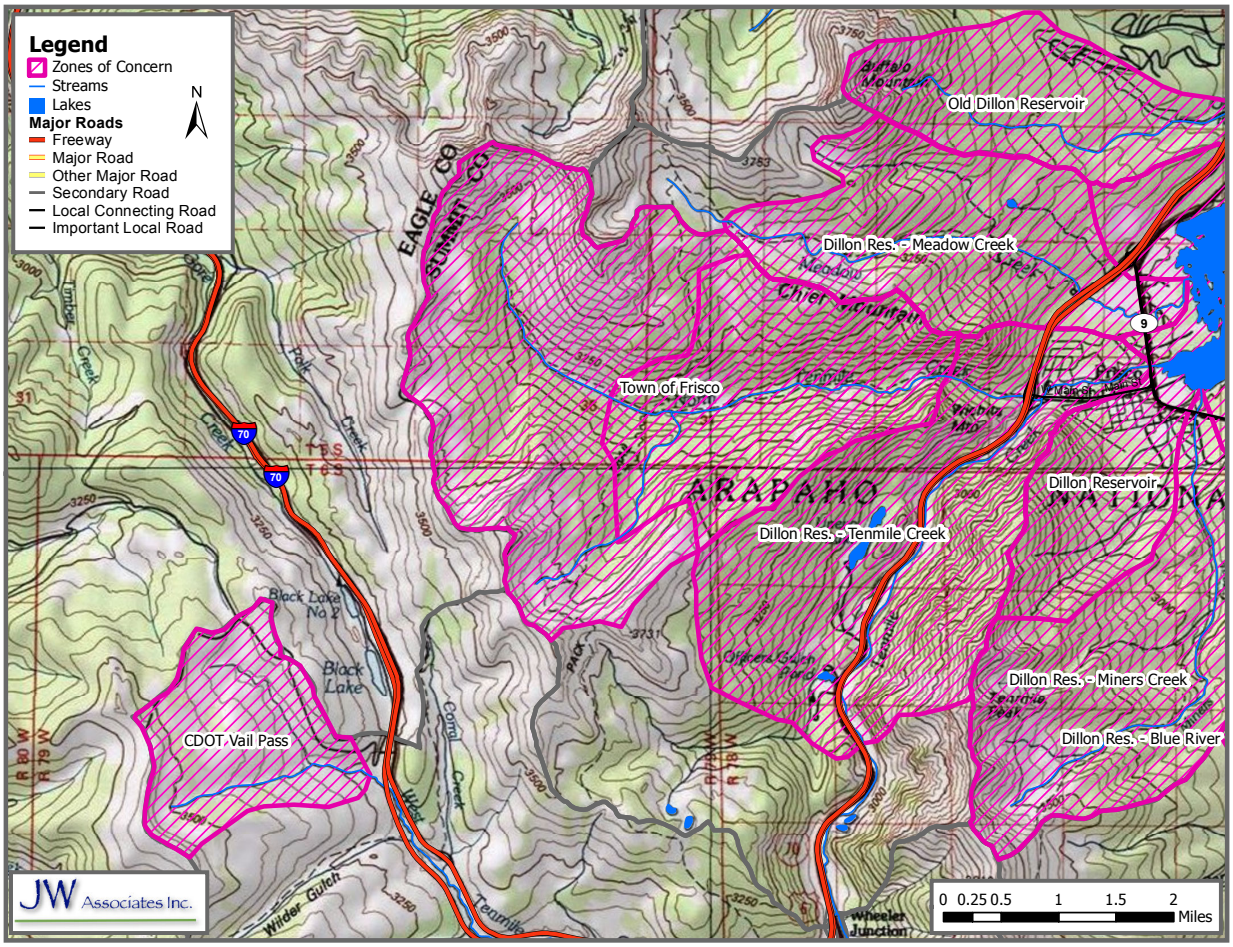

Figure 29. Town of Frisco and Dillon Reservoir-Tenmile Creek ZoC Location

Town of Frisco and Dillon Reservoir-Tenmile Creek Ownership

The ZoC is dominated by National Forest System lands. There are areas of private land around Uneva Lake and some mining claims (Figure 30).

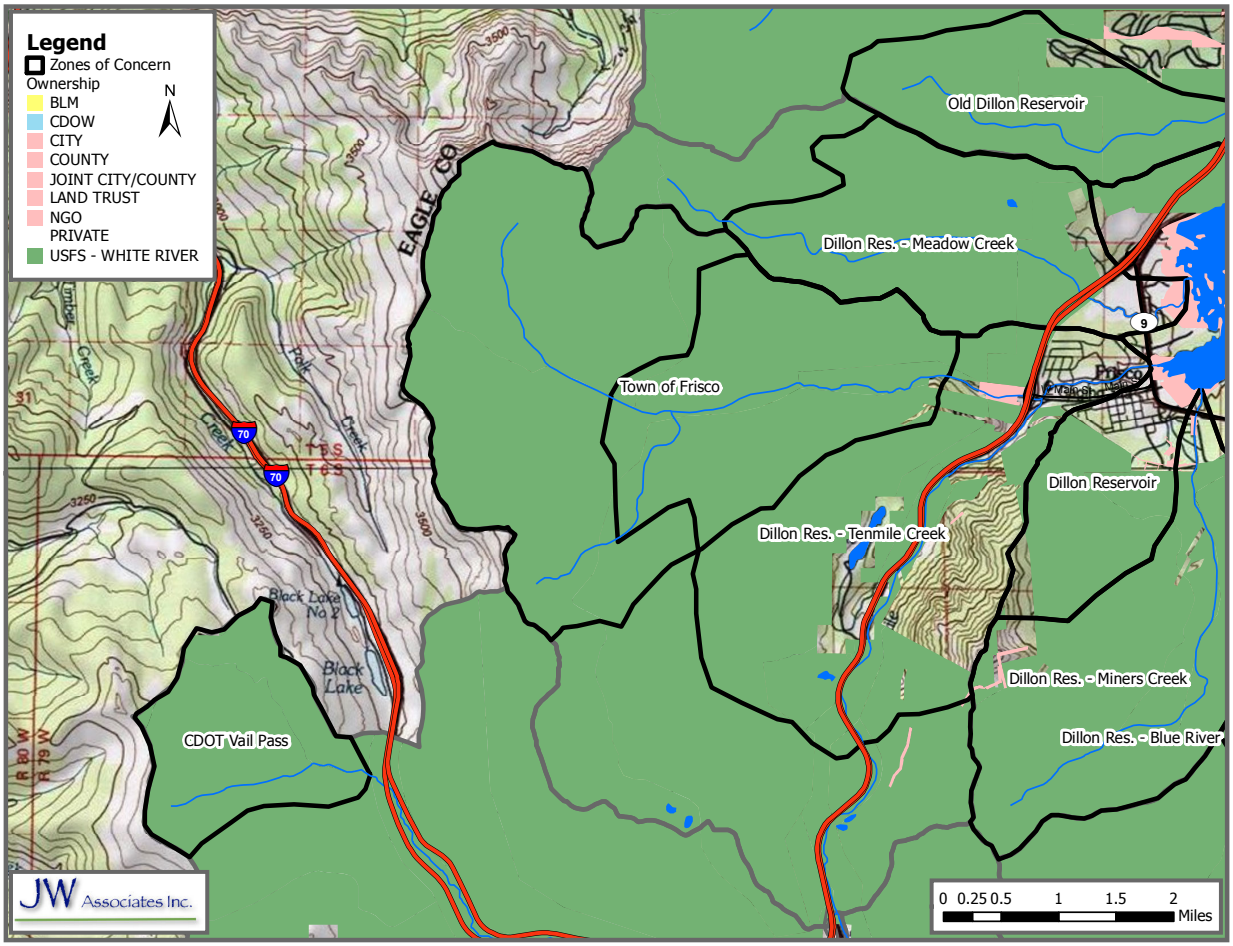

Figure 30. Town of Frisco and Dillon Reservoir-Tenmile Creek ZoC Ownership

Town of Frisco and Dillon Reservoir-Tenmile Creek Watershed Priority

The Lower Tenmile Creek watershed (Figure 31) is Orange overall (Category 4). Soil Erodibility and Wildfire Hazard are Red (Category 5 - highest). The Composite ranking is Orange (Category 4.

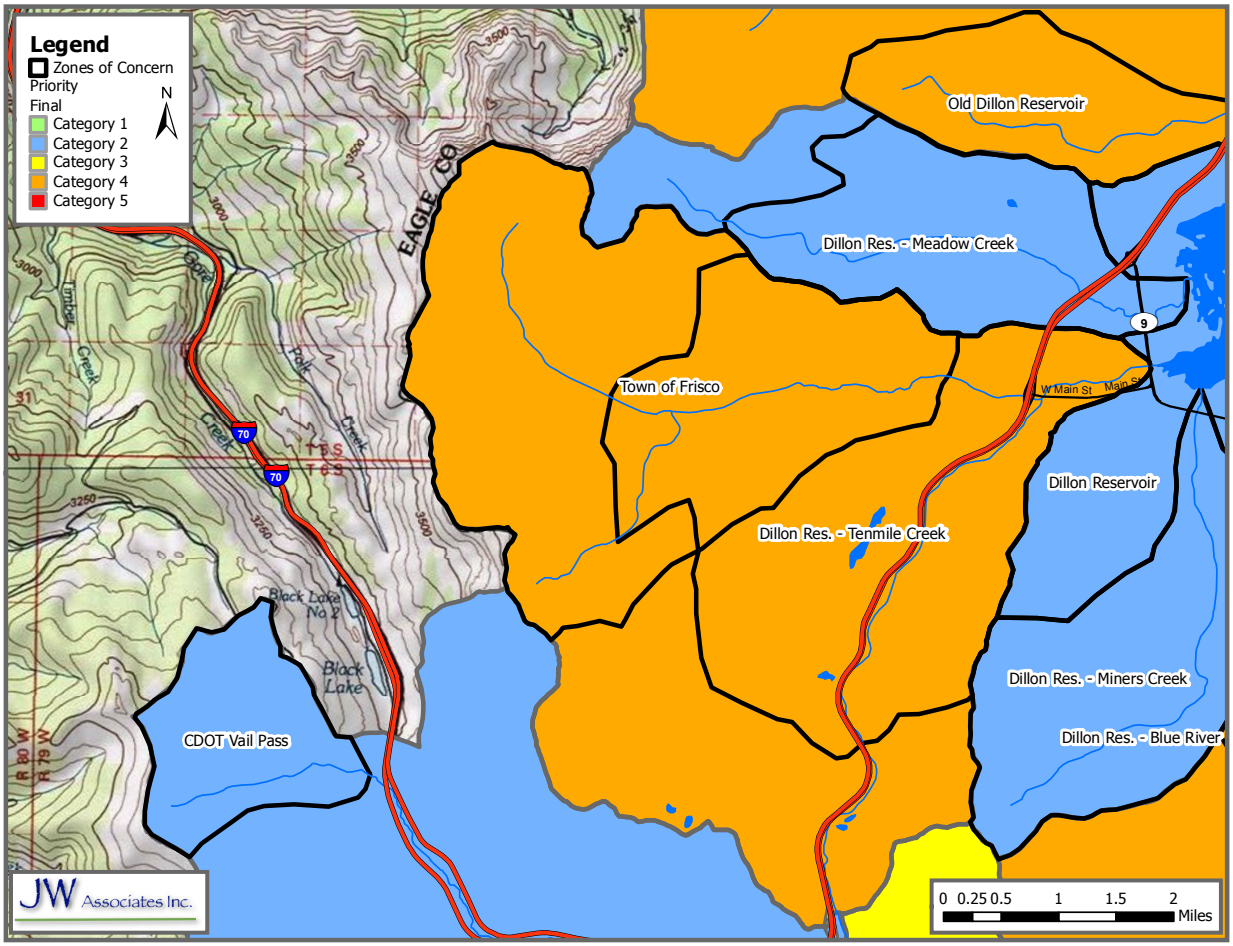

Figure 31. Town of Frisco and Dillon Reservoir-Tenmile Creek ZoC Watershed Priority

Town of Frisco and Dillon Reservoir-Tenmile Creek Slopes

There are large areas of steep slopes that cover much of this ZoC (Figure 32).

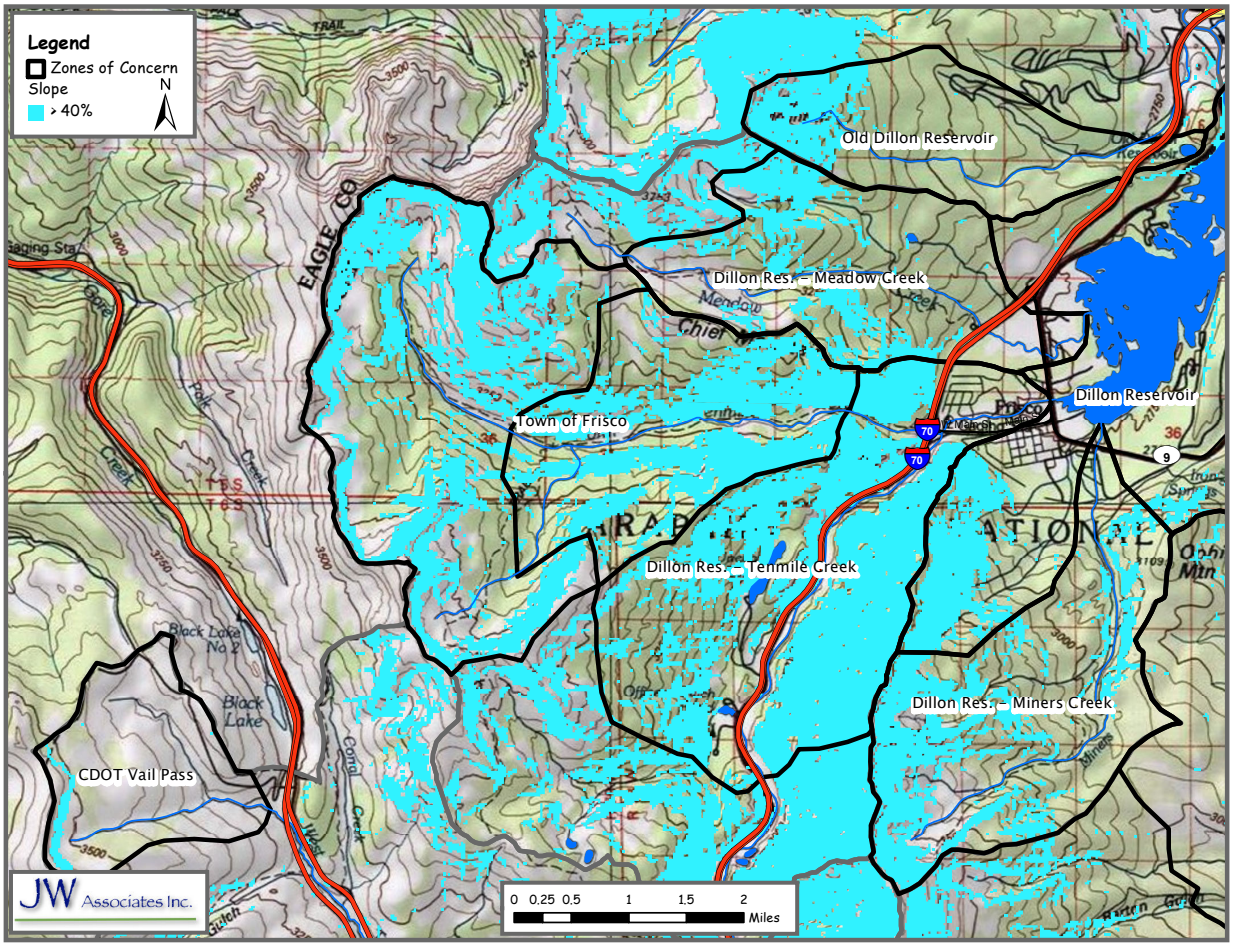

Figure 32. Town of Frisco and Dillon Reservoir-Tenmile Creek ZoC Slope

Town of Frisco and Dillon Reservoir-Tenmile Creek Special Management Areas

The Eagles Nest Wilderness Area covers the majority of the ZoC, except for the private lands east of Tenmile Creek (Figure 33).

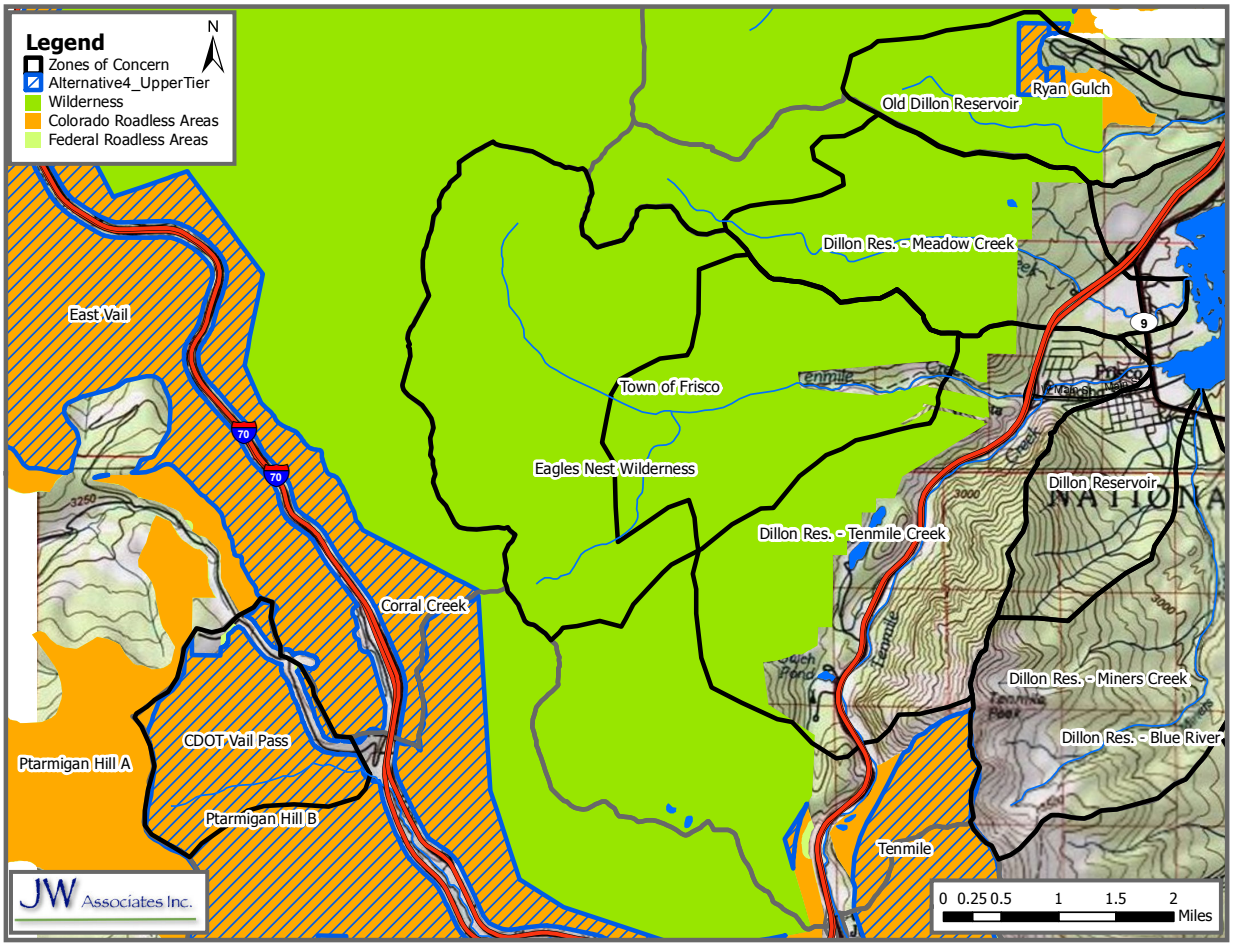

Figure 33. Town of Frisco and Dillon Reservoir-Tenmile Creek ZoC Special Areas

Town of Frisco and Dillon Reservoir-Tenmile Creek Vegetation

The stream valleys are dominated by a mixture of aspen and lodgepole pine (Figure 34). The upper elevations are dominated by spruce-fir, transitioning to alpine, barren and snow-ice at the highest elevations. Colorado has long-experienced the impacts of mountain pine beetles in lodgepole pine. Stakeholders should be aware that spruce beetles are becoming more prevalent in spruce/fir stands in many areas of the state and management needs of this species should not be ignored. The local situation should be monitored closely and adjustments made to treatment and protection plans as warranted.

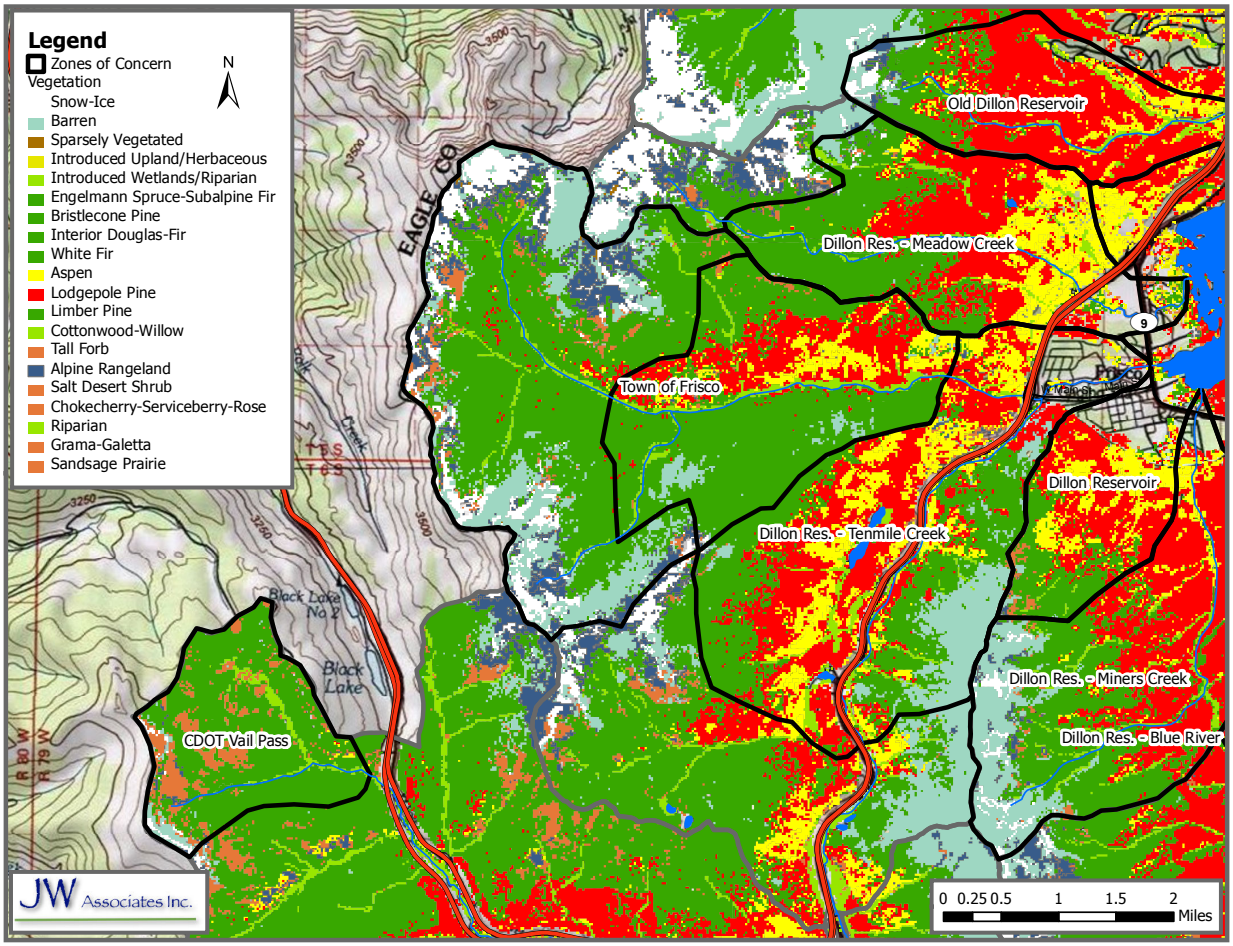

Figure 34. Town of Frisco and Dillon Reservoir-Tenmile Creek ZoC Vegetation

Town of Frisco and Dillon Reservoir-Tenmile Creek Access

Existing road access is limited to roads in the Tenmile Creek Canyon. Though it appears that opportunities are limited, where roads exist, consider using them as 'jump-off points' for development of temporary roads or the use of forwarders, mastication or other alternative harvesting equipment to implement treatments where slopes allow (Figure 35).

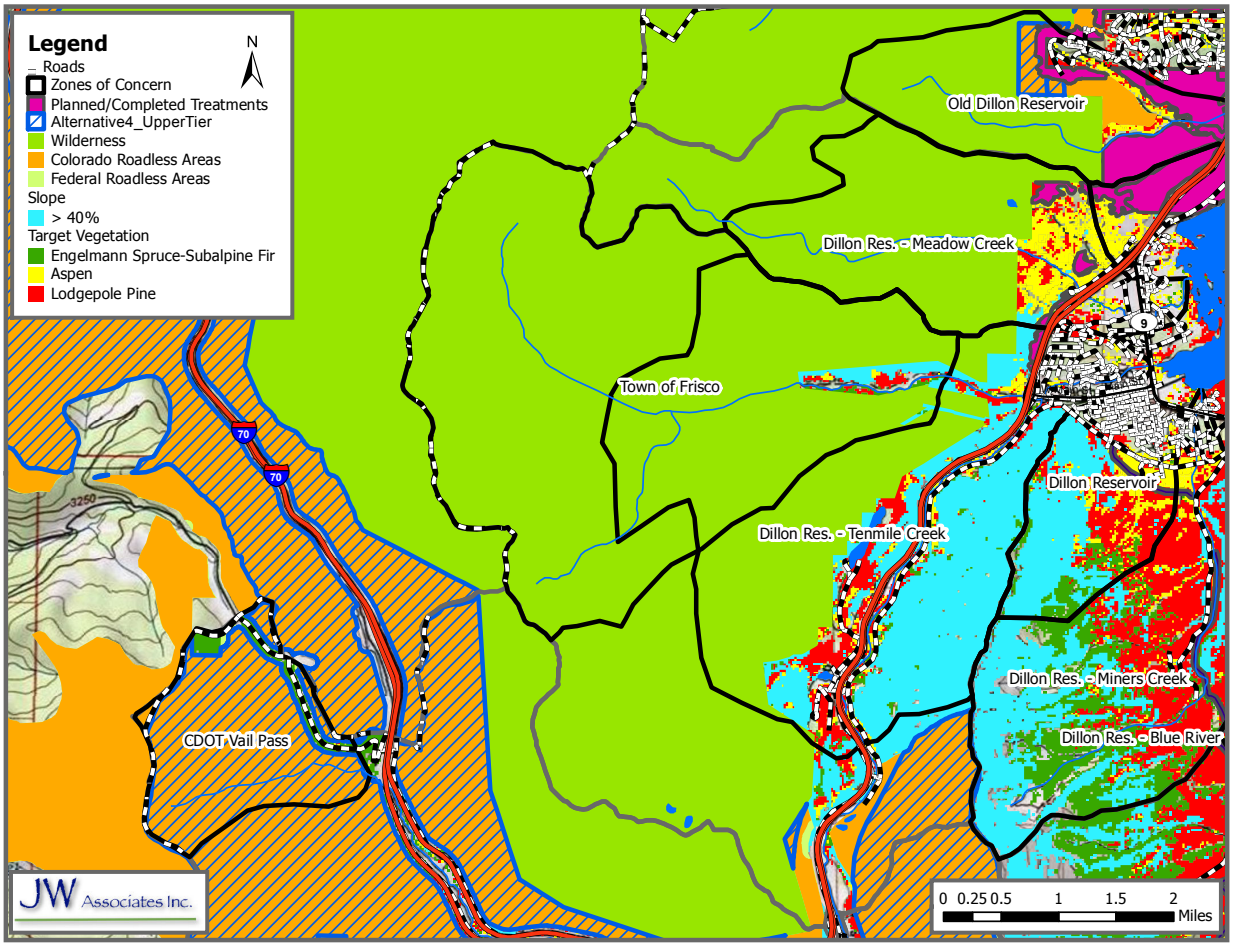

Figure 35. Town of Frisco and Dillon Reservoir-Tenmile Creek ZoC Opportunities

Town of Frisco and Dillon Reservoir-Tenmile Creek Opportunities

There appears to be few management opportunities in this ZoC (Figure 35). However, there are some operable areas in the non-federal land. In valley bottoms and where road access exists, work to maintain the mixture of aspen and lodgepole pine. Focus efforts at lower elevations and along the trail corridor to help prevent human-caused fires from moving up-slope into the watershed. In the wilderness area, planning should be conducted to allow and maximize fire use opportunities to create diversity in these inaccessible areas.

Because of the large amount of steep slopes, wilderness areas and limited opportunity for forest treatments to reduce fire intensities and spread, water providers should plan now for post-fire erosion events, focusing on development of sediment dams and/or other structures that might be needed. There may be opportunity to partner with the County Emergency Services and down-stream subdivisions and communities and communities to seek FEMA grants for fuels treatments, pre-flooding preparations and other activities.

Stakeholders include: Town of Frisco, Denver Water, US Forest Service, Colorado State Forest Service and Summit County.

Miners Creek, Blue River and Soda Creek ZoC

This section discusses the Miners Creek, Blue River and Soda Creek ZoC because they are adjacent to each other (Figure 36). Note that the ZoC are shown here in pink with crosshatching, but in the remaining figures the outlines appear as bold black lines with no crosshatching.

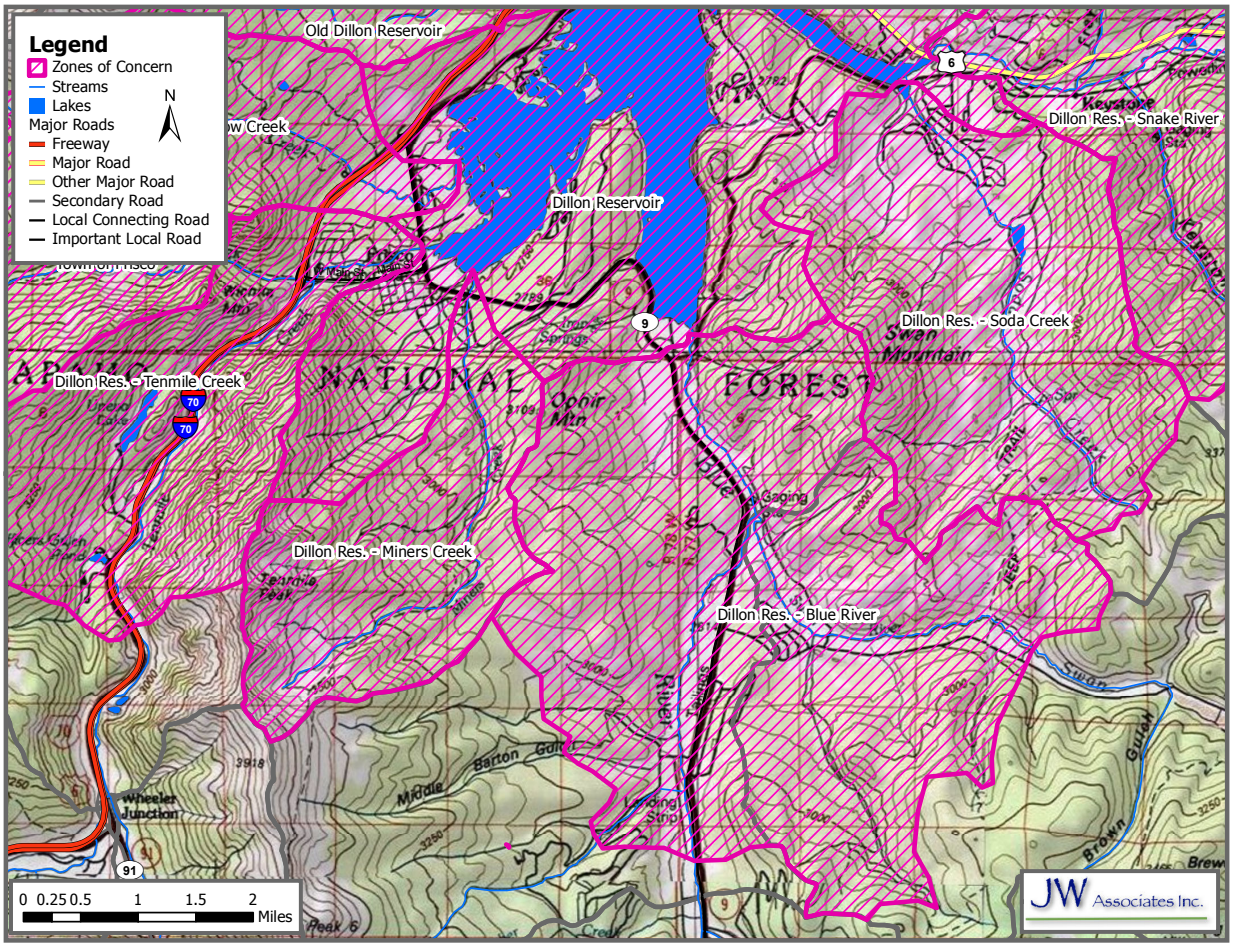

Figure 36. Miners Creek, Blue River and Soda Creek ZoC Location

Miners Creek Ownership

This ZoC is dominated by National Forest System lands. There are some areas of private land in the lowest portions of the ZoC and some mining claims in other portions of the ZoC (Figure 37).

Blue River Ownership

This ZoC is dominated by National Forest System lands to the east and west of Highway 9. There is a large area of private land south of the Swan River and east of the Blue River in this ZoC (Figure 37).

Soda Creek Ownership

This ZoC is mostly National Forest System lands with private lands surrounding Reynolds Reservoir and lower (Figure 37).

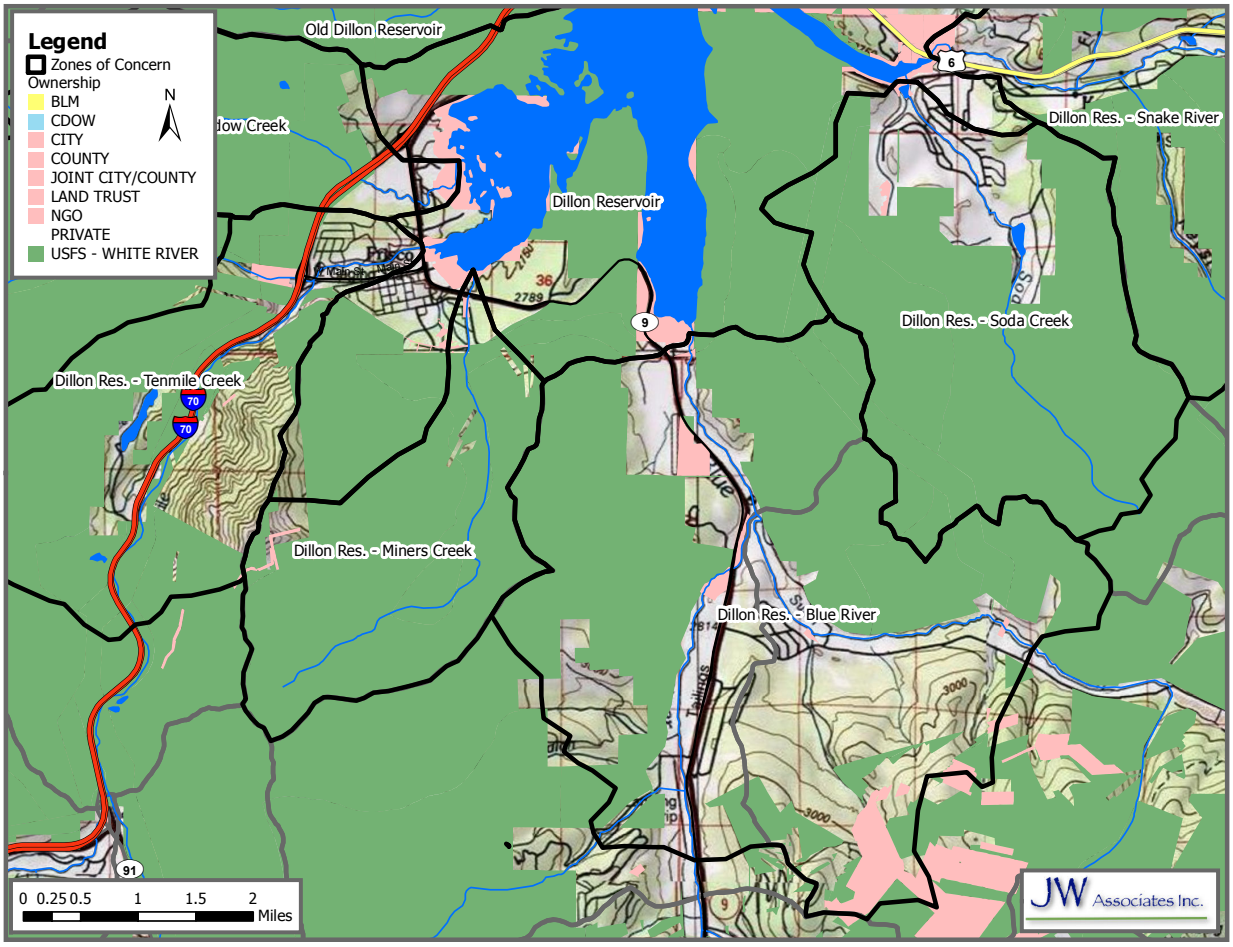

Figure 37. Miners Creek, Blue River and Soda Creek ZoC Ownership

Miners Creek Watershed Priority

The Dillon Reservoir watershed is Blue overall (Category 2). Wildfire Hazard is Orange (Category 4) (Figure 38).

Blue River Watershed Priority

The Gold Hill-Blue River watershed (Figure 38) is Orange overall (Category 4) and the Wildfire Hazard is Red (Category 5 - highest). The Swan River watershed is Yellow overall (Category 3), the Wildfire Hazard is Red (Category 5 - highest) and the Composite Hazard is Orange (Category 4).

Soda Creek Watershed Priority

The Dillon Reservoir watershed (Figure 38) is Blue overall (Category 2). Wildfire Hazard is Orange (Category 4).

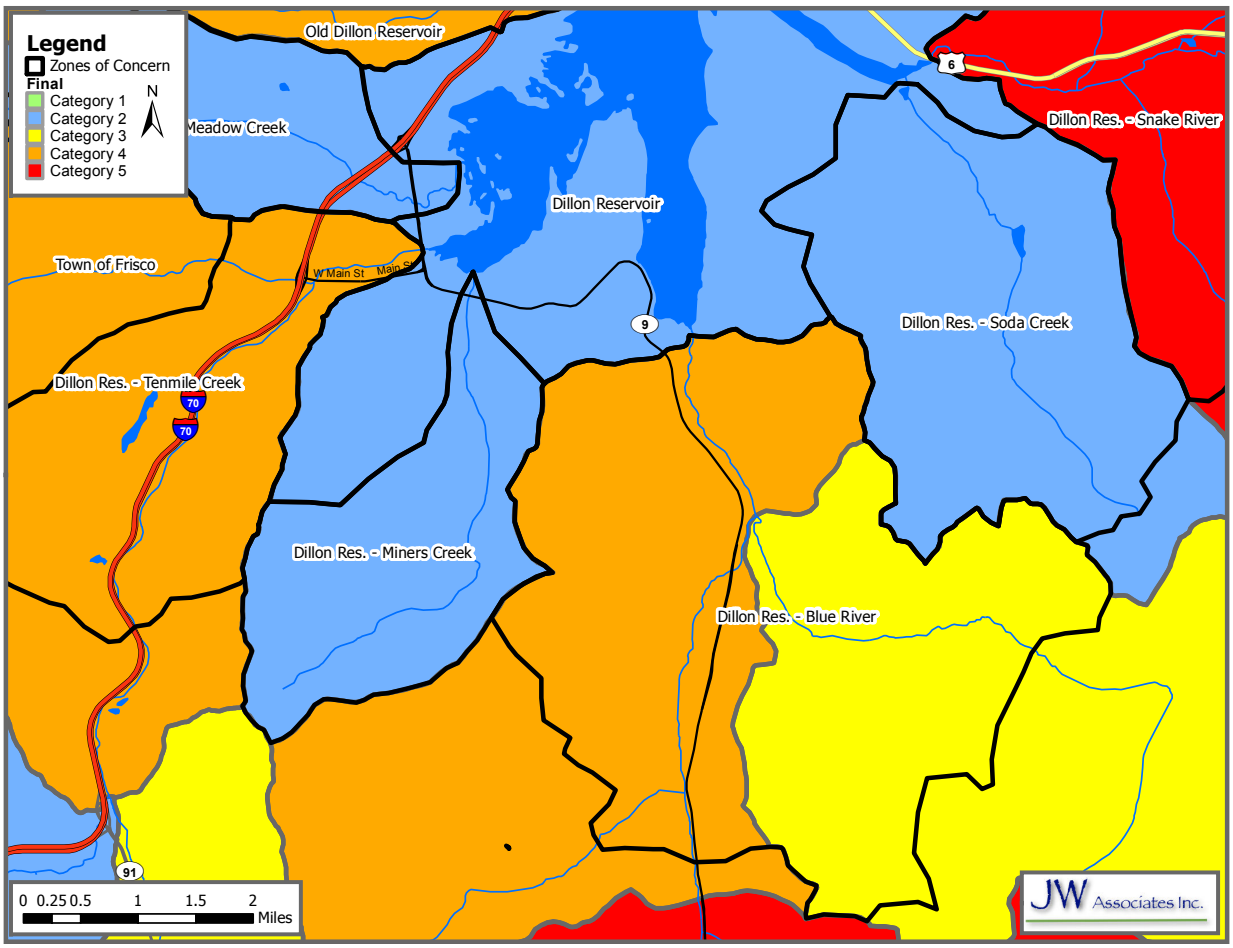

Figure 38. Miners Creek, Blue River and Soda Creek ZoC Watershed Priority

Miners Creek Slopes

There are some areas of steep slopes, east of the middle section of Miners Creek and in the highest elevations of this ZoC (Figure 39).

Blue River Slopes

There are only a few areas of steep slopes, mostly in some of the stream valleys (Figure 39).

Soda Creek Slopes

There are some areas of steep slopes, mostly high in the ZoC to the east and west of Soda Creek (Figure 39).

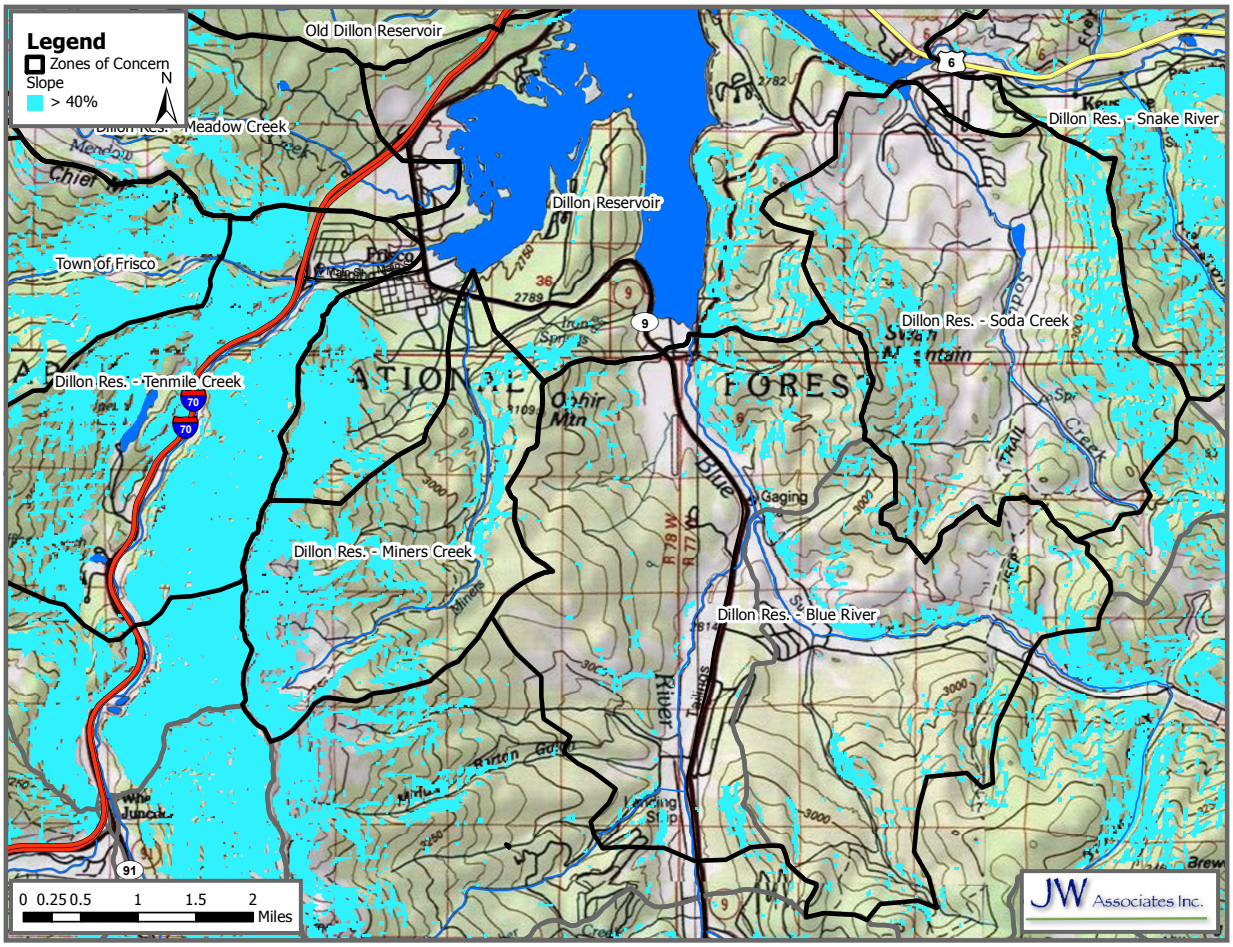

Figure 39. Miners Creek, Blue River and Soda Creek ZoC Slope

Miners Creek Special Management Areas

There are no wilderness or roadless areas in this ZoC (Figure 40).

Blue River Special Management Areas

There are no wilderness or roadless areas in this ZoC (Figure 40).

Soda Creek Special Management Areas

There are no wilderness or roadless areas in this ZoC (Figure 40).

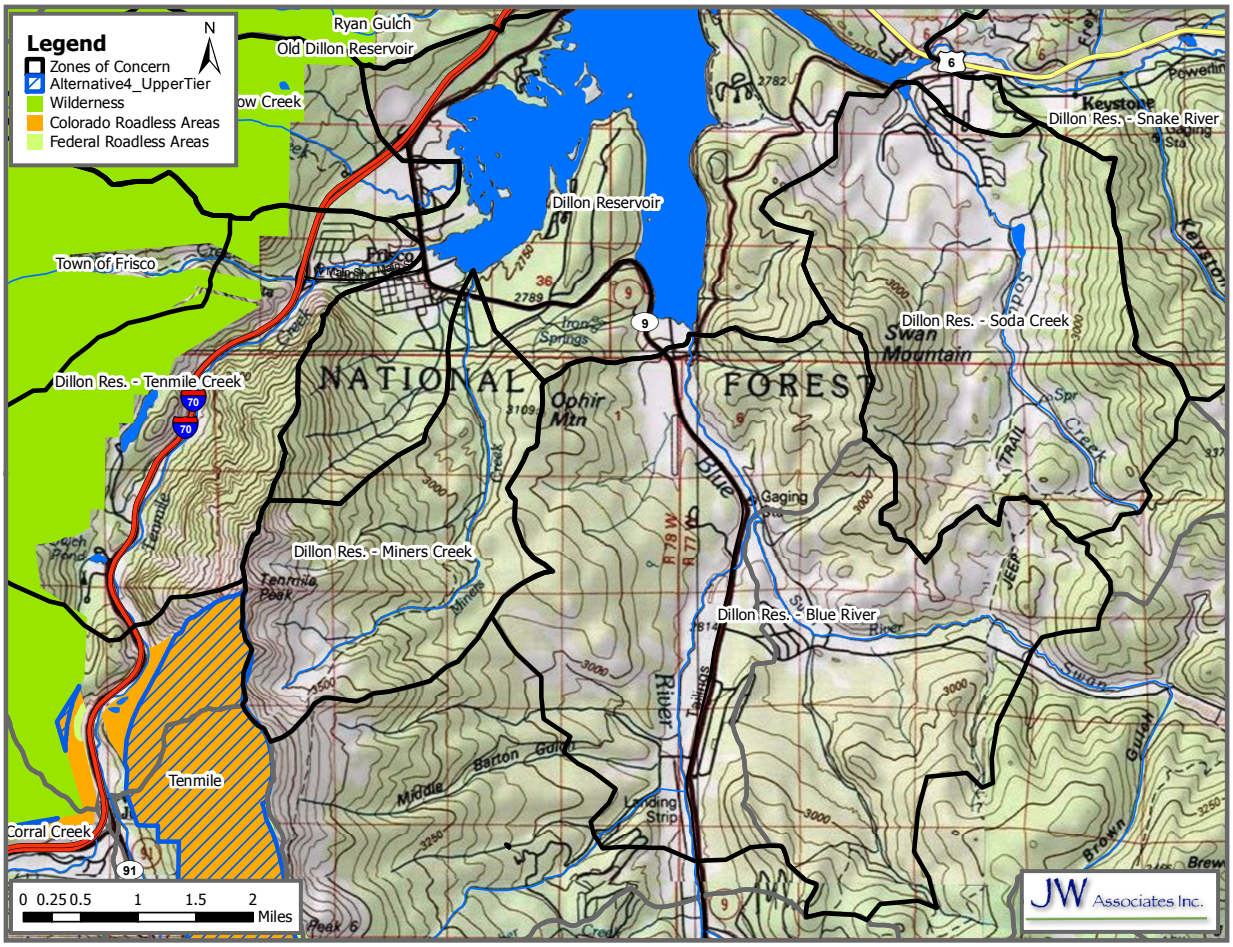

Figure 40. Miners Creek, Blue River and Soda Creek ZoC Special Areas

Miners Creek Vegetation

In the lowest portions of this ZoC there are some areas of aspen and development. There is a large area of lodgepole pine in this ZoC, transitioning to spruce-fir and then alpine at the highest elevations (Figure 41).

Blue River Vegetation

This ZoC is dominated by lodgepole pine and has been heavily impacted by mountain pine beetle. There are some areas of aspen scattered throughout (Figure 41).

Soda Creek Vegetation

This ZoC is dominated by lodgepole pine, and mountain pine beetles have been very active in much of this watershed. There are some areas of aspen scattered throughout (Figure 41).

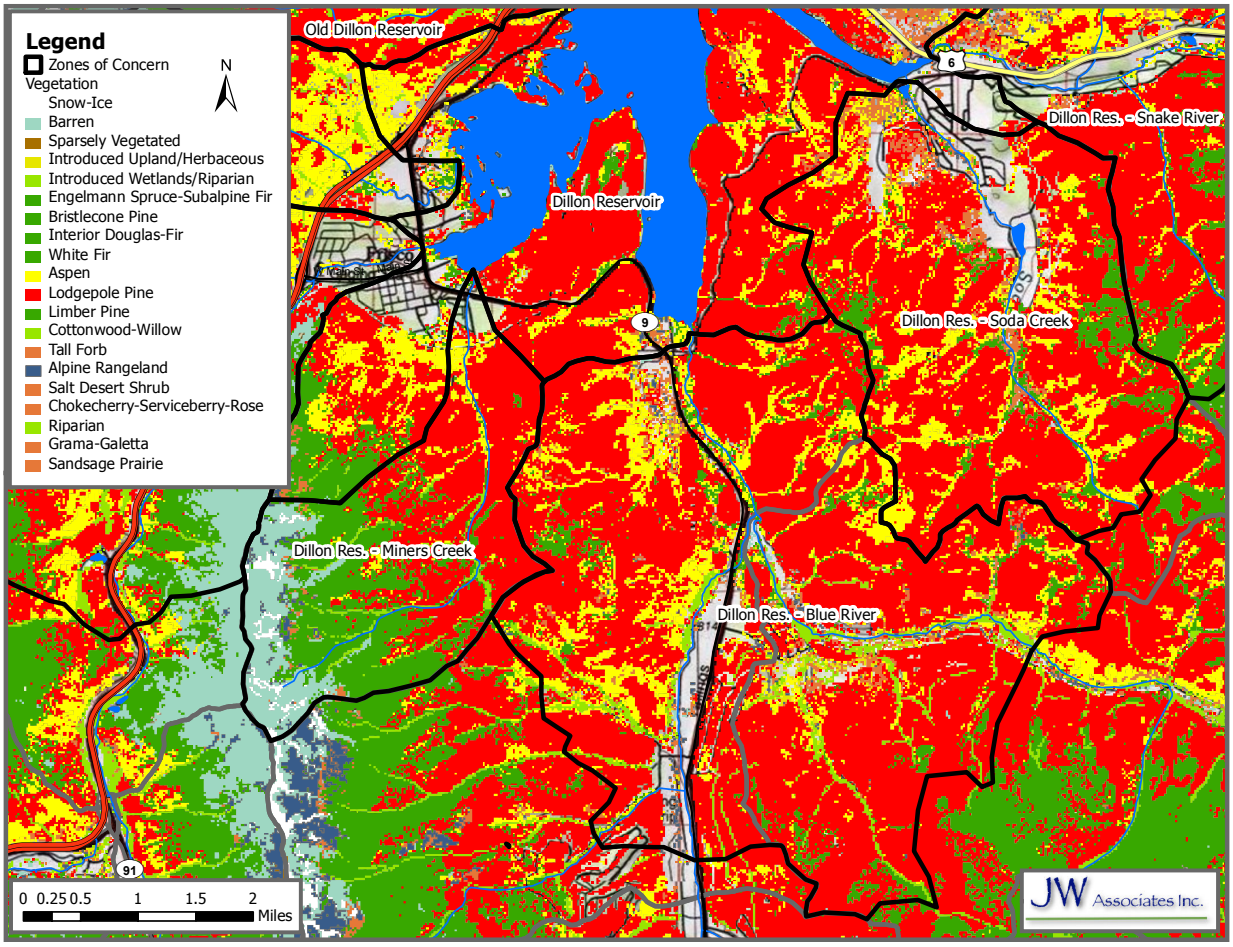

Figure 41. Miners Creek, Blue River and Soda Creek ZoC Vegetation

Miners Creek Access

There are some roads accessing this ZoC that provide access to the large areas of lodgepole pine (Figure 42). Where roads exist, consider using them as 'jump-off points' for development of temporary roads or the use of forwarders, mastication or other alternative harvesting equipment to implement treatments where slopes allow.

Blue River Access

There are many roads accessing this ZoC that provide access to the large areas of lodgepole pine (Figure 42). However, access east of Highway 9 and north of the Swan River is very limited. Where roads exist, consider using them as 'jump-off points' for development of temporary roads or the use of forwarders, mastication or other alternative harvesting equipment to implement treatments where slopes allow.

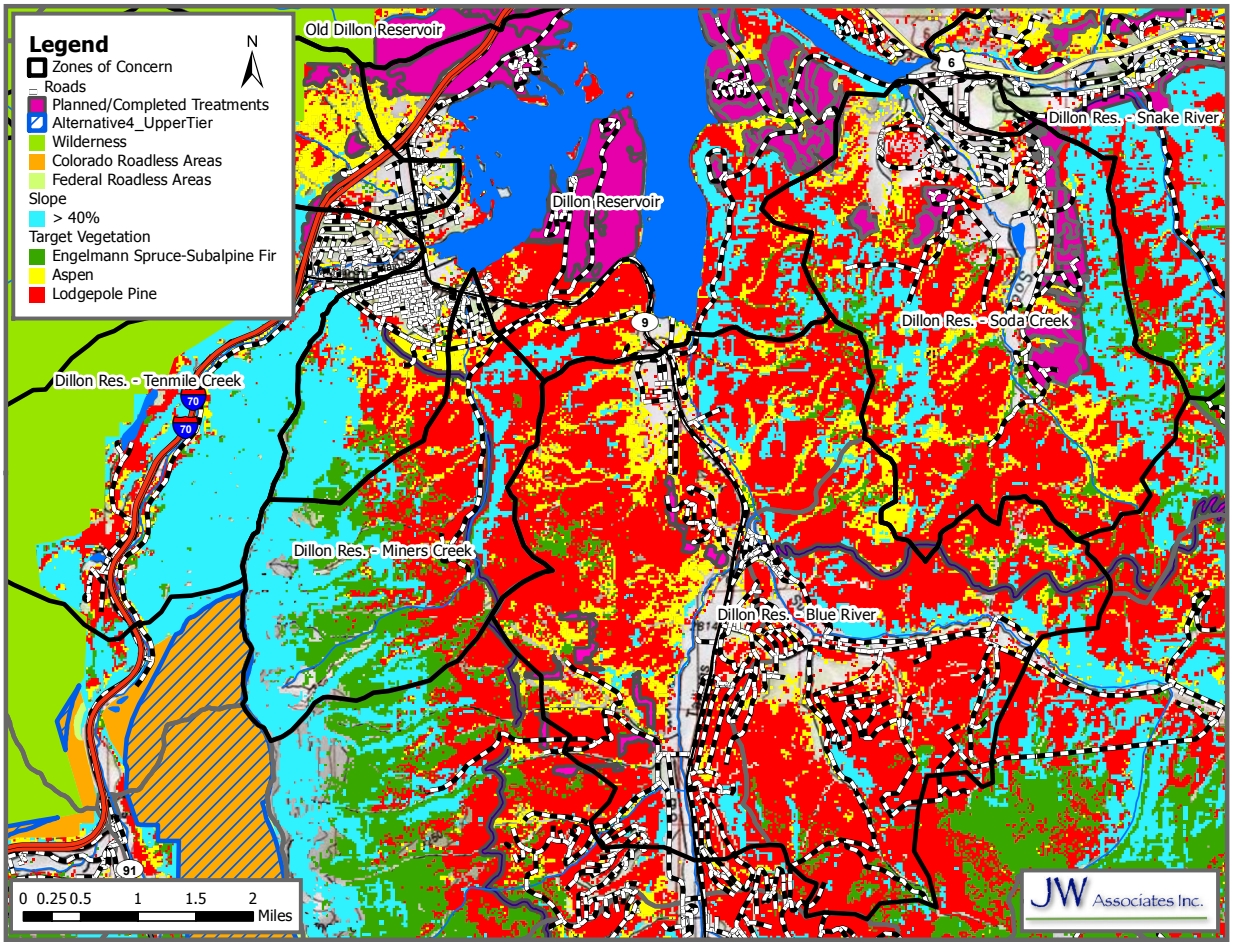

Figure 42. Miners Creek, Blue River and Soda Creek ZoC Opportunities

Soda Creek Access

There are a few roads that provide access in this ZoC, but much of it has no to limited access (Figure 42). Where roads exist, consider using them as 'jump-off points' for development of temporary roads or the use of forwarders, mastication or other alternative harvesting equipment to implement treatments where slopes allow.

Miners Creek Opportunities

There appears to be some opportunities in this ZoC in the lodgepole pine that has access and operable terrain (Figure 42). Currently there are no planned or completed treatments. Consider treatments in the vicinity of Rainbow Lake and to the south, as well as east of Miners Creek and south of Ophir Mountain. There are significant operable areas in the vicinity of the Colorado Trail west of Gold Hill.

Where bark beetles have heavily impacted lodgepole pine, explore opportunities to salvage or masticate dead trees to allow regeneration that will be relatively free from the heavy fuels that would normally build up following tree death and the resultant snag fall. Also look for opportunities to convert and maintain areas as open meadows or parks, thus creating much-needed diversity and areas that could be used as fuelbreaks or safety zones. Similarly, where aspen is a significant component of the lodgepole stands, explore converting and maintaining these areas as aspen. Colorado has long-experienced the impacts of mountain pine beetles in lodgepole pine. Stakeholders should be aware that spruce beetles are becoming more prevalent in spruce/fir stands in many areas of the state and management needs of this species should not be ignored. The local situation should be monitored closely and adjustments made to treatment and protection plans as warranted.

Where aspen stands currently exist, decide which stands contribute most to the landscape diversity and block the potential movement of fires. Manage these stands over the long term to maintain them as aspen, interrupting their normal succession to conifer stands.

The Summit County CWPP and any local CWPPs that might be developed in the future should be reviewed and updated as necessary to incorporate watershed protection as a value to be protected, along with specific treatment recommendations. Water providers should become active partners in these CWPPs to give them standing with other participants.

Stakeholders include: Denver Water, US Forest Service, Colorado State Forest Service, Summit County, and private landowners.

Blue River Opportunities

There are some planned and many completed treatments in this ZoC (Figure 42). There appears to be continued opportunities in this ZoC wherever there is lodgepole pine that has access and operable terrain slopes, and even between completed treatment units. Investigate use of forwarders to access potential treatment units north of the Swan River.

Where bark beetles have heavily impacted lodgepole pine, explore opportunities to salvage or masticate dead trees to allow regeneration that will be relatively free from the heavy fuels that would normally build up following tree death and the resultant snag fall. Also look for opportunities to convert and maintain areas as open meadows or parks, thus creating much-needed diversity and areas that could be used as fuelbreaks

or safety zones. Similarly, where aspen is a significant component of the lodgepole stands, explore converting and maintaining these areas as aspen. Colorado has long-experienced the impacts of mountain pine beetles in lodgepole pine. Stakeholders should be aware that spruce beetles are becoming more prevalent in spruce/fir stands in many areas of the state and management needs of this species should not be ignored. The local situation should be monitored closely and adjustments made to treatment and protection plans as warranted.

Where aspen stands currently exist, decide which stands contribute most to the landscape diversity and block the potential movement of fires. Manage these stands over the long term to maintain them as aspen, interrupting their normal succession to conifer stands.

The Summit County CWPP and any local CWPPs that might be developed in the future should be reviewed and updated as necessary to incorporate watershed protection as a value to be protected, along with specific treatment recommendations. Water providers should become active partners in these CWPPs to give them standing with other participants.

Stakeholders include: Denver Water, US Forest Service, Colorado State Forest Service, Summit County, and private landowners.

Soda Creek Opportunities

There appears to be significant opportunities in this ZoC in the lodgepole pine and aspen where access and operable slopes are found (Figure 42). There are some planned treatments in this ZoC, but significant areas that could be worked remain. Use of forwarders and other alternative logging equipment could prove very useful in these areas.

Where bark beetles have heavily impacted lodgepole pine, explore opportunities to salvage or masticate dead trees to allow regeneration that will be relatively free from the heavy fuels that would normally build up following tree death and the resultant snag fall. Also look for opportunities to convert and maintain areas as open meadows or parks, thus creating much-needed diversity and areas that could be used as fuelbreaks or safety zones. Similarly, where aspen is a significant component of the lodgepole stands, explore converting and maintaining these areas as aspen. Colorado has long-experienced the impacts of mountain pine beetles in lodgepole pine. Stakeholders should be aware that spruce beetles are becoming more prevalent in spruce/fir stands in many areas of the state and management needs of this species should not be ignored. The local situation should be monitored closely and adjustments made to treatment and protection plans as warranted.

Where aspen stands currently exist, decide which stands contribute most to the landscape diversity and block the potential movement of fires. Manage these stands over the long term to maintain them as aspen, interrupting their normal succession to conifer stands.

Because of the limited permanent access in this ZoC, water providers should plan now for post-fire erosion events, focusing on development of sediment dams and/or other structures that might be needed. There may be opportunity to partner with the County Emergency Services and down-stream subdivisions and communities and communities to seek FEMA grants for fuels treatments, pre-flooding preparations and other activities.

The County CWPP and any local CWPPs that might be developed in the future should be reviewed and updated as necessary to incorporate watershed protection as a value to be protected, along with specific treatment recommendations. Water providers should become active partners in these CWPPs to give them standing with other participants.

Stakeholders include: Denver Water, US Forest Service, Colorado State Forest Service, Summit County, and private landowners.

Snake River, Keystone, and Keystone A-Basin ZoC

The Snake River, Keystone, and Keystone A-Basin ZoC are adjacent and are analyzed and presented together (Figure 43). Note that the ZoC are shown here in pink with crosshatching, but in the remaining figures the outlines appear as bold black lines with no crosshatching.

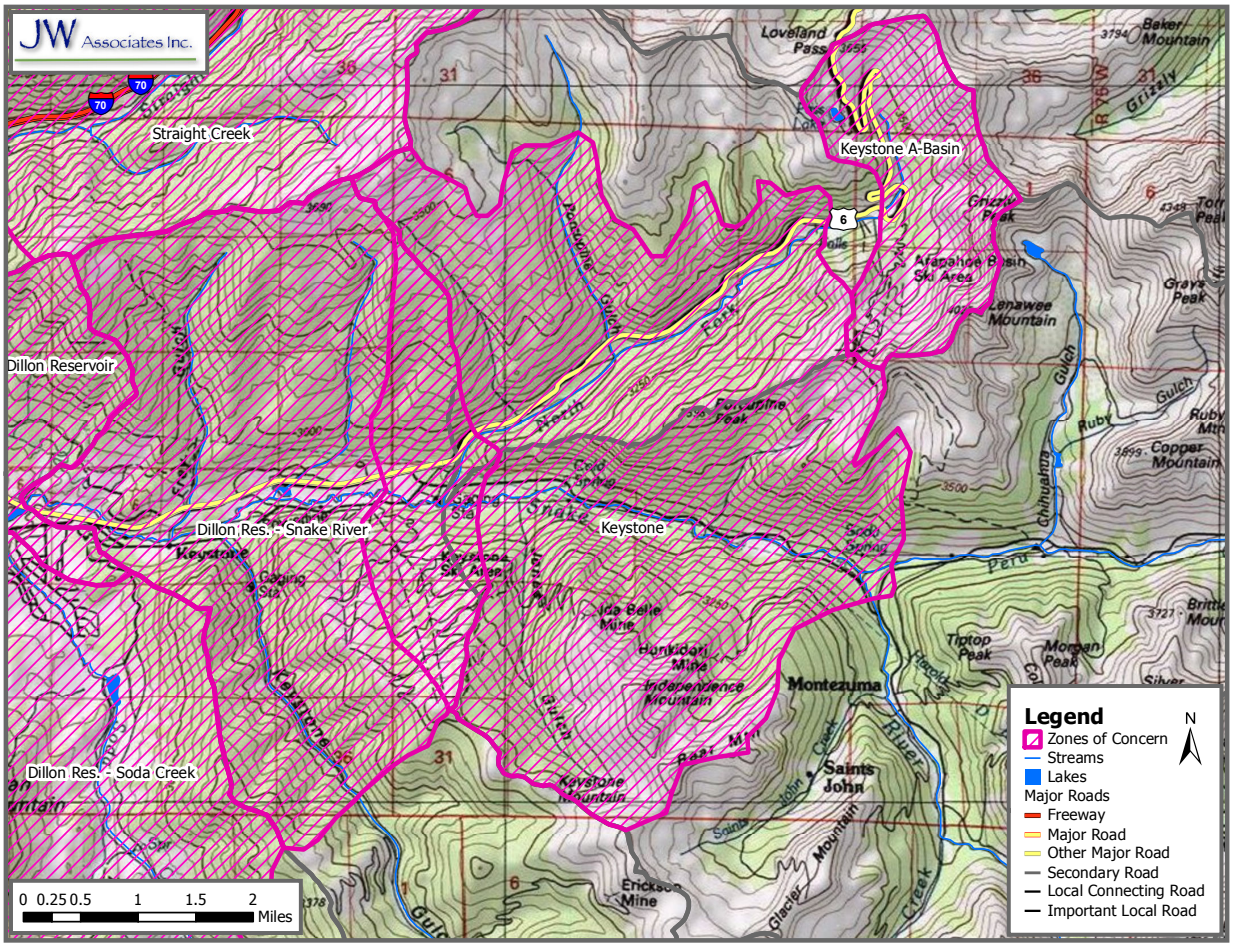

Figure 43. Snake River, Keystone, and Keystone A-Basin ZoC Location

Snake River, Keystone, and Keystone A-Basin Ownership

This ZoC is mostly National Forest System lands with private lands surrounding the Snake River, Keystone Gulch, some Denver Water lands and scattered mining claims (Figure 44).

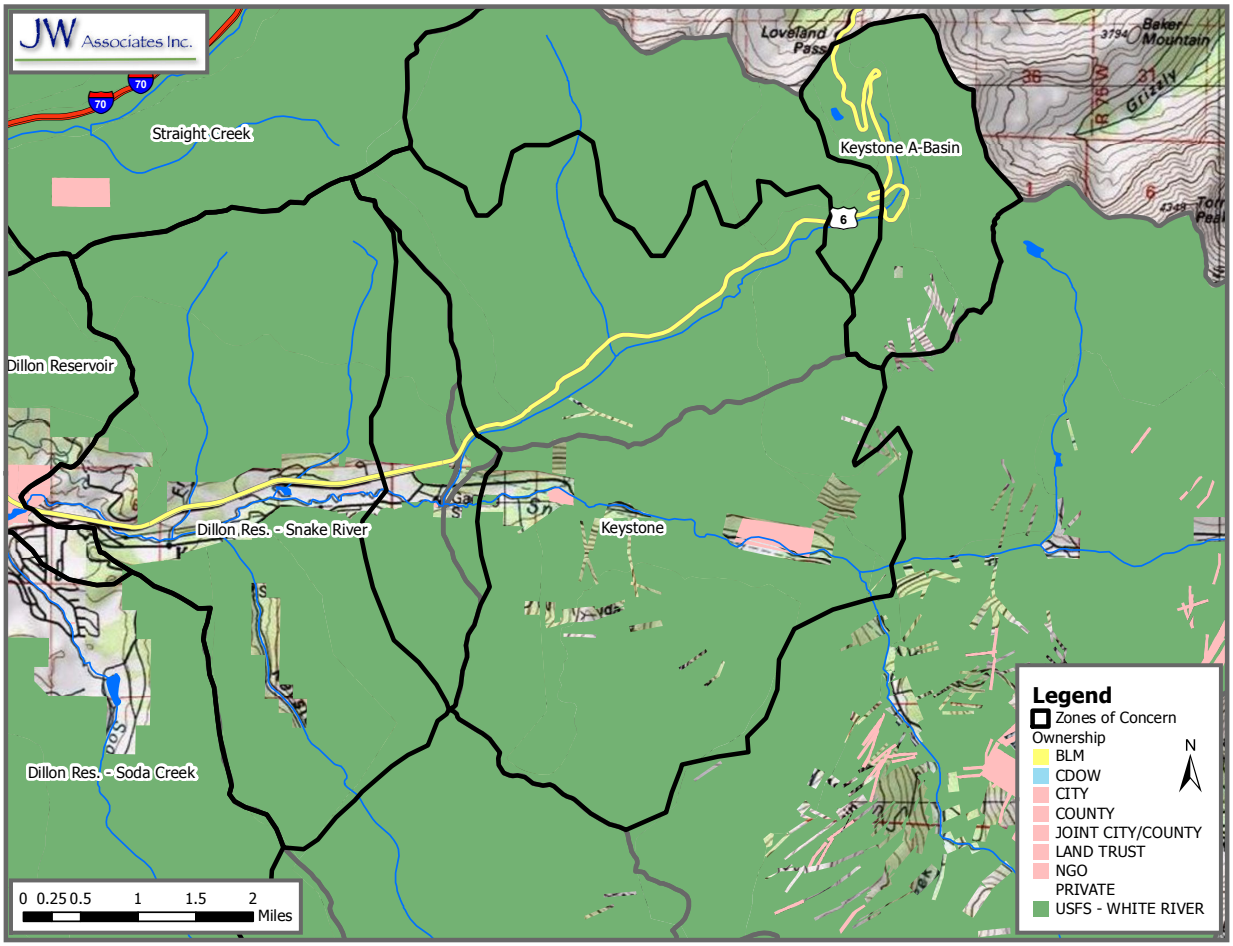

Figure 44. Snake River, Keystone, and Keystone A-Basin ZoC Ownership

Snake River, Keystone, and Keystone A-Basin Watershed Priority

This ZoC is composed of three watersheds; Keystone Gulch-Snake River, North Fork Snake River and Peru Creek - Snake River (Figure 45). The Keystone Gulch-Snake River watershed is Red overall (Category 5 - highest). It is also rated as Red (Category 5 - highest) for Wildfire Hazard, Soil Erodibility and Composite Hazard. The North Fork Snake River watershed is Red overall (Category 5 - highest). It is also rated as Orange (Category 4) for Flooding/Debris Flow Hazard, Soil Erodibility and Composite Hazard. The Peru Creek - Snake River watershed is Yellow overall (Category 3). It is also rated as Orange (Category 4) for Flooding/ Debris Flow Hazard, and Soil Erodibility.

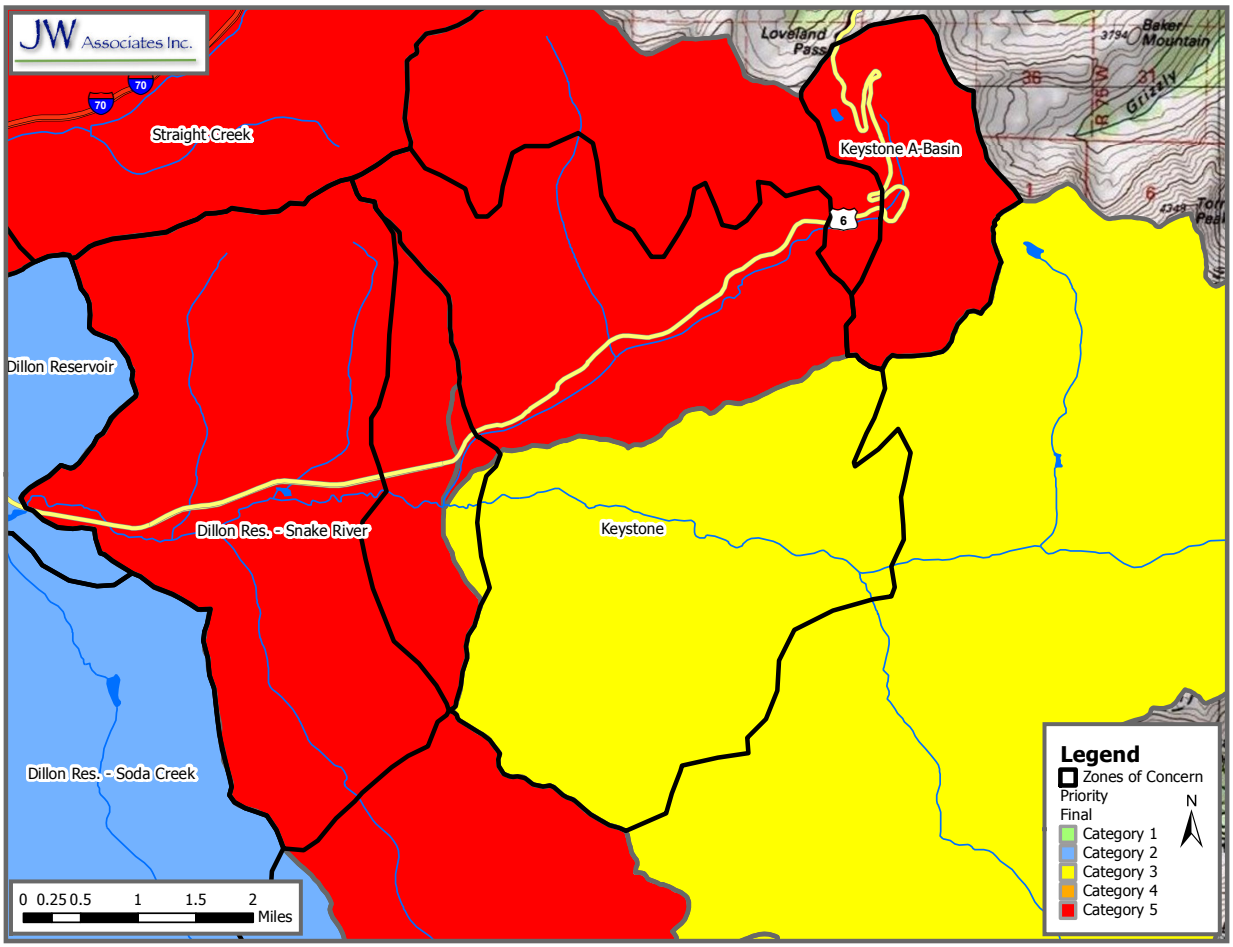

Figure 45. Snake River, Keystone, and Keystone A-Basin ZoC Watershed Priority

Snake River, Keystone, and Keystone A-Basin Slopes

There are many areas of steep slopes, particularly above the North Fork confluence (Figure 46). Much of the upper watershed is quite steep.

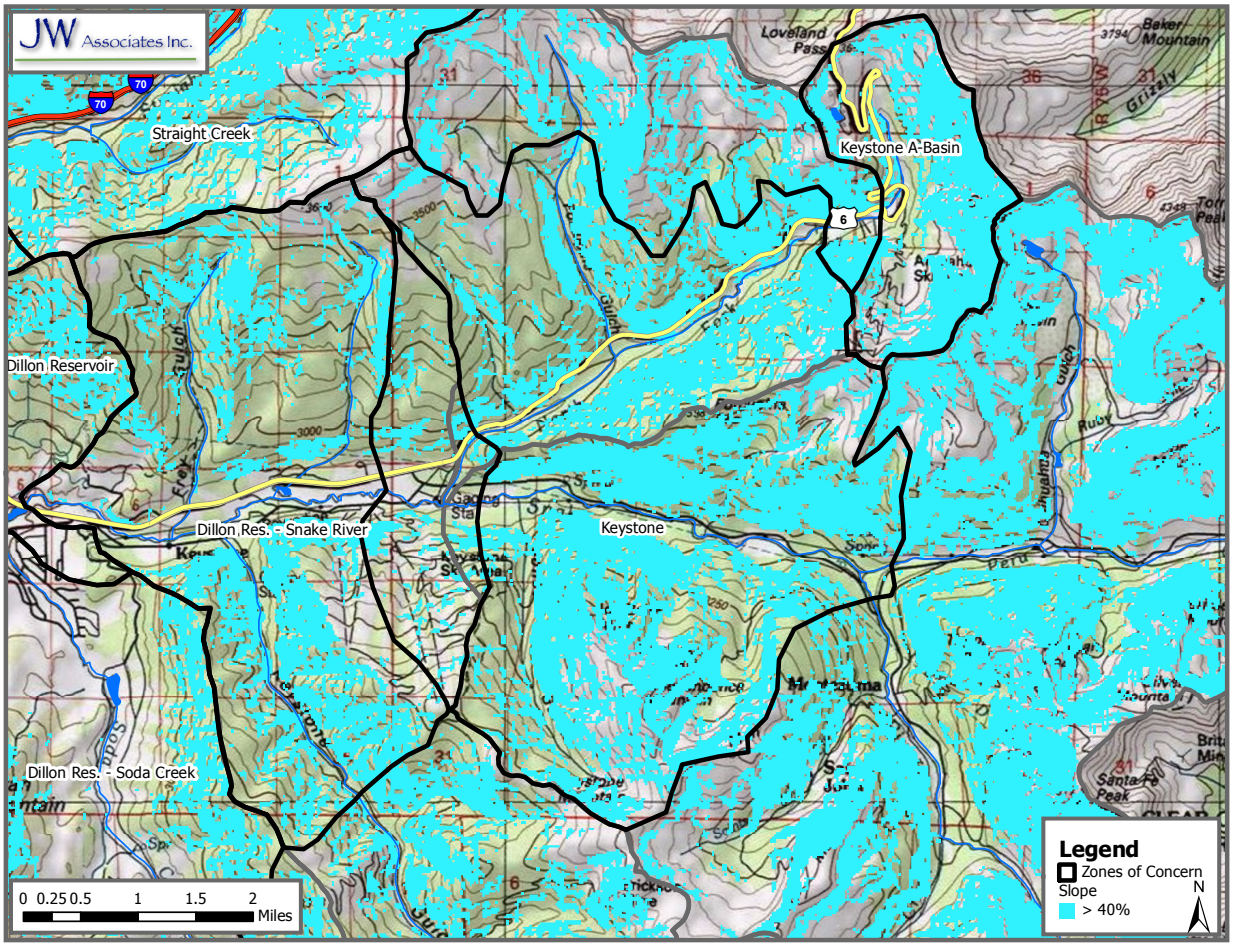

Figure 46. Snake River, Keystone, and Keystone A-Basin ZoC Slope

Snake River, Keystone, and Keystone A-Basin Special Management Areas

There are no wilderness areas in this ZoC. The Porcupine Peak and Tenderfoot Roadless Areas, both are designated as Upper Tier, occupy most of the ZoC above the North Fork confluence, north of the Snake River (Figure 47).

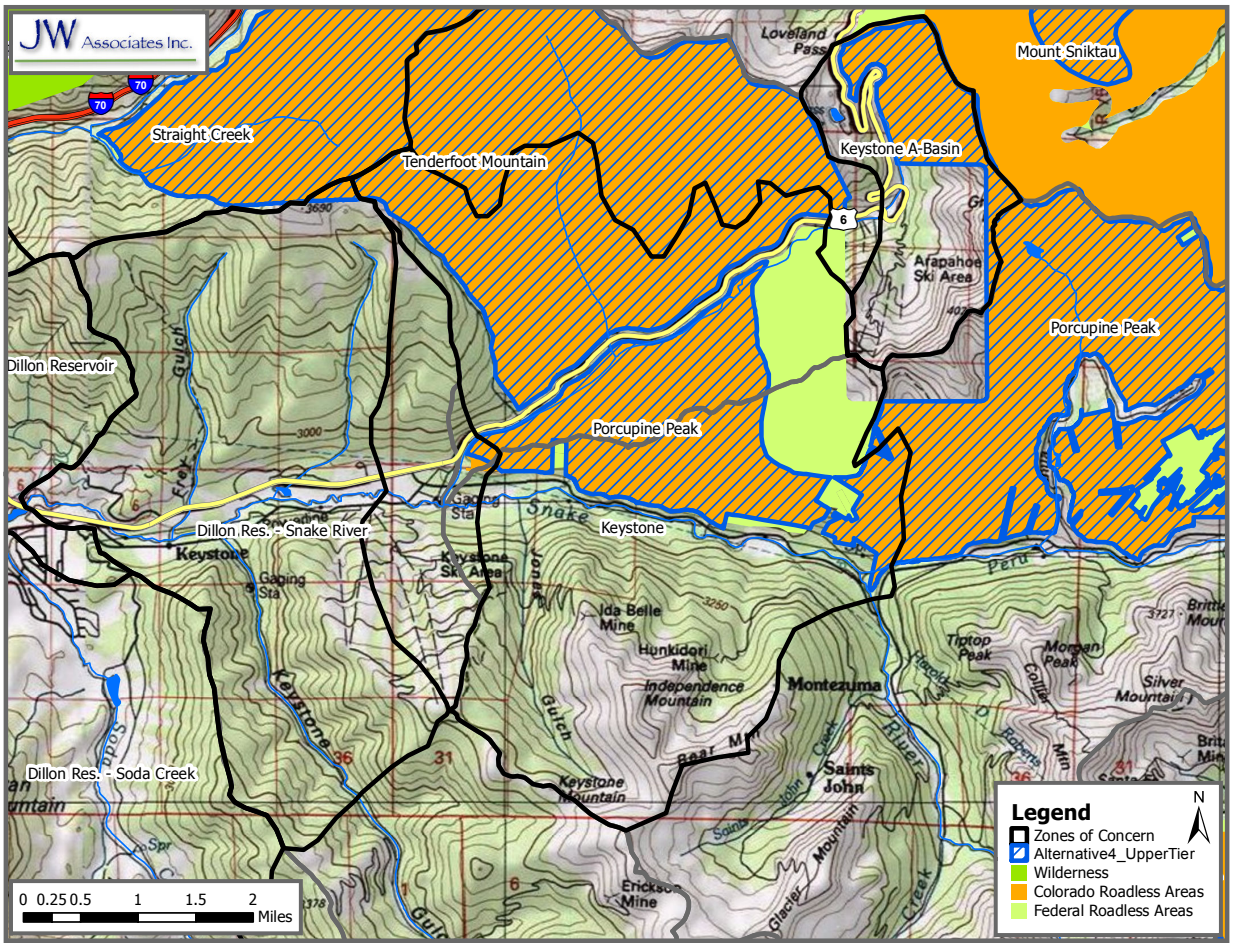

Figure 47. Snake River, Keystone, and Keystone A-Basin ZoC Special Areas

Snake River, Keystone, and Keystone A-Basin Vegetation

There are some large areas of lodgepole pine, especially lower in the ZoC (Figure 48). There are also some areas of aspen scattered throughout the lodgepole pine. The ZoC transitions to spruce-fir above the aspen and lodgepole pine; with some areas of alpine, barren and snow-ice at the highest elevations. Colorado has long-experienced the impacts of mountain pine beetles in lodgepole pine. Stakeholders should be aware that spruce beetles are becoming more prevalent in spruce/fir stands in many areas of the state and management needs of this species should not be ignored. The local situation should be monitored closely and adjustments made to treatment and protection plans as warranted.

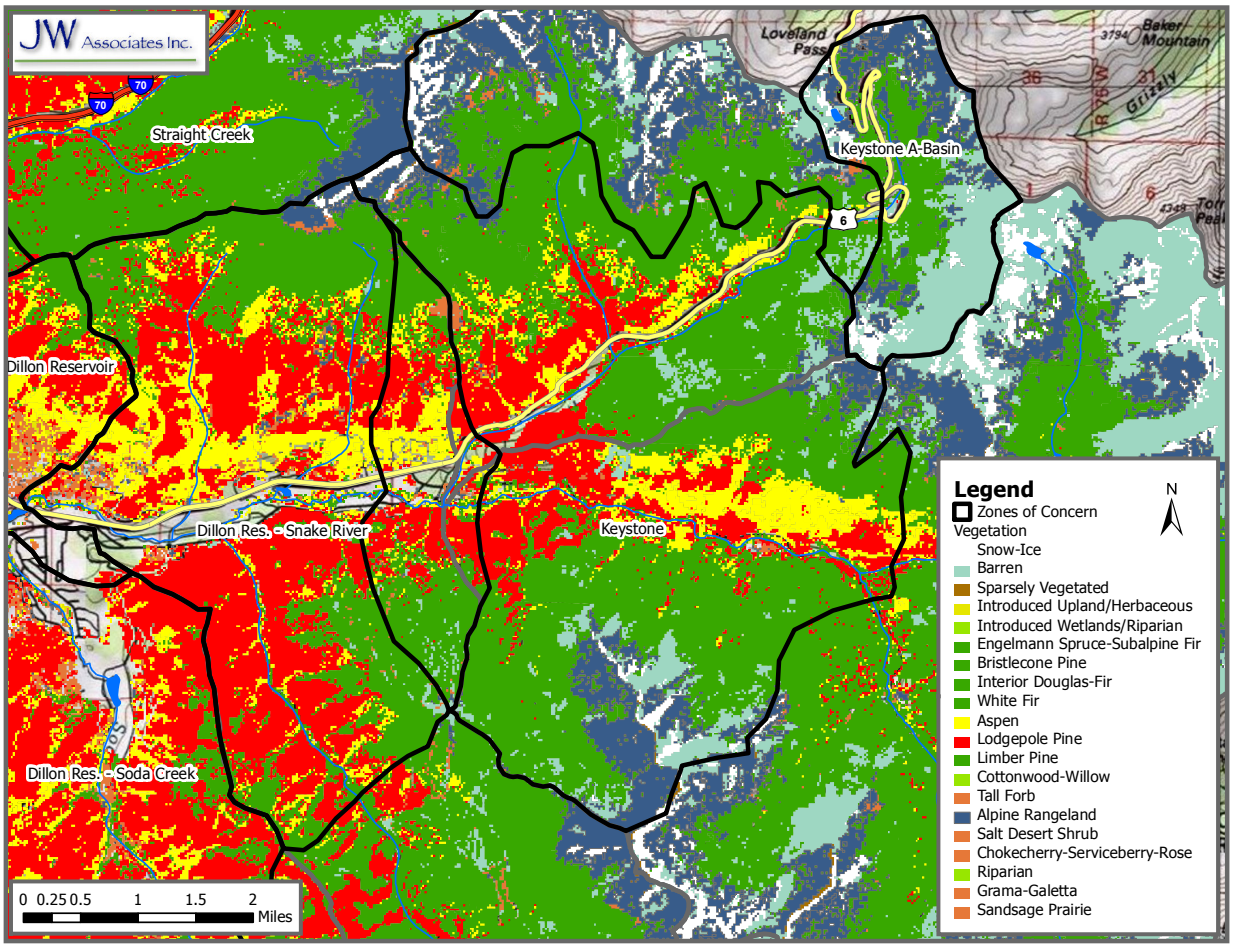

Figure 48. Snake River, Keystone, and Keystone A-Basin ZoC Vegetation

Snake River, Keystone, and Keystone A-Basin Access

There are many roads that provide access in this ZoC, but some large areas have no to limited access (Figure 49). Where roads exist, consider using them as 'jump-off points' for development of temporary roads or for the use of forwarders, mastication or other alternative harvesting equipment to implement treatments where slopes allow.

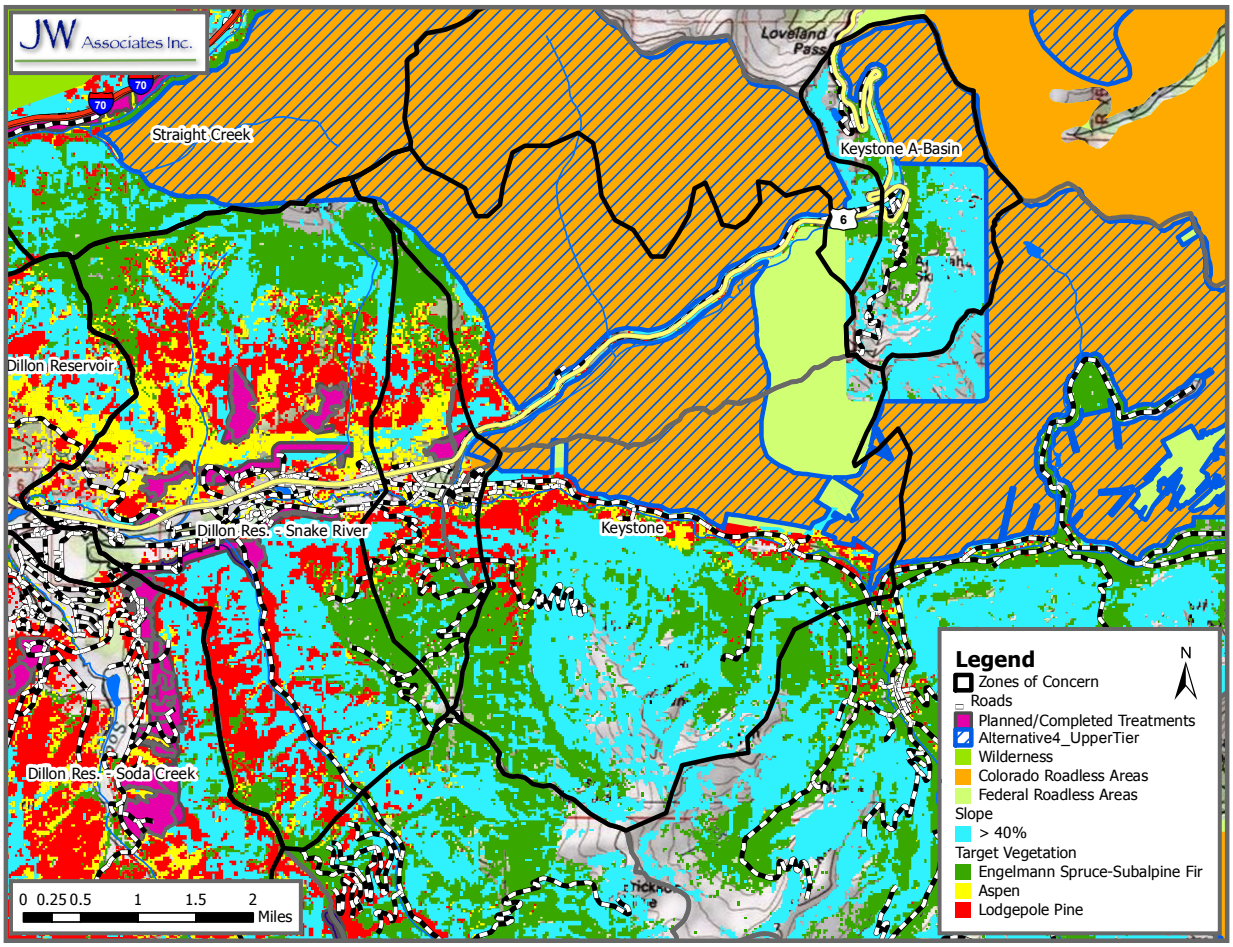

Figure 49. Snake River, Keystone, and Keystone A-Basin ZoC Opportunities

Snake River, Keystone, and Keystone A-Basin Opportunities

Most opportunities & operable ground are in the Keystone Gulch-Snake River portion of this ZoC (Figure 49). There appears to be some opportunities in this ZoC in the lower portions of the ZoC in areas of lodgepole pine and aspen that have access and more operable slopes. For example, operable areas are found both east and west of Frey Gulch, near the Mouth of Jones Gulch, and at the high elevations west of Porcupine Gulch. There is a dominant ridgeline west of Keystone Gulch where a fuelbreak might be considered.

The ski runs north of Keystone Mountain break up timber stands in that area. There are existing treated areas north of Highway 6. There are some planned treatments in this ZoC, but it appears there may be some additional areas between treated and planned areas that could be linked with additional treatments.

Where bark beetles have heavily impacted lodgepole pine, explore opportunities to salvage or masticate dead trees to allow regeneration that will be relatively free from the heavy fuels that would normally build up following tree death and the resultant snag fall. Also look for opportunities to convert and maintain areas as open meadows or parks, thus creating much-needed diversity and areas that could be used as fuelbreaks or safety zones. Similarly, where aspen is a significant component of the lodgepole stands, explore converting and maintaining these areas as aspen. Where aspen stands currently exist, decide which stands contribute most to the landscape diversity and block the potential movement of fires. Manage these stands over the long term to maintain them as aspen, interrupting their normal succession to conifer stands.

Fully explore and comprehensively plan treatment opportunities within roadless areas and capitalize on the extent of treatments that are allowed for Wildland-Urban Interface (WUI) and Watershed Protection areas within roadless areas. Where treatments are feasible, permission should be sought for the entire watershed ZoC as opposed to piecemeal permission for individual projects. In the remaining roadless areas, planning should be conducted to allow and maximize fire use opportunities to create diversity in these inaccessible areas.

Because of the large amount of steep slopes, roadless areas and other locations with limited opportunity for forest treatments to reduce fire intensities and spread elsewhere in this ZoC, water providers should plan now for post-fire erosion events, focusing on development of sediment dams and/or other structures that might be needed. There may be opportunity to partner with the County Emergency Services and down-stream subdivisions and communities and communities to seek FEMA grants for fuels treatments, pre-flooding preparations and other activities.

The County CWPP and any local CWPPs that might be developed in the future should be reviewed and updated as necessary to incorporate watershed protection as a value to be protected, along with specific treatment recommendations. Water providers should become active partners in these CWPPs to give them standing with other participants

Stakeholders include: Keystone, A-Basin, US Forest Service, Colorado State Forest Service, Summit County, and private landowners.

Straight Creek ZoC

The Straight Creek and CDOT Eisenhower Tunnel ZoC are combined in this section because they combine to form the Straight Creek watershed (Figure 50). Note that the ZoC are shown here in pink with crosshatching, but in the remaining figures the outlines appear as bold black lines with no crosshatching.

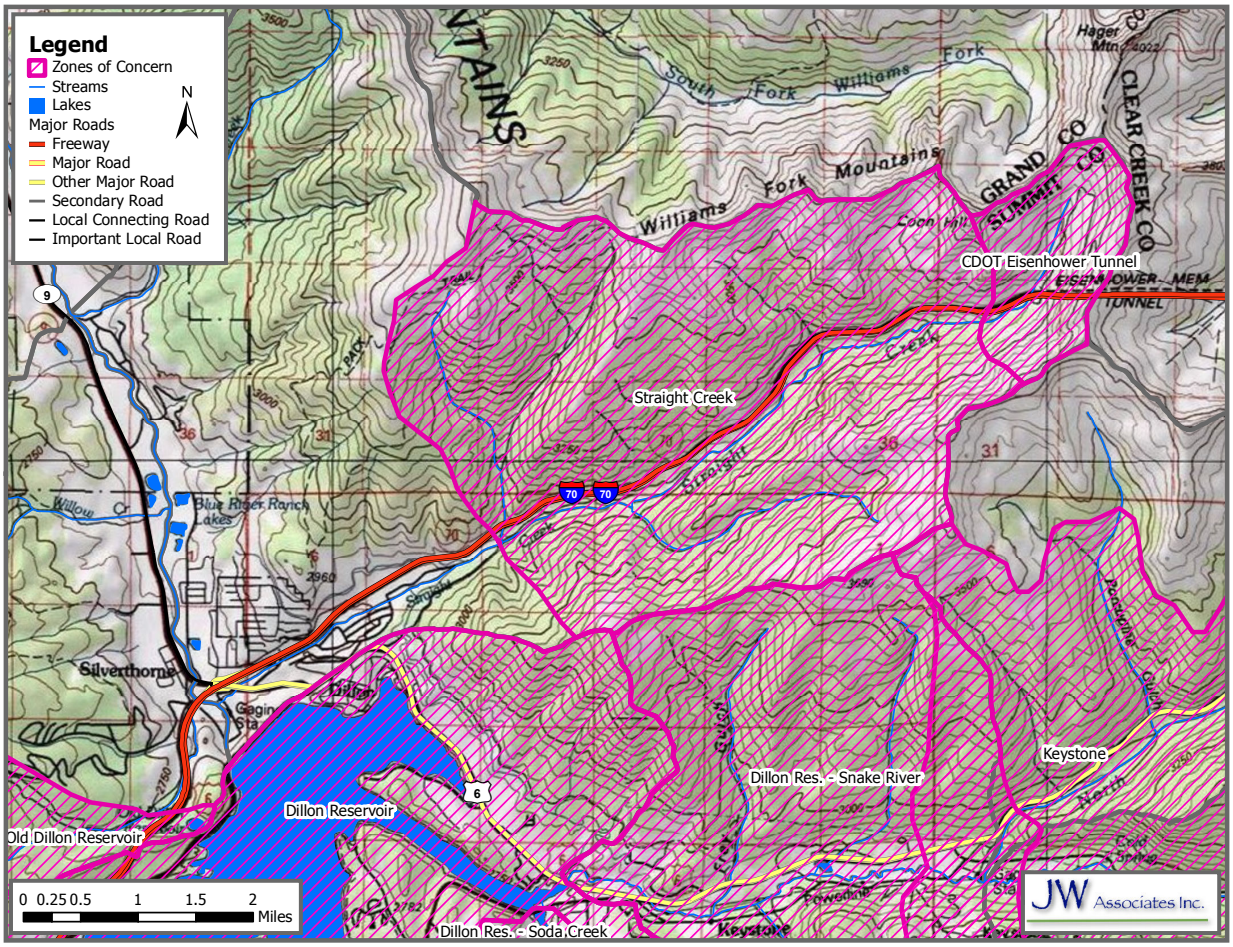

Figure 50. Straight Creek ZoC Location

Straight Creek Ownership

This ZoC is almost entirely National Forest System lands with two parcels of Denver Water lands (Figure 51).

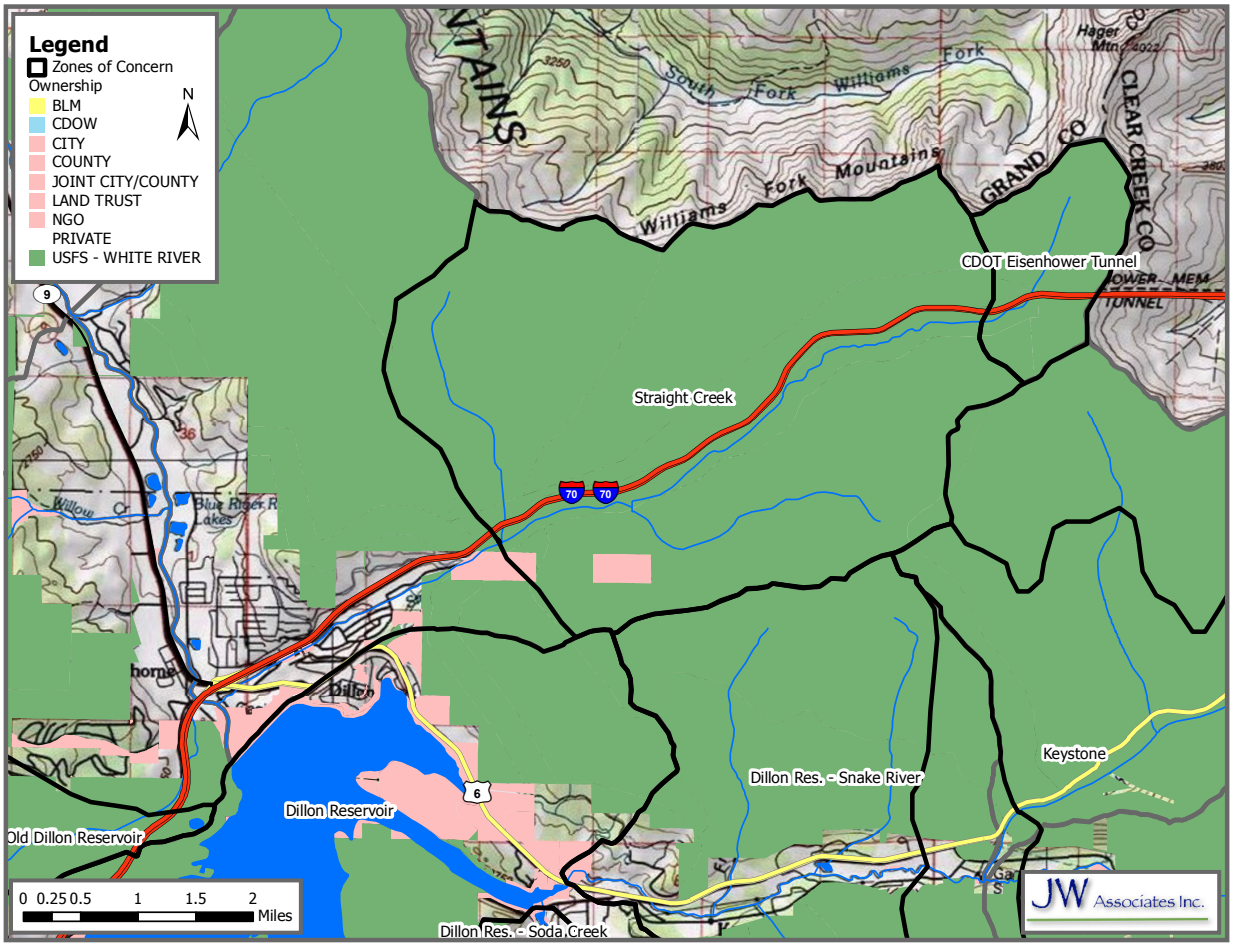

Figure 51. Straight Creek ZoC Ownership

Straight Creek Watershed Priority

The Straight Creek watershed (Figure 52) is Red overall (Category 5 - highest). Wildfire Hazard, Soil Erodibility and Composite Hazard are Orange (Category 4).

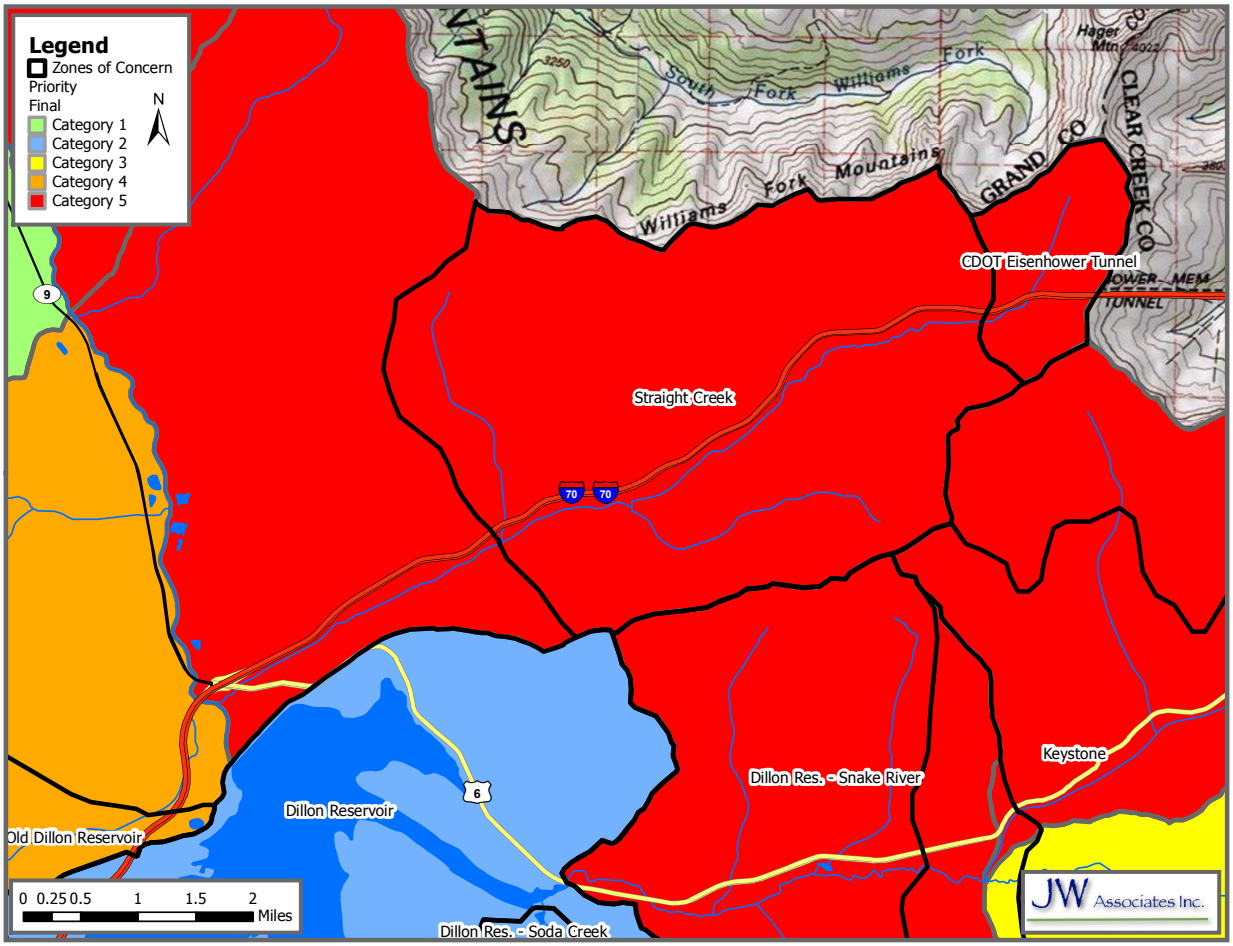

Figure 52. Straight Creek ZoC Watershed Priority

Straight Creek Slopes

There are many areas of steep slopes throughout this watershed (Figure 53).

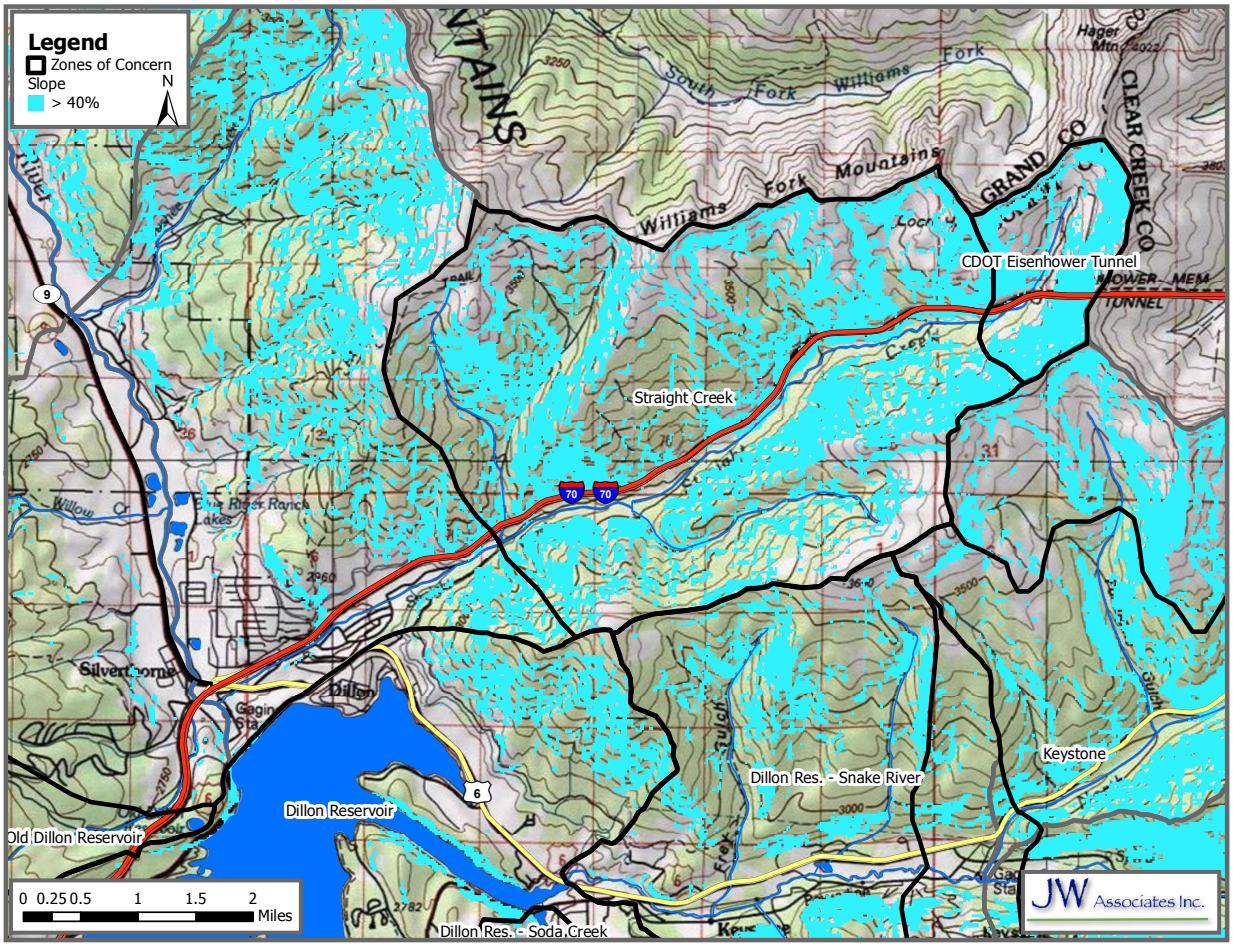

Figure 53. Straight Creek ZoC Slope

Straight Creek Special Management Areas

The Ptarmigan Peak Wilderness occupies much of the land north of Straight Creek and the Tenderfoot Mountain Roadless Area, designated as Upper Tier, occupies much of the land south of Straight Creek in this ZoC (Figure 54). Fully explore and comprehensively plan treatment opportunities within Roadless Areas and capitalize on the extent of treatments that are allowed for Wildland-Urban Interface (WUI) and Watershed Protection areas within Roadless Areas. Where treatments are feasible, permission should be sought for the entire watershed ZoC as opposed to piecemeal permission for individual projects. In the remaining wilderness and roadless areas, planning should be conducted to allow and maximize fire use opportunities to create diversity in these inaccessible areas.

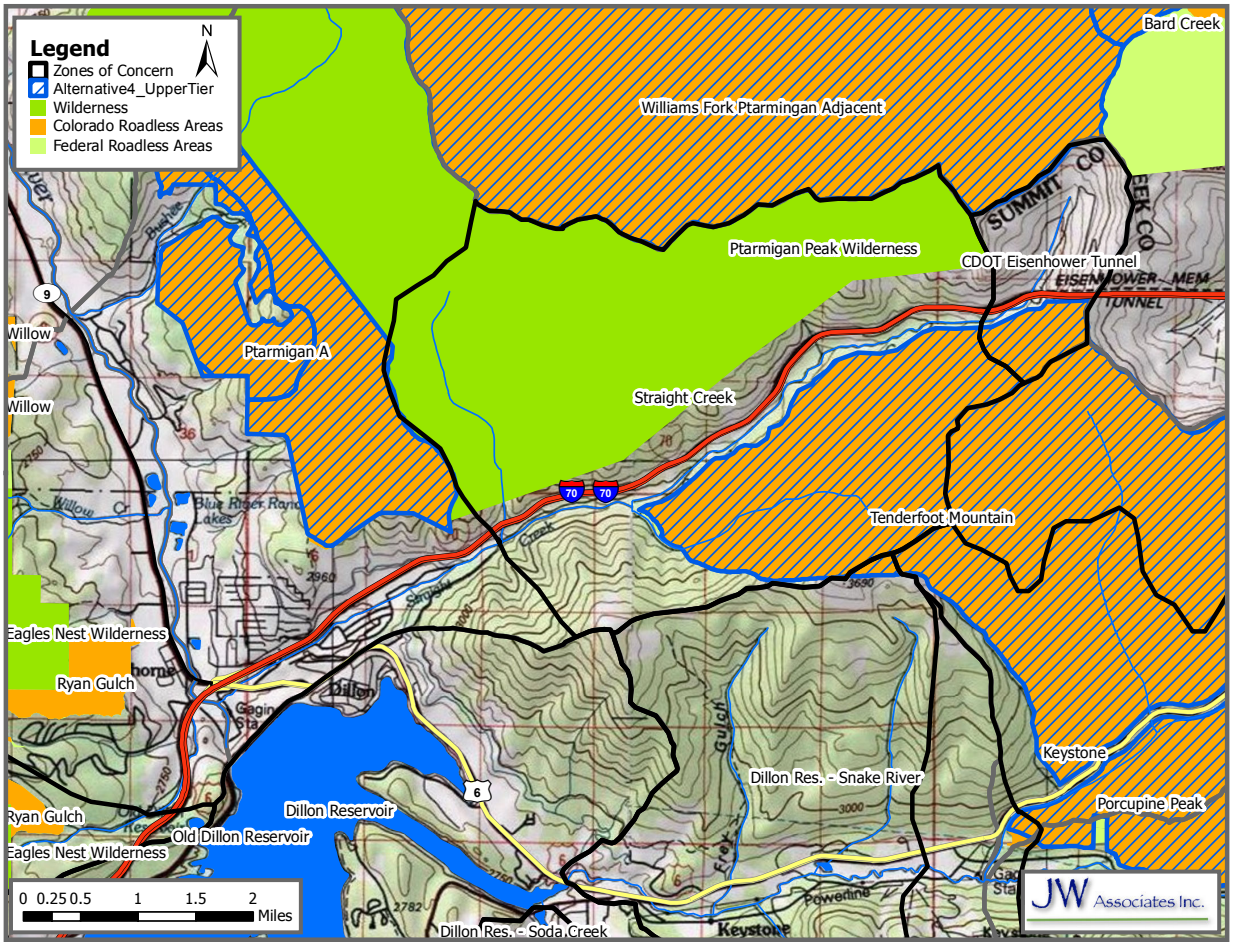

Figure 54. Straight Creek ZoC Special Areas

Straight Creek Vegetation

There are some large areas dominated by lodgepole pine in the lower portions of the ZoC with some areas of aspen scattered throughout these areas of lodgepole pine (Figure 55). The vegetation transitions quickly to spruce-fir, and then to alpine, barren and snow-ice at the highest elevations. Colorado has long-experienced the impacts of mountain pine beetles in lodgepole pine. Stakeholders should be aware that spruce beetles are becoming more prevalent in spruce/fir stands in many areas of the state and management needs of this species should not be ignored. The local situation should be monitored closely and adjustments made to treatment and protection plans as warranted.

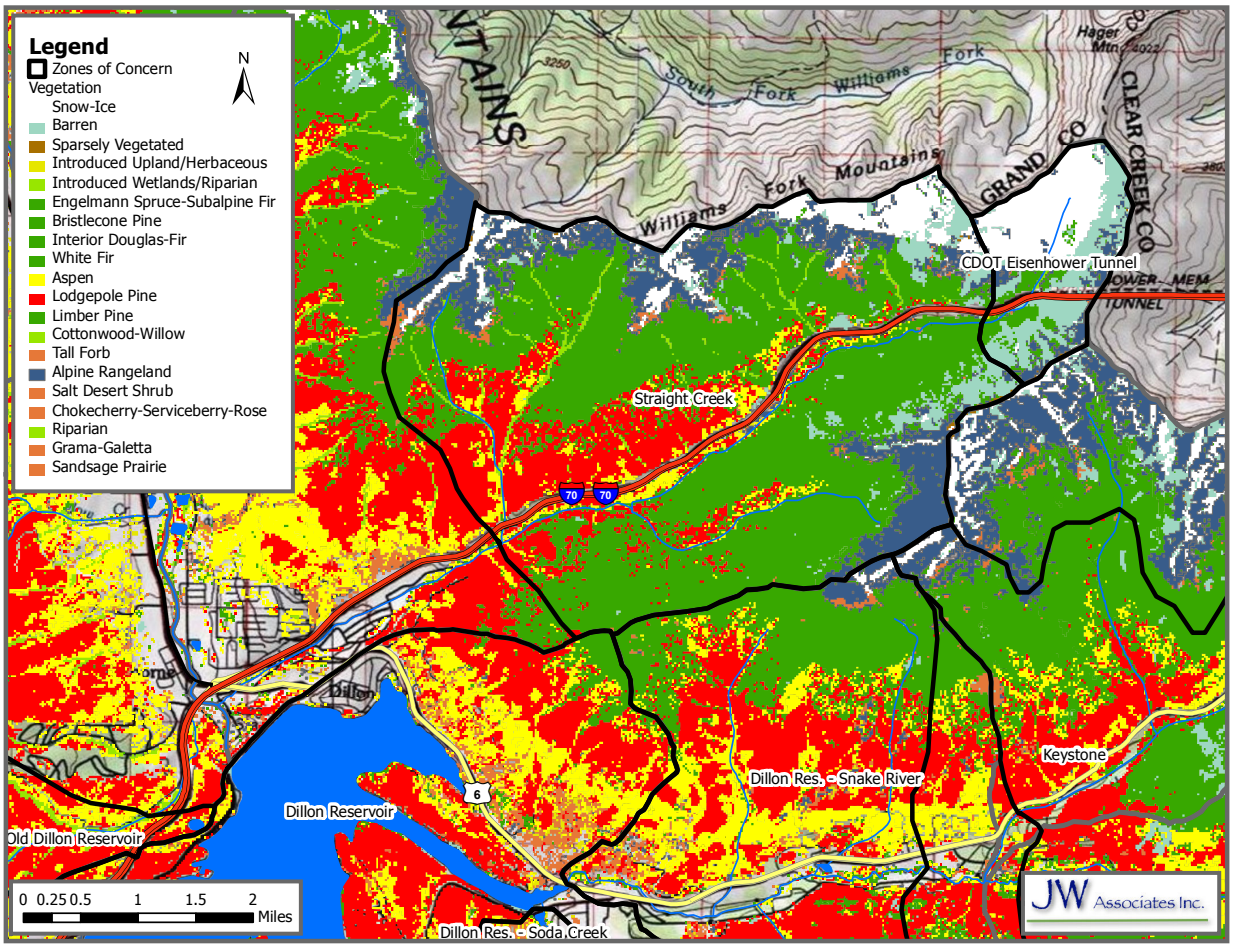

Figure 55. Straight Creek ZoC Vegetation

Straight Creek Access

There are very few roads in this ZoC, and much of it has no to very limited access. Where roads exist, consider using them as 'jump-off points' for development of temporary roads or for the use of forwarders, mastication or other alternative harvesting equipment to implement treatments wherever slopes allow (Figure 56).

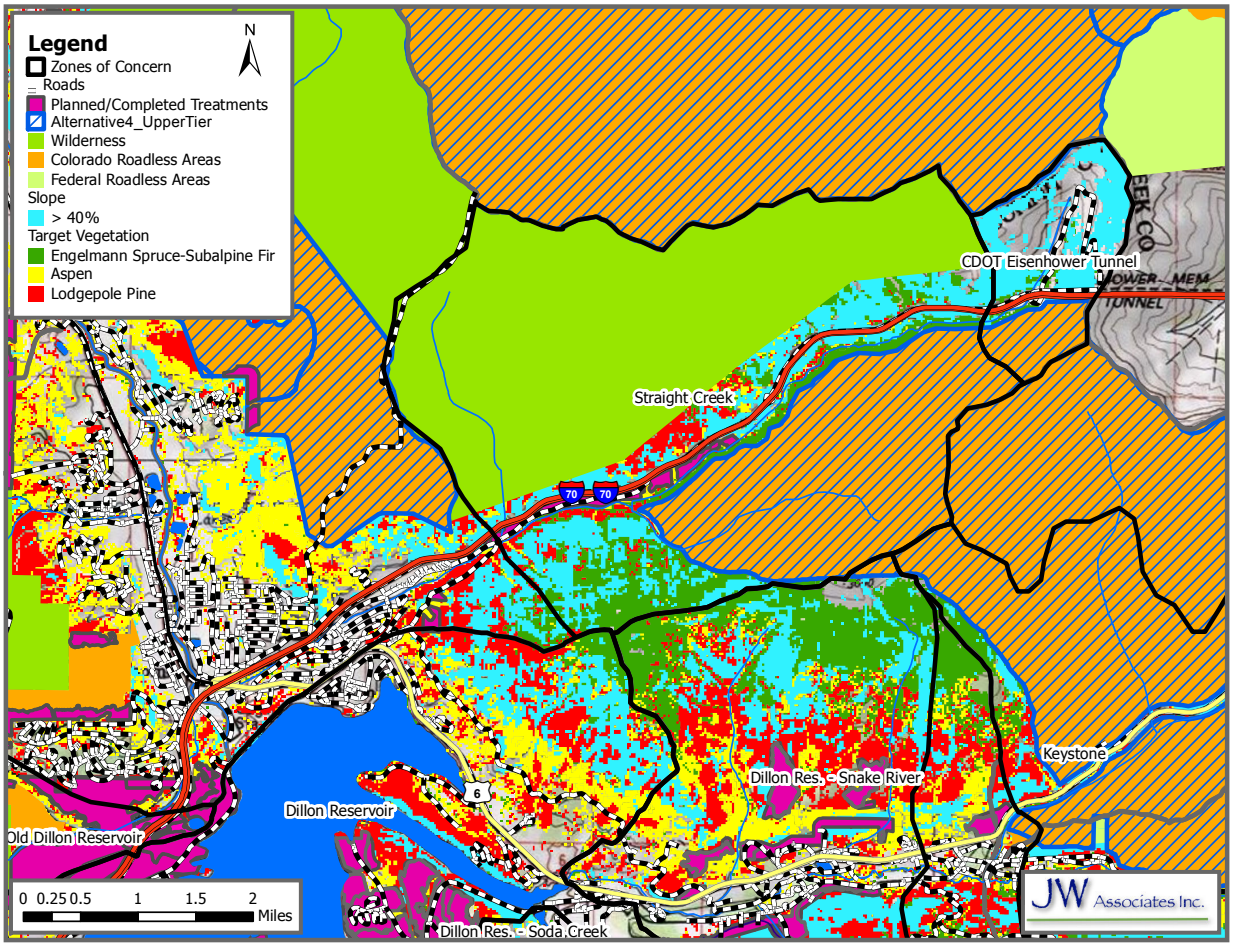

Figure 56. Straight Creek ZoC Opportunities

Straight Creek Opportunities

Treatment opportunities are fairly limited in this ZoC, although there appears to be some opportunities south of Straight Creek and west of the roadless area. There are both planned and completed treatments in this ZoC.

Where bark beetles have heavily impacted lodgepole pine, explore opportunities to salvage or masticate dead trees to allow regeneration that will be relatively free from the heavy fuels that would normally build up following tree death and the resultant snag fall. Also look for opportunities to convert and maintain areas as open meadows or parks, thus creating much-needed diversity and areas that could be used as fuelbreaks or safety zones. Similarly, where aspen is a significant component of the lodgepole stands, explore converting and maintaining these areas as aspen. Where aspen stands currently exist, decide which stands contribute most to the landscape diversity and block the potential movement of fires. Manage these stands over the long term to maintain them as aspen, interrupting their normal succession to conifer stands.

Because of the large amount of steep slopes, roadless areas and other locations with limited opportunity for forest treatments to reduce fire intensities and spread, water providers should plan now for post-fire erosion events, focusing on development of sediment dams and/or other structures that might be needed. There may be opportunity to partner with the County Emergency Services and down-stream subdivisions and communities and communities to seek FEMA grants for fuels treatments, pre-flooding preparations and other activities.

The Summit County CWPP and any local CWPPs that might be developed in the future should be reviewed and updated as necessary to incorporate watershed protection as a value to be protected, along with specific treatment recommendations. Water providers should become active partners in these CWPPs to give them standing with other participants

Stakeholders include: Town of Dillon, Dillon Valley Municipal District, Denver Water, US Forest Service, Colorado State Forest Service, and Summit County.

REFERENCES

Cannon, S.H. and S.L. Reneau. 2000. Conditions for generation of fire-related debris flows, Capulin Canyon, New Mexico. Earth Surface Processes and Landforms 25: 1103-1121.

Colorado Department of Public Health and Environment. 2004. Surface Water Assessment Methodology for Surface Water Sources and Ground Water Sources Under the Direct Influence of Surface Water. November 2004. http://www.cdphe.state.co.us/wq/sw/swaphom.html

Colorado State Forest Service. 2002. Colorado wildland urban interface hazard assessment. Available at: http://csfs.colostate.edu/pages/documents/ColoradoWUIHazardAssessmentFinal.pdf

Colorado State Forest Service. 2007. Forest Restoration Guidelines in Ponderosa Pine on the Front Range of Colorado. Available at: http://csfs.colostate.edu/pages/forests-restoration.html

Colorado State Forest Service. 2009. Lodgepole Pine Management Guidelines for Land Managers in the Wildland-Urban Interface. Available at: http://csfs.colostate.edu/pages/documents/lpp-guide-LS-www.pdf

Federal Geographic Data Committee. 2004. Draft Federal Standards for Delineation of Hydrologic Unit Boundaries, Version 2. Available at: ftp://ftp-fc.sc.egov.usda.gov/NCGC/products/watershed/hu-standards.pdf

Colorado Watershed Protection Data Refinement Work Group. 2009. Protecting Critical Watersheds in Colorado from Wildfire: A Technical Approach to Watershed Assessment and Prioritization.

Graham, R., Harvey, A., Jain, T., and Tonn, J., 1999. The Effects of Thinning and Similar Stand Treatments on Fire Behavior in Western Forests. USDA Forest Service, USDI Bureau of Land Management, General Technical Report, PNW-GTR-463, Pacific Northwest Research Station, Portland, OR.

Graham, R., McCaffrey, S., and Jain, T. 2004. Science Basis for Changing Forest Structure to Modify Wildfire Behavior and Severity. USDA Forest Service, General Technical Report RMRS-GTR-120, Rocky Mountain Research Station, Ft. Collins, CO.

Hungerford, R.D., M.G. Harrington, W.H. Frandsen, K.C. Ryan, and G.J. Niehoff. 1991. Influence of Fire on Factors that Affect Site Productivity. In: Neuenschwander, L.F., and A.E. Harvey. Comps. Management and Productivity of Western-Montane Forest Soils. General Technical Report INT-280. U.S. Dept. of Agriculture, Forest Service, Intermountain Research Station. Ogden, UT. pp 32–50.

Ice, G.G. 1985. Catalog of landslide inventories for the Northwest. Tech. Bull. 456. New York: National Council of the Paper Industry for Air and Stream Improvement. 78 p.

Megan, W., and W. Kidd. 1972. Effects of logging and logging roads on erosion and sediment deposition from steep terrain. Journal of Forestry 70:136-41.

Melton, M.A. 1957. An analysis of the relations among elements of climate, surface properties, and geomorphology. Technical Report 11. Department of Geology, Columbia University. New York, NY. p. 102.

Moody, J.A. and D.A. Martin. 2001. Initial hydrologic and geomorphic response following a wildfire in the Colorado Front Range. Earth Surface Processes and Landforms 26: 1049-1070.

Moody, J.A., D.A. Martin, S.L. Haire, D.A. Kinner. 2008. Linking runoff response to burn severity after a wildfire. Hydrological Processes 22: 2063-2074.

Neary, D.G.; Ryan, K.C.; DeBano, L.F (eds) 2005 (revised 2008). Wildland fire in ecosystems: effects of fire on soils and water. General Technical Report RMRS-GTR-42-vol.4. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 250 p. Available at: http://www.fs.fed.us/rm/pubs/rmrs_gtr042_4.pdf

Oucalt, K.K. and D.D. Wade. 1999. The value of fuel management in reducing wildfire damage.*In*: Neuenschwander, L.F.; Ryan, K.C., eds. Proceedings of the conference on crossing the millennium: integrating spatial technologies and ecological principles for a new age in fire management. Moscow, Univ. of Idaho; 1–11.

Pollet, J. and P.N. Omi. 2002. Effect of thinning and prescribed burning on crown fire severity in ponderosa pine forests. International Journal of Wildland Fire 11(1) 1-10.

Robichaud, P.R., and T.A. Waldrop. 1994. A Comparison of surface runoff and sediment yields from low- and high-intensity prescribed burns. Water Resources Bulletin 30(1):27-34.

Soto, B., R. Basanta, E. Benito, R. Perez, and F. Diaz-Fierros. 1994. Runoff and erosion from burnt soils in Northwest Spain. In: Sala, M., and J.L. Rubio (eds). Soil Erosion and Degradation as a Consequence of Forest Fires: Proceedings. Barcelona, Spain: 91–98.

Swanson, F.J.; Benda, L.E.; Duncan, S.H.; Grant, G.E.; Megahan, W.F.; Reid, L.M.; Ziemer, R.R. 1987. Mass failures and other processes of sediment production in Pacific Northwest forest landscapes. In: Salo, Ernest O.; Cundy, Terrance W., eds. Streamside management: forestry and fishery interactions: Proceedings of a symposium; 1986 February 12-14; Seattle. Contribution No. 57. Seattle: University of Washington, Institute of Forest Resources: 9-38. Chapter 2.

USDA Natural Resource Conservation Service. 1997. National Forestry Manual, title 190. Washington, D.C., Government Printing Office, June 1997.

Wells, C.G., R.E. Campbell, L.F. DeBano, C.E. Lewis, R.L. Fredriksen, E.C. Franklin, R.C. Froelich, and P.H. Dunn. 1979. Effects of Fire on Soil, a State-of-Knowledge Review. General Technical Report WO-7. U.S. Department of Agriculture, Forest Service. Washington, DC. p 34.

APPENDIX A

BLUE RIVER WATERSHED STAKEHOLDERS

Table A-1. Blue River Watershed Stakeholders List

Blue River Stakeholder List - January 25th, 2011

Organization	Last	First	Phone	email
BLM	Paul	Doug	970.244.3106	Douglas_Paul@blm.gov
Blue River Watershed Group	McCold	Cora	970.485.5581	cora@blueriverwatershed.org
Blue Valley Ranch	Kossler	John	970.724.3768	jkoss70@gmail.com
Breckenridge Ski Resort	Sramik	Rick	970.453.3211	rsramek@vailresorts.com
City of Aurora	McHugh	Mike	303.739.7006	mmchugh@auroragov.org
Colorado Department of Health and Environment	Duggan	John	303.692.3534	john.duggan@state.co.us
Colorado Division of Water Resources	Hummer	Scott	970.468.2442	Scott.Hummer@state.co.us
Colorado Environmental Coalition	Smith	Lisa	303.405.6707	lisa@cecenviro.org
Colorado Environmental Coalition	Long	Becky	303.405.6714	becky@cecenviro.org
Colorado River Water Conservation District	Treese	Chris	(970) 945-8522	ctreese@crwcd.org
Colorado River Water Conservation District	Eytel	Michael	970.945.8522	meytel@crwcd.org
Colorado Springs Utilities	Howell	Eric	719.668.4554	ehowell@csu.org
Colorado State Forest Service	Cousineau	Ron	970.887.3121	roncous@lamar.colostate.edu
Colorado State Forest Service	Cada	Paul	970.887.3121	Paul.Cada@colostate.edu
Colorado State Senator	Gibbs	Dan	970.333.4707	sendangibbs@gmail.com
Colorado Timber Industry Association	Fishering	Nancy	(970) 209-1767	mqm@montrose.net
Copper Mountain Resort	Hodson	Bruce	970.390.5196	hodsonb@coppercolorado.com
Denver Water	Kennedy	Don	303.628.6528	don.Kennedy@denverwater.org
Dillon Valley Water	Winston	Francis	970.921.3738	winstonwaterworks@msn.com
East Dillon, Hamilton Creek and Mesa Cortina Metro Dist.	Polich	Bob	970.453.4600	admin@eastdillon.com
Everist Materials/Maryland Creek Ranch	Everist	Steve	734.645.5549	steverist@mac.com
Forest Health Task Force	Briggs	Sandy	9703890987	ForestHealthTF@aol.com
Forest Restoration Solutions	Dennis	Chuck	303.659.4381	cdennis@lamar.colostate.edu
Friends of the Lower Blue River	Richardson	Marty		friendsofthelowerblueriver@gmail.com
Greenlands Reserve	Hallman	Howard	970.468.9134	future1946@yahoo.com
Intrawest Colorado	Baum	Bill	970.726.9806	bbaum@skiwinterpark.com
Keystone Science School	Miller	Dave	970.455.4229	dmiller@keystone.org
Middle Park Conservation District	Koblitz	Bonnie	970-724-3456	bonnie.koblitz@co.nacdnet.net
Northwest Council of Governments	Koenig	Shanna	970.468.0295 ext117	QQWater@colorado.net
Pebble Creek Ranch/Friends of the Lower Blue River	Kirk	Sam	970-468-2649	samkirk@wildblue.net
Representative Polis CO-2	Erickson	Nissa	970.409.7301	Nissa.Erickson@mail.house.gov
Summit County	Huron	Beth	970.668.3595	bethh@co.summit.co.us
Summit County Commissioner	French	Bob	970.453.3411	bobf@co.summit.co.us
Summit County Commissioner	Stiegelmeier	Karn	970.468.9013	karns@co.summit.co.us
Summit County Wildfire Council & Willow Brook Metro District	Tormey	Pat	970.389.0390	pbtormey@gmail.com

Organization	Last	First	Phone	email
Summit Daily	Berwyn	Bob	970.331.5996	bberwyn@comcast.net
Summit Daily	Kurbjun	Janice	970.668.4630	jkurbjun@summitdaily.com
Ten Mile Planning Commissioner	Dziomba	Richard	(303)912-1921	rdziomba@qwest.net
Town of Breckenridge	Grosshuesch	Peter	970.453.3162	peterg@townofbreckenridge.com
Town of Breckenridge	Daugherty	Tom	970.453.3175	tomd@townofbreckenridge.com
Town of Dillon	Parsons	Don	970.406.1341	parsondo@hotmail.com
Town of Dillon	Holgerson	Eric	970.262.3408	erich@townofdillon.com
Town of Dillon	Granbery	Devin	970.262.3402	deving@townofdillon.com
Town of Dillon	Giles	Trevor	970.418.0536	trevorg@townofdillon.com
Town of Frisco	Penny	Michael	970.668.5276 x3033	michaelp@townoffrisco.com
Town of Frisco	Davies	Eileen	970.389.2073	egdavies@q.com
Town of Silverthorne	Margolis	Zach	970.262.7344	zachm@silverthorne.org
Town of Silverthorne	Batchelder	Kevin	970.262.7305	kbatch@silverthorne.org
Trout Unlimited	Barclay	Sarah	970.401.4697	skilikeagirl61@yahoo.com
Trout Unlimited	Nickum	David	(303) 440-2937	DNickum@tu.org
Trout Unlimited	Russell	Elizabeth	303.440.2937	ERussell@tu.org
US Fish and Wildlife Service	Ellwood	Leslie	303.275.2383	eslie_ellwood@fws.gov
US Forest Service	Crary	Brett	970.827.5182	bcrary@fs.fed.us
US Forest Service	Cutts	Jan	970.262.3451	jcutts@fs.fed.us
US Forest Service	Wilmore	Ross	970.328.6388	rwilmore@fs.fed.us
US Forest Service	Green	Cary	970.827.5160	cgreen@fs.fed.us
Wilderness Workshop	Shoemaker	Sloan		sloan@wildernessworkshop.org
	Taylor	John		johntaylor1712@comcast.net
	Eiler	Dylan		dylaneiler@gmail.com
	Balch	Eddy	970.641.3936	eddy.balch@gmail.com

APPENDIX B

BLUE RIVER WILDFIRE HAZARD MODELING METHODOLOGY

The forest conditions that are of concern for the assessments are the wildfire hazard based on existing forest conditions. The wildfire hazard (Flame Length) was determined using the Fire Behavior Assessment Tool (FBAT) (http://www.fire.org) which is an interface between ArcMap and FlamMap. The input spatial data were collected from LANDFIRE project (http://www.landfire.gov/).

After a mountain pine beetle outbreak there are substantial increases in the amount of fine dead fuels in the canopy. The majority of these fuels remain in the canopy for 2-3 years post outbreak (Knight 1987, Schmid and Amman 1992). Therefore, certain input spatial data sets were updated reflecting Mountain Pine Beetle (MPB) mortality conditions using USDA Forest Service, Rocky Mountain Region Aerial Detection Survey (ADS) Data from the years 2002 - 2007 (http://www.fs.fed.us/r2/resources/fhm/aerialsurvey/). The following modeling settings and spatial data modification were used:

Modeling Setting

1. Scott and Burgan (2005) Fire Behavior Model (Fuel Moisture is shown in Table A-1)
2. Uphill wind direction
3. Scott & Reinhardt (2001) crown fire calculation
4. Foliar Moisture at 100%

Spatial Data Modifications

1. Canopy Cover was assigned a value of 10% when coincident with MPB mortality from ADS for years 2002-2007.
2. Canopy Base Height (CBH) was reduced by 25% for MPB mortality derived from ADS for the years 2002-2006.
3. CBH was reassigned a value of 0 for MPB mortality from ADS for the year 2007.
4. Canopy Bulk Density (CBD) was reduced by 50% for MPB mortality derived from ADS for the years 2002-2006

Table B-1. Fuel Moisture (percent) used in FBAT Model Runs

Scott and Burgan (2005) fuel model	1-Hour Fuel	10-Hour Fuel	100-Hour Fuel	Live Herbaceous	Live Woody
1	4	5	8	200	95
2	4	5	8	150	95
3	4	5	8	85	95
4	4	5	8	85	95
5	4	5	8	85	150
6	4	5	8	85	95
7	4	5	8	85	95
8	4	5	8	85	95
9	4	5	8	85	95
10	4	5	8	85	95
11	4	5	8	85	95
12	4	5	8	85	95
13	4	5	8	85	95
14	3	4	8	85	95
15	3	4	8	85	95
16	3	4	8	85	95
17	3	4	8	85	95
18	3	4	8	85	95
19	3	4	8	85	95
20	3	4	8	85	95
21	3	4	8	85	95
22	3	4	8	85	95
23	3	4	8	85	95
24	3	4	8	85	95
25	3	4	8	85	95
26	3	4	8	85	95
27	3	4	8	85	95
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29	3	4	8	85	95
30	3	4	8	85	95
31	3	4	8	85	95
32	3	4	8	85	95
33	3	4	8	85	95
34	3	4	8	85	95
35	3	4	8	85	95
36	3	4	8	85	95
37	3	4	8	85	95
38	3	4	8	85	95
39	3	4	8	85	95
40	3	4	8	85	95
41	3	4	8	85	95
42	3	4	8	85	95
43	3	4	8	85	95
44	3	4	8	85	95
45	3	4	8	85	95
46	3	4	8	85	95
47	3	4	8	85	95
48	3	4	8	85	95
49	3	4	8	85	95
50	3	4	8	85	95

Weather Data

The weather data used comes from the Colorado Wildfire Risk Assessment Statewide (CRA) dataset prepared by Sandborn under contract to the Colorado State Forest Service. For the Colorado Fire Risk Assessment nine weather influence zones (WIZ) were developed for analysis purposes. A WIZ is an area where for analysis purposes the weather on any given day is uniform. Within each WIZ, daily weather data was gathered for the years 1980-2006. Where not available, the weather data was gathered from the earliest year through 2006. Several weather stations were analyzed within each WIZ. From this analysis, one representative weather station was selected for each WIZ. From this data set, percentile weather was developed for each WIZ using the Fire Family Plus software package.

For this watershed assessment the percentile weather for WIZ CO 02 (Dowd 1986-2006) was used for all watersheds on the west side of the continental divide and WIZ CO 03 (Coral Creek 1980-2006) was used for all watersheds on the east side of the continental divide. The 20-foot wind speeds for the "High" case was used in the modeling runs (Table B-2).

In addition the wind direction was assumed to be uphill (parallel with slope) in all instances. This setting encourages crown fire initiation and establishes a common baseline for the evaluation of areas within the landscape based upon the fuels hazard represented by vegetation conditions.

Table B-2. Wind Speed (Miles per Hour) used in FBAT Model Runs

Watershed Name	Wind Speed (mph)	Probable Momentary Gust Speed (mph)
North Platte	15	29
Upper North Platte	15	29
Crow/Medicine Bow/Upper Laramie/Upper Lodgepole	12	25
Clear/Bear Creek	12	25
Big Thompson	12	25
Cache la Poudre	12	25
Blue River	15	29
Eagle River	15	29
Upper Yampa	15	29
Little Snake	15	29
Upper White	15	29
Lower Colorado	15	29
Upper Colorado	15	29
Saint Vrain	12	25
Roaring Fork	15	29

Categorization of Results

The FBAT model results were divided into five categories of flame length. These values range from lowest (Category 0) to highest (Category 4) based upon flame length. The flame length categories that were used are:

Flame Length Category 0 - 0 meters

Flame Length Category 1 - 1 to 10 meters

Flame Length Category 2 - 11 to 25 meters

Flame Length Category 3 - 26 to 40 meters

Flame Length Category 4 - >40 meters

APPENDIX C

DETAILED BLUE RIVER WILDFIRE/WATERSHED ASSESSMENT RESULTS

Table C-1. Blue River Watershed Wildfire Hazard Ranking

Sixth-level Watershed Name	Watershed Area (acres)	Wildfire Hazard Calculation	Wildfire Hazard Rank
Elliott Creek	9,610	66.7%	*5.5*
Swan River	24,059	66.3%	*5.5*
Gold Hill-Blue River	10,424	61.1%	*5.0*
Lower Tenmile Creek	15,655	59.0%	*4.8*
Willow Creek	14,723	46.2%	*4.8*
Keystone Gulch-Snake River	12,841	58.0%	*4.8*
French Gulch-Blue River	17,341	51.0%	*4.2*
Dillon Reservoir	25,623	48.2%	*3.9*
West Tenmile Creek	17,538	47.3%	*3.9*
Straight Creek	20,818	46.2%	*3.8*
Pioneer Creek	6,651	43.3%	*3.5*
Rock Creek-Boulder Creek	23,347	43.3%	*3.5*
Middle Tenmile Creek	10,413	42.9%	*3.5*
Headwaters Blue River	27,034	42.2%	*3.4*
Black Creek-Cataract Creek	39,423	31.1%	*2.5*
Horse Creek	14,983	31.1%	*2.5*
Deep Creek	19,142	30.8%	*2.5*
King Creek	8,937	30.8%	*2.5*
Pass Creek-Acorn Creek	19,242	30.4%	*2.5*
Slate Creek	19,756	30.4%	*2.5*
North Fork Snake River	10,232	30.3%	*2.4*
Peru Creek-Snake River	26,667	26.7%	*2.1*
Upper Tenmile Creek	15,804	13.8%	*1.1*
Lower Elliot Creek	12,372	7.2%	*0.5*

Table C-2. Blue River Watershed Ruggedness Ranking[1, 2]

Sixth-level Watershed Name	Maximum Elevation	Minimum Elevation	Difference Elevation	Ruggedness	Ruggedness Rank
Pioneer Creek	12,339	8,403	3,936	0.2312	*5.5*
North Fork Snake River	13,314	9,334	3,980	0.2309	*5.5*
Headwaters Blue River	14,261	9,887	4,374	0.2208	*5.0*
Rock Creek-Boulder Creek	13,330	8,393	4,938	0.2190	*5.0*
French Gulch-Blue River	13,677	9,463	4,214	0.2168	*4.9*
Slate Creek	13,191	7,998	5,193	0.2168	*4.9*
Black Creek-Cataract Creek	13,555	7,943	5,612	0.2141	*4.8*
Elliott Creek	11,948	7,687	4,261	0.2082	*4.5*
Pass Creek-Acorn Creek	12,234	8,000	4,234	0.2068	*4.4*
Peru Creek-Snake River	14,249	9,337	4,912	0.2038	*4.3*
Deep Creek	11,476	7,462	4,014	0.1966	*4.0*
Middle Tenmile Creek	13,852	9,687	4,166	0.1956	*3.9*
Straight Creek	12,984	8,589	4,395	0.1931	*3.8*
Upper Tenmile Creek	13,901	10,331	3,570	0.1924	*3.8*
Keystone Gulch-Snake River	12,420	9,031	3,389	0.1896	*3.7*
Willow Creek	13,314	8,591	4,723	0.1865	*3.5*
Lower Tenmile Creek	12,907	9,035	3,871	0.1816	*3.3*
Swan River	13,301	9,155	4,146	0.1811	*3.3*
West Tenmile Creek	13,188	9,684	3,504	0.1793	*3.2*
Gold Hill-Blue River	12,842	9,023	3,819	0.1792	*3.2*
Horse Creek	11,611	7,943	3,667	0.1758	*3.1*
King Creek	10,889	7,467	3,422	0.1734	*3.0*
Lower Elliot Creek	10,131	7,333	2,797	0.1205	*0.7*
Dillon Reservoir	12,905	9,008	3,897	0.1166	*0.5*

[1] Ruggedness is based on Melton (1957)

[2] These watersheds were manually adjusted because they do not accurately reflect the ruggedness in those watersheds. The original values were; Headwaters Blue River (0.1275), French Gulch-Blue River (0.1533), Swan River 0.1281), North Fork Snake River 0.1885), Peru Creek-Snake River (0.1441), Keystone Gulch-Snake River (0.1433), Upper Tenmile Creek (0.1361), West Tenmile Creek (0.1268), Lower Tenmile Creek (0.1483), Straight Creek (0.1459), Rock Creek-Boulder Creek (0.1548), Pass Creek-Acorn Creek (0.1462), Slate Creek (0.1770), Black Creek-Cataract Creek (0.1354), Horse Creek (0.1435), and Deep Creek (0.1390).

Table C-3. Blue River Watershed Road Density Ranking[3]

Sixth-level Watershed Name	Roads (miles)	Roads Adjusted (miles)	Watershed Area (sq. mi.)	Road density (miles per sq. mi.)	Road Density Rank
French Gulch-Blue River	178.3	89.1	27.09	3.29	*5.5*
Gold Hill-Blue River	53.6	53.6	16.29	3.29	*5.5*
Willow Creek	70.7	70.7	23.00	3.07	*5.0*
Upper Tenmile Creek	71.8	71.8	24.69	2.91	*4.7*
Straight Creek	89.5	89.5	32.53	2.75	*4.3*
Headwaters Blue River	114.1	114.1	42.14	2.71	*4.2*
Swan River	133.5	100.2	37.59	2.66	*4.1*
Keystone Gulch-Snake River	104.7	52.4	20.06	2.61	*4.0*
King Creek	36.3	36.3	13.96	2.60	*4.0*
Peru Creek-Snake River	108.1	108.1	41.67	2.60	*4.0*
Horse Creek	51.2	51.2	20.23	2.53	*3.9*
West Tenmile Creek	68.7	68.7	27.40	2.51	*3.8*
Deep Creek	74.8	74.8	29.91	2.50	*3.8*
Dillon Reservoir	157.7	78.8	35.15	2.24	*3.2*
Pioneer Creek	22.6	22.6	10.39	2.17	*3.1*
Lower Elliot Creek	39.4	39.4	19.33	2.04	*2.8*
North Fork Snake River	28.9	28.9	15.99	1.81	*2.3*
Elliott Creek	26.5	26.5	15.02	1.76	*2.2*
Pass Creek-Acorn Creek	52.7	52.7	30.07	1.75	*2.2*
Lower Tenmile Creek	39.4	39.4	24.46	1.61	*1.8*
Slate Creek	34.7	34.7	30.87	1.13	*0.8*
Middle Tenmile Creek	18.3	18.3	16.27	1.12	*0.8*
Rock Creek-Boulder Creek	38.6	38.6	36.48	1.06	*0.6*
Black Creek-Cataract Creek	61.2	61.2	61.60	0.99	*0.5*
Totals	1675.6	1421.9	660.37	2.15	

[3] The road density was adjusted based upon the procedure discussed in the report (p. 12). The original road density values were; French Gulch-Blue River (6.58), Swan River (3.55), Keystone Gulch-Snake River (5.22), and Dillon Reservoir (4.49).

Table C-4. Blue River Watershed Flooding/Debris Flow Hazard Ranking[4]

Sixth-level Watershed Name	Ruggedness Ranking	Road Density Ranking	Combined Numeric Rank	Combined Ranking
French Gulch-Blue River	*4.9*	*5.5*	15.24	*5.5*
Headwaters Blue River	*5.0*	*4.2*	14.32	*4.8*
Pioneer Creek	*5.5*	*3.1*	14.07	*4.7*
North Fork Snake River	*5.5*	*2.3*	13.25	*4.1*
Peru Creek-Snake River	*4.3*	*4.0*	12.60	*3.6*
Upper Tenmile Creek	*3.8*	*4.7*	12.28	*3.4*
Willow Creek	*3.5*	*5.0*	12.13	*3.3*
Straight Creek	*3.8*	*4.3*	12.00	*3.2*
Gold Hill-Blue River	*3.2*	*5.5*	11.96	*3.1*
Deep Creek	*4.0*	*3.8*	11.76	*3.0*
Keystone Gulch-Snake River	*3.7*	*4.0*	11.38	*2.7*
Elliott Creek	*4.5*	*2.2*	11.17	*2.6*
Pass Creek-Acorn Creek	*4.4*	*2.2*	11.02	*2.5*
Swan River	*3.3*	*4.1*	10.76	*2.3*
Rock Creek-Boulder Creek	*5.0*	*0.6*	10.57	*2.1*
Slate Creek	*4.9*	*0.8*	10.53	*2.1*
West Tenmile Creek	*3.2*	*3.8*	10.27	*1.9*
Horse Creek	*3.1*	*3.9*	10.02	*1.7*
Black Creek-Cataract Creek	*4.8*	*0.5*	10.01	*1.7*
King Creek	*3.0*	*4.0*	9.95	*1.7*
Middle Tenmile Creek	*3.9*	*0.8*	8.67	*0.8*
Lower Tenmile Creek	*3.3*	*1.8*	8.51	*0.7*
Dillon Reservoir	*0.5*	*3.2*	8.40	*0.6*
Lower Elliot Creek	*0.7*	*2.8*	8.30	*0.5*

[4] Dillon Reservoir and Lower Elliot Creek watersheds were skewing the categorization because of their low Combined Numeric Rank values (originally 4.22 and 4.11 respectively) and were manually given a score slightly lower than the next lowest score

Table C-5. Blue River Watershed Soil Erodibility Ranking[5, 6, 7]

Sixth-level Watershed Name	Severe (%)	Very Severe (%)	Soil Erodibility Value	Soil Erodibility Rank
Pioneer Creek	40.9%	2.0%	0.300	*5.5*
Middle Tenmile Creek	22.6%	6.9%	0.290	*5.3*
Keystone Gulch-Snake River	11.4%	8.1%	0.276	*5.0*
Lower Tenmile Creek	24.4%	1.2%	0.269	*4.9*
Peru Creek-Snake River	23.7%	0.2%	0.242	*4.4*
North Fork Snake River	23.5%	0.0%	0.236	*4.2*
King Creek	11.2%	6.2%	0.235	*4.2*
Headwaters Blue River	15.5%	3.8%	0.231	*4.1*
Straight Creek	17.5%	0.0%	0.226	*4.0*
Pass Creek-Acorn Creek	12.8%	3.3%	0.193	*3.4*
Slate Creek	16.7%	1.2%	0.190	*3.3*
Swan River	12.8%	1.3%	0.154	*2.6*
Horse Creek	12.5%	0.6%	0.137	*2.3*
Black Creek-Cataract Creek	11.6%	1.0%	0.136	*2.3*
Deep Creek	6.1%	3.5%	0.131	*2.2*
Elliott Creek	4.9%	4.0%	0.129	*2.1*
Upper Tenmile Creek	11.5%	0.2%	0.119	*1.9*
Lower Elliot Creek	11.7%	0.0%	0.117	*1.9*
French Gulch-Blue River	9.4%	0.7%	0.108	*1.7*
Dillon Reservoir	8.8%	0.4%	0.096	*1.5*
Willow Creek	7.9%	0.4%	0.086	*1.3*
Gold Hill-Blue River	5.8%	0.2%	0.062	*0.8*
West Tenmile Creek	5.6%	0.0%	0.057	*0.7*
Rock Creek-Boulder Creek	4.3%	0.1%	0.046	*0.5*

[5] Soil Erodibility Value is percentage of Severe plus 2 times the percentage of Very Severe.

[6] The soil erodibility value for Straight Creek was adjusted up (original value of 0.176) due to the presence of large quantities of highway sand that increase the concern for soil erosion.

[7] Middle Tenmile Creek and Pioneer Creek watersheds were skewing the categorization because of their high soil erodibility values (originally 0.364 and 0.449 respectively) and were manually given a score slightly higher than the next highest score.

Table C-6. Blue River Watershed Composite Hazard Ranking[8, 9]

Sixth-level Watershed Name	Wildfire Hazard Rank	Flooding/ Debris Flow Rank	Soil Erodibility Rank	Composite Numeric Rank	Composite Hazard Rank
Pioneer Creek	3.5	4.7	5.5	13.7	5.5
Keystone Gulch-Snake River	4.8	2.7	5.0	12.5	4.8
Headwaters Blue River	3.4	4.8	4.1	12.4	4.8
French Gulch-Blue River	4.2	5.5	1.7	11.4	4.2
Straight Creek	3.8	3.2	4.0	11.0	3.9
North Fork Snake River	2.4	4.1	4.2	10.7	3.8
Lower Tenmile Creek	4.8	0.7	4.9	10.4	3.6
Swan River	5.5	2.3	2.6	10.4	3.6
Elliott Creek	5.5	2.6	2.1	10.2	3.5
Peru Creek-Snake River	2.1	3.6	4.4	10.1	3.4
Middle Tenmile Creek	3.5	0.8	5.3	9.6	3.1
Willow Creek	4.8	3.3	1.3	9.3	3.0
Gold Hill-Blue River	5.0	3.1	0.8	9.0	2.8
King Creek	2.5	1.7	4.2	8.4	2.5
Pass Creek-Acorn Creek	2.5	2.5	3.4	8.3	2.4
Slate Creek	2.5	2.1	3.3	7.9	2.2
Deep Creek	2.5	3.0	2.2	7.6	2.0
Horse Creek	2.5	1.7	2.3	6.5	1.4
Black Creek-Cataract Creek	2.5	1.7	2.3	6.5	1.4
West Tenmile Creek	3.9	1.9	0.7	6.5	1.4
Upper Tenmile Creek	1.1	3.4	1.9	6.4	1.3
Rock Creek-Boulder Creek	3.5	2.1	0.5	6.2	1.2
Dillon Reservoir	3.9	0.6	1.5	6.0	1.1
Lower Elliot Creek	0.5	0.5	1.9	5.0	0.5

[8] The Composite Hazard Rank is the average of the Wildfire Hazard Rank, Flooding/Debris Flow Rank, and Soil Erodibility Rank that is re-categorized into 5 categories using the procedure described in Front Range Watershed Protection Data Refinement Work Group (2009).

[9] Lower Elliot Creek watershed was skewing the categorization because of its low Composite Numeric Rank value (2.9) and was manually given a score slightly lower than the next lowest score

Table C-7. Blue River Watershed Water Supply Ranking

Sixth-level Watershed Name	Watershed Area	Sources & Diversions	Reservoirs	Water Ranking
Headwaters Blue River	27,034	2		*1*
French Gulch-Blue River	17,341	1		*1*
Gold Hill-Blue River	10,424	1		*1*
North Fork Snake River	10,232	1		*1*
Keystone Gulch-Snake River	12,841	1		*1*
Upper Tenmile Creek	15,804	0	1	*1*
West Tenmile Creek	17,538	1		*1*
Lower Tenmile Creek	15,655	1		*1*
Dillon Reservoir	25,623	1	1	*1*
Straight Creek	20,818	1		*1*
Willow Creek	14,723	0	1	*1*
Black Creek-Cataract Creek	39,423	0	1	*1*
Horse Creek	14,983	0	1	*1*
Swan River	24,059	0		*0*
Peru Creek-Snake River	26,667	0		*0*
Middle Tenmile Creek	10,413	0		*0*
Pioneer Creek	6,651	0		*0*
Rock Creek-Boulder Creek	23,347	0		*0*
Pass Creek-Acorn Creek	19,242	0		*0*
Slate Creek	19,756	0		*0*
Elliott Creek	9,610	0		*0*
Deep Creek	19,142	0		*0*
King Creek	8,937	0		*0*
Lower Elliot Creek	12,372	0		*0*

Table C-8. Blue River Watershed Final Watershed Ranking

Sixth-level Watershed Name	Wildfire Hazard	Flooding/ Debris Flow	Soil Erodibility	Composite	Node Ranking	Overall Ranking
Keystone Gulch-Snake River	4.8	2.7	5.0	4.8	1	5.5
Headwaters Blue River	3.4	4.8	4.1	4.8	1	5.4
Pioneer Creek	3.5	4.7	5.5	5.5	0	5.2
French Gulch-Blue River	4.2	5.5	1.7	4.2	1	4.9
Straight Creek	3.8	3.2	4.0	3.9	1	4.7
North Fork Snake River	2.4	4.1	4.2	3.8	1	4.5
Lower Tenmile Creek	4.8	0.7	4.9	3.6	1	4.3
Willow Creek	4.8	3.3	1.3	3.0	1	3.8
Gold Hill-Blue River	5.0	3.1	0.8	2.8	1	3.6
Swan River	5.5	2.3	2.6	3.6	0	3.4
Elliott Creek	5.5	2.6	2.1	3.5	0	3.3
Peru Creek-Snake River	2.1	3.6	4.4	3.4	0	3.2
Middle Tenmile Creek	3.5	0.8	5.3	3.1	0	3.0
King Creek	2.5	1.7	4.2	2.5	0	2.3
Pass Creek-Acorn Creek	2.5	2.5	3.4	2.4	0	2.3
Horse Creek	2.5	1.7	2.3	1.4	1	2.3
Black Creek-Cataract Creek	2.5	1.7	2.3	1.4	1	2.3
West Tenmile Creek	3.9	1.9	0.7	1.4	1	2.2
Upper Tenmile Creek	1.1	3.4	1.9	1.3	1	2.2
Slate Creek	2.5	2.1	3.3	2.2	0	2.1
Dillon Reservoir	3.9	0.6	1.5	1.1	1	2.0
Deep Creek	2.5	3.0	2.2	2.0	0	1.9
Rock Creek-Boulder Creek	3.5	2.1	0.5	1.2	0	1.1
Lower Elliot Creek	0.5	0.5	1.9	0.5	0	0.5