NATURAL RESOURCES

# WILDFIRE-ASSOCIATED LANDSLIDE EMERGENCY RESPONSE TEAM REPORT

## 2025 Crown Creek Fire

**Stevens County, Washington**

by Kara Fisher, Casey Langstroth, Trevor Contreras, and Mitch Allen

WASHINGTON
GEOLOGICAL SURVEY
WALERT Report
November 2025

# WILDFIRE-ASSOCIATED LANDSLIDE EMERGENCY RESPONSE TEAM REPORT

## 2025 Crown Creek Fire

**Stevens County, Washington**

by Kara Fisher, Casey Langstroth,
Trevor Contreras, and Mitch Allen

WASHINGTON
GEOLOGICAL SURVEY
WALERT Report
November 2025

## DISCLAIMER

**Disclaimer of Warranties**
No express or implied warranty of any kind is made regarding the information contained herein, including, but not limited to, the warranty of merchantability, warranty of fitness for a particular purpose, or warranties of content, completeness, accuracy, reliability, usefulness, or that use would not infringe on privately-owned rights.

**Use at Your Own Risk**
The information presented here is intended for use as a general screening tool in community planning or for creating awareness and understanding of geologic information and is neither intended to constitute advice nor is it to be used as a substitute for site-specific advice from a licensed professional. You use this information at your own risk and should not act (or refrain from acting) based upon the information without independently verifying the information and, as appropriate, obtaining professional advice regarding your particular facts and circumstances.

**Limitation on Liability**
User agrees there shall not be liability on the State of Washington, Washington Department of Natural Resources, or their officers, agents, representatives, or employees for any damages allegedly resulting from any use of or reliance on this information. Under this limitation, there shall be no liability for any damages whatsoever, including but not limited to any damages in contract or tort for compensatory, consequential, punitive, direct, indirect, or special damages such as personal injuries, property damage, loss of profits, or any other losses or expenses.

**No Endorsement**
Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement, recommendation, or favoring. Further, the views and opinions of authors expressed herein do not necessarily state or reflect those of the State of Washington or any agency thereof.


## WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES

Dave Upthegrove—*Commissioner of Public Lands*

## WASHINGTON GEOLOGICAL SURVEY

Casey R. Hanell—*State Geologist*
Jessica L. Czajkowski—*Assistant State Geologist*
Ana Shafer—*Assistant State Geologist*
Alexander N. Steely—*Assistant State Geologist*

## WASHINGTON GEOLOGICAL SURVEY

*Mailing Address:*
MS 47007
Olympia, WA 98504-7007

*Street Address:*
Natural Resources Bldg., Rm 148
1111 Washington St SE
Olympia, WA 98501

Phone: 360-902-1450; Fax: 360-902-1785
E-mail: geology@dnr.wa.gov
Website: http://www.dnr.wa.gov/geology

*Publications List:*
https://www.dnr.wa.gov/programs-and-services/geology/publications-and-data/publications-and-maps#publications-list

*Washington Geology Library Catalog:*
https://www.dnr.wa.gov/programs-and-services/geology/washington-geology-library#search-the-library-catalog

*Washington State Geologic Information Portal:* https://www.dnr.wa.gov/geologyportal

# Contents

Key points ..... 1
Introduction ..... 1
Wildfire overview ..... 1
Geography, geology, and climate ..... 1
    Soil burn severity ..... 2
    U.S. Geological Survey (USGS) post-fire debris flow hazard assessment ..... 2
        Modeling results ..... 2
Observations and interpretations ..... 3
    Site-specific summaries ..... 3
        BNSF Railway crossing of SR 25 (Site 1) ..... 3
        Fans along SR 25, MP 103–105 (Site 2) ..... 4
        Cistern (Site 3) ..... 4
        Hawks Road and Widow Road (Site 4) ..... 4
        Flora Road and West Fork of Onion Creek (Site 5) ..... 4
        Impoundment on tributary of Bruce Creek (Site 6) ..... 5
        Alluvial fan with nearby home (Site 7) ..... 5
Summary and recommendations ..... 5
References ..... 6
Limitations ..... 6
Appendix A: Geological background ..... 7
    Hillslope processes ..... 7
    Flash floods and debris flows ..... 7
        Flash floods ..... 7
        Debris flows ..... 7
    Alluvial fans ..... 7

**PLATES**

*(Plates are located at the end of this document)*

**Plate 1.** Map with alluvial fans and locations mentioned in this report for the Crown Creek Fire

**Plate 2.** Soil burn severity for the Crown Creek Fire with locations mentioned in this report

**Plate 3.** USGS post-fire debris flow modeling for 24 mm/hr rainfall rate for the Crown Creek Fire with locations mentioned in this report

# Wildfire-Associated Landslide Emergency Response Team Report for the 2025 Crown Creek Fire

by Kara Fisher[1], Casey Langstroth[1], Trevor Contreras[1], and Mitch Allen[1]

[1] Washington Geological Survey
MS 47007
Olympia, WA 98504-7007

## KEY POINTS

- The soils within the burned area experienced mostly unburned/very low and low burn severity with some pockets of moderate and high severity along the east-facing slopes at the bases of Grande and Staghorn Mountains.
- The area has little to no history of recent wildfire, flooding, or debris flows. However, the Crown Creek Fire may have altered hydrologic conditions, potentially increasing rates of flooding or debris flows downstream or within the burn area.
- Post-fire debris flow hazard model results indicate mostly moderate and low hazard ratings in the burned area, suggesting an increase in debris flow hazards due to wildfire impacts.

## INTRODUCTION

A Wildfire-Associated Landslide Emergency Response Team (WALERT) assessment was conducted to evaluate the potential risks posed by flash floods and debris flows from the Crown Creek Fire in Stevens County, Washington. Wildfires can significantly change the hydrologic response of a watershed so that even modest amounts of rainfall can produce dangerous flash floods and debris flows. Increased runoff, flash floods, and debris flow hazards may remain elevated for several years after the fire.

WALERT assessed the wildfire burn scar and the areas downslope to determine whether debris flows or flooding could impact infrastructure, structures, and other areas where public safety is a concern. Definitions and background information about these hazards are provided in Appendix A. In addition, WALERT looked for historical evidence of debris flows using field reconnaissance, interpretation of lidar elevation data, and aerial orthoimagery. We also used lidar data to map alluvial fans, which are cone-shaped sediment deposits that form where streams flow onto wide, flat surfaces. Alluvial fan mapping from lidar elevation data can identify the potential runout zones of stream runoff, flooding, and debris flows.

This report is primarily a qualitative assessment of post-wildfire landslide hazards based on our professional judgment and experience. The report is further supported by field-validated satellite data and debris flow modeling. The assessment was performed as part of emergency response with the intent to produce a rapid report for decision-makers, land managers, landowners, and other interested parties.

## WILDFIRE OVERVIEW

Both the Crown Creek and Blackhawk Mountain Fires ignited during a lightning storm on the evening of August 29, 2025, approximately 10 miles south of Northport. On September 7, 2025, the fires merged along Onion Creek Road and burned 14,192 acres in brush, grass, and timber (National Interagency Fire Center, 2025). We refer to the merged fire as the Crown Creek Fire. The burned area consists entirely of timberland, primarily privately owned, with some portions under federal management (Bureau of Land Management) and others managed by the Washington Department of Natural Resources (DNR).

## GEOGRAPHY, GEOLOGY, AND CLIMATE

The Crown Creek Fire burned east of the Columbia River approximately 4 miles east and southeast of the community of Marble. Peaks within the burned area include Blackhawk, Alice Mae, O'Toole, Grande, and Staghorn Mountain, which reach elevations up to ~4,100 feet (Plate 1). The bedrock geology of this small mountain range is primarily Cretaceous granite (the Spirit pluton) and Paleozoic marine metasedimentary rock (Joseph, 1990). Along the eastern base of Alice Mae, O'Toole, Grande, and Staghorn Mountains, the slopes are mantled in Quaternary glacial drift, which is poorly sorted and unconsolidated sediment deposited by ice during the last glacial maximum. Eastern slopes within the Crown Creek burned area drain into Onion Creek, a tributary to the Columbia River. Along the western and northwestern edge of the burned area, downslope locations primarily consist of

Quaternary glaciolacustrine (glacial lake deposits of silt and clay) and Quaternary alluvium. Along the northwest boundary of the fire, numerous alluvial fans are observed at the bases of drainages where stream channels exit the mountains and the burned area. Some of these fans intersect infrastructure such as water supplies, access roads, State Route 25 (SR 25) and the railroad. There are also homes and barns on some of these alluvial fans. Of note, a large alluvial fan on the northwest side of the Crown Creek Fire hosts several structures, crosses SR 25, and abuts a portion of BNSF Railway (Plate 1).

The climate in the area is continental. A weather station in Northport, WA, 5 miles north of the Crown Creek Fire, records average summer month highs of around 80 °F, winter month highs of around 34 °F, and an annual average of 20 inches of precipitation (National Oceanic and Atmospheric Precipitation, 2020). Although most of the precipitation falls in the winter, convective summer thunderstorms are not uncommon. Additionally, moderate precipitation continues to fall in the spring, which is concerning given that portions of the burn scar are within a rain-on-snow regime[1] (Washington State Department of Natural Resources, 2024). Rapid snowmelt in the spring has created flooding in the area, most recently in March of 2017, and previously in 1974, 1956, and 1904 (Tucker, 2019). Vegetation in the area is mostly conifer forest with isolated clearings of grasses and shrubs.

## Soil burn severity

The burned area reflectance classification (BARC) data, a satellite-derived data layer of changes between pre- and post-fire vegetation conditions, was generated by our team using satellite imagery collected on August 23 and September 16, 2025 and processed using the QGIS Fire Mapping Tool (Monitoring Trends in Burn Severity, 2024). Using the protocol developed by Parsons and others (2010), we conducted a field evaluation of soil burn severity (SBS) across the burned area to refine the BARC data into a more accurate SBS map (Table 1; Plate 2). We assessed 16 locations within the burned area which were used to calibrate the thresholds between unburned/very low, low, moderate, and high soil burn severity. If you need assistance accessing or analyzing these data, please contact us and we can provide the data and support.

**Table 1.** SBS threshold adjustments based on field validation

| Soil burn severity | BARC values | SBS values | Percentage of area |
|---|---|---|---|
| High | 196–256 | 211–256 | 2% |
| Moderate | 138–196 | 138–211 | 20% |
| Low | 77–138 | 74–138 | 26% |
| Very low or unburned | 0–77 | 0–74 | 52% |

SBS mapping indicates approximately 7,380 acres of the area affected by the Crown Creek Fire was either unburned or had very low soil burn severity, 3,690 acres experienced low soil burn severity, 2,838 acres experienced moderate soil burn severity, and 284 acres experienced high soil burn severity.

## U.S. Geological Survey (USGS) post-fire debris flow hazard assessment

### MODELING RESULTS

The USGS has developed a post-wildfire debris flow model that uses SBS data and topographic variables to estimate debris flow volume, likelihood, and a combined hazard rating which incorporates both likelihood and volume (King and others., 2025). There are various outputs and ways to view the model results. Here we will discuss the relative combined debris flow hazard ratings for both hydrologic basins and stream segments (Plate 3). The hazard rating of modeled basins is based on the hazard rating of the farthest downstream segment within that basin. Several basins modeled for this fire encompass multiple fans. Some of the modeled segments flowing to those individual fans have a higher hazard rating than that of the associated hydrologic basin. To assess post-fire debris flow hazards on those individual fans we reference the associated segment's modeled hazard rating, in addition to the hazard rating of the greater hydrologic basin. We focus our assessment on locations where public safety and infrastructure could be impacted. If you need assistance accessing or analyzing the debris flow assessment data, please contact us and we can provide support.

The USGS debris flow model hazard results reported here are based on a design storm event with a peak rainfall intensity of approximately 0.25 inches of rain in a 15-minute period or 1 inch of rain in a 60-minute period (6 mm/15 minutes or

[1] More information and maps for rain-on snow zones in Washington State can be found at *https://data-wadnr.opendata.arcgis.com/datasets/4a8339bfe8ca46b8a0a674195827e6d3_6/about*

24 mm/hour, respectively). Of note, this model does not consider the effect of rain-on-snow or rapid snowmelt events in a recently burned area. Debris flows and flash floods may occur during rain-on-snow events that do not meet the modeled rainfall intensity.

The modeling data are typically available on the USGS Post-Fire Debris Flow Hazard Assessment Viewer within a few weeks of being generated (https://usgs.maps.arcgis.com/apps/dashboards/c09fa874362e48a9afe79432f2efe6fe#fire_id=Crown%20Creek_2025-08-30_v1.0). Be aware that when you view the modeling results on the USGS platform, the default display shows you the likelihood results for hydrologic basins, not the combined hazard rating used in this assessment. If access is needed prior to these data being made available, please contact us and we can provide some support.

The USGS model results indicate that there are primarily low post-fire debris flow hazards in drainages burned in the Crown Creek Fire area (Plate 3). Of note, several drainages which supply sediment to alluvial fans occupied by infrastructure on the northwest side of Alice Mae Mountain are modeled as moderate post-wildfire debris flow hazard. The USGS model results did not show any locations with a high post-wildfire debris flow hazard within the burned area.

## OBSERVATIONS AND INTERPRETATIONS

WALERT conducted a field assessment of the Crown Creek burned area on October 6 and 7, 2025. Our field assessment included visiting sites of interest (discussed in more detail below) and some contact with homeowners and residents. Pre-field remote review of available lidar and aerial imagery included mapping alluvial fans within and downstream of the burned area, searching for evidence of historical debris flow events, and locating any potential structures or infrastructure at risk. This remote evaluation identified 74 alluvial fans within and downstream from the Crown Creek burned area (Plate 1).

Aerial imagery and lidar were also used during a remote assessment of the area to identify historically active alluvial fans or any areas where debris flows may have initiated in the past. We did not find any documentation or evidence of previous wildfires occurring within the burned area since 1973 (Washington State Department of Natural Resources, 2023), indicating this area has had little recent fire activity. Our review of historical aerial imagery did not reveal any locations where debris flows, rockfall, or landslides have initiated in the past, with the exception of a road that appears to have been rerouted around what may be a landslide in the drainage above Site 1. However, the area was heavily vegetated in the aerial photos, and it is possible signatures of past debris flow activity are obscured by the dense tree canopy. While the evidence for previous debris flow activity is lacking, it does not indicate that post-fire debris flow risk is absent. Wildfire can alter the landscape drastically and can increase the potential for debris flows in areas that may not have a high background rate of debris flows.

Using lidar, we reviewed alluvial fans for evidence of historical activity such as debris flow levees, channel avulsions, or hummocky surfaces. One fan (Site 1), located on the western edge of the burned area, shows some clear indicators of past activity, including visible channel avulsions and debris flow levees. This fan is fed by several drainage basins classified as having low and moderate post-fire debris flow hazards. Aerial imagery shows significant human modification and sparse vegetation in this drainage basin upslope of the fan, likely due to logging. Much of this basin is unburned or experienced low soil burn severity with patches of moderate severity (Plate 2).

In contrast, the remaining alluvial fans within or downslope of the Crown Creek Fire do not show clear evidence of historical activity. These fans exhibit relatively smooth surfaces and uniform gradients, with no distinct signs of channel avulsion or debris flow levees. As noted above, the absence of evidence for historical activity does not suggest the alluvial fans are immune to debris flows or flooding. Rather, the burned area may have low background debris flow rates under unburned conditions. As such, the Crown Creek Fire may contribute to an increased rate of flooding or debris flows compared to what the landscape has experienced in the past.

### Site-specific summaries

The following section highlights sites within and downslope from the Crown Creek burned area where post-wildfire debris flows or flash flooding may impact infrastructure or public safety.

#### BNSF RAILWAY CROSSING OF SR 25 (SITE 1)

There are several basins above the fan at this crossing with low and moderate combined debris flow hazards (Plate 3). The drainage basin above this fan experienced burn severity ranging from unburned to moderate (Plate 2). Remote review of the watershed using lidar data revealed signs of historic slope failures with apparent impacts to roadways. The fan itself has multiple distributary channels, suggesting historic debris flow or flooding activity. Subangular to subrounded cobbles and boulders (~1–2 feet in diameter) observed in the primary channel may also indicate previous debris flow activity. Two culverts (with diameters of ~18-inches and ~30-inches respectively) were seen running under the crossing, both of which spill into a cobble-armored drainage (~2–4-foot wide) downslope of and subparallel to the highway. Multiple culverts with armored outflows imply stream flows occupy multiple channels on the fans surface during times of high flows or flooding.

Signs of previous slope instability along with the moderate debris flow hazard modeled in this basin indicate that there could be an increased risk of flooding or debris flows impacting the highway or railroad located on the fan below. The two culverts appear in good condition and free of debris. However, if culverts become blocked by larger debris, increased influx of water and sediment could impede or damage the highway and (or) railroad.

### FANS ALONG SR 25, MP 103–105 (SITE 2)

Along this stretch of SR 25, there are five fans that intersect the highway that are fed by drainages within the burned area, four of which have houses built on them. The northernmost and largest of these fans is below a drainage basin modeled as moderate debris flow hazard. Two other fans that cross SR 25 are below basins modeled with low and moderate debris flow hazards, while the basins above the remaining two fans were not modeled due to their relatively small sizes. The fans along this stretch of SR 25 do not show readily apparent signs of channel avulsion, and are predominately comprised of fine sediments, although the northernmost fan has large cobbles and boulders present near its apex. This implies that past debris flow and flooding events may have been powerful enough to transport cobbles and boulders to the upper part of the fans while finer sediments were transported to lower elevations on the fan. The Washington Department of Transportation (WSDOT) reported previous issues with road maintenance as recently as July of 2022 on the southernmost fan, and as recently as February of 2024 on the northernmost fan. We saw no other indications of historic flooding or debris flow activity in this area.

### CISTERN (SITE 3)

The basin above this fan is modeled as moderate debris flow hazard. The surface of the fan at this site is smooth and shows no evidence of avulsion. The composition appears to be primarily finer-grained sediments, but boulders up to ~4 feet in diameter and cobbles are present halfway between the fan apex and fan base, and are prevalent near the apex, suggesting that relatively large debris flow or flooding events may have on this fan in the past. Some structures are scattered near the base of the fan, but one structure of note found at the apex of fan appears to be a cistern and likely a residential water source. The stream channel at this location was not deeply incised but did have water actively flowing (estimated ~10 gallons per minute). Flooding or debris flows in this channel would likely compromise the cistern structure and the water supplied from it.

We spoke with a homeowner in this area, who reported no previous issues with flooding during his time of residence since 1990. Nonetheless, changes to the local hydrology due to the fire could lead to future flooding, especially in the first few years following the fire. Much of the basin above this site burned with low and moderate soil burn severity (Plate 2).

### HAWKS ROAD AND WIDOW ROAD (SITE 4)

The basins above Hawks Road and Widow Road are modeled primarily as moderate debris flow hazard, with low debris flow hazard on the eastern edge of the burned area (Plate 3). Portions of the basins burned with high and moderate soil burn severity (Plate 2). While the basins above mapped fans are modeled with a moderate debris flow hazard, we did not find evidence of debris flows on the fans below, suggesting that past debris flows may not have traveled far enough downslope to reach elevations where fans have formed. Evidence of ash from the fire washing downslope was observed during our field visit. Rills, or small streams, were seen at higher elevations, some of which were incised ~2 inches into the ash layer. The basin above these roads contains abundant glacial sediment that may be easily entrained by flowing water should intense precipitation events occur.

Downstream of the burned area, we encountered a fan with a residence on it (Site 4). Here we did not find evidence of previous debris flows. The fan was gently sloping, and comprised primarily of silts and fine sands, with some fine gravel interspersed near the apex. The homeowner of the residence indicated that the creek level varies year over year but reported no previous issues with sediment from the creek. Despite the reported absence of prior issues with sediment delivery, changes to the soil and hydrology due to the fire could result in increased sediment delivery.

### FLORA ROAD AND WEST FORK ONION CREEK (SITE 5)

The basin above the western end of Flora Road exhibited the greatest concentration of high soil burn severity in the burn area and is modeled as moderate debris flow hazard (Plates 2 and 3). The basin contains abundant glacial sediment that may be easily entrained by flowing water should intense precipitation occur. We spoke with a homeowner who said he had never had issues with flooding or sediment on the property along the drainage. However, the absence of past flooding does not mean that flooding will not occur here in the future. Alterations to the hydrology of the landscape due to the fire could still significantly increase the risk of flooding, particularly in or near the creek bed.

There is another fan south of the intersection of Flora Road and Clugston Creek Branch Road that we could not assess in the field due to property access issues, but the aerial imagery reveals multiple structures on the fan, including one near the apex. The basin above this fan is modeled as moderate debris flow hazard (Plate 3), but aerial imagery and lidar do not show any apparent signs of recent activity. Given the modeled moderate hazard, and the presence of high and moderate soil burn severity in

the basin above (Plate 2), property owners may consider contacting a geotechnical engineer for guidance on how to best remediate flooding and debris flow hazards. Until vegetation is reestablished, culverts along this section of Flora Road should be monitored to ensure that they are in good condition and free of debris to minimize potential risk of flooding.

While there are erodible glacial sediments, the area suffered high and moderate soil burn severity, and some basins are modeled as moderate debris flow hazard, fans are not well developed with deeply incised channels or recent debris flow deposits. Despite lack of evidence for recent debris flows emanating from these basins, the modeling results suggest that the wildfire may have increased the likelihood of debris flows here.

### IMPOUNDMENT ON TRIBUTARY OF BRUCE CREEK (SITE 6)

A stream impounded by an artificial embankment was observed in aerial photos on a tributary of Bruce Creek at Site 6, near the apex of a fan. The basin above this site is modeled with a moderate debris flow hazard (Plate 3) and some portions were burned with moderate soil burn severity (Plate 2), though much of the basin experienced low burn severity or was unburned. The property owner may want to ask for technical assistance evaluating flooding or debris flow hazards in the basin above and associated risk to the embankment impounding the stream channel.

### ALLUVIAL FAN WITH NEARBY HOME (SITE 7)

A fan on the southwestern portion of the burned area contains multiple structures at or near the fan apex. Soil burn severity on the slopes above was predominately very low or unburned with some moderate and very little high (Plate 2). The overall basin is modeled as having low debris flow hazard, but importantly, the individual stream segment leading to this fan is modeled as moderate severity (Plate 3). We did not find evidence of previous debris flows in the lidar or aerial imagery, though this does not mean that such events may occur in the future given changes to the hydrologic conditions of the surrounding basin as a result of the wildfire. The property owner may consider purchasing flood insurance or contacting a geotechnical engineer to discuss possible hazard remediation option.

## SUMMARY AND RECOMMENDATIONS

This WALERT assessment suggests that, following the Crown Creek Fire, debris flows, flash flooding and increased runoff may present a risk to public safety and could impact infrastructure during intense precipitation such as thunderstorms, rain-on-snow events, or rapid snow melt during the spring.

The northwestern portion of the burned area has alluvial fans with evidence of past debris flows, although signs of recent activity were not observed (Sites 1 to 3). These fans are directly connected to the stream channels that drain areas modeled with a moderate debris flow hazard, although the basins may not have burned with high soil burn severity. The confined stream channels are relatively steep and appear capable of transporting debris to the down-slope fans. These alluvial fans are areas where we might expect post-fire debris flows and flooding during intense rainstorms.

We are uncertain about how the eastern portion of the burned area will respond to intense precipitation events. While areas of the eastern portion burned intensely with ample areas of high and moderate soil burn severity (Plate 2), and are modeled with moderate debris flow hazard (Plate 3), the area doesn't appear to have a history of debris flows—such as well-developed alluvial fans, or well-defined, connected, and steep stream channel networks. This area also does not have large boulders on the surfaces of alluvial fans, even though boulders present in the glacial sediments that underlie the basin's slopes are available for incorporation into a debris flow should one occur. The stream channel gradients are comparatively low, and the few fans appear to have sand and silt on them, rather than boulders. It is possible that stream gradients are not steep enough to produce flow rates capable of transporting coarse debris to the fans. The lack of evidence supporting past debris flows on these slopes seems at odds with the moderate debris flow hazard modeling. Perhaps the area will not see debris flows, but may still experience flooding and sedimentation should an intense precipitation event occur before vegetation is able to recover.

Our greatest area of concern for impacts of flooding and debris flows is the alluvial fan at the SR 25/BNSF Railway crossing on the westernmost part of the burn scar (Site 1). This fan shows the most evidence of recent flooding or debris flow activity, and the basin above this site shows signs of historic slope failures, which have likely added more material to the channel that could be mobilized in a future debris flow. The upper portion of this basin is modeled with a moderate debris flow hazard. We recommend continued monitoring of the culverts beneath SR 25, particularly following periods of intense or prolonged rainfall.

Other infrastructure of concern includes, but is not limited to, structures, roads, and culverts. An elevated risk of post-fire debris flows and flooding is present for structures and infrastructure that are in or near stream channels, fans, and adjacent areas. The hydrology of some basins has changed, and additional flooding may occur in areas where historically it has not.

Managers of transportation networks and private landowners should be informed of the increased likelihood of flooding sediment transport and deposition, and (or) erosion impacts following wildfires. We further recommend inspecting culverts within channels draining areas impacted by the fires both before and after storm events. Blocked culverts can cause additional flooding and damage, which could otherwise be minimized. For more information on how to stay safe when at risk from debris flows,

please consult our Floods After Fire pamphlet and the USGS's fact sheet with safety tips relating to post-fire debris flows (links in Appendix A below).

Landowners needing advice and assistance with recovery and or reforestation can connect with resources at the After the Fire Washington website: https://afterthefirewa.org/.

## REFERENCES

Joseph, N. L., compiler, 1990, Geologic map of the Colville 1:100,000 quadrangle, Washington–Idaho: Washington Division of Geology and Earth Resources Open File Report 90-13, 78 p., 1 plate. [http://www.dnr.wa.gov/Publications/ger_ofr90-13_geol_map_colville_100k.zip]

King, J. M.; Kostelnik, J.; Kean, J. W.; Barnhart, K. R.; Graber, A. P.; Rengers, F. K.; Thomas, M. A., 2025, Post-wildfire debris flow hazard assessment (PWFDF) collection: U.S. Geological Survey data release. [https://doi.org/10.5066/P14EWYME]

National Oceanic and Atmospheric Administration, 2025, Summary of Monthly Normals 1991-2020 [webpage]: National Oceanic and Atmospheric Administration. [accessed Nov. 6, 2025 at https://www.ncei.noaa.gov/access/services/data/v1?dataset=normals-monthly-1991-2020&startDate=0001-01-01&endDate=9996-12-31&stations=USC00455946&format=pdf]

Monitoring Trends in Burn Severity, 2024, QGIS Fire Mapping Tool, FMT for QGIS 3.x [software]: Monitoring Trends in Burn Severity. [accessed 10/22/2025 online at: https://www.mtbs.gov/qgis-fire-mapping-tool]

National Interagency Fire Center, 2025, IMSR Incident Locations View: Final Occurrence Year-To-Date [webpage]. National Interagency Fire Center. [accessed 9/12, 2025 at https://data-nifc.opendata.arcgis.com/datasets/85d3f50b5eee4dcfa48f5e4fb23aa9e1_0/explore?location=48.781186%2C-117.714064%2C10.93&showTable=true].

Parsons, Annette; Robichaud, P. R.; Lewis, S. A.; Napper, Carolyn; Clark, J. T., 2010, Field guide for mapping post-fire soil burn severity: U.S. Department of Agriculture General Technical Report RMRS-GTR-243, 49 p. [https://www.fs.usda.gov/rm/pubs/rmrs_gtr243.pdf]

Tucker, Brad, 2019, Stevens County, Washington, hazard mitigation plan: Northwest Management, Inc., 187 p. [https://files.municipalone.com/stevenscounty-wa/HazardMitigationPlanPDF1403113344041423AM.pdf]

Washington State Department of Natural Resources, 2024, Rain on Snow (FP) [GIS data]: Washington State Department of Natural Resources. [https://gis.dnr.wa.gov/site2/rest/services/Public_Forest_Practices/WADNR_PUBLIC_FP_Watershed/FeatureServer/6]

Washington State Department of Natural Resources, 2023, Washington Large Fires 1973-2023 [GIS data]: Washington State Department of Natural Resources. [https://geo.wa.gov/datasets/wadnr::washington-large-fires-1973-2023/explore?location=47.213099%2C120.438127%2C8.14]

## LIMITATIONS

WALERT aims to quickly identify and assess geologic hazards associated with wildfires to inform decision making and help focus the efforts of local officials and residents who may be impacted by post-wildfire hazards. All observations and interpretations are based on empirical evidence and local knowledge. Not all areas or hazards were evaluated. We encourage landowners, land managers, and those potentially at risk from post-wildfire hazards to consult qualified professionals for site-specific analysis of geological hazards and flood risk and prepare accordingly.

# APPENDIX A: GEOLOGICAL BACKGROUND

## Hillslope processes

A variety of factors contribute to the probability of debris flows occurring in burned areas. These include hillslope gradient, channel convergence, availability of fine sediments, severity of hydrophobic (water repellant) soil conditions, burn severity, and the removal of a protective canopy and diminished root strength caused by fire.

Hydrophobic soil conditions in burned areas can increase water runoff potential on hillslopes during a storm by preventing water from infiltrating into the subsurface. Overland flow can result in rills and gullies that further channel water downhill.

When effective ground cover has been denuded after intense fire, soils are also exposed to erosive forces such as raindrop impact and wind. The steepest slopes are most prone to erosion, particularly where soils are shallow or where there is a restrictive subsurface layer such as bedrock. Soils that have developed in volcanic ash and glacial till are easily detachable, having low cohesion and structure, and contain relatively low amounts of organics, resulting in moderately thin topsoil horizons.

## Flash floods and debris flows

Debris flows have a specific geologic definition that is often misused by the media, the public, and scientists. Most observed "debris flows" are actually sediment-laden flash floods known as hyperconcentrated flows (HCFs). In the following sections, we explain the differences between these two types of flows.

### FLASH FLOODS

Flash floods, especially those that originate from recently burned areas, are often described as "debris flows" due to the sediment-laden water transporting woody and vegetative debris, trash, gravel, cobbles, and occasionally boulders. Though "debris flow" may be an observer's description of the event, a true debris flow has specific properties, behaviors, and characteristics that differentiate it from a flash flood. An HCF is the transition between a flash flood and a debris flow. One way geologists differentiate the three is by the percent of sediment (by volume) carried by the flowing water. A flood contains less than 5 percent sediment by volume, an HCF carries around 5 to 60 percent sediment by volume, and a debris flow exceeds 50 percent sediment by volume.

### DEBRIS FLOWS

Debris flows are often described as having the appearance of flowing, wet concrete. These flows travel quickly in steep, convergent channels. A moving debris flow can be very loud because it can buoy cobbles, boulders, and debris to the front and sides of the flow. The sound is often compared to that of a freight train and may cause the ground to vibrate. In a post-fire situation, a debris flow may start as a flash flood surge that picks up sufficient sediment to transform into an HCF and, if soil and slope conditions are suitable, can transform into a debris flow.

Debris flow deposits tend to be distinct and include channel-adjacent levees of gravel, cobbles, and boulders. Channel-adjacent trees display upslope damage such as scarring on bark from rock or debris impact. Mud and gravel may be splashed onto trees and other channel-adjacent objects. Because of the ability of a debris flow to buoy these materials to the front of the moving mass, debris flows are extremely dangerous to public safety and infrastructure.

## Alluvial fans

Alluvial fans are low-gradient, cone-shaped deposits that consist of sediment and debris. These features often accumulate immediately below a significant change in channel gradient and (or) valley confinement. This might occur at the mouth of a canyon or steep channel that drains from mountainous terrain and emerges onto a low gradient area such as a flood plain. Sediment on the alluvial fan is deposited by streams, floods, HCFs, and (or) debris flows and is typically sourced from a single channel.

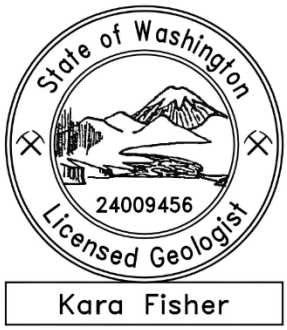
Alluvial fans are attractive locations to build cabins and homes due to the slight elevation above the flood plain. However, alluvial fans are active depositional areas that accumulate sediment over time. The sediment can be deposited both slowly, such as during a spring melt when high streamflow transports and deposits fine sediment on the fan, or quickly, when a flash flood, HCF, or debris flow transports sediment and debris to the fan.

**Information flyers about alluvial fan hazards are available on our website in both English and Spanish**

- https://www.dnr.wa.gov/publications/ger_fs_alluvial_fans.pdf
- https://www.dnr.wa.gov/publications/ger_fs_alluvial_fans_esp.pdf
- The USGS's fact sheet on post-fire debris flows safety: *https://pubs.usgs.gov/fs/2022/3078/fs20223078.pdf*

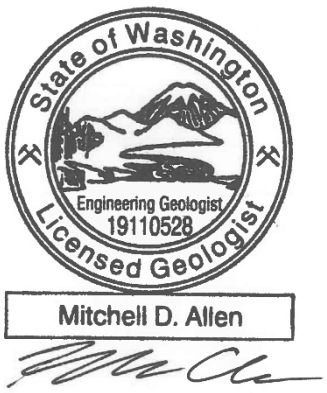

November, 2025

**Trevor Contreras**
Licensed Geologist #2687
Washington Geological Survey
Washington State Dept. of Natural Resources
Olympia, WA
Cell: 360-810-0005
Email: trevor.contreras@dnr.wa.gov




November, 2025

**Kara Fisher**
Licensed Geologist #24009456
Washington Geological Survey
Washington State Dept. of Natural Resources
Olympia, WA
Cell: 360-999-0114
Email: kara.fisher@dnr.wa.gov




November, 2025

**Mitchell D. Allen**
Licensed Engineering Geologist #19110528
Washington Geological Survey
Washington State Dept. of Natural Resources
Olympia, WA
Cell: 360-819-0436
Email: mitchell.allen@dnr.wa.gov

**Plate 1**

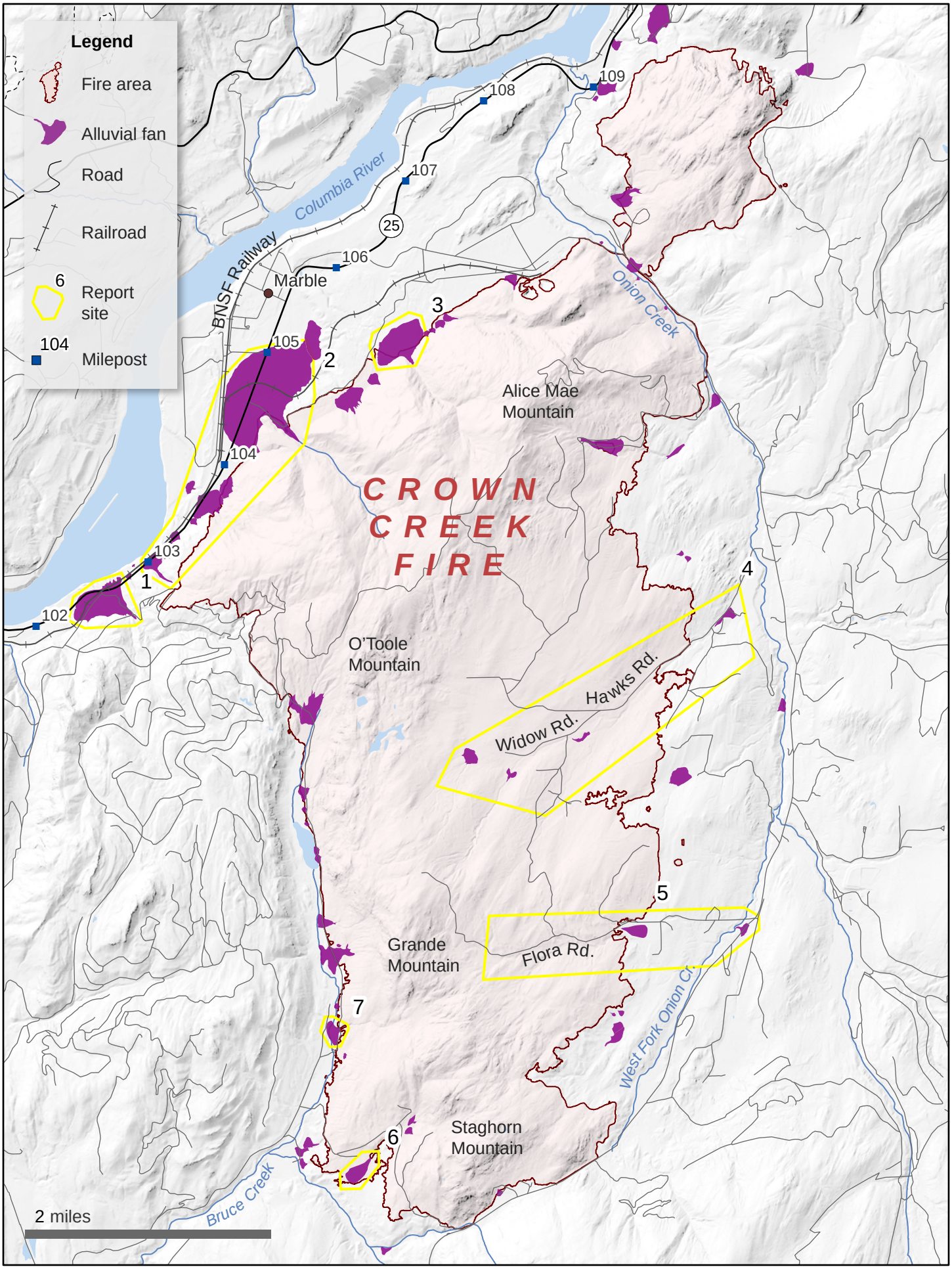

Legend
Fire area
Alluvial fan
Road
Railroad
6
Report site
104
Milepost
Columbia River
BNSF Railway
Marble
Onion Creek
Alice Mae Mountain
CROWN CREEK FIRE
O'Toole Mountain
Hawks Rd.
Widow Rd.
Flora Rd.
Grande Mountain
West Fork Onion Cr
Staghorn Mountain
Bruce Creek
102
103
104
105
106
107
108
109
25
1
2
3
4
5
6
7
2 miles

**Plate 2**

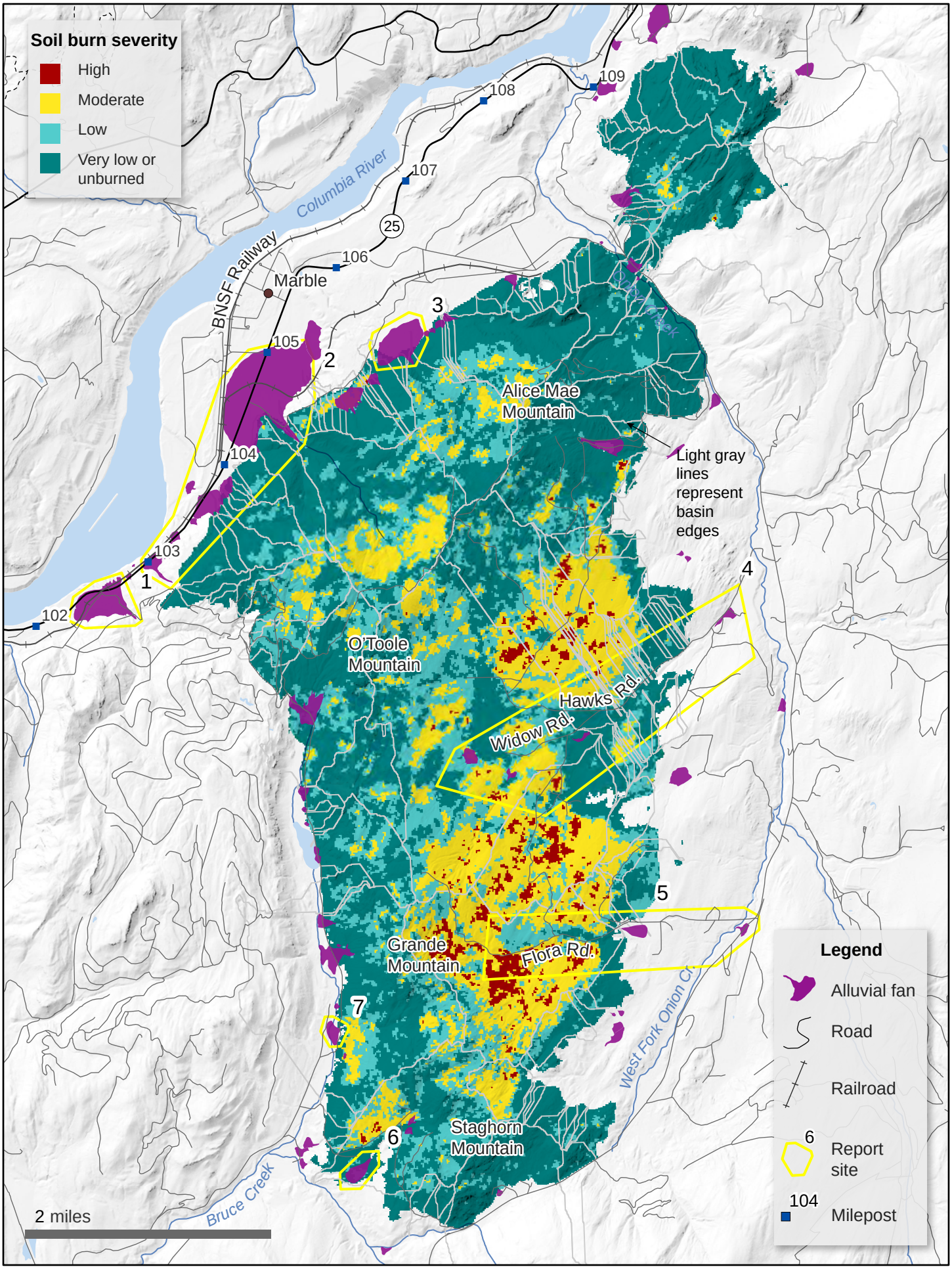
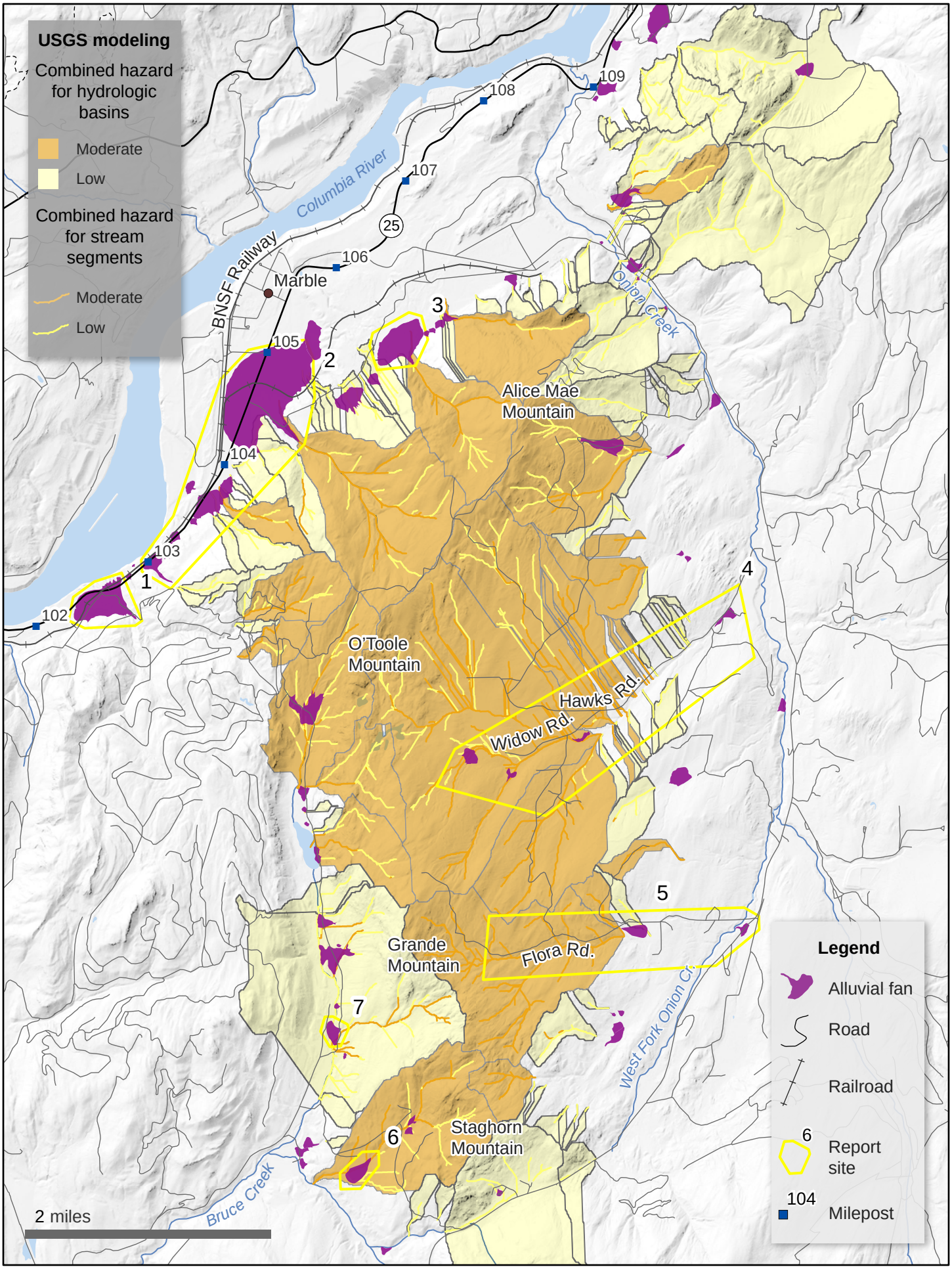

Soil burn severity
High
Moderate
Low
Very low or unburned
Columbia River
BNSF Railway
Marble
102
103
104
105
106
107
108
109
25
1
2
3
4
5
6
7
Alice Mae Mountain
O'Toole Mountain
Grande Mountain
Staghorn Mountain
Hawks Rd.
Widow Rd.
Flora Rd.
Light gray lines represent basin edges
West Fork Onion Cr
Bruce Creek
2 miles
Legend
Alluvial fan
Road
Railroad
6
Report site
104
Milepost

**Plate 3**


USGS modeling
Combined hazard for hydrologic basins
Moderate
Low
Combined hazard for stream segments
Moderate
Low
Columbia River
BNSF Railway
Marble
Onion Creek
Alice Mae Mountain
O'Toole Mountain
Hawks Rd.
Widow Rd.
Flora Rd.
Grande Mountain
Staghorn Mountain
West Fork Onion Cr.
Bruce Creek
102
103
104
105
106
107
108
109
25
1
2
3
4
5
6
7
2 miles
Legend
Alluvial fan
Road
Railroad
6
Report site
104
Milepost