R E S O U R C E S

N A T U R A L

# WILDFIRE-ASSOCIATED LANDSLIDE EMERGENCY RESPONSE TEAM REPORT

## Ford Corkscrew Fire

**Stevens County, Washington**

by Trevor Contreras and Mitchell Allen

WASHINGTON
GEOLOGICAL SURVEY
WALERT Report
September 15, 2021

WASHINGTON STATE DEPARTMENT OF
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## DISCLAIMER



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# Wildfire-Associated Landslide Emergency Response Team Report for the Ford Corkscrew Fire

by Trevor Contreras[1] and Mitchell Allen[1]

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## INTRODUCTION

A Wildfire-Associated Landslide Emergency Response Team (WALERT) assessment was conducted to evaluate the potential risk posed by landslides and debris flows from the Ford Corkscrew Fire. Wildfires can significantly change the hydrologic response of a watershed so that even modest rainstorms can produce dangerous flash floods and debris flows.

In coordination with the Stevens County Conservation District and the Natural Resources Conservation District (NRCS), WALERT assessed soil burn severity and areas downstream of slopes burned by wildfire to determine whether debris flows or flooding could impact roads, structures, or other areas where public safety is a concern. Further information about these hazards is provided in Appendix A.

WALERT looked for historical evidence of debris flows using field reconnaissance, lidar interpretation, Burned Area Reflectance Classification (BARC) maps, and orthoimagery. The NRCS provided satellite-based BARC data and we field checked it to determine soil burn severity throughout the burned area. This data will be used for flood modeling by NRCS and can be used by property owners and land managers to make decisions on recovery efforts.

This report is primarily a qualitative assessment of post-wildfire landslide hazards based on our professional judgment and experience. 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 stakeholders.

## WILDFIRE OVERVIEW

The Ford Corkscrew Fire started on August 15, 2021, roughly 20 miles northwest of Spokane, Washington, near the communities of Ford and Tumtum (Plate 1). The fire burned 15,718 acres of largely forestland slopes that are bounded by broad agricultural valleys to the east and west. The majority of the land that burned is privately owned (57.6% of the total burned area), with a patchwork of land managed by industrial timber companies and the Washington State Department of Natural Resources (DNR) (Table 1). Most of the vegetation that burned was mixed conifer and pine stands in higher elevations, with some burning of agricultural fields along valley bottoms. The burned extent utilized in this assessment was obtained from the National Incident Feature Service on September 14, 2021 (https://data-nifc.opendata.arcgis.com/datasets).

**Table 1.** Ownership distribution of burned area.

| Land Owner/Manager | Acres | Percent of burned area |
|---|---|---|
| Private ownership | 9,051.2 | 57.6 |
| Industrial Timber Companies | 4,544.1 | 28.9 |
| Washington Dept. of Natural Resources (DNR) | 2,122.7 | 13.5 |
| Total | 15,718.0 | 100.0 |

## OBSERVATIONS AND INTERPRETATIONS

Field assessments were performed September 8 and 9 while mop-up operations were occurring. The work focused on areas where wildfire effects on watershed hydrology could put life and property at risk along portions of Rail Canyon. The field work also assessed soil burn severity within the fire perimeter.

## Soil burn severity and Burned Area Reflectance Classification (BARC) data

### OBSERVATIONS

The soil burn severity was assessed by the WALERT team using Burned Area Reflectance Classification (BARC) data provided by NRCS. The BARC data were field-checked using guidance from the report of Parson and others (2010).

For the most part, the satellite-derived data was accurate and we did not find significant problems with the data. Through field observations, we refined the thresholds slightly to more accurately reflect soil burn severity conditions after the fire. Table 2 outlines the values we used to calibrate the BARC data to get a more accurate soil burn severity map.

**Table 2.** BARC threshold calibration numbers used for the soil burn severity mapping

| Soil burn severity | Standard Values | Calibrated Values (0–255) |
|---|---|---|
| High | 188-255 | 230–254 |
| Moderate | 110-187 | 132–229 |
| Low | 76-109 | 75–131 |
| Unburned soil | 0-75 | 0–74 |

Approximately 46 percent of the area affected by the fire was either unburned or had low soil burn severity, and 7,390 acres (47%) burned with moderate soil burn severity. The 1,022 acres (6.5%) that were marked as high burn severity are predominantly restricted to riparian corridors and north- and east-facing drainages in higher elevations of the burned area. See Table 3 and Plate 1.

We observed moderate hydrophobicity throughout the burned area across all soil burn severities, typically at the contact of the burned ash layer and the mineral soil. We are uncertain if this is an artifact of preexisting hydrophobicity due to the presence of volcanic ash in the soil as we did not evaluate hydrophobicity in adjacent unburned areas.

We provide an overview of the soil burn severity thoughout the burned area in Table 3 for property owners, state agencies, and the Stevens County Conservation District, who may work on post-fire restoration efforts. If you need assistance accessing or analyzing the data, please contact us and we can provide support.

**Table 3.** Distribution of soil burn severity for the Ford Corkscrew fire.

| Soil burn severity | Acres | Percent of burned area |
|---|---|---|
| High | 1,022.3 | 6.5 |
| Moderate | 7,390.6 | 47.1 |
| Low | 5,880.9 | 37.5 |
| Unburned soil | 1,407.4 | 8.9 |
| Total | 15,701.2[1] | 100 |

[1] This value does not match the 15,718 acres burned reported above. An unknown error left 17 acres unaccounted for, approximately 0.1 percent.

### INTERPRETATIONS

Low soil burn severity was found throughout the burned area, indicating that the plants and roots were not subjected to intense heat by the fire. If precipitation and snow pack allow it, the vegetation will likely reestablish in these areas.

Moderate soil burn severity affected a wide swath of the burned area in drainages and the uplands where vegetation was denser. Areas with moderate and high burn severity may need additional mitigation to get vegetation reestablished, depending on the long-term goals of the land owners and managers.

A few drainages had some high soil burn severity on steeper slopes. These include the north-facing slopes along the southern portions of Rail Canyon, and the headwaters of unnamed, west-flowing drainage basins to the south. East-facing slopes in the northeast portion of the burned area, approximately 1.5 miles northeast of Scoop Mountain, experienced moderate soil burn severity; however, the soil burn severity data locally show high soil burn severity. We did not alter the data here as these isolated inconsistencies may be related to recent timber harvests or fire suppression acitivities. In general, field observations of soil burn severity were generally consistent with the remotely mapped conditions.

Erosion is expected in the steeper portions of these drainages where the fire burned the vegetation and where soil burn severity is higher. Sedimentation may occur in the valley bottom downslope of these channels. Local concerns about future flooding were voiced by landowners within Rail Canyon, where relatively steep north-facing slopes along the southern portions of the canyon experienced high soil burn severity (Plate 1).

## RECOMMENDATIONS

Landowners and managers may choose to take action to prevent excessive soil erosion, reduce flooding, and promote revegetation to meet their management and economic goals. Utilizing the soil burn severity map provided to find areas of high and moderate burn severity should assist in this evaluation. Seeking technical assistance from Stevens County Conservation District may also be helpful.

Our assessment suggests that flash flooding is the hazard most likely to impact the areas evaluated downstream of the burned area. We did not observe evidence of previous debris flows throughout most of the burned area and do not expect debris flows to impact homes as a result of this fire. At locations within and downstream of the burned area, residents should be prepared for additional flooding during periods of intense precipitation. NRCS is expected to do additional analysis to determine potential flood impacts. Residents of homes built on alluvial fans and (or) adjacent to streams flowing from burned areas should be informed of potential post-fire flash flood hazards.

Managers of transportation networks should be reminded of the increased likelihood of sediment transport, sediment deposition, and (or) erosion to highways and roads, as well as potential issues with blocked culverts. We suggest reminding transportation network managers to inspect culverts from channels draining areas impacted by the fires both before and after storm events, otherwise culverts could be blocked, causing additional flooding and damage.

## REFERENCES

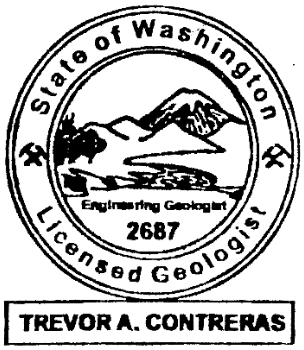
Parsons, Annette; Robichaud, P. R.; Lewis, S. A.; Napper, Carolyn; Clark, J. T., 2010, Field guide for mapping post-fire soil burn severity: U.S. Department of Agriculture General Technical Report RMRS-GTR-243, 49 p. [https://www.fs.fed.us/rm/pubs/rmrs_gtr243.pdf]

## LIMITATIONS

WALERT aims to quickly identify and assess geologic hazards associated with wildfires in order to inform decision making and to 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.

## ACKNOWLEDGMENTS

WALERT thanks our partners, especially Dean Hellie at Stevens County Conservation District for coordinating access to the burned area and assisting with reviewing soil burn severity sites. We also thank Matt Garringer at Hancock Forest Management, and Clay Chambers at the Washington State Department of Natural Resources for providing access to the lands they manage. Kara Jacobacci and Dan Coe assisted with making the map plate.




September 2021

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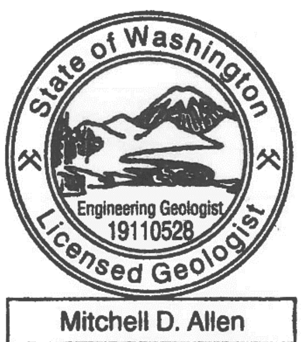


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# APPENDIX A: GEOLOGICAL BACKGROUND

## 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.

An information flyer about alluvial fan hazards is available on our website in both English (https://www.dnr.wa.gov/publications/ger_fs_alluvial_fans.pdf) and Spanish (https://www.dnr.wa.gov/publications/ger_fs_alluvial_fans_esp.pdf).

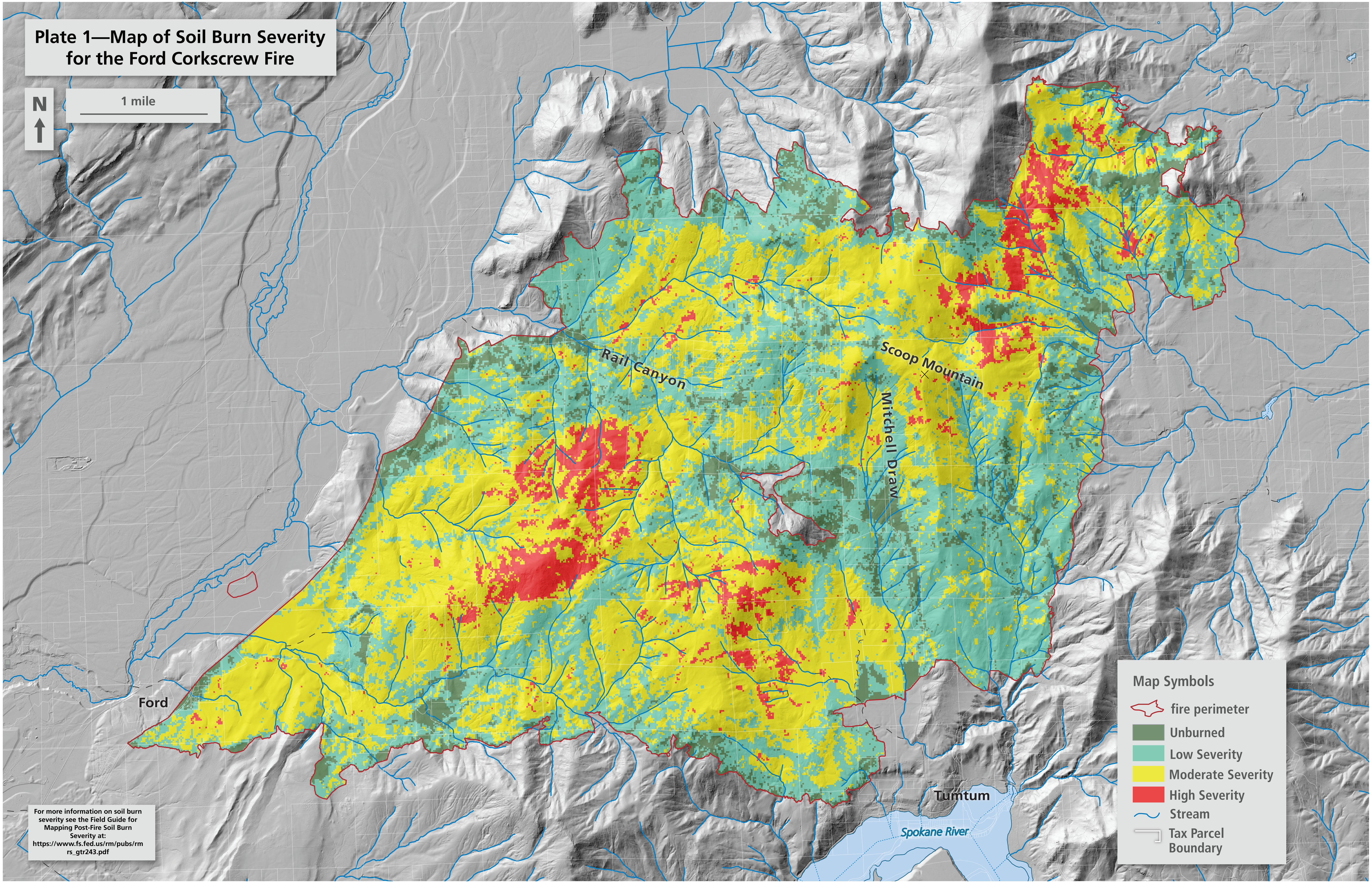
Plate 1—Map of Soil Burn Severity for the Ford Corkscrew Fire
N
1 mile
Rail Canyon
Scoop Mountain
Mitchell Draw
Ford
Tumtum
Spokane River
Map Symbols
fire perimeter
Unburned
Low Severity
Moderate Severity
High Severity
Stream
Tax Parcel Boundary
For more information on soil burn severity see the Field Guide for Mapping Post-Fire Soil Burn Severity at: https://www.fs.fed.us/rm/pubs/rmrs_gtr243.pdf