NATURAL RESOURCES

WILDFIRE-ASSOCIATED LANDSLIDE EMERGENCY RESPONSE TEAM REPORT

Lick Creek and Silcott Fires

Asotin and Garfield Counties, Washington

by Trevor Contreras and Kara Jacobacci

WASHINGTON
GEOLOGICAL SURVEY
WALERT Report
August 27, 2021

WASHINGTON STATE DEPARTMENT OF
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Wildfire-Associated Landslide Emergency Response Team Report for the Lick Creek and Silcott Fires

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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 two fires near Asotin, Washington. 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 Asotin Conservation District and the U.S. Forest Service (USFS), WALERT assessed soil burn severity and areas downstream of slopes burned by wildfires to determine whether debris flows or flooding could impact roads, structures, and 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, satellite data from HazMapper.org, and orthoimagery. The USFS Burned Area Emergency Response (BAER) team working on the Lick Creek Fire finalized a soil burn severity map based on satellite data, and this data was provided to partners. We have provided a map of this data as Plate 2 in this report.

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 OVERVIEWS

Lick Creek Fire

Lightning strikes on July 7 ignited several fires southwest of Asotin, Washington. The Dry Gulch Fire merged with the Lick Creek Fire on July 8. The combined fire retained the name Lick Creek. The fire burned 80,421 acres, primarily in tall grass, brush, and timber (INCI Web, 2021). See Table 1 and Plate 1 for more information on land management distribution in the burned area.

Table 1. Land management distribution of burned area for Lick Creek Fire

Land Owner/Manager	Acres	Percent of burned area
U.S. Forest Service (USFS)	53,742	66.8
Washington Dept. of Fish and Wildlife (WDFW)	15,797	19.6
Washington Dept. of Natural Resources (DNR)	6,686	8.3
Private Ownership	4,116	5.1
Bureau of Land Management (BLM)	88	0.1
Total	80,429[1]	99.9

[1] This value does not match the number of burned acres as reported by INCI Web. The reported burned acreage was 80,421. The acreage as reported here reflects a deviation of approximately 0.01%.

Silcott Fire

The Silcott Fire started on July 7 in the vicinity of Silcott Grade road, burning a total of 8,633 acres (Table 2). The fuels were primarily brush and tall grass (INCI Web, 2021). The land use in the fire area is largely agricultural or rangeland, with some areas left as grassland to provide wildlife habitat (Brad Riehle, Asotin Conservation Dist., oral commun., 2021).

Table 2. Land management distribution of burned area for Silcott Fire

Land Owner/Manager	Acres	Percent of burned area
Private Ownership	8,133	94.2
Washington Dept. of Natural Resources (DNR)	499	5.8
Total	8,632[1]	100

[1] This value does not match the number of burned acres as reported by INCI Web. The reported burned acreage was 8,633. The acreage as reported here reflects a deviation of approximately 0.01%.

OBSERVATIONS AND INTERPRETATIONS

Field assessments were performed on August 16 and 17, after the fires were contained and roads were opened to the public. The Washington Geological Survey WALERT team focused on areas where wildfire effects on watershed hydrology could put life and property at risk along portions of Asotin Creek Road near the Lick Creek and Silcott Fires. These locations are outside of the Umatilla National Forest where the USFS BAER team does not operate.

Satellite-derived data in the form of a calibrated Soil Burn Severity map was available for the Lick Creek Fire and was provided by the USFS BAER team. The team reviewed the map for the federal lands and calibrated it for application throughout the burned area. We provide this data in Plate 2 for state and local partners to use for recovery purposes.

For the Silcott Fire we utilized satellite data from HazMapper.org (Scheip and Wegmann, 2021) that relies on relative vegetation change. Since the BARC and Soil Burn Severity data were not available, we used the Hazmapper data to rapidly evaluate the soil burn severity throughout the burned area.

History of flooding in Asotin Creek

Asotin Creek is the main stream of concern in this area in regard to flooding that could be exacerbated post-fire. There is a documented history of flood events occurring along the creek over the past 100 years. Asotin Creek flows along the eastern flank of the Lick Creek Fire area and the south side of the Silcott Fire area. Tributary streams in both fire areas drain into Asotin Creek. The largest floods in Asotin Creek are either associated with rapid snowmelt and (or) rain-on-snow events, or localized high-intensity thunderstorms during the summer months (Bennett and others, 2018). Asotin Creek saw two large flood events during 1996–1997 in which several structures were damaged and sections of the creek were partially filled in with sediment (Lewiston Tribune, 1997). Other documentation suggests that floods occurred in the early 1900s and in 1925, 1948, 1964, and 1974 (Phil Dougherty, 2006; John Vorous, 2013; Washington Rural Heritage, 2013). These events are not directly tied to fires in the area, but they demonstrate the prior effects of flooding along Asotin Creek.

Lick Creek Fire

We observed alluvial fans along Asotin Creek along the eastern perimeter of the Lick Creek Fire, suggesting that drainages that meet the main stem of Asotin Creek have been active in the past. We did not go too far into the burned area beyond the road and made few observations due to the lack of homes, barns, and infrastructure. The eastern edge of the burned area is primarily within land managed by the Washington Department of Fish and Wildlife (WDFW) and the Department of Natural Resources (DNR) (Plate 1). This area is between approximately 4,000 and 1,600 feet, which is lower in elevation than the National Forest land. The area is also less forested than the area to the southwest that is within the National Forest. The vegetation in the area is light on the uplands and south facing slopes, with more dense vegetation in the riparian corridors and north facing slopes and drainages.

Silcott Fire

Much of the Silcott Fire appears to have burned with low soil burn severity due to the sparse grasses and vegetation available to burn in the fire. The few places where moderate soil burn severity was observed were in more densely vegetated areas. This included the wildlife grasslands between Asotin Creek and Peola Road and the north-facing slopes that drain to Page Creek on the north side of the fire.

We do not expect either of these locations with moderate soil burn severity to produce debris flows that would directly impact homes or infrastructure. The grasslands are on relatively flat land on the upland, and if the north facing slopes that drain to Page Creek produce debris flows, there would be ample travel distance for larger sediment to drop out before the flows encounter structures.

We expect there could be flooding and sedimentation along Page Creek during periods of intense precipitation. There were approximately 2,000 acres burned within the fire that drain to Page Creek. We do not expect major impacts to Asotin Creek from the Silcott Fire. Most of the burned area that drains to Asotin Creek, approximately 5,300 acres, burned with low soil burn severity in cropland on relatively flat ground that drains to Maguire Gulch prior to merging with Asotin Creek. An additional 1,200 acres that drain to Asotin Creek were on south facing step slopes with sparse vegetation along the southern perimeter of the fire. While these are steep and drain toward Asotin Creek Road, we did not observe evidence of high soil burn severity from viewpoints along the road. This suggests that additional debris flows are not expected to occur within Asotin Creek as a result of the fire.

Soil burn severity and Burned Area Reflectance Classification (BARC) data for the Lick Creek Fire

OBSERVATIONS

The soil burn severity was assessed by the USFS BAER team using Burned Area Reflectance Classification (BARC) data for the Lick Creek fire only. The BARC data was field-checked using guidance from the report of Parson and others (2010), and the data was found to be accurate enough that no changes were necessary to utilize as Soil Burn Severity mapping. We provide a portion of the Soil Burn Severity mapping for the properties outside of the National Forest that include private land and Washington State managed land (Plate 2). We encourage interested parties to consult the USFS data for further information. If you need assistance accessing or analyzing the data, please contact us and we can provide support.

INTERPRETATIONS

Outside of the Umatilla National Forest, on the eastern portion of the burned area, the Lick Creek Fire burned mostly light fuels of grasses and shrubs. The majority of this area burned with low soil burn severity, while drainages along north-facing slopes with more dense vegetation burned with moderate soil burn severity. The vast majority of the high soil burn severity was within the Umatilla National Forest. The few drainages outside of the National Forest with some high and moderate soil burn severity include most drainages within the burned area that drain into the North and South Forks of Asotin Creek. These include Lick Creek, North Fork Asotin Creek, and other isolated areas.

Dry Gulch on the north end of the fire did not have any high soil burn severity but some basins did have moderate soil burn severity in the north-facing drainages with more available vegetation.

Low soil burn severity occurred throughout the burned area and was likely the result of sparse vegetation (grasses and lighter fuels), such that 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 primarily affected the riparian corridors and north-facing drainages where vegetation was denser. Areas with moderate and high soil 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 with more dense vegetation. Erosion is expected in the steeper portions of these drainages during periods of heavy precipitation. Sedimentation may occur in the valley bottom downslope of these channels.

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

MODELING RESULTS

The USGS provided a debris flow assessment for the Lick Creek Fire based on the field-validated soil burn severity data provided by the USFS. The data can be viewed directly at their website (https://landslides.usgs.gov/hazards/postfire_debrisflow/detail.php?objectid=361).

There are various outputs and ways to view the data using the website. Here we discuss the combined relative debris flow hazard, which uses both probability and volume from the USGS model to provide three different hazard ratings: Low, Moderate, and High. We focus on the eastern margin of the fire, on private and state-managed land.

INTERPRETATIONS

The USGS modeling suggests that there is Low, Moderate, and High debris flow hazard in drainages throughout the burned area (see Plate 3). This is based on a modeled storm event with a peak rainfall intensity of approximately one quarter of an inch of rain in a 15-minute period. The private and state-managed lands appear to be a patchwork of Low and Moderate debris flow hazard and the High debris flow hazard areas appear to be confined to basins within the National Forest. During heavy precipitation events these drainages could be impacted by flooding, erosion and sedimentation, and (or) debris flows. This would most likely occur as a result of thunderstorms in the spring or summer within the next few years following the fire, or until vegetation is reestablished.

Along the eastern perimeter of the fire, most of the steep, short drainages that drain directly into Asotin Creek from the east and west sides of the valley (downstream from the confluence of the North and South Forks) are shown as very low to low debris flow susceptibility.

Dry Gulch

In Dry Gulch, an east–west trending drainage that flows into Asotin Creek, the USGS debris flow model shows mostly Low hazard basins on the north side and a patchwork of Low and Moderate hazard basins on the south side.

There is a dike at the mouth of Dry Gulch near Asotin Creek Road that appears to be constructed to keep flood waters directed north, away from the home on the south side of the alluvial fan. We do not expect debris flows to transport from the upper portion of the watershed to the fan, but flash floods could impact the alluvial fan.

Charley Creek

In Charley Creek, the first 1.5 miles on both sides are modeled with Low debris flow hazard. Upstream there are many small basins with Moderate hazard. They seem to concentrate in the drainages on the south side of Charley Creek up to a point marked as “Corral” on topographic maps, approximately 5.8 miles upstream. Upstream of the “Corral”, both sides of the creek are modeled as Moderate hazard and this extends into the National Forest.

There is a home on the south side of Charley Creek at Asotin Creek Road, approximately 675 feet downstream of where the channel is less confined. The home sits on a broad alluvial fan and currently, the channel of Charley Creek is on the north edge of the valley about 170 feet from the home. We do not expect debris flow to transport downstream to the home but flash floods and sediment could impact the area.

Lick Creek

The first 2.7 miles of Lick Creek are modeled as Low hazard. Two isolated basins on the south side of the creek are modeled as Moderate hazard, and these are approximately 1.3 miles upstream of the confluence with Asotin Creek. Beyond this, the creek models show Moderate hazard on the south side. At the mouth of Cottonwood Gulch there are a few buildings that are apparent in aerial photos. The Cottonwood basin is modeled as Low debris flow hazard but there are areas upstream with moderate soil burn severity that could shed sediment down Cottonwood Gulch in an intense rainstorm and impact these buildings. The south side of the creek above the state-managed parcels and into the National Forest is consistently modeled as Moderate hazard.

North Fork Asotin Creek

The basins along the North Fork of Asotin Creek are modeled as Low debris flow hazard for approximately 1 mile upstream of the confluence with Lick Creek. Above this, the north side of the creek is Low hazard and the south side is Moderate hazard for most drainages, and this pattern continues upstream into the National Forest.

South Fork Asotin Creek

The basins along the South Fork of Asotin Creek are a patchwork of Low and Moderate debris flow hazard. Further upstream, smaller tributaries flowing into the South Fork show Moderate to High debris flow hazard. These drainages are located within the National Forest.

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 by the USFS as a tool to find areas of high and moderate burn severity should assist in this evaluation (see Plate 2). We are willing to provide the data in various formats as needed.

We did not model additional flooding in Asotin Creek and instead direct people to consult the USFS, the Natural Resources Conservation Service (NRCS), or hydrologists and engineers to assess this. Should it be determined that flash flooding to the main stem of Asotin Creek is likely, then residents should be prepared for additional flooding during periods of intense precipitation.

Our assessment suggests that flash flooding is the hazard most likely to impact the areas evaluated downstream of the burned area. However, there are drainages where Moderate debris flow hazards exist, and during periods of intense precipitation (approximately one quarter of an inch of rain in a 15-minute period), these drainages may have debris flow activity.

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. This is most likely closest to the burned area, in the areas near Charley Creek and Dry Gulch.

The drainages near the buildings along Lick Creek at Cottonwood Gulch should be evaluated to ensure that they can efficiently convey potential flood water away from the buildings. The parking lot and dispersed camping area at Lick Creek may need signs to warn the public of flash flood hazards during heavy rainstorms.

Managers of transportation networks should be reminded of the increased likelihood of sediment transport, sediment deposition, and (or) erosion to 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

Bennett, Stephen; Camp, Reid; Wheaton, Joe; Bouwes, Nick; O'Brien, Gary; Hill, Andrew; Floyd, Ben; and Drury, Tracy, 2018, Asotin County Watershed Assessment: Technical Document and Appendices: unpublished report prepared for Asotin County Conservation District, 220 p. [https://snakeriverboard.org/wp-content/uploads/2018/08/AsotinGeomorphicAssessment_compressed.pdf]

Dougherty, Phil, 2006. Major flooding strikes Asotin County on February 7th, 1996 [webpage]: History Link. [accessed Aug. 21, 2021 at https://historylink.org/File/7629]

INCI Web, 2021, Lick Creek Fire [webpage]: INCI Web. [accessed Aug. 17, 2021 at https://inciweb.nwcg.gov/incident/7615/]

INCI Web, 2021, Silcott Fire [webpage]: INCI Web. [accessed Aug. 17, 2021 at https://inciweb.nwcg.gov/incident/7626/]

Lewiston Tribune, 1997, Asotin County flood victims appeal for preventative actions [webpage]: Lewiston Tribune. [accessed August 21, 2021 at https://lmtribune.com/northwest/asotin-county-flood-victims-appeal-for-preventative-actions-those-whose-homes-were-damaged-tell-commissioners/article_787eac87-4378-5d84-afc6-33648cfc2a5a.html]

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]

Scheip, C. M.; Wegmann, K. W., 2021, HazMapper: A global open-source natural hazard mapping application in Google Earth Engine: Natural Hazards and Earth Systems Science, v. 21, no. 5, p. 1495–1511. [https://doi.org/10.5194/nhess-21-1495-2021]

Vorous, John, Snake River/Asotin Creek flooding 1948: YouTube, uploaded Aug. 19, 2013. [accessed Aug. 21, 2021 at www.youtube.com/watch?v=O2bSLRwKPOU]

Washington Rural Heritage, 2013, Asotin Creek pipeline photo collage [webpage]: Washington Rural Heritage. [accessed Aug. 21, 2021 at https://www.washingtonruralheritage.org/digital/collection/asotin/id/1802/]

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, Brad Riehle of the Asotin Conservation District for coordinating access to the burned area and assisting with reviewing soil burn severity sites, and Brien Park (USFS), who provided the soil burn severity data.

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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).

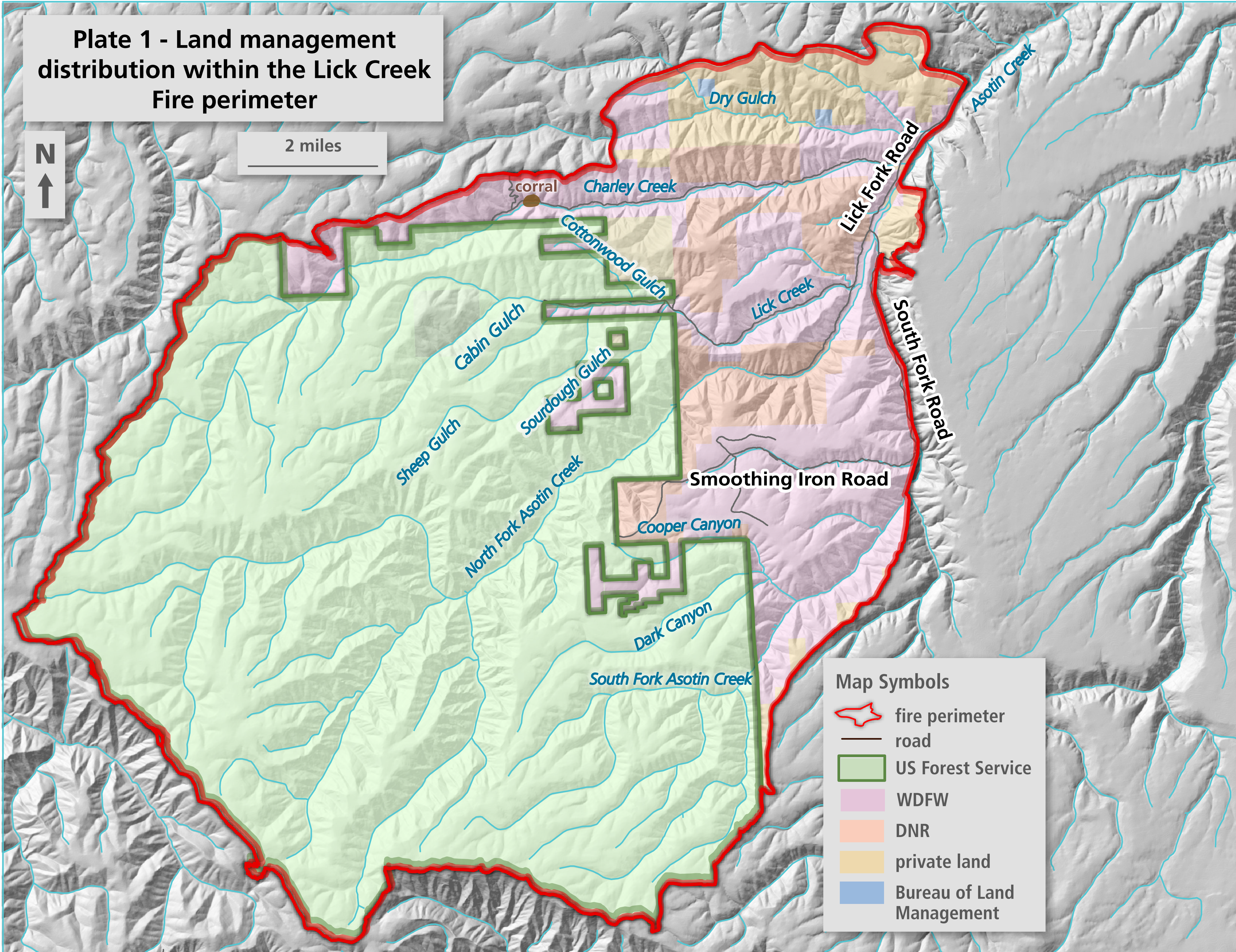
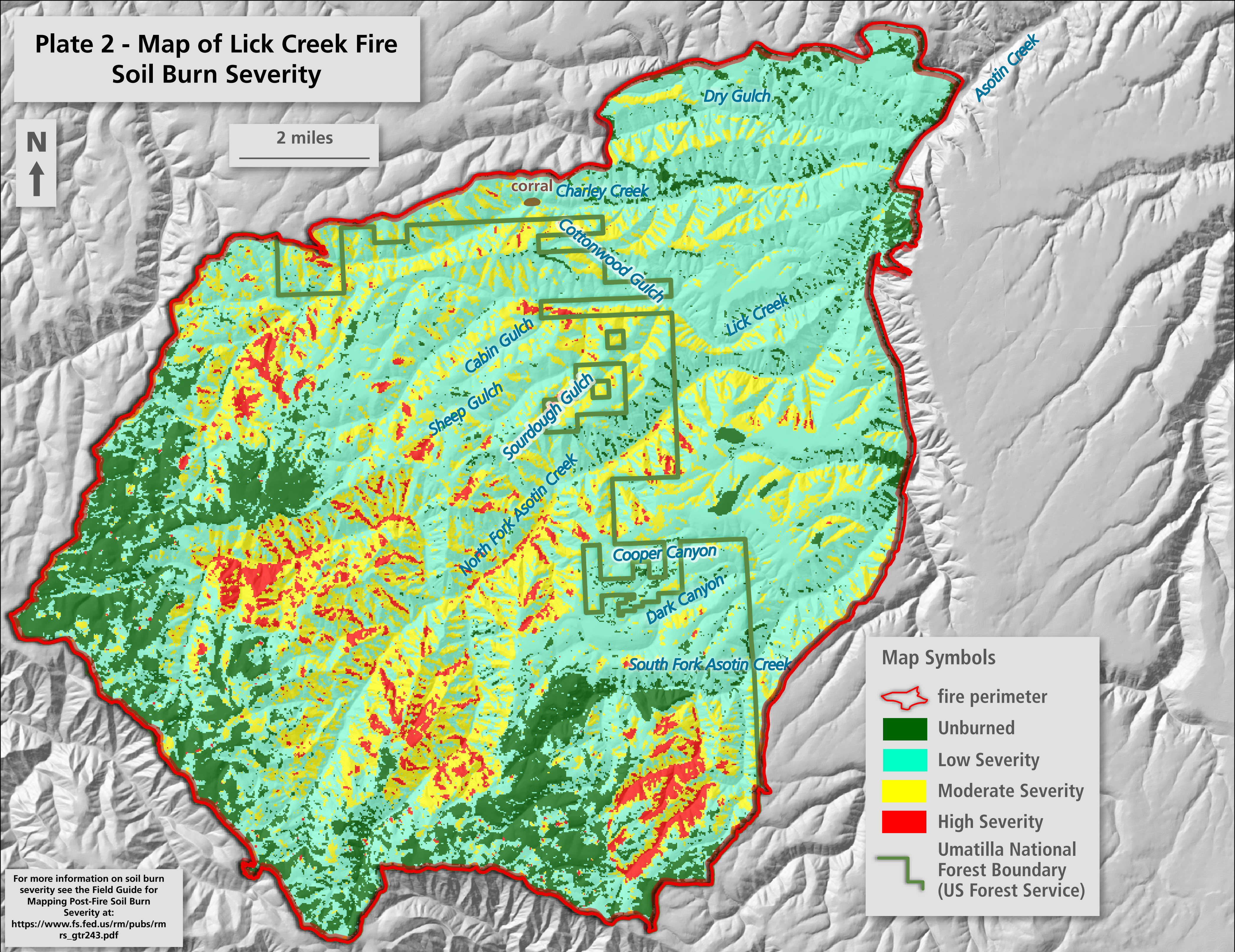


Plate 1 - Land management distribution within the Lick Creek Fire perimeter
N
2 miles
corral
Charley Creek
Dry Gulch
Asotin Creek
Lick Fork Road
Cottonwood Gulch
Lick Creek
Cabin Gulch
Sourdough Gulch
Sheep Gulch
South Fork Road
North Fork Asotin Creek
Smoothing Iron Road
Cooper Canyon
Dark Canyon
South Fork Asotin Creek
Map Symbols
fire perimeter
road
US Forest Service
WDFW
DNR
private land
Bureau of Land Management

Plate 2 - Map of Lick Creek Fire Soil Burn Severity



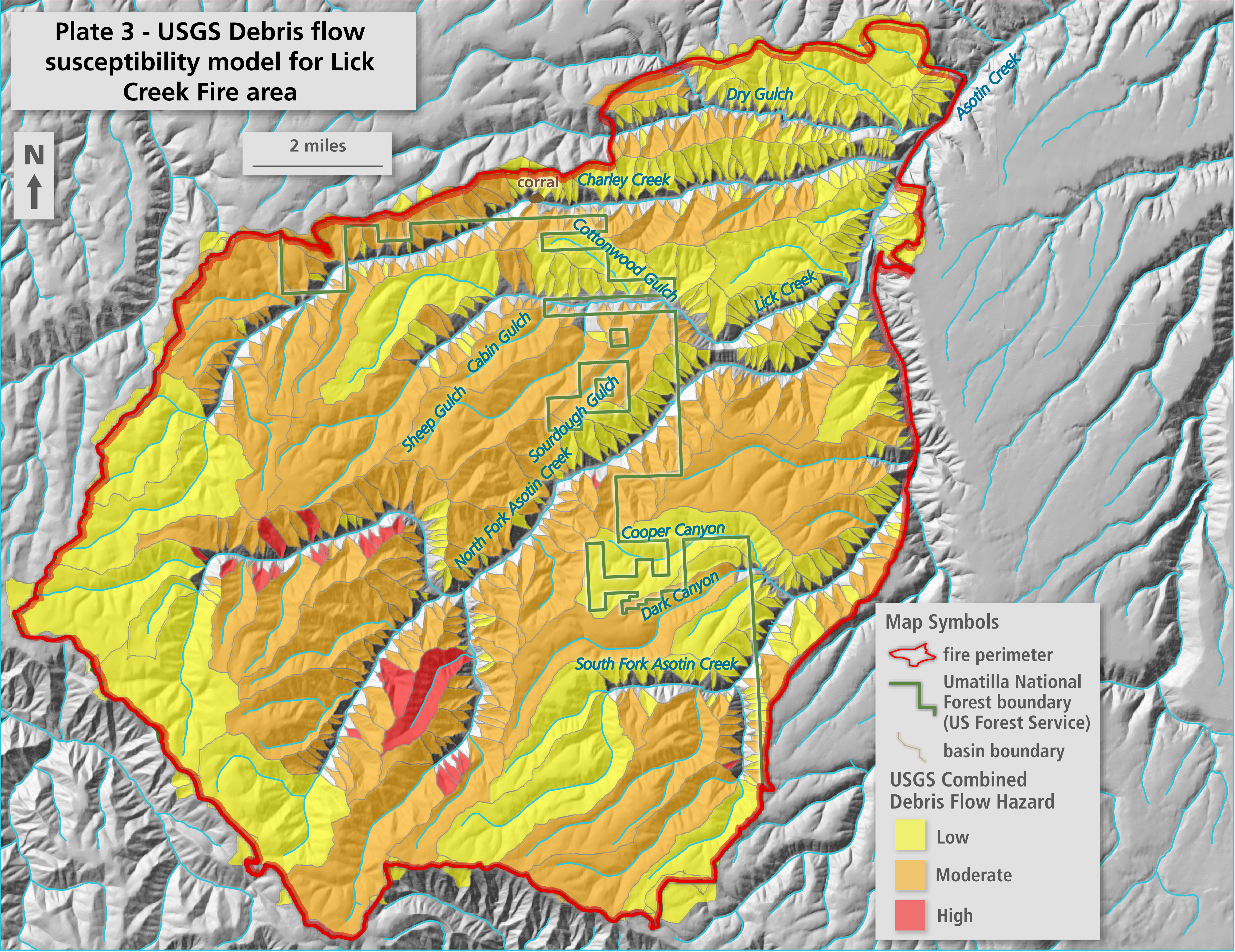


Plate 3 - USGS Debris flow susceptibility model for Lick Creek Fire area
N
2 miles
corral
Charley Creek
Dry Gulch
Asotin Creek
Cottonwood Gulch
Lick Creek
Cabin Gulch
Sheep Gulch
Sourdough Gulch
North Fork Asotin Creek
Cooper Canyon
Dark Canyon
South Fork Asotin Creek
Map Symbols
fire perimeter
Umatilla National Forest boundary (US Forest Service)
basin boundary
USGS Combined Debris Flow Hazard
Low
Moderate
High