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WILDFIRE-ASSOCIATED LANDSLIDE EMERGENCY RESPONSE TEAM REPORT

Chuweah Creek Fire

Nespelem Water Tanks, Okanogan County, Washington

by Trevor Contreras

WASHINGTON
GEOLOGICAL SURVEY
WALERT Report
August 3, 2021

WASHINGTON STATE DEPARTMENT OF
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Wildfire-Associated Landslide Emergency Response Team Report for the Slope Stability of the Water Tanks at Nespelem as a Result of the Chuweah Creek Fire

by Trevor Contreras

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INTRODUCTION

A Wildfire-Associated Landslide Emergency Response Team (WALERT) assessment was conducted to evaluate the potential risk to the water tanks for the community of Nespelem after the area burned in the Chuweah Creek Fire. The fire started on July 12, 2021 near Nespelem, Washington and burned approximately 36,752 acres south and east of the town of Nespelem. Wildfires can significantly change the hydrologic response of a watershed and the community's water system has an active landslide behind it that may become unstable and further damage this critical water infrastructure.

In coordination with the Confederated Tribes of the Colville Reservation's Burned Area Emergency Response (BAER) Coordinator (Rebecca Peone), WALERT, representatives from the Watershed Program, and Nespelem Public Works, we visited the site on July 28, 2021. We observed the landslide, the water tanks, and the burned area surrounding the tanks. This report outlines our observations and supports the need for quick landslide stabilization and a drainage system to be installed to protect this critical infrastructure.

LANDSLIDE OVERVIEW

The water tanks are part of the Nespelem Water Department, which serves 175 full-time, single-family residences on the southeast side of Nespelem. The tanks are accessed by a steep gravel road near the intersection of F Street and 7th Street.

The landslide that has the potential to impact the two water tanks appears to be an ongoing problem just south of the water tanks (Fig. 1). Due to the fire, the potentially unstable area may receive additional surface water runoff that could impact the infrastructure. Quick landslide stabilization and installing an adequate drainage system will ensure that this water system can continue to operate normally after the fire.

OBSERVATIONS AND INTERPRETATIONS

Field assessments were performed on July 28, 2021. The external portion of the tank and building pad were inspected along with the retaining wall. The landslide was evaluated and GPS locations were noted to document the extent of the landslide. The water tanks appeared plumb, with no observable damage, and a recent internal cleaning and inspection reported no abnormalities. The pad where the tanks are built appeared intact. However, small, isolated areas along the edge, where material has been placed without being compacted, have sloughed after the fire.

The two tanks sit on a bench at an elevation of approximately 2,056 feet. The crown of the landslide is at approximately 2,143 feet in elevation. The landslide is currently about 150 feet long from north to south with 87 feet of relief. It is approximately 65 feet wide at the top, widening to about 85 feet wide downslope, near a retaining wall made of ecology blocks (Fig. 2). An estimate of pre-failure topography suggests that an almost 20-foot-thick package of material has been evacuated from the landslide area. The pre-failure slope is estimated to be 30 degrees, with an estimated areal extent of 0.2 acres. The contributing basin size, including the landslide body, is estimated to be 1.4 acres.

The landslide material appeared dry and no wet areas were observed. The area had been burned in the fire, so indicators of hydrophytic vegetation were not noted. Landslide deposits from this winter suggest that flowing water sometimes moves sand and silt-sized sediment from the landslide toe through the retaining wall and into the fenced area around the tanks.

The landslide appears to be failing within the glacial diamict, with no observed glaciolacustrine or bedrock layers acting as hydrologic barriers. However, a hydrologic barrier near the surface must be present, based on reports of springs running in the winter from behind the retaining wall and below the tanks. The glacial diamict is an unsorted mixture of material ranging in size from silt to boulders approximately 3 feet in diameter (Fig. 3). The deposits were mapped as unit Qgd in the 1:100,000 scale geologic map compiled by Joseph (1990). A thin veneer of well-drained, permeable soil up to about 1 foot thick is mapped as Conconully Soils (from a parent material of glacial till with a component of loess and volcanic ash) in the Soil Survey of the Colville Indian Reservation (NRCS, 2002). The landslide body appears to consist of blocks of glacial diamict approximately 5 to 10 feet thick that detach, translate downslope, and disaggregate, accumulating behind the retaining wall. The wall is likely built on landslide material as suggested by its deformation. It appears that precipitation erodes the unvegetated slope, washing the finer sediment downslope to accumulate behind and pass through the wall.

A review of the surrounding lidar topographic data (Fig. 1) suggests that the likely style of landslide movement is shallow failure of a few tens of feet. Movement occurs where the slope is oversteepened and periodically saturated.

The landslide appears in all aerial photos on Google Earth Pro, going back to at least July 1991. The landslide likely initiated when the hillside was cut to construct the water tanks. It has continued to be active in aerial photos through 2017 (the most recent; see Fig. 4), showing bare soil and incorporating larger trees through time.

The previous security fence surrounding the tanks was damaged by landslide movement about 5 years ago. A new fence was installed and an ecology block wall was built to protect the fence and retain the slide material. The wall consists of stacked blocks three and four courses high, with some basalt coarse quarry spall added to armor the edges. The wall is about 15 feet south of the western tank (Fig. 2). Behind the wall is a 4 inch drain pipe that was not flowing and we were unable to determine if it was functioning.

The wall is holding back some sediment from the slide but has also been deformed by the landslide. The whole stack has tilted to the north approximately 2 inches, and the middle and west ends are both noticeably deformed. The middle is sagging down approximately 1 foot while the western edge is warped northward up to 1.5 feet (Fig. 5).

The soil burn severity mapping done by the Burned Area Emergency Response (BAER) team indicates that much of the 1.4 acre basin above the landslide burned as moderate soil burn severity. When effective ground cover has been denuded after intense fire, and the soils heated, the soils are exposed to erosive forces such as raindrop impact and wind. Additional water runoff occurs, causing increased overland flow and erosion. The steepest slopes are most prone to erosion, particularly where soils are shallow or where there is a restrictive subsurface layer such as bedrock, or in this case glacial drift. Soils that have developed in volcanic ash and glacial till are easily detachable, having low cohesion and structure. The 1.4-acre basin above the slide is expected to increase overland flow during periods of intense precipitation, which will continue to erode the area.

We were unable to determine if the water tanks are built into bedrock, glacial diamict, or landslide deposits because site plans and designs were unavailable at the time of report writing. It's possible that the tanks are built on bedrock as there appears to be a bedrock exposure approximately 150 feet to the northeast of the eastern tank exposed in the drainage. Based on extrapolation of the geologic mapping nearby, the bedrock is likely to be volcanic breccia of the Sanpoil Volcanics, mapped geologic unit Evc_s (Joseph, 1990).

There are two benches on the hillside, one where the current pair of water tanks are built and one below where a previously used and smaller tank resides. We were unable to determine if both sets of water tanks were built on an older landslide due to the extent of regrading that has occurred at the site over the years. It's possible that the tanks are built on an older landslide due to the report of intermittent springs existing on the slope between the older and newer water tanks. A quick walk through the burned area was inconclusive in finding traces of a seasonal spring. If there is one, it doesn't appear to flow enough to create an obvious channel. But due to the density and existence of vegetation in the area, it's likely that there are perennial springs in the area.

RECOMMENDATIONS

We recommend getting geotechnical engineering support to develop plans and stabilize the landslide and drain any surface or subsurface water away from the water tank infrastructure. Additional water to the area will continue to destabilize the area.

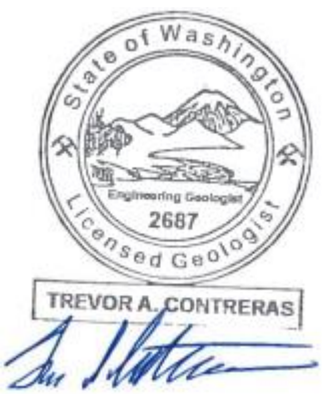
REFERENCES

Natural Resources Conservation Service, U.S. Department of Agriculture, 2002, Soil survey of Colville Indian Reservation, Washington, Parts of Ferry and Okanogan Counties: Natural Resources Conservation Service, U.S. Department of Agriculture, 1 CD and 64 plates with 1700 pages of text, scale 1:24,000. [https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/washington/WA648/0/colville.pdf]

Joseph, N. L., compiler, 1990, Geologic map of the Nespelem 1:100,000 quadrangle, Washington: Washington Division of Geology and Earth Resources Open File Report 90-16, 47 p., 1 plate. [https://www.dnr.wa.gov/Publications/ger_ofr90-16_geol_map_nespelem_100k.zip]

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.



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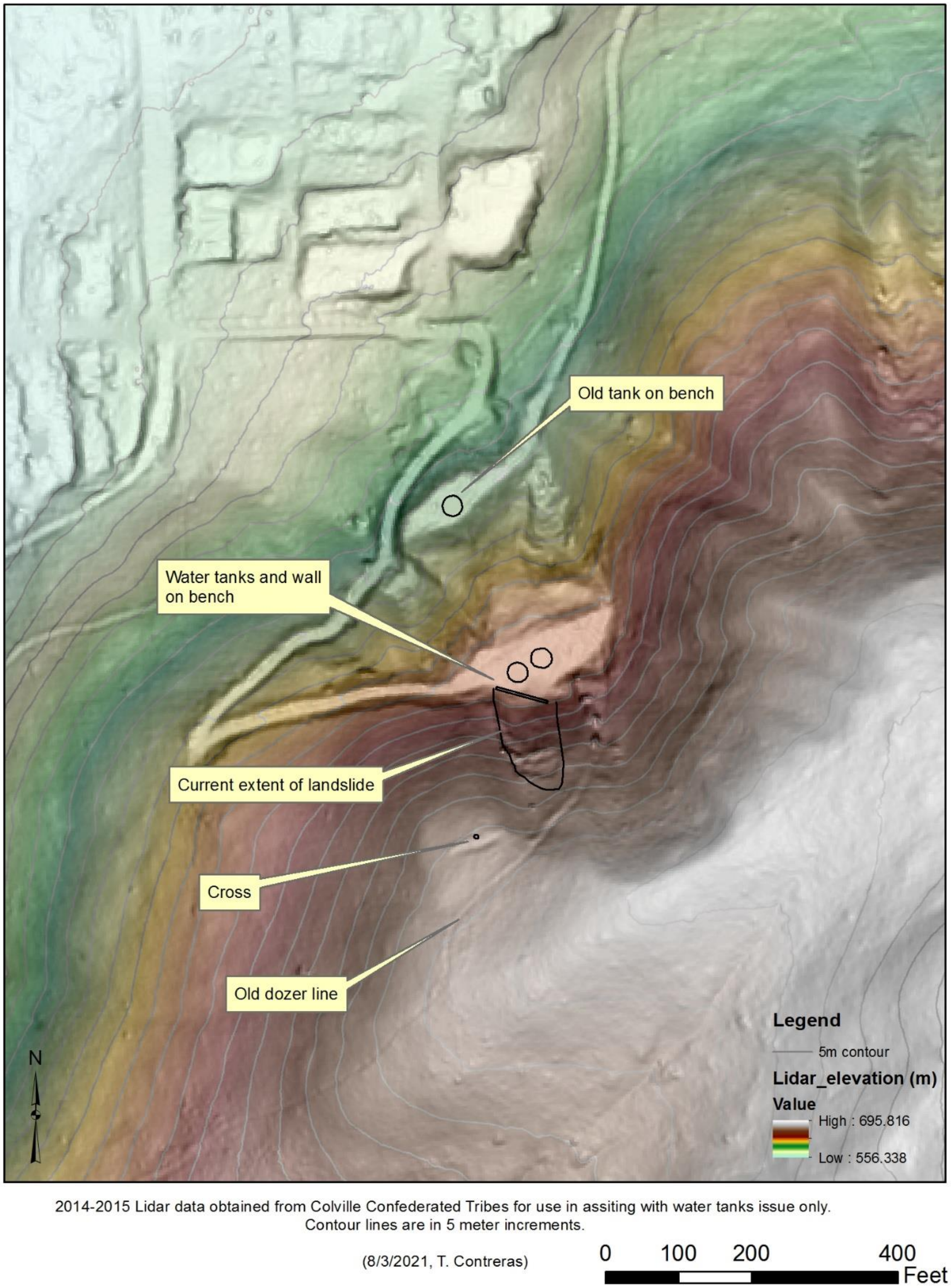

Figure 1. Map showing lidar data for the area surrounding the water tanks. Key features are labeled.

Figure 2. Retaining wall made of ecology blocks behind water tanks, approximately 15 feet from the western tank. Photo shows recent sediment deposited against the wall.

Figure 3. Landslide with glacial diamict exposed behind wall and light-colored sediment deposited within security fence.

Figure 4. Orthophoto from 2017 showing vegetation on the hillslopes surrounding the water tanks.

Figure 5. Deformation of 5-year-old retaining wall made of ecology blocks, looking west.