# Appendix F

## Geologic Reconnaissance and Preliminary Geotechnical Evaluation

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# MEMORANDUM

**To:** C. Scott Richman, AICP, PMP and Mara Krinke/ David Evans and Associates, Inc.

**Date:** August 6, 2015

**GRI Project No.:** 5588

**From:** Michael Zimmerman, PE, GE, CEG and George Freitag, CEG

**Re:** Geologic Reconnaissance and Preliminary Geotechnical Evaluation
Lolo Pass Road Access Alternatives Study
OR CLACK 37005(1)
Task Order No. DTFH7015F19002
Clackamas County, Oregon

***DRAFT***

As a subconsultant to David Evans and Associates, Inc. (DEA), and for the Western Federal Lands Highway Division, GRI is providing geotechnical and geologic consultation for a preliminary planning-level evaluation of access alternatives for Lolo Pass Road in Clackamas County, Oregon. Flooding of the Sandy River in recent years has damaged the section of Lolo Pass Road between Barlow Trail Road and Michigan Avenue, requiring closures and extensive repairs to the road. The purpose of an alternative access will be to provide a route or new alignment that is less susceptible to damage and closures caused by flooding and erosion along the Sandy River. Our work to date has included participation in a kickoff meeting in April 2014, review of published geologic mapping of the area, review of aerial photographs of the site from the 1960's, and a ground-level reconnaissance by a geotechnical engineer and engineering geologist from GRI on July 16, 2014. This memorandum summarizes our work and provides preliminary conclusions regarding the significant geotechnical- and geologic-related issues associated with the design and construction of the three access alternatives under consideration.

## Project Description

Three access alternatives have been evaluated as part of this study: two of the alternatives utilize a new bridge located near the east end of Autumn Lane and one alternative would modify Lolo Pass Road by replacing the existing bridge over the Sandy River with two 200-ft-long bridges separated by an approximately 50-ft-long roadway embankment. The general location of the three access alternatives is shown on the Geologic Hazard Map, Figure 1. The field reconnaissance portion of our work was limited to the alternative closest to the existing Autumn Lane alignment, referred to as the West Zigzag Mountain Alternative. Therefore, our work for the a significant portion of the East Zigzag Mountain Alternative was limited to review of available published geologic mapping and topographic maps derived from publicly available airborne lidar (light detection and ranging) survey information from the Oregon Department of Geology and Mineral Industries (DOGAMI). The three access alternatives are discussed in further detail below.

**Geologic Setting**

Lolo Pass Road is located along the upper part of the Sandy River drainage, about 10 mi west of Mount Hood. In the project area, the Sandy River occupies a channel about 0.25 to 0.75 mi in width. The river channel migration zone is bounded by upland areas underlain by Quaternary and Tertiary volcanic rocks. The channel is underlain by granular materials (sand, gravel, cobbles, and boulders) from volcanic debris flow deposits, older consolidated alluvial terrace deposits, and recent alluvial deposits in the active Sandy River channel.

**Modify Existing Lolo Pass Road Alternative**

The alternative to modify Lolo Pass Road includes construction of two 200-ft-long bridges separated by approximately 50-ft of roadway embankment. The primary geotechnical considerations for design of bridge foundations will be the characteristics of alluvial and debris flow sediments underlying the project alignment and the depth and quality of the underlying rock.

The bridge approach embankments, connecting roadway embankment, and portion of Lolo Pass road adjacent to the active river channel will be susceptible to river bank erosion, especially during high river levels. Near the north end of the alignment for this option, the road would continue to be susceptible to flooding and erosion occurring along the outside of a meander bend located about 1,900 to 2,500 ft eastbound of the existing bridge over the Sandy River. This option will likely require more maintenance and will have a significant risk of long-term road closures due to continued scour and erosion of the river bank at this meander bend in the river channel.

**Zigzag Mountain Alternatives (East and West)**

These two access alternatives include a new approximately 800-ft-long bridge that would cross the Sandy River in the vicinity of the east end of Autumn Lane. The Zigzag Mountain Alternatives (East and West) include cut slopes traversing alluvial fan deposits, landslide areas, a multi-span bridge over the active and dynamic river channel, large fills over river sediment and debris flow deposits for the bridge approaches, and an area of landslide debris identified at the north end of the alignment. Fills up to about 50 ft will be needed to construct the approach embankments for the new bridge over the Sandy River.

**Geologic Hazards**

Geologic hazards mapped in the vicinity of the alignment alternatives are shown on the Geologic Hazard Map, Figure 1, and include landslides, debris flows, and alluvial fans. The extent of debris flow deposits from the Old Maid Flats eruptive period of Mount Hood (1780 to 1801 AD) are shown as debris flow (yellow area) on Figure 1 (Pierson et, al., 2009). The upstream end of channel migration hazard identified by DOGAMI (English et. al., 2011) extends about a quarter mile upstream of the existing Lolo Pass Road bridge over the Sandy River and appears to correspond with the width of the area mapped as debris flow deposits. For the purpose of our evaluation, the area mapped as covered by the debris flows along the Sandy River is considered to be the channel migration hazard area; although mapping by the Federal Emergency Management Agency indicates a significantly narrower floodplain for the purposes of flood insurance mapping. Our assessment of the potential for river channel migration is supported by evaluation of US Army Corps of Engineers aerial photographs from 1961 and 1964, lidar data from 2011, and our observations of changes in the river channel location that have occurred since 2011. In our opinion, the actively meandering river channel could relocate to any portion of the area mapped as debris flow within the design life of the proposed bridge. Therefore, we recommend considering a bridge length that will

likely be longer than would be required to pass the design level flood in order to allow for future river channel migration.. The channel migration zone at the existing and proposed bridge sites and the potential effects on approach embankments constructed within the channel migration zone should be evaluated as part of the design of this project. As shown on Figure 1, several alluvial fans are mapped at the base of the ridge located southeast of Autumn Lane. About 5,500 ft of the East alternative and about 1,400 ft of the West alternative traverse the alluvial fans. The portion of the alignment near the east end of Autumn Lane is located on one of these alluvial fans. No active stream channel was observed on the alluvial fan at the time of our reconnaissance and further evaluation of the stream channel(s) will be needed as part of design for this access alternative. Considering the relatively small drainage basins collected by the streams that form these alluvial fan deposits, we anticipate that large-span culverts will likely be appropriate for these stream channel crossings. However, a significant portion of the roadway will be established in cuts up to about 35 ft below existing grades and additional cut and channel reconstruction will be needed for stream channels that cross the cut portions of alignment. Stormwater management and accumulation of debris deposited by the streams will be considerations for these alternatives, especially the East alternative.

For preliminary planning purposes, we recommend that cut and fill slopes should be graded no steeper than 2H:1V. Construction of cut slopes may require overexcavation and buttressing with compacted fill composed of hard, angular fragmental rock.

The area where the Zigzag Mountain alternatives would connect with Lolo Pass Road is mapped as Pleistocene to Holocene age landslide deposits (Sherrod and Scott, 1995). The origin of these deposits and the potential for recurrent landslide activity is not discussed in the published literature. We anticipate additional evaluation of the landslide debris area will be needed as the project progresses.

**Further Geotechnical Investigation**

A geotechnical investigation will be needed to design the proposed bridges over the Sandy River and the approach embankments. The primary geotechnical considerations for design of bridge foundations will be the characteristics of alluvial and debris flow sediments underlying the site and the depth and quality of the underlying rock. We anticipate that large cobbles and boulders are present within the sediments. Considering the constructability of foundations in this material and the possibility that the foundations will extend into the rock, we recommend considering small diameter drilled shaft foundations that can be drilled using down-hole hammer equipment, typically limited to diameters of about 30 in. A geotechnical investigation will be needed to evaluate the subsurface conditions for design of bridge foundations, embankment subgrades, and roadway cuts.

We recommend completing a preliminary geotechnical investigation to evaluate the characteristics of the sediments and depth to rock at the proposed bridge location. The information gathered by the preliminary geotechnical investigation will be useful in conceptual planning, preliminary design, and preliminary cost estimating for the three proposed access alternatives. We recommend using sonic drilling methods to complete the borings. For the Lolo Pass Rd. Modification Alternative, we recommend three borings; one at the southernmost bridge abutment, one at the roadway embankment between the bridges, and one at the northernmost bridge abutment. For the Zigzag Mountain alternatives, we recommend three borings; one boring on each the north and south sides of the river, and one in the area of landslide debris in the vicinity of the north bridge approach. We anticipate the boring located south of the river can be made in

the Autumn Lane right-of-way. The boring north of the river will likely require access onto private property for the exploration to be reasonably close to the proposed bridge location. The boring in the vicinity of the north bridge approach can be located in Lolo Pass Road and should include installation of an inclinometer to monitor for movement within the landslide debris.

The embankment fill for all three alternatives will be constructed on materials that are relatively loose and potentially susceptible to seismically induced liquefaction. The need for ground improvement methods to reduce the risk of liquefaction should be evaluated as part of the preliminary geotechnical investigation. Ground improvements would most likely be completed prior to constructing the embankment fills.

**Limitations**

This memorandum has been prepared to aid in the evaluation and conceptual planning of access alternatives for Lolo Pass Road. The information provided in this memorandum is preliminary and is intended for project planning and scoping purposes and is based on a limited ground-level reconnaissance and other sources of information described herein.

Please contact the undersigned if you have any questions.

Submitted for GRI,

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5588 ALTERNATIVES STUDY MEMO

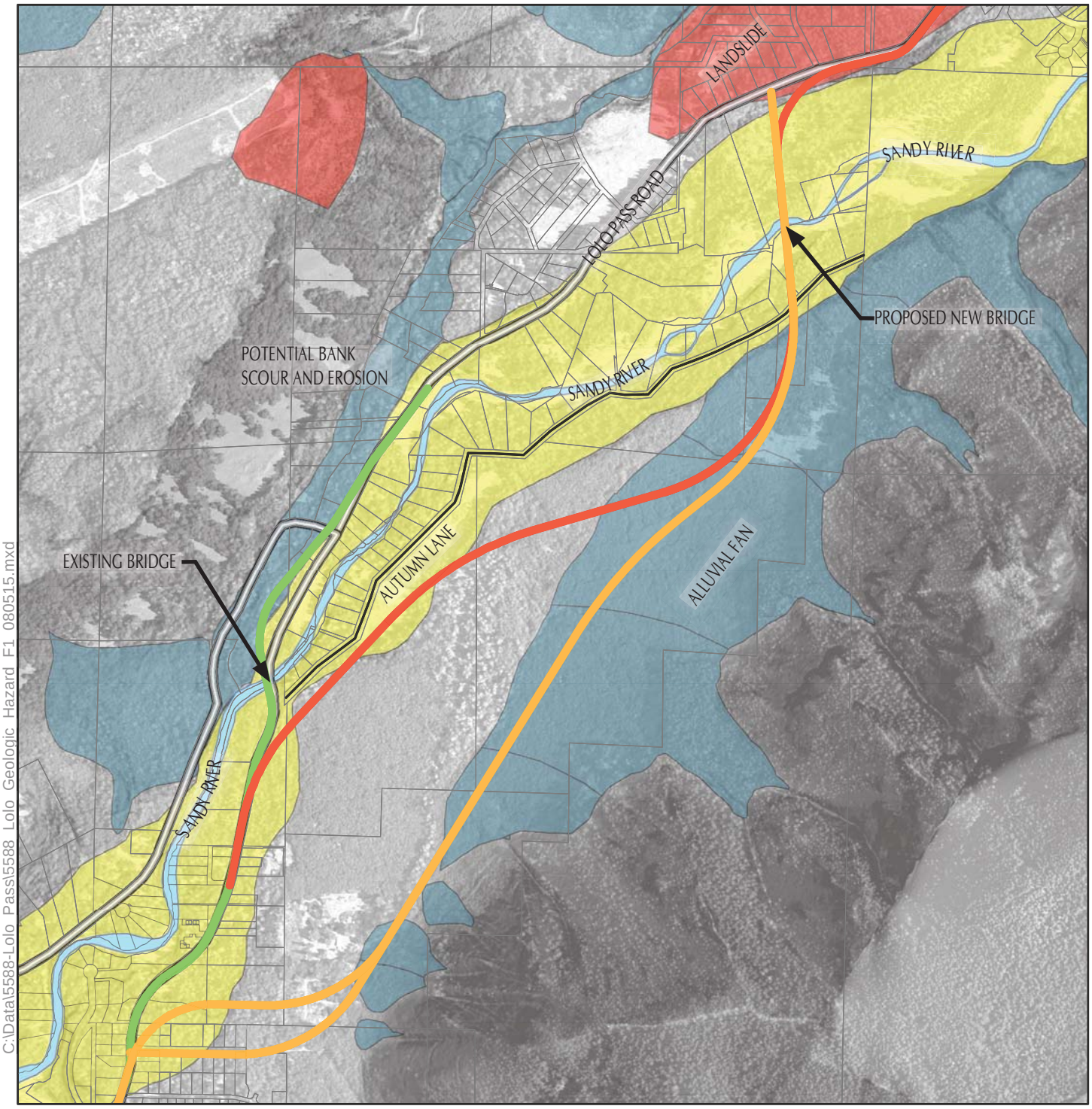
**References:**


Burns,W.J., and Watzig, R.J., 2014. Statewide Landslide Information Database for Oregon: Release 3.0., Oregon Department of Geology and Mineral Industries, SLIDO-3.

English, J.T., Coe, D.E., and Chappell, R.D., 2011, Channel Migration Hazard Map for the Sandy River, Multnomah and Clackamas Counties, Oregon, Plate 12; Oregon Department of Geology and Mineral Industries, Open-File Report O-11-13

Pierson, T.C., Scott, W.E., Vallance, J.W., and Pringle, P.T., 2009, Eruption-related Lahars and sedimentation response downstream of Mount Hood: Field guide to volcaniclastic deposits along the Sandy River, Oregon; The Geological Society of America, Field Guide 15.

Sherrod, D.R., and Scott, W.E., 1995, Preliminary geologic map of the Mount Hood 30- by 60-minute quadrangle, northern Cascade Range, Oregon: U.S. Geological Survey Open-File report 95-219

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North

0 1,000 2,000 FT

**ALIGNMENT ALTERNATIVES**

- MODIFY LOLO PASS ROAD
- ZIG ZAG MOUNTAIN WEST
- ZIG ZAG MOUNTAIN EAST

**GEOLOGIC HAZARD**

- ALLUVIAL FAN
- LANDSLIDE
- DEBRIS FLOW

GRI

DAVID EVANS AND ASSOCIATES, INC.
LOLO PASS ROAD ACCESS ALTERNATIVES

# GEOLOGIC HAZARD MAP

AUG. 2015 JOB NO. 5588-A FIG. 1