Cobalt Geosciences, LLC
P.O. Box 82243
Kenmore, Washington 98028

August 12, 2021

Ted Davis
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RE: Limited Geotechnical Evaluation
Proposed Residence
Parcel No. 8649400720
Skykomish, Washington

In accordance with your authorization, Cobalt Geosciences, LLC has prepared this letter to discuss the results of our limited geotechnical evaluation of the subject property. We visited the site in August 2021 to observe the current topography and vegetation.

Site Description & Proposed Construction

The site is located at the north end of 757th Avenue NE in Skykomish, Washington. The site consists of one irregularly shaped parcel (No. 8649400720) with an approximate area of 11,749 square feet. The attached figures show the property location and other features/information.

The property is undeveloped and vegetated with grasses, ferns, ivy, understory, and variable diameter trees. Most of the site is nearly level to slightly sloping downward to the north and northwest. There is a short slope along the north-northwest property line. This slope is about 15 feet tall and has magnitudes of 35 to 50 percent.

There is a stream approximately 170 feet southwest of the site. The Skykomish River is located approximately 250 feet northwest of the property.

The site is situated at the west end of landslide run-out material from a very large pre-historic debris flow landslide. The landslide originated near the top of a south-facing slope located about one third of a mile to the northeast. The attached figures show the site area, Lidar imagery, and mapped landslides. There are numerous mapped landslides in the Skykomish valley of varying ages, sizes, and likely causes.

The proposed construction includes a new residential structure in the southern portion of the property. A short driveway is anticipated to be graded with minimal cuts/fills.

Area Geology

The Geologic Map of King County indicates that the site is underlain by Vashon Recessional Outwash.

In this area, the recessional outwash consists of coarse sand and gravel with less amounts of silt and silty-sands. These materials are typically medium dense and highly permeable.

Nearby geologic units include landslide debris, alluvium, and in sloped areas, Jurassic-Cretaceous metamorphic and Igneous rocks (mostly schist and granodiorite). The mapped large-scale landslide appears to have originated on slopes comprised of schist and granodiorite. The slide material likely consists of highly weathered bedrock (soil and colluvium) that periodically flowed following saturation. The mountain slopes are very steep and locally devoid of large vegetation.

Landslide Hazards

Typical Critical Areas Ordinances (CAO) designate slopes with magnitudes greater than about 40 percent and vertical relief of at least 10 feet as geologically hazardous (steep slope/landslide hazards). This criterion is expanded to include slope areas where permeable soils overlie silt and clay, slopes with spring activity, areas of historic landslide activity, and in alluvial fan zones.

The subject property is located at the west end of landslide run-out debris that originated on very steep slopes (mountainsides) located northeast of the property. The topographic maps indicate that the site is at or near an elevation of 1,000 feet while the top of the ridge where the landslide scarp is located is at about 5,000 feet.

Based on our review, the landslide activity that resulted in the deposition of the run-out occurred at least 150 years ago. Many areas around the property are developed with residences and roadways. The steep slope from which the landslide originated currently has a logging road traversing across the slope about half-way up the mountain.

It is our opinion that the risk of similar landslide activity affecting the subject property during the design life of new structures is relatively low. The weathering activities required to create a large enough volume of soil to slide and run-out to this location from area mountainsides will likely take thousands of years.

There is a localized short steep slope in the northern portion of the property. The slope is about 15 feet tall and has magnitudes of 35 to 50 percent. We recommend a minimum 15 feet effective building setback and buffer from the top of this slope. This setback/buffer is 15 feet total and not additive (not 30 feet combined). The setback can be achieved by deepening foundation elements to create an equivalent effective setback. Please notify us if this is proposed or if clarity is required to understand this terminology.

No setbacks or buffers are required from the historic landslide hazard areas or run-out zones. The Skykomish River flows west and southwest north and west of the property. The site is within an interior corner which will not be affected by long-term river meandering. The meander erosion is expected to occur on the west side of the river, away from this development area.

Conclusions & Recommendations

It is our opinion that the landslide run-out and alluvial or recessional outwash soils that underlie the site are generally stable and the risk of future mass-wastage and debris flows that could result in structural damage is low. This is based on the historic age of the deposits, time of soil and rock weathering/deposition, and nature of the geologic units (mostly bedrock). Furthermore, there is no evidence of recent large-scale debris flows or landslide activity in the vicinity and the area of the property is well developed.

Based on the results of our review, no specific mitigation for debris flows is warranted. The proposed development will not adversely affect the slope stability within the property or adjacent areas.

We recommend a minimum 15 feet effective building setback and buffer from the top of the short slope in the northern portion of the site. This setback/buffer is 15 feet total and not additive (not 30 feet combined). The setback can be achieved by deepening foundation elements to create an equivalent effective setback. Please notify us if this is proposed or if clarity is required to understand this terminology.

We have included design parameters for use in foundation and basement retaining wall construction, if this information is necessary. Based on the likely variable composition and density of the shallow soils, some overexcavation may be required. We can provide additional recommendations upon request.

Foundation Design

The proposed residence may be supported on a shallow spread footing foundation system bearing on undisturbed dense or firmer native soils or on properly compacted structural fill placed on the suitable native soils. Any undocumented fill or loose soils should be removed and replaced with structural fill below foundation elements. Structural fill below footings should consist of clean angular rock 5/8 to 2 inches in size.

For shallow foundation support, we recommend widths of at least 16 and 24 inches, respectively, for continuous wall and isolated column footings supporting the proposed structure. Provided that the footings are supported as recommended above, a net allowable bearing pressure of 2,000 pounds per square foot (psf) may be used for design.

A 1/3 increase in the above value may be used for short duration loads, such as those imposed by wind and seismic events. Structural fill placed on bearing, native subgrade should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. Footing excavations should be inspected to verify that the foundations will bear on suitable material.

Exterior footings should have a minimum depth of 18 inches below pad subgrade (soil grade) or adjacent exterior grade, whichever is lower. Interior footings should have a minimum depth of 12 inches below pad subgrade (soil grade) or adjacent exterior grade, whichever is lower.

If constructed as recommended, the total foundation settlement is not expected to exceed 1 inch. Differential settlement, along a 25-foot exterior wall footing, or between adjoining column footings, should be less than ½ inch. This translates to an angular distortion of 0.002. Most settlement is expected to occur during construction, as the loads are applied. However, additional post-construction settlement may occur if the foundation soils are flooded or saturated. All footing excavations should be observed by a qualified geotechnical consultant.

Resistance to lateral footing displacement can be determined using an allowable friction factor of 0.40 acting between the base of foundations and the supporting subgrades. Lateral resistance for footings can also be developed using an allowable equivalent fluid passive pressure of 225 pounds per cubic foot (pcf) acting against the appropriate vertical footing faces (neglect the upper 12 inches below grade in exterior areas). The frictional and passive resistance of the soil may be combined without reduction in determining the total lateral resistance.

Care should be taken to prevent wetting or drying of the bearing materials during construction. Any extremely wet or dry materials, or any loose or disturbed materials at the bottom of the footing excavations, should be removed prior to placing concrete. The potential for wetting or drying of the bearing materials can be reduced by pouring concrete as soon as possible after completing the footing excavation and evaluating the bearing surface by the geotechnical engineer or his representative.

Slab-on-Grade

We recommend that the upper 18 inches of the existing fill and/or native soils within slab areas be re-compacted to at least 95 percent of the modified proctor (ASTM D1557 Test Method).

Often, a vapor barrier is considered below concrete slab areas. However, the usage of a vapor barrier could result in curling of the concrete slab at joints. Floor covers sensitive to moisture typically requires the usage of a vapor barrier. A materials or structural engineer should be consulted regarding the detailing of the vapor barrier below concrete slabs. Exterior slabs typically do not utilize vapor barriers.

The American Concrete Institutes ACI 360R-06 Design of Slabs on Grade and ACI 302.1R-04 Guide for Concrete Floor and Slab Construction are recommended references for vapor barrier selection and floor slab detailing.

Slabs on grade may be designed using a coefficient of subgrade reaction of 210 pounds per cubic inch (pci) assuming the slab-on-grade base course is underlain by structural fill placed and compacted as outlined in Section 8.1. A 4- to 6-inch-thick capillary break layer should be placed over the prepared subgrade. This material should consist of pea gravel or 5/8 inch clean angular rock.

A perimeter drainage system is recommended unless interior slab areas are elevated a minimum of 12 inches above adjacent exterior grades. If installed, a perimeter drainage system should consist of a 4-inch diameter perforated drain pipe surrounded by a minimum 6 inches of drain rock wrapped in a non-woven geosynthetic filter fabric to reduce migration of soil particles into the drainage system. The perimeter drainage system should discharge by gravity flow to a suitable stormwater system.

Exterior grades surrounding buildings should be sloped at a minimum of one percent to facilitate surface water flow away from the building and preferably with a relatively impermeable surface cover immediately adjacent to the building.

Concrete Retaining Walls

The following table, titled **Wall Design Criteria**, presents the recommended soil related design parameters for retaining walls with a level backslope. Contact Cobalt if an alternate retaining wall system is used. This has been included if detention vaults are to be utilized.

Wall Design Criteria	
"At-rest" Conditions (Lateral Earth Pressure – EFD+)	55 pcf (Equivalent Fluid Density)
"Active" Conditions (Lateral Earth Pressure – EFD+)	35 pcf (Equivalent Fluid Density)
Seismic Increase for "At-rest" Conditions (Lateral Earth Pressure)	10H* (Uniform Distribution) (1 in 500 year event)
Seismic Increase for "Active" Conditions (Lateral Earth Pressure)	5H* (Uniform Distribution)
Passive Earth Pressure on Low Side of Wall	Neglect upper 2 feet, then 250 pcf EFD+

(Allowable, includes F.S. = 1.5)	
Soil-Footing Coefficient of Sliding Friction (Allowable; includes F.S. = 1.5)	0.40

*H is the height of the wall; Increase based on one in 500 year seismic event (10 percent probability of being exceeded in 50 years),
+EFD – Equivalent Fluid Density

The stated lateral earth pressures do not include the effects of hydrostatic pressure generated by water accumulation behind the retaining walls. Uniform horizontal lateral active and at-rest pressures on the retaining walls from vertical surcharges behind the wall may be calculated using active and at-rest lateral earth pressure coefficients of 0.3 and 0.5, respectively. A soil unit weight of 125 pcf may be used to calculate vertical earth surcharges.

To reduce the potential for the buildup of water pressure against the walls, continuous footing drains (with cleanouts) should be provided at the bases of the walls. The footing drains should consist of a minimum 4-inch diameter perforated pipe, sloped to drain, with perforations placed down and enveloped by a minimum 6 inches of pea gravel in all directions.

The backfill adjacent to and extending a lateral distance behind the walls at least 2 feet should consist of free-draining granular material. All free draining backfill should contain less than 3 percent fines (passing the U.S. Standard No. 200 Sieve) based upon the fraction passing the U.S. Standard No. 4 Sieve with at least 30 percent of the material being retained on the U.S. Standard No. 4 Sieve. The primary purpose of the free-draining material is the reduction of hydrostatic pressure. Some potential for the moisture to contact the back face of the wall may exist, even with treatment, which may require that more extensive waterproofing be specified for walls, which require interior moisture sensitive finishes.

We recommend that the backfill be compacted to at least 90 percent of the maximum dry density based on ASTM Test Method D1557. In place density tests should be performed to verify adequate compaction. Soil compactors place transient surcharges on the backfill. Consequently, only light hand operated equipment is recommended within 3 feet of walls so that excessive stress is not imposed on the walls.

Erosion and Sediment Control

Erosion and sediment control (ESC) is used to reduce the transportation of eroded sediment to wetlands, streams, lakes, drainage systems, and adjacent properties. Erosion and sediment control measures should be implemented, and these measures should be in general accordance with local regulations. At a minimum, the following basic recommendations should be incorporated into the design of the erosion and sediment control features for the site:

- All work should take place during the dry season (generally May through September).
- All site work should be completed and stabilized as quickly as possible.
- Additional perimeter erosion and sediment control features may be required to reduce the possibility of sediment entering the surface water. This may include additional silt fences, silt fences with a higher Apparent Opening Size (AOS), construction of a berm, or other filtration systems.

- Any runoff generated by dewatering discharge should be treated through construction of a sediment trap if there is sufficient space. If space is limited other filtration methods will need to be incorporated.

Closure

The information presented herein is based upon professional interpretation utilizing standard practices and a degree of conservatism deemed proper for this project. We emphasize that this report is valid for this project as outlined above and for the current site conditions and should not be used for any other site.

Sincerely,

Cobalt Geosciences, LLC

8/12/2021

Phil Haberman, PE, LG, LEG
Principal

PH/sc

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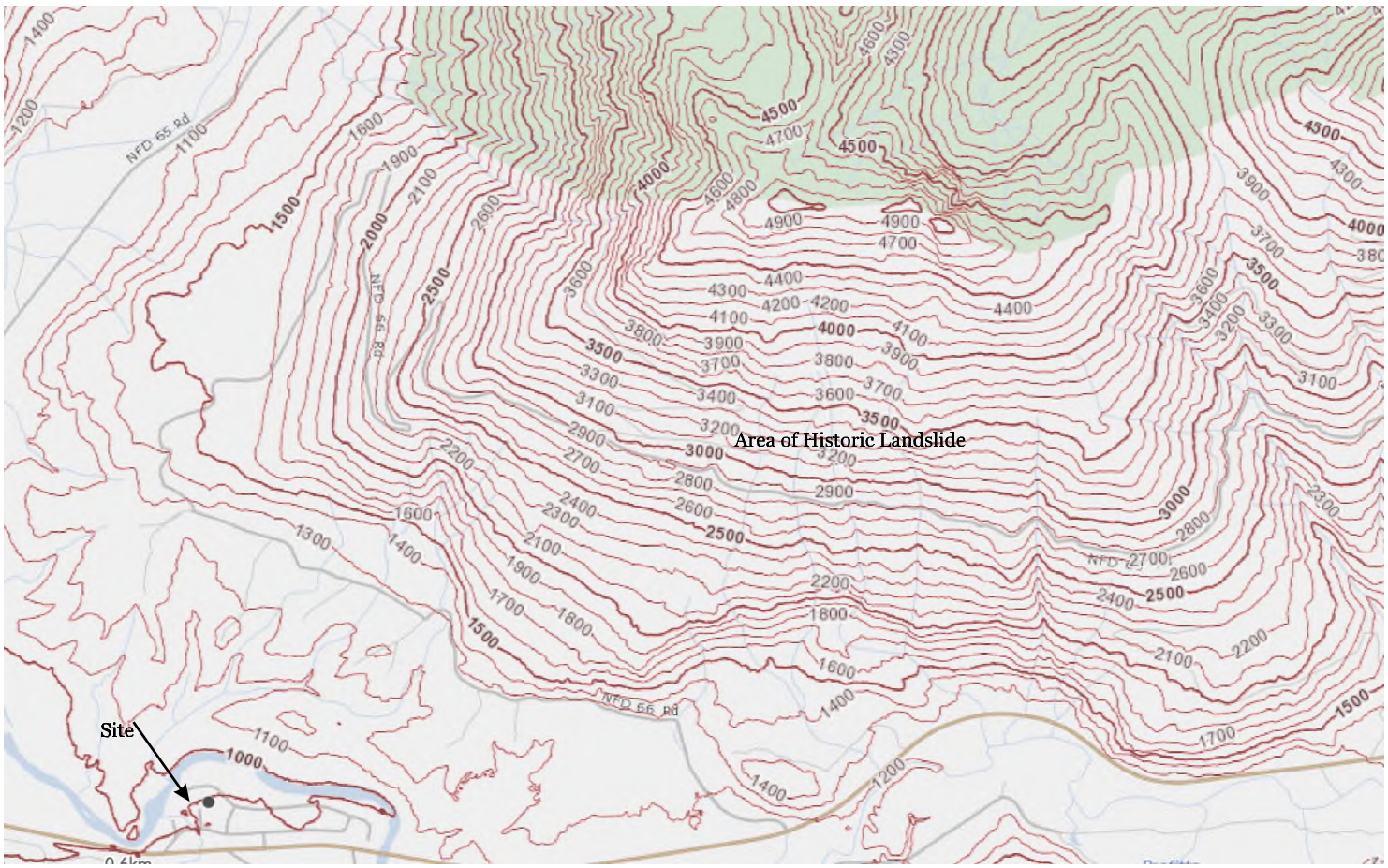
COBALT GEOSCIENCES	Proposed Residence 122xx 757th Avenue NE Skykomish, Washington	**Site Map** **Figure 1**	Cobalt Geosciences, LLC P.O. Box 82243 Kenmore, WA 98028 (206) 331-1097 www.cobaltgeo.com cobaltgeo@gmail.com



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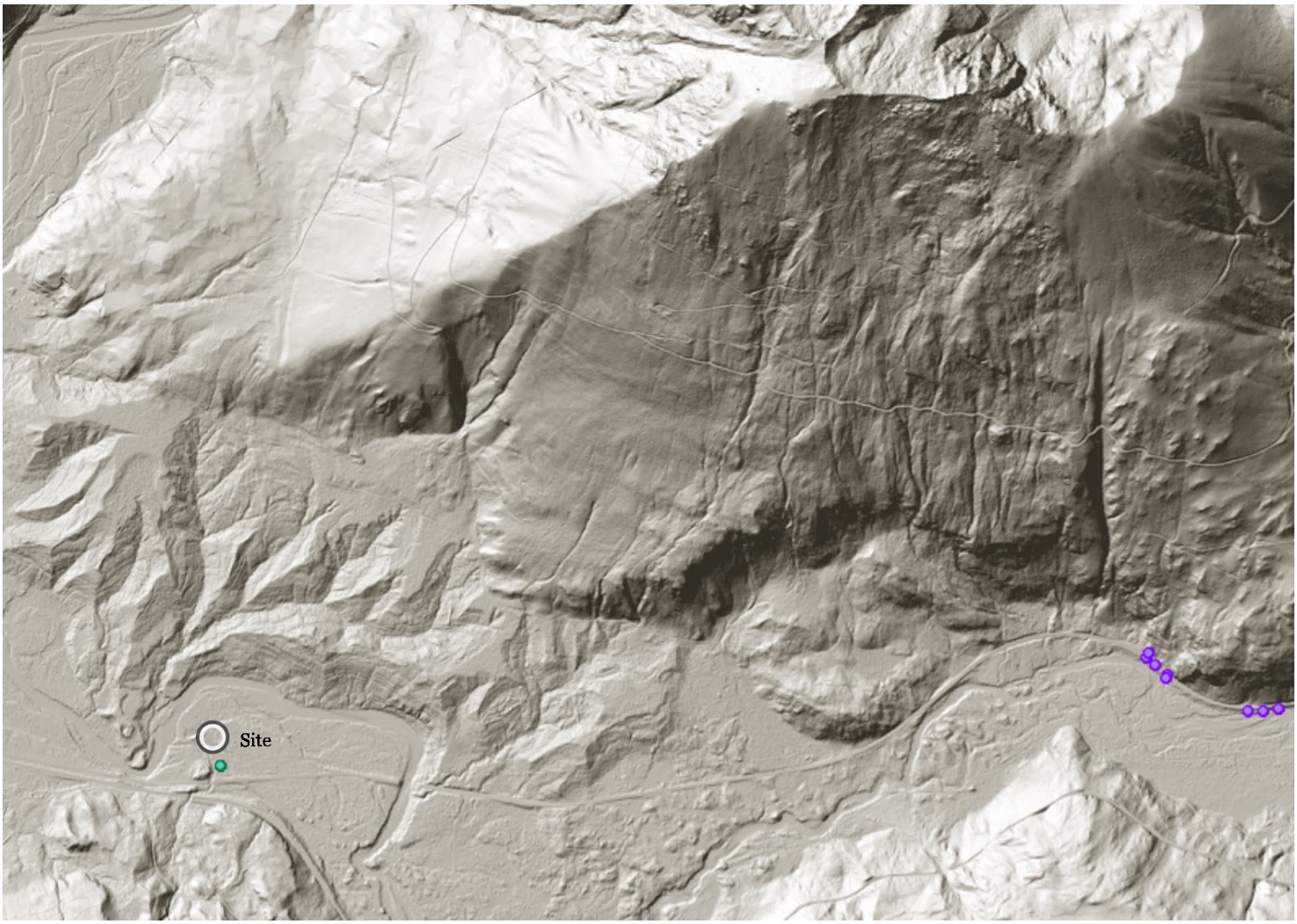
From King County Imap Topography

COBALT GEOSCIENCES	Proposed Residence 122xx 757th Avenue NE Skykomish, Washington	**Area Map** **Figure 2**	Cobalt Geosciences, LLC P.O. Box 82243 Kenmore, WA 98028 (206) 331-1097 www.cobaltgeo.com cobaltgeo@gmail.com



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From DNR Website

COBALT GEOSCIENCES

Proposed Residence
122xx 757th Avenue NE
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Lidar Image
Figure 3

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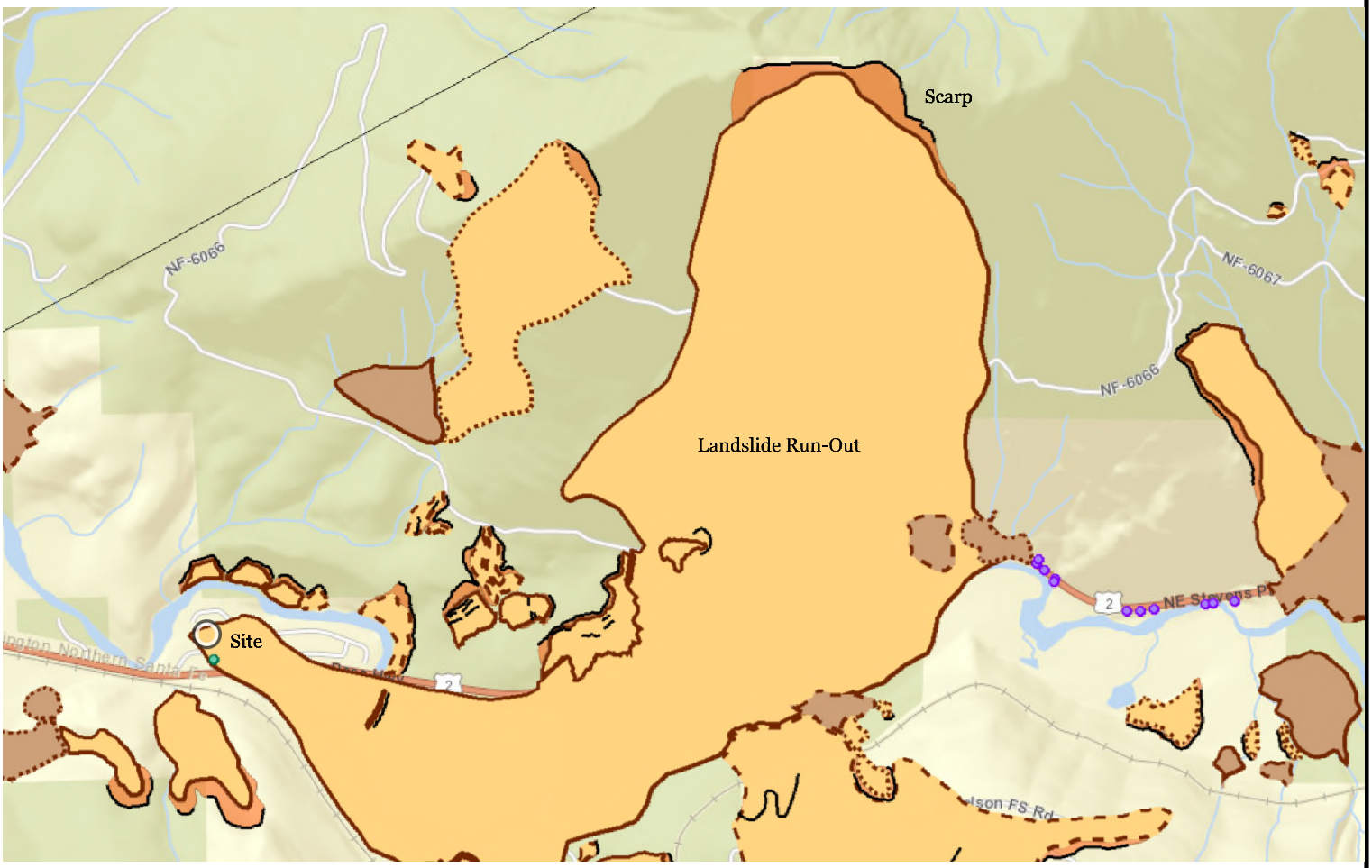

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From DNR Website

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Landslide Locations Figure 4

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