December 9, 2019

Mr. Spencer Stephens
1141 East 2800 North
North Ogden, Utah
84414

Subject: **Report**
Professional Geologist Site Reconnaissance and Review
123-Acre Old Snowbasin Road Property
South of the intersection of Old Snowbasin Road and Basinview Road.
Huntsville, Weber County, Utah
CMT Project No.: 13739

Mr. Stephens,

INTRODUCTION

Submitted herewith is the report of our geological reconnaissance study for the above referenced site. The 123 Acre Property parcel consists of mountainous lands located in the vicinity of Old Snowbasin Road, in the Huntsville Area of Ogden Valley in Weber County, Utah. The Site location relative to mapped topographic and improved features is provided on Figure 1. Vicinity Map. Figure 2 provides aerial coverage of the site and detail of the current (2018) layout of the site and vicinity. The property consists of a single property parcel herein named the Wadman Parcel, and is indexed by Weber County as parcel #20-034-0003.

The subject parcel and surrounding properties are zoned by Weber County as Forest Zone FV-3 (Forest Valley Zone - 3) land-use zone, with Forest Zone F-40 (Forest Zone - 40) land use zone for the public lands located to the north of the parcel. According to the Weber County Code of Ordinances *the purpose of the Forest Valley Zone, FV-3 is to provide area for residential development in a forest setting at a low density, as well as to protect as much as possible the naturalistic environment of the development.* The prescribed minimum building lot area in the FV-3 Zone is 3 acres (excluding cluster type provision areas), with single-family residences included as a permitted use.

It is our understanding that current development plans are not finalized for the property at this time, however we expect the site will be subdivided and improved to accommodate six single-family home sites. We expect that site development will require a moderate to significant amount of earthwork in the form of site cutting, filling and grading. Individual homes will likely to be constructed with basement levels supported on conventional spread and strip footings. Above grade levels will consist of wood frame construction one to three levels in height. Projected individual home site grading is anticipated to consist primarily of cutting into the existing ground to construct the residence, with very little fill projected for the home sites. Access roads and service connections are also anticipated for the proposed site development.

Because the site appears to be located on a hillslope area in the vicinity of mapped landslide hazards, marginal soils, and FEMA floodplain areas, and for permitting Weber County will request that geological site reconnaissance be performed to assess whether all or parts of the site are exposed to the hazards that are included in the Weber County Code, Section 108-22 Natural Hazard Areas (Weber County, 2019). These hazards include, but are not limited to: Surface-Fault Ruptures, Landslide, Tectonic Subsidence, Rock Fall, Debris Flows, Liquefaction Areas, Flood, or other Hazardous Areas.

The purpose of this **Professional Geologist Site Reconnaissance Review** is to evaluate if the proposed development is outside or within areas identified as Natural Hazards Area, and if within or exposed to a hazard area, to recommend appropriate additional studies that comply with the purpose and intent of the Section 108-14 Weber County Hillside Development Review Procedures and Standards (Weber County, 2019) to evaluate and/or mitigate the hazard exposure for the proposed developments.

LITERATURE AND RESOURCE REVIEW

To evaluate the potential exposure of sites to geological hazards that impact sites or site improvements, Weber County has compiled a series of Geographic Information Systems (GIS) data mapping layers of geological hazard related information. These data may be queried on-line using the Weber County Geo-Gizmo web server application at:

http://www.co.weber.ut.us/gis/maps/gizmo/.

Using the Geo-Gizmo application, under the Engineering Layers category, is listed geological hazard related layers that may be toggled on and off to determine potential hazards exposure to sites in the county. These mapping layers include the following categories; *Quake Epicenters, FEMA Flood Zone Line, FEMA Base Flood Elevation, Wasatch Faults, Landslide Scarps, Geologic Faults, Faults, Quaternary Faults, FEMA Flood Zone, FEMA LOMR, Engineering Problems; Liquefaction Potential, Landslide, FEMA Letters of Map Change, and FEMA Flood Zones.* These layers have been compiled from the respective agencies including the Federal Emergency Management Agency (FEMA), the Utah Geological Survey (UGS), and the U.S. Geological Survey (USGS). These mapping layers consist of regional compilation hazards data but are not compiled at scales that are necessarily applicable for site specific usage and planning. When hazard layer data on the Geo-Gizmo are found to interact with Permit Applicant site improvement locations, Weber County Engineers and Planners will request that the Permit Applicant have a Professional Geologist Site Reconnaissance Review, such as presented herein, conducted for the site.

In addition to the Geo-Gizmo site screening, the Weber County Engineers and Planners rely on recently published UGS geological Survey mapping (Coogan and King, 2016), that includes much of Weber County, for determining if a site is located upon a potentially hazardous geological mapping unit, thus requiring a geological reconnaissance. This interactive Weber County Geologic Map may be viewed on-line at:

https://weber.maps.arcgis.com/apps/webappviewer/index.html?id=bd557ebafc0e4ed58471342bb03fdac5

Our preliminary review of the Geo-Gizmo indicated that much of the subject property was within an area classified as "*landslide*" hazard units according the UGS landslide database (Elliott and Harty, 2010), however the location did not show exposure to any of the other aforementioned hazard layer areas, Including; *Quaternary Faults* (USGS and UGS, 2006)*, Engineering Problems* (Mulvey, 1992) and *FEMA Flood Zone* (FEMA, 2015).

The review of the Weber County Geologic Map indicated the site was located upon (**Qms**) Mass movement (landslide) deposits Holocene and Pleistocene age; (**Qmso?(Tn)**) Mass movement deposits, Pleistocene? Age; (**Qms?(ZYp)**) Mass movement bedrock block deposits Holocene and Pleistocene age; and (**Tn**) Norwood Formation rocks, Tertiary age (Coogan and King, 2016); which are ALL mapping units that have been determined as potentially hazardous by Weber County, thus requiring these geologic studies.

Our site-specific review consisted of a GIS data integration effort that included:

1. Reviews of previous mapping and literature pertaining to site and regional geology including and Sorensen and Crittenden (1979), Mulvey (1992), USGS and UGS (2016), Elliott and Harty (2010), King and others (2008), King and McDonald (2014), and Coogan and King (2016).

2. An analysis of vertical and stereoscopic aerial photography for the site including a 1946 black and white 1:20,000 stereoscopic sequence (frames, AAJ-2B-51 and AAJ-2B-51), a 1987 color/infrared 1:40,000 NAPP stereoscopic sequence (frames, 315-38 and 315-39), 2012 5.0 inch digital HRO coverage, and 2018 0.6 meter digital NAIP coverage of the site.

3. A GIS analysis using the QGIS® GIS platform to geoprocess and analyze 2016 0.5 meter LiDAR digital elevation data made available for the site by the Utah Automated Geographic Reference Center (AGRC). The GIS analysis included using the QGIS® platform Geospatial Data Abstraction Library (GDAL, 2013) Contour; the GRASS® (Geographic Resources Analysis Support System, 2013) r.slope and r.shaded.relief modules.

For the best site-specific documentation for this review we relied on geologic mapping by King and others (2008), which provided the best scale (1:24,000) rendering of geological mapping for the site location. Mapping by Coogan and King (2016) was also used to support this review. The geological mapping for this review is provided on Figure 3, Geologic Mapping. Topographic, slope, and elevation data for this review were supported through the aforementioned LiDAR analysis which is presented on Figure 4, LiDAR Analysis.

REVIEW FINDINGS

The site is located on the eastern flank of Mount Ogden, the western flank of which comprises the Wasatch Front. The surficial geology of the site vicinity is the result of the uplift and exposure of older

Precambrian rocks which forms the crest of Mount Ogden west of the site. This exposure was the result of movement along high-angle faults during late Tertiary and Quaternary age (Bryant, 1988). Bounding the east foothill flank of Mount Ogden are mid Tertiary units of the Norwood Formation that ramp along the base of the mountains south and west of the Ogden Valley floor. The Norwood Formation is described as "light-gray to light brown, altered tuff (claystone), tuffaceous siltstone, sandstone, and conglomerate" derived from volcanic ash deposition, and has been measured to be as much as 7,000 feet thick in the vicinity of the site (King, and others, 2008). The existing surface of the site and vicinity appears to have been modified by Quaternary age erosion, and localized late-Quaternary stream, lacustrine processes (Currey and Oviatt, 1985), residual soil weathering and development, and mass movement processes (King and others, 2008).

Topographically the site is located on base foothills on the northeast side of Mount Ogden and overlooks Ogden Valley and the South Fork of the Ogden River floodplain, which is inundated by Pineview Reservoir waters to the north of the site. As shown on Figure 2 the site consists of an area of approximately 123 acres in size that is currently vacant and undeveloped. The topography of the site vicinity consists of a foothill ridge crest and side slopes with about 530 feet of local vertical relief across the property, with elevations on the property ranging between 5,464 feet (msl) on the northeast side of the site and 5,994 feet on the west side of the site.

Site Geology

Figure 3, Geologic Mapping shows the location of the site relative to GIS overlays including geological mapping layers transcribed from King and others (2008). A summary of the geological units shown on Figure 3, as described by King and others (2008), are paraphrased below in relative age sequence (youngest to oldest):

Qac - Alluvium and colluvium (Holocene and Pleistocene) - Includes stream and fan alluvium, colluvium, and locally mass-movement deposits...

Qc - Mass movement colluvial deposits (Holocene and Pleistocene) Unsorted clay- to boulder-sized material...

Qmc - Landslide and slump, and colluvial deposits, undivided (Holocene and Pleistocene)... (slopewash and soil creep)...

Qmsy - Younger landslide and slump deposits (Holocene) - Poorly sorted clay- to boulder-sized material...

Qms - Landslide and slump deposits (Holocene and Pleistocene) - Poorly sorted clay- to boulder-sized material...

Qms(Tn) - **Qms?(Tn)** - Landslide deposits likely comprised of Norwood Formation (**Tn**) blocks...

Qmso - Older landslide and slump deposits (Pleistocene) - Poorly sorted clay- to boulder-sized material...

Qms(ZYp) - **Qms(ZYpp?)** - **Qms?(ZYpp?)** - Landslide deposits (Holocene and Pleistocene) likely comprised of Formation of Perry Canyon (ZYp) blocks...

Qmso(Tn) - **Qmso?(Tn)** - Older landslide deposits (Pleistocene) likely comprised of Norwood Formation (Tn) blocks...

Tn- Norwood Formation (lower Oligocene and upper Eocene) - Typically light-gray to light brown, altered tuff (claystone), tuffaceous siltstone, sandstone, and conglomerate...

ZYp - Formation of Perry Canyon, undivided bedrock (Neoproterozoic and possibly Mesoproterozoic) Argillite to meta-graywacke upper unit, middle meta-diamictite, and basal slate, argillite, and meta-sandstone; locally phyllitic…

A site-specific discussion of the geological units mapped on the property, in relative youngest to oldest age order, is provided as follows:

The **Qac** deposits consist of alluvium and colluvium that are Holocene to Pleistocene in age, deposited 0 to 15,000 years before present (ybp). Where these deposits are present on the site, it is likely these deposits are thin and overlie older landslide deposits (**Qms** and **Qmso(Tn)**) discussed as follows.

The **Qmc** deposits are **l**andslide and slump, and colluvial deposits, undivided Holocene and Pleistocene in age (0 to 30,000 ybp). The **Qmc** mapped units typically include smaller landslide slopes and slopes comprised of thin slopewash and soil-creep deposits. The **Qmsy**, and **Qms** deposits include landslide slump deposits associated with failed or moving slopes, deeper than **Qmc** deposits. The **Qmsy** deposits are interpreted as younger, being Holocene in age (0 to 12,000 ybp), whereas the **Qms** deposits are older and extend from Holocene and Pleistocene in age (0 to 30,000 ybp).

The **Qms(ZYp)**, **Qms?(ZYpp?)**, and the **Qmso?(Tn)** deposits are block failure deposits, that consist of existing older rock masses that have moved as blocks during Holocene and Pleistocene time (0 to 30,000 ybp). The **Qms(ZYp)** and **Qms?(ZYpp?)**, consist of Proterozoic age blocks that moved during Holocene and Pleistocene time (0 to 30,000 ybp), and the **Qmso?(Tn)** deposits are Tertiary aged blocks that moved earlier during the Pleistocene time, likely prior to 12,000 ybp.

The Tertiary Norwood Formation, **Tn,** is a lower Oligocene and upper Eocene (20 to 30 million ybp) ash deposit that originated from regional volcanic activity. The Norwood Formation typically consists of light-gray to light-brown altered tuff (claystone), altered tuffaceous siltstone and sandstone, and conglomerate. The Norwood Formation, comprised of soft rocks, has a notoriety of poor stability performance (particularly within steep slopes), and geotechnically challenging (expansive) soils throughout the area (Mulvey, 1992).

Geologic/Natural Hazards

The natural hazards discussed herein are those included in the Section 108-22 Natural Hazard Areas of the Weber County Code (2019). These hazards include but are not limited to: Surface-Fault Ruptures,

Landslide, Tectonic Subsidence, Rock Fall, Debris Flows, Liquefaction Areas, Flood, or other Hazardous Areas. The occurrence of these hazards and the context of these hazards to the site, are summarized as follows:

1. **Landsliding:** Landsliding-mass movement mechanisms including slope creep (Varnes, 1978); would include geological units on the site mapped as **Qmc, Qms, Qms(ZYp)**, **Qms?(ZYpp?)**, and **Qmso(Tn)** and **Qmso?(Tn)** as shown on Figure 3. These areas (units) have experienced movement within the past 30,000 years should be considered unstable or potentially unstable for future land use considerations.

2. **Alluvial fan debris flow processes** including flash flooding and debris flow hazard: The nearest potential debris flow process deposits to the site are mapped as **Qafp** by King and others (2008), and occur approximately a half-mile northeast of the site (not shown on Figure 3). These deposits and processes do not appear to be a potential impact to the site.

3. **Seismic Hazards - Surface fault rupture hazards, strong earthquake ground motion, tectonic subsidence and liquefaction:**

   Surface fault rupture hazards: The nearest active (Holocene) earthquake fault to the site is the Weber segment of the Wasatch fault zone (UT2351E) which is located 5.5 miles west of the site (Black and others, 2004), thus fault rupture hazards are not considered present on the site. The Ogden Valley southwestern margin fault (UT2375) crosses on the west side the site, as shown on Figure 3, however the most recent movement along this fault is estimated to be pre-Holocene (>15,000 ybp), shows no surficial expression on the site, and this fault is not considered an active risk for this location (Black and others, 1999).

   Strong earthquake ground motion: Strong ground motion originating from the Wasatch fault or other near-by seismic sources is capable of impacting the site. The Wasatch fault zone is considered active and capable of generating earthquakes as large as magnitude 7.3 (Arabasz and others, 1992). Based on probabilistic estimates (Peterson, and others, 2014) queried for the site, the expected peak horizontal ground acceleration (PGA) on rock from a large earthquake with a ten-percent probability of exceedance in 50 years is as high as 0.16*g.* For a two-percent probability of exceedance in 50 years, the PGA is as high as 0.35 *g* for the site.

   The ten-percent probability of exceedance in 50 years event has a return period of 475 years, and the 0.16*g* acceleration for this event corresponds with "strong" perceived shaking with "light" potential damage based on instrument intensity correlations. The two-percent probability of exceedance in 50 years event has a return period of 2,475 years, and the 0.35*g* acceleration for this event corresponds with "very strong" perceived shaking with "moderate" potential damage based on instrument intensity correlations (Wald and others, 1999).

   Future ground accelerations greater than these are possible but will have a lower probability of occurrence.

Tectonic Subsidence is surface tilting subsidence that occurs along the boundaries of normal faults in response to surface-faulting earthquakes (Keaton, 1986). Because the site is not located in near proximity to active earthquake faults, tectonic subsidence hazards are not considered a risk to the site.

Liquefaction potential hazards: In conjunction with strong earthquake ground motion potential of large magnitude seismic events as discussed previously, certain soil units may also possess a potential for liquefaction during a large magnitude event. Liquefaction is a phenomenon whereby loose, saturated, granular soil units lose a significant portion of their shear strength due to excess pore water pressure buildup resulting from dynamic loading, such as that caused by an earthquake. Among other effects, liquefaction can result in densification of such deposits causing settlements of overlying layers after an earthquake as excess pore water pressures are dissipated. Horizontally continuous liquefied layers may also have a potential to spread laterally where sufficient slope or free-face conditions exist. The primary factors affecting liquefaction potential of a soil deposit are: (1) magnitude and duration of seismic ground motions; (2) soil type and consistency; and (3) occurrence and depth to groundwater.

Liquefaction potential hazards have not been studied or mapped for the Ogden Valley area, as has occurred in other parts of northern Utah (Anderson and others, 1994). Liquefaction commonly occurs in saturated non-cohesive soils such as alluvium, which may be present in the Qac deposits mapped on parts of the site. However, according to Weber County Sec. 108-22-3 - Studies and reports required, liquefaction hazard potential hazard evaluations are not required for residential subdivisions or single lots.

4. **Rockfall and avalanche hazards**: The site is more than 2000 feet from steep slope areas, and is not located precipitously below areas where such hazards may originate.

5. **Flooding:** No significant waterways pass in the vicinity of the site and detailed flood insurance rate mapping by Federal Emergency Management Agency for the site vicinity has not been prepared for this area at this time (FEMA, 2015). Local sheet flow, slope wash, and seasonally perched soil water typical of sloping areas should be anticipated for the proposed site development.

6. **Sloping surfaces:** The site vicinity slopes developed from our LiDAR analysis range from level to well over 50-percent as shown on Figure 4, LiDAR Analysis. The calculated average slopes for the 123-acre property is 33.4 percent.

   The limiting gradient for slope development considerations and hillside review according to the Weber County Section 108-14-3 includes slopes greater than 25-percent (Weber County Code, 2019).

7. **Radon exposure:** Radon is a naturally occurring radioactive gas that has no smell, taste, or color, and comes from the natural decay of uranium that is found in nearly all rock and soil.

Radon has been found to occur in the Ogden Valley area, and can be a hazard in buildings because the gas collects in enclosed spaces. Indoor testing following construction to detect and determine radon hazard exposure should be conducted to determine if radon reduction measures are necessary for new construction. The radon-hazard potential mapping has been prepared for most of Ogden Valley by the Utah Geological Survey (Solomon, 1996), however that mapping does not extend far enough to the south to include the subject property. The radon-hazard potential is mapped as "Moderate" for the area directly north of the site (600 feet) included in studies by the UGS (Solomon, 1996). For new structures, radon-resistant construction techniques as provided by the EPA (2016) should be considered.

8. **Mass Movement and Steep Slope Limitations, Hazards Overlay Map:** Figure 5, Hazards Overlay, presents the combined areas of "potentially active" slopes, and slope areas greater than 25-percent. This map is provided as preliminary site development planning guideline, and should not be considered a final determination as to the slope stability conditions on the site. The potentially active slope areas include areas classified as **Qmsy** and **Qms** on Figure 3, and the limiting gradient is shown as greater than 25-percent areas on Figure 5.

Site Reconnaissance

The site was reconnoitered on November 1, 2019. The site was accessed from Old Snowbasin Road by a two-track vehicle trail through neighboring property on the southeast side of the parcel. In general, the property slopes gently to steeply down to the east, with surface drainage also directed eastward into forks of Poison Hollow to the east of the site, as shown on Figure 1.

At the time of our visit, cover on the property consisted of dense clusters of scrub oak and maple trees, with a few juniper and spruce individuals. Tall dormant bunch grasses, desiccated mule ear, sage brush and weeds occupied the open areas on the site. The soils observed on the surface of the site and in shallow pits excavated on the site, appeared to consist of gravelly clays with sub-angular cobble and boulder sized particles. A completed well casing was observed on the west side of the site. The well apparently serves the Basinview Subdivision located to the southwest of the property. The Utah Water Rights records for this well can be queried at:

https://www.waterrights.utah.gov/asp_apps/exprint/exprint.asp?exnum=E5295

With the exception of the well, the site was generally observed to be unimproved. Estate home site developments were observed on adjacent properties to the southeast along Old Snowbasin Road, and single family home sites were observed to the southwest where the Basinview Subdivision borders the property. The lands to the east, west and north of the site consisted of undeveloped meadows and woodlands.

CONCLUSIONS

Based upon the findings of this review we believe for preliminary subdivision and site development planning, that areas on Figure 5, delimited as "Potentially Active Slopes" and "Greater than 25-Percent Slopes" areas should be avoided for siting dwellings and human occupancy structures. Subdivision and

site development of the property areas outside the "Potentially Active Slopes" and "Greater than 25-Percent Slopes" areas should undergo procedures outlined in Section 108-14 Weber County Hillside Development Review Procedures and Standards (Weber County, 2019).

Because mass movement (landslide) hazards classifications are mapped for almost the entirety of the property (**Qac, Qmc, Qmsy. Qms, Qms(ZYp)**, **Qms?(ZYpp?)**, and **Qmso?(Tn)**), or are underlain by potentially unstable Norwood Formation (**Tn**) rocks**,** we also believe that the guidance provided by the Weber County Natural Hazards Overlay Section 108-22-2 - Potential Hazards Section (2) Landslides, should be integrated with Hillside Review studies for subdivision and site development for all areas of the property. The Weber County Natural Hazards Overlay Section 108-22-2 - Potential Hazards Section (2) Landslides, provides the following for development in these potentially hazardous areas:

> *…Many methods have been developed for reducing a landslide hazard. Proper planning and avoidance is the least expensive measure, if landslide-prone areas are identified early in the planning and development process. Care in site grading with proper compaction of fills and engineering of cut slopes is a necessary follow-up to good land use planning. Where avoidance is not feasible, various engineering techniques are available to stabilize slopes, including de-watering (draining), retaining structures, piles, bridging, weighting or buttressing slopes with compacted earth fills and drainage diversion. Since every landslide and unstable slope has differing characteristics, any development proposed within an identified landslide hazard area shall require the submittal and review of a study and report, as provided in section 108-22-3. The study and report shall address slope stability (including natural or proposed cut slopes), evaluate slope-failure potential, effects of development and recommendations for mitigative measures. Slope stability analysis shall include potential for movement under static, development-induced and earthquake-induced conditions as well as likely groundwater conditions…*

The Hillside Review and Natural Hazards Overlay studies will likely require additional Geological, Geotechnical and Slope Stability studies for subdivision and site development.

LIMITATIONS

The conclusions provided herein were limited to the scope of work discussed in the introduction section of this report. The results provided by this study are limited to geological hazards included as "potential hazards" in Section 108-22 Natural Hazard Areas of the Weber County Code (2019). Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering and engineering geology principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

REFERENCES

Anderson, L.R., Keaton, J.R., and Bay, J.A., 1994, Liquefaction potential map for the northern Wasatch Front, Utah, complete technical report: Utah Geological Survey Contract Report 94-6, 150 p., 6 plates, scale 1:48,000.

Arabasz, W.J., Pechmann, J.C., and Brown, E.D., 1992, Observational seismology and the evaluation of earthquake hazards and risk in the Wasatch Front area, Utah, in Gori, P.L., and Hays, W.W., (eds.), Assessment of regional earthquake hazards and risk along the Wasatch Front, Utah: U.S. Geological Survey Professional Paper 1500-D, 36 p.

Black, B.D., DuRoss, C.B., Hylland, M.D., McDonald, G.N., and Hecker, S., compilers, 2004, Fault number 2351e, Wasatch fault zone, Weber section, in Quaternary fault and fold database of the United States: U.S. Geological Survey *website, http://earthquakes.usgs.gov/hazards/qfaults, accessed 06/20/2016 02:49 PM.*

Black, B.D., Hylland, M.D., and Hecker, S., compilers, 1999, Fault number 2375, Ogden Valley southwestern margin faults, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults.

Bryant, B.B., 1988, Geology of the Farmington Canyon Complex, Wasatch Mountains, Utah: USGS Professional Paper 1476, 54 p., 1 scale 1:50,000

Coogan, J.C., and King, J.K., 2016, Interim geologic map of the Ogden 30' x 60' quadrangle, Box Elder, Cache, Davis, Morgan, Rich, and Summit Counties, Utah, and Uinta County, Wyoming: Utah Geological Survey Open File Report 653DM, for use at 1:62,500 scale, 3 plates, 147 p.

Currey, D.R., and Oviatt, C.G., 1985, Durations, average rates, and probable causes of Lake Bonneville expansion, still-stands, and contractions during the last deep-lake cycle, 32,000 to 10,000 years ago, in Kay, P.A., and Diaz, H.F., (eds.), Problems of and prospects for predicting Great Salt Lake levels - Processing of a NOAA Conference, March 26-28, 1985: Salt Lake City, Utah.

Elliott, A.H., and Harty, K.M., 2010, Landslide Maps of Utah, Utah Geological Survey Map 246DM, 14 p., 46 plates, 1:100,000 scale

EPA 2016, Radon-Resistant Construction Basics and Techniques: Environmental Protection Agency website, https://www.epa.gov/radon/radon-resistant-construction-basics-and-techniques accessed 07/20/2016

FEMA, 2015, Flood Insurance Rate Map, 2015 Weber County, Utah, Panel 49057C0475F, Scale 1 inch equals 1000 feet.

GDAL-SOFTWARE-SUITE, 2013, Geospatial data abstraction library. http://www.gdal.org.

GRASS-PROJECT, 2013. Geographic resource analysis support system. http://grass.osgeo.org.

Keaton, J.R., 1986, Potential consequences of tectonic deformation along the Wasatch fault: Utah State University, Final Technical Report to the U.S. Geological Survey for the National Earthquake Hazards Reduction Program, Grant 14-08-0001-G0074, 23 p.

King, J.K., Yonkee, W.A., and Coogan, J.C., 2008, Interim geologic map of the Snow Basin and part of the Huntsville quadrangle, Davis, Morgan, and Weber Counties, Utah: Utah Geological Survey Open-File Report 536, scale 1:24,000.

Mulvey, W.E., 1992, Soil and rock causing engineering geologic problems in Utah: Utah Geological Survey Special Study 80, 23 p., scale 1:500,000.

Petersen, M.D., Moschetti, M.P., Powers, P.M., Mueller, C.S., Haller, K.M., Frankel, A.D., Zeng, Yuehua, Rezaeian, Sanaz, Harmsen, S.C., Boyd, O.S., Field, Ned, Chen, Rui, Rukstales, K.S., Luco, Nico, Wheeler, R.L., Williams, R.A., and Olsen, A.H., 2014, Documentation for the 2014 update of the United States national seismic hazard maps: U.S. Geological Survey Open-File Report 2014–1091, 243 p.

Solomon, B.J., 1996, Radon-hazard potential in Ogden Valley, Weber County, Utah: Utah Geological Survey Public Information Series 36, 2 p., 1 figure, approximate scale 1:83,300.

Sorensen, M.L., and Crittenden, M.D., Jr., 1979, Geologic map of the Huntsville quadrangle, Weber and Cache Counties, Utah: U.S. Geological Survey Geologic Quadrangle Series Map GQ-1503, scale 1:24,000.

U.S. Geological Survey and Utah Geological Survey, 2006, Quaternary fault and fold database for the United States, from USGS web site: http//earthquakes.usgs.gov/hazards/qfaults/

Varnes, D.J., 1978, Slope movement types and processes, in Schuster, R.L., and Krizek, R.J., eds., Landslides—Analysis and control: National Research Council, Washington, D.C., Transportation Research Board, Special Report 176, p. 11–33.

Wald, D.J., Quitoriano, V., Heaton, T.H., and Kanamori, H., 1999, Relationship between Peak Ground Acceleration, Peak Ground Velocity, and Modified Mercalli Intensity in California: Earthquake Spectra, v. 15, no. 3, p. 557-564

Weber County Code (2019), retrieved from:
https://www.municode.com/library/ut/weber_county/codes/code_of_ordinances

Weber County Inspection (2019), retrieved from:
http://www.webercountyutah.gov/inspection/documents/Development Process Packet.pdf

We appreciate the opportunity to work with you on this project and look forward to assisting with you in the future. If you have any questions or need additional information on this or other reporting, please do not hesitate to contact us at (801) 870-6730.

Sincerely,
CMT Engineering Laboratories

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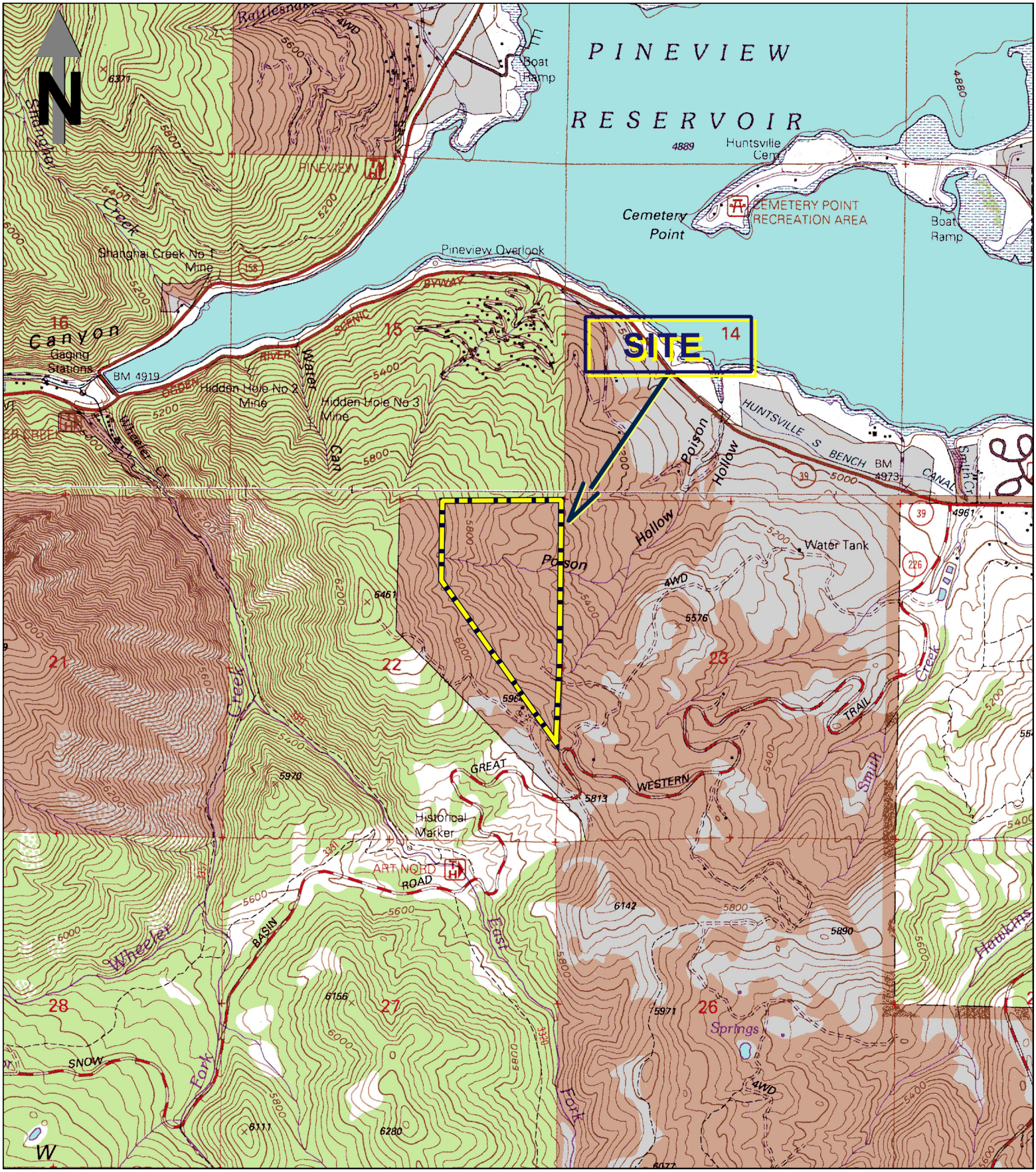
Attachments:

Figure	1	Vicinity Map
Figure	2	Aerial Coverage
Figure	3	Geologic Mapping
Figure	4	LiDAR Analysis
Figure	5	Hazard Overlay

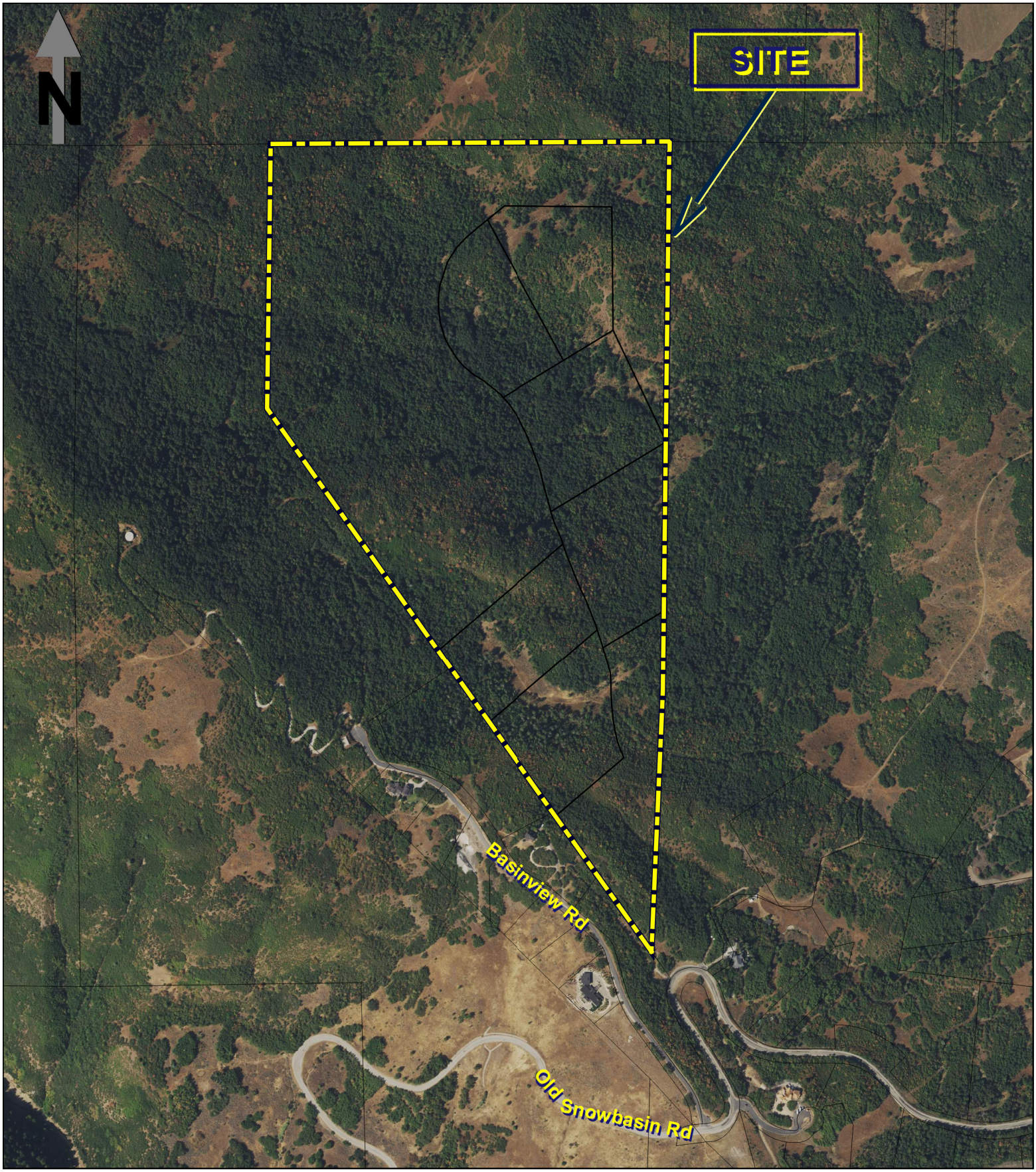


Base:
1998 7.5 Minute USGS Toporgraphic Maps
Titled Snowbasin, Utah, and Huntsville, Utah.

0 2000 4000 ft

1:24,000

123-Acre Old Snowbasin Road Property Huntsville, Weber County, Utah	CMT ENGINEERING LABORATORIES		Figure 1
	Vicinity Map	Date:	1-Nov-19
		Job #	13739



Base:
2018 0.6m Color NAIP Orthoimagery,
from Utah AGRC; http://gis.utah.gov/

0 600 1200 ft

1:7,200

123-Acre Old Snowbasin Road Property
Huntsville, Weber County, Utah

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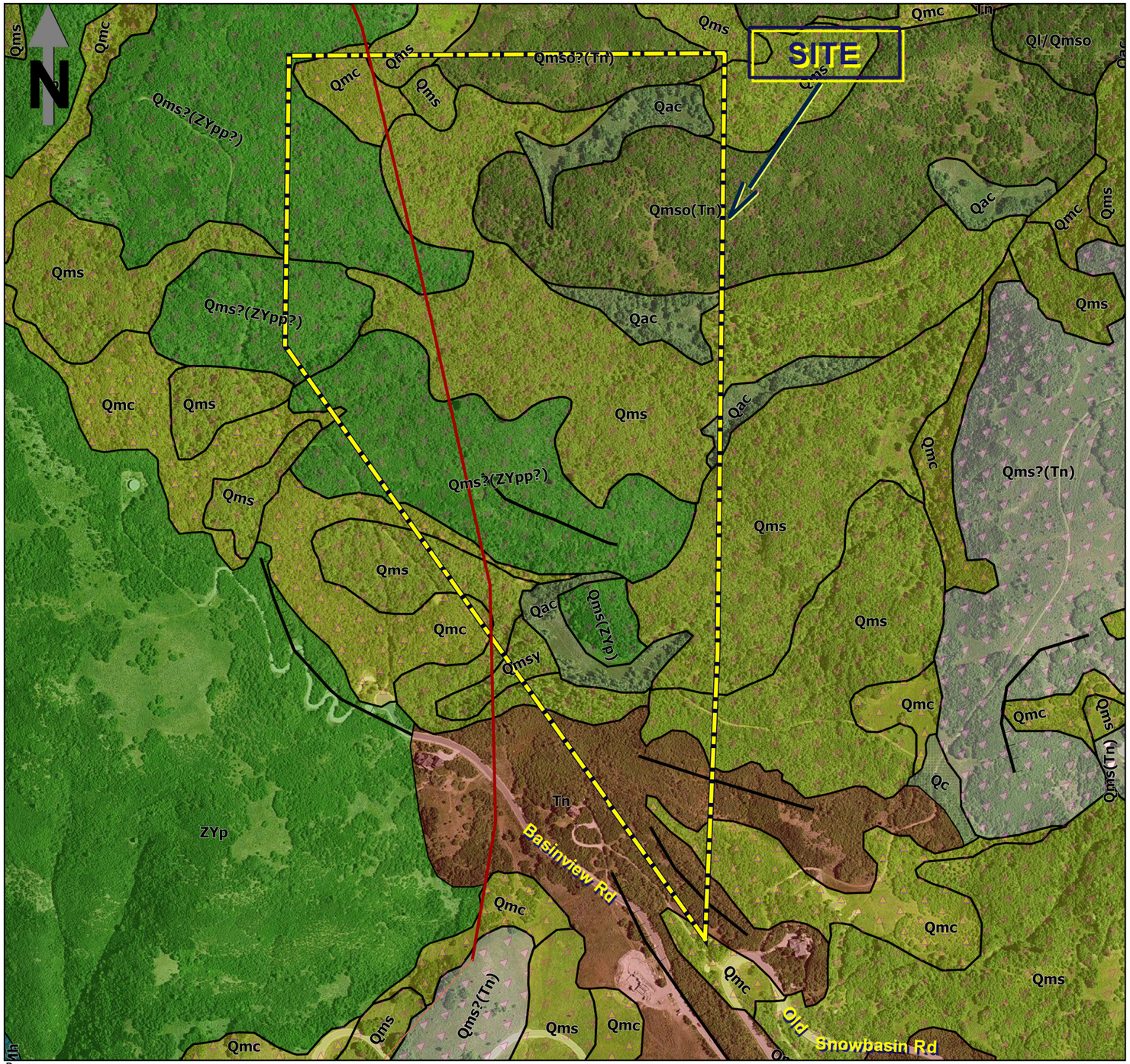
Aerial Coverage

Date:	1-Nov-19
Job #	13739

Figure 2



Base:
2014 1.0m Color NAIP Orthoimagery, from Utah AGRC; http://gis.utah.gov/
Geology after King and others, 2008

0 500 1000 ft

1:6,000

Explanation

Geology after King others 2018

- Qac - Alluvium and colluvium (Holocene and Pleistocene) - Includes stream and fan alluvium, colluvium, and locally mass-movement deposits...
- Qc - Mass movement colluvial deposits (Holocene and Pleistocene) Unsorted clay- to boulder-sized material...
- Qmc Landslide and slump, and colluvial deposits, undivided (Holocene and Pleistocene)... (slopewash and soil creep)...
- Qmsy - Qms - Landslide and slump deposits (Holocene and Pleistocene) - Poorly sorted clay- to boulder-sized material...Qmsy indicate probable Holocene age...
- Qms(Tn) - Qms?(Tn) - Landslide deposits (Holocene and Pleistocene) likely comprised of Norwood Formation (Tn) blocks...
- Qms(ZYp) - Qms(ZYpp?) - Qms?(ZYpp?) - Landslide deposits (Holocene and Pleistocene) likely comprised of Formation of Perry Canyon (ZYp) blocks...
- Qmso(Tn) - Qmso?(Tn) - Older landslide deposits (Pleistocene) likely comprised of Norwood Formation (Tn) blocks...
- Tn - Norwood Formation bedrock (lower Oligocene and upper Eocene) - Typically light-gray to light brown, altered tuff (claystone), tuffaceous siltstone, sandstone, and conglomerate...
- ZYp - Formation of Perry Canyon, undivided bedrock (Neoproterozoic and possibly Mesoproterozoic) Argillite to meta-graywacke upper unit, middle meta-diamictite, and basal slate, argillite, and meta-sandstone; locally phyllitic…
- Landslide Head Scarp
- Ogden Valley southwestern margin faults (after Black and others, 1999)

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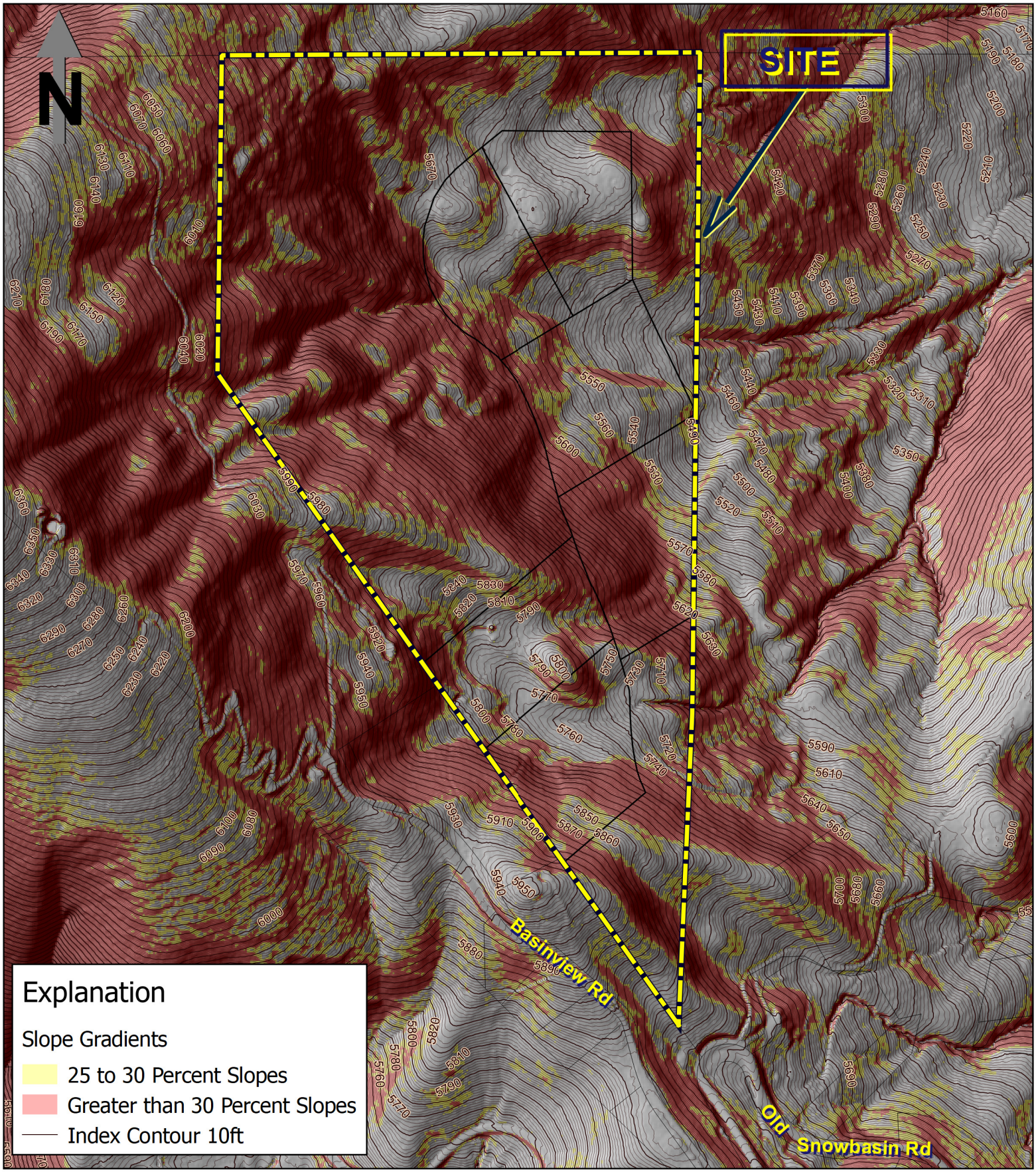
123-Acre Old Snowbasin Road Property
Huntsville, Weber County, Utah

GEOLOGIC MAPPING

Date:	22-Nov-19
Job #	13739

Figure 3



Base:
2006 2m LiDAR Imagery
from Utah AGRC; http://gis.utah.gov/

0 500 1000 ft

1:6,000

123-Acre Old Snowbasin Road Property

Huntsville, Weber County, Utah

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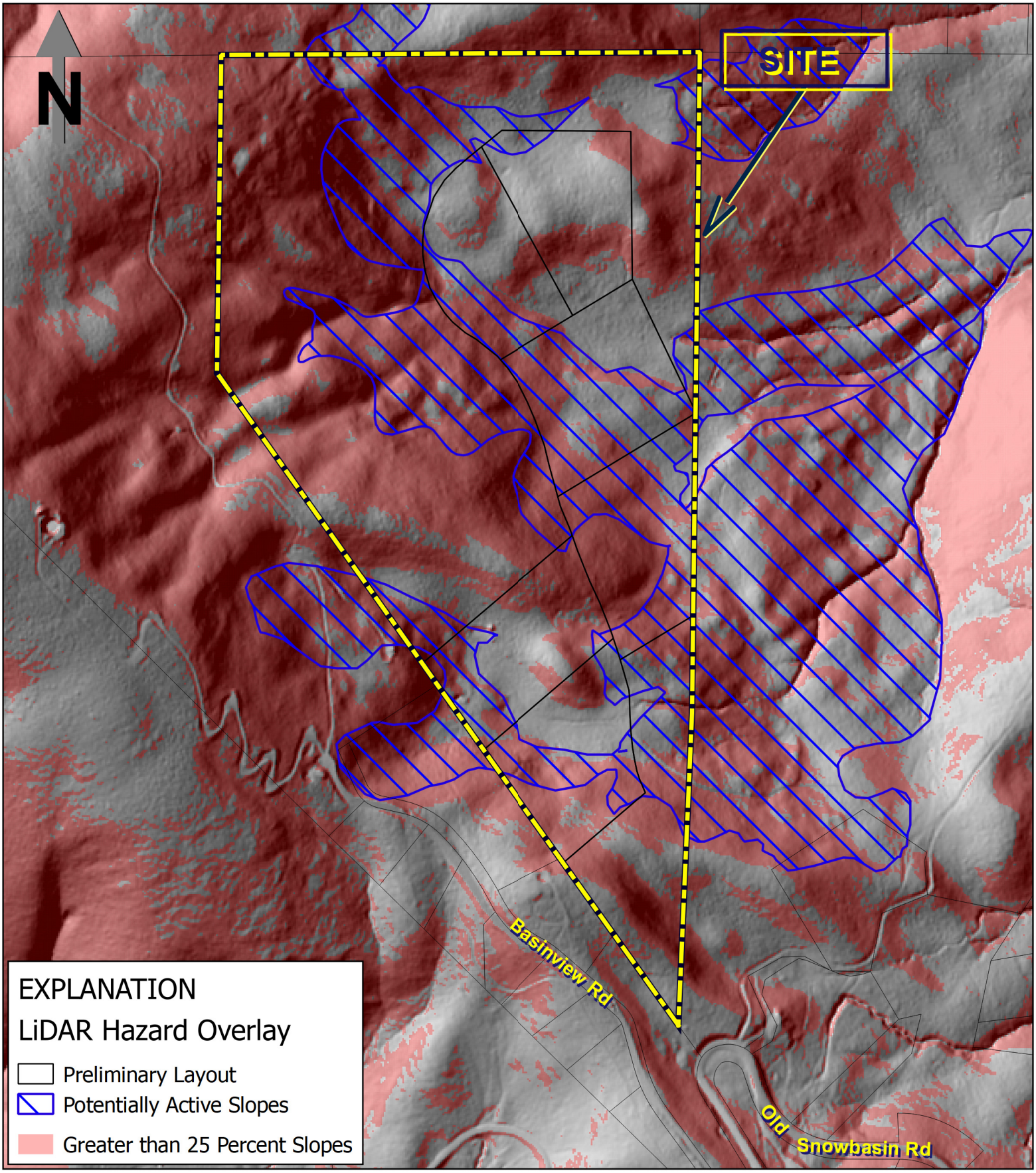
LiDAR Analysis

Date:	1-Nov-19
Job #	13739

Figure 4



Base:
2006 2m LiDAR Imagery
from Utah AGRC; http://gis.utah.gov/

0 500 1000 ft

1:6,000

123-Acre Old Snowbasin Road Property Huntsville, Weber County, Utah	CMT ENGINEERING LABORATORIES		Figure 5
	LiDAR Overlay	Date: 1-Nov-19 Job # 13739	