GCS Geoscience

Report Professional Geologist Site Reconnaissance and Review
11.3-Acre Parcel # 20-035-0040
Approximately 5900 East Old Snowbasin Road
Huntsville, Weber County, Utah

For:

Mr. Palmer DePaulis
834 South 600 East Street
Salt Lake City, Utah
84102

By:

GCS Geoscience
554 South 7700 East Street
Huntsville, Utah 84317

November 18, 2020
GCS File No: 2020.68

GCS Geoscience

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Mr. Palmer DePaulis
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Attention: Mr. DePaulis

Subject: **Report**
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INTRODUCTION

In response to your request, GCS Geoscience (GCS) has prepared this Professional Geologist site reconnaissance review report for the above referenced site. The subject parcel consists of an approximately 11.3-acre undeveloped property located in the Huntsville Area in Weber County, Utah, as shown on attached Figure 1. Figure 2 provides aerial coverage of the site and detail of the current (2018) layout of the site vicinity.

The subject parcel and surrounding properties are zoned by Weber County as Forest Zone FV-3 (Forest Valley Zone - 3) land-use zone. 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 you are developing the property for future use and sale as a single-family homesite. We expect that the eventual single-family homesite construction will be typical and consist of a single-family residence structure, likely to be constructed with a basement level and supported on conventional spread and strip footings. Above grade levels will consist of wood frame construction one to three levels in height. Projected site grading is anticipated to consist primarily of cutting into the existing ground to construct the residence, with very little fill projected for the site.

Because the proposed site appears to be located in part on a hillslope area in the vicinity of mapped landslide hazards, marginal soils, and FEMA floodplain areas, Weber

County will request that a 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 before a building permit will be issued. 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 Weber County Natural Hazards Area guidelines and standards in order to be "cleared" for building permit issuance by the county, as outlined by the Weber County Development Process packet provided by the Weber County Building Inspection Department (2020).

The objectives and scope of this study were presented to Mr. Palmer DePaulis (**Client**) in our (GCS) Proposal-Agreement dated November 2, 2020, and was signed November 3, 2020 by Mr. DePaulis.

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 of detail 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 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 mapping layers indicated that the 11.3-acre property was within an area classified as "*landslide*" hazard according the UGS landslide database (Elliott and Harty, 2010), and was within "*Engineering Problems*" areas identified by UGS database layers (Mulvey, 1992). The location did not show exposure to the other aforementioned hazard area layers, including; *Quaternary Faults* (USGS and UGS, 2006), and *FEMA Flood Zone* (FEMA, 2015).

The Weber County Geologic Map shows the site is underlain by mass movement - block failure deposits (**Qms?(Tn)**), and mass movement deposits (**Qms**), both geologic units that have been identified by Weber County as potentially hazardous.

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

1. Reviews of previous mapping and literature pertaining to site geology including King and others (2008), and Coogan and King (2016).

2. An analysis of vertical and stereoscopic aerial photography for the site including; a historical 1947 1:20,000 stereoscopic sequence, a 2012 5.0-inch digital HRO coverage, and a 2018 0.6-meter digital NAIP orthoimagery 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. Smaller scale mapping by Coogan and King (2016) was also used to support this review, but is a more spatially generalized reference for this area. The geological mapping for this review is provided on Figure 3, Geologic Mapping. Topographic, slope, and elevation data for this review was 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 which western flank comprises the Wasatch Front. The surficial geology of the site vicinity is the result of the uplift and

exposure of older pre-Cambrian rocks which forms the crest of Mount Ogden east 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 7000 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 (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 11.3-acre site is currently vacant and undeveloped. The topography of the site vicinity consists of a foothill ridge crest with about 280 feet of local vertical relief, with elevations on the property ranging between 5292 feet (msl) on the east side of the site to 5560 feet on the west side of the site.

The site, as shown on Figure 2 (2018 imagery), is bordered on the west by Old Snowbasin Road, and by adjacent similar vacant undeveloped properties on the north, south, and east.

Site Geology

Figure 3, Geologic Mapping, shows the location of the site relative to GIS overlays including geological mapping layers drawn by King and others (2008), and modified herein. A summary of the geological mapping of the site vicinity is provided as follows:

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

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...

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...

The 11.3-acre property is shown on Figure 3 to be located partly upon **Qms** landslide deposits; **Qmc** landslide slump, and colluvial deposits; **Qms?(Tn)** landslide deposits likely comprised of Norwood Formation (**Tn**) blocks; and **Qmsy** younger landslide and slump deposits. The **Qmsy** landslide deposits, are classified as Holocene and in age, and should be considered susceptible to future landslide-slope movement, particularly when disturbed. The **Qms** and **Qmc** deposits appear to be presently stable under the existing slope conditions but are likely to be sensitive to disturbance and grading, particularly on steep slopes. The **Qms?(Tn)** deposits are block failure deposits that appear to be presently stable under the existing slope conditions but are also likely to be sensitive disturbance and grading. The Norwood Formation (**Tn**) bedrock which underlies the surficial deposits (**Qmsy, Qms**, **Qmc and Qms?(Tn)**) on the site, and from which the surficial deposits have derived, has a notoriety of poor stability performance (particularly with steep slopes), and geotechnically challenging (expansive) soils throughout the area (Mulvey, 1992).

Geologic/Natural Hazards

In addition to the review and location query we searched for nearby or proximal classifications or conditions that could possibly present hazardous conditions to the site. A summary of this search is provided as follows:

1. **Landsliding:** On the basis of mapping by King and others (2008), and mapped herein, the nearest potentially active landslide units are mapped as **Qmsy** deposits that are located near the center of the 11.3-Acre property. The **Qmsy** deposits mapped on the site appear to have been recently active, and should be avoided for the placement of structures, and/or significant grading cuts and fills.

2. **Alluvial fan debris flow processes** including flash flooding and debris flow hazard: The nearest alluvial fan debris flow process deposits to the site, are mapped as **Qafy,** and occur approximately 2300 feet east of the 11.3-acre property, and are not shown on Figure 3. These deposits and the location of these potential processes do not appear to be a potential impact to the site.

3. **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 6.3 miles west of the site (Black and others, 2004). Accordingly, fault rupture hazards are not considered present on the site. The Ogden Valley southwestern margin faults (UT2375) are located much closer to the site, approximately 0.7 miles to the west, however the most recent movement along this fault is estimated to be pre-Holocene (>15,000 ybp), and presently is not considered an active risk (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 USGS probabilistic estimates (Petersen, and others, 2014) queried for the site, the expected peak horizontal ground acceleration on rock from a large earthquake with a ten-percent probability of exceedance in 50 years is as high as 0.17*g,* and for a two-percent probability of exceedance in 50 years is as high as 0.38*g* for the site.

The ten-percent probability of exceedance in 50 years event has a return period of 475 years, and the 0.17*g* acceleration for this event corresponds "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 2475 years, and the 0.38*g* acceleration for this event corresponds "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 is not found on the 11.3-acre property, consequently the conditions susceptible to liquefaction do not appear to be present at the site.

4. **Rockfall and avalanche hazards:** The site is over a mile from steep slope areas where such hazards may originate.

5. **Flooding:** No significant water ways pass in the vicinity of the site and 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 site, and site improvements.

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. As shown on Figure 4, the 11.3-acre site is situated near a ridge with the site surface sloping gently to steeply to the east. The calculated average slopes for the property is 32.7 percent.

   The boundary 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, 2020). The areas shown on Figure 2 and Figure 4 delimited as “Suggested Building Areas” include areas on the site with slopes approximately 25 percent or less.

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 and has been found 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 parcel. The radon-hazard potential is mapped as "Moderate" for the area directly northeast 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.

SITE RECONNAISSANCE

The 11.3-acre site was reconnoitered on November 6, 2020. The site was accessed from Old Snowbasin Road on the west side of the parcel, where a moderately steep vehicle ramp has been graded from the road onto the property. From the property frontage on the west side of the Old Snowbasin Road, the site surface slopes gently to steeply down to the east, becoming significantly steep within 150 to 200 feet east of the frontage. At the time of our visit, cover on the property consisted of dense clusters of scrub oak and maple trees, with a few juniper individuals. Dormant bunch grasses, mule ear chaff, sage brush and weeds occupied the open areas on the site. The surficial soils on the site appeared to consist of gravelly clays with sub-angular cobble and boulder sized particles. An open excavation, approximately 6- to 8-feet in depth was observed on the west side of the parcel, and location is visible on the LiDAR imagery on Figure 4. We presume that this excavation was constructed in the past for the purposes of wastewater percolation testing. At two locations near the center of the site, buried PVC stand-pipes were observed placed into the ground. It is our understanding that these stand-pipes were placed for currently on-going groundwater monitoring for future wastewater systems placement.

CONCLUSIONS

Based upon the findings of this review we believe that the "Suggested Building Areas" shown on Figure 2 and Figure 4 may be used for the proposed homesite development. We believe that the proposed construction in these areas will not be adversely exposed to the geological hazards specified in the Section 108-22 Natural Hazard Areas of the Weber County Code (2020).

With this finding we point out that the "Suggested Building Areas" are located upon **Qmc**, **Qms**, and **Qms?(Tn)** mass movement deposits derived from Norwood Formation (**Tn**) bedrock, a unit that has a notoriety of poor stability performance and geotechnically challenging soils throughout the region. Also, active landslide hazards, **Qmsy** deposits, were shown to occur on parts of the site as shown on Figure 3, and we reiterate that the **Qmsy** areas should be avoided for the proposed construction on the site.

Because groundwater and subsurface soils conditions for the site are presently unevaluated, and because the proposed homesite is to be upon Norwood Formation (**Tn**) bedrock and related soils, we recommend that site specific geotechnical engineering soils and groundwater study be performed by a Utah licensed Geotechnical Engineer for homesite design and construction.

We also recommend that the steep slope areas, in excess of 25-percent slope on the property be avoided for the improvements proposed for the site development.

Summarily, the area identified as "Suggested Building Area" on Figure 2 and Figure 4, avoids both steep slope areas (greater than 25 percent slopes), and active **Qmsy** - Landslide and slump deposits identified in this review.

Although not addressed by the Weber County ordinances, we recommend that radon exposure be evaluated to determine if radon reduction measures are necessary for the new construction. It is our understanding that new construction in Ogden Valley area often includes radon remedial measures as part of final design.

LIMITATIONS

Our services 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 (2020). The reporting provided here is not based upon any subsurface observations, and should in no way preclude the results of a geotechnical engineering soils and groundwater studies for foundations, earthwork, and geoseismic design prepared by a professional engineer licensed in the State of Utah.

Although risk can never be eliminated, more detailed and extensive studies yield more information, which may help understand and manage the level of risk. The recommendations contained in this report are based on our site observations, available data, probabilities, and our understanding of the facilities investigated. This report was prepared in accordance with the generally accepted standard of practice at the time the report was written. No warranty, express or implied, is made.

This report may be used only by the client and only for the purposes stated within a reasonable time from its issuance. The regulatory requirements and the "state of practice" can and do change from time to time, and the conclusions presented herein may not remain current. Based on the intended use of the report, or future changes to design, GCS Geoscience may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else, unless specifically agreed to in advance by GCS Geoscience in writing will release GCS Geoscience from any liability resulting from the use of this report by any unauthorized party.

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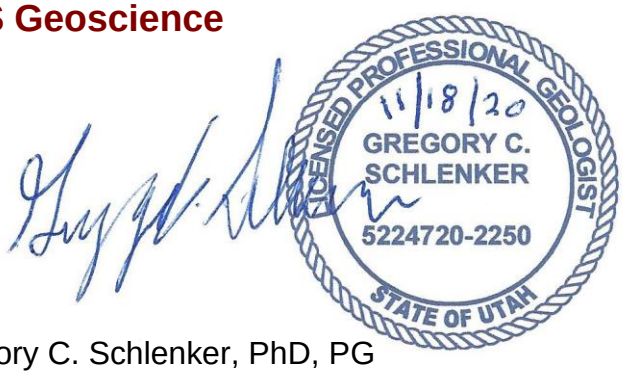
Closing

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 contact the undersigned at (801) 745-0262 or (801) 458-0207.

Respectfully submitted,

GCS Geoscience



Gregory C. Schlenker, PhD, PG
State of Utah No. 5224720-2250
Principal Geologist

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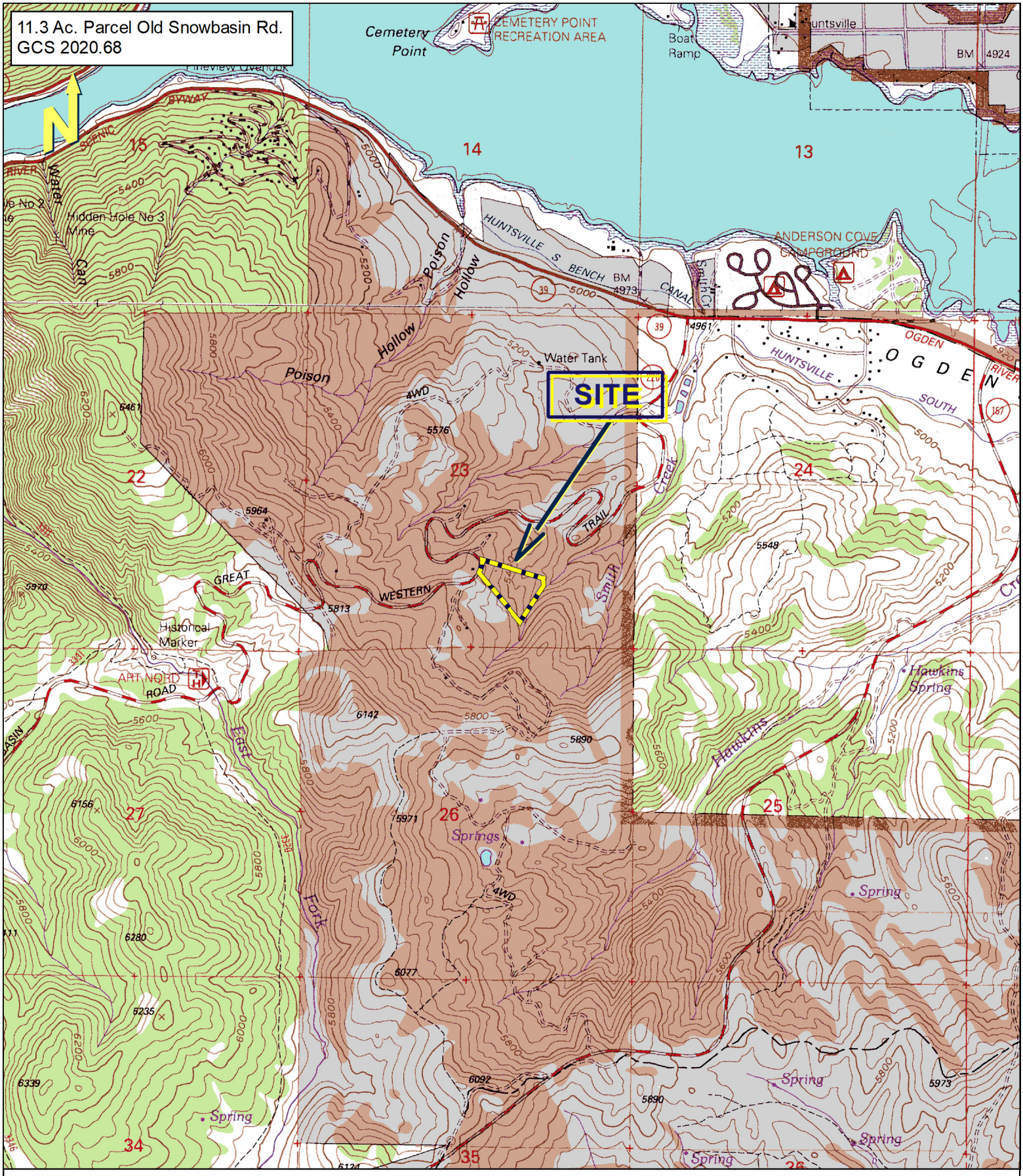
Huntsville, Utah 84317

Encl. Figure 1, Vicinity Map
Figure 2, Aerial Coverage
Figure 3, Geologic Mapping
Figure 4, LiDAR Analysis



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

0 2000 4000 ft

1:24,000

FIGURE 1
VICINITY MAP

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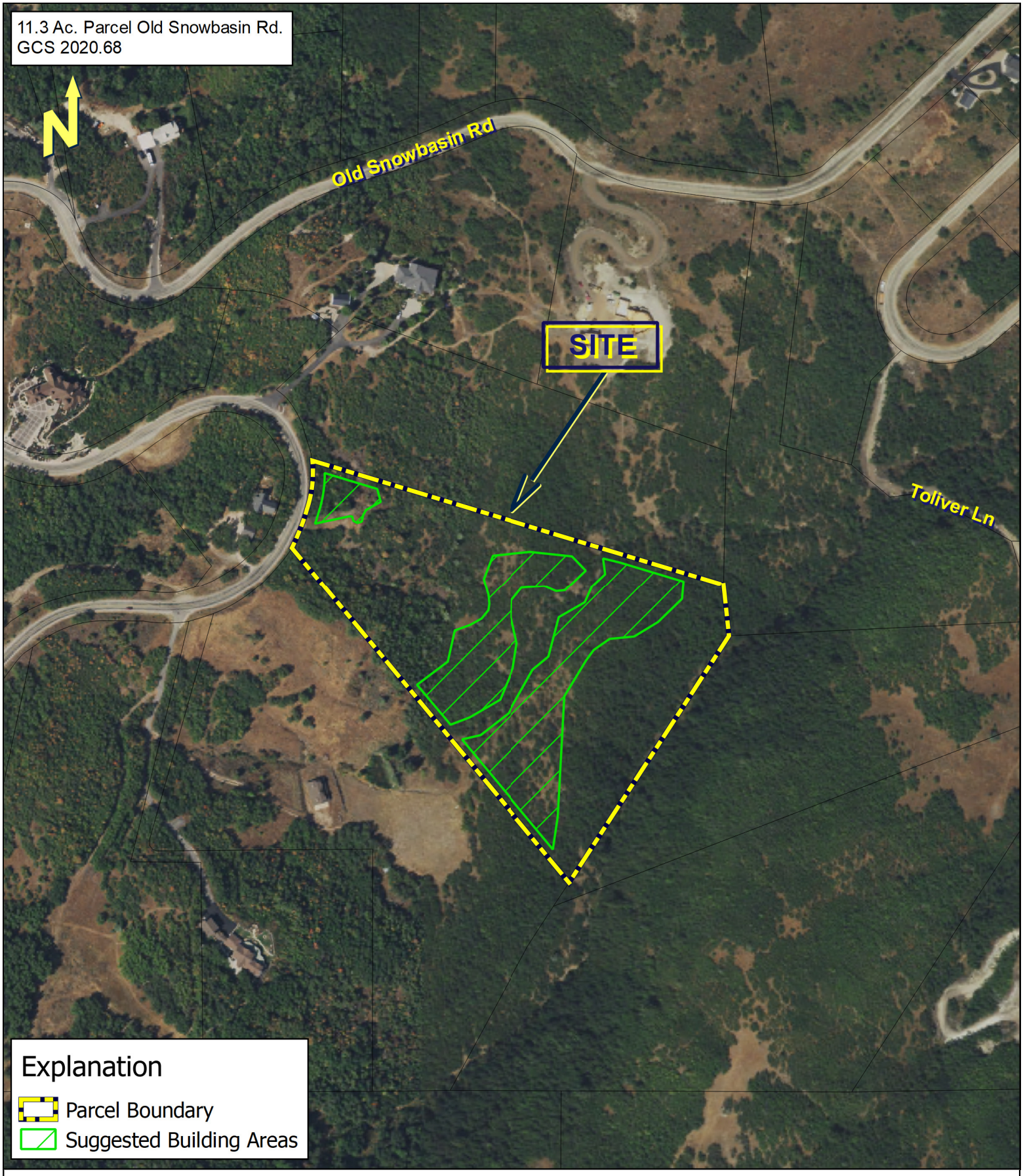


Base:
2018 0.6m Color NAIP Orthoimagery,
from Utah AGRC; http://gis.utah.gov/

0 300 600 ft

1:3,600

FIGURE 2
AERIAL COVERAGE

GCS Geoscience

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

0 400 800 ft

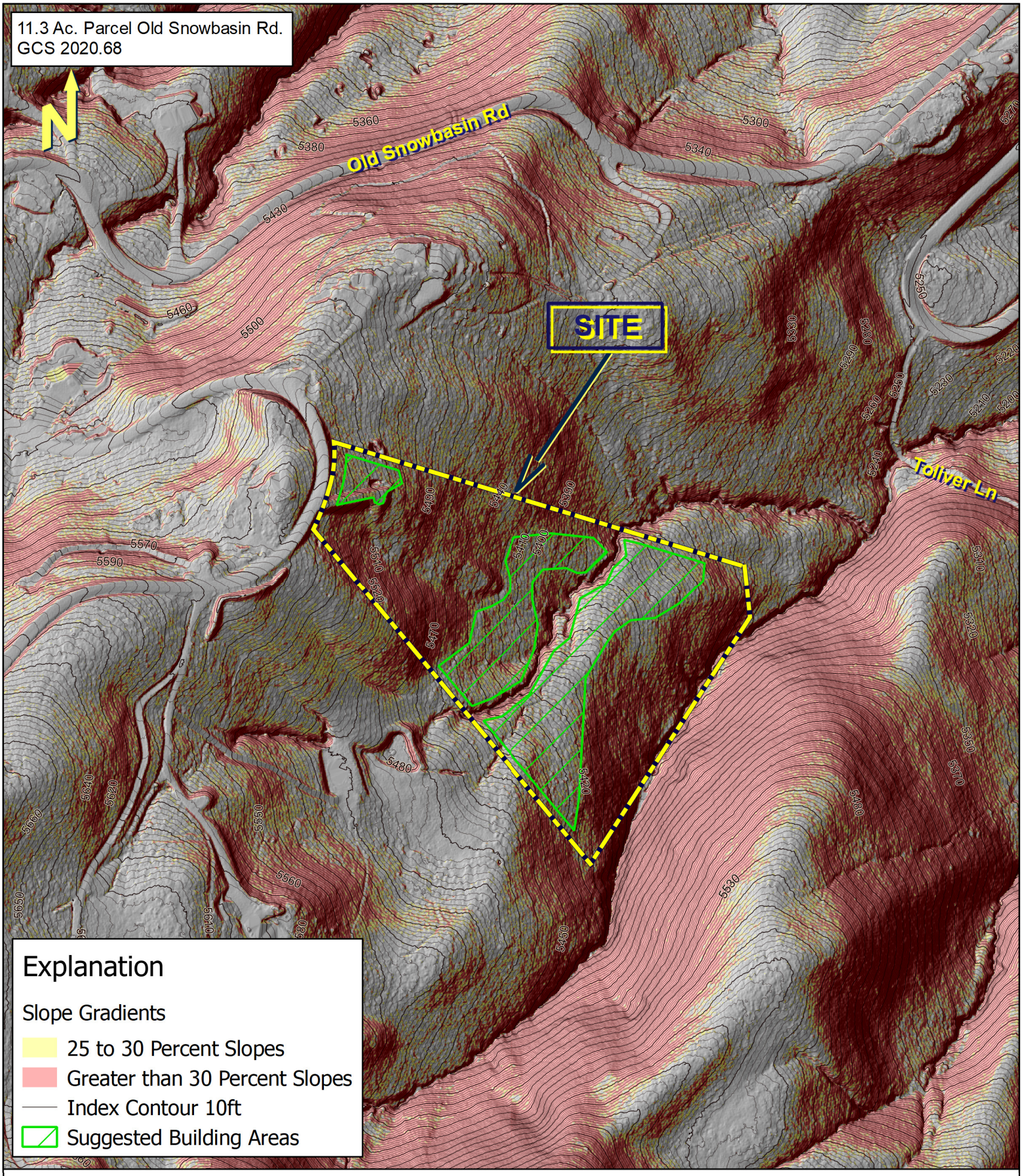
1:4,800

Explanation

Geology after King and Others, 2008

- Qac - Alluvium and colluvium (Holocene and Pleistocene) - Includes stream and fan alluvium, colluvium, and locally mass-movement deposits...
- 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...
- Qmso - Older landslide and slump deposits (Pleistocene) - Poorly sorted clay- to boulder-sized material
- Qms(Tn) - Qms?(Tn) - Landslide deposits likely comprised of Norwood Formation (Tn) blocks...
- Qmso(Tn) - Older block landslide and slump deposits (Pleistocene) - Comprised of underlying Norwood Formation (lower Oligocene and upper Eocene) rocks...
- Tn - Norwood Formation (lower Oligocene and upper Eocene) - Typically light-gray to light brown, altered tuff (claystone), tuffaceous siltstone, sandstone, and conglomerate...
- Landslide headscarps

FIGURE 3
GEOLOGIC MAPPING
GCS Geoscience



Base:
2016 0.5 m LiDAR Imagery
from Utah AGRC; http://gis.utah.gov/

0 300 600 ft

1:3,600

FIGURE 4
LiDAR ANALYSIS

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