GCS Geoscience

Report Professional Geologist Site Reconnaissance and Review
Hammons Subdivision Project
7.003 Acre Parcel #22-004-0126 and
7.002 Acre Parcel #22-004-0123
Includes Parts of Sec. 7, T 7 N., R 1 E., SLBM
Liberty, Weber County, Utah

For:

Mr. Jesse Hammons
6422 North Fork Road
Liberty, Utah
84310

By:

GCS Geoscience
554 South 7700 East Street
Huntsville, Utah 84317

November 28, 2017
GCS File No: 2017.44

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Attn: Mr. Hammons

Subject: Report
Professional Geologist Site Reconnaissance and Review
Hammons Subdivision Project
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In response to your request, GCS Geoscience (GCS) has prepared this Professional Geologist site reconnaissance review report for the above referenced site. The subject parcels consist of an approximately 14.005 acre property located in the Liberty Area in Weber County, Utah, as shown on attached Figure 1, Vicinity Map. Figure 2 provides aerial coverage of the site and detail of the current (2014) layout of the site vicinity. The subject parcels consist of two adjoining properties, 7.003 acres and 7.002 acres in area. The two properties are a presently undeveloped, and are being used for agricultural purposes. The subject parcels and surrounding properties are currently zoned by Weber County as either Agricultural Valley AV-3 or as Forest Valley Zone FV-3. The entirety of Parcel #22-004-0126 lies within the AV-3 Zone, and Parcel #22-004-0123 lies within both AV-3 and FV-3 zones. According to the Weber County Code of Ordinances *the purpose of the AV-3 Zone is to designate farm areas, which are likely to undergo a more intensive urban development, to set up guidelines to continue agricultural pursuits, including the keeping of farm animals, and to direct orderly lowdensity residential development in a continuing rural environment. 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*. Excluding cluster provisions, the minimum lot size for the two zoning classifications is 3.0 acres.

It is our understanding you intend to subdivide both parcels into single-lot subdivision parcels for, single family residential development lots. At this time we understand that you intend to construct a residential structure (dwelling) on the south parcel (#22-004-123), within an approximately 0.44 acre area shown as "Proposed Homesite Location" on Figure 2. We expect that the residential 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 on a hillside area in the vicinity of mapped landslide hazards, marginal soils, and FEMA floodplain areas, Weber County is requesting that a geological site reconnaissance be performed to asses whether all or parts of the parcel are exposed to the hazards that are included in the Weber County Code, Section 108-22 Natural Hazard Areas. 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 (Weber County Code, 2017).

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 Overlay District, and if within 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 as provided by the Weber County Building Inspection Department (Weber County Inspection, 2017).

Literature and Resource Review

To evaluate the potential exposure of building sites to geological hazards that may 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,; 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 relevant for site specific usage. When hazard layer data on the Geo-Gizmo are found to interact with Applicant site improvement locations, Weber County Engineers and Planners will request that the Applicant have a Professional Geologist Site Reconnaissance Review, such as presented herein, conducted for the site.

Our preliminary review of the Geo-Gizmo indicated that the site is located nearby "Landslide undifferentiated" classification on the *Landslide* layer, and also nearby "Zones A and AE" on the FEMA Flood Zone 2105 layer. The site specific exposure of these preliminary conditions will be discussed in the following sections of this report.

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 Crittenden and Sorensen (1985), USGS and UGS (2016), Elliott and Harty (2010), and Coogan and King (2016).

2. An analysis of vertical and stereoscopic aerial photography for the site including a 1946 1:20,000 stereoscopic sequence, 2012 5.0 inch digital HRO coverage, and 2014 1.0 meter digital NAIP coverage of the site.

3. A GIS analysis using the QGIS® GIS platform to geoprocess and analyze 2011 1.0 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 Coogan and King (2016), which provides the most up-to-date rendering of geological mapping for the site location. Supporting documentation by Crittenden and Sorensen (1985) was also used to conduct this review. The geological mapping for this review is provided on Figure 3, Geologic and Flood Hazard Map. 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 in the North Fork area of Liberty in Ogden Valley on the eastern flank of Ben Lomond Peak. Ogden Valley is a northwest trending fault bounded graben structure, with the Wasatch Range comprising the western flank of the valley and the Bear River Range the eastern flank (Avery, 1995). Older Precambrian rocks underlie the area at depth, and are parts of eastward thrusted plates including the Willard thrust sheet, which is believed to have moved onto the vicinity during the Cretaceous Sevier orogeny, occurring approximately 140 million years ago. The older Precambrian rocks have since been exposed on adjacent mountain slopes by uplift along the valley bounding faults that has been occurring over the past 10 million years.

During the most recent stage of geologic time, the Quaternary Period, which includes the past 1.6 million years, permanent (year-round) ice and glaciers have periodically occupied the higher elevation summits surrounding the site, and the waters of Lake

Bonneville have risen almost to the elevation of the site, occurring as recently as 15,000 years ago (Currey and Oviatt, 1985).

Topographically the site is located on valley margin slopes positioned between Ben Lomond Peak on the west and floodplains of the North Fork of the Ogden River on the east. Ben Lomond Peak is located approximately 4.0 miles west of the site, and stands 9712 feet in elevation. The floodplain areas of the North Fork of the Ogden River are located approximately 500 feet east of the site, and are approximately 5230 feet in elevation in the vicinity of the site. The elevation of the site is slightly elevated from the floodplain areas at roughly 5290 feet, with elevations on the two parcels ranging between approximately 5270 feet on the east side of the site, and 5350 feet on the west side of the site as shown on Figure 4.

Geological Mapping: Figure 3 shows the location of the site relative to GIS overlays including geological mapping drawn from Coogan and King (2016). A summary of the geological mapping of the site vicinity, as paraphrased from Coogan and King (2016), is provided as follows:

> **Qal -** Stream alluvium and flood-plain deposits (Holocene and uppermost Pleistocene) – Sand, silt, clay, and gravel in channels, flood plains, and terraces...
>
> **Qafy -** Younger alluvial-fan deposits (Holocene and uppermost Pleistocene) – Mostly sand, silt, and gravel that is poorly bedded and poorly sorted...
>
> **Qac -** Alluvium and colluvium (Holocene and Pleistocene) – Unsorted to variably sorted gravel, sand, silt, and clay in variable proportions; includes stream and fan alluvium, colluvium, and, locally, mass-movement deposits...
>
> **Qab - Qab? - Qap? -** Lake Bonneville-age alluvium (upper Pleistocene) – Related to shorelines of Lake Bonneville, unconsolidated to weakly consolidated alluvium...
>
> **Qafb? -** Lake Bonneville-age alluvial-fan deposits (upper Pleistocene) — Related to shorelines of Lake Bonneville, Mostly sand, silt, and gravel that is poorly bedded and poorly sorted...
>
> **Qalp? -** Lake Bonneville regression-age stream alluvium (upper Pleistocene?) – Pebble and cobble gravel, gravelly sand and silty sand, with minor clay in channel incised into Lake Bonneville deltaic and lacustrine deposits...
>
> **Qms -** Landslide deposits (Holocene and upper and middle? Pleistocene) – Poorly sorted clay- to boulder sized material; includes slides, slumps, and locally flows and floods...

Qms?(QTms) - Block landslide and possible block landslide deposits (Holocene and upper and middle? Pleistocene) – Mapped where nearly intact block is visible in landslide (mostly block slide) with stratal strikes and dips that are different from nearby in-place bedrock...comprised of Quaternary and/or Tertiary mega-landslide (Pleistocene and/or Pliocene) – Jumbled mass of formation of Perry Canyon (ZYp) with blocks of rock from North Ogden divide.

QTms(ZYp) - Quaternary and/or Tertiary mega-landslide (Pleistocene and/or Pliocene) – Jumbled mass of formation of Perry Canyon (ZYp) with blocks of rock from North Ogden divide...

In summary, the west side of the site is located upon geological units classified as younger Pleistocene age (**Qms?**) landslide deposits composed of older Quaternary/Tertiary age block failure movement (**QTms**) of much older Neoproterozoic rocks of the Formation of Perry Canyon (**ZYp**) rocks (Coogan and King, 2016), and the east side of the site is covered with alluvial deposits (**Qab?** and **Qap?**) that were laid down to grade when Lake Bonneville inundated parts Ogden Valley during the late Pleistocene approximately 15,000 years ago (Currey and Oviatt, 1985). The alluvial deposits (**Qab?** and **Qap?**) appear to buttress, and morphostratigraphically superimpose, the landslide (**Qms?[QTms]**) on the west. Because the landslide deposits (**Qms?[QTms]**) on the west side of the site do not appear to have disturbed or deformed the surfaces of the Lake Bonneville age alluvial deposits (**Qab?** and **Qap?**) on the east side of the site, we interpret the landslide deposit movement to be inactive since at least Lake Bonneville time, approximately 15,000 years ago (Currey and Oviatt, 1985).

A concealed normal fault, identified as Ogden Valley North Fork fault (Black and Hecker, 1999), is shown on Figure 3 as crossing the site on a northwest strike, however its location is concealed by overlying Quaternary age deposits.

Hazards Review: 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 Coogan and King (2016), the nearest landslide units are mapped as **Qms?(QTms)** deposits that are located west side of the site. These units are described by Coogan and King (2016) as "block landslide deposits... comprised of Quaternary and/or Tertiary mega-landslide (Pleistocene and/or Pliocene)...'

   The slope and apparent movement of the **Qms?(QTms)** unit is from the west to the east, and involves much older Neoproterozoic rocks of the Formation of

Perry Canyon (**ZYp**). This unit (**Qms?[QTms]**) appears to have moved downslope during the past in response to inherent weakened rock structures affiliated with Willard Thrust sheet, and steep slope conditions in this area, and has complex "jumbled" morphology (Coogan and King, 2016). Based upon our observation and analysis of the slopes on the west side of the site, we believe that movement of the **Qms?(QTms)** unit is presently inactive, as evidenced by the morhpostritigraphic conformity of the adjacent Lake Bonneville age alluvial deposits (**Qab?** and **Qap?**) on the east side of the site. Although, considered presently stable, the **Qms?(QTms)** unit on the west side of the site has undergone movement during the past (Pleistocene and/or Pliocene), and the structure of this unit has been disturbed, such that the deposits in this area are possibly near threshold slope stability conditions, insomuch that site development on steeper slope areas on this unit, specifically slopes steeper than 25 percent on Figure 4, should be avoided for dwelling structures.

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 **Qafy** by Coogan and King (2016)**,** and occur just to the north of the site. These deposits are associated with Thimbleberry Creek which passes approximately 400 feet north of the site, and debris flow processes associated with these deposits do not appear to be a risk to the site, or the proposed homesite location.

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 section of the Wasatch fault zone (UT2351E) which is located 3.2 miles southwest of the site, thus active fault rupture hazards are not considered present on the site (Black and others, 2004). The Ogden Valley North Fork fault (UT2376) is shown on Figure 3 to as crossing the site on a northwest strike. This fault is mapped on the site as concealed by Coogan and King (2016) because movement on this fault has not displaced overlying Pleistocene age deposits. The most recent movement along this fault is estimated by the USGS and UGS compilers (Black and Hecker, 1999) to be pre-Holocene and likely pre-Quaternary age (<2.6 million years in age), and is not considered an active risk to the site. Active earthquake faults are generally considered to be faults which have disrupted the ground surface within the past 11,000 years of earth history (the Holocene epoch). Implied with this definition is that such faults are likely to disrupt the ground surface in the relatively near future (Lund and others, 2016).

   Strong earthquake ground motion originating from the Wasatch fault or other near-by seismic sources is capable of impacting the property. 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, 2008) 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 0.18*g,* and for a two-percent probability of exceedance in 50 years is as high as 0.43*g* for the site.

The a ten-percent probability of exceedance in 50 years event has a return period of 475 years, and the 0.18*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 0.43*g* acceleration for this event corresponds "severe" perceived shaking with "moderate to heavy" 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 combined saturated and non-cohesive soils such as groundwater saturated alluvium (i.e. floodplain areas adjacent to the North Fork of the Ogden River), which conditions are not found on the property, consequently the conditions susceptible to liquefaction do not appear to be present at the site.

4. **Rockfall and avalanche hazards**: The site is not in close proximity to steep slope areas where such hazards may originate.

5. **Flooding:** No significant water ways pass in close proximity of the site and flood insurance rate mapping by Federal Emergency Management Agency for the site vicinity shown on Figure 3 indicates that the site is outside the 100-year Flood Zone (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 slope gradients developed from our LiDAR analysis range from level to well over 50-percent as shown on Figure 4. Within the property area slope gradients vary from relatively gentle to moderately steep on the west side of the site. The calculated average slope for overall property is 9.9 percent. For the 0.44 acre area shown as "Proposed Homesite Location" the average slope is calculated to be 15.2 percent.

   The threshold gradient for site slope development considerations and hillside review according to the Weber County Section 108-14-3 includes slopes greater that 25-percent (Weber County Code, 2017). On the basis of these guidelines we beleive that the moderately steep slope section on the west side of the site, shown as in excess of 25-perecent slopes on Figure 4, should be avoided for placement of dwelling structures.

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), and the property appears to be located in an area mapped as having a "Moderate" to "High" radon potential classification. For new dwelling structures radon-resistant construction techniques as provided by the EPA (2017) should be considered.

Site Reconnaissance

The site was reconnoitered on November 15, 2017. The access roadway for the site, Shaw Drive, consisted of an improved gravel surface, and electrical and water service connections for the site appeared to be in place along the roadway at the time of our visit. The site was observed to be a mostly rectangular shaped property occupying approximately 900 feet east to west, and 770 feet north to south in plan dimensions. From the east side property frontage on Shaw Drive, the site surface steeps up approximately eight feet and becomes nearly level to gently slopping upwards to the west for approximately 670 feet, then the surface becomes moderately steep sloped for the remaining 200 feet to the west boundary of the two parcel site. At the time of our visit, cover on the property consisted of cut pasture grass, with scrub oak and maple

trees occupying the sloping areas on the west side of the site. The surficial soils on the site appeared to consist of gravelly sands with sub-angular cobble and boulder sized clast appearing on the sloping surfaces.

Established single-family estate style homesites were observed on near-by properties, however most of the adjacent properties surrounding the site appear to be undeveloped and being used for agricultural purposes at the time of our reconnaissance.

During our reconnaissance no conditions of active geologic hazards or ongoing processes were observed on the site.

Conclusions

Based upon the findings of this review we believe that the subject 14.005 acre property is not eminently exposed to the geological hazards specified in the Section 108-22 Natural Hazard Areas of the Weber County Code (2017). With this finding we point out that parts of the western side of the site, include steep slope areas, greater than 25 percent slope, that should be avoided for the placement dwelling structures. Cuts and fills for access roadways on the sloping areas should be designed conservatively to minimize erosion and oversteepened slopes.

It is our opinion that the "Proposed Homesite Location" area shown on Figure 2 and Figure 4, is suitable for the proposed development as described in the opening of this report, provided that the steep slope areas on the northeast corner of this area are avoided for the placement of dwelling structures. We recommend that a 15 foot setback from the 25 percent or greater slopes be used to appropriately avoid the steep slope areas for the dwelling structure placement.

Because groundwater and subsurface soils conditions for the site are presently unevaluated, and because the proposed building site is located upon block landslide deposits soils (**Qms?[QTms]**) we; 1) optionally suggest that site specific geotechnical engineering soils and groundwater study be considered for the homesite design and construction, and 2) minimally we recommend that a licensed Geotechnical Engineer observe the foundation excavations prior to the setting of the footings of the proposed structures, to confirm the suitability of the foundation soils for the proposed homesite construction.

The proposed homesite should be constructed to current established seismic hazards codes to reduce risk and damage from a future strong earthquake ground motion event.

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 homesite 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 in the Weber County Code, Section 108-22 Natural Hazard Areas (Weber County, 2017). The reporting provided here is not based upon any subsurface observations, and should not 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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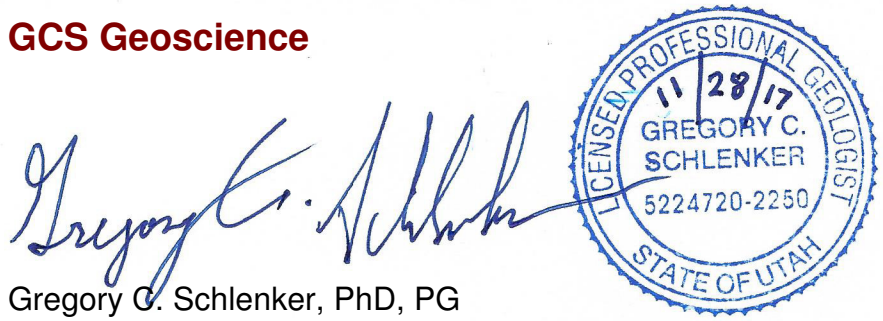
We appreciate the opportunity to work with you on this project and look forward to assisting you in the future. If you have any questions or need additional information on this or other reporting, please contact the undersigned at (801) 745-0262 or (801) 458-0207.

Respectfully submitted,

GCS Geoscience



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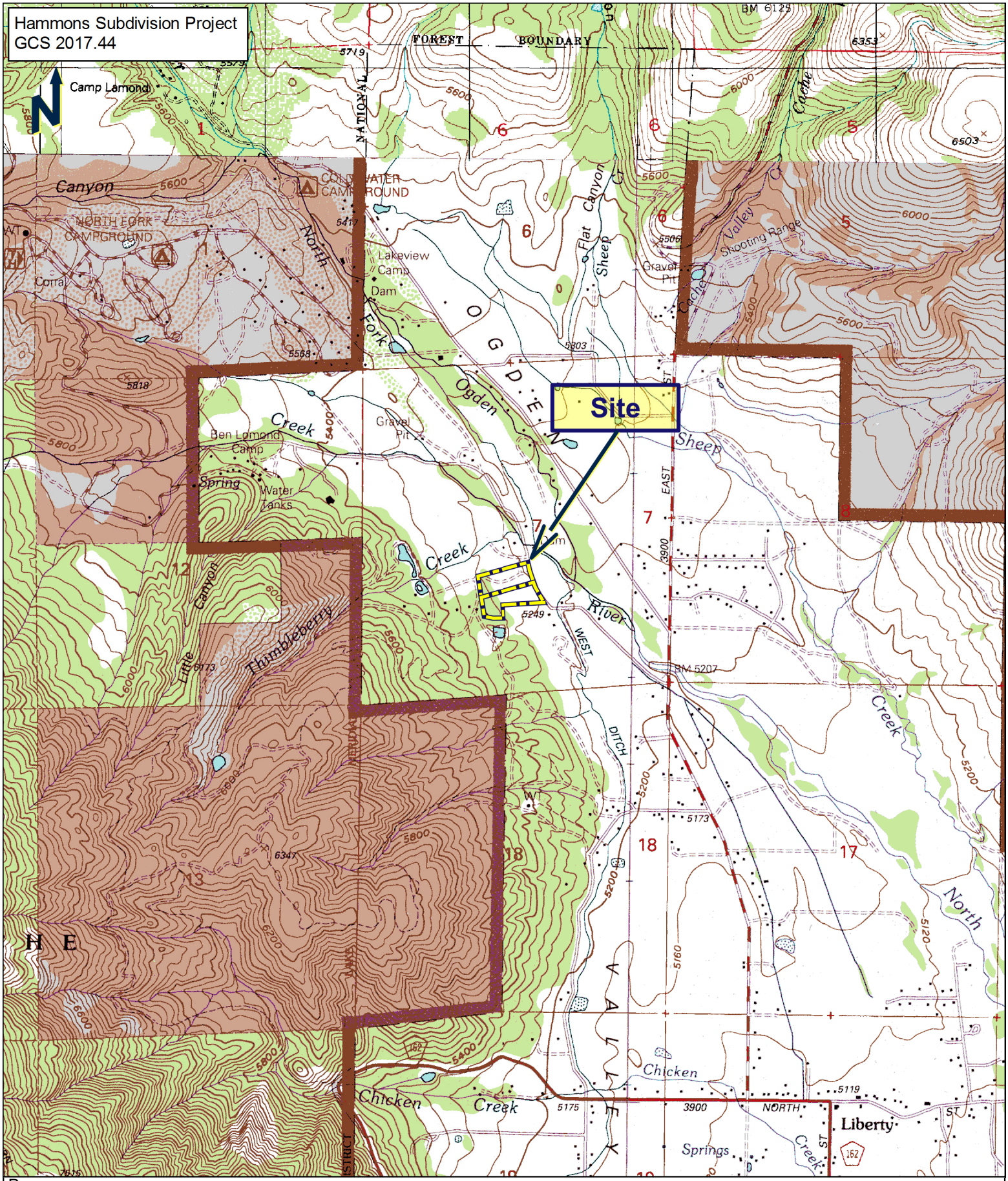
Encl. Figure 1, Site Vicinity Map
Figure 2, Aerial Coverage
Figure 3, Geologic and Flood Hazard Map
Figure 4, LiDAR Analysis



Base:
USGS 7.5 Minute topographic maps titled "North Ogden, Utah 1998; Mantua, Utah, 1991; James Peak , Utah 1991; and Huntsville, Utah 1998" from Utah AGRC; http://gis.utah.gov/

0 2000 4000 ft

1:24,000

FIGURE 1
VICINITY MAP

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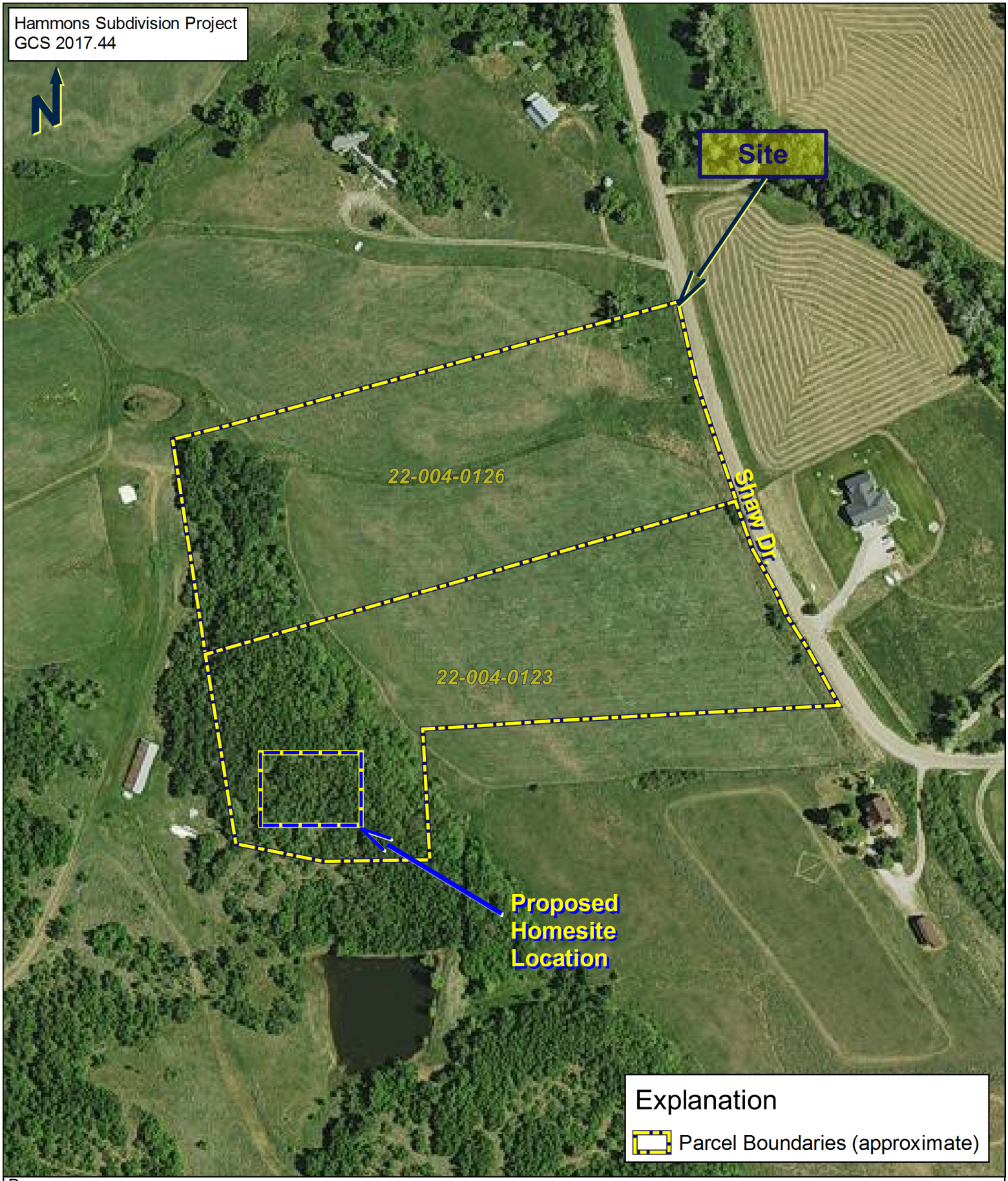

Base:
2014 1.0m NAIP Color Orthoimagery,
from Utah AGRC; http://gis.utah.gov/

0 200 400 ft

1:2,400

FIGURE 2
AERIAL COVERAGE

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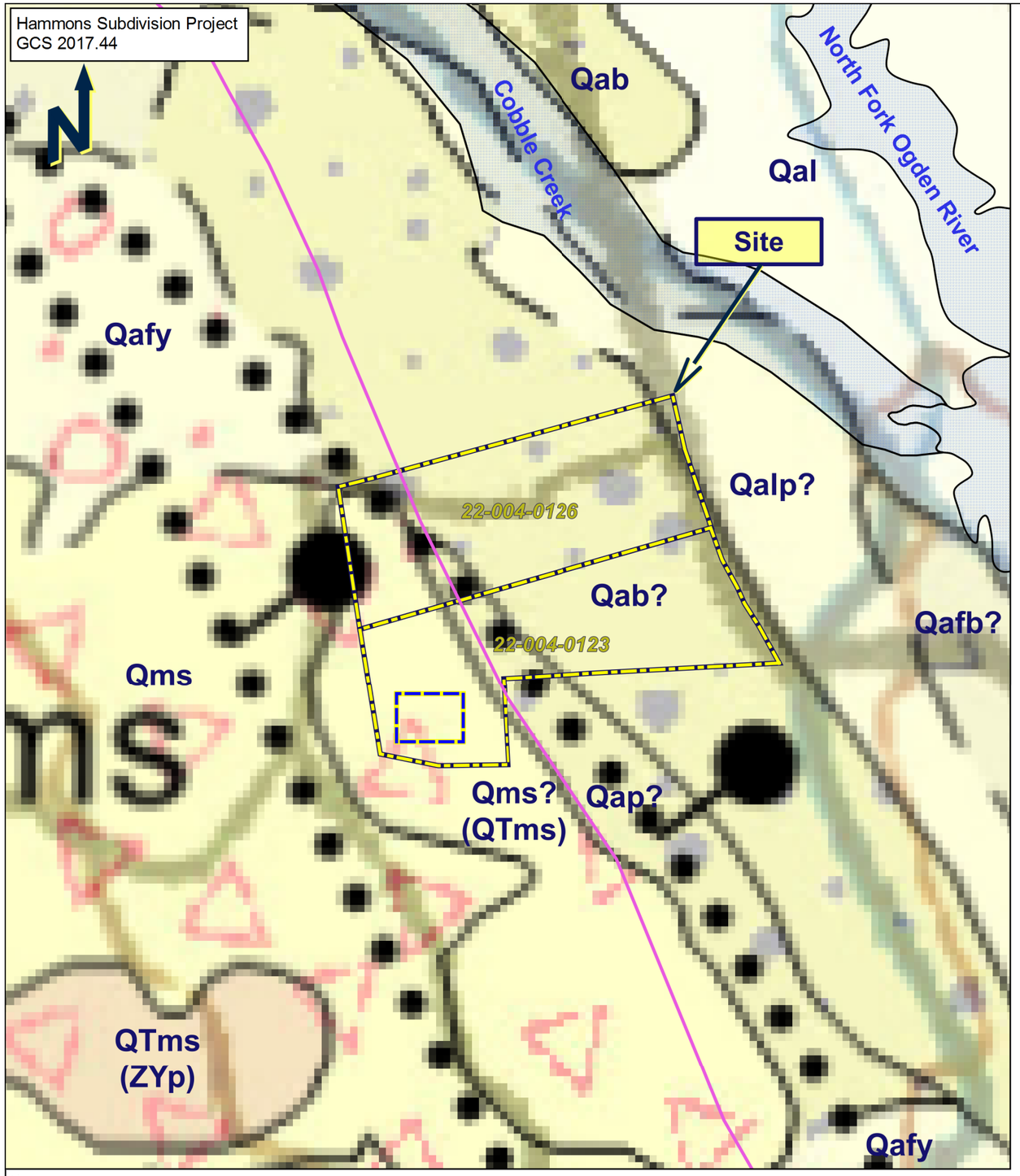

Base:
Coogan and King, 2016.

0 300 600 ft

1:3,600

Geologic Classification

Geology after Coogan and King, 2016

Qal - Stream alluvium and flood-plain deposits (Holocene and uppermost Pleistocene) – Sand, silt, clay, and gravel in channels, flood plains, and terraces...

Qafy - Younger alluvial-fan deposits (Holocene and uppermost Pleistocene) – Mostly sand, silt, and gravel that is poorly bedded and poorly sorted...

Qac - Alluvium and colluvium (Holocene and Pleistocene) – Unsorted to variably sorted gravel, sand, silt, and clay in variable proportions; includes stream and fan alluvium, colluvium, and, locally, mass-movement deposits...

Qab - Qab? - Qap? - Lake Bonneville-age alluvium (upper Pleistocene) – Related to shorelines of Lake Bonneville, unconsolidated to weakly consolidated alluvium...

Qafb? - Lake Bonneville-age alluvial-fan deposits (upper Pleistocene) — Related to shorelines of Lake Bonneville, Mostly sand, silt, and gravel that is poorly bedded and poorly sorted...

Qalp? - Lake Bonneville regression-age stream alluvium (upper Pleistocene?) – Pebble and cobble gravel, gravelly sand and silty sand, with minor clay in channel incised into Lake Bonneville deltaic and lacustrine deposits...

Qms - Landslide deposits (Holocene and upper and middle? Pleistocene) – Poorly sorted clay- to boulder sized material; includes slides, slumps, and locally flows and floods...

Qms?(QTms) - Block landslide and possible block landslide deposits (Holocene and upper and middle? Pleistocene) – Mapped where nearly intact block is visible in landslide (mostly block slide) with stratal strikes and dips that are different from nearby in-place bedrock...comprised of Quaternary and/or Tertiary mega-landslide (Pleistocene and/or Pliocene) – Jumbled mass of formation of Perry Canyon (ZYp) with blocks of rock from North Ogden divide

QTms(ZYp) - Quaternary and/or Tertiary mega-landslide (Pleistocene and/or Pliocene) – Jumbled mass of formation of Perry Canyon (ZYp) with blocks of rock from North Ogden divide...

Normal Fault Concealed

Quaternary Faults and Folds

Ogden Valley North Fork Fault (Black and Hecker, 1999)

Flood Hazards

FEMA - Flood Insurance Rating Zones (2015)

Zone A and AE - Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

FIGURE 3
GEOLOGIC AND
FLOOD HAZARD MAP

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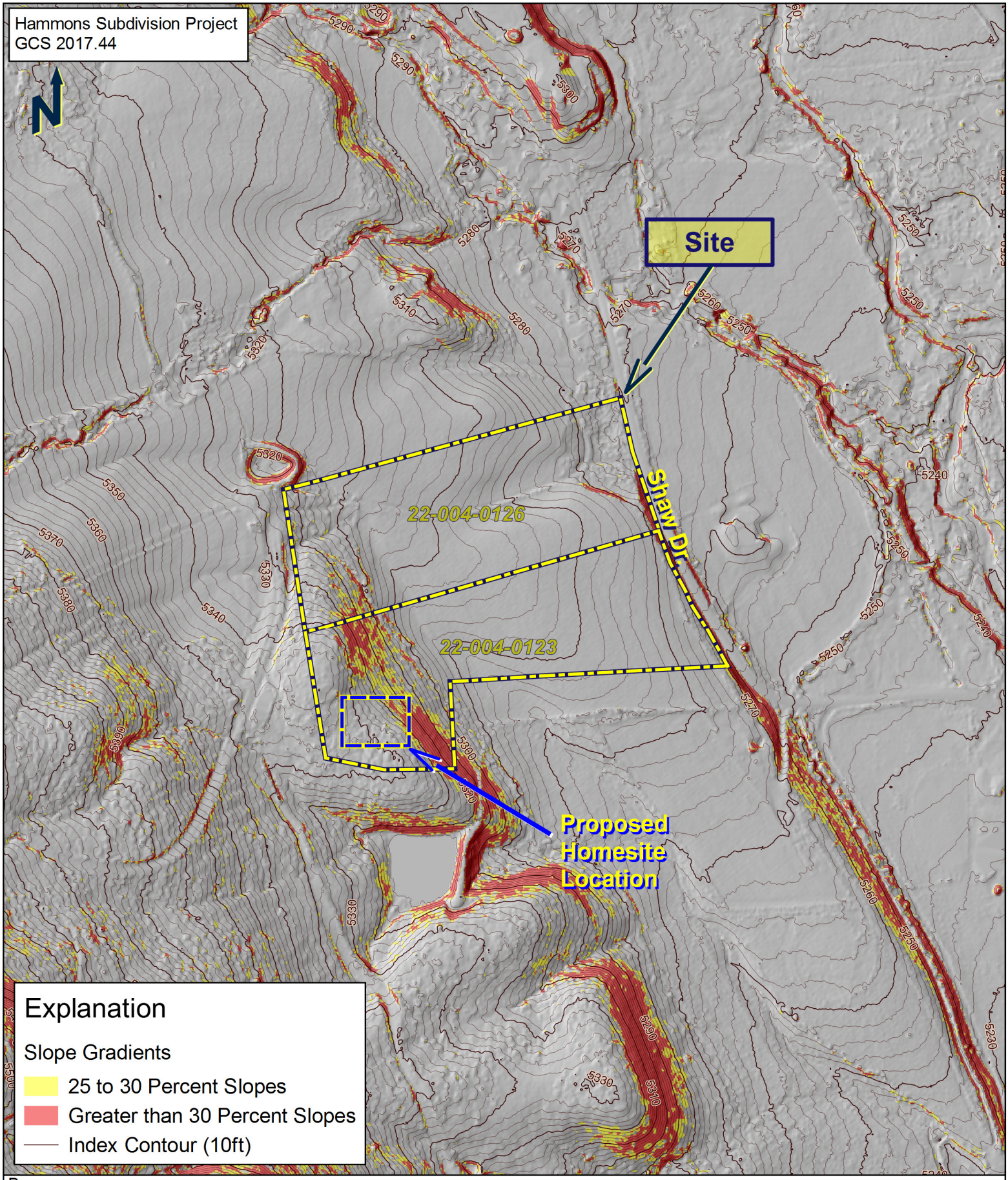

Base:
2011 1.0m LiDAR Imagery
from Utah AGRC; http://gis.utah.gov/

0 300 600 ft

1:3,600

FIGURE 4
LiDAR ANALYSIS

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