REPORT

GEOLOGIC HAZARDS EVALUATION

BECKSTEAD PROPERTY

ABOUT 1860 NORTH BIG SKY DRIVE

EDEN, WEBER COUNTY, UTAH

Prepared for

Brandon Janis
562 South 1100 West
Farmington, UT 84025

October 8, 2018

Prepared by

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October 8, 2018

Brandon Janis
562 South 1100 West
Farmington, UT 84025

SUBJECT: Geologic Hazards Evaluation
Beckstead Property
About 1860 North Big Sky Drive
Eden, Weber County, Utah

Dear Mr. Janis:

This report presents the results of an engineering geology and geologic hazards review and evaluation conducted by Western GeoLogic, LLC (Western GeoLogic) for the Beckstead Property at about 1860 North Big Sky Drive in Eden, Utah (Figure 1 – Project Location). The Project is in northwestern Ogden Valley slightly southeast of Nordic Valley in the SW1/4 Section 33, Township 7 North, Range 1 East (Salt Lake Baseline and Meridian). The property consists of a 2.29-acre, triangular-shaped parcel identified as Weber County Assessor parcel number 22-040-0023. The site is adjacent to the Big Sky Estates development to the west and undeveloped land identified as the WAJ Enterprises property to the north, but does not have a formal address. Elevation of the site ranges from about 5,600 feet to 5,700 feet above sea level. It is our understanding that current plans are for development of one single-family home, although no formalized plans were provided.

PURPOSE AND SCOPE

The purpose and scope of this investigation is to identify and interpret surficial geologic conditions at the site to identify potential risk from geologic hazards to the Project. This investigation is intended to: (1) provide preliminary geologic information and assessment of geologic conditions at the site; (2) identify potential geologic hazards that may be present and qualitatively assess their risk to the intended site use; and (3) provide recommendations for additional site- and hazard-specific studies or mitigation measures, as may be needed based on our findings. Such recommendations could require further multi-disciplinary evaluations, and/or may need design criteria that are beyond our professional scope.

The following services were performed in accordance with the above stated purpose and scope:

- A site reconnaissance conducted by an experienced certified engineering geologist to assess the site setting and look for adverse geologic conditions;

- Review of readily-available geologic maps, reports, and air photos;
- Logging of two test pits at the site in conjunction with a geotechnical evaluation conducted by Christensen Geotechnical (the Project geotechnical engineer);
- Preparation of one geologic cross section based on LIDAR and subsurface data; and
- Evaluation of available data and preparation of this report, which presents the results of our study.

The engineering geology section of this report has been prepared in accordance with Bowman and Lund (2016) and current generally accepted professional engineering geologic principles and practice in Utah, and meets specifications provided in Chapter 27 of the Weber County Land Use Code within the above stated scope. We do not include discussion of radon hazard potential, as recommended in Bowman and Lund (2016), because radon gas poses an environmental health hazard and indoor levels are heavily influenced by several post-construction, non-geologic factors. The hazard from radon should be evaluated by long-term testing following construction.

HYDROLOGY

The U.S. Geological Survey (USGS) topographic map of the Huntsville Quadrangle shows the site is on the northwest margin of Ogden Valley slightly east of Coal Hollow (Figure 1). Coal Hollow Creek flows northeastward about 500 feet northwest of the Project and downslope into the valley, where it merges with the North Fork of the Ogden River. Grover Hollow is further east (Figure 1). No active or seasonal drainages, springs, or seeps were observed or are indicated at the site on Figure 1. Coal Hollow Creek was flowing at the time of our investigation, but ephemeral drainages that feed Coal Hollow all appeared dry.

The site is on the northwestern margin of Ogden Valley about 1.2 miles west-northwest of the north arm of Pineview Reservoir. The valley bottom to the east is dominated by unconsolidated lacustrine and alluvial basin-fill deposits, whereas slopes in the site area are mainly in weathered Tertiary-age tuffaceous bedrock and colluvium from mass-wasting and erosional processes. The Utah Division of Water Rights Well Driller Database shows three water wells within about a mile of the site. Reported depths to static groundwater for these wells is 50 feet, 132 feet, and 30 feet respectively. Given the above and site observations, we anticipate groundwater at the site is more than 30 feet deep. However, groundwater depths may vary annually from climatic fluctuations and also seasonally from snowmelt runoff and man-made sources such as landscape irrigation. Seasonal variations would be typical for an alpine environment. Perched conditions above less-permeable, clay-rich bedrock layers may also be present in the subsurface that could cause locally shallower groundwater levels. Groundwater flow should be generally to the northeast into Ogden Valley.

Avery (1994) indicates groundwater in Ogden Valley occurs under perched, confined, and unconfined conditions in the valley fill to depths of 750 feet or more. A well-stratified lacustrine silt layer forms a leaky confining bed in the upper part of the valley-fill aquifer. The aquifer below the confining beds is the principal aquifer, which is in primarily fluvial and alluvial-fan deposits. The principal aquifer is recharged from precipitation, seepage from surface water, and subsurface inflow from bedrock into valley fill along the valley margins (Avery, 1994). The confined aquifer is typically overlain by a shallow, unconfined aquifer recharged from surface flow and upward leakage. Groundwater flow is generally from the valley margins into the valley fill, and then toward the head of Ogden Canyon (Avery, 1994).

GEOLOGY

Surficial Geology

The site is located on the northwestern margin of Ogden Valley, a sediment-filled intermontane valley within the Wasatch Range, a major north-south trending mountain range marking the eastern boundary of the Basin and Range physiographic province (Stokes; 1977, 1986). Surficial geology of the site is mapped by Coogan and King (2016; Figure 2) as mainly Pleistocene to Holocene landslide deposits (unit Qms) situated between two areas underlain by Tertiary Norwood Formation (unit Tn) to the northwest and northeast. A concealed trace of the Ogden Valley southwestern margin fault follows the northern site boundary (Figure 2). Further upslope to the southwest is Paleozoic-age bedrock of the Maple Canyon Formation (unit Zmcg, Figure 2).

Coogan and King (2016) describe surficial geologic units in the site area on Figure 2 as follows:

> ***Qh, Qh?*** *- Human disturbances (Historical).* Mapped disturbances obscure original deposits or rocks by cover or removal; only larger disturbances that pre-date the 1984 aerial photographs used to map the Ogden 30 x 60- minute quadrangle are shown; includes engineered fill, particularly along Interstate Highways 80 and 84, the Union Pacific Railroad, and larger dams, as well as aggregate operations, gravel pits, sewage-treatment facilities, cement plant quarries and operations, brick plant and clay pit, Defense Depot Ogden (Browning U.S. Army Reserve Center), gas and oil field operations (for example drill pads) including gas plants, and low dams along several creeks, including a breached dam on Yellow Creek.
>
> ***Qay, Qa2, Qa2?, Qa3, Qa3?, Qa4, Qa4?, Qa4-5, Qa5, Qa6*** *- Alluvium (Holocene and Pleistocene).* Sand, silt, clay, and gravel in stream and alluvial-fan deposits that are not close to late Pleistocene Lake Bonneville and are geographically in the Huff Creek and upper Bear River drainages; variably sorted; variably consolidated; composition depends on source area; deposits lack fan shape of Qaf and are distinguished from terraces (Qat) based on upper surface sloping toward adjacent streams from sides of drainage, or are shown where fans and terraces are too small to show separately at map scale; Qay is at to slightly above present drainages and not incised by active drainages, so is the youngest unit; generally 6 to 20 feet (2-6 m) thick.
>
> Age-number and letter suffixes on alluvium (undivided, channel, flood plain, terrace, and fan) that is not close to late Pleistocene Lake Bonneville are relative and only apply to the local drainage, with suffix 2 being the second youngest; the relative age is queried where age uncertain, generally due to the height not fitting into the typical order of surfaces. The various numbered deposits listed, Qa2 through Qa6, are 20 to 180 feet (6-55 m) above the Bear River, Saleratus Creek, and Yellow Creek. Qa5 and Qa3? are only used in stacked units (Qa5/Tfb and Qa3?/Tfb).

Qal, Qal1, Qal2, Qal2? - *Stream alluvium and flood-plain deposits (Holocene and uppermost Pleistocene).* Sand, silt, clay, and gravel in channels, flood plains, and terraces typically less than 16 feet (5 m) above river and stream level; moderately sorted; unconsolidated; along the same drainage Qal2 is lower than Qat2 and has likely been subject to flooding, at least prior to dam building; present in broad plains along the Bear, Ogden, and Weber Rivers and larger tributaries like Deep, Cottonwood, East Canyon, Lost, and Saleratus Creeks, along Box Elder, Heiners, and Yellow Creeks, and in narrower plains of larger tributary streams; locally includes muddy, organic overbank and oxbow lake deposits; composition depends on source area, so in back valleys typically contains many quartzite cobbles recycled from the Wasatch Formation; mostly Holocene, but deposited after regression of Lake Bonneville from the late Pleistocene Provo shoreline; width in Morgan Valley is combined flood plain of Weber River and East Canyon and Deep Creeks; 6 to 20 feet (2-6 m) thick and possibly as much as 50 feet (15 m) along Weber River and thinner in the Kaysville quadrangle; greater thicknesses (>50 feet [15 m]) are reported in Morgan Valley (Utah Division of Water Rights, well drilling database), but likely include Lake Bonneville and older Pleistocene deposits.

Suffixes 1 and 2 indicate ages where they can be separated, with 1 including active channels and 2 including low terraces 10 to 20 feet (3-6 m) above the Weber and Ogden Rivers, and the South Fork Ogden River that may have been in the flood plain prior to damming of these waterways. Qal2 queried in low terraces above Bear River, Saleratus Creek, and Dry Creek where deposits may not be in the flood plain.

Qaf, Qafy, Qaf3, Qaf3?, Qaf4, Qaf4?, Qaf5 **-** *Alluvial-fan deposits (Holocene and Pleistocene).* Mostly sand, silt, and gravel that is poorly bedded and poorly sorted and that is not close to late Pleistocene Lake Bonneville and is geographically in the Huff Creek and upper Bear River drainages; variably consolidated; includes debris flows, particularly in drainages and at drainage mouths (fan heads); generally less than 60 feet (18 m) thick. Qaf with no suffix used where age uncertain or for composite fans where portions of fans with multiple ages cannot be shown separately at map scale; toes of some fans have been removed by human disturbances, so their age cannot be determined.

Where possible, subdivided into relative ages, indicated by letter and number suffixes (like Qa and Qat suffixes) and relative ages only apply to the local drainage, with unit Qafy being the lowest (youngest) fans and unit 3 may or may not post-date Lake Bonneville. Relative ages of these fans are partly based on heights above present drainages at drainage-eroded edge of fan. The relative age is queried where the age is uncertain, generally due to the height not fitting into the typical order of surfaces. The various deposits listed, Qafy and Qaf3 through Qaf5, are 20 to 140 feet (6-40 m) above and west of Saleratus Creek, and also above Yellow Creek and the Bear River. Qafy fans are active, impinge on present-day floodplains, divert active streams, and overlie low terraces.

Qafp, Qafp?, Qafb, Qafb?, Qafpb, Qafpb? - *Lake Bonneville-age alluvial-fan deposits (upper Pleistocene).* Like undivided alluvial fans, but height above present drainages appears to be related to shorelines of Lake Bonneville and is within certain limits (see table

1); these fans are inactive, unconsolidated to weakly consolidated, and locally dissected; fans labeled Qafp and Qafb are related to the Provo (and slightly lower) and Bonneville shorelines of late Pleistocene Lake Bonneville, respectively, while unit Qafpb is used where fans may be related to the Provo or Bonneville shoreline (for example Qafpb is ~40 feet [12 m] above Lost Creek Valley), or where fans of different ages cannot be shown separately at map scale; Qafp fans typically contain well-rounded, recycled Lake Bonneville gravel and sand and are moderately well sorted; generally 10 to less than 60 feet (3-18 m) thick. Lake Bonneville-age fans are queried where relative age is uncertain (see Qaf for details); fans labeled Qafpb? are above the Bonneville shoreline and might be Qafo or like Qafm; see the note under Qao about two possible ages of older alluvium (Qao, Qato, and Qafo).

Most of the Lake Bonneville-age fans in the James Peak quadrangle are far from the Bonneville shoreline and their age is inferred from their stratigraphic relationship(s) to coeval Pinedale glacial outwash (see age equality in Table 3).

The channels (Qafp/Qdlb) on the Weber River delta and Lake Bonneville fines (Qafp on Qlfb) probably record scour and fill during the rapid drawdown of the lake as it fell from the Bonneville shoreline to the Provo shoreline.

Qap, Qap?, Qab, Qab?, Qapb - *Lake Bonneville-age alluvium (upper Pleistocene).* Like undivided alluvium but height above present drainages appears to be related to shorelines of Lake Bonneville and is within certain limits, and unconsolidated to weakly consolidated; alluvium labeled Qap and Qab is related to Provo (and slightly lower) and Bonneville shorelines of Lake Bonneville (at ~4800 to 4840 feet [1463-1475 m] and 5180 feet [1580 m] in Morgan Valley), respectively; suffixes partly based on heights above adjacent drainages near Morgan Valley (see tables 1 and 2); Qap is typically about 15 to 40 feet (5-12 m) above present adjacent drainages, but is locally 45 feet (12 m) above; Qapb is used where more exact age cannot be determined, typically away from Lake Bonneville, or where alluvium of different ages cannot be shown separately at map scale; Qap is up to about 50 feet (15 m) thick, with Qapb and Qab, at least locally up to 40 and 90 feet (12 and 27 m) thick, respectively. Queried where classification or relative age uncertain (see Qa).

A prominent surface ("bench") is present on Qap and Qatp at about 4900 feet (1494 m) elevation and about 25 to 40 feet (8-12 m) above the Weber River in Morgan Valley and along the South Fork Ogden River.

In the Devils Slide quadrangle, the Qab that is mapped about 80 to 95 feet (24-29 m) above Round Valley and 40 to 50 feet (12-15 m) above adjacent drainages at the mouth of Geary Hollow appears unique. Based on heights above adjacent drainages, these deposits would be Qao (see table 1), but similar alluvial deposits to the east near Phil Shop Hollow have a Bonneville shoreline cut in them and are much thinner than 40 feet (12 m). The lack of a Bonneville shoreline, and small thickness and heights above drainages indicate the deposits could be a Bonneville shoreline fan-delta.

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 too small to show at map scale; typically mapped along smaller drainages that lack flat bottoms; more extensive east of Henefer where Wasatch Formation (Tw) strata easily weather to debris that "chokes" drainages; 6 to 20 feet (2-6 m) thick. Some deposits are "perched" on benches 80 feet (25 m) and more above present-day drainages like Left Fork Heiners Creek (Heiners Creek quadrangle) and Harris Canyon (Henefer quadrangle). In the Devils Slide quadrangle, some deposits are "perched" on benches about 60 to 130 feet (18-40 m) above Quarry Cottonwood Canyon indicating the alluvium is at least partly Lake Bonneville age and older (see Qab and Qao in tables 1 and 2).

Qms, Qms?, Qmsy, Qmsy?, Qmso, Qmso? - *Landslide deposits (Holocene and upper and middle? Pleistocene).* Poorly sorted clay- to boulder sized material; includes slides, slumps, and locally flows and floods; generally characterized by hummocky topography, main and internal scarps, and chaotic bedding in displaced blocks; composition depends on local sources; morphology becomes more subdued with time and amount of water in material during emplacement; Qms may be in contact with Qms when landslides are different/distinct; thickness highly variable, up to about 20 to 30 feet (6-9 m) for small slides, and 80 to 100 feet (25-30 m) thick for larger landslides. Qmsy and Qmso queried where relative age uncertain; Qms queried where classification uncertain. Numerous landslides are too small to show at map scale and more detailed maps shown in the index to geologic mapping should be examined.

Qms without a suffix is mapped where the age is uncertain (though likely Holocene and/or late Pleistocene), where portions of slide complexes have different ages but cannot be shown separately at map scale, or where boundaries between slides of different ages are not distinct. Estimated time of emplacement is indicated by relative-age letter suffixes with: Qmsy mapped where landslides deflect streams or failures are in Lake Bonneville deposits, and scarps are variably vegetated; Qmso typically mapped where deposits are "perched" above present drainages, rumpled morphology typical of mass movements has been diminished, and/or younger surficial deposits cover or cut Qmso. Lower perched Qmso deposits are at Qao heights above drainages (95 ka and older) and the higher perched deposits may correlate with high level alluvium (QTa_) (likely older than 780 ka) (see table 1). Suffixes y and o indicate probable Holocene and Pleistocene ages, respectively, with all Qmso likely emplaced before Lake Bonneville transgression. These older deposits are as unstable as other slides, and are easily reactivated with the addition of water, be it irrigation or septic tank drain fields.

Qls, Qls?, Qlsp, Qlsb, Qlsb? - *Lake Bonneville sand (upper Pleistocene).* Mostly sand with some silt and gravel deposited nearshore below and near the Provo shoreline (Qlsp) and between the Provo and Bonneville shorelines (Qlsb); Qls mapped downslope from slope break below Provo shoreline beach deposits where thin Lake Bonneville regressional sand may overlie transgressional sand; grades downslope into unit Qlf with decreasing sand content and laterally with more gravel into units Qdlp, Qdlb, and upslope with more gravel into unit Qlgb; Qls and Qlsb queried where grain size or unit identification uncertain; may be as much as 75 feet (25 m) thick, and thickest near Ogden; typically less than 20 feet (6 m) thick in Morgan Valley; may include small deltas and deltas that lack typical delta shape.

Qadb, Qadb? - *Transgressive and Bonneville-shoreline alluvial and deltaic deposits (upper Pleistocene).* Cobbly gravel, sand, silt, and clay deposited above (subaerial) and in Lake Bonneville (subaqueous); typically mapped where shorelines are obscure, so that line cannot be drawn between alluvial fan and delta; include rounded to subangular clasts in a matrix of sand and silt with interbeds of sand and silt; mapped above the Provo shoreline and deposited as lake transgressed to and was at the Bonneville shoreline; typically better sorted delta and lake deposits over poorly sorted alluvial-fan deposits; Qadb prominent along Deep Creek (Morgan quadrangle) and Strawberry Creek (Snow Basin quadrangle); 0 to at least 40 feet (0-12+ m) thick.

Note that the Bonneville-shoreline fan-delta unit (Qadb), at 80 to 100 feet (24-30 m) above present drainages, is typically higher than the related alluvial units (Qab, Qafb) (see table 1). A fan-delta is built when an alluvial fan enters a lake or ocean, and includes both the fan and the delta.

Qla, Qla? - *Lake Bonneville lacustrine deposits and post- and pre-Lake Bonneville alluvial deposits, undivided (Holocene and upper? Pleistocene).* Mostly poorly sorted and poorly bedded sand, silt, and clay, with some gravel; mapped where Lake Bonneville deposits are reworked by later stream action or covered by thin stream and fan deposits, and where lake deposits are thin and overlie older alluvial deposits; unit queried where may be dominantly alluvium; deposits typically eroded from shallow Norwood Formation; mostly mapped near Bonneville shoreline; also mapped in Peterson quadrangle along upper Deep Creek above Bonneville shoreline where lake deposits seem to indicate landslide dam of creek; thickness uncertain.

Qafo, Qafo? - *Older alluvial-fan deposits (mostly upper Pleistocene).* Incised and at least locally dissected fans of mostly sand, silt, and gravel that is poorly bedded and poorly sorted; includes debris flows, particularly in drainages and at drainage mouths (fan heads); older fans are typically above the Bonneville shoreline, with an eroded bench at the shoreline; upstream and above the Bonneville shoreline, unit Qafo is topographically higher than fans graded to the Bonneville shoreline (Qafb), and is typically dissected; generally less than 60 feet (18 m) thick. In Mantua Valley, exposed thickness up to about 100 feet (30 m), but water wells (sections 26 and 27, T. 9 N., R. 1 W.) were still in gravelly to bouldery valley fill at depths of 505 and 467 feet (154 and 142 m), respectively, and red coloration that may indicate Wasatch Formation bedrock was not noted (see Bjorklund and McGreevy, 1973, p. 16).

Qafo queried where relative age is uncertain (see Qaf for details), for example in Mantua quadrangle where it is as high as Qafoe in Morgan Valley (see table 1). Qafo queried in East Canyon graben because the deposits are not dissected and some deposits mantle Qafoe (see also unit Qafm above), resulting in a reversal of relative height and only local incision.

These irregular deposits are likely the result of salt movement in the East Canyon graben. Our Qafo is roughly shown to south by Bryant (1990) as Qgp (pediment gravel); farther south he showed Qoa (dissected alluvium) adjacent to the East Canyon fault, which may be the QTaf or Qafoe we mapped.

Amino-acid age estimates presented in Sullivan and Nelson (1992) imply Qafo north of Morgan considerably predates Lake Bonneville and is middle Pleistocene in age (>400 ka). However, the Bonneville shoreline is obscure on this fan, and soil-carbonate age estimates (>70-100 ka) and other amino-acid age estimates (~98-155 ka) in Sullivan and others (1988) imply these older fans are related to Bull Lake glaciation (95,000 to 130,000 years old; see Chadwick and others, 1997; Phillips and others, 1997). As noted under Qao, Qafo deposits may contain two ages (levels) of alluvial surfaces that are not easily recognized in Morgan Valley but are recognized upstream in the Henefer and Lost Creek Valleys (Devils Slide quadrangle) and along the North and South Forks of Ogden River.

Tn, Tn? - *Norwood Formation (lower Oligocene and upper Eocene).* Typically light-gray to light-brown altered tuff (claystone), altered tuffaceous siltstone and sandstone, and conglomerate; unaltered tuff, present in type section south of Morgan, is rare; locally colored light shades of red and green; variable calcareous cement and zeolitization; involved in numerous landslides of various sizes; estimate 2000-foot (600 m) thick in exposures on west side of Ogden Valley (based on bedding dip, outcrop width, and topography). Norwood Formation queried where poor exposures may actually be surficial deposits. For detailed Norwood Formation information see description under heading “Sub-Willard Thrust - Ogden Canyon Area” since most of this unit is in and near Morgan Valley and covers the Willard thrust, Ogden Canyon, and Durst Mountain areas.

Zmcg, Zmcg? - *Maple Canyon Formation, Lower (green arkose) member (Neoproterozoic).* Grayish-green, fine-grained arkosic (feldspathic) meta-sandstone and sandy argillite (meta-graywacke), with local quartzite lenses up to 200 feet (60 m) thick; weathers darker gray to brown to greenish-gray and greenish-brown; 500 to 1000 feet (150-305 m) thick and lower thickness would eliminate the need for faulting in southwest part of Huntsville quadrangle. This unit is prone to slope failures.

Zpu, Zpu? - *Formation of Perry Canyon, Upper member (Neoproterozoic).* Olive drab to gray, thin-bedded slate to argillite to phyllite to micaceous meta-siltstone to meta-graywacke to meta-sandstone in variable proportions such that unit looks like both the “greywacke-sandstone” and “mudstone” members of previous workers; unit identification based on underlying diamictite in Mantua quadrangle; rare meta-gritstone and meta-diamictite (actually conglomerate?); locally schistose; meta-sandstone contains poorly sorted lithic, quartz, and feldspar grains in silty to micaceous matrix; meta-sandstone is quartzose in outcrops on west margin of Mantua quadrangle (Crittenden and Sorensen, 1985a) and medial zone of sandstone is feldspathic east of Ogden Valley, where mapped and described as argillite member of Maple Canyon Formation by Crittenden (1972) and Sorensen and Crittenden (1979); thickness uncertain, but appears to be about 600 feet (180 m) thick on west flank of Grizzly Peak in the Mantua quadrangle and about 1000 feet (300 m) thick between Ogden Canyon and North Ogden divide. In Ogden Valley typically non-resistant and tan weathering such that gray to green to dark-gray fresh color is seldom seen except in cut slopes and excavations. This unit is prone to slope failures.

Citations, tables, and figures above are not provided herein, but are in Coogan and King (2016).

Seismotectonic Setting
The property is located at the northwestern margin of Ogden Valley, a roughly 40-square mile back valley described by Gilbert (1928) as a structural trough similar to Cache and Morgan Valleys to the north and south, respectively. The back valleys of the northern Wasatch Range are in a transition zone between the Basin and Range and Middle Rocky Mountains provinces (Stokes, 1977, 1986). The Basin and Range is characterized by a series of generally north-trending elongate mountain ranges, separated by predominately alluvial and lacustrine sediment-filled valleys and typically bounded on one or both sides by major normal faults (Stewart, 1978). The boundary between the Basin and Range and Middle Rocky Mountains provinces is the prominent, west-facing escarpment along the Wasatch fault zone at the base of the Wasatch Range. Late Cenozoic normal faulting, a characteristic of the Basin and Range, began between about 17 and 10 million years ago in the Nevada (Stewart, 1980) and Utah (Anderson, 1989) portions of the province. The faulting is a result of a roughly east-west directed, regional extensional stress regime that has continued to the present (Zoback and Zoback, 1989; Zoback, 1989). The back valleys are morphologically similar to valleys in the Basin and Range, but exhibit less structural relief (Sullivan and others 1988).

Ogden Valley occupies a structural trough created by up to 2,000 feet of vertical displacement on normal faults bounding the east and west sides of the valley. The Ogden Valley southwestern margin fault and North Fork fault (Black and others, 2003) are shown on Figure 2 trending northwestward along the northern site boundary and about 4,500 feet to the northeast, respectively. The most recent movement on these faults is pre-Holocene (Sullivan and others, 1986). The faults are concealed where mantled by late Pleistocene and Holocene surficial deposits (Figure 2, dashed and dotted bold lines). Norwood Formation mapped in the site area (Figure 2, unit Tn) likely represents an in-place faulted block preserved between the faults (Jon King, Utah Geological Survey, verbal communication, February 2016).

The site is also situated near the central portion of the Intermountain Seismic Belt (ISB). The ISB is a north-south-trending zone of historical seismicity along the eastern margin of the Basin and Range province which extends for approximately 900 miles from northern Arizona to northwestern Montana (Sbar and others, 1972; Smith and Sbar, 1974). At least 16 earthquakes of magnitude 6.0 or greater have occurred within the ISB since 1850, with the largest of these events the M_S 7.5 1959 Hebgen Lake, Montana earthquake. However, none of these events have occurred along the Wasatch fault zone or other known late Quaternary faults in the region (Arabasz and others, 1992; Smith and Arabasz, 1991). The closest of these events to the site was the 1934 Hansel Valley (M_S 6.6) event north of the Great Salt Lake and south of the town of Snowville.

Lake Bonneville History

Lakes occupied nearly 100 basins in the western United States during late-Quaternary time, the largest of which was Lake Bonneville in northwestern Utah. The Bonneville basin consists of several topographically closed basins created by regional extension in the Basin and Range (Gwynn, 1980; Miller, 1990), and has been an area of internal drainage for much of the past 15 million years. Lake Bonneville consisted of numerous topographically closed basins, including the Salt Lake and Cache Valleys (Oviatt and others, 1992). Portions of Ogden Valley were inundated by Lake Bonneville at its highstand, and sediments from Lake Bonneville are mapped at lower elevations (below about 5,200 feet) in Ogden Valley.

Timing of events related to the transgression and regression of Lake Bonneville is indicated by calendar age estimates of significant radiocarbon dates in the Bonneville Basin (Oviatt, 2015). Approximately 30,000 years ago, Lake Bonneville began a slow transgression (rise) to its highest level of 5,160 to 5,200 feet above mean sea level. The lake rise eventually slowed as water levels approached an external basin threshold in northern Cache Valley at Red Rock Pass near Zenda, Idaho. Lake Bonneville reached the Red Rock Pass threshold and occupied its highest shoreline, termed the Bonneville beach, around 18,000 years ago. During the transgression and highstand, major drainages that emanate from within the Wasatch Range (such as the Weber River) formed large deltaic complexes in the lake at their canyon mouths. Headward erosion of the Snake River-Bonneville basin drainage divide then caused a catastrophic incision of the threshold and the lake level lowered by roughly 360 feet in fewer than two months (Jarrett and Malde, 1987; O'Conner, 1993). The Project is above the highest Bonneville shoreline, which is mapped on Figure 2 (blue line and B) about 5,500 feet to the north.

Following the Bonneville flood, the lake stabilized and formed a lower shoreline referred to as the Provo shoreline between about 16,500 and 15,000 years ago. Climatic factors then caused the lake to regress rapidly from the Provo shoreline, and by about 13,000 years ago the lake had eventually dropped below historic levels of Great Salt Lake. Drainages that fed Lake Bonneville began downcutting through stranded deltaic complexes and near-shore deposits as the lake receded from the Provo shoreline. Oviatt and others (1992) deem this low stage the end of the Bonneville lake cycle. Great Salt Lake then experienced a brief transgression around 11,600 years ago to the Gilbert level at about 4,250 feet before receding to and remaining within about 20 feet of its historic average level (Lund, 1990).

SITE CHARACTERIZATION

Air Photo Observations

Black and white aerial photography from 1997, one-meter bare earth DEM LIDAR from 2011, and color high-resolution orthophotography from 2012 available from the Utah AGRC (Figures 3A-C) were reviewed to obtain information about the geomorphology of the Project area. The property is at the northwestern margin of Ogden Valley between Coal Hollow and Grover Hollow on northeast-facing slopes overlooking the valley. Coal Hollow Creek flows northeastward about 500 feet northwest of the Project; Grover Hollow Creek is further east, off the east edge of Figures 3A-C.

The Project is situated in an area of various remnant knobs of Tertiary-age Norwood Formation bedrock surrounded by gently sloping meadow areas. Further northwest and northeast are a terrace and a north-trending ridge underlain by similar bedrock. The bedrock knobs are inferred by Coogan and King (2016) to be rafted landslide blocks, although the source area for such a large slide is no longer evident. However, we note that the bedrock knobs follow the trace of the Ogden Valley southwestern margin fault (Figure 2). Norwood Formation is similarly found in the area on the upthrown (southwest) side of this fault and as remnant knobs on the downthrown (northeast) side. Except for an arcuate-shaped degraded scarp that extends into the northeast part of the site from a prehistoric landslide, no evidence of active or seasonal drainages, springs, seeps, recent or ongoing landsliding or other geologic hazards was observed on the photos. Slopes at the site show an overall roughly 4.5:1 (horizontal:vertical) gradient.

Empirical Observations

On September 21, 2018, Mr. Bill D. Black of Western GeoLogic conducted a reconnaissance of the property in conjunction with subsurface exploration discussed below. Weather at the time of the site reconnaissance was clear to partly cloudy with temperatures in the 70's (°F). The site is in an area heavily vegetated by mature pine trees, scrub oak, and grasses. Coal Hollow Creek flows northeastward about 500 feet west of the Project, but no active or ephemeral drainages were observed crossing the site.

As indicated in the Air Photo Observations Section above, the site straddles a series of heavily vegetated, remnant bedrock knobs surrounded by low-lying meadow areas where alluvial and colluvial deposits eroded from these knobs and upslope areas have accumulated since Pleistocene time. The knobs are mantled by boulders and cobbles suggestive of tuffaceous conglomerate facies within the Norwood Formation. No evidence of recent or ongoing slope instability or other geologic hazards was observed or noted during the reconnaissance.

Subsurface Investigation

Two walk-in test pits were previously excavated at the property and examined on September 21, 2018 to evaluate subsurface conditions. The test pit locations are shown on Figures 3A-C. Figures 4A-B are logs of the test pits at a scale of 1-inch equals five feet (1:60). Test pit locations were measured using a hand-held GPS unit and by trend and distance methods from known points. The test pits were logged following methodology in McAlpin (1996), and digitally photographed to document the exposures. The photos are not provided herein, but are available on request.

Both test pits at the site exposed tuffaceous bedrock of the Tertiary Norwood Formation overlain by a thin veneer of slope colluvium. Bedding strike and dips measured in the test pits were 293° N 18° NE (TP-1, Figure 4A) and 290° N 18° NE (TP-2, Figure 4B). These strike and dips are similar to those measured in Norwood Formation bedrock on the north-adjoining WAJ Enterprises property (Western GeoLogic, 2018; Figures 3A-C in red) and regionally on Figure 2. No groundwater was encountered in the test pits to their explored depths. One test pit was excavated on the north-adjoining WAJ Enterprises property in the landslide deposit on Figures 3A-C by Western GeoLogic (2018) that exposed backtilted tuffaceous conglomerate bedrock with a B-horizon vertisol forming at the surface. This evidence suggests that the landslide extending into the northeast part of the site is of late Pleistocene age.

Cross Section

Subsurface data in Western GeoLogic (2018) and obtained from the test pits at the Project suggest the bedrock knobs at the Project and in the area are intact remnants of Norwood Formation, rather than rafted blocks, surrounded by meadows where a mixture of alluvial and colluvial sediments eroded from the knobs and upslope areas has accumulated since Pleistocene time. Figure 5 shows a geologic cross section across the site and the landslide to the northeast at a scale of 1-inch equals 60 feet with no vertical exaggeration. Units and contacts are based on subsurface data from the test pits (Figures 4A-B) and Western GeoLogic (2018). Topographic profiles are based on 2011 LIDAR data.

GEOLOGIC HAZARDS

Assessment of potential geologic hazards and the resulting risks imposed is critical in determining the suitability of the site for development. Table 1 below shows a summary of the geologic hazards reviewed at the site, as well as a relative (qualitative) assessment of risk to the Project for each hazard. A "high" hazard rating (H) indicates a hazard is present at the site (whether currently or in the geologic past) that is likely to pose significant risk and/or may require further study or mitigation techniques. A "moderate" hazard rating (M) indicates a hazard that poses an equivocal risk. Moderate-risk hazards may also require further studies or mitigation. A "low" hazard rating (L) indicates the hazard is not present, poses little or no risk, and/or is not likely to significantly impact the Project. Low-risk hazards typically require no additional studies or mitigation. We note that these hazard ratings represent a conservative assessment for the entire site and risk may vary in some areas. Careful selection of development areas can minimize risk by avoiding known hazard areas.

Table 1. *Geologic hazards summary.*

Hazard	H	M	L
Earthquake Ground Shaking	X		
Surface Fault Rupture			X
Liquefaction and Lateral-spread Ground Failure			X
Tectonic Deformation			X
Seismic Seiche and Storm Surge			X
Stream Flooding			X
Shallow Groundwater			X
Landslides and Slope Failures	X		
Debris Flows and Floods			X
Rock Fall			X
Problem Soil		X	

Earthquake Ground Shaking

Ground shaking refers to the ground surface acceleration caused by seismic waves generated during an earthquake. Strong ground motion is likely to present a significant risk during moderate to large earthquakes located within a 60 mile radius of the project area (Boore and others, 1993). Seismic sources include mapped active faults, as well as a random or "floating" earthquake source on faults not evident at the surface. Mapped active faults within this distance include the East and West Cache fault zones; the Brigham City, Weber, Salt Lake, and Provo segments of the Wasatch fault zone; the East Great Salt Lake fault zone; the Morgan fault; the West Valley fault zone; the Oquirrh fault zone; and the Bear River fault zone (Black and others, 2003).

The extent of property damage and loss of life due to ground shaking depends on factors such as: (1) proximity of the earthquake and strength of seismic waves at the surface (horizontal motions are the most damaging); (2) amplitude, duration, and frequency of ground motions; (3) nature of foundation materials; and (4) building design (Costa and Baker, 1981). Based on 2015 IBC provisions, a site class of D (stiff soil), and a risk category of I-III, USGS calculated uniform-hazard and deterministic ground motion values with a 2% chance of exceedance in 50 years are as follows:

Table 2. *Seismic hazards summary.*
(Site Location: 41.293618º N, -111.848648º W)

S_S	*0.974 g*
S_1	*0.335 g*
S_{MS} (F_a x S_S)	*1.081 g*
S_{M1} (F_v x S_1)	*0.580 g*
S_{DS} (2/3 x S_{MS})	*0.721 g*
S_{D1} (2/3 x S_{M1})	*0.386 g*
Site Coefficient, F_a	*= 1.111*
Site Coefficient, F_v	*= 1.730*

Given the above information, earthquake ground shaking poses a high risk to the site. Earthquake ground shaking is a regional hazard that is mitigated by design and construction of homes in accordance with appropriate building codes. The Project geotechnical engineer, in conjunction with the builder or architect, should confirm and evaluate the seismic ground-shaking hazard and provide appropriate seismic design parameters as needed.

Surface Fault Rupture

Movement along faults at depth generates earthquakes. During earthquakes larger than Richter magnitude 6.5, ruptures along normal faults in the intermountain region generally propagate to the surface (Smith and Arabasz, 1991) as one side of the fault is uplifted and the other side down dropped. The resulting fault scarp has a near-vertical slope. The surface rupture may be expressed as a large singular rupture or several smaller ruptures in a broad zone. Ground displacement from surface fault rupture can cause significant damage or even collapse to structures located on an active fault.

The nearest active fault to the site is the Weber segment of the Wasatch fault zone about 4.4 miles to the west, and no evidence of active surface faulting is mapped or was evident at the site. Given this, the risk from surface faulting appears to be low.

Liquefaction and Lateral-spread Ground Failure
Liquefaction occurs when saturated, loose, cohesionless, soils lose their support capabilities during a seismic event because of the development of excessive pore pressure. Earthquake-induced liquefaction can present a significant risk to structures from bearing-capacity failures to structural footings and foundations, and can damage structures and roadway embankments by triggering lateral spread landslides. Earthquakes of Richter magnitude 5 are generally regarded as the lower threshold for liquefaction. Liquefaction potential at the site is a combination of expected seismic (earthquake ground shaking) accelerations, groundwater conditions, and presence of susceptible soils.

The anticipated depth to groundwater at the Project is greater than 30 feet. The NRCS (https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx) maps two soil units at the site comprised of very cobbly loam, gravelly clay, gravelly loam, and clay loam soils formed in colluvium derived from sandstone and quartzite on mountain slopes and mountain sides. We do not therefore anticipate any soils susceptible to liquefaction are present at the site. Given the above, we rate the risk from liquefaction as low.

Tectonic Deformation
Tectonic deformation refers to subsidence from warping, lowering, and tilting of a valley floor that accompanies surface-faulting earthquakes on normal faults. Large-scale tectonic subsidence may accompany earthquakes along large normal faults (Lund, 1990). Tectonic subsidence is believed to mainly impact those areas immediately adjacent to the downthrown side of a normal fault. The site is not on the downthrown side of any active faults. Given this, we rate the hazard from tectonic subsidence as low.

Seismic Seiche and Storm Surge
Earthquake-induced seiche presents a risk to structures within the wave-oscillation zone along the edges of large bodies of water, such as the Great Salt Lake. Given the elevation of the subject property and distance from any large bodies of water, the risk from seismic seiches and storm surges is rated as low.

Stream Flooding
Stream flooding may be caused by direct precipitation, melting snow, or a combination of both. In much of Utah, floods are most common in April through June during spring snowmelt. High flows may be sustained from a few days to several weeks, and the potential for flooding depends on a variety of factors such as surface hydrology, site grading and drainage, and runoff.

No active or seasonal drainages are mapped crossing the site or were observed. The nearest active drainage is Coal Hollow Creek about 500 feet to the northwest. Given this, the risk from stream flooding is rated as low. Site hydrology and drainage should be addressed in the civil engineering design for the development in accordance with all applicable local government development guidelines.

Shallow Groundwater

Groundwater at the site is likely more than 30 feet deep. Although conditions may fluctuate seasonally and perched groundwater could be found in some areas over less-permeable layers, we rate the risk from shallow groundwater as low. We do not anticipate shallow groundwater will pose a significant development constraint, but the Project geotechnical engineer may recommend the use of a foundation drainage system to mitigate seasonal groundwater, particularly given the alpine location.

Landslides and Slope Failures

Slope stability hazards such as landslides, slumps, and other mass movements can develop along moderate to steep slopes where a slope has been disturbed, the head of a slope loaded, or where increased groundwater pore pressures result in driving forces within the slope exceeding restraining forces. Slopes exhibiting prior failures, and also deposits from large landslides, are particularly vulnerable to instability and reactivation.

Tertiary Norwood Formation bedrock, which is a known landslide-prone unit, is mapped in the site area and was exposed in the test pits at the Project. One landslide sourced in this bedrock is in the northeast part of the Project that was confirmed by test pit data in Western GeoLogic (2018), although no other evidence of landsliding or recent or ongoing slope instability was observed at the site on air photos or during our reconnaissance. Bedding strike and dips measured at the Project suggest the bedrock in the area of the test pits is intact and undeformed. However, given that the Project is in an area underlain by landslide-prone bedrock, we conservatively rate the risk from landslides as high. We recommend that stability of slopes at the site be evaluated by the Project geotechnical engineer based on site-specific data and data provided in this report. Recommendations should be provided to reduce the landslide hazard risk if factors of safety are determined to be unsuitable. Water, steep man-made cuts, and non-engineered fill materials are often major contributors to slope instability. Care should therefore also be taken to maintain proper site drainage, that site grading does not destabilize slopes at the site without prior geotechnical analysis and grading plans, and that water from sources such as landscape irrigation is minimized in and adjacent to potentially unstable slope areas.

Debris Flows

Debris flow hazards are typically associated with unconsolidated alluvial fan deposits at the mouths of large range-front drainages, such as those along the Wasatch Front. Debris flows have historically significant damage in the Wasatch Front area. The site is not in any mapped alluvial-fan deposits, and no evidence of debris-flow channels, levees, or other debris-flow features was observed. Based on the above, we rate the hazard from debris flows at the site as low.

Rock Fall

No bedrock outcrops were observed at the site or in higher adjacent slopes that could present a source area for rock fall clasts. Based on the above, we rate the hazard from rock falls as low.

Swelling and Collapsible Soils

Surficial soils that contain certain clays can swell or collapse when wet. Given observed subsurface conditions, clay-rich layers are present in the subsurface in some areas that may be susceptible to a low degree of swelling. We therefore rate the hazard from problem soils as moderate. The Project geotechnical engineering evaluation should address soil conditions and provide specific recommendations for site grading, subgrade preparation, and footing and foundation design.

CONCLUSIONS AND RECOMMENDATIONS

Earthquake ground shaking and landslides are identified as geologic hazards posing a high relative risk to the Project. The following recommendations are provided to reduce risk from these hazards and for proper site development:

- ***Seismic Design*** **–** All habitable structures developed at the property should be constructed to current seismic hazards to reduce the risk of damage, injury, or loss of life from earthquake ground shaking.

- ***Site Grading and Drainage*** **–** No unplanned cuts should be made in the slopes at the site without prior geotechnical analyses, and proper site drainage should be maintained.

- ***Excavation Backfill Considerations*** **–** The test pits may be in areas where a structure could subsequently be placed. However, backfill may not have been replaced the excavations in compacted layers. The fill could settle with time and upon saturation. Should structures be located in an excavated area, no footings or structure should be founded over the excavation unless the backfill has been removed and replaced with structural fill, if the fill is to support a structure.

- ***Geotechnical Evaluation*** **–** A design-level geotechnical engineering study should be conducted prior to construction to: (1) address soil conditions at the site for use in foundation design, site grading, and drainage; and (2) evaluate stability of slopes at the site, including providing recommendations for reducing the risk of landsliding if the factors of safety are deemed unsuitable. The evaluation should be based on geologic characterizations in this report and site-specific geotechnical data, and provide recommendations for reducing the risk of landsliding if the factors of safety are deemed unsuitable. The stability evaluation should account for perched groundwater, seasonal fluctuations, and water from sources such as landscape irrigation and septic systems.

- ***Report Availability*** **–** This report should be made available to architects, building contractors, and in the event of a future property sale, real estate agents and potential buyers. The report should be referenced for information on technical data only as interpreted from observations and not as a warranty of conditions throughout the site. The report should be submitted in its entirety, or referenced appropriately, as part of any document submittal to a government agency responsible for planning decisions or geologic review. Incomplete submittals void the professional seals and signatures we provide herein. Although this report and the data herein are the property of the client, the report format is the intellectual property of Western Geologic and should not be copied, used, or modified without express permission of the authors.

LIMITATIONS

This investigation was performed at the request of the Client using the methods and procedures consistent with good commercial and customary practice designed to conform to acceptable industry standards. The analysis and recommendations submitted in this report are based upon the data obtained from site-specific observations and compilation of known geologic information. This information and the conclusions of this report should not be interpolated to adjacent properties without additional site-specific information. In the event that any changes are later made in the location of the proposed site, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or approved in writing by the engineering geologist.

This report has been prepared by the staff of Western GeoLogic for the Client under the professional supervision of the principal and/or senior staff whose seal(s) and signatures appear hereon. Neither Western GeoLogic, nor any staff member assigned to this investigation has any interest or contemplated interest, financial or otherwise, in the subject or surrounding properties, or in any entity which owns, leases, or occupies the subject or surrounding properties or which may be responsible for environmental issues identified during the course of this investigation, and has no personal bias with respect to the parties involved.

The information contained in this report has received appropriate technical review and approval. The conclusions represent professional judgment and are founded upon the findings of the investigations identified in the report and the interpretation of such data based on our experience and expertise according to the existing standard of care. No other warranty or limitation exists, either expressed or implied.

The investigation was prepared in accordance with the approved scope of work outlined in our proposal for the use and benefit of the Client; its successors, and assignees. It is based, in part, upon documents, writings, and information owned, possessed, or secured by the Client. Neither this report, nor any information contained herein shall be used or relied upon for any purpose by any other person or entity without the express written permission of the Client. This report is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose without the advance written consent of Western GeoLogic.

In expressing the opinions stated in this report, Western GeoLogic has exercised the degree of skill and care ordinarily exercised by a reasonable prudent environmental professional in the same community and in the same time frame given the same or similar facts and circumstances. Documentation and data provided by the Client, designated representatives of the Client or other interested third parties, or from the public domain, and referred to in the preparation of this assessment, have been used and referenced with the understanding that Western GeoLogic assumes no responsibility or liability for their accuracy. The independent conclusions represent our professional judgment based on information and data available to us during the course of this assignment. Factual information regarding operations, conditions, and test data provided by the Client or their representative has been assumed to be correct and complete. The conclusions presented are based on the data provided, observations, and conditions that existed at the time of the field exploration.

It has been a pleasure working with you on this project. Should you have any questions, please call.

Sincerely,
Western GeoLogic, LLC

Bill. D. Black, P.G.
Senior Engineering Geologist

Reviewed by:

Craig V. Nelson, P.G.
Principal Engineering Geologist

ATTACHMENTS

Figure 1. Location Map (8.5"x 11")
Figure 2. Geologic Map (8.5"x 11")
Figure 3A. 1997 Air Photo (8.5"x 11")
Figure 3B. 2011 LIDAR Image (8.5"x 11")
Figure 3C. 2012 Air Photo (8.5"x 11")
Figures 4A-4B. Test Pit Logs (two 8.5"x 11" sheets)
Figures 5. Cross Section (11" x 17" landscape)

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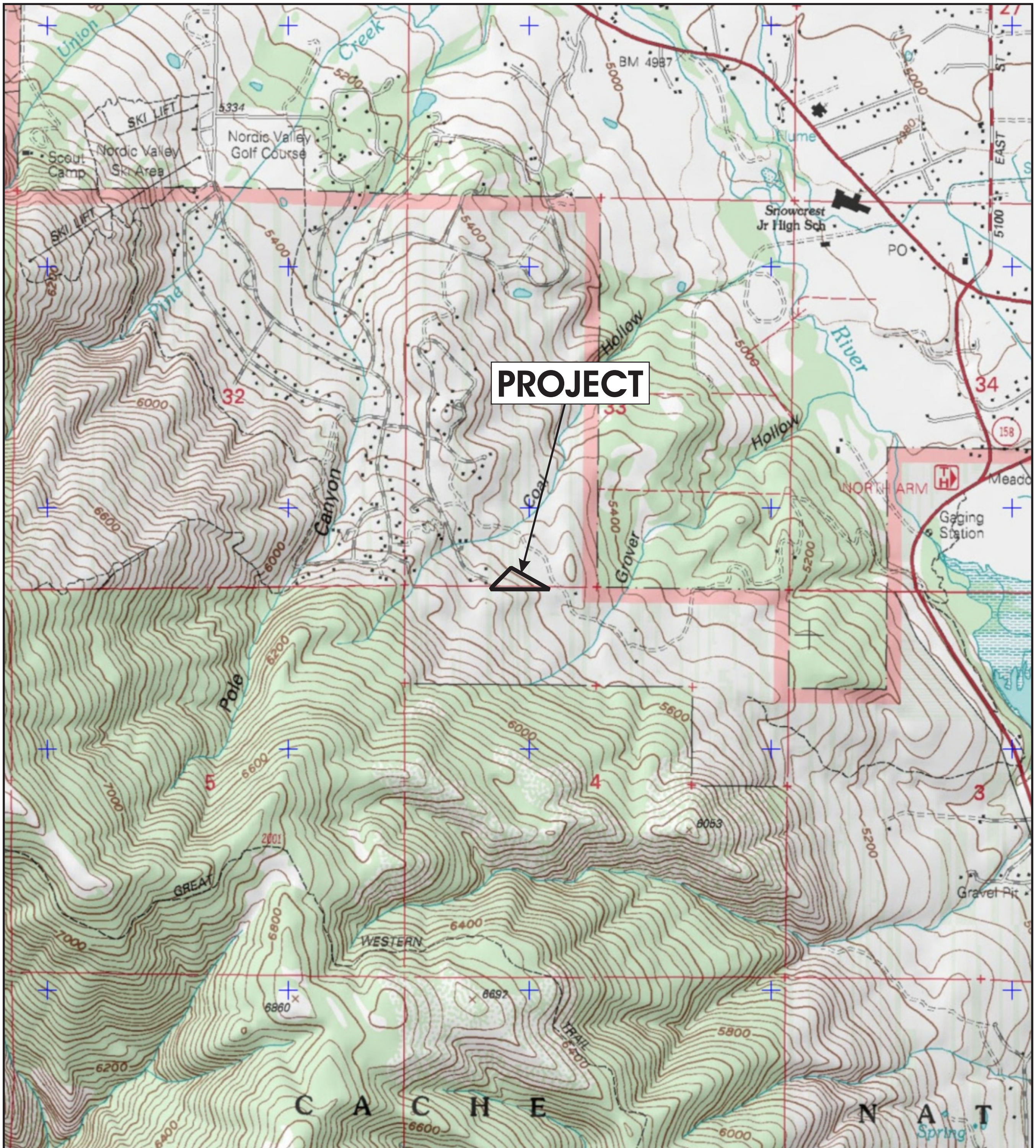
FIGURES



Source: U.S. Geological Survey 7.5 Minute Series Topographic Maps, Utah - Huntsville, 1998;
Project location SW1/4, Section 33, T7N, R1E (SLBM); about 5,600 to 5,700 feet elevation (ASL).

Scale 1:24,000
(1 inch = 2000 feet)

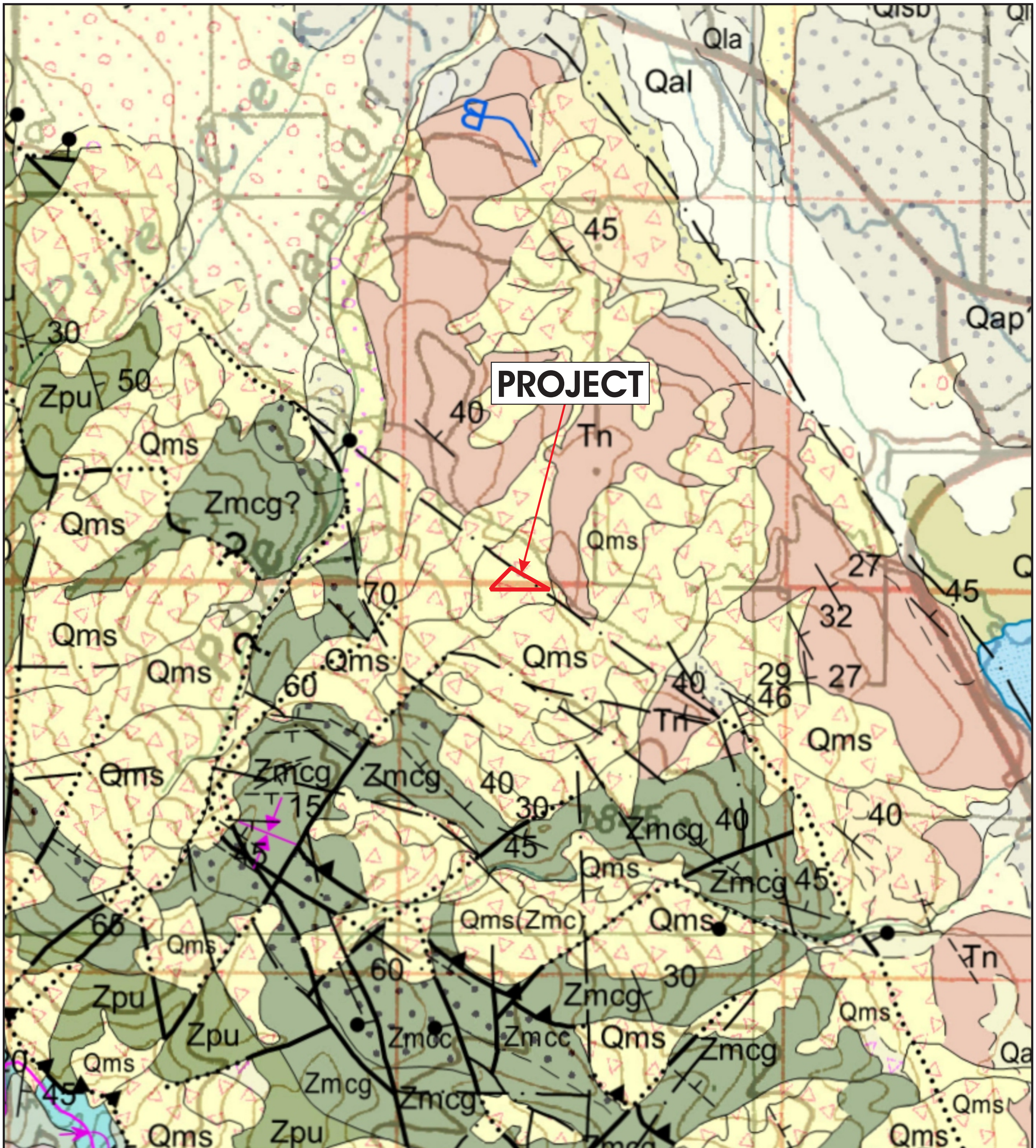
0 1000 2000 feet

LOCATION MAP

GEOLOGIC HAZARDS EVALUATION

Beckstead Property
About 1860 North Big Sky Drive
Eden, Weber County, Utah

FIGURE 1



Source: Coogan and King (2016), original map scale 1:100,000.
See text for explanation of nearby surficial geologic units.

WESTERN GEOLOGIC

N
W E
S

0 1000 2000 feet

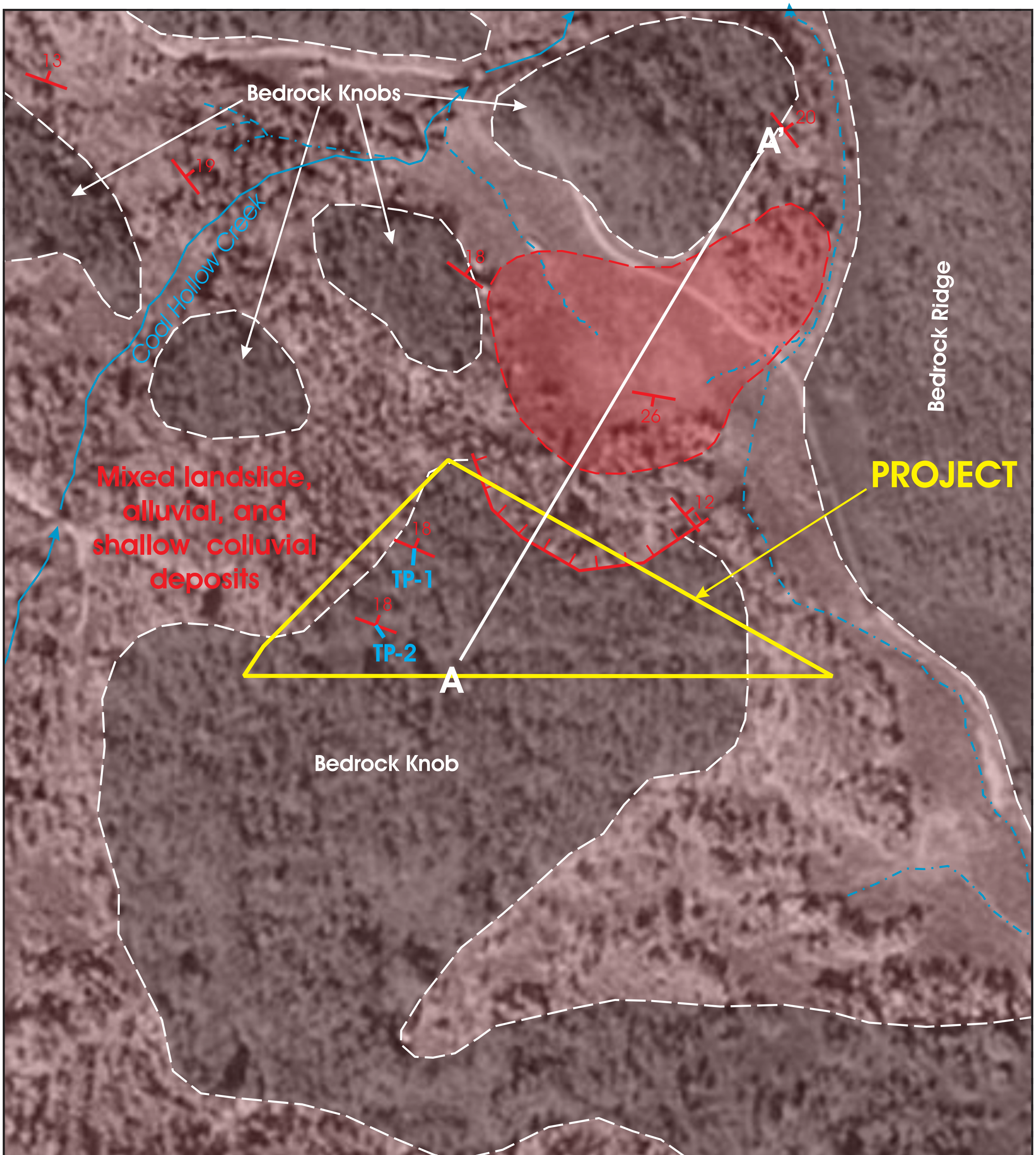
Scale 1:24,000
(1 inch = 2000 feet)

GEOLOGIC MAP

GEOLOGIC HAZARDS EVALUATION

Beckstead Property
About 1860 North Big Sky Drive
Eden, Weber County, Utah

FIGURE 2



Source: Utah AGRC Digital Orthophoto Quadrangle.

WESTERN GEOLOGIC

N W E S

0 100 200 feet

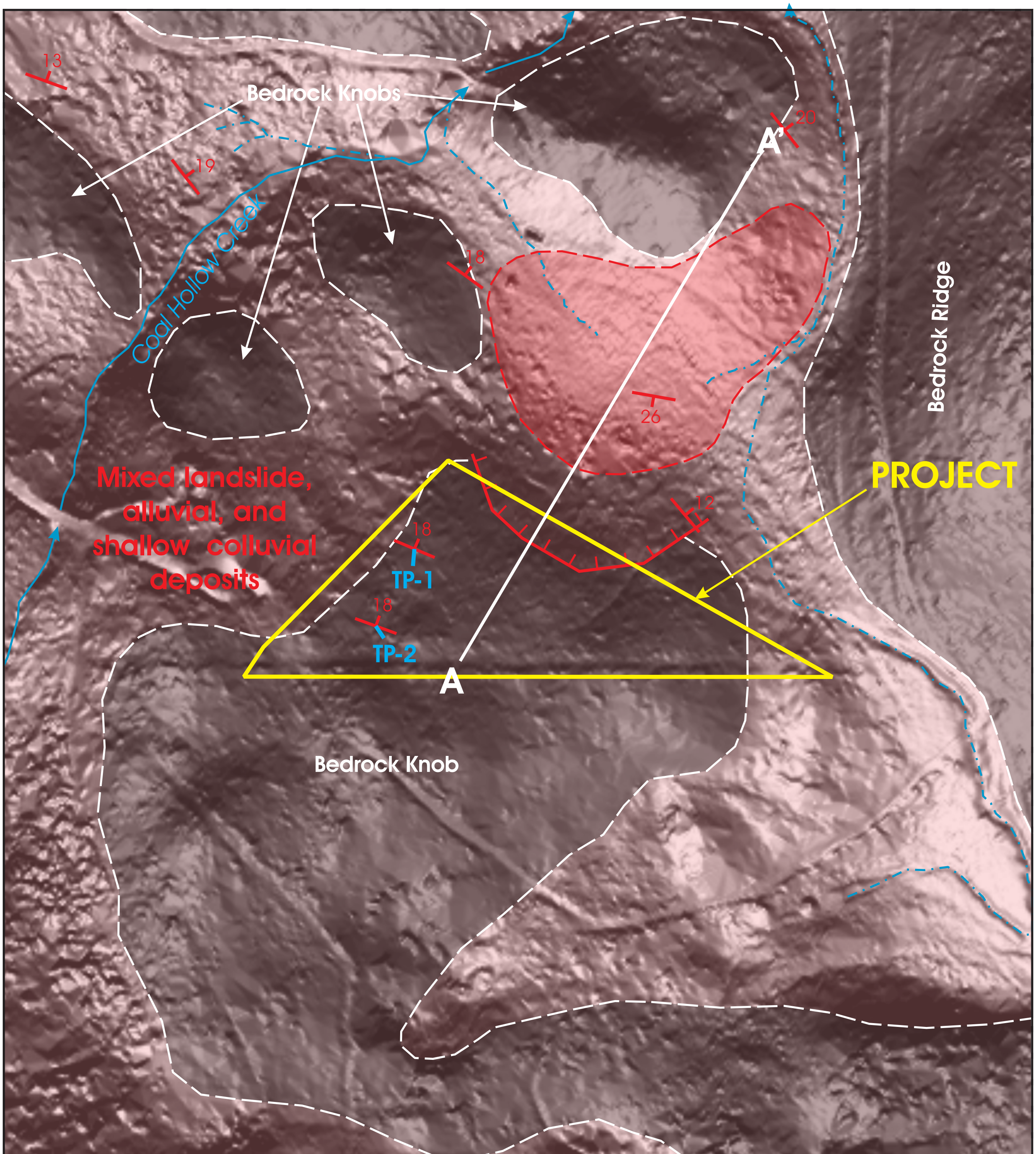
Scale 1:2,400
(1 inch = 200 feet)

1997 AERIAL PHOTO

GEOLOGIC HAZARDS EVALUATION

Beckstead Property
About 1860 North Big Sky Drive
Eden, Weber County, Utah

FIGURE 3A



Source: Utah AGRC, 2011 LIDAR Bare Earth DEM, one meter resolution.

WESTERN GEOLOGIC

N W E S

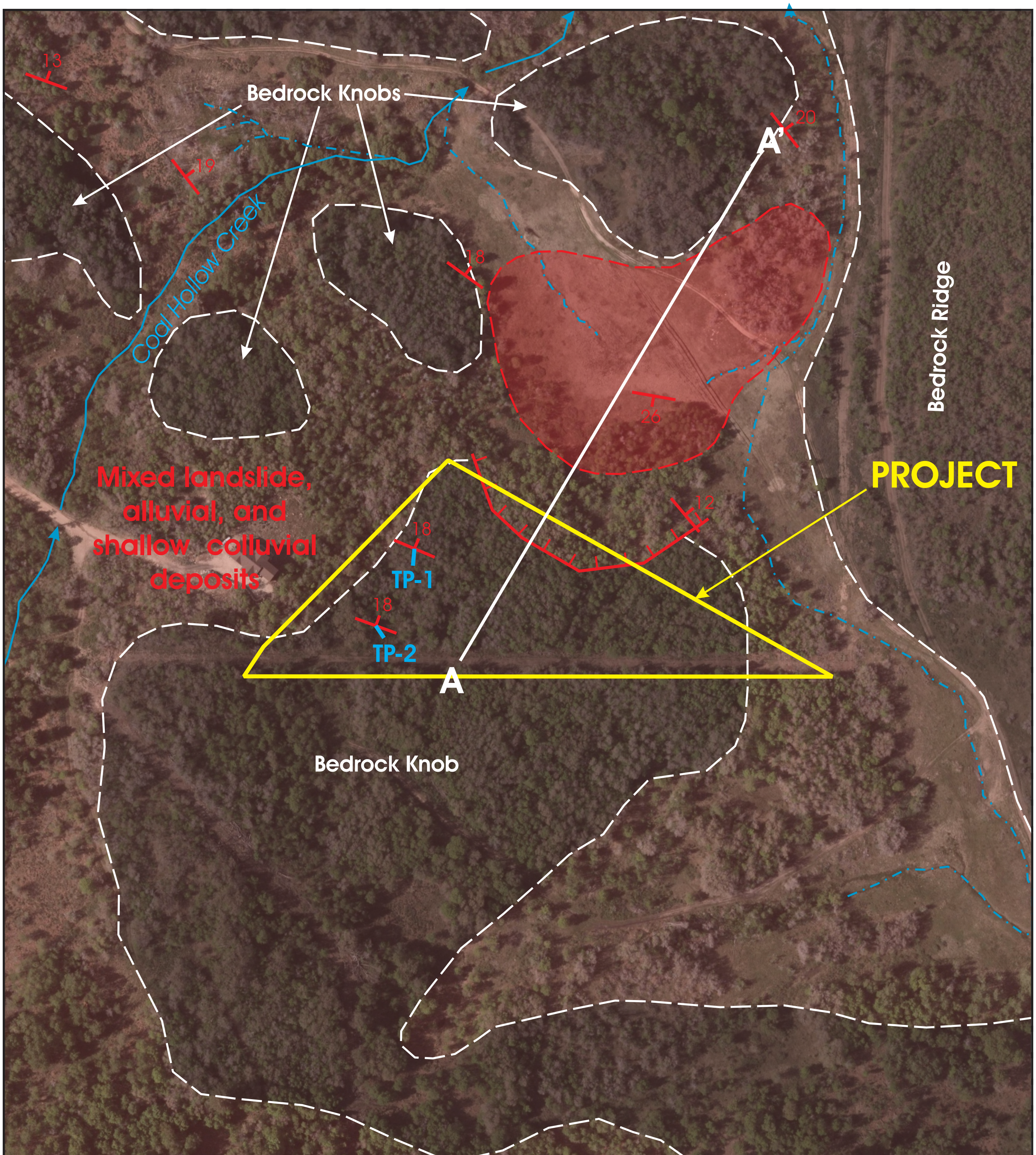
0 100 200 feet

Scale 1:2,400
(1 inch = 200 feet)

2011 LIDAR IMAGE

GEOLOGIC HAZARDS EVALUATION
Beckstead Property
About 1860 North Big Sky Drive
Eden, Weber County, Utah

FIGURE 3B



Source: Utah AGRC, 2012 High Resolution Orthophoto, six inch resolution; parcel boundary from Weber County GIS data.

Scale 1:2,400 (1 inch = 200 feet)

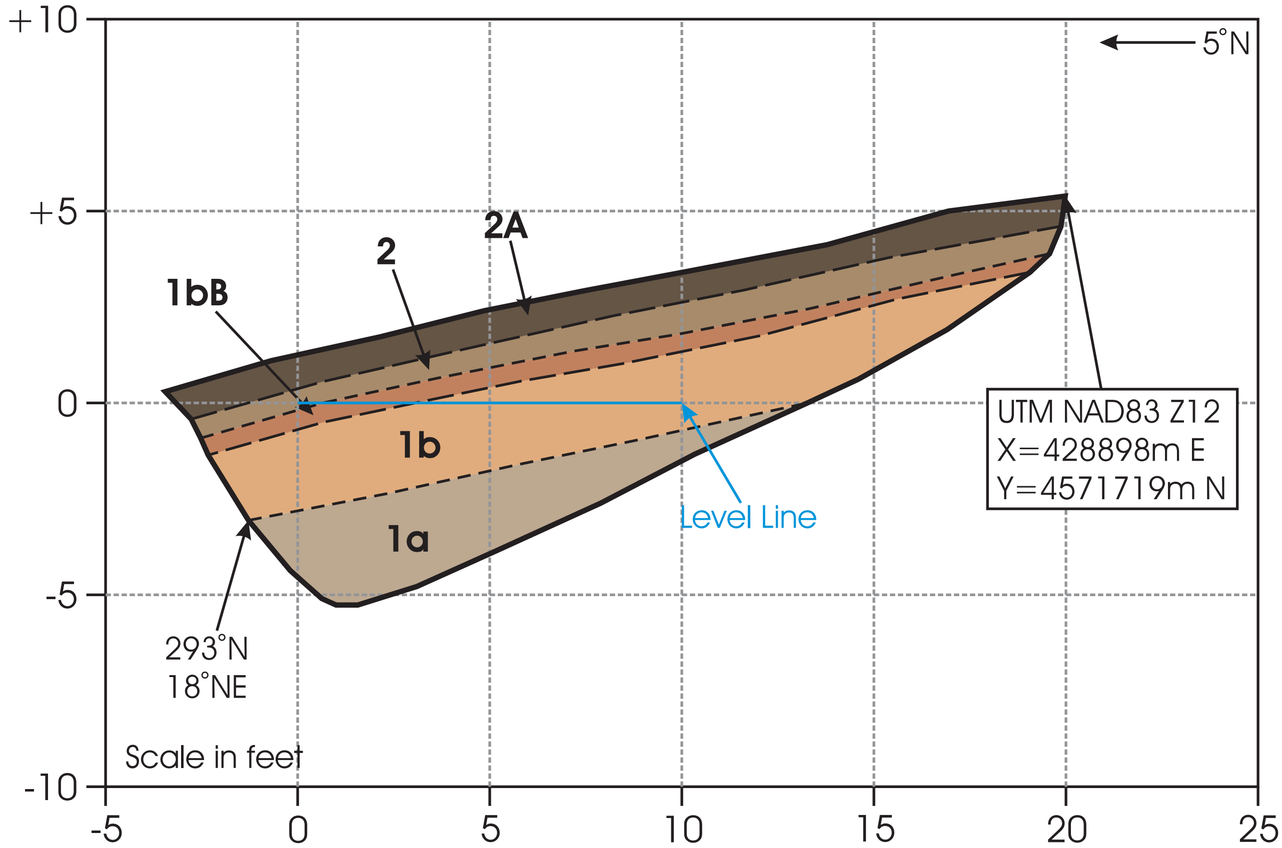
0 100 200 feet

2012 AIR PHOTO

GEOLOGIC HAZARDS EVALUATION

Beckstead Property
About 1860 North Big Sky Drive
Eden, Weber County, Utah

FIGURE 3C



UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - Sequence of weathered tuffaceous claystone and sandstone comprised of: (**1a**) a lower, brownish-gray , dense, poorly bedded, silty to clayey sand (SM); and (**1b**) an upper, pinkish-brown, dense, poorly bedded, lean to fat clay (CL/CH).

1bB. Bt soil horizon formed in unit 1b.

Unit 2. *Holocene Colluvium* - Brown to dark-brown, moderate density, massive, clayey sand to sandy clay (SM/CL) with gravel, cobbles, and trace small boulders; organic enriched; clasts subangular with stage II carbonate.

2A. Modern A-horizon soil formed in unit 2.

WESTERN GEOLOGIC

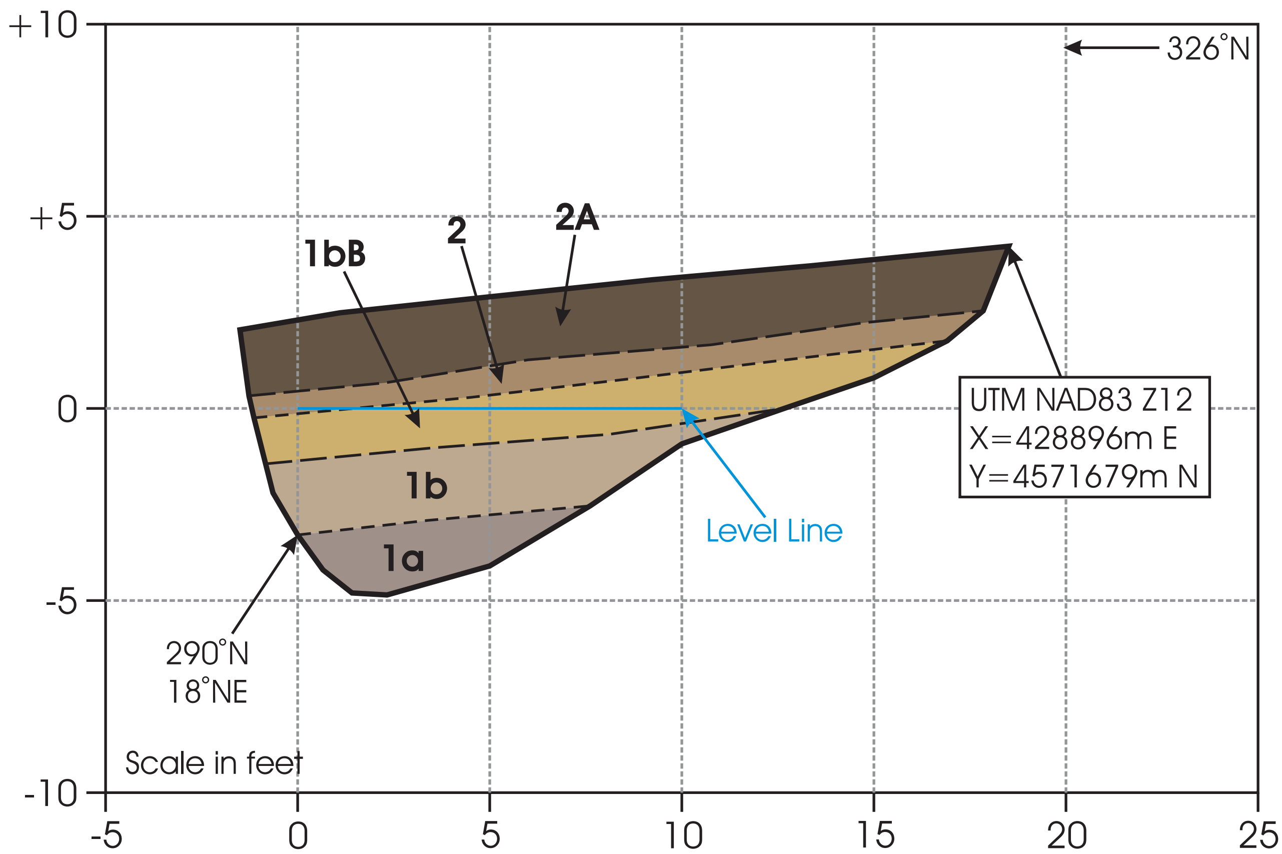
SCALE: 1 inch = 5 feet
(no vertical exaggeration)

Logged by Bill D. Black, P.G.
on September 21, 2018
Reviewed by
Craig V. Nelson, P.G.

TEST PIT 1 LOG

GEOLOGIC HAZARDS EVALUATION
Beckstead Property
About 1860 North Big Sky Drive
Eden, Weber County, Utah

FIGURE 4A



UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - Sequence of weathered tuffaceous conglomerate comprised of: (**1a**) a lower, brown, dense, poorly bedded, sandy to clayey gravel with subangular cobbles and trace boulders; and (**1b**) an upper, yellowish-brown to brown, dense, massive to poorly bedded, sandy to gravelly clay (CL) with trace cobbles in lower part.

1bB. Bt soil horizon formed in unit 1b.

Unit 2. *Holocene Colluvium* - Brown to dark-grayish-brown, moderate density, massive, clayey sand with gravel and cobbles (SM); root penetrated and organic enriched; slightly vesicular.

2A. Modern A-horizon soil formed in unit 2.

WESTERN GEOLOGIC

SCALE: 1 inch = 5 feet
(no vertical exaggeration)

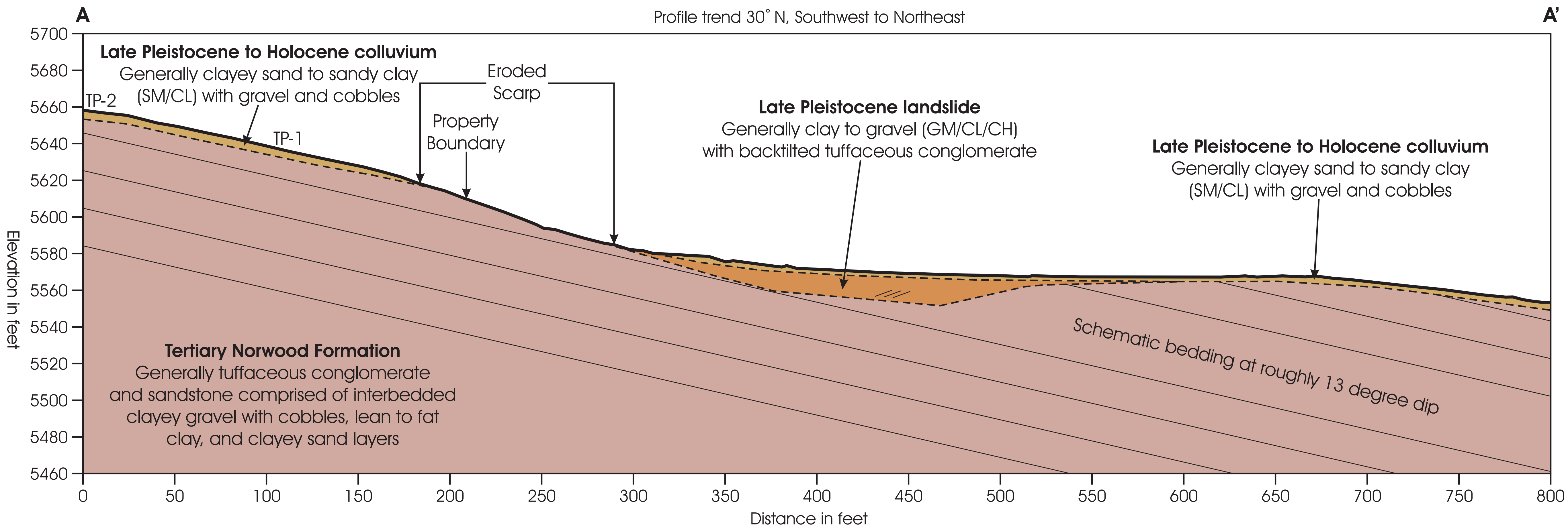
Logged by Bill D. Black, P.G.
on September 21, 2018
Reviewed by
Craig V. Nelson, P.G.

TEST PIT 2 LOG

GEOLOGIC HAZARDS EVALUATION

Beckstead Property
About 1860 North Big Sky Drive
Eden, Weber County, Utah

FIGURE 4B



Scale 1 inch equals 60 feet, no vertical exaggeration.
Topographic profile from 2011 LIDAR data. Profile location on Figures 3A-C.
Units and contacts approximate based on subsurface information.

WESTERN GEOLOGIC

CROSS SECTION

GEOLOGIC HAZARDS EVALUATION
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FIGURE 5