REPORT

GEOLOGIC HAZARDS EVALUATION

WHISPER RIDGE VILLAGE PHASE 1
SECTIONS 22 AND 23, TOWNSHIP 8 NORTH, RANGE 2 EAST
UNINCORPORATED WEBER COUNTY, UTAH

Prepared for

BIO-WEST, Inc.
1063 West 1400 North
Logan, Utah 84321

June 12, 2020

Prepared by

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June 12, 2020

Wes Thompson, P.G.
Principal
BIO-WEST, Inc.
1063 West 1400 North
Logan, Utah 84321

Letter of Transmittal: REPORT
Geologic Hazards Evaluation
Whisper Ridge Village Phase 1
Sections 22 and 23, Township 8 North, Range 2 East
Unincorporated Weber County, Utah

Dear Mr. Thompson:

Western Geologic & Environmental has completed a Geologic Hazards Evaluation for proposed Whisper Ridge Village Phase 1 development located near Davenport Creek Road in unincorporated Weber County, Utah and submits the attached report for your review.

If you have any questions regarding this report, please contact us at (801) 359-7222.

Sincerely,

Western Geologic & Environmental LLC	Reviewed By:
Bill. D. Black, P.G. Subcontract Geologist	Kevin J. Thomas, P.G. Principal Geologist

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WG&E Project No. 5428

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1.0 INTRODUCTION

This report presents the results of a geology and geologic hazards review and evaluation conducted by Western Geologic & Environmental LLC (Western Geologic) for the proposed Whisper Ridge Village Phase 1 development in unincorporated Weber County, Utah (Figure 1 – Project Location). The Project is in an intermontane area at the head of Right Fork Middle Fork Ogden River about 10 miles northeast of Eden, Utah in Sections 22 and 23, Township 8 North, Range 2 East (Salt Lake Base Line and Meridian; Figure 1). Elevation of the Project area ranges from about 7,636 feet to 7,876 feet above sea level. The Project area (Project, Figure 1) is currently proposed for development of 5 cabins with various ancillary infrastructure, and is within Weber County Assessor parcel number 23-045-0004. A gravel access road (La Plata Ranch Road) extends westward to the Project a total of about 7.2 miles from Ant Flat Road and Highway 39 (Access Road, Figure 1).

2.0 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. Our investigation was conducted concurrently with a geotechnical engineering study performed at the Project by CMT Engineering Laboratories.

2.1 Methodology

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 four walk-in test pits in the area of the proposed cabins to assess subsurface conditions;
- Preparation of one cross-section profile based on site-specific subsurface data and inferred conditions; 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. However, 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.

2.2 Limitations and Exceptions

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 BIO-WEST, Magleby Construction, and Whisper Ridge Mountain Holdings LLC; 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.

3.0 GEOLOGY

3.1 Surficial Geology

The site is in an intermontane area within the Wasatch Range about 10 miles northeast of Ogden Valley. The Project area is slightly south of the Weber-Cache County line, although the access road crosses into both counties. The Wasatch Range is 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 Cambrian-age sedimentary rocks of the Hodges Shale and Middle Limestone Members of the Bloomington Formation, and the Blacksmith Formation (units Cbh, Cbm and Cbk, respectively; Figure 2). Coogan and King (2016) describe surficial geologic units in the area of the Project and access road on Figure 2 as follows:

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).

Qmc
Landslide and colluvial deposits, undivided (Holocene and Pleistocene) – Poorly sorted to unsorted clay- to boulder-sized material; mapped where landslide deposits are difficult to distinguish from colluvium (slope wash and soil creep) and where mapping separate, small,

intermingled areas of landslide and colluvial deposits is not possible at map scale; locally includes talus and debris flow and flood deposits; typically mapped where landslides are thin ("shallow"); also mapped where the blocky or rumpled morphology that is characteristic of landslides has been diminished ("smoothed") by slope wash and soil creep; composition depends on local sources; 6 to 40 feet (2-12 m) thick. These deposits are as unstable as other landslide units (Qms, Qmsy, Qmso).

Qmdf, Qmdf?
Debris- and mud-flow deposits (Holocene and upper and middle? Pleistocene) – Very poorly sorted, clay- to boulder-sized material in unstratified deposits characterized by rubbly surface and debris-flow levees with channels, lobes, and mounding; variably vegetated; in drainages typically form mounds, an indication of more viscous Qmdf, rather than being flat like unit Qac; Qmdf queried where may not be mostly debris- and mud-flow deposits; many debris flows cannot be shown separately from alluvial fans at map scale; 0 to 40 feet (0-12 m) thick. Age(s) uncertain; deposits in drainages likely post-date the Provo shoreline of Lake Bonneville, while deposits above drainages, like north of the Right Hand Fork Peterson Creek, are likely as old as Bull Lake glaciation, but could pre-date Bull Lake glaciation and be middle Pleistocene.

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.

Tw, Tw?
Wasatch Formation (Eocene and upper Paleocene) – Typically red to brownish-red sandstone, siltstone, mudstone, and conglomerate with minor gray limestone and marlstone locally (see Twl); lighter shades of red, yellow, tan, and light gray present locally and more common in uppermost part, complicating mapping of contacts with overlying similarly colored Norwood and Fowkes Formations; clasts typically rounded Neoproterozoic and Paleozoic sedimentary rocks, mainly Neoproterozoic and Cambrian quartzite; basal conglomerate more gray and less likely to be red, and containing more locally derived angular clasts of limestone, dolomite and sandstone, typically from Paleozoic strata, for example in northern Causey Dam quadrangle; sinkholes indicate karstification of limestone beds; thicknesses on Willard thrust sheet likely up to about 400 to 600 feet (120-180 m) in Sharp Mountain, Dairy Ridge, and Horse Ridge quadrangles (Coogan, 2006a-b), about 1300 feet (400 m) in Monte Cristo Peak quadrangle, about 1100 feet (335 m) in northeast Browns Hole quadrangle, about 2200 feet (670 m) in southwest Causey Dam quadrangle, about 2600 feet (800 m) at Herd Mountain in Bybee Knoll quadrangle, and about 1300 feet (400 m) in northwest Lost Creek Dam quadrangle, estimated by elevation differences between pre-Wasatch rocks exposed in drainages and the crests of gently dipping Wasatch Formation on adjacent ridges (King); thickness varies locally due to considerable relief on basal erosional surface, for example along Right Fork South Fork Ogden River, and along leading edge of Willard thrust; much thicker, about 5000 to 6000 feet (1500-1800 m), south of Willard thrust sheet near Morgan. Wasatch Formation is queried (Tw?) where poor exposures may actually be surficial deposits. The Wasatch Formation is prone to slope failures. Other information on the Wasatch Formation is in Tw descriptions under the heading "Sub-Willard Thrust - Ogden Canyon Area" since Tw strata are extensive near Morgan Valley and cover the Willard thrust, Ogden Canyon, and Durst Mountain areas.

Along the South Fork Ogden River, Wasatch strata are mostly pebble, cobble, and boulder conglomerate with a matrix of smaller gravel, sand, and silt in the Browns Hole quadrangle, and coarse-grained sandstone to granule conglomerate as well as siltstone and mudstone to the east in the Causey Dam quadrangle; note thinning to east away from source area. The Wasatch weathers to boulder-covered dip(?) slopes north of the South Fork Ogden River, for example in Evergreen Park. Along the South Fork, the Wasatch Formation is separated from the underlying Hams Fork Member of the Evanston Formation by an angular unconformity of a few degrees, with the Hams Fork containing less siltstone and mudstone than the Wasatch and having a lighter color.

The Herd Mountain surface is developed on the Wasatch Formation at elevations of 7600 to 8600 feet (2300-2620 m) in the Bybee Knoll quadrangle and in remnants in the Huntsville, Browns Hole, and Sharp Mountain quadrangles. The origin of this boulder-strewn surface is debated (see Eardley, 1944; Hafen, 1961; Mullens, 1971). Eardley's (1944) Herd Mountain surface is flat lying or gently east dipping, about the same as the underlying Wasatch Formation, and is strewn with quartzite boulders to pebbles that King thinks are residual and colluvial deposits of uncertain age that were derived from the Wasatch Formation. The other characteristic of this surface is the presence of pimple mounds and, given the elevations of greater than about 7500 feet (2300 m), possible periglacial patterned ground. Photogrammetric dips on the Wasatch Formation under the surface are nearly flat (<3°) and an apparent angular unconformity is present in the Wasatch since dips on older Wasatch strata are greater than 3 degrees. King mapped this unconformity as a marker bed, but Coogan does not agree that this is an unconformity.

Twl, Twl?
Limestone of Wasatch Formation (Eocene and upper Paleocene) – Gray, oncolitic limestone and light gray to white marlstone; discontinuous, grades laterally into Tw; mapped in Monte Cristo Peak and Sharp Mountain quadrangles; 0 to 300 feet thick (0-90 m). The setting of limestone in a syncline and likely lacustrine origin are possible evidence for a piggy-back basin on Willard thrust sheet; see Coogan (1992b) for the piggy-back basin on Crawford thrust sheet. Limestone of Wasatch Formation queried where poor exposures may actually be surficial deposits.

Similar limestones were described by Oaks and Runnells (1992) in the Cowley Canyon Member of the Wasatch Formation to the north in the Bear River Range. These Cowley Canyon strata directly overlie Paleozoic rocks, as well as being within the Wasatch red beds, and are thicker in north-south-trending grabens (Oaks and Runnells, 1992).

The Monte Cristo Peak and Sharp Mountain limestone outcrops were described as tuffaceous and stromatolitic oncolitic) limestone in the Salt Lake Group by Hafen (1961) and Smith (1965). Smith (1965) collected one *Planorbis* sp. (his designation) fresh-water gastropod fossil from a limestone. This gastropod genus and the Planorbidae family of gastropods are not restricted to the Pliocene and/or Miocene, so they are present in rocks that are older than the Salt Lake Group/Formation (see for example Yen, 1948; Pierce, 1993).

Cn, Cn?
Nounan Formation (Upper Cambrian) – Medium-gray to dark-gray, very thick to thick-bedded, light to medium gray and tan-weathering, typically cliff forming, variably sandy and silty dolomite and lesser limestone, with crude laminae to partings and mottling of sandstone and siltstone that weather tan or reddish; little sandstone and siltstone in more resistant lower part; about 600 to 1150 feet (180-350 m) thick.

The Nounan Formation thickness range in our map area is based on numerous studies. It is about 800 feet (245 m) thick in the Huntsville quadrangle, using Coogan's mapping of about 300 feet (90 m) each of the Blacksmith and Langston Formations; about 900- and 999-foot (275 and 300 m) thicknesses reported at the South Fork Little Bear River in the James Peak quadrangle (Ezell, 1953; Gardiner, 1974; respectively) and 1145 feet (350 m) thick at Sharp Mountain (Hafen, 1961). To the east the Nounan thins southward from 1025 feet (312.5 m) thick in the Curtis Ridge quadrangle (Hansen, 1964) to 800 feet (245 m) thick in Sugar Pine Canyon (Creek) in the Dairy Ridge quadrangle (Gardiner, 1974; Coogan, 2006a) to 675 feet (205 m) thick in the Horse Ridge quadrangle (Coogan, 2006b). The Nounan is about 630 feet (190 m) thick in the Causey Dam quadrangle (Mullens, 1969), possibly the "average" of the 571 feet (174 m) and 696 feet (210 m) measured by

Rigo (1968, aided by Mullens) and Gardiner (1974), respectively, on Baldy Ridge in the quadrangle, with Gardiner's (1974) thickness more closely matching Mullens' (1969) mapped thickness. So the Nounan thins to the south and east over the Tooele arch (see Hintze, 1959).

Williams (1948) reported that the Nounan was Late Cambrian in age, using unpublished fossil collections (in part from Maxey, 1941). In the Wellsville Mountains north of our map, Oviatt (1986) reported the upper Nounan was Dresbachian (Late Cambrian) in age based on *Dunderbergia*(?) and *Crepicephalus* zone trilobite fauna.

Cbc, Cbc?
Calls Fort Shale Member (Middle Cambrian) – Brown-weathering, slope-forming, olive-gray to tan gray, thin bedded, shale and micaceous argillite with minor, thin-bedded, dark-gray, silty limestone; *Bolaspidella* sp. trilobite fossils reported by Rigo (1968, USGS No. 5965-CO) in the Causey Dam quadrangle; 75 to 125 feet (23-40 m) thick on the leading edge of the Willard thrust sheet (Coogan, 2006ab; see Rigo, 1968, aided by Mullens), 100 to 120 feet (30-35 m) thick in Causey Dam quadrangle (King this report), and about 400 feet (120 m) thick in Huntsville quadrangle (King this report).

Cbm, Cbm?
Middle limestone member (Middle Cambrian) – Dark to medium-gray, thick- to thin-bedded, argillaceous limestone with tan-, yellow-, and red-weathering, wavy, silty layers and partings; contains subordinate olive-gray and tan-gray, thin-bedded, shale and micaceous argillite; typically forms "rib" or cliff between less resistant shale members; on leading edge of Willard thrust sheet, thickens southward from 425 feet (130 m) along Sugar Pine Creek, Dairy Ridge quadrangle, to 850 feet (260 m) along Sawmill Canyon, Horse Ridge quadrangle (Coogan, 2006a-b), and 548 feet (167 m) thick at Baldy Ridge section (Rigo, 1968, aided by Mullens) in Causey Dam or Horse Ridge quadrangle, but may be faulted, since about 400 feet (120 m) thick on flanks of Baldy and Knighton Ridges (King this report); 680 feet (200 m) thick in Huntsville quadrangle (Coogan, this report).

Cbh, Cbh?
Hodges Shale Member (Middle Cambrian) – Brown-weathering, slope-forming, olive-gray to tan-gray, thin-bedded, shale and micaceous argillite, and thin- to thick-bedded, dark- to medium-gray limestone with tan-, yellow-, and red-weathering, wavy, silty layers and partings; typically vegetated slope former; along leading edge of Willard thrust sheet thickens southward from 410 feet (125 m) along Sugar Pine Creek, Dairy Ridge quadrangle, to 600 feet (180 m) along Sawmill Canyon, Horse Ridge quadrangle (Coogan, 2006a-b); reportedly 281 feet (86 m) thick at Baldy Ridge section (Rigo, 1968, aided by Mullens) in Causey Dam or Horse Ridge quadrangle and about 300 feet (90 m) thick on flank of Baldy Ridge (King this report); 300 feet (90 m) thick in Huntsville quadrangle (Coogan, this report). The lower Bloomington of Mullens (1969) in the Causey Dam quadrangle is likely the Hodges Shale, and it is about 250 feet (75 m) thick.

Cbk, Cbk?
Blacksmith Formation (Middle Cambrian) – Typically medium-gray, very thick to thick-bedded, dolomite and dolomitic limestone with tan-weathering, irregular silty partings to layers; weathers to lighter gray cliffs and ridges; 250 to 760 feet (75-230 m) thick in our map area.

The Blacksmith Formation on the leading edge of the Willard thrust sheet thickens southward from 600 feet (180 m) along Sugar Pine Creek in the Dairy Ridge quadrangle, to about 760 feet (230 m) in the northwestern Horse Ridge quadrangle (Coogan, 2006a-b). To the south and west, the Blacksmith is about 500 feet (150 m) thick near Causey Dam (Mullens, 1969), with a 530-foot (161 m) thickness reported at the Baldy Ridge section (Rigo, 1968, aided by Mullens) in the Causey Dam or Horse Ridge quadrangle. Farther west, the Blacksmith is reportedly 409 feet (125 m) thick in the Sharp Mountain area (Hafen, 1961) and is about 250 feet (75 m) thick near the South Fork Wolf Creek in the Huntsville quadrangle (Coogan this report); still farther west, this unit is reportedly about 700 to 800 feet (210-245 m) thick near Mantua (Williams, 1948; Ezell, 1953; Sorensen and Crittenden, 1976a). So the thickness of the Blacksmith Formation is low in the Huntsville quadrangle and thickens to north, west, and east, and thickens southward on leading edge of thrust sheet.

The Blacksmith to the north of our map area is about 475 feet (144 m) thick in the Porcupine Reservoir quadrangle (Rigo, 1968; Hay, 1982), about 450 feet (137 m) thick near the Blacksmith Fork River (Maxey, 1958), and 410 feet (125 m) thick in Blacksmith Fork Canyon (Hay, 1982). The Blacksmith thickness in the Browns Hole area is uncertain due to poorly exposed Cambrian strata. Laraway's (1958) Blacksmith contacts are not those of Crittenden (1972) or our mapping (see also Hodges member above); so his reported 730-foot (220 m) thickness is suspect. Laraway's (1958) report of *Bolaspidella* and *Ehmaniella* trilobite fossils in his Blacksmith is also problematic because these fossils are characteristic of the Bloomington and Ute Formations, respectively (Maxey, 1958). Also, Laraway's description of covered intervals in typically cliff-forming Blacksmith imply a fault repetition of the Ute or his measuring at least 986 feet (300 m) of Ute (see Ute description for comparison) and less than 403 feet (123 m) of Blacksmith; further, Crittenden's (1972) large thicknesses (~1300 or less likely 1150 feet [~400 or <350 m]) and mixed carbonates above Ute shale on his lithologic column imply fault repetition(s). Our Blacksmith-Bloomington contact is above a non-resistant Ute interval that overlies a resistant cliffy interval in the Ute. This makes the Ute about 700 feet (215 m) thick on Crittenden's (1972) lithologic column, and the Blacksmith and lower Bloomington about 650 feet (200 m) thick on his column. Finally, Crittenden's (1972) lithologies are not like what Laraway (1958) reported in his measured section.

Cu, Cu?
Ute Formation (Middle Cambrian) – Interbedded gray thin- to thick-bedded limestone with tan-, yellowish-tan-, and reddish-tan-weathering, wavy, silty layers and partings, and olive-gray to tan-gray, thin-bedded shale and micaceous argillite; and minor, medium-bedded, gray to light-gray dolomite; sand content in limestone increases upward such that

calcareous sandstone is present near top of formation; mostly slope and thin ledge former; base less resistant (more argillaceous) than underlying Langston Formation; *Zacanthoides*, *Kootenia*, *Bathyuriscus*, and *Peronopsis* sp. trilobite fossils reported by Rigo (1968, USGS No. 5960-CO) in Causey Dam quadrangle; estimate 450 to 1000 feet (140-300 m) thick and thinnest on leading edge of Willard thrust sheet.

The thickness range for the Ute Formation is based on multiple studies. It is reportedly 600 to 700 feet (180-210 m) thick west of Sharp Mountain (see Ezell, 1953; Crittenden, 1972; Deputy, 1984), and though a 840-foot (256 m) thickness was reported north of our map area in the Porcupine Reservoir area (Rigo, 1968), the Ute only looks about 600 feet (180 m) thick on the Porcupine Reservoir map of Berry (1989). The Ute is reportedly 1090 and 1380 feet (330 and 420 m) thick in the Sharp Mountain area (Hafen, 1961; Rigo, 1968, respectively), but these thicknesses are suspect since the Ute is thinner to the north, east, and west. We suspect that Hafen (1961) used dips that were too steep (~30 degrees vs ~16.5 degrees) so the real Ute thickness is about 620 feet (190 m) where he measured his section; we do not know what Rigo (1968) measured. North of our map area in the Hardware Ranch quadrangle, Deputy (1984) measured 681 feet (207.6 m) of Ute. To the east, the Ute is about 450 feet (137 m) thick in the Horse Ridge and Dairy Ridge quadrangles (Coogan, 2006a-b) and 515 feet (157 m) thick at the Baldy Ridge section (Rigo, 1968) in the Horse Ridge quadrangle. The thickest Ute may be near the South Fork Wolf Creek in the Huntsville quadrangle, where Coogan estimates a 1000-foot (300 m) thickness, 1150 feet (350 m) thick if steeper dip, while King estimates the Ute is about 1100 feet (335 m) thick, based on a higher Ute-Langston contact than Coogan picked. Rigo (1968) reported 1370 feet (418 m) of Ute near the South Fork Wolf Creek, but his contacts are not used on our map. To the south in the Browns Hole quadrangle, about 700 feet (210 m) of mixed shale and limestone was shown by Crittenden (1972) and his depiction is likely derived from the 659 feet (201 m) of Ute reported by Laraway (1958) along the South Fork Ogden River; this is about what Laraway (1958) mapped. But Crittenden (1972) did not map the Ute-Blacksmith contact; further, see problems above under Blacksmith Formation.

The Ute Formation as first mapped in the James Peak, Mantua, and Huntsville quadrangles was too thick because Coogan mapped the lower shale in the Langston Formation as the entire Langston, not realizing the base of the Ute is a shale above the upper carbonate (typically dolomite) of the Langston. He did this because the upper carbonate is not distinct in these quadrangles, like it is to the west in the Mount Pisgah quadrangle and to the east in the Sharp Mountain quadrangle. The same problem exists locally in the Sharp Mountain quadrangle. Though King revised the present map to place the upper Langston carbonate in the Langston, problems with this contact and Ute and Langston Formation thicknesses may persist.

Cgc, Cgc?
Geertsen Canyon Quartzite (Middle and Lower Cambrian and possibly Neoproterozoic) – In the west mostly buff (off-white and tan) quartzite, with pebble conglomerate beds; pebbles are mostly rounded light-colored quartzite; contains cross

bedding, and pebble layers and lenses; colors vary from tan and light to medium gray, with pinkish, orangish, reddish, and purplish hues; outcrops darker than these fresh quartzite colors; cliff forming; some brown-weathering, interbedded micaceous argillite and quartzite common at top and mappable locally; pebble to cobble conglomerate lenses more abundant in middle part of quartzite, and basal, very coarse-grained arkose locally; near Huntsville, total thickness about 4200 feet (1280 m), including upper argillite about 375 feet (114 m) thick and basal coarse-grained arkose (arkosic to feldspathic quartzite) about 300 to 400 feet (90-120 m) thick (Crittenden and others, 1971). Overall seems to be thinner near Browns Hole. Called Prospect Mountain Quartzite and Pioche Shale (argillite at top) by some previous workers.

Upper and lower parts of Crittenden and others (1971; Crittenden, 1972; Sorensen and Crittenden, 1979) are not mappable outside the Browns Hole and Huntsville quadrangles, likely because the marker cobble conglomerate and change in grain size and feldspar content reported by Crittenden and others (1971) is not at a consistent horizon; quartz-pebble conglomerate beds are present in most of the Geertsen Canyon Quartzite. To the east on leading margin of Willard thrust sheet, the Geertsen Canyon is thinner, an estimated 3200 feet (975 m) total thickness (Coogan, 2006a-b), and may be divided into different members, though informal members to west and east are based on conglomerate lenses near member contact and feldspathic lower member (see Crittenden and others, 1971; Coogan, 2006a-b).

Descriptions of other geologic units on Figure 2 not included above, as well as their citations, tables and figures, are provided in Coogan and King (2016).

3.2 Seismotectonic Setting

The property is located about 10 miles northeast 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 physiographic 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 marked by 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).

The site is also in the central portion of the Intermountain Seismic Belt (ISB), a generally north-south trending zone of historical seismicity along the eastern margin of the Basin and Range province extending 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; the largest of these earthquakes was a M 7.5 event in 1959 near Hebgen Lake, Montana. None of these earthquakes occurred along the Wasatch fault or other known late Quaternary faults (Arabasz and others, 1992; Smith and Arabasz, 1991). The closest event was the 1934 Hansel Valley (M 6.6) event north of the Great Salt Lake. The March 18, 2020 M 5.7 earthquake north of Magna, Utah reportedly showed a style, location, and slip depth consistent with an earthquake on the Wasatch fault system (https://earthquake.usgs.gov/earthquakes/eventpage/uu60363602/executive). Despite being moderate in size (less than magnitude 6.0), this earthquake was felt from southern Idaho to south-central Utah and damaged multiple buildings (https://www.ksl.com/article/46731630/). The nearest active (Holocene-age) fault to the site is the Wellsville section of the West Cache fault zone about 14.9 miles to the northwest (Black and others, 2003).

4.0 SITE CHARACTERIZATION

4.1 Empirical Observations

On May 18, 2020, Mr. Bill D. Black of Western Geologic conducted a reconnaissance of the Project area to observe geomorphic and surficial conditions. The reconnaissance was conducted in conjunction with the subsurface exploration. Weather at the time of the reconnaissance was partly cloudy with temperatures in the 70's (°F).

The proposed development area straddles a small intermontane valley at the confluence of two drainages. The drainage confluence is at the head of Right Fork Middle Fork Ogden River. The area is accessed by a 7.2 mile-long gravel road from Ant Flat Road and Highway 39. Several existing ponds are in the drainage bottom that are fed by Mill Spring, which flows from a fractured limestone bedrock outcrop and is improved for limited storage. The proposed cabin sites are on and at the nose of a northeast-trending ridge south of the spring. Thinly bedded dolomitic shale was observed in a cut for and the spoils from a level pad graded east of the proposed cabin sites. The level pad is currently occupied by several yurt structures. A surficial limestone bedrock exposure is about 100 feet south of graded area. No evidence for landslides or ongoing slope instability, bedrock outcrops that could pose a source area for rockfall clasts, debris flow features, or evidence for geologic hazards was observed. Native vegetation in the Project area appeared to consist of grasses, sage brush, wildflowers, and mature aspen and pine trees.

4.2 Air Photo Observations

High-resolution color orthophotography and autocorrelated DEM imagery from 2006 available from Utah AGRC (Figures 3A-B) were reviewed to obtain information about the geomorphology of the Project area. The development plan and Project features have been superimposed on the air photos (Figures 3A-B). Figure 3B also shows a slope gradient map from geoprocessed DEM data at gradient intervals of < 15% (unshaded), 15-25% (in yellow) and > 25% (in red). The Project area is underlain by a sequence of sedimentary bedrock units with a thin veneer of alluvium and colluvium from mixed sources. Except for the surface water features, no geologic hazards are evident on the air photos.

4.3 Subsurface Investigation

Four walk-in test pits were excavated at the Project on May 18 to assess subsurface conditions. The test pits were logged by Bill D. Black, P.G. of Western Geologic concurrently with the Project geotechnical investigation conducted by CMT Engineering Laboratories. Locations of the test pits are shown on Figures 3A-B. The test pit locations were measured using a hand-held GPS unit and by trend and distance methods. The test pits were logged at a scale of 1-inch equals five feet (1:60) following methodology in McCalpin (1996), and digitally photographed at 5-foot intervals to document the exposures. The photos are not provided herein, but are available on request. Logs of the test pits are provided on Figures 4A-B. Stratigraphic interpretations and descriptions are provided on the logs.

4.4 Cross Section

Figure 5 shows one cross section (A-A') across the site, as located on Figure 3B, at a scale of 1 inch equals 60 feet with no vertical exaggeration. Units and contacts are inferred based on the geologic mapping on Figures 3A-B and subsurface data from the test pits (Figures 4A-B). The topographic profile is based on geoprocessed 2006 DEM data. Units and contacts should be considered approximate and inferred, and variations should be expected at depth and laterally. We caution that some portions of the cross section have limited or no subsurface data, particularly at depth. Bedrock unit dips were calculated using https://app.visiblegeology.com/ based on the profile trend (70° N) and an average strike and dip of 62° N 25° NW from our data and one nearby measurement by Coogan and King (2016; Figure 2).

5.0 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 and Rock			X

5.1 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. The Utah Geological Survey Quaternary Fault Database (Black and others, 2003; January 2017 update) shows numerous class A faults within 60 miles of the Project that may pose potential seismic sources.

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. Based on 2018 IBC provisions, a site class of B (rock), and a risk category of II, calculated seismic values for the site (centered on 41.413498° N, -111. 699896° W) are summarized below:

Table 2. *Seismic hazards summary.*

Type	Value
S_S	*0.767 g*
S_1	*0.261 g*
S_{MS} (F_a x S_S)	*0.69 g*
S_{M1} (F_v x S_1)	*0.209 g*
S_{DS} (2/3 x S_{MS})	*0.46 g*
S_{D1} (2/3 x S_{M1})	*0.139 g*
Site Coefficient, F_a	*= 0.9*
Site Coefficient, F_v	*0.8*
Peak Ground Acceleration, PGA	*= 0.332 g*

The site class should be confirmed by the Project geotechnical engineer. Given the above information, earthquake ground shaking poses a moderate to high risk to the site. Earthquake ground shaking is a regional hazard common to all Wasatch Front areas. The hazard is mitigated by design and construction in accordance with the current adopted building code.

5.2 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.

No evidence of active surface faulting is mapped or was evident at the site. A bedrock shear zone was observed in test pit TP-1 (Figure 4A) that showed no evidence for displacement of overlying Pleistocene- to Holocene-age alluvial and colluvial deposits. The shear zone appears to be on trend with where the bedrock fault mapped further southeast makes an abrupt 80-degree bend and continues to the west-southwest (Figure 2 and Figures 3A-B). This fault is mapped as being concealed where it crosses Quaternary-age sediments east-southeast of the Project on Figure 2. The nearest mapped active (Holocene-age) fault to the site is the Wellsville section of the West Cache fault zone 14.9 miles to the northwest (Black and others, 2003).

Given the above, we rate the risk from surface faulting as low. No investigation regarding surface faulting appears needed given the proposed development plan and current paleoseismic information.

5.3 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 accelerations (earthquake ground shaking), groundwater conditions, and presence of susceptible soils.

Given subsurface conditions (shallow bedrock) observed in the test pits, we rate the risk from liquefaction as low.

5.4 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 active normal faults.

The Project is not in close proximity to and on the downthrown side of any mapped active (Holocene) faults. Based on this, we rate the risk from tectonic subsidence as low.

5.5 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 large bodies of water, we rate the risk from seismic seiches as low.

5.6 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.

The Project is at the head of Right Fork Middle Fork Ogden River and straddles a narrow intermontane valley at the confluence of two small drainages. Figures 3A-B show a 75-foot stream protection zone around the drainages. The proposed cabins are outside this zone. Given the above, we rate the risk from stream flooding to the cabin sites as low. Care should be taken that proper surface drainage is maintained.

5.7 Shallow Groundwater

No groundwater was observed in the test pits at the site to their explored depths. Depths shallower than 10 feet likely occur only in the valley bottom in close proximity to and mimicking flows of the small streams. Groundwater is likely deeper than 30 feet in areas outside of the stream protection zone on Figures 3A-B, including the proposed cabin sites, although this is unconfirmed. Groundwater depths at the site likely vary seasonally from snowmelt runoff and annually from climatic fluctuations. Such variations would be typical for an alpine area. Given the above, we rate the risk from shallow groundwater as low.

5.8 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.

No landsides are mapped in the area of the cabin sites or were observed during our reconnaissance. Given this and bedrock conditions observed in the test pits, we rate the risk from landslides to the proposed cabins sites as low. However, given that slopes steeper than 25% are above and below the cabin sites, we conservatively recommend that their stability be evaluated by the Project geotechnical engineer based on site-specific soil conditions and the 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 man-made sources is minimized in potentially unstable slope areas.

The central part of the access road to the Project (between about stations 182+09 and 234+29) crosses several areas containing landslide, debris flow and mudflow deposits, as indicated on Figure 6. The remainder of the road crosses Tertiary and Cambrian-age bedrock and limited areas of alluvium on Figure 2. To minimize the risk of failure of the access road, which is the only ingress and egress pathway to the cabin sites, the Project geotechnical engineer should evaluate and provide recommendations regarding pavement design, cuts, fills, drainage, and/or slope retention as needed for the road sections on Figure 6 that cross landslide, debris flow and mudflow deposits.

5.9 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.

No evidence for debris-flow channels, levees, or other debris-flow features was observed on air photos or during our reconnaissance in the area of the cabin sites. Based on the above, we rate the existing risk from debris flows at the site as low.

5.10 Rock Fall

No significant bedrock outcrops are in the area of the cabin sites or in adjacent higher slopes that could pose a source area for rock fall clasts. Based on the above, we rate the hazard from rock falls as low.

5.11 Problem Soil and Rock

Surficial soils that contain certain clays can swell or collapse when wet. Based on subsurface conditions observed in the test pits at the Project, we rate the risk from problem soil as low. Soil conditions and specific recommendations for site grading, subgrade preparation, and footing and foundation design should be provided in the Project geotechnical engineering evaluation.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Earthquake ground shaking is identified as posing a high relative risk to the proposed development. The following recommendations are provided with regard to the geologic characterizations in this report:

- ***Seismic Design*** **–** All habitable structures developed at the property should be constructed to current adopted seismic building codes to reduce the risk of damage, injury, or loss of life from earthquake ground shaking. The Project geotechnical engineer should confirm the ground-shaking hazard and provide appropriate seismic design parameters as needed. We note that earthquake ground shaking is a common hazard for all Wasatch Front areas.

- ***Geotechnical Considerations*** **–** Given the steep slopes at the site, a design-level geotechnical engineering study should be conducted prior to construction to assess soil foundation conditions and evaluate slope stability in the area of the cabin sites. The stability 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 Project geotechnical engineer should further provide recommendations regarding pavement design, cuts, fills, drainage, and/or slope retention for portions of the access road that cross landslide, debris flow and mudflow deposits on Figure 6.

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

- ***Hazard Disclosures and Report Availability* –** All hazards identified as posing a high risk at the site should be disclosed to future buyers so that they may understand and be willing to accept any potential developmental challenges and/or risks posed by these hazards. 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.

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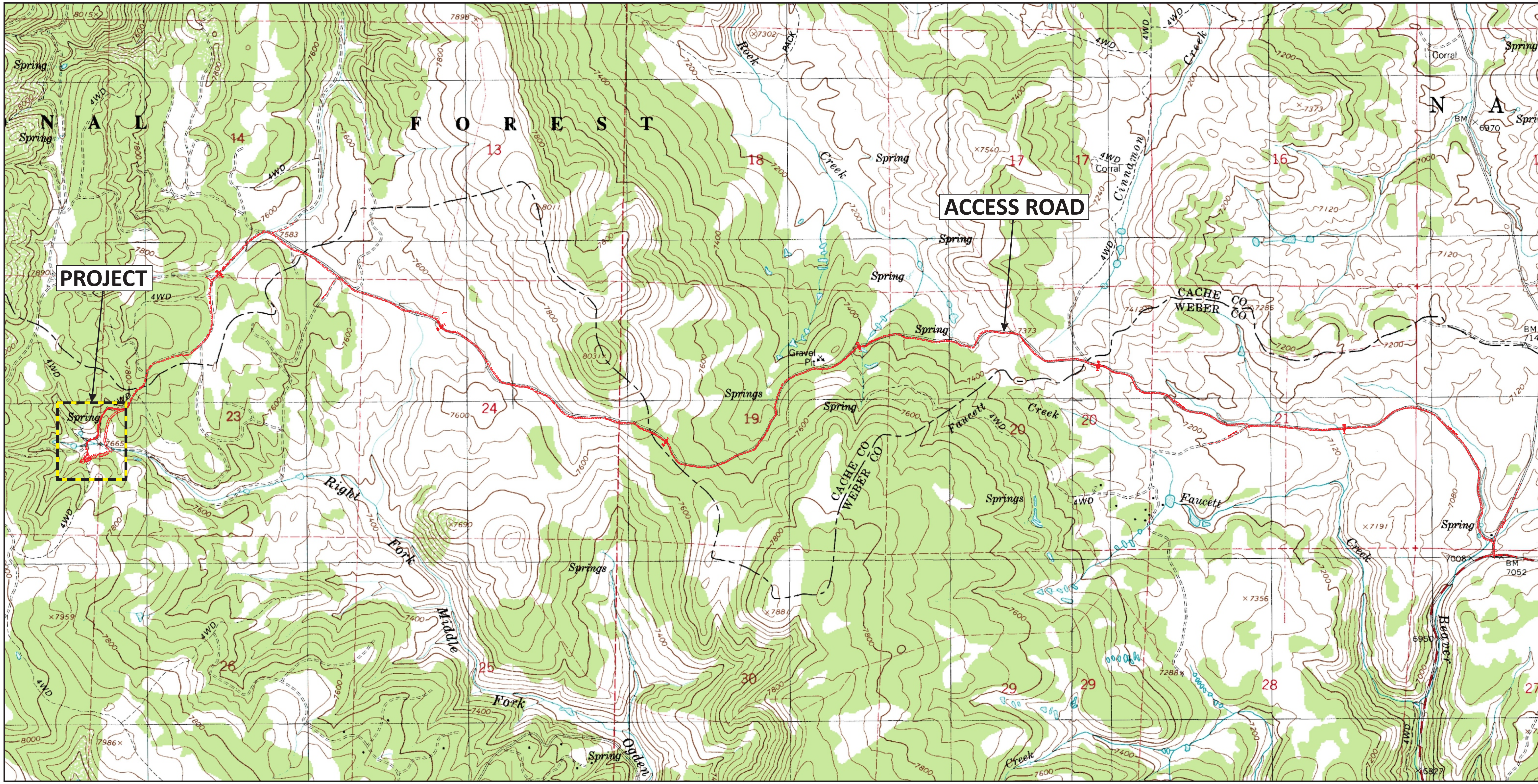
FIGURES



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WESTERN GEOLOGIC

LOCATION MAP

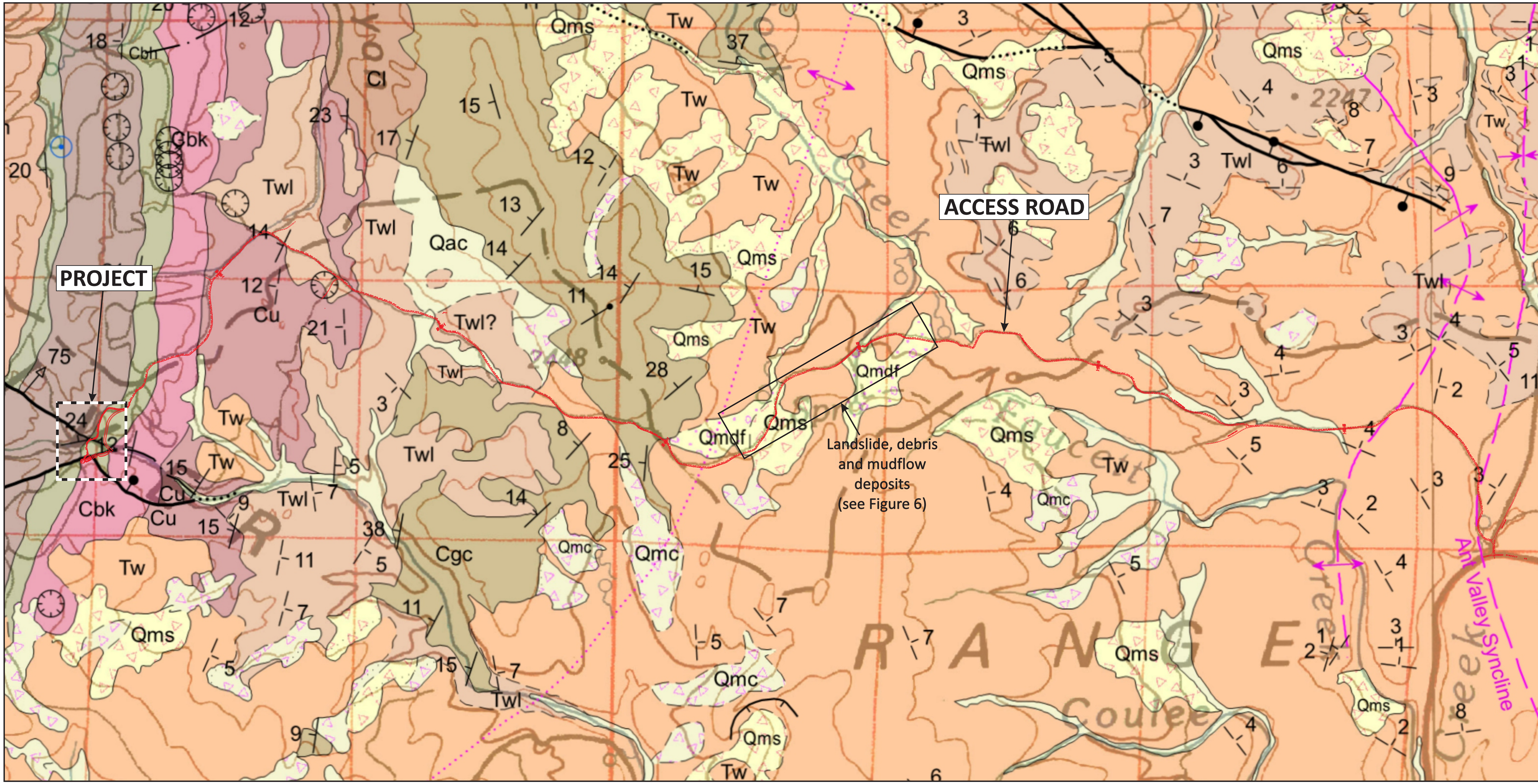
GEOLOGIC HAZARDS EVALUATION

Whisper Ridge Village Phase 1

Sections 22 and 23, Township 8 North, Range 2 East

Unincorporated 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 S W E

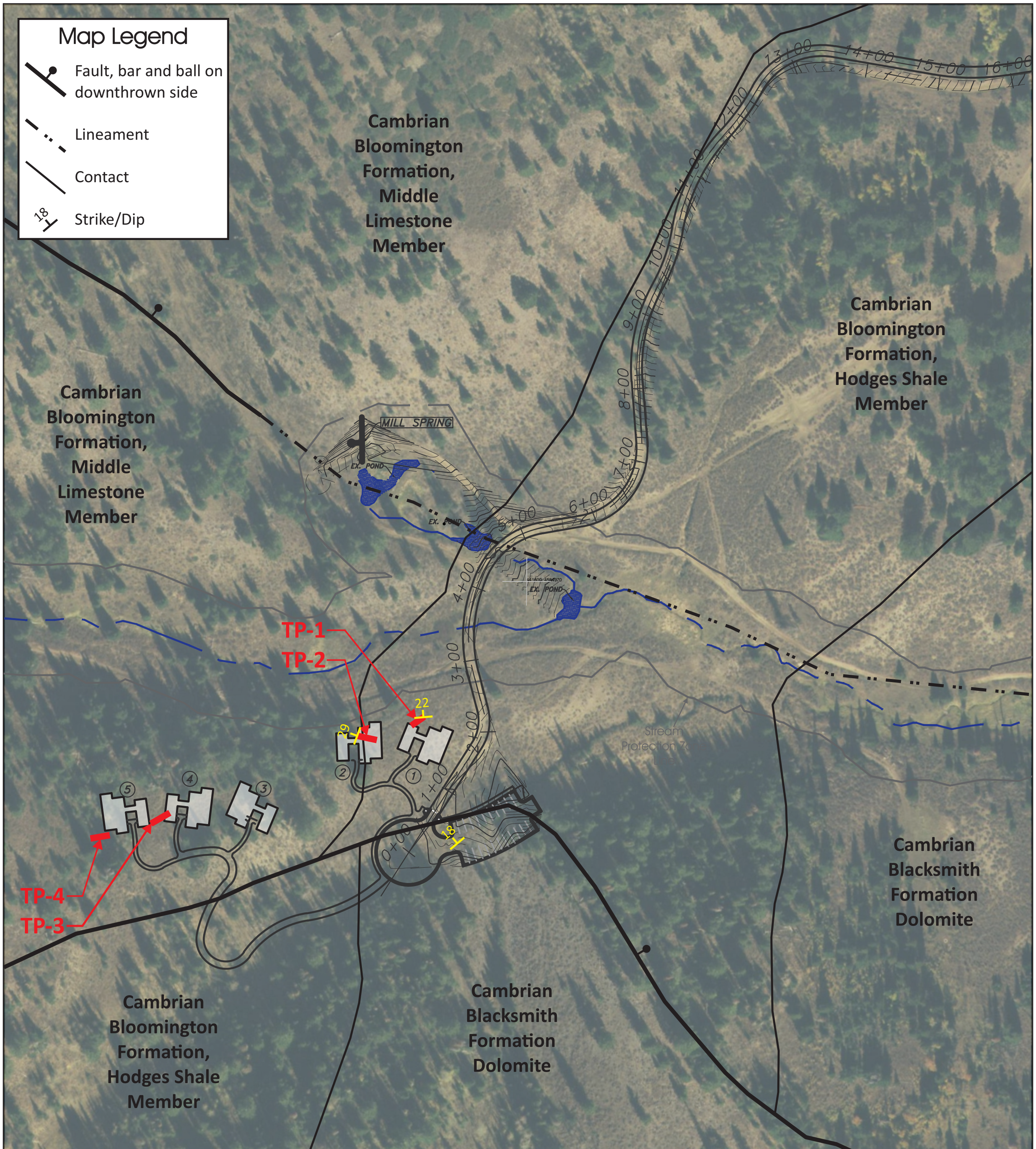
0 2000 4000 feet
Scale 1:24,000 (1 inch equals 2000 feet)

GEOLOGIC MAP

GEOLOGIC HAZARDS EVALUATION

Whisper Ridge Village Phase 1
Sections 22 and 23, Township 8 North, Range 2 East
Unincorporated Weber County, Utah

FIGURE 2



Source: Utah AGRC 2006 High Resolution Orthophoto, 25 cm resolution.

2006 AERIAL PHOTO

GEOLOGIC HAZARDS EVALUATION

Whisper Ridge Village Phase 1
Sections 22 and 23, Township 8 North, Range 2 East
Unincorporated Weber County, Utah

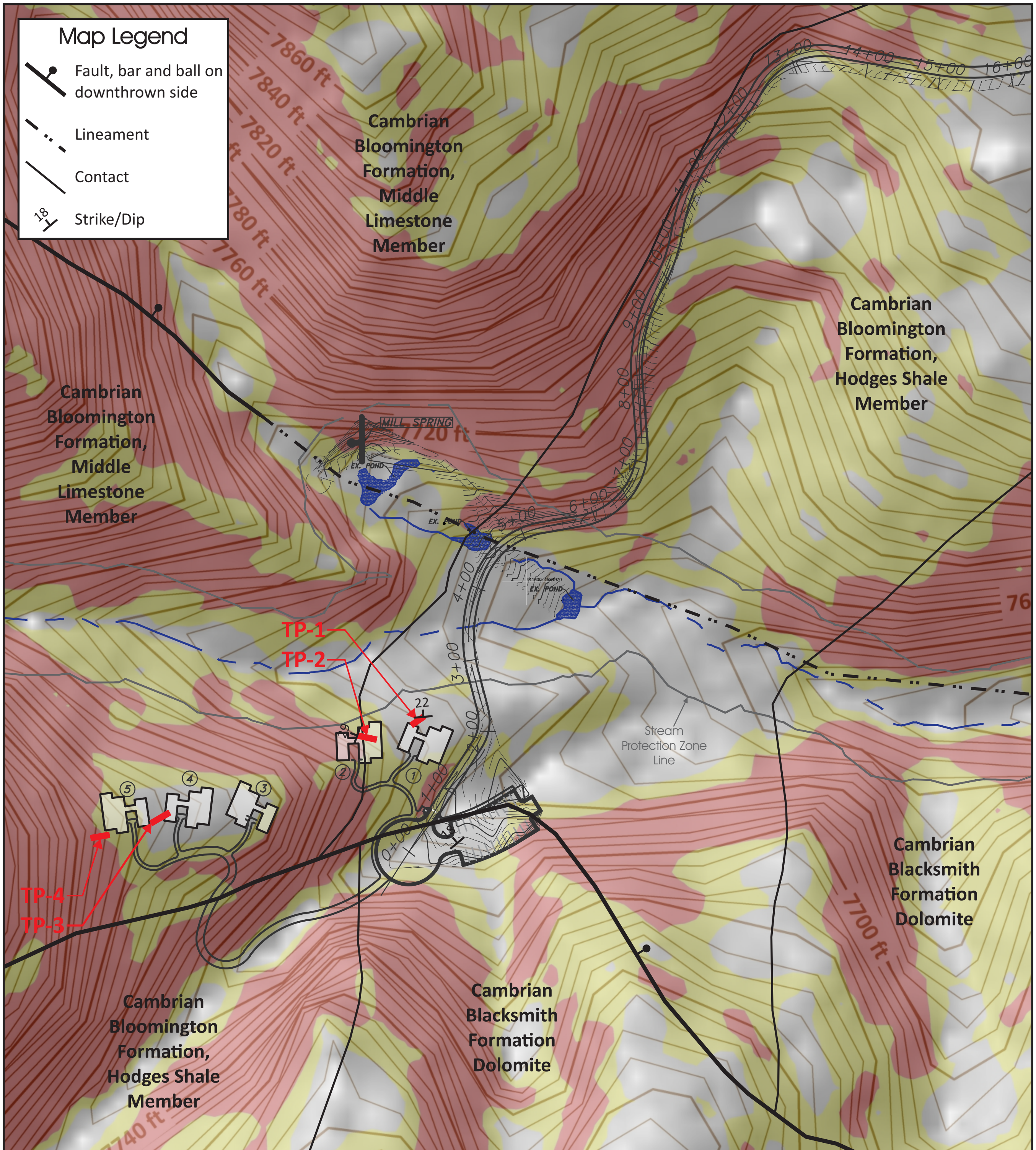
FIGURE 3A

WESTERN GEOLOGIC

N W E S

0 100 200 feet

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



Source: Utah AGRC 2006 Autocorrelated DEM, 25 cm resolution; slope gradients < 15% unshaded, 15-25% shaded in yellow, and > 25% shaded in red. Contours generated by Global Mapper, 4 foot interval.

WESTERN GEOLOGIC

0 100 200 feet

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

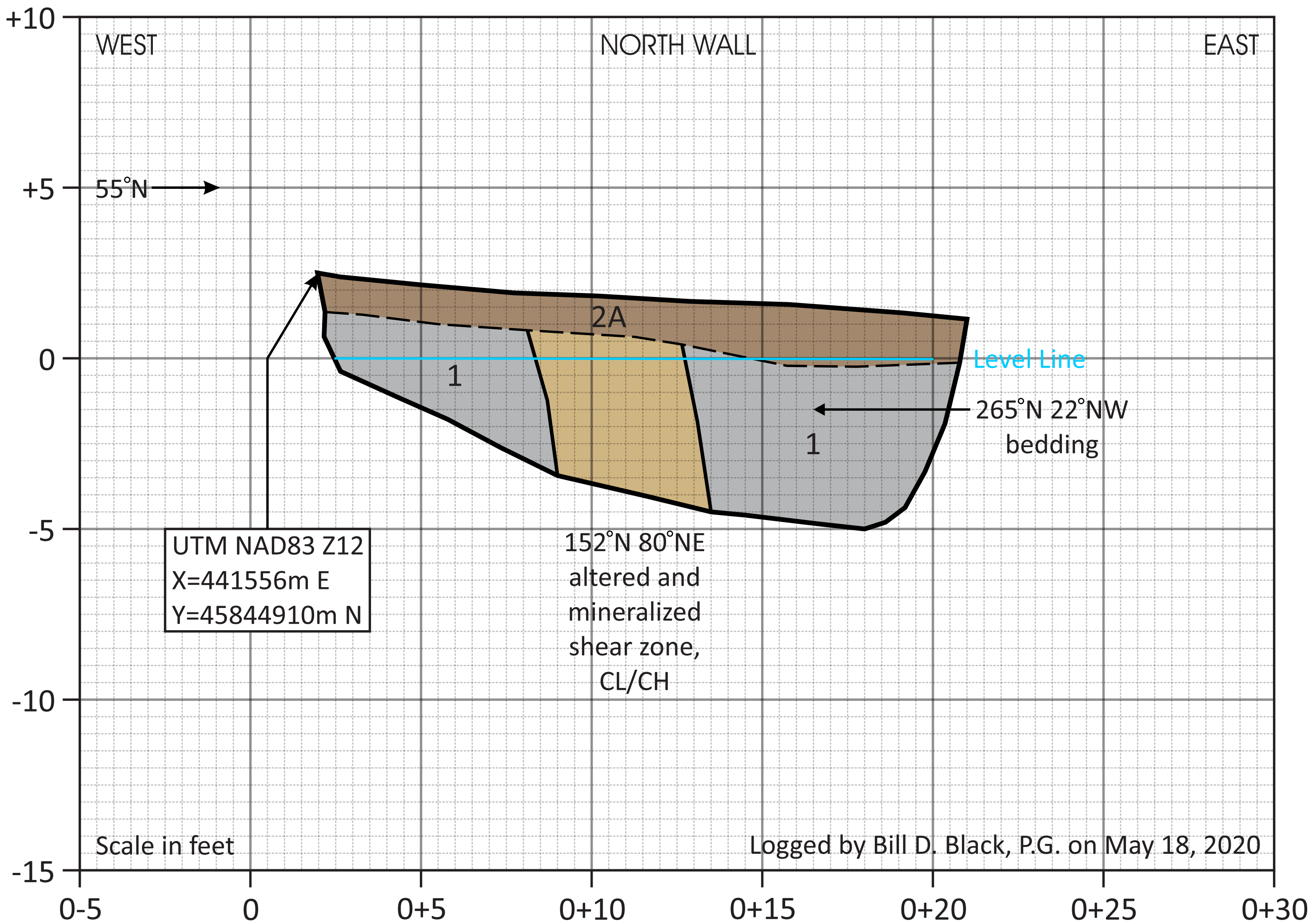
SLOPE ANALYSIS

GEOLOGIC HAZARDS EVALUATION

Whisper Ridge Village Phase 1
Sections 22 and 23, Township 8 North, Range 2 East
Unincorporated Weber County, Utah

FIGURE 3B

TEST PIT 1

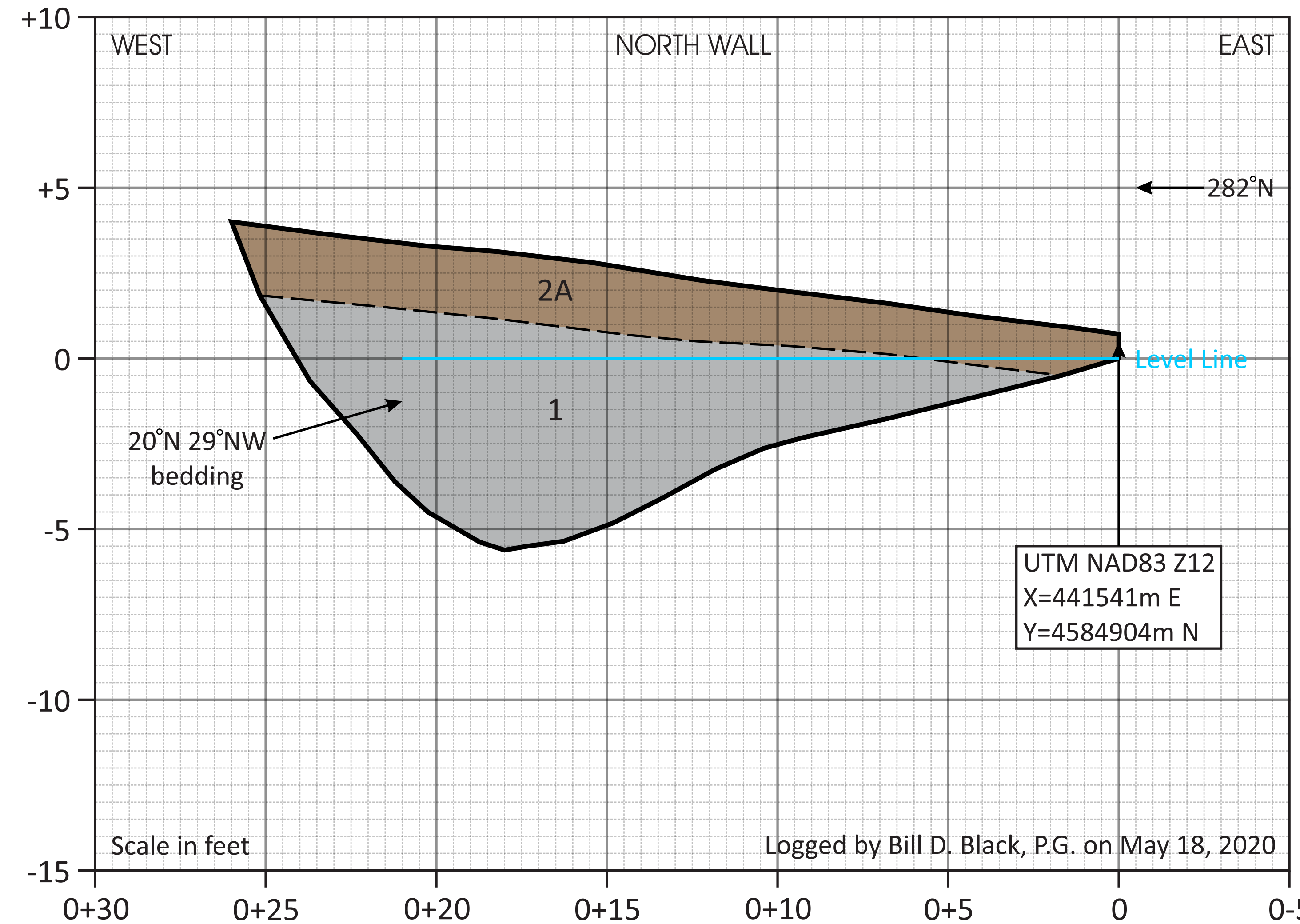


UNIT DESCRIPTIONS

Unit 1. *Cambrian Bloomington Formation, Hodges Shale Member* - Weathered, blue-gray to gray, thinly bedded, fractured dolomitic shale, bedding 1/2" to 2" thick with fat clay between bedding planes.

Unit 2A. *Pleistocene to Holocene alluvium and colluvium* - Mixed alluvial and colluvial deposits comprised of brown (7.5 YR 4/4), loose to firm, massive, root-penetrated, sandy silt with clay (ML); modern A horizon formed in unit.

TEST PIT 2



UNIT DESCRIPTIONS

Unit 1. *Cambrian Bloomington Formation, Hodges Shale Member* - Weathered, blue-gray to gray, thinly bedded, fractured dolomitic shale, bedding 1/2" to 2" thick with fat clay between bedding planes.

Unit 2A. *Pleistocene to Holocene alluvium and colluvium* - Mixed alluvial and colluvial deposits comprised of brown (7.5 YR 4/4), loose to firm, massive, root-penetrated, sandy silt with clay (ML); modern A horizon formed in unit.

Scale 1 inch equals 5 feet with no vertical exaggeration

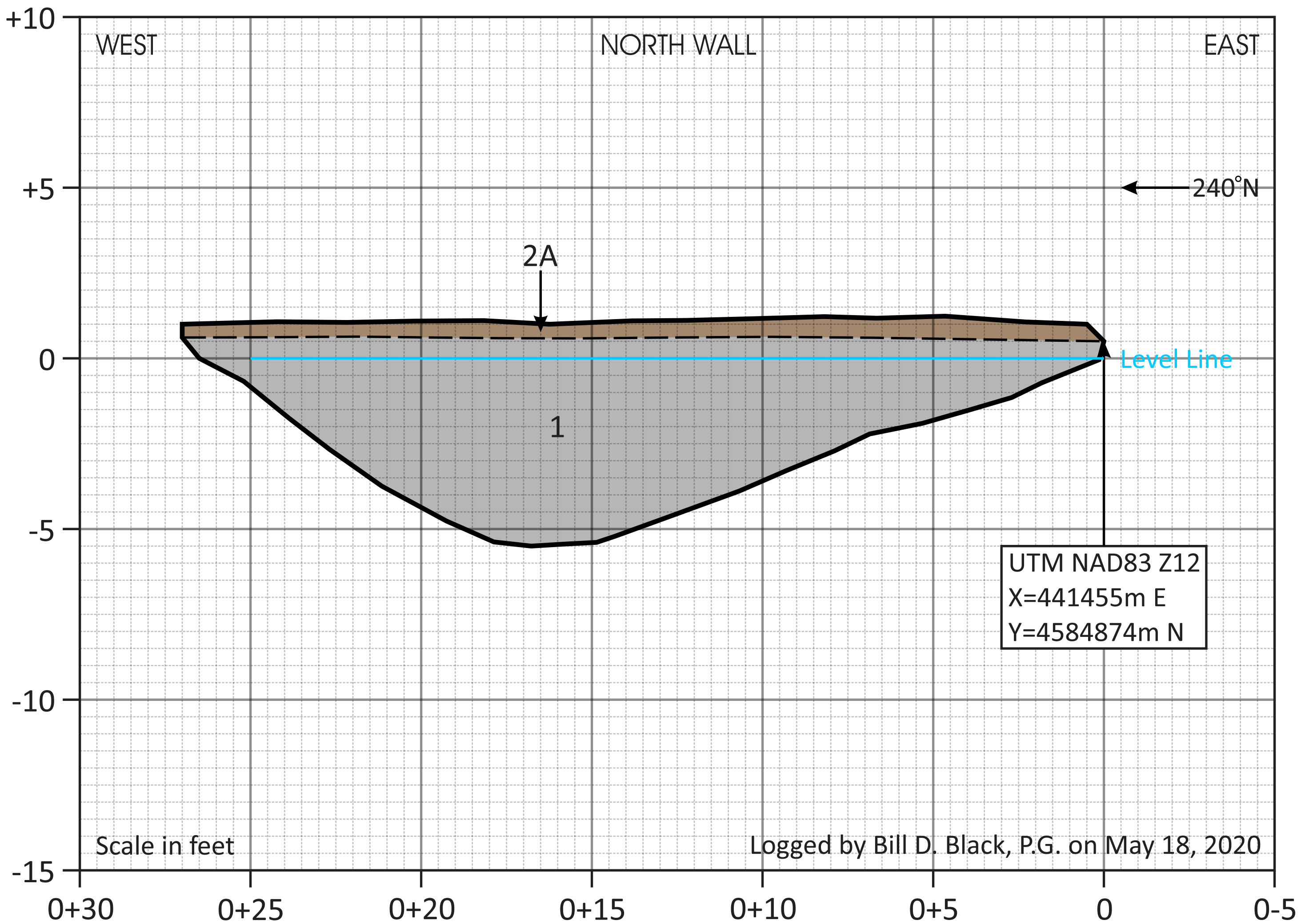
WESTERN GEOLOGIC

TEST PIT LOGS, SHEET 1

GEOLOGIC HAZARDS EVALUATION
Whisper Ridge Village Phase 1
Sections 22 and 23, Township 8 North, Range 2 East
Unincorporated Weber County, Utah

FIGURE 4A

TEST PIT 3

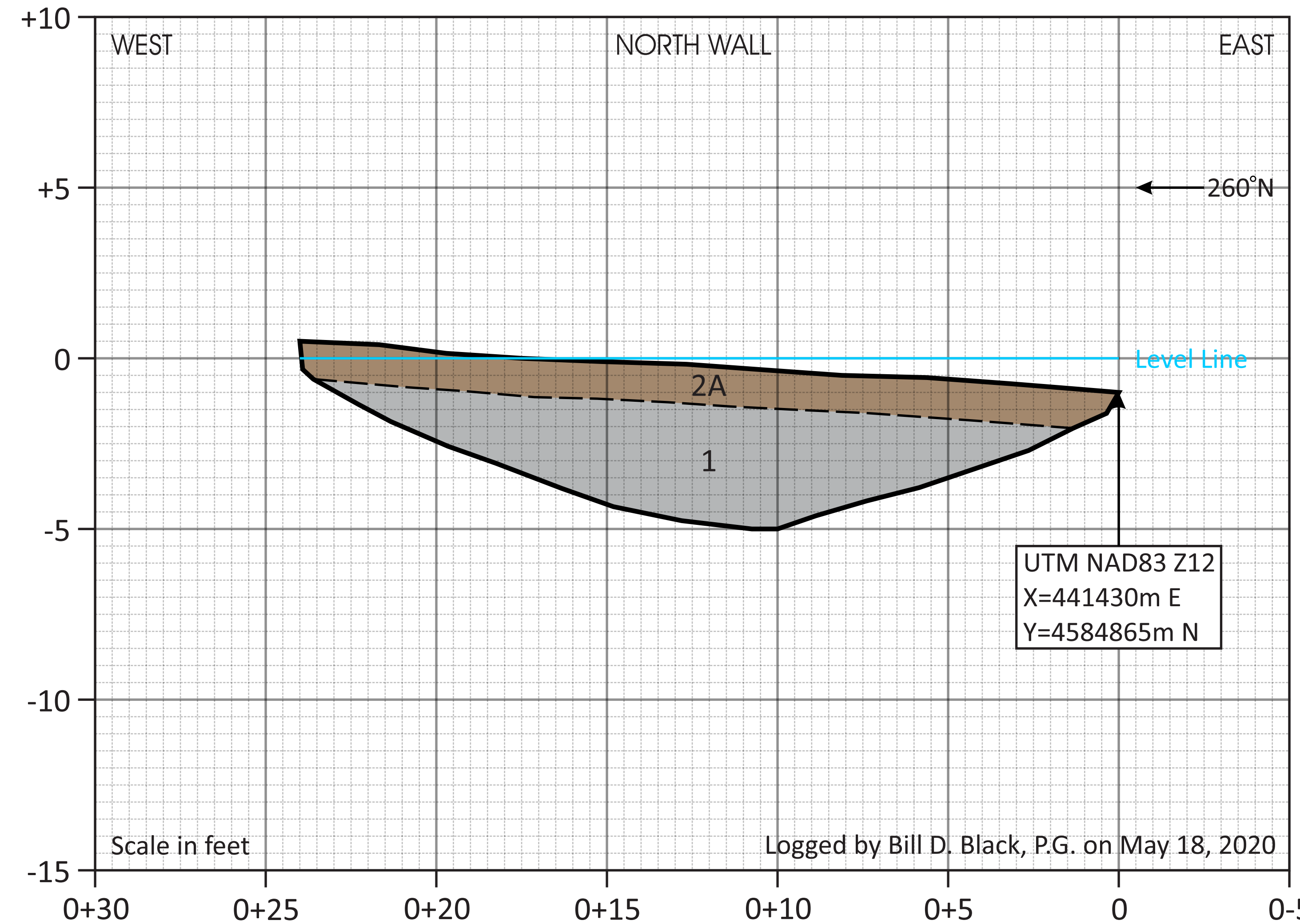


UNIT DESCRIPTIONS

Unit 1. *Cambrian Bloomington Formation, Middle Limestone Member* - Weathered, olive- to brownish-gray, thinly bedded, dolomite to limestone.

Unit 2A. *Pleistocene to Holocene alluvium and colluvium* - Mixed alluvial and colluvial deposits comprised of brown (7.5 YR 4/4), loose to firm, massive, root-penetrated, sandy silt with clay (ML); modern A horizon formed in unit.

TEST PIT 4



UNIT DESCRIPTIONS

Unit 1. *Cambrian Bloomington Formation, Middle Limestone Member* - Dense to very dense, olive- to brownish-gray, thinly bedded, dolomite to limestone, refusal at 4.5'.

Unit 2A. *Pleistocene to Holocene alluvium and colluvium* - Mixed alluvial and colluvial deposits comprised of brown (7.5 YR 4/4), loose to firm, massive, root-penetrated, sandy silt with clay (ML); modern A horizon formed in unit.

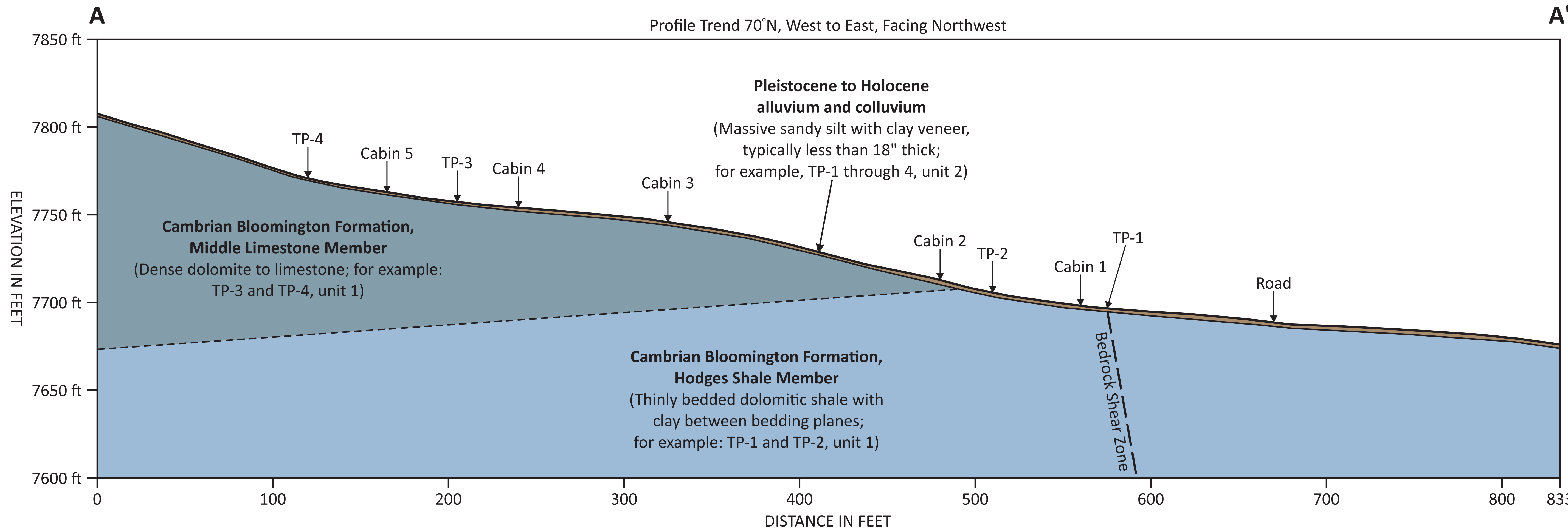
Scale 1 inch equals 5 feet with no vertical exaggeration

WESTERN GEOLOGIC

TEST PIT LOGS, SHEET 2

GEOLOGIC HAZARDS EVALUATION
Whisper Ridge Village Phase 1
Sections 22 and 23, Township 8 North, Range 2 East
Unincorporated Weber County, Utah

FIGURE 4B



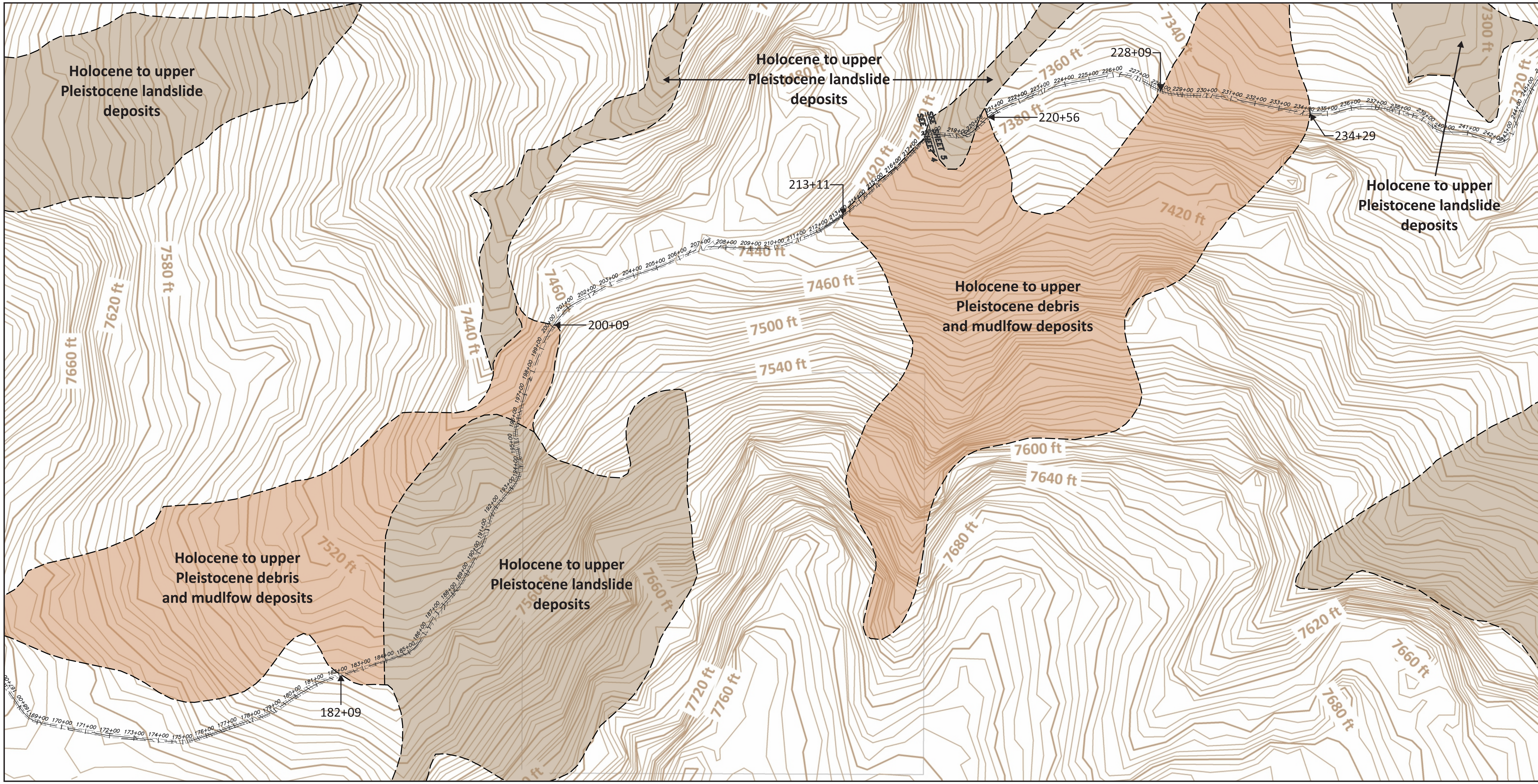
SCALE: 1 inch = 60 feet
(no vertical exaggeration)
Unit and subunit contacts are approximate and inferred; slope
profile generated by Global Mapper from geoprocessed DEM data.

WESTERN GeoLogic

CROSS SECTION A-A'

GEOLOGIC HAZARDS EVALUATION
Whisper Ridge Village Phase 1
Sections 22 and 23, Township 8 North, Range 2 East
Unincorporated Weber County, Utah

FIGURE 5



Source: Mapping from Coogan and King (2016; Figure 2). Contours generated by Global mapper, 4 foot interval.

N W E S

0 400 800 feet
Scale 1:4,800 (1 inch equals 400 feet)

WESTERN GEOLOGIC

ACCESS ROAD HAZARD AREAS

GEOLOGIC HAZARDS EVALUATION

Whisper Ridge Village Phase 1
Sections 22 and 23, Township 8 North, Range 2 East
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FIGURE 6