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GEOTECHNICAL AND GEOLOGIC HAZARD INVESTIGATION
Lot 79R of Summit Eden Phase 1C
8469 E. Spring Park Road
Summit Powder Mountain Resort
Weber County, Utah

IGES Project No. 02904-001

October 30, 2018

Prepared for:

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical and geologic hazard investigation conducted for Lot 79R of Summit Eden Phase 1C, part of the currently on-going expansion at the Powder Mountain Ski Resort in Weber County. The purpose of our investigation was to assess the nature and engineering properties of the subsurface soils at the project site and to provide recommendations for the design and construction of foundations, grading, and drainage. In addition, geologic hazards have been assessed for the property. The scope of work completed for this study included literature review, site reconnaissance, subsurface exploration, engineering analyses, and preparation of this report.

Our services were performed in accordance with our proposal dated July 25, 2018, and your signed authorization. The recommendations presented in this report are subject to the limitations presented in the "Limitations" section of this report (Section 6.1).

1.2 PROJECT DESCRIPTION

Our understanding of the project is based primarily on our previous involvement with the Summit Powder Mountain Resort project, which included two geotechnical investigations for the greater 200-acre Powder Mountain Resort expansion project (IGES, 2012a and 2012b), as well as numerous lot-specific and site-specific geotechnical and geologic hazard investigations in various locations across the greater Powder Mountain Resort expansion area.

The Summit Powder Mountain Resort expansion project is located southeast of SR-158 (Powder Mountain Road), south of previously developed portions of Powder Mountain Resort, in unincorporated Weber County, Utah (Figure A-1 in Appendix A, *Site Vicinity Map*). The Summit Powder Mountain project area is accessed by Powder Ridge Road. Lot 79R is located within Phase 1C of the Powder Mountain expansion project (Summit Eden), on the south side of Summit Pass – the street address is 84694 East Spring Park Road. The 0.494-acre residential lot has an approximate buildable area (building envelope) of 5,535 square feet. The proposed improvements will include a single-family home, presumably a high-end vacation home, with associated improvements such as utilities and hardscape. Construction plans were not available for our review; however, based on previous nearby developments, the new home is likely be a two- to three- level structure, with the lowest level consisting of a partial walk-out basement, founded on conventional spread footings.

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2.0 METHODS OF STUDY

2.1 LITERATURE REVIEW

2.1.1 Geotechnical

The earliest geotechnical report for the area is by AMEC (2001), which was a reconnaissance-level geotechnical and geologic hazard study. IGES later completed a geotechnical investigation for the Powder Mountain Resort expansion in 2012 (2012a, 2012b). Our previous work included twenty-two test pits and one soil boring excavated at various locations across the 200-acre development; as a part of this current study, the logs from relevant nearby test pits and other data from our reports were reviewed. IGES has also completed geotechnical/geologic hazard work for other nearby lots, including Lots 71R, 74R, 75R, and 44R.

2.1.2 Geological

Several pertinent publications were reviewed as part of this assessment. Sorensen and Crittenden, Jr. (1979) provides 1:24,000 scale geologic mapping of the Huntsville Quadrangle, and Crittenden, Jr. (1972) provides 1:24,000 scale geologic mapping of the Brown's Hole Quadrangle (Figure A-2). Coogan and King (2001) provide more recent geologic mapping of the area, but at a 1:100,000 scale. Western Geologic (2012) conducted a reconnaissance-level geologic hazard study for the greater 200-acre Powder Mountain expansion project, including the Lot 79R area (Figure A-3). The Western Geologic (2012) study modified some of the potential landslide hazard boundaries that had previously been mapped at a regional scale (1:100,000) by Coogan and King (2001) and Elliott and Harty (2010). An updated Coogan and King (2016) regional geologic map (1:62,500 scale) provides the most recent published geologic mapping that covers the project area (Figure A-4). The corresponding United States Geological Survey (USGS) topographic maps for the Huntsville and Brown's Hole Quadrangles (2017) provide physiographic and hydrologic data for the project area. Regional-scale geologic hazard maps pertaining to landslides (Elliott and Harty, 2010; Colton, 1991), faults (Christenson and Shaw, 2008a; USGS and Utah Geological Survey (UGS), 2006), debris-flows (Christenson and Shaw, 2008b), and liquefaction (Christenson and Shaw, 2008c; Anderson et al., 1994) that cover the project area were also reviewed. The Quaternary Fault and Fold Database (USGS and UGS, 2006), was reviewed to identify the location of proximal faults that have had associated Quaternary-aged displacement.

Stereo-paired aerial imagery for the project site and recent and historic Google Earth imagery was also reviewed to assist in the identification of potential adverse geologic conditions. The aerial photographs reviewed are documented in the *References* section of this report.

2.2 FIELD INVESTIGATION

Subsurface soils were investigated by excavating one test pit at a central location within the building envelope of the property. The approximate location of the test pit is illustrated on the

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Geotechnical and Local Geology Map (Figure A-5 in Appendix A). The soil types were visually logged at the time of our field work in general accordance with the *Unified Soil Classification System* (USCS). Soil classifications and descriptions are included on the test pit log, Figure A-6 in Appendix A. A key to USCS symbols and terminology is included as Figure A-7, and a key to physical rock properties is included as Figure A-8.

2.3 LABORATORY TESTING

Samples retrieved during the subsurface investigation were transported to the IGES laboratory for evaluation of engineering properties. Specific laboratory tests included:

- Grain-Size Distribution (ASTM D6913)
- Direct Shear (ASTM D3080)

Results of the laboratory testing are discussed in this report and presented in Appendix B.

3.0 GEOLOGIC CONDITIONS

3.1 GENERAL GEOLOGIC SETTING

The Lot 79R property is situated in the western portion of the northern Wasatch Mountains, approximately 4 miles northeast of Ogden Valley. The Wasatch Mountains contain a broad depositional history of thick Precambrian and Paleozoic sediments that have been subsequently modified by various tectonic episodes that have included thrusting, folding, intrusion, and volcanics, as well as scouring by glacial and fluvial processes (Stokes, 1987). The uplift of the Wasatch Mountains occurred relatively recently during the Late Tertiary Period (Miocene Epoch) between 12 and 17 million years ago (Milligan, 2000). Since uplift, the Wasatch Front has seen substantial modification due to such occurrences as movement along the Wasatch Fault and associated spurs, the development of the numerous canyons that empty into the current Salt Lake Valley and Utah Valley and their associated alluvial fans, erosion and deposition from Lake Bonneville, and localized mass-movement events (Hintze, 1988).

The Wasatch Mountains, as part of the Middle Rocky Mountains Province (Milligan, 2000), were uplifted as a fault block along the Wasatch Fault (Hintze, 1988). Ogden Valley itself is a fault-bounded trough that was occupied by Lake Bonneville (Sorensen and Crittenden, Jr, 1979) before being cut through by the Ogden River and subsequently dammed to form the Pineview Reservoir.

The Wasatch Fault and its associated segments are part of an approximately 230-mile long zone of active normal faulting referred to as the Wasatch Fault Zone (WFZ), which has well-documented evidence of late Pleistocene and Holocene (though not historic) movement (Lund, 1990; Hintze, 1988). The faults associated with the WFZ are almost entirely normal faults, exhibiting block movement down to the west of the fault and up to the east. The WFZ is contained within a greater area of active seismic activity known as the Intermountain Seismic Belt (ISB), which runs approximately north-south from northwestern Montana, along the Wasatch Front of Utah, through southern Nevada, and into northern Arizona. In terms of earthquake risk and potential associated damage, the ISB ranks only second in North America to the San Andreas Fault Zone in California (Stokes, 1987).

The WFZ consists of a series of ten segments of the Wasatch Fault that each display different characteristics and past movement, and are believed to have movement independent of one another (UGS, 1996). The Lot 79R property is located approximately 10.1 miles to the northeast of the Weber Segment of the Wasatch Fault, which is the closest documented Holocene-aged (active) fault to the property and trends north-south along the Wasatch Front (USGS and UGS, 2006).

3.2 SURFICIAL GEOLOGY

According to Sorensen and Crittenden, Jr. (1979), the property is entirely underlain by the undivided Tertiary/Cretaceous Wasatch and Evanston Formations (TKwe), described as “unconsolidated pale-reddish-brown pebble, cobble, and boulder conglomerate, forms boulder-covered slopes. Clasts are mainly Precambrian quartzite and are tan, gray, or purple; matrix is mainly poorly consolidated sand and silt.” A generalized bedding attitude shows this unit striking due north and dipping 10 degrees to the east. This map forms the basemap for the *Regional Geology Map 1* (Figure A-2). Coogan and King (2001) shows the property to be underlain by mass-movement deposits (Qm), described as “slides, slumps, and flows, as well as colluvium, talus, and alluvial fans that are mostly debris flows”. Western Geologic (2012) identified a number of landslide deposits contained within the Powder Mountain Resort expansion area (*Regional Geology Map 2,* Figure A-3). In this map, the property is located within mapped landslide deposits described as “mixed slope colluvium, shallow landslides, and talus”. A large Holocene to Late Pleistocene-aged landslide deposit is also mapped immediately south of the southern margin of the property. Finally, Coogan and King (2016) updated their 2001 map, which shows the property to be entirely underlain by landslide deposits (Qms) described as “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” (*Regional Geology Map 3*, Figure A-4). The northern margin of the property is mapped as at or very near the contact between the landslide deposits (to the south) and the Wasatch Formation (to the north). Wasatch Formation bedrock in the area is shown to be striking approximately to the north-northeast, and dipping between approximately 3 and 6 degrees to the east-southeast.

3.3 HYDROLOGY

The USGS topographic maps for the Huntsville and Brown’s Hole Quadrangles (2017) show that the Lot 79R project area is situated on a slope, with the local topographic gradient down to the southwest towards a larger west-trending ephemeral drainage locally known as Lefty’s Canyon (see Figure A-1). A small ephemeral stream drainage passes northeast-southwest through the southeast portion of the property, which passes downslope to the southwest and empties into Lefty’s Canyon. No springs are known to occur on the property, though it is possible that springs may occur on various parts of the property during peak runoff. Groundwater seepage is known to occur in the spring at the base of the slope at the road cut along the southern margins of Lots 74R and 75R (IGES, 2017).

Baseline groundwater depths for the Lot 79R property are currently unknown, but are anticipated to fluctuate both seasonally and annually. A known spring is located approximately 530 feet south-southeast of the property (Figure A-1); it is possible that the Lot 74R and 75R excavations have intersected the hydrologic pathway for this spring.

3.4 GEOLOGIC HAZARDS FROM LITERATURE

Based upon the available geologic literature, regional-scale geologic hazard maps that cover the Lot 79R project area have been produced for landslide, fault, debris-flow, and liquefaction hazards. The following is a summary of the data presented in these regional geologic hazard maps.

3.4.1 Landslides

Two regional-scale landslide hazard maps have been produced that cover the project area. Colton (1991) does not show the property to be underlain by landslide deposits, though south and west-trending landslide deposits are noted nearby to the west and south. Elliott and Harty (2010) show the property to be located within mapped landslide deposits described as "Landslide undifferentiated from talus and/or colluvial deposits". As noted above, both Western Geologic (2012; Figure A-3) and Coogan and King (2016; Figure A-4) show the property to be located within mapped landslide deposits.

3.4.2 Faults

Neither Christenson and Shaw (2008a) nor the Quaternary Fault and Fold Database of the United States (USGS and UGS, 2006) show any Quaternary-aged (~2.6 million years ago to the present) faults to be present on or projecting towards the subject property. The Weber County Natural Hazards Overlay Districts defines an active fault to be "a fault displaying evidence of greater than four inches of displacement along one or more of its traces during Holocene time (about 11,000 years ago to the present)" (Weber County, 2015). The closest active fault to the property is the Weber Segment of the Wasatch Fault Zone, located approximately 10.1 miles southwest of the western margin of the property (USGS and UGS, 2006).

3.4.3 Debris Flows

Christenson and Shaw (2008b) do not show the project area to be located within a debris-flow hazard special study area.

3.4.4 Liquefaction

Anderson, et al. (1994) and Christenson and Shaw (2008c) both show the project area to be located in an area with very low potential for liquefaction.

3.5 REVIEW OF AERIAL IMAGERY

A series of aerial photographs that cover project area were taken from the UGS Aerial Imagery Collection and analyzed stereoscopically for the presence of adverse geologic conditions across the property. This included a review of photos collected from the years 1946, 1952, and 1963. A table displaying the details of the aerial photographs reviewed can be found in the *References* section at the end of this report.

No geologic lineaments, fault scarps, landslide headscarps, or landslide deposits were observed on the subject property in the aerial photography.

Google Earth imagery of the property from between the years of 1993 and 2017 were also reviewed. No landslide or other geological hazard features were noted in the imagery, though the ephemeral drainage that passes through the southeastern side of the property was readily evident in the imagery.

At the time of this report, no LiDAR data for the project area was available to be reviewed.

3.6 SEISMICITY

Following the criteria outlined in the 2015 International Building Code (IBC, 2015), spectral response at the site was evaluated for the *Maximum Considered Earthquake* (MCE) which equates to a probabilistic seismic event having a two percent probability of exceedance in 50 years (2PE50). Spectral accelerations were determined based on the location of the site using the *U.S. Seismic "DesignMaps" Web Application* (USGS, 2012/15); this software incorporates seismic hazard maps depicting probabilistic ground motions and spectral response data developed for the United States by the U. S. Geological Survey as part of NEHRP/NSHMP (Frankel et al., 1996). These maps have been incorporated into both *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures* (FEMA, 1997) and the *International Building Code* (IBC) (International Code Council, 2015).

Table 3.6
Short- and Long-Period Spectral Accelerations for MCE

Parameter	Short Period (0.2 sec)	Long Period (1.0 sec)
MCE Spectral Response Acceleration (g)	$S_S = 0.813$	$S_1 = 0.269$
MCE Spectral Response Acceleration Site Class C (g)	$S_{MS} = S_s F_a = 0.873$	$S_{M1} = S_1 F_v = 0.412$
Design Spectral Response Acceleration (g)	$S_{DS} = S_{MS} * {}^2/_3 = 0.582$	$S_{D1} = S_{M1} * {}^2/_3 = 0.275$

To account for site effects, site coefficients that vary with the magnitude of spectral acceleration and *Site Class* are used. Site Class is a parameter that accounts for site amplification effects of soft soils and is based on the average shear wave velocity of the upper 100 feet; based on our field exploration and our understanding of the geology in this area, the subject site is appropriately classified as Site Class C (*soft rock*). Based on IBC criteria, the short-period (F_a) coefficient is 1.075 and long-period (F_v) site coefficient is 1.531. Based on the design spectral response accelerations for a *Building Risk Category* of I, II or III, the site's *Seismic Design Category* is D. The short- and long-period *Design Spectral Response Accelerations* are presented in Table 3.6; a summary of the *Design Maps* analysis is presented in Appendix C. The *peak ground acceleration* (PGA) may be taken as $0.4 * S_{MS}$.

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3.7 GEOLOGIC HAZARD ASSESSMENT

Geologic hazard assessments are necessary to determine the potential risk associated with particular geologic hazards that are capable of adversely affecting a proposed development area. As such, they are essential in evaluating the suitability of an area for development and provide critical data in both the planning and design stages of a proposed development. The geologic hazard assessment discussion below is based upon a qualitative assessment of the risk associated with a particular geologic hazard, based upon the data reviewed and collected as part of this investigation.

A "low" hazard rating is an indication that the hazard is either absent, is present in such a remote possibility so as to pose limited or little risk, or is not anticipated to impact the project in an adverse way. Areas with a low-risk determination for a particular geologic hazard do not require additional site-specific studies or associated mitigation practices with regard to the geologic hazard in question. A "moderate" hazard rating is an indication that the hazard has the capability of adversely affecting the project at least in part, and that the conditions necessary for the geologic hazard are present in a significant, though not abundant, manner. Areas with a moderate-risk determination for a particular geologic hazard may require additional site-specific studies, depending on location and construction specifics, as well as associated mitigation practices in the areas that have been identified as the most prone to susceptibility to the particular geologic hazard. A "high" hazard rating is an indication that the hazard is very capable of or currently does adversely affect the project, that the geologic conditions pertaining to the particular hazard are present in abundance, and/or that there is geologic evidence of the hazard having occurred at the area in the historic or geologic past. Areas with a high-risk determination always require additional site-specific hazard investigations and associated mitigation practices where the location and construction specifics are directly impacted by the hazard. For areas with a high-risk geologic hazard, simple avoidance is often considered.

The following is a summary of the geologic hazard assessment for the Lot 79R property.

3.7.1 Landslides/Mass Movement

According to the most recent geologic maps produced that cover the property, the property is situated within mapped landslide deposits (Coogan and King, 2016; Western Geologic, 2012; Elliott and Harty, 2010). However, landslide deposits or geomorphic features indicative of landsliding were not observed on the property in the aerial imagery, during the site reconnaissance, or in the subsurface. Shallow Wasatch Formation bedrock found in the test pit excavated on the property is indicative that that landslide deposits are not present on the property, and the mapped deposits are likely to be found further to the south of the property. Given the geologic data alone, the risk associated with landslides is considered low to moderate, given the proximity to mapped landslide deposits.

Shallow groundwater is known to be present downslope at an identified spring and upslope during peak runoff in the spring, which may possibly be representative of a perennial condition. However, groundwater was not encountered in TP-1 to a depth of 12 feet below existing grade. Shallow groundwater conditions provide an increased risk to slope instabilities, and it is possible that shallow groundwater conditions may be present on the site during peak runoff in the spring.

Slope stability modeling performed as part of our assessment indicates that the existing slope is stable under both static and seismic conditions (see Section 4.3). The slope stability modeling supports the landslide hazard risk classification for the property as being low to moderate.

3.7.2 Rockfall

Though the property is on a slope, no bedrock outcrops are exposed upslope of the property. As such, the rockfall hazard associated with the property is considered to be low.

3.7.3 Surface-Fault Rupture and Earthquake-Related Hazards

No faults are known to be present on or project across the property, and the closest active fault to the property is the Weber Segment of the Wasatch Fault Zone, located approximately 10.1 miles to the southwest of the property (USGS and UGS, 2006). Given this information, the risk associated with surface-fault-rupture on the property is considered low.

The entire property is subject to earthquake-related ground shaking from a large earthquake generated along the active Wasatch Fault. Given the distance from the Wasatch Fault, the hazard associated with ground shaking is considered to be moderate. Proper building design according to appropriate building code and design parameters can assist in mitigating the hazard associated with earthquake ground shaking.

3.7.4 Liquefaction

During our subsurface investigation the site was found to be underlain by the Wasatch Formation, a poorly consolidated sedimentary rock unit (conglomerate). Rock units such as these are not considered susceptible to liquefaction; as such, the potential for liquefaction occurring at the site is considered low.

3.7.5 Debris-Flows and Flooding Hazards

The property contains an ephemeral drainage that passes northeast-southwest through the southeastern portion of the lot. However, there are no debris-flow source areas upslope of the property, and site grading is anticipated to utilize the preexisting drainage to funnel stormwater away from the proposed residence. Given these conditions, the debris-flow and flooding hazard associated with the property is considered to be low.

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3.7.6 Shallow Groundwater

Groundwater was not observed in the test pit excavation, though shallow groundwater conditions were observed in the test pit excavated during the geotechnical work for Lot 75R and Lot 74R (IGES, 2017; IGES, 2018b), as well as in the foundation excavation for Lot 44R in May/June of 2018 (IGES, 2018a), where potential perennial spring conditions were observed in the subsurface. Additionally, the road cut along the southern margin of Lot 74R and 75R is known to exhibit seepage during spring runoff. Given these conditions, the shallow groundwater hazard is considered to be moderate. Adverse conditions, should they occur, would be more likely in the early part of the year during and immediately following primary snow melt.

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4.0 GENERALIZED SITE CONDITIONS

4.1 SITE RECONNAISSANCE

Ms. Kaitlin L. Askelson, G.I.T., of IGES conducted reconnaissance of the site and the immediate adjacent properties on August 29, 2018. The site reconnaissance was conducted with the intent to assess the general geologic conditions present across the property, with specific interest in those areas identified in the geologic literature and aerial imagery reviews as potential geologic hazard areas. Additionally, the site reconnaissance provided the opportunity to geologically map the surficial geology of the area. Figure A-5 is a site-specific geologic map of the Lot 79R property and adjacent areas.

At the time of the site reconnaissance, the lot was in a relatively natural state and was largely covered with vegetation, including aspens, grasses and shrubs. Common variously-sized quartzite cobbles and boulders were observed across the site, with the maximum clast size observed to be approximately 3 feet in diameter. The surface topography was observed to consistently slope downhill to the southwest.

No springs, seeps, or running water were observed on the property at the time of the site visit. No adverse geologic conditions were observed on the property at this time.

4.2 SUBSURFACE CONDITIONS

On August 29, 2018, a single exploration test pit was excavated in the south-central portion of the lot (see Figure A-5). The test pit was excavated to a depth of approximately 12 feet below existing grade with the aid of a Caterpillar 315C tracked excavator. Upon completion of logging, the test pit was backfilled without compactive effort. A detailed log of the test pit is displayed in Figure A-6. Three distinct geologic units were encountered in the subsurface. The soil and moisture conditions encountered during our investigation are discussed in the following paragraphs.

4.2.1 Earth Materials

<u>A/B Soil Horizon</u>: This topsoil unit was found to be between approximately 4 to 6 inches thick. The unit was a pale yellowish brown, loose, dry, sandy lean CLAY with gravel (CL), with gravel and larger-sized quartzite clasts comprising between approximately 15 and 20% of the unit. The topsoil was found to be forming upon the underlying colluvium unit.

<u>Colluvium:</u> This unit was approximately 1 to 1½ feet thick. The unit consisted of a moderate yellowish brown, medium stiff loose, dry, sandy lean CLAY with gravel (CL). Gravel and larger-sized subrounded to subangular quartzite clasts comprised between approximately 30 and 40% of the unit. Individual clasts were as much as 2 to 3 feet in diameter, though the mode clast size was approximately 3 to 4 inches in diameter. The unit also contained a topsoil matrix.

Wasatch Formation: This unit was at least 10 feet thick and extended to the maximum depth of exploration within the test pit. The unit consisted of poorly consolidated conglomerate bedrock that had largely disaggregated to a moderate reddish brown, dense to very dense, moist, clayey SAND with gravel (SC) gradational to a clayey GRAVEL with sand (GC). Gravel and larger-sized subrounded quartzite clasts comprised between approximately 33% of the unit, with individual clasts up to 2 feet in diameter, with a mode clast size of approximately 2 inches. The unit also contained an approximately 6-inch to 1-foot thick grayish purple to medium dark gray, stiff to very stiff, slightly moist, fat CLAY (CH) lens that was discontinuously present along the upper contact.

4.2.2 Groundwater

Groundwater was not encountered in the test pit excavated for this project to a depth of 12 feet below existing grade. However, it should be noted that the pit was excavated in late August, and the groundwater level was likely to be trending towards its seasonal low.

4.3 SLOPE STABILITY

4.3.1 Global Stability

The stability of the existing natural slope has been assessed in accordance with methodologies set forth in Blake et al. 2002 and AASHTO LRFD for Bridge Design Specifications with respect to a representative cross-section, illustrated on Plate D-1 in Appendix D (the section is identified in plan-view on Figure A-2). The stability of the slope was modeled using SLIDE, a computer application incorporating (among others) Spencer's Method of analysis. Calculations for stability were developed by searching for the minimum factor of safety for a circular-type failure mode. Analysis was performed for both static and seismic (pseudo-static) cases.

Groundwater, e.g. a piezometric groundwater surface, was not encountered during our subsurface investigation; hence, groundwater was not modeled in our analysis. Saturated parallel seepage, which could occur during spring run-off, has been modeled in a separate analysis (see Section 4.3.2).

Soil strength parameters were selected based on soil types observed, laboratory test results (direct shear), local experience, and correlation with index properties. Based on this assessment, the following soil strength parameters were selected for this analysis:

Table 4.3.1a
Soil Strength Parameters

Earth Materials	Friction angle (degrees)	Cohesion (psf)	Unit Weight (pcf)
Colluvium (Qc)	30	50	125
Bedrock (Tw)	40	100	125

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Pseudo-static (seismic screening) analysis of the proposed slope was performed in general conformance with Blake et al. 2002, ASCE 7-10 and AASHTO LRFD for Bridge Design Specifications. The design seismic event was taken as the ground motion with a 2 percent probability of exceedance in 50 years (2PE50). Based on information provided on the USGS website ground motion calculator, the Peak Ground Acceleration (PGA) associated with a 2PE50 event is estimated to be 0.35g. Half of the PGA, (0.175g), was taken as the horizontal seismic coefficient (k_h) (Hynes and Franklin, 1984), and used in the pseudo-static seismic screen analysis. The results of the analyses have been summarized in Table 4.3.1b.

Table 4.3.1b
Results of Slope Stability Analyses

Analysis	Static Factor of Safety	Pseudo-Static Factor of Safety
Existing Condition, circular	2.68	1.53

The results of the analysis indicated the existing conditions meet the minimum required factors-of-safety of 1.5 and 1.0 for both the static and seismic (pseudo-static) case, respectively. The planned improvements will likely include a basement level, which would tend to unload the slope and further improve the stability of the slope; significant fill placement on the slope, which would tend to load the slope and decrease stability, is not anticipated. A summary of the slope stability analysis is presented in Appendix D.

4.3.2 Surficial Stability

Our subsurface investigation indicates that the near-surface soils generally consist of sandy lean clay with gravel (CL). Material identified as 'topsoil' (A/B Horizon) is generally on the order of 4 to 6 inches thick; the topsoil has developed on the prevailing colluvial cover, and therefore consists largely of gravelly clay, but with a higher organic component (abundant roots).

IGES assessed the potential for the upper 2 feet to become mobilized under saturated parallel seepage conditions. Our assessment assumes 2 feet of clayey colluvium and/or topsoil, fully saturated, and a 3H:1V slope (this would be a transient condition that could occur during primary spring run-off and snowmelt). Our model assumes an estimated effective friction angle of 30 degrees and a cohesion of 50 psf, and a saturated unit weight of 136 pcf. Based on this model, a factor-of-safety of 1.55 results. Sample calculations are presented in Appendix D.

Our calculations do not take into account the beneficial effects of plant roots, which were commonly observed throughout the topsoil units. Areas where existing natural slopes are thickly vegetated are expected to have an even lower risk of shallow surficial slope instability.

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Based on our infinite slope model, and the foregoing discussion, IGES considers the potential for surficial slope instability on this site to be low.

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5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 GENERAL CONCLUSIONS

Based on the results of the field observations, literature review, and slope stability analyses, **the subsurface conditions are considered suitable for the proposed development provided that the recommendations presented in this report are incorporated into the design and construction of the project.**

Supporting data upon which the following conclusions and recommendations are based have been presented in the previous sections of this report. The recommendations presented herein are governed by the physical properties of the earth materials encountered in the subsurface explorations. If subsurface conditions other than those described herein are encountered in conjunction with construction, and/or if design and layout changes are initiated, IGES must be informed so that our recommendations can be reviewed and revised as deemed necessary.

5.2 GEOLOGIC CONCLUSIONS AND RECOMMENDATIONS

Based upon the data collected and reviewed as part of the geologic hazard assessment, IGES makes the following conclusions regarding the geological hazards present at the Lot 79R project area:

- **The Lot 79R project area does not appear to have geological hazards that are capable of adversely impacting the development as currently proposed under the existing conditions.**

- Though recent geologic mapping shows the site to be underlain by landslide deposits, no evidence of landsliding was observed on the surface or in the subsurface of the property. Therefore, the landslide hazard risk is considered to be low to moderate, considering the proximity to mapped landslide deposits and potential seasonal shallow groundwater conditions.

- Earthquake ground shaking may potentially affect all parts of the project area and is considered to pose a moderate risk.

- Shallow groundwater conditions were not observed in the test pit. However, a known spring is present downslope of the property, and shallow groundwater conditions have been identified in several nearby lots. As such, shallow groundwater conditions are considered to be moderate and may represent a seasonal risk; this also could cause difficulties during construction activities.

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- Rockfall, surface-fault-rupture, debris-flow, flooding, and liquefaction hazards are considered to be low for the property.

Given the conclusions listed above, IGES makes the following recommendations:

- Because landslide deposits are noted near the property, an IGES engineering geologist or geotechnical engineer should observe the foundation excavation to assess the absence (or presence) of landslide-induced shearing.

- Effort should be made to limit the introduction of water into the subsurface near the proposed residence. Appropriate grading and drainage away from the home and xeriscape or natural landscaping will assist in reducing the risk of landsliding.

- Given the potential presence of shallow groundwater conditions, foundation drains should be installed across every planned subgrade level. Temporary drains may need to be used during construction operations to minimize groundwater seepage onto the foundation excavation. Alternatively, an on-grade structure (no basement) would preclude the need for extensive shallow groundwater mitigation.

5.3 EARTHWORK

5.3.1 General Site Preparation and Grading

Below proposed structures, fills, and man-made improvements, all vegetation, topsoil, debris and undocumented fill (if any) should be removed. Any existing utilities should be re-routed or protected in place. The exposed native soils should then be proof-rolled with heavy rubber-tired equipment such as a scraper or loader. Any soft/loose areas identified during proof-rolling should be removed and replaced with structural fill. All excavation bottoms should be observed by an IGES representative during proof-rolling or otherwise prior to placement of engineered fill to evaluate whether soft, loose, or otherwise deleterious earth materials have been removed, and to assess compliance with the recommendations presented in this report.

5.3.2 Excavations

Soft, loose, or otherwise unsuitable soils beneath structural elements, hardscape or pavements may need to be over-excavated and replaced with structural fill. If over-excavation is required, the excavations should extend one foot laterally for every foot of depth of over-excavation. Excavations should extend laterally at least two feet beyond flatwork, pavements, and slabs-on-grade. Structural fill should consist of granular materials and should be placed and compacted in accordance with the recommendations presented in this report.

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Prior to placing engineered fill, all excavation bottoms should be scarified to at least 6 inches, moisture conditioned as necessary at or slightly above optimum moisture content (OMC), and compacted to at least 90 percent of the maximum dry density (MDD) as determined by ASTM D-1557 (Modified Proctor).

5.3.3 Excavation Stability

The contractor is responsible for site safety, including all temporary trenches excavated at the site and the design of any required temporary shoring. The contractor is responsible for providing the "competent person" required by Occupational Safety and Health (OSHA) standards to evaluate soil conditions. For planning purposes, Soil Type C is expected to predominate at the site (sands and gravels). Close coordination between the competent person and IGES should be maintained to facilitate construction while providing safe excavations.

Based on OSHA guidelines for excavation safety, trenches with vertical walls up to 5 feet in depth may be occupied. Where very moist soil conditions or groundwater is encountered, or when the trench is deeper than 5 feet, we recommend a trench-shield or shoring be used as a protective system to workers in the trench. As an alternative to shoring or shielding, trench walls may be laid back at one and one-half horizontal to one vertical (1½H:1V) (34 degrees) in accordance with OSHA Type C soils. Trench walls may need to be laid back at a steeper grade pending evaluation of soil conditions by the geotechnical engineer. Soil conditions should be evaluated in the field on a case-by-case basis. Large rocks exposed on excavation walls should be removed (scaled) to minimize rock fall hazards.

5.3.4 Structural Fill and Compaction

All fill placed for the support of structures, flatwork or pavements should consist of structural fill. Structural fill should consist of granular native soils, which may be defined as soils with less than 25% fines, 10-60% sand, and contain no rock larger than 4 inches in nominal size (6 inches in greatest dimension). Structural fill should also be free of vegetation and debris. All structural fill should be 1 inch minus material when within 1 foot of any base coarse material. Soils not meeting these criteria may be suitable for use as structural fill; however, such soils should be evaluated on a case by case basis and should be approved by IGES prior to use.

All structural fill should be placed in maximum 4-inch loose lifts if compacted by small hand-operated compaction equipment, maximum 6-inch loose lifts if compacted by light-duty rollers, and maximum 8-inch loose lifts if compacted by heavy duty compaction equipment that is capable of efficiently compacting the entire thickness of the lift. Additional lift thickness may be allowed by IGES provided the Contractor can demonstrate sufficient compaction can be achieved with a given lift thickness with the equipment in use. We recommend that all structural fill be compacted on a horizontal plane, unless otherwise approved by IGES. Structural fill underlying all shallow footings and pavements should be compacted to at least 95 percent of the MDD as determined by

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ASTM D-1557. **The moisture content should be at, or slightly above, the OMC for all structural fill**. Any imported fill materials should be approved prior to importing. Also, prior to placing any fill, the excavations should be observed by IGES to assess whether unsuitable materials have been removed. In addition, proper grading should precede placement of fill, as described in the General Site Preparation and Grading subsection of this report.

Specifications from governing authorities such as Weber County and/or special service districts having their own precedence for backfill and compaction should be followed where more stringent.

5.3.5 Oversize Material

Based on our observations, there is a potential for the presence of oversize materials (larger than 6 inches in greatest dimension). Large rocks, particularly boulders (>12 inches), may require special handling, such as segregation from structural fill, and disposal.

5.3.6 Utility Trench Backfill

Utility trenches should be backfilled with structural fill in accordance with Section 5.3.4 of this report. Utility trenches can be backfilled with the onsite soils free of debris, organic and oversized material. Prior to backfilling the trench, pipes should be bedded in and shaded with a uniform granular material that has a Sand Equivalent (SE) of 30 or greater. Pipe bedding may be water-densified in-place (jetting). Alternatively, pipe bedding and shading may consist of clean ¾-inch gravel. Native earth materials can be used as backfill over the pipe bedding zone. All utility trenches backfilled below pavement sections, curb and gutter, and hardscape, should be backfilled with structural fill compacted to at least 95 percent of the MDD as determined by ASTM D-1557. All other trenches should be backfilled and compacted to approximately 90 percent of the MDD (ASTM D-1557). However, in all cases the pipe bedding and shading should meet the design criteria of the pipe manufacturer. Specifications from governing authorities having their own precedence for backfill and compaction should be followed where they are more stringent.

5.4 FOUNDATION RECOMMENDATIONS

Based on our field observations and considering the presence of relatively competent native earth materials, we recommend that the footings for the proposed home be founded either *entirely* on competent native earth materials or *entirely* on structural fill. Native/fill transition zones are not allowed. Furthermore, if part of the foundation excavation exposes hard/cemented colluvium and/or conglomerate bedrock, all foundations should be deepened such that the entire foundation system is placed on similarly firm earth materials.

If soft, loose, or otherwise deleterious earth materials are exposed in the footing excavations, then the footings should be deepened such that all footings bear on relatively uniform, competent native earth materials. Alternatively, the foundation excavation may be over-excavated a minimum of 2 feet below the bottom of proposed footings and replaced with structural fill, such that the footings

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bear entirely on a uniform fill blanket. We recommend that IGES assess the bottom of the foundation excavation prior to the placement of steel or concrete to identify the competent native earth materials as well as any unsuitable soils or transition zones. Additional over-excavation may be required based on the actual subsurface conditions observed.

Shallow spread or continuous wall footings constructed entirely on competent, uniform native earth materials or on a minimum of 2 feet of *structural fill* extending down to competent native material may be proportioned utilizing a maximum net allowable bearing pressure of **2,900 pounds per square foot (psf)** for dead load plus live load conditions. The net allowable bearing value presented above is for dead load plus live load conditions. The minimum recommended footing width is 20 inches for continuous wall footings and 30 inches for isolated spread footings.

All conventional foundations exposed to the full effects of frost should be established at a minimum depth of 42 inches below the lowest adjacent final grade. Interior footings, not subjected to the full effects of frost (i.e., *a continuously heated structure*), may be established at higher elevations, however, a minimum depth of embedment of 12 inches is recommended for confinement purposes.

Foundation drains must be installed around below-ground foundations (e.g., basement walls) to minimize the potential for flooding from water seepage (spring-like conditions), which may be present at various times during the year, particularly during spring run-off.

5.5 SETTLEMENT

5.5.1 Static Settlement

Static settlements of properly designed and constructed conventional foundations, founded as described in Section 5.4, are anticipated to be on the order of 1 inch or less. Differential settlement is expected to be half of total settlement over a distance of 30 feet.

5.5.2 Dynamic Settlement

Dynamic settlement (or seismically-induced settlement) consists of dry dynamic settlement of unsaturated soils (above groundwater) and liquefaction-induced settlement (below groundwater). During a strong seismic event, seismically-induced settlement can occur within loose to moderately dense sandy soil due to reduction in volume during, and shortly after, an earthquake event. Settlement caused by ground shaking is often non-uniformly distributed, which can result in differential settlement.

Based on the subsurface conditions encountered, dynamic settlement arising from a MCE seismic event is expected to be low; for design purposes, settlement on the order of ½ inch over 40 feet may be assumed.

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5.6 EARTH PRESSURES AND LATERAL RESISTANCE

Lateral forces imposed upon conventional foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footing and the supporting soils. In determining the frictional resistance against concrete, a coefficient of friction of 0.45 for sandy/gravelly native soils or structural fill should be used.

Ultimate lateral earth pressures from *granular* backfill acting against retaining walls, temporary shoring, or buried structures may be computed from the lateral pressure coefficients or equivalent fluid densities presented in Table 5.6. These lateral pressures should be assumed even if the backfill is placed in a relatively narrow gap between a vertical bedrock cut and the foundation wall. These coefficients and densities assume no buildup of hydrostatic pressures. The force of water should be added to the presented values if hydrostatic pressures are anticipated.

Clayey soils drain poorly and may swell upon wetting, thereby greatly increasing lateral pressures acting on earth retaining structures; therefore, clayey soils should not be used as retaining wall backfill. Backfill should consist of native granular soil with an Expansion Index (EI) less than 20.

Walls and structures allowed to rotate slightly should use the active condition. If the element is to be constrained against rotation (i.e., a basement wall), the at-rest condition should be used. These values should be used with an appropriate factor of safety against overturning and sliding. A value of 1.5 is typically used. Additionally, if passive resistance is calculated in conjunction with frictional resistance, the passive resistance should be reduced by ½.

Table 5.6
Lateral Earth Pressure Coefficients

Condition	**Level Backfill**		**2H:1V Backfill**	
	Lateral Pressure Coefficient	**Equivalent Fluid Density (pcf)**	**Lateral Pressure Coefficient**	**Equivalent Fluid Density (pcf)**
Active (Ka)	0.333	40.0	0.537	64.4
At-rest (Ko)	0.50	60.0	0.81	96.8
Passive (Kp)	3.0	360	—	—
Seismic Active	0.115	13.8	0.368	44.1
Seismic Passive	-0.339	-40.6	—	—

For seismic analyses, the *active* earth pressure coefficient provided in the table is based on the Mononobe-Okabe pseudo-static approach and only accounts for the dynamic horizontal thrust produced by ground motion. Hence, the resulting dynamic thrust pressure *should be added* to the static pressure to determine the total pressure on the wall. The pressure distribution of the dynamic horizontal thrust may be closely approximated as an inverted triangle with stress decreasing with

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depth and the resultant acting at a distance approximately 0.6 times the loaded height of the structure, measured upward from the bottom of the structure.

5.7 CONCRETE SLAB-ON-GRADE CONSTRUCTION

To minimize settlement and cracking of slabs, and to aid in drainage beneath the concrete floor slabs, all concrete slabs should be founded on a minimum 4-inch layer of compacted gravel overlying properly prepared subgrade. The gravel should consist of free-draining gravel or road base with a 3/4-inch maximum particle size and no more than 5 percent passing the No. 200 mesh sieve. The layer should be compacted to at least 95 percent of the MDD as determined by ASTM D-1557.

All concrete slabs should be designed to minimize cracking as a result of shrinkage. Consideration should be given to reinforcing the slab with a welded wire fabric, re-bar, or fibermesh. Slab reinforcement should be designed by the structural engineer; however, as a minimum, slab reinforcement should consist of 4''×4'' W2.9×W2.9 welded wire mesh within the middle third of the slab. We recommend that concrete be tested to assess that the slump and/or air content is in compliance with the plans and specifications. We recommend that concrete be placed in general accordance with the requirements of the American Concrete Institute (ACI). A Modulus of Subgrade Reaction of **250 psi/inch** may be used for design.

A moisture barrier (vapor retarder) consisting of 10-mil thick Visqueen (or equivalent) plastic sheeting should be placed below slabs-on-grade where moisture-sensitive floor coverings or equipment is planned. Prior to placing this moisture barrier, any objects that could puncture it, such as protruding gravel or rocks, should be removed from the building pad. Alternatively, the subgrade may be covered with 2 inches of clean sand**.**

5.8 MOISTURE PROTECTION AND SURFACE DRAINAGE

Surface moisture should not be allowed to infiltrate into the soils in the vicinity of the foundations. As such, design strategies to minimize ponding and infiltration near the structures should be implemented. The new home may be subject to sheet flow during periods of heavy rain or snow melt; therefore, the Civil Engineer may also wish to consider construction of additional surface drainage to intercept surface runoff, or a curtain drain to intercept seasonal groundwater flow.

We recommend roof runoff devices be installed to direct all runoff a minimum of 10 feet away from foundations. The builder should be responsible for compacting the exterior backfill soils around the foundation; failure to properly compact the basement backfill can result in excessive settlement and damage to exterior improvements such as pavement or other flatwork. Additionally, the ground surface within 10 feet of the structures should be constructed so as to slope a minimum of **five** percent away from the structure. Pavement sections should be constructed to divert surface water off the pavement into storm drains, curb/gutter, or another suitable location.

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Where basements are planned, IGES recommends a perimeter foundation drain be constructed in accordance with the International Residential Code (IRC).

5.9 SOIL CORROSION POTENTIAL

Laboratory testing of representative soil samples obtained from nearby lots for previous investigations (44R, 75R) indicated that the soil samples tested had soluble sulfate contents of 74 516 ppm. Accordingly, the soils are classified as having a 'low potential' for deterioration of concrete due to the presence of soluble sulfate. As such, conventional Type II Portland cement may be used for all concrete in contact with site soils.

To evaluate the corrosion potential of ferrous metal in contact with native soil, testing for resistivity, soluble chloride and pH is typically prescribed. Testing of soils on nearby lots (44R, 74R) during previous investigations indicated that the soil tested had a minimum soil resistivity of 5,071 and 9,373 OHM-cm, soluble chloride content of 8.46 and 72.0 ppm and a pH of 5.24 and 5.57. Based on these results, the onsite native soil is considered to be *mildly corrosive* to ferrous metal. To address the acidic soil conditions, we recommend a lower water/cement ratio, ~0.4, for reinforced concrete. The lower water/cement ratio will reduce permeability of the concrete and reduce the susceptibility of the reinforcing steel to acidic corrosion.

5.10 CONSTRUCTION CONSIDERATIONS

5.10.1 Over-Size Material

The site is overlain with bouldery colluvium, largely derived from the underlying Wasatch Formation, which consists of cobbly/bouldery conglomerate. Large rocks may require special handling, such as segregation from structural fill, and disposal.

5.10.2 Groundwater

Water was not observed in the test pit excavated for this investigation; however, water has been observed seeping from the 2H:1V cut slope north of Lot 97R that descends toward the cul-de-sac during the site reconnaissance for both Lot 74R and Lot 75R, and significant water was observed earlier this year seeping into the foundation excavation for Lot 75R. Although this water is not considered groundwater in the conventional sense (a piezometric surface), it is very likely that this water represents a localized perched groundwater body and is in effect a localized underground spring. Water flow is expected to be maximum during spring run-off, and will likely taper off as the season progresses, although the water seepage may continue year-round. The Contractor and Civil Engineer should be aware of the possibility of seepage during construction, particularly in the earlier part of the year; the design of the structure should take into account the possibility of seepage, and subterranean portions of the home should be well-drained. Temporary dewatering may be required during construction.

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6.0 CLOSURE

6.1 LIMITATIONS

The concept of risk is a significant consideration of geotechnical analyses. The analytical means and methods used in performing geotechnical analyses and development of resulting recommendations do not constitute an exact science. Analytical tools used by geotechnical engineers are based on limited data, empirical correlations, engineering judgment and experience. As such the solutions and resulting recommendations presented in this report cannot be considered risk-free and constitute IGES's best professional opinions and recommendations based on the available data and other design information available at the time they were developed. IGES has developed the preceding analyses, recommendations and designs, at a minimum, in accordance with generally accepted professional geotechnical engineering practices and care being exercised in the project area at the time our services were performed. No warrantees, guarantees or other representations are made.

The information contained in this report is based on limited field testing and our understanding of the project. The subsurface data used in the preparation of this report were obtained largely from the exploration made on Lot 79R. It is very likely that variations in the soil, rock, and groundwater conditions exist between and beyond the point explored. The nature and extent of the variations may not be evident until construction occurs and additional explorations are completed. If any conditions are encountered at this site that are different from those described in this report, IGES must be immediately notified so that we may make any necessary revisions to recommendations presented in this report. In addition, if the scope of the proposed construction or grading changes from those described in this report, our firm must also be notified.

This report was prepared for our client's exclusive use on the project identified in the foregoing. Use of the data, recommendations or design information contained herein for any other project or development of the site not as specifically described in this report is at the user's sole risk and without the approval of IGES, Inc. It is the client's responsibility to see that all parties to the project including the designer, contractor, subcontractors, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

We recommend that IGES be retained to review the final design plans, grading plans and specifications to determine if our engineering recommendations have been properly incorporated in the project development documents. We also recommend that IGES be retained to evaluate construction performance and other geotechnical aspects of the project as construction initiates and progresses through its completion.

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6.2 ADDITIONAL SERVICES

The recommendations made in this report are based on the assumption that an adequate program of tests and observations will be made during the construction. IGES staff or other qualified personnel should be on site to verify compliance with these recommendations. These tests and observations should include at a minimum the following:

- Observations and testing during site preparation, earthwork and structural fill placement.
- Consultation as may be required during construction.
- Quality control on concrete placement to verify slump, air content, and strength.

We also recommend that project plans and specifications be reviewed by us to verify compatibility with our conclusions and recommendations. Additional information concerning the scope and cost of these services can be obtained from our office.

We appreciate the opportunity to be of service on this project. Should you have any questions regarding the report or wish to discuss additional services, please do not hesitate to contact us at your convenience at (801) 748-4044.

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7.0 REFERENCES

AMEC, 2001. Report Engineering Geologic Reconnaissance/Geotechnical Study Powder Mountain Resort.

American Geologic Institute (AGI), 2005, Glossary of Geology, Fifth Edition, revised, Neuendorf, K.K.E., Mehl, Jr. J.P., and Jackson, J.A., editors: American Geological Institute, Alexandria, Virginia, 783 p.

Anderson, L.R., Keaton, J.R., and Bay, J.A., 1994, Liquefaction Potential Map for the Northern Wasatch Front, Utah, Complete Technical Report: Utah Geological Survey Contract Report 94-6, 169 p.

Blake, T.F., Hollingsworth, R.A. and Stewart, J.P., Editors (2002), Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for analyzing and mitigating landslide hazards in California: organized by the Southern California Earthquake Center.

Christenson, G.E., and Shaw, L.M., 2008a, Surface Fault Rupture Special Study Areas, Wasatch Front and Nearby Areas, Utah: Utah Geological Survey Supplement Map to Utah Geological Survey Circular 106, 1 Plate, Scale 1:200,000.

Christenson, G.E., and Shaw, L.M., 2008b, Debris-Flow/Alluvial Fan Special Study Areas, Wasatch Front and Nearby Areas, Utah: Utah Geological Survey Supplement Map to Utah Geological Survey Circular 106, 1 Plate, Scale 1:200,000.

Christenson, G.E., and Shaw, L.M., 2008c, Liquefaction Special Study Areas, Wasatch Front and Nearby Areas, Utah: Utah Geological Survey Supplement Map to Utah Geological Survey Circular 106, 1 Plate, Scale 1:200,000.

Colton, R.B., 1991, Landslide Deposits in the Ogden 30' x 60' Quadrangle, Utah and Wyoming: U.S. Geological Survey Open-File Report 91-297, 1 Plate, 8 p., Scale 1:100,000.

Coogan, J.C., and King, J.K., 2001, Progress Report Geologic Map of the Ogden 30' x 60' Quadrangle, Utah and Wyoming – Year 3 of 3: Utah Geological Survey Open-File Report 380, 1 Plate, 33 p., Scale 1:100,000.

Coogan, J.C., and King, J.K., 2016, Interim Geologic Map of the Ogden 30' x 60' Quadrangle, Box Elder, Cache, Davis, Morgan, Rich, and Summit Counties, Utah, and Uinta County, Wyoming: Utah Geological Survey Open-File Report 653DM, 1 Plate, 151 p., Scale 1:100,000.

Crittenden, Jr., M.D., 1972, Geologic Map of the Browns Hole Quadrangle, Utah: U.S. Geological Survey Geologic Quadrangle Map GQ-968, 1 Plate, Scale 1:24,000.

Elliott, A.H., and Harty, K.M., 2010, Landslide Maps of Utah, Ogden 30' X 60' Quadrangle: Utah Geological Survey Map 246DM, Plate 6 of 46, Scale 1:100,000.

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REFERENCES (Cont.)

Federal Emergency Management Agency [FEMA], 1997, *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures,* FEMA 302, Washington, D.C.

Frankel, A., Mueller, C., Barnard, T., Perkins, D., Leyendecker, E.V., Dickman, N., Hanson, S., and Hopper, M., 1996, *National Seismic-hazard Maps: Documentation*, U.S. Geological Survey Open-File Report 96-532, June.

Giraud, R.E., Shaw, L.M., 2007, Landslide Susceptibility Map of Utah, Utah Geological Survey Map 228DM, Plate 1, Scale 1:500,000.

Hintze, L.F., 1988, Geologic History of Utah: Brigham Young University Geology Studies Special Publication 7, Provo, Utah, 202 p.

Hynes, M.E. and A. G. Franklin (1984). "Rationalizing the Seismic Coefficient Method" Miscellaneous Paper GL-84-13, U.S. Army Waterways Experiment Station, Vicksburg, Miss.

IGES, Inc., 2012a, Preliminary Geotechnical Investigation, Powder Mountain Resort, Weber County, Utah, Project No. 01628-001, dated July 26, 2012.

IGES, Inc., 2012b, Design Geotechnical Investigation, Powder Mountain Resort, Weber County, Utah, Project No. 01628-003, dated November 9, 2012.

IGES, Inc., 2017, Geotechnical & Geologic Hazard Investigation Report (Rev 1), Lot 75R of Summit Powder Mountain Resort, 8452 E. Spring Park, Weber County, Utah: IGES Project No. 02347-001, dated June 9, 2017.

IGES, Inc., 2018a, Geotechnical and Geologic Hazard Investigation, Lot 44R of Summit Eden Phase 1C, 8645 E. Copper Crest, Summit Powder Mountain Resort, Weber County, Utah, Project No. 02732-001, dated March 19, 2018.

IGES, Inc., 2018b, Geotechnical and Geologic Hazard Investigation, Lot 74R of Summit Eden Phase 1C, 8645 E. Spring Park Road, Summit Powder Mountain Resort, Weber County, Utah, Project No. 02732-001, dated June 22, 2018.

International Building Code [IBC], 2015, International Code Council, Inc.

Lund, W.R., 1990, editor, Engineering geology of the Salt Lake City metropolitan area, Utah: Utah Geological Survey Bulletin 126, 66 p.

Milligan, M.R., 2000, How was Utah's topography formed? Utah Geological Survey, Survey Notes, v. 32, no.1, pp. 10-11.

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

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REFERENCES (Cont.)

Stokes, W.L., 1987, Geology of Utah: Utah Museum of Natural History and Utah Geological and Mineral Survey Department of Natural Resources, Salt Lake City, UT, Utah Museum of Natural History Occasional Paper 6, 280 p.

U.S. Geological Survey, 2012/15, U.S. *Seismic "Design Maps" Web Application*, site: https://geohazards.usgs.gov/secure/designmaps/us/application.php.

U.S. Geological Survey, 2017, Topographic Map of the Huntsville Quadrangle, Huntsville, Utah: Scale 1:24,000.

U.S. Geological Survey, 2017, Topographic Map of the Brown's Hole Quadrangle, Brown's Hole, Utah: Scale 1:24,000.

U.S. Geological Survey, 2017, Topographic Map of the James Peak Quadrangle, James Peak, Utah: Scale 1:24,000.

U.S. Geological Survey, 2017, Topographic Map of the Sharp Mountain Quadrangle, Sharp Mountain, Utah: Scale 1:24,000.

U.S. Geological Survey and Utah Geological Survey, 2006, Quaternary fault and fold database for the United States, accessed 7-3-17, from USGS website: http://earthquakes.usgs.gov/regional/qfaults

Utah Geological Survey, 2016, Utah Geological Survey Aerial Imagery Collection https://geodata.geology.utah.gov/imagery/

Weber County, 2015, Natural Hazards Overlay Districts, Chapter 27 of Title 104 of the Weber County Code of Ordinances, adopted on December 22, 2015.

Western Geologic, 2012, Report: Geologic Hazards Reconnaissance, Proposed Area 1 Mixed-Use Development, Powder Mountain Resort, Weber County, Utah, dated August 28, 2012.

AERIAL PHOTOGRAPHS

Data Set	Date	Flight	Photographs	Scale
1947 AAJ	August 10, 1946	AAJ_1B	88, 89, 90	1:20,000
1953 AAI	September 14, 1952	AAI_4K	34, 35, 36	1:20,000
1963 ELK	June 25, 1963	ELK_3	57, 58, 59	1:15,840

*https://geodata.geology.utah.gov/imagery/

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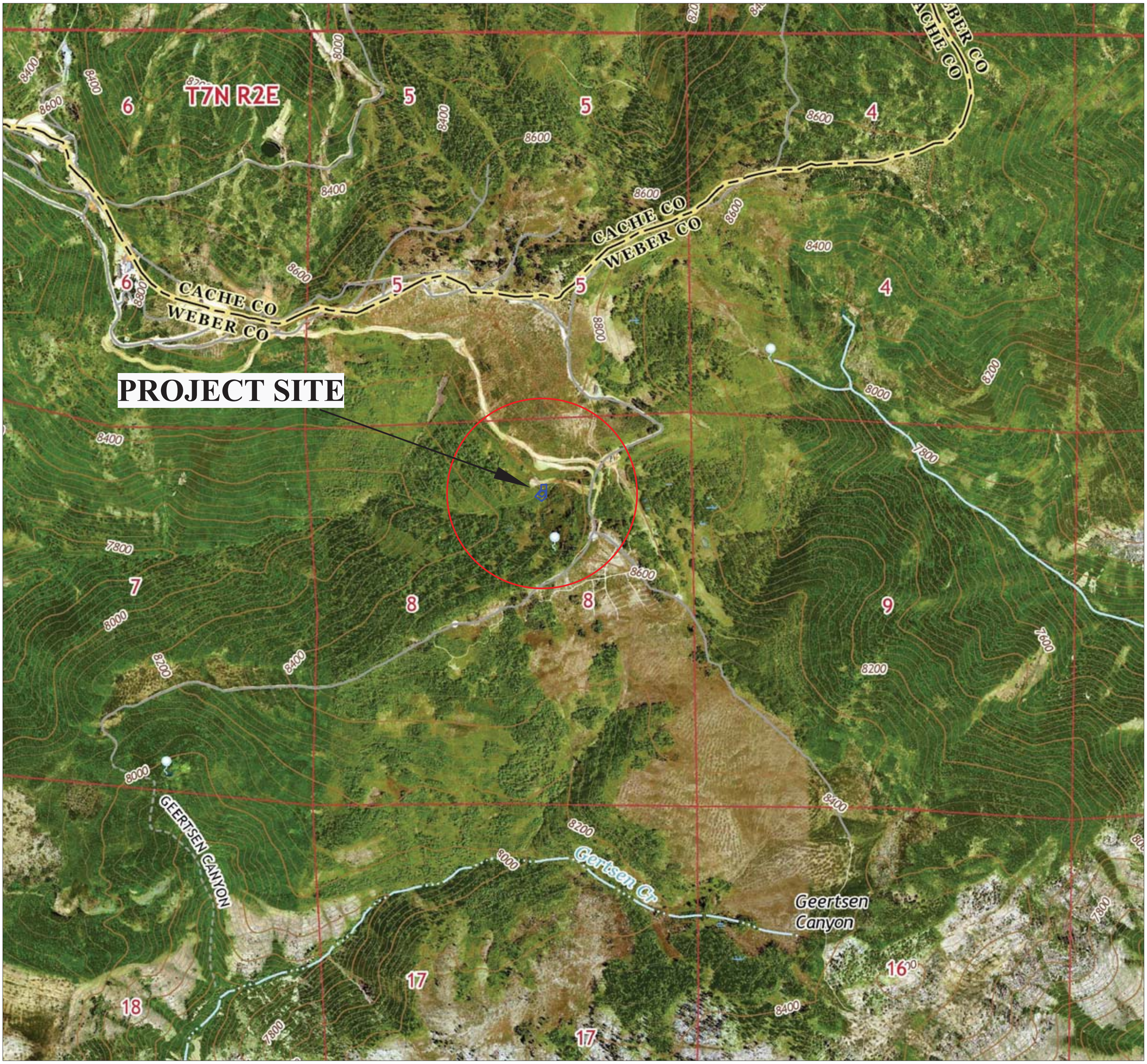
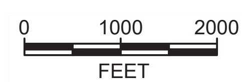
APPENDIX A



Base Maps:

-USGS *Huntsville, Brown's Hole, James Peak* and *Sharp Mountain* 7.5-Minute Quadrangles (2017)



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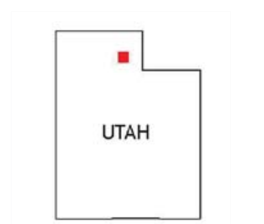


QUADRANGLE LOCATION

IGES®

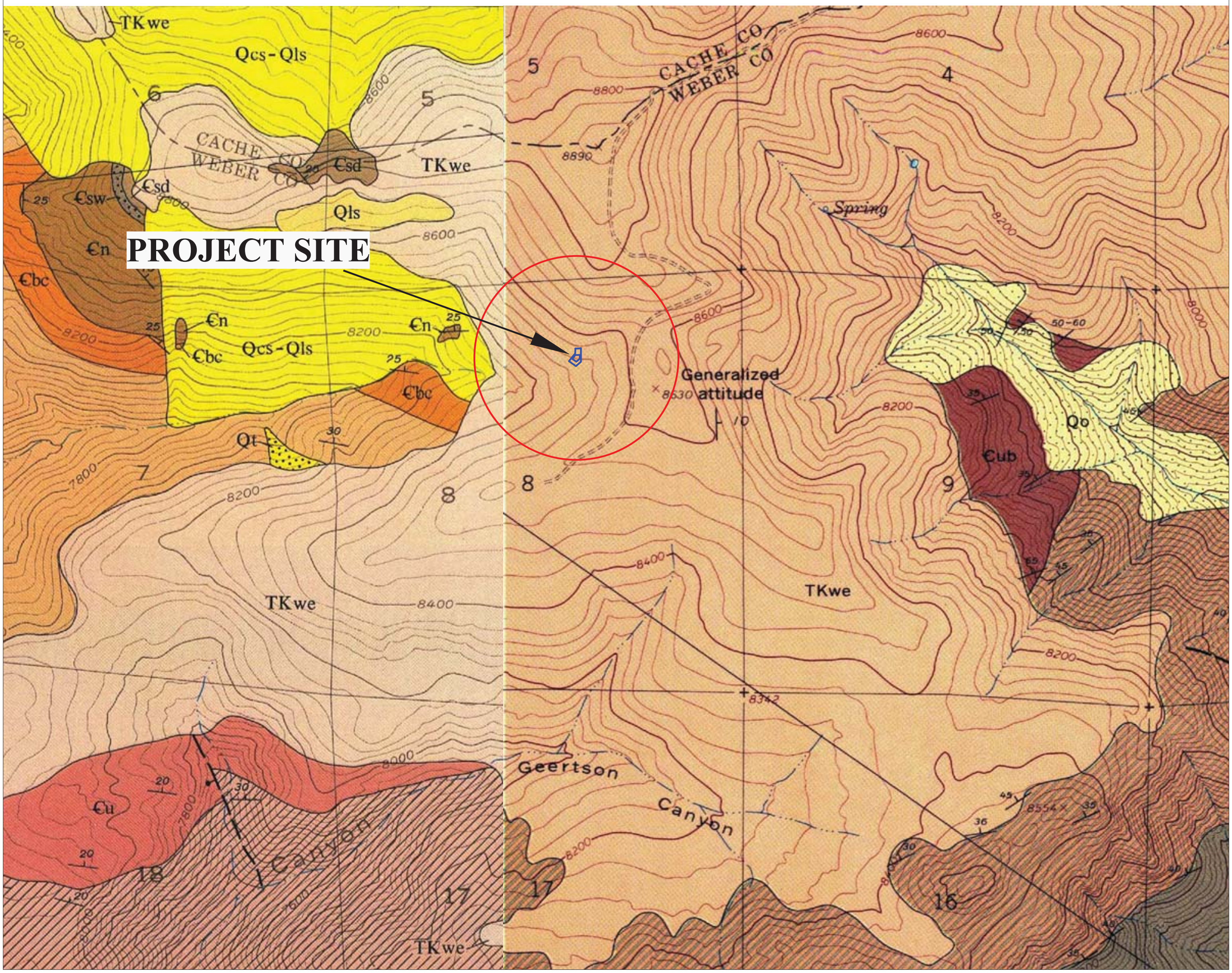
Project No: 02904-001

Geotechnical and Geologic Hazard Investigation
Lot 79R of Summit Eden Phase 1C
Summit Powder Mountain Resort
Weber County, Utah

Site Vicinity Map

Figure A-1

Edge of Mapped Area



Base Maps:

-USGS *Huntsville* 7.5-Minute Geologic Quadrangle Map (GQ-1503), Sorensen and Crittenden Jr. (1979)

-USGS *Brown's Hole* 7.5-Minute Geologic Quadrangle Map (GQ-968), Crittenden Jr. (1972)

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QUADRANGLE LOCATION

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Project No: 02904-001

Geotechnical and Geologic Hazard Investigation
Lot 79R of Summit Eden Phase 1C
Summit Powder Mountain Resort
Weber County, Utah

Regional Geology Map 1

Figure

A-2a

MAP LEGEND

Qal	ALLUVIAL DEPOSITS, UNDIFFERENTIATED (Holocene) – Unconsolidated gravel, sand, and silt deposits in presently active stream channels and floodplains; thickness 0-6 m
Qcs	COLLUVIUM AND SLOPEWASH (Holocene) – Bouldery colluvium and slopewash chiefly along eastern margin of Ogden Valley; in part, lag from Tertiary units; thickness 0-30 m
Qf	ALLUVIAL FAN DEPOSITS (Holocene) – Alluvial fan deposits; postdate, at least in part, time of highest stand of former Lake Bonneville; thickness 0-30 m
Qls	LANDSLIDE DEPOSITS (Holocene) – thickness 0-6 m
Qt	TALUS DEPOSITS (Holocene) – thickness 0-6 m
TKwe	WASATCH AND EVANSTON(?) FORMATIONS, UNDIVIDED (Eocene, Paleocene, and Upper Cretaceous?) – Unconsolidated pale-reddish-brown pebble, cobble, and boulder conglomerate; forms boulder-covered slopes. Clasts are mainly Precambrian quartzite and are tan, gray, or purple; matrix is mainly poorly consolidated sand and silt; thickness 0-150 m
	ST. CHARLES LIMESTONE (Upper Cambrian) – Includes:
Ꞓsd	Dolomite member – Thin- to thick-bedded, finely to medium crystalline, light- to medium-gray, white- to light-gray-weathering, cliff-forming dolomite; linguloid brachiopods common in basal 15 m; thickness 150-245 m
Ꞓsw	Worm Creek Quartzite Member – Thin-bedded, fine- to medium-grained, medium- to dark-gray, tan- to brown-weathering calcareous quartzitic sandstone; detrital grains well-sorted and well-rounded; thickness 6 m
Ꞓn	NOUNAN DOLOMITE (Upper and Middle Cambrian) – Thin- to thick-bedded, finely crystalline, medium-gray, light- to medium-gray-weathering, cliff-forming dolomite; white twiggy structures common throughout unit; thickness 150-230 m
Ꞓbc	CALLS FORT SHALE MEMBER OF BLOOMINGTON FORMATION (Middle Cambrian) – Olive-drab to light-brown shale and light- to dark-blue-gray limestone with intercalated orange to rusty-brown silty limestone; intraformational conglomerate common throughout unit; thickness 23-90 m
Ꞓlu	CAMBRIAN LIMESTONES, UNDIVIDED (Middle Cambrian) – Includes limestone and Hodges Shale Members of Bloomington Formation, and Blacksmith and Ute Limestones
Ꞓb	BLACKSMITH LIMESTONE (Middle Cambrian)) – Medium- to thin-bedded, light-gray to dark-blue-gray limestone; thin-bedded, flaggy-weathering, gray to tan silty limestone and interbedded siltstone; light- to dark-gray dolomite, with some reddish siliceous partings; thickness 400? m

MAP LEGEND

€u — UTE LIMESTONE (Middle Cambrian) – Medium- to thin-bedded, finely crystalline, light- to dark-gray silty limestone with irregular wavy partings, mottled and streaked surfaces, worm tracks, and twiggy structures common throughout unit; oolites and *Girvanella* in many beds; olive-drab fissile shale interbedded throughout unit. Includes thin-bedded, gray-weathering, pale-tan to brown dolomite exposed at base of unit, 18-24 m at head of Geertsen Canyon and 0-3 m elsewhere; thickness 245? m

BRIGHAM GROUP (Crittenden and others, 1971) – Includes:

GEERTSEN CANYON QUARTZITE (Lower Cambrian) – Includes:

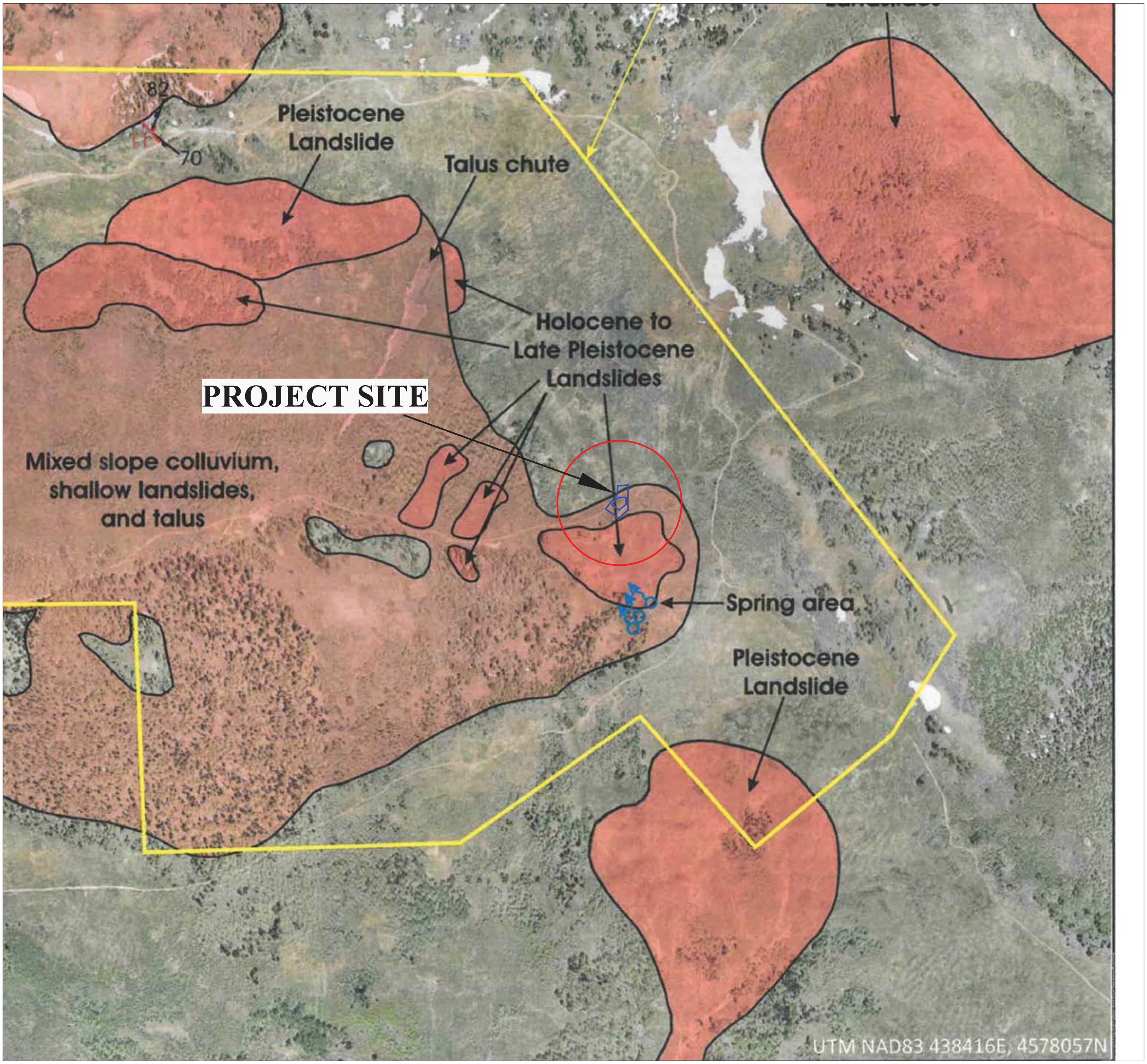
€gcu — Upper member – Pale-buff to white or flesh-pink quartzite, locally streaked with pale red or purple. Coarse-grained; small pebbles occur throughout unit and increase in abundance downward. Base marked by zone 30-60 m thick of cobble conglomerate in beds 30 cm to 2 m thick; clasts, 5-10 cm in diameter, are mainly reddish vein quartz or quartzite, sparse gray quartzite, or red jasper; thickness 730-820 m

€gcl — Lower member – Pale-buff to white and tan quartzite with irregular streaks and lenses of cobble conglomerate decreasing in abundance downward. Lower 90-120 m strongly arkosic, streaked greenish or pinkish. Feldspar clasts increase in size to 0.6-1.3 cm in lower part of unit; thickness 490-520 m

Recently active normal fault – Dashed where inferred. Ticks on downthrown side

Pre-Tertiary normal fault – Dotted where concealed Bar and ball on downthrown side

Thrust fault – Dashed where inferred Sawteeth on upper plate



Base Maps:

-Western Geologic (2012) Geologic Hazards Reconnaissance Report, Figure 3

N

0 500 1000
FEET
1" = 1000'

QUADRANGLE LOCATION

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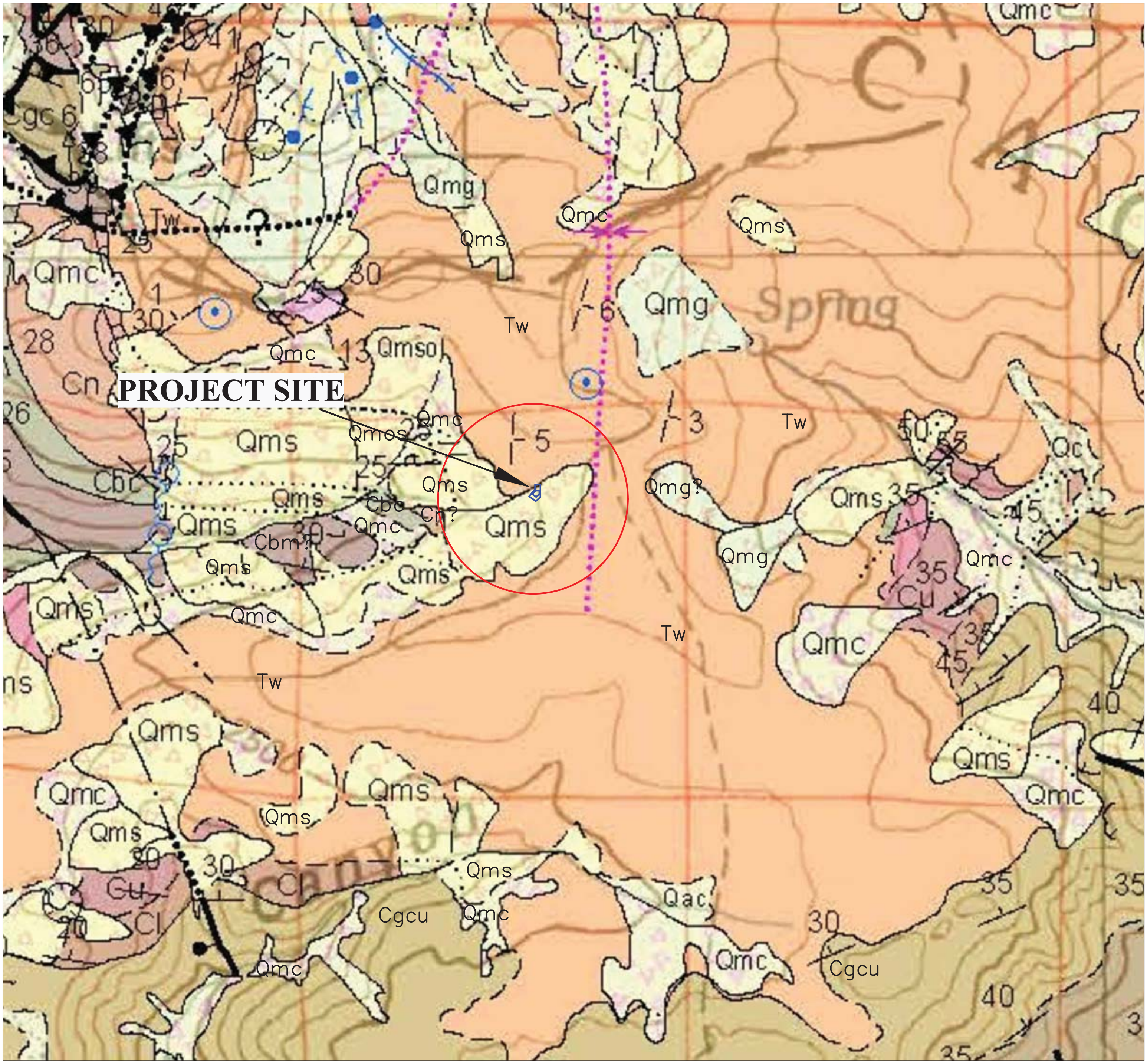
Lot 79R of Summit Eden Phase 1C
Summit Powder Mountain Resort
Weber County, Utah

Regional Geology Map 2

Figure

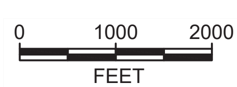
A-3



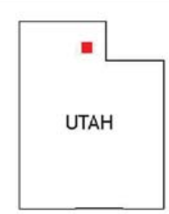
Base Maps:

-UGS *Ogden* 30' x 60' Geologic Quadrangle Map (OFR-635DM), Coogan and King (2016)

N



1" = 2000'



QUADRANGLE LOCATION

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Lot 79R of Summit Eden Phase 1C
Summit Powder Mountain Resort
Weber County, Utah

Regional Geology Map 3

Figure

A-4a

MAP LEGEND

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.

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 (slopewash 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 slopewash 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).

Qmg, Qmg?

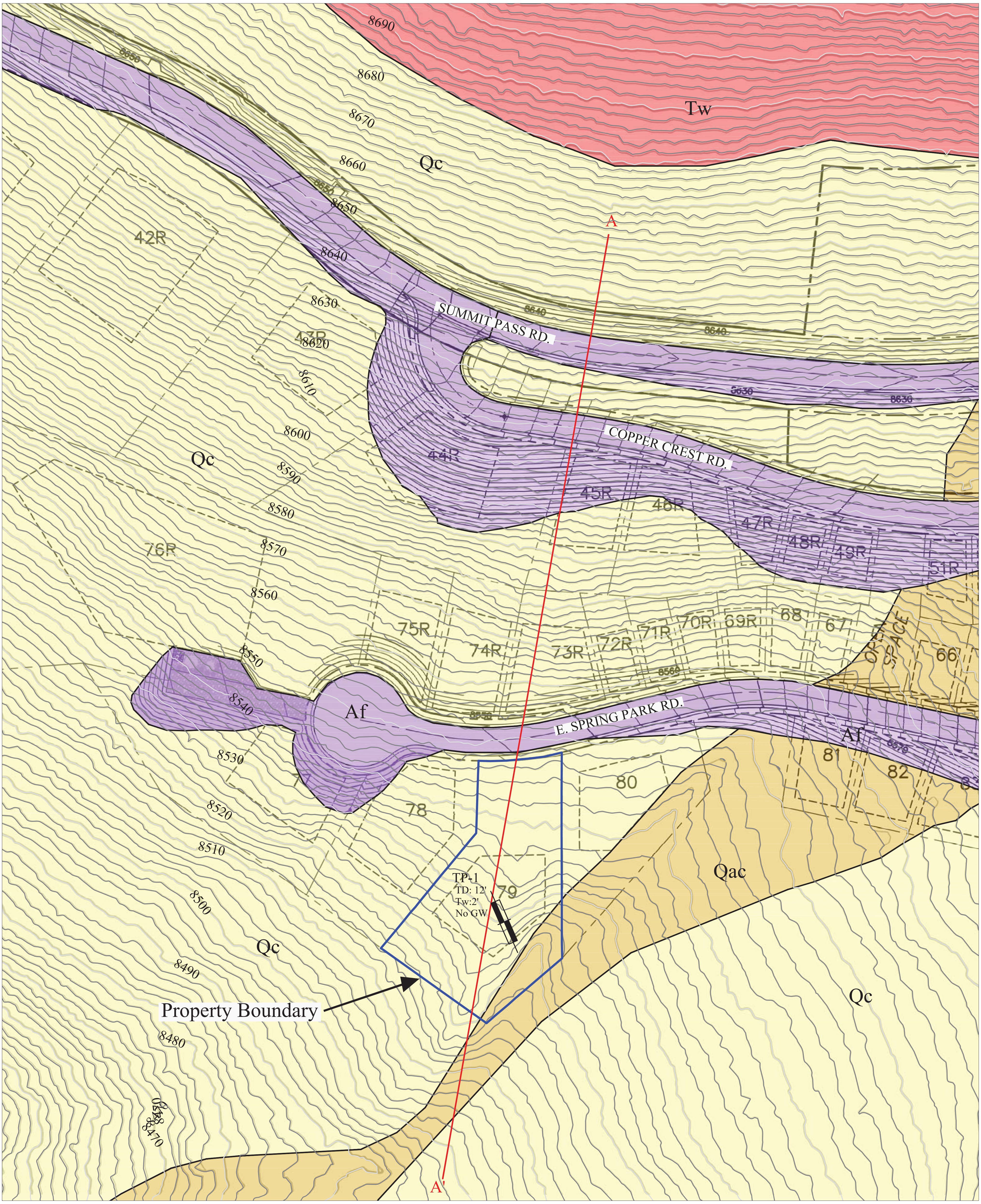
Mass-movement and glacial deposits, undivided (Holocene and Pleistocene) – Unsorted and unstratified clay, silt, sand, and gravel; mapped where glacial deposits lack typical moraine morphology, and appear to have failed or moved down slope; also mapped in upper Strawberry Bowl (Snow Basin quadrangle) where glacial deposits have lost their distinct morphology and the contacts between them and colluvium and talus in the cirques cannot be mapped; likely less than 30 feet (9 m) thick, but may be thicker in Mantua, James Peak, North Ogden, Huntsville, and Peterson quadrangles.

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.

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.

- Contact, well located
- Thrust fault, concealed
- Normal fault, approximately located
- Moraine crest, asymmetrical
- Anticline, overturned, concealed
- Syncline, upright, concealed
- Water well
- Sinkhole
- Select spring



LEGEND

Base Map:

-Undated 100-Scale Map of Phase 1C-1D Prepared By NV5

Contour Interval: 2'

Af Artificial Fill

Qc Colluvium

Qac Alluvium & Colluvium

Tw Wasatch Formation

All Geologic Contacts Approximate

Property Boundary

TP-1 Test Pit

A A' Cross Section

N

0 80 160

FEET

1" = 80'

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Project No: 02904-001

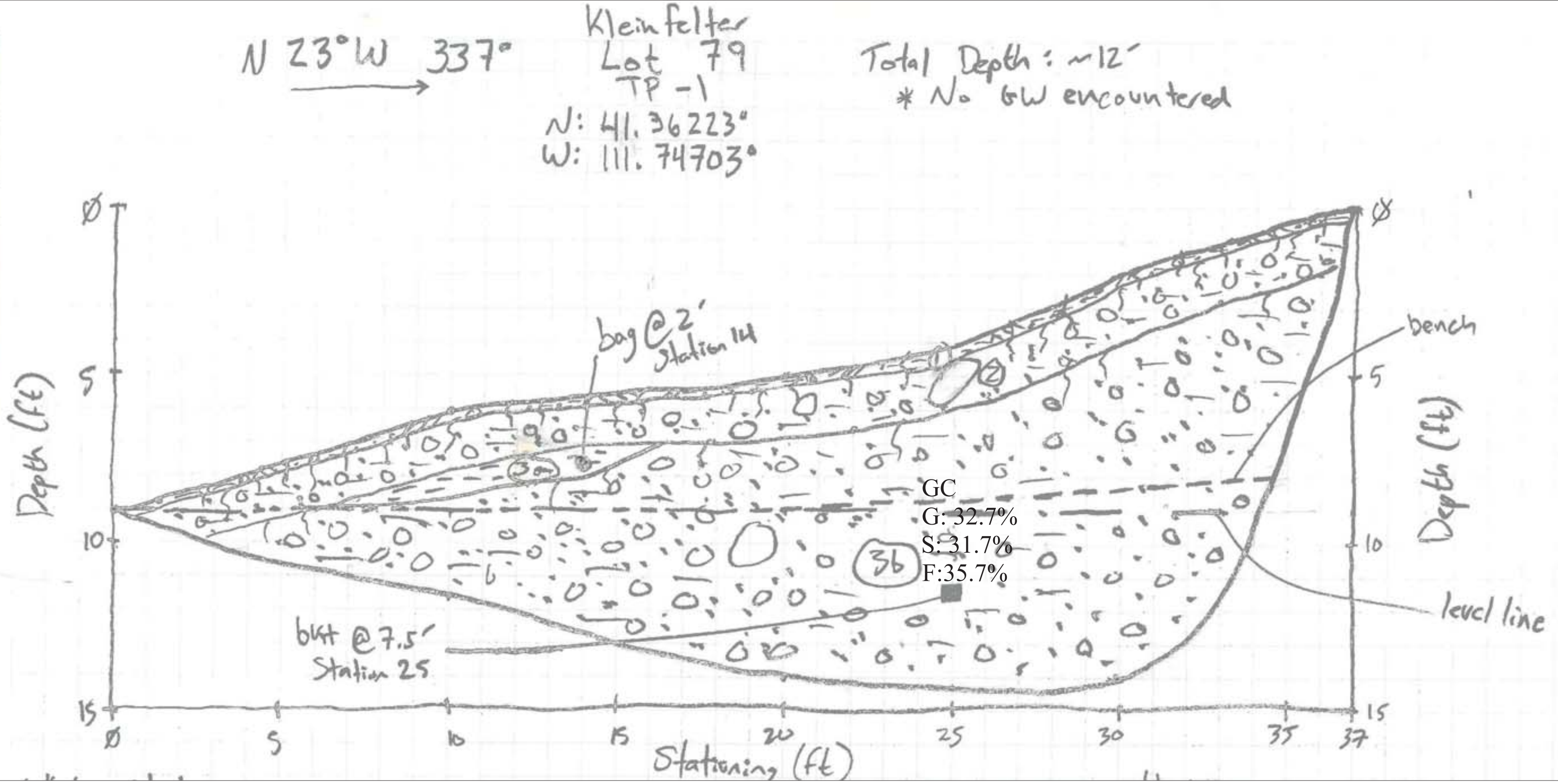
Geotechnical and Geologic Hazard Investigation
Lot 79R of Summit Eden Phase 1C
Summit Powder Mountain Resort
Weber County, Utah

Geotechnical and Local Geology Map

Figure

A-5

Project No. 02904 -001
Date 8/29/18 by JWB
Ckd by ______ on ______



LITHOLOGIC UNIT DESCRIPTIONS

1. A/B Soil Horizon: ~4-6" thick; pale yellowish brown (10YR $\frac{6}{2}$) sandy lean CLAY with gravel (CL); loose, dry, low plasticity, massive; gravel and larger sized clasts comprise ~15-20% of the unit; clasts are subrounded to subangular moderate orange pink (5Y $\frac{8}{4}$), light gray (N7), and grayish purple (5P $\frac{4}{2}$) quartzite up to 2-3' in diameter, though mode clast size is ~1"; abundant plant and tree roots; gradational, irregular basal contact.

2. Colluvium: ~1-1.5' thick; pale yellowish brown (10YR $\frac{6}{2}$) to moderate yellowish brown (10YR $\frac{5}{4}$) sandy lean CLAY with gravel (CL); medium stiff to loose, dry, low plasticity, massive; gravel and larger sized clasts comprise ~30-40% of the unit; clasts are subrounded to subangular quartzite as above up to 2-3' in diameter, though mode clast size is ~3-4"; topsoil matrix; common to abundant plant and tree roots; sharp, irregular basal contact.

3. Wasatch Formation (Tw): >10' thick; 2 subunits; 3a) ~6"-1' thick; grayish purple (5P $\frac{4}{2}$) to medium dark gray (N4) fat CLAY (CH), stiff to very stiff, slightly moist, high plasticity, massive; gravel and larger sized clasts comprise <5% of the unit, clasts are subrounded to subangular quartzite as above up to 6" in diameter, though mode clast size is <0.5"; fat clay sheen; mechanically induced slickensides up to 0.5-1" long; greasy feel when wetted; small and discontinuous unit; probably Wasatch Formation clay seam; sharp, irregular basal contact; 3b) >10' thick; moderate reddish brown (10R $\frac{4}{6}$) clayey SAND with gravel (SC) gradational to clayey GRAVEL with sand (GC), dense to very dense, slightly moist to moist, medium plasticity fines, massive; gravel and larger sized clasts comprise ~33% of the unit, clasts are subrounded to subangular quartzite as above up to 2' in diameter, though mode clast size is ~2"; sand is fine grained; few plant and tree roots.

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Geotechnical and Geologic Hazard Investigation
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Summit Powder Mountain Resort
Weber County, Utah

TP-1 Log

Figure

A-6

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			USCS SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			SC	CLAYEY SANDS SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid limit less than 50)		ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid limit greater than 50)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

LOG KEY SYMBOLS

BORING SAMPLE LOCATION

TEST-PIT SAMPLE LOCATION

WATER LEVEL (level after completion)

WATER LEVEL (level where first encountered)

CEMENTATION

DESCRIPTION	DESCRIPTION
WEAKELY	CRUMBLES OR BREAKS WITH HANDLING OR SLIGHT FINGER PRESSURE
MODERATELY	CRUMBLES OR BREAKS WITH CONSIDERABLE FINGER PRESSURE
STRONGLY	WILL NOT CRUMBLE OR BREAK WITH FINGER PRESSURE

OTHER TESTS KEY

C	CONSOLIDATION	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	DS	DIRECT SHEAR
UC	UNCONFINED COMPRESSION	T	TRIAXIAL
S	SOLUBILITY	R	RESISTIVITY
O	ORGANIC CONTENT	RV	R-VALUE
CBR	CALIFORNIA BEARING RATIO	SU	SOLUBLE SULFATES
COMP	MOISTURE/DENSITY RELATIONSHIP	PM	PERMEABILITY
CI	CALIFORNIA IMPACT	-200	% FINER THAN #200
COL	COLLAPSE POTENTIAL	Gs	SPECIFIC GRAVITY
SS	SHRINK SWELL	SL	SWELL LOAD

MODIFIERS

DESCRIPTION	%
TRACE	<5
SOME	5 - 12
WITH	>12

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
DRY	ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
MOIST	DAMP BUT NO VISIBLE WATER
WET	VISIBLE FREE WATER, USUALLY SOIL BELOW WATER TABLE

STRATIFICATION

DESCRIPTION	THICKNESS	DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2"	OCCASIONAL	ONE OR LESS PER FOOT OF THICKNESS
LAYER	1/2 - 12"	FREQUENT	MORE THAN ONE PER FOOT OF THICKNESS

GENERAL NOTES

1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.
2. No warranty is provided as to the continuity of soil conditions between individual sample locations.
3. Logs represent general soil conditions observed at the point of exploration on the date indicated.
4. In general, Unified Soil Classification designations presented on the logs were evaluated by visual methods only. Therefore, actual designations (based on laboratory tests) may vary.

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT (blows/ft)	MODIFIED CA. SAMPLER (blows/ft)	CALIFORNIA SAMPLER (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
VERY LOOSE	<4	<4	<5	0 - 15	EASILY PENETRATED WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
LOOSE	4 - 10	5 - 12	5 - 15	15 - 35	DIFFICULT TO PENETRATE WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
MEDIUM DENSE	10 - 30	12 - 35	15 - 40	35 - 65	EASILY PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
DENSE	30 - 50	35 - 60	40 - 70	65 - 85	DIFFICULT TO PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
VERY DENSE	>50	>60	>70	85 - 100	PENETRATED ONLY A FEW INCHES WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPT (blows/ft)	TORVANE UNTRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)	FIELD TEST
VERY SOFT	<2	<0.125	<0.25	EASILY PENETRATED SEVERAL INCHES BY THUMB. EXUDES BETWEEN THUMB AND FINGERS WHEN SQUEEZED BY HAND.
SOFT	2 - 4	0.125 - 0.25	0.25 - 0.5	EASILY PENETRATED ONE INCH BY THUMB. MOLDED BY LIGHT FINGER PRESSURE.
MEDIUM STIFF	4 - 8	0.25 - 0.5	0.5 - 1.0	PENETRATED OVER 1/2 INCH BY THUMB WITH MODERATE EFFORT. MOLDED BY STRONG FINGER PRESSURE.
STIFF	8 - 15	0.5 - 1.0	1.0 - 2.0	INDENTED ABOUT 1/2 INCH BY THUMB BUT PENETRATED ONLY WITH GREAT EFFORT.
VERY STIFF	15 - 30	1.0 - 2.0	2.0 - 4.0	READILY INDENTED BY THUMBNAIL.
HARD	>30	>2.0	>4.0	INDENTED WITH DIFFICULTY BY THUMBNAIL.

Rock Classification Should Include:
1. Rock name (or classification) 2. Color 3. Weathering 4. Fracturing 5. Competency 6. Additional comments indicating rock characteristics which might affect engineering properties

Weathering

Weathering	Field Test
Fresh	No visible sign of decomposition or discoloration. Rings under hammer impact.
Slightly Weathered	Slight discoloration inwards from open fractures, otherwise similar to Fresh.
Moderately Weathered	Discoloration throughout. Weaker minerals such as feldspar are decomposed. Strength somewhat less than fresh rock but cores cannot be broken by hand or scraped with a knife. Texture preserved.
Highly Weathered	Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with a knife. Core stones present in rock mass. Texture becoming indistinct but fabric preserved.
Completely Weathered	Minerals decomposed to soil but fabric and structure preserved. Specimens easily crumble or penetrated.

Fracturing

Spacing	Description
>6 ft	Very Widely
2-6 ft	Widely
8-24 in	Moderately
2 ½-8 in	Closely
¾-2 ½ in	Very Closely

Bedding of Sedimentary Rocks

Splitting Property	Thickness	Stratification
Massive	>4.0 ft	Very thick bedded
Blocky	2.0-4.0 ft	Thick-bedded
Slabby	2 ½-24 in	Thin-bedded
Flaggy	½-2 ½ in	Very thin-bedded
Shaly or platy	⅛ – ½ in	Laminated
Papery	< ⅛ in	Thinly laminated

RQD

RQD (%)	Rock Quality
90-100	Excellent
75-90	Good
50-75	Fair
25-50	Poor
0-25	Very Poor

Competency

Class	Strength	Field Test	Approximate Range of Unconfined Compressive Strength (tsf)
I	Extremely Strong	Many blows with geologic hammer required to break intact specimen.	>2000
II	Very Strong	Hand-held specimen breaks with pick end of hammer under more than one blow.	2000-1000
III	Strong	Cannot by scraped or peeled with knife, hand-held specimen can be broken with single moderate blow with pick end of hammer	1000-500
IV	Moderately Strong	Can just be scraped or peeled with knife. Indentations 1-3 mm show in specimen with moderate blow with pick end of hammer.	500-250
V	Weak	Material crumbles under moderate blow with pick end of hammer and can be peeled with a knife, but is hard to hand-trim for triaxial test specimen.	250-10
VI	Friable	Material crumbles in hand.	N/A

APPENDIX B

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

IGES
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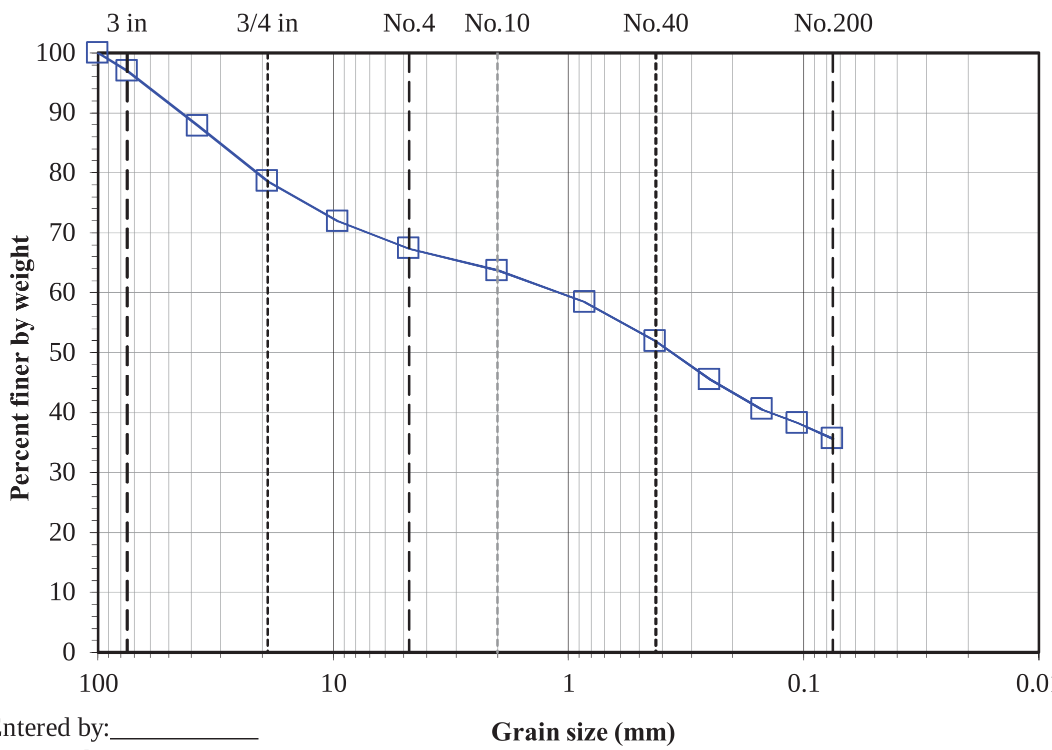
Project: Kleinfelter - Lot 79
No: 02904-001
Location: Powder Mountain, UT
Date: 9/21/2018
By: JWB

Boring No.: TP-1
Sample: 25
Depth: 7.5'
Description: Red clayey gravel with sand

Split:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	25238.70	24064.35
+3/8" Coarse fraction (g):	6797.00	6772.37
-3/8" Split fraction (g):	303.96	285.01
Split fraction:	0.719	

Water content data	C.F.(+3/8")	S.F.(-3/8")
Moist soil + tare (g):	3133.42	430.61
Dry soil + tare (g):	3123.20	411.66
Tare (g):	312.76	126.65
Water content (%):	0.4	6.6

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	100.0	
3"	727.75	75	97.0	
1.5"	2931.84	37.5	87.8	
3/4"	5152.46	19	78.6	
3/8"	6772.37	9.5	71.9	←Split
No.4	17.96	4.75	67.3	
No.10	32.60	2	63.6	
No.20	53.31	0.85	58.4	
No.40	79.13	0.425	51.9	
No.60	104.67	0.25	45.5	
No.100	124.30	0.15	40.5	
No.140	133.41	0.106	38.2	
No.200	143.59	0.075	35.7	



Gravel (%): 32.7
Sand (%): 31.7
Fines (%): 35.7

Entered by:___________
Reviewed:___________

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

© IGES 2009, 2018

Project: Kleinfelter - Lot 79
No: 02904-001
Location: Powder Mountain, UT
Date: 9/26/2018
By: EH

Boring No.: TP-1
Station: 25
Depth: 7.5'
Sample Description: Reddish brown sandy clay
Sample type: Arbitrary remold

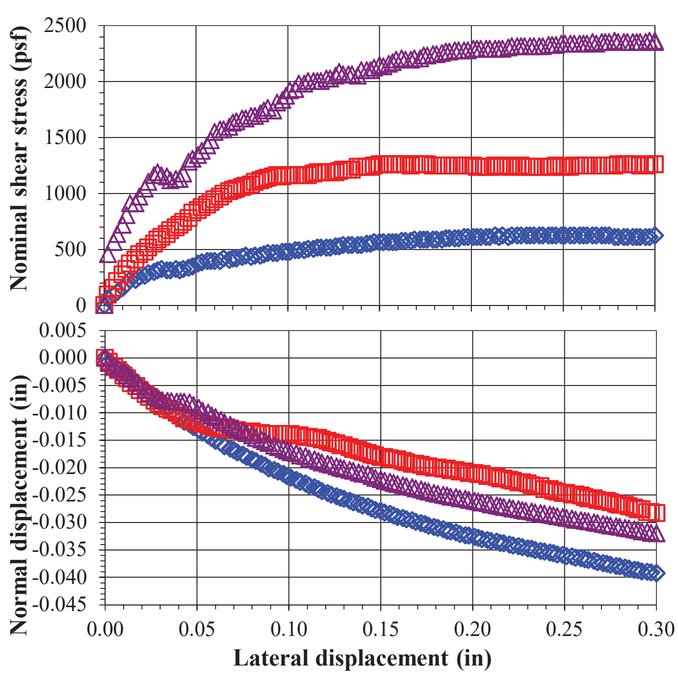
Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0010
Specific gravity, Gs: 2.70 Assumed

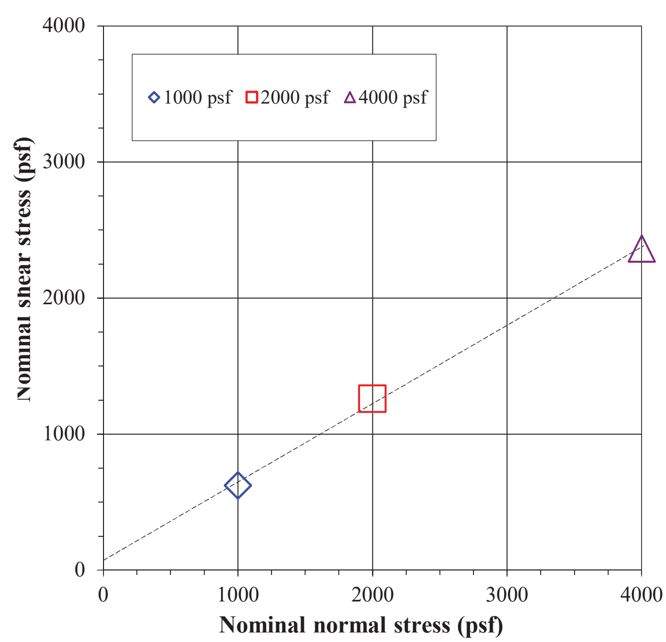
	Sample 1		Sample 2		Sample 3	
Nominal normal stress (psf)	1000		2000		4000	
Peak shear stress (psf)	624		1260		2364	
Lateral displacement at peak (in)	0.213		0.150		0.278	
Load Duration (min)	150		470		1280	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Sample height (in)	1.001	0.956	0.997	0.922	0.998	0.890
Sample diameter (in)	2.416	2.416	2.416	2.416	2.417	2.417
Wt. rings + wet soil (g)	176.12	192.18	175.01	188.71	175.23	186.47
Wt. rings (g)	45.98	45.98	45.20	45.20	45.21	45.21
Wet soil + tare (g)	281.56		281.56		281.56	
Dry soil + tare (g)	267.34		267.34		267.34	
Tare (g)	126.81		126.81		126.81	
Water content (%)	10.1	23.7	10.1	21.7	10.1	19.6
Dry unit weight (pcf)	98.1	102.7	98.3	106.2	98.2	110.1
Void ratio, e, for assumed Gs	0.72	0.64	0.72	0.59	0.72	0.53
Saturation (%)*	38.0	100.0	38.2	100.0	38.2	100.0

ϕ' (deg)	30
c' (psf)	72

Average of 3 samples	Initial	Pre-shear
Water content (%)	10.1	21.7
Dry unit weight (pcf)	98.2	106.3

*Pre-shear saturation set to 100% for phase calculations





Comments:
Test specimens remolded to estimated 90% of maximum dry unit weight at estimated optimum water content.

Entered by:___________
Reviewed:___________

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

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Project: Kleinfelter - Lot 79
No: 02904-001
Location: Powder Mountain, UT

Boring No.: TP-1
Station: 25
Depth: 7.5'

Nominal normal stress = 1000 psf			Nominal normal stress = 2000 psf			Nominal normal stress = 4000 psf		
Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)
0.000	0	0.000	0.000	0	0.000	0.000	0	0.000
0.002	60	-0.001	0.002	96	-0.001	0.002	456	-0.001
0.005	96	-0.001	0.005	156	-0.002	0.005	564	-0.001
0.007	120	-0.002	0.007	216	-0.002	0.007	636	-0.002
0.010	156	-0.002	0.010	276	-0.003	0.010	720	-0.003
0.012	192	-0.003	0.012	324	-0.004	0.012	804	-0.003
0.014	228	-0.004	0.014	372	-0.005	0.014	912	-0.004
0.017	228	-0.004	0.017	408	-0.005	0.017	912	-0.004
0.019	252	-0.005	0.019	456	-0.006	0.019	972	-0.005
0.022	264	-0.006	0.022	480	-0.007	0.022	1044	-0.006
0.024	288	-0.006	0.024	516	-0.007	0.024	1104	-0.006
0.027	300	-0.007	0.027	552	-0.008	0.027	1164	-0.007
0.029	312	-0.008	0.029	588	-0.008	0.029	1188	-0.007
0.031	324	-0.008	0.031	612	-0.009	0.031	1164	-0.008
0.034	312	-0.009	0.034	636	-0.009	0.034	1152	-0.008
0.036	312	-0.010	0.036	672	-0.010	0.036	1116	-0.008
0.039	324	-0.011	0.039	696	-0.010	0.039	1128	-0.008
0.041	312	-0.011	0.041	720	-0.011	0.041	1128	-0.008
0.043	324	-0.012	0.043	744	-0.011	0.043	1176	-0.008
0.046	336	-0.012	0.046	780	-0.011	0.046	1284	-0.008
0.048	348	-0.013	0.048	828	-0.012	0.048	1308	-0.009
0.051	372	-0.013	0.051	852	-0.012	0.051	1344	-0.009
0.053	384	-0.014	0.053	876	-0.012	0.053	1380	-0.010
0.056	396	-0.014	0.056	900	-0.012	0.056	1428	-0.010
0.058	396	-0.015	0.058	924	-0.012	0.058	1476	-0.011
0.060	396	-0.015	0.060	948	-0.013	0.060	1548	-0.011
0.063	396	-0.016	0.063	972	-0.013	0.063	1572	-0.011
0.065	420	-0.016	0.065	996	-0.013	0.065	1572	-0.012
0.068	408	-0.017	0.068	1020	-0.013	0.068	1596	-0.012
0.070	420	-0.017	0.070	1032	-0.013	0.070	1632	-0.013
0.072	420	-0.017	0.072	1044	-0.013	0.072	1644	-0.013
0.075	432	-0.018	0.075	1056	-0.013	0.075	1668	-0.013
0.077	444	-0.018	0.077	1068	-0.013	0.077	1668	-0.014
0.080	432	-0.019	0.080	1080	-0.013	0.080	1692	-0.014
0.082	444	-0.019	0.082	1104	-0.014	0.082	1692	-0.015
0.085	444	-0.019	0.085	1116	-0.014	0.085	1716	-0.015
0.087	456	-0.020	0.087	1128	-0.014	0.087	1740	-0.015
0.089	468	-0.020	0.089	1140	-0.014	0.089	1764	-0.016
0.092	468	-0.020	0.092	1152	-0.014	0.092	1740	-0.016
0.094	468	-0.021	0.094	1164	-0.014	0.094	1812	-0.016
0.097	480	-0.021	0.097	1152	-0.014	0.097	1836	-0.017
0.099	480	-0.022	0.099	1164	-0.014	0.099	1872	-0.017
0.101	480	-0.022	0.101	1164	-0.014	0.101	1920	-0.017
0.104	492	-0.022	0.104	1164	-0.014	0.104	1932	-0.017
0.106	492	-0.023	0.106	1164	-0.014	0.106	1980	-0.018
0.109	492	-0.023	0.109	1164	-0.014	0.109	1980	-0.018
0.111	504	-0.023	0.111	1164	-0.014	0.111	2004	-0.018
0.114	504	-0.024	0.114	1176	-0.015	0.114	2004	-0.019
0.116	516	-0.024	0.116	1188	-0.015	0.116	2004	-0.019
0.118	516	-0.024	0.118	1188	-0.015	0.118	2004	-0.019
0.121	516	-0.025	0.121	1188	-0.015	0.121	2028	-0.019
0.123	516	-0.025	0.123	1188	-0.015	0.123	2028	-0.020
0.126	528	-0.025	0.126	1188	-0.016	0.126	2052	-0.020
0.128	528	-0.026	0.128	1200	-0.016	0.128	2088	-0.020
0.130	540	-0.026	0.130	1212	-0.016	0.130	2064	-0.020
0.133	540	-0.026	0.133	1212	-0.016	0.133	2064	-0.020
0.135	540	-0.026	0.135	1212	-0.017	0.135	2064	-0.021
0.138	540	-0.027	0.138	1236	-0.017	0.138	2052	-0.021
0.140	540	-0.027	0.140	1236	-0.017	0.140	2100	-0.021
0.143	552	-0.027	0.143	1236	-0.017	0.143	2100	-0.021
0.145	552	-0.027	0.145	1236	-0.018	0.145	2100	-0.022
0.147	564	-0.028	0.147	1248	-0.018	0.147	2124	-0.022
0.150	564	-0.028	0.150	1260	-0.018	0.150	2148	-0.022
0.152	564	-0.028	0.152	1260	-0.018	0.152	2136	-0.022
0.155	564	-0.028	0.155	1260	-0.018	0.155	2160	-0.023

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

IGES

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Project: Kleinfelter - Lot 79
No: 02904-001
Location: Powder Mountain, UT

Boring No.: TP-1
Station: 25
Depth: 7.5'

Nominal normal stress = 1000 psf			Nominal normal stress = 2000 psf			Nominal normal stress = 4000 psf		
Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)
0.157	564	-0.029	0.157	1260	-0.019	0.157	2172	-0.023
0.159	564	-0.029	0.159	1260	-0.019	0.159	2196	-0.023
0.162	576	-0.029	0.162	1260	-0.019	0.162	2208	-0.023
0.164	576	-0.029	0.164	1260	-0.019	0.164	2196	-0.023
0.167	576	-0.030	0.167	1248	-0.019	0.167	2196	-0.024
0.169	588	-0.030	0.169	1260	-0.019	0.169	2208	-0.024
0.172	588	-0.030	0.172	1260	-0.020	0.172	2208	-0.024
0.174	588	-0.030	0.174	1260	-0.020	0.174	2232	-0.024
0.176	588	-0.031	0.176	1260	-0.020	0.176	2232	-0.024
0.179	588	-0.031	0.179	1248	-0.020	0.179	2244	-0.025
0.181	588	-0.031	0.181	1248	-0.020	0.181	2244	-0.025
0.184	588	-0.031	0.184	1248	-0.020	0.184	2256	-0.025
0.186	600	-0.032	0.186	1248	-0.020	0.186	2268	-0.025
0.188	600	-0.032	0.188	1248	-0.021	0.188	2268	-0.025
0.191	600	-0.032	0.191	1248	-0.021	0.191	2280	-0.025
0.193	600	-0.032	0.193	1248	-0.021	0.193	2280	-0.026
0.196	612	-0.032	0.196	1248	-0.021	0.196	2280	-0.026
0.198	612	-0.032	0.198	1248	-0.021	0.198	2280	-0.026
0.201	612	-0.033	0.201	1248	-0.021	0.201	2292	-0.026
0.203	612	-0.033	0.203	1236	-0.021	0.203	2292	-0.026
0.205	612	-0.033	0.205	1236	-0.021	0.205	2292	-0.026
0.208	612	-0.033	0.208	1236	-0.022	0.208	2292	-0.027
0.210	612	-0.033	0.210	1236	-0.022	0.210	2292	-0.027
0.213	624	-0.034	0.213	1248	-0.022	0.213	2292	-0.027
0.215	612	-0.034	0.215	1236	-0.022	0.215	2292	-0.027
0.217	624	-0.034	0.217	1248	-0.022	0.217	2292	-0.027
0.220	612	-0.034	0.220	1248	-0.022	0.220	2304	-0.027
0.222	624	-0.034	0.222	1236	-0.022	0.222	2316	-0.028
0.225	624	-0.034	0.225	1236	-0.023	0.225	2316	-0.028
0.227	624	-0.035	0.227	1248	-0.023	0.227	2316	-0.028
0.230	624	-0.035	0.230	1236	-0.023	0.229	2316	-0.028
0.232	624	-0.035	0.232	1236	-0.023	0.232	2316	-0.028
0.234	624	-0.035	0.234	1236	-0.023	0.234	2316	-0.028
0.237	624	-0.035	0.237	1236	-0.023	0.237	2316	-0.028
0.239	624	-0.035	0.239	1236	-0.024	0.239	2316	-0.028
0.242	624	-0.036	0.242	1236	-0.024	0.242	2328	-0.029
0.244	624	-0.036	0.244	1236	-0.024	0.244	2328	-0.029
0.246	624	-0.036	0.246	1248	-0.024	0.246	2328	-0.029
0.249	624	-0.036	0.249	1236	-0.025	0.249	2340	-0.029
0.251	624	-0.036	0.251	1236	-0.025	0.251	2340	-0.029
0.254	624	-0.036	0.254	1236	-0.025	0.254	2340	-0.029
0.256	624	-0.036	0.256	1248	-0.025	0.256	2340	-0.030
0.259	624	-0.037	0.259	1248	-0.025	0.259	2340	-0.030
0.261	624	-0.037	0.261	1248	-0.025	0.261	2340	-0.030
0.263	624	-0.037	0.263	1248	-0.026	0.263	2340	-0.030
0.266	624	-0.037	0.266	1248	-0.026	0.266	2352	-0.030
0.268	624	-0.037	0.268	1248	-0.026	0.268	2340	-0.030
0.271	624	-0.037	0.271	1248	-0.026	0.271	2352	-0.030
0.273	624	-0.038	0.273	1248	-0.026	0.273	2352	-0.030
0.275	624	-0.038	0.275	1248	-0.026	0.275	2352	-0.031
0.278	612	-0.038	0.278	1248	-0.027	0.278	2364	-0.031
0.280	612	-0.038	0.280	1260	-0.027	0.280	2352	-0.031
0.283	612	-0.038	0.283	1260	-0.027	0.283	2352	-0.031
0.285	612	-0.038	0.285	1260	-0.027	0.285	2352	-0.031
0.288	612	-0.039	0.288	1260	-0.027	0.288	2352	-0.031
0.290	612	-0.039	0.290	1260	-0.028	0.290	2352	-0.031
0.292	612	-0.039	0.292	1248	-0.028	0.292	2352	-0.032
0.295	612	-0.039	0.295	1248	-0.028	0.295	2352	-0.032
0.297	612	-0.039	0.297	1260	-0.028	0.297	2364	-0.032
0.300	624	-0.039	0.300	1260	-0.028	0.300	2364	-0.032
0.300	624	-0.039	0.300	1260	-0.028	0.300	2352	-0.032

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

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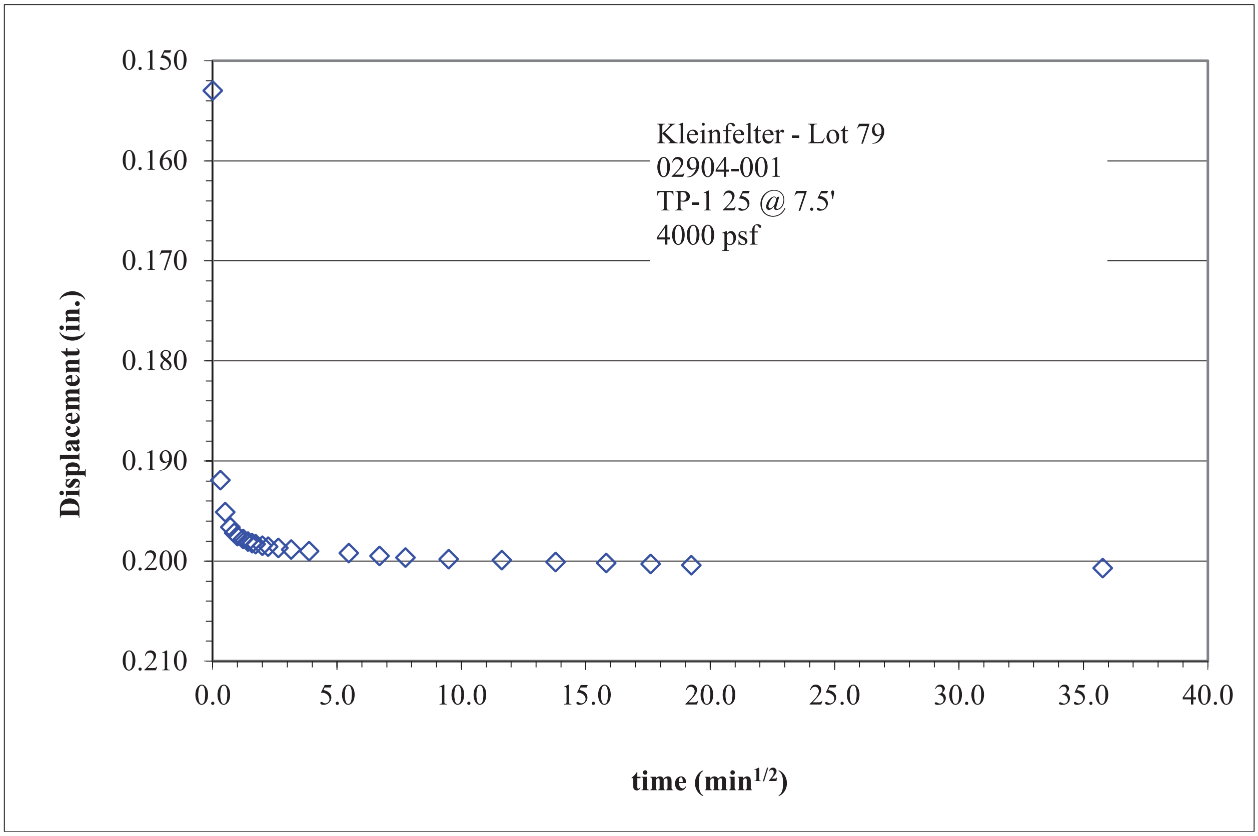
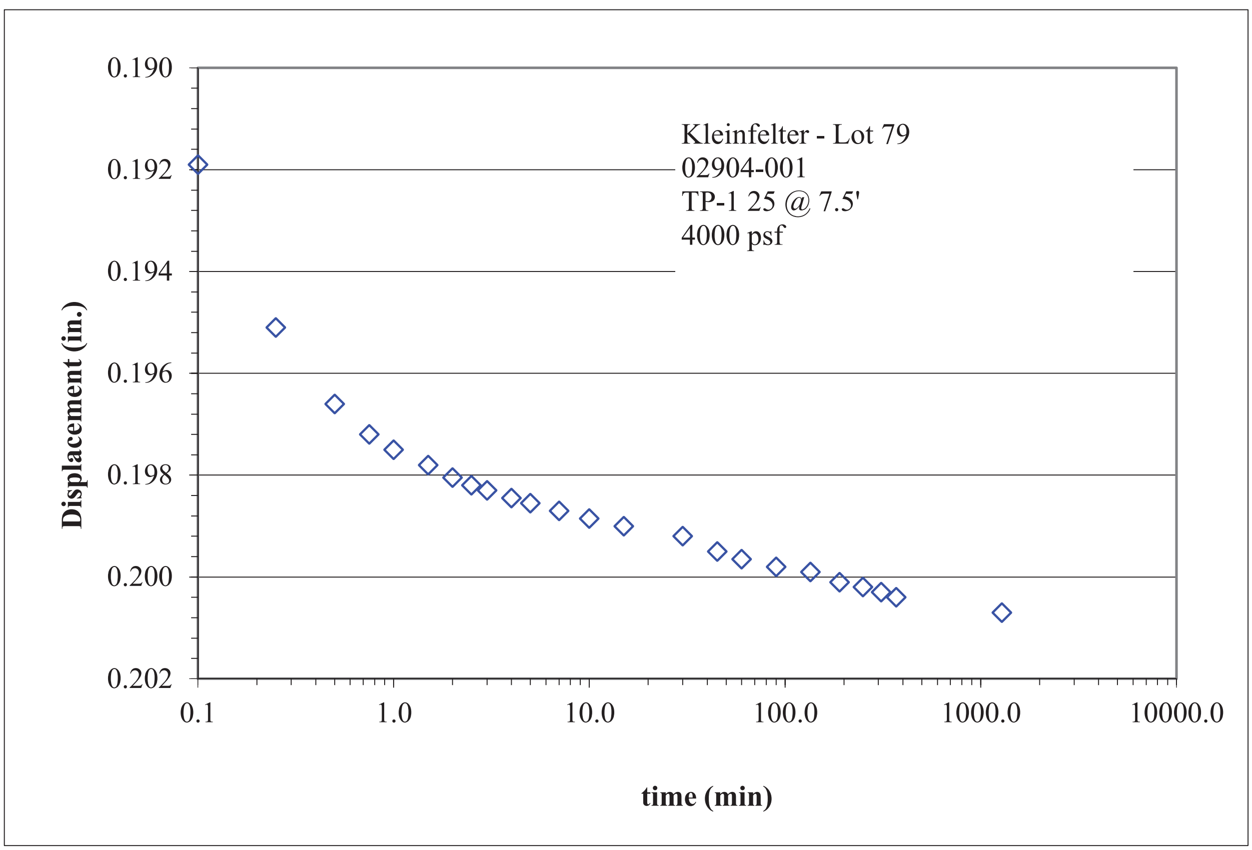
Project: Kleinfelter - Lot 79
No: 02904-001
Location: Powder Mountain, UT

Boring No.: TP-1
Station: 25
Depth: 7.5'





APPENDIX C

USGS Design Maps Summary Report

User–Specified Input

Report Title Lot 79R
Tue October 16, 2018 22:33:02 UTC

Building Code Reference Document 2012/2015 International Building Code
(which utilizes USGS hazard data available in 2008)

Site Coordinates 41.36249°N, 111.74733°W

Site Soil Classification Site Class C – "Very Dense Soil and Soft Rock"

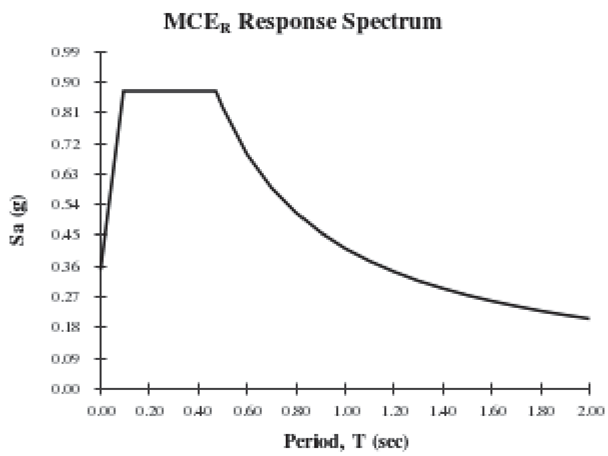
Risk Category I/II/III

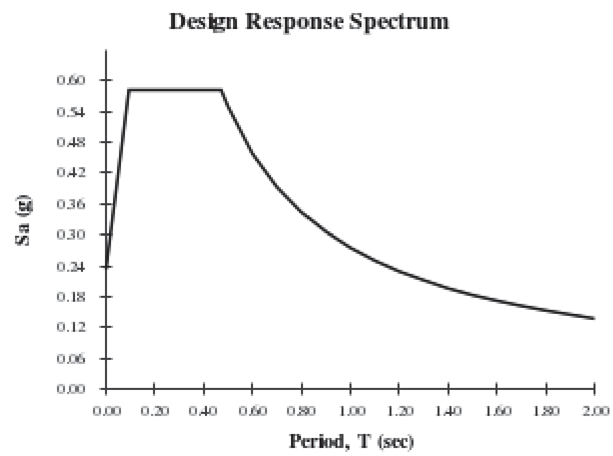
USGS–Provided Output

$S_S =$ 0.813 g $S_{MS} =$ 0.873 g $S_{DS} =$ 0.582 g

$S_1 =$ 0.269 g $S_{M1} =$ 0.412 g $S_{D1} =$ 0.275 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

Design Maps Detailed Report

2012/2015 International Building Code (41.36249°N, 111.74733°W)

Site Class C – "Very Dense Soil and Soft Rock", Risk Category I/II/III

Section 1613.3.1 — Mapped acceleration parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2012/2015 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.3.3.

From Figure 1613.3.1(1) [1]	S_S = 0.813 g
From Figure 1613.3.1(2) [2]	S_1 = 0.269 g

Section 1613.3.2 — Site class definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class C, based on the site soil properties in accordance with Section 1613.

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content *w* ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 1613.3.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a

Site Class	Mapped Spectral Response Acceleration at Short Period				
	$S_S \le 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = C and S_S = 0.813 g, F_a = 1.075

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v

Site Class	Mapped Spectral Response Acceleration at 1–s Period				
	$S_1 \le 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \ge 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = C and S_1 = 0.269 g, F_v = 1.531

Equation (16-37): $S_{MS} = F_aS_S = 1.075 \times 0.813 = 0.873$ g

Equation (16-38): $S_{M1} = F_vS_1 = 1.531 \times 0.269 = 0.412$ g

Section 1613.3.4 — Design spectral response acceleration parameters

Equation (16-39): $S_{DS} = ⅔\, S_{MS} = ⅔ \times 0.873 = 0.582$ g

Equation (16-40): $S_{D1} = ⅔\, S_{M1} = ⅔ \times 0.412 = 0.275$ g

Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 0.582 g, Seismic Design Category = D

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.275 g, Seismic Design Category = D

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

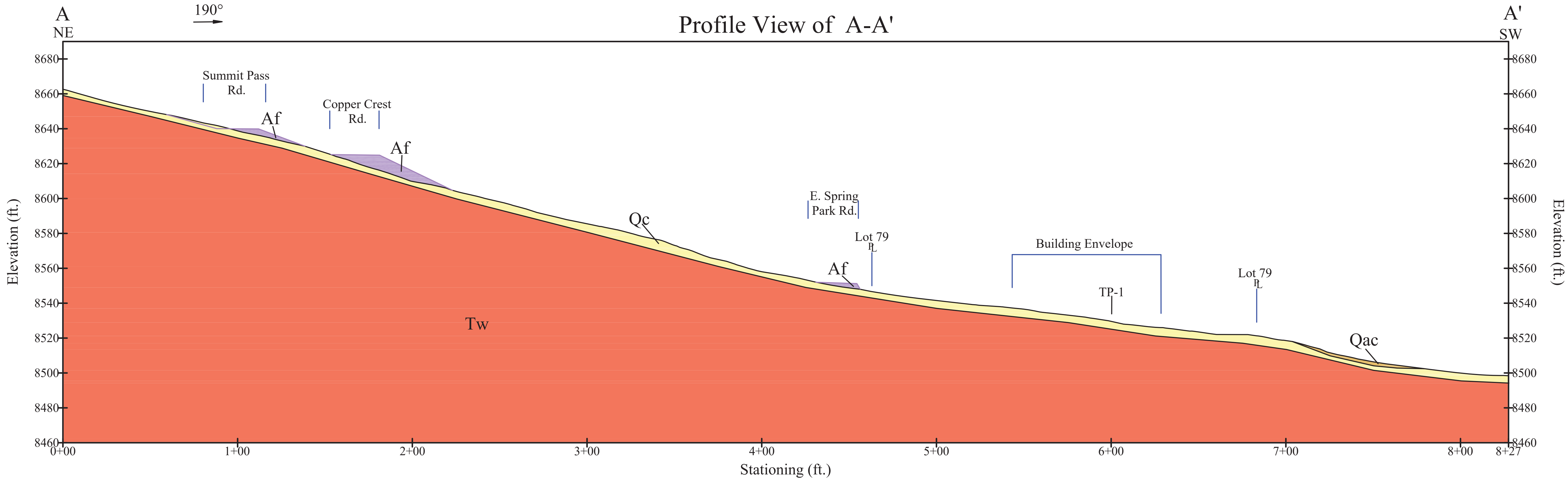
Seismic Design Category ≡ "the more severe design category in accordance with Table 1613.3.5(1) or 1613.3.5(2)" = D

Note: See Section 1613.3.5.1 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 1613.3.1(1)*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(1).pdf
2. *Figure 1613.3.1(2)*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(2).pdf

APPENDIX D



No Vertical Exaggeration

All Geologic Contacts Approximate

LEGEND

Af Artifical Fill

Qc Colluvium

Qac Alluvium and Colluvium

Tw Wasatch Formation

0 60 120
FEET

1"=60'

IGES®

Project No: 02904-001

Geotechnical and Geologic Hazard Investigation
Lot 79R of Summit Eden Phase 1C
Summit Powder Mountain Resort
Weber County, Utah

Cross Section

Figure D-1

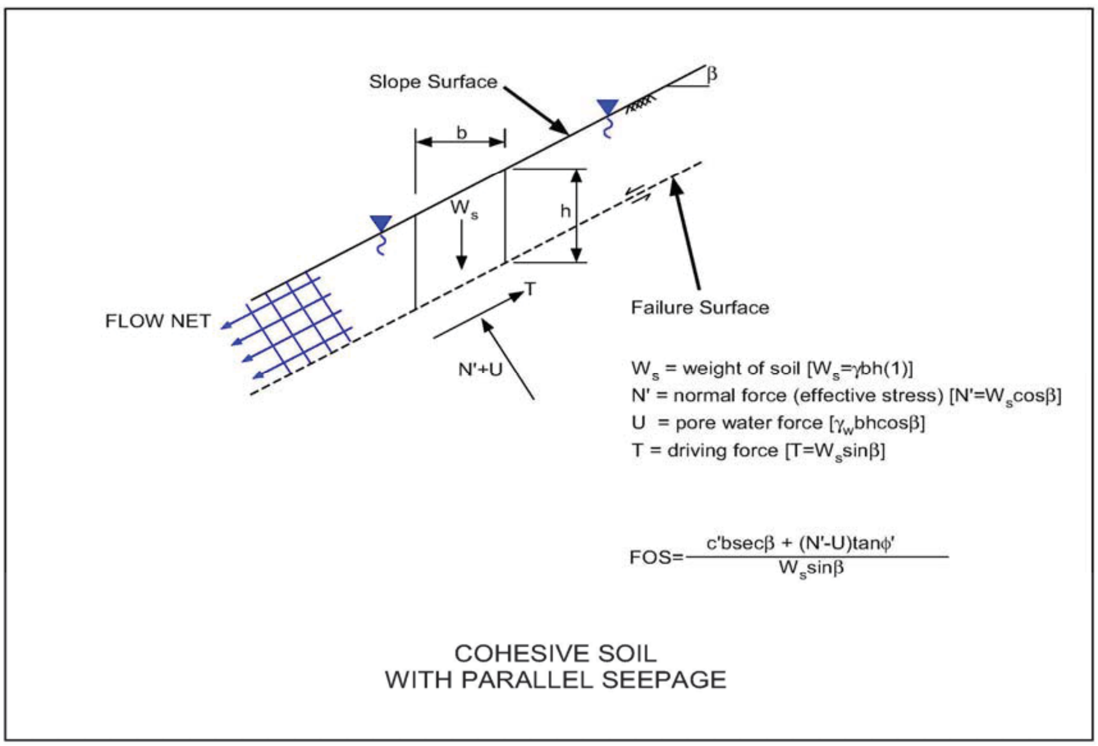
Klinefelter/Lot 79R
02904-01
10/30/2018

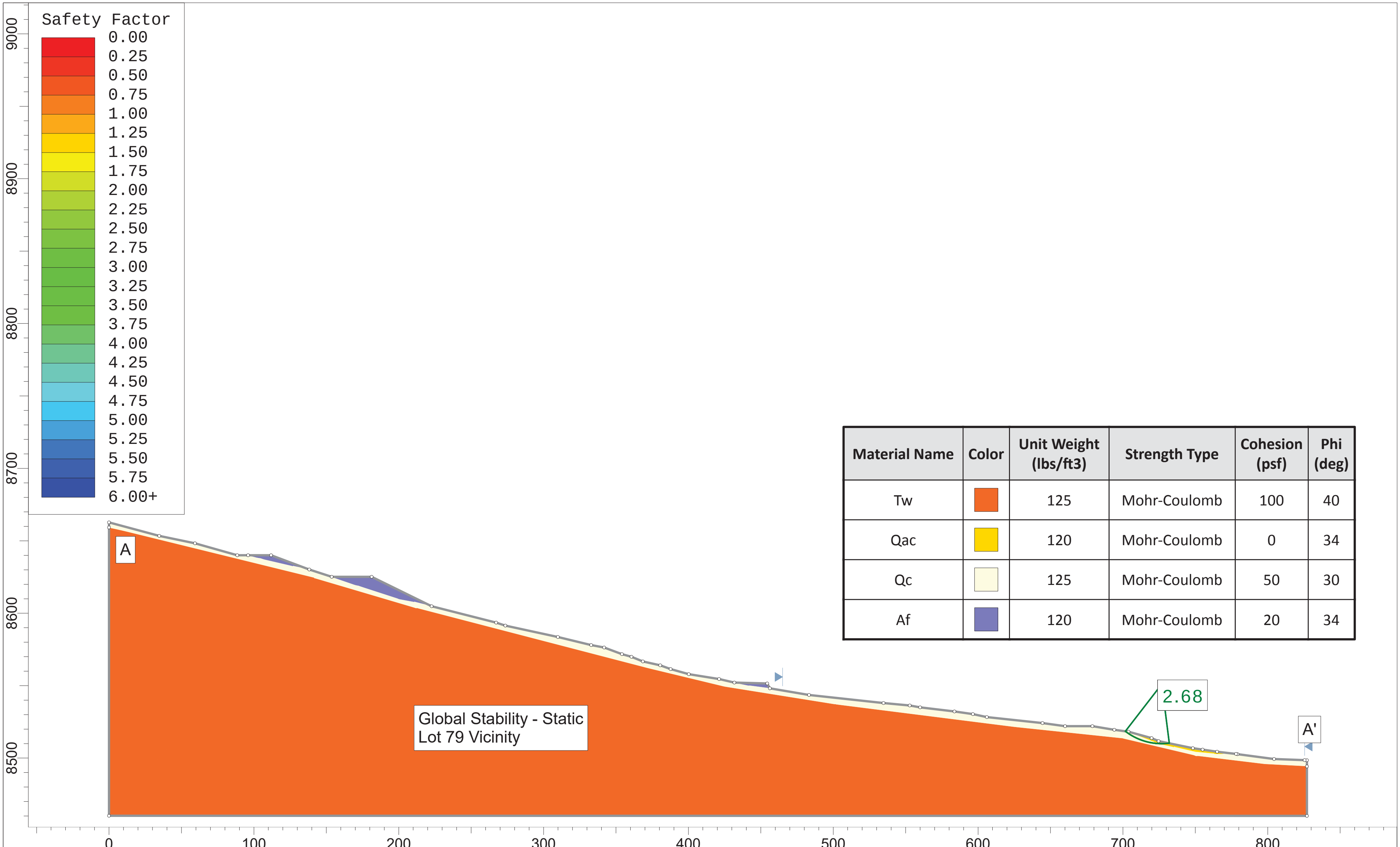
c'	50	psf	Effective Cohesion
ϕ'	30	deg	Effective Friction Angle
Y_{sat}	136	pcf	Saturated Unit Weight of Soil
Y_w	62.4	pcf	Unit weight of water
h	2	ft	Depth to shear surface
β	18.4	deg	Slope Gradient (3H:1V)

FS	1.55

(yellow)	Input Variable
(green)	Calculated Value

This model assumes c>0 and the face of the slope is saturated to depth h





Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Tw		125	Mohr-Coulomb	100	40
Qac		120	Mohr-Coulomb	0	34
Qc		125	Mohr-Coulomb	50	30
Af		120	Mohr-Coulomb	20	34

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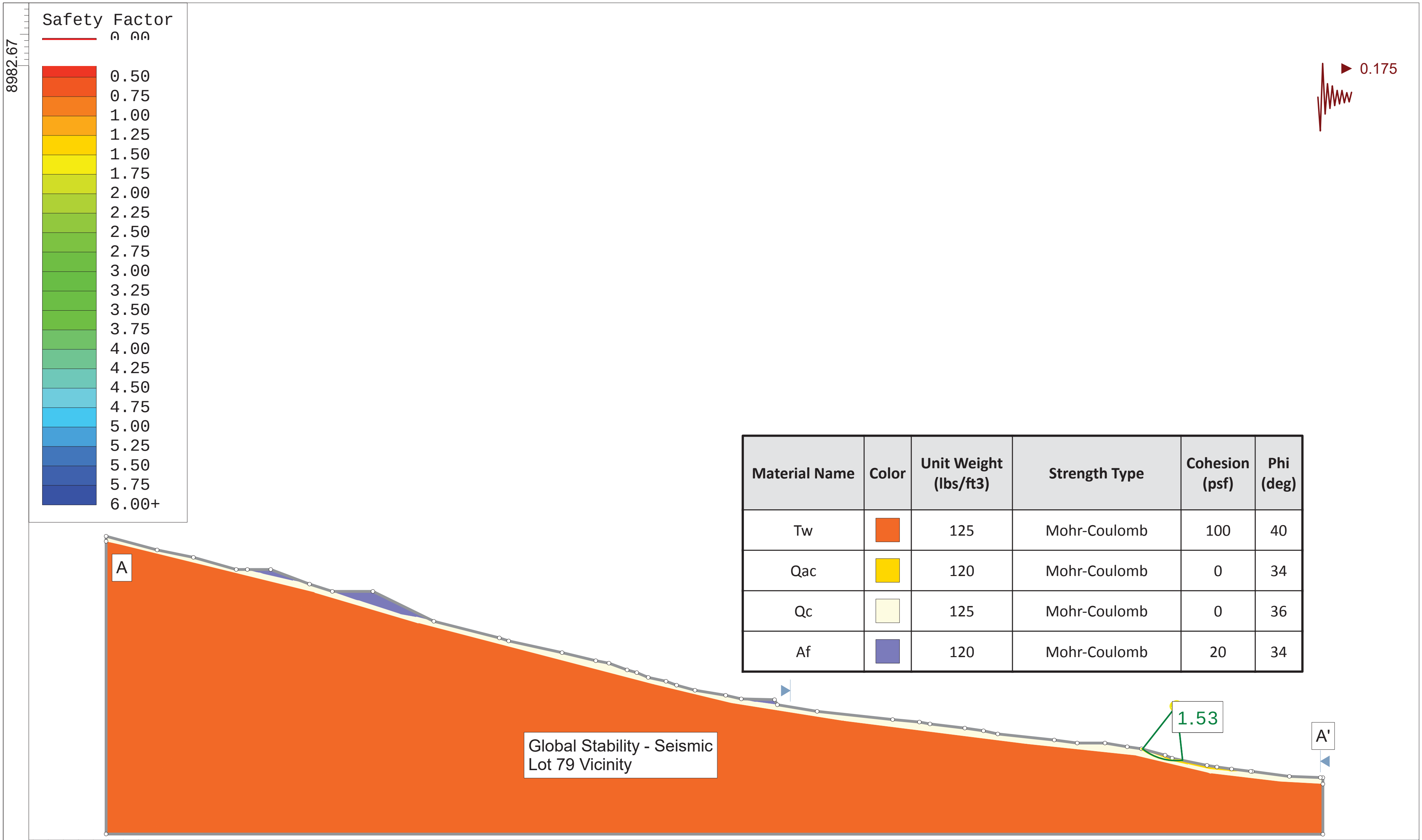
SLIDEINTERPRET 8.008

Project	Lot 79R of Summit Eden Phase 1C		
Analysis Description	A-A' 02904-001		
Drawn By EBF	*Scale* 1:1100	*Company*	IGES Inc
Date	10/30/2018	*File Name*	A-A'.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Tw		125	Mohr-Coulomb	100	40
Qac		120	Mohr-Coulomb	0	34
Qc		125	Mohr-Coulomb	0	36
Af		120	Mohr-Coulomb	20	34

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SLIDEINTERPRET 8.008

Project	Lot 79R of Summit Eden Phase 1C
Analysis Description	A-A' 02904-001
Drawn By	EBF
Scale	1:1
Company	IGES Inc
Date	10/30/2018
File Name	A-A'.slim