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Attn: Mr. Rick Everson

IGES Project No. 01628-012

Subject: Geologic Hazards Assessment
Phase 1E, 1F, and 1G and Adjacent Areas
Summit Powder Mountain Resort
Weber County, Utah

Mr. Everson:

This letter report presents the results of the geologic hazards investigation performed by Intermountain GeoEnvironmental Services, Inc. (IGES) for the Phase 1E, 1F, and 1G property, plus selected adjacent areas, as part of the greater Powder Mountain Resort development in Weber County, Utah (Figure A-1). The report identifies the nature and associated risk of the applicable geologic hazards associated with the property, based upon the results of the literature review, site reconnaissance, and subsurface investigation conducted as part of this assessment.

INTRODUCTION

The Summit Powder Mountain project consists of developing approximately 200 of 2,000 acres of lightly forested land just south of the existing Powder Mountain Ski Resort. Powder Mountain is undergoing a major expansion that will include golf courses, ski lifts, residential, and commercial property development. Site development will include site infrastructure such as roads and bridges, retaining structures, and associated underground utilities. IGES has previously completed a preliminary geotechnical investigation for the project as a whole (IGES, 2012), as well as provided recommendations and construction observation services for several individual structures currently being developed or in planning stages. IGES also recently completed a design-level geotechnical investigation of the Summit Eden Phase 1E, 1F, and 1G project area, which included rockery design and associated slope stability analysis (IGES, 2015a, 2015b).

The Phase 1E, 1F, and 1G project is proposed to be developed within approximately one mile south of the Powder Mountain Ski Resort in Weber County, Utah (see Figure A-1, *Site Vicinity Map*). It is our understanding that the proposed development will include six large estate lots (Lots 1R, 2R, 3R, 4R, 9R, and 10R) and associated infrastructure, including roadways and utilities, over an approximately 100-acre site. A geotechnical investigation covering these six lots and the associated roadway has been completed by IGES (2015a). As a part of this geologic hazard assessment, the study area has been expanded to include Lots 5R, 6R, and 119 (formerly Lots 7A and 7B) (see Figure A-5). The site is on a hillside with a natural gradient generally ranging between 3.5H:1V to 4H:1V; as such, access roads will be constructed with a series of cuts and fills, necessitating a series of cut slopes and fill slopes ranging in height up to 30 feet. Construction drawings prepared by NV5 illustrate a 20-foot tall, 3-tiered rockery near the entrance to the project area; this rockery is expected to have an area of roughly 10,000 square feet. The tallest rockery planned will have four tiers, accommodating a 30-foot grade change. In addition, seven smaller rockeries are planned along the private drives to accommodate access and installation of various utilities. The project area encompasses parts of the southwestern quarter of Section 6, and the northwestern quarter of Section 7, in Township 7 North, Range 2 East. The cumulative acreage for the project area is approximately 100 acres. The property is bound on all sides by undeveloped lands, though the northeastern part of the property abuts Horizon Run.

PURPOSE AND SCOPE

This study was performed as a site-specific geologic hazards assessment to identify any surficial or subsurface geologic hazards that may be extant on the property or have the capability to adversely impact the property. The study was conducted in response to the observation of landslide-indicative features in some of the test pits excavated for the recently completed geotechnical investigation on the property (IGES, 2015a). Specifically, this study was conducted to:

- Analyze the existing geologic conditions present on the property and relevant adjacent areas;
- Assess the geologic hazards that pose a risk to development across the property, and determine an associated risk for each hazard; and
- Identify the most significant geologic hazard risks, and provide recommendations for appropriate additional studies and/or mitigation practices, if necessary.
- Provide an assessment the geologic suitability of the property for development, based upon the findings of this investigation.

In order to achieve the purpose and scope outlined above, the following services were performed as part of this investigation:

- Review of available published geologic reports and maps for the subject property and surrounding areas;
- Stereoscopic review of aerial photographs and analysis of additional available aerial imagery;

- Site reconnaissance by an engineering geologist licensed in the state of Utah to map the surficial geology, determine site conditions, and assess the property for geologic hazards;

- Subsurface excavation and the logging and soil sampling of the trenches; plus index testing of representative soil samples to assist in soil classification;

- Preparation of this report, based upon the data reviewed and collected in this investigation.

REVIEW OF GEOLOGIC LITERATURE

A number of pertinent publications were reviewed as part of this investigation. Sorensen and Crittenden, Jr. (1979) provides 1:24,000 scale geologic mapping of the Huntsville Quadrangle, which is the only 1:24,000 scale mapping of the project area to date. Coogan and King (2001) provide more recent geologic mapping of the area, but at a 1:100,000 scale. 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. Western Geologic (2012) conducted a reconnaissance-level geologic hazard study for the greater 200-acre Powder Mountain expansion project, including the Phase 1E, 1F, and 1G area. 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). The corresponding United States Geological Survey (USGS) topographic map for the Huntsville Quadrangle (2014) provides 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 Utah Geological Survey (UGS), 2006), was reviewed to identify the location of proximal faults that have had associated Quaternary-aged displacement. The geotechnical investigation for the greater Powder Mountain property performed by IGES (2012), as well as the recently completed geotechnical investigation for the Phase 1E, 1F, and 1G property (IGES, 2015a) were reviewed in detail to provide an understanding of the nature of the subsurface materials at the site and to assist in the geologic mapping of the potential landslide hazard areas.

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.

General Geologic Setting

The Phase 1E, 1F, and 1G property is located 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 all 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 Phase 1E, 1F, and 1G property is located approximately 8.5 miles to the east 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).

The property is underlain by Cambrian bedrock which comprise the upper plate of the Willard Thrust (Sorensen and Crittenden, Jr., 1979), and comprise an allocthonous[1] block of rock that has been transported eastward to its present location from the Cordilleran geosyncline[2] (Stokes, 1987). The Willard Thrust is believed to connect and be structurally continuous with the Charleston-Nebo Thrust, which passes through the Salt Lake Valley and beneath Strawberry Reservoir, with the two thrusts connecting near Antelope Island (Stokes, 1987).

Surficial Geology

Several extant geologic maps cover the Phase 1E, 1F, and 1G property. Sorensen and Crittenden, Jr. (1979) provides the most detailed mapping of the general geology of the area, and serves as the base map for the *Regional Geologic Map 1* shown in Figure A-2. According to Sorensen and Crittenden, Jr. (1979), the property is largely underlain by several Cambrian

[1] Allocthonous: Formed or produced elsewhere than in its present place; of foreign origin, or introduced. (AGI, 2005)

[2] Geoysncline: As originally defined, a mobile downwarping of the crust of the Earth, either elongate or basinlike, measured in scores of kilometers, in which sedimentary and volcanic rocks accumulate to thicknesses of thousands of meters. (AGI, 2005)

sedimentary bedrock units, with the easternmost portion of the property mantled with undifferentiated Holocene colluvium, slopewash, and landslide deposits. The Cambrian bedrock units are mapped as striking to the northwest and dipping between 15 and 35 degrees to the northeast, and as such increase in age as one passes from east to west across the property. From youngest to oldest, these bedrock units include the Worm Creek Quartzite Member (Csw) of the St. Charles Limestone, the Nounan Dolomite (Cn), the Calls Fort Shale Member of the Bloomington Formation (Cbc), and undivided Cambrian limestones (Clu), including the Limestone and Hodges Shale Members of the Bloomington Formation, the Blacksmith Limestone, and the Ute Limestone. Collective thicknesses of these units may be approximately 4,000 feet, whereas the undifferentiated Holocene sediments (Qcs-Qls) found near the eastern margin of the property may be collectively as much as 118 feet thick (Sorensen and Crittenden, Jr., 1979).

The younger sediments found on the eastern portion of the property represent the western margin of a large body of undifferentiated mass-movement deposits that extend over ¾ mile to the east of the property (Sorensen and Crittenden, Jr., 1979). Another large lobe of these undifferentiated mass-movement deposits encroaches the northern margin of the property and extends approximately ½ mile to the north. Both of these bodies of mass-movement deposits had their contacts further delineated by Coogan and King (2001, 2016) and Western Geologic (2012) in subsequent mapping efforts. Across the Phase 1E, 1F, and 1G property, the Coogan and King (2001, 2016) and Western Geologic (2012) outline of these deposits are largely consistent with one another. Coogan and King (2016) updated their 2001 map by differentiating the previously-mapped mass-movement deposits into individual landslide deposits. These are 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" (Coogan and King, 2016). Coogan and King (2001, 2016) also separate the undifferentiated Cambrian bedrock on the western portion of the property into the Hodges Shale Member of the Bloomington Formation, the Blacksmith Dolomite, the Ute Formation, and the Langston Dolomite. Figure A-3 is *Regional Geology Map 2*, based upon the Western Geologic (2012) mapping effort, while Figure A-4 is *Regional Geology Map 3*, based upon the most recent mapping across the property (Coogan and King, 2016).

Whereas Sorensen and Crittenden, Jr. (1979) display a series of older (pre-Tertiary), northwest-southeast trending normal faults that offset Cambrian bedrock between approximately 0.6 and 0.8 miles to the west of the property (Figure A-2), the same faults are mapped as thrust faults by Coogan and King (2001, 2016 (Figure A-4)). Both Sorensen and Crittenden, Jr. (1979) and Coogan and King (2001) map a pre-Tertiary northwest-trending normal fault, downdropped to the west, at the head of Goertsen Canyon approximately one mile southeast of the property. Coogan and King (2016) show this fault as extending to the northwest to approximately 0.15 miles south of the property. Additionally, Coogan and King (2016) show another northwest-trending bedrock normal fault, downdropped to the east, passing through the westernmost portion of the property (Figure A-4).

Hydrology

The USGS topographic map for the Huntsville Quadrangle shows that the Phase 1E, 1F, and 1G project area generally consists of highlands that are straddled by the South Fork Wolf Creek drainage to the west and an unnamed ephemeral stream drainage to the south. Both drainages flow to the southwest, with the unnamed drainage joining the South Wolf Creek drainage approximately ¾ of a mile to the southwest of the property. Streamflow from these drainages ultimately adjoin the Odgen River and empties into the Pineview Reservoir, located approximately 5.25 miles to the southwest of the property.

On the property, two small ephemeral stream drainages are found. The larger of the two drainages runs generally north-south along the easternmost portion of the property, while the smaller drainage passes generally north-south through the middle of the property. No springs have been noted on or adjacent to the property.

Groundwater depths for the property are currently unknown, but are anticipated to fluctuate both seasonally and annually. The recently completed geotechnical investigation of the property completed in the June of 2015 (IGES, 2015a) did not encounter groundwater in any of the test pits, and groundwater was not encountered in any of the trenches excavated as part of this geologic hazard assessment.

Geologic Hazards

Based upon the available geologic literature, regional-scale geologic hazard maps that cover the Phase 1E, 1F, and 1G 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 and other geologic hazard maps and literature.

Landslides

As discussed above, Sorensen and Crittenden, Jr. (1979) show the easternmost portion and some of the northern margin of the Phase 1E, 1F, and 1G property to contain mass-movement deposits that include shallow landslide deposits. Colton (1991) maps the outline of these deposits largely consistent with Sorensen and Crittenden, Jr. (1979), and shows the direction of slide movement for the eastern deposits to be to the south. The more detailed contact for these deposits originally mapped by Coogan and King (2001) was also used by Elliott and Harty (2010), who mapped these deposits as "landslide undifferentiated from talus and/or colluvial deposits." Western Geologic (2012; Figure A-3) maintains the same contact outline and description for these deposits along the eastern and northern portion of the property as Coogan and King (2001). Coogan and King (2016) maintain the same contact outline for these deposits, but identify them distinctly as landslide deposits (Figure A-4).

The recent IGES geotechnical investigation of the property (IGES, 2015a) noted "chaotic, jumbled soil" in three of the 16 test pits excavated (TP-01, TP-06, and TP-14), which may be associated with landslide deposits. Two (TP-06 and TP-14) of the three test pits with this description were excavated near the southern margin of the property, while TP-01 was located in the easternmost portion of the property in the area mapped as potential landslide deposits. Notably, two additional test pits (TP-12 and TP-13) were excavated in the area mapped as potential landslide deposits, but “chaotic, jumbled soil” was not noted in either of these test pits.

Faults

According to the Weber County Code of Ordinances, an active fault is defined as “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). Because surface-fault-rupture hazards are only associated with active faults, it is imperative that the precise locations of active faults are known. Christenson and Shaw (2008a) show that the property is not located within a surface-fault-rupture *special study area.* As noted above, there are several inactive, pre-Tertiary bedrock faults within several miles of the property. The Quaternary Fault and Fold Database of the United States (USGS and UGS, 2006) shows four Quaternary-aged faults to be located within 5 miles of the property. This includes three faults with ages of less than 130,000 years (the James Peak Fault, located approximately 3.5 miles to the northwest of the property, the Broadmouth Canyon Faults, located approximately 4 miles to the west of the property, and the East Cache Fault Zone, located approximately 3.75 miles to the north of the property) and one fault with an age of less than 1.6 million years (the Ogden Valley Northeastern Margin Fault, located approximately 2 miles to the south of the property).

No active faults have currently been mapped on the property. The closest active fault to the property is the Weber Segment of the Wasatch Fault, located approximately 8.5 miles to the west of the property (USGS and UGS, 2006).

Debris-Flows

Christensen and Shaw (2008b) do not show the project area to be located within a debris-flow hazard special study area. No additional maps have been produced to document the debris-flow hazard associated with the property, though the description by Coogan and King (2001) for the mapped mass-movement deposits on the easternmost portion of the property include the possibility that some of the material was deposited by way of debris-flows.

Liquefaction

Christenson and Shaw (2008c) and Anderson, et al. (1994) show the project area to be within a zone of very low potential for liquefaction hazards.

REVIEW OF AERIAL IMAGERY

A series of aerial photographs covering the Phase 1E, 1F, and 1G project area were taken from the UGS Aerial Imagery Collection (UGS, 2016) and analyzed stereoscopically for the presence of adverse geologic conditions across the property. This included a review of photos collected from the years 1947, 1953, and 1963. A table displaying the details of the aerial photographs reviewed can be found in the *References* section of this report.

No geologic lineaments or fault scarps were observed in the aerial photography. However, a large curvilinear feature approximately 400 feet wide was seen to pass northwest to southeast through the western portion of the property where bedrock does not appear to be exposed at the surface. Upon referencing the geologic maps covering the property, it was noted that this feature corresponds to the mapped Calls Fort Shale Member of the Bloomington Formation, a slope-forming geologic unit and is therefore not a potential landslide feature. This was confirmed during the site reconnaissance and field mapping.

The middle of the property was observed to have irregularly knobby, though not necessarily hummocky, topography. Test pits excavated in this vicinity in the geotechnical investigation for the property (IGES, 2015a) suggest that this irregular topography is more a product of the erosion of the carbonate bedrock than small, shallow, localized landslide deposits. Additionally, a small curvilinear feature potentially indicative of a landslide headscarp was noted approximately 400 feet to the southeast of the southeastern property margin. This feature is located within an area mapped as Nounan Dolomite.

Google Earth imagery of the property from between the years of 1993 and 2015 were also reviewed. Light-colored, near-surface bedrock was readily observed over much of the property in the more recent images, though the older images display an increased expression of the near-surface bedrock, especially in the west-central portion of the property. Surficial bedrock expression was observed to be limited in the eastern one-third of the property, especially in a northwest to southeast-trending swath of land that is fairly well-vegetated, and passes immediately east of Lot 4.

No LiDAR data for the project area was readily available to be reviewed at the time of this report.

SITE RECONNAISSANCE

Mr. Peter E. Doumit, P.G., C.P.G., of IGES conducted reconnaissance of the site and the immediate adjacent properties between June 21 and June 29, 2016. 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 Phase 1E, 1F, and 1G property and adjacent areas.

In general, variously-sized boulders and cobbles were found scattered across the property, as part of a surficial geologic unit considered to be either weathered Wasatch Formation or colluvial deposits derived from weathered Wasatch Formation. These were typically subangular to subrounded, and were found to be as large as two feet in diameter. The rock clasts were found to be comprised predominantly of pink to purple massive to banded to conglomeratic quartzite, though in some areas angular clasts of Cambrian-aged dolomitic bedrock were observed as part of the colluvial detritus.

Much of the property was observed to be densely vegetated with aspen trees, grasses, or low-lying bushes, some of which showed evidence of downslope soil creep. The southern and western portion of the property exhibited common outcrops of Cambrian bedrock, which included outcrops of several different formations (see Figure A-5). No springs or hydrophilic plants indicative of shallow groundwater conditions were observed across the property, despite the site reconnaissance taking place near expected peak groundwater levels. The eastern and southeastern portions of the property contained the most irregular topography and surficial features potentially indicative of landsliding, and these areas were subsequently investigated with subsurface excavations.

Eight different lithologic units were observed on the surface during the site reconnaissance, while an additional unit was observed only in a road cut:

Qcq: Quaternary-aged (Holocene to Pleistocene) colluvial deposits derived from weathered Wasatch Formation. This unit was the most prevalent across the property, and consisted entirely of subrounded to subangular quartzite cobbles and boulders up to several feet in diameter.

Qcb: Quaternary-aged (Holocene to Pleistocene) colluvial deposits derived from both weathered Wasatch Formation and weathered Cambrian bedrock outcrops. This unit was generally found between Cambrian bedrock outcrops and Wasatch Formation-only derived colluvial deposits in the middle portion of the property, and was also observed downslope (south) of Cambrian bedrock outcrops in the southern and western portions of the property. It consisted of a combination of cobbles and boulders of subrounded quartzite and angular limestone and dolomite up to several feet in diameter.

Qls: Quaternary-aged (Holocene to Pleistocene) landslide deposits. This unit was observed in the eastern and southeastern portions of the property, coinciding with irregular, hummocky topography and occasional small sag ponds. In some areas, small headscarps could be delineated. The unit was found to be predominantly associated with the Qcq and Qcb unit lithologies, and did not appear to involve large blocks of Cambrian bedrock units.

Tw: Tertiary-aged (Eocene to Paleocene) Wasatch Formation. This unit was observed on the ridge to the northeast of the property, and was the formation from which the quartzite boulders of the colluvial units were derived. The unit is a reddish-brown conglomerate bedrock with subrounded quartzite cobbles and boulders that commonly weathers to a sandy gravel. As such, the unit was not exposed in outcrop but rather was identified by way of its surficial weathering. It was distinguished from the Qcq unit in that it has a higher sand component and the matrix has a reddish hue.

Csd: Cambrian-aged Dolomite Member of the St. Charles Limestone. This unit was observed as a sliver of outcrop found immediately north of Horizon Run northeast of the property. The unit was a light gray to pinkish orange thickly bedded sparry, sandy dolomite. Though the unit also exhibited blocky jointing, the unit weathered with rounded edges.

Csw: Cambrian-aged Worm Creek Quartzite Member of the St. Charles Limestone. This unit was observed as a sliver of outcrop immediately north of Horizon Run northeast of the property, and along Horizon Run at the northeastern property margin. The unit was a dark gray calcareous sandstone gradational to sandy dolomite with thin shaley beds, and appeared similar in appearance to the underlying Nounan Dolomite (unit Cn).

Cn: Cambrian-aged Nounan Dolomite. This unit was observed in outcrops across much of the eastern half of the property. The unit was a thinly to thickly bedded medium gray to dark gray sparry to finely sparry sandy dolomite and limestone. In outcrop, the unit commonly exhibited blocky jointing and weathered to a light gray color. The unit also was found to contain beds of white to very light gray coarsely sparry dolomite and light bluish gray, highly etched sparry limestone in places.

Cbc: Cambrian-aged Calls Fort Shale Member of the Bloomington Formation. This slope-forming unit was found in the southern portion of the property, and consisted of a greenish gray, thinly bedded, calcareous silty shale. It was only exposed in outcrop where roads for the geotechnical test pits had uncovered the hillside, and therefore was covered on the surface by the Qcb unit.

Cbm: Cambrian-aged Middle Limestone Member of the Bloomington Formation. This unit was observed to outcrop in the southwestern portion of the property, and typically consisted of a dark gray, mottled, thickly bedded, finely sparry to micritic limestone with some thin shaley interbeds.

Because landslide and potential landslide features were observed during the site reconnaissance, it was determined that subsurface excavations were necessary to assess the landslide hazard risk associated with the property.

SUBSURFACE INVESTIGATION

Between September 21 and September 26, 2016, seven exploration trenches were excavated at representative locations across the property, where potential landslide hazards had been identified during the site reconnaissance and field mapping (Figure A-5). The trenches were excavated to depths ranging between 10 and 15 feet below existing grade with the aid of a Caterpillar 315C tracked excavator. Detailed logs for each of the trenches are displayed in Figures A-6 through A-12. Shallow Cambrian bedrock was encountered in all seven trenches between the depths of 4 and 9 feet below existing grade, and refusal was noted in all trenches except TR-2. Groundwater was not encountered in any of the test pits. Evidence of mass-movement was observed in only TR-1 and TR-2. In general, the subsurface profile consisted of topsoil forming upon colluvial units, which was underlain by Cambrian bedrock that was commonly highly weathered at the colluvium/bedrock interface. The following geologic units were encountered in the subsurface in the exploration trenches:

A/B Soil Horizon: This topsoil unit was found to be between 1 and 3 feet thick. The unit consisted of loose to medium-stiff, slightly moist to moist, dark brown to grayish brown lean CLAY with gravel (CL) that contained abundant plant and tree roots. Most of the gravel clasts encountered were quartzite, though some dolomite bedrock clasts were encountered in this unit in TR-2, TR-4, TR-6, and TR-7. Topsoil was the matrix to the loose colluvial unit seen at the surface in TP-5. The topsoil was typically found to be forming upon an underlying colluvium unit.

Quartzite Colluvium (Qcq): This unit was found to be underlying the topsoil in TR-2 and TR-3. The unit was between 1 and 2 feet thick, and consisted of a medium-stiff to loose, moist to slightly moist, dark brown to light brown lean CLAY with gravel (CL) gradational to clayey GRAVEL (GC). Gravel and larger-sized subrounded to subangular quartzite clasts comprised between 30% and 75% of the unit, with individual clasts up to 10 inches in diameter, though the mode clast size was 3 to 4 inches. Pinhole voids 1 to 2 mm in diameter were observed in TR-2. Plant and tree roots were common within the unit.

Bedrock Colluvium (Qcb): This unit was found to be underlying the Qcq unit in TR-3, underlying the topsoil in TR-4, and at the surface and associated with the topsoil in TR-5, TR-6, and TR-7. The unit was between 1 and 6 feet thick, and consisted of loose to very stiff, slightly moist, dark brown lean CLAY with gravel (CL) gradational to clayey GRAVEL (GC). Gravel and larger-sized clasts consisted of a combination of both quartzite and dolomite bedrock, and comprised between 25% and 60% of the unit, with individual clasts up to 1 foot in diameter.

Shallow Landslide (Qls): This unit was found to be underlying the topsoil unit in TR-1 and possibly TR-2. The unit was between 1 and 3 feet thick, and consisted of stiff to very stiff, dry, light brown lean CLAY with gravel (CL). Gravel and larger-sized clasts consisted entirely of subrounded to subangular quartzite, which comprised between 25% and 30% of the unit, with individual clasts up to 6 inches in diameter. Pinhole voids between 1 and 2 mm in diameter were abundant within the unit. The unit appeared similar to a cemented colluvial unit observed in other trenches on Powder Mountain, with the exception that this unit has a distinct slide plane immediately underlying it.

Wasatch Formation? (Tw): This unit was observed only in TR-2 underlying the Qcq unit and in contact with weathered and largely unweathered Nounan Dolomite bedrock. The unit was between 5 and 7 feet thick, and consisted of a medium dense, moist, dark reddish brown clayey SAND (SC) with gravel gradational to sandy fat CLAY with gravel (CH). Gravel and larger-sized clasts comprised between 25% and 30% of the unit, and consisted of a combination of quartzite and dolomite up to 2.5 feet in diameter. The unit is queried in that it appeared very similar to the Wasatch Formation in color and USCS classification; however, the Wasatch Formation doesn’t typically contain dolomite clasts, and the unit was found to have an odd semi-vertical contact with the Nounan Dolomite.

Nounan Dolomite (Cn): This unit was observed in all seven of the exploration trenches, and extended in thickness beyond the depths of exploration. The unit typically contained several feet of highly weathered and oxidized dolomite bedrock overlying the in-situ bedrock. In one instance (TR-1), a paleosol was developed within the highly-weathered bedrock. The bedrock was a thinly bedded to massive, sparry to finely sparry, dark gray to bluish gray sandy dolomite that commonly weathered to a fine sand. Though heavily jointed with blocky jointing, many individual blocks were hard to very hard.

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 affecting 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 are the results of the geologic hazard assessment for the Phase 1E, 1F, and 1G property.

Landslides/Mass Movement

Landslide deposits have been mapped across the easternmost portion and northern margin of the property (Coogan and King, 2016; Western Geologic, 2012). Site reconnaissance of these areas as part of this investigation did not observe clear evidence of landsliding in these areas (scarps, hummocky topography, etc.), though uneven ground and small slope breaks were observed. The subsequent trenching performed as part of this investigation was intended to further define this landslide area. All seven trenches were spotted in locations that were considered to be potential landslide areas, based upon the site reconnaissance. However, subsurface evidence of mass-movement was only encountered in trenches TR-1 and TR-2, and the nature of the mass-movement appeared to be different in these two trenches.

In TR-1, a slickensided slide plane clay was present that had formed on the top of the weathered bedrock, dipping downslope to the southwest at approximately 16 degrees. A jumbled, shallow landslide unit was found overlying the slide plane. In TR-2, a similar, though wavy, non-planar slickensided clay was found overlying the dolomite bedrock. The nature of the surface and associated shear gave the indication of soil creep, though an odd semi-vertical contact between the bedrock and possibly the Wasatch Formation was also observed. This contact is interpreted to be depositional in nature, as a large quartzite boulder and Wasatch-like material was observed below both the slickensided clay and a weathered dolomite lens that was continuous with the bedrock (see Figure A-7). This suggests that the boulder and Wasatch-like material was originally deposited under an overhang of bedrock that subsequently weathered, and post-depositional soil creep has ensued.

Given that there are no prominent surficial features indicative of landsliding in the TR-1 and TR-2 area, the mass-movement deposits associated with these two trenches is considered to be Pleistocene in age. The approximate trace of the area affected by these deposits is exhibited in Figure A-5. The deposits are indicative of shallow and not deep-seated landsliding, affecting only up to approximately 10 feet below the existing grade. Additionally, because the deposits appear different in TR-1 and TR-2, it is likely that they represent distinct, localized events that have been highly modified. This is evidenced by a lack of geomorphic expression at the surface, and multiple feet of topsoil/colluvial cover present in these areas.

Additional landslide deposits were observed along the southern margin and just south of the southern margin of the property during the site reconnaissance (see Figure A-5). The trace of these deposits is far enough south as to not impact any of the proposed development, and these appear to be shallow slides similar to what was encountered in TR-1 and TR-2.

Given this data, the risk associated with landslide and slope stability hazards on the property is considered to be low for all areas and lots outside of the landslide outlines shown on Figure A-5, and moderate for all areas and lots located inside the landslide outlines – this finding primarily impacts Lot 6R and Lot 119, and potentially Lot 5R, Lot 8, and other lots east of the property.

Rockfall

Bedrock outcrops are found at a number of places across the property, though these outcrops largely do not extend more than 10 feet above the ground surface, and in most cases are weathering out at ground level. Additionally, bedrock blocks that have weathered off the outcrops were not observed to have been transported downslope more than approximately 50 feet. Given this data, the rockfall hazard associated with most of the property is considered to be low. The rockfall hazard is considered to be low to moderate for only those limited parts of the property immediately downslope of an outcrop.

Surface-Fault-Rupture and Earthquake-Related Hazards

A single bedrock fault (inactive) has been mapped on the property, passing through the southwestern portion of the property (Figure A-4; Coogan and King, 2016). The closest active fault to the property is the Weber Segment of the Wasatch Fault Zone, located approximately 8.5 miles to the west 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.

Liquefaction

The site is underlain by several different Cambrian bedrock units comprised of hard dolomite and limestone. Bedrock units such as these are not considered susceptible to liquefaction; as such, the potential for liquefaction occurring at the site is considered low.

Debris-Flows and Flooding Hazards

The property is located near the top of the ridge that drains to the south and into the South Fork of the Wolf Creek drainage, and the property is not located adjacent to any active drainages. Though several small ephemeral drainages are present on the property, the lots are not located within or adjacent to these drainages. Given these conditions, the debris-flow and flooding hazards associated with the property are considered to be low.

Shallow Groundwater

Groundwater was not encountered in any of the 16 test pits excavated as part of the geotechnical investigation (IGES, 2015), nor in the 7 trenches excavated as part of this investigation. Additionally, no springs, ponds, or hydrophilic plants indicative of shallow groundwater conditions were observed on the property during the site reconnaissance.

It is expected that groundwater levels will fluctuate both seasonally and annually; however, given the existing data, the risk associated with shallow groundwater hazards is considered low.

CONCLUSIONS AND RECOMMENDATIONS

Based upon the data collected and reviewed as part of this assessment, IGES makes the following conclusions regarding the geological hazards present at the Phase 1E, 1F, and 1G project area:

- **The Phase 1E, 1F, and 1G project appears to have geological hazards that could potentially adversely affect a portion of the development as currently proposed. Geological hazards in the form of landslides and other mass-movement processes, including soil creep, are capable of adversely affecting the lots in the northeastern part of the property. IGES concludes, however, that the geologic conditions are such that appropriate mitigation practices (discussed in the recommendations outlined below) can reduce the level of landslide/mass movement hazard risk to an acceptable level for development.**

- Landslide hazards are considered to be moderate for Lots 5R, 6R, 119, and 9R. This designation is based upon the presence of shallow landslide and/or soil creep features and associated shearing observed in TR-1 and TR-2, and the unknown northwestern extent of these deposits. Landslide hazards are considered to be low for the remaining lots on the property, including Lots 1R, 2R, 3R, 4R, and 10R.

- The preexisting landslide appears to be stable based on the current location of the slide, estimated soil strengths, current and proposed grades, and limit equilibrium slope stability analysis performed for the proposed development (IGES, 2015b). Anticipated grading (construction of homes with basements, moderate cuts and fills for grading around the homes, etc.) is not expected to alter the stability of the slope in a meaningful way. The primary concern for slope instability would be for highly localized ground movement associated with the older, concealed surficial landslide deposits identified in TR-1 and TR-2 – this primarily impacts Lots 5R, 6R, Lot 119, and potentially Lot 9R. However, this hazard can be mitigated with proper excavation and grading within the building footprint. Consequently, **the site is considered suitable for the proposed development, provided the recommendations presented in the following paragraphs are followed.**

- Earthquake ground shaking is the only hazard that may potentially affect all parts of the project area and is considered to pose moderate risk, while other hazards have the potential to affect only limited portions of the project area, or pose minimal risk.

- Rockfall hazards are considered to be low to moderate for Lot 1R, and low for all other lots on the property.

- Surface-fault-rupture, liquefaction, debris-flow, flooding, and shallow groundwater hazards are considered to be low for the property.

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

- The recommendations provided in the IGES geotechnical report (2015a) and rockery design submittal (2015b) should be followed for all proposed development on the subject property, except as amended herein. As a result of the additional subsurface exploration conducted for this report, the referenced geotechnical report may be considered to encompass Lots 5R, 6R, and 119 (these three lots were not a part of the original scope in 2015).

- For those areas identified as having moderate landslide risk, overexcavation of the landslide deposits and through the slide/shear zones to competent earth materials must occur preceding the emplacement of footings. In these areas, conventional spread footings are to be founded upon competent earth materials or appropriately compacted structural fill that immediately overlies the competent bedrock. The overexcavation must extend over the entire building footprint (not just the footings), and should extend a minimum of four feet beyond the exterior foundations.

- For Lot 1R, to reduce the rockfall hazard risk to low, an earthen berm or rock wall approximately 3 feet high is recommended on the north side of the proposed structure.

- Because landslide deposits are noted on and near the property, an IGES geologist should observe the foundation excavations to assess the removal of potentially hazardous landslide deposits and to observe that the foundation footprint has been excavated down to competent, stable earth materials.

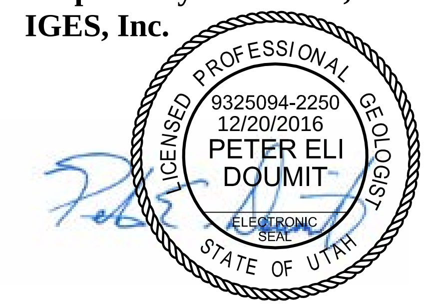
LIMITATIONS

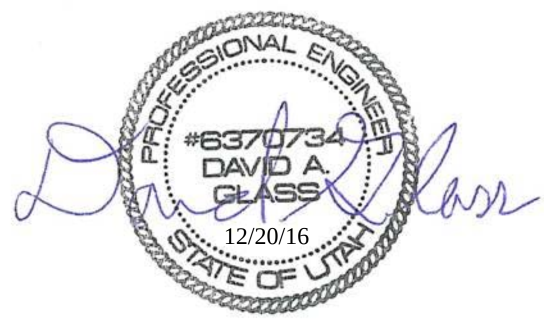
The conclusions and recommendations presented in this report are based on limited geologic literature review, site reconnaissance, subsurface investigation, and our understanding of the proposed construction. It should be noted that construction activities may expose adverse geologic conditions that were hitherto unknown. Therefore, the geologic hazard classifications as denoted in this report are potentially subject to change with data collected from additional excavations across the property. This report was prepared in accordance with the generally accepted standard of practice at the time the report was written. No warranty, expressed or implied, is made.

CLOSURE

We appreciate the opportunity to provide you with our services. If you have any questions, please contact the undersigned at your convenience at (801) 748-4044.

Respectfully Submitted,
IGES, Inc.





Peter E. Doumit, P.G., C.P.G.
Senior Geologist

David A. Glass, P.E.
Senior Geotechnical Engineer

Attachments:

References

Appendix A	Figure A-1	Site Vicinity Map
	Figure A-2	Regional Geology Map 1
	Figure A-3	Regional Geology Map 2
	Figure A-4	Regional Geology Map 3
	Figure A-5	Local Geology Map
	Figures A-6 to A-12	Trench Logs

Appendix B Laboratory Results

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AERIAL PHOTOGRAPHS

Data Set	Date	Flight	Photographs	Scale
1947 AAJ	August 10, 1946	AAJ_1B	88-90	1:20,000
1947 AAJ	August 10, 1946	AAJ_2B	34-35	1:20,000
1953 AAI	September 14, 1952	AAI_3K	130-131	1:20,000
1953 AAI	September 14, 1952	AAI_4K	34-36	1:20,000
1963 ELK	June 25, 1963	ELK_2	202-203	1:15,840
1963 ELK	June 25, 1963	ELK_3	57-59	1:15,840

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

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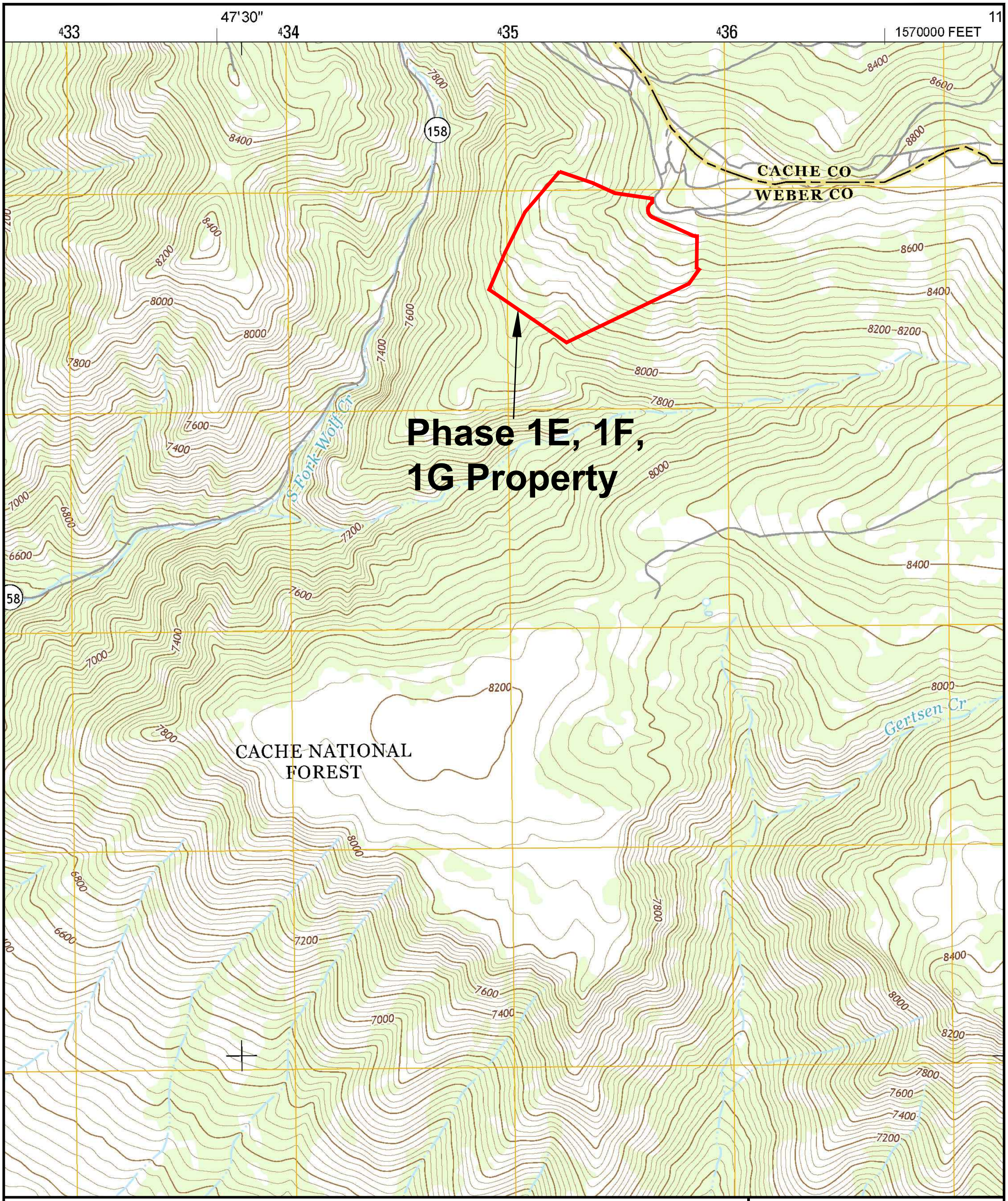
APPENDIX A



BASE MAP:

-USGS Huntsville 7.5-Minute Topographic Quadrangle Map (2014)

FIGURE A-1

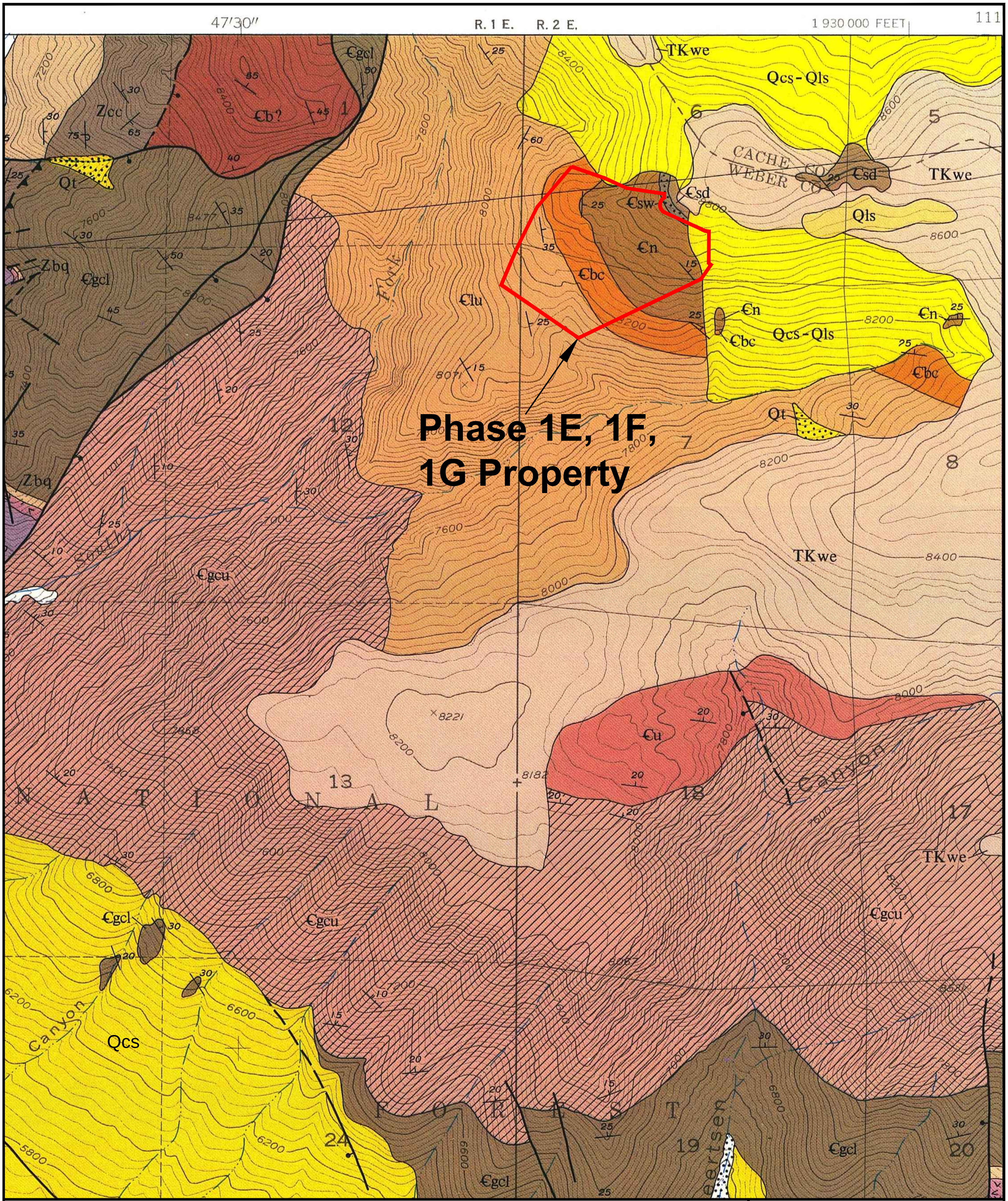
SITE VICINITY MAP

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/30/2016 | SCALE: 1"=2,000'
PROJECT:01628-012

IGES



BASE MAP:

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

UTAH

QUADRANGLE LOCATION

N

0 1000 2000 3000

FEET

FIGURE A-2a

REGIONAL GEOLOGY MAP 1

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/30/2016
PROJECT:01628–012
SCALE: 1"=2,000'
IGES

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

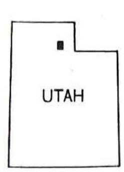
Ꞓsw Worm Creek Quartzite Member – Thin-bedded, fine- to medium-grained, medium- to dark-gray, tan- to brown-weathering calcareous quartzitic sandstone; detrital grains well-sorted and well-rounded; thickness 6 m

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

BASE MAP:

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



QUADRANGLE LOCATION

N

0 1000 2000 3000

FEET

FIGURE A-2b

REGIONAL GEOLOGY MAP 1

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/30/2016
PROJECT:01628–012
SCALE: 1"=2,000'
IGES

MAP LEGEND

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

Ꞓu 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

GEERTSEN CANYON QUARTZITE (Lower Cambrian) – Includes:

Ꞓgcu 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

Ꞓgcl 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

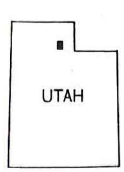
Recently active normal fault – Dashed where inferred. Ticks on downthrown side

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

Thrust fault – Dashed where inferred Sawteeth on upper plate

BASE MAP:

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



QUADRANGLE LOCATION

N

0 1000 2000 3000
FEET

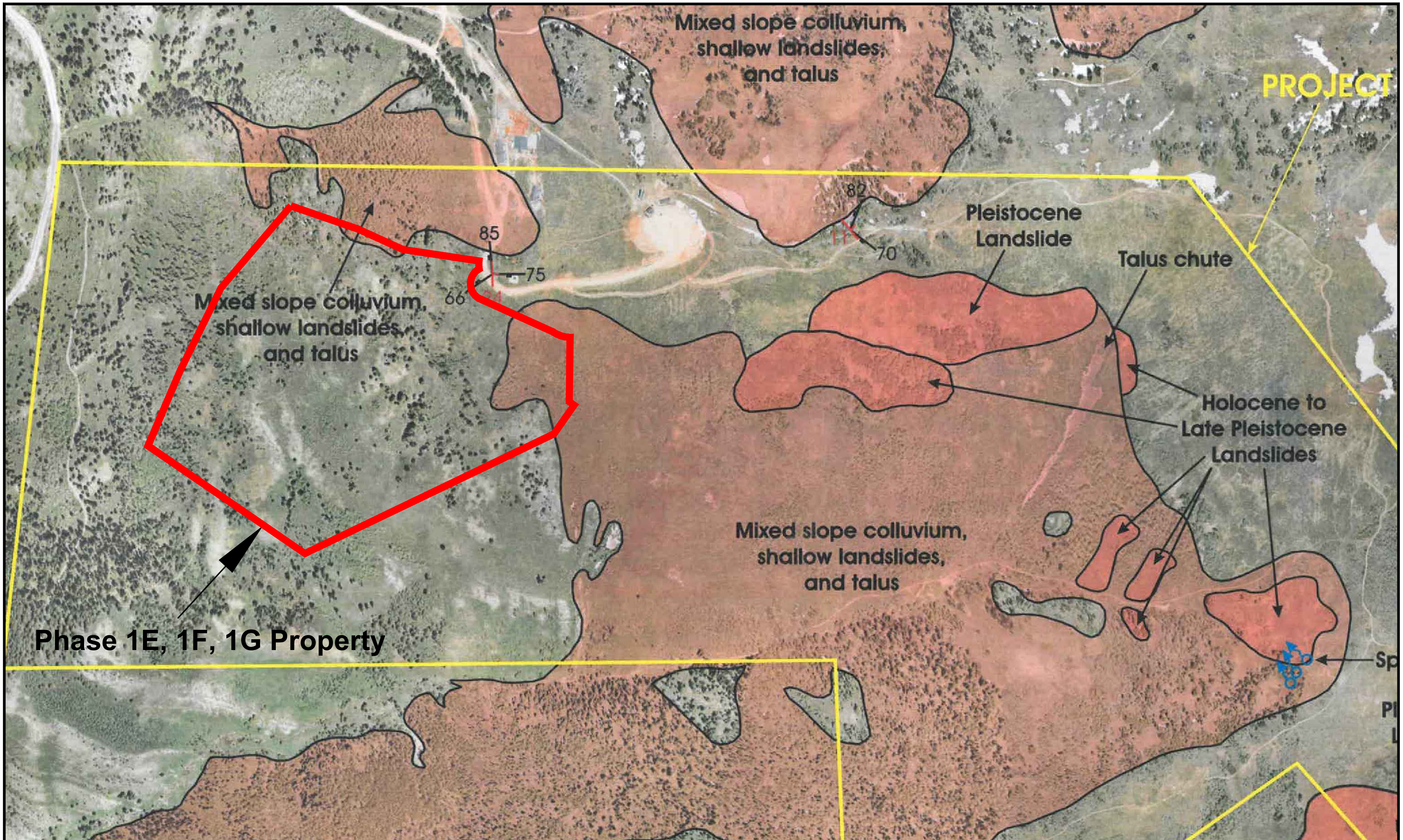
FIGURE A-2c

REGIONAL GEOLOGY MAP 1

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/30/2016
PROJECT:01628–012
SCALE: 1"=2,000'
IGES



BASE MAP:

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

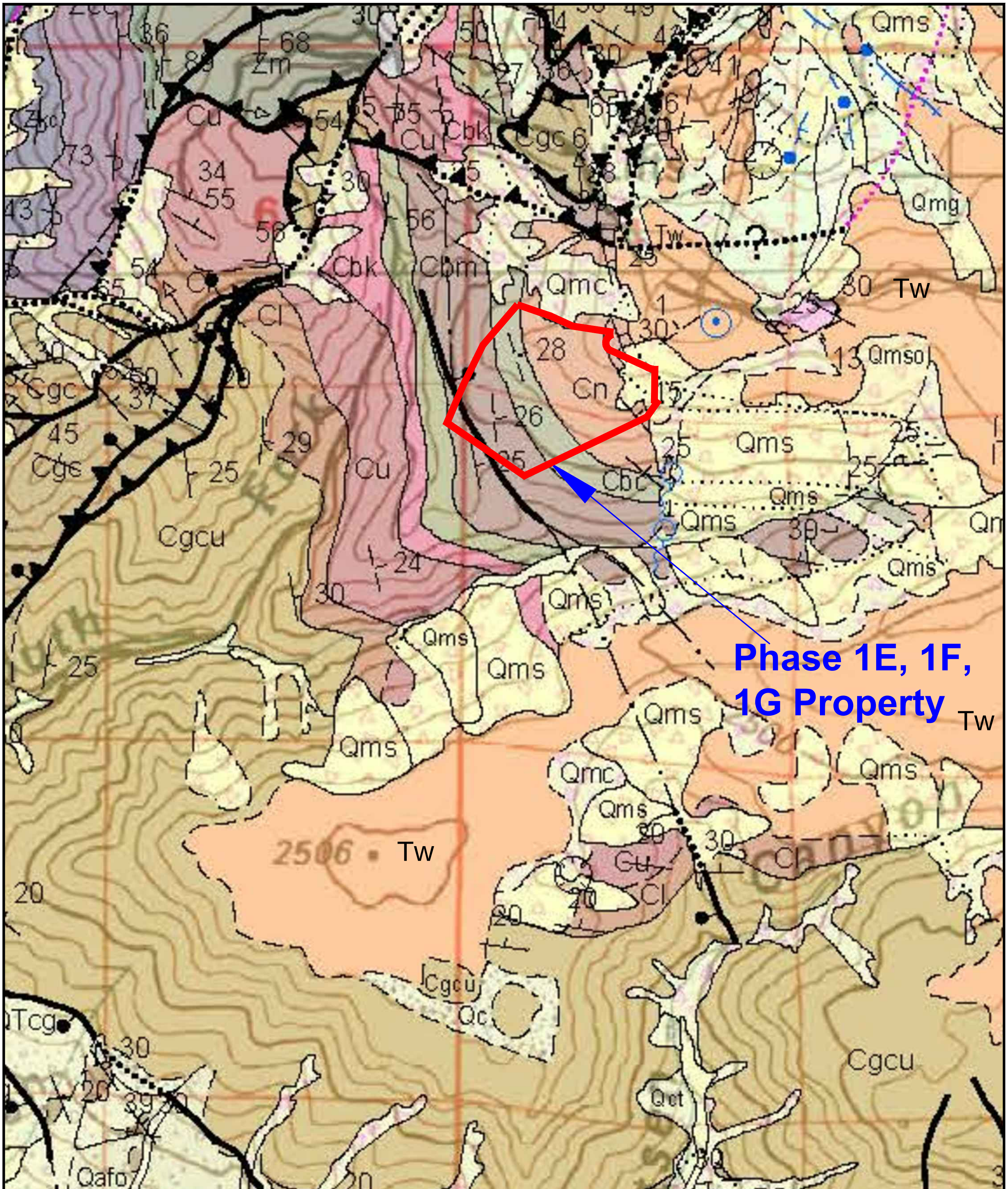
FIGURE A-3

REGIONAL GEOLOGY MAP 2

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT AT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/30/2016
PROJECT:01628-012
SCALE: 1"=1,000'
IGES



BASE MAP:

-Utah Geological Survey
Ogden 30' x 60' Geologic Quadrangle
Map (OFR-653DM, Plate 1),
Coogan and King (2016)

UTAH

QUADRANGLE LOCATION

N

0 1000 2000 3000

FEET

FIGURE A-4a

REGIONAL GEOLOGY MAP 3

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/30/2016
PROJECT:01628–012
SCALE: 1"=2,000'
IGES

MAP LEGEND

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).

Qms, Qms?, Qmsy, Qmsy?, Qmso, Qmso?

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

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

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.

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

BASE MAPS:

-Utah Geological Survey
Ogden 30' x 60' Geologic Quadrangle Map (OFR-653DM, Plate 1), Coogan and King (2016)

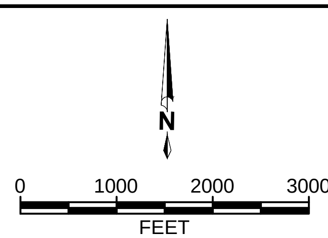


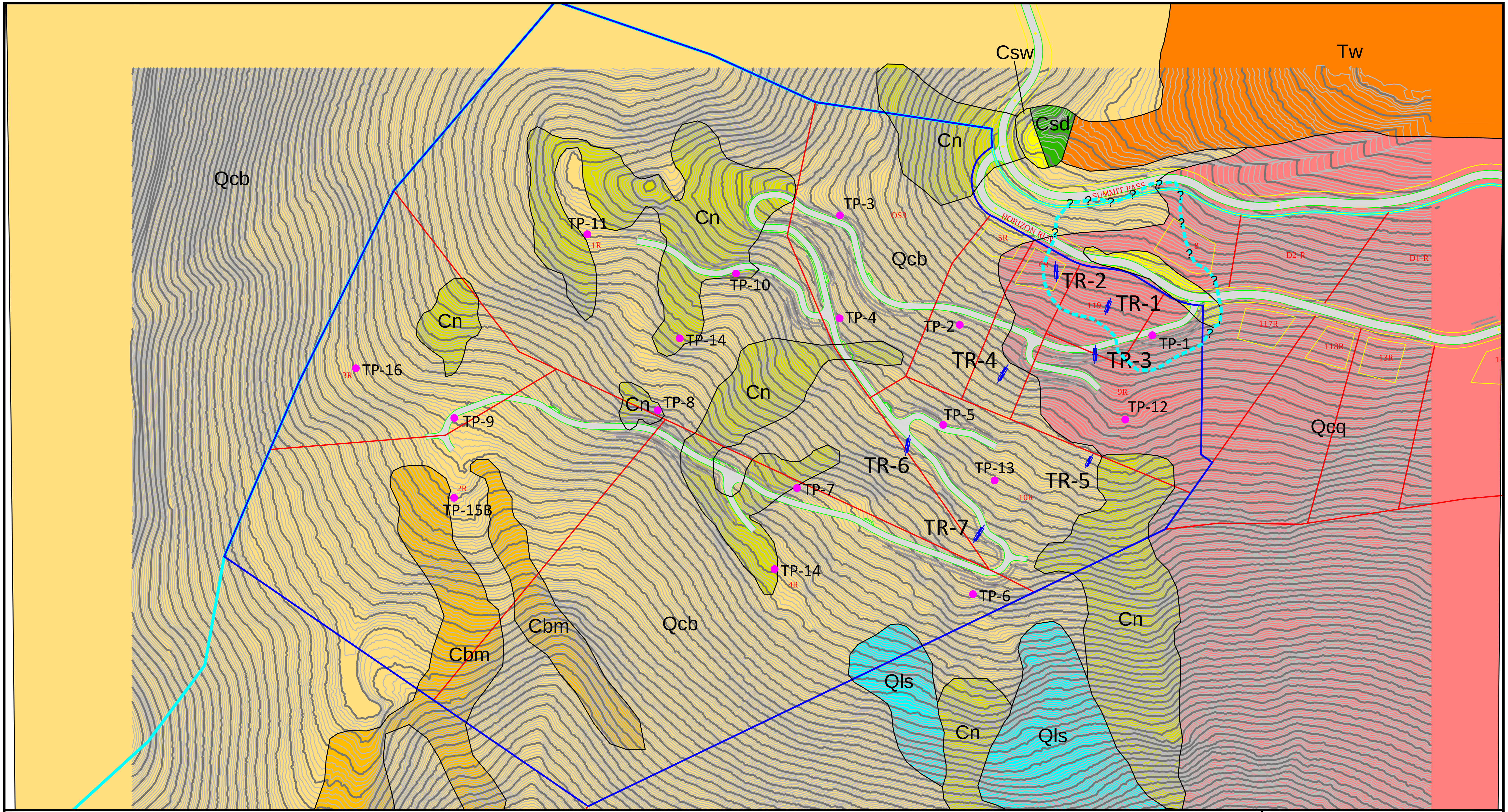
FIGURE A-4b

REGIONAL GEOLOGY MAP 3

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN RESORT
WEBER COUNTY, UTAH

DATE: 11/30/2016 | SCALE: 1"=2,000' | IGES
PROJECT:01628–012



LEGEND

Qcq QUARTZITIC COLLUVIUM (HOLOCENE-PLEISTOCENE)

Qcb BEDROCK COLLUVIUM (HOLOCENE-PLEISTOCENE)

Qls SHALLOW LANDSLIDE DEPOSITS (HOLOCENE-PLEISTOCENE)

Tw WASATCH FORMATION (EOCENE-PALEOCENE)

Csd DOLOMITE MEMBER OF ST. CHARLES LIMESTONE (CAMBRIAN)

Csw WORM CREEK QUARTZITE MEMBER OF ST. CHARLES LIMESTONE (CAMBRIAN)

Cn NOUNAN DOLOMITE (CAMBRIAN)

Cbm MIDDLE LIMESTONE MEMBER OF BLOOMINGTON FORMATION (CAMBRIAN)

PHASE 1E, 1F, 1G PROPERTY BOUNDARY

TR-3 TRENCH LOCATION (2016)

TP-16 TEST PIT LOCATION (2015)

APPROXIMATE SUBSURFACE (CONCEALED) LANDSLIDE DEPOSITS (PLEISTOCENE); QUERIED WHERE UNCERTAIN

N

0 300

FEET

BASEMAP PROVIDED BY NV5.

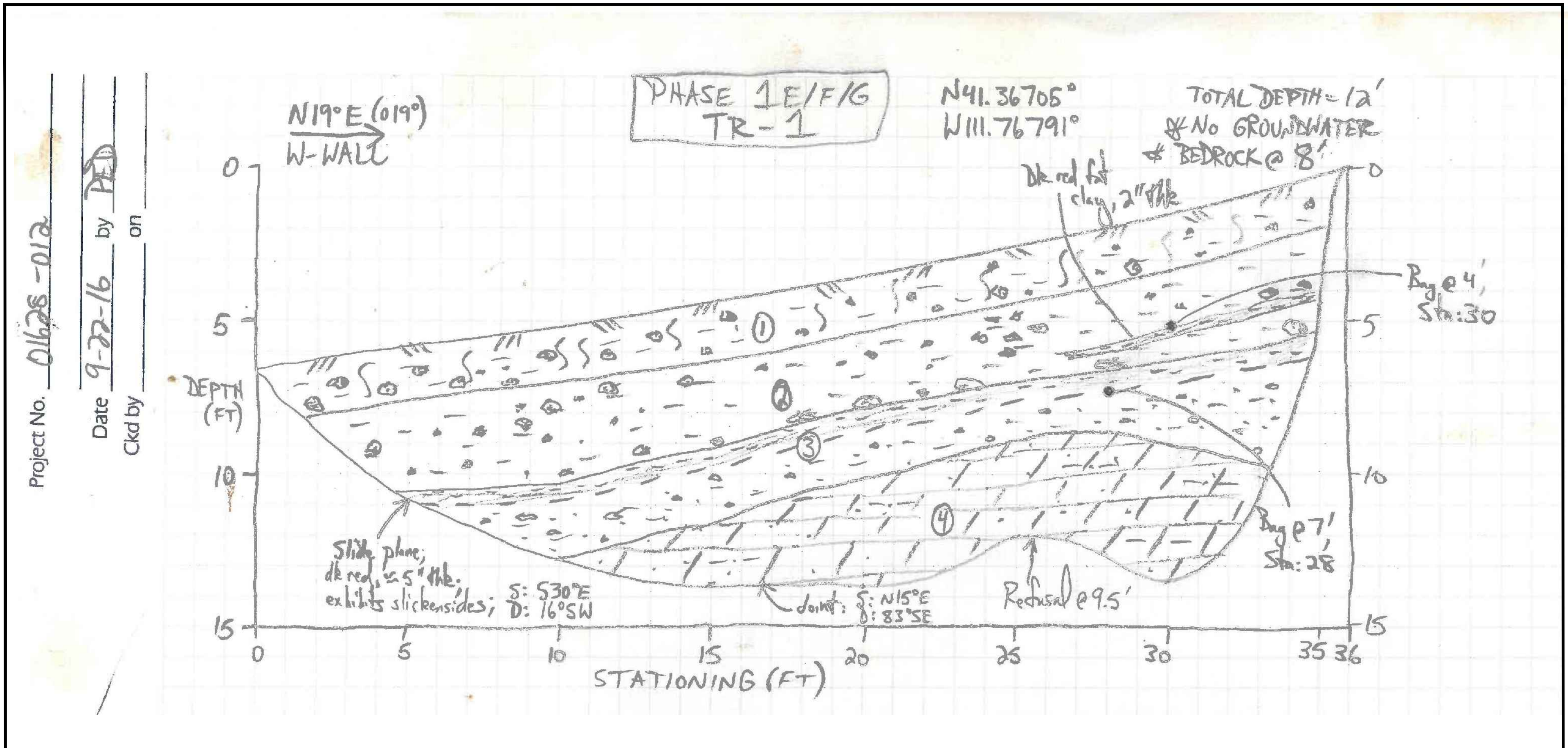
FIGURE A-5

LOCAL GEOLOGY MAP

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MTN RESORT
WEBER COUNTY, UTAH

DATE: 12/14/2016	SCALE: 1"=300'	IGES
PROJECT:01628-012		



LITHOLOGIC UNIT DESCRIPTIONS:

1. A/B Soil Horizon: ~2' thick; dark yellowish brown (10YR 4/2) lean CLAY with gravel (CL), loose, slightly moist, low plasticity, massive; upper ~1' is A-Horizon with abundant plant and tree roots with less clast concentration (~15%) than underlying B-Horizon; basal ~1' is B-Horizon with clast concentration ~30-40% of unit; clasts entirely subrounded to subangular pale yellowish orange (10YR 8/6) quartzite up to 1.5' in diameter, though mode size is 4-6"; sharp, planar basal contact.

2. Shallow Landslide: ~2-3' thick; light brown (5YR 6/4) lean CLAY with gravel (CL), stiff to very stiff, dry, low plasticity, massive; jagged expression on wall of trench; unit is identical to cemented colluvium unit seen elsewhere on Powder Mountain; blocky texture; gravel and larger-sized clasts comprise ~25-30% of unit; clasts are entirely subrounded to subangular pale yellowish orange (10YR 8/6) quartzite up to 6" in diameter, though mode size is 3-4", with almost equal proportion of subrounded and subangular clasts; abundant pinholes (1-2 mm) throughout; clasts irregularly spread through unit; unit underlain by dark red slide plane; sharp, irregular basal contact.

3. Paleosol: ~2-3' thick; dark reddish brown (10R 3/4) to dark yellowish brown (10YR 4/2); mottled appearance; sandy fat CLAY with gravel (CH), stiff, slightly moist, moderate plasticity, thickly bedded (>5"); gravel and larger-sized clasts comprise ~25-30% of unit; clasts are entirely angular, very finely sparry, thinly bedded, medium dark gray (N4) dolomite up to 5" in diameter, though mode size is 1-2"; pinholes throughout (1-2 mm diameter); uppermost ~5" is dark red slide plane that exhibits slickensides; sharp, irregular basal contact.

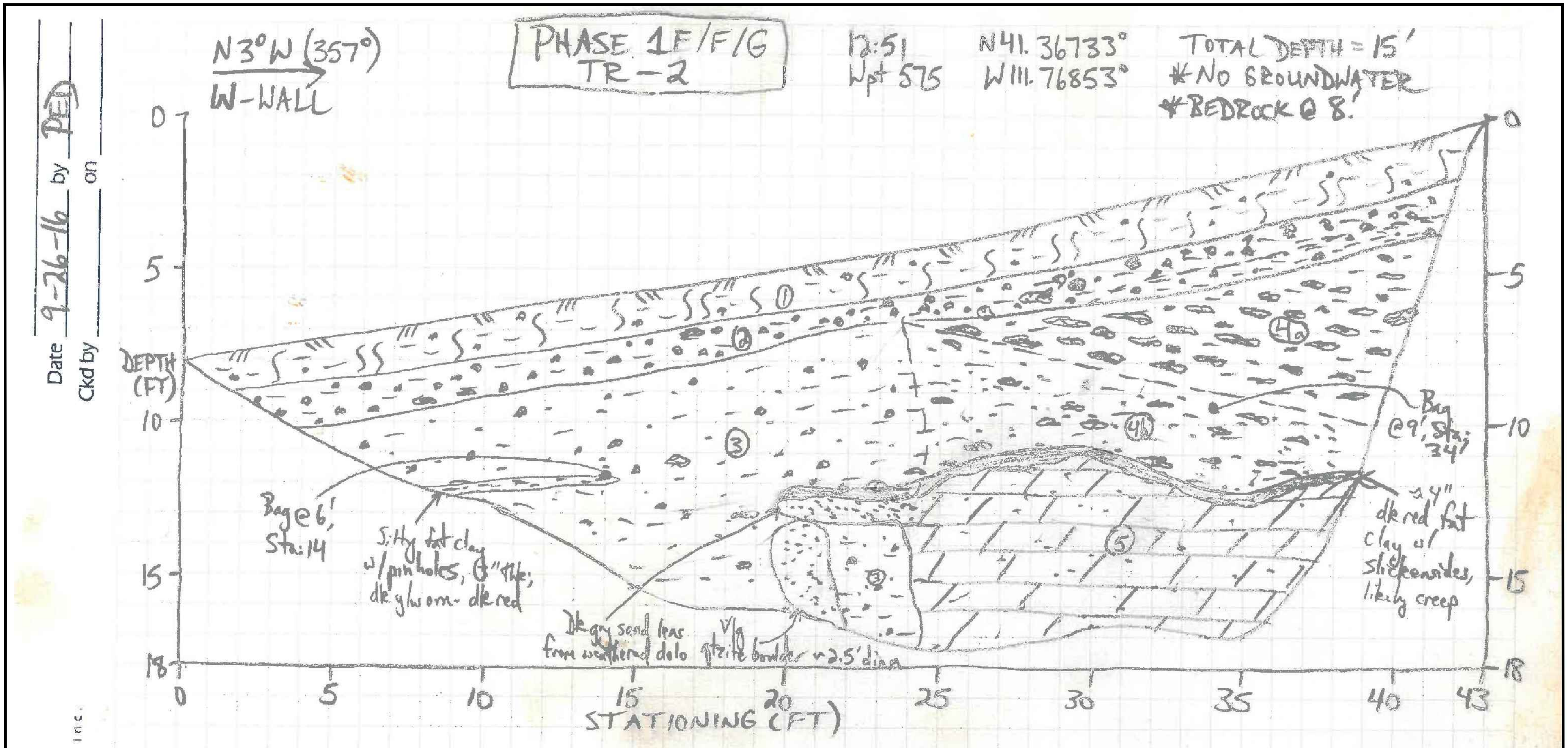
4. Nounan Dolomite: >4' thick; medium dark gray (N4) to medium gray (N5) silty dolomite, very finely sparry, finely bedded (< 1 cm); partly weathered/oxidized; blocky jointing; weathers to fine sand in places; bedding orientation unclear due to weathering, though upslope portion may have relict orientation of N40°W, 9°NE.

FIGURE A-6
TR-1 LOG

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN
WEBER COUNTY, UTAH

DATE: 12/12/2016	SCALE: 1"=5'	IGES
PROJECT: 01628-012		



LITHOLOGIC UNIT DESCRIPTIONS:

1.A/B Soil Horizon: ~1.5-2' thick; grayish brown (5Y 3/2) to dark reddish brown (10R 3/4) lean CLAY with gravel (CL), loose, moist, low plasticity, massive; gravel and larger-sized clasts comprise ~10-15% of unit; clasts consist of ~90% pale yellowish orange (10YR 8/6) subrounded to subangular quartzite, and ~10% medium gray (N5), angular, finely sparry dolomite; clasts are up to 6" in diameter, though mode size ~1"; abundant plant and tree roots; sharp, wavy basal contact.

2.Colluvium (Qcq): ~1-1.5' thick; dark yellowish orange (10YR 6/6) to moderate yellowish brown (10YR 5/4) lean CLAY with gravel (CL) gradational to clayey GRAVEL (GC), medium stiff, moist, moderate plasticity, massive; gravel and larger-sized clasts comprise ~30-60% of unit; clasts are almost exclusively subrounded to subangular quartzite as above, up to 10" in diameter, though mode size ~3-4"; matrix-supported, and north side of trench appears reversely graded; abundant pinholes throughout (1-2 mm); clasts appear imbricated downslope; similar to shallow landslide unit seen in TR-1, though appears less chaotic and no evident slide plane; abundant plant and tree roots; sharp, irregular basal contact.

3. Wasatch Fm?: ~5-7' thick; dark reddish brown (10R 3/4) conglomeratic bedrock nearly entirely disaggregated into clayey SAND (SC) with gravel gradational to sandy fat CLAY with gravel (CH), medium dense, moist, moderate plasticity, massive; gravel and larger-sized clasts comprise ~25-30% of unit; clasts are ~60% quartzite as above and ~40% dolomite as above, and up to 2.5' in diameter; common pinholes throughout (1 mm); occasional plant and tree roots; possible landslide deposit?

4. Highly Weathered Bedrock: 4a: up to 5' thick; blocky dolomite bedrock, possibly bedrock colluvium weathered into dark reddish brown (10R 3/4) to dark yellowish brown (10YR 4/2) clayey GRAVEL (GC), medium dense, slightly moist, low plasticity, massive; largely clast-supported, with entirely dolomite clasts comprising ~50-70% of subunit and up to 1.5' in diameter; 4b: up to 4' thick; dark reddish brown (10YR 3/4) to medium gray (N5) clayey SAND with gravel (SC), medium dense, moist, moderate plasticity, some relict banding; matrix-supported, with entirely dolomite clasts comprising ~25-30% of subunit and up to 14" in diameter.

5. Nounan Dolomite: >5' thick; medium gray (N5) to medium dark gray (N4) to dark reddish brown (10R 3/4) sandy dolomite bedrock, finely sparry, thinly bedded in places; highly weathered to fine sand in places; highly inconsistently weathered, with some hard to very hard dolomite blocks next to patches of sand; most blocks moderately hard; blocky jointing.

FIGURE A-7

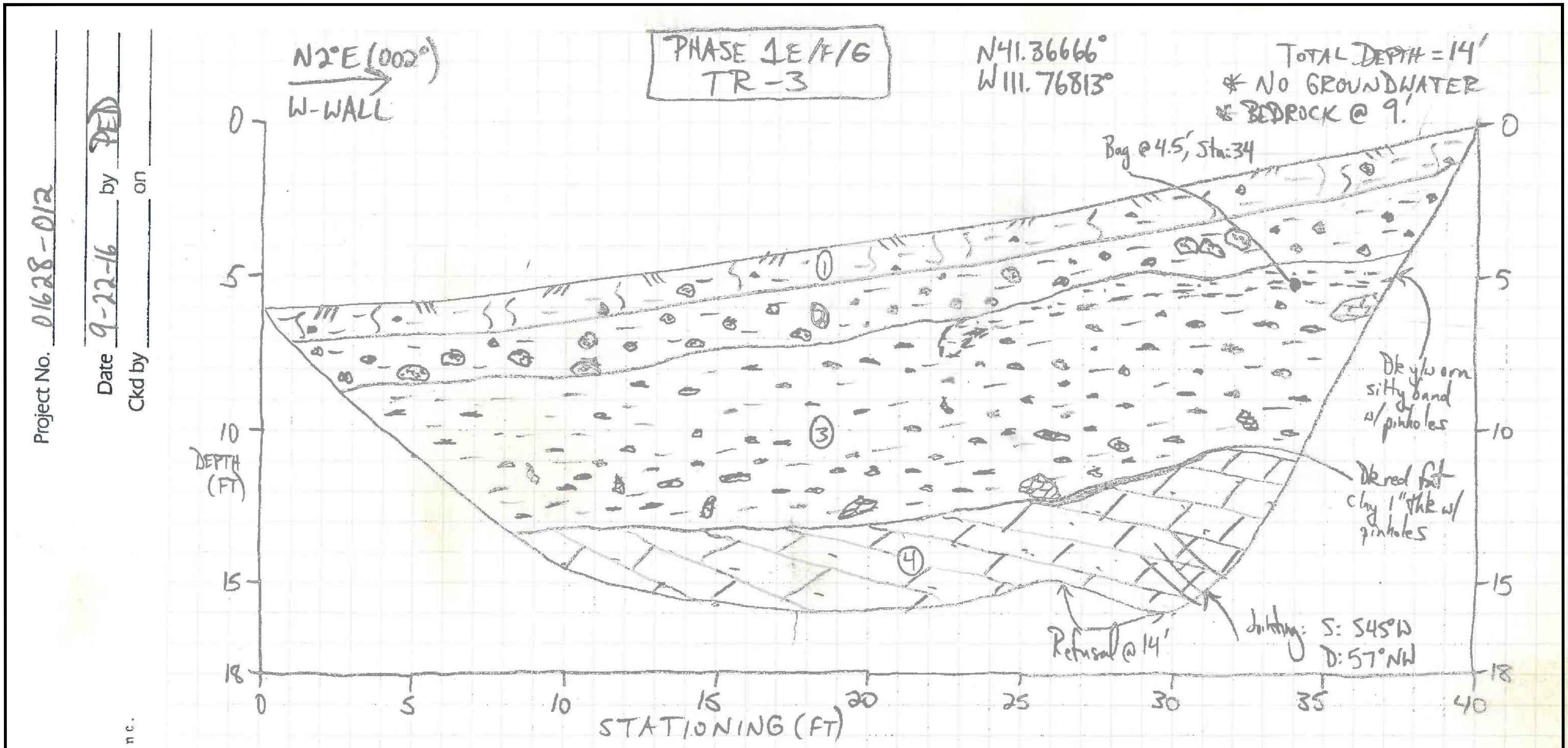
TR-2 LOG

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN
WEBER COUNTY, UTAH

DATE: 12/13/2016	SCALE:
PROJECT: 01628-012	1"=5'

IGES



LITHOLOGIC UNIT DESCRIPTIONS:

1. A/B Soil Horizon: ~1-1.5' thick; dark yellowish brown (10YR 4/2) to moderate yellowish brown (10YR 5/4) lean CLAY with gravel (CL), loose, slightly moist, low plasticity, massive; gravel and larger-sized clasts comprise ~5-10% of unit; clasts entirely pale yellowish orange (10YR 8/6) subrounded to subangular quartzite up to 4" in diameter, though mode size <1"; abundant plant and tree roots, though largely restricted to uppermost ~6" of unit.

2. Colluvium (Qcq): ~2' thick; dark yellowish brown (10YR 4/2) to light brown (5YR 6/4) gravelly lean CLAY (CL) gradational to clayey GRAVEL (GC), medium stiff to loose, slightly moist, low plasticity, massive; gravel and larger-sized clasts comprise ~50-75% of unit; matrix-supported, though locally clast-supported; clasts are entirely subrounded to subangular pale yellowish orange (10YR 8/6) quartzite up to 10" in diameter, though mode size ~4"; common plant and tree roots; sharp, wavy basal contact.

3. Bedrock Colluvium (Qcb): ~5-6' thick; dark reddish brown (10R 3/4) to dark yellowish orange (10YR 6/6); silty CLAY with gravel (CL), stiff to very stiff, slightly moist, low plasticity, massive; gravel and larger-sized clasts comprise ~30-50% of unit, and increase in frequency with depth; clasts are entirely angular and blocky, finely sparry, medium gray (N5) dolomite up to 1' in diameter, though mode size is ~2"; possible downslope imbrication of clasts; very similar in appearance to Wasatch Formation, except not as sandy and no quartzite; uppermost ~6"-1' is largely devoid of clasts and is pinholed (<1 mm); may grade with depth into highly weathered bedrock; occasional to common plant and tree roots; gradational, irregular basal contact.

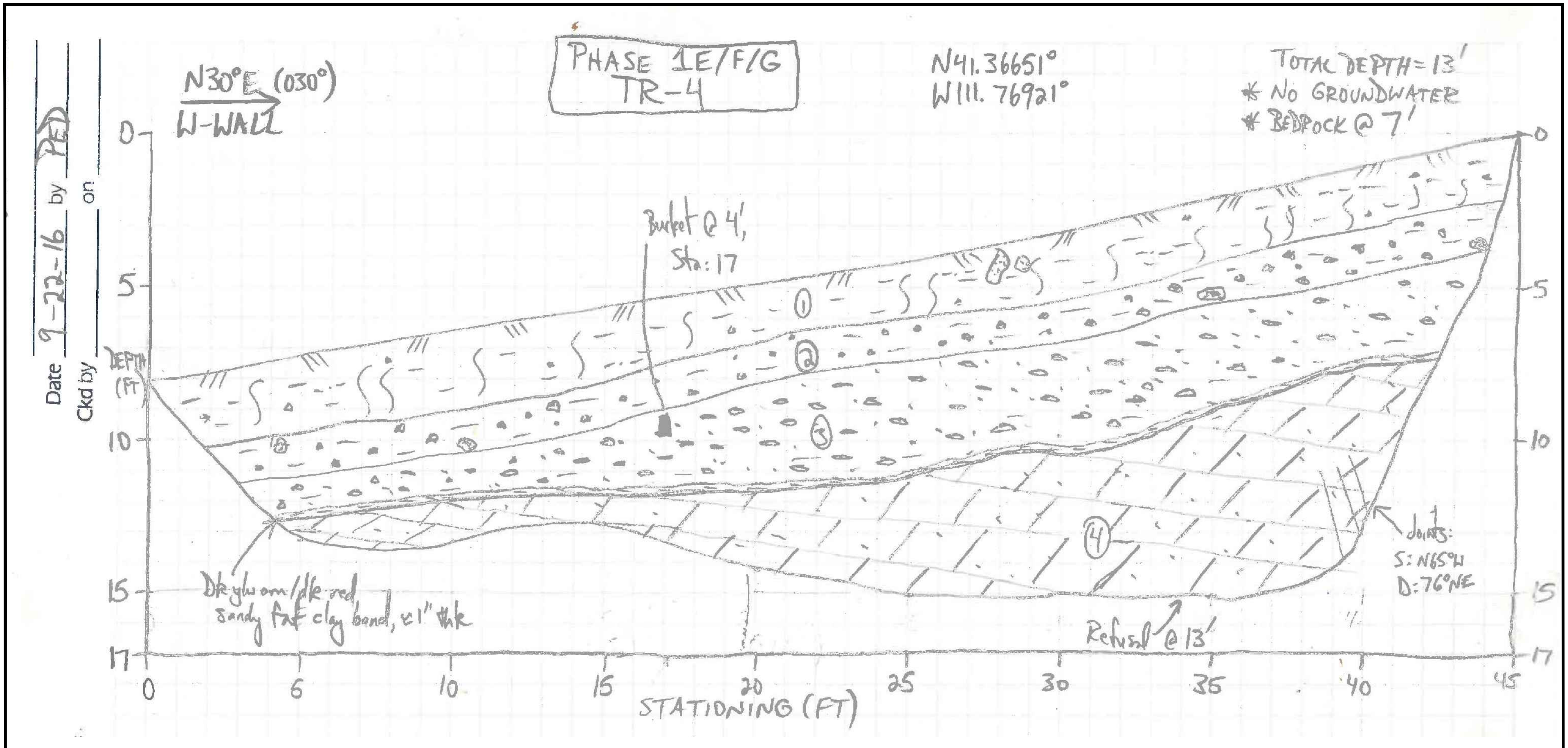
4. Nounan Dolomite: >5' thick; medium gray (N5) to medium dark gray (N4) sandy dolomite, finely sparry to sparry, massive; partly weathered/oxidized to moderate reddish brown (10R 4/6); heavily fractured and jointed with blocky jointing; common calcite stringers and nodules; blocks are largely hard to very hard; weathers to fine sand in places; occasional plant and tree roots in fractures; discontinuous clay lens at top of unit may be indicative of soil creep; bedding orientation unclear due to weathering.

FIGURE A-8
TR-3 LOG

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN
WEBER COUNTY, UTAH

DATE: 12/13/2016
PROJECT: 01628-012
SCALE: 1"=5'
IGES



LITHOLOGIC UNIT DESCRIPTIONS:

1. A/B Soil Horizon: ~2-3' thick; dark yellowish brown (10YR 4/2) to dark reddish brown (10R 3/4) lean CLAY with gravel (CL), loose, slightly moist, low plasticity, massive; gravel and larger-sized clasts comprise ~5-10% of unit; clasts are ~75% pale yellowish orange (10YR 8/6) subrounded quartzite and ~25% medium gray (N5) to medium dark gray (N4) subrounded finely sparry dolomite with calcite nodules and stringers; clasts are up to 15" in diameter, though mode size <1"; abundant plant and tree roots; gradational, irregular basal contact.

2. Colluvium (Qcb): ~1-1.5' thick; dark yellowish brown (10YR 4/2) to moderate reddish brown (10R 4/6) gravelly lean CLAY (CL) gradational to clayey GRAVEL (GC), loose, slightly moist, low plasticity, massive; gravel and larger-sized clasts comprise ~50-60% of unit, though matrix-supported; clasts are ~75% pale yellowish orange (10YR 8/6) subrounded quartzite and ~25% subrounded to subangular medium gray (N5) dolomite as above and white (N9) dolomitic quartzite; clasts are up to 8" in diameter, though mode size ~2-4"; common plant and tree roots; sharp, planar basal contact.

3. Highly Weathered Bedrock: ~4' thick; moderate reddish brown (10R 4/6) to dark yellowish orange (10YR 6/6); dolomite bedrock almost entirely disaggregated into clayey GRAVEL with sand (GC), medium dense, slightly moist, massive; gradational between clast and matrix-supported; sand is fine-grained, and comprised of angular grains of dolomite and quartzite; gravel and larger-sized clasts comprise ~50-80% of unit; clasts are entirely angular medium gray (N5) to medium dark gray (N4) finely sparry dolomite with abundant calcite stringers and nodules, and up to 6" in diameter, though mode size <1"; base of unit is ~1" thick dark yellowish orange to dark reddish brown (10R 3/4) sandy fat CLAY (CH) with abundant pinholes (up to 1 mm) and may represent creep surface; becomes clayey with depth; common plant and tree roots; gradational, irregular basal contact.

4. Nounan Dolomite: >6' thick; medium gray (N5) to medium dark gray (N4) sandy dolomite, finely sparry to sparry, massive; common calcite stringers and nodules; partly weathered/oxidized; heavily fractured and jointed with blocky jointing, though still largely hard to very hard; occasional roots within fractures; bedding orientation not discernible.

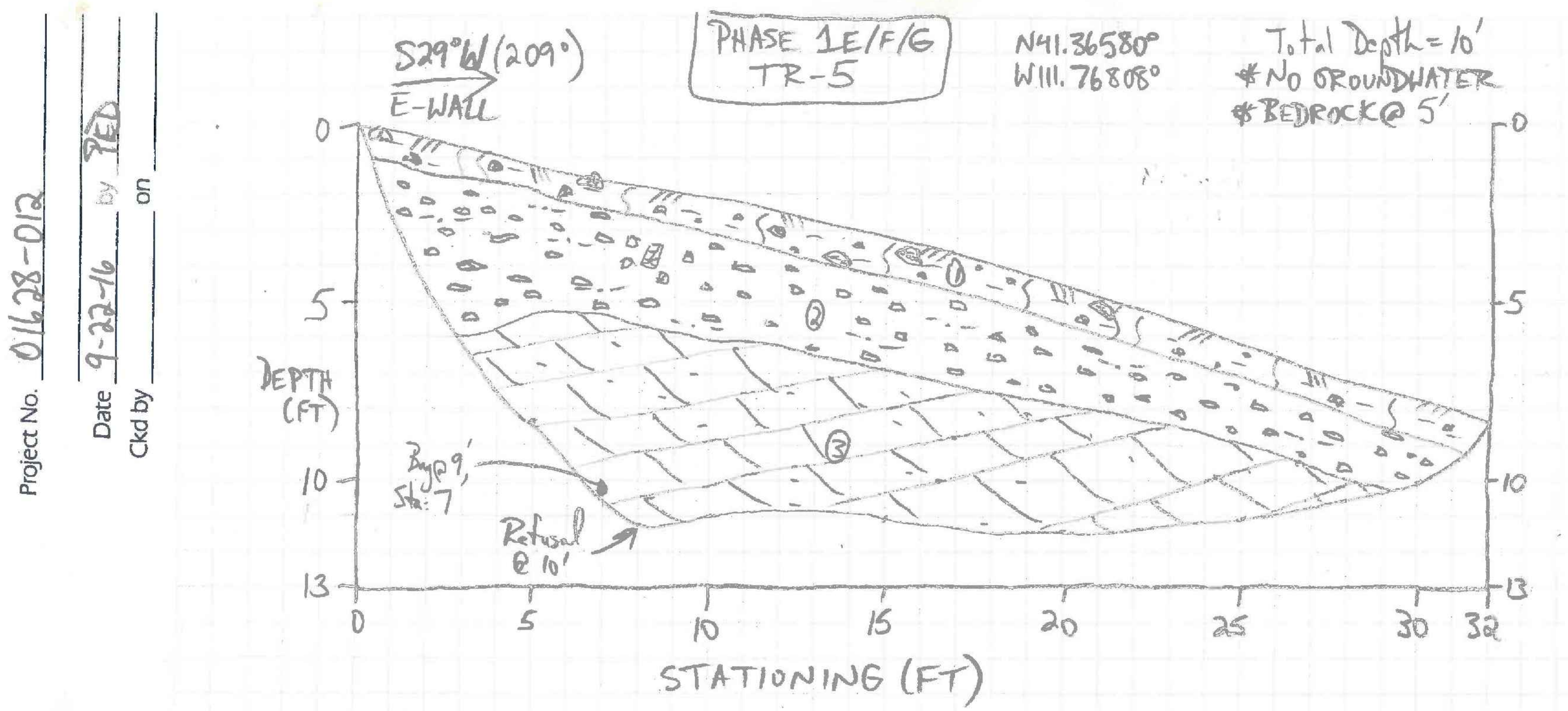
FIGURE A-9
TR-4 LOG

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN
WEBER COUNTY, UTAH

DATE: 12/13/2016	SCALE:
PROJECT: 01628-012	1"=5'

IGES



LITHOLOGIC UNIT DESCRIPTIONS:

1. Colluvium (Qcb): ~1-1.5' thick; dark yellowish brown (10YR 4/2) to light brown (5YR 6/4) lean CLAY with gravel (CL), loose, moist, low plasticity, massive; A/B topsoil forming on and within unit such that it is indistinguishable from unit; organic-rich topsoil only in uppermost ~4-6"; gravel and larger-sized clasts comprise ~25-30% of unit; clasts are ~80% pale yellowish orange (10YR 8/6) subrounded quartzite and ~20% angular medium dark gray (N4) finely sparry dolomite to limestone with abundant calcite veining; clasts are up to 2' in diameter, though mode size ~6-8"; abundant plant and tree roots; sharp, irregular basal contact.

2. Highly Weathered Bedrock: ~2-4' thick; moderate yellowish brown (10YR 5/4) to medium gray (N5) dolomite bedrock largely disaggregated to silty GRAVEL (GC), medium dense, slightly moist, low plasticity, massive; clast-supported; gravel and larger-sized clasts comprise ~75% of unit, and are entirely angular, blocky dolomite as above up to 1' in diameter, though mode size ~2-3"; silty, sandy matrix with some lean clay; common plant and tree roots; gradational, irregular basal contact.

3. Nounan Dolomite: >5' thick; medium dark gray (N4) to medium gray (N5) sandy dolomite, finely sparry to sparry, massive; common white calcite veining and small (up to 5 mm) nodules; weathers to dark yellowish orange (10YR 6/6); weathers to fine sand in places; partially oxidized, though most blocks are still hard to very hard; highly fractured and jointed, though bedding and jointing are indiscernible.

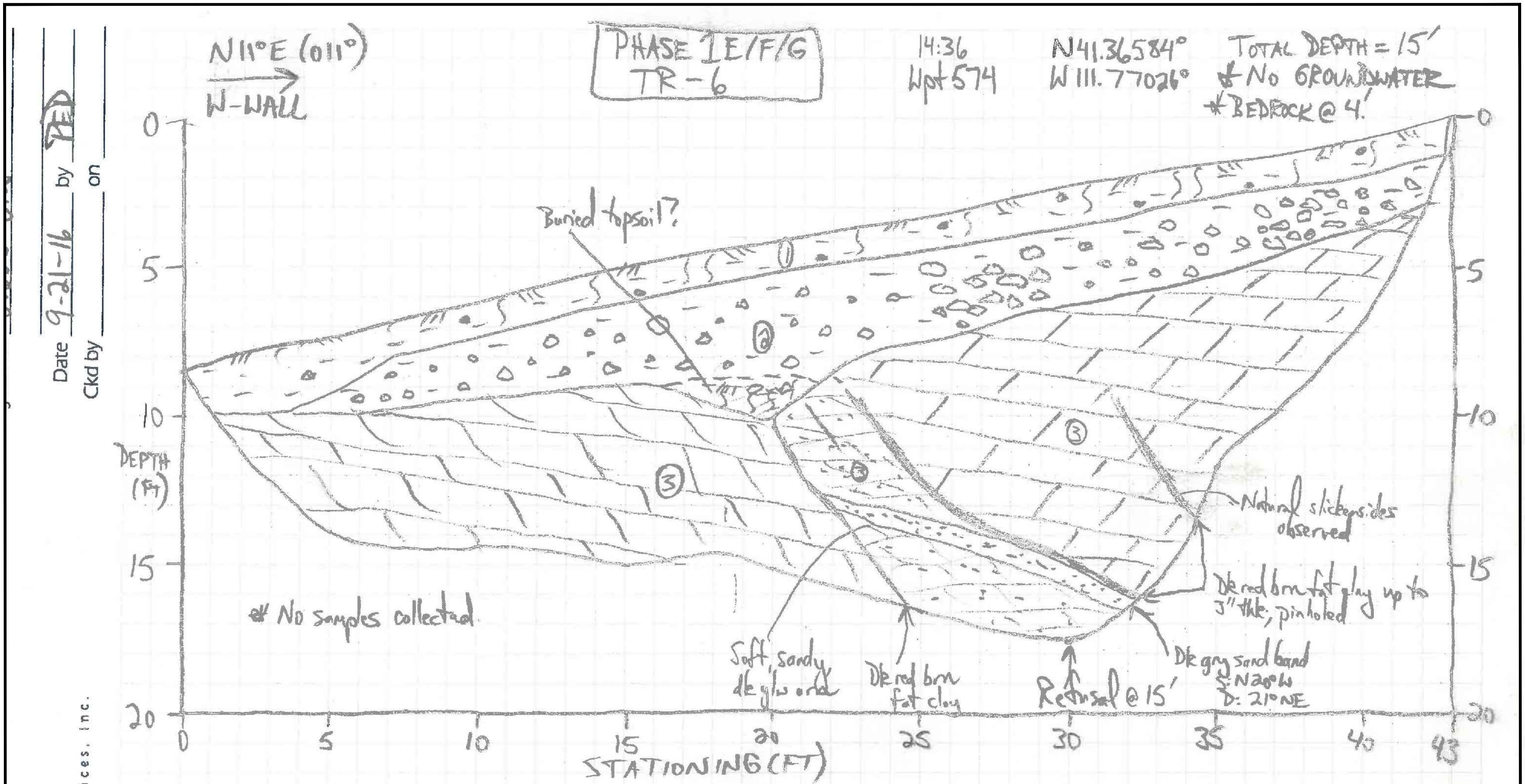
*** Excavator noted that this was the hardest trench to dig.**

FIGURE A-10
TR-5 LOG

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN
WEBER COUNTY, UTAH

DATE: 12/13/2016	SCALE: 1"=5'	IGES
PROJECT: 01628-012		



LITHOLOGIC UNIT DESCRIPTIONS:

1. A/B Soil Horizon: ~1-1.5' thick; grayish brown (5Y 3/2) to brownish black (5YR 2/1) lean CLAY with gravel (CL), medium stiff, slightly moist, low plasticity, massive; silty; gravel and larger-sized clasts comprise ~10-15% of unit; clasts are ~85% medium gray (N5) subrounded quartzite and ~15% pale yellowish orange (10YR 8/6) weathering, white (N9) subangular to subrounded sparry dolomite; clasts are up to 6" in diameter; basal ~1' is moderate reddish brown (10R 4/6) stiff, lean clay, possibly colluvium derived from Wasatch Fm; sharp, irregular basal contact.

2. Highly Weathered Bedrock: ~2.5-5' thick; dark reddish brown (10R 3/4) to dark yellowish orange (10YR 6/6); possibly colluvium, though some in situ dolomite bedrock blocks; disaggregated into clayey GRAVEL with sand (GC), medium dense, slightly moist, low plasticity, massive; sand component increases with depth; gravel and larger-sized clasts comprise ~50-80% of unit; clasts are entirely very pale blue (5B 8/2) angular, sparry, quartzitic dolomite up to 1' in diameter; unit contains a possible buried topsoil between stations 15 and 20, though this is likely slough from excavation or deeper roots associated with the jointing in the weathered bedrock.

3. Nounan Dolomite: >11' thick; very light gray (N8) to dark gray (N3) silty dolomite, sparry, fine to medium-bedded (up to 4"); highly weathered/oxidized to sand or soft bedrock in between clay seams; contains multiple dark reddish brown (10R 3/4) fat clay seams, with slickensides observed on northernmost seam; all clay seams are pinholed and dip upslope; abundant fractures and jointing throughout.

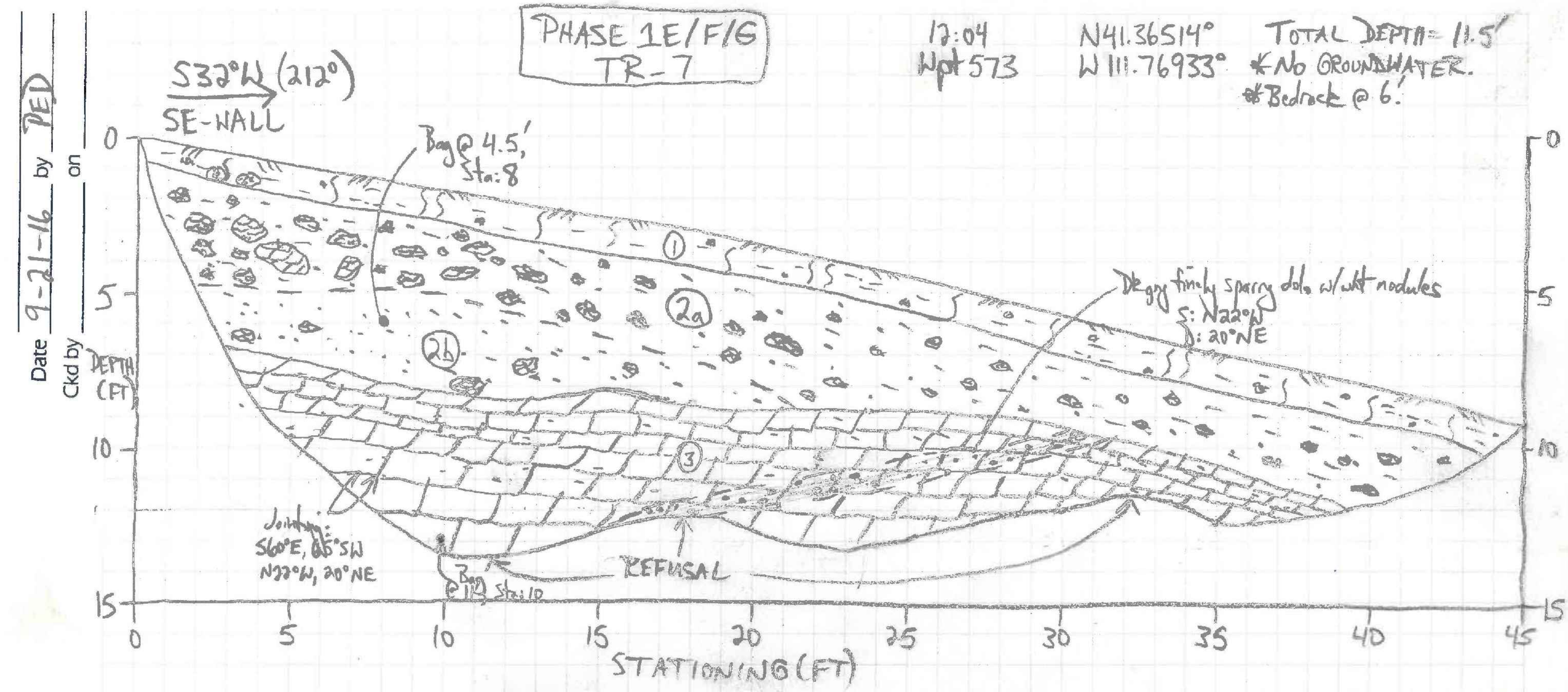
FIGURE A-11

TR-6 LOG

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN
WEBER COUNTY, UTAH

DATE: 12/13/2016
PROJECT: 01628-012
SCALE: 1"=5'
IGES



LITHOLOGIC UNIT DESCRIPTIONS:

1. A/B Soil Horizon: ~1-1.5' thick; grayish brown (5Y 3/2) to brownish black (5YR 2/1) lean CLAY with gravel (CL), medium stiff, slightly moist, low plasticity, massive; silty; gravel and larger-sized clasts comprise ~10-15% of unit; clasts are ~85% medium gray (N5) subrounded quartzite and ~15% pale yellowish orange (10YR 8/6) weathering, white (N9) subangular to subrounded sparry dolomite; clasts are up to 6" in diameter; basal ~1' is moderate reddish brown (10R 4/6) stiff, lean clay, possibly colluvium derived from Wasatch Fm; abundant plant and tree roots; sharp, irregular basal contact.

2. Highly Weathered Bedrock: Subunit 2a: ~2.5-3.5' thick; dark reddish brown (10R 3/4) to dark yellowish orange (10YR 6/6) dolomite bedrock, possibly colluvium, though some in situ blocks; largely disaggregated to clayey GRAVEL with sand (GC), medium dense, slightly moist, low plasticity, massive; sand component increases with depth; fewer clasts to south; gravel and larger-sized clasts comprise ~50-80% of subunit; clasts entirely very light gray (N8) to white (N9) sparry sandy dolomite that weathers to pale yellowish orange (10YR 8/6) and dark yellowish orange; clasts are moderately hard to hard, angular to subrounded, heavily jointed, and up to 1.5' in diameter; common plant and tree roots; sharp, irregular basal contact.

2. Highly Weathered Bedrock: Subunit 2b: up to 3' thick, light gray (N7) to dark yellowish orange (10YR 6/6); well graded SAND with gravel (SW), loose, slightly moist, massive; gravel and larger-sized clasts comprise ~10-15% of subunit, entirely dolomite as above up to 8" diameter; sand is medium-grained and angular, comprised of both dolomite and quartzite grains; occasional to common plant and tree roots; likely derived from soft bedrock; sharp, irregular basal contact.

3. Nounan Dolomite: >5' thick; very pale blue (5B 8/2) sandy dolomite, sparry to finely sparry, massive; hard to very hard; partially weathered to fine-grained sand; commonly oxidized to moderate reddish brown (10R 4/6); heavily jointed with blocky jointing; contains a ~1' thick dark gray (N3) finely sparry dolomite bed; becomes finely sparry with depth.

FIGURE A-12
TR-7 LOG

PHASE 1E, 1F, 1G

GEOLOGIC HAZARD ASSESSMENT
SUMMIT POWDER MOUNTAIN
WEBER COUNTY, UTAH

DATE: 12/13/2016
PROJECT: 01628-012
SCALE: 1"=5'
IGES

APPENDIX B

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

Project: Summit - Phase 1E/F/G
No: 01628-012
Location: Powder Mountain, UT
Date: 10/10/2016
By: BSS/ET/NB

Sample Info.	Boring No.	TR-1	TR-1	TR-2					
	Sample								
	Depth	4.0'	7.0'	6.0'					
	Split	Yes	No	No					
	Split sieve	3/8"							
Total sample (g)		3999.50							
Moist coarse fraction (g)		1003.10							
Moist split fraction (g)		2996.40							
	Sample height, H (in)								
	Sample diameter, D (in)								
	Mass rings + wet soil (g)								
	Mass rings/tare (g)								
	Moist unit wt., γ_m (pcf)								
Coarse Fraction	Wet soil + tare (g)	1313.48							
	Dry soil + tare (g)	1304.91							
	Tare (g)	310.40							
	Water content (%)	0.9							
Split Fraction	Wet soil + tare (g)	357.30	464.20	2069.78					
	Dry soil + tare (g)	341.12	411.15	1804.30					
	Tare (g)	124.68	126.91	409.82					
	Water content (%)	7.5	18.7	19.0					
Water Content, w (%)		**5.7**	**18.7**	**19.0**					
Dry Unit Wt., γ_d (pcf)									

Entered by:___________

Reviewed:___________

Z:\PROJECTS\01628_Powder_Mountain\012_Summit\[MDv2.xlsx]1

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Summit - Phase 1E/F/G
No: 01628-012
Location: Powder Mountain, UT
Date: 10/12/2016
By: BRR

Boring No.: TR-1
Sample:
Depth: 4.0'
Description: Reddish brown lean clay

Preparation method: Wet
Liquid limit test method: Multipoint

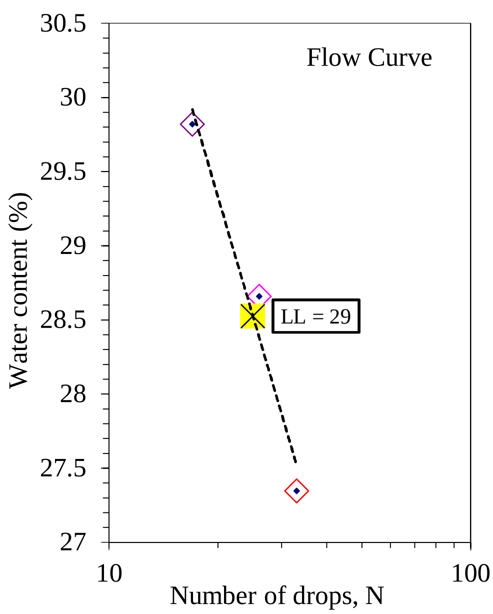
Plastic Limit

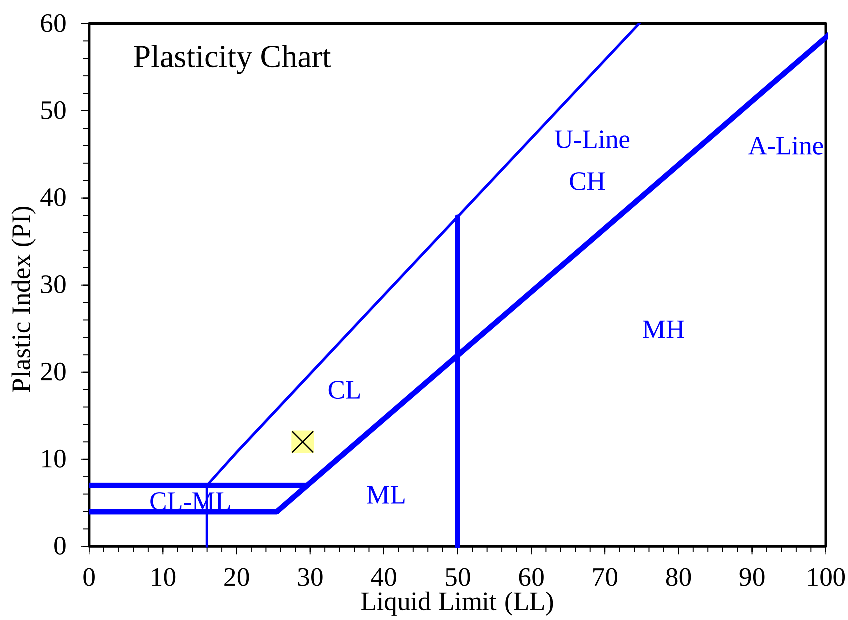
Determination No	1	2				
Wet Soil + Tare (g)	28.02	27.91				
Dry Soil + Tare (g)	27.09	27.03				
Water Loss (g)	0.93	0.88				
Tare (g)	21.53	21.75				
Dry Soil (g)	5.56	5.28				
Water Content, w (%)	16.73	16.67				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	33	26	17			
Wet Soil + Tare (g)	31.41	30.44	30.71			
Dry Soil + Tare (g)	29.37	28.56	28.56			
Water Loss (g)	2.04	1.88	2.15			
Tare (g)	21.91	22.00	21.35			
Dry Soil (g)	7.46	6.56	7.21			
Water Content, w (%)	27.35	28.66	29.82			
One-Point LL (%)		29				

Liquid Limit, LL (%)	**29**
Plastic Limit, PL (%)	**17**
Plasticity Index, PI (%)	**12**





Entered by:____________
Reviewed:____________

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: **Summit - Phase 1E/F/G**
No: **01628-012**
Location: Powder Mountain, UT
Date: 10/12/2016
By: BRR

Boring No.: **TR-1**
Sample:
Depth: **7.0'**
Description: Reddish brown fat clay

Preparation method: Wet
Liquid limit test method: Multipoint

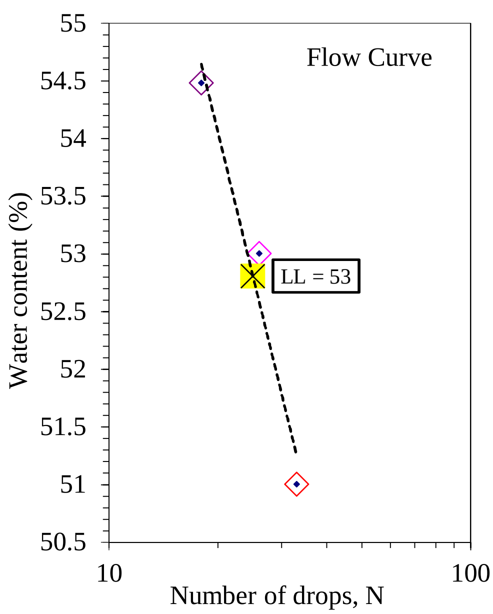
Plastic Limit

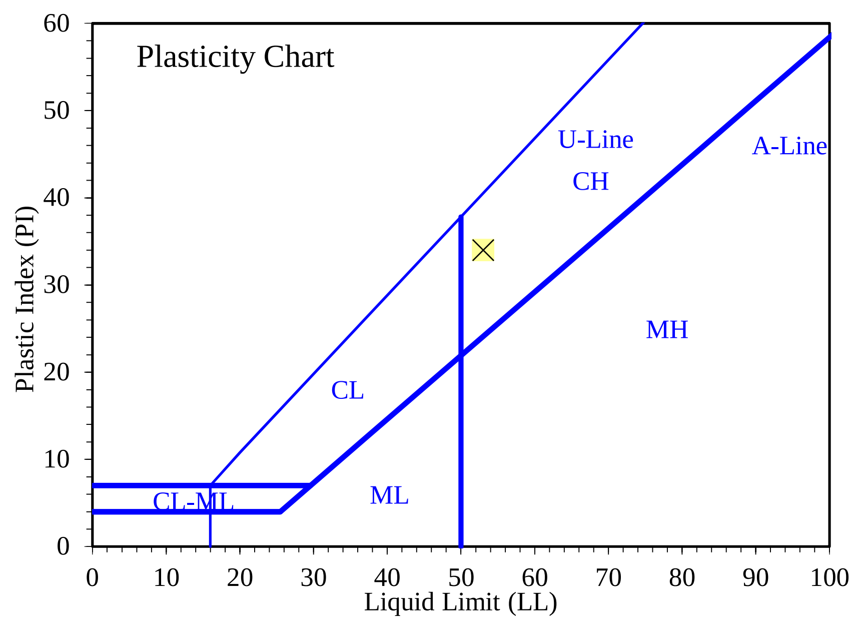
Determination No	1	2				
Wet Soil + Tare (g)	27.88	28.33				
Dry Soil + Tare (g)	26.89	27.34				
Water Loss (g)	0.99	0.99				
Tare (g)	21.56	22.08				
Dry Soil (g)	5.33	5.26				
Water Content, w (%)	18.57	18.82				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	33	26	18			
Wet Soil + Tare (g)	29.52	29.23	28.84			
Dry Soil + Tare (g)	26.98	26.76	26.47			
Water Loss (g)	2.54	2.47	2.37			
Tare (g)	22.00	22.10	22.12			
Dry Soil (g)	4.98	4.66	4.35			
Water Content, w (%)	51.00	53.00	54.48			
One-Point LL (%)		53				

Liquid Limit, LL (%)	**53**
Plastic Limit, PL (%)	**19**
Plasticity Index, PI (%)	**34**





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Amount of Material in Soil Finer than the No. 200 (75µm) Sieve

(ASTM D1140)

IGES

Project: **Summit - Phase 1E/F/G**
No: **01628-012**
Location: Powder Mountain, UT
Date: 10/11/2016
By: BSS/ET/NB

Sample Info.	Boring No.	TR-1	TR-1	TR-2					
	Sample								
	Depth	4.0'	7.0'	6.0'					
	Split	Yes	No	No					
	Split Sieve*	3/8"							
	Method	B	B	B					
	Specimen soak time (min)	240	460	200					
	Moist total sample wt. (g)	3999.50	337.29	1659.96					
	Moist coarse fraction (g)	1003.11							
	Moist split fraction + tare (g)	357.30							
	Split fraction tare (g)	124.68							
	Dry split fraction (g)	216.44							
	Dry retained No. 200 + tare (g)	203.15	191.76	1207.41					
	Wash tare (g)	124.68	126.91	409.82					
	No. 200 Dry wt. retained (g)	78.47	64.85	797.59					
	Split sieve* Dry wt. retained (g)	994.54							
	Dry total sample wt. (g)	3782.51	284.24	1394.48					
Coarse Fraction	Moist soil + tare (g)	1313.48							
	Dry soil + tare (g)	1304.91							
	Tare (g)	310.40							
	Water content (%)	0.86							
Split Fraction	Moist soil + tare (g)	357.30	464.20	2069.78					
	Dry soil + tare (g)	341.12	411.15	1804.30					
	Tare (g)	124.68	126.91	409.82					
	Water content (%)	7.48	18.66	19.04					
	Percent passing split sieve* (%)	**73.7**							
	Percent passing No. 200 sieve (%)	**47.0**	**77.2**	**42.8**					

Entered by:___________
Reviewed:___________

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

(ASTM D6913)

Project: Summit - Phase I E/F/G
No: 01628-012
Location: Powder Mountain, UT
Date: 10/11/2016
By: NB

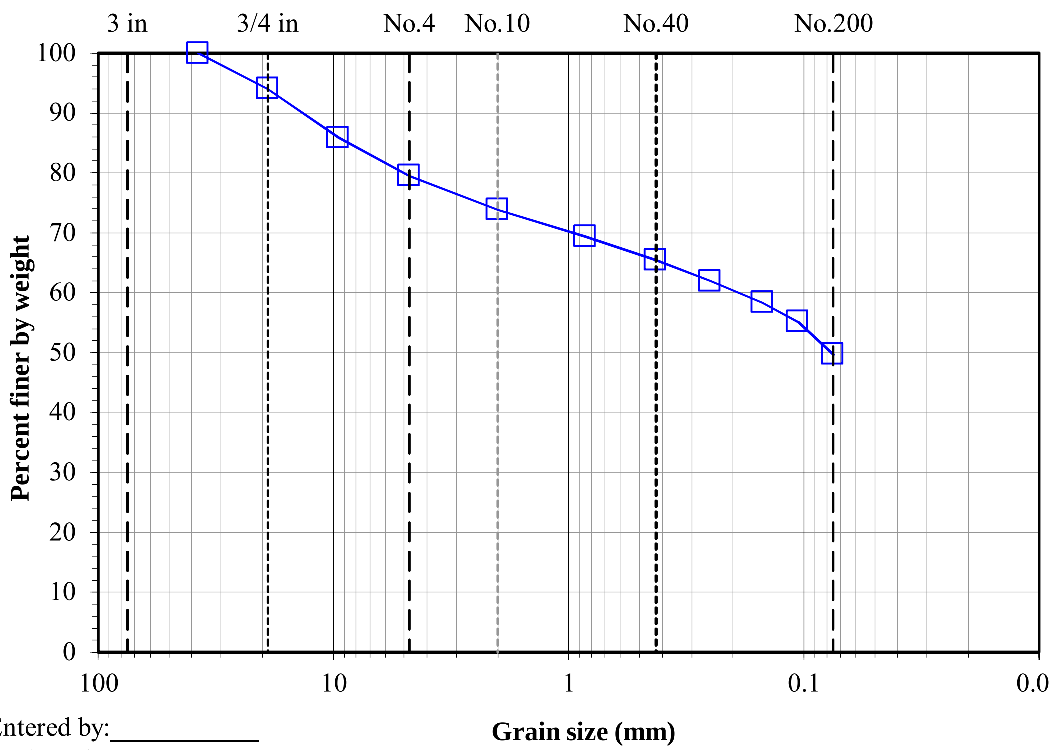
Boring No.: TR-2
Sample:
Depth: 9.0'
Description: Reddish brown clayey sand with gravel

Split:	No	
	-	
	Moist	Dry
Total sample wt. (g):	3893.28	3050.28
Split fraction:	1.000	

Water content data

Moist soil + tare (g):	-	4828.20
Dry soil + tare (g):	-	3985.20
Tare (g):	-	934.92
Water content (%):	0.0	27.6

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
8"	-	200	-
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	100.0
3/4"	182.36	19	94.0
3/8"	431.59	9.5	85.9
No.4	624.66	4.75	79.5
No.10	797.50	2	73.9
No.20	934.54	0.85	69.4
No.40	1055.13	0.425	65.4
No.60	1160.44	0.25	62.0
No.100	1270.86	0.15	58.3
No.140	1367.71	0.106	55.2
No.200	1534.38	0.075	49.7



Gravel (%): 20.5
Sand (%): 29.8
Fines (%): 49.7

Entered by:___________
Reviewed:___________

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

(ASTM D6913)

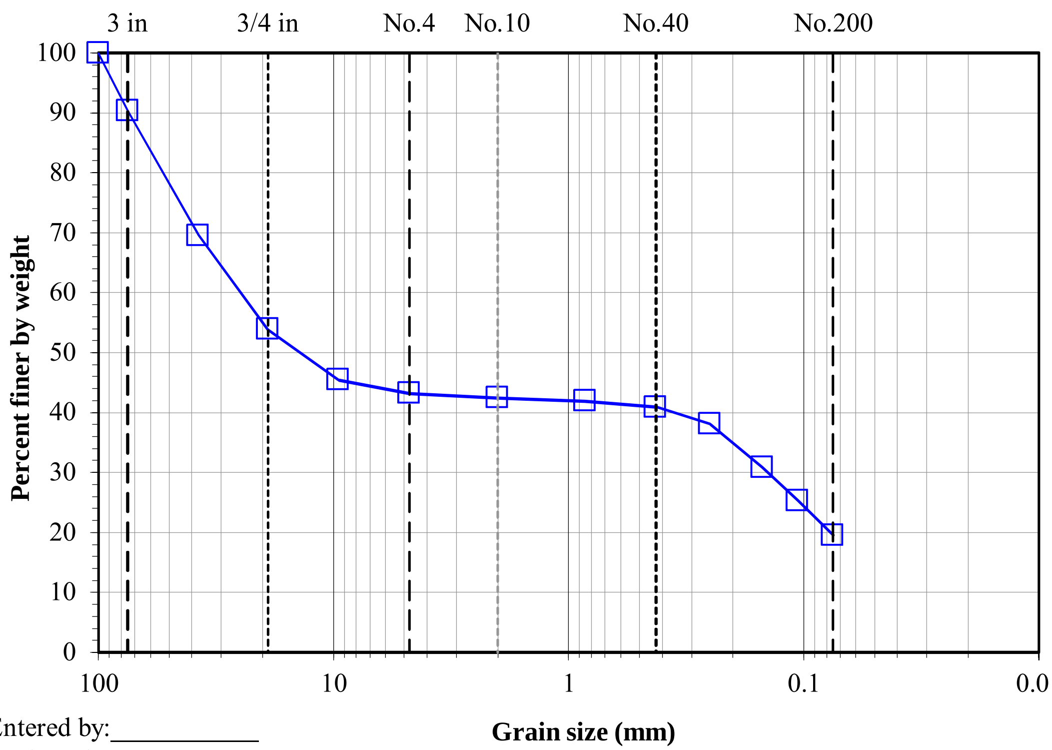
Project: Summit - Phase I E/F/G
No: 01628-012
Location: Powder Mountain, UT
Date: 10/11/2016
By: NB

Boring No.: TR-4
Sample:
Depth: 4.0'
Description: Reddish brown clayey gravel with sand

	Moist	Dry
Split:	Yes	
Split sieve:	3/4"	
Total sample wt. (g):	25631.86	24726.44
+3/4" Coarse fraction (g):	11477.27	11399.00
-3/4" Split fraction (g):	1495.81	1408.40
Split fraction:	0.539	

Water content data	C.F.(+3/4")	S.F.(-3/4")
Moist soil + tare (g):	12818.00	1826.68
Dry soil + tare (g):	12736.60	1739.27
Tare (g):	882.14	330.87
Water content (%):	0.7	6.2

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	100.0	
3"	2386.10	75	90.4	
1.5"	7534.70	37.5	69.5	
3/4"	11399.00	19	53.9	←Split
3/8"	220.76	9.5	45.5	
No.4	280.36	4.75	43.2	
No.10	299.77	2	42.4	
No.20	312.94	0.85	41.9	
No.40	340.25	0.425	40.9	
No.60	414.41	0.25	38.0	
No.100	602.79	0.15	30.8	
No.140	747.97	0.106	25.3	
No.200	898.21	0.075	19.5	



Gravel (%): 56.8
Sand (%): 23.6
Fines (%): 19.5

Entered by:___________
Reviewed:___________

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

(ASTM D6913)

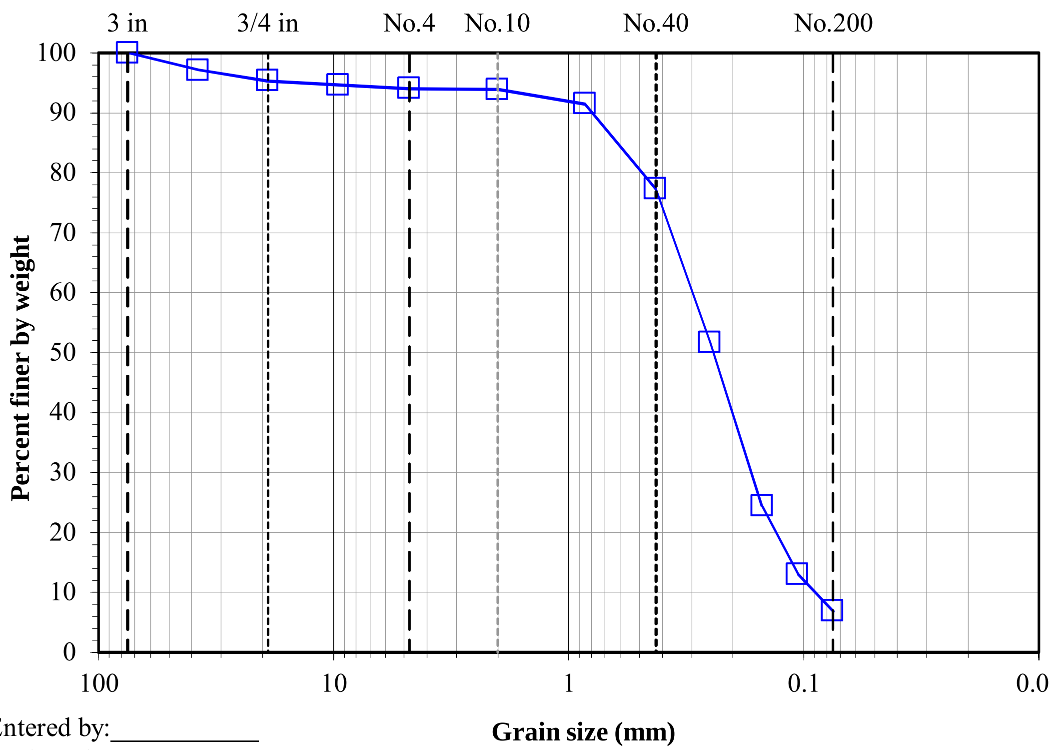
Project: Summit - Phase I E/F/G
No: 01628-012
Location: Powder Mountain, UT
Date: 10/11/2016
By: NB

Boring No.: TR-7
Sample:
Depth: 4.5'
Description: Brown sand with silt

Split:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	5204.24	5125.55
+3/8" Coarse fraction (g):	277.38	275.67
-3/8" Split fraction (g):	364.17	358.48
Split fraction:	0.946	

Water content data	C.F.(+3/8")	S.F.(-3/8")
Moist soil + tare (g):	553.93	570.15
Dry soil + tare (g):	551.81	564.46
Tare (g):	210.99	205.98
Water content (%):	0.6	1.6

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	100.0	
1.5"	148.31	37.5	97.1	
3/4"	238.80	19	95.3	
3/8"	275.67	9.5	94.6	←Split
No.4	2.17	4.75	94.0	
No.10	2.72	2	93.9	
No.20	11.92	0.85	91.5	
No.40	65.72	0.425	77.3	
No.60	162.93	0.25	51.6	
No.100	266.01	0.15	24.4	
No.140	309.12	0.106	13.0	
No.200	332.49	0.075	6.9	



Gravel (%): 6.0
Sand (%): 87.2
Fines (%): 6.9

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Reviewed:___________

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