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May 18, 2017

Watts Enterprises
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Attn: Mr. Rick Everson

IGES Project No. 01855-010

Subject: Reconnaissance-Level Geologic Hazards Assessment
Remaining Undeveloped Lots
Trappers Ridge at Wolf Creek Subdivision, Phases 5, 6, and 7
Eden, Utah

Mr. Everson:

At your request, IGES has performed a reconnaissance-level geologic hazard assessment for the remaining undeveloped lots of the Trappers Ridge at Wolf Creek Subdivision, Phases 5, 6, and 7, located in the city of Eden in Weber County, Utah (Figure A-1). This letter-report identifies the nature and associated risk of the applicable geologic hazards associated with the lots, based upon the results of the literature review and site reconnaissance conducted as part of this assessment.

INTRODUCTION

Phases 5 and 6 of the Trappers Ridge at Wolf Creek Subdivision are largely developed, with roadways and utilities installed and most residential lots developed, while Phase 7 is currently completely undeveloped and has no infrastructure yet. Remaining undeveloped lots within Phase 5 include Lots 70, 74, 76, 77, and 79. Remaining undeveloped lots within Phase 6 include Lots 110, 111, 112, 114, 115, 116, 117, 118, and 119. Phase 7 development is to include the construction of 20 residential homes (Lots 130 through 149), an extension of Big Horn Parkway, and the northernmost part of Telluride Road (Figure A-2). IGES recently completed an individual geologic hazard assessment for the Lot 110 property (IGES, 2017), so it is not included in this assessment.

It is our understanding that the proposed residential development will generally consist of two-story single-family residences founded on spread footings with slab-on-grade flooring. The Phase 5, 6, and 7 properties are located in the northwestern quarter of Section 26 of Township 7 North, Range 1 East, approximately 2 miles north of Pineview Reservoir. The properties are bound on the east by the developed Trappers Ridge Phases 1, 2, 3, and 4 lots, on the north by undeveloped Phase 8 property, and on the south and west by undeveloped farmland.

PURPOSE AND SCOPE

This study was performed as a reconnaissance-level geologic hazards assessment to identify any surficial or subsurface geologic hazards that may be extant on the remaining undeveloped

Phase 5, 6, and 7 lots or have the capability to adversely impact the lots. Specifically, this study was conducted to:

- Analyze the existing geologic conditions present on the lots and relevant adjacent areas;
- Assess the geologic hazards that pose a risk to development of the lots, 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.

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 properties and surrounding areas;
- Stereoscopic review of aerial photographs and analysis of additional available aerial imagery, including LiDAR;
- Site reconnaissance by an engineering geologist licensed in the state of Utah to map the surficial geology, determine site conditions, and assess the lots for geologic hazards; and
- 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 assessment. Sorensen and Crittenden, Jr. (1979) provides the most recent published 1:24,000 scale geologic mapping that covers the area in which the property of interest is located. Coogan and King (2016) provide more recent geologic mapping of the area, but at a regional (1:62,500) scale; this map is an updated version of a previous map by the same authors (Coogan and King, 2001) that had long been used as the most recent geologic map of the area. A United States Geological Survey (USGS) topographic map for the Huntsville Quadrangle (2014) provides physiographic and hydrologic data for the project area. A Federal Emergency Management Agency (FEMA) flood map (effective in 2015) that covers the project area was reviewed. Regional-scale geologic hazard maps pertaining to landslides (Elliott and Harty, 2010; Colton, 1991), faults (USGS and Utah Geological Survey (UGS), 2006), liquefaction (Christenson and Shaw, 2008; Anderson et al., 1994), and radon (Solomon, 1996) that cover the project area were also reviewed. More site-specific, IGES recently completed a reconnaissance-level geologic hazard assessment for the Lot 110 property (IGES, 2017).

General Geologic Setting

The Trappers Ridge Phases 5, 6, and 7 properties are situated within the northern part of the eastern end of Ogden Valley, along the foothills of the Wasatch Mountains with the westernmost (Phase 5) lots approximately 0.2 miles southeast of the Heinz Canyon drainage (see Figure A-1). Ogden Valley separates the western part of the Wasatch Range from the Bear River Range to the east, a subgroup of mountains that are part of the parent Wasatch Range. 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.

Surficial Geology

According to Sorensen and Crittenden, Jr. (1979), the Trappers Ridge Phase 5, 6, and 7 properties are located entirely on Holocene-aged (~11,700 years ago to the present) colluvium and slopewash (Qcs) deposits (Figure A-3). The unit is likely underlain by the Norwood Tuff (Tn), as several small exposures of the Norwood Tuff are present within a one-mile radius of the properties.

Most recently, Coogan and King (2016; Figure A-4) map the properties as being underlain primarily by older (upper and middle? Pleistocene-aged) block landslide deposits (Qmso(QTcg?)), which are described as "mapped where nearly intact block is visible in landslide (mostly block slide) with stratal strikes and dips that are different from nearby in-place bedrock." The QTcg? Unit, which is the block unit contained within the slide deposit, is described as Pleistocene and/or Pliocene-aged gravelly colluvial deposits, represented by "unconsolidated, poorly sorted pebble to cobble to boulder clasts in light-colored gravelly silt and sand matrix that weathers to an indistinct soil" (Coogan and King, 2016). The northernmost part of the Phase 5 property is shown to contain the contact between the Qmso (QTcg?) deposits and alluvium and colluvium deposits (Qac). The westernmost part of the Phase 5 property contains some mapped older landslide deposits (Qmso), though no lots are platted in this area. Similarly, a large southwest-trending lobe of younger landslide deposits (Qms) has been mapped through the middle of the Phase 6 property, though these are located in an area where no houses have been developed or lots platted.

Neither of the aforementioned geologic maps show any faults on the property, though Sorensen and Crittenden, Jr. (1979) show a number of faults within approximately ½ mile to the north and northwest that potentially project onto the property, all of which are cutting across the Holocene-aged colluvium (see Figure A-3). It should be noted that several of these faults are absent from the more recent (Coogan and King, 2016) publication, though the features have been reinterpreted in Coogan and King (2016) as landslide headscarps (see Figure A-4). One such headscarp is shown to extend onto the southwestern part of the Phase 5 property in an area absent of houses.

Hydrology

The USGS topographic map for the Huntsville Quadrangle (2014) shows that the Trappers Ridge Phase 5, 6, and 7 properties are situated near the middle of a broad (approximately 0.6 miles wide) topographic high that separates the Heinz Canyon drainage on the west from a sizable unnamed drainage on the east (see Figure A-1). Both drainages trend to the southwest and are noted as flowing intermittently throughout the course of a year. A smaller unnamed ephemeral drainage represents the closest watercourse to the properties, trending west before turning sharply to the southwest and separating the Phase 5 and Phase 8 areas. No springs are known to occur on the properties, though springs have been mapped approximately ½ mile to the north of the Phase 5 property and several have been noted near the large unnamed drainage, within approximately ¼ mile to the east of the Phase 7 property. Though springs are not anticipated to occur on the properties, some springs may be present during peak spring runoff times.

Baseline groundwater depths for the Phase 5, 6, and 7 properties are currently unknown, but are anticipated to fluctuate both seasonally and annually. The annual high groundwater level is likely to be attained following peak spring runoff.

The FEMA flood maps that cover the Phase 5, 6, and 7 properties show that the property is outside of the 500-year flood floodplain for both the Heinz Canyon drainage and the large unnamed drainage to the east of the property (FEMA, 2015a,b).

Geologic Hazards

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

Landslides

Two regional-scale landslide hazard maps have been produced that cover the project area. Colton (1991) shows the properties to be located within a large area that is queried as a possible landslide deposit. More recent mapping by Elliott and Harty (2010) refined the area queried by Colton (1991) and show the properties to be located within an area classified as “Landslide and/or landslide undifferentiated from talus, colluvial, rockfall, glacial, or soil-creep deposits.” As noted above, the most recent geologic map of the area (Coogan and King, 2016; see Figure A-4) displays the property to be within a large older block landslide deposit, with a younger landslide deposit (unit Qms) extending into the central part of the Phase 6 area.

Faults

Neither Coogan and King (2016) 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 properties. The closest Quaternary-aged fault to the property is the Ogden Valley Northeastern Margin Fault, which trends northwest to southeast approximately 1.3 miles northeast of the properties (USGS and UGS, 2006). 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 mapped active fault to the property is the Weber Segment of the Wasatch Fault Zone, located approximately 6.1 miles west of the western margin of the Phase 6 property (USGS and UGS, 2006).

Debris-Flows
Coogan and King (2016) do not show any mapped young alluvial fan deposits on the properties, though these deposits are found in the Heinz Canyon drainage to the west and a larger unnamed drainage to the east of the properties.

Liquefaction
Anderson, et al. (1994) and Christenson and Shaw (2008) both show the project area to be located in an area designated as having a very low potential for liquefaction.

Radon
The Solomon (1996) study area only encompasses the southwestern approximately ½ of the subject lots, all of which are shown to be located in an area with moderate radon levels. It is assumed that all lots outside of the Solomon (1996) study area also have moderate radon levels.

REVIEW OF AERIAL IMAGERY

A series of aerial photographs that cover project area were taken from the UGS Aerial Imagery Collection (UGS, 2017) and analyzed stereoscopically for the presence of adverse geologic conditions across the properties. This included a review of photos collected from the years 1946 and 1963 that were all taken prior to the development of the nearby residences and their neighborhoods. 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 in the aerial photography on the subject properties.

Google Earth imagery of the properties from between the years of 1993 and 2016 were also reviewed. No landslide or other geological hazard features were noted in the imagery. The properties were observed to have various stages of human disturbance throughout this time, beginning in August of 2003 as a product of the extensive development taking place around the subject properties during this time. This included a scarred surface, stacked oversized boulders, and multiple temporary roads utilized by construction machinery. The properties appear to have been largely unchanged between June of 2010 and the present time. The most recent imagery (July of 2016) shows the properties to be largely covered in low-lying vegetation, with scattered boulders and cobbles found in places. The Phase 7 area was observed to have large piles of boulders stacked on the property from previous excavation operations.

Utah Geological Survey 1 meter LiDAR data (UGS, 2011) for the project area was reviewed. No landslide or other geologic hazard features were readily identified on the properties, except for a suspicious feature initially considered a potential landslide scarp observed in the southwestern part of the Phase 7 property. This feature was subsequently determined from the site reconnaissance and a secondary review of historic Google Earth imagery to most likely be the product of construction activities and not represent a landslide scarp.

SITE RECONNAISSANCE

Mr. Peter E. Doumit, P.G., C.P.G., of IGES conducted reconnaissance of the site and the immediate adjacent properties on May 10, 2017. The site reconnaissance was conducted with the intent to assess the general geologic conditions present across the properties, with specific interest in the undeveloped lots and those areas identified in the geologic literature and aerial imagery reviews as potential geologic hazard areas (if identified). Additionally, the site reconnaissance provided the opportunity to geologically map the surficial geology of the area. Aside from the extensive human-disturbed areas, the local geology was observed to be consistent with that as-mapped and described by Coogan and King (2016; see Figure A-4), and therefore a site-specific geologic map was not produced for the properties.

The remaining undeveloped Phase 5 lots were all observed to have a notable approximately east-west trending break in slope near the middle of the lots, with the northern part of the lots being between 5 and 10 feet lower in elevation than the southern part of the lots. A secondary review of historic Google Earth images following the site reconnaissance showed this break in slope to coincide with previous Phase 5 construction roads. This break in slope corresponds to the contact between the alluvium and colluvium and older landslide block mapped by Coogan and King (2016; see Figure A-4), and may have been the feature used to delineate the contact. The Phase 5 lots were all bordered on the north by a small east-west trending gully that contained slowly running water at the time of the site reconnaissance. Much of the northern part of these lots also contained cattails, reeds, and other hydrophilic plants, as well as some mature trees, indicating the sustained presence of shallow groundwater in these areas. The lots were observed to generally have irregular ground surfaces that were gently sloping to the north. Scattered subangular to subrounded boulders and cobbles up to 5 feet in diameter were observed. These rocks consisted predominantly of pink to white banded to pebbly quartzite, though some pale reddish brown fine-grained, well-cemented sandstone and rare black and white speckled diorite were also observed. Construction debris, including concrete blocks, wood pieces, and other items, were also commonly found on the lots. Aside from possible shallow groundwater, no evident geologic hazards were observed for these lots during the site reconnaissance.

The remaining undeveloped Phase 6 lots were found largely to be sloping gently to the southwest, with an elevation change of at most approximately 12 feet from northeast to southwest. An uneven ground surface, the product of human disturbance, was found to be covered largely in grass across the property. Scattered across the rest of the property are angular to subangular cobbles and boulders that are variable in size, but are most commonly between 3 and 5 inches in diameter. The rock clasts present on the surface are predominantly white to purple to pink banded amorphous to pebbly quartzite, derived from the Geertsen Canyon Quartzite bedrock exposures upslope. Rare orange quartzitic sandstone, dark gray micritic limestone, and blocks of concrete were also found in areas, and represent non-native materials. Similar to as seen in the undeveloped Phase 5 lots, the northeastern side of the Phase 6 lots exhibited a southeast-trending break in slope that was subsequently found to correspond to previous excavation roads and activities, based upon a secondary review of historic Google Earth imagery. Surficial soil appeared to be a clayey sand with gravel, and commonly exhibited desiccation cracks with 2 to 4 inch spacing. No standing or running water was observed across these lots, and no hydrophilic plants were observed. No evident geologic hazards were observed for these lots during the site reconnaissance.

The Phase 7 property was observed to have an extension of Big Horn Parkway pass as a gravel road east-west through the property. North of the gravel road, the ground surface was found to have a gentle, consistent slope to the south covered in low-lying vegetation and scattered white to pink feldspathic quartzite cobbles and boulders up to 4 feet in diameter, though the mode rock size was between 8 and 12 inches in diameter. The western side of the property north of the gravel road exhibited abundant cattails. Aside from the detention basin found in the northeastern part of the property, the ground north of the gravel road was observed to have little human disturbance. South of the gravel road, the ground surface was highly irregular due to numerous piles of boulders, soil, and construction debris that had been dumped in this area. The most irregular ground including a significant break in slope was observed in the southwestern part of the property near Lots 148 and 149, and a small break in slope was observed to roughly parallel the gravel road immediately south of the road. In both cases, subsequent secondary review of historic Google Earth images indicate that these were a product of previous construction activities, and do not represent natural landslide-related features. Standing water was observed in the detention pond and in a small pond found near the east-central margin of the property. Aside from possible shallow groundwater, no evident geologic hazards were observed for the Phase 7 property during the site reconnaissance.

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 and 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 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. For areas with a high-risk geologic hazard, simple avoidance is often considered.

The following are the results of the reconnaissance-level geologic hazard assessment for the remaining undeveloped lots within the Trappers Ridge Phases 5, 6, and 7 areas.

Landslides/Mass Movement/Slope Stability

On the geologic maps reviewed for this assessment, the predominant surficial geology of the property is mapped as various forms of mass-movement deposits, including colluvium and an older block landslide. Additionally, the landslide hazard maps that cover these properties show the properties within an area that contains landslide deposits undifferentiated from colluvial deposits. Though a mapped landslide scarp extends onto the southwestern part of the Phase 5 property and a younger mapped landslide extends into the south-central part of the Phase 6 property, none of the remaining undeveloped lots are located in these areas. No landslide hazards for the property were observed in the aerial imagery or during the site reconnaissance, and the shallowly exposed surficial materials observed during the site reconnaissance were consistent with the gravelly colluvial deposits (QTcg) denoted as being the block slide material. Slopes across these properties have an average gradient ranging between approximately 7:1 and 10:1 (horizontal to vertical), and as such do not warrant site-specific local slope stability analyses. Given this data, the site-specific landslide, mass-movement, and slope stability hazard associated with these properties is considered to be low.

It should be noted, however, that the surficial deposits that cover the properties are possibly underlain by the Norwood Tuff, a geologic unit known to be landslide-prone (Ashland, 2010). Additionally, the stability of the larger, older landslide mass within which the properties are contained is unknown and beyond the scope of work for this assessment.

Rockfall

No bedrock is exposed immediately upslope of any of the lots, therefore there is no rockfall source area. As such, the rockfall hazard associated with the property is considered to be low.

Surface-Fault-Rupture and Earthquake-Related Hazards

No faults are known to be present on or projecting towards the properties, and the closest mapped active fault to the properties is the Weber Segment of the Wasatch Fault Zone, located approximately 6.1 miles to the west of the western margin of the Phase 6 property (USGS and UGS, 2006). Given this information, the risk associated with surface-fault-rupture on the property is considered low.

The entire project area 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

According to the existing geologic literature for the area, the risk associated with earthquake-induced liquefaction is expected to be low. However, both shallow groundwater and granular soils are possible to be present on the properties; therefore, we cannot preclude the possibility for liquefaction to occur onsite. A liquefaction study, which would include borings and/or CPT soundings to a depth of at least 50 feet, was not performed for this project and is not a part of our scope of work.

Debris-Flows and Flooding Hazards

The Phase 5, 6, and 7 properties are generally located on a broad topographic high between two drainages, and no alluvial fan deposits have been mapped on the property. Additionally, the properties are located outside of the 500-year floodplain for both of the drainages (FEMA, 2015a,b). Given this information, the risk associated with debris-flows and flooding hazards on the property is considered to be low. Though the Phase 5, Lot 70 property abuts the small gully near its northern margin, the drainage is considered to be too small to pose a flooding hazard, and the proposed residence is anticipated to be elevated several feet above the drainage, akin to what has been done with the developed residences present on Lots 69, 71, and 72.

Shallow Groundwater

Groundwater levels are currently unknown for the property; however, the presence of hydrophilic plants on a number of the lots suggests that shallow groundwater conditions do exist. The risk associated with shallow groundwater is to be considered high for any proposed residences that include basements. For any proposed residence that will be an on-grade structure (will not include a basement), the presence of shallow groundwater (if encountered) could necessitate localized dewatering for construction of foundations and/or utilities.

Radon

Limited data is available to address the radon hazard across the properties. However, at least one study (Solomon, 1996) shows the remaining undeveloped Phase 5 and Phase 6 lots within an area designated as having a moderate radon hazard. Though the Phase 7 lots are located outside of the Solomon (1996) study area, it is assumed that these lots also fall within an area designated as having a moderate radon hazard. As such, the radon hazard associated with all lots is considered to be moderate, and a site-specific radon hazard assessment is recommended for each individual lot to adequately address radon concerns across the properties.

CONCLUSIONS AND RECOMMENDATIONS

Based upon the data collected and reviewed as part of this assessment, IGES makes the following reconnaissance-level conclusions regarding the geological hazards present at the remaining undeveloped lots of the Trappers Ridge Phases 5, 6, and 7 properties:

- **From a reconnaissance-level perspective, the remaining undeveloped lots of the Trappers Ridge Phases 5, 6, and 7 properties do not appear to have geological hazards that would adversely affect the development as currently proposed. This includes Lots 70, 74, 75, 76, and 77 of Phase 5, Lots 111, 112, and 114 through 119 of Phase 6, and Lots 130 through 149 of Phase 7. As such, no subsurface geologic**

hazards investigative methods are considered to be necessary for the properties preceding development, and the properties are considered buildable from a geologic perspective.

- Earthquake ground shaking, shallow groundwater, and radon are the only hazards that may potentially affect all parts of the project area, while other hazards pose minimal risk.

- Landslide, rockfall, surface-fault-rupture, debris-flow, and flooding hazards are considered to be low for all of the aforementioned lots.

- Groundwater levels are currently unknown, but are likely to be near-surface. Shallow groundwater hazards are considered to pose high risk to development for any proposed residents with a basement. Shallow groundwater is considered to pose minimal risk to development for any proposed residence that is to be an on-grade structure, though the presence of shallow groundwater (if encountered) could necessitate localized dewatering for construction of foundations and/or utilities.

- Published literature indicates that the liquefaction potential for the site is expected to be low. However, due to the likely presence of granular soils, unknown depth to groundwater, and the unknown character of the subsurface soils, the potential for liquefaction occurring at the site cannot be ruled out.

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

- To adequately address the radon hazard, a site-specific radon assessment for each individual lot is recommended.

- To avoid hazards associated with shallow groundwater, it is generally recommended that all of the proposed residences be on-grade structures without basements, unless site-specific subsurface data suggests otherwise. In some cases, residences with walk-out basements may be feasible without additional mitigation. For those residences that involve the construction of a basement, it is recommended that data regarding the anticipated groundwater levels be ascertained preceding development, such that appropriate mitigation practices for dealing with shallow groundwater hazards can be implemented (if necessary). If a basement is planned, a foundation drainage system is recommended.

- Though no landslide features were observed on the lots, the surficial deposits present across the Phase 5, 6, and 7 properties are mapped as being located within a larger block landslide mass and potentially underlain by the Norwood Tuff, which is a known landslide-prone unit. Individual lot owners should understand and accept that, while the potential for landslides impacting the site is qualitatively assessed to be low, considering these items of note, the risk associated with landslide is not zero. Additionally, it is recommended that IGES observe the foundation excavation for all lots identified in this report to assess subsurface soil conditions and to assess the presence of evidence of any near-surface landslide-related features that may pose a localized threat to development on the lots.

- Given that many of the lots have excavation-induced breaks in slope present on them, appropriate grading measures are necessary on a lot-by-lot basis to reduce the risk that residences are susceptible to potential small-scale localized slope instabilities. For all lots in which these features are present, a setback of the proposed structure from the steeper slope of at least 15 feet is recommended, measured horizontally from the bottom of the foundation to the face of the slope. Additionally, reducing the risk of over-steepened slopes may include retaining walls, rockeries, and/or grading of the slope to a 2:1 H:V gradient.

LIMITATIONS

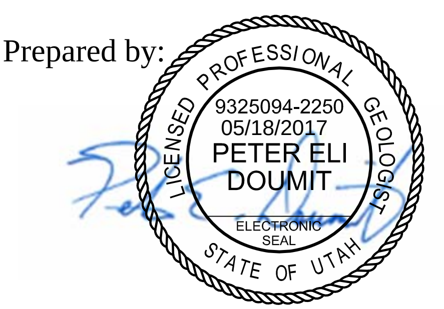
The conclusions and recommendations presented in this report are based on limited geologic literature review and site reconnaissance, and our understanding of the proposed construction. It should be noted that these conclusions are based solely upon the readily-available geological data available at the time of the preparation of this report. It is possible that geologic hazards are present that may not be identified until construction activities expose adverse geologic conditions. Therefore, the geologic hazard classifications as denoted in this report are potentially subject to change with data collected from site-specific 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.

Prepared by:



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Attachments:

References
Figure A-1: Site Vicinity Map
Figure A-2: Site Plan Map
Figure A-3: Regional Geology Map 1
Figure A-4: Regional Geology Map 2

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U.S. Geological Survey, 2014, Topographic Map of the Huntsville Quadrangle, Huntsville, Utah: Scale 1:24,000.

U.S. Geological Survey and Utah Geological Survey, 2006, Quaternary fault and fold database for the United States, accessed 5-9-17, from USGS website: http://earthquakes.usgs.gov/regional/qfaults

Utah Geological Survey, 2017, Utah Geological Survey Aerial Imagery Collection https://geodata.geology.utah.gov/imagery/

AERIAL PHOTOGRAPHS

Data Set	Date	Flight	Photographs	Scale
1947 AAJ	August 10, 1946	2B	32, 33	1:20,000
1963 ELK	June 25, 1963	2	205, 206	1:15,840

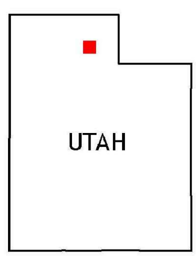
*https://geodata.geology.utah.gov/imagery/

Utah Geological Survey, 2011, Utah Geological Survey 1-Meter Lidar: data downloaded from opentopography.org.

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

BASE MAP:

USGS Huntsville 7.5-Minute Topographic Quadrangle Map (2014)



QUADRANGLE LOCATION

N

0' 1,000' 2,000' 4,000'

SCALE: 1"=2,000'

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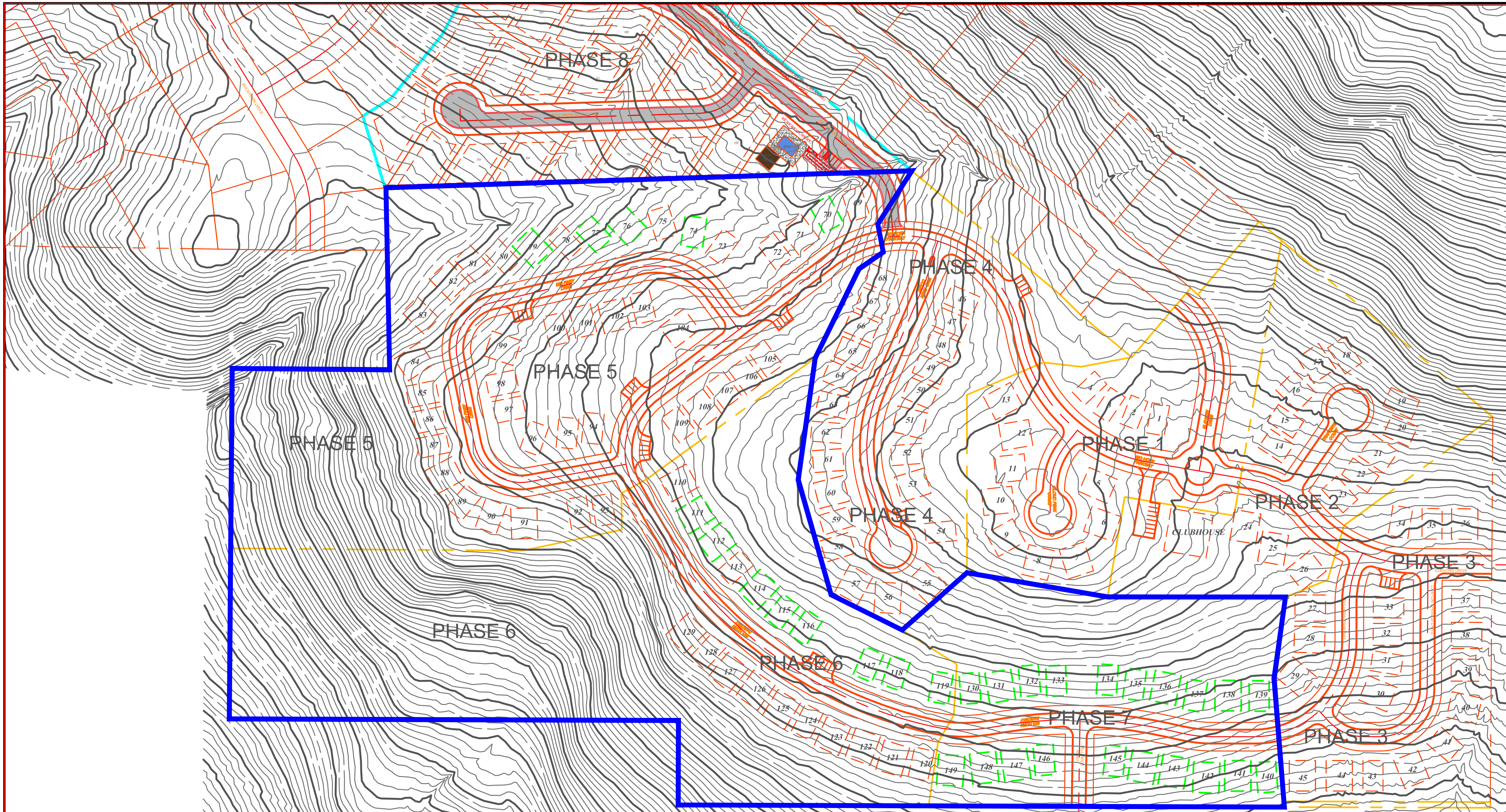
Geologic Hazard Assessment
Trapper Ridge Phases 5, 6, and 7
City of Eden
Weber County, Utah

SITE VICINITY MAP

Figure

A-1



LEGEND

PHASE 5, 6, AND 7 PROPERTIES

UNDEVELOPED LOTS OF THIS STUDY

BASE MAP PROVIDED BY CLIENT. CONTOUR INTERVAL = 2'.

0' 100' 200' 400'

SCALE: 1"=200'

N

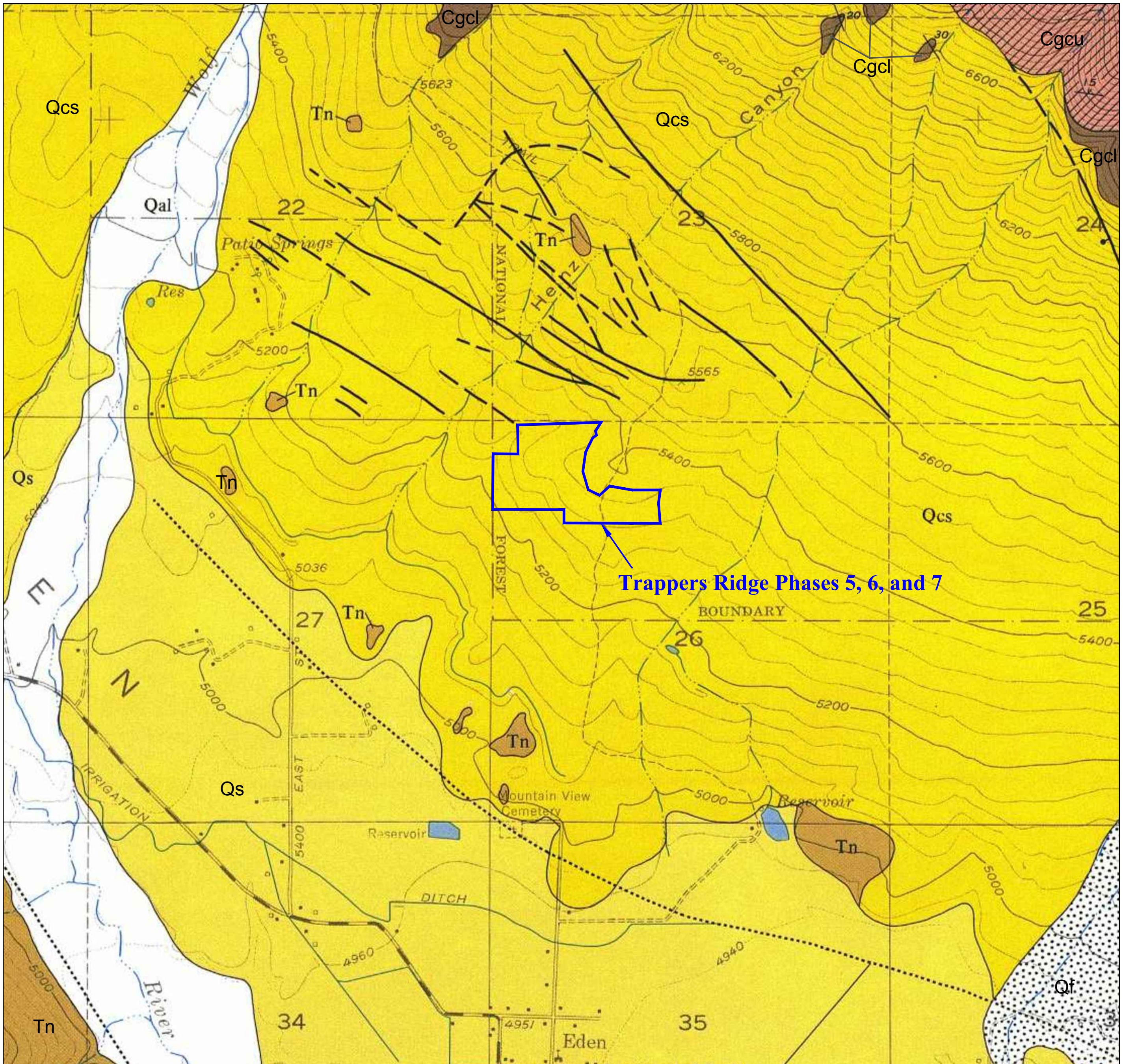
IGES

FIGURE A-2

SITE PLAN MAP

GEOLOGIC HAZARD ASSESSMENT
TRAPPERS RIDGE PHASES 5, 6, AND 7
CITY OF EDEN
WEBER COUNTY, UTAH

DATE: 05/17/2017
PROJECT:01855-010
SCALE: 1"=200'



BASE MAP:

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

QUADRANGLE LOCATION

N

0' 1,000' 2,000' 4,000'

SCALE: 1"=2,000'

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Trappers Ridge Phases 5, 6, and 7
City of Eden
Weber County, Utah

REGIONAL GEOLOGY MAP 1

Figure

A-3a

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

Qtd TERRACE AND DELTA(?) DEPOSITS (Pleistocene) – In North Fork Ogden River, gravel, sand, and silt in stream terraces graded to high stand of former Lake Bonneville; at mouth of Middle and South Fork Ogden River, pinkish-tan sand and silt in delta(?) remnants deposited during high stands of Lake Bonneville; thickness 0-45 m

Qs SILT DEPOSITS (Pleistocene) – Tan silt and sand forming extensive flats in Ogden Valley; deposited during high stands of Lake Bonneville, but may include older alluvial units; thickness 0-60 m

Tn NORWOOD TUFF (lower Oligocene and upper Eocene) – Fine- to medium-bedded, fine-grained, friable, white- to buff-weathering tuff and sandy tuff, probably waterlain and in part reworked; thickness 0-450+(?) m

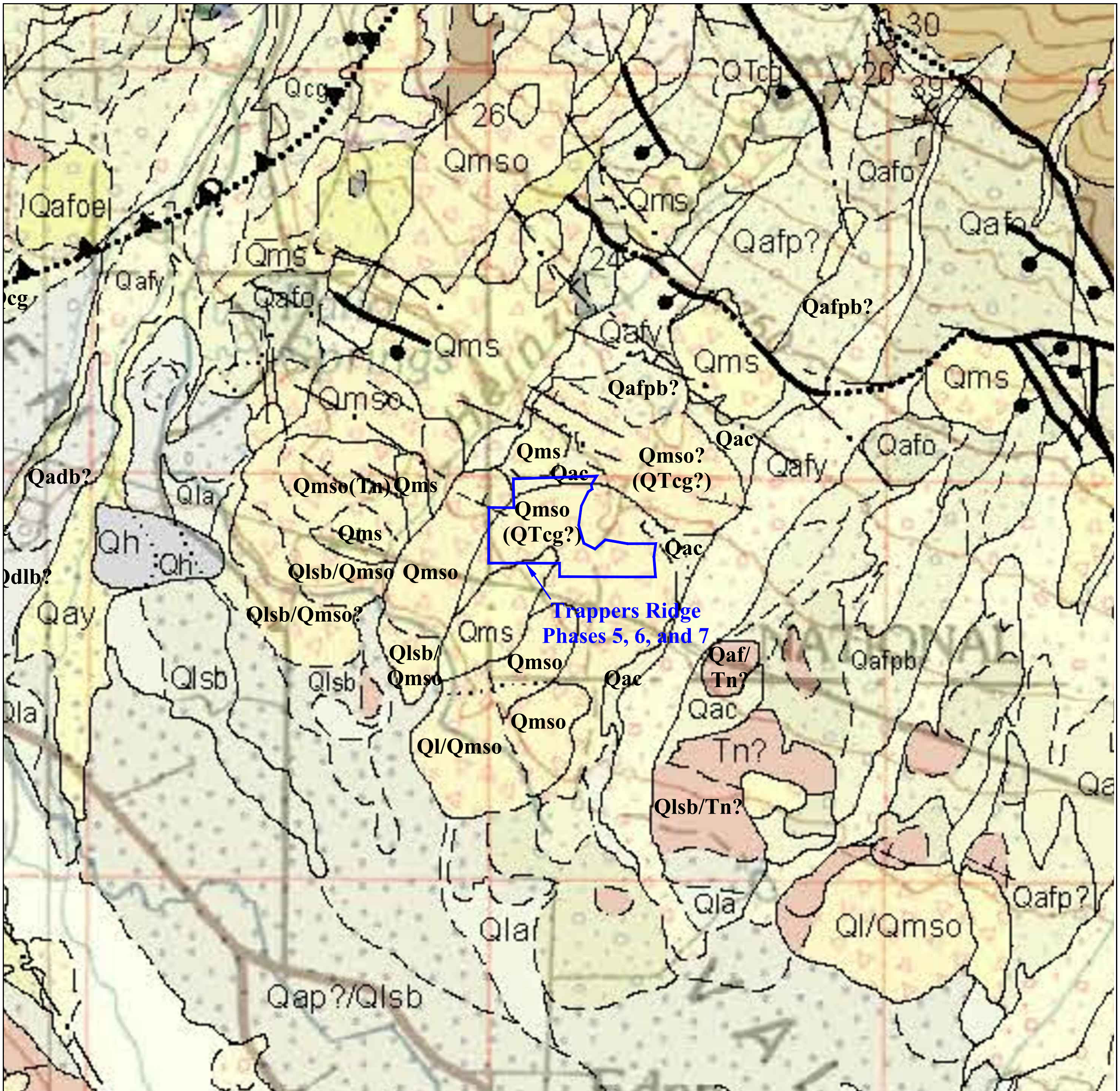
€gcu GEERTSEN CANYON QUARTZITE (Lower Cambrian) – Includes:
Upper member – Pale-buff to white or flesh-pink quartzite, locally streaked with pale red or purple. Coarse-grained; small pebbles occur throughout unit and increase in abundance downward. Base marked by zone 30-60 m thick of cobble conglomerate 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

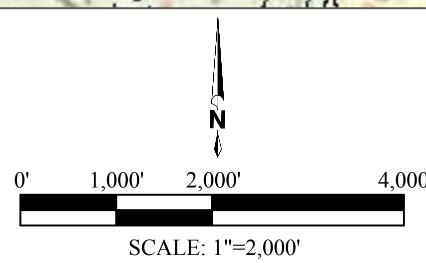
Pre-Tertiary normal fault – Dotted where concealed Bar and ball on downthrown side

Thrust fault – Dashed where inferred Sawteeth on upper plate



BASE MAP:

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



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Trappers Ridge Phases 5, 6, and 7
City of Eden
Weber County, Utah

REGIONAL GEOLOGY MAP 2

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.

Qac **Alluvium and colluvium (Holocene and Pleistocene)** – Unsorted to variably sorted gravel, sand, silt, and clay in variable proportions; includes stream and fan alluvium, colluvium, and, locally, mass-movement deposits too small to show at map scale; typically mapped along smaller drainages that lack flat bottoms; more extensive east of Henefer where Wasatch Formation (Tw) strata easily weather to debris that "chokes" drainages; 6 to 20 feet (2-6 m) thick.

QTcg, QTcg?

Gravelly colluvial deposits (Pleistocene and/or Pliocene) – Unconsolidated, poorly sorted pebble to cobble to boulder clasts in light-colored gravelly silt and sand matrix that weathers to an indistinct soil; mapped on east side of Ogden Valley; no tuff noticed in soil but thin Norwood Formation may be present in subsurface; rounded quartzite and Paleozoic carbonate clasts are like those upslope in the gravel-rich Wasatch Formation, but matrix not reddish like material typically derived from Wasatch Formation; angular clasts appear to be from underlying Geertsen Canyon Quartzite; unlike younger colluvial gravels (Qcg), stone stripes, which trend downhill, are not present or visible on aerial photographs; generally 6 to 20 feet (2-6 m) thick, but may be as much as 80 feet (25 m) thick. Some QTcg deposits previously shown as Pliocene(?) (Huntsville) fanglomerate (see Lofgren, 1955, in particular figure 19). QTcg queried where material may be units QTng or QTaf.

Qmso(QTcg?), Qmso(Ts), Qmso(Tn), Qmso(Tf), Qmso(Keh), Qmso(Xfc)
Qmso?(Qafoe), Qmso?(QTcg?), Qmso?(Ts), Qmso?(Tcg), Qmso?(Tn), Qmso?(Tf), Qmso?(Xfc)

Block landslide and possible block landslide deposits (Holocene and upper and middle? Pleistocene) – Mapped where nearly intact block is visible in landslide (mostly block slide) with stratal strikes and dips that are different from nearby in-place bedrock; unit involved in landslide shown in parentheses, for example Qms(Tw) and composition depends bedrock unit; rx shown where bedrock unit in block not known or multiple units are in the block, with Zrx shown where the units are Neoproterozoic; see surficial deposits or rock unit in parentheses for descriptions of blocks; thickness highly variable, up to about 20 to 30 feet (6-9 m) for small slides, and cross sections show larger blocks are about 150 feet (45 m) thick. Relative ages are like those for other landslide deposits (Qms, Qmso).

Qms and Qmso queried (Qms?, Qmso?) where bedrock block may be in place, that is stratal strikes and dips in queried block are about the same as nearby in-place bedrock.

MAP LEGEND

Qaf1, Qaf2, Qaf2?, Qafy, Qafy?

Younger alluvial-fan deposits (Holocene and uppermost Pleistocene) – Like undivided alluvial fans, but all of these fans are unconsolidated and should be considered active; height above present drainages is low and is within certain limits; generally less than 40 feet (12 m) thick; near former Lake Bonneville, fans are shown as Qafy where Qaf1 and Qaf2 cannot be separated, and all contain well-rounded recycled Lake Bonneville gravel. Younger alluvial fan deposits are queried where relative age is uncertain (see Qaf for details).

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

- Normal fault, approximately located
- Normal fault, approximately located, queried
- Normal fault, concealed
- Normal fault, concealed, queried
- Normal fault, well located
- Shear zone, concealed
- Shear zone, well located
- Thrust fault, approximately located
- Thrust fault, approximately located, queried
- Thrust fault, concealed
- Thrust fault, concealed, queried
- Thrust fault, well located
- Older thrust fault, concealed
- Older thrust fault, well located
- Thrust fault with later normal offset, approximately located
- Thrust fault, approximately located, queried
- Thrust fault, concealed
- Thrust fault, concealed, queried
- Thrust fault, well located
- Older thrust fault, concealed
- Older thrust fault, well located
- Thrust fault with later normal offset, approximately located
- Thrust fault with later normal offset, approximately located, queried
- Thrust fault with later normal offset, concealed
- Thrust fault with later normal offset, well located
- Fault, uncertain sense of movement, approximately located
- Fault, uncertain sense of movement, approximately located, queried
- Fault, uncertain sense of movement, concealed
- Fault, uncertain sense of movement, concealed, queried
- Fault, uncertain sense of movement, well located
- Scarp, landslide
- Scarp, terrace
- Scarp, undefined