



December 11, 2015

Summit Powder Mountain
c/o Ms. Andrea Milner
3632 North Wolf Creek Drive
Eden, Utah 84310

IGES Project No. 01628-008

Subject: Response to Additional Review Comments - Geology
Geotechnical Investigation
The Ridge Nests Development
Powder Mountain Resort
Weber and Cache Counties, Utah

Ms. Milner:

As requested, IGES has prepared the following response to additional review comments regarding the referenced geotechnical report and second review response dated November 4, 2015 for the Ridge Nests development, part of the larger Powder Mountain Resort expansion project in Weber County, Utah. The review comments to be addressed were prepared by Simon Associates LLC (SA) in a letter dated November 29, 2015; the latest comments by SA are in regard to the review response by IGES (2015d), which was prepared in response to SA's second geologic review letter (SA, 2015b) that was regarding the original review response by IGES (2015c).

The review letter by SA was intended to address Lot 13; however, in consideration that the comments by SA could also be applicable to several other lots, it is the intention of IGES to address the comments with respect to the entire Ridge Nests development. For convenience, the review comments will be presented first, followed by our response.

Comment No. 1

“Item 1 of the October 14, 2015, SA review letter, recommended Weber County request documentation of the bedding, joint, and/or fracture properties, and incorporation of the geologic data in the slope stability analyses.

On page 2 (second paragraph) of the November 4, 2015, IGES response letter, IGES states: “... These lithologies tended to fracture into rectangular blocks with highly variable dimensions, ranging in width and length from between a couple inches to several feet, though larger blocks (with dimensions of several feet x several feet x several feet) were most common (Photo 2). (italics added for emphasis).

It appears the preceding sentence from the November 4, 2015, IGES response letter is incomplete. SA recommends Weber County request IGES clarify the seeming discrepancy.”

Response to Comment No. 1

There is no discrepancy in the statement. To clarify, the larger blocks had the dimensions of several feet in length by several feet in width by several feet in height, as shown in the referenced Photo 2 of our November 4, 2015 response letter, and it was these large-dimensioned blocks that were most commonly observed on the property.

Comment No. 2

“On page 5 (first bullet) of the November 4, 2015, IGES response letter, IGES provides a definition for inactive fault, referencing Chapter 38-3 of the Weber County Natural Hazards Overlay Districts. Chapter 38-3 of the Weber County Natural Hazards Overlay Districts is obsolete (see Weber County, 2015). SA is unaware of the Weber County Code of Ordinances providing a definition for “inactive fault.” SA recommends Weber County request IGES provide definitions from current references.”

Response to Comment No. 2

An active fault is defined in Section 104-27-3 *Supplementary Hazard Definitions* of Chapter 27 of the Weber County Natural Hazards Overlay Districts (Weber County, accessed 12-08-15) 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).”

http://webercounty-ut.elaws.us/code/coor_ptii_title104_ch27

Regardless, it is deemed appropriate that a usable definition for an inactive fault, based upon the accepted definition for an active fault, is “a fault displaying evidence of equal to or less than four inches of displacement along one or more of its traces during Holocene time (approximately 11,000 years ago to the present),” or “... a fault in which the most recent displacement along one or more of its traces has occurred prior to Holocene time.” This is consistent with other geologic hazard codes in common use, e.g. the Alquist-Priolo Act of 1972 and the Draper City Geologic Hazard Ordinance, among others. For this project, the definition presented in Section 104-27-3 is considered appropriate and reasonable.

Comment No. 3

“On page 5 of the October 14, 2015, SA review letter, SA stated:

“However, regardless of the definitions, SA considers several of the factors not to be applicable in regards to timing of surface-fault-rupture, for instance: ... ‘The fault extends up to, but not through, the overlying soil profile.’ Without the age of the overlying soil profile, the statement is unsubstantiated.”

On page 5 (second paragraph) of the November 4, 2015, IGES letter, IGES responded:

“Though the age of the soil profile overlying the faults is unknown, the presence of undisturbed soil provides a lower limit for most recent displacement along the fault traces. Soil formation can take hundreds to thousands of years to develop. Taking the conservative estimate of 100 years per inch of topsoil development (NRCS)², and the fact that 3.5 feet of soil were

encountered in TP-1, provides a lower limit of at least 3,600 years since last displacement along the faults.”

The USDA National Resource Conservation Service (NRCS) referenced in the November 4, 2015, IGES letter states the following in regards to soil formation:

“One of the first processes to occur during soil formation is the movement of organic matter into the surface of a soil giving it a characteristic dark color. An often asked question is, “How long does it take to form an inch of topsoil?” This question has many different answers but most soil scientists agree that it takes at least 100 years and it varies depending on climate, vegetation, and other factors.”

“In a wet, hot climate soil horizons will form fairly quickly compared to those in cold, dry environments. Therefore, soils in cold, dry climates develop rather slowly in comparison. It is not just the amount of time that determines the degree of soil development but also the parent material, climate, vegetation, and intensity of soil- forming factors during that time that ultimately determine soil development.”

Consistent with long-established, geologic standards-of-practice (Birkeland, 1999; McCalpin, 2009), when using pedogenic development (i.e., “soil genesis”) to estimate fault activity, it is appropriate to document soil-stratigraphic development by providing at least one, representative, standard soil-profile (at times supplemented by radiocarbon ages for the pedogenic horizons) (i.e., Birkeland, 1999).

Should IGES decide to pursue pedogenic development as an “individual piece of evidence that collectively indicates fault activity,” SA recommends Weber County request IGES:

- a. Provide at least one, representative, standard soil-profile measurement and description, including the location of the profile on the site-specific geologic map.*
- b. Provide the climatic, vegetation, and other factors unique, to the subject site, supporting the applicability of the NRCS generality that it takes at least 100 years to form an inch of topsoil (which can vary depending on climate, vegetation, and other factors).*
- c. Clarify how the 3.5 feet of soil documented by IGES in TP-1 translates to 3,600 years.*
- d. Clarify how a lower limit of 3,600 years for the soil profile precludes Holocene displacement.”*

Response to Comment No. 3

IGES will not pursue pedogenic development as “an individual piece of evidence that collectively indicates fault activity,” and retracts the statements concerning an estimate of the lower limit of fault displacement based upon pedogenic development.

Comment No. 4

“On page 6 (first paragraph), of the October 14, 2015, SA review letter, SA states:

“Additionally, SA recommends Weber County suggest IGES consider the following, long established standard of practice, methods for evaluating the potential for surface-fault-rupture along the documented faults... Review of aerial photographs and surface observations to identify any fault-related geomorphic features indicative of past surface faulting at or near the property (e.g., fault scarps, vegetation lineaments, gullies, vegetation/soil contrasts, aligned springs and seeps, sag ponds, aligned or disrupted drainages, faceted spurs, grabens, and/or displaced landforms such as terraces, shorelines, geologic units, etc.).”

On page 6, fourth paragraph, of the November 4, 2015, IGES letter, IGES responded:

“IGES is unaware of any paleoseismic studies that pertain to similar geologic conditions as found in this investigation, but rather the conclusion of fault inactivity is by way of taking all of the geologic data collectively through the application of the geological principles of cross-cutting relationships and uniformitarianism.”

SA recommends Weber County request IGES:

- a. Clarify the relevance of the preceding response by IGES regarding SA’s suggestion that IGES review of aerial photographs and surface observations to identify fault-related geomorphic features is indicative of past surface faulting at or near the property.*
- b. Provide a summary with site specific examples of IGES’ “...application of the geological principles of cross-cutting relationships and uniformitarianism.””*

Response to Comment No. 4a

The paragraph in question was mistakenly placed below the stated SA paragraph regarding review of aerial photographs and surface observations. The paragraph was supposed to be placed above the SA paragraph regarding review of aerial photographs and surface observations, and was to be the conclusion paragraph for the response to SA Comment 2, not the initial paragraph of the response to the “additional recommendations.”

Response to Comment No. 4b

The principle of cross-cutting relationships is generally stated as “the geologic feature which cuts another geologic feature is the younger of the two features,” and is used as a means of the relative dating of features in geology (Vreeken, 1984). In the specific case for the faults on the Ridge Nests property, the faults do not cut across the soil and have not produced any notable fault-related geomorphic features on the surface. Application of the principle of cross-cutting relationships displays that the fault and movement along the fault are older than the soil, vegetation, and the present geomorphic surfaces extant at the site (note: the fact that the faults do not displace the soil or vegetation is an observation intended to respond to the reviewer’s question and is not intended herein to present evidence to preclude Holocene-age fault activity).

The principle of uniformitarianism is defined as “the fundamental principle that geological processes and natural laws now operating to modify the earth’s crust have acted in much the same manner and with essentially the intensity throughout geologic time, and that past geologic events can be explained by forces observable today; the classical concept that ‘the present is

the key to the past.’ The doctrine does not imply that all change is at a uniform rate, and does not exclude minor local catastrophes.” (AGI, 1984).

Application of the principle of uniformitarianism to the Ridge Nests site shows that the slow rate of weathering seen in dolomite in modern environments (see Gauri et al., 1992) is likely to have been slow in the geologic past. Because an active fault would induce 4+ inches of displacement of the dolomite bedrock during Holocene time, and given the known weathering rate of dolomite, an active Holocene-aged fault would still show some surficial geomorphic expression of the fault scarp. Since there is no such fault scarp observed, it can be reasonably concluded that the faults are inactive based upon the definition of an inactive fault provided in the response to Comment 2.

Comment No. 5

“In regards to SA’s recommendation that Weber County suggest IGES review aerial photographs to identify fault-related geomorphic features indicative of past surface faulting at or near the property, the November 4, 2015, IGES letter stated (page 6):

“Regarding the additional recommendations from SA, IGES reviewed aerial photographs, conducting surface observations, and reviewing the USGS Quaternary Fault and Fold Database of the United States prior to the submittal of the September 23, 2015 letter; regrettably, this information was not incorporated into our response. Prior to undertaking the fieldwork for this investigation, IGES reviewed the Western GeoLogic report for the area (Western GeoLogic, 2012), in which aerial photographs were analyzed and no faults were identified. Additionally, the USGS Quaternary Fault and Fold Database of the United States was reviewed, with the closest fault to the area of investigation being approximately 2.5 miles to the southwest. IGES also analyzed current and historic Google Earth imagery for the area, and did not identify any surficial features relating to faulting in the area. Finally, surface observations were made during the field investigation, and no surficial expression of the faults were found except in the road cut north of the planned development.”

SA recommends Weber County request IGES:

- a. Clarify if IGES actually reviewed aerial photographs or is deferring to Western GeoLogic (2012) report.*
- b. Provide the source, date, flightline number, and scale of the stereoscopic aerial photographs reviewed, if any.*
- c. Provide site specific data to support “...no surficial expression of the faults were found except in the road cut north of the planned development.”*

Response to Comment No. 5

IGES reviewed three stereo pairs of aerial photographs that cover the Ridge Nests property and adjacent areas. The aerial photographs reviewed for this exercise are listed in Table 1. The aerial photographs were examined stereoscopically for the presence of photo-lineaments which might be indicative of faulting, as well as other additional geomorphic features. No photo-lineaments

were observed either crossing or projecting toward the subject property. Additionally, no fault-related geomorphic features indicative of past surface faulting at or near the property, including fault scarps, vegetation lineaments, gullies, vegetation/soil contrasts, aligned springs or seeps, sag ponds, aligned or disrupted drainages, faceted spurs, grabens, or displaced landforms were observed in either the aerial photograph reviewed or the site reconnaissance (surface observations detailed in the IGES response letter dated September 1, 2015).

Table 1
Stereoscopic Aerial Photographs Reviewed

| SOURCE* | DATE | FLIGHT | PHOTOGRAPHS | SCALE |
|----------|--------------------|--------|-------------|----------|
| 1947 AAJ | August 10, 1946 | AAJ_1B | 88-90 | 1:20,000 |
| 1953 AAI | September 14, 1952 | AAI_4K | 34-36 | 1:20,000 |
| 1963 ELK | June 25, 1963 | ELK_3 | 57-59 | 1:15,840 |

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

IGES reviewed the USGS Quaternary Fold and Fault Database of the United States, and no faults have been mapped on the property. The closest fault to the area of investigation is located approximately 2.5 miles to the southwest.

The absence of lineaments and fault-related geomorphic evidence in the aerial photograph and surface observation investigations constitutes reasonable geologic evidence that the faults observed in the road cut are pre-Holocene age and are to be considered inactive. As a result, from the standpoint of surface-fault-rupture, the area investigated is suitable for the proposed development.

Closure

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

Respectfully Submitted,
IGES, Inc.

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

Reviewed by:

C. Charles Payton, P.G.
Engineering Geologist

Attachments:

References

References

- American Geological Institute (AGI), 1984, Dictionary of Geological Terms, Robert L. Bates and Julia A. Jackson (editors), published by Doubleday.
- Gauri, K.L., Tambe, S.S., and Caner-Saltik, E.N., 1992, Weathering of Dolomite in Industrial Environments: Environmental Geology and Water Sciences, Vol. 19, Iss. 1, pp. 55-63.
- IGES, Inc., 2014, Geotechnical Investigation, The Ridge Nests Development, Powder Mountain Resort, Weber and Cache Counties, Utah Project No. 01628-008, dated September 16, 2014.
- IGES, Inc., 2015a, Response to Review Comments, Geotechnical Investigation, The Ridge Nests Development, Powder Mountain Resort, Weber and Cache Counties, Utah Project No. 01628-008, dated April 7, 2015.
- IGES, Inc., 2015b, Addendum to Geotechnical Report, The Ridge Nests Development, Powder Mountain Resort, Weber and Cache Counties, Utah Project No. 01628-008, dated August 18, 2015.
- IGES, Inc., 2015c, Response to Review Comments – Geology, Geotechnical Investigation, The Ridge Nests Development, Powder Mountain Resort, Weber and Cache Counties, Utah, Project No. 01628-008, dated September 23, 2015.
- IGES, Inc., 2015d, Response to Additional Review Comments – Geology, Geotechnical Investigation, The Ridge Nests Development, Powder Mountain Resort, Weber and Cache Counties, Utah, Project No. 01628-008, dated November 4, 2015.
- Simon Associates, LLC, 2015a, Geologic Review, Lot 13, Ridge Crest Subdivision, 7914 East Heartwood Drive, Eden, Utah, SA Project No. 15-160, dated August 18, 2015.
- Simon Associates, LLC, 2015b, Geologic Review, Lot 13, Ridge Nests Subdivision, 7914 East Heartwood Drive, Eden, Utah, SA Project No. 15-160, dated October 14, 2015.
- Simon Associates, LLC, 2015c, Geologic Review, Lot 13, Ridge Nests Subdivision, 7914 East Heartwood Drive, Eden, Utah, SA Project No. 15-160, dated November 29, 2015.
- Vreeken, W.J., 1984, Relative Dating of Soils and Paleosols, in *Quaternary Dating Methods*, Mahaney, W.C. (editor), Elsevier Science Publishing Co. 1984.
- Western Geologic, 2012, Report: Geologic Hazards Reconnaissance, Proposed Area 1 Mixed-Use Development, Powder Mountain Resort, Weber County, Utah, dated August 28, 2012.