GORDON
GEOTECHNICAL
ENGINEERING, INC.

January 11, 2017
Job No. 406-01A-16

Distinct Homes, LLC
2490 Wall Avenue
Ogden, Utah 84401

Attention: Mr. Kevin Parkinson

Re: Professional Geologist Review and Supplemental Addendum

for:

Geologic Reconnaissance Study
Buildable Area Expansion
Emerson Hills Subdivision Lot #12
Liberty, Utah
September 23, 2016

INTRODUCTION

This letter has be prepared as a review and a supplemental information addendum in support of our previous September 23, 2016 Geological Reconnaissance Study referenced above.

In our previous study we addressed Slope Stability and Landslide Hazards, Rockfall Hazard, Flood zone hazards, Shallow Groundwater, Expansive Soil and Rock, and Indoor Radon-Hazards issues. For this review supporting and concurrent information is provided to support September 23, 2016 Report.

The purpose of the review is to address the hazards that are included in the Weber County Code, Chapter 27, Natural Hazards Overlay District criteria. These hazards include, but are not limited to: Surface-Fault Rupture, Landslide,
Tectonic Subsidence, Rock Fall, Debris Flows, Liquefaction Areas, Flood, or other Hazardous Areas (Weber County Code, 2016).

Resources supporting this review included; our previous September 23 2016, report (Gordon Geotechnical Engineering, Inc., 2016a); previous reports within the site vicinity (AGRA Earth & Environmental, 1997; GCS Geoscience, 2016), and a GIS data integration effort that included previous mapping and literature pertaining to site geology including Coogan and King (2016),

Crittenden and Sorensen (1985); an analysis of vertical and stereoscopic aerial photography for the site including a 1946 1:20,000 stereoscopic sequence, a 2014 1.0 meter color digital NAIP coverage, and a 2012 5.0 inch digital color HRO coverage of the site; and a GIS analysis using the QGIS® GIS platform to geoprocess and analyze 2011 1.0 meter LiDAR digital elevation data made available for the site by the Utah Automated Geographic Reference Center (AGRC).

GEOLOGIC HAZARDS REVIEW

The summation of our review is presented on Figure 1, Geologic Hazards Review, which presents the site layout and limiting geoenvironmental conditions. Also shown on Figure 1, are property boundaries and "buildable area" zones that were projected from Gardner Engineering drawings titled "Topographic Site Plan For Kevin Parkinson, Lot 12, Emerson Hills Subdivision Phase 3," dated September 6, 2016, and assumed as reliable.

In addition to the review and location query we searched for nearby or proximal classifications or conditions that could possibly present hazardous conditions to the site. A summary of our findings is provided as follows:

1. Landsliding: The nearest landslide units as mapped by Cogan and King (2016) are located approximately 875 feet to the east of the property, and should not potentially impact the proposed buildable areas on the site.

2. Alluvial fan debris flow processes, including flash flooding and debris flow hazard: The nearest occurrence of alluvial fan debris flow deposits occurs at the mouth of Durfee Creek, where Durfee Creek joins the North Fork Ogden River. These deposits occur on the very northeastern margin of the property, on the north side of North Fork Ogden River. The proximity of these deposits to the buildable areas on the site indicate these hazards to be improbable to the homesite building areas.

3. Surface fault rupture hazards, strong earthquake ground motion, and liquefaction:

Active Earthquake Faults: The nearest active (Holocene) earthquake fault to the site is the Weber segment of the Wasatch fault zone (UT2351E) which is located 3.5 miles southwest of the site, thus fault rupture hazards are not considered present on the site (Black et al., 2004). The Ogden Valley North Fork fault (UT2376) is located much closer to the site, approximately 2500 feet to the west of the property, however the most recent movement along this fault is estimated to be pre-Holocene (greater than 15,000 years before present), and presently is not considered an active risk (Black, et al., 1999).

Strong earthquake ground motion originating from the Wasatch fault or other near-by seismic sources is capable of impacting the surrounding region including the site. The Wasatch fault zone is considered active and capable of generating earthquakes as large as

magnitude 7.3 (Arabasz et al., 1992). Based on probabilistic estimates (Peterson, et al., 2008) queried for the site, the expected peak horizontal ground acceleration on rock from a large earthquake with a ten-percent probability of exceedance in 50 years is as high as 0.19*g*, and for a two-percent probability of exceedance in 50 years is as high as 0.44*g* for the site.

The a 10-percent probability of exceedance in 50 years event has a return period of 475 years, and the 0.19*g* acceleration for this event corresponds "very strong" perceived shaking with "moderate" potential damage based on instrument intensity correlations (Wald et al., 1999).

The 2-percent probability of exceedance in 50 years event has a return period of 2475 years, and the 0.44*g* acceleration for this event corresponds "severe" perceived shaking with "moderate to heavy" potential damage based on instrument intensity correlations (Wald et al., 1999).

Future ground accelerations greater than these are possible but will have a lower probability of occurrence.

Liquefaction Potential Hazards: In conjunction with strong earthquake ground motion potential of large magnitude seismic events as discussed previously, certain soil units may also possess a potential for liquefaction during a large magnitude event. Liquefaction is a phenomenon whereby loose, saturated, granular soil units lose a significant portion of their shear strength due to excess pore water pressure buildup resulting from dynamic loading, such as that caused by an earthquake. Among other effects, liquefaction can result in densification of such deposits causing settlements of overlying layers after an earthquake as excess pore water pressures are dissipated. Horizontally continuous liquefied layers may also have a potential to spread laterally where sufficient slope or freeface conditions exist. The primary factors affecting liquefaction potential of a soil deposit are: (1) magnitude and duration of seismic ground motions; (2) soil type and consistency; and (3) occurrence and depth to groundwater.

Liquefaction potential hazards have not been studied or mapped for the Ogden Valley area, as has occurred in other parts of northern Utah (Anderson et al., 1994). Because this phenomena is known to occur in susceptible alluvial sediments in conjunction with shallow groundwater conditions, we consider areas mapped as alluvium such as those in the site vicinity along the North Fork Ogden River as potentially susceptible to liquefaction during a future earthquake event. In Weber County, where "High/Moderate" liquefaction potential conditions have been identified or mapped, liquefaction hazard studies are nevertheless not required for residential subdivisions, however the disclosure that "High/Moderate" liquefaction potential may be present is required, as specified by Chapter 27, Sec. 104-27-5 of the Weber County Code (Weber County Code, 2016).

5. Rockfall and Avalanche hazards: The site is over a mile from steep slope areas where such hazards may originate.

6. Flooding: Mapping by Federal Emergency Management Agency (FEMA, 2015) is shown on Figure 1. The Zone A shown on Figure 1, includes the 100-year flood hazard zone as delimited by recent FEMA studies conducted in the Ogden Valley area. On the basis of the FEMA determination *...mandatory flood insurance purchase requirements and floodplain management standards apply...*for improvements made in the Zone A area shown on Figure 1. Shown on Figure 1, the Zone A FEMA mapping for the North Fork Ogden River does not appear to contact the "buildable area" parts of the site where the river crosses on the north side the site.

Also shown on Figure 1, is the UTABA Dam Failure Inundation mapping as prepared by Weber county to evaluate the area of inundation should dam failure occur at the UTABA Dam which is located approximately 1.3 miles up-stream from the site on the North Fork Ogden River (Bridges, 1977). The estimated inundation area from failure of the UTABA Dam is shown on Figure 1, and is presumed to be the worst-case scenario calculated by the County Engineers (Weber County Engineering, 1994), and probability of this occurrence is very low.

7. Sloping Surfaces: The surface of site slopes developed from our LiDAR analysis range from level to well over 50-percent as shown on Figure 1. For the overall 5.44-acre area of the site, slope gradients averaged 36.4 percent, with the slopes ranging from 0.0 to 100.0 percent. For the existing buildable area the slope gradient averaged 23.9 percent, and the proposed-expanded buildable area the slope gradient averaged 17.1 percent.

The steeper slope areas in excess of 25 percent are shown on Figure 1, with the steeper sloping surfaces on the site concentrated on a steep riser slope located immediately to the southwest of the existing and proposed-expanded buildable areas on the site. The threshold gradient for slope development considerations and hillside review according to the Weber County Section 108-14-3 (Weber County Code, 2016), includes slopes greater that 25-percent.

8. Expansive Soil and Rock and Collapsible Soils: A previous geotechnical evaluation for the buildable areas on the site was conducted by our office, and a report summarizing our findings was prepared on August 12, 2016 (Gordon Geotechnical Engineering, Inc., 2016b). No expansive soil and rock, or collapsible soils were encountered in the two test pits excavated for the geotechnical study, however geotechnical recommendations for site preparation and development were provided.

9. Radon Exposure: Radon is a naturally occurring radioactive gas that has no smell, taste, or color, and comes from the natural decay of uranium that is found in nearly all rock and soil. Radon and has been found occur in the Ogden Valley area, and can be a hazard in buildings because the gas collects in enclosed spaces. Indoor testing following construction to detect and determine radon hazard exposure should be conducted to determine if radon reduction measures are necessary for new construction. The radon-hazard potential mapping has been

prepared for most of Ogden Valley by the Utah Geological Survey (Solomon, 1996), and the site appears to be located in an area mapped as having a "Moderate" to "High" radon potential classification. For new structures radon-resistant construction techniques as provided by the EPA (EPA 2016) should be considered.

CONCLUSIONS

Based upon the findings of this review we believe that the proposed homesite development within the identified existing and proposed-expanded buildable areas located on the 5.44-acre property will not be excessively exposed to the geological hazards specified by the Weber County Natural Hazards Overlay District code (Weber County Code, Chapter 27) to preclude this development.

Although not addressed by the Weber County ordinances, we recommend that radon exposure be evaluated for all proposed dwellings to determine if radon reduction measures are necessary for the new residential construction. It is our understanding that new construction in Ogden Valley area often includes radon remedial measures as part of final design.

CLOSURE

If you have any questions or would like to discuss these items further, feel free to contact us at (801) 327-9600.

Respectfully submitted,

Gordon Geotechnical Engineering, Inc.

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Encl. Figure 1, Geologic Hazards Review

Addressee (email only)

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Weber County Engineering, 1994, Weber County, Utah UTABA Dam Failure Inundation Map: Weber County Engineering unpublished mapping, scale 1:24,000

Emerson Hills Subdivision Lot #12
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Property

North Fork Road

Durfee Creek

North Fork Ogden River

Cold Canyon

Explanation

- Property Boundary (5.44 acres)
- Recorded Buildable Area (2008)
- Proposed-Expanded Buildble Area (this study)

Note:
Property boundaries and "buildable area" zones are projected from Gardner Engineering drawings titled "Topographic Site Plan For Kevin Parkinson, Lot 12, Emerson Hills Subdivision Phase 3," dated 9/6/16, and are assumed reliable

Slope Gradients

- 25% to 30%
- Greater than 30%
- Index Contour (10ft)

Flood Hazards

- FEMA Zone A - Areas subject to inundation by the 1-percent-annual-chance flood event generally determined sing approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply (FEMA 2015).
- UTABA Dam Failure Innundation Mapping (1994) Rainy Day Inundation Zone

Base:
2012 5.0 inch HRO Color Orthoimagery,
from Utah AGRC; http://gis.utah.gov/
Topography/Slope:
2011 1.0m LiDAR Imagery
from Utah AGRC; http://gis.utah.gov/

0 100 200 300 ft

1:1,200

FIGURE 1
GEOLOGIC HAZARDS REVIEW

GORDON GEOTECHNICAL ENGINEERING, INC.