COLORADO GEOLOGICAL SURVEY

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Karen Berry
State Geologist

June 4, 2015

Lonna Thelen, AICP, LEED AP
Planning & Development, Land Use Review Division
City of Colorado Springs
P.O. Box 1575
Colorado Springs, CO 80901

Location:
NW¼ SE¼ NW¼ Section 29,
T13S, R66W of the 6th P.M.
38.8926, -104.807

Subject: Bates Student Housing – 702 Cragmor Road
City of Colorado Springs, El Paso County, CO; CGS Unique No. EP-15-0024

Dear Ms. Thelen:

Colorado Geological Survey has reviewed the Bates Student Housing referral at 702 Cragmor Road. I understand the applicant proposes a five- to six-story, approx. 700 ft x 240 ft, 217-unit student housing building with a five-story parking garage (one parking level will be below-grade), clubhouse/fitness center, pool, and other amenities on 5.7 acres. With this referral, CGS received a Drainage Report (JPS Engineering, April 28, 2015), a Preliminary Geologic Hazards Study and Geotechnical Report (Terracon, May 15, 2015), and a set of six Development, Landscape, Site Grading and Erosion Control, and Utility Plans, and Conceptual Elevation drawings (NES, April 29, 2015, various authors and dates).

The site is located west of the UCCS campus, northeast of the intersection of Cragmor Road and Stanton Street. Katherine Lee Bates Elementary School (now closed) occupies the site. It is our understanding that the school building will be demolished and the site regraded for the apartment development.

Terracon provides a valid description of site geology (older fan deposits overlying coal-bearing Laramie Formation), geotechnical constraints and preliminary foundation design recommendations, and a valid *preliminary* mine subsidence hazard assessment.

The site is undermined by the Altitude/Williamsville Mine at depths between 120 and 139 feet below the ground surface. The coal seam was reported as between 3-4 feet thick, but the mined thickness may have been greater for access purposes. An air shaft, mapped as Air Shaft No. 7, may be located in the northern part of the site. It is not known whether this shaft, if present, has been properly sealed and capped. A subsidence event (recorded as a "cave-in"), possibly related to the air shaft, was reported to OSM in the late 1970s. Numerous subsidence events and sinkholes, some involving damage to residential structures and requiring mitigation, have been documented south and southwest of the site.

Additional borings and downhole logging. Terracon's three deep borings are insufficient to adequately characterize the condition of mine workings, voids, and subsidence hazard for a structure this large. CGS agrees with Terracon that additional borings on approximately 40-50 ft spacing within and around the footprints of all proposed structures will be needed to adequately characterize the subsidence hazard on this site, to determine maximum strain values (based on observed void thicknesses and depth and width of mine workings) and maximum predicted subsidence for use in determining allowable foundation lengths and

designing foundations. CGS is concerned that the proposed foundation length may be too long to withstand potential ground movement without sustaining appreciable or greater damage. Foundations must be sized and designed to withstand maximum anticipated strains without experiencing greater than slight structural damage as described in an accepted source such as the UK National Coal Board's Subsidence Engineers' Handbook. The borings must penetrate the mined interval, and downhole caliper, density and gamma logging should be conducted. Caliper data is needed to determine the presence and thickness of voids for use in the strain analysis. The borings do not necessarily need to be cored, although coring generally produces the cleanest borehole for logging purposes.

Air shaft and geophysical techniques. The shaft, thought to be associated with the cave-in reported to OSM in 1979, must be located, stabilized and capped, and documentation of proper abandonment should be provided to CGS. A non-buildable setback of a **minimum** of 30 feet from the sealed shaft should be incorporated into development plans. Terracon states that they may perform multi-point electrical resistivity ground surveys in an effort to characterize lateral extent of mine workings, and that a ground penetrating radar survey is planned to locate Air Shaft No. 7 and other potential subsidence features. Geophysics can be useful characterization tools, but should not be considered a replacement for borings and a visual inspection to confirm the location of the shaft.

In summary, a more thorough subsidence investigation should be required before the development as proposed is determined to be feasible. CGS strongly suggests the investigation be performed and submitted to CGS for review prior to development approval.

Based on the results of the subsidence investigation, elements of the development plan will likely need to be adjusted. This may include moving the location of the fitness/clubhouse building, pool, and northern portion of the building away from the shaft location, adjusting development plans to create smaller foundation segments, realignment of the development to minimize potential subsidence damage, and designing foundations, pavements, and utilities to withstand expected strains or ground deformations.

CGS looks forward to reviewing additional subsidence hazard analysis, recommendations, and shaft location and stabilization results submitted by the applicant. If you have questions or require further review, please call me at 303-384-2643, or e-mail carlson@mines.edu.

Sincerely,

Jill Carlson, C.E.G.
Engineering Geologist