UTAH GEOLOGICAL SURVEY
a division of
Utah Department of Natural Resources

Plate 7
Utah Geological Survey Special Study 127
Geologic Hazards and Adverse Construction Conditions,
St. George–Hurricane Metropolitan Area, Washington County, Utah

PLATE 7

COLLAPSIBLE-SOIL-SUSCEPTIBILITY MAP FOR THE ST. GEORGE–HURRICANE METROPOLITAN AREA

by

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Approximate mean declination, 2007

Map Location

Basemap consists of National Agricultural Imagery Program natural color aerial photography.

Universal Transverse Mercator Projection, zone 12.
North American Datum 1983.

Scale 1:24,000

1 0.5 0 1 2 Miles

1 0.5 0 1 2 Kilometers

SYMBOLS

- Municipality boundary
- Interstate Highway
- State Highway
- Major local surface street
- Other road

EXPLANATION

HCS Area of known high collapse soils. Areas identified by geotechnical consultants working in the St. George – Hurricane metropolitan area as containing high collapse (≥6 percent) soils. Soils in these areas have a high potential for collapsible soil problems.

CS_A Unconsolidated geologic units with reported collapse values of ≥3 percent.

CS_B Unconsolidated geologic units lacking collapse data, but for which other geotechnical information (chiefly low unit weight and moisture content) are indicative of collapse-susceptible material.

CS_C Geologically young (Holocene) unconsolidated geologic units for which no geotechnical data are available, but whose genesis or texture are permissive of collapse (chiefly geologically young alluvial, colluvial, and eolian deposits).

CS_D Older unconsolidated geologic units (Pleistocene) for which no geotechnical data are available, but like category CS_C, have a genesis or texture permissive of collapse. Because of their age, these deposits have had greater exposure to natural wetting and collapse may have occurred, and/or the deposits may have become cemented by secondary calcium carbonate or other soluble minerals.

Geologic Deposits Known or Likely to Have a Significant Potential for Soil Collapse

Type of Deposit	Map Units[1]	Collapsible Soil Category
Stream and Terrace Alluvium	Qal$_1$, Qal$_2$, Qal$_3$, Qal$_4$, Qal$_5$, Qal$_6$, Qal$_7$, Qal$_8$, Qal$_9$, Qal$_{10}$, QTal$_1$, QTal$_2$, QTal$_3$, QTal$_4$, QTal$_5$, QTal$_6$, QTal$_7$, Qaly, Qas	CS_A, CS_B, CS_D
Fan Alluvium	Qae, Qaic, Qaip, Qafi, Qafo$_1$, Qafo$_2$, Qaeo	CS_A, CS_C, CS_D
Eolian Deposits	Qa, Qaes, Qaec, Qafy, Qac, Qap$_1$, Qap$_2$, Qaeo	CS_C, CS_D
	Qaeg, Qah, Qabo, Qap, Qap$_1$, Qap$_2$, Qap$_3$, Qafi$_1$, Qafi$_2$, Qmfo, Qaiw	CS_D
	Qes, Qea, Qea$_1$, Qea$_2$, Qes/Qafi, Qes/Qafo, Qe/Qmtry	CS_A
	Qes$_1$, Qec	CS_C
	Qes$_2$, Qec^1, Qeo	CS_D
Colluvial Deposits	Qcs	CS_A
	Qmt	CS_B
	Qc	CS_C
	Qmto, Qcao, Qco	CS_D

[1]Refer to UGS 1:24,000-scale geologic maps (see SOURCES OF DATA and REFERENCES sections in accompanying text) for a description of map units.

DISCUSSION

Collapsible soils have considerable dry strength and stiffness in their dry natural state, but can settle up to 10 percent of the susceptible deposit thickness when they become wet for the first time following deposition causing damage to property and structures. Collapsible soils are common in the St. George – Hurricane metropolitan area, and are typically geologically young materials, chiefly debris-flow sediments in Holocene-age alluvial fans, and some wind-blown and colluvial deposits. Collapsible sediments typically have a high void ratio and corresponding low unit weight and relatively low moisture content, all characteristics that result from the initial rapid deposition and drying of the sediments. Intergranular bonds form between the larger grains (sand and gravel) of a collapsible deposit; these bonds develop through capillary tension or a binding agent such as silt, clay, or salt. Later wetting of the soil results in a loss of capillary tension or the softening of the bonding material allowing the larger particles to slip past one another into a denser structure. Alluvial-fan soils exhibiting dramatic collapse behavior typically contain 10 to 15 percent clay-size material; at clay contents greater than about 12 to 15 percent, the expansive nature of the clay begins to dominate and the soil is subject to swell rather than collapse. Naturally occurring deep percolation of water into collapsible deposits is uncommon after deposition due to the arid conditions in which the deposits typically form, and the steep gradient of many alluvial-fan surfaces. Therefore, soil collapse is usually triggered by human activity such as irrigation, urbanization, or disposal of waste water. Because collapsible soil rarely if ever causes rapid, catastrophic property damage or is a threat to life safety, for purposes of this study, collapsible soil is considered an adverse construction condition and not a geologic hazard.

For additional information about collapsible soil in the St. George – Hurricane metropolitan area, refer to the Problem-Soil-and-Rock text document in this report.

USING THIS MAP

The Collapsible-Soil-Susceptibility Map shows the location of known and suspected collapsible-soil conditions in the St. George – Hurricane metropolitan area. The map is intended for general planning purposes to indicate where collapsible-soil conditions may exist and special studies may be required. The UGS recommends performing a site-specific geotechnical foundation/geologic-hazards study for all development at all locations in the study area. Site-specific studies can resolve uncertainties inherent in generalized mapping and help ensure safety by identifying the need for special foundation designs or mitigation techniques. The presence and severity of collapsible soil along with other adverse construction conditions and geologic hazards should be addressed in these investigations. If collapsible soil is present at a site, appropriate design recommendations should be provided.

MAP LIMITATIONS

The Collapsible-Soil-Susceptibility Map is based on limited geologic and geotechnical data; site-specific studies are required to produce more detailed geotechnical information. The map also depends on the quality of those data, which varies throughout the study area. The mapped boundaries between susceptibility categories are approximate and subject to change with additional information. The susceptibility may be different than shown at any particular site because of geological variations within a map unit, gradational and approximate map-unit boundaries, and the small map scale. This map is not intended for use at scales other than the published scale, and is designed for use in general planning to indicate the need for site-specific studies.

MITIGATION

Although potentially costly when not recognized and properly accommodated in project design and construction, problems associated with collapsible soil rarely are life threatening. As with most adverse construction conditions, early recognition and avoidance is the most effective way to mitigate potential problems. However, collapsible soil is widespread in the St. George – Hurricane metropolitan area, and avoidance is generally not a viable or cost-effective mitigation option.

In Utah, soil-test requirements are specified in the soil and foundations provisions of IBC Chapter 18 (p. 343) and the foundations provisions of IRC Chapter 4 (p. 42), which are adopted statewide. IBC Section 1802.2.1 (p. 343) contains requirements for soil investigations in areas where questionable soil (soil classification, strength, or compressibility) is present. IRC Section R401.4 (p. 67) states that the building official shall determine whether to require a soil test to determine the soil's characteristics in areas likely to have expansive, compressible, shifting, or other unknown soil characteristics. Where the presence of collapsible soil is confirmed, possible mitigation techniques include soil removal and replacement with noncohesive, compacted backfill; use of special foundation designs such as drilled pier and beam foundations or stiffened slab-on-grade construction; moisture barriers; foundation soil prewetting (Nelson and Miller, 1992; Pawlak, 1998); and careful site landscape and drainage design to keep moisture away from buildings and collapse-prone soils (Keller and Blodgett, 2006).