Report of Investigation

Utah Geological and Mineral Survey

No. 147

Geologic and Topographic Constraints to Land Use, Big Cottonwood Canyon Salt Lake County, Utah

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INTRODUCTION

This report presents the results of a study conducted by the Utah Geological and Mineral Survey to determine the extent to which geologic and topographic conditions will impose constraints upon the development of privately held ground in Big Cottonwood Canyon. The study was prepared at the request of the Salt Lake City Planning Commission, the organization charged with the responsibility of developing an effective land use plan for this environmentally sensitive area. The two principal planning tools to result from this study are: 1) an impact map which shows the relative degrees of constraint on development imposed upon the private parcels by geologic and topographic conditions, and 2) a series of property summary sheets which provide corroborating detailed information on each parcel. These will eventually be incorporated into the masterplan document being prepared by the County for the Big Cottonwood Canyon area. As an interim measure, the map and data sheets along with a brief accompanying text are being released by Utah Geological and Mineral Survey as Report of Investigation No. 147. This report is considered to be a first-stage planning tool and is intended to provide an overview of geotechnical conditions as they exist within the study area. All actual development should, of course, be preceded by detailed feasibility and site studies.

STUDY METHODOLOGY

The primary objective of this study was to gather and analyze all pertinent geologic, soils, hydrologic and topographic information available on the privately held land in Big Cottonwood Canyon, and to present that information in a condensed format useful to planners and others interested in the development of Big Cottonwood Canyon. To accomplish that objective, the following scope of work was undertaken:

1. A review of published and available unpublished literature including reports, maps, and other data pertaining to geology, soils, and hydrology of the study area.

2. Consultation with federal, state, and county agencies that are directly concerned with various aspects of land use management in Big Cottonwood Canyon.

3. Examination of black and white aerial photographs for a portion of the study area.

4. Two weeks of field work utilizing a four-wheel drive vehicle to verify data gathered during the literature search and to obtain additional data relative to actual field conditions.

5. Evaluation of potential geologic, soil, and hydrologic hazards (exclusive

of avalanche hazards) that exist within, or may affect, the privately held land in the canyon.

6. Preparation of an impact map that shows the extent and degree to which constraints on development exist for the private parcels in the canyon.

7. Preparation of individual property summary sheets, one for each parcel considered, that outline the conditions that exist at that property.

8. Preparation of this short report containing information supportive to the map and data sheets.

This study was prepared by the Utah Geological and Mineral Survey, Urban and Engineering Geology Section, under the direction of Bruce N. Kaliser, Chief Engineering Geologist. William R. Lund, UGMS geologist was the principal investigator and author of this report.

IMPACT MAP AND PROPERTY SUMMARY SHEETS

In order to derive the fullest benefit from the impact map and property summary sheets, they must be used in conjunction with one another. The impact map separates the privately held ground in Big Cottonwood Canyon into twenty-three parcels (primarily along existing boundary lines as determined by the County Planner's office) and then further divides those parcels into subunits on the basis of geologic and topographic characteristics. The subunits within each parcel have been labled alphabetically "A", "B", "C", etc. These letter designations are unique to each property and no correlation (other than coincidentally) can be made between parcels. Each subunit is ranked according to a four-tiered classification system that indicates the relative degree to which geologic constraints are expected to impact development in that area. The rankings are indicated on the map by Roman numerals as follows:

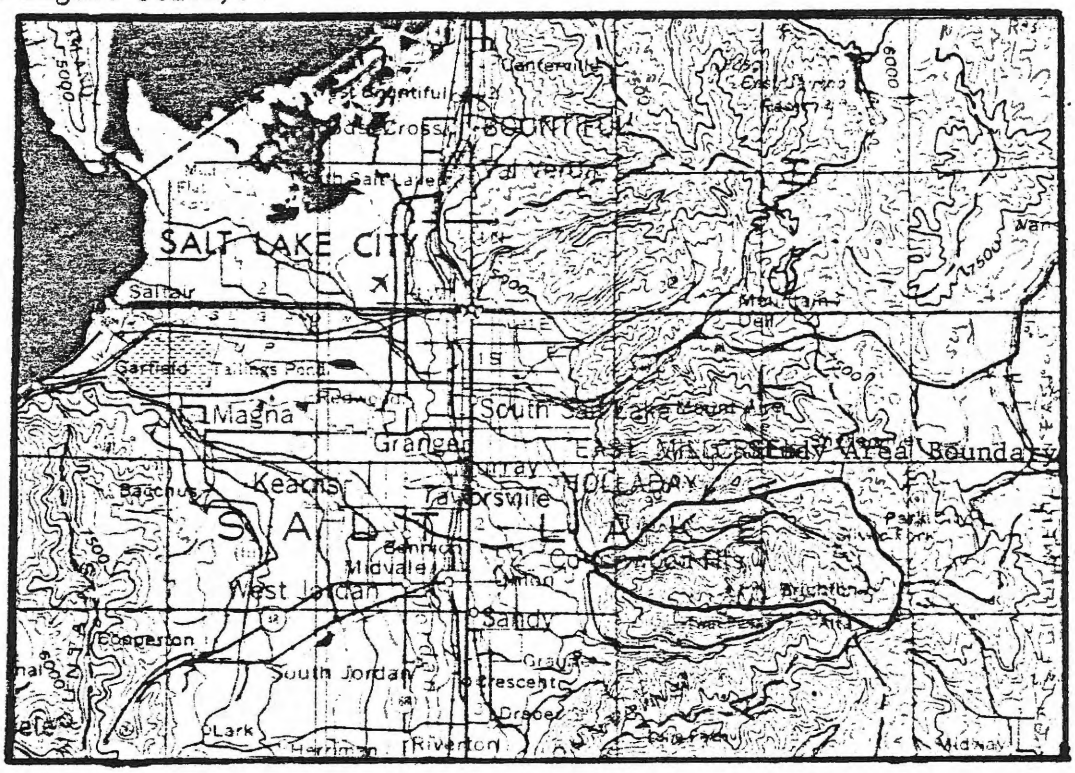
I	None or only slight impact
II	Slight to moderate impact
III	Moderate to severe impact
IV	Severe impact

The Arabic numerals 1 and 2 have been subscripted to the letter designations for each subunit, for example: A2 or D1. They are qualitative indicators of a lesser "1" or a greater "2" degree of constraint within a given classification rank. They are meant to reflect differences in conditions that are significant to the development of an area but which are not large enough to justify a change in the subunits classification to a higher or lower rank. In several instances parcel subunits with the same overall ranking are shown on the impact map with dual classifications, i.e. C1, C2. This indicates that the conditions affecting development change from one portion of the subunit to the other, but that the changes are gradational and cannot be defined by rigid boundaries.

The property summary sheets that have been prepared for the twenty-three private parcels provide general information for each property with regard to location, access, existing facilities and sources of culinary water. In addition, detailed information on slope angles, soil and rock types, vegetative cover, and geologic hazards are presented for each of the parcel subunits. It was on the basis of this information that the subunit rankings were determined.

SETTING

Big Cottonwood Canyon is one of the several major canyons that have been eroded into the steep western front of the Wasatch Range. It is long and narrow, extending for several miles in an east-west direction before swinging sharply to the south and terminating at the crest of the drainage divide south of Brighton (see figure below).



General location map showing boundaries of Big Cottonwood Canyon study area. Scale 1" = 500,000'

Much of the Big Cottonwood area is characterized by rugged, treeless peaks, often extending to elevations of 11,000 feet or more. These rise above the bottoms of steep, walled, tributary gulches and the main canyon with a relief of 6,000 to 8,000 feet. The gulches to the south of the main canyon have been glaciated and are generally several miles in length and bounded by steep cliffs. North of the main canyon there were no glaciers and as a result, the gulches are shorter and steeper and have a greater development of soil and vegetation.

Access to the Big Cottonwood Canyon area is provided by a paved highway (State 152) from Salt Lake Valley to Brighton. A graded dirt road extends from near Brighton to Guardsman Pass on the Salt Lake - Wasatch County line and rough dirt roads extend into most of the major tributary gulches. Access to several of these roads is restricted either by locked gates or by U. S. Forest Service regulations. Brighton and Silver Fork are the only villages in the canyon and consist for the most part of summer homes. Solitude and Brighton Ski Resorts are also located in the canyon as are several other summer home type developments.

GEOLOGIC MATERIALS

The following section provides a general description of the consolidated and unconsolidated geologic materials found within the study area. The terminology presented here is the same as that used in the property summary sheets. The consolidated materials have been described on the basis of rock types, i.e. limestone, shale, quartzite, etc., because it is believed that this is the information that will be of the most use to planners and others using this report. Formation names, relative ages, and stratigraphic sequences can be obtained by consulting the geologic maps that are available for the area (see list of references that accompanies this report). The U. S. Soil Conservation Service has prepared a soils map for a portion of the Wasatch Front that includes the study area. However, the large number of map units defined by their agriculturally oriented soil classification system, and the basic similarity of many of those units to one another, both in terms of physical and engineering characteristics, makes their data cumbersome and poorly suited to inclusion in a summary report of this type. For that reason, the unconsolidated materials within the study area have been classified according to their mode or origin. Such a system is generally satisfactory when the area being considered is small, since unconsolidated deposits of similar origin usually possess similar textural characteristics. Allowances must be made for differences in parent material and notations have been made in the property summary sheets in those instances where parent material is expected to have a major affect on the properties of the deposit.

Consolidated Materials

Quartzite: A very hard rock frequently forming vertical cliffs and consisting chiefly of well-cemented quartz grains. Quartzites can be excavated only with great difficulty and unless fractured by faulting are very resistant to weathering.

Sandstone: A medium-grained sedimentary rock composed of abundant rounded to angular, sand-size fragments set in a fine-grained matrix (silt or clay) and more or less firmly united by a cementing material. Sandstones range from soft to hard, have varying degrees of resistance to weathering and, therefore, may be found in the study area forming both cliffs and slopes.

Tillite: A consolidated sedimentary rock formed by the induration of glacial till. The tillite found in the Big Cottonwood Canyon area is very hard and consists of boulders, cobbles and gravel in a sand matrix. Tillite crops out over a relatively small portion of the study area and is commonly marked by very steep slopes.

Limestone: A sedimentary rock consisting chiefly (more than 50%) of calcium carbonate. The limestones in the study area are generally white to gray in color and, except where fractured by faulting, are very hard. Some limestones found along the Wasatch Front are cavernous due to solution of calcium carbonate along joints and bedding planes. The only solution-caused voids observed during this study were in the limestones on parcel No. 7 where they were of minor extent and confined to a restricted area. Dolomite and marble are two rock types

that are closely associated with limestone and which may be present in some areas. Limestones generally form steep slopes or cliffs.

Shale: A fine-grained, indurated sedimentary rock formed by the consolidation of clay, silt or mud. Depending upon the age of the formation and its degree of induration, shales exhibit poor to high resistance to weathering and form both cliffs and moderate to gentle slopes in the study area. The foundation characteristics of shales are generally considered to be suspect and should be carefully investigated prior to any development in which they might be involved.

Granite: A coarse-grained igneous rock consisting primarily of quartz and feldspar. Due to the tight interlocking structure between individual mineral grains, granites are often hard and resistant to weathering. Most surface outcrops have a rounded appearance due to weathering along strongly developed joint sets. Those areas in Big Cottonwood Canyon where granite outcrops, are nearly devoid of soil cover and are marked by steep slopes and cliffs.

Diorite: A medium-to-coarse grained igneous rock composed of feldspar, dark colored minerals and minor quartz. Diorite only occurs in a small portion of the study area and is generally a slope former due to its high degree of weathering.

Unconsolidated Deposits

Stream Alluvium: The non-to-well stratified deposits of sand, gravel, cobbles, and boulders deposited by streams along their channels. Due to the high gradients possessed by most of the streams in the Big Cottonwood drainage basin, these deposits are usually very coarse-grained. Thicknesses may vary from several to a few tens of feet along major drainages to a thin veneer over bedrock in other areas.

Alluvium: A term applied in this report to the coarse-grained material found in alluvial fan deposits. Composed of both stream laid and mudflow deposits, these materials are highly variable, both horizontally and vertically, in terms of their texture and gradation.

Colluvium: Loose, usually hetergeneous deposits of silt, sand, and gravel developed on mountain slopes from the weathering of bedrock. Colluvial deposits range from thin veneers of very rocky soil over bedrock in areas where steep slopes predominate, to relatively thick deposits of silty and gravelly sands on gentler slopes. Because colluvial materials are generally transported only a short distance from their point of origin, their physical properties are strongly dependent upon the characteristics of their parent material.

Glacial Till: Unsorted and unstratified material deposited by a glacier; generally consisting of a heterogeneous mixture of sand, gravel, cobbles, and boulders varying widely in size and shape. The till deposits found

along Big Cottonwood Canyon and its tributaries show considerable variation in areal extent, thickness, and age. Numerous boulders, some five feet or more in diameter, were observed in the till deposits that underlie the village of Silver Fork. Near Forest Glen subdivision, located on parcel No. 23, the till is older and a well developed soil profile containing considerable clay has developed over the gentler slopes in that area.

Talus: A collection of fallen rock debris that has accumulated at the base of a steep slope or cliff. The size of the individual talus particles is strongly dependent upon the characteristics of the bedrock from which it was derived. Talus derived from poorly consolidated material contains considerable sand and fines along with gravel and cobble-size material. Talus derived from hard, well indurated rock usually consists of cobbles and boulders, the size and shape of which depends upon the spacing of bedding planes and/or joints. Talus slopes are often formed at, or very near to, the angle of repose (the maximum slope angle at which a material such as soil or loose rock remains stable) so that any disturbance such as road building or lot grading is likely to induce a slope failure. By the very nature of their mode of deposition, areas in which talus accumulates are subject to a high rockfall hazard.

Lacustrine Deposits: Fine-grained sands and silts deposited in and adjacent to mountain lakes. These materials are generally dark brown to black in color due to their high organic content. Deposits of this type are of very limited areal extent being confined, for the most part, to the bottoms of small glacial cirques.

WATER SUPPLY

All water rights in the Big Cottonwood Canyon drainage basin are held by Salt Lake City. Any new development wishing to locate in the canyon must secure the right to an adequate supply of water through negotiations with the City. Both the State and the Salt Lake City/County Health Departments maintain jurisdiction over the water systems in the canyon, and their regulations concerning water quality, source protection, and distribution system specifications must be complied with before a building permit can be issued. A number of the water systems in the study area were established prior to the existence of any laws governing their development. Most of those systems do not meet the State or City/County codes, but when possible, attempts are being made to bring them up to acceptable standards. The following table, which was compiled from data supplied by the Utah State Division of Environmental Health, lists the water systems that are known to exist on, or to serve, privately held parcels in Big Cottonwood Canyon.

Water System Name	Parcel No.	Source Type	Connections*
Bear Trap Fork**	17	spring	3
Cardiff Area**	13	Mill D South Fork	not known

Water System Name	Parcel No.	Source Type	Connections (cont)
Episcopal Camp	23	spring	1
Evergreen Subdivision**	23	spring	not known
Forest Glen Plat A	23	spring	11
Forest Glen Plat B & C	23	spring	18
Individual residences	several	springs	not known
Lady of the Lake Subdivision	23	mine tunnel	10
Mt. Haven Owners Association	13	spring	45 (maximum allowed)
Mule Hollow	. 2	spring	6
Pine Tree Water Company	17	spring	13
Silver Lake Company	23	mine tunnel	159
Silver Lake Estates Subdivision	23	spring	27
Silverfork Pipeline Corporation	18, 19	mine tunnel	144
Solitude Ski Resort**	14,20,23	mine tunnel	not known

*Does not infer that system has met Health Department standards.

**Data supplied by Mr. Kent Miner, Salt Lake City/County Health Department

At present the possibilities for developing additional culinary water supplies in Big Cottonwood Canyon are limited to springs and mine tunnels that are making water. The reasons for this are two-fold: first, it has been Salt Lake City's policy in the past when entering into water sharing agreements, to prohibit the drilling of wells. It is expected that this policy will continue into the foreseeable future. Second, State and County health officials will not approve any surface water sources for domestic use unless the water can be treated to bring it within the guidelines of the Utah Safe Drinking Water Act. To date the installation of a facility capable of providing that level of treatment has proven to be prohibitively expensive for canyon developers. Several potential sources of water either on or near to private parcels, were observed during this study. The most promising are listed in the following table:

Source	Location	Estimated Flow	Parcel No.
Maxfield Mine	Big Cottonwood Canyon near the mouth of Mill A Gulch	15-20 gpm	12
Montreal Spring	Mill D South Fork	not known	near 7, 8

Source	Location	Estimated Flow	Parcel No.
South Price Tunnel	Mill D South Fork	15-20 gpm	near 7, 8
Spring near Parcel 5	Headwaters of Mill B South Fork	not known	near 5
Wasatch Tunnel	Mineral Creek	200-300 gpm	near 4
Willow Heights Spring	Willow Creek	not known	18

Note: The flow rates shown above are estimates made during October, 1980. Prior to formulation of any development plans involving one of these sources, it would be necessary to accurately measure the rate of flow and to determine the chemical quality of the water.

WASTE DISPOSAL

Because Salt Lake City relies upon the Big Cottonwood Canyon watershed for a significant percentage of its culinary water supply, the disposal of solid and liquid wastes within the canyon must be carefully controlled. Dumps and/or sanitary landfills are not permitted. Commercial sanitation firms under contract to the County collect all solid wastes and transport them to an approved landfill in the Salt Lake Valley. The method used to dispose of fluid wastes depends upon the nature of the wastewater. Gray water (wastewater generated by kitchen sinks showers, etc.) may be disposed of through the use of a septic tank and drainfield, provided that the system meets all applicable State and County standards. Black water (raw sewage) must be collected in leak-proof vaults. At regular intervals the sewage is pumped from the vaults into specially designed tank trucks which then transport the material out of the canyon to a landfill that is approved for the disposal of hazardous wastes. The responsibility for maintaining the vaults in good condition, and for arranging for the removal of the sewage, rests with the individual home or resort owner. To date, these methods of waste management appear to have been largely successful in protecting the watershed from contamination. The chemical quality of the surface waters in the canyon have been carefully monitored for more than twenty years and those test results show no statistically significant decrease in surface water quality during that time (oral communication, Kent Miner). It should be noted, however, that the potential for a severe contamination problem exists, should one of those tank trucks hauling raw sewage ever be involved in an accidental spill incident to Big Cottonwood Creek.

The two geologic factors which are of the greatest significance to the disposal of fluid wastes on the private parcels considered in this study are: 1) depth to rock, and 2) soil permeability. In many areas, particularly on the steeper mountain slopes, the soil cover is too thin to allow installation of septic systems to State standards. If development is to take place in those areas alternative methods for disposing of the gray water will have to be devised. The property summary sheets identify those parcels on which depth to rock is expected to be a problem. Soil permeability is a measure of the rate at which water can be absorbed by a particular soil. The rate of absorption varies between different soil types and is primarily dependent upon soil texture and composition. State regulations specify that soils suitable for use in septic tank absorption field must have permeability rates

that are no faster than five minutes per inch and no slower than sixty minutes per inch. It is unlikely that any of the unconsolidated materials observed during this study have permeabilities that are slower than those acceptable to the State, but there can be no question that some types of deposits have rates that are higher. The following table lists the relative permeabilities for the various catagories of unconsolidated materials defined in this report and gives an estimate of their suitability for use in septic tank and drainfield systems.

Type of Deposit	Relative Permeability	Suitability
Stream alluvium	Very high	Not suitable - normally associated with high water table.
Alluvium	Low to high	Generally suitable.
Colluvium	Low to very high	Generally suitable if a sufficient thickness of soil is present.
Glacial Till	Low to very high, permeability will vary with the age and size distribution of the deposit.	May be suitable but requires careful evaluation by experienced personnel. May be associated with a seasonal high water table in some areas.
Talus	Very high	Not suitable.
Lacustrine Deposits	Low to moderate	Generally suitable if high water table is absent.

SLOPES

The slope of the ground has a major role to play in determining the manner and extent to which any parcel of land may be developed. Generally, it can be said that as the slope angle increases, so do the costs and difficulties associated with building most types of facilities. Steeper slopes also mean increased danger from land or rockslides, rockfall, erosion, and sedimentation. Unfortunately, there is no ready formula that is applicable in every case for determining the maximum slope angle beyond which development is no longer feasible or practical. The determination of that angle must be arrived at by considering a number of factors, including: the type of development planned; the nature of the earth materials underlying the slope; the local groundwater regime; the surrounding topography; vegetation; climate; and ultimately, costs. It must be remembered that a dollar figure for remedying slope problems, which is unacceptable to a developer wishing to build homes may seem perfectly reasonable to a mining company intent upon reopening a gold or silver mine. The following four broad slope catagories have been established for this report.

0 - 10%	Gentle
10 - 30%	Moderate
30 - 50%	Steep
> 50%	Very steep

Slope angles of less than 10% are expected to have a minimal impact on most types of development, unless particularly unstable materials are present beneath the site. Slopes in the 10-30% range cover a middle ground from little or no impact to a strong impact depending upon those external factors such as earth material characteristics and ground water regime listed above. Steep slopes in the 30-50% range will have a strong impact on development and may, under certain circumstances be enough to preclude development from occurring. Slopes greater than 50% should be viewed with extreme caution. It may be possible to successfully construct certain types of facilities in these areas, but only if designs are adequate and construction practices carefully controlled.

Close attention was paid to the relationships that exist between slope angle and the other physical characteristics of each of the private parcels when the subunit rankings shown on the impact map were determined. These relationships are often reflected not only in the subunits major ranking, but also by the subscripted numerals 1 and 2 shown on the map.

GROUNDWATER

Shallow groundwater in Big Cottonwood Canyon occurs in unconsolidated deposits adjacent to perennial streams and mountain lakes, and locally in some glacial till deposits along the floor of Big Cottonwood Canyon. The depth to water in the materials directly adjacent to streams and lakes will correspond roughly to the difference in elevation between the ground surface and the body of water. The elevation of the water table in the glacial till, which results from the infiltration of spring runoff, is variable and depends upon such factors as the thickness of the deposit, nature of the underlying bedrock, vegetative cover and local topography. Elsewhere in the study area, groundwater is found at greater depth in joints and fractures in bedrock. Those areas in which shallow groundwater is known to exist have been noted on the property summary sheets. Water contained in bedrock is not expected to present any problems to development unless deep rock excavations or tunneling is planned.

FOUNDATION CONDITIONS

Examination of the buildings already constructed in Big Cottonwood Canyon revealed little evidence of problems associated with poor foundation conditions. The reasons for this appear to be as follows:

- Most structures are located on free draining, nonplastic, granular soils or on rock.
- Most of the structures in the canyon are lightly constructed summer homes.
- The use of fill to construct building pads has been minimal.
- Most structures are located on level or gently sloping ground.

It is expected that as development continues in the canyon it will eventually become necessary to build in areas possessing less than optimum foundation characteristics, either in terms of slope angle or earth material properties. It should be possible, through a combination of proper foundation design, based upon preconstruction investigations, and careful control of construction practices, to mitigate most of the problems associated with building on these less suitable sites. However, certain types of soil and rock material have such poor foundation

characteristics that they are best avoided whenever possible. Those materials include most shale and poorly consolidated sandstone, any highly fractured bedrock, rock talus, organic rich saturated silts found adjacent to some mountain lakes, and low density alluvial deposits that may be subjected to subsidence when wetted. Building upon abandoned mine waste dumps may or may not present foundation problems depending on the individual site characteristics. The property summary sheets identify those areas where poor foundation conditions are known or suspected to exist.

GEOLOGIC HAZARDS

The geologic hazards that are of the greatest concern in the study area are landslides, rockslides, rockfall, flooding and seismic shaking. Avalanche hazards also exist at several locations within the canyon, but since the County is already in possession of a map showing all known avalanche tracks, they were not considered in this report. The first four hazards listed are all site specific; that is, they are present in some locations and absent in others. However, due to the close proximity of the Wasatch fault with its potential for generating an earthquake of Richter magnitude 7 or greater, all of the parcels in the study area can expect to experience some degree of ground shaking. The intensity of the shaking will depend upon the size of the seismic event and the location of the epicenter. Although each is capable of occurring independently, the danger from land and rockslides, rockfall and avalanche in the canyons would be greatly increased during a large earthquake. The effects of even a moderate earthquake with its epicenter located in or near steep mountainous terrain was demonstrated by the 1971 San Fernando earthquake, Richter magnitude 6.5, which generated thousands of landslides and rockfalls in the nearby San Gabriel Mountains (Bolt and others, 1975). The danger from flood hazard for those parcels located along the upper reaches of Big Cottonwood Creek would also be increased during a major earthquake. Both the Lake Mary and the Twin Lakes Reservoir dams are located in small cirque basins just to the south of, and at a considerably higher elevation than, the village of Brighton. These two dams are both concrete arch type structures built around the turn of the century. It is highly unlikely that their original designs either considered or compensated for the types of dynamic stresses generated by an earthquake. Should they fail, their combined reservoir capacity is more than 900 acre feet of water.

The geologic hazards associated with each parcel are listed on the individual property summary sheets and are reflected in the subunit rankings on the impact map.

SUMMARY

It will be necessary to maintain careful control over future development within Big Cottonwood Canyon if that area is to continue to serve in its traditional capacity as both a watershed and recreation area for Salt Lake City. The two physical factors that will go the furthest towards limiting development are the concurrent availability of water and suitable building sites. It is in the identification of the latter that it is believed this study will be of the greatest use. Most of the best land in the canyon has already either been occupied, or is included within the boundaries of the Wasatch National Forest. As development expands to less desirable sites, it is hoped that by referencing this report both the planner and the developer will be better informed as to the types of problems each faces and, therefore, be in a better position to mitigate those problems through careful planning design.

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APPENDIX

PROPERTY SUMMARY SHEETS

Parcel No. 1

LOCATION: Mouth of Big Cottonwood Canyon above the bench on the north side of Big Cottonwood Creek.

ACCESS: Good, paved road to Holladay Gun Club, dirt roads to southern property boundary.

EXISTING FACILITIES: Abandoned mine shaft and waste dump, no buildings standing. Property forms the back drop for the Holladay Gun Club and Sheriff's Department rifle and pistol ranges.

AVAILABLE SOURCE OF CULINARY WATER: City/County water lines extend to gun club.

MAP UNIT EXPLANATIONS:

A2 Alluvial fan at base of steep mountain slopes

Slopes:	15% - 30%
Bedrock:	Not exposed, quartzite and shale at depth.
Soils:	Alluvium, moderate to thick, abundant gravel but few boulders.
Vegetative cover:	Grasses and occasional low brush.
Factors affecting development:	Moderate slopes, minor flood hazard, minor to moderate rock fall hazard, close proximity to Wasatch fault, limited available space.
Constraints:	Slight to moderate.

B1 Shallow bedrock beneath steep mountain slopes

Slopes:	50% plus
Bedrock:	Fractured quartzite.
Soils:	Colluvium, thin, rocky.
Vegetative cover:	Grasses and occasional small trees.
Factors affecting development:	Steep slopes, shallow depth to rock, fractured nature of rock, proximity to Wastach fault, rockfall/rockslide hazard.
Constraints:	Severe

B2 Shallow bedrock beneath steep mountain slopes

Slopes:	50% plus
Bedrock:	Shale
Soils:	Thin, rocky and clayey sands.
Vegetative cover:	Grasses and occasional small trees.

Factors affecting development:	Steep slopes, shallow depth to rock, poor foundation characteristics of shale, proximity to Wasatch fault, rockfall/rockslide hazard.
Constraints:	Severe

Remarks: Due to the very close proximity of the Wasatch fault, it is believed that the rockfall/rockslide hazard would be very high on this parcel during a major earthquake.

Parcel No. 2

LOCATION: Big Cottonwood Canyon between Mule Hollow and Mill B South Fork.

ACCESS: State Highway 152 parallels Big Cottonwood Creek across the parcel, access to the mountain slopes is by foot path only.

EXISTING FACILITIES: Maxfield Lodge (several buildings) and three private residences. All are located along Big Cottonwood Creek.

AVAILABLE SOURCE OF CULINARY WATER: Maxfield Lodge obtains its water from springs located in Mule Hollow; the private residences obtain their water from springs along Big Cottonwood Creek.

MAP UNIT EXPLANATIONS:

A1, A2 Flood plain along Big Cottonwood Creek

Slopes:	0% - 5%
Bedrock:	Not exposed.
Soils:	Stream alluvium, numerous large cobbles and boulders.
Vegetative cover:	Heavy, trees and low/tall brush.
Factors affecting development:	High rockfall/rockslide hazard, flood hazard, shallow depth to water table, limited available space.
Constraints:	Moderate to severe, ratings of 1 or 2 based upon anticipated rockfall/rockslide hazard and susceptibility to flooding.

B2 Alluvial fan at the mouth of Whipple Fork

Slopes:	5% - 20%
Bedrock:	Not exposed.
Soils:	Alluvium, moderate to thick accumulations of sand and gravel.
Vegetative cover:	Medium to heavy, trees and low/tall brush.
Factors affecting development:	High rockfall/rockslide hazard, moderate flood hazard, limited available space.
Constraints:	Moderate to severe.

C2 Glacial till beneath steep slopes

Slopes:	30% - 50%
Bedrock:	Not exposed.

Soil:	Glacial till, gravelly silty sand over a coarse-grained sand, gravel, cobble, boulder mix.
Vegetative cover:	Heavy, trees with some low/tall brush.
Factors affecting development:	Steep slopes, possible rapid soil permeability.
Constraints:	Moderate to severe.

D2 Shallow bedrock beneath steep mountain slopes

Slopes:	50% plus, ledge rock and cliffs common.
Bedrock:	Shale and quartzite.
Soils:	None to patchy, talus on upper slopes, localized thin to thick colluvial deposits of gravelly sand along lower slopes.
Vegetative cover:	None to sparse on north side of canyon, medium to thick on the south side, trees and low/tall brush.
Factors affecting development:	Very steep slopes and cliffs, shallow depth to rock, high rockfall/rockslide hazard, poor foundation conditions associated with the shale.
Constraints:	Severe

Remarks: The narrowness of the canyon, the over steep bedrock slopes, and the close proximity to the Wasatch fault all combine to produce a very high rockfall/ rockslide hazard on this parcel.

Parcel No. 3

LOCATION: Above Lake Blanche on the east wall of the cirque at the head of Mill B South Fork.

ACCESS: Foot path up Mill B South Fork.

EXISTING FACILITIES: None.

AVAILABLE SOURCE OF CULINARY WATER: None known.

MAP UNIT EXPLANATIONS:

A1 Bench at the 9080 foot mark on the cirque headwall

Slopes:	15% - 25%
Bedrock:	Quartzite
Soils:	None
Vegetative cover:	None
Factors affecting development:	20% slopes, lack of soil cover, high rockfall/ rockslide hazard, potential for pollution of Lake Blanche, limited available space.
Constraints:	Severe

B2 Shallow bedrock beneath steep slopes

Slopes:	50% plus.
Bedrock:	Quartzite
Soils:	Patchy, talus and thin colluvial deposits of gravelly sands with boulders and cobbles.
Vegetative cover:	Sparse to medium, trees and low/tall brush.
Factors affecting development:	Very steep slopes and cliffs, lack of soil cover, high rockfall/rockslide hazard, potential for pollution of Lake Blanche.
Constraints:	Severe

Remarks: Lakes Blanche, Florence, and Lillian all lie in the basin below this property and contribute directly to the Salt Lake City water supply. Slopes are glacially oversteepened.

Parcel No. 4

LOCATION: West wall of the cirque at the head of Mineral Fork Canyon.

ACCESS: Jeep trail to the east corner of the property.

EXISTING FACILITIES: None

AVAILABLE SOURCE OF CULINARY WATER: None on site. Possible source from the Wasatch Mine (abandoned) which lies a quarter mile to the northeast. Mine tunnel is making an estimated 300-500 gpm, but iron staining of stream bed indicates a high dissolved solids content.

MAP UNIT EXPLANATION:

A2 Shallow bedrock beneath steep mountain slopes

Slopes:	50% plus, ledge rock and cliffs locally.
Bedrock:	Tillite, very hard.
Soils:	None to patchy, talus and a thin layer of coarse-grained sands and gravel with boulders and cobbles.
Vegetative cover:	Sparse to medium, low/tall brush and some trees
Factors affecting development:	Very steep slopes, lack of adequate soil cover, high rockfall/rockslide hazard, unstable talus slopes.
Constraints:	Severe

Remarks: The tillite bedrock that underlies this property is very hard and well indurated.

Parcel No. 5

LOCATION: Cirque basins and arete ridges at the head of Mill B South Fork and Mineral Fork.

ACCESS: Jeep trail up Mineral Fork, foot paths.

EXISTING FACILITIES: Regulator Johnson Mine (abandoned), tunnel entrance has caved, abandoned miners cabin.

AVAILABLE SOURCE OF CULINARY WATER: None on the property. A spring located several hundred feet south of the property represents a possible limited source of water.

MAP UNIT EXPLANATION:

A1 Narrow cirque basin underlain by shallow bedrock

- Slopes: 15% - 30%
- Bedrock: Quartzite and shale.
- Soils: None to patchy, accumulations of coarse sand and gravel with boulders and cobbles.
- Vegetative cover: Sparse to moderate, low/tall brush.
- Factors affecting development: High rockfall/rockslide hazard, moderate to steep slopes, shallow depth to rock, poor foundation conditions associated with shale bedrock.
- Constraints: Severe

B2 Cirque basin underlain by talus

- Slopes: 0% - 20%
- Bedrock: Quartzite on walls of cirque.
- Soils: Talus, boulders common.
- Vegetative cover: None to sparse, low/tall brush.
- Factors affecting development: High rockfall/rockslide hazards, unstable talus slopes, high permeability of talus.
- Constraints: Severe

C2 Steep slopes underlain by shallow bedrock

- Slopes: 50% plus, ledge rock and cliffs very common.
- Bedrock: Quartzite, shale, tillite.
- Soils: Talus and localized, thin accumulations of coarse-grained sands and gravel.
- Vegetative cover: None to moderate, low/tall brush, few trees.

Factors affecting development:	Very steep slopes and cliffs, unstable talus slopes, high rockfall/rockslide hazard, shallow depth to rock in many places.
Constraints:	Severe

Remarks: The numerous talus slopes on this property make slope stability a very high concern at this property.

Parcel No. 6

LOCATION: West of Montreal Hill along the crest and on both sides of the ridge that separates Mineral Fork and Mill D South Fork.

ACCESS: Foot paths.

EXISTING FACILITIES: None

AVAILABLE SOURCE OF CULINARY WATER: None known

MAP UNIT EXPLANATION:

A2 Ridge top

Slopes:	0% - 10%
Bedrock:	Quartzite and some shale.
Soils:	None
Vegetative cover:	None to sparse, low/tall brush.
Factors affecting development:	Limited area available, bedrock at the surface, possible foundation problems associated with shale bedrock.
Constraints:	Moderate if limited to developments such as ski lifts.

B2 Shallow bedrock beneath steep mountain slopes

Slopes:	50% plus.
Bedrock:	Quartzite and shale, fractured.
Soils:	Colluvium, thin to thick accumulations of silty and clay gravelly sands.
Vegetative cover:	Sparse, grass and some low/tall brush.
Factors affecting development:	Steep slopes, possible foundation problems associated with shale bedrock, shallow depth to rock in many areas.
Constraints:	Severe

C2 Cliffs and ledge rock with talus slopes at base

Slopes:	50% plus, cliffs are predominant
Bedrock:	Quartzite and shale.
Soils:	Talus, many large boulder size blocks.
Vegetative cover:	Sparse to medium, low/tall brush and trees on talus slopes.

Factors affecting development:	Cliffs and very steep bedrock slopes, high rockfall/rockslide hazard, unstable talus slopes.
Constraints:	Severe

Remarks: West side of ridge is much more rugged and precipitous than the east side.

Parcel No. 7

LOCATION: West side of Mill D South Fork near Montreal Hill.

ACCESS: Dirt road and jeep trail up Mill D South Fork.

EXISTING FACILITIES: Two small abandoned mine prospects.

AVAILABLE SOURCE OF CULINARY WATER: None known on the property. Montreal Spring is located approximately ¼ mile to the northeast.

MAP UNIT EXPLANATION:

A1 Bedrock beneath gentle to moderate slopes

Slopes:	5% - 20%
Bedrock:	Shale, fractured.
Soils:	Colluvium, thin to moderately thick accumulations of silty and clayey sands grading with depth to gravel, cobbles and boulders.
Vegetative cover:	Moderate to thick, grass, low/tall brush and some trees.
Factors affecting development:	Localized areas of shallow bedrock, minor rockfall/rockslide hazard.
Constraints:	Slight to moderate.

B1 Shallow bedrock beneath moderate slopes

Slopes:	15% - 30%
Bedrock:	Limestone, fractured.
Soils:	Colluvium, thin accumulations of silty sand and gravel.
Vegetative cover:	Medium to thick, trees and grass.
Factors affecting development:	Moderate slopes, shallow depth to rock, fractured and sometimes cavernous nature of the limestone bedrock.
Constraints:	Moderate to severe.

C2 Shallow bedrock beneath steep slopes

Slopes:	50% plus, cliffs and ledge rock common.
Bedrock:	Limestone, fractured.
Soils:	None to thin accumulations of colluvial sand and gravel, talus slopes locally.
Vegetative cover:	Medium to thick, trees and grass.

Factors affecting development:	Steep slopes and cliffs, shallow depth to bedrock, fractured and sometimes cavernous nature of the limestone bedrock.
Constraints:	Severe

Remarks: Jointing and solution activity has produced small caverns in the limestone bedrock.

Parcel No. 8

LOCATION: Mill D South Fork. Parcel extends from the bottom of Mill D South Fork to a point about 3/4 of the way up the side of Reed and Benson Ridge.

ACCESS: Dirt road up Mill D South Fork.

EXISTING FACILITIES: Abandoned prospect, adit has caved.

AVAILABLE SOURCE OF CULINARY WATER: None known on the property. Both Montreal Spring and the South Price Mine tunnel, which is making an estimated 15 - 20 gpm of water, are located a few hundred feet west of the property.

MAP UNIT EXPLANATION:

A1 Flood plain of Mill D South Fork

- Slopes: 0% - 15%
- Bedrock: Not exposed.
- Soils: Glacial till, coarse-grained, gravelly sand with numerous cobbles and boulders.
- Vegetative cover: Moderate to thick, trees and low/tall brush.
- Factors affecting development: Moderate to high rockfall/rockslide hazard, flood hazard, high permeability soils.
- Constraints: Moderate to severe.

B2 Talus slopes

- Slopes: 30% - 50%
- Bedrock: Not exposed.
- Soils: Talus, mostly cobble-size material.
- Vegetative cover: Thick except along small avalanche and rockfall tracks, trees and low/tall brush.
- Factors affecting development: Steep slopes, high rockfall/rockslide hazard, unstable talus slopes, high permeability soils.
- Constraints: Severe

C2 Shallow bedrock beneath steep slopes

- Slopes: 50% plus, ledge rock and cliffs common.
- Bedrock: Limestone, dolomite, quartzite and shale.
- Soils: Colluvium, none to thin accumulations of sand and gravel.

Vegetative cover:	Sparse, some trees and low/tall brush.
Factors affecting development:	Very steep slopes and cliffs, very high rockfall/rockslide hazard, shallow depth to bedrock.
Constraints:	Severe

Remarks: Cliffs and near vertical rock slopes along the crest of Reed and Benson Ridge produce a very high rockfall/rockslide hazard in this area.

Parcel No. 9

LOCATION: East side of Reed and Benson Ridge near the head of Days Fork Canyon.

ACCESS: Foot path.

EXISTING FACILITIES: None

AVAILABLE SOURCE OF CULINARY WATER: None known.

MAP UNIT EXPLANATION:

A2 Shallow bedrock beneath steep slopes

Slopes:	50% plus, cliffs and ledge rock locally.
Bedrock:	Limestone
Soils:	None near ridge crest, elsewhere talus and thin accumulations of colluvial sand and gravel.
Vegetative cover:	Sparse, grass and low/tall brush.
Factors affecting development:	Very steep slopes and cliffs, high rockfall/rockslide hazard, unstable talus deposits, shallow depth to bedrock in many areas.
Constraints:	Severe

Remarks: Property is located on glacially oversteepened slopes at the head of a narrow canyon.

Parcel No. 10

LOCATION: North side of Big Cottonwood Canyon between Mill A Creek and Butler Fork.

ACCESS: Foot path.

EXISTING FACILITIES: None

AVAILABLE SOURCE OF CULINARY WATER: None known.

MAP UNIT EXPLANATION:

A2 Shallow bedrock beneath steep slopes

Slopes:	50% plus.
Bedrock:	Quartzite and limestone
Soils:	Colluvium, thin to locally thick accumulations of silty sands and gravel.
Vegetative cover:	Sparse to moderate, low brush.
Factors affecting development:	Very steep slopes, shallow depth to rock, lack of adequate soil cover in many areas.
Constraints:	Severe

Remarks: Well defined avalanche track crosses property.

Parcel No. 11

LOCATION: Both sides of Big Cottonwood Canyon just downstream from the confluence of Butler's Fork and Big Cottonwood Canyon.

ACCESS: State Highway 152 and dirt roads.

EXISTING FACILITIES: None

AVAILABLE SOURCE OF CULINARY WATER: None known.

MAP UNIT EXPLANATION:

A2 Flood plain along Big Cottonwood Creek

Slopes:	0% - 5%
Bedrock:	Not exposed.
Soils:	Stream alluvium, coarse gravel and cobbles with some boulders.
Vegetative cover:	Sparse to medium, low/tall brush.
Factors affecting development:	Limited area available, flood hazard, shallow depth to water table, high soil permeability.
Constraints:	Slight to moderate.

B1 Glacial till beneath gentle to moderate slopes

Slopes:	5% - 20%
Bedrock:	Not exposed.
Soils:	Glacial till, gravelly silty sands over nonstratified sand, gravel, cobbles, and boulders.
Vegetative cover:	Heavy, trees and low/tall brush.
Factors affecting development:	Moderate slopes, possible rapid soil permeability, somewhat hummocky terrain.
Constraints:	Slight to moderate.

C2 Glacial till beneath steep slopes

Slopes:	30% - 50%
Bedrock:	Not exposed.
Soils:	Glacial till, boulders and cobbles.
Vegetative cover:	Heavy, trees and low/tall brush.
Factors affecting development:	Steep slopes, possible rapid soil permeability.
Constraints:	Moderate to severe.

D2 Shallow bedrock beneath steep slopes

Slopes:	50% plus
Bedrock:	Quartzite, limestone, some shale and igneous dikes.
Soils:	Colluvium, coarse-grained gravelly sands and sandy gravel with admixtures of silt and clay in varying amounts.
Vegetative cover:	Moderate, grass, low/tall brush and trees.
Factors affecting development:	Steep slopes, shallow depth to rock in many areas, poor foundation conditions associated with shale bedrock.
Constraints:	Severe

Remarks: A small deposit of glacial till is exposed along Highway 152 north of Big Cottonwood Creek.

Parcel No. 12

LOCATION: Both sides of Big Cottonwood Canyon. This parcel includes steep mountain slopes on the north side of Big Cottonwood Creek west and east of its confluence with Mill A Gulch; portions of the flood plains of both Big Cottonwood Creek and Mill D South Fork; and large acreages on the ridges that separate Mineral Fork from Mill D South Fork and Mill D South Fork from Days Fork.

ACCESS: State Highway 152, dirt road up to Mill D South Fork, foot paths.

EXISTING FACILITIES: Numerous abandoned mines and prospects, the most notable of these are: the Maxfield Mine, the Silver Mountain Mine, the Little Giant Mine, the Carbonate Mine, and the East Carbonate Tunnel. A total of 17 tunnels, 2 shafts, and 3 prospects are known to exist on the property. Their conditions range from maintained with restricted access to abandoned with no restrictions on entry.

AVAILABLE SOURCE OF CULINARY WATER: No known developed source. The Maxfield Mine was observed to be making an estimated 15-20 gpm from its caved tunnel.

MAP UNIT EXPLANATION:

A1 Flood plain of Big Cottonwood Creek

Slopes: 0% - 5%

Bedrock: Not exposed.

Soils: Stream alluvium, coarse-grained sand and gravel covered locally with silt and fine sand.

Vegetative cover: Medium to thick, low/tall brush.

Factors affecting development: Limited available space, flood hazard, shallow depth to water table, rockfall/landslide hazard from adjacent slopes.

Constraints: Slight to moderate.

B2 Alluvial fan at the mouth of Mill A Gulch

Slopes: 30% - 50%

Bedrock: Limestone, minor igneous intrusives.

Soils: Alluvium, thick accumulations of coarse-grained sands and gravel with some boulders and cobbles Material has been removed locally for use as road fill.

Vegetative cover: Medium, low/tall brush and trees where not removed.

Factors affecting development:	Moderate to steep slopes, limited available space, moderate rockfall/rockslide hazard, minor flood hazard.
Constraints:	Moderate to severe.

C2 Glacial till beneath moderate to steep slopes

Slopes:	20% - 50%
Bedrock:	Not exposed.
Soils:	Glacial till, large cobbles and boulders are common.
Vegetative cover:	Thick, low/tall brush and trees.
Factors affecting development:	Moderate to steep slopes, possible rapid soil permeability.
Constraints:	Moderate to severe.

D2 Glacial till beneath very steep mountain slopes

Slopes:	50% plus
Bedrock:	Not exposed.
Soils:	Glacial till.
Vegetative cover:	Thick, low/tall brush and trees.
Factors affecting development:	Very steep slopes, landslide hazard, possible rapid permeability.
Constraints:	Severe

E2 Ridge tops

Slopes:	5% - 20%
Bedrock:	Limestone
Soils:	None to very thin accumulations of gravelly sand.
Vegetative cover:	Sparse to medium, low/tall brush and trees.
Factors affecting development:	Limited space available, shallow bedrock.
Constraints:	Moderate if limited to developments such as ski lifts.

F1, F2 Talus beneath moderate to steep slopes

Slopes:	20% - 50% plus
Bedrock:	Not exposed.
Soils:	Talus, large boulders are not common.
Vegetative cover:	Sparse to thick, low/tall brush and trees.
Factors affecting development:	Moderate to steep slopes, unstable talus slopes, high rockfall/rockslide hazard, highly permeable soils.
Constraints:	Severe, ratings of 1 or 2 are dependent primarily on slope angles.

G2 Shallow bedrock beneath steep slopes

Slopes:	50% plus, ledge rock and cliffs common on Reed and Benson Ridge.
Bedrock:	Quarzite, limestone, dolomite, shale, diorite.
Soils:	Colluvium, thin to thick accumulations of gravelly sands and sandy gravels with silt and clay.
Vegetative cover:	Sparse to thick, grass, low/tall brush, and trees.
Factors affecting development:	Steep to very steep slopes and cliffs. Shallow depth to rock in many areas, rockfall/rockslide hazard, poor foundation conditions associated with shale bedrock.
Constraints:	Severe

H1 Flood plain of Mill D South Fork

Slopes:	5% - 15%
Bedrock:	Not exposed
Soils:	Stream alluvium, in many areas only a thin veneer over bedrock.
Vegetative cover:	Moderate to thick, low/tall brush and some trees.
Factors affecting development:	Local flood hazard, moderate rockfall/rockslide hazard.
Constraints:	Moderate to severe.

Remarks: Cliffs along the crest of Reed and Benson Ridge create a high rockfall/rockslide hazard in many places along Mill D South Fork.

Parcel No. 13

LOCATION: Both sides of Big Cottonwood Canyon at the confluence of Butler Fork and Mill D South Fork with Big Cottonwood Creek.

ACCESS: State Highway 152, dirt road up Mill D South Fork, subdivision roads in Mr. Haven subdivision and adjoining areas.

EXISTING FACILITIES: Mt. Haven subdivision and numerous homes in the Cardiff area. Total number of homes estimated at 25 to 30.

AVAILABLE SOURCE OF CULINARY WATER: Mt. Haven subdivision obtains its water from springs that have been developed by the Mt. Haven Owners Association. The summer homes in the Cardiff area are obtaining water directly from Mill D South Fork.

MAP UNIT EXPLANATION

A1, A2 Glacial till beneath gentle to moderate slopes

Slopes:	0% - 20%, locally steeper
Bedrock:	Not exposed.
Soils:	Glacial till, gravel, cobbles and boulders are common. Moderately deep, dark brown silty soils have developed on the till in many places
Vegetation:	Medium to heavy, low/tall brush and trees.
Factors affecting development:	Locally steep slopes, rapid soil permeability, hummocky topography.
Constraints:	None to slight, ratings of 1 or 2 are dependent upon slope angle.

B2 Flood plain along Big Cottonwood Creek

Slopes:	0% - 5%
Bedrock:	Not exposed.
Soils:	Stream alluvium, large cobbles and boulders are common at the confluence of Big Cottonwood Creek and Mill D South Fork.
Vegetative cover:	Medium to thick, low/tall brush.
Factors affecting development:	Limited area available, flood hazard, shallow depth to water table.
Constraints:	Slight to moderate.

C1 Possible shallow bedrock beneath gentle to moderate slopes

Slopes:	0% - 15%

Bedrock:	Quartzite, no outcrops noted.
Soils:	Dark brown sandy silts similar to those observed in the areas underlain by glacial till.
Vegetative cover:	Heavy, low/tall brush and trees.
Factors affecting development:	Possible shallow bedrock indicated on geologic maps of area.
Constraints:	Slight to moderate.

D2 Shallow bedrock beneath steep slopes

Slopes:	50% plus
Bedrock:	Quartzite
Soils:	Colluvium, thin layer of silty gravelly sands.
Vegetative cover:	Medium, low/tall brush and some trees.
Factors affecting development:	Steep slopes, shallow depth to rock, rockfall/rockslide hazard.
Constraints:	Severe

E1 Glacial till beneath moderate to steep slopes

Slopes:	30% - 50%
Bedrock:	Not exposed.
Soils:	Glacial till.
Vegetative cover:	Thick, low/tall brush and trees
Factors affecting development:	Steep slopes, possible high soil permeability.
Constraints:	Moderate to severe.

F2 Possible shallow bedrock beneath moderate to steep slopes

Slopes:	30% - 50% plus
Bedrock:	Quartzite
Soils:	Silty, gravelly sands, (glacial till?)
Vegetative cover:	Thick, low/tall brush and trees.
Factors affecting development:	Moderate to steep slopes, possible shallow depth to rock, flood hazard.
Constraints:	Moderate to severe.

G2 Glacial till beneath steep mountain slopes

Slopes:	50% plus.
Bedrock:	Not exposed
Soils:	Glacial till
Vegetation cover:	Moderate, low/tall brush and trees.
Factors affecting development:	Very steep slopes, possible rapid soil permeability, slope stability.
Constraints:	Severe

Remarks: The areas of shallow bedrock located south of Big Cottonwood Creek (C1 and F2 on the map) are inferred from geologic maps of the area. Rock outcrops are rare in those areas and a considerable thickness of soil may exist in many places.

Parcel No. 14

LOCATION: Upper Mill D South Fork, Honeycomb Fork, Upper Mill F South Fork, Emma Ridge from near Superior Peak to Mt. Evergreen, the Honeycomb Cliffs, the southern end of Reed and Benson Ridge and portions of the ridges separating Days Fork from Silver Fork, Silver Fork from Honeycomb Fork, and Honeycomb Fork from Mill F South Fork.

ACCESS: Dirt roads up Mill D South Fork, Silver Fork, and Mill F South Fork. Service roads for Solitude ski area on the ridge separating Honeycomb Fork from Mill F South Fork.

EXISTING FACILITIES: Numerous abandoned mines and prospects, the most notable of these are: the Monte Cristo Mine, the Reed and Benson Mine, the Cardiff Mine, Howell Tunnel, Kennebec Tunnel, Eclipse Mine, Prince of Wales Shaft, Woodlawn Mine, Solitude Tunnel, and Black Bess Shaft. A total of 27 shafts and 60 tunnels are known to exist on the property and there could be many more. There are a number of deteriorating buildings still standing at several of the mines. Three ski lifts and a small lodge, all of which are part of the Solitude Ski Resort, are located on the ridge between Honeycomb Fork and Mill F South Fork.

AVAILABLE SOURCE OF CULINARY WATER: Solitude Ski Resort obtains its water supply from two mines, the Kentucky Utah and the Alta Drain Tunnel. Prior to their development, water was obtained from Lake Solitude.

MAP UNIT EXPLANATION:

A2 Talus beneath gentle to moderate slopes

Slopes:	10% - 20%
Bedrock:	Not exposed.
Soils:	Talus, large cobble size material is common, boulders are rare.
Vegetative cover:	Medium to heavy, low/tall brush and trees.
Factors affecting development:	High soil permeability, possible instability of cuts made in talus, rockfall/rockslide hazard.
Constraints:	Moderate to severe.

B2 Talus beneath steep slopes

Slopes:	30% - 50%
Bedrock:	Not exposed.
Soils:	Talus

Vegetative cover:	Sparse to heavy, low/tall brush and trees.
Factors affecting development:	Steep slopes, unstable nature of talus slopes, high rockfall/rockslide hazard, high soil permeability.
Constraints:	Severe

C2 Shallow bedrock beneath gentle to moderate slopes

Slopes:	0% - 30%
Bedrock:	Quartzite, limestone, dolomite, shale.
Soils:	None to thin accumulations of coarse-grained colluvial sand and gravel.
Vegetative cover:	None to medium, grass, low/tall brush and trees.
Factors affecting development:	High rockfall/rockslide hazard, shallow depth to rock.
Constraints:	Moderate to severe.

D1, D2 Flood plain areas along canyon bottoms

Slopes:	0% - 15%
Bedrock:	Not exposed.
Soils:	Alluvium and/or glacial till, boulders and cobbles are common, soil cover is very thin in many areas.
Vegetative cover:	Medium, grass and trees.
Factors affecting development:	Minor to moderate rockfall/rockslide hazard, locally permeable soils, minor flood hazard.
Constraints:	Slight to moderate, ratings of 1 or 2 are dependent upon the estimated rockfall/rockslide hazard.

E1, E2 Ridge tops and saddles

Slopes:	0% - 20%
Bedrock:	Limestone, quartzite, shale.
Soils:	None to thin accumulations of coarse-grained colluvial sand and gravel.
Vegetative cover:	None to moderate, low/tall brush and trees.
Factors affecting development:	Limited space available in some areas, shallow depth to rock, poor foundation conditions associated with shales.

Constraints:	Moderate if limited to ski lifts and similar facilities, ratings of 1 or 2 are dependent on slope angle and available space.

F1 Glacial till beneath moderate slopes

Slopes:	15% - 30%
Bedrock:	Not exposed.
Soils:	Glacial till, boulders and cobbles are common.
Vegetative cover:	Medium to heavy, low/tall brush and trees, much of the vegetation has been removed from these areas to accommodate ski runs.
Factors affecting development:	Moderate slopes, possible rapid soil permeability.
Constraints:	Slight to moderate.

G1, G2 Glacial till beneath moderate to steep slopes

Slopes:	30% - 50% plus
Bedrock:	Not exposed.
Soils:	Glacial till, boulders and cobbles are common.
Vegetative cover:	Medium to heavy, low/tall brush and trees, much of the vegetation has been removed from these areas to accommodate ski runs.
Factors affecting development:	Locally steep slopes, possible rapid soil permeability.
Constraints:	Moderate to severe, ratings of 1 or 2 based upon slope angle.

H2 Shallow bedrock beneath steep slopes

Slopes:	30% - 50% plus, cliffs and ledge rock common in many areas.
Bedrock:	Quartzite, limestone, dolomite, shale, igneous dikes.
Soils:	Absent in many places, elsewhere, thin to moderately thick accumulations of colluvial sand and gravel with varying amounts of silt and clay.
Vegetative cover:	None to thick, grass, low/tall brush and trees.

Factors affecting development:	Very steep slopes and cliffs, shallow depth to rock, high rockfall/rockslide hazard in many areas, possible poor foundation conditions associated with shale.
Constraints:	Severe

Remarks: Cirque walls at the head of many canyons are near vertical.

Parcel No. 15

LOCATION: North of Big Cottonwood Canyon along Bear Trap Fork.

ACCESS: Jeep trail part way up Bear Trap Fork then foot paths.

EXISTING FACILITIES: None

AVAILABLE SOURCE OF CULINARY WATER: None known.

MAP UNIT EXPLANATION:

A1 Flood plain along Bear Trap Fork

- Slopes: 0% - 10%
- Bedrock: Not exposed.
- Soils: Stream alluvium, gravelly silty sands overlying a coarse-grained mixture of sand, gravel, and cobbles.
- Vegetative cover: Heavy, grass and trees.
- Factors affecting development: Minor flood hazard.
- Constraints: None to slight.

B1 Bedrock beneath moderate to steep slopes

- Slopes: 20% - 40%
- Bedrock: Quartzite, limestone
- Soils: Colluvium, thin to moderately thick accumulations of gravelly silty sand.
- Vegetative cover: Thick, low/tall brush and trees.
- Factors affecting development: Moderate to steep slopes, shallow depth to rock in some areas.
- Constraints: Moderate to severe.

C1 Shallow bedrock beneath steep slopes

- Slopes: 50% plus
- Bedrock: Quartzite and limestone.
- Soils: Colluvium, thin accumulations of gravelly sandy silt.
- Vegetative cover: Medium to thick, low/tall brush, some trees.
- Factors affecting development: Steep slopes, shallow depth to bedrock.
- Constraints: Severe

Remarks: Flood plain along this portion of Bear Trap Fork is a nearly level meadow. Stream is incised 0.5 to 2.0 feet.

Parcel No. 16

LOCATION: South side of Big Cottonwood Canyon between Days Fork and Silver Fork.

ACCESS: Jeep trail.

EXISTING FACILITIES: One or two summer homes associated with Pine Tree subdivision may lie within the boundaries of this parcel.

AVAILABLE SOURCE OF CULINARY WATER: Pine Tree subdivision obtains its water from springs. It is assumed that the homes on this parcel get their water from the same source.

MAP UNIT EXPLANATIONS:

A1 Flood plain along Big Cottonwood Creek

Slopes:	0% - 15%
Bedrock:	Not exposed.
Soils:	Glacial till and stream alluvium, boulders and cobbles are common.
Vegetative cover:	Heavy, trees and low brush.
Factors affecting development:	Minor flood hazard, possible rapid soil permeability.
Constraints:	None to slight.

B2 Bedrock beneath steep slopes

Slopes:	50% plus.
Bedrock:	Limestone
Soils:	Colluvium, moderately thick to thick accumulations of silty sands and gravels with cobbles and boulders at depth.
Vegetative cover:	Heavy, trees and low brush.
Factors affecting development:	Very steep slopes, local shallow depth to bedrock, rapid soil permeability.
Constraints:	Severe

C2 Glacial till beneath moderate to steep slopes

Slopes:	30% - 50%
Bedrock:	Not exposed.
Soils:	Glacial till.

Vegetative cover:	Heavy, trees and low brush.
Factors affecting development:	Moderate to steep slopes, possible rapid soil permeability.
Constraints:	Moderate to severe.

Remarks: Parcel adjoins Green's Basin an area of gentle to moderate slopes.

Parcel No. 17

LOCATION: Big Cottonwood Canyon at the confluence of Bear Trap Fork and Big Cottonwood Creek.

ACCESS: State Highway 152 and subdivision roads.

EXISTING FACILITIES: Pine Tree subdivision and three summer homes at the mouth of Bear Trap Fork.

AVAILABLE SOURCE OF CULINARY WATER: Pine Tree subdivision and the homes at the mouth of Bear Trap Fork obtain their water from springs.

MAP UNIT EXPLANATION:

A1 Flood plain along Big Cottonwood Creek

Slopes:	0% - 10%
Bedrock:	Not exposed.
Soils:	Glacial till and stream alluvium, very coarse grained.
Vegetative cover:	Medium to thick, low/tall brush and trees.
Factors affecting development:	Minor to moderate flood hazard adjacent to the stream.
Constraints:	None to slight if facilities are protected from flooding.

B1 Glacial till beneath moderate to steep slopes

Slopes:	30% - 50%
Bedrock:	Not exposed.
Soils:	Glacial till, boulders and large cobbles are common.
Vegetative cover:	Medium to heavy, low/tall brush and trees.
Factors affecting development:	Steep slopes, possible rapid soil permeability, minor flood hazard along Bear Trap Fork.
Constraints:	Moderate to severe.

Remarks: Mountain slopes are steeper on the west side of Bear Trap Fork.

Parcel No. 18

LOCATION: Big Cottonwood Canyon at the confluence of Willow Creek with Big Cottonwood Creek.

ACCESS: State Highway 152 and jeep trails.

EXISTING FACILITIES: Several summer homes are located near the western property boundary.

AVAILABLE SOURCE OF CULINARY WATER: The homes on this property are believed to receive water from the Silver Fork Pipeline Corporation. The corporation obtains its water from the Utah-Kentucky Mine tunnel.

MAP UNIT EXPLANATIONS:

A1 Flood plain along Big Cottonwood Creek

Slopes:	0% - 50% plus locally, generally 10% or less.
Bedrock:	Not exposed.
Soils:	Glacial till and stream alluvium, coarse-grained.
Vegetative cover:	Sparse to medium, grass, low/tall brush and some trees.
Factors affecting development:	Steep slopes where Big Cottonwood Creek has incised it channel, possible rapid soil permeability.
Constraints:	None to slight.

B1 Glacial till beneath moderate slopes

Slopes:	10% - 20%
Bedrock:	Not exposed.
Soils:	Glacial till.
Vegetative cover:	Medium to thick, low/tall brush, trees.
Factors affecting development:	Moderate slopes, flooding along Willow Creek.
Constraints:	Slight to moderate.

C1, C2 Glacial till beneath moderate to steep slopes

Slopes:	30% - 50%
Bedrock:	Not exposed.
Soils:	Glacial till, cobbles and boulders are common.
Vegetative cover:	Medium to thick, low/tall brush and trees.

Factors affecting development:	Steep slopes, possible rapid soil permeability.
Constraints:	Moderate to severe, ratings of 1 and 2 are dependent upon slope angle.

D1 Shallow bedrock beneath steep slopes

Slopes:	50% plus.
Bedrock:	Quartzite and limestone.
Soils:	Colluvium, thin to moderately thick.
Vegetative cover:	Medium, low/tall brush and trees.
Factors affecting development:	Steep slopes, shallow depth to rock in places.
Constraints:	Severe

E1 Glacial till and alluvium beneath gentle slopes

Slopes:	0% - 10%
Bedrock:	Not exposed.
Soils:	Glacial till overlain by silty sands and sandy silts.
Vegetative cover:	Medium, grass and some trees.
Factors affecting development:	Ground around Willow Heights pond could become boggy during wet weather
Constraints:	None to slight.

Remarks: Willow Height pond lies directly adjacent to the property on the north. The pond was created by a beaver dam and is almost entirely silted up.

Parcel No. 19

LOCATION: Big Cottonwood Canyon, village of Silver Fork and immediate vicinity.

ACCESS: State Highway 152 and town streets.

EXISTING FACILITIES: Numerous summer homes and a restaurant.

AVAILABLE SOURCE OF CULINARY WATER: Silver Fork Pipeline Corporation supplies water to the town of Silver Fork. The corporation obtains the water from the old Utah-Kentucky Mine tunnel.

MAP UNIT EXPLANATION:

A1 Flat to gently sloping ground along Big Cottonwood Creek

Slopes:	0% - 12%
Bedrock:	Not exposed.
Soils:	Glacial till and stream alluvium along creek bottom, large boulders noted in till.
Vegetative cover:	Sparse to heavy, grass, low/tall brush and trees.
Factors affecting development:	Minor flood hazard along creek, possible rapid soil permeability, large boulders in glacial till deposits, high water table locally
Constraints:	None to slight.

B1, B2 Glacial till beneath moderate slopes

Slopes:	20% - 30%
Bedrock:	Not exposed.
Soils:	Glacial till, boulders common.
Vegetative cover:	Medium to heavy, low/tall brush and trees.
Factors affecting development:	Moderate to locally steep slopes, possible rapid soil permeability.
Constraints:	Slight to moderate, ratings of 1 or 2 are dependent upon slope angle.

C2 Glacial till beneath moderate to steep slopes

Slopes:	30% - 50%
Bedrock:	Not exposed.
Soils:	Glacial till, variable tickness.
Vegetative cover:	Heavy, low/tall brush and trees.

Factors affecting development:	Steep slopes, possible rapid soil permeability.
Constraints:	Moderate to severe.

D1 Bedrock beneath steep slopes

Slopes:	50% plus.
Bedrock:	Quartzite, limestone, dolomite.
Soils:	Colluvium, thin to moderately thick.
Vegetative cover:	Heavy, low/tall brush and trees.
Factors affecting development:	Very steep slopes, shallow depth to rock.
Constraints:	Severe

Remarks: Ground moraine containing large boulders and cobbles covers the floor of Big Cottonwood Canyon.

Parcel No. 20

LOCATION: Mill F Flat in Big Cottonwood Canyon.

ACCESS: Dirt road from the Solitude Ski area parking lot.

EXISTING FACILITIES: Two buildings associated with the Solitude ski area.

AVAILABLE SOURCE OF CULINARY WATER: Assumed to be the same as that for the rest of the Solitude Ski Resort

MAP UNIT EXPLANATION:

A1 Flat to gently sloping ground along Big Cottonwood Creek

Slopes:	0% - 10%
Bedrock:	Not exposed.
Soils:	Glacial till, numerous large boulders and cobbles.
Vegetative cover:	Sparse to medium, low/tall brush and trees.
Factors affecting development:	Possible rapid soil permeability.
Constraints:	None to slight.

B2 Glacial till beneath steep slopes

Slopes:	40% - 50%
Bedrock:	Not exposed.
Soils:	Glacial till.
Vegetative cover:	Medium, low/tall brush
Factors affecting development:	Steep slopes, possible rapid soil permeability, flood hazard.
Constraints:	Moderate to severe.

Remarks: Steep slopes exist along Big Cottonwood Creek where that stream has incised its channel.

Parcel No. 21

LOCATION: The upper cirque basin at the head of Big Cottonwood Canyon.

ACCESS: Jeep trail and foot paths.

EXISTING FACILITIES: Big Cottonwood Mine (abandoned), a few deteriorating wooden structures are still standing around the mine.

AVAILABLE SOURCE OF CULINARY WATER: None known.

MAP UNIT EXPLANATION:

A2 Bedrock beneath gentle to moderate slopes

- Slopes: 0% - 15%
- Bedrock: Granite
- Soils: None
- Vegetative cover: Sparse, low brush and some trees.
- Factors affecting development: Bedrock at the surface, potential for pollution of Lakes Mary and Martha and Dog Lake.
- Constraints: Slight to moderate for small structures.

B2 Cirque basin with lacustrine deposits

- Slopes: 0% - 10%
- Bedrock: Not exposed, assumed to be granite at depth.
- Soils: Fine grained sands and silts deposited in and adjacent to Dog Lake. Ground is wet and boggy around the lake.
- Vegetative cover: Medium to thick, bunch grass, low/tall brush.
- Factors affecting development: Soft, wet soils adjacent to Dog Lake, shallow depth to rock in some areas, potential for pollution of Dog Lake.
- Constraints: Slight to moderate.

C2 Glacial till beneath moderate slopes

- Slopes: 10% - 20%
- Bedrock: Not exposed.
- Soils: Glacial till, large cobbles and boulders are common.
- Vegetative cover: Medium to heavy, low/tall brush and trees.

Factors affecting development:	Moderate slopes, possible rapid soil permeability.
Constraints:	Slight to moderate.

D2 Talus beneath steep slopes

Slopes:	50% plus.
Bedrock:	Granite
Soils:	Talus, large blocks several feet in diameter are common.
Vegetative cover:	None
Factors affecting development:	Steep slopes, unstable nature of talus depsoits, high rockfall/rockslide hazard.
Constraints:	Severe

E2 Bedrock beneath steep slopes

Slopes:	50% plus, cliffs and ledge rock are common.
Bedrock:	Granite, limestone.
Soils:	None to thin accumulations of colluvial sand and gravel. Small talus slopes occur locally.
Vegetative cover:	None to heavy, grass, low/tall brush and trees.
Factors affecting development:	Cliffs and very steep slopes, shallow depth to rock in many areas, high rockfall/rockslide hazard.
Constraints:	Severe

Remarks: Portions of this property would be flooded if Lake Mary Dam were to rupture.

Parcel No. 22

LOCATION: Head of Big Cottonwood Canyon, southeast of the Brighton Ski Lodge.

ACCESS: Dirt roads connecting to the Brighton circle.

EXISTING FACILITIES: Several summer homes. The Majestic and Mary ski lifts cross the property.

AVAILABLE SOURCE OF CULINARY WATER: The summer homes on this parcel obtain their water from individual springs.

MAP UNIT EXPLANATION:

A1 Glacial till beneath moderate slopes

Slopes:	15% - 25%
Bedrock:	Not exposed.
Soils:	Glacial till, large cobbles and boulders are common.
Vegetative cover:	Medium to heavy, low brush and trees. Vegetation has been removed along the ski runs.
Factors affecting development:	Moderate to locally steep slopes, possible rapid soil permeability.
Constraints:	Slight to moderate.

Remarks: The glacial till may represent only a thin veneer over bedrock in some areas. This property would be subject to flooding if the Lake Mary Dam were to rupture.

Parcel No. 23

LOCATION: At the head of Big Cottonwood Canyon. Portions of the village of Brighton and its immediate vicinity, parts of the ridges separating Big Cottonwood Canyon from Mill F South Fork and Mill F East Fork, and most of the mountain slopes north and east of Brighton from Clayton Peak to near Willow Creek.

ACCESS: State Highway 152, the Guardsman Pass Road, numerous village and subdivision streets and jeep trails.

EXISTING FACILITIES: The parcel includes all or portions of: the village of Brighton, Lady of the Lakes Subdivision, Evergreen Subdivision, Silver Lake Estates, Forest Glen Subdivision, an Episcopal Church Camp, and numerous other summer homes on individual lots. There are also several mines, some still maintained, on the mountain slopes north and east of Brighton. The most notable of these are: the Scottish Chief Mine, the American Tunnel, and the Iowa Copper Tunnel. A total of 9 tunnels, 4 shafts and 4 prospects are known to exist on the property and there may be several more

AVAIALBLE SOURCES OF CULINARY WATER: The Silver Lake Water Company which serves the village of Brighton obtains its water from a mine tunnel. The subdivisions and the Episcopal Camp obtain their water from springs.

MAP UNIT EXPLANATION:

A1 Flat to gently sloping ground underlain by glacial till

Slopes:	0% - 10%, steper locally
Bedrock:	Not exposed.
Soils:	Glacial till and stream alluvium, till contains many cobbles and boulders, well developed, clay rich soil profiles have developed in some of the older till deposits.
Vegetative cover:	Sparse to heavy, grass, low/tall brush and trees.
Factors affecting development:	Local minor flood hazard, possible high water table in some areas, possible rapid soil permeability.
Constraints:	None to slight.

B1, B2 Glacial till beneath moderate slopes

Slopes:	15% - 30%
Bedrock:	Not exposed.
Soils:	Glacial till, large boulders and cobbles are common.

Vegetative cover:	Medium to heavy, low/tall brush and trees.
Factors affecting development:	Moderate slopes, local minor flood hazard, possible rapid soil permeability.
Constraints:	Slight to moderate, ratings of 1 or 2 are dependent upon slope angle.

C1, C2 Glacial till beneath steep slopes

Slopes:	30% - 50% plus locally
Bedrock:	Not exposed.
Soils:	Glacial till.
Vegetative cover:	Medium to heavy, low/tall brush and trees.
Factors affecting development:	Steep to very steep slopes, possible rapid soil permeability.
Constraints:	Moderate to severe, ratings of 1 or 2 are dependent upon slope angle.

D1 Bedrock beneath steep slopes

Slopes:	30% - 50% plus, minor ledge rock and cliffs.
Bedrock:	Granite, quartzite, and limestone.
Soils:	Colluvium, thin to moderately thick, predominantly gravelly, silty sands.
Vegetative cover:	Medium to thick, trees and low/tall brush south of Mill F East Fork. Sparse to medium, trees and low/tall brush north of Mill F East Fork.
Factors affecting development:	Steep to very steep slopes, shallow depth to rock in many areas, local talus slopes.
Constraints:	Severe:

E1, E2 Marshy ground or ground with a high water table

Slopes:	0% - 5%
Bedrock:	Not exposed.
Soils:	Highly organic silts and clays.
Vegetative cover:	Medium to thick, grass, low/tall brush and some trees.
Factors affecting development:	Soft, wet ground, high water table, flood hazard.
Constraints:	Moderate to severe, areas rated as 2 are marshy.

F1, F2 Ridge tops

Slopes:	5% - 15%
Bedrock:	Granite
Soils:	Colluvium, thin to moderately thick accumulations of gravelly, silty sand.
Vegetative cover:	sparse to medium, grass and trees
Factors affecting development:	Limited area available, shallow depth to rock.
Constraints:	Moderate to severe, ratings of 1 or 2 are dependent upon slope angles.

G2 Bedrock beneath steep mountain slopes

Slopes:	30% - 50%
Bedrock:	Shale and poorly consolidated sandstones.
Soils:	Colluvium, thin to thick accumulations of gravelly, silty sands.
Vegetative cover:	Sparse to moderate, grass and some trees.
Factors affecting development:	Steep to very steep slopes, shallow depth to rock in some areas, poor foundation characteristics of the shale bedrock.
Constraints:	Severe

Remarks: The portions of this property around Brighton and along Big Cottonwood Creek would be subject to flooding if either Lake Mary or Twin Lakes Reservoir Dams were to rupture.

—SOURCE—

UTAH GEOLOGICAL AND MINERAL SURVEY
Donald Mc Millan, Director

URBAN AND ENGINEERING GEOLOGY SECTION
Bruce N. Kaliser, Chief
William Lund, Geologist and Principal Investigator

GEOLOGIC AND TOPOGRAPHIC IMPACT
BIG COTTONWOOD CANYON

Map Showing The Extent To Which Geologic And Topographic Conditions Can Be Expected To Impact The Development Of Privately Held Ground In Big Cottonwood Canyon.

—LEGEND—

I	NONE OR ONLY SLIGHT IMPACT
II	SLIGHT TO MODERATE IMPACT
III	MODERATE TO SEVERE IMPACT
IV	SEVERE IMPACT

The subscripted numerals 1 and 2 are qualitative indicators representing a lesser (1) or greater (2) impact within a given classification.

Letter designation "A", "B", "C", etc. refer to subunits of each property that have been established on the basis of their geologic and topographic characteristics. The letters are assigned to the subunits of any given property are valid only for that property and are not correlatable across the map. Complete descriptions for the subunits contained within each property are provided in the Property Summary Sheets that accompany this map.

USE OF THIS MAP

— Consult the property of interest. Color and subscripted numerals give an immediate indication of the relative degree of constraints for land use in each subunit area.

— Note property number and subunit letter designation. Turn to Property Summary Sheet for further information on subunit characteristics.

NOTE: The Word "COLOR" Should Read as Follows, "The [redacted] Roman Numerals"

ROADS
STREAMS
LAKES
DRY LAKES
PROPERTY LINES

NORTH

1000 2000 3000 4000 5000 6000
1 MILE
SCALE 1 INCH = 1000 FT.
CONTOUR INTERVALS 40 FT.

PREPARED BY SALT LAKE COUNTY PLANNING COMMISSION — MARCH 1980