SOILS STUDIES & OPINION REPORTS

Rollins, Brown and Gunnell	June 8, 1977
William Lund	May 1979
SHB Agra	April 22, 1994

SHBA AGRA

April 27, 1994

REPORT
ENGINEERING GEOLOGY RECONNAISSANCE
SWEENEY PROPERTIES
WEST OF "OLD TOWN AREA"
PARK CITY, UTAH

Prepared For:

Sweeney Properties
115 Woodside
Park City, Utah 84060

SHB AGRA Job No. E93-2267

SHB AGRA, INC.
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April 22, 1994

Sweeney Properties
115 Woodside
Park City, Utah 84060

SHB AGRA Job No. E93-2267

Attention: Dr. Patrick Sweeney

Re: Report
Engineering Geology Reconnaissance
Sweeney Properties
West of "Old Town Area"
Park City, Utah

Gentlemen:

1. INTRODUCTION

1.1. General

Presented in this report are the results of our engineering geology reconnaissance of the Sweeney Properties site which is located west of the Old Town portion of Park City, Utah. The general location of the site with respect to major topographic features and existing facilities, as of 1975, is shown on Figure 1, Vicinity Map. A more detailed layout of the site showing general topography, ski trails, major outcrops, and mine workings, are presented on Figure 2, Site Plan.

1.2. Objectives and Scope

The objectives and scope of this study were planned in discussions between Dr. Patrick Sweeney of Sweeney Properties, and Dr. Jeffrey R. Keaton of SHB AGRA, Inc. The objectives of this study were to:

1. Inventory and evaluate the engineering geology parameters of bedrock exposed at abandoned mine openings and primary bedrock outcrops at the site.
2. Provide initial discussions pertaining to the engineering geology characteristics of the site.

In accomplishing these objectives, our scope has included the following:

1. An initial office program including a review of the geologic literature, existing mine opening inventories, geologic maps, and the examination of stereoscopic aerial photographs.
2. A field program consisting of an engineering geologic reconnaissance of mine openings and outcrops.
3. Preparation of this summary report.

1.3. Authorization

Authorization was provided by Dr. Patrick Sweeney by signing a copy of our Professional Services Agreement dated June 28, 1993.

1.4. Professional Statements

Supporting data upon which our recommendations are based are presented in subsequent sections of this report. Recommendations presented herein are governed by the geologic conditions encountered at the mine openings and outcrops, and our other reconnaissance data.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices used at this time.

If additional information is found at the site during the construction phase of the project, we need to be notified immediately so that our recommendations can be reviewed and modifications can be made to this report, if necessary.

2. SITE DESCRIPTION

The site is a moderately to moderately steeply sloping trapezoidal-shaped parcel of land having an area of approximately 125 acres. The boundaries of the site and existing site topography are shown on Figure 1. Elevations on the property range from 7040 feet on the northeast side of the site, to 7800 feet on the southwest side. Vegetation consists of scrub oak, aspen, fir, and spruce, with open areas occupied by sagebrush and grasses. An operating ski-lift and an abandoned mine gondola cross the northern portion of the site. A loading platform for the ski lift and three ski trails are also present on the site. Scattered on the site are several abandoned mine openings.

3. PROPOSED DEVELOPMENT

At the time of this study, overall detailed site development plans had not been finalized. It is our understanding that 15 acres within the northeast portion of the site will be developed for residential home sites, with lots ranging from one-quarter to over one-half acre in size. In other areas, clusters of two to three level condominium structures and possibly high density four to six level resort type structures have been considered.

Homes and two to three level condominium structures will generally be of wood-frame construction above grade, and reinforced concrete construction below grade. Loads imposed by bearing walls and columns will generally be light to moderately light.

The four to six level structure could be of wood-frame or possibly reinforced concrete construction, and would impose moderate to moderately high loads.

Site development will require the construction of primary access and secondary roads. Everything will be done to minimize cuts and fills associated with the roadway. However, in many areas, cuts and fills of 15 to 20 feet may be required. Similar cuts and fills may be required in the higher density building development areas.

4. INVESTIGATIONS

4.1. Field Program

Prior to our field program, a detailed review of literature, inventory reports, and aerial photography were performed. This was followed by a general site reconnaissance of mine openings and rock outcrops. The mine openings and rock outcrops examined during our reconnaissance were selected on the basis of proximity to the portion of the site that will be developed. These locations are shown on Figure 2.

5. SITE GEOLOGY

The prominent rock type of the site area is the Weber Quartzite. This formation has been described as "pale gray and tan weathering quartzite and limy sandstone; some interbedded gray to white limestone and dolomite" (Bromfield and Crittenden, 1971). The Weber Quartzite is estimated to be from 1,300 to 1,500 feet thick and comprises the oldest exposed rocks in the area. Overlying the Weber Quartzite is the Park City Formation, which is comprised of limestones, cherts, sandstone, and shale, that ranges from 550 to 650 feet in thickness. The Weber formation was deposited during the late Pennsylvanian, and the Park City formation consists of Permian age rocks.

The area of the site has been subject to anticlinal folding and thrust faulting (Bromfield, 1968). The most prominent structural feature in the area is the Park City anticline, which runs on a northeast plunging axis. The axis of the anticline is located approximately 700 feet to the west of the site (Bromfield and Crittenden, 1971; Crittenden, Calkins, and Sharp, 1966).

The nearest know active faults are associated with the Wasatch fault zone which lies approximately 12 miles west of the site.

The geology exposed in the mine openings and outcrops consisted of massive bedded quartzite containing some interbeds of fine-grained sandstone laminae. The beds were found to be near horizontal, generally dipping gently to the southwest. Vertical to near vertical joints spaced 1 to 3.5 feet apart were observed in the exposures. Two joint orientation trends appear to have developed in the quartzite beds. A primary trend is oriented at roughly 230 degrees, and a secondary trend is oriented at about 70 degrees. Near the surface, the quartzite was observed to be more highly fractured from weathering and spalling processes.

A tabulation of the engineering geology parameters of the exposures is presented on Table 1, Engineering Geology Parameters of Mine Openings and Outcrops. Additional information with respect to observations taken at the exposures is presented in Appendix A, Site Exposure Inventory. The bedrock exhibits high strength and low compressibility characteristics, and is not moisture sensitive. The bedrock is overlain by colluvial soils, which can best be described as mixtures of silt; some clay; and angular sand, gravel, rubble, and boulder sized pieces of quartzite.

The soils are not moisture sensitive and generally exhibit moderately high strength and low compressibility characteristics.

The true static groundwater table is at significant depth and should not affect design, construction, or performance of the proposed facilities. Near surface perched groundwater conditions which will be most prevalent during the late spring and summer months will, however, be significant.

The combination of fairly steep slopes, colluvial soils, and near surface perched groundwater, has resulted in some relatively shallow soil slope instability in the area of the proposed development.

6. DISCUSSIONS AND RECOMMENDATIONS

6.1. Discussions of Findings

By far, the most significant geotechnical aspects of the site which will affect design and development, are 1) cuts and fills, 2) slope stability and 3) groundwater. All attempts must be made in the layout of the primary and secondary roadways to minimize the amounts of cuts and fills which will be required. However, considering the magnitude of the site and the overall slopes, even with very careful alignment detailing moderate cuts and fills will be required in some areas. To minimize areas of disturbance and thus make the development most aesthetically pleasing, we strongly recommend the utilization of reinforced earth systems, retain downslope fills.

Some instability has been noted within and immediately adjacent to the site. The slope instability, in all cases, has been related to the movement of the surficial colluvial soils over the underlying bedrock. In all cases, to our knowledge, the movement has been associated with either long time or seasonal near surface groundwater conditions. Therefore, in conjunction with overall site development, it will be necessary to install subdrains.

In all anticipated conditions, the proposed structures may be supported upon conventional spread and continuous wall foundations established upon suitable colluvial soils, bedrock, and/or structural fill extending to suitable materials. Foundation conditions should generally not have any significant affect on overall site development.

There are numerous abandoned mine workings in the site area. Obviously, the structures should not be established over these workings, unless the workings are at extreme depth. Individual workings will have to be evaluated on a site specific basis, when they fall within the area of the proposed structure.

In the following sections, detailed discussions pertaining to stability, subdrains, earthwork, foundations, and other geotechnical aspects which will effect initial site development, are presented.

6.2. Slope Stability

6.2.1. General

Instability, where it has been observed within or adjacent to the site, and in the general geologic setting, has been related to the colluvial soils overlying bedrock. To the best of our knowledge, no mass instability within the quartzite bedrock has occurred at this site or in other immediate areas in the same geologic setting.

The instability of the colluvial soils is also generally related to near surface groundwater conditions. A combination of groundwater colluvial soils, and steep slopes, has and can lead to "natural" instability. Extensive earthwork operations, especially cutting soils out of the toe of these potentially unstable areas, loading the heads of slide areas, or directing water to these areas, significantly increases the potential for instability. Overall stability in these conditions is best maintained or improved by 1) the installation, in some cases, of some very extensive and deep subdrains, and 2) very cautious earthwork operations. From an overall site development standpoint, even though the stability of these potentially unstable areas, can be improved. Our strongest recommendation for site development is to avoid these areas. The site is large enough, and the number of potentially unstable areas few enough, that this should not drastically affect site development plans. Areas of potentially unstable colluvial soils can best be identified and related to areas of major or even shallow natural drainages.

6.2.2. Bedrock

Both deep seated (mass) and shallow or erosional-type stability must be considered. The quartzite bedrock found at the site, based upon our field observations, seems to be of higher quality, that is less fractured, then typically encountered in other portions of Park City.

Mass, that is deep seated instability, has not been a problem in quartzite in the Park City area, and is not anticipated at this site for the maximum depths of cuts projected. The greatest concern is related to surficial instability, that is erosion, sloughing, etc. Highly fractured quartzite of the type encountered in other portions of Park City, can be cut to very steep slopes, even near vertical, and will remain stable in a mass stability standpoint, indefinitely. However, highly fractured bedrock will ravel and within a few years, will result in erosional slopes on the order of 1.2 to 1.4 horizontal to 1 vertical. This is essentially the angle of repose of the angular fractured pieces of quartzite bedrock. Generally from an overall highway maintenance standpoint, slopes in highly fractured quartzite bedrock are generally designed to be cut at one horizontal to one vertical, with the understanding that some clean-up of ravelled materials will be periodically required. Park City's philosophy has, however, been that final grading should be such as to minimize the amount of long-term maintenance. If this philosophy prevails, cuts in these highly fractured soils will generally have to be 1.3 to 1.4 horizontal to 1 vertical. As stated previously, the bedrock at this site does not appear to be as highly fractured as others. Still, even though Park City might recommend flatter slopes, we will, from a planning standpoint, recommend that the final cut slopes in fractured bedrock be one horizontal to one vertical.

Much steeper slopes, on the order of one-quarter to one-half horizontal to one vertical, to heights of 15 to 20 feet, may be utilized in the more massive quartzite bedrock. If cuts greater than these depths are required, then benches sloping slightly back into the overall slope, and at least four feet wide, are required every 15 feet in total vertical height. Some chain netting, or other precautions may be required to catch and retain small to moderately sized bedrock particles from spalling off at steep cut slopes.

6.2.3. Soils

In natural colluvial soils, where groundwater is not a problem, excavations of as much as six feet in height can be constructed at slopes of one-half horizontal to one vertical, and maintain mass stability. However, these slopes are extremely susceptible to erosion and sloughing, and would, therefore, have to be covered by rock walls or other similar type structures. Cuts in excess of six feet in height, should generally be no steeper than one and one-half horizontal to one vertical. Again, the surface must be protected against erosion. Where groundwater is encountered, similar type construction can be employed, only after the groundwater conditions have been controlled by extensive subsurface drainage. Any kind of cut activities in colluvial soils with uncontrolled groundwater most likely will lead to some long-term instability.

Fill slopes should be held to a minimum whenever possible. Where angular pieces of quartzite bedrock are utilized, the fill slopes can be constructed at one and one-half horizontal to one vertical and provide both mass and surficial stability. In soils, the fill slopes would generally have to be constructed at least two horizontal to one vertical to provide mass and surficial stability. Because of the steepness of the site, these slopes would essentially "chase" the natural slopes, and would result in extensive disruption to natural terrain and vegetation. Therefore, whenever substantial fills are required, we strongly recommend the consideration be given to reinforced soil structures. These structures can range from rough finish wire wall or reinforced timber crib walls, to structures faced with reinforced concrete panels of different types. Numerous examples are present within the Park City area. The general soils available are suitable to construct reinforced earth structures, provided that appropriate drainage is part of the overall design. Costs, assuming that fairly substantial amounts of reinforced earth structures will be utilized, could range anywhere from approximately $13.00 per face foot, to $30.00 per face foot, considering the type of facing. Considering the mining heritage, the rustic-look of properly engineered and designed treated timber-facing might be quite acceptable.

6.3. Earthwork

6.3.1. Excavations

Excavations of surficial highly fractured bedrock, generally to depths of no more than three to four feet and the colluvial soil, can be carried out utilizing heavy track-mounted equipment. Excavations of more than a few feet into the bedrock, will in nearly all cases, require drilling and blasting.

Temporary construction excavations not exceeding four feet in depth in cohesive soils above the water table, may be constructed with near vertical sideslopes. Deeper excavations up to 10 to 12 feet, again within predominantly cohesive soils above the water table, should be constructed with sideslopes on the order of one-half to three-quarters horizontal to one vertical. If groundwater is encountered in any excavations, significantly flatter sideslopes will be required.

Temporary construction excavations up to 10 to 15 feet in bedrock can generally be constructed with near vertical to one-quarter horizontal to one vertical sideslopes. Deeper excavations should incorporate minimum of 4-foot wide benches on 15-foot vertical increments. For temporary excavations, proper control of spall of the rock off the steep walls must be provided.

All excavations must be inspected periodically be qualified personnel. If any signs of instability are noted, immediate remedial action must be initiated.

6.3.2. Fill Material

Structural fill will be required as backfill over foundations and utilities, and site grading fill. All structural fill must be free of sod, rubbish, construction debris, frozen soils, and other deleterious materials. Structural site grading fill is defined as fill which is placed over fairly large open areas to raise overall site grade. Generally, for this type of fill, we recommend that the maximum particle size generally not exceed four inches, although occasional larger particles of up to six to eight inches may be incorporated provided that they do not result in "honeycombing" or preclude the obtainment of the desired degree of compaction. In confined areas, we recommend that the maximum particle size generally not exceed two and one-half inches. For fairly substantial structural site grading fills in parking or roadway areas, larger particles can be incorporated into the structural fill with the understanding that these types of fills would be subjected to totally unacceptable settlements for structures, but acceptable settlements for roadways and parking areas.

6.3.3. Fill Placement and Compaction

Soil meeting the fairly stringent maximum particle size requirements, as stated above, should be placed in lifts not exceeding eight inches in loose thickness. Under buildings, we generally recommend that the fills be compacted to at least 95 percent of the maximum dry density as determined by the AASHTO[1] T-180 (ASTM[2] D-1557) compaction criteria. As backfill over foundations and utilities, compaction of at least 90 percent of the above defined criteria is recommended. The 90 percent criteria is also applicable for roadways and parking areas.

Where materials with large particle sizes and thicker lifts are utilized, procedural specifications will be developed.

6.4. Subdrains

From a geotechnical standpoint, that the most cost effective systems or facilities which can be utilized are subdrains. Wherever there is any concern with regard to significant near surface groundwater flows in cut and fill areas, and upgradient of below grade structures, it is essential that extensive subdrain systems be employed. The subdrains generally will consist of a minimum four to six inch diameter slotted or perforated plastic or other durable material pipe encased in a free-draining granular materials, such as "pea" gravel or three-quarter to one inch minus clean gap-graded gravel. The gravel will generally extend 2 inches below and laterally, and at least 12 to 18 inches above the pipe. To reduce the possibility of long-term plugging, the gravel should be wrapped in a geotextile fabric such as Mirafi 140N or equivalent. The slope of the subdrain pipe should generally be at least 0.5 percent, to a suitable point of gravity discharge.

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1 American Association of State Highway and Transportation Officials

2 American Society for Testing and Materials

The backfill, in most cases, will act as a chimney drain portion of the overall system, and must consist of a free-draining sand and gravel extending to within two feet of final grade. The subdrains must be installed as far in advance of other construction as possible.

6.5. Spread and Continuous Wall Foundations

6.5.1. Design Data

All indications are that the structures, as proposed, can be supported upon conventional spread and continuous wall foundations established upon suitable natural soils, bedrock, and/or structural fill extending to suitable natural soils or bedrock. All footings exposed to the full effects of frost and established upon soils or highly fractured bedrock, should be established at a minimum of three and one-half feet below lowest adjacent final grade. Footings protected from the full effects of frost may be established at a higher elevation, although a minimum depth of embedment of 18 inches is recommended for confinement purposes. Floor slabs and pavements may be considered equivalent to soil in determining depth of embedment. Minimum recommended width for footings established upon soils is 18 inches for continuous wall footings, and 24 inches for isolated spread footings.

Where sound, that is only slightly fractured bedrock is encountered, the footings may be established directly upon the bedrock without any specific depths of embedment. To resist lateral loading, and to provide passive resistance, however, we do recommend that the footings be tied with anchors to the bedrock, and that some outside backfill be utilized to minimum thicknesses of approximately 18 inches. Minimum recommended widths for footings established on massive bedrock are 12 inches for continuous wall foundations, and 18 inches for isolated spread footings.

For preliminary design, the following bearing pressures for real vertical loads may be utilized:

Suitable soils	-	3,000 psf
Highly fractured bedrock	-	5,000 psf
Massive bedrock	-	12,000 psf

The above bearing pressures for footings established on soils may be increased by 50 percent for total load conditions. Real loads are defined as the total of all dead plus frequently applied (reduced) live loads. The term "net bearing pressure" refers to the pressure imposed by the portion of the structure above lowest adjacent final grade. Therefore, the weight of the footing and backfill to lowest adjacent grade, need not be considered. For bedrock, the real load pressure may be increased by 100 percent for total load conditions. Maximum edge bearing pressures which can be utilized must be evaluated depending upon the type of loading, and the materials upon which the footings are established.

6.5.2. Settlements

Settlements of foundations designed and installed in accordance with the above recommendations, will ultimately be designed and selected to induce settlements generally no more than five-eighths to three-quarters of an inch.

6.6. Lateral Resistance

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. In determining frictional resistance, a coefficient of friction of 0.40 should be utilized. Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 300 pounds per cubic foot. Below the water table, this granular soil should be considered equivalent to a fluid with a density of 150 pounds per cubic foot.

A combination of passive earth resistance and friction may be utilized provided that the friction component of the total is divided by 1.5.

6.7. Lateral Pressures

The lateral pressure parameters, as presented within this section, assume that the backfill will consist of a drained granular soil placed and compacted in accordance with the recommendations presented herein. The lateral pressures imposed upon subgrade facilities will, therefore, be basically dependent upon the relative rigidity and movement of the backfilled structure. For active walls, such as retaining walls which can move outward (away from the backfill), granular backfill may be considered equivalent to a fluid with a density of 35 pounds per cubic foot in computing lateral pressures. For more rigid basement walls that are not more than 10 inches thick and 12 feet or less in height, granular backfill may be considered equivalent to a fluid with a density of 45 pounds per cubic foot. For very rigid nonyielding walls, granular backfill should be considered equivalent to a fluid with a density of at least 60 pounds per cubic foot. The above values assume that the surface of the soil slope behind the wall is horizontal, that the granular fill has been placed and lightly compacted, not as a structural fill. If the fill is placed as a structural fill, the values should be increased to 45 pounds per cubic foot, 60 pounds per cubic foot, and 120 pounds per cubic foot, respectively. If the slope behind the wall is two horizontal to one vertical, the values for purely active walls and basement walls should increase to 57 pounds per cubic foot and 67 pounds per cubic foot, respectively.

The above equivalent fluid pressures are for static loading conditions. All of the equivalent fluid pressures should be increased by 18 pounds per cubic foot for dynamic lateral pressures which would be imposed during a moderately severe earthquake. It should be noted that the lateral pressures, as quoted, assume that the backfill materials will not become saturated.

6.8. Additional Studies

The primary purpose of this report was to provide general geotechnical parameters which can be utilized in overall site development planning. Obviously, for any significant structure, whether building, roadway, retaining wall, etc., site specific studies will be required.

We appreciate the opportunity of providing this service for you. If you have any questions, or desire additional information, please do not hesitate to contact the undersigned.

Respectfully submitted,
SHB AGRA, Inc.

By ______________________
William J. Gordon
Professional Engineer No. 3457
State of Utah

WJG/sp (94-4-6)

Copies: Addressee (3)

Attachments: References
Table 1, Engineering Geology Parameters of Mine Openings and Outcrops
Figure 1, Vicinity Map
Figure 2, Site Plan
Appendix A1 through A8, Site Exposure Inventory

REFERENCES

Bromfield, C.S., 1968, General geology of the Park City Region, Utah, in Erickson, A.J., Phillips, W.R., and Garmoe, W.J., eds., Guidebook to the Geology of Utah, No. 22, Park City District, Utah: Utah Geological Society, Salt Lake City, Utah, p.11-29.

Bromfield, C.S., and Crittenden, M.D. Jr., 1971, Geologic map of the Park City East Quadrangle, Summit and Wasatch Counties, Utah: U.S. Geological Survey, Geologic Quadrangle Map GQ-852, Scale 1:24,000.

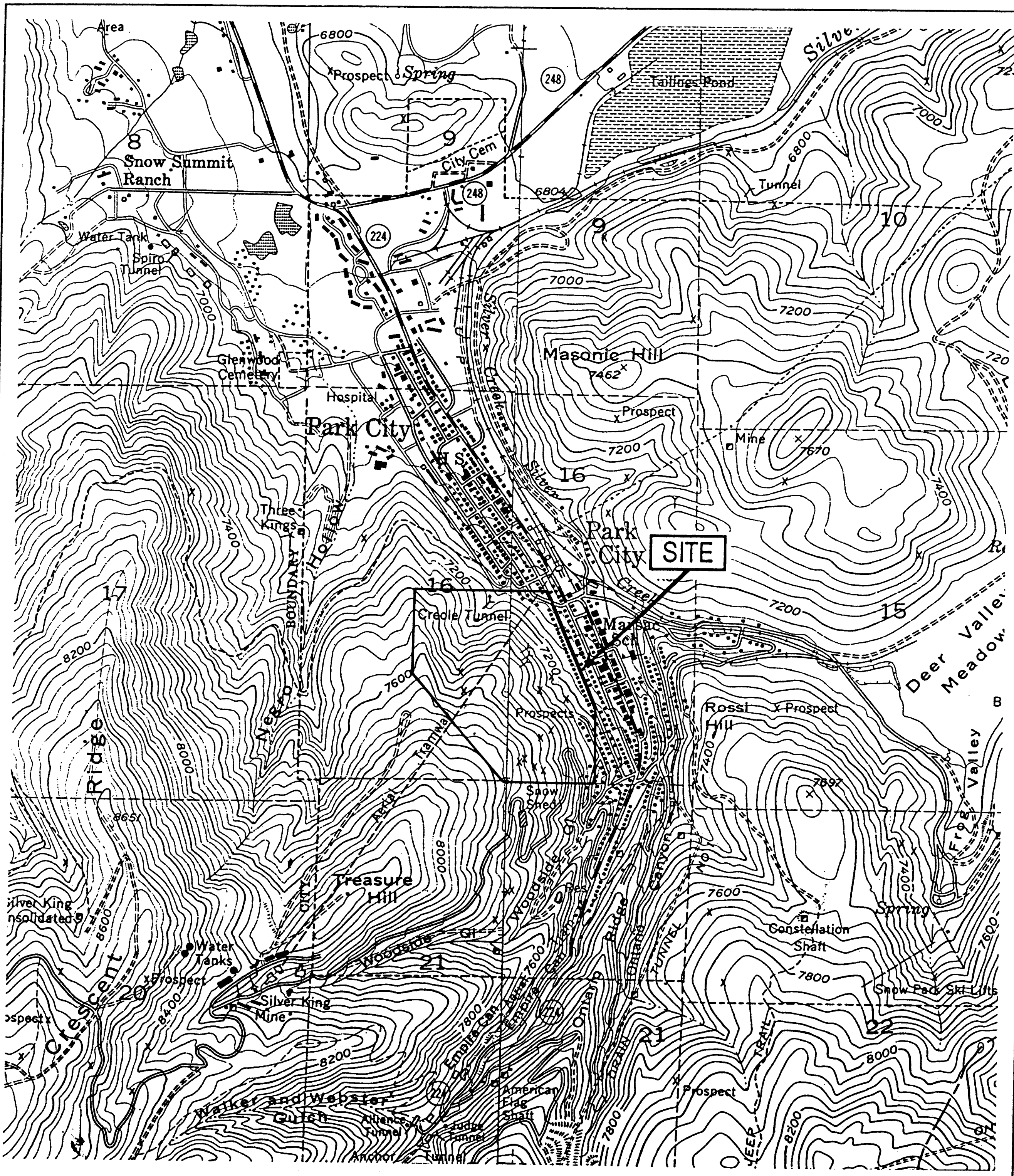
Crittenden, M.D. Jr., Calkins, F.C., and Sharp, B.J., 1966, Geologic map of the Park City West Quadrangle, Utah: U.S. Geological Survey, Geologic Quadrangle Map GQ-535, Scale 1:24,000.

Table 1
Engineering Geology Parameters of Mine Openings and Outcrops

Exposure	Adit Orientation	Rock Type	Bedding Stike	Bedding Dip	Joint-set 1	Joint-set 2	Joint Spacing
Adit HO30	273°	Quartzite	255°	16°	317°	235°	1.5'
Adit HO31	207°	Quartzite	109°	22°	249°	190°	3.5 - 2.0'
Adit HO32	252°	Quartzite	28°	17°	252°	214°	*
Adit HC13	137°	Quartzite	250°	13°	290°	*	*
Outcrop 1	*	Quartzite	258°	5°	334°	200°	*
Outcrop 2	*	Quartzite	213°	10°	244°	182°	*
Outcrop 3	*	Quartzite	245°	10°	273°	210°	*

* Not observed

SWEENEY PROPERTIES
SHB AGRA JOB NO. E93-2267



SCALE IN FEET

1000 0 1000 2000

FIGURE 1
VICINITY MAP

REFERENCE:
USGS TOPOGRAPHIC MAPS TITLED "PARK CITY EAST, UTAH", 1955;
AND "PARK CITY WEST, UTAH", 1955, PHOTOREVISED 1975

SHB AGRA, INC.
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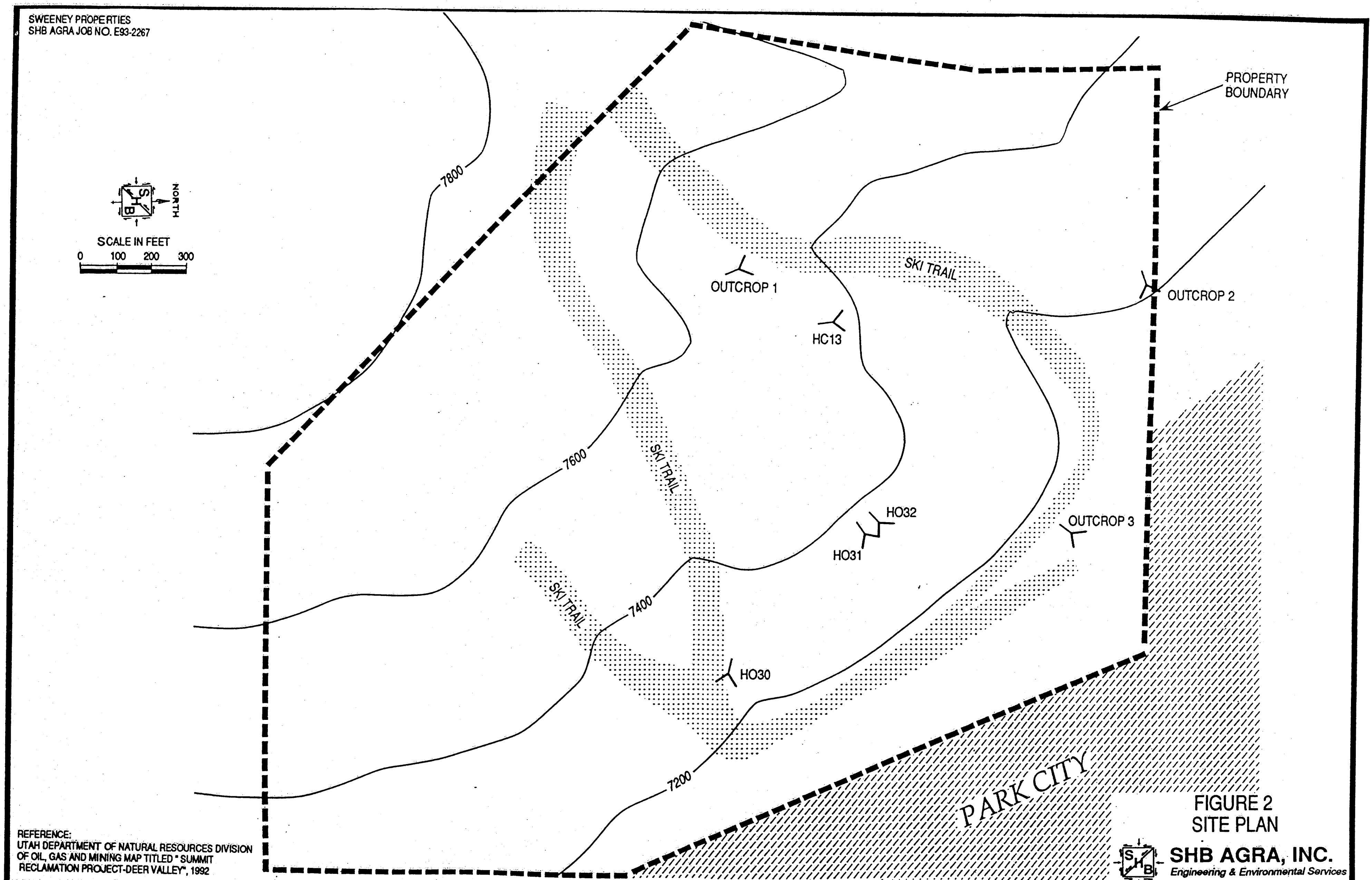
SWEENEY PROPERTIES
SHB AGRA JOB NO. E93-2267



REFERENCE:
UTAH DEPARTMENT OF NATURAL RESOURCES DIVISION OF OIL, GAS AND MINING MAP TITLED " SUMMIT RECLAMATION PROJECT-DEER VALLEY", 1992

FIGURE 2
SITE PLAN

SHB AGRA, INC.
Engineering & Environmental Services

N69310

APPENDIX A

Site Exposure Inventory A1

Exposure: HO30

Location: SW1/4, NW1/4, SE1/4; Sec. 16; T. 2 S., R.4 E.,

Exposure Type: Shaft

Exposure dimensions:

Width 5' Height 6' Length 54'

Orientation 273° Inclination 3°

Rock Type: Quartzite

Description of Rocks: Massive pale-colored quartzite with interbedded fine-grained sandstone laminations, and near vertical joints spaced 1.5 to 3 feet apart

Bedding:

Bed form Massive-Laminated

Bedding strike 255°

Bedding dip 16°

Jointing:

Joint strike 317° & 235°

Joint angle 69° & 81°

Joint spacing 1.5' & 1.5'

Remarks: No signs of groundwater seepage; no timbering observed

Site Exposure Inventory A2

Exposure: HQ31

Location: SW1/4, NW1/4, SE1/4; Sec. 16; T. 2 S., R.4 E.,

Exposure Type: Shaft

Exposure dimensions:

Width 4.5' Height 5.5' Length +100'

Orientation 207° Inclination 7°-32°

Rock Type: Quartzite

Description of Rocks: Massive pale-colored quartzite with interbedded fine-grained sandstone laminations, and near vertical joints spaced 2.0 to 3 feet apart

Bedding:

Bed form Massive-Laminated

Bedding strike 109°

Bedding dip 22°

Jointing:

Joint strike 249° & 190°

Joint angle 87° & 79°

Joint spacing 3.5' & 2.0'

Remarks: No signs of groundwater seepage; no timbering observed; Depth to bedrock 2.0' to 3.0'

Site Exposure Inventory A3

Exposure: HO31

Location: SW1/4, NW1/4, SE1/4; Sec. 16; T. 2 S., R.4 E.,

Exposure Type: Shaft

Exposure dimensions:

Width 4.5' Height 5.5' Length +100'

Orientation 207° Inclination 7°-32°

Rock Type: Quartzite

Description of Rocks: Massive pale-colored quartzite with interbedded fine-grained sandstone laminations, and near vertical joints spaced 2.0 to 3 feet apart

Bedding:

Bed form Massive-Laminated

Bedding strike 109°

Bedding dip 22°

Jointing:

Joint strike 249° & 190°

Joint angle 87° & 79°

Joint spacing 3.5' & 2.0'

Remarks: No signs of groundwater seepage; no timbering observed; entrance partially collapsed; Depth to bedrock 0.5' to 1.0'

Site Exposure Inventory A4

Exposure: HO32

Location: SW1/4, NW1/4, SE1/4; Sec. 16; T. 2 S., R.4 E.,

Exposure Type: Shaft

Exposure dimensions:

Width 4.5' Height 4.0' Length 15'

Orientation 252° Inclination 23°

Rock Type: Quartzite

Description of Rocks: Massive pale-colored quartzite with near vertical joints

Bedding:

Bed form Massive

Bedding strike 28°

Bedding dip 17°

Jointing:

Joint strike 252° & 214°

Joint angle 66° & 84°

Joint spacing 3.5' & 2.0'

Remarks: No signs of groundwater seepage; no timbering observed; entrance nearly closed; Depth to bedrock 0.5'

Site Exposure Inventory A5

Exposure: HC13

Location: SW1/4, NW1/4, SE1/4; Sec. 16; T. 2 S., R.4 E.,

Exposure Type: Adit

Exposure dimensions:

Width 6.5' Height 5.0' Length 14'

Orientation 137° Inclination 21°

Rock Type: Quartzite

Description of Rocks: Massive pale-colored quartzite with near vertical joints

Bedding:

Bed form Massive

Bedding strike 250°

Bedding dip 13°

Jointing:

Joint strike 290°

Joint angle 77°

Joint spacing NA

Remarks: No signs of groundwater seepage; No timbering observed; Entrance nearly closed; Depth to bedrock 0.5'

Site Exposure Inventory A6

Exposure: Outcrop 1

Location: SW1/4, NW1/4, SE1/4; Sec. 16; T. 2 S., R.4 E.; On south side of Town Run ski trail

Exposure Type: Outcrop

Exposure dimensions:

Width 30.0' Height 30.0' Length NA

Orientation NA° Inclination NA°

Rock Type: Quartzite

Description of Rocks: Massive pale-colored quartzite with near vertical joints

Bedding:

Bed form Massive

Bedding strike 258°

Bedding dip 13°

Jointing:

Joint strike 334 ° &200

Joint angle 74° & 79°

Joint spacing NA

Remarks: Roughly triangular shaped outcrop

Site Exposure Inventory A7

Exposure: Outcrop 2

Location: SW1/4, NW1/4, SE1/4; Sec. 16; T. 2 S., R.4 E.; North of ski-lift loading platform

Exposure Type: Outcrop

Exposure dimensions:

Width 30.0' Height 7.0' Length NA

Orientation NA° Inclination NA°

Rock Type: Quartzite

Description of Rocks: Massive pale-colored quartzite with near vertical joints

Bedding:

Bed form Massive

Bedding strike 213°

Bedding dip 10°

Jointing:

Joint strike 244 ° & 182

Joint angle 84° & 88°

Joint spacing NA & 2.0'

Remarks: Road cut outcrop

Site Exposure Inventory A8

Exposure: Outcrop 3

Location: SE1/4, SE1/4, SE1/4; Sec. 16; T. 2 S., R.4 E.; Below power-line

Exposure Type: Outcrop

Exposure dimensions:

Width 8.0' Height 3.0' Length NA

Orientation NA° Inclination NA°

Rock Type: Quartzite

Description of Rocks: Massive pale-colored quartzite with near vertical joints

Bedding:

Bed form Massive

Bedding strike 245°

Bedding dip 10°

Jointing:

Joint strike 273 ° & 210

Joint angle 84° & 89°

Joint spacing NA

Remarks: Road cut outcrop; Depth to bedrock 1.0"