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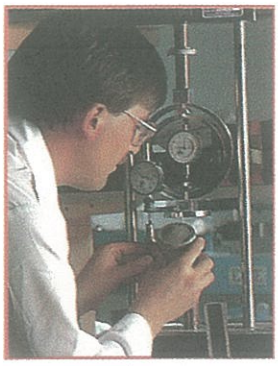

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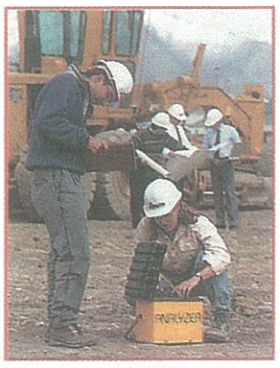

QUALITY CONTROL

GEOLOGIC HAZARDS STUDY
POLE PATCH SUBDIVISION
PHASE I (LOTS 4, 5, 6) and PHASE II
(LOTS 2, 4, 5, 11, 13, 15, 16, 19, 21, 22, 23, 26, 28, 30, 32)
PLEASANT VIEW, UTAH

Prepared for:

Pole Patch Landowners Association

c/o Mr. David L. Gladwell

4185 Harrison Boulevard

Ogden, Utah 84403
84414

JOB NO. 3579

June 1, 1995

466-C Lawndale Drive, Salt Lake City, Utah 84115 Tele. (801) 487-7754 FAX (801) 484-7941
1125 West 1130 North, St. George, Utah 84770 Tele. (801) 628-9536 FAX (801) 628-9589
33282 Golden Lantern, Suite 121, Dana Point, CA 92629 Tele. (714) 259-1992

Delta
GEOTECHNICAL CONSULTANTS INC

June 1, 1995

Mr. David L. Gladwell
Pole Patch Landowners Association
4185 Harrison Boulevard
Ogden, Utah 84403

Subject: Geologic Hazards Study
Pole Patch Subdivision
Phase I (Lots 4, 5, 6) and Phase II (Lots 2,4,5, 11,13,15,16,19,21,22,23,26,28,30,32)
Pleasant View, Utah

Delta Job No. 3579

Dear Mr. Gladwell:

We have completed our geologic hazards study for the subject lots located in Phases I and II of the Pole Patch Subdivision in Pleasant View, Utah. Details of our conclusions and recommendations, along with the supporting field data, are presented in the attached report.

Portions of the site are suitable for locating single family dwellings if the recommendations of the report are implemented.

It has been a pleasure to serve you on this project. Please call us if you have any questions or need additional information.

Very truly yours,

DELTA GEOTECHNICAL CONSULTANTS, INC.

HOVIK BAGHOOMIAN, P.E., Ph.D.
President

Submitted in Six Copies

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INTRODUCTION

Delta Geotechnical Consultants, Inc. was requested to perform a geologic hazards study for 18 lots in Pole Patch Subdivision Phases I and II located in Pleasant View, Utah (SE ¼ Section 7, SW ¼ Section 8, NW ¼ Section 17, and NE ¼ Section 18, T 7 N, R 1 W, Salt Lake Base and Meridian (Figure A-1)).

This study was authorized by Mr. David Gladwell, representing the Pole Patch Landowners Association on March 17, 1995.

PURPOSE AND SCOPE

The purpose of this investigation was to evaluate the hazards at the site posed by earthquake ground shaking, surface fault rupture, landslides, rockfall, debris flows and floods as required by Pleasant View City. More specifically, the goal of this study was to identify the locations of potential hazards on the lots and recommend appropriate mitigation measures to reduce the risk of the hazard or to determine a "buildable" area for the proposed homes that will help avoid potential hazards.

The scope of work included reviewing available published and unpublished data, analysis of aerial photographs taken in 1966, a field reconnaissance, a meeting with Utah Geological Survey (UGS) reviewers, site data collection and analysis, and map and final report preparation.

GEOLOGIC SETTING

The site is located on the Pleasant View salient along the base of the Wasatch Range on several coalescing active alluvial fans at the mouth of Pine and Ridge Canyons and an unnamed

drainage hereafter referred to as Canyon No. 3 (Figure A-1). The surficial deposits are composed of upper Holocene (younger than 10,000 years old) fan alluvium, soil, and colluvium (Personius, 1990). The bedrock on the steep upper portion of the lot has been mapped as high-grade metamorphic rocks of the Farmington Canyon Complex (early Proterozoic to Archean in age). The lots are partially to mostly covered with dense scrub oak growth.

GEOLOGIC HAZARDS

Earthquake Ground Shaking

Seismic ground acceleration is likely to effect all of the lots during moderate to large earthquakes along the Wasatch Fault Zone and other nearby earthquake generating faults. The intensity of the shaking at the site will vary with the size of the earthquake, the distance from the earthquake epicenter and the ground response of the soils at the site.

Surface Fault Rupture

The U.S. Geological Survey (Personius, 1990) has mapped a single trace of the Brigham City segment of the active Wasatch Fault across the site. To further define the location of the fault across the site, slope profiles were traversed across portions of lots 22, 26, 28 and 30 and aerial photographs (Olympus Aerial Surveys, 1966) were reviewed. Based on the scarp morphology from the profiles and aerial photos, we agree with the mapping done by the U.S. Geological Survey. The fault trace follows a northwest trend across lots 21, 22, 24, 25, 26, 27, 28, 29, and 30. The location of the fault scarp at the site is shown on the site plan (Figure A-3).

Landslides

No evidence of recent landslides, slumps or other slope failures were noted on the site. Portions of the lots along the base of the mountain range are quite steep. These slopes are composed of stable Farmington Canyon Complex bedrock with a surficial cover of soil and talus. The lower portion of these lots (where the building pads will be located) typically slope at 20 degrees or less and are largely composed of soil and cobble-sized alluvial fan sediments. These materials are typically stable at slopes of less than 30 to 35 degrees.

Rockfall

No evidence of fallen rock clasts were noted on the site. There are only a few prominent outcrops of the Farmington Canyon Complex on the hillside area above the lots along the northeast portion of the subdivision. Inspection of these outcrops suggested that the joint patterns in the bedrock tend to produce weakly indurated, "plate" shaped clasts with a maximum size of about 1 to 2 feet in diameter and about 6 inches in thickness. Well rounded, quartzite cobbles and small boulders were noted in the upper portions of the three drainage channels, but these appear to have been deposited during alluvial fan deposition and not from rockfall.

Debris Flows

The active channels of the three intermittent drainages (Pine Canyon, Ridge Canyon, and Canyon No. 3) pass through several of the lots as shown on Figure A-3. The channels are fairly well developed at the apex of the fans with 3 to 4 foot high levees on each side of a 10 to 15 foot wide channel. The levees and channel are composed of cobble- and small boulder-sized rocks.

Relative Dating of Debris Flow Events. Debris flows are typically generated when unconsolidated material from the hillside is washed into the canyon drainage (perhaps originating from a landslide). Sediment stored in the channel is scoured out and the debris is transported down the canyon and out onto the alluvial fan. Once the drainage has been scoured from a large event and the debris removed, the potential for another large debris flow is low until the veneer of colluvium re-accumulates in the channel. It is difficult to estimate the rate of sediment accumulation in the channels, but given the similarity of geology, aspect and slope, the rates are similar to be similar in all three canyons. The rate of channel filling corresponds to the minimum interval between large debris flow events, and assuming the recent Cameron Cove Subdivision debris flow in nearby North Ogden (Mulvey and Lowe, 1991) is representative of a large, channel scouring event, the recurrence interval has been estimated at about 1000 years.

Field inspection of each of the canyons suggests that large debris flows have occurred fairly recently in Pine Canyon, Ridge Canyon and Canyon No. 3. The evidence for this is outlined below:

1. Large sections of the drainage channel in the canyons are scoured to bedrock and the material remaining is predominantly cobble- and boulder-sized (with some gravel and sand matrix). This scour is clearly visible in the aerial photos.
2. The cross-section profile of all three channels is similar to that observed in Parrish and Rudd Canyons (located in Centerville and Farmington, Utah, respectively) following large debris flow events (Williams and Lowe, 1990),

3. The diameter of the lichen *R. geographicum* was measured on boulders and cobbles in the bottom of each of the drainages in an effort to determine the approximate age of the most recent events in each drainage (Lock and others, 1970). The maximum thallus diameter measured in each canyon and corresponding age (McCalpin, in preparation) was as follows:

   - Pine Canyon: 13mm or approximately 90 years in age
   - Ridge Canyon: 18mm or approximately 130 years in age
   - Canyon No. 3: 9mm or approximately 70 years in age

   These relative dates for the most recent event correlate with field observations of the relative "freshness" of the channels (based on channel profile and degree of bedrock scour, for example). In relative terms, Canyon No. 3 appears to have been scoured most recently, followed closely by Pine Canyon and Ridge Canyon (although still fairly recently) appears to have had the most elapsed time since a large scouring event.

Debris Flow Sediment Yield Analyses. The relative dating provides some idea of the timing for large debris flow events but does not necessarily address the sediment generated during smaller debris generating events (following a hillside fire, for example). Several methods were used to calculate the estimated sediment yield and the results are summarized in Table 1.

Davis County Model. An empirical relationship comparing sediment volume to contributing channel length was developed by Williams and others (1988) following the Davis County debris flow events of 1983. They calculated between 11 and 12 cubic feet of sediment were generated per foot of channel length. The result for Pine, Ridge and No. 3 Canyons are presented in Table 1. This method is probably not representative of the subject canyons because of the difference in size of the drainages (Rudd Canyon is 3 times as large), geology, and the fact that the subject canyons have recently been scoured.

Modified Los Angeles County Curve Method. Wieczorek and others (1983) modified the L.A. County debris production rate curves (L.A. County, 1979) to reflect the sediment yield for the Rudd Canyon event. Because of the differences between the subject canyons and Rudd Canyon discussed earlier, the L.A. County curves were calibrated using the sediment volume from the 1991 Cameron Cove Subdivision event. This method suggests that the debris production from the Cameron Cove event falls along the DPA-3 curve which falls between Wieczorek and others' moderate and severe flood curves for the Wasatch Front. The estimated debris volumes are summarized in Table 1. It is believed this method provides a more realistic sediment volume for a "worst case" long recurrence interval debris flow event.

PSIAC Method. The Pacific Southwest Inter-Agency Committee (PSIAC) method (Renard, 1980) has been used along the Wasatch Front to estimate sediment yield from canyon drainages following removal of vegetative cover by wild fires. The USDA-SCS recently calculated the PSIAC ratings for all major drainages in Weber and Davis Counties (Evanstad and Mueller, 1994). The sediment yields calculated for high and low intensity burns are summarized in the table below.

TABLE 1: Estimated Debris Flow Sediment Yield

Method	Pine Canyon	Ridge Canyon	Canyon No. 3
Davis County (12yd^3/ft)	64,800 yd^3	37,200 yd^3	36,000 yd^3
Modified LA County Curves	24,300 yd^3	18,700 yd^3	21,840 yd^3
PSIAC High Intensity Burn	475 yd^3	262 yd^3	343 yd^3
PSIAC Low Intensity Burn	179 yd^3	101 yd^3	131 yd^3

Debris Flow Runout Analysis. The mouth of Canyon No. 3 is located within the study area, and any debris generated from this source will be deposited into the channel beginning in Lot 27. However, the outlets of Pine and Ridge Canyons are some distance from the nearest lots, perhaps beyond the runout of a moderate to large debris flow. In order to determine the run out potential of a typical, long-recurrence interval debris flow event from Pine and Ridge Canyons, the geometry of the Cameron Cove subdivision event was used to model the likely runout. Based on the sediments volumes estimated from the worst case scenarios (modified LA County curve data) and an average width of 150 feet and average thickness of 3.3 feet, the potential runout distance can be calculated for each drainage (Table 2).

TABLE 2: Estimated Debris Runout Distances

	Sediment Volume[1]	Average Width[2]	Average Thickness[2]	Runout Distance	Distance to Subdivision	Lots Effected?
Pine Canyon	24,300 yd^3	150 ft	3.3 ft	1325 ft	2050 ft	No
Ridge Canyon	18,700 yd^3	150 ft	3.3 ft	1020 ft	1150 ft	No
Canyon No. 3	21,840 yd^3	150 ft	3.3 ft	1191 ft	0 ft	Yes

1 based on Modified L.A. County Curves (Table 1) 2 based on Cameron Cove Subdivision event

Stream Flooding

Pine, Ridge and No. 3 Canyons are the major areas above the site that collect and concentrate runoff from snow melt and the occasional storm. All three drainage channels are considered intermittent, and interviews with residents indicated that most storm water discharge infiltrates the cobble-lined channel before it reaches the alluvial fan.

The principal drainage channel paths are mapped with the cross shading patterns in Figure A-3. The drainages for Pine and Ridge Canyons are likely to be interrupted by the street as show in the site plan.

Pleasant View City requires that the discharge from the 100-year storm be addressed. Results of our analyses and channel requirements are discussed in the conclusions.

CONCLUSIONS

Earthquake Ground Shaking

All of the lots will be subject to earthquake Ground Shaking during moderate to large earthquakes in the area. Because this hazard is widespread it cannot be avoided, and is likely to effect structures all along the Wasatch Front. However, the risk from shaking can be reduced by adequate design and construction of the building to resist the ground motion. The earthquake Ground Shaking hazard for a properly-designed and well-constructed home on the site is rated as *low*.

Surface Fault Rupture

There is evidence that a single active fault crosses the site as shown in Figure A-3. It is likely that the ground surface along this fault will be displaced during the next large earthquake (magnitude

6.2 or above) along the Brigham City Segment of the Wasatch Fault. The displacement will likely be confined to the area within the fault zone that has ruptured in the past. Buildings located an adequate distance away from the fault, at least 50 feet in this case, may avoid rupture-induced damage and therefore the surface fault rupture hazard for the building pad area is rated as *low*.

Landslides

There is no evidence of past landsliding on the site. Given the general stability of the slopes and materials on the site the landslide hazard on natural slopes is rated as *low*. Stability of cut slopes are discussed in the recommendations section.

Rockfall

There are a few bedrock outcrops upslope of the site that might produce clasts capable of generating rockfall events. However, the bedrock outcrops are typically weakly indurated and tend to produce plate-shaped rock clasts not prone to rolling. No large, loose boulders were observed perched above the site and there was no evidence of fallen rock accumulations on the site below. Given the exposure, strength, joint spacing and shape of the bedrock outcrops the rockfall hazard for the lower portion of the site is rated as *low*.

Debris Flow

There is evidence for recent debris flow events in each of the three drainages above the site. Given the timing of relatively recent debris flow events in each canyon (70 to 130 years) coupled with the relatively long expected recurrence interval between events (perhaps 500 to 1000 years), the risk to structures in the study area would be rated as *low* over the next several hundred years.

Based on the run out analysis, if there were to be an event of comparable size to the 1991 Cameron Cove debris flow, only debris from Canyon No. 3 would likely enter the subdivision. Given this, no special debris flow mitigation should be required for those lots in the western portion of the subdivision.

Because of the proximity of Canyon No. 3 to the subdivision there is a potential for debris generated in the drainage to enter the channel that passes though Lots 27, 26, 25 and 23. However, given the field evidence, the risk from this in the near-term (100 years), is not high. A relative risk matrix (Table 3) was prepared to help the Landowners Association understand the relative risks and determine an appropriate risk-avoidance or reduction strategy based on their risk preferences. For example, if there is little tolerance for risk, construction of a debris basin at the mouth of Canyon No. 3 would provide long-term protection from debris flows, but at a high cost. Alternatively, if no channel improvements are made, the risk will be low in the near-term but increase as the channel slowly accumulates sediment (in this case the requirements to contain the 100-year storm discharge may negate this choice).

TABLE 3: Relative Risk To Structures From Debris Flow In Canyon No. 3

	MITIGATION STRATEGIES (increasing costs ---->)			
RELATIVE TIME EXPOSURE	Do Nothing and Accept the Risk	Avoid Existing Channels	Improve Existing Channels	Construct Debris Basin
500+ years	HIGH	HIGH	MODERATE	LOW
100-500 years	MOD-HIGH	MODERATE	LOW - MOD	V. LOW
<100 years	LOW-MOD	LOW	LOW	V. LOW

Stream Flooding

The rational method was used to estimate the expected discharge from each drainage for the 100-year storm and Manning's formula was used to model the channel size required to contain the expected flows.

Pine and Ridge Canyon Channels. Analyses suggest that the existing drainage channels from Pine and Ridge Canyons should be adequate to contain the discharge from the 100-year storm. However, we recommend that buildings should be setback from the active channels (shaded channels in Figure A-3) in Lots 7,8, 9, 19 and 20 to provide an adequate drainage path.

Canyon No. 3 Channel. Because of the proximity to the canyon mouth and the past modifications to the channel the minimum channel size requirements for the channel in Lots 23, 25, 26, and 27 are presented in Table 4.

TABLE 4: Channel Requirements - 100 Year Storm

Width of Channel (ft.)	Channel Cross Section (sq. ft.)	Depth of Flow (ft.)
3	12.9	4.3
4	12.2	3.0
5	12.0	2.4
6	12.2	2.0
7	12.4	1.8
8	12.7	1.6
9	13.0	1.4
10	13.3	1.3
12	14.0	1.2
20	12.2	0.8

It is important to note that the values presented in the table **do not** include any allowance for freeboard. We recommend that a minimum of one foot of additional channel wall height be added to increase the factor of safety.

The calculations assume a roughly rectangular cross-section for the channel. The cross section shape of the channel is a much more significant factor than the cross sectional area alone. Two channels could have the same cross sectional area but one could be very wide and shallow, and the other very deep and narrow. The storm flow capacity for the channels would be quite different although the areas are the same.

If the channel has sloping sides it might be necessary to estimate a "rectangular" width by measuring the width of the channel from the points where the sides begin to slope up. This will provide a conservative channel width for the model and increase the ultimate factor of safety.

The size requirements given can be compared to the actual cross-sectional dimensions of the active drainage channel. We recommend that any section of the channel that does not contain sufficient cross-sectional area should be modified to increase the capacity. Specific attention should be given in areas where the channel bends or if culverts will be installed.

Should channel modifications be necessary, gabion baskets (rock-filled, wire mesh structures) can be installed along the channel walls to increase the channel capacity and act as berms to prevent storm flow from entering the abandoned channels.

RECOMMENDATIONS

Development recommendations to avoid or minimize the geologic hazards at each lot are summarized in the following pages.

RECOMMENDATIONS: LOT 4 - PHASE I

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined to be about 2,800 feet northeast of this lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 5 - PHASE I

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined to be about 2,500 feet northeast of this lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 6 - PHASE I

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined to be about 2,300 feet northeast of this lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 2 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined to be about 1,800 feet northeast of this lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 4 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined to be about 1,400 feet northeast of this lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 5 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined to be about 1,300 feet northeast of this lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 11 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined to be about 1,800 feet northeast of this lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 13 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined to be about 1,100 feet northeast of this lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 15 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined to be about 1,800 feet northeast of this lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Flooding

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 16 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined to be about 550 feet northeast of this lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 19 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined to be about 550 feet northeast of this lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow hazards from the canyon drainages. We recommend that the hazard from flooding from the 100 year storm be reduced by avoiding the active channel (shaded area around the channel shown in Figure A-3).

RECOMMENDATIONS: LOT 21 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined pass through the north east portion of the lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture if a minimum 50-foot setback is observed in locating the building pad for the home.

Excavation Inspection. Because the location of the fault was mapped based on slope profiles and aerial photo interpretation, and to further insure safety, we recommend that the excavation for the home be inspected during construction by a qualified engineering geologist to confirm that the structure is not located over any faulting or deformation not observed on the surface. If evidence is observed that would increase the risk of surface fault rupture, recommendations for relocating the structure can be provided. A certification of inspection and recommendations (if any) should be sent to Pleasant View City.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code

Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 22 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined pass through a portion of the lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture if a minimum 50-foot setback is observed in locating the building pad for the home.

Excavation Inspection. Because the location of the fault was mapped based on slope profiles and aerial photo interpretation, and to further insure safety, we recommend that the excavation for the home be inspected during construction by a qualified engineering geologist to confirm that the structure is not located over any faulting or deformation not observed on the surface. If evidence is observed that would increase the risk of surface fault rupture, recommendations for relocating the structure can be provided. A certification of inspection and recommendations (if any) should be sent to Pleasant View City.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code

Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 23 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined to be about 400 feet northeast of this lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

We recommend that the hazard from the 100-year storm discharge be reduced by insuring the channel meets the capacity requirements outlined in Table 4, avoiding the recommended channel set-back as illustrated in Figure A-3, and maintaining the channel following any deposition events.

RECOMMENDATIONS: LOT 26 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined pass through the north east portion of the lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture if a minimum 50-foot setback is observed in locating the building pad for the home.

Excavation Inspection. Because the location of the fault was mapped based on slope profiles and aerial photo interpretation, and to further insure safety, we recommend that the excavation for the home be inspected during construction by a qualified engineering geologist to confirm that the structure is not located over any faulting or deformation not observed on the surface. If evidence is observed that would increase the risk of surface fault rupture, recommendations for relocating the structure can be provided. A certification of inspection and recommendations (if any) should be sent to Pleasant View City.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code

Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

We recommend that the hazard from the 100-year storm discharge be reduced by insuring the channel meets the capacity requirements outlined in Table 4, avoiding the recommended channel set-back as illustrated in Figure A-3, and maintaining the channel following any deposition events.

RECOMMENDATIONS: LOT 28 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined pass through a portion of the lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture if a minimum 50-foot setback is observed in locating the building pad for the home.

Excavation Inspection. Because the location of the fault was mapped based on slope profiles and aerial photo interpretation, and to further insure safety, we recommend that the excavation for the home be inspected during construction by a qualified engineering geologist to confirm that the structure is not located over any faulting or deformation not observed on the surface. If evidence is observed that would increase the risk of surface fault rupture, recommendations for relocating the structure can be provided. A certification of inspection and recommendations (if any) should be sent to Pleasant View City.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code

Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 30 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined pass through a portion of the lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture if a minimum 50-foot setback is observed in locating the building pad for the home.

Excavation Inspection. Because the location of the fault was mapped based on slope profiles and aerial photo interpretation, and to further insure safety, we recommend that the excavation for the home be inspected during construction by a qualified engineering geologist to confirm that the structure is not located over any faulting or deformation not observed on the surface. If evidence is observed that would increase the risk of surface fault rupture, recommendations for relocating the structure can be provided. A certification of inspection and recommendations (if any) should be sent to Pleasant View City.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code

Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainages.

RECOMMENDATIONS: LOT 32 - PHASE II

Earthquake Ground Shaking

We recommend that the structure on this lot be designed and constructed to Uniform Building Code Seismic Zone 3 requirements, as a minimum. The owner's architect and structural engineer should be consulted to determine what earthquake-resistant design features can be incorporated in the design of the home. The architect should work closely with the contractor to inspect the construction.

Surface Fault Rupture

Based on the evidence discussed in the geologic hazards section of this report, the location of the active Wasatch Fault has been determined to be about 150 feet northeast of this lot (Figure A-3). Given this information and our current understanding that surface fault rupture and deformation tend to follow past patterns, it is believed that a single family dwelling may be constructed without undo risk from surface fault rupture.

Landslides

No special considerations are recommended for mitigation or avoidance of landslides on this lot. However, to avoid slope stability problems from construction of the home we recommend that all permanent cut slopes higher than three feet be graded to 2 horizontal to 1 vertical unless an engineered retaining system is used. The requirements and standards in Uniform Building Code Chapters 29 (Excavations, Foundations and Retaining Walls) and 70 (Excavation and Grading) should be carefully followed during design and construction.

Rockfall

No special considerations are recommended for mitigation or avoidance of rockfall hazards.

Debris Flow and Canyon Storm Discharge

Given the location of this lot on the alluvial fan, no special considerations are recommended for mitigation or avoidance of debris flow and flooding hazards from the canyon drainage provided that the mitigation measures are implemented on the adjacent lots.

LIMITATIONS

The analysis and recommendations submitted in this report are based on the data obtained from published mapping, field and aerial photograph mapping, and surficial profiling. This report does not reflect any subsurface variations which may occur across the site. The nature and extent of variations may not become evident until the course of construction and are sometimes sufficient to necessitate changes in the locations of the building pad; thus, it is important that we observe subsurface materials exposed in the excavations of Lots 21, 22, 26, 28, 30, and 32.

This report has been prepared in order to assist the Pole Patch Landowners Association in developing their lots as depicted in the drawings and information supplied to Delta; the conclusions and recommendations contained in this report shall not be considered valid unless subsequent changes are reviewed and conclusions of this report modified or approved in writing by the engineering geologist. We also recommend that the *final* plans and specifications be reviewed by our office to evaluate whether our recommendations were properly understood and implemented.

The report should be available to the architect and contractors for information on technical data only as interpreted from the surficial analysis and not as a warranty of subsurface conditions.

It is recommended that the availability of this report be disclosed to future lot or home buyers.

Very truly yours,

DELTA GEOTECHNICAL CONSULTANTS, INC.

CRAIG V NELSON, C.E.G.
Senior Engineering Geologist

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APPENDIX

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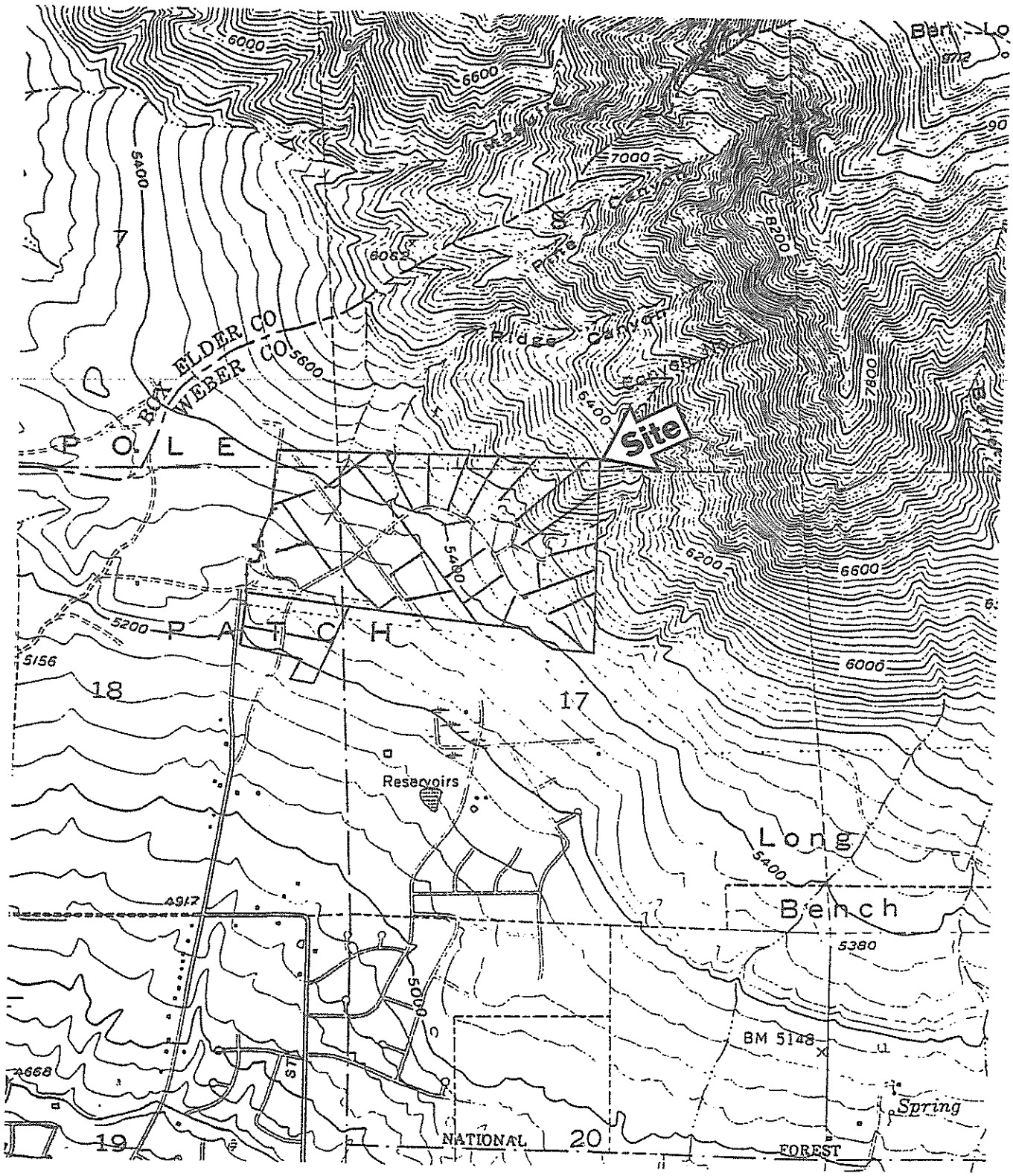


VICINITY MAP

N

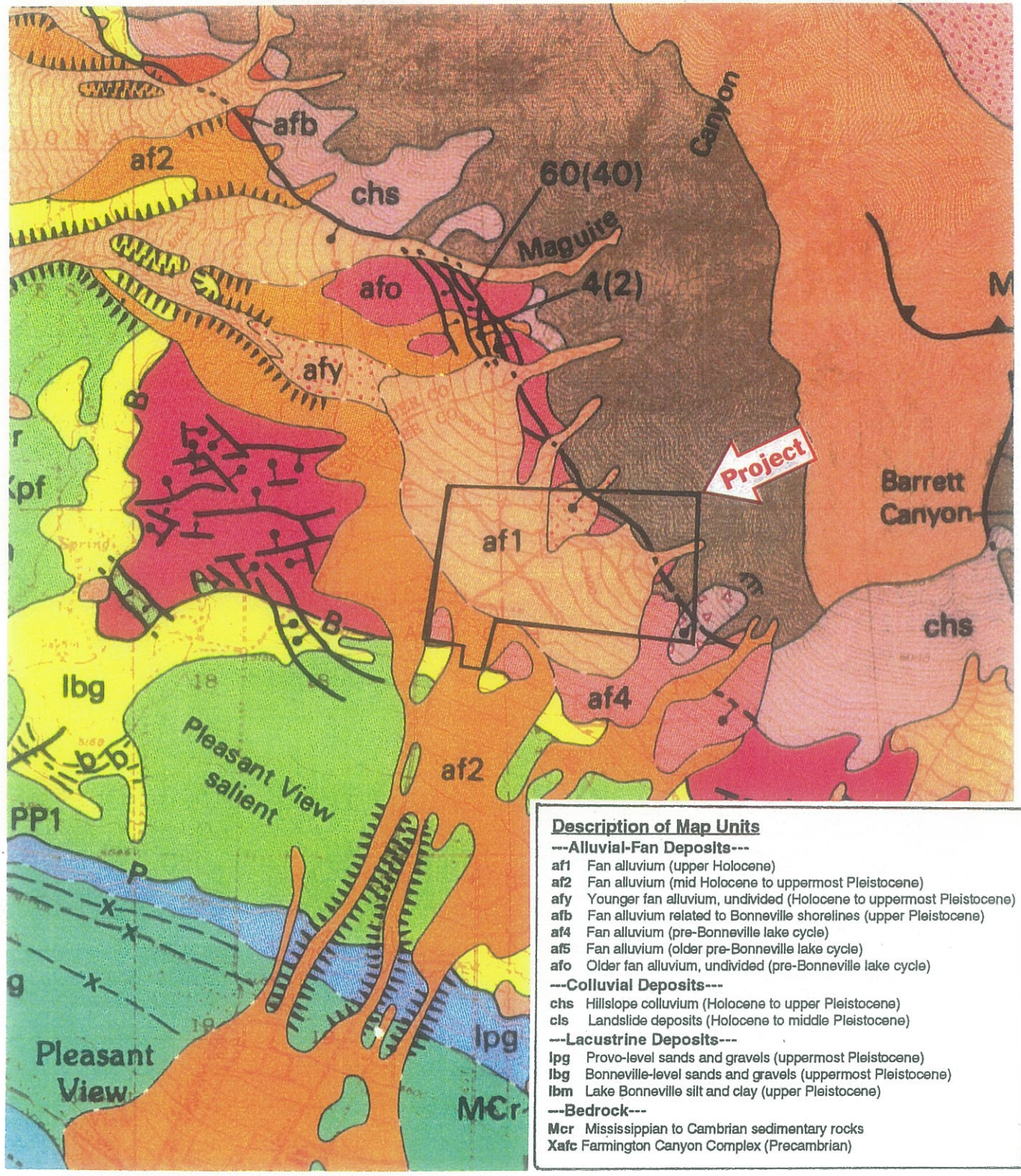
SCALE: 1 INCH = 2000 FEET

REFERENCE: NORTH OGDEN, UTAH QUADRANGLE
USGS 7.5 MINUTE SERIES
(PHOTOREVISED 1986)

JOB NO. 3579

FIGURE A-1

Delta
GEOTECHNICAL CONSULTANTS, INC.



Description of Map Units

---Alluvial-Fan Deposits---

- **af1** Fan alluvium (upper Holocene)
- **af2** Fan alluvium (mid Holocene to uppermost Pleistocene)
- **afy** Younger fan alluvium, undivided (Holocene to uppermost Pleistocene)
- **afb** Fan alluvium related to Bonneville shorelines (upper Pleistocene)
- **af4** Fan alluvium (pre-Bonneville lake cycle)
- **af5** Fan alluvium (older pre-Bonneville lake cycle)
- **afo** Older fan alluvium, undivided (pre-Bonneville lake cycle)

---Colluvial Deposits---

- **chs** Hillslope colluvium (Holocene to upper Pleistocene)
- **cls** Landslide deposits (Holocene to middle Pleistocene)

---Lacustrine Deposits---

- **lpg** Provo-level sands and gravels (uppermost Pleistocene)
- **lbg** Bonneville-level sands and gravels (uppermost Pleistocene)
- **lbm** Lake Bonneville silt and clay (upper Pleistocene)

---Bedrock---

- **Mcr** Mississippian to Cambrian sedimentary rocks
- **Xafc** Farmington Canyon Complex (Precambrian)

GEOLOGY MAP

N

SCALE: 1 INCH = APPROX. 2100 FEET

REFERENCE: PERSONIUS, S.F., 1990, SURFICIAL GEOLOGY MAP OF THE BRIGHAM CITY SEGMENT AND ADJACENT PARTS OF THE WEBER AND COLLINSTON SEGMENTS, WASATCH FAULT ZONE, BOX ELDER AND WEBER COUNTIES, UTAH: U.S. GEOLOGICAL SURVEY MAP I-1979

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FIGURE A-2