REVIEW REPORT
FAULT RUPTURE HAZARD/
GEOTECHNICAL EVALUATION
PROPOSED HIGHLANDS PUD
RESIDENTIAL DEVELOPMENT
APPROXIMATELY 2670 SOUTH HIGHLAND DRIVE
SALT LAKE COUNTY, UTAH

Submitted To:

American Housing Development Corporation
1010 Boston Building
Salt Lake City, Utah 84111

Submitted By:

AGRA Earth & Environmental, Inc.
Salt Lake City, Utah

June 12, 1995

Job No. E95-2196

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June 12, 1995
Job No. E95-2196

American Housing Development Corporation
1010 Boston Building
Salt Lake City, Utah 84111

Attention: Mr. Jeff Jonas

Gentlemen:

Re: Review Report
Fault Rupture Hazard/Geotechnical Evaluation
Proposed Highlands PUD Residential Development
Approximately 2670 South Highland Drive
Salt Lake County, Utah

1. INTRODUCTION

1.1. GENERAL

Presented in this report are the results of our fault rupture hazard/geotechnical evaluation review performed for the above referenced site in Salt Lake County, Utah. This review was conducted to evaluate previous studies of the site performed by Delta Geotechnical Consultants, Inc. (Delta)[1,2]. The site is located approximately 250 feet northwest of the intersection of the Highland Drive and 2700 South street and is shown with respect to major topographic features and existing facilities, as of 1975, on Figure 1, Vicinity Map. A more detailed layout of the site showing site-specific topography and the proposed locations of the residential structures is presented on Figure 2, Site Plan.

During the course of this study, many of the conclusions and recommendations summarized herein were discussed with Mr. Jeff Jonas.

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[1] "Surface Fault Rupture Hazard Study, Proposed Residential Development, Approximately 2670 South Highland Drive, Salt Lake City, Utah" Delta Geotechnical Consultants, inc., October 3, 1993, For IHT Incorporated Job No. 3168

[2] "Geotechnical Study, Proposed Apartment Complex, Approximately 2670 South Highland Drive, Salt Lake City, Utah" Delta Geotechnical Consultants, Inc., June 21, 1994, For IHT Incorporated Job No. 3246

1.2. OBJECTIVES AND SCOPE

The objectives and scope of this study were planned during discussions between Mr. Jeff Jonas of American Housing Development Corporation and Mr. Greg Schlenker of AGRA Earth & Environmental, Inc. (AGRA).

The objectives of this study were to:

1. Review and evaluate the previous fault rupture hazard and geotechnical studies conducted by Delta.

2. Evaluate the recommendations made in the Delta reports and provide additional recommendations as they pertain to amended development plans currently proposed by American Housing Development Corporation.

In accomplishing these objectives, our scope included the following:

1. An initial office program including a review of the existing reports, geologic literature, land-use ordinances, maps, and an examination of stereoscopic aerial photographs.

2. Field reconnaissances at the site.

3. A final office program consisting of compilation of available data, engineering analyses, and the preparation of this summary report.

1.3. AUTHORIZATION

Authorization was provided verbally by Mr. Jeff Jonas.

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, soils, and groundwater conditions described in the previously prepared Delta reports and our 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 we can make observations in order that our recommendations can be reviewed and modifications can be made to this report, if necessary.

2. SITE CONDITIONS

2.1. HISTORY

It is our understanding that the site has been previously developed. The previous uses for the site include single-family homes, and a maintenance facility for U.S. West, Inc. The previous 1993 studies conducted by Delta were in conjunction to plans by IHT, Incorporated to construct a 54-unit apartment complex on the site. For reasons unknown to us the construction proposed by IHT, Incorporated was not initiated.

AGRA was contacted in April of 1995 by Mr. Jeff Jonas who requested that we review the reports prepared for IHT, Incorporated, and to make amended recommendations as they pertain to current development plans proposed by American Housing Development Corporation. At the time of our site reconnaissance the structures on the site had been raised, and general site grading was in progress.

Photocopies of the previous reports prepared by Delta have been placed in the Appendix A and Appendix B of this report.

2.2. PROPOSED DEVELOPMENT

The proposed development is to be used for single-family homesite structures. The structures will be two or more levels in height, and may include full-depth basements. Below grade, the structures will be of reinforced concrete construction. Above grade, the structures will be wood-frame construction with some brick, stone, or stucco veneer. Structural loads will be transmitted through bearing walls and columns to supporting foundations. We project that the maximum wall and column loads will be on the order of 2 to 3 kips per lineal foot and 20 to 30 kips, respectively. Floor-slabs will be light.

Around the perimeter of the proposed structures will be paved roadways. Traffic across the pavements is estimated to consist of a moderate volume of automobiles and light trucks, light volume of medium-weight trucks and only an occasional heavy-weight truck.

As recommended in the Delta report, site development at the time of our recommaisences, has included the removal of non-engineered fills, pavements and the existing structure including foundations and floor slabs from the site. Site development from the time of our reconnissances will include a moderate amount of earthwork primarily in the form of site grading fills. Maximum fills are anticipated to be on the order of six to eight feet. Site grading cuts should generally not exceed one to two feet.

3. SITE INVESTIGATIONS

3.1. FIELD PROGRAM

The 1993 field program conducted by Delta consisted of the excavation and logging four exploration trenches on the site. The trenches were excavated to evaluate fault rupture hazards. The trenches were located on the west side of the site where faulting was suspected to be present and extended in a generally east to west axis so as to intercept north to south trending fault traces that have been mapped in the vicinity of "the site in several previous studies". The locations of the trenches are shown on Figure 4 of the Delta report (Appendix A). The geotechnical report prepared by Delta was based upon the general observations of the subsurface conditions observed in the trenches during the fault rupture hazard study.

During the trenching faulting was observed by the Delta scientists. The faulting consisted of a narrow zone of traces, or a single trace, that extends generally north to south across the site. The location of the fault trace, as projected by Delta, is shown on Figure 4 of the Delta report (Appendix A).

3.2. LABORATORY TESTING

No mention of laboratory testing of soils is made in the Delta reports.

4. SITE DESCRIPTION

4.1. SURFACE

The site consists of an irregular-shaped property having an area of 2.271 acres. The site is proposed to be developed into a 14-unit single-family structure Planned Unit Development. The boundaries of the site are shown on Figure 2. The elevation of the site ranges from 4379 feet on the southwest side of the site to over 4,395 feet on the northeast side of the site. At the time of our reconnaissance the vegetation on the site had been removed. On the western portion of the site, an escarpment drops downward to the west 10 to 20 feet. This escarpment is believed to be the result of the faulting described on the Delta fault rupture hazard report. The southwestern boundary of the site affronts 2700 South Street, and a 123-foot long right-of-way connects the eastern side of the site to Highland Drive.

4.2. SUBSURFACE SOIL AND GROUNDWATER

The subsurface conditions exposed in the Delta trenches were described as follows in the Delta Geotechnical Report (Appendix B):

"Fault trenches excavated at the site encountered from 3 to 10 feet of man-made fill overlying the western portion of the site. Subsoils encountered beneath the fill and in other areas of the trenches consisted of silty sand and sandy gravels. Silty clay subsoils were encountered beneath the granular soils at depths of 7.5 to 13 feet below the existing ground surface. Groundwater was not encountered in the trenches during excavation."

The descriptions of the soils in the Delta report are generally consistent with our observations at other sites in the vicinity of the proposed development.

Groundwater was not encountered to the depths of the Delta trench excavations. We believe that shallow groundwater conditions may be present on the western portion of the site, to the west of the fault trace shown on Figure 4 of the Delta report (Appendix A).

5. DISCUSSIONS AND RECOMMENDATIONS

The following discussions and recommendations pertain to our review of the previous reports prepared by Delta, and our site reconnaissances.

5.1. SUMMARY OF FINDINGS

Evidence of rupture and deformation from faulting was observed in the Delta trenches. The location of the faulting is on the western portion of the site, and crosses the site in a generally north to south axis as shown on Figure 4 of the Delta report (Appendix A) and Figure 2 of this report. The faulting is described by the Delta scientist as being active, and having a minimum displacement of about seven feet. Set-backs for slab-on-grade structures specified in the Delta report (Appendix A), are 15 feet on the upthrown (eastern) side of the faulting, and 20 feet on the downthrown (western) side of the faulting.

Groundwater was not encountered on the surface nor in the trenches. We suspect that shallow groundwater conditions may exist on the west side of the fault trace shown on Figure 4 of the Delta report (Appendix A).

Geotechnically, the native soils on the site are described as being predominantly granular with silty clay subsoils beneath the granular soils. The native soils when undisturbed will exhibit relatively high strength and low compressibility characteristics and are not moisture sensitive.

The man-made fill deposits will exhibit variable and generally very poor engineering characteristics.

The proposed residential structures may be supported upon conventional spread and continuous wall foundations established upon suitable undisturbed natural soils and/or granular structural fill extending to suitable natural soils. Floor slabs must be established over the same soil sequence.

Pavements and outside flatwork, more than five feet from the perimeter of the structures, may be established upon suitable natural soils, properly prepared non-engineered fill, if encountered, and/or upon structural fill extending to properly prepared soils. Some longer-term settlements of pavements and outside flatwork established upon non-engineered fill should be anticipated.

In the following sections, detailed discussions pertaining to the geoseismic setting of the site, faulting, liquefaction potential, groundwater limitations, foundations, floor slabs, cement types, earthwork, pavements, and other geotechnical and geoseismic parameters which could affect the design, construction, or performance of the proposed facility are presented.

5.2. GEOSEISMIC CONSIDERATIONS

5.2.1. General

The site is located within a "Zone 3 Area" as defined by the Seismic Risk Map of the United States in the Uniform Building Code (UBC) 1994 edition. The "Zone 3 Area" is defined as follows: "Major damage which corresponds to Intensity VIII on the Modified Mercalli Scale of 1931." As a minimum, the criteria stated within the UBC for Zone 3 Seismic Areas should be incorporated into the design of the proposed structure.

5.2.2. Faulting

Evidence of rupture and deformation from faulting was observed in the Delta trenches. The projected location of the faulting is shown on Figure 4 of the Delta report (Appendix A). The faulting is described as being active, with a minimum displacement of about seven feet. The faulting is believed to be associated with a branch trace of the East Bench Segment of the Wasatch fault zone.

The Wasatch fault zone is considered active and capable of generating earthquakes as large as magnitude 7.0 to 7.5 (Machette and others, 1991). Surface faulting commonly occurs in conjunction with events of magnitude 6 or larger.

The Salt Lake County Natural Hazards Ordinance, Chapter 19.75, Section 19.75.080 specifies that no structures designed for human occupancy shall be built astride an active fault. Active earthquake faults are generally considered to be faults which have disrupted the ground surface within the past 10,000 years of earth history (the Holocene epoch). Implied with this definition is that such faults are relatively likely to disrupt the ground surface in the relatively near future.

We believe that the set-backs specified by Delta for slab-on-grade structures (Appendix A), are appropriate. However, it is our understanding that the footings of structures adjacent to the east side of the faulting proposed by American Housing Development Corporation, specifically units 4, 12, 13, and 14, are to extend at least eight feet below existing grade. Because the faulting is downthrown to the west, and because the fault traces dip to the west from 71 degrees to 55 degrees, structures with below-grade footings on the east side of the faulting may be established closer than the 15-foot set-back specified for structures with slab-on-grade footings. We recommend that <u>the footings</u> of units 4, 12, 13, and 14, on the east side of the faulting be set-back <u>at least 15 feet from the below-grade projection of the fault traces.</u> This minimum set-back distance has been calculated and is shown on Figure 2 of this report.

We understand that proposed units 1, 2, and 3, which are on the west side of the faulting are to be slab-on-grade structures. Plans prepared for American Housing Development Corporation indicate that these structures will be set-back at least 20 feet to the west of the faulting. The minimum 20-foot set-back on the west side of the faulting is also shown on Figure 2.

On the basis of the information obtained from the Delta reports, we believe that if the structures proposed for the site are set-back as shown on Figure 2, that hazards related to fault rupture and deformation will be minimized.

5.2.3. Liquefaction

Liquefaction is defined as the condition when saturated, loose, granular soils loose their support capabilities because of excessive pore water pressure which develops during a seismic event. The site is located in an area classified on the Salt Lake County Natural Hazards Maps as having a "moderate" liquefaction potential.

The near-surface natural granular soils are unsaturated and not susceptible to liquefaction even during a major seismic event. The underlying silty clay soils encountered to the maximum depth penetrated, 13 to 14 feet, even if saturated, are cohesive and not susceptible to liquefaction during a seismic event.

A more detailed liquefaction study would require a boring to 30 feet to determine deeper subsurface soil and groundwater conditions.

5.3. GROUNDWATER LIMITATIONS

During the trenching conducted by Delta and our site reconnaissances, no indications of shallow groundwater was observed in the excavations or on the surface of the site. We project the static groundwater level to be greater than 15 feet below the site surface. However, our experience with faulted sites in the general area is such that shallow groundwater conditions are often encountered on the downthrown block of fault traces. It is our understanding that proposed units 1, 2, and 3 which are on the west side of the faulting are to be slab-on-grade structures, and will probably be unaffected by shallow groundwater conditions.

5.4. SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.4.1. Design Criteria

The results of our analyses indicate that the single-family homes may be supported upon conventional spread and continuous wall foundations. Foundations may be supported by suitable natural granular or near-surface silty clay soils and/or granular structural fill extending to undisturbed suitable natural soils. It is essential that the footings not be established overlying the existing non-engineered fill, or upon loose or disturbed soils, or improperly placed and compacted fill soils.

Footings which will be exposed to the full effects of frost must be protected by installing them at least two and one-half feet below adjacent final grade. The interior footing may be established at a higher level although 15 inches is recommended for confinement purposes. Floor slabs may be considered equivalent to soil in determining the depth of embedment.

The minimum recommended width for continuous wall footings is 18 inches, while the minimum recommended width for spread footings is 24 inches.

Considering that silty clay soils underlying granular soils may be the design subgrade, spread and continuous wall footings established as recommended above may be proportioned utilizing a conservative maximum net bearing pressure of 1,500 pounds per square foot for real (dead plus reduced live) load conditions. The sand and gravel natural soils are capable of higher bearing pressures, but footing sizes are typically controlled by minimum footing widths. If higher bearing pressures are required, we should be notified for additional recommendations. The term "net bearing pressure" refers to the pressures imposed by that portion of the structure located above lowest adjacent final grade. Therefore, the weight of the footing and the backfill, up to lowest adjacent grade, may be neglected. For total load conditions, the bearing pressure may be increased by 50 percent.

5.4.2. Installation

Subsequent to excavations and prior to the construction of footings, we must be contacted for a site visit to verify the suitability of subgrade soils.

Under no circumstances should the footings be installed upon loose or disturbed soil, non-engineered fill, sod, rubbish, construction debris, frozen soil, or within ponded water. If unsuitable soils are encountered, they must be removed and replaced with granular structural fill. If the granular soils upon which the footings are to be established become loose or disturbed, they must be recompacted before the concrete is poured.

The width of replacement granular fill should be equal to the width of the footing plus one foot for each foot of fill thickness. Therefore, if the footing is three feet wide and the fill is three feet thick, the replacement fill would be six feet wide.

5.4.3. Settlements

Settlements of foundations designed and installed in accordance with the above recommendations and supporting the maximum loads, as discussed in Section 2, should experience long-term settlements on the order of three-eighths of an inch.

Differential settlements should be minor, not exceeding one-quarter of an inch. Approximately 50 to 60 percent of the quoted settlements should occur during construction.

5.5. 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.

5.6. LATERAL PRESSURE

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 and 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 15 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.

5.7. FLOOR SLABS

Floor slabs may be established upon properly prepared suitable natural soils, and/or upon structural fill extending to properly prepared natural soils. To provide a moisture break, it is recommended that floor slabs be directly underlain by at least four inches of "free draining" fill such as "pea" gravel or three-quarters to one inch minus clean gap-graded gravel. Settlement of floor slabs should be negligible.

5.8. EARTHWORK

5.8.1. Site Preparation

As stated previously, site preparation has included the removal of surface vegetation, non-engineered fill, pavements and the demolition and removal of the existing structure and subsurface foundations and floor slabs. Analysis of the 1953 aerial photography indicates that the southern portion of the site, affronting 2700 South Street, was previously occupied by residential structures although no above grade portions of the structures are presently visible on-site. If the below-grade portions of the structure, basement walls, floor slabs, and foundations are encountered they must be removed to a minimum depth of 18 inches below all new construction. If any non-engineered fill is encountered in proposed building areas, including fill around below grade structures, it must be removed from the area extending at least three feet from the perimeter of proposed buildings. Existing floor slabs if encountered, may be allowed to remain beneath the new construction provided it is perforated so it does not act as a watertrap.

Non-engineered fill, if properly prepared and not containing significant amounts of deleterious materials, may be allowed to remain in pavement areas and beneath outside flatwork more than three feet from the building. It should be noted that broken-up asphalt and concrete, if it meets gradational requirements for structural fill, can be reutilized on-site as structural fill; however, if this material is in "excess," proper arrangements for its legal disposal must be provided.

Prior to the placement of the structural site grading fill, floor slabs and pavements, the proposed subgrade soils must be proofrolled by running moderate weight rubber tire-mounted construction equipment uniformly over the surface at least three times. If any unsuitable soils are encountered, they must be removed to a maximum depth of two feet and replaced with compacted granular fill.

Following the completion of the above operations, pavements, floor slabs, or structural site grading fill may be placed in areas of the proposed structures.

5.8.2. Excavations

Shallow temporary excavations not exceeding four feet in depth nor penetrating the groundwater table or non-engineered fill, may be constructed with near-vertical sideslopes. Deeper excavations not exceeding eight feet in depth and/or not penetrating the groundwater table or non-engineered fill should be constructed with sideslopes no steeper than one-half horizontal to one vertical. Deeper excavations, still not penetrating the water table, should be constructed with sideslopes of one and one-half horizontal to one vertical.

In areas where clean granular soil and/or groundwater are encountered in shallow or temporary excavations, much flatter sideslopes, bracing and shoring, and possibly extensive temporary dewatering, will be required. Excavation of clean granular soils beneath the water table will be very difficult.

Some sloughing of the sandy soils on the sides of the excavations must be anticipated. If excessive sloughing occurs, sideslopes should be flattened.

All excavations should be observed periodically by qualified personnel. If any signs of instability or excessive sloughing are noted, immediate remedial action must be initiated.

5.8.3. Fill Material

Structural fill is defined as all fill which will ultimately be subjected to structural loadings such as imposed by footings, floor slabs, and pavements. Structural fill will be required as backfill and as site grading fill and possibly as replacement fill below footings. Structural fill must be free of sod, topsoil, rubbish, frozen soil, and other deleterious materials. For structural site grading fill, maximum particle size should generally not exceed four inches. However, occasional larger particles not exceeding eight inches in diameter may be incorporated and placed randomly in a manner such that "honeycombing" does not occur and the required compaction can be achieved. Maximum particle size, within structural fill placed within confined areas, should generally be restricted to two inches.

On-site granular soils, excluding topsoil, can be used as structural fill. Granular soils and non-engineered granular on-site fill and broken-up pieces of asphalt and concrete may be utilized as structural fill, provided they are free of deleterious materials. Fine grained soils, if encountered, may be utilized as structural fill; however, proper placement will require that close moisture control be maintained. This will be difficult during warm and dry periods of the year and very difficult, if not, impossible, during wet and cold periods of the year.

Nonstructural site grading fill is defined as all fill material not designated as structural fill and may consist of any cohesive or granular soil not containing excessive amounts of degradable material.

5.8.4. Fill Placement and Compaction

Structural fill should be placed in lifts not exceeding 8 inches in loose lift thickness. Fills in excess of five feet in thickness should be compacted to a minimum of 95 percent of the maximum dry density as determined by the AASHTO[3] T-180 (ASTM[4] D-1557) method of compaction. Fills less than five feet should be compacted to 90 percent of the above criteria.

Subsequent to stripping and prior to the placement of structural site grading fill, the subgrade should be prepared as discussed in section 5.9.1, Site Preparation, of this report. In confined areas, such as below footings, subgrade preparation should consist of the removal of all loose or disturbed soils.

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[3] American Association of State Highway and Transportation Officials
[4] American Society for Testing and Materials

Non-structural fill may be placed in lifts not exceeding 12 inches in loose thickness and compacted by passing construction, spreading, or hauling equipment over the surface at least twice.

5.8.5. Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) should be placed at the same density requirements established for structural fill. If the surface of the backfill becomes disturbed during the course of construction, the backfill should be proofrolled and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proofrolling may be performed by passing moderately loaded rubber tire-mounted construction equipment uniformly over the surface at least twice. If excessively loose or soft areas are encountered during proofrolling, they should be removed to a maximum depth of two feet below design finish grade and replaced with structural fill.

5.9. CEMENT TYPES

Based on our general experience in the area, we recommend that concrete which will be in contact with the site soils need not be prepared using sulfate resistant cement. Type I or IA cement will be adequate.

5.10. PAVEMENTS

On-site natural surface soils will exhibit generally excellent pavement support characteristics. Based upon our general experience with these soils and experience in the Salt Lake Valley area, our recommended pavement cross section is presented below:

Roadways
(Moderate Volume of Automobiles and Light Trucks
with Light Volume of Medium-Weight Trucks
and Occasional Heavy-Weight Trucks)

3.0 inches	Asphalt concrete
7.0 inches	Granular base
Over	Properly prepared natural granular soils and/or granular structural fill.

Pavements may be established upon properly prepared non-engineered fill, natural soils, and/or structural fill extending to properly prepared subgrade soils. In "dumpster" areas, a six and one-half-inch-thick leveling coarse of base coarse fill is recommended.

The above rigid pavement sections are for nonreinforced Portland cement concrete. Construction of the rigid pavement should be in sections 10 to 12 feet in width with construction or expansion joints or one-quarter depth saw-cuts on no more than 12-foot centers. Saw-cuts must be completed within 24 hours of the "initial set" of the concrete and should be performed under the direction of the concrete paving contractor. The concrete should have a minimum 28-day unconfined compressive strength of 4,000 pounds per square inch and contain 6 percent $\pm$1 percent air-entrainment.

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

Respectfully submitted,

AGRA Earth & Environmental, Inc.

Greg C. Schlenker
Project Geologist

Reviewed by:

William J. Gordon,
Professional Engineer

Bret DeBernardi
Staff Geotechnical Engineer

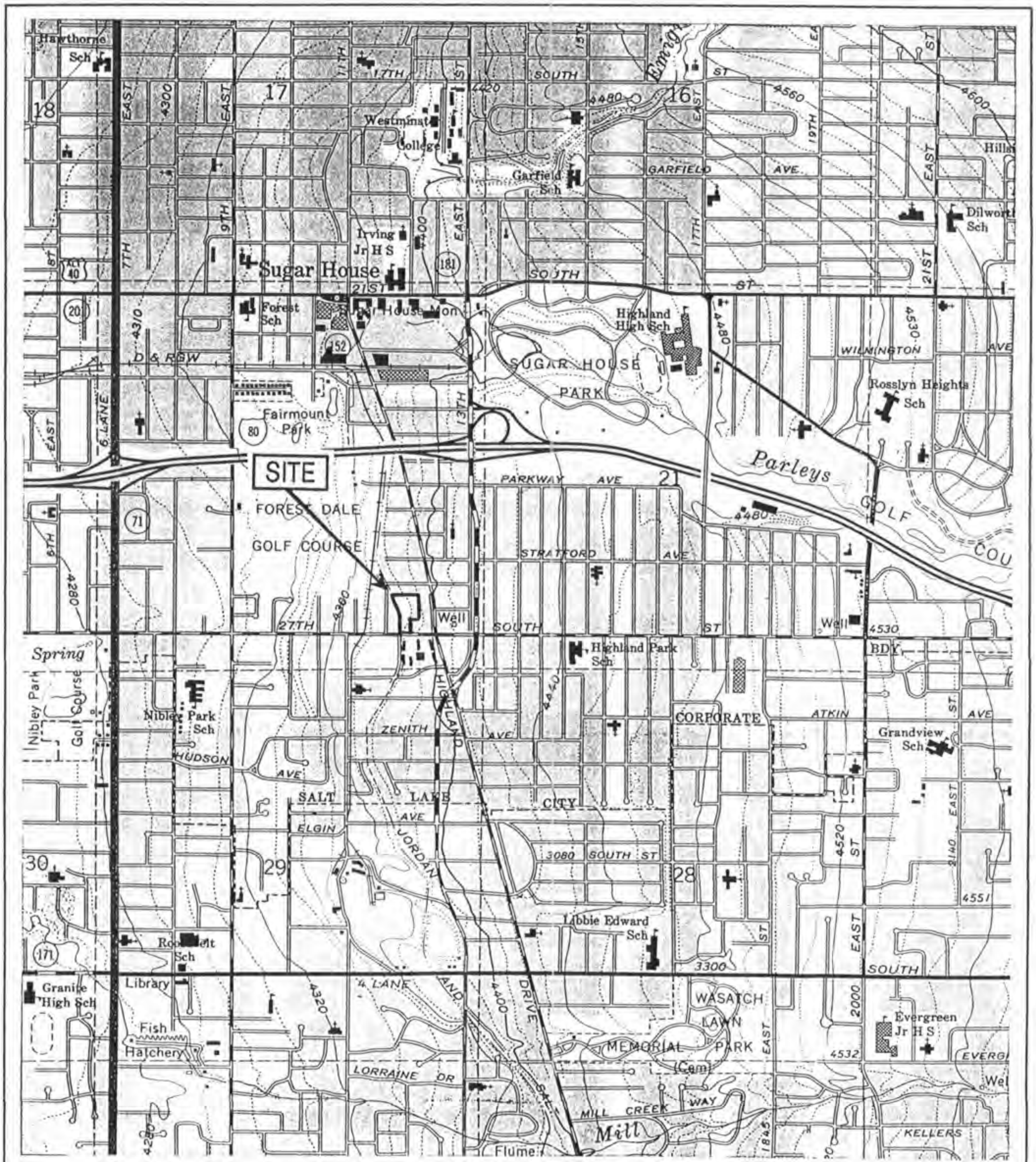
GCS:WJG/mh (95-6-9b)

Encl. References
Figure 1, Vicinity Map
Figure 2, Site Plan
Appendix A, Delta Geotechnical Consultants, Inc., Report, Job No. 3168
Appendix B, Delta Geotechnical Consultants, Inc., Report, Job No. 3246

REFERENCES

Machette, M.N., Personius, S.F., Nelson, A.R., Schwartz, D.P, and Lund, W.R., 1991, The Wasatch Fault Zone Utah - Segmentation and History of Holocene Earthquakes: Journal of Structural Geology, v.12, no. 2, p. 137-149.

HIGHLANDS RESIDENTIAL DEVELOPMENT
AGRA JOB NO. E95-2196



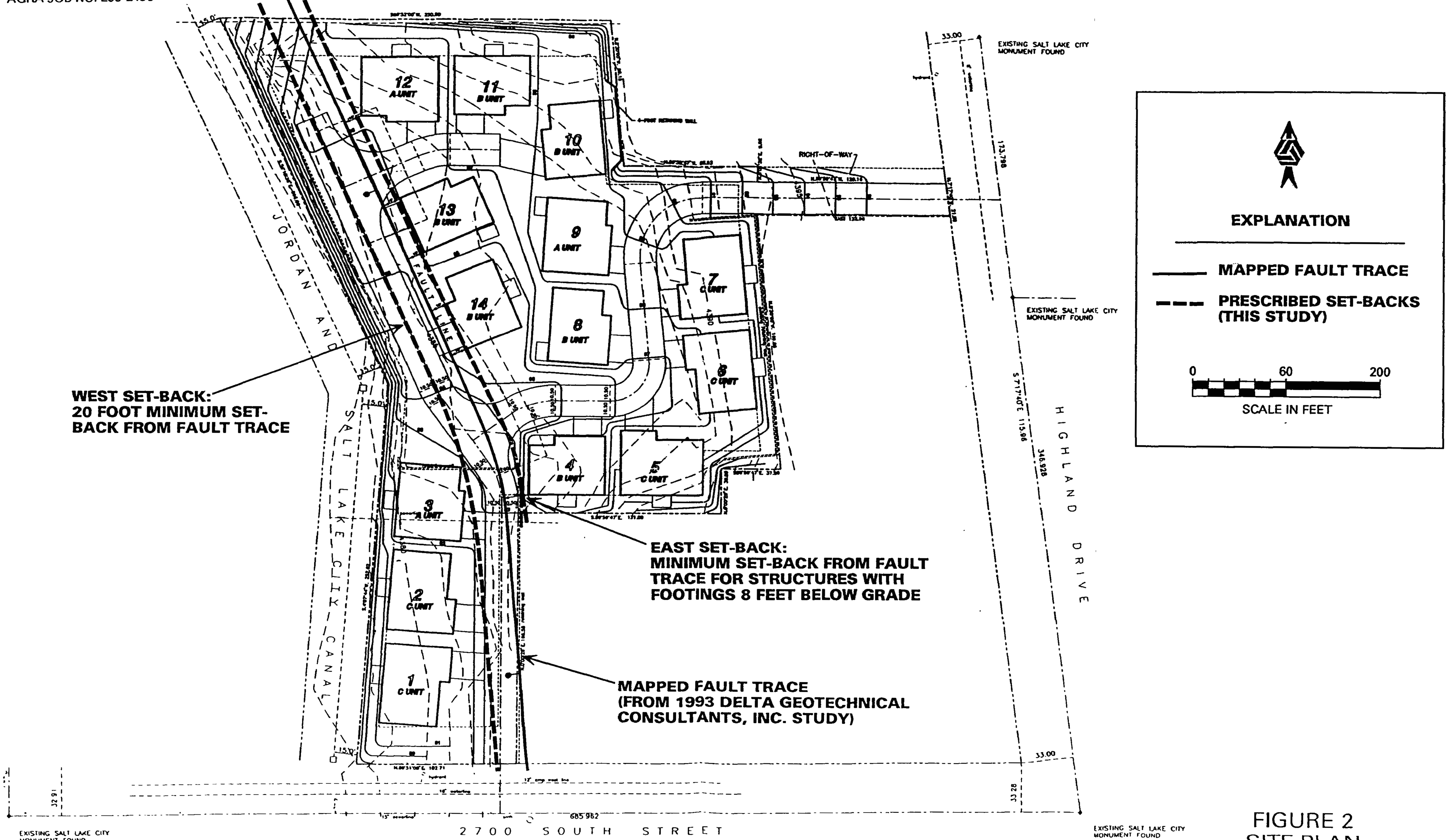
SCALE IN FEET
1000 0 1000 2000

FIGURE 1
VICINITY MAP

AGRA
Earth & Environmental

REFERENCE:
USGS TOPOGRAPHIC MAP TITLED "SUGAR HOUSE, UTAH", 1963, PHOTOREVISED 1969 AND 1975

HIGHLANDS RESIDENTIAL DEVELOPMENT
AGRA JOB NO. E95-2196



REFERENCE:
1994 SITE PLAN TITLED "THE HIGHLANDS"
BY VANWAGONER AND ASSOCIATES ENGINEERING
AND PLANNING, SALT LAKE CITY, UTAH

FIGURE 2
SITE PLAN

AGRA
Earth & Environmental

APPENDIX A

Delta Geotechnical Consultants, Inc., Report, Job No. 3168

SURFACE FAULT RUPTURE HAZARD STUDY
prepared for Mr. Bryson Garbett, IHT, Inc.
PROPOSED RESIDENTIAL DEVELOPMENT
2670 SOUTH HIGHLAND DRIVE
SALT LAKE CITY, UTAH

Prepared for:

Mr. Bryson Garbett

IHT, Inc.

8438 South Gad Way

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JOB NO. 3168 **October 3, 1993**

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GEOTECHNICAL CONSULTANTS INC

October 3, 1993

Mr. Bryson Garbett, President
IHT, Incorporated
8438 South Gad Way
Sandy, Utah 84093

Subject: Surface Fault Rupture Hazard Study
Proposed Residential Development
Approximately 2670 South Highland Drive
Salt Lake City, Utah

Delta Job No. 3168

Dear Mr. Garbett:

We have completed our fault study for your proposed residential development located at about 2670 South on Highland Drive in Salt Lake City, Utah. Details of our conclusions and recommendations, along with the supporting field data, are presented in the attached report.

A large portion of the site is suitable for locating a residential 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.
President

CVN/cvn

Submitted in Three Copies

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INTRODUCTION

Delta Geotechnical Consultants. Inc. (Delta) was requested to perform a surface fault rupture hazard study for a proposed residential subdivision development located on the site of a former U.S. West Service Center at about 2670 South Highland Drive in Salt Lake City, Utah (SE 1/4 SE 1/4 Section 20, T 1 S, R 1 E, Salt Lake Base and Meridian (Figure 1)).

This study was authorized by Mr. Bryson Garbett of IHT Inc. on September 20, 1993. The proposed trench excavations and scope of work were also discussed with and approved by Ms. Dellene Stonehocker, a representative of the property owner, U.S. West, Inc.

PURPOSE AND SCOPE

The purpose of this investigation was to evaluate the surface fault rupture potential hazard at the site as required by Salt Lake City Development Ordinances. More specifically, the goals of this study were to identify the presence and location of active faults in the immediate vicinity of the proposed building areas, to assess the zone of fault-related deformation, and to recommend appropriate fault set-back distances and safe "buildable" areas should faults be discovered..

The scope of work included reviewing readily available published and unpublished data, a field reconnaissance, supervising the exploration trenching and logging the exposed sediments, a field review with the Salt Lake County Geologist and Utah Geological Survey personnel and preparation of this final report.

PREVIOUS WORK

The East Bench portion of the Wasatch Fault Zone has been mapped across the general area of the site in several previous studies (Nelson, 1987, Personius and Scott, 1992). These studies map the position of the East Bench Fault near the western property boundary of the site, roughly along the alignment of the canal. These investigations used surface morphology and aerial photography analysis to map the scarp, no subsurface exploration was used to confirm the actual location of the fault.

GEOLOGIC SETTING

The site is located on the east bench area of the Salt Lake Valley about 3¼ miles west of the base of the Wasatch Mountain Range (Figure 1). The surficial deposits are composed of historic fill and recent (younger than 10,000 years old) colluvium. Pleistocene-age (older than about 10,000 years) Lake Bonneville silt, clay, sand and gravel deposits and pre-Bonneville alluvial fan sediments are covered.

SURFACE FAULT RUPTURE

An west-dipping active fault has been mapped along the north-south trending topographic break-in-slope along the western boundary of the subject property (Personius and Scott, 1990 and Nelson, 1989; Figure 2). Faults are considered "active" if they have ruptured the surface at least once in the past 10,000 years. By this definition, the East Bench portion of the Wasatch Fault Zone is considered active given its average recurrence interval between large surface-rupturing earthquake events of about 1890-2200 years.

An exploration program consisting of a series of four east-west trending trenches was conducted to determine the nature and extent of fault deformation across the site (Figure 3).

Subsurface Exploration. Trenches were excavated with a backhoe at angles closely perpendicular to expected faults. The south trench walls were logged (scale: 1 inch = 5 feet) using a level line to insure accuracy. Exploration depths ranged from 3 to 15 feet. The depth of the trenches varied depending on the depth required to penetrate Holocene sediments and locate "marker beds" known to be at least 10,000 years old. The contact between Pleistocene Lake Bonneville gravel or silty-clay deposits provided excellent marker beds in the trenches.

Trench 1. Trench 1 was excavated from west to east across the northern portion of the property for a total distance of about 200 feet (Figures 3 and 5). The trench was logged on September 23, 1993.

This trench exposed almost 10 feet of fill material over colluvium and Lake Bonneville sediments at the western edge of the property. At about 45 feet from the western end of the excavation a west dipping fault with at least 7 feet of displacement was discovered. This fault placed post-Bonneville colluvium in contact with pre-Bonneville alluvium and Pleistocene Lake Bonneville silty sand. Some drag folding was expressed in the upthrown block sediments. The central and eastern portions of the trench exposed a clear sequence of unfaulted, undeformed Lake Bonneville sediments.

Because of the difficulty in maneuvering the backhoe under the covered parking at the eastern end of the trench, it was necessary to turn the backhoe around and excavate toward the west. The small offset trench is shown on the site plan (Figure 3) and the ends of the trenches were overlapped to prove the continuity of the stratigraphy. The trench log (Figure 5) presents the subsurface profile from both trenches in a composite log format.

Trench 2. Trench 2 was excavated from east to west across the central portion of the property (just north of the existing building) for a total of about 28 feet (Figures 3 and 6). This trench was excavated and logged on September 23, 1993. Trenches 2 and 3 were located based on projecting the strike of the fault from trench 1 to the south.

Trench 2 exposed a fault with a minimum displacement of at least 5 feet placing post-Bonneville colluvium in contact with pre-Bonneville and Bonneville-age sediments.

Trench 3. Trench 3 was excavated from west to east across the north end of the southern parking lot for a total distance of about 50 feet (Figures 3 and 6). This trench displayed a somewhat different style of fault deformation than trenches 1 and 2. Silty-clay Lake Bonneville sediments were in fault contact (displacement of at least 5 feet) with pre-Bonneville and Bonneville-age sandy gravel. The dip on this fault was variable and a smaller step fault (displacement of about 6 inches) was noted about 5 feet west of the larger fault. The sediments on the downthrown block (western side) displayed about 10 feet of drag folding deformation.

<u>Trench 4</u>. Trench 4 was excavated from <u>west</u> to <u>east</u> across the southern portion of the property (lower parking lot) for a total distance of about 100 feet (Figures 3 and 7). This trench was logged on September 22, 1993.

Trench 4 exposed 4 to 6 feet of post-Bonneville colluvium and recent fill overlying a very well cemented layer of Lake Bonneville gravel about 8 to 14 inches thick. Beneath this "hard pan"-like gravel layer were laminated Lake Bonneville silty clays. No evidence of faulting or fault-related deformation was observed this Trench.

The locations of all faults located in the trenches have been transferred to the fault map (Figure 4).

CONCLUSIONS

Active faults, by definition, have ruptured the ground surface at least once in the past 10,000 years. Sediments and marker beds known to be older than 10,000 years and unfaulted, conclusively demonstrate the absence of active faulting. Therefore, the unfaulted and non-deformed Pleistocene-age Lake Bonneville sediments and marker contacts exposed in the central and eastern portion of trench 1 and all of trench 4 provide a high degree of confidence that no active faults are present across a significant portion of the subject site.

The active fault discovered during this study is likely the same fault mapped by the previous studies. However, because of the disturbance of the original topography by grading of the parking lot and building pad and the fill that was apparently pushed over the edge of the original scarp, the fault was previously mapped 60 to 100 feet west of its actual location.

The trenches exposed an active fault with a minimum of about 7 feet of displacement that trends north-northwest to south across the site (Figure 4). The true displacement of the fault is likely to be greater since no similar sediments could be matched on opposite blocks of the fault. The zone of deformation observed consisted of some drag folded bedding adjacent to the fault observed in the trenches. About 10 feet of such drag-folding deformation was noted on the downthrown side of the fault and about 2 feet was observed on the upthrown side.

The pattern of faulting and deformation observed in the approximately 25,000 year sediment record at this site suggest that future fault rupture will likely be confined to the existing fault area and future ground deformation will be similar in nature to that observed in the trenches.

In summary, if the following recommendations are taken into consideration in the layout of the proposed development, there are no fault-related constraints that would prevent the successful development of a residential development.

RECOMMENDATIONS

<u>**Non-Buildable Area.**</u> Given the nature of the faulting and the deformation observed in the trenches, it is recommended that the proposed shallow footing, slab on grade residential buildings be located no closer than 15 feet from the projected surface location of the fault on the upthrown (eastern) side and no closer than 20 feet on the downthrown (western) side. This recommended non-buildable area is shown as the shaded zone on Figure 4.

Buildable Area. The Lake Bonneville sediments observed in the non-shaded, "buildable" area show no evidence of faulting or deformation since they were deposited over 10,000 years ago. In this same period there have been at least 3 (and perhaps 4 or 5) large surface-rupturing earthquakes along the Salt Lake Segment of the Wasatch Fault Zone. Based on this information and our current understanding that surface fault rupture and deformation tend to follow past patterns it is believed that residential dwellings may be constructed without undo risk from surface fault rupture or severe ground deformation if located out of the fault setback area.

LIMITATIONS

The analysis and recommendations submitted in this report are based upon the data obtained from the trenches excavated as indicated on Figure 3. This report does not reflect any variations which may occur laterally away from these trenches. 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 building pads; thus, it is important that we observe subsurface materials exposed in the building excavations to take advantage of all opportunities to recognize differing conditions which would affect the performance of the structure being planned.

This report has been prepared in order to assist IHT, Inc. in selecting the proposed building pad locations. In the event that future changes are made in the location of the buildable areas as outlined in this report, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or approved in writing by the engineering geologist. We also recommend that the final site plans be reviewed by our office to evaluate whether our recommendations were properly understood and implemented.

The backfill was not placed in the trenches in compacted layers. The fill is likely to settle with time and upon saturation. Therefore, no footings or structures should be founded on the trench sites until the trench backfill has been removed and replaced with structural fill, if the fill is to support a structure.

The report should be made available to the architect, the building contractors, and in the event of a future property sales, real estate agents and potential buyers. This report should be referenced for information on technical data only as interpreted from the exploratory trench and not as a warranty of subsurface conditions.

Very truly yours,

DELTA GEOTECHNICAL CONSULTANTS, INC.

REGISTERED GEOLOGIST
CRAIG V. NELSON
No. EG 1585
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

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

REFERENCES

Nelson, C.V., 1989, *Surface fault rupture and liquefaction potential special study areas map, Salt Lake County, Utah*: Salt Lake County Planning Division, Salt Lake City, Utah.

Personius, S.F. and Scott, W.E., 1990, *Preliminary surficial geologic map of the Salt Lake City segment and parts of adjacent segments of the Wasatch Fault Zone, Davis, Salt Lake, and Utah Counties, Utah*: U.S. Geological Survey Map MF-2114, scale 1:50,000.

APPENDIX

FIGURE 1 . . . . . . VICINITY MAP

FIGURE 2 . . . . . . SURFACE FAULT RUPTURE SPECIAL STUDY AREA MAP

FIGURE 3 . . . . . . SITE PLAN

FIGURE 4 . . . . . . FAULT MAP

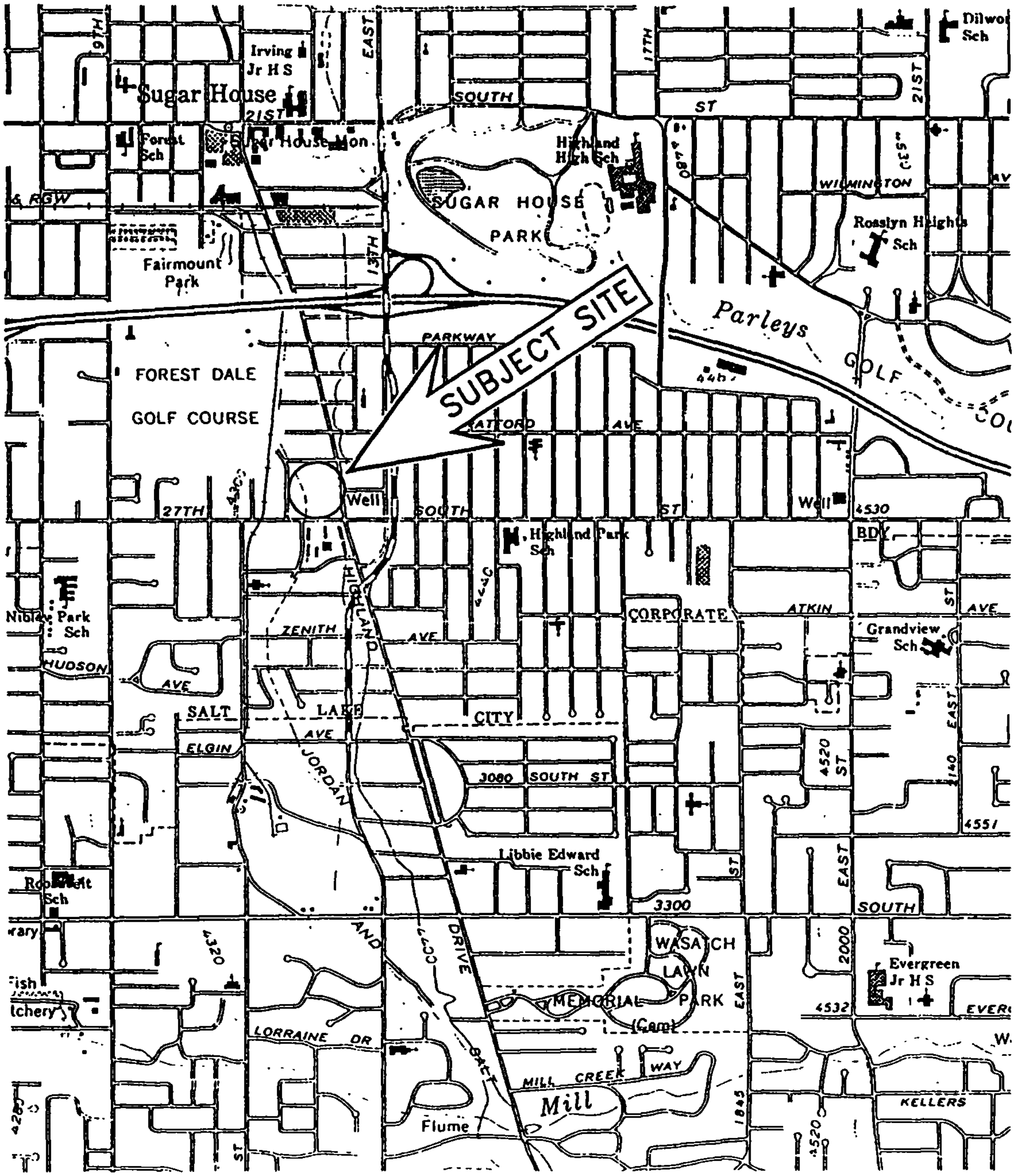
FIGURE 5 . . . . . . TRENCH LOG: TRENCH 1

FIGURE 6 . . . . . . TRENCH LOGS: TRENCHES 2 and 3

FIGURE 7 . . . . . . TRENCH LOG: TRENCH 4

FIGURE 8 . . . . . . QUALIFICATIONS - CRAIG V NELSON

Delta
GEOTECHNICAL CONSULTANTS, INC.



VICINITY MAP

Reference: Sugar House, Utah Quadrangle
USGS 7.5 Minute Series
(Photorevised 1969 and 1975)

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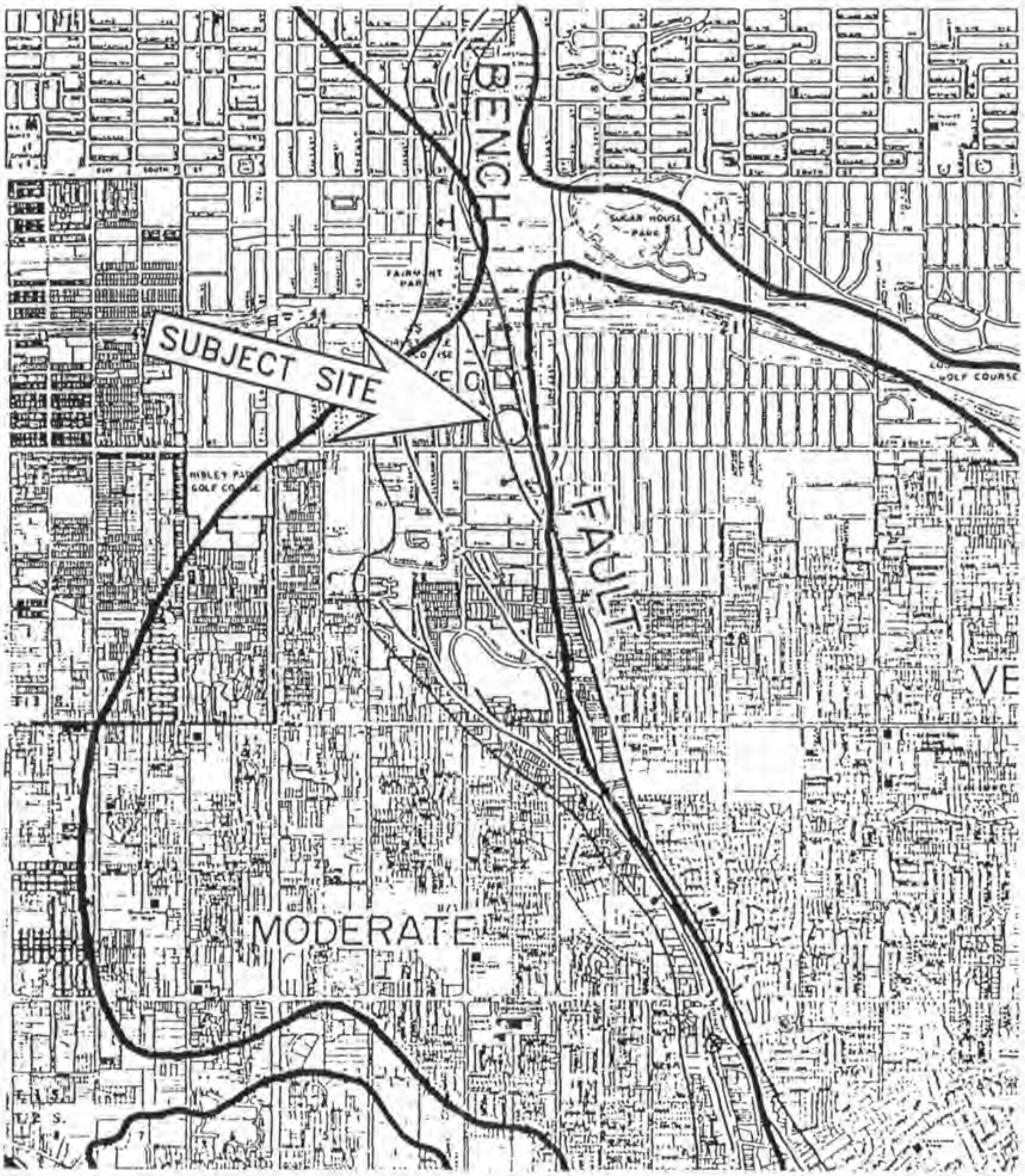
FIGURE 1

GEOTECHNICAL CONSULTANTS, INC.



SURFACE FAULT RUPTURE
SPECIAL STUDY AREA MAP

Nelson, C.V., 1989, Surface fault rupture and liquefaction potential special study areas map, Salt Lake County, Utah: Salt Lake County Planning Division, Salt Lake City, UT

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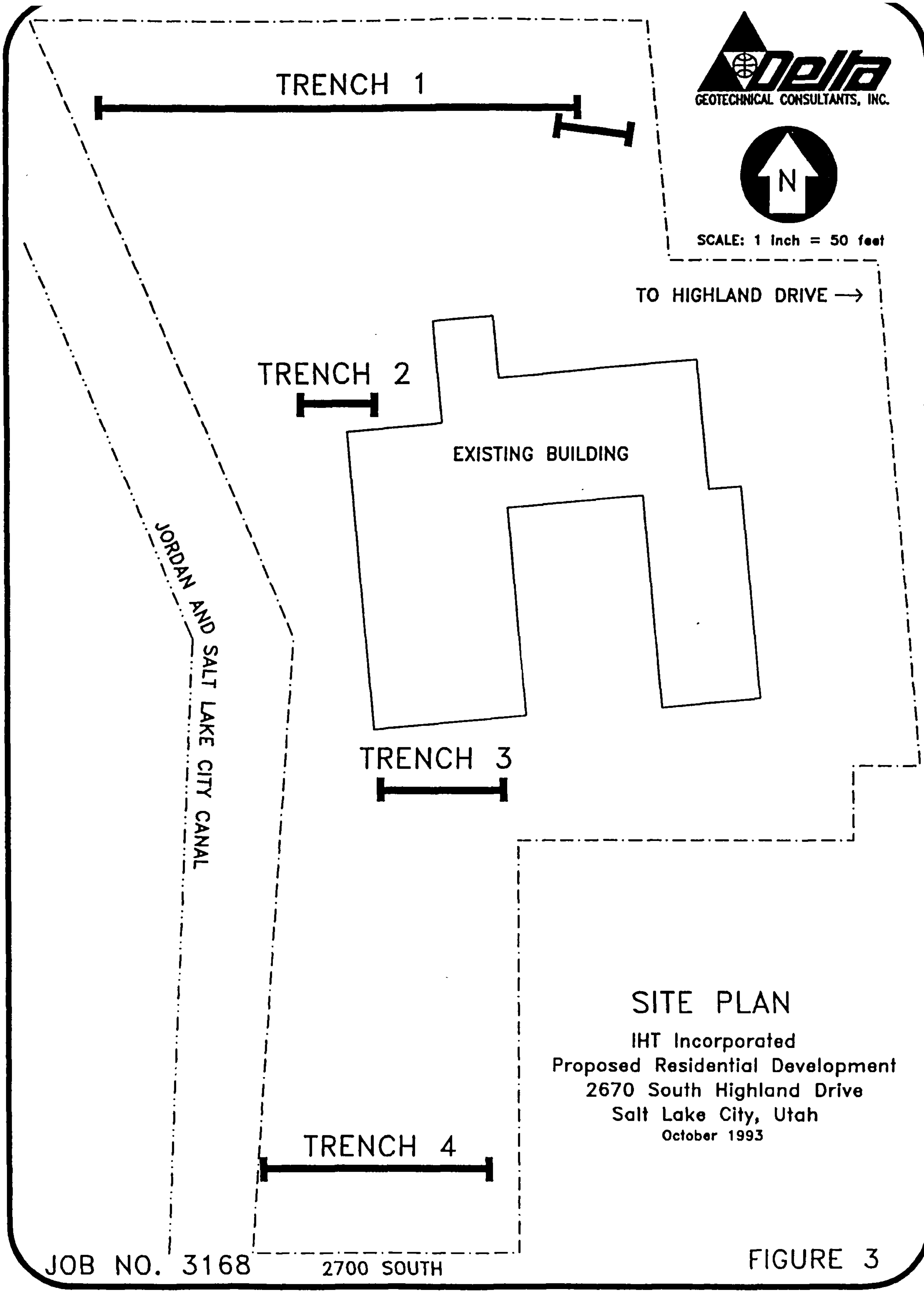
FIGURE 2

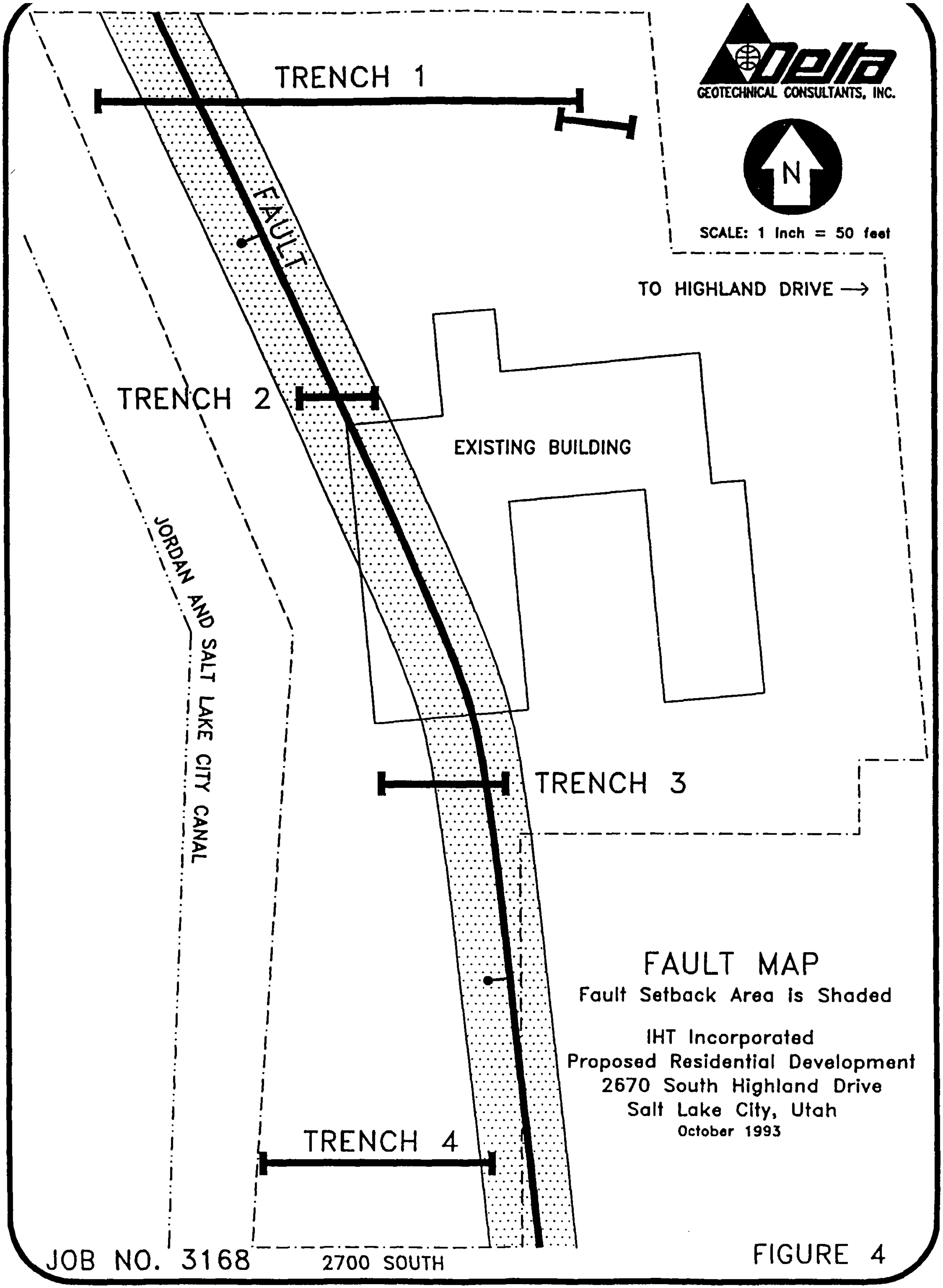


SITE PLAN

IHT Incorporated
Proposed Residential Development
2670 South Highland Drive
Salt Lake City, Utah
October 1993

JOB NO. 3168

FIGURE 3

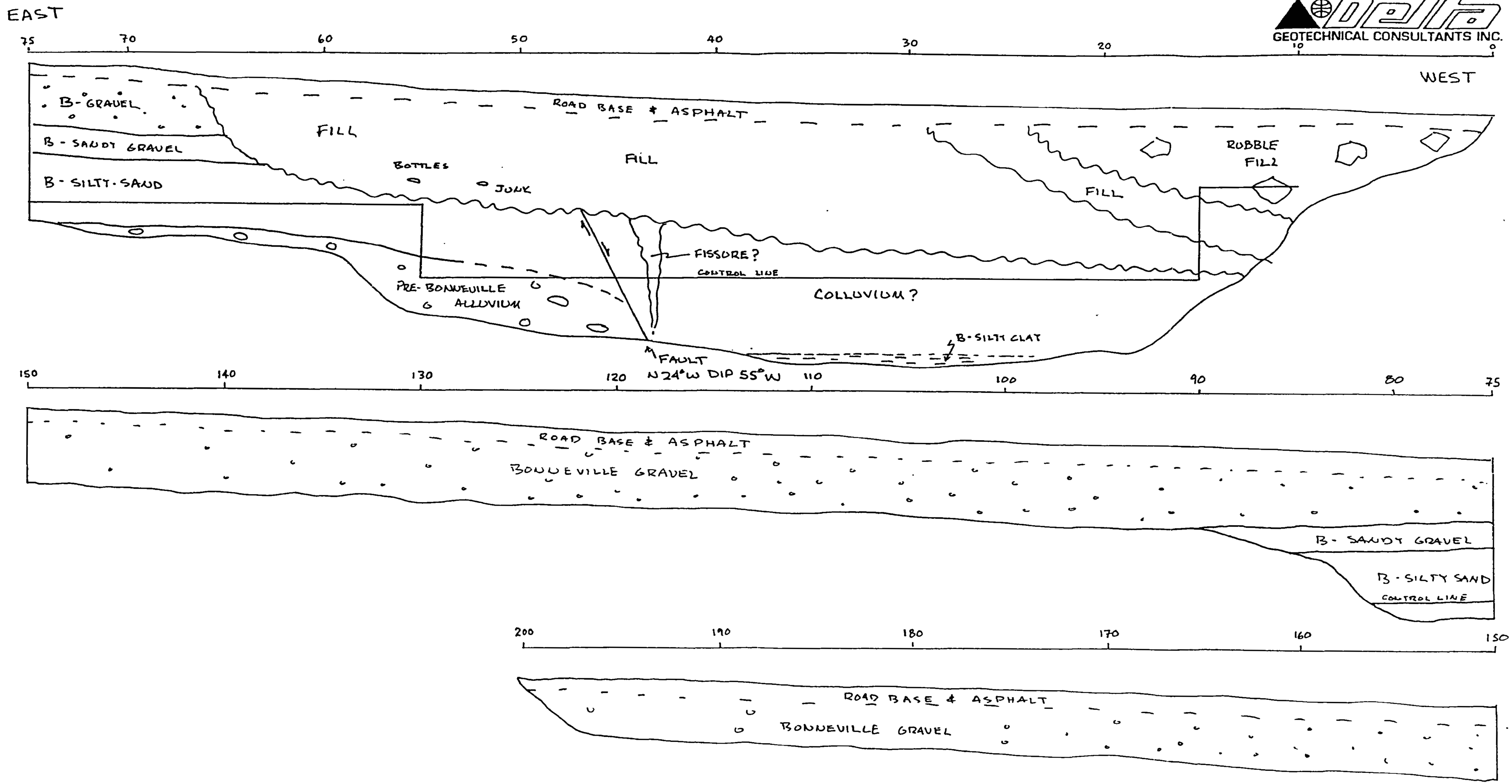


FAULT MAP
Fault Setback Area is Shaded

IHT Incorporated
Proposed Residential Development
2670 South Highland Drive
Salt Lake City, Utah
October 1993

FIGURE 4

GEOTECHNICAL CONSULTANTS INC.



TRENCH LOG - TRENCH 1
-SOUTH WALL-
SCALE: 1inch = 5 feet
(no vertical exageration)

FIGURE 5

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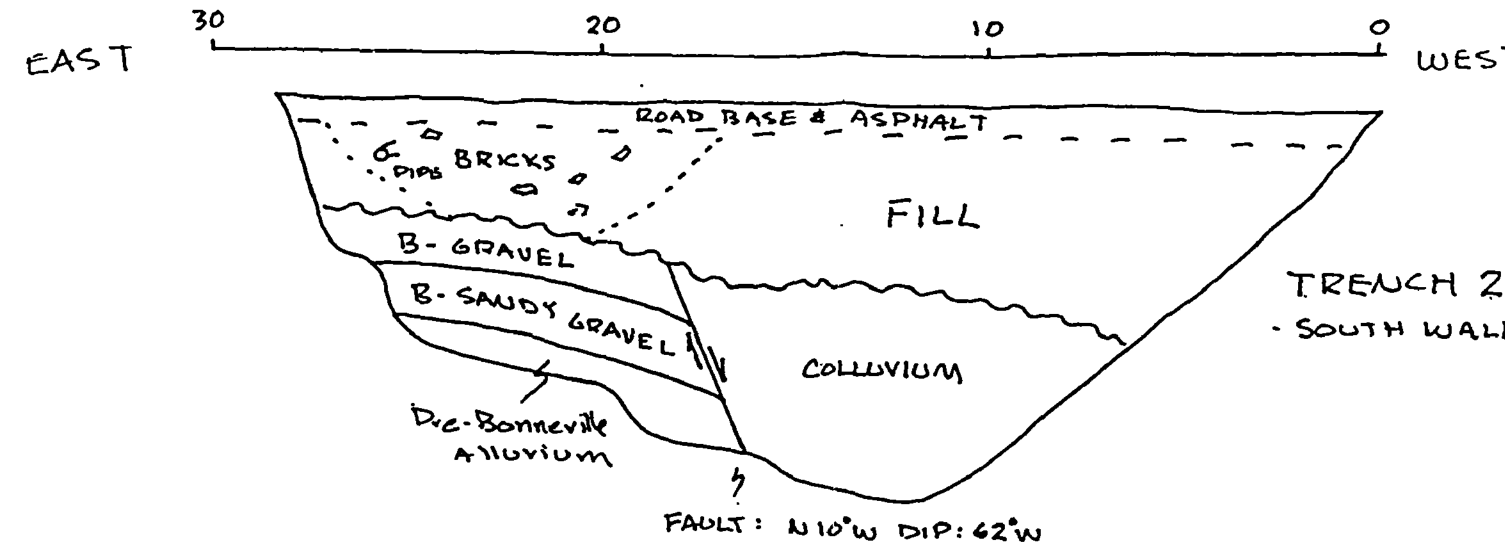
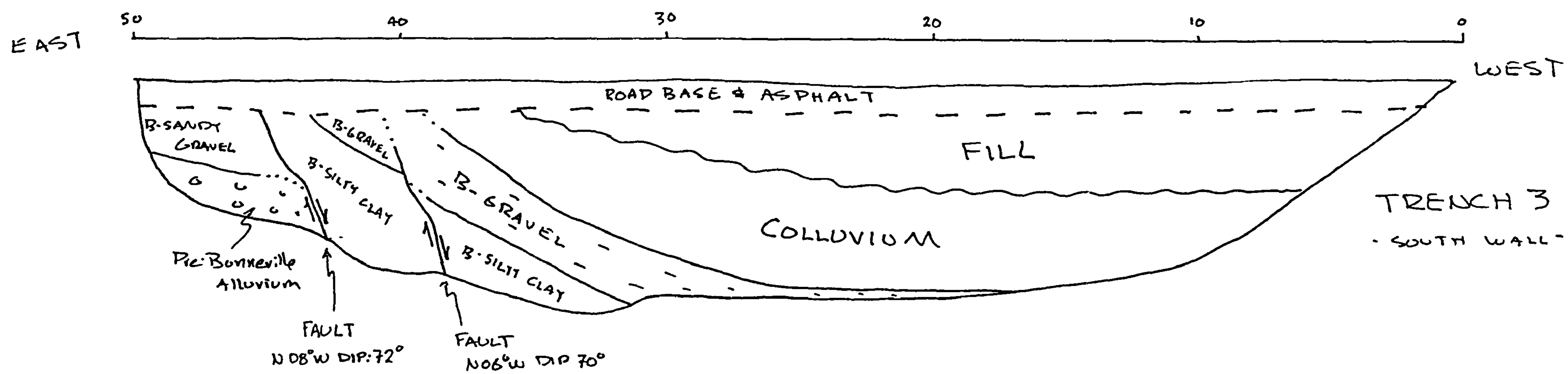
LOGGED: SEPTEMBER 23, 1993

GEOTECHNICAL CONSULTANTS INC.



TRENCH 2
· SOUTH WALL ·

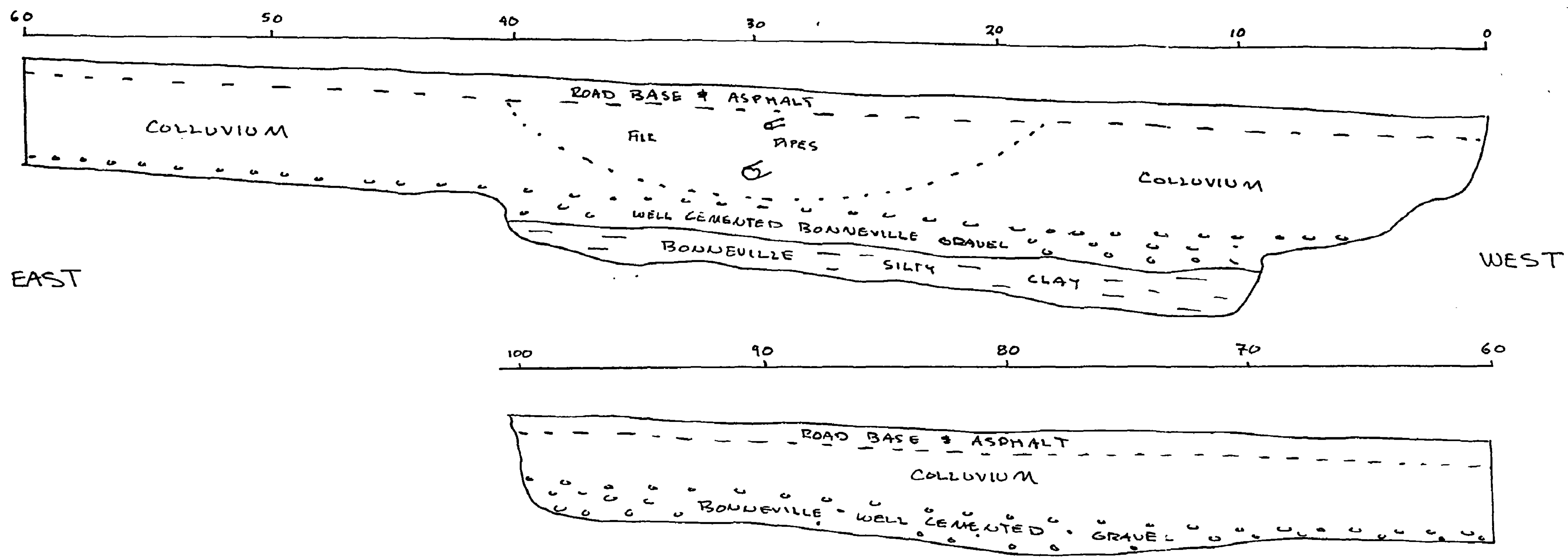


TRENCH 3
· SOUTH WALL ·

SCALE: 1inch = 5feet
(no vertical exageration)
Logged: September 23, 1993

JOB NO. 3168

FIGURE 6



TRENCH 4
-SOUTH WALL-
SCALE: 1inch = 5 feet
(no vertical exaggeration)
Logged: September 22, 1993

JOB NO. 3168

FIGURE 7

APPENDIX B

Delta Geotechnical Consultants, Inc., Report, Job No. 3246

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

GEOTECHNICAL CONSULTANTS INC

June 21, 1994

Mr. Bryson Garbett, President
IHT, Incorporated
8438 South Gad Way
Sandy, Utah 84093

Subject: Geotechnical Study
Proposed Apartment Complex
Approximately 2670 South Highland Drive
Salt Lake City, Utah

Delta Job No. 3246

Dear Mr. Garbett:

We have completed our geotechnical study for the proposed apartment complex located at approximately 2670 South Highland Drive in Salt Lake City, Utah. Details of our findings and recommendations are presented in this report.

PROPOSED CONSTRUCTION

We understand the proposed development will consist of a three-story, 54-unit apartment building. The structure will be of wood framed construction with slab-on-grade floors for the lower level. Structural loads will be relatively light with continuous wall loads on the order of 1,500 to 2,000 pounds per lineal foot. Paved driveways and parking areas are planned west, north, and east of the new building.

Due to the sloping topography, the eastern side of the bottom building level will be 3 to 4 feet below grade, whereas the western side will be at grade. Final finished elevations for the surrounding site were not available at the time this report was prepared, but are expected to be within 1 to 2 feet of the existing ground surface.

SITE CONDITIONS

The site is an old U.S. West Communications facility with an existing U-shaped one-story building located near the center of the irregular-shaped property. It is unknown whether this building has any below-grade structures. The remaining areas of the property are entirely paved with asphaltic concrete parking lots and drives. Pavement quality is generally fair to poor with frequent cracks, depressions, and potholes. A retaining wall 3 to 5 feet high bounds the south and west portions of the old building. An 8- to 10-foot high retaining wall is located along a portion of the eastern property boundary, whereas a 2- to 4-foot high wall forms the north and northeast property boundaries. Two open carport structures are located adjacent to the northern and western retaining walls. The existing surface topography varies across the site but generally follows a gradual regional slope down the west.

The site is bound to the north and south by private homes, to the east by a parking lot and retail businesses, and to the west by the Jordan and Salt Lake City Canal. The canal in this area is either covered or has been replaced by a conduit.

SUBSOIL CONDITIONS

Subsurface conditions used for this report are based on information obtained during the excavation of four fault trenches for a Surface Fault Rupture Hazard Study conducted by Delta Geotechnical Consultants, Inc. The fault study report was previously submitted under Delta Job No. 3168, dated October 3, 1993. The Site Plan, included as Figure 1 in the Appendix, shows the existing structure, proposed building, fault line, and trench locations.

Fault trenches excavated at the site encountered from 3 to 10 feet of man-made fill overlying the western portion of the site. Subsoils encountered beneath the fill and in other areas of the trenches consisted of silty sand and sandy gravels. Silty clay subsoils were encountered beneath the granular soils at depths of 7.5 to 13 feet below the existing ground surface. Ground water was not encountered in the trenches during excavation.

Assuming subsoil conditions are consistent across the site, and in consideration of anticipated floor slab and footing elevations, conventional spread footings are expected to bear on several feet of sands and gravels underlain by silty clay. The westernmost footings, however, will likely bear on old fill. Further, a significant portion of the new structure is to be located within the existing building footprint. In order to provide adequate foundation support for the new structure, the proposed building areas will require complete removal of the old fill and existing structures, and those areas replaced with structural fill as detailed in the following sections.

SITE PREPARATION AND GRADING

All pavements, existing utilities and structures, and existing fill should be totally removed from the proposed building areas, this includes all foundations, floor slabs, and other structures that may underlie the site. Removal of the existing fill should extend beyond the building perimeters for a distance equal to the depth of fill beneath the footings.

Following site stripping and removal of the existing structures, the site and foundation excavations should be inspected and approved by Delta Geotechnical prior to the placement of structural fill. If soft, wet, or loose areas are encountered, additional undercutting may be required.

Structural fill should be used to fill voids and depressions created by removal of existing structures, and to raise the site to required grades. The on-site fill, less construction debris, organics, garbage, and other deleterious materials, may be used as structural fill subject to approval by Delta Geotechnical. In general, structural fill should consist of native soils or imported granular material meeting the following minimum specifications:

TABLE 1

Guideline Specifications for Imported Structural Fill

Sieve Size	Percent by Weight Passing
3 Inch	100
3/4 Inch	70 - 100
No. 40	15 - 70
No. 200	5 - 20
Liquid Limit	35 Maximum
Plastic Index	15 Maximum

These recommendations are intended as guidelines to specify a readily available, prequalified material. Adjustments to the recommended limits can be provided to allow the use of other granular, nonexpansive material. Any such adjustments must be made and approved by Delta Geotechnical in writing prior to importing fill to the site.

Native subgrades to receive footings or structural fill should be well compacted to a firm, non-yielding surface. Structural fill should be placed in 8-inch horizontal loose lifts, within 2 percent of the moisture content optimum for compaction, and compacted to at least 95 percent of the modified Proctor (ASTM D 1557) maximum dry density under footings and floor slabs, and 90 percent density under the exterior slab and pavement areas.

All site grading and fill operations should be observed by a representative from Delta Geotechnical Consultants, Inc., to determine the adequacy of site preparation, the suitability of fill materials, and compliance with compaction requirements.

FOUNDATION RECOMMENDATIONS

Spread footings founded on compacted native subsoils or structural fill should provide adequate support for the proposed structure. The following design and construction details should be observed:

1. Spread footings founded on native subsoils or structural fill may be designed for a maximum net allowable soil pressure of 2,000 psf. This may be increased by one-third for short-term transient wind and seismic loads. Under this pressure the total footing settlement is expected to be about 1.0 inch. The differential settlement between adjacent footings or for a 25-foot span of continuous wall footing should be about one-half this amount.
2. Continuous (wall) and individual (column) footings should be at least 16 and 24 inches wide, respectively, and should be placed a minimum of 2.5 feet below the lowest adjacent final grade.

3. Continuous foundation walls should be adequately reinforced both top and bottom. As a guide, we suggest an amount of steel equivalent to that required for a simply supported span of 10 feet.

4. Footing excavations should be well compacted prior to forming and pouring concrete or placing structural fill.

5. Structural fill, when used beneath footings, should extend horizontally beyond footing perimeters for a distance equal to the fill depth.

PAVEMENT DESIGN AND EXTERIOR FLATWORK

Areas to receive new pavement should be stripped of existing pavements, man-made structures and fill, and undercut as necessary to allow placement of subbase and base materials. The existing roadbase may be stockpiled for future use if carefully stripped so as to prevent mixing with fill and other deleterious materials.

For new pavements, we recommend a section of 2.5 inches of asphaltic concrete and 6 inches of high quality base material in parking lots. Three (3) inches and 8 inches, respectively, are recommended for drives. Areas subject to occasional heavy loads, such as adjacent to dumpsters, should be paved with 3.5 inches of asphalt and 12 inches of base. Alternatively, 5 inches of portland cement concrete and 6 inches of base could be used in these areas. These recommendations are based on a subbase layer of at least 12 inches of compacted native granular soils or structural fill meeting the requirements previously given under SITE PREPARATION AND GRADING. Areas of new pavement underlain by old fill may require additional overexcavation and replacement, as determined by Delta Geotechnical.

Compaction of the base and subbase layers should be 95 and 90 percent, respectively, of the modified Proctor (ASTM D 1557) maximum dry density. Asphalt should be densified to at least 96 percent of the Marshall density. Concrete should have a minimum strength of 4000 psi with at least 6 percent air entrainment.

Exterior concrete slabs and walkways should be underlain by 6 inches of base material placed over native subsoils recompacted to a firm, nonyielding surface. Surface drainage and irrigation should be directed away from flatwork. Excessive saturation of flatwork subgrades could cause differential movement and cracking of the concrete.

PLANS AND SPECIFICATIONS REVIEW

We recommend that one of our engineers review the geotechnical aspects of the project's specifications and plans prior to submission for bids. This review allows us to check whether these documents reflect the intent of our recommendations. In addition, we could possibly identify contractual provisions that present the owner with an elevated risk of geotechnically related construction "extras."

CONSTRUCTION INSPECTION

As previously discussed, subsurface conditions used for this report are based on information obtained from four trenches previously excavated at the site; no information on

subsoil conditions is available for the western portions of the proposed building. Therefore, it is imperative that Delta Geotechnical inspect the site prior to structural fill placement and footing construction to verify our assumptions and design criteria.

LIMITATIONS

The analysis and recommendations submitted in this report are based upon the data obtained from four trenches excavated for a fault study conducted by Delta Geotechnical under Delta Job No. 3168 dated October 2, 1993. This report does not reflect any variations which may occur between the trenches or at other locations 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 designs; thus, it is essential that we observe subsurface materials exposed in the excavations to take advantage of all opportunities to recognize differing conditions which would affect the performance of the facility being planned.

This report has been prepared in order to assist the architect and engineer in the design of this project. In the event that any changes are planned in the design, location or elevation of the building as outlined in this report, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or approved in writing by Delta Geotechnical.

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

Very truly yours,

DELTA GEOTECHNICAL CONSULTANTS, INC.

JOHN MANCINI
Geotechnical Engineer

Reviewed by:

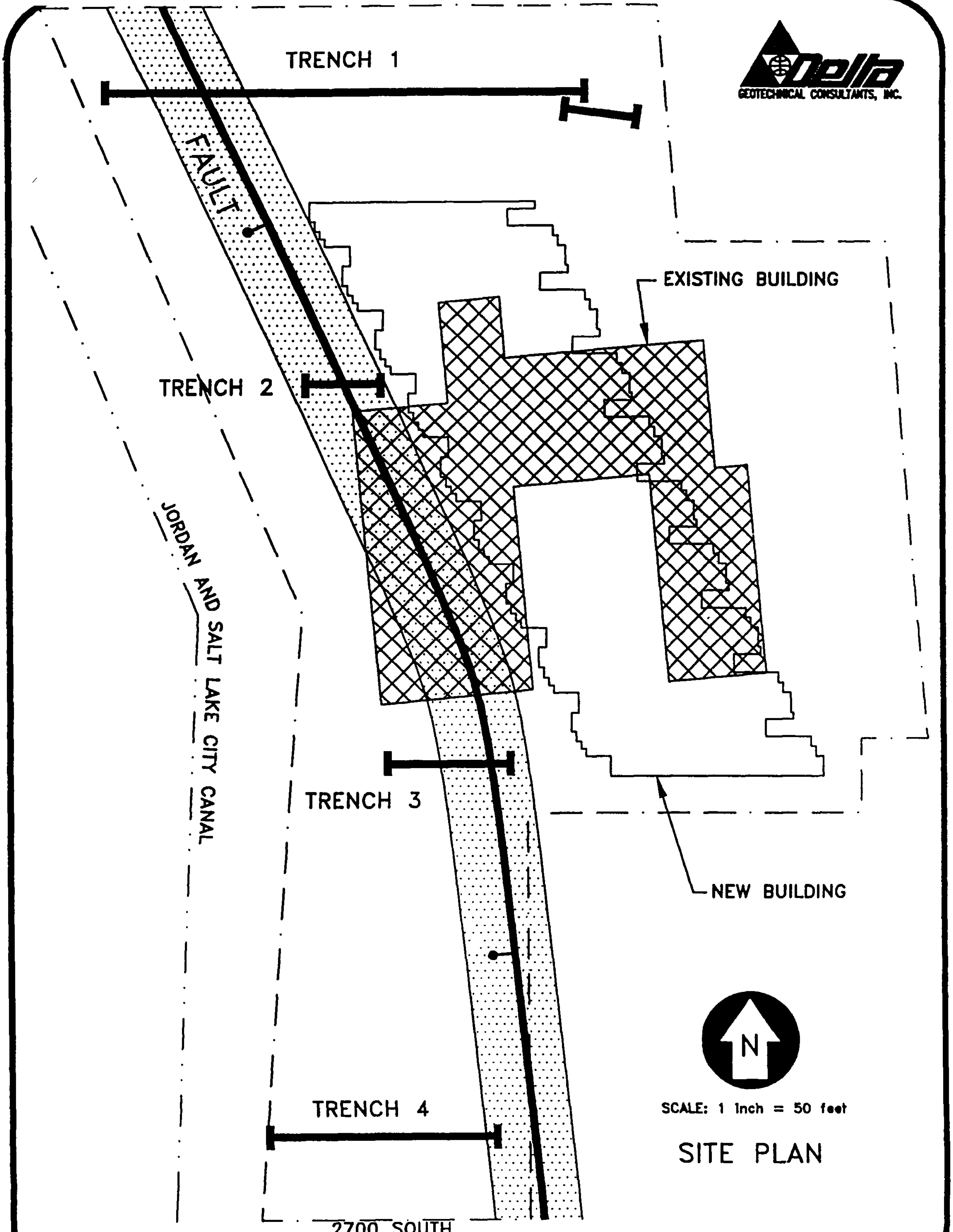
HOVIK BAGHOOMIAN, P.E., Ph.D.
President

REGISTERED PROFESSIONAL ENGINEER
No. 3215
HOVIK
BAGHOOMIAN
STATE OF UTAH

JM-HB/fg

APPENDIX

Figure 1 . . . . Site Plan



JOB NO. 3246

FIGURE 1

NOTES