REPORT
PRELIMINARY GEOTECHNICAL EVALUATION
BUFFALO SPRINGS 158-ACRE
RESIDENTIAL DEVELOPMENT
APPROXIMATELY 12600 SOUTH
AND 4800 WEST STREETS
SALT LAKE COUNTY, UTAH

Submitted To:

Wasatch Pacific
P.O. Box 711879
Salt Lake City, Utah 92008

Submitted By:

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

June 15, 1999

Job No. 9-817-002324

AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

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June 15, 1999
Job No. 9-817-002324

Wasatch Pacific
P.O. Box 711879
Salt Lake City, Utah 92008

Attention: Mr. Mark Garza

Gentlemen:

Re: Report
Preliminary Geotechnical Evaluation
Buffalo Springs 158-Acre Residential Development
Approximately 12600 South and 4800 West Streets
Salt Lake County, Utah

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our preliminary geotechnical investigation performed at the site of the proposed 158-acre single-family housing development located at approximately 12600 South and 4800 West Streets in Salt Lake County, Utah. The general location of the site with respect to major topographic features and existing facilities, as of 1975, is presented on Figure 1, Vicinity Map. A basic layout of the site showing existing roadways and proposed development areas is presented on Figure 2, Site Plan. The locations of the test pits excavated in conjunction with this investigation and extent of surface mining at the site are presented on Figure 3, 1999 Aerial Photograph.

During the course of this study, many of the conclusions and recommendations summarized herein were transmitted verbally to Mr. Mark Garza of Wasatch Pacific. AGRA conducted a preliminary site reconnaissance of the site dated August 9, 1996[1].

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1 Letter, Preliminary Site Reconnaissance, Geologic and Geotechnical Conditions, Proposed Buffalo Springs Subdivision, Salt Lake County,Utah" AGRA job Number 6-817-000488.

1.2 OBJECTIVES AND SCOPE

The objectives and scope of this study were planned in discussions with Mr. Mark Garza and Mr. Kevin White of Agra Earth and Environmental, Inc. (AGRA).

In general, the objectives of this investigation were to:

1. Define and evaluate the subsurface soil and groundwater conditions across the site.

2. Provide preliminary foundation, earthwork, and pavement recommendations to be utilized in the design of the proposed development.

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

1. A field program consisting of the excavation, logging, and sampling of 17 exploration test pits.

2. A laboratory testing program.

3. An office program consisting of the correlation of available data, engineering analyses, and the preparation of this summary report.

1.3 AUTHORIZATION

This geotechnical study was authorized by Wasatch Pacific by signing and returning our Professional Services Agreement (PSA) dated May 5, 1999. This study was conducted in general accordance with our proposal No. PL98-0485, dated April 30, 1999.

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 physical properties of the soils encountered in the exploration test pits, projected groundwater conditions, and the layout and design data discussed in Section 2, Proposed Construction, of this report. If subsurface conditions other than those described in this report are encountered and/or if design and layout changes are implemented, AGRA must be informed so that our recommendations can be reviewed and amended, if necessary.

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

2. PROPOSED CONSTRUCTION

At this time, the project is in preliminary planning stages and detailed structural information is not available. We anticipate that the site will be developed with single-family houses, roadways, and open spaces. We anticipate that the structural loads are to be transmitted primarily through bearing walls and isolated columns. For the residential developments, we project that the maximum real wall and column loads will be on the order of 2 to 3 kips per linear foot and 20 to 30 kips, respectively. Floor slab loads are expected to be light.

We project traffic over primary roadways within the development to be a moderate to heavy volume of automobiles and light trucks, and a light volume of medium- and heavy-weight trucks.

Because site development plans have not been finalized at this time, detailed information regarding proposed site grading is not available. Considering the relatively uneven flat terrain in the previously mined areas, we anticipate that the cutting and filling required to establish roads at the proper grades and to create level building pads for the structures will be a maximum of three to five feet.

3. SITE INVESTIGATIONS

3.1 FIELD PROGRAM

In order to define and evaluate the subsurface conditions in the area, 17 exploration test pits were excavated to depths ranging from 15 to 17 feet with a rubber tire-mounted backhoe. Locations of the test pits in this investigation are presented on Figure 3.

The field portion of our investigation was under the direct control and continual supervision of an experienced member of our geotechnical staff. During the course of the excavation operations, a continuous log of the subsurface conditions encountered was maintained. In addition, relatively undisturbed and disturbed samples of the typical soils were obtained for subsequent laboratory testing and examination. The soils were classified in the field based upon visual and textural examination. These classifications were later supplemented by subsequent observation and testing in our laboratory. Detailed graphical representation of the subsurface conditions encountered are presented on Figures 4A through 4Q, Log of Test Pits. The nomenclature utilized to describe the soil types is presented on Figure 5, Unified Soil Classification System.

Groundwater was not encountered in any of the test pits during our field program. Therefore, slotted PVC pipe was not installed in any test pits to provide a means of monitoring groundwater fluctuations.

Following completion of excavating operations, each test pit was backfilled. Although an effort was made to compact the backfill, the soil was not placed in uniform lifts and compacted to a specific density. Consequently, settlement of the backfill over time is likely to occur.

3.2 LABORATORY TESTING

3.2.1 General

To aid in classifying the soils and to provide data necessary for our engineering analyses, moisture, density, Atterberg limits, chemical, and collapse tests were performed on selected undisturbed samples. A description of the tests plus a summary of the test results are presented in the following sections.

3.2.2 Moisture and Density Tests

To aid in classifying the soils and to help correlate other test data, moisture and density tests were performed on selected samples. The results of these tests are presented on the test pit logs, Figures 4A through 4Q.

3.2.3 Atterberg Limits

Atterberg limits tests were performed on the near-surface silty soils encountered at the site to aid in soil classification and to provide index parameters. The test results are tabulated below:

Test Pit No.	Depth (feet)	Liquid Limit (percent)	Plastic Limit (percent)	Plasticity Index (percent)	Unified Soil Classification System
TP-1	3	NP	NP	NP	ML
TP-10	3	NP	NP	NP	ML

NP = Non plastic

3.2.4 Chemical Tests

To determine if the natural site soils will react detrimentally with concrete, soluble sulfates and pH tests were performed on each of two representative samples of the site soils. The results of the chemical tests are tabulated below:

Test Pit No.	Sample Depth, ft	Soluble Sulfates (SO_4), percent by weight	pH	USCS Soil Type
TP-3	2	<0.0125	9.1	ML
TP-11	1.5	<0.0125	8.7	ML

3.2.5 Collapse Tests

A collapse test was performed on each of five representative samples of the near-surface silty soils encountered at the site to assess their moisture sensitivity characteristics. The samples exhibited a slight pinhole structure. The data obtained from these tests were used to calculate foundation settlements that could occur under the anticipated foundation loadings. The collapse tests were performed as follows:

1. Load sample at in-situ moisture content to specific axial pressure.
2. Measure and record axial deflection.
3. Saturate sample.
4. Measure and record collapse.

The results of the collapse portion of the tests are tabulated below:

Test Pit No.	Depth (feet)	USCS Soil Type	Natural Dry Density (pcf)	Natural Moisture Content (Percent)	Axial Load When Saturated (psf)	Collapse (-) or Swell (+) (%)
TP-1	3	ML	78	14.3	1600	-2.0
TP-3	5	ML	74	30.2	800	-0.2
TP-5	6	ML	63	38.0	1600	-0.6
TP-10	5	ML	74	42.4	400	0.0
TP-12	5	ML	76	28.7	1600	-0.2

The results of the collapse portion of the tests indicate that the tested samples exhibits no to slight moisture sensitivity. It is our opinion that some of the collapse is due to sample disturbance.

Following the collapse portion of the test, a consolidation test was performed on a representative sample of the silty soils in order to provide data on the compressibility and stress history characteristics of these soils. The consolidation test indicated that the tested soil is moderately to highly over-consolidated. These soils will exhibit relatively low compressibility characteristics when loaded below the preconsolidation pressures. Detailed results of the tests are maintained within our files and can be transmitted at your request.

4. SITE CONDITIONS

4.1 SURFACE

The site consists of approximately 158.44 acres of essentially undeveloped land once used as a sand and gravel mine. No permanent structures are present on the site, and none were identified on the site during AGRA's review of historical documentation conducted during our Phase I Environmental Site Assessment[2] dated May 19, 1999. The eastern portion of the site appears to have been historically farmed and AGRA considers it likely that the western portion was farmed as well, prior to mining activities.

The original topography of the site was likely relatively flat with subdued hills and swales. East-west flowing tributaries of Barneys Creek intersect the north, central, and southern portions of the site. Moderately steep and variable sideslopes occur along portions of the most northern drainage. Site topography is more severe where mining operations have modified the surface. Piles of soil at least 10 feet high are present on the site, often with very steep slopes.

Vegetation at the unmined portions of the site consists of natural grasses and sagebrush.

4.2 SUBSURFACE SOIL CONDITIONS

The subsurface soil conditions encountered in the test pit locations at this site were somewhat variable. At test pit locations outside the previously mined disturbed areas, a thin one to four-inch thick layer contains major roots and has been classified as topsoil. Although not noted in the test pit logs, the upper 12 to 16 inches of soils in agricultural areas typically have been loosened during farming operations.

At Test Pits TP-1 through TP-7, located at the eastern portion of the site as shown on Figure 3, the soils extending to depths of approximately 8 to 13 feet generally consist of silt with some fine sand, clayey silt, and silty clay. These soils generally are typically slightly moist, soft and loose grading to medium dense and stiff to very stiff with depth, and range from gray-brown, brown, and light brown in color.

Beneath the fine-grained soils described above and at the remaining test pits at the more western locations, Test Pits TP-8 through TP-17, and extending to the maximum depths explored of from 15 to 17 feet, fine to coarse sand and fine and coarse gravel with varying amount of silt and some cobbles were encountered. The granular soils range from medium dense to dense, are red-brown and light brown in color, and when undisturbed will exhibit moderate to high strength and low compression characteristics within the anticipated loading range. Within the predominantly

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2 "Report, Phase I Environmental Site Assessment, Proposed Buffalo Springs Development Property Located at Approximately 12600 South 4800 West, Riverton, Utah 84065" AGRA, Job No. 9-817-002323.

granular soils at most test pit locations, layers varying in thickness from 1 to 11 feet of clayey silt, silty clay, and silt with some clay were encountered to depths ranging from 1 to 14 feet. The fine grained soils are typically soft to medium stiff in consistency, are light brown and gray-brown in color.

It should be noted that a slight pinhole structure was noted in the fine-grained samples from about 1 to 13 feet depth. Often, a porous pinhole structure is indicative of moisture sensitive collapsible soils. Collapsible soils exhibit moderate strength and low to high compressibility characteristics when dry but lose strength, become highly compressible, and collapse upon significant increases in moisture. However, as previously discussed, testing on these soils indicated no to slight moisture sensitivity characteristics.

4.3 GROUNDWATER CONDITIONS

Groundwater was not encountered to the depths penetrated at the time of excavating. Groundwater levels are influenced by seasonal and climatic conditions which can result in fluctuations in the elevation of the groundwater table over time. Fluctuations on the order of one to two feet should be anticipated.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 DISCUSSIONS OF FINDINGS

The results of this preliminary investigation indicate that the site is suitable for construction of the proposed development. The primary geotechnical concern of the site is the presence of silts and clays which exhibit a slight pinhole structure. Collapsible soils exhibit moderate strength and compressibility characteristics when dry, but lose strength and "collapse" with increasing moisture contents. Most typically, moisture sensitive collapsible soils are identified by a porous pinhole structure. Although testing performed on samples obtained for this study did not indicate significant collapse potential, it has been our experience that the area is prone to more variable and random sequences of these soils.

We anticipate that structures which have their lowest levels extending approximately four to five feet below grade and with the footings extending generally one to one and one-half feet deeper, will extend through the zone where potentially collapsible soils are most prevalent. However, at a few scattered test pit locations, potentially collapsible soils extend to greater depths. During excavation, if soils exhibiting a porous pinhole structure are encountered, AGRA should be contacted for a site visit. At a minimum, removal of the potentially collapsible soils beneath the footings and to a point where there is no more than two feet remaining below the slabs will be required. The depth of potentially collapsible soils must be confirmed during the site visit.

The proposed structures may be supported upon conventional spread and continuous wall foundations established upon suitable undisturbed natural non-moisture sensitive soils and/or upon structural fill extending to suitable undisturbed natural non-moisture sensitive soils. Under no circumstances should footings be established upon or over the upper 10 to 16 inches of loose disturbed surficial soils or potentially collapsible soils.

Pavements may be established upon properly prepared natural soils including the 12 to 15 inches of disturbed soils, and/or structural fill extending to these soils.

Although this is a preliminary geotechnical study, based upon our knowledge of the soil conditions at the site and in the area, the recommendations presented herein will be generally applicable for final design. We do, however, recommend that AGRA review final buildings layouts, configurations and general grades to determine if additional studies are warranted. This will allow any field programs to be tailored to each of the individual facilities and will help attain the most useful data so that the recommendations can be "fine-tuned".

In the following sections, detailed discussions pertaining to earthwork, foundations, floor slabs, lateral resistance, lateral pressure, pavements, and the geoseismic setting of the site are discussed.

5.2 EARTHWORK

5.2.1 Site Preparation

Site preparation must include the removal of any surface vegetation, topsoil, soil stockpiles and other deleterious materials from all areas which will ultimately be structurally loaded. Vegetation and deleterious materials should be removed from the site. Topsoil, although unsuitable for utilization as structural fill, may be stockpiled and subsequently utilized for landscaping purposes. Topsoil is anticipated to be on the order of one to four inches in thickness at the unmined portions of the site only.

Following stripping and prior to the placement of structural fill, pavements, or floor slabs, the subgrade must be proofrolled by running over the surface continuously at least three times with moderate-weight rubber tire-mounted construction equipment. If any loose or disturbed zones are encountered beneath pavements or floor slabs, they must be removed to a maximum depth of two feet and replaced with granular structural fill. Beneath footings, all loose and disturbed soils must be removed. Also, we recommend that no more than two feet of potentially collapsible soils remain beneath floor slab areas. Consideration should be given to completely removing potentially collapsible soils from floor slab areas as well to reduce the possibility of collapse.

5.2.2 Excavations

Temporary construction excavations in cohesive soils not exceeding four feet in depth, nor encountering the water table, may be constructed with near-vertical sideslopes. In cohesive soils, even if groundwater is encountered, near-vertical sideslopes remain applicable. Deeper excavations of up to 8 to 10 feet, and above the water table may be constructed with sideslopes no steeper than three-quarters horizontal to one vertical.

Excavations not exceeding four feet in depth in sands and gravels and above the water table may be constructed no steeper than three-quarters horizontal to one vertical and one and one-half to one vertical up to eight feet depth.

If groundwater is encountered and/or extensive zones of granular soils are encountered below the water table in shallow or deeper excavations, much flatter sideslopes, shoring/bracing, or dewatering, will be required. Some sloughing of excavations in the sandy and gravelly soils must be anticipated. If excessive sloughing occurs, sideslopes should be flattened.

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

5.2.3 Structural Fill

Structural fill will be required as site grading fill, backfill over foundations and utilities, and possibly as replacement fill below footings. All structural fill should be free of sod, rubbish, frozen soil, and other deleterious materials. Structural fill placed to stabilize soft subgrade soils, or placed below a level one-foot above the water table at the time of construction, should consist of a mixture of clean coarse gravels and cobbles or mixture of the two-inch minus clean gap-graded gravel.

The maximum particle size within structural site grading fill should generally not exceed four inches, although occasional particles of up to six to eight inches may be incorporated provided that they do not result in "honeycombing" or preclude the obtainment of the desired degree of compaction. Structural site grading fill is defined as fill placed over fairly large open areas to raise overall site grade. Maximum particle size of granular soils within confined areas should generally not exceed two inches.

The on-site sands, gravels, and silty and clayey soils may be utilized as structural fill at the site. However, where the presence of moisture sensitive soils is confirmed, it is recommended that permeable soils not be utilized within 20 feet of the proposed building area. Permeable soils, if utilized, would provide a conduit for infiltration of moisture into potentially collapsible soils. We, therefore, recommend that the predominant structural fill within 20 feet of buildings consists of fine-grained on-site soils or silty/clayey granular soils. The use of the fine-grained silts and clays will require that close moisture control be maintained. <u>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.</u> Only granular soils should be used in confined areas, such as beneath footings, and in utility trenches unless within 20 feet of the proposed building areas where moisture sensitive soils are encountered.

5.2.4 Fill Placement and Compaction

Where required for stabilization, coarse gravel and cobbles may be end-dumped to a maximum loose lift thickness of 15 inches, with each lift then being compacted by dropping a backhoe bucket uniformly over the surface continuously at least three times.

All structural fill should be placed in lifts not exceeding eight inches in loose lift thickness and moisture content within two percent of optimum. When the finer-grained soils are utilized in confined areas, loose lift thickness should be reduced to approximately three to four inches to facilitate compaction. All structural fill placed beneath footings, or if the fills are 5 feet or more in thickness, should be compacted to at least 95 percent of the maximum dry density as determined by the AASHTO[3] T-180 (ASTM[4] D-1557) compaction criteria. Structural fill 10 feet or more in thickness in any building areas must be placed at or within 3 to 5 percent above the optimum moisture content and compacted to 98 to 100 percent of the Modified Proctor maximum dry density. All other structural fill should be compacted to at least 90 percent of the above defined criteria.

Prior to the placement of structural site grading fill, the subgrade should be prepared as discussed in Section 5.2.1., Site Preparation. In confined areas, preparation of the subgrade must include the removal of all loose and disturbed soils.

5.2.5 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 backfill is disturbed during construction operations, the subgrade should be proofrolled prior to 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.

5.3 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.3.1 Preliminary Design Criteria

The proposed lightly loaded residential structures may be supported upon conventional spread and continuous wall foundations. The footings may be established upon suitable undisturbed natural

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[3] American Association of State Highway and Transportation Officials

[4] American Society for Testing and Materials

non-moisture sensitive soils and/or upon structural fill extending to these soils. Also, it is essential that footings not be established upon or over the upper 4 to 16 inches of surficial disturbed soils. For preliminary design, the following parameters can be utilized:

Minimum Recommended Depth of Embedment for Frost Protection	-	30 inches
Minimum Recommended Depth of Embedment for Non-frost Conditions	-	15 inches
Recommended Minimum Width for Continuous Wall Footings	-	18 inches
Minimum Recommended Width for Isolated Spread Footings	-	24 inches
Recommended <u>Maximum</u> Net Bearing Pressure for Real Load Conditions **footings on suitable undisturbed non-moisture sensitive natural soils and/or structural fill extending to these soils**		1,500 pounds per square foot
Bearing Pressure Increase for Seismic Loading	-	50 percent

The bearing pressures presented above are conservative for the loose to medium dense granular soils encountered in large portions of the site, but should be adequate for the anticipated light structural loads and minimum footing widths. Higher bearing pressures may be possible in certain instances, however, we will need specific building locations, loading conditions, and layout information in order to provide increased allowable pressures.

The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade. Therefore, the weight of the footing and backfill up to lowest adjacent final grade need not be considered. Real loads are defined as the total of all dead plus frequently applied live loads. Total loads include all dead and live loads, including seismic and wind loads. The bearing pressure increase should not be applied for short-term loads on granular soils.

5.3.2 Installation

Under no circumstances should the footings be installed upon loose or disturbed soil, sod, rubbish, upper 4 to 16 inches of surficial soils, topsoil, frozen soil, more than 2 feet of moisture sensitive soils, other deleterious materials, or within ponded water. If unsuitable soils are encountered, they must be totally removed and replaced with compacted granular structural fill. If fine-grained silts and clays become disturbed, they should be removed and replaced with granular structural fill. If granular natural soil or structural fill becomes loose or disturbed, they must be properly recompacted before the footings are poured or be removed and replaced with structural fill.

If used beneath footings, structural fill should extend laterally beyond the footing perimeters for a distance equal to one-half foot for each foot of fill thickness. For example, if the footing is two feet wide and the thickness of structural fill is two feet, the total width of fill would be four feet.

5.3.3 Settlements

Settlement of foundations designed and installed in accordance with the above recommendations and supporting maximum loads as discussed in Section 2, Proposed Construction, should not exceed one-half of an inch. Settlements will occur rapidly, with approximately 60 to 80 percent of the quoted settlements occurring during construction.

5.4 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 non-yielding 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 placed 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 2 horizontal to 1 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.

5.5 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 for footings on natural clayey soils, and 0.45 for footings on natural granular soils or granular structural fill. 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 provided the backfill extends horizontally at least 10 feet in the direction of the lateral force. For buildings near descending slopes, a reduction of the passive equivalent fluid pressure may be necessary.

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 FLOOR SLABS

At-grade floor slabs may be established directly upon properly prepared suitable natural soils, no more than two feet of slightly collapsible soil, if properly prepared, and/or structural fill extending to suitable soils. Because of the depth of the water table and the desire not to provide a conveyance point for moisture into potentially collapsible soils, we do <u>not</u> recommend that a layer of free-draining granular material be placed beneath the slabs.

Settlements of lightly loaded floor slabs established upon non-collapsible soils is anticipated to be negligible. Settlements of floor slabs established upon a maximum of two feet of potentially collapsible soils is difficult to predict. However, considering a collapse potential of two percent, settlements on the order of one half inch are estimated. To reduce the potential for collapse settlements under floor slabs, consideration should be given to totally removing potentially collapsible soils from beneath floor slab areas. <u>At a minimum, the thickness of potentially collapsible soils must be confirmed beneath any floor slab</u>.

5.7 CEMENT TYPE

Laboratory test results indicate that the soils typically contain a negligible percentage of water soluble sulfates. Based upon this data, sulfate resistant cement will not be required for concrete in contact with the natural site soils.

5.8 SPECIAL INSPECTION

As stated previously, it has been our experience that the area is prone to variable and random sequences of these soils. During excavation, if soils exhibiting a pinhole structure are encountered, AGRA should be contacted for a site visit.

5.9 PAVEMENTS

Slightly collapsible surface and near-surface soils will exhibit extremely poor pavement support characteristics when saturated or near-saturated. Therefore, a subbase component to the pavement section is recommended when this subgrade is encountered. The subbase should consist of a silty and/or clayey mixtures of sands and gravels such that when properly compacted will exhibit low permeability characteristics, yet exhibit relatively high pavement support characteristic when saturated or near-saturated. Based upon these conditions, the following pavement sections are recommended:

<u>Light Traffic - Cul-de-Sacs, Parking Areas</u>

(Light to Moderate Volume of Automobiles and Light Trucks,
Occasional Medium-Weight Trucks,
and No Heavy-Weight Trucks, EAL = 5,000, 20 years design period)

2.5 inches	Asphalt concrete
6.0 inches	Granular base
6.0 inches	Granular subbase *
Over	Properly prepared subgrade

<u>Residential Streets</u>

(Moderate Volume of Automobiles and Light Trucks,
Light Volume of Medium-and Heavy-Weight Trucks,
EAL = 50,000, 20 years design period)

3.0 inches	Asphalt concrete
8.0 inches	Granular base
8.0 inches	Granular subbase *
Over	Properly prepared subgrade

<u>Arterial Streets</u>

(Moderate to Heavy Volume of Automobiles and Light Trucks,
Medium Volume of Medium-and Heavy-Weight Trucks,
EAL = 500,000, 20 years design period)

4.0 inches	Asphalt concrete
6.0 inches	Granular base
8.0 inches	Granular subbase
Over	Properly prepared subgrade

* <u>The subbase is not required if the subgrade consists of suitable non moisture sensitive natural gravelly soils and/or a minimum of eight inches of structural site grading fill</u>.

We do not recommend the use of rigid pavements in areas where potentially moisture sensitive soils are encountered.

5.10 GEOSEISMIC SETTING

5.10.1 General

The site is located within "Seismic Zone 3" as defined by the Seismic Zone Map of the United States in the Uniform Building Code (UBC) 1997 edition. Seismic Zone 3 is expected to experience moderately frequent, potentially damaging earthquakes. In terms of damage potential, Seismic Zone 3 is second only to Zone 4, which includes parts of California, Nevada, and Alaska. As a minimum, the criteria for lateral forces stated within the UBC for Seismic Zone 3 should be incorporated into the design of the proposed structure.

5.10.2 Faulting

Review of available literature indicates that no known active faults pass through or immediately adjacent to the site.

5.10.3 Site Coefficient

Based upon Table 16-J, Section 1636 - Site Characterization Procedure, Soil Profile Types of the UBC 1997 edition, the site would be predominantly classified as S_D.

5.10.4 Liquefaction

The encountered subsurface soils consists of unsaturated gravelly and clayey material. Considering that groundwater was not encountered to the depths explored, the potential for surface expression of deeper liquefaction is very low.

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.

Kevin White

J. Kevin White, State of Utah No. 346403
Professional Engineer
Project Engineer

Reviewed by:

Douglas G. Beck

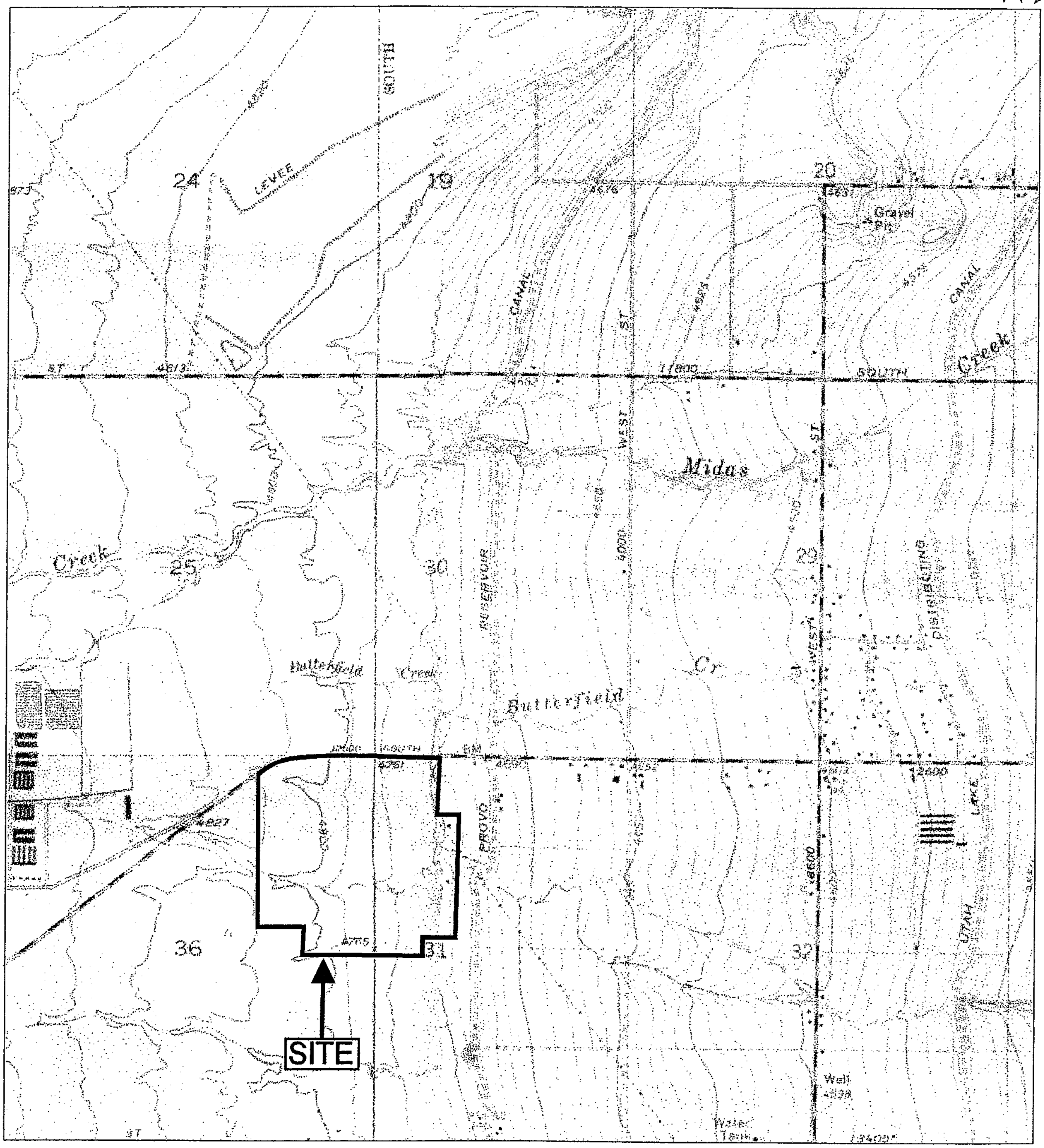
Douglas G. Beck, State of Utah No. 160201
Professional Engineer

JKW/ps

Encl. Figure 1, Vicinity Map
Figure 2, Site Plan
Figure 3, Aerial Photograph
Figures 4A to 4Q, Log of Test Pits
Figure 5, Unified Soil Classification System

Addressee (3)

WASATCH PACIFIC
JOB NO. 9-817-002324



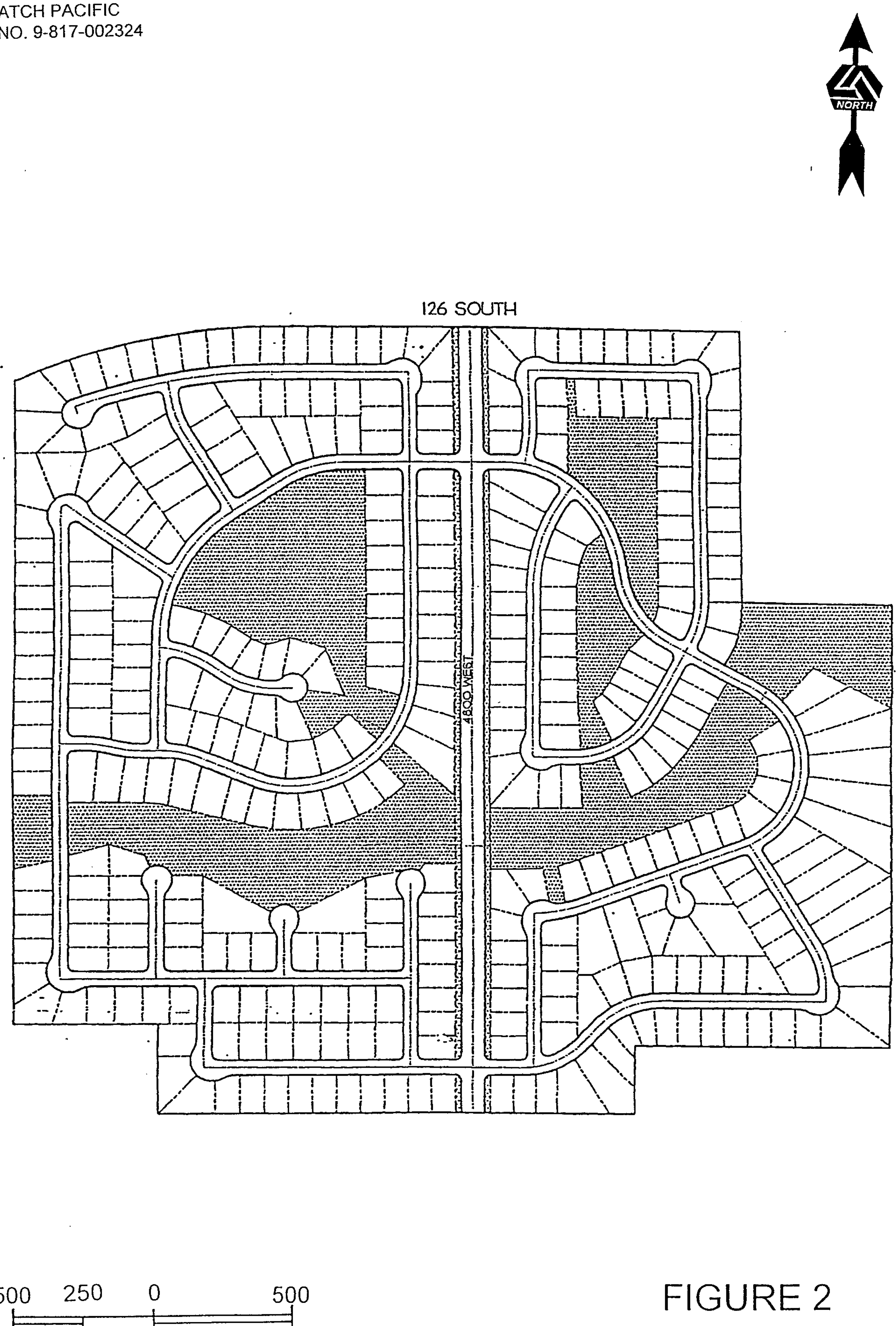
SCALE IN FEET
1000 0 1000 2000

REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAP
TITLED "LARK, UTAH"
DATED 1952, PHOTOREVISED 1969 AND 1975
TITLED "MIDVALE, UTAH"
DATED 1963, PHOTOREVISED 1969 AND 1975

FIGURE 1
VICINITY MAP

AGRA
Earth & Environmental

WASATCH PACIFIC
JOB NO. 9-817-002324



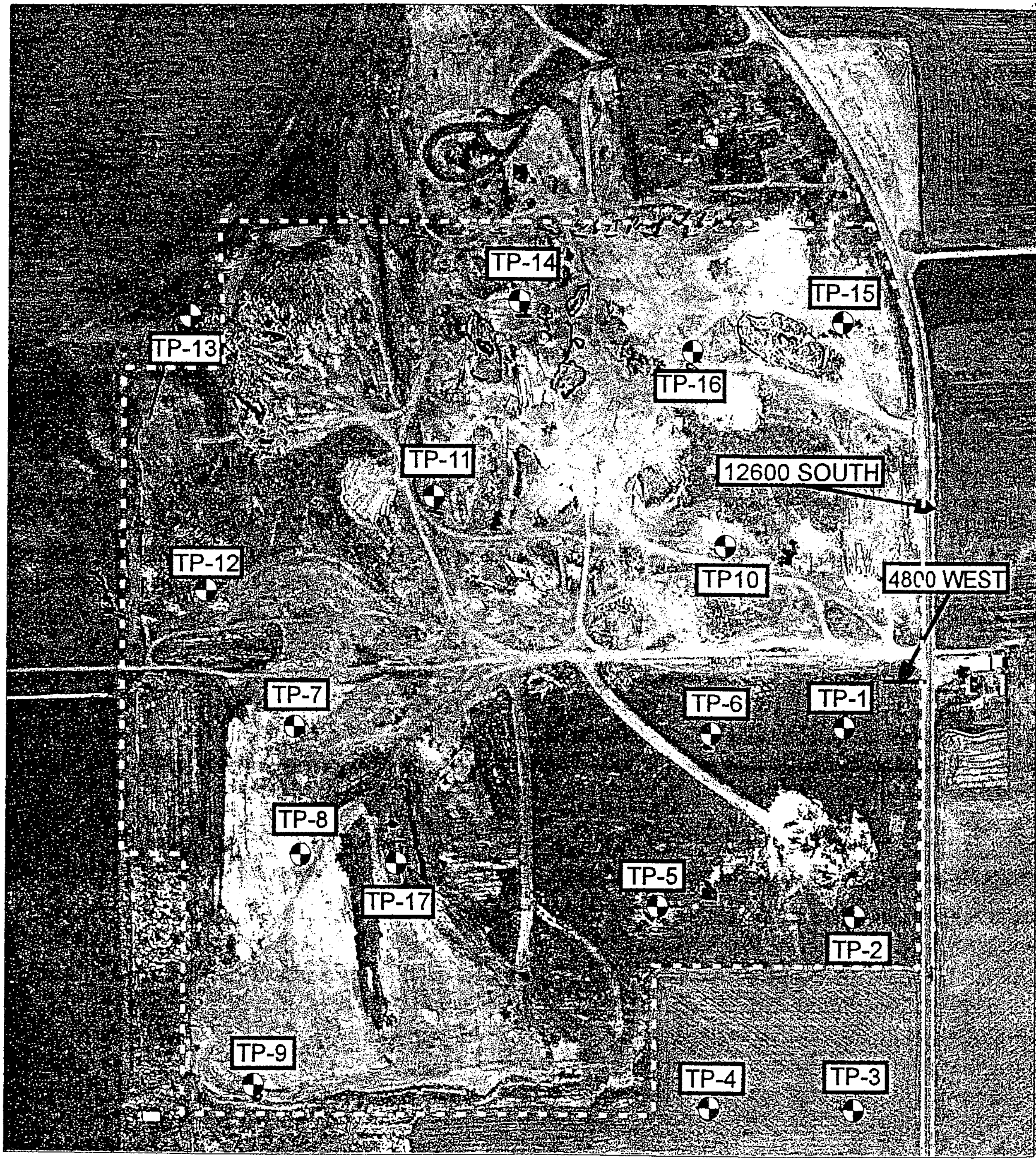
REFERENCE:
DRAWING PROVIDED BY CLIENT

FIGURE 2
SITE PLAN

AGRA Earth & Environmental

FILE NO. ______ BY ______ DATE ______ CHECKED BY ______ DATE ______

WASATCH PACIFIC.
JOB No. 9-817-002324



SCALE IN FEET
500 0 500 1000

REFERENCE:
PHOTOGRAPH BY OLYMPUS
AERIAL SURVEYS DATED MARCH 24, 1999

FIGURE 3
AERIAL PHOTOGRAPH

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Earth & Environmental

LOG OF TEST PIT NO. TP-1

PROJECT: Buffalo Springs
12600 South 4800 West, Riverton, Utah
JOB NO. 9-817-002324 DATE 05-10-99

GROUNDWATER		
DEPTH	HOUR	DATE
	*	

BACKHOE TYPE JCB 214-S
LOCATION
ELEVATION
DATUM

Depth in Feet	Sample Type	Moisture in % Dry Density Pcf	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			ML	slightly moist "soft"	**CLAYEY SILT** with some fine sand; major roots (topsoil) to 4"; brown
	D	28.6			
					grades to silt with trace to some clay; pinhole structure; light brown
	TW				
5	TW	30.2		"medium dense" to "dense"	
					grades to gray-brown; pinholes
	D				
	D				trace pinholes
10					
	D		SP	"medium dense"	**SAND** with trace to some silt; fine to medium sand; light brown
	D				grades with frequent coarse gravels and cobbles
			SM	"medium dense"	**SILTY SAND** with some fine gravel and cobbles; brown to light brown
	D				
15					
					Stopped excavating at 16.0'.
					No significant sidewall caving.
					* Groundwater not encountered.
20					
					The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25					

SAMPLE TYPE
B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA
Earth & Environmental

FIGURE 4A

LOG OF TEST PIT NO. TP-2

PROJECT Buffalo Springs
12600 South 4800 West, Riverton, Utah
JOB NO. 9-817-002324 DATE 05-10-99

GROUNDWATER

DEPTH	HOUR	DATE
	*	

BACKHOE TYPE JCB 214-S
LOCATION
ELEVATION
DATUM

Depth in Feet	Sample	Sample Type	Moisture in % / Dry Density Pcf	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				ML	slightly moist	**CLAYEY SILT** with major roots (topsoil) to 3"; brown
					"soft"	
		TW	28.6			
					"medium dense"	grades silt with trace clay and pinhole structure
		TW	26.1			
5						grades gray
		D				
				GP	"dense"	**SANDY GRAVEL**; fine to coarse sand; fine and coarse gravel and cobbles; red-brown
		D		SM	"medium dense"	**SILTY SAND**; fine to medium sand with some fine gravel and cobbles; brown
10		D				
		D				
15						Stopped excavating at 15.0'.
						No significant sidewall caving.
						* Groundwater not encountered.
20						
						The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25						

SAMPLE TYPE

B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4B

LOG OF TEST PIT NO. TP-3

PROJECT: Buffalo Springs, 12600 South 4800 West, Riverton, Utah

JOB NO. 9-817-002324 DATE 05-10-99

BACKHOE TYPE: JCB 214-S
LOCATION:
ELEVATION:
DATUM:

GROUNDWATER

DEPTH	HOUR	DATE
	*	

Depth in Feet	Sample Type	Unified Soil Classification	Remarks	Visual Classification
0		ML	slightly moist	**SILT** with trace clay; major roots (topsoil) to 5"; brown
	TW	CL	"soft" to "medium stiff"	**SILTY CLAY**; gray-brown
5	D	SM	"medium dense"	**SAND** with trace to some silt; fine to medium sand; brown
	D	ML	"medium stiff"	**SILT** with trace to some clay; trace pinhole structure; brown
10	D	SM	"medium dense"	**SAND** with some silt; fine to medium sand; light brown grades to gravelly sand with trace silt and cobbles; fine to coarse sand; fine and coarse gravel
15				Stopped excavating at 15.0'. No significant sidewall caving. * Groundwater not encountered.
20–25				The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.

SAMPLE TYPE
B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4C

PROJECT Buffalo Springs
12600 South 4800 West, Riverton, Utah
JOB NO. 9-817-002324 DATE 05-10-99

LOG OF TEST PIT NO. TP-4

GROUNDWATER		
DEPTH	HOUR	DATE
	*	

BACKHOE TYPE JCB 214-S
LOCATION
ELEVATION
DATUM

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture in % Dry Density Pcf	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML	slightly moist "soft"	**CLAYEY SILT** with major roots (topsoil) to 4"; brown
							grades to light brown pinhole structure
			TW				
						"medium stiff"	
5			TW				grades to clayey silt or silty clay slight, pinhole structure
			D		SM	"medium dense"	**SAND** with some coarse gravel and cobbles; fine to medium sand; brown
10			D				
15							
							Stopped excavating at 15.5'.
							No significant sidewall caving.
							* Groundwater not encountered.
20							
							The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25							

SAMPLE TYPE

B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4D

PROJECT Buffalo Springs
12600 South 4800 West, Riverton, Utah
JOB NO. 9-817-002324 DATE 05-10-99

LOG OF TEST PIT NO. TP-5

BACKHOE TYPE JCB 214-S
LOCATION
ELEVATION
DATUM

GROUNDWATER

DEPTH	HOUR	DATE
	*	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture in % Dry Density Pcf	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML	slightly moist "soft" to "medium stiff"	**CLAYEY SILT**; major roots (topsoil) to 2"; pinhole structure; light brown
			TW	29.4			
5							
			TW				
			D				
10							
			D		SM	"medium dense"	**SILTY SAND** with some fine and coarse gravel; light brown
15							
							Stopped excavating at 15.5'.
							No significant sidewall caving.
							* Groundwater not encountered.
20							
							The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25							

SAMPLE TYPE

B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4E

LOG OF TEST PIT NO. TP-6

PROJECT: Buffalo Springs
12600 South 4800 West, Riverton, Utah

JOB NO. 9-817-002324 DATE 05-10-99

BACKHOE TYPE JCB 214-S
LOCATION
ELEVATION
DATUM

GROUNDWATER

	DEPTH	HOUR	DATE
▽		*	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture in % / Dry Density Pcf	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML	slightly moist "soft" to "medium dense"	**CLAYEY SILT**; major roots (topsoil) to 3"; brown
			TW	29.7			grades with trace pinhole structure
5			TW	25.2			
			D				
10					SM	"medium dense"	**SAND** with trace to some silt; fine to medium sand; brown
			D				grades with some fine and coarse gravel
15							Stopped excavating at 15.5'. No significant sidewall caving. * Groundwater not encountered.
20							
25							The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.

SAMPLE TYPE

B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4F

LOG OF TEST PIT NO. TP-7

PROJECT Buffalo Springs
12600 South 4800 West, Riverton, Utah
JOB NO. 9-817-002324 DATE 05-10-99

BACKHOE TYPE JCB 214-S
LOCATION
ELEVATION
DATUM

GROUNDWATER

DEPTH	HOUR	DATE
	*	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture in %	Dry Density Pcf	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0						ML	slightly moist "soft" to "medium dense"	**SILT** with trace clay and some fine to coarse gravel; major roots (topsoil) to 2"; light brown; trace pinhole structure
			TW					
5			TW			CL	"stiff" to "very stiff"	**SILTY CLAY** with trace pinhole structure; light brown
						SM	"medium dense"	**SAND** with trace silt; fine to medium sand; brown
			D					
10								grades with trace to some fine gravel
								grades without fine gravel
			D					
						ML	"medium stiff"	**SILT** with trace clay; no pinholes; brown
15								Stopped excavating at 15.0'. No significant sidewall caving. * Groundwater not encountered.
20								
								The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25								

SAMPLE TYPE

B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4G

LOG OF TEST PIT NO. TP-8

PROJECT: Buffalo Springs, 12600 South 4800 West, Riverton, Utah

JOB NO. 9-817-002324 DATE 05-10-99

BACKHOE TYPE JCB 214-S
LOCATION
ELEVATION
DATUM

GROUNDWATER

DEPTH	HOUR	DATE
	*	

Depth in Feet	Sample	Sample Type	Moisture in %	Dry Density Pcf	Unified Soil Classification	Remarks	Visual Classification
0					GM	slightly moist "medium dense" to "dense"	**SANDY GRAVEL**; fine to coarse gravel; major roots (topsoil) to 1"; light brown
	X	D			GP		**SANDY GRAVEL** with trace silt and cobbles; fine to coarse sand; fine and coarse gravel; brown
	X	D					
5							
					GM	"medium dense"	**SILTY GRAVEL** with some sand; fine to coarse sand; fine and coarse gravel; brown
	X	D					
10					ML	"medium stiff"	**SILT** with trace to some clay; no pinholes
							grades with some fine to medium gravel
					SM/GM		**SAND AND GRAVEL** with some silt; fine to coarse sand; fine and coarse gravel and cobbles
15							Stopped excavating at 15.0'.
							No significant sidewall caving.
							* Groundwater not encountered.
20							
							The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25							

SAMPLE TYPE

B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4H

LOG OF TEST PIT NO. TP-9

PROJECT: Buffalo Springs
12600 South 4800 West, Riverton, Utah
JOB NO. 9-817-002324 DATE 05-10-99

GROUNDWATER

DEPTH	HOUR	DATE
	*	

BACKHOE TYPE JCB 214-S
LOCATION
ELEVATION
DATUM

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture in %	Dry Density Pcf	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0						GM	slightly moist "medium dense" to "dense"	**SANDY GRAVEL** with some fine to medium sand; major roots (topsoil) to 1"; brown
		X	D					
						CL		**SILTY CLAY**; slight pinhole structure; light brown
		X	D					
5								
						GP		**SANDY GRAVEL**; fine to coarse sand; fine and coarse gravel with cobbles; brown
10								
		X	D					
								grades with some silt
15								
								Stopped excavating at 15.5'. No significant sidewall caving. * Groundwater not encountered.
20								
								The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25								

SAMPLE TYPE
B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 41

LOG OF TEST PIT NO. TP-10

PROJECT: Buffalo Springs, 12600 South 4800 West, Riverton, Utah
JOB NO. 9-817-002324 DATE 05-11-99

BACKHOE TYPE: JCB 214-S
LOCATION:
ELEVATION:
DATUM:

GROUNDWATER

DEPTH	HOUR	DATE
	*	

Depth in Feet	Sample	Sample Type	Moisture in % / Dry Density Pcf	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				ML/SM	slightly moist "loose" to "medium stiff"	**SANDY SILT OR SILTY SAND**; fine sand; major roots (topsoil) to 1"; light brown
				ML		**SILT** with some fine sand; trace pinhole structure; light brown
		TW				
			33.8			
5		TW				
						grades to with trace to some clay
		D	69.8		slightly moist to moist	
10		D		SM	"medium dense"	**GRAVELLY SAND** with some silt; fine to coarse sand; fine and coarse gravel; light brown
						grades with trace silt and cobbles
					slightly moist	
						grades with trace silt
15						
						Stopped excavating at 15.5'.
						No significant sidewall caving.
						* Groundwater not encountered.
20						
						The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25						

SAMPLE TYPE
B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4J

LOG OF TEST PIT NO. TP-11

PROJECT Buffalo Springs
12600 South 4800 West, Riverton, Utah
JOB NO. 9-817-002324 DATE 05-11-99

BACKHOE TYPE JCB 214-S
LOCATION
ELEVATION
DATUM

GROUNDWATER		
DEPTH	HOUR	DATE
	*	

Depth in Feet	Sample	Sample Type	Moisture in %	Dry Density Pcf	Unified Soil Classification	Remarks	Visual Classification
0					SM/ML	moist	**SAND AND SILT** with some clay; fine sand; major roots (topsoil) to 1"; brown
					ML	slightly moist "soft"	**SILT** with some clay; light brown, trace pinhole structure
	X	TW					
5	X	TW					grades blocky; mottled gray to red-brown
	X	D					
					SM	slightly moist "loose" to "medium dense"	**SAND** with trace silt; fine to medium sand; brown
10	X	D					
					ML	moist "soft" to "medium dense"	**SILT** with trace clay; brown, trace pinhole structure
					SM	"loose" to "medium dense"	**GRAVELLY SAND**; fine and coarse gravel; fine to coarse sand; trace silt
15							Stopped excavating at 15.0'.
							No significant sidewall caving.
							* Groundwater not encountered.
20							
							The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25							

SAMPLE TYPE

B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4K

LOG OF TEST PIT NO. TP-12

PROJECT Buffalo Springs
12600 South 4800 West, Riverton, Utah
JOB NO. 9-817-002324 DATE 05-11-99

BACKHOE TYPE JCB 214-S
LOCATION
ELEVATION
DATUM

GROUNDWATER

DEPTH	HOUR	DATE
	*	

Depth in Feet	Sample	Sample Type	Moisture in %	Dry Density Pcf	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		SD			SM	slightly moist "medium dense"	**SAND** with trace to some gravel and trace silt; fine to coarse sand; fine to medium gravel; major roots (topsoil) to 3"; brown
5	TW	TW			ML	"soft"	**SILT**; trace to some pinholes; light brown
	D	D					grades to mottled reddish-brown and light brown; frequent pinholes
10							grades to light brown; trace pinholes
15	D	D			SM/GM	"medium dense" to "dense"	**SILTY SAND** with some gravel; fine and coarse gravel; fine to coarse sand; brown
20							Stopped excavating at 16.0'. No significant sidewall caving. * Groundwater not encountered.
25							The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.

SAMPLE TYPE

B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4L

LOG OF TEST PIT NO. TP-13

PROJECT: Buffalo Springs
12600 South 4800 West, Riverton, Utah
JOB NO. 9-817-002324 DATE 05-11-99

BACKHOE TYPE: JCB 214-S
LOCATION:
ELEVATION:
DATUM:

GROUNDWATER

	DEPTH	HOUR	DATE
▽		*	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture in % Dry Density Pcf	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		X	D		GM	slightly moist	**SILTY GRAVEL** with trace fine to coarse sand; fine and coarse gravel; major roots (topsoil) to 2"; brown
5		X	D		GP	"dense"	**SANDY GRAVEL**; fine to coarse sand; fine and coarse gravel; brown
		X	D		ML	"medium dense"	**CLAYEY SILT** with trace fine sand and fine gravel; fine to medium sand; gray-brown
10					SP/GP	"medium dense"	**GRAVEL AND SAND** with trace silt; fine to coarse sand; fine and coarse gravel; red-brown
15		X	D		SM	"loose" to "medium dense"	**SAND** with some silt; fine to medium sand; light brown
20							Stopped excavating at 16.0'. No significant sidewall caving. * Groundwater not encountered. The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25							

SAMPLE TYPE

B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4M

LOG OF TEST PIT NO. TP-14

PROJECT: Buffalo Springs, 12600 South 4800 West, Riverton, Utah

JOB NO. 9-817-002324 DATE 05-11-99

BACKHOE TYPE JCB 214-S
LOCATION
ELEVATION
DATUM

GROUNDWATER

DEPTH	HOUR	DATE
	*	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture in %	Dry Density Pcf	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0						SP/GP	slightly moist "medium dense" to "dense"	**SAND AND GRAVEL** with some silt; fine to coarse sand; fine and coarse gravel; no major roots (topsoil); brown
		X	D					
5		X	D					
						SM	"medium dense"	**SAND** with some fine and coarse gravel; trace silt; fine to coarse sand; light brown
		X	D					grades with occasional fine and coarse gravel
10								
						ML/SM	"medium dense"	**LAYERED SILT** with trace clay and sand with trace to some silt; fine to medium sand; 2" to 8" layers, brown
15								
		X	D			SM/GM	"medium dense" to "dense"	**SAND AND GRAVEL**; fine to coarse sand; fine and coarse gravel; with trace to some silt; brown
								Stopped excavating at 16.5'.
								No significant sidewall caving.
								* Groundwater not encountered.
20								
								The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25								

SAMPLE TYPE

B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4N

LOG OF TEST PIT NO. TP-15

PROJECT: Buffalo Springs, 12600 South 4800 West, Riverton, Utah
JOB NO. 9-817-002324 DATE 05-11-99

GROUNDWATER

DEPTH	HOUR	DATE
	*	

BACKHOE TYPE JCB 214-S
LOCATION
ELEVATION
DATUM

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture in % / Dry Density Pcf	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					SP	slightly moist "medium dense"	**GRAVELLY SAND** with trace to some silt; fine to coarse sand; fine and coarse gravel; no major roots (topsoil); light brown
		X	D				grades to sand with sand occasional to trace fine gravel
5		X	D				
		X	D				
10							
		X	D		ML	"medium dense"	**SANDY SILT**; fine sand; gray-brown
							grades to silt with trace clay
15							grades to clayey silt
							Stopped excavating at 16.5'.
							No significant sidewall caving.
							* Groundwater not encountered.
20							
							The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25							

SAMPLE TYPE

B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 40

LOG OF TEST PIT NO. TP-16

PROJECT: Buffalo Springs
12600 South 4800 West, Riverton, Utah
JOB NO. 9-817-002324 DATE 05-11-99

GROUNDWATER

DEPTH	HOUR	DATE
	*	

BACKHOE TYPE: JCB 214-S
LOCATION:
ELEVATION:
DATUM:

Depth in Feet	Sample	Sample Type	Moisture in %	Dry Density Pcf	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					SM	slightly moist "medium dense"	**SILTY SAND** with gravel; fine to coarse sand; fine and coarse gravel; major roots (topsoil) to 2"; brown
	X	D					
					SP		**SAND** with trace to some silt; fine to coarse sand; brown
5	X	D					
							grades fine to medium sand
	X	D					grades with occasional fine to medium gravel
10							
					CL		**SILTY CLAY**; gray-brown
					SM		**SAND** with trace to some silt; occasional fine to medium gravel; brown
15					ML		**SILT** with some clay; brown
					CL		**SILTY CLAY**; gray-brown
							Stopped excavating at 17.0'.
							No significant sidewall caving.
20							* Groundwater not encountered.
							The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25							

SAMPLE TYPE

B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4P

PROJECT Buffalo Springs
12600 South 4800 West, Riverton, Utah
JOB NO. 9-817-002324 DATE 05-11-99

LOG OF TEST PIT NO. TP-17

BACKHOE TYPE JCB 214-S
LOCATION
ELEVATION
DATUM

GROUNDWATER

DEPTH	HOUR	DATE
	*	

Depth in Feet	Sample	Sample Type	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			GM	slightly moist "dense"	**SANDY GRAVEL** with some silt; fine to coarse sand; fine and coarse gravel; no major roots (topsoil); brown
	X	D			
5			SP	"medium dense"	**SAND** with some silty gravel; fine to coarse sand; fine and coarse gravel; brown
	X	D			
			ML	"soft" to "medium stiff"	**SILT** with trace clay; gray-brown
	X	D			
			SM	"medium dense"	**GRAVELLY SAND** with some silt; fine to coarse gravel; fine to coarse gravel
10					grades to silty, gravelly sand
15					
					Stopped excavating at 15.5'.
					No significant sidewall caving.
					* Groundwater not encountered.
20					
					The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary to a proper understanding of the nature of the subsurface materials.
25					

SAMPLE TYPE

B - Bucket Sample
D - Disturbed Bulk Sample
SW - Sidewall Sample
TW - Thinwall Sample

AGRA Earth & Environmental

FIGURE 4Q

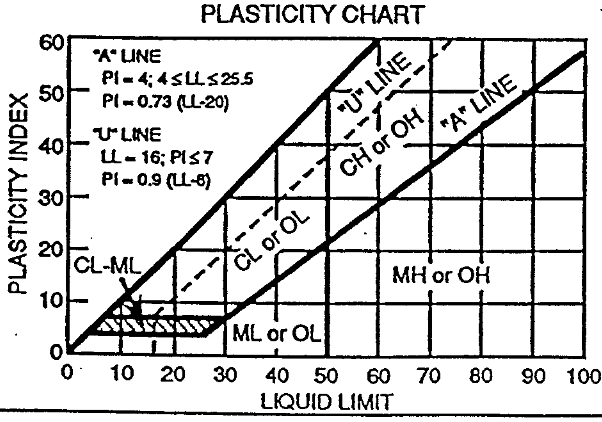
UNIFIED SOIL CLASSIFICATION SYSTEM

Soils are visually classified for engineering purposes by the Unified Soil Classification System. Grain-size analyses and Atterberg Limits tests often are performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. Graphic symbols are used on boring logs presented in this report. For a more detailed description of the system, see "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)" ASTM Designation: 2488-84 and "Standard Test Method for Classification of Soils for Engineering Purposes" ASTM Designation: 2487-85.

MAJOR DIVISIONS				GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures
					GP	Poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixtures
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (50% or more of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)			SW	Well graded sands, gravelly sands
					SP	Poorly graded sands, gravelly sands
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS Limits plot below "A" line & hatched zone on plasticity chart	SILTS OF LOW PLASTICITY (Liquid Limit less than 50)			ML	Inorganic silts, clayey silts of low to medium plasticity
		SILTS OF HIGH PLASTICITY (Liquid Limit 50 or more)			MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts
	CLAYS Limits plot above "A" line & hatched zone on plasticity chart	CLAYS OF LOW PLASTICITY (Liquid Limit less than 50)			CL	Inorganic clays of low to medium plasticity, gravelly, sandy, and silty clays
		CLAYS OF HIGH PLASTICITY (Liquid Limit 50 or more)			CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity
	ORGANIC SILTS AND CLAYS	ORGANIC SILTS AND CLAYS OF LOW PLASTICITY (Liquid Limit less than 50)			OL	Organic silts and clays of low to medium plasticity, sandy organic silts and clays
		ORGANIC SILTS AND CLAYS OF HIGH PLASTICITY (Liquid Limit 50 or more)			OH	Organic silts and clays of high plasticity, sandy organic silts and clays
ORGANIC SOILS		PRIMARILY ORGANIC MATTER (dark in color and organic odor)			PT	Peat

NOTE: Coarse-grained soils with between 5% and 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone on the plasticity chart have dual classifications.

PLASTICITY CHART



DEFINITION OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Boulders	Above 12 in.
Cobbles	12 in. to 3 in.
Gravel	3 in. to No. 4 sieve
Coarse gravel	3 in. to 3/4 in.
Fine gravel	3/4 in. to No. 4 sieve
Sand	No. 4 to No. 200 sieve
Coarse sand	No. 4 to No. 10 sieve
Medium sand	No. 10 to No. 40 sieve
Fine sand	No. 40 to No. 200 sieve
Fines (silt and clay)	Less than No. 200 sieve

AGRA Earth & Environmental FIGURE 5

NOTES