BUCKHORN GEOTECH
Civil, Structural & Geotechnical Engineers
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PRELIMINARY GEOLOGIC AND GEOTECHNICAL SITE ASSESSMENT LIONSBACK RESORT MOAB, COLORADO

Executive Summary

The proposed Lionsback Village development near Moab, Utah is suitable for the intended construction with special attention to foundation design, site preparation, erosion control, and management of drainage. We drilled 9 boreholes and excavated 11 test pits in April 2006 at the property. The following is a summary of our findings:

- Geology of the site consists of Navajo Sandstone covered by a thin mantle of silty eolian sand. Depth to the Navajo Sandstone was mostly less than 5 feet across the property.
- No groundwater was observed in any of the shallow explorations.
- Several small ephemeral drainages cross the property. A portion of the property drains southeast to Mill Creek, while a portion of the property drains northwest to the City of Moab.
- Minor rockfall areas were observed adjacent to some of the Navajo Sandstone fins. However, rockfall areas are not extensive and can be easily avoided.

Below is a summary of our conclusions and recommendations. See the *Conclusions and Recommendations* section of this report for more detailed explanations.

- Spread footing foundations are considered suitable for the proposed development. Footings and foundation components should be extended to or into the sandstone bedrock. Erosion and settlement are concerns for foundations placed on silty sand soils.
- Slabs on-grade may be used for garage and interior floor slabs. Slabs on grade should be placed on bedrock or on compacted fill placed on the bedrock.
- The native sandy soils may be used as structural fill if they are properly moisture conditioned and are laterally confined.
- All of the recommendations presented in the *Conclusions and Recommendations* section of this report should be incorporated into design and construction at this site.

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August 27, 2007

Calvin Wilbourne, P.C.
Telluride Architects
P.O. Box 853
Telluride, CO 81435

RE: LIONSBACK RESORT CONCEPT SITE PLAN (6/26/07)
MOAB, UTAH

Dear Cal,

Buckhorn Geotech, Inc. has reviewed an updated site plan for the proposed Lionsback Resort near Moab, Utah. You provided us this plan, titled "Lionsback Resort Concept Site Plan" dated 6/26/07, on 8/16/07. The plan is attached to this letter. The site plan has evolved since our geotechnical site investigation (Buckhorn Geotech, 2006). Most notably, the area immediately west of Sand Flats Road now includes development. Previously, this area was designated open space, and therefore no boreholes or excavations were included in this area.

Overall, the updated site plan appears to be outside of identified hazard areas. Based on our telephone discussion, we understand that the current drainage plan has evaluated the effects of the gullies and washes adjacent to proposed structures (e.g., southern portion of development). The recommendations provided in our referenced report are considered valid. We recommend additional investigation to characterize the areas excluded from the original investigation (i.e., immediately west of Sand Flats Road).

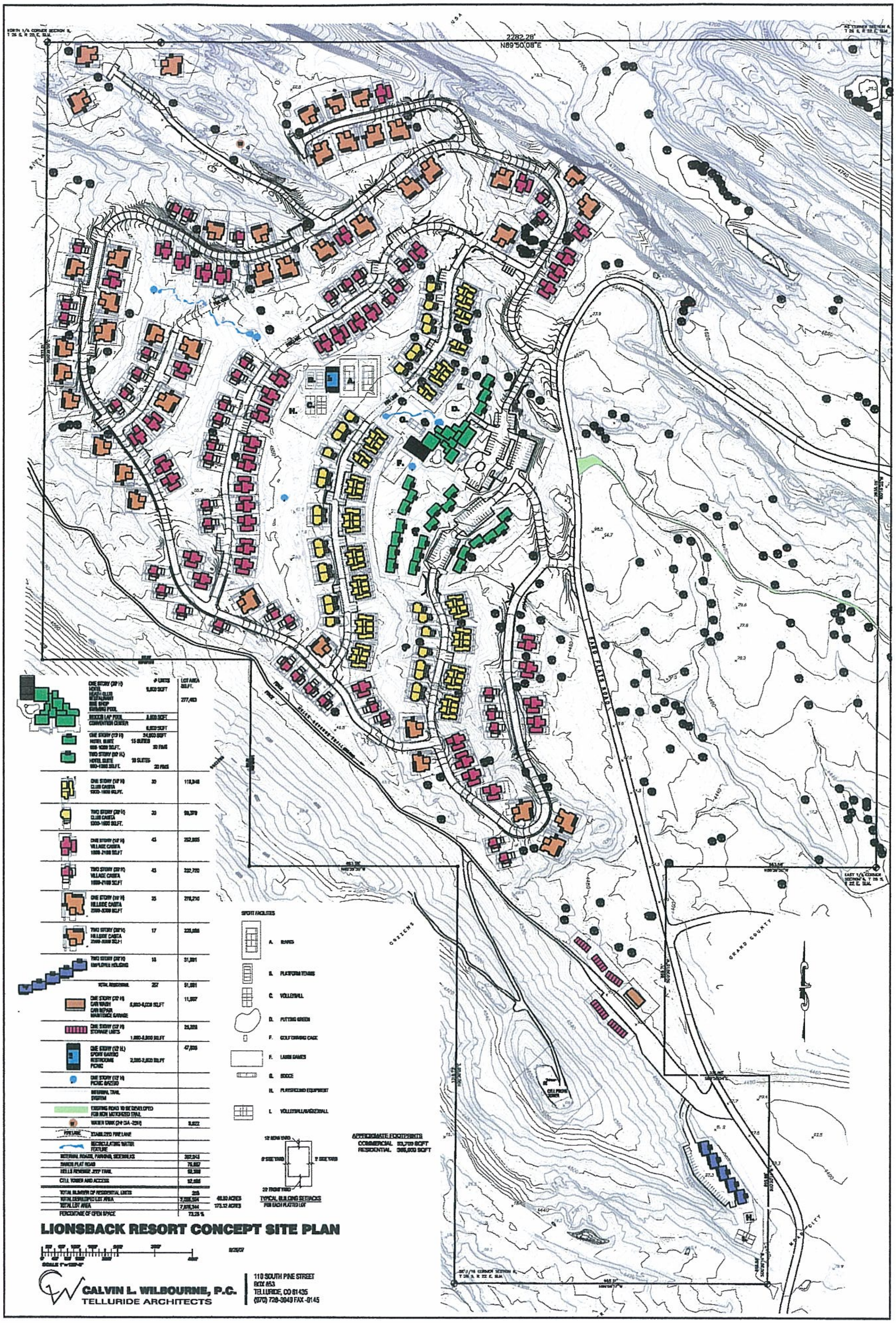
We appreciate the opportunity to work with you on this project. Please contact us with any questions.

Buckhorn Geotech, Inc. (2006). "Preliminary Geologic and Geotechnical Site Assessment, Lionsback Village, Moab, Utah", report dated 5/10/06.

Respectfully Submitted,
BUCKHORN GEOTECH, INC.

Brett Byler

Brett R. Byler, P.E.
Geotechnical Engineer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SPORT FACILITIES
A. BARNS
B. PLATFORM TENNIS
C. VOLLEYBALL
D. PUTTING GREEN
F. LAWN GAMES
G. BOCCE
H. PLAYGROUND EQUIPMENT
I. VOLLEYBALL/BASKETBALL
APPROXIMATE FOOTPRINTS
COMMERCIAL 23,700 SQFT
RESIDENTIAL 365,000 SQFT
TYPICAL BUILDING SETBACKS
FOR EACH PLATTED LOT
UNITS
LOT AREA SQ.FT.
CLUB CASITA
VILLAGE CASITA
HILLSIDE CASITA
EMPLOYEE HOUSING
STORAGE UNITS
PICNIC GAZEBO
INTERNAL TRAIL SYSTEM
EXISTING ROAD TO BE DEVELOPED FOR NON MOTORIZED TRAIL
STABILIZED FIRE LANE
RECIRCULATING WATER FEATURE
INTERNAL ROADS, PARKING, SIDEWALKS
CELL TOWER AND ACCESS
TOTAL NUMBER OF RESIDENTIAL UNITS
TOTAL LOT AREA
PERCENTAGE OF OPEN SPACE
GRAND COUNTY
LIONSBACK RESORT CONCEPT SITE PLAN
CALVIN L. WILBOURNE, P.C.
TELLURIDE ARCHITECTS
110 SOUTH PINE STREET
BOX 653
TELLURIDE, CO 81435

Introduction

Buckhorn Geotech, Inc. conducted an investigation of site and subsurface conditions on April 20 and 21, 2006 at the proposed Lionsback Village development in Moab, Utah. This work was performed at the request of Mr. Mike Badger of LB Moab Land, LLC. The purpose of the investigation was to provide a general geotechnical assessment of the property for the proposed development and provide general geotechnical engineering recommendations for construction and site development. The site geotechnical investigation included a site inspection, nine drilled boreholes and eleven test pit excavations. This report presents the findings of our site investigation and our geotechnical engineering recommendations for site preparation, development, and foundation design. It is beyond the scope of this report to evaluate the geologic hazards for the entire property. However, we did identify the known geologic hazards pertinent to the proposed building sites so the owner is aware of the construction constraints imposed by those hazards.

Proposed Development

The Lionsback Village property totals approximately 178 acres. Development is proposed for 48 acres while 130 acres are slated for open space. The proposed development consists of approximately 175 lots for single-family residences. The lots range in size from 2,400 to 6,750 square feet. As indicated on the attached Site Plan, the majority of lots are planned for the west side of Sand Flats Road, while 8 lots are proposed east of Sand Flats Road. A centrally located clubhouse, including dining, pool, spa, laundry, and bike shop, is also planned. Houses will range in size from 1,400 to 2,500 square feet and are anticipated to be one and two story. We are not aware of any basements planned for these homes. Other house construction details were not available to us at the writing of this report.

Site Conditions

The subject property is owned by the State of Utah School and Institutional Trust Lands Administration (SITLA) and is on Sand Flats Road, in an unincorporated part of Grand County, Utah. The property is located in Section 6, Township 26 South, Range 22 East, Salt Lake Base and Meridian as shown on the attached Vicinity Map. The north portion of the property is abutted on the west, north and east by the Sand Flats Recreation Area administered by the Bureau of Land Management (BLM) and Grand County as a fee area for recreational activities. The southern portion of the property is abutted by residential use, vacant land, and public property in use for the County landfill.

The property on the west side of Sand Flats Road is in use as a campground facility and has an on-site water well, fully contained chemical toilets, and no sanitary waste facility. There are numerous primitive roads and trails crossing the campground area. There is overhead power on the west side of the road that services the campground and also crosses the property on the east side of the road. There is a communications tower on the ridge at the south end of the property. There is public land access through the property. The property on the east side of Sand Flats

Road is vacant and has a walking trail that appears to be open to the public. There is a drainage culvert under Sand Flats Road allowing runoff from the west to continue southeast in a natural drainage.

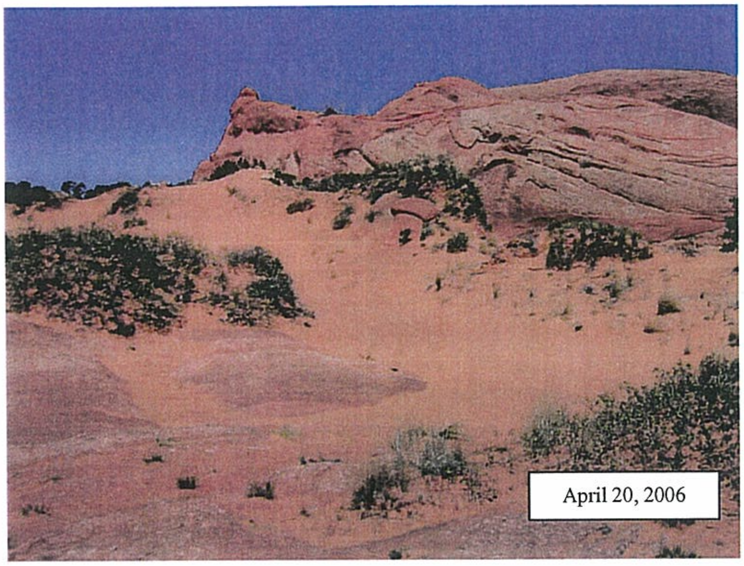
The site located above the east side of the City of Moab at elevations ranging from approximately 4,440 feet at the southeast corner of the property to an elevation of approximately 4,600 feet on ridges at the northwest corner of the property. On the west side of Sand Flats Road, two northwest – southeast trending ridges border a wide central valley. A saddle divides the drainage of the valley; with a portion sloping southeast at approximately 5 to 20% and a portion sloping northwest at similar grades. Drainage to the southeast enters Mill Creek approximately 1 mile downgradient. Sparse low desert type vegetation was observed on the property. The attached Site Plan shows the topography of the property and the approximate locations of our borings and test pits with respect to the proposed development.

We drilled 9 boreholes and excavated 11 test pits across the property. The explorations were intended to broadly characterize the property, but were tailored to the proposed development. The findings of our field and laboratory testing are discussed in the *Subsurface Conditions* section of this report.

Geologic Setting

According to Doelling et al. (2002), Moab is located in the northwest-trending, fold and fault belt of the salt-cored anticline region in the northern Paradox Basin. The Moab-Spanish Valley is a salt diapir structure, where the overlying brittle strata of the anticlinal fold have been ruptured by injection of the plastic salt core. Salt dissolution and erosion through the late Cenozoic contributed to the collapse and removal of the overlying rocks, leaving behind the linear Moab-Spanish Valley. Most of the exposed bedrock in the vicinity of Moab ranges from Pennsylvanian to Jurassic in age and consists of sandstone, siltstone, limestone, and some evaporites. The formation underlying the valley is the Pennsylvanian Paradox Formation, deposited in a marine basin at the southwestern edge of the ancestral Uncompahgre Uplift in the late Paleozoic. The Paradox Formation consists of interbedded evaporites (halite, potash, and anhydrite), dolomite, gypsiferous mudstone and carbonaceous shale.

The proposed Lionsback Village is located on a bench above the City of Moab on the east side of the Moab-Spanish Valley and north of the Mill Creek drainage. According to Doelling et al. (2002), there are two units identified on the subject property. One unit is the Jurassic Navajo Sandstone Formation (*Jn*) and the other unit is a surficial deposit of Quaternary Eolian (dune) sand (*Qes*). The Navajo Sandstone is "pale-orange to light-gray to red-orange, fine-grained, quartzose eolian (i.e., wind-blown) sandstone; calcareous and silica cemented; fine-grained and well-sorted; medium to massively bedded, commonly with large-scale sweeping cross-beds; locally contains thin, gray , cherty, sandy carbonate beds; forms smooth vertical cliffs and rounded knolls." This unit is well-cemented and forms the dominant features that the region is famous for such as fins, massive monoliths ("slick rock" areas), rounded cliffs and domes, and arches. The locally known "Lionsback", an undulating fin on the north edge of the property, is composed of Navajo Sandstone, as are the many other red-colored sandstone outcrops throughout the parcel. The photograph below, taken looking north in the northwestern portion of the proposed Lionsback Village, shows a typical outcropping of the Navajo Sandstone as fins (upper right) and low rounded surfaces poking up through the dune sand (lower left and foreground).



The deposit overlying the Navajo Sandstone throughout much of the property is Quaternary eolian sand dunes. These Holocene (geologically recent) deposits are "well-sorted, fine- to medium-grained, quartzose sand with silt; light red-orange to light red-brown; typically form thin, discontinuous sheets and small dunes, and locally fill hollows; sand is derived from nearby outcrops of Lower and Middle Jurassic sandstone formations (e.g., Wingate, Kayenta, Navajo, Entrada); generally less than 6 feet thick, but can be up to 30 feet thick." Where stabilized by vegetation, the eolian sand is generally at least several feet thick. However, where not protected by vegetation, such as along disturbed areas or roads, the dune sand is thinner.

It is worth noting that the contact of the Navajo Sandstone with the older Kayenta Formation outcrops immediately outside of the southern edge of the proposed Lionsback Village. The Kayenta is described as orange- to red-brown, fluvial sandstone with some conglomerate interbedded with weaker strata of siltstone and mudstone forming stepped slopes of alternating resistant and weak layers.

Geologic Hazards

The geologic hazards of the Lionsback Village proposed development were identified during our field investigation and by review of available publications such as Doelling et al. (2002), Hylland and Mulvey (2003), and other publications as discussed below. According to the Hylland and Mulvey (2003), the principal hazards in the Moab-Spanish Valley area are expansive soil and rock, gypsiferous soil and rock, stream and alluvial-fan flooding and debris flows, collapsible soils, soil susceptible to piping and erosion, rockfall, shallow groundwater, fractured rock, and to a lesser extent, earthquakes, subsidence due to salt dissolution, landslides, and indoor radon. Of these hazards, expansive soil and rock, gypsiferous soil and rock, stream and alluvial fan flooding and debris flows, collapsible soils, shallow groundwater, fractured rock, subsidence and landslides appear to be negligible or non-existent at the proposed development. The hazards that we have identified as being present or which are worthy of discussion because of their mapped presence in the project area (Hylland and Mulvey, 2003) are discussed below. If mitigation is necessary, options are also discussed.

Unstable Slopes

As indicated in the *Geologic Setting* section, the proposed Lionsback Village is situated on a sandstone bench composed of Navajo Sandstone overlain by a thin layer of eolian dune sand and silt deposits. The Navajo Sandstone is competent, well-cemented, and vertically jointed, which makes it an excellent bearing surface for foundations and roadways. The dune sand is, by nature, a dynamic surface that changes in depth and extent during wind storms or heavy runoff events. The silty sands are non-cohesive (exhibiting apparent cohesion when damp), variable in thickness, highly susceptible to both wind and water erosion, and is not considered a stable landform.

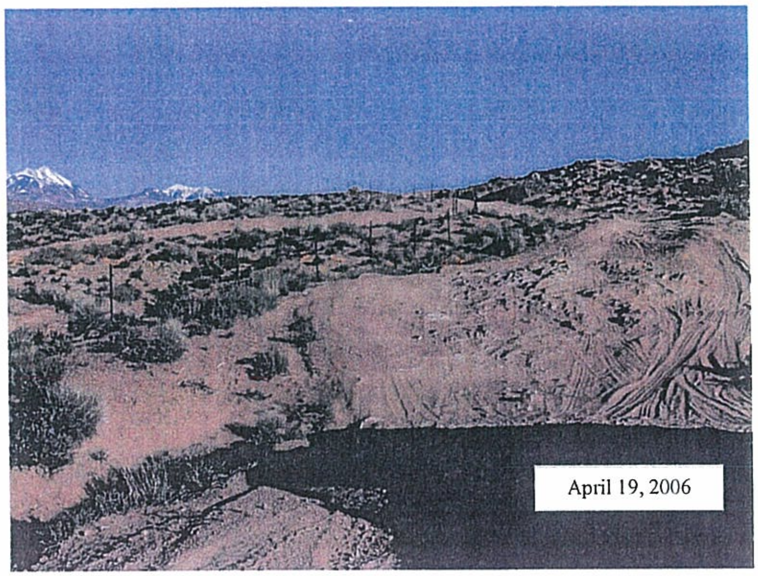
Slope stability is generally not a concern for the proposed development at this property. We are not aware of any large excavations planned for the development. To maintain site stability, recommendations for foundation design, surface and subsurface drainage should be followed.

Erosion and Piping

Erosion and piping are processes relating to the weathering and transport of soil particles. Water and wind play major roles in eroding soils in desert environments such as this. Desert soils are particularly vulnerable to erosion and piping due to the lack of vegetation to protect the surface from wind and water with foliage and to bind the soils with roots. Piping is a type of erosion that occurs in permeable, unconsolidated soil materials when groundwater seepage exiting at the ground surface erodes finer soil particles (i.e., sand, silt and clay) along subsurface pathways ("pipes"). As the pathways enlarge they are capable of carrying more water towards an arroyo or drainage. Eventually, the ceilings of the pipes collapse, creating areas of subsidence on the ground surface. According to Hylland and Mulvey (2003), the eolian deposits within the Lionsback Village are mapped as having "soil potentially susceptible to piping and erosion." Although there was clear evidence of surficial erosion on the property, discussed below, there was no evidence of piping in the vicinity of any of the planned development.

Erosion is generally controlled by vegetation cover, soil type, topography, and climate. The silty sand eolian soils present at the subject property are considered prone to erosion. There is a drainage divide near the west central portion of the property. The majority of runoff from the Lionsback Village property drains to the southeast towards the Mill Creek drainage. Although there are no perennial drainages on the property, there are shallow "washes" that concentrate runoff in the southeasterly direction, passing under Sand Flats Road in culverts, and incising in more distinct channels near the northeast corner of the property. The drainage basin for these washes is not large. The area west of the drainage divide drains towards the City of Moab. Sheetflow runoff from this area drains to an incised drainage flowing directly to Moab.

The photograph below, taken along the Hell's Revenge Trail at the southwestern portion of the property, shows the impacts of soil disturbance on erosion. The right half of the photograph shows an area devoid of vegetation due to heavy vehicular use. Not only does this disturbance strip the surface of vegetation that binds the soil, as evidenced by the exposed bedrock in this area, but it also contributes sediment to the nearby washes, as seen in the lower left corner of the photograph. Notice how the relatively undisturbed area on the left half of the photograph contains healthy native vegetation growing on stabilized dune sand.



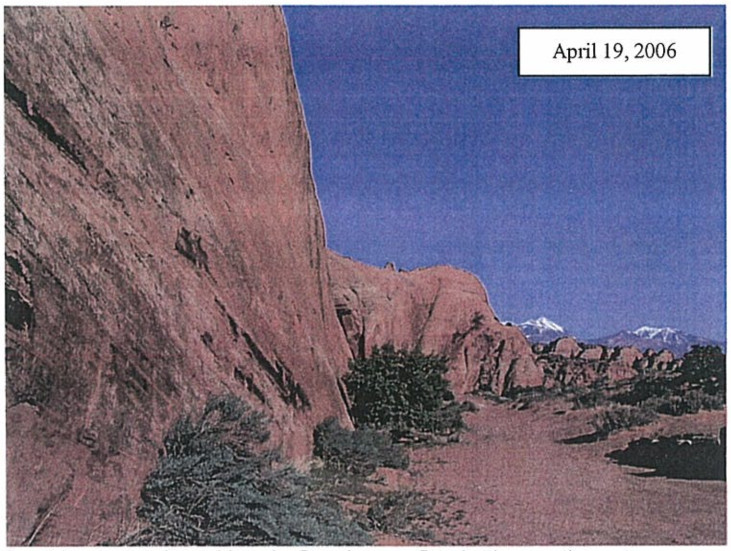
The concerns with erosion and concentrated runoff are the loss of soil, contribution of sediment to the stream systems, and loss of native vegetation. Fortunately, the watersheds are small and the concentrated runoff is localized. No evidence was observed of rainfall "pour-offs" from the sandstone fin outcrops adjacent to proposed home sites. Care should be taken to minimize and phase the disturbance of the native soil and vegetation during and after construction.

Careful soil and water management is recommended to control drainage and disperse runoff to minimize the potential for erosion. Due to the large area to be disturbed and the potential for airborne dust as well as increased erosion and sediment transport, the use of a dust palliative may be considered to act as both a dust suppressant and an erosion control measure. There are a variety of dust palliative types available today that function by binding soil particles together, absorbing water and/or reducing soil moisture evaporation (thereby increasing water surface tension). Many products are environmentally safe, do not harm vegetation, are biodegradable, and are easily mixed on-site and applied with hand- or truck-mounted water spraying equipment. Other erosion control measures are discussed in the *Conclusions and Recommendations* section of this report.

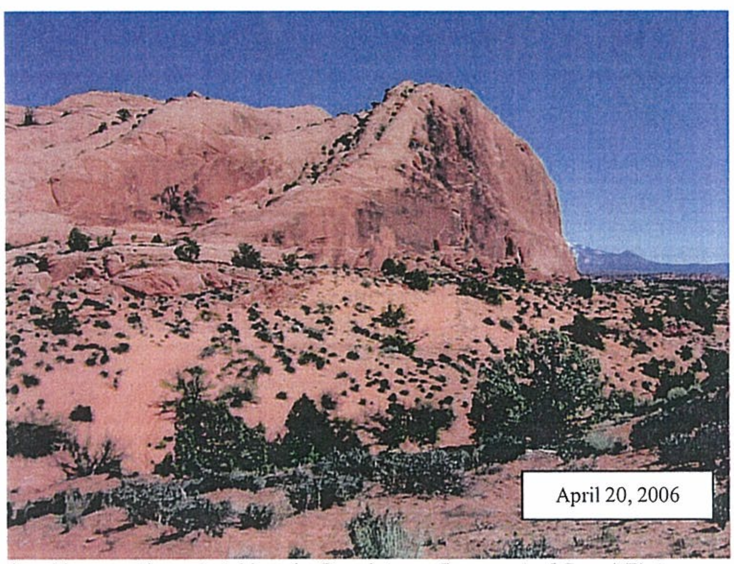
Rockfall

According to Hylland and Mulvey (2003), the northern portion of the Lionsback Village where the Navajo Sandstone outcrops is identified as having "moderate potential rockfall hazard".

Areas mapped with "moderate" rockfall hazard were based on "shadow zones" downhill of steep rock outcrops, but were not based on site-specific evidence. The UGS, therefore, recommended site-specific analysis before development. Although the bedrock fins on the property are exposed at very steep angles, often nearly vertical, the Navajo Sandstone in this area is a well-cemented, even-bedded, competent sandstone with vertical joints (parallel to the long axis of the valley). Some evidence of rockfall was observed on the property, but none was at the proposed building sites. The nature of the sandstone and lack of rockfall debris on the slopes below are shown in the following photograph.



Looking east along Navajo Sandstone fins in the northwestern portion of the proposed development. Note the massive structure of the sandstone and lack of rockfall accumulation.



Looking southeast at Navajo Sandstone fins east of Sand Flats Road. Some rockfall accumulation is observed near the base of the vertical rock face. Current development plans avoid development at the base of the cliff.

Mitigation for rockfall is best achieved by avoidance of those areas immediately below potential source areas. This has already been accomplished since none of the proposed homesites have been located within rockfall prone areas.

Flooding/Debris Flows/Mudflows

Although not identified by Hylland and Mulvey (2003), some minor flooding, debris flow and mudflow hazard should be expected in the immediate vicinity of the small natural drainages and at gaps in the base of the Navajo Sandstone fins on the northern portion of the property. Although no well-developed alluvial or debris flow fans were observed, there is the potential for runoff to be concentrate in these areas during extreme thunderstorm events. Avoiding these areas, as is proposed, is the best mitigation of this hazard.

Compressive Soil

Compressive soils may be characterized by high void ratio, a loose particle structure, and weak or brittle soil particles. Often these soils have been deposited rapidly. Compressive soils typically have a large proportion of fines (i.e., silt and clay). However, some sandy and gravelly soils may also be compressible. Saturated soils with significant fines content may exhibit time-dependent consolidation when subjected to loading. Also, lowering of the groundwater table may result in soil compression.

The potential hazard from compressive soil is excessive settlement or differential settlement of foundation soils under loads applied through the foundation. Mitigation of the hazard depends on the nature and extent of the compressible soil, however, settlement can often be minimized by treatment of foundation soils, control of on-site drainage, foundation systems that extend to more competent soil or bedrock, design of foundation systems that have sufficient strength to resist differential movements, or removal and recompaction of native soil or replacement with compacted structural fill. These methods are discussed in further detail in the *Conclusions and Recommendations* section of this report.

Earthquakes

Hylland and Mulvey (2003) indicate that although there are many mapped faults in the Moab-Spanish Valley, the area has low historical earthquake activity. Earthquakes that have occurred have been infrequent and of small to moderate magnitude. Not all earthquakes occur on mapped faults, but faults do represent areas of past movement and can be weaker zones of the earth's crust where future stresses can be released. According to Black et al. (2003), and Doelling et al. (2002), there are numerous faults, anticlines and synclines, all of which are oriented in a northwest-southeast direction, within a 1-mile radius of the proposed Lionsback Village. An anticlinal axis passes through the middle of the development, suggesting structural upwarping, with a parallel synclinal axis along the southern boundary of the property. According to Hylland and Mulvey (2003), these structures and their parallel faults are all associated with deformation of the buried salt deposits in the Moab salt-cored anticline and the structural collapse of this feature which is believed to have occurred mostly in the Quaternary. These fractures are either due to the upward migration of salt (diapirism) or the collapse due to salt dissolution. Therefore, these faults are considered by the UGS to be shallow, they are not capable of producing significant earthquakes or ground shaking, and "the surface-fault-rupture hazard along these faults during an earthquake appears to be low." There is one Quaternary fault system, the Uncompahgre Fault Zone, located 30 miles northeast of the Moab-Spanish Valley that is considered associated with regional crustal stresses, rather than salt movement. The UGS considers this fault zone to have the most potential for producing earthquakes and ground shaking in the Moab area.

The Moab-Spanish Valley is located in the Colorado Plateau Physiographic Province where the UGS suggests that the maximum magnitude of earthquakes could approach M 6.5 (Hylland and Mulvey, 2003). A seismograph network was not installed in the area until 1979, so recorded data is over a limited time period. However, since then in the larger Colorado Plateau region, only a few earthquakes have been recorded of M 5 or larger. Hylland and Mulvey (2003) discuss calculations made for probabilistic ground motions for various earthquake return periods. The report states, "Even the highest probabilistic ground motions for the Moab-Spanish Valley area, which have the lowest probability of occurrence in any given year, would likely only cause slight to moderate damage to well-built structures." Avoiding placing foundations on sand, which can be susceptible to liquefaction, and bearing directly on sandstone bedrock is most desirable. Hylland and Mulvey (2003) recommend that all new structures should be designed and built in accordance with the seismic provisions in the IBC and International Residential Code (IRC), as appropriate.

Radon Gas

Radon gas is produced by decay of radioactive minerals in subsurface rock and soil. The U.S. Environmental Protection Agency (EPA) has determined that radon is the 2nd leading cause of lung cancer and that radon can accumulate in homes if the gas is not properly removed through passive or active methods. The federal EPA map of radon zones indicates that all of Grand County, Utah is in Zone 1 (*www.epa.gov/iaq/radon/zonemap/utah.htm*). Although there is no known safe level of radon, Zone 1 is the zone of highest risk for exposure to radon gas [i.e., greater than 4 picoCuries per Liter (pCi/L)]. According to a statewide evaluation of geologic factors, based on outcrop and mine talus assay data, the Moab-Spanish Valley was found to have a low to moderate radon hazard potential (UGS Map 149 by Black: 1993). However, in the same study, the Colorado Plateau Province in which Moab lies, has moderate to high radon hazard potential. Areas with Tertiary volcanic rocks, such as the nearby La Sal Mountains to the east, have high radon potential as they have been found to be uranium-enriched. According to a statewide study of radon levels in homes indicated that the two homes tested in Moab (actual locations not known) had indoor radon levels of 0.7 and 5.6 pCi/L (UGS Circular 81, by Sprinkel and Solomon: 1990).

Although radon is found in almost all rock and soil in very small concentrations, in the Moab-Spanish Valley area it is most commonly found in the Honaker Trail, Cutler and Chinle Formations (Hylland and Mulvey, 2003). Radon is also found in granite, metamorphic rocks, black shales, and volcanic rocks transported to the area by streams. Radon potential can vary considerably within the same geologic unit. This has to do with the non-uniform distribution of uranium, secondary leaching, and the accumulation of uranium and other radioactive elements into other strata.

The EPA recommends testing radon levels in existing homes, but it has not developed a sampling test that will determine levels of radon gas in the native soils prior to construction. This is due to the fact that there are too many factors that affect the movement of radon through soils, such as soil moisture, soil types, weather patterns, and wind, and these factors cannot be completely accounted for or controlled during testing. However, based on levels of radon recorded in existing homes in the region and the presence of rock types that are known to produce radon, it is reasonable to assume that radon is present in the Moab area. The EPA and the National Association of Home Builders (NAHB) recommend that all new homes constructed in Zone 1 should include radon-resistant features. These organizations also recommend that after the house is constructed, radon should be measured in the home and if the results are greater than 4 pCi/L, the system should be upgraded from passive to active (usually by installing a fan). In the EPA publication entitled, *Building Radon Out: A Step-by-Step Guide on How to Build Radon-Resistant Homes* (USEPA Office of Air and Radiation EPA/402-K-01-002, April 2001), three practical and inexpensive alternatives for passive, sub-slab depressurization systems are presented: gravel with vents, perforated pipes, or soil gas collection mats. As stated in that EPA publication, radon-reduction techniques not only reduce radon in the home but also are "consistent with state-of-the-art energy-efficient construction…which will result in energy savings and lower utility bills for the homeowner" and they have the added benefits of "decreasing moisture and other soil gases in the home, reducing molds, mildews, methane, pesticide gases, volatile organic compounds, and other indoor air quality problems." It is estimated that retrofitting a house after construction with radon resistant features is 2 to 10 times more expensive than if it had been included in the original construction. Other recommendations for passive and active design and construction techniques for reducing radon gas can be found on the EPA radon website *www.epa.gov/radon/*.

Subsurface Conditions

The site investigation for the proposed Lionsback Village was conducted April 20 and 21, 2006. Nine boreholes were drilled and eleven test pits were excavated to evaluate subsurface conditions. The boreholes are designated BH-01 through BH-09 and the test pits are designated TP#1 through TP#11. Borehole and test pit locations were selected to provide an overall assessment of the property and are based on proposed development plans provided to us by Gibson Architects prior to the investigation. Approximate locations of the boreholes and test pits are presented on the attached Site Plan. The subsurface conditions were logged by a geotechnical engineer, and representative samples of soils encountered were brought back to our laboratory for detailed examination and testing. The subsurface conditions encountered in the boreholes and test pits are presented on the attached Soil Logs.

The boreholes were advanced with 4¼-inch solid continuous flight augers using a Simco 2800 H.S. truck-mounted drill rig. Bulk soil samples were collected from auger cuttings. Standard penetration tests (SPT) were performed and Modified California split spoon samples were collected in the few boreholes where bedrock was not encountered at or near the ground surface.

The nine boreholes were drilled mostly in the existing Lionsback campground area. Due to loose sand and rough roads, the drill rig could not access portions of the northwestern, southern and eastern extents of the property. Test pits were excavated by hand at these areas inaccessible by drill rig. As discussed below, shallow bedrock was encountered uniformly across the property, therefore we were able to advance all excavations to the bedrock.

Subsurface conditions encountered in the boreholes and excavations were mostly similar and uniform across the property. In general, we encountered a thin mantle of wind-blown, silty fine sand overlying sandstone bedrock. The silty fine sand was typically damp and loose to compact. Sandstone bedrock was generally encountered at depths of zero to three feet. The deepest bedrock was observed in borehole BH-01, drilled near the "Lionsback" sandstone fins. The depth to bedrock in this borehole was approximately 12 feet. This may be due to increased weathering next to the fins. Most boreholes and test pits were advanced along existing roads; depth to bedrock is anticipated to be slightly greater on sand dunes. Bedrock was characterized as fresh to slightly weathered, weak to extremely weak, fine grained sandstone. Drilling resistance tended to increase with depth, indicating increased strength. The sandstone fins and select portions of the sandstone may be considered to be medium strong.

Boreholes were drilled to near refusal in bedrock and excavations were generally advanced to the bedrock or slightly into the bedrock. No groundwater was observed in any of the boreholes or excavations.

Laboratory Testing

Laboratory testing was conducted on select soil samples to characterize the index properties and geochemical characteristics. Tests performed include Atterberg limits, gradation, geochemical tests, standard Proctor, and California Bearing Ratio. Laboratory test results are discussed herein and summarized in Table 1. Individual results for each sample presented as an attachment to this report.

A total of nine gradations and Atterberg limits tests were performed on samples of eolian dune sand collected from the boreholes and test pits. The samples were found to be composed of approximately 0 to 12% gravel, with an average gravel content of 2.5%, approximately 51 to 94% sand, with an average sand content of 77.5%, and approximately 7 to 44% fines (i.e., silt and clay), with an average fines content of 20%. All samples were found to be non-plastic. Based on these laboratory test results and our field observations, the soils at the site generally classify as silty sand (SM) according to the Unified Soil Classification System (USCS). Natural moisture contents of the samples ranged from approximately 1 to 4%.

Three standard proctors and California Bearing Ratio (CBR) tests were conducted on samples from boreholes BH-04 (sample BS1) and BH-09 (sample BS2), and from test pit TP#6 (sample BS3). The samples were found to have maximum dry densities of 113.5 to 115.3 pcf with optimum moisture contents of 8.7 to 10.2%. For each CBR, three specimens were compacted to target moisture contents around the optimum moisture content at three compactive efforts.

California Bearing Ratios were selected for each sample at approximately 95% of the maximum dry density according to the standard Proctor. CBR values ranged from 14 to 19, with an average of 17. These are typical CBR values for silty sand soils.

A series of geochemical tests were conducted on three bulk soil samples collected from borehole BH-09 (sample BS2) and from test pits TP#6 (sample BS3) and TP#11 (sample GS8). The soil samples were tested for water soluble sulfates content, chloride content, pH, and electro-conductivity to evaluate the corrosivity of the soil. The samples were found to have a water soluble sulfate concentrations of 0.001 to 0.014%, chloride contents of 10 ppm, electro-conductivities of 12 to 34 μS/cm, and pH of 6.8 to 7.7. These values are not indicative of corrosive soil.

In summary, subsurface conditions across the proposed development consist uniformly of shallow, silty eolian sands overlying Navajo Sandstone bedrock. Depth to the bedrock was generally less than 5 feet. The near surface bedrock was fresh to slightly weathered, extremely weak to medium strong, fine grained quartzose sandstone. Bedrock strength may increase with depth. Excavations and borings in the sandstone are anticipated to meet low to moderate resistance.

Table 1. Summary of Laboratory Testing

BORING/ TEST PIT ID	SAMPLE NUMBER	SAMPLE DEPTH (ft)	NATURAL MOISTURE (%)	ATTERBERG LIMITS			GRAIN SIZE DISTRIBUTION			USCS	COMPACTION		CALIFORNIA BEARING RATIO	
				LL	PL	PI	% GRAVEL	% SAND	% FINES		Dry Density (pcf)	O.M.C. (%)	Dry Density (pcf)	CBR
BH-01	GS1	2-5	1.7	NP	NP	NP	1.0	79.5	19.5	SM				
BH-04	BS1	0-3	2.5	NP	NP	NP	3.3	81.4	15.3	SM	114.0	10.1	108.3	14
BH-05	GS2	0-3	3.3	NP	NP	NP	5.1	51.0	43.8	SM				
BH-09	BS2	0-2	1.7	NP	NP	NP	0.1	75.1	24.8	SM	115.3	8.7	109.5	19
TP#1	GS4	0-1	1.3	NP	NP	NP	12.1	63.1	24.8	SM				
TP#2	GS5	0-1	1.8	NP	NP	NP	0.0	90.3	9.7	SP-SM				
TP#3	GS6	0-1	1.2	NP	NP	NP	0.0	93.5	6.5	SP-SM				
TP#6	BS3	0-3	3.7	NP	NP	NP	0.2	85.4	14.3	SM	113.5	10.2	107.8	19
TP#11	GS8	0-1	2.3	NP	NP	NP	0.5	78.2	21.3	SM				

NOTES:

LL = LIQUID LIMIT
PL = PLASTIC LIMIT
PI = PLASTICITY INDEX
NP = NON-PLASTIC
USCS = UNIFIED SOIL CLASSIFICATION SYSTEM

CONCLUSIONS AND RECOMMENDATIONS

Based upon our site inspection and results of the shallow soil exploration, it appears that the property is suitable for the proposed development with special attention to foundation design, site preparation, erosion control, and management of drainage. The following general recommendations are offered as measures to enhance the stability of the proposed development and the long-term performance of the foundation soils. It should be noted that the mitigation measures offered address only the construction at the building sites. They cannot and will not arrest or prevent large-scale geologic processes that may be on-going elsewhere on the property and within the Moab area. The recommended measures are intended to be reasonable and prudent but cannot be considered as absolute protection against the vagaries of nature.

This report does not contain job specifications. The recommendations given are provided to guide the design process. We anticipate these recommendations, together with site-specific geotechnical information, will be used by the design team to formulate specifications for construction of buildings, infrastructure, and grading.

General Design Criteria

1. The local building official should be contacted to determine the required snow design load for this property.

2. Shallow components of the foundation system should be extended into the soil a minimum depth below finished grade as prescribed by the local building official to reduce the negative effects of frost heave.

Seismic Design Criteria

In accordance with Section 1615 of the *2003 International Building Code* (IBC) and our knowledge of the site, this site may be designated as Site Class B. The mapped spectral response acceleration at short periods (0.2 second, S_s) is 0.240g and at one second (S_1) is 0.065g. These values are taken from the USGS website, and are referenced to the National Earthquake Hazard Reduction Program (NEHRP) 1997 and 2000 maps, reproduced in the IBC.

Foundations

Shallow spread footings are considered suitable for the single-family residences proposed for this property. The shallow spread footing or basement foundation components should be extended to the sandstone bedrock where practical. The foundation components should rest upon uniform bedrock conditions (like material), usually indicated by similar rock type, degree of weathering, and strength. Due to potential for erosion and settlement, shallow foundations are not recommended on the native eolian sand deposits.

The following recommendations are provided to guide foundation design and construction.

1. The footings, bearing pads, and retaining walls to be placed on the prepared sandstone bedrock should be designed using an allowable bearing capacity (q_a) of 2,500 psf.

2. If extending the foundation components to sandstone bedrock is impractical due to the depth to bedrock, additional site specific geotechnical investigation is recommended to evaluate foundation alternatives.

3. After excavation to foundation depth, the exposed sandstone bedrock surface at the footing locations should be cleaned of any soil or other deleterious materials. If any fill is needed to elevate the slab area to the desired foundation grade, compacted structural fill as specified in Table 3 may be used. The use of angular (e.g., crushed rock) in the structural fill is recommended to increase the bond to the sandstone bedrock and minimize lateral spreading of the fill. Lean concrete may be used as an alternative to the structural fill.

4. Foundation walls should be designed with sufficient strength to resist lateral earth pressures and to bridge an unsupported span of at least 10 feet. The components of the foundations should be sufficiently interconnected to ensure that they act as a unit. This will provide resistance to the forces associated with soil movement and will provide unity to the foundation systems.

5. If the ground surface on the hillside below the foundation slopes at 2H:1V or greater, the foundation must be set back a distance of at least 10 feet measured horizontally from the bottom outside corner of the footing to the face of the slope.

Floor Systems

Slabs on-grade may be used at the site for garage and interior floor slabs if the slab will not be susceptible to groundwater seepage and/or hydraulic forces. Slabs on grade may be placed on sandstone bedrock, or on native eolian sands provided the sand is laterally confined (i.e., by the footings and stemwalls). The following recommendations are provided for slabs on-grade.

1. To provide an adequate bearing surface, topsoil, loose fill, man-made debris, and organic material should be removed.

2. The slabs on-grade should be placed on clean, sandstone bedrock. If fill is required to elevate the slab to a higher grade, compacted structural fill may be used. Native sandy soils may be used provided the sand is laterally confined (i.e., by the footings and stemwalls). The fill should be moisture conditioned and compacted in accordance with design specifications.

3. To avoid potential for settlement, slabs on-grade should not span multiple material types (e.g., sandstone bedrock and native sands).

4. To provide a capillary break, slabs on-grade should be placed on 4 inches of ¾-inch to 1½-inch washed rock on the prepared subgrade. If any fill is needed to elevate the slab area to the desired foundation grade, this can be accomplished using structural fill. Where moisture-sensitive interior floor finishes are applied to the slab, an unpunctured vapor barrier between the gravel and the floor slab is also recommended.

5. We recommend under-slab plumbing be avoided where possible to minimize the potential for leakage under the slab. Where necessary, under-slab plumbing should be provided with flexible couplings and should be leak-tested prior to being placed in service.

6. Suspended floors may be considered for use at this site. Suspended floors can consist of conventionally-framed wood flooring systems, thin concrete slabs supported on steel or wood decking, or prestressed slabs.

Exterior Concrete Flatwork

1. Flatwork should be placed on native bedrock or moisture conditioned and compacted native soil. If fill is needed, it should consist of structural fill, placed and compacted in accordance with project specifications.

2. Flatwork adjacent to buildings should not be placed over loosely compacted fill. To minimize future settlement and damage to the flatwork and/or adjacent foundations, the fill should consist of approved material placed and compacted per project specifications.

3. Flatwork adjacent to exterior doorways should be dowelled into the foundation to prevent long-term differential movement between the flatwork and structure.

4. Exterior concrete flatwork should be designed and constructed so that it drains freely away from the structure. Concrete flatwork adjacent to the foundation should slope away at a rate of at least ¼-inch per foot.

5. Site grading and landscaping must prevent wind and/or water erosion of foundation support beneath exterior flatwork.

6. All concrete used at this site in contact with native soil should comply with the recommendations in the *Concrete* section of this report.

Retaining Structures

1. Walls acting to restrain soil should be designed using the lateral earth pressures provided in Table 2 below. These values assume a level backslope with no hydraulic pressures behind the wall, the use of native soil, and no surcharge loads applied within the backslope zone. We should be contacted to recommend lateral earth pressure values for increased backslope angles or loading within the backslope zone.

Table 2. Lateral Earth Pressures

	Native Soil	
Active Earth Pressure	35	pcf*
Passive Earth Pressure	300	pcf
At-Rest Earth Pressure	65	pcf
Unit weight of soil	120	pcf**
Coefficient of Friction	0.32	***

* pounds per cubic foot (fluid equivalent)
** pounds per cubic foot
*** concrete on dry soil conditions

2. The retaining walls should have provisions for drainage so that hydrostatic pressures are not allowed to build up. This is usually accomplished by providing free-draining granular backfill between the wall and retained soil, with a collection drain provided at the bottom of this granular zone, and/or the use of weep holes through the face of the wall. The drain system should be continuous and have a positive outfall which releases the collected water well away from the wall in a manner that minimizes the erosive energy of concentrated flow. The design engineer should ensure that drainage design is compatible with design assumptions.

3. Excavations for retaining and foundation walls should be laid back a minimum of 35° from the vertical prior to backfilling against retaining structures (see attached Foundation Excavation Detail). For safety, excavations should also be in accordance with OSHA Regulations 29 CFR 1926. Consequently, gentler excavation faces may be required.

4. Fill material placed behind the walls should consist of free-draining granular material (specified below) compacted as per the design engineer's specifications. Clean native soil material (less than 10% passing the #200 sieve) can be used for this purpose if approved by the design engineer. Compaction of 85 to 90% of standard Proctor maximum dry density is typically specified to minimize post-construction settlement of the backfill. Over-compaction of the backfill should be avoided so that excessive pressures are not placed against the retaining wall. Unless expressly approved by the design engineer, only hand-operated light-duty compaction equipment should be used within three feet of the wall. The upper one foot of backfill should consist of clayey soil to create a barrier against infiltration of surface runoff.

Concrete

Geochemical tests conducted on soil samples collected from our boreholes and excavations indicate the soil to be non-corrosive. Based on this information, Type I or I/II cement may be used in all concrete in contact with native soil at this site.

Foundation Drainage and Ventilation

It is important to prevent moisture from penetrating into the soil beneath or adjacent to the structure. Moisture can accumulate as a result of poor surface drainage, over-irrigation of landscaped areas, waterline leaks, melting snow, subsurface seepage, or condensation from vapor transport.

1. Roof drainage should be captured by eave gutters. Downspouts should be fitted with extensions to discharge a minimum of 10 feet away from houses or piped into a closed underground drain system and evacuated away from foundations. In no case should the downspouts be directed into or near foundations or slabs. These points of discharge should be identified in the site drainage plan so that water is readily removed from the site.

2. Floor systems and confined areas above concrete floor slabs should be properly ventilated to allow for the release of radon gas. See the *Radon Gas* section of this report for more radon information.

3. If site conditions indicate potential for accumulation of moisture around or adjacent to foundations, a perimeter foundation drain should be installed to collect and evacuate any such water.

Erosion Control

1. Minimization of disturbance to native soils, vegetation, and cryptobiotic crust should be the foremost consideration for erosion control during and after development of the area. It is recommended that small areas be developed and reclaimed before disturbing adjacent areas. Phased construction sequencing, consideration of the prevailing wind direction, utilization of existing roads, and temporary drainage ditches will also aid in erosion control.

2. Application of a surfactant or soil binder may be effective to reduce soil erosion and suppress dust by binding soil particles and retaining soil moisture. Water may also be used to temporarily suppress dust, although evaporation during hot months may render water applications impractical.

3. Maintaining native vegetation and planting native grasses and shrubs will help to control erosion both during and after construction.

4. Lath fences may also be used during construction to manage dune migration and wind erosion.

Site Preparation and Grading

1. The site drainage plan, in tandem with the landscape and grading plans, should ensure that the construction does not impede natural drainage patterns. Surface water should be removed and not allowed to accumulate or stand anywhere near building foundations either during or after completion of construction. This includes water from landscaped areas, patios, decks, and roofs. Drainage plans should ensure that precipitation, snowmelt, and runoff are conveyed around and away from buildings, driveways, and roadways. This runoff should be dispersed (not concentrated) in a manner consistent with the natural, pre-construction drainage pattern.

2. Final grading around foundation perimeters should slope downward with at least one foot of drop within the first 10 feet of horizontal distance. Concrete flatwork adjacent to the foundation should slope away at a rate of at least ¼-inch per foot.

3. Grading of all permanent cut and fill slopes should not exceed 2H:1V. All slopes greater than 2H:1V and over 3 feet in vertical height should be restrained by an engineered retaining structure/system.

4. Backfill placed in utility trenches leading to houses should be compacted in accordance with project specifications. This will inhibit surface water infiltration and migration towards the foundation, as well as minimize post-construction settlement of the trench backfill.

5. Disturbed areas should be revegetated as soon as practical to reduce soil erosion. Application of dust palliatives or erosion control mats may be needed to hold soil surfaces until vegetation is established.

6. Fill used at this site should meet the gradational and compaction requirements listed in Tables 3 and 4 below. Fill should be placed and compacted in maximum 6-inch lifts, unless otherwise directed by the design engineer. Structural fill should not be placed on frozen or wet native soil. It is recommended that the foundation excavation be open a minimum period of time to avoid degradation of the foundation soils. Clean native soil material with all deleterious material and over-size rock removed may be used as structural fill for certain applications if approved by the design engineer.

Table 3. Gradation Requirements for Fill Material

Type	Sieve	%Passing, by weight
Structural Fill (roadbase)	3/4" (19.0 mm)	100
	#4 (4.75 mm)	30-65
	#8 (2.36 mm)	25-55
	#200 (0.075 mm)	3-12
Structural Fill (base course)	2.5" (63.5 mm)	100
	2" (50 mm)	95-100
	#4 (4.75 mm)	30-65
	#200 (0.075 mm)	3-15
Fill under exterior concrete flatwork	3" (75 mm)	100
	#200 (0.075 mm)	0-5
Free-draining fill	3" (75 mm)	100
	¾" (19 mm)	20-90
	#4 (4.75 mm)	0-20
	#200 (0.075 mm)	0-3

Note: The Plasticity Index for all fill soils should be less than 6.

Table 4. Compaction Requirements for Fill Material

Application	Compaction Requirement	Proctor	Moisture
Under footings and slabs	95% max. dry density	Modified	±2% of optimum
Under exterior flatwork	90% max. dry density	Modified	±2% of optimum
Road Subgrade	95% max. dry density	Standard	0-4% above optimum
Road Subbase	95% max. dry density	Modified	±2% of optimum
Road base course	95% max. dry density	Modified	±2% of optimum
Behind retaining walls	Per project specifications*		
Utility Trenches	Per project specifications*		
General landscaping	Per project specifications*		

*As specified by the design engineer on project documents or in accordance with local municipal requirements.

7. Any soils containing organics, debris, topsoil, and other deleterious materials shall not be used for anything other than landscaping unless authorized by the foundation engineer.

8. A representative of Buckhorn Geotech should be called out to the site to observe placement of structural fill and verify the compacted density. We recommend that the owner contact Buckhorn Geotech in advance of the excavations to discuss the specific testing requirements, budget, and scheduling needed for these services.

Excavation and Shoring

1. Temporary excavations should be in accordance with Occupational Safety and Health Administration (OSHA) regulations and with worker safety in mind. If slopes cannot be laid back in accordance with OSHA regulations, an engineered excavation stabilization plan is required.

2. We anticipate that the excavation of the site soils and weak sandstone can be accomplished by conventional excavating equipment. Removal of more competent sandstone may require the use of a pneumatic or hydraulic hammer.

Pavement Section Design

We understand that preliminary pavement sections designs are desired for conceptual planning. The preliminary pavement sections are discussed below.

Daily traffic volumes have been estimated based on the density of development proposed and a 20-year pavement life. Two methods were used to estimate the traffic loading, with the first method based upon Colorado Department of Transportation (CDOT) correlations for residential and commercial developments (*CDOT Pavement Design Manual, 2005)*, and the second method utilizing estimations of traffic based upon Institute of Transportation Engineer's trip generations and estimated construction traffic. The traffic volumes using the second method account for construction traffic and a phased build-out, as well as yearly volume growth. Traffic loads were calculated based on the second method for the east, north and south accesses separately, then a combined north and south access (for a more conservative pavement section). The estimated total traffic that the development will generate under each of these scenarios were correlated to an 18-kip Equivalent Single Axle Load (ESAL) for arterial road design purposes. Calculations for these correlations are appended to this report.

From CDOT, a lane factor of 0.60 was used since all proposed roads for the Lionsback Village development will be two-lane roads with one lane in each direction.

Based upon a combination of these estimations, residential traffic loadings from 37,000 to 570,000 18-kip ESALs for the access roads were analyzed. This analysis provides a quick comparison of pavement sections, load carrying capacity, and performance.

Individual laboratory testing results on the soil samples obtained from the investigation are presented above in the *Subsurface Conditions* section and appended to this report as individual laboratory test results. For the purposes of this analysis, a California Bearing Ratio (CBR) value of 19 was used for the reddish-yellow silty fine sand (SM) and a Resilient Modulus (M_R) of 50,000 psi was used as a default value for the fresh to slightly weathered, very weak, light brown, fine-grained and thinly-bedded sandstone. The CBR for the silty fine sand was correlated to a M_R of 21,500 psi using a procedure provided in the *Pavement Design Manual.*

The design parameters provided below were used in the analysis of the pavement sections, and are derived from the CDOT *Pavement Design Manual*, Utah Department of Transportation's *Pavement Management and Pavement Design Manual* (UDOT, 1998), and the Colorado Asphalt Pavement Association's (CAPA) *Guidelines for the Design and Use of Asphalt Pavements for Colorado Roadways*. Note that in the absence of drainage design data, the default drainage coefficient is 1.0. A reliability of 75% has been assumed for this project, given the nature of the roads (relatively low volume rural roads but high demand performance). Consistent with UDOT requirements, a serviceability loss of 2.5 psi has been used. Typical strength coefficients have been used for calculating the strength of the final sections. The treated subgrade coefficient assumes a minimum 7-day unconfined compressive strength of 300 psi.

Table 5. Subgrade Characteristics

Parameter	Silty SAND (SM)	SANDSTONE
Resilient Modulus (psi)	21,500	500,000
Drainage coefficient	1.0	1.0
Reliability (%)	75	75
Serviceability Loss (psi)	2.0	2.0
Strength coefficients:		
HMA	0.40	0.40
ABC	0.10	0.10
Subbase	0.08	0.08
Treated Subgrade	0.13	N/A

For construction and long-term performance reasons, UDOT recommends that the following minima are prescribed: 2.5 inches of hot-mix asphalt; 4 inches of aggregate base course; and 6 inches of granular borrow (subbase, where used). However, "best practices" considers 3.0 inches of asphalt as an industry standard for roads that do not enjoy the routine maintenance provided by UDOT. Our design, therefore, is based on a 3-inch asphalt thickness.

The pavement sections presented suggest that where sandstone is encountered as the subgrade, the pavement section has sufficient strength with just the asphalt surfacing on the rock; however, it is recommended to place a minimum 4-inch layer of angular (crushed rock) roadbase on the sandstone to form a leveling course. It is also recommended that the bedrock surface be roughened to provide some bond between the roadbase and bedrock.

Based upon the results of our geotechnical investigation and analyses, it is recommended that where possible the road sections bear directly upon competent sandstone. We recommend against using the silty sand as a subgrade unless the subgrade is treated a minimum of one foot below the pavement section, and preferably full depth to the sandstone contact. In our opinion, the best base and subgrade treatment for the silty sand encountered in our investigation is either Portland cement or Type "C" flyash, blended, moisture conditioned, placed, and compacted in accordance with project specifications.

The base and subbase courses should have sufficient width to fully extend beneath areas of shoulders or curb and gutter, where used. Construction of the roadway prism should promote drainage away from the prism and subgrade. Borrow ditches and culverts should be provided and, where needed, lateral and/or crossdrains should be installed to keep water away from the roadways. Because of the erosive nature of the native silty sand, measures should be provided to minimize soil loss adjacent to the road prism from drainage concentration, such as riprap at discharge points and the use of vegetation and/or other erosion control measures in drainages.

Table 6. Preliminary Pavement Section Design

18K $ESAL_{20}$	M_R[1]	Req'd SN[2]	Thicknesses: Asphalt (in.)	Base (in.)	Subbase (in.)	Treated Subgrade (in.)	SN[3]	Subgrade	Application
Any	500000	0.78	3	0	0	0	1.2	sandstone	All roads
37,000	21500	1.14	3	0	0	0	1.2	SM	East Road
285,000	21500	1.66	3	5	0	0	1.7	SM	North Access
570,000	21500	1.87	3	0	0	12	2.76	SM	South Access

1. M_R = Subgrade Resilient Modulus, calculated from CBR or R-value
2. Req'd SN = required structural number (measure of required structural strength of pavement section)
3. SN = structural number, as calculated from the pavement section

References

Black, B.D., Hecker, S., Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003. *Quaternary Fault and Fold Database and Map of Utah,* Map 193DM, Utah Geological Survey, 2003.

Doelling, H.H., Ross, M.L., and Mulvey, W.E., 2002. *Geologic Map of the Moab 7.5' Quadrangle, Grand County, Utah,* Utah Geological Survey, 2002.

Hylland and Mulvey, 2003. *Geologic Hazards of Moab-Spanish Valley, Grand County, Utah,* Special Study 107, Utah Geological Survey, 2003.

Closing Considerations

This report has been prepared in a manner consistent with local standards of professional geotechnical engineering practice. Investigation of the site for environmental contaminants was not part of our scope of services performed at this site. The classification of soils and interpretation of subsurface stratigraphy is based on our training and years of experience, but is necessarily based on limited subsurface observation and testing. As such, inferred ground conditions cannot be guaranteed to be exact. No other warranty, Express or Implied, is made.

If the proposed construction changes from what we have described in this report, we should be notified to reevaluate our recommendations. Also, if during excavation, soil and groundwater conditions are discovered that vary from these discussed herein, construction should be stopped until the situation has been assessed by a representative of Buckhorn Geotech. Construction should be resumed only when remedies or design adjustments, as necessary, have been prescribed.

Additional Services

Buckhorn Geotech is a full-service engineering firm providing foundation, on-site wastewater system, site drainage, structural, and retaining structure design services, as well as surveying, construction materials testing, and inspections. Please visit **www.buckhorngeo.com** for a full description of our services.

Thank you for the opportunity to perform this soil investigation for you. If you require any of these services or have any questions regarding this report, please do not hesitate to contact us.

Respectfully Submitted,
May 10, 2006

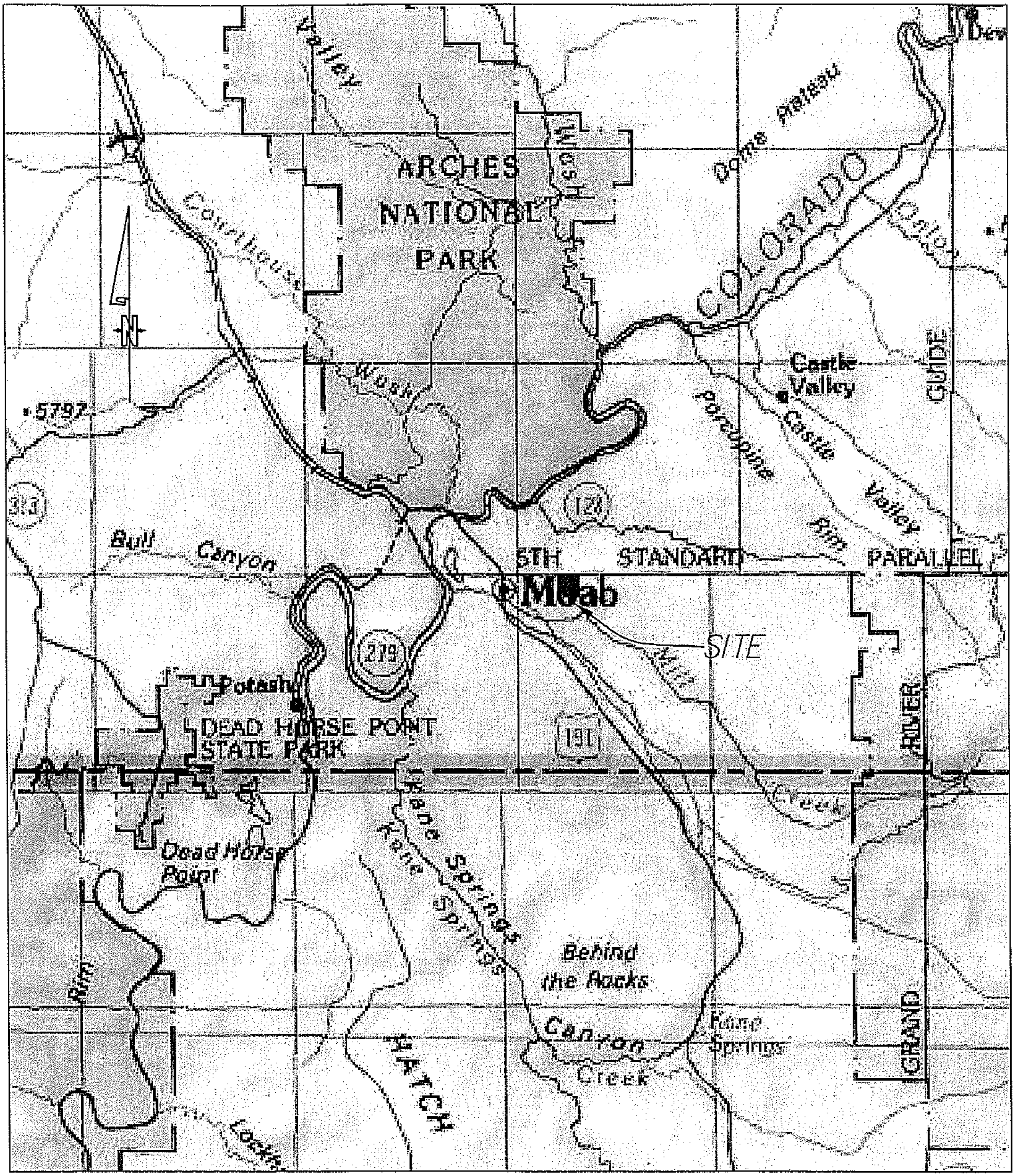
Brett R. Byler, P.E.
Geotechnical Engineer

Reviewed by:

Thomas E. Griepentrog, P.E., P.G.
Principal

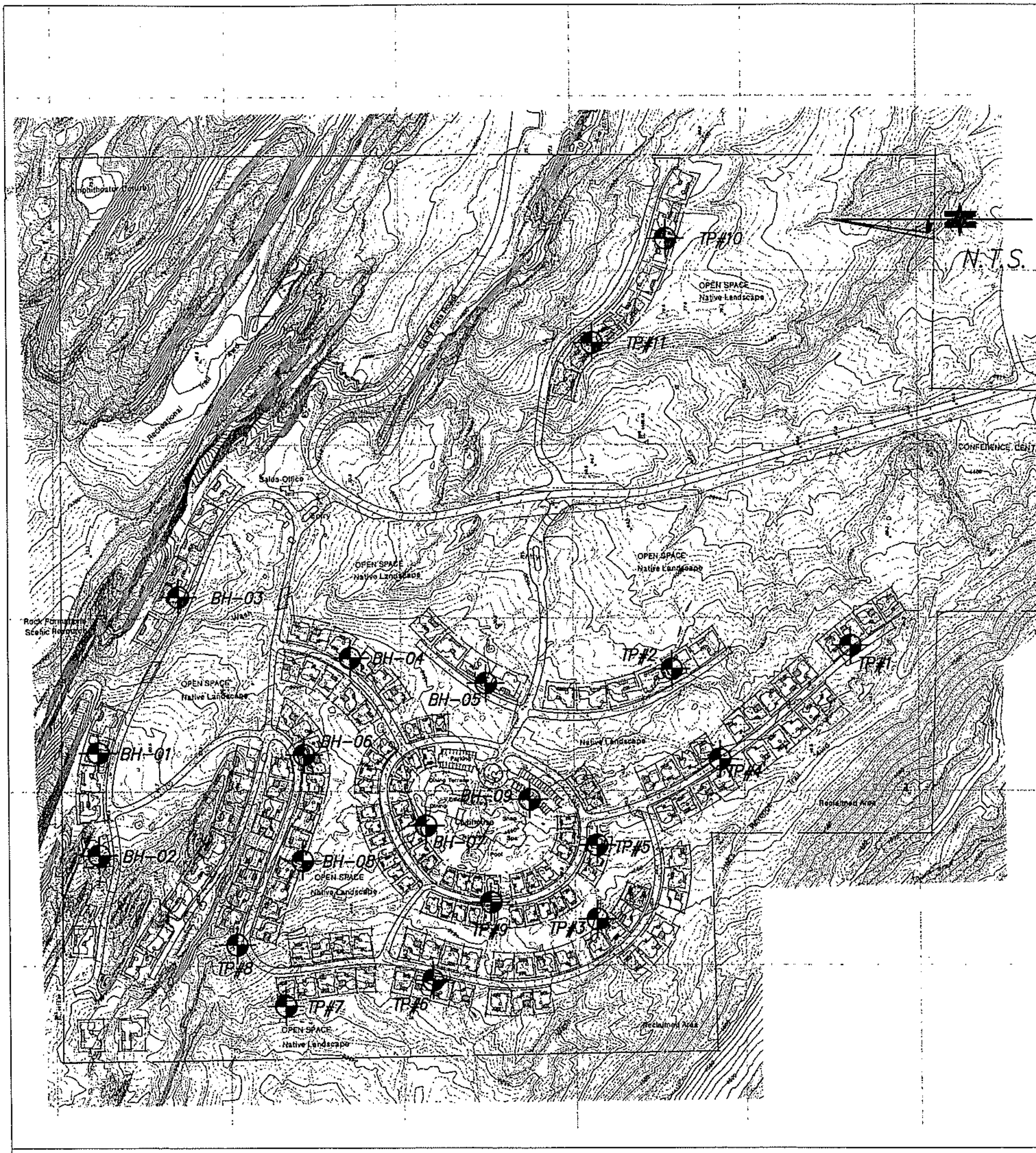
Enclosures: Vicinity Map, Site Plan, Borehole and Test Pit Logs, Atterberg Limits and Sieve Analysis results, Corrosivity Series results, Proctor results, California Bearing Ratio results

VICINITY MAP



DRAWING NUMBER	INVESTIGATION	BB	LB MOAB LAND LLC	BUCKHORN GEOTECH
1	DRAFTER	JG	LIONSBACK VILLAGE	Civil, Structural, and Geotechnical Engineers, Inc.
	DATE	4/21/06	MOAB, UTAH	222 South Park Avenue, Montrose, Colorado 81401
OF 1	JOB NO.	06-132-GEO		Phone (970) 249-6828 Fax (970) 249-0945

SITE PLAN



SITE LAYOUT PROVIDED COURTESY OF GIBSON ARCHITECTS, LLC

SHEET 1 OF 1		LB MOAB LAND, LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH
INVESTIGATION	BRB		
DRAFTER	BRB		
DATE	4/20-21/06		
JOB NO.	06-132-GEO		

BUCKHORN GEOTECH
Civil, Structural, and Geotechnical Engineers, Inc.
222 South Park Avenue
Montrose, Colorado 81401
Phone (970) 249-6828 Fax (970) 249-0945

LOG OF EXPLORATORY DRILLING – BOREHOLE BH-01

SURFACE ELEVATION:
DRILLER: Scott McCracken
DRILL RIG: Simco 2800 HS
DRILL STEM: 4" Solid-stem continuous flight auger
SAMPLER: 1.375" I.D. Standard and 2" I.D. California split spoon
CASING: None used
NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers comments

DEPTH (ft)	GRAPHIC	WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	SPT BLOW COUNTS	SPT 'N' VALUE (bpf)	RECOVERY (in.)	SOIL DESCRIPTION	FIELD & LABORATORY TEST RESULTS
0								damp, compact, light brown, fine SAND, poorly graded with trace fine sandstone gravel, little silt	
2–4				GS1					(GS1) NON-PLASTIC GF=1.0% SF=79.5% F200=19.5% MC=1.7% USCS Classification=SM
5					5 6 8	14			
7								increase in density to dense @7'	
10					17 22 26	48		damp, dense, light brown fine SAND, very weakly cemented, poorly graded with trace to little very pale orange, medium grained sandstone gravel [possibly weak bedrock]	
12								incresed scratching, more cementation @12'	
15					50/ 3"			same as 10–11.5'	
16.5								end of boring @16.5' no groundwater	

SHEET 1 OF 1		
INVESTIGATION	BB	LB MOAB LAND LLC
DRAFTING	JG	LIONSBACK VILLAGE
DATE	4/20/06	MOAB, UTAH
JOB NO.	06-132-GEO	

BUCKHORN GEOTECH
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Montrose, Colorado 81401
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LOG OF EXPLORATORY DRILLING – BOREHOLE BH-02

SURFACE ELEVATION:
DRILLER: Scott McCracken
DRILL RIG: Simco 2800 HS
DRILL STEM: 4" Solid-stem continuous flight auger
SAMPLER: 1.375" I.D. Standard and 2" I.D. California split spoon
CASING: None used
NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers comments

DEPTH (ft.)	GRAPHIC	WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	SPT BLOW COUNTS	SPT 'N' VALUE (bpf)	RECOVERY (in.)	SOIL DESCRIPTION	FIELD & LABORATORY TEST RESULTS
0–2								damp to moist, loose to compact, light brown fine SAND, poorly graded with little to some subangular sandstone gravels, and little silt (0–2')	
2								sandstone bedrock @2', weak to very weak	
2.5								end of boring @2.5' no groundwater	

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18

SHEET 1 OF 1	INVESTIGATION BB DRAFTING JG DATE 4/20/06 JOB NO. 06-132-GEO	LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

LOG OF EXPLORATORY DRILLING - BOREHOLE BH-03

SURFACE ELEVATION:
DRILLER: Scott McCracken
DRILL RIG: Simco 2800 HS

DRILL STEM: 4" Solid-stem continuous flight auger
SAMPLER: 1.375" I.D. Standard and 2" I.D. California split spoon
CASING: None used

NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers comments

DEPTH (ft.)	GRAPHIC	WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	SPT BLOW COUNTS	SPT 'N' VALUE (bpf)	RECOVERY (in.)	SOIL DESCRIPTION	FIELD & LABORATORY TEST RESULTS
0								moist, dense to very dense, light brown, fine SAND, poorly graded with some flat sided sandstone pieces and little silt	
5				-	29 45	74		fresh to slightly weathered, very weak SANDSTONE, light brown, fine grained, thinnly bedded	
7								end of boring @7'—harder drilling no groundwater	

Depth scale (ft.): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18

SHEET 1 OF 1		LB MOAB LAND LLC	BUCKHORN GEOTECH
INVESTIGATION	BB	LIONSBACK VILLAGE	Civil, Structural, and Geotechnical Engineers, Inc.
DRAFTING	JG	MOAB, UTAH	222 South Park Avenue
DATE	4/20/06		Montrose, Colorado 81401
JOB NO.	06-132-GEO		Phone (970) 249-6826 Fax (970) 249-0945

LOG OF EXPLORATORY DRILLING – BOREHOLE BH-04

SURFACE ELEVATION:
DRILLER: Scott McCracken
DRILL RIG: Simco 2800 HS
DRILL STEM: 4" Solid-stem continuous flight auger
SAMPLER: 1.375" I.D. Standard and 2" I.D. California split spoon
CASING: None used
NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers comments

DEPTH (ft.)	GRAPHIC	WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	SPT BLOW COUNTS	SPT 'N' VALUE (bpf)	RECOVERY (in.)	SOIL DESCRIPTION	FIELD & LABORATORY TEST RESULTS
0–1								damp to moist, loose, light brown, fine SAND, poorly graded, with little silt (0–1')	
1–4			X	BS1				fresh to slightly weathered, very weak to weak, light brown, fine grained, thinly bedded, Navajo SANDSTONE	(BS1) NON–PLASTIC GF=3.3% SF=81.4% F200=15.3% MC=2.5% USCS Classification=SM Max. DD=114.0 pcf Opt. Moisture=10.1%
4								end of boring @4'–near refusal no groundwater	

Depth scale: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

SHEET 1 OF 1	INVESTIGATION BB	LB MOAB LAND LLC	BUCKHORN GEOTECH
	DRAFTING JG	LIONSBACK VILLAGE	Civil, Structural, and Geotechnical Engineers, Inc.
	DATE 4/20/06	MOAB, UTAH	222 South Park Avenue, Montrose, Colorado 81401
	JOB NO. 06–132–GEO		Phone (970) 249-6828 Fax (970) 249-0945

LOG OF EXPLORATORY DRILLING – BOREHOLE BH-05

SURFACE ELEVATION:
DRILLER: Scott McCracken
DRILL RIG: Simco 2800 HS
DRILL STEM: 4" Solid-stem continuous flight auger
SAMPLER: 1.375" I.D. Standard and 2" I.D. California split spoon
CASING: None used
NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers comments

DEPTH (ft)	GRAPHIC	WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	SPT BLOW COUNTS	SPT 'N' VALUE (bpf)	RECOVERY (in.)	SOIL DESCRIPTION	FIELD & LABORATORY TEST RESULTS
0–2			X	GS2				damp to moist, loose, light brown, fine SAND, poorly graded with little silt and trace sandstone gravels, increasing sandstone pieces below 0.5' (0–2') grinding starts @0.5'	(GS2) NON–PLASTIC GF=5.1% SF=51.0% F200=43.8% MC=3.3% USCS Classification=SM
2								hard grinding @2'	
2.5–4								fresh to slightly weathered, weak to very weak, light brown, fine grained SANDSTONE	
4								end of boring @4' no groundwater	

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18

SHEET 1 OF 1	INVESTIGATION BB	LB MOAB LAND LLC
	DRAFTING JG	LIONSBACK VILLAGE
	DATE 4/20/06	MOAB, UTAH
	JOB NO. 06–132–GEO	

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Civil, Structural, and Geotechnical Engineers, Inc.
222 South Park Avenue
Montrose, Colorado 81401
Phone (970) 249-6828 Fax (970) 249-0945

LOG OF EXPLORATORY DRILLING – BOREHOLE BH-06

SURFACE ELEVATION:
DRILLER: Scott McCracken
DRILL RIG: Simco 2800 HS
DRILL STEM: 4" Solid-stem continuous flight auger
SAMPLER: 1.375" I.D. Standard and 2" I.D. California split spoon
CASING: None used
NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers comments

DEPTH (ft.)	GRAPHIC	WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	SPT BLOW COUNTS	SPT 'N' VALUE (bpf)	RECOVERY (in.)	SOIL DESCRIPTION	FIELD & LABORATORY TEST RESULTS
0								damp to moist, loose, light brown, fine grained SAND, poorly graded, little silt (0–1.5')	
1								fresh to slightly weathered, weak, light brown, fine-grained SANDSTONE	
2								end of boring @2' no groundwater	
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									

SHEET 1 OF 1	INVESTIGATION	BB	LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH
	DRAFTING	JG		Civil, Structural, and Geotechnical Engineers, Inc.
	DATE	4/20/06		222 South Park Avenue, Montrose, Colorado 81401
	JOB NO.	06-132-GEO		Phone (970) 249-6828 Fax (970) 249-0945

LOG OF EXPLORATORY DRILLING – BOREHOLE BH-07

SURFACE ELEVATION:
DRILLER: Scott McCracken
DRILL RIG: Simco 2800 HS
DRILL STEM: 4" Solid-stem continuous flight auger
SAMPLER: 1.375" I.D. Standard and 2" I.D. California split spoon
CASING: None used
NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers comments

DEPTH (ft.)	GRAPHIC	WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	SPT BLOW COUNTS	SPT 'N' VALUE (bpf)	RECOVERY (in.)	SOIL DESCRIPTION	FIELD & LABORATORY TEST RESULTS
0			☒					*damp, loose, light brown, fine SAND, poorly graded, little fine to medium gravel and little silt (0–2.5')*	
1				GS3					
2								*fresh to slightly weathered, very weak to weak, light brown SANDSTONE*	
3									
4								*hard @4'* *end of boring @4.5'* *no groundwater*	
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									

SHEET 1 OF 1		LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH
INVESTIGATION	BB		Civil, Structural, and Geotechnical Engineers, Inc.
DRAFTING	JG		222 South Park Avenue
DATE	4/20/06		Montrose, Colorado 81401
JOB NO.	06-132-GEO		Phone (970) 249-6828 Fax (970) 249-0945

LOG OF EXPLORATORY DRILLING – BOREHOLE BH-08

SURFACE ELEVATION:
DRILLER: Scott McCracken
DRILL RIG: Simco 2800 HS
DRILL STEM: 4" Solid-stem continuous flight auger
SAMPLER: 1.375" I.D. Standard and 2" I.D. California split spoon
CASING: None used
NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers comments

DEPTH (ft.)	GRAPHIC	WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	SPT BLOW COUNTS	SPT 'N' VALUE (bpf)	RECOVERY (in.)	SOIL DESCRIPTION	FIELD & LABORATORY TEST RESULTS
0								moist, loose, light brown, fine SAND, poorly graded, trace to little gravel, little silt (0–1.5')	
1									
2								end of boring @2' in hard sandstone no groundwater	
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									

SHEET 1 OF 1		LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH
INVESTIGATION	BB		
DRAFTING	JG		
DATE	4/20/06		
JOB NO.	06-132-GEO		

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Civil, Structural, and Geotechnical Engineers, Inc.
222 South Park Avenue
Montrose, Colorado 81401
Phone (970) 249-6828 Fax (970) 249-0945

LOG OF EXPLORATORY DRILLING – BOREHOLE BH–09

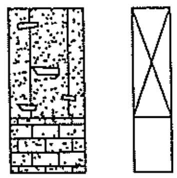
SURFACE ELEVATION:
DRILLER: Scott McCracken
DRILL RIG: Simco 2800 HS
DRILL STEM: 4" Solid-stem continuous flight auger
SAMPLER: 1.375" I.D. Standard and 2" I.D. California split spoon
CASING: None used
NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers comments

DEPTH (ft.)	GRAPHIC	WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	SPT BLOW COUNTS	SPT 'N' VALUE (bpf)	RECOVERY (in.)	SOIL DESCRIPTION	FIELD & LABORATORY TEST RESULTS
0–2			X					moist, loose, light brown, fine SAND, poorly graded, trace sandstone gravel, little silt (0–2') BS2	(BS2) NON–PLASTIC GF=0.1% SF=75.1% F200=24.8% MC=1.7% Sulfates=0.001% Chlorides=10 ppm Electro–conduct.=34 μS/cm pH=7.71 USCS Classification=SM Max. DD=115.3 pcf Opt. Moisture=8.7%
2–4								hard drilling @2'; fresh to slightly weathered, weak fine grained SANDSTONE	
4								end of boring @4' no groundwater	

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18

SHEET 1 OF 1	INVESTIGATION BB	LB MOAB LAND LLC	BUCKHORN GEOTECH
	DRAFTING JG	LIONSBACK VILLAGE	Civil, Structural, and Geotechnical Engineers, Inc.
	DATE 4/20/06	MOAB, UTAH	222 South Park Avenue, Montrose, Colorado 81401
	JOB NO. 06–132–GEO		Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT TP#1

Depth (ft)	Symbol	Sample	Soil Description	Laboratory Test Results
0 – 1			dry, loose to compact, dark yellowish orange, slightly silty SAND with some subangular weak sandstone gravel and little silt (0–1') bulk sample "GS4" @0–1'	(GS4) NON–PLASTIC GF=12.1% SF=63.1% F200=24.8% MC=1.3% USCS Classification=SM
1 – 1.5			fresh to slightly weathered, weak, grayish orange, fine grained SANDSTONE	
			end of excavation @1.5' no groundwater encountered	

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

SHEET 1 OF 1	INVESTIGATION BB DRAFTING JG DATE 4/21/06 JOB NO. 06–132–GEO	LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT TP#2

Depth (ft)	Symbol	Sample	Soil Description	Laboratory Test Results
0–1	▨	☒	dry, loose, light brown, fine grained SAND, poorly graded, little silt (0-1') bulk sample "GS5" @0-1'	(GS5) NON-PLASTIC GF=0.0% SF=90.3% F200=9.7% MC=1.8% USCS Classification=SM
1–1.5	▦	☐	fresh to slightly weathered, weak to very weak, light brown, fine grained SANDSTONE end of excavation @1.5' no groundwater encountered	

Depth (ft): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

SHEET 1 OF 1	INVESTIGATION BB DRAFTING JG DATE 4/21/06 JOB NO. 06-132-GEO	LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT TP#3

Depth (ft)	Symbol	Sample	Soil Description	Laboratory Test Results
0–1		☒	damp, compact, light brown, fine SAND, poorly graded with trace sandstone gravel (0–1') bulk sample "GS6" @0–1'	(GS6) NON–PLASTIC GF=0.0% SF=93.5% F200=6.5% MC=1.2% USCS Classification=SP–SM
1–1.5		☐	fresh to slightly weathered, very weak to extremely weak, light brown, fine grained SANDSTONE end of excavation @1.5' no groundwater encountered	

Depth scale (ft): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

SHEET			
1 OF 1	INVESTIGATION BB DRAFTING JG DATE 4/21/06 JOB NO. 06–132–GEO	LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT TP#4

Depth (ft)	Symbol	Sample	Soil Description	Laboratory Test Results
0–0.5			dry, loose, light brown, fine SAND, poorly graded with little angular sandstone gravel and little silt (0–0.3') fresh to slightly weathered, very weak, light brown, fine grained SANDSTONE end of excavation @0.5' no groundwater encountered	

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

SHEET 1 OF 1	INVESTIGATION BB DRAFTING JG DATE 4/21/06 JOB NO. 06-132-GEO	LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT TP#5

Depth (ft)	Symbol	Sample	Soil Description	Laboratory Test Results
0–1			damp, loose, light brown, fine SAND, poorly graded, little silt (0–0.5') fresh to slightly weathered, very weak to extremely weak, light brown, fine grained SANDSTONE (0.5–1') end of excavation @1' no groundwater encountered	

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

SHEET 1 OF 1		LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH
INVESTIGATION	BB	
DRAFTING	JG	
DATE	4/21/06	
JOB NO.	06-132-GEO	

BUCKHORN GEOTECH
Civil, Structural, and Geotechnical Engineers, Inc.
222 South Park Avenue
Montrose, Colorado 81401
Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT TP#6

Depth (ft)	Soil Description	Laboratory Test Results
0–3.5	damp to moist, compact, light brown, fine SAND, poorly graded, little silt (0–3.5')	(BS3) NON–PLASTIC GF=0.2% SF=85.4% F200=14.3% MC=3.7% Sulfates=0.001% Chlorides=10 ppm Electro–conductivity=25 μS/cm pH=6.88 USCS Classification=SM Max. DD=113.5 pcf Opt. Moisture=10.2%
0–3	bucket sample "BS3" @0–3'	
3.5	fresh to slightly weathered, very weak, light brown, fine grained SANDSTONE end of excavation @3.5' no groundwater encountered	

Depth (ft): 0 1 2 3 4 5 6 7 8 9 10 11 12

SHEET 1 OF 1		LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH
	INVESTIGATION BB		
	DRAFTING JG		
	DATE 4/21/06		
	JOB NO. 06–132–GEO		

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222 South Park Avenue
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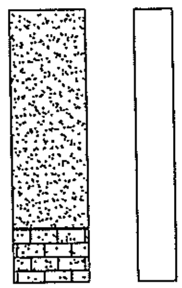
Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT TP#7

Depth (ft)	Symbol	Sample	Soil Description	Laboratory Test Results
0			moist, compact, light brown, fine grained SAND with little silt. poorly graded (0–2')	
1				
2			fresh to slightly weathered, very weak, light brown, fine grained SANDSTONE	
			end of excavation @2.5' no groundwater encountered	
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				



SHEET 1 OF 1	INVESTIGATION BB DRAFTING JG DATE 4/21/06 JOB NO. 06-132-GEO	LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH

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SOIL LOG TEST PIT TP#8

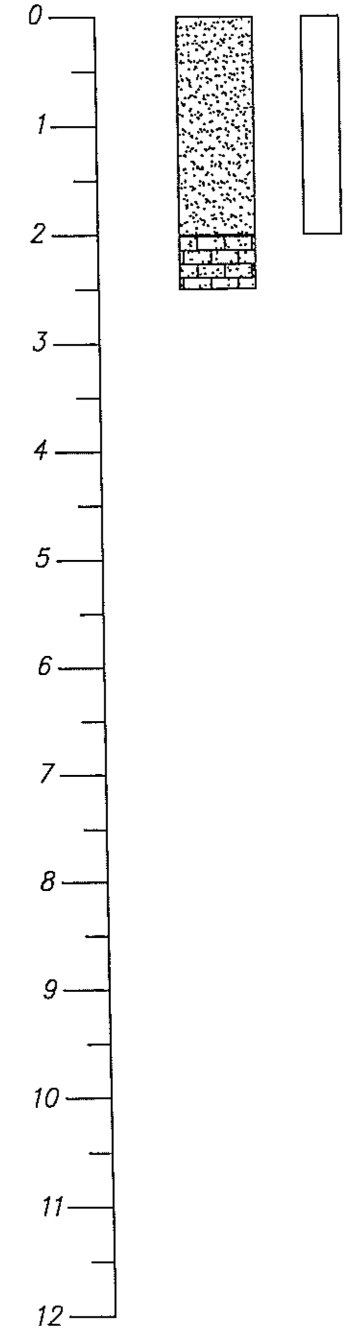
Depth (ft)	Symbol	Sample	Soil Description	Laboratory Test Results
0–2			damp to moist, compact, light brown, fine SAND, poorly graded with little silt (0–2') bulk sample "GS7" @0–2'	Dry Density= MC=%
2			fresh to slightly weathered, very weak, light brown, fine grained SANDSTONE end of excavation @2' no groundwater encountered	

Depth scale (ft): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

SHEET 1 OF 1	INVESTIGATION BB DRAFTING JG DATE 4/21/06 JOB NO. 06-132-GEO	LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT TP#9

Depth (ft) | Symbol | Sample | Soil Description | Laboratory Test Results



damp to moist, compact, light brown, fine SAND, poorly graded with little silt (0–2')

fresh to slightly weathered, very weak, light brown, fine grained SANDSTONE
end of excavation @2'
no groundwater encountered

SHEET 1 OF 1	INVESTIGATION BB DRAFTING JG DATE 4/21/06 JOB NO. 06-132-GEO	LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

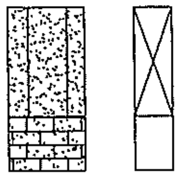
SOIL LOG TEST PIT TP#10

Depth (ft)	Symbol	Sample	Soil Description	Laboratory Test Results
0			slightly weathered, weak, light brown, fine grained SANDSTONE end of excavation @0.5' no groundwater encountered	
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

SHEET 1 OF 1	INVESTIGATION BB DRAFTING JG DATE 4/21/06 JOB NO. 06-132-GEO	LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT TP#11

Depth (ft)	Symbol	Sample	Soil Description	Laboratory Test Results
0			damp, loose, light brown, fine SAND with trace silt, poorly graded (0–1') bulk sample "GS8" @0–1'	(GS8) NON–PLASTIC GF=0.5% SF=78.2% F200=21.3% MC=2.3% Sulfates=0.014% Chlorides=10 ppm Electro–conductivity=12 μS/cm pH=6.8 USCS Classification=SM
1			fresh to slightly weathered, very weak, fine grained SANDSTONE end of excavation @1.5' no groundwater encountered	
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				



SHEET			
1 OF 1	INVESTIGATION BB DRAFTING JG DATE 4/21/06 JOB NO. 06–132–GEO	LB MOAB LAND LLC LIONSBACK VILLAGE MOAB, UTAH	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

BUCKHORN GEOTECH

Civil, Structural & Geotechnical Engineers

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Sieve Analysis and Atterberg Limits

Project Name	Lionsback Village	Date	4/24/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	BH-01 @2-5'	Tested by	BAU
Sample #	GS1		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	99.5
#4	4.75	99.0
#10	2.0	98.2
#40	0.425	95.1
#200	0.075	19.5

Atterberg Limits

ASTM D4318

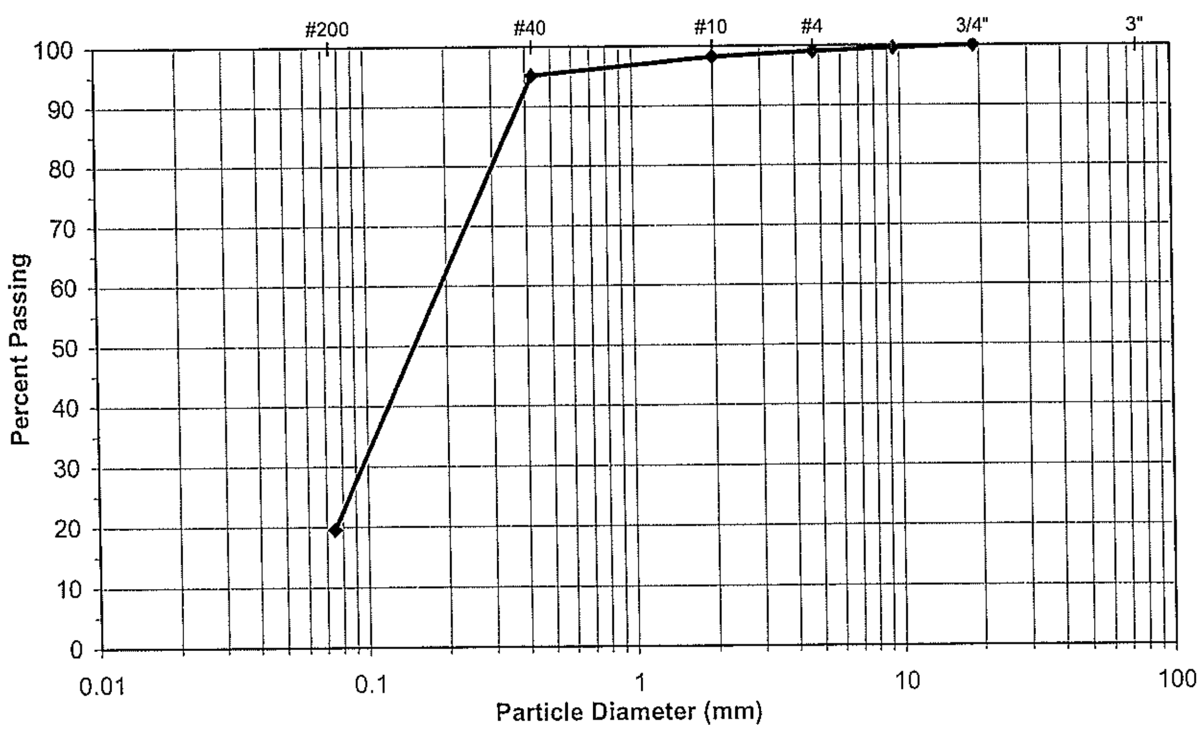
Liquid Limit (LL)	NP
Plastic Limit (PL)	NP
Plasticity Index (PI)	NP

NP = Non-Plastic

Natural Moisture Content (%) = 1.7%

Soil Description: reddish yellow silty SAND

USCS Classification: SM



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 19.5 % Sand = 79.5 % Gravel = 1.0

BUCKHORN GEOTECH

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Sieve Analysis and Atterberg Limits

Project Name	Lionsback Village	Date	4/24/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	BH-05 @0-3'	Tested by	BAU
Sample #	GS2		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	99.4
#4	4.75	94.9
#10	2.0	89.7
#40	0.425	89.4
#200	0.075	43.8

Atterberg Limits

ASTM D4318

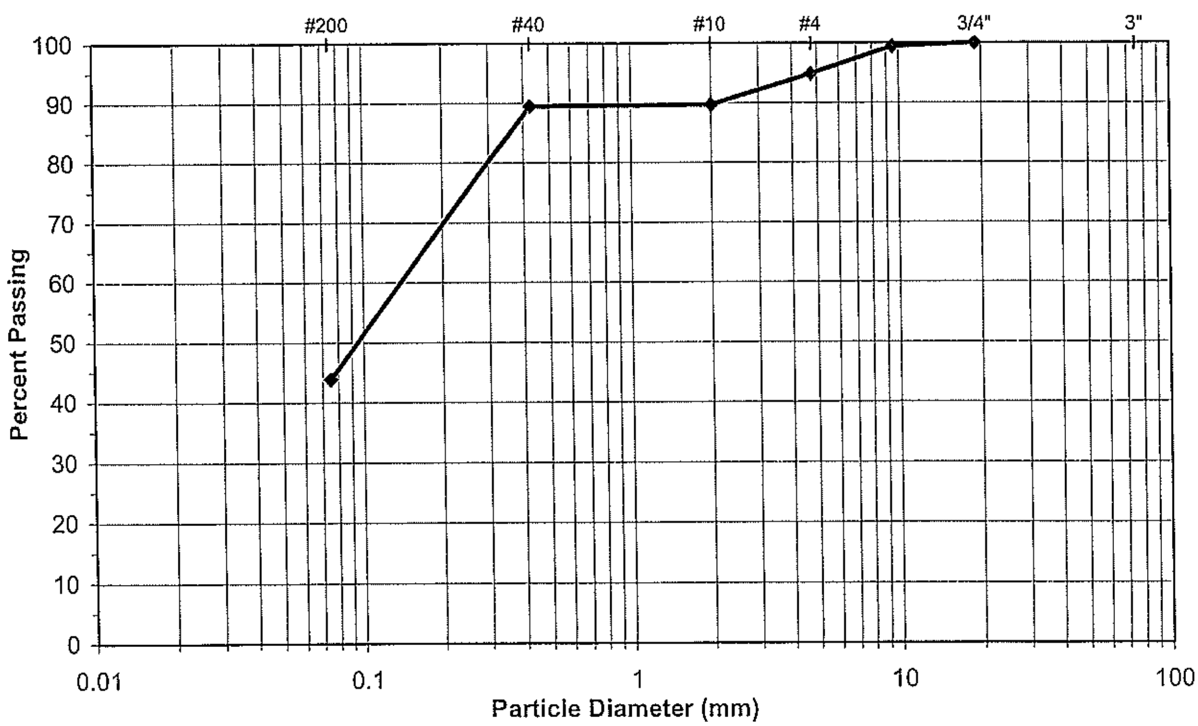
Liquid Limit (LL)	NP
Plastic Limit (PL)	NP
Plasticity Index (PI)	NP

NP = Non-Plastic

Natural Moisture Content (%) = 3.3%

Soil Description: light red silty SAND

USCS Classification: SM



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 43.8 % Sand = 51.0 % Gravel = 5.1

BUCKHORN GEOTECH

Civil, Structural & Geotechnical Engineers

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Ph.: (970) 249-6828 • FAX: (970) 249-0945

Sieve Analysis and Atterberg Limits

Project Name	Lionsback Village	Date	4/25/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	TP#1 @0-1'	Tested by	BAU
Sample #	GS4		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	95.7
3/8"	9.5	90.3
#4	4.75	87.9
#10	2.0	85.0
#40	0.425	83.6
#200	0.075	24.8

Atterberg Limits

ASTM D4318

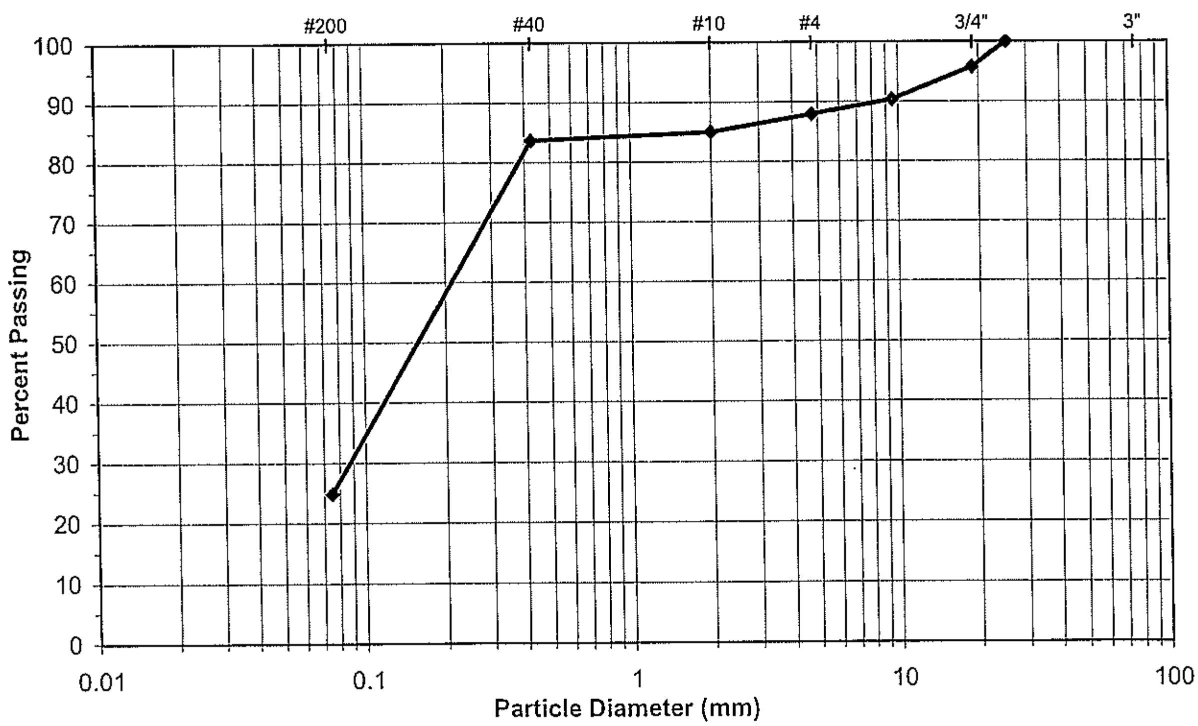
Liquid Limit (LL)	NP
Plastic Limit (PL)	NP
Plasticity Index (PI)	NP

NP = Non-Plastic

Natural Moisture Content (%) = 1.3%

Soil Description: yellow silty SAND

USCS Classification: SM



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 24.8 % Sand = 63.1 % Gravel = 12.1

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Sieve Analysis and Atterberg Limits

Project Name	Lionsback Village	Date	4/27/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	BH-04 @0-3'	Tested by	TH/VB
Sample #	BS1		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	98.8
#4	4.75	96.7
#10	2.0	94.5
#40	0.425	90.4
#200	0.075	15.3

Atterberg Limits

ASTM D4318

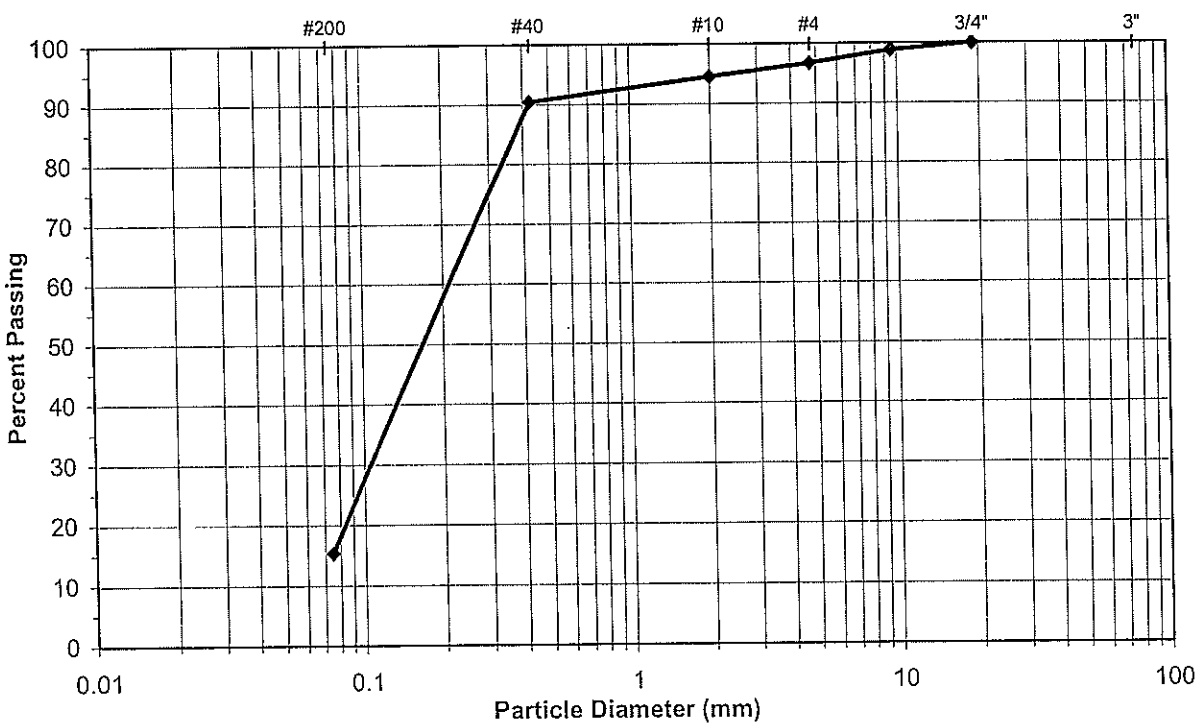
Liquid Limit (LL)	NP
Plastic Limit (PL)	NP
Plasticity Index (PI)	NP

NP = Non-Plastic

Natural Moisture Content (%) = 2.5%

Soil Description: reddish yellow silty SAND

USCS Classification: SM



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 15.3 % Sand = 81.4 % Gravel = 3.3

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Sieve Analysis and Atterberg Limits

Project Name	Lionsback Village	Date	4/27/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	BH-09 @0-2'	Tested by	VB
Sample #	BS2		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	100.0
#4	4.75	99.9
#10	2.0	96.2
#40	0.425	93.5
#200	0.075	24.8

Atterberg Limits

ASTM D4318

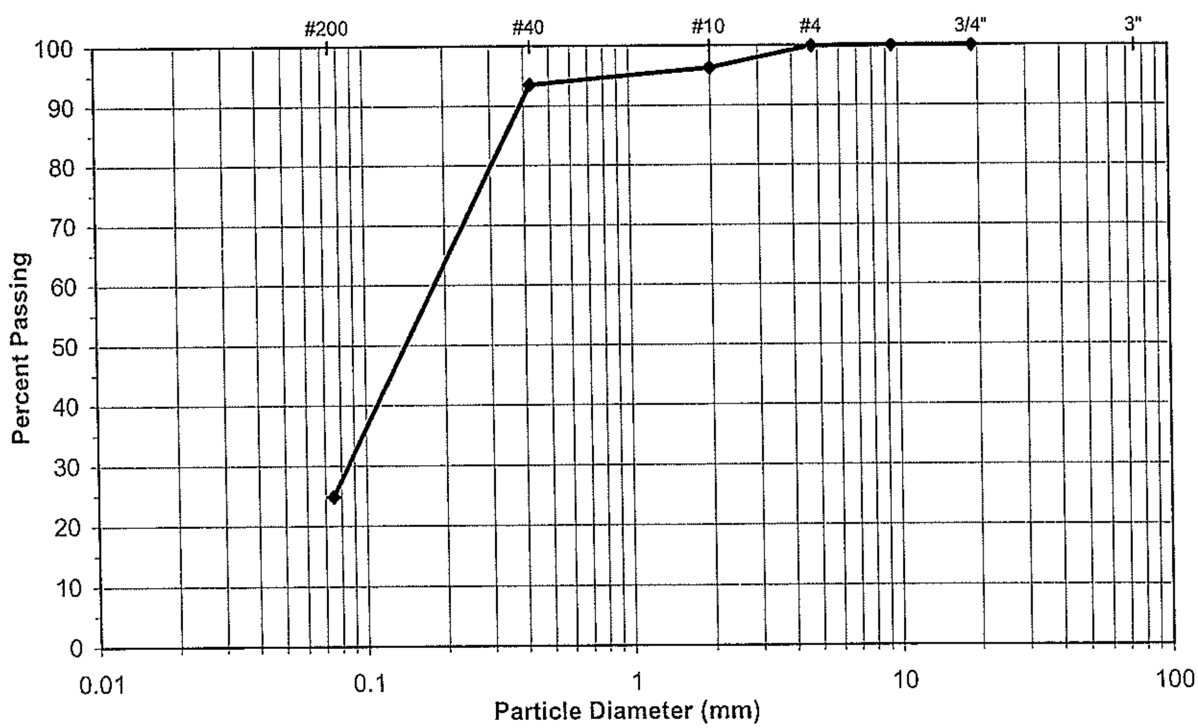
Liquid Limit (LL)	NP
Plastic Limit (PL)	NP
Plasticity Index (PI)	NP

NP = Non-Plastic

Natural Moisture Content (%) = 1.7%

Soil Description: reddish yellow silty SAND

USCS Classification: SM



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 24.8 % Sand = 75.1 % Gravel = 0.1

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Sieve Analysis and Atterberg Limits

Project Name	Lionsback Village	Date	4/25/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	TP#2 @0-1'	Tested by	TH
Sample #	GS5		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.0	99.6
#40	0.425	98.3
#200	0.075	9.7

Atterberg Limits

ASTM D4318

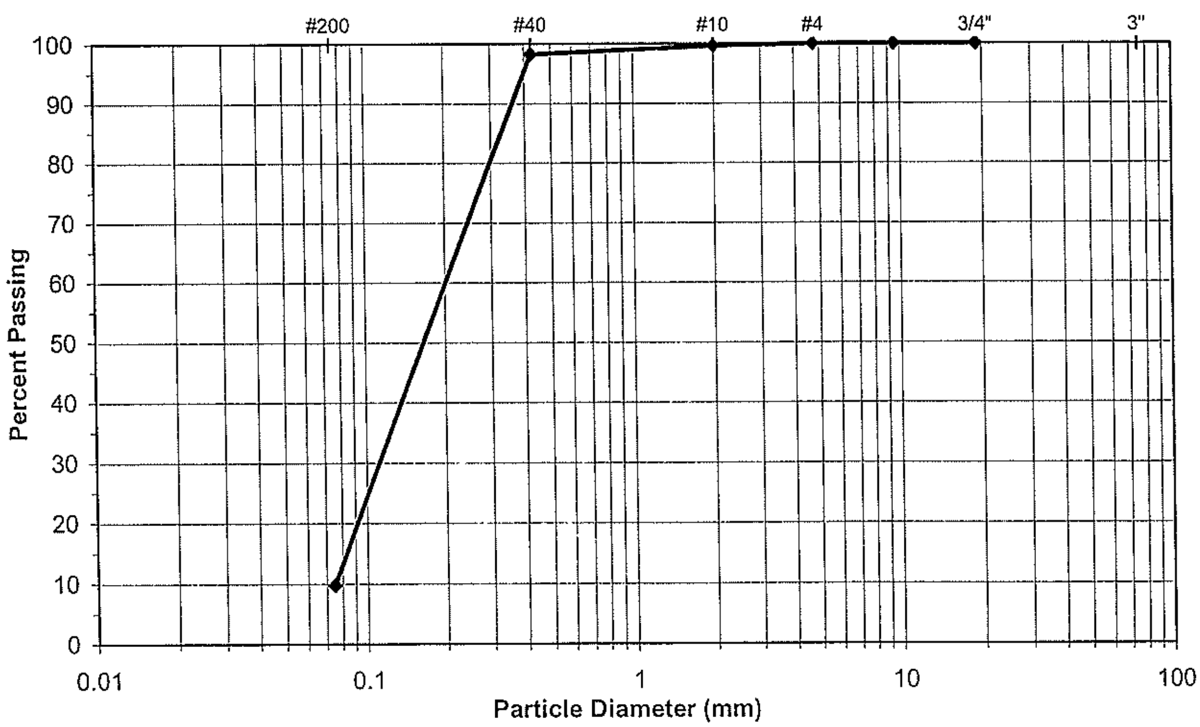
Liquid Limit (LL)	NP
Plastic Limit (PL)	NP
Plasticity Index (PI)	NP

NP = Non-Plastic

Natural Moisture Content (%) = 1.8%

Soil Description: reddish yellow poorly graded SAND with silt

USCS Classification: SP-SM



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 9.7 % Sand = 90.3 % Gravel = 0.0

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Sieve Analysis and Atterberg Limits

Project Name	Lionsback Village	Date	4/25/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	TP#3 @0-1'	Tested by	TH
Sample #	GS6		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.0	87.7
#40	0.425	81.0
#200	0.075	6.5

Atterberg Limits

ASTM D4318

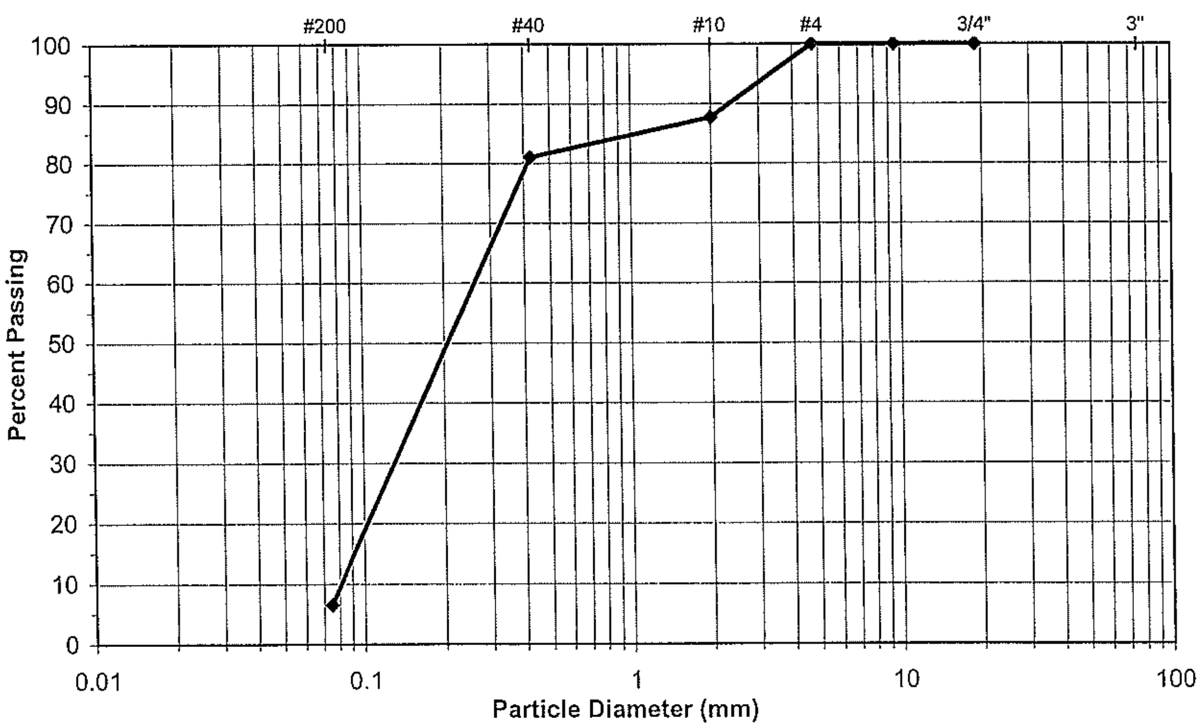
Liquid Limit (LL)	NP
Plastic Limit (PL)	NP
Plasticity Index (PI)	NP

NP = Non-Plastic

Natural Moisture Content (%) = 1.2%

Soil Description: reddish yellow poorly graded SAND with silt

USCS Classification: SP-SM



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 6.5 % Sand = 93.5 % Gravel = 0.0

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Sieve Analysis and Atterberg Limits

Project Name	Lionsback Village	Date	4/27/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	TP#6 @0-3'	Tested by	BAU
Sample #	BS3		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	100.0
#4	4.75	99.8
#10	2.0	99.0
#40	0.425	96.8
#200	0.075	14.3

Atterberg Limits

ASTM D4318

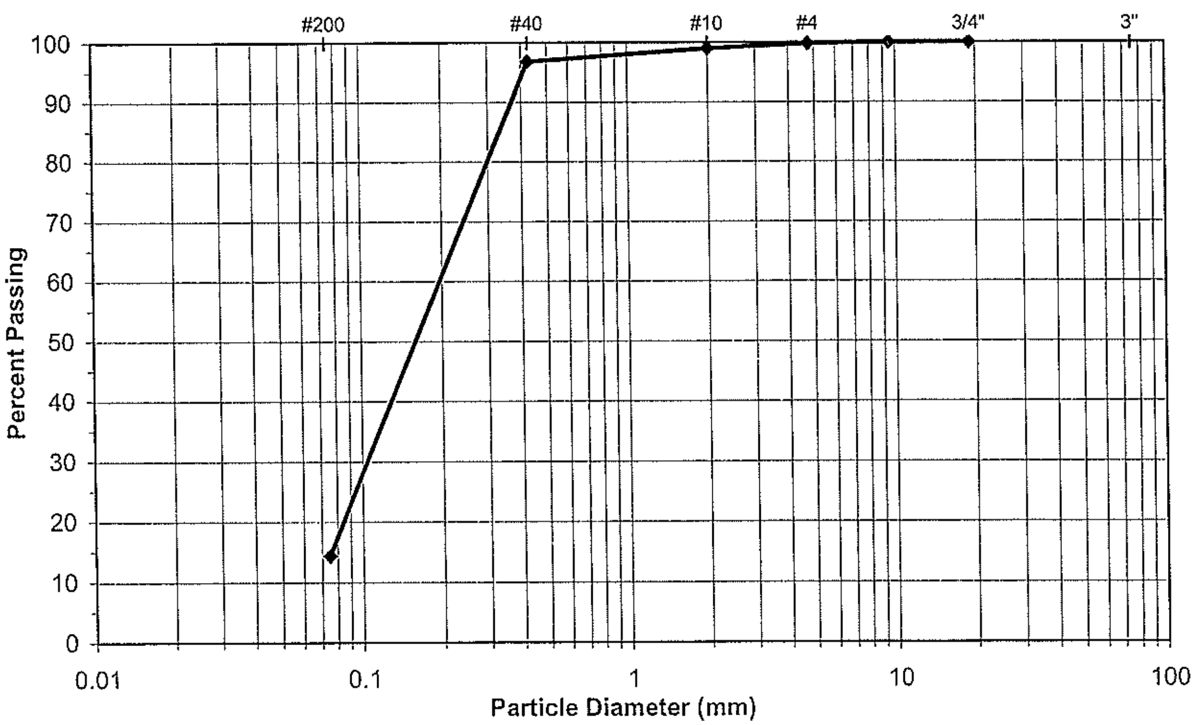
Liquid Limit (LL)	NP
Plastic Limit (PL)	NP
Plasticity Index (PI)	NP

NP = Non-Plastic

Natural Moisture Content (%) = 3.7%

Soil Description: reddish yellow silty SAND

USCS Classification: SM



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 14.3 % Sand = 85.4 % Gravel = 0.2

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Sieve Analysis and Atterberg Limits

Project Name	Lionsback Village	Date	4/26/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	TP#11 @0-1'	Tested by	BAU/VB
Sample #	GS8		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	99.6
#4	4.75	99.5
#10	2.0	98.4
#40	0.425	95.9
#200	0.075	21.3

Atterberg Limits

ASTM D4318

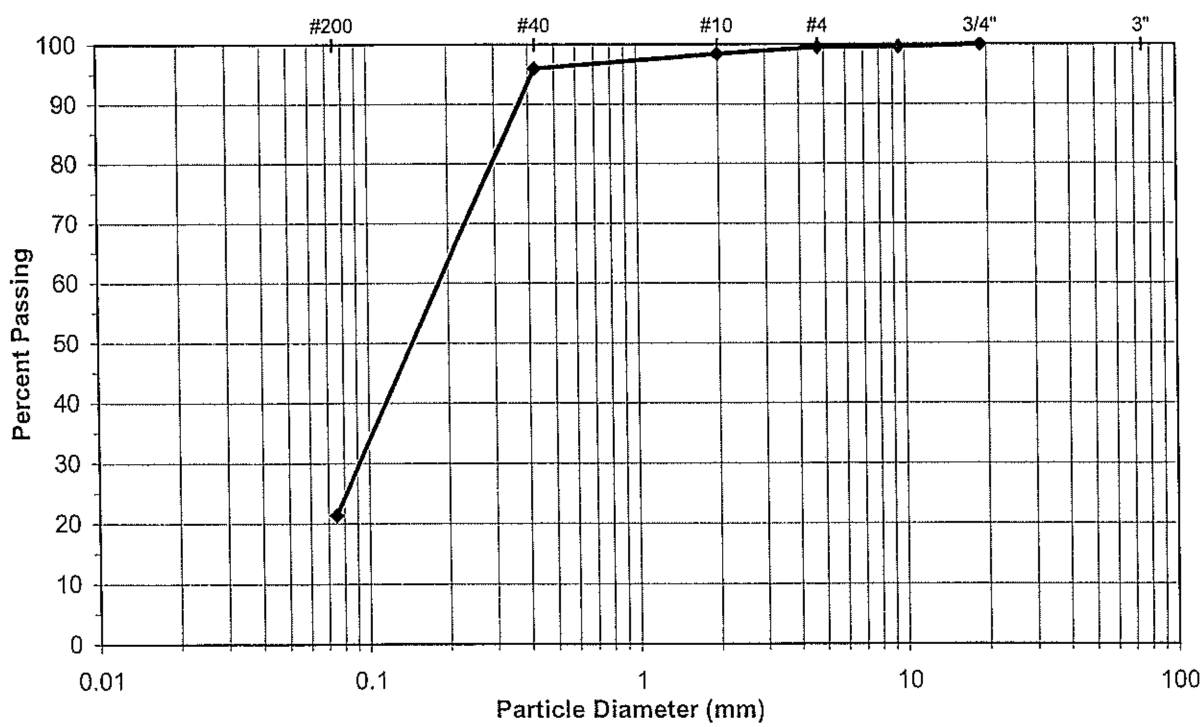
Liquid Limit (LL)	NP
Plastic Limit (PL)	NP
Plasticity Index (PI)	NP

NP = Non-Plastic

Natural Moisture Content (%) = 2.3%

Soil Description: yellow brown silty SAND

USCS Classification: SM



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 21.3 % Sand = 78.2 % Gravel = 0.5

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Corrosivity Series

Based on HACH methods

Project Name	Lionsback Village	Date Tested	4/24/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sampled by	BB
Test Location	BH-09 @0-2'	Test by	BAU
Sample #	BS2		
Soil Description	reddish yellow silty SAND (SM)		

In-situ Moisture Content	1.7	%
Water-soluble sulfates, dry soil basis	0.001	%
Chlorides	10	ppm
Electro-conductivity	34	µS/cm
pH	7.7	

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Corrosivity Series

Based on HACH methods

Project Name	Lionsback Village	Date Tested	4/24/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sampled by	BB
Test Location	TP#6 @0-3'	Test by	BAU
Sample #	BS3		
Soil Description	reddish yellow silty SAND (SM)		

In-situ Moisture Content	3.7	%
Water-soluble sulfates, dry soil basis	0.001	%
Chlorides	10	ppm
Electro-conductivity	25	µS/cm
pH	6.9	

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Corrosivity Series

Based on HACH methods

Project Name	Lionsback Village	Date Tested	4/26/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sampled by	BB
Test Location	TP#11 @0-1'	Test by	BAU
Sample #	GS8		
Soil Description	yellow brown silty SAND (SM)		

In-situ Moisture Content	**2.3**	**%**
Water-soluble sulfates, dry soil basis	**0.014**	**%**
Chlorides	**10**	**ppm**
Electro-conductivity	**12**	**μS/cm**
pH	**6.8**	

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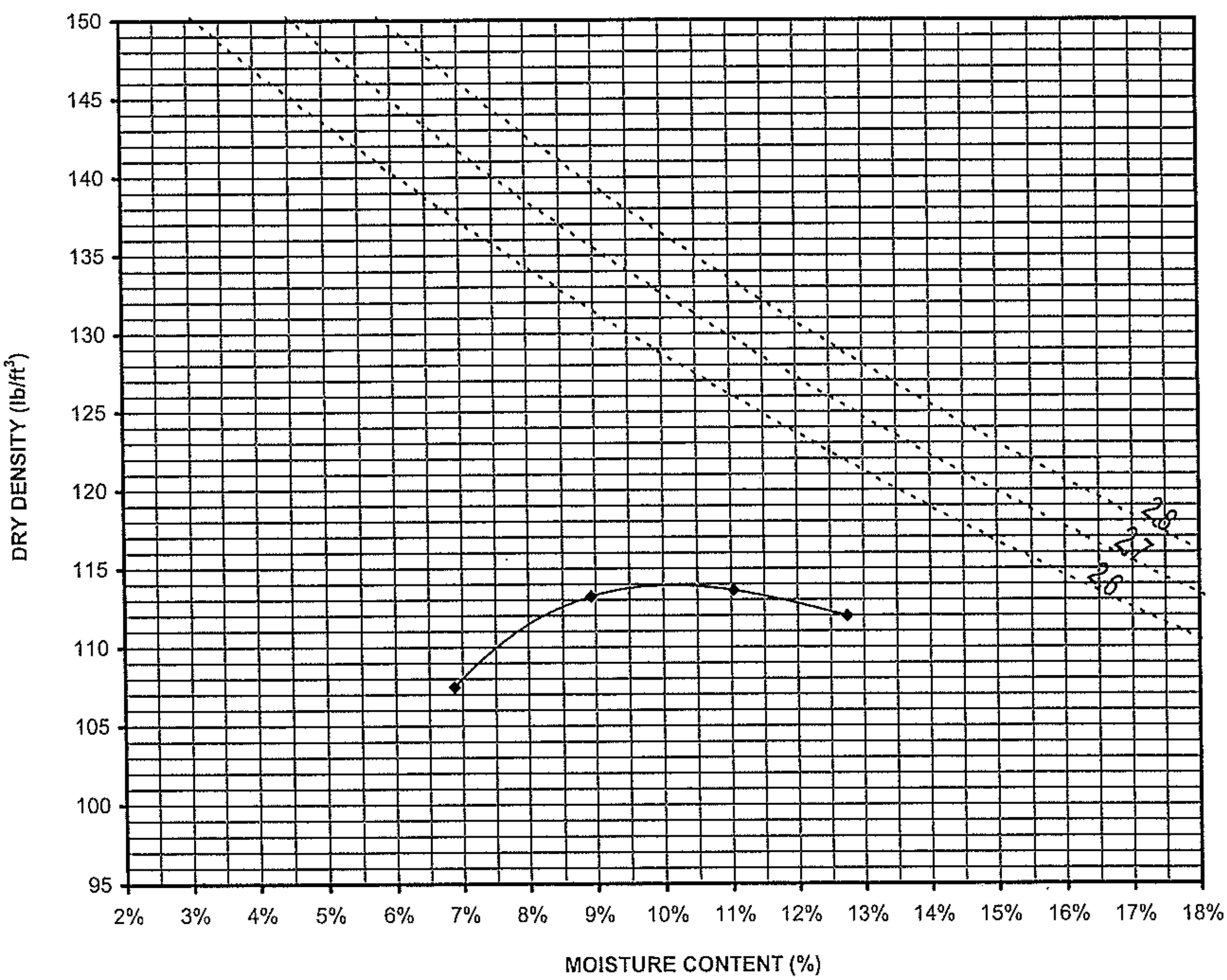
MODIFIED PROCTOR ASTM D 1557
METHOD A

Project name	Lionsback Village
Project Location	Moab Ut
Client	LB Moab Land LLC
Test Location	BH-04 @0-3'
Sample ID	BS1
Soil Description	reddish yellow silty SAND (SM)

Date	4/26/2006
Project #	06-132-GEO
Sample by	BB
Test by	JM

Oversize Particles Determined by Sieve: #4

Max. Dry Density (pcf): 114.0
Optimum Moisture Content (%): 10.1



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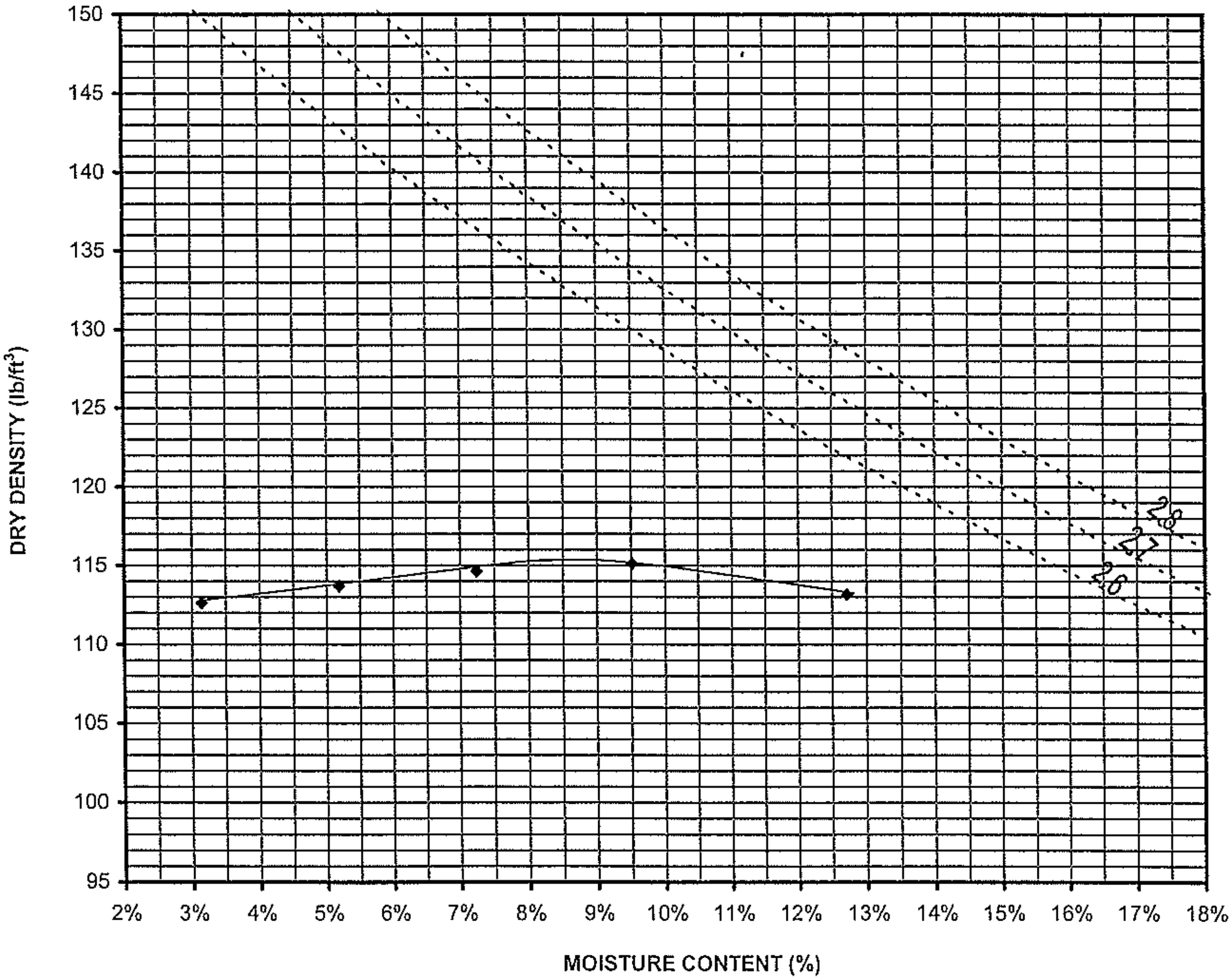
MODIFIED PROCTOR ASTM D 1557
METHOD A

Project name	Lionsback Village	Date	4/25/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	BH-09 @0-2'	Test by	VB
Sample ID	BS2		
Soil Description	reddish yellow silty SAND (SM)		

Oversize Particles Determined by Sieve: #4

Max. Dry Density (pcf): 115.3
Optimum Moisture Content (%): 8.7



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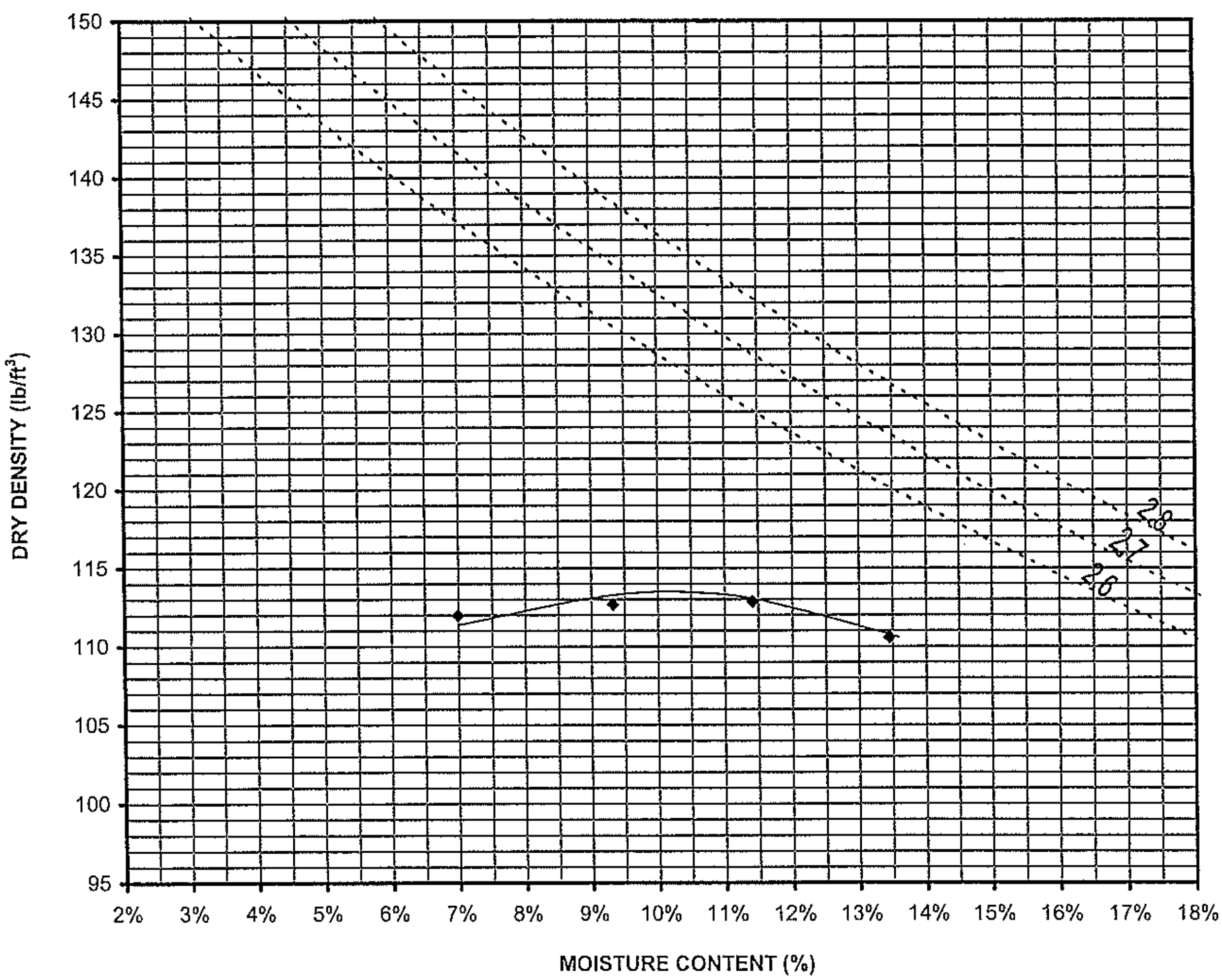
MODIFIED PROCTOR ASTM D 1557
METHOD A

Project name	Lionsback Village	Date	4/28/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	TP#6 @ @0-3'	Test by	TH
Sample ID	BS3		
Soil Description	reddish yellow silty SAND (SM)		

Oversize Particles Determined by Sieve: #4

Max. Dry Density (pcf): 113.5
Optimum Moisture Content (%): 10.2



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CALIFORNIA BEARING RATIO
ASTM D1883-99

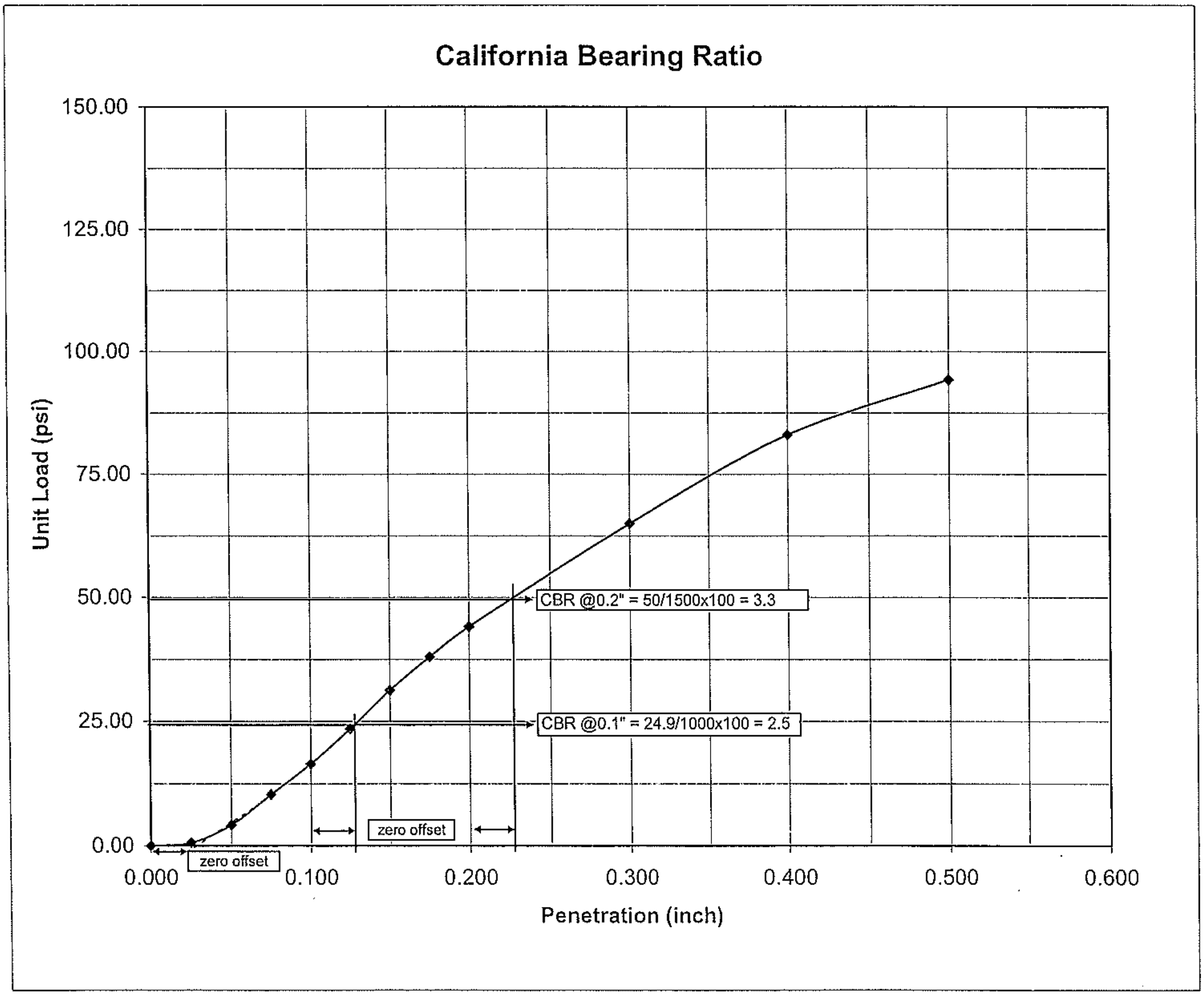
Project Name	Lionsback Village	Date	4/25/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	BH-04 @0-3'	Test by	LS/VB
Sample #	BS1		
Soil description	reddish yellow silty SAND (SM)		

CBR @0.1 inch Penetration = 3
CBR @0.2 inch Penetration = 3

Target Moisture Content (%) = 10.1%
Surcharge Weight (pounds) = 10.0

Test Dry Density (pcf) = 103.9
Test Moisture Content--Before Soaking (%) = 8.4%
Average Moisture Content--After Soaking (%) = 16.3%
Top 1 inch Moisture Content--After Soaking (%) = 19.2%
Swell (%) = 0.0%

6 BLOWS



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CALIFORNIA BEARING RATIO
ASTM D1883-99

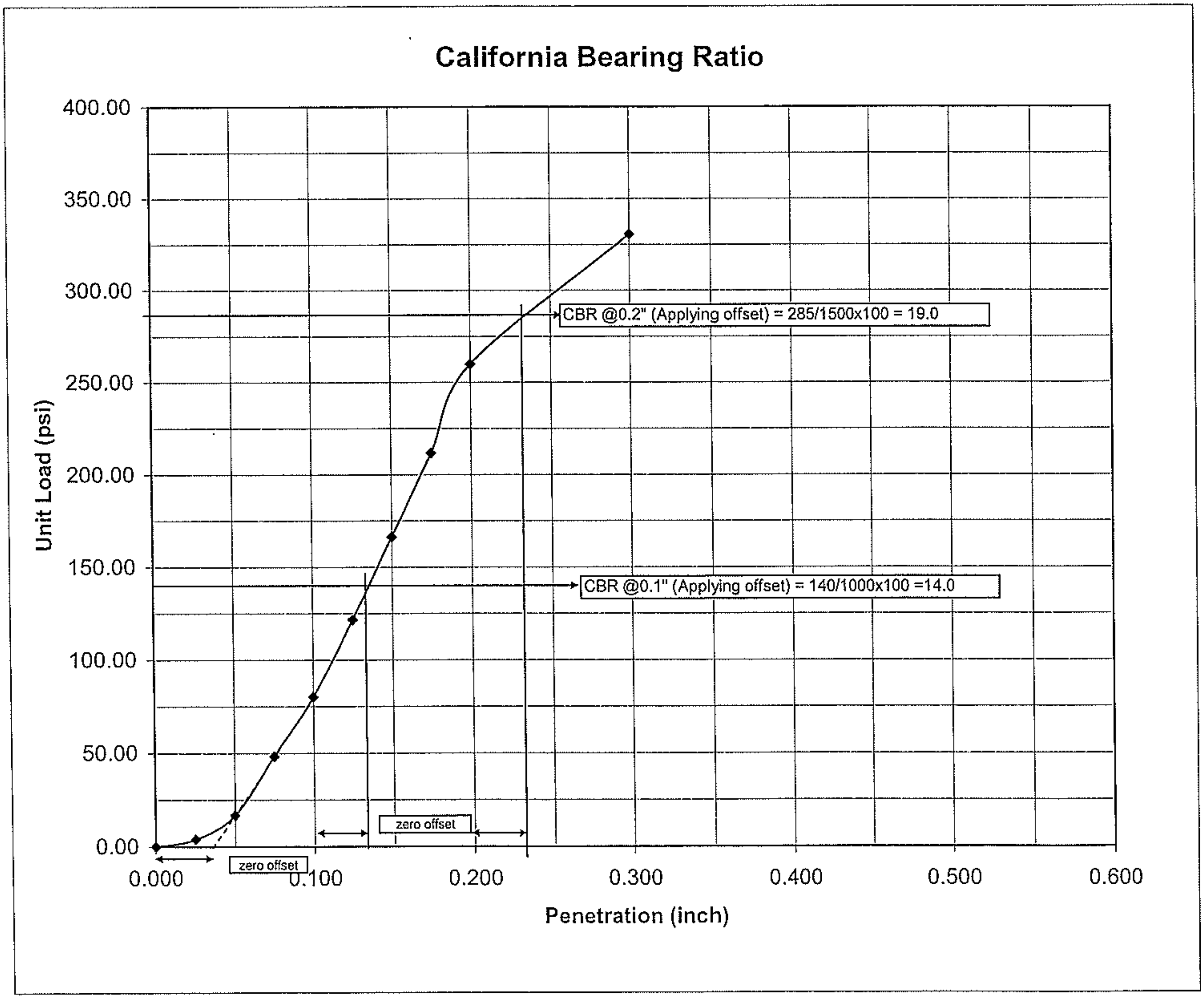
Project Name	Lionsback Village	Date	4/25/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	BH-04 @0-3'	Test by	LS/VB
Sample #	BS1		
Soil description	reddish yellow silty SAND (SM)		

CBR @0.1 inch Penetration = 14
CBR @0.2 inch Penetration = 19

Target Moisture Content (%) = 10.1%
Surcharge Weight (pounds) = 10.0

Test Dry Density (pcf) = 110.8
Test Moisture Content--Before Soaking (%) = 7.2%
Average Moisture Content--After Soaking (%) = 16.0%
Top 1 inch Moisture Content--After Soaking (%) = 16.6%
Swell (%) = 0.0%

25 BLOWS



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CALIFORNIA BEARING RATIO
ASTM D1883-99

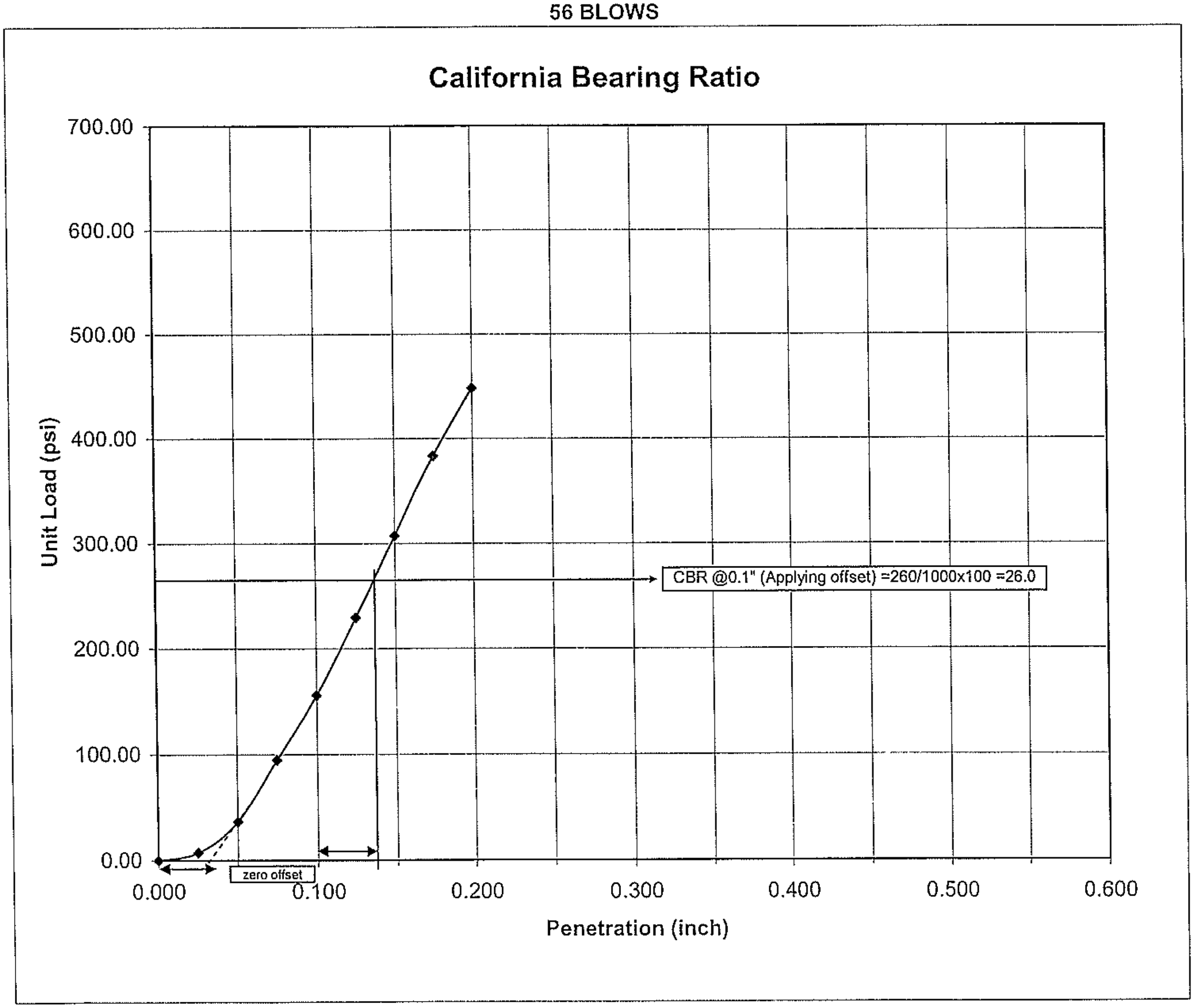
Project Name	Lionsback Village	Date	4/25/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	BH-04 @0-3'	Test by	LS/VB
Sample #	BS1		
Soil description	reddish yellow silty SAND (SM)		

CBR @0.1 inch Penetration = 26
CBR @0.2 inch Penetration = N/A

Target Moisture Content (%) = 10.1%
Surcharge Weight (pounds) = 10.0

Test Dry Density (pcf) = 116.0
Test Moisture Content--Before Soaking (%) = 7.2%
Average Moisture Content--After Soaking (%) = 13.6%
Top 1 inch Moisture Content--After Soaking (%) = 15.9%
Swell (%) = 0.1%

56 BLOWS



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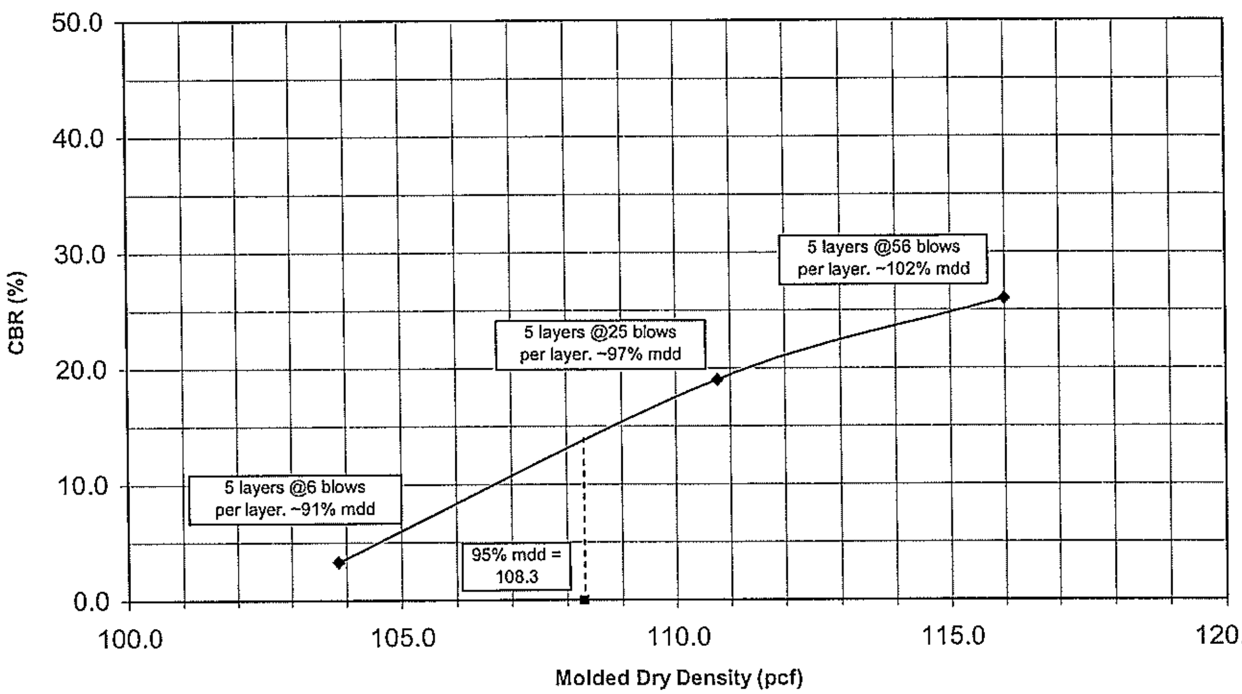
CALIFORNIA BEARING RATIO

ASTM D1883-99

Project Name	Lionsback Village	Date	4/25/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	BH-04 @0-3'	Test by	VB/TH
Sample #	BS1		
Soil description	reddish yellow silty SAND (SM)		

CBR vs Molded Dry Density



*mdd = max. dry density

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ASTM D1883-99

Project Name	Lionsback Village
Project Location	Moab Ut
Client	LB Moab Land LLC
Test Location	BH-09 @0-2'
Sample #	BS2
Soil description	reddish yellow silty SAND (SM)

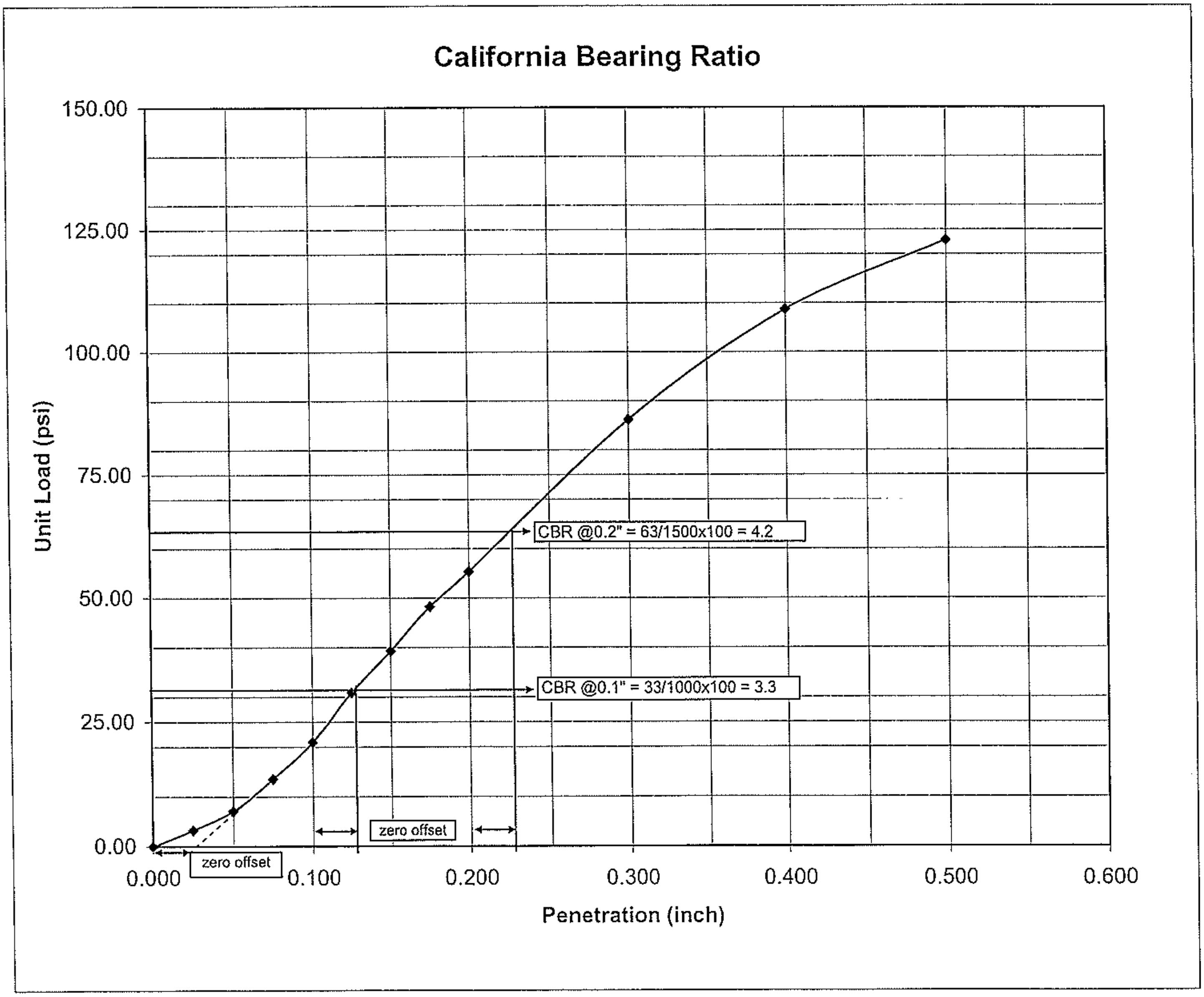
Date	4/25/2006
Project #	06-132-GEO
Sample by	BB
Test by	VB

CBR @0.1 inch Penetration = 3
CBR @0.2 inch Penetration = 4

Target Moisture Content (%) = 8.7%
Surcharge Weight (pounds) = 10.0

Test Dry Density (pcf) = 106.0
Test Moisture Content--Before Soaking (%) = 7.7%
Average Moisture Content--After Soaking (%) = 16.6%
Top 1 inch Moisture Content--After Soaking (%) = 19.6%
Swell (%) = 0.1%

5 BLOWS



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CALIFORNIA BEARING RATIO
ASTM D1883-99

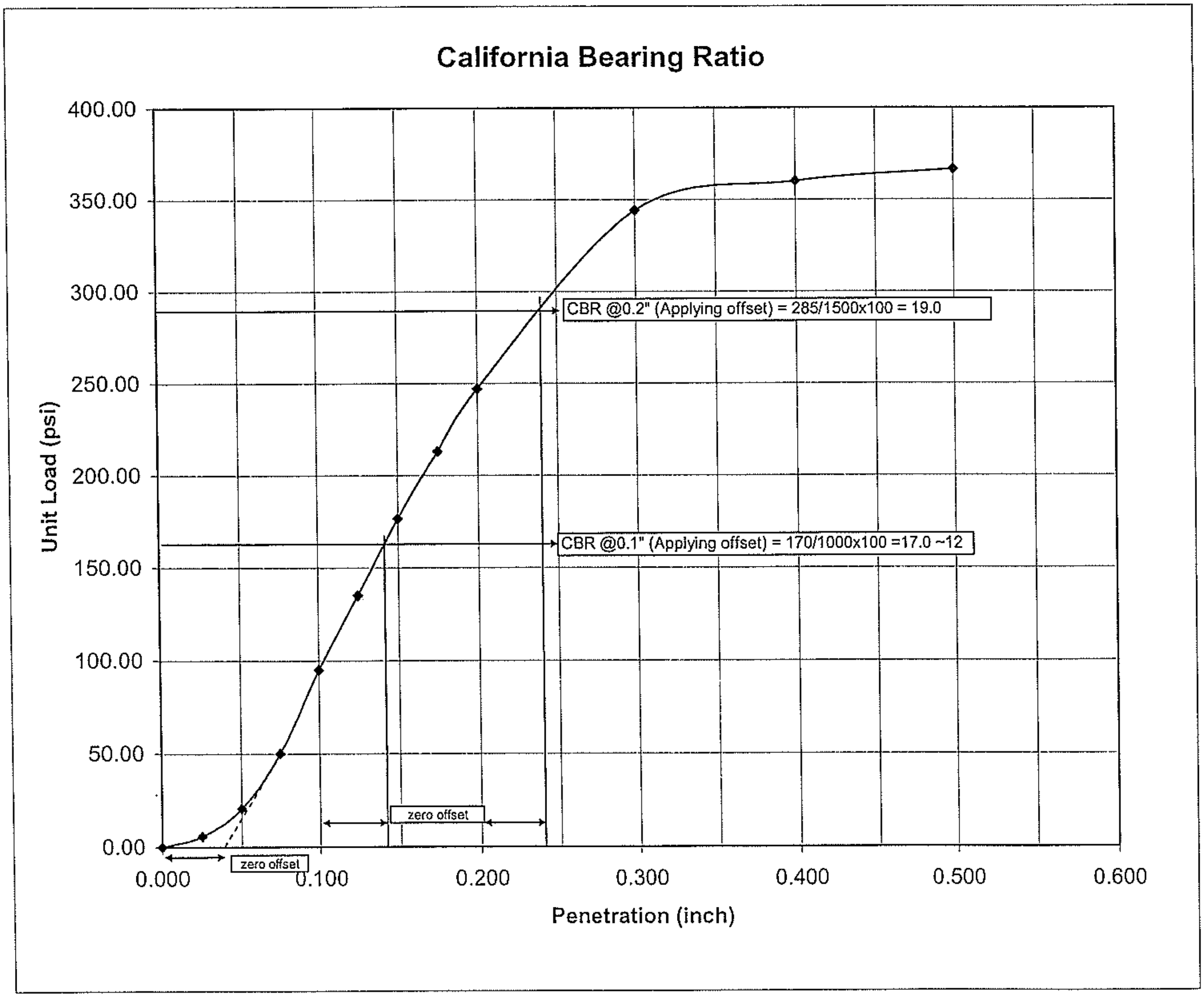
Project Name	Lionsback Village	Date	4/25/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	BH-09 @0-2'	Test by	VB
Sample #	BS2		
Soil description	reddish yellow silty SAND (SM)		

CBR @0.1 inch Penetration = 17
CBR @0.2 inch Penetration = 19

Target Moisture Content (%) = 8.7%
Surcharge Weight (pounds) = 10.0

Test Dry Density (pcf) = 109.4
Test Moisture Content--Before Soaking (%) = 7.7%
Average Moisture Content--After Soaking (%) = 13.4%
Top 1 inch Moisture Content--After Soaking (%) = 17.5%
Swell (%) = 0.1%

25 BLOWS



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CALIFORNIA BEARING RATIO

ASTM D1883-99

Project Name	Lionsback Village
Project Location	Moab Ut
Client	LB Moab Land LLC
Test Location	BH-09 @0-2'
Sample #	BS2
Soil description	reddish yellow silty SAND (SM)

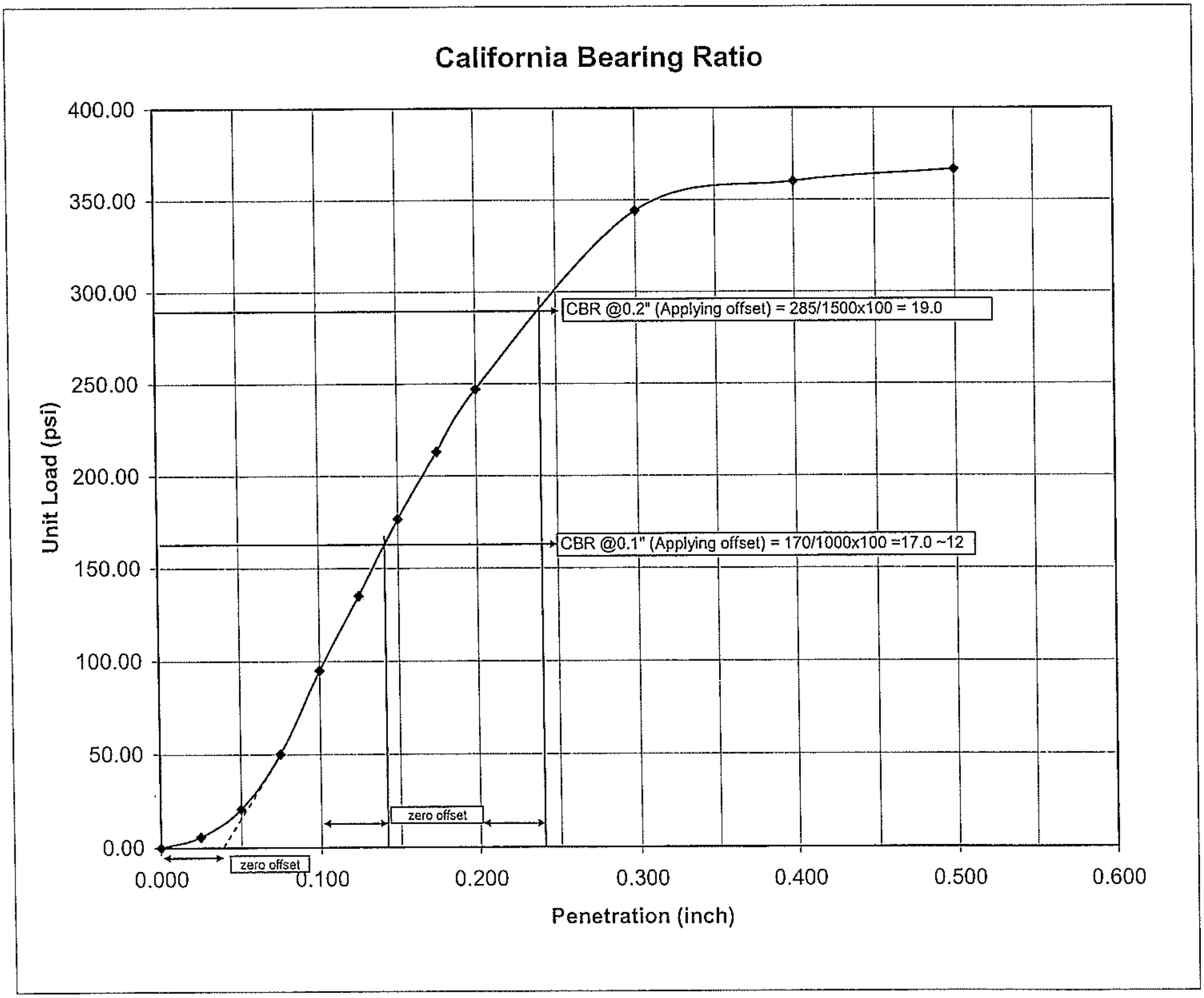
Date	4/25/2006
Project #	06-132-GEO
Sample by	BB
Test by	VB

CBR @0.1 inch Penetration = 17
CBR @0.2 inch Penetration = 19

Target Moisture Content (%) = 8.7%
Surcharge Weight (pounds) = 10.0

Test Dry Density (pcf) = 109.4
Test Moisture Content--Before Soaking (%) = 7.7%
Average Moisture Content--After Soaking (%) = 13.4%
Top 1 inch Moisture Content--After Soaking (%) = 17.5%
Swell (%) = 0.1%

25 BLOWS



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CALIFORNIA BEARING RATIO
ASTM D1883-99

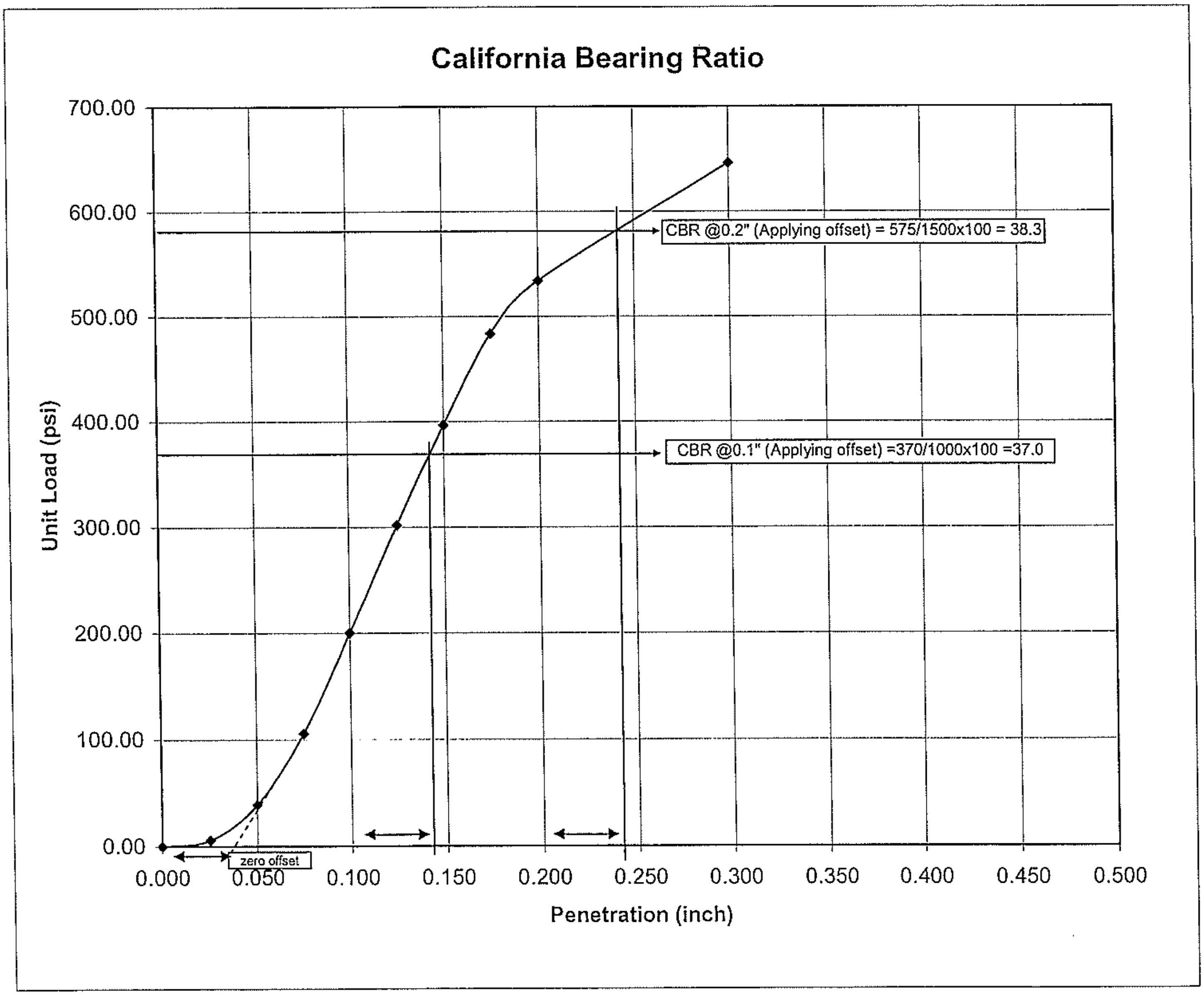
Project Name	Lionsback Village	Date	4/25/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	BH-09 @0-2'	Test by	VB
Sample #	BS2		
Soil description	reddish yellow silty SAND (SM)		

CBR @0.1 inch Penetration = 37
CBR @0.2 inch Penetration = 38

Target Moisture Content (%) = 8.7=%
Surcharge Weight (pounds) = 10.0

Test Dry Density (pcf) = 115.0
Test Moisture Content--Before Soaking (%) = 7.7%
Average Moisture Content--After Soaking (%) = 15.4%
Top 1 inch Moisture Content--After Soaking (%) = 13.8%
Swell (%) = 0.1%

56 BLOWS



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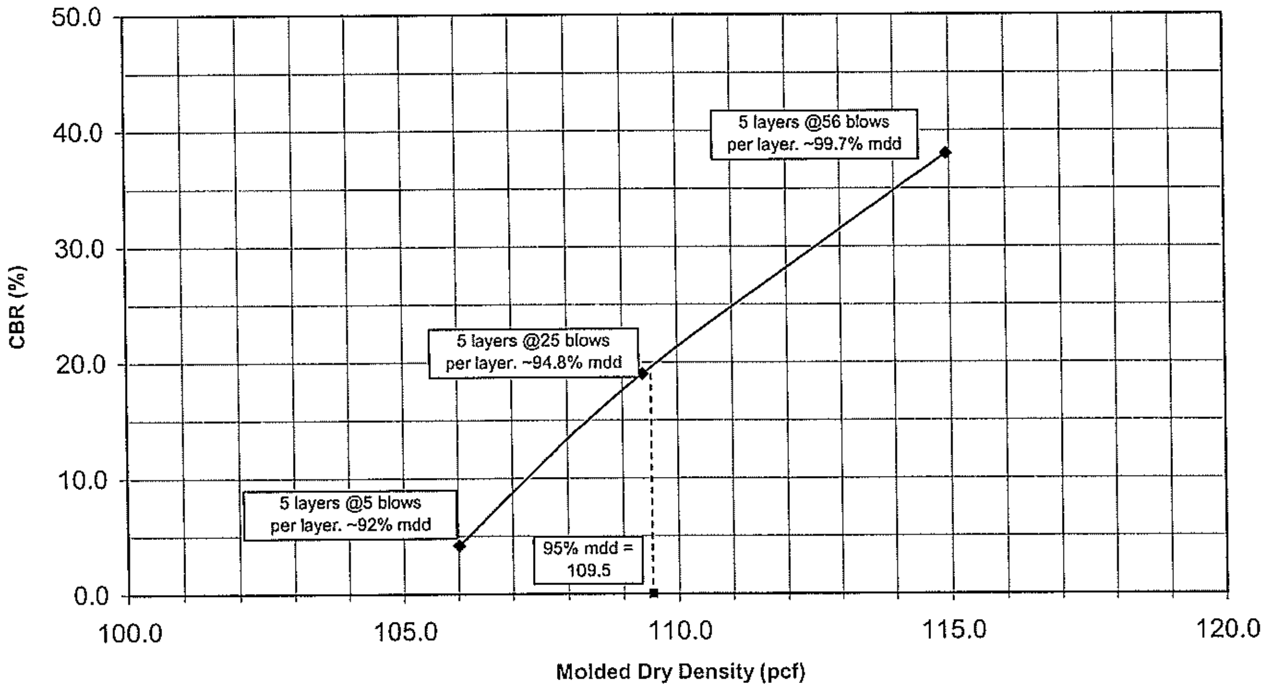
CALIFORNIA BEARING RATIO
ASTM D1883-99

Project Name	Lionsback Village	Date	4/25/2006
Project Location	Moab Ut	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	BH-09 @0-2'	Test by	VB/TH
Sample #	BS2		
Soil description	reddish yellow silty SAND (SM)		

CBR vs Molded Dry Density



*mdd = max. dry density

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CALIFORNIA BEARING RATIO

ASTM D1883-99

Project Name	Lionsback Village
Project Location	Moab, UT
Client	LB Moab Land LLC
Test Location	TP#6 @0-3'
Sample #	BS3
Soil description	reddish yellow silty SAND (SM)

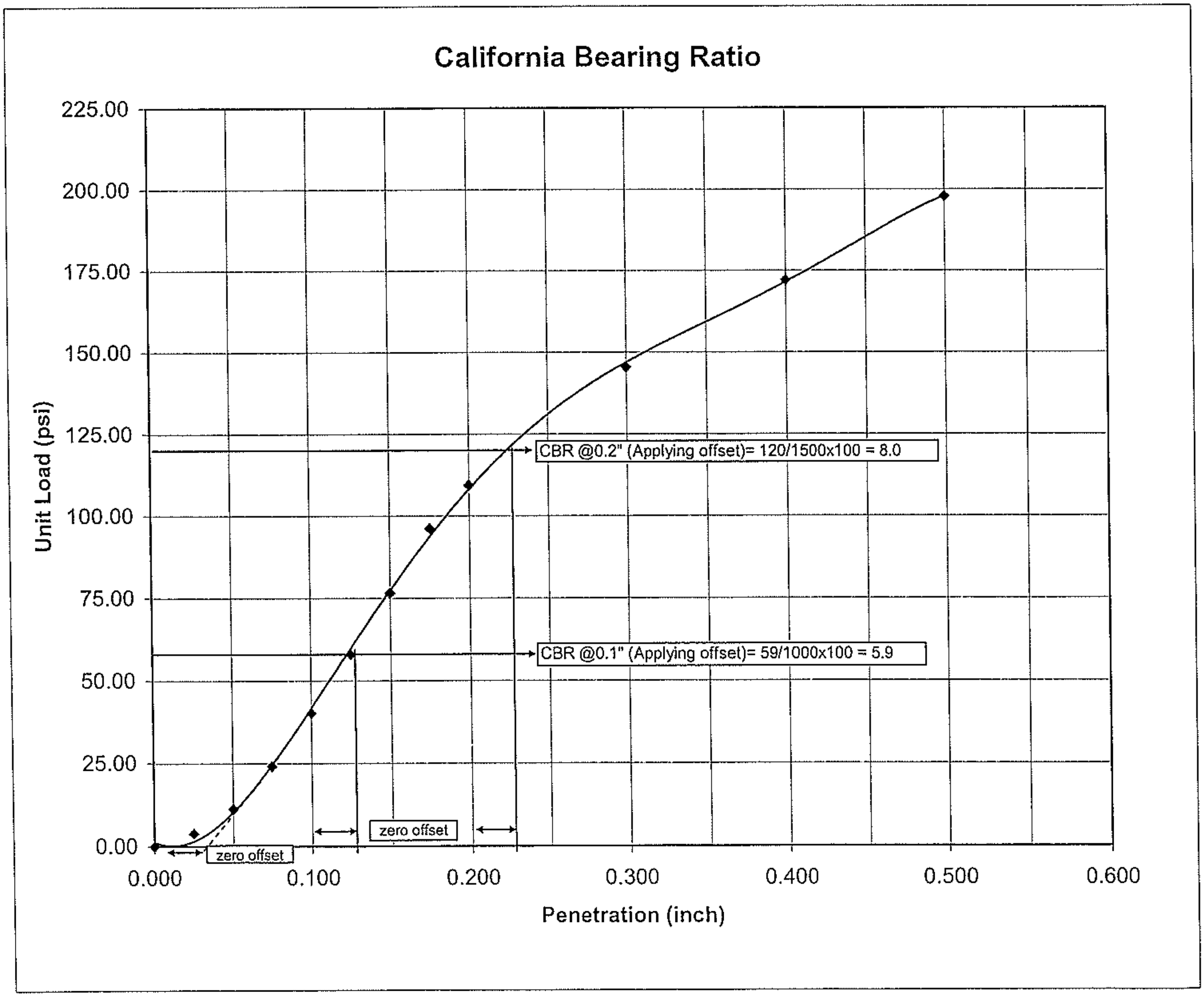
Date	4/25/2006
Project #	06-132-GEO
Sample by	BB
Test by	VB/TH

CBR @0.1 inch Penetration = 6
CBR @0.2 inch Penetration = 8

Target Moisture Content (%) = 10.2%
Surcharge Weight (pounds) = 10.0

Test Dry Density (pcf) = 102.7
Test Moisture Content--Before Soaking (%) = 9.7%
Average Moisture Content--After Soaking (%) = 17.8%
Top 1 inch Moisture Content--After Soaking (%) = 18.6%
Swell (%) = -1.8%

10 BLOWS



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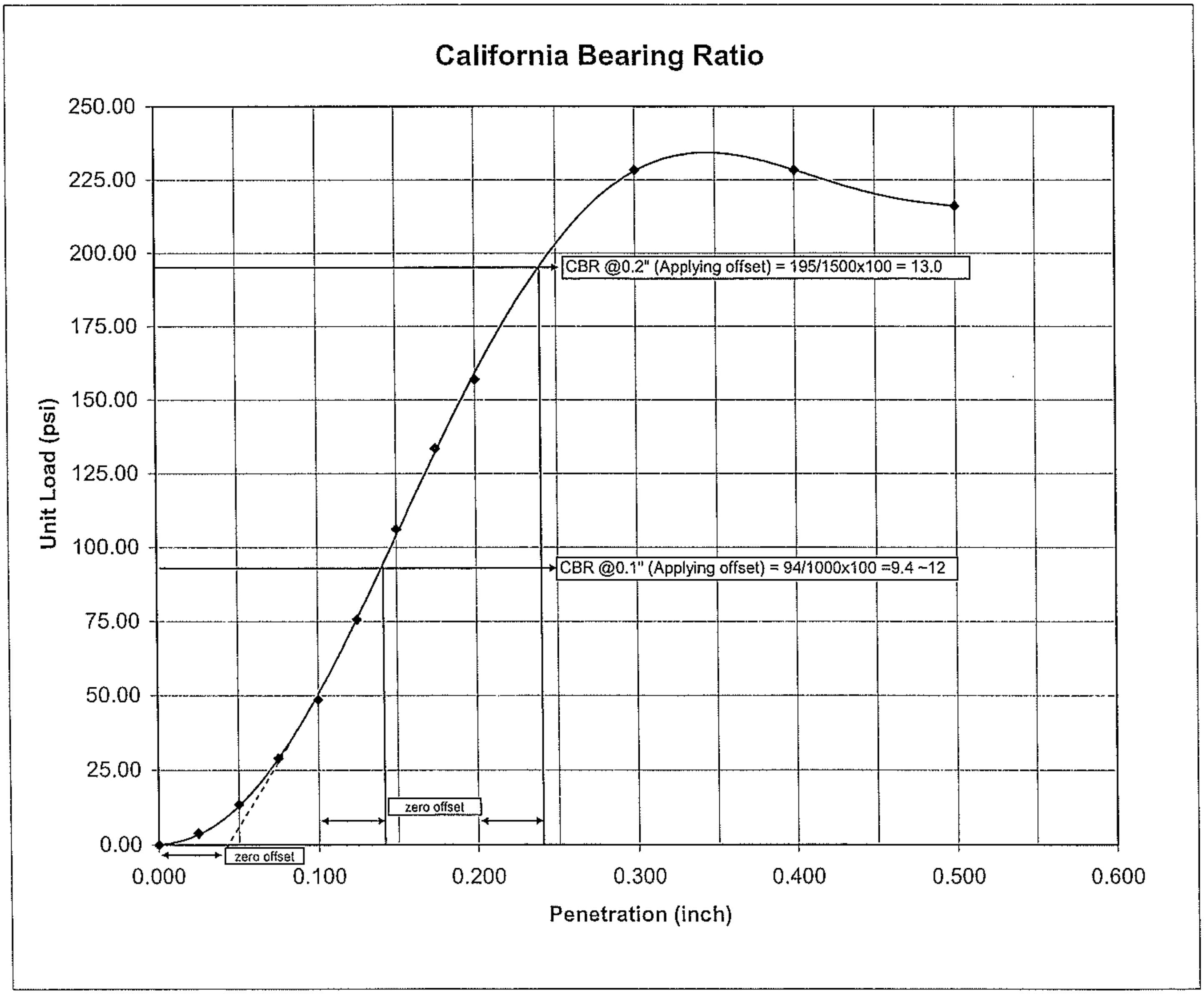
Project Name	Lionsback Village	Date	4/25/2006
Project Location	Moab, UT	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	TP#6 @0-3'	Test by	VB/TH
Sample #	BS3		
Soil description	reddish yellow silty SAND (SM)		

CBR @0.1 inch Penetration = 9
CBR @0.2 inch Penetration = 13

Target Moisture Content (%) = 10.2%
Surcharge Weight (pounds) = 10.0

Test Dry Density (pcf) = 105.9
Test Moisture Content--Before Soaking (%) = 9.9%
Average Moisture Content--After Soaking (%) = 15.9%
Top 1 inch Moisture Content--After Soaking (%) = 18.1%
Swell (%) = -1.8%

25 BLOWS



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CALIFORNIA BEARING RATIO
ASTM D1883-99

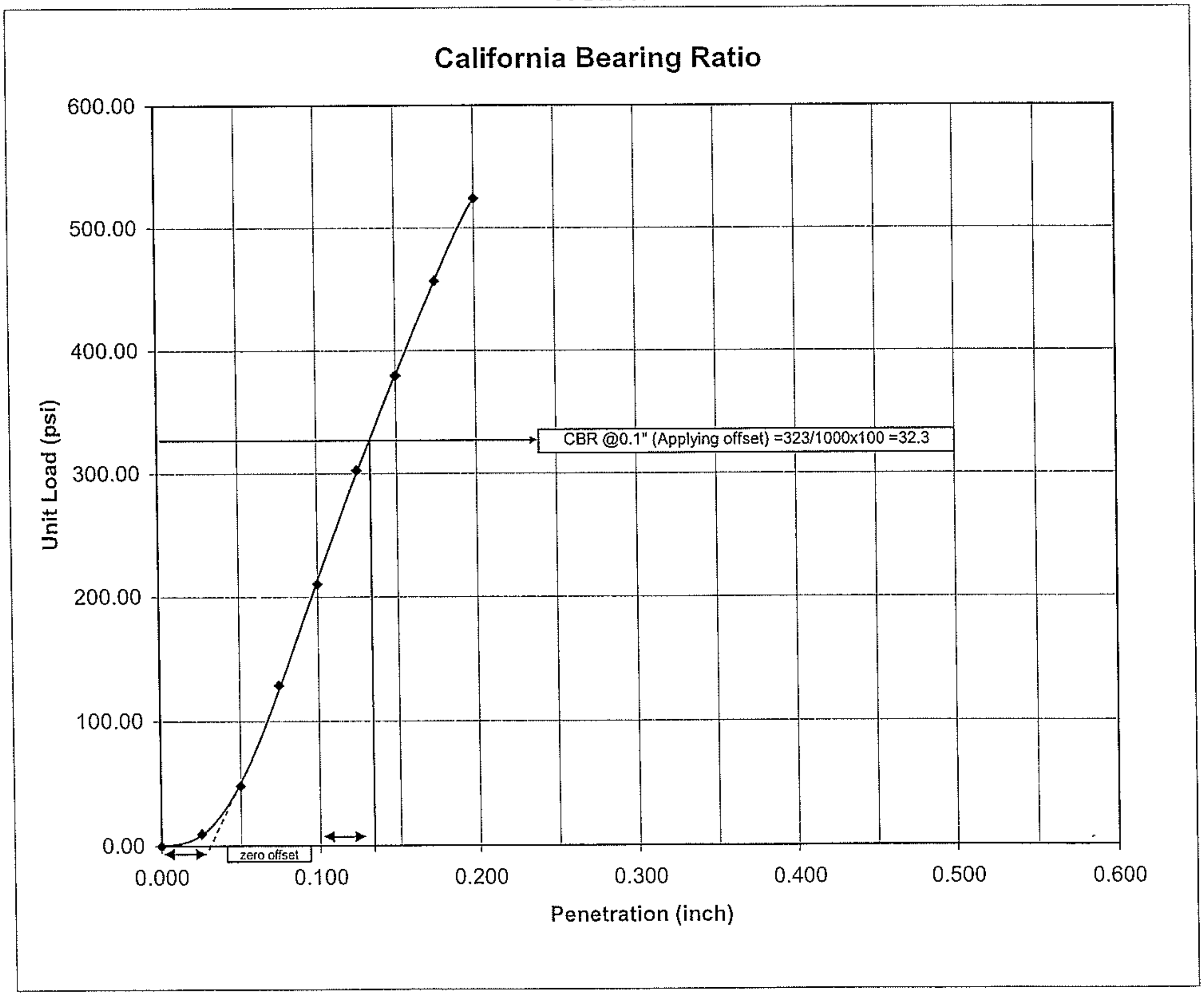
Project Name	Lionsback Village	Date	4/25/2006
Project Location	Moab, UT	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	TP#6 @0-3'	Test by	VB/TH
Sample #	BS3		
Soil description	reddish yellow silty SAND (SM)		

CBR @0.1 inch Penetration = 32
CBR @0.2 inch Penetration = N/A

Target Moisture Content (%) = 10.2%
Surcharge Weight (pounds) = 10.0

Test Dry Density (pcf) = 109.8
Test Moisture Content--Before Soaking (%) = 10.1%
Average Moisture Content--After Soaking (%) = 15.3%
Top 1 inch Moisture Content--After Soaking (%) = 13.8%
Swell (%) = -1.7%

56 BLOWS



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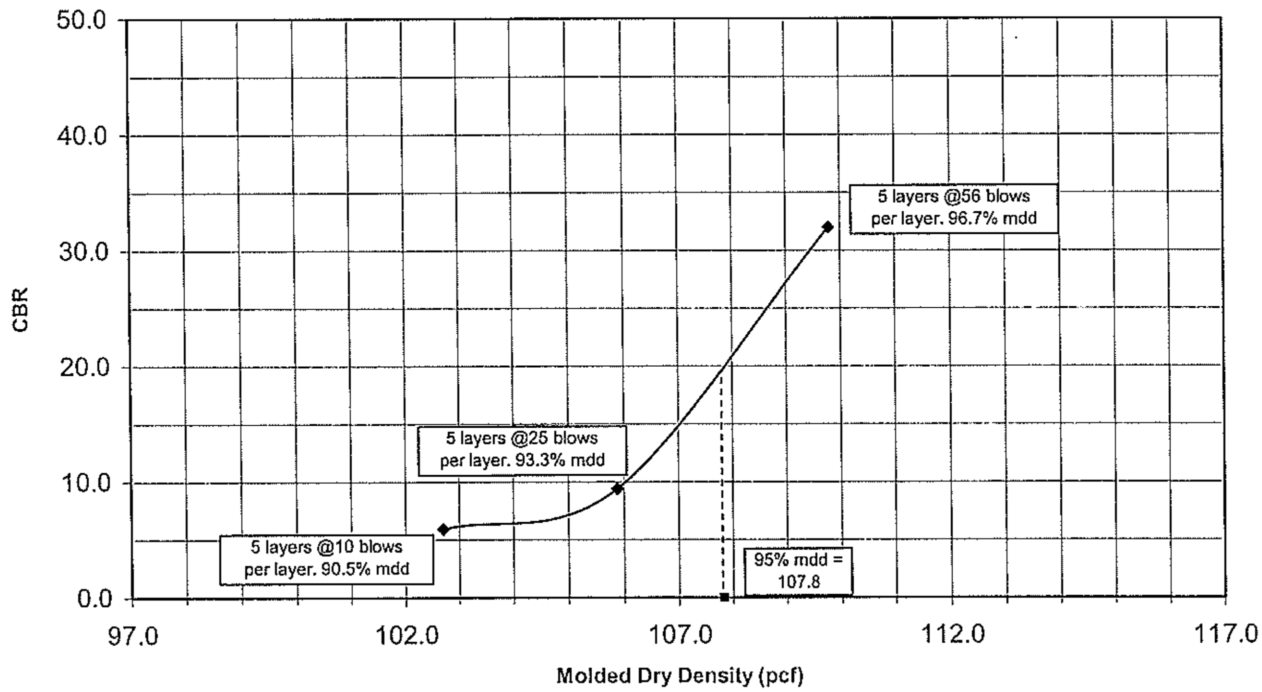
ASTM D1883-99

Project Name	Lionsback Village	Date	4/25/2006
Project Location	Moab, UT	Project #	06-132-GEO
Client	LB Moab Land LLC	Sample by	BB
Test Location	TP#6 @0-3'	Test by	VB/TH
Sample #	BS3		
Soil description	reddish yellow silty SAND (SM)		

CBR vs Molded Dry Density



*mdd = max. dry density