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SUBSOIL STUDY
FOR FOUNDATION DESIGN
PROPOSED COMMERCIAL BUILDING
LOT 3, PERRY SUBDIVISION
435 EBY CREEK ROAD
EAGLE, COLORADO

JOB NO. 107 0341

JUNE 19, 2007

PREPARED FOR:

DAVID NUDELL
c/o PRUDENTIAL COLORADO PROPERTIES
27 MAIN STREET, SUITE 105
EDWARDS, COLORADO 81632

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PURPOSE AND SCOPE OF STUDY

This report presents the results of a subsoil study for a proposed commercial building to be located on Lot 3, Perry Subdivision, 435 Eby Creek Road, Eagle, Colorado. The project site is shown on Figure 1. The purpose of the study was to develop recommendations for the foundation design. The study was conducted in accordance with our agreement for geotechnical engineering services to David Nudell dated May 7, 2007.

A field exploration program consisting of exploratory borings was conducted to obtain information on the subsurface conditions. Samples of the subsoils and bedrock obtained during the field exploration were tested in the laboratory to determine their classification, compressibility or swell and other engineering characteristics. The results of the field exploration and laboratory testing were analyzed to develop recommendations for foundation types, depths and allowable pressures for the proposed building foundation. This report summarizes the data obtained during this study and presents our conclusions, design recommendations and other geotechnical engineering considerations based on the proposed construction and the subsurface conditions encountered.

PROPOSED CONSTRUCTION

The building will be a single story structure over a walkout basement level located on the lot as shown on Figure 1. The lower level will be parking and have a slab-on-grade floor. We assume floor elevations of about 1,055 feet for the lower level and about 1,070 feet for the main level. Grading for the structure is expected to require cut depths between about 4 to 20 feet. We assume moderate foundation loadings, typical of the proposed type of construction. The development will include asphalt paved access drive and parking areas.

If building loadings, location or grading plans change significantly from those described above, we should be notified to re-evaluate the recommendations contained in this report.

SITE CONDITIONS

The site is vacant and the ground surface appears mostly natural. The terrain is an easterly sloping hillside with moderately steep grades. Slopes range from about 15 to 25% in the lower part of the lot increasing to about 30 to 40% above the proposed building site. Elevation difference across the building site is about 20 feet. Vegetation consists of grass and weeds with moderately thick sage bush transitioning to relatively thick pinon and juniper trees on the steeper portion of the hillside.

SUBSIDENCE POTENTIAL

Bedrock of the Pennsylvanian age Eagle Valley Evaporite underlies the site and nearby areas These rocks are a sequence of gypsiferous shale, fine-grained sandstone and siltstone with some massive beds of gypsum and limestone. There is a possibility that massive gypsum deposits associated with the Eagle Valley Evaporite underlie portions of the lot. Dissolution of the gypsum under certain conditions can cause sinkholes to develop and can produce areas of localized subsidence. During previous work in the area, several sinkholes were observed scattered throughout the Eagle area. These sinkholes appear similar to others associated with the Eagle Valley Evaporite in other areas of the Eagle River valley.

Sinkholes were not observed in the immediate area of the subject lot. No evidence of cavities was encountered in the subsurface materials; however, the exploratory borings were relatively shallow, for foundation design only. Based on our present knowledge of the subsurface conditions at the site, it cannot be said for certain that sinkholes will not develop. The risk of future ground subsidence on Lot 3 throughout the service life of the proposed commercial building, in our opinion, is low; however, the owner should be made aware of the potential for sinkhole development. If further investigation of possible cavities in the bedrock below the site is desired, we should be contacted.

FIELD EXPLORATION

The field exploration for the project was conducted on May 24 and 25, 2007. Seven exploratory borings were drilled at the locations shown on Figure 1 to evaluate the subsurface conditions. Borings 1 through 3 were drilled in the access drive/parking areas and Borings 4 through 7 were drilled in the proposed building area. The borings were advanced with 4 inch diameter continuous flight augers powered by a track-mounted CME 45 drill rig. The track rig was needed due to the moderately steep hillside and the thick trees. The borings were logged by a representative of Hepworth-Pawlak Geotechnical, Inc.

Samples of the subsoils and bedrock were taken with 1⅜ inch and 2 inch I.D. spoon samplers. The samplers were driven into the subsoils and bedrock at various depths with blows from a 140 pound hammer falling 30 inches. This test is similar to the standard penetration test described by ASTM Method D-1586. The penetration resistance values are an indication of the relative density or consistency of the subsoils and hardness of the bedrock. Depths at which the samples were taken and the penetration resistance values are shown on the Logs of Exploratory Borings, Figure 2. The samples were returned to our laboratory for review by the project engineer and testing.

SUBSURFACE CONDITIONS

Graphic logs of the subsurface conditions encountered at the site are shown on Figure 2. The subsoils encountered in the access drive/parking area borings (Borings 1 through 3), below about ½ foot of topsoil, consisted of stiff, very sandy silty clay and medium dense, very clayey silty sand that extended to the depths drilled of 10 feet. The subsoils encountered in the building area borings (Borings 4 through 7), below about ½ foot of topsoil, consisted of medium dense, silty clayey sandy gravel and cobbles with scattered small boulders underlain at depths from about 11½ to 20 feet by very stiff, sandy silty clay with scattered shale fragments. Below depths from about 11½ to 20 feet in Borings 4 through 6, hard claystone/siltstone of the Eagle Valley Evaporite was encountered.

Drilling in the course granular soils with auger equipment was occasionally difficult due to the cobbles and boulders and drilling refusal was encountered at relatively shallow depths in Boring 7 in the deposit.

Laboratory testing performed on samples obtained from the borings included natural moisture content and density, gradation analyses, Atterberg limits, and unconfined compressive strength. Results of swell-consolidation testing performed on relatively undisturbed drive samples, presented on Figures 4 and 5, indicate generally low to moderate compressibility under conditions of loading and wetting. A sample of the silty clayey sand matrix soils (Boring 5 at 9 feet) showed a low hydro-compression potential and high compressibility when load after wetting and was probably partly disturbed. Results of gradation analyses performed on small diameter drive samples (minus 1½ inch fraction) of the coarse granular subsoils are shown on Figure 6. The laboratory testing is summarized in Table 1.

No free water was encountered in the borings at the time of drilling. The subsoils were slightly moist to moist to occasionally very moist with depth, and the bedrock was slightly moist to moist.

FOUNDATION BEARING CONDITIONS

The course granular soils possess moderate bearing capacity and generally low settlement potential. The building excavation could transition the granular soils and clay soils in deep cut areas. Lightly loaded spread footings bearing on the natural soils should be feasible for foundation support of the building. There could be some potential for differential settlement due to the assumed variable bearing conditions and if the bearing soils become wetted precautions should be taken to prevent wetting of the bearing soils.

An alternate foundation system to reduce the settlement potential would be to extend the bearing level down into the underlying claystone/siltstone, such as with screw piles or drilled piers. Provided below are recommendations for spread footings. If recommendations for screw piles or drilled piers are desired, we should be contacted.

DESIGN RECOMMENDATIONS

FOUNDATIONS

Considering the subsurface conditions encountered in the exploratory borings and the nature of the proposed construction, we recommend the building be founded with spread footings bearing on the natural soils with some risk of movement.

The design and construction criteria presented below should be observed for a spread footing foundation system.

1) Footings placed on the undisturbed natural soils should be designed for an allowable bearing pressure of 2,000 psf. Based on experience, we expect settlement of footings designed and constructed as discussed in this section will be about 1 inch. There could be some additional settlement if the bearing soils become wetted. The magnitude of the additional settlement would depend on the depth and extent of the wetting but may be on the order of ½ inch.
2) The footings should have a minimum width of 18 inches for continuous walls and 2 feet for isolated pads.
3) Exterior footings and footings beneath unheated areas should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 42 inches should be adequate for this area.
4) Continuous foundation walls should be well reinforced top and bottom to span local anomalies and better withstand the effects of some differential movement such as by assuming an unsupported length of at least 12 feet. Foundation walls acting as retaining structures should also be designed to resist lateral earth pressures as discussed in the "Foundation and Retaining Walls" section of this report.

5) All existing fill, topsoil and any loose or disturbed soils should be removed and the footing bearing level extended down to the relatively dense natural granular or stiff clay soils. The exposed soils in footing area should then be moistened and compacted. The clay soils should be further evaluated for settlement/heave potential at the time of construction.

6) A representative of the geotechnical engineer should observe all footing excavations prior to concrete placement to evaluate bearing conditions.

FOUNDATION AND RETAINING WALLS

Foundation walls and retaining structures which are laterally supported and can be expected to undergo only a slight amount of deflection should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of at least 50 pcf for backfill consisting of the on-site granular soils. Cantilevered retaining structures which are separate from the building and can be expected to deflect sufficiently to mobilize the full active earth pressure condition should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of at least 40 pcf for backfill consisting of the on-site granular soils. The wall backfill should not contain topsoil or oversized rocks.

All foundation and retaining structures should be designed for appropriate hydrostatic and surcharge pressures such as adjacent footings, traffic, construction materials and equipment. The pressures recommended above assume drained conditions behind the walls and a horizontal backfill surface. The buildup of water behind a wall or an upward sloping backfill surface will increase the lateral pressure imposed on a foundation wall or retaining structure. An underdrain should be provided to prevent hydrostatic pressure buildup behind walls.

Backfill should be placed in uniform lifts and compacted to at least 90% of the maximum standard Proctor density at a moisture content near optimum. Backfill in pavement and walkway areas should be compacted to at least 95% of the maximum standard Proctor density. Care should be taken not to overcompact the backfill or use large equipment near the wall, since this could cause excessive lateral pressure on the wall. Some settlement of deep foundation wall backfill should be expected, even if the material is placed correctly, and could result in distress to facilities constructed on the backfill. Use of a select granular material and increasing compaction to 100% standard Proctor density should help mitigate the settlement potential.

The lateral resistance of foundation or retaining wall footings will be a combination of the sliding resistance of the footing on the foundation materials and passive earth pressure against the side of the footing. Resistance to sliding at the bottoms of the footings can be calculated based on a coefficient of friction of 0.40. Passive pressure of compacted backfill against the sides of the footings can be calculated using an equivalent fluid unit weight of 350 pcf. The coefficient of friction and passive pressure values recommended above assume ultimate soil strength. Suitable factors of safety should be included in the design to limit the strain which will occur at the ultimate strength, particularly in the case of passive resistance. Fill placed against the sides of the footings to resist lateral loads should be granular material compacted to at least 95% of the maximum standard Proctor density at a moisture content near optimum.

FLOOR SLABS

The natural on-site soils, exclusive of topsoil, are suitable to support lightly loaded slab-on-grade construction. There could be some slab settlement if the compressible soils below the slab become wetted as previously discussed. To reduce the effects of some differential movement, floor slabs should be separated from all bearing walls and columns with expansion joints which allow unrestrained vertical movement. Floor slab control joints should be used to reduce damage due to shrinkage cracking. The requirements for joint spacing and slab reinforcement should be established by the designer based on experience and the intended slab use. A minimum 4 inch layer of free-draining gravel should be placed beneath basement level slabs to facilitate drainage. This material should consist of minus 2 inch aggregate with at least 50% retained on the No. 4 sieve and less than 2% passing the No. 200 sieve.

All fill materials for support of floor slabs should be compacted to at least 95% of maximum standard Proctor density at a moisture content near optimum. Required fill can consist of the on-site granular soils devoid of vegetation, topsoil and oversized rocks.

UNDERDRAIN SYSTEM

Although free water was not encountered during our exploration, it has been our experience in the area and where clay soils are present that local perched groundwater can develop during times of heavy precipitation or seasonal runoff. Frozen ground during spring runoff can also create a perched condition. We recommend below-grade construction, such as retaining walls, crawlspace and basement areas, be protected from wetting and hydrostatic pressure buildup by an underdrain system.

The drains should consist of drainpipe placed in the bottom of the wall backfill surrounded above the invert level with free-draining granular material. The drain should be placed at each level of excavation and at least 1 foot below lowest adjacent finish grade and sloped at a minimum 1% to a suitable gravity outlet. Free-draining granular material used in the underdrain system should contain less than 2% passing the No. 200 sieve, less than 50% passing the No. 4 sieve and have a maximum size of 2 inches. The drain gravel backfill should be at least 1½ feet deep. An impervious membrane such as 20 or 30 mil PVC should be placed beneath the drain gravel in a trough shape and attached to the foundation wall with mastic to prevent wetting of the bearing soils.

SITE GRADING

The risk of construction-induced slope instability at the site appears low provided the building is located in the less steep part of the lot as planned and cut and fills depths are limited. We assume the cuts for the basement level will not exceed about 20 feet in depth and be laid back to a stable grade or shored. Fills should be limited to about 8 to 10 feet deep and be compacted to at least 95% of the maximum standard Proctor density near optimum moisture content. Prior to fill placement, the subgrade should be carefully prepared by removing all vegetation and topsoil and compacting to at least 95% of the maximum standard Proctor density. The fill should be benched into the portions of the hillside exceeding 20% grade.

Permanent unretained cut and fill slopes should be graded at 2 horizontal to 1 vertical or flatter and protected against erosion by revegetation or other means. The risk of slope instability will be increased if seepage is encountered in cuts and flatter slopes may be necessary. If seepage is encountered in permanent cuts, an investigation should be conducted to determine if the seepage will adversely affect the cut stability.

SURFACE DRAINAGE

Positive surface drainage is an important aspect of the project to prevent wetting of the bearing soils. The following drainage precautions should be observed during construction and maintained at all times after the building has been completed:

1) Inundation of the foundation excavations and underslab areas should be avoided during construction.
2) Exterior backfill should be adjusted to near optimum moisture and compacted to at least 95% of the maximum standard Proctor density in pavement and slab areas and to at least 90% of the maximum standard Proctor density in landscape areas.
3) The ground surface surrounding the exterior of the building should be sloped to drain away from the foundation in all directions. We recommend a minimum slope of 12 inches in the first 10 feet in unpaved areas and a minimum slope of 2½ inches in the first 10 feet in paved areas. Free-draining wall backfill should be capped with about 2 feet of the on-site finer graded soils to reduce surface water infiltration.

4) Roof downspouts and drains should discharge well beyond the limits of all backfill.

5) Landscaping which requires regular heavy irrigation, such as sod, and sprinkler heads should be located at least 10 feet from foundation walls. Consideration should be given to use of xeriscape to reduce the potential for wetting of soils below the building caused by irrigation.

PAVEMENT SECTION

We understand that asphalt pavement is proposed for the access drive and parking areas. Traffic loadings have not been provided but are assumed to be typical of the proposed commercial type building development. We estimate an 18 kip equivalent daily load application (EDLA) of about 15 for the access drives and 5 for the parking lot areas. The subgrade soils encountered at the site are generally low plasticity silty clay and clayey silty sands with AASHTO classifications of A-4 and Group Indices of 0 and 2 on the samples tested. These soils are considered a relatively poor support for pavement sections and moderately to highly susceptible to frost heave. We estimate a Hveem stabilometer "R" value of about 8 for these soils.

Using CDOT design procedures, the above assumed 18kip EDLA's, a Hveem "R" value of 8, a Regional Factor of 2.25 and a serviceability index of 2.0, we recommend the minimum pavement section thickness consist of 4 inches of asphalt on 9 inches of base course for the access drives and 3 inches of asphalt on 9 inches of base course for the automobile only parking areas. For tight turning areas and areas subjected to regular truck traffic, such as delivery and trash pick-up, we suggest the use of at least 6 inches of portland cement concrete on 4 inches of base course.

The asphalt should be a batched hot mix, approved by the engineer and placed and compacted to the project specifications. The base course should meet CDOT Class 6 specifications. All base course and required subgrade fill should be compacted to at least 95% of the maximum standard Proctor density at a moisture content within 2% of optimum. Concrete should have a minimum 28 day compressive strength of 4,000 psi and be air entrained.

Required fill used to establish design subgrade level can consist of the on-site soils or suitable imported granular soils approved by the geotechnical engineer. Prior to fill placement the subgrade should be scarified to a depth of 8 inches, adjusted to near optimum moisture and compacted to at least 95% of standard Proctor density. In soft or wet areas, the subgrade may require drying or stabilization prior to fill placement. A geogrid and/or subexcavation and replacement with aggregate base soils may be needed for the stabilization. The subgrade should be proofrolled. Areas that deflect excessively should be corrected before placing pavement materials. The subgrade improvements and placement and compaction of base and asphalt materials should be monitored on a regular basis by a representative of the geotechnical engineer. Once traffic loadings are better known, we should review our pavement section recommendations.

LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering principles and practices in this area at this time. We make no warranty either express or implied. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory borings drilled at the locations indicated on Figure 1, the proposed type of construction and our experience in the area. Our services do not include determining the presence, prevention or possibility of mold or other biological contaminants (MOBC) developing in the future. If the client is concerned about MOBC, then a professional in this special field of practice should be consulted. Our findings include interpolation and extrapolation of the subsurface conditions identified at the exploratory borings and variations in the subsurface conditions may not become evident until excavation is performed. If conditions encountered during construction appear different from those described in this report, we should be notified so that re-evaluation of the recommendations may be made.

This report has been prepared for the exclusive use by our client for design purposes. We are not responsible for technical interpretations by others of our information. As the project evolves, we should provide continued consultation and field services during construction to review and monitor the implementation of our recommendations, and to verify that the recommendations have been appropriately interpreted. Significant design changes may require additional analysis or modifications to the recommendations presented herein. We recommend on-site observation of excavations and foundation bearing strata and testing of structural fill by a representative of the geotechnical engineer.

Respectfully Submitted,

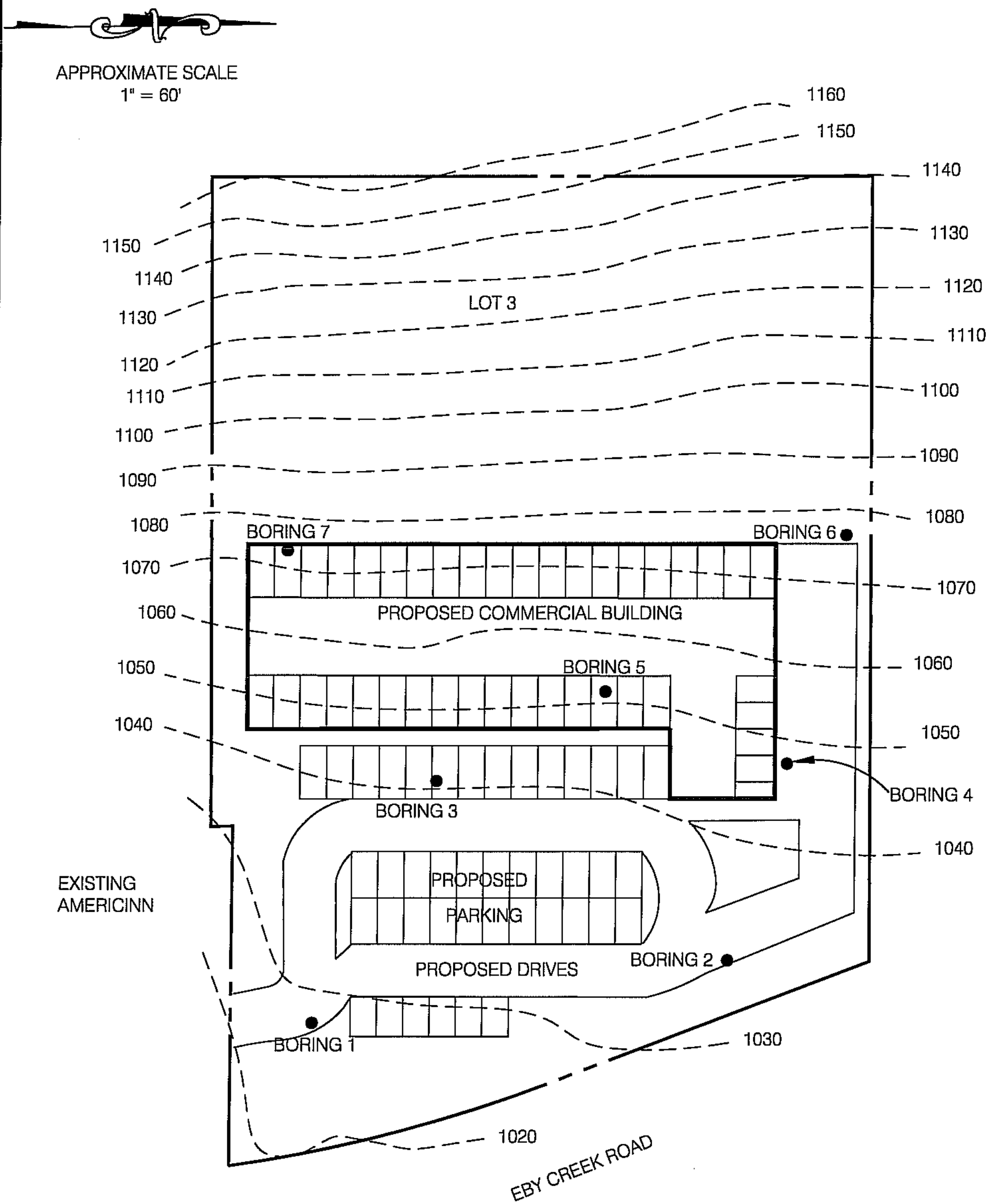
HEPWORTH - PAWLAK GEOTECHNICAL, INC.

David A. Young, P.E.

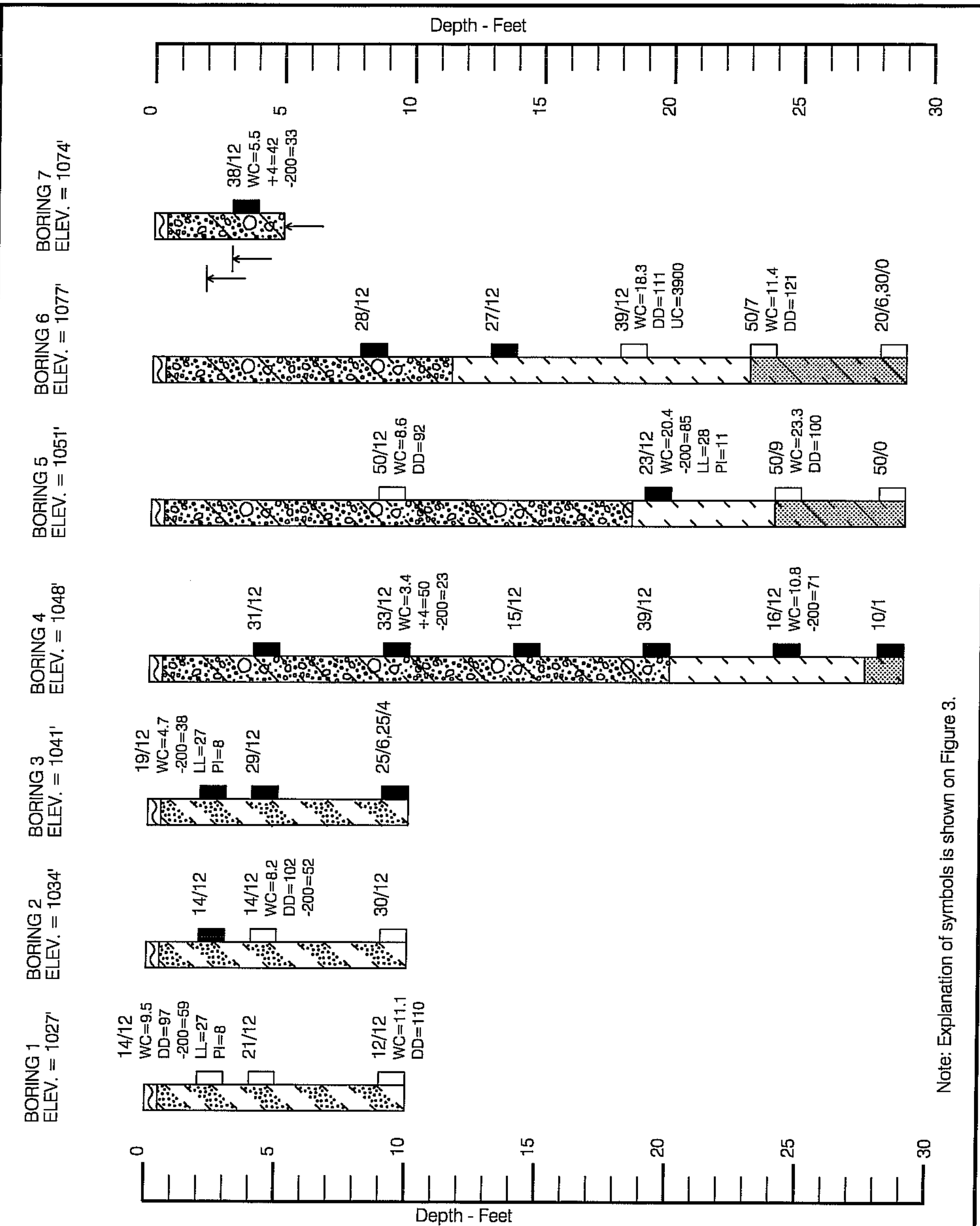
Reviewed by:

Steven L. Pawlak, P.E.

DAY/vad



107 0341	HP Geotech HEPWORTH-PAWLAK GEOTECHNICAL	LOCATION OF EXPLORATORY BORINGS	Figure 1



Note: Explanation of symbols is shown on Figure 3.

107 0341	HP Geotech HEPWORTH-PAWLAK GEOTECHNICAL	LOGS OF EXPLORATORY BORINGS	Figure 2

LEGEND:

TOPSOIL; organic silty clay to silty clayey sand with scattered gravel and cobbles, slightly moist, dark brown.

CLAY (CL-SC); very sandy to very clayey sand, silty, stiff/medium dense, brown, low to medium plasticity.

GRAVEL AND COBBLES (GM-GC); with small boulders, sandy to very sandy, silty, clayey, medium dense, slightly moist, brown, subrounded to subangular rocks.

CLAY (CL); silty, sandy, scattered shale fragments, stiff to very stiff, slightly moist to very moist, lot to medium plasticity..

CLAYSTONE/SILTSTONE; medium hard to hard, slightly moist to moist, grey-brown. Eagle Valley Evaporite.

Relatively undisturbed drive sample; 2-inch I.D. California liner sample.

Drive sample; standard penetration test (SPT), 1 3/8 inch I.D. split spoon sample, ASTM D-1586.

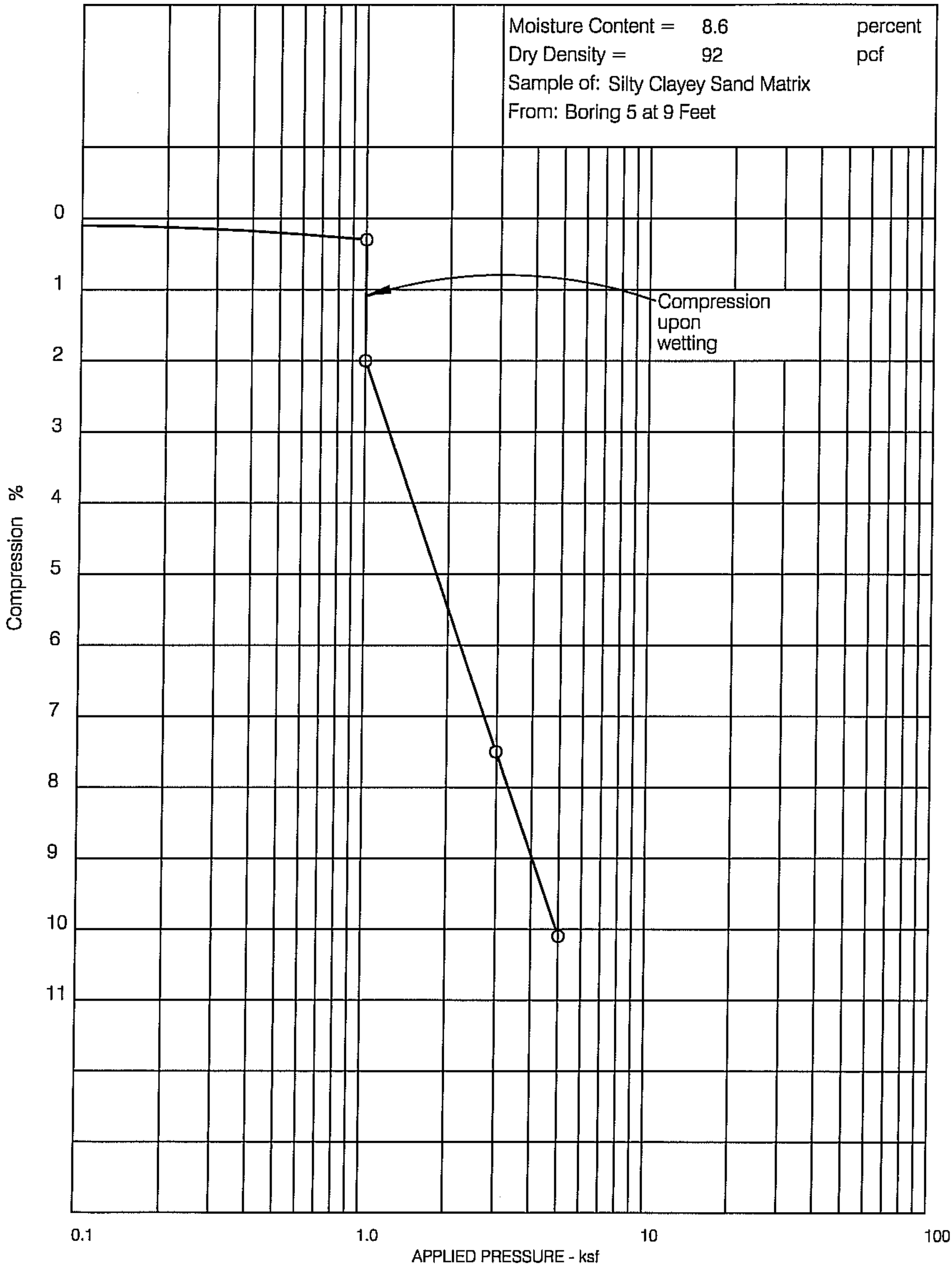
14/12 Drive sample blow count; indicates that 14 blows of a 140 pound hammer falling 30 inches were required to drive the California or SPT sampler 12 inches.

Practical drilling refusal. Where shown above bottom of log, indicates that multiple attempts were made to advance the boring.

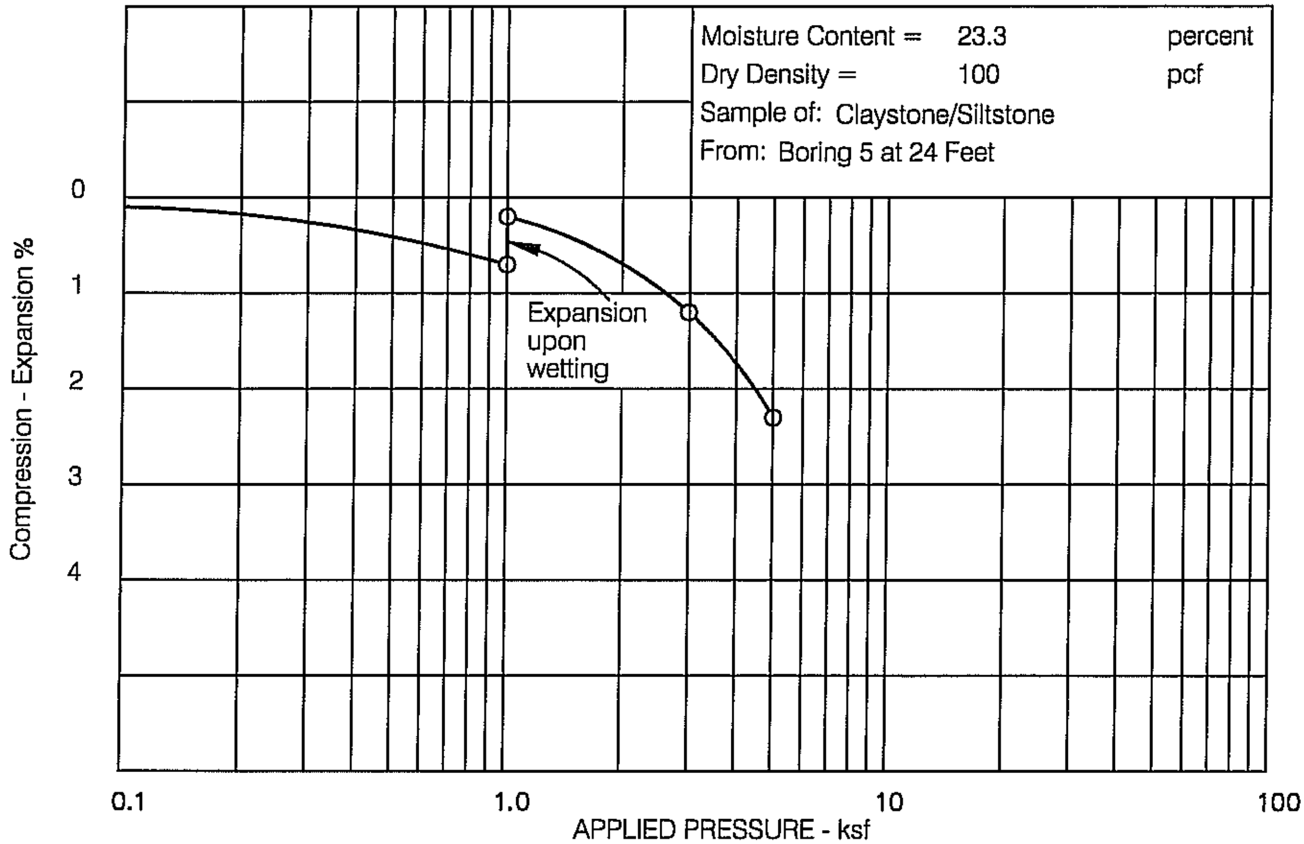
NOTES:

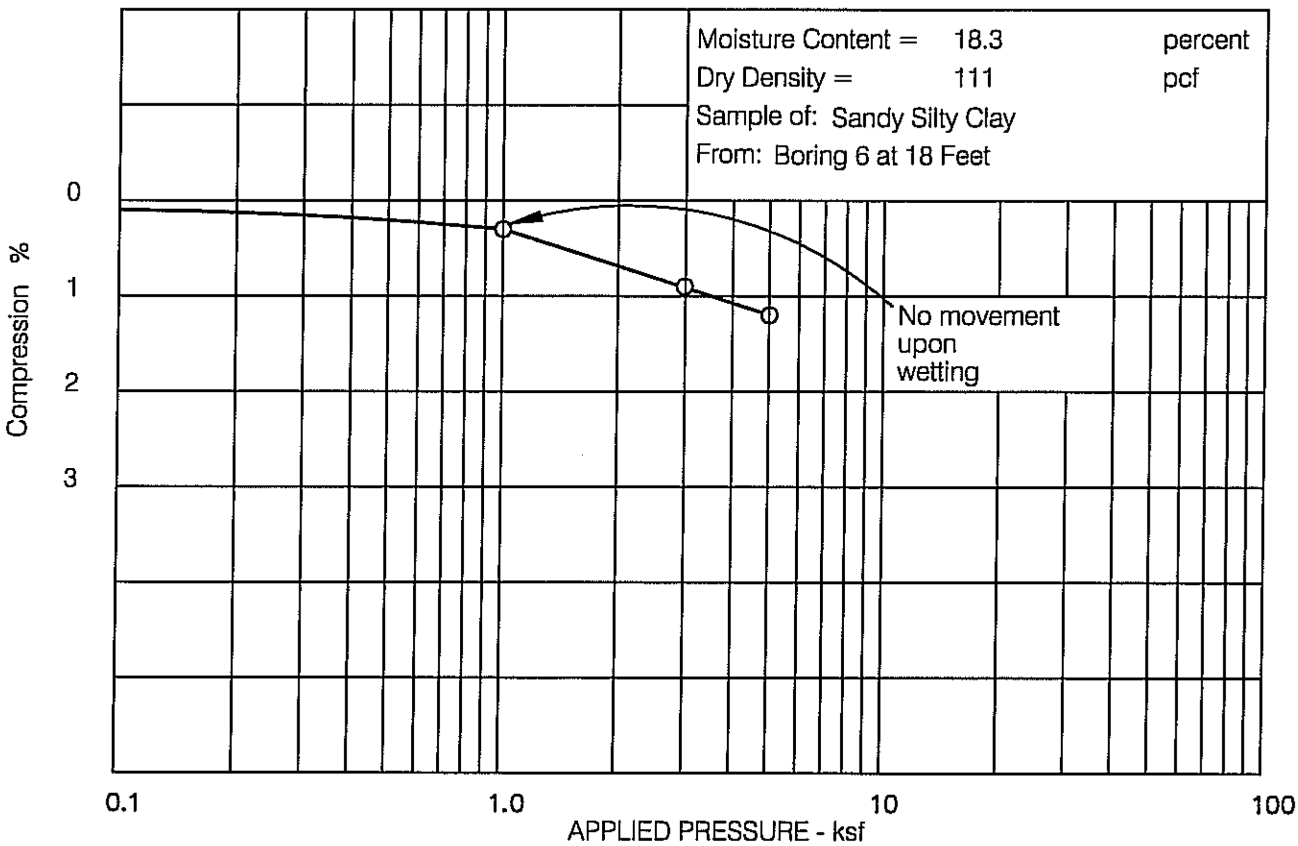
1. Exploratory borings were drilled on May 24 and 25, 2007 with 4-inch diameter continuous flight power auger.
2. Locations of exploratory borings were measured approximately by pacing from features shown on the site plan provided.
3. Elevations of exploratory borings were obtained by interpolation between contours shown on the site plan provided and checked by instrument level. Boring logs are drawn to depth.
4. The exploratory boring locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between materials shown on the exploratory boring logs represent the approximate boundaries between material types and transitions may be gradual.
6. No free water was encountered in the borings at the time of drilling. Fluctuation in water level may occur with time.
7. Laboratory Testing Results:
   WC = Water Content (%)
   DD = Dry Density (pcf)
   +4 = Percent retained on the No. 4 sieve
   -200 = Percent passing No. 200 sieve
   LL = Liquid Limit (%)
   PI = Plasticity Index (%)
   UC = Unconfined Compressive Strength (psf)

107 0341	HP Geotech HEPWORTH-PAWLAK GEOTECHNICAL	LEGEND AND NOTES	Figure 3

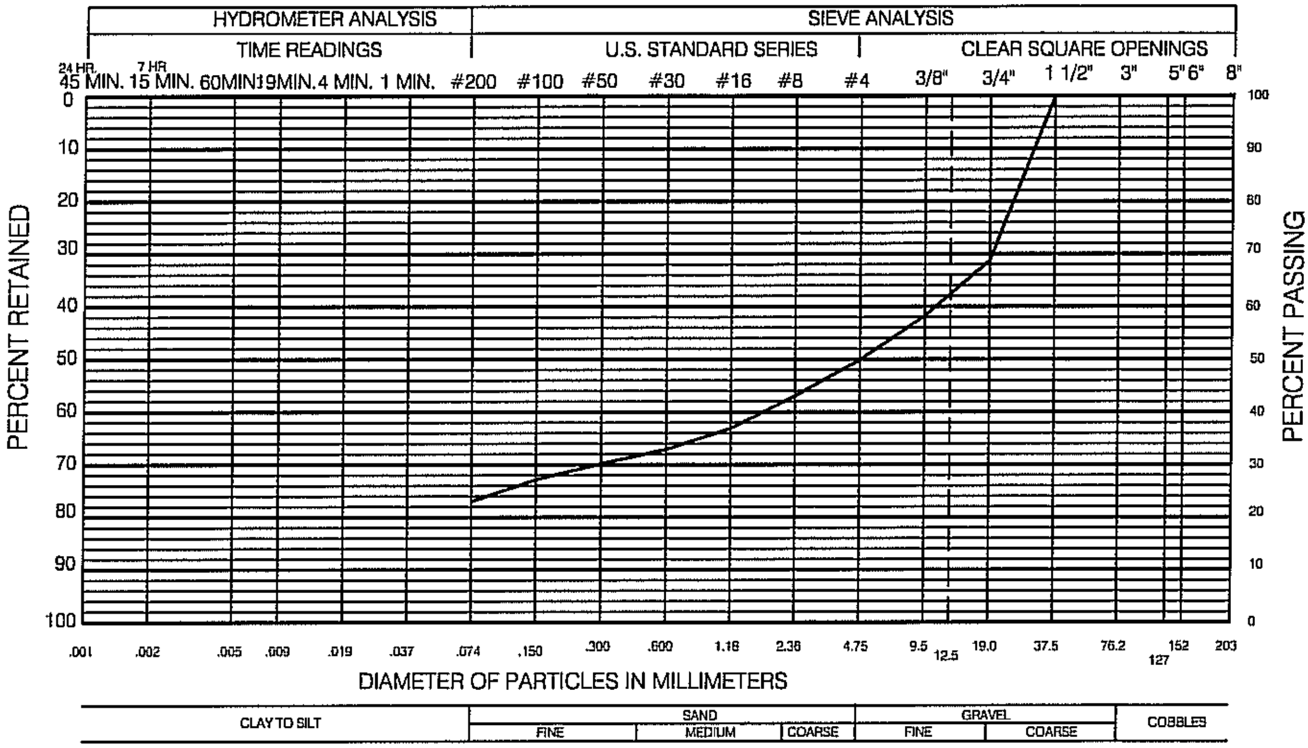


107 0341	HP Geotech HEPWORTH-PAWLAK GEOTECHNICAL	SWELL-CONSOLIDATION TEST RESULTS	Figure 4





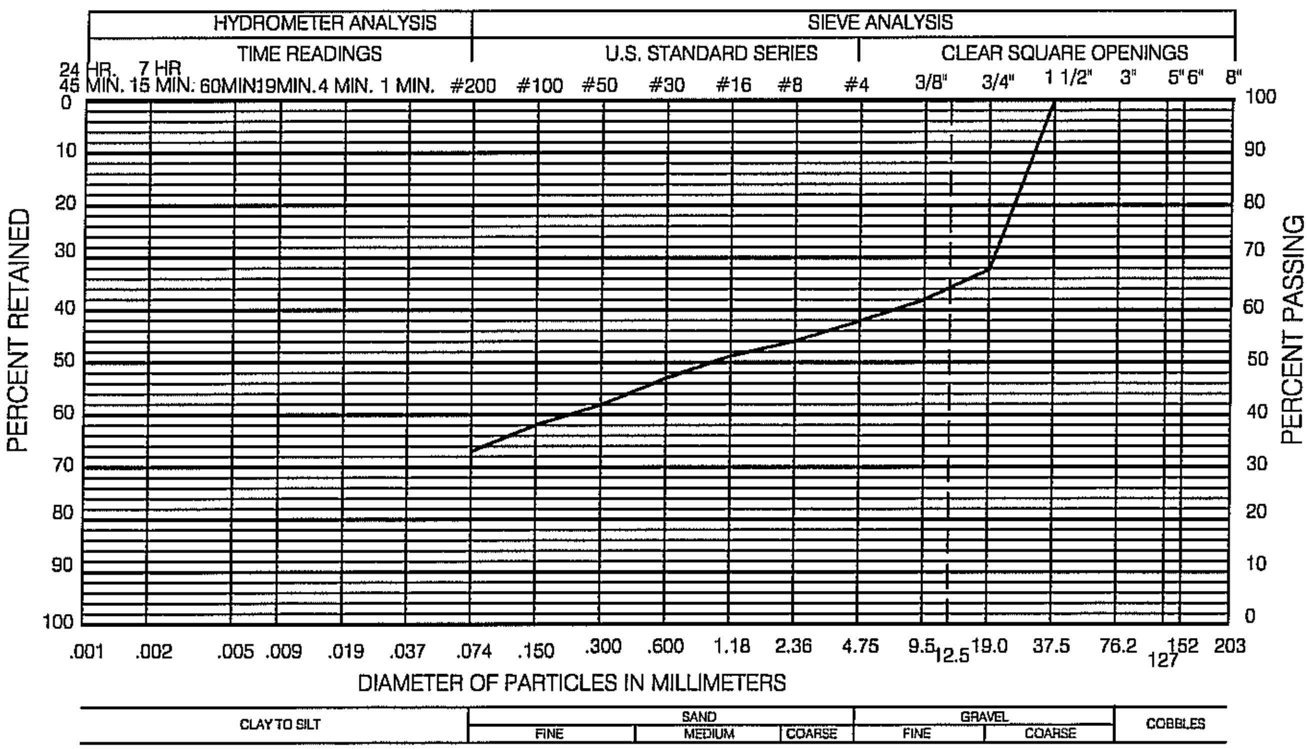
107 0341	HP Geotech HEPWORTH-PAWLAK GEOTECHNICAL	SWELL-CONSOLIDATION TEST RESULTS	Figure 5



GRAVEL 50 % SAND 27 % SILT AND CLAY 23 %

LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF: Silty Clayey Sandy Gravel FROM: Boring 4 at 9 Feet



GRAVEL 42 % SAND 25 % SILT AND CLAY 33 %

LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF: Silty Clayey Sandy Gravel FROM: Boring 7 at 3 Feet

107 0341	HP Geotech HEPWORTH-PAWLAK GEOTECHNICAL	GRADATION TEST RESULTS	Figure 6

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Job No. 107 0341

TABLE 1
SUMMARY OF LABORATORY TEST RESULTS

SAMPLE LOCATION		NATURAL MOISTURE CONTENT	NATURAL DRY DENSITY	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH	AASHTO CLASSIFICATION	SOIL OR BEDROCK TYPE
BORING	DEPTH (ft)	(%)	(pcf)	GRAVEL (%)	SAND (%)		LIQUID LIMIT (%)	PLASTIC INDEX (%)	(PSF)		
1	2	9.5	97			59	27	8		A-4(2)	Very sandy silty clay
	9	11.1	110								Very sandy silty clay
2	4	8.2	102			52					Very sandy silty clay
3	2	4.7				38	27	8		A-4(0)	Very clayey silty sand
4	9	3.4		50	27	23					Silty clayey sandy gravel
	24	10.8				71					Sandy silty clay with shale fragments
5	9	8.6	92								Silty clayey sand matrix
	19	20.4				85	28	11			Sandy silty clay
	24	23.3	100								Claystone/siltstone
6	18	18.3	111						3900		Sandy silty clay
	23	11.4	121								Claystone/siltstone
7	3	5.5		42	25	33					Silty clayey sandy gravel