HP Geotech
HEPWORTH - PAWLAK GEOTECHNICAL

Hepworth-Pawlak Geotechnical, Inc.
5020 County Road 154
Glenwood Springs, Colorado 81601
Phone: 970-945-7988

Fax: 970-945-8454
email: hpgeo@hpgeotech.com

SUBSOIL STUDY
FOR FOUNDATION DESIGN
PROPOSED COMMERCIAL BUILDINGS
LOT 3, COLORADO RIVER INDUSTRIAL PARK
2222 DEVEREUX ROAD
GLENWOOD SPRINGS, COLORADO

JOB NO. 103 489

AUGUST 7, 2003

PREPARED FOR:

TECTONICS
ATTN: BRAD HENDERSON
5677 COUNTY ROAD 106
ELBERT, COLORADO 80106

TABLE OF CONTENTS

PURPOSE AND SCOPE OF STUDY

This report presents the results of a subsoil study for proposed commercial buildings to be located on Lot 3, Colorado River Industrial Park, 2222 Devereux Road, Glenwood Springs, Colorado. The project site is shown on Figure 1. The purpose of the study was to develop recommendations for the foundation design and pavement section thickness. The study was conducted in accordance with our proposal for geotechnical engineering services to Tectonics dated April 30, 2003.

A field exploration program consisting of exploratory borings was conducted to obtain information on the subsurface conditions. Samples of the subsoils 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 and pavement section thickness. 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 subsoil conditions encountered.

PROPOSED CONSTRUCTION

The proposed buildings will be single story, steel frame and metal skin structures approximately 4,500 and 9,600 square feet in size located on the eastern half of the lot as shown on Figure 1. We understand that a monolithic slab foundation is being considered for support of the buildings. Ground floors will be slab-on-grade. Grading for the structures is assumed to be relatively minor with cut depths between about 3 to 5 feet. We assume relatively light to moderate foundation and slab loadings carried by a combination of perimeter walls and interior columns. Asphalt paved driveways and parking areas will be located around to the buildings.

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 western half of the lot is occupied by a single story, steel frame and metal skin building operated by Ford Fleet Sales as shown on Figure 1. The lot is bordered by the Union Pacific Railroad tracks to the south and Devereux Road to the north. The proposed buildings will be located in the paved parking areas located east of the existing building. The existing pavement is in fair to poor condition. Site grading for the current development consisting of shallow cuts and fills (up to about 6 feet) was observed across the lot. The proposed building areas had been graded flat as part of the current site development with gentle slopes generally down to the north. There is about 2 feet of elevation difference across the entire building area. Vegetation outside pavement areas consists mainly of grass and weeds with scattered sagebrush along the rear of the lot and some landscaping along the northern lot boundary.

GEOLOGIC CONDITIONS

The proposed development area currently consists of flat graded parking area located in generally strong to moderately sloping terrain uphill of Devereux Road. The Union Pacific Railroad tracks border the uphill side of the property. The site is mapped as debris fan deposits overlying Colorado River alluvium (Lincoln-DeVore, 1978). The river alluvium is exposed below Devereux Road along the river bank. Subsurface exploration on the lot indicates the debris fan deposits are on the order of 17 to 18½ feet deep in the proposed building areas.

There are no geologic conditions which could prevent further development of the site. However, two conditions need to be considered in the planning and design; namely: (1) hydrocompressive soils, and (2) drainage and potential debris flow. The hydrocompressive soils are of limited depth and can probably be mitigated by proper foundation design as described in the "Design Recommendations" section of this report. The potential debris flow hazard on the site is described as "slight" by Lincoln-DeVore (1978). Based on our observations, we concur that the debris flow risk is low and can probably be managed by proper grading and drainage design. The drainage plan should consider the potential for off-site surface runoff from sources upslope of the property and on-site runoff.

FIELD EXPLORATION

The field exploration for the project was conducted on August 1, 2003. Three exploratory borings were drilled at the locations shown on Figure 1 to evaluate the subsurface conditions. The borings were advanced with 4-inch diameter continuous flight augers powered by a truck mounted CME-45B drill rig. The borings were logged by a representative of Hepworth-Pawlak Geotechnical, Inc.

Samples of the subsoils were taken with 1⅜ inch and 2 inch I.D. spoon samplers. The samplers were driven into the subsoils 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. 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, below the asphalt, consist of about 17 to 18½ feet of loose, slightly clayey to clayey sand and silt overlying dense gravel alluvium down to the maximum explored depth of 22 feet. Drilling in the dense gravel alluvium with auger equipment was difficult due to the cobbles and boulders and drilling refusal was encountered in the deposit at each boring.

Laboratory testing performed on samples obtained from the borings included natural moisture content, density and percent finer than sand size gradation analyses. Results of swell-consolidation testing performed on relatively undisturbed drive samples, presented on Figures 4 and 5, generally indicate low to moderate compressibility under conditions of loading and wetting. The samples from Boring 1 at 5 feet and Boring 2 at 10 showed a low collapse potential (settlement under a constant load) after wetting. The laboratory testing is summarized in Table 1.

No free water was encountered in the borings at the time of drilling or when checked on August 6, 2003 and the subsoils were slightly moist to moist.

FOUNDATION BEARING CONDITIONS

The upper sand and silt soils encountered to depths of about 17 and 18 ½ feet have relatively low bearing capacity and moderate settlement potential. The underlying dense gravel alluvium is relatively incompressible. Shallow spread footings bearing on the sand and silt soils should be suitable for support of relatively light to moderate loading with some settlement risk. The subgrade should be moisture conditioned and compacted in footing areas and precautions taken to prevent post-construction wetting of the bearing soils. Due to the settlement potential of the subsoils, we recommend that interior slabs be separated from exterior walls rather then placed monolithic.

DESIGN RECOMMENDATIONS

FOUNDATIONS

Considering the subsoil 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 subsoils.

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

1) Footings placed on the undisturbed natural subsoils should be designed for an allowable bearing pressure of 1,500 psf. Based on experience, we expect settlement of footings designed and constructed as discussed in this section will be about 1 inch or less. Additional settlement on the order of 1 inch could occur if the bearing soils become wetting and could be differential between interior pads and perimeter footings.
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 36 inches below exterior grade is typically used in this area.
4) Continuous foundation walls should be reinforced top and bottom to span local anomalies such as by assuming an unsupported length of at least 12 feet. Foundation walls acting as retaining structures, if any, should also be designed to resist a lateral earth pressure corresponding to an equivalent fluid unit weight of 50 pcf.
5) Any existing fill, and loose or disturbed soils should be removed and the footing bearing level extended down to undisturbed natural soils. The

exposed soils in footing areas should then be moistened and compacted prior to forming footings.

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

FLOOR SLABS

The natural on-site soils are suitable to support lightly loaded slab-on-grade construction with some risk of settlement if the subgrade soils were to become wet. 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 road base should be placed beneath interior slabs for slab support. This material should consist of minus 2-inch aggregate with at least 50% retained on the No. 4 sieve and less than 12% 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 soils devoid of vegetation, topsoil and oversized rock.

SURFACE DRAINAGE

The following drainage precautions should be observed during construction and maintained at all times after the buildings have 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 6 inches in the first 10 feet in unpaved areas and a minimum slope of 3 inches in the first 10 feet in paved areas.

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

5) Landscaping which requires regular heavy irrigation should be located at least 10 feet from foundation walls.

PAVEMENT SECTION THICKNESS

The driveway and parking areas for the development are proposed to be asphalt paved. Minor site grading consisting of shallow cuts and fills may be performed to adjust the current subgrade level. Traffic loading information was not available at the time of this study. We assume an 18 kip equivalent daily load application (EDLA) of 2 for the drives and automobile parking areas. The subgrade soils encountered at the site are typically low plasticity clayey sand and silt soils which are considered a relatively poor subgrade for support of pavement materials. A Hveem stabilometer 'R' value of 15 was used in our analysis. A regional factor of 1.75 was used for this site.

Based on the soil conditions encountered in the exploratory borings and the assumed traffic loading, the pavement section should consist of 3 inches of asphalt pavement over 6 inches of base course for the drives and automobile parking areas. The base course should meet CDOT Class 6 specifications and be compacted to at least 95% of the maximum standard Proctor density at a moisture content near optimum. Base course materials could be placed on well broken asphalt.

Prior to placing the pavement materials, the entire subgrade in natural areas should be stripped of any vegetation and topsoil, scarified to a depth of 8 inches, adjusted to a moisture content near optimum and compacted to at least 95% of standard Proctor density. The existing pavement can be left in place but should be broken up with a bull-dozer or heavy sheepsfoot compactor. The pavement subgrade should be proof-rolled with a heavily loaded pneumatic-tired vehicle. Areas which deform excessively should be removed and replaced to achieve a stable subgrade prior to placing pavement materials. Required structural fill below pavement areas should be compacted to at least 95% of standard Proctor density at near optimum moisture content. 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.

The collection and diversion of surface drainage away from paved areas is extremely important to the satisfactory performance of pavement. Drainage design should provide for the removal of water from paved areas and prevent wetting of the subgrade soils.

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 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.

Respectively Submitted,

HEPWORTH - PAWLAK GEOTECHNICAL, Inc.

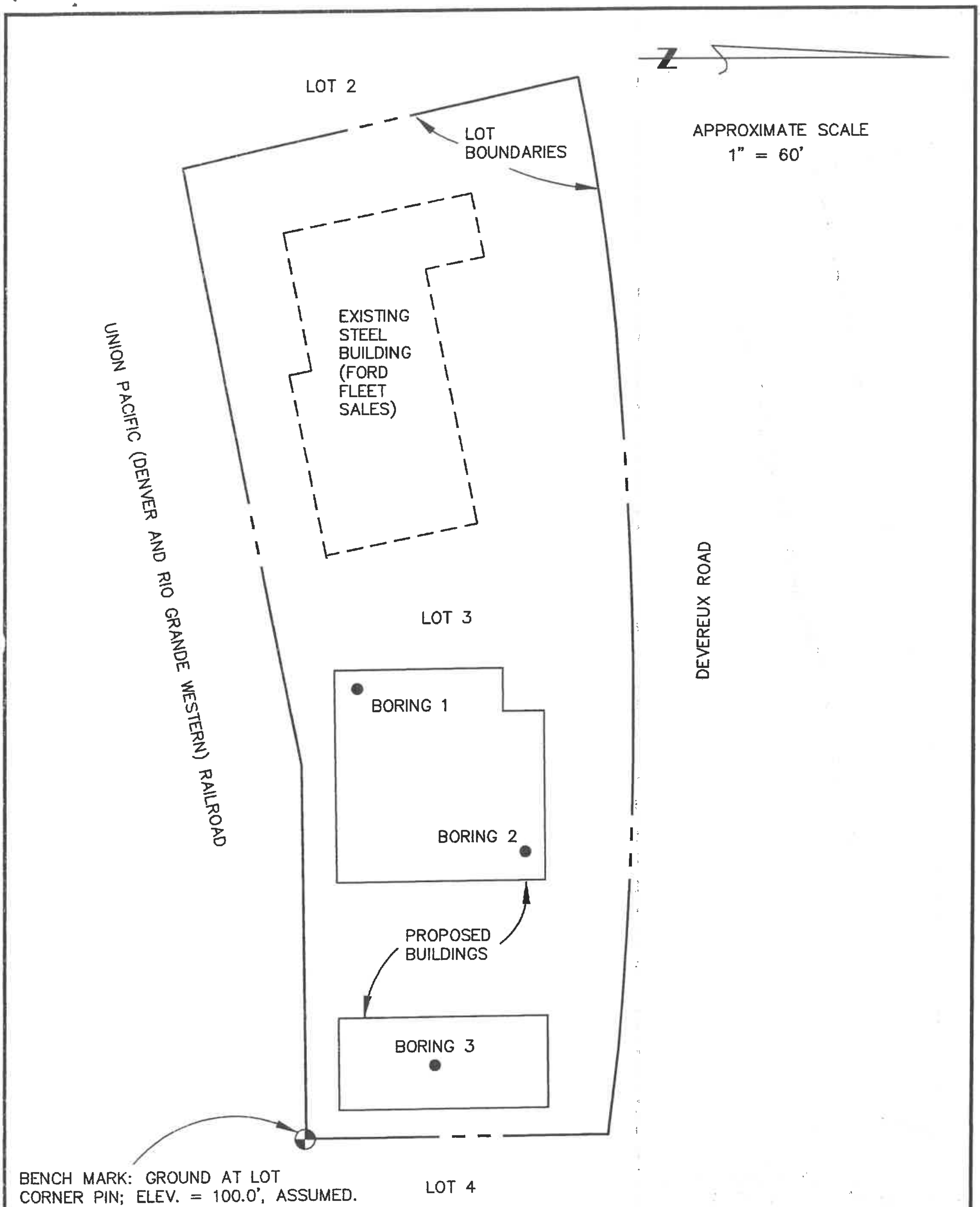
Trevor L. Knell

Reviewed by:

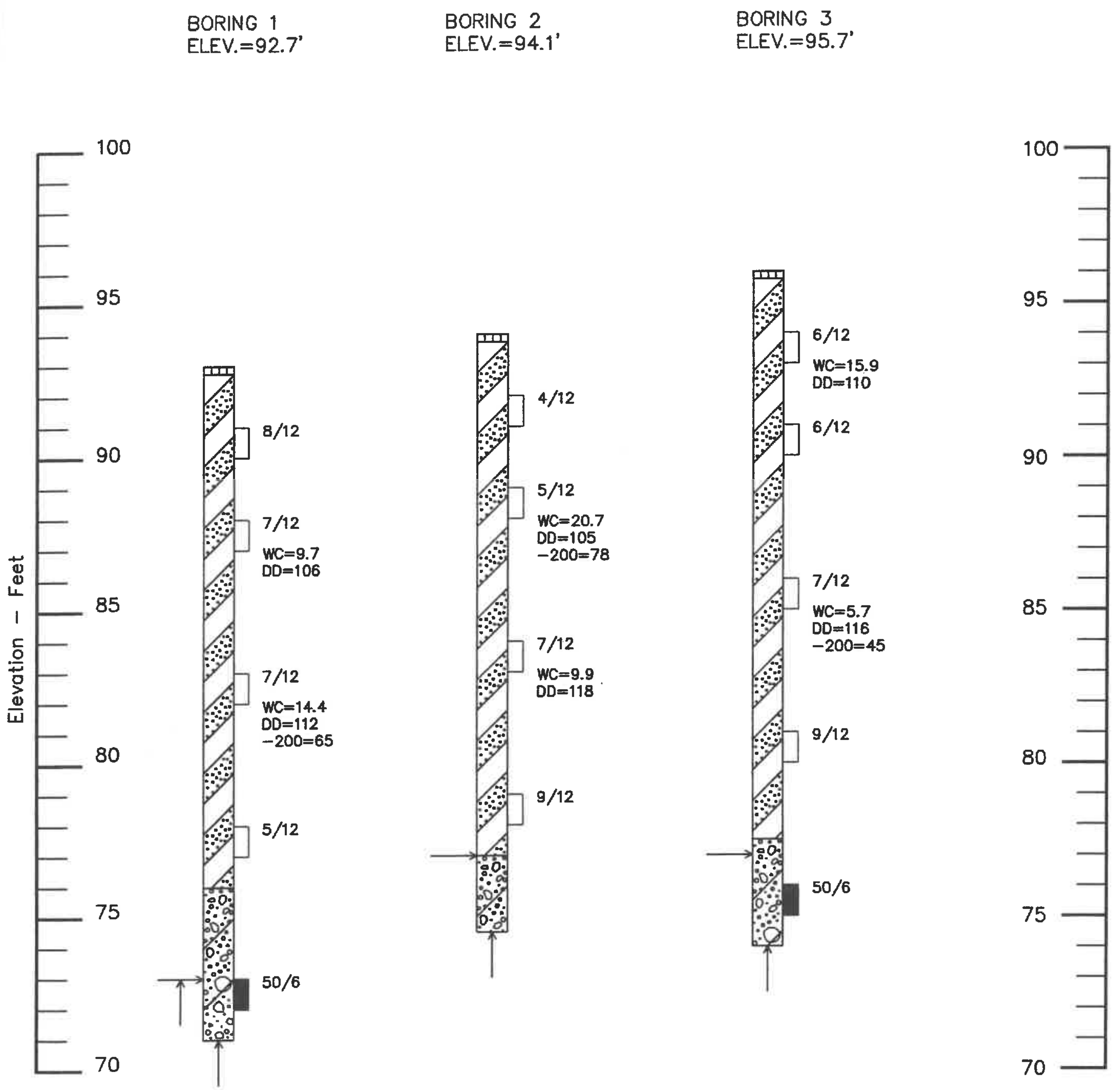
Daniel E. Hardin, P.E.

TLK/ksw

cc: Boundaries Unlimited - Attn: Deric Walter



103 489	HEPWORTH–PAWLAK GEOTECHNICAL, INC.	LOCATION OF EXPLORATORY BORINGS	Figure 1



Note: Explanation of symbols is shown on Figure 3.

103 489	HEPWORTH-PAWLAK GEOTECHNICAL, INC.	LOGS OF EXPLORATORY BORINGS	Figure 2

LEGEND:

ASPHALT; approximately 3 inches thick.

SAND AND SILT (SM–ML); slightly clayey to clayey, with clay layers at depth, stratified, loose, slightly moist to moist, red–brown.

GRAVEL AND COBBLES (GP–GM); sandy, slightly silty, with boulders, dense to very dense, slightly moist, brown, river terrace.

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.

8/12 Drive sample blow count; indicates that 8 blows of a 140 pound hammer falling 30 inches were required to drive the California or SPT sampler 12 inches.

⟶ Depth at which boring caved after drilling.

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

NOTES:

1. Exploratory borings were drilled on August 1, 2003 with a 4–inch diameter continuous flight power auger.

2. Locations of exploratory borings were measured approximately by taping from the features shown on the site plan provided.

3. Elevations of exploratory borings were measured by instrument level and refer to the Bench Mark shown on Figure 1.

4. The exploratory boring locations and elevations should be considered accurate only to the degree implied by the method used.

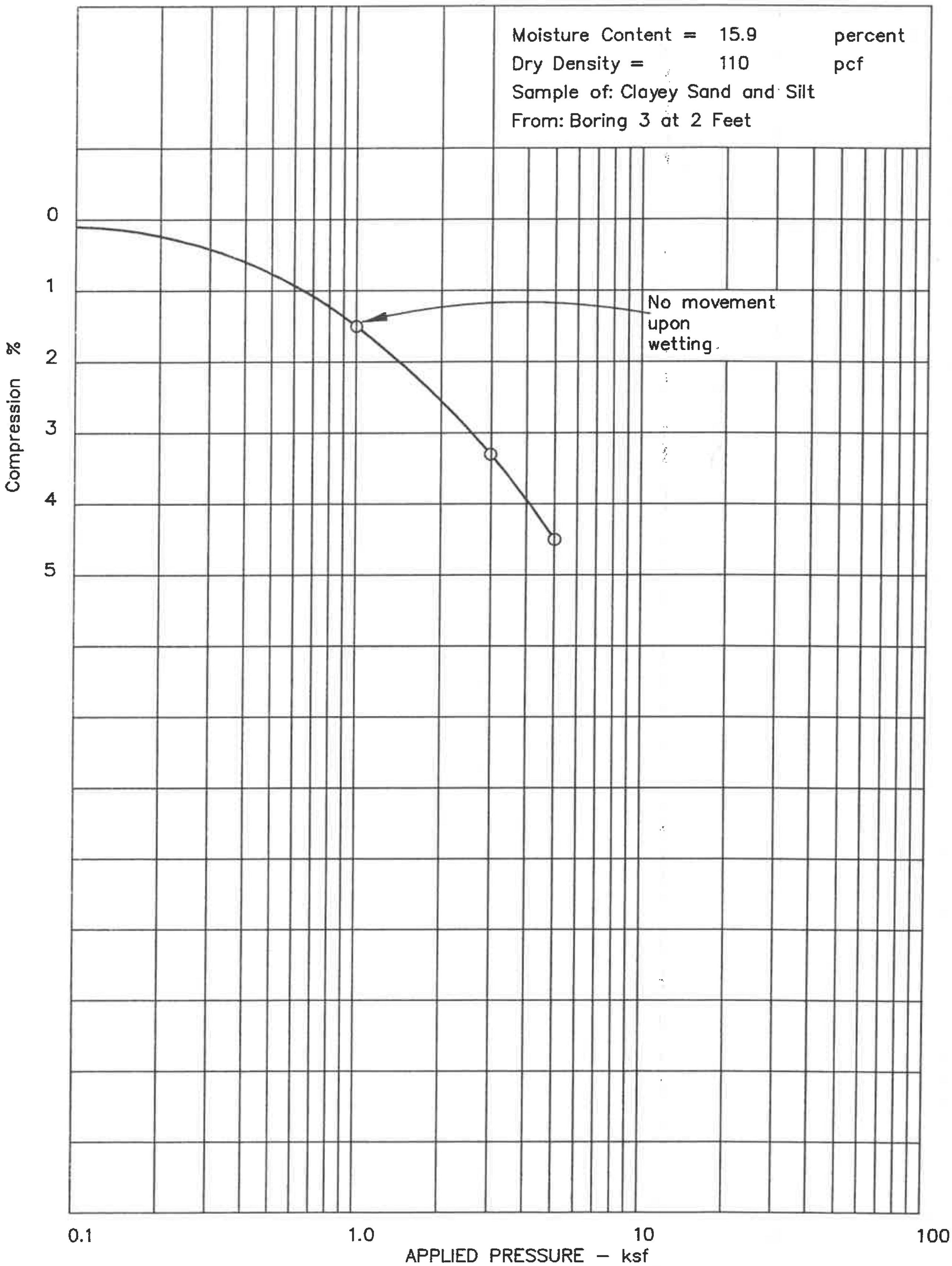
5. The lines between materials shown on the exploratory boring logs represent the approximate boundaries between material types and transitions may be gradual.

6. No free water was encountered in the borings at the time of drilling or when checked 5 days later.

7. Laboratory Testing Results:

WC = Water Content (%)
DD = Dry Density (pcf)
–200 = Percent passing No. 200 sieve.

103 489	HEPWORTH–PAWLAK GEOTECHNICAL, INC.	LEGEND AND NOTES	Figure 3



103 489	HEPWORTH–PAWLAK GEOTECHNICAL, INC.	SWELL–CONSOLIDATION TEST RESULTS	Figure 5

HEPWORTH-PAWLAK GEOTECHNICAL, INC.

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

JOB NO. 103 489

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)		SOIL OR BEDROCK TYPE
BORING	DEPTH (feet)			GRAVEL (%)	SAND (%)		LIQUID LIMIT (%)	PLASTIC INDEX (%)			
1	5	9.7	106								clayey sand and silt
	10	14.4	112			65					clayey sand and silt
2	5	20.7	105			78					clayey sandy silt
	10	9.9	118								slightly clayey sandy silt
3	2	15.9	110								clayey sand and silt
	10	5.7	116			45					clayey silty sand