SOILS AND FOUNDATION INVESTIGATION AND SUBGRADE INVESTIGATION AND PAVEMENT DESIGN FOR PRIVATE STREETS POUDRE VALLEY HEALTH SYSTEM HARMONY CAMPUS MEDICAL CENTER HARMONY ROAD AND TIMBERLINE ROAD FORT COLLINS, COLORADO

Prepared For:

THE HAMMES COMPANY
13952 West Denver West Parkway, Suite 305
Golden, Colorado 80401

Attention: Mr. Travis Messina

Job No. FC-1116

December 28, 1998

CTL/THOMPSON, INC.
CONSULTING ENGINEERS
375 E. HORSETOOTH RD. ■ THE SHORES OFFICE PARK ■ BLDG. 3, SUITE 201 ■ FT. COLLINS, CO 80525
(970) 206-9455

TABLE OF CONTENTS

INTRODUCTION

This report presents the results of our geotechnical investigation for the proposed Harmony Campus Medical Center to be located southeast of the intersection of Harmony Road and Timberline in Fort Collins, Colorado. The purpose of our investigation was to evaluate the subsurface conditions at the site and to provide geotechnical recommendations and design criteria for the project. The scope of this report is for the foundations, slab-on-grade floors, private pavements, utilities, site grading and surface drainage for the center area. The subgrade investigation and pavement design for the public streets is in a separate report. Seismic criteria for building construction was not requested. The investigations and design for relocation/abandonment of the Harmony Lateral Irrigation Ditch which flows through the middle of the site will be by others. The highlights of our investigation follow. More detailed criteria and information are contained in the body of the report.

HIGHLIGHTS

1. In general, our borings in the area of the building pad penetrated 12 feet to 22 feet of stiff clays over nil to 14 feet of medium dense silty sands and/or dense sands underlain at 19 feet to 26 feet by hard to very hard interlayered claystone and sandstone bedrock or hard to very hard claystone bedrock with the upper nil to 3 feet weathered. Ground water was measured in the borings in the building pad area at depths from 13 to 34 feet during drilling, and 14 to 23 feet several weeks after drilling.

2. We opine drilled piers would be an excellent foundation for the proposed building and would be the alternative with the least risk of unacceptable foundation movement when compared to footings. Our analyses show the bedrock is harder with depth, therefore, allowable bearing capacity and skin friction can be increased with depth. Criteria for drilled pier and footing foundations are provided in this report.

3. The subsoils anticipated below the proposed building are considered to have low swell potential. We judged the conditions generally suitable for slab-on-grade construction. Recommendations for construction details which will reduce the risk of damage in the event of slab movement are contained in this report.

4. Our borings drilled along the proposed private streets and parking areas at this site penetrated stiff, sandy clays to the depth explored of 5 to 10 feet. These soils generally classified as AASHTO category A-6 and A-7 with group indices of 11 to 19. For light traffic and parking areas we recommend 4 inches of asphalt concrete over 8 inches aggregate base course or a full depth asphaltic concrete pavement with thickness of 6.5 inches. Thicker sections are recommended for areas with heavier traffic.

SITE CONDITIONS

The Harmony Campus Medical Center site consists of approximately 70 acres located southeast of the intersection of Harmony Road and Timberline Road in Fort Collins, Colorado. Much of the area surrounding the medical center site has been recently or is being currently developed. Mountain Crest Health Services is located east of the site. A grade school is under construction southeast of the site and the Timber Creek and Stetson Creek Subdivisions are in various stages of construction located south of the site. The medical center site itself is currently vacant and covered with native grasses and weeds. According to a geotechnical engineering report by others from earlier this year, several small structures once occupied the northeast corner of the site. These structures had been razed by the time of our investigation, however, we are unaware if old foundations exist. The Harmony Lateral Irrigation Ditch runs from west to east across the north third of the site through the middle of the proposed building area. The north half of the site is fairly flat while the south half slopes very gradually to the south. Signs of site grading or possible previously placed fill were not observed during our site visits.

PROPOSED CONSTRUCTION

The construction currently proposed consists of a building, three parking areas and associated drives located predominantly in the northwest corner of the site. The building can be separated into two primary components; the western part will be three stories tall (medical office building) and the east part will be two stories tall (ambulatory care center). Some of the appurtenances to the building will be one-story tall. We understand the building has been designed with slab-on-grade floors and no basements, loading dock or retaining walls. The entire first floor of the building has a finished floor elevation of 4960. Maximum column loads of 200 to 350 kips are anticipated.

The three parking areas are located on the north and west sides of the building. They are connected by a series of private drives. A portion of the investigation for a public street which follows the parameter of the site is contained in this report, however, recommendations for public street design and construction will be contained in our forthcoming report. We anticipate the parking areas will experience predominantly light automobile traffic, while some of the private drives may undergo heavier traffic due to supply trucks, garbage trucks, fire trucks and ambulances.

Over most of the site, grading will be performed which will include cuts and fills of 5 to 6 feet with 2 exceptions namely, a) eight feet of fill will be placed in the landscape berms along Timberline Road and b) cuts of up to 13 feet will be required for construction of the detention ponds on the east side of the site. Site grading plans show the ground sloping away from the building. Site development will also include the installation of various utilities.

PREVIOUS INVESTIGATION

A previous geotechnical investigation was performed at this site by Terracon and summarized in a report No. 20985059, dated May 1, 1998. Their investigation consisted of 14 borings spaced in a grid-like pattern across the northwest corner of the site. Their borings extended to depths of 25.5 to 41.5 feet. Four of the borings were cored and indicated less bedrock weathering at elevations between 4924 to 4928 feet. Their laboratory testing showed low clay and bedrock swell. In general, their field and laboratory data matched ours except our borings were extended deeper and our penetration test blow counts were higher. This difference in blow counts commonly occurs between California and Standard Split Spoon sampling devices.

INVESTIGATION

Our field investigation consisted of drilling six borings to depths of 35 to 55 feet in the area of the proposed building and twenty-one borings to depths of 4 to 9 feet in the proposed alignments of the parking areas and private drives. Locations of our exploratory borings are shown in Figs. 1 and 2. The borings were advanced using 4-inch diameter continuous flight power auger and a truck mounted rig. Drive samples were taken at 5 to 10 feet intervals. Summary logs of the subsurface penetrated by our borings are contained in Figs. 4 through 6.

Drive samples were returned to our laboratory where they were classified by a geotechnical engineer. Select samples were tested for moisture content, dry density, Atterberg limits, unconfined compressive strength, swell/consolidation and water soluble sulfates. Laboratory test results are shown in Figs. 7 through 12 and summarized on Table I.

SUBSURFACE

In general our borings in the building area penetrated 12 feet to 22 feet of stiff clays over nil to 14 feet of medium dense silty sands and/or dense sands underlain at depths of 19 feet to 26 feet (elevations of 4931 to 4944 feet) by hard to very hard interlayered claystone and sandstone or hard to very hard claystone bedrock with the upper nil to 3 feet weathered. Ground water was measured in 3 of the 6 borings at depths from 13 to 34 feet (elevations of 4933 to 4945 feet) when the holes were drilled. Ground water was measured in all of the borings at depths from 14 to 23 feet (elevations of 4938 to 4944 feet) when rechecked several weeks after drilling. Our borings in the areas of the proposed pavements penetrated stiff sandy clays to the depths explored of 5 to 10 feet.

Samples of the upper clays showed nearly nil swell potential due to wetting in our one-dimensional odometer tests. A sample of the silty sands contained 36 percent silt and clay size particles (passing the No. 200 sieve). The sands exhibited caving in one of our borings during drilling. Samples of the claystone bedrock showed low swell due to wetting in our one-dimensional odometer tests. Our penetration tests revealed the bedrock in our borings was gradually harder with depth. Our estimate of the elevation to the top of bedrock is shown on Fig. 3.

The extent of ground water and caving sands will vary with location and depend on season of the year. Casing will be necessary to clean and dewater most of the pier holes.

SITE GRADING

In our opinion, the soils penetrated by our borings can be excavated using conventional heavy duty earthworking equipment. No exceptionally soft or loose soils were identified which would hamper mobility on the site.

Prior to placing fill, vegetation and organics should be stripped from the ground surface the the surface should be scarified to a depth of 6 inches, moisture conditioned and compacted with 5 passes of a heavy tractor towed roller or self propelled compactor. Fill should not be placed on frozen subgrade. Any remaining improvements or construction debris, such as any existing foundations in the northeast corner of the site, should be removed prior to earth work.

We anticipate up to 5 feet of fill will be placed in the building and parking lot areas to raise grades to the desired elevations and up to 8 feet of fill will be placed in landscaping areas. All materials used in site grading can consist of on-site soils free of organics or other deleterious materials and absent of cobble and debris greater than 6 inches in diameter. If import fill materials are required, they should be similar to on-site materials and have low swell potential. Samples of all proposed import materials should be submitted to our office for approval prior to hauling to the site. Fill placement and compaction activities should not be conducted when the fill material is frozen.

Site grading fill should be placed in 8-inch maximum thick loose lifts at 2 percent below to 2 percent above optimum moisture content and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698) with a heavy tractor towed roller or self-propelled compactor. A representative from our office should be on-site to observe and test fill placement during construction.

Special consideration should be given to site grading for the assumed abandonment of the Harmony Lateral Irrigation Ditch, which extends below the proposed parking areas and building pad. The berm on the south side of the irrigation ditch is likely man-placed fill of unknown compaction. The berm should be leveled and its materials reprocessed during site grading. In our experience, seepage often continues to follow the paths of old drainages. We recommend additional care be taken to scarify the soils along the bottom of the irrigation ditch to achieve proper "marriage" with the site grading fill.

Site grading in areas of landscaping where no future improvements are planned can be placed at a density of at least 90 percent of standard Proctor maximum dry density (ASTM D 698). Example site grading specifications are given in Appendix C.

UTILITIES

Utility excavation sides will need to be sloped or braced. We believe the clays penetrated by our borings are Type B as described in the Occupational Safety and Health Administration (OSHA) standards governing excavations published by the Department of Labor. The publication indicates a minimum slope of 1:1 (horizontal:vertical) for Type B soils above the groundwater level. Soils removed from an excavation should not be stockpiled at the edge of the excavation. We recommend the excavated soils be placed at a distance from the top of the excavation equal to at least the depth of the excavation. OSHA regulations require bracing and/or slopes for excavations greater than 20 feet tall be designed by a Registered Professional Engineer.

The width of the top of an excavation may be limited in some areas. Bracing or "trench box" construction may be necessary. Bracing systems include sheet piling, braced sheeting and others. Lateral loading of bracing depends on the depth of excavation, slope of excavation above the bracing, surface loads, hydrostatic pressures, and allowable movement. For trench boxes and bracing allowed to move enough to mobilize the strength of the soils with associated cracking of the ground surface, the "active" earth pressure conditions are appropriate for design. If movement is not tolerable, the "at rest" earth pressures are appropriate. We suggest an equivalent fluid weight of 30 pcf for "active" earth pressure and 45 pcf for "at rest" earth pressure, assuming level backfill. These pressures do not include allowances for surcharge loading or for hydrostatic conditions. We are available to assist further with bracing design if desired.

Utility trenches should be backfilled using the materials and criteria discussed in the SITE GRADING section of this report.

FOUNDATIONS

Drilled piers and footings were considered relevant foundation alternatives for the proposed building. Drilled piers generally outperform footing foundations on sites similar to the hospital site. A discussion of each of these alternatives and appropriate foundation design criteria are provided in the sections which follow.

Drilled Piers

We penetrated and sampled the bedrock as much as 35 feet with our borings. Our analysis of the data show the bedrock is harder with depth. There are three layers. The first about 10 feet of the bedrock is not as hard as about the next 10 feet, which, in turn, is not as hard as that layer at least 20 feet below the top of the bedrock. We opine drilled piers would be an excellent foundation for the proposed building and would be the alternative with the least risk of unacceptable foundation movement.

In our opinion, piers should penetrate the unweathered bedrock at least 4 feet. Piers bottoming in the bedrock above elevation 4930 (Upper Bedrock Zone in Fig. 4) should be designed for a maximum end-bearing pressure of 25,000 pounds per square foot (psf), a side shear of 2,500 psf for that part of the pier in bedrock, and a minimum dead load pressure of 10,000 psf based on the cross-sectional area of the pier at the top to help concentrate the building loads to resist uplift from the claystone if it gets wetter. Piers bottoming in the bedrock between elevations 4930 and 4920 (Middle Bedrock Zone in Fig. 4) can be designed for a maximum end-bearing pressure of 50,000 psf, a side shear of 5,000 psf for that part of the pier between elevations 4930 and 4920, a side shear of 2,500 psf for that part of the pier in bedrock above elevation 4930 and a minimum dead load pressure of 10,000 psf based on the cross-sectional area of the pier at the top. Piers bottoming in the bedrock below 4920 (Deeper Bedrock Zone in Fig. 4) can be designed for a maximum end-bearing pressure of 65,000 psf, a side shear of 6,500 psf for that part of the pier below elevation 4920, a side shear of 5,000 psf for that part of the pier between elevations 4930 and 4920, a side shear of 2,500 psf for that part of the pier in the bedrock above elevation 4930 and a minimum dead load pressure of 10,000 psf based on the cross-sectional area of the pier at the top. We recommend the following additional criteria for drilled pier design:

1. For designing the uplift resistance of piers for wind and seismic loads, the skin friction values given above for the bedrock can be used provided the sides of the pier hole in bedrock are grooved.

2. Piers should be reinforced the full length of the pier with Grade 60 reinforcing steel having a combined area at least 0.005 times the pier cross-sectional area. Reinforcement should extend into grade beams. Additional reinforcement may be necessary depending on structural loads.

3. There should be a 4-inch (or thicker) continuous void beneath all grade beams between piers to concentrate the dead load of the buildings on the piers.

4. Piers should be cleaned prior to placing concrete. We found water in our borings , therefore, the pier holes will need to be temporarily cased to clean and dewater the holes. Concrete should be placed immediately after the holes are drilled, cleaned and inspected utilizing the "drill-and-pour" procedure to avoid possible contamination of the open pier holes. Needed casing should be available on-site during pier hole drilling.

5. Concrete should have a sufficient slump so it will fill the pier holes and will not hang on the sides of the casing during extraction. We recommend a slump in the range of 5 to 7 inches.

6. Formation of "mushrooms" or enlargements at the top of piers should be avoided during drilling and subsequent construction operations.

7. Installation of drilled piers should be observed by a representative of our firm to identify the bearing strata.

The piers may be required to resist lateral loads applied to the structure. There are several methods available for designing piers subjected to lateral loads. L-pile is one of the methods used to model the various layers of materials. For purpose of design, we believe the following geotechnical criteria can be used in the L-pile method.

<u>Clays</u>

wet density (pcf)	120
cohesion (psf)	2,000
strain corresponding to one-half the Principal stress difference (E_{50})	0.005
modulus of horizontal subgrade reaction (pci)	1,000

<u>Sands (above water)</u>

wet density (pcf)	125
angle of internal friction (deg)	35
modulus of horizontal subgrade reaction (pci)	200

<u>Sands (below water)</u>

submerged density (pcf)	63
angle of internal friction (deg)	35
modulus of horizontal subgrade reaction (pci)	100

<u>Bedrock</u>

Elevation-top of bedrock to 4930 (Upper Bedrock Zone)

wet density (pcf)	120
cohesion (psf)	4,000
strain corresponding to one-half the Principal stress difference (E_{50})	0.003
modulus of horizontal subgrade reaction (pci)	2,000

Elevation-4930 to 4920 (Middle Bedrock Zone)

wet density (pcf)	120
cohesion (psf)	6,000
strain corresponding to one-half the Principal stress difference (E_{50})	0.002
modulus of horizontal subgrade reaction (pci)	3,000

Elevation-below 4920 (Deeper Bedrock Zone)

wet density (pcf)	120
cohesion (psf)	8,000
strain corresponding to one-half the Principal stress difference (E_{50})	0.001
modulus of horizontal subgrade reaction (pci)	4,000

The above design values for the L-pile method do not include a factor of safety. The earlier design values for drilled piers (contained in items 1 through 7 and paragraph above) are "working values" and do include a factory of safety.

Footings

An alternative foundation for the buildings is footings bearing on the natural soils and/or densely compacted site grading fill placed to realize the elevation for certain footings. Buildings founded with footings will probably experience greater foundation movement than pier founded buildings and there is more risk that the movement that does occur will be unacceptable, although, we believe this risk is low if footings are designed with the criteria we have given below.

1. Footings should bear on undisturbed natural soils or densely compacted man-placed fill. Where soil is loosened during excavation, it should be removed and replaced with on-site soils compacted following the criteria contained in the SITE GRADING section of this report.

2. Footings bearing on the natural soils and/or compacted site grading fill can be designed for a maximum soil bearing pressure of 3,000 pounds per square foot and a minimum dead load pressure of 1,000 pounds per square foot to resist the potential swell pressure of the clays.

3. Footings should have a minimum width of at least 16 inches. Foundations for isolated columns should have minimum dimensions of 24 inches by 24 inches. Larger sizes may be required depending on load and the structural system used.

4. The subsoils beneath footing pads can be assigned a coefficient of friction of 0.4 to resist lateral loads. The ability of grade beams, or footing backfill to resist lateral loads can be designed for using a passive equivalent fluid pressure of 250 pcf. This assumes the backfill is densely compacted and will not be removed. Backfill should be placed in thin lifts and compacted to 95 percent of standard Proctor maximum dry density (ASTM D 698) at a moisture content within 2 percent of optimum.

5. To meet the minimum deadload criteria, a continuous void with minimum 4-inch thickness should be placed below grade beams between pads to concentrate the load of the structures on the footing pads.

6. Exterior footings should be protected from frost action. We believe 30 inches of frost cover is appropriate for this site.

7. Foundation walls for continuous footings should be well reinforced both top and bottom. We recommend the amount of steel equivalent to that required for a simply supported span of 10 feet. The soils bearing pressure can be increased 30 percent for short duration live loads such as wind loads.

8. Completed footing excavations should be inspected by a representative of our firm to confirm that the soils are as we anticipated from our test holes. Occasional loose soils may be found in foundation excavations. If this occurs, we recommend the loose soils be removed prior to forming footings.

SLAB-ON-GRADE FLOORS

The subgrade for slab-on-grade floors will be the natural clays and/or man-placed fill needed to achieve the desired subgrade elevations. The natural clays showed low swell potential in samples we tested from our borings. We also have results from an investigation of the ground just south of the Center which confirms the low swell potential in these clays.

In our opinion, it is reasonable to use slab-on-grade floors for the proposed building. Any fill placed for the floor subgrade should be built with densely compacted, site grading fill like discussed in the SITE GRADING section of this report.

It is impossible to construct slab-on-grade floors with no risk of movement. We believe movements due to swell will be on less than 1 inch at this site. We recommend the following details to minimize the risk of damage in the event of slab movement.

1. The slabs should bear directly on the subgrade. Immediately prior to slab placement, the subgrade should be scarified to a depth of 6 to 8 inches, moisture conditioned to within 2 percent of optimum moisture content and compacted to at least 95 percent of standard of standard Proctor maximum dry density (ASTM D 698). The area should be proof rolled using a pneumatic tired vehicle (such as a water truck) to identify soft, wet or yielding areas. These areas should be removed and replaced with properly compacted fill.

2. Slabs should be designed to support the anticipated equipment loads. A subgrade modulus of 100 pci can be assumed for the natural soils and completed fill for slab design.

3. Slabs should be separated from exterior walls, interior bearing members and all slab projections with a slip joint which allows free vertical movement of the slab. Utilities which pass through the slab should be isolated form the slab. Interior partitions should be designed to prevent the transmission of upward slab movement to the upper stories of the building.

4. Frequent control joints should be provided in the slab to reduce problems associated with shrinkage. The American Concrete Institute (ACI) recommendations should be followed.

PAVEMENTS

Only private streets and parking areas will be addressed here. The public streets along the perimeter of the site will be addressed in our forthcoming report.

Subgrade soils were investigated by drilling borings on approximately 400 feet centers along each private street and drilling one boring in each of the three parking areas. Laboratory tests completed to date on select representative samples indicated the sandy clays that will be the subgrade for provate pavements generally classify as AASHTO category A-6 and A-7 with a group indices of 11 to 19. We anticipate pavements in areas that will receive site grading fill will be supported by materials with similar characteristics. We used the group index approach to estimate the support characteristics of the anticipated subgrade in our design calculations.

We have considered both flexible asphaltic concrete and rigid Portland cement concrete pavements. Alternatives which include each material are provided below. Our designs are based on the AASHTO design method and our experience. For design calculations we assumed a daily traffic number (DTN) of 10 for those areas of parking which will be subjected to automobile traffic only and a DTN of 50 for access drives which will be used for heavy delivery trucks, trash trucks, fire trucks and ambulances. We envision that a member of the design team that ultimately configures the parking and access drives will select the locations for which the different pavement sections will be used.

Using the criteria discussed above we recommend the following minimum pavement sections:

Pavement Classification	Full-Depth Asphalt	Asphalt + Aggregate Base Course	Portland Cement Concrete
Parking	6.5"	4.0" + 8.0"	6.0"
Access Drives	8.0"	5.0" + 10.0"	7.0"

Our experience indicates rigid Portland cement concrete pavements generally perform better than asphalt pavements. Concrete pavements generally require lower maintenance. Pavement failures have occurred in areas where heavy trucks and trash trucks start and stop and make slow turning movements. In areas such as entrances, loading and unloading zones, and trash collection areas, we recommend Portland cement concrete pavement be used. Concrete pavement appears to perform better in these areas because the concrete better distributes wheel loads over a larger area resulting in lower subgrade stresses.

Design of the pavement section is a function of paving materials and support characteristics of the subgrade. The quality of paving materials is reflected in the structural coefficients we used in the above evaluation. If the pavement is constructed of inferior material, then its serviceability and life will be reduced.

The asphaltic concrete component of the pavement section was evaluated assuming at least a 1650 pound Marshall stability and asphalt aggregate which is relatively impermeable to moisture and well graded. We recommend a job mix design be performed and periodic checks at the job site be made to verify compliance with the specifications as asphaltic concrete is placed.

The structural coefficient assumed for the aggregate base course in our above evaluation is an R-value of 78. The Colorado Department of Highways Class 5 or Class 6 base courses will normally meet these requirements. Base course varies

considerably and can be sensitive to change in moisture, therefore, we recommend the material planned for base course be laboratory tested prior to importing it to the site.

Our designs are based on the assumed modulus of rupture (flexural strength) of 600 psi for concrete. We recommend concrete contain a minimum of 5.5 sacks of cement per cubic yard and between 5 and 7 percent entrained air. A mix design should be prepared for paving using the aggregate and cement that will be used during construction.

If the construction material selected cannot meet the above requirements the pavement design should be re-evaluated using strength parameters for the available materials. Materials and placement methods should conform to the requirements of the State Department of Highways, Division of Highways, State of Colorado "Standard Specifications for Road and Bridge Construction". All material planned for construction should be submitted and tested to verify compliance with the project specifications.

Experience shows construction methods can effect serviceability and the life of the pavement. The compacted fill needed beneath pavements can be inorganic on-site or similar off-site soils with 100 percent 6 inches or finer, placed in 8-inch maximum loose lifts at 2 percent below to 2 percent above optimum moisture content and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698). See Appendix A for additional recommendations.

Construction control and inspections should be carried out during subgrade preparation and paving operations by a representative of our firm. Concrete should be carefully monitored for quality control. To avoid problems associated with scaling and to continue strength gain, we recommend deicing salts not be used the first year after placement.

Utilities such as water and sewer are usually placed beneath pavement. Utilities should be installed, tested, and approved prior to paving. There may be pre-existing utility trenches across a portion of this site not identified during this investigation. If any are found, the top 2 feet of backfill should be replaced as fill compacted to 95 percent of ASTM D 698. If utility trench backfill was not moisture treated and densely compacted, differential settlement will result which will destroy the pavement. Placement and compaction of trench backfill should be observed, tested, and approved prior to paving. Careful attention should be paid to compaction at curb backs and around manholes.

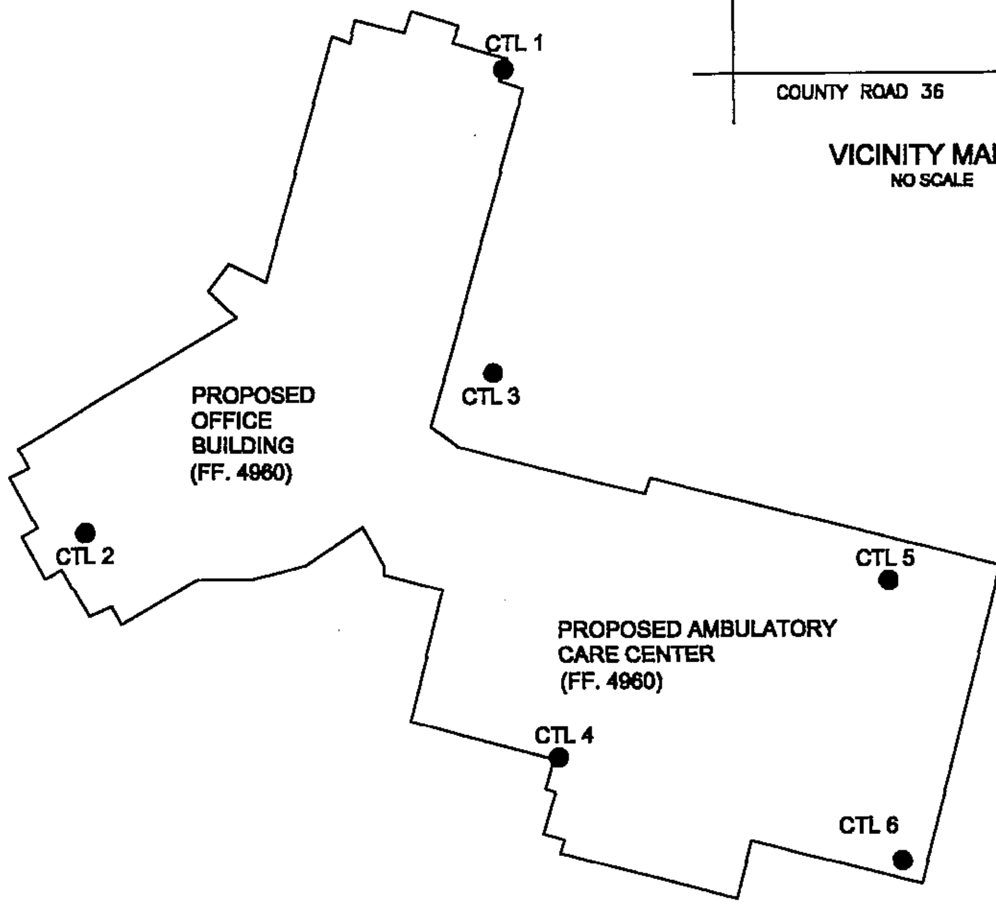
Excavation of completed pavement for utility construction or repair can destroy the integrity of the pavement and result in a severe decrease in serviceability. To restore the pavement top original serviceability, careful backfill compaction before repaving is necessary.

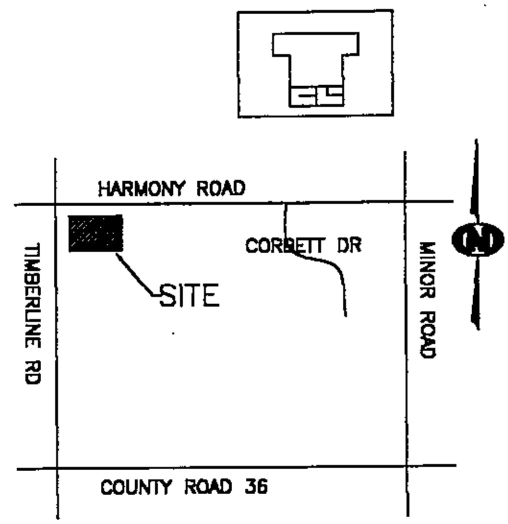
The primary cause of premature pavement deterioration is infiltration of water into the pavement system. This increase in moisture content usually results in the softening of base course and subgrade and eventual failure of the pavement. We recommend pavements and surrounding ground surface be sloped to cause surface water to rapidly run off and away from pavements. Curb and gutter should be

2 CC: Mr. Wayne Muir, PE
Structural Consultants, Inc.
3400 East Bayand Avenue, Ste 300
Denver, Colorado 80209

2 CC: Mr. Dennis Ashley
M.A. Mortenson Company
1875 Lawrence, Ste 600
Denver, Colorado 80202

SCALE: 1"=100'





VICINITY MAP
NO SCALE

LEGEND:

CTL 6 ● APPROXIMATE LOCATION OF EXPLORATORY BORING

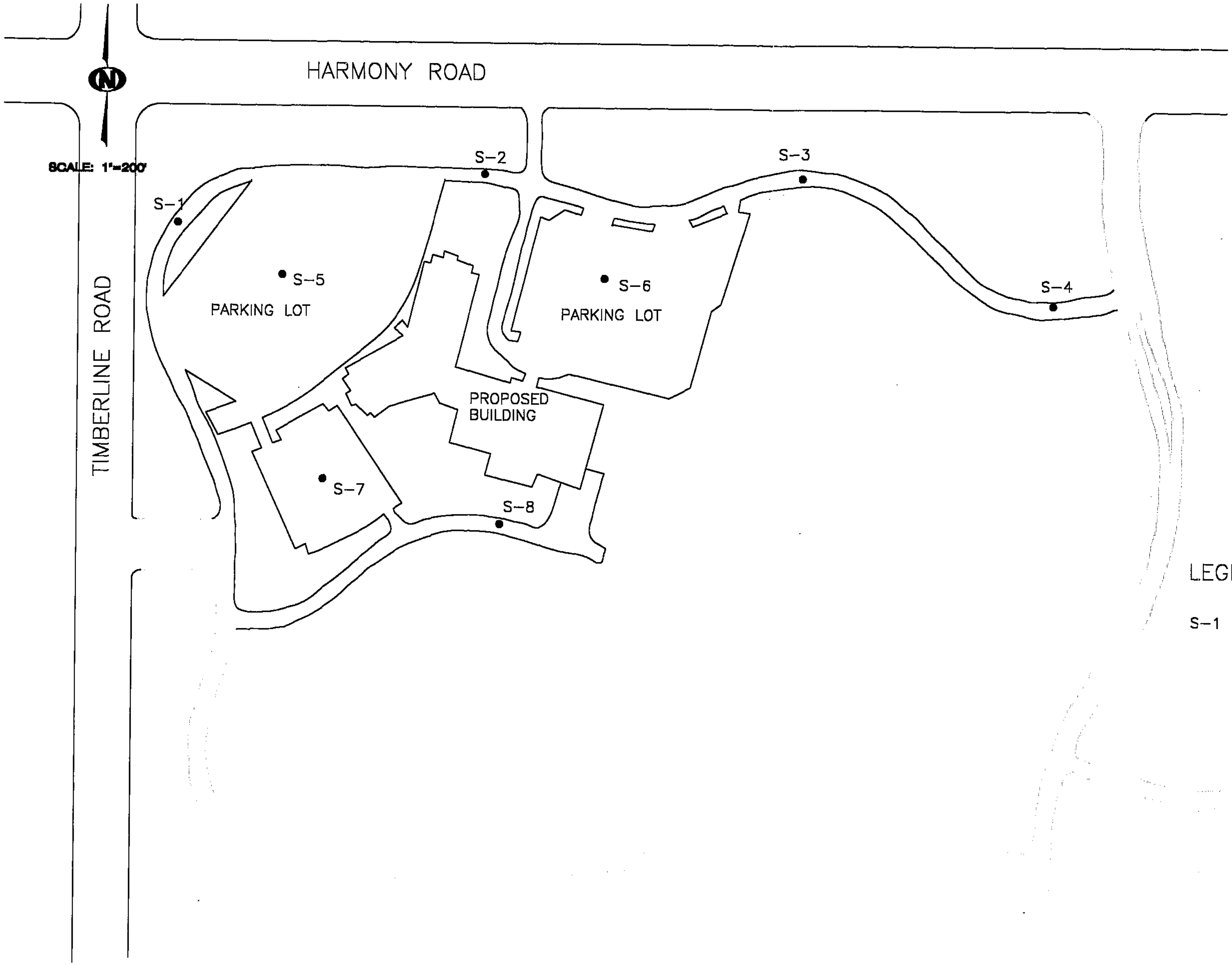
FC-1116_F1 11/25/98 JO

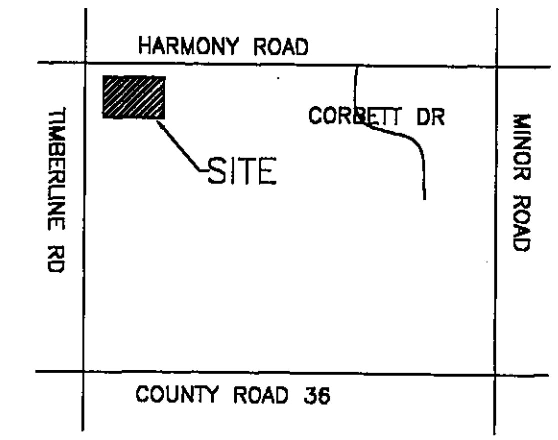
Poudre Valley Health System
HARMONY CAMPUS MEDICAL CENTER

Job No. FC-1116

Locations of Exploratory Borings

Fig. 1





VICINITY MAP
NO SCALE

LEGEND:

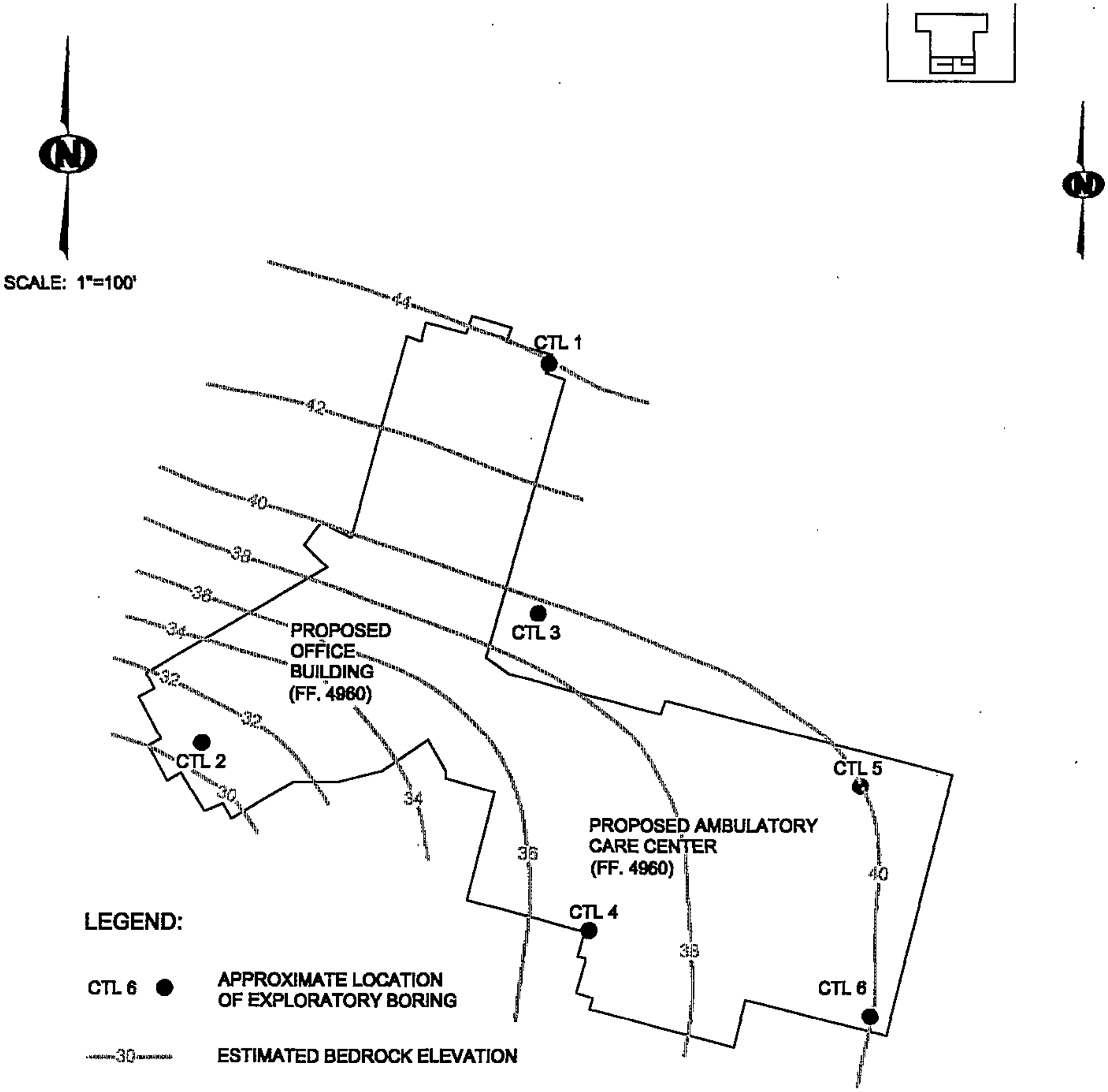
S-1 ● APPROXIMATE LOCATION OF EXPLORATORY BORING

Poudre Valley Health System
HARMONY CAMPUS MEDICAL CENTER
Job No. FC-1116

Locations of Exploratory Borings

Fig. 2

FC-1116_F2 11/25/98 JO



Note: This estimate is based on subsurface conditions revealed in our borings. Bedrock elevation will differ between our borings. Bedrock elevation should be field verified by a representative from our office during pier drilling.

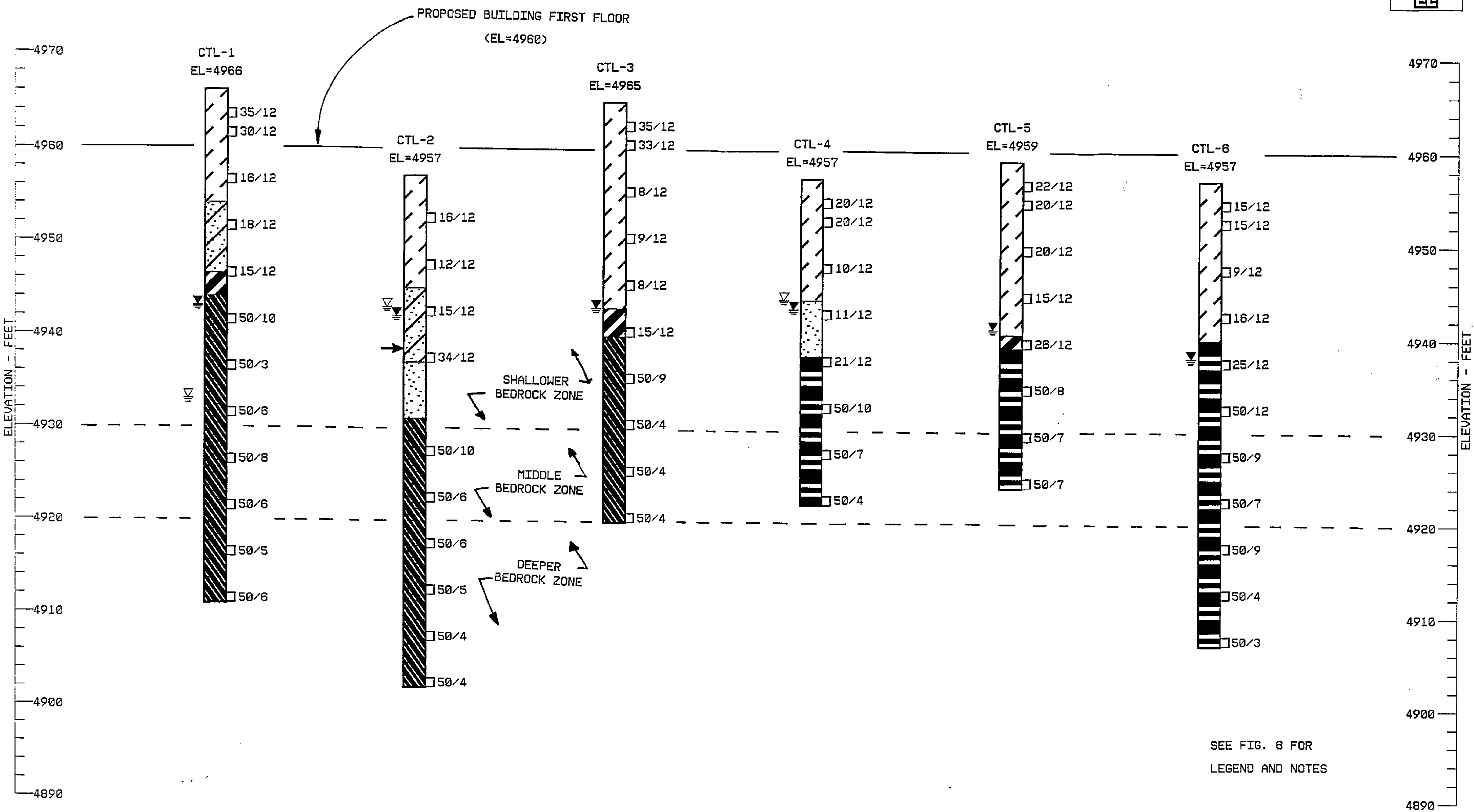
FC-1116_F1 11/25/98 JO

Poudre Valley Health System
HARMONY CAMPUS MEDICAL CENTER

Job No. FC-1116

Estimated Elevation to Bedrock

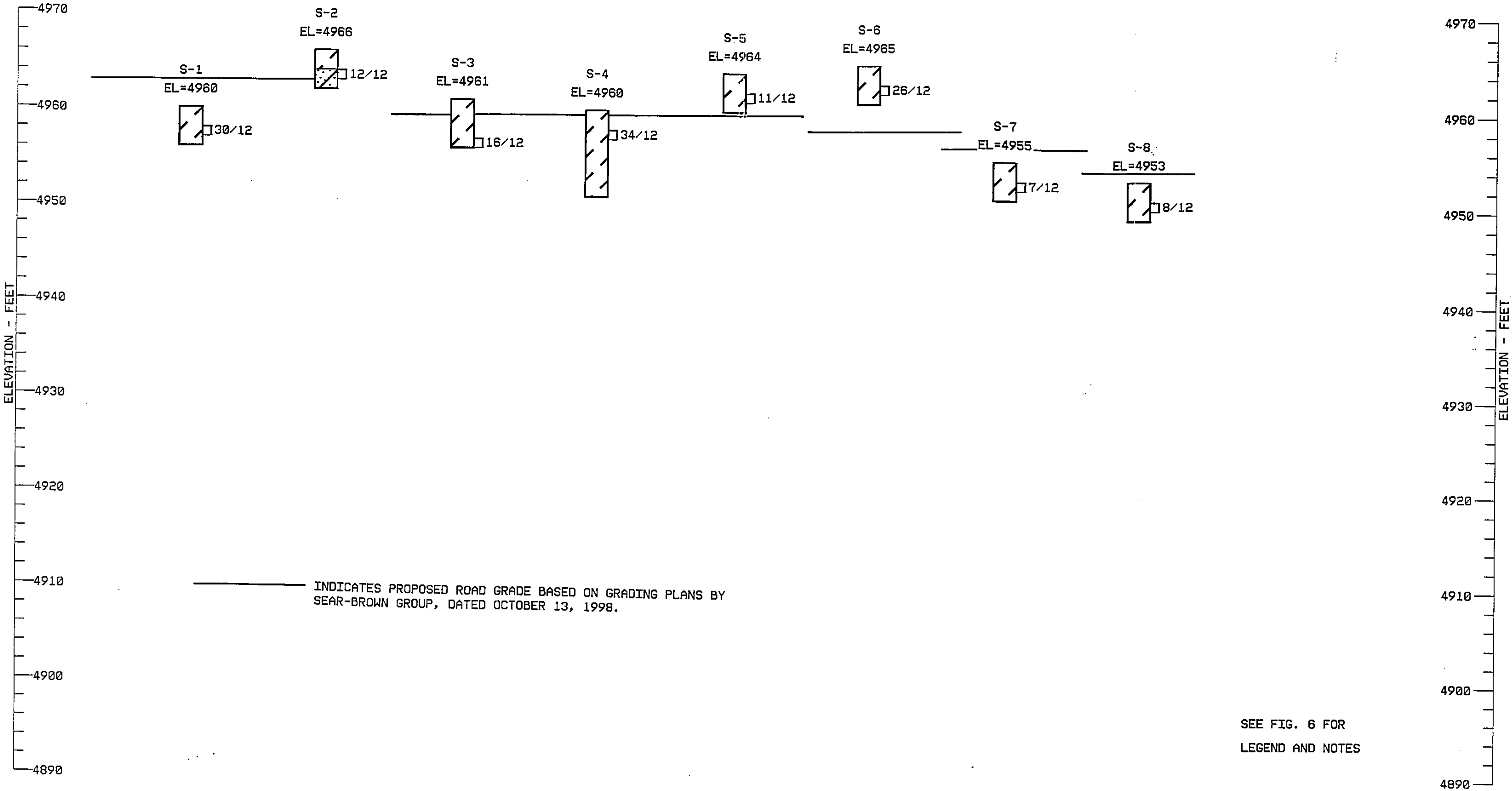
Fig. 3



SUMMARY LOGS OF EXPLORATORY BORINGS

JOB NO. FC-1116

FIG. 4



INDICATES PROPOSED ROAD GRADE BASED ON GRADING PLANS BY SEAR-BROWN GROUP, DATED OCTOBER 13, 1998.

SEE FIG. 6 FOR LEGEND AND NOTES

SUMMARY LOGS OF EXPLORATORY BORINGS

JOB NO. FC-1116

FIG. 5

LEGEND:

CLAY, SANDY, SILTY, VERY STIFF, SLIGHTLY MOIST, DARK BROWN, BROWN (CL).

SAND, CLEAN TO SLIGHTLY SILTY, DENSE, WET, REDDISH BROWN (SP-SM).

SAND, SLIGHTLY SILTY, SLIGHTLY GRAVELLY, MEDIUM DENSE, REDDISH BROWN (SM).

WEATHERED, INTERBEDDED CLAYSTONE AND SANDSTONE, SLIGHTLY MOIST, OLIVE, BROWN (WEATHERED BEDROCK).

INTERBEDDED CLAYSTONE AND SANDSTONE, HARD TO VERY HARD, SLIGHTLY MOIST, GRAY, DARK GRAY, OLIVE, RUST (BEDROCK).

CLAYSTONE, HARD TO VERY HARD, SLIGHTLY MOIST, OLIVE, RUST, BROWN (BEDROCK).

DRIVE SAMPLE. THE SYMBOL 35/12 INDICATES THAT 35 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5 INCH O.D. SAMPLER 12 INCHES.

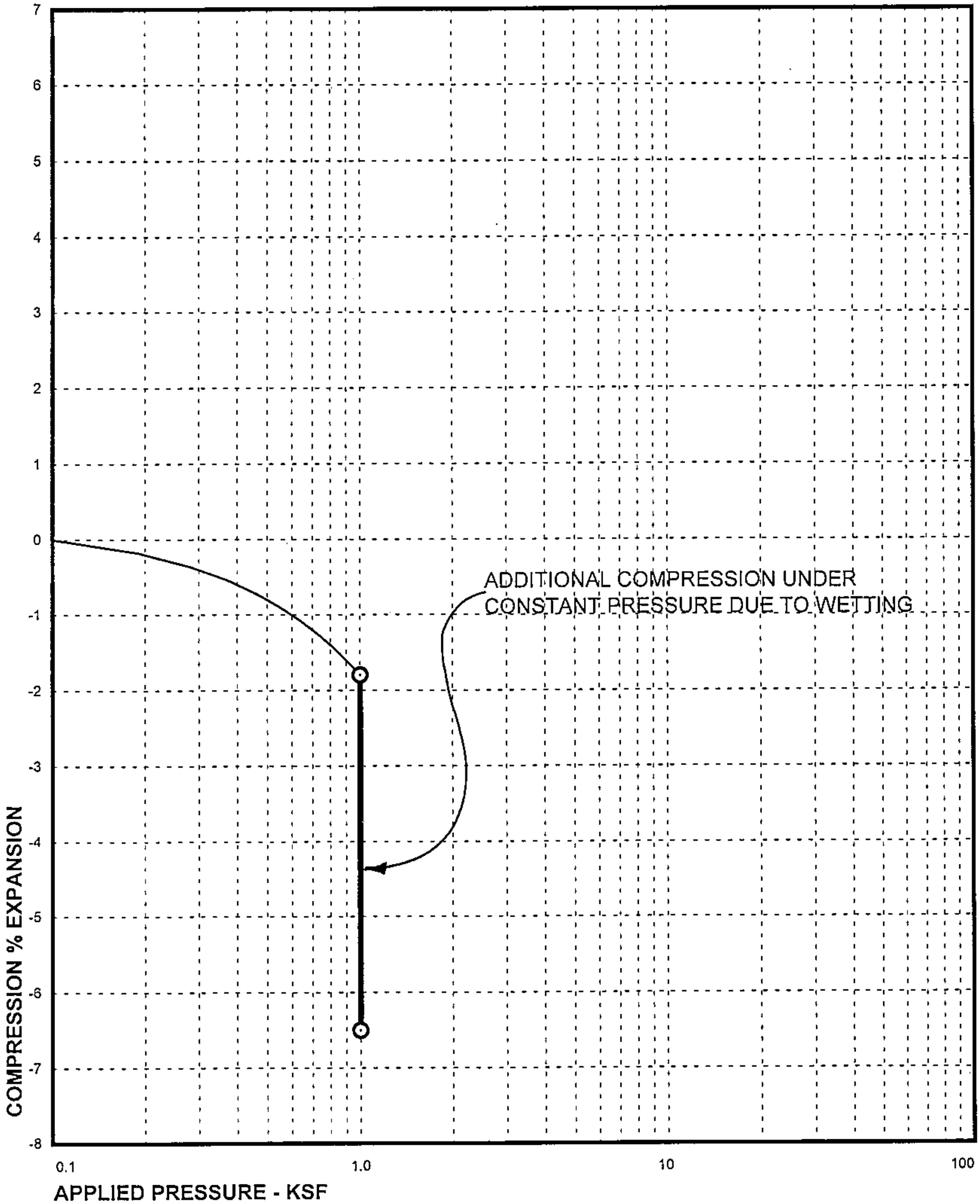
INDICATES WATER LEVEL MEASURED AT THE TIME OF DRILLING.

INDICATES WATER LEVEL MEASURED SEVERAL DAYS AFTER DRILLING.

INDICATES DEPTH AT WHICH HOLE CAVED DURING DRILLING.

NOTES:

1. BORINGS WERE DRILLED NOVEMBER 5 THROUGH 13, 1998 USING 4-INCH DIAMETER, CONTINUOUS FLIGHT, POWER AUGER AND TRUCK-MOUNTED RIG.
2. BORING ELEVATIONS WERE SURVEYED BY PRECISION SURVEY AND MAPPING, INC. EXCEPT BORINGS CTL-6, S-7, AND S-8 WERE TAKEN FROM TOPOGRAPHIC MAP FURNISHED BY THE SEAR-BROWN GROUP.
3. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS AND CONCLUSIONS IN THIS REPORT.



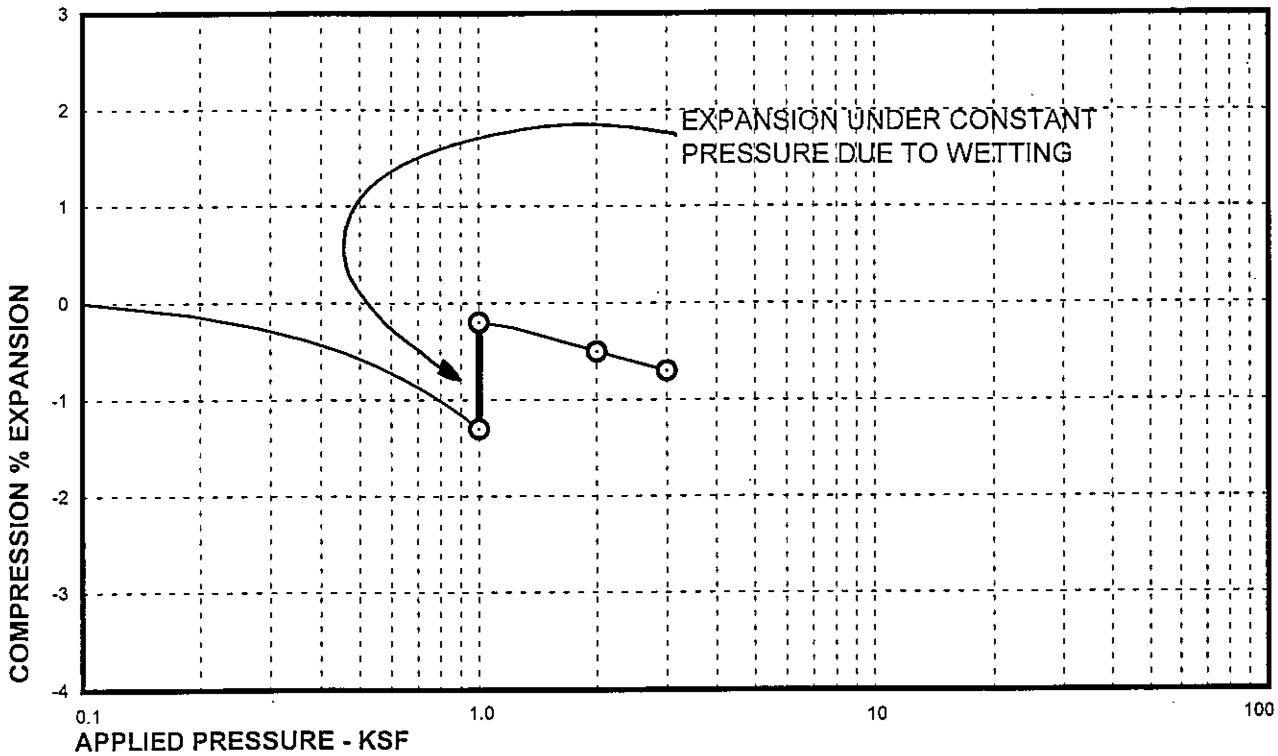
Sample of CLAY, SANDY (CL)
From CTL- 1 AT 9 FEET

NATURAL DRY UNIT WEIGHT= ______ PCF
NATURAL MOISTURE CONTENT= 10.6 %

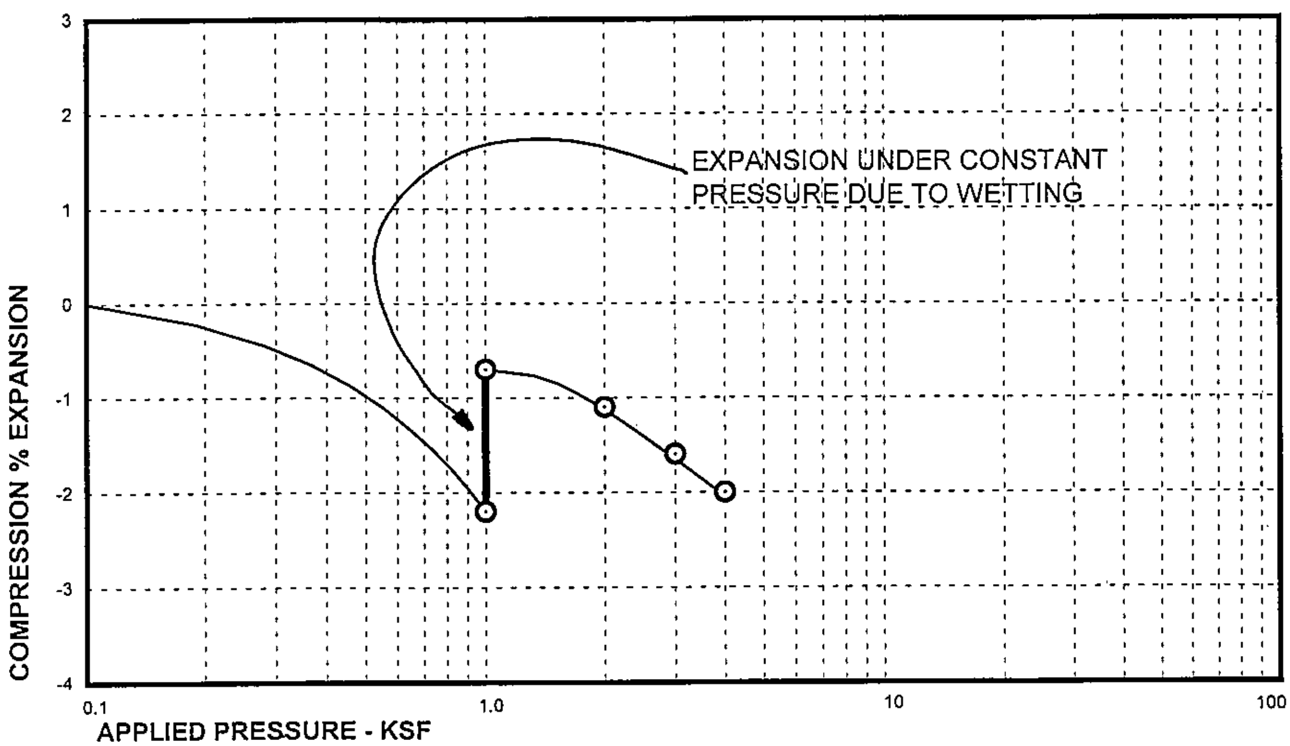
Swell Consolidation Test Results

JOB NO. FC-1116

FIG. 7



Sample of	INTERBEDDED CLAYSTONE/SANDSTONE	NATURAL DRY UNIT WEIGHT=	117	PCF
From	CTL- 1 AT 24 FEET	NATURAL MOISTURE CONTENT=	16.4	%

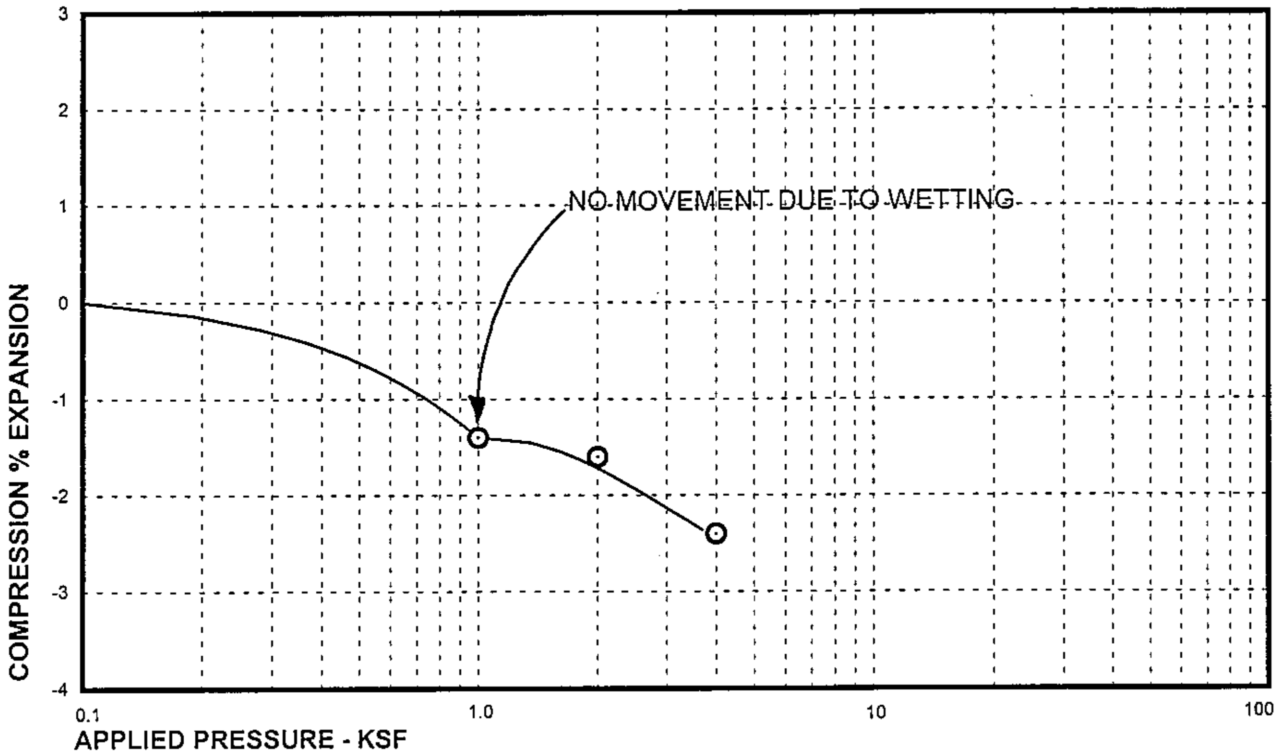


Sample of	CLAYSTONE	NATURAL DRY UNIT WEIGHT=	106	PCF
From	CTL- 2 AT 44 FEET	NATURAL MOISTURE CONTENT=	18.2	%

Swell Consolidation Test Results

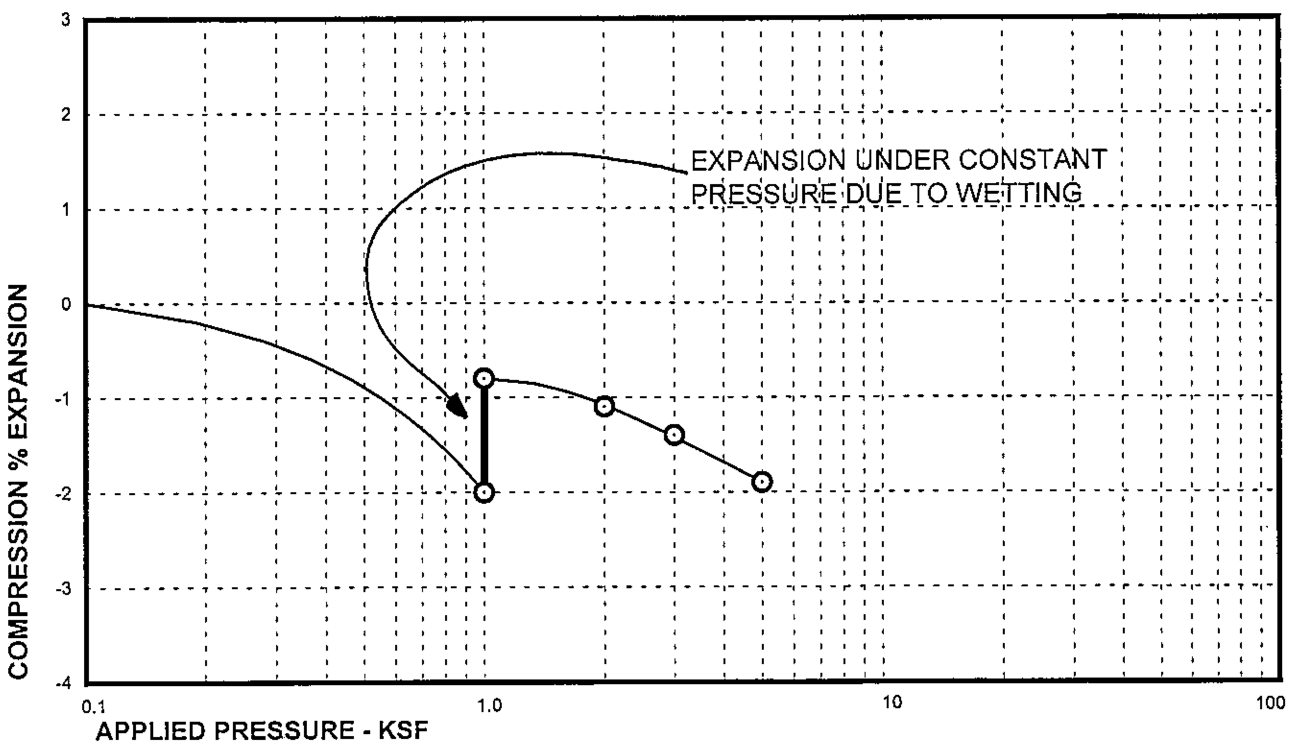
JOB NO. FC-1116

FIG. 8



Sample of CLAY, SANDY (CL)
From CTL- 3 AT 9 FEET

NATURAL DRY UNIT WEIGHT= PCF
NATURAL MOISTURE CONTENT= 17.9 %



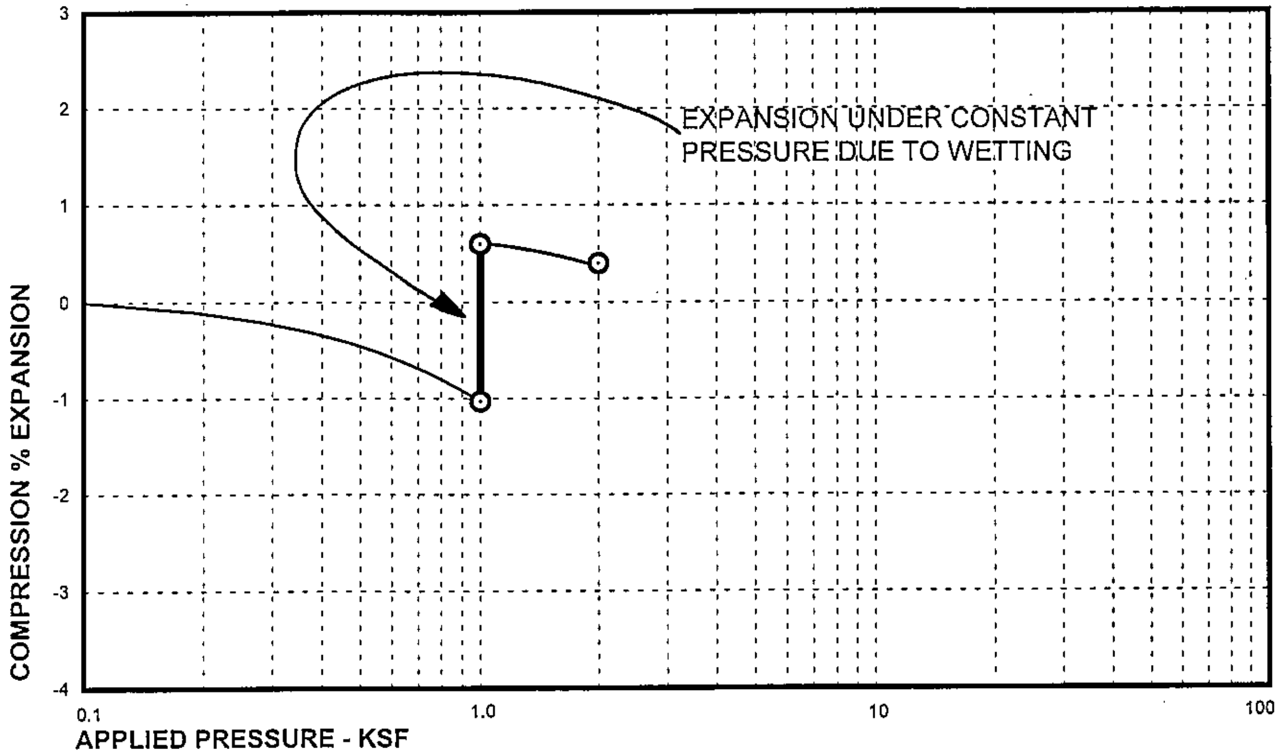
Sample of CLAYSTONE
From CTL- 3 AT 39 FEET

NATURAL DRY UNIT WEIGHT= 113 PCF
NATURAL MOISTURE CONTENT= 16.2 %

Swell Consolidation Test Results

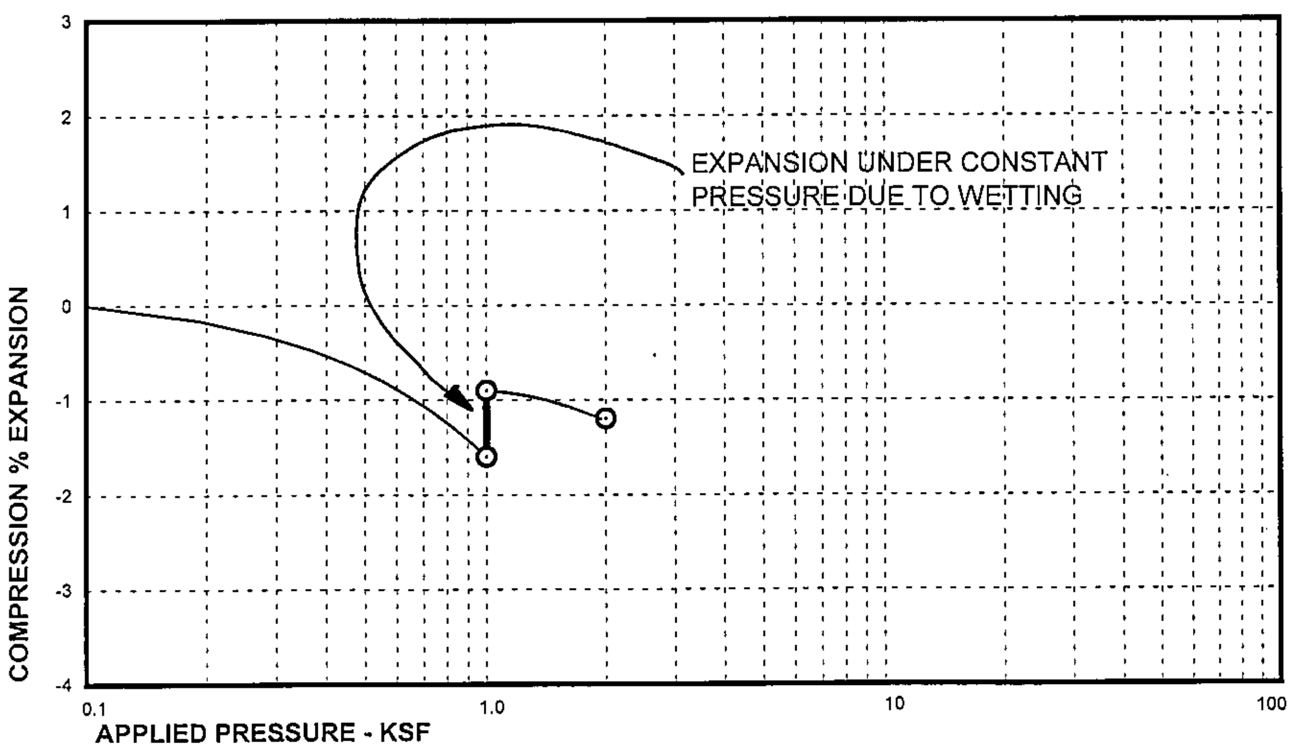
JOB NO. FC-1116

FIG. 9



Sample of CLAYSTONE
From CTL- 4 AT 19 FEET

NATURAL DRY UNIT WEIGHT= 102 PCF
NATURAL MOISTURE CONTENT= 22.2 %



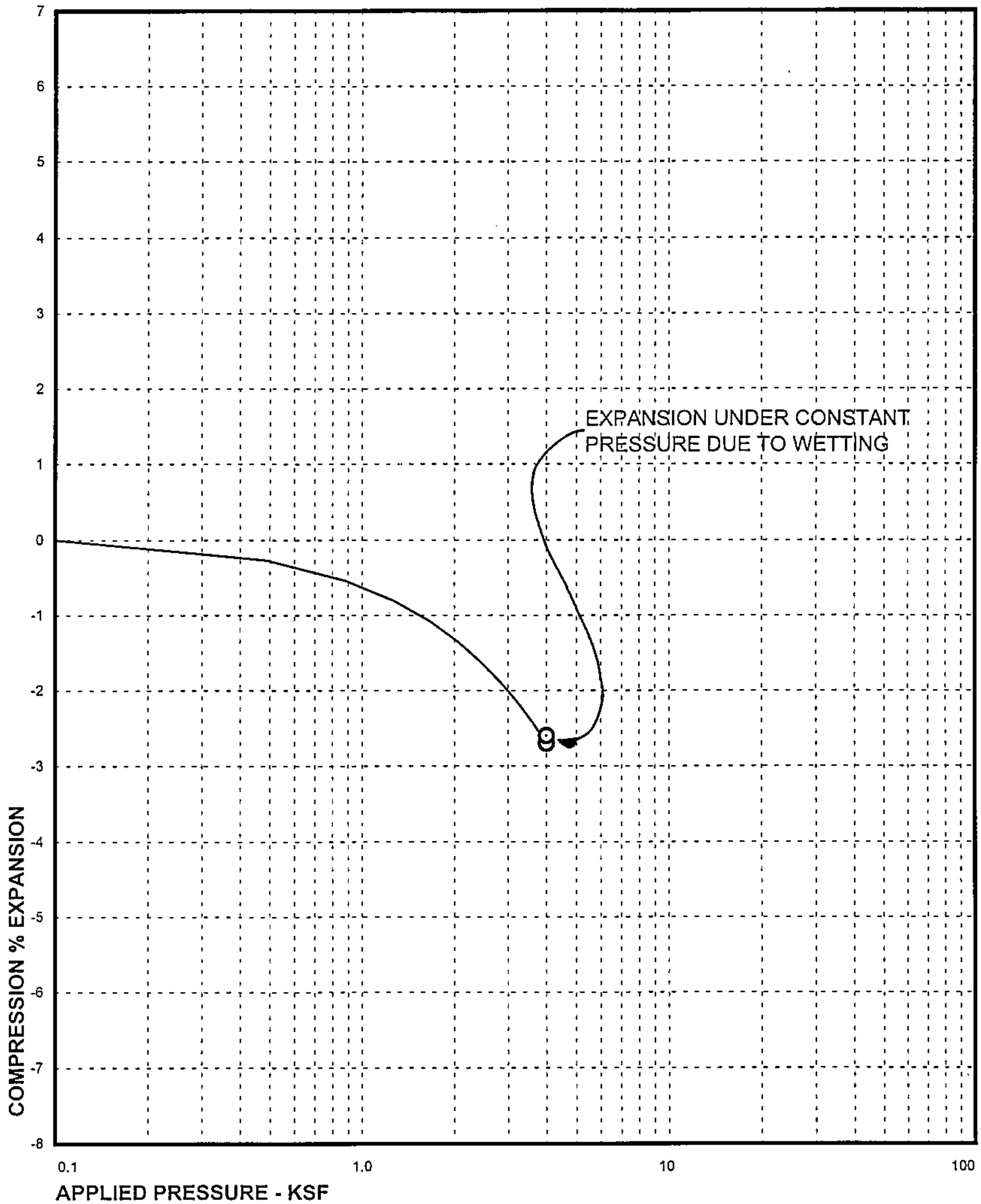
Sample of CLAY, SANDY (CL)
From CTL- 5 AT 2 FEET

NATURAL DRY UNIT WEIGHT= 112 PCF
NATURAL MOISTURE CONTENT= 18.1 %

Swell Consolidation Test Results

JOB NO. FC-1116

FIG. 10



Sample of CLAY, SANDY (CL)

From CTL- 5 AT 4 FEET

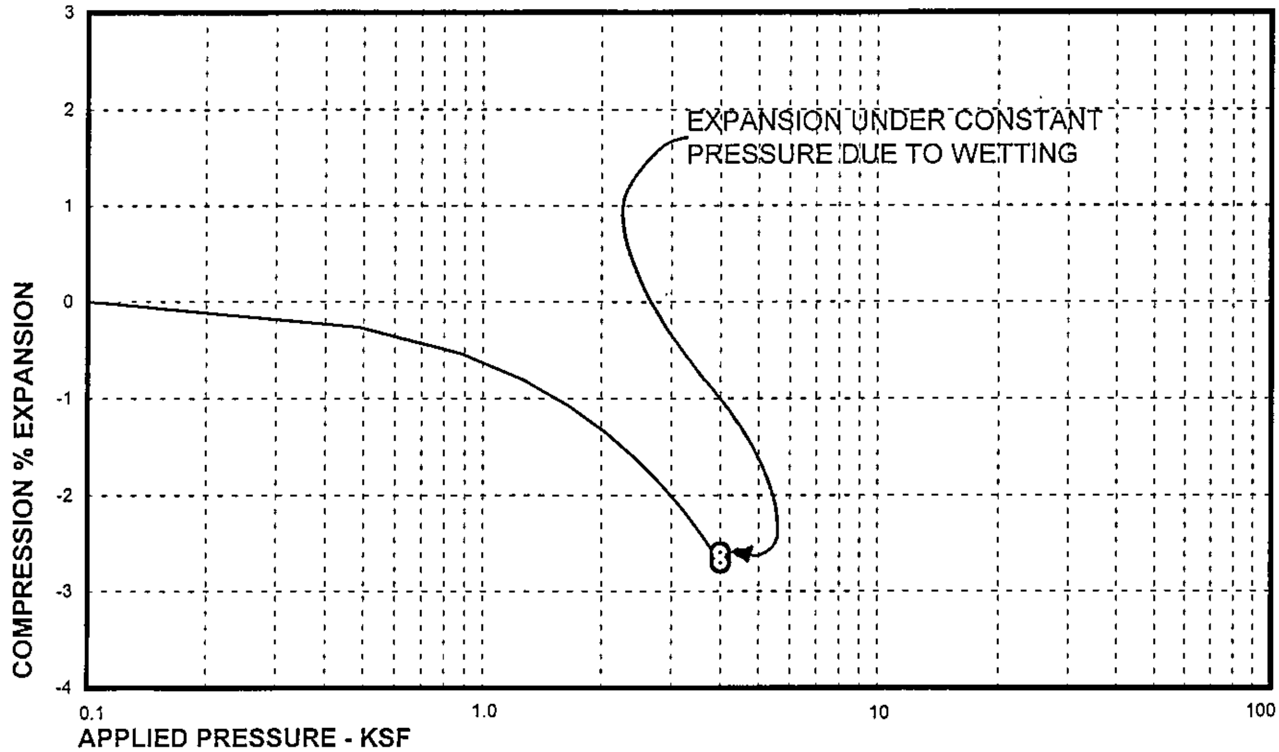
NATURAL DRY UNIT WEIGHT= ______ PCF

NATURAL MOISTURE CONTENT= 15.4 %

Swell Consolidation Test Results

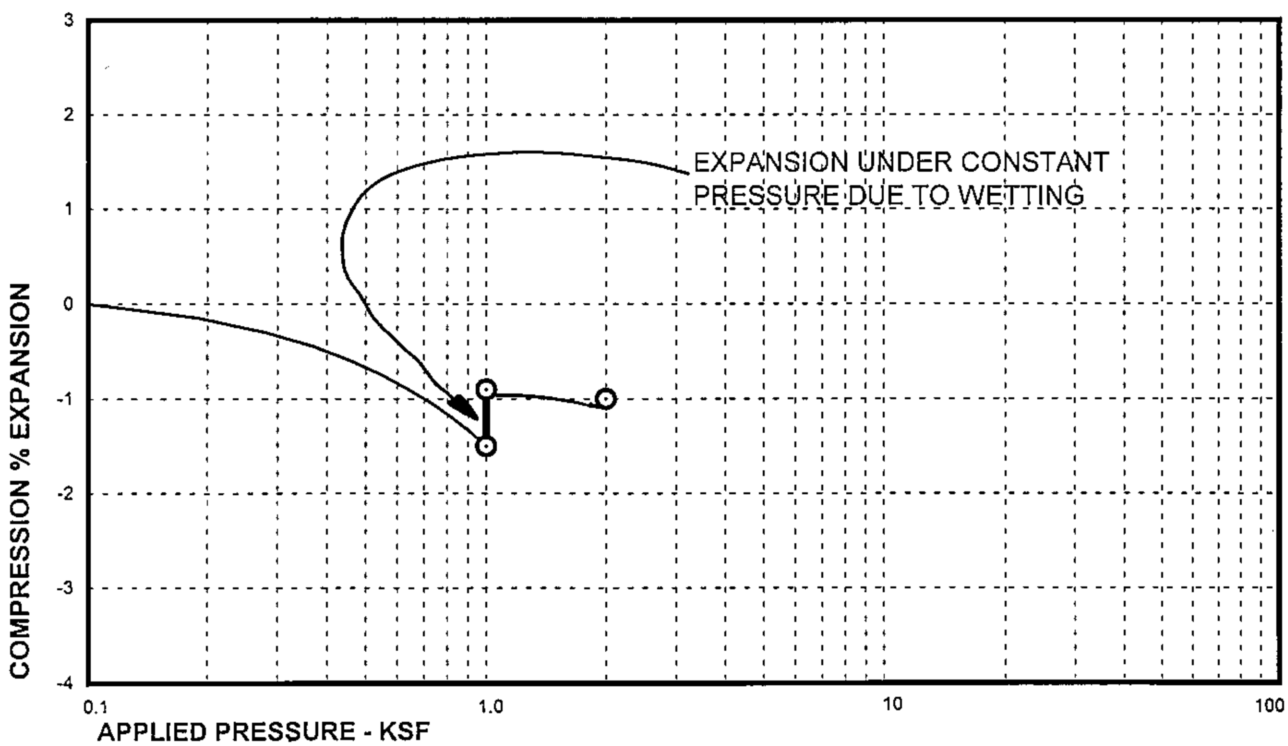
JOB NO. FC-1116

FIG. 11



Sample of CLAY, SANDY (CL) NATURAL DRY UNIT WEIGHT= PCF

From CTL- 5 AT 4 FEET NATURAL MOISTURE CONTENT= 15.4 %



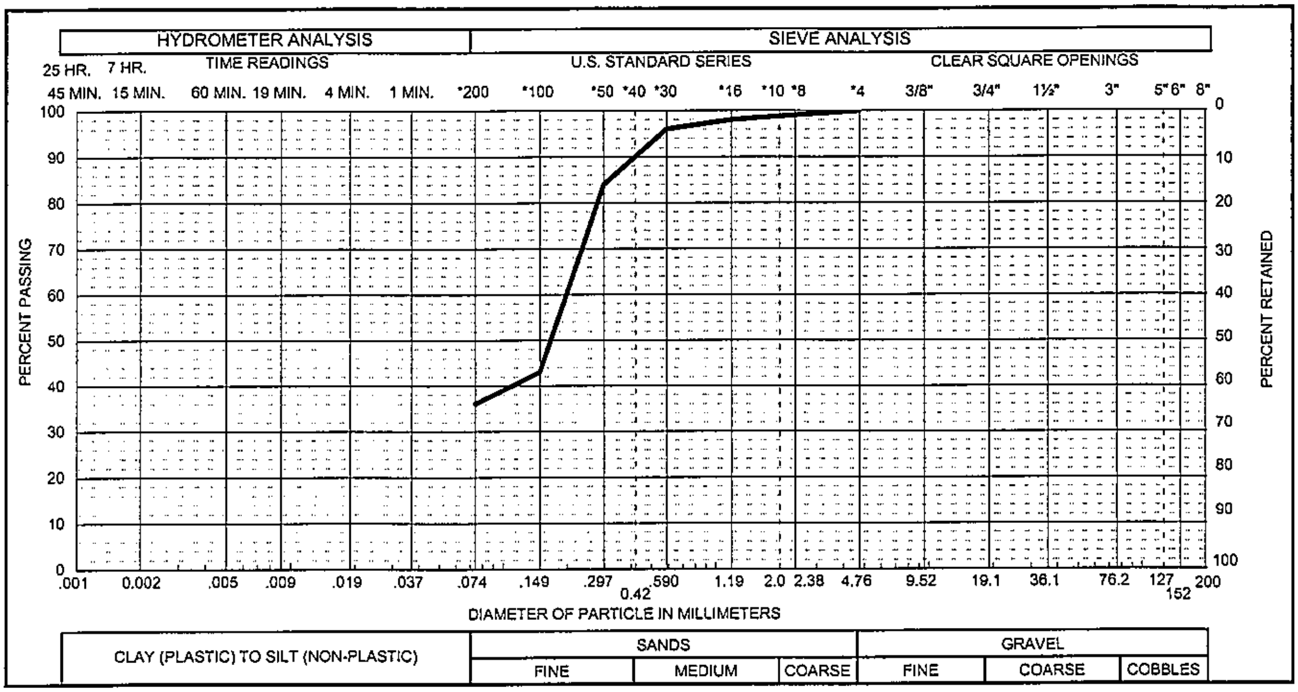
Sample of WEATHERED CLAYSTONE NATURAL DRY UNIT WEIGHT= 93 PCF

From CTL- 5 AT 19 FEET NATURAL MOISTURE CONTENT= 22.5 %

Swell Consolidation Test Results

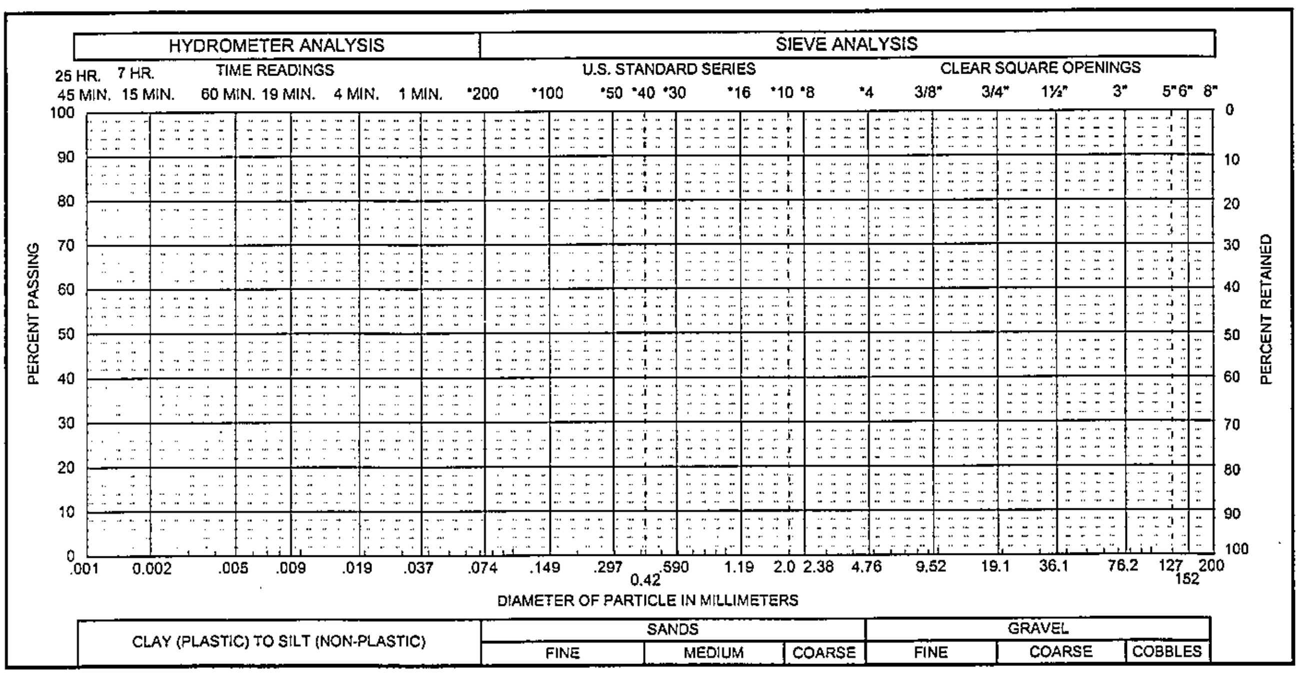
JOB NO. FC-1116

FIG. 11



Sample of SAND, SILTY (SM)
From CTL - 2 AT 19 FEET

GRAVEL 0 % SAND 64 %
SILT & CLAY 36 % LIQUID LIMIT - %
PLASTICITY INDEX - %



Sample of
From

GRAVEL % SAND %
SILT & CLAY % LIQUID LIMIT %
PLASTICITY INDEX %

Gradation Test Results

Job No. FC-1116

Fig. 12

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

BORING	DEPTH (ft)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (pcf)	SWELL* (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	UNCONFINED COMPRESSIVE STRENGTH (psf)	SOLUBLE SULFATE CONTENT (%)	PASSING NO. 200 SIEVE (%)	SOIL TYPE
CTL-1	2				41	21				CLAY, SANDY (CL)
CTL-1	4	9.8								CLAY, SANDY (CL)
CTL-1	14				NL	NP				SAND, SILTY (SM)
CTL-1	44	17.0	107				11000			CLAYSTONE
CTL-2	4	15.7	104				8000			CLAY, SANDY (CL)
CTL-2	19	15.6			NL	NP			36	SAND, SILTY (SM)
CTL-2	29	18.2	108				8000			CLAYSTONE
CTL-2	34	14.1	111				8000			CLAYSTONE
CTL-2	44	18.2	106	1.5						CLAYSTONE
CTL-3	9	17.9		0.0						CLAY, SANDY (CL)
CTL-3	39	16.2	113	1.2						CLAYSTONE
CTL-6	4	12.3	102				11,000	0.004		CLAY, SANDY (CL)
CTL-4	4	11.0	118				17000			CLAY, SANDY (CL)
CTL-4	19	22.2	102	1.6						CLAYSTONE
CTL-5	2	18.1	112	0.7						CLAY, SANDY (CL)
CTL-5	4	15.4		0.1						CLAY, SANDY (CL)
CTL-5	19	22.5	93	0.6						WEATHERED CLAYSTONE
CTL-6	44	18.3	101				9000			CLAYSTONE
CTL-2	9	22.4								CLAY, SANDY (CL)
CTL-1	9	10.6	97	-4.7						CLAY, SANDY (CL)
CTL-5	9	9.2	121	0.2						CLAY, SANDY (CL)
CTL-3	14	12.8	117				6000	0.004		CLAY, SANDY (CL)
CTL-1	24	16.4	117	1.1						INTERBEDDED CLAYSTONE/SANDSTONE
CTL-3	29	15.2								CLAYSTONE
CTL-1	29	11.6	118							CLAYSTONE
CTL-4	34	14.4								CLAYSTONE
CTL-6	39	20.2	108				19000			CLAYSTONE

* - Swell due to wetting at an applied pressure of 1,000 psf, exept CTL-5 at 4' depth was at 4,000 psf. Negative values indicate consolidation.

APPENDIX A

FLEXIBLE PAVEMENT CONSTRUCTION RECOMMENDATIONS

FLEXIBLE PAVEMENT CONSTRUCTION RECOMMENDATIONS

Experience has shown that construction methods can have a significant effect on the life and serviceability of a pavement system. We recommend the proposed pavement be constructed in the following manner:

1. The subgrade should be stripped of organic matter, scarified, moisture treated, and compacted. Soils should be moisture treated to optimum to 2 percent above optimum moisture content and compacted to at least 95 percent of maximum standard Proctor dry density (ASTM D 698, AASHTO T 99).

2. Utility trenches and all subsequently placed fill should be properly compacted and tested prior to paving. As a minimum, fill should be compacted to 95 percent of maximum standard Proctor dry density.

3. After final subgrade elevation has been reached and the subgrade compacted, the area should be proof-rolled with a heavy pneumatic-tired vehicle (i.e. a loaded ten-wheel dump truck). Subgrade that is pumping or deforming excessively should be scarified, moisture conditioned and compacted.

4. If areas of soft or wet subgrade are encountered, the material should be subexcavated and replaced with properly compacted structural backfill. Where extensively soft, yielding subgrade is encountered, we recommend the excavation be inspected by a representative of our office.

5. Aggregate base course should be laid in thin, loose lifts, moisture treated to within 2 percent of optimum moisture content, and compacted to at least 95 percent of maximum modified Proctor dry density (ASTM D 1557, ASSHTO T 180).

6. Asphaltic concrete should be hot plant-mixed material compacted to at least 95 percent of maximum Marshall density. The temperature at laydown time should be near 235 degrees F. The maximum compacted lift should be 3.0 inches and joints should be staggered.

7. The subgrade preparation and the placement and compaction of all pavement material should be observed and tested. Compaction criteria should be met prior to the placement of the next paving lift. The additional requirements of Larimer County and the Colorado Department of Transportation Specifications should apply.

APPENDIX B

RIGID PAVEMENT CONSTRUCTION RECOMMENDATIONS

RIGID PAVEMENT CONSTRUCTION RECOMMENDATIONS

Rigid pavement sections are not as sensitive to subgrade support characteristics as flexible pavement. Due to the strength of the concrete, wheel loads from traffic are distributed over a large area and the resulting subgrade stresses are relatively low. The critical factors affecting the performance of a rigid pavement are the strength and quality of the concrete, and the uniformity of the subgrade. We recommend subgrade preparation and construction of the rigid pavement section be completed in accordance with the following recommendations:

1. Natural soils should be stripped of organic matter, scarified, moisture treated, and compacted. We recommend the top one foot of the subgrade be moisture treated to between optimum and 2 percent above optimum moisture content. Soils should be compacted to at least 95 percent of maximum standard Proctor dry density (ASTM D 698, AASHTO T 99). Moisture treatment and compaction recommendations also apply where additional fill is necessary.

2. The resulting subgrade should be checked for uniformity and all soft or yielding materials should be replaced prior to paving. Concrete should not be placed on soft, spongy, frozen, or otherwise unsuitable subgrade.

3. The subgrade should be kept moist prior to paving.

4. Curing procedures should protect the concrete against moisture loss, rapid temperature change, freezing, and mechanical injury for at least 3 days after placement. Traffic should not be allowed on the pavement for at least one week.

5. A white, liquid membrane curing compound, applied at the rate of 1 gallon per 150 square feet, should be used.

6. Construction joints, including longitudinal joints and transverse joints, should be formed during construction or should be sawed shortly after the concrete has begun to set, but prior to uncontrolled cracking. All joints should be sealed.

7. Construction control and inspection should be carried out during the subgrade preparation and paving procedures. Concrete should be carefully monitored for quality control. The additional requirements of the Colorado Department of Highways Specifications should apply.

The design section is based upon a 20-year Period. Experience in the Fort Collins area indicates virtually no maintenance or overlays are necessary for the design period. To avoid problems associated with scaling and to continue the strength gain, we recommend deicing salts not be used for the first year after placement.

APPENDIX C

SAMPLE SITE GRADING SPECIFICATIONS

SAMPLE SITE GRADING SPECIFICATIONS

1. DESCRIPTION

This item shall consist of the excavation, transportation, placement and compaction of materials from locations indicated on the plans, or staked by the Engineer, as necessary to achieve preliminary street and overlot elevations. These specifications shall also apply to compaction of excess cut materials that may be placed outside of the subdivision and/or filing boundaries.

2. GENERAL

The Soils Engineer shall be the Owner's representative. The Soils Engineer shall approve fill materials, method of placement, moisture contents and percent compaction, and shall give written approval of the completed fill.

3. CLEARING JOB SITE

The Contractor shall remove all trees, brush and rubbish before excavation or fill placement is begun. The Contractor shall dispose of the cleared material to provide the Owner with a clean, neat appearing job site. Cleared material shall not be placed in areas to receive fill or where the material will support structures of any kind.

4. SCARIFYING AREA TO BE FILLED

All topsoil and vegetable matter shall be removed from the ground surface upon which fill is to be placed. The surface shall then be plowed or scarified until the surface is free from ruts, hummocks or other uneven features, which would prevent uniform compaction by the equipment to be used.

5. COMPACTING AREA TO BE FILLED

After the foundation for the fill has been cleared and scarified, it shall be disked or bladed until it is free from large clods, brought to the proper moisture content ($\pm$ 2 percent of optimum) and compacted to not less than 95 percent of maximum density as determined in accordance with ASTM D 698.

6. FILL MATERIALS

Fill soils shall be free from vegetable matter or other deleterious substances, and shall not contain rocks or lumps having a diameter greater than six (6) inches. Fill materials shall be obtained from cut areas shown on the plans or staked in the field by the Engineer.

On-site materials classifying as CL, CH, SC, SM, SW, SP, GP, GC and GM are acceptable. Concrete, asphalt, organic matter and other deleterious materials or debris shall not be used as fill.

7. MOISTURE CONTENT

Fill materials shall be moisture treated to within 0 to 2 percent above optimum moisture content specified for soils classifying as CH, CL, and SC. Non-expansive soils classifying as SM, SW, SP, GP, GC and GM shall be moisture treated to within 4 ± percent of optimum moisture content as determined from Proctor compaction tests. Sufficient laboratory compaction tests shall be made to determine the optimum moisture content for the various soils encountered in borrow areas.

The Contractor may be required to add moisture to the excavation materials in the borrow area if, in the opinion of the Soils Engineer, it is not possible to obtain uniform moisture content by adding water on the fill surface. The Contractor may be required to rake or disk the fill soils to provide uniform moisture content through the soils.

The application of water to embankment materials shall be made with any type of watering equipment approved by the Soils Engineer, which will give the desired results. Water jets from the spreader shall not be directed at the embankment with such force that fill materials are washed out.

Should too much water be added to any part of the fill, such that the material is too wet to permit the desired compaction from being obtained, rolling and all work on that section of the fill shall be delayed unit the material has been allowed to dry to the required moisture content. The Contractor will be permitted to rework wet material in an approved manner to hasten its drying.

8. COMPACTION OF FILL AREAS

Selected fill material shall be placed and mixed in evenly spread layers. After each fill layer has been placed, it shall be uniformly compacted to not less than the specified percentage of maximum density. Expansive soils classifying as CL, CH, or SC shall be compacted to at least 95 percent of the maximum density as determined in accordance with ASTM D 698. At the option of the Soils Engineer, soils classifying as SW, SP, GP, GC or GM may be compacted to 90 percent of the maximum density as determined in accordance with ASTM D 1557. Fill materials shall be placed such that the thickness of loose material does not exceed 10 inches and the compacted lift thickness does not exceed 6 inches.

Compaction, as specified above, shall be obtained by the use of sheepsfoot rollers, multiple-wheel pneumatic-tired rollers, or other equipment approved by the Engineer for soils classifying as CL, CH, or SC. Granular fill shall be compacted using vibratory equipment or other equipment approved by the Soils Engineer. Compaction shall be accomplished while the fill material is at the specified moisture content. Compaction of each layer shall be continuous over the entire area. Compaction equipment shall make sufficient trips to insure that the required density is obtained.

9. COMPACTION OF SLOPES

Fill slopes shall be compacted by means of sheepsfoot rollers or other suitable equipment. Compaction operations shall be continued until slopes are stable, but not too dense for planting, and there is no appreciable amount of loose soil on the slopes. Compaction of slopes may be done progressively in increments of three to five feet (3' to 5') in height or after the fill is brought to its total height. Permanent fill slopes shall not exceed 3:1 (horizontal to vertical).

10. DENSITY TESTS

Field density tests shall be made by the Soils Engineer at locations and depths of his choosing. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density tests shall be taken in compacted material below the disturbed surface. When density tests indicate that the density or moisture content of any layer of fill or portion thereof is below that required, the particular layer or portion shall be reworked until the required density or moisture content has been achieved.

11. COMPLETED PRELIMINARY GRADES

All areas, both cut and fill, shall be finished to a level surface and shall meet the following limits of construction:

A. Overlot cut or fill areas shall be within plus or minus 2/10 of one foot.

B. Street grading shall be within plus or minus 1/10 of one foot.

The civil engineer, or duly authorized representative, shall check all cut and fill areas to observe that the work is in accordance with the above limits.

12. SUPERVISION AND CONSTRUCTION STAKING

Observation by the Soils Engineer shall be continuous during the placement of fill and compaction operations so that he can declare that the fill was placed in general conformance with specifications. All inspections necessary to test the placement of fill and observe compaction operations will be at the expense of the Owner. All construction staking will be provided by the Civil Engineer or his duly authorized representative. Initial and final grading staking shall be at the expense of the owner. The replacement of grade stakes through construction shall be at the expense of the contractor.

13. SEASONAL LIMITS

No fill material shall be placed, spread or rolled while it is frozen, thawing, or during unfavorable weather conditions. When work is interrupted by heavy precipitation, fill operations shall not be resumed until the Soils Engineer indicates that the moisture content and density of previously placed materials are as specified.

14. NOTICE REGARDING START OF GRADING

The contractor shall submit notification to the FHA, Soils Engineer and Owner advising them of the start of grading operations at least three (3) days in advance of the starting date. Notification shall also be submitted at least 3 days in advance of any resumption dates when grading operations have been stopped for any reason other than adverse weather conditions.

15. REPORTING OF FIELD DENSITY TESTS

Density tests made by the Soils Engineer, as specified under "Density Tests" above, shall be submitted progressively to the Owner. Dry density, moisture content, of each test taken and percentage compaction shall be reported for each test taken.

16. DECLARATION REGARDING COMPLETED FILL

The Soils Engineer shall provide a written declaration stating that the site was filled with acceptable materials, or was placed in general accordance with the specifications.

17. DECLARATION REGARDING COMPLETED GRADE ELEVATIONS

A registered Civil Engineer or licensed Land Surveyor shall provide a declaration stating that the site grading has been completed and resulting elevations are in general conformance with the accepted detailed development plan.