CTL | THOMPSON
INCORPORATED

GEOTECHNICAL INVESTIGATION
CONSTITUTION AVE AND MARKSHEFFEL RD
MULTIFAMILY DEVELOPMENT
COLORADO SPRINGS, COLORADO

Prepared For:

THE GARRETT COMPANIES
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Attention: Karl Stout

CTL|T Project No. CS19460-125

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SCOPE

This report presents the results of our Geotechnical Investigation for the proposed apartment complex to be constructed southwest of the intersection of Constitution Avenue and Marksheffel Road in Colorado Springs, Colorado (Fig. 1). The purpose of our investigation was to evaluate the subsurface conditions at the site and provide geotechnical recommendations and criteria for design and construction of foundations, floor systems, and pavement section alternatives for private drives, as well as surface drainage precautions. The scope of our services was described in our proposal (CS-21-0114) dated September 9, 2021.

This report was prepared from data developed during our field exploration, laboratory testing, engineering analysis, and our experience in the area. The report was prepared for use by The Garrett Companies in design and construction of the planned apartment buildings and the associated site improvements. Other types of construction may require revision of this report and the recommended design criteria. A summary of our conclusions and recommendations follows. More detailed design criteria are presented within the report.

SUMMARY

1. Subsurface conditions encountered in our exploratory borings consisted of widespread areas of surficial sandy to very sandy clay fill with lenses of clayey to very clayey sand fill approximately 6 to 12 feet thick. Natural slightly clayey to very clayey sand was encountered either at the surface or underlying fill material. Silty sand was identified in TH-6 and a lens of very sandy clay was identified in TH-7. Claystone bedrock underlies the surficial soils and was encountered in six borings. Some of the pertinent engineering characteristics of the soil and bedrock encountered, as well as groundwater conditions, are described in the following paragraphs.

2. At the time of drilling, groundwater was encountered in six borings at depths between 18.5 to 23.5 feet below the existing ground surface. When water levels were checked again a few days after the completion of drilling operations groundwater was found in seven borings at depths between 16 and 26 feet below ground surface. Groundwater levels may

rise in response to variations in precipitation and after construction in response to landscaping irrigation.

3. The presence of undocumented fill implies risk that slabs-on-grade and foundations will settle or heave. We believe the recommendations presented in this report will help to control risk of damage; they will not eliminate that risk.

4. We understand the intent is to support the apartment buildings and garages on post-tensioned, slab-on-grade (PTS) foundations. For the PTS system, the foundations are structurally integrated with the floor slabs and should therefore exhibit more reliable, long-term performance than conventional slabs-on-grade. Foundation design and construction criteria are presented in the report.

5. Surface drainage should be designed, constructed, and maintained to provide rapid removal of runoff away from the proposed buildings. Very conservative irrigation practices should be followed to avoid excessive wetting. The use of Xeriscape landscaping principles should be incorporated into construction where practical.

6. The design and construction criteria for foundations and slabs-on-grade included in this report were compiled with the expectation that all other recommendations presented related to surface drainage, landscaping irrigation, backfill compaction, etc. will be incorporated into the project and that the property manager will maintain the structures, use prudent irrigation practices, and maintain surface drainage. It is critical that all recommendations in this report are followed.

SITE CONDITIONS

The apartment site is located southwest of the intersection of Constitution Avenue and Marksheffel Road in Colorado Springs, Colorado (Fig. 1). The site is currently vacant and slopes gently to the south and west. Based on a review of available historic aerial photos from Google Earth, The City of Colorado Springs Historic Map Explorer and the Phase 1 investigation of the site, there was a drainage on the western side of the property, which has been piped and the outlet structure is located on the southwestern corner of the property. It appears the site had been used for agricultural purposes until about the 1960s. The aerial photo from 1960 shows grading disturbance on the property and small stockpiles, likely from end dumps, are on the site in the 1969, 1972, and 1983 aerials. In the 1993 aerial the site has been graded level. It appears the drainage was piped between 2013 and 2015.

Vegetation consists of a very sparse cover of grasses, weeds, and cactus plants. The land to the north of Constitution Avenue and immediately west of the site is undeveloped. The land to the southwest is residential subdivision. The land to the east, on the other side of Marksheffel Road, has commercial development including a grocery store, bank and coffee shop. The property south of the eastern half of the project area is a commercial/industrial use with a storage yard, and the property south of the western half of the project area is undeveloped.

PROPOSED CONSTRUCTION

We understand two apartment buildings, a swimming pool, and six stand-alone garage structures are planned. We anticipate the buildings will be wood-frame structures, two to three stories in height. Foundation loads are expected to be light to moderate. No habitable, below-grade areas such as basements or garden level areas are planned. Paved access roads and surface parking areas will be provided throughout the complex. Other exterior site improvements include the extension of Akers Drive and a detention pond. Geotechnical recommendations for the extension of Akers Drive and the detention pond will be provided under separate cover.

Grading plans were not available for our review. Based on existing grades we anticipate cuts and fills less than 10 feet, will be necessary for site development of the apartment buildings, pool and garages. The location of exploratory borings with the building layout provided to us is presented in Fig. 1.

GEOLOGY

Geologic mapping by Richard F. Madole and Jon P. Thorson of the United States Geological Survey ("Geology of the Elsmere Quadrangle, El Paso County, Colorado," 2002) indicates the site is underlain by younger eolian sand (Qes_1) and middle alluvium (Qam). Bedrock consisting of the Dawson Formation Facies unit two underlies the surficial soils. The Dawson Formation member consists of interbedded sandstone and claystone. Based on our experience, claystone is predominant in this area. Conditions encountered in our borings generally confirm the mapping.

INVESTIGATION

The field investigation included drilling a total of twenty-eight borings using 4-inch diameter, continuous-flight auger and a truck-mounted drill rig. The borings extended to depths between 20 and 30 feet. Drilling was observed by our field representative who logged the conditions found in the borings and obtained samples. Summary logs of the borings, results of field penetration resistance tests, and some laboratory test data are presented in the Summary Logs of Exploratory Borings (Appendix A).

Soil and bedrock samples obtained during drilling were returned to our laboratory and visually classified. Laboratory testing was then assigned to representative samples and included moisture content and dry density, swell-consolidation, Atterberg Limits, gradation, and water-soluble sulfate concentration tests. Results of laboratory tests are presented in Appendix B and are summarized in Table B-1.

Five test pits were excavated on October 25, 2021 as part of the environmental site assessment of the project (CTL|T Project No. CS19460-205, dated October 28, 2021). Subsurface conditions in the test pits are consistent with the conditions logged in our borings.

SUBSURFACE CONDITIONS

Subsurface conditions encountered in our exploratory borings consisted of areas of surficial sandy to very sandy clay fill with lenses of clayey to very clayey sand fill approximately 6 to 12 feet thick. Natural slightly clayey to very clayey sand was encountered at the surface or underlying fill material. Silty sand was identified in TH-6 and a lens of very sandy clay was identified in TH-7. Claystone bedrock underlies the surficial soils and was encountered in six borings. Some of the pertinent engineering characteristics of the soil and bedrock encountered, as well as groundwater conditions, are described in the following paragraphs.

Fills

Sandy to very sandy clay fill with lenses of clayey to very clayey sand fill was encountered in sixteen borings. The fill ranged from 6 to 12 feet in thickness. Due to the variability of the fill and the likely nature in which it was placed, it is possible that more fill exists on the site than was identified in the borings. A small amount of trash (wire, PVC pipe, asphalt and concrete chunks) was observed on the surface of the site and in the test pits.

The fill was medium dense to very dense based on field penetration resistance testing. Eleven samples of the fill classified as sandy to very sandy clay and thirteen samples of the fill classified as clayey to very clayey sand. Eleven samples of the fill contained 15 to 53 percent silt and clay-sized particles (passing the No. 200 sieve). Twelve samples of the fill were swell tested in our laboratory. The fill samples exhibited slight compression to moderate swell potential when wetted under estimated overburden pressure. The Liquid Limits ranged from 30 to 39 and the Plasticity Indexes ranged from 11 to 18. The measured moisture contents of the fill ranged from 2.3 to 11.6 percent. The relative densities observed in the fill are generally consistent and indicative compaction effort was applied. Fill placement records were not available at the time of this investigation and the fill is considered to be undocumented. If documentation such as field observation and density testing reports is available, it should be provided to our office.

Natural Soils

A layer of natural soils was encountered either at the surface or underlying fill material in each of our borings. The natural soils were generally slightly clayey to very clayey sand. Silty sand was identified in TH-6 and a lens of very sandy clay was identified in TH-7. The natural sands were medium dense to dense and the clay was very stiff based on the results of field penetration resistance tests. One sample of clayey sand compressed 0.9 when wetted under estimated overburden pressure. We believe the natural granular materials at this site are generally not expansive. One sample of the clay compressed 0.0 percent when wetted under estimated overburden pressure. Thirty-five sand samples tested contained 8 to 41 percent silt and clay-sized particles (passing the No. 200 sieve) and one samples of the clay contained 67 percent silt and clay-sized particles.

Claystone

Claystone bedrock was encountered in six of our borings underlying natural soils and fill at depths between 18 and 27 feet below the existing ground surface. The claystone was hard to very hard based on field penetration resistance tests. Two samples of the claystone exhibited measured swell between 0.1 and 0.2 percent when wetted under estimated overburden pressures.

Groundwater

At the time of drilling, groundwater was encountered in six borings at depths between 18.5 to 23.5 feet below the existing ground surface. When water levels were checked again a few days after the completion of drilling operations groundwater was found in seven borings at depths between 16 and 26 feet below ground surface. Groundwater levels may rise in response to variations in precipitation and after construction in response to landscaping irrigation.

Seismicity

This area, like most of Colorado, is subject to a degree of seismic activity. We believe the soils on the property classify as Site Class D according to the 2015 International Building Code (2015 IBC).

SITE DEVELOPMENT

The site is currently vacant and slopes gently to the south and west. Grading plans were not available for our review. Based on existing grades we anticipate minimal cuts and fills (less than 10 feet) will be necessary for site development of the apartment buildings, pool and garages. The most significant constraint to development from a geotechnical standpoint is the presence of undocumented fill. This concern is addressed in more detail below.

Undocumented Fill

Undocumented fill was identified during this investigation. Undocumented fill increases the risk of poor structure performance, as it is possible that poorly compacted or unstable materials may be present within the fill. If documentation such as the field observation and density testing reports of the placement of the fill is available, we can review the documentation and determine the suitability of the existing fill. As mentioned previously, field penetration resistance testing and results of our laboratory testing indicates the fill was likely placed with compactive effort. The most reliable approach to reduce risk of differential movement associated with variations of the existing fill is to remove all existing, undocumented fill from below the proposed structures; however, this would result in substantial additional cost. We believe the existing fill may remain below structures, provided the fill material is further evaluated by a representative of this office during site grading and the owner accepts the risk of potential movements and associated damage. Utilizing a post-tension slab-on-grade foundation system as currently planned will significantly reduce this risk. Evaluation of existing fill material during site grading may include visual observations, probing, potholing, and field density tests.

The risk of excessive differential movement associated with undocumented fill can be reduced by constructing the buildings0on at least a 4-foot-thick layer of new grading fill or sub-excavation backfill. The thickness of fill should be measured from the perimeter turn down of post-tensioned slabs.

The sub-excavation zone should extend laterally at least 5 feet beyond the outer edges of the structures and should have a uniform bottom elevation throughout the structure footprint. After the existing material is removed, the on-site existing fill materials, or imported granular fill can be used as excavation backfill. The sub-excavation zone should be backfilled to the bottom of foundation elevations with densely compacted fill that has been properly moisture conditioned and compacted as described in the Fill Placement and Compaction section.

Our representative should observe the completed excavation prior to any backfill placement to verify the conditions exposed in the excavation are as expected. The placement and compaction of fill below foundations and foundation subgrade preparation should be observed and tested by a representative of our firm during construction.

Excavation

We believe the soils can be excavated with conventional, heavy-duty excavation equipment. Based on our investigation and Occupational Safety and Health Administration (OSHA) standards, we believe the on-site surficial, granular soils classify as Type C soil. A maximum slope inclination of 1.5:1 (horizontal to vertical) is required for Type C soils for dry conditions. Excavation slopes specified by OSHA are dependent upon the types of soil and groundwater conditions encountered. The contractor's "competent person" should identify the soils encountered in the excavations and refer to OSHA standards to determine appropriate slopes. Stockpiles of soils and equipment should not be placed within a horizontal distance equal to one-half the excavation depth, from the edge of the excavation.

Fill Placement and Compaction

Prior to fill placement, vegetation, or organic topsoil should be stripped from the ground surface. The ground surface in areas to receive fill should be scarified deeply, moisture conditioned and compacted to a high density to establish a stable subgrade for fill placement.

The on-site, natural soils and existing fill are suitable for use during site grading. A small amount of trash (wire, PVC pipe, asphalt chunks, and concrete chunks) were observed on the surface of the site and in the test pits. Due to the nature of our investigation and the previous uses of the site, it is possible additional pockets of debris may be found on the site. Trash should be removed from existing fill that will be re-used.

The existing fill and natural sands may be relatively dry. Significant addition of water, mixing, and mellowing will be required to achieve uniform moisture contents near or above optimum. This type of process is also complicated by freezing temperatures in the winter months. Careful consideration should be given when selecting an experienced earthwork contractor.

The sandy clay materials should be compacted to at least 95 percent of maximum standard Proctor dry density (ASTM D 698). The more granular soils should be compacted to at least 95 percent of the maximum modified Proctor dry density (ASTM D 1557). The sandy clays should be moisture conditioned to between 1 and 4 percent above optimum moisture content. We recommend the moisture content be reduced to within 2 percent of optimum in the upper few feet of pavement areas, to reduce problems associated with unstable subgrade materials. The more granular soils may be placed at moisture contents within 2 percent of optimum. The placement and compaction of the grading fill should be observed and tested by a representative of our office during construction. Detailed site grading recommendations are set forth in Appendix D.

Water and sewer lines are often constructed beneath paved areas. Compaction of utility trench backfill will have a significant effect on the life and serviceability of pavements. We recommend utility trenches be backfilled with the on-site soil and bedrock materials in accordance with City of Colorado Springs and Colorado Springs Utilities specifications. Personnel from our firm should periodically observe backfill placement and test the density of the fill materials.

FOUNDATIONS

We anticipate the near-surface soils found at or near shallow foundation levels will consist of a variety of materials including sandy to very sandy clay fill with lenses of clayey to very clayey sand fill, slightly clayey to very clayey sand, and silty sand. We understand current plans call for the apartment buildings and garages to be constructed with post-tensioned, slab-on-grade (PTS) foundations. PTS foundations may be utilized for support of the proposed structures, provided the remedial grading and sub-excavation recommendations set forth previously are performed. Design and construction criteria are provided below.

PTS foundation design is based on a method developed by the Post-Tensioning Institute (PTI, 3rd Edition, 2004 with 2008 Supplement). Various climate and relevant soil factors are required to evaluate the PTI design criteria. The PTI slab design includes evaluation of two mechanisms of soil movement (edge lift and center lift) based on assumptions that the wetting and drying of the foundation soils are primarily affected by the climate. These values were calculated using software titled VOLFLO 1.5 and the parameters presented below.

PTI Parameters

Parameter	Design Value
Thornthwaite Moisture Index	-20
Constant Soil Suction	3.6 pF
Depth of Seasonal Moisture Variation	15 feet
Percent Finer than 2 Microns	20 for fill and 15 for sands
Soil Fabric Factor	1.0

Our experience indicates that the foundation soils will normally undergo a significant increase in moisture content due to covering of the ground surface by the buildings and pavements, and irrigation around the structures. Depending on the surface drainage or the amount of available water, the movement mechanism, which controls the design, could be as high as total heave. The edge moisture variation distance can also be more than the design values provided in the PTI manual. Considering the limitations of the current PTI design, we believe a conservative approach with reasonable engineering judgment is necessary to prepare geotechnical recommendations for PTS foundation design.

The PTI design method estimates movements for a depth of wetting of 9 feet below the ground surface. Based on our experience in the area and field data, the depth of wetting will likely be 12 to 15 feet below the ground surface. It is possible wetting will not penetrate this deep; however, we believe it is a reasonable design assumption. The PTI design procedure does not predict soil movements that result from site conditions such as irrigation or poor surface drainage that may lead to deeper wetting. If deeper wetting of the foundation soils occurs, the foundation movement may exceed the design movements predicted in the PTI procedure. If surface drainage is properly designed and maintained, it is unlikely the total calculated heave would occur and manifest at the surface. We expect total heave or settlement will be on the order of 1 to 1.5 inches. PTS foundation design is based on the potential differential movement of the slabs due to both settlement and heave of the subsoils. The estimated differential soil movement (y_m) were evaluated for two cases: post-equilibrium and post-construction. In our opinion, the post-construction case is considered more appropriate due to the potential for variability within the existing fill materials, the magnitude of potential movement and our experience with the local climate.

Design criteria for PTS foundations developed from analysis of field and laboratory data and our experience are presented below.

Post-Tensioned, Slabs-On-Grade (PTS)

1. PTS foundations should be constructed on the natural sand soils, existing fill material, or newly placed grading fill. For new grading fill or where soil is loosened during excavation or in the forming process, or if soft or loose soils are exposed, the soils should be moisture and compacted according to the recommendations provided.

2. The foundations should be designed for a maximum allowable soil pressure of 2,000 psf.

3. For the PTI design method, we recommend differential movements for the following conditions:

PTI Post Equilibrium Parameters

Condition	ym (in)	Change in Suction Design Envelope
Center Lift (Shrinking)	-0.34	Wet to Constant
Edge Lift (Swelling)	0.65	Dry to Constant

PTI Post Construction Parameters

Condition	y_m (in)	Change in Suction Design Envelope
Center Lift (Shrinking)	-0.98	Wet to Dry
Edge Lift (Swelling)	1.44	Dry to Wet

The Structural Engineer should select which case is appropriate for the design.

4. Based on the Thornthwaite Moisture Index (PTI Manual, Edition 3), an edge moisture variation distance (e_m) of 4.7 feet for the edge lift condition and 9.0 feet for the center lift condition should be used in design.

5. We understand the PTI design method assumes the slab is somewhat flexible. Some of the above-grade construction may not be flexible, such as drywall, brick, and stucco. We are aware of situations where minor differential slab movement has caused distress in finish materials. One way to enhance performance would be to place reinforcing steel in the bottoms of the stiffening beams. The structural engineer should evaluate the merits of this approach and other potential alternatives.

6. Stiffening beams may be poured "neat" into trenches excavated in the building pads. Soils may cave or slough during trench excavation for the stiffening beams. Disturbed soils should be removed from trench bottoms prior to placement of concrete. Formwork or other methods may be required for proper stiffening beam installation.

7. Exterior stiffening beams must be protected from frost action. Normally, 30 inches of frost cover is provided in the Colorado Springs area.

8. For slab tensioning design, a coefficient of friction value of 0.75 or 1.0 can be assumed for slabs on polyethylene sheeting or a sand layer, re-

spectively. A coefficient of friction of 2 should be used for slabs on clay or clay fill.

9. A representative of our firm should observe the completed excavations. A representative of the structural engineer should observe the placement of the reinforcing tendons and reinforcement prior to placing the slabs and beams.

FLOOR SYSTEMS

Our investigation indicates the materials near the anticipated first floor levels of the proposed apartment buildings will consist of natural silty to clayey sand, existing fill and/or new sub-excavation grading fill. As discussed in the FOUNDATIONS section, we expect the anticipated movement up to about 1.5 inches. For the PTS system, the foundations are structurally integrated with the floor slab and should exhibit more reliable long-term performance, as compared to conventional slab-on-grade floors. Underslab utilities such as water and sewer lines should be pressure tested prior to installing slabs. Utilities that penetrate slabs should be provided with sleeves and flexible connections that allow for independent movement of the slab and reduce likelihood of damaging buried pipes. We recommend these details allow at least 1.5 inches of differential movement between the slabs and pipes.

EXTERIOR FLATWORK

Exterior flatwork, including sidewalks and porch slabs, is normally constructed as a slab-on-grade. Performance of conventional slabs-on-grade on expansive soils is erratic. Various properties of the soils and environmental conditions influence the magnitude of movement and other performance characteristics of slabs underlain by expansive soils. Increases in the moisture content of expansive soils will cause heaving and may result in cracking of slabs-on-grade. Exterior flatwork should be designed and constructed to move independently relative to the proposed building foundations.

SWIMMING POOL

We anticipate the proposed swimming pool will range in depth from between 3 and 6 feet deep and be constructed of a reinforced shotcrete (gunite) with surrounding concrete deck areas. Our investigation indicates new or existing fill or silty to clayey sand will be present within the area of the swimming pool. We anticipate movement due to expansive soils will be less than 1 inch for conventional deck slabs in the pool area. Settlement due to wetting could also cause slab distress. Cracking of the pool deck is possible and will require maintenance. Cracks and joints in the deck should be sealed regularly. Pool walls will need to be designed to resist lateral earth loads. An at-rest equivalent fluid pressure of 70 pcf may be used for design.

Movement of the deck should not be transmitted to the swimming pool. The deck slab should be reinforced to function as an independent unit. Frequent control joints should be provided to reduce problems associated with potential soil movements. Panels that are approximately square generally perform better than rectangular areas.

Cracking of the pool shell and deck may allow water to infiltrate the subgrade soils. This water can result in swelling or expansive layers and exacerbate cracking. A drain should be installed below the base of the swimming pool shell to help collect seepage. The drain should be sloped to a sump where water can be removed by pumping. In addition, an impermeable membrane consisting of PVC sheeting should be placed between the gravel drain and the excavated subgrade. Field joints in the membrane (if necessary) should be sealed. Details for construction of the drainage layer are shown on Fig. 2.

PAVEMENTS

Our exploratory borings and understanding of the proposed construction suggest the subgrade soils within the planned access driveways and parking areas will consist predominantly of sandy clay to clayey sand fill, and natural, clayey to silty sand. The anticipated pavement subgrade samples tested in our laboratory classified as A-6 materials according to the American Association of State Highway Transportation Officials (AASHTO) classification system. The A-6 type material generally exhibits fair to poor pavement support characteristics. Based on our laboratory classification testing (Atterberg Limits and sieve analysis), a Hveem Stabilometer ("R") value of 10 was assigned to the subgrade materials for design purposes.

We anticipate the access driveways could be subjected to occasional heavy vehicle loads such as trash trucks and moving vans. We considered daily traffic numbers (DTN) of 2 for the parking stalls and 10 for the access driveways, which correspond to 18-kip Equivalent Single-Axle Loads (ESAL) of 14,600 and 73,000, respectively, for a 20-year pavement design life. We believe the parking stalls can be paved with 6 inches of asphalt concrete or 4 inches of asphalt concrete over 6 inches of aggregate base course. The access driveways and other portions of the proposed paved areas subjected to occasional truck traffic should be paved with 7 inches of asphalt concrete or 4 inches of asphalt underlain by 9 inches of aggregate base course. Our calculations are based on regionally accepted structural coefficients of locally available materials.

We recommend a concrete pad be provided at each trash dumpster site. The pad should be at least 8 inches thick and long enough to support the entire length of the trash truck and dumpster. Joints between concrete and asphalt pavements should be sealed with a flexible compound.

Our design considers pavement construction will be completed in accordance with City of Colorado Springs specifications. The specifications contain requirements for the pavement materials (asphalt, base course, and concrete) as well as the construction practices used (compaction, materials sampling, and proof-rolling). Of particular importance are those recommendations directed toward subgrade and base course compaction and proof-rolling. During proof-rolling, attention should be directed toward the areas of confined backfill compaction. Areas that pump excessively should be stabilized prior to pavement construction. A representative of our office should be present at the site during placement of fill and construction of pavements to perform density testing.

SUBSURFACE DRAINAGE

It is our understanding that no habitable, below-grade construction such as a basement level is planned for the proposed structures. If plans change and habitable, below-grade areas will be included in the buildings, our office should be contacted to provide design criteria for lateral earth pressures and subsurface drain systems.

Due to the predominant lack of shallow groundwater at the site, and the absence of basements or other habitable, below-grade construction, we do not anticipate the need for foundation drains for the apartment buildings.

SURFACE DRAINAGE, IRRIGATION AND MAINTENANCE

The soils of the southern Colorado region are sensitive to the addition of excessive amounts of irrigation water. Proper design, construction, and maintenance of surface drainage are critical to the satisfactory performance of foundations, slabs-on-grade, pavements, and other improvements.

Surface drainage should be designed to provide rapid runoff of surface water away from proposed buildings. Proper surface drainage and irrigation practices can help control the amount of surface water that penetrates to foundation levels and contributes to heaving or settlement of soils that support foundations and floor systems. Surface drainage should be maintained, and irrigation systems should be installed in substantial conformance with the following recommendations.

1. Wetting or drying of the open foundation excavations should be avoided.

2. Excessive wetting of foundation soils before, during, and after construction can cause heaving or softening of fill and foundation soils and result in foundation and slab movements. Proper surface drainage around the buildings is critical to control wetting.

3. The ground surface surrounding the exterior of each structure should be sloped to drain away from the building in all directions. We recommend a minimum constructed slope of at least 12 inches in the first 10 feet (10 percent) in landscaped areas around each building, where practical.

   We do not view the recommendation to provide a 10 percent slope away from the foundation as an absolute. It is desirable to create this slope where practical, because we know that backfill will likely settle to some degree. By starting with sufficient slope, positive drainage can be maintained for most settlement conditions. There are many situations around a building where a 10 percent slope cannot be achieved practically, such as around patios, at inside foundation corners, and between a structure and nearby sidewalk. In these areas, we believe it is desirable to establish as much slope as practical and to avoid irrigation. We believe it is acceptable to use a slope on the order of 5 percent perpendicular to the foundation in these limited areas.

4. Swales used to convey water across landscaped areas and between buildings should be sloped so that water moves quickly and does not pond for extended periods of time. We suggest minimum slopes of about 2 to 2.5 percent in grassed areas and about 2 percent where landscaping rock or other materials are present. If slopes less than about 2 percent are necessary, concrete-lined channels or plastic pipe should be used.

5. Backfill around the foundation walls should be moistened and compacted.

6. Roof downspouts and drains should discharge well beyond the limits of all backfill. Splash blocks and/or extensions should be provided at all downspouts so that water discharges onto the ground beyond the backfill. We generally recommend against burial of downspout discharge. Where it is necessary to bury downspout discharge, solid pipe should be used and it should slope to an open gravity outlet. Downspout extensions, splash blocks, and buried outlets must be maintained to be effective.

7. <u>The importance of proper irrigation practices cannot be overemphasized. Irrigation should be limited to the minimum amount sufficient to maintain vegetation. Application of more water will increase likelihood of slab and foundation movements.</u> Landscaping should be carefully designed and maintained to minimize irrigation. Plants placed close to foundation walls should be limited to those with low moisture requirements. Irrigated grass should not be located within 5 feet of the foundation. Sprinklers should not discharge within 5 feet of foundations. Plastic sheeting should not be placed beneath landscaped areas adja-

cent to foundation walls or grade beams. Geotextile fabric will inhibit weed growth yet still allow natural evaporation to occur.

8. The design and construction criteria for foundations were compiled with the expectation that all other recommendations presented in this report related to surface drainage, landscaping irrigation, backfill compaction, etc. will be incorporated into the project. It is critical that all recommendations in this report are followed.

CONCRETE

Concrete in contact with soils can be subject to sulfate attack. We measured water-soluble sulfate concentrations in six samples from this site. Concentrations were measured as less than 0.1 percent. Sulfate concentrations less than 0.1 percent indicate Class 0 exposure to sulfate attack for concrete in contact with the subsoils, according to ACI 201.2R-01 as published in the 2008 ACI Manual of Concrete Practice. For this level of sulfate concentration, the American Concrete Institute (ACI) indicates Type I cement can be used for concrete in contact with the subsoils. In our experience, superficial damage may occur to the exposed surfaces of highly permeable concrete, even though sulfate levels are relatively low. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious material ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist due to surface drainage or highwater tables. Concrete subjected to freeze-thaw cycles should be air entrained.

CONSTRUCTION OBSERVATIONS

We recommend that CTL|Thompson, Inc. provide observation and testing services during construction to allow us the opportunity to verify whether soil conditions are consistent with those found during this investigation. If others perform these observations, they must accept responsibility to judge whether the recommendations in this report remain appropriate.

GEOTECHNICAL RISK

The concept of risk is an important aspect with any geotechnical evaluation primarily because the methods used to develop geotechnical recommendations do not comprise an exact science. We never have complete knowledge of subsurface conditions. Our analysis must be tempered with engineering judgment and experience. Therefore, the recommendations presented in any geotechnical evaluation should not be considered risk-free. Our recommendations represent our judgment of those measures that are necessary to increase the chances that the structures will perform satisfactorily. It is critical that all recommendations in this report are followed during construction.

LIMITATIONS

This report has been prepared for the exclusive use of The Garrett Companies for the purpose of providing geotechnical design and construction criteria for the proposed project. The information, conclusions, and recommendations presented herein are based on consideration of many factors including, but not limited to, the type of structures proposed, the geologic setting, and the subsurface conditions encountered. The conclusions and recommendations contained in the report are not valid for use by others. Standards of practice continuously evolve in the area of geotechnical engineering. The recommendations provided are appropriate for about three years. If the proposed structures are not constructed within about three years, we should be contacted to determine if we should update this report.

Our borings were located to obtain a reasonably accurate indication of subsurface foundation conditions. The borings are representative of conditions encountered at the exact boring location only. Variations in subsurface conditions not indicated by the borings are possible. We recommend a representative of our office observe the completed foundation excavations to verify subsurface conditions are as anticipated from our borings. Representatives of our firm should be present during construction to provide construction observation and materials testing services.

We believe this investigation was conducted with that level of skill and care normally used by geotechnical engineers practicing under similar conditions. No warranty, express or implied, is made.

If we can be of further service in discussing the contents of this report or in the analysis of the influence of subsurface conditions on design of the buildings from a geotechnical engineering point-of-view, please call.

CTL | THOMPSON, INC.

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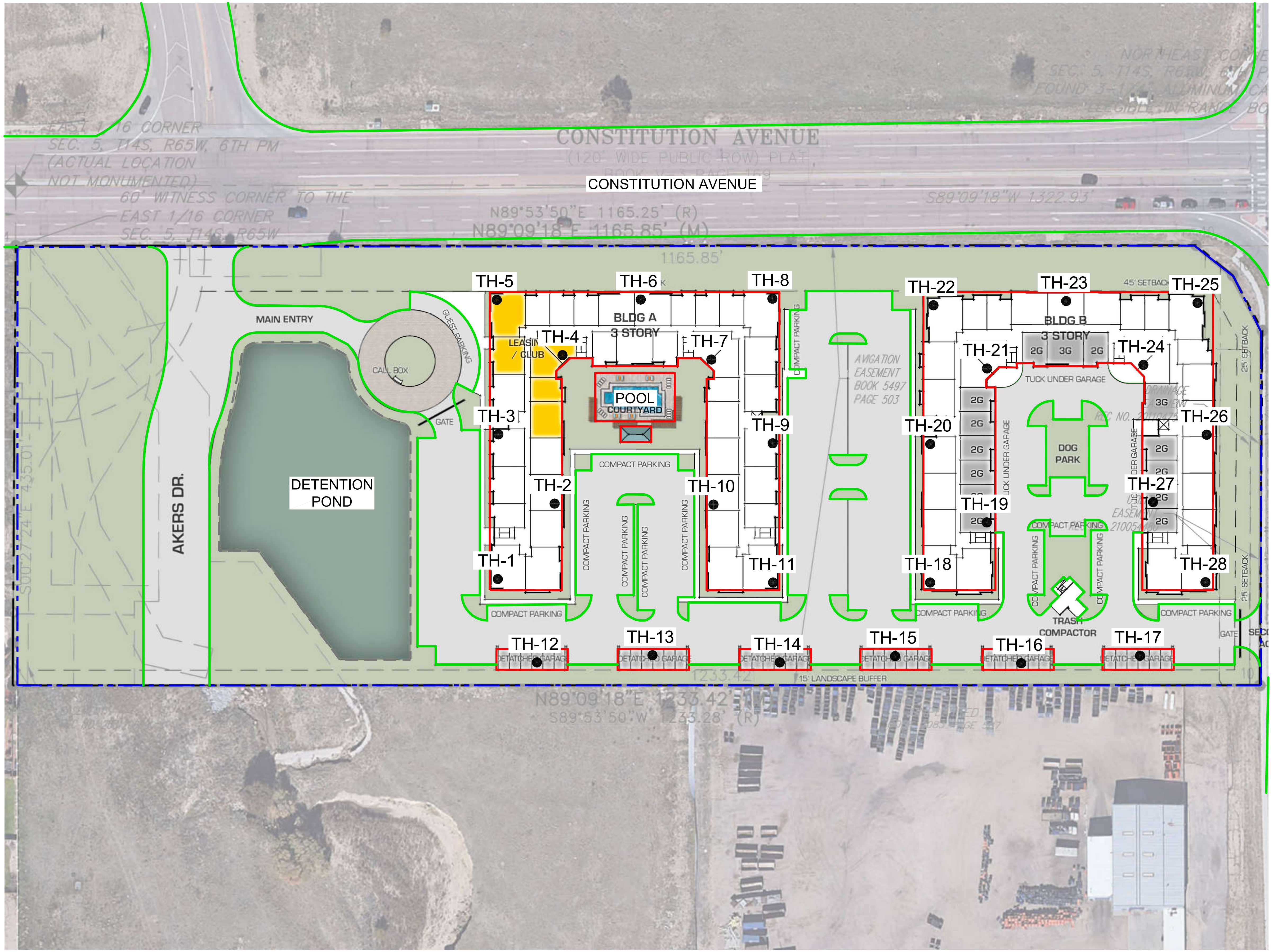
GE:JMJ:cw

(3 copies sent)

Via email: karl@thegarrettco.com



VICINITY MAP

(NOT TO SCALE)

LEGEND:

TH-1 ● APPROXIMATE LOCATION OF EXPLORATORY BORING.

PROJECT BOUNDARY

LOCATION OF PROPOSED BUILDING FOOTPRINT.

LOCATION OF PROPOSED DRIVE LANES AND PARKING AREAS.

LOCATION OF PROPOSED DETENTION POND.

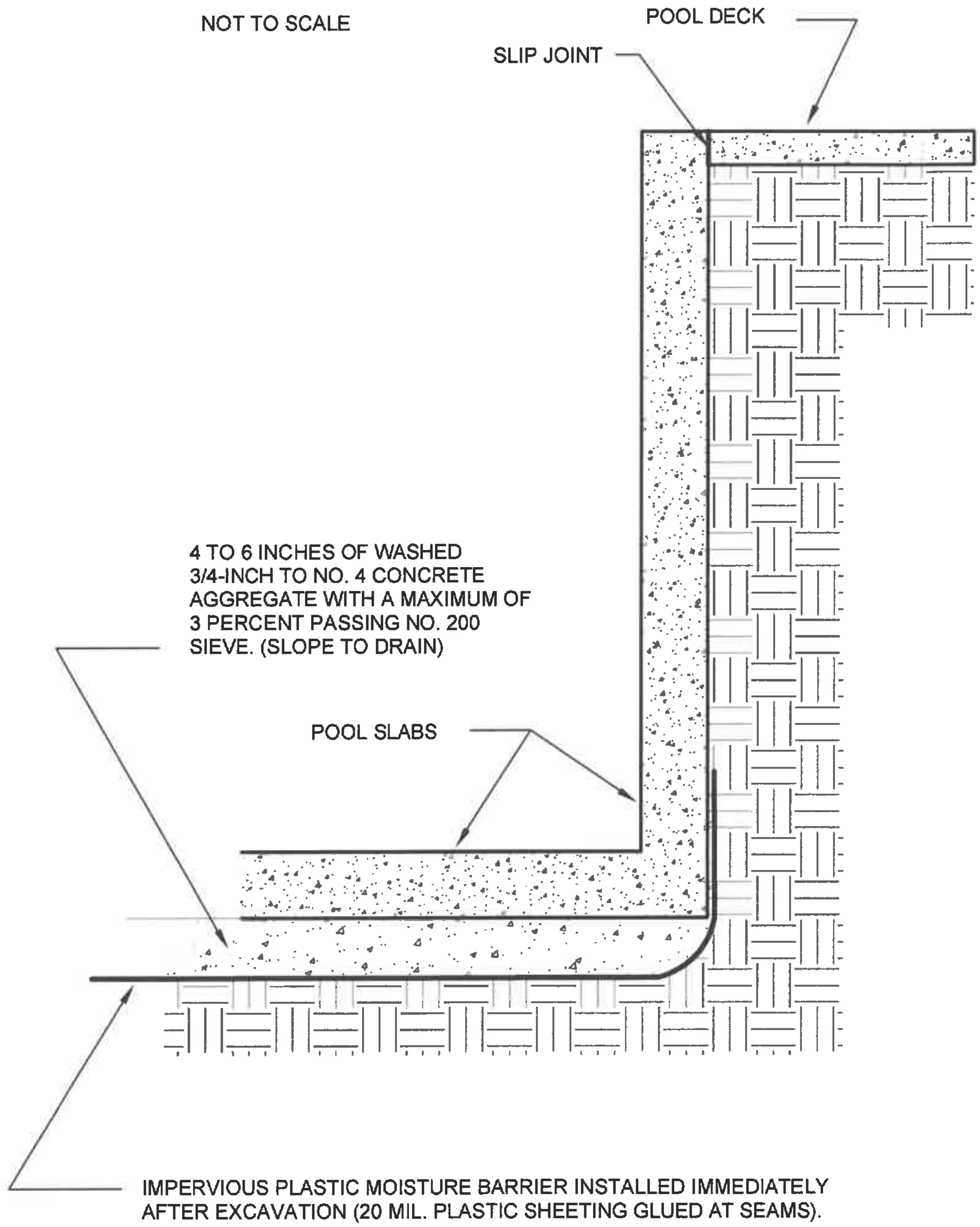
0 50' 100'

SCALE: 1" = 100'

Location of Exploratory Borings

FIG. 1

THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

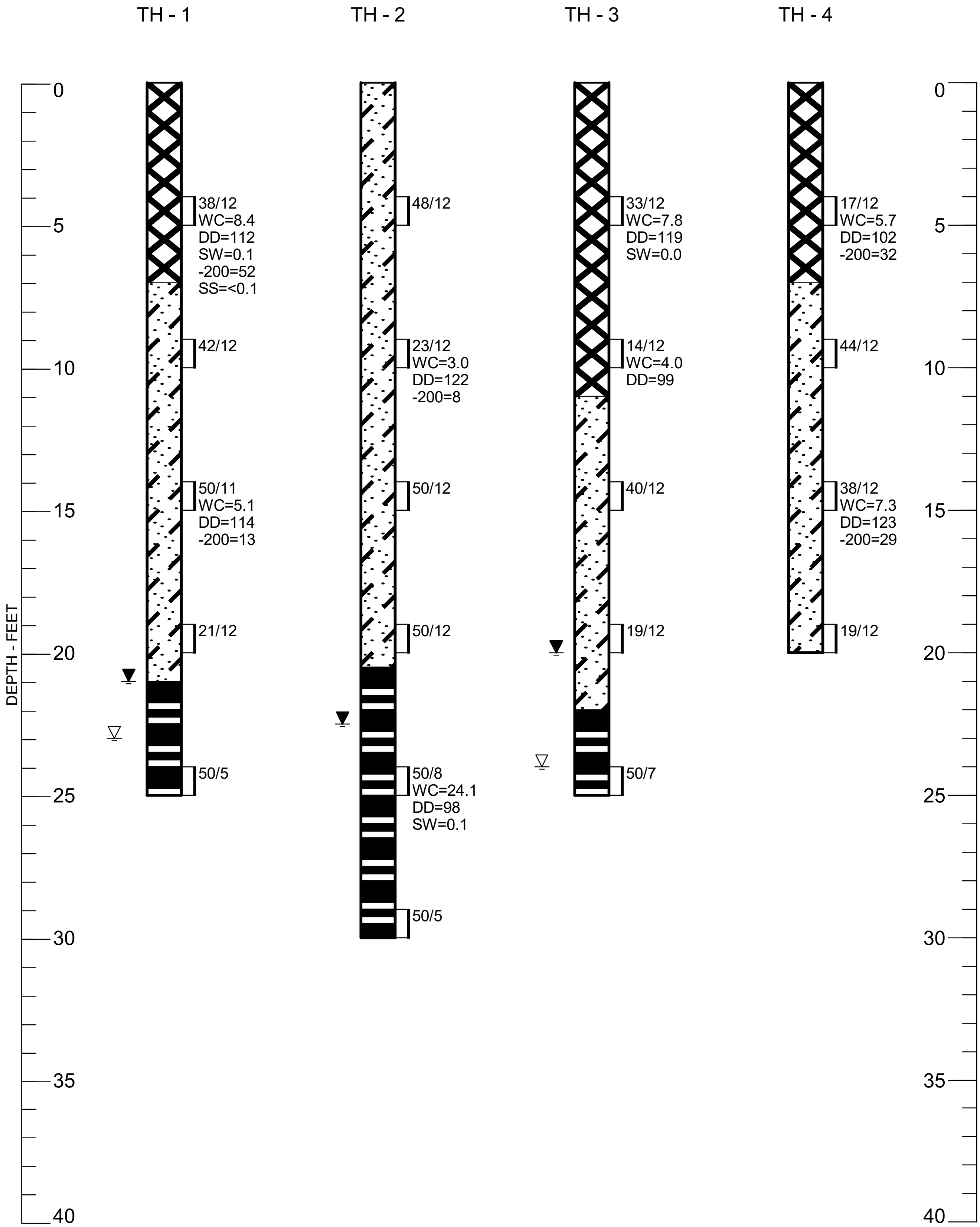


RECOMMENDED POOL DRAIN DETAIL

FIG. 2

APPENDIX A

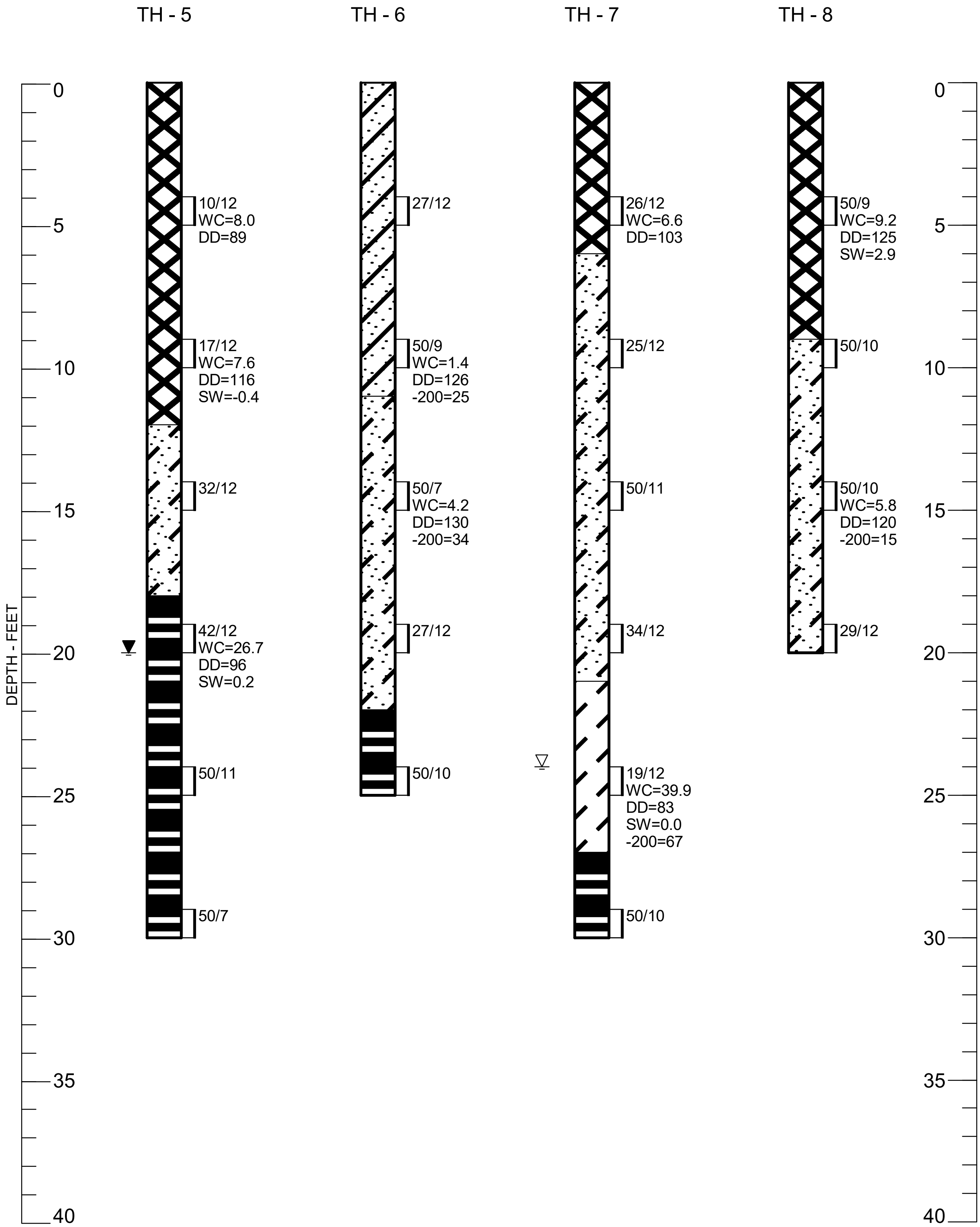
SUMMARY LOGS OF EXPLORATORY BORINGS



THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Summary Logs of Exploratory Borings

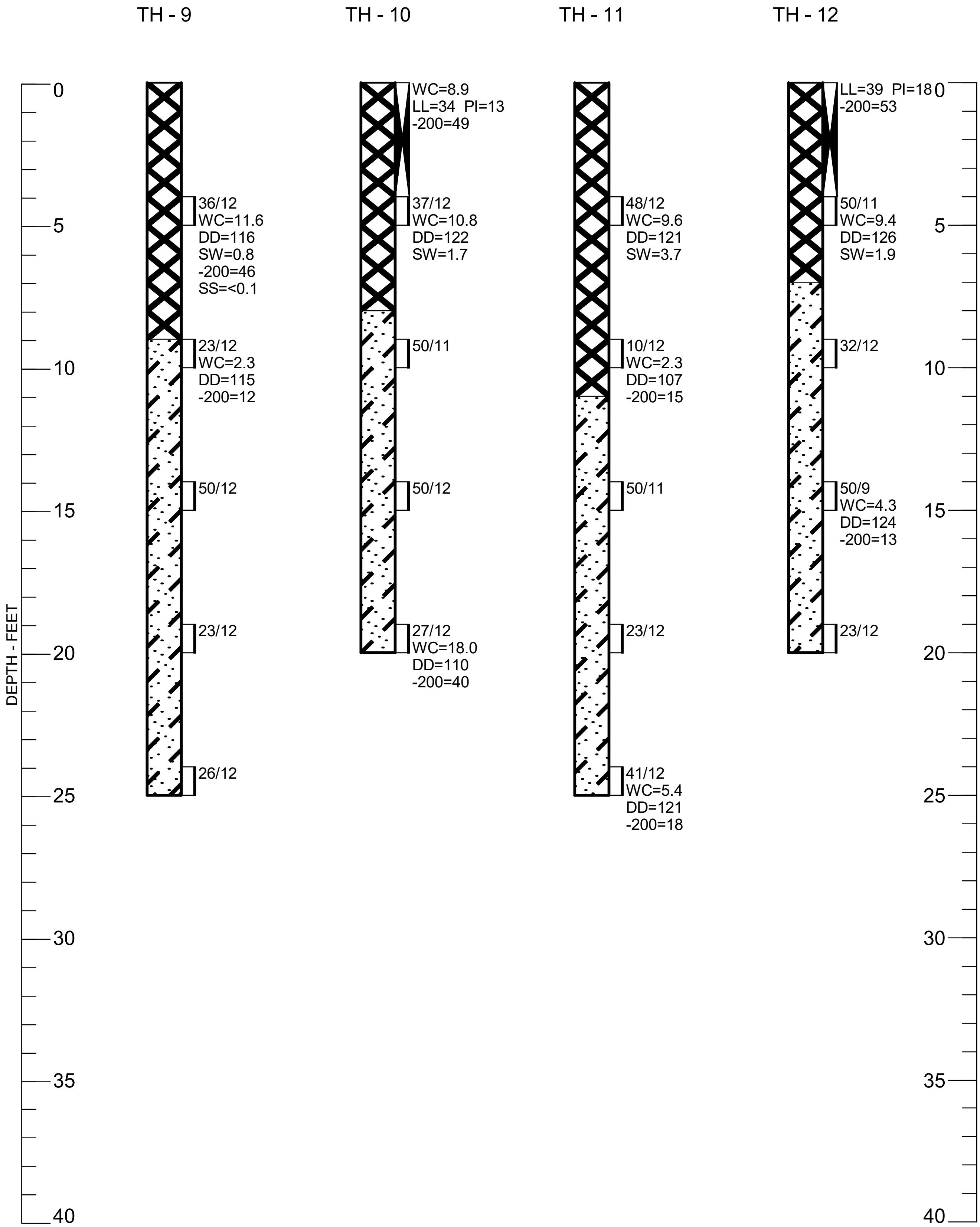
FIG. A-1



THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Summary Logs of Exploratory Borings

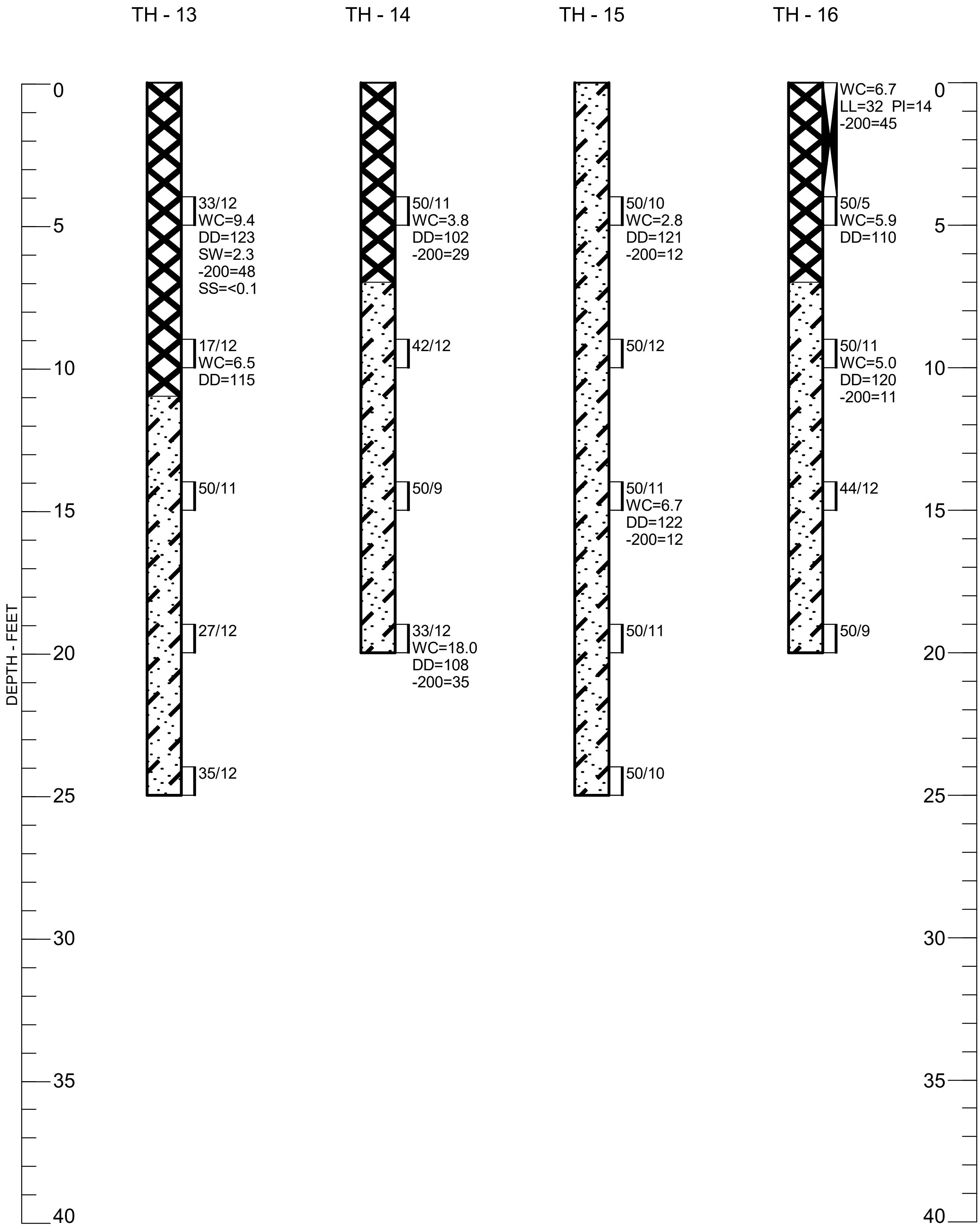
FIG. A-2



THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Summary Logs of Exploratory Borings

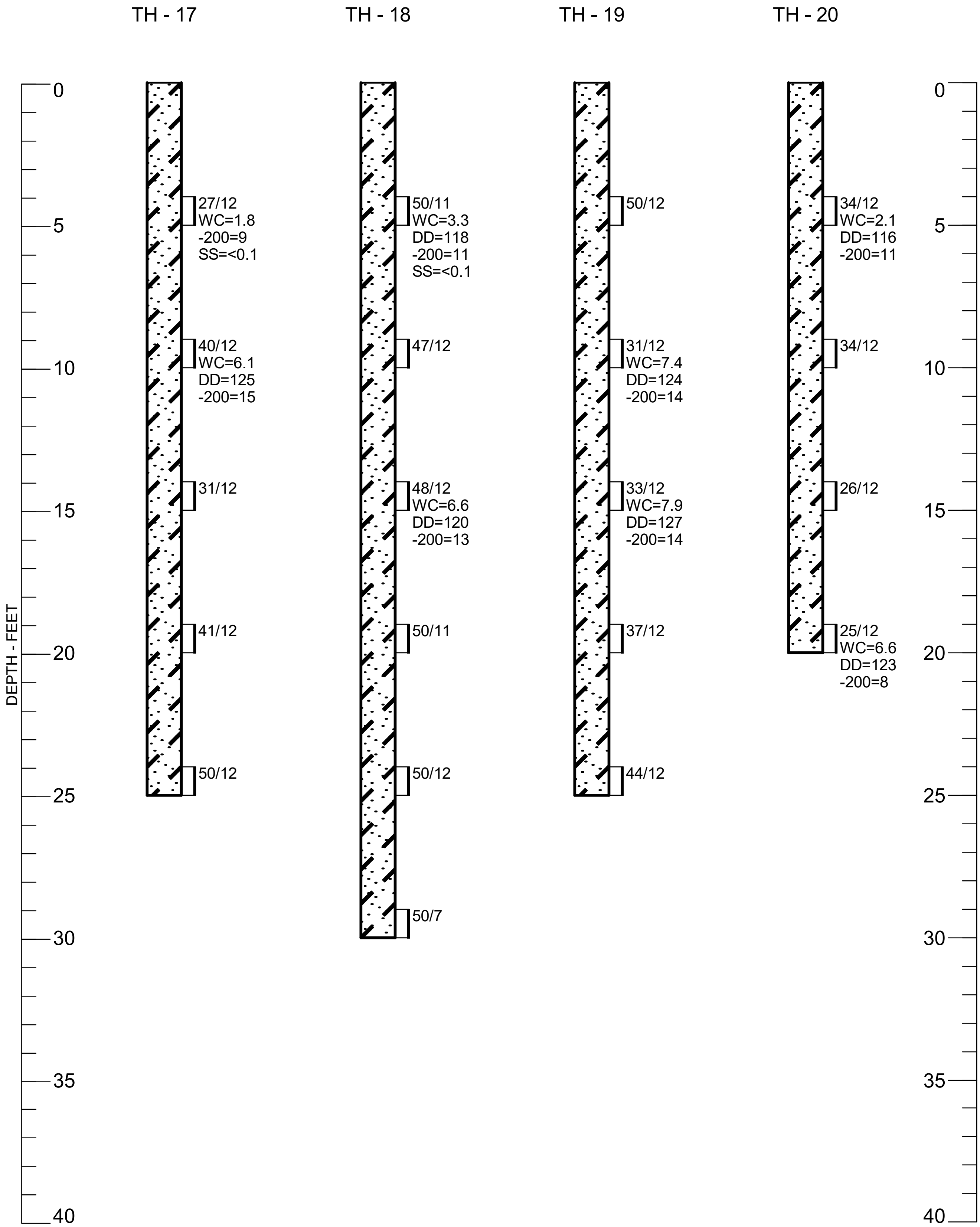
FIG. A-3



THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Summary Logs of Exploratory Borings

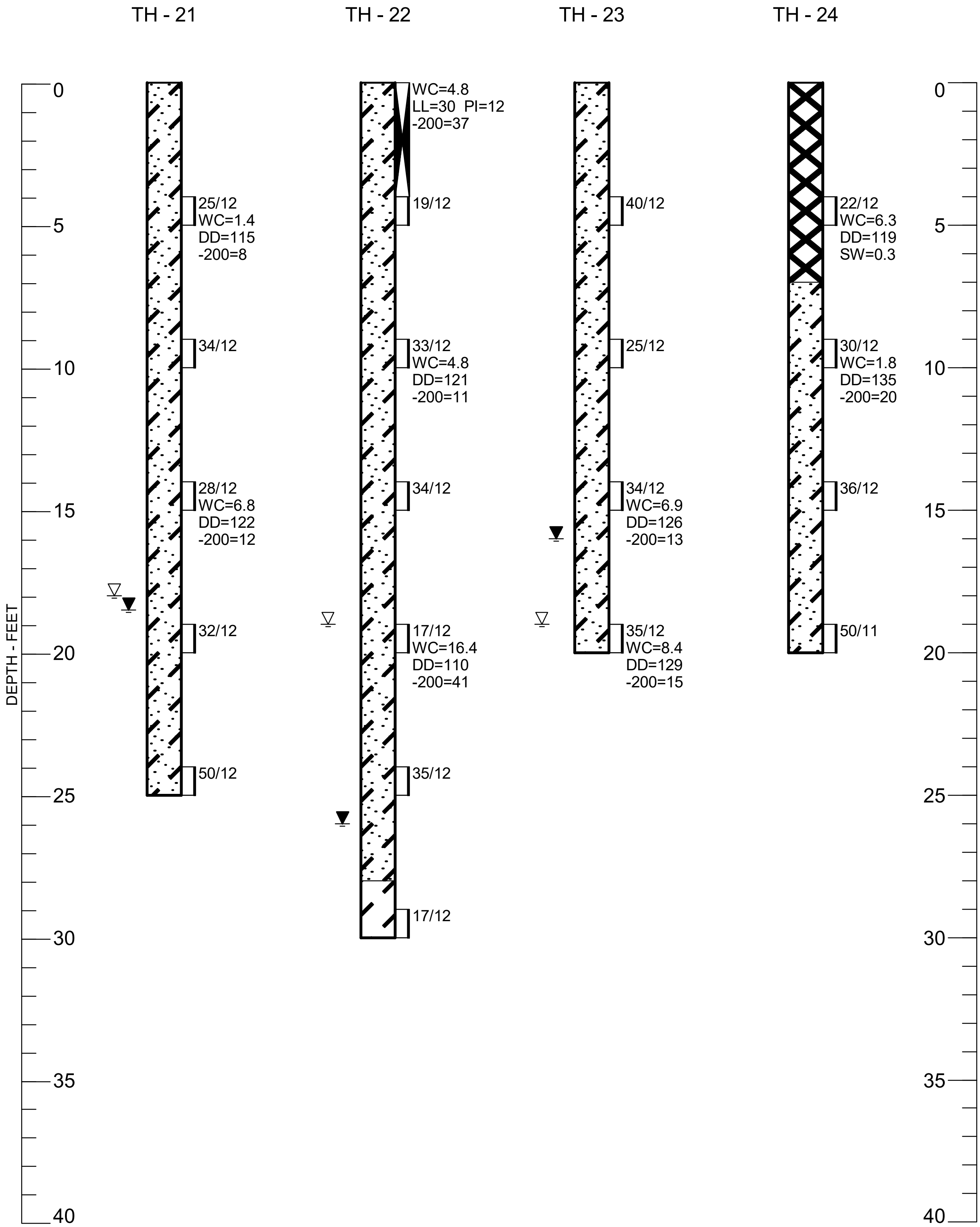
FIG. A-4



THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Summary Logs of Exploratory Borings

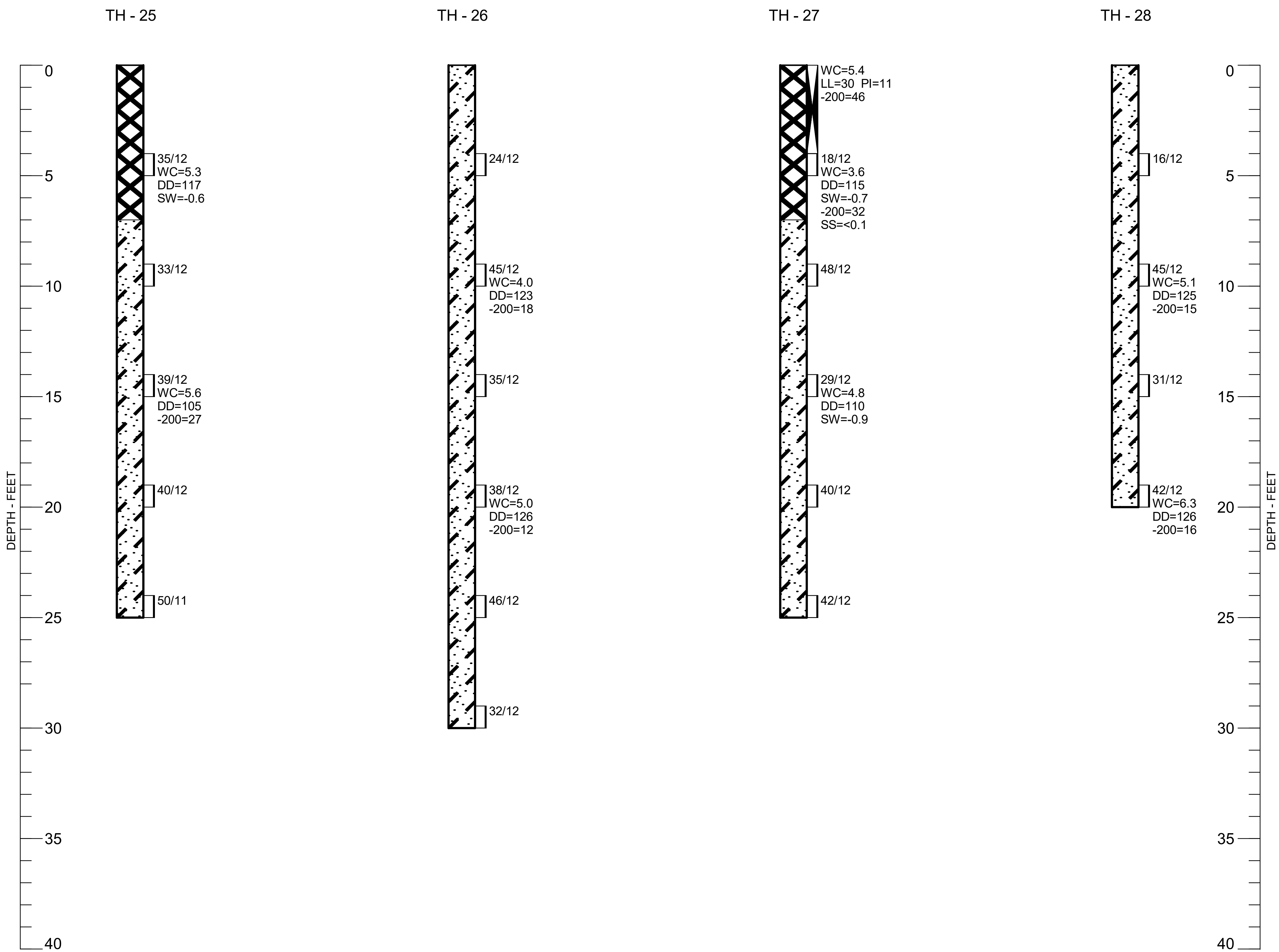
FIG. A-5



THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Summary Logs of Exploratory Borings

FIG. A-6



LEGEND:

FILL, CLAY, SANDY TO VERY SANDY WITH LENSES OF CLAYEY TO VERY CLAYEY SAND, MEDIUM DENSE TO VERY DENSE, DRY TO SLIGHTLY MOIST, DARK BROWN.

SAND, SILTY, MEDIUM DENSE TO DENSE, DRY, LIGHT BROWN (SM).

SANDY, SLIGHTLY CLAYEY TO VERY CLAYEY, MEDIUM DENSE TO VERY DENSE, DRY TO WET, LIGHT BROWN TO BROWN (SC, SP-SC, SW-SC).

CLAY, VERY SANDY, VERY STIFF, WET, GRAY TO BROWN (CL).

CLAYSTONE, SANDY, HARD TO VERY HARD, SLIGHTLY MOIST TO MOIST, GRAY TO BROWN.

DRIVE SAMPLE. THE SYMBOL 38/12 INDICATES 38 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.

INDICATES BULK SAMPLE OBTAINED FROM AUGER CUTTINGS.

GROUNDWATER LEVEL MEASURED AT TIME OF DRILLING.

GROUNDWATER LEVEL MEASURED AFTER DRILLING.

NOTES:

1. THE BORINGS WERE DRILLED SEPTEMBER 27, AND 28, 2021 USING A 4-INCH DIAMETER, CONTINUOUS-FLIGHT AUGER AND A CME-45, TRUCK-MOUNTED DRILL RIG.
2. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS, AND CONCLUSIONS AS CONTAINED IN THIS REPORT.
3. WC - INDICATES MOISTURE CONTENT. (%)
   DD - INDICATES DRY DENSITY. (PCF)
   SW - INDICATES SWELL WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE. (%)
   LL - INDICATES LIQUID LIMIT. (NV : NO VALUE)
   PI - INDICATES PLASTICITY INDEX. (NP : NON-PLASTIC)
   -200 - INDICATES PASSING NO. 200 SIEVE. (%)
   SS - INDICATES WATER-SOLUBLE SULFATE CONTENT. (%)

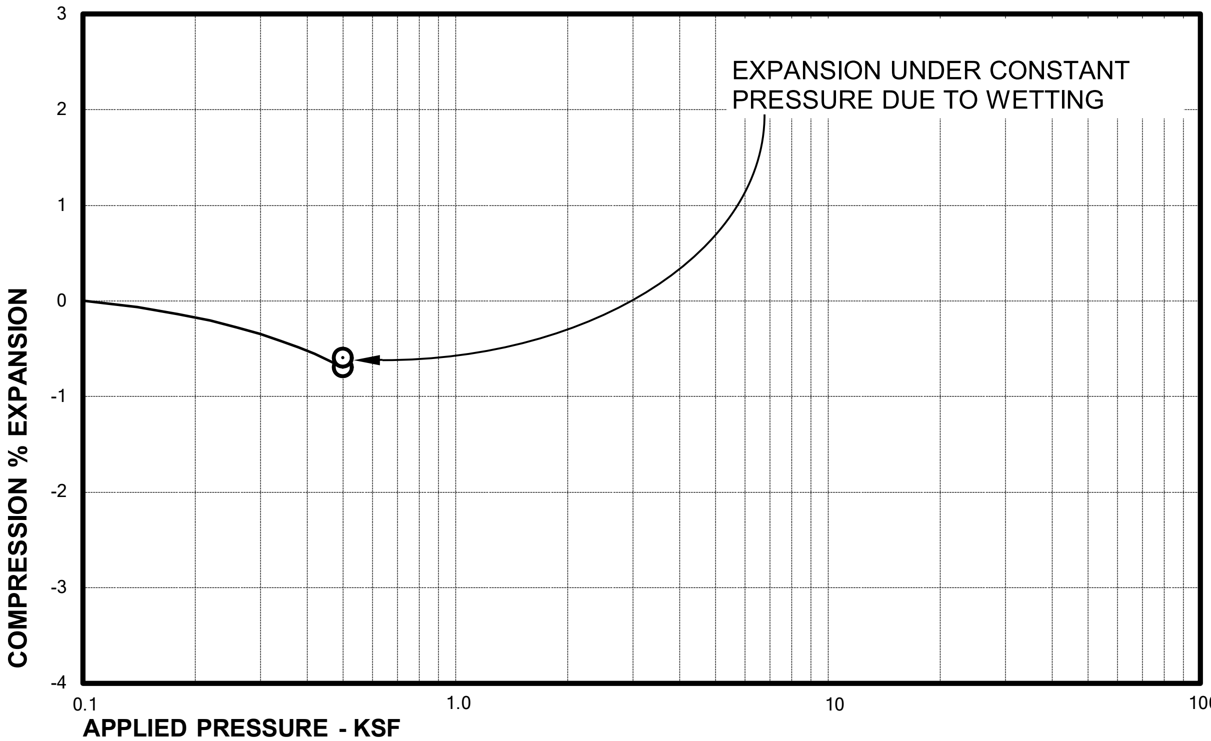
THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Summary Logs of Exploratory Borings

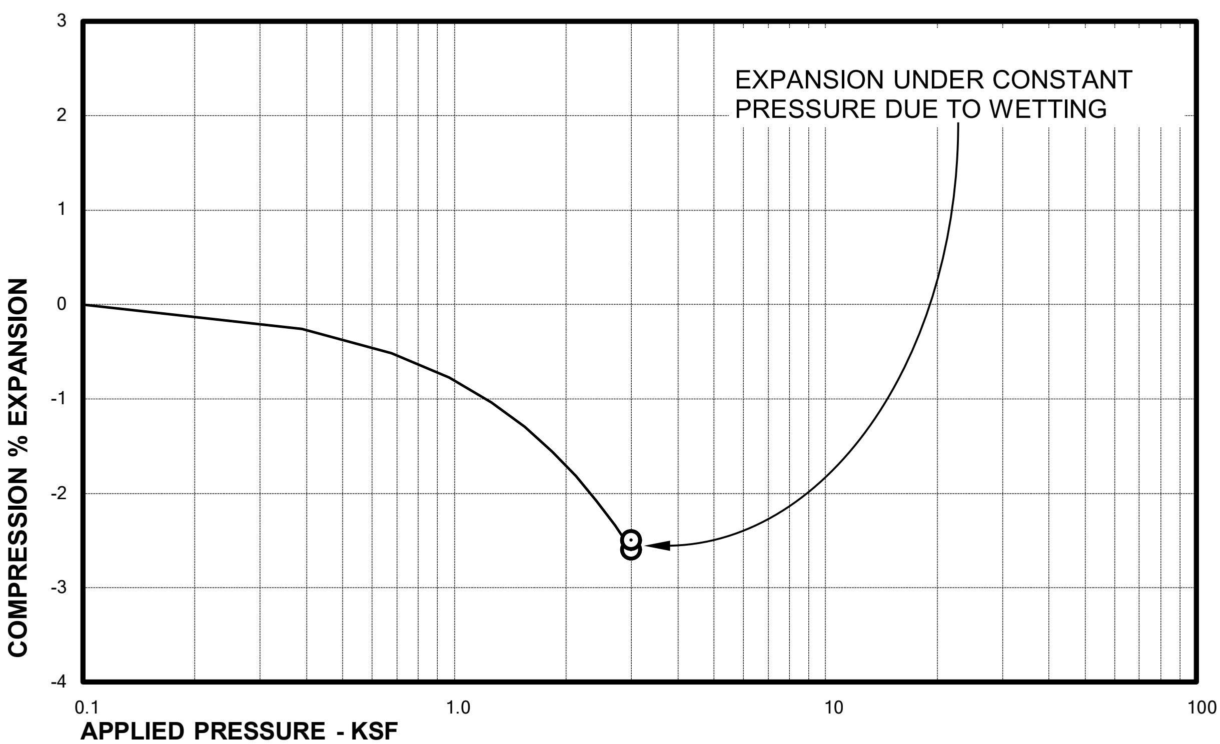
FIG. A-7

APPENDIX B

LABORATORY TEST RESULTS
TABLE A-1: SUMMARY OF LABORATORY TESTING

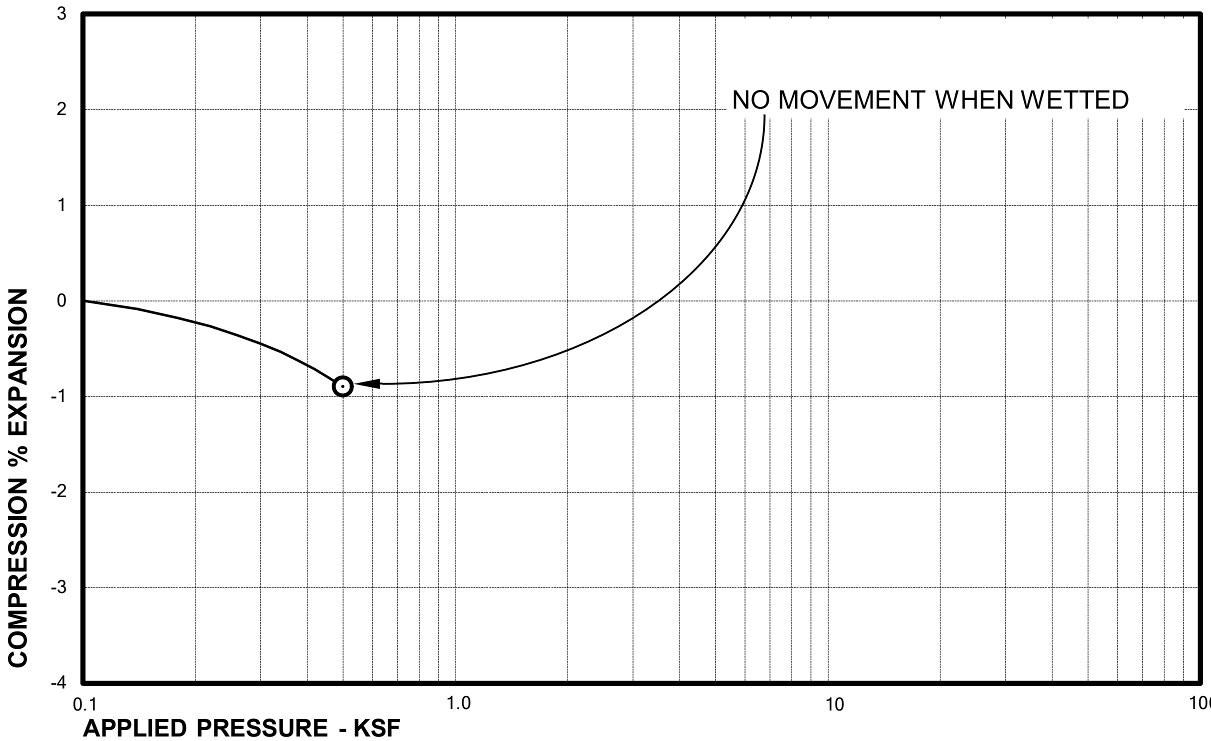


Sample of	FILL, CLAY, VERY SANDY	DRY UNIT WEIGHT=	112	PCF
From	TH-1 AT 4 FEET	MOISTURE CONTENT=	8.4	%



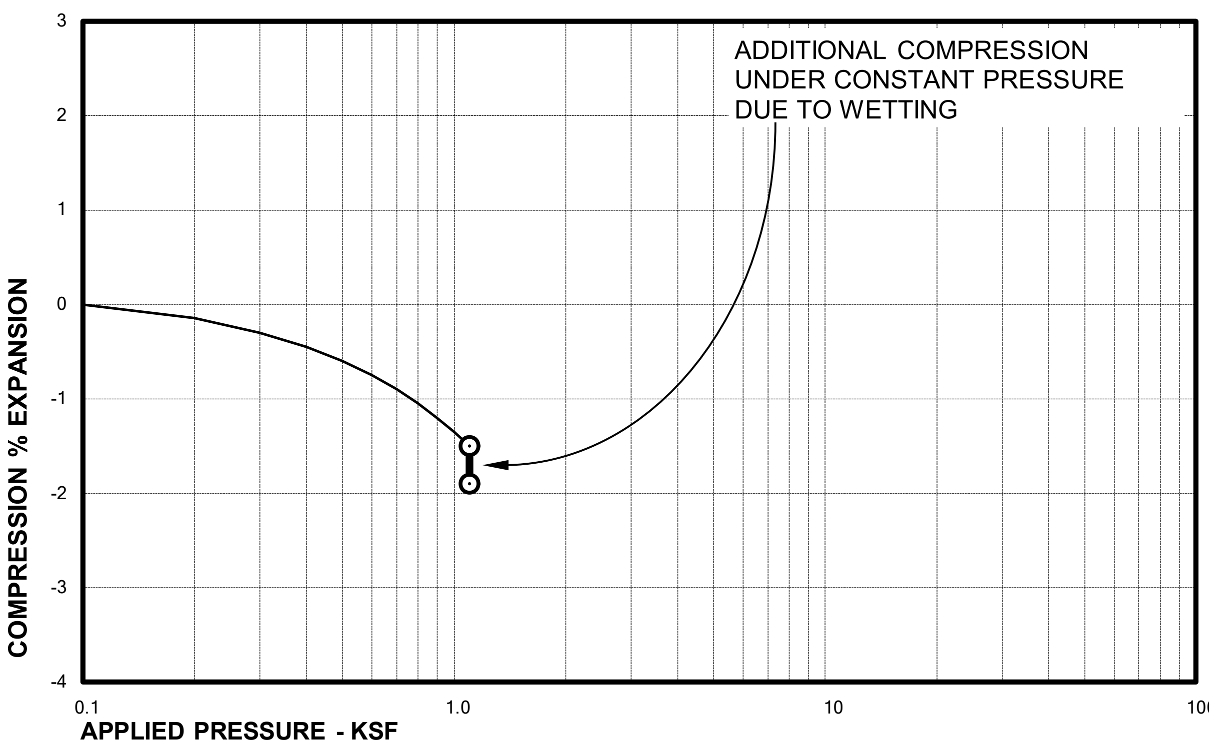
Sample of	CLAYSTONE	DRY UNIT WEIGHT=	98	PCF
From	TH-2 AT 24 FEET	MOISTURE CONTENT=	24.1	%

Swell Consolidation Test Results



Sample of FILL, CLAY, SANDY — DRY UNIT WEIGHT= 119 PCF

From TH-3 AT 4 FEET — MOISTURE CONTENT= 7.8 %



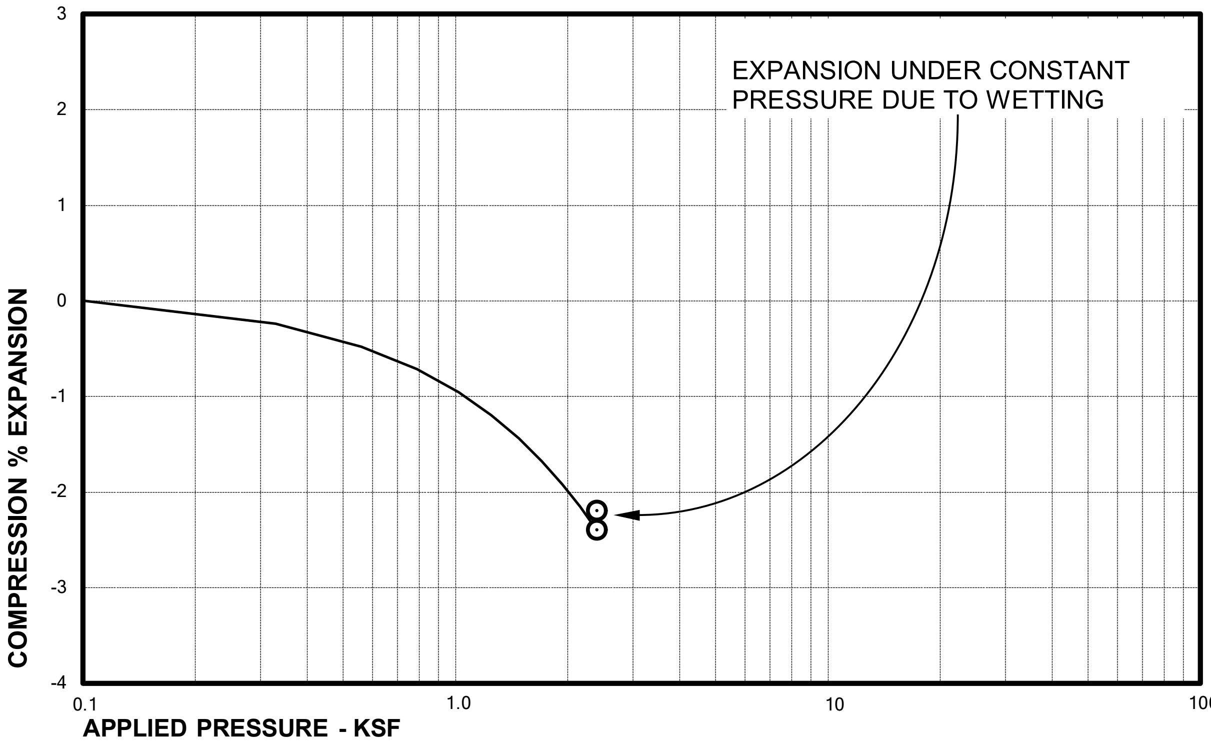
Sample of FILL, CLAY, SANDY — DRY UNIT WEIGHT= 116 PCF

From TH-5 AT 9 FEET — MOISTURE CONTENT= 7.6 %

THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

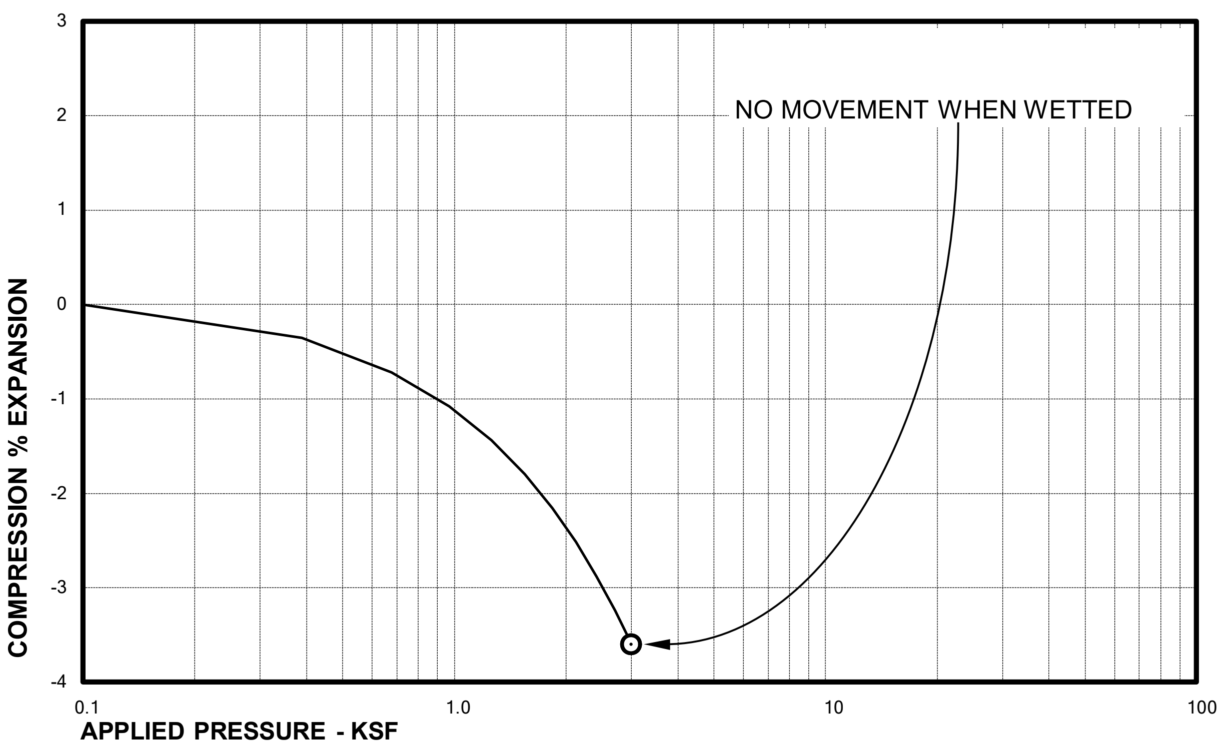
Swell Consolidation Test Results

FIG. B-2



Sample of CLAYSTONE, SANDY
From TH-5 AT 19 FEET

DRY UNIT WEIGHT= 96 PCF
MOISTURE CONTENT= 26.7 %



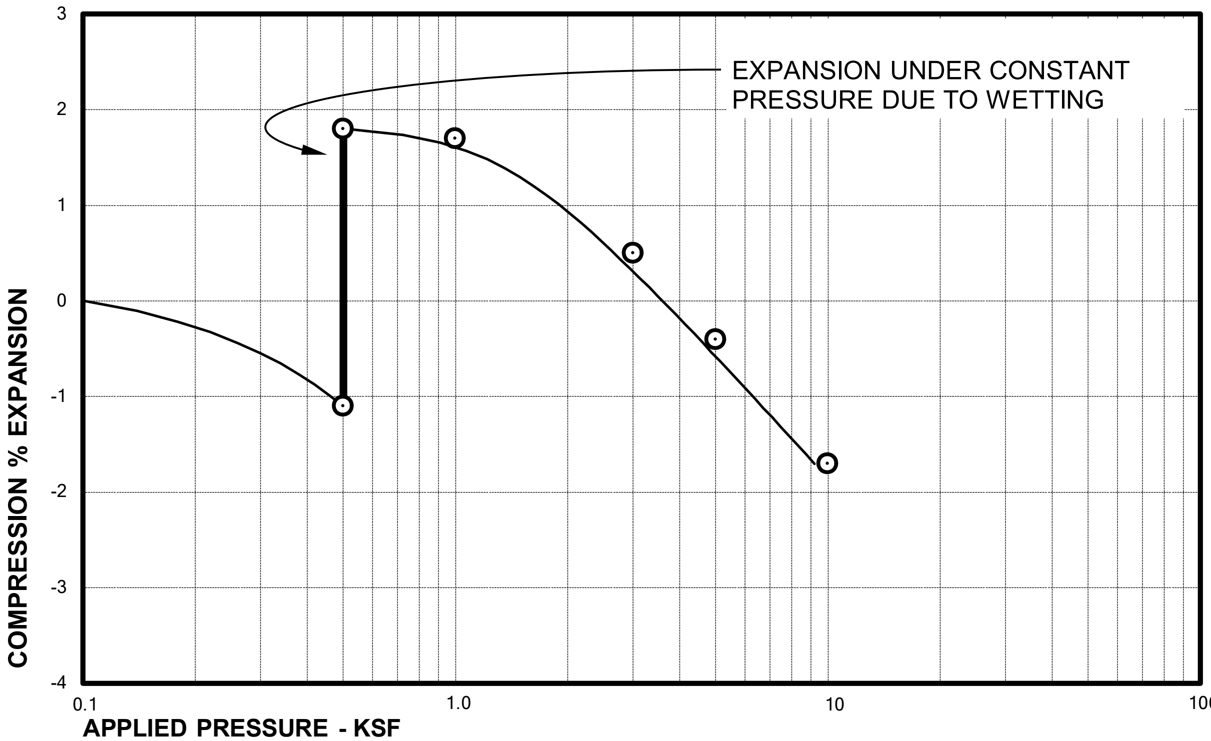
Sample of CLAY, VERY SANDY (CL)
From TH-7 AT 24 FEET

DRY UNIT WEIGHT= 83 PCF
MOISTURE CONTENT= 39.9 %

THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Swell Consolidation Test Results

FIG. B-3

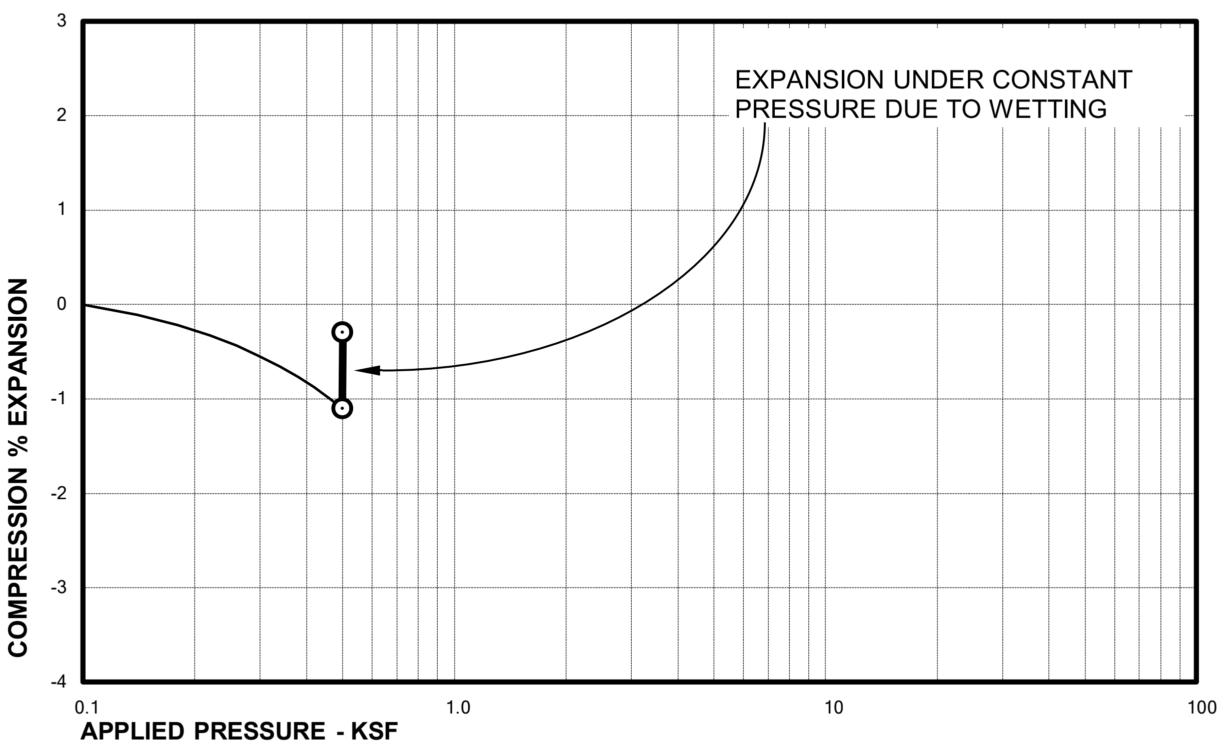


Sample of FILL, CLAY, SANDY

From TH-8 AT 4 FEET

DRY UNIT WEIGHT= 125 PCF

MOISTURE CONTENT= 9.2 %



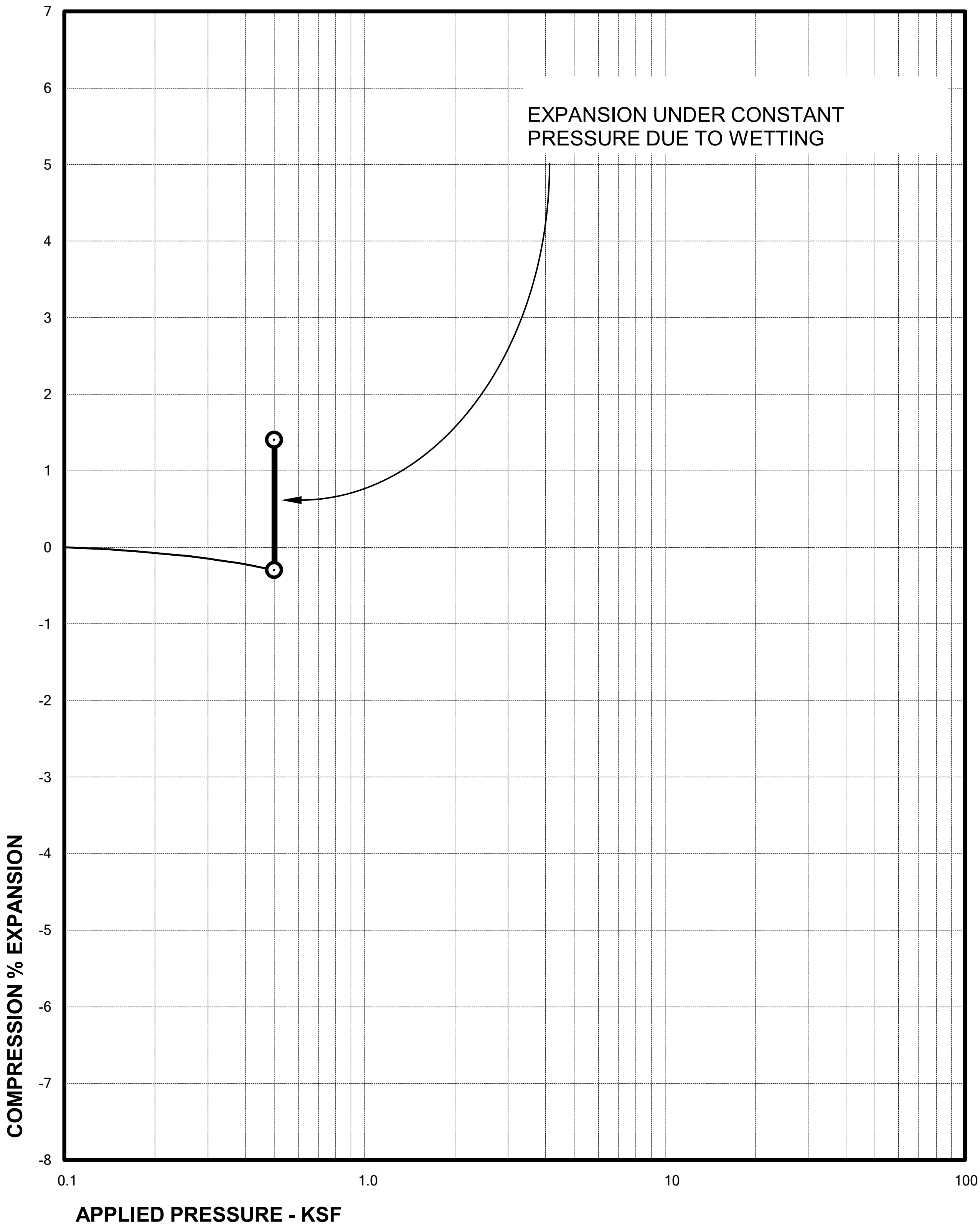
Sample of FILL, SAND, VERY CLAYEY

From TH-9 AT 4 FEET

DRY UNIT WEIGHT= 116 PCF

MOISTURE CONTENT= 11.6 %

Swell Consolidation Test Results



Sample of FILL, SAND, VERY CLAYEY

From TH-10 AT 4 FEET

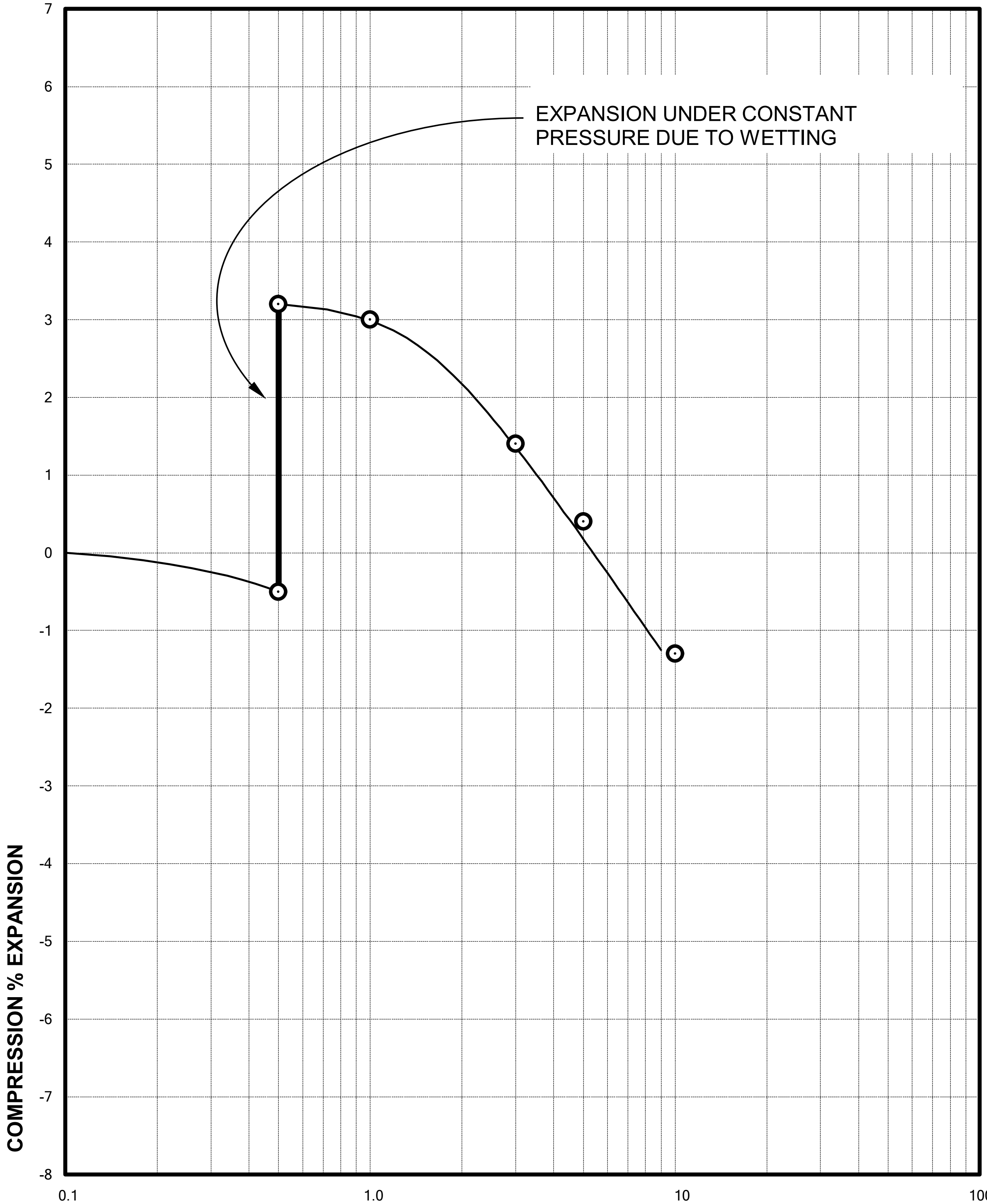
DRY UNIT WEIGHT= 122 PCF

MOISTURE CONTENT= 10.8 %

THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Swell Consolidation Test Results

FIG. B-5



Sample of FILL, SAND, CLAYEY

From TH-11 AT 4 FEET

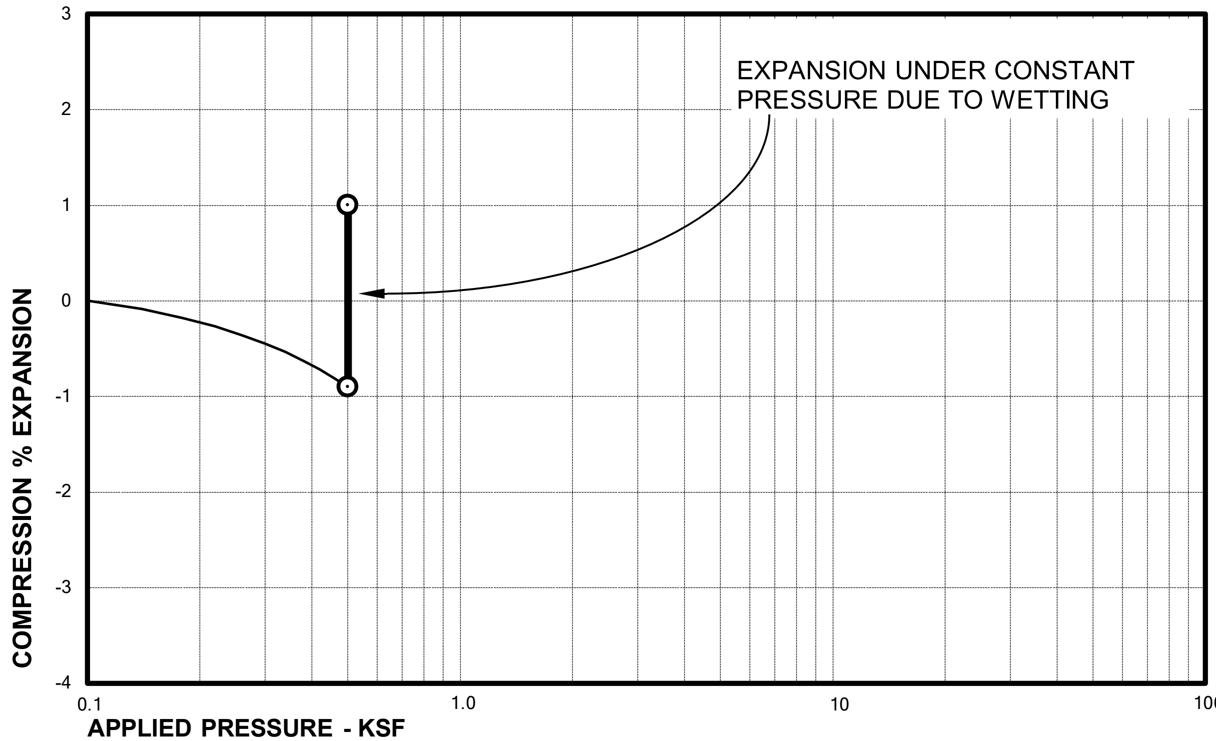
DRY UNIT WEIGHT= 121 PCF

MOISTURE CONTENT= 9.6 %

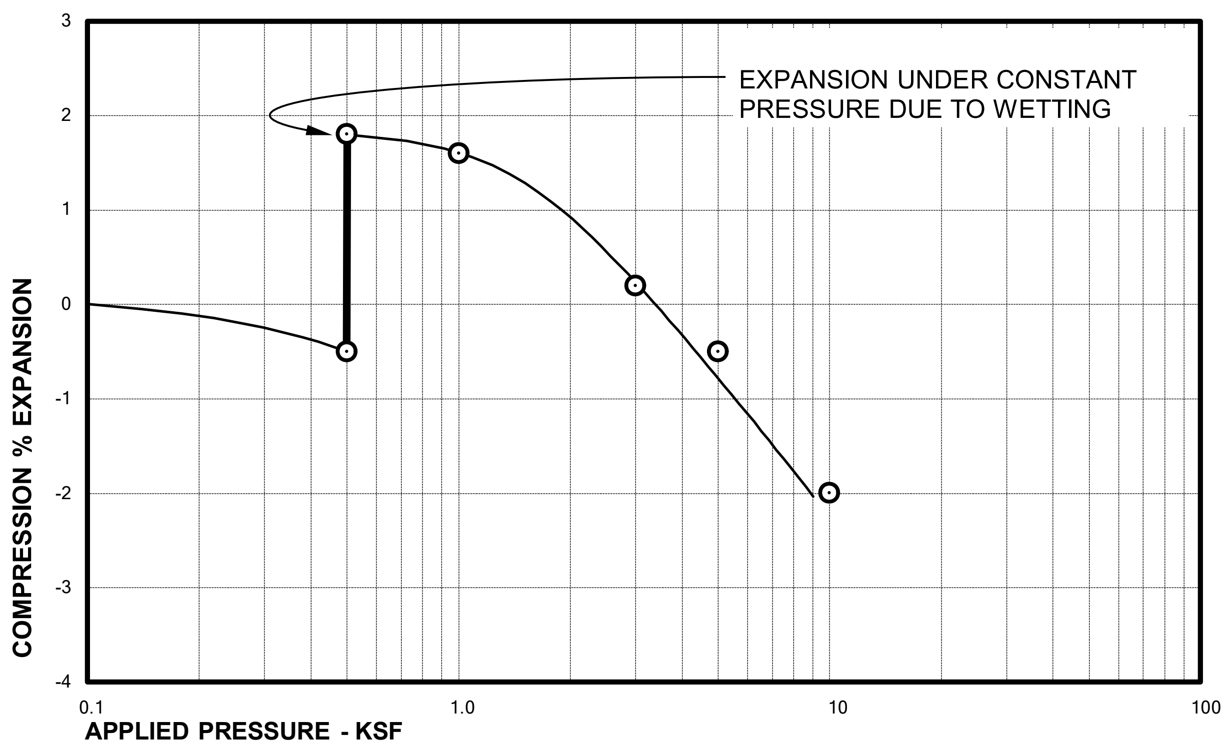
THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Swell Consolidation Test Results

FIG. B-6



Sample of	FILL, CLAY, VERY SANDY	DRY UNIT WEIGHT=	126	PCF
From	TH-12 AT 4 FEET	MOISTURE CONTENT=	9.4	%



Sample of	FILL, SAND, VERY CLAYEY	DRY UNIT WEIGHT=	123	PCF
From	TH-13 AT 4 FEET	MOISTURE CONTENT=	9.4	%

THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
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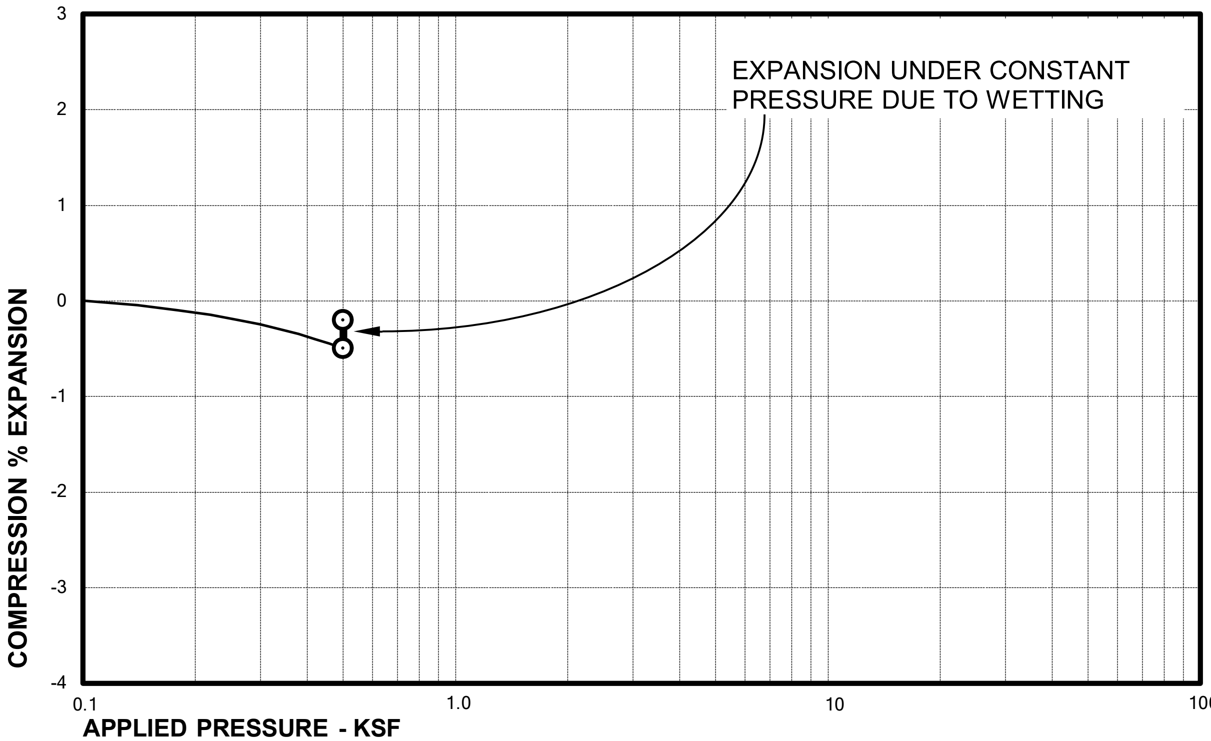
Swell Consolidation Test Results

FIG. B-7

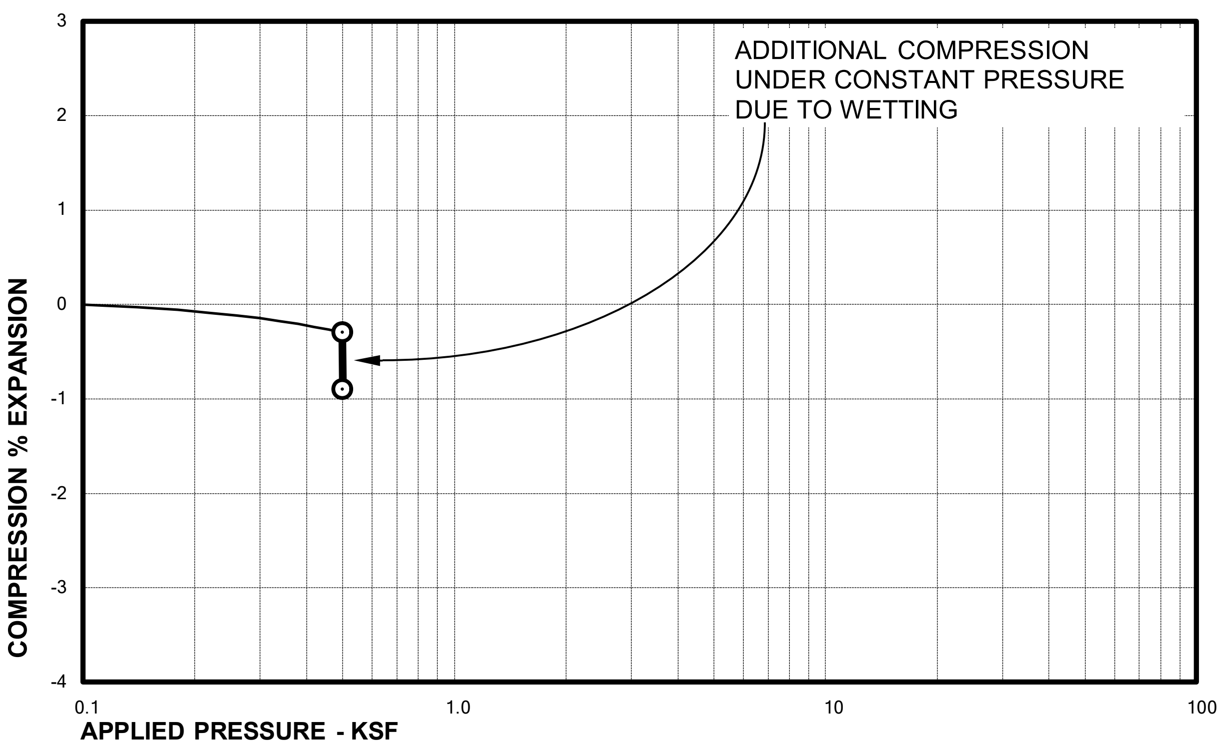


Sample of FILL, CLAY, SANDY

From TH-24 AT 4 FEET

DRY UNIT WEIGHT= 119 PCF

MOISTURE CONTENT= 6.3 %



Sample of FILL, CLAY, SANDY

From TH-25 AT 4 FEET

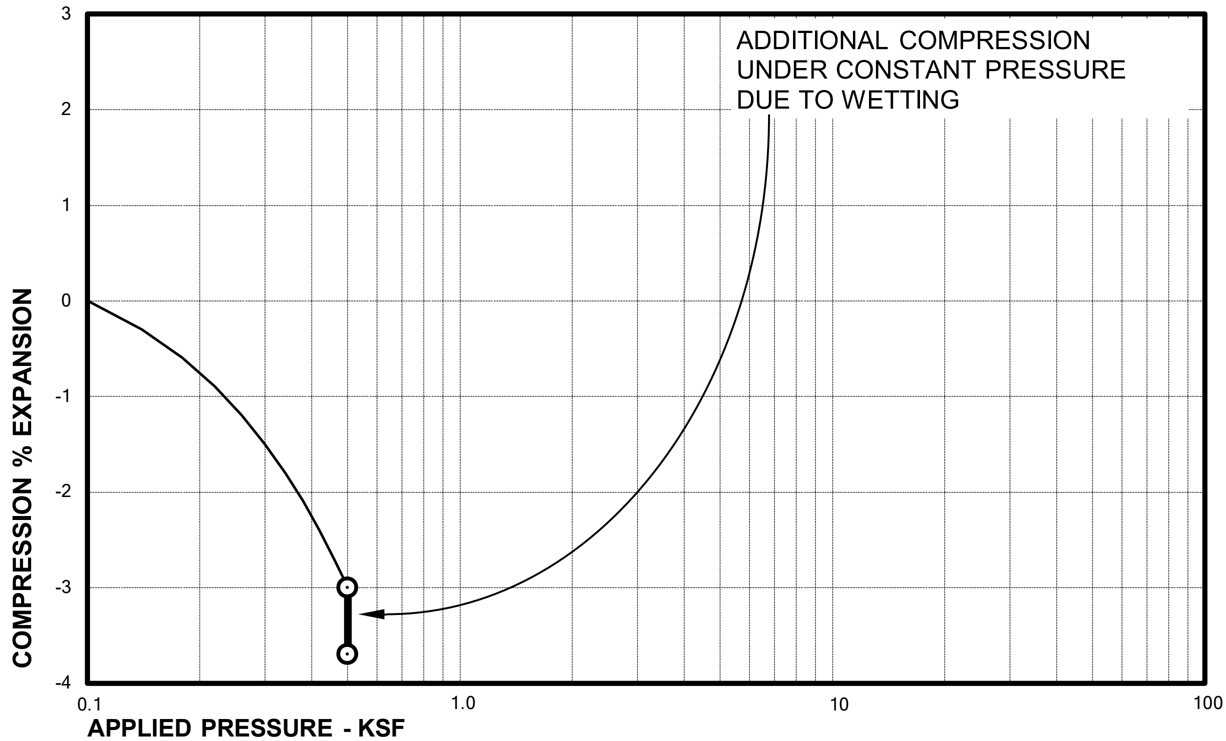
DRY UNIT WEIGHT= 117 PCF

MOISTURE CONTENT= 5.3 %

THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Swell Consolidation Test Results

FIG. B-8

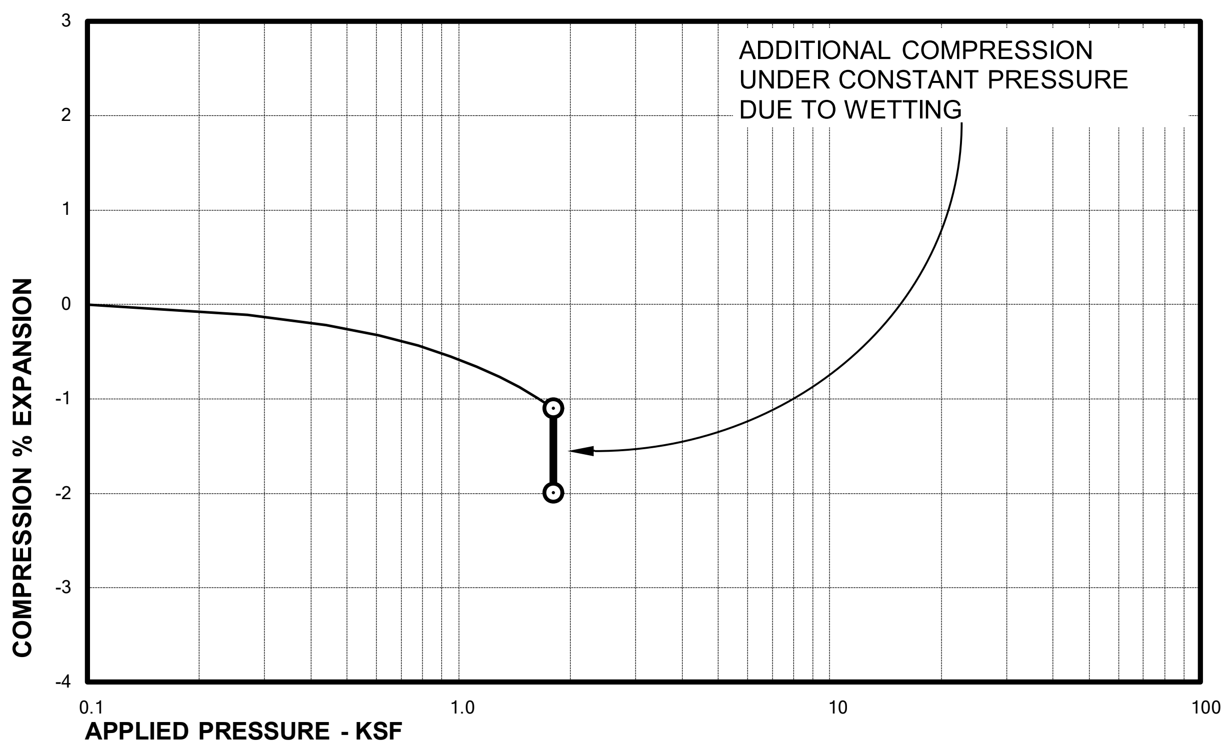


Sample of FILL, SAND, CLAYEY

From TH-27 AT 4 FEET

DRY UNIT WEIGHT= 115 PCF

MOISTURE CONTENT= 3.6 %



Sample of SAND, CLAYEY (SC)

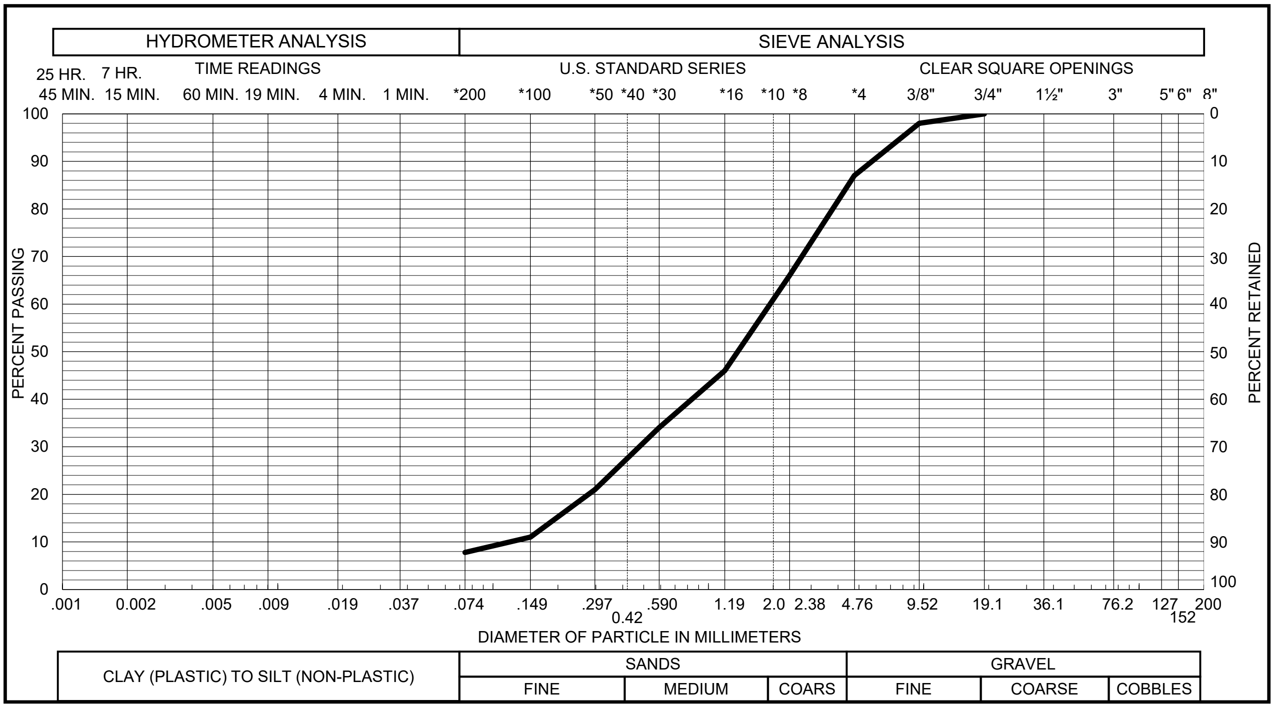
From TH-27 AT 14 FEET

DRY UNIT WEIGHT= 110 PCF

MOISTURE CONTENT= 4.8 %

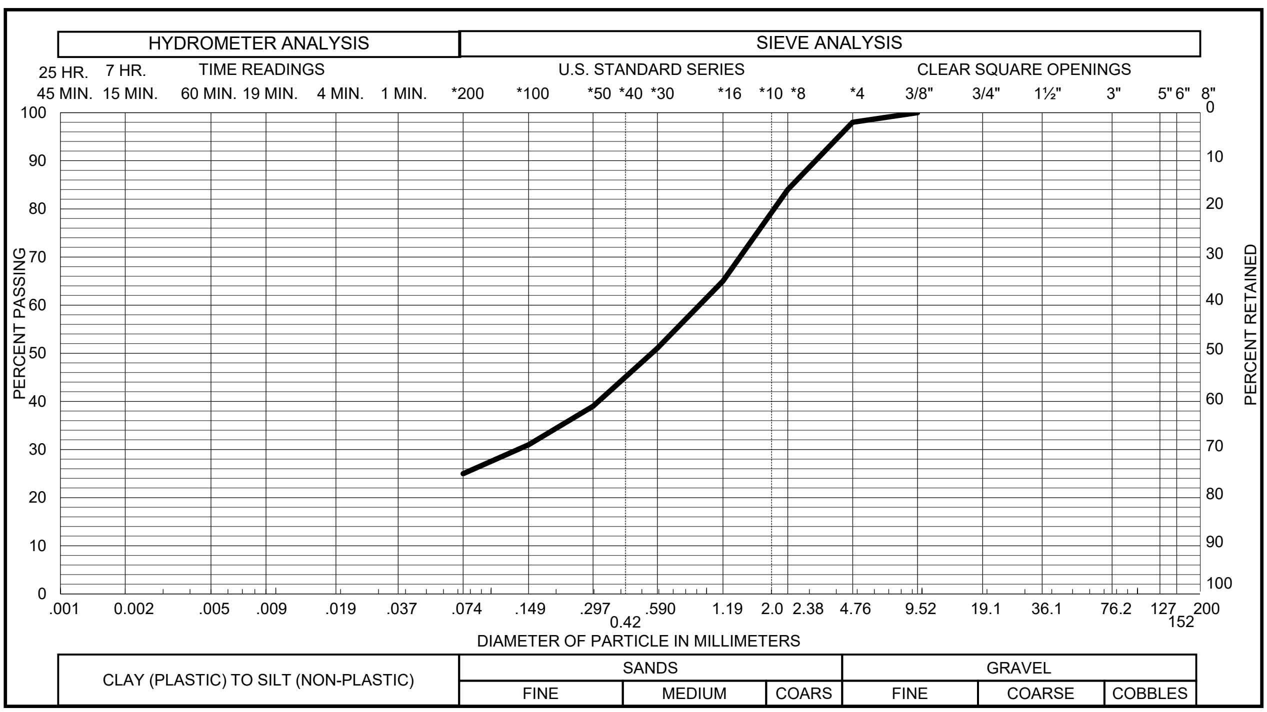
Swell Consolidation Test Results

FIG. B-9



Sample of SAND, SLIGHTLY CLAYEY (SP-SC)
From TH - 2 AT 9 FEET

GRAVEL 13 % SAND 79 %
SILT & CLAY 8 % LIQUID LIMIT
PLASTICITY INDEX



Sample of SAND, SILTY (SM)
From TH - 6 AT 9 FEET

GRAVEL 2 % SAND 73 %
SILT & CLAY 25 % LIQUID LIMIT
PLASTICITY INDEX

THE GARRETT COMPANIES
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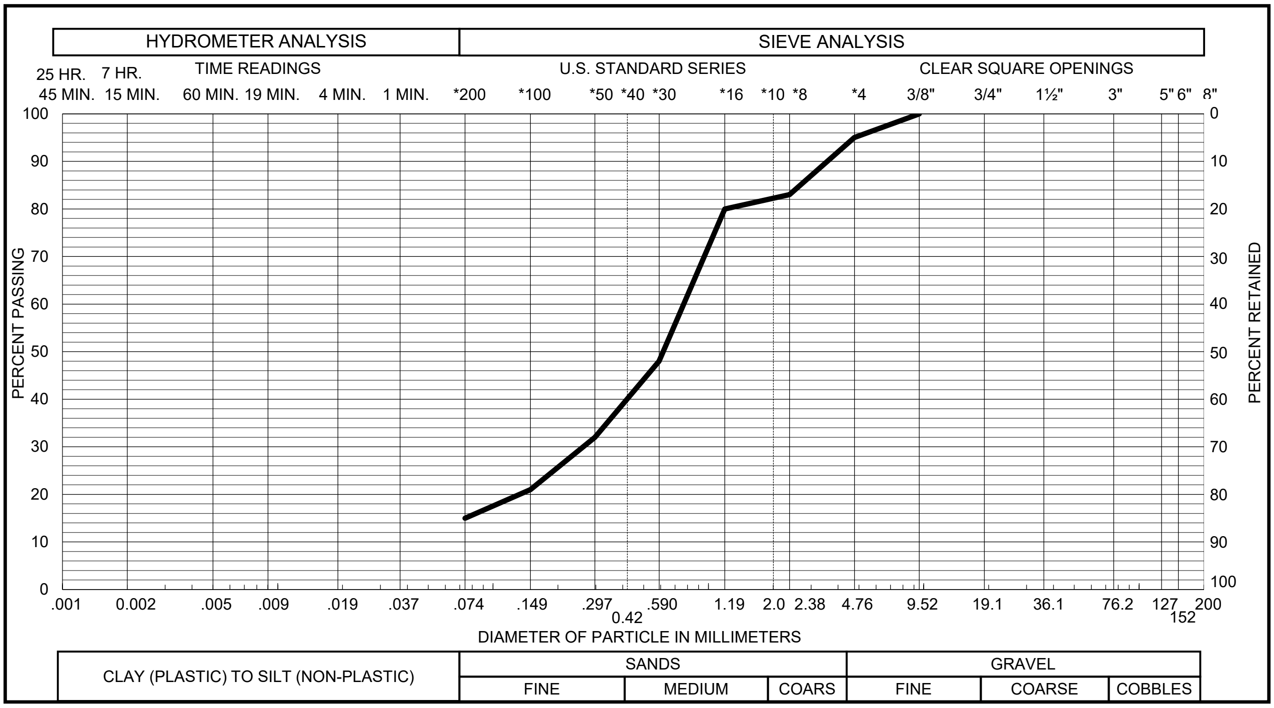
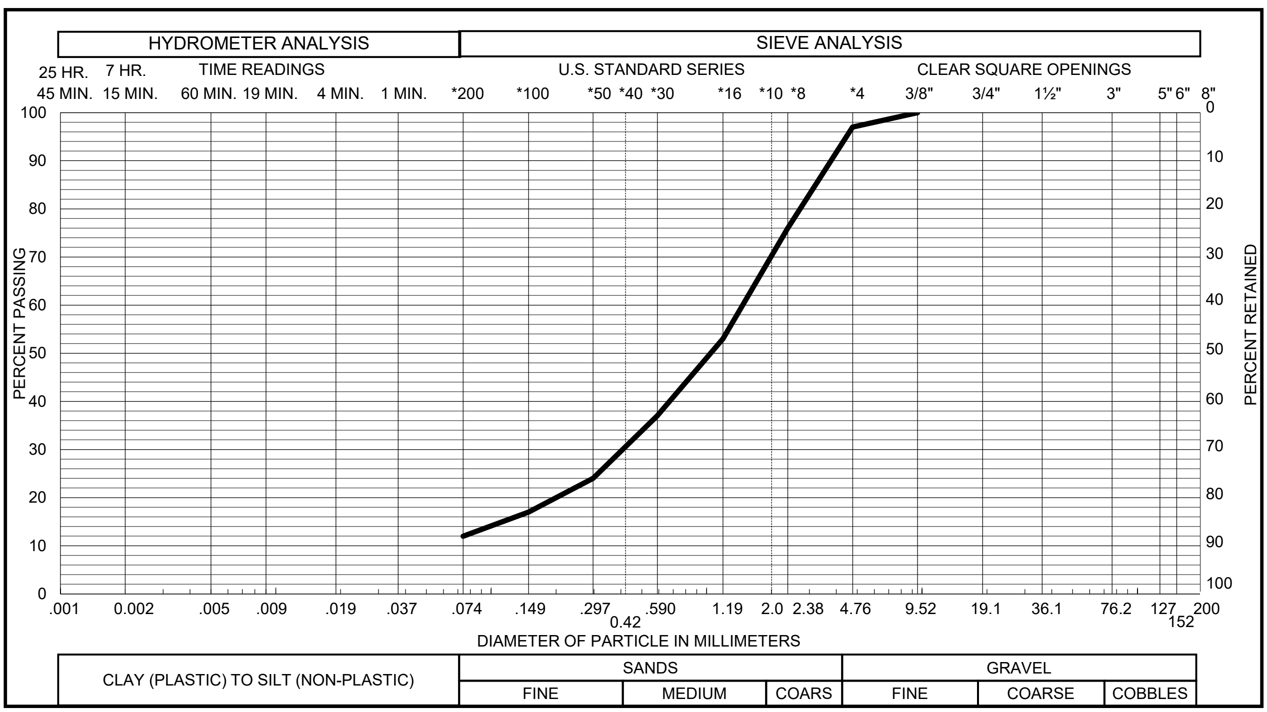
Gradation Test Results

FIG. B-10



Sample of SAND, CLAYEY (SC)
From TH - 8 AT 14 FEET

GRAVEL 5 % SAND 80 %
SILT & CLAY 15 % LIQUID LIMIT
PLASTICITY INDEX



Sample of SAND, SLIGHTLY CLAYEY (SW-SC)
From TH - 9 AT 9 FEET

GRAVEL 3 % SAND 85 %
SILT & CLAY 12 % LIQUID LIMIT
PLASTICITY INDEX

THE GARRETT COMPANIES
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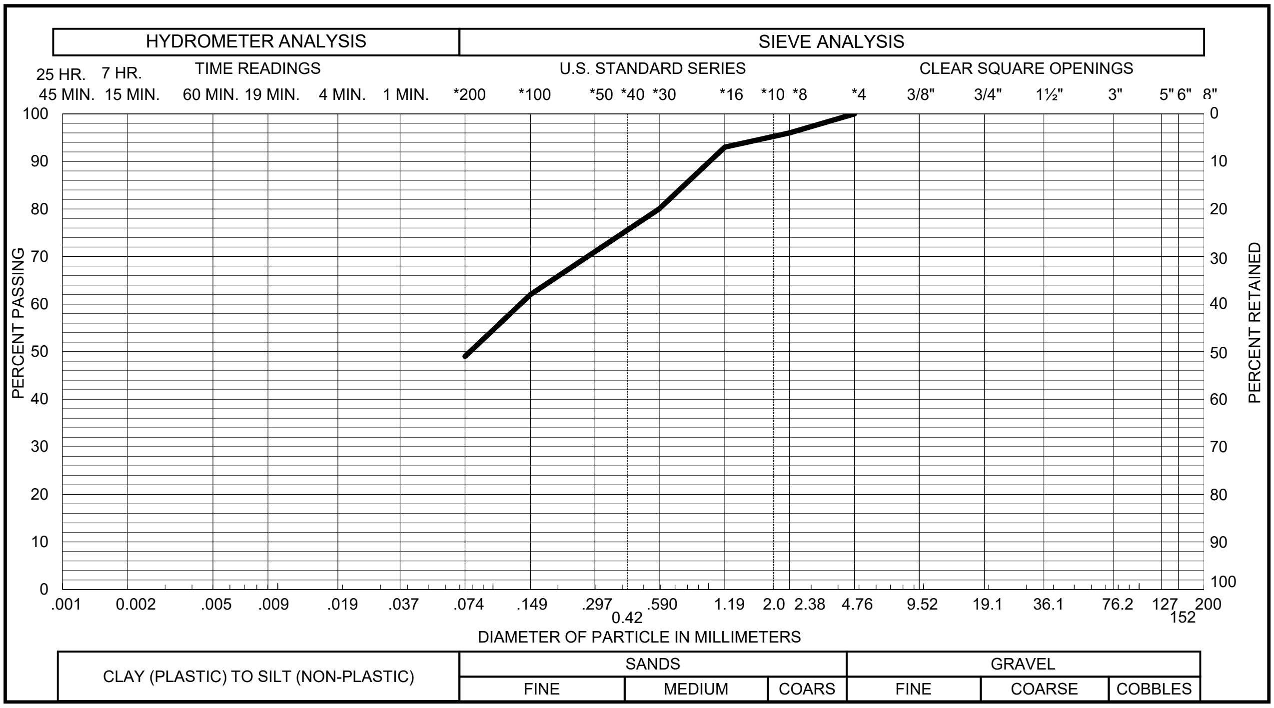
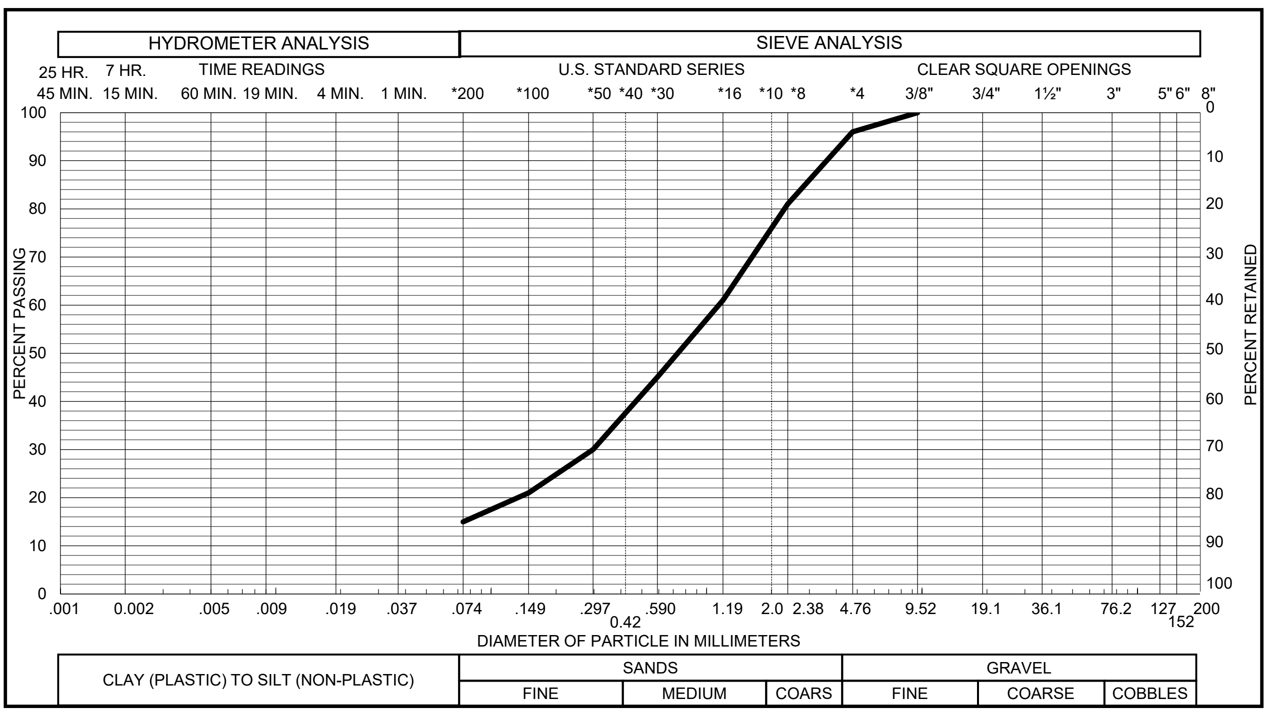
Gradation Test Results

FIG. B-11



Sample of FILL, SAND, VERY CLAYEY
From TH - 10 AT 0-4 FEET

GRAVEL 0 % SAND 51 %
SILT & CLAY 49 % LIQUID LIMIT
PLASTICITY INDEX



Sample of FILL, SAND, CLAYEY
From TH - 11 AT 9 FEET

GRAVEL 4 % SAND 81 %
SILT & CLAY 15 % LIQUID LIMIT
PLASTICITY INDEX

THE GARRETT COMPANIES
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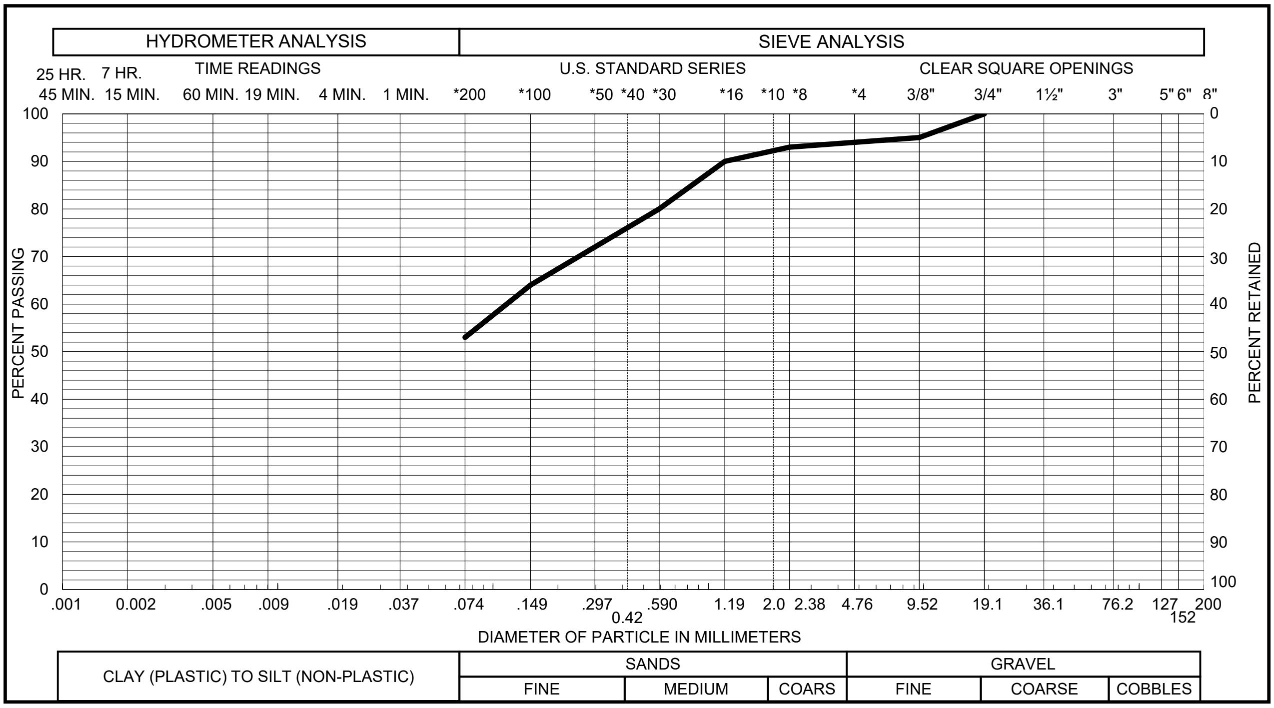
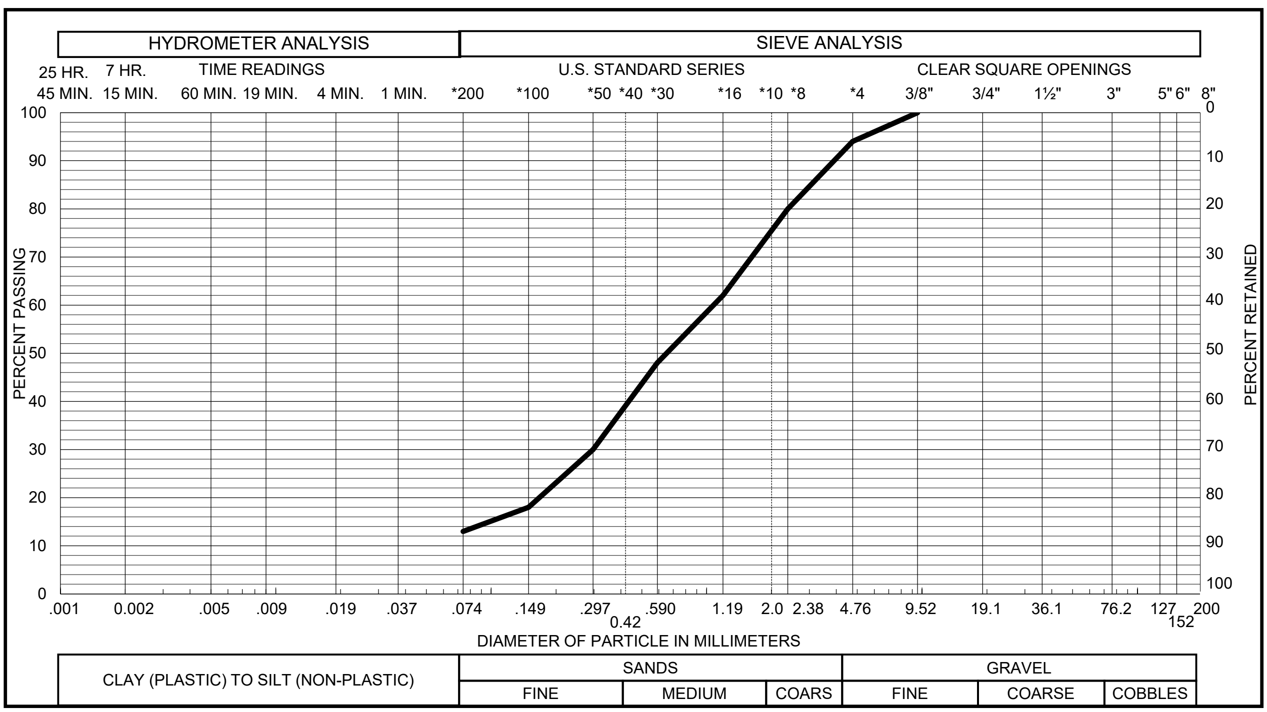
Gradation Test Results

FIG. B-12



Sample of FILL, CLAY, VERY SANDY
From TH - 12 AT 0-4 FEET

GRAVEL 6 % SAND 41 %
SILT & CLAY 53 % LIQUID LIMIT
PLASTICITY INDEX



Sample of SAND, CLAYEY (SC)
From TH - 12 AT 14 FEET

GRAVEL 6 % SAND 81 %
SILT & CLAY 13 % LIQUID LIMIT
PLASTICITY INDEX

THE GARRETT COMPANIES
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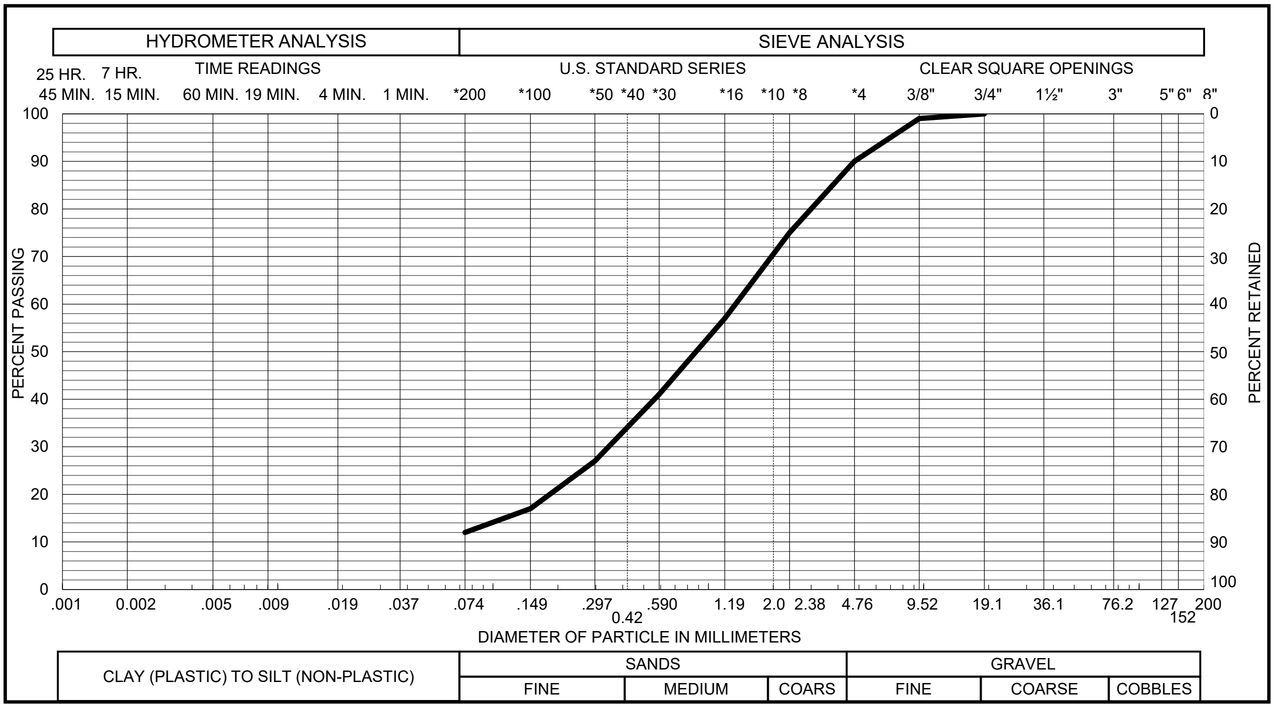
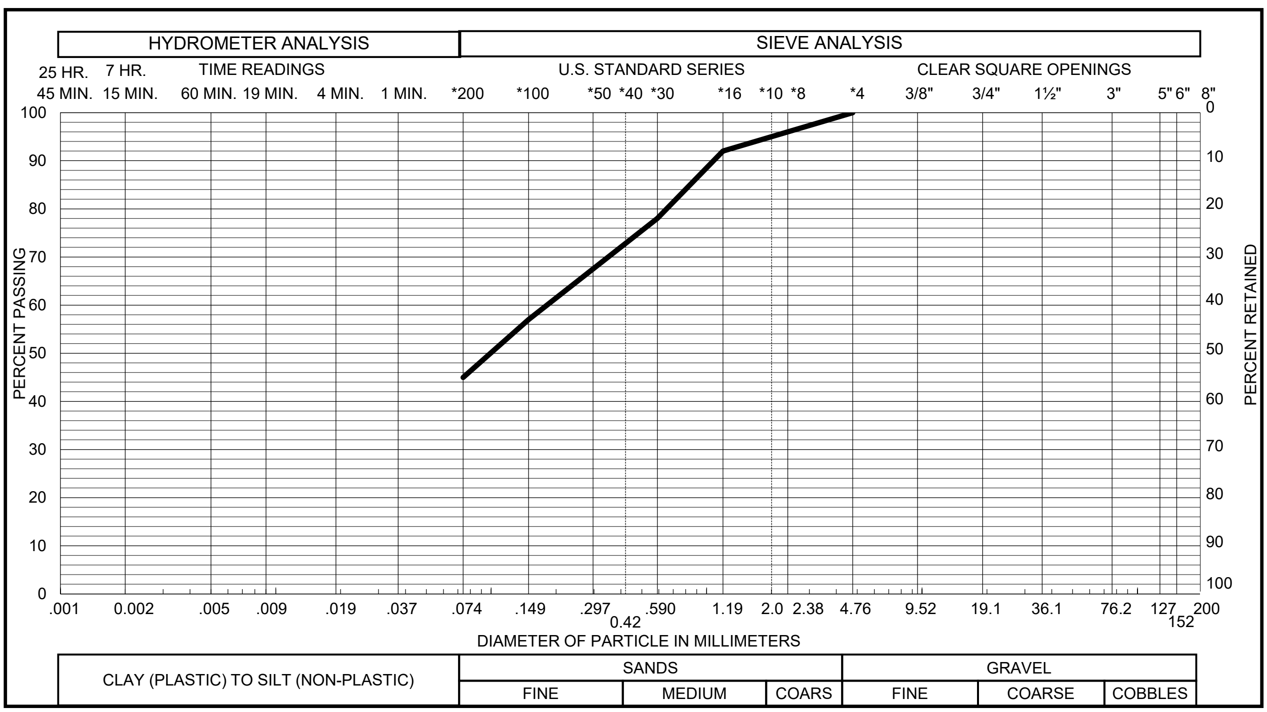
Gradation Test Results

FIG. B-13



Sample of SAND, SLIGHTLY CLAYEY (SW-SC)
From TH - 15 AT 4 FEET

GRAVEL 10 % SAND 78 %
SILT & CLAY 12 % LIQUID LIMIT
PLASTICITY INDEX



Sample of FILL, SAND, VERY CLAYEY
From TH - 16 AT 0-4 FEET

GRAVEL 0 % SAND 55 %
SILT & CLAY 45 % LIQUID LIMIT
PLASTICITY INDEX

THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
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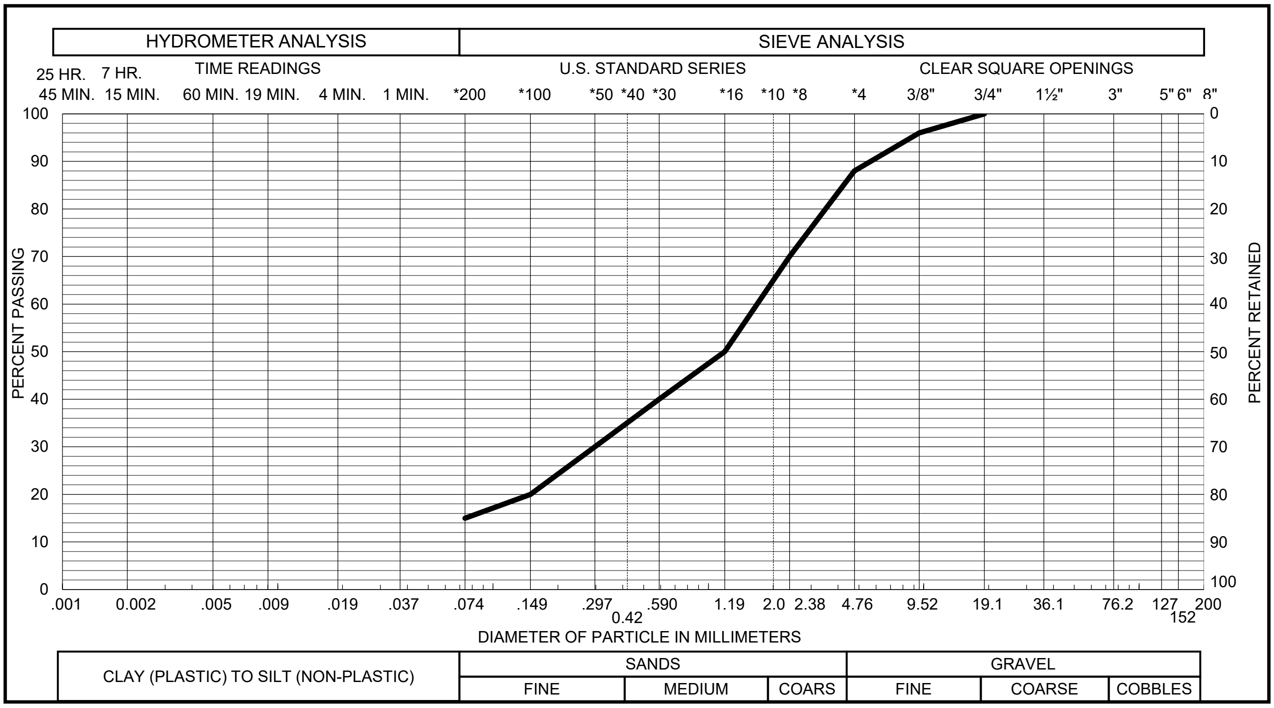
Gradation Test Results

FIG. B-14



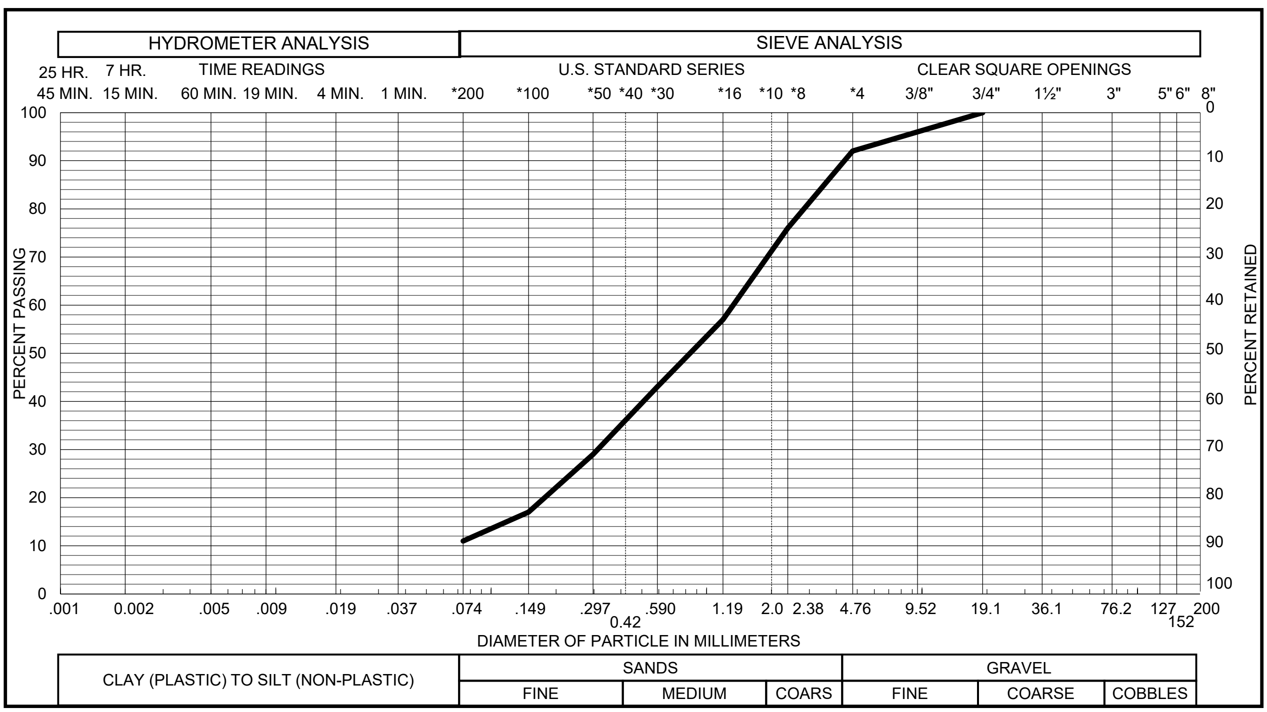
Sample of SAND, CLAYEY (SC)

From TH - 17 AT 9 FEET

GRAVEL 12 % SAND 73 %

SILT & CLAY 15 % LIQUID LIMIT

PLASTICITY INDEX



Sample of SAND, SLIGHTLY CLAYEY (SP-SC)

From TH - 18 AT 4 FEET

GRAVEL 8 % SAND 81 %

SILT & CLAY 11 % LIQUID LIMIT

PLASTICITY INDEX

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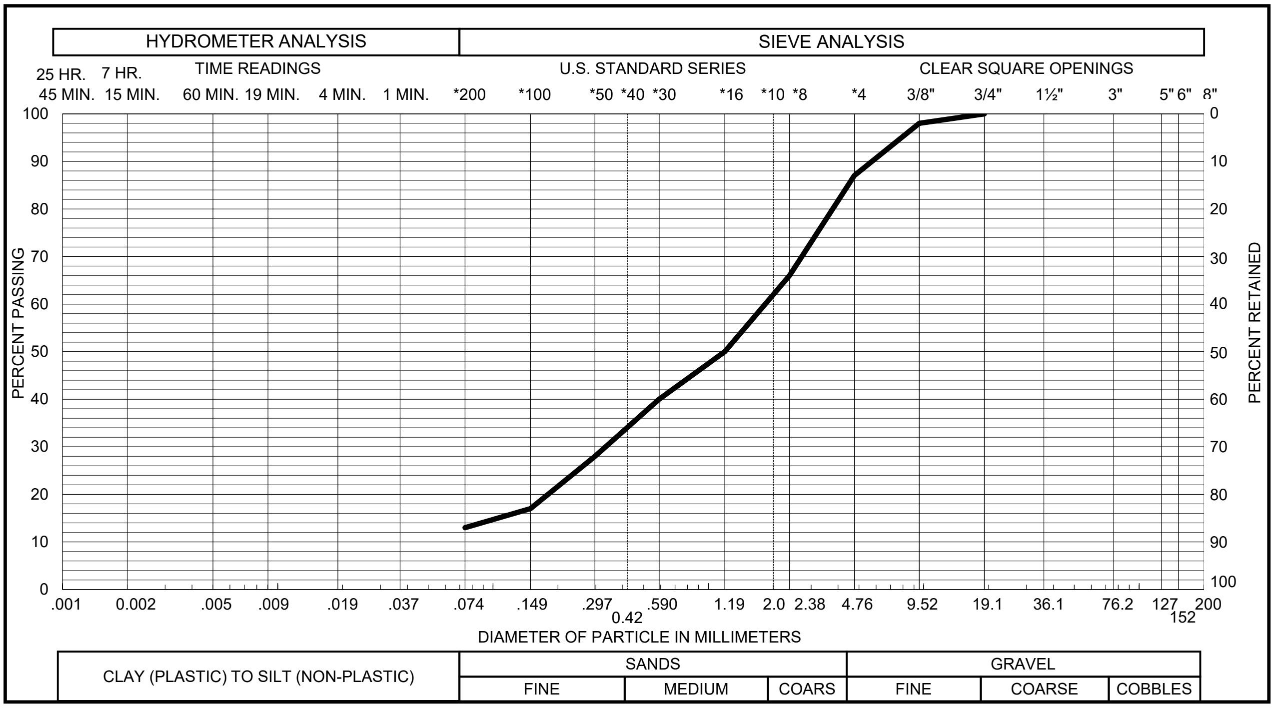
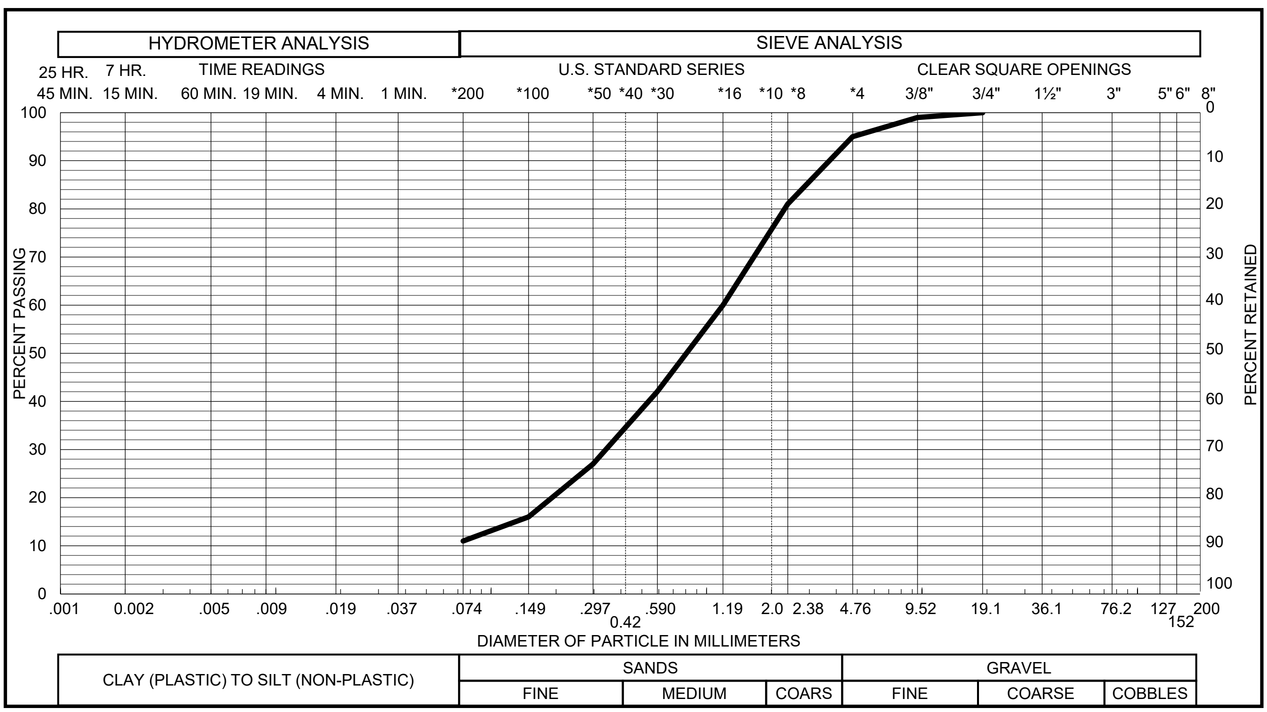
Gradation Test Results

FIG. B-15



Sample of SAND, CLAYEY (SC)
From TH - 18 AT 14 FEET

GRAVEL 13 % SAND 74 %
SILT & CLAY 13 % LIQUID LIMIT
PLASTICITY INDEX



Sample of SAND, SLIGHTLY CLAYEY (SW-SC)
From TH - 20 AT 4 FEET

GRAVEL 5 % SAND 84 %
SILT & CLAY 11 % LIQUID LIMIT
PLASTICITY INDEX

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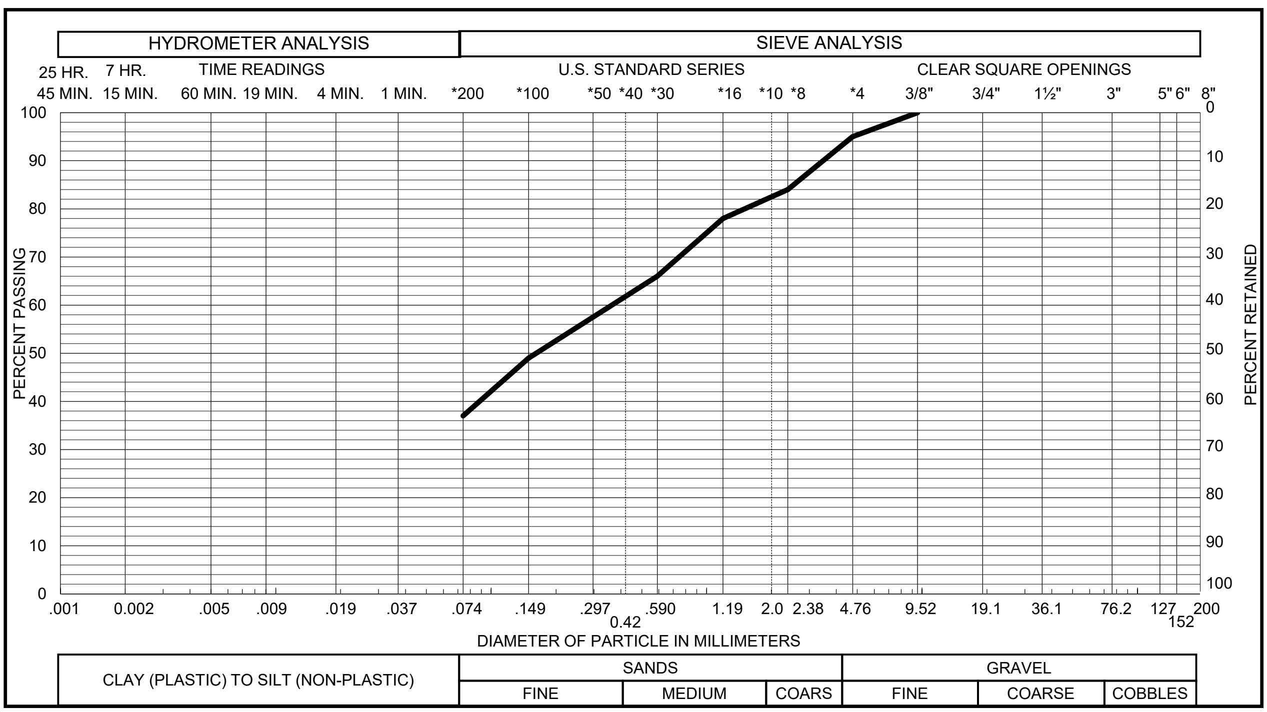
Gradation Test Results

FIG. B-16

Sample of SAND, SLIGHTLY CLAYEY (SP-SC)
From TH - 21 AT 14 FEET

GRAVEL 8 % SAND 80 %
SILT & CLAY 12 % LIQUID LIMIT
PLASTICITY INDEX



Sample of SAND, CLAYEY (SC)
From TH - 22 AT 0-4 FEET

GRAVEL 5 % SAND 58 %
SILT & CLAY 37 % LIQUID LIMIT
PLASTICITY INDEX

THE GARRETT COMPANIES
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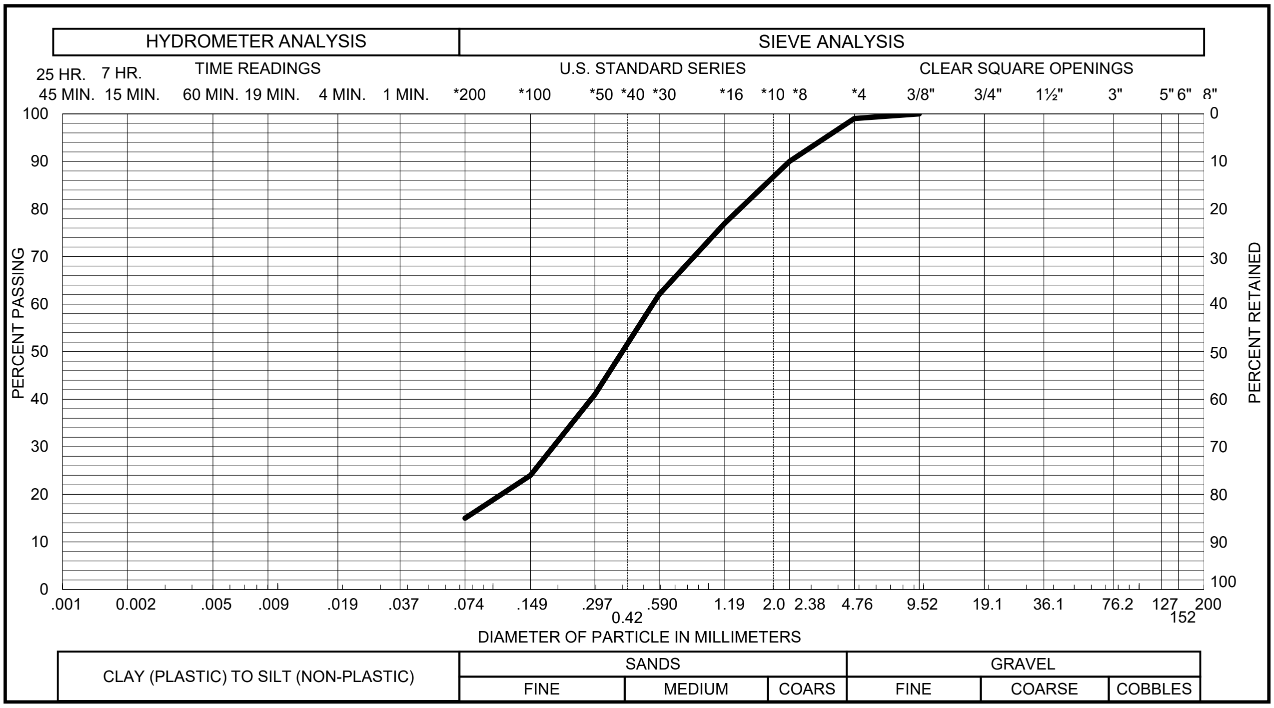
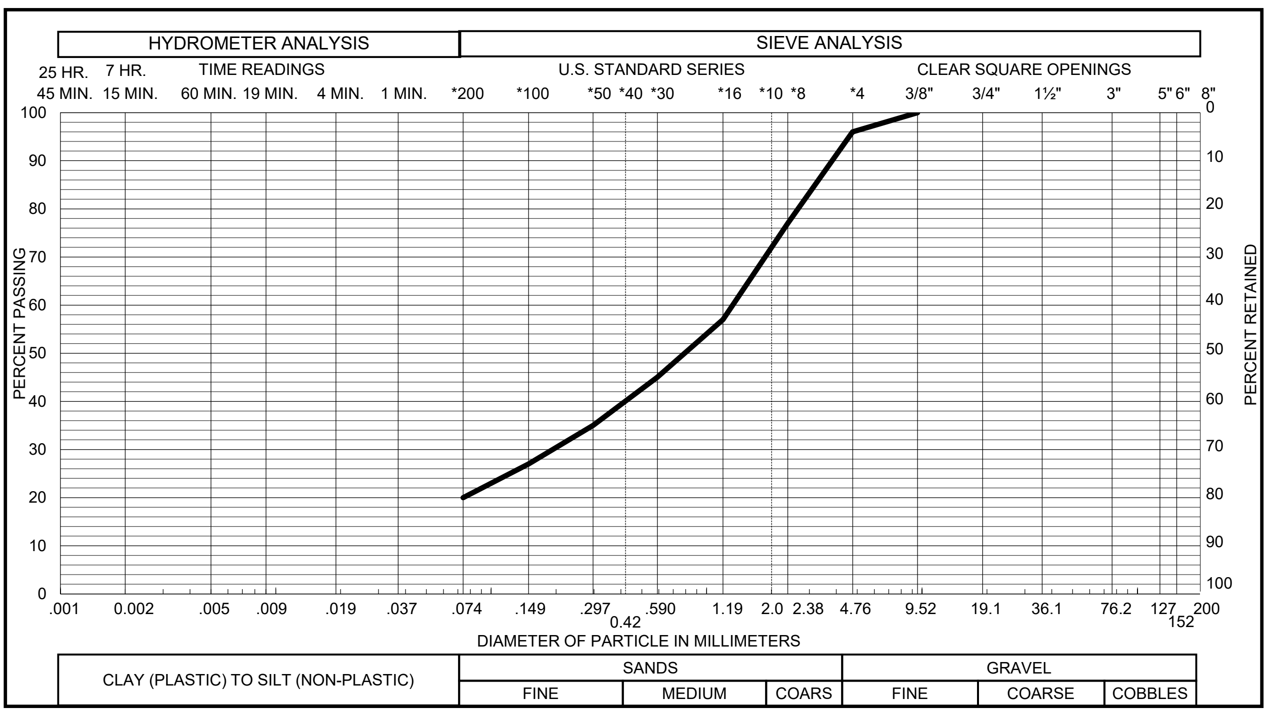
Gradation Test Results

FIG. B-17



Sample of SAND, CLAYEY (SC)
From TH - 23 AT 19 FEET

GRAVEL 1 % SAND 84 %
SILT & CLAY 15 % LIQUID LIMIT
PLASTICITY INDEX



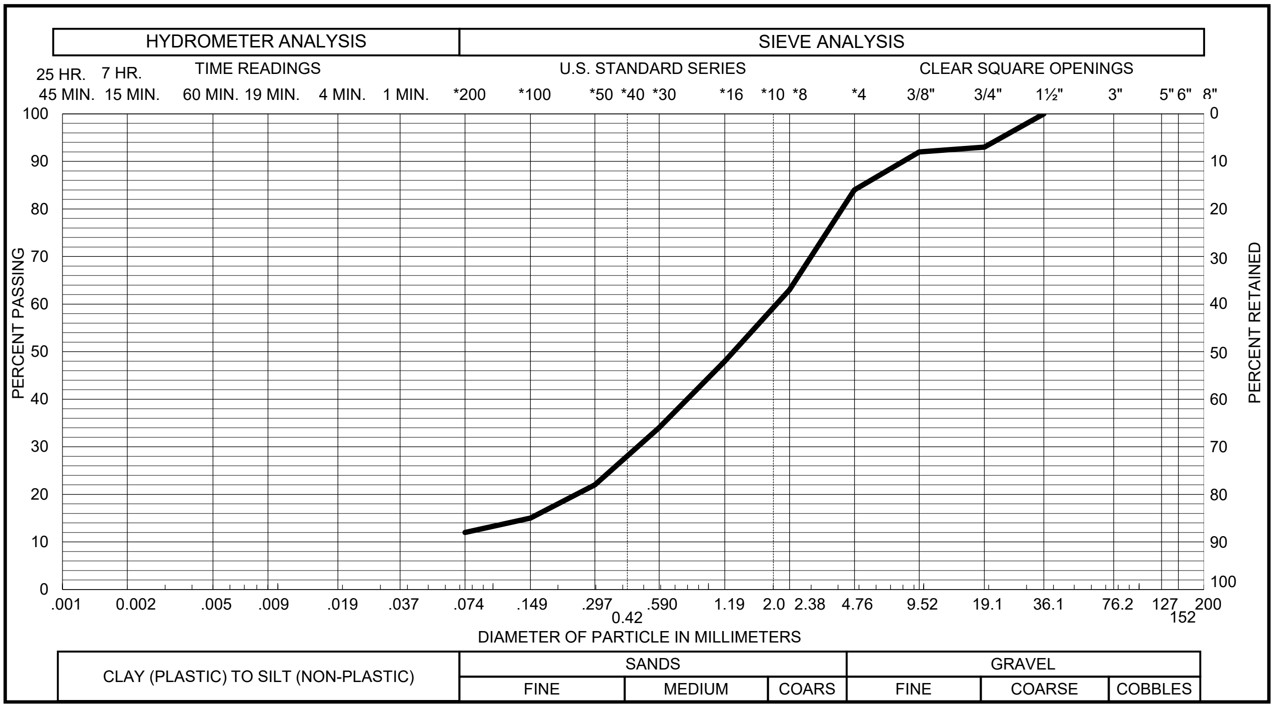
Sample of SAND, CLAYEY (SC)
From TH - 24 AT 9 FEET

GRAVEL 4 % SAND 76 %
SILT & CLAY 20 % LIQUID LIMIT
PLASTICITY INDEX

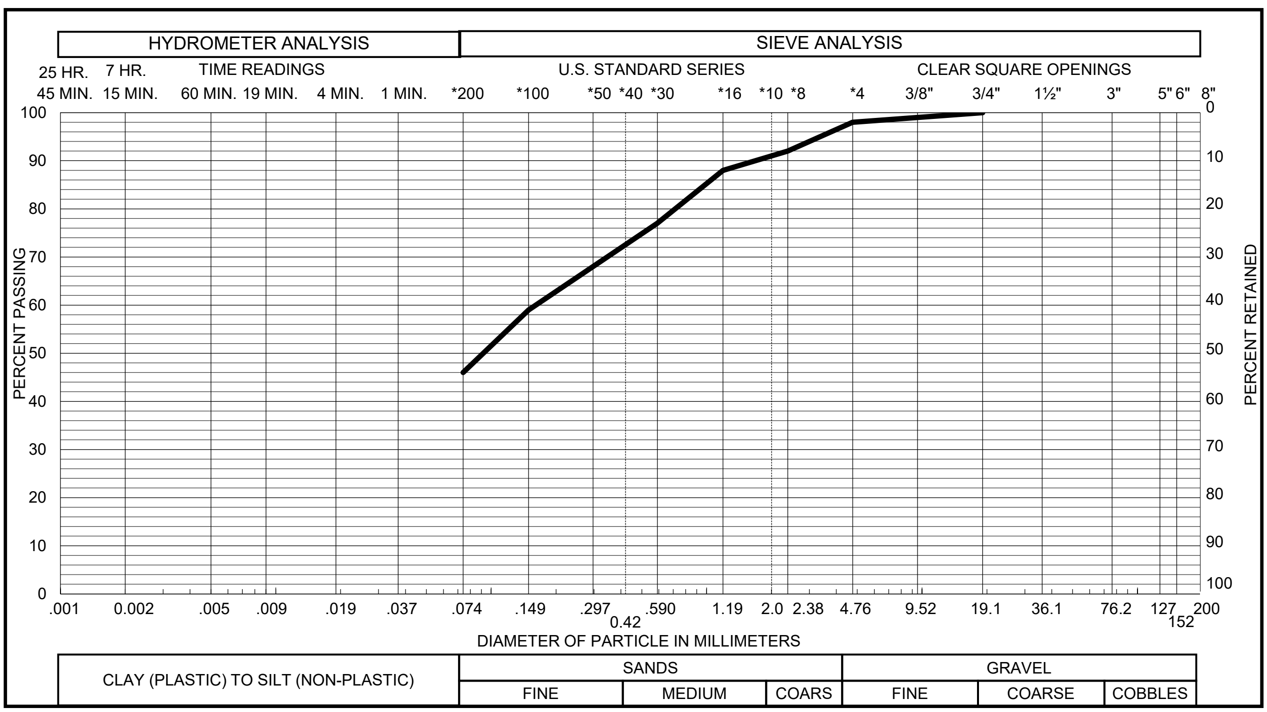
THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Gradation Test Results

FIG. B-18



Sample of	SAND, SLIGHTLY CLAYEY (SW-SC)	GRAVEL	16 %	SAND	72 %
From	TH - 26 AT 19 FEET	SILT & CLAY	12 %	LIQUID LIMIT	
		PLASTICITY INDEX			

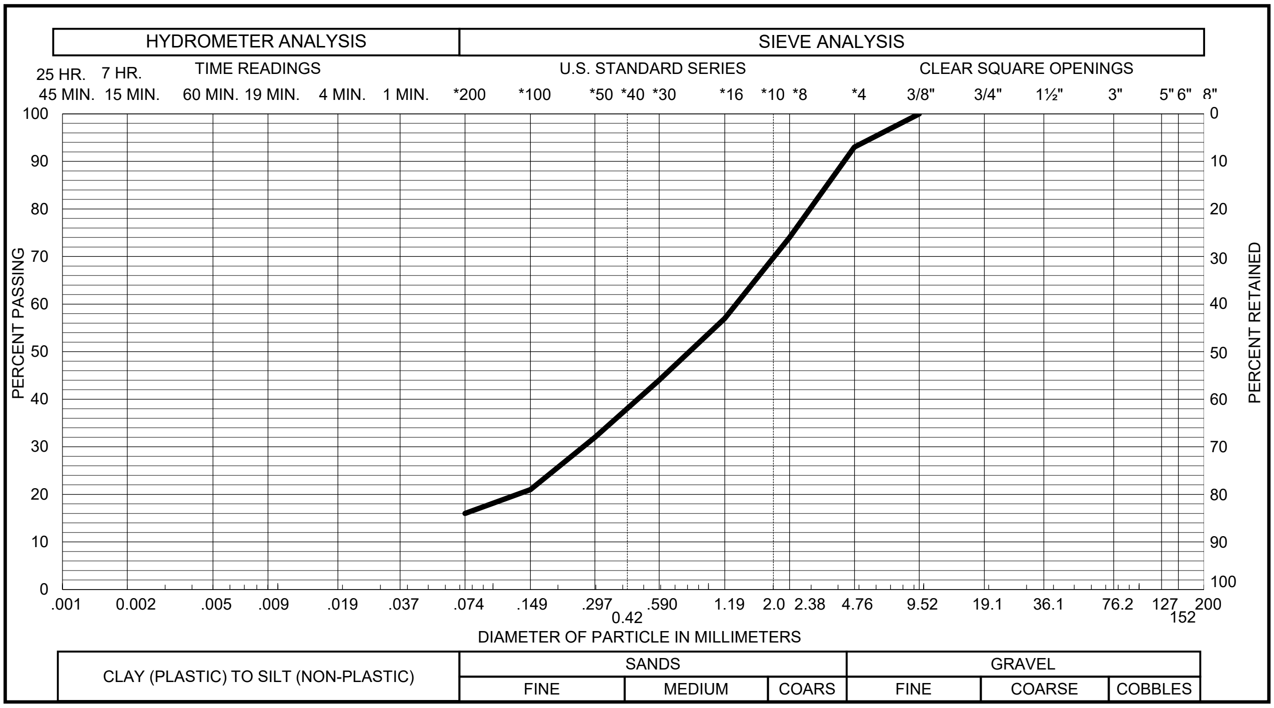


Sample of	FILL, SAND, VERY CLAYEY	GRAVEL	2 %	SAND	52 %
From	TH - 27 AT 0-4 FEET	SILT & CLAY	46 %	LIQUID LIMIT	
		PLASTICITY INDEX			

THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Gradation Test Results

FIG. B-19



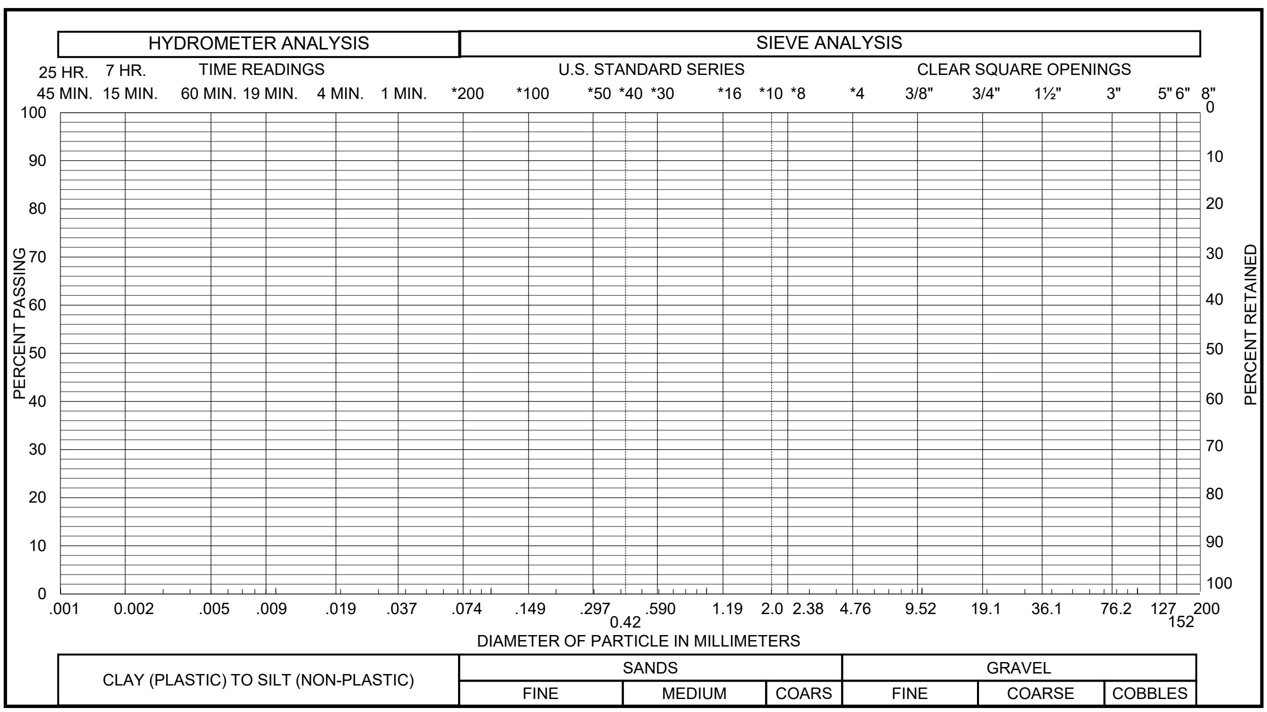
Sample of SAND, CLAYEY (SC)

From TH - 28 AT 19 FEET

GRAVEL 7 % SAND 77 %

SILT & CLAY 16 % LIQUID LIMIT

PLASTICITY INDEX



Sample of

From

GRAVEL % SAND %

SILT & CLAY % LIQUID LIMIT

PLASTICITY INDEX

THE GARRETT COMPANIES
CONSTITUTION AVE. & MARKSHEFFEL RD. MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-125

Gradation Test Results

FIG. B-20

TABLE B-1

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS19460-125

BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS		SWELL TEST RESULTS*			PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
				LIQUID LIMIT	PLASTICITY INDEX	SWELL (%)	APPLIED PRESSURE (PSF)	SWELL PRESSURE (PSF)			
TH-1	4	8.4	112			0.1	500	-	52	<0.1	FILL, CLAY, VERY SANDY
TH-1	14	5.1	114						13		SAND, CLAYEY (SC)
TH-2	9	3.0	122						8		SAND, SLIGHTLY CLAYEY (SP-SC)
TH-2	24	24.1	98			0.1	3000	-			CLAYSTONE
TH-3	4	7.8	119			0.0	500	-			FILL, CLAY, SANDY
TH-3	9	4.0	99								FILL, CLAY, SANDY
TH-4	4	5.7	102						32		FILL, SAND, CLAYEY
TH-4	14	7.3	123						29		SAND, CLAYEY (SC)
TH-5	4	8.0	89								FILL, CLAY, SANDY
TH-5	9	7.6	116			-0.4	1100	-			FILL, CLAY, SANDY
TH-5	19	26.7	96			0.2	2400	-			CLAYSTONE, SANDY
TH-6	9	1.4	126						25		SAND, SILTY (SM)
TH-6	14	4.2	130						34		SAND, CLAYEY (SC)
TH-7	4	6.6	103								FILL, CLAY, SANDY
TH-7	24	39.9	83			0.0	3000	-	67		CLAY, VERY SANDY (CL)
TH-8	4	9.2	125			2.9	500	9000			FILL, CLAY, SANDY
TH-8	14	5.8	120						15		SAND, CLAYEY (SC)
TH-9	4	11.6	116			0.8	500	-	46	<0.1	FILL, SAND, VERY CLAYEY
TH-9	9	2.3	115						12		SAND, SLIGHTLY CLAYEY (SW-SC)
TH-10	0-4	8.9		34	13				49		FILL, SAND, VERY CLAYEY
TH-10	4	10.8	122			1.7	500	-			FILL, SAND, VERY CLAYEY
TH-10	19	18.0	110						40		SAND, VERY CLAYEY (SC)
TH-11	4	9.6	121			3.7	500	6800			FILL, SAND, CLAYEY
TH-11	9	2.3	107						15		FILL, SAND, CLAYEY
TH-11	24	5.4	121						18		SAND, CLAYEY (SC)
TH-12	0-4			39	18				53		FILL, CLAY, VERY SANDY
TH-12	4	9.4	126			1.9	500	-			FILL, CLAY, VERY SANDY
TH-12	14	4.3	124						13		SAND, CLAYEY (SC)
TH-13	4	9.4	123			2.3	500	4500	48	<0.1	FILL, SAND, VERY CLAYEY
TH-13	9	6.5	115								FILL, SAND, VERY CLAYEY
TH-14	4	3.8	102						29		FILL, SAND, CLAYEY
TH-14	19	18.0	108						35		SAND, CLAYEY (SC)
TH-15	4	2.8	121						12		SAND, SLIGHTLY CLAYEY (SW-SC)
TH-15	14	6.7	122						12		SAND, SLIGHTLY CLAYEY (SP-SC)
TH-16	0-4	6.7		32	14				45		FILL, SAND, VERY CLAYEY
TH-16	4	5.9	110								FILL, SAND, VERY CLAYEY

* SWELL MEASURED UNDER ESTIMATED IN-SITU OVERBURDEN PRESSURE.
NEGATIVE VALUE INDICATES COMPRESSION.

TABLE B-1

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS19460-125

				ATTERBERG LIMITS		SWELL TEST RESULTS*					
BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASTICITY INDEX	SWELL (%)	APPLIED PRESSURE (PSF)	SWELL PRESSURE (PSF)	PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
TH-16	9	5.0	120						11		SAND, SLIGHTLY CLAYEY (SP-SC)
TH-17	4	1.8							9	<0.1	SAND, SLIGHTLY CLAYEY (SP-SC)
TH-17	9	6.1	125						15		SAND, CLAYEY (SC)
TH-18	4	3.3	118						11	<0.1	SAND, SLIGHTLY CLAYEY (SP-SC)
TH-18	14	6.6	120						13		SAND, CLAYEY (SC)
TH-19	9	7.4	124						14		SAND, CLAYEY (SC)
TH-19	14	7.9	127						14		SAND, CLAYEY (SC)
TH-20	4	2.1	116						11		SAND, SLIGHTLY CLAYEY (SW-SC)
TH-20	19	6.6	123						8		SAND, SLIGHTLY CLAYEY (SP-SC)
TH-21	4	1.4	115						8		SAND, SLIGHTLY CLAYEY (SP-SC)
TH-21	14	6.8	122						12		SAND, SLIGHTLY CLAYEY (SP-SC)
TH-22	0-4	4.8		30	12				37		SAND, CLAYEY (SC)
TH-22	9	4.8	121						11		SAND, SLIGHTLY CLAYEY (SP-SC)
TH-22	19	16.4	110						41		SAND, VERY CLAYEY (SC)
TH-23	14	6.9	126						13		SAND, CLAYEY (SC)
TH-23	19	8.4	129						15		SAND, CLAYEY (SC)
TH-24	4	6.3	119			0.3	500	-			FILL, CLAY, SANDY
TH-24	9	1.8	135						20		SAND, CLAYEY (SC)
TH-25	4	5.3	117			-0.6	500	-			FILL, CLAY, SANDY
TH-25	14	5.6	105						27		SAND, CLAYEY (SC)
TH-26	9	4.0	123						18		SAND, CLAYEY (SC)
TH-26	19	5.0	126						12		SAND, SLIGHTLY CLAYEY (SW-SC)
TH-27	0-4	5.4		30	11				46		FILL, SAND, VERY CLAYEY
TH-27	4	3.6	115			-0.7	500	-	32	<0.1	FILL, SAND, CLAYEY
TH-27	14	4.8	110			-0.9	1800	-			SAND, CLAYEY (SC)
TH-28	9	5.1	125						15		SAND, CLAYEY (SC)
TH-28	19	6.3	126						16		SAND, CLAYEY (SC)

* SWELL MEASURED UNDER ESTIMATED IN-SITU OVERBURDEN PRESSURE.
NEGATIVE VALUE INDICATES COMPRESSION.

APPENDIX C

GUIDELINE SITE GRADING SPECIFICATIONS
CONSTITUTION AVE AND MARKSHEFFEL RD MULTIFAMILY DEVELOPMENT
COLORADO SPRINGS, COLORADO

GUIDELINE SITE GRADING SPECIFICATIONS

CONSTITUTION AVE AND MARKSHEFFEL RD MULTIFAMILY DEVELOPMENT COLORADO SPRINGS, COLORADO

1. DESCRIPTION

This item consists 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 pavement and building pad elevations. These specifications also apply to compaction of materials that may be placed outside of the project.

2. GENERAL

The Soils Engineer will be the Owner's representative. The Soils Engineer will approve fill materials, method of placement, moisture contents and percent compaction.

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, vegetable matter, and existing fill 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 that would prevent uniform compaction by the equipment to be used.

5. PLACEMENT OF FILL ON NATURAL SLOPES

Where natural slopes are steeper than 20 percent (5:1, horizontal to vertical) and fill placement is required, horizontal benches shall be cut into the hillside. The benches shall be at least 12 feet wide or 1-1/2 times the width of the compaction equipment and be provided at a vertical spacing of not more than 5 feet (minimum of two benches). Larger bench widths may be required by the Engineer. Fill shall be placed on completed benches as outlined within this specification.

6. COMPACTING AREA TO BE FILLED

After the foundation for the fill has been cleared and scarified, it shall be disced or bladed until it is free from large clods, brought to a workable moisture content and compacted.

7. 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 three (3) inches. Fill materials shall be obtained from cut areas shown on the plans or staked in the field by the Engineer or imported to the site.

8. MOISTURE CONTENT

For fill material classifying as CH or CL, the fill shall be moisture treated to between 1 and 4 percent above optimum moisture content as determined by ASTM D 698, if it is to be placed within 15 feet of the final grade. For deep cohesive fill (greater than 15 feet below final grade), it shall be moisture conditioned to within ±2 percent of optimum. Soils classifying as SM, SC, SW, SP, GP, GC and GM shall be moisture treated to within 2 percent of optimum moisture content as determined by ASTM D 1557. Sufficient laboratory compaction tests shall be made to determine the optimum moisture content for the various soils encountered in borrow areas.

The Contractor should expect to add significant moisture to the excavation materials, 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 disc the fill soils to provide uniform moisture content throughout 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 to be obtained, all work on that section of the fill shall be delayed until 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.

9. 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. Granular fill placed less than 15 feet below final grade shall be compacted to at least 95 percent of maximum dry density as determined in accordance with ASTM D 1557. Cohesive fills placed less than 15 feet below final grade shall be compacted to at least 95 percent of maximum dry density as determined in accordance with ASTM D 698. For deep, cohesive fill (to be placed 15 feet or deeper below final grade), the material shall be compacted to at least 98 percent of maximum standard Proctor dry density (ASTM D 698). Granular fill placed more than 15 feet below final grade shall be compacted to at least 95 percent of maximum modified Proctor dry density (ASTM D 1557). Deep fills shall be placed within 2 percent of optimum moisture content. Fill materials shall be placed such that the thickness of loose materials 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 Soils Engineer for soils classifying as claystone, 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 ensure that the required density is obtained.

10 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 3 to 5 feet in height or after the fill is brought to its total height. Permanent fill slopes shall not exceed 3:1 (horizontal to vertical).

11. DENSITY TESTS

Field density tests will be made by the Soils Engineer at locations and depths of his/her choosing. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density tests will be taken in compacted material below the disturbed surface. When density tests indicate 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. The criteria for acceptance of fill shall be:

A. Moisture

The allowable ranges for moisture content of the fill materials specified above in "Moisture Content" are based on design considerations. The moisture shall be controlled by the Contractor so that moisture content of the compacted earth fill, as determined by tests performed by the Soils Engineer, shall be within the limits given. The Soils Engineer will inform the Contractor when the placement moisture is less than or exceeds the limits specified above and the Contractor shall immediately make adjustments in procedures as necessary to maintain placement moisture content within the specified limits.

B. Density

1. The average dry density of all material shall not be less than the dry density specified.

2. No more than 20 percent of the material represented by the samples tested shall be at dry densities less than the dry density specified.

3. Material represented by samples tested having a dry density more than 2 percent below the specified dry density will be rejected. Such rejected materials shall be reworked until a dry density equal to or greater than the specified dry density is obtained.

12. 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 the moisture content and density of previously placed materials are as specified.

13. NOTICE REGARDING START OF GRADING

The Contractor shall submit notification to the 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 three days in advance of any resumption dates when grading operations have been stopped for any reason other than adverse weather conditions.

14. REPORTING OF FIELD DENSITY TESTS

Density tests made by the Soils Engineer, as specified under “Density Tests” above, will be submitted progressively to the Owner. Dry density, moisture content and percent compaction will be reported for each test taken.