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GEOLOGIC HAZARD EVALUATION AND GEOTECHNICAL INVESTIGATION POWERS AND GRINNELL APARTMENTS EL PASO COUNTY, COLORADO

Prepared For:

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TABLE OF CONTENTS

SCOPE ... 1
SUMMARY OF CONCLUSIONS ... 1
SITE CONDITIONS ... 2
PROPOSED DEVELOPMENT ... 4
INVESTIGATION ... 4
SUBSURFACE CONDITIONS ... 5
Natural Soils ... 5
Groundwater ... 5
Seismicity ... 6
SITE GEOLOGY ... 6
GEOLOGIC HAZARDS ... 7
Expansive and Collapse Prone Soils ... 7
Flooding ... 8
Seismicity ... 9
Erosion ... 10
Radon/Radioactivity ... 10
Recoverable Minerals ... 10
SITE DEVELOPMENT ... 11
Site Grading ... 11
Buried Utilities ... 12
FOUNDATIONS ... 13
Post-Tensioned, Slabs-On-Ground (PTS) ... 13
FLOOR SYSTEMS ... 15
EXTERIOR FLATWORK ... 16
SITE RETAINING WALLS ... 16
BELOW-GRADE CONSTRUCTION ... 17
SWIMMING POOL ... 17
PAVEMENTS ... 18
SURFACE DRAINAGE, IRRIGATION AND MAINTENANCE ... 19
CONCRETE ... 20
CONSTRUCTION OBSERVATIONS ... 22
GEOTECHNICAL RISK ... 22
LIMITATIONS ... 22

FIG. 1 – LOCATIONS OF EXPLORATORY BORINGS

FIG. 2 – ENGINEERING GEOLOGIC CONDITIONS

FIG. 3 – SWIMMING POOL DRAIN DETAIL

APPENDIX A – SUMMARY LOGS OF EXPLORATORY BORINGS

APPENDIX B – LABORATORY TEST RESULTS
TABLE B-1: SUMMARY OF LABORATORY TESTING

APPENDIX C – GUIDELINE SITE GRADING SPECIFICATIONS

SCOPE

This report presents the results of our Geologic Hazards Evaluation and Geotechnical Investigation for the proposed Powers and Grinnell Multi-Family Development. The proposed development is located south of Powers Boulevard and east of Grinnell Road within the unincorporated Security-Widefield area of El Paso County, Colorado (Fig. 1). The purpose of our investigation was to evaluate the property for the occurrence of geologic hazards and their potential effect on the proposed development, and to evaluate subsurface conditions at the site to provide geotechnical recommendations and criteria for design and construction of foundations and floor systems, as well as surface drainage precautions. The scope was described in our Proposal (CS-23-0056) dated May 5, 2023. Evaluation of the property for the presence of potentially hazardous materials (Environmental Site Assessment) will be provided under a separate cover.

The report includes descriptions of the subsurface conditions encountered in our exploratory borings, and discussions of construction as influenced by geotechnical considerations. The report was prepared for use by Evergreen Development in design and construction of the planned apartment buildings, clubhouse, stand-alone garages, swimming pool, 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, with more detailed discussion in the report.

SUMMARY OF CONCLUSIONS

1. Subsurface conditions encountered in our exploratory borings consisted of complexly interbedded natural, silty sand, clayey sand and sandy clay. The near surface soils are predominantly non-expansive or exhibit low expansion potential. Localized layers of moderately expansive soils are also present. Bedrock was not encountered to the maximum depths explored of up to 30 feet.

2. Groundwater was not encountered at the time of drilling. When checked after drilling our borings were found to be dry. Groundwater levels will fluctuate seasonally and rise in response to precipitation and landscaping irrigation.

3. We did not identify geotechnical or geologic constraints at this site that we believe preclude construction of the multi-family development. The primary geotechnical concerns are the sporadic lenses of low to moderately expansive clay, localized layers of collapse-prone soils, and erosion. We believe

these concerns can be mitigated with proper planning, engineering, design, and construction.

4. We understand the proposed apartment buildings, clubhouse building, and stand-alone garage structures are to be constructed with post-tensioned slab-on-ground foundations. Foundation design and construction criteria are presented in the report.

5. Post-tensioned slab-on-ground foundation systems structurally integrate the floor slabs and foundations and should exhibit more reliable, long-term performance than conventional slabs-on-grade. In our opinion, a low risk of movement and damage will exist for post-tensioned slabs underlain by the natural, on-site soils.

6. Full-depth asphalt and concrete pavement section alternatives are presented in the report for the planned automobile parking lots and access driveways.

7. Control of surface drainage will be critical to the performance of foundations and slabs-on-grade. Overall surface drainage should be designed to provide rapid removal of surface runoff away from the proposed residences. Conservative irrigation practices should be followed to avoid excessive wetting.

8. 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 Powers and Grinnell Apartments site consists of approximately 16.5 acres of undeveloped land located east of Grinnell Road and south of South Powers Boulevard within the Security-Widefield area of El Paso County, Colorado. The site location and approximate extents are shown in Fig. 1. The site is bordered to the north by South Powers Boulevard, to the east by Cudahy Drive, the south by Goldfield Drive, and to the west by Grinnell Boulevard. Undeveloped land is present on the

View of site looking northwest

opposite side of the Grinnell Boulevard and single-family residential developments are located to the east and southeast. Amazon facilities are located to the north.

Portions of the site have been previously rough graded. Fill soils appear to be present adjacent to the surrounding roads. The southwest corner of the site contains an asphalt paved driveway. Various underground utilities are located around the perimeter and a "primary underground" electric line approximately bisects the site in a north/south direction. A stockpile of rip rap was present on the northern portion of the site with some placed at the head of a drainage, and as check dams in the erosion channel.

Overall, the site slopes in a general southwest direction at gradients between about 5 and 10 percent with some locally steeper slopes around the perimeter. A drainage channel begins in the northeastern portion of the site, where water has been directed into a concrete culvert beneath the road and onto the site. The channel was actively flowing at the time of our subsurface exploration and flows in a general northeast to southwest direction across the site and into another culvert near Grinnell Road. The drainage channel varies in depth and is up to approximately 10 feet deep with steeply sloping to vertical side walls as a result of erosion. It appears flow within the drainage has significantly increased as a result of recent commercial development across Powers Boulevard.

View looking downstream from where channel enters the site

Corrugated plastic pipes placed within channel

Three corrugated plastic pipes were present in the channel, partially covered with soil. The pipes appeared to be approximately 10 feet in length. We believe this is the location of the electric line crossing. Vegetation on the site consists of grass and weeds. Numerous prairie dog mounds were observed at the surface throughout the site.

PROPOSED DEVELOPMENT

We understand the proposed development will consist of an apartment complex with 3-story apartment buildings, stand-alone garage structures, and a clubhouse with an out-door swimming pool. No habitable below-grade construction is anticipated. The proposed buildings will be constructed using post-tension, slab-on-ground foundations. Drive under garage units are planned at the ground level of some buildings.

A preliminary grading plan prepared by Harris Kocher Smith (HKS), dated April 11, 2023, indicates several site retaining walls are planned. Additional exterior improvements will include asphalt paved access driveways and parking spaces, areas of concrete flatwork, underground utilities, and a stormwater detention pond. The existing drainage is expected to be rerouted. A cut/fill exhibit also prepared by HKS, dated March 2, 2023, indicates fills of up to 20 feet and cuts of up to 15 feet are planned.

INVESTIGATION

Subsurface conditions at the site were investigated by our firm by drilling a total of forty exploratory borings. The borings were drilled to depths between 15 and 30 feet. The approximate locations of the borings are shown in Fig. 1. Our representative observed the drilling operations, logged the subsurface conditions found in the borings, and obtained samples for laboratory testing. Summary logs of the borings, results of field penetration resistance tests, and some laboratory test data are presented in Appendix A.

Soil 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, gradation analysis, Atterberg limits, swell-consolidation, and water-soluble sulfate concentration. Swell-consolidation and gradation test results are presented in Appendix B. Laboratory test data are summarized in Table B-1.

SUBSURFACE CONDITIONS

Strata encountered in our exploratory borings generally consisted of natural, slightly silty to very silty sand, clayey to very clayey sand, and sandy to very sandy clay extending to the maximum depths explored of 15 to 30 feet. Areas of undocumented fill material may be present around the perimeter of the site as well as where the asphalt driveway and dirt access road are present. Some of the pertinent engineering characteristics of the soil and bedrock are described in the following paragraphs.

Natural Soils

Natural soils were encountered at the surface in each of our borings and extended to the maximum depths explored of 15 to 30 feet. The natural soils consisted of slightly silty to very silty, clayey to very clayey sand, and sandy to very sandy clay.

The sand was loose to dense based on field penetration resistance testing. Thirty samples of the sand contained between 12 and 47 percent silt and clay sized particles. Two samples of the sand exhibited 0.1 and 2.1 percent swell, one sample exhibited no movement, and three samples compressed 0.3 to 2.4 percent when wetted under estimated overburden pressures.

The clay was stiff to very stiff based on field penetration resistance testing. Fourteen samples of the clay tested in our laboratory contained 50 to 81 percent silt and clay-sized particles (passing the No. 200 sieve). Four samples of the clay exhibited 0.3 to 2.5 percent swell and one sample compressed 0.7 percent when wetted under estimated overburden pressures.

Groundwater

Groundwater was not encountered in our borings during drilling. Our borings were checked between one and eight days after drilling and found to be dry. Groundwater may develop and fluctuate seasonally and rise in response to development, precipitation, and landscape irrigation.

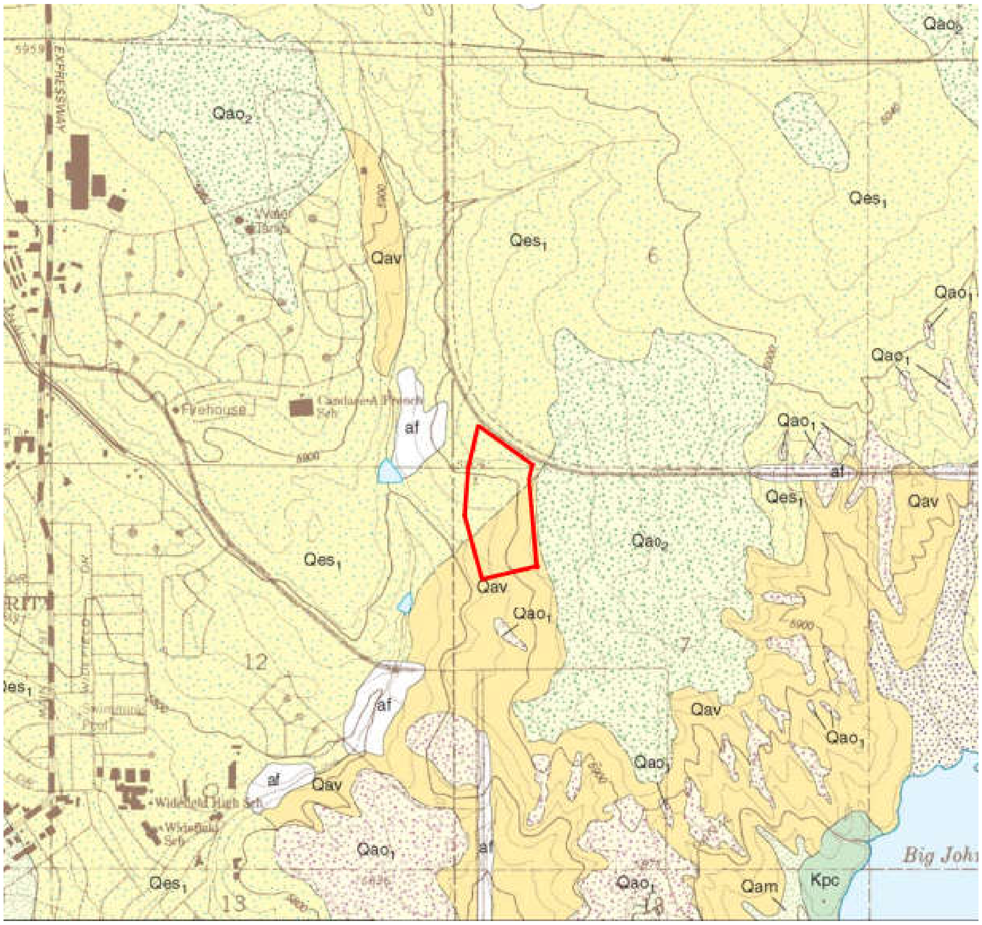
Seismicity

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

SITE GEOLOGY

The surficial geology at the site was evaluated by reviewing published geologic maps and our own site reconnaissance. The site lies within the area of the Elsmere Quadrangle Geologic map published by the Colorado Geological Survey (2002).

As shown in the excerpt below, the site is divided among two geologic units consisting of younger eolian sand (Qes_1) within the northwestern portion of the site and Holocene and late Pleistocene Valley-Side Alluvium (Qav) in the southeastern portion of the site. The eolian sand consists of very pale brown, pale-brown, and light-yellowish brown sand. The alluvium consists of brown to light-yellowish-brown, extremely poorly sorted, sand, silty and clayey sand, and minor amounts of mostly pebble size gravel. Conditions at the site were found to be similar to the mapped conditions.



Excerpt from Elsmere Quadrangle Geologic Map, El Paso County, Colorado, 2002.

GEOLOGIC HAZARDS

Geologic hazards we identified at the site include expansive soils, collapse-prone soils, and erosion. No geologic hazards were noted that we believe preclude the proposed development. We believe potential hazards can be mitigated with proper engineering, design, and construction practices, as discussed in this report. Figure 2 shows our interpretation of the engineering geology modified from the system used by Charles Robinson & Associates (1977).

<u>Expansive and Collapse Prone Soils</u>

Colorado is a challenging location to practice geotechnical engineering. The climate is relatively dry and the near-surface soils are typically dry and comparatively stiff. These soils and related sedimentary bedrock formations react to changes in moisture conditions. Some of the soils swell as they increase in moisture and are referred to as expansive soils.

Other soils can compress significantly upon wetting and/or additional loading (from foundations or site grading fill) and are identified as compressible or collapsible soils. Covering the ground with structures, streets, driveways, patios, etc., coupled with lawn irrigation and changing drainage patterns, leads to an increase in subsurface moisture conditions. As a result, some soil movement due to heave or settlement is inevitable.

Low to moderately expansive clay soils are present at this site. There is risk that foundations and slab-on-grade floors will experience heave or settlement and damage. Collapse-prone soils are also present at this site. Collapse-prone soils may be susceptible to hydro-collapse, a phenomenon where soils undergo a decrease in volume (consolidate rapidly) upon an increase in moisture content, with or without an increase in external loads. The presence of collapse-prone soils implies risk that slabs-on-grade and foundations will settle and be damaged. Analysis of moisture contents, dry densities, gradation, and Atterberg limits generally indicate low susceptibility of collapse. The soils are complexly interbedded and the layers of expansive and collapse-prone soils are sporadic. As such, it isn't possible to define areas where these materials should be expected. Expansive and collapse-prone soils may be present in all portions of the site.

Engineered planning, design and construction of grading, pavements, foundations, slabs-on-grade, and drainage can mitigate, but not eliminate, the effects of expansive and collapse-prone soils. We believe the expansive and collapse-prone soils at this site present a low to moderate risk and can be effectively mitigated with the use of post-tension, slab-on-ground foundations. After construction, owners must assume responsibility for maintaining the structures and use appropriate practices regarding drainage and landscaping.

Flooding

The majority of the site lies within Zone D (undetermined flood hazard) as shown below on FIRM Community Map Numbers 08041C0763G and 08041C0764G, revised December 7, 2018. Zone D indicates floods are possible, but not likely.

Excerpt from FEMA National Flood Hazard Layer Viewer

Based on the topography at the site, the potential for a flood to impact the majority of the site area is low; however, a drainage that is directed onto the site from a culvert beneath Powers Boulevard does present a flood risk. We recommend this stormwater flow be re-routed as part of the site development. Development of the site will increase the relative area of impervious surfaces, which can lead to drainage problems and erosion if surface water flow is not adequately designed. Surface drainage design and evaluation of flood potential should be performed by a civil engineer as part of the project design.

Seismicity

This area, like most of Colorado, is subject to a low degree of seismic risk. The soil and bedrock units are not expected to respond unusually to seismic activity. According to the 2015 International Building Code and based upon the results of our investigation, we judge the site classifies as Seismic Site Class C.

Erosion

The site is susceptible to the effects of wind and water erosion. At the time of our subsurface investigation water was flowing within the drainage channel that crosses the site as shown below. The channel has become incised with steep to vertical side walls as a result of erosion. We expect the drainage will be rerouted as part of the site development. The surficial sandy soils are relatively stable and resistant to wind erosion where vegetation is established. Disturbance of the vegetative cover and long-term exposure of these deposits to the erosive power of wind and water increases the potential for erosion. Maintaining vegetative cover and utilizing surface drainage collection and distribution systems will reduce the potential for erosion from wind and water.

Erosion in Drainage Channel

Radon/Radioactivity

We believe no unusual hazard exists from naturally occurring sources of radioactivity on the site. However, the materials found in this area are often associated with the production of radon gas and concentrations in excess of those currently accepted by the EPA can occur. Passive and active mitigation procedures are commonly employed in this region to effectively reduce the buildup of radon gas. Measures that can be taken after a structure is enclosed during construction include installing a blower connected to the foundation drain and sealing the joints and cracks in concrete floors and foundation walls. If the occurrence of radon is a concern, we recommend structures be tested after they are enclosed. The EPA provides guidance on construction of radon resistant structures.

Recoverable Minerals

The project site is included in the Aggregate Resources of Colorado mapping from the Colorado Geological Survey. The mapping does not indicate any commercial sand or gravel pits near the project site. We observed no evidence of surface or subsurface mining at the site.

SITE DEVELOPMENT

A cut/fill map was provided to our office and indicates fills of up to 20 feet and cuts of up to 15 feet will be required for the proposed development. We recommend grading plans consider long-term cut and fill slopes no steeper than 3:1 (horizontal to vertical). Use of flatter slopes (4:1) is preferable to control erosion from run-off and sheet-flow. Seeding and re-vegetation can also be used to reduce erosion. The heavily eroded drainage channel that bisects the site will need to be rerouted. Concentrated water flows over slopes should be avoided.

Site Grading

Vegetation and organic materials as well as any existing undocumented fill, if encountered, should be removed from the ground surface of areas to be filled. Soft or loose soils, if encountered, should be stabilized or removed to expose stable material prior to placement of fill.

Prairie dog burrow holes were observed throughout the site. The burrow holes typically lead to tunnels that are 3 to 7 feet deep or more with dome shaped mounds present around the burrow entrances. Burrow holes may affect site improvements. Therefore, we recommend removing and/or backfilling the prairie dog holes that are encountered during site grading, as much as practical.

An active drainage channel was present at the site at the time of our site reconnaissance and subsurface exploration. Water flow will need to be rerouted prior to placement of fill within the channel. Standing water, elevated moisture contents, and soft/yielding subgrade conditions should be anticipated at the channel bottom. Soils within the channel bottom will deflect under the load of equipment traffic resulting in heavy rutting. We expect the channel bottom will require stabilization prior to placement of new fill. The depth and extent of soft/yielding conditions will need to be evaluated during construction; however, we expect stabilization can be accomplished by crowding well-graded, 4 to 8-inch size angular rock into the soft/yielding soils.

The onsite materials are generally suitable for use as grading fill, and excavation backfill, provided they are free of debris, vegetation/organics, and other deleterious materials. Based on our laboratory test results the majority of the onsite soils are generally below optimum moisture content and will require significant moisture conditioning to process the soils to near optimum. The silty to very silty sands require close control of moisture content to achieve compaction and can be particularly difficult to compact during cold weather.

If imported fill is necessary, it should ideally consist of granular material with 100 percent passing the 2-inch sieve and less than 35 percent material passing the No. 200 sieve. The import soils should exhibit low plasticity with a liquid limit less than 30 and a plasticity index less than 10. A sample of the import material should be submitted to our office for testing before transporting to the site.

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 properties of the fill will affect the performance of foundations, slabs-on-grade, and pavements. Detailed recommendations for moisture conditioning, placement, and compaction of grading fill are set forth in Appendix C. Placement and compaction of the grading fill should be periodically observed and tested by our representative during construction.

Buried Utilities

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 majority of on-site surficial soils classify as Type C materials. OSHA requires Type C materials should be braced or laid back to a maximum slope inclination of 1.5:1 (horizontal to vertical) for dry conditions. If groundwater conditions change and becomes more shallow, the granular materials may “flow” into the excavation. 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.

Water and sewer lines are usually constructed beneath paved areas. Compaction of trench backfill will have a significant effect on the life and serviceability of pavements. We recommend trench backfill be moisture conditioned and compacted in accordance with the recommendations set forth in Appendix C and El Paso County standards. Personnel from our firm should periodically observe and test the placement and compaction of the trench backfill during construction.

FOUNDATIONS

In our opinion the proposed buildings can be constructed with post-tensioned, slab-on-ground foundation systems (PTS). A PTS foundation will help mitigate risk of foundation/slab movement associated with expansive and collapse-prone soils. The following paragraphs present our design and construction recommendations for PTS foundations.

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

PTS foundation design is based on a method developed by the Post-Tensioning Institute (PTI) and is outlined in PTI's third edition of *Design of Post-Tensioned Slabs-On-Ground* (2004 with 2008 Supplement). Various climate and relevant soil factors are required to evaluate the PTI design criteria. These include Thornthwaite Moisture Index (I_m), suction compression index (γ_h), unsaturated diffusion coefficient (α), depth of probable moisture variation, initial and final soil suction profiles, and percent clay fraction and predominant clay mineral. In the project area, I_m is about -20.

The PTS foundation design method is based on the potential differential movement of the slab edges (y_m) over a specified edge distance (e_m). Further, the PTI design method, evaluates two mechanisms of soil movement (edge lift and center lift) based on assumptions that wetting and drying of the foundation soils are primarily affected by seasonal climate changes. In the 2004 design manual, PTI recommends evaluating movements for a minimum depth of wetting of 9 feet below the ground surface. This value can be reasonable for a seasonal moisture variation; however, our experience indicates the foundation soils will normally undergo an increase in moisture due to covering the ground surface with buildings and flatwork, coupled with the introduction of landscape irrigation around the buildings. Based on our experience and the subsurface conditions at the site, the depth of wetting can be about 15 to 20 feet or more below the ground surface for the proposed type of development.

The wetting may not penetrate this deep; however, we believe it is a reasonable design assumption when evaluating the edge lift for this site. For the deeper depths of wetting, ground movements can be estimated based on swell or suction profiles, or using a computer program (such as “VOLFLO” by Geostructural Tool Kit, Inc.). The PTI design method does not predict soil movement caused by site conditions such as excessive irrigation or poor surface drainage that may lead to differential foundation movement in excess of the movements estimated by the PTI design method. These conditions may also increase the edge moisture variation distance above the design values provided in the PTI manual.

Considering the limitations of the current PTI design method, we believe a conservative approach with reasonable engineering judgement is merited in PTS foundation design. Design criteria for PTS foundations are presented below. Criteria were developed from analysis of field and laboratory data, the PTS design method outlined in PTI’s third edition of *Design and Construction of Post-Tensioned Slabs-On-Ground* (2004 with 2008 Supplement), and our experience.

1. PTS foundations should be constructed on new moisture-conditioned and compacted fill or directly on the natural soils. If soft/loose soils or relatively dry soils are exposed in footing excavations or are the result of the excavation/forming process, these soils should be removed, moisture conditioned as needed, and recompacted.

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

3. For design of uniform thickness PTS foundations or point loads, a modulus of subgrade reaction (K_s) of 100 pci can be used.

4. A differential soil movement (y_m) of 1.46 inches for the edge lift condition and -1.0 inches for the center lift condition can be used.

5. An edge moisture variation distance (e_m) of 8.5 feet for the edge lift condition and 4.4 feet for the center lift condition can be used.

6. We understand the PTI design method assumes the slab is somewhat flexible. The above-grade construction, such as framing, drywall, brick and stucco should be considered when determining the appropriate slab stiffness. We are aware of situations where minor differential slab movement has caused distress to finish materials. One way to enhance performance would be to place reinforcing steel in the bottoms of stiffening beams. The structural engineer should evaluate the merits of this approach, as well as other potential alternatives to reduce damage to finish materials. The slab stiffness should be evaluated per section 6.10 of the PTI 2008 Supplement as it relates to different superstructure materials.

7. Stiffening beams and edge beams may be poured "neat" into excavated trenches. Soil may cave or slough during trench excavation for the stiffening beams. Disturbed soil should be removed from trench bottoms prior to placement of concrete. Formwork or other methods may be required for proper stiffening beam installation.

8. Exterior stiffening beams should be protected from frost action. Normally 30 inches of frost cover is assumed in the area. If exterior patios are incorporated into the PTS, we believe the stiffening beams around the patios should be as deep as those around the building exterior to increase the likelihood they will perform similarly to the rest of the PTS.

9. 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, respectively. A coefficient of friction of 2.0 should be used for slabs on clay soils. We believe use of polyethylene is preferable because it serves as a vapor retarder which helps to control moisture migration up through the slabs.

10. A representative of our firm should observe the completed excavations. A representative of the structural engineer or our firm should observe the placement of the reinforcing tendons and any mild reinforcement prior to pouring the slabs and beams, and observe the tendon stressing.

FLOOR SYSTEMS

For the PTS system, the foundations are structurally integrated with the floor slab and should exhibit more reliable long-term performance. In our opinion, a low risk of poor slab performance (movement and damage) will exist for floor slabs underlain by the natural, on-site soils and/or densely compacted, grading fill placed in accordance with the recommendations set forth in Appendix C.

For the slab-on-ground foundation approach, the foundation is structurally integrated with the floor slab and should exhibit more reliable long-term performance, as compared to conventional slab-on-grade floors. Conventional spread footing foundations will settle relative to more lightly loaded slab-on-grade floors.

Underslab utilities such as water and sewer lines should be pressure tested prior to installing slabs. Utilities that penetrate the slab foundations should be provided with sleeves and flexible connections that allow for independent movement of the slab and that reduce the likelihood of damaging buried pipes. We recommend these details allow at least 1-1/2 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. Various properties of the soils and environmental conditions influence the magnitude of movement and other performance characteristics of slabs. Exterior flatwork should be designed and constructed to move independently relative to the proposed building foundations.

SITE RETAINING WALLS

Site retaining walls will be incorporated into this project. We assume the walls will be either gravity block, segmental block MSE, or cast-in-place concrete cantilever walls. A detailed scope of services and estimated fee for retaining wall design can be provided upon request.

Site retaining walls may be designed for a maximum allowable bearing pressure of 2,000 psf. Retaining walls will be subject to lateral earth loads which are dependent on the height of the wall, soil type, and backfill configuration. Backfill behind site retaining walls may be sloped in some areas. We expect site retaining walls will be subject to “active” earth pressures where walls are free to rotate, and the soil moves toward the wall away from the soil mass. The active pressures are fully mobilized at horizontal movements of about 0.5 percent of the wall height for cohesionless soils, such as sands and gravels. Passive stresses exist when the wall moves toward the soil mass. Passive resistance requires relatively more movement than active, at-rest, or base friction to generate resistance. The wall designer should carefully evaluate the use of passive pressure where slopes exist in front of the wall. The recommended equivalent fluid densities assume no surcharge loads next to the top of the wall and free-draining, granular backfill, with an angle of internal friction (ϕ) of at least 28 degrees, a unit weight of 125 pounds per cubic foot (pcf), and cohesion of 0 psf. Site retaining walls may be designed for an active equivalent fluid pressure of 45 pcf. For passive resistance to we recommend an equivalent fluid pressure of 250 pcf. Passive pressure should only be used when movement is tolerable, backfill is level, and the soil is well compacted and will not be removed. Gravity walls and mechanically stabilized earth walls may be designed using the soil parameters provided above.

Care must be exercised when compacting backfill against retaining walls. To reduce temporary construction loads on the walls, heavy equipment should not be used for placing and compacting fill within a region as determined by a 0.5H:1V line drawn upward from the bottom of the wall. Granular backfill behind any new site retaining walls should be compacted to 90 percent of the maximum modified Proctor dry density (ASTM D 1557). Thinner lifts should be used when utilizing smaller compaction equipment.

Adequate drainage is essential to the performance of retaining walls. New walls should include installation of a drainpipe that discharges away from the wall. For site retaining walls drainage measures could include free-draining granular backfill and perforated drainpipes leading to a positive gravity outlet or granular backfill with weep holes.

BELOW-GRADE CONSTRUCTION

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

SWIMMING POOL

We understand a swimming pool is planned in association with the proposed clubhouse. No plans were available at the time of this investigation. We anticipate the pool structure may consist of spray-applied gunite against natural soil, or possibly a steel or a fiberglass shell. Because of the granular nature of the on-site soils, vertical excavation of the pool walls required for gunite pool construction may not be possible. A fiberglass or steel shell placed in an enlarged excavation may then be the more feasible options. If gunite methods are used, the cement slurry should be properly reinforced.

We recommend the pool be underlain by a drain system that collects water leakage and provides for discharge of the water to a sump or gravity outfall. The drain system should consist of free-draining gravel covering the bottom of the pool excavation. The excavation should slope to a 3 to 4-inch diameter, perforated or slotted pipe placed within the gravel layer. The drain should lead to a positive gravity outlet, such as a subdrain located beneath the sewer, or to a sump where water can be removed by pumping. A conceptual pool drain system is presented in Fig. 3. Overall surface drainage patterns should be planned to provide for the rapid removal of storm runoff and water that splashes over the edges of the pool. The precautions described in SURFACE DRAINAGE, IRRIGATION, AND MAINTENANCE should be followed surrounding the swimming pool, as well as for all areas of the site.

The swimming pool structure may settle more than the flatwork surrounding the pool. To avoid damage to the pool structure, a slip joint should be used around the perimeter of the pool structure and adjacent to any other structural elements. Utility lines that penetrate the pool structure should be separated and isolated with joints to allow for free vertical movement. All ducts with connections between the pool structure and surrounding soil should be flexible or "crushable," to allow some relative movement.

PAVEMENTS

Private paved automobile parking lots and access roads will be constructed throughout the site. Access driveway will extend into the development from one or more of the surrounding streets. Our exploratory borings and understanding of the proposed construction suggest the subgrade soils within the planned access driveways and parking areas will predominantly consist of a mixture of silty to clayey sand and localized areas of sandy clay. Samples of the onsite materials tested in our laboratory classified as A-2-4, A-2-6, A-4, and A-6 materials according to the American Association of State Highway Transportation Officials (AASHTO) classification system. These materials will exhibit variable pavement support characteristics. Based on our laboratory classification testing (Atterberg Limits and gradation analysis), a Hveem Stabilometer ("R") value of 15 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 3 for parking stalls and 10 for the access driveways, which correspond to 18-kip Equivalent Single-Axle Loads (ESAL) of 21,900 and 73,000, respectively, for a 20-year pavement design life. Based on the estimated design traffic and pavement design input parameters, we recommend the following flexible pavement sections.

- Standard Duty Asphalt Pavements:
  - Full Depth Asphalt - 5 inches or more of Asphalt
  - Composite Section - 3 inches of Asphalt over 8 inches of Aggregate Base Course
- Heavy Duty Asphalt Pavements:
  - Full Depth Asphalt - 6 inches or more of Asphalt
  - Composite Section - 4 inches of Asphalt over 8 inches of Aggregate Base Course

El Paso County does not allow the use of full depth asphalt pavements. Full depth asphalt pavement use may be limited within county rights-of-way.

We recommend a concrete pad be provided at trash dumpster sites. 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 the El Paso County "Standard Specifications" and the Pikes Peak Region Asphalt Paving 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. Soft or loose subgrade or 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.

SURFACE DRAINAGE, IRRIGATION AND MAINTENANCE

Proper design, construction, and maintenance of surface drainage are critical to the satisfactory performance of foundations, slabs-on-grade, and other improvements. Landscaping and irrigation practices will also affect performance. Overall surface drainage should be designed, constructed, and maintained to provide rapid removal of surface water runoff away from the proposed buildings and site retaining walls and off pavements and flatwork. Final grading of pavement subgrade should be carefully controlled so that the designed slopes are maintained and low spots in the subgrade that could trap water are eliminated. We recommend the following precautions be observed during construction and maintained at all times after construction is completed.

1. Wetting or drying of open foundation, utility, and earthwork excavations should be avoided.
2. Positive drainage should be provided away from the buildings. We recommend a minimum slope of at least 5 percent in the first 5 to 10 feet away from the foundations in landscaped areas. In flatwork areas adjacent to the buildings, the slope may be reduced to grades that comply with ADA requirements. Paved surfaces should be sloped to drain away from the buildings. A minimum slope of 2 percent is suggested. More slope is desirable. Concrete curbs and sidewalks may "dam" surface runoff adjacent to the buildings and disrupt proper flow. Use of "chase" drains or weep holes at low points in the curb should be considered to promote proper drainage.
3. Foundation wall backfill should be thoroughly compacted to decrease permeability and reduce the potential for irrigation and stormwater to migrate behind retaining walls or below floor slabs. Areas behind curb and gutter should be backfilled and well compacted to reduce ponding of surface water. Seals should be provided between the curb and pavement to reduce infiltration.
4. Landscaping should be carefully designed to minimize irrigation. Plants placed close to foundation walls should be limited to those with low moisture requirements. Irrigation should be limited to the minimum amount sufficient to maintain vegetation. Application of more water will increase likelihood of slab and foundation movements and associated damage. Landscaped areas should be adequately sloped to direct flow away from the buildings and improvements. Area drains can be used to drain areas that cannot be provided with adequate slope.
5. Impervious plastic membranes should not be used to cover the ground surface immediately adjacent to the foundations. These membranes tend to trap moisture and prevent normal evaporation from occurring. Geotextile fabrics can be used to control weed growth and allow evaporation.
6. Roof drains should be directed away from the buildings and discharge beyond backfill zones or into an appropriate storm sewer or detention area. Downspout extensions and splash blocks should be provided at all discharge points. Roof drains can also be connected to buried, solid pipe outlets. Roof drains should not be directed below slab-on-grade floors. Roof drain outlets should be maintained.

CONCRETE

Concrete in contact with soil can be subject to sulfate attack. We measured water-soluble sulfate concentrations of less than 0.1 percent in three samples. As indicated in our tests and ACI 318-19, the sulfate exposure class is *Not Applicable* or *S0.*

SULFATE EXPOSURE CLASSES PER ACI 318-19

Exposure Classes		Water-Soluble Sulfate (SO_4) in Soil [A] (%)
Not Applicable	S0	< 0.10
Moderate	S1	0.10 to 0.20
Severe	S2	0.20 to 2.00
Very Severe	S3	> 2.00

A) Percent sulfate by mass in soil determined by ASTM C1580

For this level of sulfate concentration, ACI 318-19 *Code Requirements* indicates there are no special cement type requirements for sulfate resistance as indicated in the table below.

CONCRETE DESIGN REQUIREMENTS FOR SULFATE EXPOSURE PER ACI 318-19

Exposure Class		Maximum Water/ Cement Ratio	Minimum Compressive Strength (psi)	Cementitious Material Types [A]			Calcium Chloride Admixtures
				ASTM C150/ C150M	ASTM C595/ C595M	ASTM C1157/ C1157M	
S0		N/A	2500	No Type Restrictions	No Type Restrictions	No Type Restrictions	No Restrictions
S1		0.50	4000	II [B]	Type with (MS) Designation	MS	No Restrictions
S2		0.45	4500	V [B]	Type with (HS) Designation	HS	Not Permitted
S3	Option 1	0.45	4500	V + Pozzolan or Slag Cement [C]	Type with (HS) Designation plus Pozzolan or Slag Cement [C]	HS + Pozzolan or Slag Cement [C]	Not Permitted
S3	Option 2	0.4	5000	V [D]	Type with (HS) Designation	HS	Not Permitted

A) Alternate combinations of cementitious materials shall be permitted when tested for sulfate resistance meeting the criteria in section 26.4.2.2(c).
B) Other available types of cement such as Type III or Type I are permitted in Exposure Classes S1 or S2 if the C3A contents are less than 8 or 5 percent, respectively.
C) The amount of the specific source of pozzolan or slag to be used shall not be less than the amount that has been determined by service record to improve sulfate resistance when used in concrete containing Type V cement. Alternatively, the amount of the specific source of the pozzolan or slab to be used shall not be less than the amount tested in accordance with ASTM C1012 and meeting the criteria in section 26.4.2.2(c) of ACI 318.
D) If Type V cement is used as the sole cementitious material, the optional sulfate resistance requirement of 0.040 percent maximum expansion in ASTM C150 shall be specified.

Superficial damage may occur to the exposed surfaces of highly permeable concrete. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious materials ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist due to surface drainage or high-water tables. Concrete should have a total air content of 6 percent ± 1.5 percent. We advocate damp-proofing of all foundation walls and grade beams in contact with the subsoils.

CONSTRUCTION OBSERVATIONS

We recommend that CTL|Thompson, Inc. provide construction observation services 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 by Evergreen Development 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 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 and garages from a geotechnical engineering point-of-view, please call.

CTL|THOMPSON, INC.

COLORADO LICENSED PROFESSIONAL ENGINEER JEFFREY MARK JONES 47539 5/11/23

Jeffrey M. Jones, P.E.
Associate Engineer

Reviewed by

Timothy A. Mitchell, P.E.
Principal Engineer

JMJ:TAM:cw
(2 copies sent)

Via e-mail: rplace@evgre.com

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Colorado Geological Survey. (1991). Results of the 1987-88 EPA Supported Radon Study in Colorado, with a Discussion on Geology, Colorado Geological Survey Open File Report 91-4.

Colorado Geological Survey, (2002), Geologic Map of the Elsmere Quadrangle, El Paso County, Colorado, Madole, Richard F., and Thorson, Jon P.

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Harris Kocher Smith, Powers & Grinnell Overall Site Plan, dated April 1, 2023.

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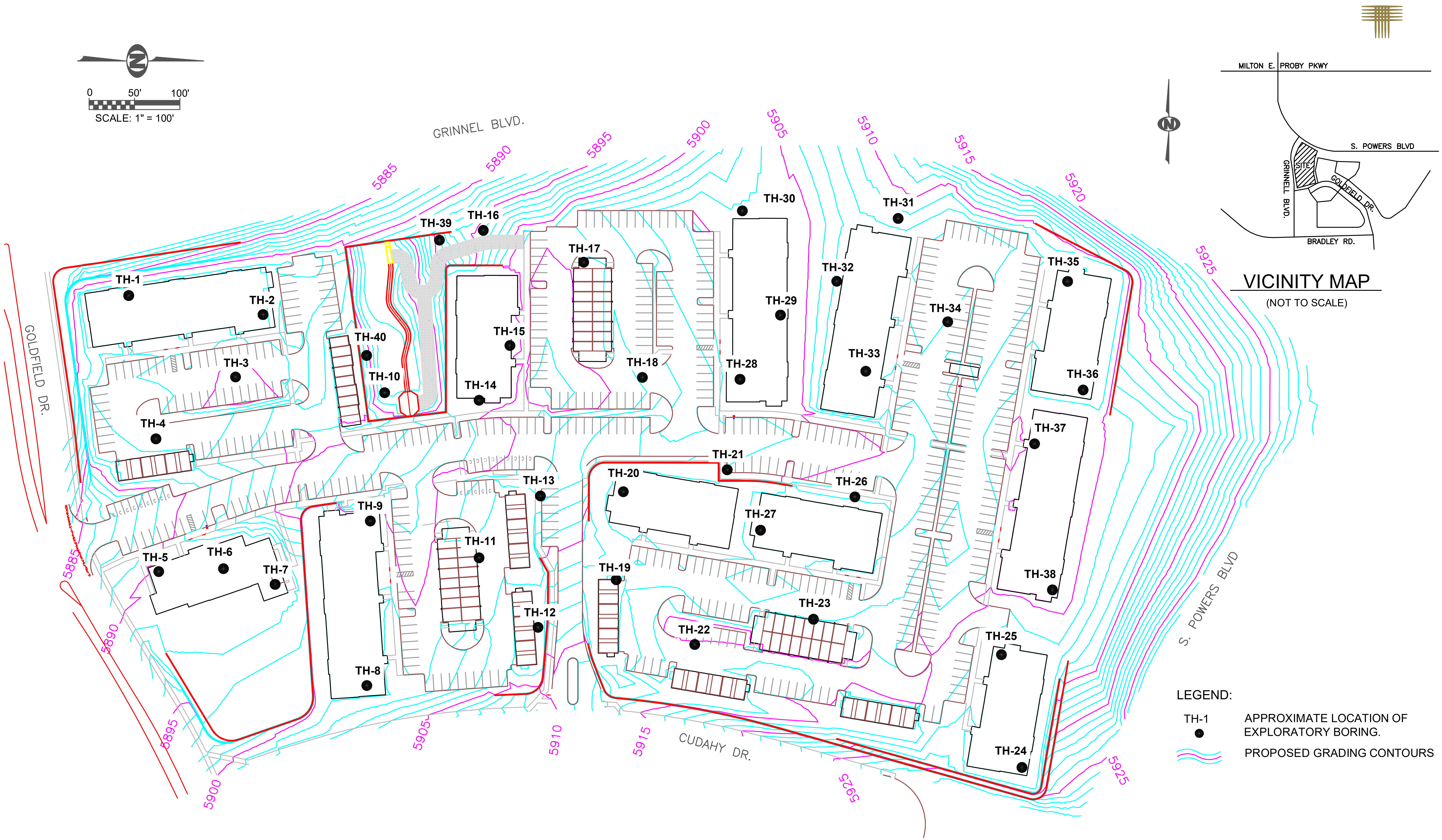
Kirkham, R.M. & Rogers, W.P. (1981). Earthquake Potential in Colorado. Colorado Geological Survey, Bulletin 43.

Robinson and Associates, Inc. (1977). El Paso County, Colorado - Potential Geologic Hazards and Surficial Deposits, Environmental and Engineering Geologic Maps and Tables for Land Use Maps.

Paul E. Soister (1968), Geologic Map of the Corral Bluffs Quadrangle, El Paso County, Colorado, Colorado Geological Survey.



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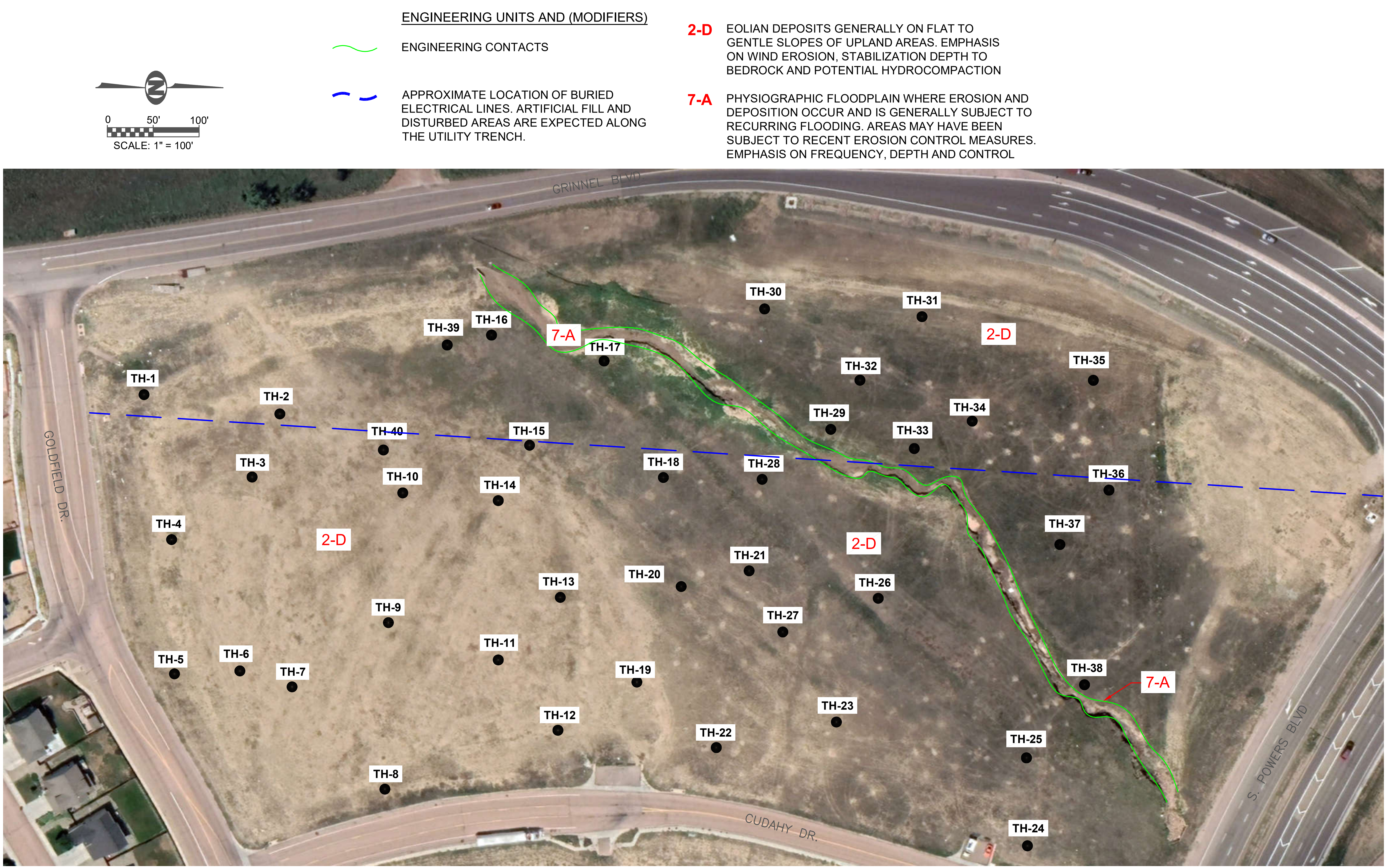
Location of Exploratory Borings

FIG. 1



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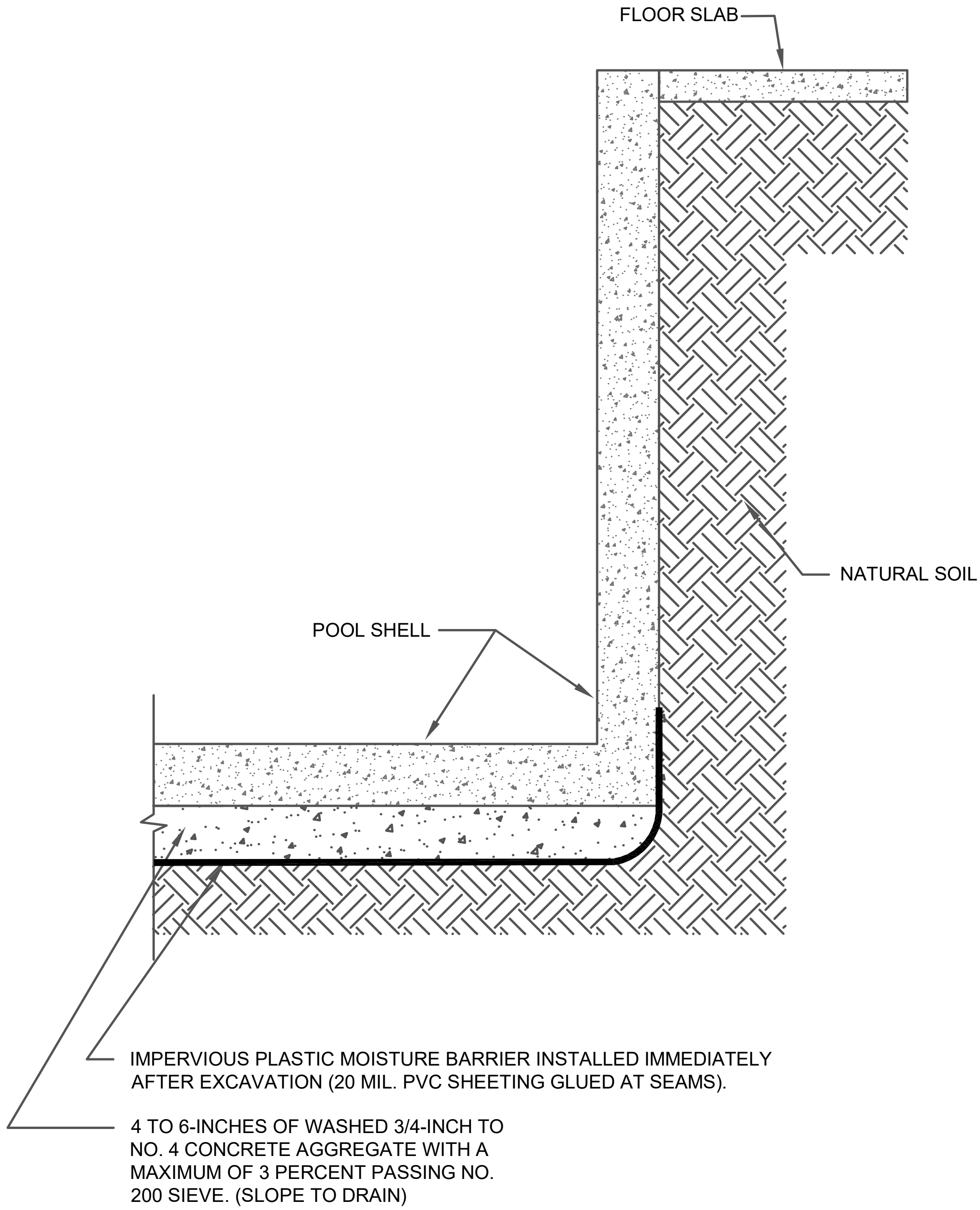
CTL|T PROJECT NO. CS19678-125

Engineering Geologic Conditions

FIG. 2



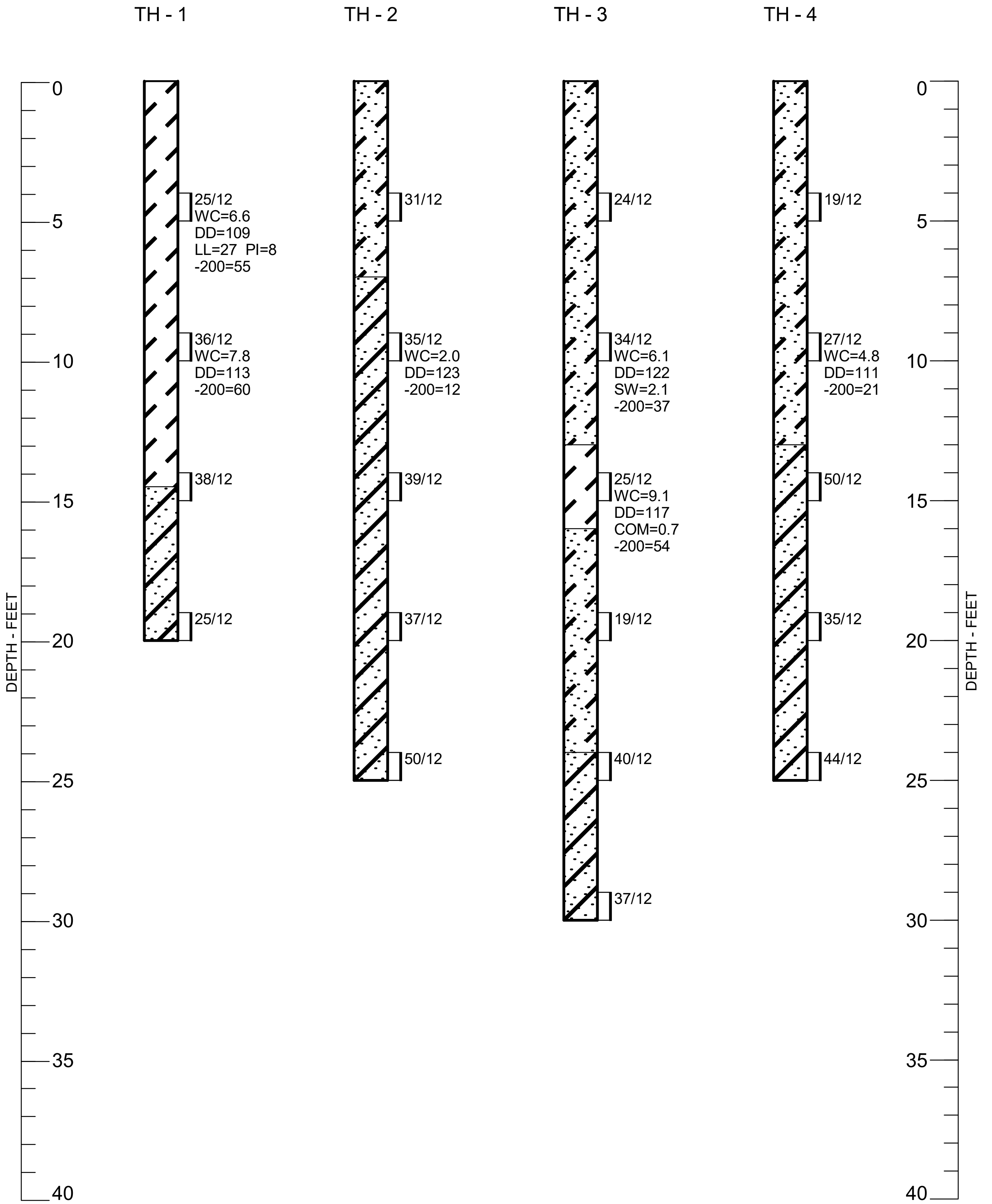
NOTE:
DRAIN PIPE SHOULD CONSIST OF A 3 OR 4-INCH DRAIN PIPE WITH A MINIMUM SLOPE OF 1/8 INCH DROP PER FOOT, TO A POSITIVE GRAVITY OUTLET OR TO A SUMP WHERE WATER CAN BE REMOVED BY PUMPING.

Recommended Pool Drain Detail

FIG. 3

APPENDIX A

SUMMARY LOGS OF EXPLORATORY BORINGS



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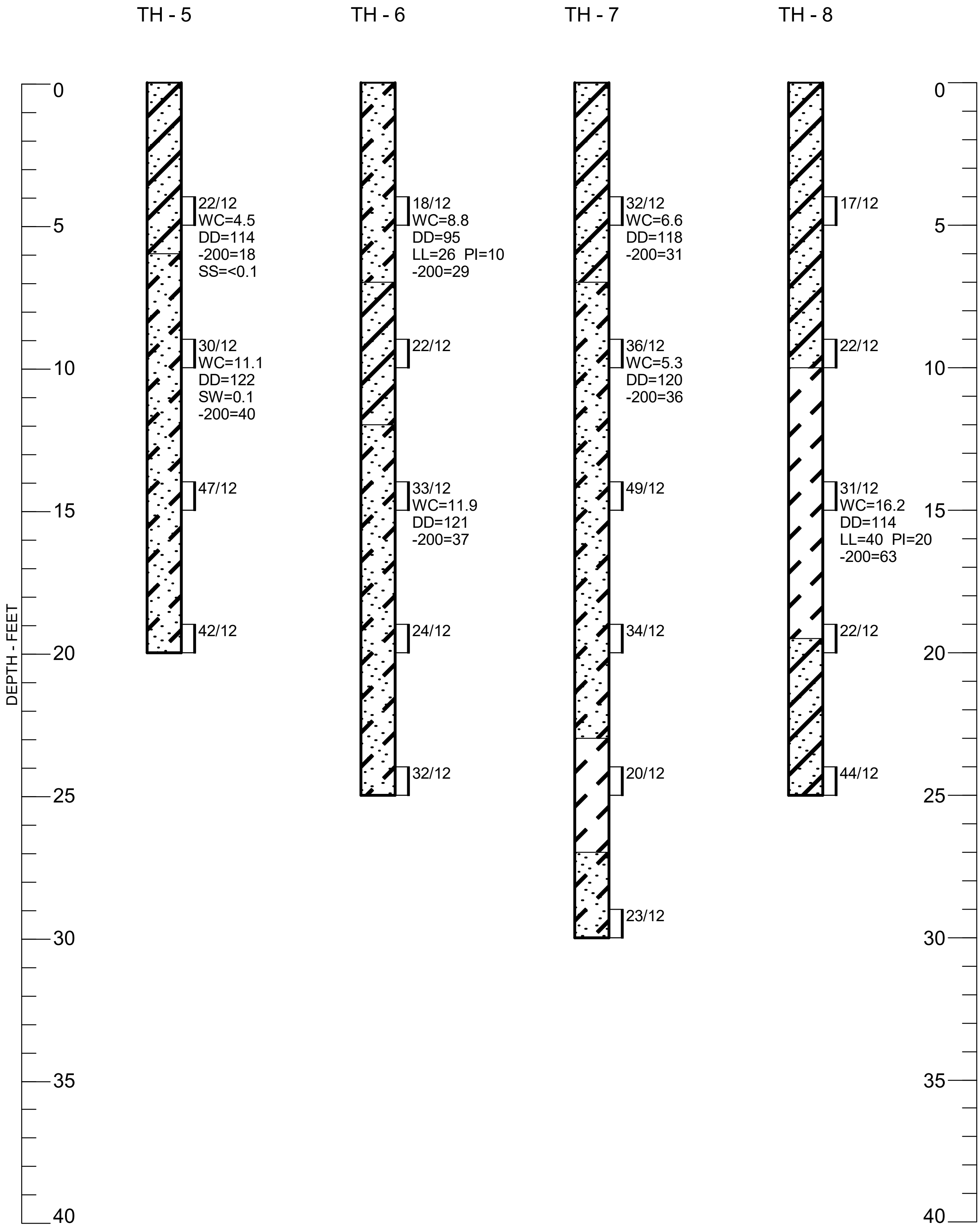
POWERS AND GRINNELL APARTMENTS
CTL|T PROJECT NO. CS19678-125

Summary Logs of Exploratory Borings

FIG. A-1



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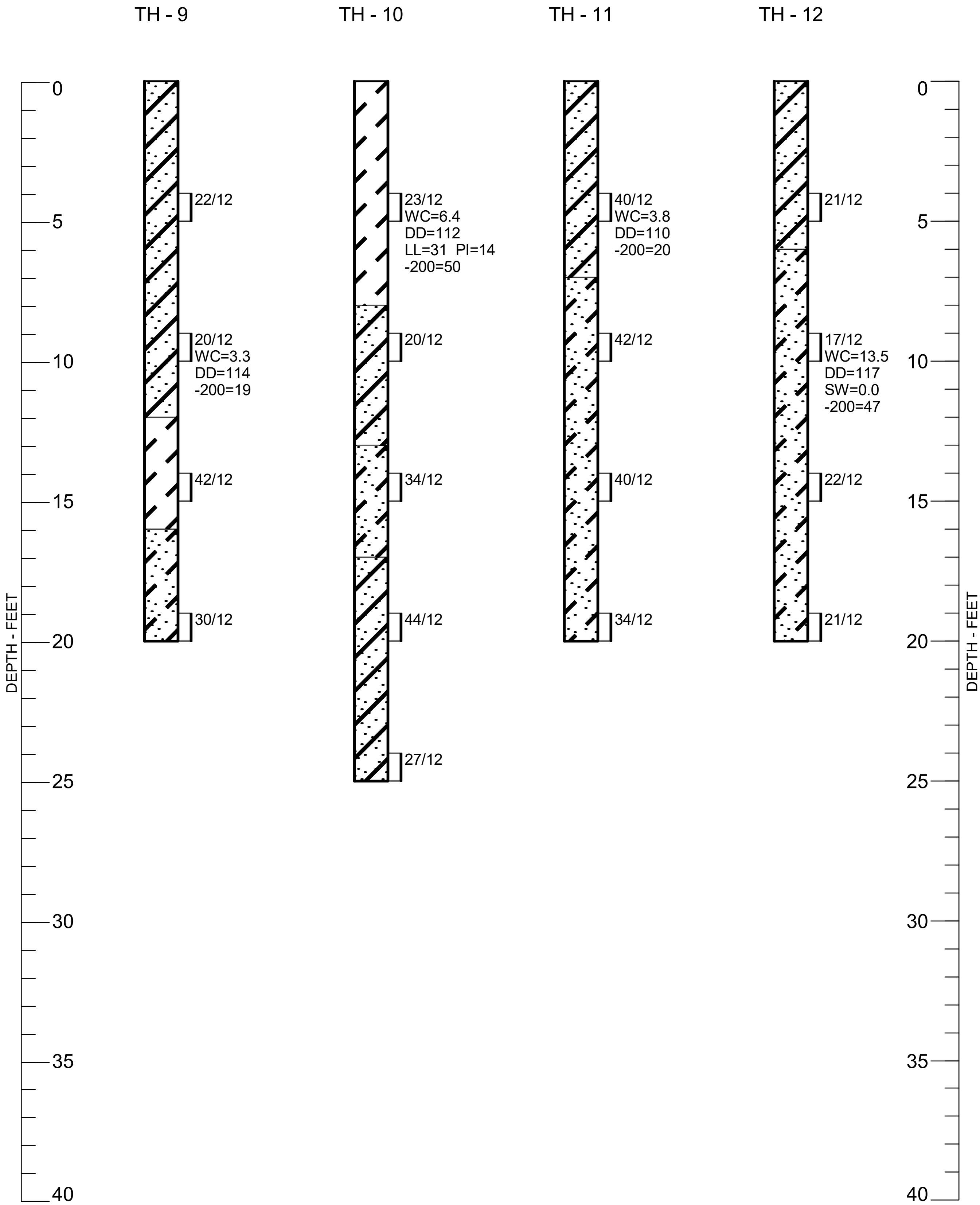
CTL|T PROJECT NO. CS19678-125

Summary Logs of Exploratory Borings

FIG. A-2



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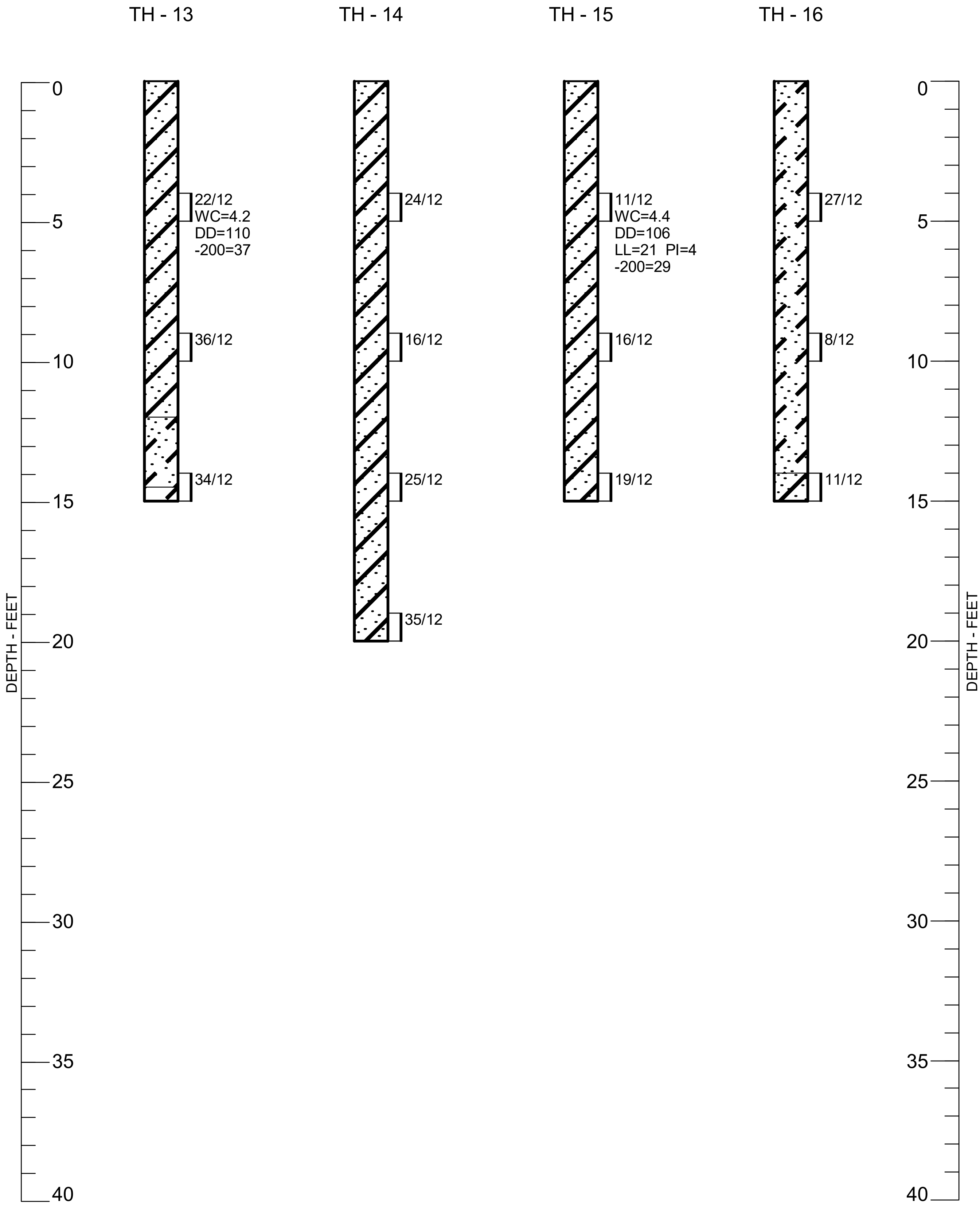
CTL|T PROJECT NO. CS19678-125

Summary Logs of Exploratory Borings

FIG. A-3



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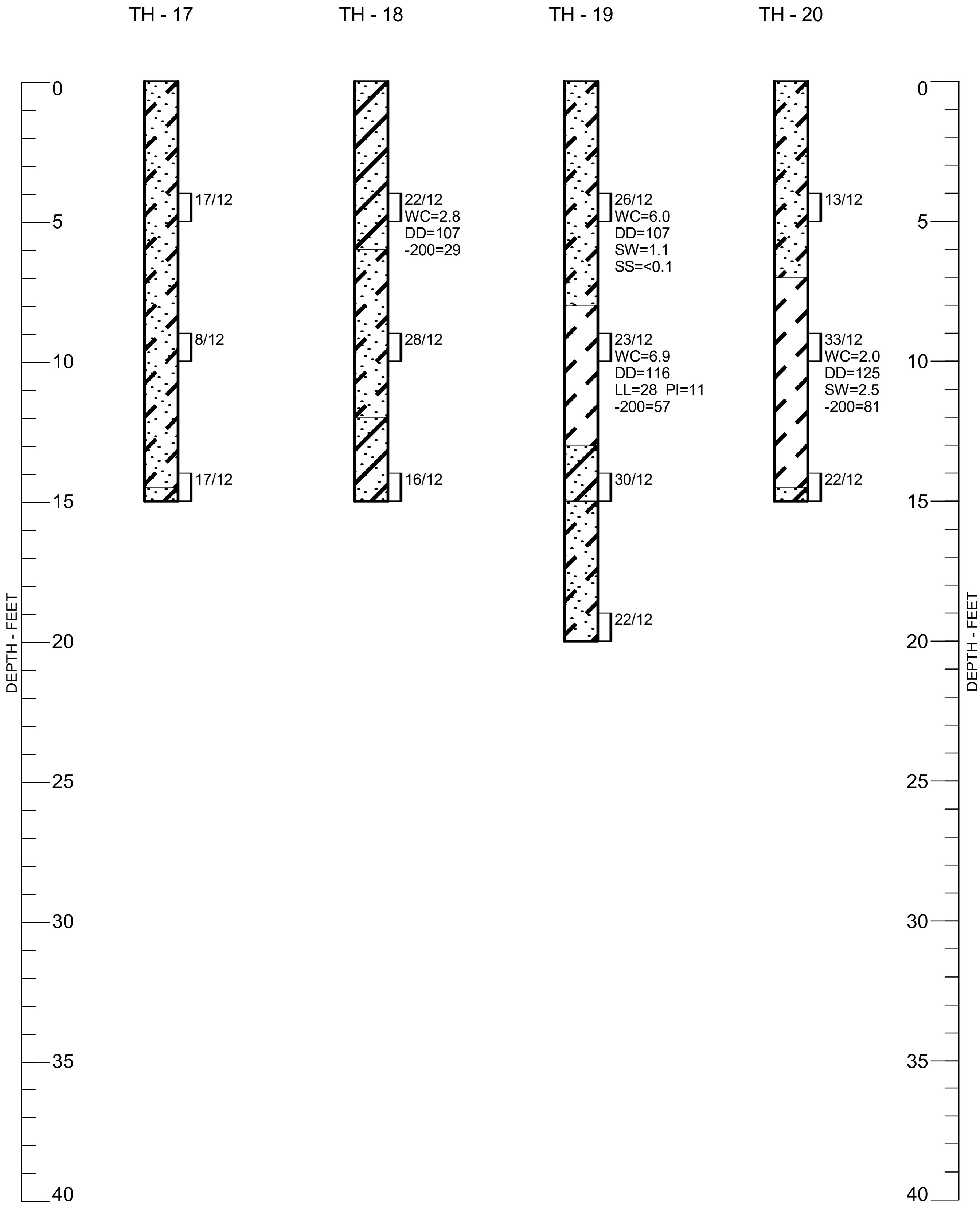
CTL|T PROJECT NO. CS19678-125

Summary Logs of Exploratory Borings

FIG. A-4



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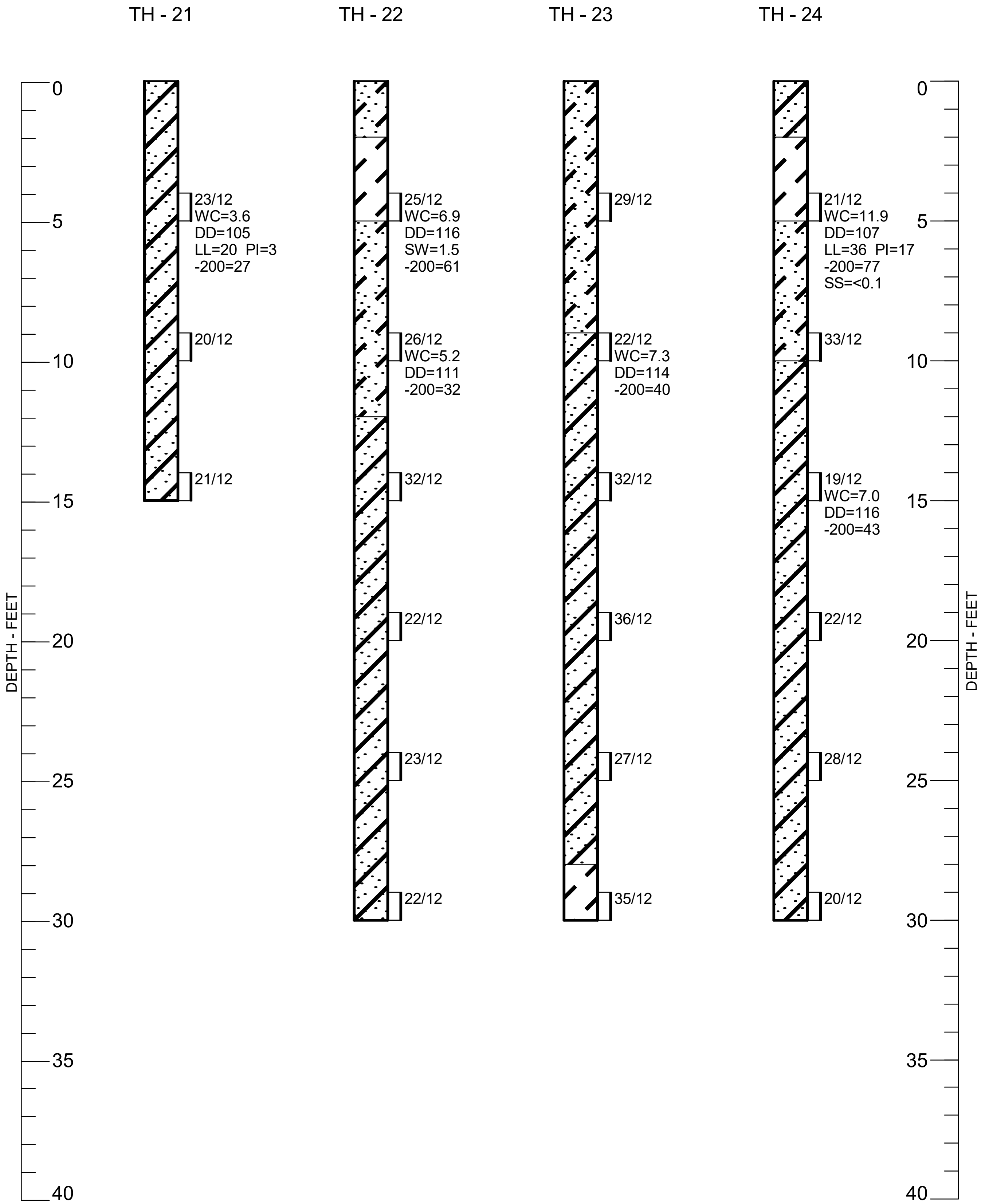
Summary Logs of Exploratory Borings

FIG. A-5



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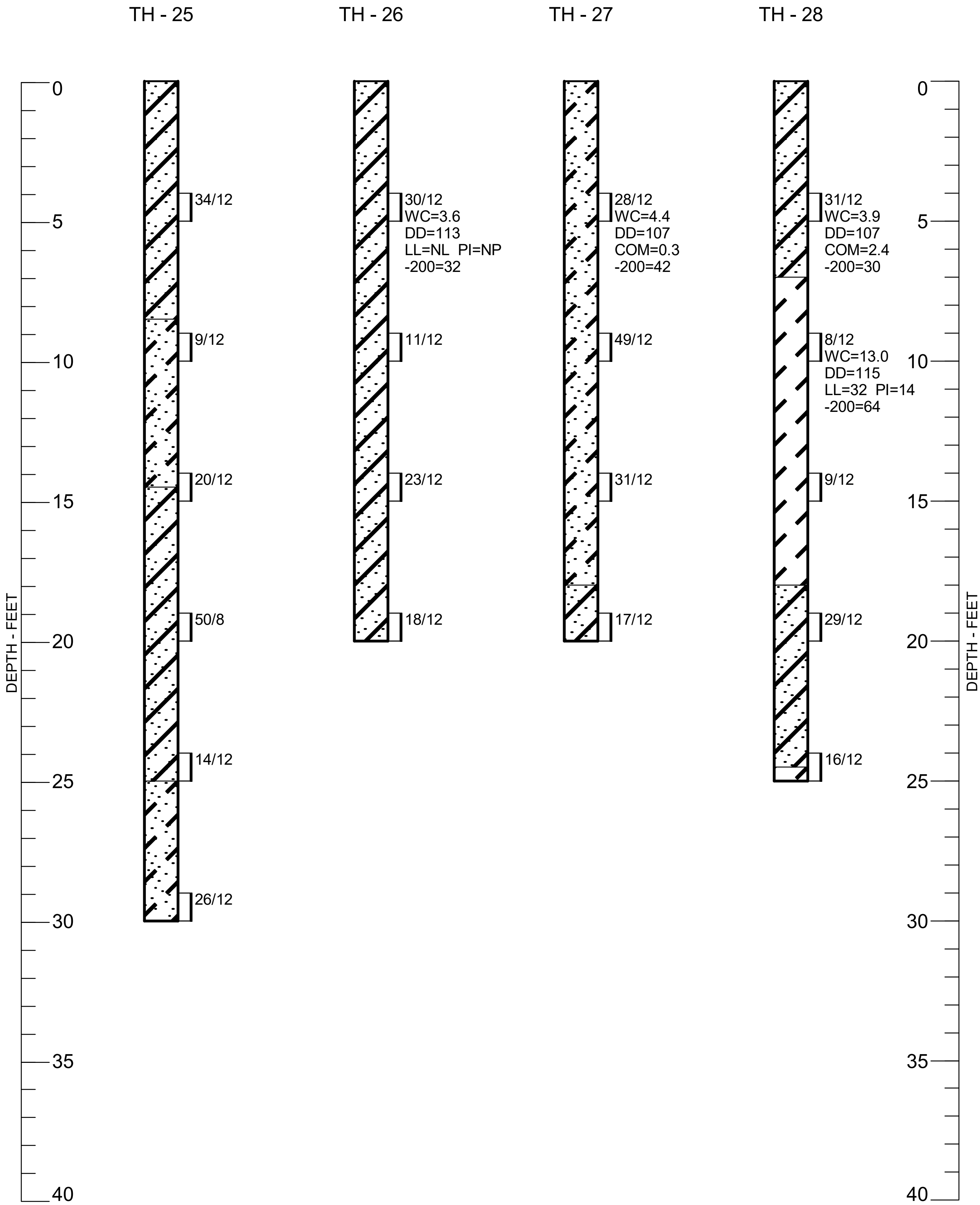
Summary Logs of Exploratory Borings

FIG. A-6



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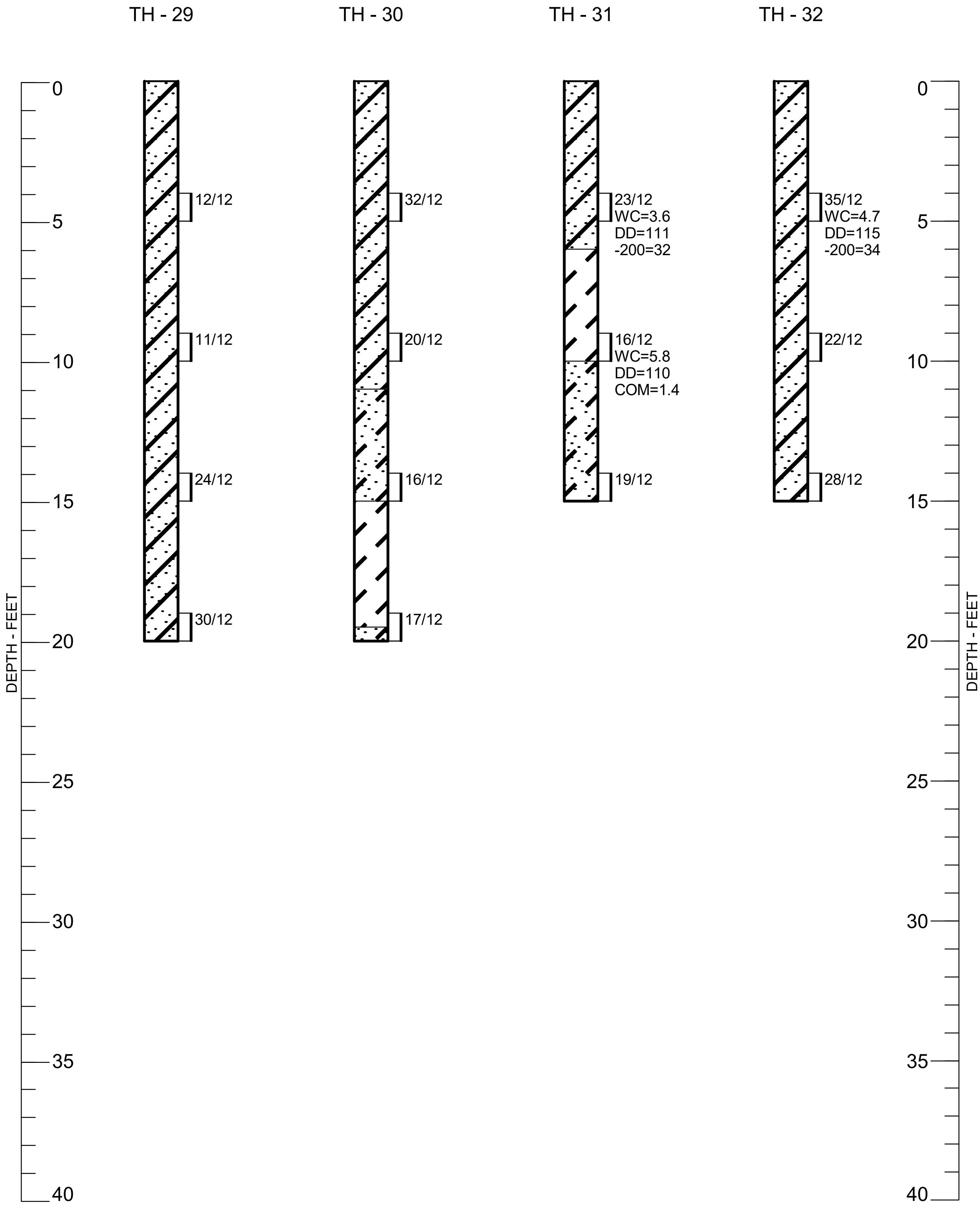
CTL|T PROJECT NO. CS19678-125

Summary Logs of Exploratory Borings

FIG. A-7



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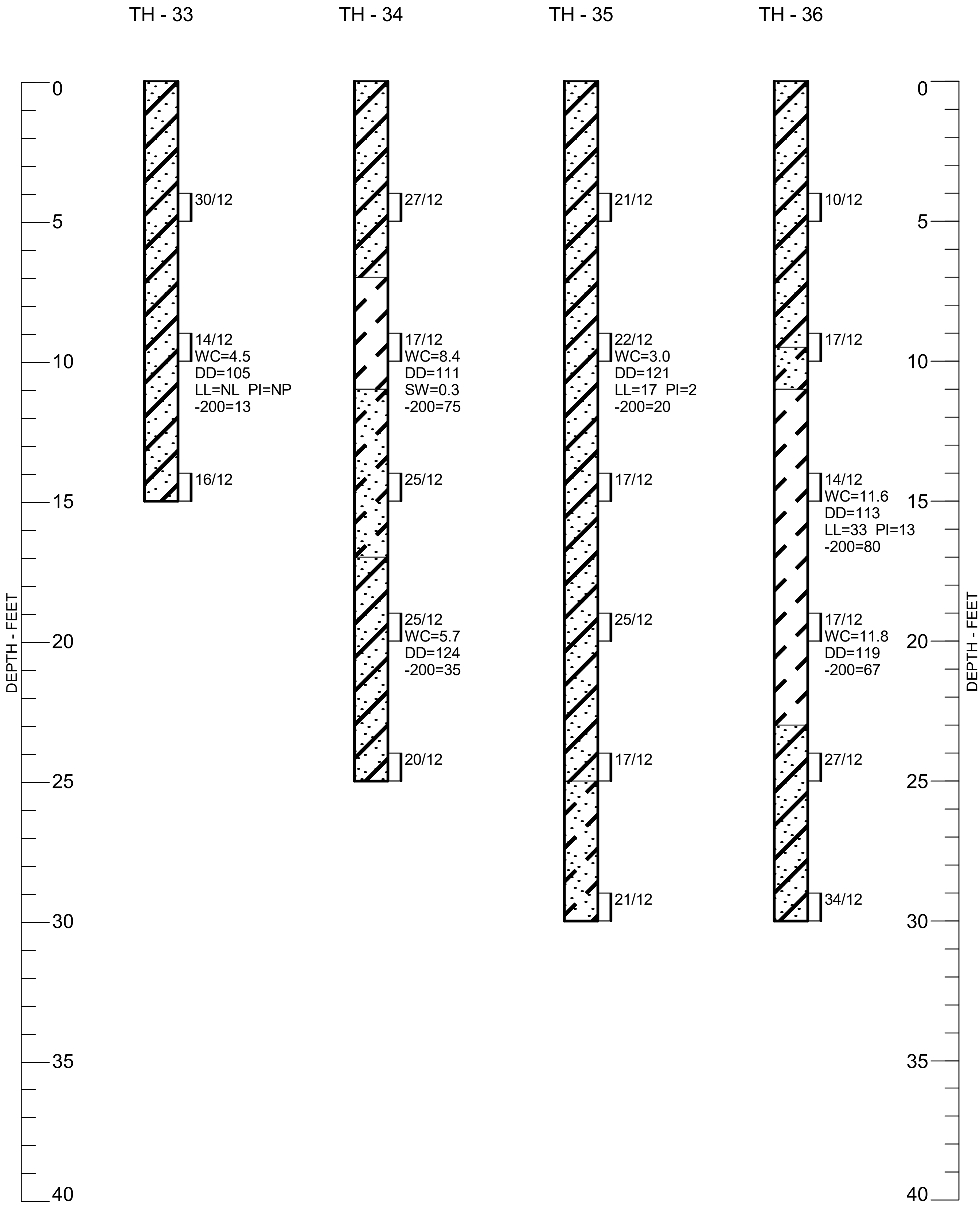
CTL|T PROJECT NO. CS19678-125

Summary Logs of Exploratory Borings

FIG. A-8



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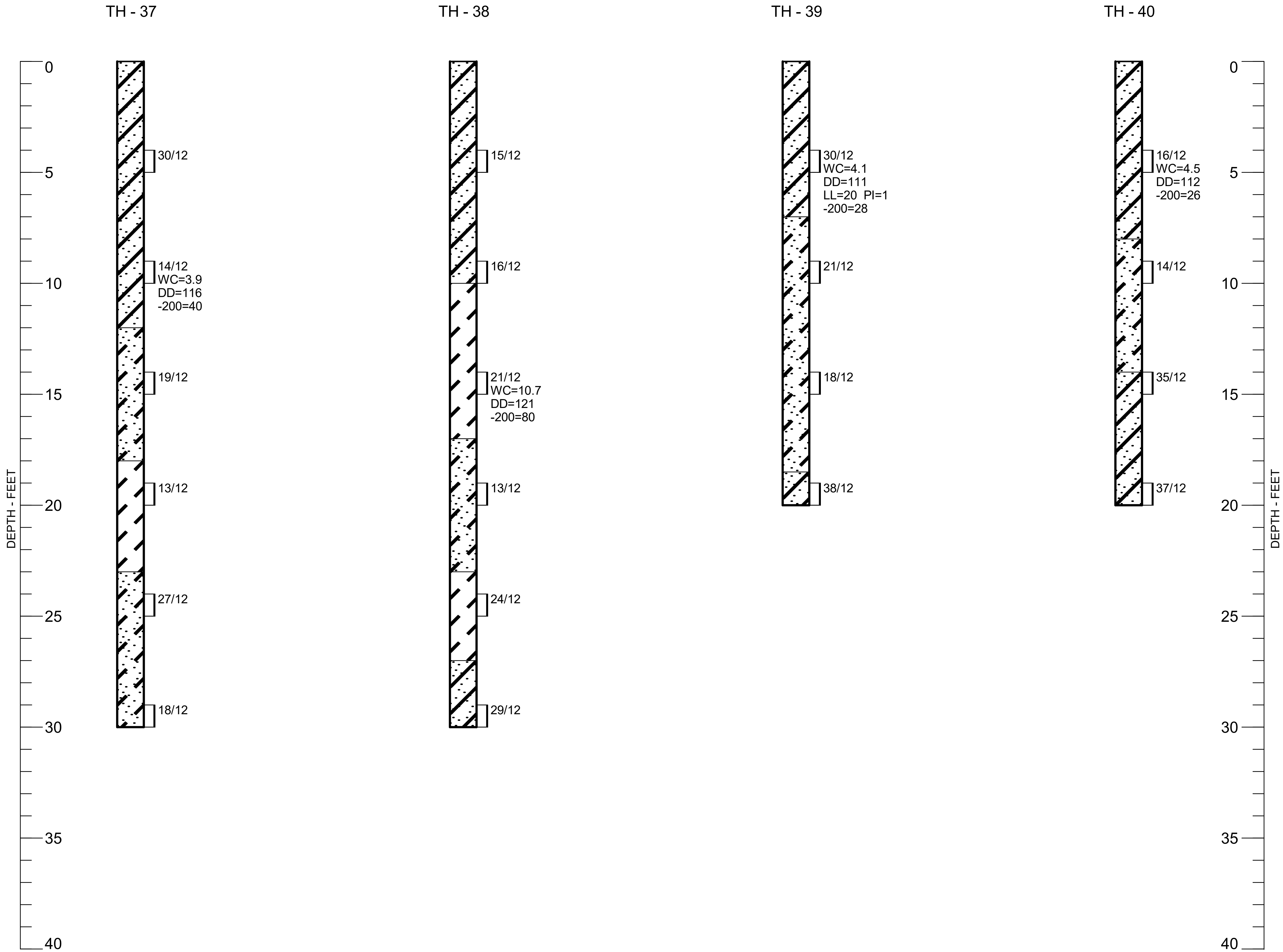
CTL|T PROJECT NO. CS19678-125

Summary Logs of Exploratory Borings

FIG. A-9



LEGEND:

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

SAND, CLAYEY, LOOSE TO DENSE, SLIGHTLY MOIST, DARK BROWN, GRAY (SC, SC-SM).

SAND, SLIGHTLY SILTY TO VERY SILTY, MEDIUM DENSE TO DENSE, SLIGHTLY MOIST, BROWN, GRAY (SM, SP-SM).

DRIVE SAMPLE. THE SYMBOL 25/12 INDICATES 25 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.

NOTES:

1. THE BORINGS WERE DRILLED BETWEEN APRIL 11 AND 18, 2023 USING A 4-INCH DIAMETER, CONTINUOUS-FLIGHT AUGER AND A CME-45 OR CME-55, TRUCK-MOUNTED DRILL RIG.

2. GROUNDWATER WAS NOT ENCOUNTERED IN THE EXPLORATORY BORINGS DURING THIS INVESTIGATION.

3. WC - INDICATES MOISTURE CONTENT. (%)
   DD - INDICATES DRY DENSITY. (PCF)
   SW - INDICATES SWELL WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE. (%)
   COM - INDICATES COMPRESSION 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. (%)

4. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS, AND CONCLUSIONS AS CONTAINED IN THIS REPORT.

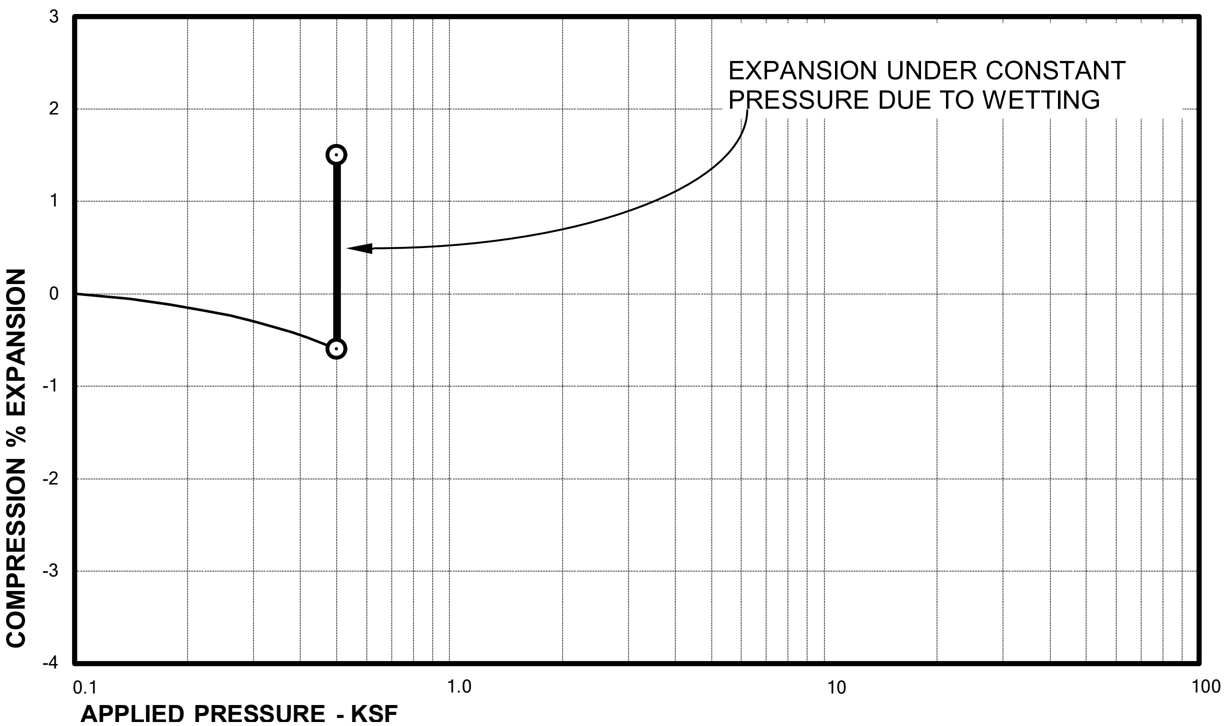
EVERGREEN DEVELOPMENT
POWERS AND GRINNELL APARTMENTS
CTL|T PROJECT NO. CS19678-125

Summary Logs of Exploratory Borings

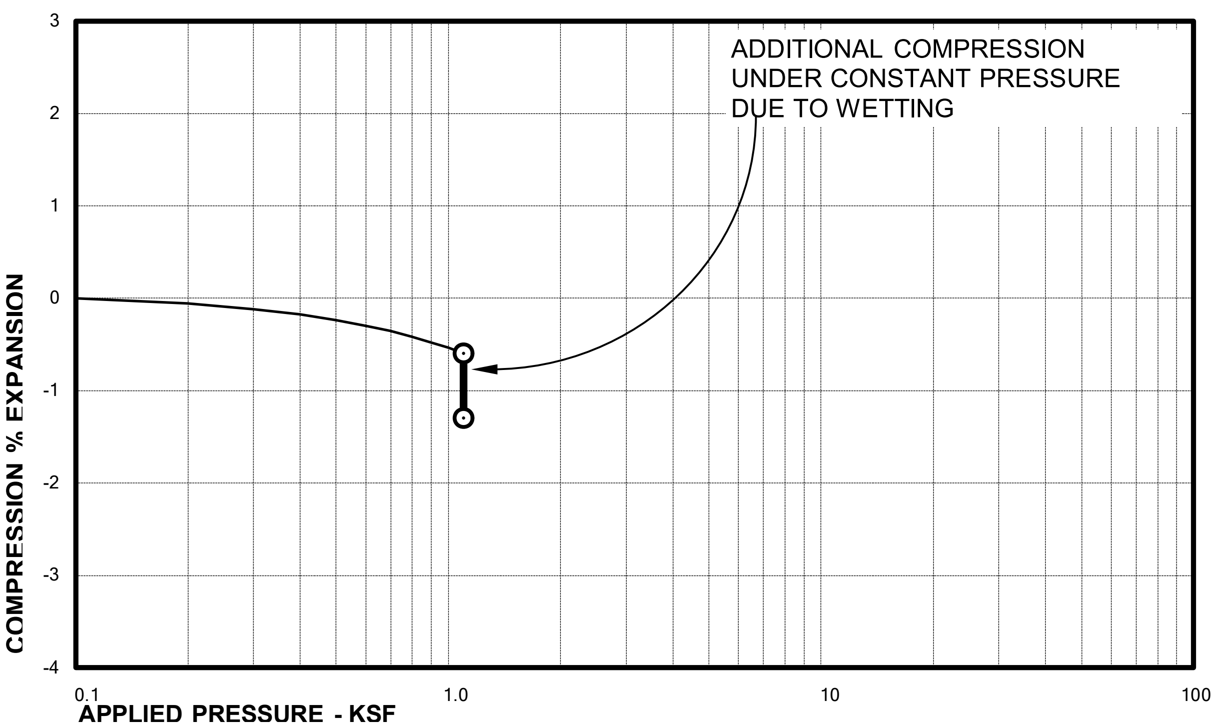
FIG. A-10

APPENDIX B

LABORATORY TEST RESULTS
TABLE B-I – SUMMARY OF LABORATORY TEST RESULTS



Sample of	SAND, VERY CLAYEY (SC)	DRY UNIT WEIGHT=	122 PCF
From	TH-3 AT 9 FEET	MOISTURE CONTENT=	6.1 %



Sample of	CLAY, VERY SANDY (CL)	DRY UNIT WEIGHT=	117 PCF
From	TH-3 AT 14 FEET	MOISTURE CONTENT=	9.1 %

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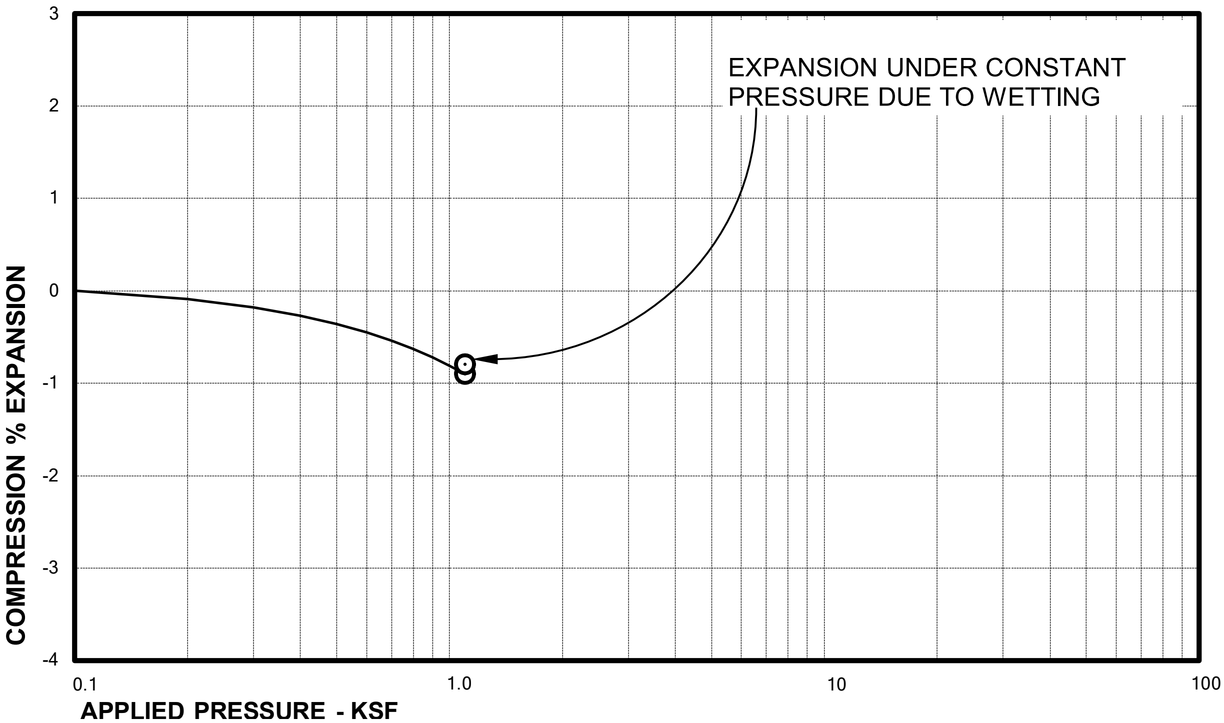
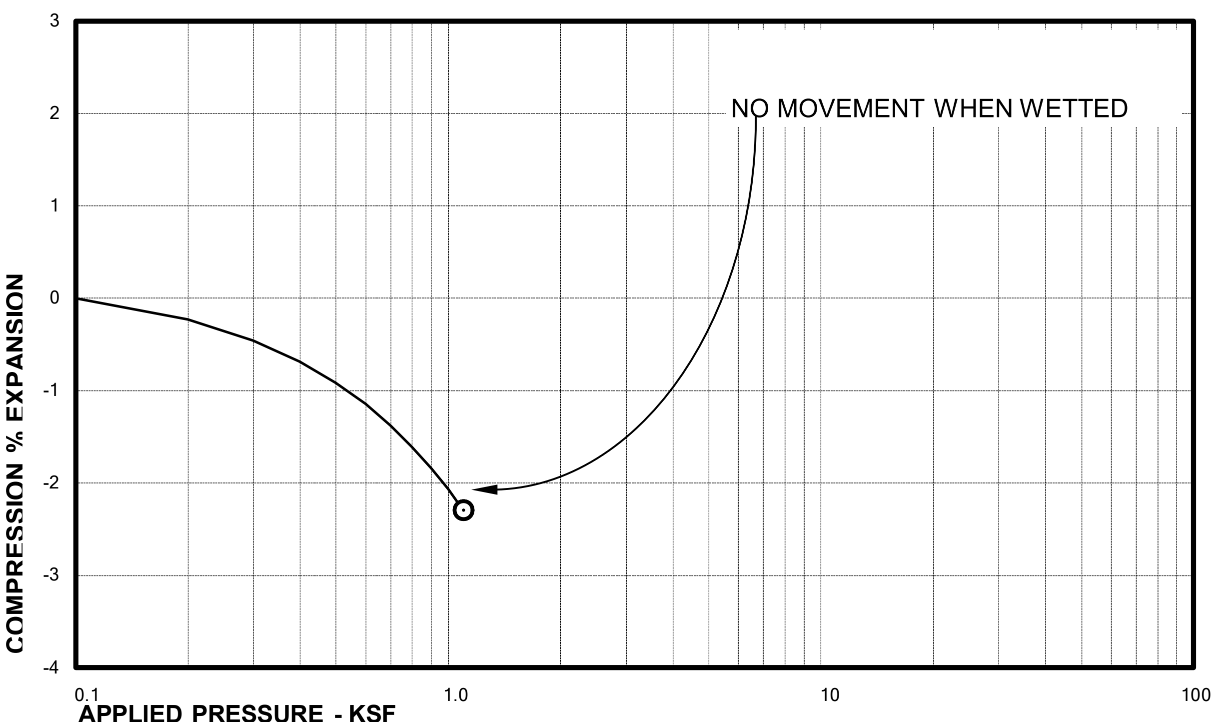
POWERS AND GRINNELL APARTMENTS
CTL|T PROJECT NO. CS19678-125

Swell Consolidation Test Results

FIG. B-1



Sample of	SAND, VERY CLAYEY (SC)	DRY UNIT WEIGHT=	122	PCF
From	TH-5 AT 9 FEET	MOISTURE CONTENT=	11.1	%



Sample of	SAND, VERY CLAYEY (SC)	DRY UNIT WEIGHT=	117	PCF
From	TH-12 AT 9 FEET	MOISTURE CONTENT=	13.5	%

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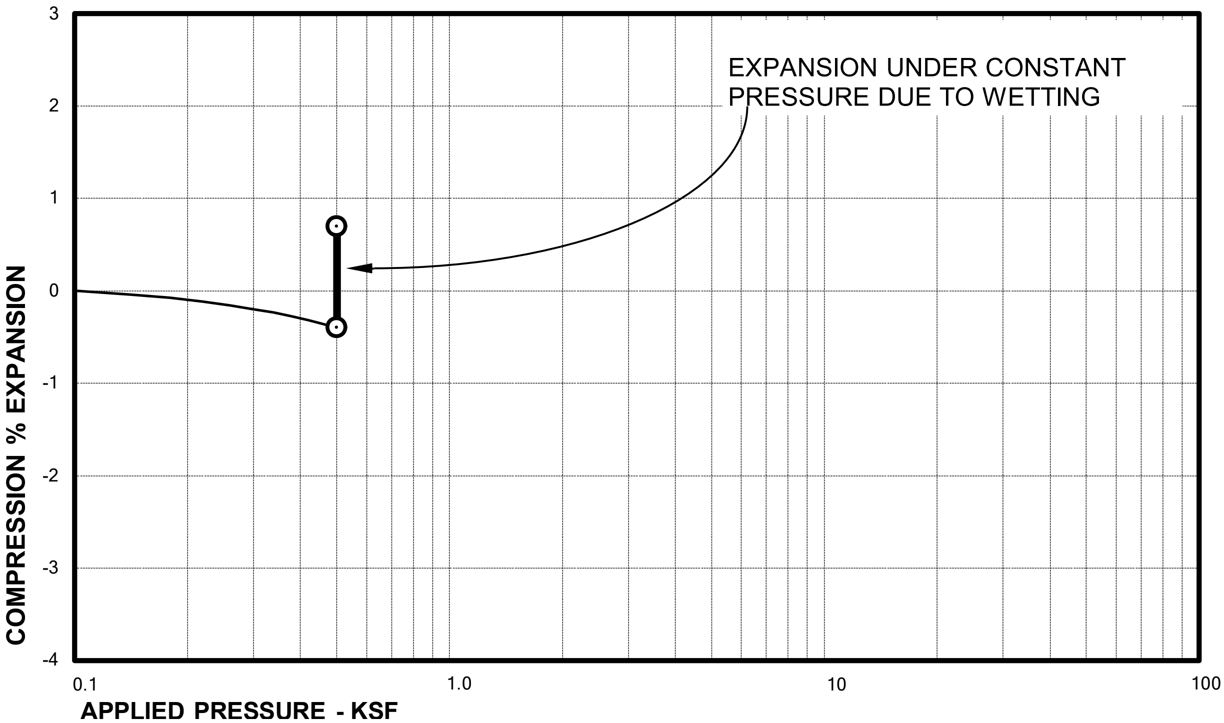
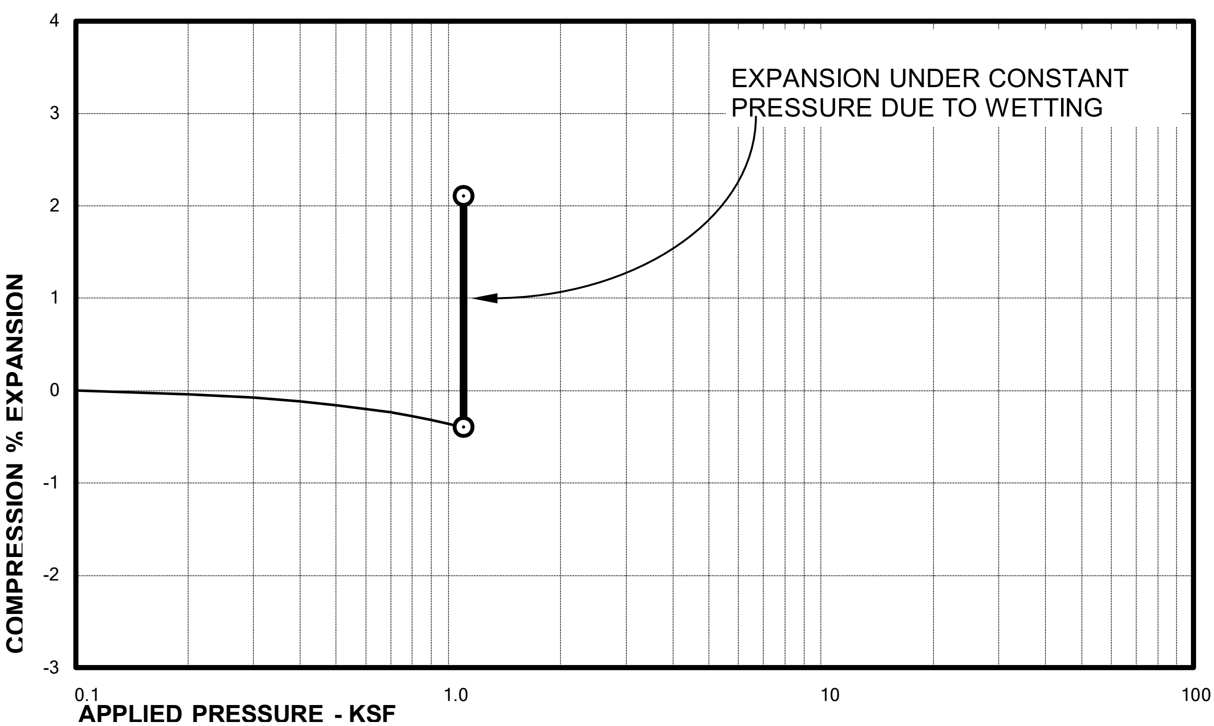
POWERS AND GRINNELL APARTMENTS
CTL|T PROJECT NO. CS19678-125

Swell Consolidation Test Results

FIG. B-2



Sample of	CLAY, VERY SANDY (CL)	DRY UNIT WEIGHT=	107	PCF
From	TH-19 AT 4 FEET	MOISTURE CONTENT=	6.0	%



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	125	PCF
From	TH-20 AT 9 FEET	MOISTURE CONTENT=	2.0	%

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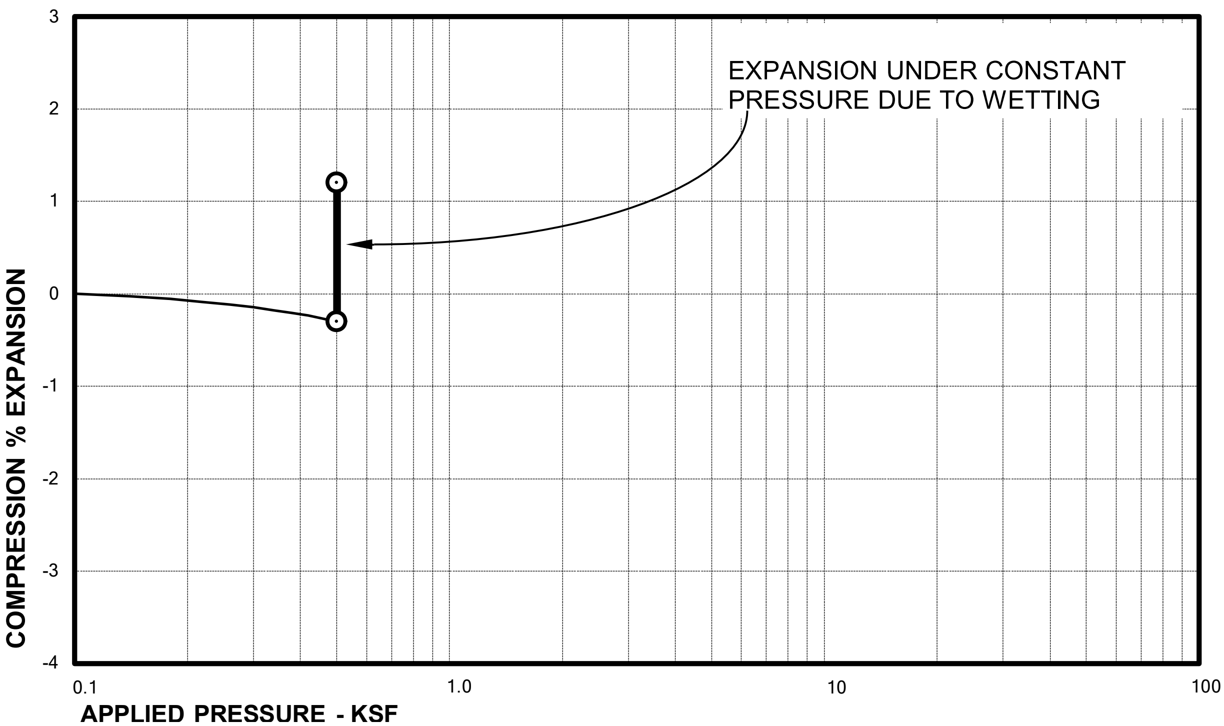
POWERS AND GRINNELL APARTMENTS
CTL|T PROJECT NO. CS19678-125

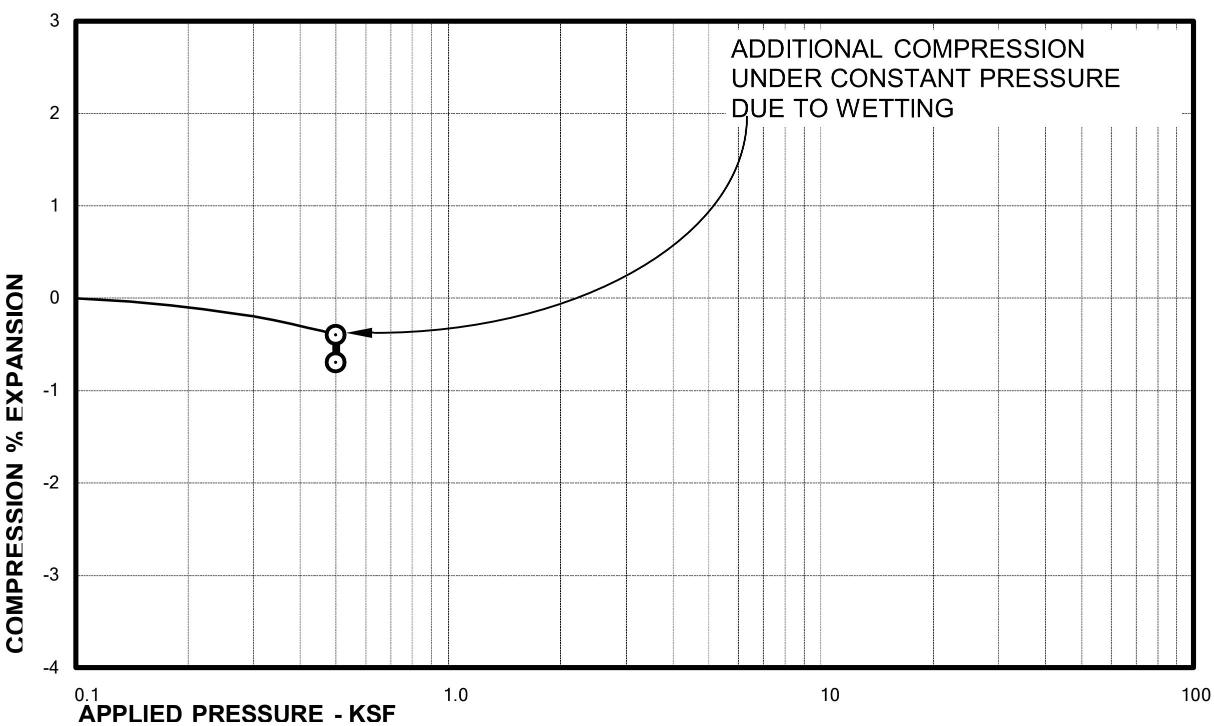
Swell Consolidation Test Results

FIG. B-3



Sample of CLAY, VERY SANDY (CL)
From TH-22 AT 4 FEET

DRY UNIT WEIGHT= 116 PCF
MOISTURE CONTENT= 6.9 %



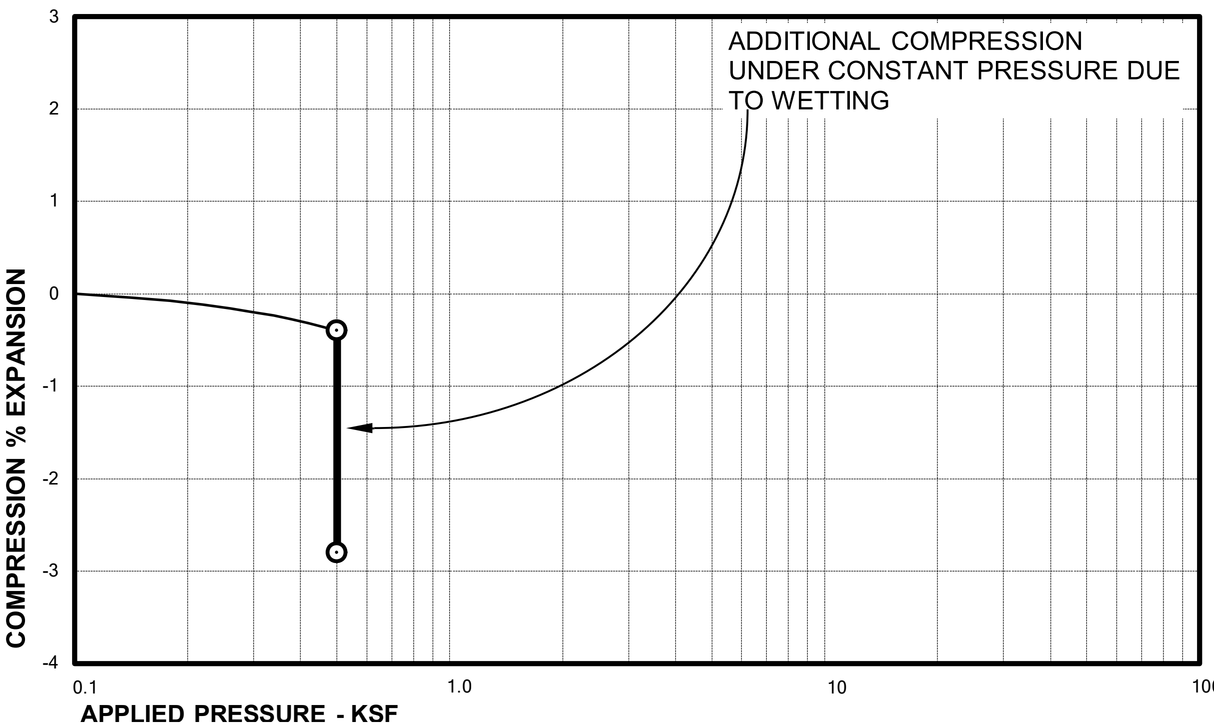
Sample of SAND, VERY SILTY (SM)
From TH-27 AT 4 FEET

DRY UNIT WEIGHT= 107 PCF
MOISTURE CONTENT= 4.4 %

EVERGREEN DEVELOPMENT
POWERS AND GRINNELL APARTMENTS
CTL|T PROJECT NO. CS19678-125

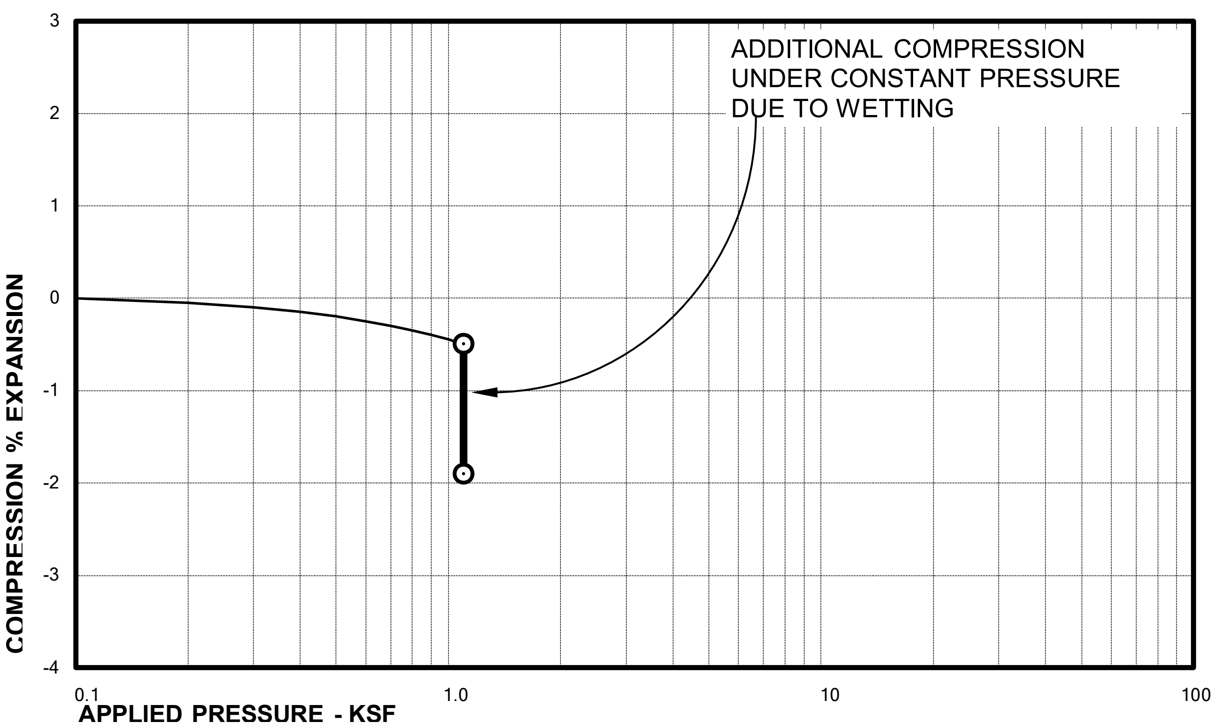
Swell Consolidation Test Results

FIG. B-4



Sample of SAND, SILTY (SM)
From TH-28 AT 4 FEET

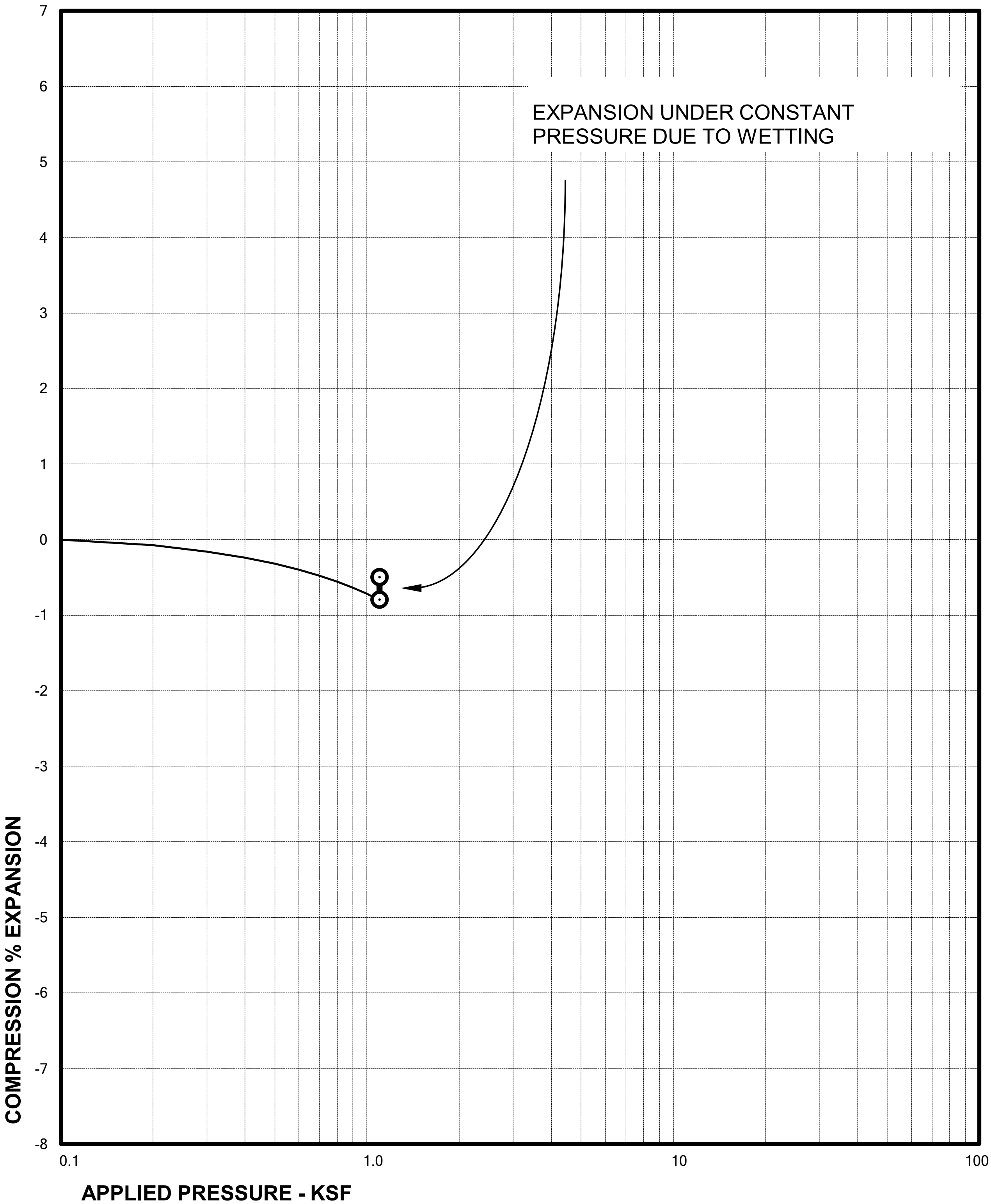
DRY UNIT WEIGHT= 107 PCF
MOISTURE CONTENT= 3.9 %



Sample of SAND, SILTY (SM)
From TH-31 AT 9 FEET

DRY UNIT WEIGHT= 110 PCF
MOISTURE CONTENT= 5.8 %

Swell Consolidation Test Results



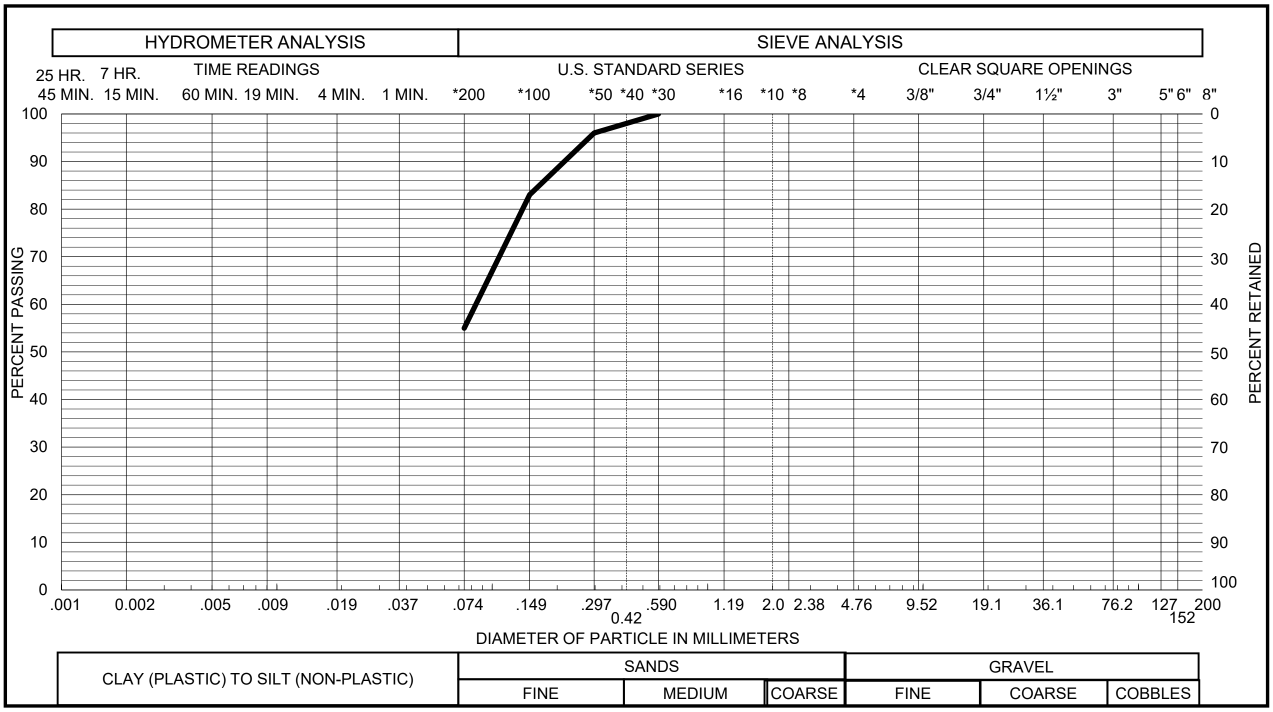
Sample of CLAY, SANDY (CL)
From TH-34 AT 9 FEET

DRY UNIT WEIGHT= 111 PCF
MOISTURE CONTENT= 8.4 %

EVERGREEN DEVELOPMENT
POWERS AND GRINNELL APARTMENTS
CTL|T PROJECT NO. CS19678-125

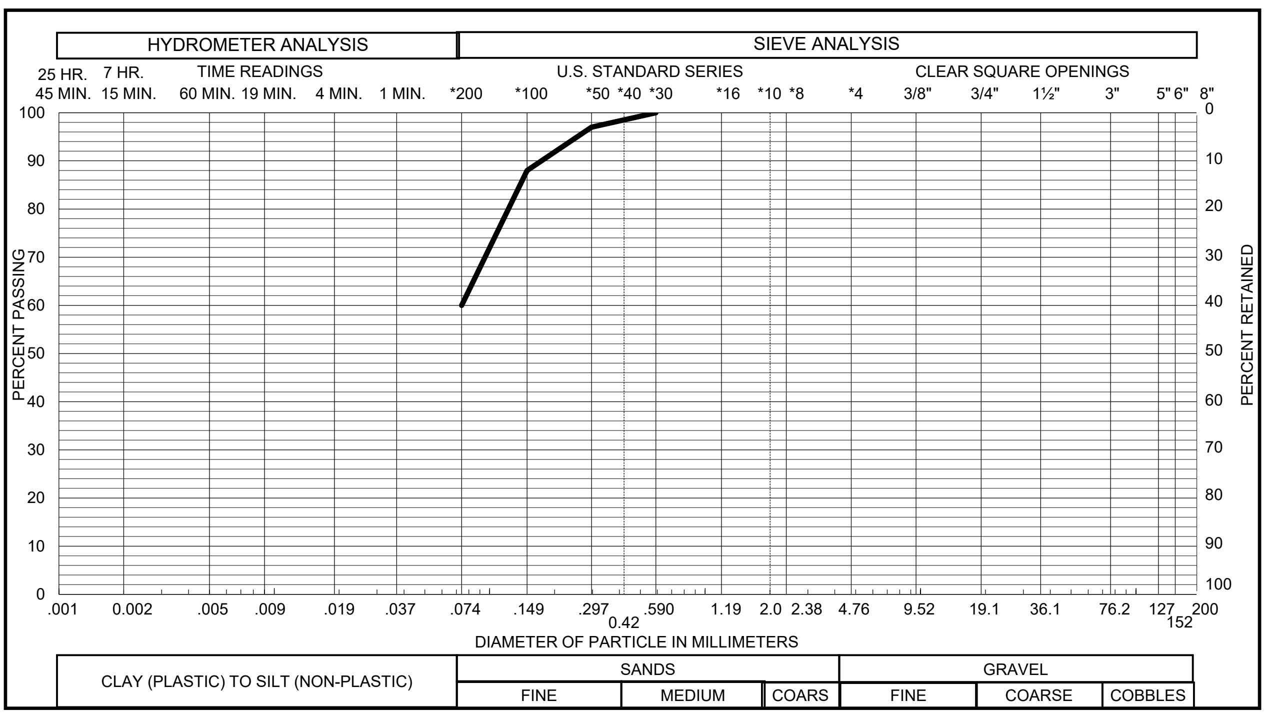
Swell Consolidation Test Results

FIG. B-6



Sample of CLAY, VERY SANDY (CL)
From TH - 1 AT 4 FEET

GRAVEL 0 % SAND 45 %
SILT & CLAY 55 % LIQUID LIMIT 27
PLASTICITY INDEX 8



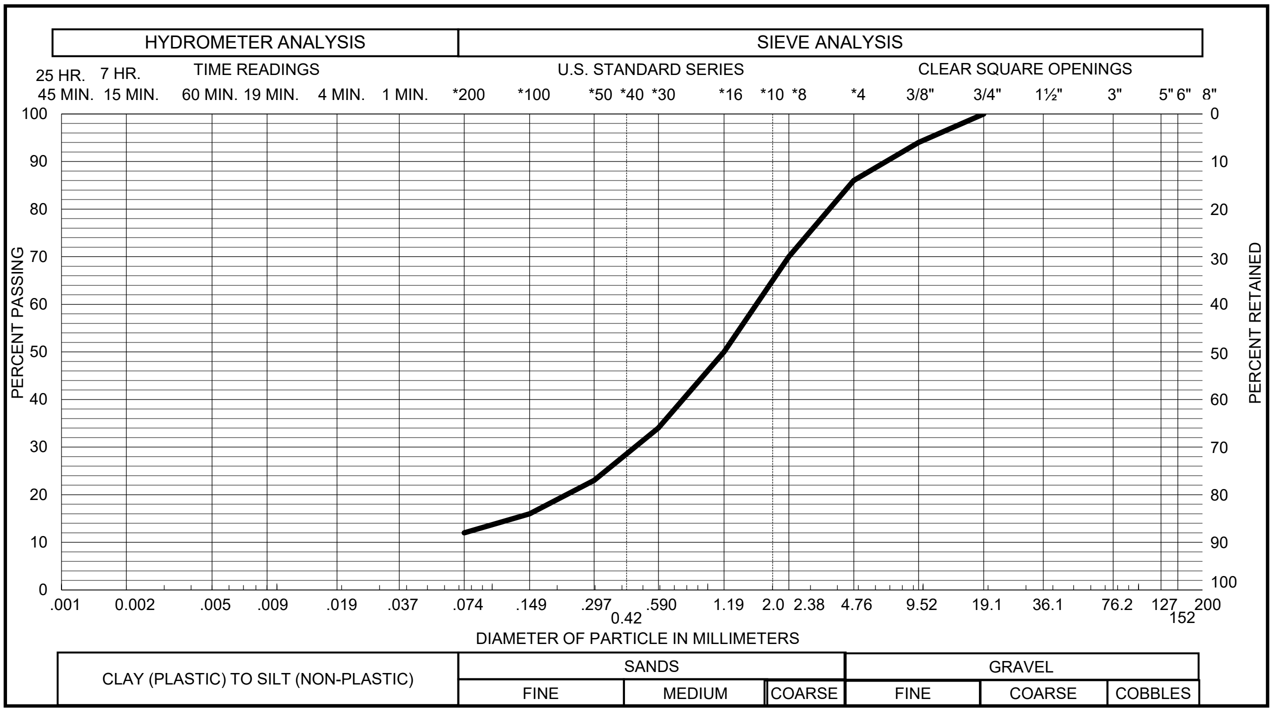
Sample of CLAY, VERY SANDY (CL)
From TH - 1 AT 9 FEET

GRAVEL 0 % SAND 40 %
SILT & CLAY 60 % LIQUID LIMIT
PLASTICITY INDEX

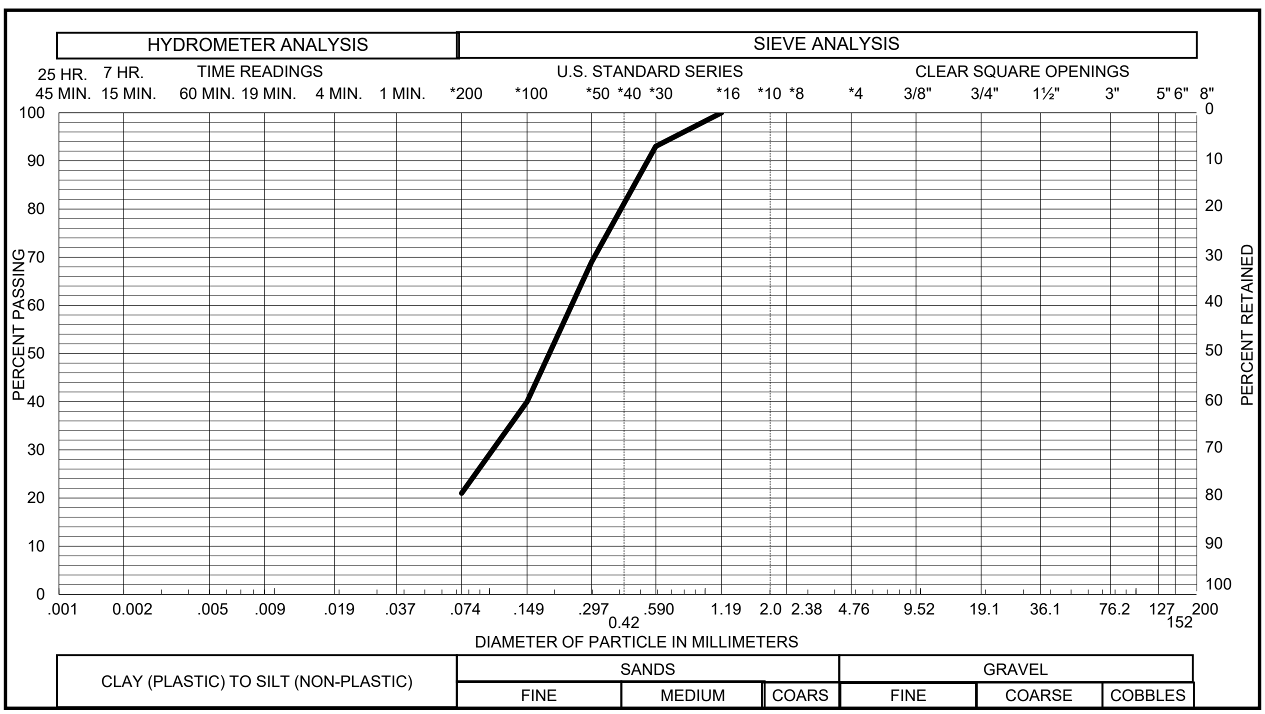
EVERGREEN DEVELOPMENT
POWERS AND GRINNEL APARTMENTS
CTL|T PROJECT NO. CS19678-125

Gradation Test Results

FIG. B-7



Sample of	SAND, SLIGHTLY SILTY, GRAVELLY (SP-SM)	GRAVEL 14 %	SAND 74 %
From	TH - 2 AT 9 FEET	SILT & CLAY 12 %	LIQUID LIMIT
		PLASTICITY INDEX	

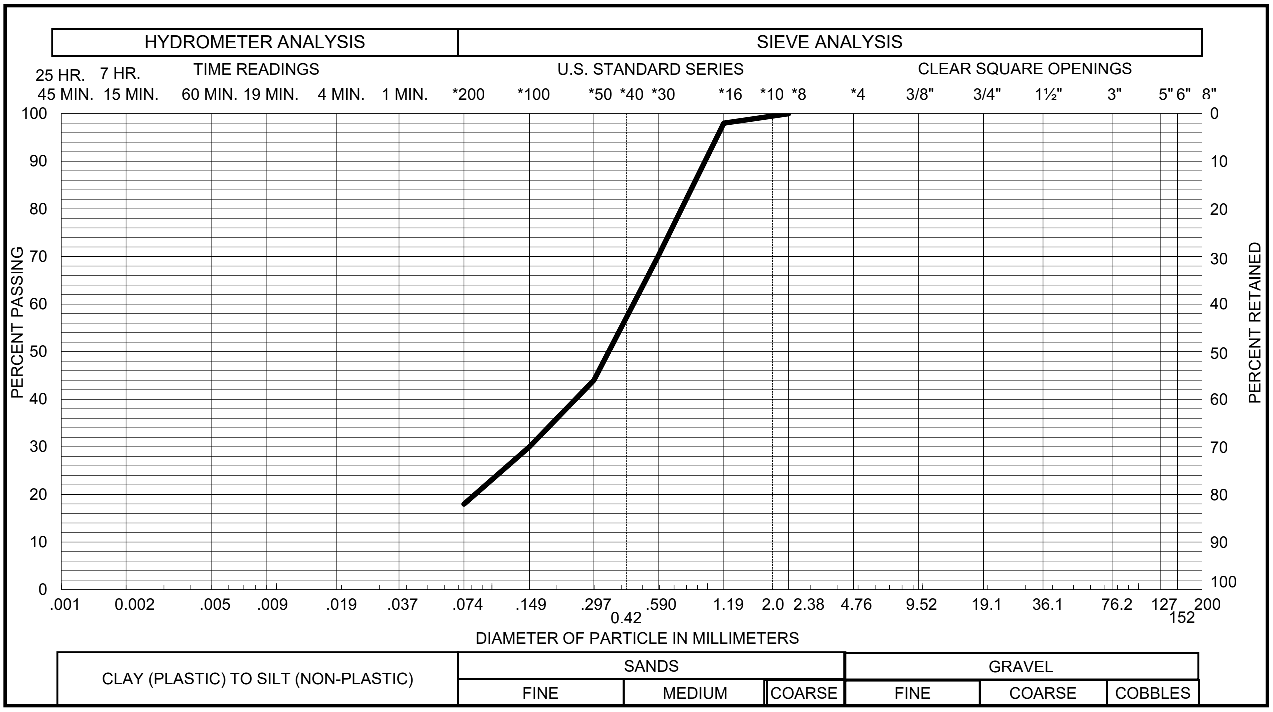


Sample of	SAND, SILTY (SM)	GRAVEL 0 %	SAND 79 %
From	TH - 4 AT 9 FEET	SILT & CLAY 21 %	LIQUID LIMIT
		PLASTICITY INDEX	

EVERGREEN DEVELOPMENT
POWERS AND GRINNEL APARTMENTS
CTL|T PROJECT NO. CS19678-125

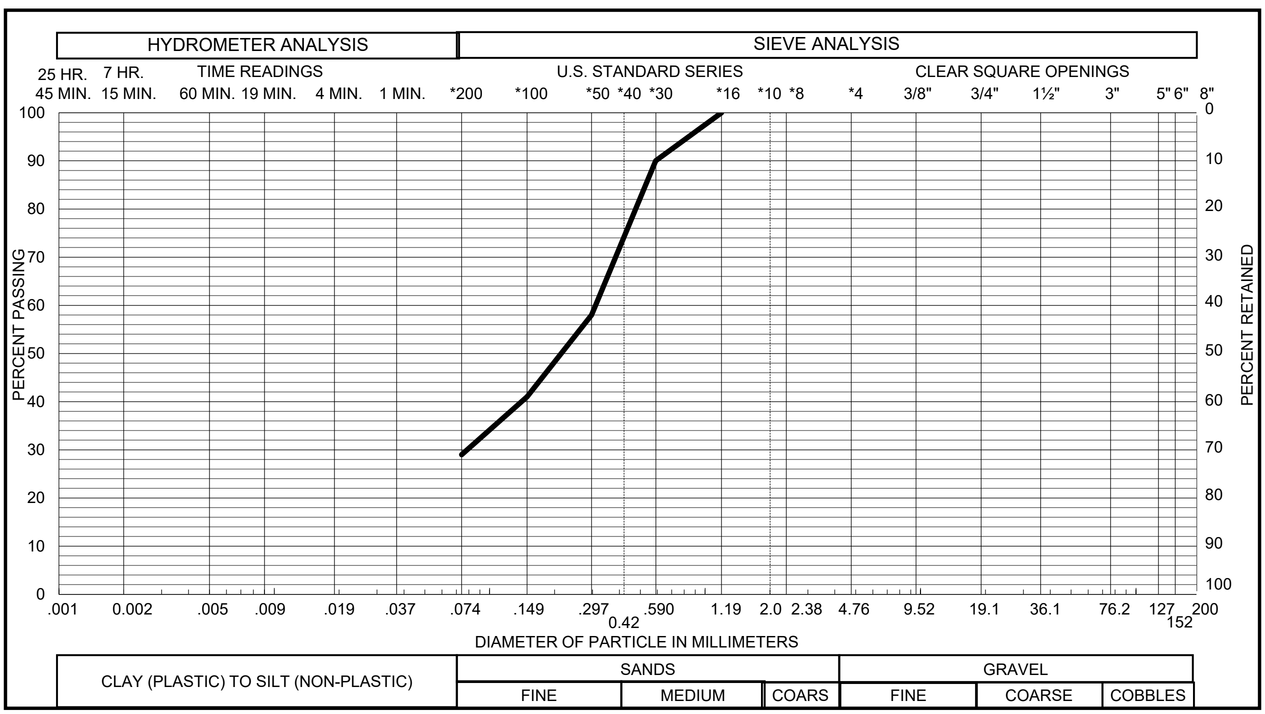
Gradation Test Results

FIG. B-8



Sample of SAND, SILTY (SM)
From TH - 5 AT 4 FEET

GRAVEL 0 % SAND 82 %
SILT & CLAY 18 % LIQUID LIMIT
PLASTICITY INDEX



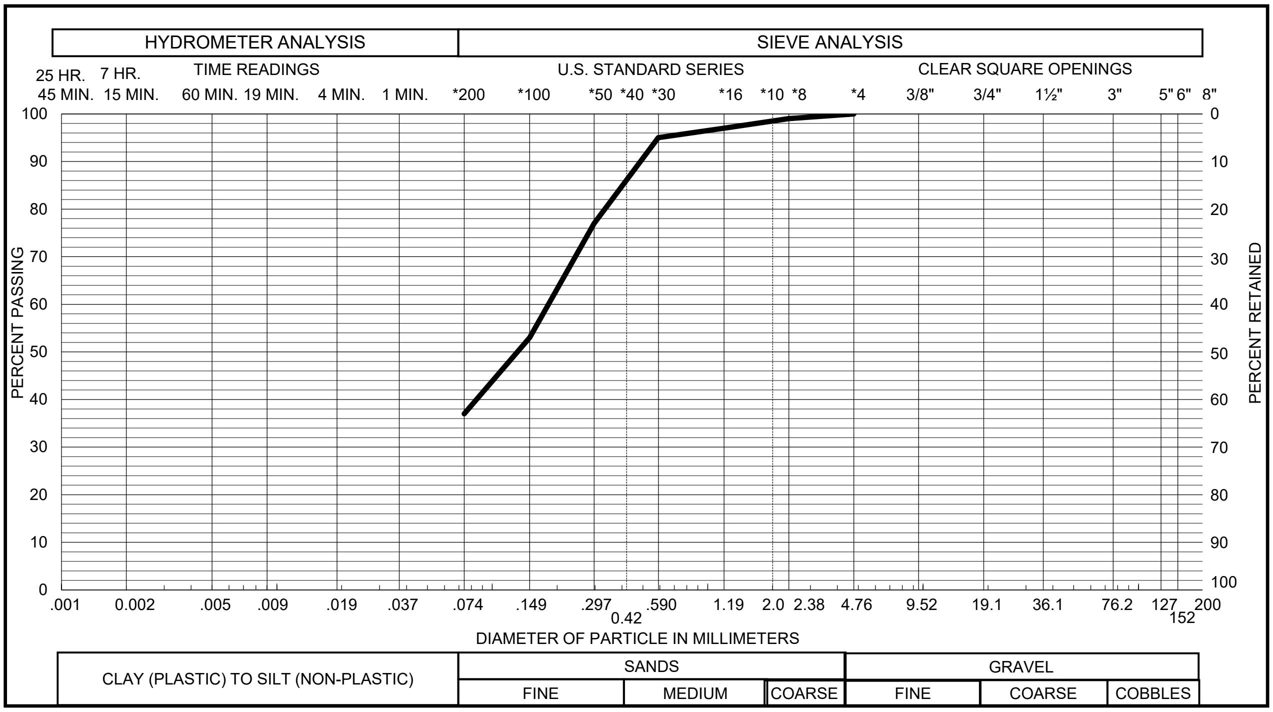
Sample of SAND, CLAYEY (SC)
From TH - 6 AT 4 FEET

GRAVEL 0 % SAND 71 %
SILT & CLAY 29 % LIQUID LIMIT 26
PLASTICITY INDEX 10

EVERGREEN DEVELOPMENT
POWERS AND GRINNEL APARTMENTS
CTL|T PROJECT NO. CS19678-125

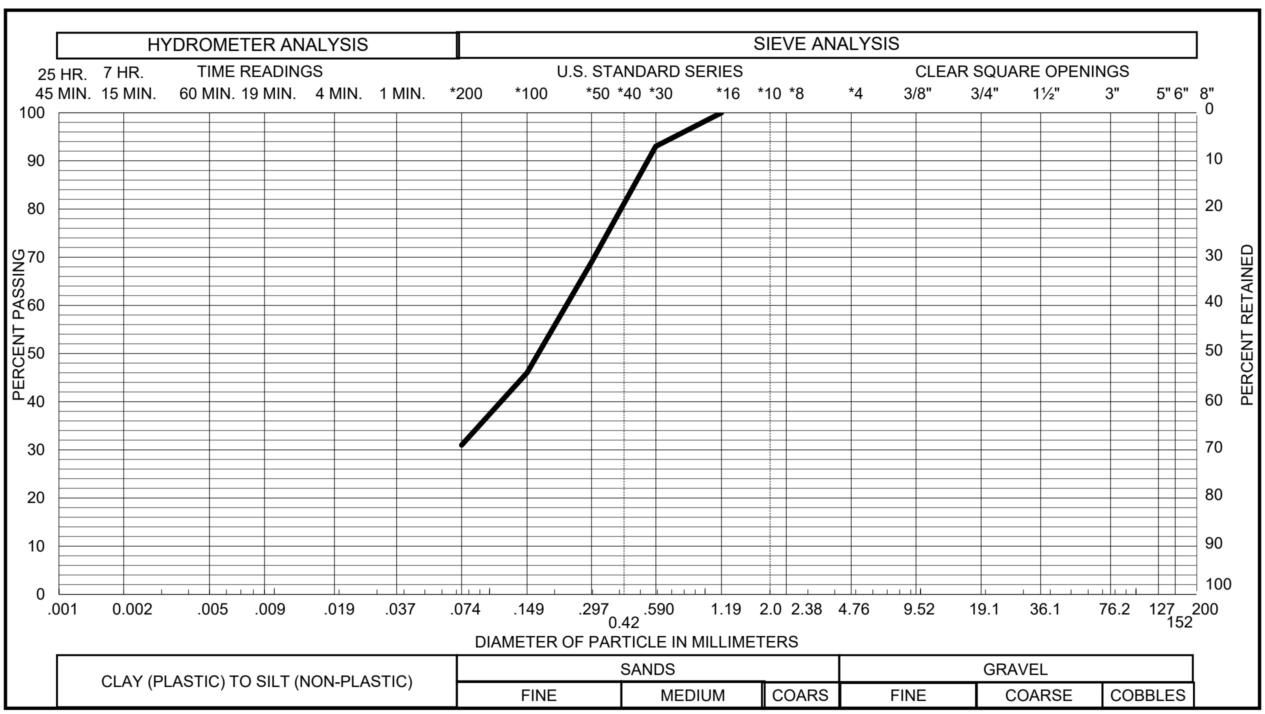
Gradation Test Results

FIG. B-9



Sample of SAND, VERY CLAYEY (SC)
From TH - 6 AT 14 FEET

GRAVEL 0 % SAND 63 %
SILT & CLAY 37 % LIQUID LIMIT
PLASTICITY INDEX



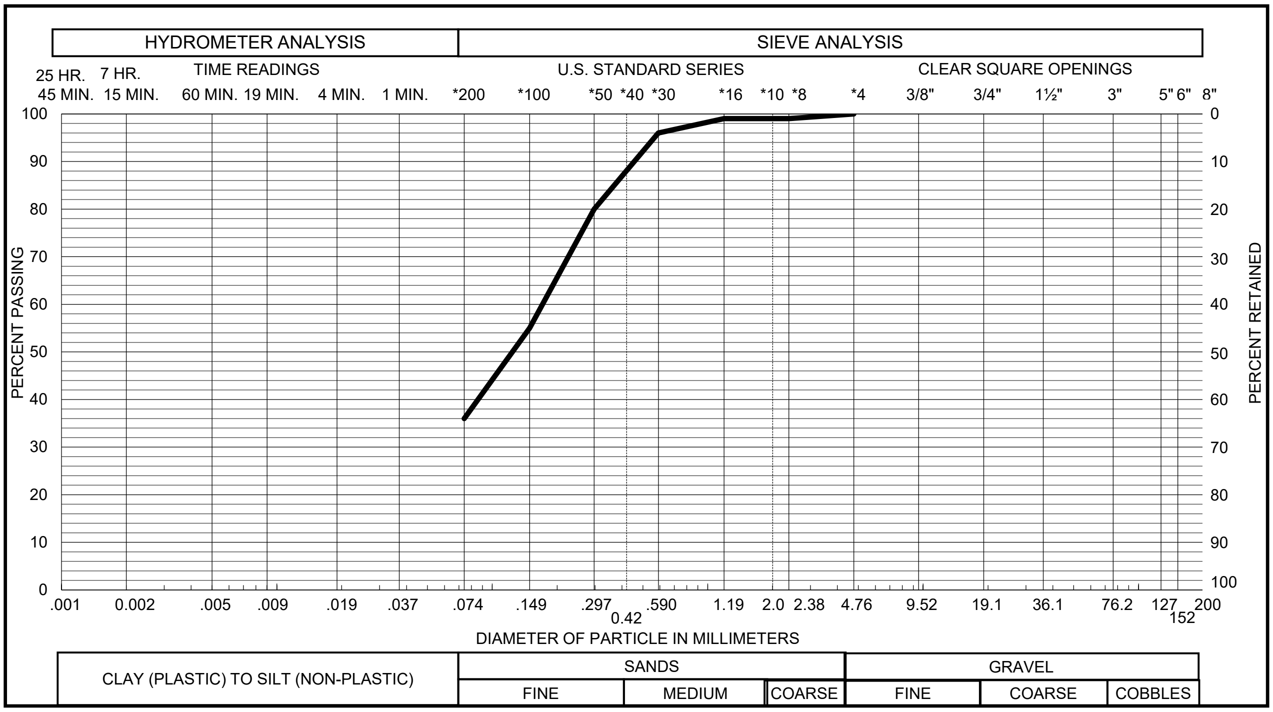
Sample of SAND, SILTY (SM)
From TH - 7 AT 4 FEET

GRAVEL 0 % SAND 69 %
SILT & CLAY 31 % LIQUID LIMIT
PLASTICITY INDEX

EVERGREEN DEVELOPMENT
POWERS AND GRINNEL APARTMENTS
CTL|T PROJECT NO. CS19678-125

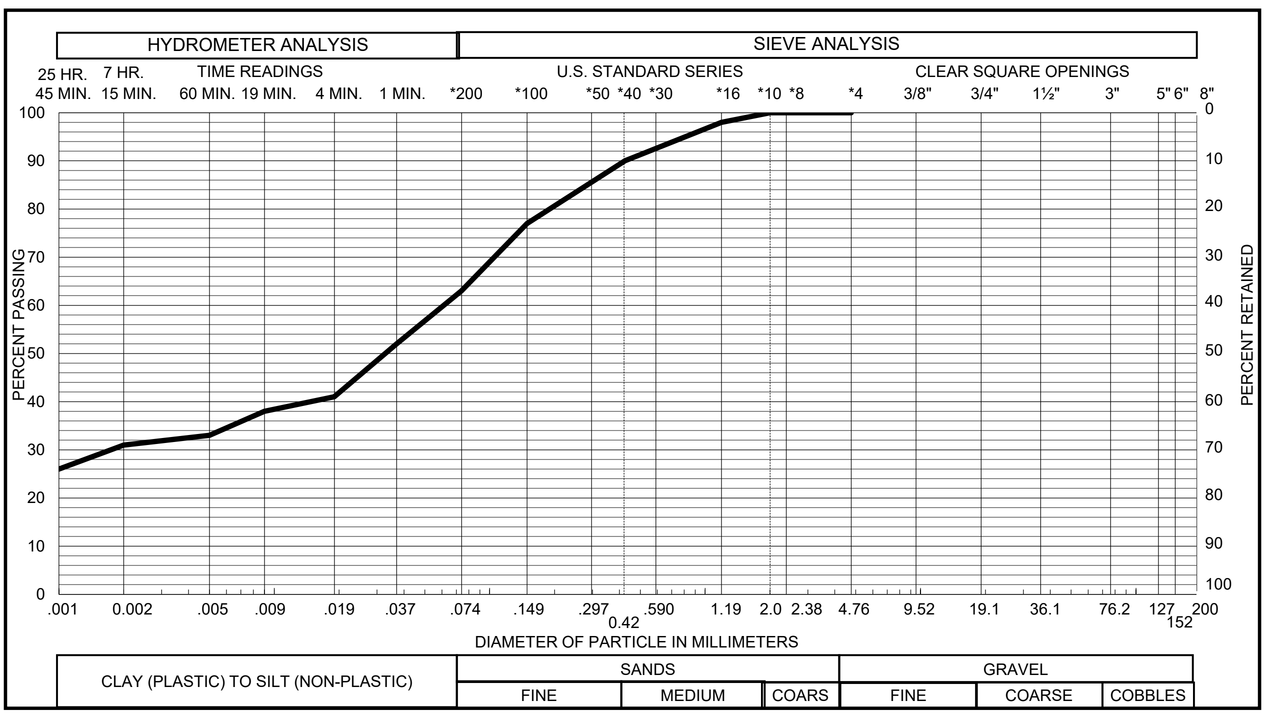
Gradation Test Results

FIG. B-10



Sample of SAND, VERY SILTY (SM)
From TH - 7 AT 9 FEET

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



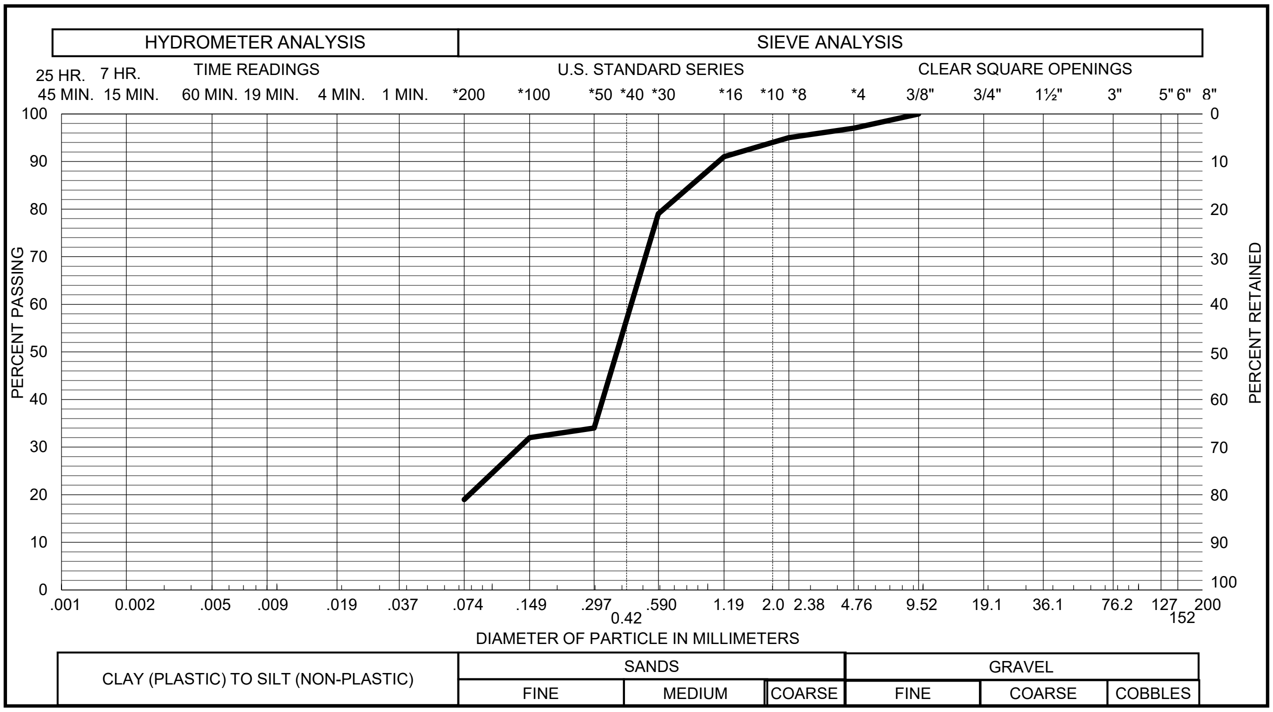
Sample of CLAY, VERY SANDY (CL)
From TH - 8 AT 14 FEET

GRAVEL 0 % SAND 37 %
SILT & CLAY 63 % LIQUID LIMIT 40
PLASTICITY INDEX 20

EVERGREEN DEVELOPMENT
POWERS AND GRINNEL APARTMENTS
CTL|T PROJECT NO. CS19678-125

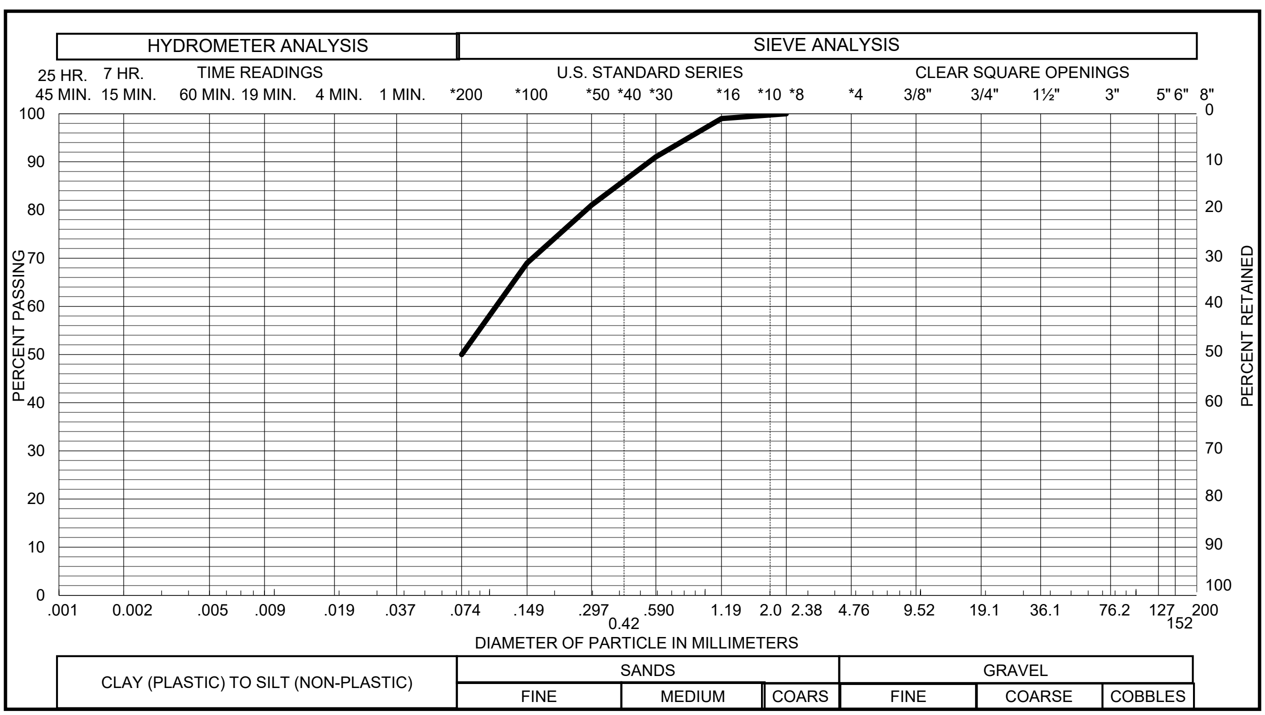
Gradation Test Results

FIG. B-11



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

GRAVEL 3 % SAND 78 %
SILT & CLAY 19 % LIQUID LIMIT
PLASTICITY INDEX



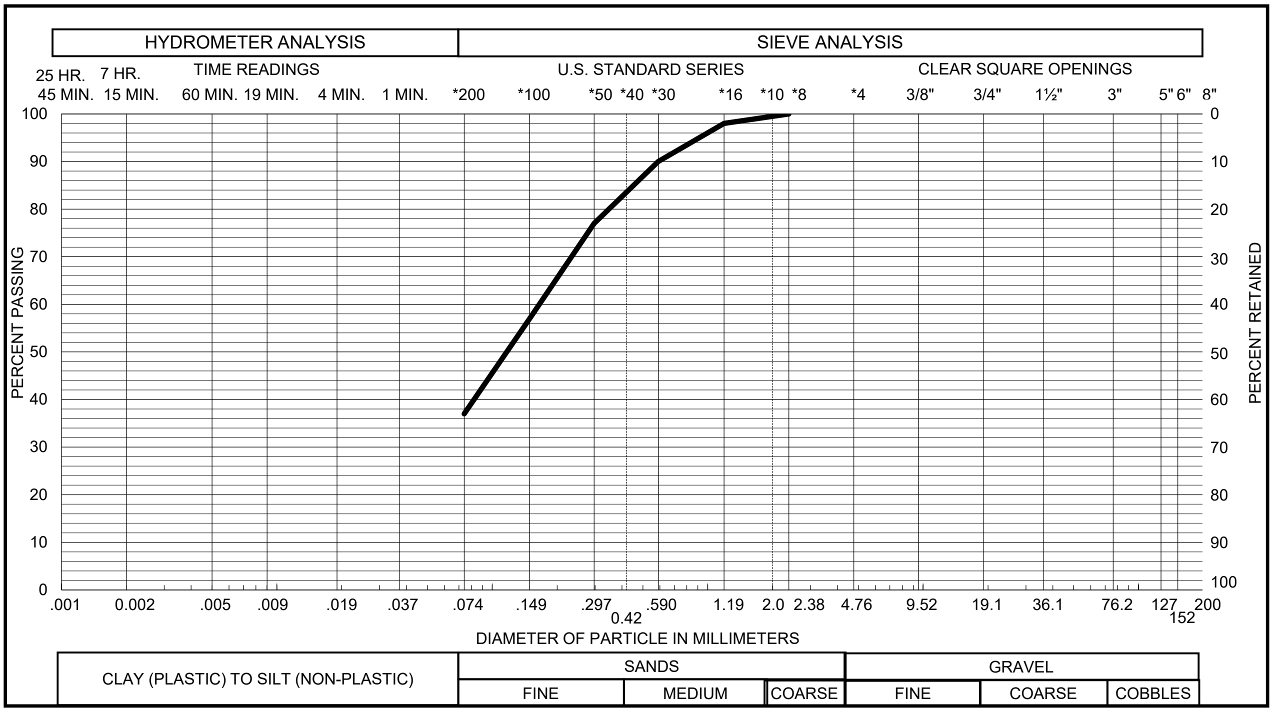
Sample of CLAY, VERY SANDY (CL)
From TH - 10 AT 4 FEET

GRAVEL 0 % SAND 50 %
SILT & CLAY 50 % LIQUID LIMIT 31
PLASTICITY INDEX 14

EVERGREEN DEVELOPMENT
POWERS AND GRINNEL APARTMENTS
CTL|T PROJECT NO. CS19678-125

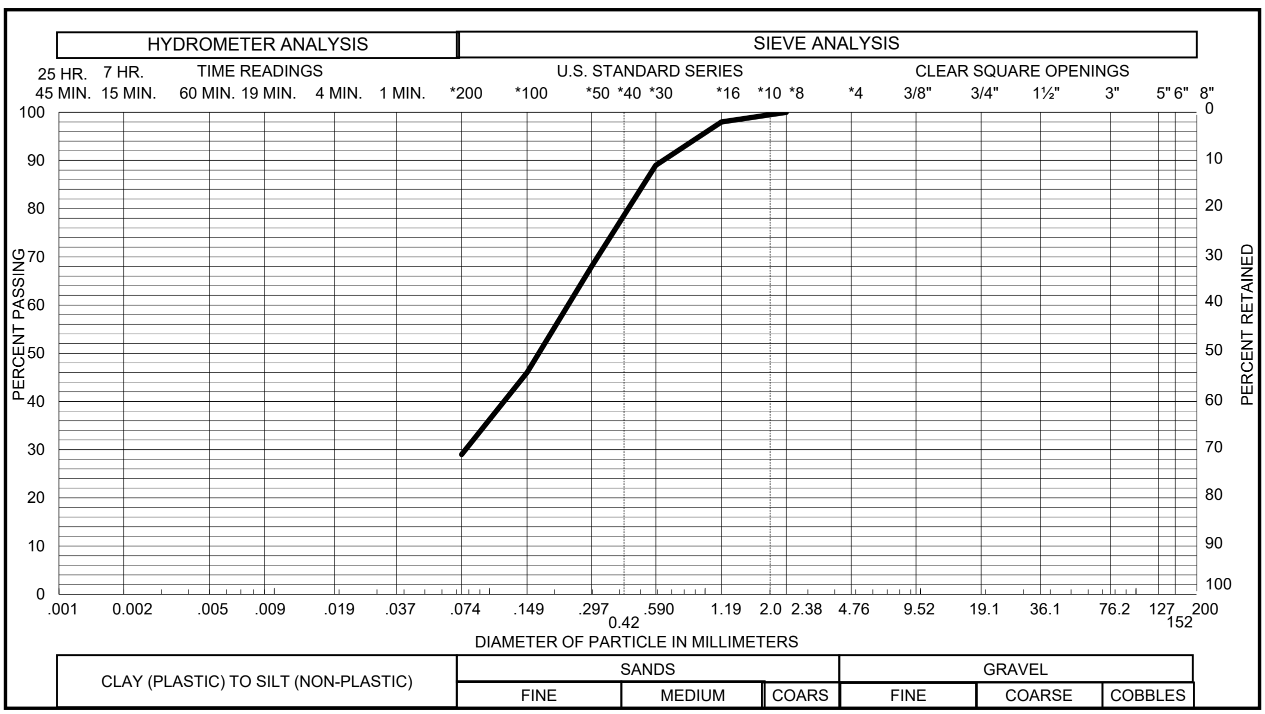
Gradation Test Results

FIG. B-12



Sample of SAND, VERY SILTY (SM)
From TH - 13 AT 4 FEET

GRAVEL 0 % SAND 63 %
SILT & CLAY 37 % LIQUID LIMIT
PLASTICITY INDEX



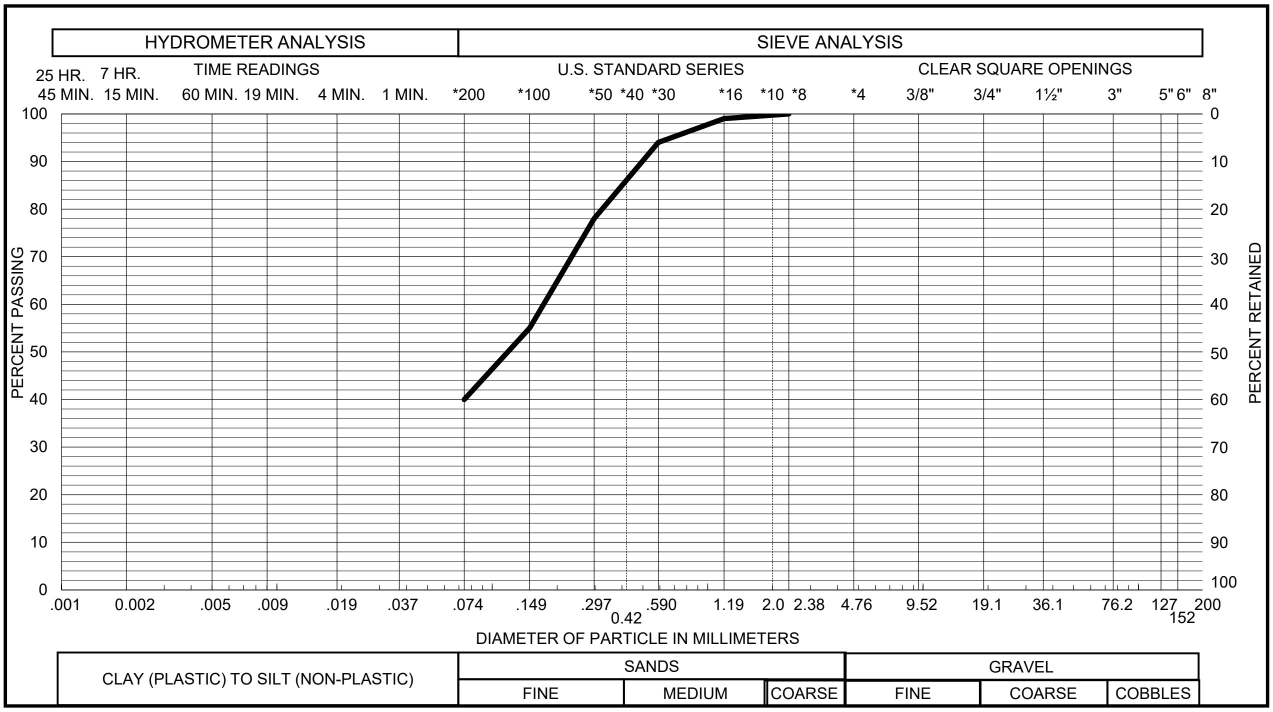
Sample of SAND, SILTY (SM)
From TH - 15 AT 4 FEET

GRAVEL 0 % SAND 71 %
SILT & CLAY 29 % LIQUID LIMIT 21
PLASTICITY INDEX 4

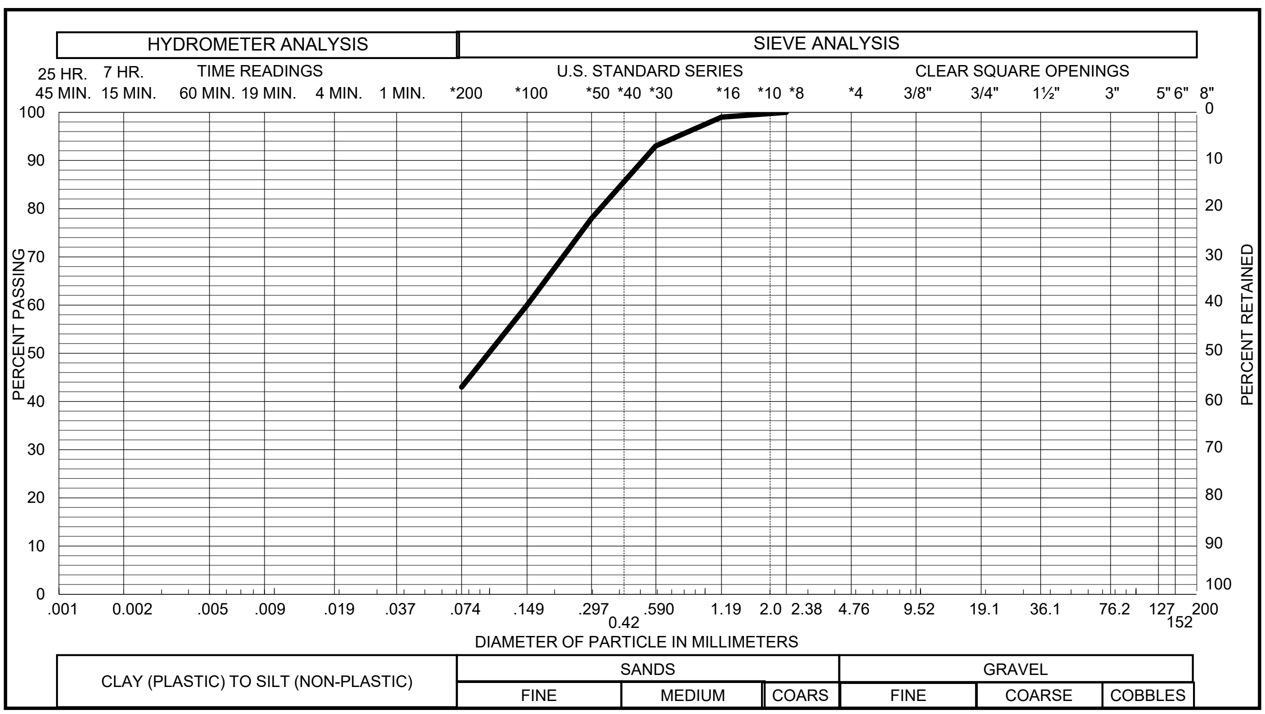
EVERGREEN DEVELOPMENT
POWERS AND GRINNEL APARTMENTS
CTL|T PROJECT NO. CS19678-125

Gradation Test Results

FIG. B-13



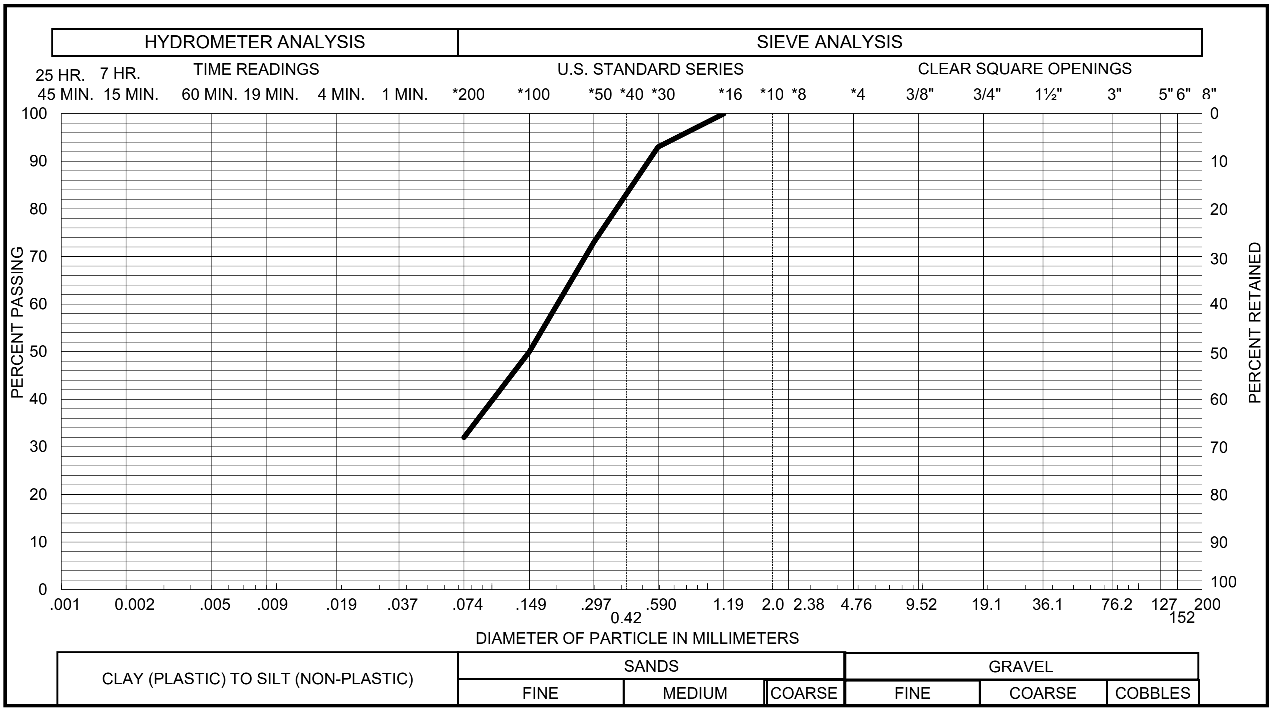
Sample of	SAND, VERY SILTY (SM)	GRAVEL	0 %	SAND	60 %
From	TH - 23 AT 9 FEET	SILT & CLAY	40 %	LIQUID LIMIT	
		PLASTICITY INDEX			



Sample of	SAND, VERY SILTY (SM)	GRAVEL	0 %	SAND	57 %
From	TH - 24 AT 14 FEET	SILT & CLAY	43 %	LIQUID LIMIT	
		PLASTICITY INDEX			

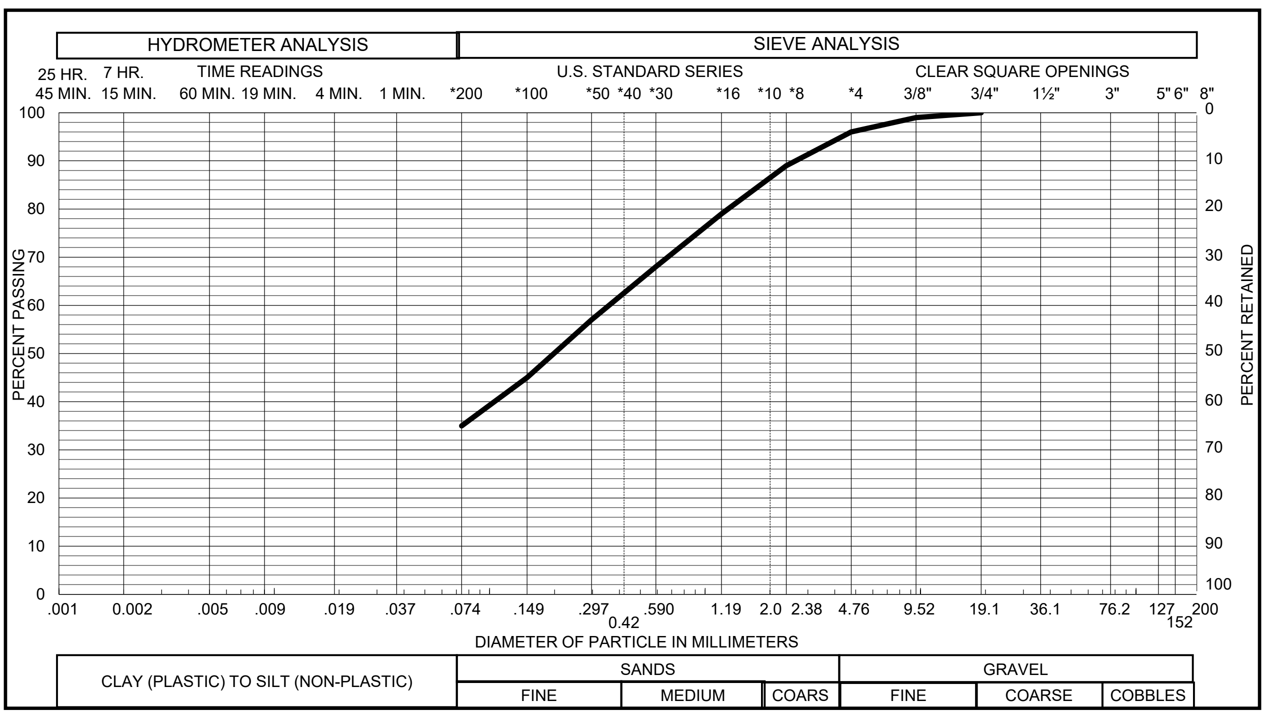
Gradation Test Results

FIG. B-14



Sample of SAND, SILTY (SM)
From TH - 26 AT 14 FEET

GRAVEL 0 % SAND 68 %
SILT & CLAY 32 % LIQUID LIMIT
PLASTICITY INDEX



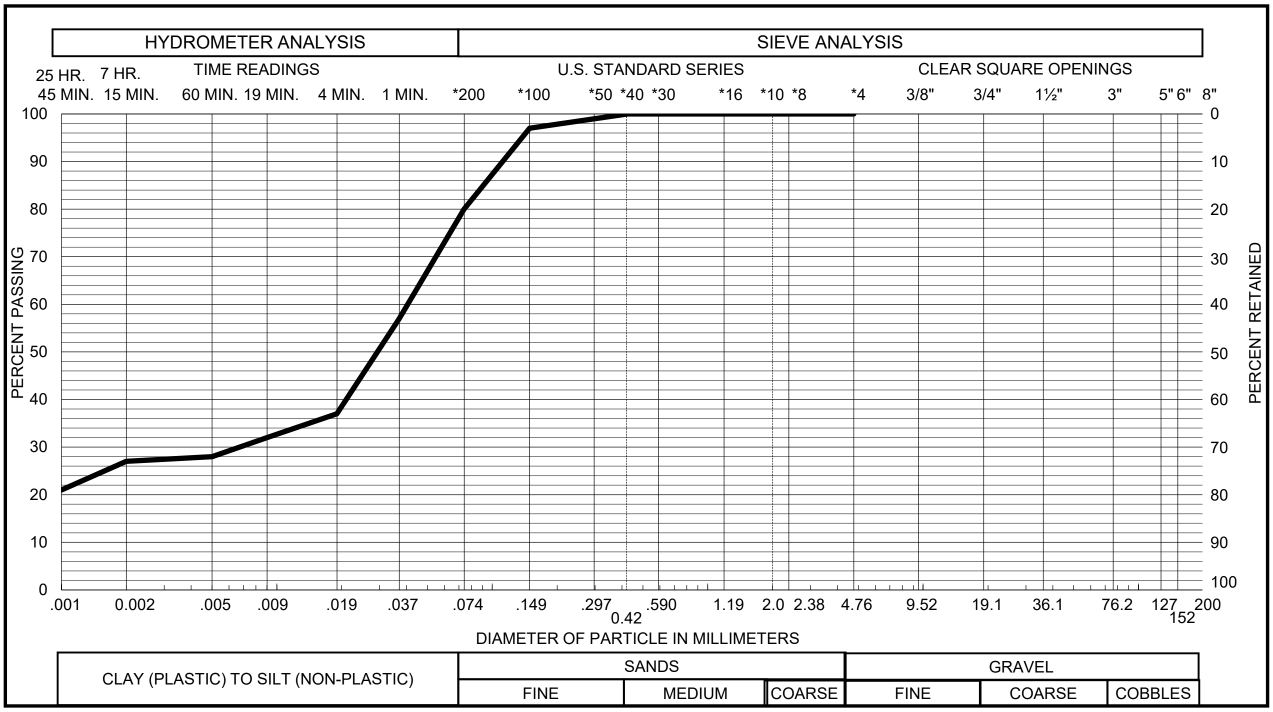
Sample of SAND, SILTY (SM)
From TH - 34 AT 19 FEET

GRAVEL 4 % SAND 61 %
SILT & CLAY 35 % LIQUID LIMIT
PLASTICITY INDEX

EVERGREEN DEVELOPMENT
POWERS AND GRINNEL APARTMENTS
CTL|T PROJECT NO. CS19678-125

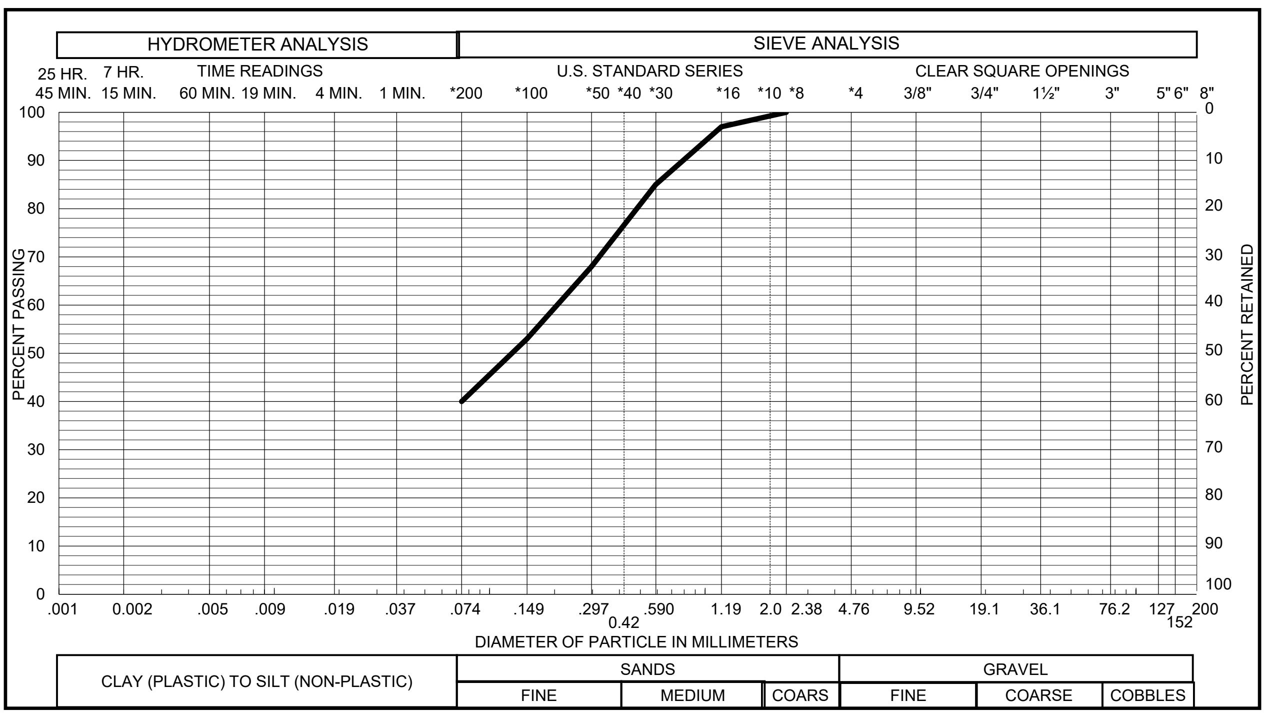
Gradation Test Results

FIG. B-15



Sample of CLAY, SANDY (CL)
From TH - 36 AT 14 FEET

GRAVEL 0 % SAND 20 %
SILT & CLAY 80 % LIQUID LIMIT 33
PLASTICITY INDEX 13



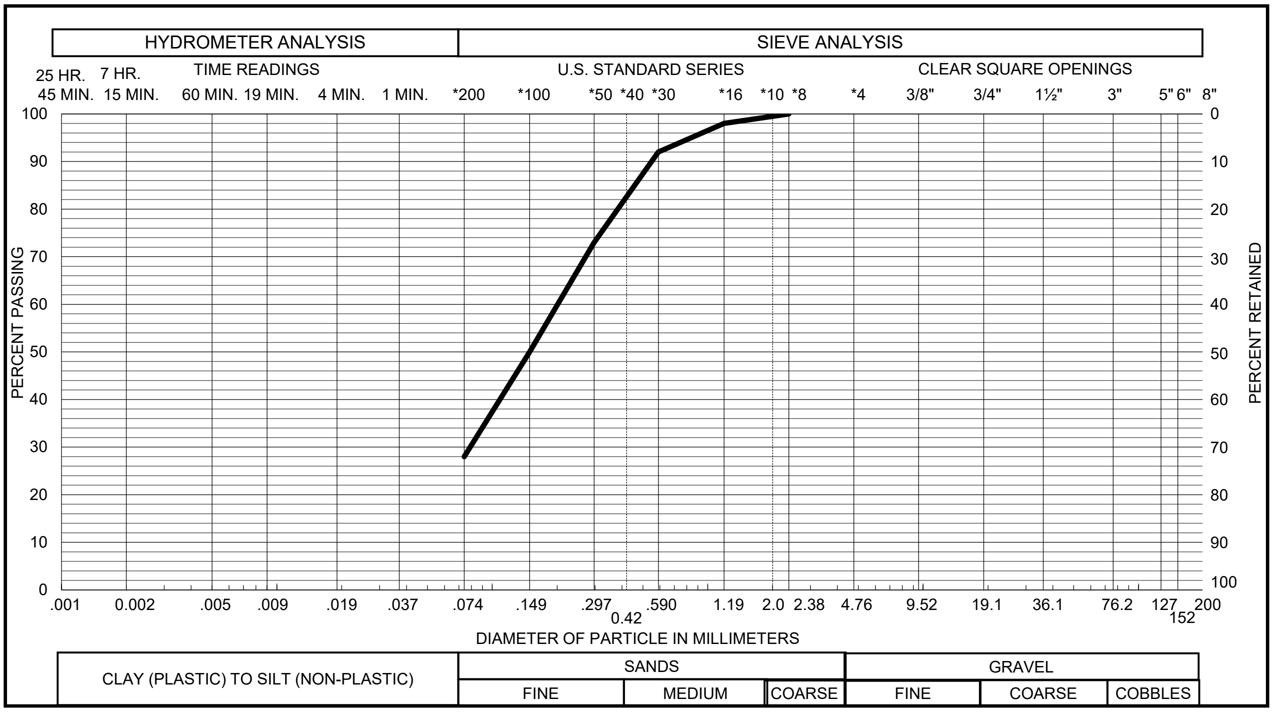
Sample of SAND, VERY SILTY (SM)
From TH - 37 AT 9 FEET

GRAVEL 0 % SAND 60 %
SILT & CLAY 40 % LIQUID LIMIT
PLASTICITY INDEX

EVERGREEN DEVELOPMENT
POWERS AND GRINNEL APARTMENTS
CTL|T PROJECT NO. CS19678-125

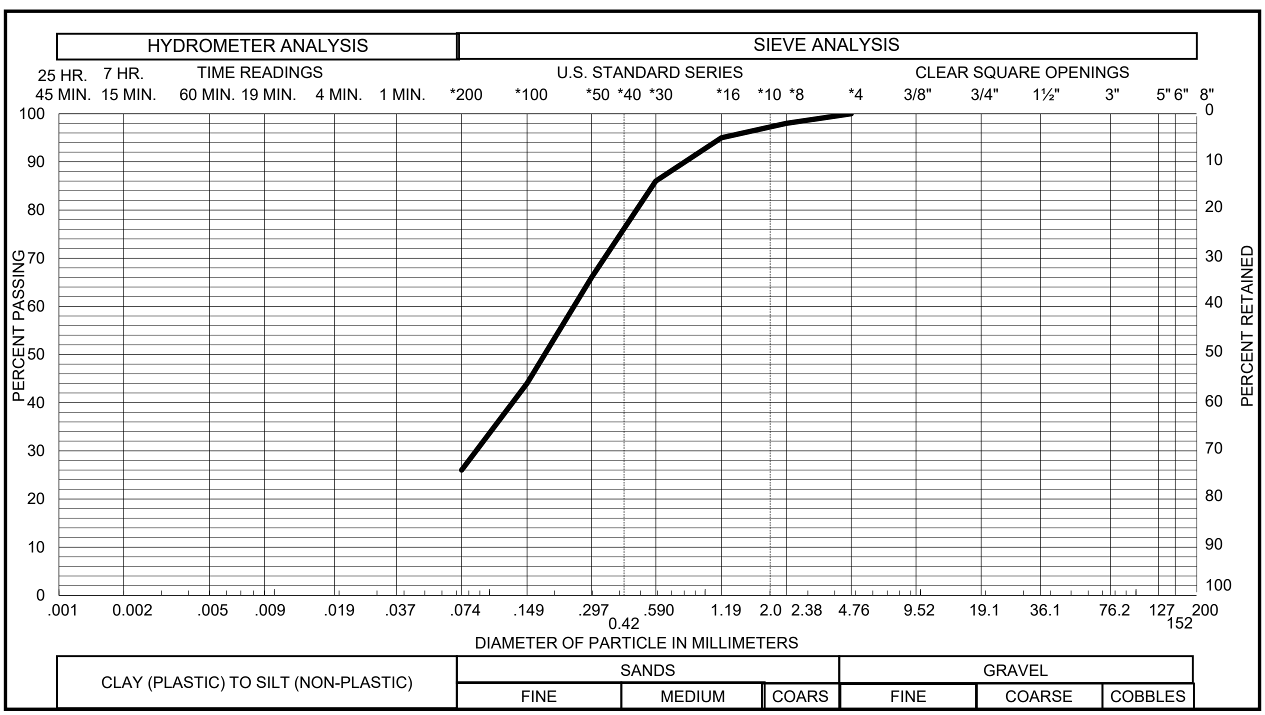
Gradation Test Results

FIG. B-16



Sample of SAND, SILTY (SM)
From TH - 39 AT 4 FEET

GRAVEL	0 %	SAND	72 %
SILT & CLAY	28 %	LIQUID LIMIT	20
PLASTICITY INDEX			1



Sample of SAND, SILTY (SM)
From TH - 40 AT 4 FEET

GRAVEL	0 %	SAND	74 %
SILT & CLAY	26 %	LIQUID LIMIT	
PLASTICITY INDEX			

EVERGREEN DEVELOPMENT
POWERS AND GRINNEL APARTMENTS
CTL|T PROJECT NO. CS19678-125

Gradation Test Results

FIG. B-17

TABLE B-1

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS19678-125

BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	SWELL TEST RESULTS* SWELL (%)	SWELL TEST RESULTS* APPLIED PRESSURE (PSF)	SWELL TEST RESULTS* SWELL PRESSURE (PSF)	PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
TH-1	4	6.6	109	27	8				55		CLAY, VERY SANDY (CL)
TH-1	9	7.8	113						60		CLAY, VERY SANDY (CL)
TH-2	9	2.0	123						12		SAND, SLIGHTLY SILTY, GRAVELLY (SP-SM)
TH-3	9	6.1	122			2.1	1100		37		SAND, VERY CLAYEY (SC)
TH-3	14	9.1	117			-0.7	1800		54		CLAY, VERY SANDY (CL)
TH-4	9	4.8	111						21		SAND, SILTY (SM)
TH-5	4	4.5	114						18	<0.1	SAND, SILTY (SM)
TH-5	9	11.1	122			0.1	1100		40		SAND, VERY CLAYEY (SC)
TH-6	4	8.8	95	26	10				29		SAND, CLAYEY (SC)
TH-6	14	11.9	121						37		SAND, VERY CLAYEY (SC)
TH-7	4	6.6	118						31		SAND, SILTY (SM)
TH-7	9	5.3	120						36		SAND, VERY SILTY (SM)
TH-8	14	16.2	114	40	20				63		CLAY, VERY SANDY (CL)
TH-9	9	3.3	114						19		SAND, SILTY (SM)
TH-10	4	6.4	112	31	14				50		CLAY, VERY SANDY (CL)
TH-11	4	3.8	110						20		SAND, SILTY (SM)
TH-12	9	13.5	117			0.0	1100		47		SAND, VERY CLAYEY (SC)
TH-13	4	4.2	110						37		SAND, VERY SILTY (SM)
TH-15	4	4.4	106	21	4				29		SAND, SILTY, CLAYEY (SC-SM)
TH-18	4	2.8	107						29		SAND, SILTY (SM)
TH-19	4	6.0	107			1.1	500			<0.1	CLAY, VERY SANDY (CL)
TH-19	9	6.9	116	28	11				57		CLAY, VERY SANDY (CL)
TH-20	9	2.0	125			2.5	1100		81		CLAY, SANDY (CL)
TH-21	4	3.6	105	20	3				27		SAND, SILTY, CLAYEY (SC-SM)
TH-22	4	6.9	116			1.5	500		61		CLAY, VERY SANDY (CL)
TH-22	9	5.2	111						32		SAND, SILTY, CLAYEY (SC-SM)
TH-23	9	7.3	114						40		SAND, VERY SILTY (SM)
TH-24	4	11.9	107	36	17				77	<0.1	CLAY, SANDY (CL)
TH-24	14	7.0	116						43		SAND, VERY SILTY (SM)
TH-26	4	3.6	113	NL	NP				32		SAND, SILTY (SM)
TH-27	4	4.4	107			-0.3	500		42		SAND, VERY SILTY (SM)
TH-28	4	3.9	107			-2.4	500		30		SAND, SILTY (SM)
TH-28	9	13.0	115	32	14				64		CLAY, VERY SANDY (CL)
TH-31	4	3.6	111						32		SAND, SILTY (SM)
TH-31	9	5.8	110			-1.4	1100				SAND, SILTY (SM)
TH-32	4	4.7	115						34		SAND, SILTY (SM)
TH-33	9	4.5	105	NL	NP				13		SAND, SILTY (SM)
TH-34	9	8.4	111			0.3	1100		75		CLAY, SANDY (CL)
TH-34	19	5.7	124						35		SAND, SILTY (SM)
TH-35	9	3.0	121	17	2				20		SAND, SILTY (SM)

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

TABLE B-1

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS19678-125

BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	SWELL TEST RESULTS* SWELL (%)	SWELL TEST RESULTS* APPLIED PRESSURE (PSF)	SWELL TEST RESULTS* SWELL PRESSURE (PSF)	PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
TH-36	14			33	13				80		CLAY, SANDY (CL)
TH-36	19	11.8	119						67		CLAY, SANDY (CL)
TH-37	9	3.9	116						40		SAND, VERY SILTY (SM)
TH-38	14	10.7	121						80		CLAY, SANDY (CL)
TH-39	4	4.1	111	20	1				28		SAND, SILTY (SM)
TH-40	4	4.5	112						26		SAND, SILTY (SM)

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

APPENDIX C

GUIDELINE SITE GRADING SPECIFICATIONS
POWERS AND GRINNELL APARTMENTS
EL PASO COUNTY, COLORADO

GUIDELINE SITE GRADING SPECIFICATIONS

POWERS AND GRINNELL APARTMENTS
EL PASO COUNTY, 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 six (6) 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 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 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 10 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 10 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 10 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 10 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.