LGC Geotechnical, Inc.

November 18, 2011 Project No. 11142-01

Mr. Craig Cristina
Brookfield Homes
3090 Bristol St., Ste. 200
Costa Mesa, CA 92626

Subject: ***Geotechnical Evaluation of the Proposed Residential Development of The Village at Foothill Ranch, City of Lake Forest, California***

In accordance with your request, LGC Geotechnical, Inc. has performed a geotechnical evaluation for the proposed residential development of The Village at Foothill Ranch, City of Lake Forest, California. The purpose of our work was to evaluate the existing subsurface geotechnical conditions and review the readily available geotechnical and geologic reports and maps pertinent to the site. This report presents the results of our subsurface exploration and geotechnical analysis and provides a summary of our conclusions and preliminary recommendations relative to the proposed development of the site.

Should you have any questions regarding this report, please do not hesitate to contact our office. We appreciate this opportunity to be of service.

Respectfully,

LGC Geotechnical, Inc.

Katie Maes, CEG 2216
Project Geologist

REGISTERED GEOLOGIST
KATHERIN M. MAES
No. 2216
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

Dennis Boratynec, GE 2770
Vice President

REGISTERED PROFESSIONAL ENGINEER
DENNIS BORATYNEC
No. 2770
Exp. 12/31/12
GEOTECHNICAL
STATE OF CALIFORNIA

BJE/KTM/DJB/abs

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1.0 INTRODUCTION

1.1 Purpose and Scope of Services

This report presents the results of our geotechnical evaluation for the proposed residential development of The Village at Foothill Ranch in the City of Lake Forest, California (see Figure 1 - Site Location Map). The purpose of our work was to evaluate the geotechnical conditions at the site and to provide preliminary geotechnical recommendations relative to the proposed development of the site.

Our scope of services included:

- Review of pertinent readily available geotechnical reports and geologic maps (Appendix A);
- Subsurface evaluation consisting of four hollow stem-auger borings (HS-1 through HS-4) to depths of up to approximately 50.5 feet below existing grade. A representative of LGC Geotechnical was onsite to coordinate the subsurface work, collect samples, and log the borings (Appendix B). The borings were backfilled with the excavated materials;
- Perform three in-situ field infiltration test to assess the onsite infiltration characteristics;
- Laboratory testing on relatively undisturbed and bulk samples obtained during our subsurface evaluation (Appendix C);
- Geotechnical analysis of the data reviewed/obtained; and
- Preparation of this report presenting our findings, conclusions, and preliminary recommendations with respect to the proposed site development.

1.2 Existing Site Conditions and Proposed Project

The site consists of an irregular piece of land located south of the intersection of Bake Parkway and Portola Parkway in the City of Lake Forest. The northern portion of the site is currently developed with a former car dealership while the southern portion is currently vacant land with minor vegetation and a few isolated piles of soil. Existing topography at the site is generally sheet graded to drain to the southwest corner of the area. A small descending slope with a toe-of-slope retaining wall adjacent to an existing commercial site defines the southern boundary of the site, and another descending, slightly variable slope to the adjacent Bake Parkway defines the western boundary of the site. At the northern boundary of the site, an east-west trending berm currently exists, with a gentle gradient down to Portola Parkway at the north side and a steeper gradient down to the south side that has a small retaining wall at the toe.

Existing improvements at the site will be demolished, removed, and replaced with slab-on-grade multi-family residential buildings and associated interior streets and utilities as depicted on the base map dated October 18, 2011, utilized for the Geotechnical Map, Figure 2 (Rear of Text). Additionally, along the northern and western boundaries of the site, retaining walls are proposed.

1.3 Subsurface Evaluation

Our subsurface evaluation consisted of the excavation of four small-diameter hollow stem auger borings. One boring (HS-1) was advanced to a depth of approximately 50.5 feet below existing ground surface, and the remaining borings (HS-2 through HS-4) were drilled to depths of approximately 16.5 feet below existing ground surface. During drilling, the borings were sampled and logged from the surface by field personnel from our firm to evaluate the geotechnical characteristics of the subsurface materials. The hollow stem borings were geotechnically logged and sampled using California Ring Samplers (Ring) at selected intervals. The Ring samplers were driven using a 140-pound hammer falling freely for 30 inches until a total penetration of 18 inches was achieved; the number of blow counts required for each 6 inches of sampler penetration was recorded. In addition, bulk samples were collected at various depths from selected borings.

Three of the borings were utilized to assess infiltration characteristics of the onsite materials. Infiltration testing was performed in boreholes with the installation of perforated PVC pipe, backfilled with pea gravel. Upon completion of the tests, the PVC pipe was removed and the remaining voids were backfilled with cuttings.

Descriptions of the materials encountered during our subsurface exploration are further discussed in Section 2.2 of this report and are also presented in the boring logs in Appendix B. The approximate locations of the borings are indicated on our Geotechnical Map, Figure 2.

1.4 Laboratory Testing

Representative bulk and driven (relatively undisturbed) samples were obtained during our subsurface exploration for laboratory testing. Laboratory testing included in-situ moisture content and in-situ density, laboratory hydraulic conductivity, sieve and hydrometer, expansion potential, direct shear, and corrosion potential.

- In-situ dry density values ranged from approximately 96 pounds per cubic foot (pcf) to 127 pcf, with an average of approximately 118 pcf. Field moisture contents ranged from approximately 6 percent to 12 percent, with an average of approximately 9 percent.
- Hydraulic conductivity values were determined to range between 1.7×10^{-5} cm/sec and 3.6×10^{-7} cm/sec based on laboratory test results.
- Sieve and hydrometer testing indicated the fines content ranges between 17 to 26 percent.
- The results of an expansion potential test indicated an expansion index ranging from 8 to 24, which corresponds to the "Very Low" category (per Chapter 18 of the 2007 C.B.C.; ASTM D 4829 Section 5.3).
- Direct shear testing was performed on one sample. The results indicate peak friction angle of 39 degrees and cohesion of 1089 psf.
- Corrosion testing performed on a representative bulk sample from an approximate depth of 4 to 7 feet resulted in a pH of 7.3, chloride content of 31 ppm, a sulfate content of 55 ppm, and a minimum resistivity value of 1,350 ohm-cm.
- A summary of the results are presented in Appendix C. The moisture and density test results are presented on the boring logs in Appendix B.

LGC Geotechnical, Inc.	**FIGURE 1** **Site Location Map**	PROJECT NAME: Brookfield - Lake Forest PROJECT NO.: 11142-01 ENG. / GEOL.: DJB / KTM SCALE: Not to Scale DATE: November 2011

2.0 GEOTECHNICAL CONDITIONS

2.1 Regional Geology

The site is located within the foothills of the Santa Ana Mountains, part of the Peninsular Ranges Geomorphic Province. The region consists of dissected foothills bordering the Los Angeles Basin to the northwest and the granite-core Santa Ana Mountains to the east. The Southern California Batholith forms the core of the Santa Ana Mountains, which is overlain by a thick sequence of sedimentary units, which comprise the foothills. The foothills have been tilted, folded, and faulted since deposition as a result of regional uplift. Drainage from the nearby mountains has dissected the subject area and alluvial deposits in a previously existing (prior to grading) southwest-trending finger canyon underlie the site at depth; ultimately those alluvial deposits are connected to alluvium of the Tustin Plain to the southwest of the site. Late Miocene to Early Pliocene bedrock materials that underlie a portion of the subject site are primarily composed of sandstone and silty sandstone.

2.2 Site-Specific Geology

Prior to grading of the subject site, a southwest-trending canyon with alluvial deposits existed at the western portion of the site, some of which remains in place. The flank of the canyon rising to the eastern portion of the site exposed the bedrock geologic unit mapped as the Oso Member of the Tertiary-aged Capistrano Formation. Grading activities for the nearby Bake Parkway resulted in placement of engineered fill at depth along the western portion of the site, followed by additional grading activities that resulted in engineered fill placement to the current grades at the western portion of the site. The eastern/northeastern portion of the site was left as cut bedrock at the surface, with the exception of the placement of engineered fill for overexcavation of a cut to fill transition in support of the existing car dealership structure at the northeast portion of the site (Coleman, 2005). The three phases of fill placement are undifferentiated on the Geotechnical Map (Figure 2, rear of text). Limited zones of undocumented stockpiled materials were observed in piles during the recent site work, reportedly from nearby building excavations.

Based on our review of the State of California Seismic Hazard Zones El Toro 7.5 Minute Quadrangle (CDMG, 2001), no zones of potential earthquake induced landslide or potential liquefaction are depicted within the limits of the site.

The following material types are anticipated to underlie the subject area. Approximate limits of the materials are depicted on the Geotechnical Map, Figure 2, and described in the boring logs, Appendix B, where observed during the recent subsurface evaluation.

2.2.1 Quaternary Alluvium/Colluvium (Map Symbol – Qac)

Alluvium was not encountered during our subsurface field work. However, descriptions by others indicate up to 7 feet of alluvium, consisting of clayey sand, moist, dense, was left in place below the engineered fill. The alluvium was tested for hydro collapse potential by others and was evaluated to posses approximately 0.5 inch of potential collapse if fully saturated (PSE, 2007).

2.2.2 Artificial Fill - Older (Map Symbol – Afo)

As described in Section 2.2, three phases of older engineered fill materials were identified on the site associated with the grading of Bake Parkway on the western side of the site, construction of the current graded superpad configuration, and construction of the car dealership structure at the northeast portion of the site (References). In general, the existing fill materials should be considered suitable to receive additional fill placement and/or for support of the proposed improvements, with the exception of the near surface materials which are anticipated to be desiccated and contain some organics.

2.2.3 Capistrano Formation – Oso Member (Map Symbol - Tco)

The Oso Member of the Tertiary Capistrano Formation is exposed within the western portion of the site and underlies the majority of the site at depth. As encountered, this material generally consists of medium to coarse, weakly cemented, dense to very dense silty sandstone. The material is generally light gray to off-white in color.

2.3 Ground Water

During our subsurface evaluation, ground water was not encountered. Seasonal fluctuations of ground water elevations should be expected over time. In general, ground water levels fluctuate with the seasons and local zones of perched ground water may be present within the near-surface deposits due to local seepage or during rainy seasons. Local perched ground water conditions or surface seepage may develop once site development is completed and landscape irrigation commences.

2.4 Assessment of Infiltration Characteristics

Field infiltration testing consisted of utilizing three hollow-stem auger borings (HS-2, HS-3 and HS-4) that were each drilled to the depth of approximately 16 feet below existing grade. Boring HS-2 was excavated into bedrock, Boring HS-3 was excavated into a thin layer of fill over bedrock, and Boring HS-4 was excavated into existing engineered fill materials that were previously placed by others. Three-inch-diameter perforated PVC pipe was placed in each hole and the annulus filled with pea gravel. Prior to conducting the infiltration tests, each location was presoaked overnight with water. Results of infiltration testing indicate the site to posses a relatively low infiltration rate as discussed in Section 4.6 of this report.

2.5 Faulting

California is located on the boundary between the Pacific and North American Lithospheric Plates. The average motion along this boundary is on the order of 50-mm/yr in a right-lateral sense. The majority of the motion is expressed at the surface along the northwest trending San Andreas Fault Zone with lesser amounts of motion accommodated by sub-parallel faults located predominantly west of the San Andreas including the Elsinore, Newport-Inglewood, Rose Canyon, and Coronado Bank Faults. Within Southern California, a large bend in the San Andreas Fault north of the San Gabriel Mountains has resulted in a transfer of a portion of the right-lateral motion between the plates into left-lateral displacement and vertical uplift. Compression south and west of the bend has resulted in folding, left-lateral reverse thrust faulting, and regional uplift creating the east-west trending Transverse Ranges and several east-west trending faults. Further south within the Los Angeles Basin, "blind thrust" faults are believed to have developed below the surface also as a result of this compression, which have resulted in earthquakes such as the 1994 Northridge event along faults with little to no surface expression.

Prompted by damaging earthquakes in Northern and Southern California, State legislation and policies concerning the classification and land-use criteria associated with faults have been developed. Their purpose was to prevent the construction of urban developments across the trace of active faults. The result is the Alquist-Priolo Earthquake Fault Zoning Act, which was most recently revised in 1997. According to the State Geologist, an active fault is defined as one, which has had surface displacement within the Holocene Epoch (roughly the last 11,000 years). A potentially active fault is defined as any fault, which has had surface displacement during Quaternary time (last 1,600,000 years), but not within the Holocene. Earthquake Fault Zones have been delineated along the traces of active faults within California. Where developments for human occupation are proposed within these zones, the state requires detailed fault evaluations be performed so that engineering geologists can mitigate the hazards associated with active faulting by identifying the location of active faults and allowing for a setback from the zone of previous ground rupture.

The subject site is not located within an Alquist-Priolo Earthquake Fault Zone and no faults were identified on the site during our site evaluation or previous site evaluations by others during grading. The possibility of damage due to ground rupture is considered low since no active faults are known to transect the site.

Secondary effects of seismic shaking resulting from large earthquakes on the major faults in the Southern California region, which may affect the site, include ground lurching and shallow ground rupture, soil liquefaction, and dynamic settlement. These secondary effects of seismic shaking are a possibility throughout the Southern California region and are dependant on the distance between the site and causative fault and the onsite geology. Seiches and tsunamis are potential hazards for sites near bodies of water and the ocean, respectively. The closest major active faults that could produce these secondary effects include the Elsinore, Whittier, Chino-Central and Newport Inglewood Fault Systems. A discussion of these secondary effects is provided in the following sections.

2.5.1 Lurching and Shallow Ground Rupture

Soil lurching refers to the rolling motion on the ground surface by the passage of seismic surface waves. Effects of this nature are not likely to be significant where the thickness of soft sediments does not vary appreciably under structures.

Ground rupture, due to active faulting, is not likely to occur on site due to the absence of known active fault traces. Minor cracking of near-surface soils, due to shaking from distant seismic events, is not considered a significant hazard, although it is a possibility at any site in the region.

2.5.2 Liquefaction and Dynamic Settlement

Liquefaction and liquefaction-induced dynamic settlement of soils can be caused by strong vibratory motion due to earthquakes. Liquefaction is typified by a build-up of pore-water pressure in the affected soil layer to a point where a total loss of shear strength occurs, causing the soil to behave as a liquid. Liquefaction primarily occurs in loose, saturated, granular soils while cohesive soils such as silty clays and clays are generally not considered susceptible to soil liquefaction. The effect of liquefaction may be manifested at the ground surface by rapid settlement and/or sand boils. Based on our review of the State of California Seismic Hazard Zones El Toro 7.5 Minute Quadrangle (CDMG, 2001), no zones having a potential for liquefaction have been depicted within the proposed site. Based on the proposed finish grades, depth of compacted fill, and lack of a shallow groundwater table, the potential for post construction liquefaction and liquefaction-induced settlement is considered very low.

2.5.3 Lateral Spreading

Lateral spreading is a type of liquefaction induced ground failure associated with the lateral displacement of surficial blocks of sediment resulting from liquefaction in a subsurface layer. Once liquefaction transforms the subsurface layer into a fluid mass, gravity plus the earthquake inertial forces may cause the mass to move downslope towards a free face (such as a river channel or an embankment). Lateral spreading may cause large horizontal displacements and such movement typically damages pipelines, utilities, bridges, and structures.

Due to the low potential for liquefaction, the potential for lateral spreading is also considered very low.

2.6 Seismic Design Parameters

The site seismic characteristics were evaluated per the guidelines set forth in Chapter 16, Section 1613 of the 2010 C.B.C. Site coordinates of latitude 33.6767 degrees north and longitude -117.6615 degrees west, which are representative of the site, were utilized in our analyses. The initial results of our analyses for the maximum considered earthquake spectral response accelerations (S_S and S_1) are presented in Table 1.

TABLE 1

Seismic Design Values

Selected Parameters from the 2010 C.B.C. Section 1613 - Earthquake Loads	**Seismic Design Values**
Site Class per Table 1613.5.2	D
Spectral Acceleration for Short Periods (S_S)*	1.397 g
Spectral Accelerations for 1-Second Periods (S_1)*	0.501 g
Site Coefficient F_a per Table 1613.5.3(1)	1.0
Site Coefficient F_v per Table 1613.5.3(2)	1.5

* Calculated from the USGS computer program "Seismic Hazard Curves, Response Parameters and Design Parameters" v5.1.0 (02/20/11)

The spectral response accelerations (S_{MS} and S_{M1}) and design spectral response acceleration parameters (S_{DS} and S_{D1}), adjusted for Site Class D, were evaluated for the site in general accordance with section 1613 of the 2010 C.B.C. These site class adjusted parameters are presented in Table 2.

TABLE 2

Seismic Design Values Modified for Site Class D

Selected Parameters from the 2010 C.B.C. Section 1613 - Earthquake Loads	**Seismic Design Values Modified for Site Class D**
Site Modified Spectral Acceleration for Short Periods (S_{MS}) for Site Class D [Note: $S_{MS} = F_aS_S$]	1.397 g
Site Modified Spectral Acceleration for 1-Second Periods (S_{M1}) for Site Class D [Note: $S_{M1} = F_vS_1$]	0.751 g
Design Spectral Acceleration for Short Periods (S_{DS}) for Site Class D [Note: $S_{DS} = (^2/_3)S_{MS}$]	0.931 g
Design Spectral Acceleration for 1-Second Periods (S_{D1}) for Site Class D [Note: $S_{D1} = (^2/_3)S_{M1}$]	0.501 g

In accordance with Tables 1613.5.6 (1 & 2), the seismic design category for the subject site is Category D, where $S_{DS} \geq 0.50$g and $S_{D1} \geq 0.20$g.

Section 1803.5.12 of the 2010 C.B.C. states that the PGA for a site may be defined as $S_{DS}/2.5$. The S_{DS} for the subject site has been calculated as 0.931 g. Therefore, PGA =
0.931 /2.5 = **0.37 g**

2.7 Corrosivity to Concrete and Metal

Based on our laboratory test results of representative site soil samples, onsite soils should be considered as having a severity categorization of "not applicable" and are designated class "S0" per ACI 318, Table 4.2.1, sulfate. As a result, the minimum compressive strength of the concrete shall be 2,500 psi.

Due to the low minimum resistivity, the onsite soils may be corrosive to buried metal. However, LGC Geotechnical is not a corrosion consultant and does not provide recommendations related to corrosion. Laboratory testing may need to be performed at the completion of grading by the project corrosion engineer to further evaluate the as-graded soil corrosivity characteristics. Accordingly, revision of the corrosion potential may be needed, should future test results differ substantially from the conditions reported herein. The client and/or other members of the development team should consider this during the design and planning phase of the project, and formulate an appropriate course of action.

3.0 CONCLUSIONS

Our geotechnical evaluation has included a review of previous geotechnical reports, limited subsurface exploration, laboratory testing, and geotechnical analyses of the data collected. Based on geotechnical data gathered/reviewed and the results of our analyses, it is our opinion that the subject site is located within a geotechnically favorable area, and that development of the subject site for residential construction is considered feasible from a geotechnical standpoint. The major geotechnical items to be considered in the design, and ultimately construction of the proposed project, are discussed in greater detail below.

- Near-surface fill materials have been exposed to the elements over the years and will need to be reworked to provide support of future site development. Additionally, structures that are planned in areas of cut-fill transitions or that are underlain by fill less than 5 feet thick with a transition to deep fill under the same structure, should be overexcavated followed by replacement with engineered compacted fill. Recommendations for near surface improvement and site preparation are presented in Section 4.1 of this report.
- Excavations into the existing site materials (engineered fill and bedrock) should be achievable with heavy construction equipment in good working order. We anticipate that the earth materials generated from the recommended earthwork will be generally suitable for re-use as compacted fill, provided they are relatively free of rocks larger than 6 inches in dimension, demolition debris, and organic material.
- Future compacted fill materials derived from site excavations are anticipated to have a very low to low expansion potential. However, future testing and analysis needs to be performed after grading has been completed.
- Future compacted fill materials derived from onsite materials are anticipated to have sulfate severity categorization of "not applicable" and are designated class "S0" with regards to potential sulfate attack on concrete. However, further testing will be needed to confirm this upon completion of grading.
- Ground water was not encountered within the upper 50.5 feet of the site during our subsurface evaluation. Laboratory test results from moisture and density testing indicate that the average degree of saturation of the subsurface materials is also relatively low.
- The subject study area is not located within a mapped Earthquake Fault-Rupture Zone and based upon our review of published geologic mapping, no known active or potentially active faults cross the site. The nearest mapped active fault, the Elsinore Fault, is located more than approximately 16 kilometers away from the site. Therefore, the potential for ground rupture as a result of faulting is considered remote.
- The subject site is not located within an area considered susceptible to liquefaction.
- Laboratory testing by others indicates that a deep, thin layer of alluvial material left in place during grading of the site, has the potential to collapse up to approximately 0.5 inch when inundated with water (PSE, 2007).
- Seismic hazards associated with a significant earthquake generated from one of the active regional faults include ground shaking. The estimated peak horizontal ground acceleration is 0.37g. **New improvements will need to be designed for seismic forces in accordance with current building codes and regulations.** However, there is still a risk that the proposed structures and associated improvements could be damaged as a result of an earthquake. Repair of the planned residential structures may be needed after a seismic event.

4.0 RECOMMENDATIONS

The following recommendations are to be considered preliminary and should be confirmed upon completion of final development plans, grading, and earthwork operations. In addition, they should be considered minimal from a geotechnical viewpoint, as there may be more restrictive requirements from the architect, structural engineer, building codes, governing agencies, or the owner. A grading plan review should also be performed by LGC Geotechnical prior to the start of earthwork activities. Additional and/or revised recommendations may be provided at the conclusion of plan review, including recommendations for additional subsurface evaluation and laboratory testing.

It should be noted that the following geotechnical recommendations are intended to provide the owner with sufficient information to develop the site in general accordance with the 2010 C.B.C. requirements. With regard to the potential occurrence of potentially catastrophic geotechnical hazards such as fault rupture, earthquake-induced landslides, liquefaction, etc., the following geotechnical recommendations should provide adequate protection for the proposed development to the extent required to reduce seismic risk to an "acceptable level". The "acceptable level" of risk is defined by the California Code of Regulations as "that level that provides reasonable protection of the public safety, though it does not necessarily ensure continued structural integrity and functionality of the project" [Section 3721(a)]. Therefore, repair and remedial work of the proposed structures may be required after a significant seismic event. With regards to the potential for less significant geologic hazards to the proposed development, the recommendations contained herein are intended as a reasonable protection against the potential damaging effects of geotechnical phenomena such as expansive soils, soil settlement, groundwater seepage, etc. It should be understood, however, that our recommendations are intended to maintain the structural integrity of the proposed development and structures given the site geotechnical conditions, but cannot preclude the potential for some cosmetic distress or nuisance issues to develop as a result of the site geotechnical conditions.

4.1 Site Earthwork

We anticipate that after demolition of existing improvements and asphalt parking lots at the northern portion of the site is complete, rough grading earthwork at the site will then generally consist of clearing and grubbing of demolition debris and organic materials, earthwork cuts and overexcavations below structures in accordance with project specifications, remedial removals for areas of fill and shallow cuts, and placement of engineered compacted fill to design grades. Precise grading earthwork will include shallow trenching for construction of slab-on-grade type foundations and utilities. Site earthwork operations should be performed in accordance with the following recommendations, in addition to those contained in the 2010 C.B.C., and the General Earthwork and Grading Specifications for Rough Grading included in Appendix D of this report. In case of conflict, the following recommendations shall supersede those included as a part of Appendix D.

4.1.1 Site Preparation

Prior to grading, the proposed construction areas should be stripped of all vegetation and any remaining construction debris; these materials should be removed and properly disposed of offsite. Holes resulting from the removal of buried obstructions should be replaced with suitable compacted fill material (refer to Section 4.1.4). Soft or yielding subgrade materials encountered within bottom excavations should also be removed to a depth that exposes firm materials. The

actual depth of removals in these areas will be determined by the geotechnical consultant in the field based on the observed conditions.

4.1.2 Remedial Measures

The subject site has been previously graded to the current existing superpad grades, and the southern portion has been left vacant for several years. The northern portion of the site has been improved with a structure, a parking lot and associated utilities and landscaping. Approximate limits of recommended remedial earthwork are presented on the Remedial Measures Map, Figure 3 (Rear of Text).

Actual limits of over-excavation below structures may vary significantly depending on the actual thickness of fill encountered during grading. Limits of the recommended 10 feet over-excavation area, shown on Figure 3, are based on limited subsurface information. Actual limits of the western boundary of the 10 feet overexcavation area shall be determined based on field observations during grading.

Removal bottom areas and over-excavated bottom areas to receive compacted fill should be scarified to a minimum depth of 6 inches, brought to a near-optimum moisture condition, and recompacted to at least 90 percent relative compaction (based on American Standard of Testing and Materials, ASTM, Test Method D1557).

Local conditions, such as deeper than anticipated weathered or unsuitable fill or excessively loose and yielding native materials, may be encountered during excavation. These conditions could require additional removals beyond the above noted minimum in order to obtain an acceptable subgrade. The actual depths and lateral extents of remedial grading will be determined by the geotechnical consultant in the field, based on subsurface conditions encountered during grading.

4.1.3 Earthwork Shrinkage and Bulking

Based upon the results of our subsurface evaluation and laboratory testing, it is our opinion that the existing fill material will shrink less than approximately 5 percent. We estimate that the surface bedrock materials will bulk on the order of 5 to 10 percent. The actual amount of shrinkage depends on many factors including type of equipment used, contractor's technique, homogeneity of onsite soils, etc.

4.1.4 Fill Placement and Compaction

The onsite engineered fill and bedrock are considered generally suitable for use as compacted fill provided they are screened of rocks greater than 6 inches in dimension, excessive organic materials, and demolition debris. Fill materials should be moisture conditioned or dried (as needed) to near optimum-moisture content and recompacted to at least 90 percent relative compaction (based on ASTM Test Method D1557). The optimum lift thickness to produce a uniformly compacted fill will depend on the type and size of compaction equipment used. In general, fill should be placed in uniform lifts not exceeding 8 inches in thickness. Placement and compaction of fill should be performed in accordance with local grading ordinances under the observation and testing of LGC Geotechnical.

Import soils (if required) should consist of granular soils of low expansion potential (expansion index 50 or less based on ASTM D4829 Section 5.3 Classification), and should be free of organic debris and hard materials over 6 inches in dimension. Prior to import, LGC should be provided with the location of the import source for geotechnical evaluation.

Aggregate base or crushed miscellaneous base material should be placed at a minimum relative compaction of 95 percent based on ASTM Test Method D1557 and conform to the specifications of the current edition of the Standard Specifications for Public Works Construction ("Greenbook").

4.1.5 Trench Backfill and Compaction

Utility trench backfills should be compacted to a minimum relative compaction of 90 percent. Trench backfill materials should be placed in loose lifts no greater than approximately 8 inches in thickness, moisture-conditioned to optimum-moisture content or greater, and compacted with conventional compaction equipment. If trenches are shallow and conventional equipment may result in damage to the utilities, clean sand, having sand equivalent (SE) of 30 or greater, may be imported to bed and shade the utilities. Sand backfill should be densified. Densification by jetting or flooding may be considered, but tamping of the sand with relatively light, hand-operated equipment should be employed to ensure adequate compaction. A representative from LGC Geotechnical should observe, probe, and test the bedding sand and compacted backfill to verify compliance with the project specifications.

4.2 Preliminary Foundation Recommendations

Given that the expansion index exceeds 20, the foundation system shall be designed for effects of expansive soil. The foundation designer/client may elect to design the foundation in accordance with either the WRI or post-tensioned methodology. Due to potential for hydro-consolidation, either foundation system should be designed to accommodate an anticipated differential settlement of approximately ½ inch in 40 feet.

4.2.1 Conventional Foundation Recommendations (WRI Methodology)

Shallow foundation slabs may be designed in accordance with the Wire Reinforcement Institute, Inc. method (WRI/CRSI-81 Design of Slab-on-ground Foundations - with 1996 Update) using an effective plasticity index value of 15 for the subgrade soils. From a geotechnical perspective, we recommend a minimum slab thickness of 4 inches.

4.2.2 Post-Tensioned Foundation Recommendations

A post-tensioned slab should be designed by the foundation designer using the parameters in Table 3. The geotechnical parameters presented in Table 3 were determined in general accordance with the 2010 California Building Code (C.B.C.)

TABLE 3

Post-Tensioned Foundation Design Parameters

Parameter	PT Slab with Perimeter Footing
Thornthwaite Moisture Index	-20
Depth to Constant Soil Suction (depth to constant moisture content over time, but within C.B.C. limits)	7 feet
Constant Soil Suction	PF 3.6
Moisture Velocity	0.7 in/month
Center Lift Edge moisture variation distance, e_m Center lift, y_m	 9.0 feet 0.50 inches
Edge Lift Edge moisture variation distance, e_m Edge lift, y_m	 5.5 feet 0.75 inch
Minimum Perimeter footing embedment below finish grade	12 inches
Minimum slab thickness	5 inches[1]

4.3 Bearing Pressure

A soil bearing pressure of 2,000 psf may be used for a minimum of 12-inch-wide continuous footings extending a minimum of 12 inches below adjacent pad grade. Resistance to lateral loads can be provided by friction acting at the base of foundations and by passive earth pressure. A coefficient of friction of 0.35 may be assumed with dead-load forces. An ultimate passive lateral earth pressure of 300 psf per foot of depth to a maximum of 3,000 psf may be used for the sides of footings poured against properly compacted fill. This passive pressure is applicable for level (ground slope equal to or flatter than 5H:1V) conditions only.

Bearing values indicated above are for total dead loads and frequently applied live loads. The above vertical bearing may be increased by ⅓ for short durations of loading which will include the effect of wind or seismic forces. The passive pressure may be increased by ⅓ due to wind or seismic forces. These lateral and frictional resistance values represent ultimate values, so appropriate safety factors should be applied by the structural designer during design.

4.4 Slab Underlayment

Slab underlayment (for the purpose of reducing moisture transmission through the slab) should, at a minimum, comprise of a 10-mil polyolefin (or approved equivalent) moisture/vapor retarder. The vapor retarder should meet or exceed the permeance, puncture resistance and tensile strength requirements of an ASTM E 1745 Class A material, and be properly installed in accordance with ACI publication 302. The use of a sand or gravel layer above and/or below the vapor retarder is the purview of the foundation engineer.

4.5 Non-structural Concrete Flatwork

Concrete flatwork (such as walkways, patio slabs, etc.) has a potential for cracking due to changes in soil volume related to soil-moisture fluctuations. To reduce the potential for excessive cracking and lifting, concrete should be designed in accordance with the guidelines outlined in Table 4. These guidelines will help reduce the potential for irregular cracking and promote cracking along construction joints, but will not eliminate all cracking or lifting. Thickening the concrete and/or adding additional reinforcement will further reduce cosmetic distress.

TABLE 4

Preliminary Geotechnical Parameters for Non-structural Concrete Flatwork

	Homeowner Sidewalks	**Private Drives**	**Patios/Entryways**	**City Sidewalk Curb and Gutters**
Minimum Thickness (in.)	4 (nominal)	4 (full)	4 (full)	City/Agency Standard
Presoaking	Wet down prior to placing	Wet down prior to placing	Wet down prior to placing	City/Agency Standard
Reinforcement	—	No. 3 at 36 inches on-centers	No. 3 at 36 inches on-centers	City/Agency Standard
Thickened Edge	—	8 inches wide x 8 inches total thickness	—	City/Agency Standard
Crack Control Joints	Saw cut or tool joint minimum 0.75 inches	Saw cut or tool joint minimum 0.75 inches	Saw cut or tool joint minimum 0.75 inches	City/Agency Standard
Maximum Joint Spacing	10 feet	10 feet or quarter cut whichever is closer	6 feet	City/Agency Standard
Aggregate Base Thickness (in.)	—	—	—	City/Agency Standard

To reduce the potential for sidewalks to separate from the building slab, the owner may elect to install dowels to tie these two elements together.

4.6 Pavement Recommendations

We recommend that the pavement sections within the subject area be designed in accordance with the City of Lake Forest's Standards. Based on the City of Lake Forest's Street Section Standard (163), a pavement section consisting of 4 inches of asphalt over 4 inches of crushed aggregate base for a local road is considered geotechnically adequate. This design shall be confirmed after grading, and should be confirmed with final traffic indices provided by the civil engineer and the City of Lake Forest.

4.7 Excavation Stability and Shoring Requirements

During earthwork operations and site construction, temporary excavations should be made in accordance with the requirements of Cal/OSHA Construction Safety Orders. It is the contractor's responsibility to ensure that these requirements are met. In general, vertical excavations up to approximately 3 feet in height may be considered temporarily stable. Given the sandy nature of the site soils, excavations deeper than 3 feet may need to be either laid back at a 1.5:1 (horizontal to vertical)

gradient or may require the use of shoring. Special consideration may be necessary when working adjacent to sensitive improvements.

4.8 Storm Water Mitigation System

It is our understanding that a portion of the onsite storm water may be infiltrated into the subsurface soils. It should be noted that intentionally collecting and concentrating surface water for the purpose of subsurface infiltration has conflicting objectives with the fundamentals of geotechnical engineering as it relates to satisfactory performance of slopes, foundations, and other improvements. In general we recommend that surface water be collected and transported off of the site in a storm drain system and not infiltrated into the subsurface soils. However, we have conducted a field infiltration evaluation because we understand the local agency is requiring infiltration of storm water.

Given the results of our infiltration testing, and that the majority of the site near-surface materials consist of a combination of well sorted sands and fine grained materials, the recommended design infiltration rate is 0.25 inches per hour. Due to the relatively low infiltration rate, any infiltration system proposed for the site should have an overflow system that connects to the local storm drain system. This rate shall be confirmed once the type of the infiltration system has been determined and the corresponding head of water is known.

The design infiltration rate assumes that the storm water system which is entering the system is clear and does not contain suspended soil particles. The presence of suspended solids may clog the pores within the soil and thereby reduce the infiltration rate.

Please note, as a result of directing large quantities of water into the underlying soils, there is the potential for soil settlement (hydro collapse) to occur and/or to have nuisance related water issues, etc. It is our opinion that if soil settlement occurs, the majority of it will occur within 10 to 20 feet from the edge of the infiltration system. Therefore, we recommend that settlement sensitive improvements not be constructed within this zone. As for nuisance water related issues, due to variability in geologic and hydraulic conductivity characteristics, these effects may be experienced at the onsite locations and/or potentially at other locations beyond the physical limits of the subject site.

4.9 Control of Surface Water and Drainage Control

Positive drainage of surface water away from structures is very important. Water should not be allowed to pond adjacent to buildings or to flow freely down a graded slope. Positive drainage may be accomplished by providing drainage away from buildings. Where necessary, drainage paths may be shortened by use of area drains and collector pipes. Eave gutters are recommended and should reduce water infiltration into the subgrade soils if the downspouts are properly connected to appropriate outlets.

Planters with open bottoms adjacent to buildings should be avoided. Planters should not be designed adjacent to buildings unless provisions for drainage, such as catch basins, liners, and/or area drains, are made. Over watering must be avoided.

4.10 Construction Observation, Testing, & Geotechnical Plan Review

The recommendations provided in this report are based on limited subsurface observations and geotechnical analysis. The interpolated subsurface conditions should be checked in the field during grading operations by a representative of LGC Geotechnical.

Construction observation and testing should also be performed by LGC Geotechnical during future earthwork grading at the site. Grading plans and final project drawings should be reviewed by this office prior to the start of construction.

Observation and/or testing should be performed by LGC Geotechnical at the following stages:

- During rough grading, precise grading, and pad recertification process (where applicable);
- After building footing and retaining wall footing excavation and prior to placing concrete and/or reinforcing;
- During installation of retaining wall drainage and placing backfill;
- After moisture conditioning of building pads and other concrete-flatwork subgrades, but prior to the placement of concrete;
- During preparation of subgrade and placing of aggregate base; and
- When any unusual soil conditions are encountered during any construction operation subsequent to issuance of this report.

5.0 LIMITATIONS

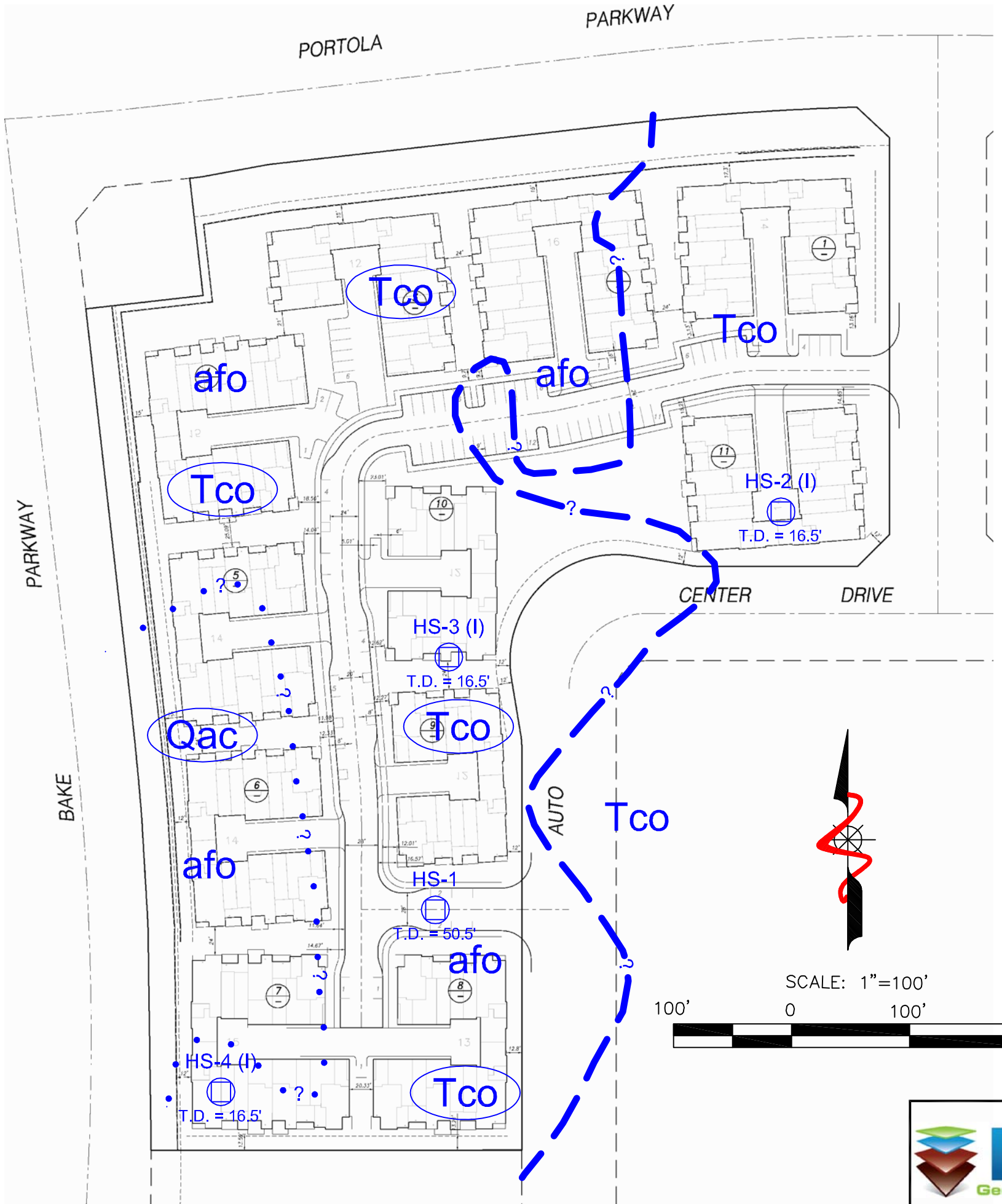
Our services were performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable soils engineers and geologists practicing in this or similar localities. No other warranty, expressed or implied, is made as to the conclusions and professional advice included in this report.

This report is based on data obtained from limited observations of the site, which have been extrapolated to characterize the site. While the scope of services performed is considered suitable to adequately characterize the site geotechnical conditions relative to the proposed development, no practical evaluation can completely eliminate uncertainty regarding the anticipated geotechnical conditions in connection with a subject site. Variations may exist and conditions not observed or described in this report may be encountered during construction.

This report is issued with the understanding that it is the responsibility of the owner, or of his/her representative, to ensure that the information and recommendations contained herein are brought to the attention of the other consultants and incorporated into the plans. The contractor should properly implement the recommendations during construction and notify the owner if they consider any of the recommendations presented herein to be unsafe, or unsuitable.

The findings of this report are valid as of the present date. However, changes in the conditions of a site can and do occur with the passage of time, whether they be due to natural processes or the works of man on this or adjacent properties. The findings, conclusions, and recommendations presented in this report can be relied upon only if LGC Geotechnical has the opportunity to observe the subsurface conditions during grading and construction of the project, in order to confirm that our preliminary findings are representative for the site. This report is intended exclusively for use by the client, any use of or reliance on this report by a third party shall be at such party's sole risk.

In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and modification.



LEGEND:

afo	Older artificial fill by others (undifferentiated)
Qac	Quaternary alluvium/colluvium, circled where buried
Tco	Tertiary Capistrano formation, Oso member, circled where buried
— — ? —	Approximate location of geologic contact, queried where uncertain
· · · ? · ·	Approximate location of buried geologic contact, queried where uncertain
HS-4 (I) T.D. = 16.5'	Approximate location of hollow-stem auger boring with total depth in feet. "(I)" indicates infiltration test location

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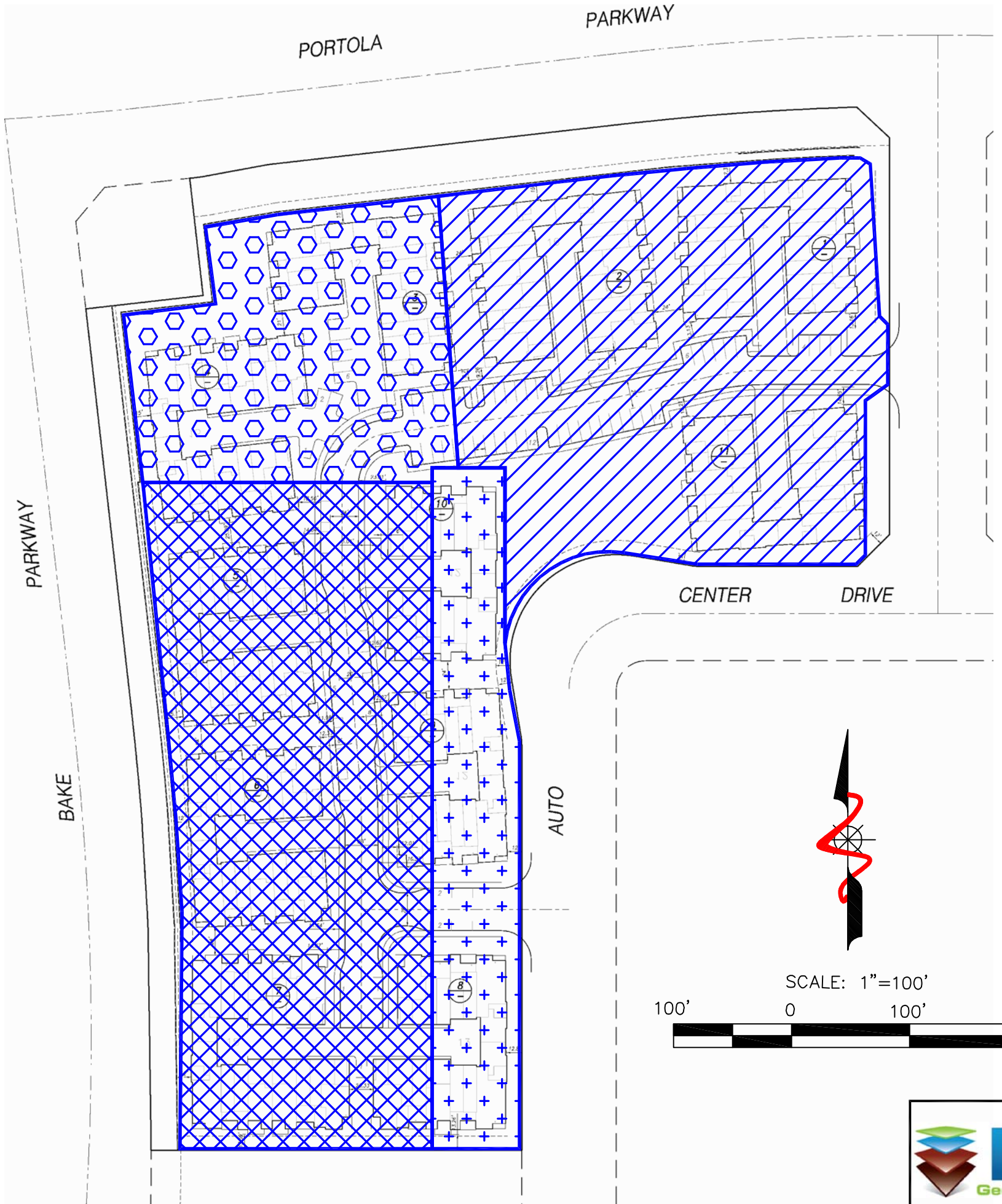
FIGURE 2
Geotechnical Map

PROJECT NAME	Brookfield - Lake Forest
PROJECT NO.	11142-01
ENG. / GEOL.	DJB / KTM
SCALE	1" = 100'
DATE	November 2011



LEGEND OF RECOMMENDED REMEDIAL EARTHWORK:

- Five (5) foot overexcavation below **finished pad grade**
- Ten (10) foot overexcavation below **finished pad grade** (Note - western boundary is approximate)
- Two (2) foot removal below **existing grade**
- Three (3) foot removal below **existing grade**

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FIGURE 3
Remedial Measures Map

PROJECT NAME	Brookfield - Lake Forest
PROJECT NO.	11142-01
ENG. / GEOL.	DJB / KTM
SCALE	1" = 100'
DATE	November 2011

Appendix A
References

APPENDIX A

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Appendix B
Boring Logs

Geotechnical Boring Log Borehole HS-1

Date: 9/22/2011	**Drilling Company:** Martini Drilling
Project Name: Brookfield - Lake Forest	**Type of Rig:** HSA
Project Number: 11142-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~788' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 2

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0							Grass covered topsoil; Gravelly SAND: dark brown, dry, very dense	
								Older Artificial Fill: Afo	
750	5	B-1	R-1	10 23 30	115.9	8.8	SM-SP	Silty SAND to SAND with Silt and trace Clay: mottled light gray and brown with black biotite grains, moist, dense to very dense, very fine to medium subangular grains	EI
745	10		R-2	10 17 21	120.1	11.9	SP	SAND with Silt and trace Clay: light gray with dark specks, moist, dense to very dense, subangular grains	#200
740	15		R-3	13 30 50/5"	127.5	8.9	SP	SAND with Silt: light gray with dark specks, moist, very dense, coarse grains	DS
735	20		R-4	8 17 31	120.5	10.9	SW	SAND with some Silt: mottled light gray and light brown, moist, very dense, fine to coarse subangular grains, few fine gravels	
730	25	B-2	R-5	8 19 30	120.2	9.4	SC-SM	Interbedded Sandy CLAY to Clayey SAND and Silty SAND: gray and brown, moist, dense to very dense	
	30								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
S&H	SIEVE AND HYDROMETER
EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 10/6/2011

Geotechnical Boring Log Borehole HS-1

Date: 9/22/2011	**Drilling Company:** Martini Drilling
Project Name: Brookfield - Lake Forest	**Type of Rig:** HSA
Project Number: 11142-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~788' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 2 of 2

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
725	30		R-6	10 18 33	119.5	7.2	SM	Silty SAND: light gray brown, moist, dense to very dense, fine to coarse grains	#200
720	35		R-7	10 20 32	120.8	7.2	SM	Silty SAND: light gray brown, moist, dense to very dense, fine to medium grains with few coarse	
715	40		R-8	31 50/3"	107.9	5.9	SM	Silty SAND: light gray/white with faint greenish oxidation, moist, very dense, well indurated near shoe, possibly bedrock	
								Tertiary Capistrano Formation, Oso Member (Tso)	
710	45		R-9	50/6"	96.8	5.9	[SM]	Silty SANDSTONE: light gray/white with faint greenish oxidation, moist, very dense, lacks cementation	
705	50		R-10	50/5"	107.3	6.5	[SM]	same as above	
								Total Depth = 50.5' Groundwater Not Encountered Backfilled with Cuttings on 9/22/2011	
700	55								
	60								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
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CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Geotechnical Boring Log Borehole HS-2

Date: 9/22/2011	**Drilling Company:** Martini Drilling
Project Name: Brookfield - Lake Forest	**Type of Rig:** HSA
Project Number: 11142-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~791' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0	B-1						3" Asphalt over 4" base **Tertiary Capistrano Formation, Oso Member (Tso)**	
750	5		R-1	6 15 20	121.3	7.9	[SM]	Silty SANDSTONE with trace Clay: mottled light gray and brown, moist, dense, very fine to coarse subangular grains	
745	10		R-2	30 50/3"	122.7	7.7	[SM]	Silty SANDSTONE with trace Clay: light gray, moist, very dense, fine to coarse subangular grains, well indurated, lacks cementation	#200
740	15		R-3	19 50/4"	111.3	7.8	[SM]	same as above	S&H, Perm
735	20							Total Depth = 16' Groundwater Not Encountered Backfilled with 2" Diameter Slotted PVC Pipe and Pea Gravel on 9/22/2011; Pipe Pulled and Cuttings Placed in Void on 9/23/11	
730	25								
	30								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
S&H	SIEVE AND HYDROMETER
EI	EXPANSION INDEX
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CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 10/6/2011

Geotechnical Boring Log Borehole HS-3

Date: 9/22/2011	**Drilling Company:** Martini Drilling
Project Name: Brookfield - Lake Forest	**Type of Rig:** HSA
Project Number: 11142-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~787' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0							Grass covered topsoil; dark brown, dry, dense **Older Artificial Fill (Afo)**	
								Tertary Capistrano Formation, Oso Member (Tso)	
750	5		R-1	10 22 26	124.2	7.6	[SM]	Silty SANDSTONE: light gray and brown, moist, dense, very fine to coarse subangular grains, well indurated, lacks cementation	
745	10		R-2	12 21 34	123.3	8.4	[SM]	same as above	
740	15		R-3	12 18 31	125.3	7.5	[SM]	same as above	S&H, Perm
735	20							Total Depth = 16' Groundwater Not Encountered Backfilled with 2" Diameter Slotted PVC Pipe and Pea Gravel on 9/22/2011; Pipe Pulled and Cuttings Placed in Void on 9/23/11	
730	25								
	30								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
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CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 10/6/2011

Geotechnical Boring Log Borehole HS-4

Date: 9/22/2011	**Drilling Company:** Martini Drilling
Project Name: Brookfield - Lake Forest	**Type of Rig:** HSA
Project Number: 11142-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~786' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0							Grass covered topsoil; dark brown, dry, dense **Older Artificial Fill (Afo)**	
750	5	B-1	R-1	10 15 16	119.2	9.8	SC-CL	Clayey SAND - Sandy CLAY: brown, moist, dense, sand is very fine to medium with few coarse grains	EI CR
745	10		R-2	7 12 18	119.2	12.1	SC	Clayey SAND: brown, moist, dense, sand is very fine to medium with few coarse grains	
740	15		R-3	8 14 28	120.5	12.1	SC	Clayey SAND: brown, moist, dense, sand is fine to coarse	#200
735	20							Total Depth = 16' Groundwater Not Encountered Backfilled with 2" Diameter Slotted PVC Pipe and Pea Gravel on 9/22/2011; Pipe Pulled and Cuttings Placed in Void on 9/23/11	
730	25								
	30								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
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EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 10/6/2011

Appendix C
Laboratory Test Results

Location	Sample No.	Depth (ft)	Molding Moisture Content (%)	Initial Dry Density (pcf)	Final Moisture Content (%)	Expansion Index	Expansion Classification[1]
LGC-1	B-1	5'-8'	7.6	110.5	14.5	8	Very Low

[1] Per ASTM D4829-08a

LGC Geotechnical, Inc.

EXPANSION INDEX
(ASTM D 4829)

Project Number: 11142-01
Date: Nov-11

Brookfield Lake Forest

Location	Sample No.	Depth (ft)	Percent Passing No. 200 Sieve
LGC-1	R-2	10	19
LGC-1	R-6	30	19
LGC-2	R-2	10	17
LGC-4	R-3	15	26

LGC Geotechnical, Inc.

PERCENT PASSING THE No. 200 SIEVE

Project Number: 11142-01
Date: Nov-11

Brookfield Lake Forest

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Project Name: Lake Forest
Tested By : A. Santos
Date: 10/18/11
Project No. : 11142-01
Data Input By: J. Ward
Date: 10/27/11
Exploration No.: LGC-2
Sample No.: R-3
Depth (feet) : 15.0
Soil Identification: White clayey sand (SC)

% Gravel	0	Soil Type
% Sand	79	SC
% Fines	21	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	154.64
Wt.of Air-Dry Soil + Cont. (g)	512.10	Wt. of Container No.___ (g)	1.00	1.00	76.37
Wt. of Container	109.15	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	402.95	Wt. of Dry Soil (g)			78.27

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.00	100.0
No. 10	27.59	93.2
Pan		

Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	93.2
No. 16	10.82	89.2	83.1
No. 30	31.69	68.3	63.7
No. 50	51.95	48.1	44.8
No. 100	67.86	32.2	30.0
No. 200	77.72	22.4	20.8
Pan			

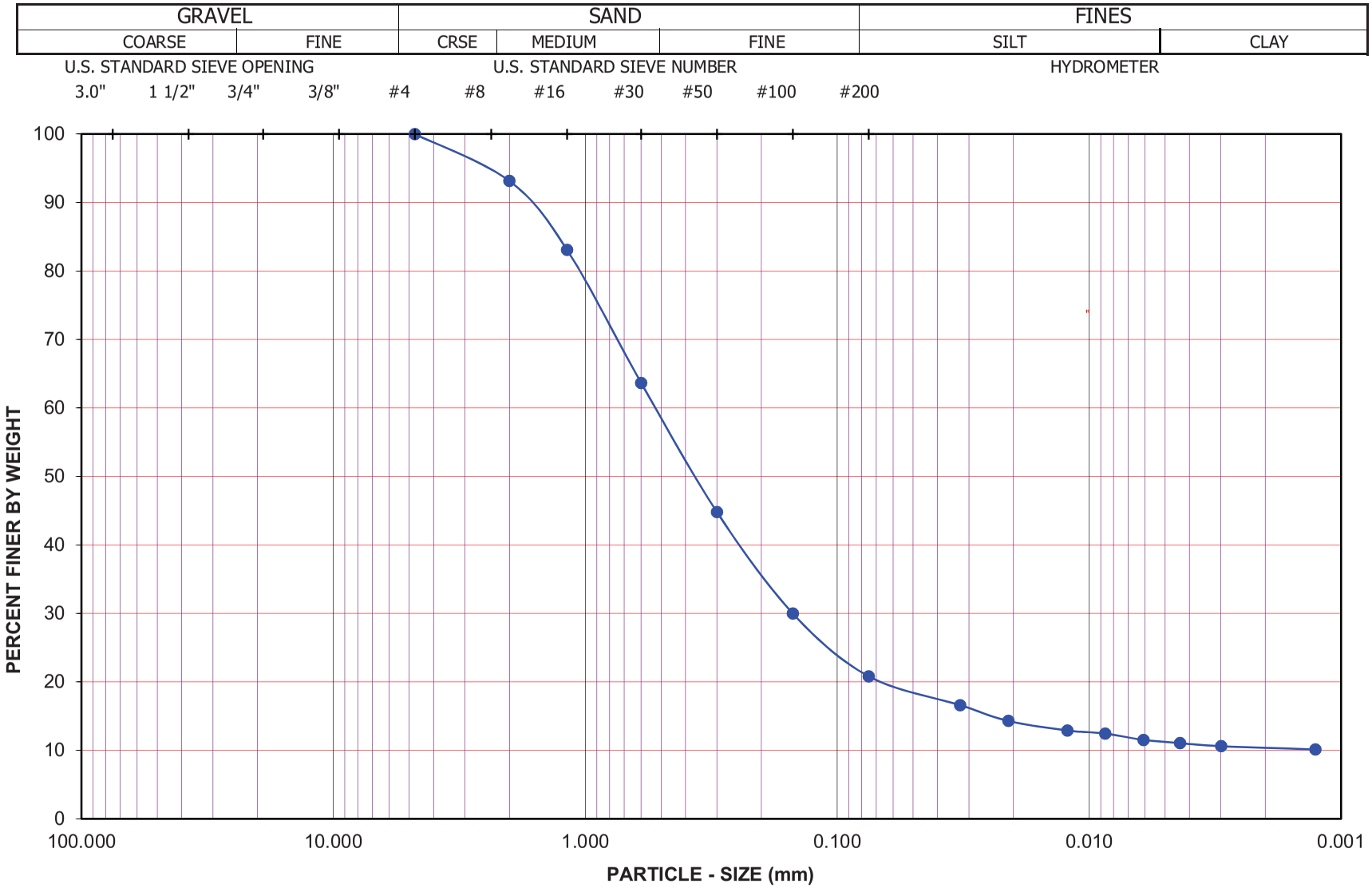
Hydrometer

Wt. of Air-Dry Soil (g) 100.10

Wt. of Dry Soil (g) 100.10

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
19-Oct-11	9:29	0		6.5			
	9:31	2	22.7	6.5	24.5	16.6	0.0325
	9:34	5	22.7	6.5	22.0	14.3	0.0209
	9:44	15	22.8	6.5	20.5	12.9	0.0122
	9:59	30	22.9	6.5	20.0	12.5	0.0086
	10:29	60	23.1	6.5	19.0	11.5	0.0061
	11:29	120	22.9	6.5	18.5	11.1	0.0044
	13:39	250	23.2	6.5	18.0	10.6	0.0030
20-Oct-11	9:29	1440	22.6	6.5	17.5	10.2	0.0013



Project Name: Lake Forest

Project No.: 11142-01

Exploration No.: LGC-2

Sample No.: R-3

Depth (feet) : 15.0

Soil Type : SC

Soil Identification: White clayey sand (SC)

GR:SA:FI : (%) **0 : 79 : 21**

PARTICLE - SIZE DISTRIBUTION ASTM D 422

Oct-11

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Project Name: Lake Forest | Tested By : A. Santos | Date: 10/18/11

Project No. : 11142-01 | Data Input By: J. Ward | Date: 10/27/11

Exploration No.: LGC-3

Sample No.: R-3 | Depth (feet) : 15.0

Soil Identification: Very light gray clayey sand (SC)

% Gravel	0	Soil Type
% Sand	79	SC
% Fines	21	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	153.78
Wt.of Air-Dry Soil + Cont. (g)	554.80	Wt. of Container No.___ (g)	1.00	1.00	75.17
Wt. of Container	108.50	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	446.30	Wt. of Dry Soil (g)			78.61

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.45	99.9
No. 10	26.05	94.2
Pan		

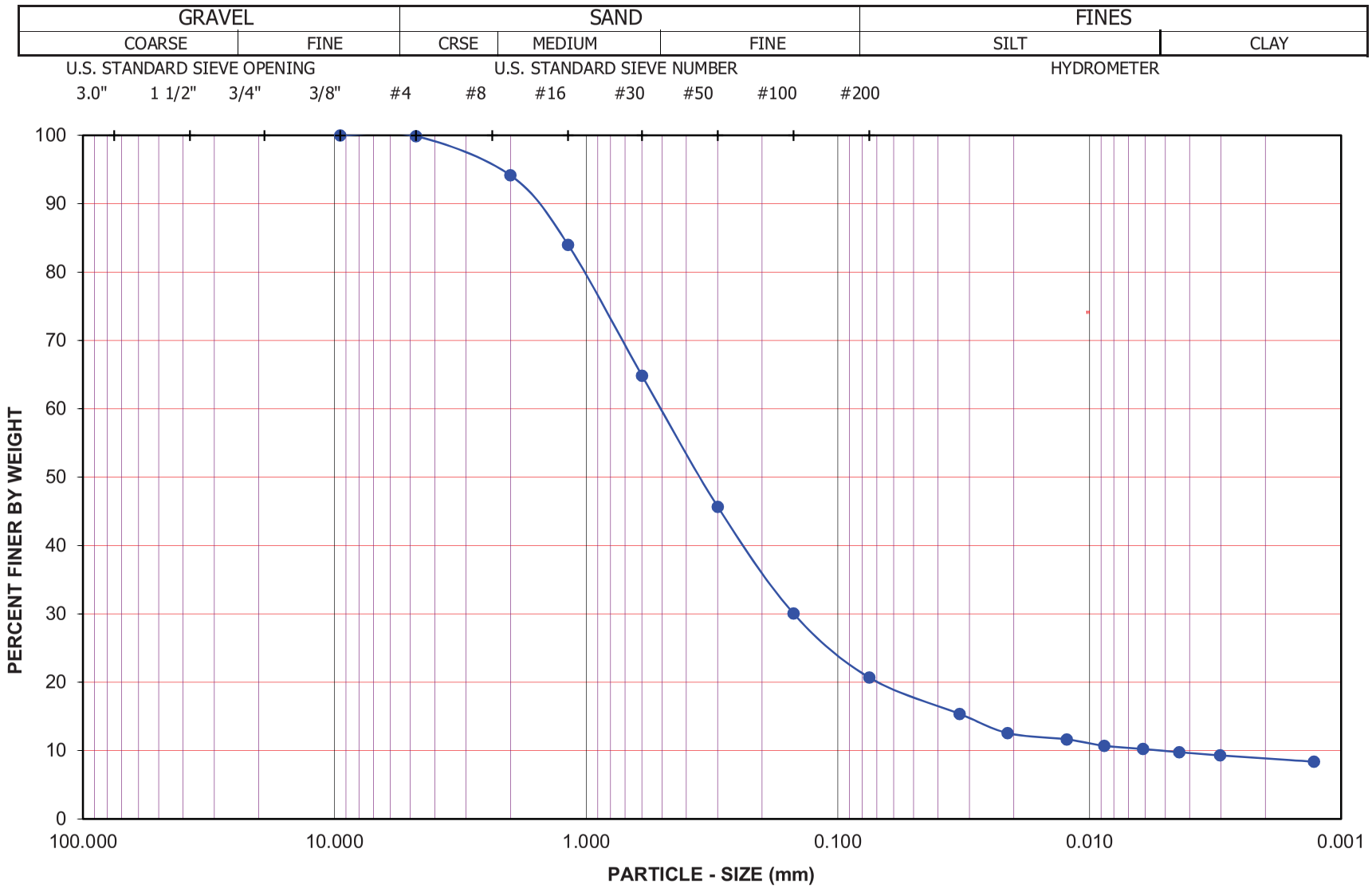
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	94.2
No. 16	10.81	89.2	84.0
No. 30	31.18	68.9	64.9
No. 50	51.59	48.5	45.7
No. 100	68.20	31.9	30.1
No. 200	78.17	22.0	20.7
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 100.20 Wt. of Dry Soil (g) 100.20

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
19-Oct-11	9:25	0		6.5			
	9:27	2	22.7	6.5	23.0	15.4	0.0328
	9:30	5	22.7	6.5	20.0	12.6	0.0212
	9:40	15	22.8	6.5	19.0	11.7	0.0123
	9:55	30	22.9	6.5	18.0	10.7	0.0087
	10:25	60	23.1	6.5	17.5	10.3	0.0061
	11:25	120	22.9	6.5	17.0	9.8	0.0044
	13:35	250	23.2	6.5	16.5	9.3	0.0030
20-Oct-11	9:25	1440	22.6	6.5	15.5	8.4	0.0013



Project Name: Lake Forest

Project No.: 11142-01

Exploration No.: LGC-3

Sample No.: R-3

Depth (feet) : 15.0

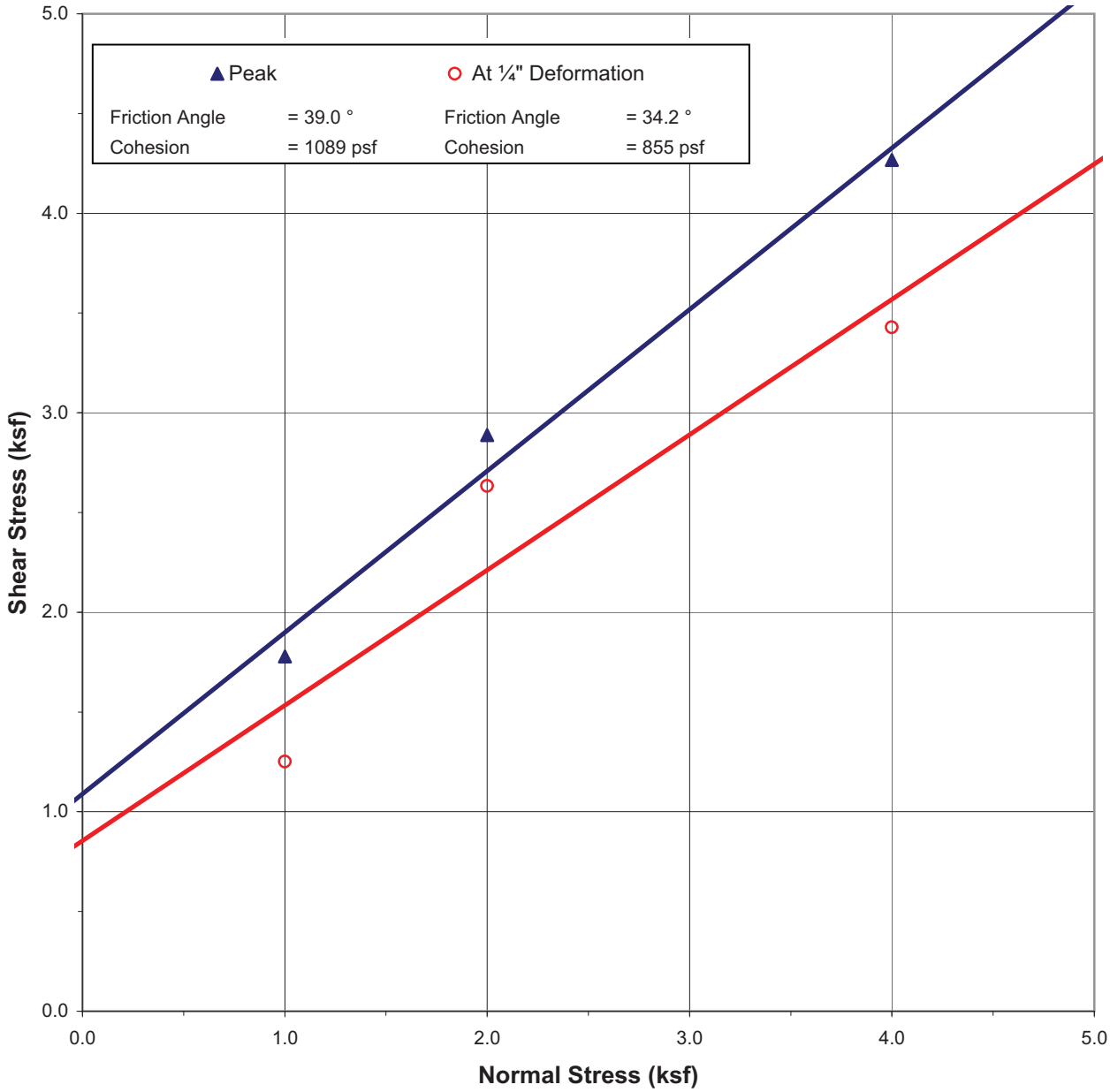
Soil Type : SC

Soil Identification: Very light gray clayey sand (SC)

GR:SA:FI : (%) **0 : 79 : 21**

PARTICLE - SIZE DISTRIBUTION ASTM D 422

Oct-11



Location:	Sample No.:	Depth (ft)	Sample Type	Shear Rate (inch/min)	Dry Density (pcf)	Initial Moisture Content (%)	Final Moisture Content (%)
LGC-1	**R-3**	**15**		**0.004**	**127.5**	**8.9**	**15.3**

Sample Description: Silty Sand

LGC Geotechnical, Inc.

DIRECT SHEAR PLOT

Project Number: 11142-01
Date: Nov-11

Brookfield Lake Forest

SATURATED HYDRAULIC CONDUCTIVITY

FALLING HEAD METHOD

ASTM D 5084

Project Name:	Lake Forest	Tested by:	A. Santos	Date:	10/17/11
Project No.:	11142-01	Input By:	J. Ward	Date:	10/27/11
Boring No.:	LGC-2	Sample Type:	Drive		
Sample No.:	R-3	Depth (ft.)	15.0		
Soil Identification:	White clayey sand (SC)				

		INITIAL CONDITION	FINAL CONDITION
Diameter (in)	1	2.424	2.416
	2	2.425	2.415
	3	2.423	2.410
	Average	2.424	2.414
Height (in)	1	2.998	2.984
	2	3.001	2.994
	3	2.997	2.990
	Average	2.999	2.989
Moisture Content (%)		7.82	16.15
Wt. Wet Sample + Container (g)		543.60	545.30
Wt. Dry Sample + Container (g)		512.10	479.80
Wt. Container (g)		109.15	74.26
Density and Saturation			
Wt. Wet Sample + Container (g)		544.60	Calculated from initial dry weight and final moisture
Wt. Container (g)		102.70	
Wet Density (pcf)		121.6	132.6
Dry Density (pcf)		112.8	114.2
Void Ratio		0.494	0.476
Total Porosity		0.331	0.323
Pore Volume (cc)		75.0	72.3
% Saturation		42.7	91.5

Specific Gravity, Gs (assumed) = 2.70

Back Pressure Saturation

B Value (%) = 97

Consolidation

Cell Pressure (psi) =	113.65	Burette Area (sq. in.)=	0.380
Back Pressure(psi) =	101.30	Initial Burette Ht.(cm)=	15.6
Effective Pressure (psi) =	12.35	Final Burette Ht.(cm)=	16.8

SATURATED HYDRAULIC CONDUCTIVITY

FALLING HEAD METHOD (ASTM D 5084)

Project Name:	Lake Forest	Cell Pressure:	113.65	psi	Initial Sample Height:	2.9987	in
Project No:	11142-01	Bottom Pressure (Pb):	102.90	psi	Initial Area of Sample:	4.6148	in.²
Boring No.:	LGC-2	Top Pressure (Pt):	101.30	psi	Final Sample Ht.* (L):	2.9857	in
Sample No. :	R-3	Consolidation Pressure:	12.35	psi	Final Sample Area* (A):	4.5747	in.²
Depth(ft):	15.0	Burette Area (influent) (Ai):	0.390	in.²			
Sample Type:	Drive	Burette Area (effluent) (Ao):	0.380	in.²			
Soil Identification:	White clayey sand (SC)	Vol. Change During Consol.:	0.180	in.³			

* After Consolidation

Date	Time (min.)	Incremental Elapsed Time (t) (min)	Temperature (°C)	Water Height Influent Burette (hi) (cm)	Water Height Effluent Burette (ho) (cm)	Uncorrected Hydraulic Conductivity (cm/sec)	Corrected Conductivity at 20 °C (cm/sec)	Inflow Rate / Outflow Rate	RESULTS	
20-Oct-11	09:04:00	0		27.9	2.9	Initial Reading			**Hydraulic Conductivity (cm/sec)**	
20-Oct-11	09:14:00	10	22.7	25.1	5.9	2.3E-05	2.2E-05	0.96		
20-Oct-11	09:24:00	10	22.8	22.7	8.4	2.0E-05	1.9E-05	0.99	**Average of Last 4 Readings**	**1.7E-05**
20-Oct-11	09:34:00	10	22.8	20.4	10.7	2.0E-05	1.8E-05	1.03		
20-Oct-11	09:44:00	10	22.8	18.3	12.8	1.9E-05	1.7E-05	1.03	Upper Limit	2.1E-05
20-Oct-11	09:54:00	10	22.8	16.5	14.6	1.6E-05	1.5E-05	1.03	Lower Limit	1.2E-05
20-Oct-11	10:04:00	10	22.8	14.8	16.3	1.6E-05	1.5E-05	1.03	Remarks	

k=Ai.Ao.L.ln(h1/h2)/(A.t.(Ai+Ao)) where h1, h2= ((Pb-Pt)/Y+(hi-ho) at t0-(change in hi + change in ho) at t1 and t2

SATURATED HYDRAULIC CONDUCTIVITY

FALLING HEAD METHOD

ASTM D 5084

Project Name:	Lake Forest	Tested by:	A. Santos	Date:	10/17/11
Project No.:	11142-01	Input By:	J. Ward	Date:	10/27/11
Boring No.:	LGC-3	Sample Type:	Drive		
Sample No.:	R-3	Depth (ft.)	15.0		
Soil Identification:	Very light gray clayey sand (SC)				

		INITIAL CONDITION	FINAL CONDITION
Diameter (in)	1	2.423	2.423
	2	2.422	2.424
	3	2.425	2.424
	Average	2.423	2.424
Height (in)	1	3.015	3.016
	2	3.016	3.019
	3	3.014	3.018
	Average	3.015	3.018
Moisture Content (%)		7.51	12.49
Wt. Wet Sample + Container (g)		588.30	579.70
Wt. Dry Sample + Container (g)		554.80	523.80
Wt. Container (g)		108.60	76.20
Density and Saturation			
Wt. Wet Sample + Container (g)		594.90	Calculated from initial dry weight and final moisture
Wt. Container (g)		102.70	
Wet Density (pcf)		134.8	140.9
Dry Density (pcf)		125.4	125.3
Void Ratio		0.344	0.346
Total Porosity		0.256	0.257
Pore Volume (cc)		58.3	58.6
% Saturation		58.9	97.6

Specific Gravity, Gs (assumed) = 2.70

Back Pressure Saturation

B Value (%) = 97

Consolidation

Cell Pressure (psi) =	103.40	Burette Area (sq. in.)=	0.391
Back Pressure(psi) =	91.04	Initial Burette Ht.(cm)=	19.1
Effective Pressure (psi) =	12.36	Final Burette Ht.(cm)=	20.0

SATURATED HYDRAULIC CONDUCTIVITY

FALLING HEAD METHOD (ASTM D 5084)

Project Name:	Lake Forest	Cell Pressure:	103.40	psi	Initial Sample Height:	3.0150	in
Project No:	11142-01	Bottom Pressure (Pb):	94.06	psi	Initial Area of Sample:	4.6123	in.²
Boring No.:	LGC-3	Top Pressure (Pt):	91.04	psi	Final Sample Ht.* (L):	3.0050	in
Sample No. :	R-3	Consolidation Pressure:	12.36	psi	Final Sample Area* (A):	4.5815	in.²
Depth(ft):	15.0	Burette Area (influent) (Ai):	0.382	in.²			
Sample Type:	Drive	Burette Area (effluent) (Ao):	0.391	in.²			
Soil Identification:	Very light gray clayey sand (SC)	Vol. Change During Consol.:	0.139	in.³			

* After Consolidation

Date	Time (min.)	Incremental Elapsed Time (t) (min)	Temperature (°C)	Water Height Influent Burette (hi) (cm)	Water Height Effluent Burette (ho) (cm)	Uncorrected Hydraulic Conductivity (cm/sec)	Corrected Conductivity at 20 °C (cm/sec)	Inflow Rate / Outflow Rate	RESULTS	
20-Oct-11	09:17:00	0		26.00	4.10	Initial Reading			**Hydraulic Conductivity (cm/sec)**	
20-Oct-11	09:27:00	10	22.8	25.90	4.20	4.6E-07	4.3E-07	0.98		
20-Oct-11	10:00:00	33	22.8	25.60	4.50	4.2E-07	3.9E-07	0.98	**Average of Last 4 Readings**	**3.6E-07**
20-Oct-11	10:30:00	30	22.8	25.35	4.75	3.8E-07	3.6E-07	0.98		
20-Oct-11	11:00:00	30	22.9	25.10	5.00	3.8E-07	3.6E-07	0.98	Upper Limit	4.5E-07
20-Oct-11	11:30:00	30	22.9	24.85	5.25	3.8E-07	3.6E-07	0.98	Lower Limit	2.7E-07
20-Oct-11	12:00:00	30	23.0	24.60	5.50	3.9E-07	3.6E-07	0.98	Remarks	

k=Ai.Ao.L.ln(h1/h2)/(A.t.(Ai+Ao)) where h1, h2= ((Pb-Pt)/Y+(hi-ho) at t0-(change in hi + change in ho) at t1 and t2

EXPANSION INDEX of SOILS

ASTM D 4829

Project Name:	Lake Forest	Tested By:	S. Felter	Date:	11/01/11
Project No. :	11142-01	Checked By:	J. Ward	Date:	11/03/11
Boring No.:	LGC-4	Depth (ft.)	4-7		
Sample No. :	B-4				
Soil Identification:	Very dark gray clayey sand (SC)				

Dry Wt. of Soil + Cont.	(g)	1000.00
Wt. of Container No.	(g)	0.00
Dry Wt. of Soil	(g)	1000.00
Weight Soil Retained on #4 Sieve		0.00
Percent Passing # 4		100.00

MOLDED SPECIMEN		Before Test	After Test
Specimen Diameter	(in.)	4.01	4.01
Specimen Height	(in.)	1.0000	1.0240
Wt. Comp. Soil + Mold	(g)	611.50	428.34
Wt. of Mold	(g)	208.70	0.00
Specific Gravity (Assumed)		2.70	2.70
Container No.		O	O
Wet Wt. of Soil + Cont.	(g)	798.10	637.04
Dry Wt. of Soil + Cont.	(g)	725.50	574.90
Wt. of Container	(g)	0.00	208.70
Moisture Content	(%)	10.01	16.97
Wet Density	(pcf)	121.5	126.2
Dry Density	(pcf)	110.4	107.9
Void Ratio		0.526	0.563
Total Porosity		0.345	0.360
Pore Volume	(cc)	71.4	76.3
Degree of Saturation (%) [S_{meas}]		**51.3**	81.4

SPECIMEN INUNDATION in distilled water for the period of 24 h or expansion rate < 0.0002 in./h

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
11/01/11	8:00	1.0	0	0.2220
11/01/11	8:10	1.0	10	0.2220
Add Distilled Water to the Specimen				
11/01/11	10:44	1.0	154	0.2445
11/02/11	6:12	1.0	1322	0.2460
11/02/11	7:15	1.0	1385	0.2460

Expansion Index (EI_{meas}) = ((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	**24**

TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS

Project Name: Lake Forest | Tested By : V. Juliano | Date: 10/31/11

Project No. : 11142-01 | Data Input By: J. Ward | Date: 11/03/11

Boring No.	LGC-4			
Sample No.	B-4			
Sample Depth (ft)	4-7			
Soil Identification:	Very dark gray (SC)			
Wet Weight of Soil + Container (g)	155.20			
Dry Weight of Soil + Container (g)	152.50			
Weight of Container (g)	56.00			
Moisture Content (%)	2.80			
Weight of Soaked Soil (g)	100.20			

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	8			
Crucible No.	21			
Furnace Temperature (°C)	830			
Time In / Time Out	7:50/8:35			
Duration of Combustion (min)	45			
Wt. of Crucible + Residue (g)	18.8063			
Wt. of Crucible (g)	18.8050			
Wt. of Residue (g) (A)	0.0013			
PPM of Sulfate (A) x 41150	53.50			
PPM of Sulfate, Dry Weight Basis	**55**			

CHLORIDE CONTENT, DOT California Test 422

ml of Chloride Soln. For Titration (B)	30			
ml of AgNO3 Soln. Used in Titration (C)	0.5			
PPM of Chloride (C -0.2) * 100 * 30 / B	30			
PPM of Chloride, Dry Wt. Basis	**31**			

pH TEST, DOT California Test 532/643

pH Value	**7.25**			
Temperature °C	20.5			

SOIL RESISTIVITY TEST

DOT CA TEST 532 / 643

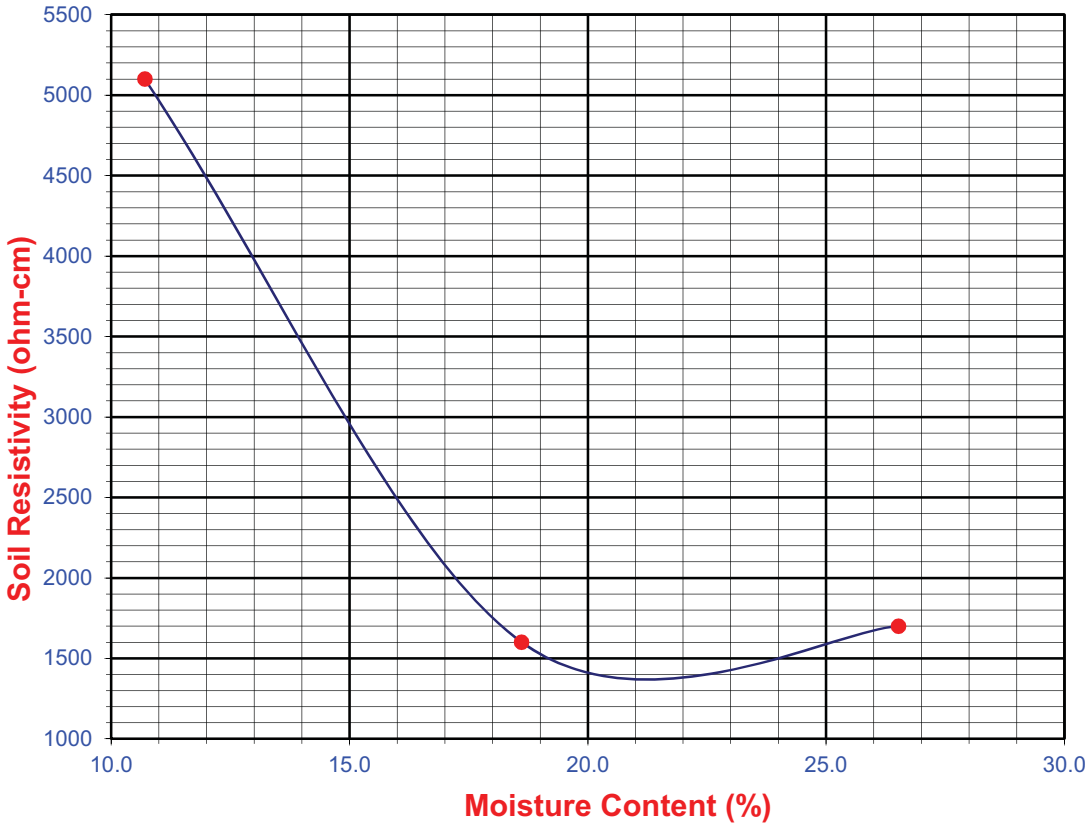
Project Name:	Lake Forest	Tested By :	V. Juliano	Date:	11/01/11
Project No. :	11142-01	Data Input By:	J. Ward	Date:	11/03/11
Boring No.:	LGC-4	Depth (ft.) :	4-7		
Sample No. :	B-4				
Soil Identification:*	Very dark gray (SC)				

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	10	10.71	5100	5100
2	20	18.61	1600	1600
3	30	26.52	1700	1700
4				
5				

Moisture Content (%) (MCi)	2.80
Wet Wt. of Soil + Cont. (g)	155.20
Dry Wt. of Soil + Cont. (g)	152.50
Wt. of Container (g)	56.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.00
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
1350	**21.2**	**55**	**31**	**7.25**	**20.5**



Appendix D
General Earthwork and Grading Specifications for Rough Grading

APPENDIX D

General Earthwork and Grading Specifications For Rough Grading

1.0 General

1.1 Intent: These General Earthwork and Grading Specifications are for the grading and earthwork shown on the approved grading plan(s) and/or indicated in the geotechnical report(s). These specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the specific recommendations in the geotechnical report shall supersede these more general specifications. Observations of the earthwork by the project Geotechnical Consultant during the course of grading may result in new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

1.2 The Geotechnical Consultant of Record: Prior to commencement of work, the owner shall employ a qualified Geotechnical Consultant of Record (Geotechnical Consultant). The Geotechnical Consultant shall be responsible for reviewing the approved geotechnical report(s) and accepting the adequacy of the preliminary geotechnical findings, conclusions, and recommendations prior to the commencement of the grading.

Prior to commencement of grading, the Geotechnical Consultant shall review the "work plan" prepared by the Earthwork Contractor (Contractor) and schedule sufficient personnel to perform the appropriate level of observation, mapping, and compaction testing.

During the grading and earthwork operations, the Geotechnical Consultant shall observe, map, and document the subsurface exposures to verify the geotechnical design assumptions. If the observed conditions are found to be significantly different than the interpreted assumptions during the design phase, the Geotechnical Consultant shall inform the owner, recommend appropriate changes in design to accommodate the observed conditions, and notify the review agency where required.

The Geotechnical Consultant shall observe the moisture-conditioning and processing of the subgrade and fill materials and perform relative compaction testing of fill to confirm that the attained level of compaction is being accomplished as specified. The Geotechnical Consultant shall provide the test results to the owner and the Contractor on a routine and frequent basis.

1.3 The Earthwork Contractor: The Earthwork Contractor (Contractor) shall be qualified, experienced, and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept the plans, geotechnical report(s), and these Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing the grading in accordance with the project plans and specifications. The Contractor shall prepare and submit to the owner and the Geotechnical Consultant a work plan that indicates the sequence of earthwork grading, the number of "equipment" of work and the estimated quantities of daily earthwork contemplated for the

site prior to commencement of grading. The Contractor shall inform the owner and the Geotechnical Consultant of changes in work schedules and updates to the work plan at least 24 hours in advance of such changes so that appropriate personnel will be available for observation and testing. The Contractor shall not assume that the Geotechnical Consultant is aware of all grading operations.

The Contractor shall have the sole responsibility to provide adequate equipment and methods to accomplish the earthwork in accordance with the applicable grading codes and agency ordinances, these Specifications, and the recommendations in the approved geotechnical report(s) and grading plan(s). If, in the opinion of the Geotechnical Consultant, unsatisfactory conditions, such as unsuitable soil, improper moisture condition, inadequate compaction, insufficient buttress key size, adverse weather, etc., are resulting in a quality of work less than required in these specifications, the Geotechnical Consultant shall reject the work and may recommend to the owner that construction be stopped until the conditions are rectified. It is the contractor's sole responsibility to provide proper fill compaction.

2.0 Preparation of Areas to be Filled

2.1 ***Clearing and Grubbing:*** Vegetation, such as brush, grass, roots, and other deleterious material shall be sufficiently removed and properly disposed of in a method acceptable to the owner, governing agencies, and the Geotechnical Consultant.

The Geotechnical Consultant shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 1 percent of organic materials (by volume). No fill lift shall contain more than 5 percent of organic matter. Nesting of the organic materials shall not be allowed.

If potentially hazardous materials are encountered, the Contractor shall stop work in the affected area, and a hazardous material specialist shall be informed immediately for proper evaluation and handling of these materials prior to continuing to work in that area.

As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminate dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed. The contractor is responsible for all hazardous waste relating to his work. The Geotechnical Consultant does not have expertise in this area. If hazardous waste is a concern, then the Client should acquire the services of a qualified environmental assessor.

2.2 ***Processing:*** Existing ground that has been declared satisfactory for support of fill by the Geotechnical Consultant shall be scarified to a minimum depth of 6 inches. Existing ground that is not satisfactory shall be overexcavated as specified in the following section. Scarification shall continue until soils are broken down and free of oversize material and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction.

2.3 ***Overexcavation:*** In addition to removals and overexcavations recommended in the approved geotechnical report(s) and the grading plan, soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be overexcavated to competent ground as evaluated by the Geotechnical Consultant during grading.

2.4 ***Benching:*** Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), the ground shall be stepped or benched. Please see the Standard Details for a graphic illustration. The lowest bench or key shall be a minimum of 15 feet wide and at least 2 feet deep, into competent material as evaluated by the Geotechnical Consultant. Other benches shall be excavated a minimum height of 4 feet into competent material or as otherwise recommended by the Geotechnical Consultant. Fill placed on ground sloping flatter than 5:1 shall also be benched or otherwise overexcavated to provide a flat subgrade for the fill.

2.5 ***Evaluation/Acceptance of Fill Areas:*** All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by the Geotechnical Consultant as suitable to receive fill. The Contractor shall obtain a written acceptance from the Geotechnical Consultant prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys, and benches.

3.0 Fill Material

3.1 ***General:*** Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by the Geotechnical Consultant prior to placement. Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to the Geotechnical Consultant or mixed with other soils to achieve satisfactory fill material.

3.2 ***Oversize:*** Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 8 inches, shall not be buried or placed in fill unless location, materials, and placement methods are specifically accepted by the Geotechnical Consultant. Placement operations shall be such that nesting of oversized material does not occur and such that oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 vertical feet of finish grade or within 2 feet of future utilities or underground construction.

3.3 ***Import:*** If importing of fill material is required for grading, proposed import material shall meet the requirements of the geotechnical consultant. The potential import source shall be given to the Geotechnical Consultant at least 96 hours (4 working days) before importing begins so that its suitability can be determined and appropriate tests performed.

4.0 Fill Placement and Compaction

4.1 ***Fill Layers:*** Approved fill material shall be placed in areas prepared to receive fill in near-horizontal layers not exceeding 8 inches in loose thickness. The Geotechnical Consultant may accept thicker layers if testing indicates the grading procedures can adequately compact the thicker layers. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.

4.2 ***Fill Moisture Conditioning:*** Fill soils shall be watered, dried back, blended, and/or mixed, as necessary to attain a relatively uniform moisture content at or slightly over optimum. Maximum density and optimum soil moisture content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM Test Method D1557).

4.3 ***Compaction of Fill:*** After each layer has been moisture-conditioned, mixed, and evenly spread, it shall be uniformly compacted to not less than 90 percent of maximum dry density (ASTM Test Method D1557). Compaction equipment shall be adequately sized and be either specifically designed for soil compaction or of proven reliability to efficiently achieve the specified level of compaction with uniformity.

4.4 ***Compaction of Fill Slopes:*** In addition to normal compaction procedures specified above, compaction of slopes shall be accomplished by backrolling of slopes with sheepsfoot rollers at increments of 3 to 4 feet in fill elevation, or by other methods producing satisfactory results acceptable to the Geotechnical Consultant. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of maximum density per ASTM Test Method D1557.

4.5 ***Compaction Testing:*** Field tests for moisture content and relative compaction of the fill soils shall be performed by the Geotechnical Consultant. Location and frequency of tests shall be at the Consultant's discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations shall be selected to verify adequacy of compaction levels in areas that are judged to be prone to inadequate compaction (such as close to slope faces and at the fill/bedrock benches).

4.6 ***Frequency of Compaction Testing:*** Tests shall be taken at intervals not exceeding 2 feet in vertical rise and/or 1,000 cubic yards of compacted fill soils embankment. In addition, as a guideline, at least one test shall be taken on slope faces for each 5,000 square feet of slope face and/or each 10 feet of vertical height of slope. The Contractor shall assure that fill construction is such that the testing schedule can be accomplished by the Geotechnical Consultant. The Contractor shall stop or slow down the earthwork construction if these minimum standards are not met.

4.7 ***Compaction Test Locations:*** The Geotechnical Consultant shall document the approximate elevation and horizontal coordinates of each test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that the Geotechnical Consultant can determine the test locations with sufficient accuracy. At a minimum, two grade stakes within a horizontal distance of 100 feet and vertically less than 5 feet apart from potential test locations shall be provided.

5.0 ***Subdrain Installation***

Subdrain systems shall be installed in accordance with the approved geotechnical report(s), the grading plan, and the Standard Details. The Geotechnical Consultant may recommend additional subdrains and/or changes in subdrain extent, location, grade, or material depending on conditions encountered during grading. All subdrains shall be surveyed by a land surveyor/civil engineer for line and grade after installation and prior to burial. Sufficient time should be allowed by the Contractor for these surveys.

6.0 ***Excavation***

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by the Geotechnical Consultant during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by the Geotechnical Consultant based on the field evaluation of exposed conditions during grading. Where fill-over-cut slopes are to be graded, the cut portion of the slope shall be made, evaluated, and accepted by the Geotechnical Consultant prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by the Geotechnical Consultant.

7.0 ***Trench Backfills***

7.1 The Contractor shall follow all OHSA and Cal/OSHA requirements for safety of trench excavations.

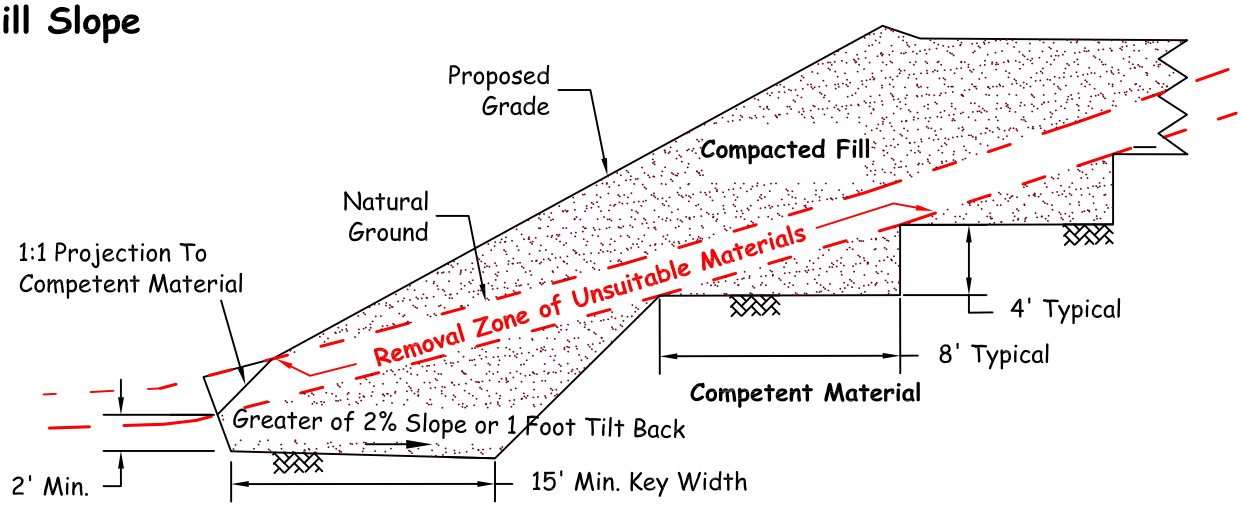
7.2 All bedding and backfill of utility trenches shall be done in accordance with the applicable provisions of Standard Specifications of Public Works Construction. Bedding material shall have a Sand Equivalent greater than 30 (SE>30). The bedding shall be placed to 1 foot over the top of the conduit and densified by jetting. Backfill shall be placed and densified to a minimum of 90 percent of maximum from 1 foot above the top of the conduit to the surface.

7.3 The jetting of the bedding around the conduits shall be observed by the Geotechnical Consultant.

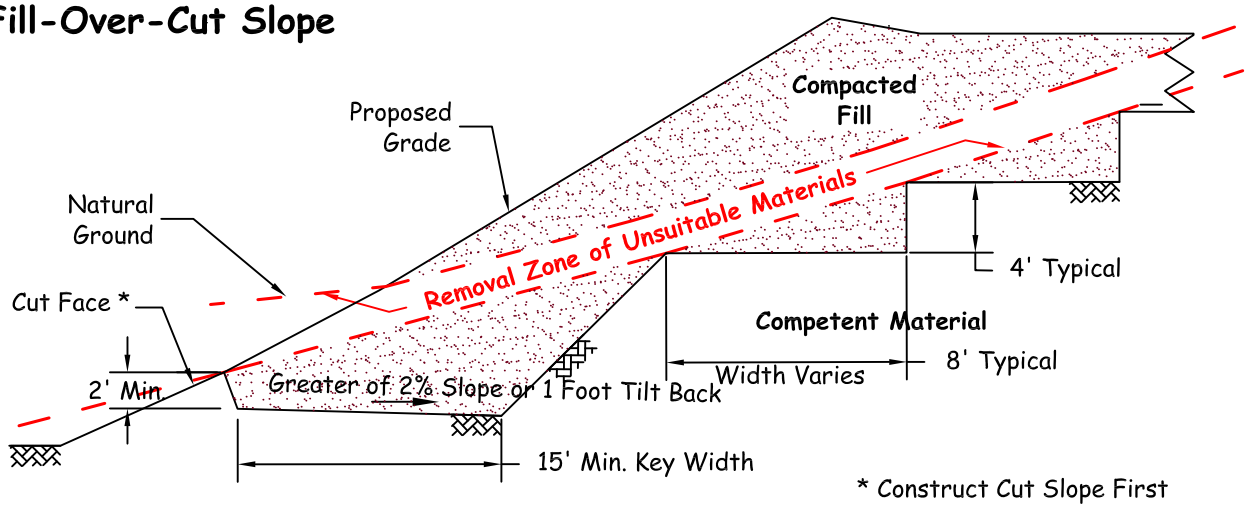
7.4 The Geotechnical Consultant shall test the trench backfill for relative compaction. At least one test should be made for every 300 feet of trench and 2 feet of fill.

7.5 Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to the Geotechnical Consultant that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method.

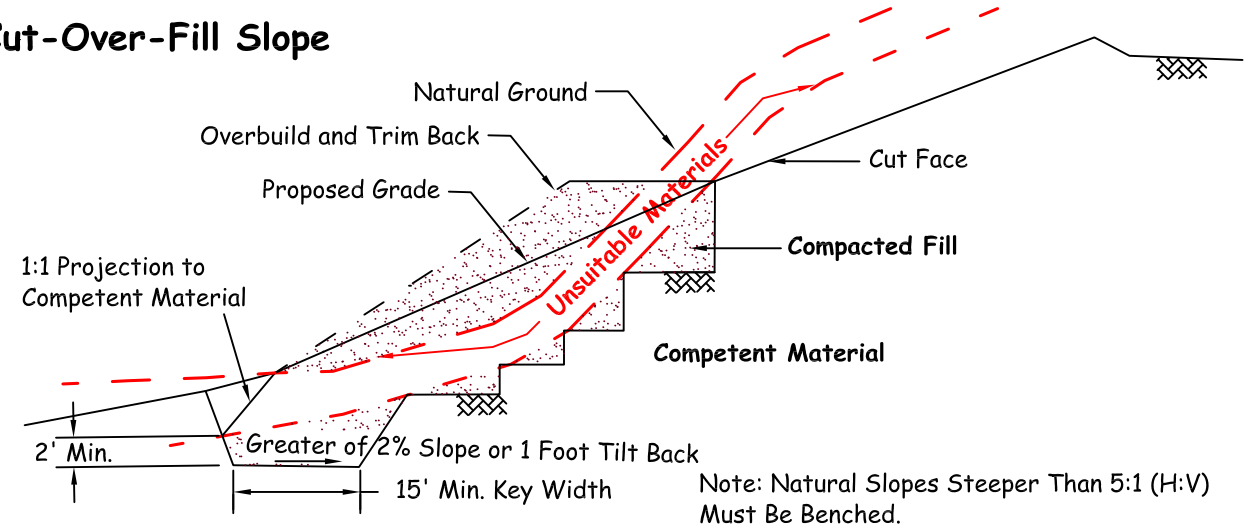
Fill Slope



Fill-Over-Cut Slope



Cut-Over-Fill Slope



Note: Natural Slopes Steeper Than 5:1 (H:V) Must Be Benched.

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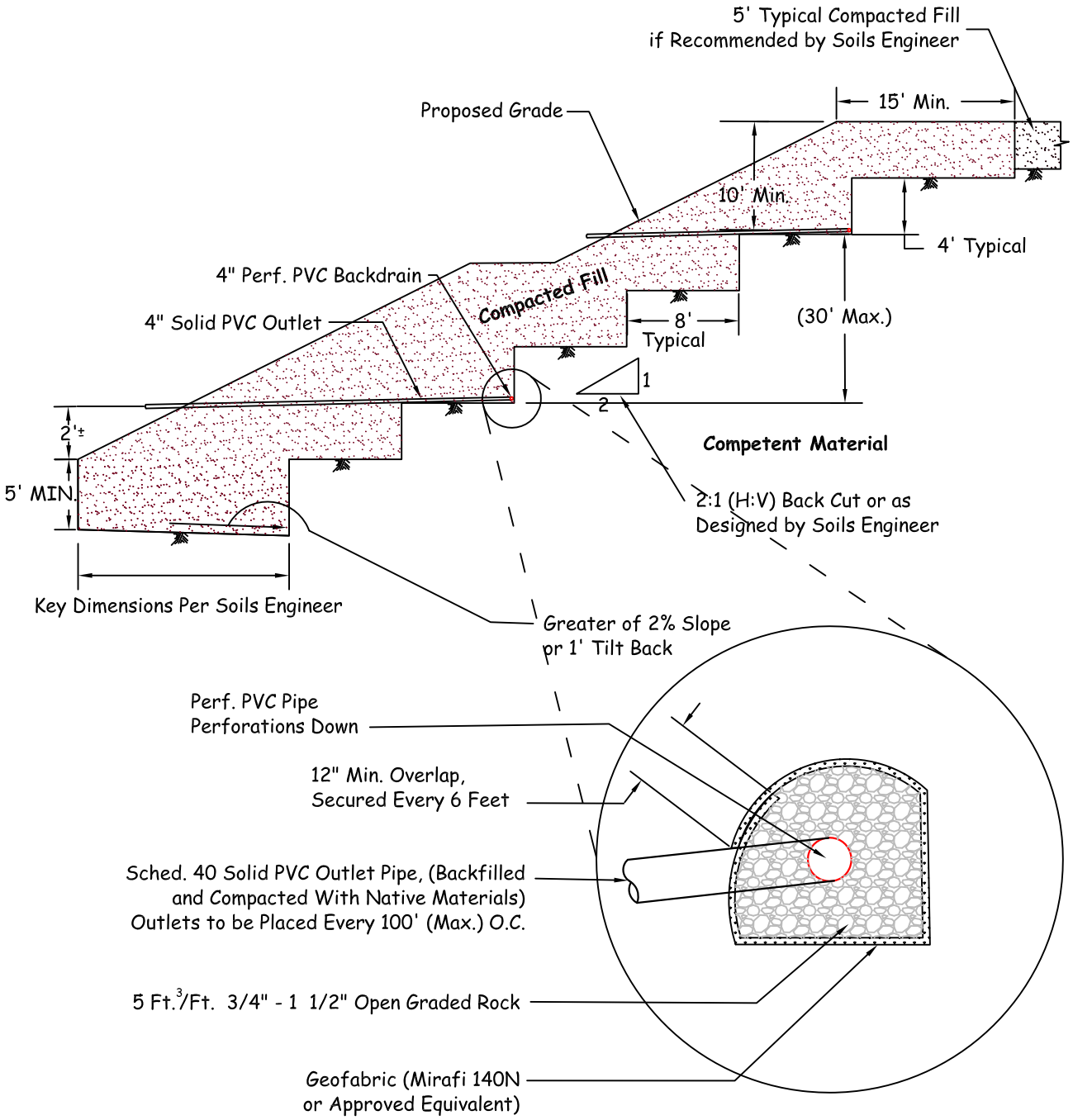
KEYING AND BENCHING



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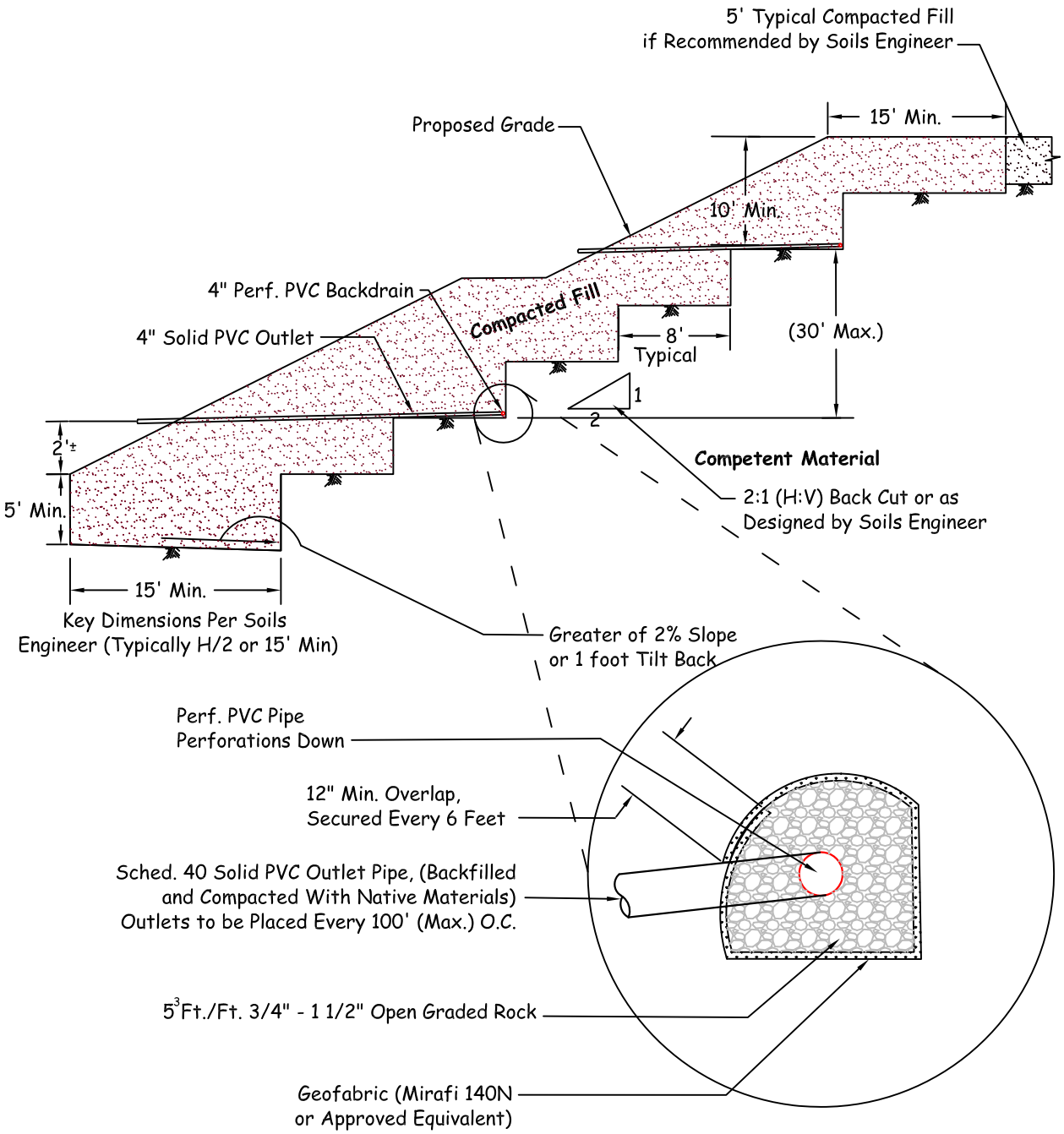
TYPICAL BUTTRESS DETAIL



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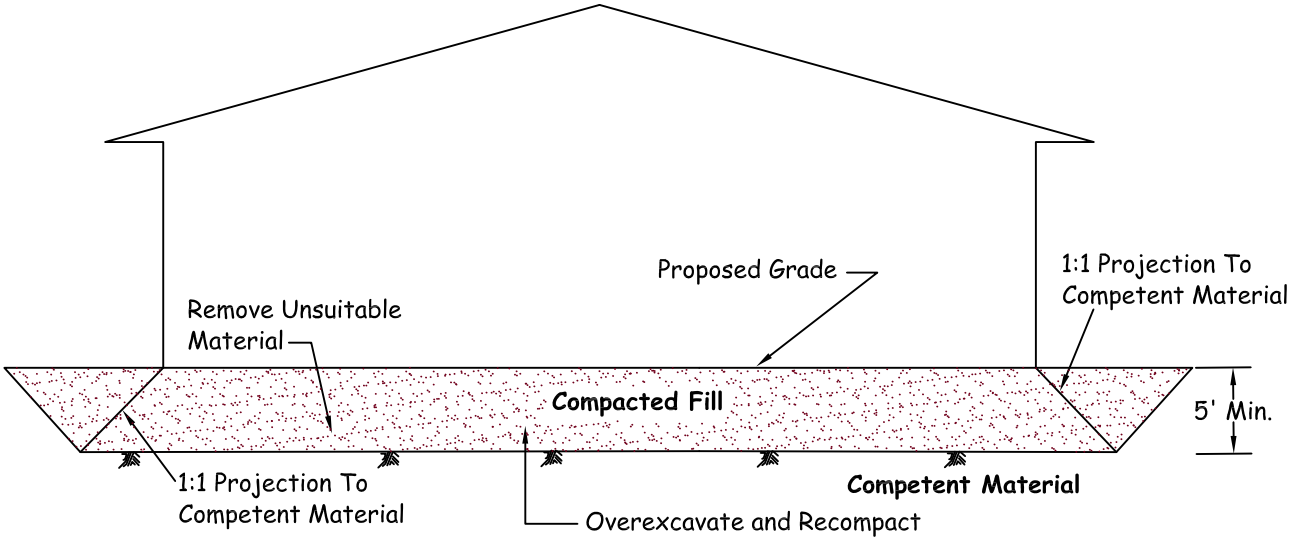
TYPICAL STABILIZATION FILL DETAIL

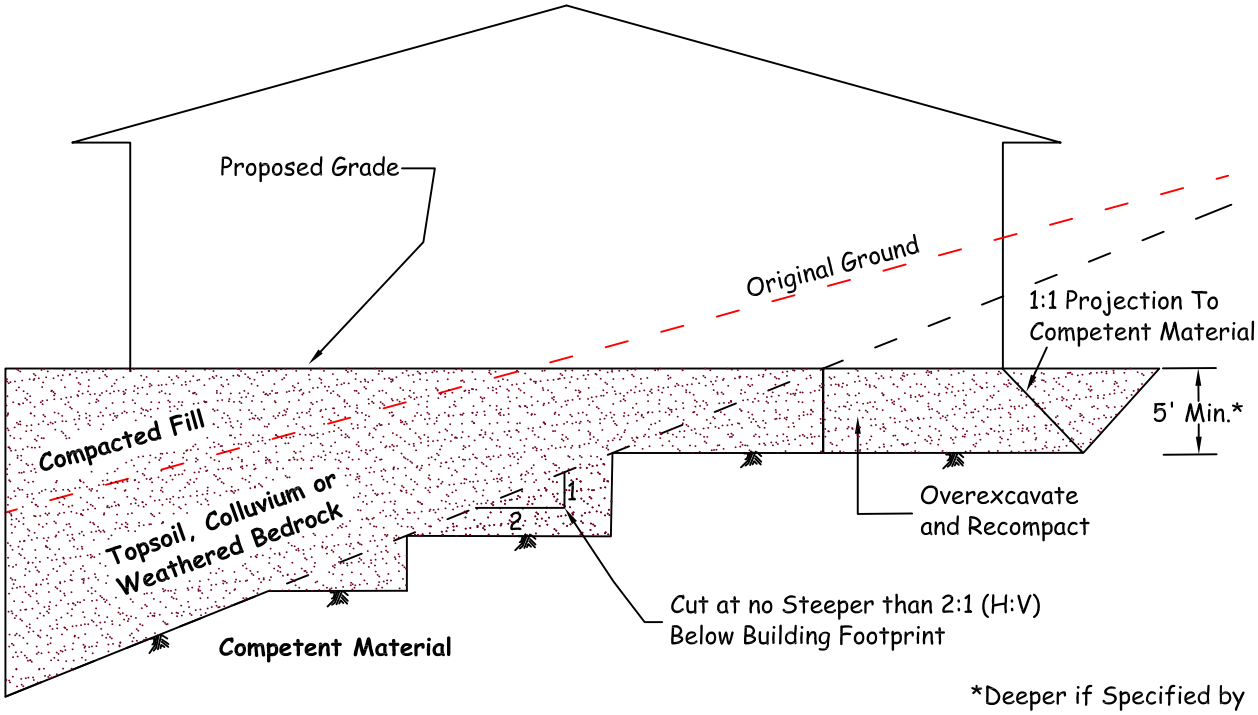
Cut Lot
(Exposing Unsuitable Soils at Design Grade)



Note 1: Removal Bottom Should be Graded With Minimum 2% Fall Towards Street or Other Suitable Area (as Determined by Soils Engineer) to Avoid Ponding Below Building

Note 2: Where Design Cut Lots are Excavated Entirely Into Competent Material, Overexcavation May Still be Required for Hard-Rock Conditions or for Materials With Variable Expansion Characteristics.

Cut/Fill Transition Lot



*Deeper if Specified by Soils Engineer

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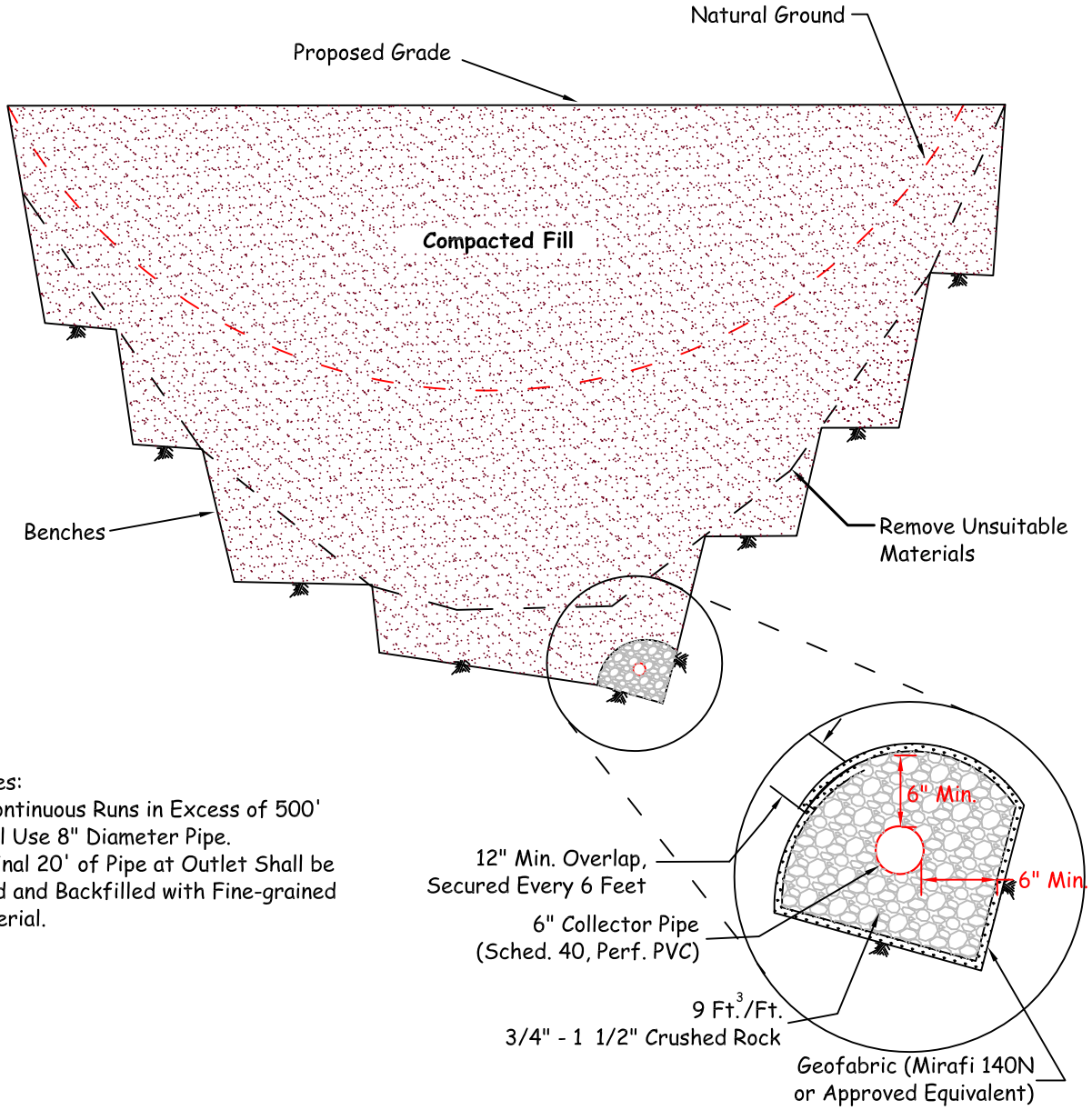
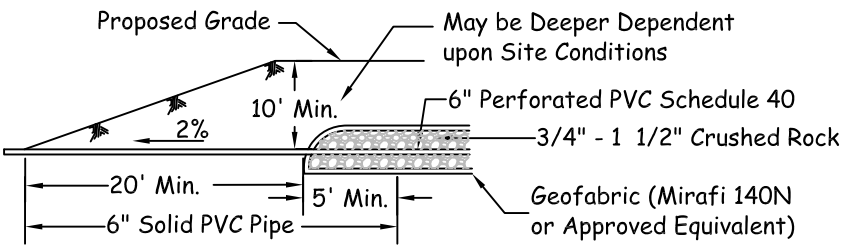
CUT AND TRANSITION LOT OVEREXCAVATION DETAIL



Notes:
1) Continuous Runs in Excess of 500' Shall Use 8" Diameter Pipe.
2) Final 20' of Pipe at Outlet Shall be Solid and Backfilled with Fine-grained Material.

Proposed Outlet Detail



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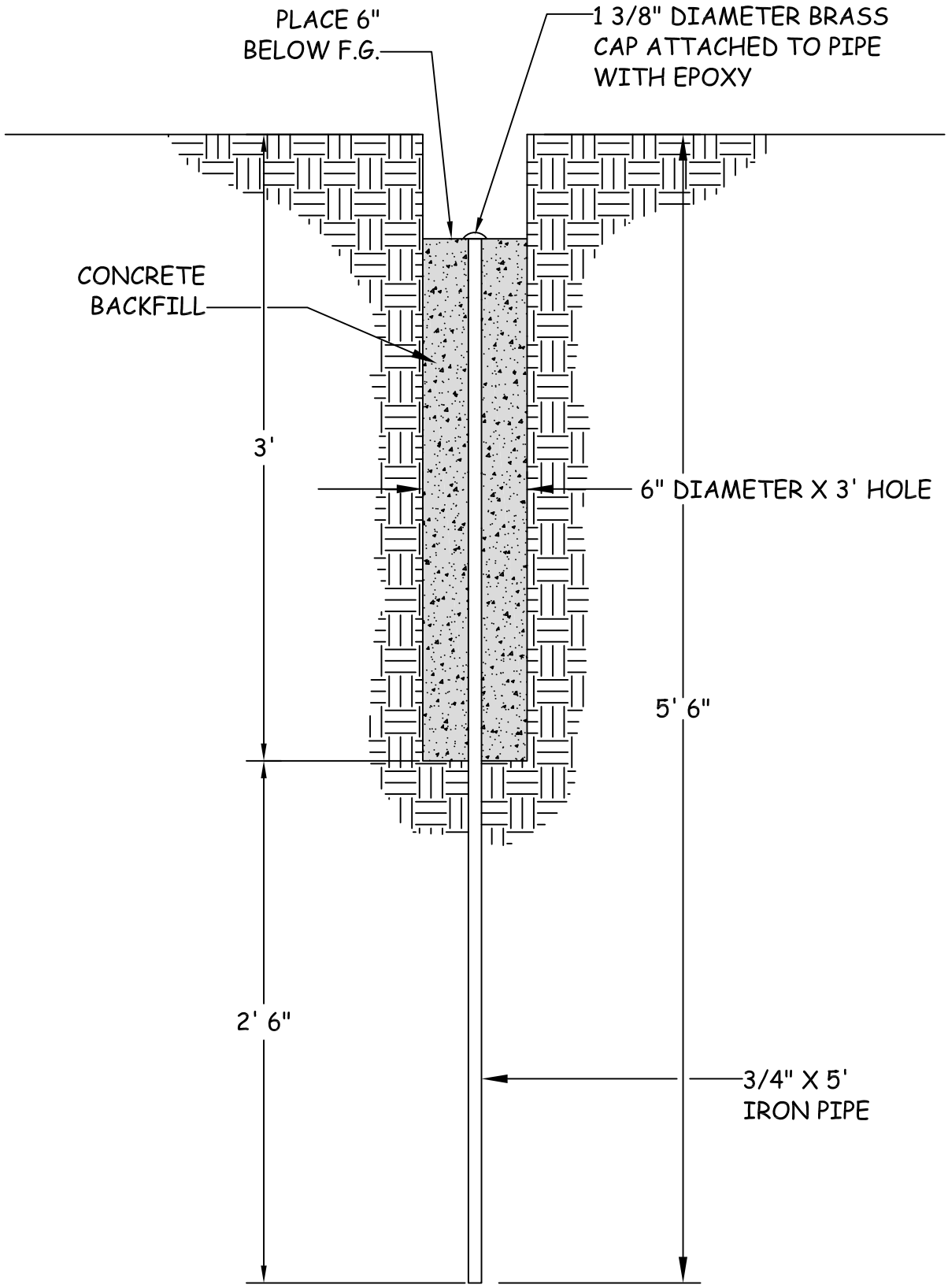
CANYON SUBDRAINS



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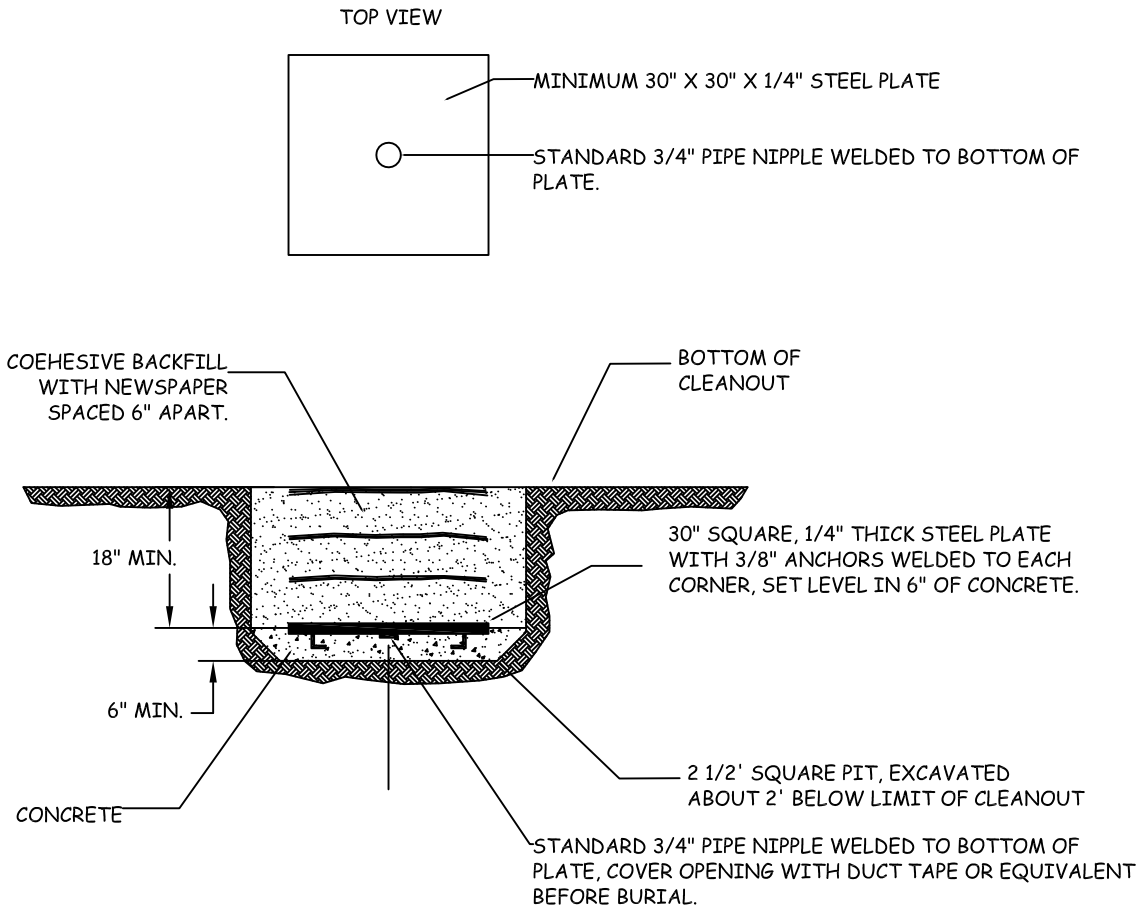
TYPICAL SURFACE SETTLEMENT MONUMENT



1. SURVEY FOR HORIZONTAL AND VERTICAL LOCATION TO NEAREST .01 INCH PRIOR TO BACKFILL USING KNOW LOCATIONS THAT WILL REMAIN INTACT DURING THE DURATION OF THE MONITORING PROGRAM. KNOW POINTS EXPLICITELY NOT ALLOWED ARE THOSE LOCATED ON FILL OR THAT WILL BE DESTROYED DURING GRADING.
2. IN THE EVENT OF DAMAGE TO SETTLEMENT PLATE DURING GRADING, CONTRACTOR SHALL IMMEDIATELY NOTIFY THE GEOTECHNICAL ENGINEER AND SHALL BE RESPONSIBLE FOR RESTORING THE SETTLEMENT PLATES TO WORKING ORDER.
3. DRILL TO RECOVER AND ATTACH RISER PIPE.

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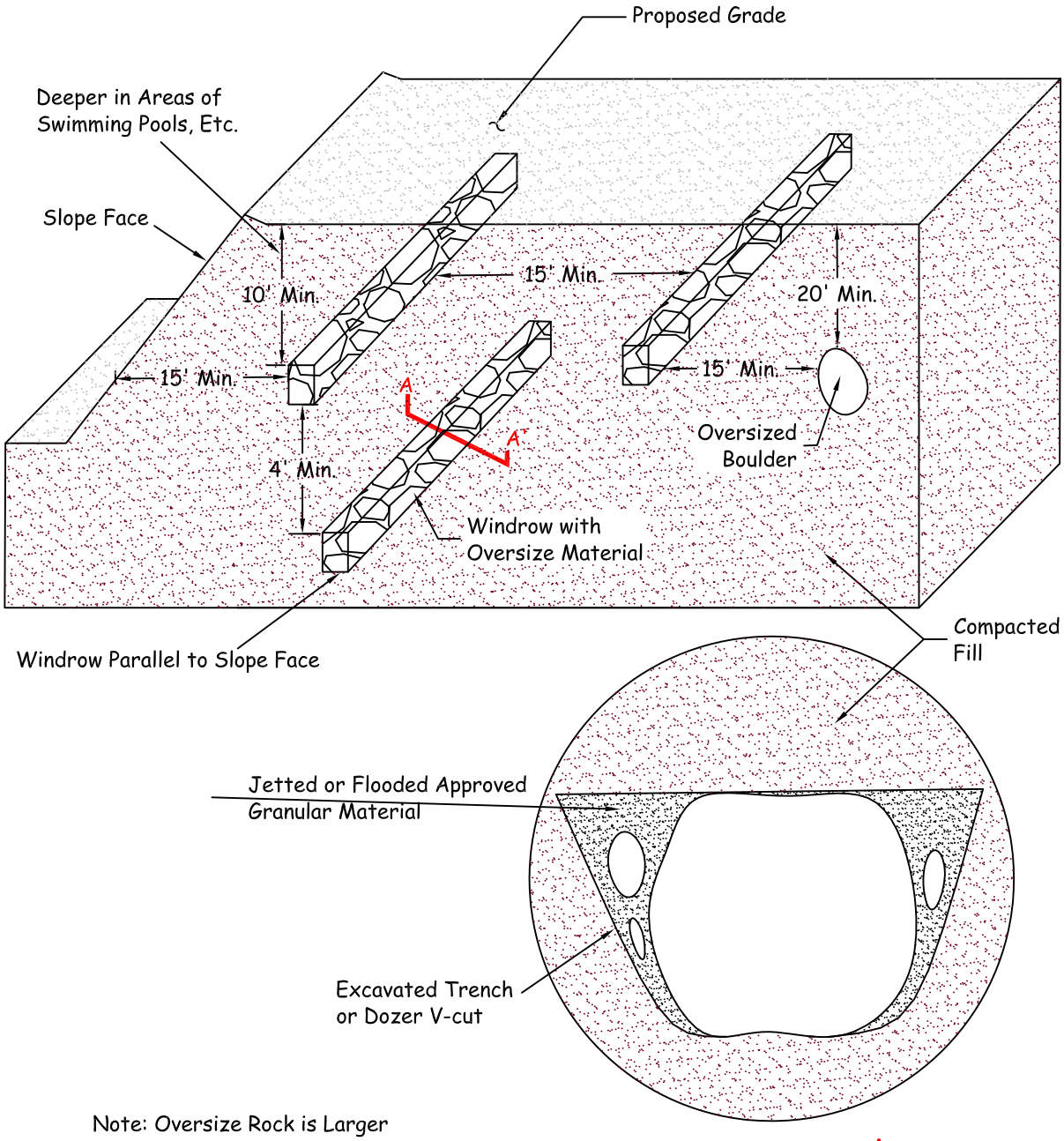
TYPICAL SETTLEMENT PLATE AND RISER



Note: Oversize Rock is Larger than 8" in Maximum Dimension.

Section A-A'

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OVERSIZE ROCK DISPOSAL DETAIL