PRELIMINARY GEOTECHNICAL SUBSURFACE EXPLORATION
BOULDER CREEK COMMONS
BOULDER, COLORADO
EEC PROJECT NO. 1122042

Prepared for:

BCC, LLC
1526 Spruce Street, Suite 260
Boulder, Colorado 80302

Attn: Mr. Michael Boyers

Prepared by:

Earth Engineering Consultants, Inc.
4396 Greenfield Drive
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June 15, 2012

EARTH ENGINEERING CONSULTANTS, INC.

BCC, LLC
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Attn: Mr. Michael Boyers - michael.boyers5@gmail.com

Re: Preliminary Geotechnical Subsurface Exploration
Boulder Creek Commons
Boulder, Colorado
EEC Project No. 1122042

Mr. Boyers:

Enclosed, herewith, are the results of the preliminary geotechnical subsurface exploration completed by Earth Engineering Consultants, Inc. (EEC) personnel for the referenced project. The proposed development is generally located east of Manhattan Drive and north of Illini Way in Boulder, Colorado. For this study, a total of fifteen (15) preliminary test borings were drilled at select locations within the proposed development parcel. The preliminary borings were drilled to approximate depths of 15 to 25 feet below existing site grades. This study was completed in general accordance with our proposal dated May 2, 2012.

In summary, the subsurface materials encountered in the preliminary test borings completed for this study consisted of a thin mantle (approximately 1-3 feet) of native silty and/or clayey sands, transitioning to a sand and gravel strata below. Intermittent cobbles were encountered across the site at varying depths in each of the borings. Claystone/siltstone/sandstone bedrock was encountered in the preliminary borings at approximate depths of 7 to 14 feet below site grades and extended to the depths explored, approximately 15 to 25 feet. Groundwater was encountered during drilling operations in each of the preliminary test borings at approximate depths of 2 to 8 feet below site grades.

Based on the materials observed within the preliminary boring locations and the anticipated foundation loads, we believe the proposed lightly loaded residential structures, having slab-on-grade construction could be supported on conventional type spread footings bearing on native subsoils or on a zone of engineered/controlled fill material placed and compacted as described within this report. Due to the relatively shallow depth to groundwater and the possibility of ground modifications to achieve stable bearing conditions at various locations, consideration could be given to the use of post-tensioned slab-on-grade foundation systems. Consideration could also be given to supporting the residential structures on a grade beam and straight shaft drilled pier foundation system extending into the underlying bedrock formation

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We understand earthwork improvements/ground modifications will include "cuts" on the order of zero (0) to two (2) feet along with "fills" ranging from zero (0) to approximate five (5) feet. In general the building pad/residential lot building footprints and interior roadway could receive up to about three (3) of fill material, with isolated areas possibly five (5) feet. The open-space areas will generally remain at or near existing "native" grades. Ground modification procedures, such as over-excavation and replacement of existing silty/clayey sand materials as approved engineered fill and placement of an approved imported fill material may be needed prior to placement of the new fill materials. Additionally, the slightly cohesive subsoil materials, especially the more "silt" containing subsoils, may be subject to strength loss and instability when wetted.

Preliminary geotechnical recommendations concerning design and construction of foundations and support of floor slabs and pavements are provided within the text of the enclosed report. We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the enclosed report, or if we can be of further service to you in any other way, please do not hesitate to contact us.

Very truly yours,
Earth Engineering Consultants, Inc.

David A. Richer, P.E.
Senior Geotechnical Engineer

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INTRODUCTION

The preliminary subsurface exploration for the proposed Boulder Creek Commons development to be located southwest of the existing East Boulder Community Park off of 55th Street in Boulder, Colorado has been completed. For this exploration, a total of fifteen (15) test borings were drilled at select locations within the proposed development parcel. The preliminary borings were drilled to approximate depths of 15 to 25 feet below existing site grades in conjunction with the 15 preliminary borings. Three (3) shallow soil percolation borings drilled to depths of approximately 3 to 5 feet below site grades in close proximity to B-5, B-8 and B-10 to evaluate infiltration characteristics. Individual boring logs and a site diagram indicating the approximate boring locations are provided with this report.

We understand The Boulder Creek Commons development includes approximately 18 acres to be developed for single family residential units with senior housing apartments within the eastern portion of the property. The development will include associated on-site roadways to accommodate the anticipated traffic flow. We understand earthwork improvements/ground modifications will include "cuts" on the order of zero (0) to two (2) feet along with "fills" ranging from zero (0) to approximate five (5) feet. In general the building pad/residential lot building footprints and interior roadway could receive up to about three (3) of fill material, with isolated areas possibly five (5) feet. The open-space areas will generally remain at or near existing "native" grades. A preliminary site layout is shown on the attached boring location diagram. An existing residential home site with outbuildings is located near the east boundary of the site in the proposed senior housing area.

We anticipate proposed site structures will have light foundation loads with continuous wall loads on the order of 1 to 3 kips per lineal foot and individual column loads on the order of 15 to 50 kips. Floor loads are expected to be light. Roadway traffic is expected to consist of low volumes of light vehicles with occasional trash truck and moving van loads.

The purpose of this report is to describe the subsurface conditions encountered in the preliminary borings, analyze and evaluate the test data and provide preliminary geotechnical recommendations concerning design and construction of the foundations and support of floor slabs and pavements.

EXPLORATION AND TESTING PROCEDURES

The boring locations were selected and located in the field by Earth Engineering Consultants, Inc. (EEC) personnel by pacing and estimating angles from identifiable site references. The approximate boring locations are indicated on the attached boring location diagram. The locations of the borings should be considered accurate only to the degree implied by the methods used to make the field measurements.

The test borings were completed using a truck mounted, CME-45 drill rig equipped with a hydraulic head employed in drilling and sampling operations. The boreholes were advanced using 4-inch nominal diameter continuous flight augers. Samples of the subsurface materials encountered were obtained using split barrel and California barrel sampling procedures. In the split barrel and California barrel sampling procedures, standard sampling spoons are advanced into the ground by means of a 140-pound hammer falling a distance of 30 inches. The number of blows required to advance the split barrel and California barrel samplers is recorded and is used to estimate the in-situ relative density of cohesionless soils and, to a lesser degree of accuracy, the consistency of cohesive soils and hardness of weathered bedrock. In the California barrel sampling procedure, relatively undisturbed samples are obtained in removable brass liners. All samples obtained in the field were sealed and returned to the laboratory for further examination, classification, and testing.

Moisture content tests were completed on each of the recovered samples. In addition, the unconfined strength of appropriate samples was estimated using a calibrated hand penetrometer. Atterberg Limits and washed sieve analysis tests were completed to evaluate the quantity and plasticity of fines in the subgrade samples. Swell/consolidation tests were completed to evaluate the potential for the subgrade materials to change volume with variation in moisture and load. Shallow soil percolation borings were completed in close proximity to borings B-5, B-8 and B-10. Results of the outlined field and lab tests are indicated on the attached boring logs and summary sheets.

As part of the testing program, all samples were examined in the laboratory by an engineer and classified in accordance with the attached General Notes and the Unified Soil Classification System, based on the soil's texture and plasticity. The estimated group symbol for the Unified Soil Classification System is indicated on the boring logs and a brief description of that classification system is included with this report. Classification of the bedrock was based on visual and tactual observation of disturbed samples and auger cuttings. Coring and/or petrographic analysis may reveal other rock types.

SUBSURFACE CONDITIONS

An EEC field engineer was on site during drilling to evaluate the subsurface conditions encountered and direct the drilling activities. Field logs prepared by EEC site personnel were based on visual and tactual observation of disturbed samples and auger cuttings. The final boring logs included with this report may contain modifications to the field logs based on the results of laboratory testing and evaluation. Based on the results of the field borings and laboratory evaluation, subsurface conditions can be generalized as follows.

Surficial materials at the boring locations generally consisted of sparse vegetation. Occasional cobbles were observed at ground surface. Brown to light brown clayey sand was typically encountered beneath the surface vegetation and extended to depths on the order of 1 to 5 feet below ground surface. The clayey sand was not observed in borings B-4 and B-6. Sand and gravel was encountered beneath the vegetation in borings B-4 and B-6 and beneath the clayey sand at the other boring locations. The sand and gravel contained occasional apparent cobbles. The sands and gravels were generally medium dense. Sandstone/siltstone/claystone bedrock was encountered beneath the granular soils at depths of approximately 7 to 14 feet below surface grades. The mixed bedrock was generally soft to moderately hard and extended to the bottom of the borings at depths of approximately 15 to 25 feet.

The stratification boundaries indicated on the boring logs represent the approximate locations of changes in soil and rock types. In-situ, the transition of materials may be gradual and indistinct.

GROUNDWATER CONDITIONS

Observations were made while drilling and a few days after completion of the borings to detect the presence and depth to hydrostatic groundwater. At the time of our field exploration and when checked a few days later, groundwater was encountered in the preliminary borings at approximate depths of 3 to 8 feet below site grades.

Fluctuations in groundwater levels can occur over time depending on variations in hydrologic conditions, and other conditions not apparent at the time of this report. Monitoring in cased borings sealed from the infiltration of surface water would be required to more accurately evaluate the depth and fluctuation in groundwater levels.

Zones of perched and/or trapped groundwater may occur at times in the subsurface soils overlying bedrock, on top of the bedrock surface or within permeable fractures in the bedrock materials. The location and amount of perched water is dependent upon several factors, including hydrologic conditions, type of site development, irrigation demands on or adjacent to the site and seasonal and weather conditions. The observations submitted with this report represent groundwater conditions at the time of the field exploration and may not be indicative of other times, or at other locations.

ANALYSIS AND RECOMMENDATIONS

General Considerations

The subject site is generally overlain by approximately 1 to 5 feet of native subsoils classified as silty and/or clayey sands. Groundwater was encountered at relatively shallow depths of 2 to 8 feet below present site grades.

High silt content soils can be problematic and certain precautions will be necessary during the design and construction phases of the site to reduce the potential impact/movement these soils may have. The slightly cohesive materials with elevated silt content are generally unstable at elevated moisture contents, susceptible to frost heave, (especially in areas where shallow groundwater is present) and silts are easily erodible.

Frost heave potential can be reduced by using non-frost susceptible soils, removing the water source or reducing the exposure to freezing temperatures. Placement of up to about 3 to 5-feet of fill material within the various residential building footprints will generally put the silty/clayey sands below a typical frost depth of 30 inches. Ground modification procedures as further discussed herein will be required to enhance the stability and structural integrity of these soils.

The on-site clayey sand would be suitable for reuse in select locations as fill material; however the silt soils should not be used as fill in structural related areas. The silt material could be reused in landscape portions of the site. Consideration could be given to the installation of an area underdrain system to lower or control the shallow groundwater levels as well as lower/decrease the moisture content of the overburden soils. Additional geotechnical engineering design recommendations regarding an area underdrain system can be provided upon request.

We understand earthwork improvements/ground modifications will include "cuts" on the order of zero (0) to two (2) feet along with "fills" ranging from zero (0) to approximate five (5) feet. In general the building pad/residential lot building footprints and interior roadway could receive up to about three (3) of fill material, with isolated areas possibly five (5) feet. The open-space areas will generally remain at or near existing "native" grades. The recommendations contained in this report assume that fill will be required, and will be placed as provided herein. If there are any significant deviations from the assumptions concerning fill placement when the final site plan is developed, the conclusions and recommendations of this report should be reviewed and confirmed/modified as necessary to reflect the final planned site configuration.

Swell – Consolidation Test Results

The swell-consolidation test is performed to evaluate the swell or collapse potential of soils or bedrock for determining foundation, floor slab and pavement design criteria. In this test, relatively undisturbed samples obtained directly from the California sampler or thin-walled tubes are placed in a laboratory apparatus and inundated with water under a predetermined load. The swell-index is the resulting amount of swell or collapse after the inundation period, expressed as a percent of the sample's initial thickness. After the inundation period additional incremental loads are applied to evaluate the swell pressure and consolidation.

For this preliminary assessment, we conducted four (4) swell-consolidation tests on relatively undisturbed samples obtained from the siltstone/sandstone/claystone bedrock. The swell index values for the samples analyzed revealed low to moderate swell characteristics on the order of 0.0 to (+) 1.5%. The (+) test results indicate the soil materials swell potential characteristics, while the (-) test results indicate the soil materials tendency to consolidate upon inundation with water and increased loads.

Colorado Association of Geotechnical Engineers (CAGE) uses the following information in Table II, to provide uniformity in terminology between geotechnical engineers to provide a relative correlation of slab performance risk to measured swell. "The representative percent swell values are not necessarily measured values; rather, they are a judgment of the swell of the soil and/or bedrock profile likely to influence slab performance." Geotechnical engineers use this information to also evaluate the swell potential risks for foundation performance based on the risk categories.

TABLE II: Recommended Representative Swell Potential Descriptions and Corresponding Slab Performance Risk Categories

Slab Performance Risk Category	Representative Percent Swell (500 psf Surcharge)	Representative Percent Swell (1000 psf Surcharge)
Low	0 to < 3	0 < 2
Moderate	3 to < 5	2 to < 4
High	5 to < 8	4 to < 6
Very High	> 8	> 6

Based on the laboratory test results, the in-situ samples analyzed for this project at current moisture contents and dry densities generally were within the low range. The sampling and testing completed for this preliminary evaluation was limited. It should be noted that intermittent claystone lenses within the bedrock formation may exhibit moderate to high swell-index values. A more complete testing protocol would be required during final design stages of the project.

Site Preparation

Demolition of the existing residence and various outbuildings, etc., should include complete removal of all foundation systems within the proposed development area. This should include removal of any loose backfill found adjacent to existing foundations. All materials derived from

the demolition of all existing structures should be removed from the site and either not be allowed for use in any on-site fills, or processed and re-evaluated for possible reuse.

After stripping any vegetation and/or topsoil from the site and completing all cuts and prior to placement of any fill or site improvements, we recommend the exposed soils be scarified to a minimum depth of 12-inches, adjusted in moisture content to within ±2% of standard Proctor optimum moisture content and compacted to at least 95% of the material's standard Proctor maximum dry density as determined in accordance with ASTM Specification D-698. Due to potential soft/compressible characteristics of native cohesive clay and silt soils, ground stabilization mechanism may be necessary to create a working platform for construction equipment. Placement of a granular material, such as a 3-inch minus recycled concrete or equivalent, may be necessary as a subgrade enhancement layer embedded into the soft soils, prior to placement of additional fill material or operating heavy earth-moving equipment. Supplemental recommendations can be provided upon request.

Fill soils required for developing the building, pavement and site subgrades, after the initial zone has been stabilized, should consist of approved, low-volume-change materials, which are free from organic matter and debris. It is our opinion the on-site silt, clayey sand soils could be used as general site fill outside of the building areas, provided adequate moisture treatment and compaction procedures are followed. We recommend structural fill materials be placed and compacted within the building footprint(s) and consist of essentially granular soils with less than 20% material passing the number 200 sieve, such as a CDOT Class 7 aggregate base course (ABC) type material or equivalent. We recommend fill materials be placed in loose lifts not to exceed 9 inches thick and adjusted in moisture content, generally +/- 2% of optimum moisture content, and compacted to at least 95% of the materials maximum dry density as determined in accordance with ASTM Specification D-698, the standard Proctor procedure.

Care should be exercised after preparation of the subgrades to avoid disturbing the subgrade materials. Positive drainage should be developed away from the structures to avoid wetting of subgrade materials. Subgrade materials becoming wet subsequent to construction of the site structure can result in unacceptable performance.

In areas where excavations will extend below existing groundwater table, placement of cleaner granular fill material would be desirable. Those materials should be placed in lifts and compacted to at least 70% relative density.

Areas of deeper fills may experience settlement from underlying native soils and within the placed fill materials. Settlement on the order of 1-inch or more per each 10 feet of fill depth would be estimated. The rate of settlement will be dependent on the type of fill material placed and construction methods. This estimate is only for the fill materials, underlying softer subsoils beneath the fill zone would show additional settlement. Granular soils will consolidate essentially immediately upon placement of overlying loads. Cohesive soils will consolidate at a slower rate.

Areas of shallow groundwater will also need to be addressed in the development; consideration could be given to the installation of an area underdrain system. Additional geotechnical engineering recommendations can be provided upon request.

Foundation Systems – General Considerations

The site appears acceptable for the proposed construction based on the results of our field exploration and review of the proposed development plans. The slightly cohesive subsoils with elevated silt contents in this area will require particular attention in the design and construction to reduce the amount of movement, should the subsoils become elevated in moisture content.

The following foundation systems were evaluated for use on the site; however final subsurface explorations should be performed after building footprints have been more defined and actual design loads determined:

- Conventional type spread footings bearing on native subsoils or engineered controlled fill material.
- Post-Tensioned-Slab foundation system bearing on native subsoils or engineered controlled fill material, and
- Grade beams and straight shaft piers/caissons drilled into the bedrock

Preliminary Foundation Systems - Conventional Type Spread Footings

With the anticipated loads, the type of construction proposed and the soil conditions encountered, the proposed lightly loaded residential type structures could probably be supported using a conventional type spread footing foundation system bearing on approved native subsoils, approved moisture conditioned engineered/controlled fill material, or on a zone of approved imported fill material. Consideration should be given for placement of a uniform zone of material placed/prepared and compacted beneath the entire building footprint(s) to reduce differential movement. The depth of the fill material may vary with each building footprint/lot and owners risk tolerance. We would expect a minimum depth of 3 feet below foundation bearing elevation. However, a final/more thorough subsurface exploration should be performed for each residential lot after final design layout of the proposed development and actual design loads are more defined.

It is our opinion, the on-site upper native cohesive subsoils, and/or moisture conditioned engineered fill material would be capable of supporting a foundation systems designed using a maximum net allowable bearing pressure ranging from 1,500 to 2,500 psf. For preliminary design purposes, a minimum dead load pressure may not be warranted. Higher allowable bearing pressures could be achieved with the use of imported essentially granular structural fill materials.

For fill material placement, full-time quality control measures should be performed to test for compliance to the project specifications. Footings for each residential structure should be placed on similar soils to reduce the potential for differential movement between soil types. Footings should be proportioned to reduce differential foundation movement. Proportioning on the basis of equal total movement is recommended; however, proportioning to relative constant dead-load pressure will also reduce differential movement between adjacent footings. Quality control/field monitoring should include but not limited to moisture content, dry density, percent compaction, swell mitigation to less than 1% when inundated and pre-loading at 500 psf and less than 2% when inundated and pre-loaded at 150 psf, and lift thicknesses for the fill material being placed.

Areas of loose soils may be encountered at foundation bearing depths after excavation is completed for the residential footings. When such conditions exist beneath planned footing areas, the subgrade soils should be compacted prior to placement of the foundation system. In addition, large cobbles or boulder sized materials may be encountered beneath footing areas. Such conditions could create point loads on the bottom of footings, increasing the potential for

differential foundation movement. If such conditions are encountered in the footing excavations, the cobbles and/or boulder sized materials should be removed and be replaced with engineered fill, conditioned to near optimum moisture content and compacted.

Exterior footings and foundations in unheated areas must be protected from frost action. The normal depth of frost protection in this area is estimated to be around 30-inches. Continuous wall footings would have minimum width in the range of 16-inches. Isolated column pads would have minimum dimensions on the order of 24-inches by 24-inches.

In the site design, it is imperative that positive drainage be maintained during construction and throughout the life of the structures to minimize the potential for surface water infiltration. It is EEC's opinion that sub-excavation and replacement with controlled/engineered fill material combined with good positive drainage will reduce the settlement/expansive potential and will create a more stable bearing stratum. However, movement potential cannot be eliminated in expansive and/or consolidation prone subgrade materials.

Preliminary Foundation Systems – Post-Tensioned-Slabs (PTS)

Due to the relatively shallow depths to groundwater and depending upon the amount fill material placed to elevate the residential building footprints, consideration could be given to the use of a post-tensioned-slab (PTS) on grade foundation system. Preliminary design criteria for the use of a PTS foundation for the "slightly compressible soil" case are presented in the following table. These values should not be used for final design foundations, only for preliminary design purposes.

Table III – Preliminary PTS Design Criteria		
Maximum Allowable Bearing Pressure, psf		1,000 psf
Edge Moisture Variation Distance, e_m	**Center Lift Condition, ft.**	5.5 feet
	Edge Lift Condition, ft.	2.5 feet
Total Soil Movement, δ		1 to 1-1/2-inches
Slab-Subgrade friction coefficient, μ	**on polyethelene sheeting**	0.75
	on cohesionless soils – (sands)	1.0
	on cohesive soils – (clays)	2.0

Post-tensioned slabs, thickened or turn-down edges and/or interior beams should be designed and constructed with the requirements of the Post-Tensioning Institute (PTI) and the American Concrete Institute (ACI).

Preliminary Foundation Systems – Drilled Piers/Caissons

As an alternative to the use of a spread footing or a PTS system, and depending upon final layout, amount of fill material placed and compacted, and design loads for each residential site, consideration could also be given to supporting the proposed residential structures on a grade beam and straight shaft drilled pier/caisson foundation system extending into the underlying bedrock formation. The bedrock stratum varies across the site, generally from about 7 to 14 feet below existing site grades; thus requiring piers, possibly in the range of about 20 to 30 feet depending upon actual design loads. For axial compression loads, we expect the drilled piers could be designed using maximum end bearing pressures ranging between 15,000 to 30,000 pounds per square foot (psf), along with a skin-friction values ranging between 1,500 to 3,000 psf for the portion of the pier extended into the underlying firm and/or harder bedrock formation. Straight shaft piers are typically drilled a minimum of 10 to 15-feet into competent or harder bedrock and generally extend to minimum depths of 25-feet or greater below finish site grades. Final, lot-specific drilled pier recommendations, including laboratory testing, (i.e., swell-consolidation characteristics on the bedrock formation), would be provided after each lot has completed an independent subsurface exploration. The values provided herein are preliminary and should be confirmed at the time of a final exploration for each residential lot.

Drilling caissons to design depth should be possible with conventional heavy-duty single flight power augers equipped with rock teeth on the majority of the site. However, areas of well-cemented sandstone bedrock lenses may be encountered throughout the site at various depths where specialized drilling equipment and/or rock excavating equipment may be required. Excavation penetrating the well-cemented sandstone bedrock may require the use of specialized heavy-duty equipment, together with rock augers and/or core barrels.

Drilled shafts will most likely not remain open without stabilizing measures. Groundwater was encountered at varying depths at the time of our drilling operations. Therefore, encountering groundwater should be expected during drilled pier installation. Temporary casing could be needed to seal off the drill shafts from groundwater seams. Allowing water depths to stabilize

and using tremie procedures to place the concrete could also be considered. However, pier concrete should be placed soon after completion of drilling and cleaning.

Preliminary Floor Slab Design and Construction

As presented on the boring logs and the swell-consolidation test results, the subsurface soils on the site exhibited low expansive and slightly consolidation prone characteristics. Therefore, subgrade modifications and positive drainage away from the building footprint(s) to reduce the potential for surface water infiltration from impacting the underlying slab subgrade material should be expected.

Use of a structural floor system, which is structurally supported independent of the subgrade soils, is a positive means of reducing the potentially detrimental effects of floor movement. Structural floors should be used for any residential building where risk of some floor movement would not be acceptable.

Floor slab and pavement subgrades should be prepared as outlined under "Site Preparation" in this report. As opposed to the use of a structural floor slab, assuming a greater potential risk for movement, we suggest ground modifications such either an overexcavation and replacement procedure, or elevating each site with a zone of imported structural fill material. For the over-excavation and replacement method, we would expect areas beneath the floor slabs, depending upon building location and subsurface profile as encountered during the final/more thorough field exploration would be undercut to the granular soil layer. The overexcavated areas would be backfilled with moisture conditioned on-site cohesive subsoils or imported structural fill to provide stable subgrades. Depending upon the final grade for each residential lot, placement and compaction of at least 3-feet of imported structural fill could be considered for use a stable/slab support zone. An underslab gravel layer or thin leveling course could be used underneath the concrete floor slabs and concrete pavement areas to provide a leveling course for the concrete placement. Greater or lesser overexcavation depths may be appropriate for each specific residential lot.

Ground modification procedures, such as over-excavation and moisture conditioning measures will be required to reduce post-construction movement. However, post-construction movement cannot be completely eliminated. The silty/clayey sand soil materials may also be subject to strength loss and instability when wetted.

Preliminary Pavements – Design and Construction Recommendations

We expect the site pavements will include areas designated as jurisdictional local residential roadways. For preliminary purposes we assumed equivalent daily load axle (EDLA) rating of 10 for the pavement improvement area on-site. A final pavement design exploration and report will be required for the development.

Proofrolling and recompacting the subgrade is recommended immediately prior to placement of the aggregate road base section. Soft or weak areas delineated by the proofrolling operations should be undercut or stabilized in-place to achieve the appropriate subgrade support. Based on the subsurface conditions encountered at the site, and the laboratory test results, it is suggested for preliminary design purposes that the on-site pavement improvement areas, (i.e., the local residential roadway), be designed using an R-value of 10. That value will depend on the materials used to develop final site grades.

Hot Mix Asphalt (HMA) underlain by crushed aggregate base course with or without a fly ash treated subgrade, and non-reinforced concrete pavement underlain by an approved subgrade zone may be feasible alternatives for the proposed on-site pavement areas. Eliminating the risk of movement within the proposed pavement section may not be feasible due to the characteristics of the subsurface materials; but it may be possible to further reduce the risk of movement if significantly more expensive subgrade stabilization measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request.

Pavement design methods are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support. The support characteristics of the subgrade for pavement design do not account for shrink/swell movements of an expansive clay subgrade or consolidation of a wetted subgrade. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade. It is, therefore, important to minimize moisture changes in the subgrade to reduce shrink/swell movements.

Suggested preliminary pavement sections are provided below in Table IV. HMA pavements may show rutting and distress in truck loading and turning areas. Concrete pavements should be

considered in those areas. A final pavement design thickness evaluation will be determined when a pavement design exploration is completed.

TABLE IV – PRELIMINARY PAVEMENT SECTIONS	
	Local Residential Roadways
EDLA	10
Reliability	75%
Resilient Modulus	3562
PSI Loss – (Initial 4.5, Terminal 2.3)	2.2
Design Structure Number	2.63
Composite Section without Fly Ash – Alternative A	
Hot Mix Asphalt (HMA) Grading S (75) PG 58-28	4"
Aggregate Base Course ABC – CDOT Class 5 or 6	8”
Design Structure Number	(2.64)
Composite Section with Fly Ash – Alternative B	
Hot Mix Asphalt (HMA) Grading S (75) PG 58-28	4"
Aggregate Base Course ABC – CDOT Class 5 or 6	6"
Fly Ash Treated Subgrade	12″
Design Structure Number	(3.02)
PCC (Non-reinforced) – placed on an approved subgrade layer	5-1/2″

Site grading is generally accomplished early in the construction phase. However as construction proceeds, the subgrade may be disturbed due to utility excavations, construction traffic, desiccation, or rainfall. As a result, the pavement subgrade may not be suitable for pavement construction and corrective action will be required. The subgrade should be carefully evaluated at the time of pavement construction for signs of disturbance, such as but not limited to drying, or excessive rutting. If disturbance has occurred, pavement subgrade areas should be reworked, moisture conditioned, and properly compacted to the recommendations in this report immediately prior to paving.

Infiltration Characteristics for On-Site Detention Ponds

We understand as part of the stormwater run-off and on-site detention pond, that infiltration of flows into the underlying granular strata is being considered. To assist in the design phase, we were requested to evaluate the soil percolation characteristics at select locations across the site. EEC personnel during the field exploration/drilling phase drilled and evaluated shallow soil percolation borings in close proximity to boring B-5, B-8, and B-10. Subsurface conditions within the planned

stormwater infiltration areas generally consisted of silty, clayey sand with gravel transitioning to "cleaner" sand with gravel and cobbles at increased depths. The granular strata extended to the bedrock formation below.

For this project, we conducted three (3) soil percolation tests within the zone of materials in which the proposed infiltration/detention ponds will be constructed. Soil percolation testing within these proposed infiltration/detention pond areas, conducted for a period of approximately 60 minutes after an initial "24-hour soaking period", are summarized as follows:

Percolation Test Results			
Test Hole	**Depth (feet)**	**Soil Classification**	**Percolation Rate (minutes/inch)**
B-5	1 to 5	Silty Clayey Sand with Gravel (SM-SC)	Less than 5
B-8			
B-10			

The percolation rates in detention ponds and/or infiltration basins can be affected over time by several factors including, but not limited to siltation and vegetative growth. For design purposes we would suggest a soil percolation rate of approximately 10 to 15 minutes per inch be used for the on-site silty, clayey sand with gravel subsoils encountered within the detention pond area.

Other Considerations

Positive drainage should be developed away from the structures and pavement areas with a minimum slope of 1-inch per foot for the first 10-feet away from the improvements in landscape areas. Care should be taken in planning of landscaping adjacent to the building and parking and drive areas to avoid features which would pond water adjacent to the pavement, foundations or stemwalls. Placement of plants which require irrigation systems or could result in fluctuations of the moisture content of the subgrade material should be avoided adjacent to site improvements. Lawn watering systems should not be placed within 5 feet of the perimeter of the building and parking areas. Spray heads should be designed not to spray water on or immediately adjacent to the structure or site pavements. Roof drains should be designed to discharge at least 5 feet away from the structure and away from the pavement areas.

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. Excavation penetrating the bedrock or cemented soils may require the use of specialized heavy-duty equipment, together with drilling and blasting to facilitate rock break-up and removal. Consideration should be given to obtaining a unit price for difficult excavation in the contract documents for the project.

Some additional effort may be necessary to extract boulder sized materials, particularly in deep narrow excavations such as utility trenches. Consideration should be given to obtaining a unit price for difficult excavation in the contract documents for the project.

Excavations into the on-site soils may encounter a variety of conditions. Excavations into the on-site soils may encounter caving soils and most likely shallow groundwater, depending upon the final depth of excavation. The individual contractor(s) should be made responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. All excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards.
The individual contractor(s) should be made responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. All excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards.

Seismic Considerations

The project site is located in Seismic Risk Zone I of the Seismic Zone Map of the United States as indicated by the 1997 Uniform Building Code. Based upon the nature of the subsurface materials, Soil Profile Type "Sc" should be used for the design of structures for the proposed project (1997 Uniform Building Code, Table No. 16-J). A site classification "C" would be appropriate for the design of structures for the proposed project (2003 International Building Code, Table No. 1615.1.1).

GENERAL COMMENTS

The analysis and recommendations presented in this report are based upon the data obtained from the soil borings performed at the indicated locations and from any other information discussed in

this report. This report does not reflect any variations, which may occur between borings or across the site. The nature and extent of such variations may not become evident until construction. If variations appear evident, it will be necessary to re-evaluate the recommendations of this report.

It is recommended that the geotechnical engineer be retained to review the plans and specifications so comments can be made regarding the interpretation and implementation of our geotechnical recommendations in the design and specifications. It is further recommended that the geotechnical engineer be retained for testing and observations during earthwork and foundation construction phases to help determine that the design requirements are fulfilled.

This report has been prepared for the exclusive use of BCC, LLC for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranty, express or implied, is made. In the event that any changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report are modified or verified in writing by the geotechnical engineer. Additional exploration/evaluation will be necessary to provide specific recommendations for individual users/buildings in part, to match owner expectations with geotechnical recommendations.

DRILLING AND EXPLORATION

DRILLING & SAMPLING SYMBOLS:

SS: Split Spoon - 13/8" I.D., 2" O.D., unless otherwise noted
ST: Thin-Walled Tube - 2" O.D., unless otherwise noted
R: Ring Barrel Sampler - 2.42" I.D., 3" O.D. unless otherwise noted
PA: Power Auger
HA: Hand Auger
DB: Diamond Bit = 4", N, B
AS: Auger Sample
HS: Hollow Stem Auger
PS: Piston Sample
WS: Wash Sample
FT: Fish Tail Bit
RB: Rock Bit
BS: Bulk Sample
PM: Pressure Meter
WB: Wash Bore

Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. split spoon, except where noted.

WATER LEVEL MEASUREMENT SYMBOLS:

WL : Water Level
WCI: Wet Cave in
DCI: Dry Cave in
AB : After Boring
WS : While Sampling
WD : While Drilling
BCR: Before Casing Removal
ACR: After Casting Removal

Water levels indicated on the boring logs are the levels measured in the borings at the time indicated. In pervious soils, the indicated levels may reflect the location of ground water. In low permeability soils, the accurate determination of ground water levels is not possible with only short term observations.

DESCRIPTIVE SOIL CLASSIFICATION

Soil Classification is based on the Unified Soil Classification system and the ASTM Designations D-2488. Coarse Grained Soils have move than 50% of their dry weight retained on a #200 sieve; they are described as: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are described as : clays, if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse grained soils are defined on the basis of their relative in-place density and fine grained soils on the basis of their consistency. Example: Lean clay with sand, trace gravel, stiff (CL); silty sand, trace gravel, medium dense (SM).

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Consistency
< 500	Very Soft
500 - 1,000	Soft
1,001 - 2,000	Medium
2,001 - 4,000	Stiff
4,001 - 8,000	Very Stiff
8,001 - 16,000	Very Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS:

N-Blows/ft	Relative Density
0-3	Very Loose
4-9	Loose
10-29	Medium Dense
30-49	Dense
50-80	Very Dense
80 +	Extremely Dense

PHYSICAL PROPERTIES OF BEDROCK

DEGREE OF WEATHERING:

Slight	Slight decomposition of parent material on joints. May be color change.
Moderate	Some decomposition and color change throughout.
High	Rock highly decomposed, may be extremely broken.

HARDNESS AND DEGREE OF CEMENTATION:

Limestone and Dolomite:

Hard	Difficult to scratch with knife.
Moderately Hard	Can be scratched easily with knife.
Hard	Cannot be scratched with fingernail.
Soft	Can be scratched with fingernail.

Shale, Siltstone and Claystone:

Hard	Can be scratched easily with knife, cannot be scratched with fingernail.
Moderately Hard	Can be scratched with fingernail.
Soft	Can be easily dented but not molded with fingers.

Sandstone and Conglomerate:

Well Cemented	Capable of scratching a knife blade.
Cemented	Can be scratched with knife.
Poorly Cemented	Can be broken apart easily with fingers.

UNIFIED SOIL CLASSIFICATION SYSTEM

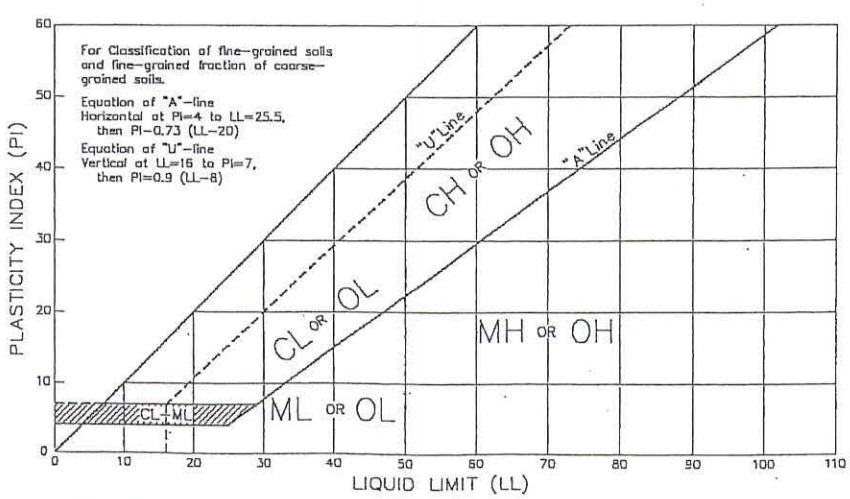
Criteria for Assigning Group Symbols and Group names Using Laboratory Tests				Soil Classification: Group Symbol	Soil Classification: Group Name
Coarse-Grained Soils more than 50% retained on No. 200 sieve	Gravels more than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines	$Cu \geq 4$ and $< Cc \leq 3$ [E]	GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]	GP	Poorly-graded gravel [F]
		Gravels with Fines more than 12% fines	Fines classify as ML or MH	GM	Silty gravel, G,H
			Fines classify as CL or CH	GC	Clayey Gravel [F,G,H]
	Sands 50% or more coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines	$Cu \geq 6$ and $1 < Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]	SP	Poorly-graded sand [I]
		Sands with Fines more than 12% fines	Fines classify as ML or MH	SM	Silty sand [G,H,I]
			Fines classify as CL or CH	SC	Clayey sand [G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid Limit less than 50	inorganic	PI>7 and plots on or above "A"Line [J]	CL	Lean clay [K,L,M]
			PI<4 or plots below "A"Line [J]	ML	Silt [K,L,M]
		organic	Liquid Limit – oven dried / Liquid Limit – not dried <0.75	OL	Organic clay [K,L,M,N] / Organic silt [K,L,M,O]
	Silts and Clays Liquid Limit 50 or more	inorganic	PI plots on or above "A"Line	CH	Fat clay [K,L,M]
			PI plots below "A"Line	MH	Elastic Silt [K,L,M]
		organic	Liquid Limit – oven dried / Liquid Limit – not dried <0.75	OH	Organic clay [K,L,M,P] / Organic silt [K,L,M,Q]
Highly organic soils		Primarily organic matter, dark in color, and organic odor		PT	Peat

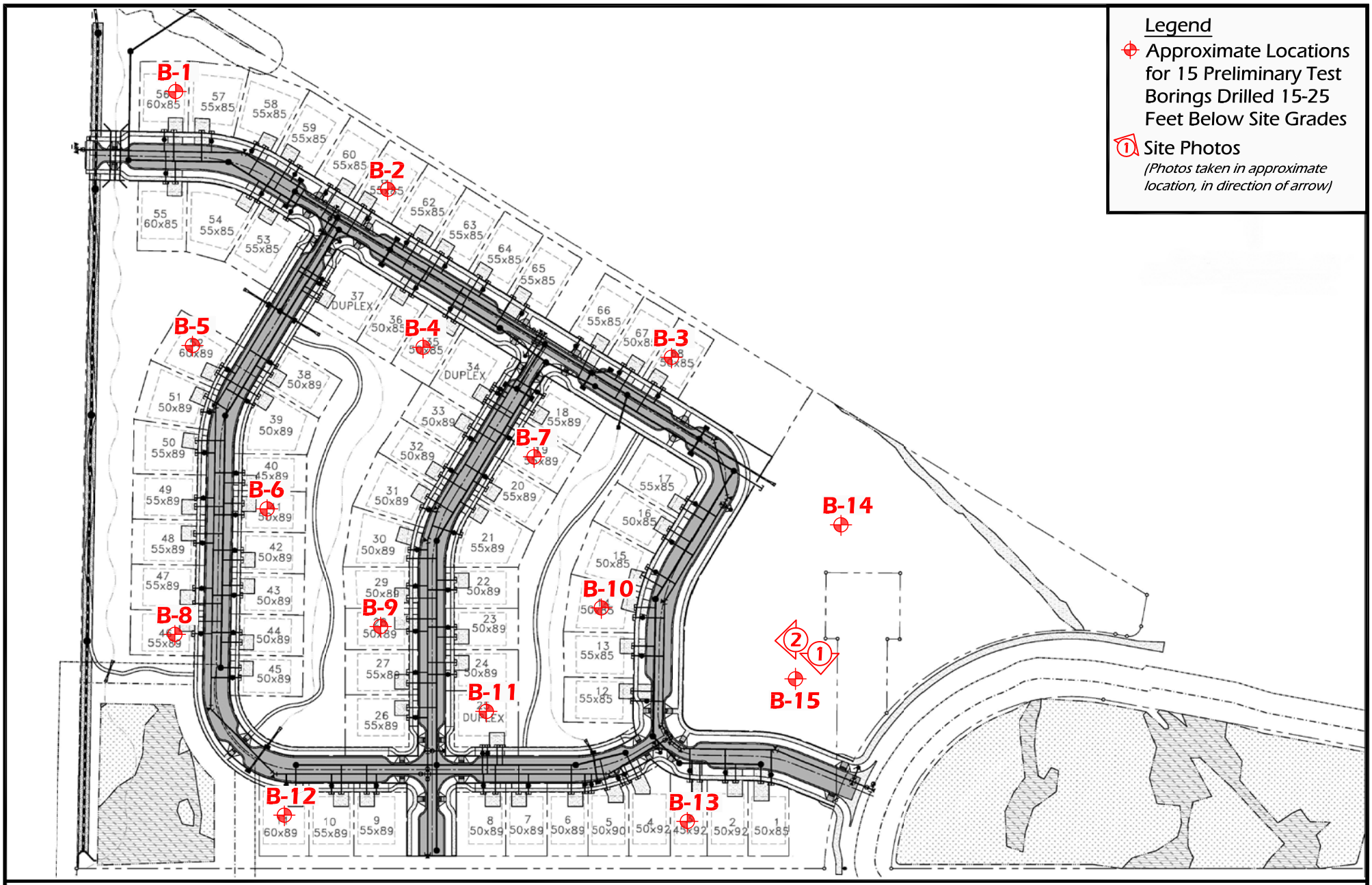
[A]Based on the material passing the 3-in. (75-mm) sieve
[B]If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C]Gravels with 5 to 12% fines required dual symbols:
GW-GM well graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly-graded gravel with silt
GP-GC poorly-graded gravel with clay
[D]Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_1$ $Cc = \frac{(D_{30})}{D \times D}$

[F]If soil contains ≥15% sand, add "with sand" to group name.
[G]If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H]If fines are organic, add "with organic fines" to group name
[I]If soil contains >15%gravel, add "with gravel" to group name.
[J]If Atterberg limits plots shaded area, soil is a CL-ML, silty clay.

[K]If soil contains 15 to 29%plus No. 200, add "with sand" or "with gravel", whichever is predominant.
[L]If soil contains ≥ 30" plus No. 200 predominantly sand, add "sandy to group name.
[M]If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravely" to group name.
[N]PI≥4 and plots on or above "A" line.
[O]PI≤4 or plots below "A" line.
[P]Pi plots on or above "A" line.
[Q]PI plots below "A" line.





North
Not to Scale

Boring Location Diagram
Boulder Creek Commons
Boulder, Colorado
EEC Project Number: 1122042 Date: May 2012

EARTH ENGINEERING CONSULTANTS, INC.

BOULDER CREEK COMMONS
BOULDER, COLORADO
EEC PROJECT NO. 1122042
MAY 2012

BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-1		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/16/2012	WHILE DRILLING	5'
AUGER TYPE: 4" CFA	FINISH DATE 5/16/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SPARSE VEGETATION											
CLAYEY SAND (SC)		1									
brown		2									
SAND & GRAVEL (SP-GP)		3									
brown		4									
medium dense											
with apparent cobbles			Clippings	--	4.8						
		5									
		6									
		7									
		8									
		9									
			Clippings	--	4.5						
		10									
		11									
		12									
		13									
		14									
SANDSTONE / SILTSTONE / CLAYSTONE			Clippings	8500	20.7						
brown / rust / grey		15									
soft to moderately hard		16									
		17									
		18									
		19									
			--								
BOTTOM OF BORING DEPTH 19.5'		20									
		21									
		22									
		23									
		24									
		25									

Earth Engineering Consultants

BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-2		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/16/2012	WHILE DRILLING	5.0'
AUGER TYPE: 4" CFA	FINISH DATE 5/16/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SILTY CLAYEY SAND (SM-SC)		1									
brown		2									
SAND & GRAVEL (SP-GP)		3									
brown		4									
medium dense											
with apparent cobbles	SS	**5**	**50/9.5"**	**--**	**3.3**						
		6									
		7									
		8									
		9									
	SS	**10**	**Clippings**	**--**	**8.5**						
		11									
		12									
		13									
		14									
SANDSTONE / SILTSTONE / CLAYSTONE	SS	**15**	**--**								
grey		16									
soft to moderately hard		17									
		18									
		19									
	SS	**20**	**50/5"**	**9000+**	**13.6**						
BOTTOM OF BORING DEPTH 20.5'		21									
		22									
		23									
		24									
		25									

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BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-3		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/11/2012	WHILE DRILLING	5.0'
AUGER TYPE: 4" CFA	FINISH DATE 5/16/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SPARSE VEGETATION		1									
SILTY CLAYEY SAND (SM-SC)											
brown											
with apparent cobbles		2									
	SS	3	22	--	3.9						
SAND & GRAVEL (SP-GP)		4									
brown											
medium dense											
with apparent cobbles	SS	5	19	--	7.8						
		6									
		7									
		8									
		9									
	SS	10	20	--	12.0	129.8					
SANDSTONE / SILTSTONE / CLAYSTONE		11									
brown / rust / grey											
soft to moderately hard		12									
		13									
		14									
	CS	15	50/3"	2000	21.2					4000 psf	% @ 1000 psf 1.6%
		16									
		17									
		18									
		19									
	SS	20	50/3"	2000	21.2						
BOTTOM OF BORING DEPTH 20.5'		21									
		22									
		23									
		24									
		25									

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BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-4		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/11/2012	WHILE DRILLING	8.0'
AUGER TYPE: 4" CFA	FINISH DATE 5/11/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SPARSE VEGETATION & COBBLES		1									
SAND & GRAVEL (SP-GP)		2									
brown											
medium dense		3									
with apparent cobbles		4									
	SS	**5**	**Bounce on apparent cobbles**								
		6									
		7									
		8									
		9									
	ss	**10**	**40/5"**	**--**	**8.1**						
		11	**Bounce on apparent cobbles**								
		12									
		13									
SILTSTONE / SANDSTONE / CLAYSTONE		14									
brown / grey / rust											
soft to moderately hard	ss	**15**	**31/9"**	**9000**	**19.0**						
		16									
		17									
		18									
		19									
grey	SS	**20**	**50/4"**	**9000+**	**16.8**						
BOTTOM OF BORING DEPTH 20.5'		21									
		22									
		23									
		24									
		25									

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BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-5		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/11/2012	WHILE DRILLING	4.5'
AUGER TYPE: 4" CFA	FINISH DATE 5/11/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	5/17/2012	4.0'

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SPARSE VEGETATION		1									
SILTY CLAYEY SAND (SM-SC)											
medium dense		2									
SAND & GRAVEL (SP / GP)		3									
brown											
medium dense		4									
with apparent cobbles	SS	5	23	--	7.5						
		6									
		7									
		8									
		9									
	SS	10	50/5"	3000	9.0						
		11									
		12									
SILTSTONE / SANDSTONE / CLAYSTONE		13									
grey											
soft to moderately hard		14									
	SS	15	--								
		16									
		17									
		18									
		19									
	SS	20	50/8"	9000+	14.7		58	27	57.7		
BOTTOM OF BORING DEPTH 20.5'		21									
		22									
		23									
		24									
		25									

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BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-6		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/16/2012	WHILE DRILLING	5.5'
AUGER TYPE: 4" CFA	FINISH DATE 5/16/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SPARSE VEGETATION & COBBLES		1									
SAND & GRAVEL		2									
brown											
medium dense		3									
with apparent cobbles		4									
	SS	**5**	**Clippings**	**--**	**2.7**						
		6									
		7									
		8									
		9									
	SS	**10**	**Clippings**	**--**	**12.1**						
		11									
		12									
		13									
		14									
SANDSTONE / SILTSTONE / CLAYSTONE	SS	**15**	**--**	**9000**	**16.1**						
brown / grey / rust											
BOTTOM OF BORING DEPTH 15.5'		16									
		17									
		18									
		19									
		20									
		21									
		22									
		23									
		24									
		25									

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BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-7		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/16/2012	WHILE DRILLING	7.5'
AUGER TYPE: 4" CFA	FINISH DATE 5/16/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SPARSE VEGETATION											
SILTY CLAYEY SAND (SM-SC)		1									
SAND & GRAVEL (SP-GP)		2									
medium dense											
with apparent cobbles		3									
		4									
	SS	5	21	--	6.7						
		6									
		7									
		8									
		9									
	SS	10	60	--	14.8						
		11									
		12									
		13									
SANDSTONE / SILTSTONE / CLAYSTONE		14									
grey											% @ 1000 psf
soft to moderately hard	SS	15	50/11"	9000+	16.5		40	20	46.5	<1000 psf	None
BOTTOM OF BORING DEPTH 15.5'		16									
		17									
		18									
		19									
		20									
		21									
		22									
		23									
		24									
		25									

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BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-8		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/11/2012	WHILE DRILLING	5.0'
AUGER TYPE: 4" CFA	FINISH DATE 5/11/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	5/17/2012	2'9"

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SILTY CLAYEY SAND (SM/ SC)		1									
brown											
medium dense		2									
with apparent cobbles											
SAND & GRAVEL (SP / GP)		3									
with silt											
brown		4									
medium dense											
with apparent cobbles	SS	**5**	**30**	**--**	**10.5**						
		6									
		7									
		8									
		9									
SANDSTONE / SILTSTONE / CLAYSTONE											
grey	SS	**10**	**--**								
soft to moderately hard		11									
		12									
		13									
		14									
	SS	**15**	**50/11"**	**8000**	**18.1**						
		16									
		17									
		18									
		19									
	CS	**20**	**25/2"**	**4000**	**16.1**	**127.1**					
BOTTOM OF BORING DEPTH 20.0'		21									
		22									
		23									
		24									
		25									

BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-9		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/11/2012	WHILE DRILLING	5.0'
AUGER TYPE: 4" CFA	FINISH DATE 5/11/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SPARSE VEGETATION		1									
SILTY CLAYEY SAND (SM-SC)											
with cobbles		2									
SAND & GRAVEL (SP / GP)		3									
brown											
medium dense		4									
with apparent cobbles	SS	**5**	**50/9"**	**--**	**3.3**						
		6									
		7									
		8									
		9									
	SS	**10**	**25/3"**	**--**	**12.4**						
		11	**(Bounce on apparent cobbles)**								
		12									
SANDSTONE / SILTSTONE / CLAYSTONE		13									
grey											
soft to moderately hard		14									
	SS	**15**	**--**								
		16									
		17									
		18									
		19									
	CS	**20**	**50/1"**	**8000**	**12.2**	**119.3**					
BOTTOM OF BORING DEPTH 20.0'		21									
		22									
		23									
		24									
		25									

BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-10		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/11/2012	WHILE DRILLING	4.0'
AUGER TYPE: 4" CFA	FINISH DATE 5/11/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	5/17/2012	3'10"

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SPARSE VEGETATION											
SILTY CLAYEY SAND (SM-SC)		1									
brown, medium dense											
with apparent cobbles / gravel		2									
SAND & GRAVEL (SP / GP)		3									
brown											
medium dense		4									
with apparent cobbles											
	SS	**5**	**33**	**--**	**6.0**						
		6									
		7									
		8									
SANDSTONE / SILSTONE / CLAYSTONE		9									
grey / brown / rust											
soft to moderately hard	SS	**10**	**39/10"**	**9000+**	**20.8**						
		11									
		12									
		13									
		14									
	CS	**15**	**50/5"**	**9000+**	**13.5**	**122.4**				**2500 psf**	**1.6%**
		16									
		17									
		18									
		19									
	SS	**20**	**50/2"**	**7000**	**12.2**						
		21									
		22									
		23									
		24									
	CS	**25**	**50/1"**	**9000+**	**9.9**	**128.1**					
BOTTOM OF BORING DEPTH 25.0'											

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BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-11		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/11/2012	WHILE DRILLING	4.0'
AUGER TYPE: 4" CFA	FINISH DATE 5/11/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SPARSE VEGETATION		1									
SILTY CLAYEY SAND (SC-SM)		2									
brown											
with apparent cobbles		3									
		4									
SAND & GRAVEL (SP / GP)											
brown			--	--	2.3						
medium dense		5									
with apparent cobbles		6									
		7									
		8									
		9									
	SS	10	50/6"	--	10.8						
		11									
SANDSTONE / SILTSTONE / CLAYSTONE		12									
brown / grey / rust											
soft to moderately hard		13									
		14									
	CS	15	35/1"	9000+	13.0						
		16									
		17									
		18									
		19									
	SS	20	50/6"	9000+	11.4						
BOTTOM OF BORING DEPTH 20.5'		21									
		22									
		23									
		24									
		25									

BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-12		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/11/2012	WHILE DRILLING	5.0'
AUGER TYPE: 4" CFA	FINISH DATE 5/11/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SPARSE VEGETATION		1									
SILTY CLAYEY SAND (SM-SC)											
brown, medium dense		2									
with apparent cobbles											
SAND & GRAVEL (SP / GP)		3									
brown											
medium dense		4									
with apparent cobbles											
	SS	**5**	**41**	**--**	**11.9**						
		6									
		7									
		8									
		9									
	SS	**10**	**--**								
		11									
SILTSTONE / CLAYSTONE / SANDSTONE		12									
brown / grey / rust											
soft to moderately hard		13									
		14									
	SS	**15**	**50/7"**	**9000+**	**13.6**						
		16									
		17									
		18									
		19									
	SS	**20**	**--**								
BOTTOM OF BORING DEPTH 20.5'		21									
		22									
		23									
		24									
		25									

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BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-13		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/11/2012	WHILE DRILLING	2.5'
AUGER TYPE: 4" CFA	FINISH DATE 5/11/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
TOPSOIL & VEGETATION		1									
CLAYEY SAND (SC), brown											
SAND & GRAVEL (SP / GP)		2									
brown											
medium dense	SS	3	8	--	8.6						
with apparent cobbles		4									
	SS	5	34/10"	--	16.1						
		6									
		7									
CLAYSTONE / SILTSTONE / SANDSTONE		8									
brown / grey / rust											
soft to moderately hard		9									
	CS	10	34/12"	9000+	9.5	124.3					
		11									
		12									
		13									
		14									
	CS	15	50/4"	9000+	18.2	125.1					
BOTTOM OF BORING DEPTH 15.0'		16									
		17									
		18									
		19									
		20									
		21									
		22									
		23									
		24									
		25									

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BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		**DATE: MAY 2012**	
	LOG OF BORING B-14		
RIG TYPE: CME45	**SHEET 1 OF 1**	**WATER DEPTH**	
FOREMAN: DG	**START DATE** 5/16/2012	**WHILE DRILLING**	**7.0'**
AUGER TYPE: 4" CFA	**FINISH DATE** 5/16/2012	**AFTER DRILLING**	**N/A**
SPT HAMMER: MANUAL	**SURFACE ELEV** N/A	**24 HOUR**	**N/A**

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
TOPSOIL & VEGETATION											
SILTY CLAYEY SAND (SC-SM)		1									
brown, with apparent cobbles		2									
SAND & GRAVEL (SP / GP)											
brown		3									
medium dense											
with apparent cobbles		4									
	SS	**5**	**49**	**--**	**3.1**						
		6									
		7									
		8									
		9									
SANDSTONE / SILTSTONE / CLAYSTONE	SS	**10**	**20**	**7000**	**22.0**				**46.5**		
brown / grey / rust											
soft to moderately hard		11									
		12									
		13									
		14									
	CS	**15**	**50/4"**	**9000+**	**14.7**						
		16									
		17									
		18									
		19									
	SS	**20**	**50/5"**	**5000**	**13.4**						
		21									
		22									
		23									
		24									
	CS	**25**	**50/1"**	**8000**	**17.3**						
BOTTOM OF BORING DEPTH 25.0'											

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BOULDER CREEK COMMONS
BOULDER, COLORADO

PROJECT NO: 1122042		DATE: MAY 2012	
	LOG OF BORING B-15		
RIG TYPE: CME45	SHEET 1 OF 1	WATER DEPTH	
FOREMAN: DG	START DATE 5/11/2012	WHILE DRILLING	7.5'
AUGER TYPE: 4" CFA	FINISH DATE 5/16/2012	AFTER DRILLING	N/A
SPT HAMMER: MANUAL	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SPARSE VEGETATION with COBBLES		1									
CLAYEY SILT / SANDY CLAY (ML / CL)											
brown, stiff to very stiff		2									
with apparent cobbles											
CLAYSTONE / SILTSTONE / SANDSTONE		3									
brown / grey / rust		4									
soft to moderately hard	CS	**5**	**10/3"**	**--**	**31.0**						
		6	**(Bounce on apparent cobbles)**								
		7									
		8									
		9									
	CS	**10**	**50/9"**	**9000**	**18.1**	**113.3**	**37**	**17**	**73.7**	**<500 psf**	**None**
		11									
		12									
		13									
		14									
	SS	**15**	**50/10"**	**8000**	**15.7**						
		16									
		17									
		18									
		19									
	CS	**20**	**50/1"**	**8000**	**20.7**						
BOTTOM OF BORING DEPTH 20.0'		21									
		22									
		23									
		24									
		25									

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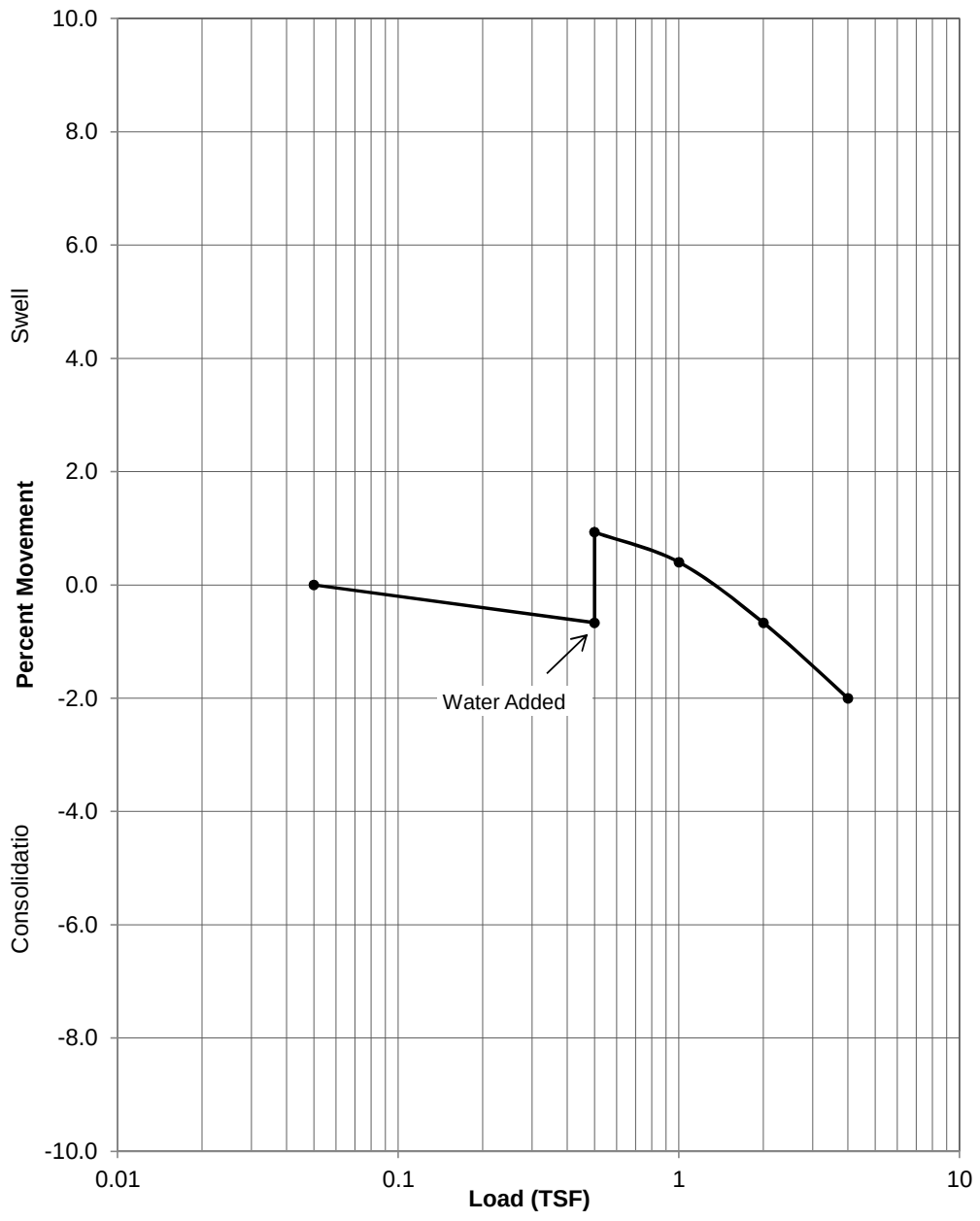
SWELL / CONSOLIDATION TEST RESULTS

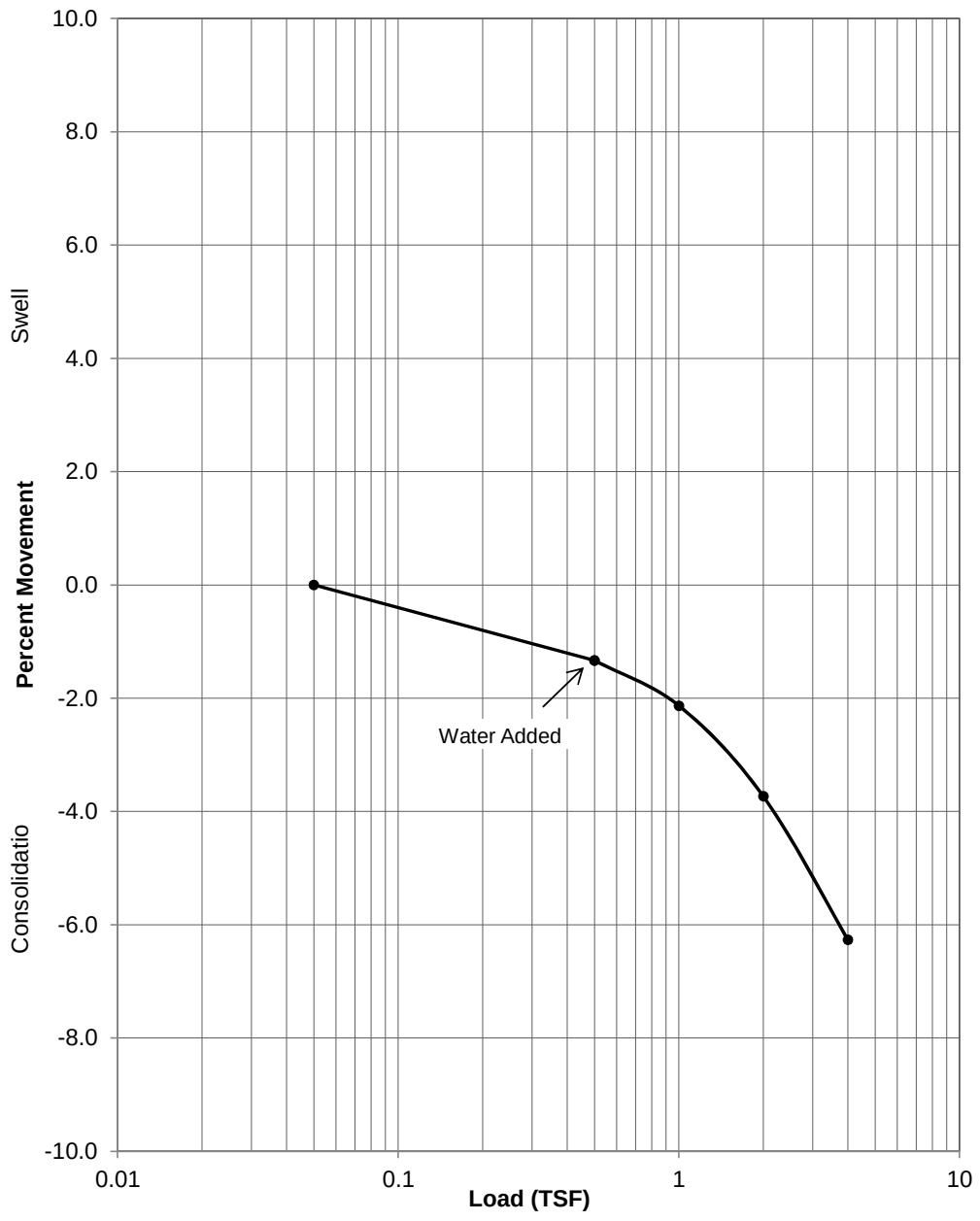
Material Description: Brown / Rust / Grey Sandstone / Siltstone / Claystone		
Sample Location: Boring 3, Sample 4, Depth 14'		
Liquid Limit: - -	Plasticity Index: - -	% Passing #200: - -
Beginning Moisture: 12.0%	Dry Density: 121.4 psf	Ending Moisture: 13.3%
Swell Pressure: 4000 psf	% Swell @ 1000: 1.6%	



Project: Boulder Creek Commons
Location: Boulder, Colorado
Project #: 1122042
Date: May 2012

SWELL / CONSOLIDATION TEST RESULTS

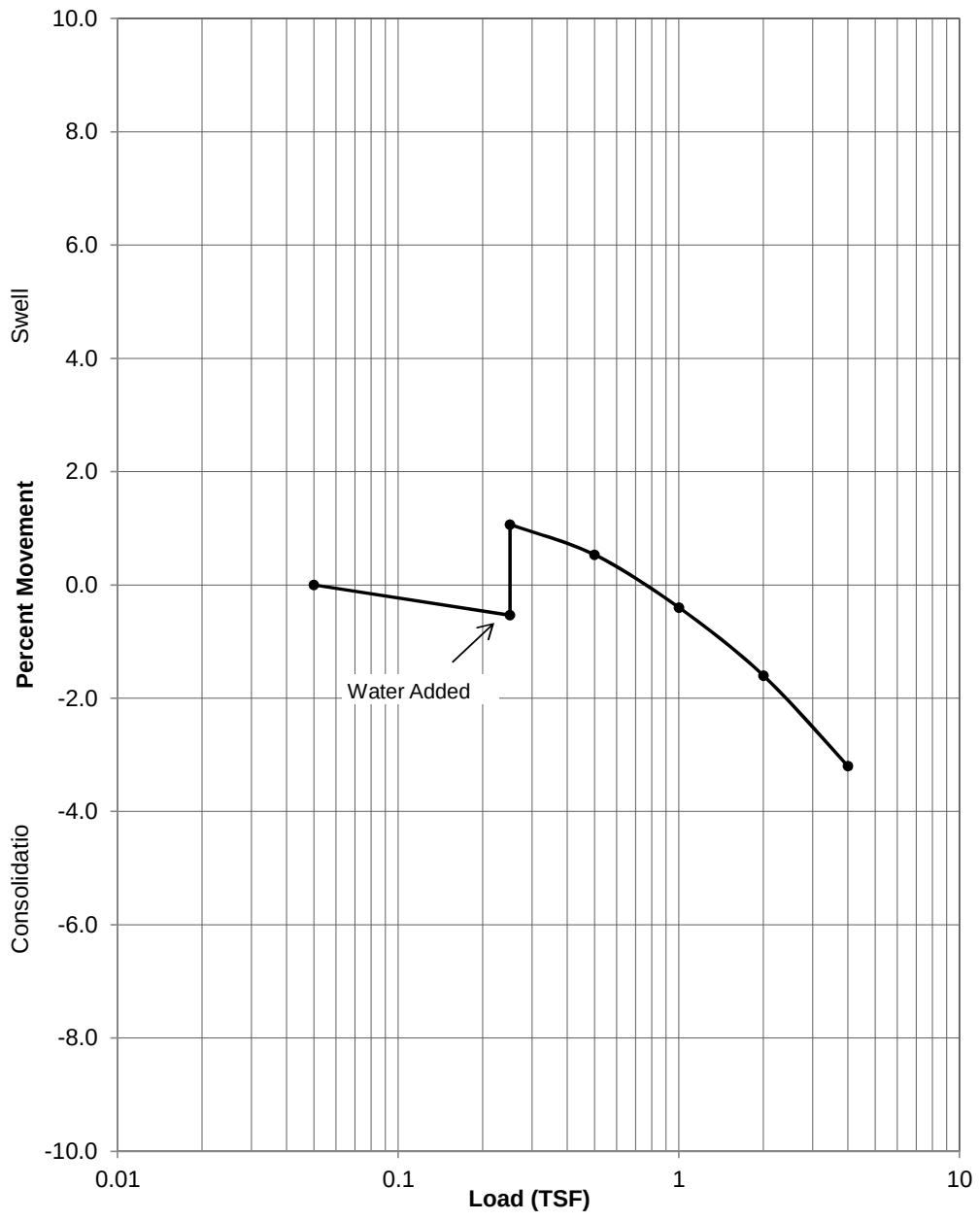
Material Description: Grey Sandstone / Siltstone / Claystone		
Sample Location: Boring 7, Sample 3, Depth 14'		
Liquid Limit: 40	Plasticity Index: 20	% Passing #200: 46.5%
Beginning Moisture: 16.5%	Dry Density: 103.9 psf	Ending Moisture: 22.1%
Swell Pressure: <1000 psf	% Swell @ 1000: None	



Project: Boulder Creek Commons
Location: Boulder, Colorado
Project #: 1122042
Date: May 2012

SWELL / CONSOLIDATION TEST RESULTS

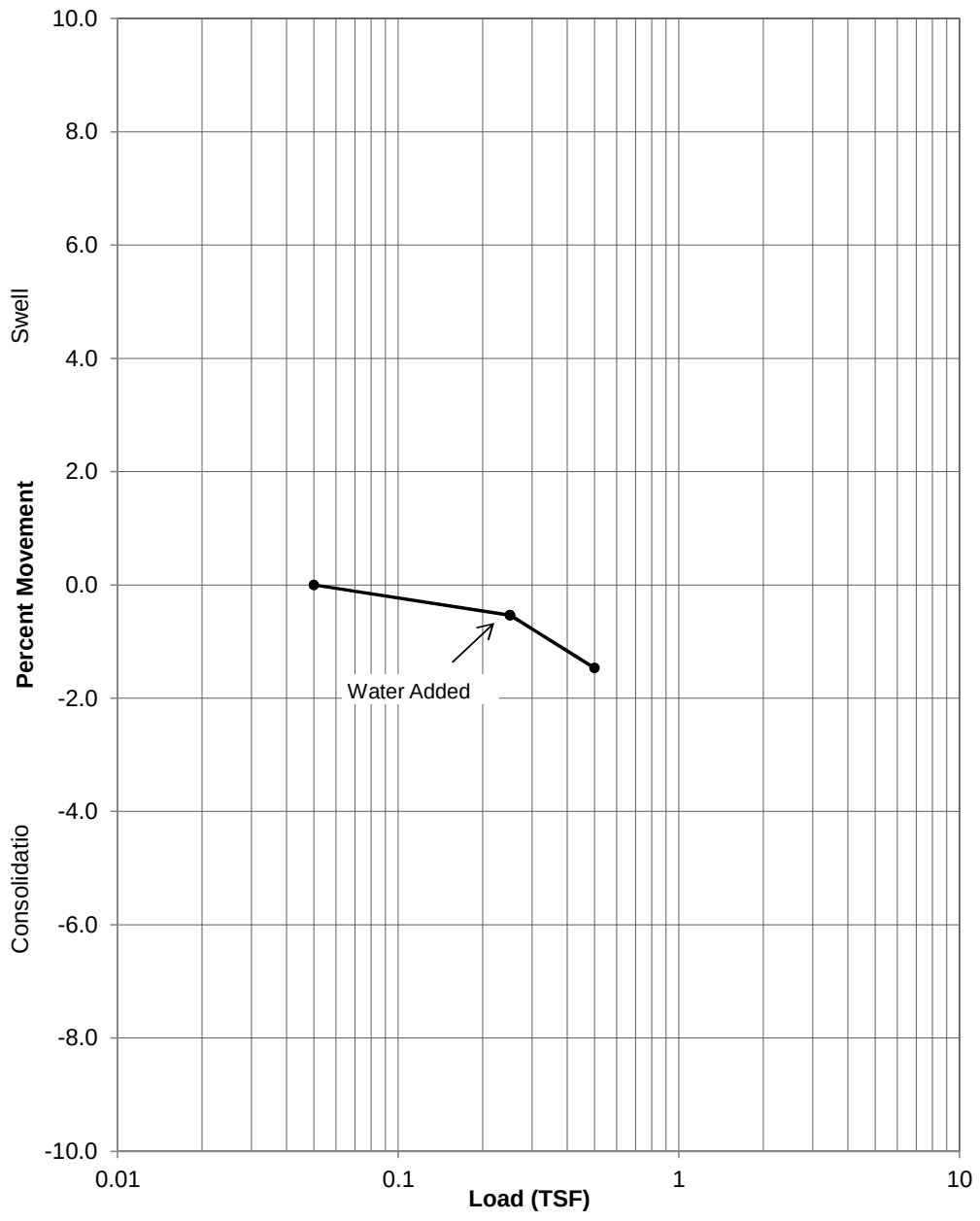
Material Description: Sandstone / Siltstone / Claystone		
Sample Location: Boring 10, Sample 3, Depth 14'		
Liquid Limit: - -	Plasticity Index: - -	% Passing #200: - -
Beginning Moisture: 13.5%	Dry Density: 124.7 psf	Ending Moisture: 15.4%
Swell Pressure: 2500 psf	% Swell @ 500: 1.6%	



Project: Boulder Creek Commons
Location: Boulder, Colorado
Project #: 1122042
Date: May 2012

SWELL / CONSOLIDATION TEST RESULTS

Material Description: Brown / Grey / Rust Claystone / Siltstone / Sandstone		
Sample Location: Boring 15, Sample 2, Depth 9'		
Liquid Limit: 37	Plasticity Index: 17	% Passing #200: 73.7%
Beginning Moisture: 18.1%	Dry Density: 114.5 psf	Ending Moisture: 19.9%
Swell Pressure: <500 psf	% Swell @ 500: None	



Project: Boulder Creek Commons
Location: Boulder, Colorado
Project #: 1122042
Date: May 2012

EARTH ENGINEERING CONSULTANTS, INC.

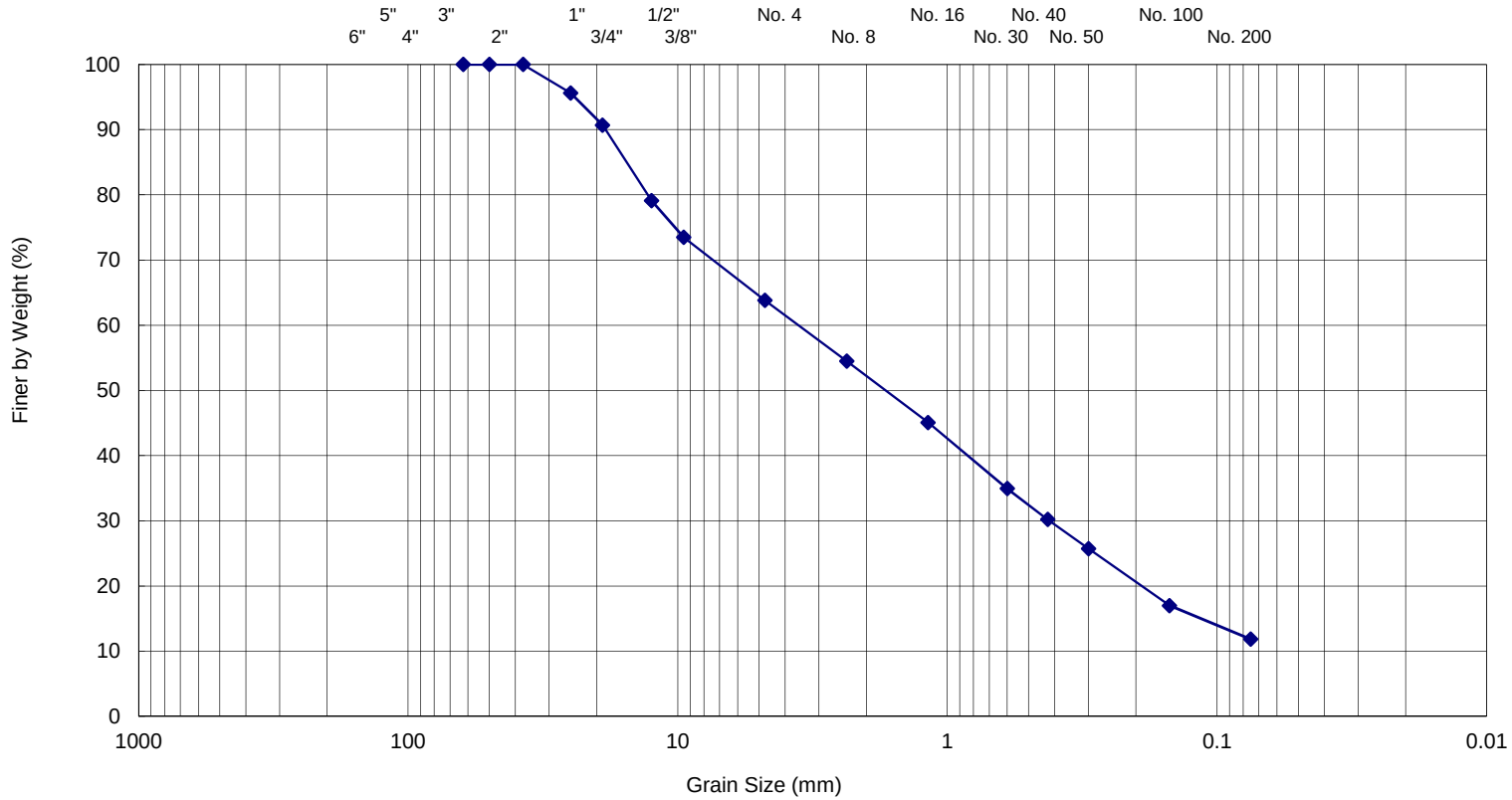
SUMMARY OF LABORATORY TEST RESULTS

Sieve Analysis (AASHTO T 11 & T 27 / ASTM C 117 & C 136)		
Sieve Size		Percent Passing
2 1/2"	(63 mm)	100
2"	(50 mm)	100
1 1/2"	(37.5 mm)	100
1"	(25 mm)	96
3/4"	(19 mm)	91
1/2"	(12.5 mm)	79
3/8"	(9.5 mm)	73
No. 4	(4.75 mm)	64
No. 8	(2.36 mm)	54
No. 16	(1.18 mm)	45
No. 30	(600 μm)	35
No. 40	(425 μm)	30
No. 50	(300 μm)	26
No. 100	(150 μm)	17
No. 200	(75 μm)	11.8

Project: Boulder Creek Commons
Location: Boulder, Colorado
Project No: 1122042
Sample Desc.: B-2, S-1, 4
Date: May 2012

EARTH ENGINEERING CONSULTANTS, INC.

Summary of Washed Sieve Analysis Tests (ASTM C117 & C136)



Cobble	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Project: Boulder Creek Commons
Location: Boulder, Colorado
Project Number: 1122042
Sample Desc.: B-2, S-1, 4
Date: May 2012

EARTH ENGINEERING CONSULTANTS, INC.

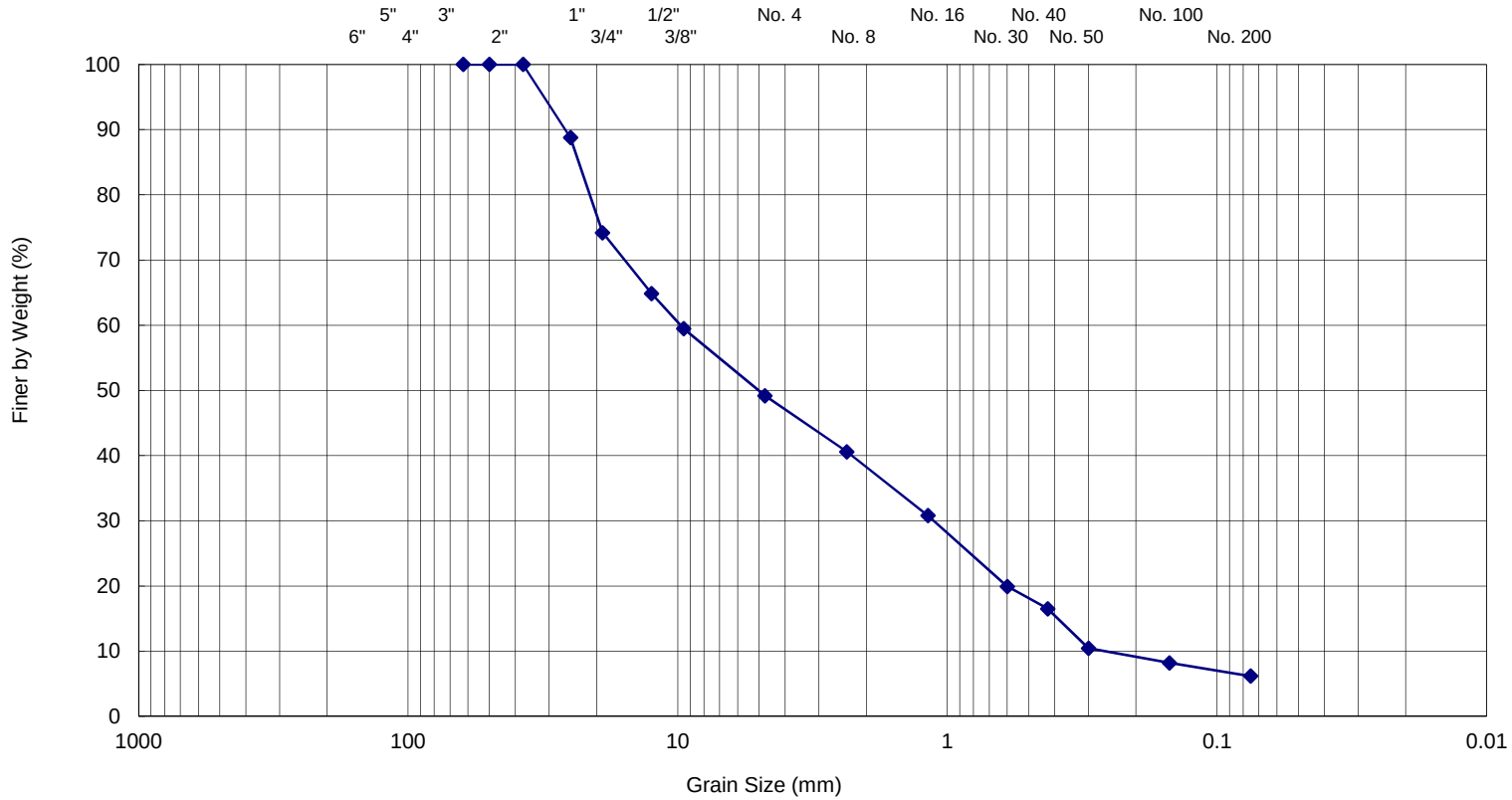
SUMMARY OF LABORATORY TEST RESULTS

Sieve Analysis (AASHTO T 11 & T 27 / ASTM C 117 & C 136)		
Sieve Size		Percent Passing
2 1/2"	(63 mm)	100
2"	(50 mm)	100
1 1/2"	(37.5 mm)	100
1"	(25 mm)	89
3/4"	(19 mm)	74
1/2"	(12.5 mm)	65
3/8"	(9.5 mm)	59
No. 4	(4.75 mm)	49
No. 8	(2.36 mm)	41
No. 16	(1.18 mm)	31
No. 30	(600 μm)	20
No. 40	(425 μm)	17
No. 50	(300 μm)	10
No. 100	(150 μm)	8
No. 200	(75 μm)	6.2

Project: Boulder Creek Commons
Location: Boulder, Colorado
Project No: 1122042
Sample Desc.: B-3, S-2, 4
Date: May 2012

EARTH ENGINEERING CONSULTANTS, INC.

Summary of Washed Sieve Analysis Tests (ASTM C117 & C136)



Cobble	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Project: Boulder Creek Commons
Location: Boulder, Colorado
Project Number: 1122042
Sample Desc.: B-3, S-2, 4
Date: May 2012

EARTH ENGINEERING CONSULTANTS, INC.

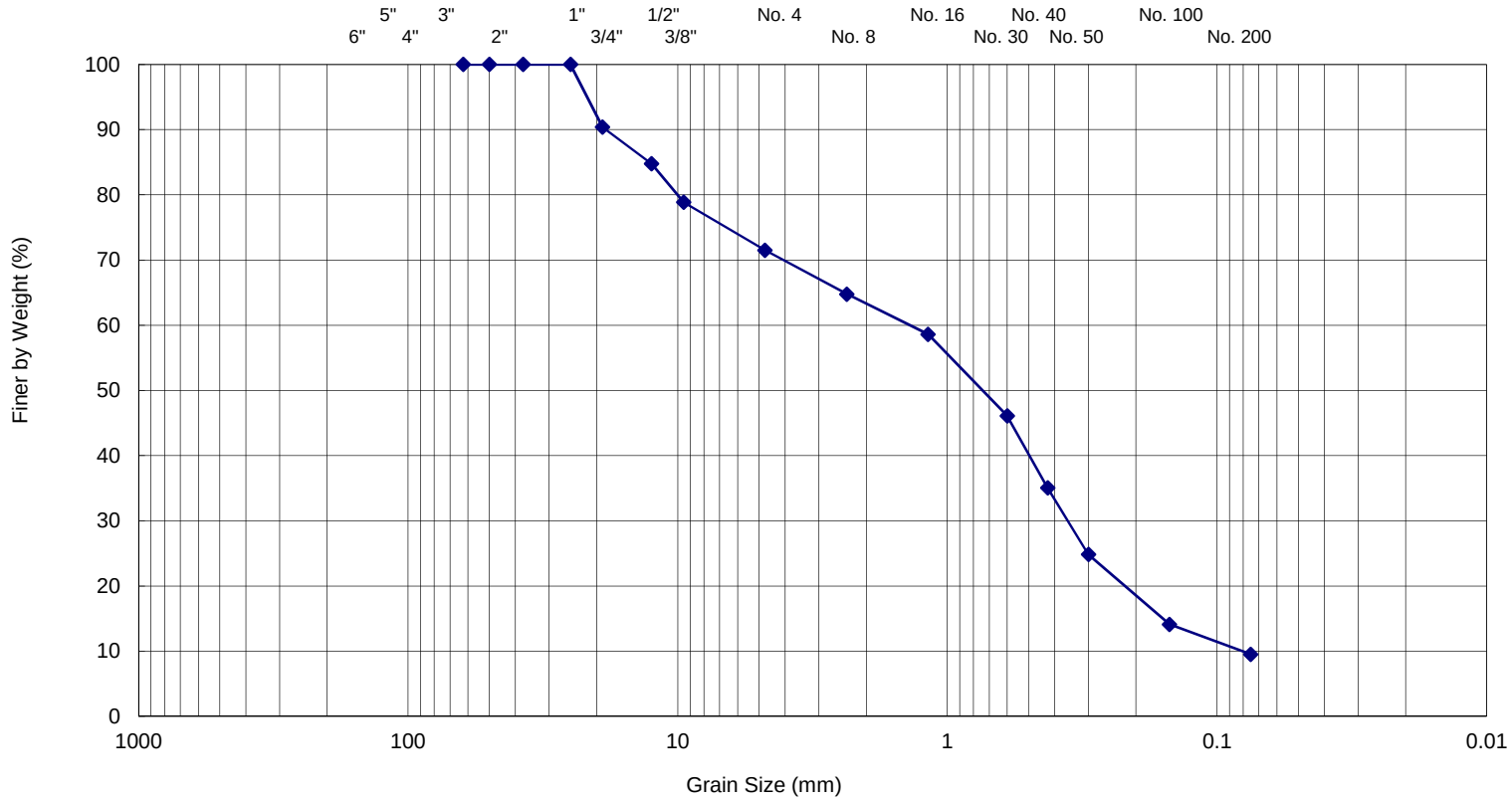
SUMMARY OF LABORATORY TEST RESULTS

Sieve Analysis (AASHTO T 11 & T 27 / ASTM C 117 & C 136)		
Sieve Size		Percent Passing
2 1/2"	(63 mm)	100
2"	(50 mm)	100
1 1/2"	(37.5 mm)	100
1"	(25 mm)	100
3/4"	(19 mm)	90
1/2"	(12.5 mm)	85
3/8"	(9.5 mm)	79
No. 4	(4.75 mm)	71
No. 8	(2.36 mm)	65
No. 16	(1.18 mm)	59
No. 30	(600 μm)	46
No. 40	(425 μm)	35
No. 50	(300 μm)	25
No. 100	(150 μm)	14
No. 200	(75 μm)	9.5

Project: Boulder Creek Commons
Location: Boulder, Colorado
Project No: 1122042
Sample Desc.: B-7, S-2, 9
Date: May 2012

EARTH ENGINEERING CONSULTANTS, INC.

Summary of Washed Sieve Analysis Tests (ASTM C117 & C136)



Cobble	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Project: Boulder Creek Commons
Location: Boulder, Colorado
Project Number: 1122042
Sample Desc.: B-7, S-2, 9
Date: May 2012

EARTH ENGINEERING CONSULTANTS, INC.

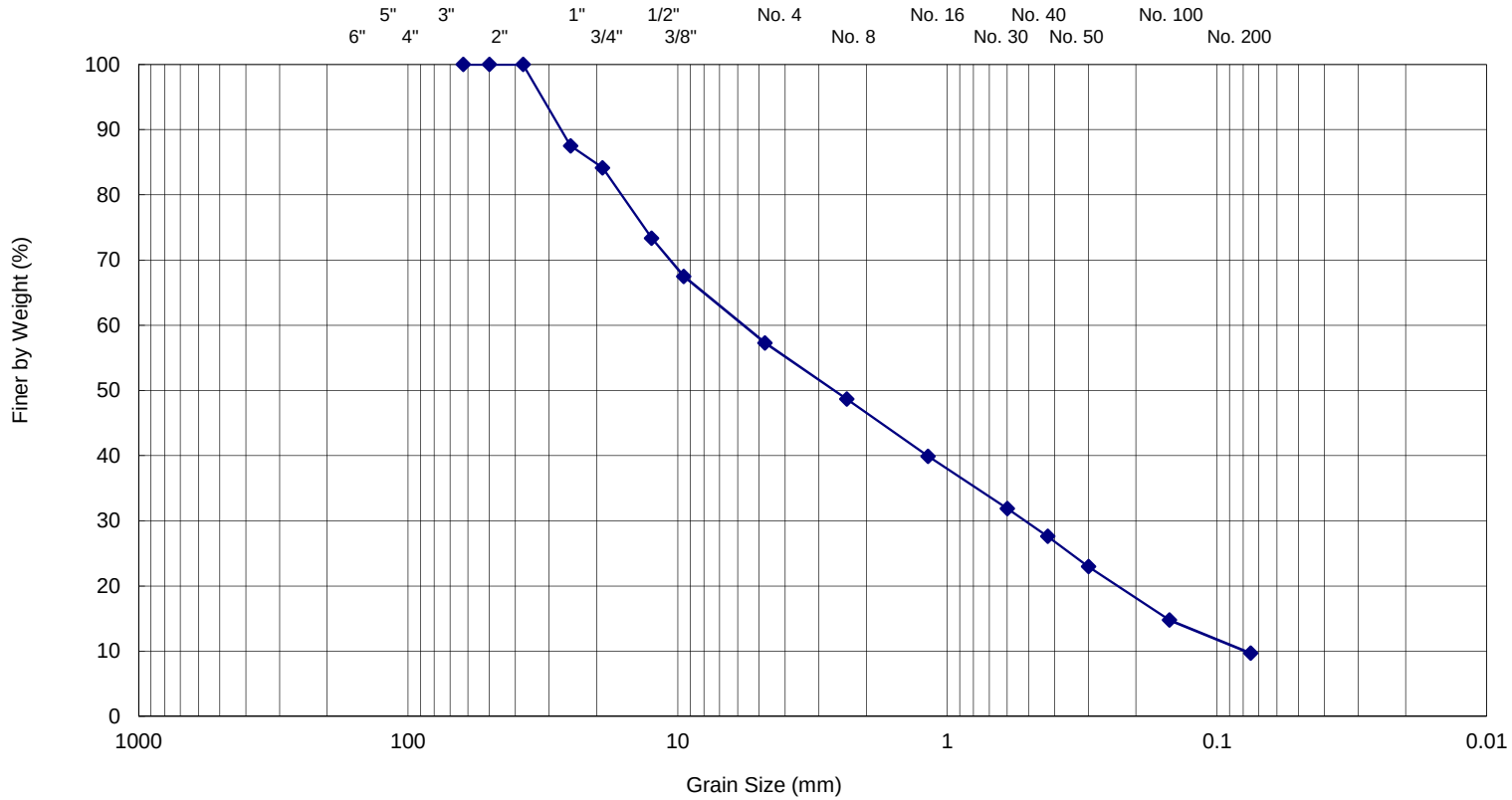
SUMMARY OF LABORATORY TEST RESULTS

Sieve Analysis (AASHTO T 11 & T 27 / ASTM C 117 & C 136)		
Sieve Size		Percent Passing
2 1/2"	(63 mm)	100
2"	(50 mm)	100
1 1/2"	(37.5 mm)	100
1"	(25 mm)	88
3/4"	(19 mm)	84
1/2"	(12.5 mm)	73
3/8"	(9.5 mm)	67
No. 4	(4.75 mm)	57
No. 8	(2.36 mm)	49
No. 16	(1.18 mm)	40
No. 30	(600 μm)	32
No. 40	(425 μm)	28
No. 50	(300 μm)	23
No. 100	(150 μm)	15
No. 200	(75 μm)	9.7

Project: Boulder Creek Commons
Location: Boulder, Colorado
Project No: 1122042
Sample Desc.: B-10, S-1, 4
Date: May 2012

EARTH ENGINEERING CONSULTANTS, INC.

Summary of Washed Sieve Analysis Tests (ASTM C117 & C136)



Cobble	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Project: Boulder Creek Commons
Location: Boulder, Colorado
Project Number: 1122042
Sample Desc.: B-10, S-1, 4
Date: May 2012

EARTH ENGINEERING CONSULTANTS, INC.

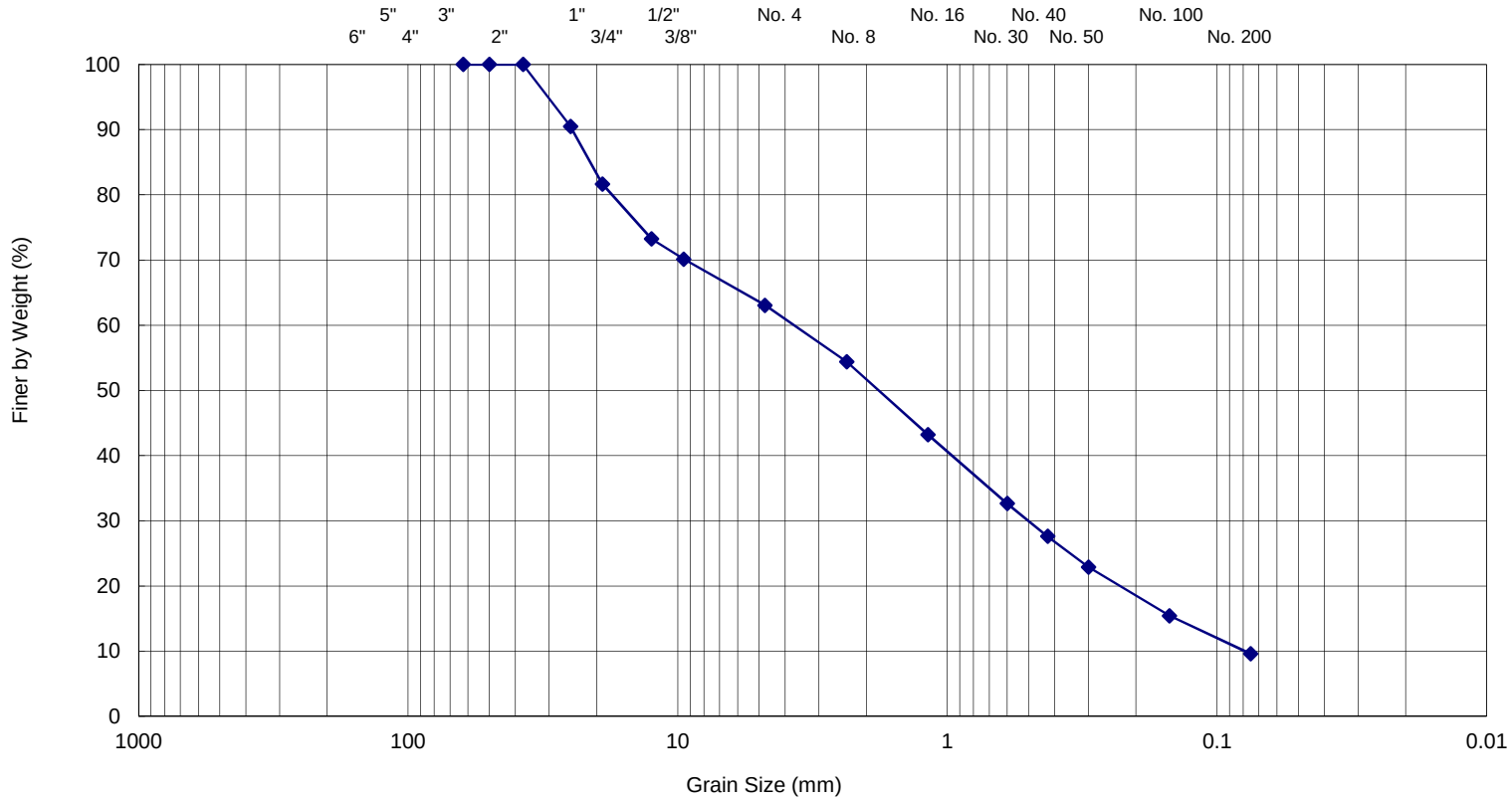
SUMMARY OF LABORATORY TEST RESULTS

Sieve Analysis (AASHTO T 11 & T 27 / ASTM C 117 & C 136)		
Sieve Size		Percent Passing
2 1/2"	(63 mm)	100
2"	(50 mm)	100
1 1/2"	(37.5 mm)	100
1"	(25 mm)	90
3/4"	(19 mm)	82
1/2"	(12.5 mm)	73
3/8"	(9.5 mm)	70
No. 4	(4.75 mm)	63
No. 8	(2.36 mm)	54
No. 16	(1.18 mm)	43
No. 30	(600 μm)	33
No. 40	(425 μm)	28
No. 50	(300 μm)	23
No. 100	(150 μm)	15
No. 200	(75 μm)	9.6

Project: Boulder Creek Commons
Location: Boulder, Colorado
Project No: 1122042
Sample Desc.: B-12, S-1, 4
Date: May 2012

EARTH ENGINEERING CONSULTANTS, INC.

Summary of Washed Sieve Analysis Tests (ASTM C117 & C136)



Cobble	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Project: Boulder Creek Commons
Location: Boulder, Colorado
Project Number: 1122042
Sample Desc.: B-12, S-1, 4
Date: May 2012

EARTH ENGINEERING CONSULTANTS, INC.

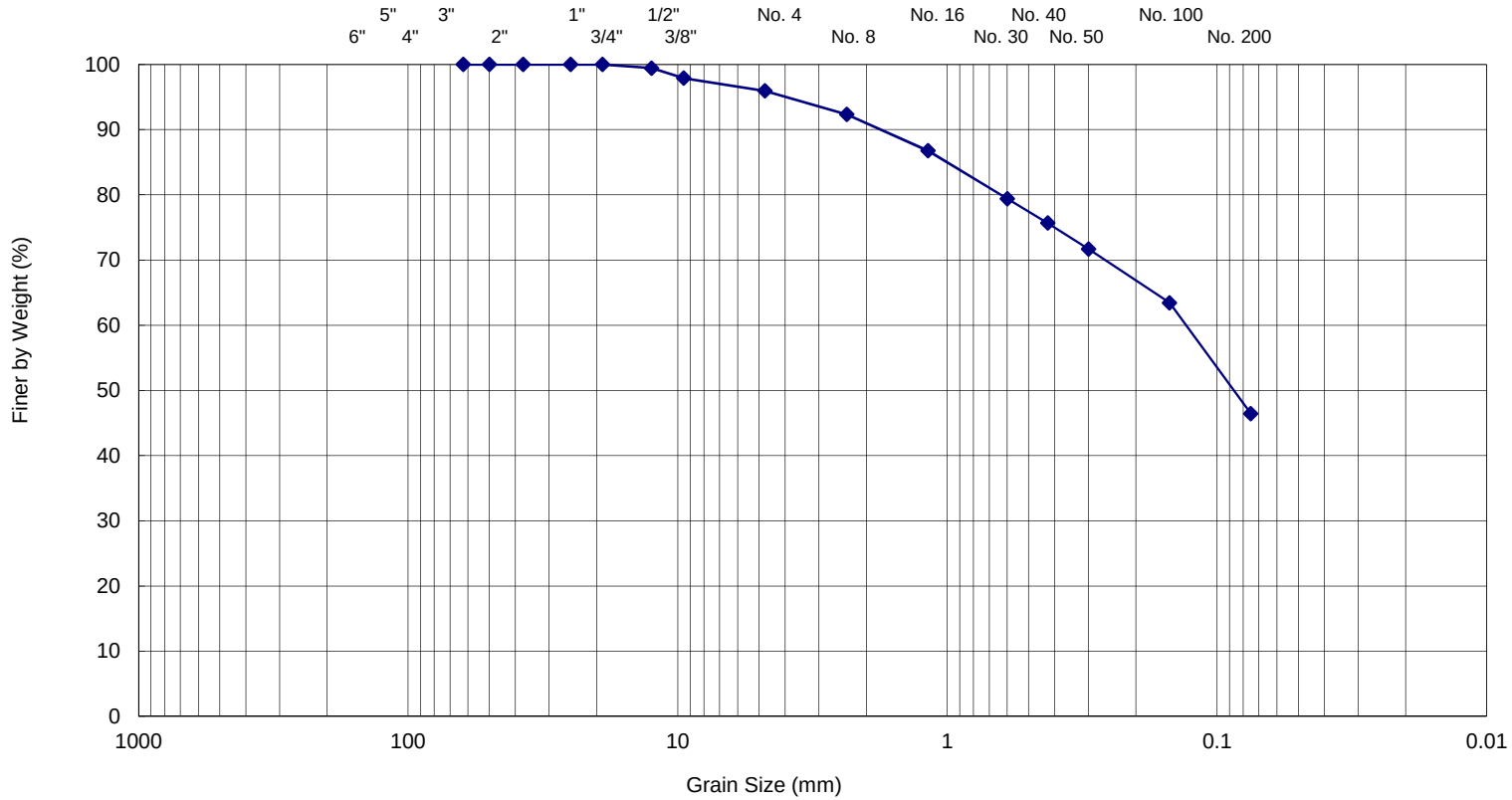
SUMMARY OF LABORATORY TEST RESULTS

Sieve Analysis (AASHTO T 11 & T 27 / ASTM C 117 & C 136)		
Sieve Size		Percent Passing
2 1/2"	(63 mm)	100
2"	(50 mm)	100
1 1/2"	(37.5 mm)	100
1"	(25 mm)	100
3/4"	(19 mm)	100
1/2"	(12.5 mm)	99
3/8"	(9.5 mm)	98
No. 4	(4.75 mm)	96
No. 8	(2.36 mm)	92
No. 16	(1.18 mm)	87
No. 30	(600 μm)	79
No. 40	(425 μm)	76
No. 50	(300 μm)	72
No. 100	(150 μm)	63
No. 200	(75 μm)	46.5

Project: Boulder Creek Commons
Location: Boulder, Colorado
Project No: 1122042
Sample Desc.: B-14, S-2, 9
Date: May 2012

EARTH ENGINEERING CONSULTANTS, INC.

Summary of Washed Sieve Analysis Tests (ASTM C117 & C136)



Cobble	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Project: Boulder Creek Commons
Location: Boulder, Colorado
Project Number: 1122042
Sample Desc.: B-14, S-2, 9
Date: May 2012