City of Camdenton, Missouri

Camdenton Community Center

1205 N. Business Route 5
Camdenton, MO 65020

Project No. 191012

PROJECT MANUAL

100% Construction Documents
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DIVISION 02 – EXISTING CONDITIONS

024113 REMOVAL OF IMPROVEMENTS

Description

Removal of improvements shall include, but is not limited to, removing existing structures, sidewalks, pavement and driveway sections, and drainage pipes and other underground structures or improvements. The plans will not show a complete list or details of all items to be removed. The Contractor shall determine for himself the amount and extent of the work to be performed under this item and shall base his bid accordingly.

Rock Excavation is unclassified and no extra compensation will be allowed for rock excavation.

The use of dynamite or other blasting materials will not be permitted.

Construction Procedures

The Contractor shall dispose of all removed improvements, not to be retained by the Owner, in a legal manner off of the project site.

Areas disturbed by the Contractor outside the limits of construction shall be restored at the Contractors' expense to a condition similar to, or better than, that prior to construction operations.

DIVISION 03 -- CONCRETE

032111 REINFORCING STEEL

Description

This work shall consist of providing all materials, labor and equipment necessary for the placement of reinforcing steel in accordance with the plans and/or as herein specified.

Materials

A. Reinforcing Steel - Reinforcing shall be deformed bars meeting the requirements of AASHTO M31, Grade 60.

Construction Procedure

Under no circumstances shall concrete be poured until the steel placement is approved by the Owner's Representative.

The ends of all reinforcing bars shall be hooked unless specifically noted to the contrary on the drawings or in places where hooks are not feasible because of other construction conditions.

The metal reinforcement shall be protected by the thickness of concrete indicated in the plans. Where not otherwise shown, the thickness of concrete over the reinforcement shall be as follows:

A. Where concrete is deposited against the ground without the use of forms, not less than three inches.

B. Where concrete is exposed to the weather, or exposed to the ground but placed in forms, not less than two inches for bars more than 5/8 inches in diameter and 1½ inches for bars 5/8 inches or less in diameter.

C. In slabs and walls not exposed to the ground or to the weather, not less than 1½ inches.

D. In beams, girders and columns not exposed to the ground or to the weather, not less than ½ inches.

E. In all cases, the thickness of concrete over the reinforcement bars shall be at least equal to the diameter of the bars.

F. Exposed reinforcement bars intended for bonding with future extensions shall be protected from corrosion by concrete or other adequate covering.

All reinforcement shall be free from rust, scale or other coatings that will destroy or reduce the bond of the concrete to the steel. Where there may be a delay in

depositing concrete, the reinforcement shall be reinspected and when necessary, cleaned to the satisfaction of the Owner's Representative.

Anchor bolts for all equipment shall be provided and placed in the concrete in accordance with the manufacturer's directions. Unless otherwise noted, dowels or continuous reinforcement shall be provided at all construction joints. The dowels shall be of the same size as the largest reinforcing bar and shall provide a minimum lap of 24 dowel diameters. Corner bars shall be used at the outside of all corners. Corner bars shall be lapped a minimum of 24 diameters.

033053 CONCRETE

Description

The work to be performed under this section of the specifications shall consist of furnishing all labor, materials and equipment necessary to complete the construction of all concrete structures in accordance with the plans and/or as herein specified, including all necessary excavation, fill and testing.

Materials

A. Portland Cement - Portland Cement used in this work shall conform to the latest specifications of the American Society for Testing Materials (ASTM C150), Type I and III. All cement shall be tested before using. Tests shall conform to the latest standards of the American Society for Testing Materials and a report of cement tests shall be made available to the Owner's Representative, at least 14 days before the placement of any concrete on the project. When the temperature of air is near freezing, it is recommended that the Contractor use high early strength Portland Cement (Type III).

B. Fine Aggregate - Fine aggregate shall consist of sand having clean, hard, durable uncoated grains, free from deleterious substances. Fine aggregate shall range in size from fine to coarse within the following percentage by weight: (ASTM C 117 and ASTM C 136)

Passing 3/8"	sieve	100%
Passing #4	sieve	95 to 100%
Passing #8	sieve	80 to 100%
Passing #16	sieve	50 to 80%
Passing #20	sieve	40 to 75%
Passing #30	sieve	25 to 60%
Passing #50	sieve	5 to 30%
Passing #100	sieve	0 to 10%

The limits of deleterious substances are as follows:

	Percent by Weight
Clay lumps (ASTM C142)	0.25
Material finer than No. 200 sieve (ASTM C 117)	2.0
Coal and Lignite (ASTM C 40)	0.25

and as further provided in Section 1005 of the Missouri Standard Specifications for Highway Construction.

Fine aggregate shall be free of injurious amounts of organic impurities. Except as

herein provided, aggregates subjected to the test for organic impurities and producing a color darker than the standard shall be rejected. A fine aggregate failing in the test may be used provided that the discoloration is due principally to the presence of small quantities of coal, lignite, or similar discrete particles (ASTM C 40).

Fine aggregate subjected to five cycles of the soundness test shall show a loss not greater than 10 percent when sodium sulfate is used or 15 percent when magnesium sulfate is used (ASTM C 88).

C. Coarse Aggregate - Coarse aggregate shall consist of well graded, clean, hard, tough, durable crushed stone or washed gravel. It shall be free from soft, thin, elongated, fossil or laminated pieces, disintegrated stone, vegetable or other deleterious matter. In no case shall coarse aggregate containing lumps of frozen or partially cemented materials be used. Coarse aggregate shall be well graded from coarse to fine within the following percentages by weight:

Passing 1½"	sieve	100%
Passing 1"	sieve	95 to 100%
Passing 3/4"	sieve	70 to 90%
Passing ½"	sieve	25 to 60%
Passing 3/8"	sieve	10 to 30%
Passing # 4	sieve	0 to 8%
Passing #10	sieve	0 to 3%

The maximum size of coarse aggregate shall, in any case, be not larger than one-fifth the narrowest dimensions between forms of the members to be poured, nor larger than three-fourths of the clear distance between the reinforcing bars and imbedded items.

The limits for deleterious substances are as follows:

	Percent by weight
Clay lumps (ASTM C142)	1.0
Material finer than No. 200 sieve (ASTM C 117)	1.0
Coal and Lignite (ASTM C 40)	0.5

Coarse aggregate subjected to five cycles of the soundness test shall show a loss not greater than 12 percent when sodium sulfate is used or 18 percent when magnesium sulfate is used (ASTM C 88).

Coarse aggregate tested for abrasion shall have a loss of not more than 40%. (ASTM C 131 or ASTM C 535).

All aggregate used on this project shall undergo the above tests and reports of the results shall be made available to the Owner's Representative. No aggregate shall be used without prior approval of test results from the Owner's

Representative. Tests shall be scheduled at least 14 days in advance of the scheduled pouring of concrete.

D. Water - Mixing water shall be free from oil, acid, and injurious amounts of vegetable matter, alkali or other salts. Water known to be of potable quality may be used without testing.

E. Admixtures - An air-entraining agent shall be used in all concrete. All admixtures shall conform to ASTM C-260 and shall be added to the mixer in the amount necessary to produce the specified air content. The designated quantity of air by volume shall be 5½ percent with an operating tolerance of 1½ percentage points. The Contractor shall submit certificates indicating that the air-entraining agent meets all of the requirements. The Contractor may be required to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Other admixtures may be used only upon written approval by the Owner's Representative. All certificates and any test data required shall be submitted at least 14 days before the scheduled date for concrete pouring.

F. Cover Material for Curing - Curing materials shall conform to one of the following specifications:

1. Liquid membrane-forming compounds - ASTM C 309, Type 2.

2. White polyethylene film - ASTM C 171.

3. White burlap-polyethylene sheeting - ASTM C 171.

4. Waterproof paper - ASTM C 171.

The Contractor shall furnish manufacturer's certificates indicating that the cover material selected meets all of the requirements for the cited specifications. Such certificates shall be furnished to the Owner's Representative, at least 21 days before the scheduled date for concrete pouring.

G. Concrete Proportions

1. Proportion Ingredients - Unless otherwise specified or indicated on the plans, concrete shall be made of Portland Cement, fine aggregate, coarse aggregate, water and an air-entraining agent as specified under Section 033053 A-E. The Contractor shall supply a concrete design mix to the Owner's Representative, at least 21 days prior to the scheduled date of concrete pour. The Contractor shall include in the design mix report test results from a trial batch, to include aggregate gradation, slump, air content, 7 day and 28 day strengths.

Designed mixtures shall be based upon sieve analysis of the aggregates available. In no case shall less than six sacks of cement per cubic yard of concrete be used to obtain the minimum allowed strength of 4,500 pounds per square inch. The method of measuring concrete materials in

batch-mixes or at ready-mix plants shall be by weight, and shall be such that the proportions can be accurately controlled and easily checked at any time during the work.

The above mixtures are stated by volume. Measured quantities shall be placed in mixtures by equivalent weight with due allowances for moisture in the aggregate and bulging of sand.

2. Water-Cement Ratio - The proportioning of materials shall be based on the requirements of a workable mix containing not more than six gallons of water per sack of cement. Water in the aggregate must be included in the quantity of water specified and shall be subtracted from the amount of water not exceeding that of the approved design mix.

   Moisture in the aggregate shall be measured daily during placing of concrete by methods satisfactory to Owner's Representative, and the specified quantity of water shall be adjusted accordingly to provide for a total amount of water not exceeding that of the approved design mix.

3. Workability - The consistency of the concrete shall be such that the concrete can be readily worked around reinforcing bars and into all angles and corners when vibrated. The slump of the concrete shall not be less than two inches nor more than four inches. The methods of measuring the slump shall conform to ASTM C 143. Owner's Representative shall reject any truck load having a slump greater than that specified above. The Contractor shall remove the concrete already placed from such rejected load at his own expense.

Construction Procedures

A. Control of Concrete Mixes - The Contractor shall be responsible for making and curing concrete test cylinders (ASTM C 31). Curing of the cylinders will be by covering with approved cover material specified in Section 033053. During the first 24 hours all test specimens shall be stored under conditions that maintain the temperature immediately adjacent to the specimens in the range of 60°F to 80°F and prevent loss of moisture. After 48 hours test specimens shall be removed from the field to the testing laboratory. Care shall be taken during transport to prevent damage to the specimens from jarring, freezing temperatures, or moisture loss.

   Each cylinder shall be labeled on the side with the date, project name and number if any, cylinder I.D. number or letter, and Contractor's name. All such information shall appear on the testing laboratory's reports. Such testing laboratory reports shall be in the mail to the Owner's Representative within 3 working days from the date of testing. Testing of concrete test cylinders taken from the concrete actually placed in the work will be paid for by the Contractor.

   Three test cylinders, six inches in diameter by twelve inches in height shall be taken from a batch of concrete selected at random from each 50 cubic yards of concrete poured, but in no case shall less than one set of cylinders for each 50

cubic yards of concrete, or each day's pour be taken. Concrete test cylinders shall be broken as follows: one each at seven and twenty-eight days with the remaining cylinder held. The third cylinder tested shall be as directed by the Owner's Representative. The results of each test shall be reported to the Owner's Representative (ASTM C 39). Test cylinder results shall be as follows:

7 day cylinders-75% of the specified strength, or better.

28 day cylinders-100% of the specified strength, or better.

Failure of test cylinders to meet the specified strength will result in the rejection of poured areas from which samples were taken and the Contractor will be required to remove and reconstruct any such condemned areas at his own expense. No concrete shall be placed upon other concrete poured on this project for which the 7 day test cylinder results have not been received and approval given.

Other field tests to be performed are as follows:

Test	Frequency
Aggregate gradation ASTM C 136	1 per 750 cubic yards*
Slump and air content ASTM C 143 & ASTM C 138 or ASTM C 231	1 set per 50 cubic yards*
Yield ASTM C 138	1 per 750 cubic yards

* or per day, whichever is the more frequent.

Tests, analysis and inspections shall be made in accordance with pertinent standards of the ASTM and shall meet with the approval of the Owner's Representative.

B. Ready-mix Concrete - The use of plant-mix concrete delivered to the job in revolving drum mixture trucks will be approved if evidence is submitted to establish the adequacy of the proposed concrete plant's equipment and facilities. Plant-mixed concrete shall conform to ASTM C-94. No water shall be added to the ready-mix concrete at the job site without the specific approval of the Owner's Representative.

C. Depositing Concrete - Concrete shall be placed from the transporting vehicle to the place of final deposit as rapidly as practicable by methods approved by the Owner's Representative, which shall prevent the separation or loss of ingredients.

Under no circumstances shall concrete that has partially hardened be deposited in the work. Concrete shall be deposited in the forms as nearly as practicable in

its final position to avoid rehandling. It shall be so deposited as to maintain, until completion of the unit, a plastic surface approximately horizontal.

D. Retempering - Retempering of concrete which has partially hardened will not be permitted.

E. Vibrating - Internal vibrators shall be used in all walls, floors, and in all reinforced work. Vibrators shall be of sturdy construction, adequately powered and capable of transmitting to the concrete not less than 3,600 impulses per minute when operating under load. A sufficient number of vibrators shall be used so that, at any rate of placement, complete vibration and compaction will be sustained throughout the entire volume of each layer of concrete. Internal vibrators shall be kept constantly moving in the concrete and shall be applied at points uniformly spaced not farther apart than the radius over which the vibrator is visibly effective. The vibrator shall not be held in one location long enough to draw a pool of laitance from the surrounding concrete.

F. Curing - Exposed surfaces of concrete shall be protected from premature drying caused by the hot sun, drying winds, or other causes. Freshly placed concrete shall be protected from damage from rain.

When concrete is placed while the air temperature is less than 40°F or when freezing is probable within 48 hours, all sand, aggregate, and water shall be heated, and the concrete, when being placed, shall have a temperature of not less than 70°F nor more than 100°F. Care must be taken to prevent too rapid drying of the concrete when it is heated. During freezing weather suitable means shall be provided for maintaining the temperature of the concrete at not less than 50°F for a period of five days for normal concrete curing.

G. Finishing - Unless otherwise specified, exposed concrete wall surfaces shall be finished by wetting, thoroughly rubbing with a carborundum brick, and rinsing with water. Floor and wall finishes shall be finished by floating with a wood float in a manner that will thoroughly compact the concrete and will provide a smooth, even surface. Final floor finish will be attained with a steel trowel. Unexposed concrete shall have a float finish.

H. Patching - If, after the removal of the forms, voids, or other blemishes exist in any concrete surface, the Contractor shall remove all loose material and cut back at least one inch into solid concrete with square edges, after which he shall thoroughly moisten the surface with clean water, apply a coat of neat cement and fill the openings with grout of the same proportions as the original mix. This shall be done immediately upon removal of the forms. Tie holes, left by the withdrawal of tie rods, or holes left by the removal of ends of ties shall be filled solid with mortar.

I. Construction Joints - Concrete for tunnels, trenches, and walls shall be poured in units as large as possible in order to lessen the number of construction joints. The location of all joints not shown on the plans shall be approved by the Owner's Representative. Where joints are to be made, the surface of the concrete shall be thoroughly cleaned and all latents removed. In addition to the

foregoing, vertical joints shall be thoroughly wetted but not saturated, and slushed with a coat of neat cement grout immediately before the placing of new concrete.

J. Openings and Recesses - The Contractor shall provide all openings and recesses in the concrete as shown on the plans, or as directed by the Owner's Representative.

K. Forms and Centering - Forms shall be constructed so that the finished concrete walls will conform to the shape, lines, grades and dimensions indicated on the plans. The forms shall be substantial, and sufficiently tight to prevent the leakage of mortar and shall not deflect under the weight of the wet concrete or construction loads.

Forms for exposed surfaces shall be coated with nonstaining mineral oil applied before the reinforcement is placed. After oiling, any surface oil on the reinforcing steel shall be removed. Earth trenches used for footings shall be clean, even, vertical and true. The bottoms of earth footings shall be level, clean and without fill. Where caving of the footings exists, the footings shall be formed with boards to their entire depth as shown on the plans. Forms shall not be removed until it is evident that the concrete has attained sufficient strength to carry all loads to which it shall be subjected.

L. Form Ties - Unless otherwise specified, form ties shall be of a design approved by the Owner's Representative. Ties shall be such that when forms are removed no metal shall be within one inch of the finished surface. Holes remaining in the concrete after the form ties have been removed shall be filled with mortar.

DIVISION 31 -- EARTHWORK

312323.13 SUBGRADE COMPACTION

Description

This work shall consist of compacting the earth subgrade on a previously graded surface. This work shall be performed prior to any subgrade preparation.

Construction Procedures

A. The subgrade for the full width of the paved surface shall be scarified to a depth of at least 6 inches, and the scarified material brought to a uniform moisture content either by drying or by adding water, and manipulating with suitable equipment. At the Contractor's option, the upper 6 inches of soil may be removed and replaced with satisfactory material, or removed and manipulated with suitable equipment before replacing. The material shall be compacted to produce a subgrade having a density not less than 98%, by the use of approved equipment producing satisfactory results.

B. If it is determined that the required subgrade density cannot be obtained by moisture control and compaction of the upper 6 inches, the unsuitable material shall be excavated to a depth not to exceed 18 inches, and replaced with satisfactory material compacted in layers not to exceed 6 inches, except as otherwise permitted by the Owner’s Representative. Each 6 inch layer shall be processed, wetted or dried as necessary, and compacted to the required density.

C. AASHTO T-99, Method C, will be used as the Standard Compaction Test for determining the moisture density relations of soils. The optimum moisture as determined by the Standard Compaction Test may be used as a guide in determining the proper moisture content at which each soil type should be compacted. Water shall be added or removed as necessary to permit obtaining the required density and moisture control. The field density after compaction will be determined in accordance with AASHTO T-239, or other method as approved by the Engineer. The calculated density obtained in a field density test will be compared with the maximum density as established by the Standard Compaction Test to determine the percent compaction attained.

All paved subgrades shall be compacted to at least 98% of maximum density, as determined by the Standard Compaction Test.

312333 EXCAVATION OF TRENCHES

Description

The work in this section consists of furnishing all equipment, labor, and tools necessary for the excavation of trenches as required by the plans and specifications.

Trenches shall be constructed to the lines and grades shown on the plans or as directed by the Owner's Representative. The Contractor shall furnish all laser equipment for establishing grade of trench bottom, bedding material, and pipe inverts.

The Contractor shall be careful to preserve stakes and survey marks from damage or dislocation.

Material

The Contractor shall be responsible for the acceptability and storage of all material furnished by him and shall assume responsibility for the replacement of all such material found damaged or defective in manufacture. This shall include the furnishing of all material and labor required for the replacement of installed material discovered to be defective prior to the final acceptance of the work.

Construction Procedures

A. Trench Excavation and Backfill - All excavation and backfill work shall be done in accordance with pipe manufacturers and industry recommendations, standards and practices.

1. Clearing and Care of Surface Materials - The Contractor shall furnish all the labor, materials and equipment necessary to complete all clearing of brush, trees, or other obstructions required to complete all work under this heading.

   Where existing roads are cut or disturbed by the excavation of the trenches, or otherwise damaged by the Contractor's equipment, the roads and streets shall be replaced and repaired with surface materials matching the existing paving materials in such a manner satisfactory to Owner's Representative. Fences, power poles, and other property shall be protected by the Contractor, unless their removal is authorized. All property shall be satisfactorily restored by the Contractor at his expense to the approval of the Owner's Representative.

2. Protection of Trees and Shrubs - All trees and shrubs adjacent to the proposed property shall be adequately protected by the Contractor. No excavation material shall be placed so as to injure trees or shrubs. Trees and shrubs damaged or destroyed by the Contractor shall be replaced by him with new stocks of a similar size and age, and at the proper season, and at the sole expense of the Contractor.

3. Alignment Grade and Trench Preparation - Trenches shall be located as

shown on the drawings, or as directed by the Owner's Representative.

Whenever obstructions not shown on the plans are encountered during the progress of the work and interfere to such an extent that an alteration in the plans is required, the Owner's Representative shall have the sole authority to change the plans and order a deviation from the line or grade, or arrange with the Owners of the structures for the removal, relocation, or reconstruction of the obstructions. If the change of plans results in a change in the amount of work by the Contractor, such altered work shall be done on the basis of payment to the Contractor for extra work, or credit to the Owner for less work.

The Contractor shall proceed with caution in the excavation and preparation of the trench so that the exact location of the underground structures, both known and unknown, may be determined, and he shall be responsible for the repair of such structures when broken, or otherwise damaged because of carelessness on his part.

4. Trenching and Excavating - Excavation of trenches may be either by hand, or machinery. Contractor shall overdig such that excavating shall extend below the finished grade. Select backfill as directed by the Owner's Representative, thoroughly compacted to the shape and grade required, shall be placed before the placement of the pipe. Backfill material may be earth, sand, gravel, or concrete as approved by the Owner's Representative. Backfill shall be continuous and uniform and shall not contain objects larger than one inch in diameter.

   The sides of all trenches shall be as nearly as possible vertical. Excessive width of trenches will not be allowed. From a point six inches above the finished grade to the finished grade line, the excavation shall conform as nearly as possible to the size and shape of the pipe so that the pipe may rest on undisturbed soil.

   Materials excavated from the trenches shall be deposited along the sides and beyond the reach of possible slides with the banks trimmed so that as little as possible inconvenience to public travel or tenants occupying adjoining property will ensue. The bottom of the trench shall provide continuous uniform bearing for the pipe.

   In the event it is necessary to place the excavated materials on any traveled way, the Contractor shall keep the excavated materials a minimum of four feet from the front of all buildings and from the inner portion of the traveled way.

   All areas are to be cleaned thoroughly and open to pedestrian traffic when work is not in progress. Barricades and portable flashing beacons shall be provided at each end, and at such other locations as required by the Owner's Representative to provide safety for the general public. Where the excavated material has been deposited on green grass plots, the Contractor shall remove the excavated material carefully when

backfilling so as not to destroy the grass.

5. Sheeting, Shoring and Bracing - Where necessary to prevent caving, trench excavation in sand, gravel, sandy soils or other unsuitable materials shall be adequately sheeted and braced. Where sheeting and bracing are used, the clear trench width shall not be less than that specified for unsheeted trenches. As back-fill is placed, the sheeting shall be withdrawn in sections for proper compaction of the fill materials.

   Excavation surfaces too steep to be safe and stable if unsupported shall be supported as necessary to safeguard the work and workmen, to prevent sliding or settling of the adjacent ground, and to avoid damaging existing improvements. The width of the excavation shall be increased if necessary to provide space for sheeting, bracing, shoring, and other supporting installations. The Contractor shall furnish, place and subsequently remove such supporting installations.

6. Pipe Clearance in Rock - A minimum clearance to rock of at least six (6) inches shall be provided below and on each side of any and all pipe. All rock, boulders, ledge rock and other large stones shall be removed to provide a minimum of six inches clearance.

   This minimum specified clearance is a minimum clear distance which will be permitted between any part of the pipe being laid to a point of projection of such rock, boulder, or stone. Before the pipe is installed, all irregularities of the rock shall be filled with earth, or sand that has been well rammed into place and the bottom of the trench brought to the proper grade and shape.

7. Rock Excavation - Trench Excavation is unclassified and no extra compensation will be allowed for rock excavation.

8. Blasting - The use of dynamite or other blasting materials will not be permitted.

9. Dewatering Trenches - Adequate provisions shall be made by the Contractor for the removal and disposal of all water entering the excavation and for the maintenance of the same in a dry condition until the pipe lines and other parts of the work have been satisfactorily installed.

   When large quantities of ground water are encountered, crushed stone or gravel may be used as a subdrain to facilitate drainage to trench or sump pumps. A dam shall be provided in the subdrain to minimize the possibility of undercutting the trench foundation from excessive ground water flows. Ground water will be pumped away from the trenches and area that will be excavated.

   When dewatering of a section is completed and the dewatering process is terminated, the termination will be done in such a manner to allow the

pressures to increase gradually.

B. Backfilling

1. Backfilling the Trench - The pipe will be covered and tamped by hand, or approved mechanical methods, with selected backfill.

   a. For backfilling under rigid or non-rigid surfacing, crushed limestone shall be placed to the bottom of the surfacing. All replacement surfacing shall be asphalt or concrete complying with Sections 321216, and 334000, respectfully**,** as applicable, to provide replacement surfacing of the same type as existing surfacing.

2. Backfilling and Cleanup - The bottom of the trench shall be backfilled with material as specified above and shall be deposited in the trench simultaneously on both sides of the pipe and to a distance above the top of the pipe as specified on plans. This backfill shall be tamped in even layers solid bearing and backing.

   The upper portion of the trench shall be backfilled with materials as specified above and shall be compacted by hand tamping, wheel compaction, or other mechanical method, approved by the Owner's Representative.

   Upon completing the backfill of the trenches, the trench shall be maintained in a safe condition relative to transportation for a period of twelve (12) months in such manner that no standing water will occur over the trenches. All excess excavation materials shall be moved from the alignment of the trench and disposed of at the direction of the Owner and the Owner's Representative. If extra trench fill is needed, approved material shall be provided by the Contractor at no additional cost to the Owner.

3. Backfill in Unsuitable Material - Where the bottom of the trench at subgrade is found to be unstable or to include ashes, cinders refuse vegetable or other organic material that in the judgment of the Owner's Representative should be removed; the Contractor shall excavate any such unsuitable material to the width and depth ordered by the Owner's Representative. Before the pipe is laid, the subgrade shall be made by backfilling with an approved material in six (6) inch layers. These layers shall be thoroughly tamped to provide uniform and continuous bearing for the pipe.

   Where the bottom of the trench at subgrade is found to consist of material that is unstable to such a degree that, in the opinion of the Owner's Representative it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, the Contractor shall construct a foundation for the pipe, consisting of piling,

timbers, or other materials, in accordance with plans prepared by Darren Krehbiel Consultants, LLC.

4. Restoration of Original Surfaces - All surplus materials, excavated and not required for backfill in the excavations, shall be removed from the area by the Contractor and deposited and graded at accessible points as directed by the Owner or otherwise removed legally from the site. The cost of hauling, deposit, and grading of the waste materials shall be done at the expense of the Contractor. Upon completing the backfill of the trenches, the trench shall be maintained in a safe condition relative to transportation and maintenance for a period of twelve (12) months in such a manner that no standing water will occur over the trenches.

312400 SUBGRADE PREPARATION

Description

This work shall consist of preparing the subgrade upon which a base course is to be constructed or a surfacing placed.

Construction Procedures

A. The subgrade shall be substantially uniform in density throughout its entire width. It shall conform to the lines, grades, and typical cross sections shown on the plans, or as established by the Owner's Representative. The subgrade shall be constructed to drain surface water to the designed locations and structures as shown on the plans and drainage patterns shall be kept open by the Contractor. Where hauling results in ruts or other objectionable irregularities, the Contractor shall reshape and reroll the subgrade before the base or surfacing is placed.

B. Prior to laying base or setting paving forms, the subgrade shall conform to the moisture and density requirements for compaction. Soft spots and unsuitable material shall be removed and backfilled with approved stable material.

C. The finished subgrade at the time of paving shall be moist, but sufficiently firm to resist rutting or deforming under construction traffic.

DIVISION 32 – EXTERIOR IMPROVMENTS

321100 BASE-CRUSHED AGGREGATE

Description

This work shall consist of the furnishing and placing of an aggregate base on a prepared subgrade in conformity with the thickness and typical cross sections shown on the plans or as established by the Owner's Representative.

Materials

The aggregate shall be crushed limestone consisting of hard, durable particles or fragments of stone, free from dirt or other objectionable matter.

The crushed aggregate shall meet the requirements of the gradation given in the following table.

Table 321100-1

SIEVE SIZE	PERCENT BY WEIGHT PASSING SIEVES
1 ½ in.	100
1 in.	70-95
¾ in.	55-85
No. 4	30-60
No. 40	10-25
No. 200	3-10

Type 5 MoDOT base shall also be accepted.

Construction Procedures

A. All work on that portion of the subgrade on which the base is to be constructed shall be completed in accordance with the requirements of Section 312400, Subgrade Preparation, prior to the placing of any base material on that portion. No base-crushed aggregate will be placed on frozen subgrade. The Contractor shall sprinkle the subgrade, if the moisture content is not acceptable, before spreading the base material.

B. The aggregate mixture will have an even moisture content throughout for maximum compaction and will be placed with an approved spreading and finishing machine. Aggregates shall not be deposited on the pavement and bladed or dozed into place. The maximum compacted thickness of any one layer shall not exceed 3 inches. The base material shall not be allowed to segregate during the placing and compacting operations.

C. All base-crushed aggregate compaction shall be at least 100% of Standard

Proctor Compaction (ASTM D698). Base shall be tested in accordance with AASHTO T-99, Method C. The moisture content of the base shall be maintained in accordance with AASHTO T-99 by wetting or drying as required.

D. The field density of the base-crushed aggregate course after compaction will be determined in accordance with AASHTO T-191 or AASHTO T-239. The calculated density obtained in a field density test will be compared with the maximum density as established by the AASHTO T-99, Method C, to determine the percent compaction attained.

E. The deviation of the completed surface of the aggregate base shall not exceed a maximum of ½ inch.

F. The surface of the aggregate base shall be well drained at all times. It shall be the Contractor's responsibility to restore, at his expense, the earth subgrade and the aggregate base to the required grade, if at any time the compacted aggregate base or subgrade becomes unstable. The Contractor shall maintain the required density and surface condition of any portion of the completed base until the succeeding course or pavement is placed.

321213.13 TACK COAT

Description

This work shall consist of preparing and treating an existing bituminous or concrete surface with bituminous material, and blotter material, if required, in accordance with these specifications and in conformity with the plans or as established by the Owner's Representative.

Materials

The bituminous material shall be either cutback asphalt, emulsified asphalt, or tar and shall conform to the requirements of the following table. The type, grade, controlling specification, and application temperature of bituminous material to be used shall be specified by the Owner's Representative.

Type and Grade	Specification	Application Temperature Deg. F	Deg. C
Emulsified Asphalt			
SS-1, SS-h	ASTM D977	75-130	25-55
CSS-1, CSS-ah	ASTM D2397	75-130	25-55
Cutback Asphalt			
RC-70	ASTM D2028	120-160	50-70
Tar			
RTCB 5, RTCB 6	ASSHTO M52	60-120	15-50

Construction Procedures

A. Weather Limitations - The tack coat shall be applied only when the existing surface is dry and the atmospheric temperature is above 40°F. The temperature requirements may be waived, but only when so directed by the Owner's Representative.

B. Application of Bituminous Material - Immediately before applying the tack coat, the full width of surface to be treated shall be swept with a power broom and/or airblast to remove all loose dirt and other objectionable material.

Emulsified asphalt shall be diluted by the addition of water in such proportion that the resulting mixture will contain not more than 50 percent of added water when directed by the Owner's Representative, and shall be heated at the time of application to a temperature specified by the Owner's Representative, in accordance with the table above. The tack coat shall be uniformly applied with a bituminous distributor at the rate of 0.02 to 0.15 gallons per square yard depending on the condition of the existing surface. The type of bituminous material and application rate shall be approved by the Owner's Representative, prior to application. The tack coat shall be applied in such a manner as to cause

the least inconvenience to traffic and to prevent pickup or tracking of the tack coat.

If the asphalt distributor is not equipped with an operable quick shut-off valve, the priming operation should begin and finish on building paper.

Following the application, the surface shall be allowed to cure without being disturbed for such period of time as may be necessary to permit drying out and setting of the tack coat. The surface shall then be maintained by the Contractor until the next course has been placed. Suitable precautions shall be taken by the Contractor to protect the surface against damage during this interval.

The Contractor shall remove any sand that was used to blot up excessive material prior to constructing the overlay.

321213.19 PRIME COAT

Description

This work shall consist of preparing and treating an existing surface with bituminous material, and blotter material, if required, in accordance with these specifications and in conformity with the plans or as established by the Owner's Representative.

Materials

The types, grades, controlling specifications, and application temperatures for the bituminous material are given below. Owner's Representative shall approve the specific material to be used.

Table 321213.19-1

Type	Grade	AASHTO Specification	Application Temperatures
RC	70	M81	120° - 160° F
MC	70	M82	120° - 160° F
SC	70	M141	120° - 160° F
RC	250	M81	160° - 200° F
MC	250	M52	160° - 200° F
SC	250	M141	160° - 200° F

Construction Procedures

A. Weather Limitations - The prime coat shall be applied only when: either the air temperature or the temperature of the surface to be primed is above 60°F; the existing surface is dry or contains only sufficient moisture to get uniform distribution of the bituminous material; the weather is not rainy or foggy.

B. Preparation of Surface - Before the prime coat is applied the base course shall be slightly damp. The surface of the base course shall be free from all ruts, corrugations, segregated material, or other irregularities and shall be uniformly compacted by rolling. Immediately before applying the prime coat, the full width of the surface to be primed shall be swept with a power broom to remove all loose dirt and other objectionable material.

C. Application - The application of the bituminous material shall be made by means of a pressure distributor at the temperature, pressure, and in the amounts directed by the Owner's Representative. The application rate shall be between 0.2 and 0.5 gallon per square yard. The temperature shall be specified by the Owner's Representative.

If the asphalt distributor is not equipped with an operable quick shut-off valve, the priming operation should begin and finish on building paper. Pools of primer material remaining on the surface after the application shall be removed.

Following the application, the primed surface shall be allowed to dry not less than 48 hours without being disturbed or for such additional time as may be necessary to permit the drying out of the prime until it will not be picked up by traffic or equipment. This period shall be determined by the Owner's Representative. The surface shall then be maintained by the Contractor until the surfacing has been placed. Suitable precautions shall be taken by the Contractor to protect the surface against damage during this interval.

The Contractor shall use sand to blot up excess prime coat material.

The Contractor shall remove any sand that was used to blot up excessive material prior to constructing the overlay.

D. Acceptance Sampling - Samples of the bituminous materials that the Contractor proposes to use, together with a statement as to their source and character, must be submitted and approved before use of such material begins. The Contractor shall require the manufacturer or producer of the bituminous materials to furnish material subject to this and all other pertinent requirements of the contract. Only satisfactory materials, so demonstrated by service tests, shall be acceptable.

The Contractor shall furnish vendor's certified test reports for each carload, or equivalent, of bituminous material shipped to the project. The report shall be delivered to the Owner's Representative before permission is granted for use of the material. The furnishing of the vendor's certified test report for the bituminous material shall not be interpreted as basis for final acceptance. All such test reports shall be subject to verification by testing samples of materials received for use on the project.

321216 ASPHALTIC CONCRETE PAVEMENT – STRUCTURAL/WEARING

Description

This item shall consist of a structural course and a wearing course composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in such proportions that the resulting mixture meets the grading requirements of the job-mix formula and in accordance with the plans and these specifications.

Each course shall be constructed to the depth, typical section or elevation required by the plans and shall be rolled, finished and approved before the placement of the next course.

Materials

A. Aggregate -

1. Coarse Aggregate - All coarse aggregate shall consist of crushed limestone having sound, tough, durable particles, free from adherent coatings of clay, organic matter and other deleterious substances. It shall show no more than 40% when tested in accordance with ASTM C 131. The gradation of coarse aggregate shall be such that the coarse aggregate, when combined with fine aggregate, will meet the gradation requirements for the type of asphaltic concrete specified.

2. Fine Aggregate - Fine aggregate shall consist of clean, sound, durable, angular particles produced by crushing stone, or gravel and shall be free from coatings of clay, silt or other objectionable matter and shall contain no clay balls.

3. Sampling and Testing - All aggregate samples required for testing shall be furnished by the Contractor. ASTM D 75 shall be used in sampling coarse aggregate and fine aggregate, and ASTM C 183 shall be used in sampling mineral filler. No aggregate shall be used in the production of mixtures without prior written approval.

4. Sources of Aggregate - Sources of aggregate shall be selected well in advance of the time the materials are required in the work. When the source producing aggregates has a satisfactory service record in bituminous pavement construction for at least five years, samples shall be submitted 14 days prior to start of production. An inspection of the producer's operation may be made by the Owner’s Representative. When new sources are to be developed, the Contractor shall indicate the sources and shall submit a plan for operation 28 days in advance of starting production. Samples from test pits, borings and other excavations shall be submitted at the same time. Approval of the source of aggregate does not relieve the Contractor in any way of the responsibility for delivery at the job site of aggregates that meet the requirements specified herein.

5. Samples of Aggregate - Samples of aggregates shall be furnished by the Contractor at the start of production and at intervals during production of bituminous mixtures. The intervals and points of sampling will be designated by the Owner's Representative. The samples will be the basis of approval of specific lots of aggregates from the standpoint of the quality requirements of this section.

   The combined coarse and fine aggregate shall have a gradation within the limits designated as follows and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be well graded from coarse to fine.

Table 321216-1
Percent Passing

Sieve Size	Structural Course	Wearing Course
1 inch	100	
¾ inch	85-100	100
½ inch	60-90	85-100
3/8 inch	50-75	60-90
No. 4	35-65	50-70
No. 8	25-50	30-55
No. 16	15-30	18-35
No. 30	10-35	10-30
No. 50	6-15	7-19
No. 100	4-12	4-11
No. 200	6-12	5-12

   MoDOT approved BP-1 and Black Base shall also be accepted. Conforming to applicable gradational requirements of MoDOT Standard Specification 401 to 403 except that sampling for testing compliance during laydown should be from hot mix samples taken behind the paver.

B. Mineral Filler - If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D 242. Prior approval shall be required for use of fly ash as a mineral filler.

C. Bituminous Material - The types, grades, controlling specifications and maximum mixing temperatures for the bituminous materials are given in Table 321216-2. Regardless of the type and grade of asphalt used, the penetration of the asphalt cement shall not to be less than 60 nor more than 100 without written approval from the Owner's Representative.

   The Contractor shall furnish vendor's certified test reports for each carload or equivalent of bitumen shipped to the project. The report shall be delivered to the Owner's Representative, before permission is granted for use of the material. The vendor's certified test report for the bituminous material can be used as a basis for final acceptance; however the Owner's Representative reserves the

right to have the material tested and reject it if the asphalt cement does not meet the specifications.

Table 321216-2
BITUMINOUS MATERIAL

TYPE AND GRADE ASPHALT CEMENT		SPECIFICATION	MAXIMUM MIXING TEMPERATURE F	C
Penetration Grade	60-70	ASTM D 946	335	170
	85-100		325	165
Viscosity Grade	AC-10	ASTM D 3381	315	155
	AC-20		330	165
Viscosity Grade	AR-4000	ASTM D 3381	325	165
	AR-8000		325	165
Tar	RT-11	ASTM D 490	250	125
	RT-12		250	125

Composition

A. Composition of Mixture - The bituminous plant mix shall be composed of a mixture of aggregate, filler, if required, and bituminous material. The aggregate fractions shall be sized, uniformly graded and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula.

B. Job Mix Formula - No bituminous mixture shall be produced for payment until a job mix formula has been approved by the Owner's Representative. The samples shall be taken from the source by the Contractor and delivered to the testing laboratory at the Contractor's expense. The samples of materials shall be of the size specified by the Owner's Representative. The Contractor's testing laboratory shall prepare the job mix formula. If the first job mix formula does not meet the requirements of these specifications or the Contractor should decide to change sources of material, the Contractor shall pay for additional job mix formulas.

Table 321216-3
MARSHALL DESIGN CRITERIA
BASE COURSE

Test Property	Pavement
No. of Blows	50
Marshall Stability	1000
Flow (0.01 in.)	8-20

Voids Criteria	Non-Absorptive Aggregate	**Absorptive Aggregate
% Air Voids	3-6	3-8
% Voids Filled With Asphalt	65-85	70-90

* When absorption of blended aggregate is less than 2.5%, use the apparent specific gravity determined in accordance with ASTM C 127 for coarse aggregate and ASTM C 128 for fine aggregate.

** When the absorption of the blended aggregates equals or exceeds 2.5%, the bulk impregnated specific gravity shall be used.

Construction Procedures

A. Weather Limitations - The bituminous mixture shall not be placed: upon a wet surface; when the surface temperature of the underlying course is less than 50°F; when weather conditions prevent the proper handling or finishing of the mixture; or between October 1 and April 1 without written approval of the Owner's Representative.

B. Preparation of Bituminous Material - The bituminous material shall be heated to the specified temperature in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature. The temperature of the bituminous material delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles but shall not exceed the application maximum temperature set forth in Table 321216-2.

C. Preparation of Mineral Aggregate - The aggregate for the mixture shall be dried and heated to the temperature designated by the job formula within the job tolerance specified. The maximum temperature and rate of heating shall be such that no permanent damage occurs to the aggregates. Particular care shall be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability. The aggregate shall not be heated

greater than 25°F above the temperature of the bituminous material.

D. Preparation of Bituminous Mixture - The aggregates and the bituminous material shall be measured or gauged and introduced into the mixer in the amount specified by the job mix formula.

The combined materials shall be mixed until complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate are secured. Wet mixing time shall be approved by the Owner's Representative, for each plant and for each type aggregate used. Normally, the mixing time after introduction of bituminous material should be less than 30 seconds. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer.

$$\text{Mixing time (seconds)} = \frac{\text{Pugmill dead capacity in pounds}}{\text{Pugmill output in pounds per second.}}$$

The dry mixing time in the batch plant shall be the time required to blend the dry aggregate in a uniform mixture. The wet mixing time begins with the introduction of the asphalt cement to the pugmill and ends with the opening of the discharge gate.

Prolonged exposure to air and heat in the pugmill hardens the asphalt film on the aggregate through oxidation; therefore, the mixing time should be the shortest time required to obtain uniform distribution of aggregate sizes and thorough coating of aggregate particles with the bituminous material.

E. Transporting, Spreading, and Finishing - The mixture shall be transported from the mixing plant to the point of use in vehicles conforming to the following requirements. Trucks used for hauling bituminous mixture shall have tight, clean, smooth, metal beds which have been thinly coated with a minimum quantity of lime solution, or other approved material to prevent the mixture from adhering to the beds. Use of diesel fuel, fuel oil or other detrimental products as a bed coating will not be allowed. Each truck shall have a securely fastened cover of canvas or other suitable material of such size as to protect the mixture from the weather. When necessary, so that the mixture will be delivered on the road at the specified temperature, truck beds shall be insulated. Deliveries shall be scheduled so that spreading and rolling of all mixtures prepared for one day's run can be completed during daylight, unless adequate artificial lighting is provided. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to ambient temperature or 6 hours, whichever is longest.

Immediately before placing the bituminous mixture, the underlying course shall be cleared of all loose or deleterious material with power blowers, power brooms or hand brooms, as directed.

The mix shall be placed at a temperature of not less than 265°F when asphalt cement is used and not less than 150°F when tar is used. Moisture content of the

mix shall not exceed 0.5%.

The intermediate lifts may be laid in thickness up to three inches provided graded control can be maintained, and no roller marks or signs of asphalt flushing can be noted in the finished product. The thickness of the final lift shall not be more than three inches nor less than twice the size of the maximum size aggregate in the mix.

Upon arrival, the mixture shall be spread to the full width by an approved bituminous paver. It shall be structured off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and shall conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the bituminous mat.

No segregation will be permitted in handling the mixture at the plant, from the truck, or during spreading operations on the roadbed. All layers shall be feathered out, by hand raking if necessary, in transitioning the depth of the surface to meet present grades at ends of projects, to provide a uniform, smooth riding surface free of irregularities. Where only the top layer of the surfacing continues across any concrete surfacing, the bottom layers shall be feathered out.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread, raked and luted by hand tools.

F. Compaction of Mixture – Asphaltic concrete shall be compacted to a minimum of 98% of Maximum Theoretical Specific Gravity (ASTM D2041).

After spreading, the mixture shall be thoroughly and uniformly compacted with power rollers. Rolling of the mixture shall be discontinued if undue displacement or cracking occurs. When abutting a previously placed lane, the longitudinal joint shall be rolled first followed by the regular rolling procedure. Alternate paths of the roller shall be of slightly different lengths. The rolling pattern may be varied to obtain proper compaction at the direction of the Owner’s Representative.

The speed of the roller shall, at times, be sufficiently slow to avoid displacement of the hot mixture. The rollers shall not travel faster than the manufacturer's recommended speed and in no case faster than 3 mph. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once by rakes and fresh mixture. The roller shall not be permitted to stand static on the hot material.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until all roller marks are eliminated, the surface is of uniform texture and true to grade and cross section, and the required field density is obtained.

To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excessive water will not be permitted.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers.

Any mixture which becomes loose and broken, mixed with dirt or in any way defective shall be removed and replaced with fresh, hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching shall not be allowed.

G. Joints - The construction of all joints shall be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture, density and smoothness as other sections of the course. All contact surfaces of previously constructed pavements that have become coated by dust, sand or other objectionable material shall be cleaned by brushing or shall be cut back with an approved power saw, as directed. The faces of these joints may be painted with a thin coating of tack coat material.

When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course, in which case the edge shall be cut back to its full depth and width on a straight line to expose a vertical face. When paving in that lane is continued, the joint shall be heated with the paver screed until the material along the joint is soft. Overheating of the material shall not be permitted. The joint shall be rolled perpendicular to the paving lane with the roller overlapping the new material approximately one foot. Boards or other devices shall be placed on the edge or edges of the paving lane to prevent roll down of the edges.

Longitudinal construction joints shall be constructed so that the surface is one continuous plane and will not pond water. The longitudinal joint shall be horizontally compacted with an asphalt lute until the surface of the joint is slightly higher than the remainder of the mat immediately after breakdown rolling operations have been completed. After this has been completed, rolling operations shall continue.

If a good longitudinal construction joint cannot be obtained or the desired compaction reached, the joint shall be heated as specified hereinafter. This includes joints that existed prior to the new project or joints created from the previous day's production.

H. Shaping Edges - While the surface is being compacted and finished, the Contractor shall carefully trim the outside edges of the pavement to 45° (degrees). Edges so formed shall be beveled, while still hot, with the back of a rake or a smooth iron and thoroughly compacted by tampers or by other satisfactory methods.

I. Acceptance Sampling and Testing of Bituminous Mixture (Compaction) - Pavement density will be determined by taking the average density of four laboratory-prepared specimens, taken from trucks delivering mixture to the site. Temperature of the mixture immediately prior to compaction shall be 250°F $\pm$ 5. The sample of mixture can be placed in an oven for not more than 30 minutes to maintain the heat, but it shall not be reheated if it cools before use. Density

samples shall not be taken in the pavement where the pavement thickness is less than 12 times the mixture aggregate size. This applies only to wedge courses and tapered transitions.

The average field density shall be equal to or greater than 98% of the average density of the laboratory-prepared specimens. Cores taken from the pavement will be used to test the field density. The density of the laboratory-prepared specimens and the cored samples will be determined in accordance with ASTM D 2726 or D 1188, whichever is applicable. The direct transmission nuclear method of test and/or the backscatter nuclear method of test may be used to determine field density.

The Contractor shall cut samples from any layer of the compacted mixture at locations designated by the Owner's Representative, and shall deliver to the field laboratory in good condition. Samples may be obtained by either sawing with a power saw or by drilling 4-inch diameter cores.

Tests for conformity with the specified slope and grade shall be made by the Contractor immediately after initial compaction. Any variation shall be corrected by the removal or addition of materials and by continuous rolling. Unless otherwise specified in writing, the Contractor shall provide a 10-foot straight edge on the job at all times.

After completion of final rolling, the smoothness of the course shall again be tested; humps or depressions exceeding the specified tolerances shall be immediately corrected. The finished surface shall not vary more than 1/8 inch for the surface course when tested with a 10-foot straight edge applied parallel with and/or at right angles to the centerline. The Contractor shall correct pavement areas not meeting these tolerances in excess of this amount by removing and replacing the defective work. If the Contractor elects to construct an overlay to correct the deficiencies, the minimum thickness of the overlay shall not be less than twice the size of maximum size aggregate.

321613 CURB AND GUTTER

Description

The work covered in this section shall consist of all labor, materials and equipment necessary to perform the work as shown on the plans or as herein specified.

Materials

A. Concrete - Concrete shall be as specified in Section 033053.

Construction Procedures

The 2'-6" combination curb (6" barrier) and gutter shall be placed on 4" of prepared crushed aggregate base as specified in Section 321100, Base-Crushed Aggregate, of these specifications. Transverse weakened-plane contraction joints shall be constructed every 15' at right angles to the curb line. Expansion joints shall be constructed at right angles to the curb line. Expansion joints will also be constructed between the back of the curb wherever it abuts a sidewalk, either existing or proposed.

321623 SIDEWALKS

Description

This work shall consist of the furnishings of all equipment, materials, skills, tools, and labor necessary for the new construction of sidewalks and the repair of sidewalks removed during the other work.

Materials

Concrete shall be as specified in Section 033053.

Asphalt shall be as specified in Section 321216.

Base Crushed Aggregate shall be as specified in Section 321100.

Construction Procedures

Sidewalks shall conform to engineer's plans or otherwise dictated by the architect. Sidewalks shall be a minimum of 4-inches thick. Construction or scored joints will be constructed a minimum of every 30', and where the sidewalk lines adjacent to: barrier curbs, curb inlets, paved approaches, and buildings.

All sidewalk surfaces shall have a coarse textured, non-slip broom finish with the finish grain lying perpendicular to the direction of pedestrian travel.

Concrete shall be placed on prepared and compacted crushed aggregate base and not on subgrade.

Replaced concrete, other than as detailed on the plans, will have a minimum thickness of 4 inches, or the same thickness as that removed, whichever is greater.

321723 ROADWAY PAINTING

Description

This item shall consist of the painting, markings, and stripes on paved surfaces applied in accordance with these specifications and at the locations shown on the plans. Layout of markings shall be performed under the supervision of the Owner's Representative.

Materials

A. Paint - Paint shall meet the requirements of Federal Specifications TT-P-1952 latest addition.

Construction Procedures

A. Weather Limitations - The painting shall be performed only when the surface is dry, when the atmospheric temperature is above 45°F (7°C), and when the weather is not foggy or windy.

B. Equipment - All equipment for the work shall be approved by Owner's Representative and shall include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, and such auxiliary hand-painting equipment as may be necessary to satisfactorily complete the job.

The mechanical marker shall be an atomizing spray-type marking machine suitable for application of traffic paint. It shall produce an even and uniform film thickness at the required coverage and shall be designed so as to apply markings of uniform cross sections and clear-cut edges without running or spattering.

C. Preparation of Surface - Immediately before application of paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other foreign material which would reduce the bond between the paint and the pavement. The area to be painted shall be cleaned by sweeping and blowing or by other methods as required to remove all dirt, laitance, and loose materials.

Paint shall not be applied to portland cement concrete pavement.

D. Layout of Markings - On those sections of pavement where no previously applied markings are available to serve as a guide, the proposed markings shall be laid out in advance of the paint application.

E. Application - Markings shall be applied at the locations and to the dimensions and spacing shown on the plans. Paint shall not be applied until the layout and condition of the surface have been approved by Owner's Representative.

The paint shall be mixed in accordance with the manufacturer's instructions and applied to the pavement with a marking machine at the rate of 110 to 140 square feet (10 to 13 square meters) per gallon (liter) or as indicated by the manufacturer. The addition of thinner will not be permitted. A period of 24 hours

shall elapse between placement of a bituminous surface course or seal coat and application of the paint.

The edges of the markings shall not vary from a straight line more than 2 inch (12mm) in 50 feet (15 M), and the dimensions shall be within a tolerance of plus or minus 5 percent.

The Contractor shall furnish certified test reports for the materials shipped to the project. The reports shall not be interpreted as a basis for the final acceptance. The Contractor shall notify Owner's Representative upon arrival of a shipment of paint to the job site. The Contractor shall provide to the Owner's Representative one (1) quart samples of paint each day the markings are applied. All emptied containers shall be returned to the paint storage area for checking by the Owner's Representative. The containers shall not be removed from the project site or destroyed until authorized by Owner's Representative.

F. Protection - After application of the paint, all markings shall be protected from damage until the paint is dry. All surfaces shall be protected from disfiguration by spatter, splashes, spillage, or drippings of paint.

329200 GRADING, SEEDING AND MULCHING

Description

This work shall consist of preparing, liming, and fertilizing a seedbed, and the furnishing and the sowing of seeds. All disturbed areas, except surfaced areas, shall be seeded.

All seeded areas will be mulched.

Materials

A. Seed - Grass seed shall be a blend of varieties composed of 60% (by weight) tall fescue cultivars, 30% (by weight) perennial ryegrass cultivars and 10% (by weight) "Ensylva" creeping red fescue.

Tall fescue component shall consist of equal portions of any three of the following cultivars:

1. Arid
2. Olympic
3. Jaguar
4. Falcon
5. Apache

Perennial reserves component shall consist of equal portions of any three of the following cultivars:

1. Citation II
2. Manhattan II
3. Blazer
4. Pennfine
5. Yorktown

B. Fertilizer - A general lawn fertilizer, Grade 13-13-13, Nitrogen-13%, Phosphoric Acid-13%; Pot Ash-13% shall be used.

C. Mulch - Vegetative mulch, such as the cereal straw from stalks of oats, rye, wheat, or barley, shall be used. It shall be relatively free of noxious and undesirable seed or foreign material.

Construction Procedures

The seedbed shall be prepared, limed and fertilized and shall be in a firm but uncompacted condition with a relatively fine texture at the time of seeding. Fertilizer shall be applied at the rate of 500 lbs. per acre.

Seeding shall be done before the proposed seedbed becomes eroded, crusted over or dried out and shall not be done when the ground is in a frozen condition or covered with snow. Seeds shall be uniformly applied at the rate of not less than 4.5 pounds per 100 square yards of area.

Dry seeding shall be done mechanically with equipment designed for even distribution of dry seed. The equipment may either be hand operated, such as a knapsack seeder, or be tractor drawn, such as a seed drill. Seed scattered on the surface shall be covered with approximately 1/4 inch of soil by raking or other approved methods. Seed placed in soil shall be 1/4 inch below the surface. After completing the seeding operation, the Contractor shall firm the area by rolling, if in the judgment of the Owner's Representative the seedbed is either too loose or contains clods which would reduce the germination of the seed. When rolling is required, a lawn type roller shall be used and care shall be taken to avoid over-compacting the soil.

Seed shall be sown during the appropriate spring or fall planting season. Seeded areas shall be mulched at a rate of 2.5 tons per acre. All mulching shall be done within 24 hours following the seeding operation. Foot or vehicular traffic shall be prohibited over the mulched area. Should any mulch become displaced, the Contractor shall immediately inspect the seeding for damage, repair any damage, and replace the mulch at once at no additional cost to the Owner.

A stand of grass shall be considered adequate when the bare spots do not exceed 1 square foot and the bare spots do not cover more than 3% of the area to be seeded.

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SECTION 32 3113
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Posts, rails, and frames.

B. Wire fabric.

C. Manual gates with related hardware.

D. Accessories.

1.02 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.

C. ASTM A428/A428M - Standard Test Method for Weight (Mass) of Coating on Aluminum-Coated Iron or Steel Articles 2010 (Reapproved 2014).

D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.

E. CLFMI CLF-FIG0111 - Field Inspection Guide 2014.

F. CLFMI CLF-SFR0111 - Security Fencing Recommendations 2014.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.

C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components. See CLFMI CLF-SFR0111 for planning and design recommendations.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

B. Fence Installer: Company with demonstrated successful experience installing similar projects and products, with not less than five years of documented experience.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MATERIALS

A. Posts, Rails, and Frames:
   1. Formed from hot-dipped galvanized steel sheet, ASTM A653/A653M, HSLAS, Grade 50, with G90 (Z275) zinc coating.
   2. Line Posts: Type I round.
   3. Terminal, Corner, Rail, Brace, and Gate Posts: Type I round.

B. Wire Fabric:
   1. ASTM A392 zinc coated steel chain link fabric.

2.02 COMPONENTS

A. Line Posts: 1.9 inch diameter.

B. Corner and Terminal Posts: 2.38 inch diameter.

C. Gate Posts: 3-1/2 inch diameter.

D. Top and Brace Rail: 1.66 inch diameter, plain end, sleeve coupled.

E. Bottom Rail: 1.66 inch diameter, plain end, sleeve coupled.

F. Gate Frame: 1.66 inch diameter for welded fabrication.

G. Fabric: 2 inch diamond mesh interwoven wire, 6 gage, 0.1920 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.

H. Tension Wire: 6 gage, 0.1920 inch thick steel, single strand.

I. Tie Wire: Aluminum alloy steel wire.

2.03 MANUAL GATES AND RELATED HARDWARE

A. Hardware for Single Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; fork latch with gravity drop and padlock hasp; keeper to hold gate in fully open position.

B. Hardware for Double Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; drop bolt on inactive leaf engaging socket stop set in concrete, active leaf latched to inactive leaf preventing raising of drop bolt, padlock hasp; keepers to hold gate in fully open position; rollers on bottom of gate to support weight.

C. Hinges: Finished to match fence components.
   1. Brackets: Round.
   2. Mounting: Center.
   3. Closing: Manual.

D. Latches: Finished to match fence components.
   1. Brackets: Round.
   2. Locking: Mechanical.

2.04 ACCESSORIES

A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.

B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.

C. Privacy Slats: Vinyl strips, sized to fit fabric weave.

2.05 FINISHES

A. Components (Other than Fabric): Galvanized in accordance with ASTM A123/A123M, at 1.7 ounces per square foot.

B. Components (Other than Fabric): Aluminum coated at 0.40 ounces per square foot, when measured in accordance with ASTM A428/A428M.

C. Components and Fabric: Vinyl coated over coating of 1.8 ounces per square foot galvanizing.

D. Hardware: Hot-dip galvanized to weight required by ASTM A153/A153M.

E. Accessories: Same finish as framing.

F. Color(s): Black.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Verify that areas are clear of obstructions or debris.

3.02 PREPARATION

A. Removal: Obstructions or debris.

3.03 INSTALLATION

A. Install framework, fabric, accessories and gates in accordance with ASTM F567.

B. Place fabric on outside of posts and rails.

C. Set intermediate posts plumb , in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.

D. Line Post Footing Depth Below Finish Grade: ASTM F567.

E. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567.

F. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.

G. Provide top rail through line post tops and splice with 6 inch long rail sleeves.

H. Install center brace rail on corner gate leaves.

I. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

J. Position bottom of fabric 2 inches above finished grade.

K. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.

L. Do not attach the hinged side of gate to building wall; provide gate posts.

M. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.

3.04 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch.

B. Maximum Offset From True Position: 1 inch.

C. Do not infringe on adjacent property lines.

3.05 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Layout: Verify that fence installation markings are accurate to design, paying attention to gate locations, underground utilities, and property lines.

C. Post Settings: Randomly inspect three locations against design for:
   1. Hole diameter.
   2. Hole depth.
   3. Hole spacing.

D. Fence Height: Randomly measure fence height at three locations or at areas that appear out of compliance with design.

E. Gates: Inspect for level, plumb, and alignment.

F. Workmanship: Verify neat installation free of defects. See CLFMI CLF-FIG0111 for field inspection guidance.

3.06 CLEANING

A. Leave immediate work area neat at end of each work day.

B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.

C. Clean fence with mild household detergent and clean water rinse well.

D. Touch up scratched surfaces using materials recommended by manufacturer. Match touched-up paint color to factory-applied finish.

3.07 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

END OF SECTION

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SECTION 32 3300
SITE FURNISHINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Bike Racks.

B. Benches.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's specifications and descriptive literature, installation instructions, and maintenance information.

C. Samples: Submit two sets of manufacturer's available colors for metal furnishings.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

1.04 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide manufacturer’s warranty against defects in materials or workmanship for site furnishings for a period of 3 years from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 METAL FURNISHINGS

A. Bike Rack: Loop-style stainless steel bike rack fabricated from 2-3/8" O.D. steel tube.
   1. Finish: Brushed Stainless Steel.
   2. Size:
      a. Length: 35 inches.
      b. Height: 31 inches.
   3. Basis of Design: Belson CBBR-2CRI: www.belson.com.
   4. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PRECAST CONCRETE FURNISHINGS

A. Precast Concrete Furnishings, General:
   1. Precast Concrete Components: Mixture of cement, aggregates, water, and mineral colors; molded to shape, and reinforced with steel bars.
      a. Finish:
         1) Horizontal Surfaces: Smooth for seats and table tops.
         2) Vertical Surfaces: Smooth for supports and sides.
      b. Color: As selected by Architect from manufacturer's standard range.
      c. Clear Sealers: Anti-graffiti.
   2. Hardware: Stainless steel.

B. Benches: Precast concrete, steel-reinforced park bench with acid wash finish.
   1. Color: To be selected by Architect from Manufacturer's standard range.
   2. Size:
      a. Length: 96 inches.
      b. Width: 18 inches.
      c. Height: 16 inches.
   3. Basis of Design: Belson Robust Concrete Park Bench, TF5037: www.belson.com.
      a. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify proper installation of mounting surfaces, preinstalled anchor bolts, and other mounting devices; and ready to receive site furnishing items.

3.02 INSTALLATION

A. Install site furnishings in accordance with approved shop drawings, and manufacturer's installation instructions.

END OF SECTION

DIVISION 33 – UTILITIES

331100 WATER LINES AND APPURTENANCES

Description

This work shall consist of the furnishing of all equipment, materials, skill, tools, and labor necessary for the installation of all waterlines and appurtenances as shown on the plans or herein specified for a complete working water distribution system.

Materials

The quality of all materials, the process of manufacture, and the finished pipe shall be subject to inspection and approval by the Owner's Representative.

Any pipe which has been damaged after delivery will be rejected and if such pipe is already laid in the conduit line, it shall be acceptably repaired, if permitted, or removed and replaced, or made good solely at the Contractor's expense.

A. Integral Bell PVC Pressure Pipe - Only PVC pipe jointed by elastomeric ring seal joint shall be used in the distribution system. PVC pipe pressure rating is to be based on ASTM Standards. The pipe is to bear the seal of NSF.

PVC pipe and fittings with elastomeric ring seal joints shall meet the requirements of ASTM D-3139. The elastomeric ring seal joints shall have been tested and approved by the National Sanitation Foundation (NSF) and certification of said approval shall be submitted.

1. General - This specification designates the general requirements and installation of Polyvinyl Chloride (PVC) pipe and fittings used for conveying potable water under pressure.

2. Pipe - All plastic pipe shall meet the requirements of the National Sanitation Foundation. Each length of pipe must also show the diameter and the commercial standard which is applicable to the type of pipe specified. Plastic pipe shall be polyvinyl chloride ASTM type 1, grade 1 (normal impact), conforming to the commercial standard which is applicable to the type of pipe specified. Plastic pipe shall conform to ASTM D2241, latest edition. Class 200 PVC pipe, shall have a maximum design stress of 2000 pounds per square inch and conform to SDR 21.

3. Certification Requirements - The Contractor shall furnish three copies of a pipe manufacturer's certification that the pipe furnished is in full compliance with the commercial standards applicable to the pipe specified. The Contractor shall furnish Owner's Representative three dated copies showing the physical properties of the pipe furnished. Properties should include normal bursting pressure, manufacturer's maximum working pressure, physical dimensions, and tolerances. Pipe shall not be purchased until approved by the Owner's Representative.

The Contractor shall have the manufacturer provide a factory representative skilled in the installation of the type of pipe purchased to instruct the Contractor's personnel in the proper procedures for connecting and laying the pipe.

4. Fittings - All fittings, couplings and adapters shall be manufactured out of materials conforming to the same standards as the pipe and having a design strength equal or better than the adjacent pipe.

Contractor's Guarantee - Pipe furnished by Contractor shall be guaranteed against rot, electrolytic corrosion, and production defects.

Contractor shall maintain the pipe lines for a period of one year from date of acceptance by Owner's Representative. Such remedial measures as required to correct leaks and similar troubles will be done by the Contractor at his own expense.

B. Gate Valves - Gate valves shall be iron-body, resilient-seated, tight closure gate valves with nonrising stems, "0" ring type packing, and complying with AWWA C509. The waterway of the valve in the fully open position shall be unobstructed. All exposed gate valves shall have flanged ends conforming to ANSI B16.1, Class 125. All buried gate valves shall be specifically designed for buried use and shall be equipped with mechanical joint ends. The gate valve wedge shall have Buna "N" or SBR rubber bond to both sides to form a double seal when the valve is closed. The operator shall be of the hand wheel type for exposed valves. Buried gate valves shall be equipped with a 2-inch square operating nut. All valves shall open in a counterclockwise direction. The valve interior and exterior shall be coated with epoxy paint standard with the valve manufacturer.

C. Valve Boxes - Valve boxes shall be provided for all gate valves on the system. Boxes shall be tough, close grained, gray cast iron free from defects, and shall be coated as specified for cast iron pipe. They shall have suitable bases to fit around the valve bodies without bearing on them. Barrels shall be made telescopic for adjustment and shall have a minimum inside diameter of five inches. They shall be designed for the depth of trench specified. Top section shall have a flange for holding it in position. Covers shall be recessed flush with top, and marked "Water" in raised letters.

D. Painting and Protection - Ferrous parts of valves and appurtenances installed in the exposed piping shall be given two coats of an asphaltum varnish on the inside and one shop coat of Inertol Quick-Drying Zinc Chromate Field Primer No. 626, made by Inertol Company, Newark, New Jersey, or approved equal suitable for field coats, on the outside applied in accordance with the instructions of the manufacturer.

Construction Procedures

A. Excavation of Trenches - All excavation of trenches shall be done in accordance with Section 312333, Excavation of Trenches, and as shown on the plans.

B. Pipe Line Installation -

1. Water Main Laying - All pipes, special castings, valves, and other appurtenances shall be carefully examined for defects, and no pipe, or other fittings shall be installed which is known to be defective. In the event such pipe or other appurtenances shall be discovered to be defective after being installed, they shall be removed and replaced with sound material at the Contractor's expense.

   Every pipe shall be cleared of all debris, dirt, etc., before being laid. Care shall be taken to preserve a good alignment and to give the pipe a firm bearing throughout its entire length. Pipe shall be laid in a satisfactory manner, true to line and depth. Pipes shall not be laid in water.

   The methods of laying pipe shall be in accordance with the recommendations of the manufacturer and as approved by Owner's Representative. Each pipe shall be aligned with that already in place, forced home completely with as nearly an axial movement as possible, and held securely in position.

   Joints shall not be pulled or cramped more than the manufacturer's recommendation to secure changes in alignment. Special care shall be taken to avoid damage to the rubber sealing gasket and each joint shall be inspected and checked with an approved device to ensure that the rubber gasket is in place.

2. Temporary Plugs and Trench Water - When pipelaying is not in progress the open ends of installed pipe shall be closed to prevent entrance of trench water into the line. The open ends of the pipe shall be closed by temporary watertight plugs, or by other approved means. If water is in the trench when work is resumed, the plug shall not be removed until all danger of water entering the pipe has passed. Enough backfill shall be placed on the pipe to prevent floatation. Any pipe that has floated shall be relaid as directed by the Owner's Representative.

3. Thrust Blocks - Thrust blocks shall be provided for all bends, tees, wyes, caps, plugs, and valves as directed by the Owner's Representative or as shown on the plans. Backing shall be of concrete, as specified, and shall be placed between solid ground and the fittings to be anchored. The backing shall be placed so that the pipe and fittings will be accessible for repairs unless otherwise directed by Owner's Representative.

C. Appurtenances Installation - Care shall be taken to prevent damage or injury to valves and appurtenances during handling and installation. All material shall be carefully inspected for defects in workmanship and materials, all debris and foreign material cleaned out of valve openings, etc., all operating mechanisms operated to check their proper functioning and all nuts and bolts checked for

tightness. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced at the Contractor's expense.

All bends, tees, caps, plugs, etc., shall be provided with thrust blocks. Valves and valve boxes shall be firmly set on a foundation or footing of concrete. The volume of the concrete base shall be not less than one (1) cubic foot. The height shall conform to the height of the connecting pipe.

Valve boxes shall be given two shop coats of asphaltum varnish or coal-tar coating.

Tees for service lines or laterals must be assembled so that no strain is placed on the pipe during, or after the backfill operation. The plastic pipe must be handled with reasonable care so that it is not crimped, scratched, or damaged when in the trench.

All finished parts shall be coated with grease to prevent corrosion during shipment and installation.

D. Parallel Installation/Horizontal Separation of Water Mains and Sewer Lines – Water mains shall be laid at least ten feet horizontally from any existing or proposed sewer. The distance shall be measured edge to edge.

E. Crossings/Vertical Separation of Water and Sewer Lines – Water mains crossing sewers shall be laid to provide a minimum vertical clear distance of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. At crossings, the full length of water pipe shall be located so both joints will be as far from the sewer as possible but in no case less than ten feet.

F. Separation of Water Mains and Sewer Manholes – No water line shall be located closer than ten feet to any part of a sanitary or combined sewer manhole.

G. Toning wire – Toning wire (also known as Locator or Tracer Wire) shall be #12 Copper Clad Steel (CCS) with High Density Polyethylene (HDPE) coating as manufactured by Kris-Tech Wire or Copperhead Industries, LLC, or approved equal.

The trace wire and trace wire products shall be domestically manufactured in the U.S.A.

The coating shall be blue in color.

All splices and/or connections shall be made with moisture resistant (displacement) connectors such as 3M DBR Direct Bury Splice Kit or Copperhead SnakeBite, or approved equal.

All mainline trace wires must be interconnected in intersections, at mainline trees and mainline crosses. At tees, the three wires shall be joined using a

single 3-way lockable connector. At crosses, the four wires shall be joined using a 4-way connector. Use of two 3-way connectors with a short jumper wire between them is an acceptable alternative.

No locking friction fit, twist on or taped connectors are prohibited.

The toning wire shall be duct taped to the top center of the pipe every 8 – 10 feet.

All trace wire termination points must utilize an approved trace wire access box specifically manufactured for this purpose. The wire length shall not exceed 2000 feet without surfacing to a locator wire box.

A minimum of 2 ft. of excess/slack wire is required on all trace wire access boxes after meeting final elevation.

All trace wire access boxes must include a manually interruptible conductive/connective link between the terminal(s) for the trace wire connection and the terminal for the grounding anode wire connection.

Trace wire must be properly grounded at all dead ends/stubs.
Grounding of trace wire shall be achieved us use of a drive-in-magnesium grounding anode rod with a minimum of 20ft of #14 red HDPE insulated copper clad steel wire connected to anode (minimum 0.5 lb.) specifically manufactured for this purpose, and buried at the same elevation as the utility.

When grounding the trace wire at dead ends/stubs, the grounding anode shall be installed in a direction 180 degrees opposite of the trace wire, at the maximum possible distance.

When grounding the trace wire in areas where the trace wire is continuous and neither the mainline trace wire or the grounding anode wire will be terminated at/above grade, install grounding anode directly beneath and in-line with the trace wire. Do not coil excess wire from grounding anode. In this installation method, the grounding anode wire shall be trimmed to an appropriate length before connecting to trace wire with a mainline to lateral lug connector.

Where the anode wire will be connected to a trace wire access box, a minimum of 2 ft. of excess/slack wire is required after meeting final elevation.

Trace wire installation shall be performed in such a manner that allows proper access for connection of line tracing equipment, proper locating of wire without loss of deterioration of low frequency (512Hz) signal for distances in excess of 1,000 linear feet, and without distortion of signal caused by multiple wires being installed in close proximity to one another.

Trace wire systems must be installed as a single continuous wire, except where using approved connectors. No looping or coiling of wire is allowed.

All new trace wire installations shall be located using typical low frequency (512Hz) line tracing equipment, witnessed by the contractor, engineer and facility owner as applicable, prior to acceptance of ownership.

This verification shall be performed upon completion of rough grading and again prior to final acceptance of the project.

The Contractor shall also perform a conductivity test upon completion of construction.

Continuity testing in lieu of actual line tracing shall not be accepted. Any defects are to be corrected at the Contractor's expense.

331100.1 PRESSURE AND LEAKAGE TESTS

Description

The work to be performed under this section of the specifications shall include the furnishing of all labor, materials and equipment necessary for the completion of pressure and leakage tests of all water lines that are to be installed as shown on the plans and/or as herein specified.

Materials

The Contractor shall furnish all the necessary materials to make the pressure and leakage tests and to perform any work incidental hereto. The Contractor shall also provide a pump to raise the pressure to the required amount above the normal operating pressures. In addition to a suitable pump, the Contractor shall provide pressure gauges, water meters and other appliances necessary for measuring the amount of water pumped in the mains that are being tested.

Construction Procedures

A. Test Pressure - Pressure tests shall be conducted between valves in sections as long as possible up to 5,000 feet and as directed by the Owner's Representative. All laid pipe shall be subjected to a hydrostatic pressure of 100 percent above normal operating pressure, but shall not exceed manufacturer's rating. The normal operating pressure shall be defined as a total hydrostatic pressure caused by the static head between the existing water reservoir and the lowest point in the new lines. The pressure shall be maintained for a period of not less than two hours for uncovered pipe joints. Where the pipe has been completely backfilled before the tests are conducted the pressure shall remain on these pipes for no more than twenty-four hours.

B. Leakage Tests - Care shall be taken to expel all air from the water and sewer lines as they are being filled with water to make the necessary pressure tests. The quantity of water forced into the mains during the time of the pressure tests shall be determined through a water meter, and this amount shall be taken as a basis to compute the leakage for a twenty-four hour period.

C. Permissible Overall Leakage - No pipe or installation shall be accepted unless, or until the leakage, determined under the test pressure, is less than ten gallons per inch of pipe diameter per mile of pipe per twenty-four hours. Test pressure shall not exceed the rating working pressure of pipe, as so stamped.

D. Correction of Leakage Defects - All pipe, fittings, valves, hydrants and joints shall be carefully examined for leakage defects. Leaking joints shall be remade and re-tested. The Contractor shall, at his own expense, continue to locate and repair the defective joints until the leakage is within the permitted allowance.

331300 WATERLINE DISINFECTION

Description

The work to be performed under this section shall include the furnishing of all labor, materials, and equipment necessary for the complete sterilization of the water distribution system. Each unit of the water distribution system shall be sterilized in accordance with AWWA Standard C 651, latest edition, with chlorine or chlorine-bearing compounds as directed by the Owner's Representative before acceptance for domestic operation.

Materials

A. Liquid chlorine shall conform to AWWA Standard B 301, latest edition.

B. Hypochlorite shall conform to AWWA Standard B 300, latest edition.

Construction Procedures

A. Laying Pipe - Every precaution shall be used to protect pipe against the entrance of foreign material before the pipe is placed in the new line. At the close of the day's work, or whenever the workmen are absent from the job, the end of the last laid section of pipe shall be plugged, capped or otherwise tightly closed to prevent the entry of foreign material of any nature.

If the Contractor, or pipe-laying crew cannot put the pipe into the trench and in place without getting earth into it, Owner's Representative may require that, before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until connection is to be made to the adjacent pipe.

B. Preventing Trench Water from Entering Pipe - At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Owner's Representative. If water is in the trench, the seal shall remain in place until the trench is pumped dry.

C. Flushing Completed Pipelines - The main shall be flushed, prior to chlorination, as thoroughly as possible with the water pressure and outlets available. Flushing shall be done after the pressure test has been made. It must be understood that flushing removes only the lighter solids and cannot be relied upon to remove heavy material allowed to get into the main during laying. If no hydrant is installed at the end of the main, a tap should be provided large enough to develop a velocity in the main of at least 2.5 feet per second.

D. Requirement of Chlorination - Before being placed in service, all new mains and repaired portions of, or extensions to, existing mains shall be chlorinated so that a chlorine residual of not less than ten ppm remains in the water after twenty-four hours standing in the pipe.

E. Liquid Chlorine - A chlorine gas-water mixture shall be applied by means of a solution-feed chlorinating device, or if approved by Owner's Representative, the dry gas may be fed directly through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solutions of the chlorine gas, or the gas itself, must provide means for preventing backflow of water into the chlorine cylinder.

F. Point of Application and Retention Period - The preferred point of application of the chlorinating agent is at the beginning of the pipeline extension, or any valved section of it and through a corporation stop (except in new distribution systems) in the top of the newly laid pipe. The water injector for delivering the chlorine-bearing water into the pipe should be supplied from a tap on the pressure side of the gate valve controlling the flow into the pipeline extension. In a new system, application of chlorine may be made at the pumping station, the elevated water storage tank the standpipe or the reservoir.

Water from the existing distribution system or other source of supply shall be controlled so as to flow slowly into the newly laid pipeline during the application of chlorine. The rate of chlorine mixture flow shall be such proportion to the rate of water entering the pipe that the chlorine dose applied to the water entering the newly laid pipe shall produce at least 10 ppm after twenty-four hours standing. This may be expected with an application of 25 ppm, although some conditions may require more. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Check valves may be used, if desired.

Treated water shall be retained in the pipe long enough to destroy all nonspore-forming bacteria. This period should be at least twenty-four hours and should produce no less than 10 ppm at the extreme end of the line at the end of retention period.

NOTE: If the circumstances are such that a shorter retention period must be used, the chlorine concentration shall be increased accordingly. For instance, for a contact period of one hour, a 100 ppm chlorine concentration is required. Under these conditions, special care should be taken to avoid attack on pipes, valves, hydrants, and other appurtenances.

In the process of chlorinating newly laid pipe, all valves, or other appurtenances shall be operated while the pipeline is filled with the chlorinating agent.

G. Final Flushing and Test - Following chlorination, all treated water shall be thoroughly flushed from the newly laid pipeline at its extremities until the replacement water throughout its length shall, upon test, be proved comparable in quality to the water served the public from the existing water supply system and approved by the regional office of the Clean Water Commission, Department of Natural Resources. This satisfactory quality of water delivered by the new

main should continue for a period of at least two full days as demonstrated by laboratory examination of samples taken from a tap located and installed in such a way as to prevent outside contamination.

If the test samples show unsatisfactory quality of water, the process of sterilization shall be repeated until satisfactory samples are obtained. The Contractor shall pay for all tests.

332216 LINEAR GRADING

Description

This work shall consist of that class of grading work necessary to bring the roadway, parking areas, and paved surfaces to the required grade and cross section within reasonable tolerances. It shall also include:

A. The construction of all inlet and outlet ditches and ditch blocks within the linear grading limits unless otherwise provided for in the contract.

B. The construction of entrances and approaches.

C. The breaking up and satisfactorily removing or incorporating into the roadway of all gravel, macadam, or bituminous surfaces.

All linear grading will be classified as hereinafter described.

Linear Grading shall consist of grading where it is necessary to excavate and haul material to bring the roadway and other surfaces to the desired grade and may involve work on high banks and side hills.

Construction Procedures

A. The roadway and other surfaces shall be brought to the required cross section and all stones and boulders shall be removed from the surface of the roadbed. Stumps, roots, rubbish or any other deleterious material shall not be placed in embankments. Where an embankment of less than 2 feet in height is to be constructed, all vegetative matter shall be cut and removed from the surface upon which the embankment is to be placed. The cut-over surface and sod shall be thoroughly broken. Backslopes shall be constructed so that they will not be steeper than the slope indicated for the material encountered. All ditches, including inlet and outlet ditches, shall be cut to the required cross section and to grades that will properly drain. The required cross section for inlet and outlet ditches leading to or from structures shall be a width not less than the width of the floor or the diameter of the structure being served. Finishing operations shall continue until the surfaces are free from sharp breaks in alignment and grade and until it has been shaped to the required cross section. Backslopes and fill slopes shall not be steeper than the slopes shown on the plans. When material is removed and considered undesirable for the subgrade, it shall be disposed of on nearby fill slopes or as otherwise directed by the Owner's Representative. Entrances and approaches shall be constructed to the required standard.

333113 SANITARY LINES AND APPURTENANCES

Description

The work in this section consists of furnishing all new materials, equipment, labor and tools necessary for the construction of sanitary sewers and appurtenances and work required by the plans and specifications.

Materials

A. PVC Sewer Pipe

1. PVC sewer pipe shall conform to the diameter and location shown on the plans, and shall be constructed of PVC pipe meeting the requirements of the current ASTM D-3034, SDR 35, or latest revision.

2. Gaskets for joints shall be suitable for pipes carrying domestic sewage and shall be of the locked-in Rieber Sealing System type.

3. The industry standard for PVC pipe construction is considered to be the Uni-Bell Plastic Pipe Association.

B. Concrete - Shall be as specified in Section 033053.

C. Manholes

1. Manholes shall be constructed as shown on the plans, whether of concrete or precast concrete, and have a minimum twenty-eight (28) day strength of thirty five hundred (3500) psi.

2. Manhole frames and covers shall be cast iron, meeting the requirements of the current ASTM A48-Class 30 Specification for gray iron castings, and as shown on plans.

3. Unless otherwise noted, only closed manhole covers shall be used. Frames and covers shall be as specified by the Owner's Representative.

Construction Procedure

All materials shall be delivered and distributed along the site of the work by the Contractor. Pipe, fittings and material shall be loaded and unloaded so as to avoid shock or damage.

A. Pipe and Sewer Lines

1. The Contractor shall be careful to preserve stakes and survey marks from damage or dislocation.

Trenches shall be constructed to the lines and grades shown on the plans

or as directed by the Owner's Representative. The Contractor shall furnish all laser equipment for establishing grade of trench bottom, bedding material, and pipe inverts.

2. Where it is necessary to cut the pipe, care must be taken not to crack the pipe or damage any lining and to cut straight and true around it. The pipe and fittings shall be inspected for defects and, while suspended above grade or standing on end, shall be rung with a light hammer to detect cracks. Damaged or unsound pipe or fittings will be rejected.

3. All pipe shall be laid with bells uphill. Joints shall be made as specified above. Before jointing the pipe, all lumps, blisters, excess coating material and any grease or oil shall be removed from gaskets and the bell and spigot ends of pipes.

4. Every precaution shall be used to protect the pipe against the entrance of foreign material before the pipe is placed in the new line. At the close of the day's work or whenever the workmen are absent from the job, the end of the last laid section of pipe shall be closed to prevent the entry of foreign material except to drain water from the trench.

5. All newly laid sewer lines shall be tested for exfiltration before being placed in service. The time of determining the leakage on each line will be selected by the Owner's Representative. The Contractor shall furnish all water, labor, assistance, etc., necessary for the performance of the tests. If the exfiltration, as determined by the tests, exceeds two hundred (200) gallons per inch of pipe diameter per mile (or if measured infiltration exceeds the above), the Contractor shall locate the principal leakage and shall make repairs as are required to reduce the total exfiltration or infiltration rate below the rate specified.

6. All newly laid sewer lines shall be lamped before being placed in service. If the lines do not lamp reasonably near a full circle, or if low spots are disclosed, the Contractor shall locate the cause and make such repairs or replacements as may be necessary to correct the defects.

7. The manhole inverts shall be constructed of concrete as specified in Section 033053, of these specifications. The invert shall be made smooth and protected from damage by water or other agents or rapid moisture loss during the curing period.

333113.1 SANITARY SEWER TESTING

Description

The following tests shall be made on all newly laid sewer lines before being placed in service. The time of determining of the leakage of each line will be selected by the Owner's Representative. The Contractor shall furnish all water, equipment, labor, assistance, etc. necessary for the performance of the test.

A. Infiltration - The allowable infiltration for any portion of sewer system should be measured by a weir or current meter placed in the appropriate manhole and should not exceed 50 gallons per inch of internal pipe diameter per mile per day, including manholes.

B. Air Testing - The minimum time duration permitted for a prescribed low pressure exfiltration pressure drop between two consecutive manholes should not be less than that shown in Table 333113.1-1. The prescribed drop should not exceed 0.5 psi from 3.5 to 3.0 psi in excess of the ground water pressure above the top of the sewer.

Table 333113.1-1

MINIUM DURATION FOR AIR TEST PRESSURE DROP

Pipe Size Inches	Time Minutes
4	2
6	4
8	5

C. Deflection Testing - Unless specified otherwise, maximum allowable pipe deflection (reduction in vertical inside diameter) should be <5%. It is required that random deflection tests of pipe be performed before final acceptance at construction locations between successive manholes where the construction encountered unstable trench walls or bottoms, heavy rainfall, frozen soil, high ground water levels, deep lines, or difficulty in attaining compaction. Locations with excessive deflection should be excavated, and repaired by re-bedding or replacement of the pipe. Optional devices for testing include a deflectometer, calibrated television or photography, or a properly sized "go, no-go" mandrel or sewer ball. For the purpose of deflection measurements the base inside pipe diameters without deflection are determined by the Owner's Representative. The maximum allowable deflection should be applied to these bases inside diameters in determining the minimum permissible diameter. It must be emphasized that to insure accurate testing, the lines must be thoroughly cleaned.

D. Lamp Testing - All newly laid sewer lines shall be lamped before being placed in service. If the lines do not lamp to reasonably near a full circle, or if low spots are disclosed, the Contractor shall locate the cause and make such repairs or replacements as may be necessary to correct the

defects.

E. Manhole Testing – The Contractor shall perform a vacuum exfiltration test on each manhole. Vacuum testing equipment shall be as manufactured by Cherne Industries, P.A. Glazier, Inc. or approved equal.

Preliminary vacuum testing shall be conducted following manhole construction, including connection to piping, and prior to backfilling. No grout shall be placed in horizontal joints until manhole has passed both vacuum tests. All lifting holes shall be grouted. Manholes which fail the test shall be reconstructed as required to adequately seal the manhole. Grouting of leak from the interior or exterior will not be acceptable. Final vacuum testing shall be performed following backfilling and setting at the lid and frame.

Plug all pipe entering manhole. Securely brace all plugs as required. Install testing lead in manhole frame and inflate seal in accordance with manufacturer's recommendation. A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With all valves closed, measure the time required for the vacuum to drop to 9 inches of mercury. The manhole shall pass if the time is greater than 120 seconds for a 48-inch diameter manhole and 150 seconds for a 60-inch diameter manhole.

If the manhole fails the initial test, perform necessary repairs and retest until an acceptable test meeting the above requirement is achieved.

F. Manhole Water Testing – Water testing of manholes, in lieu of the exfiltration test, is prohibited except where otherwise approved by the Owner's Representative. Where water testing is approved, exfiltration tests shall be conducted by blocking off all manhole openings, filling the manhole to the top with water, and measuring the water required to maintain a constant level in the manholes.

Maintain test as necessary to determine leakage but not less than 2 hours. Repeat as necessary after repairs until leakage does not exceed 50 gallons per inch of pipe diameter per day per mile of pipe (0.0375 gallon per inch of pipe diameter per hour per 100 feet of pipe).
For the purposes of determining the maximum allowable leakage, manholes shall be considered as sections of pipe of the diameter and height of the manhole.

334000 STORM SEWERS

Description

The work to be performed under this section will consist of furnishing all labor, materials and equipment necessary to complete the construction of all storm sewer structures in accordance with the plans and/or as herein specified.

Materials

All storm sewers constructed within this project shall be:

A. C.M.P. (Corrugated Metal Pipe) to be 16 gauge and/or as specified by the Owner's Representative.

B. Concrete - as specified in Section 033053.

C. Reinforcing Steel - as specified in Section 032111.

Construction Procedures

Excavation and preparation of the storm sewer shall be to the required depth as shown on the plans. The bed of the trench will be prepared with 4" of acceptable aggregate rather than shaping the trench bottom. The pipe shall be backfilled with suitable backfill material, in layers not exceeding 6", which shall be thoroughly compacted. Filling and compacting shall be continued until the material is level with the original surface.

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APPENDIX A

Survey

Performed by Darren Krehbiel Consultants LLC
January 2019

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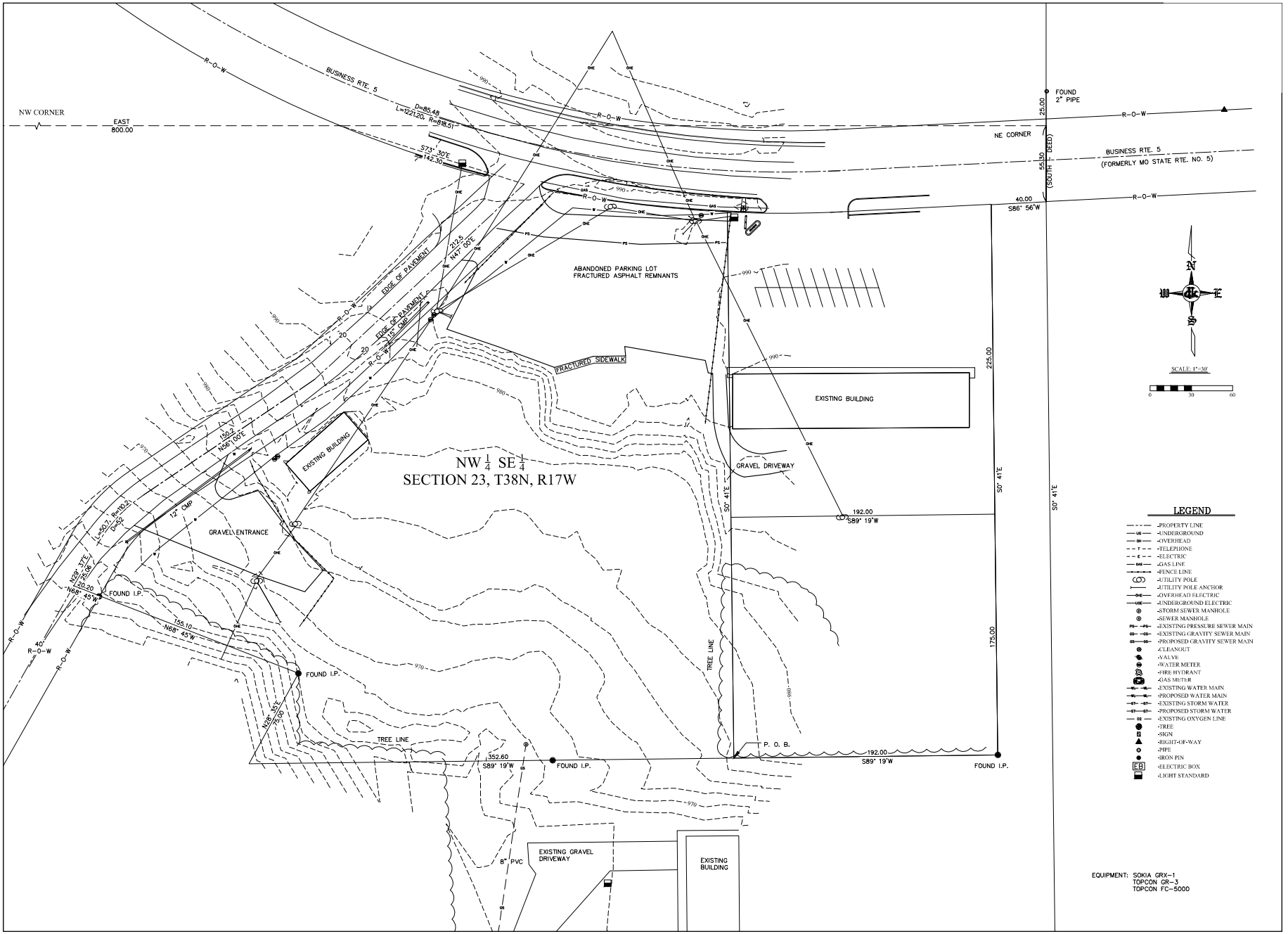

darrenkrehbiel CONSULTANTS LLC
63 Blair Avenue
CAMDENTON, MO 65020
TEL: 573.346.5316
FAX: 573.346.3851
dkc@cdoc.net

Land Surveyor

Darren Krehbiel Consultants, LLC.
Missouri State Certificate of Authority
#2011001409

SITE SURVEY FOR DESIGN OF COMMUNITY CENTER CITY OF CAMDENTON MISSOURI

REVISIONS:	BY:	DATE:

STATE OF MISSOURI
DARREN DAVID KREHBIEL
NUMBER LS-2520
1/17/2019

DARREN DAVID KREHBIEL - LAND SURVEYOR
MO# LS-2520

THE PROFESSIONAL ENGINEERS SEAL AFFIXED TO THIS SHEET APPLIES ONLY TO THE MATERIAL AND ITEMS SHOWN ON THIS SHEET. ALL DRAWINGS, INSTRUMENTS OR OTHER DOCUMENTS NOT EXHIBITING THIS SEAL SHALL NOT BE CONSIDERED PREPARED BY THIS ENGINEER, AND THIS ENGINEER EXPRESSLY DISCLAIMS ANY AND ALL RESPONSIBILITY FOR SUCH PLAN, DRAWINGS OR DOCUMENTS NOT EXHIBITING THIS SEAL.

PROJECT NO:	1274
DATE:	1/15/2019
SCALE:	1" = 30'
DRAWN BY:	LtG
SHEET TITLE:	

SITE SURVEY

SHEET NO:

C-1.0

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APPENDIX B

Geotechnical Engineering Report

Performed by Terracon Consultants, Inc.
July 2019

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Geotechnical Engineering Report

Community Center
Camdenton, Missouri
July 1, 2019
Terracon Project No. B5195019

Prepared for:
City of Camdenton, Missouri
Camdenton, Missouri

Prepared by:
Terracon Consultants, Inc.
Springfield, Missouri

July 1, 2019

City of Camdenton, Missouri
437 W. US Highway 54
Camdenton, Missouri 65020

Attn: Mr. J. Jeff Hancock – City Administrator
P: (573) 346 3600
E: jjhancock@camdentoncity.com

Re: Geotechnical Engineering Report
Community Center
1175 N. Business Route 5
Camdenton, Missouri
Terracon Project No. B5195019

Dear Mr. Hancock:

We have completed the Geotechnical Engineering services for the above-referenced project. This study was performed in general accordance with Terracon Proposal No. PB5195019, dated May 5, 2019. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs, and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

STATE OF MISSOURI
TY G. ALEXANDER
NUMBER PE-2009002087
7/1/19
PROFESSIONAL ENGINEER

For Joshua D. Elson, R.G.
Senior Staff Geologist

Ty G. Alexander, P.E.
Office Manager/Principal
Missouri: PE-2009002087

REPORT TOPICS

Note: This report was originally delivered in a web-based format. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

REPORT SUMMARY

A geotechnical exploration has been performed for the proposed Community Center located at 1175 N. Business Route 5 in Camdenton, Missouri. Seven (7) borings, designated B-1 through B-7, were performed to depths of approximately 10 to 20 feet below the existing ground surface. The following geotechnical considerations were identified:

- Existing undocumented fill or possible fill was encountered at each of the boring locations to depths ranging from approximately 3 to 6 feet. Foundations for the proposed building should not bear on or above the undocumented fill materials. Any existing fill should be removed and replaced (or improved) so foundations and floor slabs for the building bear on suitable native soils or on properly placed and compacted engineered fill extending to the suitable native soils

- The site is located in an area historically developed with commercial structures. It is common in such areas to encounter remnants of past structures, such as buried foundations and basements, during construction. If encountered, these elements should be completely removed and replaced with engineered fill as outlined in this report. We recommend the owner budget for this possibility.

- Provided the owner is willing to accept the risks associated with supporting pavements over the existing fill materials in exchange for reduced construction costs, portions of the existing fill could be left in place for support of new pavements. At least 12 inches of new engineered fill should be placed directly below the floor slab and pavements, respectively, with this option.

- Soils with liquid limits over 45 percent were encountered in the soil exploration program and are prone to volume change with variations in moisture content. The fat clay (CH) soils encountered in the soil exploration program (both as undocumented fill materials and native soils) are high in plasticity and prone to volume change with variations in moisture content. For this reason, we recommend a 24-inch thick Low Volume Change (LVC) zone be maintained or constructed beneath grade-supported floor slabs.

- Some relatively high moisture content soils were encountered in the upper levels of some of the borings and may be exposed in excavations and cuts. These soils may become unstable when disturbed. During periods of dry weather, these soils may be stable upon initial exposure; however, these soils, if exposed, may become relatively soft and unstable under construction traffic. We recommend that the owner budget for the possibility that overexcavation and/or subgrade stabilization may be required and contractors be prepared to handle potentially unstable and/or soft conditions.

- Based on our borings, the International Building Code (IBC) seismic site classification for this site is D.

The professional opinions and recommendations presented in this report are based on evaluation of data developed by testing discrete samples obtained from widely-spaced borings. Site subsurface conditions have been inferred from available data, but actual subsurface conditions will only be revealed by excavation. So that variations in subsurface conditions which may affect the design can be addressed as they are encountered, we recommend that Terracon be retained to observe excavations and perform tests during the site preparation, earthwork and foundation construction phases of the project.

This executive summary should not be separated from or used apart from this report. This report presents fully developed recommendations and opinions based on our understanding of the project at the time the report was prepared. The report limitations are described in the **General Comments** section of this report.

Geotechnical Engineering Report

Community Center
1175 N. Business Route 5
Camdenton, Missouri

Terracon Project No. B5195019
July 1, 2019

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed Community Center to be located at 1175 N. Business Route 5 in Camdenton, Missouri. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Demolition considerations
- Excavation considerations
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification per IBC
- Pavement design and construction

The geotechnical engineering services for this project included the advancement of seven (7) test borings to depths ranging from approximately 10 to 20 feet below existing site grades.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring log pages in the **Exploration Results** section.

The **General Comments** section provides an understanding of the report limitations.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at 1175 N. Business Route 5 in Camdenton, Missouri. The approximate coordinates of the site are: Lat.: 38.017948° N Long.: 92.762018° W (See **Site Location**)

Item	Description
Existing Improvements	Previously developed with a single-story structure and associated parking lot. Previous structure was demolished.
Current Ground Cover	i.e. Earthen, lightly vegetated, severely degraded asphalt paved parking lot
Existing Topography	Site is relatively flat on the northern 1/3 and then slopes moderately to the south
Geology	Based on the Geological Map of Missouri prepared by the Missouri Department of Natural Resources (MDNR), the subject site is located over the Roubidoux Formation and Gasconade Dolomite Units. The Roubidoux Formation is composed primarily of sandstone with inner bedded layers of chert and dolomite. The Gasconade Dolomite is composed primarily of dolomite and some sandstone. Small amounts and layers of shale and chert are noted within this bedrock unit.
Geological Concerns	Solution features, including springs, caves, and sinkholes, are commonly present in the Ordovician Age Ibexian Series Bedrock Unit in this area. Based on the review of information available from Missouri Department of Natural Resources databases, the subject site does not contain any previously identified sinkhole formations, although sinkholes and/or springs are noted on the **Geologic Map** in the vicinity of the site. It is difficult to predict future sinkhole activity. Site grading and drainage may alter site conditions and could possibly cause sinkholes in areas that have no history of this activity.

PROJECT DESCRIPTION

The table below presents a brief summary of our project understanding. This summary has been used as the basis of our analyses and recommendations. Any changes to this summary should be made known to Terracon immediately so revisions can be provided if necessary.

Item	Description
Information Provided	Information was provided via an email RFP issued on April 8, 2019 by Mr. Justin Roth, AIA with SFS Architecture on behalf of the City.
Project Description	The project will include the construction of a community center which will include a gymnasium, meeting rooms, fitness areas and support spaces. The proposed building will partially overlap a previously existing structure.
Proposed Structure	The project includes a single-story building with a walkout basement. The building will be slab-on-grade.
Building Construction	Building plans were not developed at the time of this proposal. We have assumed the structure will consist of either steel frame or load-bearing masonry walls with a concrete slab-on-grade floor.
Finished Floor Elevation	Not provided.

Item	Description
Maximum Loads (Estimated)	■ Columns: 200 kips ■ Walls: 6-8 kips per linear foot (klf) ■ Slabs: 150 pounds per square foot (psf)
Grading/Slopes	Finished floor elevation was not provided. Based on the limited information provided, we assume Up to 5 feet of cut and 5 feet of fill may be required to develop final grade. Final slope angles of as steep as 3H:1V (Horizontal: Vertical) are expected.
Below-Grade Structures	Walk-out basement exiting to the south.
Free-Standing Retaining Walls	Retaining walls were not indicated on the preliminary drawings but are expected to be constructed as part of site development to achieve final grades. For the purposes of this report, we have assumed retaining walls will be near proposed boring locations and wall heights will not exceed 10 feet in height. *If retaining walls will not be located near the proposed borings advanced for the structure or if wall heights exceed 10 feet additional borings and/or modifications to the boring depths may be required.
Pavements	Paved driveway and parking will be constructed on the northern and southern portions of the parcel. We assume both rigid (concrete) and flexible (asphalt) pavement sections should be considered. Please confirm this assumption. Traffic information provided for light duty pavements is as follows: ■ Autos/light trucks: 150 vehicles per day Traffic information provided for medium duty pavements is as follows: ■ Autos/light trucks: 150 vehicles per day ■ Light delivery and trash collection vehicles: 1-3 vehicles per week ■ Beverage/vending truck: 1-2 per week ■ Catering vehicles: 1 per week ■ Tractor-trailer trucks: 2-4 per year The pavement design period is 20 years.
Estimated Start of Construction	Fall of 2019

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the GeoModel can be found in the **Figures** section of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	ASPHALT	Asphalt
2	FILL	Fat clay, with gravel, tan/red/gray
3	FAT CLAY	Fat clay, trace gravel, red
4	SANDSTONE	Sandstone, highly weather, brown

Groundwater Conditions

The boreholes were observed while drilling and after completion for the presence and level of groundwater. The water levels observed in the boreholes can be found on the boring logs in **Exploration Results**, and are summarized below.

Groundwater was not observed in the borings while drilling, or for the short duration the borings could remain open. However, this does not necessarily mean the borings terminated above groundwater. Due to the low permeability of the soils encountered in the borings, a relatively long period of time may be necessary for a groundwater level to develop and stabilize in a borehole. Long-term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be different than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

General

We recommend that the exposed subgrade be thoroughly evaluated after stripping of any topsoil and at the base of all cut areas, and prior to the start of any fill operations. We recommend that the geotechnical engineer be retained to evaluate the bearing material for the foundations and subgrade soils. Subsurface conditions, as identified by the field and laboratory testing programs, have been reviewed and evaluated with respect to the proposed project plans known to us at this time.

Karst development is a common occurrence in this area due to the dissolution of the native dolomite bedrock material. Though no evidence of sinkholes was noted in the review of topography and in the borings performed at the subject site, the development of karst features on the site is a possibility over time. The current state of the practice in geotechnical engineering

does not allow for the accurate prediction of when or where sinkholes or karst-related subsidence could occur. The owner is advised that construction on this property or essentially any other site within this area, carries with it some risk that future sinkholes may develop.

Existing Undocumented Fill

Existing fill or possible fill was encountered to depths of ranging from 3 to 6 feet in the borings drilled. The fill could extend deeper in areas not explored. While the N-values obtained in the undocumented fill materials were generally equal to or higher than the existing native soils, no documentation or records regarding the placement of this fill were provided for our review. If records of the fill are available, Terracon should be supplied with these documents to better assess the suitability of the existing fill.

The site is located in an area historically developed with commercial structures that have been removed. It is common in such areas to encounter remnants of past structures, such as buried foundations and basements, during construction. If encountered, these elements should be overexcavated and replaced with engineered fill in accordance with the recommendations outlined in this report. We recommend the owner budget for this possibility.

Due to the soil properties at the subject site, differentiating between native materials and man placed fill in soil boring samples is difficult and in some cases impossible without documentation. The designation of possible fill has been given to materials that are suspected of being fill but no definite indications of fill were noted in the sampling process. These materials should be carefully observed and inspected during excavations for indications of fill by a representative of Terracon. If indications of fill are found during the excavations, then the material should be treated as fill and the recommendations noted below should be considered.

Undocumented fill may contain soft or loose soil or other unsuitable materials; these conditions may not be disclosed by the widely-spaced, relatively small-diameter borings. If these conditions are present and are not discovered and addressed during construction, then larger than normal settlement resulting in cracking, differential movement, or other damage could occur in foundations, floor slabs, pavements, and utility lines supported on or above the existing fill. Typically, larger than normal settlement of floor slabs results in reflective cracking of overlying rigid floor coverings (if any), unlevel floors, and “bumps” at locations of differential movement.

Foundations and floor slabs for the new structure should not bear on or above the undocumented fill materials. The existing fill could be removed and replaced so that the foundations and floor slabs for the new building bear on suitable native soils or on properly placed and compacted engineered fill extending to suitable native soils. If the fill is completely removed and replaced, it should be removed within the proposed building footprint and extend at least 5 feet outside the building perimeter.

Provided the owner is willing to accept the risks associated with supporting pavements over the existing fill materials in exchange for reduced construction costs, portions of the existing undocumented fill could be left in place. To reduce the risk of adverse performance from higher settlement and to provide more consistent support for pavements, some portion of the existing fill should be removed and the exposed existing fill materials observed and tested during construction. Where unsuitable conditions are observed, the materials could/should be improved by scarification and recompaction or be removed and replaced with engineered fill. At least 12 inches of new engineered fill should be placed directly below the pavement sections with this option. However, even with the recommended subgrade preparation and construction testing, there is a risk to the owner that unsuitable material within or buried by the fill will not be discovered. If the owner is not willing to accept the risks of supporting pavements over existing undocumented fill materials, the existing fill should be completely removed and replaced.

Portions of the existing fill may be suitable for removal and reuse as an engineered fill material. If this material is used as an engineered fill material, it should be first evaluated by the materials testing firm to determine if it meets the requirements listed in **Material Requirements**. If the material will be used as fill it should be placed as described in **Compaction Requirements**.

Swell Potential

High plastic clays with liquid limits over 50 were noted in the Atterberg limits tests performed on selected samples. These materials are prone to volume change with changes in moisture which may lead to excessive shrinking and swelling of floor slabs and lightly-loaded structures. We recommend a low volume change (LVC) zone be constructed beneath the at-grade floor slab. Using an LVC zone as recommended in this report may not eliminate all future subgrade volume change and resultant floor slab movements. However, the procedures outlined herein should help to reduce the potential for subgrade volume change. Existing soils can be left in place and compacted if they are tested during construction and meet LVC material requirements. Details regarding this LVC zone are provided in the **Floor Slab** section.

This report provides recommendations to help mitigate the effects of soil shrinkage and expansion. However, even if these procedures are followed, some movement and cracking in the structure could occur. The severity of cracking and other (cosmetic) damage such as uneven floor slabs will likely increase if any modification of the site results in excessive wetting or drying of the expansive soils. Eliminating the risk of movement and distress may not be feasible, but it may be possible to further reduce the risk of movement if more extensive measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request.

All grades must provide effective drainage away from the structure during and after construction. Water permitted to pond next to the structure can result in greater soil movements than those discussed in this report. These greater movements can result in unacceptable differential floor slab movements, cracked slabs and walls, and roof leaks. The recommendations made in this this report are based on effective drainage for the life of the structure and cannot be relied upon if effective drainage is not maintained.

Soft Subgrade Potential

The subgrade soils may become unstable when disturbed. During periods of dry weather, these soils may be stable upon initial exposure, however, these soils could become relatively soft and unstable under construction traffic. Further, depending upon site conditions during construction, overexcavation or stabilization of the subgrade and/or base of overexcavations may be needed to achieve a suitable working surface. Accordingly, we recommend that the owner budget for the possibility that overexcavation and/or subgrade stabilization may be required and contractors be prepared to handle potentially unstable and/or soft conditions.

EARTHWORK

Earthwork is anticipated to include clearing and grubbing, excavations, and fill placement.

Site Preparation

Prior to placing fill, existing asphalt pavements, vegetation and root mat should be removed. Complete stripping of the topsoil should be performed in the proposed building and parking/driveway areas.

The subgrade should be proofrolled with an adequately loaded vehicle such as a fully-loaded, tandem-axle dump truck. The proofrolling should be performed under the direction of the Geotechnical Engineer. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas should either be removed or modified by following the recommendations in the **Subgrade Stabilization** section. Excessively wet or dry material should either be removed, or moisture conditioned and recompacted.

Subgrade Stabilization

Methods of subgrade improvement, as described below, could include scarification, moisture conditioning and recompaction, and removal of unstable materials and replacement with granular fill (with or without geosynthetics) and chemical stabilization. The appropriate method of improvement, if required, would be dependent on factors such as schedule, weather, the size of the area to be stabilized, and the nature of the instability. More detailed recommendations can be provided during construction as the need for subgrade stabilization occurs. Performing site

grading operations during warm seasons and dry periods would help to reduce the amount of subgrade stabilization required.

If the exposed subgrade is unstable during proofrolling operations, it could be stabilized using one of the methods outlined below.

- **Scarification and Compaction** – It may be feasible to scarify, dry, and compact the exposed soils. The success of this procedure would depend primarily upon favorable weather and sufficient time to dry the soils. Stable subgrades likely would not be achievable if the thickness of the unstable soil is greater than about 1 foot, if the unstable soil is at or near groundwater levels, or if construction is performed during a period of wet or cool weather when drying is difficult.

- **Crushed Stone** – The use of crushed stone or gravel is the most common procedure to improve subgrade stability. Typical undercut depths would be expected to range from about 6 to 30 inches below finished subgrade elevation with this procedure. The use of high modulus geotextiles (i.e., engineering fabric or geogrid) could also be considered after underground work such as utility construction is completed. Prior to placing the fabric or geogrid, we recommend that all below-grade construction, such as utility line installation, be completed to avoid damaging the fabric or geogrid. Equipment should not be operated above the fabric or geogrid until one full lift of crushed stone fill is placed above it. The maximum particle size of granular material placed over geotextile fabric or geogrid should meet the manufacturer's specifications, and generally should not exceed 1½ inches.

- **Chemical Stabilization** – Improvement of subgrades with Portland cement, lime kiln dust, Code L, or Class C fly ash could be considered for improving unstable soils. Chemical modification should be performed by a prequalified contractor having experience with successfully stabilizing subgrades in the project area on similar sized projects with similar soil conditions. Results of chemical analysis of the additive materials should be provided to the geotechnical engineer prior to use. The hazards of chemicals blowing across the site or onto adjacent property should also be considered. Additional testing would be needed to develop specific recommendations to improve subgrade stability by blending chemicals with the site soils. Additional testing could include, but not be limited to, evaluating various admixtures, the optimum amounts required, the presence of sulfates in the soil, and freeze-thaw durability of the subgrade.

Further evaluation of the need and recommendations for subgrade stabilization can be provided during construction as the geotechnical conditions are exposed.

Existing Fill

As noted in **Geotechnical Characterization**, all borings encountered existing fill to depths ranging from about 3 to 6 feet. The fill appears to have been placed in a controlled manner, but we have no records to indicate the degree of control. Support of pavements on or above existing fill soils is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill will, not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following the recommendations contained in this report.

If the owner elects to construct pavements on the existing fill, the following protocol should be followed. Once the planned subgrade elevation has been reached the entire pavement area should be proofrolled. Areas of soft or otherwise unsuitable material should be undercut and replaced with either new structural fill or suitable, existing on site materials.

Fill Material Types

Materials used for fill should meet the following material property requirements:

Fill Type [1]	USCS Classification	Acceptable Location for Placement
High Plasticity Material	CH (LL≥70 or PI≥40)	3 feet below base of floors and other lightly-loaded structures; 2 feet below foundations; and 1 foot below base of pavements
Moderate to High Plasticity Material [2]	CH or CL, with 70>LL≥45 or 40>PI≥25	2 feet below base of floor slabs and any other lightly-loaded structures, 1 foot below base of pavements
Granular Material [3]	GM, GC, SM, or SC	All locations and elevations
Low Plasticity Material [4]	CL (LL<45 & PI<25) or Granular Material [3]	

1. Compacted structural fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to Terracon for evaluation. On-site soils generally appear suitable for use as fill outside of the LVC zone.
2. Delineation of moderate to high plasticity clays should be performed in the field by a qualified geotechnical engineer or their representative and could require additional laboratory testing. If fat clay material contains greater than 35 percent granular material retained on a ¾-inch sieve, it may be used in the low volume change zone.
3. Crushed limestone aggregate, limestone screenings or granular material such as sand, gravel or crushed stone containing at least 15 percent low plasticity fines.
4. Low plasticity cohesive soil or granular soil having low plasticity fines. Material should be approved by the geotechnical engineer.

Fill Compaction Requirements

Fill should meet the following compaction requirements.

Item	Description
Fill Lift Thickness[1]	9 inches or less in loose thickness
Compaction Requirements[2]	At least 95 percent of the material's maximum standard Proctor dry density[3]
Water Content Range	Low plasticity cohesive: -2 percent to +2 percent of optimum[3] High plasticity cohesive: 0 to +4 percent of optimum[3] Granular: Workable moisture levels[4]

1. Reduced lift thicknesses of 4 to 6 inches are recommended in confined areas (e.g., utility trenches, foundation excavations, and foundation backfill) and when hand-operated compaction equipment is used.
2. We recommend that engineered fill be tested for moisture content and compaction during placement. If the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved. As stated within ASTM D 698, this procedure is intended for soils with 30 percent or less material larger than ¾ inch. Accordingly, we recommend full time proofroll observation be performed instead of moisture density testing for materials containing more than 30 percent aggregate retained on the ¾-inch sieve.
3. As determined by the standard Proctor test (ASTM D 698).
4. Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the cohesionless fill material pumping when proofrolled.

Utility Trench Backfill

Utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability lean clay. The trench plug material should be placed to surround the utility line. If used, the lean clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill stated previously in this report.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and

walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5 percent away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade becomes excessively wet or dry, frozen, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to further construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of removal of vegetation and topsoil, proofrolling, and mitigation of areas delineated by the proofroll to require mitigation.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If unacceptable conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

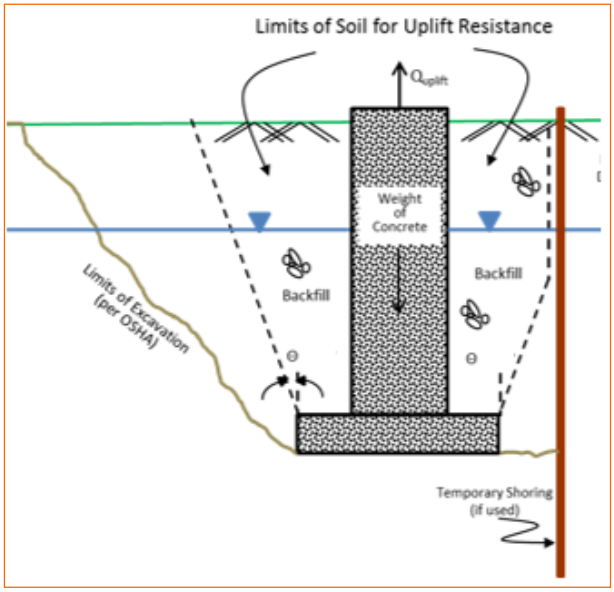
Item	Description
Maximum Net Allowable Bearing pressure [1, 2, 3]	2,000 psf (foundation bearing on 24 inches of LVC material over undisturbed soils or engineered fill)
Minimum Foundation Dimensions	Columns: 30 inches Continuous: 18 inches
Ultimate Passive Resistance [4] **(equivalent fluid pressures)**	250 pcf (cohesive backfill) 350 pcf (granular backfill)
Ultimate Coefficient of Sliding Friction [5]	0.32 (native clay) 0.40 (granular material)
Minimum Embedment below Finished Grade [6]	30 inches on soil
Estimated Total Settlement from Structural Loads [2]	Less than about 1 inch Less than about ½ inch on bedrock
Estimated Differential Settlement [2, 7]	About ¾ of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. Values assume that exterior grades are no steeper than 20 percent within 10 feet of the structure.
2. Values provided are for the maximum loads noted in **Project Description**.
3. Unsuitable or soft soils, including undocumented fill, should be overexcavated and replaced per the recommendations presented in **Earthwork**.
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions. Should be neglected if passive pressure will be used to resist lateral loads.
6. Embedment necessary for frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
7. Differential settlements are as measured over a span of up to 50 feet.

Design Parameters - Uplift Loads

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils. As illustrated on the subsequent figure, the effective weight of the soil prism defined by diagonal planes extending up from the top of the perimeter of the foundation to the ground surface at an angle, θ, of 20 degrees from the vertical can be included in uplift resistance.

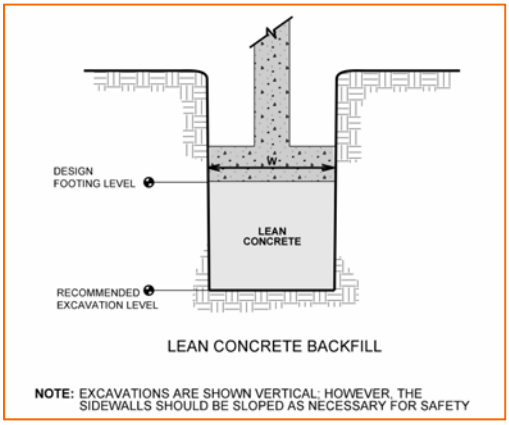
The maximum allowable uplift capacity should be taken as a sum of the effective weight of soil plus the dead weight of the foundation, divided by an appropriate factor of safety. A maximum total unit weight of 100 pcf should be used for the backfill. This unit weight should be reduced to 40 pcf for portions of the backfill or natural soils below the groundwater elevation.



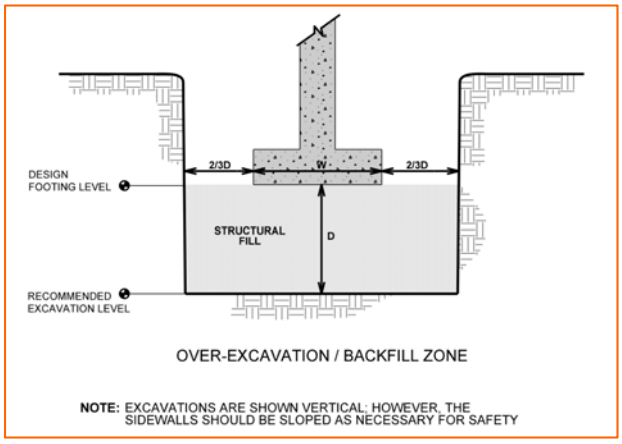
Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed. Placement of a lean concrete mudmat over the bearing soils should be considered if the excavations must remain open for an extended period of time.

If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. This is illustrated on the sketch below.



Over-excavation for structural fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation with suitable fill materials, as recommended in the **Earthwork** section.



SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the subsurface conditions encountered at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is D**. Subsurface explorations at this site were extended to a maximum depth of 20 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depths.

FLOOR SLABS

If undocumented fill is encountered, the undocumented fill should be removed and replaced or measures taken, as previously discussed if the owner is willing to accept the risks associated with construction of floor slabs over existing fill. Grade-supported floor slabs should be supported on a minimum of 24 inches of LVC material. LVC fill should be placed and compacted as recommended in section **Earthwork**.

Concrete Slab-on-Grade

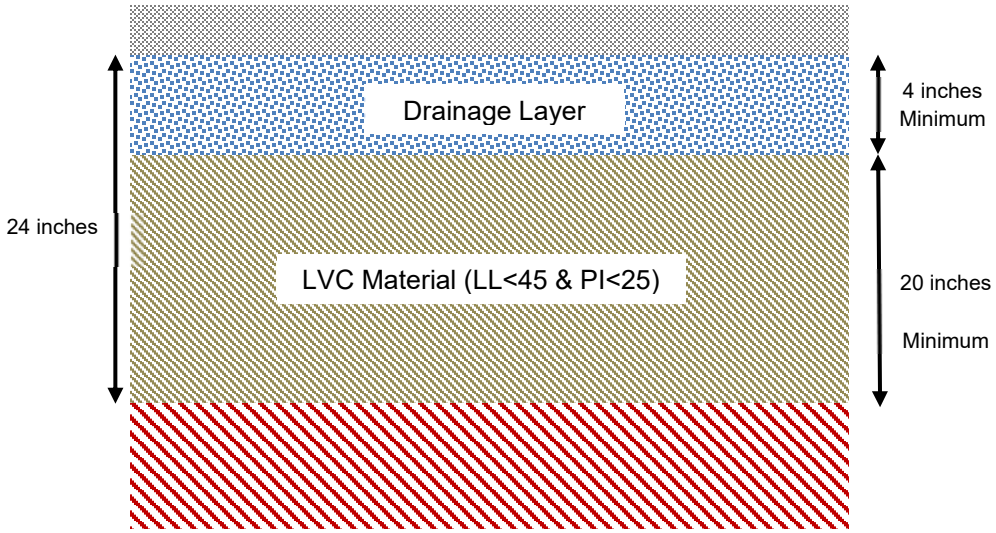


Image not to scale

Floor Slab Design Parameters

Item	Description
Floor slab support [1, 2]	A minimum 24-inch thick low volume change (LVC) layer over suitable native soil or engineered fill
Modulus of subgrade reaction	100 pounds per square inch per inch (psi/in) for point loading conditions
Granular course beneath slab [3, 4, 5]	Minimum 4 inches
Capillary break layer thickness [4, 5]	Minimum 4 inches

1. We recommend an LVC layer be present below the floor slab. This layer should be at least 24 inches thick and should meet the LVC material criteria outlined in this report in section **Earthwork**. Where existing soils meet the LVC criteria, they should be moisture conditioned and recompacted as recommended in this report.
2. We recommend subgrades be maintained in a relatively moist condition until the floor slab is constructed. If the subgrade should become excessively wet or dry prior to construction of the floor slab, the affected material

Item	Description
	should be removed or the materials be scarified, moisture conditioned, and recompacted. Upon completion of grading operations in the building area, care should be taken to maintain the recommended subgrade moisture content and density prior to construction of the building floor slab. 3. If the purpose of this layer is solely to create a level base for concrete placement to maintain a more uniform slab thickness, well-graded sand, gravel or crushed stone can be used. 4. If penetration of moisture vapor through the slab is a concern, in our opinion the floor slab design should include a capillary break layer in addition to a vapor retarder (refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of vapor retarders). In our opinion, capillary break layers should be comprised of granular materials that have less than 5 percent fines (material passing the #200 sieve). Other design considerations such as cold temperatures and condensation development could warrant additional design considerations. 5. These granular materials may be considered part of the LVC zone.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut contraction joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy-duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Settlement of floor slabs supported on existing fill materials cannot be accurately predicted but could be larger than normal and result in some cracking. Mitigation measures, as noted in **Existing Fill** within **Earthwork**, are critical to the performance of floor slabs. In addition to the mitigation measures, the floor slab can be stiffened by adding steel reinforcement, grade beams and/or post-tensioned elements.

Floor Slab Construction Considerations

Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become excessively wet or dry or damaged prior to construction of floor slabs, the affected material should be removed and structural fill should be added to replace

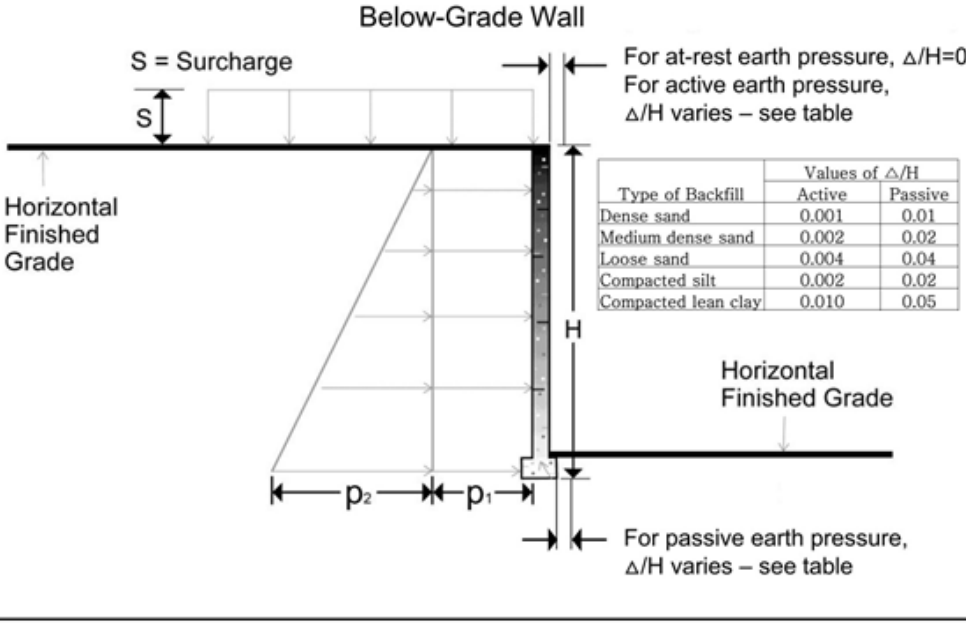
the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

LATERAL EARTH PRESSURES

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The “at-rest” condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



Type of Backfill	Values of Δ/H	
	Active	Passive
Dense sand	0.001	0.01
Medium dense sand	0.002	0.02
Loose sand	0.004	0.04
Compacted silt	0.002	0.02
Compacted lean clay	0.010	0.05

Table from Movements Required to Reach Active or Passive Earth Pressure Conditions (Clough and Duncan, 1991)

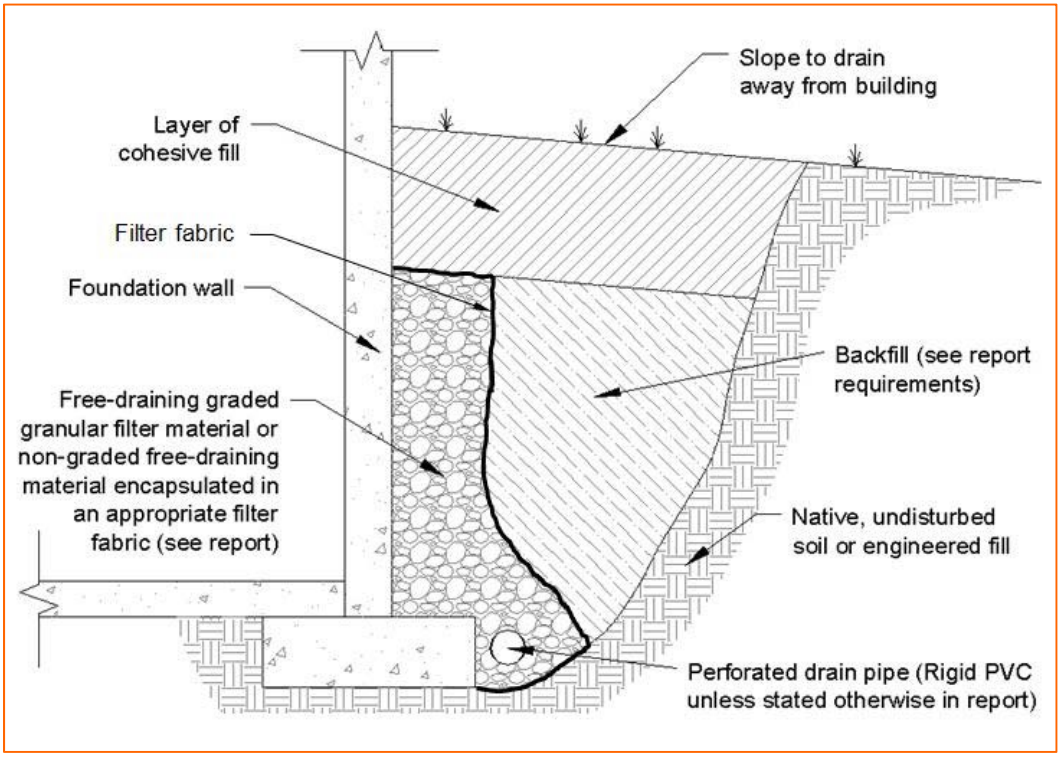
Lateral Earth Pressure Design Parameters				
Earth Pressure Condition [1]	**Coefficient for Backfill Type** [2]	**Surcharge Pressure** [3, 4, 5] **p_1 (psf)**	**Effective Fluid Pressures (psf)** [2, 4, 5]	
			Unsaturated [6]	**Submerged** [6]
Active (Ka)	Granular - 0.31 Fine Grained - 0.41	(0.31)S (0.41)S	(40)H (50)H	(80)H (85)H
At-Rest (Ko)	Granular - 0.47 Fine Grained - 0.58	0.47)S (0.58)S	(55)H (70)H	(90)H (95)H
Passive (Kp)	Granular - 3.25 Fine Grained - 2.46	--- ---	(390)H (295)H	(250)H (205)H

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.
2. Uniform, horizontal backfill, compacted to at least 95% of the ASTM D 698 maximum dry density, rendering a maximum unit weight of 120 pcf.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. No safety factor is included in these values.
6. To achieve “Unsaturated” conditions, follow guidelines in **Subsurface Drainage for Below-Grade Walls** below. “Submerged” conditions are recommended when drainage behind walls is not incorporated into the design.

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extends below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a pre-fabricated drainage structure may be used. A pre-fabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion, and is fastened to the wall prior to placing backfill.

PAVEMENTS

General Pavement Comments

Pavements are typically more tolerant of nonuniform subgrade conditions than foundations and floor slabs. As discussed in the **Geotechnical Overview** section, portions of existing undocumented fill may remain in the pavement areas if the owner is willing to accept the potential for higher than normal settlement, distress, and/or maintenance in exchange for reduced construction costs. A minimum of 1 foot of the existing fill below the pavement base rock should be replaced with newly compacted structural fill consisting of LVC material. If the owner is not willing to accept the risks of supporting pavements over existing undocumented fill materials, the existing fill should be completely removed and replaced to support pavements.

Support characteristics of subgrades for pavement design do not account for shrink/swell movements of an expansive clay subgrade, such as the soils encountered on this site. 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. To reduce the potential for

settlement/heave and associated cracking of the pavement, we recommend that at least the upper 12 inches of subgrade beneath the pavement base rock consist of LVC material.

Pavement Subgrade Preparation

On most project sites, the grading is accomplished relatively early in the construction phase. Fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas, rainfall and surface water saturate some areas, heavy traffic from concrete trucks and other delivery vehicles disturb the subgrade and many surface irregularities are filled in with loose soils to improve stability temporarily. As a result, the pavement subgrades, initially prepared early in the project, should be carefully evaluated as the time for pavement construction approaches.

We recommend the moisture content and density of the upper 9 inches of the subgrade be evaluated and the pavement subgrades be proofrolled within two days prior to commencement of actual paving operations. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and recompacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the material with compacted structural fill.

After proofrolling and repairing deep subgrade deficiencies, the entire subgrade should be scarified and developed as recommended in section **Earthwork** to provide a more consistent subgrade for pavement construction. Areas that appear desiccated (dry) following site stripping may require further undercutting and moisture conditioning. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

Pavement Design Parameters

Traffic loading provided includes:

Light duty pavements:

- Autos/light trucks: 150 vehicles per day

Medium duty pavements:

- Autos/light trucks: 150 vehicles per day
- Light delivery and trash collection vehicles: 1-3 vehicles per week
- Beverage/vending truck: 1-2 per week
- Catering vehicles: 1 per week
- Tractor-trailer trucks: 2-4 per year

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. Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to pavements should slope down from pavement edges at a minimum 2 percent;
- The subgrade and the pavement surface should have a minimum 2 percent slope to promote proper surface drainage;
- Drainage should be provided for the pavement base course;
- Joint sealant should be installed and cracks sealed immediately;
- Compacted, low permeability backfill should be placed against the exterior side of curbs and gutters, and all landscaped areas in, or adjacent to pavements to reduce moisture migration to subgrade soils; and,
- To reduce the likelihood of water seeping beneath curbs into the pavement base course; curb, gutter and/or sidewalks should bear directly on clay subgrade soils rather than on unbound granular base course materials.

Pavement Section Thicknesses

The following table provides options for AC and PCC Sections:

Asphaltic Concrete Design		
Layer	**Thickness (inches)**	
	Light-Duty [1]	**Medium-Duty** [1]
Asphalt Thickness	Asphalt Surface: 3	Asphalt Surface: 2 Asphalt Base: 2
Aggregate Base [2]	8	8

1. See **Pavement Design Parameters** section above for more specifics regarding Light-Duty and Medium-Duty traffic.
2. Crushed stone (MoDOT Type 5 aggregate)

Portland Cement Concrete Design			
Layer	**Thickness (inches)**		
	Light-Duty [1]	**Medium-Duty** [1]	**Heavy-Duty** [3]
Portland Cement Concrete [2]	5	6	7
Aggregate base [4]	4	4	4

1. See **Pavement Design Parameters** section above for more specifics regarding Light-Duty and Medium-Duty traffic.
2. 4,000 psi at 28 days, 4-inch maximum slump and 5 to 7 percent air entrained. PCC pavements are recommended for trash container pads and in any other areas subjected to heavy wheel loads and/or turning traffic.
3. In areas of anticipated heavy traffic, fire trucks, delivery trucks, or concentrated loads (e.g. dumpster pads), and areas with repeated turning or maneuvering of heavy vehicles.
4. Crushed stone (MoDOT Type 5 aggregate)

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrades should be graded to provide positive drainage within the granular base section. We recommend the subgrades beneath the pavement sections be graded to slope toward the storm water catch basins. A drainage collection and removal system (e.g., finger drains) could be used to allow water in the granular base to enter the storm sewers, or otherwise be removed from the granular base.

Pavement Maintenance

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance is usually the first priority when implementing a pavement maintenance program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required. Geosynthetic reinforcement between the subgrade and base rock could be considered to increase the time before maintenance is required.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations may occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Support of floor slabs and pavements over existing fill is discussed in this report. However, even with the recommended construction testing, there is a risk that unsuitable materials within or buried by the fill will not be discovered. This risk cannot be eliminated without removing the fill but can be reduced by thorough exploration and testing

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation costs. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation costs. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

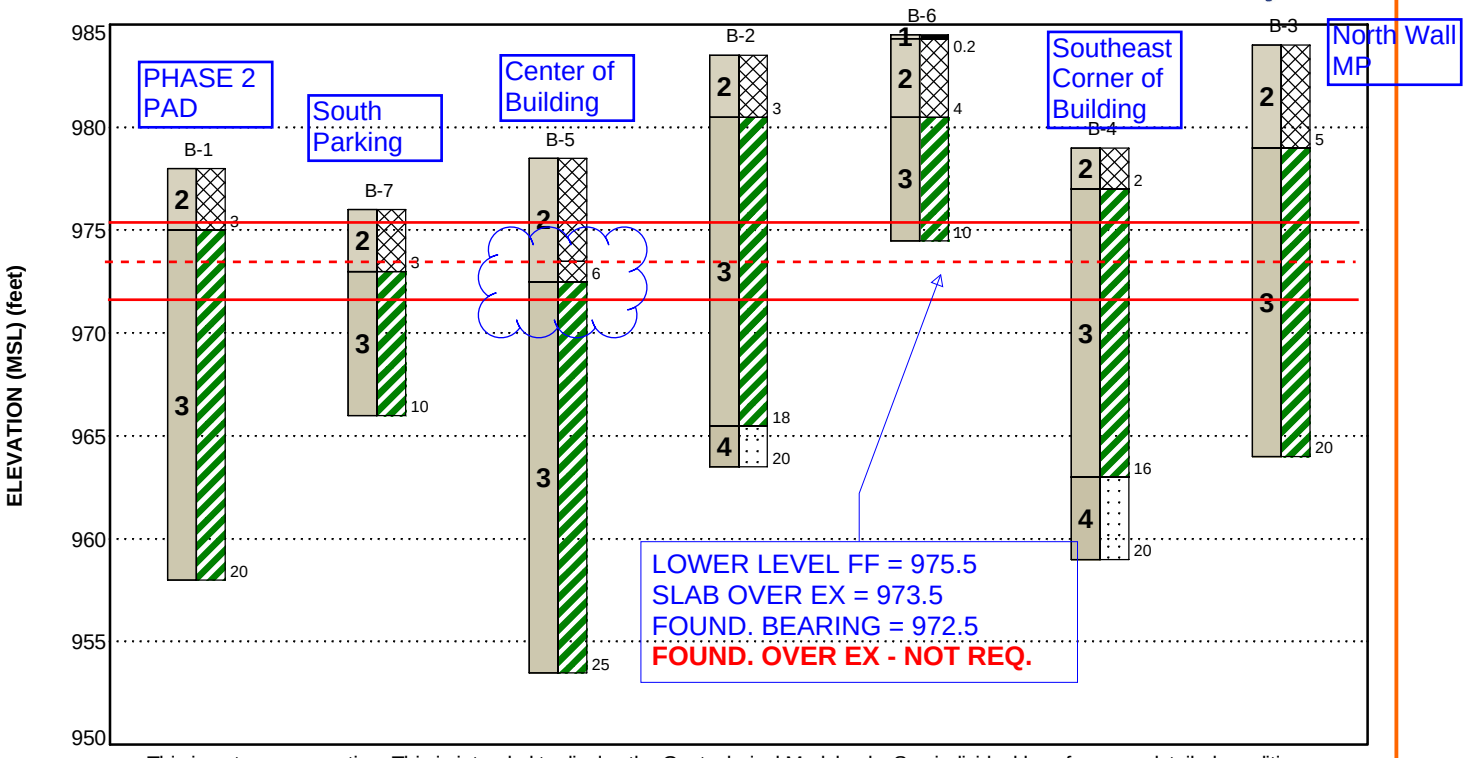
FIGURES

Contents:

GEOMODEL

Camdenton Community Center ■ Camdenton, Missouri
6/14/2019 ■ Terracon Project No. B5195019

Terracon GeoReport



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	**ASPHALT**	Asphalt
2	**FILL**	Fat clay, with gravel, tan/red/gray
3	**FAT CLAY**	Fat clay, trace gravel, red
4	**SANDSTONE**	Sandstone, highly weather, brown

LEGEND

Fill
Asphalt
Fat Clay
Sandstone

First Water Observation
Second Water Observation
Third Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet) [1]	Planned Location
B-1 to B-5	20	buildings
B-6 to B-7	10	pavement

1. Below ground surface

Boring Layout and Elevations: The boring layout was performed by Terracon. Coordinates were obtained by interpolation from Google Earth Pro with a handheld GPS unit (estimated horizontal accuracy of about ±20 feet). Approximate elevations were obtained by interpolation from a topographic map provided by the SFS Architecture and are rounded to the nearest ½-foot. If more precise boring locations and elevations are desired, we recommend the borings be surveyed.

Subsurface Exploration Procedures: The borings were advanced with an ATV-mounted rotary drill rig using continuous flight, solid-stem augers. Samples were obtained in the borings as noted in **Exploration Results.** The split-barrel sampling procedure was performed using a standard 2-inch outer diameter, split-barrel sampling spoon that was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration was recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at their respective test depths. Water levels were observed and recorded during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion. Pavements were patched with cold-mix asphalt and/or pre-mixed concrete.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

Classification of the soil samples was performed in general accordance with the Unified Soil Classification System (USCS) based on the material's texture and plasticity. The project engineer reviewed the field data and assigned laboratory tests to better understand the engineering properties of the various soil strata.

- Water (Moisture) Content of Soil and Rock by Mass
- Liquid Limit, Plastic Limit, and Plasticity Index of Soils

SITE LOCATION AND EXPLORATION PLANS

Contents:

SITE LOCATION

Community Center ■ Camdenton, Missouri
July 1, 2019 ■ Terracon Project No. B5195019

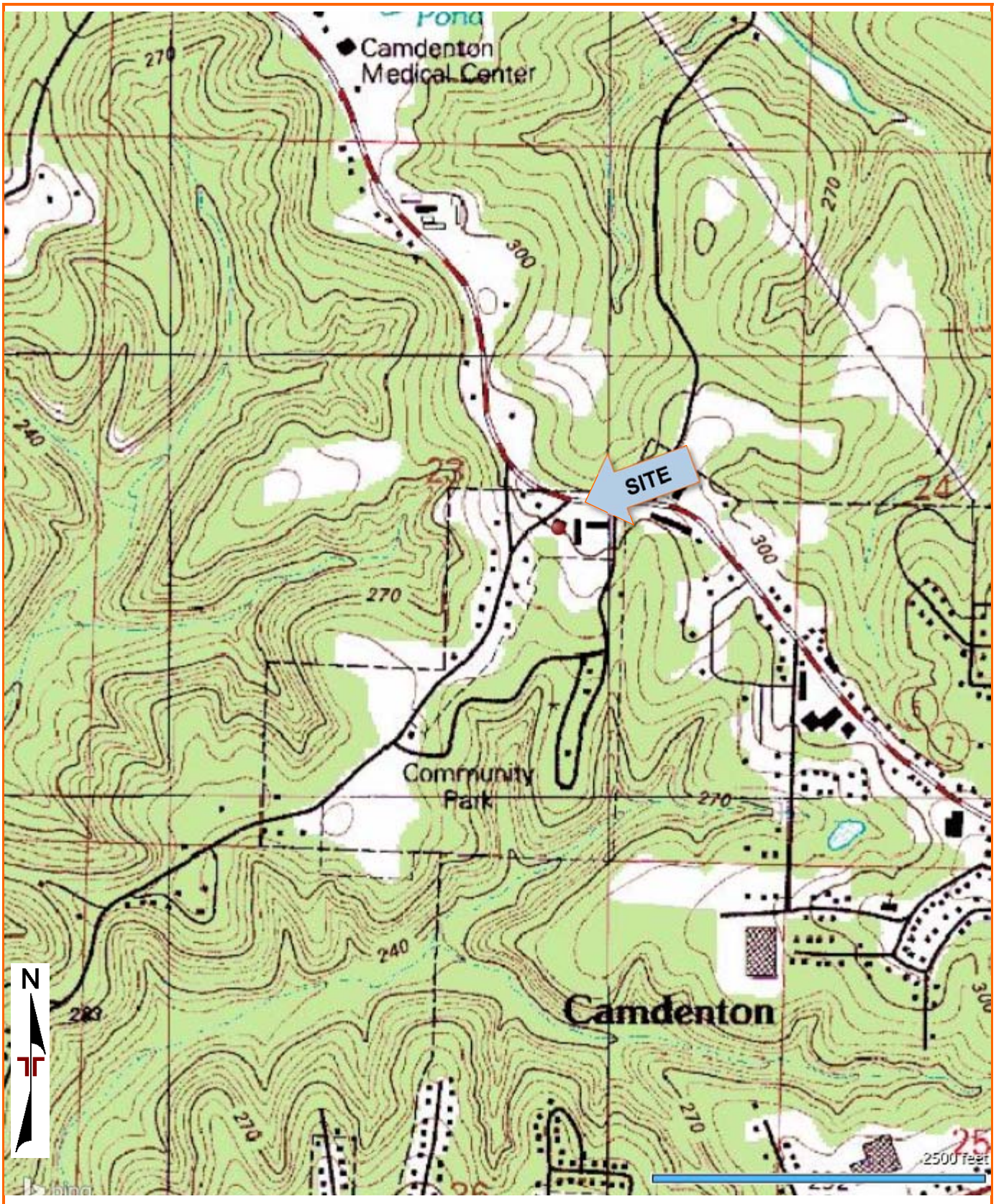


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

BORING LOCATION PLAN

Community Center ■ Camdenton, Missouri
July 1, 2019 ■ Terracon Project No. B5195019

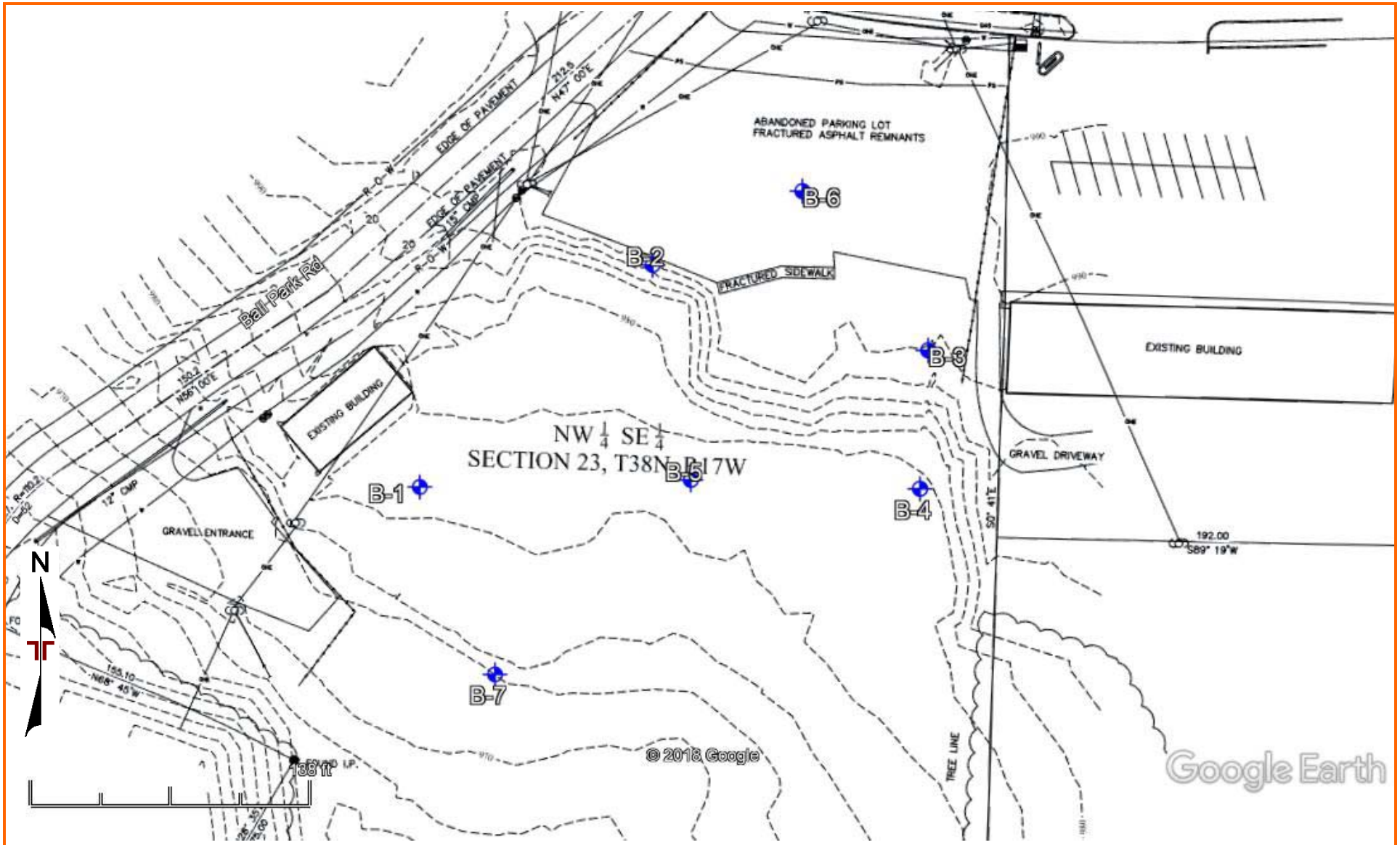


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

TOPOGRAPHIC SURVEY PROVIDED BY SITE PLAN PROVIDED BY SFS ARCHITECTURE

EXPLORATION PLAN

Community Center ■ Camdenton, Missouri
July 1, 2019 ■ Terracon Project No. B5195019

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

SITE PLAN PROVIDED BY SFS ARCHITECTURE

GEOLOGIC MAP

Community Center ■ Camdenton, Missouri
July 1, 2019 ■ Terracon Project No. B5195019

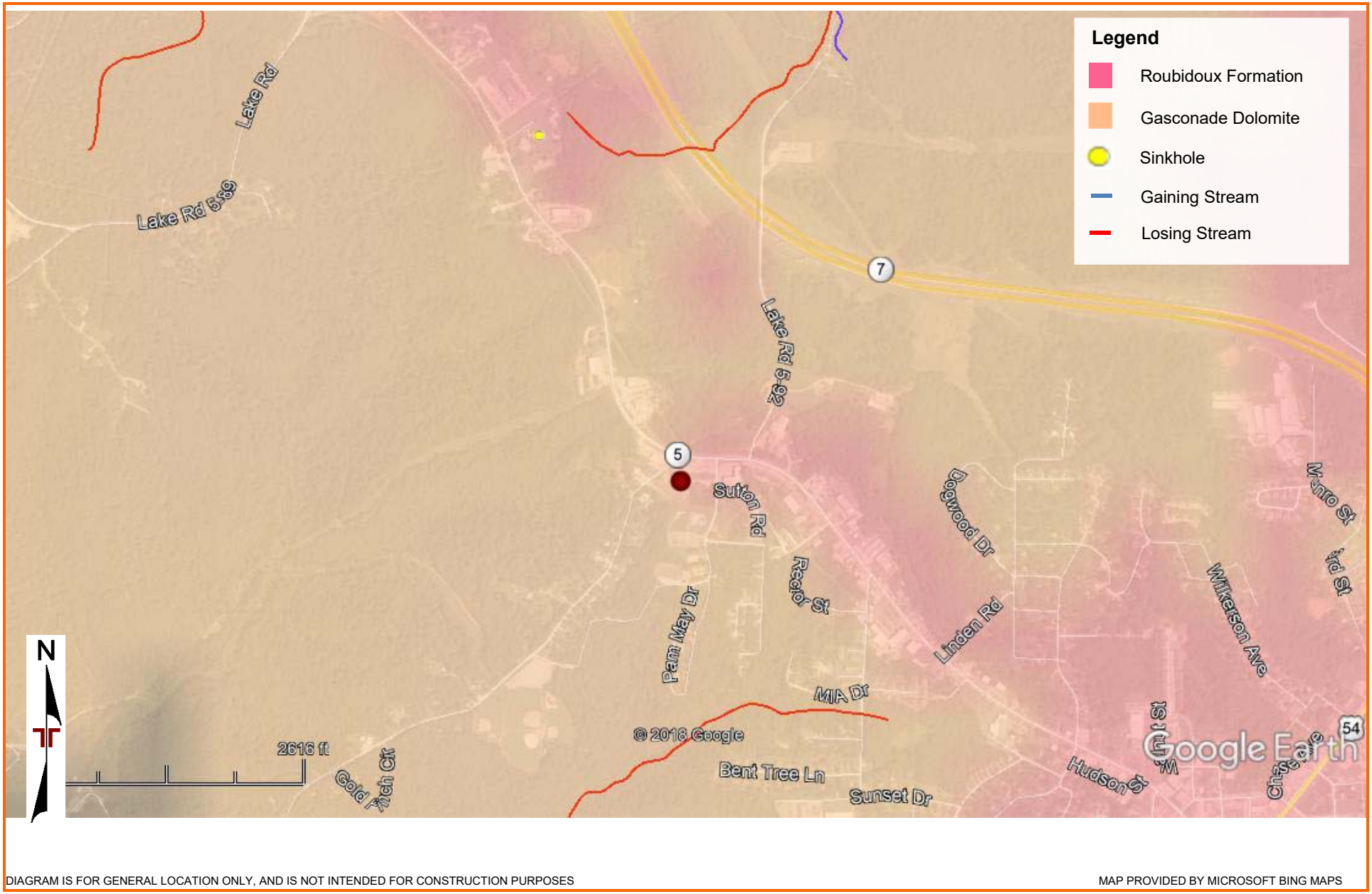


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

BORING LOG NO. B-1

PROJECT: Camdenton Community Center

CLIENT: City of Camdenton
Camdenton, Missouri

SITE: 1175 N. Business Route 5
Camdenton, Missouri

MODEL LAYER	GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 38.0177° Longitude: -92.7625° Surface Elev.: 978 (Ft.) DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2		**FILL - FAT CLAY (CH)**, with gravel, tan and red								
					X	8	4-3-4 N=7	2 (HP)	35	79-31-48
		3.0 / 975								
3		**FAT CLAY (CH)**, trace gravel, red, medium stiff to stiff								
					X	13	4-4-6 N=10	2.5 (HP)	42	82-34-48
			5		X	9	3-3-4 N=7	3 (HP)	38	
					X	8	3-4-4 N=8	2.5 (HP)	46	
			10							
					X	3	6-6-5 N=11	3 (HP)	29	
			15							
		20.0 / 958			X	3	5-6-5 N=11	3 (HP)	43	
		Boring Terminated at 20 Feet	20							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
CFA 4.5" O.D.

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

While drilling

Terracon
4765 W Junction St
Springfield, MO

Boring Started: 05-30-2019 | Boring Completed: 05-30-2019

Drill Rig: 726 | Driller: DH

Project No.: B5195019

BORING LOG NO. B-2

PROJECT: Camdenton Community Center

CLIENT: City of Camdenton
Camdenton, Missouri

SITE: 1175 N. Business Route 5
Camdenton, Missouri

LOCATION See Exploration Plan

Latitude: 38.018° Longitude: -92.7621°

Surface Elev.: 983.5 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2			**FILL - FAT CLAY (CH)**, with gravel, tan and red, (Possible Fill)			X	11	5-6-11 N=17	3 (HP)	18	
		3.0	980.5								
3			**FAT CLAY (CH)**, trace gravel, red, stiff to very stiff	5		X	10	7-9-8 N=17	3 (HP)	13	
						X	13	4-5-6 N=11	3 (HP)	40	
				10		X	12	5-5-6 N=11	3 (HP)	42	
				15		X	16	20-9-8 N=17	3.5 (HP)	21	
		18.0	965.5								
4			**SANDSTONE**, brown, highly weathered			X	18	20-30-41 N=71	3.5 (HP)	20	
		20.0	963.5	20							
			Boring Terminated at 20 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
CFA 4.5" O.D.

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

While drilling

Terracon
4765 W Junction St
Springfield, MO

Boring Started: 05-30-2019 | Boring Completed: 05-30-2019

Drill Rig: 726 | Driller: DH

Project No.: B5195019

BORING LOG NO. B-3

PROJECT: Camdenton Community Center

CLIENT: City of Camdenton
Camdenton, Missouri

SITE: 1175 N. Business Route 5
Camdenton, Missouri

LOCATION See Exploration Plan

Latitude: 38.0179° Longitude: -92.7617°

Surface Elev.: 984 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2			**FAT CLAY (CH)**, with gravel, tan and red								
								3-3-3 N=6		24	
								4-3-3 N=6		25	
		5.0	979	5							
3			**FAT CLAY (CH)**, trace gravel, red, stiff					4-5-6 N=11		38	
								6-7-7 N=14		35	
				10							
								4-5-4 N=9		42	
				15							
		20.0	964					3-4-5 N=9		40	
			Boring Terminated at 20 Feet	20							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
CFA 4.5" O.D.

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

While drilling

Terracon
4765 W Junction St
Springfield, MO

Boring Started: 05-30-2019 | Boring Completed: 05-30-2019

Drill Rig: 726 | Driller: DH

Project No.: B5195019

BORING LOG NO. B-4

PROJECT: Camdenton Community Center

CLIENT: City of Camdenton
Camdenton, Missouri

SITE: 1175 N. Business Route 5
Camdenton, Missouri

LOCATION See Exploration Plan

Latitude: 38.0177° Longitude: -92.7617°

Surface Elev.: 979 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2			**FILL - FAT CLAY (CH)**, with gravel, tan and red, (Possible Fill)								
		2.0	977			X	10	5-6-7 N=13	3 (HP)	25	62-25-37
3			**FAT CLAY (CH)**, trace gravel, red, stiff to very stiff								
						X	10	6-7-7 N=14	3 (HP)	29	62-28-34
				5							
						X	11	9-8-7 N=15	3 (HP)	35	
						X	12	8-8-6 N=14	3 (HP)	16	
				10							
						X	9	9-16-20 N=36	3 (HP)	23	
		16.0	963	15							
4			**SANDSTONE**, brown, highly weathered								
						X	8	20-20-19 N=39	3 (HP)	3	
		20.0	959	20							
			Boring Terminated at 20 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
CFA 4.5" O.D.

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

While drilling

Terracon
4765 W Junction St
Springfield, MO

Boring Started: 05-30-2019 | Boring Completed: 05-30-2019

Drill Rig: 726 | Driller: DH

Project No.: B5195019

BORING LOG NO. B-5

PROJECT: Camdenton Community Center

CLIENT: City of Camdenton
Camdenton, Missouri

SITE: 1175 N. Business Route 5
Camdenton, Missouri

LOCATION See Exploration Plan

Latitude: 38.0177° Longitude: -92.762°

Surface Elev.: 978.5 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2			**FILL - FAT CLAY (CH)**, with gravel, tan and red			X	6	4-5-6 N=11	3 (HP)	15	
						X	7	5-6-7 N=13	3 (HP)	14	
		5.0	973.5	5							
		6.0	**FAT CLAY (CH)**, gray 972.5			X	10	4-4-4 N=8	3 (HP)	47	
3			**FAT CLAY (CH)**, trace gravel, red, medium stiff to stiff			X	12	5-4-5 N=9	3 (HP)	35	
				10							
						X	10	3-4-5 N=9	3 (HP)	34	
				15							
						X	10	4-3-3 N=6	3 (HP)	43	
				20							
		25.0	953.5			X	10	5-4-5 N=9	3 (HP)	37	
				25							
			Boring Terminated at 25 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
CFA 4.5" O.D.

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

While drilling

Terracon
4765 W Junction St
Springfield, MO

Boring Started: 05-30-2019 | Boring Completed: 05-30-2019

Drill Rig: 726 | Driller: DH

Project No.: B5195019

BORING LOG NO. B-6

PROJECT: Camdenton Community Center

CLIENT: City of Camdenton
Camdenton, Missouri

SITE: 1175 N. Business Route 5
Camdenton, Missouri

LOCATION See Exploration Plan

Latitude: 38.0181° Longitude: -92.7619°

Surface Elev.: 984.5 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1		0.2	984.5								
		ASPHALT									
2		**FILL - FAT CLAY (CH)**, with gravel, tan and red, (Possible Fill)				X	10	6-9-9 N=18	3 (HP)	13	
		4.0	980.5								
3		**FAT CLAY (CH)**, trace gravel, red, stiff to very stiff		5		X	9	8-7-6 N=13	3 (HP)	12	
						X	8	10-11-12 N=23	3 (HP)	18	
						X	8	9-8-10 N=18	3 (HP)	35	
		10.0	974.5	10							
		Boring Terminated at 10 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
CFA 4.5" O.D.

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

While drilling

Terracon
4765 W Junction St
Springfield, MO

Boring Started: 05-30-2019 | Boring Completed: 05-30-2019

Drill Rig: 726 | Driller: DH

Project No.: B5195019

BORING LOG NO. B-7

PROJECT: Camdenton Community Center

CLIENT: City of Camdenton
Camdenton, Missouri

SITE: 1175 N. Business Route 5
Camdenton, Missouri

MODEL LAYER	GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 38.0175° Longitude: -92.7624° Surface Elev.: 976 (Ft.) DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2		**FILL - FAT CLAY (CH)**, with gravel, tan and red, (Possible Fill)								
					X	3	6-4-3 N=7	3 (HP)	18	
		3.0 / 973								
3		**FAT CLAY (CH)**, trace gravel, red, stiff to very stiff								
			5		X	16	5-4-2 N=6	3 (HP)	33	
					X	10	6-7-8 N=15	3 (HP)	31	
					X	10	7-5-6 N=11	3 (HP)	31	
		10.0 / 966	10							
		Boring Terminated at 10 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
CFA 4.5" O.D.

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

While drilling

Terracon
4765 W Junction St
Springfield, MO

Boring Started: 05-30-2019 | Boring Completed: 05-30-2019

Drill Rig: 726 | Driller: DH

Project No.: B5195019

SUPPORTING INFORMATION

Contents:

UNIFIED SOIL CLASSIFICATION SYSTEM

Terracon GeoReport

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
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 [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or [$Cc<1$ or $Cc>3.0$] [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F, G, H]
			Fines classify as CL or CH		GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or [$Cc<1$ or $Cc>3.0$] [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	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"		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-inch (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 require 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] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[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 plot in 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.

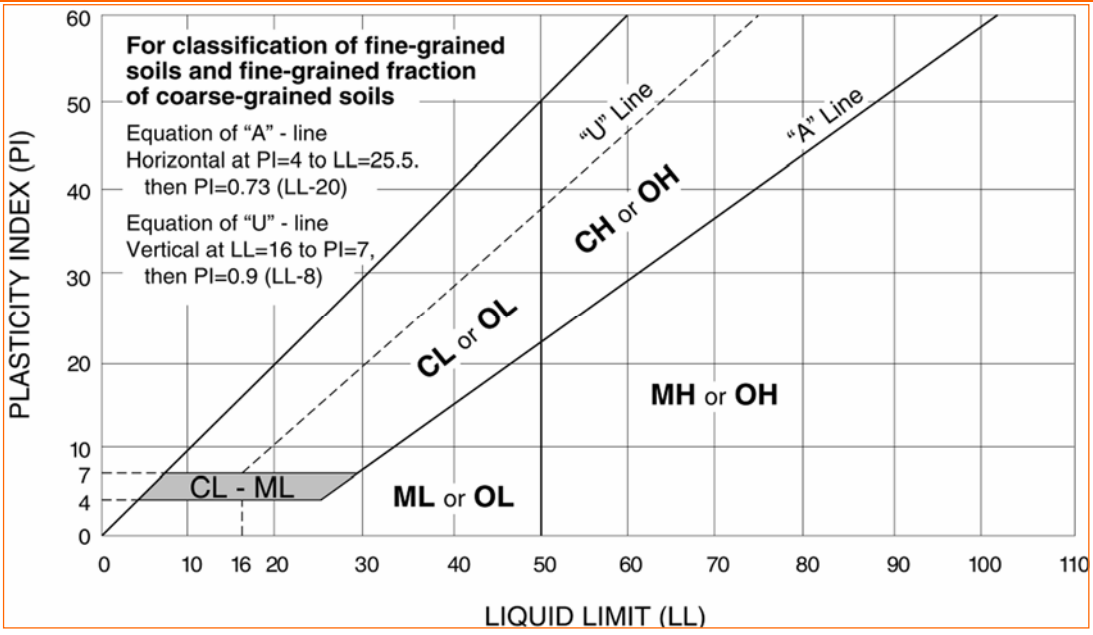
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[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.



DESCRIPTION OF ROCK PROPERTIES

WEATHERING	
Term	**Description**
Unweathered	No visible sign of rock material weathering, perhaps slight discoloration on major discontinuity surfaces.
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition.
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, psi (MPa)**
Extremely weak	Indented by thumbnail	40-150 (0.3-1)
Very weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	150-700 (1-5)
Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	700-4,000 (5-30)
Medium strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	4,000-7,000 (30-50)
Strong rock	Specimen requires more than one blow of geological hammer to fracture it	7,000-15,000 (50-100)
Very strong	Specimen requires many blows of geological hammer to fracture it	15,000-36,000 (100-250)
Extremely strong	Specimen can only be chipped with geological hammer	>36,000 (>250)

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Extremely close	< ¾ in (<19 mm)	**Laminated**	< ½ in (<12 mm)
Very close	¾ in – 2-1/2 in (19 - 60 mm)	**Very thin**	½ in – 2 in (12 – 50 mm)
Close	2-1/2 in – 8 in (60 – 200 mm)	**Thin**	2 in – 1 ft. (50 – 300 mm)
Moderate	8 in – 2 ft. (200 – 600 mm)	**Medium**	1 ft. – 3 ft. (300 – 900 mm)
Wide	2 ft. – 6 ft. (600 mm – 2.0 m)	**Thick**	3 ft. – 10 ft. (900 mm – 3 m)
Very Wide	6 ft. – 20 ft. (2.0 – 6 m)	**Massive**	> 10 ft. (3 m)

Discontinuity Orientation (Angle): Measure the angle of discontinuity relative to a plane perpendicular to the longitudinal axis of the core. (For most cases, the core axis is vertical; therefore, the plane perpendicular to the core axis is horizontal.) For example, a horizontal bedding plane would have a 0-degree angle.

ROCK QUALITY DESIGNATION (RQD) [1]	
Description	**RQD Value (%)**
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Reference: U.S. Department of Transportation, Federal Highway Administration, Publication No FHWA-NHI-10-034, December 2009
Technical Manual for Design and Construction of Road Tunnels – Civil Elements

DESCRIPTION OF ROCK PROPERTIES

WEATHERING	
Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" no discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)	
Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock [1]

Spacing	Joints	Bedding/Foliation
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

1. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

Rock Quality Designator (RQD) [1]

RQD, as a percentage	Diagnostic description
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

1. RQD (given as a percentage) = length of core in pieces 4 inches and longer / length of run

Joint Openness Descriptors

Openness	Descriptor
No Visible Separation	Tight
Less than 1/32 in.	Slightly Open
1/32 to 1/8 in.	Moderately Open
1/8 to 3/8 in.	Open
3/8 in. to 0.1 ft.	Moderately Wide
Greater than 0.1 ft.	Wide

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976. U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.