APPROVED

By: RCR Date: 8-8-16

City of Fort Collins Engineering Department

EARTH ENGINEERING CONSULTANTS, LLC

August 2, 2016

Giuliano & Father Construction, Inc.
308 Commerce Drive, #A
Fort Collins, Colorado 80524

Attn: Mr. John Giuliano (john@giulianoco.com)

Re: Pavement Thickness Design Report – ***Lager, Lambic, and Bock Streets***
Timbervine 2nd Filing – Residential Development
Fort Collins, Colorado
EEC Project No. 1154085

Mr. Giuliano:

Earth Engineering Consultants, LLC (EEC) personnel have completed the subgrade evaluation and pavement thickness design for the proposed interior roadway alignments along Lager, Lambic, and Bock Streets at the Timbervine 2nd Filing Residential Development, in general accordance with the Larimer County Urban Area Street Standard (LCUASS) Pavement Design criteria. At the time of our field exploration, the subgrades for Lager, Lambic, and Bock Streets were at or near approximate "rough" final subgrade elevations and the main sanitary sewer and water lines had been installed. Results of the subgrade evaluation are provided with this report along with recommendations for final pavement thicknesses for the referenced residential roadways as delineated on the enclosed site diagram. For design of the interior roadway alignments we are using an 18-kip equivalent daily load application (EDLA) value of 10 for Lager, Lambic, and Bock Streets.

Pavement related test borings were completed as part of this exploration at four (4) locations (identified herein as P-11 thru P-14), to evaluate subgrade conditions along Lager, Lambic, and Bock Streets. A site diagram indicating the approximate roadway alignments evaluated as part of this assessment and the approximate boring locations is provided with this report.

At boring locations P-11 through P-14, within the interior roadway alignments, two (2) soil borings were completed; one (1) within the sanitary sewer backfill area, (these are identified

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herein as the "A" borings), and one (1) within the adjacent "native" soil area, (these are identified herein as the "B" borings). The sanitary sewer alignment/backfilled borings, "A", were extended to depths of approximately 3-feet below top of subgrade and the "native" soil borings, "B", were completed to depths to approximately 10-feet below existing subgrade elevations. Samples of the subsurface materials encountered were obtained within the top 4 feet of both borings and near the 9-foot interval drilled within the "native" subsurface borings.

EXPLORATION AND TESTING PROCEDURES

The pavement related test borings were located in the field by EEC personnel by pacing and estimating angles from identifiable site references. The borings were generally positioned on approximate 500 feet spacing between each pavement boring within the interior roadway alignments as described herein. The approximate locations of the borings are indicated on the attached boring location diagram. The locations of those borings should be considered accurate only to the degree implied by the methods used to make the field measurements.

The test borings were completed using a truck mounted, CME-55 drill rig equipped with a hydraulic head employed in drilling and sampling operations. The boreholes were advanced using 4-inch nominal diameter continuous flight augers. Samples of the subsurface materials encountered were obtained using split barrel and California barrel sampling procedures in general accordance with ASTM Specifications D1586 and D3550, respectively. In the split barrel and California barrel sampling procedures, standard sampling barrels are advanced into the ground by means of a 140-pound hammer falling a distance of 30 inches. The number of blows required to advance the split barrel and California barrel samplers is recorded and is used to estimate the in-situ relative density of cohesionless soils and, to a lesser degree of accuracy, the consistency of cohesive soils. In the California barrel sampling procedure, relatively undisturbed samples are obtained in removable brass liners. All samples obtained in the field were sealed and returned to our laboratory for further examination, classification, and testing.

Laboratory moisture content tests were completed on each of the recovered samples. In addition, the unconfined strength of appropriate samples was estimated using a calibrated hand penetrometer. Atterberg limits and washed sieve analysis tests were completed on selected

samples to evaluate the quantity and plasticity of fines in the subgrade. Swell/consolidation tests were completed to evaluate the potential for the subgrade materials to change volume with variation in moisture content and load in general accordance with the LCUASS pavement design criteria. One (1) Hveem Stabilometer/R-Value test was conducted on a representative composite sample of the on-site subgrade soils to evaluate the strength characteristics and assist in determining the appropriate pavement thicknesses for the project. Results of the outlined tests are indicated on the attached boring logs and summary sheets.

As part of the testing program, all samples were examined in the laboratory and classified in general accordance with the attached General Notes and the Unified Soil Classification System, based on the soil's texture and plasticity. The estimated group symbol for the Unified Soil Classification System is indicated on the boring logs and a brief description of that classification system is included with this report.

SUBSURFACE CONDITIONS

Based on the results of the field borings and laboratory testing, subsurface conditions can be generalized as follows. Subsurface soils observed within the interior roadway alignments along Lager, Lambic, and Bock Streets (both the "A" and "B" designated borings), consisted of engineered fill material and/or native subsoils classified as sandy lean clay / clayey sand with varying amounts of gravel, which extended to the depths explored in the shallower borings and to the underlying poorly graded sand and gravel with silt granular subsoils in the deeper pavement related borings. Poorly graded sand and gravel with silt was encountered at approximate depths of 4 to 8 feet below site grades in the deeper pavement related borings and extended to the depths explored, approximately 10 feet below site grades. The upper cohesive subsoils, in general, were relatively moist in-situ; were medium stiff to very stiff in consistency and/or medium dense to dense in relative density, and exhibited low to moderate swell potential and low to moderate subgrade strength characteristics.

Observations were made while drilling and after completion of the borings to detect the presence and depth to hydrostatic ground water. Free water was observed in the deeper "B" borings at the time of drilling at approximate depths of 5 to 8½ feet below site grades. In general accordance

with LCUASS criteria, the bottom of the pavement section should be a minimum of 3-feet above the maximum anticipated rise in groundwater. Consideration could be given to the installation of pavement edge drains to control elevated groundwater levels. Fluctuations in groundwater levels can occur over time depending on variations in hydrologic conditions and other conditions not apparent at the time of this report. Longer term observations in cased holes sealed from the influence of surface water would be required to evaluate long term water level fluctuations.

ANALYSIS AND RECOMMENDATIONS

Swell – Consolidation Test Results

The swell-consolidation test is performed to evaluate the swell or collapse potential of soils or bedrock and assist to determine foundation, floor slab and pavement design criteria. In this test, relatively undisturbed samples obtained directly from the California ring barrel sampling device are placed in a laboratory apparatus and inundated with water under a predetermined load. The swell-index is the resulting amount of swell or collapse expressed as a percent of the sample's initial thickness, after the inundation period. Samples obtained at the 1 or 2-foot intervals are generally pre-loaded and inundated with water at an approximate 150 pounds per square foot (psf) increment to simulate the pavement loading conditions in general accordance with Larimer County Urban Area Street Standards (LCUASS) Pavement Design criteria. After the inundation period additional incremental loads are applied to evaluate consolidation response.

For this assessment, we conducted a total of five (5) swell-consolidation tests on subgrade samples collected during our subsurface exploration at approximate depths of 1 to 2-feet below existing site grades. The swell index values for the soil samples tested at the 150-psf inundation pressures revealed low to moderate swell characteristics on the order of (+/-) 0.0 to (+) 3.6%.

The average swell-index result for the roadway fill materials and/or native subsoils analyzed herein revealed a swell-index value less than the LCUASS 2% criteria for requiring a swell-mitigation plan, however, an isolated area revealed swell characteristics over 2%; therefore, a swell-mitigation plan consisting of fly ash treatment is recommended for the interior roadway

alignments. As further discussed within this report, fly ash treatment of the subgrades is also recommended as a stabilization approach.

Fly ash treatment would involve incorporating Class C fly ash within the upper 12-inches of the interior roadways subgrade sections from back of curb to back of curb, (in essence the full roadway width), prior to construction of the overlying pavement structure. Stabilization should consist of blending 12% by dry weight of Class C fly ash in the top 12 inches of the subgrades. The blended materials should be adjusted in moisture content to slightly dry of standard Proctor optimum moisture content and compacted to at least 95% of the materials maximum dry density as determined in accordance with the standard Proctor procedure. Compaction of the subgrade should be completed within two hours after initial blending of the Class C fly ash.

Subgrade stabilization of the proposed interior local roadways within the Timbervine 2nd Filing should be completed in general accordance with the recommendations presented in the LCUASS Pavement Design Manual – Chapter 22.

Hveem Stabilometer (R-Value)

One (1) composite sample of subgrade materials from the upper 4 feet below pavement grades was obtained during the field exploration for laboratory Hveem Stabilometer/R-Value, (ASTM Specification D2844) analyses to determine the subgrade strength characteristics of the in-place subgrade materials. A summary of those test results is provided in the table below and graphical results are presented in the Appendix of this report. As presented in the *Pavement Design and Construction* section of this report, an R-Value of 20, to be conservative, was used to determine the design structural number (SN) for the interior roadway improvements.

Table I - Summary of Laboratory (R-Value) Characteristics and Classification of Subgrade Soils

Boring Nos.	Depth, Ft.	Hveem Stabilometer R-Value	Atterberg Limits and Classification			
			Liquid Limit	Plastic Index	% (-) No. 200 Sieve	Soil Description
P-11 thru P-14	Upper 4'	24	NR	NR	NR	Sandy Lean Clay / Clayey Sand with Gravel (CL/SC)

Water Soluble Sulfates – (SO_4)

The water soluble sulfate (SO_4) testing of the on-site overburden subgrade subsoils indicated soluble sulfate contents ranging from 0.03% to 1.14%. This pavement evaluation report includes a recommendation for the type of cement for use associated with the on-site concrete in contact with the subgrade soils. Based on the results as presented above, ACI 318, Section 4.2 indicates the site soils have a low to high risk of sulfate attack on Portland cement concrete. Therefore, according to the information presented in the table below, Class 2 and/or Type I/II cement should be used for concrete on and below site grade within the overburden soils.

Table II: Requirements to Protect Against Damage to Concrete by Sulfate Attack from External Sources of Sulfate

Severity of Sulfate exposure	Water-soluble sulfate (SO4) in dry soil, percent	Water-cement ratio, maximum	Cementitious material Requirements
Class 0	0.00 to 0.10%	0.45	Class 0
Class 1	0.11 to 0.20%	0.45	Class 1
Class 2	0.21 to 2.00%	0.45	Class 2
Class 3	2.01 of greater	0.45	Class 3

Site concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

PAVEMENT – DESIGN and CONSTRUCTION

Pavement Subgrade Preparation

The subgrade soils are generally low to moderate strength sandy lean clay / clayey sand with gravel subsoil material, exhibiting low to moderate swell potential characteristics thus requiring a swell mitigation plan. For the interior residential roadway alignments, we provide herein a swell mitigation approach. Stabilization of the pavement subgrades through the addition of Class C fly ash could be considered to mitigate for swell as well as to develop stable subgrades for construction of the roadways. The stabilized subgrade should enhance the long term performance of the pavements and reduce the potential for adverse weather impacting the pavement construction. The addition of 12% Class C fly ash (based on dry weight) to the top 12

inches of the subgrades should be considered to swell mitigate and stabilize those subgrades. In accordance with LUCASS standards, the stabilization should extend from back-of-curb to back-of-curb.

Proof rolling the subgrade section is recommended immediately prior to placement of the aggregate road base section. Soft or weak areas delineated by the proof rolling operations should be undercut or stabilized in-place to achieve the appropriate subgrade support as discussed above.

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

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

Pavement section recommendations provided in this report are based on an EDLA value of 10 for Lager, Lambic, and Bock Streets, and the subgrade field and laboratory test results as previously discussed herein.

A Hveem Stabilometer/R-value of 24 was determined for the rough-graded pavement subgrades completed for the Timbervine 2nd Filing Lager, Lambic, and Bock Streets, however an R-value of 20 was used in the pavement design. Using the Colorado Department of Transportation (CDOT) and the current LCUASS Pavement Design Criteria, an R-value of 20 corresponds to a resilient modulus value of 4940 psi, which was used in the pavement evaluation for the roadways included herein.

The American Association of State Highway and Transportation Officials (AASHTO) design guidelines for pavement thicknesses were used to evaluate recommended pavement sections for this project along with the current LCUASS Pavement Design Criteria. Recommended pavement sections based on those evaluations are provided in the table below.

TABLE III: Timbervine 2nd Filing – Interior Roadways	
18 kip Equivalent Daily Load Axles (EDLA)	10 – Lager, Lambic, and Bock Streets
18 kip Equivalent Single Axle Loads (ESAL's) 20-year	73,000
Resilient Modulus (R = 20) Reliability Serviceability Loss (Initial = 4.5 and Terminal= 2.00) Design Weighted Structural Number - S_N	4940 75% 2.5 2.32
(1) Composite Section with Fly Ash: Hot Bituminous Pavement SX-75, PG 64-22 Hot Bituminous Pavement S-75, PG 58-28 Aggregate Base (Class 5 or Class 6) Fly Ash treated subgrade (12% Class C Fly ash – 12", 10" Credit) Structural Number	 1.5" @ 0.44 = 0.66 2.5" @ 0.44 = 1.10 6" @ 0.11 = 0.66 10"@ 0.05 = 0.50 2.92

(1) Provides the minimum pavement thicknesses for use of asphalt concrete surface material, Grading SX, and/or S, (i.e., a minimum of 4 inches for local residential roadways) underlain by a minimum of 6 inches of either CDOT Class 5 or 6 ABC, with a minimum of 12 inches of fly ash treated subgrade below. The City of Fort Collins typically allows for a pavement thickness reduction concept/credit of 12 inches for use of fly ash treated subgrade using a 10-inch section credit and applying a structural coefficient of either 0.05 or 0.10, depending upon the compressive strength achieved in the laboratory of the blended fly ash treated subgrade material. If in excess of 150 psi is achieved, then a strength coefficient of 0.10 for a 10-inch section could be used in the overall pavement structural number evaluation; otherwise a half-strength credit of 0.05 could be used. However, for this roadway alignment the use of fly ash would only be for swell mitigation/stabilization purposes and not for a pavement thickness reduction concept.

The collection and diversion of surface drainage away from paved areas is critical to the satisfactory performance of the pavement. Drainage design should provide for the removal of water from paved areas in order to reduce the potential for wetting of the subgrade soils.

Long-term pavement performance will be dependent upon several factors, including maintaining subgrade moisture levels and providing for preventive maintenance. The following recommendations should be considered the minimum:

- The subgrade and the pavement surface should be adequately sloped to promote proper surface drainage.
- Install pavement drainage surrounding areas anticipated for frequent wetting (e.g. landscaped and irrigated islands, etc.),
- Install joint sealant and seal cracks immediately,
- Seal all landscaped areas in, or adjacent to pavements to minimize or prevent moisture migration to subgrade soils;
- Placing compacted, low permeability backfill against the exterior side of curb and gutter; and,
- Placing curb, gutter, and/or sidewalk directly on approved proof rolled subgrade soils without the use of base course materials.

Preventive maintenance should be planned and provided for through an on-going pavement management program. Preventive maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment. Preventive 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 planned pavement maintenance program and provides the highest return on investment for pavements. Prior to implementing any maintenance, additional engineering observation is recommended to determine the type and extent of preventive maintenance.

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

Please note that if during or after placement of the stabilization or initial lift of pavement, the area is observed to be yielding under vehicle traffic or construction equipment, it is recommended that EEC be contacted for additional alternative methods of stabilization, or a change in the pavement section.

GENERAL COMMENTS

The analysis and recommendations presented in this report are based upon the data obtained from the soil borings performed at the indicated locations and from any other information discussed in this report. This report does not reflect any variations which may occur between borings or across the site. The nature and extent of such variations may not become evident until construction. If variations appear evident, it will be necessary to re-evaluate the recommendations of this report.

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

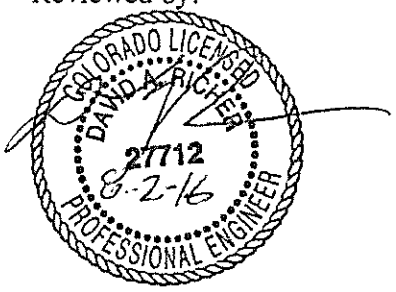
This report has been prepared for the exclusive use of Giuliano & Father Construction, Inc., for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranty, express or implied, is made. In the event that any changes in the nature, design or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report modified or verified in writing by the geotechnical engineer.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we can be of further service to you in any other way, please do not hesitate to contact us.

Very truly yours,
Earth Engineering Consultants, LLC

Jacob J. Silverman, P.E.
Project Engineer

Reviewed by:



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

cc: City of Fort Collins Mr. Rick Richter rrichter@fcgov.com
Mr. Steve Cicione scicione@fcgov.com

DRILLING AND EXPLORATION

DRILLING & SAMPLING SYMBOLS:

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

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

WATER LEVEL MEASUREMENT SYMBOLS:

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

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

DESCRIPTIVE SOIL CLASSIFICATION

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

CONSISTENCY OF FINE-GRAINED SOILS

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

RELATIVE DENSITY OF COARSE-GRAINED SOILS:

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

PHYSICAL PROPERTIES OF BEDROCK

DEGREE OF WEATHERING:

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

HARDNESS AND DEGREE OF CEMENTATION:

Limestone and Dolomite:

Hard	Difficult to scratch with knife.
Moderately Hard	Can be scratched easily with knife.
Soft	Can be scratched with fingernail.

Shale, Siltstone and Claystone:

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

Sandstone and Conglomerate:

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

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests					Soil Classification: Group Symbol	Soil Classification: Group Name
Coarse - Grained Soils more than 50% retained on No. 200 sieve	Gravels more than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines	$Cu \geq 4$ and $1 < Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly-graded gravel [F]
		Gravels with Fines more than 12% fines	Fines classify as ML or MH		GM	Silty gravel [G,H]
			Fines Classify as CL or CH		GC	Clayey Gravel [F,G,H]
	Sands 50% or more coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines	$Cu \geq 6$ and $1 < Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly-graded sand [I]
		Sands with Fines more than 12% fines	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid Limit less than 50	inorganic	PI>7 and plots on or above "A" Line		CL	Lean clay [K,L,M]
			PI<4 or plots below "A" Line		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,O]
Highly organic soils		Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines required dual symbols:
GW-GM well graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly-graded gravel with silt
GP-GC poorly-graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥15% sand, add "with sand" to

[G] If fines classify as CL-ML, use dual symbol GC-CM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name

[I] If soil contains >15% gravel, add "with gravel" to group name

[J] If Atterberg limits plots shaded area, soil is a CL-ML, Silty clay

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

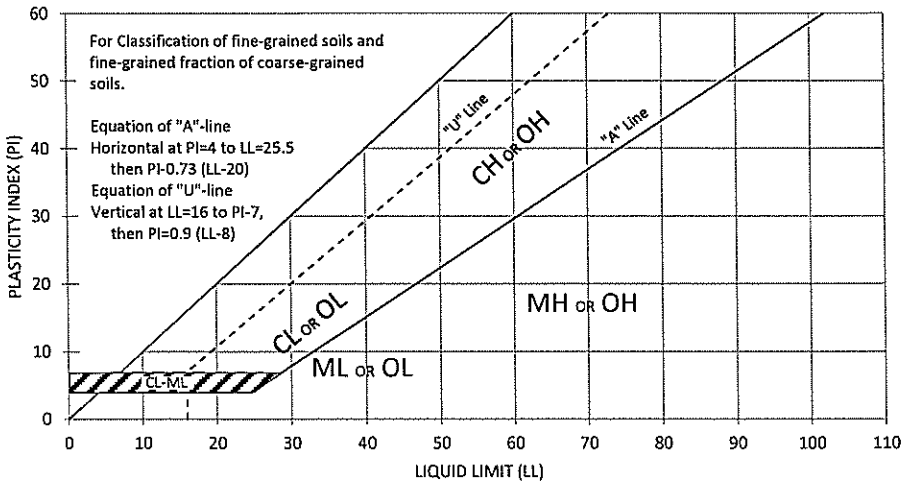
[M] If soil contains ≥30% plus No. 200 predominantly gravel, add "gravelly" to group name.

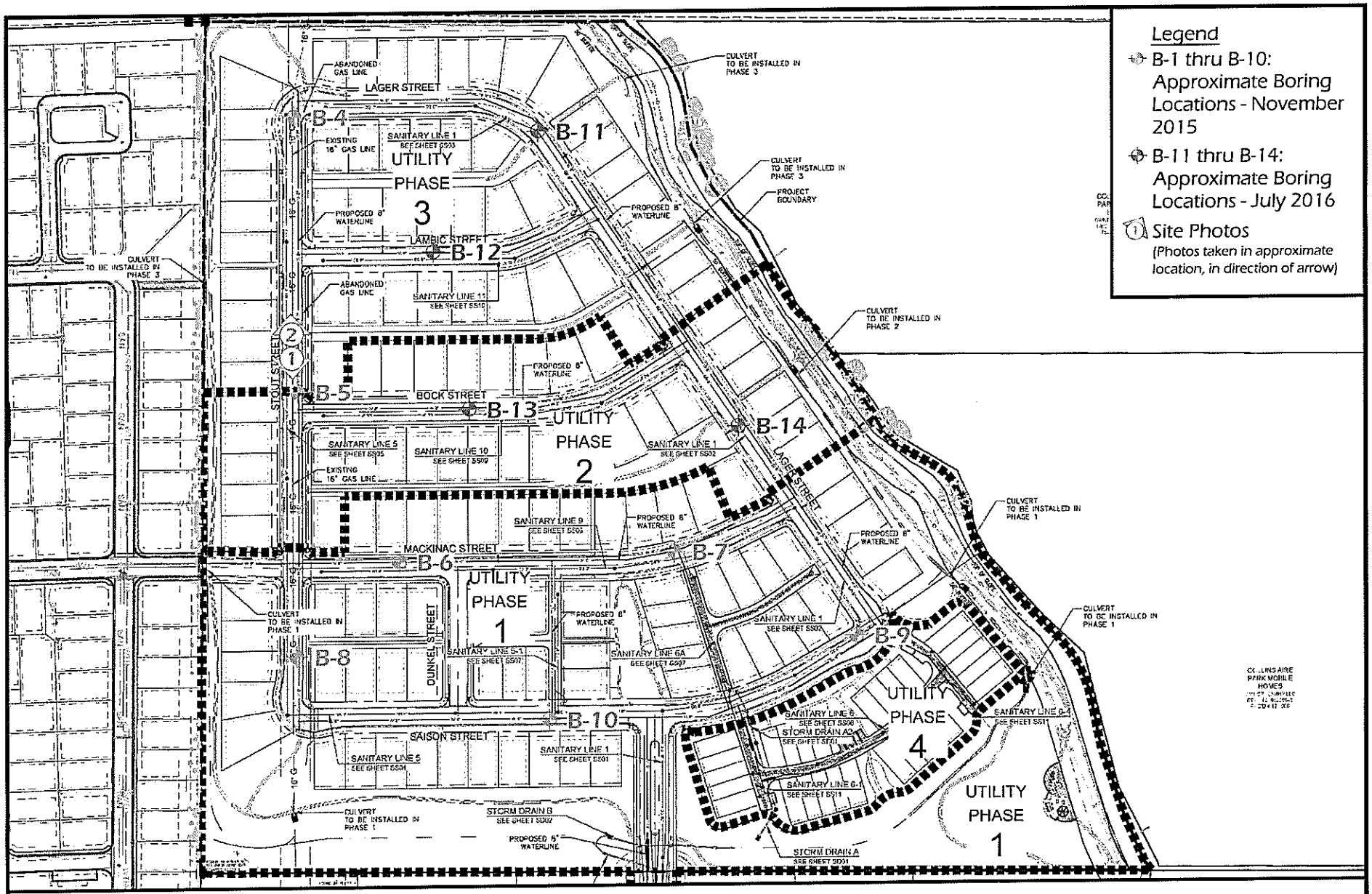
[N] PI≥4 and plots on or above "A" line.

[O] PI≤4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.





Boring Location Diagram
Timbervine 2nd Filing - Lager, Lambic, & Bock Street Pavements
Fort Collins, Colorado
EEC Project #: 1154085 Date: July 2016

North
Not to Scale

EARTH ENGINEERING CONSULTANTS, LLC

PHOTO # 1

PHOTO # 2

TIMBERVINE 2ND FILING – LAGER, LAMBIC, AND BOCK STREETS
FORT COLLINS, COLORADO
EEC PROJECT NO. 1154085
JULY 2016

TIMBERVINE 2ND FILING - LAGER, LAMBIC, AND BOCK STREETS

FORT COLLINS, COLORADO

PROJECT NO: 1154085	LOG OF BORING B-11A	DATE: JULY 2016	
RIG TYPE: CME55	*SHEET 1 OF 1*	WATER DEPTH	
FOREMAN: DG	START DATE 7/8/2016	WHILE DRILLING	None
AUGER TYPE: 4" CFA	FINISH DATE 7/8/2016	AFTER DRILLING	N/A
SPT HAMMER: AUTOMATIC	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SANDY LEAN CLAY (SC) - FILL brown stiff with traces of gravel	CS	3	8	8000	13.7	109.4	32	18	59.5	1,000 psf	1.1% @ 150 psf
BOTTOM OF BORING DEPTH 3.0'											

TIMBERVINE 2ND FILING - LAGER, LAMBIC, AND BOCK STREETS

FORT COLLINS, COLORADO

PROJECT NO: 1154085	LOG OF BORING B-11B		DATE: JULY 2016
RIG TYPE: CME55	*SHEET 1 OF 1*		WATER DEPTH
FOREMAN: DG	START DATE	7/8/2016	WHILE DRILLING 5'
AUGER TYPE: 4" CFA	FINISH DATE	7/8/2016	AFTER DRILLING N/A
SPT HAMMER: AUTOMATIC	SURFACE ELEV	N/A	24 HOUR N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SANDY LEAN CLAY (CL) brown medium stiff / loose with traces of gravel / cobbles	CS	3	5	2000	19.8	108.8					
POORLY GRADED SAND AND GRAVEL with SILT (SP/GP-SM/GM) brown dense	SS	5	50	–	14.2						
	SS	10	50	–	11.0						
BOTTOM OF BORING DEPTH 10.5'											

Earth Engineering Consultants, LLC

TIMBERVINE 2ND FILING - LAGER, LAMBIC, AND BOCK STREETS

FORT COLLINS, COLORADO

PROJECT NO: 1154085	LOG OF BORING B-12A		DATE: JULY 2016
RIG TYPE: CME55	*SHEET 1 OF 1*		WATER DEPTH
FOREMAN: DG	START DATE	7/8/2016	WHILE DRILLING: None
AUGER TYPE: 4" CFA	FINISH DATE	7/8/2016	AFTER DRILLING: N/A
SPT HAMMER: AUTOMATIC	SURFACE ELEV	N/A	24 HOUR: N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SANDY LEAN CLAY(CL) - FILL brown very stiff with gravel		1 2									% @ 150 psf
	CS	3	20	9000+	10.7	125.8				2,800 psf	3.6%
BOTTOM OF BORING DEPTH 3.0'		4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25									

TIMBERVINE 2ND FILING - LAGER, LAMBIC, AND BOCK STREETS

FORT COLLINS, COLORADO

PROJECT NO: 1154085	LOG OF BORING B-12B	DATE: JULY 2016	
RIG TYPE: CME55	*SHEET 1 OF 1*	WATER DEPTH	
FOREMAN: DG	START DATE 7/8/2016	WHILE DRILLING	8'
AUGER TYPE: 4" CFA	FINISH DATE 7/8/2016	AFTER DRILLING	N/A
SPT HAMMER: AUTOMATIC	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SANDY LEAN CLAY(CL) brown stiff with gravel	CS	3	8	8000	12.5	122.1					
	SS	5	7	5000	19.3						
POORLY GRADED SAND AND GRAVEL with SILT (SP/GP-SM/GM) brown dense *intermittent COBBLES with depth	SS	10	32	--	12.8						
BOTTOM OF BORING DEPTH 10.5'											

Earth Engineering Consultants, LLC

TIMBERVINE 2ND FILING - LAGER, LAMBIC, AND BOCK STREETS

FORT COLLINS, COLORADO

PROJECT NO: 1154085	LOG OF BORING B-13A		DATE: JULY 2016
RIG TYPE: CME55	*SHEET 1 OF 1*		WATER DEPTH
FOREMAN: DG	START DATE	7/8/2016	WHILE DRILLING: N/A
AUGER TYPE: 4" CFA	FINISH DATE	7/8/2016	AFTER DRILLING: N/A
SPT HAMMER: AUTOMATIC	SURFACE ELEV	N/A	24 HOUR: N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SANDY LEAN CLAY (SC) - FILL brown stiff with traces of gravel	CS	3	7	6000	10.2	108.1					
BOTTOM OF BORING DEPTH 3.0'											

Earth Engineering Consultants, LLC

TIMBERVINE 2ND FILING - LAGER, LAMBIC, AND BOCK STREETS

FORT COLLINS, COLORADO

PROJECT NO: 1154085	LOG OF BORING B-13B	DATE: JULY 2016	
RIG TYPE: CME55	*SHEET 1 OF 1*	WATER DEPTH	
FOREMAN: DG	START DATE 7/8/2016	WHILE DRILLING	8.5'
AUGER TYPE: 4" CFA	FINISH DATE 7/8/2016	AFTER DRILLING	N/A
SPT HAMMER: AUTOMATIC	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
											% @ 150 psf
SANDY LEAN CLAY (CL) brown very stiff to stiff with gravel	CS	3	13	9000+	13.2	118.9	29	14	61.1	1,800 psf	1.6%
		4									
with calcareous deposits	SS	5	10	9000+	9.8						
		6									
		7									
		8									
POORLY GRADED SAND AND GRAVEL with SILT (SP/GP-SM/GM) brown dense	SS	10	50/9"	–	9.4						
		9									
		11									
BOTTOM OF BORING DEPTH 10.5'		12									
		13									
		14									
		15									
		16									
		17									
		18									
		19									
		20									
		21									
		22									
		23									
		24									
		25									

TIMBERVINE 2ND FILING - LAGER, LAMBIC, AND BOCK STREETS

FORT COLLINS, COLORADO

PROJECT NO: 1154085	LOG OF BORING B-14A		DATE: JULY 2016
RIG TYPE: CME55	*SHEET 1 OF 1*		WATER DEPTH
FOREMAN: DG	START DATE	7/8/2016	WHILE DRILLING: None
AUGER TYPE: 4" CFA	FINISH DATE	7/8/2016	AFTER DRILLING: N/A
SPT HAMMER: AUTOMATIC	SURFACE ELEV	N/A	24 HOUR: N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SANDY LEAN CLAY / CLAYEY SAND (CL / SC) - FILL brown very stiff / medium dense with gravel	CS	3	20	7000	12.9	120.1				<150 psf	None
BOTTOM OF BORING DEPTH 3.0'											

Earth Engineering Consultants, LLC

TIMBERVINE 2ND FILING - LAGER, LAMBIC, AND BOCK STREETS

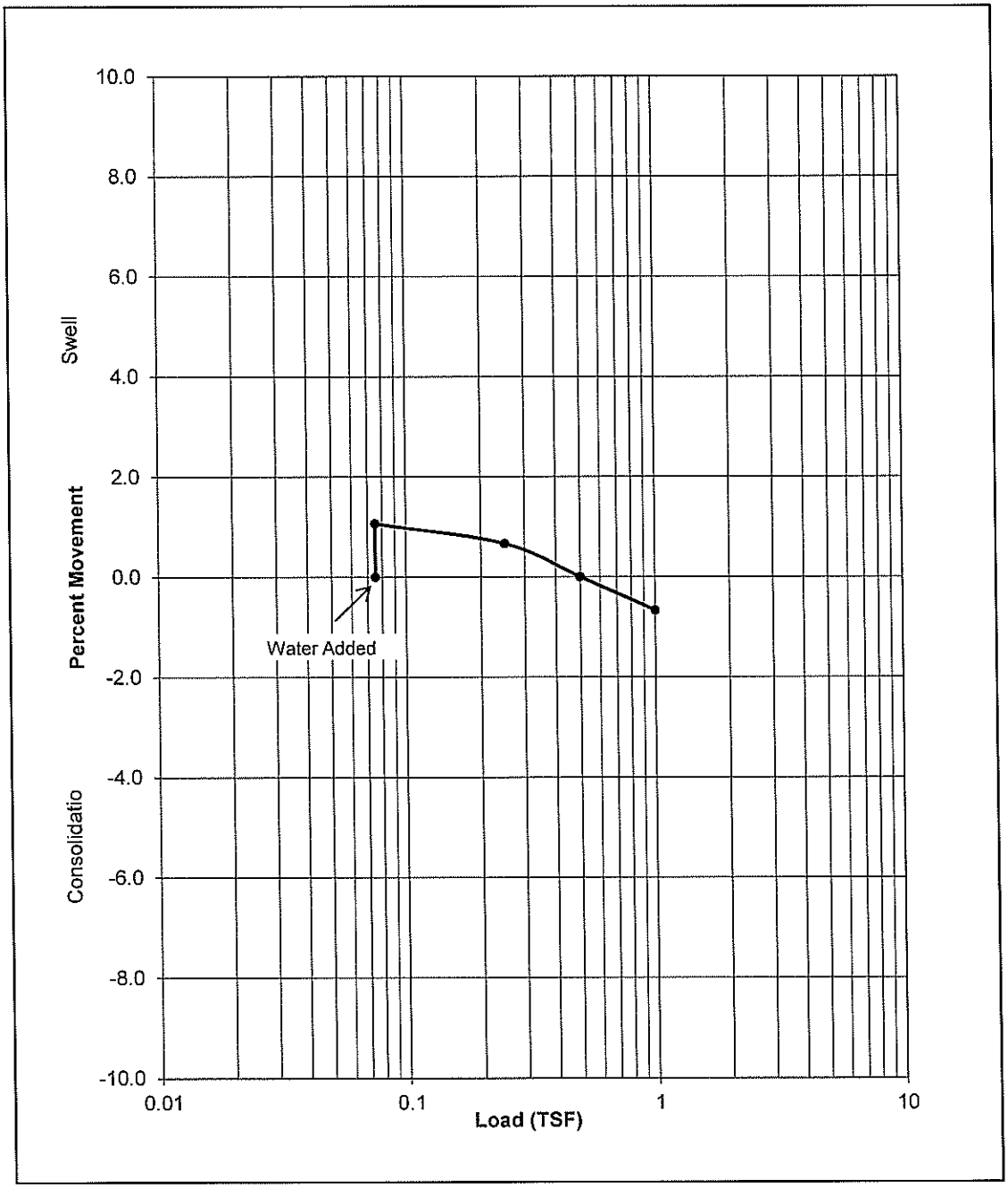
FORT COLLINS, COLORADO

PROJECT NO: 1154085	LOG OF BORING B-14B	DATE: JULY 2016	
RIG TYPE: CME55	*SHEET 1 OF 1*	WATER DEPTH	
FOREMAN: DG	START DATE 7/8/2016	WHILE DRILLING	5'
AUGER TYPE: 4" CFA	FINISH DATE 7/8/2016	AFTER DRILLING	N/A
SPT HAMMER: AUTOMATIC	SURFACE ELEV N/A	24 HOUR	N/A

SOIL DESCRIPTION	TYPE	D (FEET)	N (BLOWS/FT)	QU (PSF)	MC (%)	DD (PCF)	A-LIMITS LL	A-LIMITS PI	-200 (%)	SWELL PRESSURE	SWELL % @ 500 PSF
SANDY LEAN CLAY (CL) brown / grey / rust very stiff with calcareous deposits & traces of gravel		1 2									% @ 150 psf
	CS	3	16	9000	11.8	111.5				1,200 psf	1.5%
		4									
	SS	5	24	--	12.2						
POORLY GRADED SAND AND GRAVEL with SILT (SP/GP-SM/GM) brown dense		6 7 8 9									
	SS	10	50	--	7.5						
BOTTOM OF BORING DEPTH 10.5'		11 12 13 14 15 16 17 18 19 20 21 22 23 24 25									

SWELL / CONSOLIDATION TEST RESULTS

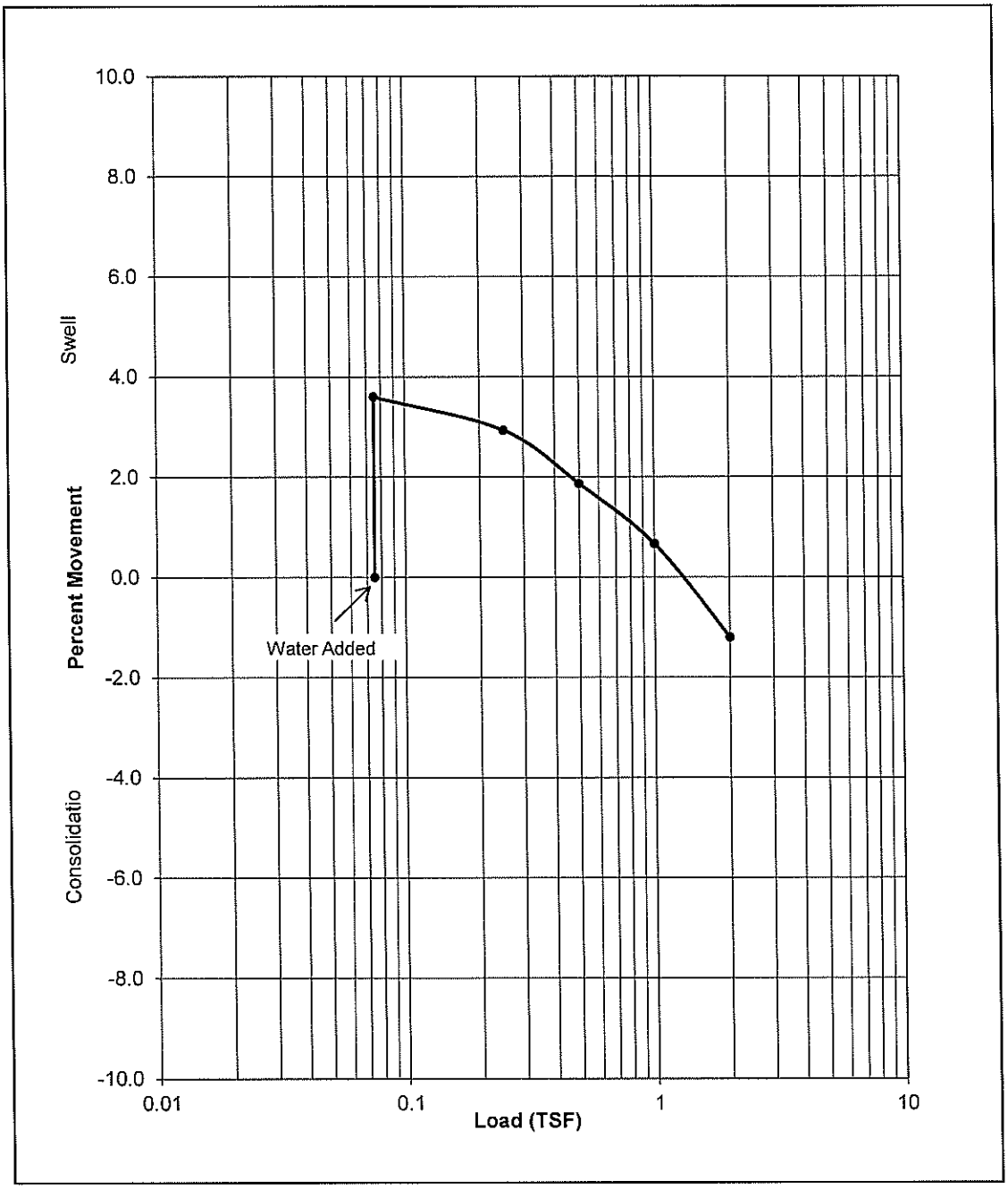
Material Description:	Fill Material: Brown SANDY LEAN CLAY (CL)		
Sample Location:	Boring 11A, Sample 1, Depth 2'		
Liquid Limit: 32	Plasticity Index: 18	% Passing #200: 59.5%	
Beginning Moisture: 13.7%	Dry Density: 117.5 pcf	Ending Moisture: 16.2%	
Swell Pressure: 1000 psf	% Swell @ 150: 1.1%		



Project: Timbervine 2nd Filing - Lager, Lambic, and Bock Streets
Location: Fort Collins, Colorado
Project #: 1154085
Date: July 2016

SWELL / CONSOLIDATION TEST RESULTS

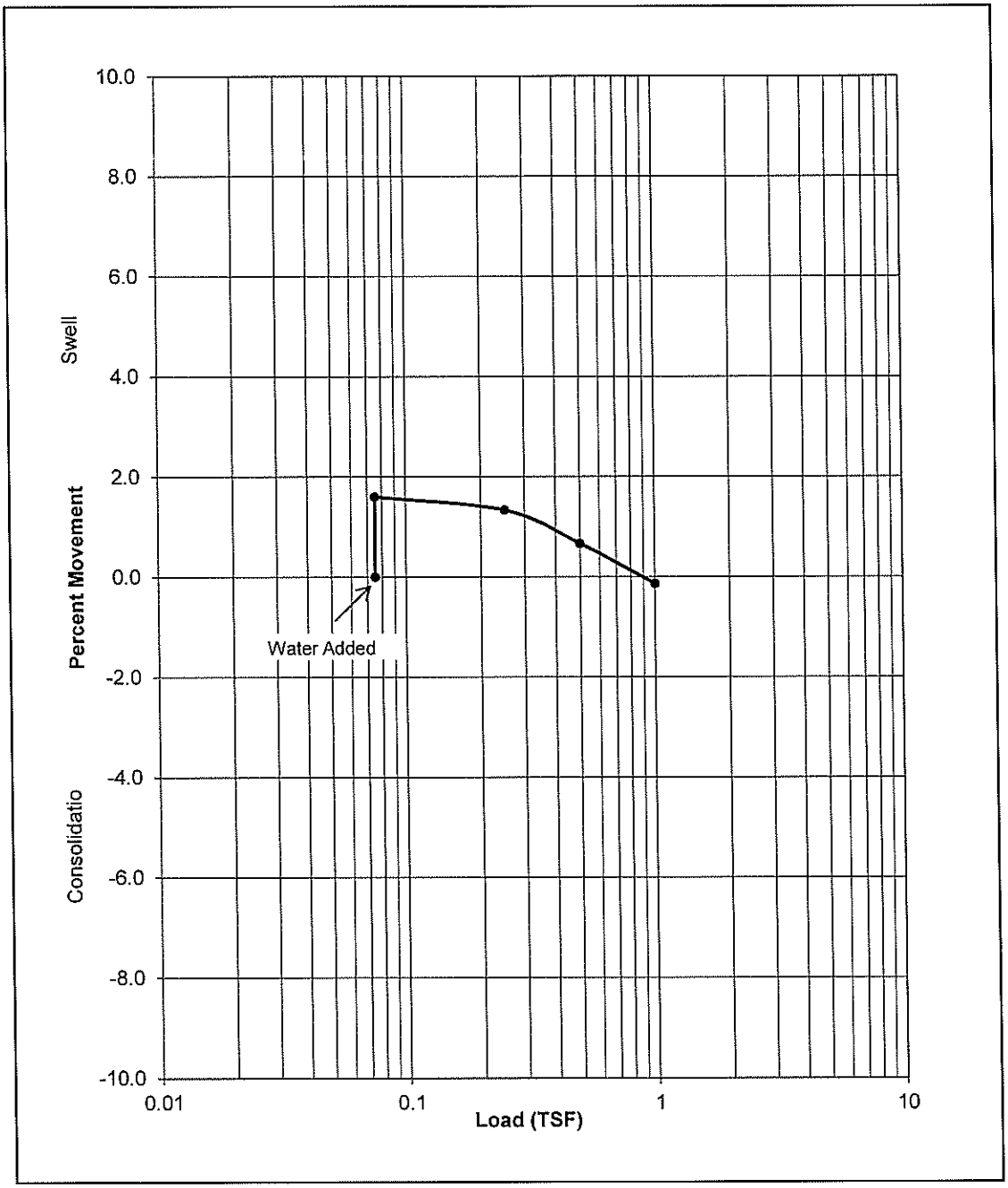
Material Description:	Fill Material: Brown SANDY LEAN CLAY (CL)		
Sample Location:	Boring 12A, Sample 1, Depth 2'		
Liquid Limit: --	Plasticity Index: --	% Passing #200: --	
Beginning Moisture: 10.7%	Dry Density: 116 pcf	Ending Moisture: 14.3%	
Swell Pressure: 2800 psf	% Swell @ 150: 3.6%		



Project: Timbervine 2nd Filing - Lager, Lambic, and Bock Streets
Location: Fort Collins, Colorado
Project #: 1154085
Date: July 2016

SWELL / CONSOLIDATION TEST RESULTS

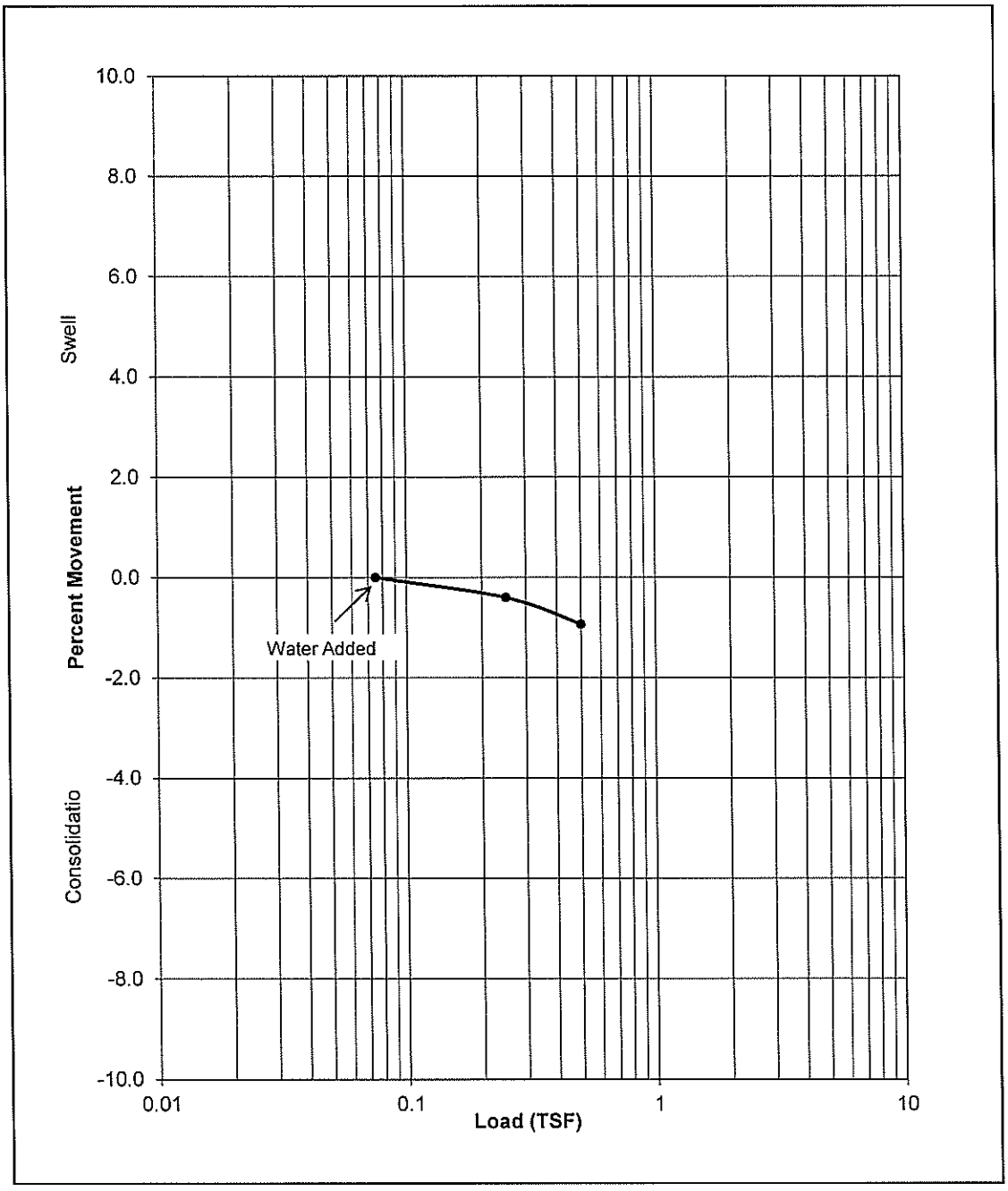
Material Description:	Brown SANDY LEAN CLAY (CL)		
Sample Location:	Boring 13B, Sample 1, Depth 2'		
Liquid Limit: 29	Plasticity Index: 14	% Passing #200: 61.1%	
Beginning Moisture: 13.2%	Dry Density: 120.1 pcf	Ending Moisture: 16.0%	
Swell Pressure: 1800 psf	% Swell @ 150: 1.6%		



Project: Timbervine 2nd Filing - Lager, Lambic, and Bock Streets
Location: Fort Collins, Colorado
Project #: 1154085
Date: July 2016

SWELL / CONSOLIDATION TEST RESULTS

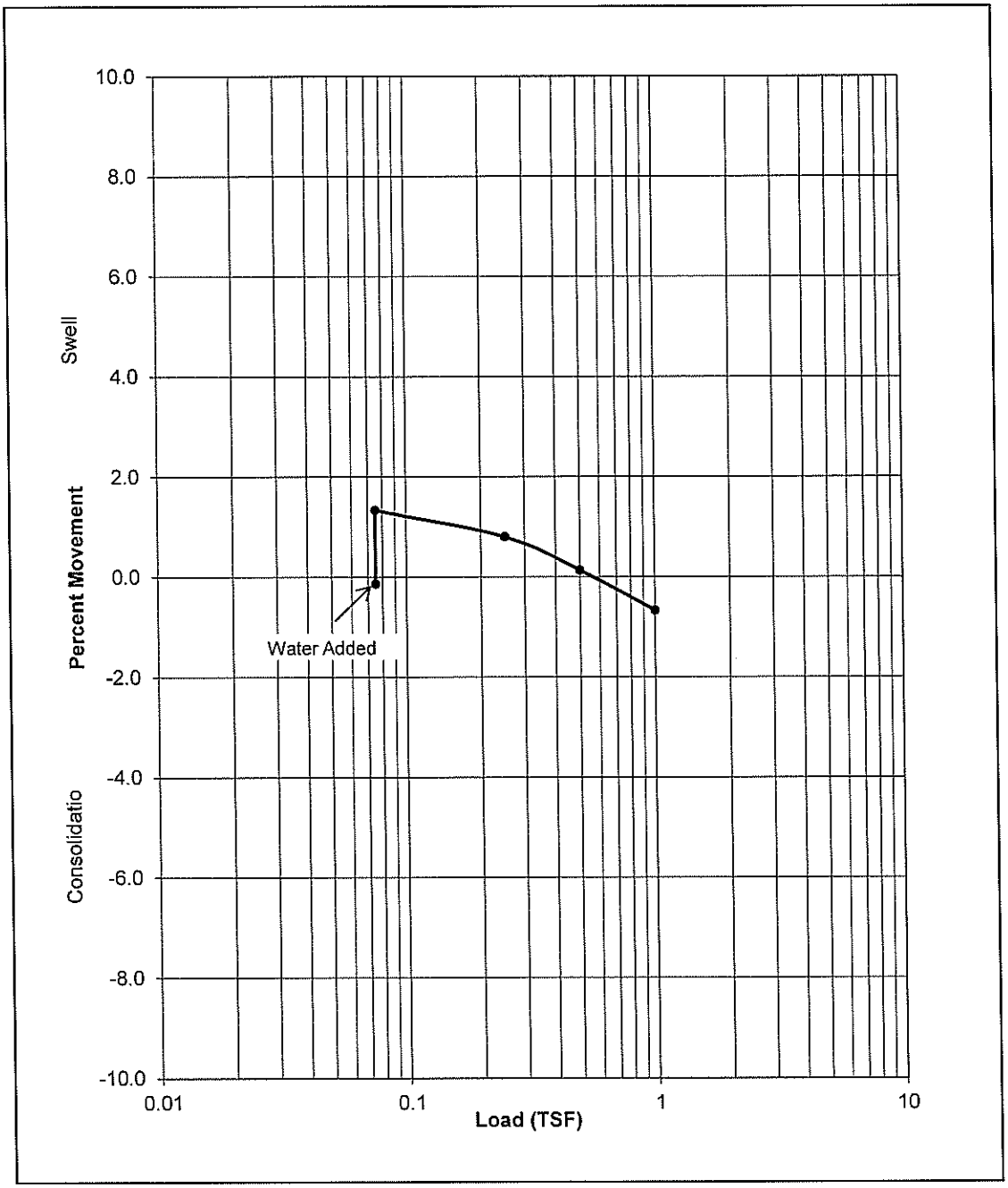
Material Description:	Fill Material: Brown CLAYEY SAND with GRAVEL (SC)		
Sample Location:	Boring 14A, Sample 1, Depth 2'		
Liquid Limit: --	Plasticity Index: --	% Passing #200: --	
Beginning Moisture: 12.9%	Dry Density: 120 pcf	Ending Moisture: 13.3%	
Swell Pressure: < 150 psf	% Swell @ 150:	None	



Project: Timbervine 2nd Filing - Lager, Lambic, and Bock Streets
Location: Fort Collins, Colorado
Project #: 1154085
Date: July 2016

SWELL / CONSOLIDATION TEST RESULTS

Material Description:	Brown SANDY LEAN CLAY (CL)		
Sample Location:	Boring 14B, Sample 1, Depth 2'		
Liquid Limit: --	Plasticity Index: --	% Passing #200: --	
Beginning Moisture: 11.8%	Dry Density: 112.6 pcf	Ending Moisture: 15.1%	
Swell Pressure: 1200 psf	% Swell @ 150: 1.5%		



Project: Timbervine 2nd Filing - Lager, Lambic, and Bock Streets
Location: Fort Collins, Colorado
Project #: 1154085
Date: July 2016

RESISTANCE R-VALUE & EXPANSION PRESSURE OF COMPACTED SOIL - ASTM D2844

PROJECT:	Timbervine 2nd Filing - Lager, Lambic, and Bock Streets	**PROJECT NO.**	1154085
LOCATION:	Fort Collins, Colorado	**DATE**	Jul-16
MATERIAL DESCRIPTION:	Sandy Lean Clay / Clayey Sand with Gravel (CL/SC)		
SAMPLE LOCATION:	Composite Subgrade Sample - Test Borings B-11 thru B-14 @ 1 - 4-feet		
LIQUID LIMIT:	NR	**PLASTICITY INDEX:** NR	**%PASSING #200:** NR

R-VALUE LABORATORY TEST RESULTS

TEST SPECIMEN NO.	1	2	3
COMPACTION PRESSURE (PSI)	200	250	275
DENSITY (PCF)	122.2	125.3	127.8
MOISTURE CONTENT (%)	11.5	10.9	10.2
EXPANSION PRESSURE (PSI)	0.00	0.00	0.00
HORIZONTAL PRESSURE @ 160 PSI	111	98	75
SAMPLE HEIGHT (INCHES)	2.57	2.51	2.50
EXUDATION PRESSURE (PSI)	238.7	447.7	636.6
UNCORRECTED R-VALUE	21.4	30.5	45.0
CORRECTED R-VALUE	22.0	30.5	45.0

R-VALUE @ 300 PSI EXUDATION PRESSURE =	**24**	**RESILIENT MODULUS, PSI =**	**5,629**