

GROUND ENGINEERING APPROVED

By: Per Date: 10-1-15

 City of Fort Collins
Engineering Department

October 1, 2015

Subsurface Exploration, Pavement
Thickness Design recommendations,
Buckingham Street Widening, Fort
Collins, Colorado

Job Number: 15-0655

Connell Resources

7785 Highland Meadows Parkway #100
Fort Collins, Co 80528

Attn: Mr. Roland Tremble

Buckingham Street is being widened on the north side from approximately 1st Street to 3rd Street in Fort Collins, Colorado. The site grading has recently been completed to include approximately 2 feet of common site fill soil. GROUND Engineering has sampled the materials within this alignment as required by Larimer County Urban Street Standards, to provide a final pavement design report for the subject roadway. A total of 3 test holes were advanced along the subject roadway alignment (at a frequency of at least 1 sample per 500 LF) to obtain drive samples and a composite sample of these materials. It should be noted that there were no utilities in the widened section.

The test holes were logged and sampled by a representative of GROUND Engineering. Locations of the test holes are shown on Figure 1, logs of the test holes on Figure 2, and the legend on Figure 3. The sampled subgrade materials were tested in the laboratory to provide final subgrade characteristics of the site soils in addition to final pavement subgrade and section recommendations. The subgrade conditions along the roadway widening generally consisted of sandy clay materials. Groundwater was not encountered to the depths explored.

The laboratory test results for the samples taken at each test hole are presented in the attached Table 1 and test results of the composite sample are presented below.

Design Traffic: Traffic information was obtained through the City of Fort Collins on October 1, 2015 and consists of an EDLA (Equivalent Daily Load Application) value of 55 for Buckingham Street. The EDLA value of 55 was converted to equivalent 18-kip single axle load (ESAL) value of 401,500 for a 20-year design life.

**Pavement Design Recommendations:
Buckingham Street, Fort Collins, Colorado**

Pavement Section Thickness Recommendations: The soil resilient modulus and the design ESAL values were used to determine the required design structural number for the proposed pavement. The required structural number was then used to develop recommended pavement sections. Pavement designs were based on the DARWin™ computer program that solves the 1993 AASHTO pavement design equation. Pavement design parameters and calculations are summarized in Appendix A. Structural coefficients of 0.44 and 0.11 were used for hot bituminous asphalt and high quality aggregate base course, respectively.

Pavement Section Table

Minimum required pavement section thickness recommendations.

Street I.D.	Road Classification	Assumed Traffic EDLA Values	Minimum ESAL Values	Composite Pavement Section: Asphalt / Agg. Base Course / Fly Ash Treated Subgrade (in. / in. / in.)
Buckingham Street Widening	Local Industrial/ Commercial	55	365,000	5.0 / 8.0 / 12.0*

***Note:** Only 10-inches of the 12-inches of fly ash treatment were accounted for in the pavement calculations at a SN credit of 0.05.

Subgrade Preparation: The majority of the site soils classify as a sandy clay material. These materials generally consist of A-6 soils based on the AASHTO classification system and are anticipated to provide relatively poor pavement support characteristics. The swell potential measured from samples of undisturbed site soils ranged from approximately 0.1 percent when tested under a surcharge pressure of 150psf.

The roadway widening had recently been filled and compacted with fills on the order of 2 feet. GROUND performed moisture density testing of fill materials. However, Connell Resources plans to Fly Ash Treat the upper 12 inches of subgrade with 12% Type C Fly Ash. Subgrade preparation should extend the full width of the pavement from back-of-curb to back-of-curb. Fly-ash treatment shall be completed in accordance with the applicable municipal specification.

Immediately prior to paving, the subgrade should be proof rolled with a heavily loaded, pneumatic tired vehicle. Areas that show excessive deflection during proof rolling should be excavated and replaced and/or stabilized. Areas allowed to pond prior to paving will require significant re-working prior to proof-rolling. All subgrade preparation must

Pavement Design Recommendations:
Buckingham Street, Fort Collins, Colorado

ultimately comply with roadway inspection, testing, and construction procedures outlined by Larimer County

Additional Observations:

The collection and diversion of surface drainage away from paved areas is extremely important to satisfactory performance of the pavements. The subsurface and surface drainage systems should be carefully designed to ensure removal of the water from paved areas and subgrade soils. Allowing surface waters to pond on pavements will cause premature pavement deterioration. Where topography, site constraints or other factors limit or preclude adequate surface drainage, pavements should be provided with edge drains to reduce loss of subgrade support. The long-term performance of the pavement also can be improved greatly by proper backfilling and compaction behind curbs, gutters, and sidewalks so that ponding is not permitted and water infiltration is reduced.

GROUND's experience indicates that longitudinal cracking is common in asphalt-pavements generally parallel to the interface between the asphalt and concrete structures such as curbs, gutters or drain pans. Distress of this type is likely to occur even where the subgrade has been prepared properly and the asphalt has been compacted properly.

GROUND recommends that an effective program of regular maintenance be developed and implemented to seal cracks, repair distressed areas, and perform thin overlays throughout the life of the pavements.

If you have any questions, please contact this office.

Sincerely,

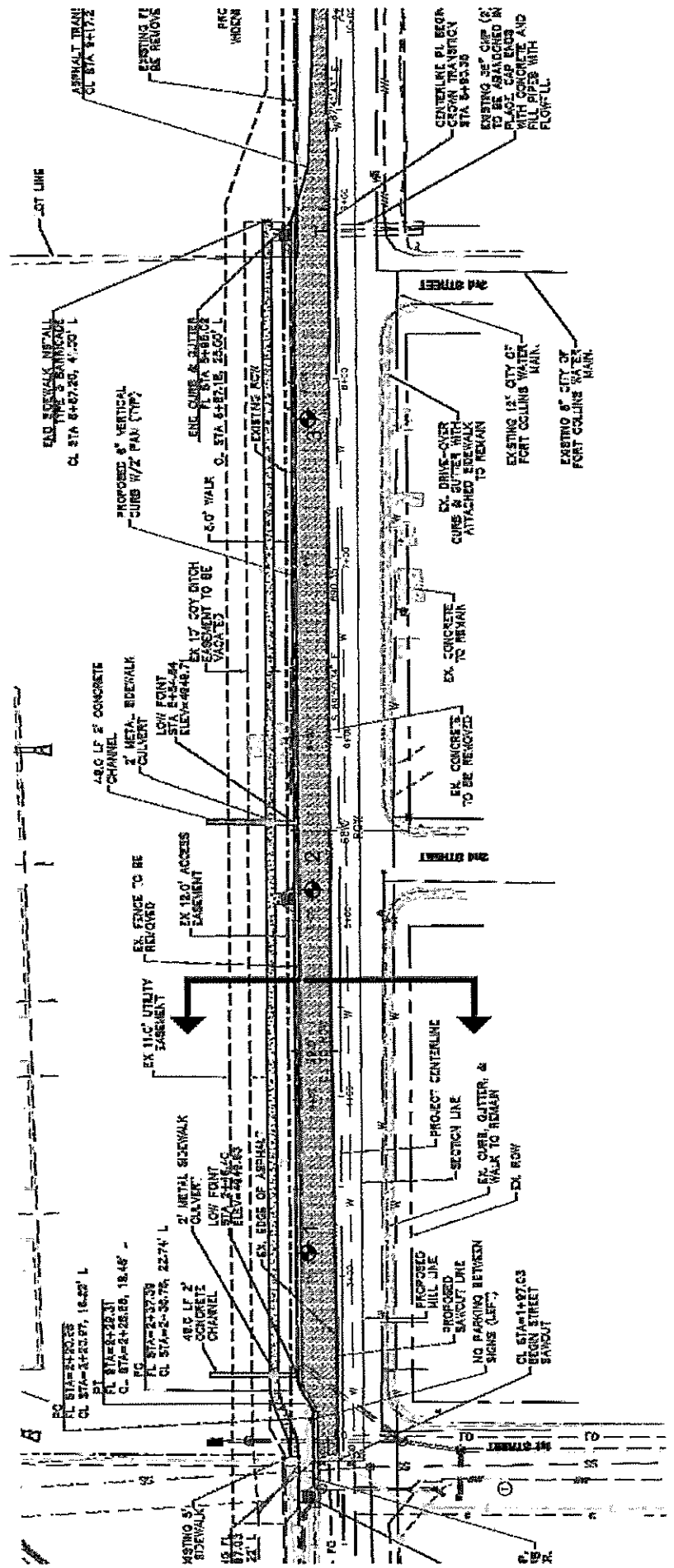
GROUND Engineering Consultants, Inc.

**Joseph
Zorack, P.E.**

Joseph Zorack, P.E.

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Date: 2015.10.01 12:39:32 -06'00'





BUCKINGHAM STREET PLAN

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LOCATION OF TEST HOLES

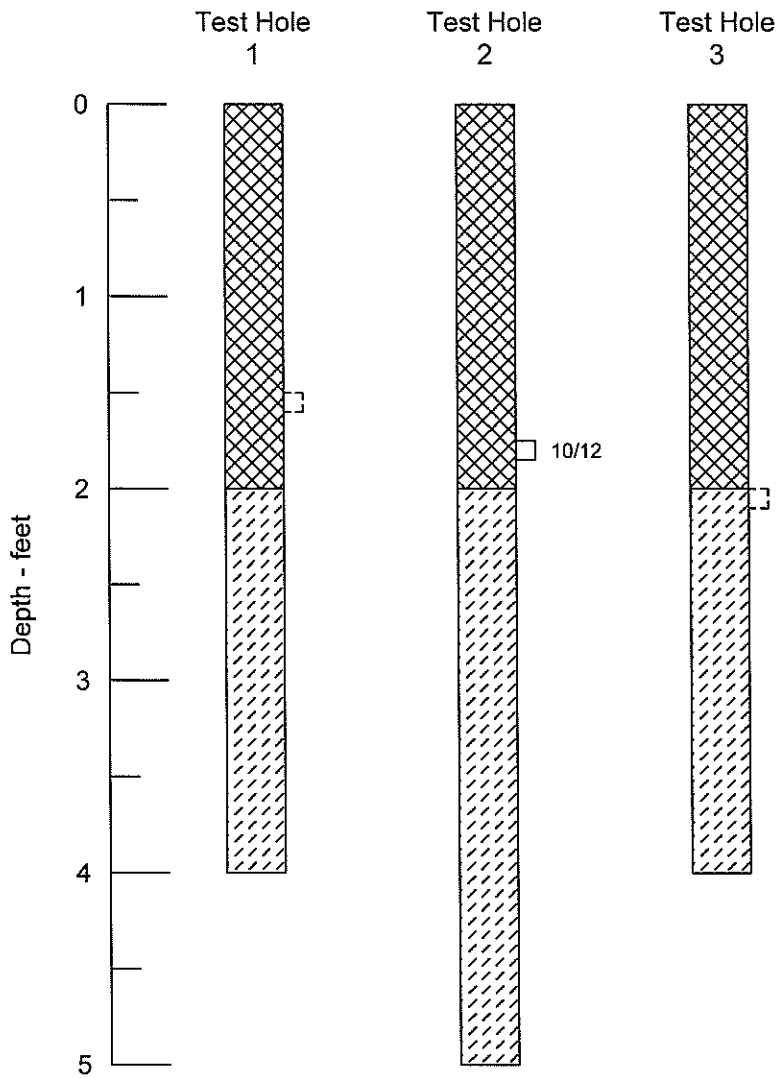
JOB NO.: 15-0655 FIGURE: 1

CADFILE NAME: 0655SITE.DWG



(Not to Scale)

1 ↗ Indicates test hole number and approximate location.



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LOGS OF TEST HOLES	
JOB NO.: 15-0655	FIGURE: 2
CADFILE NAME: 0655log.DWG	

LEGEND:



Fill: Sandy Clay, fine to coarse grained, low to medium plastic, relatively compact, moist, brown



Clay: Sandy, fine to coarse grained, low to medium plastic, stiff, slightly moist, tan to dark brown.



Small disturbed sample



Drive sample, 2-inch I.D. California liner sample

NOTES:

- 1) Test holes were drilled on 09/29/15 with 4-inch diameter continuous flight augers.
- 2) Locations of the test holes were measured approximately by pacing from features shown on the site plan provided.
- 3) Elevations of the test holes were not measured and the logs of the test holes are drawn to depth.
- 4) The test hole locations and elevations should be considered accurate only to the degree implied by the method used.
- 5) The lines between materials shown on the test hole logs represent the approximate boundaries between material types and the transitions may be gradual.
- 6) Groundwater was not encountered during drilling. Ground water levels can fluctuate seasonally and in response to landscape irrigation.
- 7) The material descriptions on this legend are for general classification purposes only. See the full text of this report for descriptions of the site materials and related information.

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LEGEND AND NOTES

JOB NO.: 15-0655

FIGURE: 3

CADFILE NAME: 0655LEG.DWG

Appendix A:

Pavement Section Calculations

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product
Network Administrator

Flexible Structural Design Module

New Belgium Brewery,
Buckingham Street Improvements
From entrance east past 3rd Street

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	401,500
Initial Serviceability	4.5
Terminal Serviceability	2
Reliability Level	75 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	3,337 psi
Stage Construction	1
Calculated Design Structural Number	3.41 in

Specified Layer Design

<u>Layer</u>	<u>Material Description</u>	Struct Coef. <u>(Ai)</u>	Drain Coef. <u>(Mi)</u>	Thickness <u>(Di)(in)</u>	Width <u>(ft)</u>	Calculated <u>SN (in)</u>
1	Asphalt	0.44	1	5	-	2.20
2	Base	0.11	1	8	-	0.88
3	Fly Ash	0.05	1	10	-	0.50
Total	-	-	-	23.00	-	3.58

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TABLE 1
SUMMARY OF LABORATORY TEST RESULTS - Buckingham Street

Sample Location Test Hole No.	Depth (feet)	Natural Moisture Content (%)	Natural Dry Density (pcf)	Percent Passing No. 200 Sieve	Atterberg Limits		Percent Swell (Surcharge Pressure of 150 psf)	Hveem R-value	AASHTO Classification (GI)	Soil or Bedrock Type
					Liquid Limit	Plasticity Index				
P-1	2	13.9	-	55	24	15	-	-	A-6	Fill: Sandy Clay
P-2	3	14.8	109.8	63	31	16	0.1	-	A-6	Fill: Sandy Clay
P-3	2	13.7	-	52	28	13	-	-	A-6	Fill: Sandy Clay
Composite	0-5'	-	-	53	29	16	-	8	A-6	Fill: Sandy Clay

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