

April 6, 2021

COLA, LLC
555 Middle Creek Parkway, Suite 200
Colorado Springs, Colorado 80921

Attn: Stephen Schoonover

Re: Pavement Recommendations – Addendum
Trails at Aspen Ridge, Filing No.1
Bradley Road Acceleration Deceleration Lane
El Paso County, Colorado

Reference: Pavement Recommendations, by Entech Engineering, Inc., dated March 10, 2020,
Revised July 16, 2020, Entech Job No.191931

Dear Mr. Schoonover:

As requested, personnel of Entech Engineering, Inc. have reviewed our above-referenced report and have provided a flexible pavement design section for the proposed Bradley Road acceleration/deceleration lane (right turn lane) for the roadway referenced above. This design is based on the soil parameters used in the above referenced report.

A pavement section was calculated for flexible asphalt pavement. Design parameters from the pavement analysis were taken from the previous pavement report. The El Paso County "Pavement Design Criteria Manual" was also referenced for other requirements. In the ESAL Calculation Memorandum letter by LSC Transportation Consultants, Inc., dated February 9, 2021, LSC# 184362, an 18K ESAL value of 855,000 was recommended for the accel/decel lanes.

An asphalt pavement section of 6 inches of asphalt on 15 inches of aggregate base course is recommended for the site. An alternative would be 6 inches of asphalt over 14 inches of cement-treated subgrade. The subgrade should be stabilized with 4 percent cement mixed into the subgrade to a depth of 14 inches. High sulfates must be mitigated if the CTS option is chosen. Design calculations are shown in Figures 1 through 3.

Other recommendations in the pavement analysis report remain valid. The roadway construction shall meet the El Paso County roadway pavement specifications.

We trust that this has provided you with the information you required. If you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.



Daniel P. Stegman

DPS/bs
Encl.

Entech Job No. 191931
2MSW/paveltr/2020/191931 pr – add



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APPROVED
Engineering Department

04/28/2021 2:31:29 PM
dsdnijkamp

EPC Planning & Community
Development Department

Reviewed by:



Joseph C. Goode, P.E.
President



EPC file number SF192

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

COLA, LLC - BRADLEY ROAD RIGHT TURN (OUT) ACCEL LANE
TRAILS AT ASPEN RIDGE, FILING 1 - PRINCIPAL ARTERIAL - 4-LANE
SOIL TYPE 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	855,000
Hveem Stabilometer (R Value) Results:	R =	6
Standard Deviation	S_o =	0.45
Loss in Serviceability	$\Delta\psi$ =	2.5
Reliability	Reliability =	90
Reliability (z-statistic)	Z_R =	-1.28
Soil Resilient Modulus	M_R =	3126

Weighted Structural Number (WSN): ➔ WSN = 4.23

DESIGN TABLES AND EQUATIONS

$$S_1 = [(R - 5) / 11.29] + 3$$

$$M_R = 10^{[(S_1 + 18.72) / 6.24]}$$

$$k = M_R / 19.4$$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

Reliability (%)	Z_R (z-statistic)
80	-0.84
85	-1.04
90	-1.28
93	-1.48
94	-1.56
95	-1.65
96	-1.75
97	-1.88
98	-2.05
99	-2.33
99.9	-3.09
99.99	-3.75

Reliability (%)	Z_R (z-statistic)
80	-0.84
85	-1.04
90	-1.28
93	-1.48
94	-1.56
95	-1.65
96	-1.75
97	-1.88
98	-2.05
99	-2.33
99.9	-3.09
99.99	-3.75

$$\log_{10} W_{18} = Z_R \cdot S_o + 9.36 \cdot \log_{10} (SN+1) - 0.20 + \frac{\log_{10} \left[\frac{\Delta \text{PSI}}{4.2 - 1.5} \right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \cdot \log_{10} M_R - 8.07$$

Left	Right	Difference
5.93	5.93	0.0

Job No. 191931

Fig. No. C-1

DESIGN CALCULATIONS

DESIGN DATA COLA, LLC - BRADLEY ROAD RIGHT TURN (OUT) ACCEL LANE
TRAILS AT ASPEN RIDGE, FILING 1 - PRINCIPAL ARTERIAL - 4-LANE
SOIL TYPE 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 855,000
Hveem Stabilometer (R Value) Results:	R = 6
Weighted Structural Number (WSN):	WSN = 4.23

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

$C_1 = 0.44$ Strength Coefficient - Hot Bituminous Asphalt

$C_2 = 0.11$ Strength Coefficient - Aggregate Base Course

$D_1 =$ Depth of Asphalt (inches)

$D_2 =$ Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$$D_1 = (WSN)/C_1 = 9.6 \text{ inches of Full Depth Asphalt}$$

Use 10.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

$$\text{Asphalt Thickness (t)} = \boxed{6} \text{ inches}$$

$$D_2 = ((WSN) - (t)(C_1))/C_2 = 14.5 \text{ inches of Aggregate}$$

Base Course, use 15.0 inches

RECOMMENDED ALTERNATIVES

1. 6.0 inches of Asphalt + 15.0 inches of Aggregate Base Course, or
2. 10.0 inches of Full Depth Asphalt

Job No. 191931
Fig. No. C-2

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA: COLA, LLC - BRADLEY RD RIGHT TURN ACCEL (OUT) LANE
TRAILS AT ASPEN RIDGE, FILING 1 - PRINCIPAL ARTERIAL - 4-LANE
SOIL TYPE 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 855,000
Hveem Stabilometer (R Value) Results:	R = 6
Weighted Structural Number (WSN):	WSN = 4.23

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

$C_1 = 0.44$ Strength Coefficient - Hot Bituminous Asphalt
 $C_2 = 0.12$ Strength Coefficient - Cement Treated Subgrade.

$D_1 =$ Depth of Asphalt (inches)

$D_2 =$ Depth of Cement Treated Subgrade (inches)

FOR FULL DEPTH ASPHALT SECTION - (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1 = 9.6$ inches of Full Depth Asphalt
Use 10.0 inches Full Depth

FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 6 inches
 $D_2 = ((WSN) - (t)(C_1))/C_2 = 13.3$ inches
Use 15.0 inches of Cement Treated Subgrade.

RECOMMENDED ALTERNATIVES

1. 6.0 inches of Asphalt + 15.0 inches of Cement Treated Subgrade.
2. 10.0 inches of Full Depth Asphalt

Job No. 191931
Fig. No. C-3

March 10, 2020



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COLA, LLC
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Attn: Steven Schoonover

Re: Cement Stabilized Subgrade Results - Laboratory Testing
Trails at Aspen Ridge, Filing 1
El Paso County, Colorado

Ref: Pavement Recommendations Report by Entech Engineering, Inc., dated March 10,
2020, Entech Job No. 191931

Dear Mr. Schoonover:

As requested, personnel of Entech Engineering, Inc. have performed strength and Swell/Consolidation testing on two sets of soil/cement composite samples for the above reference project. Testing was performed on soil samples prepared with 2% and 4% Portland Cement Type 1/2, from Martin Marietta, near Pueblo, Colorado.

The 5-day average strength values of the 2% mix was 183 psi. The 5-day average strength values of the 4% mix was 204 psi. Swells remolded with 2% cement resulted in 2.2 and 2.8 percent volume changes, which exceed the maximum allowable swell for the site soils. Swells remolded with 4 percent cement resulted in volume changes of 1.4 and 1.3 percent, which are beneath the allowable swell of 2 percent. A 4% mix is recommended based on the laboratory test results. The testing results are attached.

Pending the results of the field density testing, microfracturing of the stabilized subgrade may be required. Soil strengths in excess of 200 psi require microfracturing.

We trust this has provided you with the information you required. if you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Daniel P. Stegman



Reviewed by:

Mark H. Hauschild, P.E.
Senior Engineer

DPS/ao

Encl.

Entech Job No. 191931
AAprojects/2019/191931/191931 cssr - lab

SUMMARY OF CTS TEST RESULTS
LAB TESTING

CLIENT COLA, LLC
 PROJECT TRAILS AT ASPEN RIDGE
 FIELD SAMPLE ID TB-1 @ 0-3'
 SOIL ADDITIVE TYPE I/II CEMENT
 AASHTO CLASS. A-7-6
 SOIL TYPE NO. #1

JOB NO 191931
 DATE 12/19/19
 BY BL

ADDITIVE %	DATE SAMPLED	WATER %	DENSITY (dry)	AGE (days)	STRENGTH (psi)
2	12/13/19	12.6	104.8	5	183
2	12/13/19	12.6	104.6	5	178
2	12/13/19	12.6	104.7	5	189
AVERAGE:					183
4	12/13/19	12.6	104.7	5	214
4	12/13/19	12.6	104.6	5	190
4	12/13/19	12.6	104.5	5	207
AVERAGE:					204

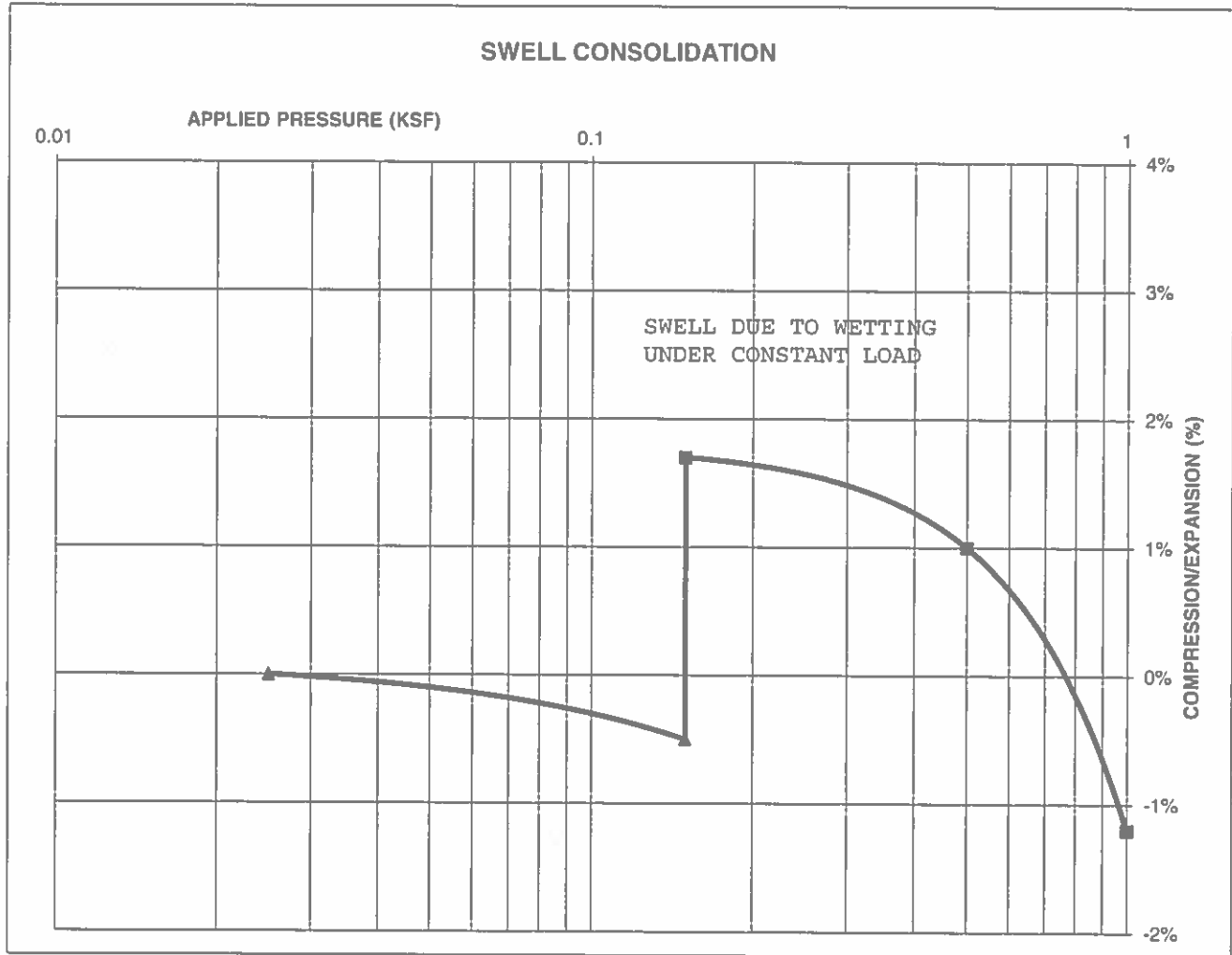
CURING METHOD

100° HUMIDIFIED OVEN

CONSOLIDATION TEST RESULTS

TEST BORING #	16	DEPTH(ft)	1-2
DESCRIPTION	CL	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			112
NATURAL MOISTURE CONTENT			12.9%
SWELL/CONSOLIDATION (%)			2.2%

JOB NO. 191931
 CLIENT COLA, LLC
 PROJECT TRAILS AT ASPEN RIDGE
 REMOLDED W/ +2% CEMENT



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**SWELL CONSOLIDATION
 TEST RESULTS**

DRAWN:

DATE:

CHECKED:

DATE

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2/9/20

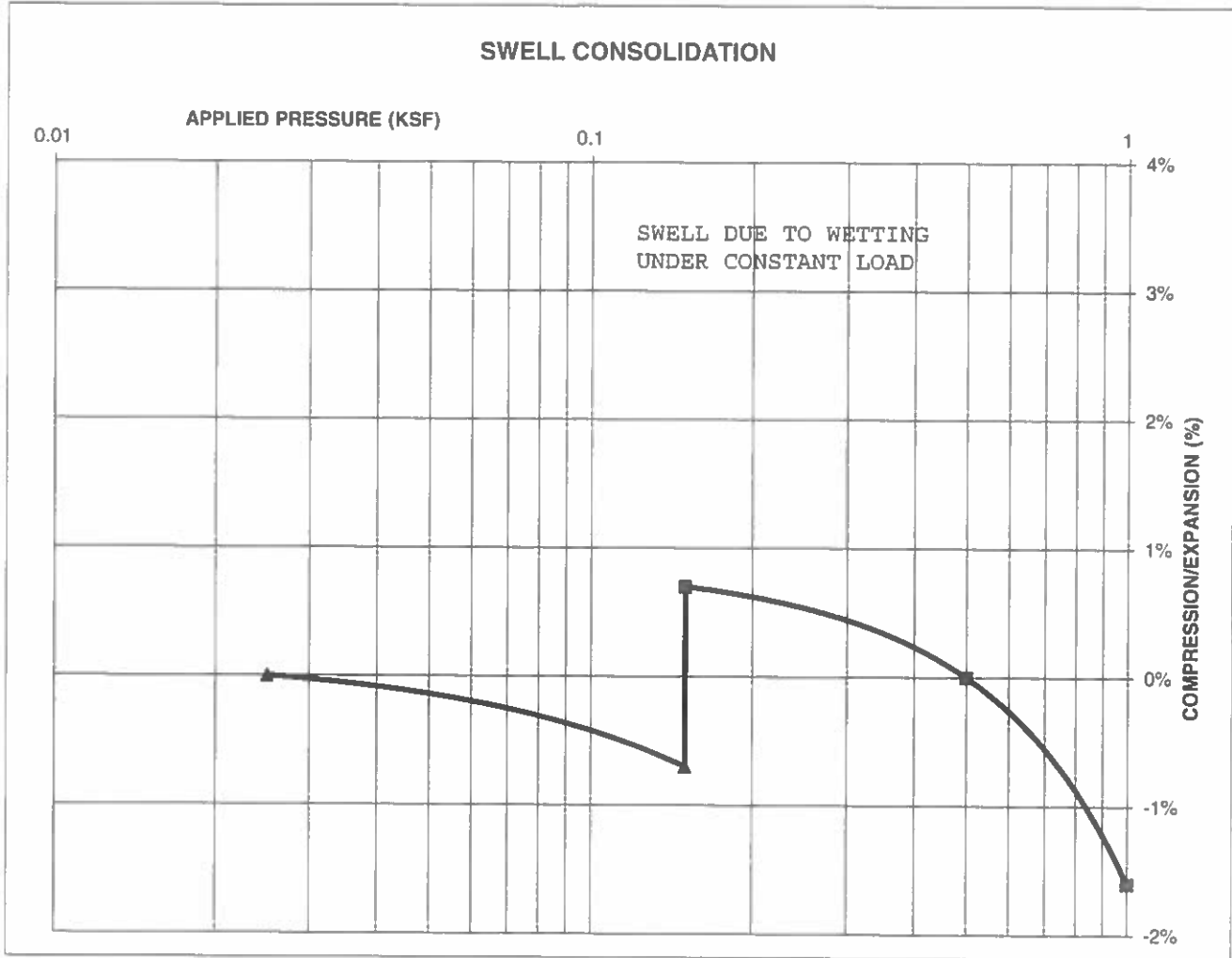
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 191931

FIG NO.:
 1

CONSOLIDATION TEST RESULTS

TEST BORING #	16	DEPTH(ft)	1-2
DESCRIPTION	CL	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			110
NATURAL MOISTURE CONTENT			18.3%
SWELL/CONSOLIDATION (%)			1.4%

JOB NO. 191931
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 REMOLDED W/ +4% CEMENT



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**SWELL CONSOLIDATION
TEST RESULTS**

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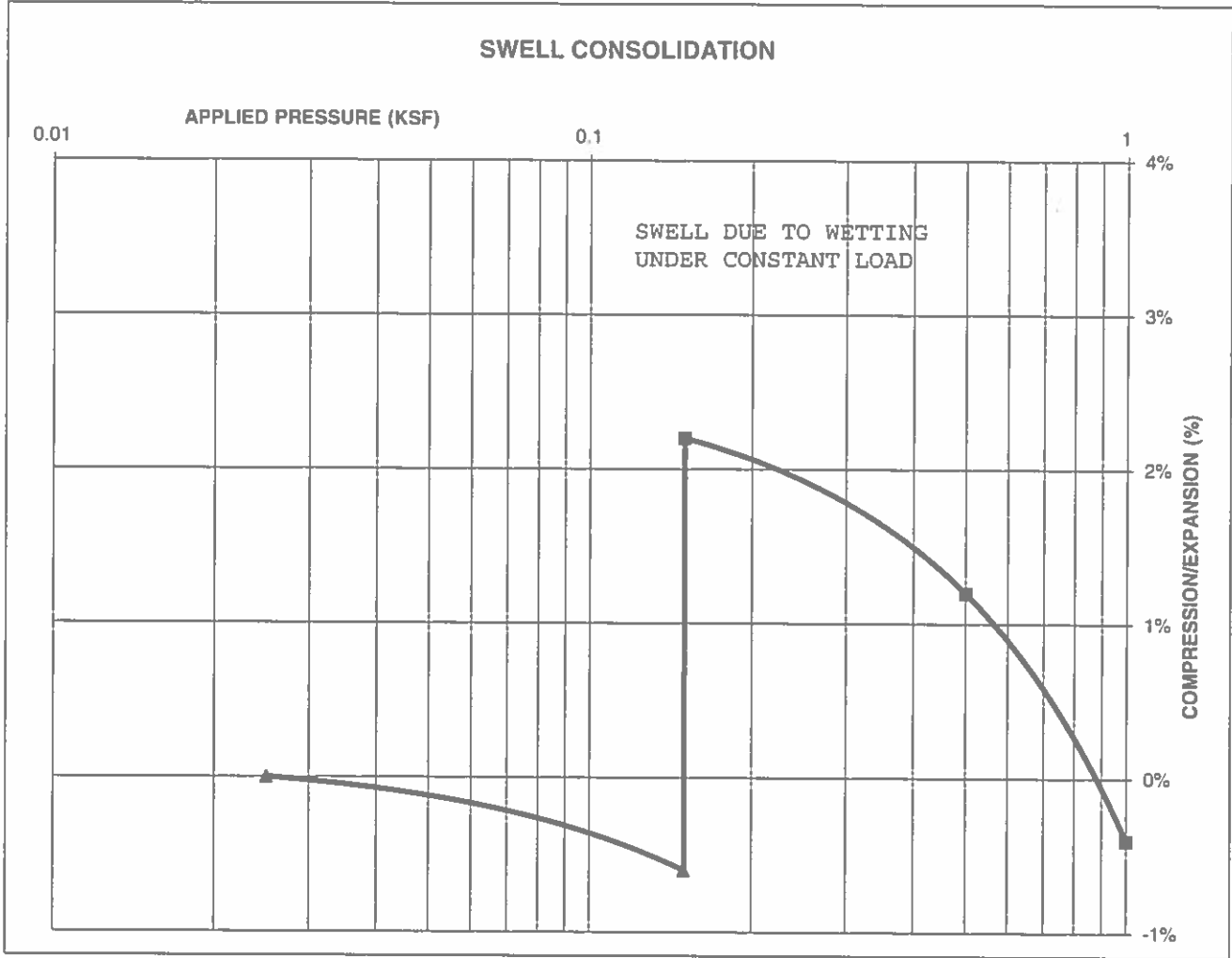
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191931

FIG NO:
2

CONSOLIDATION TEST RESULTS

TEST BORING #	21	DEPTH(ft)	1-2
DESCRIPTION	CL	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			117
NATURAL MOISTURE CONTENT (%)			12.2%
SWELL/CONSOLIDATION (%)			2.8%

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**SWELL CONSOLIDATION
 TEST RESULTS**

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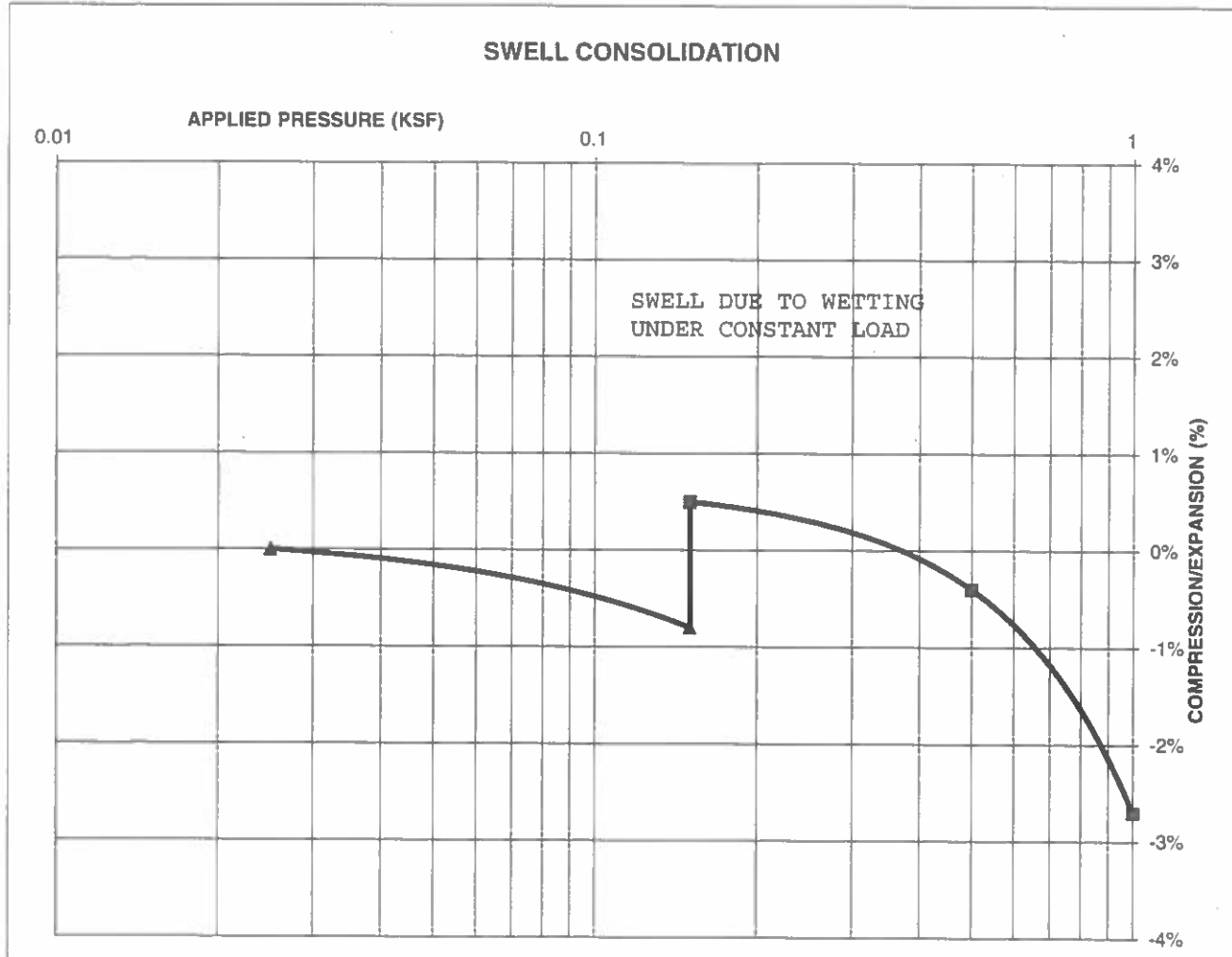
JOB NO. 191931

FIG NO. 3

CONSOLIDATION TEST RESULTS

TEST BORING #	21	DEPTH(ft)	1-2
DESCRIPTION	CL	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			109
NATURAL MOISTURE CONTENT			17.3%
SWELL/CONSOLIDATION (%)			1.3%

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**SWELL CONSOLIDATION
 TEST RESULTS**

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DATE:

JOB NO.
 191931

FIG NO.
 4