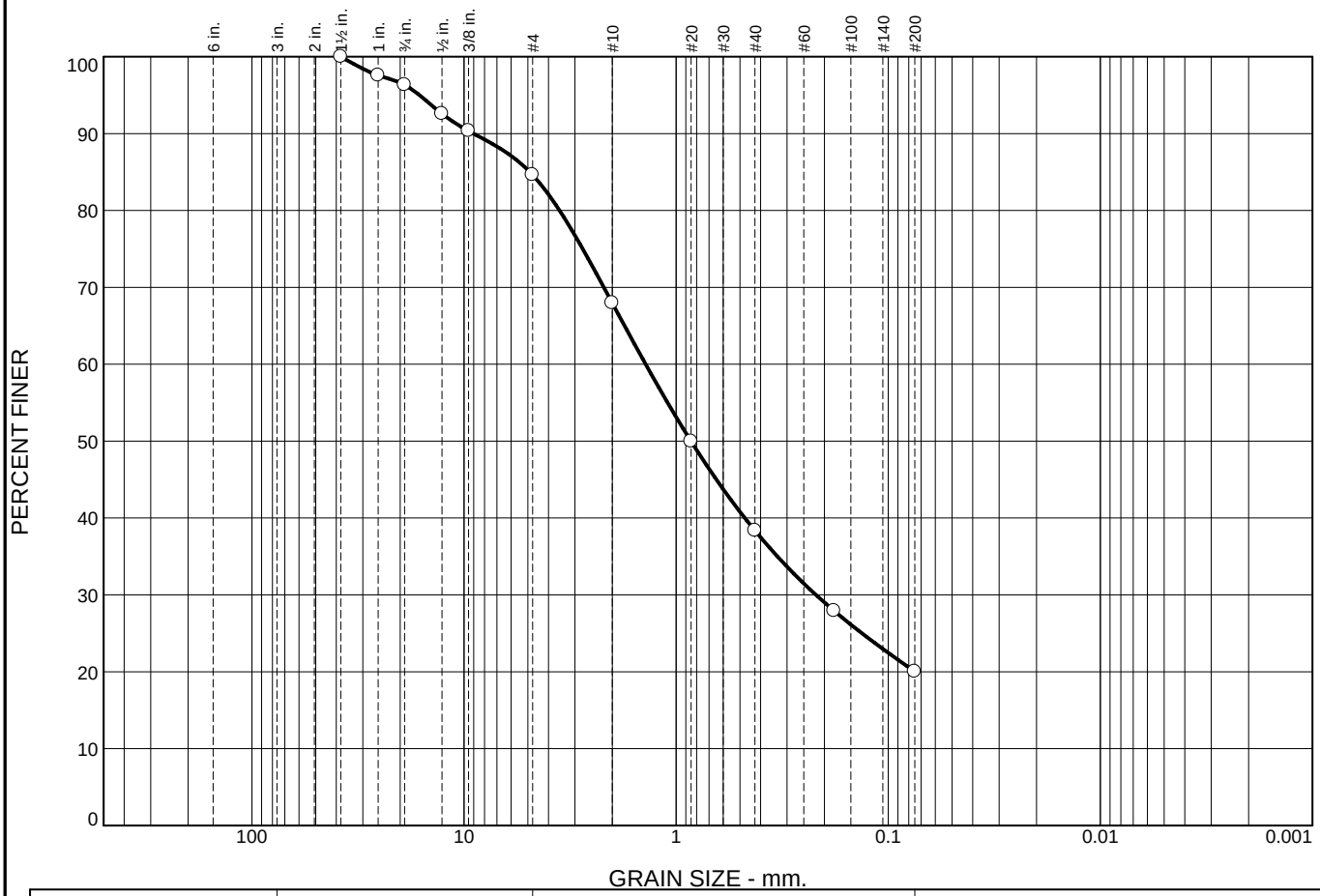
ADMINISTRATIVE RECORD

1228534 - R8 SDMS

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	3.7	11.7	16.6	29.6	18.4	20.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	31	23	4.8921	1.3915	0.8519	0.2192				

Material Description	USCS	AASHTO
○ Clayey SAND with Gravel	SC	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

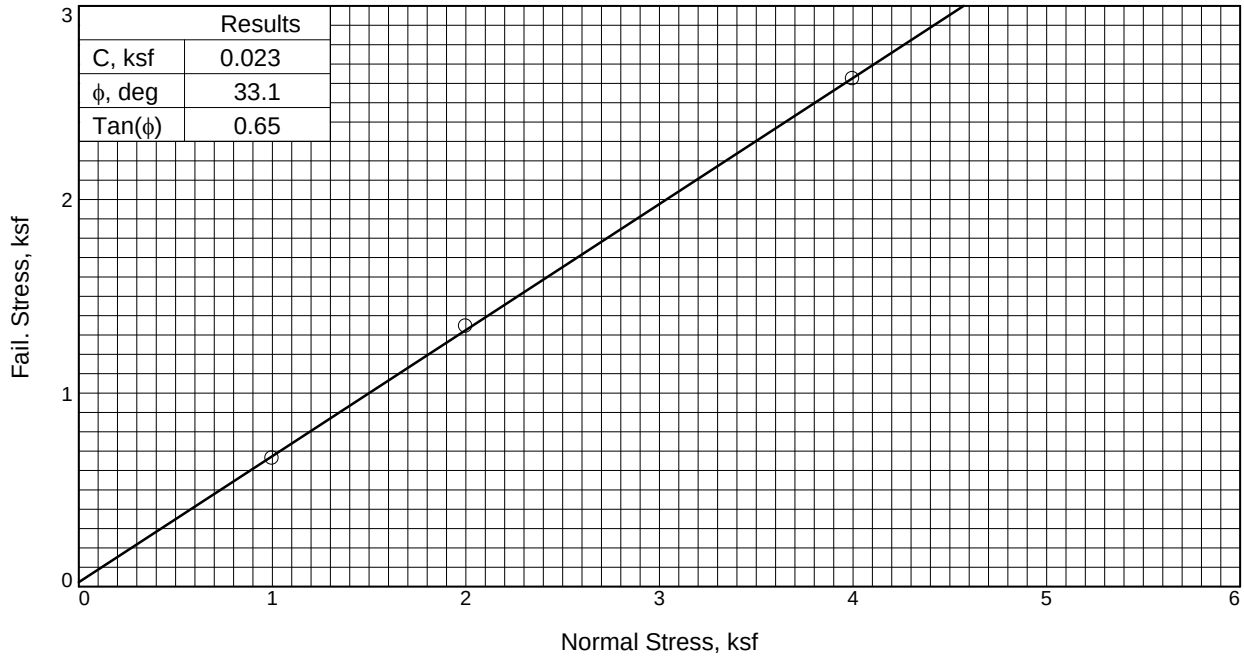
○ **Source of Sample:** SCHS-WR-E-013

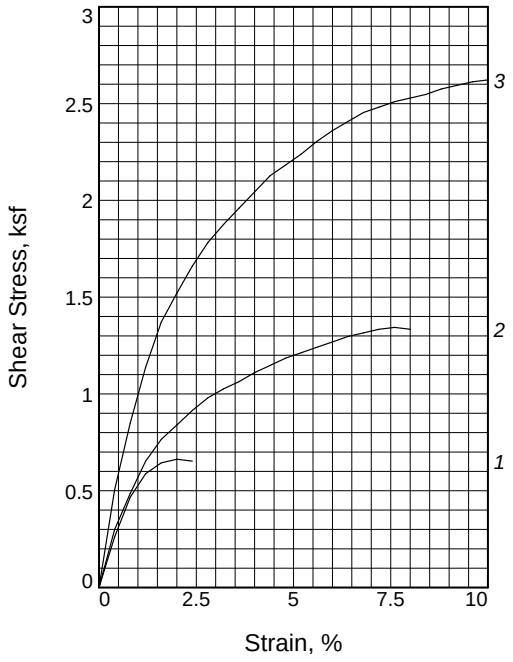
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	13.8	13.8	13.8
	Dry Density, pcf	109.0	109.0	109.0
	Saturation, %	68.2	68.2	68.2
	Void Ratio	0.5462	0.5462	0.5462
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	18.2	17.3	12.5
	Dry Density, pcf	109.0	108.6	109.6
	Saturation, %	90.2	84.5	62.8
	Void Ratio	0.5462	0.5521	0.5374
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.004	0.994
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.663	1.344	2.622
Strain, %		2.0	7.6	10.0
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.000	0.010	0.010

Sample Type: Remolded
Description: Clayey SAND with Gravel

LL= 31
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

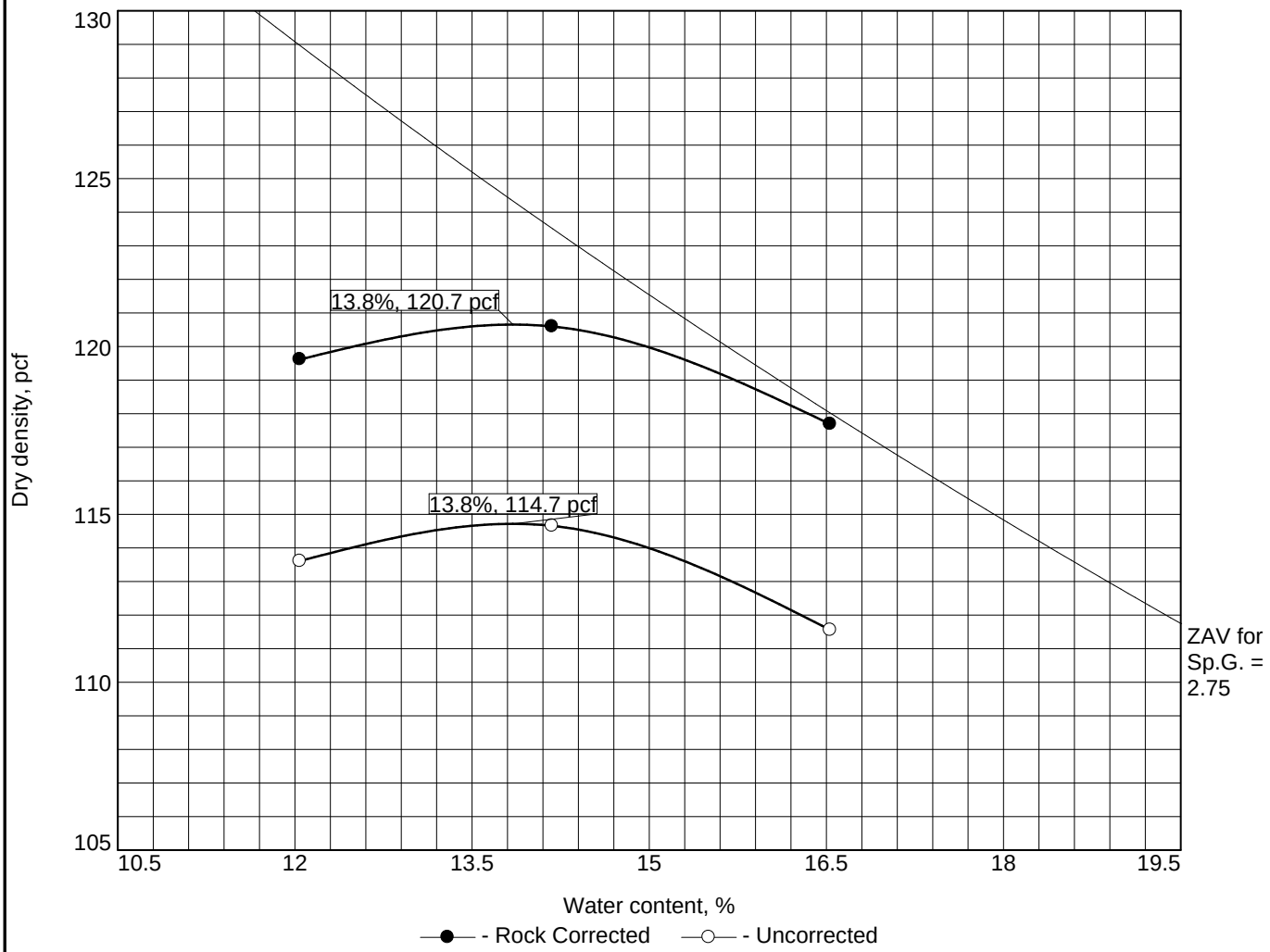
Project: Carpenter Snow Creek

Source of Sample: SCHS-WR-E-013

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	SC	A-2-4(0)		2.75	31		15.4	20.0

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 120.7 pcf	114.7 pcf	Clayey SAND with Gravel
Optimum moisture = 13.8 %	13.8 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** SCHS-WR-E-013

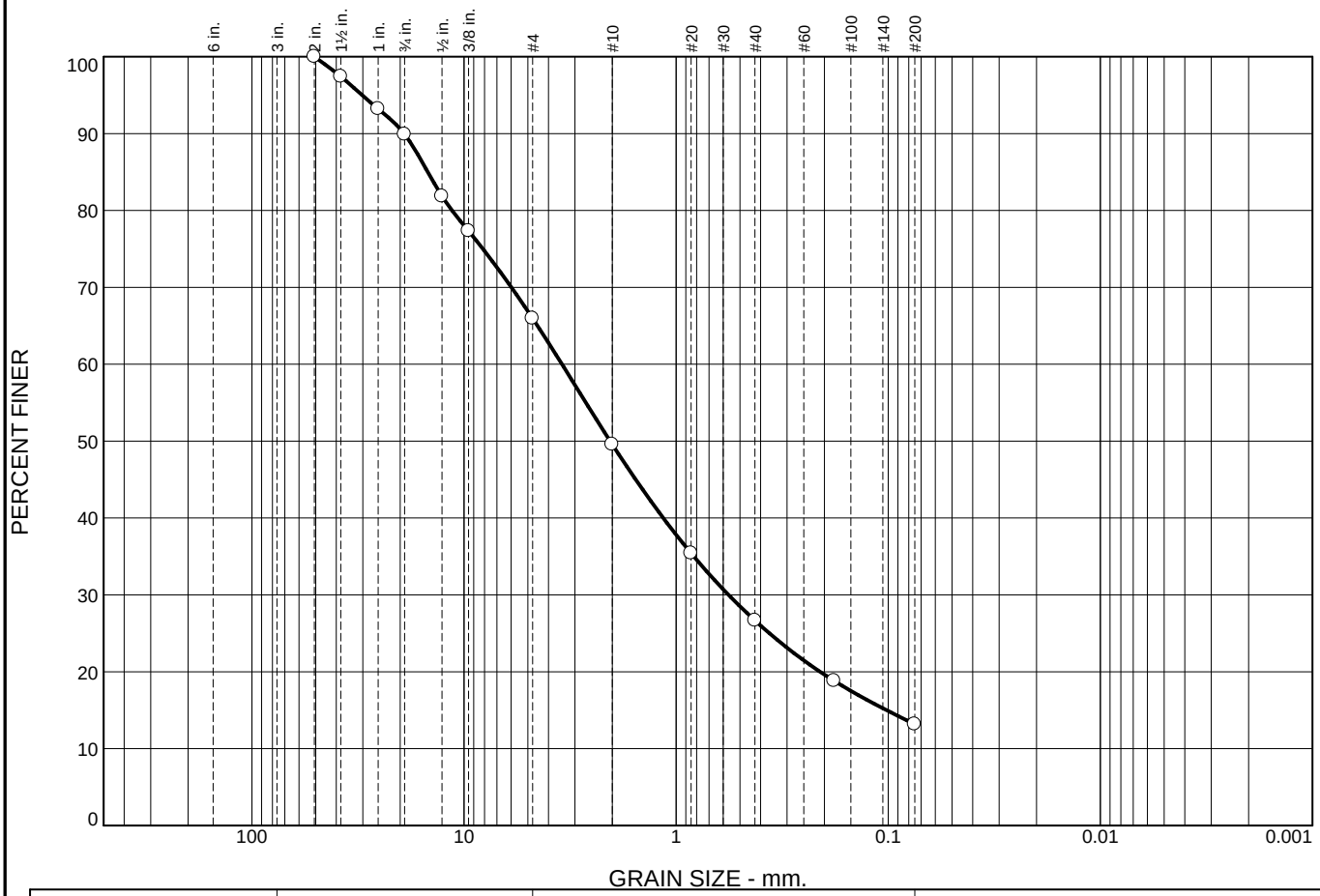
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	10.1	23.9	16.4	22.9	13.5	13.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	29	21	14.8210	3.4533	2.0469	0.5662	0.1017			

Material Description	USCS	AASHTO
○ Clayey SAND with Gravel	SC	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

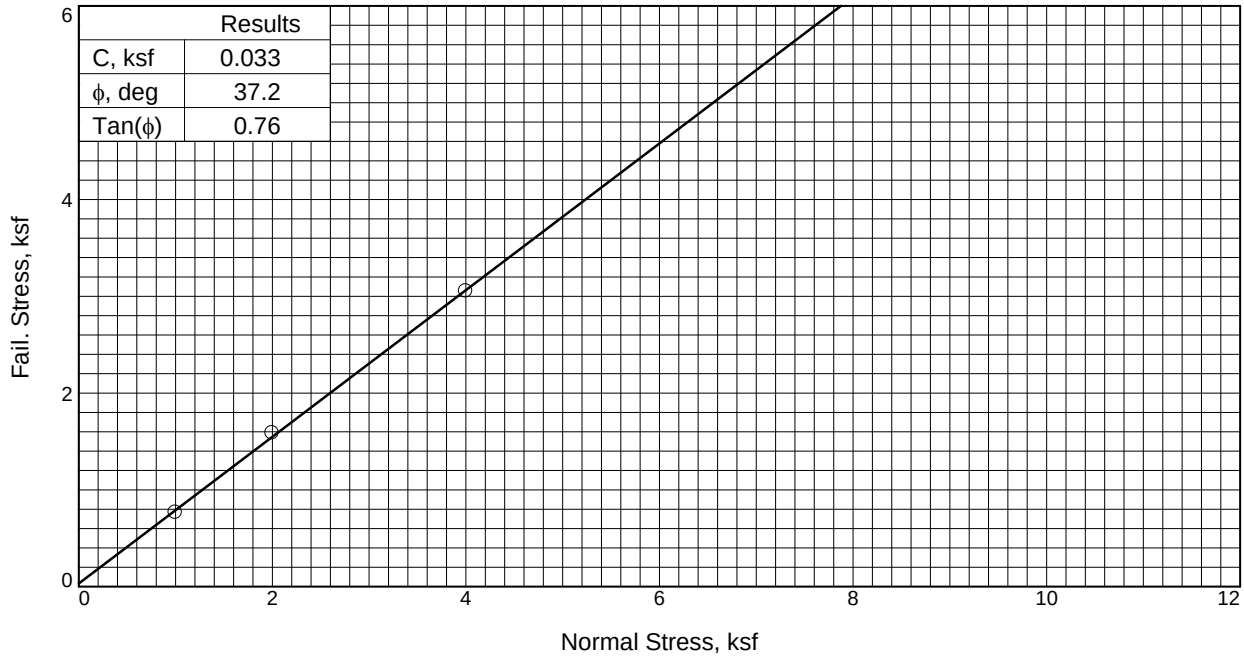
○ **Source of Sample:** SCHS-WR-E-014

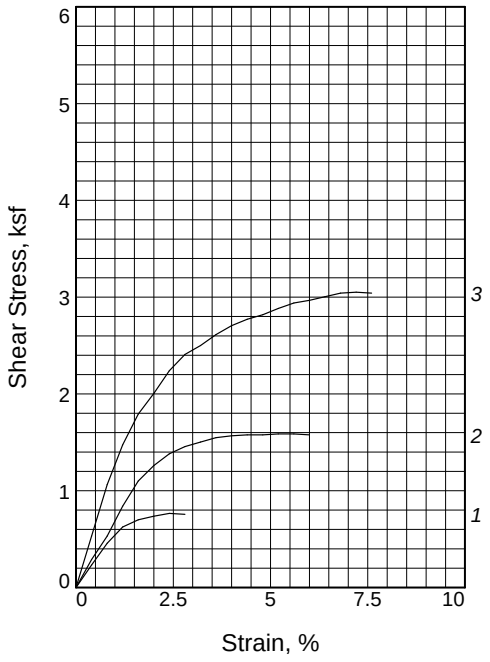
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	10.8	10.8	10.8
	Dry Density, pcf	117.3	117.3	117.3
	Saturation, %	66.7	66.7	66.7
	Void Ratio	0.4371	0.4371	0.4371
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	13.7	13.0	12.7
	Dry Density, pcf	117.5	117.6	117.8
	Saturation, %	85.3	80.9	79.5
	Void Ratio	0.4345	0.4335	0.4312
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.998	0.998	0.996
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.765	1.586	3.051
Strain, %		2.4	5.2	7.2
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type:

Description: Clayey SAND with Gravel

LL= 29

Specific Gravity= 2.70

Remarks:

Figure _____

Client: Tetra Tech EMI

Project: Carpenter Snow Creek

Source of Sample: SCHS-WR-E-014

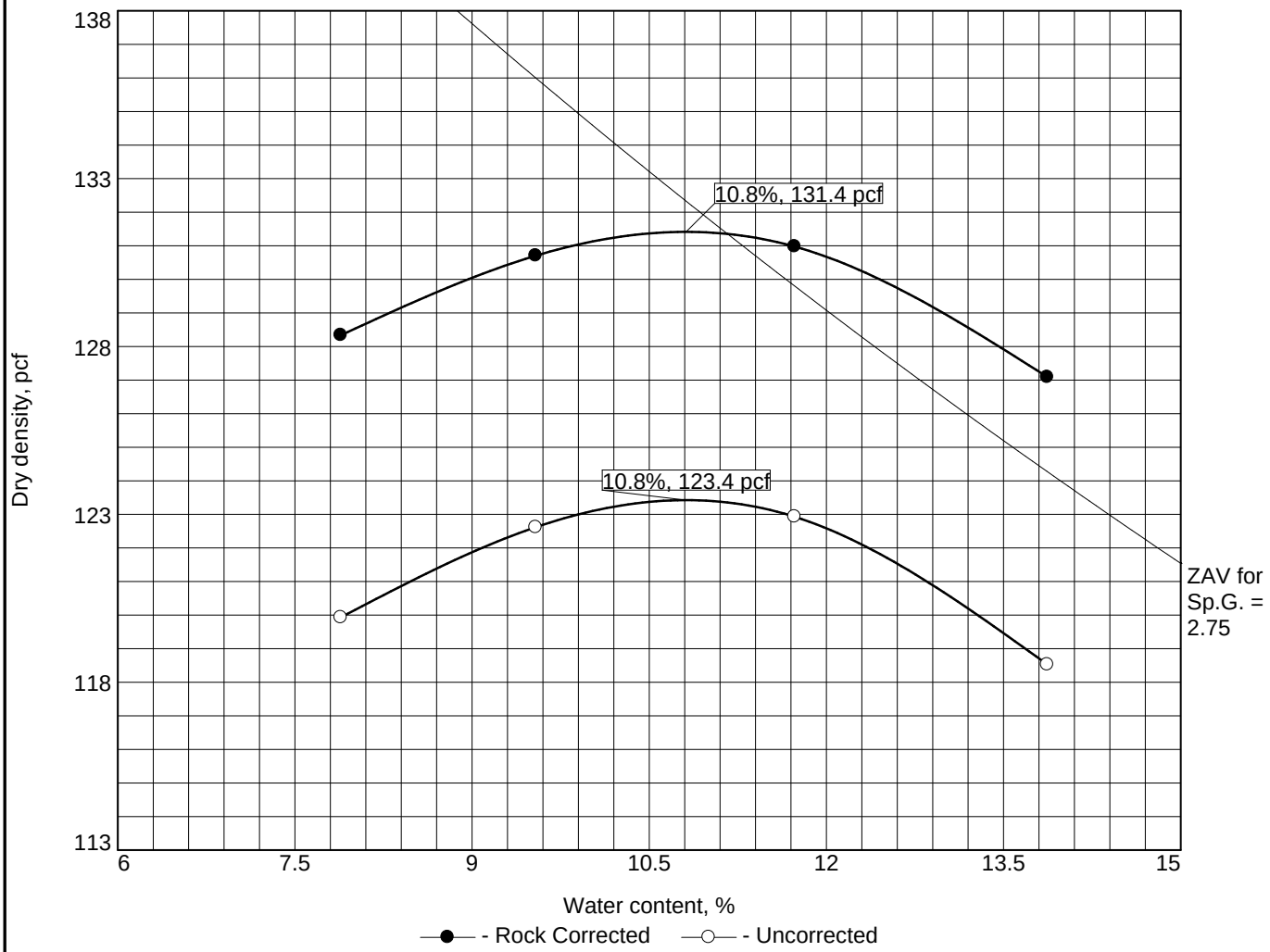
Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT

Tetra Tech

Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method B Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	SC	A-2-4(0)		2.75	29		22.7	13.2

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 131.4 pcf	123.4 pcf	Clayey SAND with Gravel
Optimum moisture = 10.8 %	10.8 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** SCHS-WR-E-014

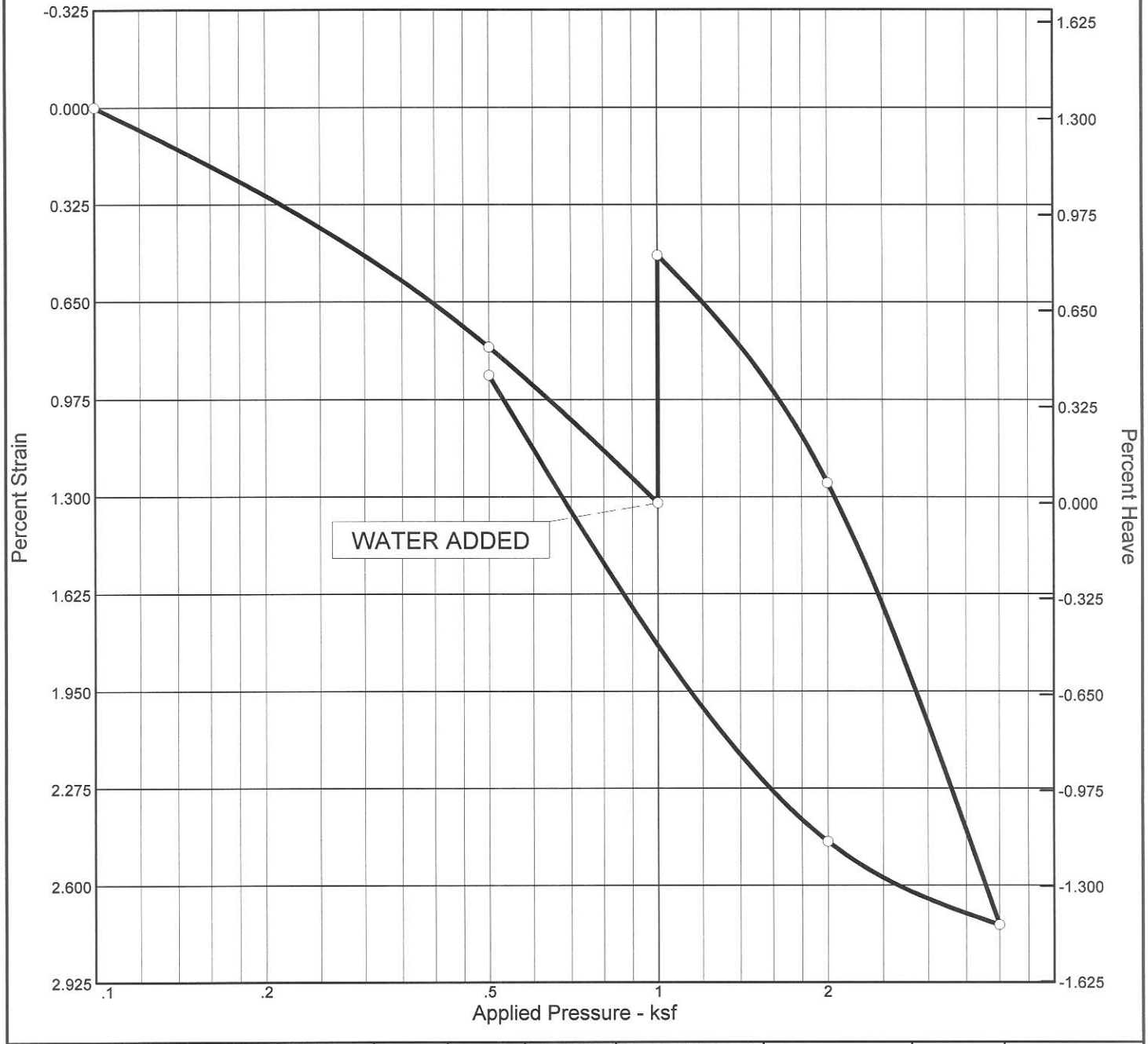
Remarks:

Tetra Tech

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
70.6 %	15.3 %	106.3	34	18	2.70		1.91	0.08	0.585

MATERIAL DESCRIPTION	USCS	AASHTO
Sandy Lean CLAY		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCUT-WT-E-001

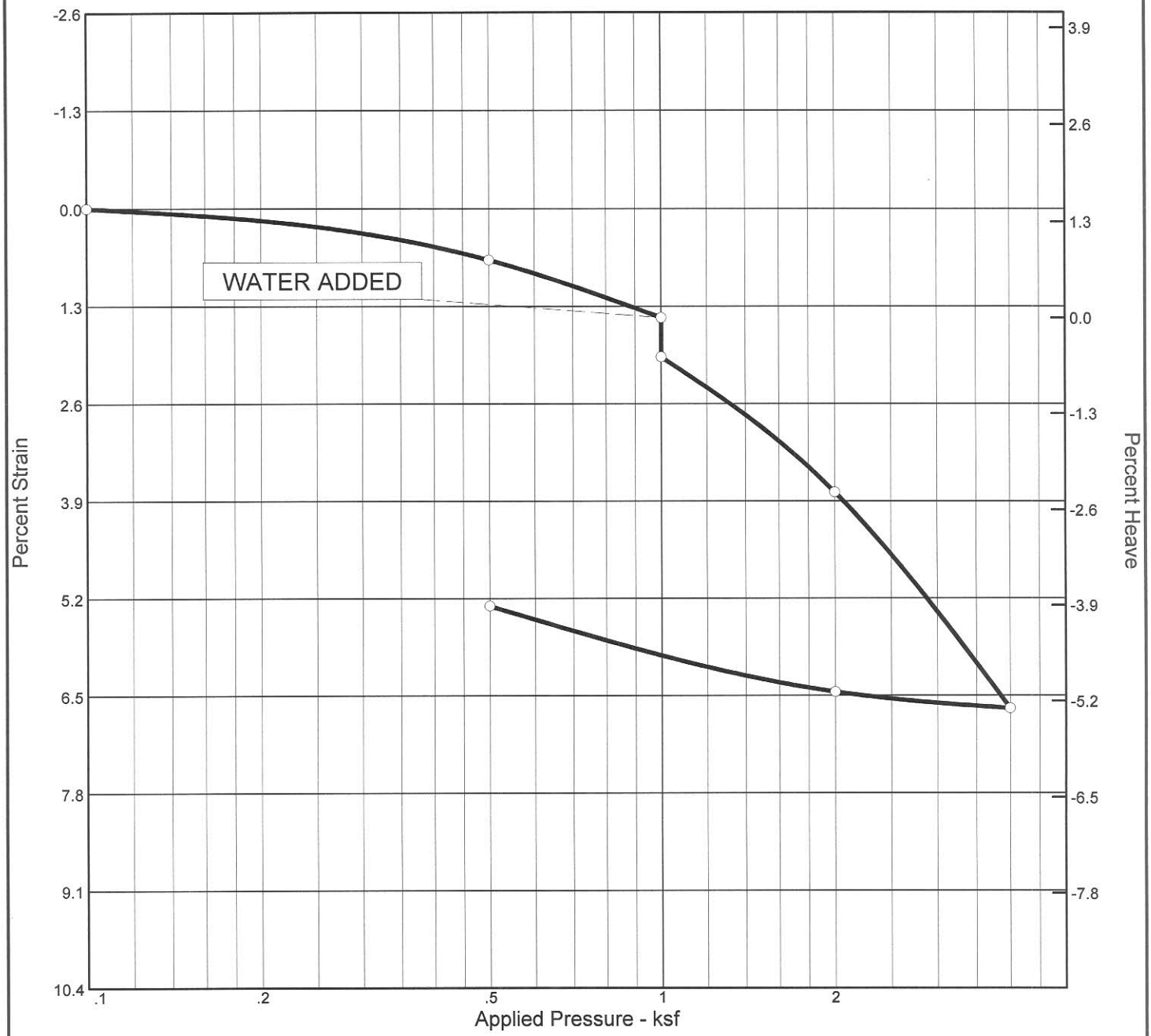
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
59.9 %	17.3 %	94.7	37	24	2.70		2.02	0.17	0.780

MATERIAL DESCRIPTION	USCS	AASHTO
Lean CLAY with Sand		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCSS-WT-E-004

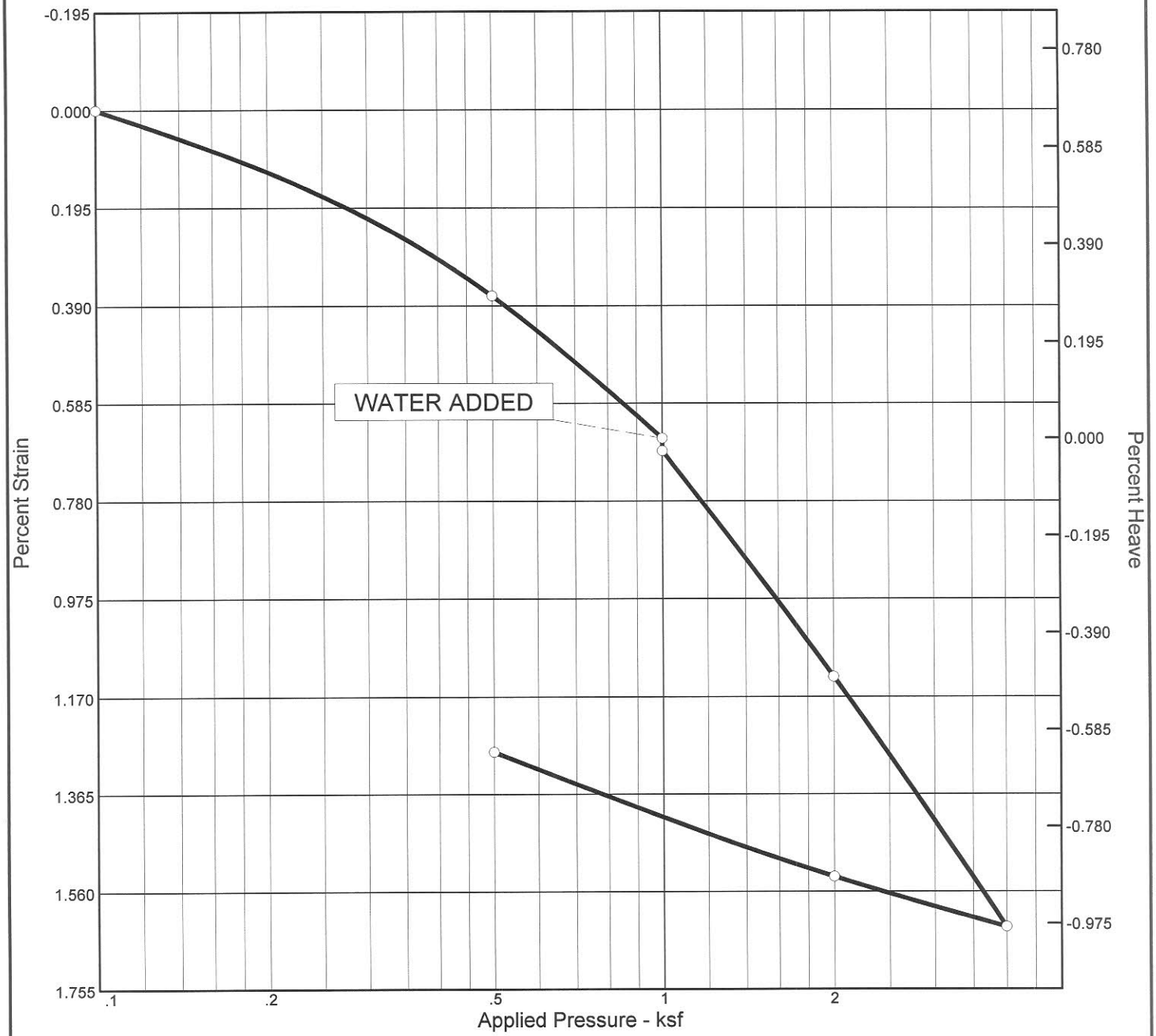
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
45.5 %	9.3 %	108.6	NV	NP	2.70		0.79	0.03	0.552

MATERIAL DESCRIPTION	USCS	AASHTO
Silty SAND with Gravel		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCSS-WT-E-005

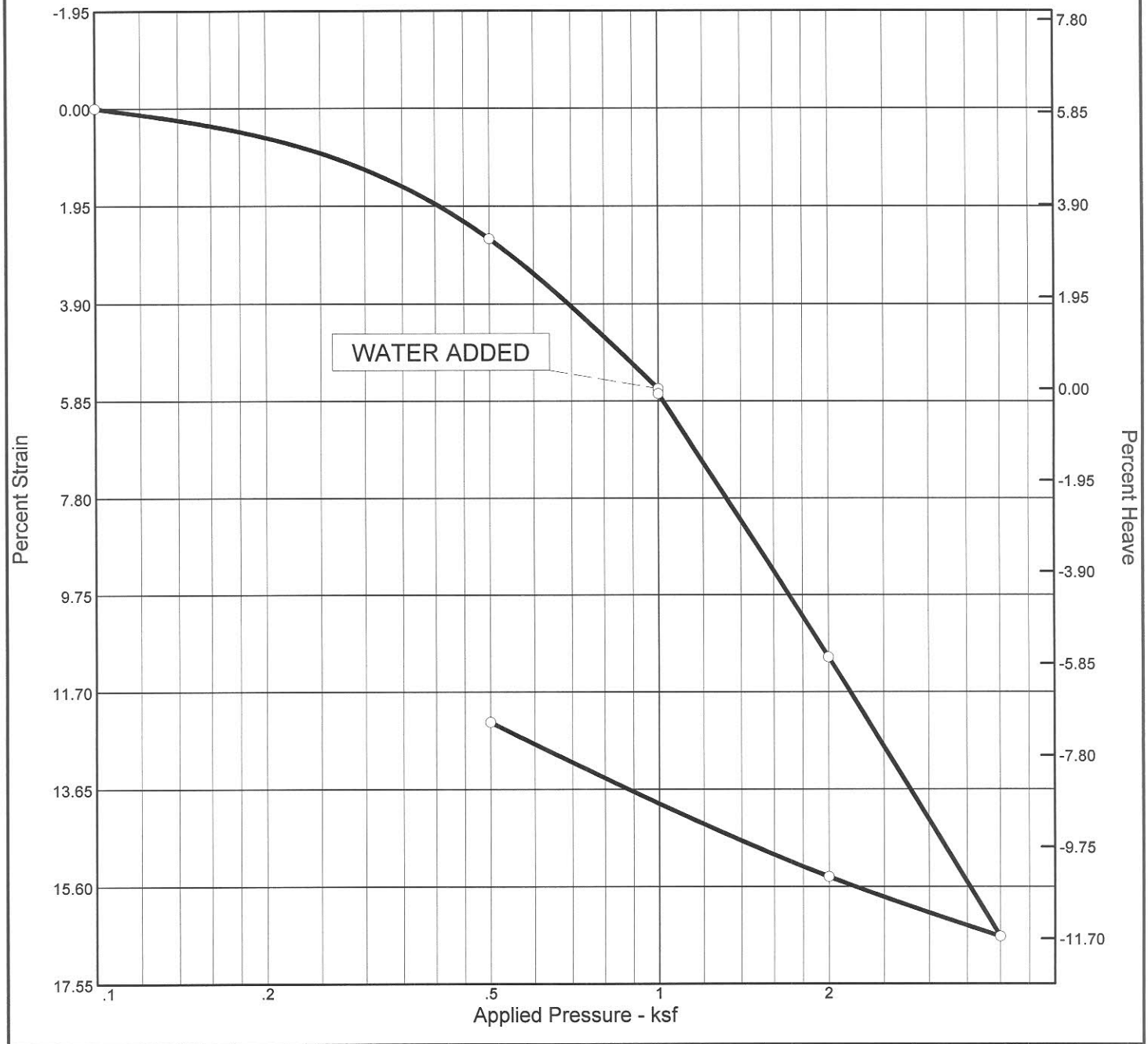
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
83.2 %	11.1 %	123.9	NV	NP	2.70		0.79	0.25	0.360

MATERIAL DESCRIPTION	USCS	AASHTO
Well-graded SAND with Gravel		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: NSHS-WR-E-004

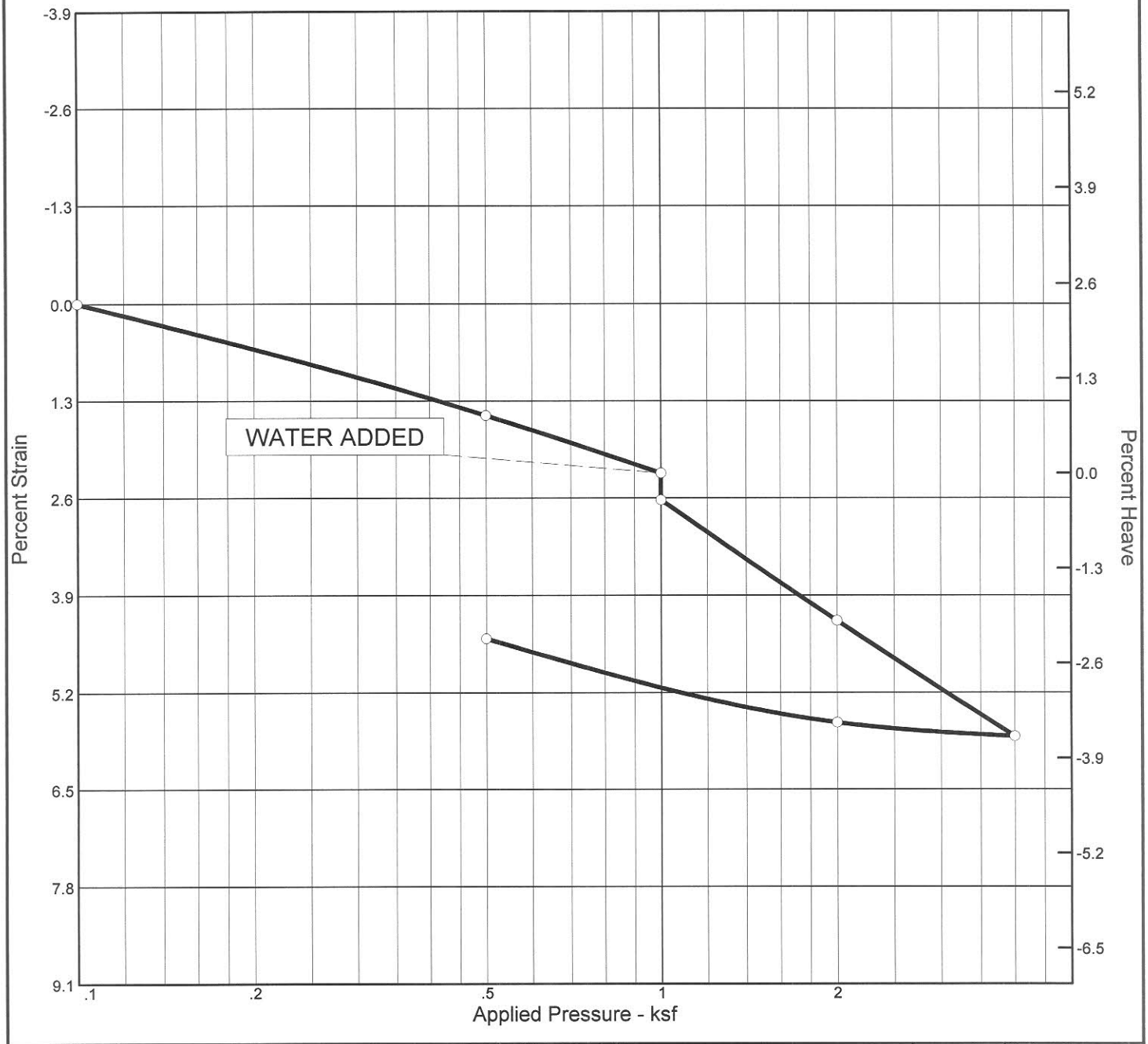
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
58.0 %	11.3 %	110.5	NV	NP	2.70		0.61	0.08	0.526

MATERIAL DESCRIPTION	USCS	AASHTO
Silty SAND with Gravel		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCHS-WR-E-005

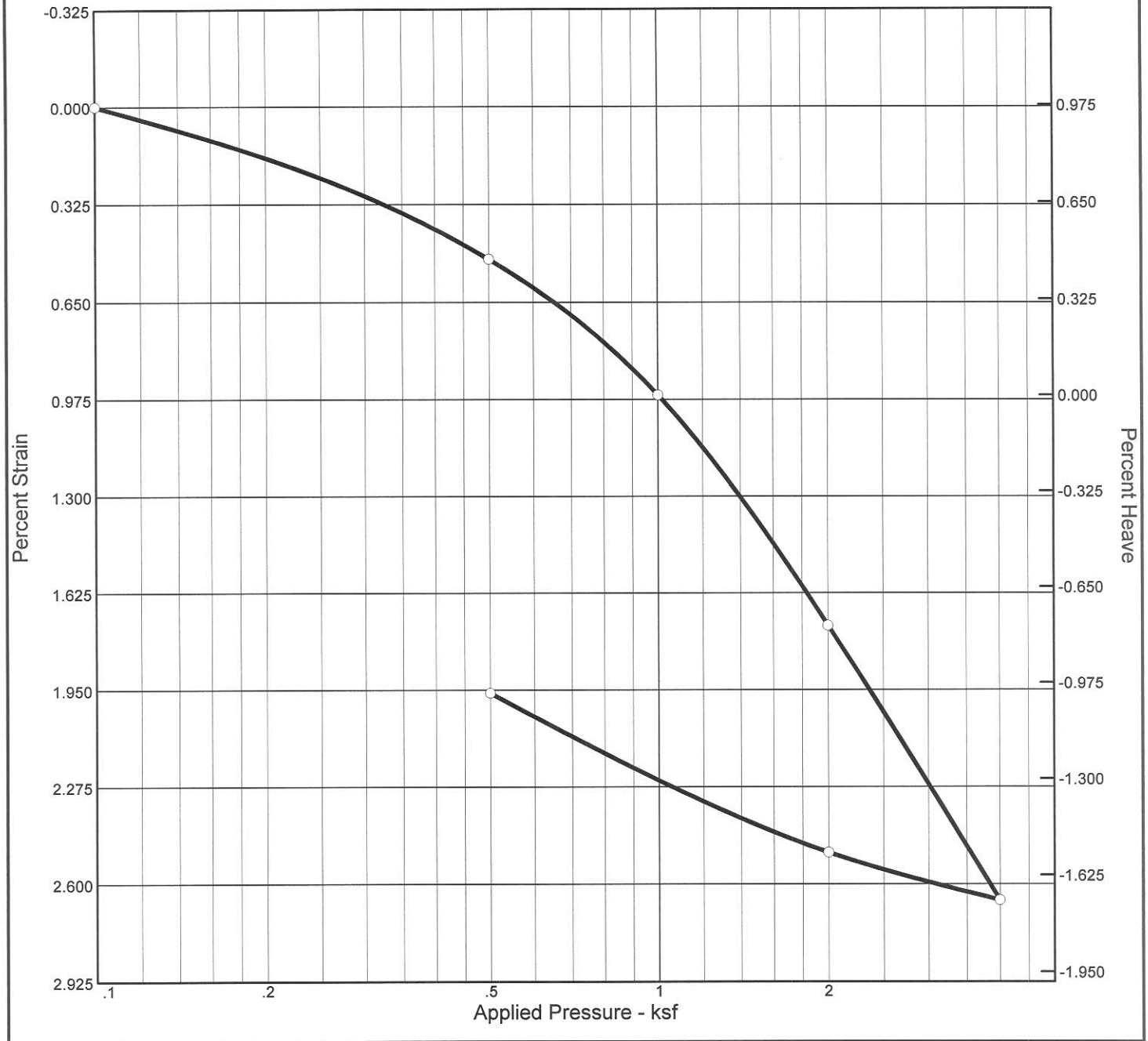
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
73.5 %	13.1 %	113.8	NV	NP	2.70		1.15	0.05	0.481

MATERIAL DESCRIPTION	USCS	AASHTO
Poorly Graded SAND with Gravel		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: SCHS-WR-E-012

Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

MOISTURE CONTENT ASTM D2216

Project: Carpenter Snow Creek
Billings Job #: 114-551059

Hole #	wet+t	dry+t	t		% m
CCHS-WT-E-001	977.6	943.50	200.80		4.6
CCHS-WR-E-001	2212.3	2049.60	223.40		8.9
CCHS-WR-E-002	587.7	568.30	100.20		4.1
CCHS-WR-E-003	1119.9	1062.40	109.20		6.0
CCHS-WR-E-005	545.3	513.20	160.10		9.1
CCLT-WT-E-001	2293.2	1865.90	114.80		24.4
CCLT-WT-E-002	2143.5	1648.90	160.20		33.2
CCSS-WT-E-001	480.3	421.20	108.80		18.9
CCSS-WT-E-002	2129.8	1971.40	219.80		9.0
CCSS-WT-E-003	1146.2	997.80	237.90		19.5
CCSS-WT-E-004	355.3	282.50	107.10		41.5
CCSS-WT-E-005	75.1	71.60	1.70		5.0
CCSS-WT-E-006	2116.6	1944.90	480.70		11.7
CCUT-WT-E-001	1417.9	1089.10	114.90		33.8
CCUT-WT-E-002	1120.2	850.50	108.80		36.4
NSHS-WR-E-001	837.2	792.90	114.80		6.5
NSHS-WR-E-002	2192.9	1901.40	228.30		17.4
NSHS-WR-E-003	2226.2	2049.6	223.4		9.7
NSHS-WR-E-004	1316.7	1265.7	219.6		4.9
NSHS-WR-E-005	375.2	353.9	98.6		8.3
NSHS-WR-E-006	1399.6	1299.1	226.5		9.4
NSHS-WR-E-007	1254.6	1167	219.6		9.2
NSHS-WR-E-008	1205.6	1124.2	121.4		8.1
NSHS-WR-E-009	2253.4	2117.8	222.8		7.2
SCHS-WR-E-001	871.5	790.2	106.4		11.9
SCHS-WR-E-010	862.6	794.2	106.7		9.9
SCHS-WR-E-011	882.4	837.8	106.6		6.1
SCHS-WR-E-012	357.4	334.7	101.7		9.7
SCHS-WR-E-013	253.3	240.5	100.8		9.2
SCHS-WR-E-014	1156.9	1112.7	109.2		4.4

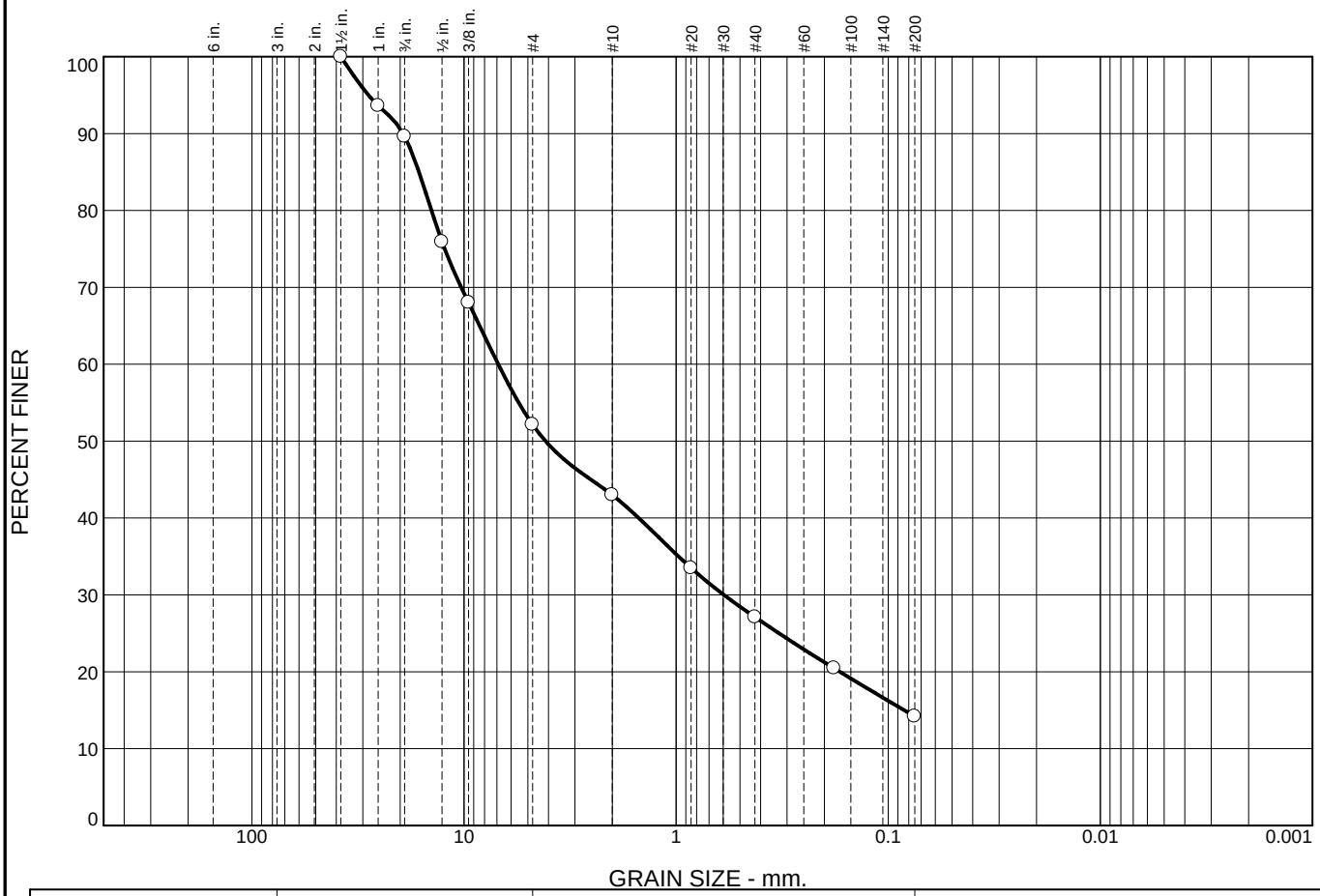
ORGANIC CONTENT ASTM D2974

Project: Carpenter Snow Creek
Billings Job #: 114-551059

	Oven Dried Sample Rec'd				After Ig	
Hole #	**dry soil + t**	**t**	**dry soil**		**soil + t**	**t**
CCHS-WT-E-001	186.45	59.42	127.03		182.21	59.42
CCHS-WR-E-001	158.95	71.94	87.01		153.64	71.93
CCHS-WR-E-002	156.43	59.40	97.03		150.02	59.42
CCHS-WR-E-003	148.33	71.94	76.39		144.97	71.94
CCHS-WR-E-005	157.88	59.41	98.47		154.17	59.40
CCLT-WT-E-001	127.37	59.40	67.97		123.68	59.40
CCLT-WT-E-002	134.71	59.42	75.29		128.42	59.42
CCSS-WT-E-001	166.63	59.40	107.23		161.66	59.40
CCSS-WT-E-002	147.22	59.41	87.81		143.59	59.41
CCSS-WT-E-003	163.47	71.94	91.53		159.45	71.94
CCSS-WT-E-004	126.00	71.93	54.07		121.68	71.93
CCSS-WT-E-005	178.57	71.94	106.63		175.75	71.93
CCSS-WT-E-006	147.23	71.94	75.29		144.44	71.93
CCUT-WT-E-001	132.08	71.95	60.13		127.70	71.94
CCUT-WT-E-002	138.07	59.41	78.66		133.02	59.41
NSHS-WR-E-001	143.15	71.93	71.22		138.84	71.93
NSHS-WR-E-002	141.68	59.41	82.27		136.60	59.40
NSHS-WR-E-003	168.21	59.41	108.80		163.40	59.40
NSHS-WR-E-004	147.50	59.40	88.10		142.24	59.40
NSHS-WR-E-005	154.30	71.94	82.36		149.18	71.94
NSHS-WR-E-006	171.07	71.94	99.13		166.87	71.92
NSHS-WR-E-007	149.46	71.94	77.52		146.63	71.94
NSHS-WR-E-008	172.39	59.42	112.97		166.08	59.40
NSHS-WR-E-009	163.98	71.94	92.04		159.36	71.94
SCHS-WR-E-001	156.24	71.94	84.30		153.06	71.95
SCHS-WR-E-010	166.81	71.93	94.88		163.53	71.95
SCHS-WR-E-011	181.98	71.93	110.05		177.37	71.94
SCHS-WR-E-012	160.99	59.40	101.59		156.90	59.40
SCHS-WR-E-013	136.73	59.41	77.32		133.16	59.41
SCHS-WR-E-014	156.89	59.40	97.49		153.20	59.41

gnition			
soil	loss	organic content	ash content
122.79	4.24	**96.7%**	**3.3%**
81.71	5.30	**93.9%**	**6.1%**
90.60	6.43	**93.4%**	**6.6%**
73.03	3.36	**95.6%**	**4.4%**
94.77	3.70	**96.2%**	**3.8%**
64.28	3.69	**94.6%**	**5.4%**
69.00	6.29	**91.6%**	**8.4%**
102.26	4.97	**95.4%**	**4.6%**
84.18	3.63	**95.9%**	**4.1%**
87.51	4.02	**95.6%**	**4.4%**
49.75	4.32	**92.0%**	**8.0%**
103.82	2.81	**97.4%**	**2.6%**
72.51	2.78	**96.3%**	**3.7%**
55.76	4.37	**92.7%**	**7.3%**
73.61	5.05	**93.6%**	**6.4%**
66.91	4.31	**93.9%**	**6.1%**
77.20	5.07	**93.8%**	**6.2%**
104.00	4.80	**95.6%**	**4.4%**
82.84	5.26	**94.0%**	**6.0%**
77.24	5.12	**93.8%**	**6.2%**
94.95	4.18	**95.8%**	**4.2%**
74.69	2.83	**96.3%**	**3.7%**
106.68	6.29	**94.4%**	**5.6%**
87.42	4.62	**95.0%**	**5.0%**
81.11	3.19	**96.2%**	**3.8%**
91.58	3.30	**96.5%**	**3.5%**
105.43	4.62	**95.8%**	**4.2%**
97.50	4.09	**96.0%**	**4.0%**
73.75	3.57	**95.4%**	**4.6%**
93.79	3.70	**96.2%**	**3.8%**

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	10.4	37.5	9.1	15.9	12.9	14.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	31	22	16.3134	6.8992	4.1281	0.5953	0.0841			

Material Description	USCS	AASHTO
○ clayey gravel with sand	GC	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

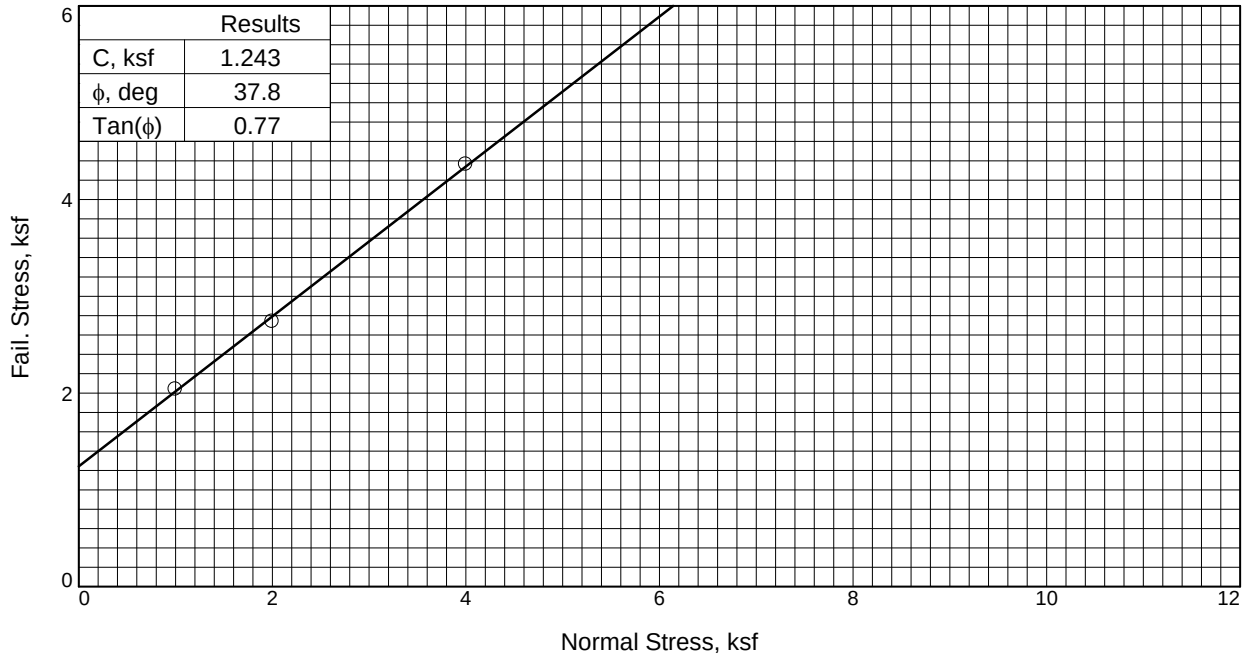
○ **Source of Sample:** CCHS-WR-E-001

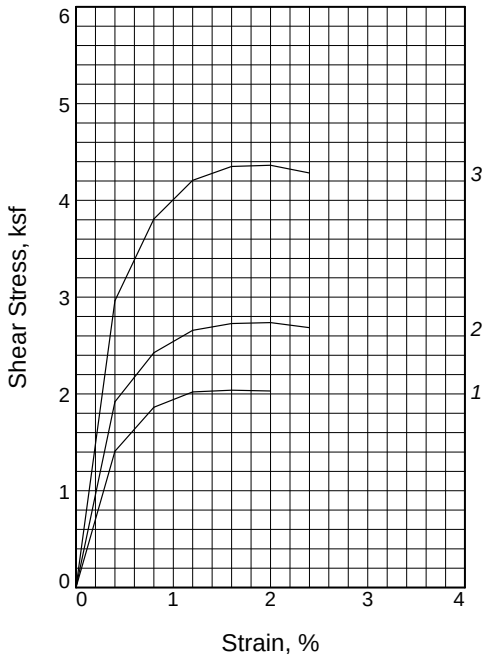
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	12.0	12.0	12.0
	Dry Density, pcf	115.5	115.5	105.0
	Saturation, %	70.5	70.5	53.6
	Void Ratio	0.4597	0.4597	0.6047
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	14.1	13.3	11.4
	Dry Density, pcf	115.9	117.0	107.6
	Saturation, %	83.9	81.7	54.5
	Void Ratio	0.4537	0.4401	0.5661
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.996	0.987	0.976
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		2.039	2.737	4.362
Strain, %		1.6	2.0	2.0
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: clayey gravel with sand

LL= 31 **PL=** 22 **PI=** 9
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

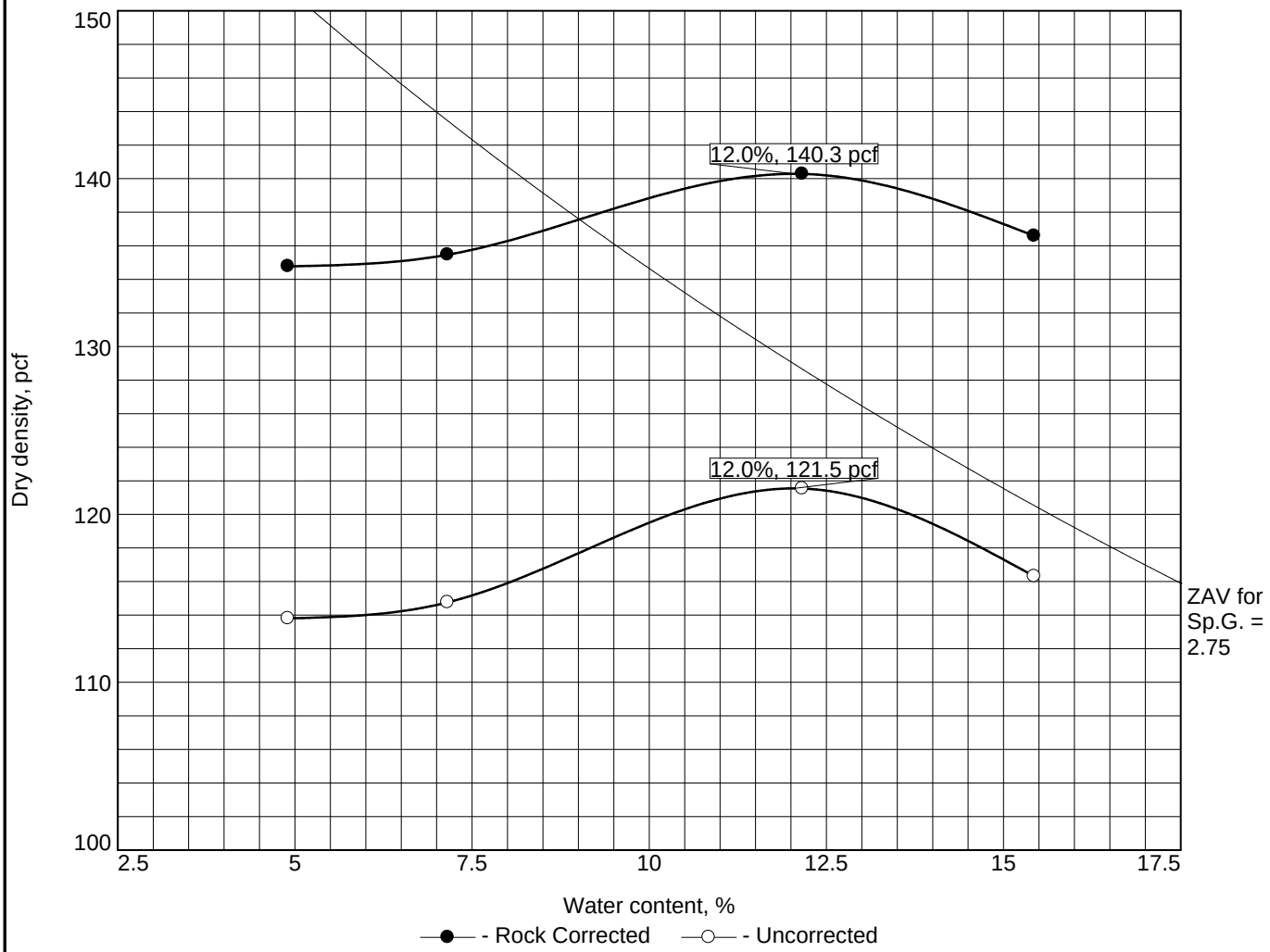
Project: Carpenter Snow Creek

Source of Sample: CCHS-WR-E-001

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-91 Procedure A Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	GC	A-2-4(0)		2.75	31	9	47.9	14.2

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 140.3 pcf	121.5 pcf	clayey gravel with sand
Optimum moisture = 12.0 %	12.0 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** CCHS-WR-E-001

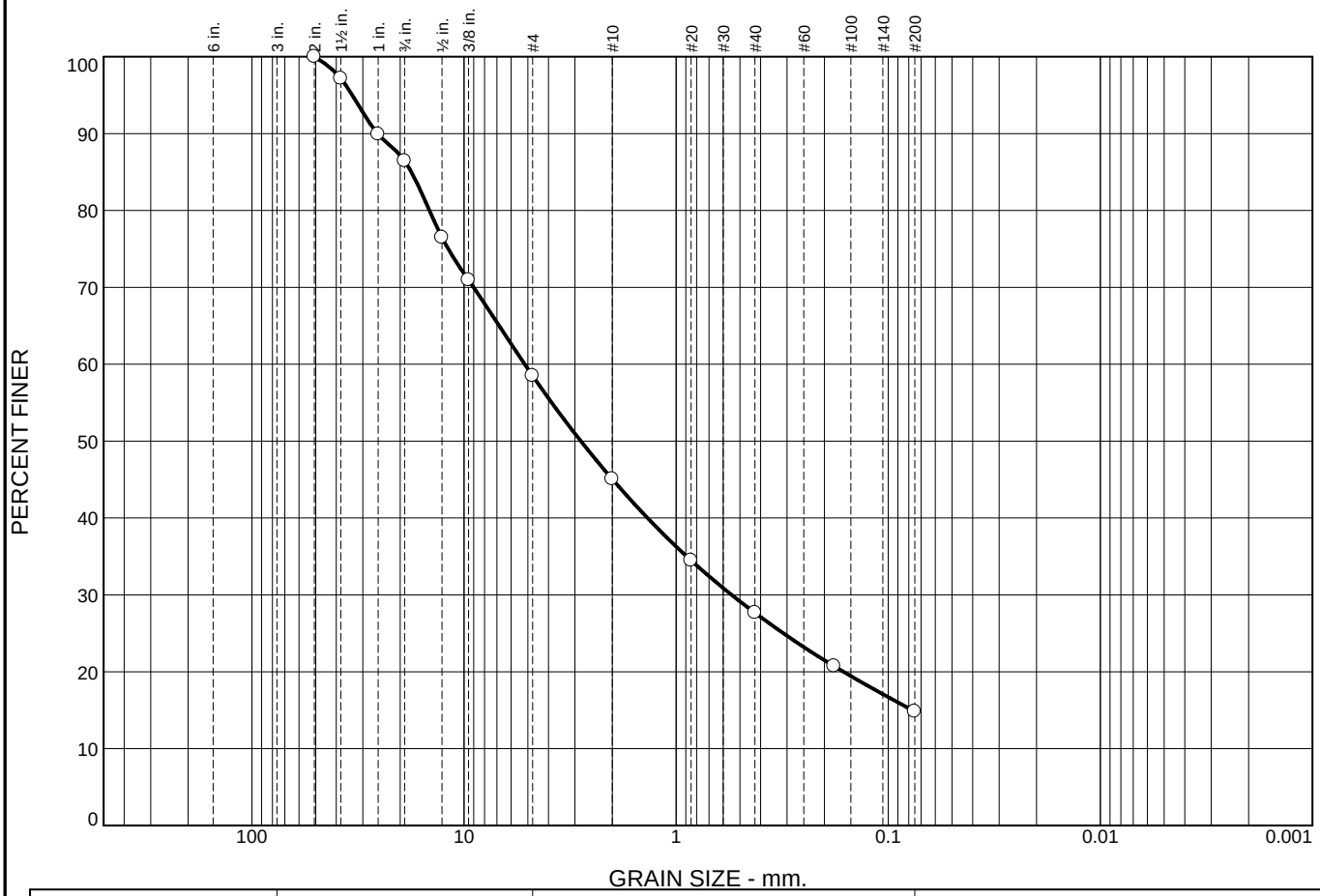
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	13.6	27.9	13.4	17.4	12.9	14.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	27	22	17.7069	5.1745	2.8135	0.5473	0.0769			

Material Description	USCS	AASHTO
○ silty, clayey sand with gravel	SC-SM	A-1-a

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

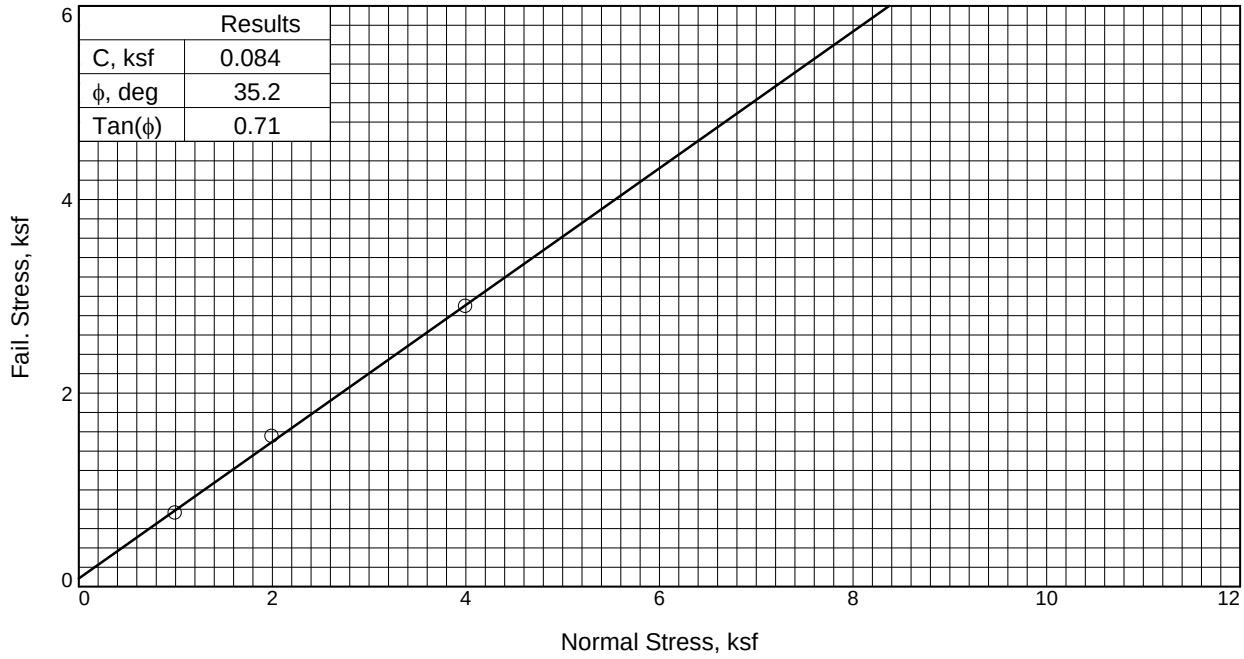
○ **Source of Sample:** CCHS-WR-E-002

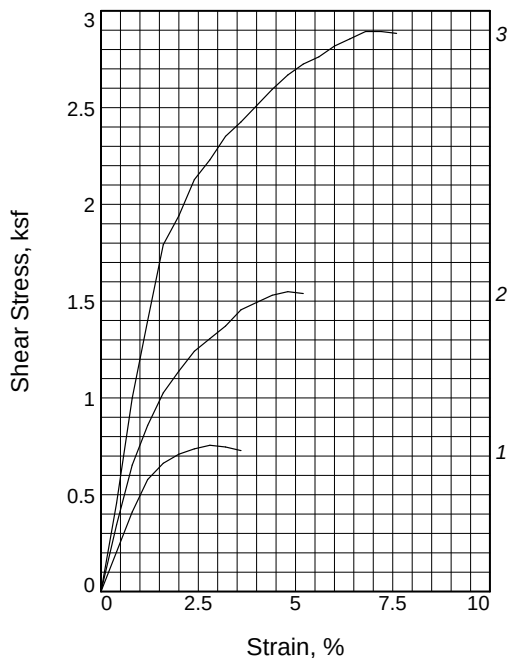
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	13.1	13.1	13.1
	Dry Density, pcf	112.6	112.6	112.6
	Saturation, %	71.2	71.2	71.2
	Void Ratio	0.4969	0.4969	0.4969
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	15.5	13.2	12.4
	Dry Density, pcf	112.9	115.1	116.4
	Saturation, %	85.0	77.0	74.8
	Void Ratio	0.4924	0.4640	0.4475
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.997	0.978	0.967
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.756	1.549	2.893
Strain, %		2.8	4.8	6.8
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: REMOLDED
Description: silty, clayey sand with gravel

LL= 27 **PL=** 22 **PI=** 5
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

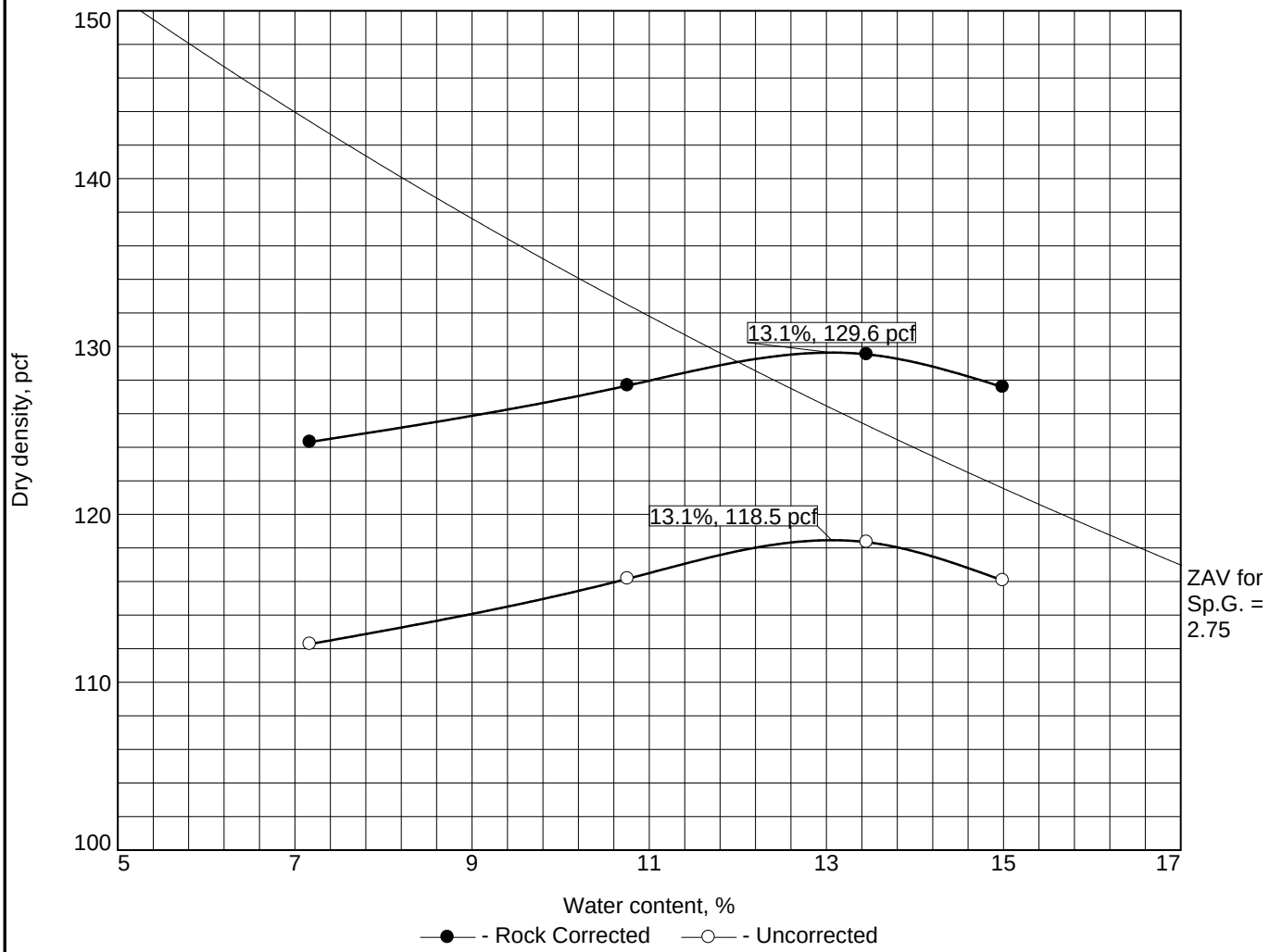
Project: Carpenter Snow Creek

Source of Sample: CCHS-WR-E-002

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method B Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	SC-SM	A-1-a		2.75	27	5	29.0	14.8

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 129.6 pcf	118.5 pcf	silty, clayey sand with gravel
Optimum moisture = 13.1 %	13.1 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** CCHS-WR-E-002

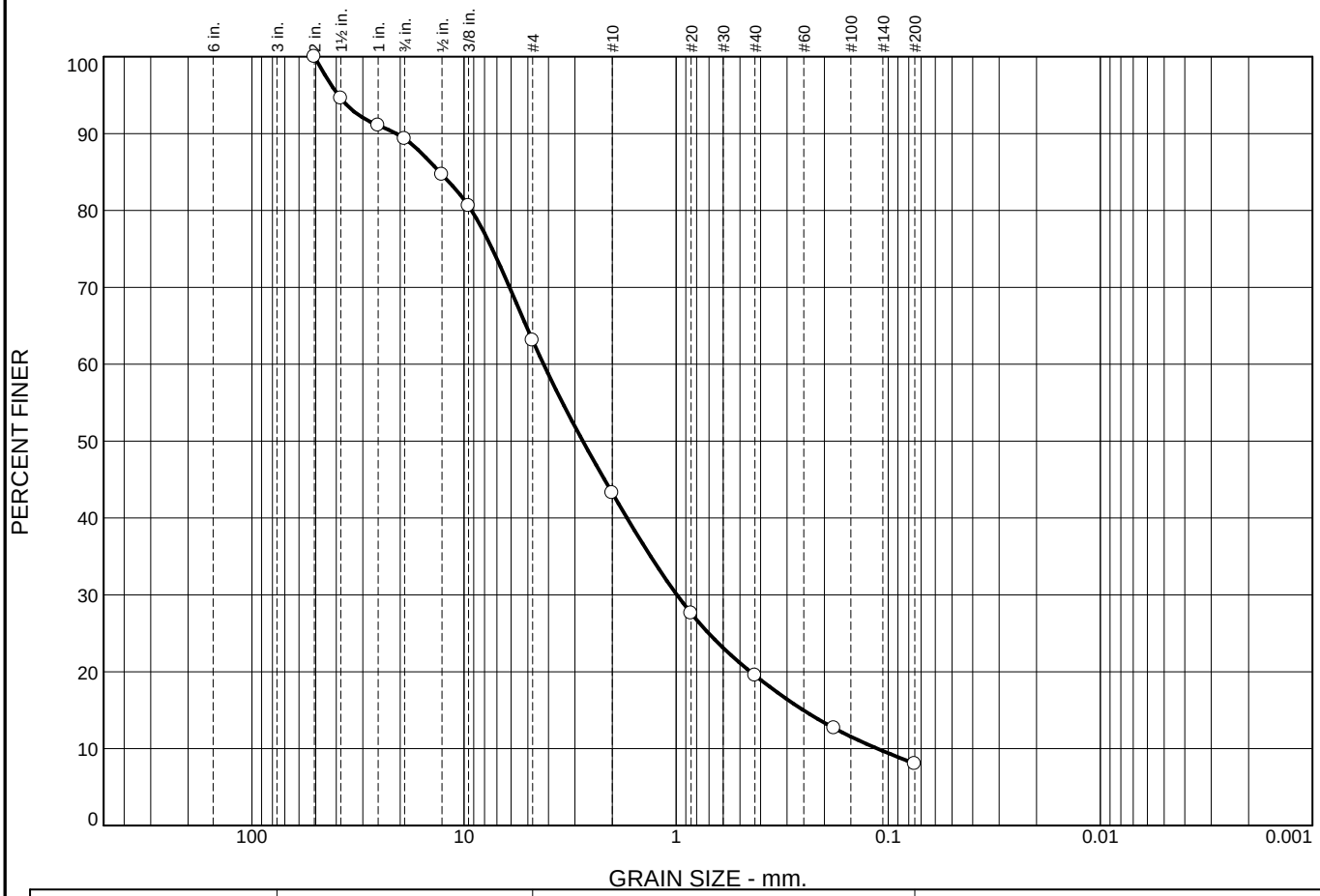
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	10.7	26.2	19.8	23.8	11.5	8.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	13.0418	4.2173	2.7532	0.9912	0.2509	0.1124	2.07	37.53

Material Description	USCS	AASHTO
○ Well Graded SAND with Silt and Gravel	SW-SM	A-1-a

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

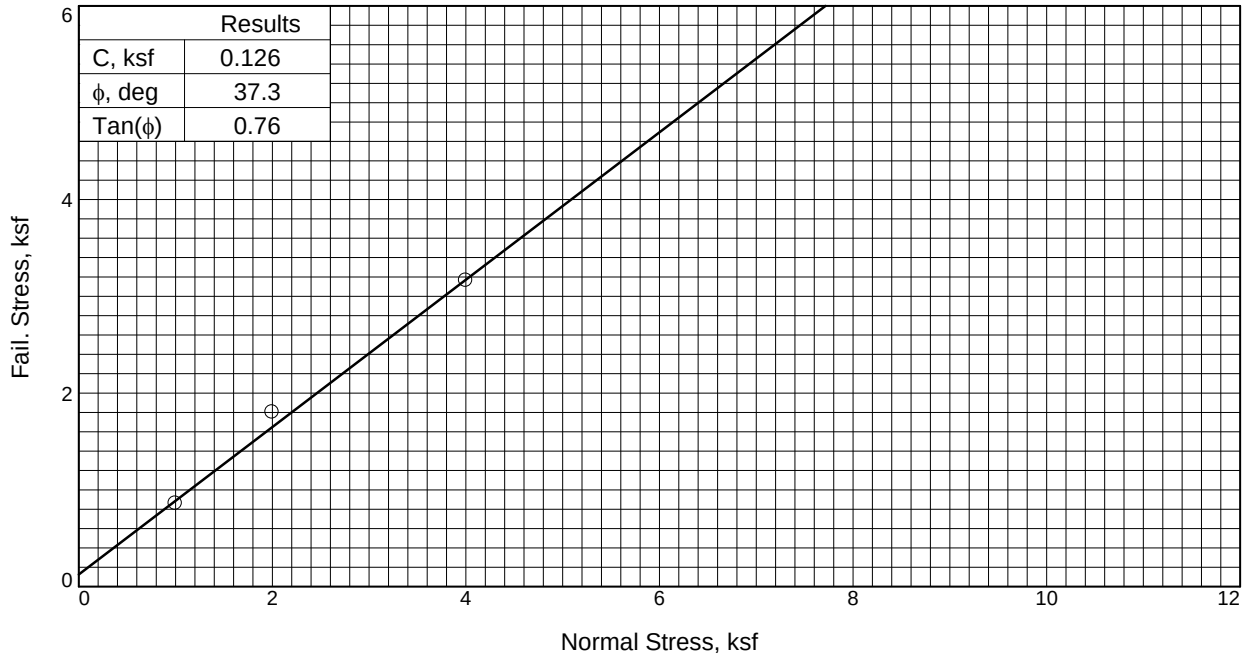
○ **Source of Sample:** CCHS-WR-E-003

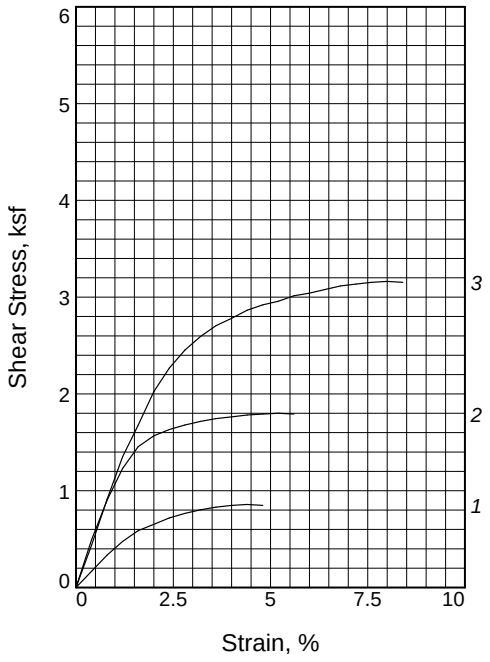
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	13.3	13.3	13.3
	Dry Density, pcf	106.6	106.6	106.6
	Saturation, %	61.8	61.8	61.8
	Void Ratio	0.5815	0.5815	0.5815
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	18.0	16.6	14.7
	Dry Density, pcf	106.8	107.0	107.3
	Saturation, %	83.9	78.0	69.6
	Void Ratio	0.5779	0.5746	0.5714
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.998	0.996	0.994
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.858	1.801	3.163
Strain, %		4.4	5.2	8.0
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded

Description: Well Graded SAND with Silt and Gravel

LL= NV **PI=** NP

Specific Gravity= 2.70

Remarks:

Figure _____

Client: Tetra Tech EMI

Project: Carpenter Snow Creek

Source of Sample: CCHS-WR-E-003

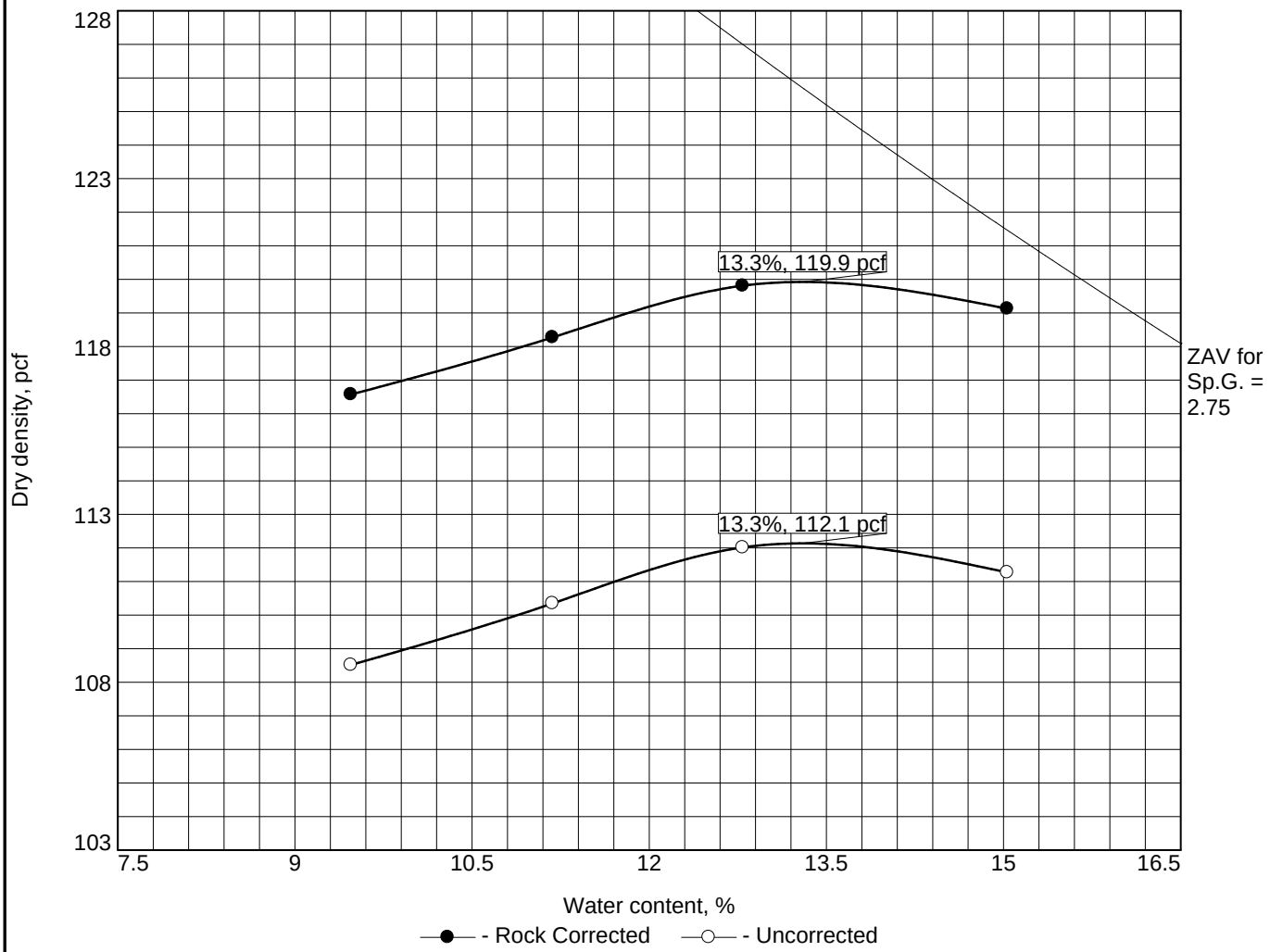
Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT

Tetra Tech

Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method B Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	SW-SM	A-1-a		2.75	NV	NP	19.4	8.0

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 119.9 pcf	112.1 pcf	Well Graded SAND with Silt and Gravel
Optimum moisture = 13.3 %	13.3 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** CCHS-WR-E-003

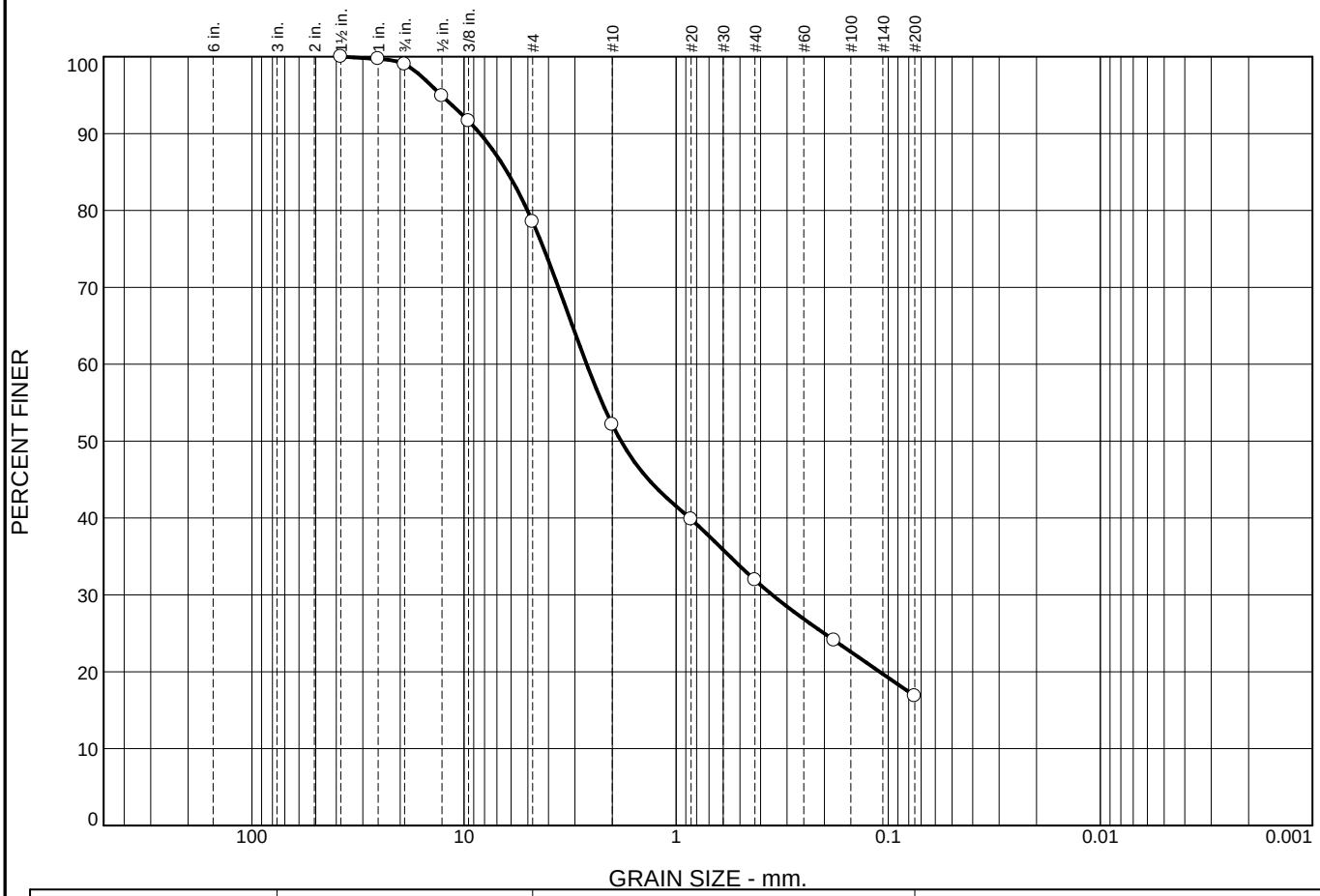
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	1.0	20.5	26.4	20.2	15.0	16.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	6.2534	2.6410	1.8182	0.3522				

Material Description	USCS	AASHTO
○ Silty SAND with Gravel	SM	A-1-b

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

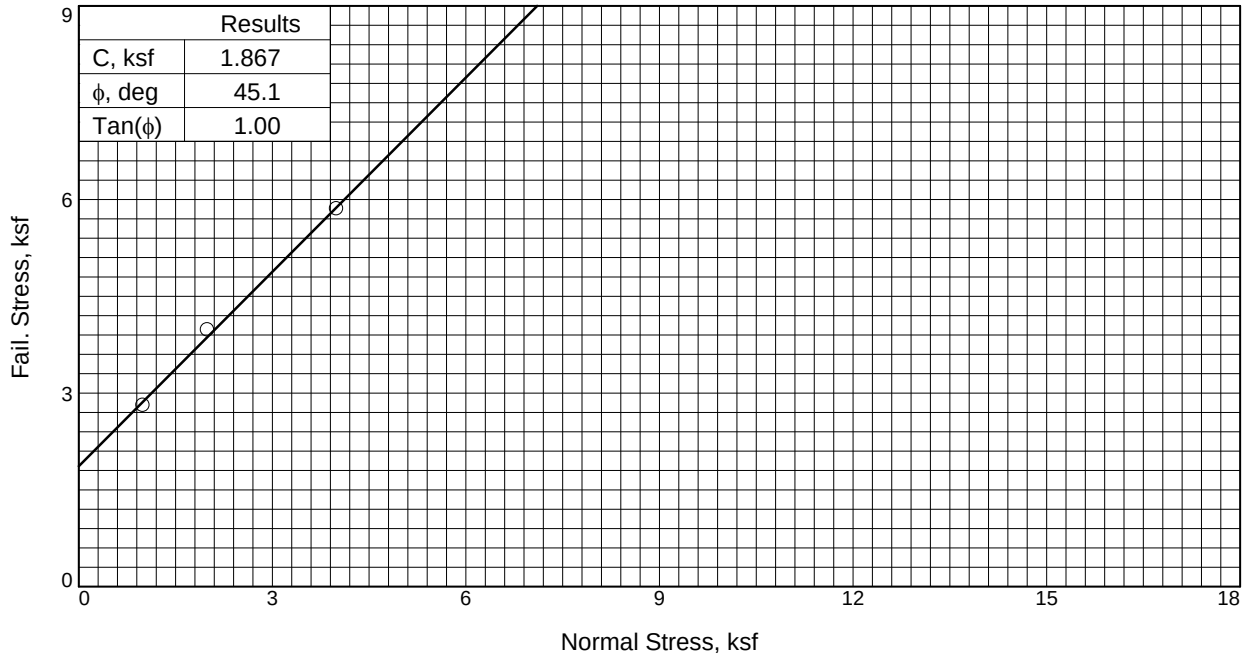
○ **Source of Sample:** CCHS-WR-E-005

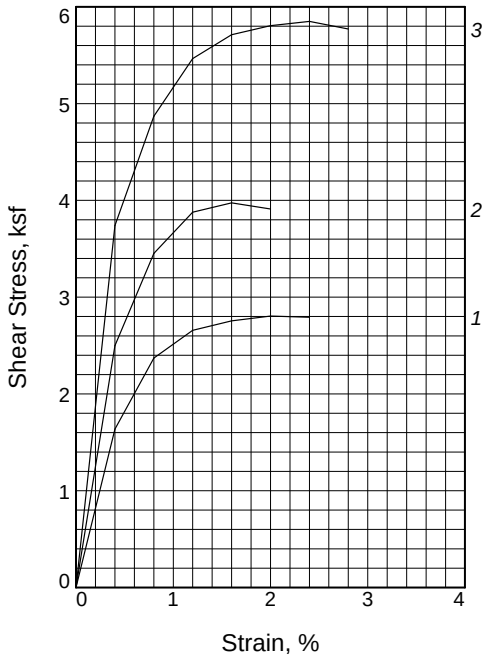
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	11.3	11.3	11.3
	Dry Density, pcf	110.4	110.4	110.4
	Saturation, %	58.0	58.0	58.0
	Void Ratio	0.5263	0.5263	0.5263
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	14.2	13.4	10.4
	Dry Density, pcf	111.4	111.9	112.2
	Saturation, %	74.4	71.6	56.2
	Void Ratio	0.5133	0.5058	0.5017
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.992	0.987	0.984
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		2.804	3.975	5.849
Strain, %		2.0	1.6	2.4
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remoloded
Description: Silty SAND with Gravel

LL= NV **PI=** NP
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

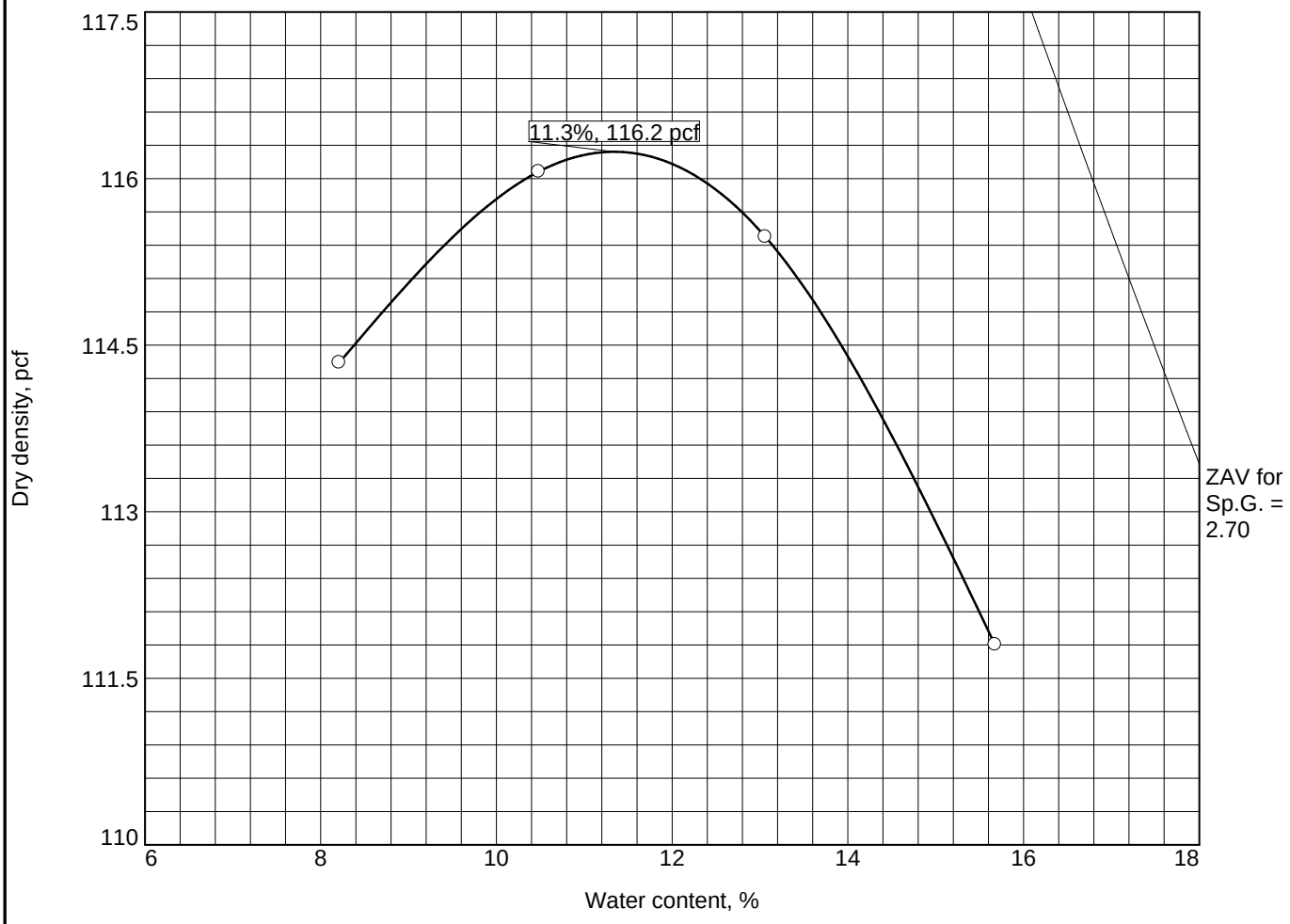
Project: Carpenter Snow Creek

Source of Sample: CCHS-WR-E-005

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	SM	A-1-b			NV	NP	21.5	16.9

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 116.2 pcf Optimum moisture = 11.3 %	Silty SAND with Gravel

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** CCHS-WR-E-005

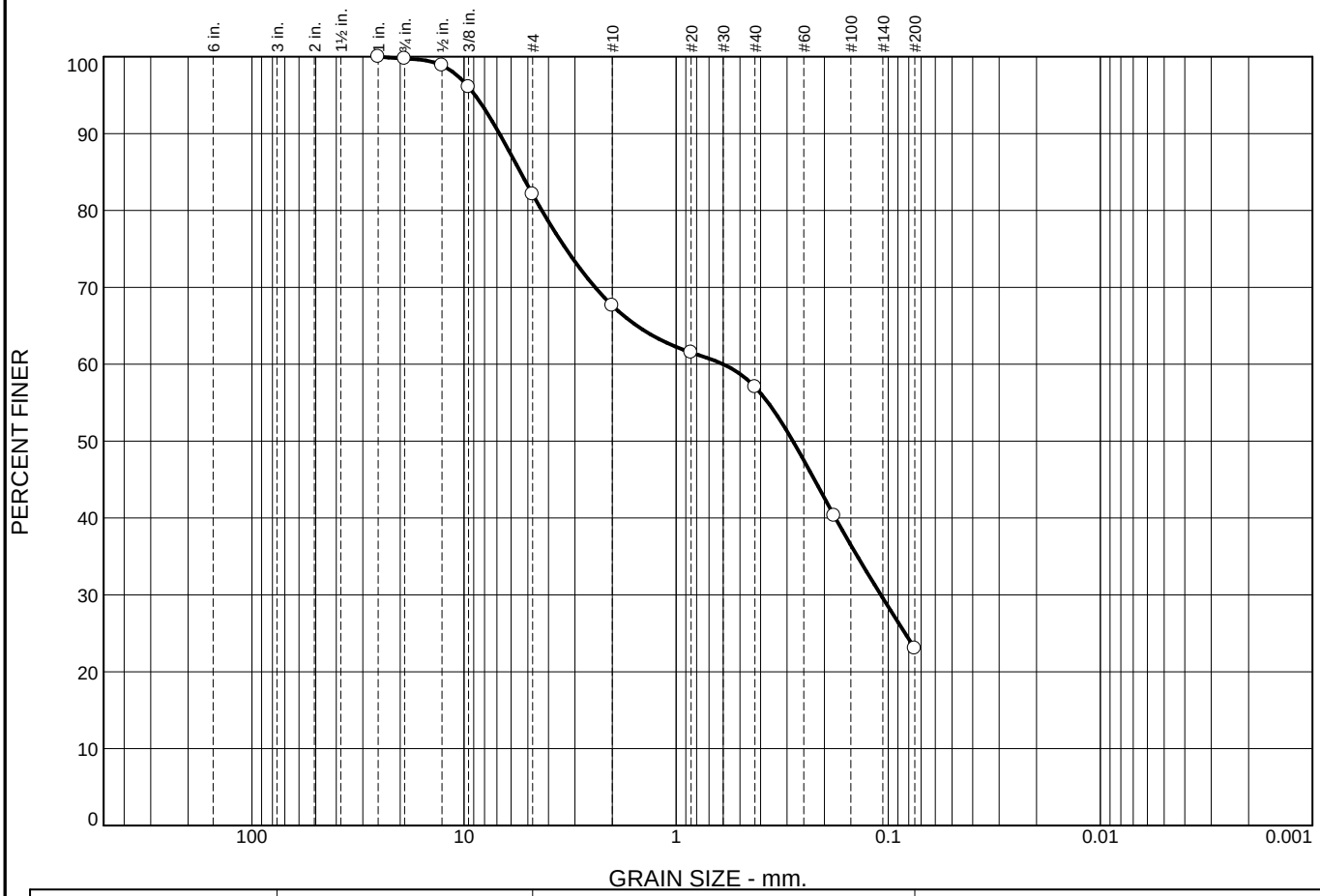
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.3	17.6	14.5	10.6	33.9	23.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	5.4222	0.6002	0.2812	0.1083				

Material Description	USCS	AASHTO
○ Silty SAND with Gravel	SM	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

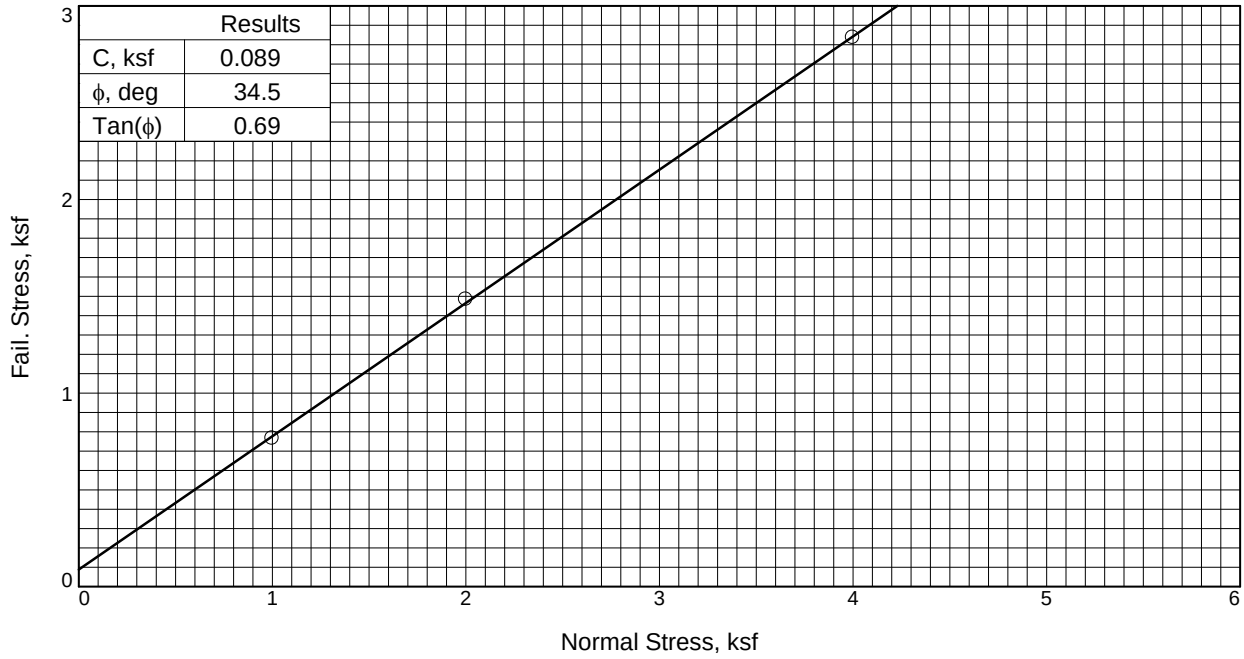
○ **Source of Sample:** CCHS-WT-E-001

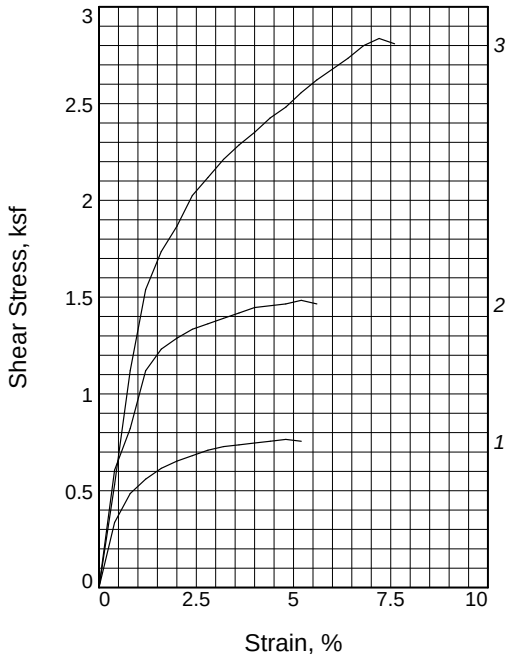
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	11.3	11.3	11.3
	Dry Density, pcf	115.6	115.6	115.6
	Saturation, %	66.6	66.6	66.6
	Void Ratio	0.4586	0.4586	0.4586
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	16.4	12.9	10.7
	Dry Density, pcf	115.8	116.1	116.5
	Saturation, %	97.3	77.2	64.7
	Void Ratio	0.4551	0.4524	0.4462
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.998	0.996	0.992
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.765	1.484	2.837
Strain, %		4.8	5.2	7.2
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Silty SAND with Gravel

LL= NV **PI=** NP
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

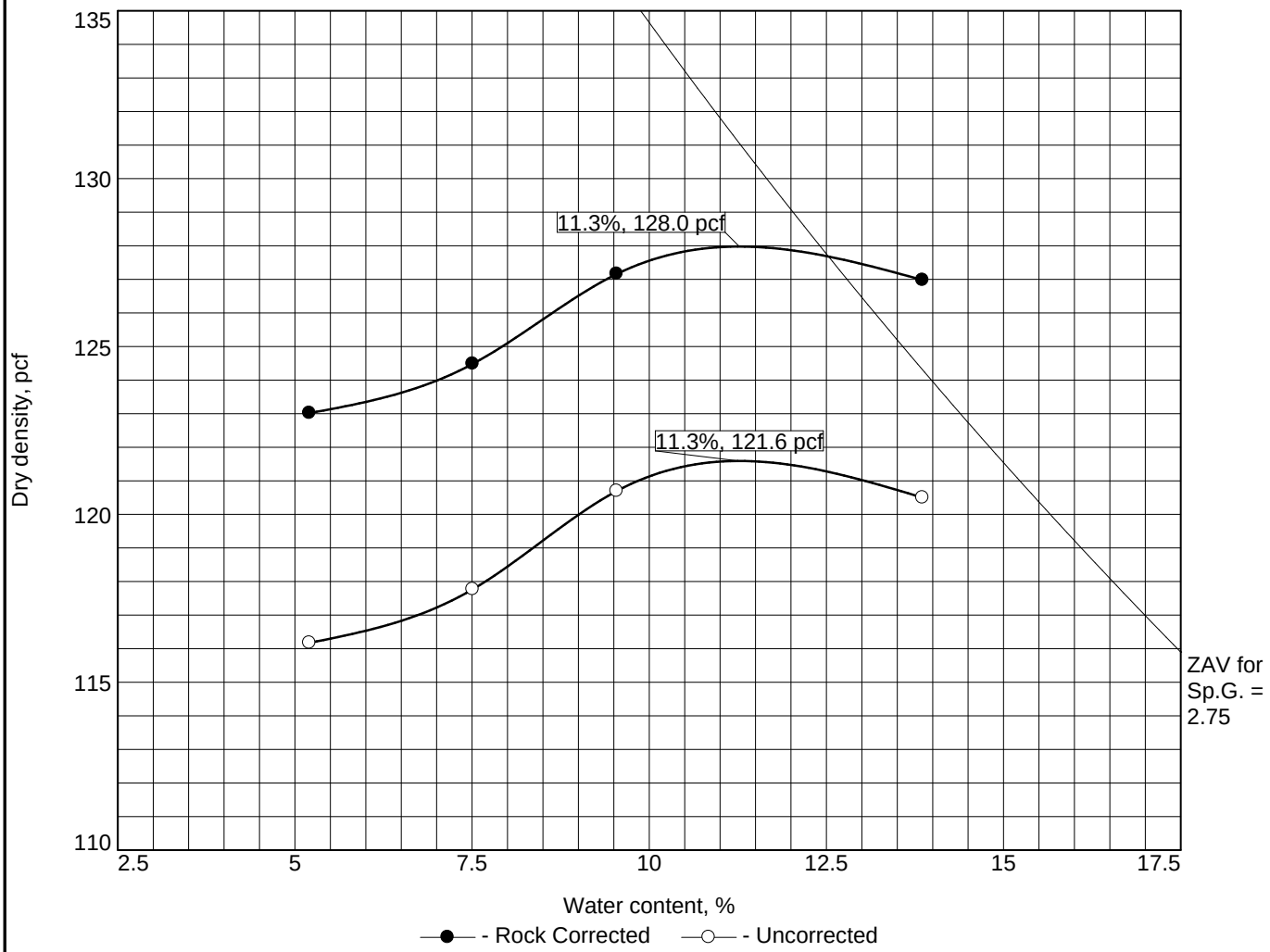
Project: Carpenter Snow Creek

Source of Sample: CCHS-WT-E-001

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-91 Procedure A Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	SM	A-2-4(0)		2.75	NV	NP	17.9	23.1

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 128.0 pcf	121.6 pcf	Silty SAND with Gravel
Optimum moisture = 11.3 %	11.3 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** CCHS-WT-E-001

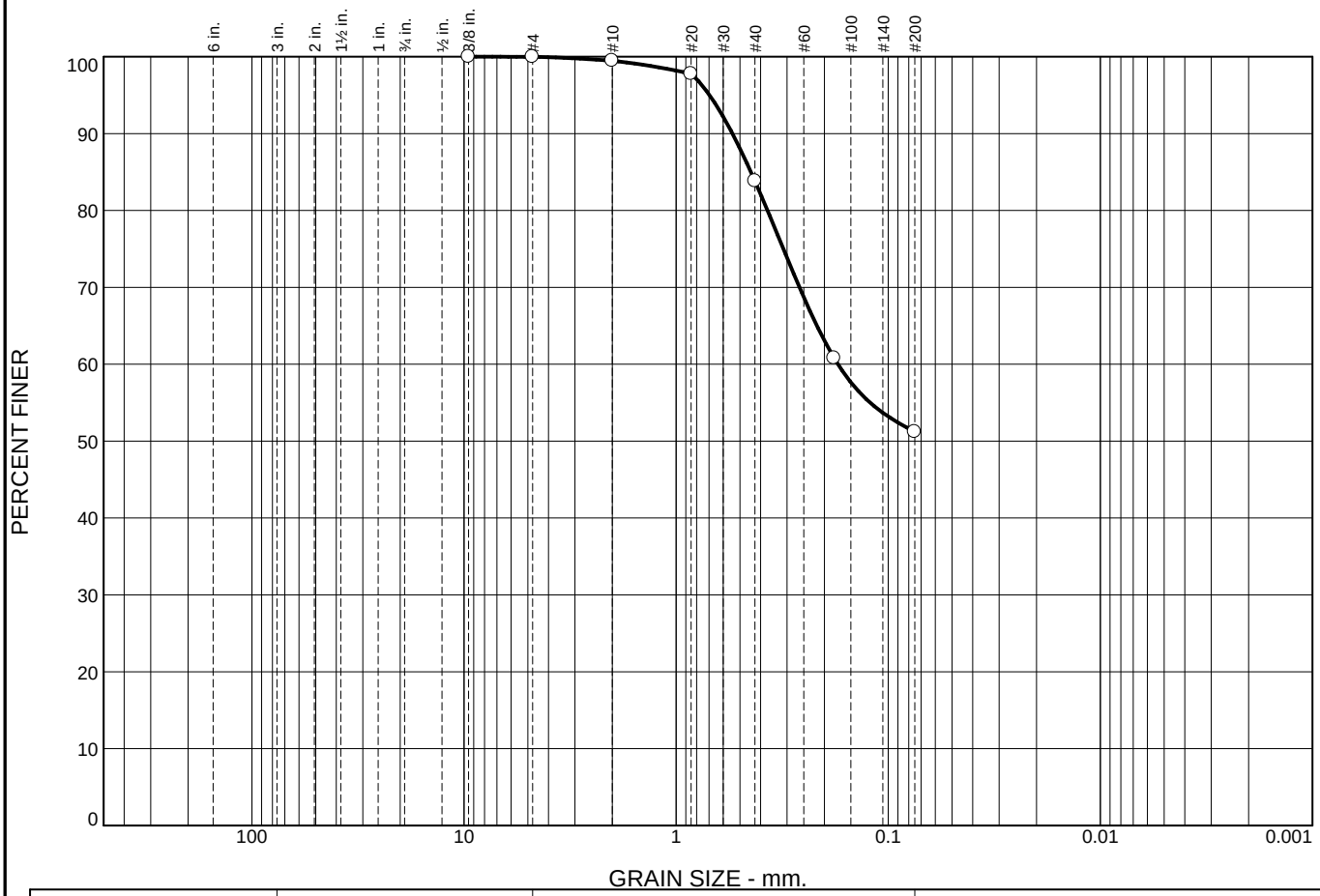
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.5	15.7	32.6	51.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	27	18	0.4441	0.1726						

Material Description	USCS	AASHTO
○ Sandy Lean CLAY	CL	A-4(2)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

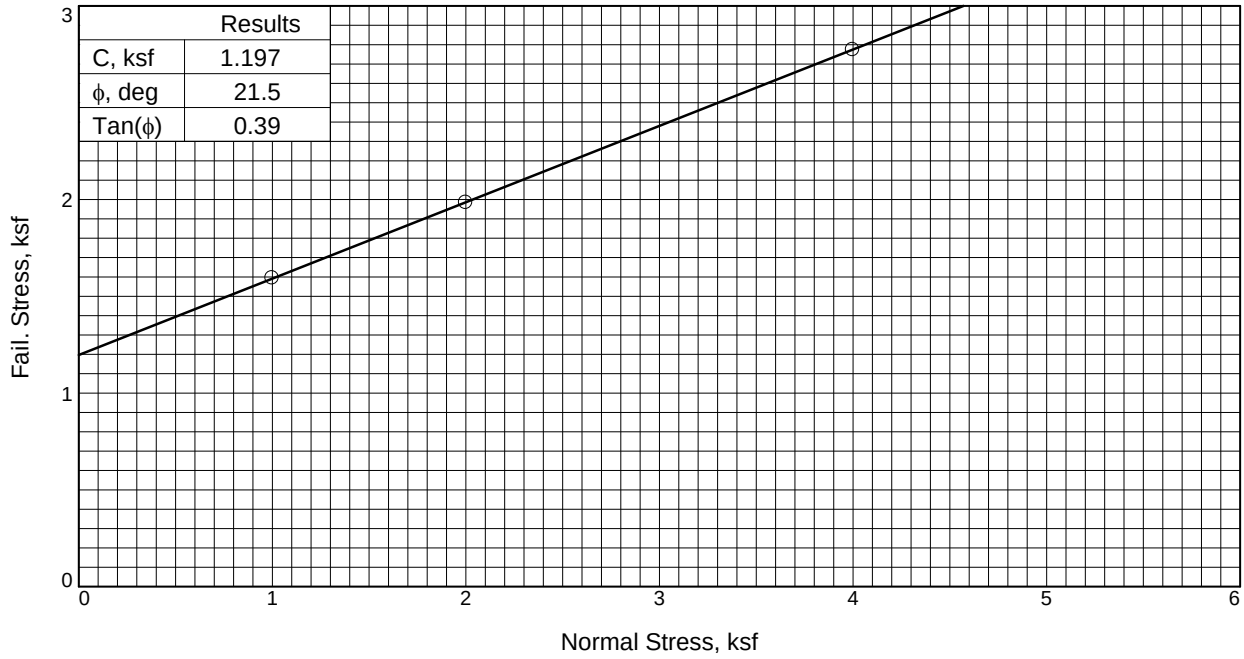
○ **Source of Sample:** CCLT-WT-E-001

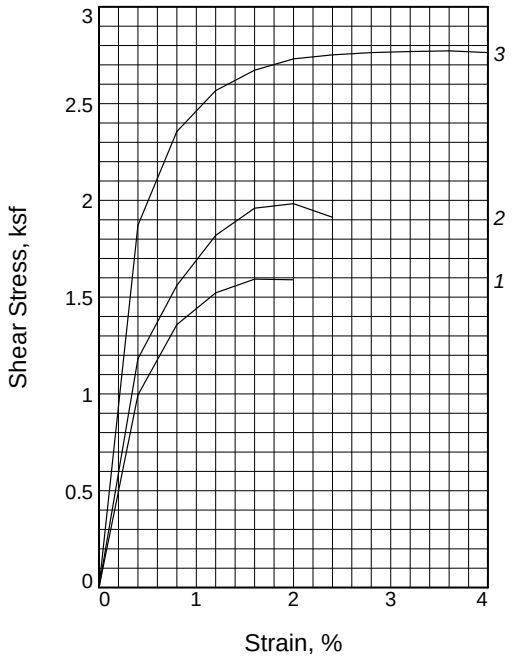
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	14.9	14.9	14.9
	Dry Density, pcf	105.8	105.8	105.8
	Saturation, %	67.8	67.8	67.8
	Void Ratio	0.5934	0.5934	0.5934
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	17.7	16.1	15.3
	Dry Density, pcf	106.0	106.6	107.0
	Saturation, %	81.2	74.6	71.8
	Void Ratio	0.5894	0.5818	0.5753
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.998	0.993	0.989
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		1.593	1.983	2.772
Strain, %		1.6	2.0	3.6
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Sandy Lean CLAY

LL= 27
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

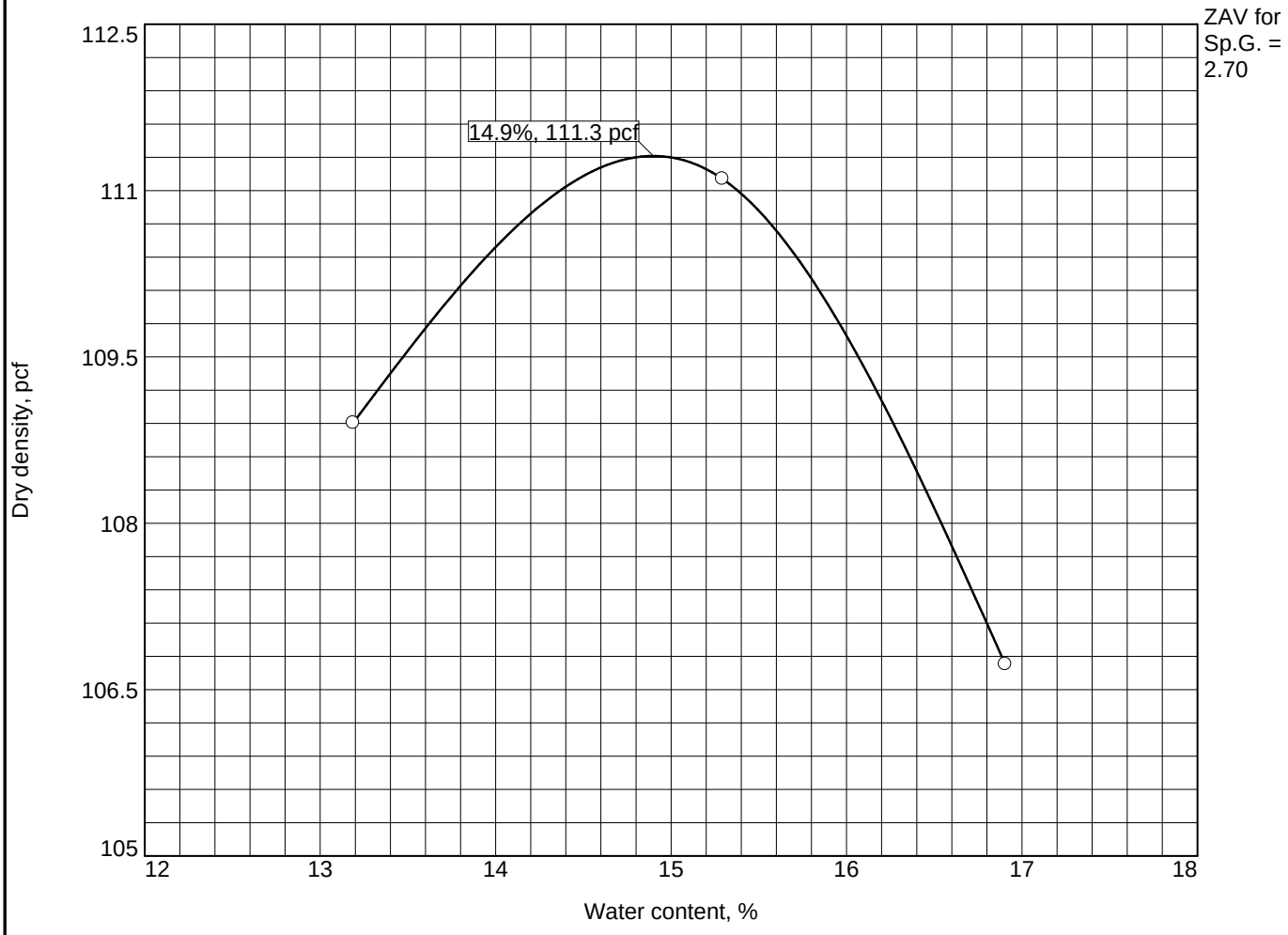
Project: Carpenter Snow Creek

Source of Sample: CCLT-WT-E-001

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	CL	A-4(2)			27		0.0	51.2

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 111.3 pcf Optimum moisture = 14.9 %	Sandy Lean CLAY

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** CCLT-WT-E-001

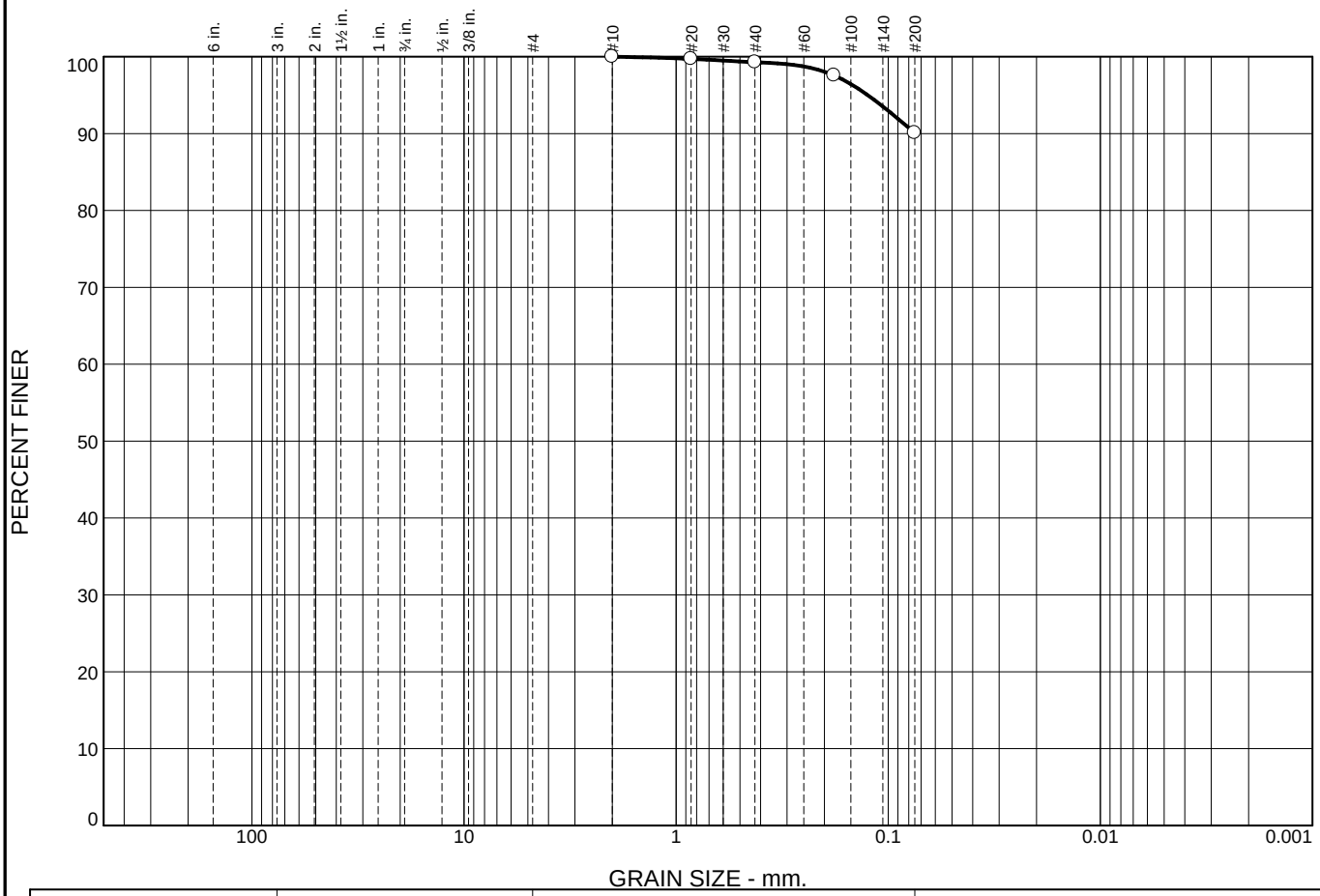
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.7	9.2	90.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	45	22								

Material Description	USCS	AASHTO
○ Lean CLAY	CL	A-7-6(22)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

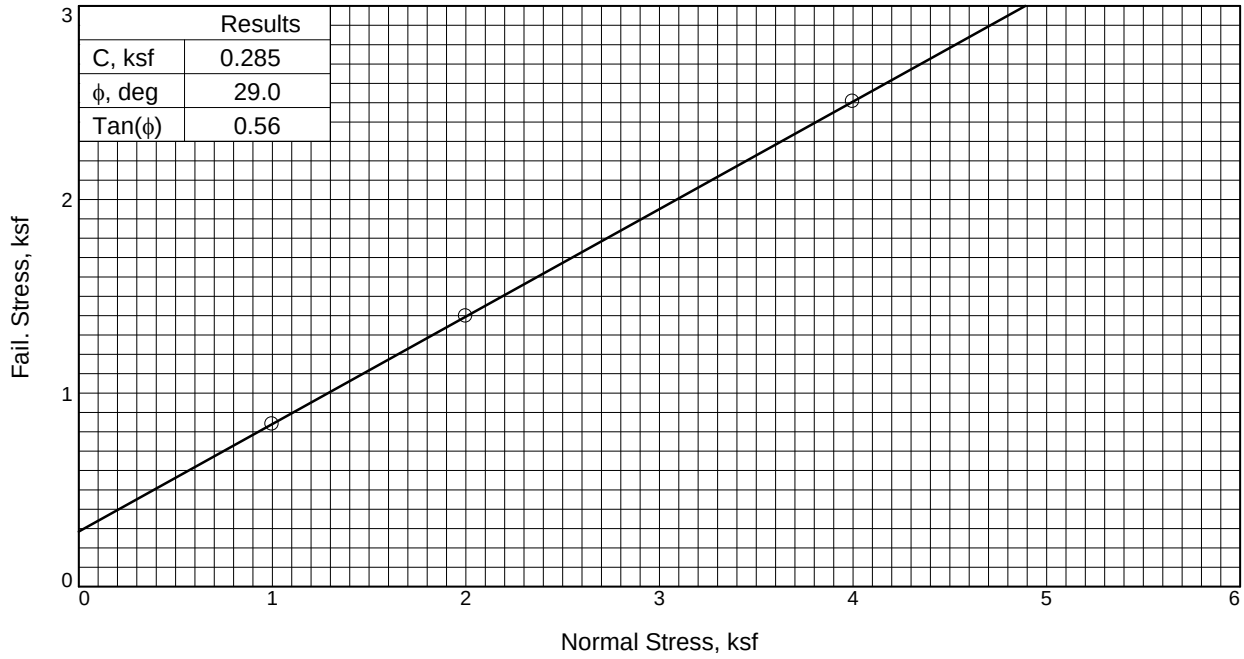
○ **Source of Sample:** CCLT-WT-E-002

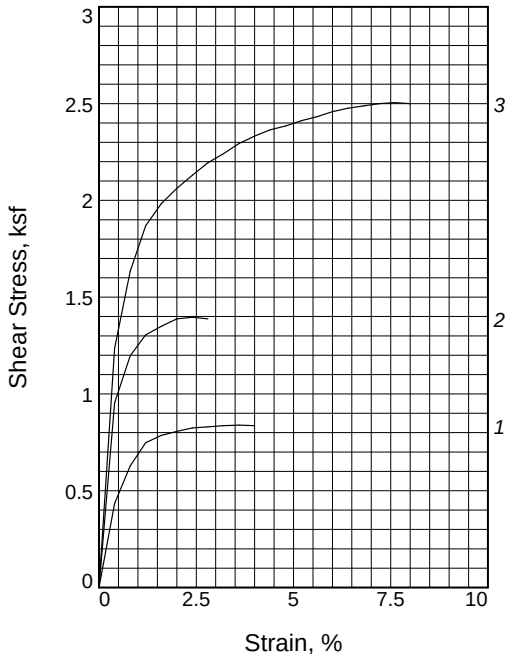
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	19.3	19.3	19.3
	Dry Density, pcf	97.1	97.1	97.1
	Saturation, %	70.9	70.9	70.9
	Void Ratio	0.7353	0.7353	0.7353
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	26.5	25.6	23.5
	Dry Density, pcf	98.0	97.9	98.9
	Saturation, %	99.5	95.8	89.9
	Void Ratio	0.7204	0.7211	0.7051
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.991	0.992	0.983
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.839	1.396	2.505
Strain, %		3.6	2.4	7.6
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Lean CLAY

LL= 45 **PL=** 22 **PI=** 23
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

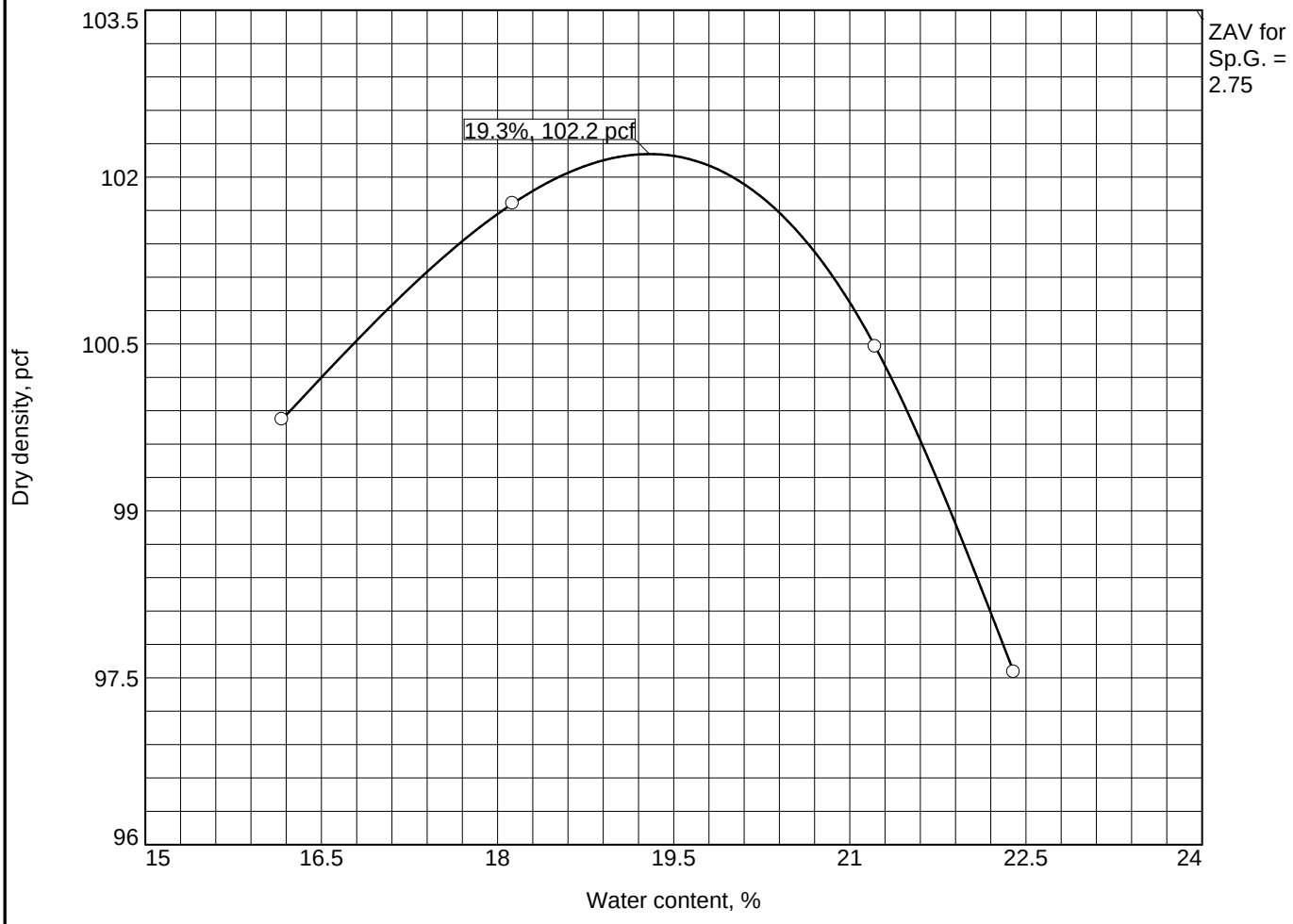
Project: Carpenter Snow Creek

Source of Sample: CCLT-WT-E-002

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	CL	A-7-6(22)		2.75	45	23	0.0	90.1

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 102.2 pcf Optimum moisture = 19.3 %	Lean CLAY

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** CCLT-WT-E-002

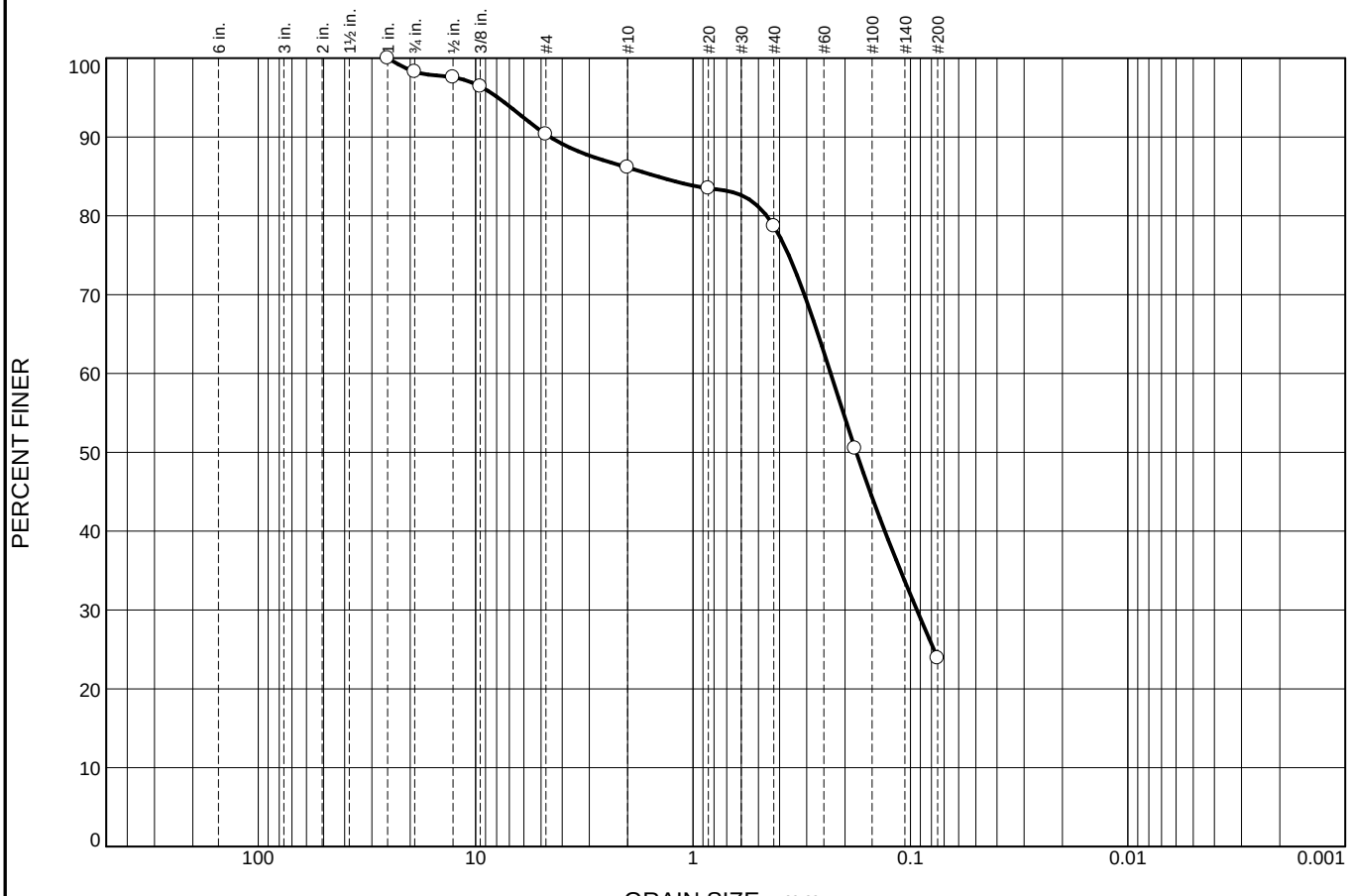
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	1.7	8.0	4.2	7.4	54.8	23.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	1.4592	0.2325	0.1774	0.0933				

Material Description	USCS	AASHTO
○ Silty SAND	SM	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

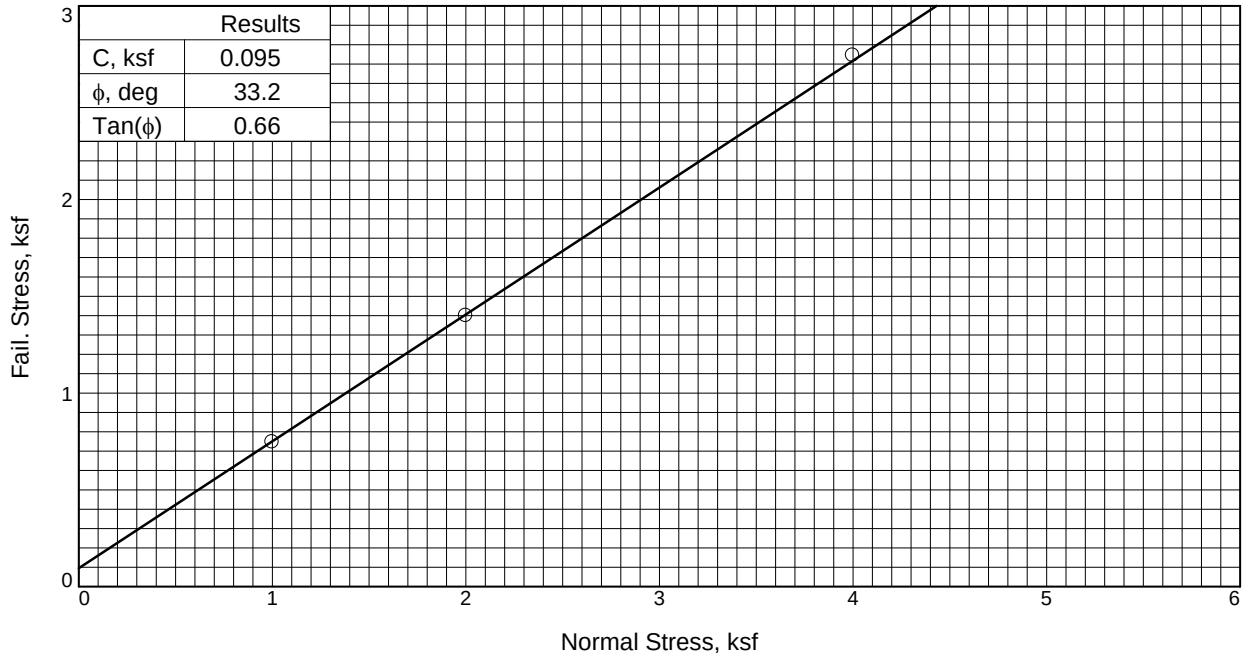
○ **Source of Sample:** CCSS-WT-E-001

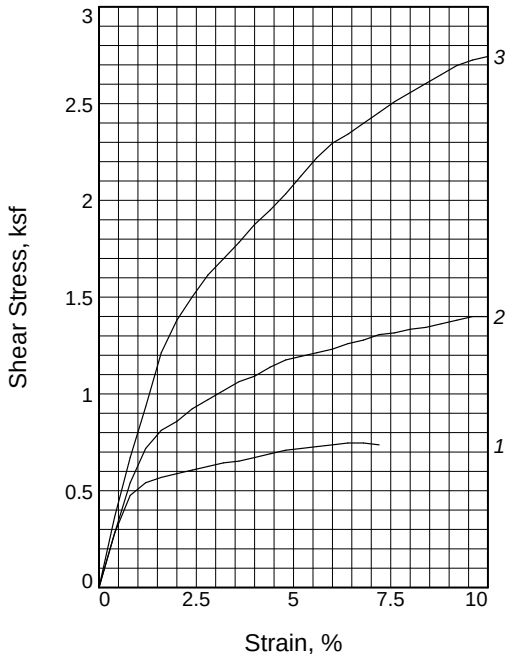
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	18.4	18.4	18.4
	Dry Density, pcf	99.7	99.7	99.7
	Saturation, %	71.9	71.9	71.9
	Void Ratio	0.6907	0.6907	0.6907
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	20.0	18.4	14.3
	Dry Density, pcf	100.6	100.9	102.0
	Saturation, %	79.9	74.2	59.0
	Void Ratio	0.6754	0.6704	0.6518
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.991	0.988	0.977
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.746	1.400	2.743
Strain, %		6.4	9.6	10.0
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Silty SAND

LL= NV **PI=** NP
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

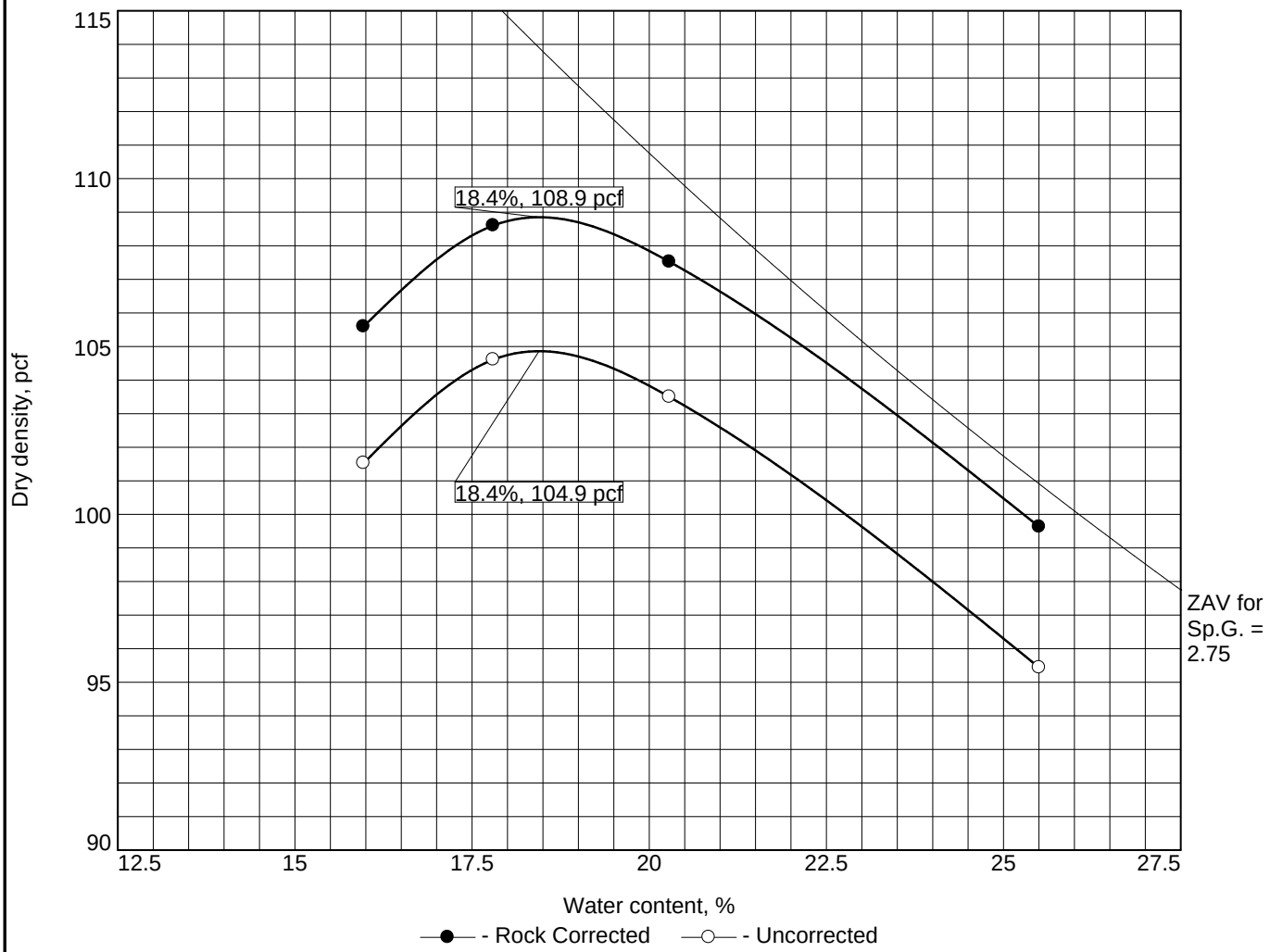
Project: Carpenter Snow Creek

Source of Sample: CCSS-WT-E-001

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-00a Method A Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification USCS	Classification AASHTO	Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	SM	A-2-4(0)		2.75	NV	NP	9.7	23.9

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 108.9 pcf	104.9 pcf	Silty SAND
Optimum moisture = 18.4 %	18.4 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** CCSS-WT-E-001

Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	8.7	6.0	6.4	18.8	38.9	21.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	4.4920	0.4229	0.2758	0.1192				

Material Description	USCS	AASHTO
○ Silty SAND	SM	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

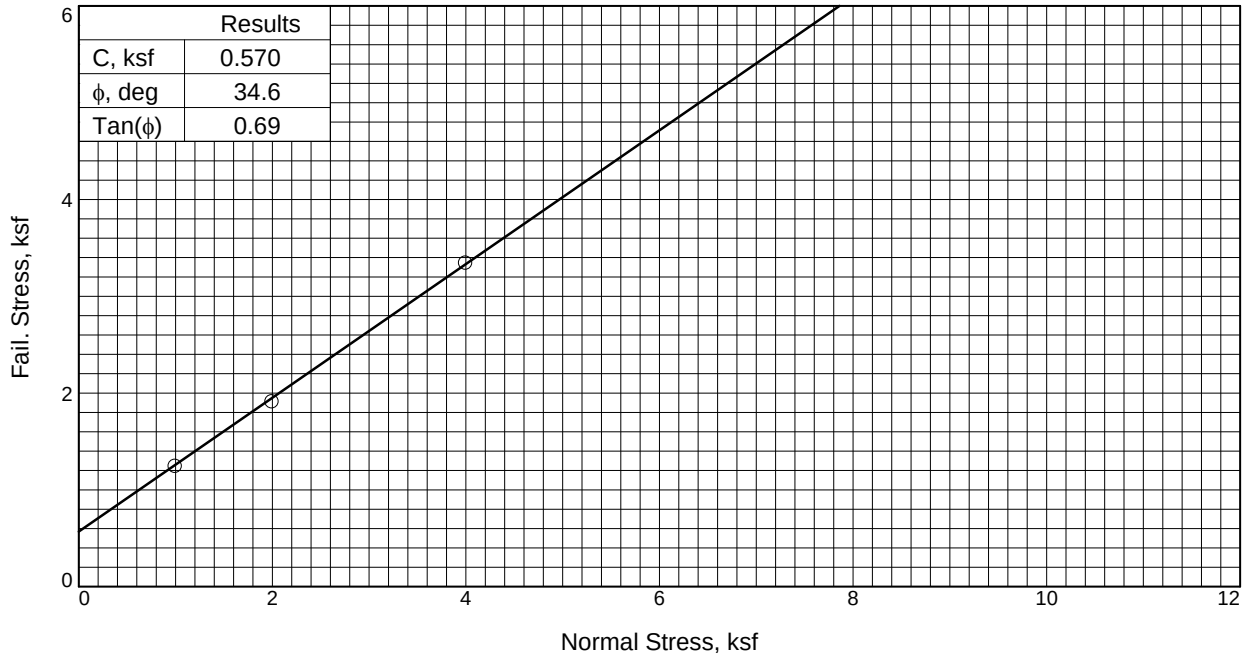
○ **Source of Sample:** CCSS-WT-E-002

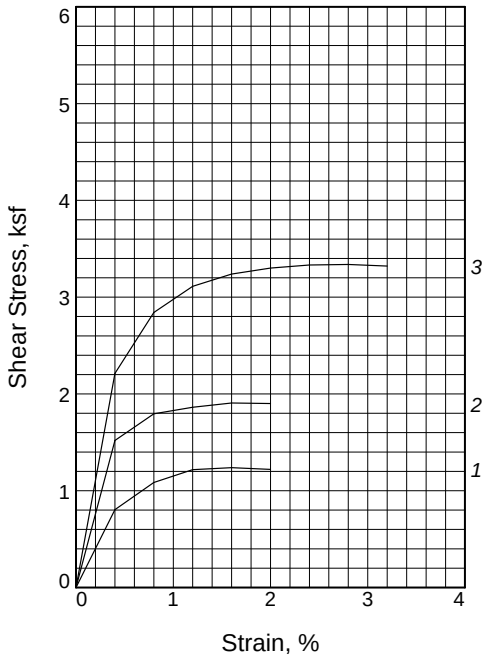
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	13.8	13.8	13.8
	Dry Density, pcf	102.0	102.0	102.0
	Saturation, %	57.0	57.0	57.0
	Void Ratio	0.6532	0.6532	0.6532
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	19.0	17.0	11.4
	Dry Density, pcf	102.8	103.1	104.1
	Saturation, %	80.3	72.4	49.7
	Void Ratio	0.6390	0.6344	0.6194
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.991	0.989	0.980
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		1.238	1.907	3.338
Strain, %		1.6	1.6	2.8
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Silty SAND

LL= NV **PI=** NP
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

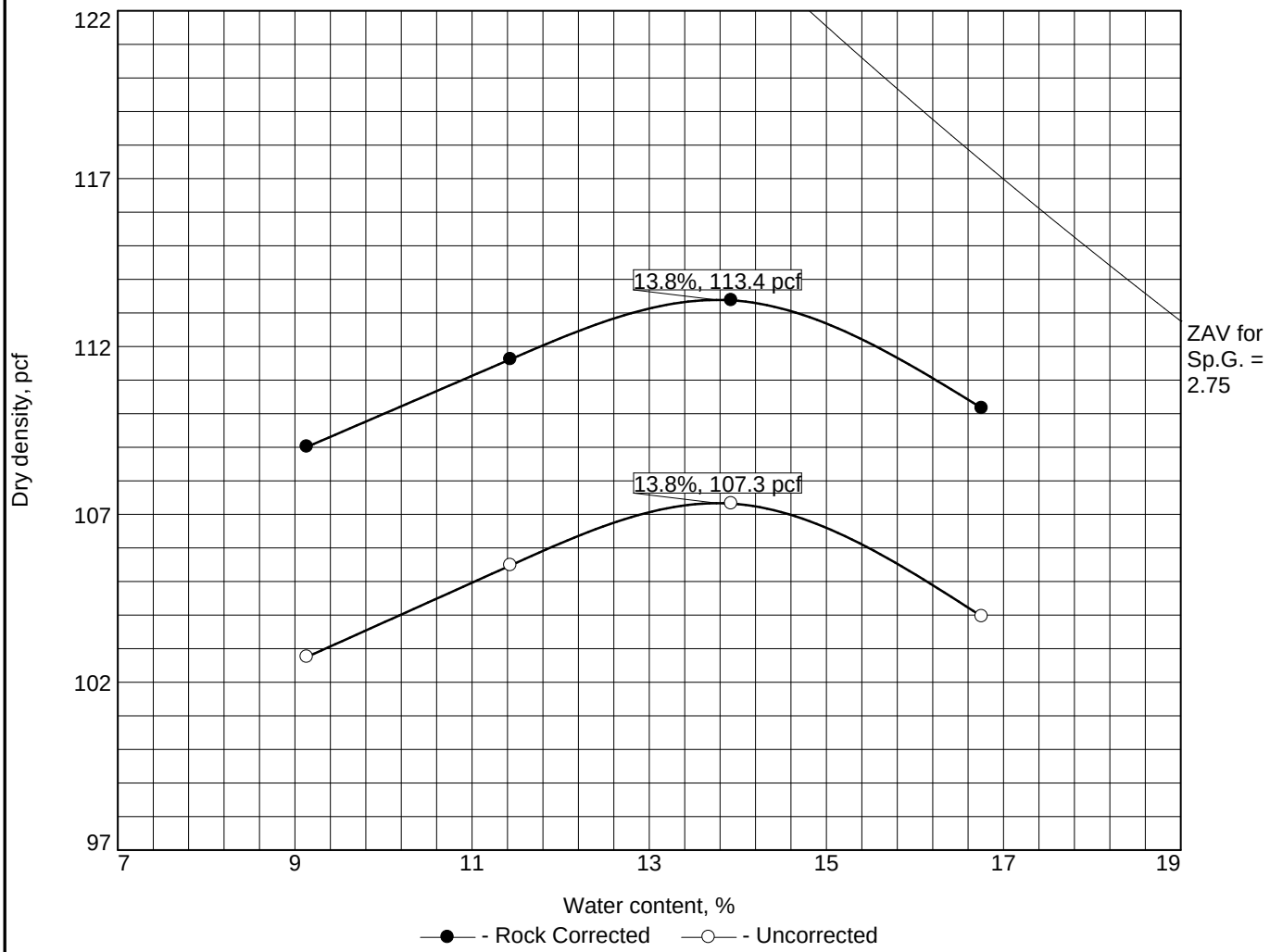
Project: Carpenter Snow Creek

Source of Sample: CCSS-WT-E-002

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-91 Procedure A Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	SM	A-2-4(0)		2.75	NV	NP	14.7	21.2

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 113.4 pcf	107.3 pcf	Silty SAND
Optimum moisture = 13.8 %	13.8 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** CCSS-WT-E-002

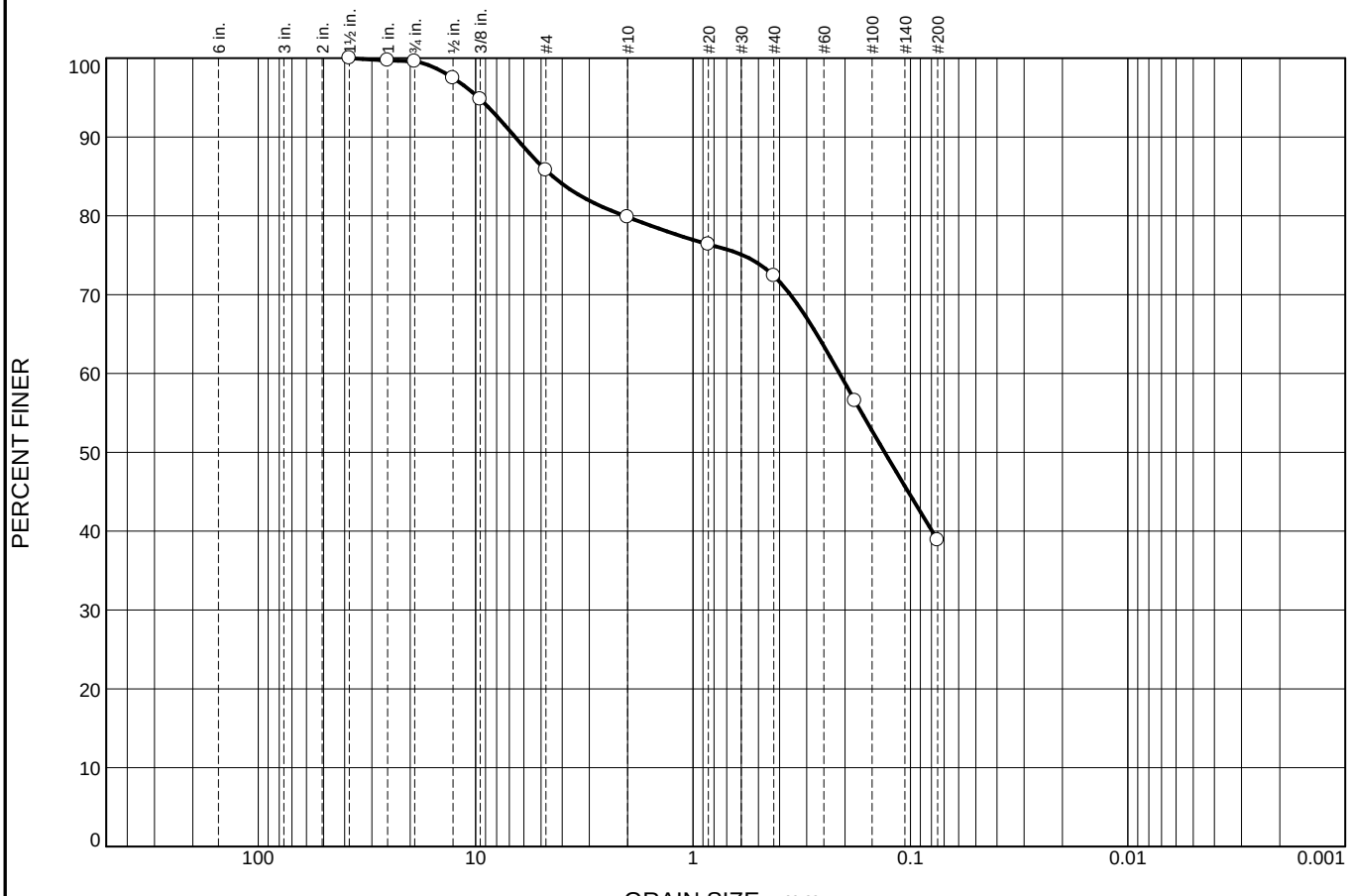
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.4	13.8	6.0	7.4	33.5	38.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	4.4136	0.2119	0.1313					

Material Description	USCS	AASHTO
○ Silty SAND	SM	A-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

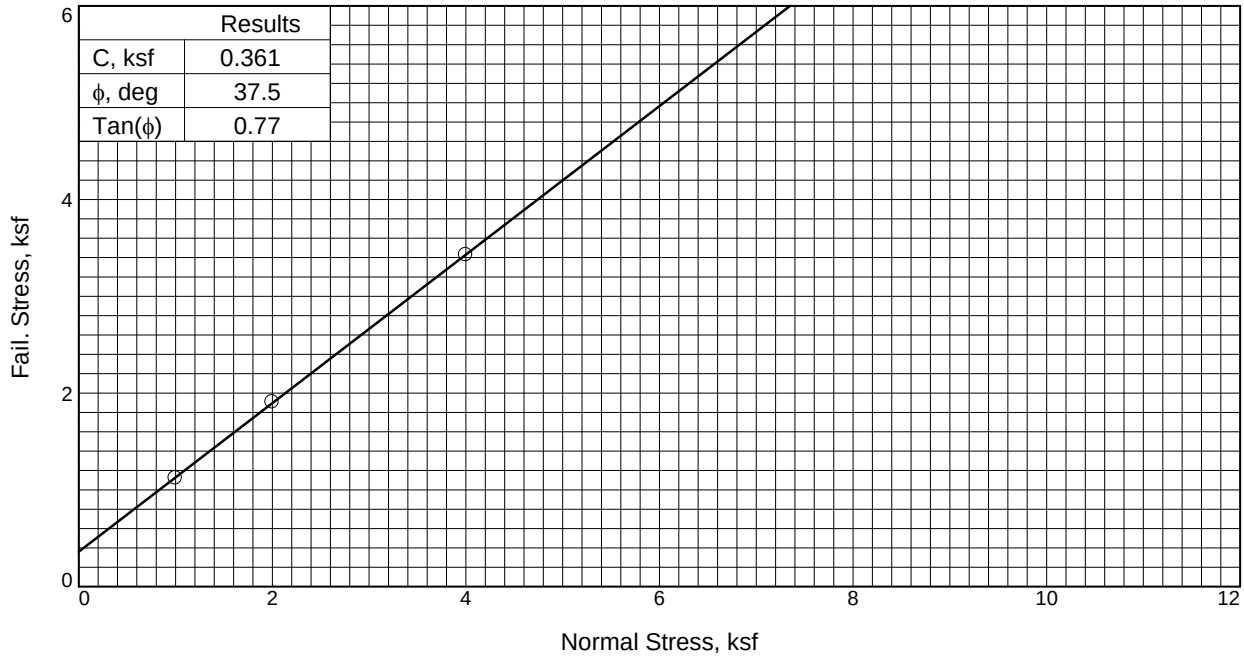
○ **Source of Sample:** CCSS-WT-E-003

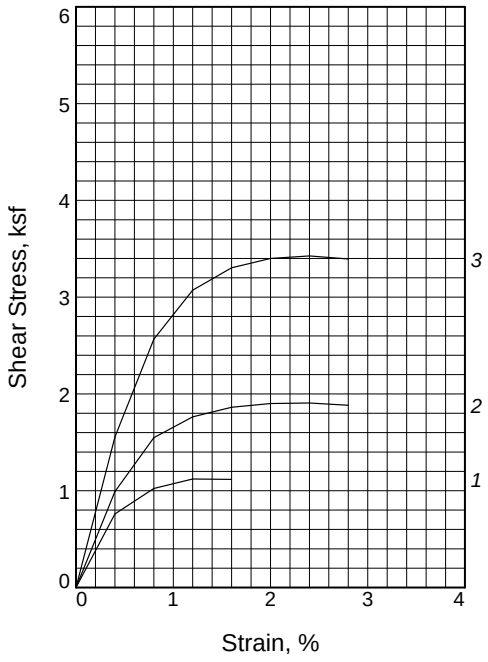
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	16.3	16.3	16.3
	Dry Density, pcf	100.6	100.6	100.6
	Saturation, %	65.1	65.1	65.1
	Void Ratio	0.6761	0.6761	0.6761
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	17.8	16.8	15.0
	Dry Density, pcf	101.4	101.6	102.5
	Saturation, %	72.8	69.0	62.9
	Void Ratio	0.6620	0.6594	0.6448
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.992	0.990	0.981
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		1.121	1.907	3.426
Strain, %		1.2	2.4	2.4
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Silty SAND

LL= NV **PI=** NP
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

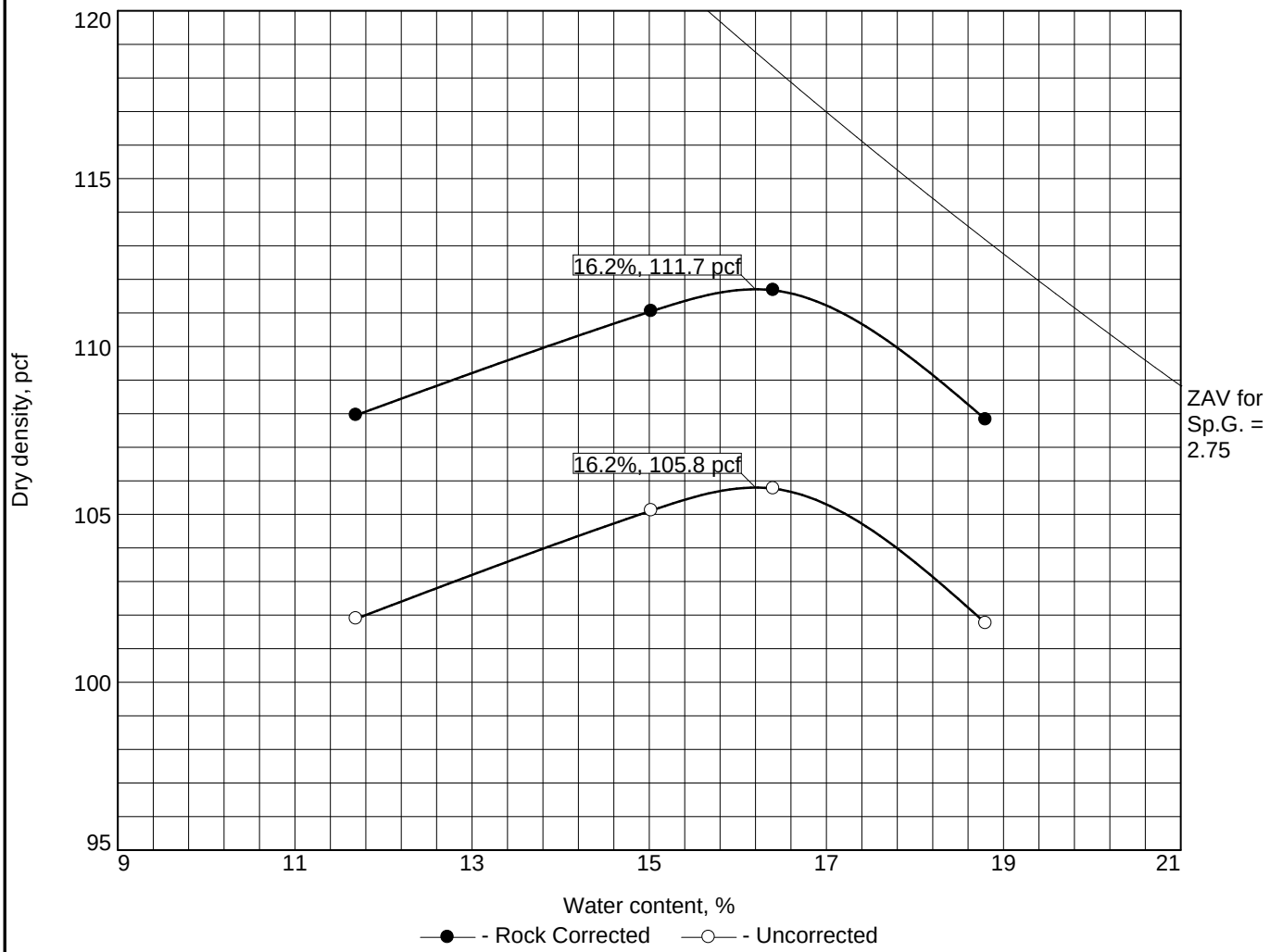
Project: Carpenter Snow Creek

Source of Sample: CCSS-WT-E-003

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	SM	A-4(0)		2.75	NV	NP	14.2	38.9

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 111.7 pcf	105.8 pcf	Silty SAND
Optimum moisture = 16.2 %	16.2 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** CCSS-WT-E-003

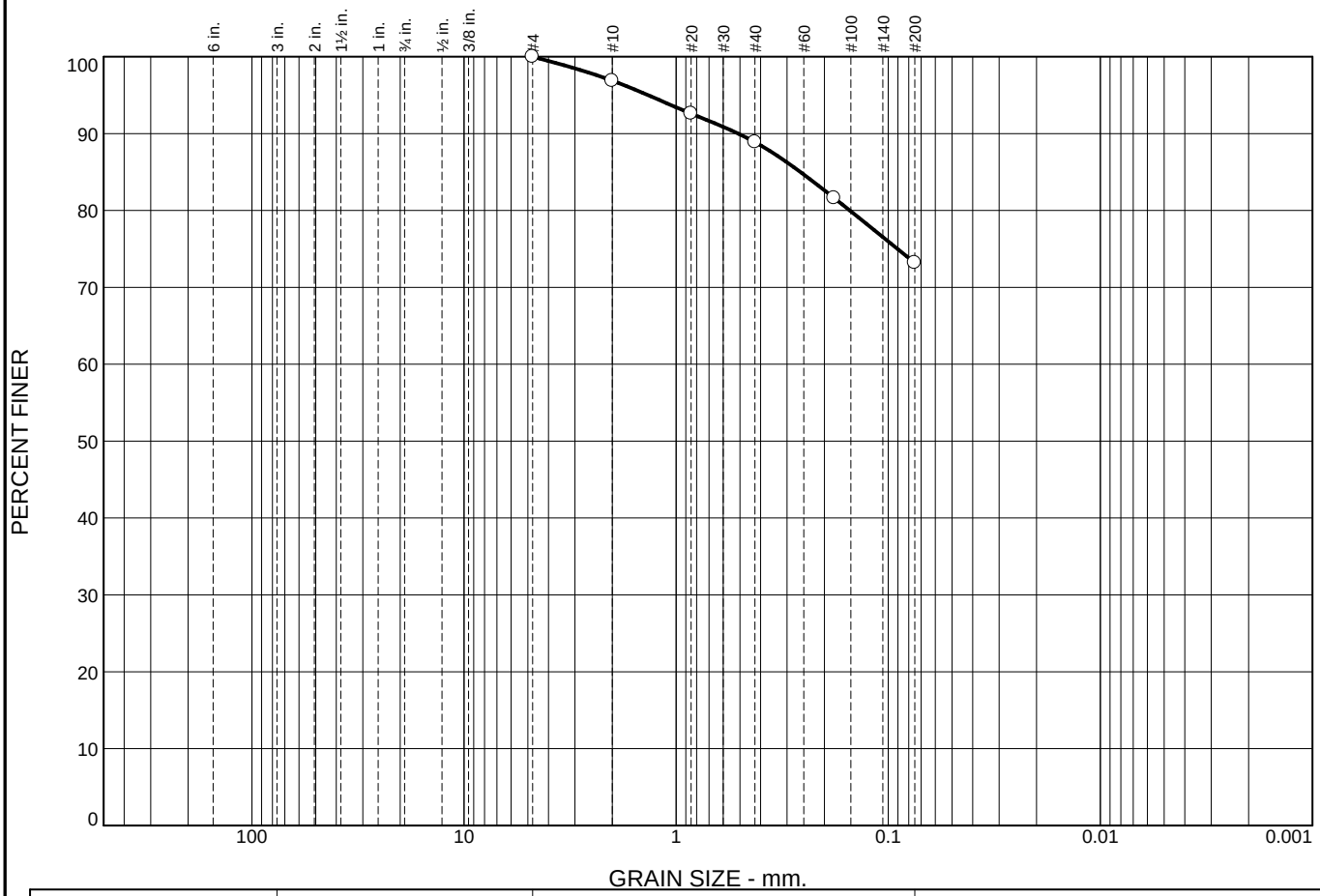
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	3.1	8.0	15.7	73.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	37	24	0.2594							

Material Description	USCS	AASHTO
○ Lean CLAY with Sand	CL	A-6(9)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

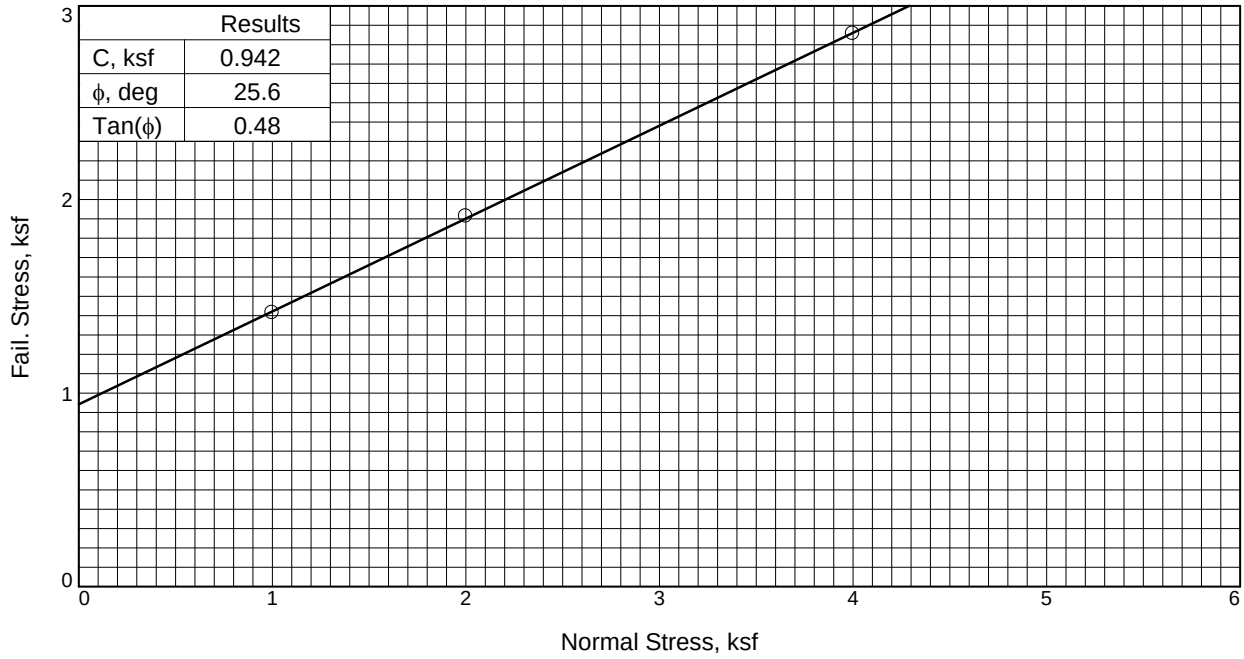
○ **Source of Sample:** CCSS-WT-E-004

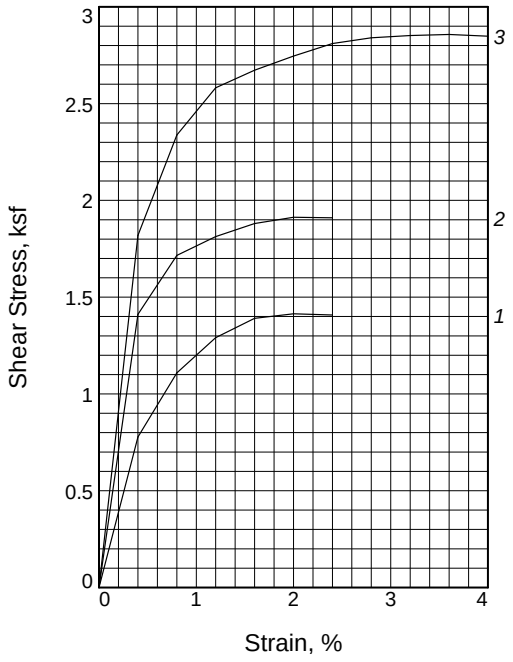
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	17.1	17.1	17.1
	Dry Density, pcf	94.8	94.8	94.8
	Saturation, %	59.4	59.4	59.4
	Void Ratio	0.7773	0.7773	0.7773
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	23.5	23.2	22.8
	Dry Density, pcf	95.7	95.9	96.6
	Saturation, %	83.5	82.5	82.6
	Void Ratio	0.7613	0.7579	0.7440
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.991	0.989	0.981
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		1.414	1.913	2.857
Strain, %		2.0	2.0	3.6
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description:

Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

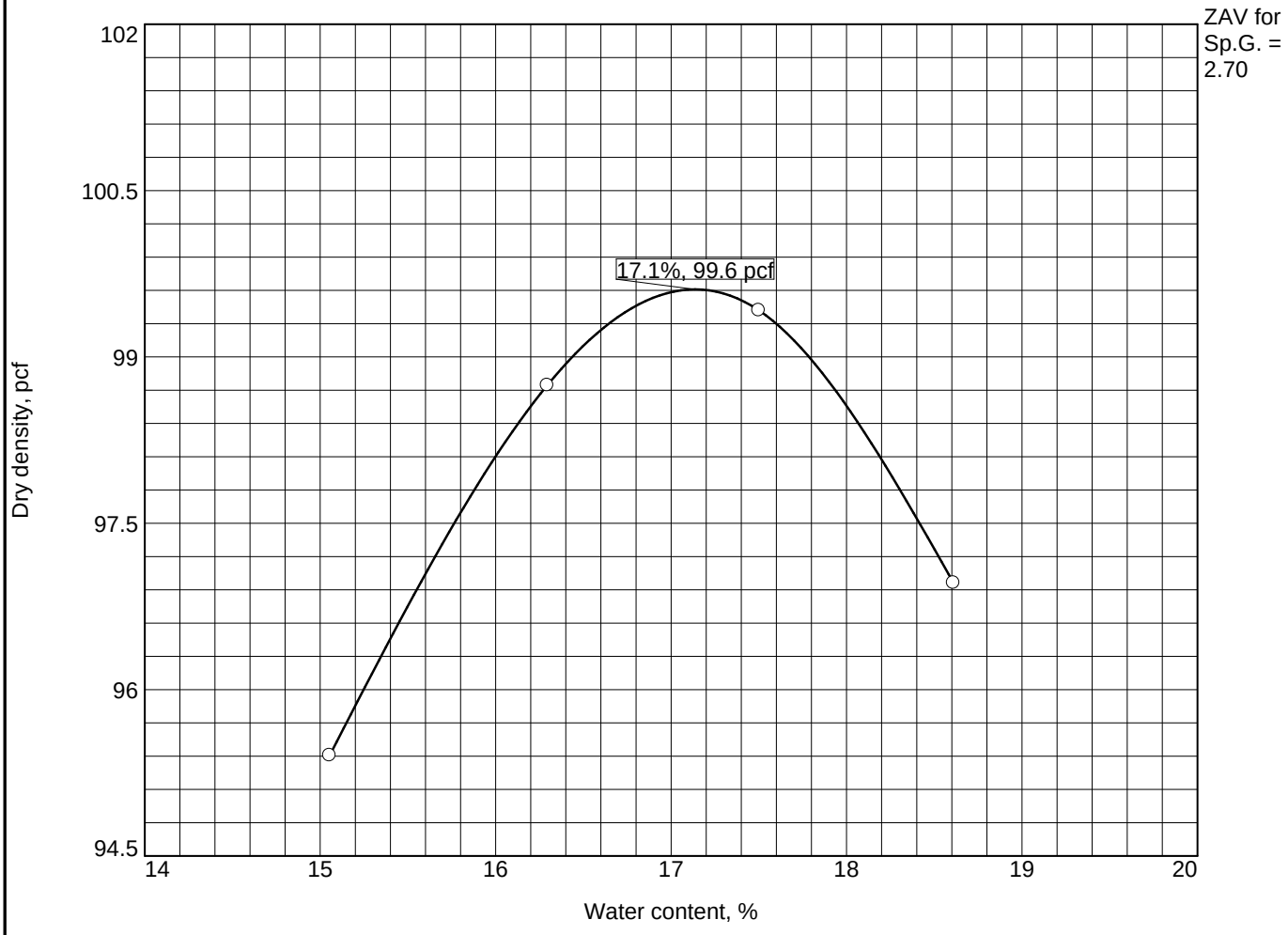
Project: Carpenter Snow Creek

Source of Sample: CCSS-WT-E-004

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT

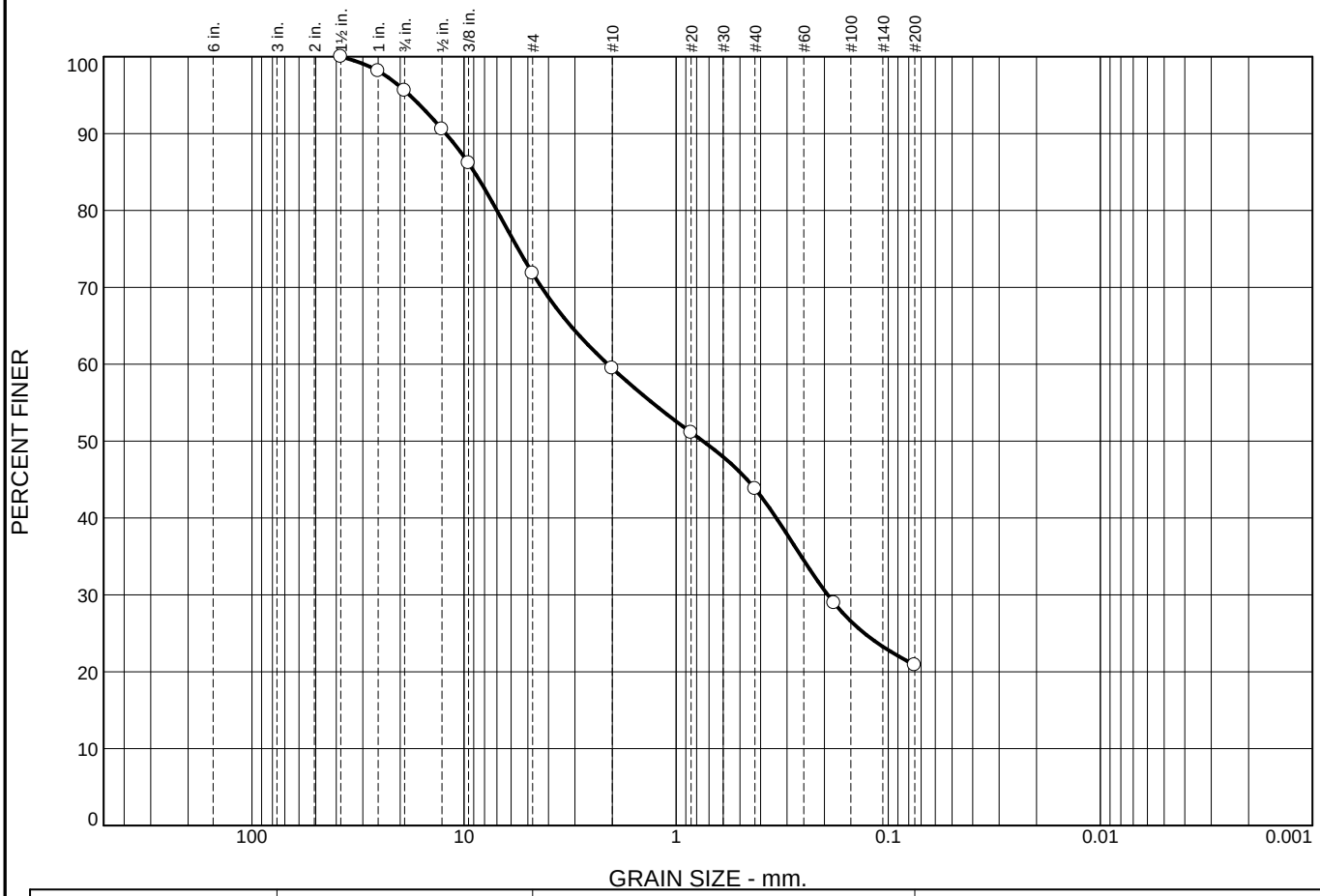


Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 99.6 pcf Optimum moisture = 17.1 %	
Project No. 114-551059 **Client:** Tetra Tech EMI **Project:** Carpenter Snow Creek ○**Source of Sample:** CCSS-WT-E-004	**Remarks:**
Tetra Tech **Billings, MT**	**Figure**

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	4.4	23.8	12.3	15.7	22.9	20.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	8.9361	2.0981	0.7480	0.1929				

Material Description	USCS	AASHTO
○ Silty SAND with Gravel	SM	A-1-b

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

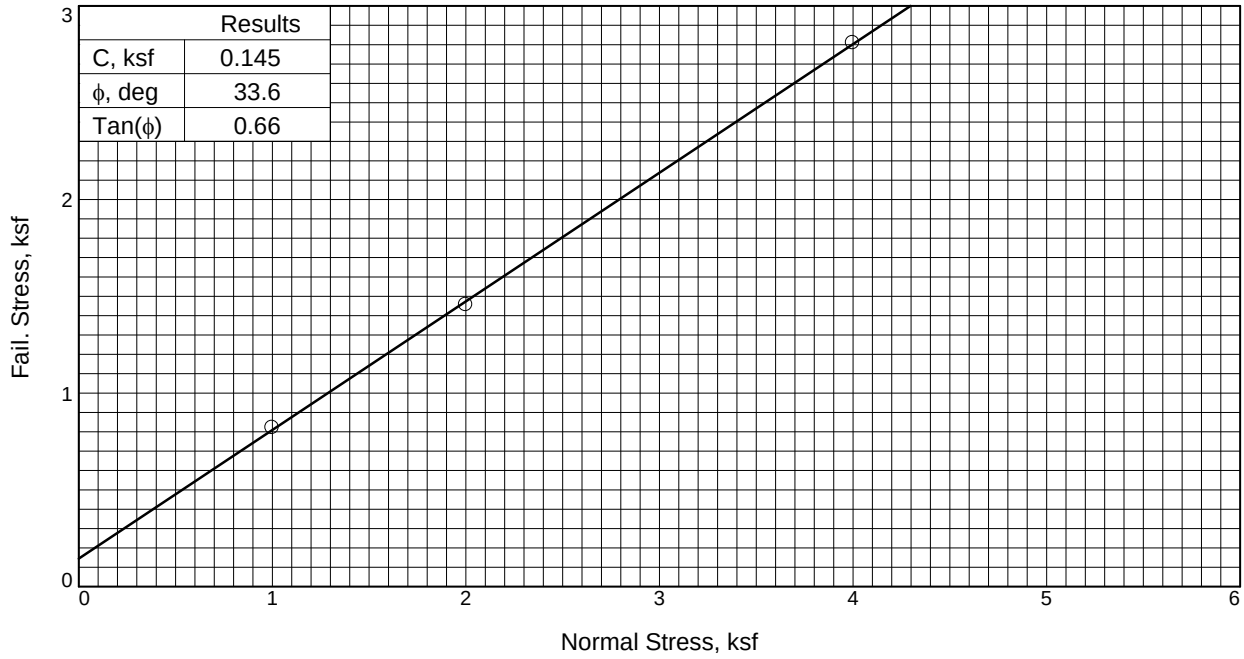
○ **Source of Sample:** CCSS-WT-E-005

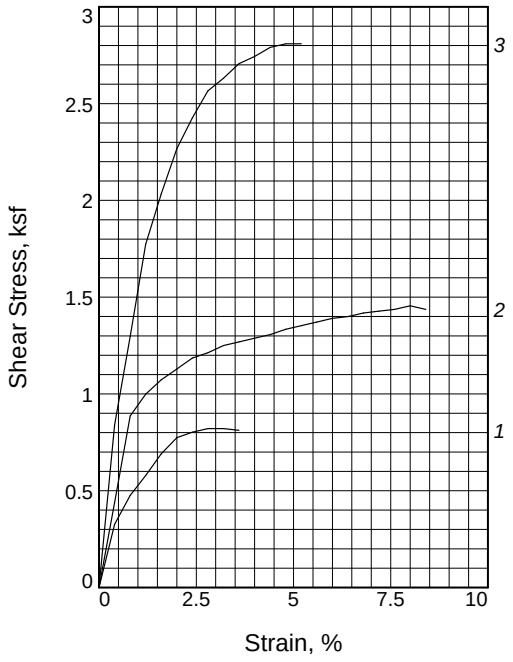
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	9.3	9.3	9.3
	Dry Density, pcf	108.6	108.6	108.6
	Saturation, %	45.5	45.5	45.5
	Void Ratio	0.5516	0.5516	0.5516
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	12.8	11.4	9.0
	Dry Density, pcf	108.8	109.1	109.2
	Saturation, %	63.0	56.5	44.8
	Void Ratio	0.5490	0.5456	0.5442
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.998	0.996	0.995
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.821	1.456	2.809
Strain, %		2.8	8.0	4.8
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Silty SAND with Gravel

LL= NV **PI=** NP
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

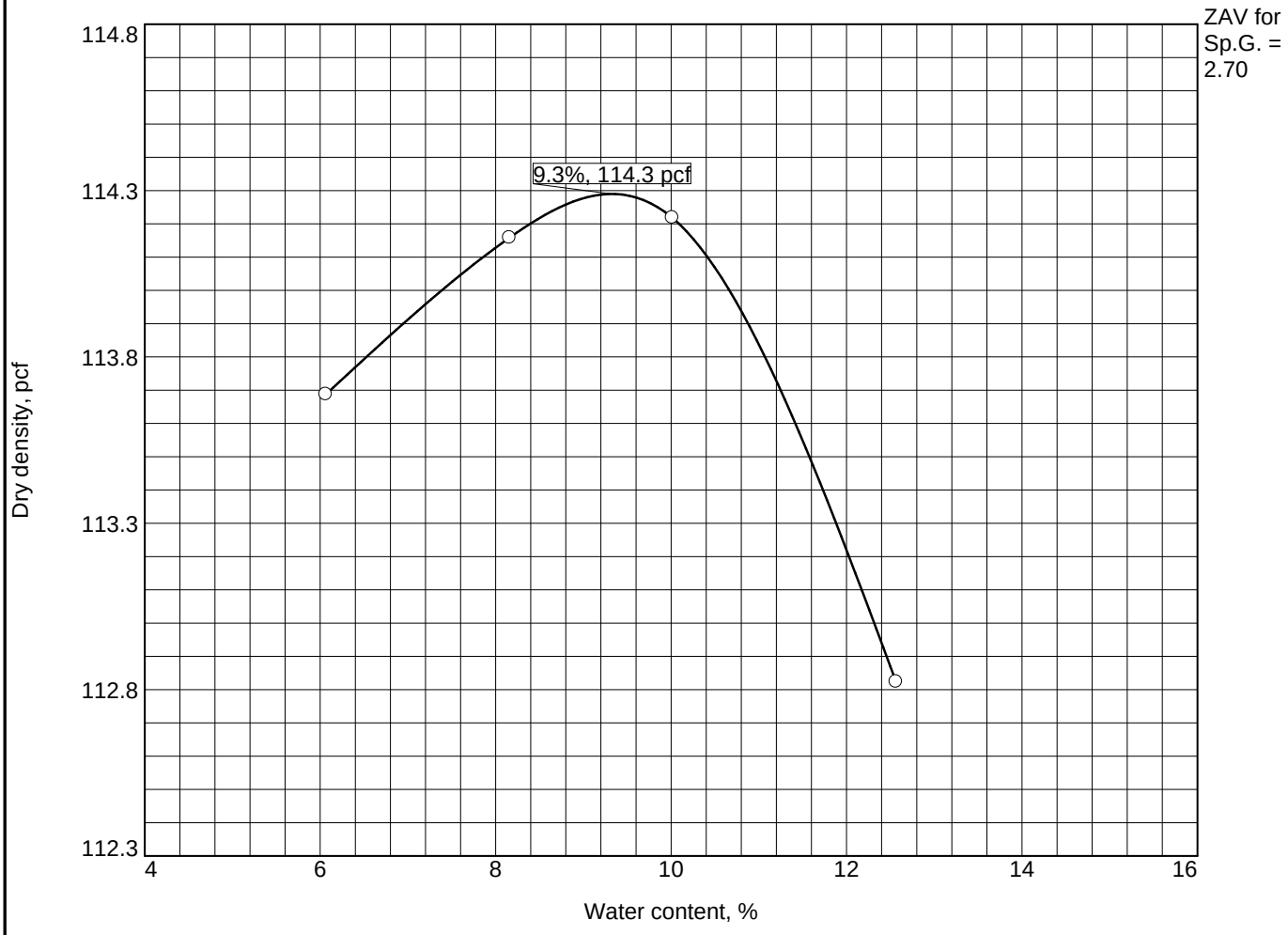
Project: Carpenter Snow Creek

Source of Sample: CCSS-WT-E-005

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	SM	A-1-b			NV	NP	28.2	20.9

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 114.3 pcf Optimum moisture = 9.3 %	Silty SAND with Gravel

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** CCSS-WT-E-005

Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.5	4.9	8.5	65.5	19.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	0.4236	0.2486	0.2053	0.1205				

Material Description	USCS	AASHTO
○ Silty SAND	SM	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

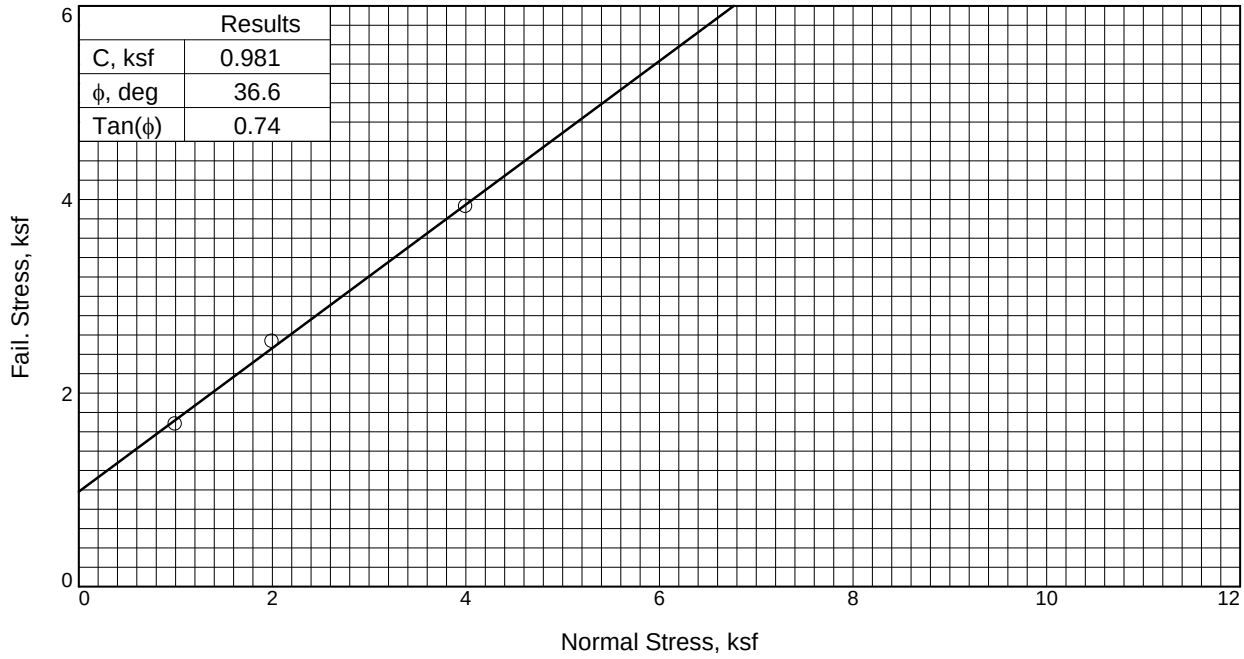
○ **Source of Sample:** CCSS-WT-E-006

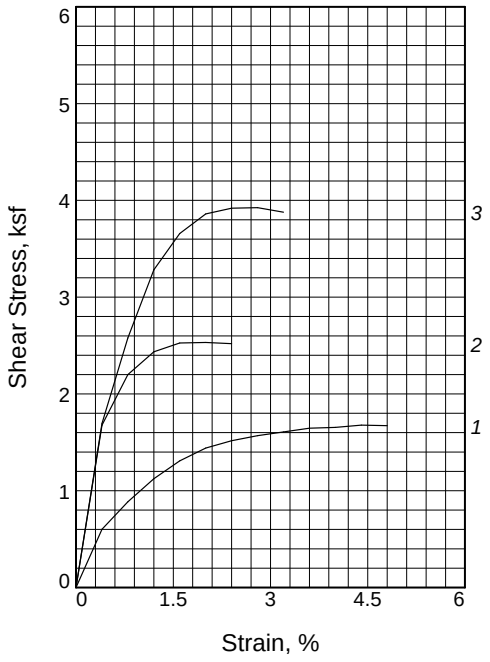
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	19.1	19.1	19.1
	Dry Density, pcf	100.0	100.0	100.0
	Saturation, %	75.1	75.1	75.1
	Void Ratio	0.6862	0.6862	0.6862
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	20.8	19.3	18.5
	Dry Density, pcf	100.3	101.2	102.6
	Saturation, %	82.4	78.1	77.7
	Void Ratio	0.6803	0.6654	0.6425
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.997	0.988	0.974
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		1.678	2.532	3.925
Strain, %		4.4	2.0	2.8
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type:

Description: Silty SAND

LL= NV **PI=** NP

Specific Gravity= 2.70

Remarks:

Figure _____

Client: Tetra Tech EMI

Project: Carpenter Snow Creek

Source of Sample: CCSS-WT-E-006

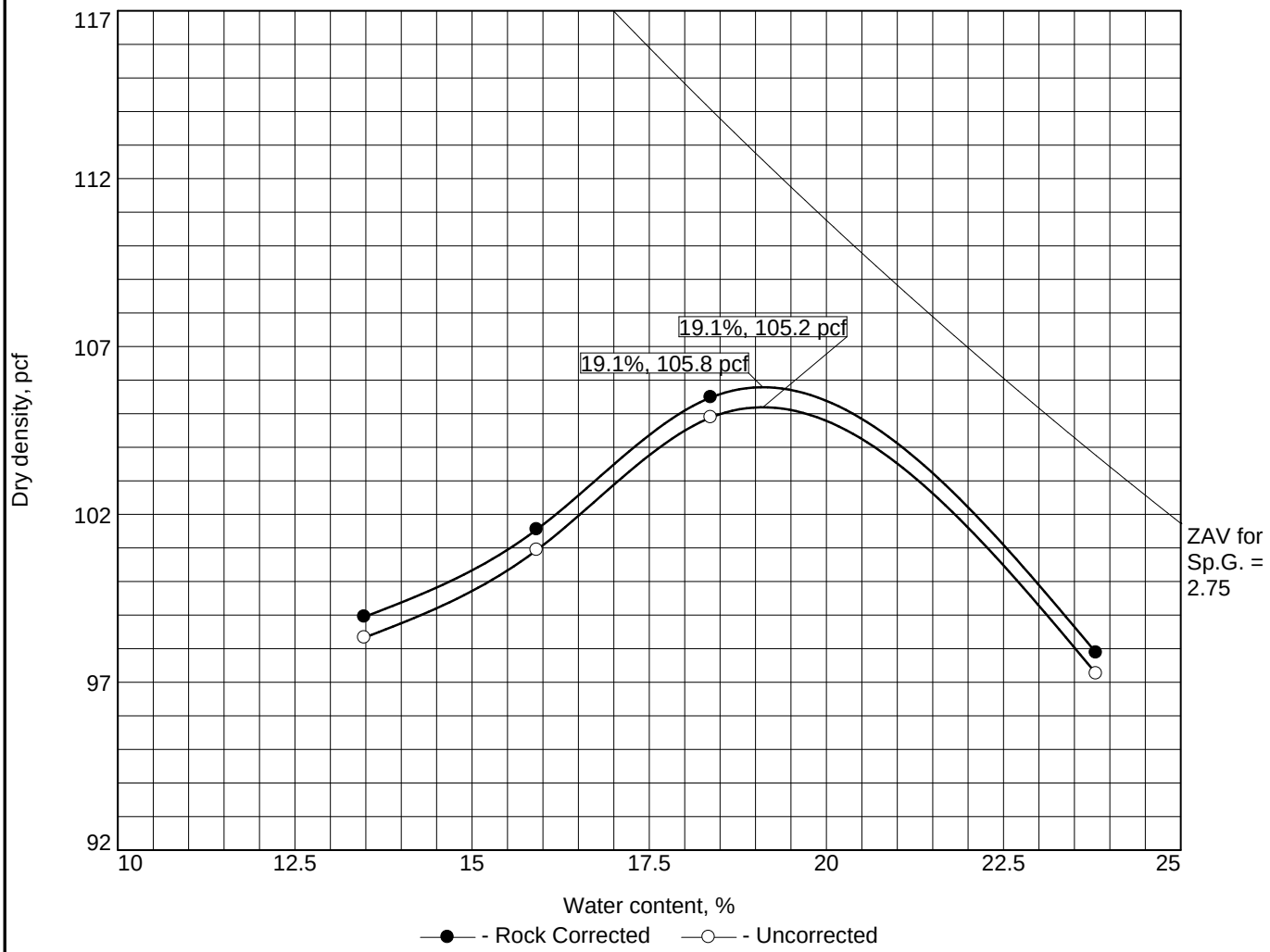
Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT

Tetra Tech

Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	SM	A-2-4(0)		2.75	NV	NP	1.5	19.6

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 105.8 pcf	105.2 pcf	Silty SAND
Optimum moisture = 19.1 %	19.1 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** CCSS-WT-E-006

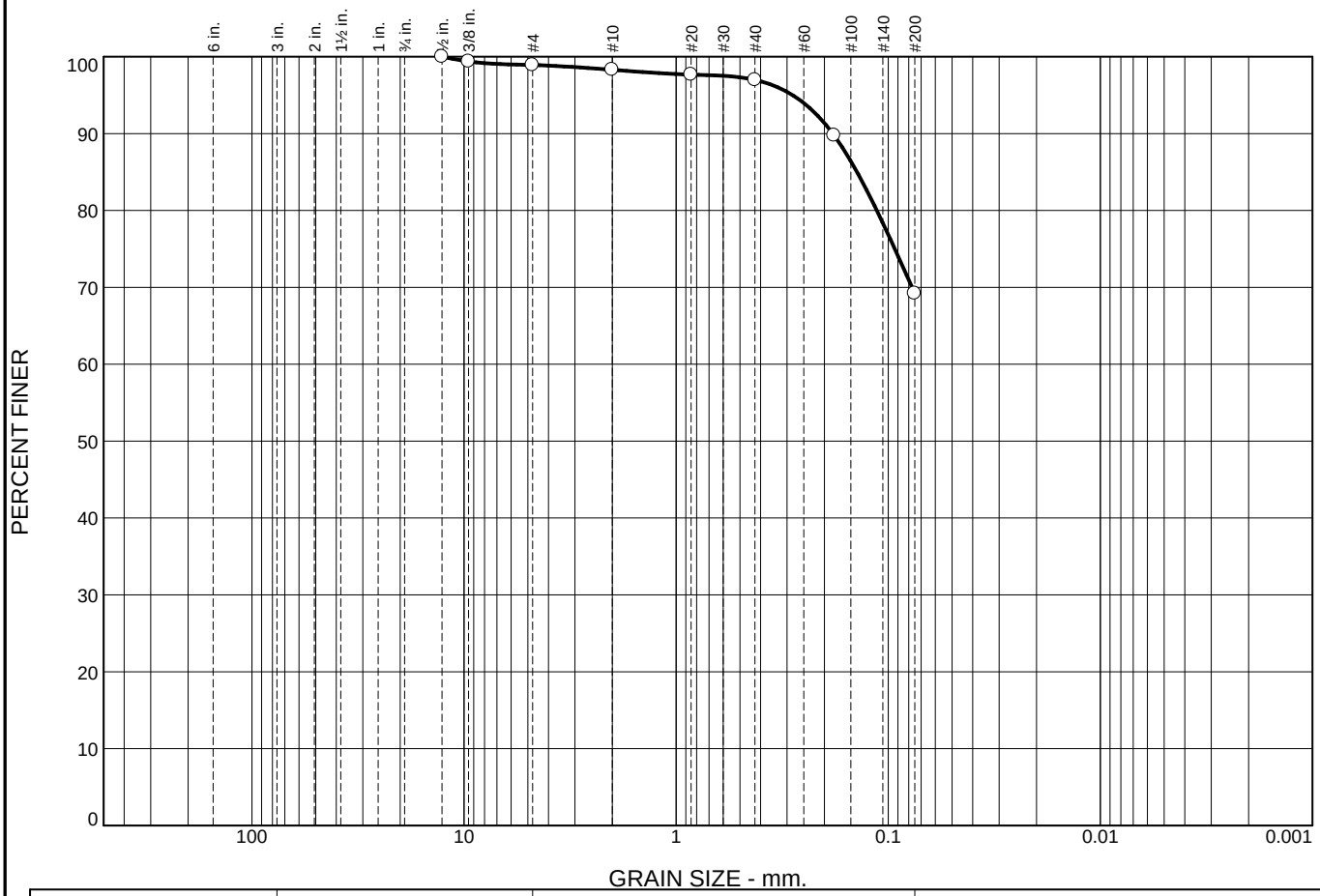
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.1	0.6	1.3	27.8	69.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	34	18	0.1404							

Material Description	USCS	AASHTO
○ Sandy lean CLAY	CL	A-6(9)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

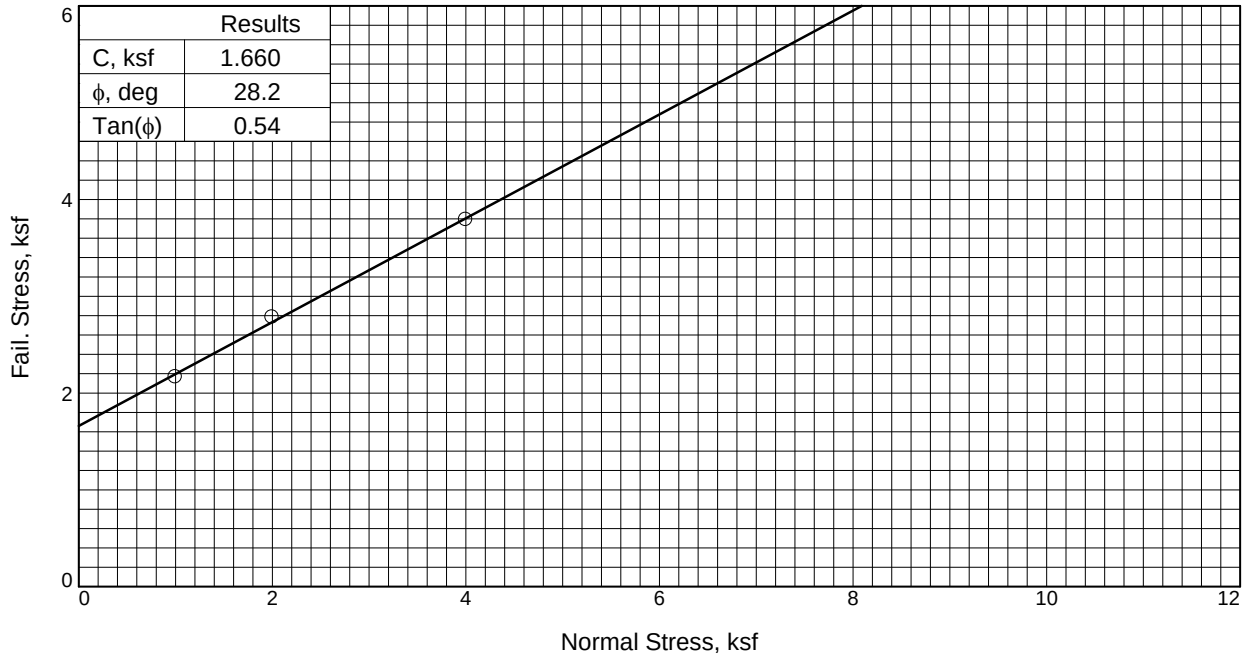
○ **Source of Sample:** CCUT-WT-E-001

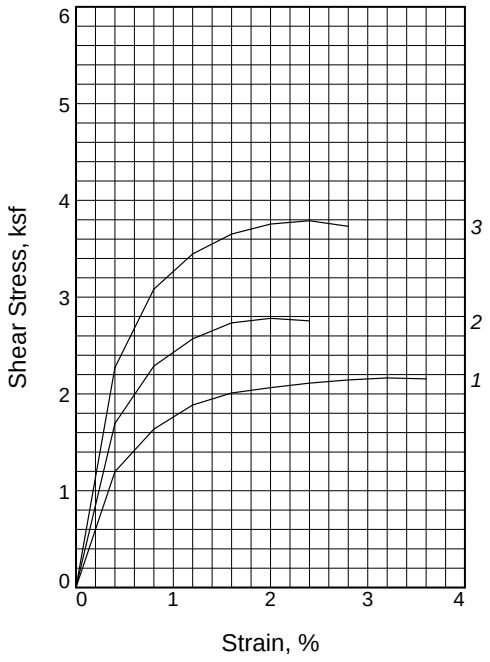
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	15.3	15.3	15.3
	Dry Density, pcf	106.7	106.7	106.7
	Saturation, %	71.2	71.2	71.2
	Void Ratio	0.5799	0.5799	0.5799
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	17.5	17.2	16.4
	Dry Density, pcf	107.0	107.1	108.2
	Saturation, %	81.8	80.9	79.3
	Void Ratio	0.5760	0.5744	0.5580
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.998	0.997	0.986
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		2.165	2.781	3.790
Strain, %		3.2	2.0	2.4
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type:

Description: Sandy lean CLAY

LL= 34

Specific Gravity= 2.70

Remarks:

Figure _____

Client: Tetra Tech EMI

Project: Carpenter Snow Creek

Source of Sample: CCUT-WT-E-001

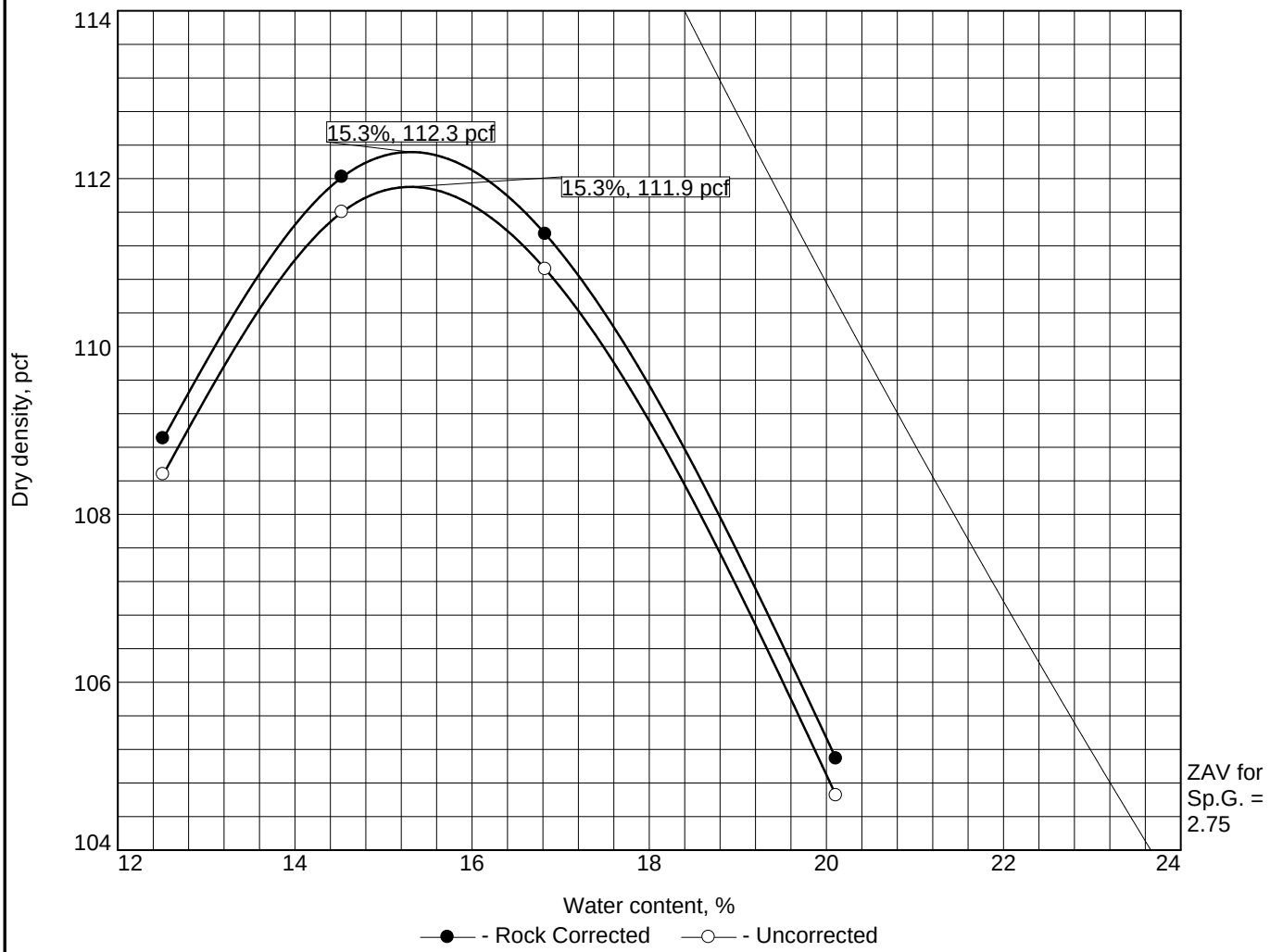
Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT

Tetra Tech

Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification USCS	Classification AASHTO	Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	CL	A-6(9)		2.75	34		1.1	69.2

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 112.3 pcf	111.9 pcf	Sandy lean CLAY
Optimum moisture = 15.3 %	15.3 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** CCUT-WT-E-001

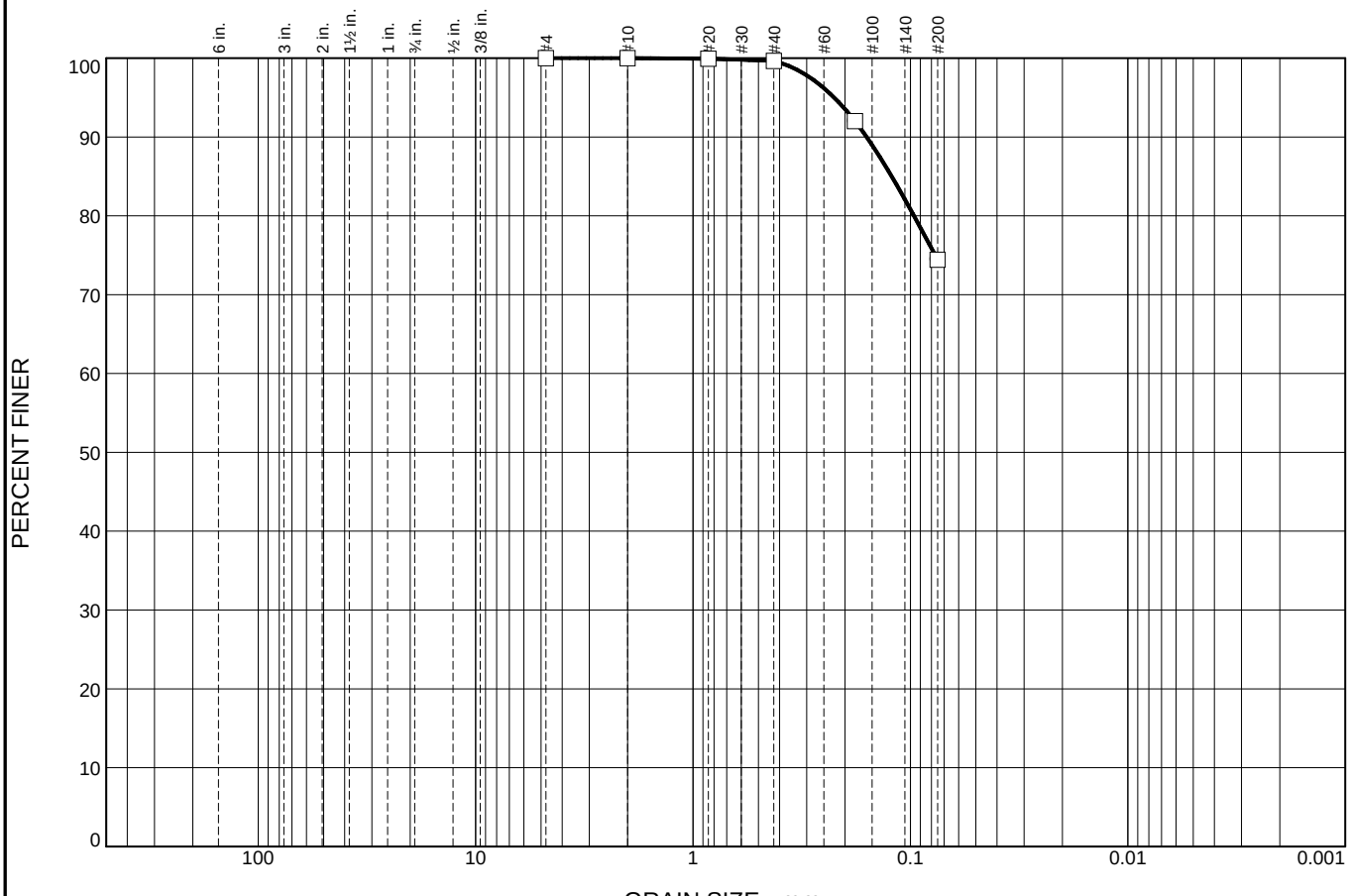
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.4	25.2	74.4	
□	0.0	0.0	0.0	0.0	0.4	25.2	74.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	41	17	0.1220							
□	41	17	0.1220							

Material Description	USCS	AASHTO
○ lean clay with sand	CL	A-7-6(16)
□ Lean CLAY with Sand	CL	A-7-6(16)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

○ **Source of Sample:** CCUT-WT-E-002

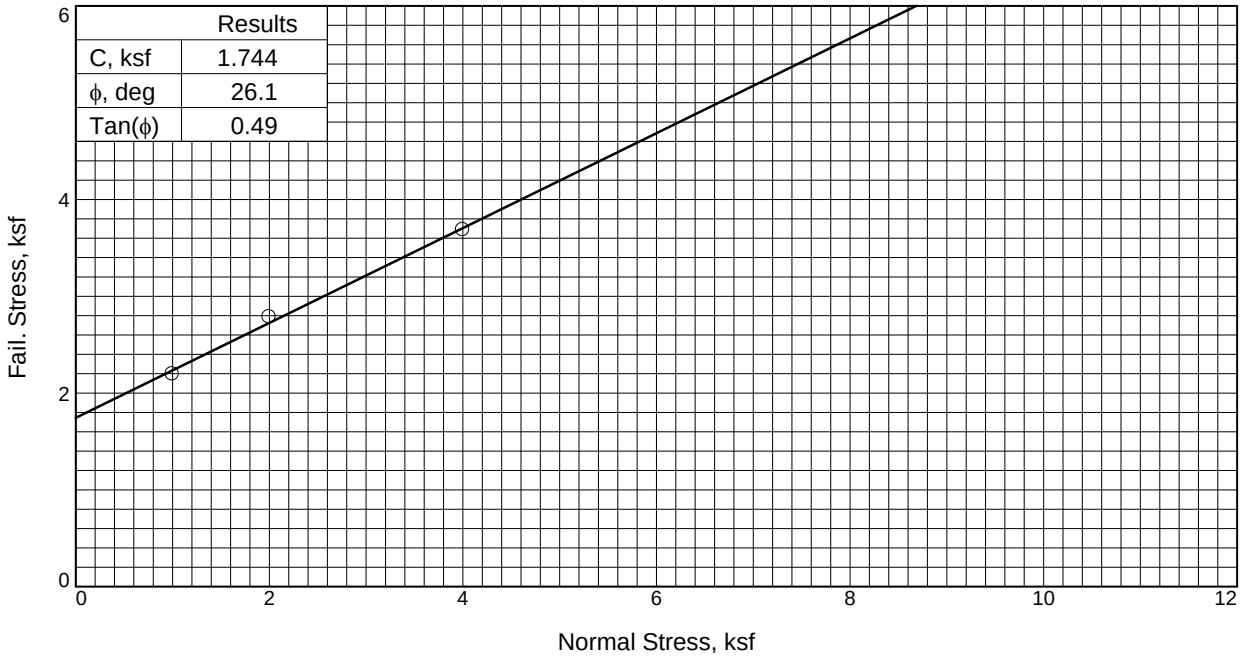
□ **Source of Sample:** CCUT-WT-E-002

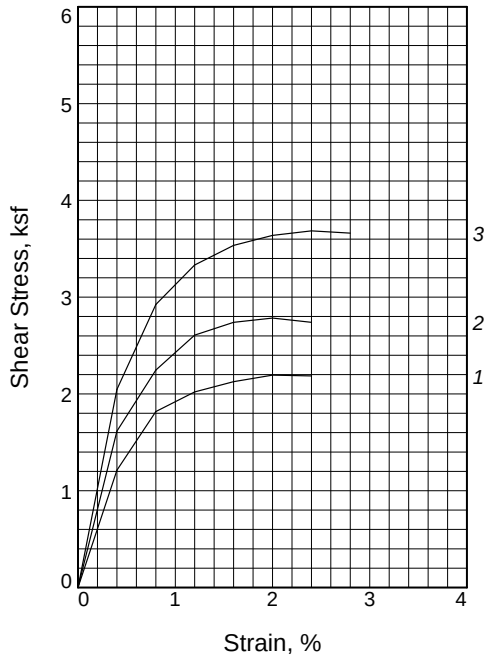
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	16.1	16.1	16.1
	Dry Density, pcf	104.3	104.3	104.3
	Saturation, %	70.6	70.6	70.6
	Void Ratio	0.6153	0.6153	0.6153
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	19.3	18.5	17.1
	Dry Density, pcf	104.3	104.6	105.5
	Saturation, %	84.6	81.8	77.3
	Void Ratio	0.6153	0.6111	0.5976
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	0.997	0.989
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		2.194	2.784	3.685
Strain, %		2.0	2.0	2.4
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded

Description:

Specific Gravity= 2.70

Remarks:

Figure _____

Client: Tetra Tech EMI

Project: Carpenter Snow Creek

Source of Sample: CCUT-WT-E-002

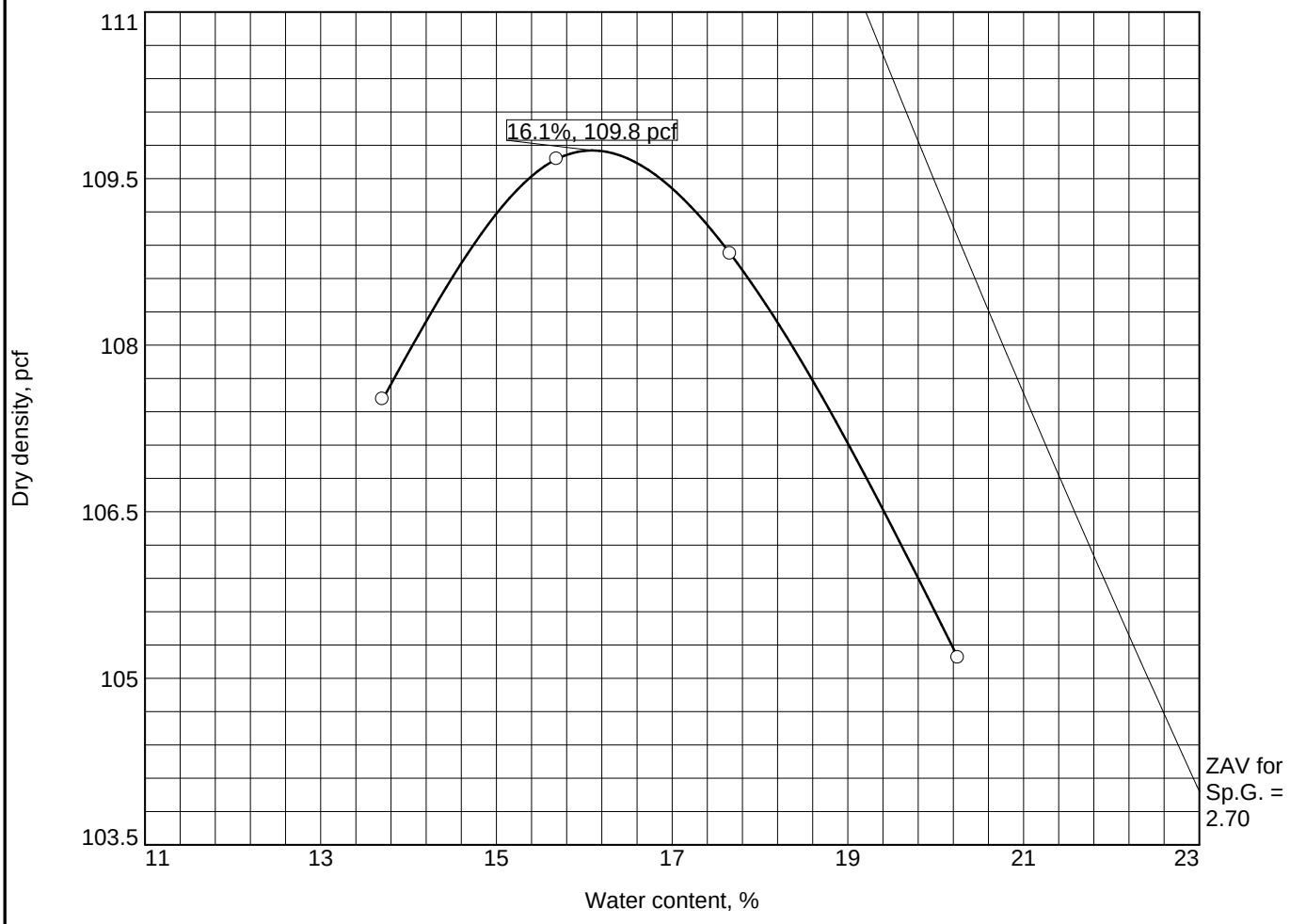
Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT

Tetra Tech

Billings, MT

COMPACTION TEST REPORT

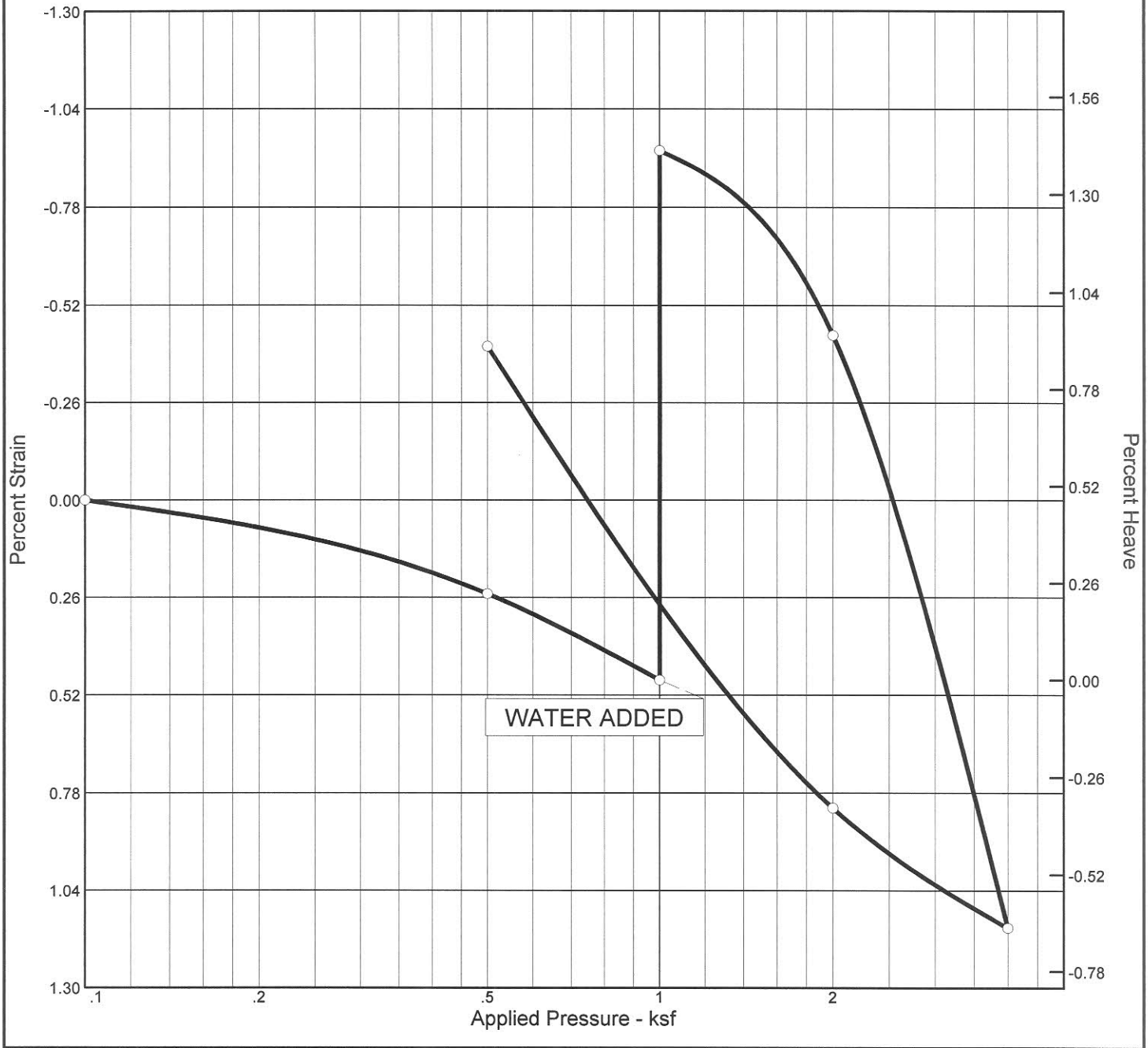


Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 109.8 pcf Optimum moisture = 16.1 %	
Project No. 114-551059 **Client:** Tetra Tech EMI **Project:** Carpenter Snow Creek ○**Source of Sample:** CCUT-WT-E-002	**Remarks:**
Tetra Tech **Billings, MT**	**Figure**

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
70.7 %	16.1 %	104.4	41	17	2.70		3.15	0.09	0.615

MATERIAL DESCRIPTION	USCS	AASHTO
Lean CLAY with Sand		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCUT-WT-E-002

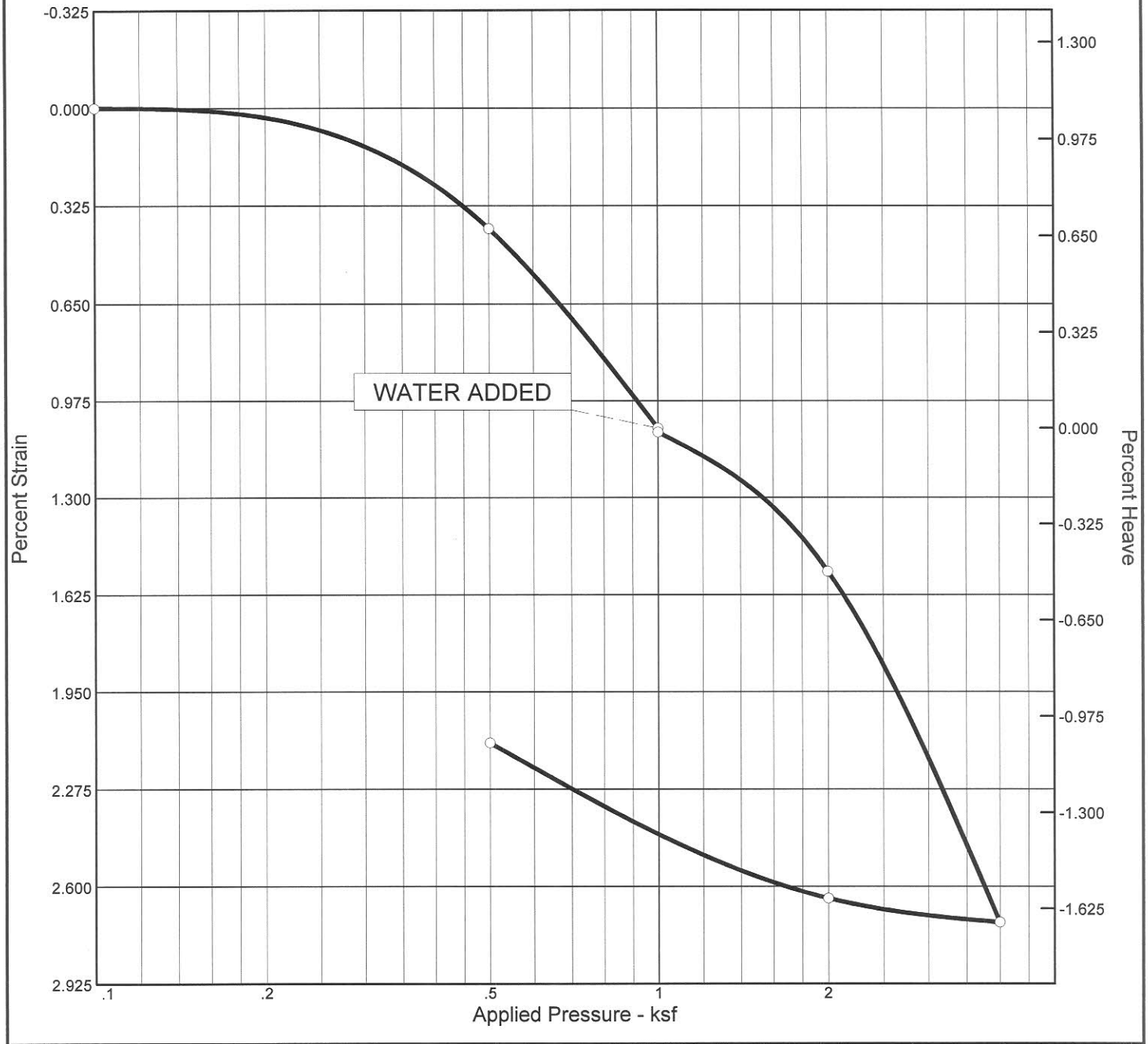
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
68.2 %	13.8 %	109.0	30	7	2.70		1.97	0.06	0.546

MATERIAL DESCRIPTION	USCS	AASHTO
Clayey SAND with Gravel		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: SCHS-WR-E-013

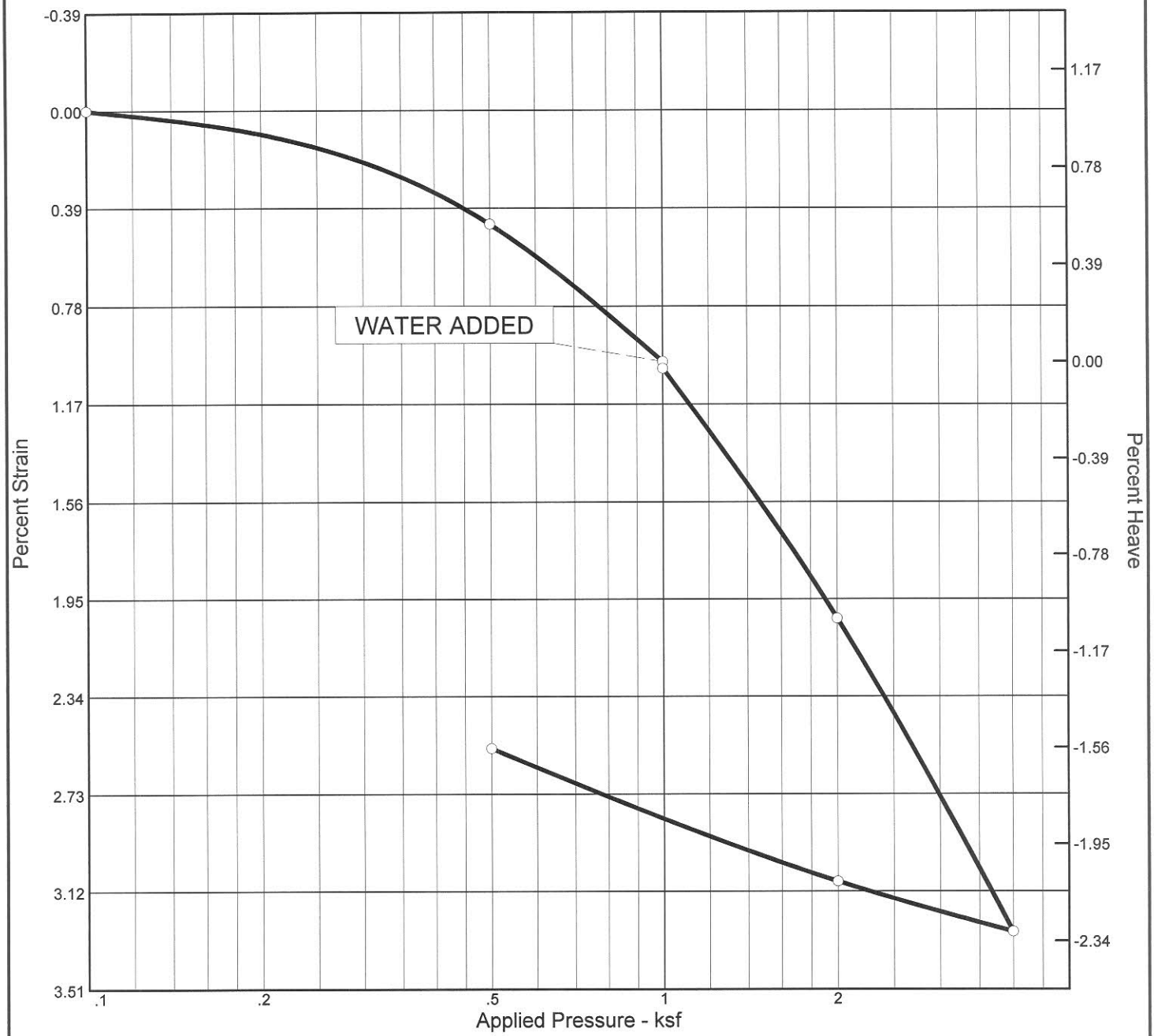
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
64.6 %	16.2 %	100.5	NV	NP	2.70		0.97	0.07	0.676

MATERIAL DESCRIPTION	USCS	AASHTO
Silty SAND		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCSS-WT-E-003

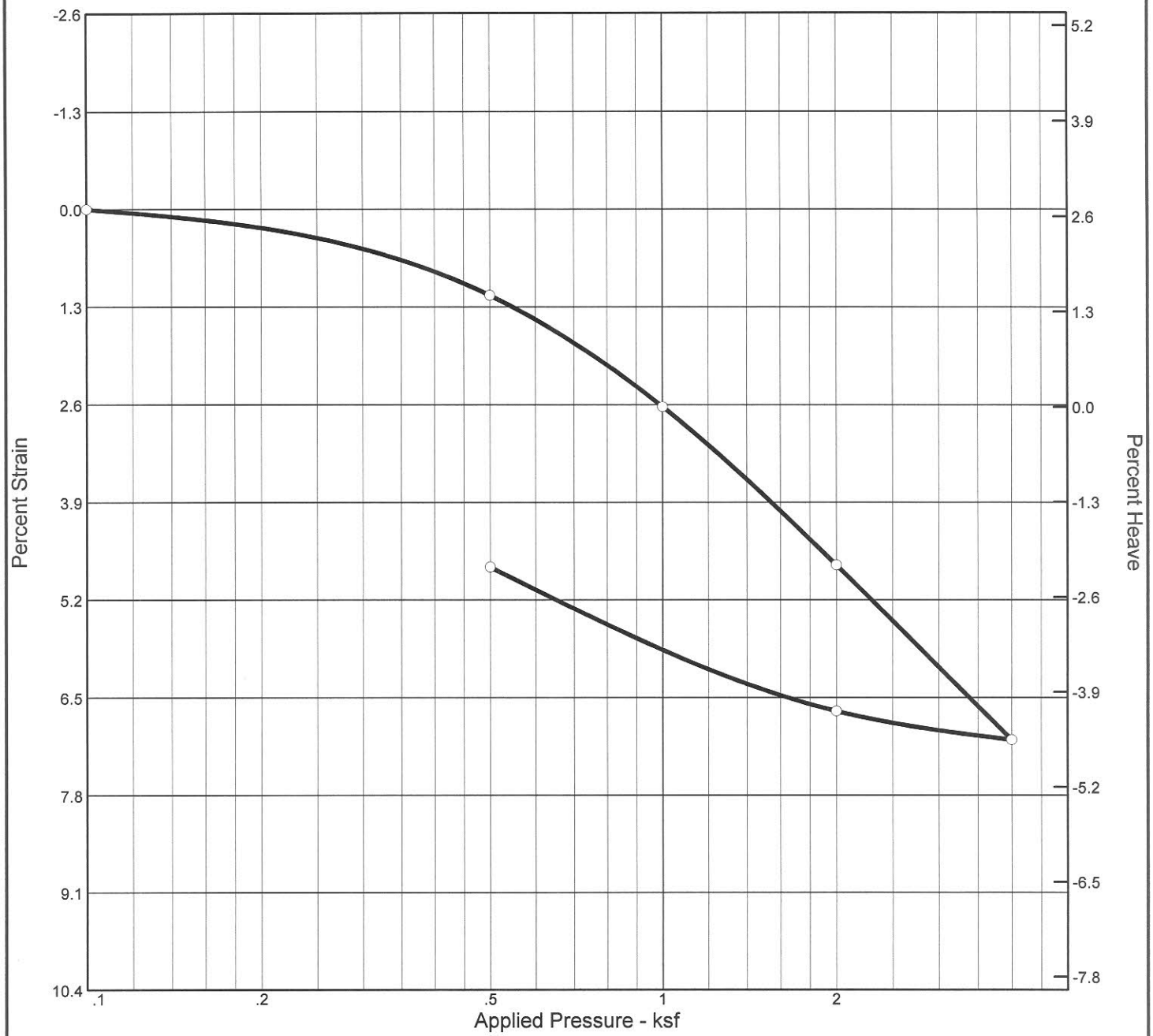
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
70.7 %	15.4 %	106.2	37	13	2.70		0.77	0.12	0.587

MATERIAL DESCRIPTION	USCS	AASHTO
Clayey SAND with Gravel		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: NSHS-WR-E-005

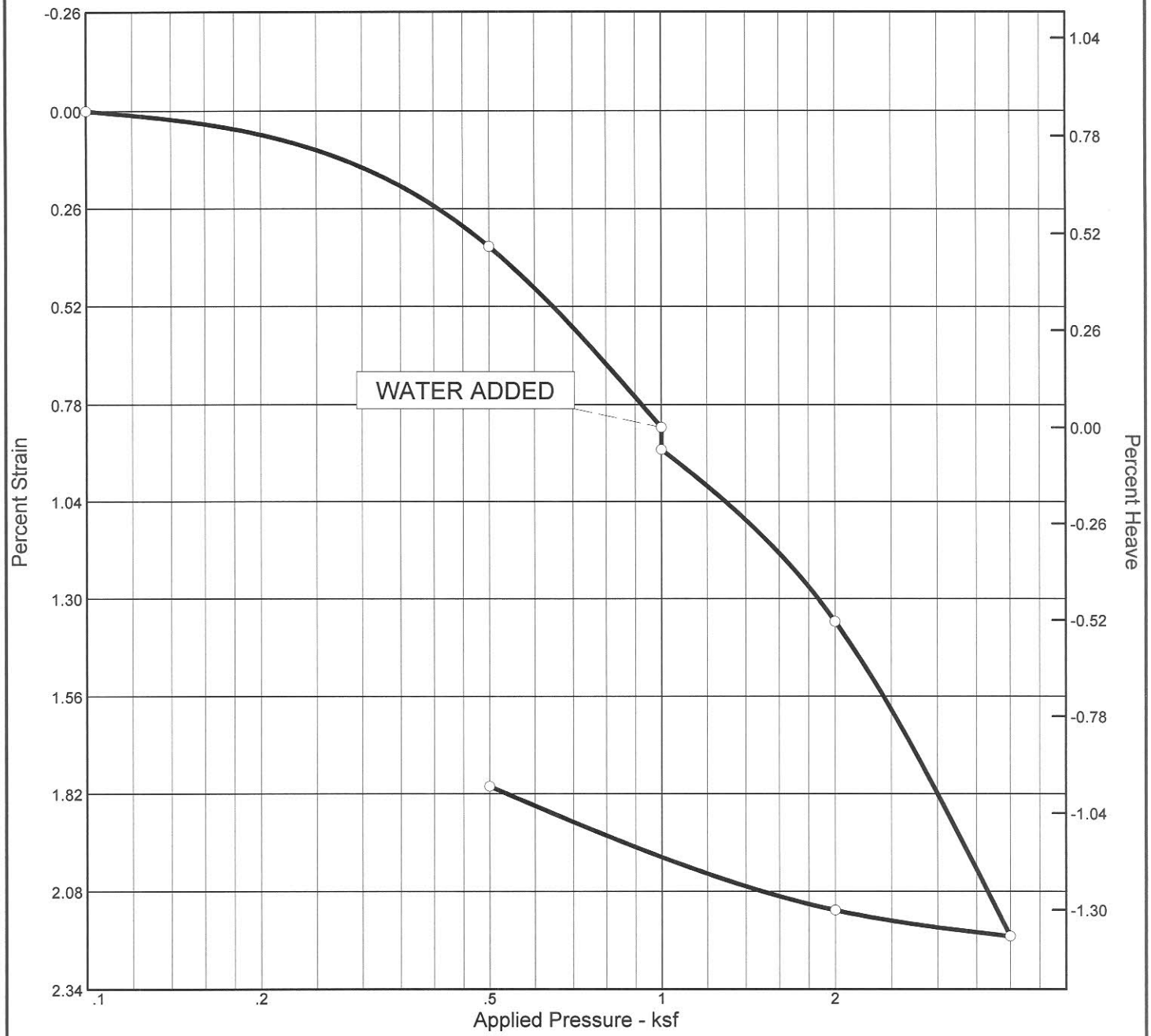
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
72.6 %	12.3 %	115.7	NV	NP	2.70		2.02	0.04	0.457

MATERIAL DESCRIPTION	USCS	AASHTO
Well Graded SAND with Silt and Gravel		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCHS-WR-E-003

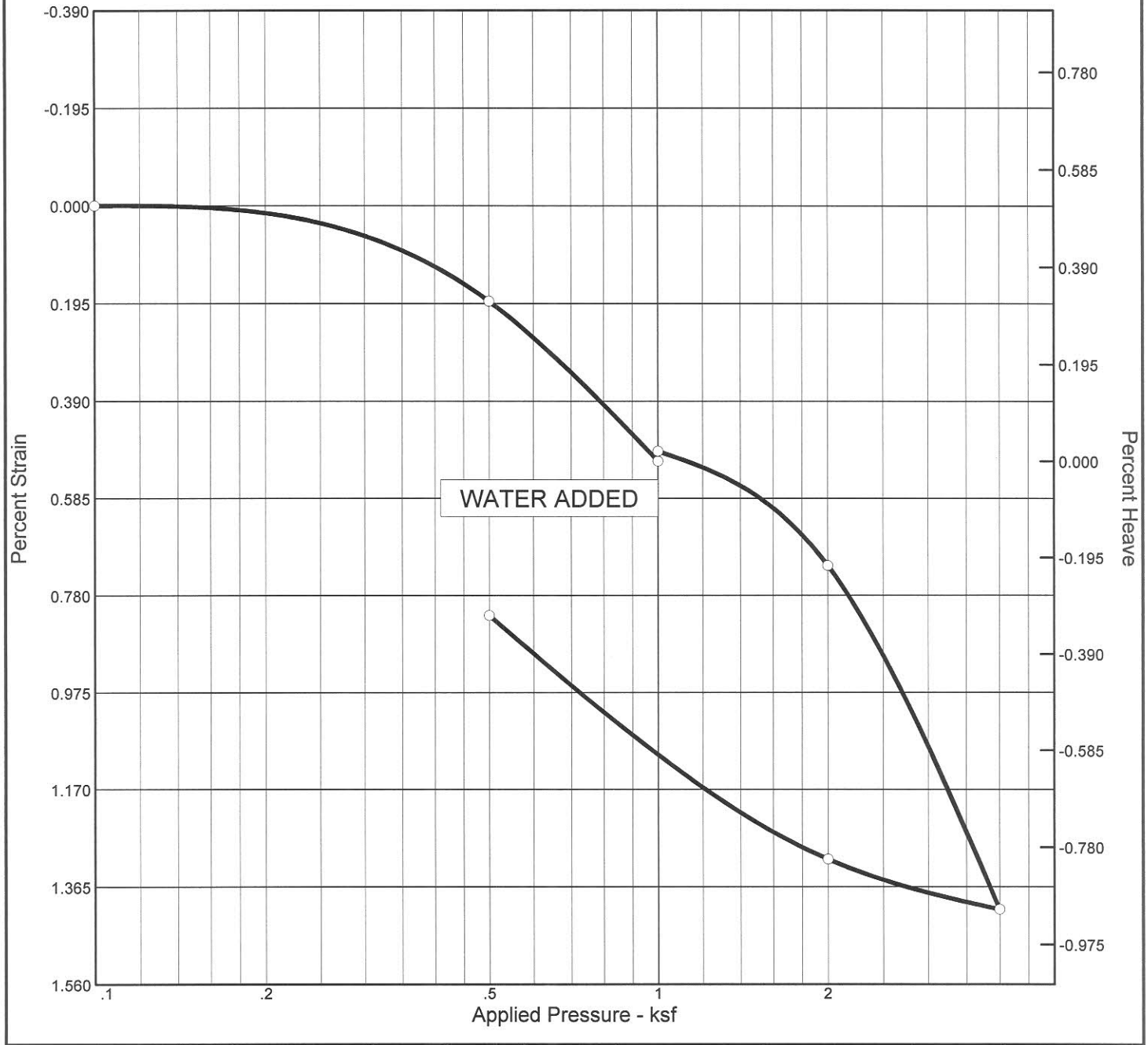
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
72.6 %	12.3 %	115.7	30	7	2.70		1.96	0.03	0.457

MATERIAL DESCRIPTION	USCS	AASHTO
Silty SAND with Gravel		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: NSHS-WR-E-003

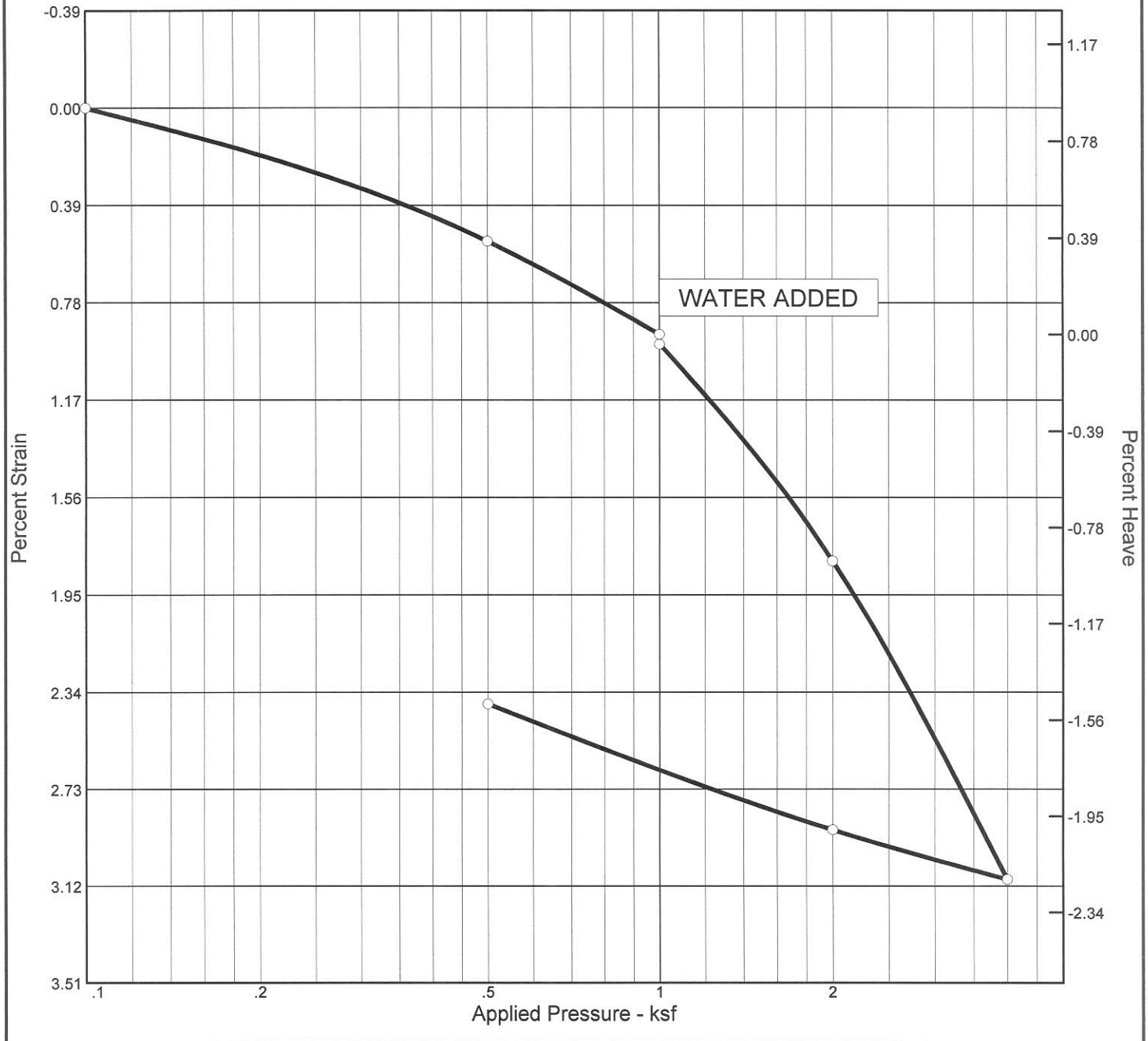
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
66.5 %	11.3 %	115.6	NV	NP	2.70		2.10	0.06	0.459

MATERIAL DESCRIPTION	USCS	AASHTO
Silty SAND with Gravel		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCHS-WT-E-001

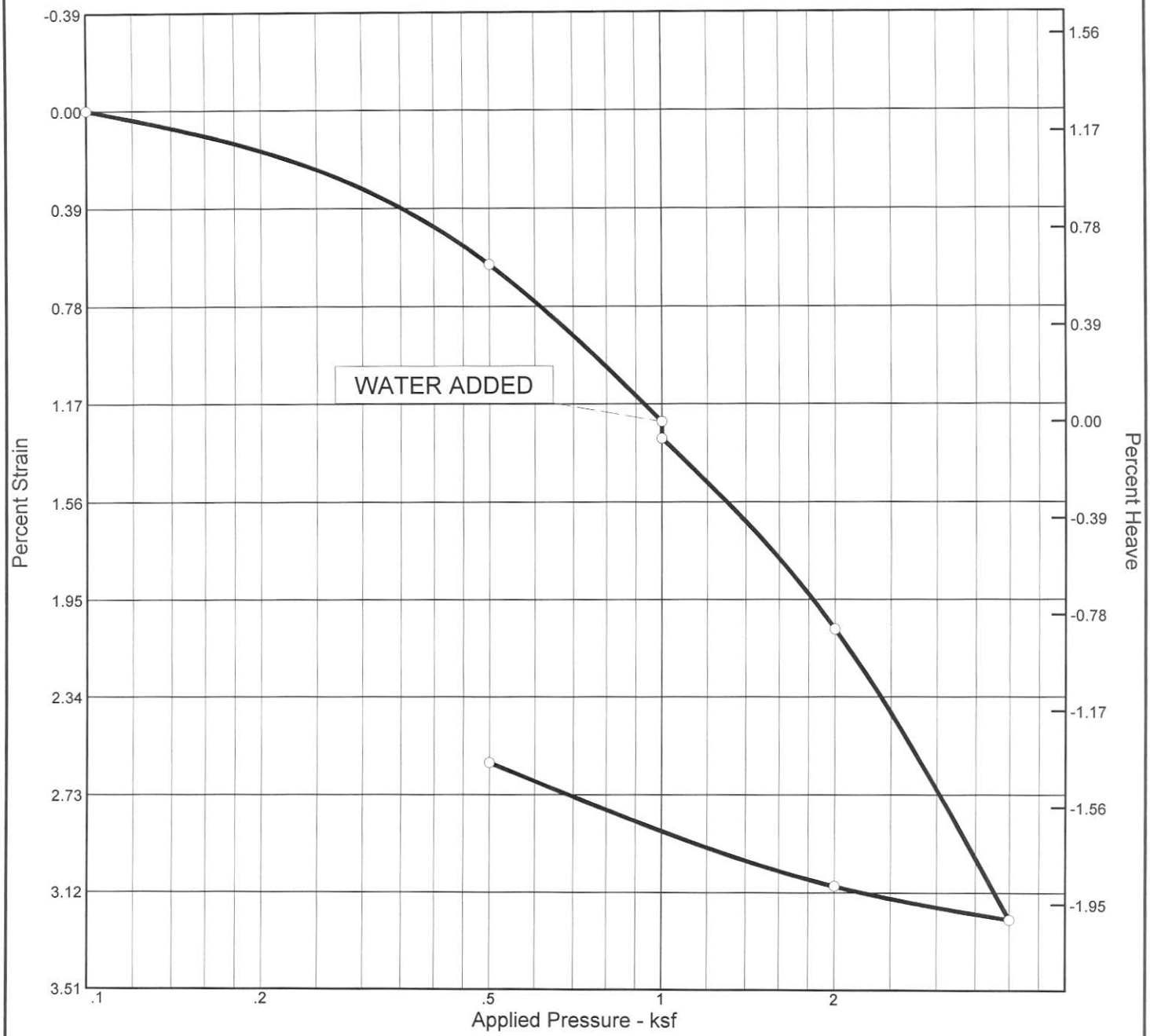
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
339.8 %	10.8 %	117.4	29	8	2..70		1.03	0.04	0.064

MATERIAL DESCRIPTION	USCS	AASHTO
Clayey SAND with Gravel		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: SCHS-WR-E-014

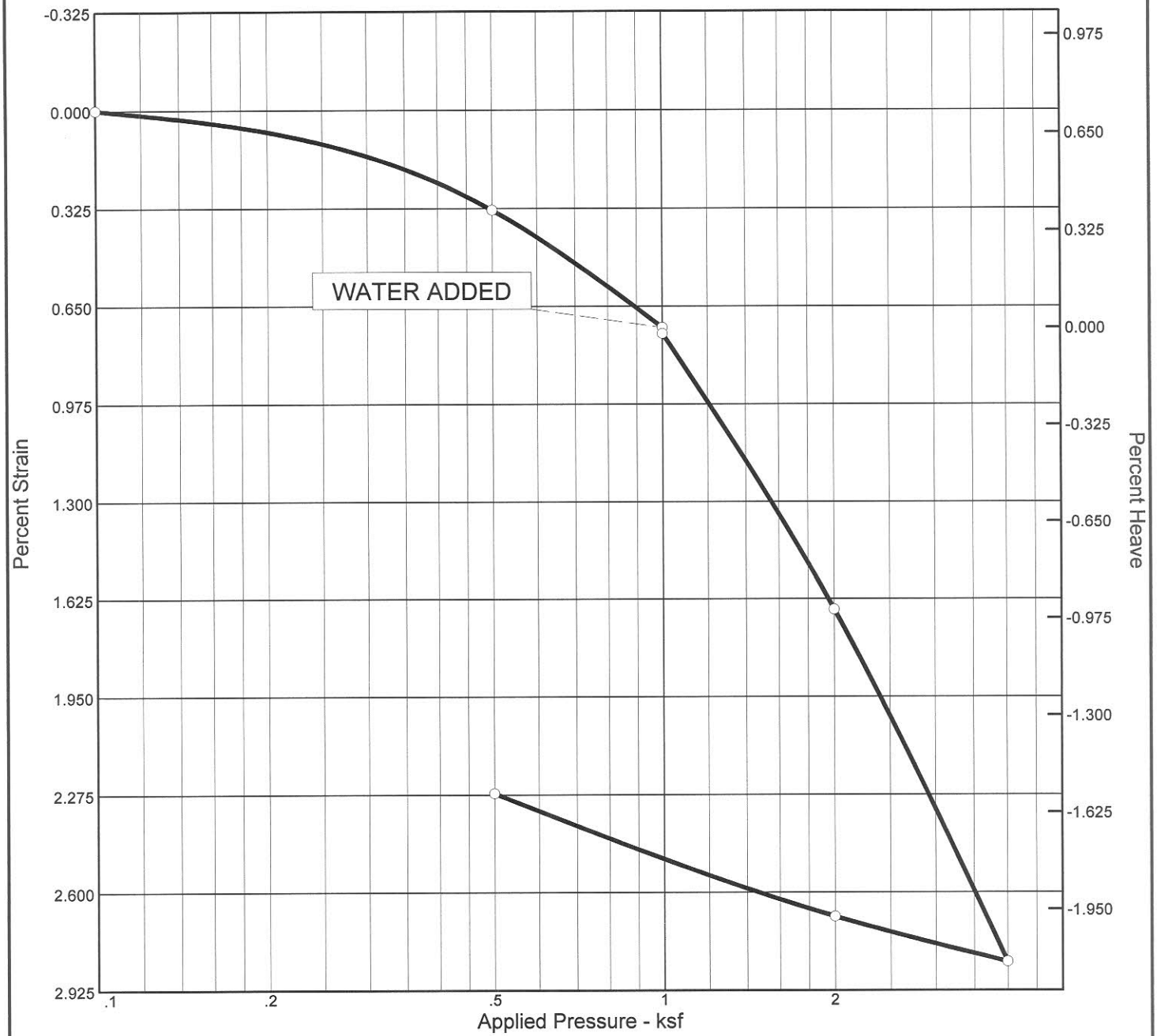
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
64.2 %	13.4 %	107.8	36	6	2.70		1.03	0.06	0.563

MATERIAL DESCRIPTION	USCS	AASHTO
Silty SAND with Gravel		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: SCHS-WR-E-001

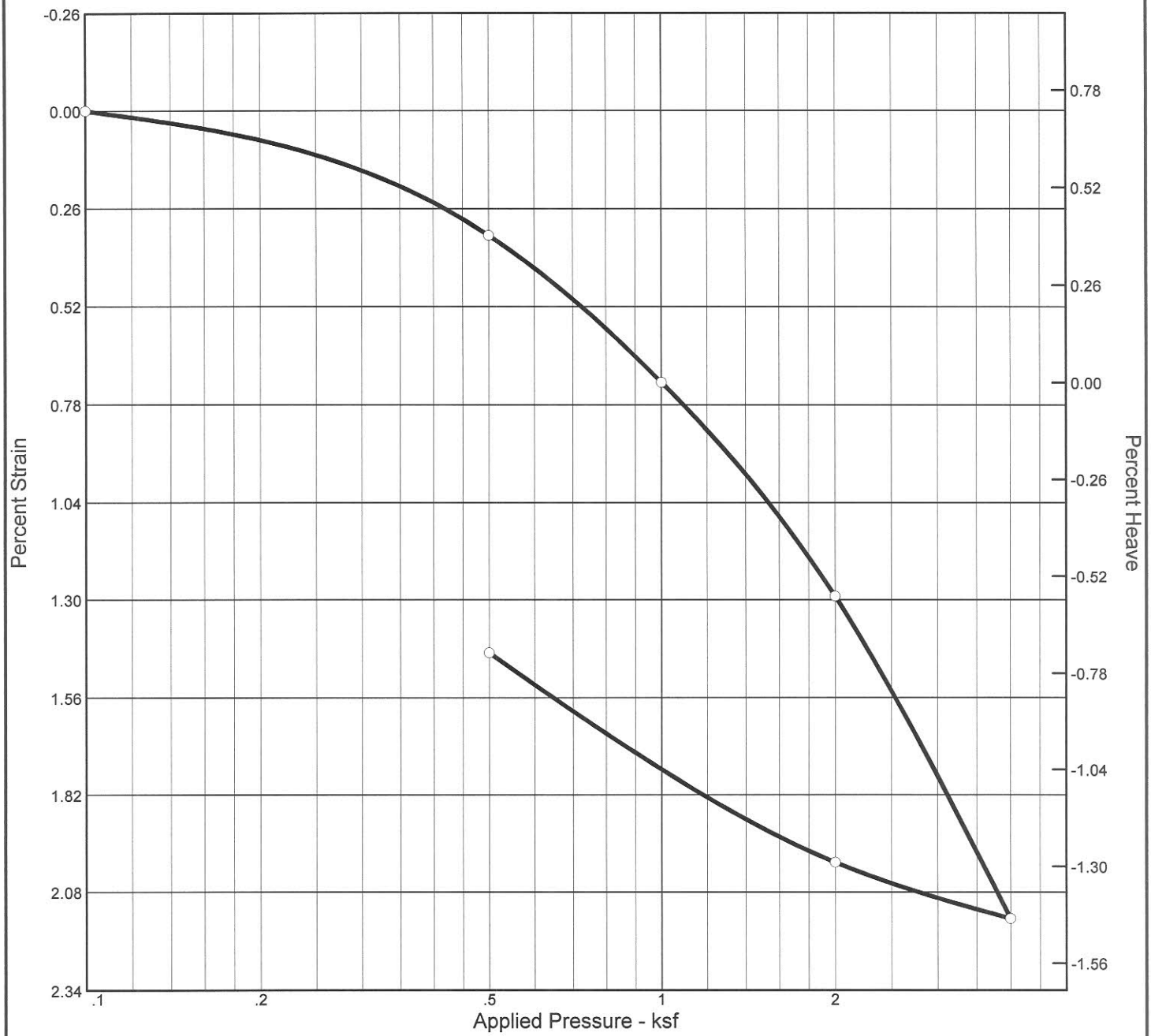
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
177.0 %	14.0 %	117.0	27	18	2.2.70		1.10	0.03	0.174

MATERIAL DESCRIPTION	USCS	AASHTO
Clayey GRAVEL with Sand		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: NSHS-WR-E-008

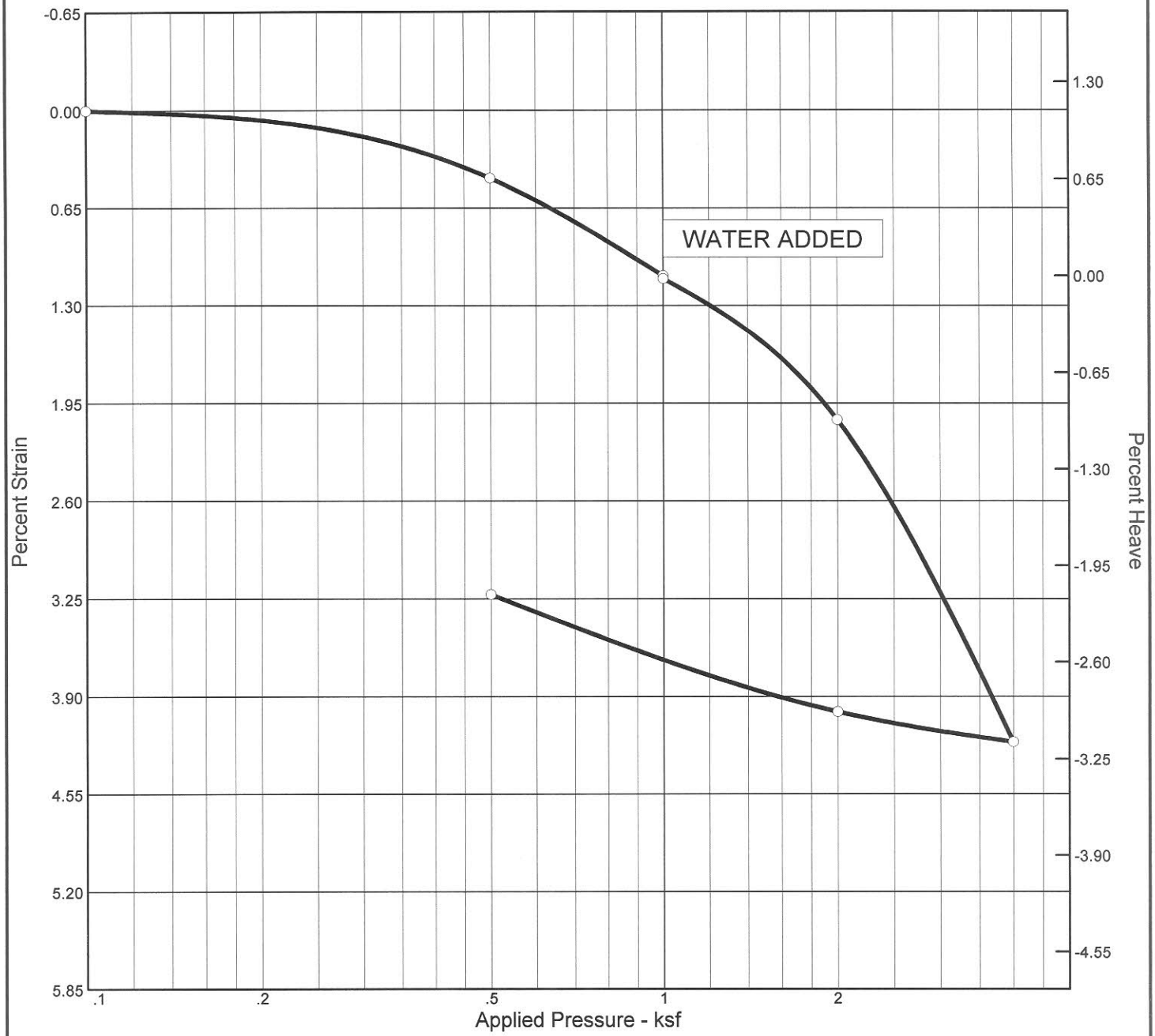
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
67.8 %	14.9 %	105.8	26	8	2.70		1.93	0.12	0.593

MATERIAL DESCRIPTION	USCS	AASHTO
Sandy Lean CLAY		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCLT-WT-E-001

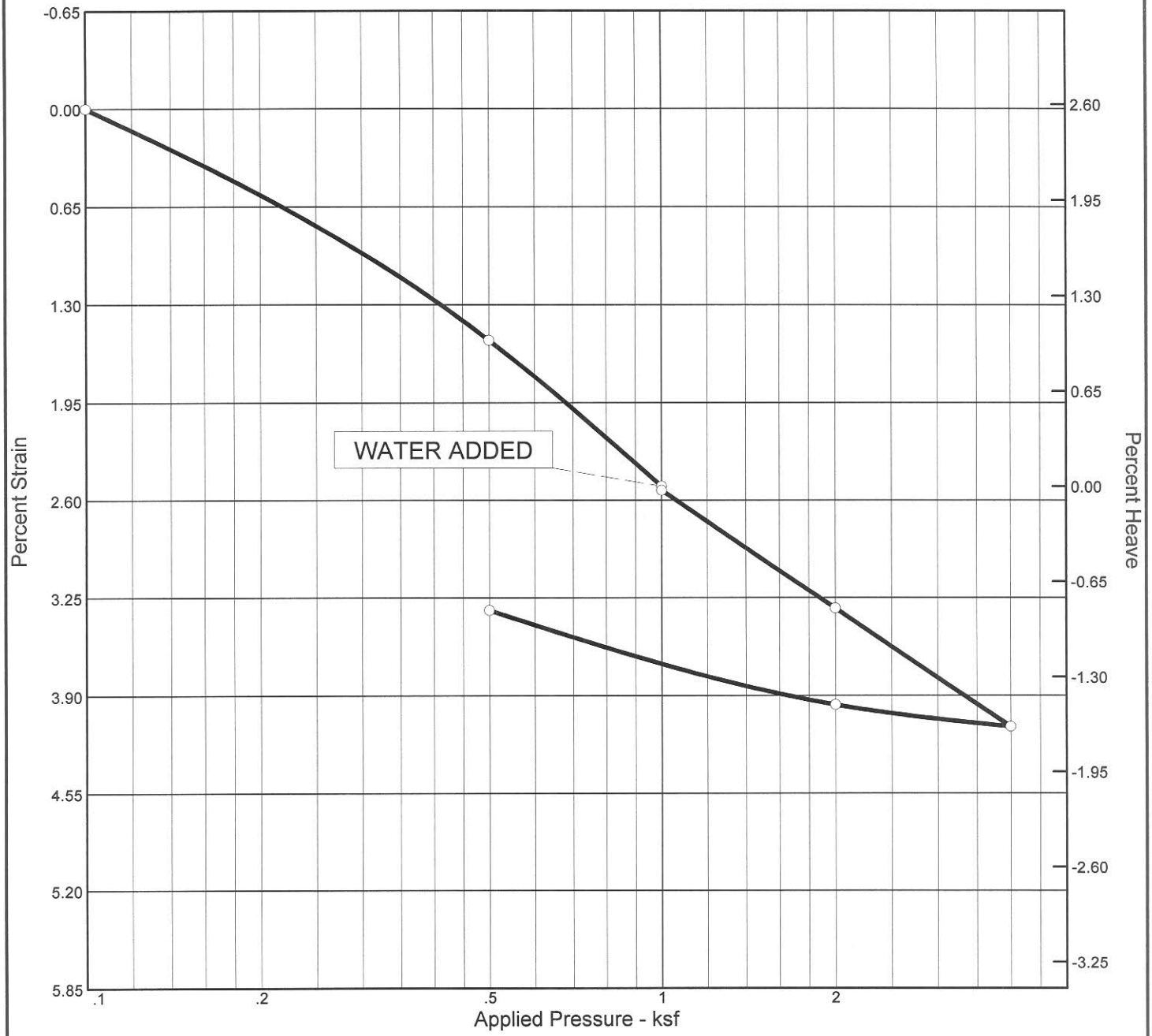
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
75.6 %	12.4 %	116.8	NV	NP	2.70		0.33	0.04	0.443

MATERIAL DESCRIPTION	USCS	AASHTO
Well-graded SAND with Silt and Gravel		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: SCHS-WR-E-011

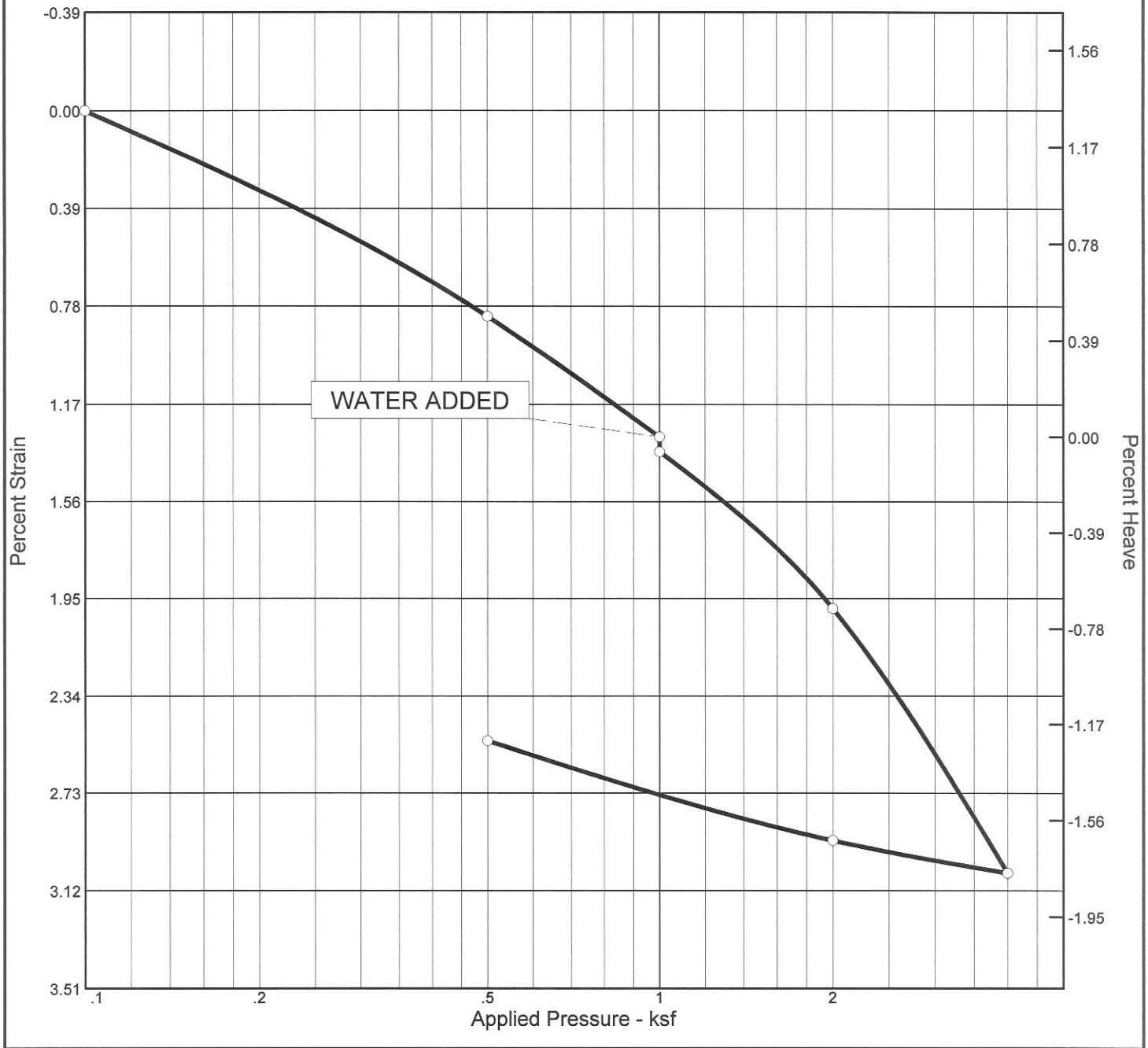
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
78.8 %	14.6 %	112.3	32	7	2.70		2.09	0.05	0.500

MATERIAL DESCRIPTION	USCS	AASHTO
Silty GRAVEL with Sand		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: NSHS-WR-E-006

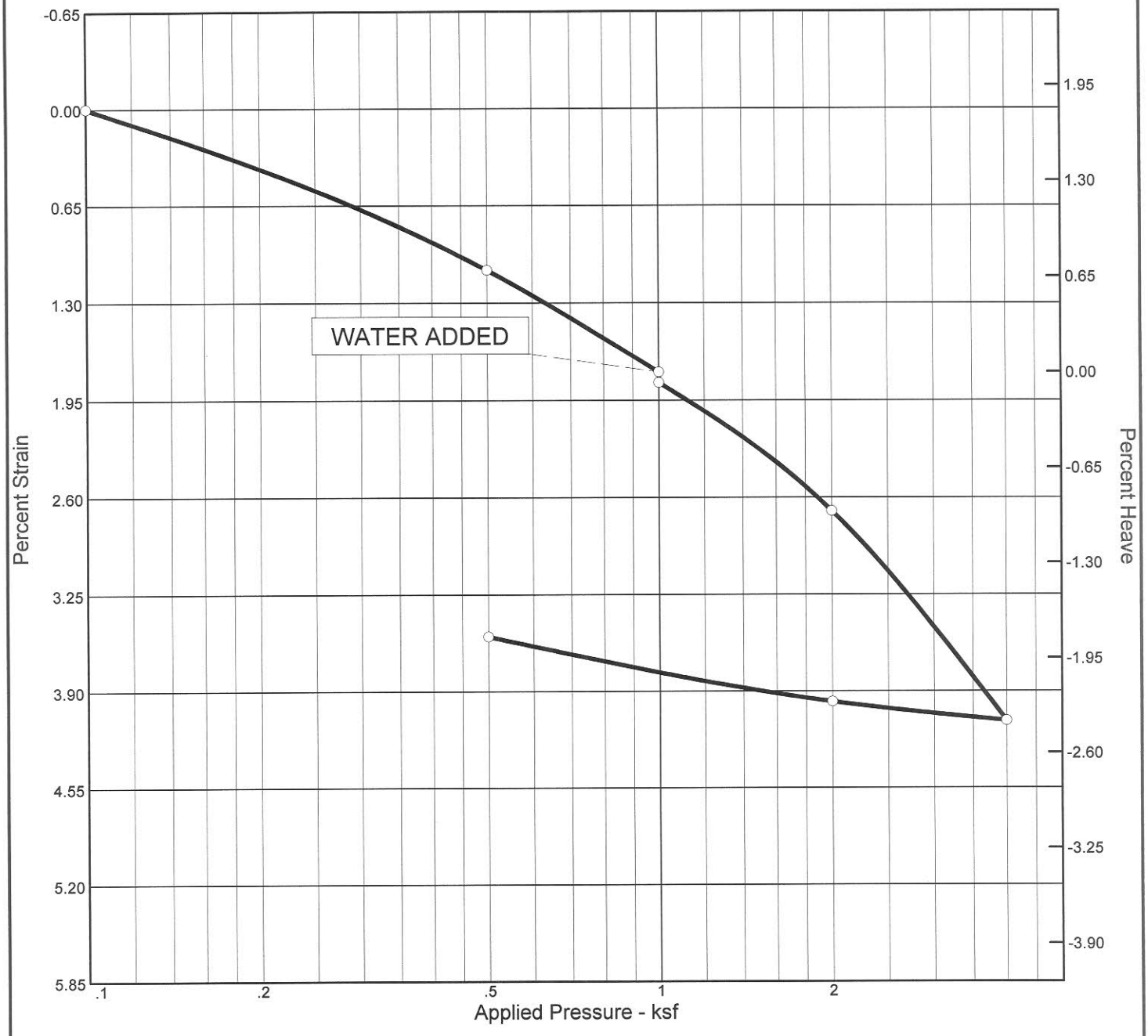
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
26.8 %	15.3 %	109.4	39	10	2070		2.11	56.68	1180.301

MATERIAL DESCRIPTION	USCS	AASHTO
Poorly Graded GRAVEL with Silt and Sand		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: SCHS-WR-E-010

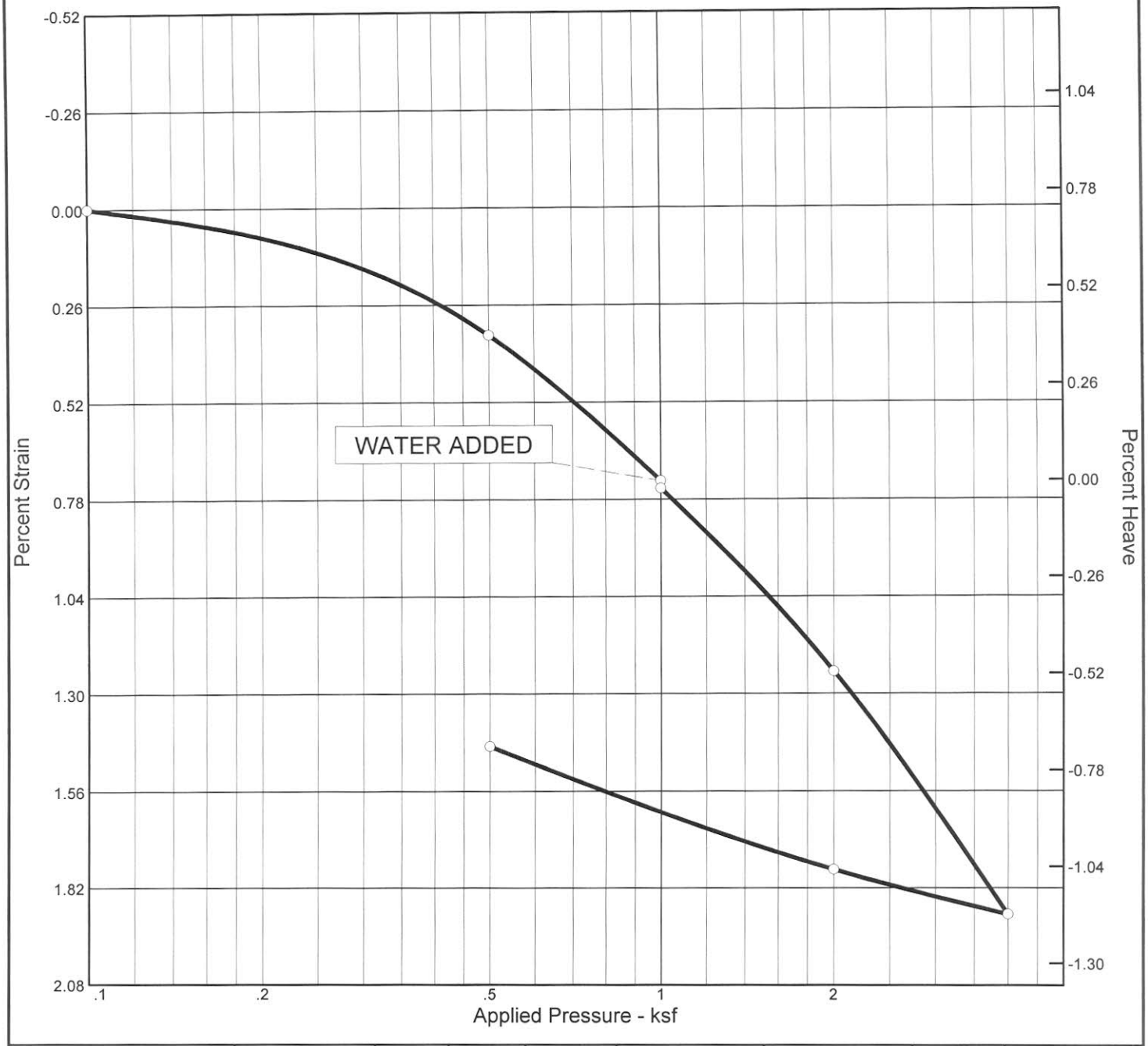
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
0.0 %	13.1 %	.0	33	10	2.70		0.92	906.94	41364.930

MATERIAL DESCRIPTION	USCS	AASHTO
Poorly Graded GRAVEL with Clay and Sand	SP-SC	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: NSHS-WR-E-007

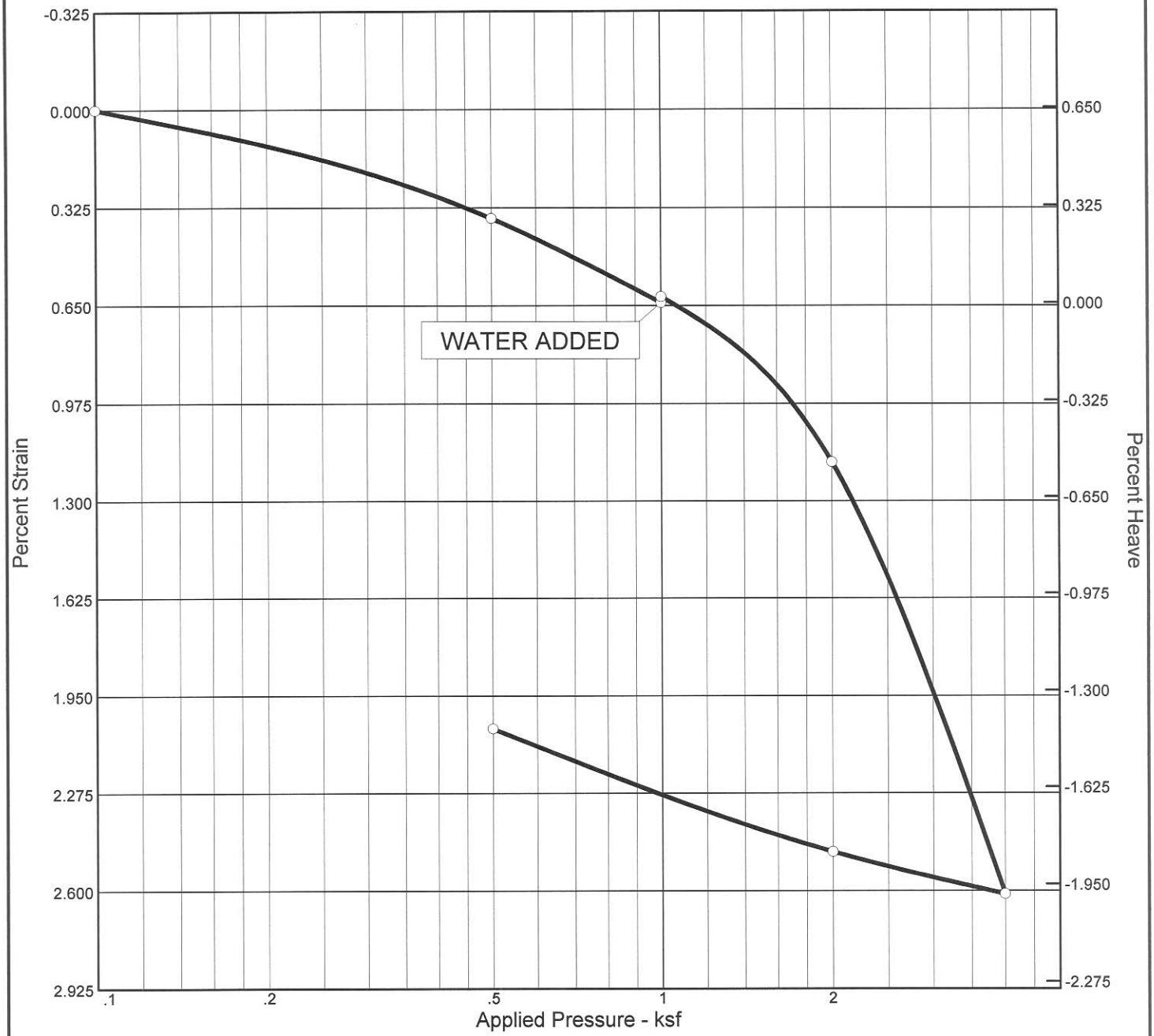
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
27.2 %	15.6 %	108.0	32	9	2.75		1.93	0.08	154.999

MATERIAL DESCRIPTION	USCS	AASHTO
Clayey SAND	SC	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: NSHS-WR-E-001

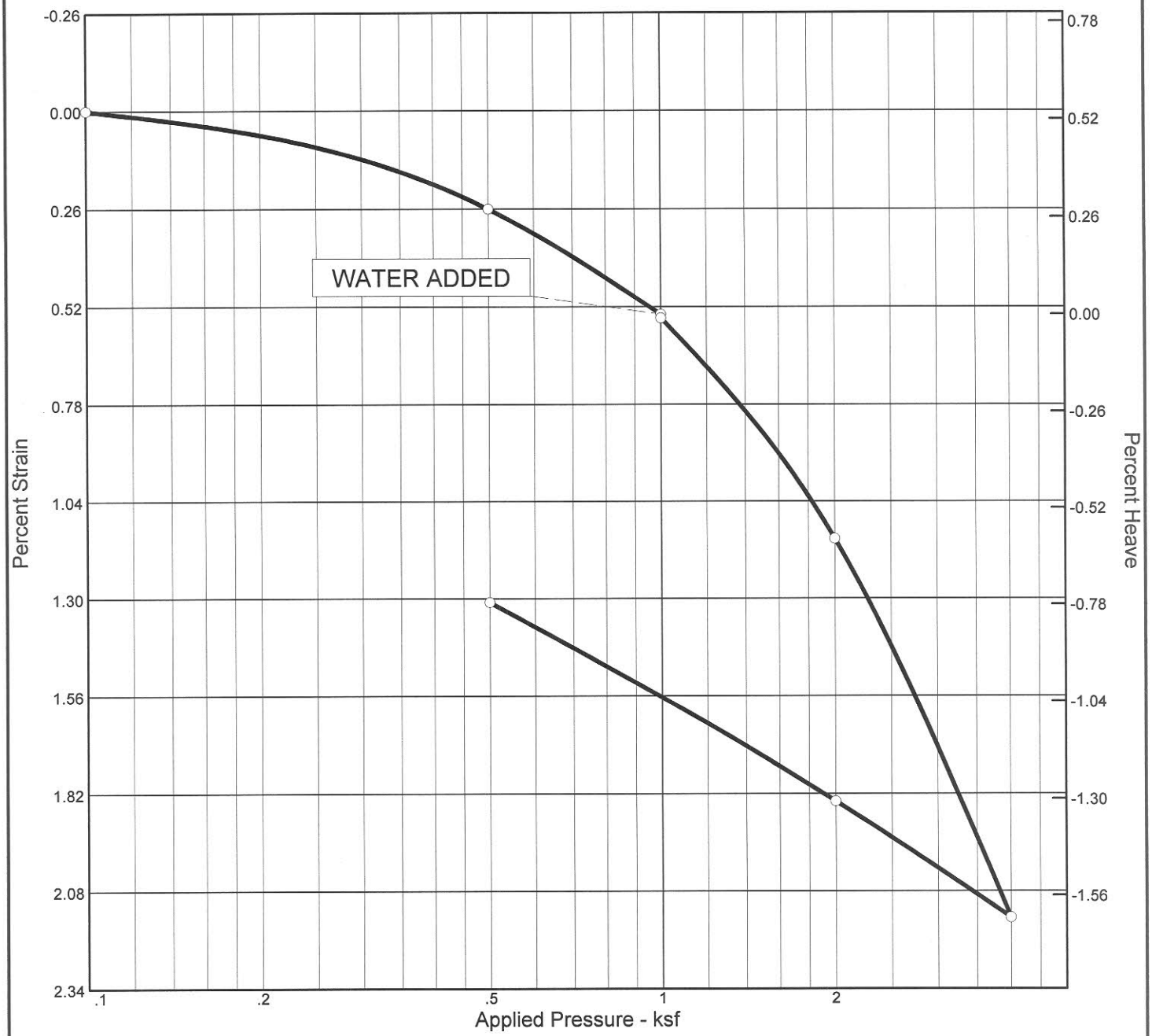
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
75.6 %	19.0 %	100.4	39	11	2.70		1.97	0.06	0.678

MATERIAL DESCRIPTION	USCS	AASHTO
Silty SAND	SM	A-2-6(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: NSHS-WR-E-002

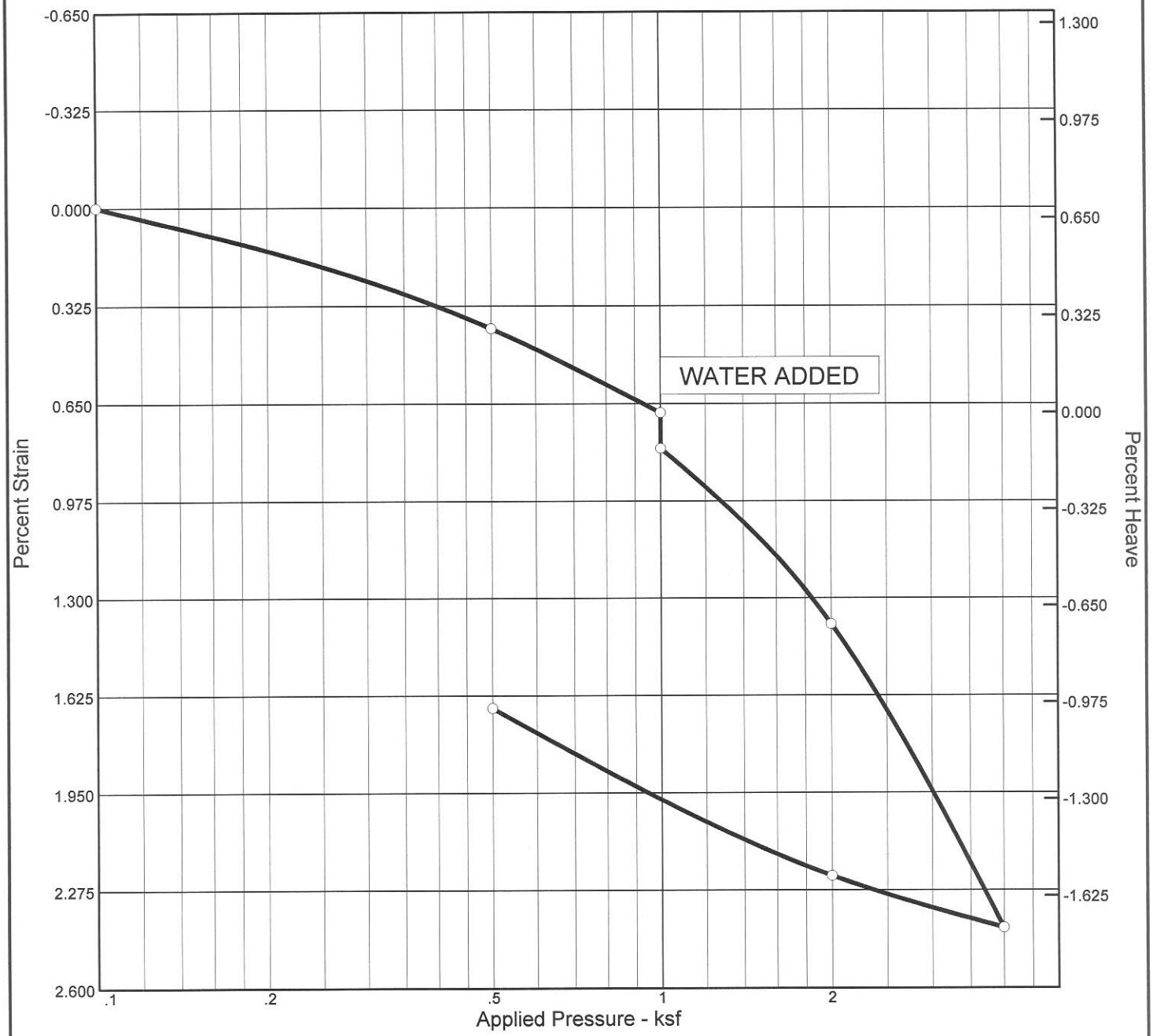
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
73.1 %	11.3 %	118.9	NV	NP	2.75		2.00	0.05	0.418

MATERIAL DESCRIPTION	USCS	AASHTO
Silty SAND	SM	A-1-b

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: NSHS-WR-E-009

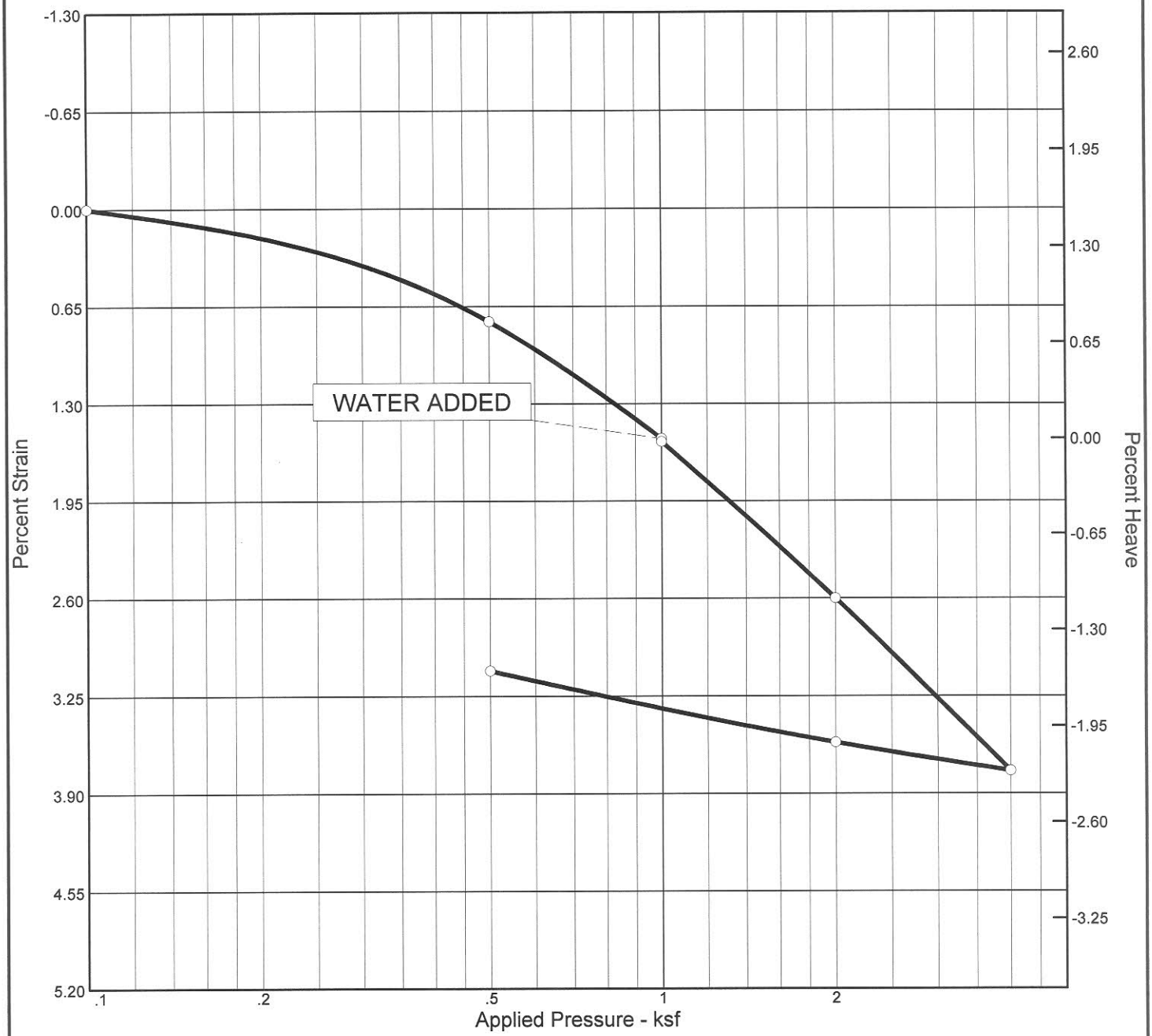
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
70.9 %	19.3 %	97.1	45	23	2.75		0.74	0.07	0.735

MATERIAL DESCRIPTION	USCS	AASHTO
Lean CLAY	CL	A-7-6(22)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCLT-WT-E-002

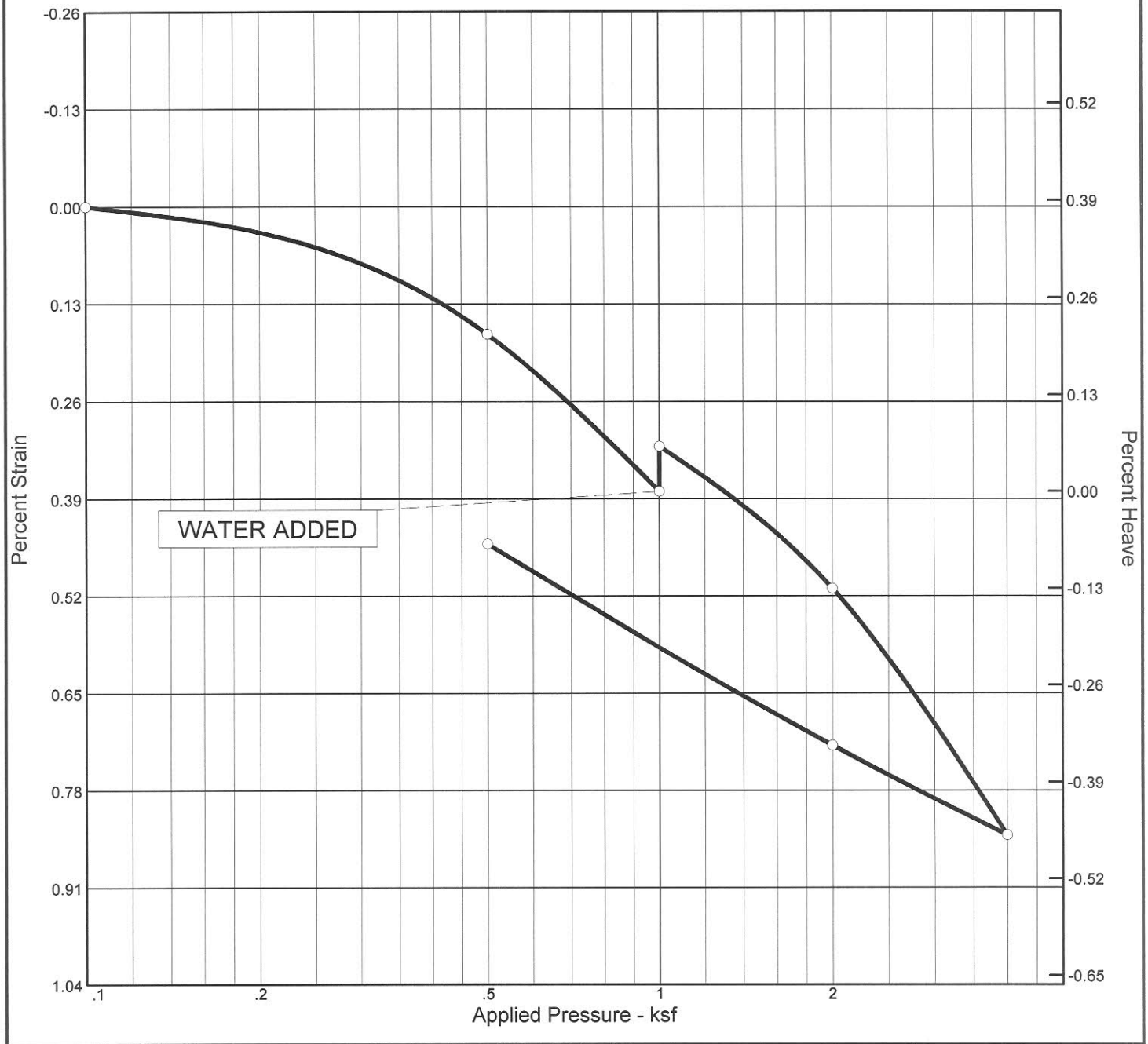
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
70.5 %	12.0 %	115.5	31	9	2.70		2.02	0.02	0.460

MATERIAL DESCRIPTION	USCS	AASHTO
Clayey GRAVEL with Sand	SC	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCHS-WR-E-001

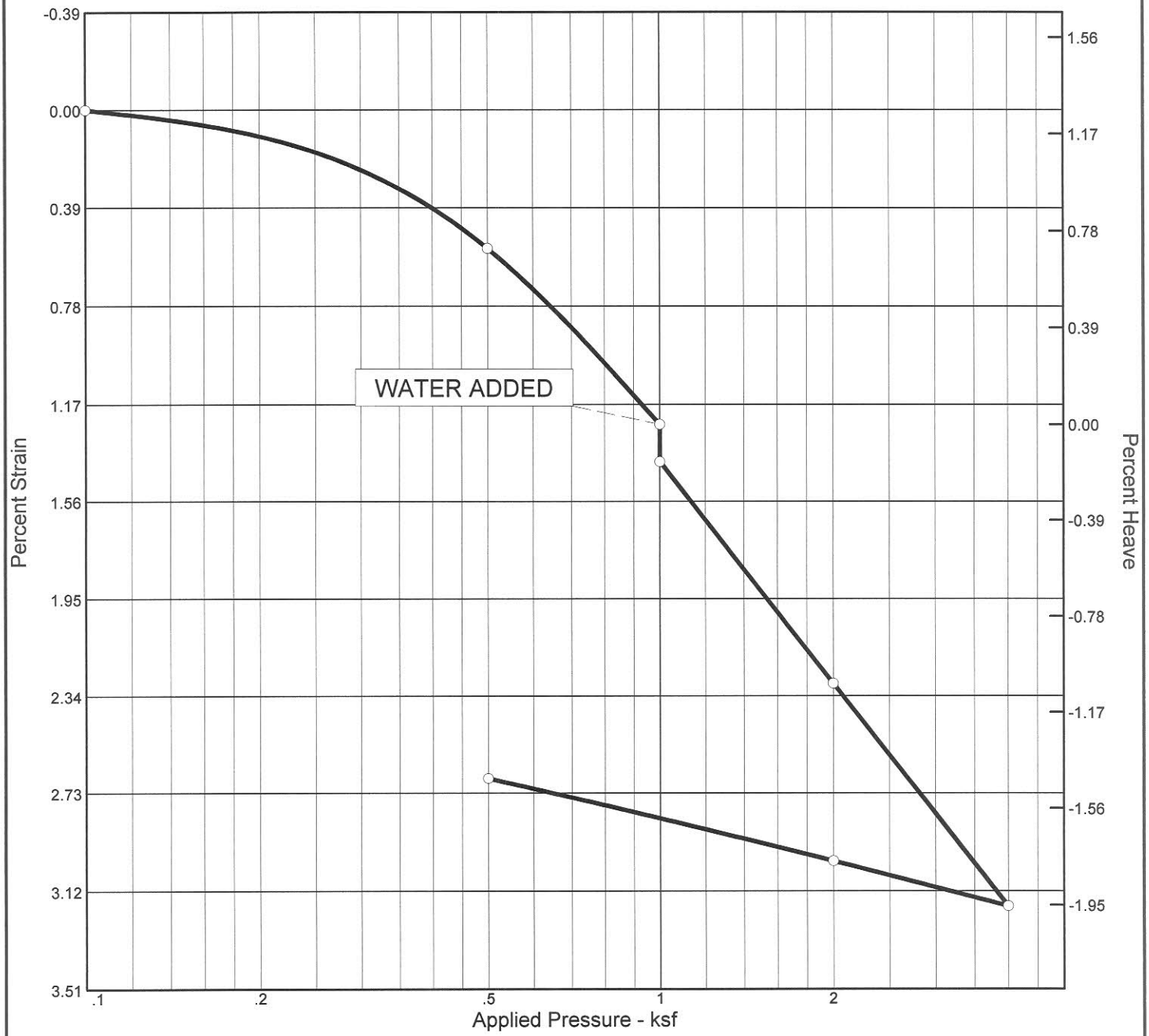
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
64.0 %	18.5 %	94.7		NP	2.75		0.52	0.05	0.780

MATERIAL DESCRIPTION	USCS	AASHTO
Silty SAND		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCSS-WT-E-001

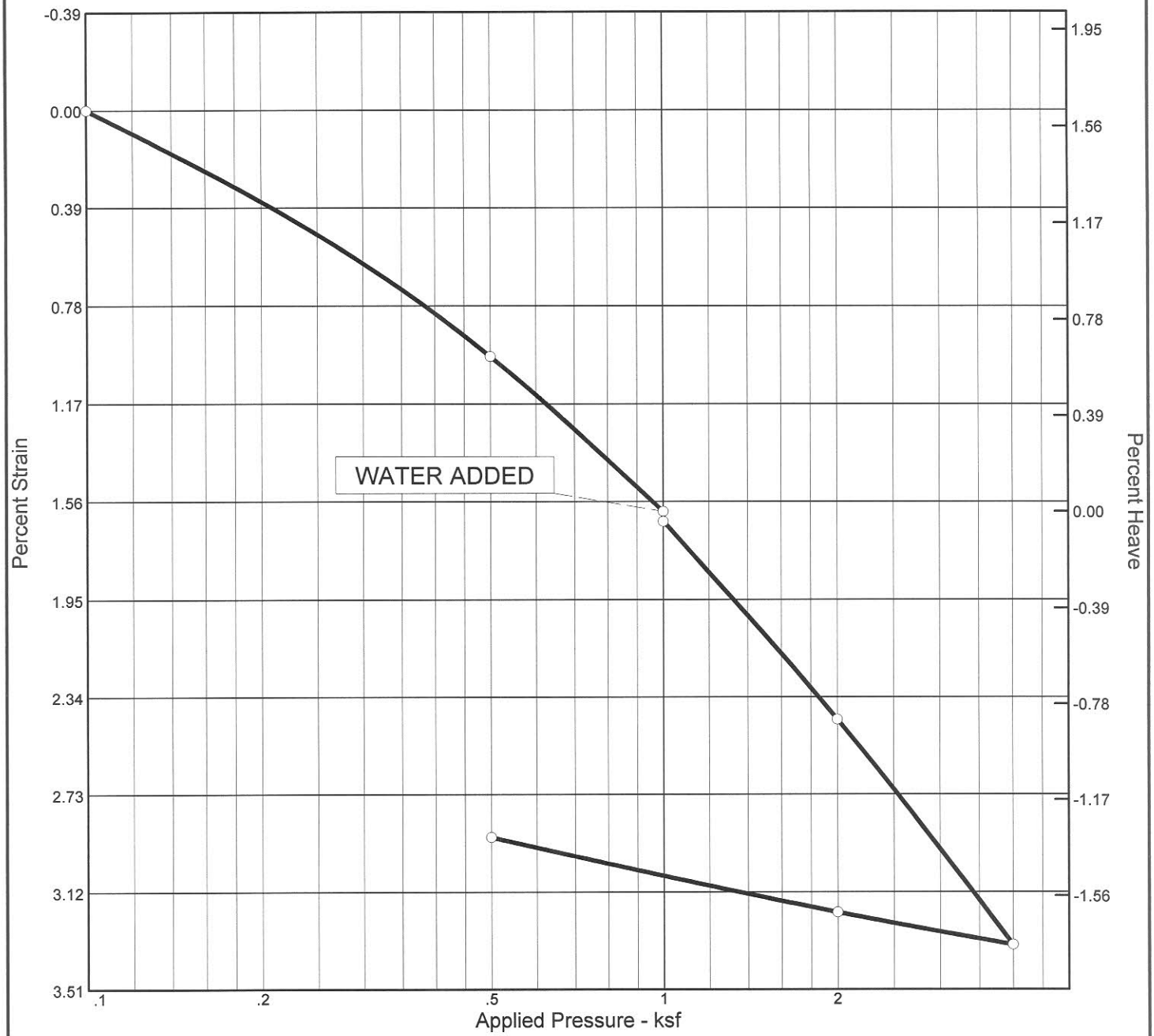
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
75.2 %	19.1 %	100.0	NV	NP	2.70		0.76	0.05	0.686

MATERIAL DESCRIPTION	USCS	AASHTO
Silty SAND		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCSS-WT-E-006

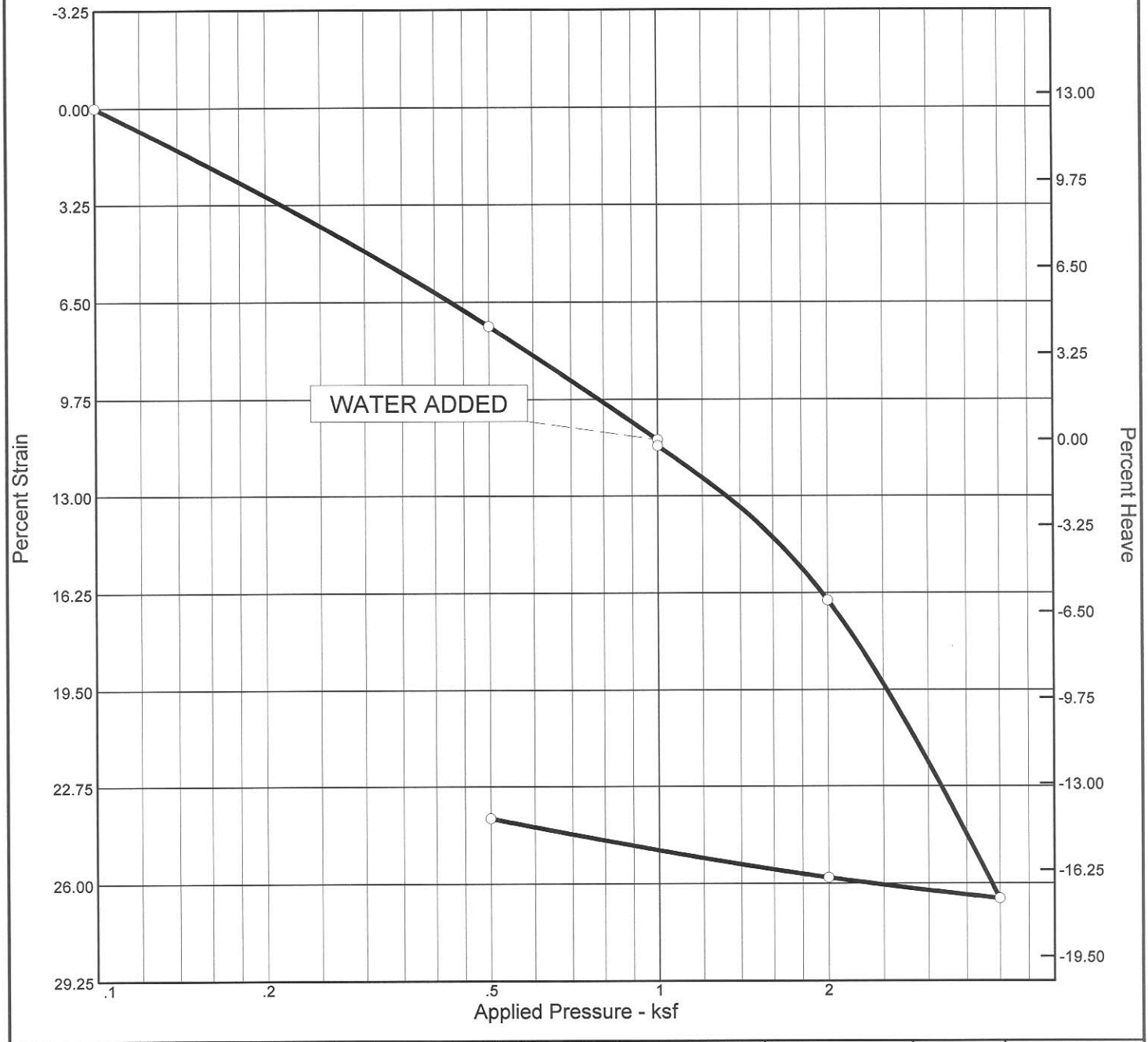
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
71.2 %	13.1 %	112.6	27	5	2.70		2.02	0.51	0.497

MATERIAL DESCRIPTION	USCS	AASHTO
Silty Clayey SAND with Geavel		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

Source: CCHS-WR-E-002

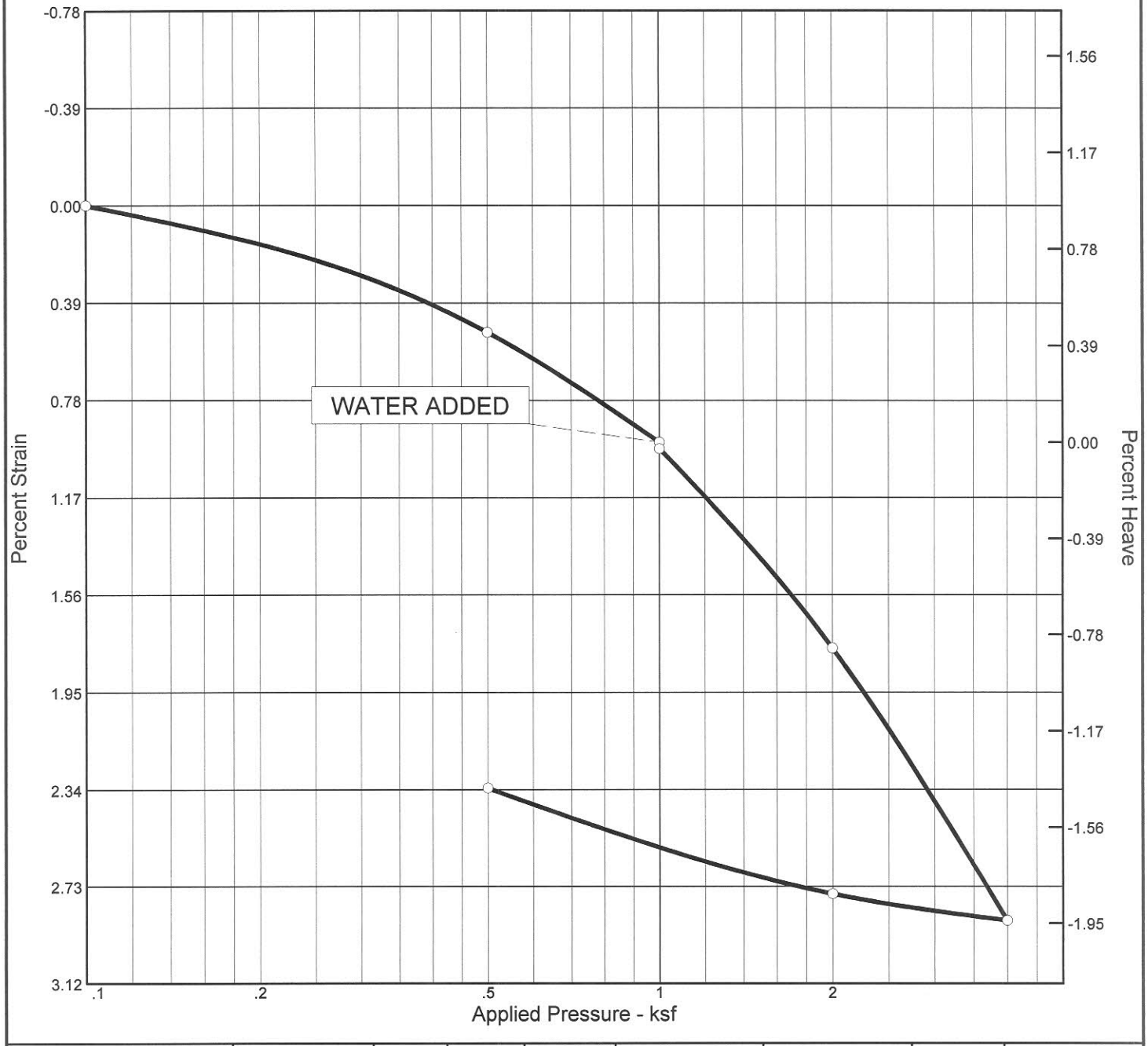
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure

PRESSURE-SWELL TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture								
57.1 %	13.8 %	102.0	NV	NP	2.70		1.05	0.06	0.652

MATERIAL DESCRIPTION	USCS	AASHTO
Silty SAND		

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

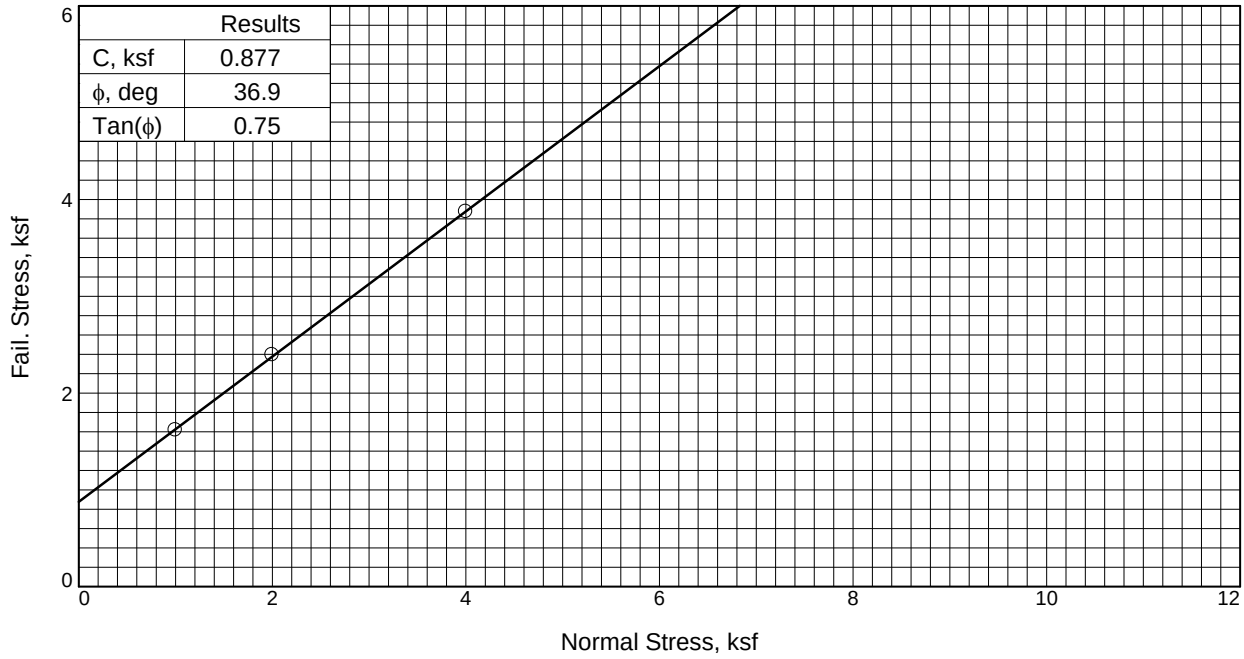
Source: CCSS-WT-E-002

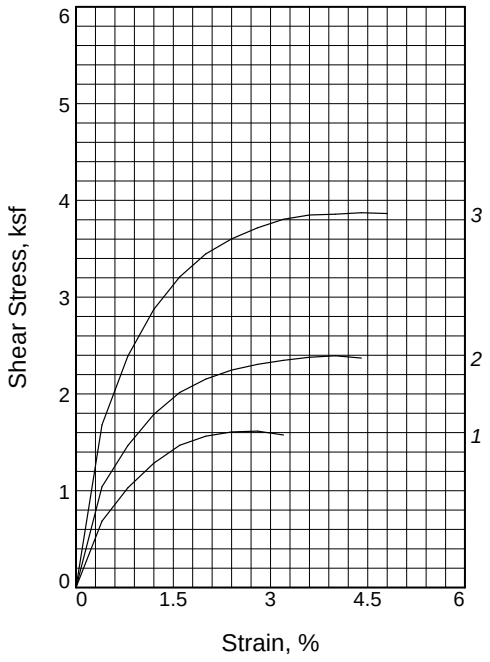
Remarks:

Tetra Tech, Inc.

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	15.6	15.6	15.6
	Dry Density, pcf	108.0	108.0	108.0
	Saturation, %	75.1	75.1	75.1
	Void Ratio	0.5612	0.5612	0.5612
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	16.3	15.9	14.8
	Dry Density, pcf	109.5	110.3	112.2
	Saturation, %	81.6	81.4	79.3
	Void Ratio	0.5395	0.5285	0.5020
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.986	0.979	0.962
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		1.616	2.394	3.872
Strain, %		2.8	4.0	4.4
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Clayey SAND

LL= 32 **PL=** 23 **PI=** 9
Assumed Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

Project: Carpenter Snow Creek

Source of Sample: NSHS-WR-E-001

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	19.0	29.9	27.3	23.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	32	23	2.4044	0.6943	0.3990	0.1183				

Material Description	USCS	AASHTO
○ Clayey SAND	SC	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

○ **Source of Sample:** NSHS-WR-E-001

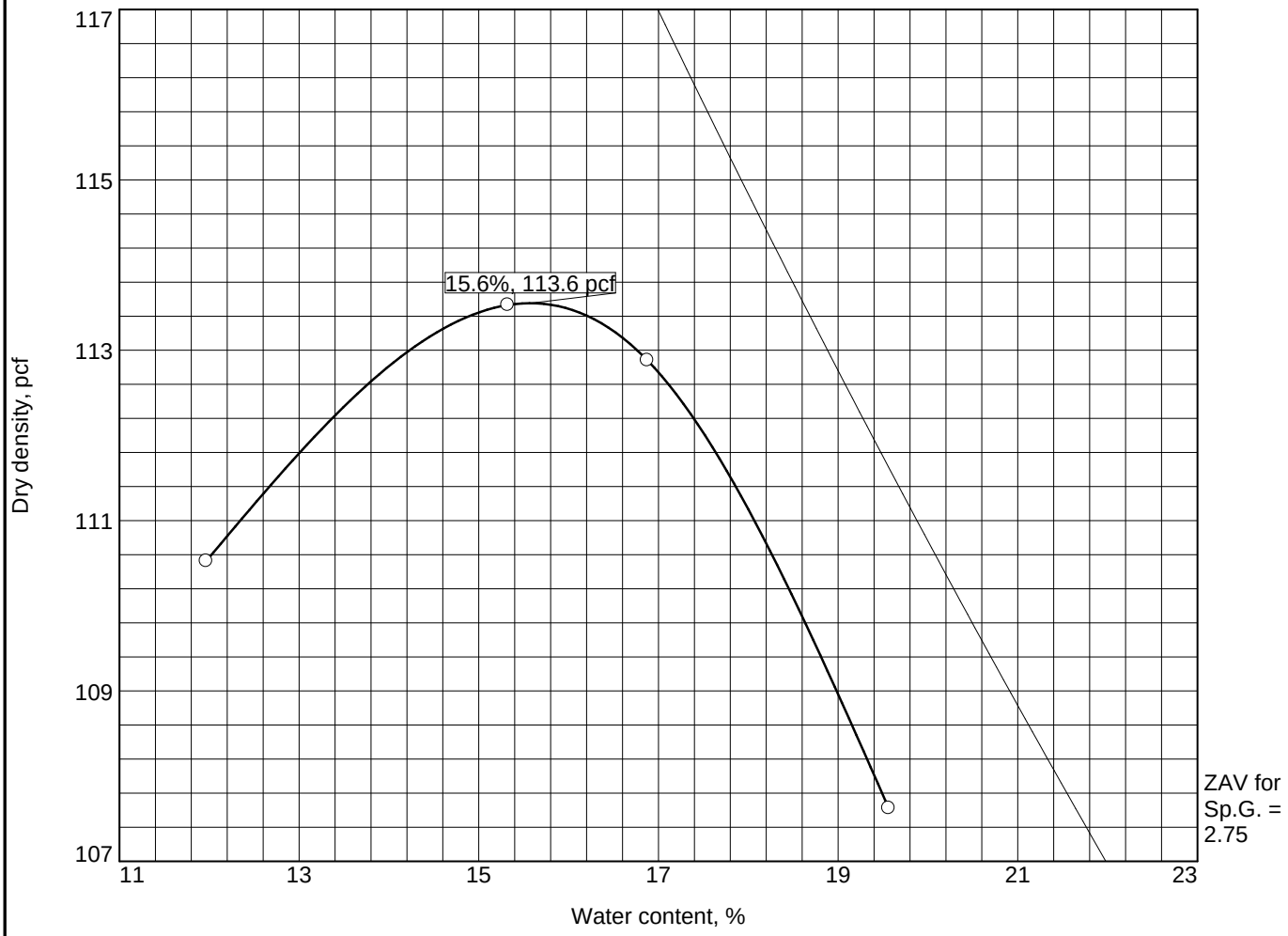
Remarks:

Tetra Tech

Billings, MT

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 698-00a Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	SC	A-2-4(0)		2.75	32	9	0.0	23.8

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 113.6 pcf Optimum moisture = 15.6 %	Clayey SAND
Project No. 114-551059 **Client:** Tetra Tech EMI **Project:** Carpenter Snow Creek ○**Source of Sample:** NSHS-WR-E-001	**Remarks:**
Tetra Tech **Billings, MT**	**Figure**

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	10.9	13.5	22.3	25.6	27.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	39	28	3.4868	0.6733	0.3377	0.0876				

Material Description	USCS	AASHTO
○ Silty SAND	SM	A-2-6(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

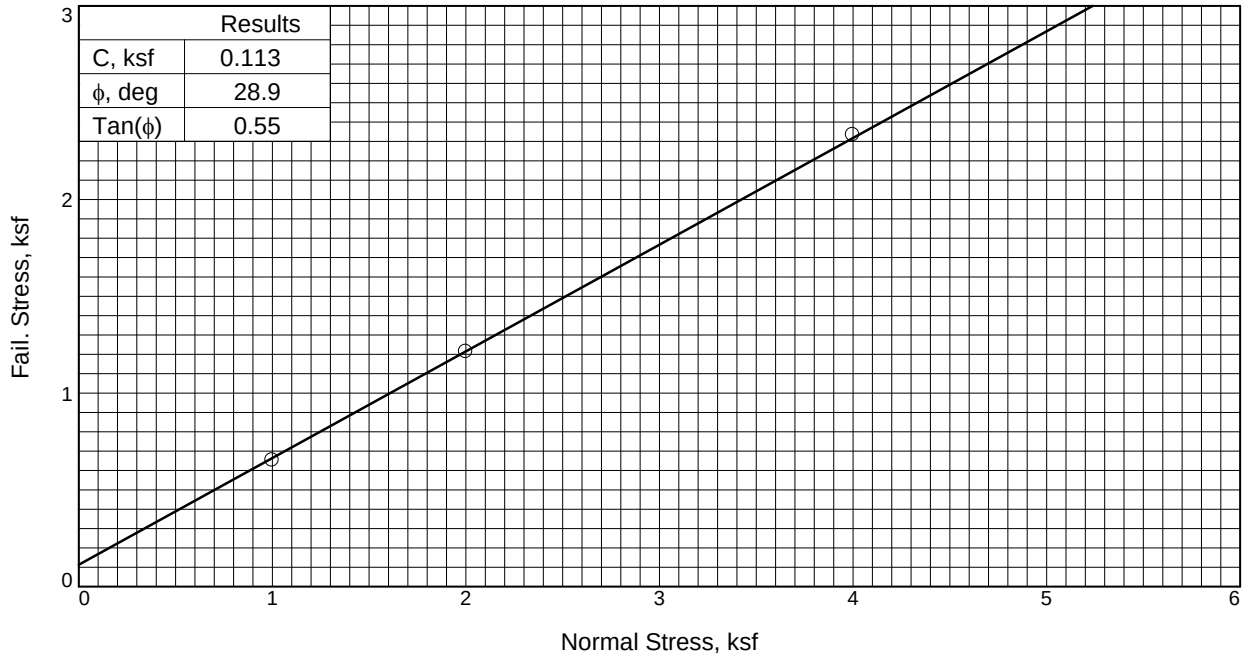
○ **Source of Sample:** NSHS-WR-E-002

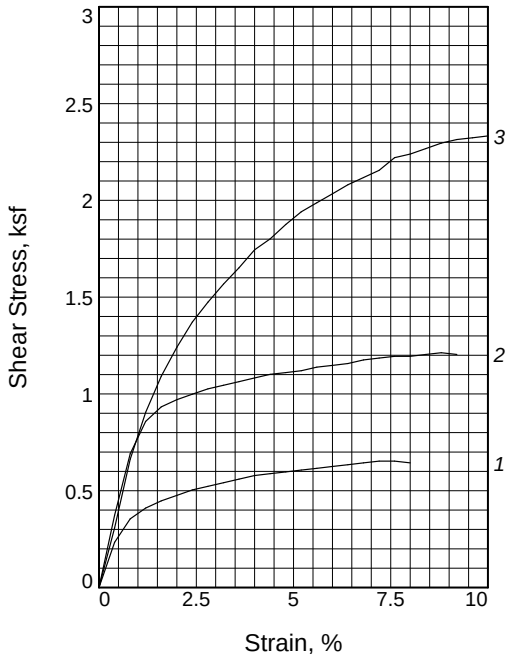
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	19.0	19.0	19.0
	Dry Density, pcf	100.5	100.5	100.5
	Saturation, %	75.7	75.7	75.7
	Void Ratio	0.6777	0.6777	0.6777
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	18.5	14.6	13.2
	Dry Density, pcf	100.6	101.7	102.9
	Saturation, %	73.9	60.0	55.9
	Void Ratio	0.6747	0.6580	0.6380
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.998	0.988	0.976
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.653	1.213	2.333
Strain, %		7.2	8.8	10.0
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Silty SAND

LL= 39 **PL=** 28 **PI=** 11
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

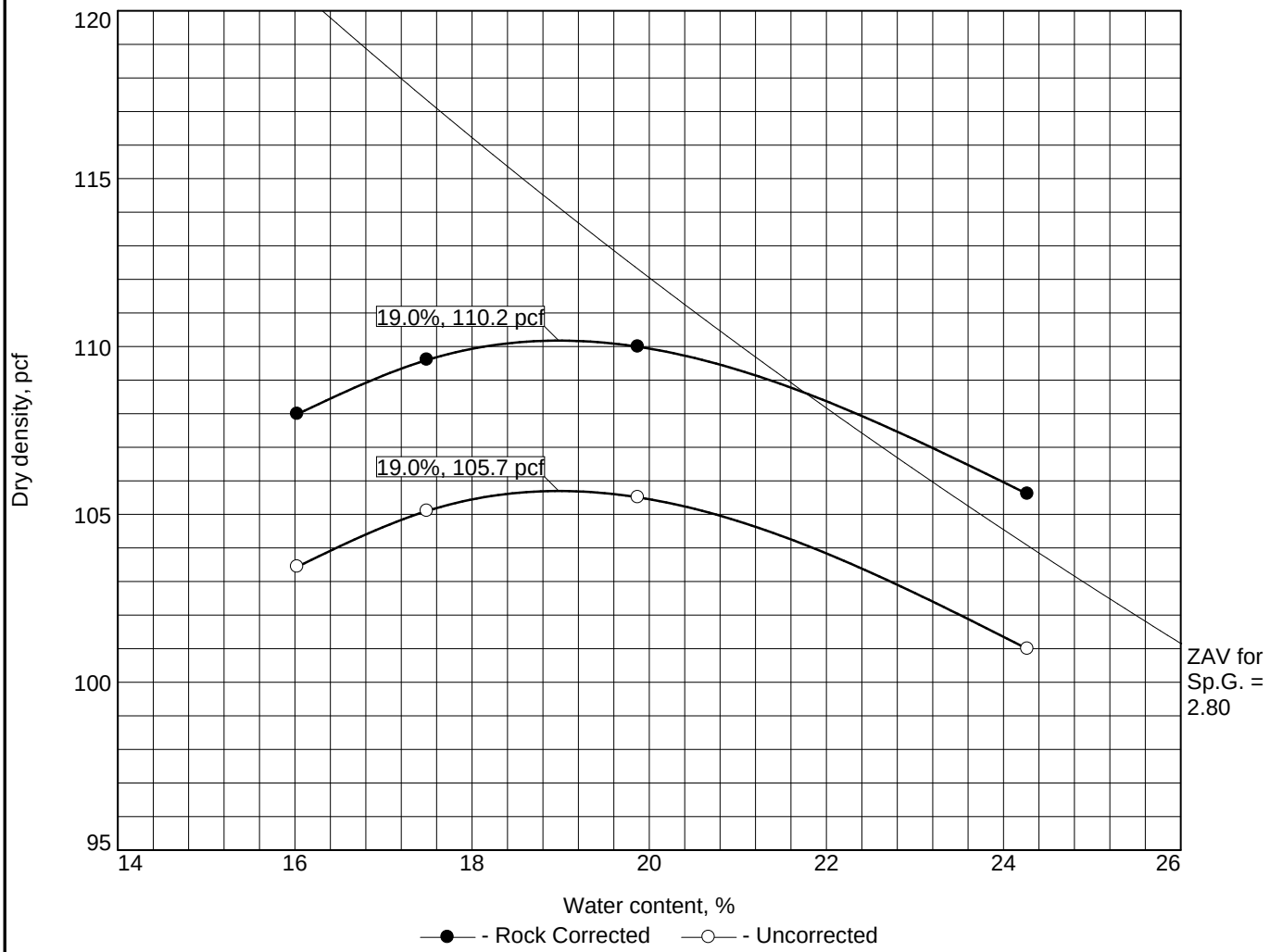
Project: Carpenter Snow Creek

Source of Sample: NSHS-WR-E-002

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-00a Method A Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	SM	A-2-6(0)		2.80	39	11	10.9	27.7

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 110.2 pcf	105.7 pcf	Silty SAND
Optimum moisture = 19.0 %	19.0 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** NSHS-WR-E-002

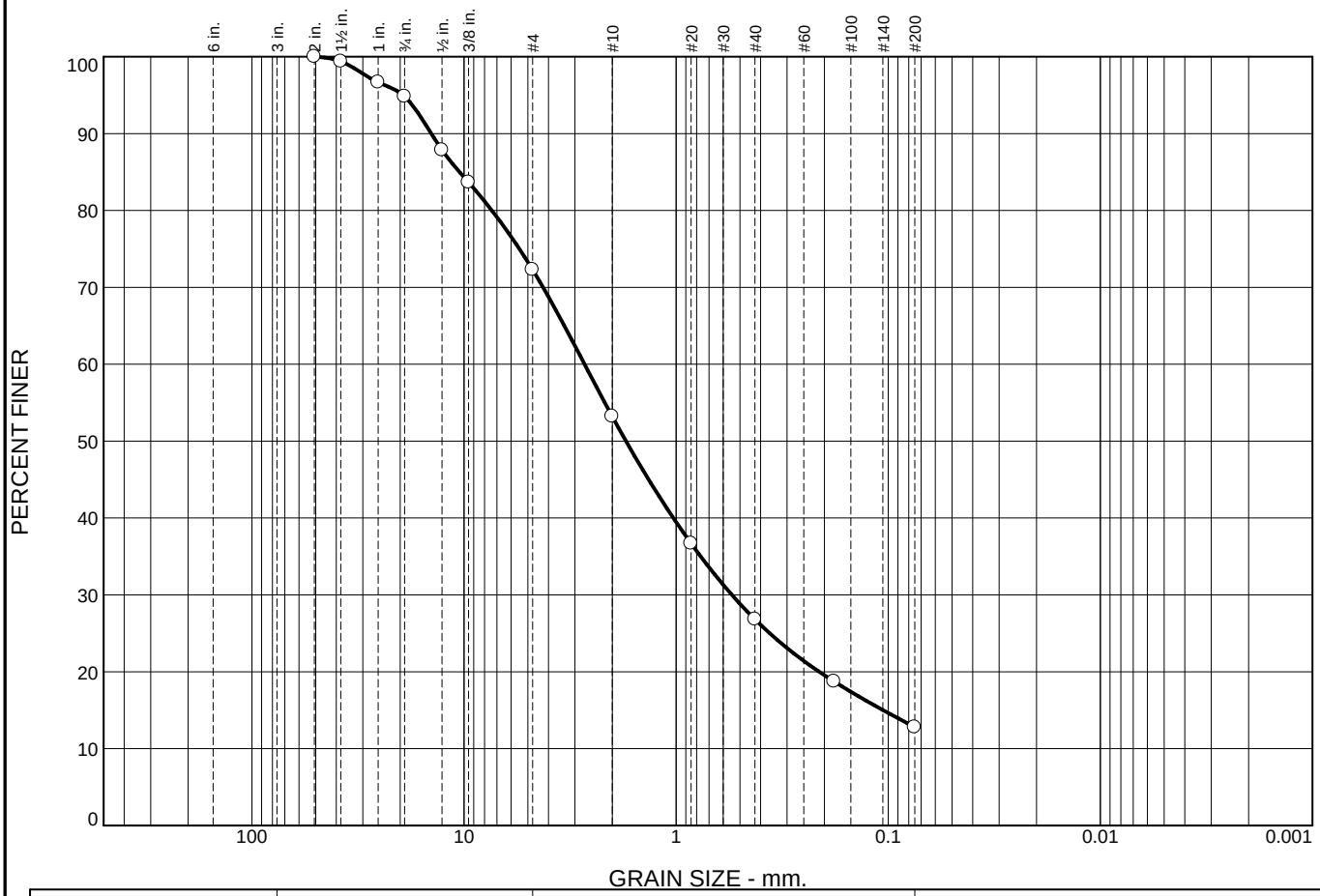
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	5.2	22.5	19.1	26.4	14.0	12.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	10.5064	2.7025	1.7233	0.5459	0.1056			

Material Description	USCS	AASHTO
○ Silty SAND with Gravel	SM	A-1-b

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

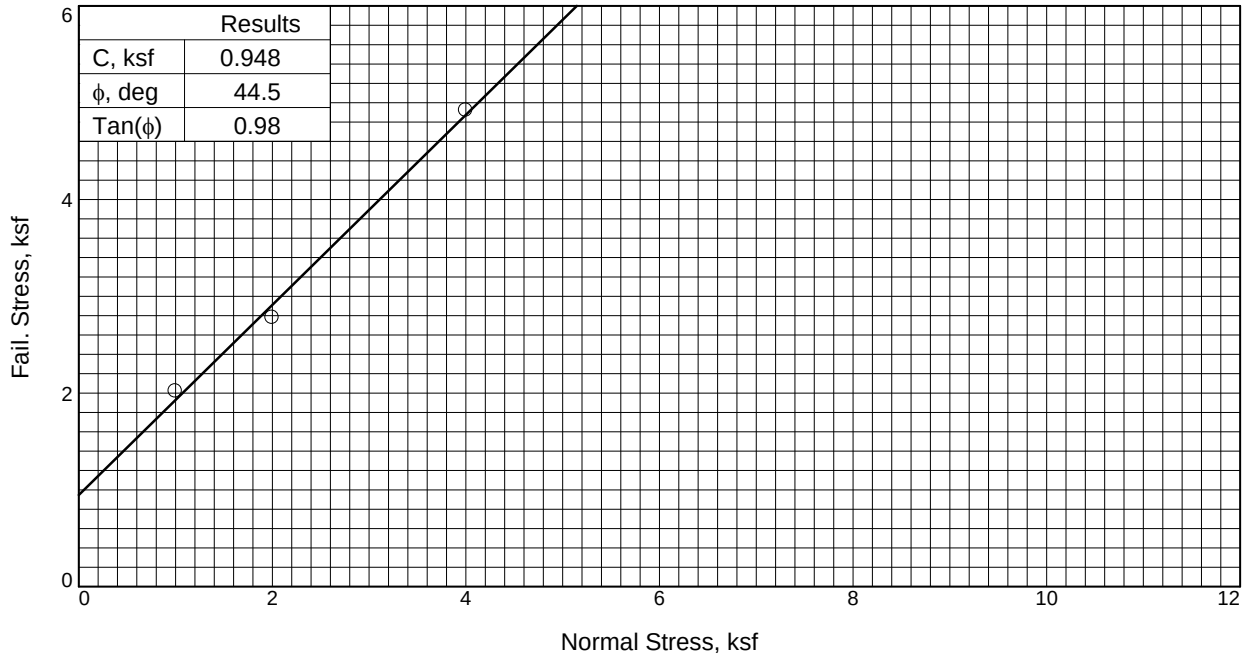
○ **Source of Sample:** NSHS-WR-E-003

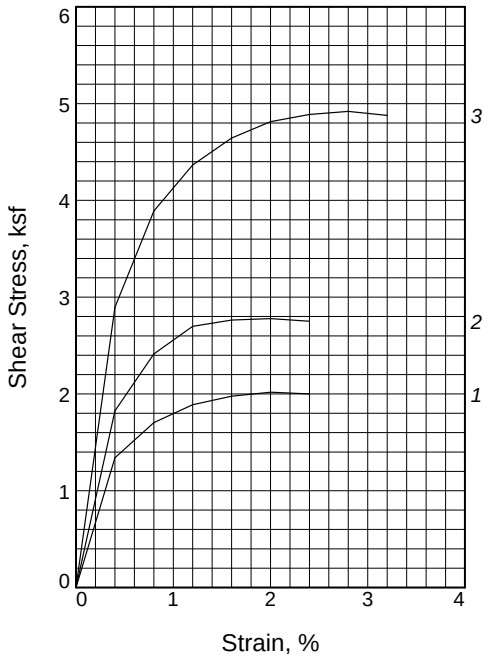
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	12.3	12.3	12.3
	Dry Density, pcf	115.7	115.7	115.7
	Saturation, %	72.6	72.6	72.6
	Void Ratio	0.4572	0.4572	0.4572
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	14.4	13.8	12.8
	Dry Density, pcf	116.3	116.6	117.3
	Saturation, %	86.3	83.5	78.9
	Void Ratio	0.4498	0.4458	0.4372
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.995	0.992	0.986
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		2.018	2.778	4.920
Strain, %		2.0	2.0	2.8
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Silty SAND with Gravel

LL= NV **PI=** NP
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

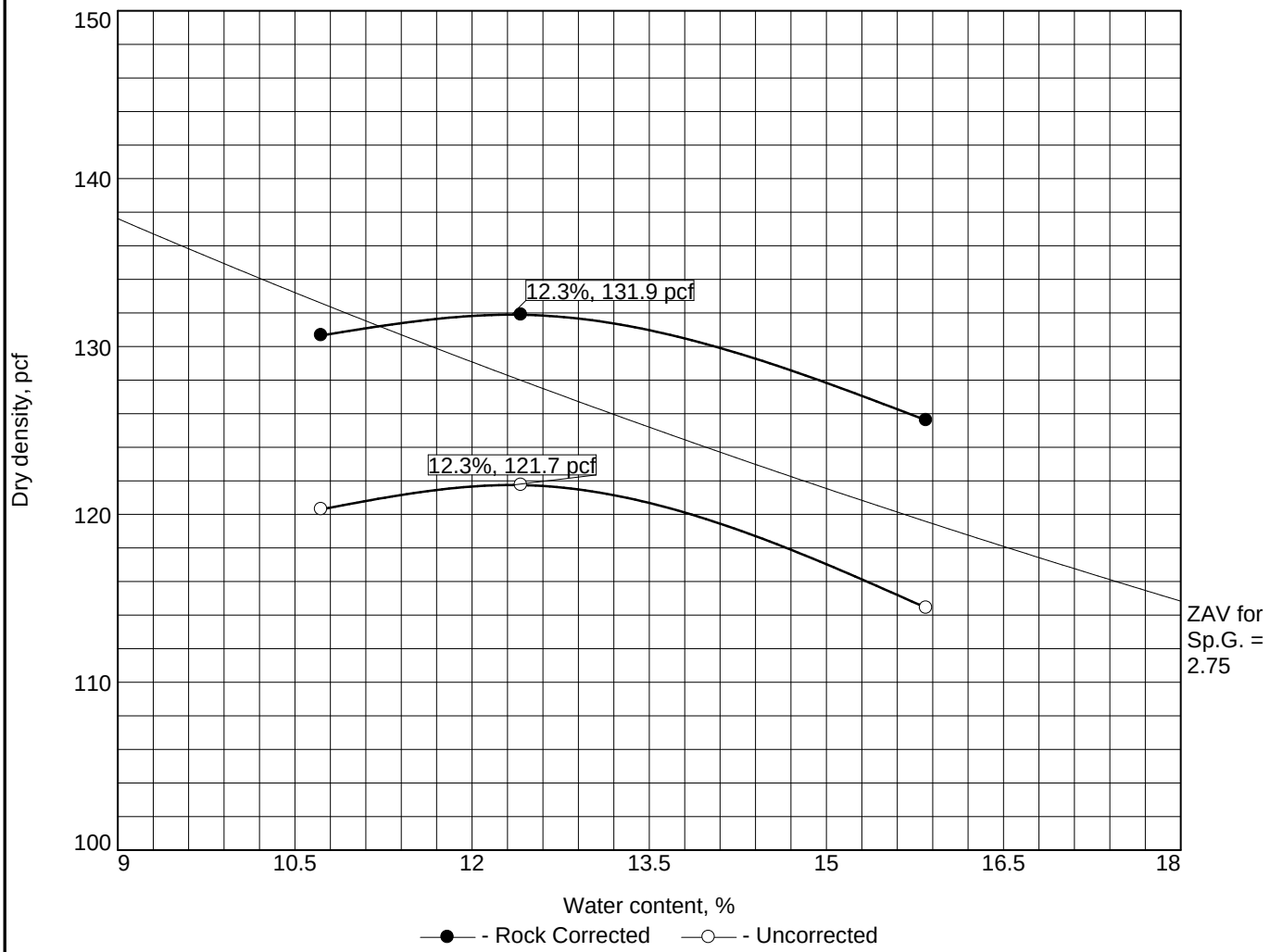
Project: Carpenter Snow Creek

Source of Sample: NSHS-WR-E-003

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	SM	A-1-b		2.75	NV	NP	27.7	12.8

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 131.9 pcf	121.7 pcf	Silty SAND with Gravel
Optimum moisture = 12.3 %	12.3 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** NSHS-WR-E-003

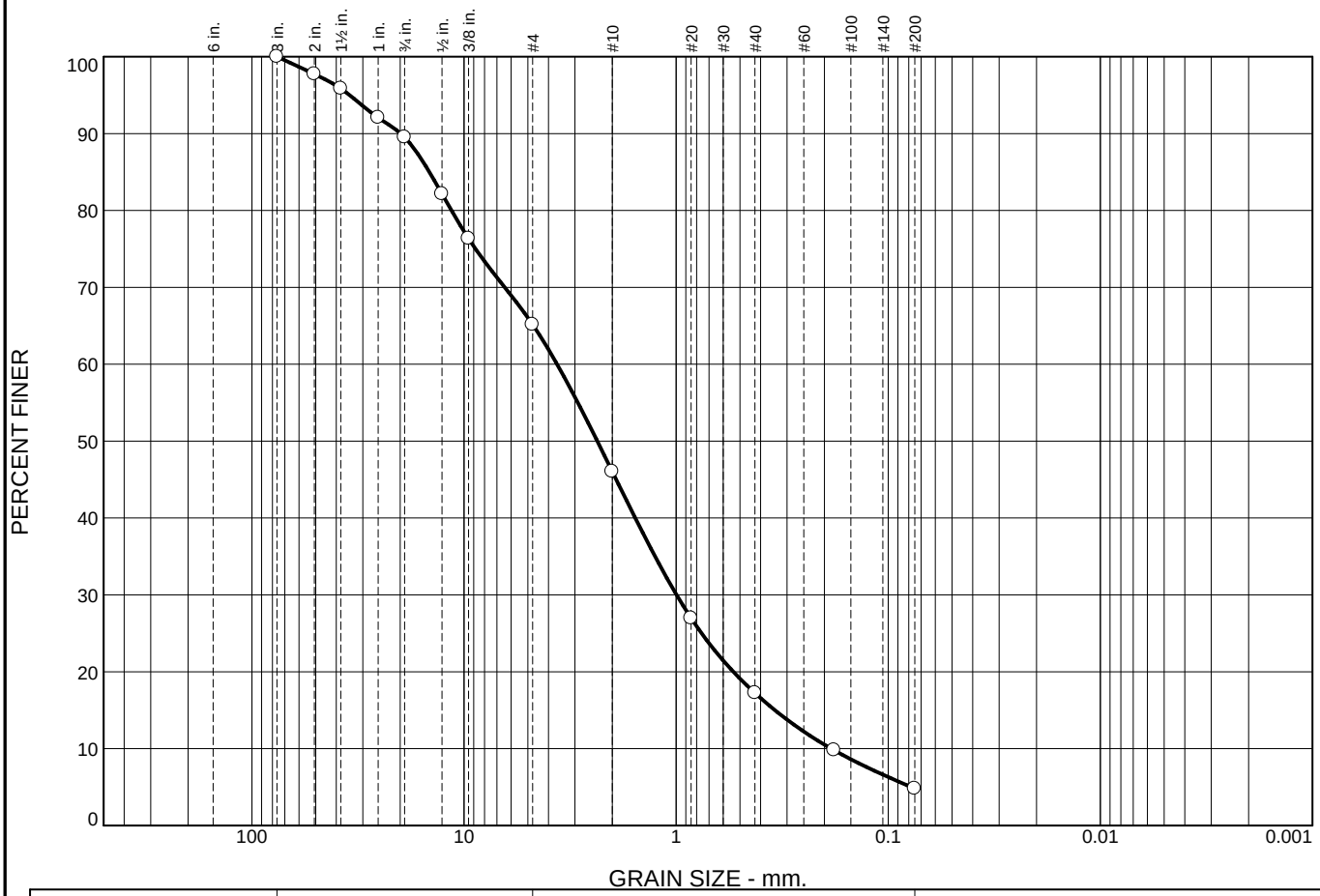
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	10.5	24.3	19.2	28.8	12.4	4.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	14.5701	3.6428	2.3537	0.9953	0.3420	0.1856	1.47	19.63

Material Description	USCS	AASHTO
○ Well-graded SAND with Gravel	SW	A-1-a

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

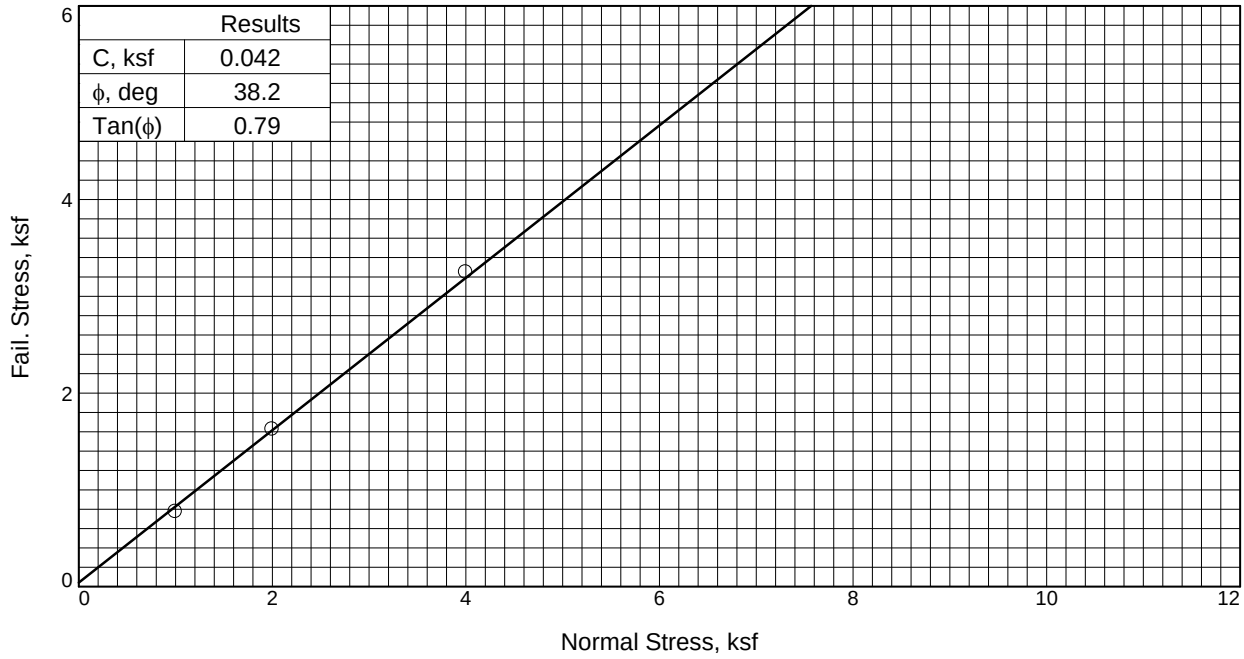
○ **Source of Sample:** NSHS-WR-E-004

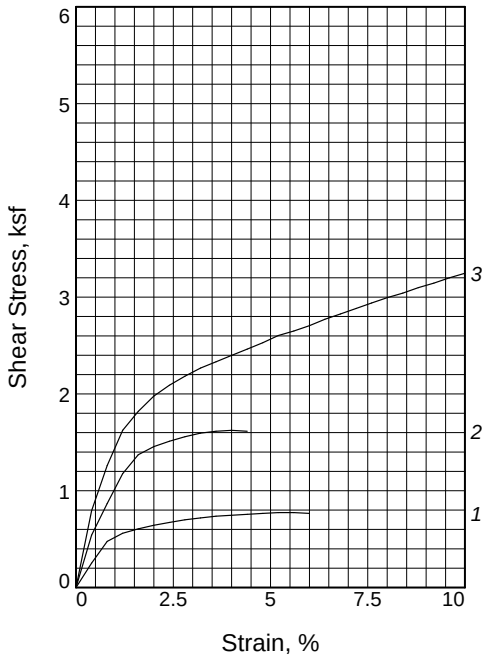
Remarks:

Tetra Tech

Billings, MT

Figure





	Sample No.	1	2	3
Initial	Water Content, %	11.0	11.0	11.0
	Dry Density, pcf	123.9	124.0	124.0
	Saturation, %	82.5	82.4	82.4
	Void Ratio	0.3600	0.3598	0.3598
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	12.9	12.8	11.5
	Dry Density, pcf	124.1	124.3	124.5
	Saturation, %	97.2	97.0	88.1
	Void Ratio	0.3585	0.3564	0.3537
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.999	0.998	0.996
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.774	1.624	3.247
Strain, %		5.2	4.0	10.0
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Well-graded SAND with Gravel

LL= NV **PI=** NP
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

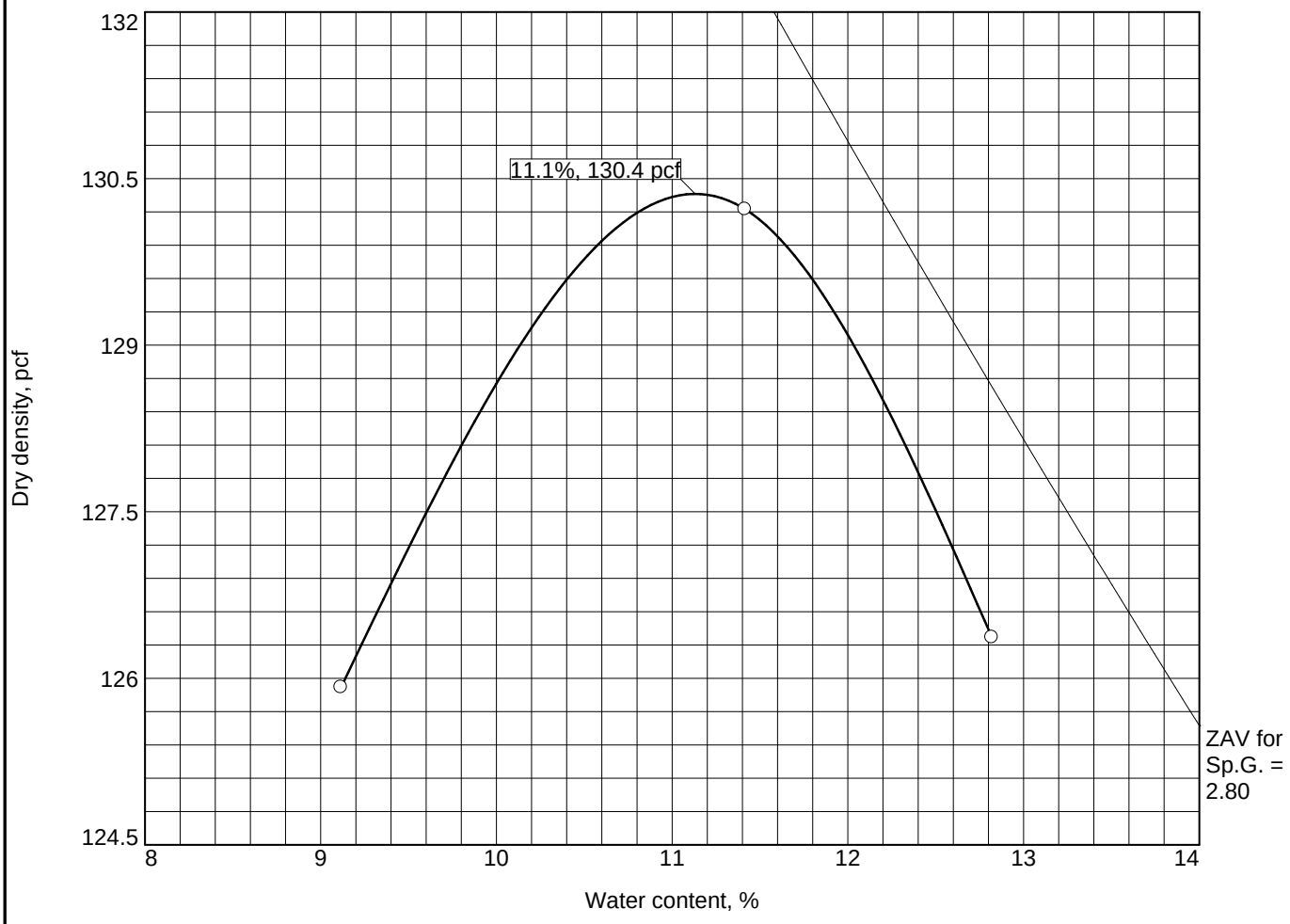
Project: Carpenter Snow Creek

Source of Sample: NSHS-WR-E-004

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	SW	A-1-a			NV	NP	23.6	4.8

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 130.4 pcf Optimum moisture = 11.1 %	Well-graded SAND with Gravel

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** NSHS-WR-E-004

Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	6.0	16.9	10.9	21.1	21.3	23.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	37	24	8.4962	1.2482	0.6069	0.1293				

Material Description	USCS	AASHTO
○ Clayey SAND with Gravel	SC	A-2-6(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

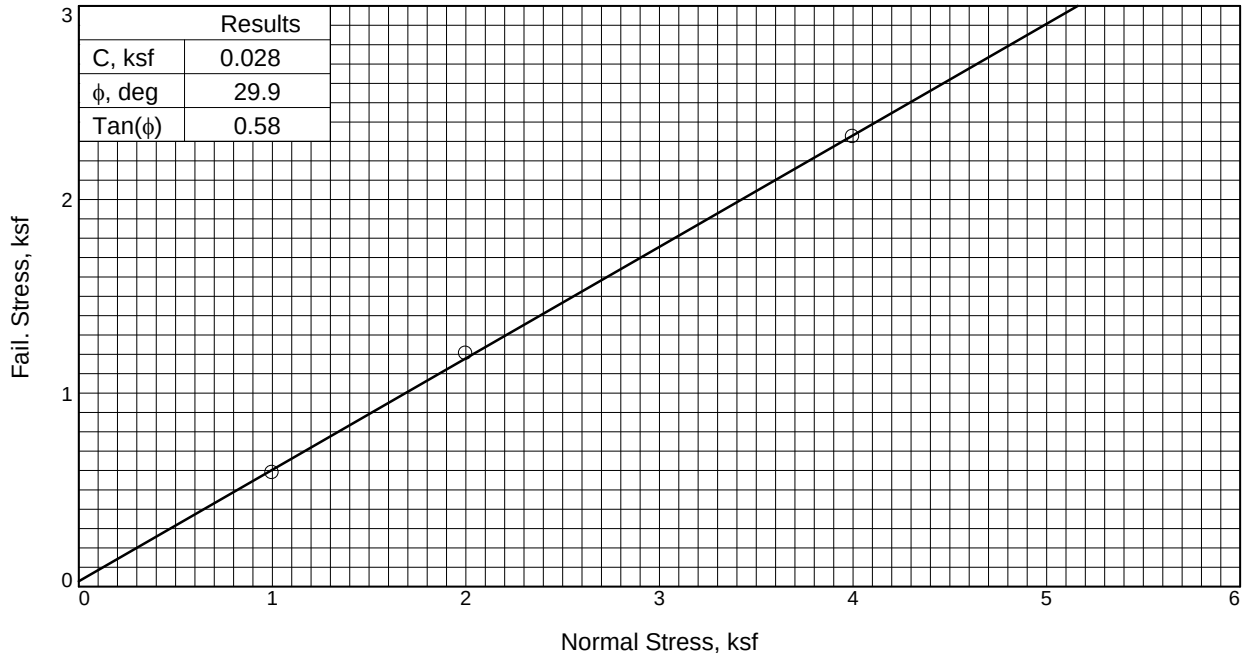
○ **Source of Sample:** NSHS-WR-E-005

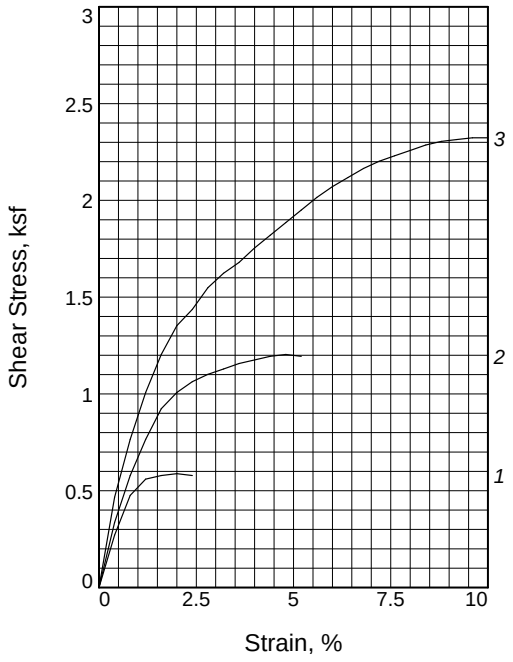
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	15.4	15.4	15.4
	Dry Density, pcf	106.6	106.6	106.3
	Saturation, %	71.5	71.5	70.9
	Void Ratio	0.5813	0.5813	0.5860
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	21.8	19.7	15.8
	Dry Density, pcf	106.9	107.2	107.2
	Saturation, %	102.2	93.0	74.6
	Void Ratio	0.5763	0.5726	0.5721
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.997	0.995	0.991
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.588	1.204	2.323
Strain, %		2.0	4.8	9.6
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Clayey SAND with Gravel

LL= 37
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

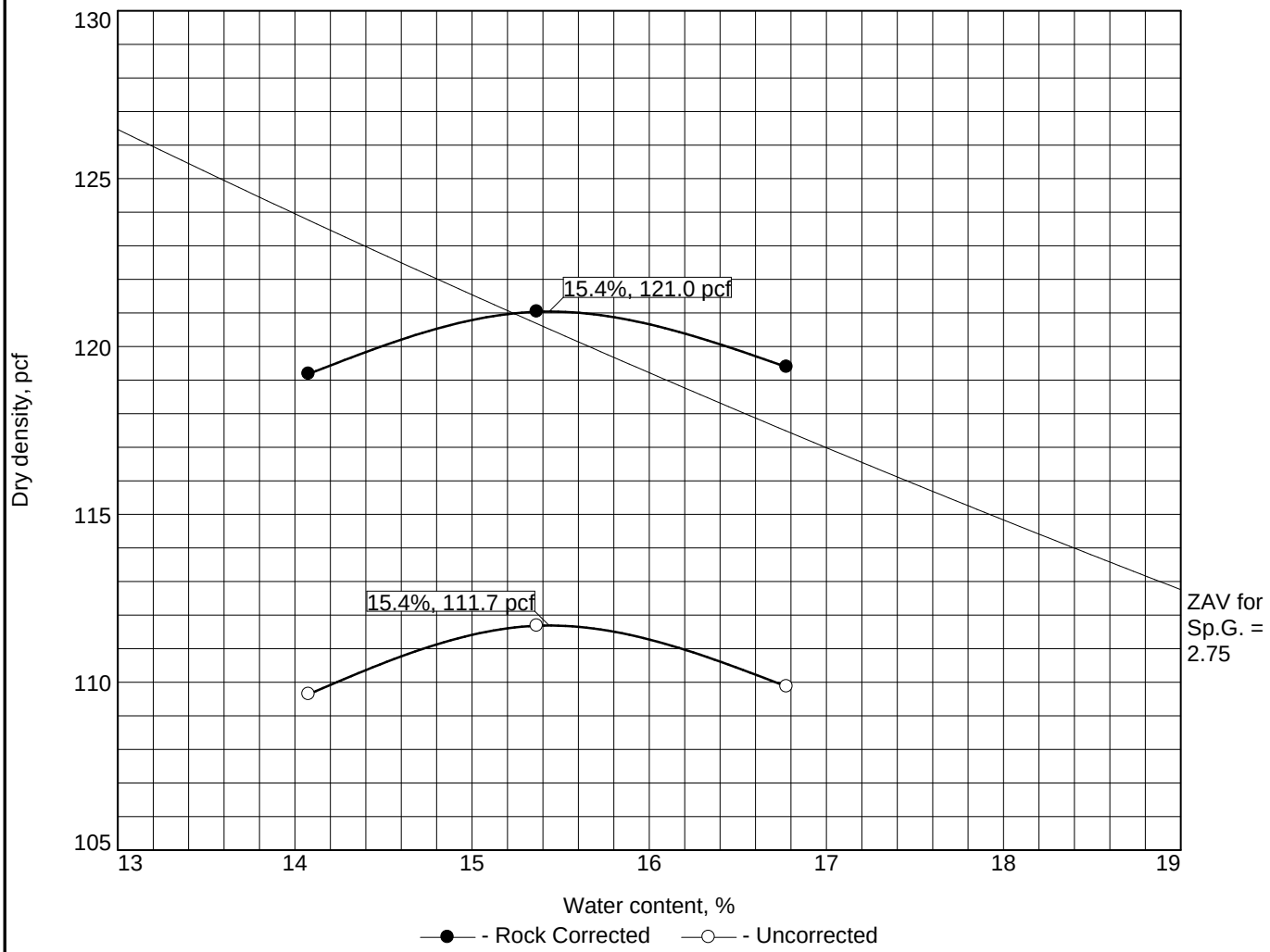
Project: Carpenter Snow Creek

Source of Sample: NSHS-WR-E-005

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification USCS	Classification AASHTO	Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	SC	A-2-6(0)		2.75	37		22.9	23.8

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 121.0 pcf	111.7 pcf	Clayey SAND with Gravel
Optimum moisture = 15.4 %	15.4 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** NSHS-WR-E-005

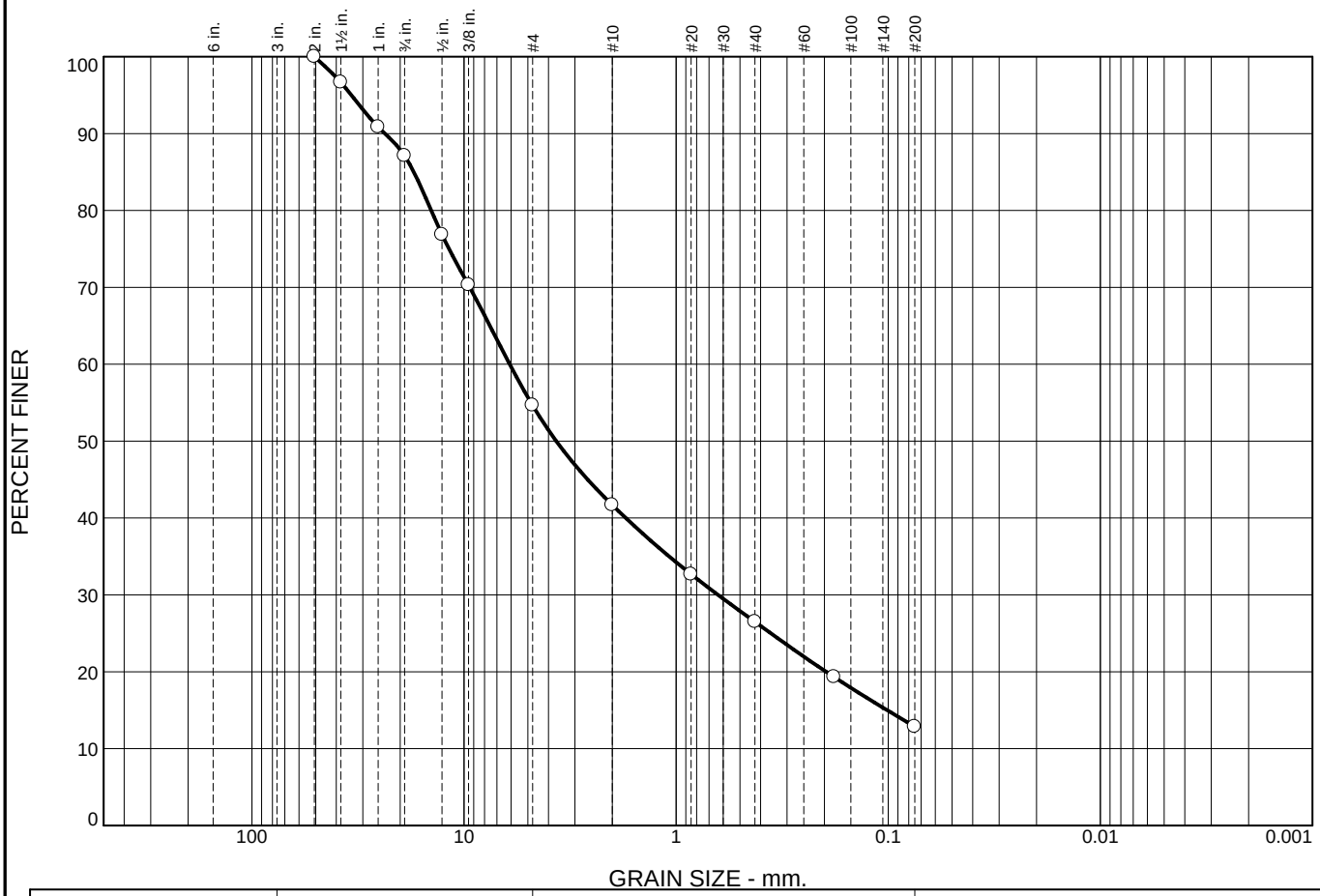
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	12.9	32.5	12.9	15.2	13.6	12.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	32	25	17.2519	6.0893	3.6745	0.6347	0.1011			

Material Description	USCS	AASHTO
○ silty gravel with sand	GM	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

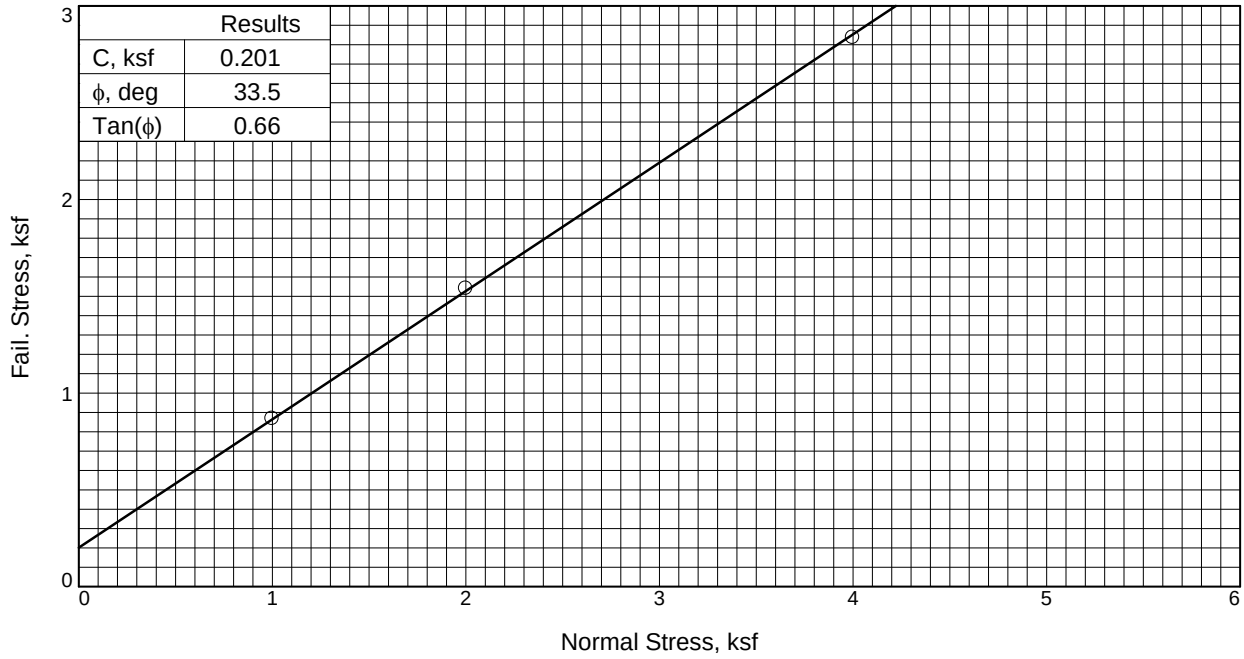
○ **Source of Sample:** NSHS-WR-E-006

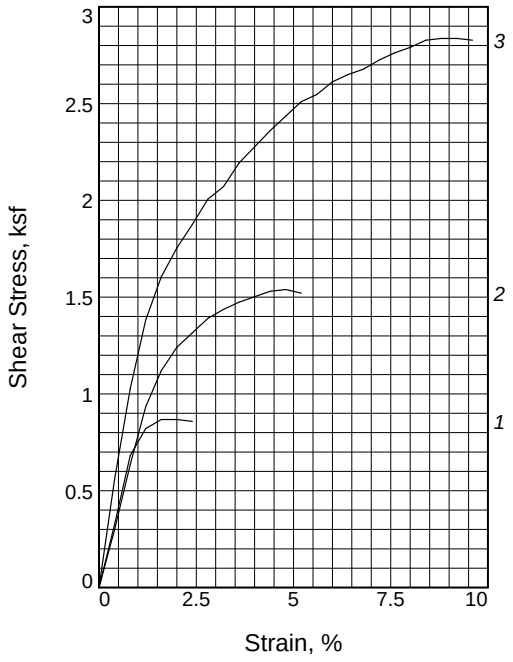
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	14.6	14.6	14.6
	Dry Density, pcf	112.3	112.3	112.3
	Saturation, %	78.8	78.8	78.8
	Void Ratio	0.5004	0.5004	0.5004
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	18.3	16.5	14.9
	Dry Density, pcf	113.4	114.3	115.8
	Saturation, %	101.6	93.7	88.4
	Void Ratio	0.4869	0.4749	0.4553
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.991	0.983	0.970
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.868	1.540	2.837
Strain, %		1.6	4.8	8.8
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: silty gravel with sand

LL= 32 **PL=** 25 **PI=** 7
Specific Gravity= 2.7
Remarks:

Figure _____

Client: Tetra Tech EMI

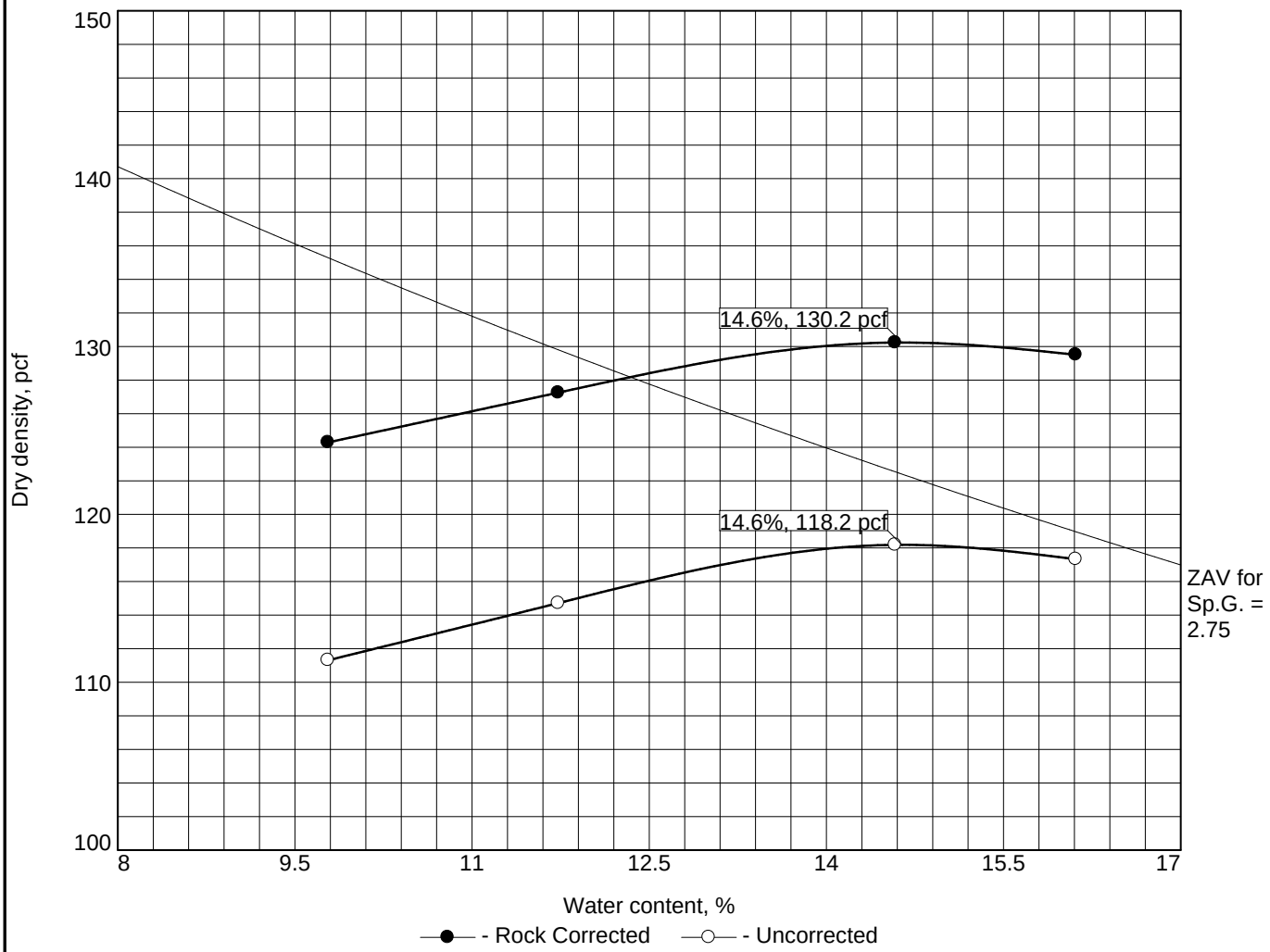
Project: Carpenter Snow Creek

Source of Sample: NSHS-WR-E-006

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method B Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	GM	A-2-4(0)		2.75	32	7	29.7	12.9

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 130.2 pcf	118.2 pcf	silty gravel with sand
Optimum moisture = 14.6 %	14.6 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** NSHS-WR-E-006

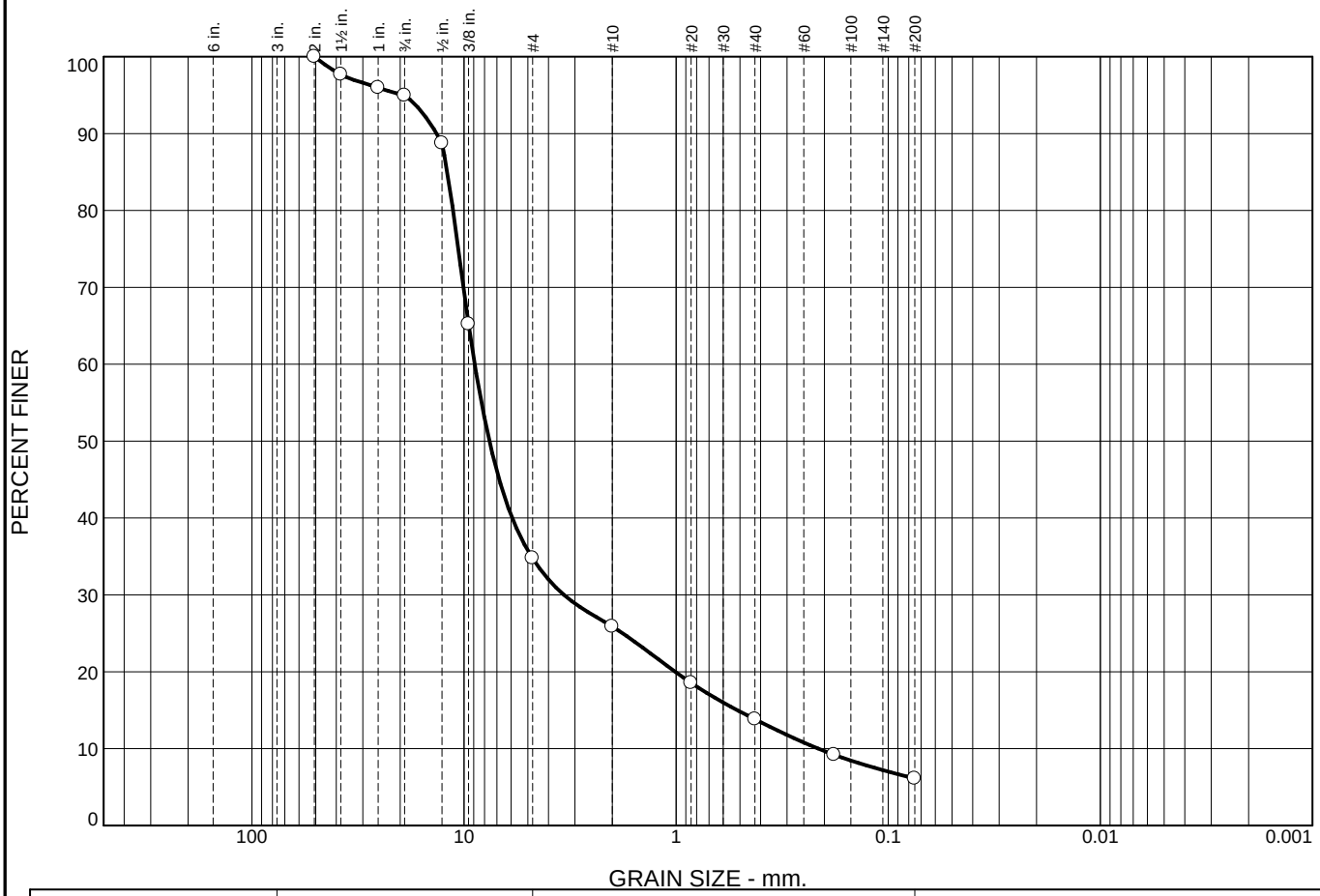
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	5.0	60.2	8.9	12.1	7.7	6.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	33	23	11.9955	8.9075	7.5922	3.3790	0.5144	0.2136	6.00	41.70

Material Description	USCS	AASHTO
○ Poorly graded GRAVEL with Clay and Sand	GP-GC	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

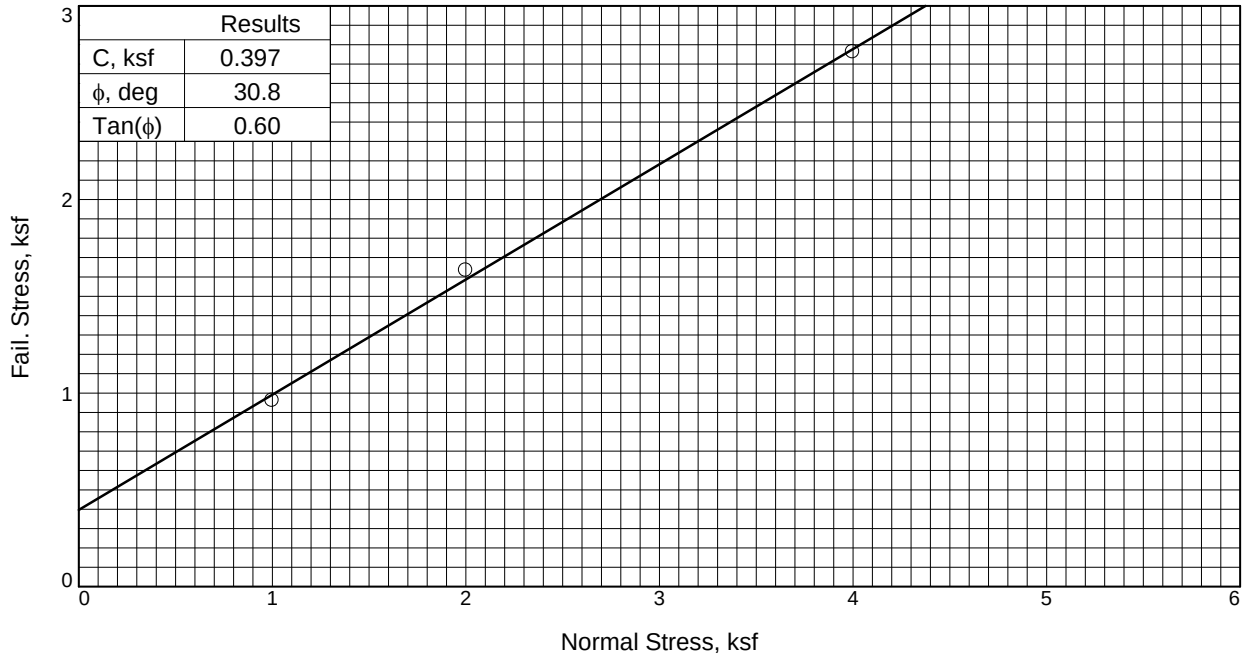
○ **Source of Sample:** NSHS-WR-E-007

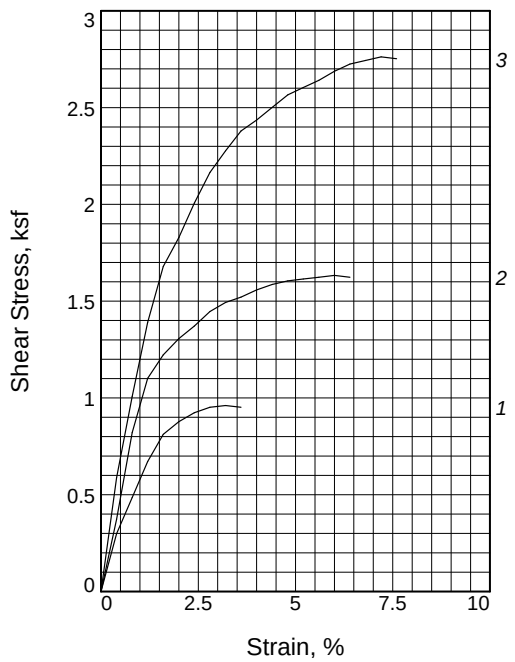
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	13.1	13.1	13.1
	Dry Density, pcf	115.6	115.6	115.6
	Saturation, %	77.2	77.2	77.2
	Void Ratio	0.4584	0.4584	0.4584
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	15.1	14.0	12.0
	Dry Density, pcf	115.9	120.1	116.0
	Saturation, %	89.8	94.0	71.6
	Void Ratio	0.4543	0.4030	0.4526
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.997	0.962	0.996
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.961	1.633	2.762
Strain, %		3.2	6.0	7.2
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded

Description: Poorly graded GRAVEL with Clay and Sand

LL= 33

Specific Gravity= 2.70

Remarks:

Figure _____

Client: Tetra Tech EMI

Project: Carpenter Snow Creek

Source of Sample: NSHS-WR-E-007

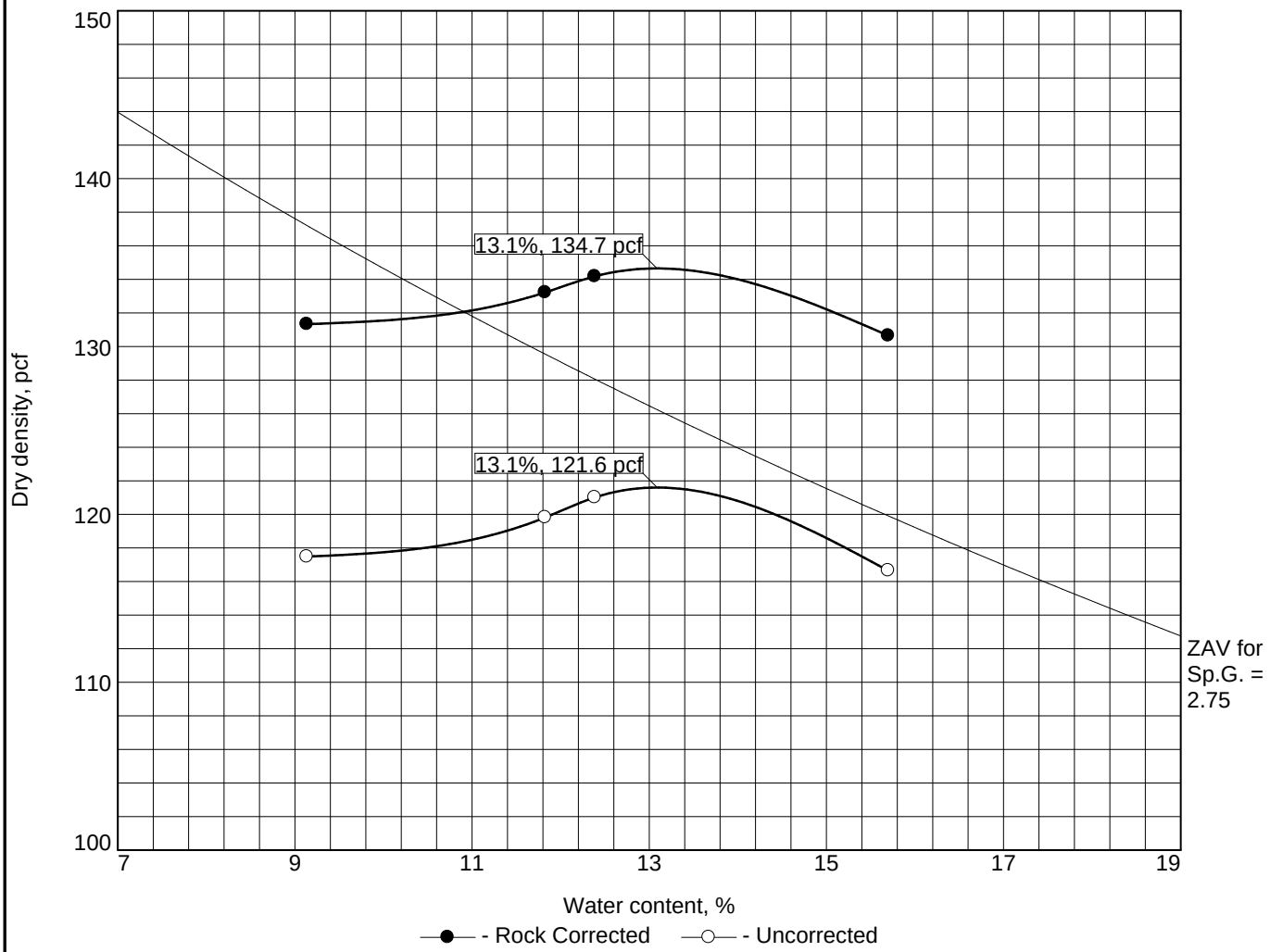
Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT

Tetra Tech

Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-91 Procedure B Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification USCS	Classification AASHTO	Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	GP-GC	A-2-4(0)		2.75	33		34.8	6.1

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 134.7 pcf	121.6 pcf	Poorly graded GRAVEL with Clay and Sand
Optimum moisture = 13.1 %	13.1 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** NSHS-WR-E-007

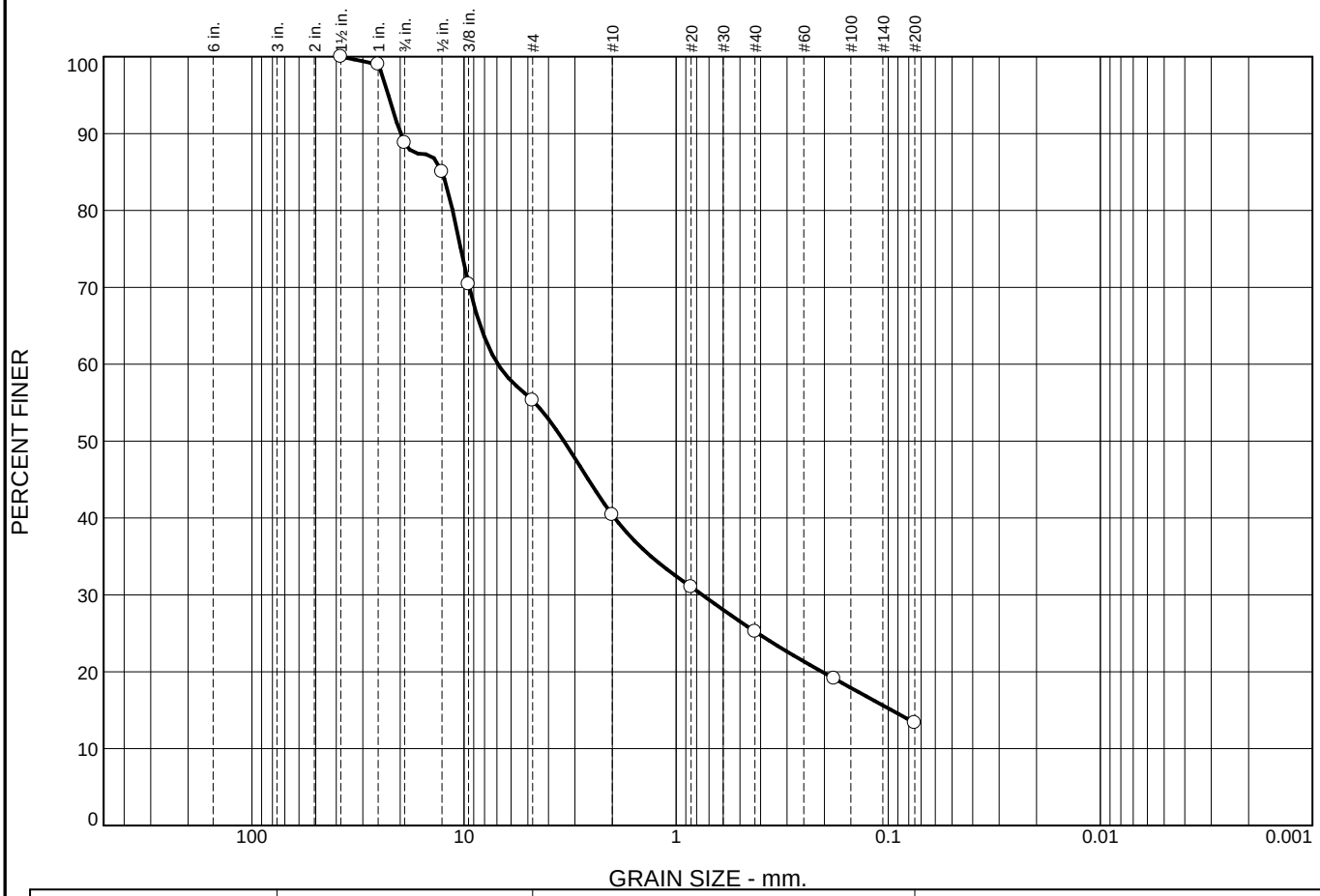
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	11.2	33.5	14.9	15.2	11.8	13.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	27	18	12.6928	6.9239	3.3826	0.7533	0.0964			

Material Description	USCS	AASHTO
○ Clayey GRAVEL with Sand	GC	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

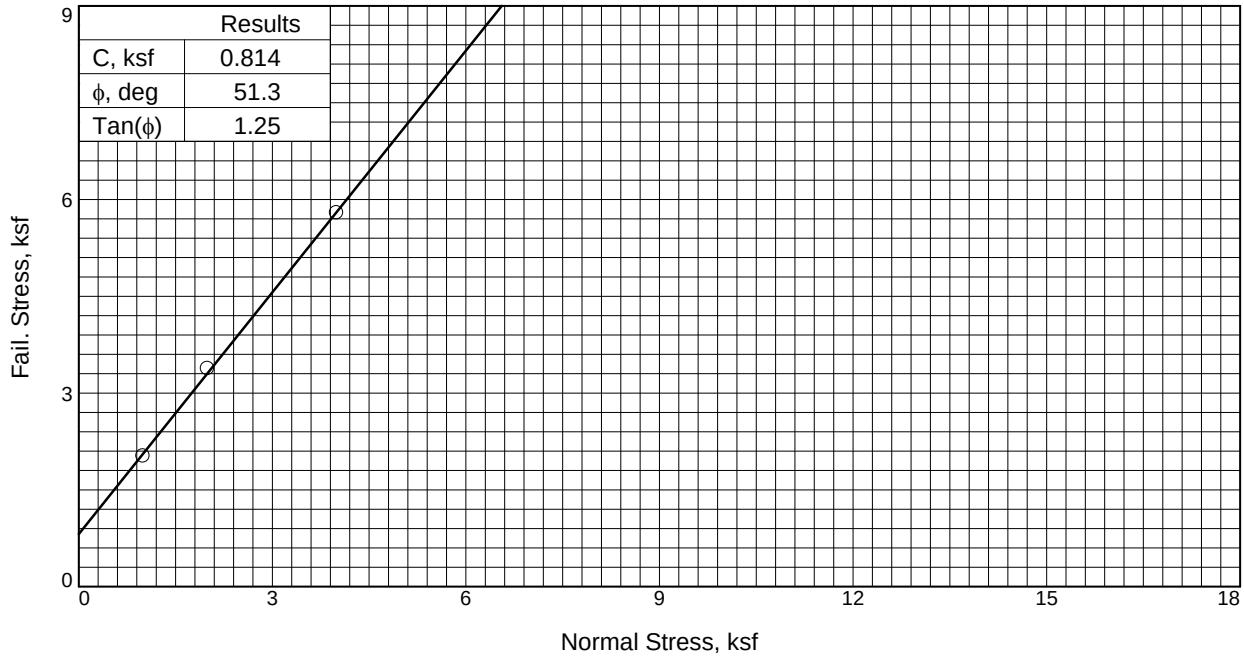
○ **Source of Sample:** NSHS-WR-E-008

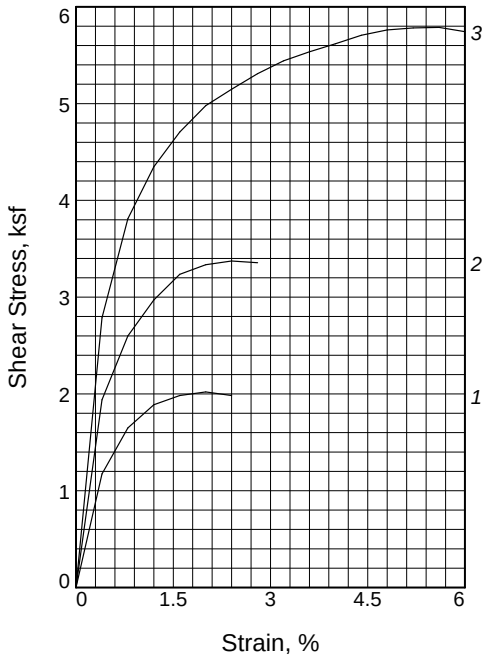
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	14.0	14.0	14.0
	Dry Density, pcf	117.0	117.0	117.0
	Saturation, %	85.8	85.8	85.8
	Void Ratio	0.4409	0.4409	0.4409
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	15.1	14.4	13.6
	Dry Density, pcf	117.5	117.9	118.6
	Saturation, %	93.7	90.8	87.3
	Void Ratio	0.4350	0.4291	0.4207
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.996	0.992	0.986
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		2.021	3.374	5.788
Strain, %		2.0	2.4	5.6
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Clayey GRAVEL with Sand

LL= 27
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

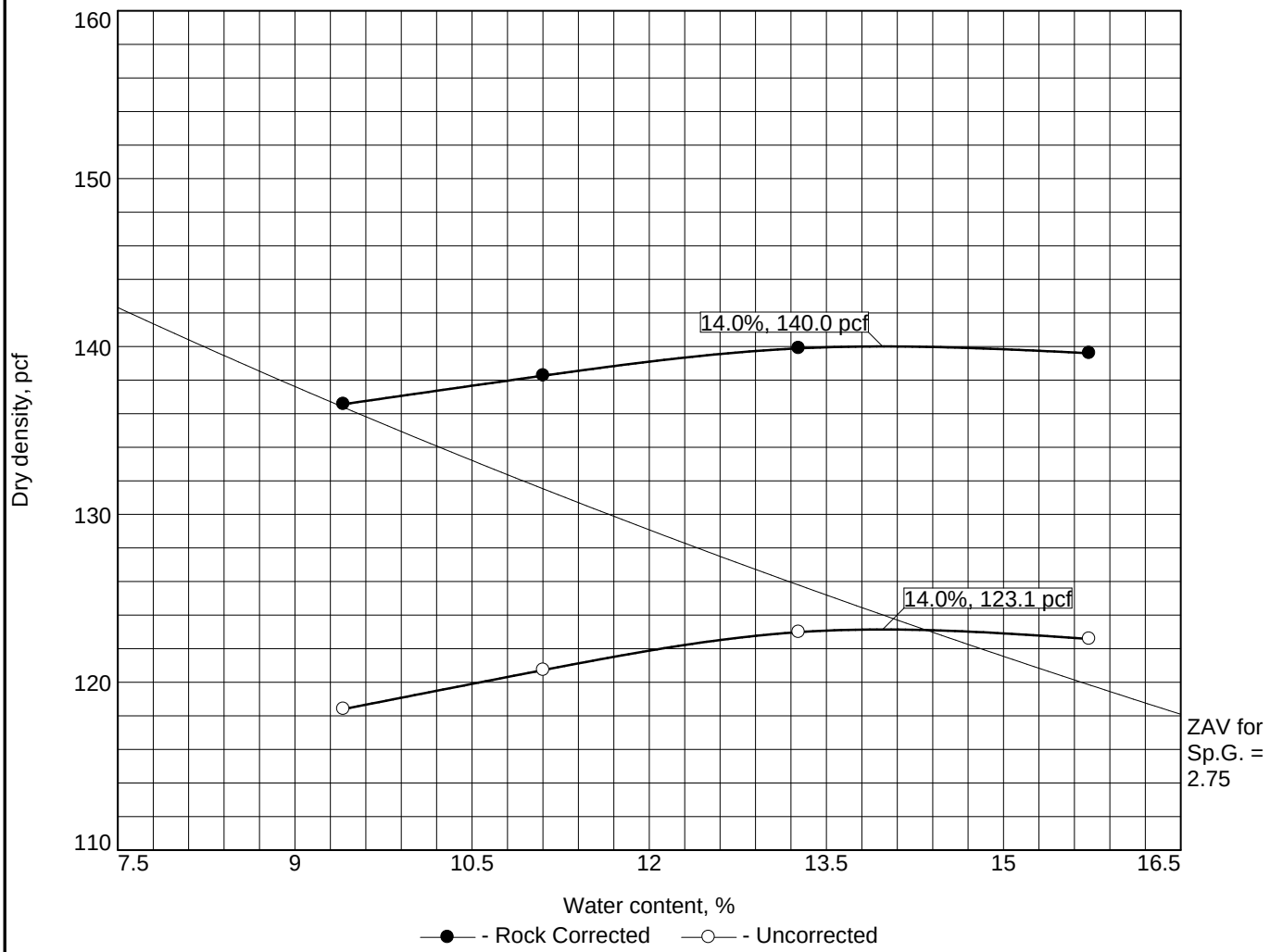
Project: Carpenter Snow Creek

Source of Sample: NSHS-WR-E-008

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-91 Procedure A Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification USCS	Classification AASHTO	Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	GC	A-2-4(0)		2.75	27		44.7	13.4

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 140.0 pcf	123.1 pcf	Clayey GRAVEL with Sand
Optimum moisture = 14.0 %	14.0 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** NSHS-WR-E-008

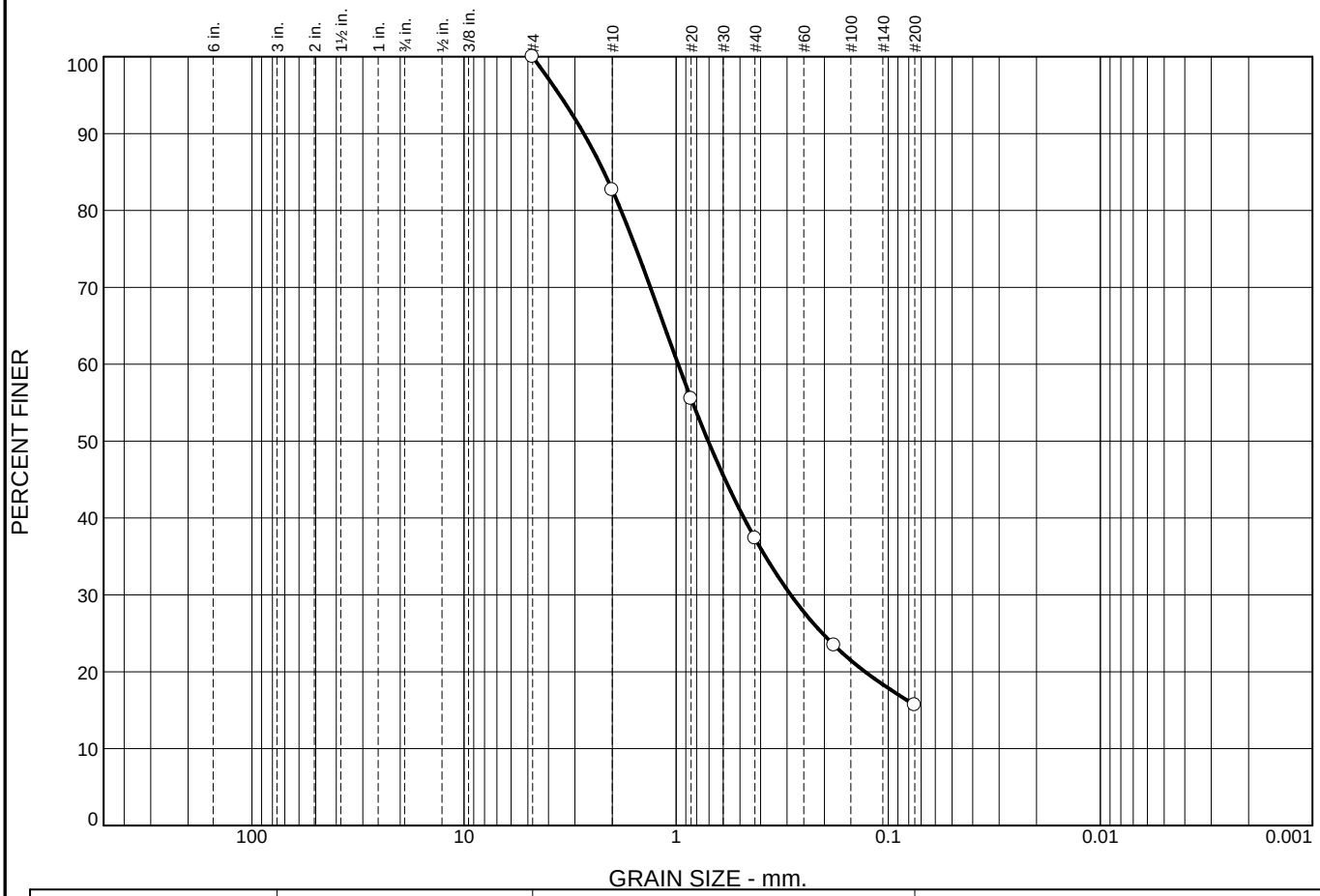
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	17.3	45.4	21.6	15.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	2.1883	0.9782	0.7062	0.2880				

Material Description	USCS	AASHTO
○ Silty SAND	SM	A-1-b

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

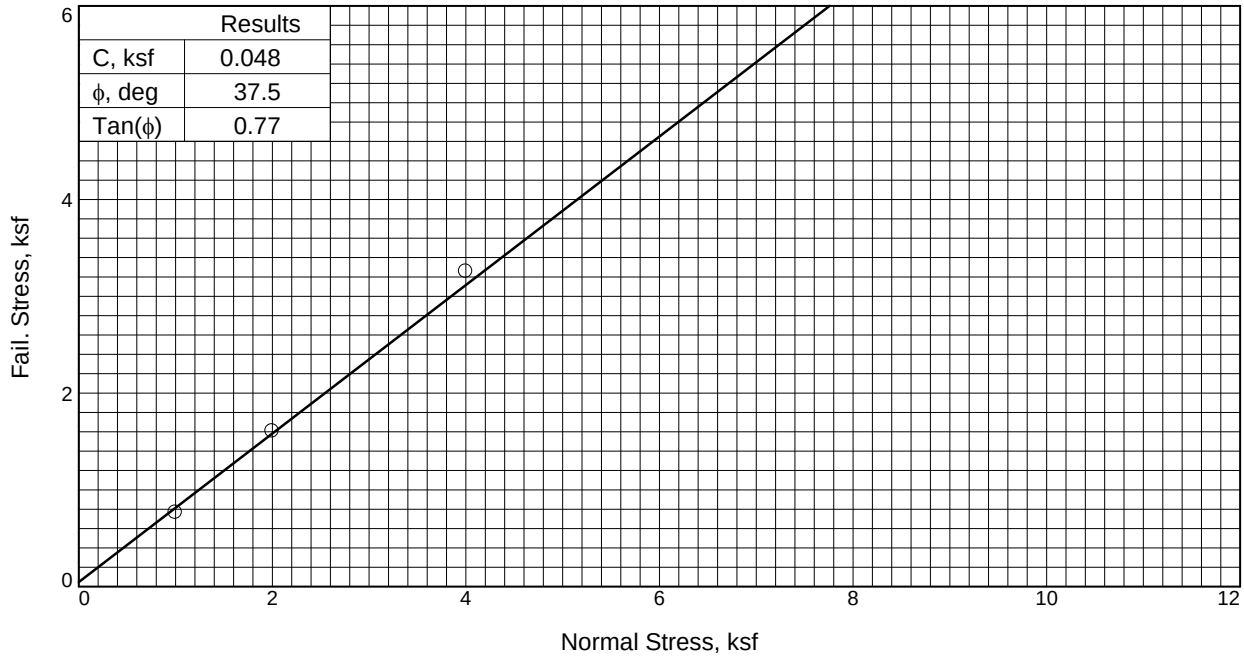
○ **Source of Sample:** NSHS-WR-E-009

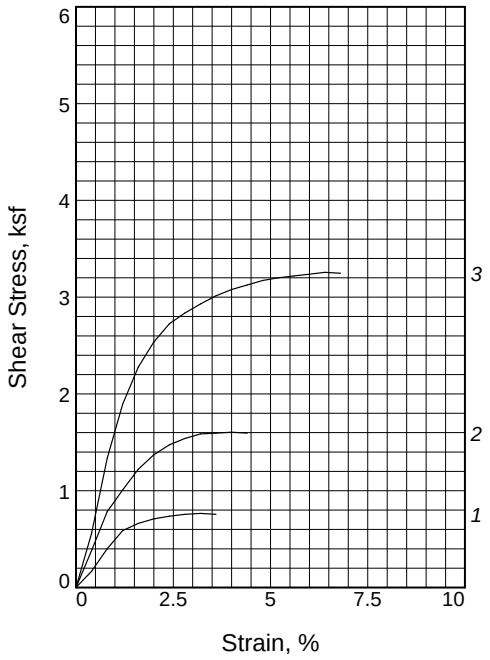
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	11.3	11.3	11.3
	Dry Density, pcf	118.9	118.9	118.9
	Saturation, %	72.5	72.5	72.5
	Void Ratio	0.4226	0.4226	0.4226
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	15.6	14.4	10.7
	Dry Density, pcf	120.5	120.7	121.2
	Saturation, %	104.8	97.6	73.5
	Void Ratio	0.4041	0.4013	0.3956
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.987	0.985	0.981
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.765	1.605	3.257
Strain, %		3.2	4.0	6.4
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Silty SAND

LL= NV **PI=** NP
Specific Gravity= 2.710
Remarks:

Figure _____

Client: Tetra Tech EMI

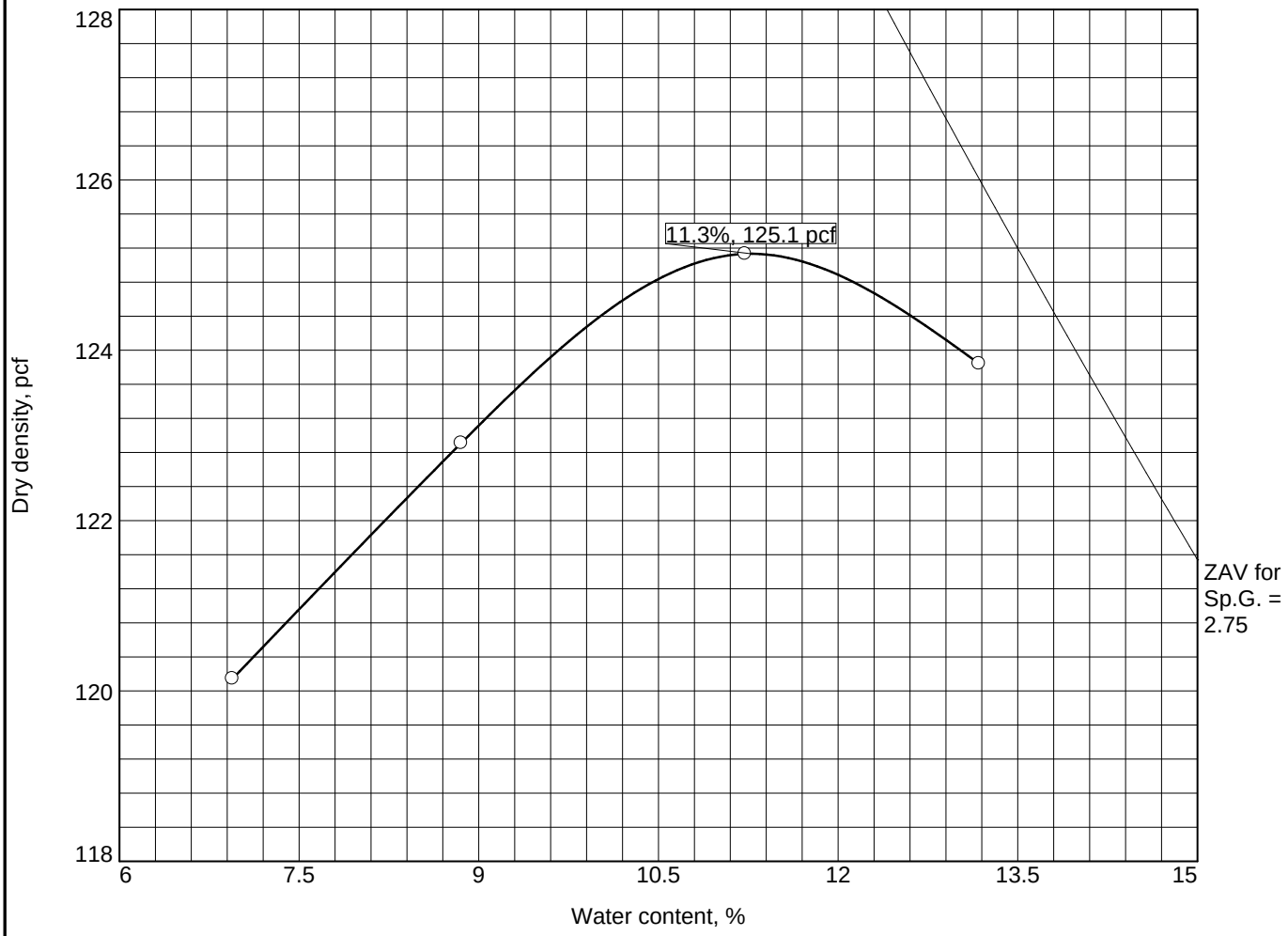
Project: Carpenter Snow Creek

Source of Sample: NSHS-WR-E-009

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	SM	A-1-b		2.75	NV	NP	0.0	15.7

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 125.1 pcf Optimum moisture = 11.3 %	Silty SAND

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** NSHS-WR-E-009

Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	4.0	25.6	13.3	22.1	17.1	17.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	36	30	11.6745	2.4170	1.2688	0.2749				

Material Description	USCS	AASHTO
○ Silty SAND with Gravel	SM	A-1-b

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

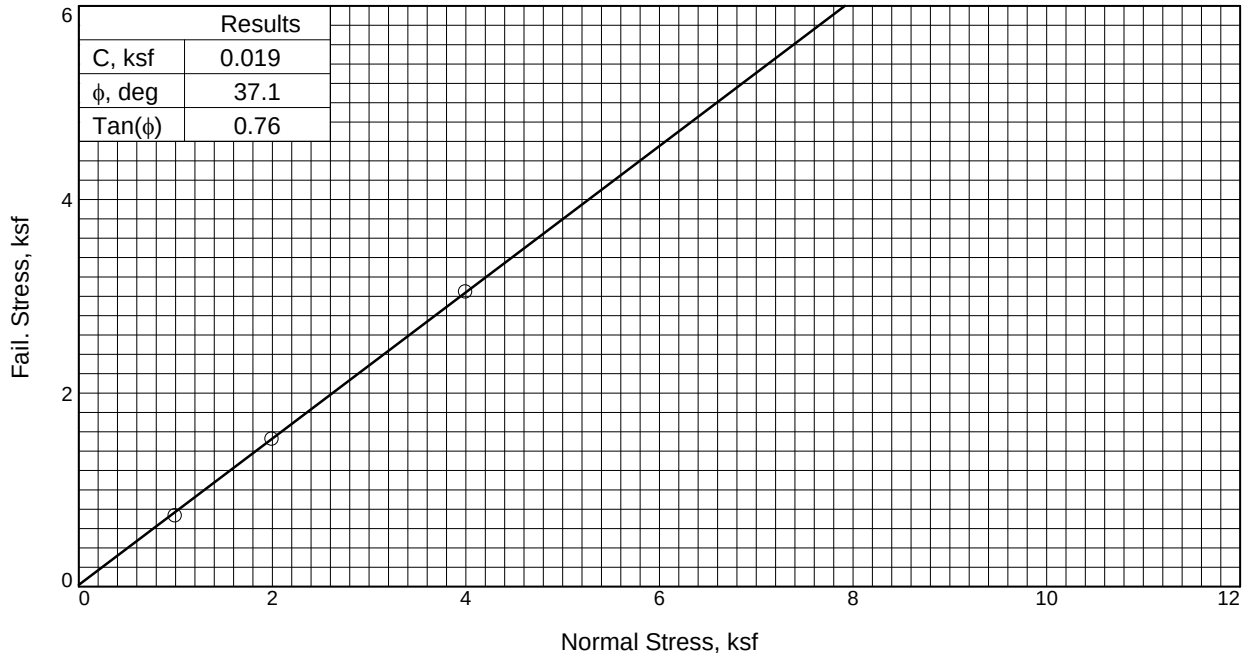
○ **Source of Sample:** SCHS-WR-E-001

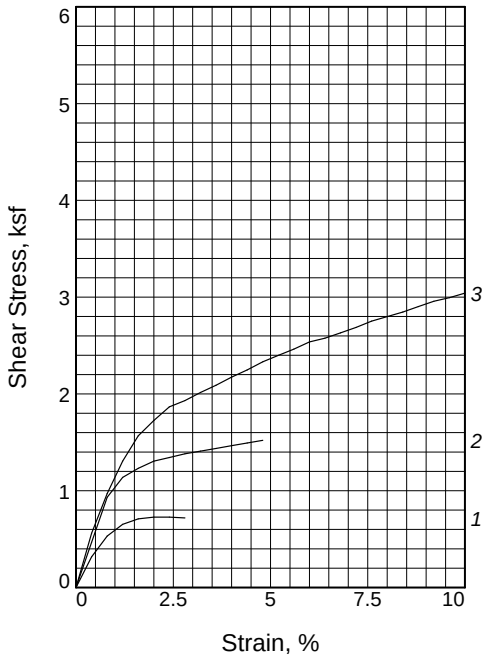
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	13.4	13.4	13.4
	Dry Density, pcf	107.8	107.8	107.8
	Saturation, %	64.2	64.2	64.2
	Void Ratio	0.5635	0.5635	0.5635
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	18.0	17.2	15.3
	Dry Density, pcf	108.0	108.1	108.3
	Saturation, %	86.7	83.1	74.1
	Void Ratio	0.5607	0.5591	0.5564
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.998	0.997	0.996
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.728	1.521	3.042
Strain, %		2.0	4.8	10.0
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Silty SAND with Gravel

LL= 36
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

Project: Carpenter Snow Creek

Source of Sample: SCHS-WR-E-001

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

COMPACTION TEST REPORT

Test specification: ASTM D 698-07 Method B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	SM	A-1-b			36		18.5	17.9

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 113.4 pcf Optimum moisture = 13.4 %	Silty SAND with Gravel

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** SCHS-WR-E-001

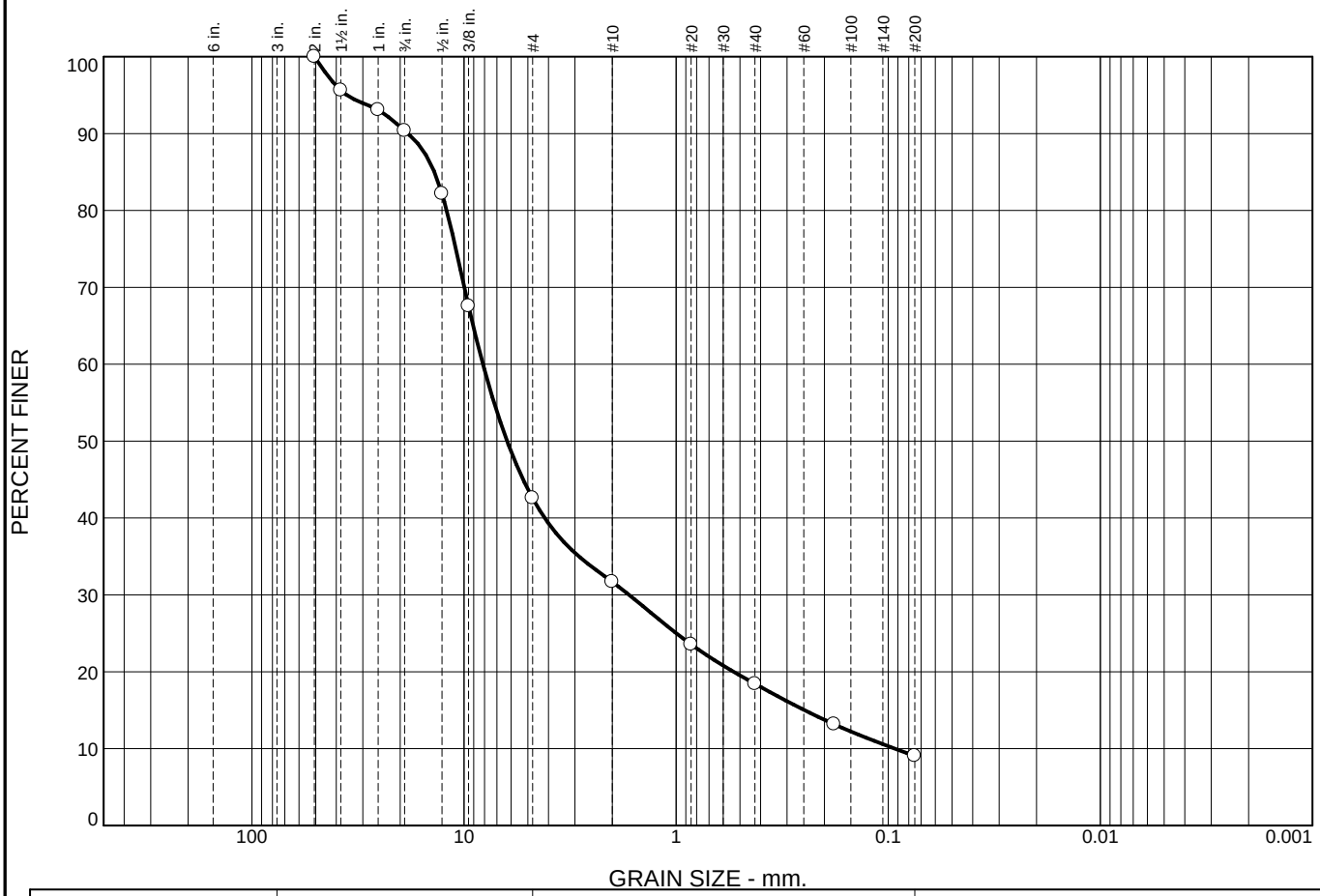
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	9.6	47.8	10.9	13.3	9.3	9.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	39	29	13.7960	8.1444	6.2651	1.6674	0.2479	0.0930	3.67	87.53

Material Description	USCS	AASHTO
○ poorly graded gravel with silt and sand	GP-GM	A-2-4(0)

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

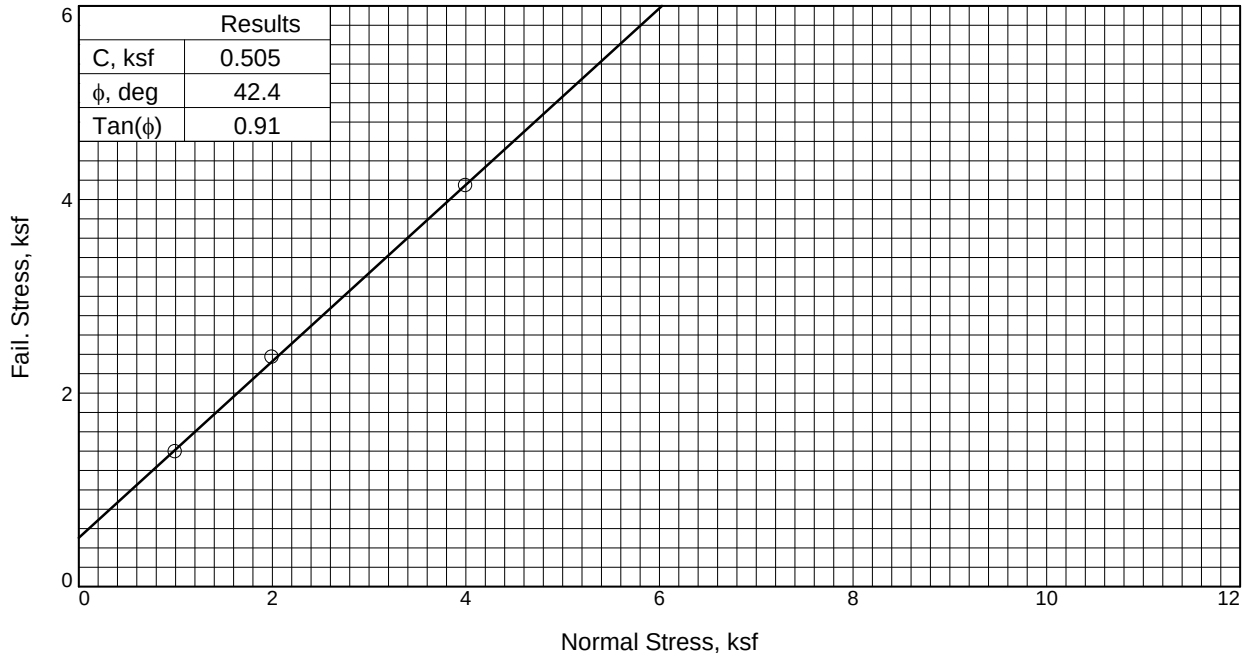
○ **Source of Sample:** SCHS-WR-E-010

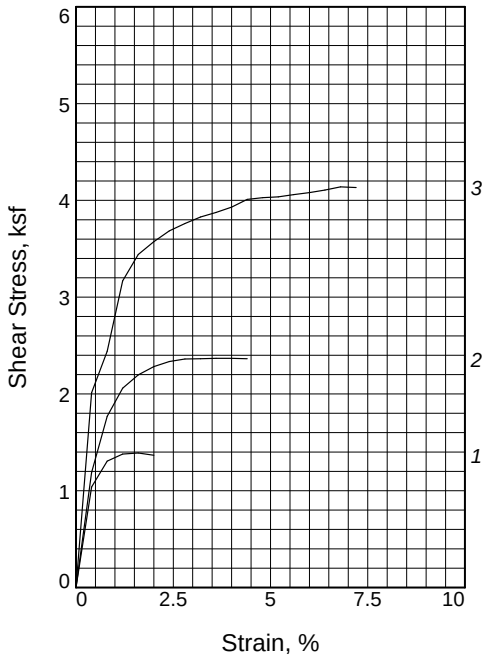
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	15.3	15.3	15.3
	Dry Density, pcf	109.4	109.4	109.4
	Saturation, %	76.4	76.4	76.4
	Void Ratio	0.5408	0.5408	0.5408
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	16.5	15.4	13.5
	Dry Density, pcf	110.6	111.7	111.5
	Saturation, %	84.9	81.9	70.9
	Void Ratio	0.5237	0.5091	0.5122
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.989	0.979	0.981
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		1.390	2.367	4.139
Strain, %		1.6	3.6	6.8
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded

Description: poorly graded gravel with silt and sand

LL= 39 **PL=** 29 **PI=** 10

Specific Gravity= 2.70

Remarks:

Figure _____

Client: Tetra Tech EMI

Project: Carpenter Snow Creek

Source of Sample: SCHS-WR-E-010

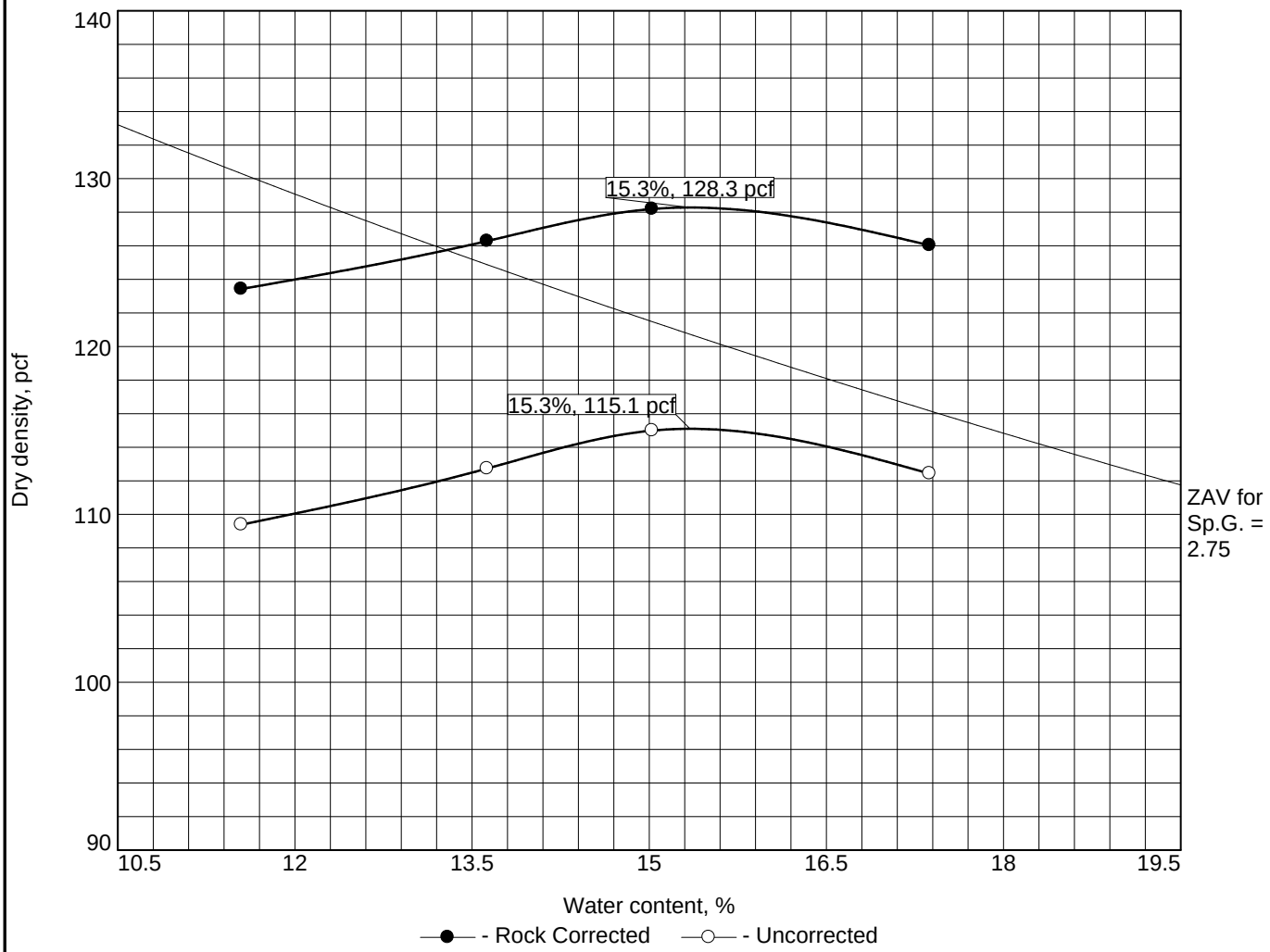
Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT

Tetra Tech

Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method B Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	GP-GM	A-2-4(0)		2.75	39	10	32.4	9.1

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 128.3 pcf	115.1 pcf	poorly graded gravel with silt and sand
Optimum moisture = 15.3 %	15.3 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** SCHS-WR-E-010

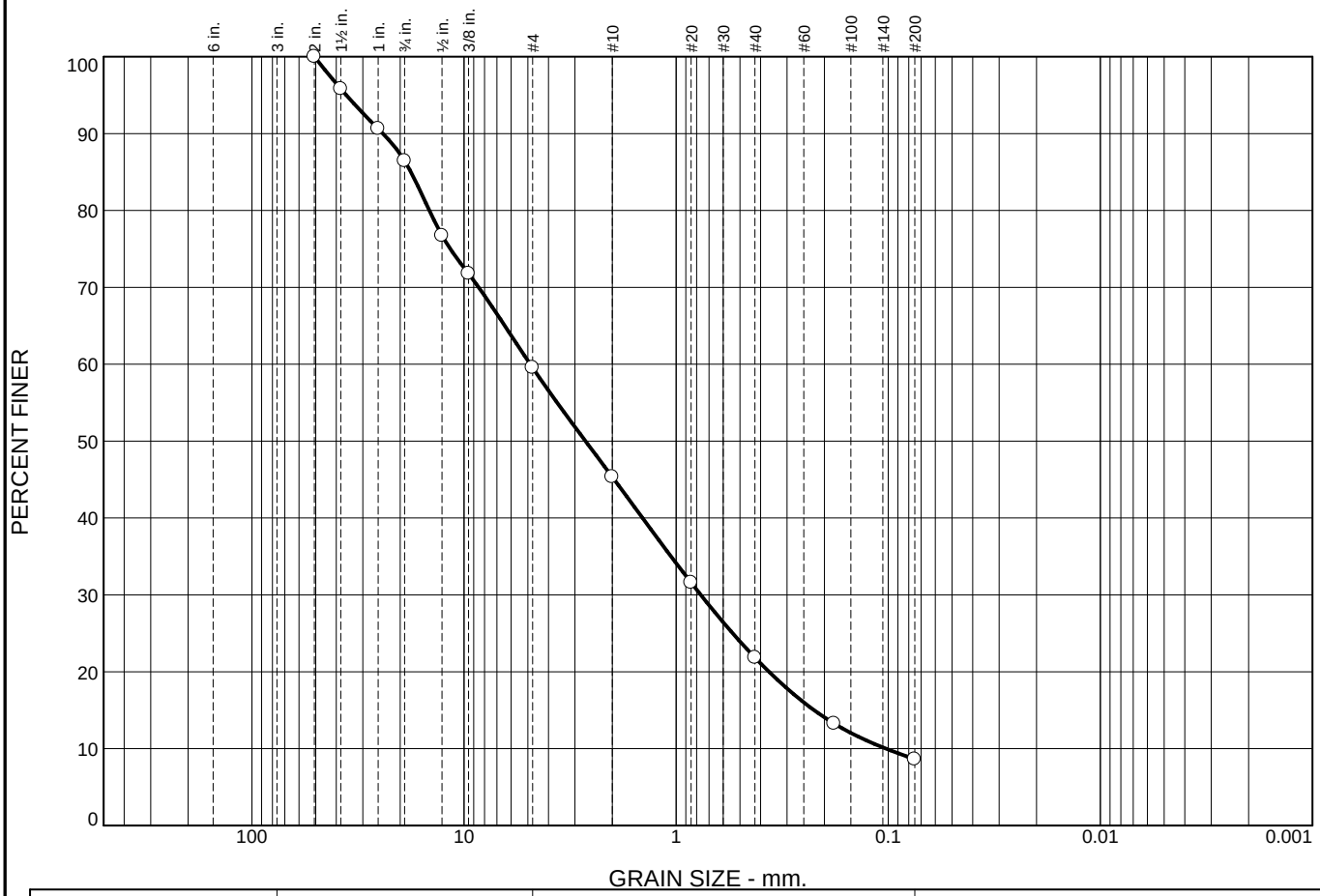
Remarks:

Tetra Tech

Billings, MT

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	13.6	26.9	14.2	23.5	13.2	8.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	17.8045	4.8725	2.6749	0.7656	0.2236	0.1024	1.17	47.57

Material Description	USCS	AASHTO
○ Well-graded SAND with Silt and Gravel	SW-SM	A-1-a

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

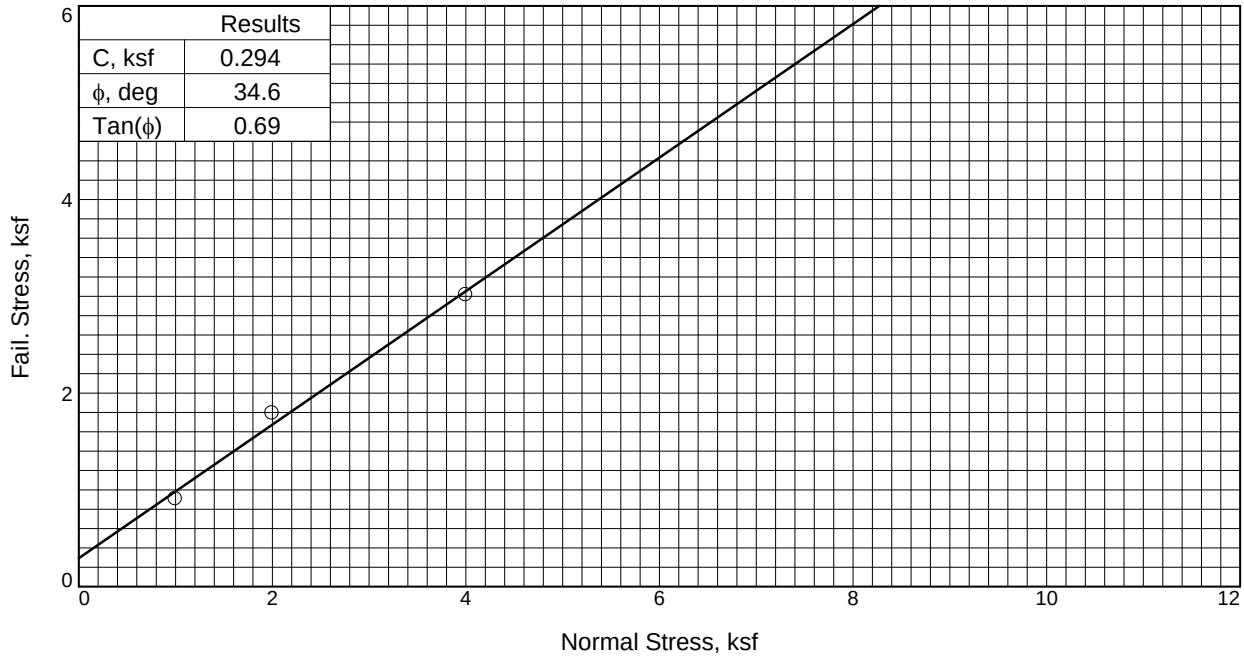
○ **Source of Sample:** SCHS-WR-E-011

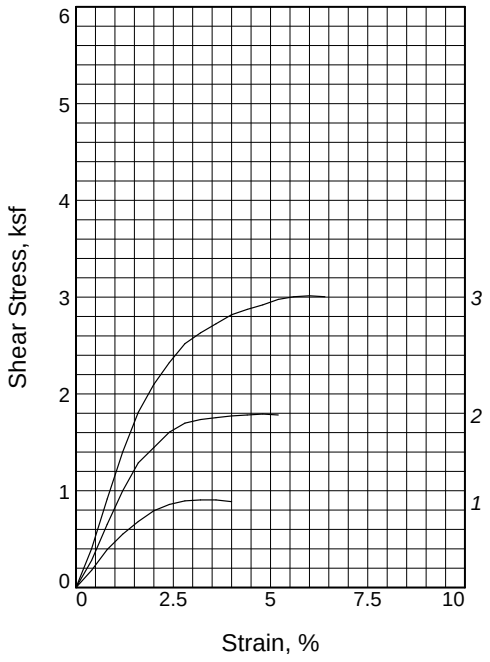
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	12.4	12.4	12.4
	Dry Density, pcf	116.9	116.9	116.8
	Saturation, %	75.8	75.7	75.6
	Void Ratio	0.4419	0.4423	0.4429
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	14.6	13.9	12.5
	Dry Density, pcf	117.2	117.3	117.9
	Saturation, %	90.1	85.6	78.6
	Void Ratio	0.4387	0.4374	0.4302
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.998	0.997	0.991
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.905	1.792	3.014
Strain, %		3.2	4.8	6.0
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded

Description: Well-graded SAND with Silt and Gravel

LL= NV **PI=** NP

Specific Gravity= 2.70

Remarks:

Figure _____

Client: Tetra Tech EMI

Project: Carpenter Snow Creek

Source of Sample: SCHS-WR-E-011

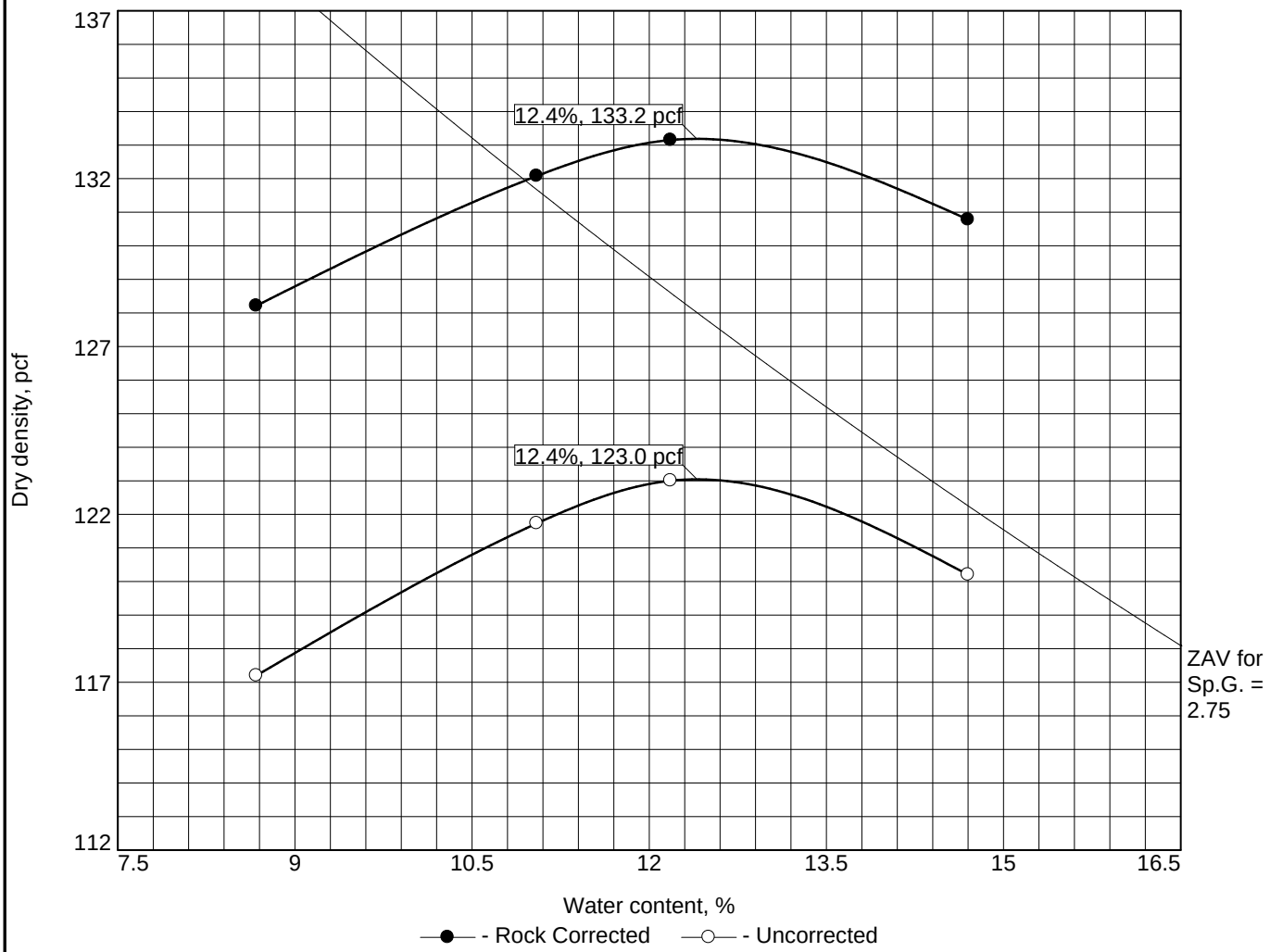
Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT

Tetra Tech

Billings, MT

COMPACTION TEST REPORT



Test specification: ASTM D 698-91 Procedure B Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	SW-SM	A-1-a		2.75	NV	NP	28.2	8.6

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 133.2 pcf	123.0 pcf	Well-graded SAND with Silt and Gravel
Optimum moisture = 12.4 %	12.4 %	

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

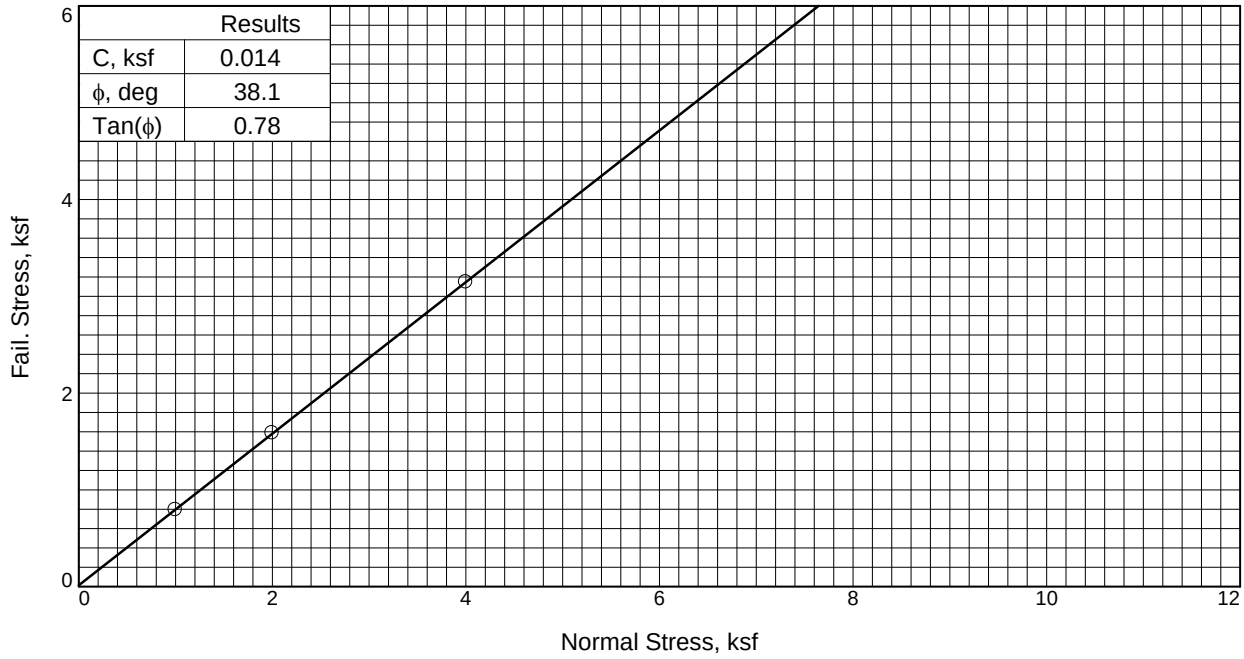
○**Source of Sample:** SCHS-WR-E-011

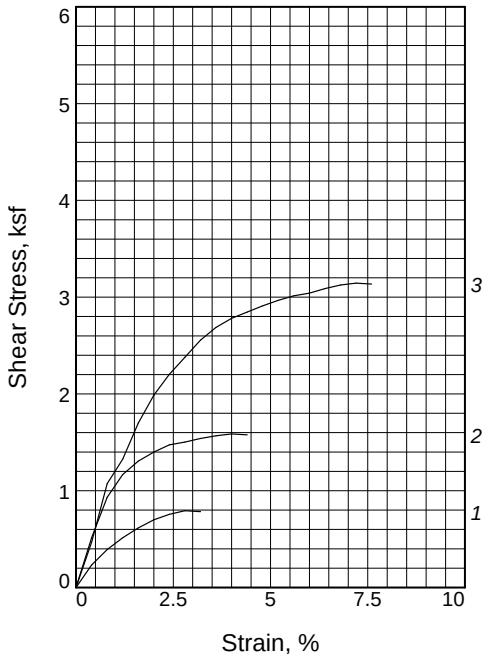
Remarks:

Tetra Tech

Billings, MT

Figure





Sample No.		1	2	3
Initial	Water Content, %	13.1	13.1	13.1
	Dry Density, pcf	113.9	113.9	113.9
	Saturation, %	73.6	73.6	73.6
	Void Ratio	0.4804	0.4804	0.4804
	Side Length, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	15.1	13.4	10.0
	Dry Density, pcf	114.1	114.3	114.6
	Saturation, %	85.7	76.1	57.4
	Void Ratio	0.4767	0.4745	0.4705
	Side Length, in.	2.500	2.500	2.500
	Height, in.	0.998	0.996	0.993
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		0.793	1.586	3.145
Strain, %		2.8	4.0	7.2
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.		0.010	0.010	0.010

Sample Type: Remolded
Description: Poorly Graded SAND with Gravel

LL= NV **PI=** NP
Specific Gravity= 2.70
Remarks:

Figure _____

Client: Tetra Tech EMI

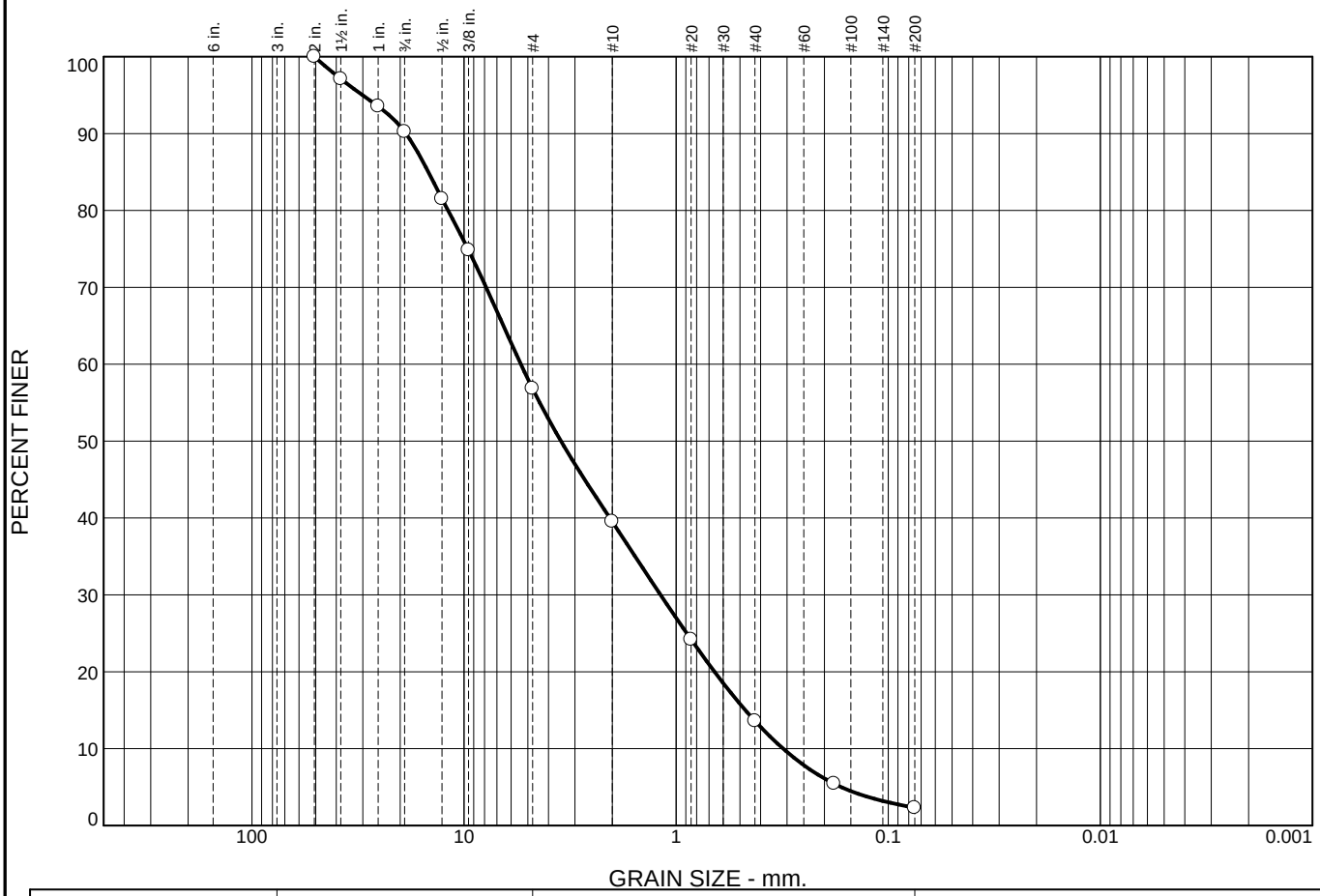
Project: Carpenter Snow Creek

Source of Sample: SCHS-WR-E-012

Proj. No.: 114-551059 **Date Sampled:**

DIRECT SHEAR TEST REPORT
Tetra Tech
Billings, MT

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	9.8	33.4	17.3	25.9	11.3	2.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	14.7301	5.3940	3.4908	1.1835	0.4717	0.3128	0.83	17.24

Material Description	USCS	AASHTO
○ Poorly Graded SAND with Gravel	SP	A-1-a

Project No. 114-551059 **Client:** Tetra Tech EMI

Project: Carpenter Snow Creek

○ **Source of Sample:** SCHS-WR-E-012

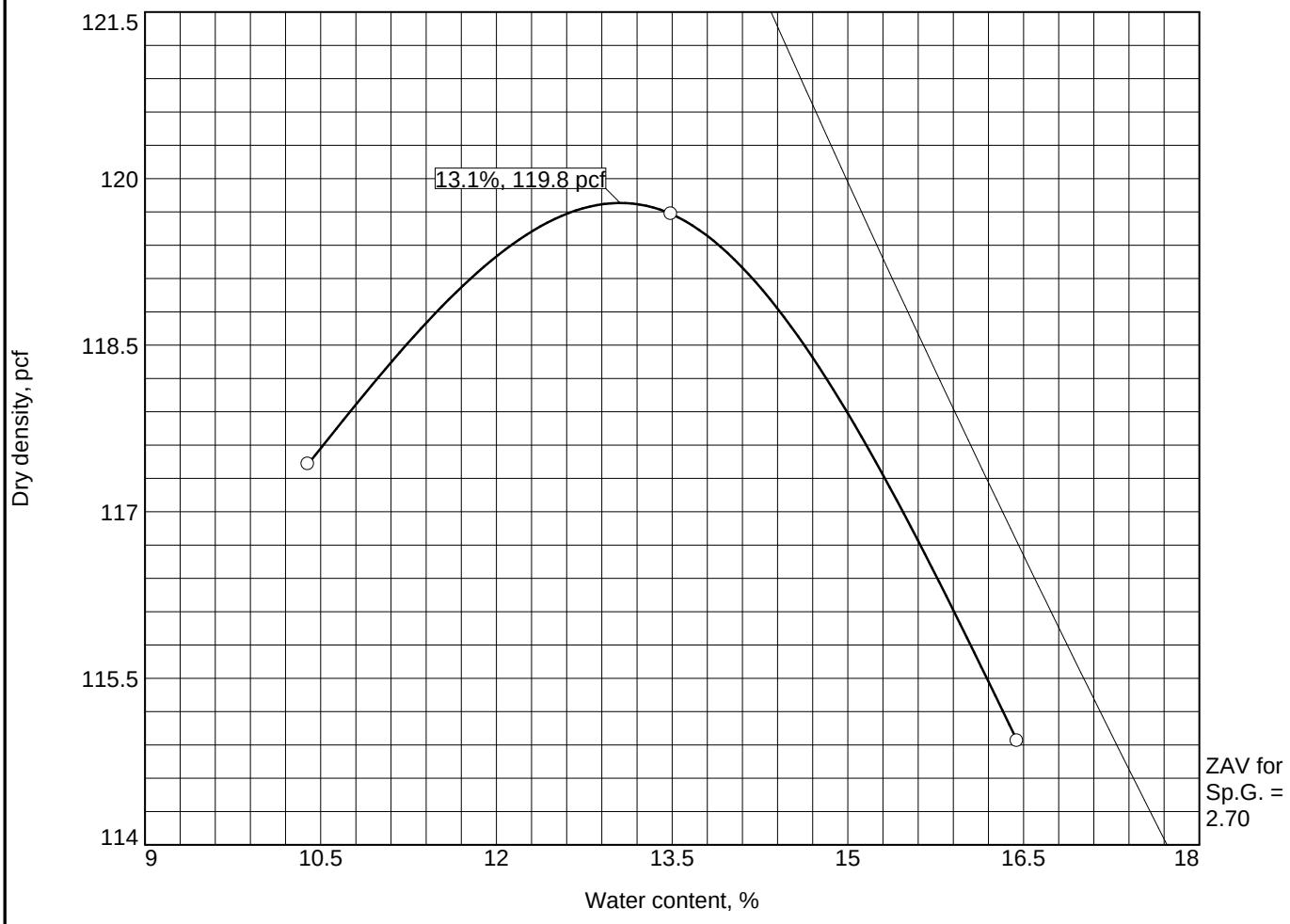
Remarks:

Tetra Tech

Billings, MT

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	SP	A-1-a			NV	NP	25.2	2.3

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 119.8 pcf Optimum moisture = 13.1 %	Poorly Graded SAND with Gravel

Project No. 114-551059 **Client:** Tetra Tech EMI
Project: Carpenter Snow Creek

○**Source of Sample:** SCHS-WR-E-012

Remarks:

Tetra Tech

Billings, MT

Figure