Attachment I-5: Selected Parameters Summary

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Summary of Selected Parameters
Unit: ALL

Computed By: KAH
Date: 4/21/2010
Revised By: KAH
Date: 9/2/2010

Selected Parameters

Formation	Unit Weight [1] γ_{sat} (pcf)	Shear Strength Parameters: Effective Stress [2] ϕ'	c' (psf)	Total Stress, c (psf): Peak [3]	Ultimate	Residual $\phi'_{residual}$
Alluvium [5]	119	31	0	assume values of Sherack		20
Sherack	118	28	0	1400	900	13.0
Plastic Laminated Sherack	112	19	0	1150	N/D	6.8
Poplar River - West Fargo	123	34	0	1900	1900	25
Poplar River - Harwood	116	26	0	1450	1200	assume values of West Fargo
Poplar River, All [6]	119	assume values of Harwood		assume values of Harwood		assume values of West Fargo
Oxidized Brenna [7]	111	19	0	1000	900	5.5
Brenna [7]	104	13	0	650	525	9.0
Argusville [7]	106	15	0	825	600	10.5
Till [8]	122	31	0	1900	1900	N/A
Sand [9]	125	32	0	N/A		N/A
Riprap [9]	125	30	0	N/A		N/A

Notes:

(1) The unit weights are taken as the average value of all laboratory test results.

(2) The effective stress parameters are based on the R-Bar triaxial and direct shear tests. The failure criterion is defined as ultimate deviator stress which equates to the deviator stress at 15% or 20% axial strain.

(3) The peak total stress parameters are based on unconsolidated-undrained triaxial shear tests with the failure criterion defined at peak deviator stress. The peak undrained shear strength parameters were used for the end-of-levee-construction condition.

(4) The ultimate total stress parameters are based on unconsolidated-undrained triaxial shear tests with the failure criterion defined at ultimate deviator stress which equates to the deviator stress at 15% axial strain. The ultimate undrained shear strength parameters were used of the end-of-excavation condition when analyzing the diversion channel excavated slopes.

(5) Alluvium undrained shear strength parameters are assumed to be that of Sherack.

(6) Poplar River formation parameters are assumed to be that of the Harwood member.

(7) For the Oxidized Brenna, Brenna, and Argusville formations, a curvilinear shear strength envelope was developed for the effective stress analysis of the diversion channel excavated slope. The curvilinear envelop is one standard deviation less than the most likely value.

(8) Assumed values based on literature review.

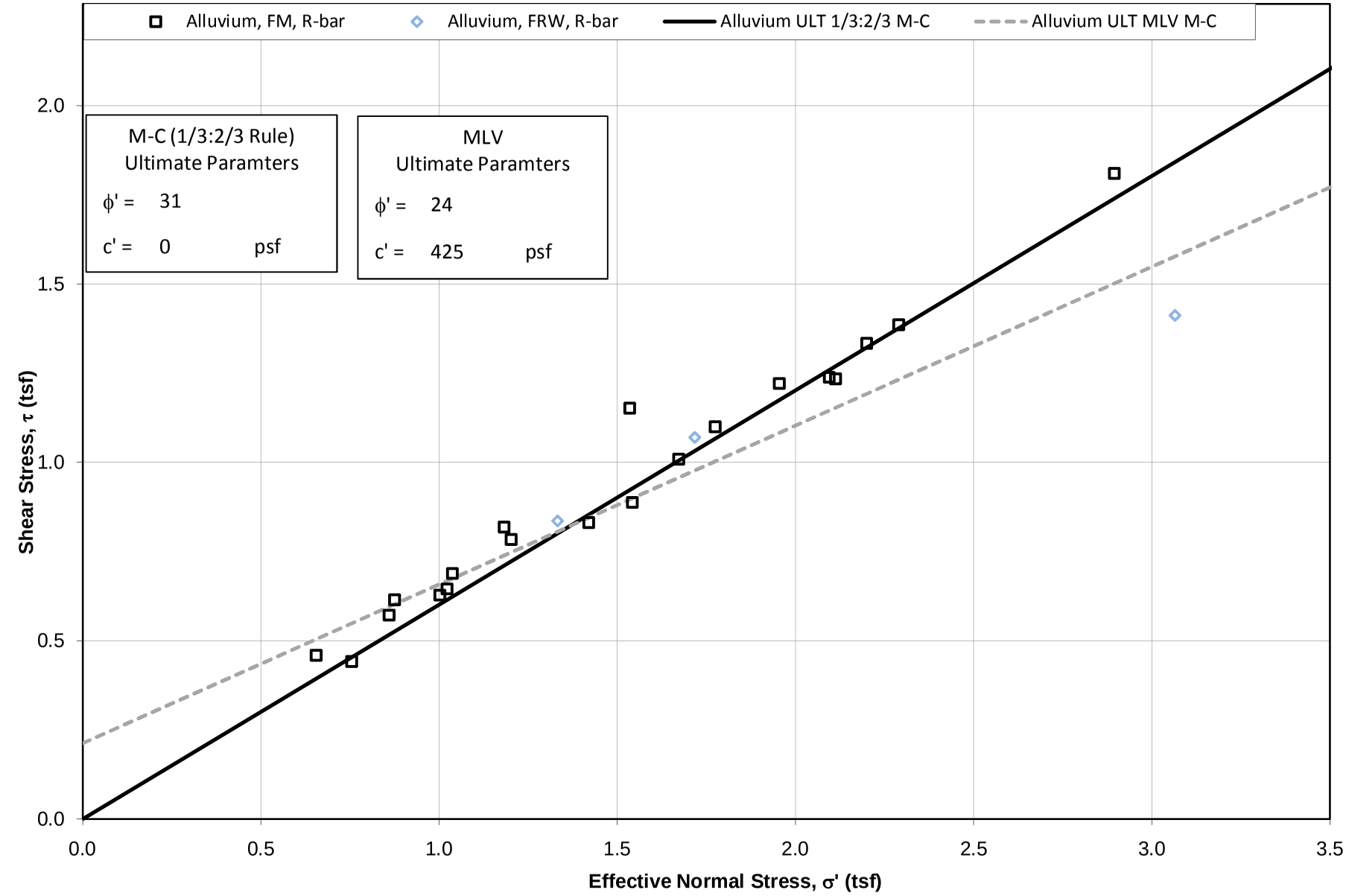
(9) Assumed values based judgment.

Curve-linear Channel Modeling Parameters

Oxidized Brenna		Brenna		Argusville	
Effective Normal Stress σ' (psf)	Effective Shear Stress τ' (psf)	Effective Normal Stress σ' (psf)	Effective Shear Stress τ' (psf)	Effective Normal Stress σ' (psf)	Effective Shear Stress τ' (psf)
0	25	0	50	0	50
200	113	200	120	200	127
1000	420	1000	333	1000	413
2000	760	2000	540	2000	653
3000	933	3000	673	3000	893
4000	1073	4000	807	4000	1093
7000	1493	6000	1033	6000	1460

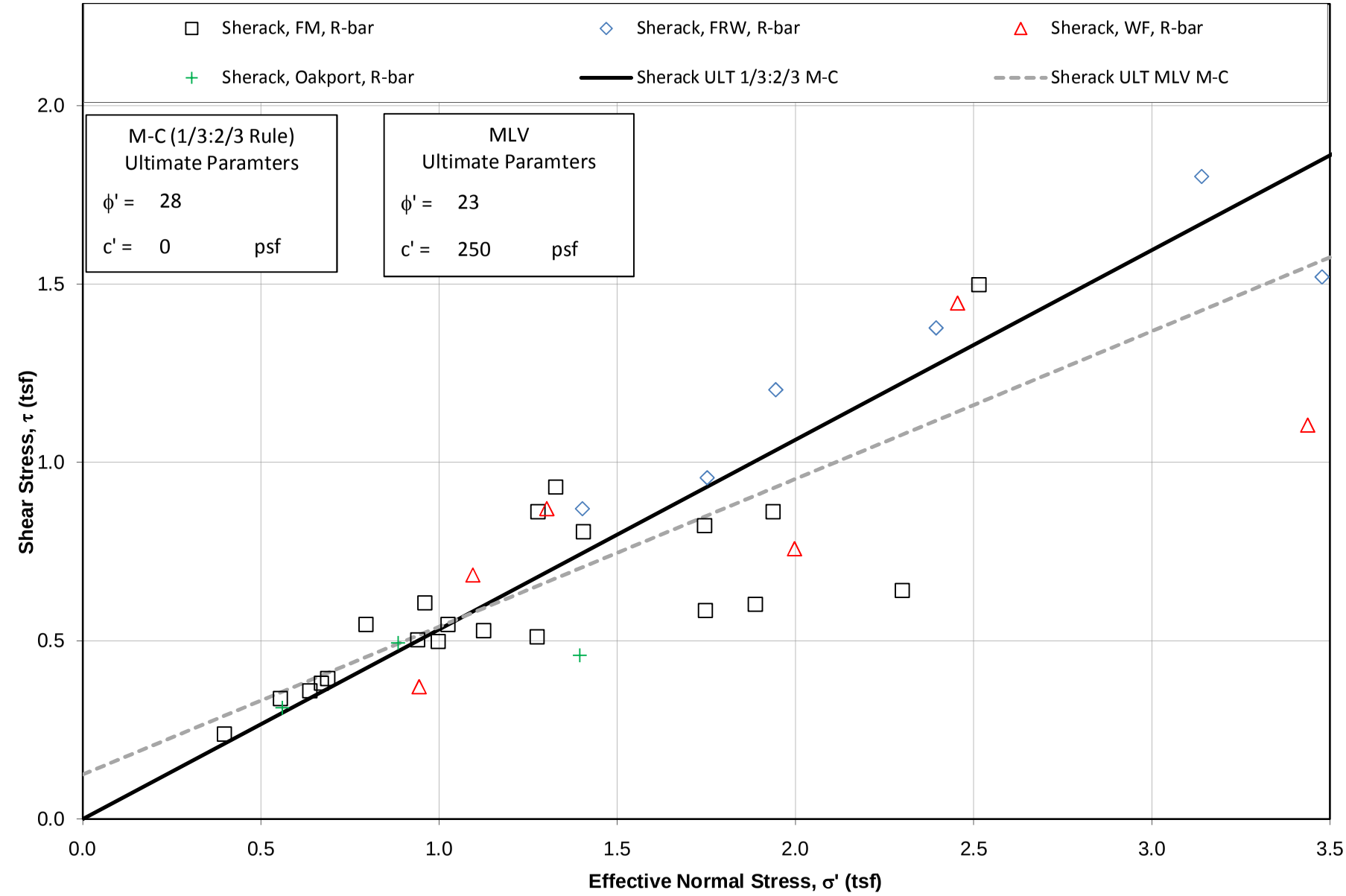
Run Make Grid Square Macro

Fargo-Moorhead Metro Feasibility Study
Alluvium Ultimate Drained Shear Strength Parameters
Mohr-Coulomb Effective Stress Plot



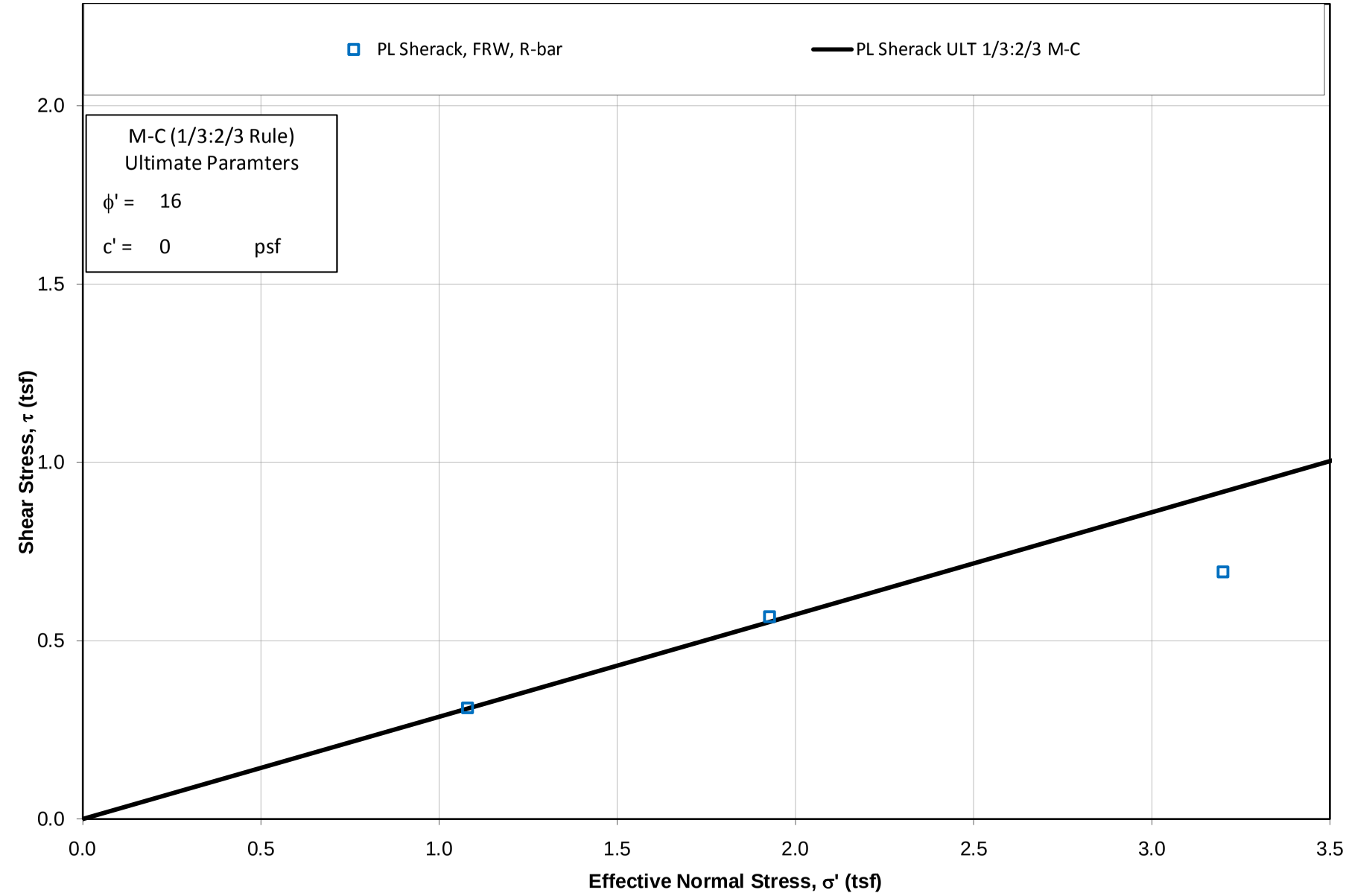
Run Make Grid Square Macro

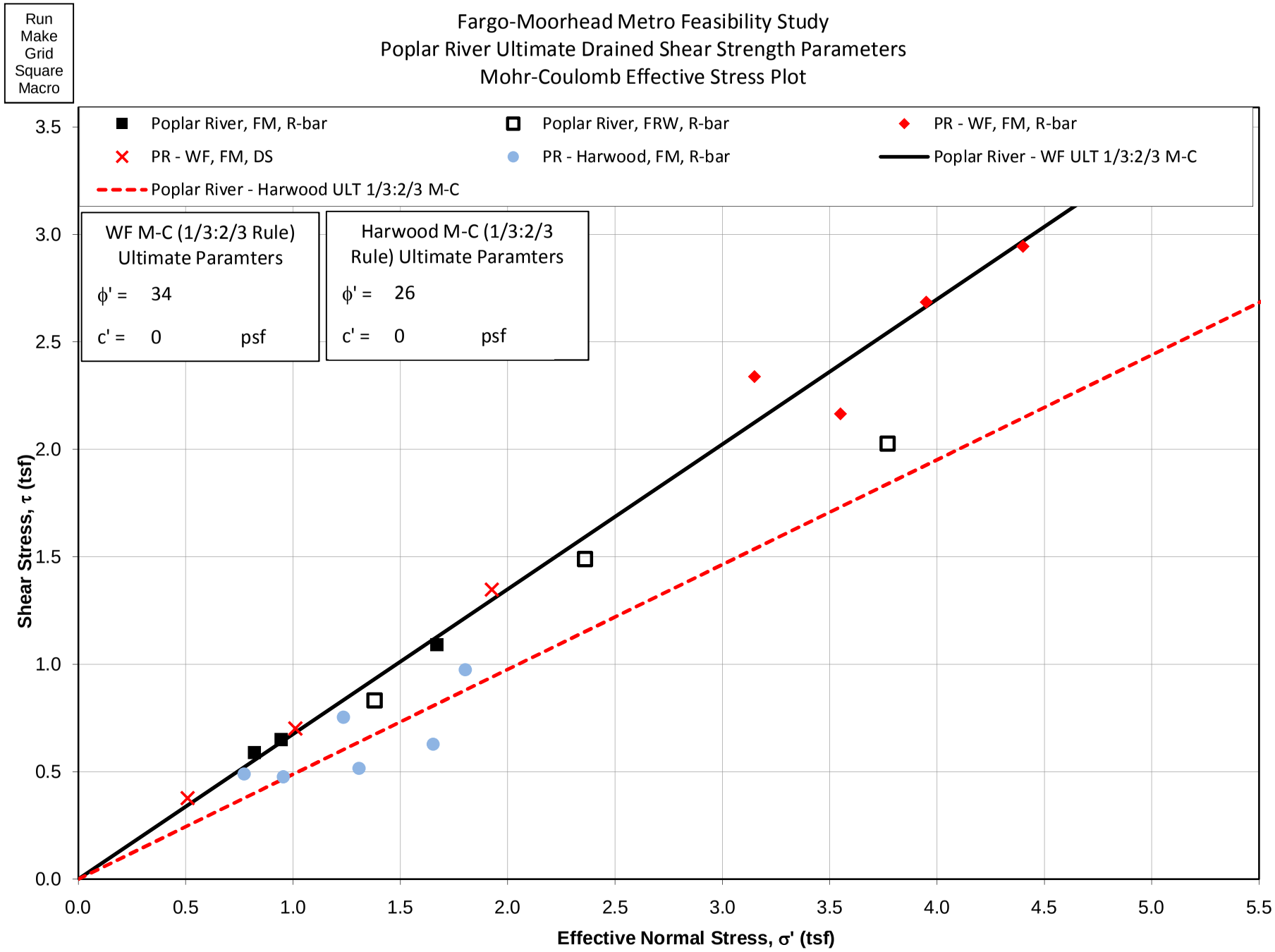
Fargo-Moorhead Metro Feasibility Study
Sherack Ultimate Drained Shear Strength Parameters
Mohr-Coulomb Effective Stress Plot



Run Make Grid Square Macro

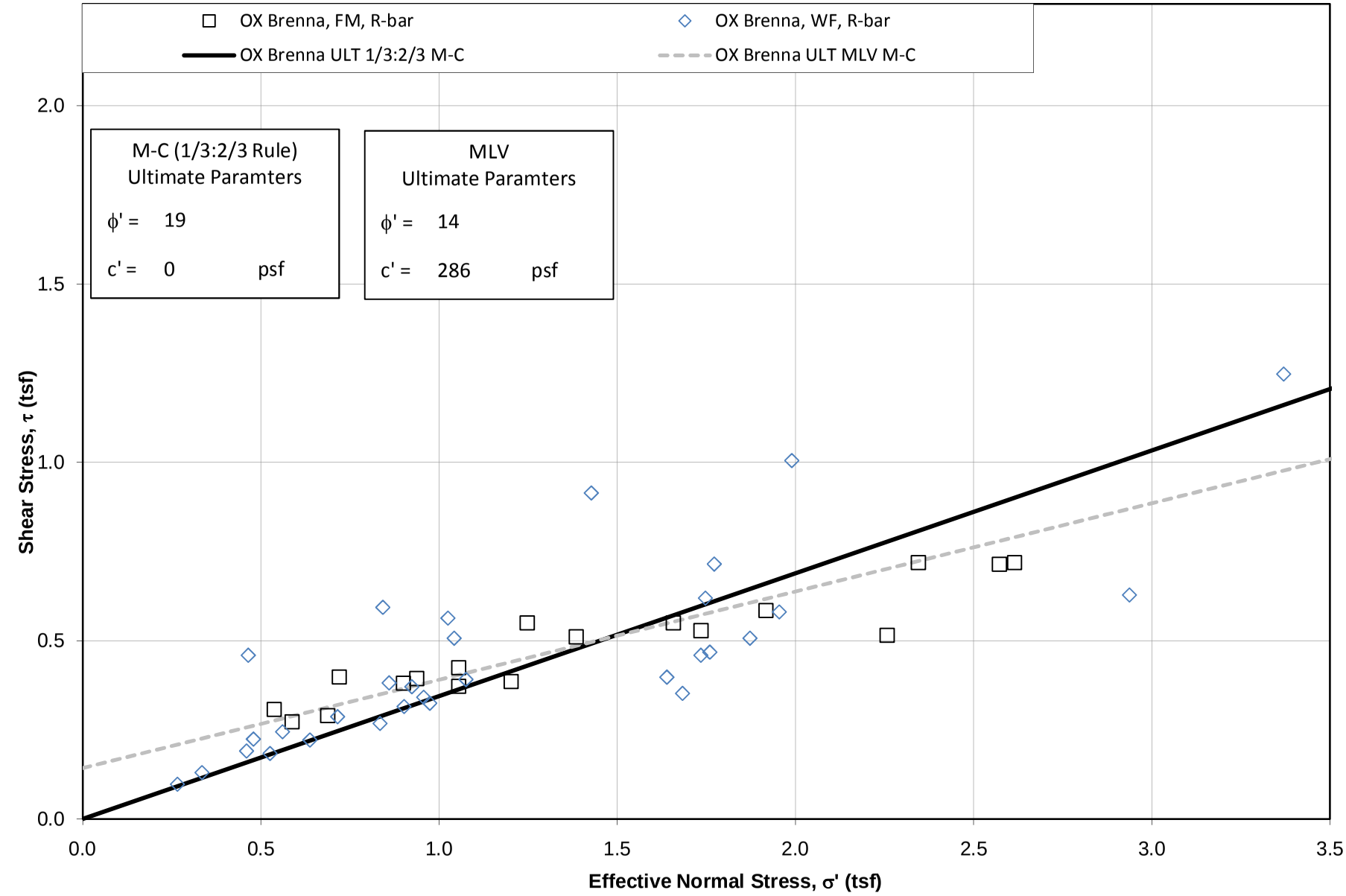
Fargo-Moorhead Metro Feasibility Study
Plastic Laminated Sherack Ultimate Drained Shear Strength Parameters
Mohr-Coulomb Effective Stress Plot




Run Make Grid Square Macro
Fargo-Moorhead Metro Feasibility Study
Poplar River Ultimate Drained Shear Strength Parameters
Mohr-Coulomb Effective Stress Plot
Poplar River, FM, R-bar
Poplar River, FRW, R-bar
PR - WF, FM, R-bar
PR - WF, FM, DS
PR - Harwood, FM, R-bar
Poplar River - WF ULT 1/3:2/3 M-C
Poplar River - Harwood ULT 1/3:2/3 M-C
WF M-C (1/3:2/3 Rule) Ultimate Paramters
ϕ' = 34
c' = 0 psf
Harwood M-C (1/3:2/3 Rule) Ultimate Paramters
ϕ' = 26
c' = 0 psf
Shear Stress, τ (tsf)
Effective Normal Stress, σ' (tsf)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5

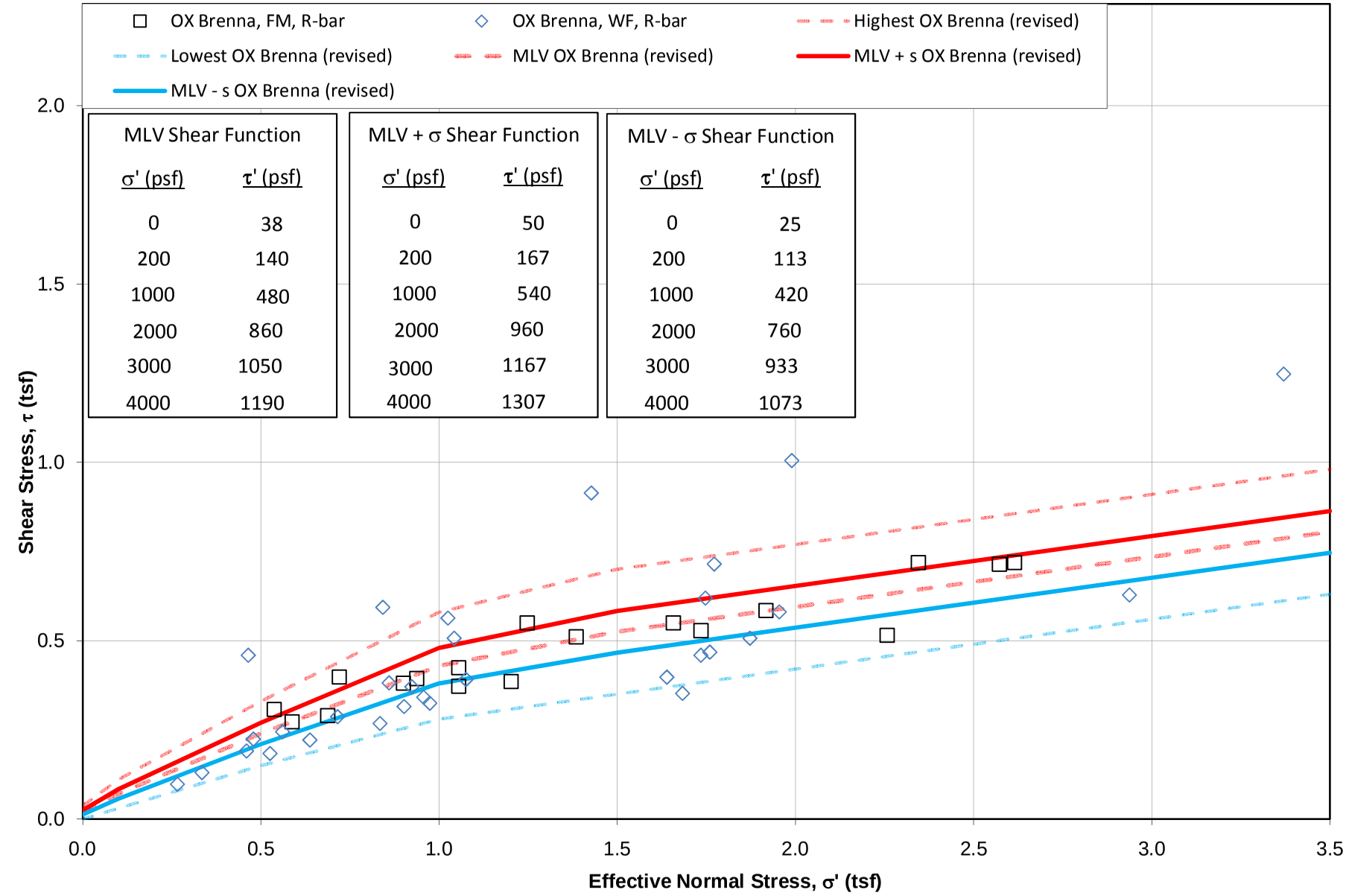
Run Make Grid Square Macro

Fargo-Moorhead Metro Feasibility Study
Oxidized Brenna Ultimate Drained Shear Strength Parameters
Mohr-Coulomb Effective Stress Plot



Run Make Grid Square Macro

Fargo-Moorhead Metro Feasibility Study
Oxidized Brenna Ultimate Drained Shear Strength Parameters
Curvilinear Effective Stress Plot



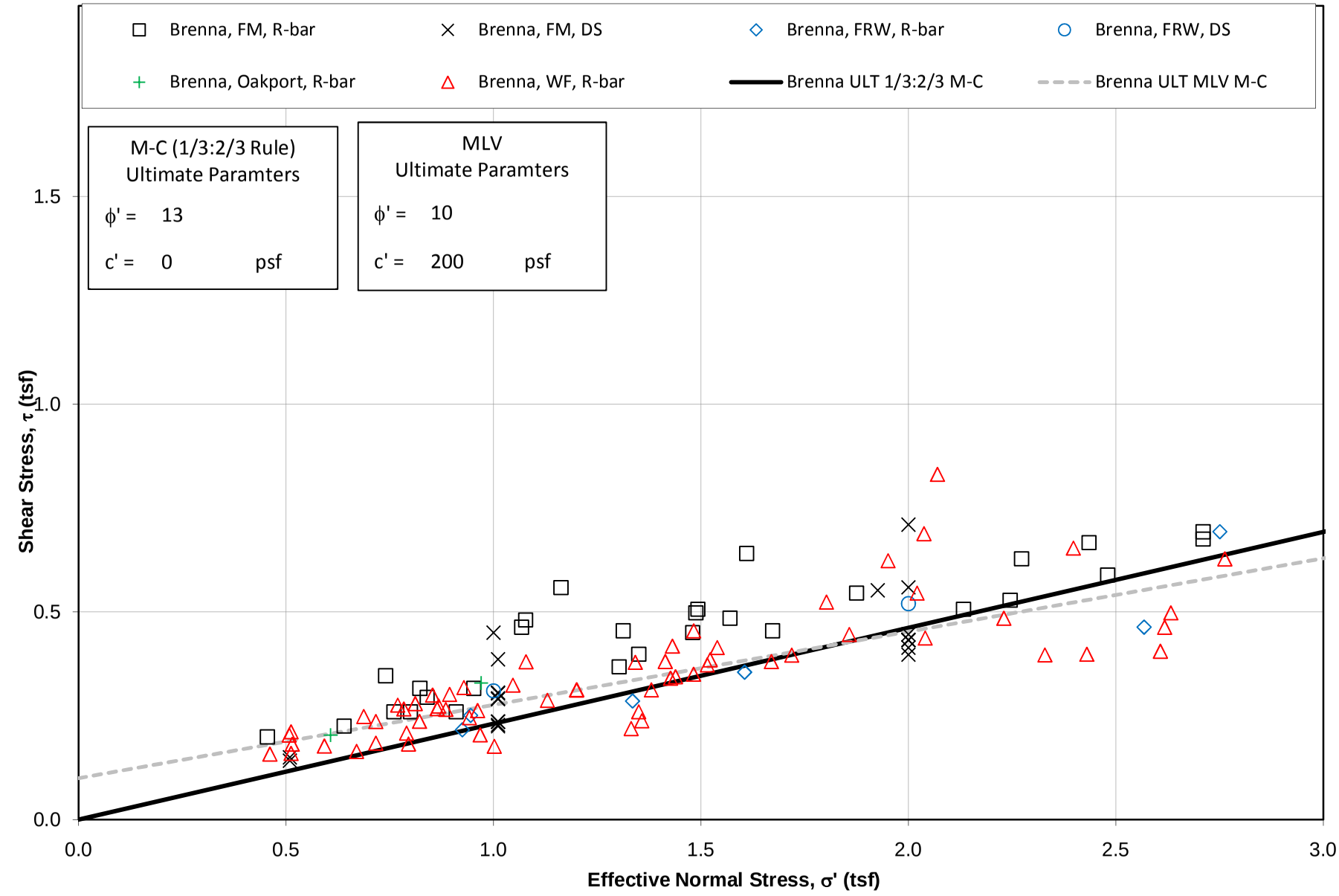
MLV Shear Function	
σ' (psf)	τ' (psf)
0	38
200	140
1000	480
2000	860
3000	1050
4000	1190

MLV + σ Shear Function	
σ' (psf)	τ' (psf)
0	50
200	167
1000	540
2000	960
3000	1167
4000	1307

MLV - σ Shear Function	
σ' (psf)	τ' (psf)
0	25
200	113
1000	420
2000	760
3000	933
4000	1073

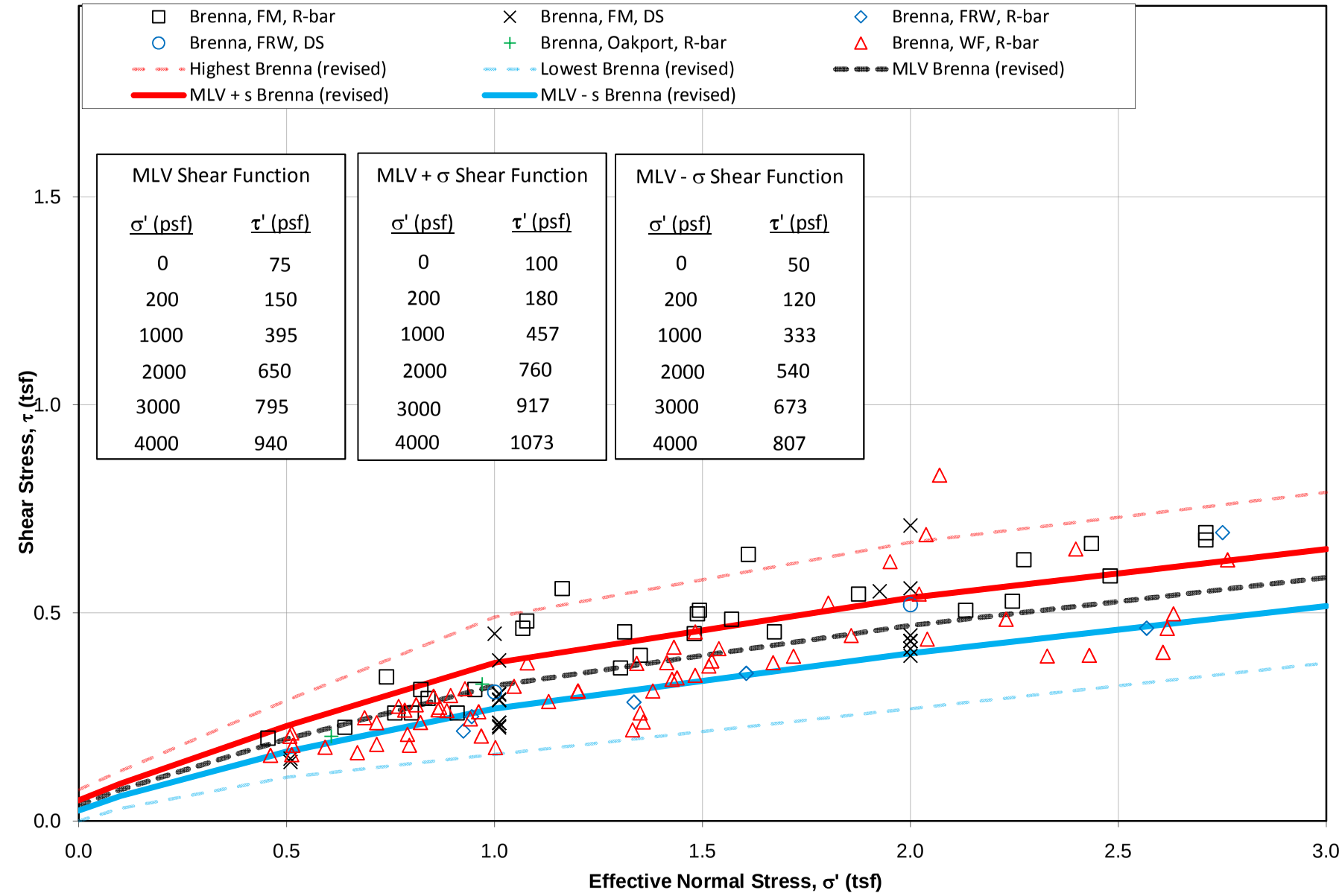
Run Make Grid Square Macro

Fargo-Moorhead Metro Feasibility Study
Brenna Ultimate Drained Shear Strength Parameters
Mohr-Coulomb Effective Stress Plot



Run Make Grid Square Macro

Fargo-Moorhead Metro Feasibility Study
Brenna Ultimate Drained Shear Strength Parameters
Curvilinear Effective Stress Plot



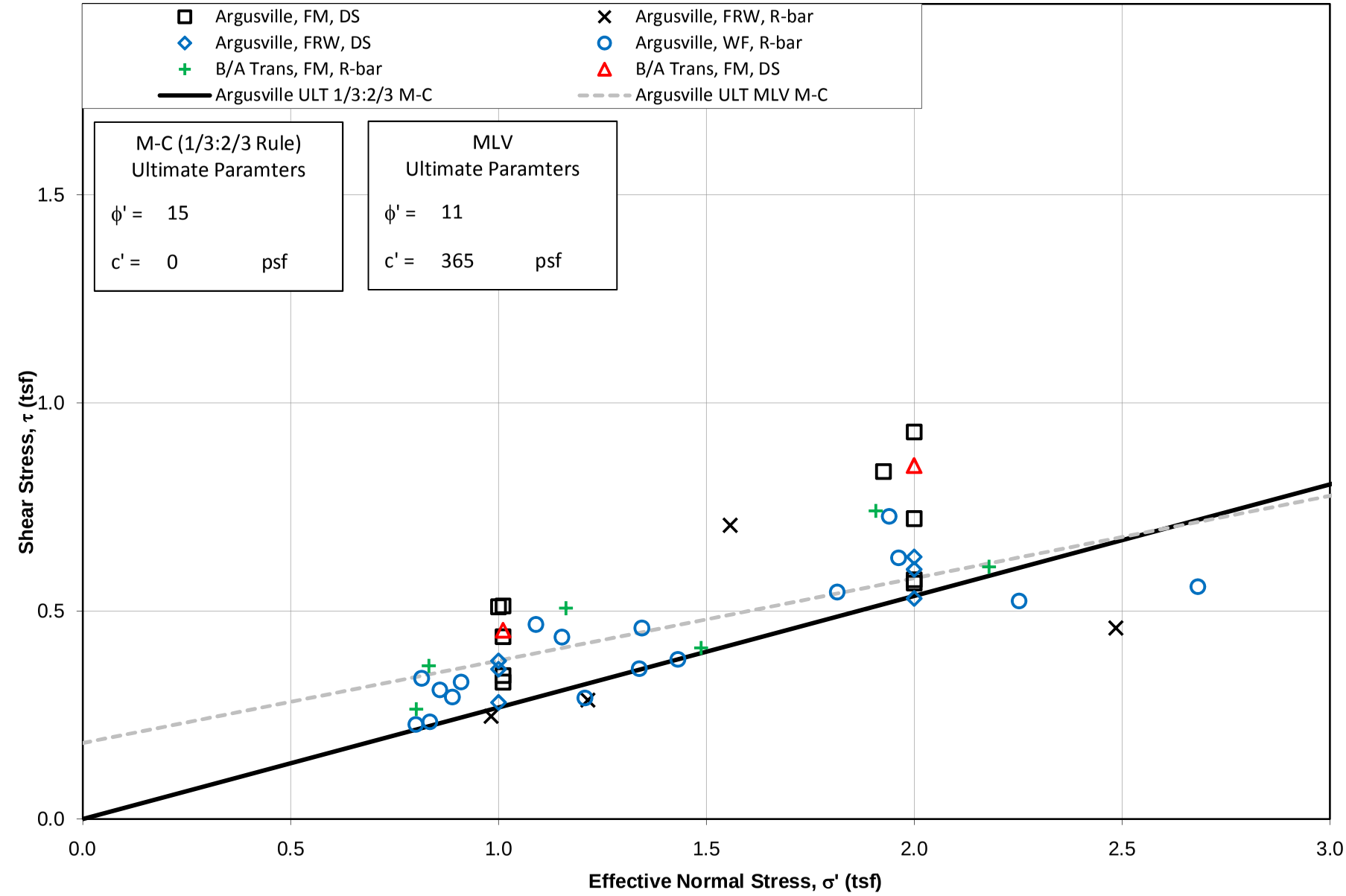
MLV Shear Function	
σ' (psf)	τ' (psf)
0	75
200	150
1000	395
2000	650
3000	795
4000	940

MLV + σ Shear Function	
σ' (psf)	τ' (psf)
0	100
200	180
1000	457
2000	760
3000	917
4000	1073

MLV - σ Shear Function	
σ' (psf)	τ' (psf)
0	50
200	120
1000	333
2000	540
3000	673
4000	807

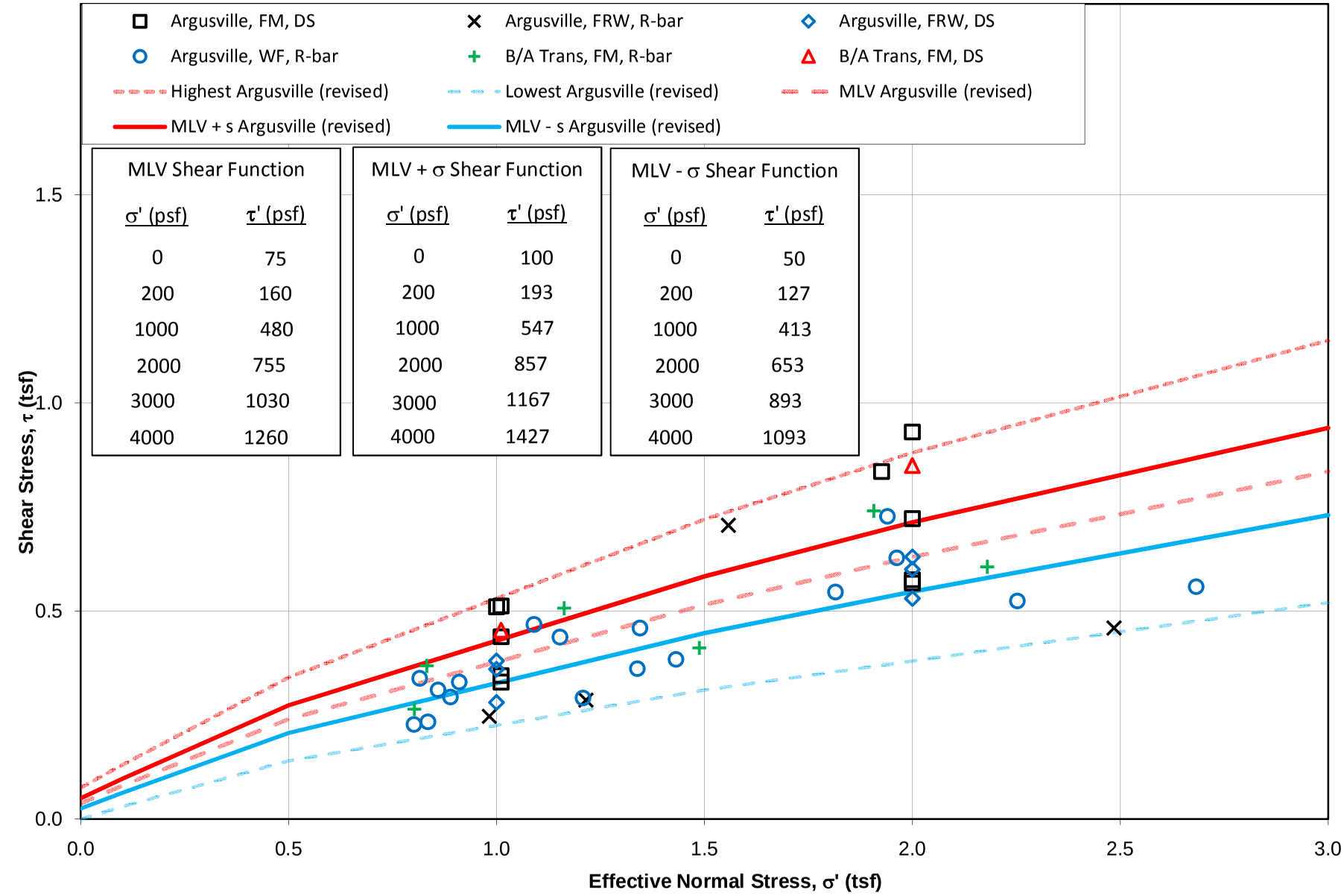
Run Make Grid Square Macro

Fargo-Moorhead Metro Feasibility Study
Argusville Ultimate Drained Shear Strength Parameters
Mohr-Coulomb Effective Stress Plot



Run Make Grid Square Macro

Fargo-Moorhead Metro Feasibility Study
Argusville Ultimate Drained Shear Strength Parameters
Curvilinear Effective Stress Plot



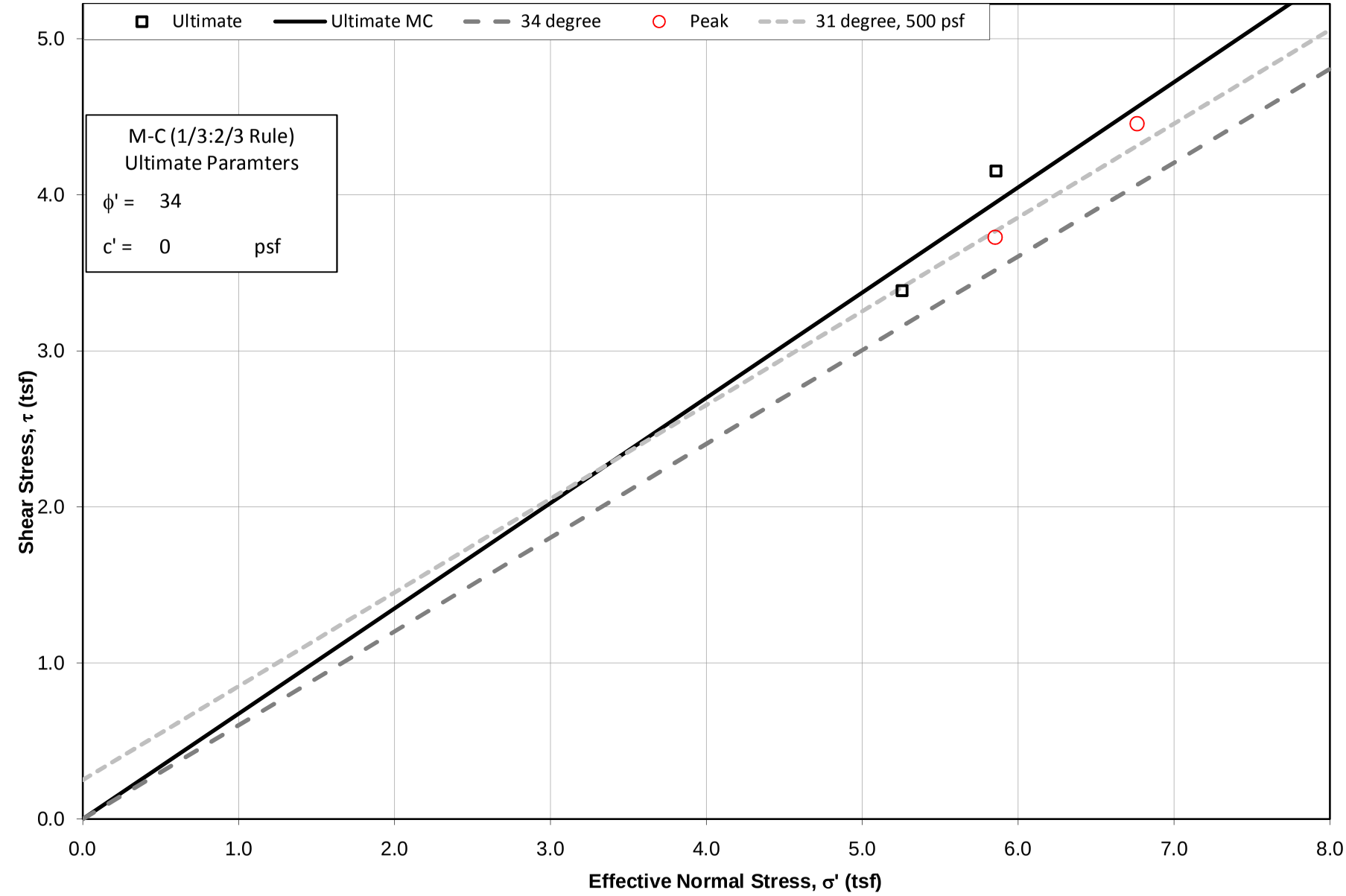
MLV Shear Function	
σ' (psf)	τ' (psf)
0	75
200	160
1000	480
2000	755
3000	1030
4000	1260

MLV + σ Shear Function	
σ' (psf)	τ' (psf)
0	100
200	193
1000	547
2000	857
3000	1167
4000	1427

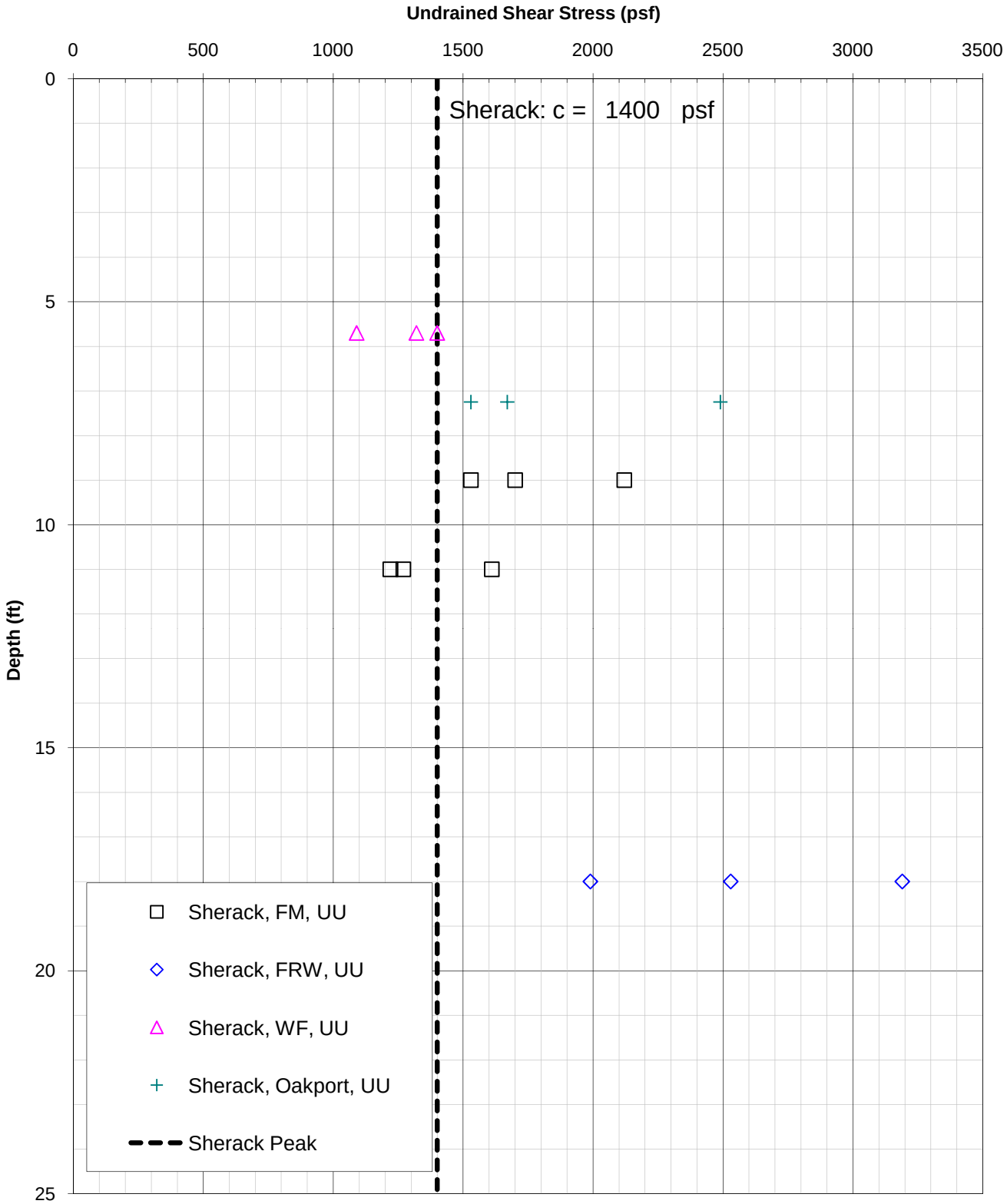
MLV - σ Shear Function	
σ' (psf)	τ' (psf)
0	50
200	127
1000	413
2000	653
3000	893
4000	1093

Run Make Grid Square Macro

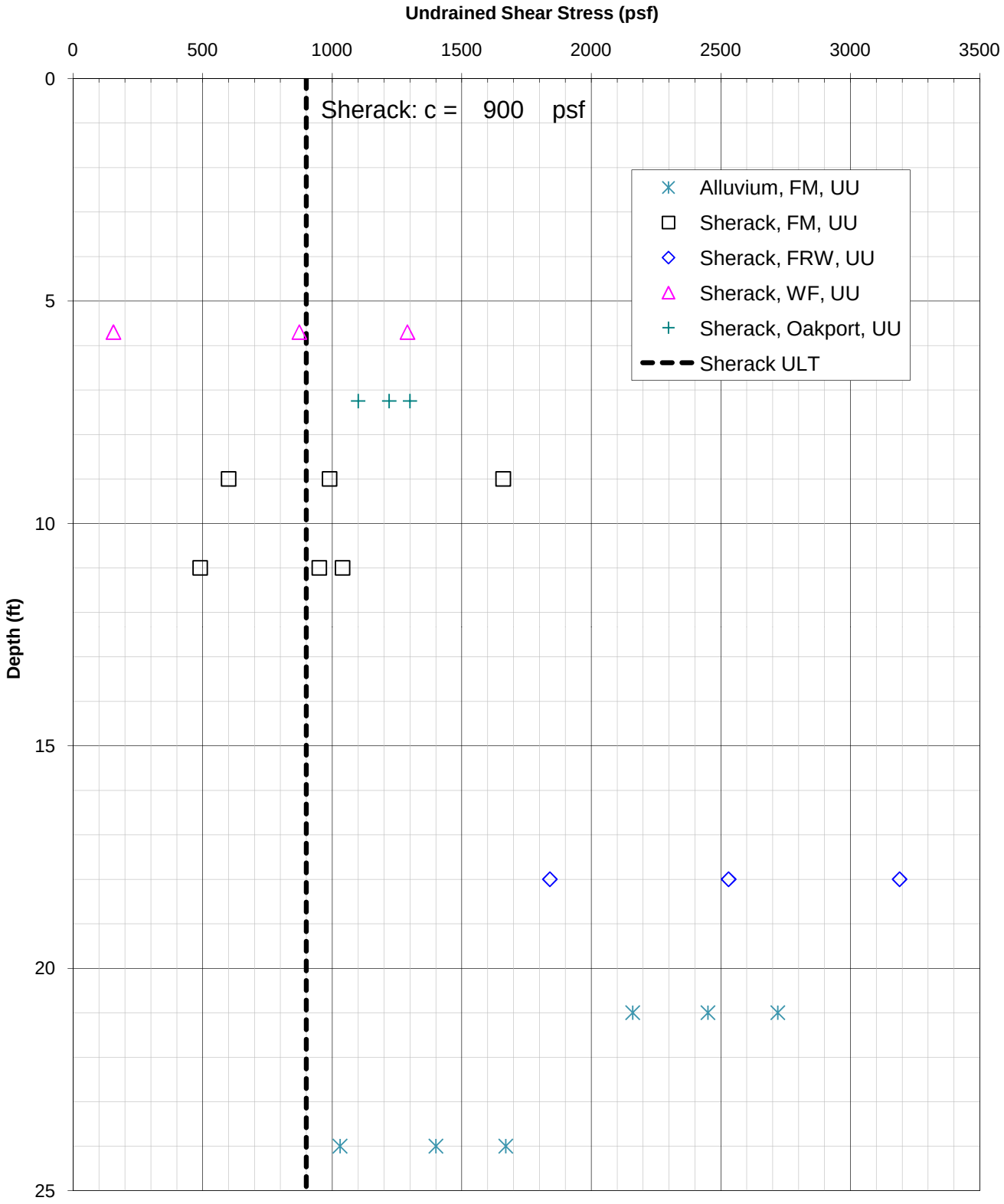
Fargo-Moorhead Metro Feasibility Study
Unit "A" Till Ultimate Drained Shear Strength Parameters
Mohr-Coulomb Effective Stress Plot



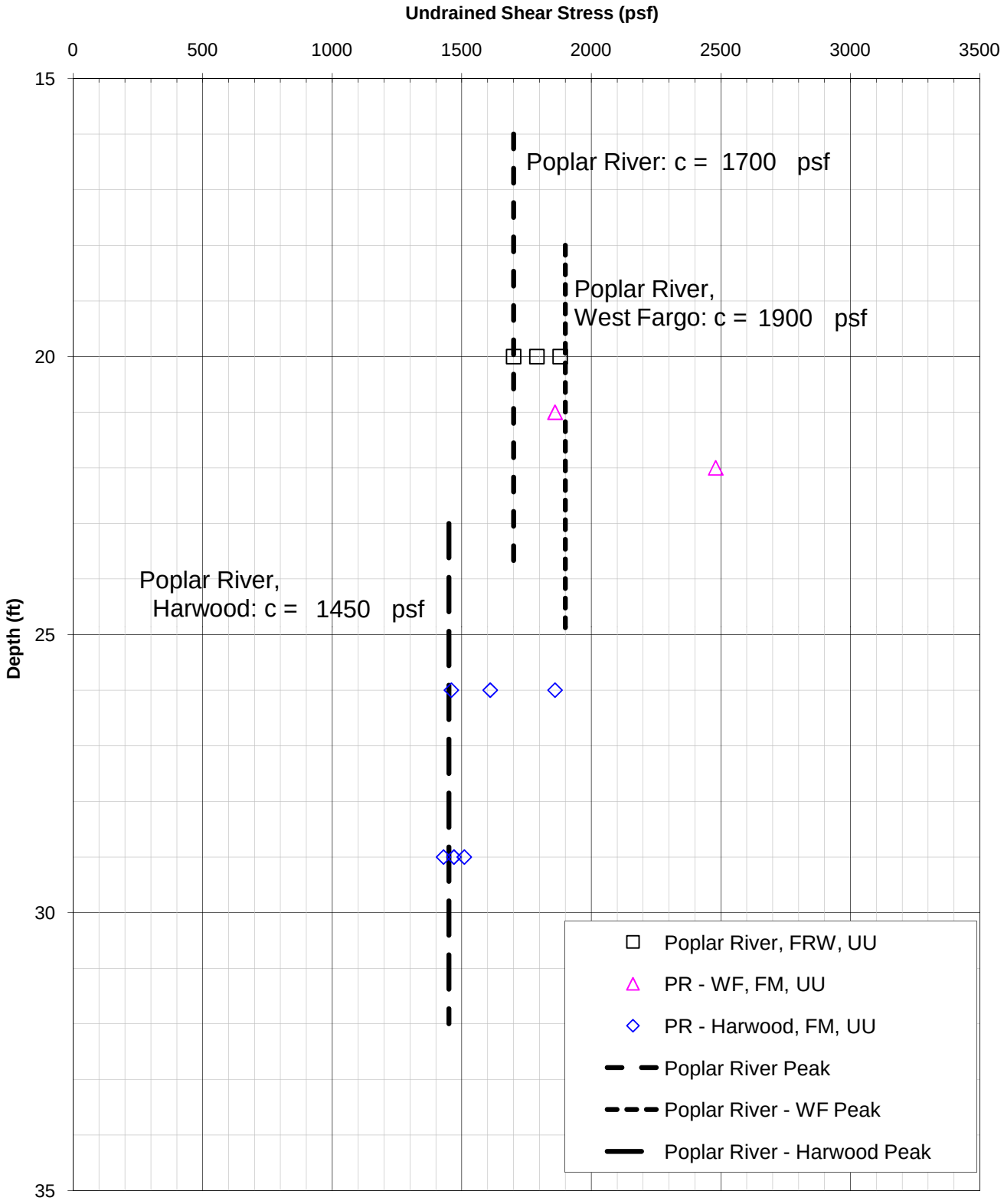
Fargo-Moorhead Metro Feasibility Study
Sherack
Peak Undrained Shear Strength (UU) Data



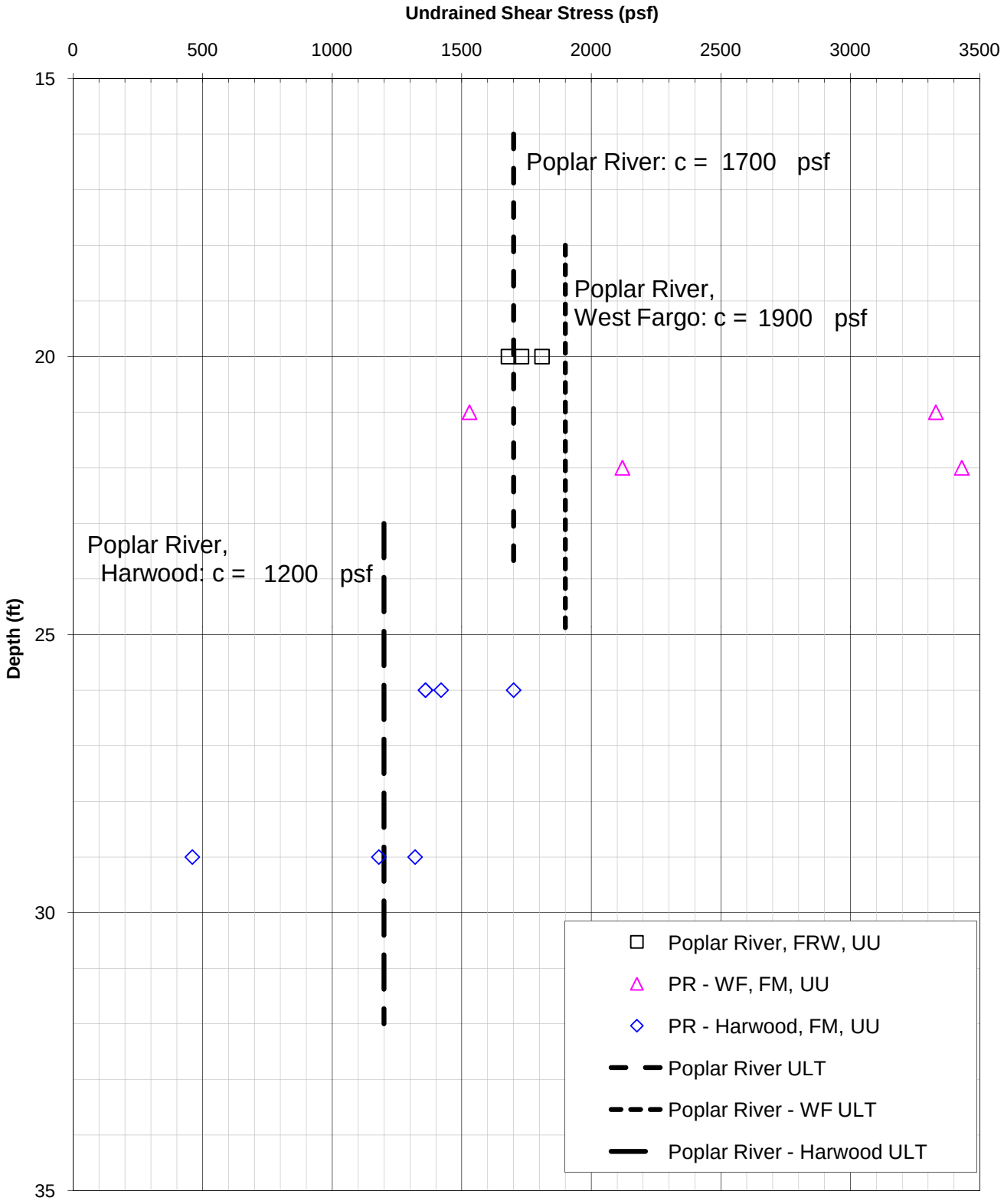
Fargo-Moorhead Metro Feasibility Study
Sherack
Ultimate Undrained Shear Strength (UU) Data



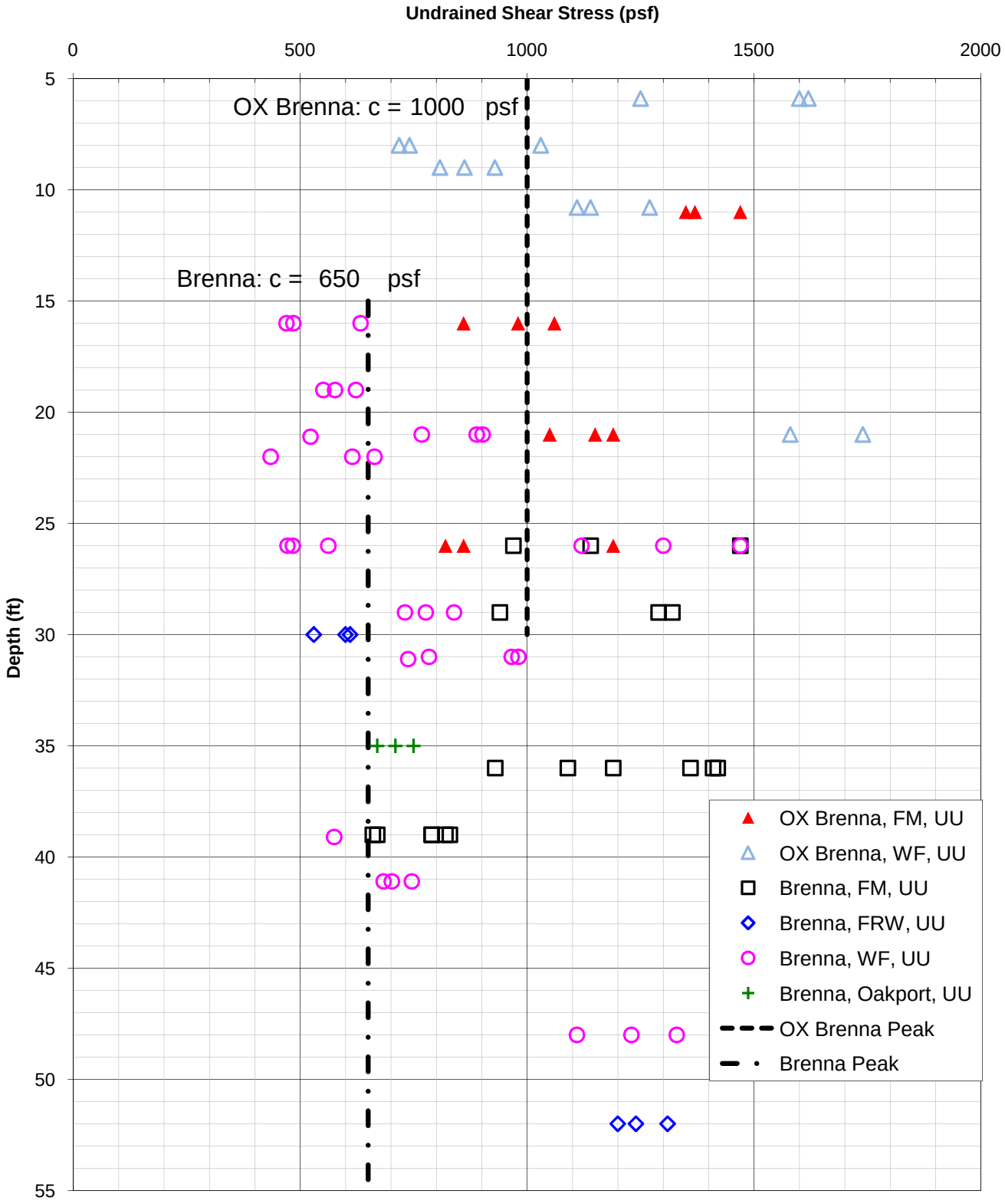
Fargo-Moorhead Metro Feasibility Study
Poplar River
Peak Undrained Shear Strength (UU) Data



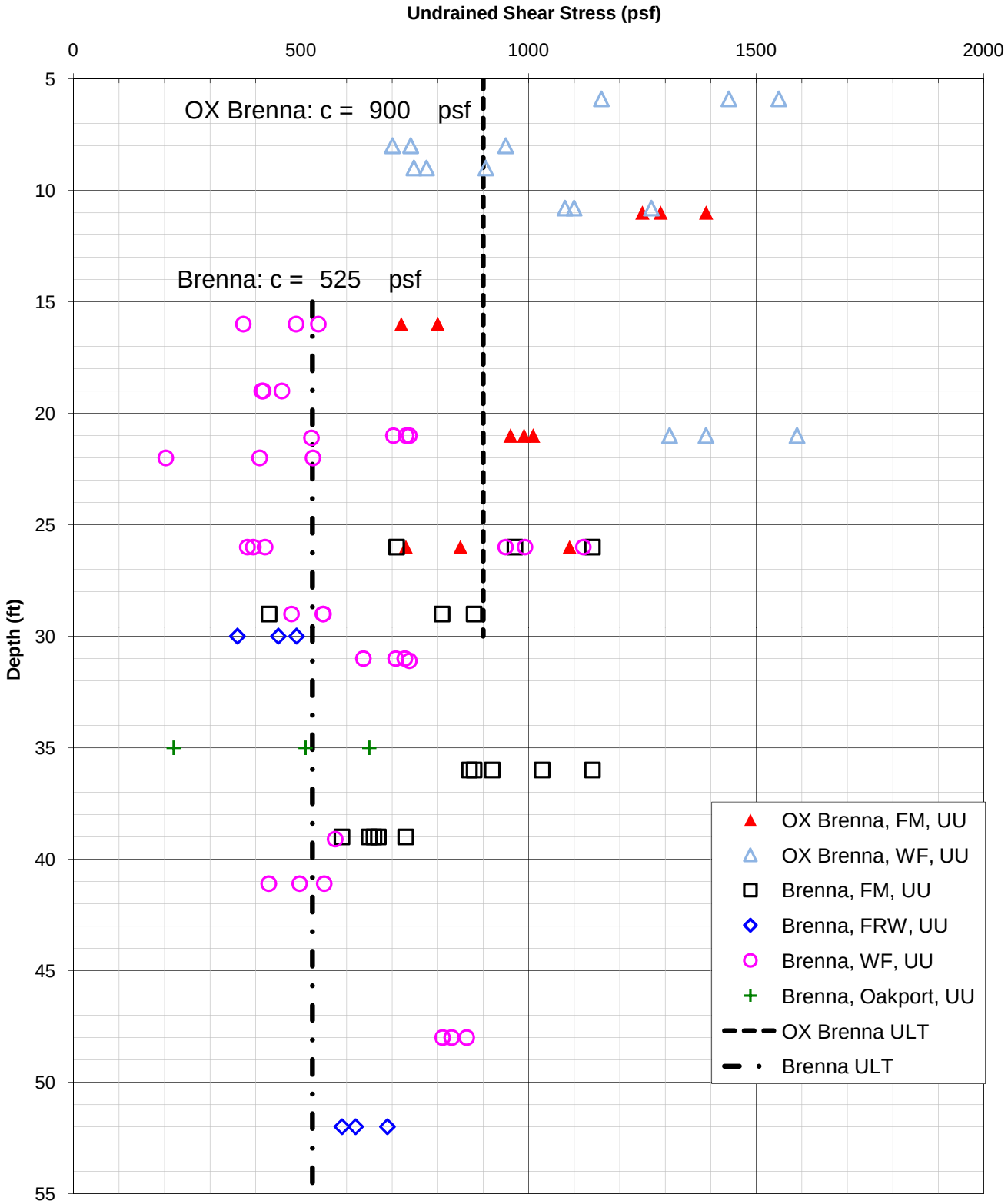
Fargo-Moorhead Metro Feasibility Study
Poplar River
Ultimate Undrained Shear Strength (UU) Data



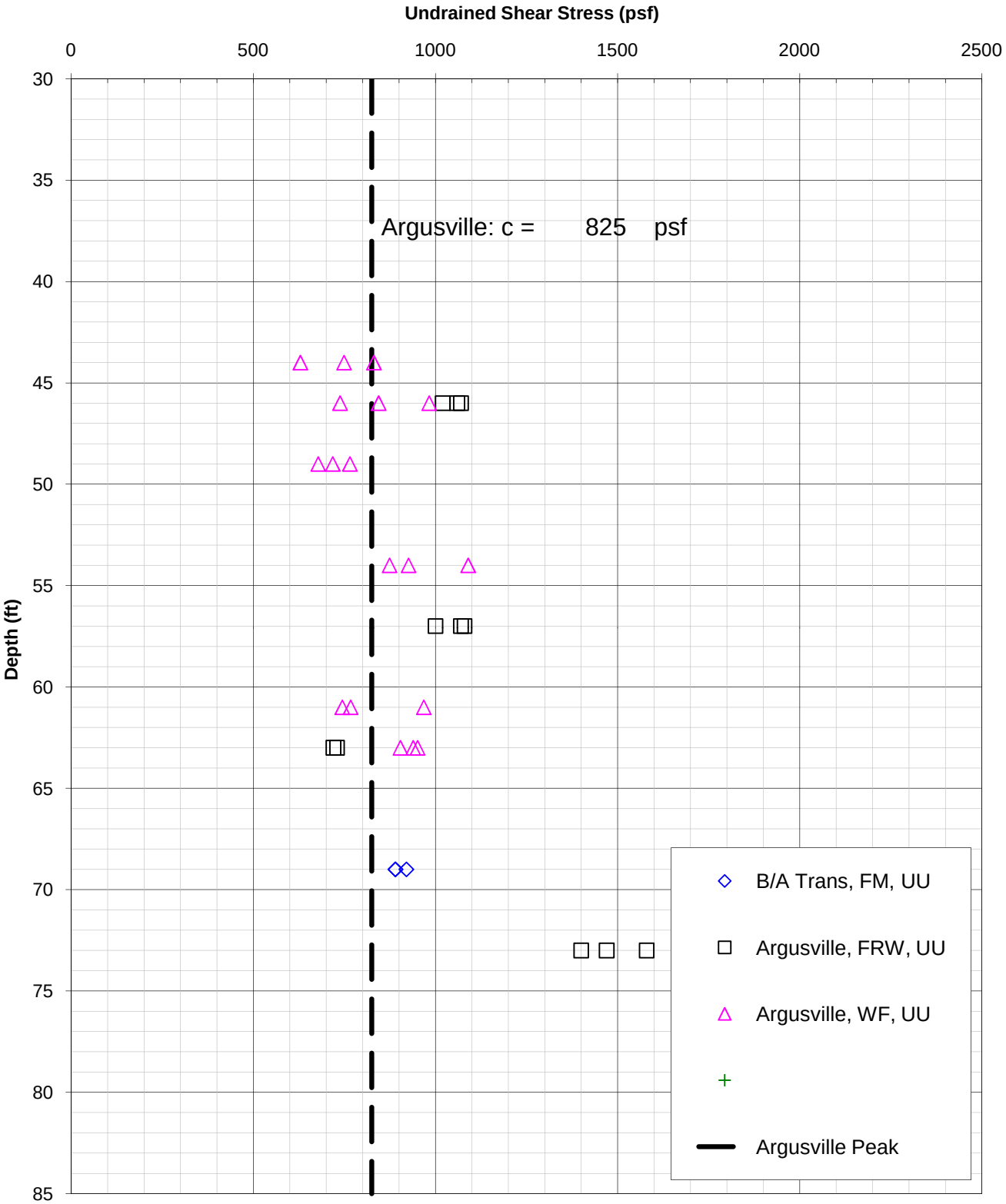
Fargo-Moorhead Metro Feasibility Study
Oxidied Brenna and Brenna
Peak Undrained Shear Strength (UU) Data



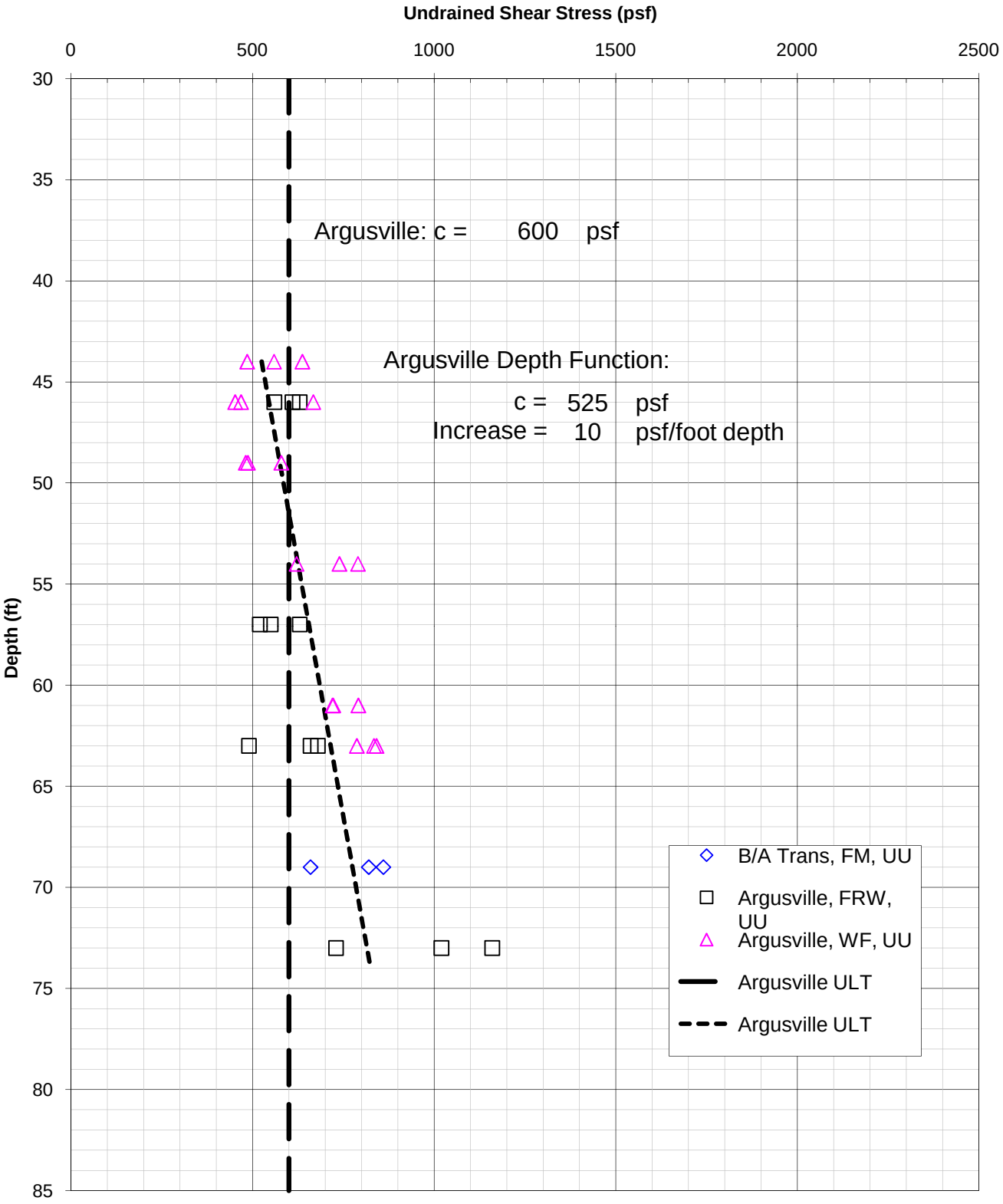
Fargo-Moorhead Metro Feasibility Study
Oxidied Brenna and Brenna
Ultimate Undrained Shear Strength (UU) Data



Fargo-Moorhead Metro Feasibility Study
Argusville
Peak Undrained Shear Strength (UU) Data

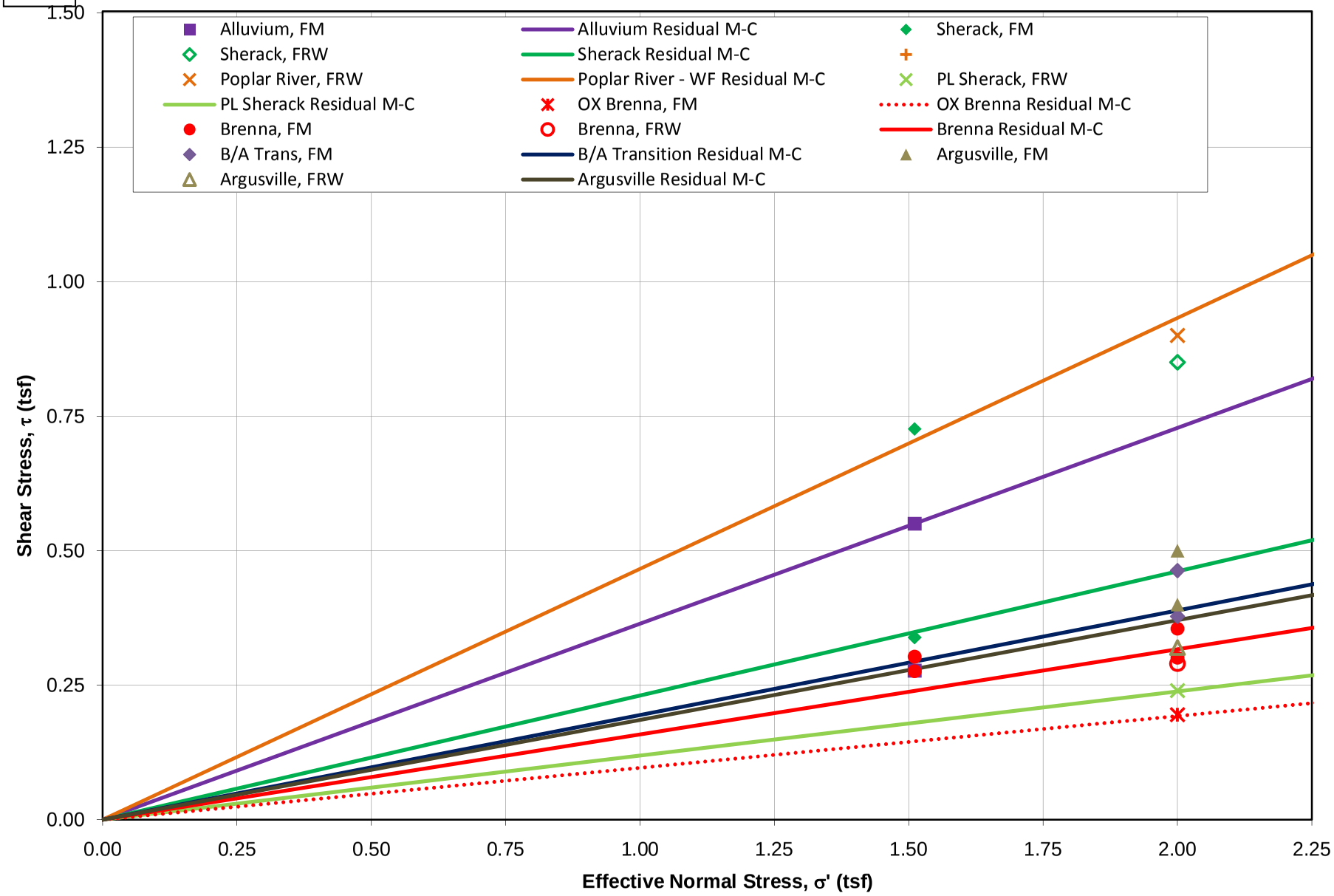


Fargo-Moorhead Metro Feasibility Study
Argusville
Ultimate Undrained Shear Strength (UU) Data



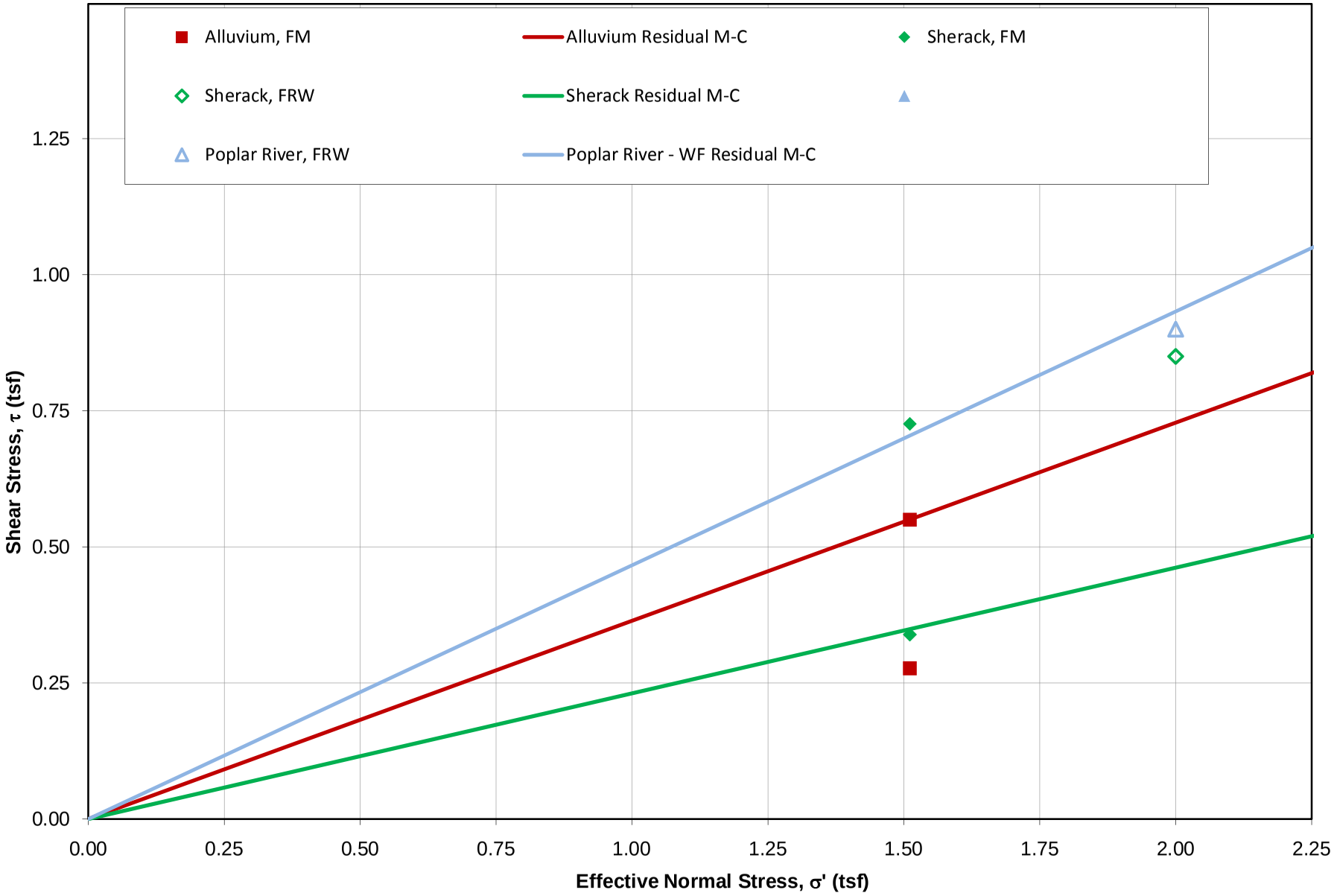
Run Make Grid Square Macro

Fargo-Moorhead Metro Feasibility Study
Ultimate Drained Residual Shear Strength Parameters
Mohr-Coulomb Effective Stress Plot



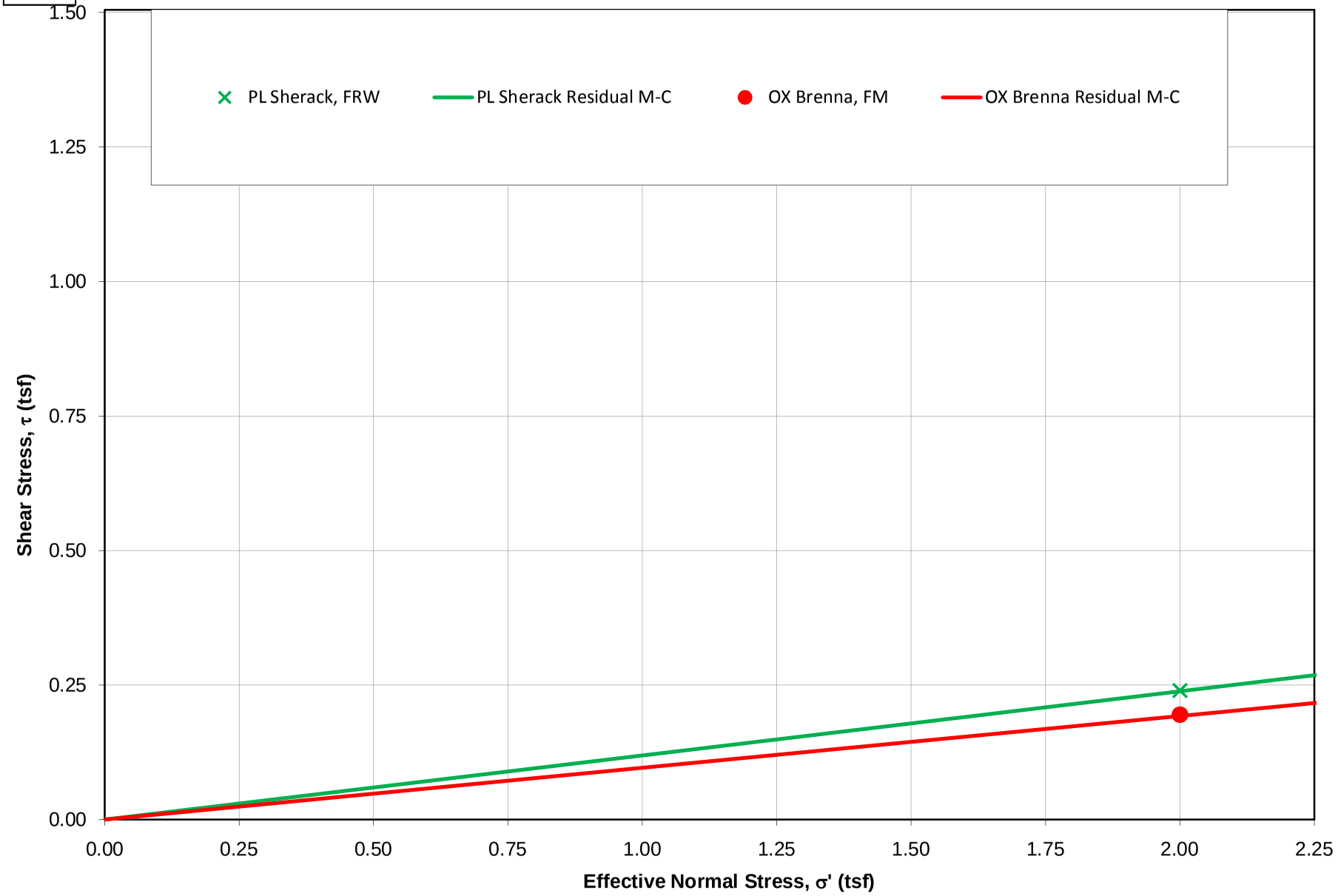
Run Make Grid Square Macro

Fargo-Moorhead Metro Feasibility Study
Ultimate Drained Residual Shear Strength Parameters
Mohr-Coulomb Effective Stress Plot



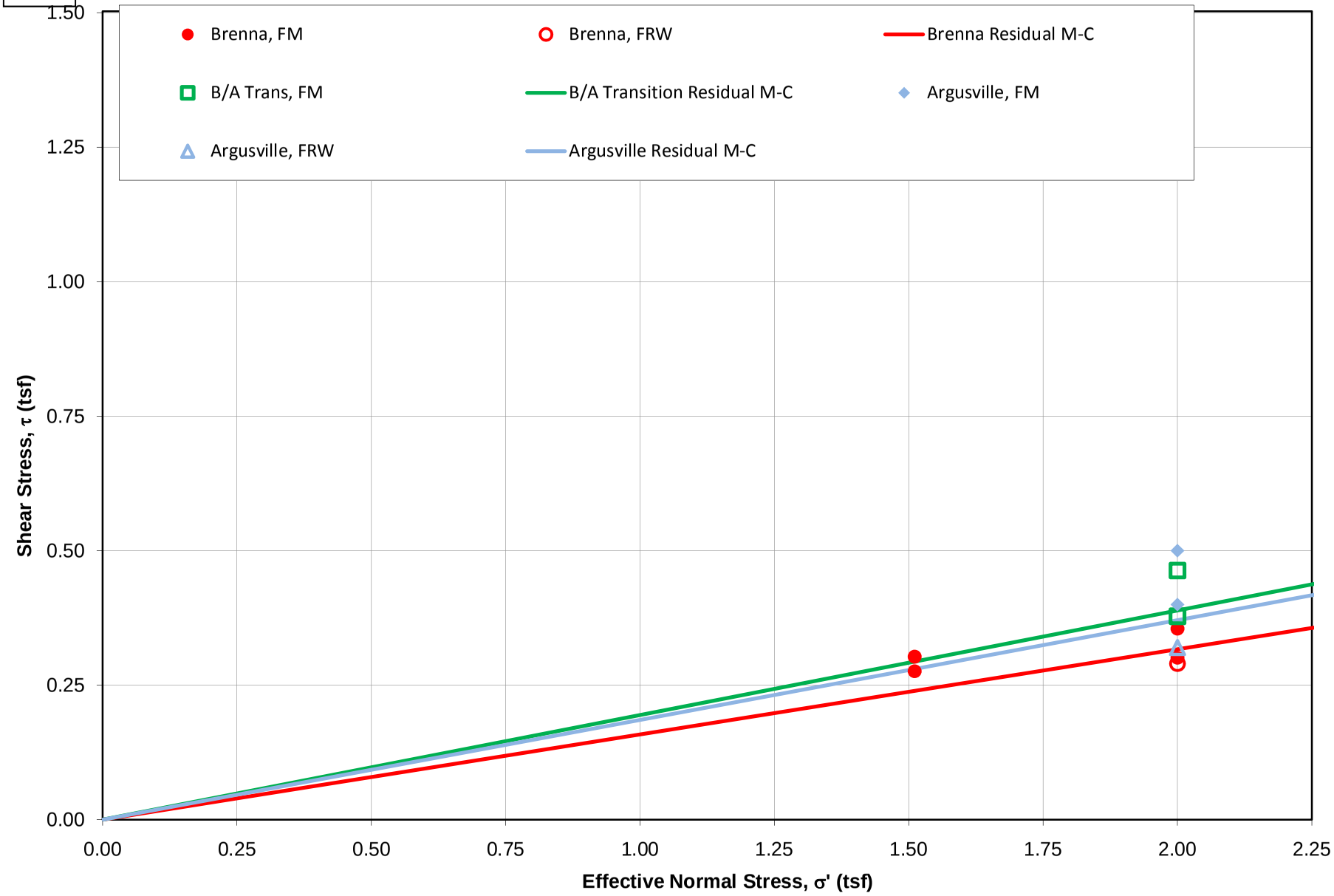
Run Make Grid Square Macro

Fargo-Moorhead Metro Feasibility Study
Ultimate Drained Residual Shear Strength Parameters
Mohr-Coulomb Effective Stress Plot



Run Make Grid Square Macro

Fargo-Moorhead Metro Feasibility Study
Ultimate Drained Residual Shear Strength Parameters
Mohr-Coulomb Effective Stress Plot



St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Alluvium Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate		DS, Ultimate	
										σ_{ff}' (tsf)	τ_{ff} (tsf)	σ_{ff}' (tsf)	τ_{ff} (tsf)
Alluvium, R-bar, Far 09-23MU, 1, 1, FM	Far 09-23MU	3.0	894.0	1	1	Alluvium	R-bar	CH	FM	0.86	0.57		
Alluvium, R-bar, Far 09-23MU, 1, 2, FM	Far 09-23MU	3.0	894.0	1	2	Alluvium	R-bar	CH	FM	1.02	0.65		
Alluvium, R-bar, Far 09-23MU, 1, 3, FM	Far 09-23MU	3.0	894.0	1	3	Alluvium	R-bar	CH	FM	1.42	0.83		
Alluvium, R-bar, Far 09-25MU, 1, 1, FM	Far 09-25MU	15.0	878.4	1	1	Alluvium	R-bar	CH	FM	0.87	0.61		
Alluvium, R-bar, Far 09-25MU, 1, 2, FM	Far 09-25MU	15.0	878.4	1	2	Alluvium	R-bar	CH	FM	1.20	0.78		
Alluvium, R-bar, Far 09-25MU, 1, 3, FM	Far 09-25MU	15.0	878.4	1	3	Alluvium	R-bar	CH	FM	2.10	1.24		
Alluvium, R-bar, Far 09-25MU, 2, 1, FM	Far 09-25MU	27.0	866.4	2	1	Alluvium	R-bar	CH	FM	0.66	0.46		
Alluvium, R-bar, Far 09-25MU, 2, 2, FM	Far 09-25MU	27.0	866.4	2	2	Alluvium	R-bar	CH	FM	1.04	0.69		
Alluvium, R-bar, Far 09-25MU, 2, 3, FM	Far 09-25MU	27.0	866.4	2	3	Alluvium	R-bar	CH	FM	2.11	1.23		
Alluvium, R-bar, Far 09-27MU, 1, 1, FM	Far 09-27MU	7.0	896.1	1	1	Alluvium	R-bar	CH	FM	0.76	0.44		
Alluvium, R-bar, Far 09-27MU, 1, 2, FM	Far 09-27MU	7.0	896.1	1	2	Alluvium	R-bar	CH	FM	1.00	0.63		
Alluvium, R-bar, Far 09-27MU, 1, 3, FM	Far 09-27MU	7.0	896.1	1	3	Alluvium	R-bar	CH	FM	1.67	1.01		
Alluvium, R-bar, Far 10-78MU, 1, 1, FM	Far 10-78MU	14.0	0.0	1	1	Alluvium	R-bar	CH	FM	1.18	0.82		
Alluvium, R-bar, Far 10-78MU, 1, 2, FM	Far 10-78MU	14.0	0.0	1	2	Alluvium	R-bar	CH	FM	1.96	1.22		
Alluvium, R-bar, Far 10-78MU, 1, 3, FM	Far 10-78MU	14.0	0.0	1	3	Alluvium	R-bar	CH	FM	2.90	1.81		
Alluvium, R-bar, Far 10-79MU, 1, 1, FM	Far 10-79MU	21.0	0.0	1	1	Alluvium	R-bar	CH	FM	1.54	0.89		
Alluvium, R-bar, Far 10-79MU, 1, 2, FM	Far 10-79MU	21.0	0.0	1	2	Alluvium	R-bar	CH	FM	2.20	1.33		
Alluvium, R-bar, Far 10-79MU, 1, 3, FM	Far 10-79MU	21.0	0.0	1	3	Alluvium	R-bar	CH	FM	3.84	1.95		
Alluvium, R-bar, Far 10-80MU, 1, 1, FM	Far 10-80MU	24.0	0.0	1	1	Alluvium	R-bar	CL-ML	FM	1.78	1.10		
Alluvium, R-bar, Far 10-80MU, 1, 2, FM	Far 10-80MU	24.0	0.0	1	2	Alluvium	R-bar	CL-ML	FM	1.54	1.15		
Alluvium, R-bar, Far 10-80MU, 1, 3, FM	Far 10-80MU	24.0	0.0	1	3	Alluvium	R-bar	CL-ML	FM	2.29	1.39		
Alluvium, R-bar, 06-16MU, 1, 1, FRW	06-16MU	20.8	857.8	1	1	Alluvium	R-bar	CH	FRW	1.33	0.84		
Alluvium, R-bar, 06-16MU, 1, 2, FRW	06-16MU	20.8	857.8	1	2	Alluvium	R-bar	CH	FRW	1.72	1.07		
Alluvium, R-bar, 06-16MU, 1, 3, FRW	06-16MU	20.8	857.8	1	3	Alluvium	R-bar	CH	FRW	3.07	1.41		

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Sherack Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate		DS, Ultimate	
										σ_{ff}' (tsf)	τ_{ff} (tsf)	σ_{ff}' (tsf)	τ_{ff} (tsf)
Sherack, R-bar, Moor 09-11MU, 1, 1, FM	Moor 09-11MU	11.0	876.6	1	1	Sherack	R-bar	CH	FM	1.28	0.86		
Sherack, R-bar, Moor 09-11MU, 1, 2, FM	Moor 09-11MU	11.0	876.6	1	2	Sherack	R-bar	CH	FM	1.33	0.93		
Sherack, R-bar, Moor 09-11MU, 1, 3, FM	Moor 09-11MU	11.0	876.6	1	3	Sherack	R-bar	CH	FM	2.52	1.50		
Sherack, R-bar, Moor 09-14MU, 1, 1, FM	Moor 09-14MU	9.0	904.1	1	1	Sherack	R-bar	CH	FM	0.80	0.55		
Sherack, R-bar, Moor 09-14MU, 1, 2, FM	Moor 09-14MU	9.0	904.1	1	2	Sherack	R-bar	CH	FM	0.96	0.61		
Sherack, R-bar, Moor 09-14MU, 1, 3, FM	Moor 09-14MU	9.0	904.1	1	3	Sherack	R-bar	CH	FM	1.41	0.81		
Sherack, R-bar, Far 09-23MU, 2, 1, FM	Far 09-23MU	11.0	886.0	2	1	Sherack	R-bar	CH	FM	0.55	0.34		
Sherack, R-bar, Far 09-23MU, 2, 2, FM	Far 09-23MU	11.0	886.0	2	2	Sherack	R-bar	CH	FM	0.94	0.50		
Sherack, R-bar, Far 09-23MU, 2, 3, FM	Far 09-23MU	11.0	886.0	2	3	Sherack	R-bar	CH	FM	1.75	0.82		
Sherack, R-bar, Moor 09-25MU, 1, 1, FM	Moor 09-25MU	9.0	889.7	1	1	Sherack	R-bar	CH	FM	0.40	0.24		
Sherack, R-bar, Moor 09-25MU, 1, 2, FM	Moor 09-25MU	9.0	889.7	1	2	Sherack	R-bar	CH	FM	0.64	0.36		
Sherack, R-bar, Moor 09-25MU, 1, 3, FM	Moor 09-25MU	9.0	889.7	1	3	Sherack	R-bar	CH	FM	1.89	0.60		
Sherack, R-bar, Far 09-26MU, 1, 1, FM	Far 09-26MU	9.0	894.5	1	1	Sherack	R-bar	CH	FM	0.69	0.39		
Sherack, R-bar, Far 09-26MU, 1, 2, FM	Far 09-26MU	9.0	894.5	1	2	Sherack	R-bar	CH	FM	1.03	0.55		
Sherack, R-bar, Far 09-26MU, 1, 3, FM	Far 09-26MU	9.0	894.5	1	3	Sherack	R-bar	CH	FM	1.94	0.86		
Sherack, R-bar, Moor 09-34MU, 1, 1, FM	Moor 09-34MU	9.0	898.9	1	1	Sherack	R-bar	CH	FM	0.67	0.38		
Sherack, R-bar, Moor 09-34MU, 1, 2, FM	Moor 09-34MU	9.0	898.9	1	2	Sherack	R-bar	CH	FM	1.13	0.53		
Sherack, R-bar, Moor 09-34MU, 1, 3, FM	Moor 09-34MU	9.0	898.9	1	3	Sherack	R-bar	CH	FM	1.75	0.58		
Sherack, R-bar, Moor 09-53MU, 1, 1, FM	Moor 09-53MU	19.0	881.5	1	1	Sherack	R-bar	CH	FM	1.00	0.50		
Sherack, R-bar, Moor 09-53MU, 1, 2, FM	Moor 09-53MU	19.0	881.5	1	2	Sherack	R-bar	CH	FM	1.28	0.51		
Sherack, R-bar, Moor 09-53MU, 1, 3, FM	Moor 09-53MU	19.0	881.5	1	3	Sherack	R-bar	CH	FM	2.30	0.64		
Sherack, R-bar, 01-4MU, 1, 1, FRW	01-4MU	19.0	880.2	1	1	Sherack	R-bar	CH/CL	FRW	1.75	0.96		
Sherack, R-bar, 01-4MU, 1, 2, FRW	01-4MU	19.0	880.2	1	2	Sherack	R-bar	CH/CL	FRW	2.40	1.38		
Sherack, R-bar, 01-4MU, 1, 3, FRW	01-4MU	19.0	880.2	1	3	Sherack	R-bar	CH/CL	FRW	3.48	1.52		
Sherack, R-bar, 06-18MU, 1, 1, FRW	06-18MU	22.0	867.7	1	1	Sherack	R-bar	CH	FRW	1.40	0.87		
Sherack, R-bar, 06-18MU, 1, 2, FRW	06-18MU	22.0	867.7	1	2	Sherack	R-bar	CH	FRW	1.95	1.20		
Sherack, R-bar, 06-18MU, 1, 3, FRW	06-18MU	22.0	867.7	1	3	Sherack	R-bar	CH	FRW	3.14	1.80		
Sherack, R-bar, 84-1M, 1, 1, WF	84-1M	5.9	890.2	1	1	Sherack	R-bar	MH	WF	0.94	0.37		
Sherack, R-bar, 84-1M, 1, 2, WF	84-1M	5.9	890.2	1	2	Sherack	R-bar	MH	WF	2.00	0.76		
Sherack, R-bar, 84-1M, 1, 3, WF	84-1M	5.9	890.2	1	3	Sherack	R-bar	MH	WF	3.44	1.10		
Sherack, R-bar, 85-12M, 1, 1, WF	85-12M	6.0	891.3	1	1	Sherack	R-bar	CH	WF	1.10	0.68		
Sherack, R-bar, 85-12M, 1, 2, WF	85-12M	6.0	891.3	1	2	Sherack	R-bar	CH	WF	1.30	0.87		
Sherack, R-bar, 85-12M, 1, 3, WF	85-12M	6.0	891.3	1	3	Sherack	R-bar	CH	WF	2.46	1.45		

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Sherack Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate		DS, Ultimate	
										σ_{ff}' (tsf)	τ_{ff} (tsf)	σ_{ff}' (tsf)	τ_{ff} (tsf)
Sherack, R-bar, 99-1M, 1, 1, Oakport	99-1M	7.0	0.0	1	1	Sherack	R-bar	CH	Oakport	0.56	0.31		
Sherack, R-bar, 99-1M, 1, 2, Oakport	99-1M	7.0	0.0	1	2	Sherack	R-bar	CH	Oakport	0.89	0.49		
Sherack, R-bar, 99-1M, 1, 3, Oakport	99-1M	7.0	0.0	1	3	Sherack	R-bar	CH	Oakport	1.40	0.46		
Sherack, R-bar, ST-8, , 1, SS-32ND	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Sherack, R-bar, ST-8, , 2, SS-32ND	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Sherack, R-bar, ST-8, , 3, SS-32ND	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Sherack, R-bar, ST-13, 1, 1, SS-32ND	ST-13	15.5	885.4	1	1	Sherack	R-bar	CH	SS-32ND	-0.15	0.52		
Sherack, R-bar, ST-13, 1, 2, SS-32ND	ST-13	15.5	885.4	1	2	Sherack	R-bar	CH	SS-32ND	1.08	0.61		
Sherack, R-bar, ST-13, 1, 3, SS-32ND	ST-13	15.5	885.4	1	3	Sherack	R-bar	CH	SS-32ND	2.41	0.76		
Sherack, R-bar, SL-3, , 1, SA-52ndAVE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Sherack, R-bar, SL-3, , 2, SA-52ndAVE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Sherack, R-bar, SL-3, , 3, SA-52ndAVE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: PL Sherack Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate		DS, Ultimate	
										σ_{ff}' (tsf)	τ_{ff} (tsf)	σ_{ff}' (tsf)	τ_{ff} (tsf)
PL Sherack, R-bar, 01-5MU, 1, 1, FRW	01-5MU	16.0	885.7	1	1	PL Sherack	R-bar	CH	FRW	1.08	0.31		
PL Sherack, R-bar, 01-5MU, 1, 2, FRW	01-5MU	16.0	885.7	1	2	PL Sherack	R-bar	CH	FRW	1.93	0.57		
PL Sherack, R-bar, 01-5MU, 1, 3, FRW	01-5MU	16.0	885.7	1	3	PL Sherack	R-bar	CH	FRW	3.20	0.69		

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Poplar Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate σ_{ff}' (tsf)	R-bar, Ultimate τ_{ff} (tsf)	DS, Ultimate σ_{ff}' (tsf)	DS, Ultimate τ_{ff} (tsf)
Poplar River, R-bar, Far 09-26MU, 2, 1, FM	Far 09-26MU	17.0	886.5	2	1	Poplar River	R-bar	CH	FM	0.82	0.59		
Poplar River, R-bar, Far 09-26MU, 2, 2, FM	Far 09-26MU	17.0	886.5	2	2	Poplar River	R-bar	CH	FM	0.95	0.65		
Poplar River, R-bar, Far 09-26MU, 2, 3, FM	Far 09-26MU	17.0	886.5	2	3	Poplar River	R-bar	CH	FM	1.67	1.09		
Poplar River, R-bar, 01-10MU, 1, 1, FRW	01-10MU	21.0	860.0	1	1	Poplar River	R-bar	CH	FRW	1.38	0.83		
Poplar River, R-bar, 01-10MU, 1, 2, FRW	01-10MU	21.0	860.0	1	2	Poplar River	R-bar	CH	FRW	2.36	1.49		
Poplar River, R-bar, 01-10MU, 1, 3, FRW	01-10MU	21.0	860.0	1	3	Poplar River	R-bar	CH	FRW	3.77	2.03		
PR - WF, R-bar, Far 09-23MU, 3, 1, FM	Far 09-23MU	21.0	876.0	3	1	PR - WF	R-bar	ML	FM	3.55	2.17		
PR - WF, R-bar, Far 09-23MU, 3, 2, FM	Far 09-23MU	21.0	876.0	3	2	PR - WF	R-bar	ML	FM	4.40	2.94		
PR - WF, R-bar, Far 09-23MU, 3, 3, FM	Far 09-23MU	21.0	876.0	3	3	PR - WF	R-bar	ML	FM	8.90	4.68		
PR - WF, R-bar, Moor 09-25MU, 2, 1, FM	Moor 09-25MU	22.0	876.7	2	1	PR - WF	R-bar	ML	FM	3.15	2.34		
PR - WF, R-bar, Moor 09-25MU, 2, 2, FM	Moor 09-25MU	22.0	876.7	2	2	PR - WF	R-bar	ML	FM	3.95	2.68		
PR - WF, R-bar, Moor 09-25MU, 2, 3, FM	Moor 09-25MU	22.0	876.7	2	3	PR - WF	R-bar	ML	FM	4.98	3.25		
PR - WF, DS, Far 09-23MU, 3, 1, FM	Far 09-23MU	21.0	876.0	3	1	PR - WF	DS	ML	FM			0.51	0.38
PR - WF, DS, Far 09-23MU, 3, 2, FM	Far 09-23MU	21.0	876.0	3	2	PR - WF	DS	ML	FM			1.01	0.70
PR - WF, DS, Far 09-23MU, 3, 3, FM	Far 09-23MU	21.0	876.0	3	3	PR - WF	DS	ML	FM			1.93	1.35
PR - Harwood, R-bar, Far 09-23MU, 4, 1, FM	Far 09-23MU	29.0	868.0	4	1	PR - Harwood	R-bar	CH	FM	0.77	0.49		
PR - Harwood, R-bar, Far 09-23MU, 4, 2, FM	Far 09-23MU	29.0	868.0	4	2	PR - Harwood	R-bar	CH	FM	1.24	0.75		
PR - Harwood, R-bar, Far 09-23MU, 4, 3, FM	Far 09-23MU	29.0	868.0	4	3	PR - Harwood	R-bar	CH	FM	1.80	0.97		
PR - Harwood, R-bar, Moor 09-25MU, 3, 1, FM	Moor 09-25MU	26.0	872.7	3	1	PR - Harwood	R-bar	CH	FM	0.95	0.48		
PR - Harwood, R-bar, Moor 09-25MU, 3, 2, FM	Moor 09-25MU	26.0	872.7	3	2	PR - Harwood	R-bar	CH	FM	1.31	0.52		
PR - Harwood, R-bar, Moor 09-25MU, 3, 3, FM	Moor 09-25MU	26.0	872.7	3	3	PR - Harwood	R-bar	CH	FM	1.65	0.63		

St. Paul District GEOLOGY GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Oxidized Brenna Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate σ_{ff}' (tsf)	R-bar, Ultimate τ_{ff} (tsf)	DS, Ultimate σ_{ff}' (tsf)	DS, Ultimate τ_{ff} (tsf)
OX Brenna, R-bar, Moor 09-26MU, 2, 1, FM	Moor 09-26MU	21.0	890.5	2	1	OX Brenna	R-bar	CH	FM	0.59	0.27		
OX Brenna, R-bar, Moor 09-26MU, 2, 2, FM	Moor 09-26MU	21.0	890.5	2	2	OX Brenna	R-bar	CH	FM	1.06	0.37		
OX Brenna, R-bar, Moor 09-26MU, 2, 3, FM	Moor 09-26MU	21.0	890.5	2	3	OX Brenna	R-bar	CH	FM	1.74	0.53		
OX Brenna, R-bar, Moor 09-34MU, 2, 1, FM	Moor 09-34MU	17.0	890.9	2	1	OX Brenna	R-bar	CH	FM	0.69	0.29		
OX Brenna, R-bar, Moor 09-34MU, 2, 2, FM	Moor 09-34MU	17.0	890.9	2	2	OX Brenna	R-bar	CH	FM	1.20	0.39		
OX Brenna, R-bar, Moor 09-34MU, 2, 3, FM	Moor 09-34MU	17.0	890.9	2	3	OX Brenna	R-bar	CH	FM	2.26	0.52		
OX Brenna, R-bar, Far 09-59MU, 1, 1, FM	Far 09-59MU	11.0	905.2	1	1	OX Brenna	R-bar	CH	FM	0.72	0.40		
OX Brenna, R-bar, Far 09-59MU, 1, 2, FM	Far 09-59MU	11.0	905.2	1	2	OX Brenna	R-bar	CH	FM	1.25	0.55		
OX Brenna, R-bar, Far 09-59MU, 1, 3, FM	Far 09-59MU	11.0	905.2	1	3	OX Brenna	R-bar	CH	FM	2.35	0.72		
OX Brenna, R-bar, Far 09-59MU, 2, 1, FM	Far 09-59MU	21.0	895.2	2	1	OX Brenna	R-bar	CH	FM	0.90	0.38		
OX Brenna, R-bar, Far 09-59MU, 2, 2, FM	Far 09-59MU	21.0	895.2	2	2	OX Brenna	R-bar	CH	FM	1.66	0.55		
OX Brenna, R-bar, Far 09-59MU, 2, 3, FM	Far 09-59MU	21.0	895.2	2	3	OX Brenna	R-bar	CH	FM	2.62	0.72		
OX Brenna, R-bar, Far 09-60MU, 1, 1, FM	Far 09-60MU	16.0	867.3	1	1	OX Brenna	R-bar	CH	FM	0.54	0.31		
OX Brenna, R-bar, Far 09-60MU, 1, 2, FM	Far 09-60MU	16.0	867.3	1	2	OX Brenna	R-bar	CH	FM	1.06	0.42		
OX Brenna, R-bar, Far 09-60MU, 1, 3, FM	Far 09-60MU	16.0	867.3	1	3	OX Brenna	R-bar	CH	FM	1.92	0.58		
OX Brenna, R-bar, Far 09-60MU, 2, 1, FM	Far 09-60MU	26.0	857.3	2	1	OX Brenna	R-bar	CH	FM	0.94	0.39		
OX Brenna, R-bar, Far 09-60MU, 2, 2, FM	Far 09-60MU	26.0	857.3	2	2	OX Brenna	R-bar	CH	FM	1.39	0.51		
OX Brenna, R-bar, Far 09-60MU, 2, 3, FM	Far 09-60MU	26.0	857.3	2	3	OX Brenna	R-bar	CH	FM	2.57	0.71		
OX Brenna, R-bar, 84-2M, 1, 1, WF	84-2M	10.8	893.8	1	1	OX Brenna	R-bar	CH	WF	0.92	0.37		
OX Brenna, R-bar, 84-2M, 1, 2, WF	84-2M	10.8	893.8	1	2	OX Brenna	R-bar	CH	WF	1.77	0.71		
OX Brenna, R-bar, 84-2M, 1, 3, WF	84-2M	10.8	893.8	1	3	OX Brenna	R-bar	CH	WF	3.37	1.25		
OX Brenna, R-bar, 84-2M, 1, 4, WF	84-2M	10.8	893.8	1	4	OX Brenna	R-bar	CH	WF	0.27	0.10		
OX Brenna, R-bar, 85-4M, 1, 1, WF	85-4M	9.0	904.2	1	1	OX Brenna	R-bar	CH	WF	0.56	0.24		
OX Brenna, R-bar, 85-4M, 1, 2, WF	85-4M	9.0	904.2	1	2	OX Brenna	R-bar	CH	WF	1.04	0.51		
OX Brenna, R-bar, 85-4M, 1, 3, WF	85-4M	9.0	904.2	1	3	OX Brenna	R-bar	CH	WF	1.87	0.51		
OX Brenna, R-bar, 85-4M, 1, 4, WF	85-4M	9.0	904.2	1	4	OX Brenna	R-bar	CH	WF	0.84	0.59		
OX Brenna, R-bar, 85-6M, 1, 1, WF	85-6M	8.0	894.2	1	1	OX Brenna	R-bar	CH	WF	0.53	0.18		
OX Brenna, R-bar, 85-6M, 1, 2, WF	85-6M	8.0	894.2	1	2	OX Brenna	R-bar	CH	WF	0.90	0.32		
OX Brenna, R-bar, 85-6M, 1, 3, WF	85-6M	8.0	894.2	1	3	OX Brenna	R-bar	CH	WF	1.76	0.47		
OX Brenna, R-bar, 85-7M, 1, 1, WF	85-7M	5.9	895.7	1	1	OX Brenna	R-bar	CH	WF	0.72	0.29		
OX Brenna, R-bar, 85-7M, 1, 2, WF	85-7M	5.9	895.7	1	2	OX Brenna	R-bar	CH	WF	0.47	0.46		
OX Brenna, R-bar, 85-7M, 1, 3, WF	85-7M	5.9	895.7	1	3	OX Brenna	R-bar	CH	WF	1.75	0.62		
OX Brenna, R-bar, 85-7M, 1, 4, WF	85-7M	5.9	895.7	1	4	OX Brenna	R-bar	CH	WF	0.34	0.13		
OX Brenna, R-bar, 85-7M, 2, 1, WF	85-7M	15.0	886.6	2	1	OX Brenna	R-bar	CH	WF	0.48	0.22		
OX Brenna, R-bar, 85-7M, 2, 2, WF	85-7M	15.0	886.6	2	2	OX Brenna	R-bar	CH	WF	0.83	0.27		
OX Brenna, R-bar, 85-7M, 2, 3, WF	85-7M	15.0	886.6	2	3	OX Brenna	R-bar	CH	WF	1.64	0.40		
OX Brenna, R-bar, 85-11M, 1, 1, WF	85-11M	16.0	883.5	1	1	OX Brenna	R-bar	CH	WF	0.64	0.22		
OX Brenna, R-bar, 85-11M, 1, 2, WF	85-11M	16.0	883.5	1	2	OX Brenna	R-bar	CH	WF	0.96	0.34		

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Oxidized Brenna Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate		DS, Ultimate	
										σ_{ff}' (tsf)	τ_{ff} (tsf)	σ_{ff}' (tsf)	τ_{ff} (tsf)
OX Brenna, R-bar, 85-11M, 1, 3, WF	85-11M	16.0	883.5	1	3	OX Brenna	R-bar	CH	WF	1.68	0.35		
OX Brenna, R-bar, 85-11M, 1, 4, WF	85-11M	16.0	883.5	1	4	OX Brenna	R-bar	CH	WF	0.46	0.19		
OX Brenna, R-bar, 85-12M, 2, 1, WF	85-12M	16.0	8957.0	2	1	OX Brenna	R-bar	CH	WF	1.03	0.56		
OX Brenna, R-bar, 85-12M, 2, 2, WF	85-12M	16.0	8957.0	2	2	OX Brenna	R-bar	CH	WF	1.43	0.91		
OX Brenna, R-bar, 85-12M, 2, 3, WF	85-12M	16.0	8957.0	2	3	OX Brenna	R-bar	CH	WF	1.99	1.00		
OX Brenna, R-bar, 86-28M, 1, 1, WF	86-28M	11.0	906.6	1	1	OX Brenna	R-bar	CH	WF	0.86	0.38		
OX Brenna, R-bar, 86-28M, 1, 2, WF	86-28M	11.0	906.6	1	2	OX Brenna	R-bar	CH	WF	1.08	0.39		
OX Brenna, R-bar, 86-28M, 1, 3, WF	86-28M	11.0	906.6	1	3	OX Brenna	R-bar	CH	WF	1.96	0.58		
OX Brenna, R-bar, 86-28M, 2, 1, WF	86-28M	21.0	896.6	2	1	OX Brenna	R-bar	CH	WF	0.97	0.32		
OX Brenna, R-bar, 86-28M, 2, 2, WF	86-28M	21.0	896.6	2	2	OX Brenna	R-bar	CH	WF	1.74	0.46		
OX Brenna, R-bar, 86-28M, 2, 3, WF	86-28M	21.0	896.6	2	3	OX Brenna	R-bar	CH	WF	2.94	0.63		

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Brenna Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate σ_{ff}' (tsf)	R-bar, Ultimate τ_{ff} (tsf)	DS, Ultimate σ_{ff}' (tsf)	DS, Ultimate τ_{ff} (tsf)
Brenna, R-bar, Moor 09-11MU, 2, 1, FM	Moor 09-11MU	31.0	856.6	2	1	Brenna	R-bar	CH	FM	0.95	0.32		
Brenna, R-bar, Moor 09-11MU, 2, 2, FM	Moor 09-11MU	31.0	856.6	2	2	Brenna	R-bar	CH	FM	1.67	0.45		
Brenna, R-bar, Moor 09-11MU, 2, 3, FM	Moor 09-11MU	31.0	856.6	2	3	Brenna	R-bar	CH	FM	2.71	0.68		
Brenna, R-bar, Moor 09-11MU, 3, 1, FM	Moor 09-11MU	41.0	846.6	3	1	Brenna	R-bar	CH	FM	1.08	0.48		
Brenna, R-bar, Moor 09-11MU, 3, 2, FM	Moor 09-11MU	41.0	846.6	3	2	Brenna	R-bar	CH	FM	1.49	0.51		
Brenna, R-bar, Moor 09-11MU, 3, 3, FM	Moor 09-11MU	41.0	846.6	3	3	Brenna	R-bar	CH	FM	2.27	0.63		
Brenna, R-bar, Moor 09-14MU, 2, 1, FM	Moor 09-14MU	16.0	897.1	2	1	Brenna	R-bar	CH	FM	0.46	0.20		
Brenna, R-bar, Moor 09-14MU, 2, 2, FM	Moor 09-14MU	16.0	897.1	2	2	Brenna	R-bar	CH	FM	0.76	0.26		
Brenna, R-bar, Moor 09-14MU, 2, 3, FM	Moor 09-14MU	16.0	897.1	2	3	Brenna	R-bar	CH	FM	1.30	0.37		
Brenna, R-bar, Far 09-25MU, 4, 1, FM	Far 09-25MU	51.0	842.4	4	1	Brenna	R-bar	CH	FM	0.80	0.26		
Brenna, R-bar, Far 09-25MU, 4, 2, FM	Far 09-25MU	51.0	842.4	4	2	Brenna	R-bar	CH	FM	1.31	0.45		
Brenna, R-bar, Far 09-25MU, 4, 3, FM	Far 09-25MU	51.0	842.4	4	3	Brenna	R-bar	CH	FM	2.13	0.51		
Brenna, R-bar, Moor 09-25MU, 4, 1, FM	Moor 09-25MU	39.0	859.7	4	1	Brenna	R-bar	CH	FM	0.64	0.23		
Brenna, R-bar, Moor 09-25MU, 4, 2, FM	Moor 09-25MU	39.0	859.7	4	2	Brenna	R-bar	CH	FM	0.74	0.35		
Brenna, R-bar, Moor 09-25MU, 4, 3, FM	Moor 09-25MU	39.0	859.7	4	3	Brenna	R-bar	CH	FM	1.88	0.55		
Brenna, R-bar, Far 09-26MU, 3, 1, FM	Far 09-26MU	29.0	874.5	3	1	Brenna	R-bar	CH	FM	0.82	0.32		
Brenna, R-bar, Far 09-26MU, 3, 2, FM	Far 09-26MU	29.0	874.5	3	2	Brenna	R-bar	CH	FM	1.49	0.50		
Brenna, R-bar, Far 09-26MU, 3, 3, FM	Far 09-26MU	29.0	874.5	3	3	Brenna	R-bar	CH	FM	2.44	0.67		
Brenna, R-bar, Far 09-27MU, 3, 1, FM	Far 09-27MU	33.0	870.1	3	1	Brenna	R-bar	CH	FM	0.91	0.26		
Brenna, R-bar, Far 09-27MU, 3, 2, FM	Far 09-27MU	33.0	870.1	3	2	Brenna	R-bar	CH	FM	1.35	0.40		
Brenna, R-bar, Far 09-27MU, 3, 3, FM	Far 09-27MU	33.0	870.1	3	3	Brenna	R-bar	CH	FM	2.25	0.53		
Brenna, R-bar, Moor 09-53MU, 2, 1, FM	Moor 09-53MU	29.0	871.5	2	1	Brenna	R-bar	CH	FM	0.84	0.29		
Brenna, R-bar, Moor 09-53MU, 2, 2, FM	Moor 09-53MU	29.0	871.5	2	2	Brenna	R-bar	CH	FM	1.48	0.45		
Brenna, R-bar, Moor 09-53MU, 2, 3, FM	Moor 09-53MU	29.0	871.5	2	3	Brenna	R-bar	CH	FM	2.48	0.59		
Brenna, R-bar, Far 10-78MU, 2, 1, FM	Far 10-78MU	26.0	0.0	2	1	Brenna	R-bar	CH	FM	1.07	0.46		
Brenna, R-bar, Far 10-78MU, 2, 2, FM	Far 10-78MU	26.0	0.0	2	2	Brenna	R-bar	CH	FM	1.61	0.64		
Brenna, R-bar, Far 10-78MU, 2, 3, FM	Far 10-78MU	26.0	0.0	2	3	Brenna	R-bar	CH	FM	2.71	0.69		
Brenna, R-bar, Far 10-80MU, 2, 1, FM	Far 10-80MU	36.0	0.0	2	1	Brenna	R-bar	CH	FM	1.16	0.56		
Brenna, R-bar, Far 10-80MU, 2, 2, FM	Far 10-80MU	36.0	0.0	2	2	Brenna	R-bar	CH	FM	1.57	0.48		
Brenna, R-bar, Far 10-80MU, 2, 3, FM	Far 10-80MU	36.0	0.0	2	3	Brenna	R-bar	CH	FM	3.05	0.61		
Brenna, DS, Moor 09-14MU, 3, 1, FM	Moor 09-14MU	39.0	874.1	3	1	Brenna	DS	CH	FM			0.51	0.15
Brenna, DS, Moor 09-14MU, 3, 2, FM	Moor 09-14MU	39.0	874.1	3	2	Brenna	DS	CH	FM			1.01	0.29
Brenna, DS, Moor 09-14MU, 3, 3, FM	Moor 09-14MU	39.0	874.1	3	3	Brenna	DS	CH	FM			3.18	0.92
Brenna, DS, Far 09-23MU, 5, 1, FM	Far 09-23MU	39.0	858.0	5	1	Brenna	DS	CH	FM			0.51	0.14
Brenna, DS, Far 09-23MU, 5, 2, FM	Far 09-23MU	39.0	858.0	5	2	Brenna	DS	CH	FM			1.01	0.24
Brenna, DS, Far 09-23MU, 5, 3, FM	Far 09-23MU	39.0	858.0	5	3	Brenna	DS	CH	FM			3.18	0.65
Brenna, DS, Far 09-23MU, 6, 1, FM	Far 09-23MU	81.0	816.0	6	1	Brenna	DS	CH	FM			1.01	0.39
Brenna, DS, Far 09-23MU, 6, 2, FM	Far 09-23MU	81.0	816.0	6	2	Brenna	DS	CH	FM			1.93	0.55

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Brenna Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate		DS, Ultimate	
										σ_{ff}' (tsf)	τ_{ff} (tsf)	σ_{ff}' (tsf)	τ_{ff} (tsf)
Brenna, DS, Far 09-23MU, 6, 3, FM	Far 09-23MU	81.0	816.0	6	3	Brenna	DS	CH	FM			4.08	1.02
Brenna, DS, Far 09-25MU, 4, 1, FM	Far 09-25MU	51.0	842.4	4	1	Brenna	DS	CH	FM			1.01	0.23
Brenna, DS, Far 09-25MU, 4, 2, FM	Far 09-25MU	51.0	842.4	4	2	Brenna	DS	CH	FM			2.00	0.43
Brenna, DS, Far 09-25MU, 4, 3, FM	Far 09-25MU	51.0	842.4	4	3	Brenna	DS	CH	FM			4.08	0.83
Brenna, DS, Moor 09-26MU, 3, 1, FM	Moor 09-26MU	29.0	882.5	3	1	Brenna	DS	CH	FM			1.01	0.24
Brenna, DS, Moor 09-26MU, 3, 2, FM	Moor 09-26MU	29.0	882.5	3	2	Brenna	DS	CH	FM			2.00	0.43
Brenna, DS, Moor 09-26MU, 3, 3, FM	Moor 09-26MU	29.0	882.5	3	3	Brenna	DS	CH	FM			4.08	0.88
Brenna, DS, Far 09-27MU, 3, 1, FM	Far 09-27MU	33.0	870.1	3	1	Brenna	DS	CH	FM			1.01	0.23
Brenna, DS, Far 09-27MU, 3, 2, FM	Far 09-27MU	33.0	870.1	3	2	Brenna	DS	CH	FM			2.00	0.45
Brenna, DS, Far 09-27MU, 3, 3, FM	Far 09-27MU	33.0	870.1	3	3	Brenna	DS	CH	FM			4.08	0.85
Brenna, DS, Far 09-27MU, 4, 1, FM	Far 09-27MU	65.0	838.1	4	1	Brenna	DS	CH	FM			1.01	0.30
Brenna, DS, Far 09-27MU, 4, 2, FM	Far 09-27MU	65.0	838.1	4	2	Brenna	DS	CH	FM			2.00	0.56
Brenna, DS, Far 09-27MU, 4, 3, FM	Far 09-27MU	65.0	838.1	4	3	Brenna	DS	CH	FM			4.08	1.11
Brenna, DS, Moor 09-34MU, 3, 1, FM	Moor 09-34MU	29.0	878.9	3	1	Brenna	DS	CH	FM			1.01	0.31
Brenna, DS, Moor 09-34MU, 3, 2, FM	Moor 09-34MU	29.0	878.9	3	2	Brenna	DS	CH	FM			2.00	0.41
Brenna, DS, Moor 09-34MU, 3, 3, FM	Moor 09-34MU	29.0	878.9	3	3	Brenna	DS	CH	FM			4.08	0.85
Brenna, DS, Far 09-60MU, 3, 1, FM	Far 09-60MU	36.0	847.3	3	1	Brenna	DS	CH	FM			1.01	0.29
Brenna, DS, Far 09-60MU, 3, 2, FM	Far 09-60MU	36.0	847.3	3	2	Brenna	DS	CH	FM			2.00	0.40
Brenna, DS, Far 09-60MU, 3, 3, FM	Far 09-60MU	36.0	847.3	3	3	Brenna	DS	CH	FM			4.08	0.82
Brenna, DS, Far 10-80MU, 2, 1, FM	Far 10-80MU	36.0	0.0	2	1	Brenna	DS	CH	FM			1.00	0.45
Brenna, DS, Far 10-80MU, 2, 2, FM	Far 10-80MU	36.0	0.0	2	2	Brenna	DS	CH	FM			2.00	0.71
Brenna, DS, Far 10-80MU, 2, 3, FM	Far 10-80MU	36.0	0.0	2	3	Brenna	DS	CH	FM			4.00	1.48
Brenna, R-bar, 01-5MU, 2, 1, FRW	01-5MU	49.0	852.7	2	1	Brenna	R-bar	CH	FRW	0.95	0.25		
Brenna, R-bar, 01-5MU, 2, 2, FRW	01-5MU	49.0	852.7	2	2	Brenna	R-bar	CH	FRW	1.34	0.29		
Brenna, R-bar, 01-5MU, 2, 3, FRW	01-5MU	49.0	852.7	2	3	Brenna	R-bar	CH	FRW	2.57	0.46		
Brenna, R-bar, 01-12MU, 2, 1, FRW	01-12MU	31.0	853.0	2	1	Brenna	R-bar	CH	FRW	0.93	0.22		
Brenna, R-bar, 01-12MU, 2, 2, FRW	01-12MU	31.0	853.0	2	2	Brenna	R-bar	CH	FRW	1.61	0.36		
Brenna, R-bar, 01-12MU, 2, 3, FRW	01-12MU	31.0	853.0	2	3	Brenna	R-bar	CH	FRW	2.75	0.69		
Brenna, DS, 06-18MU, 2, 1, FRW	06-18MU	52.0	837.7	2	1	Brenna	DS	CH	FRW			1.00	0.31
Brenna, DS, 06-18MU, 2, 2, FRW	06-18MU	52.0	837.7	2	2	Brenna	DS	CH	FRW			2.00	0.52
Brenna, DS, 06-18MU, 2, 3, FRW	06-18MU	52.0	837.7	2	3	Brenna	DS	CH	FRW			4.00	0.61
Brenna, R-bar, 99-1M, 5, 2, Oakport	99-1M	35.0	0.0	5	2	Brenna	R-bar	CH	Oakport	0.61	0.20		
Brenna, R-bar, 99-1M, 5, 3, Oakport	99-1M	35.0	0.0	5	3	Brenna	R-bar	CH	Oakport	0.97	0.33		
Oakport, Brenna, R-bar, 99-1M, 5, 3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Brenna, R-bar, 84-1M, 3, 1, WF	84-1M	19.0	877.1	3	1	Brenna	R-bar	MH	WF	0.80	0.18		
Brenna, R-bar, 84-1M, 3, 2, WF	84-1M	19.0	877.1	3	2	Brenna	R-bar	MH	WF	1.35	0.26		

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Brenna Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate		DS, Ultimate	
										σ_{ff}' (tsf)	τ_{ff} (tsf)	σ_{ff}' (tsf)	τ_{ff} (tsf)
Brenna, R-bar, 84-1M, 3, 3, WF	84-1M	19.0	877.1	3	3	Brenna	R-bar	MH	WF	2.43	0.40		
Brenna, R-bar, 84-1M, 4, 1, WF	84-1M	29.0	867.1	4	1	Brenna	R-bar	CH	WF	0.94	0.25		
Brenna, R-bar, 84-1M, 4, 2, WF	84-1M	29.0	867.1	4	2	Brenna	R-bar	CH	WF	1.36	0.24		
Brenna, R-bar, 84-1M, 4, 3, WF	84-1M	29.0	867.1	4	3	Brenna	R-bar	CH	WF	2.23	0.48		
Brenna, R-bar, 84-2M, 3, 1, WF	84-2M	21.0	883.6	3	1	Brenna	R-bar	CH	WF	0.78	0.27		
Brenna, R-bar, 84-2M, 3, 2, WF	84-2M	21.0	883.6	3	2	Brenna	R-bar	CH	WF	1.52	0.37		
Brenna, R-bar, 84-2M, 3, 3, WF	84-2M	21.0	883.6	3	3	Brenna	R-bar	CH	WF	2.76	0.63		
Brenna, R-bar, 85-4M, 3, 1, WF	85-4M	25.0	888.2	3	1	Brenna	R-bar	CH	WF	0.51	0.21		
Brenna, R-bar, 85-4M, 3, 2, WF	85-4M	25.0	888.2	3	2	Brenna	R-bar	CH	WF	0.77	0.28		
Brenna, R-bar, 85-4M, 3, 3, WF	85-4M	25.0	888.2	3	3	Brenna	R-bar	CH	WF	1.54	0.41		
Brenna, R-bar, 85-4M, 4, 1, WF	85-4M	30.8	882.4	4	1	Brenna	R-bar	CH	WF	0.81	0.28		
Brenna, R-bar, 85-4M, 4, 2, WF	85-4M	30.8	882.4	4	2	Brenna	R-bar	CH	WF	1.43	0.34		
Brenna, R-bar, 85-4M, 4, 3, WF	85-4M	30.8	882.4	4	3	Brenna	R-bar	CH	WF	2.04	0.69		
Brenna, R-bar, 85-4M, 6, 1, WF	85-4M	48.0	865.2	6	1	Brenna	R-bar	CH	WF	0.89	0.30		
Brenna, R-bar, 85-4M, 6, 2, WF	85-4M	48.0	865.2	6	2	Brenna	R-bar	CH	WF	1.43	0.42		
Brenna, R-bar, 85-4M, 6, 3, WF	85-4M	48.0	865.2	6	3	Brenna	R-bar	CH	WF	2.07	0.83		
Brenna, R-bar, 85-4M, 6, 4, WF	85-4M	48.0	865.2	6	4	Brenna	R-bar	CH	WF	0.52	0.18		
Brenna, R-bar, 85-6M, 2, 1, WF	85-6M	18.0	884.2	2	1	Brenna	R-bar	CH	WF	1.00	0.18		
Brenna, R-bar, 85-6M, 2, 2, WF	85-6M	18.0	884.2	2	2	Brenna	R-bar	CH	WF	1.05	0.32		
Brenna, R-bar, 85-6M, 2, 3, WF	85-6M	18.0	884.2	2	3	Brenna	R-bar	CH	WF	1.72	0.40		
Brenna, R-bar, 85-6M, 3, 1, WF	85-6M	31.0	871.2	3	1	Brenna	R-bar	CH	WF	0.96	0.26		
Brenna, R-bar, 85-6M, 3, 2, WF	85-6M	31.0	871.2	3	2	Brenna	R-bar	CH	WF	1.52	0.38		
Brenna, R-bar, 85-6M, 3, 3, WF	85-6M	31.0	871.2	3	3	Brenna	R-bar	CH	WF	2.33	0.40		
Brenna, R-bar, 85-7M, 3, 1, WF	85-7M	22.0	879.6	3	1	Brenna	R-bar	CH	WF	0.51	0.20		
Brenna, R-bar, 85-7M, 3, 2, WF	85-7M	22.0	879.6	3	2	Brenna	R-bar	CH	WF	0.85	0.30		
Brenna, R-bar, 85-7M, 3, 3, WF	85-7M	22.0	879.6	3	3	Brenna	R-bar	CH	WF	1.20	0.31		
Brenna, R-bar, 85-10M, 1, 1, WF	85-10M	16.0	880.1	1	1	Brenna	R-bar	CH	WF	0.51	0.16		
Brenna, R-bar, 85-10M, 1, 2, WF	85-10M	16.0	880.1	1	2	Brenna	R-bar	CH	WF	0.79	0.21		
Brenna, R-bar, 85-10M, 1, 3, WF	85-10M	16.0	880.1	1	3	Brenna	R-bar	CH	WF	1.48	0.35		
Brenna, R-bar, 85-10M, 3, 1, WF	85-10M	26.0	870.1	3	1	Brenna	R-bar	CH	WF	0.46	0.16		
Brenna, R-bar, 85-10M, 3, 2, WF	85-10M	26.0	870.1	3	2	Brenna	R-bar	CH	WF	0.72	0.18		
Brenna, R-bar, 85-10M, 3, 3, WF	85-10M	26.0	870.1	3	3	Brenna	R-bar	CH	WF	1.20	0.31		
Brenna, R-bar, 85-10M, 4, 1, WF	85-10M	37.0	859.1	4	1	Brenna	R-bar	CH	WF	0.87	0.27		
Brenna, R-bar, 85-10M, 4, 2, WF	85-10M	37.0	859.1	4	2	Brenna	R-bar	CH	WF	1.38	0.31		
Brenna, R-bar, 85-10M, 4, 3, WF	85-10M	37.0	859.1	4	3	Brenna	R-bar	CH	WF	2.40	0.65		
Brenna, R-bar, 85-11M, 4, 1, WF	85-11M	31.0	868.5	4	1	Brenna	R-bar	CH	WF	0.97	0.20		
Brenna, R-bar, 85-11M, 4, 2, WF	85-11M	31.0	868.5	4	2	Brenna	R-bar	CH	WF	1.67	0.38		
Brenna, R-bar, 85-11M, 4, 3, WF	85-11M	31.0	868.5	4	3	Brenna	R-bar	CH	WF	2.62	0.46		
Brenna, R-bar, 85-12M, 4, 1, WF	85-12M	26.0	871.3	4	1	Brenna	R-bar	CH	WF	0.59	0.18		
Brenna, R-bar, 85-12M, 4, 2, WF	85-12M	26.0	871.3	4	2	Brenna	R-bar	CH	WF	0.86	0.27		

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Brenna Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate		DS, Ultimate	
										σ_{ff}' (tsf)	τ_{ff} (tsf)	σ_{ff}' (tsf)	τ_{ff} (tsf)
Brenna, R-bar, 85-12M, 4, 3, WF	85-12M	26.0	871.3	4	3	Brenna	R-bar	CH	WF	1.48	0.45		
Brenna, R-bar, 86-6M, 6, 1, WF	86-6M	14.1	888.1	6	1	Brenna	R-bar	CH	WF	1.13	0.29		
Brenna, R-bar, 86-6M, 6, 2, WF	86-6M	14.1	888.1	6	2	Brenna	R-bar	CH	WF	1.86	0.45		
Brenna, R-bar, 86-6M, 6, 3, WF	86-6M	14.1	888.1	6	3	Brenna	R-bar	CH	WF	3.45	0.75		
Brenna, R-bar, 86-6M, 7, 1, WF	86-6M	26.1	876.1	7	1	Brenna	R-bar	CH	WF	1.08	0.38		
Brenna, R-bar, 86-6M, 7, 2, WF	86-6M	26.1	876.1	7	2	Brenna	R-bar	CH	WF	1.80	0.52		
Brenna, R-bar, 86-6M, 7, 3, WF	86-6M	26.1	876.1	7	3	Brenna	R-bar	CH	WF	3.21	0.50		
Brenna, R-bar, 86-9M, 2, 1, WF	86-9M	30.1	866.0	2	1	Brenna	R-bar	CH	WF	0.69	0.25		
Brenna, R-bar, 86-9M, 2, 2, WF	86-9M	30.1	866.0	2	2	Brenna	R-bar	CH	WF	1.41	0.38		
Brenna, R-bar, 86-9M, 2, 3, WF	86-9M	30.1	866.0	2	3	Brenna	R-bar	CH	WF	2.61	0.41		
Brenna, R-bar, 86-29M, 5, 1, WF	86-29M	39.1	864.9	5	1	Brenna	R-bar	CH	WF	0.89	0.27		
Brenna, R-bar, 86-29M, 5, 2, WF	86-29M	39.1	864.9	5	2	Brenna	R-bar	CH	WF	1.34	0.38		
Brenna, R-bar, 86-29M, 5, 3, WF	86-29M	39.1	864.9	5	3	Brenna	R-bar	CH	WF	2.63	0.50		
Brenna, R-bar, 86-31M, 3, 1, WF	86-31M	31.1	862.2	3	1	Brenna	R-bar	CH	WF	0.72	0.24		
Brenna, R-bar, 86-31M, 3, 2, WF	86-31M	31.1	862.2	3	2	Brenna	R-bar	CH	WF	1.44	0.34		
Brenna, R-bar, 86-31M, 3, 3, WF	86-31M	31.1	862.2	3	3	Brenna	R-bar	CH	WF	1.95	0.62		
Brenna, R-bar, 86-31M, 4, 1, WF	86-31M	41.1	852.2	4	1	Brenna	R-bar	CH	WF	0.82	0.24		
Brenna, R-bar, 86-31M, 4, 2, WF	86-31M	41.1	852.2	4	2	Brenna	R-bar	CH	WF	1.33	0.22		
Brenna, R-bar, 86-31M, 4, 3, WF	86-31M	41.1	852.2	4	3	Brenna	R-bar	CH	WF	2.04	0.44		
Brenna, R-bar, 86-32M, 2, 1, WF	86-32M	21.1	866.7	2	1	Brenna	R-bar	CH	WF	0.67	0.16		
Brenna, R-bar, 86-32M, 2, 2, WF	86-32M	21.1	866.7	2	2	Brenna	R-bar	CH	WF	0.93	0.32		
Brenna, R-bar, 86-32M, 2, 3, WF	86-32M	21.1	866.7	2	3	Brenna	R-bar	CH	WF	2.02	0.55		

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Argusville Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate		DS, Ultimate	
										σ_{ff}' (tsf)	τ_{ff} (tsf)	σ_{ff}' (tsf)	τ_{ff} (tsf)
Argusville, R-bar, Far 10-79MU, 2, 1, FM	Far 10-79MU	41.0	0.0	2	1	Argusville	R-bar	CH	FM	0.81	0.43		
Argusville, R-bar, Far 10-79MU, 2, 2, FM	Far 10-79MU	41.0	0.0	2	2	Argusville	R-bar	CH	FM	1.26	0.54		
Argusville, R-bar, Far 10-79MU, 2, 3, FM	Far 10-79MU	41.0	0.0	2	3	Argusville	R-bar	CH	FM	1.70	0.69		
Argusville, R-bar, Far 10-80MU, 3, 1, FM	Far 10-80MU	56.0	0.0	3	1	Argusville	R-bar	CH	FM	0.94	0.30		
Argusville, R-bar, Far 10-80MU, 3, 2, FM	Far 10-80MU	56.0	0.0	3	2	Argusville	R-bar	CH	FM	1.48	0.34		
Argusville, R-bar, Far 10-80MU, 3, 3, FM	Far 10-80MU	56.0	0.0	3	3	Argusville	R-bar	CH	FM	2.70	0.48		
Argusville, DS, Moor 09-14MU, 4, 1, FM	Moor 09-14MU	59.0	854.1	4	1	Argusville	DS	CH	FM			1.01	0.51
Argusville, DS, Moor 09-14MU, 4, 2, FM	Moor 09-14MU	59.0	854.1	4	2	Argusville	DS	CH	FM			1.93	0.84
Argusville, DS, Moor 09-14MU, 4, 3, FM	Moor 09-14MU	59.0	854.1	4	3	Argusville	DS	CH	FM			4.08	1.29
Argusville, DS, Far 09-25MU, 5, 1, FM	Far 09-25MU	67.0	826.4	5	1	Argusville	DS	CH	FM			1.01	0.33
Argusville, DS, Far 09-25MU, 5, 2, FM	Far 09-25MU	67.0	826.4	5	2	Argusville	DS	CH	FM			2.00	0.57
Argusville, DS, Far 09-25MU, 5, 3, FM	Far 09-25MU	67.0	826.4	5	3	Argusville	DS	CH	FM			4.08	0.88
Argusville, DS, Moor 09-34MU, 4, 1, FM	Moor 09-34MU	57.0	850.9	4	1	Argusville	DS	CH	FM			1.01	0.44
Argusville, DS, Moor 09-34MU, 4, 2, FM	Moor 09-34MU	57.0	850.9	4	2	Argusville	DS	CH	FM			2.00	0.72
Argusville, DS, Moor 09-34MU, 4, 3, FM	Moor 09-34MU	57.0	850.9	4	3	Argusville	DS	CH	FM			4.08	1.04
Argusville, DS, Moor 09-53MU, 3, 1, FM	Moor 09-53MU	69.0	831.5	3	1	Argusville	DS	CH	FM			1.01	0.35
Argusville, DS, Moor 09-53MU, 3, 2, FM	Moor 09-53MU	69.0	831.5	3	2	Argusville	DS	CH	FM			2.00	0.58
Argusville, DS, Moor 09-53MU, 3, 3, FM	Moor 09-53MU	69.0	831.5	3	3	Argusville	DS	CH	FM			4.08	1.15
Argusville, DS, Far 10-78MU, 3, 1, FM	Far 10-78MU	56.0	0.0	3	1	Argusville	DS	CH	FM			1.00	0.51
Argusville, DS, Far 10-78MU, 3, 2, FM	Far 10-78MU	56.0	0.0	3	2	Argusville	DS	CH	FM			2.00	0.93
Argusville, DS, Far 10-78MU, 3, 3, FM	Far 10-78MU	56.0	0.0	3	3	Argusville	DS	CH	FM			4.00	1.60
Argusville, R-bar, 01-5MU, 4, 1, FRW	01-5MU	78.0	823.7	4	1	Argusville	R-bar	CH	FRW	1.22	0.29		
Argusville, R-bar, 01-5MU, 4, 2, FRW	01-5MU	78.0	823.7	4	2	Argusville	R-bar	CH	FRW	2.49	0.46		
Argusville, R-bar, 01-5MU, 4, 3, FRW	01-5MU	78.0	823.7	4	3	Argusville	R-bar	CH	FRW	4.80	0.69		
Argusville, R-bar, 01-12MU, 3, 1, FRW	01-12MU	64.0	820.0	3	1	Argusville	R-bar	CH	FRW	0.98	0.25		
Argusville, R-bar, 01-12MU, 3, 2, FRW	01-12MU	64.0	820.0	3	2	Argusville	R-bar	CH	FRW	1.56	0.71		
Argusville, R-bar, 01-12MU, 3, 3, FRW	01-12MU	64.0	820.0	3	3	Argusville	R-bar	CH	FRW	3.59	0.84		
Argusville, DS, 06-16MU, 2, 1, FRW	06-16MU	46.0	832.6	2	1	Argusville	DS	CH	FRW			1.00	0.28
Argusville, DS, 06-16MU, 2, 2, FRW	06-16MU	46.0	832.6	2	2	Argusville	DS	CH	FRW			2.00	0.53
Argusville, DS, 06-16MU, 2, 3, FRW	06-16MU	46.0	832.6	2	3	Argusville	DS	CH	FRW			4.00	0.64
Argusville, DS, 06-16MU, 3, 1, FRW	06-16MU	57.0	821.6	3	1	Argusville	DS	CH	FRW			1.00	0.38
Argusville, DS, 06-16MU, 3, 2, FRW	06-16MU	57.0	821.6	3	2	Argusville	DS	CH	FRW			2.00	0.60
Argusville, DS, 06-16MU, 3, 3, FRW	06-16MU	57.0	821.6	3	3	Argusville	DS	CH	FRW			4.00	0.97
Argusville, DS, 06-18MU, 3, 1, FRW	06-18MU	73.0	816.7	3	1	Argusville	DS	CH	FRW			1.00	0.36
Argusville, DS, 06-18MU, 3, 2, FRW	06-18MU	73.0	816.7	3	2	Argusville	DS	CH	FRW			2.00	0.63
Argusville, DS, 06-18MU, 3, 3, FRW	06-18MU	73.0	816.7	3	3	Argusville	DS	CH	FRW			4.00	1.11

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Argusville Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate		DS, Ultimate	
										σ_{ff}' (tsf)	τ_{ff} (tsf)	σ_{ff}' (tsf)	τ_{ff} (tsf)
Argusville, R-bar, 84-2M, 6, 1, WF	84-2M	61.0	843.6	6	1	Argusville	R-bar	CH	WF	0.86	0.31		
Argusville, R-bar, 84-2M, 6, 2, WF	84-2M	61.0	843.6	6	2	Argusville	R-bar	CH	WF	1.15	0.44		
Argusville, R-bar, 84-2M, 6, 3, WF	84-2M	61.0	843.6	6	3	Argusville	R-bar	CH	WF	1.96	0.63		
Argusville, R-bar, 85-6M, 4, 1, WF	85-6M	44.0	858.2	4	1	Argusville	R-bar	CH	WF	0.84	0.23		
Argusville, R-bar, 85-6M, 4, 2, WF	85-6M	44.0	858.2	4	2	Argusville	R-bar	CH	WF	1.43	0.38		
Argusville, R-bar, 85-6M, 4, 3, WF	85-6M	44.0	858.2	4	3	Argusville	R-bar	CH	WF	2.25	0.52		
Argusville, R-bar, 85-6M, 5, 1, WF	85-6M	54.0	848.2	5	1	Argusville	R-bar	CH	WF	0.91	0.33		
Argusville, R-bar, 85-6M, 5, 2, WF	85-6M	54.0	848.2	5	2	Argusville	R-bar	CH	WF	1.35	0.46		
Argusville, R-bar, 85-6M, 5, 3, WF	85-6M	54.0	848.2	5	3	Argusville	R-bar	CH	WF	4.11	0.58		
Argusville, R-bar, 85-7M, 5, 1, WF	85-7M	46.0	855.6	5	1	Argusville	R-bar	CH	WF	0.82	0.34		
Argusville, R-bar, 85-7M, 5, 2, WF	85-7M	46.0	855.6	5	2	Argusville	R-bar	CH	WF	1.09	0.47		
Argusville, R-bar, 85-7M, 5, 3, WF	85-7M	46.0	855.6	5	3	Argusville	R-bar	CH	WF	1.94	0.73		
Argusville, R-bar, 85-12M, 7, 1, WF	85-12M	49.0	848.3	7	1	Argusville	R-bar	CH	WF	0.80	0.23		
Argusville, R-bar, 85-12M, 7, 2, WF	85-12M	49.0	848.3	7	2	Argusville	R-bar	CH	WF	1.21	0.29		
Argusville, R-bar, 85-12M, 7, 3, WF	85-12M	49.0	848.3	7	3	Argusville	R-bar	CH	WF	2.68	0.56		
Argusville, R-bar, 84-3M, 6, 1, WF	84-3M	63.0	839.2	6	1	Argusville	R-bar	CH	WF	0.89	0.29		
Argusville, R-bar, 84-3M, 6, 2, WF	84-3M	63.0	839.2	6	2	Argusville	R-bar	CH	WF	1.34	0.36		
Argusville, R-bar, 84-3M, 6, 3, WF	84-3M	63.0	839.2	6	3	Argusville	R-bar	CH	WF	1.82	0.55		
B/A Trans, R-bar, Moor 09-25MU, 5, 1, FM	Moor 09-25MU	69.0	829.7	5	1	B/A Trans	R-bar	CH	FM	0.80	0.26		
B/A Trans, R-bar, Moor 09-25MU, 5, 2, FM	Moor 09-25MU	69.0	829.7	5	2	B/A Trans	R-bar	CH	FM	1.49	0.41		
B/A Trans, R-bar, Moor 09-25MU, 5, 3, FM	Moor 09-25MU	69.0	829.7	5	3	B/A Trans	R-bar	CH	FM	2.18	0.61		
B/A Trans, R-bar, Far 09-27MU, 4, 1, FM	Far 09-27MU	65.0	838.1	4	1	B/A Trans	R-bar	CH	FM	0.83	0.37		
B/A Trans, R-bar, Far 09-27MU, 4, 2, FM	Far 09-27MU	65.0	838.1	4	2	B/A Trans	R-bar	CH	FM	1.16	0.51		
B/A Trans, R-bar, Far 09-27MU, 4, 3, FM	Far 09-27MU	65.0	838.1	4	3	B/A Trans	R-bar	CH	FM	1.91	0.74		
B/A Trans, DS, Far 09-59MU, 3, 1, FM	Far 09-59MU	36.0	880.2	3	1	B/A Trans	DS	CH	FM			1.01	0.45
B/A Trans, DS, Far 09-59MU, 3, 2, FM	Far 09-59MU	36.0	880.2	3	2	B/A Trans	DS	CH	FM			2.00	0.85
B/A Trans, DS, Far 09-59MU, 3, 3, FM	Far 09-59MU	36.0	880.2	3	3	B/A Trans	DS	CH	FM			4.08	1.63

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Unit "A" Till Formation Effective Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: 4/20/2010 Date: 10/29/2010

Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	FORMATION	TEST	USCS SOIL TYPE	PROJECT	R-bar, Ultimate		DS, Ultimate	
										σ_{ff}' (tsf)	τ_{ff} (tsf)	σ_{ff}' (tsf)	τ_{ff} (tsf)
Unit "A" Till, R-bar, Far 10-78MU, 4, 1, FM	Far 10-78MU	70.6	0.0	4	1	Unit "A" Till	R-bar	SC	FM	5.86	4.15		
Unit "A" Till, R-bar, Far 10-78MU, 4, 2, FM	Far 10-78MU	70.6	0.0	4	2	Unit "A" Till	R-bar	SC	FM	5.26	3.39		

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study

Subject: Residual Direct Shear Strength Data from Borings

Compiled By: KAH Revised By: KAH

Date: 2 DEC 09 Date: 10/29/2010

																Residual Stress Values					
Project, Formation, Test, Boring, Sample No., Specimen No.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	LL (%)	MC (%)	PL (%)	PI (%)	LI	G_S	e	γ_d (pcf)	γ_m (pcf)	γ_{sat} (pcf)	σ'_{ff} (tsf)	τ_{ff} (tsf)	USCS SOIL TYPE	TEST	FORMATION	PROJECT
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	45	44	46	47	48	49
Alluvium, Res DS, Far 09-25MU, 1, 1, FM	Far 09-25MU	15.0	878.4	1	1		31.6				2.75	0.95	88.2	116.1	118.5	1.511	0.550	CH	Res DS	Alluvium	FM
Alluvium, Res DS, Far 09-27MU, 1, 1, FM	Far 09-27MU	7.0	896.1	1	1	75	29.7	18	57	0.21	2.71	0.85	91.6	118.8	120.2	1.511	0.277	CH	Res DS	Alluvium	FM
Sherack, Res DS, Far 09-26MU, 1, 1, FM	Far 09-26MU	9.0	894.5	1	1		34.8				2.74	0.98	86.3	116.3	117.2	1.511	0.339	CH	Res DS	Sherack	FM
Sherack, Res DS, Moor 09-34MU, 1, 1, FM	Moor 09-34MU	9.0	898.9	1	1		40.5				2.75	1.17	79.2	111.3	112.8	1.511	0.339	CH	Res DS	Sherack	FM
Sherack, Res DS, Moor 09-53MU, 1, 1, FM	Moor 09-53MU	19.0	881.5	1	1	55	40.3	21	34	0.57	2.75	1.13	80.4	112.8	113.6	1.511	0.726	CH	Res DS	Sherack	FM
Sherack, Res DS, 01-12MU, 1, 1, FRW	01-12MU	19.0	865.0	1	1	53	97.2	21	32	2.38	2.68	0.72	97.2	191.7	123.3	2.000	0.850	CH	Res DS	Sherack	FRW
PL Sherack, Res DS, 01-05MU, 1, 1, FRW	01-05MU	16.0	885.7	1	1	78	35.5	28	50	0.15	2.71	1.04	82.9	112.3	114.7	2.000	0.240	CH	Res DS	PL Sherack	FRW
OX Brenna, Res DS, Moor 09-34MU, 2, 1, FM	Moor 09-34MU	15.0	883.0	2	1	114	62.5	24	90	0.43	2.70	1.69	62.7	101.9	101.9	2.000	0.195	CH	Res DS	OX Brenna	FM
	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Poplar River, Res DS, 01-10MU, 1, 1, FRW	01-10MU	21.0	860.0	1	1	61	30.3	24	37	0.17	2.73	0.85	92.3	120.3	120.8	2.000	0.900	CH	Res DS	Poplar River	FRW
Brenna, Res DS, Far 09-25MU, 4, 1, FM	Far 09-25MU	51.0	842.4	4	1	108	57.7	22	86	0.42	2.75	1.60	66.0	104.1	104.4	2.000	0.355	CH	Res DS	Brenna	FM
Brenna, Res DS, Far 09-26MU, 3, 1, FM	Far 09-26MU	29.0	874.5	3	1	110	52.1	24	86	0.33	2.75	1.45	70.0	106.5	106.9	1.511	0.303	CH	Res DS	Brenna	FM
Brenna, Res DS, Far 09-26MU, 3, 2, FM	Far 09-26MU	29.0	874.5	3	2	110	52.2	24	86	0.33	2.75	1.44	70.3	107.0	107.1	1.511	0.276	CH	Res DS	Brenna	FM
Brenna, Res DS, Far 09-27MU, 3, 1, FM	Far 09-27MU	33.0	870.1	3	1	117	65.0	25	92	0.43	2.75	1.83	60.7	100.2	101.0	2.000	0.301	CH	Res DS	Brenna	FM
Brenna, Res DS, 01-12MU, 2, 1, FRW	01-12MU	31.0	853.0	2	1	118	67.7	33	85	0.41	2.74	1.92	58.5	98.1	99.6	2.000	0.290	CH	Res DS	Brenna	FRW
B/A Trans, Res DS, Far 09-27MU, 4, 1, FM	Far 09-27MU	65.0	838.1	4	1	111	52.2	25	86	0.32	2.70	1.43	69.5	105.8	106.2	2.000	0.378	CH	Res DS	B/A Trans	FM
B/A Trans, Res DS, Far 09-27MU, 4, 2, FM	Far 09-27MU	66.0	837.1	4	2	111	49.8	25	86	0.29	2.70	1.35	71.9	107.7	107.7	2.000	0.463	CH	Res DS	B/A Trans	FM
Argusville, Res DS, Far 09-25MU, 5, 1, FM	Far 09-25MU	67.0	826.4	5	1	81	52.1	20	61	0.53	2.71	1.41	70.2	106.8	106.7	2.000	0.400	CH	Res DS	Argusville	FM
Argusville, Res DS, Moor 09-34MU, 4, 1, FM	Moor 09-34MU	57.0	841.0	4	1	79	48.5	21	58	0.47	2.75	1.37	72.6	107.8	108.6	2.000	0.500	CH	Res DS	Argusville	FM
Argusville, Res DS, 01-05MU, 4, 1, FRW	01-05MU	78.0	823.7	4	1	99	58.1	28	71	0.42	2.77	1.66	64.9	102.6	103.9	2.000	0.320	CH	Res DS	Argusville	FRW

St. Paul District GEOLOGY GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Undrained Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: OCT 09 Date: 10/29/2010

							Q Strengths								
							Ultimate Stress Values				Peak Stress Values				
TEST NO.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	σ_c' (tsf)	σ_d (tsf)	q (tsf)	q (psf)	p (tsf)	σ_d (tsf)	q (tsf)	q (psf)	p (tsf)	FORMATION
1	2	3	4	5	6	17	38	39		40	41	42		43	48
Alluvium, UU, Far 10-79MU, 1, 1, FM	Far 10-79MU	21.0		1	1	1.0	2.16	1.08	2160	2.08	2.21	1.11	2210	2.11	Alluvium
Alluvium, UU, Far 10-79MU, 1, 2, FM	Far 10-79MU	21.0		1	2	2.0	2.45	1.23	2450	3.23	2.45	1.23	2450	3.23	Alluvium
Alluvium, UU, Far 10-79MU, 1, 3, FM	Far 10-79MU	21.0		1	3	4.0	2.72	1.36	2720	5.36	2.73	1.37	2730	5.37	Alluvium
Alluvium, UU, Far 10-80MU, 1, 1, FM	Far 10-80MU	24.0		1	1	1.0	1.03	0.52	1030	1.52	1.09	0.55	1090	1.55	Alluvium
Alluvium, UU, Far 10-80MU, 1, 2, FM	Far 10-80MU	24.0		1	2	2.0	1.40	0.70	1400	2.70	1.47	0.74	1470	2.74	Alluvium
Alluvium, UU, Far 10-80MU, 1, 3, FM	Far 10-80MU	24.0		1	3	4.0	1.67	0.84	1670	4.84	1.85	0.93	1850	4.93	Alluvium
Sherack, UU, Far 09-23MU, 2, 1, FM	Far 09-23MU	11.0	886.0	2	1	0.5	0.95	0.48	950	0.98	1.22	0.61	1220	1.11	Sherack
Sherack, UU, Far 09-23MU, 2, 2, FM	Far 09-23MU	11.0	886.0	2	2	1.0	1.04	0.52	1040	1.52	1.27	0.64	1270	1.64	Sherack
Sherack, UU, Far 09-23MU, 2, 3, FM	Far 09-23MU	11.0	886.0	2	3	2.0	0.49	0.25	490	2.25	1.61	0.81	1610	2.81	Sherack
Sherack, UU, Moor 09-25MU, 1, 1, FM	Moor 09-25MU	9.0	889.7	1	1	0.5	0.99	0.50	990	1.00	1.53	0.77	1530	1.27	Sherack
Sherack, UU, Moor 09-25MU, 1, 2, FM	Moor 09-25MU	9.0	889.7	1	2	1.0	0.60	0.30	600	1.30	1.70	0.85	1700	1.85	Sherack
Sherack, UU, Moor 09-25MU, 1, 3, FM	Moor 09-25MU	9.0	889.7	1	3	2.0	1.66	0.83	1660	2.83	2.12	1.06	2120	3.06	Sherack
Sherack, UU, 01-4MU, 1, 1, FRW	01-4MU	18.0	881.2	1	1	1.0	1.84	0.92	1840	1.92	1.99	1.00	1990	2.00	Sherack
Sherack, UU, 01-4MU, 2, 2, FRW	01-4MU	18.0	881.2	2	2	2.0	2.53	1.27	2530	3.27	2.53	1.27	2530	3.27	Sherack
Sherack, UU, 01-4MU, 3, 3, FRW	01-4MU	18.0	881.2	3	3	4.0	3.19	1.60	3190	5.60	3.19	1.60	3190	5.60	Sherack
Sherack, UU, 84-1M, 1, 1, WF	84-1M	5.7	890.4	1	1	1.0	0.87	0.44	873	1.44	1.09	0.55	1090	1.55	Sherack
Sherack, UU, 84-1M, 1, 2, WF	84-1M	5.7	890.4	1	2	2.0	1.29	0.65	1290	2.65	1.32	0.66	1320	2.66	Sherack
Sherack, UU, 84-1M, 1, 3, WF	84-1M	5.7	890.4	1	3	4.0	0.16	0.08	156	4.08	1.40	0.70	1400	4.70	Sherack
Sherack, UU, 85-12M, 1, 1, WF	85-12M	6.0	891.3	1	1	0.5	4.01	2.01	4010	2.51	7.05	3.53	7050	4.03	Sherack
Sherack, UU, 85-12M, 1, 2, WF	85-12M	6.0	891.3	1	2	1.0	5.36	2.68	5360	3.68	7.29	3.65	7290	4.65	Sherack
Sherack, UU, 85-12M, 1, 3, WF	85-12M	6.0	891.3	1	3	2.0	8.55	4.28	8550	6.28	8.69	4.35	8690	6.35	Sherack
Sherack, UU, 99-1M, 1, 1, Oakport	99-1M	7.3		1	1	0.3	1.10	0.55	1100	0.80	1.53	0.77	1530	1.02	Sherack
Sherack, UU, 99-1M, 1, 2, Oakport	99-1M	7.3		1	2	0.5	1.30	0.65	1300	1.15	1.67	0.84	1670	1.34	Sherack
Sherack, UU, 99-1M, 1, 3, Oakport	99-1M	7.3		1	3	1.0	1.22	0.61	1220	1.61	2.49	1.25	2490	2.25	Sherack
????, UU, SB-1, , 1, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
????, UU, SB-1, , 2, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
????, UU, SB-1, , 3, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
????, UU, SB-11, , 1, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
????, UU, SB-11, , 2, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
????, UU, SB-11, , 3, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

St. Paul District GEOLOGY GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Undrained Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: OCT 09 Date: 10/29/2010

							Q Strengths								
							Ultimate Stress Values				Peak Stress Values				
TEST NO.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	σ_c' (tsf)	σ_d (tsf)	q (tsf)	q (psf)	p (tsf)	σ_d (tsf)	q (tsf)	q (psf)	p (tsf)	FORMATION
????, UU, SB-17, , 1, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
????, UU, SB-17, , 2, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
????, UU, SB-17, , 3, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
????, UU, SB-2, , 1, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
????, UU, SB-2, , 2, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
????, UU, SB-2, , 3, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
????, UU, ST-2, 2A, 1, SS-MP	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
????, UU, ST-7, 7A, 1, SS-MP	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
????, UU, ST-7, 7C, 1, SS-MP	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Poplar River, UU, 01-10MU, 1, 1, FRW	01-10MU	20.0	861.0	1	1	1.0	1.68	0.84	1680	1.84	1.70	0.85	1700	1.85	Poplar River
Poplar River, UU, 01-10MU, 1, 2, FRW	01-10MU	20.0	861.0	1	2	2.0	1.73	0.87	1730	2.87	1.79	0.90	1790	2.90	Poplar River
Poplar River, UU, 01-10MU, 1, 3, FRW	01-10MU	20.0	861.0	1	3	4.0	1.81	0.91	1810	4.91	1.88	0.94	1880	4.94	Poplar River
PR - WF, UU, Far 09-23MU, 3, 1, FM	Far 09-23MU	21.0	876.0	3	1	0.5	1.53	0.77	1530	1.26	1.86	0.93	1860	1.42	PR - WF
PR - WF, UU, Far 09-23MU, 3, 2, FM	Far 09-23MU	21.0	876.0	3	2	1.0	3.33	1.67	3330	2.70	3.52	1.76	3520	2.79	PR - WF
PR - WF, UU, Far 09-23MU, 3, 3, FM	Far 09-23MU	21.0	876.0	3	3	2.0	5.08	2.54	5080	4.53	5.14	2.57	5140	4.56	PR - WF
PR - WF, UU, Moor 09-25MU, 2, 1, FM	Moor 09-25MU	22.0	876.7	2	1	5.0	2.12	1.06	2120	6.06	2.48	1.24	2480	6.24	PR - WF
PR - WF, UU, Moor 09-25MU, 2, 2, FM	Moor 09-25MU	22.0	876.7	2	2	1.0	3.43	1.72	3430	2.72	3.98	1.99	3980	2.99	PR - WF
PR - WF, UU, Moor 09-25MU, 2, 3, FM	Moor 09-25MU	22.0	876.7	2	3	2.0	5.78	2.89	5780	4.89	6.30	3.15	6300	5.15	PR - WF
PR - Harwood, UU, Far 09-23MU, 4, 1, FM	Far 09-23MU	29.0	868.0	4	1	0.5	1.32	0.66	1320	1.16	1.47	0.74	1470	1.24	PR - Harwood
PR - Harwood, UU, Far 09-23MU, 4, 2, FM	Far 09-23MU	29.0	868.0	4	2	1.0	1.18	0.59	1180	1.59	1.43	0.72	1430	1.72	PR - Harwood
PR - Harwood, UU, Far 09-23MU, 4, 3, FM	Far 09-23MU	29.0	868.0	4	3	2.0	0.46	0.23	460	2.23	1.51	0.76	1510	2.76	PR - Harwood
PR - Harwood, UU, Moor 09-25MU, 3, 1, FM	Moor 09-25MU	26.0	872.7	3	1	0.5	1.36	0.68	1360	1.18	1.46	0.73	1460	1.23	PR - Harwood
PR - Harwood, UU, Moor 09-25MU, 3, 2, FM	Moor 09-25MU	26.0	872.7	3	2	1.0	1.42	0.71	1420	1.71	1.61	0.81	1610	1.81	PR - Harwood
PR - Harwood, UU, Moor 09-25MU, 3, 3, FM	Moor 09-25MU	26.0	872.7	3	3	2.0	1.70	0.85	1700	2.85	1.86	0.93	1860	2.93	PR - Harwood
OX Brenna, UU, Far 09-59MU, 1, 1, FM	Far 09-59MU	11.0	905.2	1	1	0.8	1.29	0.65	1290	1.40	1.35	0.68	1350	1.43	OX Brenna
OX Brenna, UU, Far 09-59MU, 1, 2, FM	Far 09-59MU	11.0	905.2	1	2	1.5	1.25	0.63	1250	2.13	1.37	0.69	1370	2.19	OX Brenna
OX Brenna, UU, Far 09-59MU, 1, 3, FM	Far 09-59MU	11.0	905.2	1	3	3.0	1.39	0.70	1390	3.70	1.47	0.74	1470	3.74	OX Brenna
OX Brenna, UU, Far 09-59MU, 2, 1, FM	Far 09-59MU	21.0	895.2	2	1	1.0	0.96	0.48	960	1.48	1.15	0.58	1150	1.58	OX Brenna
OX Brenna, UU, Far 09-59MU, 2, 2, FM	Far 09-59MU	21.0	895.2	2	2	2.0	0.99	0.50	990	2.50	1.19	0.60	1190	2.60	OX Brenna
OX Brenna, UU, Far 09-59MU, 2, 3, FM	Far 09-59MU	21.0	895.2	2	3	4.0	1.01	0.51	1010	4.51	1.05	0.53	1050	4.53	OX Brenna

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Undrained Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: OCT 09 Date: 10/29/2010

							Q Strengths								
							Ultimate Stress Values				Peak Stress Values				
TEST NO.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	σ_c' (tsf)	σ_d (tsf)	q (tsf)	q (psf)	p (tsf)	σ_d (tsf)	q (tsf)	q (psf)	p (tsf)	FORMATION
OX Brenna, UU, Far 09-60MU, 1, 1, FM	Far 09-60MU	16.0	867.3	1	1	0.8	0.72	0.36	720	1.11	0.86	0.43	860	1.18	OX Brenna
OX Brenna, UU, Far 09-60MU, 1, 2, FM	Far 09-60MU	16.0	867.3	1	2	1.5	0.80	0.40	800	1.90	0.98	0.49	980	1.99	OX Brenna
OX Brenna, UU, Far 09-60MU, 1, 3, FM	Far 09-60MU	16.0	867.3	1	3	3.0	0.80	0.40	800	3.40	1.06	0.53	1060	3.53	OX Brenna
OX Brenna, UU, Far 09-60MU, 2, 1, FM	Far 09-60MU	26.0	857.3	2	1	1.0	1.09	0.55	1090	1.55	1.19	0.60	1190	1.60	OX Brenna
OX Brenna, UU, Far 09-60MU, 2, 2, FM	Far 09-60MU	26.0	857.3	2	2	2.0	0.73	0.37	730	2.37	0.82	0.41	820	2.41	OX Brenna
OX Brenna, UU, Far 09-60MU, 2, 3, FM	Far 09-60MU	26.0	857.3	2	3	4.0	0.85	0.43	850	4.43	0.86	0.43	860	4.43	OX Brenna
OX Brenna, UU, 84-2M, 1, 1, WF	84-2M	10.8	893.8	1	1	1.0	1.08	0.54	1080	1.54	1.11	0.56	1110	1.56	OX Brenna
OX Brenna, UU, 84-2M, 1, 2, WF	84-2M	10.8	893.8	1	2	2.0	1.27	0.64	1270	2.64	1.27	0.64	1270	2.64	OX Brenna
OX Brenna, UU, 84-2M, 1, 3, WF	84-2M	10.8	893.8	1	3	4.0	1.10	0.55	1100	4.55	1.14	0.57	1140	4.57	OX Brenna
OX Brenna, UU, 85-4M, 1, 1, WF	85-4M	9.0	904.2	1	1	0.5	0.78	0.39	776	0.89	0.81	0.40	808	0.90	OX Brenna
OX Brenna, UU, 85-4M, 1, 2, WF	85-4M	9.0	904.2	1	2	1.0	0.91	0.45	906	1.45	0.93	0.46	929	1.46	OX Brenna
OX Brenna, UU, 85-4M, 1, 3, WF	85-4M	9.0	904.2	1	3	2.0	0.75	0.37	748	2.37	0.86	0.43	862	2.43	OX Brenna
OX Brenna, UU, 85-6M, 1, 1, WF	85-6M	8.0	894.2	1	1	0.5	0.70	0.35	701	0.85	0.72	0.36	718	0.86	OX Brenna
OX Brenna, UU, 85-6M, 1, 2, WF	85-6M	8.0	894.2	1	2	1.0	0.95	0.48	950	1.48	1.03	0.52	1030	1.52	OX Brenna
OX Brenna, UU, 85-6M, 1, 3, WF	85-6M	8.0	894.2	1	3	2.0	0.74	0.37	741	2.37	0.74	0.37	741	2.37	OX Brenna
OX Brenna, UU, 85-7M, 1, 1, WF	85-7M	5.9	895.7	1	1	0.5	1.16	0.58	1160	1.08	1.25	0.63	1250	1.13	OX Brenna
OX Brenna, UU, 85-7M, 1, 2, WF	85-7M	5.9	895.7	1	2	1.0	1.55	0.78	1550	1.78	1.60	0.80	1600	1.80	OX Brenna
OX Brenna, UU, 85-7M, 1, 3, WF	85-7M	5.9	895.7	1	3	2.0	1.44	0.72	1440	2.72	1.62	0.81	1620	2.81	OX Brenna
OX Brenna, UU, 85-12M, 2, 1, WF	85-12M	16.0	881.3	2	1	0.5	2.02	1.01	2020	1.51	2.04	1.02	2040	1.52	OX Brenna
OX Brenna, UU, 85-12M, 2, 2, WF	85-12M	16.0	881.3	2	2	1.0	2.40	1.20	2400	2.20	2.40	1.20	2400	2.20	OX Brenna
OX Brenna, UU, 85-12M, 2, 3, WF	85-12M	16.0	881.3	2	3	2.0	2.28	1.14	2280	3.14	2.28	1.14	2280	3.14	OX Brenna
OX Brenna, UU, 86-28M, 2, 1, WF	86-28M	21.0	896.6	2	1	1.0	1.31	0.66	1310	1.66	1.74	0.87	1740	1.87	OX Brenna
OX Brenna, UU, 86-28M, 2, 2, WF	86-28M	21.0	896.6	2	2	2.0	1.39	0.70	1390	2.70	1.58	0.79	1580	2.79	OX Brenna
OX Brenna, UU, 86-28M, 2, 3, WF	86-28M	21.0	896.6	2	3	4.0	1.59	0.80	1590	4.80	2.36	1.18	2360	5.18	OX Brenna
Brenna, UU, Far 09-23MU, 5, 1, FM	Far 09-23MU	39.0	858.0	5	1	0.8	0.65	0.33	650	1.08	0.79	0.40	790	1.15	Brenna
Brenna, UU, Far 09-23MU, 5, 2, FM	Far 09-23MU	39.0	858.0	5	2	1.5	0.59	0.30	590	1.80	0.82	0.41	820	1.91	Brenna
Brenna, UU, Far 09-23MU, 5, 3, FM	Far 09-23MU	39.0	858.0	5	3	3.0	0.73	0.37	730	3.37	0.83	0.42	830	3.42	Brenna
Brenna, UU, Far 09-23MU, 6, 1, FM	Far 09-23MU	81.0	816.0	6	1	1.0	0.76	0.38	760	1.38	0.86	0.43	860	1.43	Brenna
Brenna, UU, Far 09-23MU, 6, 2, FM	Far 09-23MU	81.0	816.0	6	2	2.0	0.63	0.32	630	2.32	0.76	0.38	760	2.38	Brenna
Brenna, UU, Far 09-23MU, 6, 3, FM	Far 09-23MU	81.0	816.0	6	3	4.0	0.71	0.36	710	4.36	0.71	0.36	710	4.36	Brenna
Brenna, UU, Moor 09-25MU, 4, 1, FM	Moor 09-25MU	39.0	859.7	4	1	0.8	0.66	0.33	660	1.08	0.66	0.33	660	1.08	Brenna
Brenna, UU, Moor 09-25MU, 4, 2, FM	Moor 09-25MU	39.0	859.7	4	2	1.5	0.67	0.34	670	1.84	0.67	0.34	670	1.84	Brenna
Brenna, UU, Moor 09-25MU, 4, 3, FM	Moor 09-25MU	39.0	859.7	4	3	3.0	0.67	0.34	670	3.34	0.79	0.40	790	3.40	Brenna
Brenna, UU, Far 09-26MU, 3, 1, FM	Far 09-26MU	29.0	874.5	3	1	1.0	0.43	0.22	430	1.22	1.29	0.65	1290	1.65	Brenna
Brenna, UU, Far 09-26MU, 3, 2, FM	Far 09-26MU	29.0	874.5	3	2	2.0	0.88	0.44	880	2.44	1.32	0.66	1320	2.66	Brenna
Brenna, UU, Far 09-26MU, 3, 3, FM	Far 09-26MU	29.0	874.5	3	3	4.0	0.81	0.41	810	4.41	0.94	0.47	940	4.47	Brenna
Brenna, UU, Far 09-27MU, 4, 1, FM	Far 09-27MU	65.0	838.1	4	1	1.0	0.68	0.34	680	1.34	0.79	0.40	790	1.40	Brenna
Brenna, UU, Far 09-27MU, 4, 2, FM	Far 09-27MU	65.0	838.1	4	2	2.0	0.75	0.38	750	2.38	0.86	0.43	860	2.43	Brenna
Brenna, UU, Far 09-27MU, 4, 3, FM	Far 09-27MU	65.0	838.1	4	3	4.0	0.82	0.41	820	4.41	0.84	0.42	840	4.42	Brenna

St. Paul District
GEOLOGY
GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Undrained Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: OCT 09 Date: 10/29/2010

							Q Strengths								
							Ultimate Stress Values				Peak Stress Values				
TEST NO.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	σ_c' (tsf)	σ_d (tsf)	q (tsf)	q (psf)	p (tsf)	σ_d (tsf)	q (tsf)	q (psf)	p (tsf)	FORMATION
Brenna, UU, Far 09-60MU, 3, 1, FM	Far 09-60MU	36.0	847.3	3	1	1.0	0.87	0.44	870	1.44	1.19	0.60	1190	1.60	Brenna
Brenna, UU, Far 09-60MU, 3, 2, FM	Far 09-60MU	36.0	847.3	3	2	2.0	1.03	0.52	1030	2.52	1.42	0.71	1420	2.71	Brenna
Brenna, UU, Far 09-60MU, 3, 3, FM	Far 09-60MU	36.0	847.3	3	3	4.0	1.03	0.52	1030	4.52	1.36	0.68	1360	4.68	Brenna
Brenna, UU, Far 10-78MU, 2, 1, FM	Far 10-78MU	26.0		2	1	1.0	0.71	0.36	710	1.36	0.97	0.49	970	1.49	Brenna
Brenna, UU, Far 10-78MU, 2, 2, FM	Far 10-78MU	26.0		2	2	2.0	0.97	0.49	970	2.49	1.14	0.57	1140	2.57	Brenna
Brenna, UU, Far 10-78MU, 2, 3, FM	Far 10-78MU	26.0		2	3	4.0	1.14	0.57	1140	4.57	1.47	0.74	1470	4.74	Brenna
Brenna, UU, Far 10-80MU, 2, 1, FM	Far 10-80MU	36.0		2	1	1.0	0.88	0.44	880	1.44	0.93	0.47	930	1.47	Brenna
Brenna, UU, Far 10-80MU, 2, 2, FM	Far 10-80MU	36.0		2	2	2.0	0.92	0.46	920	2.46	1.09	0.55	1090	2.55	Brenna
Brenna, UU, Far 10-80MU, 2, 3, FM	Far 10-80MU	36.0		2	3	4.0	1.14	0.57	1140	4.57	1.41	0.71	1410	4.71	Brenna
Brenna, UU, 01-12MU, 2, 1, FRW	01-12MU	30.0	854.0	2	1	1.0	0.36	0.18	360	1.18	0.53	0.27	530	1.27	Brenna
Brenna, UU, 01-12MU, 2, 2, FRW	01-12MU	30.0	854.0	2	2	2.0	0.45	0.23	450	2.23	0.60	0.30	600	2.30	Brenna
Brenna, UU, 01-12MU, 2, 3, FRW	01-12MU	30.0	854.0	2	3	4.0	0.49	0.25	490	4.25	0.61	0.31	610	4.31	Brenna
Brenna, UU, 06-18MU, 2, 1, FRW	06-18MU	52.0	837.7	2	1	1.0	0.69	0.35	690	1.35	1.24	0.62	1240	1.62	Brenna
Brenna, UU, 06-18MU, 2, 2, FRW	06-18MU	52.0	837.7	2	2	2.0	0.62	0.31	620	2.31	1.20	0.60	1200	2.60	Brenna
Brenna, UU, 06-18MU, 2, 3, FRW	06-18MU	52.0	837.7	2	3	4.0	0.59	0.30	590	4.30	1.31	0.66	1310	4.66	Brenna
Brenna, UU, 84-1M, 3, 1, WF	84-1M	19.0	877.1	3	1	1.0	0.42	0.21	417	1.21	0.55	0.28	551	1.28	Brenna
Brenna, UU, 84-1M, 3, 2, WF	84-1M	19.0	877.1	3	2	2.0	0.41	0.21	414	2.21	0.62	0.31	623	2.31	Brenna
Brenna, UU, 84-1M, 3, 3, WF	84-1M	19.0	877.1	3	3	4.0	0.46	0.23	458	4.23	0.58	0.29	577	4.29	Brenna
Brenna, UU, 84-1M, 4, 1, WF	84-1M	29.0	867.4	4	1	1.0	0.55	0.27	549	1.27	0.84	0.42	839	1.42	Brenna
Brenna, UU, 84-1M, 4, 2, WF	84-1M	29.0	867.4	4	2	2.0	0.55	0.27	548	2.27	0.73	0.37	731	2.37	Brenna
Brenna, UU, 84-1M, 4, 3, WF	84-1M	29.0	867.4	4	3	4.0	0.48	0.24	479	4.24	0.78	0.39	777	4.39	Brenna
Brenna, UU, 84-2M, 3, 1, WF	84-2M	21.0	883.6	3	1	1.0	0.70	0.35	703	1.35	0.77	0.38	768	1.38	Brenna
Brenna, UU, 84-2M, 3, 2, WF	84-2M	21.0	883.6	3	2	2.0	0.74	0.37	738	2.37	0.89	0.44	889	2.44	Brenna
Brenna, UU, 84-2M, 3, 3, WF	84-2M	21.0	883.6	3	3	4.0	0.73	0.37	731	4.37	0.90	0.45	902	4.45	Brenna
Brenna, UU, 85-4M, 6, 1, WF	85-4M	48.0	865.2	6	1	1.0	0.83	0.42	831	1.42	1.33	0.67	1330	1.67	Brenna
Brenna, UU, 85-4M, 6, 2, WF	85-4M	48.0	865.2	6	2	2.0	0.81	0.41	811	2.41	1.11	0.56	1110	2.56	Brenna
Brenna, UU, 85-4M, 6, 3, WF	85-4M	48.0	865.2	6	3	4.0	0.86	0.43	864	4.43	1.23	0.62	1230	4.62	Brenna
Brenna, UU, 85-6M, 3, 1, WF	85-6M	31.0	871.2	3	1	1.0	0.64	0.32	637	1.32	0.78	0.39	784	1.39	Brenna
Brenna, UU, 85-6M, 3, 2, WF	85-6M	31.0	871.2	3	2	2.0	0.71	0.35	708	2.35	0.98	0.49	981	2.49	Brenna
Brenna, UU, 85-6M, 3, 3, WF	85-6M	31.0	871.2	3	3	4.0	0.73	0.36	728	4.36	0.97	0.48	966	4.48	Brenna
Brenna, UU, 85-7M, 3, 1, WF	85-7M	22.0	879.6	3	1	0.5	0.20	0.10	203	0.60	0.44	0.22	435	0.72	Brenna
Brenna, UU, 85-7M, 3, 2, WF	85-7M	22.0	879.6	3	2	1.0	0.53	0.26	526	1.26	0.62	0.31	615	1.31	Brenna
Brenna, UU, 85-7M, 3, 3, WF	85-7M	22.0	879.6	3	3	2.0	0.41	0.20	409	2.20	0.66	0.33	664	2.33	Brenna
Brenna, UU, 85-10M, 1, 1, WF	85-10M	16.0	880.1	1	1	0.5	0.37	0.19	373	0.69	0.49	0.24	485	0.74	Brenna
Brenna, UU, 85-10M, 1, 2, WF	85-10M	16.0	880.1	1	2	1.0	0.54	0.27	538	1.27	0.63	0.32	633	1.32	Brenna
Brenna, UU, 85-10M, 1, 3, WF	85-10M	16.0	880.1	1	3	2.0	0.49	0.24	489	2.24	0.47	0.24	470	2.24	Brenna
Brenna, UU, 85-10M, 3, 1, WF	85-10M	26.0	870.1	3	1	0.5	0.40	0.20	395	0.70	0.48	0.24	484	0.74	Brenna
Brenna, UU, 85-10M, 3, 2, WF	85-10M	26.0	870.1	3	2	1.0	0.38	0.19	382	1.19	0.47	0.24	472	1.24	Brenna
Brenna, UU, 85-10M, 3, 3, WF	85-10M	26.0	870.1	3	3	2.0	0.42	0.21	421	2.21	0.56	0.28	562	2.28	Brenna

St. Paul District GEOLOGY GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Undrained Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: OCT 09 Date: 10/29/2010

							Q Strengths								
							Ultimate Stress Values				Peak Stress Values				
TEST NO.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	σ_c' (tsf)	σ_d (tsf)	q (tsf)	q (psf)	p (tsf)	σ_d (tsf)	q (tsf)	q (psf)	p (tsf)	FORMATION
Brenna, UU, 85-12M, 4, 1, WF	85-12M	26.0	871.3	4	1	0.5	0.95	0.47	949	0.97	1.12	0.56	1120	1.06	Brenna
Brenna, UU, 85-12M, 4, 2, WF	85-12M	26.0	871.3	4	2	1.0	1.12	0.56	1120	1.56	1.30	0.65	1300	1.65	Brenna
Brenna, UU, 85-12M, 4, 3, WF	85-12M	26.0	871.3	4	3	2.0	0.99	0.50	992	2.50	1.47	0.74	1470	2.74	Brenna
Brenna, UU, 86-29M, 5, 1, WF	86-29M	39.1	864.9	5	1		0.58	0.29	575	0.29	0.58	0.29	575	0.29	Brenna
Brenna, UU, 86-31M, 3, 1, WF	86-31M	31.1	862.2	3	1		0.74	0.37	738	0.37	0.74	0.37	738	0.37	Brenna
Brenna, UU, 86-31M, 4, 1, WF	86-31M	41.1	852.2	4	1	1.0	0.50	0.25	497	1.25	0.75	0.37	746	1.37	Brenna
Brenna, UU, 86-31M, 4, 2, WF	86-31M	41.1	852.2	4	2	2.0	0.43	0.21	429	2.21	0.68	0.34	684	2.34	Brenna
Brenna, UU, 86-31M, 4, 3, WF	86-31M	41.1	852.2	4	3	4.0	0.55	0.28	551	4.28	0.70	0.35	702	4.35	Brenna
Brenna, UU, 86-32M, 2, 1, WF	86-32M	21.1	866.6	2	1		0.52	0.26	523	0.26	0.52	0.26	523	0.26	Brenna
Brenna, UU, 99-1M, 5, 1, Oakport	99-1M	35.0		5	1	0.3	0.22	0.11	220	0.36	0.67	0.34	670	0.59	Brenna
Brenna, UU, 99-1M, 5, 2, Oakport	99-1M	35.0		5	2	0.5	0.51	0.26	510	0.76	0.71	0.36	710	0.86	Brenna
Brenna, UU, 99-1M, 5, 3, Oakport	99-1M	35.0		5	3	1.0	0.65	0.33	650	1.33	0.75	0.38	750	1.38	Brenna
B/A Trans, UU, Moor 09-25MU, 5, 1, FM	Moor 09-25MU	69.0	829.7	5	1	1.0	0.66	0.33	660	1.33	0.92	0.46	920	1.46	B/A Trans
B/A Trans, UU, Moor 09-25MU, 5, 2, FM	Moor 09-25MU	69.0	829.7	5	2	2.0	0.86	0.43	860	2.43	0.89	0.45	890	2.45	B/A Trans
B/A Trans, UU, Moor 09-25MU, 5, 3, FM	Moor 09-25MU	69.0	829.7	5	3	4.0	0.82	0.41	820	4.41	0.89	0.45	890	4.45	B/A Trans
Argusville, UU, Far 10-78MU, 3, 1, FM	Far 10-78MU	56.0		3	1	1.0	0.83	0.42	830	1.42	1.10	0.55	1098	1.55	Argusville
Argusville, UU, Far 10-78MU, 3, 2, FM	Far 10-78MU	56.0		3	2	2.0	0.96	0.48	960	2.48	1.16	0.58	1160	2.58	Argusville
Argusville, UU, Far 10-78MU, 3, 3, FM	Far 10-78MU	56.0		3	3	4.0	1.12	0.56	1120	4.56	1.21	0.61	1210	4.61	Argusville
Argusville, UU, Far 10-79MU, 2, 1, FM	Far 10-79MU	41.0		2	1	0.8	0.80	0.40	800	1.15	0.97	0.49	970	1.24	Argusville
Argusville, UU, Far 10-79MU, 2, 2, FM	Far 10-79MU	41.0		2	2	1.5	0.82	0.41	820	1.91	1.10	0.55	1100	2.05	Argusville
Argusville, UU, Far 10-79MU, 2, 3, FM	Far 10-79MU	41.0		2	3	3.0	0.91	0.46	910	3.46	1.19	0.60	1190	3.60	Argusville
Argusville, UU, Far 10-80MU, 3, 1, FM	Far 10-80MU	56.0		3	1	1.0	0.86	0.43	860	1.43	1.00	0.50	1000	1.50	Argusville
Argusville, UU, Far 10-80MU, 3, 2, FM	Far 10-80MU	56.0		3	2	2.0	0.92	0.46	920	2.46	1.04	0.52	1040	2.52	Argusville
Argusville, UU, Far 10-80MU, 3, 3, FM	Far 10-80MU	56.0		3	3	4.0	0.77	0.39	770	4.39	1.07	0.54	1070	4.54	Argusville
Argusville, UU, 01-12MU, 3, 1, FRW	01-12MU	63.0	821.0	3	1	1.0	0.49	0.25	490	1.25	0.72	0.36	720	1.36	Argusville
Argusville, UU, 01-12MU, 3, 2, FRW	01-12MU	63.0	821.0	3	2	2.0	0.66	0.33	660	2.33	0.72	0.36	720	2.36	Argusville
Argusville, UU, 01-12MU, 3, 3, FRW	01-12MU	63.0	821.0	3	3	4.0	0.68	0.34	680	4.34	0.73	0.37	730	4.37	Argusville
Argusville, UU, 06-18MU, 3, 1, FRW	06-18MU	73.0	816.7	3	1	1.0	1.02	0.51	1020	1.51	1.40	0.70	1400	1.70	Argusville
Argusville, UU, 06-18MU, 3, 2, FRW	06-18MU	73.0	816.7	3	2	2.0	0.73	0.37	730	2.37	1.47	0.74	1470	2.74	Argusville
Argusville, UU, 06-18MU, 3, 3, FRW	06-18MU	73.0	816.7	3	3	4.0	1.16	0.58	1160	4.58	1.58	0.79	1580	4.79	Argusville
Argusville, UU, 06-16MU, 2, 1, FRW	06-16MU	46.0	832.6	2	1	1.0	0.56	0.28	560	1.28	1.02	0.51	1020	1.51	Argusville
Argusville, UU, 06-16MU, 2, 2, FRW	06-16MU	46.0	832.6	2	2	2.0	0.61	0.31	610	2.31	1.06	0.53	1060	2.53	Argusville
Argusville, UU, 06-16MU, 2, 3, FRW	06-16MU	46.0	832.6	2	3	4.0	0.63	0.32	630	4.32	1.07	0.54	1070	4.54	Argusville

St. Paul District GEOLOGY GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Undrained Shear Strength Data from Borings
Compiled By: KAH Revised By: KAH
Date: OCT 09 Date: 10/29/2010

							Q Strengths								
							Ultimate Stress Values				Peak Stress Values				
TEST NO.	BORING NO.	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC. NO.	σ_c' (tsf)	σ_d (tsf)	q (tsf)	q (psf)	p (tsf)	σ_d (tsf)	q (tsf)	q (psf)	p (tsf)	FORMATION
Argusville, UU, 06-16MU, 3, 1, FRW	06-16MU	57.0	821.6	3	1	1.0	0.52	0.26	520	1.26	1.00	0.50	1000	1.50	Argusville
Argusville, UU, 06-16MU, 3, 2, FRW	06-16MU	57.0	821.6	3	2	2.0	0.55	0.28	550	2.28	1.07	0.54	1070	2.54	Argusville
Argusville, UU, 06-16MU, 3, 3, FRW	06-16MU	57.0	821.6	3	3	4.0	0.63	0.32	630	4.32	1.08	0.54	1080	4.54	Argusville
Argusville, UU, 84-2M, 6, 1, WF	84-2M	61.0	843.6	6	1	1.0	0.79	0.40	791	1.40	0.97	0.48	968	1.48	Argusville
Argusville, UU, 84-2M, 6, 2, WF	84-2M	61.0	843.6	6	2	2.0	0.72	0.36	720	2.36	0.74	0.37	744	2.37	Argusville
Argusville, UU, 84-2M, 6, 3, WF	84-2M	61.0	843.6	6	3	4.0	0.72	0.36	722	4.36	0.77	0.38	767	4.38	Argusville
Argusville, UU, 84-3M, 6, 1, WF	84-3M	63.0	839.2	6	1	1.0	0.79	0.39	787	1.39	0.90	0.45	904	1.45	Argusville
Argusville, UU, 84-3M, 6, 2, WF	84-3M	63.0	839.2	6	2	2.0	0.84	0.42	841	2.42	0.94	0.47	939	2.47	Argusville
Argusville, UU, 84-3M, 6, 3, WF	84-3M	63.0	839.2	6	3	4.0	0.83	0.42	834	4.42	0.95	0.48	951	4.48	Argusville
Argusville, UU, 85-6M, 4, 1, WF	85-6M	44.0	858.2	4	1	1.0	0.56	0.28	559	1.28	0.63	0.31	629	1.31	Argusville
Argusville, UU, 85-6M, 4, 2, WF	85-6M	44.0	858.2	4	2	2.0	0.49	0.24	485	2.24	0.83	0.42	831	2.42	Argusville
Argusville, UU, 85-6M, 4, 3, WF	85-6M	44.0	858.2	4	3	4.0	0.64	0.32	637	4.32	0.75	0.37	749	4.37	Argusville
Argusville, UU, 85-6M, 5, 1, WF	85-6M	54.0	848.2	5	1	1.0	0.74	0.37	739	1.37	0.93	0.46	926	1.46	Argusville
Argusville, UU, 85-6M, 5, 2, WF	85-6M	54.0	848.2	5	2	2.0	0.62	0.31	621	2.31	0.87	0.44	874	2.44	Argusville
Argusville, UU, 85-6M, 5, 3, WF	85-6M	54.0	848.2	5	3	4.0	0.79	0.40	790	4.40	1.09	0.55	1090	4.55	Argusville
Argusville, UU, 85-7M, 5, 1, WF	85-7M	46.0	855.6	5	1	1.0	0.47	0.23	468	1.23	0.74	0.37	738	1.37	Argusville
Argusville, UU, 85-7M, 5, 2, WF	85-7M	46.0	855.6	5	2	2.0	0.45	0.23	452	2.23	0.84	0.42	844	2.42	Argusville
Argusville, UU, 85-7M, 5, 3, WF	85-7M	46.0	855.6	5	3	4.0	0.67	0.33	667	4.33	0.98	0.49	983	4.49	Argusville
Argusville, UU, 85-12M, 7, 1, WF	85-12M	49.0	848.3	7	1	1.0	0.58	0.29	579	1.29	0.77	0.38	765	1.38	Argusville
Argusville, UU, 85-12M, 7, 2, WF	85-12M	49.0	848.3	7	2	2.0	0.48	0.24	481	2.24	0.72	0.36	718	2.36	Argusville
Argusville, UU, 85-12M, 7, 3, WF	85-12M	49.0	848.3	7	3	4.0	0.49	0.24	487	4.24	0.68	0.34	678	4.34	Argusville
Argusville, UU, SB-3, , 1, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Argusville, UU, SB-3, , 2, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Argusville, UU, SB-3, , 3, SS-40	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Argusville, UU, ST-1, 1B, 1, SS-MP	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Argusville, UU, ST-8, 8A, 1, SS-MP	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

St. Paul District GEOLOGY GEOTECHNICAL
US Army Corps of Engineers®

Project: Fargo-Moorhead Metro Feasibility Study
Subject: Consolidated Test Results
Compiled By:
Date: 2008
Revised By: KAH
Date: 2/15/2011

Project, Formation, Boring, Sample No., Specimen No.	BORING NO.	TOP BORING ELEV. (feet)		Water Table Elevation (feet)	MID-DEPTH (feet)	ELEV. (feet)	SAMPLE NO.	SPEC.	LL (%)	MC (%)	PL (%)	PI (%)	LI	G_S	e	γ_d (pcf)	γ_m (pcf)	γ_{sat} (pcf)	COE p_c' (tsf)	Lab p_c'	p_o' (tsf)	OCR	USCS SOIL TYPE	FORMATION	PROJECT
SS ST-10,	ST-10	908		898	10.0	898.0				39.8				2.70	1.13	79.2	110.7	112.2	2.52		0.57	4.45	CH		SS
SS ST-10,	ST-10	908		898	20.0	888.0				60.2				2.70	1.63	64.1	102.7	102.7	4.38		0.72	6.12	CH		SS
SS ST-10,	ST-10	908		898	30.0	878.0				64.5				2.70	1.74	61.6	101.3	101.1	2.48		0.89	2.78	CH		SS
SS SB-11,	SB-11	905		895	33.3	870.0				48.9				2.75	1.35	73.1	108.8	108.9	4.30		1.13	3.82	CH		SS
SS SB-17,	SB-17	905		895	28.3	874.0				45.2				2.75	1.26	75.9	110.2	110.7	3.70		1.06	3.49	CH		SS
SS-WRL ST-7,	ST-7	908		898	15.0	892.9								2.70	1.03	83.1		114.7	1.04		0.70	1.48	CH		SS-WRL
SS-WRL ST-7,	ST-7	908		898	25.0	883.0								2.70	1.40	70.1		106.5	3.1		0.86	3.60	CH		SS-WRL
SS-WRL ST-9,	ST-9	914		904	10.0	903.8								2.70	1.06	81.8		113.9	2.3		0.57	4.04	CH		SS-WRL
SA-52ndAVE ST-1,	ST-1	905		895	20.0	885.2				60.9				2.71	1.65	63.8	102.7	102.6	4.0		0.71	5.60	CH		SA-52ndAVE
SA-52ndAVE ST-2,	ST-2	891		879	15.0	875.7								2.67	1.18	76.4		110.2	4.5		0.72	6.22	of lean Clay (CH) and Silt (M		SA-52ndAVE
SA-52ndAVE SL-3,	SL-3	888		859	15.5	872.3			62	32.8	23	40	0.26	2.73	0.90	89.6	119.0	119.1	1.8		1.44	1.25	CH		SA-52ndAVE
SS-32ND ST-13,	ST-13	901		891	15.0	886.4			58	31.0	25	34	0.19	2.72	0.85	91.9	120.4	120.4	2.0		0.75	2.68	CH		SS-32ND
SS-32ND ST-13,	ST-13	901		891	30.0	871.0			115	64.0	31	84	0.39	2.71	1.71	62.5	102.5	101.8	2.7		0.90	2.99	CH		SS-32ND
FRW PL Sherack 01-5MU, 1	01-5MU				16.0	885.7	1		78	35.7	28	50	0.15	2.71	0.97	85.6	116.2	116.5	1.95		0.56	3.48		PL Sherack	FRW
FRW PL Sherack 01-5MU, 1	01-5MU				16.0	885.7	1		78	35.7	28	50	0.15	2.71	0.97	85.6	116.2	116.5	1.95		0.84	2.32		PL Sherack	FRW
FRW Sherack 01-12MU, 1	01-12MU				19.0	865.0	1		53	25.6	21	31	0.14	2.68	0.67	100.2	125.9	125.2	3.20		0.72	4.44		Sherack	FRW
FRW Brenna 01-5MU, 2	01-5MU				49.0	852.7	2		108	71.2	35	73	0.49	2.73	1.95	57.7	98.8	99.0	2.95		1.60	1.84		Brenna	FRW
FRW Brenna 01-5MU, 2	01-5MU				49.0	852.7	2		108	71.2	35	73	0.49	2.73	1.95	57.7	98.8	99.0	2.95		1.80	1.64		Brenna	FRW
FRW Argusville 01-5MU, 4	01-5MU				78.0	823.7	4		99	63.9	28	70	0.51	2.77	1.80	61.8	101.3	101.9	2.60		2.20	1.18		Argusville	FRW
FRW Argusville 01-5MU, 4	01-5MU				78.0	823.7	4		99	63.9	28	70	0.51	2.77	1.80	61.8	101.3	101.9	2.60		2.30	1.13		Argusville	FRW
FM Brenna Far 09-25MU, 4	Far 09-25MU	893.4	9.0	884.4	51.0	842.4	4		108	62.8	22	86	0.47	2.75	1.77	62.0	100.9	101.9	2.8		1.70	1.62	CH	Brenna	FM
FM Sherack Far 09-26MU, 1	Far 09-26MU	903.5	7.9	895.6	9.0	894.5	1		67	32.4	17	50	0.31	2.74	0.91	89.5	118.5	119.2	1.4		0.51	2.80	CH	Sherack	FM
FM Brenna Far 09-26MU, 3	Far 09-26MU	903.5	7.9	895.6	29.0	874.5	3		110	54.2	24	86	0.35	2.75	1.51	65.5	101.0	106.0	3.7		1.04	3.56	CH	Brenna	FM
FM Alluvium Far 09-27MU, 1	Far 09-27MU	903.1	7.9	895.2	7.0	896.1	1		75	29.7	18	57	0.21	2.71	0.84	92.1	119.5	120.5	1.6		0.42	3.81	CH	Alluvium	FM
FM Brenna Far 09-27MU, 4	Far 09-27MU	903.1	7.9	895.2	65.0	838.1	4		89	55.4	20	69	0.51	2.70	1.52	67.0	104.1	104.6	2.8		1.82	1.51	CH	Brenna	FM
FM OX Brenna Far 09-59MU, 2	Far 09-59MU	916.2	14.4	901.8	21.0	895.2	2		92	53.3	19	73	0.47	2.75	1.50	68.6	105.2	106.1	3.5	3.0	0.95	3.68	CH	OX Brenna	FM
FM B-A Trans Far 09-59MU, 3	Far 09-59MU	916.2	14.4	901.8	36.0	880.2	3		64	38.3	17	47	0.45	2.75	1.08	82.6	114.2	114.9	2.7	2.8	1.30	2.08	CH	B-A Trans	FM
FM OX Brenna Far 09-60MU, 2	Far 09-60MU	887.3	8.0	879.3	26.0	861.3	2		106	49.1	24	82	0.31	2.70	1.42	69.8	104.1	106.3	4.9	5.6	0.90	5.44	CH	OX Brenna	FM
FM Brenna Far 09-60MU, 3	Far 09-60MU	887.3	8.0	879.3	36.0	851.3	3		111	57.5	26	85	0.37	2.70	1.55	66.0	104.0	103.9	5.2	4.7	1.10	4.73	CH	Brenna	FM
FM Alluvium Far 10-78MU, 1	Far 10-78MU	905.7	6.7	899.0	14.0	891.7	1			29.8					0.93	89.5	116.2		2.9	3.0	0.61	4.75	CH	Alluvium	FM
FM Brenna Far 10-78MU, 2	Far 10-78MU	905.7	6.7	899.0	26.0	879.7	2			42.2					1.17	79.6	113.2		3.6	4.0	0.90	4.00	CH	Brenna	FM
FM Argusville Far 10-78MU, 3	Far 10-78MU	905.7	6.7	899.0	56.0	849.7	3			47.5					1.34	73.8	108.9		4.5	5.3	1.60	2.81	CH	Argusville	FM
FM Alluvium Far 10-79MU, 1	Far 10-79MU	905.7	10.7	895.0	21.0	884.7	1			30.3					0.84	91.7	119.5		4.0	4.0	0.93	4.30	CH	Alluvium	FM
FM Argusville Far 10-79MU, 2	Far 10-79MU	905.7	10.7	895.0	41.0	864.7	2			49.3					1.34	72.7	108.5		4.0	3.9	1.40	2.86	CH	Argusville	FM
FM Alluvium Far 10-80MU, 1	Far 10-80MU	921.1	9.6	911.5	24.0	897.1	1		28	28.7	17	11	1.06	2.67	0.75	95.3	122.7	122.0	2.2	2.0	1.00	2.20	CL & SM	Alluvium	FM
FM Brenna Far 10-80MU, 2	Far 10-80MU	921.1	9.6	911.5	36.0	885.1	2			46.1					1.31	75.3	110.0		5.1	5.0	1.30	3.88	CH	Brenna	FM
FM Argusville Far 10-80MU, 3	Far 10-80MU	921.1	9.6	911.5	56.0	865.1	3			51.8					1.45	70.8	107.5		4.7	4.4	1.70	2.76	CH	Argusville	FM
FM PR - WF Moor 09-25MU, 2	Moor 09-25MU	898.7	8.8	889.9	22.0	876.7	2		30	28.3	24	6	0.72	2.75	0.78	96.6	123.9	123.8	1.6		0.93	1.72	ML	PR - WF	FM
FM PR - Harwood Moor 09-25MU, 3	Moor 09-25MU	898.7	8.8	889.9	26.0	872.7	3		80	36.3	21	59	0.26	2.75	1.03	84.7	115.4	116.3	3.4		1.04	3.27	CH	PR - Harwood	FM
FM Brenna Moor 09-25MU, 4	Moor 09-25MU	898.7	8.8	889.9	39.0	859.7	4		116	70.5	25	91	0.50	2.75	1.99	57.3	97.7	98.9	2.9		1.34	2.15	CH	Brenna	FM
FM B-A Trans Moor 09-25MU, 5	Moor 09-25MU	898.7	8.8	889.9	69.0	829.7	5		87	55.0	22	65	0.51	2.75	1.49	69.0	107.0	106.3	2.8		1.95	1.44	CH	B-A Trans	FM
FM OX Brenna Moor 09-34MU, 2	Moor 09-34MU	907.9	9.8	898.1	17.0	890.9	2		114	60.7	24	90	0.41	2.70	1.66	63.5	102.0	102.4	3.8		0.80	4.75	CH	OX Brenna	FM

* Water Table Assumed to be 10' below ground surface (No observed water table data in boring)