APPENDIX E

I-196 MDOT DEFLECTOMETER DATA

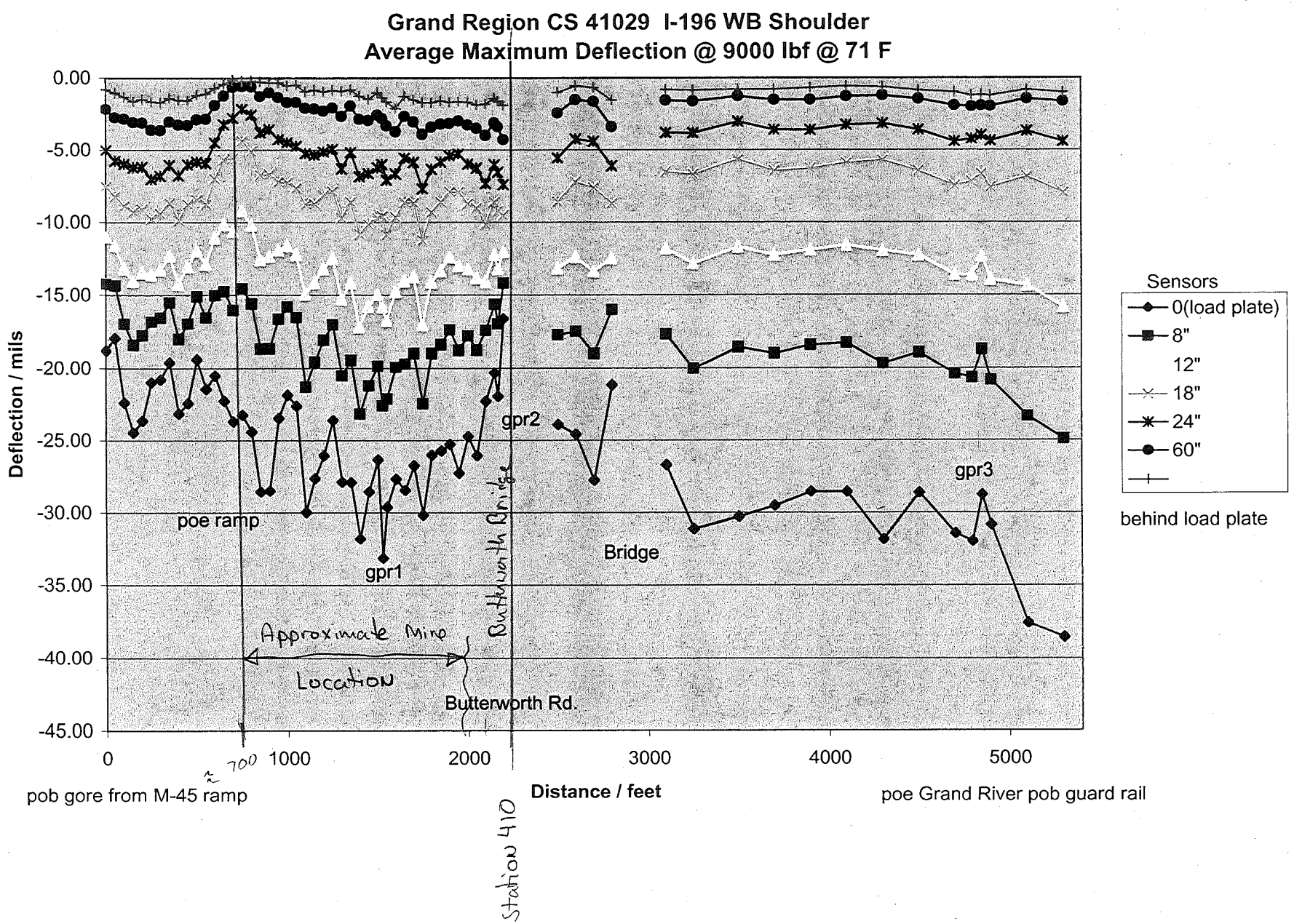
KUAB FWD FILE :	41029.FWD
Project :	Gypsum Mine Detection on I-196
Project Number :	
Route :	I-196
Direction :	WB shoulder
Location :	between Lake Michigan Dr. and Grand River
:	
Region :	Grand
Customer/Client :	MDOT
Operator :	K.Bancroft
Traffic Control :	S.Curtis
Pavement Type :	flexible shoulder
Environment :	partly cloudy,mild
Traffic :	heavy
Comments :	testing to locate void (gypsum mine)
:	
:	
Date Created :	9/10/02
Load Mode :	2 (3+3 buffers, 7 plates)
Plate Radius :	5.91 (in)
Extra Field Set :	FLEXIBLE
Drop Sequence :	2
No of drops :	3
Record Drop? :	Y
Drop Height :	1 2 3 4
Impact Load :	5000 9000 15500 20500 lbf
Sensor Number :	0 1 2 3 4 5 6 7 8
Sensor Distance :	0.00 12.00 12.00 8.00 12.00 18.00 24.00 36.00 60.00 (in)
Sensor Position :	CENTER FRONT RIGHT BEHIND BEHIND BEHIND BEHIND BEHIND BEHIND
Reference Offset :	0 ft
Testpoint spacing:	50 ft

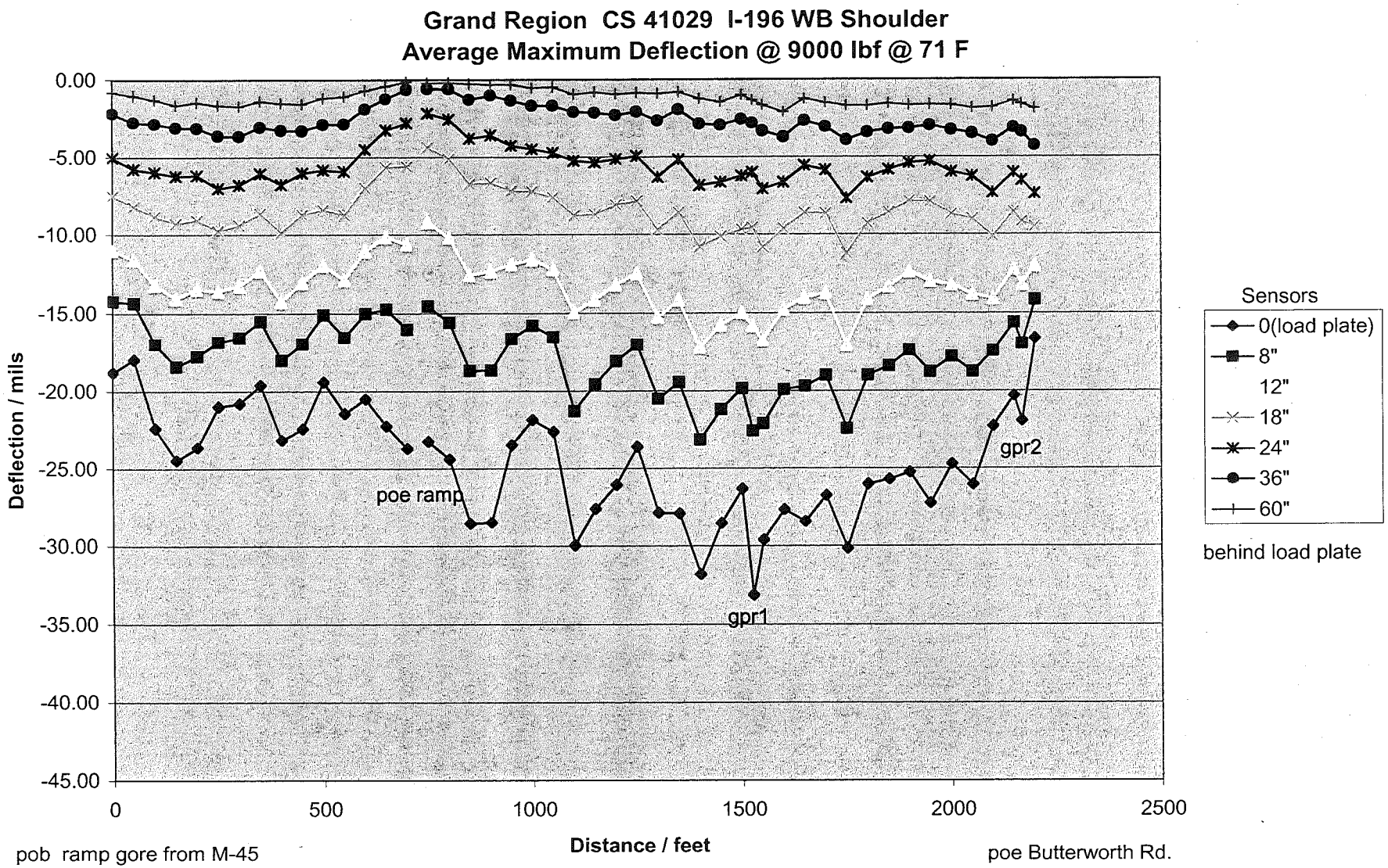
Westbound

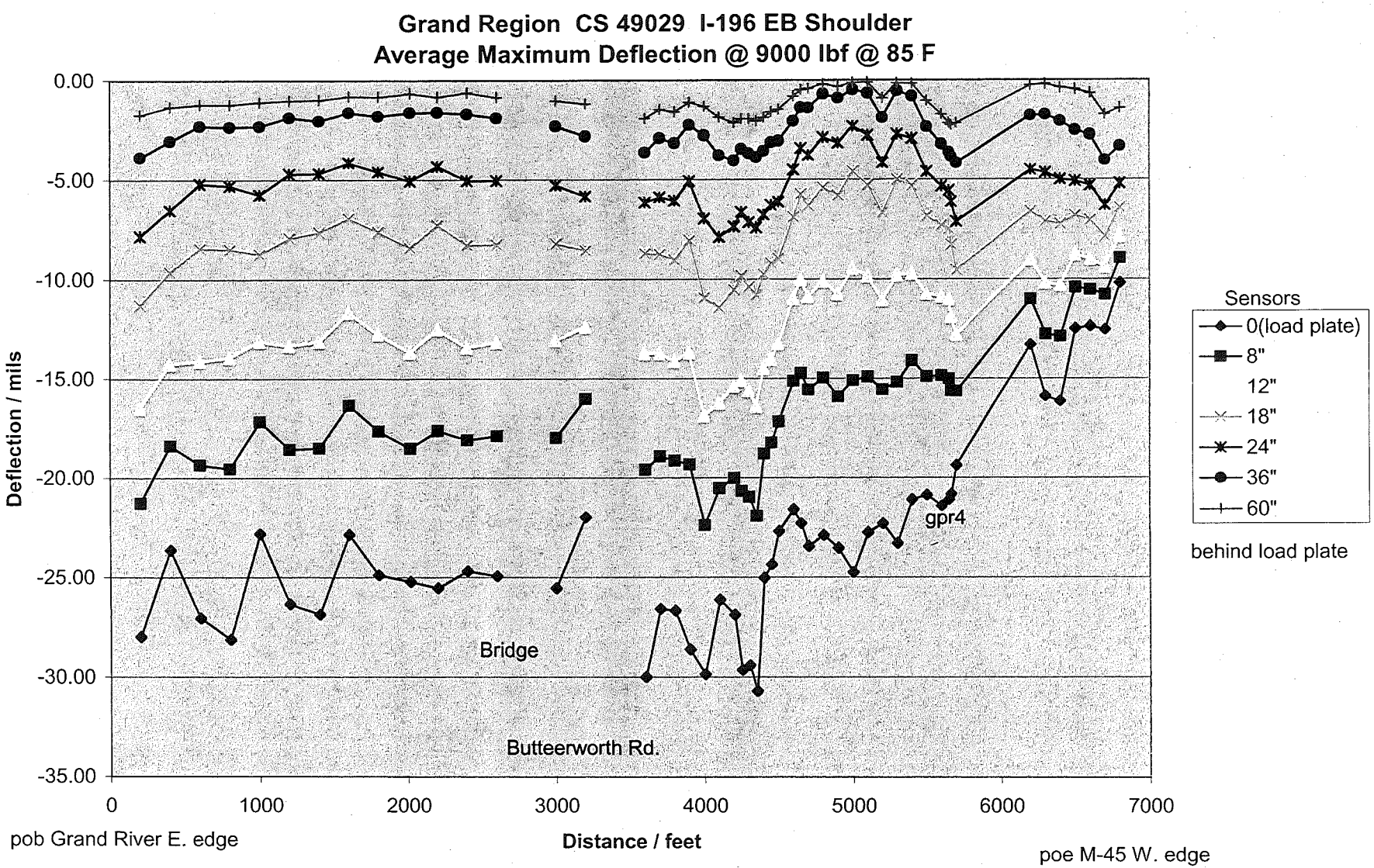
Distance ft	Load lbf	D0 mils	D3 mils	D4 mils	D5 mils	D6 mils	D7 mils	D8 mils	Air øF	Pave øF	Pvmt Cond	Pvmt Grde	Pvmt Crack	Crack Sevty	AASHTO Corrected Subgrade Resilient Modulus psi
	pob gore WB ramp from M-45														
0	9000	18.79	14.22	11.01	7.47	5.02	2.18	0.78	58	65	SHLD	CUT	NA	FLEX	5301
50	9000	17.96	14.33	11.62	8.18	5.75	2.75	1.01	59	66	SHLD	CUT	NA	FLEX	4843
100	9000	22.36	16.95	13.25	8.83	5.95	2.84	1.28	59	65	SHLD	CUT	NA	FLEX	4486
150	9000	24.44	18.40	14.07	9.27	6.19	3.08	1.61	59	66	SHLD	CUT	NA	FLEX	4273
200	9000	23.61	17.73	13.51	9.06	6.17	3.12	1.46	60	65	SHLD	CUT	NA	FLEX	4369
250	9000	20.98	16.81	13.64	9.73	6.98	3.60	1.62	61	66	SHLD	CUT	NA	FLEX	4068
300	9000	20.79	16.54	13.30	9.39	6.76	3.64	1.70	62	66	SHLD	CUT	NA	FLEX	4217
350	9000	19.59	15.48	12.34	8.64	6.04	3.04	1.38	62	67	SHLD	CUT	NA	FLEX	4585
400	9000	23.13	17.99	14.29	9.85	6.74	3.26	1.50	62	67	SHLD	CUT	NA	FLEX	4020
450	9000	22.40	16.93	13.08	8.71	6.00	3.29	1.54	64	67	SHLD	CUT	NA	FLEX	4545
500	9000	19.38	15.07	11.99	8.40	5.81	2.89	1.17	64	68	SHLD	CUT	NA	FLEX	4716
550	9000	21.42	16.53	12.92	8.73	5.91	2.85	1.07	64	67	SHLD	CUT	NA	FLEX	4538
600	9000	20.50	14.99	11.09	6.95	4.49	1.88	0.68	63	67	SHLD	CUT	NA	FLEX	5695
650	9000	22.23	14.72	10.16	5.65	3.24	1.23	0.42	64	68	SHLD	CUT	NA	FLEX	7013
700	9000	23.67	16.01	10.65	5.56	2.80	0.62	0.15	64	70	SHLD	CUT	NA	FLEX	5577
700	poe ramp from M-45		Lake Michigan Drive												
750	9000	23.21	14.53	9.21	4.34	2.16	0.58	0.20	66	70	SHLD	CUT	NA	FLEX	6452
801	9000	24.37	15.57	10.22	5.10	2.56	0.59	0.19	65	71	SHLD	CUT	NA	FLEX	5812
850	9000	28.52	18.64	12.62	6.71	3.78	1.28	0.27	65	71	SHLD	CUT	NA	FLEX	4708
901	9000	28.47	18.63	12.38	6.64	3.58	1.01	0.32	66	68	SHLD	CUT	NA	FLEX	4799
950	9000	23.46	16.61	11.95	7.15	4.24	1.35	0.33	64	69	SHLD	CUT	NA	FLEX	4972
1000	9000	21.83	15.77	11.63	7.19	4.47	1.68	0.53	65	70	SHLD	CUT	NA	FLEX	5106
1050	9000	22.60	16.50	12.26	7.58	4.71	1.68	0.49	64	69	SHLD	CUT	NA	FLEX	4846
1100	9000	29.93	21.26	14.97	8.77	5.24	2.10	0.92	63	70	SHLD	CUT	NA	FLEX	3968
1150	9000	27.59	19.52	14.20	8.71	5.35	2.13	0.82	63	68	SHLD	CUT	NA	FLEX	4184
1200	9000	26.03	18.05	13.23	8.08	5.12	2.30	0.93	62	67	SHLD	CUT	NA	FLEX	4489
1250	9000	23.57	16.99	12.53	7.82	4.93	2.08	0.85	62	67	SHLD	CUT	NA	FLEX	4741
1300	9000	27.85	20.47	15.31	9.69	6.29	2.67	0.89	61	67	SHLD	CUT	NA	FLEX	3880
1350	9000	27.88	19.40	14.20	8.58	5.16	1.93	0.79	62	67	SHLD	CUT	NA	FLEX	4182
1400	9000	31.78	23.11	17.24	10.79	6.81	2.87	1.24	62	68	SHLD	CUT	NA	FLEX	3446
1450	9000	28.52	21.17	15.83	10.12	6.60	2.95	1.45	63	69	SHLD	CUT	NA	FLEX	3753
1500	9000	26.31	19.81	15.01	9.67	6.21	2.57	1.00	64	71	SHLD	CUT	NA	FLEX	3958
1526	9000	33.10	22.53	15.86	9.54	5.99	2.83	1.32	63	74	SHLD	CUT	GPR1	FLEX	3744
1550	9000	29.60	22.08	16.79	10.82	7.04	3.32	1.65	62	73	SHLD	CUT	NA	FLEX	3539
1600	9000	27.63	19.89	14.80	9.62	6.62	3.72	2.10	63	68	SHLD	CUT	NA	FLEX	4013
1650	9000	26.41	19.67	14.07	8.60	5.55	2.66	1.25	62	70	SHLD	CUT	NA	FLEX	4223
1700	9000	26.72	18.97	13.77	8.64	5.85	3.07	1.50	63	68	SHLD	CUT	NA	FLEX	4313
1750	9000	30.14	22.41	17.10	11.22	7.64	3.91	1.69	63	69	SHLD	CUT	NA	FLEX	3474
1800	9000	26.00	18.96	14.14	9.29	6.33	3.42	1.69	62	68	SHLD	CUT	NA	FLEX	4202
1851	9000	25.70	18.37	13.38	8.58	5.83	3.20	1.57	63	68	SHLD	CUT	NA	FLEX	4441
1900	9000	25.25	17.37	12.42	7.83	5.40	3.16	1.66	63	69	SHLD	CUT	NA	FLEX	4784
1950	9000	27.23	18.76	13.02	7.87	5.27	2.98	1.63	64	72	SHLD	CUT	NA	FLEX	4562
2001	9000	24.70	17.78	13.25	8.69	5.97	3.28	1.66	65	70	SHLD	CUT	NA	FLEX	4482
2051	9000	26.04	18.73	13.86	9.00	6.24	3.50	1.86	65	70	SHLD	CUT	NA	FLEX	4287
2100	9000	22.27	17.41	14.13	10.12	7.29	3.99	1.80	64	69	SHLD	CUT	NA	FLEX	3912

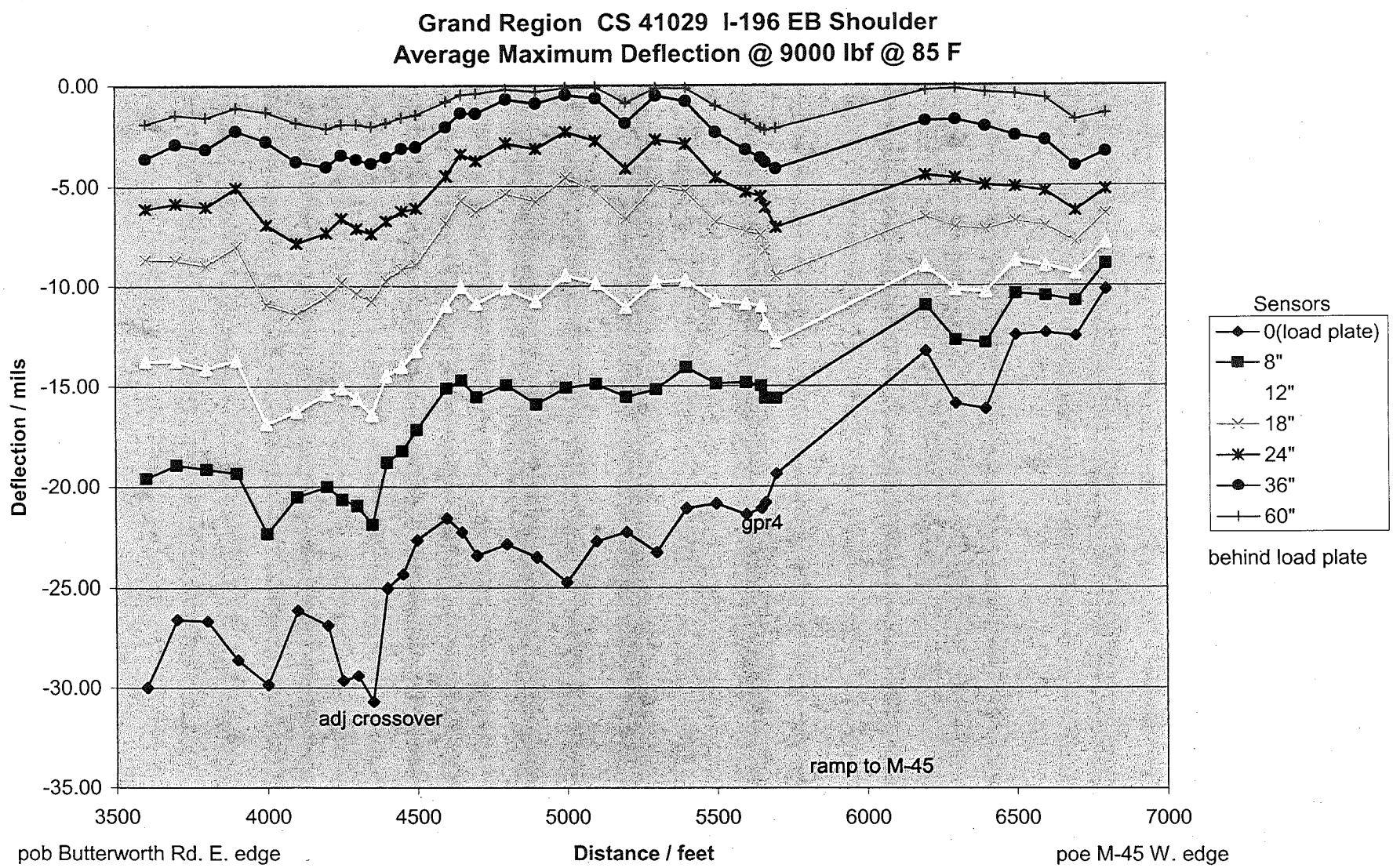
2150	9000	20.33	15.61	12.25	8.55	6.02	3.14	1.38	64	71	SHLD	FILL	NA	FLEX	**4630**
2169	9000	21.93	16.97	13.24	9.20	6.52	3.40	1.60	65	69	SHLD	FILL	GPR2	FLEX	**4304**
2200	9000	16.63	14.16	12.05	9.50	7.35	4.28	1.88	65	76	SHLD	FILL	NA	FLEX	**4039**
2239	pob Butterworth Rd.														
2450	poe Butterworth Rd.														
2500	9000	23.89	17.72	13.22	8.56	5.56	2.44	0.99	65	73	SHLD	FILL	NA	FLEX	**4494**
2600	9000	24.56	17.47	12.40	7.16	4.23	1.50	0.55	66	72	SHLD	FILL	NA	FLEX	**4792**
2700	9000	27.73	18.98	13.40	7.57	4.39	1.63	0.66	67	74	SHLD	FILL	NA	FLEX	**4432**
2800	9000	21.15	15.99	12.51	8.66	6.09	3.40	1.52	66	74	SHLD	FILL	NA	FLEX	**4571**
2834	pob bridge														
3015	poe bridge														
3100	9000	26.67	17.69	11.84	6.49	3.80	1.55	0.80	66	74	SHLD	FILL	NA	FLEX	**5017**
3250	9000	31.10	20.00	12.87	6.68	3.82	1.62	0.84	69	79	SHLD	FILL	NA	FLEX	**4617**
3500	9000	30.25	18.57	11.73	5.66	3.05	1.25	0.78	69	78	SHLD	FILL	NA	FLEX	**5063**
3700	9000	29.49	18.98	12.28	6.44	3.61	1.52	0.79	70	81	SHLD	FILL	NA	FLEX	**4836**
3900	9000	28.53	18.43	11.92	6.27	3.62	1.51	0.67	70	79	SHLD	FILL	NA	FLEX	**4983**
4100	9000	28.53	18.28	11.60	5.88	3.28	1.28	0.55	70	78	SHLD	FILL	NA	FLEX	**5121**
4301	9000	31.82	19.64	11.96	5.72	3.18	1.22	0.62	71	79	SHLD	FILL	NA	FLEX	**4965**
4501	9000	28.59	18.92	12.29	6.43	3.61	1.46	0.84	72	81	SHLD	FILL	NA	FLEX	**4833**
4700	9000	31.41	20.37	13.63	7.42	4.40	1.92	0.97	71	82	SHLD	FILL	NA	FLEX	**4358**
4795	9000	31.94	20.64	13.66	7.15	4.23	1.99	1.19	71	81	SHLD	FILL	NA	FLEX	**4350**
4850	9000	28.74	18.71	12.37	6.64	3.98	1.93	1.16	71	80	SHLD	FILL	NA	FLEX	**4801**
4900	9000	30.81	20.79	13.97	7.55	4.36	1.96	1.20	73	83	SHLD	FILL	NA	FLEX	**4253**
5100	9000	37.57	23.29	14.37	6.82	3.71	1.45	0.81	72	83	SHLD	FILL	NA	FLEX	**4133**
5300	9000	38.55	24.87	15.87	7.91	4.41	1.62	0.98	71	82	SHLD	FILL	NA	FLEX	**3744**
5763	pob Grand River														
Average		**25.94**	**18.27**	**13.16**	**8.05**	**5.16**	**2.39**	**1.09**	**65**	**71**					**4564**
Stdev.		**4.45**	**2.37**	**1.61**	**1.49**	**1.33**	**0.93**	**0.49**	**4**	**5**					**631**
Max.		**38.55**	**24.87**	**17.24**	**11.22**	**7.64**	**4.28**	**2.10**	**73**	**83**					**7013**
Min.		**16.63**	**14.16**	**9.21**	**4.34**	**2.16**	**0.58**	**0.15**	**58**	**65**					**3446**
C. of V.		**17%**	**13%**	**12%**	**18%**	**26%**	**39%**	**45%**	**5%**	**7%**					**14%**
0	EB I-196 poe Grand River														
200	9000	27.95	21.21	16.53	11.26	7.79	3.86	1.72	69	77	SHLD	FILL	NA	FLEX	**3517**
400	9000	23.60	18.35	14.27	9.60	6.51	3.04	1.30	69	81	SHLD	FILL	NA	FLEX	**4126**
600	9000	27.03	19.32	14.13	8.39	5.18	2.30	1.20	69	82	SHLD	FILL	NA	FLEX	**4205**
800	9000	28.08	19.50	13.96	8.44	5.28	2.35	1.19	69	83	SHLD	FILL	NA	FLEX	**4256**
1000	9000	22.79	17.14	13.13	8.70	5.73	2.31	1.07	69	82	SHLD	FILL	NA	FLEX	**4523**
1200	9000	26.32	18.54	13.35	7.89	4.69	1.86	1.00	67	83	SHLD	FILL	NA	FLEX	**4448**
1400	9000	26.84	18.47	13.13	7.60	4.67	2.03	0.95	68	82	SHLD	FILL	NA	FLEX	**4523**
1600	9000	22.83	16.32	11.68	6.91	4.13	1.61	0.78	68	82	SHLD	FILL	NA	FLEX	**5087**
1800	9000	24.87	17.62	12.77	7.58	4.59	1.80	0.80	69	83	SHLD	FILL	NA	FLEX	**4653**
2015	9000	25.20	18.48	13.69	8.37	5.04	1.62	0.63	70	84	SHLD	FILL	NA	FLEX	**4339**
2200	9000	25.52	17.59	12.52	7.25	4.33	1.61	0.80	70	84	SHLD	FILL	NA	FLEX	**4744**
2400	9000	24.67	18.07	13.44	8.23	5.03	1.69	0.60	69	85	SHLD	FILL	NA	FLEX	**4419**
2600	9000	24.93	17.86	13.18	8.19	5.03	1.89	0.83	68	84	SHLD	FILL	NA	FLEX	**4507**
2767	pob bridge														
2943	poe bridge														
3000	9000	25.52	17.95	13.09	8.16	5.25	2.30	1.01	69	85	SHLD	FILL	NA	FLEX	**4539**
3200	9000	21.95	16.01	12.40	8.50	5.81	2.82	1.16	70	84	SHLD	FILL	NA	FLEX	**4657**
3358	pob Butterworth Rd.														
3564	poe Butterworth Rd.														
3600	9000	29.97	19.57	13.76	8.67	6.13	3.64	1.91	70	86	SHLD	FILL	NA	FLEX	**4318**
3700	9000	26.55	18.90	13.75	8.72	5.86	2.92	1.45	71	85	SHLD	FILL	NA	FLEX	**4319**
3800	9000	26.64	19.11	14.14	8.98	6.04	3.17	1.58	73	87	SHLD	CUT	NA	FLEX	**4200**
3900	9000	28.56	19.31	13.72	8.01	5.07	2.26	1.10	72	87	SHLD	CUT	NA	FLEX	**4330**
4000	9000	29.84	22.33	16.89	10.91	6.94	2.78	1.31	72	87	SHLD	CUT	NA	FLEX	**3516**
4100	9000	26.10	20.50	16.29	11.39	7.85	3.79	1.85	74	87	SHLD	CUT	NA	FLEX	**3476**
4200	9000	26.85	19.99	15.41	10.50	7.34	4.04	2.14	74	87	SHLD	CUT	NA	FLEX	**3771**
4250	9000	29.62	20.63	15.13	9.80	6.61	3.47	1.94	73	88	SHLD	CUT	NA	FLEX	**3927**
4300	9000	29.38	20.93	15.65	10.36	7.13	3.69	1.94	72	88	SHLD	CUT	NA	FLEX	**3796**
4350	9000	30.66	21.87	16.45	10.75	7.38	3.89	2.04	72	87	SHLD	CUT	NA	FLEX	**3611**
4400	9000	25.02	18.78	14.52	9.72	6.76	3.58	1.87	73	85	SHLD	CUT	NA	FLEX	**4075**
4451	9000	24.34	18.21	14.05	9.18	6.26	3.15	1.59	75	87	SHLD	CUT	NA	FLEX	**4227**
4500	9000	22.67	17.16	13.27	8.94	6.11	3.07	1.47	73	87	SHLD	CUT	NA	FLEX	**4428**
4600	9000	21.56	15.10	11.00	6.87	4.50	2.07	0.80	73	86	SHLD	CUT	NA	FLEX	**5402**
4650	9000	22.28	14.70	10.04	5.71	3.42	1.37	0.48	73	87	SHLD	CUT	NA	FLEX	**5914**
4700	9000	23.43	15.55	10.89	6.29	3.77	1.41	0.41	72	88	SHLD	CUT	NA	FLEX	**5456**
4800	9000	22.88	14.93	10.12	5.39	2.89	0.69	0.20	71	88	SHLD	CUT	NA	FLEX	**5872**
4900	9000	23.51	15.91	10.76	5.77	3.17	0.90	0.32	71	86	SHLD	CUT	NA	FLEX	**5519**
5000	9000	24.75	15.07	9.47	4.59	2.34	0.48	0.12	71	85	SHLD	CUT	NA	FLEX	**6270**
5100	9000	22.74	14.89	9.88	5.26	2.79	0.66	0.10	71	84	SHLD	CUT	NA	FLEX	**6014**
5200	9000	22.27	15.54	11.08	6.66	4.16	1.90	0.90	71	86	SHLD	CUT	NA	FLEX	**5363**
5300	9000	23.28	15.16	9.82	4.99	2.73	0.54	0.15	71	85	SHLD	CUT	NA	FLEX	**6049**
5400	9000	21.09	14.07	9.73	5.29	2.94	0.80	0.16	71	84	SHLD	CUT	NA	FLEX	**6105**
5500	9000	20.85	14.88	10.75	6.81	4.61	2.37	1.04	70	82	SHLD	CUT	NA	FLEX	**5524**
5600	9000	21.39	14.83	10.89	7.30	5.33	3.23	1.72	71	82	SHLD	FILL	NA	FLEX	**5427**
5650	9000	21.08	14.98	11.03	7.47	5.54	3.64	2.17	71	84	SHLD	FILL	NA	FLEX	**5299**

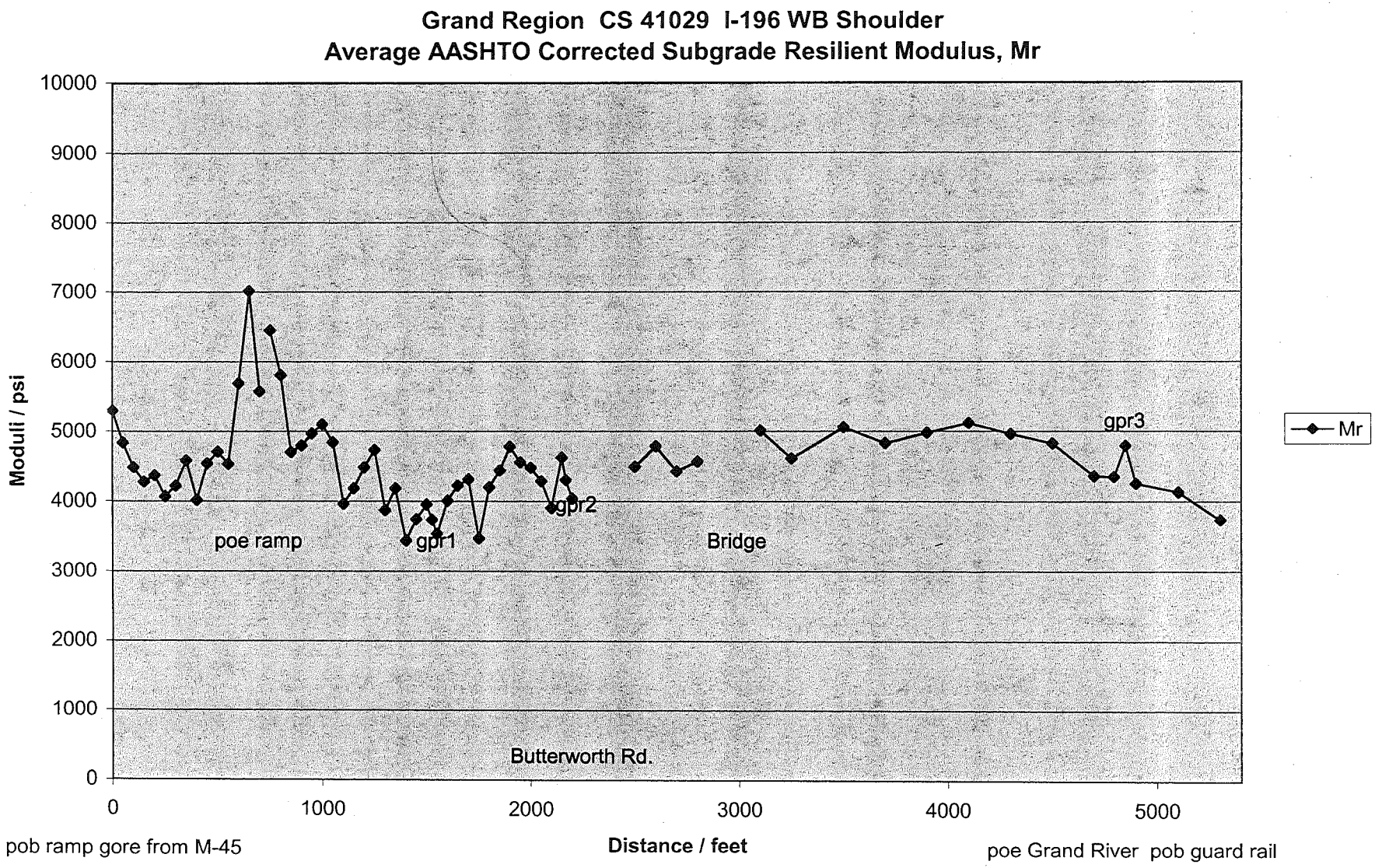
5664	9000	20.81	15.61	11.90	8.24	6.09	3.86	2.28	73	83	SHLD	FILL	NA	FLEX	**4808**
5700	9000	19.37	15.62	12.81	9.52	7.10	4.18	2.17	69	83	SHLD	FILL	NA	FLEX	**4161**
6200	9000	13.29	10.98	9.04	6.58	4.52	1.80	0.26	68	83	SHLD	CUT	NA	FLEX	**6021**
6300	9000	15.90	12.72	10.20	7.08	4.66	1.76	0.20	70	84	SHLD	FILL	NA	FLEX	**5591**
6400	9000	16.17	12.85	10.32	7.22	5.00	2.08	0.37	70	85	SHLD	FILL	NA	FLEX	**5482**
6500	9000	12.46	10.40	8.78	6.81	5.08	2.54	0.46	71	86	SHLD	FILL	NA	FLEX	**5818**
6600	9000	12.36	10.50	9.01	7.03	5.29	2.77	0.66	71	86	SHLD	FILL	NA	FLEX	**5611**
6700	9000	12.53	10.75	9.40	7.84	6.28	4.05	1.73	70	85	SHLD	FILL	NA	FLEX	**4729**
6800	9000	10.18	8.92	7.86	6.41	5.20	3.34	1.41	70	86	SHLD	FILL	NA	FLEX	**5715**
6871	poe M-45 W. edge														
Average		**23.17**	**16.67**	**12.38**	**7.92**	**5.24**	**2.46**	**1.11**	**71**	**85**					**4814**
Stdev.		**4.90**	**3.14**	**2.29**	**1.68**	**1.37**	**1.04**	**0.65**	**2**	**2**					**795**
Max.		**30.66**	**22.33**	**16.89**	**11.39**	**7.85**	**4.18**	**2.28**	**75**	**88**					**6270**
Min.		**10.18**	**8.92**	**7.86**	**4.59**	**2.34**	**0.48**	**0.10**	**67**	**77**					**3476**
C. of V.		**21%**	**19%**	**19%**	**21%**	**26%**	**42%**	**59%**	**3%**	**3%**					**17%**

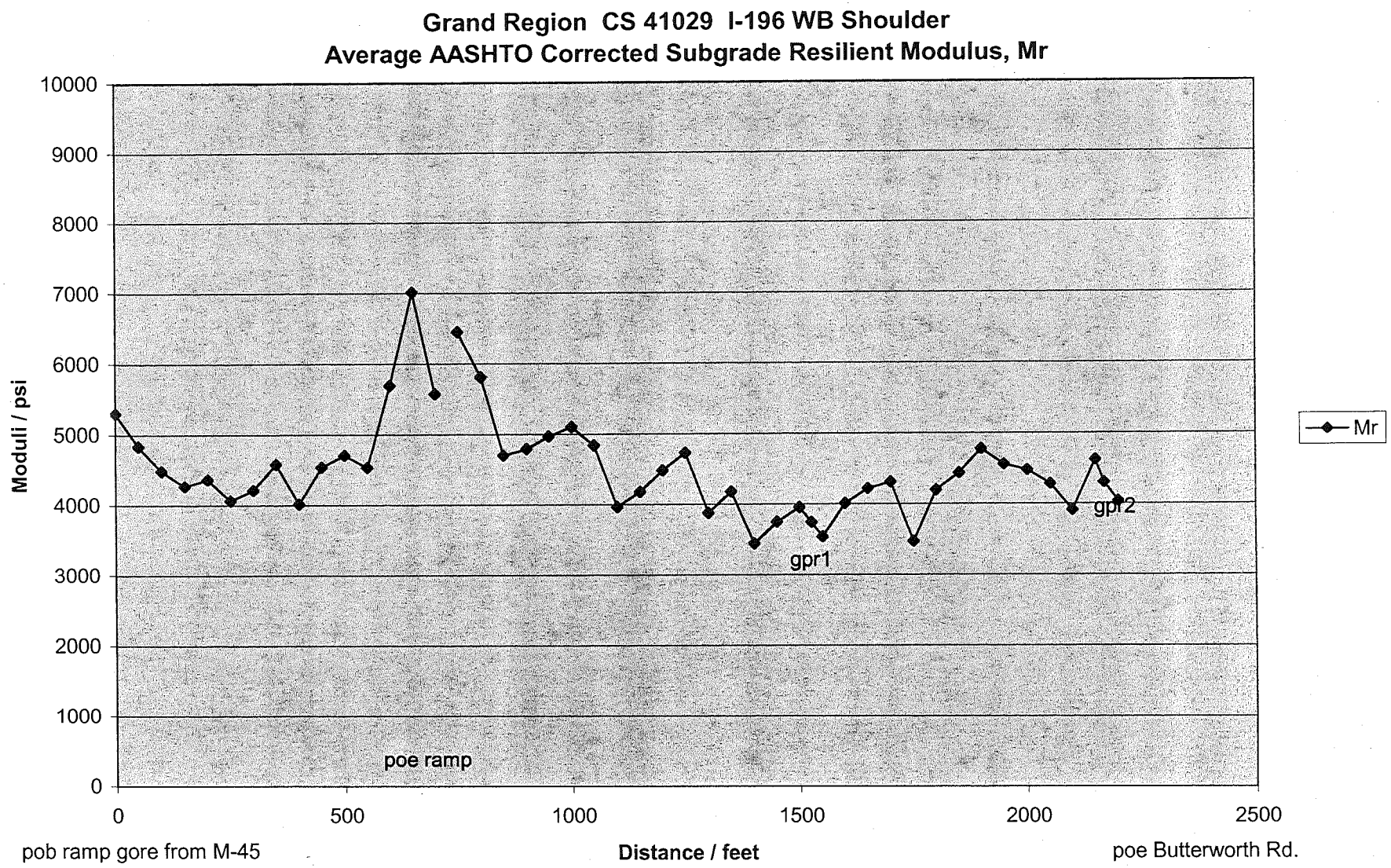

Grand Region CS 41029 I-196 WB Shoulder
Average Maximum Deflection @ 9000 lbf @ 71 F
Deflection / mils
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
-40.00
-45.00
0
1000
2000
3000
4000
5000
Distance / feet
pob gore from M-45 ramp
poe Grand River pob guard rail
poe ramp
gpr1
gpr2
gpr3
Bridge
Butterworth Bridge
Approximate Mine Location
Butterworth Rd.
Station 410
Sensors
0(load plate)
8"
12"
18"
24"
60"
behind load plate

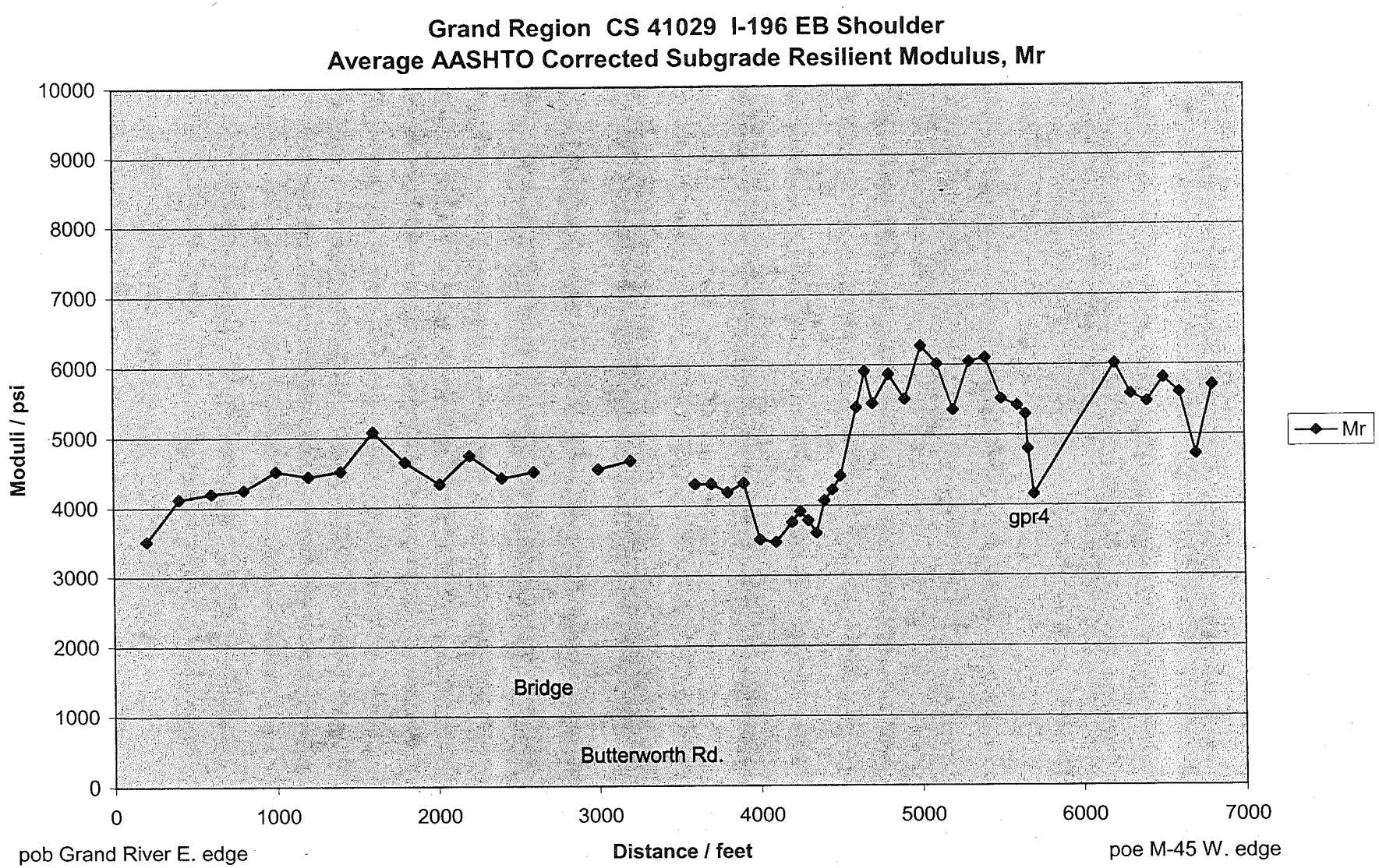

Grand Region CS 41029 I-196 WB Shoulder
Average Maximum Deflection @ 9000 lbf @ 71 F
Deflection / mils
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
-40.00
-45.00
0
500
1000
1500
2000
2500
Distance / feet
poe ramp
gpr1
gpr2
Sensors
0(load plate)
8"
12"
18"
24"
36"
60"
behind load plate
pob ramp gore from M-45
poe Butterworth Rd.

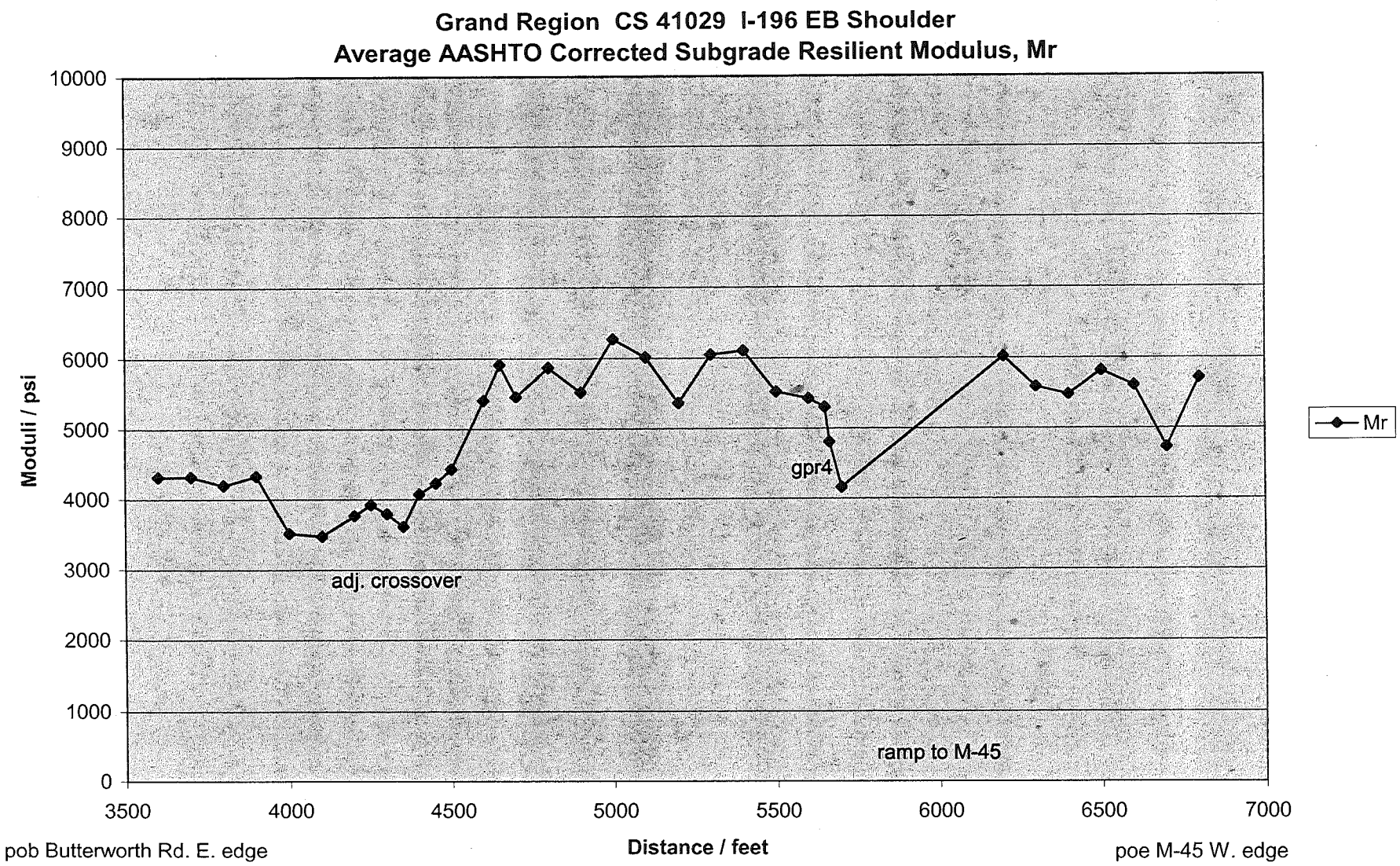

Grand Region CS 49029 I-196 EB Shoulder
Average Maximum Deflection @ 9000 lbf @ 85 F
Deflection / mils
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
0
1000
2000
3000
4000
5000
6000
7000
Distance / feet
pob Grand River E. edge
poe M-45 W. edge
Bridge
Butteerworth Rd.
gpr4
Sensors
0(load plate)
8"
12"
18"
24"
36"
60"
behind load plate


Grand Region CS 41029 I-196 EB Shoulder
Average Maximum Deflection @ 9000 lbf @ 85 F
Deflection / mils
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
3500
4000
4500
5000
5500
6000
6500
7000
Distance / feet
pob Butterworth Rd. E. edge
poe M-45 W. edge
adj crossover
gpr4
ramp to M-45
Sensors
0(load plate)
8"
12"
18"
24"
36"
60"
behind load plate


Grand Region CS 41029 I-196 WB Shoulder
Average AASHTO Corrected Subgrade Resilient Modulus, Mr
Moduli / psi
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
1000
2000
3000
4000
5000
Distance / feet
pob ramp gore from M-45
poe Grand River pob guard rail
poe ramp
gpr1
gpr2
Bridge
gpr3
Butterworth Rd.
Mr


Grand Region CS 41029 I-196 WB Shoulder
Average AASHTO Corrected Subgrade Resilient Modulus, Mr
Moduli / psi
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
500
1000
1500
2000
2500
poe ramp
gpr1
gpr2
Mr
pob ramp gore from M-45
Distance / feet
poe Butterworth Rd.


Grand Region CS 41029 I-196 EB Shoulder
Average AASHTO Corrected Subgrade Resilient Modulus, Mr
Moduli / psi
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
1000
2000
3000
4000
5000
6000
7000
Distance / feet
pob Grand River E. edge
poe M-45 W. edge
Bridge
Butterworth Rd.
gpr4
Mr


Grand Region CS 41029 I-196 EB Shoulder
Average AASHTO Corrected Subgrade Resilient Modulus, Mr
Moduli / psi
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
3500
4000
4500
5000
5500
6000
6500
7000
Distance / feet
adj. crossover
gpr4
ramp to M-45
Mr
pob Butterworth Rd. E. edge
poe M-45 W. edge