

Measuring Dust from Unpaved Roads and Its Impact on Crops & Livestock

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INTRODUCTION

- ❖ Unpaved roads are the largest source of particulate air pollution in the United States
- ❖ Effects of dust from unpaved roads include:
 - Stunting plant growth due to the shading effect and clogging of the plant's pores
 - Health problems such as hay fever and allergies
 - Reduction in visibility and causing driving hazards for drivers
 - Increasing particulate loading of lakes and streams after precipitation

PROBLEM STATEMENT

- ❖ Due to the increased traffic volumes related to energy sector in western North Dakota, dust along many unpaved roads is causing many complaints
 - Farmers and ranchers complain that dust from unpaved roads due to heavy trucks has stunted crops, damaged pasture, and caused allergic reactions in livestock
- ❖ There is a need to measure the amount of dust and its effect on crops & livestock

OBJECTIVES

- ❖ Literature review of the effect of dust from unpaved roads on crops and livestock
- ❖ Measure and compare dust from unpaved roads in five counties in North Dakota considering traffic, material type, and weather conditions
- ❖ Determine the effect of dust from unpaved roads on crops and livestock using survey

LITERATURE REVIEW

- ❖ Effect of dust on crops:
 - Reduced photosynthesis
 - Stomatal interference
 - Increased incidence of plant pests and disease
 - Reduced spray effectiveness

- ❖ Effect of dust from unpaved roads on livestock:
 - Dust pneumonia
 - Pinkeye
 - Change in grazing patterns
 - Excessive teeth wear

TEST SITES AND SETUP

County	Intersection	Counter Location	Locations of Post with Jars	
			East	West
Cass	163 rd Ave SE (Co. 11) and 15 th St SE (Co. 2), Grandin	South of Intersection	South side of 15 th St SE (Co. 2)	
Grand Forks	17 th St NE (Co. 5) and 10 th St, Manvel	South of Intersection	South side of 10 th St	
Mountrail	101 st Ave NW and 63 rd St NW, White Earth	North of Intersection	North side of 63 rd St NW	
McKenzie	155 th Ave NW and 36 th St NW, Cartwright	South of Intersection	South side of 36 th St NW	North side of 36 th St NW
Williams	119 th Ave NW (Co. 15) and 60 th St NW (Co. 8), Ray	North of Intersection	North side of 60 th St NW (Co. 8)	

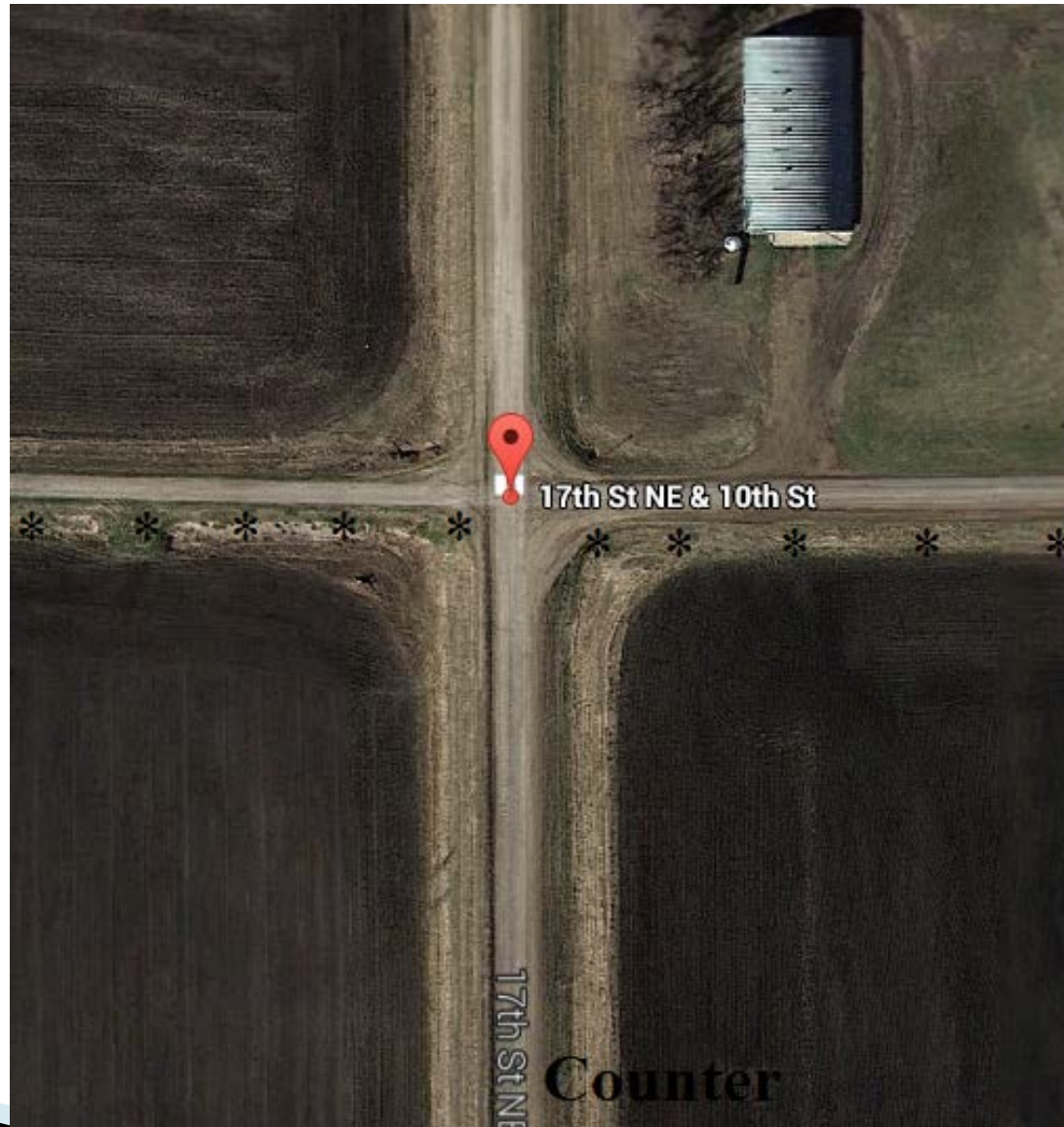


Cass County: Co. 2 & Co. 11 in Grandin



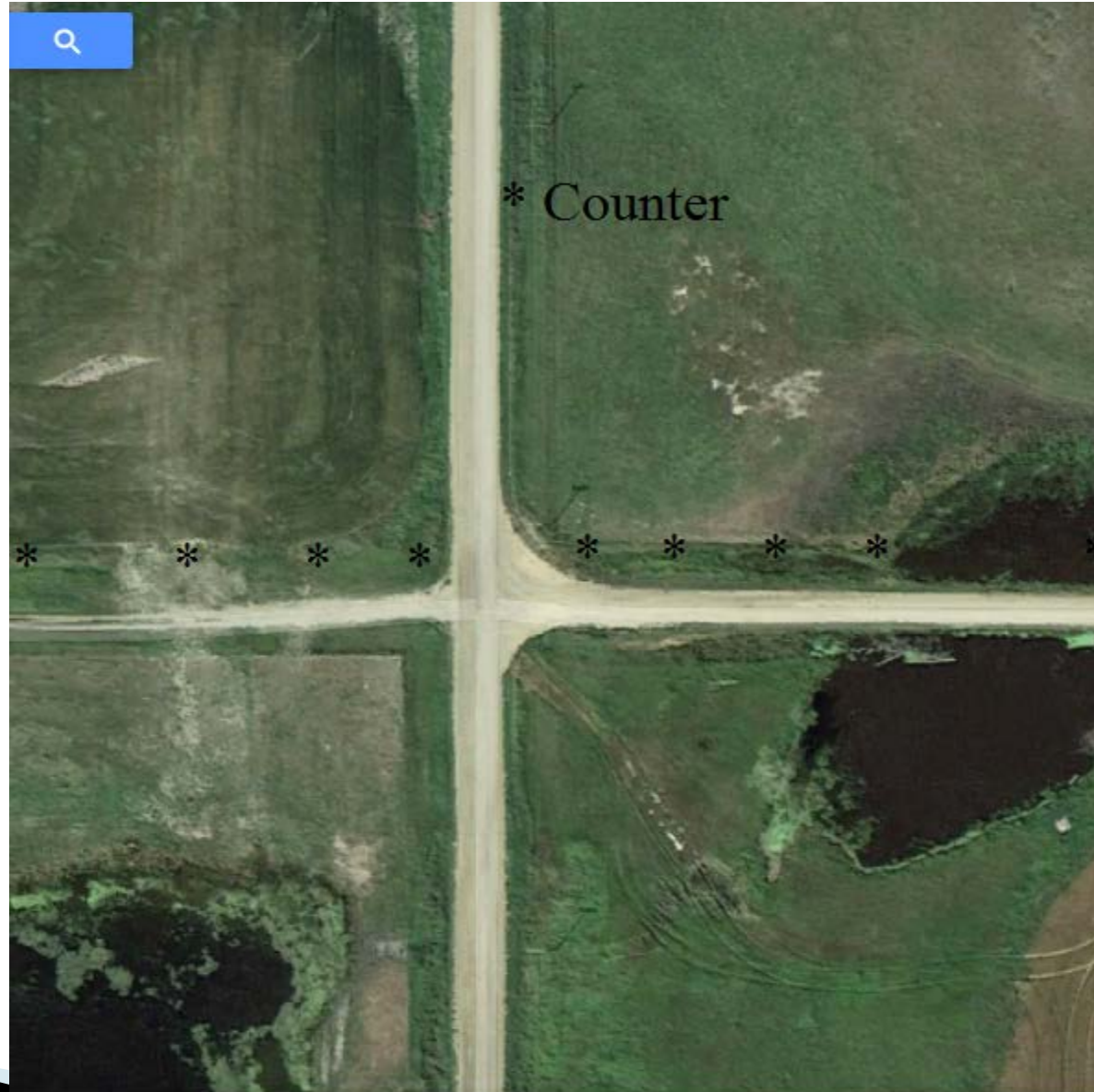


Grand Forks County: Co. 5 & 10th St in Manvel





Mountrail County: 101st Ave NW & 63rd St NW in White Earth





Mountrail County: East of 101st Ave NW on 63rd St NW



McKenzie County: 155th Ave NW & 36th St NW in Cartwright

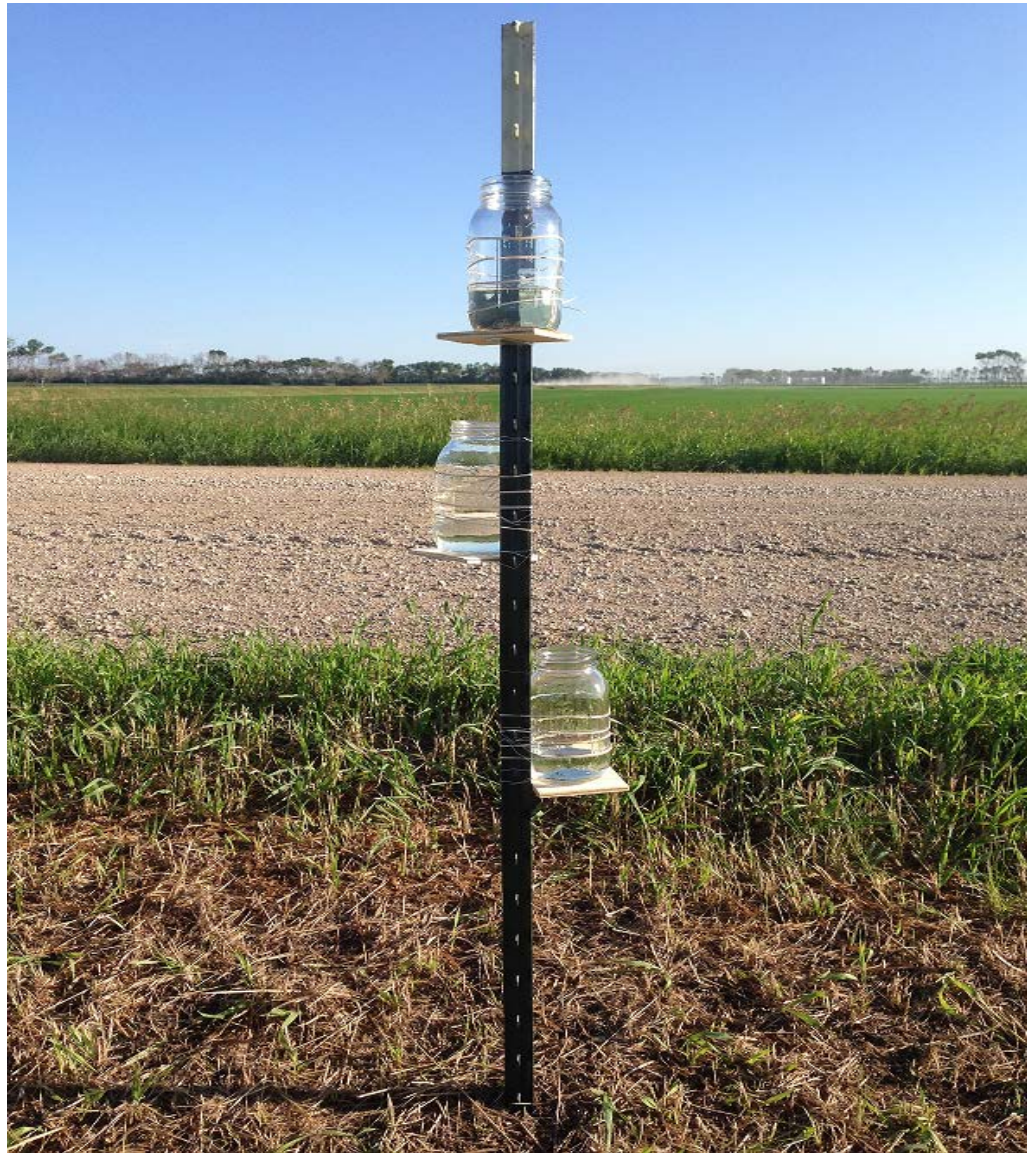


Williams County: Co. 8 & Co. 15 in Ray





Typical Metal Post with Mason Jars at Grand Forks site



Traffic Counter on Major Road at Grand Forks Site



DATA COLLECTIONS

County	July-August		August-September		September-October	
	Beginning	End	Beginning	End	Beginning	End
Cass	7-9-2014	8-9-2014	8-9-2014	9-11-2014	9-11-2014	10-8-2014
	31 days		33 days		27 days	
Grand Forks	7-9-2014	8-6-2014	8-6-2014	9-8-2014	9-8-2014	10-8-2014
	28 days		29 days		30 days	
Mountrail	7-2-2014	8-7-2014	8-7-2014	9-9-2014	9-9-2014	10-9-2014
	36 days		33 days		30 days	
McKenzie	7-3-2014	8-8-2014	8-8-2014	9-10-2014	9-10-2014	10-9-2014
	36 days		33 days		29 days	
Williams	7-2-2014	8-7-2014	8-7-2014	9-9-2014	9-9-2014	10-9-2014
	36 days		33 days		30 days	



Material and Treatment Type Data

County	Material Specification	PI (%)	Treatment Type	Treatment Frequency
Cass	4-5 inches of NDDOT Class 13	2-4	None	
Grand Forks	3-4 inches of NDDOT Class 13	2-4	None	
Mountrail	NDDOT 5		Calcium chloride (35%)	Once a month
McKenzie	NDDOT 5	0	Magnesium chloride (30%)	Once during project duration
			Water	As needed
Williams	No response			

Mountrail County Site



McKenzie County Site



Williams County Site



DATA COLLECTIONS (*Continued*)

❖ Weather Data:

- Cass -Hector International Airport in Fargo
- Grand Forks-Grand Forks International Airport
- Mountrail and Williams-Tioga Municipal Airport
- McKenzie-Watford City Municipal Airport and Sloulin Field International Airport in Williston

❖ Survey of the effect of dust from unpaved road on crop yield and livestock

- Online
- Over the phone

Response and Drop Rates for Each Question

Effect on	Question Number	Response Rate		Drop Rate	
		Number	Percent	Number	Percent
Crop Yield	2	44	77.19	3	5.3
	3	39	68.42	10	17.5
	4	20	35.09		0.0
	5	17	29.82		0.0
	6	20	35.09	1	1.8
	7	15	26.32		0.0
	8	18	31.58		0.0
	9	19	33.33	2	3.5
	10	16	28.07		0.0
	11	16	28.07	4	7.0
Livestock	12	35	61.40	13	22.8
	13	13	22.81	3	5.3
	14	9	15.79	6	10.5
	15	5	8.77		0.0
	16	5	8.77		0.0
	17	3	5.26		0.0
	18	5	8.77	1	1.8
	19	4	7.02	1	1.8

Response Dates and Corresponding Number of Respondents

Month	Date	Number	Percent
September	9	1	1.75
	16	2	3.51
	17	14	24.56
	18	7	12.28
	19	3	5.26
	21	2	3.51
	23	1	1.75
	24	1	1.75
	27	1	1.75
	29	1	1.75
October	3	8	14.04
	4	6	10.53
	5	4	7.02
	6	5	8.77
	16	1	1.75
	Total	57	100

DATA ANALYSIS

- ❖ Dust from each jars was run through Sieve No. 20 and then filtered using filter paper
- ❖ Dust retained by the filter was then oven dried
- ❖ PH of the solution in each jar was determined
- ❖ Water chemistry was analyzed at Environmental Lab at Fargo Water Treatment Plant

RESULTS

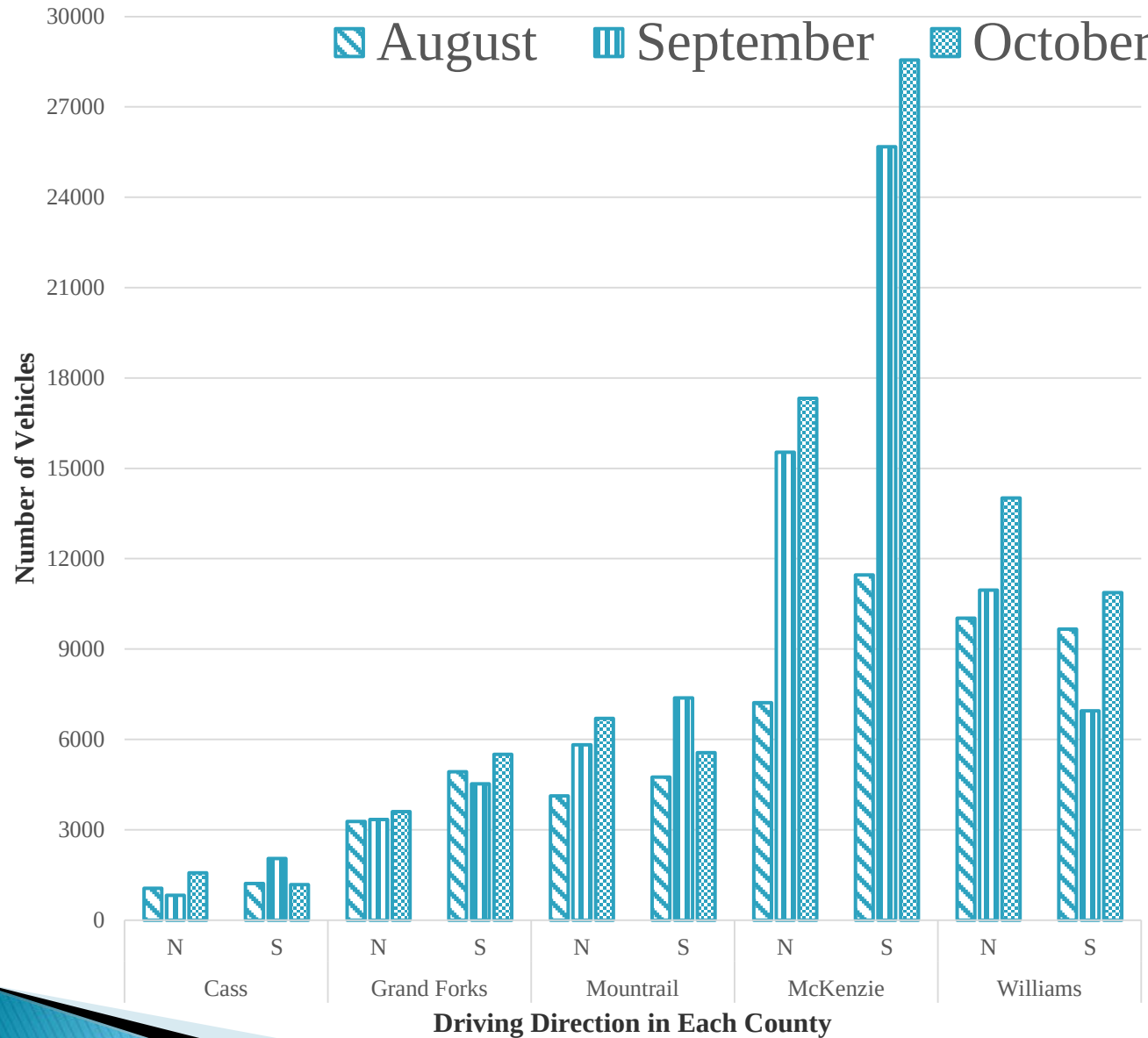


Total Number of Vehicles and Average Daily Traffic (ADT)

County	Direction	July-August		August-September		September-October	
		Vehicles	ADT	Vehicles	ADT	Vehicles	ADT
Cass	North	1063	34	824	27	1571	51
	South	1219	39	2049	66	1181	38
	Total	2282	37	2873	46	2752	44
GF	North	3275	106	3339	108	3606	116
	South	4929	159	4525	146	5509	178
	Total	8204	132	7864	127	9115	147
Mountrail	North	4130	133	5823	188	6702	216
	South	4755	153	7378	238	5566	180
	Total	8885	143	13201	213	12268	198
McKenzie	North	7226	233	15541	501	17329	559
	South	11462	370	25676	828	28559	921
	Total	18688	301	41217	665	45888	740
Williams	North	10030	324	10964	354	14020	452
	South	9660	312	6951	224	10878	351
	Total	19690	318	17915	289	24898	402

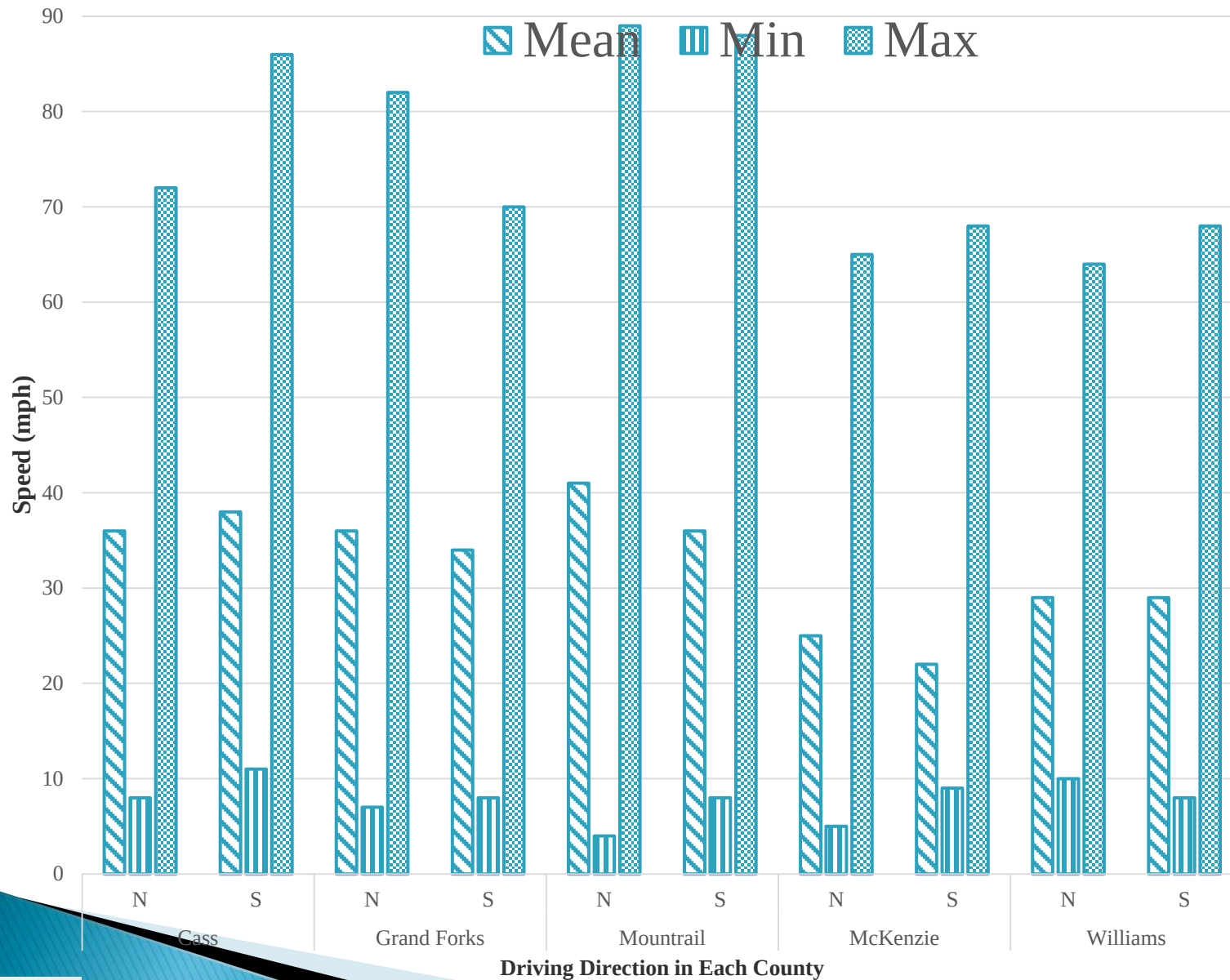


Total Number of Vehicles at Each site



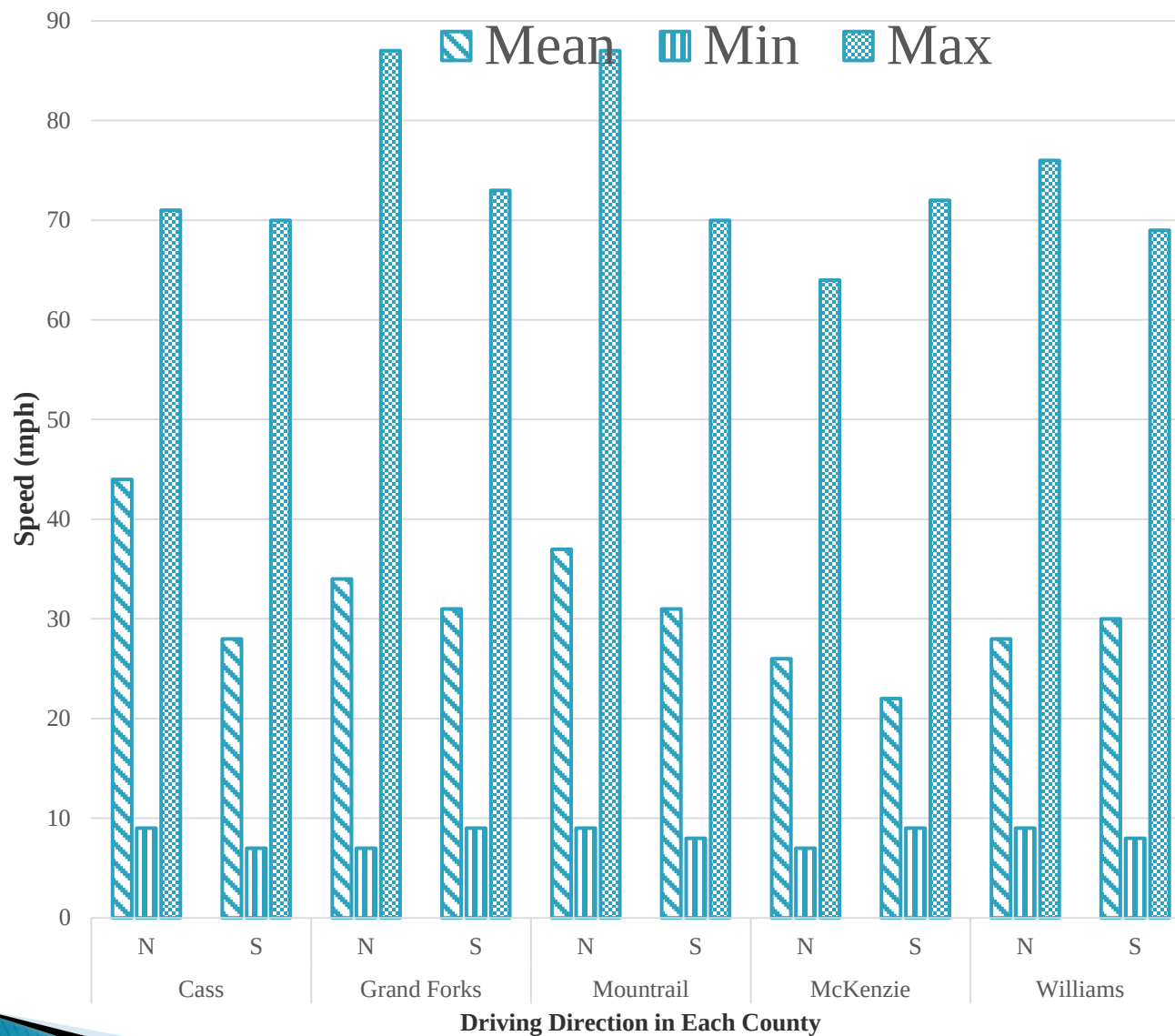


July-August Mean, Minimum, and Maximum Vehicle Speed



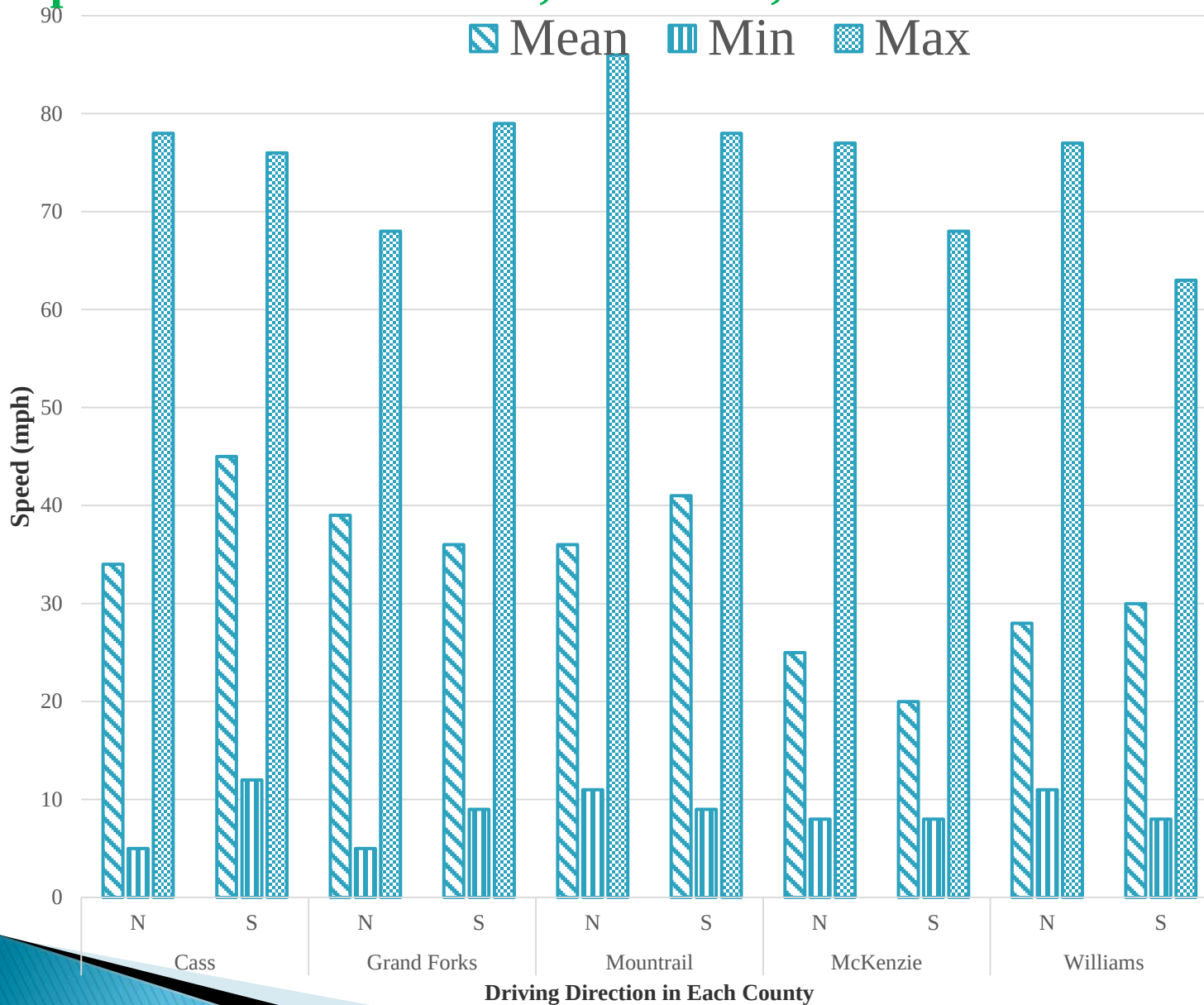


August-September Mean, Minimum, and Maximum Vehicle Speed





September-October Mean, Minimum, and Maximum Vehicle Speed





July-August Traffic Speed Frequency Distribution in Percent

Speed Range (mph)	Cass		Grand Forks		Mountrail		McKenzie		Williams	
	N	S	N	S	N	S	N	S	N	S
0-5	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
6-10	9.4	0.0	3.1	0.3	0.3	0.4	0.7	0.2	0.0	0.5
11-15	11.5	2.3	8.0	5.5	0.8	4.0	7.9	10.9	4.5	1.8
16-20	3.2	20.3	4.0	16.5	1.5	8.1	24.5	42.1	11.3	8.3
21-25	5.7	7.6	3.8	13.6	3.9	7.3	28.2	27.3	24.7	23.5
26-30	4.5	4.7	6.2	9.8	9.0	11.7	17.8	8.8	23.4	30.5
31-35	4.2	8.6	12.1	9.7	16.7	15.4	10.0	4.2	14.7	19.0
36-40	11.2	10.2	19.4	11.5	17.1	19.1	5.8	2.7	9.9	8.5
41-45	12.6	12.0	20.6	11.0	19.6	14.3	3.0	2.0	6.0	4.1
46-50	14.4	9.2	13.3	8.8	14.0	10.5	1.2	1.3	3.1	2.0
51-55	11.2	9.2	7.1	6.4	8.5	5.0	0.5	0.3	1.5	1.0
56-60	8.4	6.2	1.9	4.1	4.6	2.4	0.3	0.2	0.6	0.5
61-65	3.1	5.4	0.5	1.9	2.0	0.9	0.1	0.1	0.3	0.1
66-70	0.3	3.1	0.1	0.9	1.0	0.5	0.0	0.1	0.0	0.0
71-75	0.2	1.0	0.1	0.0	0.3	0.3	0.0	0.0	0.0	0.0
76-80	0.0	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
81-85	0.0	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0
86-90	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Total	100	100	100	100	100	100	100	100	100	100





August-September Traffic Speed Frequency Distribution in Percent

Speed Range (mph)	Cass		Grand Forks		Mountrail		McKenzie		Williams	
	N	S	N	S	N	S	N	S	N	S
0-5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6-10	0.9	2.1	0.9	2.1	0.2	0.4	0.2	0.1	0.3	0.4
11-15	1.9	35.7	1.9	35.7	1.6	2.0	2.7	5.7	5.7	3.9
16-20	1.6	8.7	1.6	8.7	3.5	8.9	17.1	40.2	16.7	10.1
21-25	2.8	3.5	2.8	3.5	9.2	21.9	33.1	33.2	29.8	21.5
26-30	5.3	4.7	5.3	4.7	14.6	20.5	24.6	13.6	18.3	20.8
31-35	8.2	4.9	8.2	4.9	22.0	15.1	13.5	3.2	9.8	16.1
36-40	11.0	5.8	11.0	5.8	16.7	13.5	5.2	1.6	7.5	12.9
41-45	17.9	6.8	17.9	6.8	11.6	8.8	2.2	1.2	5.7	7.4
46-50	18.2	8.2	18.2	8.2	10.8	5.1	1.0	0.7	3.5	3.8
51-55	19.7	6.6	19.7	6.6	5.0	2.5	0.4	0.3	2.0	2.2
56-60	8.5	5.8	8.5	5.8	2.5	0.9	0.1	0.1	0.5	0.7
61-65	3.1	4.9	3.1	4.9	1.3	0.3	0.1	0.0	0.2	0.2
66-70	0.6	2.0	0.6	2.0	0.6	0.2	0.0	0.0	0.0	0.1
71-75	0.3	0.1	0.3	0.1	0.3	0.0	0.0	0.0	0.0	0.0
76-80	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
Total	100	100	100	100	100	100	100	100	100	100



Sep.-October Traffic Speed Frequency Distribution in Percent

Speed Range (mph)	Cass		Grand Forks		Mountrail		McKenzie		Williams	
	N	S	N	S	N	S	N	S	N	S
0-5	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6-10	3.6	0.0	1.4	0.4	0.0	0.1	0.2	0.1	0.0	0.1
11-15	20.7	0.4	9.2	11.0	0.6	0.5	2.8	12.3	1.1	2.8
16-20	13.0	4.2	8.4	7.8	3.5	2.1	18.7	50.0	15.3	11.1
21-25	3.1	3.1	3.9	6.1	12.2	4.4	36.9	24.8	30.8	20.4
26-30	2.5	5.3	5.5	12.7	15.6	9.7	23.6	7.4	20.7	22.6
31-35	3.8	8.1	9.9	11.3	14.8	12.4	10.9	2.7	12.4	19.5
36-40	7.6	10.7	19.7	13.1	18.7	19.9	4.2	1.1	8.6	13.0
41-45	12.2	17.1	20.2	10.9	15.4	17.8	1.5	0.8	5.7	6.6
46-50	10.9	15.8	13.8	10.4	10.6	15.6	0.7	0.4	3.3	2.2
51-55	11.5	14.7	5.8	8.6	5.4	8.9	0.2	0.2	1.3	1.0
56-60	5.6	9.8	1.5	4.6	1.7	5.0	0.1	0.1	0.6	0.6
61-65	3.5	5.9	0.3	2.0	1.1	2.3	0.0	0.1	0.2	0.1
66-70	1.6	3.9	0.1	0.8	0.1	0.8	0.0	0.0	0.0	0.0
71-75	0.2	0.9	0.0	0.2	0.0	0.5	0.0	0.0	0.0	0.0
76-80	0.2	0.2	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0
Total	100	100	100	100	100	100	100	100	100	100

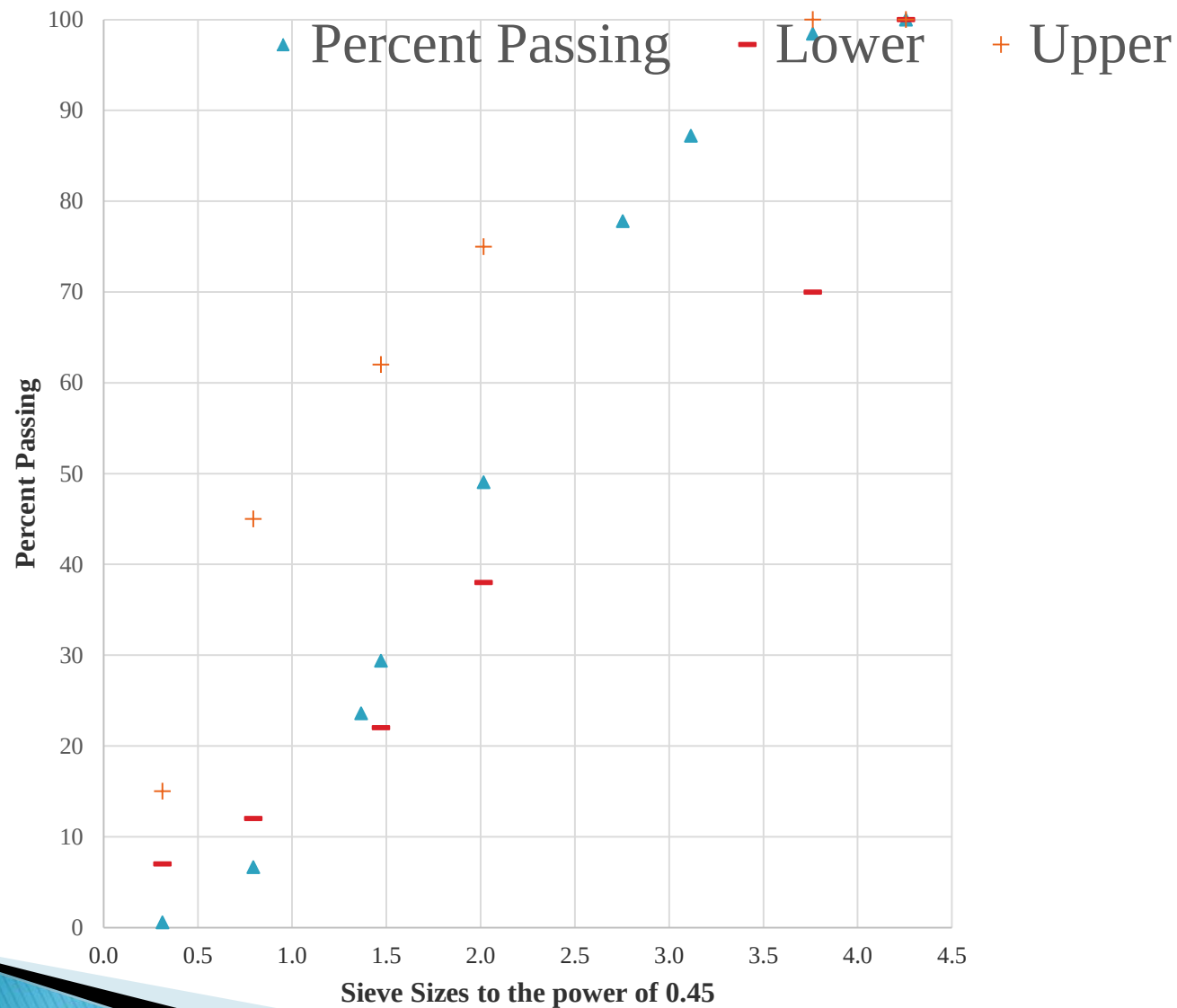


Weather Effect: Precipitation

Month	Cass	Grand Forks	Mountrail	McKenzie	Williams
July-August	1.59	2.94	2.06	0.74	2.06
August-September	3.92	3.22	2.18	1.38	2.18
September-October	0.28	1.29	0.38	0.67	0.38
Total Precipitation	5.79	7.45	4.62	2.78	4.62

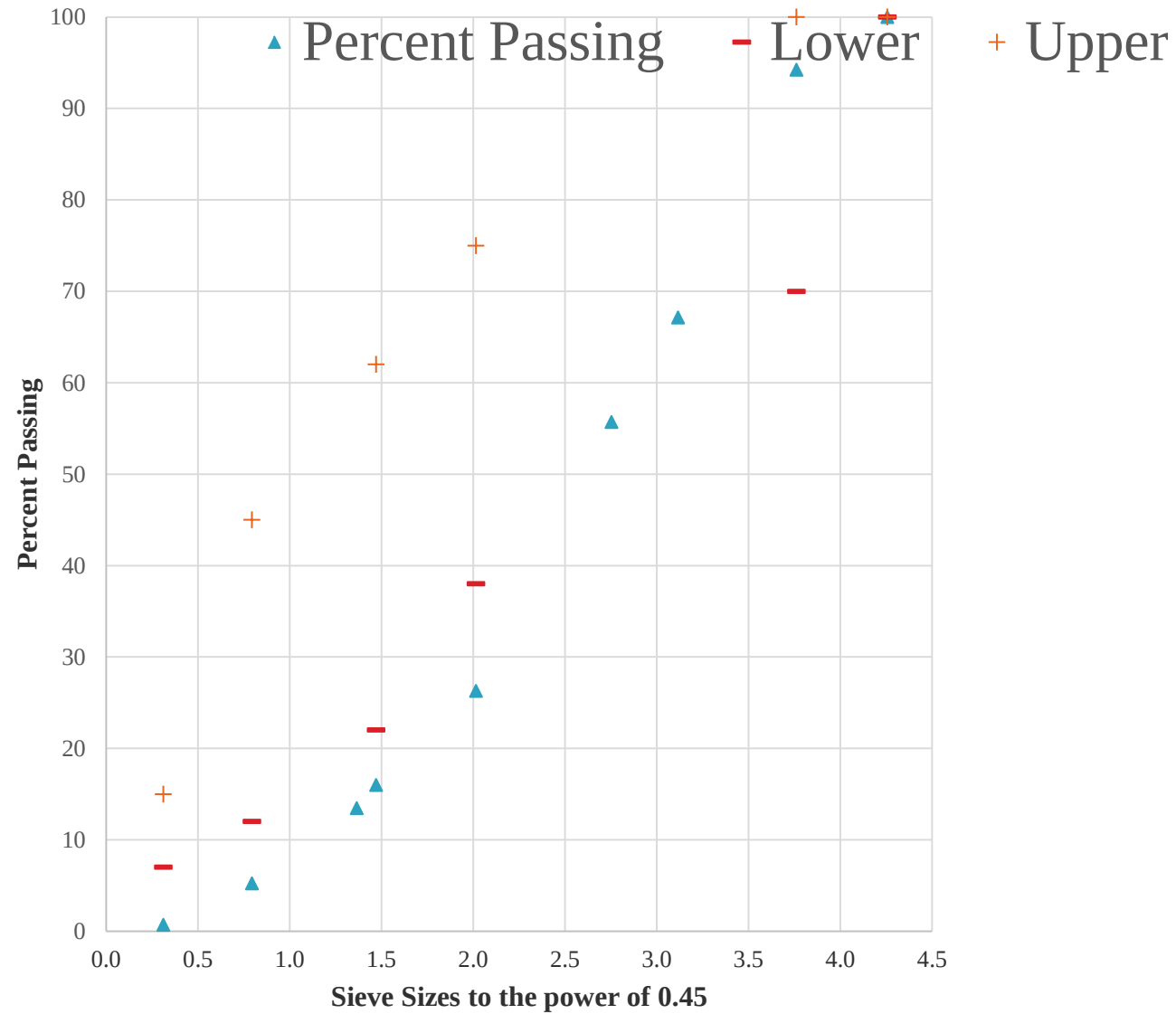


Material Effect Cass County Gradation Curve



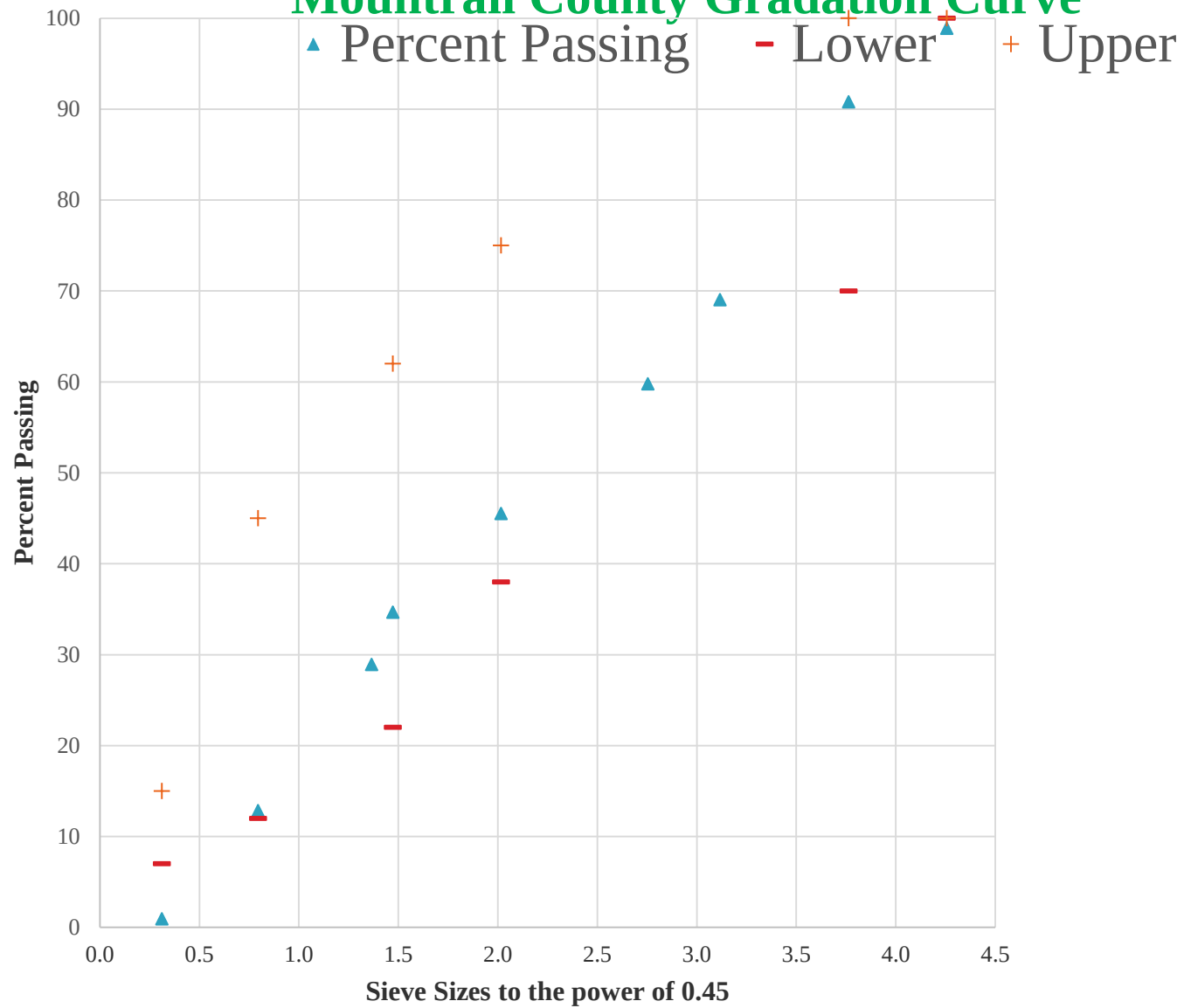


Grand Forks County Gradation Curve





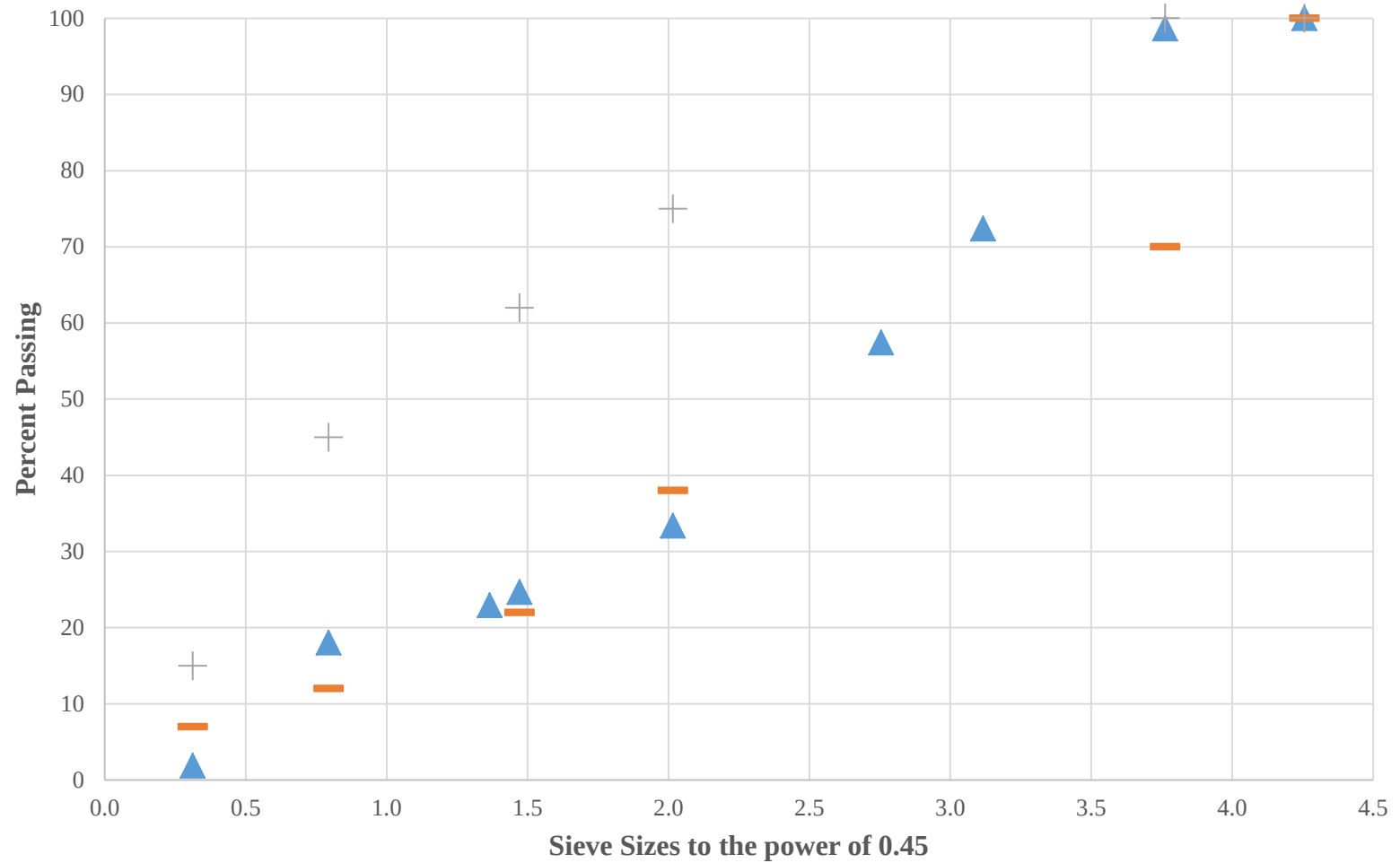
Mountrail County Gradation Curve





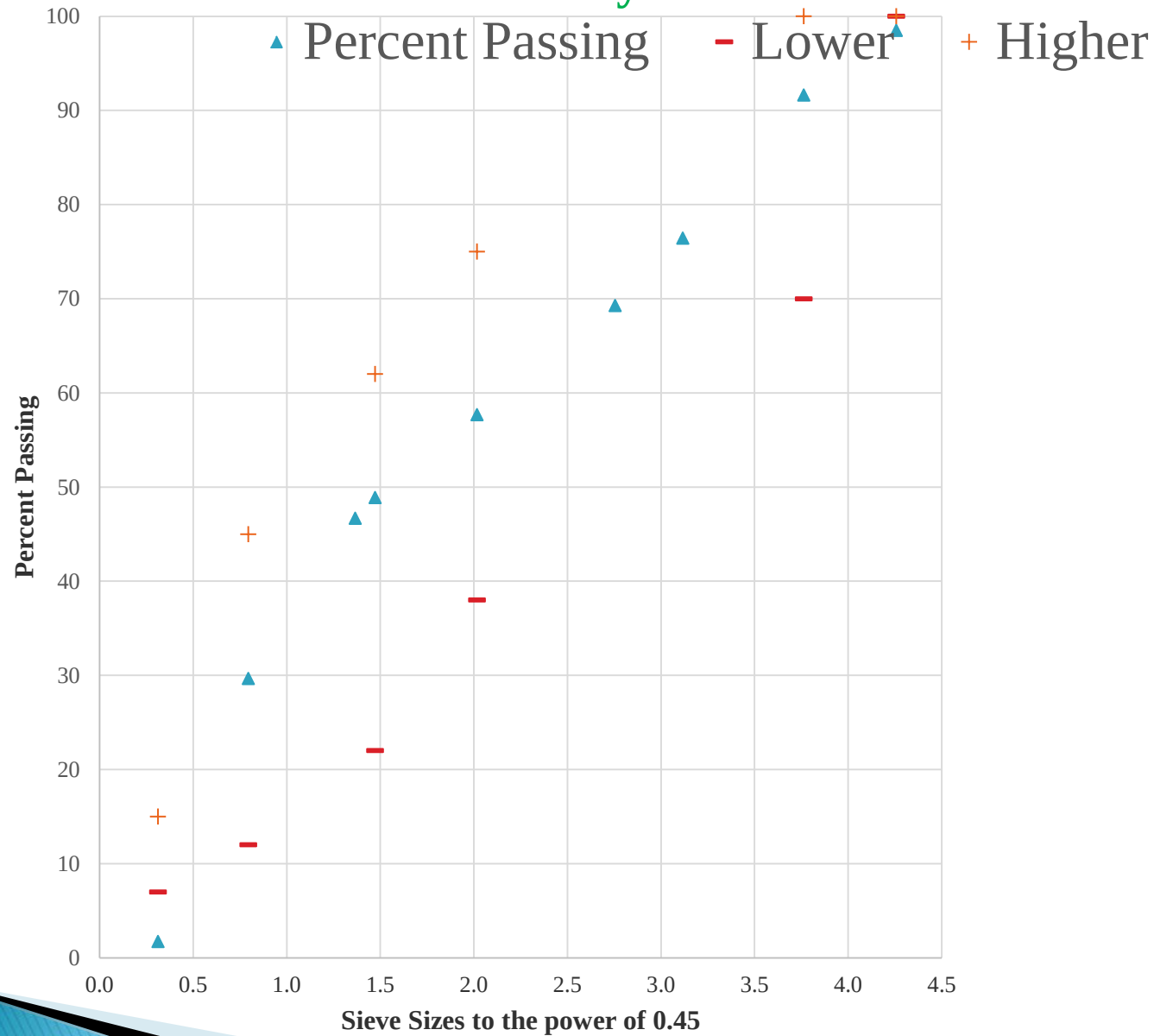
McKenzie County Gradation Curve

▲ Percent Passing — Lower + Upper





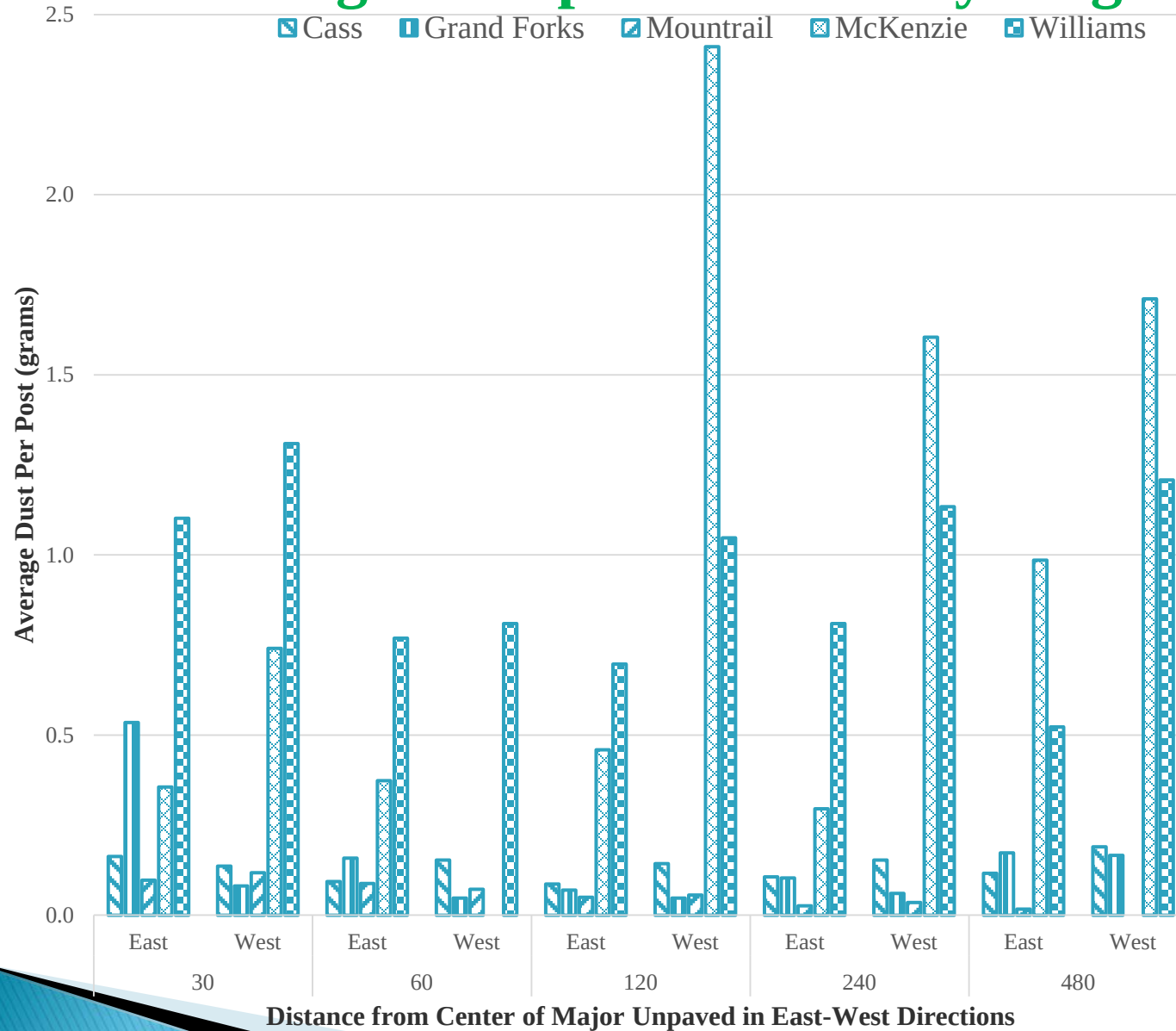
Williams County Gradation Curve



Dust Results



Average Dust per Post in July-August



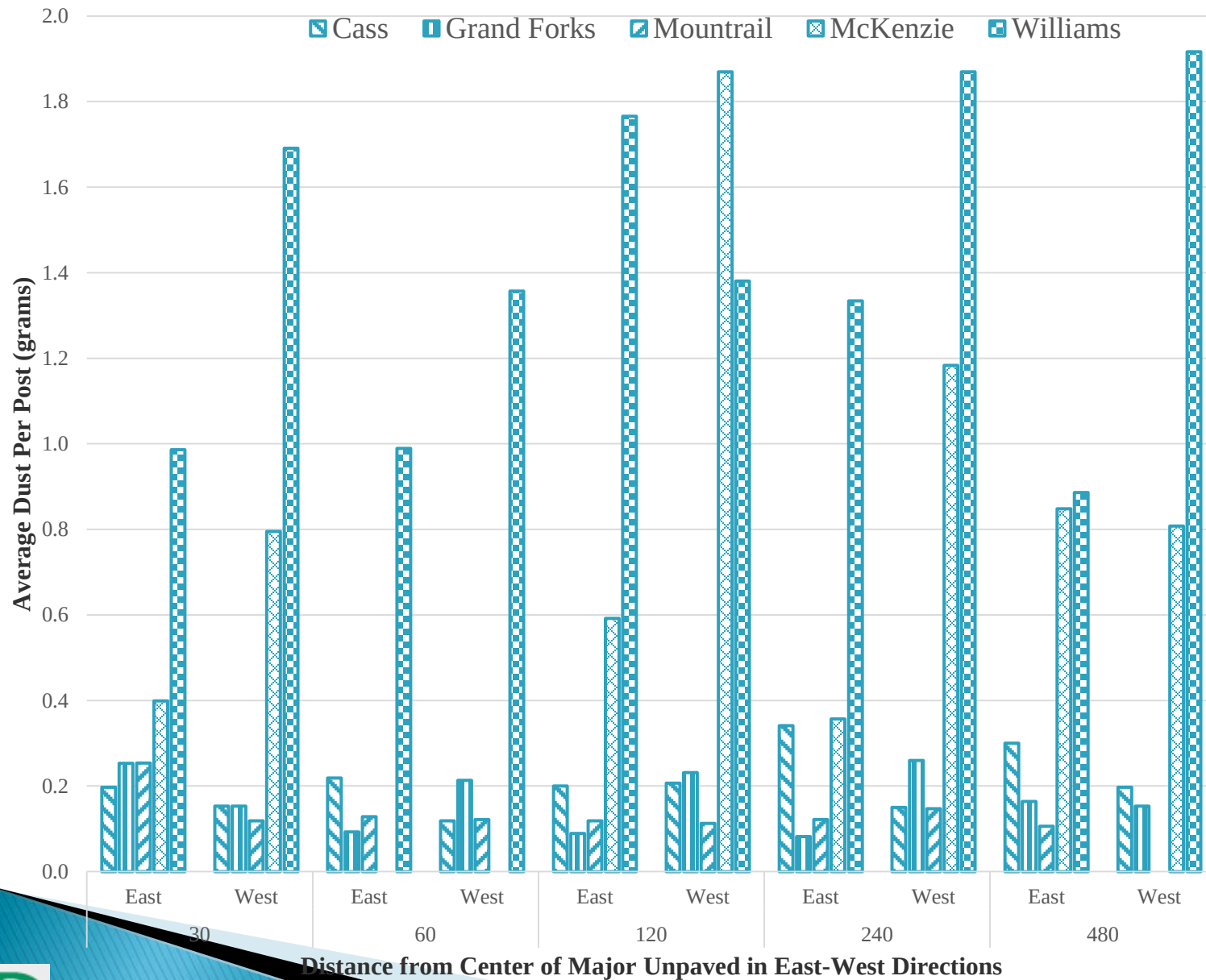


Average Dust per Post (grams) in July-August

Location	Ht (ft)	East						West					
		30	60	120	240	480	Tot	30	60	120	240	480	Tot
Cass	2	0.25	0.11	0.14	0.15	0.13	0.78	0.20	0.21	0.21	0.21	0.29	1.12
	3	0.15	0.10	0.10	0.09	0.12	0.56	0.15	0.13	0.18	0.17	0.20	0.83
	4	0.09	0.07	0.02	0.08	0.10	0.36	0.06	0.12	0.04	0.08	0.08	0.38
	M	0.16	0.09	0.09	0.11	0.12	0.57	0.14	0.15	0.14	0.15	0.19	0.78
Grand Forks	2	0.99	0.28	0.10	0.14	0.23	1.74	0.09	0.07	0.09	0.11	0.18	0.53
	3	0.41	0.11	0.06	0.09	0.20	0.86	0.09	0.06	0.03	0.01		0.19
	4	0.21	0.09	0.06	0.08	0.09	0.52	0.07	0.02	0.02		0.16	0.27
	M	0.54	0.16	0.07	0.10	0.17	1.04	0.08	0.05	0.05	0.06	0.17	0.33
Mountrail	2	0.13	0.13	0.08	0.04	0.03	0.40	0.14	0.12	0.08	0.05		0.39
	3	0.09	0.09	0.05	0.03	0.02	0.28	0.13	0.05	0.03	0.03		0.25
	4	0.07	0.05	0.02	0.01	0.01	0.16	0.09	0.04		0.02		0.15
	M	0.10	0.09	0.05	0.03	0.02	0.28	0.12	0.07	0.06	0.04		0.26
McKenzie	2	0.53	0.51	0.72	0.43	1.23	3.43	1.20		3.78	2.75	3.29	11.01
	3	0.34	0.40	0.40	0.28	0.74	2.15	0.59			1.20	1.21	3.00
	4	0.20	0.21	0.26	0.18		0.84	0.43		1.04	0.87	0.64	2.98
	M	0.36	0.37	0.46	0.30	0.99	2.14	0.74		2.41	1.60	1.71	5.66
Williams	2	1.34	0.90	0.95	0.98	0.65	4.82	1.63	0.96	1.46	1.64	1.76	7.43
	3	1.05	0.81	0.65	0.90	0.52	3.93	1.21	0.80	0.96	1.09	1.13	5.18
	4	0.91	0.60	0.50	0.54	0.40	2.95	1.09	0.67	0.72	0.68	0.74	3.91
	M	1.10	0.77	0.70	0.81	0.52	3.90	1.31	0.81	1.05	1.13	1.21	5.51



Average Dust per Post in August-September



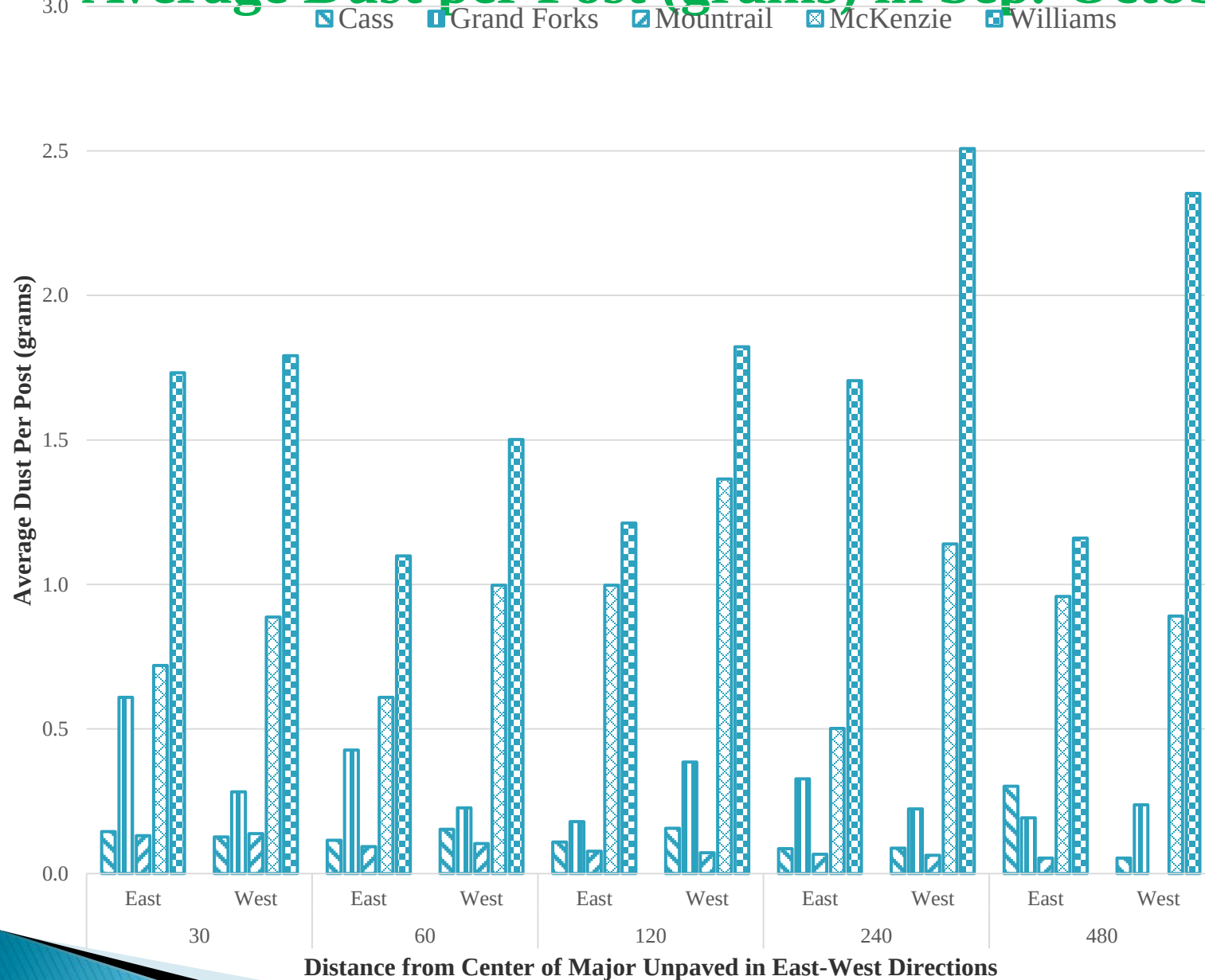


Average Dust per Post (grams) in August-September

Location	Ht (ft)	East						West					
		30	60	120	240	480	Tot	30	60	120	240	480	Tot
Cass	2	0.25	0.11	0.14	0.15	0.13	0.78	0.20	0.21	0.21	0.21	0.29	1.12
	3	0.15	0.10	0.10	0.09	0.12	0.56	0.15	0.13	0.18	0.17	0.20	0.83
	4	0.09	0.07	0.02	0.08	0.10	0.36	0.06	0.12	0.04	0.08	0.08	0.38
	M	0.16	0.09	0.09	0.11	0.12	0.57	0.14	0.15	0.14	0.15	0.19	0.78
Grand Forks	2	0.99	0.28	0.10	0.14	0.23	1.74	0.09	0.07	0.09	0.11	0.18	0.53
	3	0.41	0.11	0.06	0.09	0.20	0.86	0.09	0.06	0.03	0.01		0.19
	4	0.21	0.09	0.06	0.08	0.09	0.52	0.07	0.02	0.02		0.16	0.27
	M	0.54	0.16	0.07	0.10	0.17	1.04	0.08	0.05	0.05	0.06	0.17	0.33
Mountrail	2	0.13	0.13	0.08	0.04	0.03	0.40	0.14	0.12	0.08	0.05		0.39
	3	0.09	0.09	0.05	0.03	0.02	0.28	0.13	0.05	0.03	0.03		0.25
	4	0.07	0.05	0.02	0.01	0.01	0.16	0.09	0.04		0.02		0.15
	M	0.10	0.09	0.05	0.03	0.02	0.28	0.12	0.07	0.06	0.04		0.26
McKenzie	2	0.53	0.51	0.72	0.43	1.23	3.43	1.20		3.78	2.75	3.29	11.01
	3	0.34	0.40	0.40	0.28	0.74	2.15	0.59			1.20	1.21	3.00
	4	0.20	0.21	0.26	0.18		0.84	0.43		1.04	0.87	0.64	2.98
	M	0.36	0.37	0.46	0.30	0.99	2.14	0.74		2.41	1.60	1.71	5.66
Williams	2	1.34	0.90	0.95	0.98	0.65	4.82	1.63	0.96	1.46	1.64	1.76	7.43
	3	1.05	0.81	0.65	0.90	0.52	3.93	1.21	0.80	0.96	1.09	1.13	5.18
	4	0.91	0.60	0.50	0.54	0.40	2.95	1.09	0.67	0.72	0.68	0.74	3.91
	M	1.10	0.77	0.70	0.81	0.52	3.90	1.31	0.81	1.05	1.13	1.21	5.51



Average Dust per Post (grams) in Sep.-October



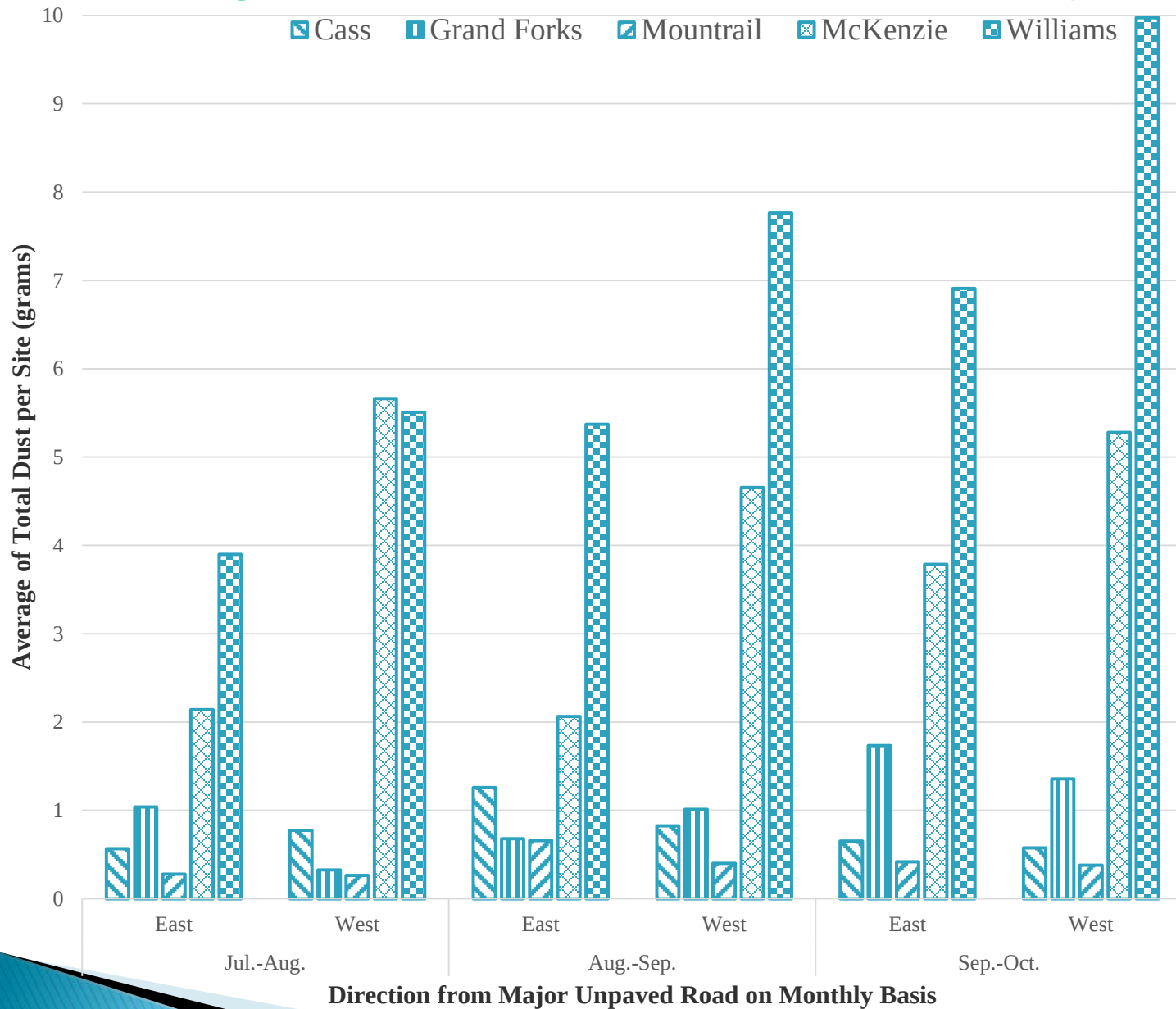


Average Dust per Post (grams) in Sep.-October

Location	Ht (ft)	East						West					
		30	60	120	240	480	Tot	30	60	120	240	480	Tot
Cass	2	0.20	0.15	0.11		0.36	0.82	0.22	0.20	0.22	0.13	0.08	0.84
	3	0.13	0.08	0.10	0.09	0.33	0.73	0.14	0.14	0.14	0.08	0.05	0.54
	4	0.11			0.08	0.22	0.41	0.02	0.13	0.11	0.06	0.03	0.36
	M	0.15	0.11	0.11	0.09	0.30	0.65	0.13	0.15	0.16	0.09	0.05	0.58
Grand Forks	2	0.92	0.60	0.25	0.36	0.26	2.39	0.41	0.35	0.54	0.32	0.40	2.03
	3	0.55	0.37	0.21	0.32	0.21	1.65	0.24	0.18	0.42	0.23	0.21	1.27
	4	0.36	0.31	0.08	0.30	0.11	1.17	0.20	0.16	0.20	0.12	0.10	0.78
	M	0.61	0.43	0.18	0.33	0.19	1.74	0.28	0.23	0.39	0.22	0.24	1.36
Mountrail	2	0.19	0.17	0.12	0.11	0.09	0.67	0.18	0.16	0.10	0.09		0.52
	3	0.12	0.08	0.07	0.06	0.05	0.39	0.12	0.10	0.08	0.07		0.38
	4	0.08	0.03	0.04	0.03	0.02	0.21	0.11	0.05	0.03	0.03		0.23
	M	0.13	0.09	0.08	0.07	0.05	0.42	0.14	0.10	0.07	0.06		0.38
McKenzie	2	0.89	0.81	1.71	0.69	1.42	5.53	1.43	1.49	2.15	2.15	1.58	8.80
	3	0.71	0.69	0.80	0.53	0.98	3.72	0.74	1.10	1.19	0.84	0.62	4.49
	4	0.57	0.32	0.48	0.28	0.47	2.12	0.49	0.41	0.76	0.43	0.47	2.55
	M	0.72	0.61	1.00	0.50	0.96	3.79	0.89	1.00	1.36	1.14	0.89	5.28
Williams	2	2.15	1.45	1.79	2.87	1.54	9.80	2.27	1.77	2.64	4.06	3.11	13.85
	3	1.67	1.01	1.14	1.31	1.24	6.38	1.87	1.58	1.74	2.19	2.55	9.93
	4	1.37	0.84	0.71	0.93	0.70	4.56	1.23	1.16	1.10	1.27	1.40	6.15
	M	1.73	1.10	1.21	1.71	1.16	6.91	1.79	1.50	1.82	2.51	2.35	9.98



Average of Total Dust at Each Site from July-October





Poor Visibility due to Dust North of Williams County Site





Effect of Dust from Unpaved Road on Leaf Temperature

County		East					West				
		30	60	120	240	480	30	60	120	240	480
Cass	Total	0.51	0.43	0.40	0.53	0.72	0.42	0.43	0.51	0.39	0.44
	Tem. (°F)	53	44	41	55	75	43	44	53	41	46
Grand Forks	Total	1.40	0.68	0.34	0.51	0.53	0.52	0.49	0.67	0.54	0.56
	Tem. (°F)	145	70	35	53	55	54	51	69	57	58
Mountrail	Total	0.48	0.31	0.24	0.19	0.14	0.37	0.28	0.22	0.18	
	Tem. (°F)	50	32	24	19	15	39	29	23	19	
McKenzie	Total	1.47	0.98	2.05	1.16	2.79	2.42	1.00	5.65	3.93	3.41
	Tem. (°F)	153	102	213	120	290	252	104	586	408	354
Williams	Total	3.82	2.86	3.68	3.85	2.57	4.79	3.67	4.25	5.51	5.48
	Tem. (°F)	453	338	435	456	304	567	434	503	653	649



Average PH from July-October

County	Height (ft)	East					West				
		30	60	120	240	480	30	60	120	240	480
Cass	Jul.-Aug.	10.40	10.25	10.32	10.27	10.37	10.25	10.58	10.24	10.24	9.55
	Aug.-Sep.	10.35	10.39	10.44	10.38	10.43	10.43	10.41	10.40	10.51	10.39
	Sep.-Oct.	10.62	10.64	10.45	10.46	10.40	10.24	10.36	10.38	10.54	10.21
Grand Forks	Jul.-Aug.	10.37	10.30	10.25	10.12	10.42	9.10	9.29	8.76	9.26	8.69
	Aug.-Sep.	10.14	10.36	10.33	10.08	10.09	10.29	10.12	10.10	10.21	10.18
	Sep.-Oct.	10.61	10.63	10.64	10.64	10.72	10.55	10.59	10.57	10.66	10.60
Mount- rail	Jul.-Aug.	10.28	10.47	10.22	10.57	8.31	10.65	10.70	7.83	10.57	
	Aug.-Sep.	10.17	10.14	10.13	10.08	10.16	10.30	10.09	10.18	10.15	
	Sep.-Oct.	10.62	10.55	10.61	10.56	10.57	10.47	10.50	10.53	10.55	
McK- enzie	Jul.-Aug.	10.44	10.22	10.32	10.33	10.50	10.37		10.64	9.75	9.60
	Aug.-Sep.	9.24		9.83	9.05	9.81	10.17		10.15	10.30	10.26
	Sep.-Oct.	10.53	10.50	10.59	10.61	10.62	10.40	10.41	10.38	10.61	10.40
Williams	Jul.-Aug.	10.39	10.43	10.36	10.12	10.37	10.41	10.58	10.72	10.64	10.63
	Aug.-Sep.	10.26	10.41	10.34	10.11	10.16	10.25	10.33	10.48	10.28	10.39
	Sep.-Oct.	10.46	10.24	10.59	10.51	10.51	10.17	10.28	10.24	10.39	10.44



Water Chemistry

Analyte	Cass	Grand Forks	Mountrail	McKenzie	Williams
Conductivity (mS/cm)	27	92	64.5	32.85	20.8
PH	10.2	10.4	10.4	10.4	10.2
TDS (mg/L)	26,600	80,600	48,800	21,240	18,240
Turbidity (NTU)	4.13	4.10	6.49	7.0	10.2
Chloride (mg/L)	10,200	29,100	20,100	9,620	8,010
Fluoride (mg/L)	<0.20	0.50	0.30	<0.20	<0.20
Sulfate (mg/L)	15.7	38.3	24.5	19.5	15.4
Calcium (mg/L)	3.14	3.69	3.45	6.05	6.54
Iron (mg/L)	0.32	0.358	0.887	0.435	1.156
Magnesium (mg/L)	1.53	<1.0	<1.0	<1.0	<1.0
Manganese (mg/L)	0.06	<0.02	<0.02	<0.02	0.037
Potassium(mg/L)	12.7	40.0	23.4	12.5	16.8
Sodium(mg/L)	8,520	24,900	16,000	7,080	6,080
TSS (mg/L)	15.4	22.0	30.6	45.3	35.0

Effect of Dust on Crop Yield

Effect of Dust on Crop Yield

- ❖ Do you own a farmland along unpaved road (s)?

#	Answer	Bar	Response	%
1	Yes		40	90.91%
2	No		4	9.09%

- ❖ Did you notice the effect of dust from unpaved road (s) on crop yield?

#	Answer	Bar	Response	%
1	Yes		29	74.36%
2	No		10	25.64%
	Total		39	100.00%

Effect of Dust on Crop Yield (*Continued*)

- ❖ What kinds of crops do you plant?
 - Wheat is the most widely planted crop

- ❖ Can you please rank the effect of dust from unpaved road (s) on the different kinds of crops?
 - Wheat is affected the most

- ❖ Do you use combine with yield monitor to harvest?

#	Answer	Bar	Response	%
1	Yes		16	80.00%
2	No		4	20.00%
	Total		20	100.00%

Effect of Dust on Crop Yield (*Continued*)

- ❖ Can you please provide percent reduction in yield at different distances from unpaved road (s)?
 - First two passes (40 foot headers) around 50 to 70 % loss compared to the opposite side of the field, next two passes 20 to 35 % yield loss, the next two none to 10% loss
 - Other responses: 5-60% reduction in yield

- ❖ At what distance from the center of unpaved road (s) do you think that the dust from unpaved road (s) does not have significant effect on crop yield?
 - Responses vary from 80 ft-1/2 mile

Effect of Dust on Crop Yield (*Continued*)

- ❖ The effect of dust from unpaved road (s) on crop yield has:

#	Answer	Bar	Response	%
1	Reduced		10	52.63%
2	Been the same		3	15.79%
3	Increased		4	21.05%
4	other		2	10.53%
	Total		19	100.00%

- ❖ If the effect of dust from unpaved road (s) on crop yield has reduced or increased, can you specify the year (s) when it happened?
 - Responses vary from 2007-2014
 - Reduction in wet years

Effect of Dust on Crop Yield (*Continued*)

- ❖ Any suggestions to reduce the effect of dust from unpaved roads on crop yield if there is any?
 - Apply suppressants frequently depending on weather and traffic conditions
 - Pave the sections with heavy traffic and maintain them
 - Reduce speed limits and enforce them

Effect of Dust on Livestock

Effect of Dust on Livestock

❖ Do you own any livestock?

#	Answer	Bar	Response	%
1	Yes		14	40.00%
2	No		21	60.00%
	Total		35	100.00%

❖ Do you feed your livestock the grass/hays from grassland along unpaved road (s)?

#	Answer	Bar	Response	%
1	Yes		8	61.54%
2	No		5	38.46%
	Total		13	100.00%

Effect of Dust on Livestock (*Continued*)

- ❖ What kinds of livestock do you own?
 - Cattle and horses

- ❖ What are the effect (s) of dust from unpaved road (s) on your livestock?
 - dust pneumonia
 - Pinkeye
 - Change in grazing patterns

Effect of Dust on Livestock (*Continued*)

- ❖ Can you rank the effect of dust from unpaved road (s) on your livestock from highest to lowest if you own more than one kinds of livestock?
 - Worse on calves and horses
 - Increased vet cost

- ❖ The effect of dust from unpaved road (s) on livestock has:

#	Answer	Bar	Response	%
1	Reduced		0	0.00%
2	Been the same		1	20.00%
3	Increased		2	40.00%
4	Other		2	40.00%
	Total		5	100.00%

CONCLUSIONS

- ❖ McKenzie and Williams county sites have had very high average daily traffic
 - There has been a significant increase in the number of vehicles at McKenzie county site
- ❖ Some of the people drive at very high speed
- ❖ Williams and Mountrail county site had the highest and lowest amount of dust in general
- ❖ Williams and Cass county sites were located at the intersection of two county roads

CONCLUSIONS (*Continued*)

- ❖ There has been a significant increase in the amount of dust at Grand Forks in September-October as compared to the previous two months
- ❖ As the height of Mason jar increases, there is a decrease in the amount of dust from unpaved roads
- ❖ As the distance from the center of major unpaved road increases, there is a decrease in the amount of dust

CONCLUSIONS (*Continued*)

- ❖ PH values of the dust from unpaved roads are very high
- ❖ The effect of dust from unpaved road (s) on crop yield could be significant
 - up to 70% reduction in yield close to unpaved road
- ❖ The effect of dust from unpaved road (s) on livestock could be significant depending on the kinds of livestock, the age of livestock, and the amount of dust
 - Calves and horses are affected the most
- ❖ The quality of life of residents close to unpaved road (s) is highly affected

RECOMMENDATIONS

- ❖ Determine the amount of money lost due to the effect of dust from unpaved roads on crop yield and livestock
- ❖ Conduct detailed economic analysis to determine the cost-effectiveness of using dust suppressants regularly on highly travelled unpaved roads (ADT more than 500) as compared to paving them
- ❖ Enforce speed limits on unpaved roads in order to reduce the amount of dust and for the safety of the public
- ❖ Investigate the effect of NDDOT's spring load restriction policy on county and township roads

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Thank you!

Questions, Comments and Suggestions?

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