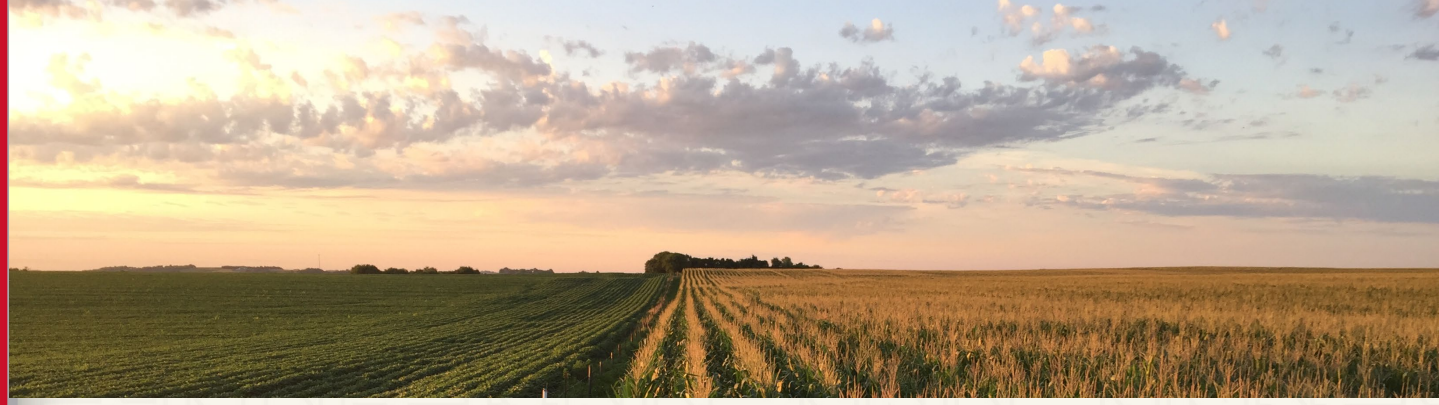

Center Pivot Performance

EXTENSION

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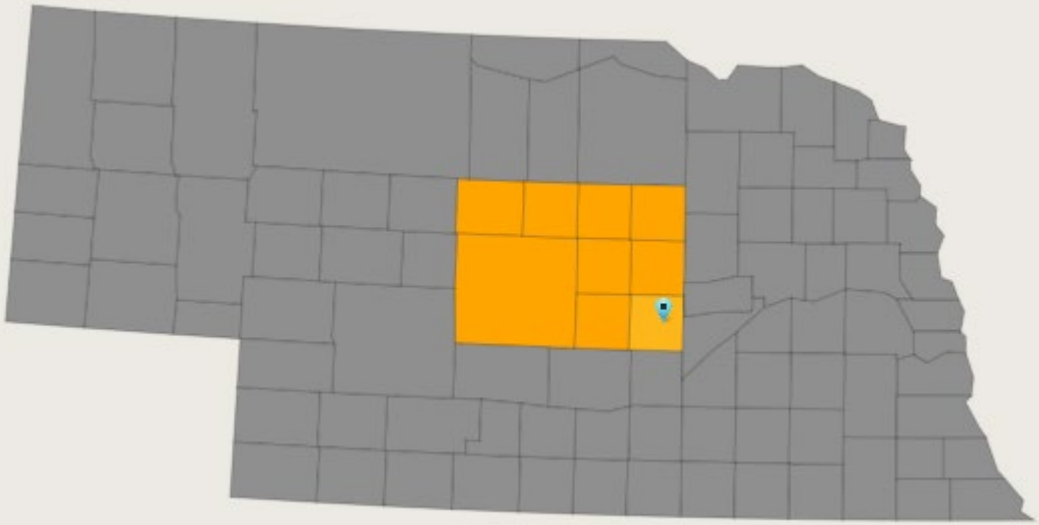
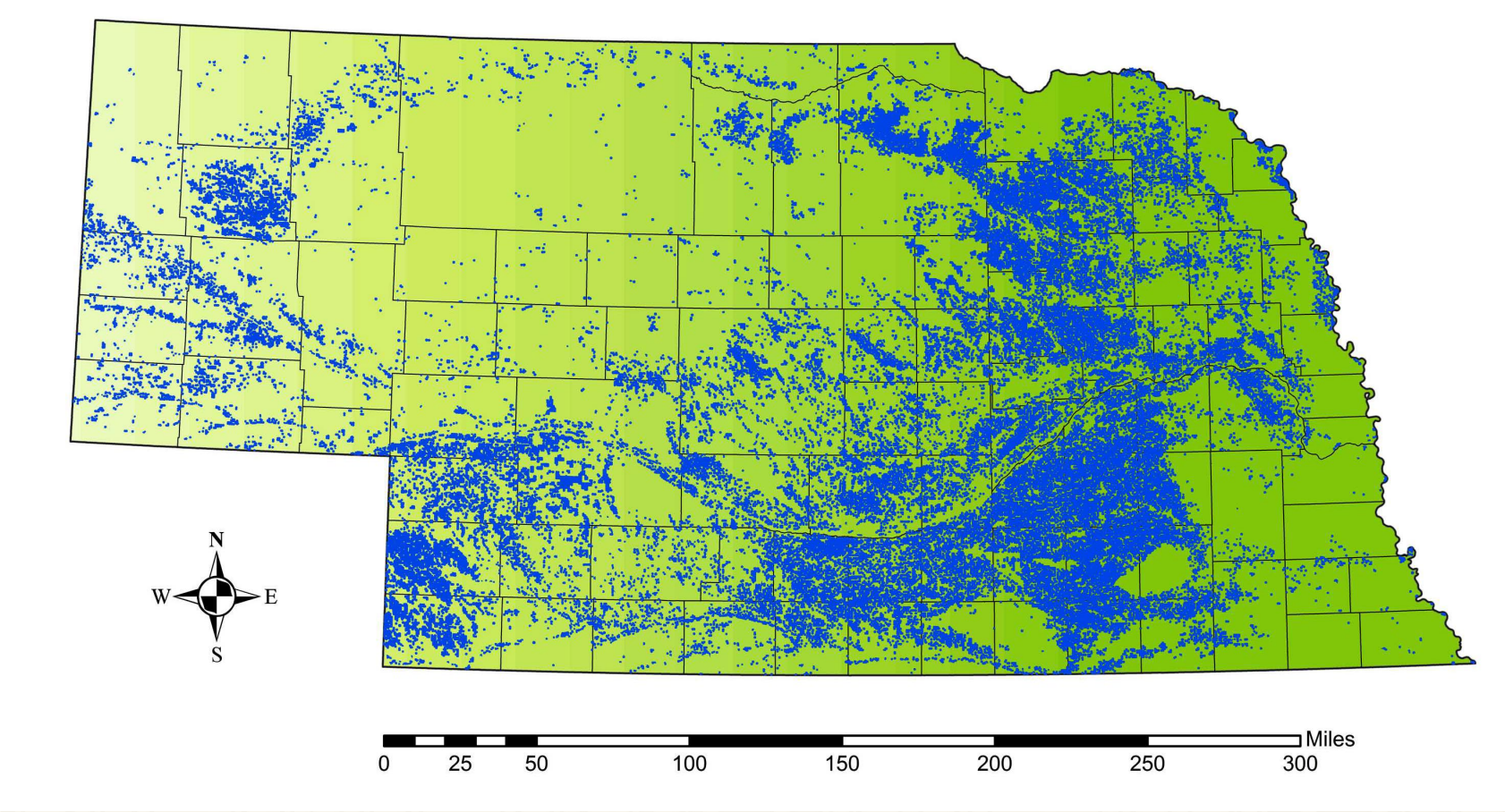


EXTENSION

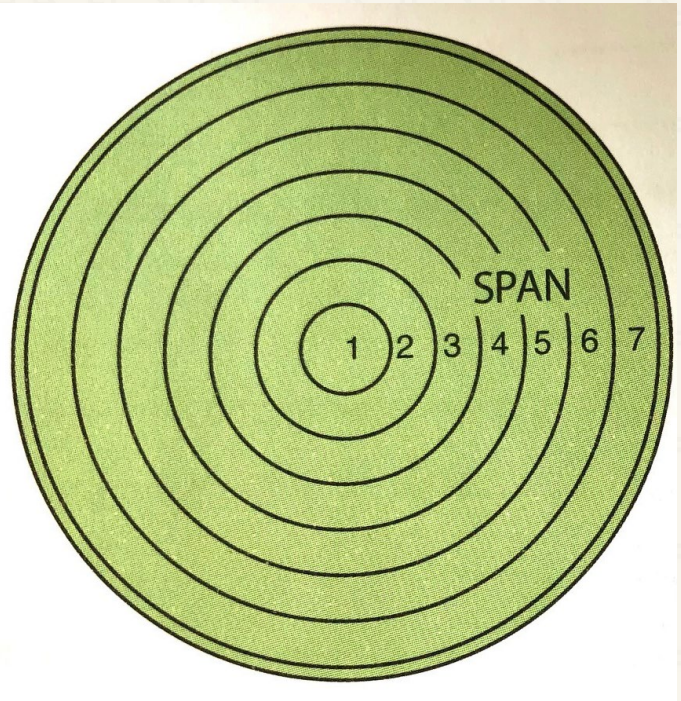
Irrigation in Nebraska

~8,300,000 Acres (2012 NASS)



EXTENSION

Center Pivot Operation



Span	End of Span (ft)	Acres Within Span	Discharge (GPM)
1	180	2.3	14
2	360	7.0	42
3	540	11.7	71
4	720	16.4	99
5	900	21.0	127
6	1080	25.7	156
7	1260	30.4	184
OH	1310	9.3	56
Total		**124**	**750**

Note, 53% of land is under the outer two spans while 2% is under the first span.

N EXTENSION

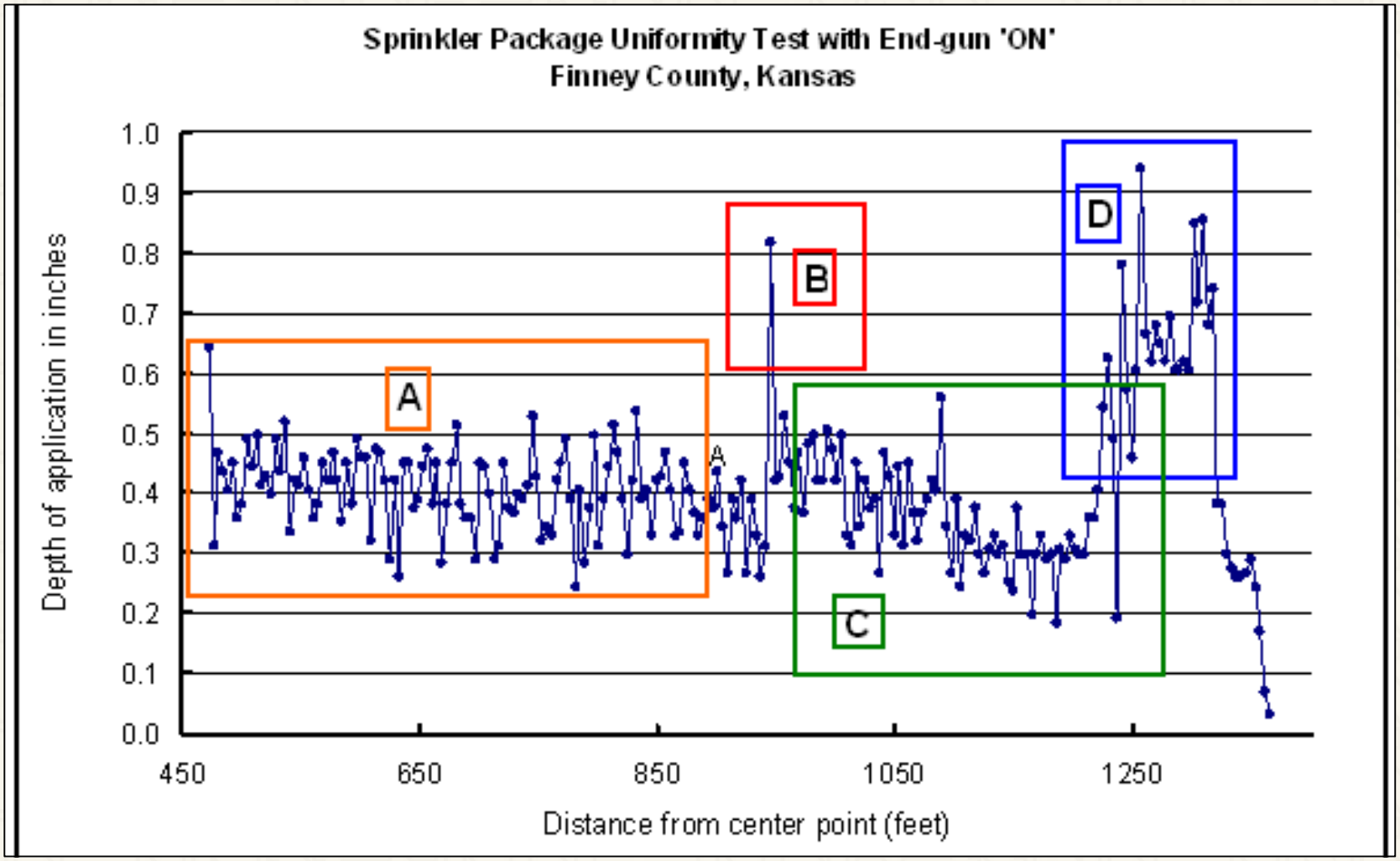
Irrigation System Maintenance

EXTENSION

Reasons for Checking Your Pivot

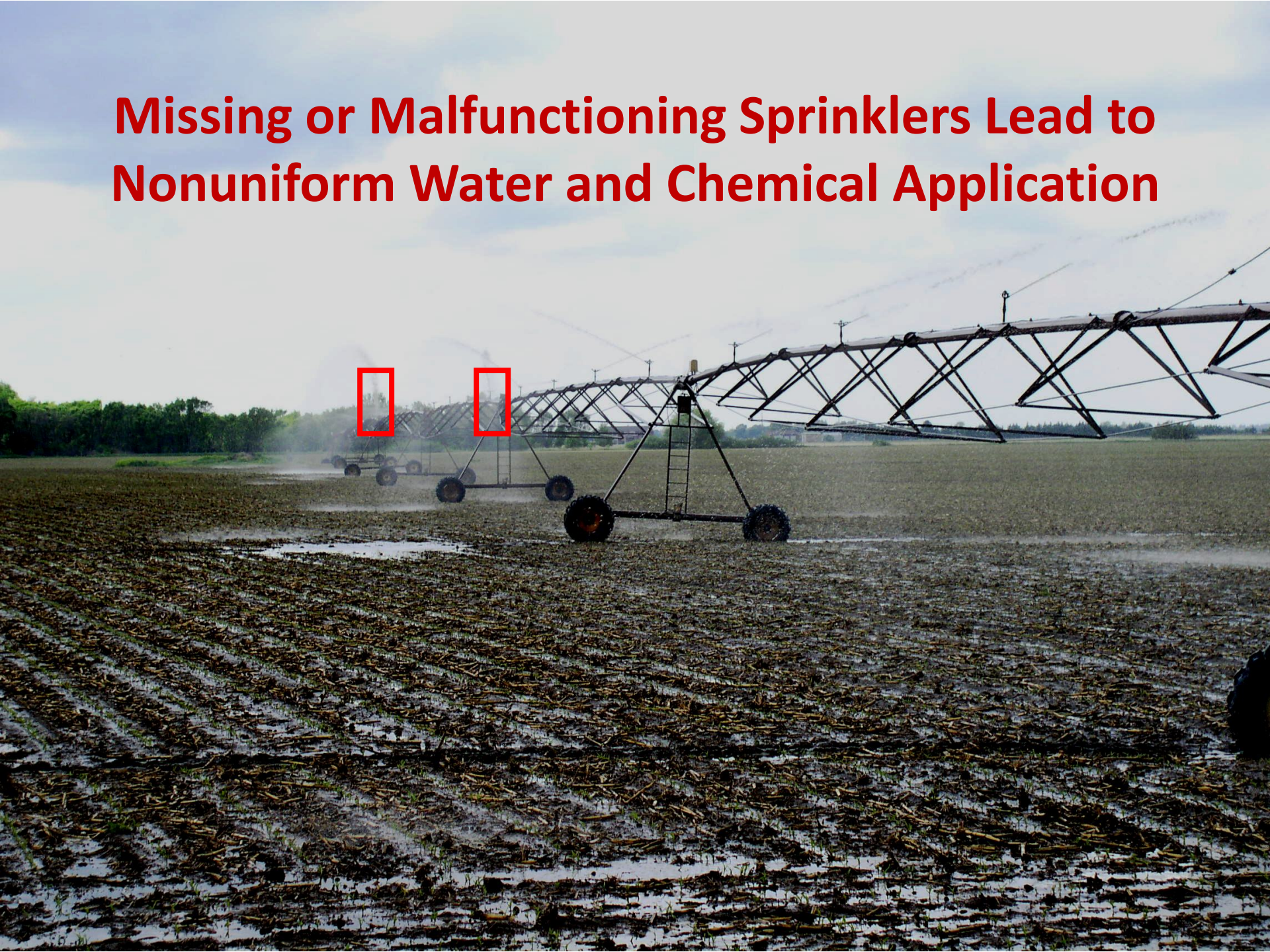
- Sprinklers not installed in correct position
- Sprinklers missing
- Sprinklers heavily worn or not operating properly
- Leaks – tower boots, drains
- Sprinkler spacing too wide
- Inappropriate sprinklers position for field conditions
- Operating pressure does not match system requirements

Sprinkler not Installed in Correct Position



Sprinklers Missing/Plugged

Missing or Malfunctioning Sprinklers Lead to Nonuniform Water and Chemical Application



Sprinkler Package Issues

Nozzle Chart

tw104 20 May 2015 LINDSAY , 7 TOWER, 700 gpm, 20 psi PAGE 2

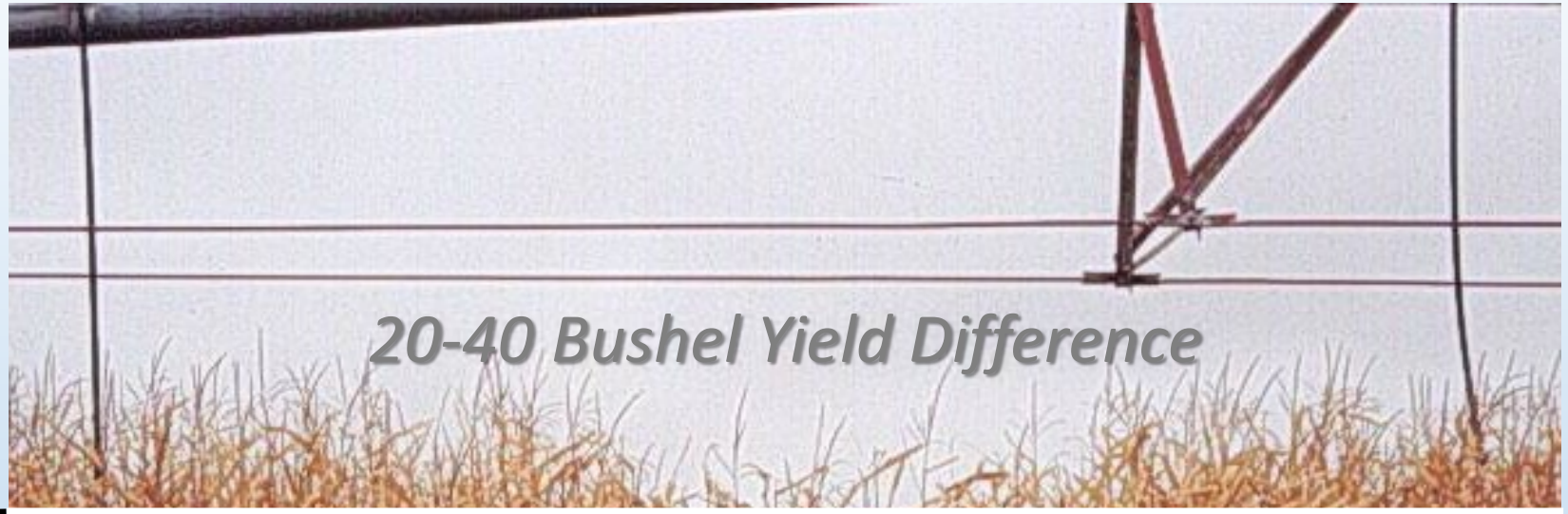
----OUTLET---- No	Loc	Sep	-REG- Model	PSI RegIn	---GPM--- Req	Del	----SPRINKLER----- Model	Plate	SpNo.	---NOZZLE---
-x-							PLUG 3			
4	22.6	22.6	LB15	30.5	0.6	1.3	R3000	Orange	1	#14 Lime
-x-							PLUG 2			
7	44.8	22.2	LB15	30.3	1.0	1.3	R3000	Orange	2	#14 Lime
-x-							PLUG 2			
10	66.6	21.8	LB15	30.0	1.1	1.3	R3000	Orange	3	#14 Lime
11	73.9						PLUG			
12	81.3	14.7	LB15	29.9	1.1	1.3	R3000	Orange	4	#14 Lime
13	88.8						PLUG			
14	95.8	14.5	LB15	29.7	1.2	1.3	R3000	Orange	5	#14 Lime
15	103.3						PLUG			
16	110.6	14.8	LB15	29.6	1.3	1.3	R3000	Orange	6	#14 Lime
17	117.9						PLUG			
18	125.3	14.7	LB15	29.4	1.3	1.3	R3000	Orange	7	#14 Lime
19	132.8						PLUG			
20	139.8	14.5	LB15	29.3	1.5	1.6	R3000	Orange	8	#15 Lime w/lav
21	147.3						PLUG			
22	154.6	14.8	LB15	29.1	1.6	1.6	R3000	Orange	9	#15 Lime w/lav
23	161.9						PLUG			
24	169.3	14.7	LB15	28.9	2.0	2.0	R3000	Orange	10	#17 Lvndr w/gra
25	176.8						PLUG			
	181.6	TOWER NO. 1			INLINE PRESSURE: 26.2 psi					
26	182.6						PLUG			
27	186.8	17.5	LB15	28.7	2.2	2.2	R3000	Orange	11	#18 Gray
28	194.3						PLUG			
29	201.6	14.8	LB15	28.6	2.2	2.2	R3000	Orange	12	#18 Gray
30	208.9						PLUG			
31	216.3	14.7	LB15	28.4	2.3	2.2	R3000	Orange	13	#18 Gray
32	223.8						PLUG			
33	230.8	14.5	LB15	28.3	2.5	2.5	R3000	Orange	14	#19 Gray w/trqu
34	238.3						PLUG			
35	245.6	14.8	LB15	28.1	2.7	2.7	R3000	Orange	15	#20 Turquoise
36	252.9						PLUG			
37	260.3	14.7	LB15	27.9	2.7	2.7	R3000	Orange	16	#20 Turquoise
38	267.8						PLUG			
39	274.8	14.5	LB15	27.8	2.9	3.0	R3000	Orange	17	#21 Trqu w/yllw
40	282.3						PLUG			
41	289.6	14.8	LB15	27.6	3.1	3.0	R3000	Orange	18	#21 Trqu w/yllw
42	296.9						PLUG			
43	304.3	14.7	LB15	27.5	3.3	3.3	R3000	Orange	19	#22 Yellow
44	311.8						PLUG			
45	318.8	14.5	LB15	27.3	3.4	3.5	R3000	Orange	20	#23 Yllw w/red
46	326.3						PLUG			
47	333.6	14.8	LB15	27.1	3.5	3.5	R3000	Orange	21	#23 Yllw w/red
48	340.9						PLUG			
49	348.3	14.7	LB15	26.9	4.1	4.2	R3000	Orange	22	#25 Red w/white
50	355.8						PLUG			
	360.6	TOWER NO. 2			INLINE PRESSURE: 24.4 psi					
51	361.6						PLUG			
52	365.8	17.5	LB15	26.8	4.2	4.2	R3000	Orange	23	#25 Red w/white
53	373.3						PLUG			

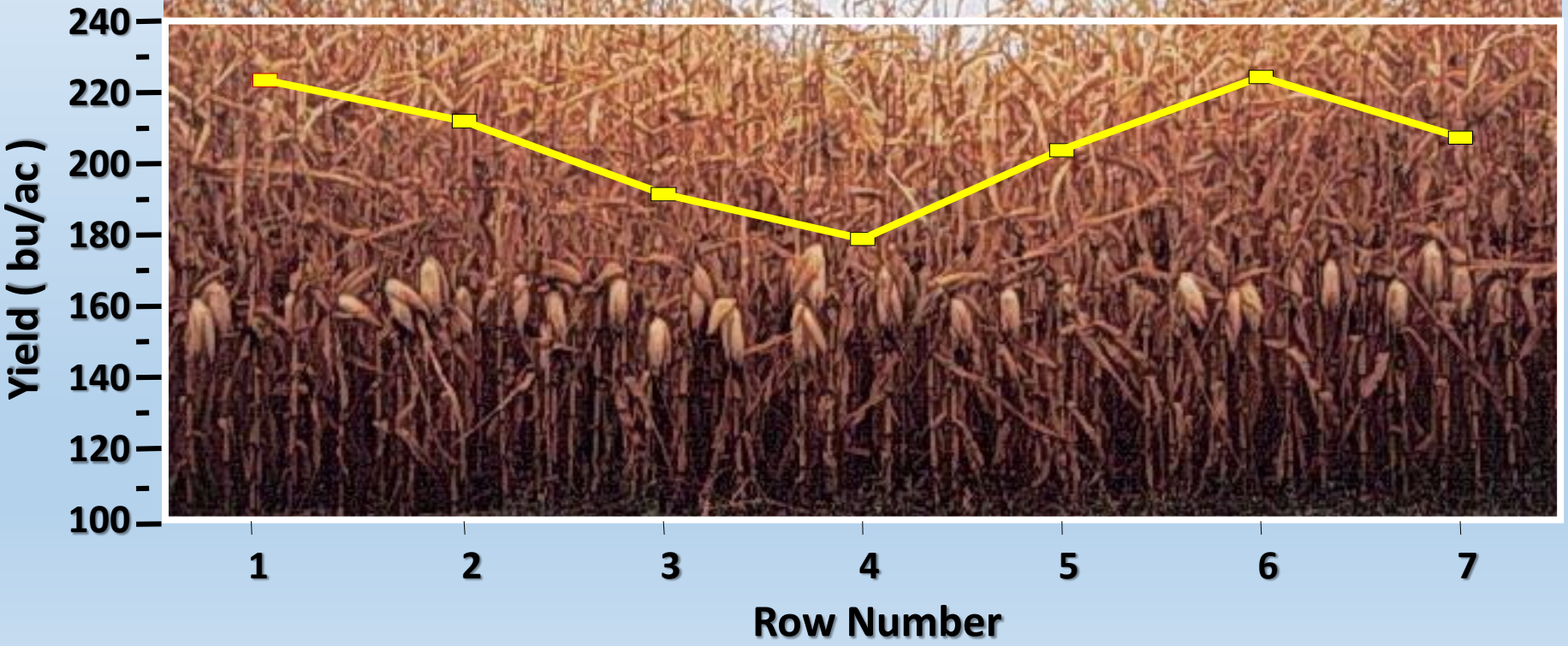
Leaks

Leaky Tower Boots Concentrate Water in Small Areas

- **Reduces Pressure in Remainder of Distribution System**
- **Contributes to Local Runoff Issues**

Sprinkler Spacing too Wide


20-40 Bushel Yield Difference


240
220
200
180
160
140
120
100
Yield (bu/ac)
1
2
3
4
5
6
7
Row Number

Operating Pressure Does not Match System Requirements

Checking System Pressure

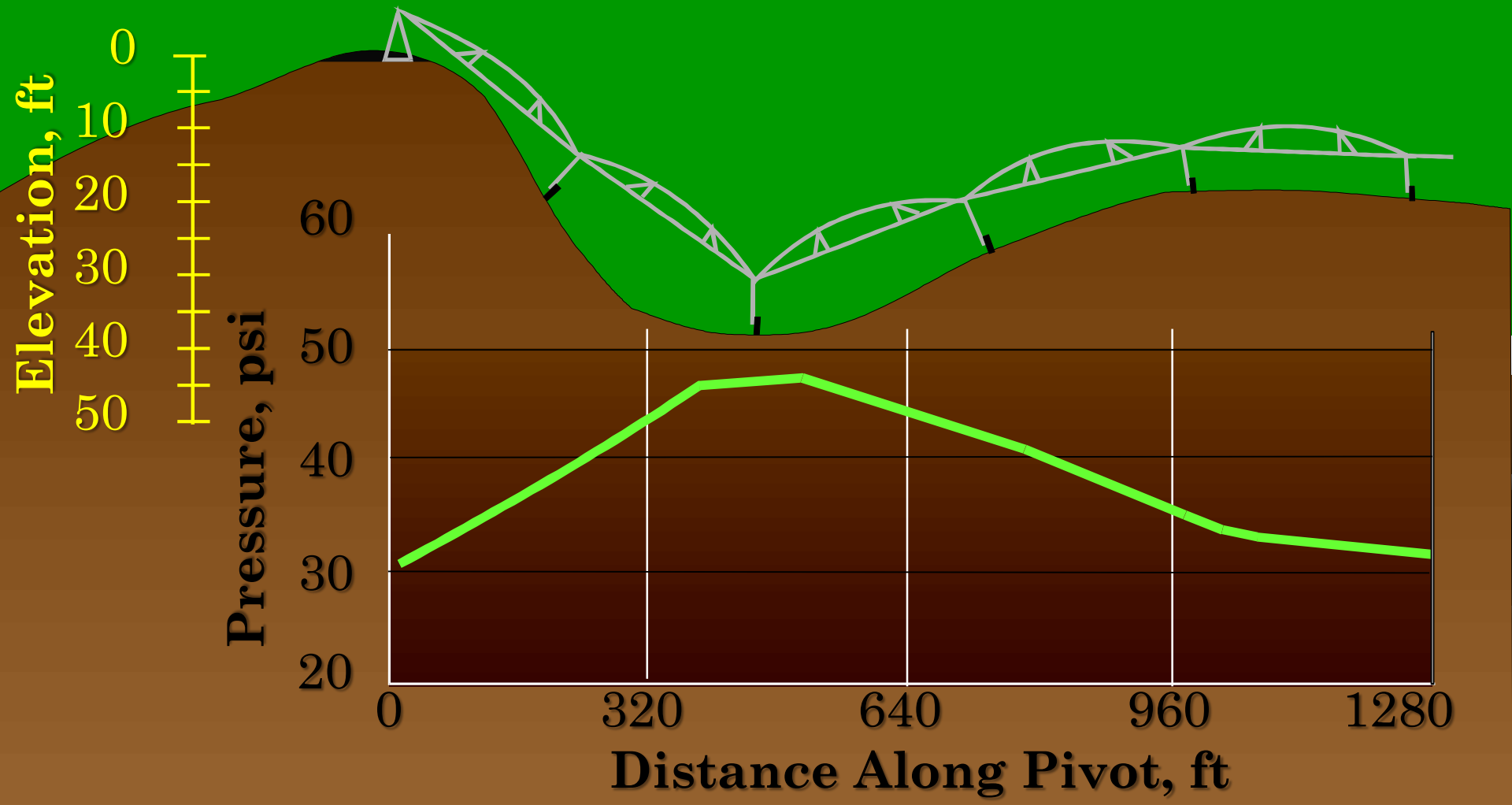
- Check pivot operating pressure with the end guns or corner arm on at the pivot point & at the end of the system at the highest elevation in the field
- System pressure should be maintained at 5 psi above the pressure rating of the regulator
- If pressure is too low - uneven water application across the pivot lateral
- If pressure is too high – increased energy cost

Pressure Regulators

Flow

Pressure loss in Regulator is about 5 psi

Pressure Variations Can Result in Application Differences



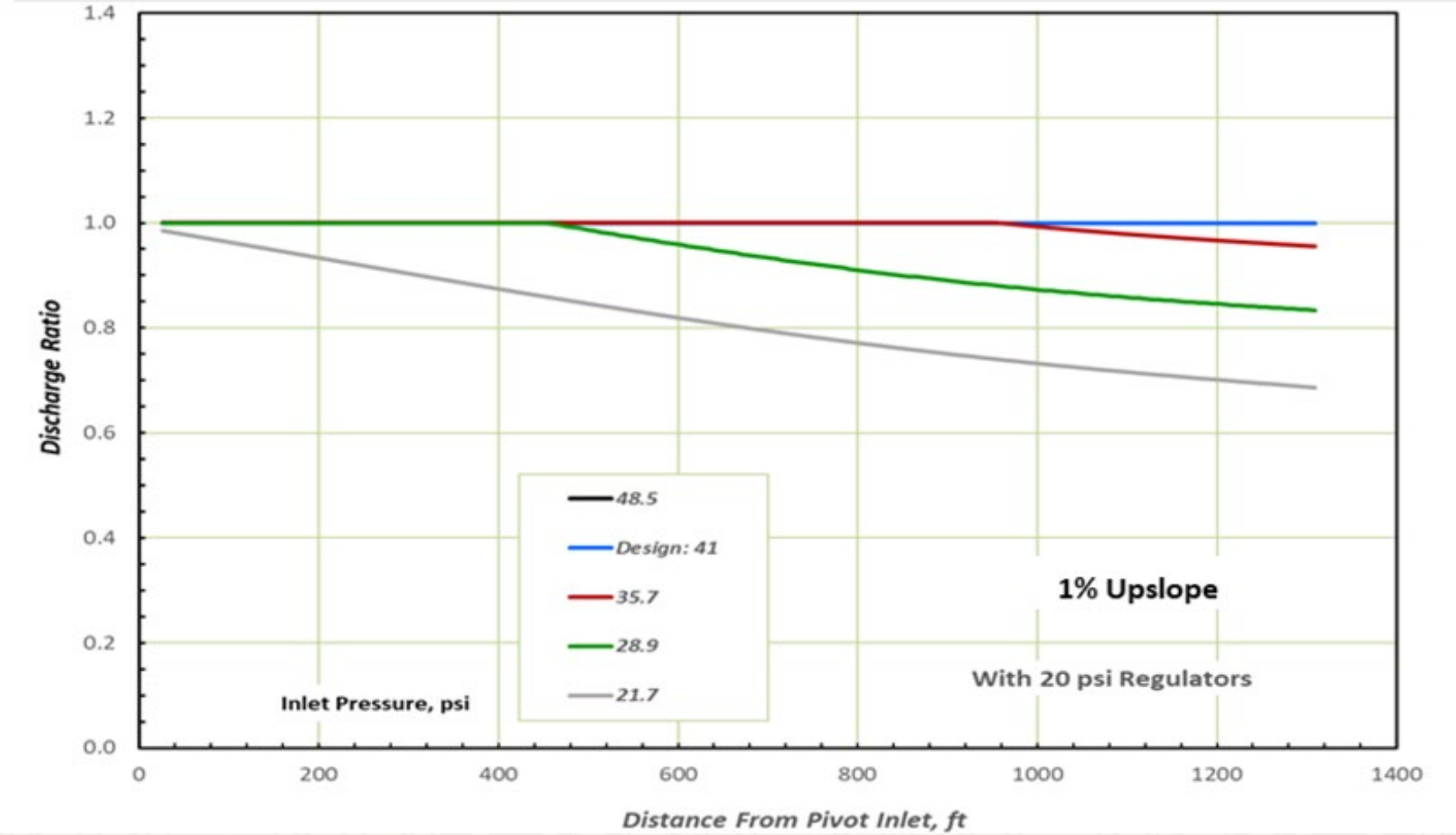
System Pressure

- Pressure Losses
  - Friction loss in the pipe: 7 – 12 psi
  - Elevation Change: 10 psi for every 23ft change in elevation
  - System leaks & worn out nozzles
  - Bad pressure regulators
  - Worn out pump

Ratio of Simulated To Design Nozzle Discharge for a Center Pivot

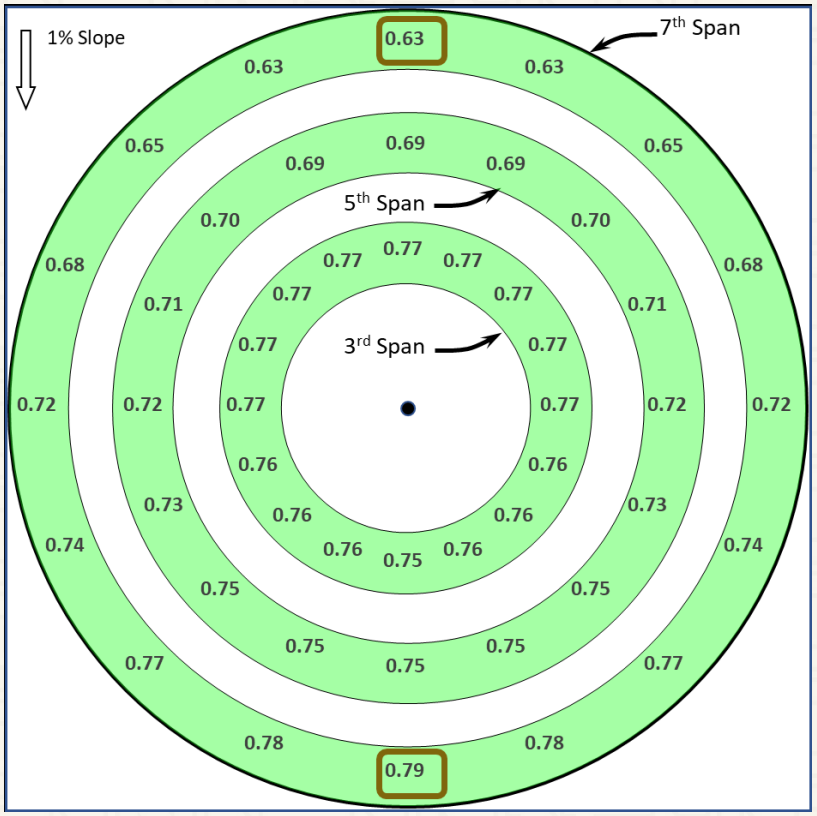
- The field has a 1% slope increasing away from the pivot
- Pivot has 20-psi regulators
- At 35.7 psi, 26% of the length of the pivot lateral (representing 45% of the field) applied less than intended
- At 28.9 psi, 65% of pivot (representing 87% of the field) applied less than intended
- Pivot point inlet pressure less than the design pressure results in an uneven distribution of water

Ratio of Simulated To Design Nozzle Discharge for a Center Pivot



EXTENSION

Variation of Relative Sprinkler Discharges for the Third, Fifth, and Seventh Spans



- Field has a 1% slope (26 ft elevation change in 2640 ft)
- Pivot has 20 psi regulators
- Upslope has 557 gpm & 18.8 psi
- Level has 583 gmp & 16.4 psi
- Downslope has 609 gpm & 14.2 psi

N EXTENSION

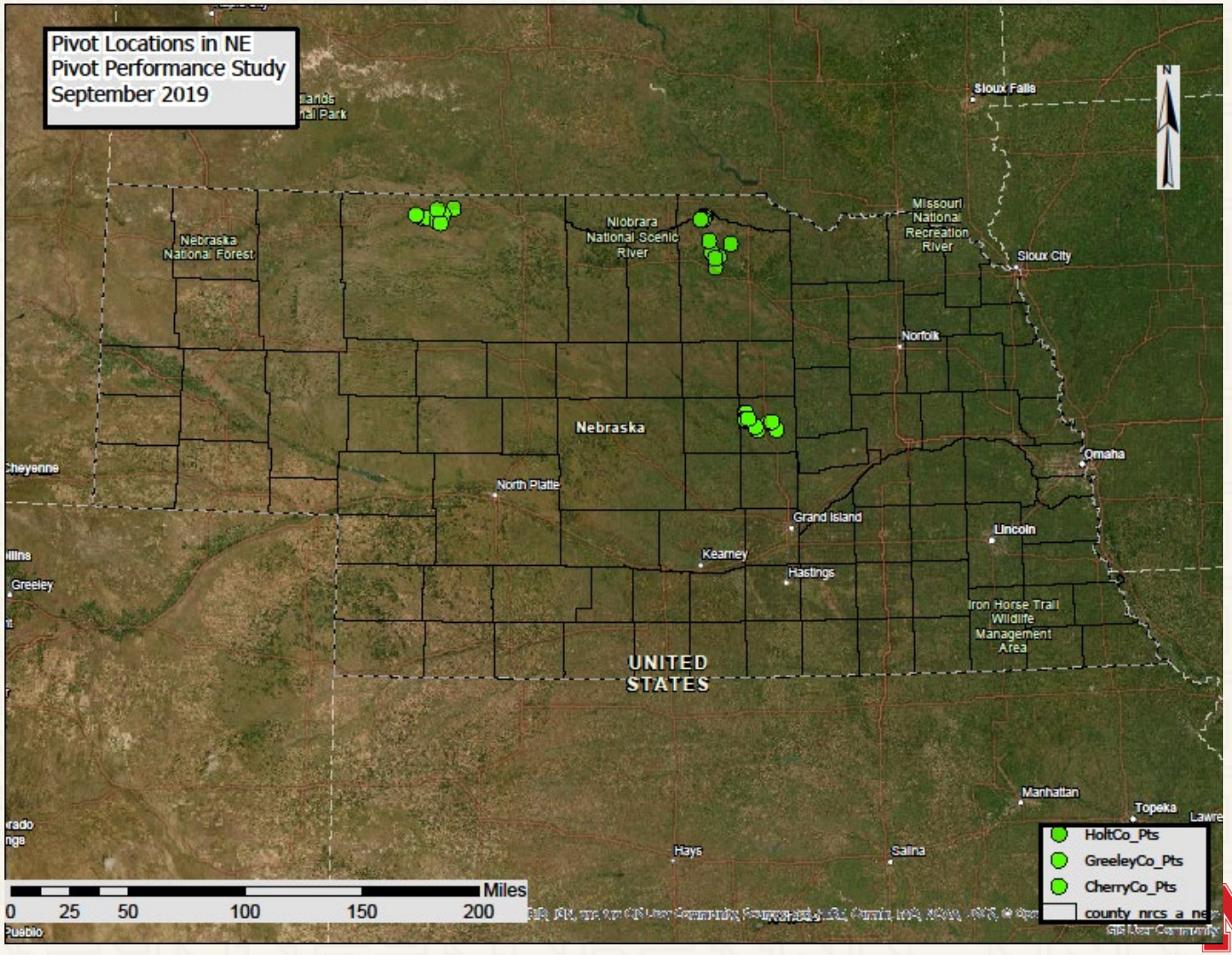
End of System Pressure Study

- Currently have 30 systems being evaluated
- Utilize technology to check/log operating pressure at the end of system
- Need to maintain 5 psi over pressure regulators for even water application

Objectives of Research

- Analyze ~100 systems from across Nebraska
- Identify center pivots with inadequate or excessive pressure
- Quantify impact on application uniformity, yield, and energy expenses
- Recommend Best Management Practices to growers

System Locations



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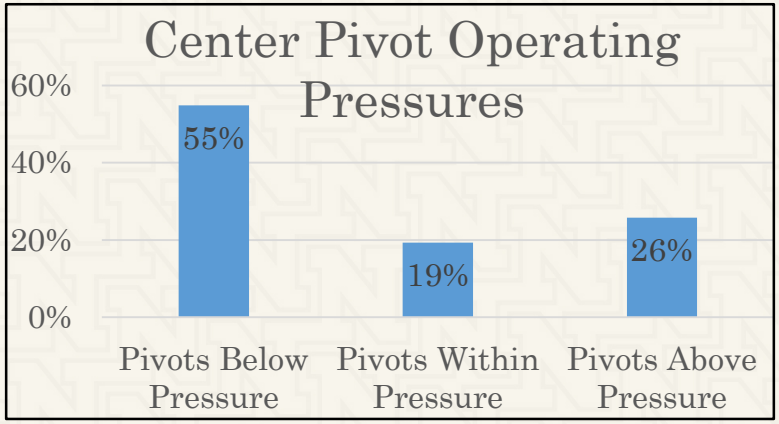
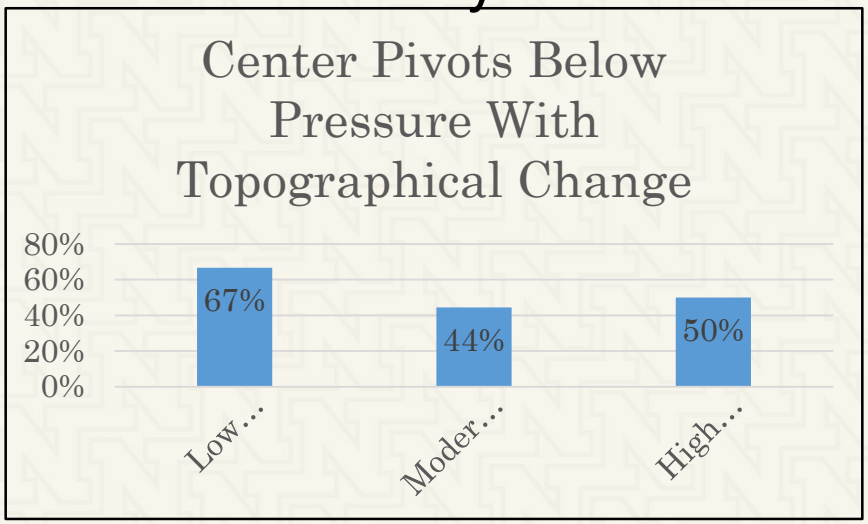
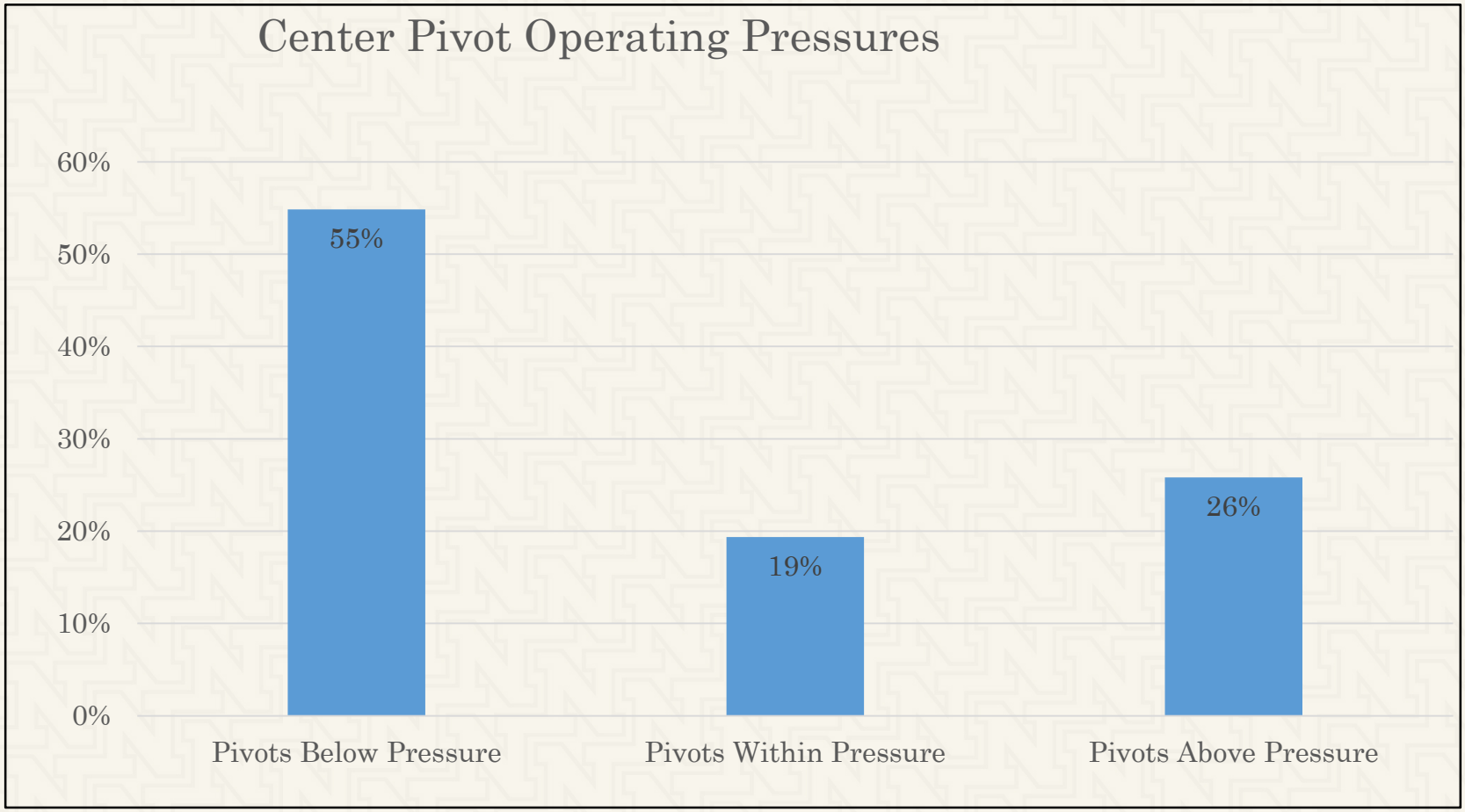
Analysis of Pivot Pressure

- Data from 31 pivots across Nebraska equipped with AgSense Field Commander monitors
- Data were analyzed and compared to operating pressure and required inlet pressure for regulators
- Pivots operating below pressure were analyzed with topographical data



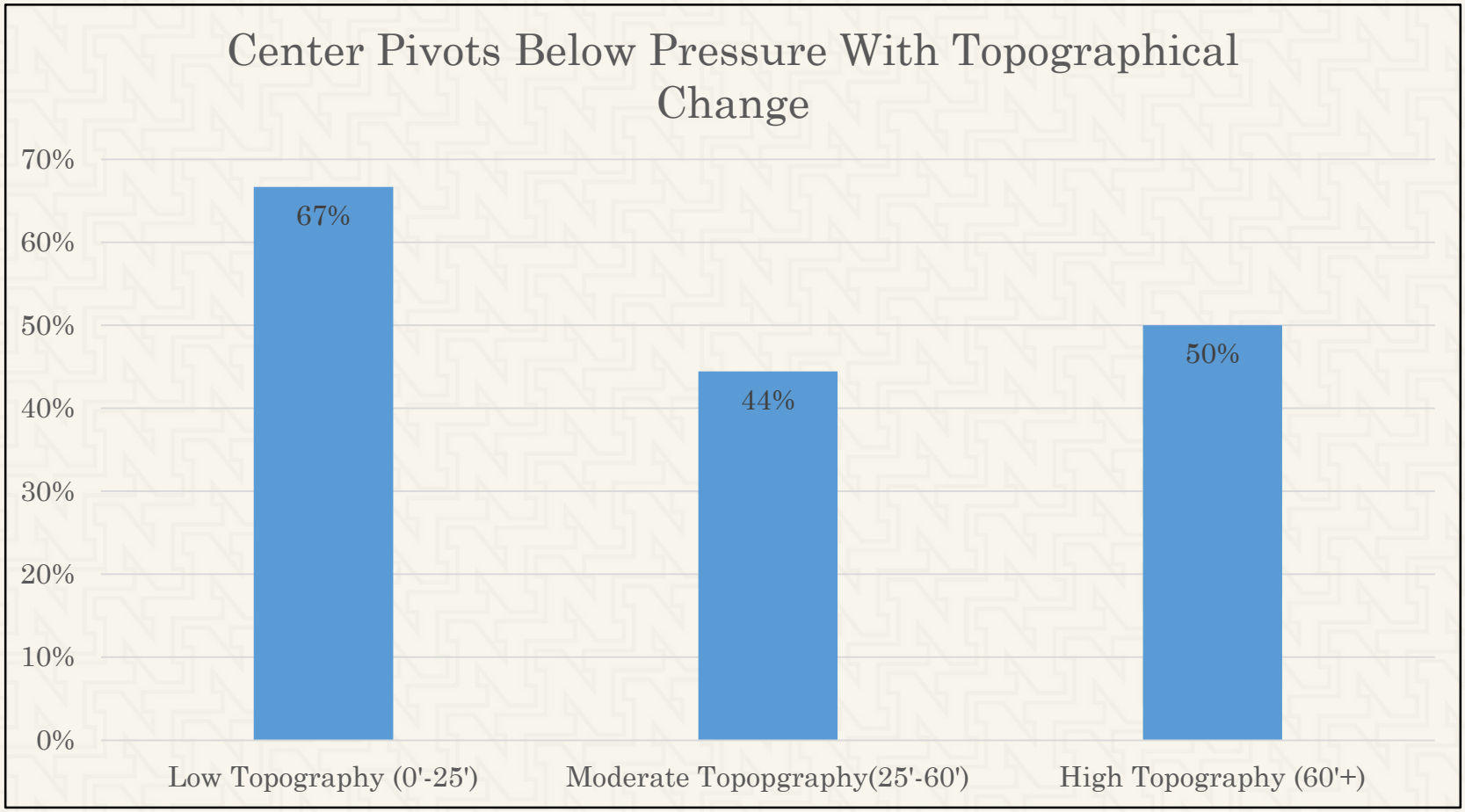


Analysis of Pivot Pressure

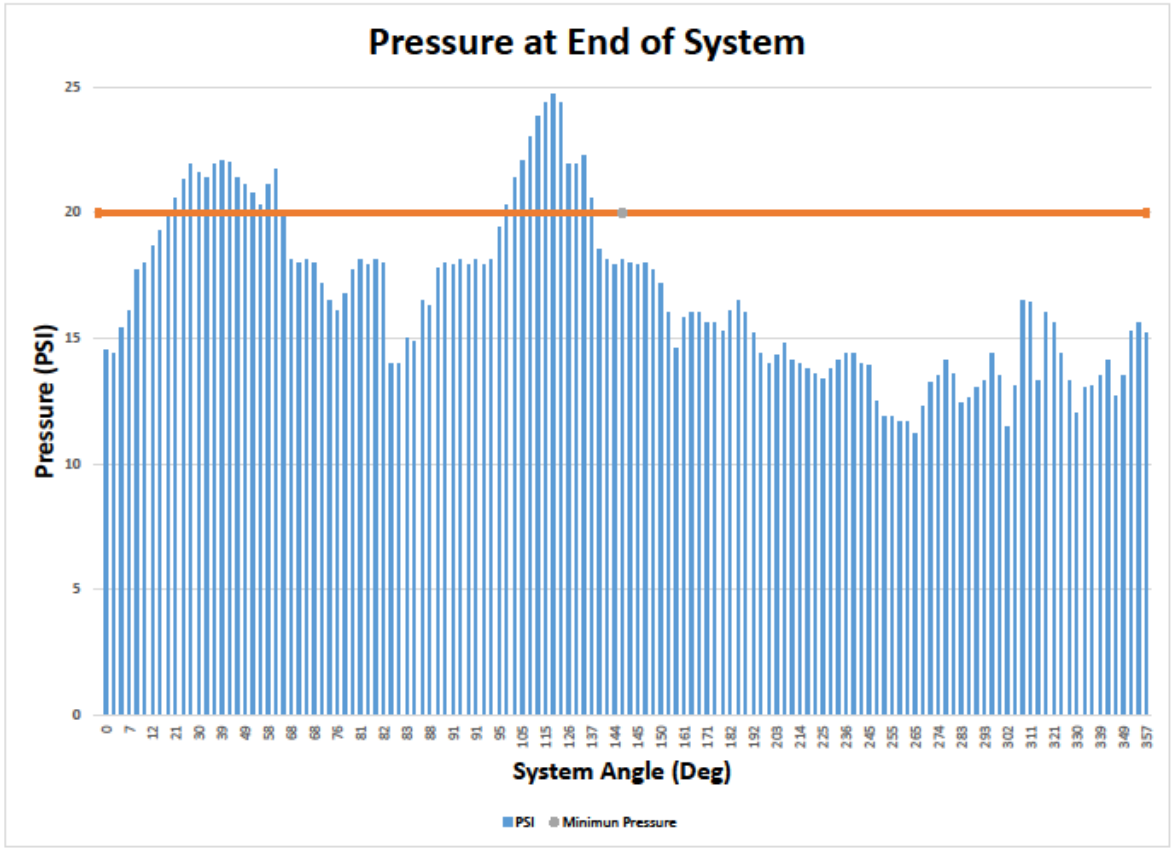


EXTENSION

Analysis of Pivot Pressure

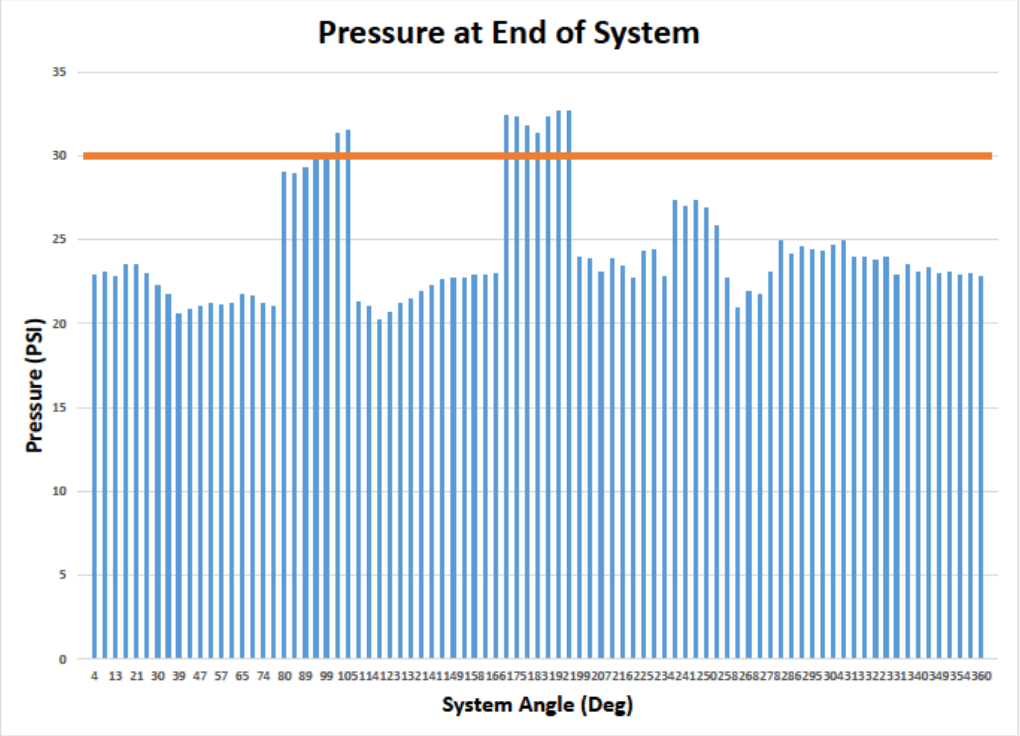


Pressure too Low



EXTENSION

Pressure Too Low



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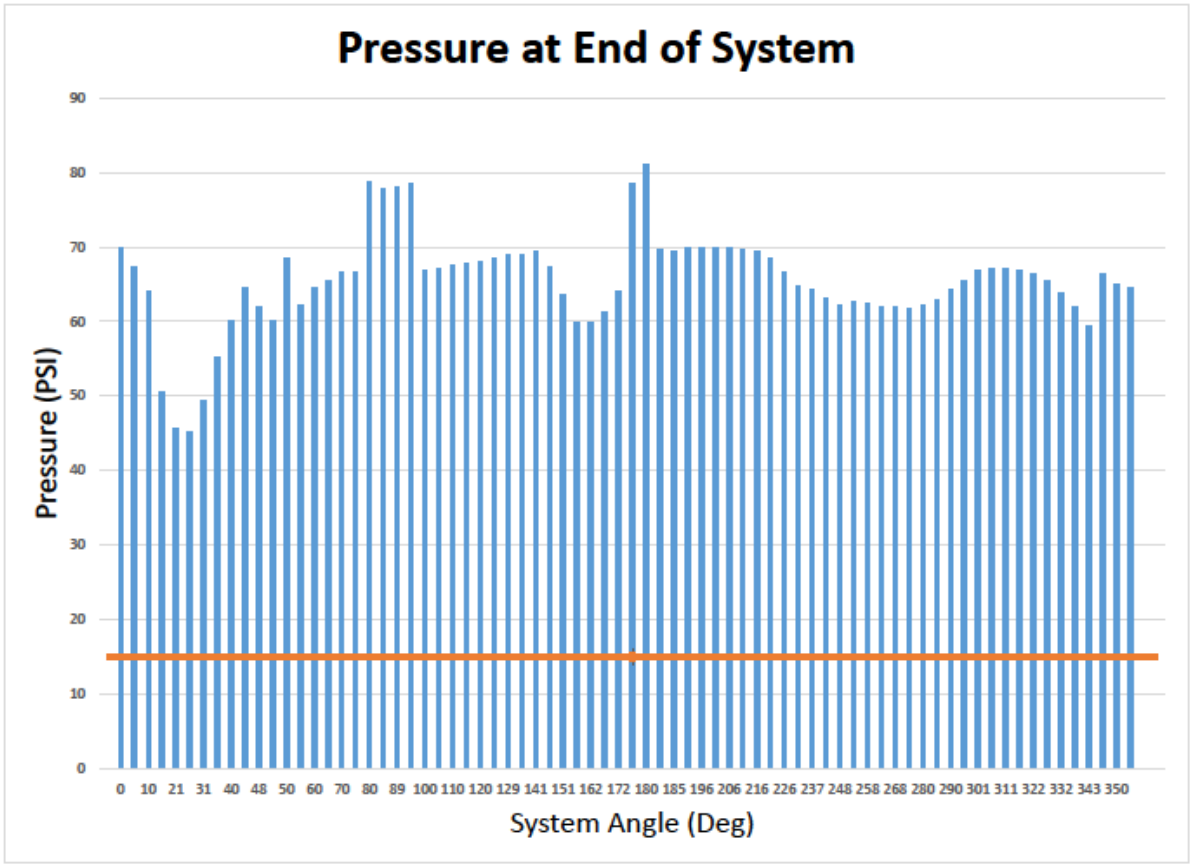
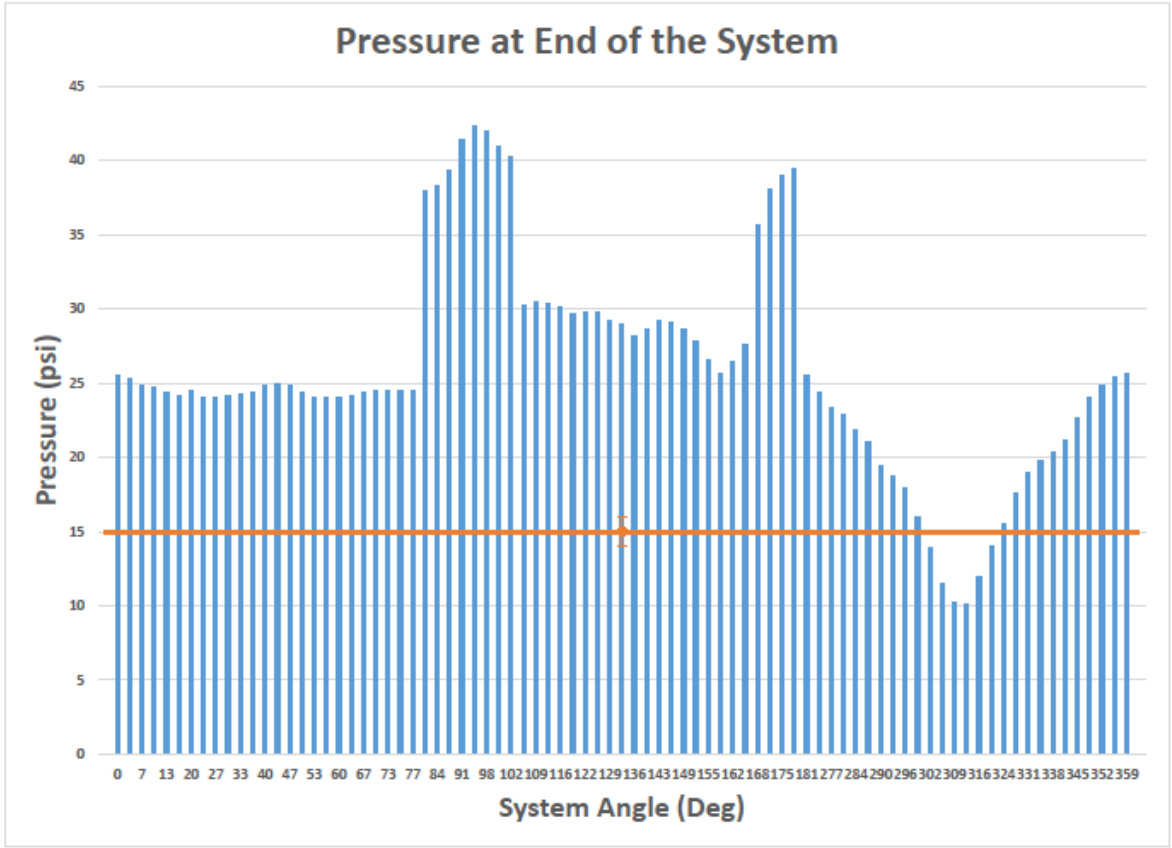
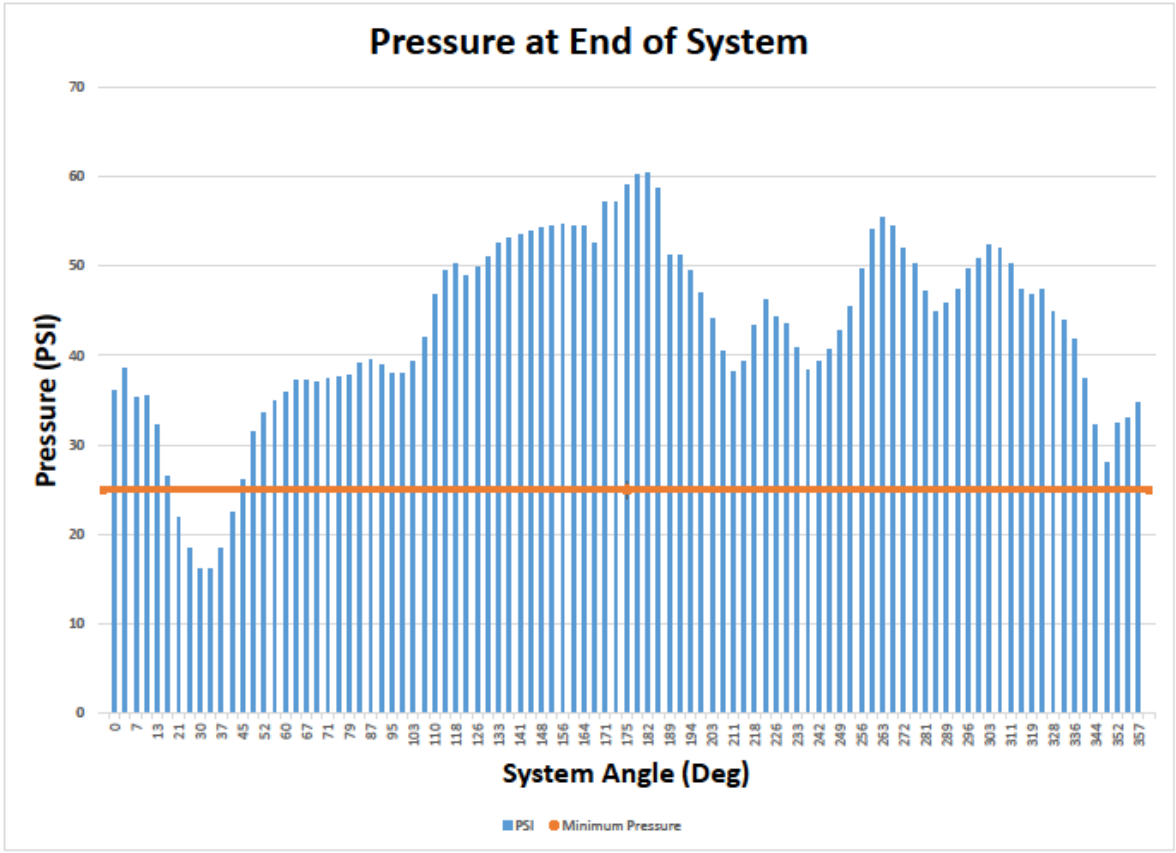
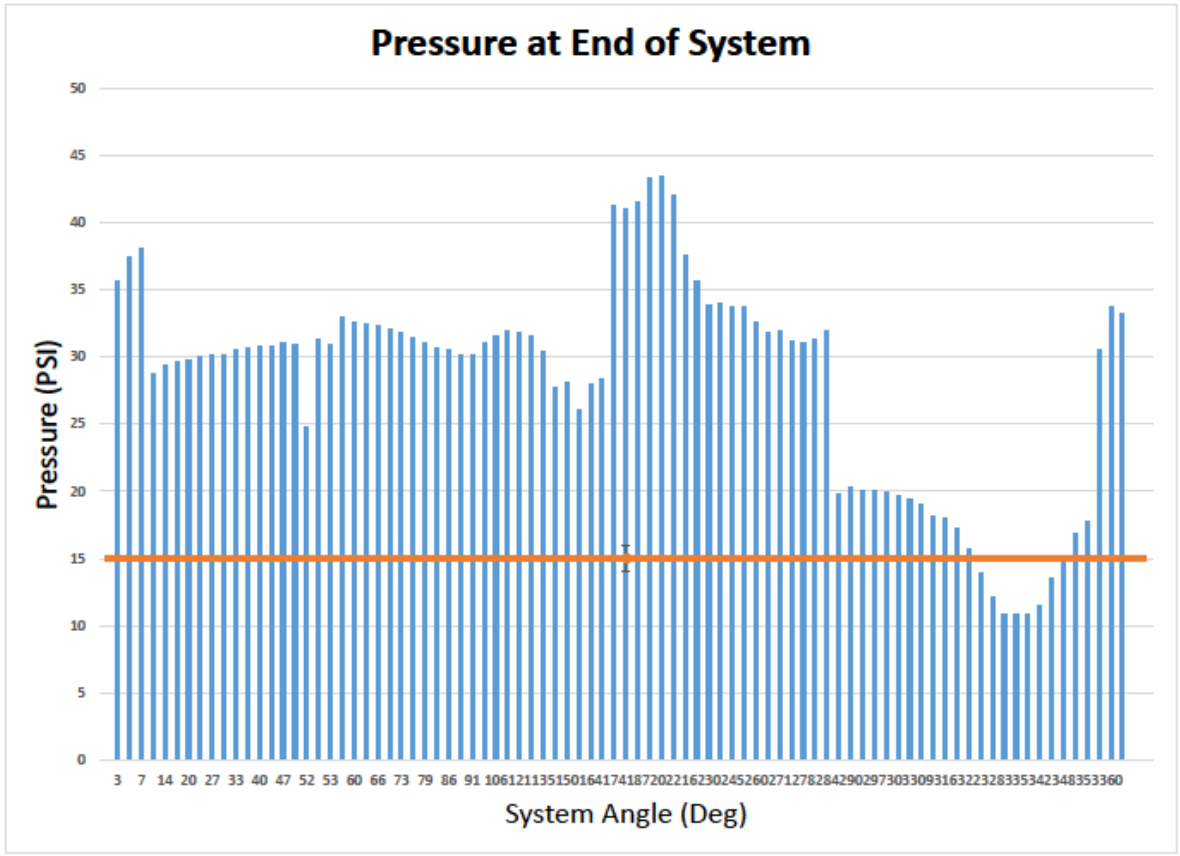
Pressure too High



EXTENSION


Pressure at End of the System
Pressure (psi)
45
40
35
30
25
20
15
10
5
0
0 7 13 20 27 33 40 47 53 60 67 73 77 84 91 98 102 109 116 122 129 136 143 149 155 162 168 175 181 277 284 290 296 302 309 316 324 331 338 345 352 359
System Angle (Deg)


Pressure at End of System
Pressure (PSI)
70
60
50
40
30
20
10
0
0 7 13 21 30 37 45 52 60 67 71 79 87 95 103 110 118 126 133 141 148 156 164 171 175 182 189 194 203 211 218 226 233 242 249 256 263 272 281 289 296 303 311 319 328 336 344 352 357
System Angle (Deg)
PSI
Minimum Pressure


Pressure at End of System
Pressure (PSI)
50
45
40
35
30
25
20
15
10
5
0
3 7 14 20 27 33 40 47 52 53 60 66 73 79 86 91 106 121 135 150 164 174 187 202 216 230 245 260 271 278 284 290 297 303 309 316 322 328 335 342 348 353 360
System Angle (Deg)

EXTENSION

How to Correct Pressure

- Fixing leaks and broken nozzles
- Re-nozzling to smaller or larger nozzles
- Exploring ways to pump more water
  - Speeding up power unit
  - Add a VFD to speed up pump

Questions?

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