Irrigation System Performance

What's working well and what are the challenges?

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Plenty of Choices

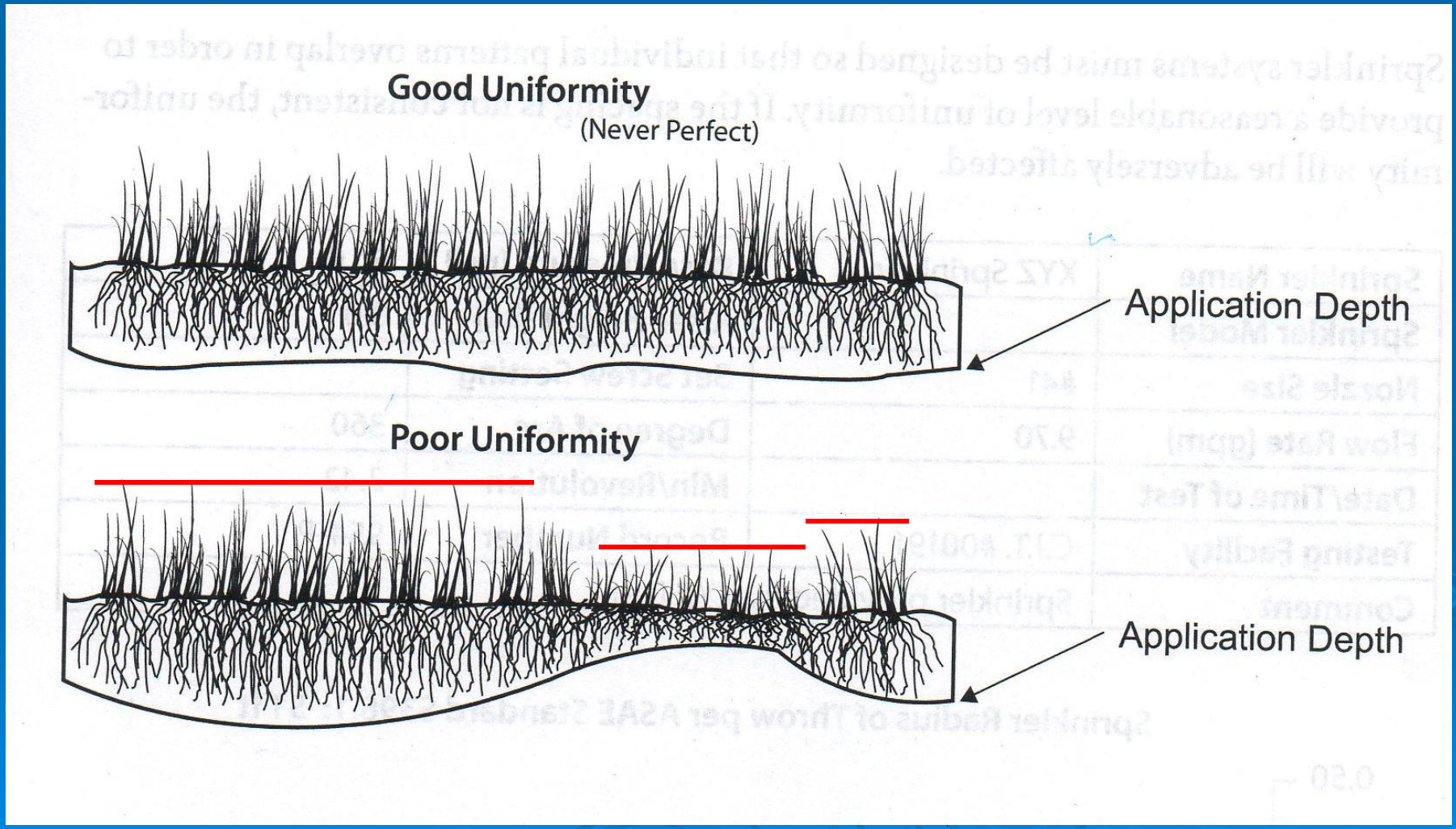
Understanding DU

- A measurement of the distribution of water across an area
- High DUs = even water distribution
  - Lower run times

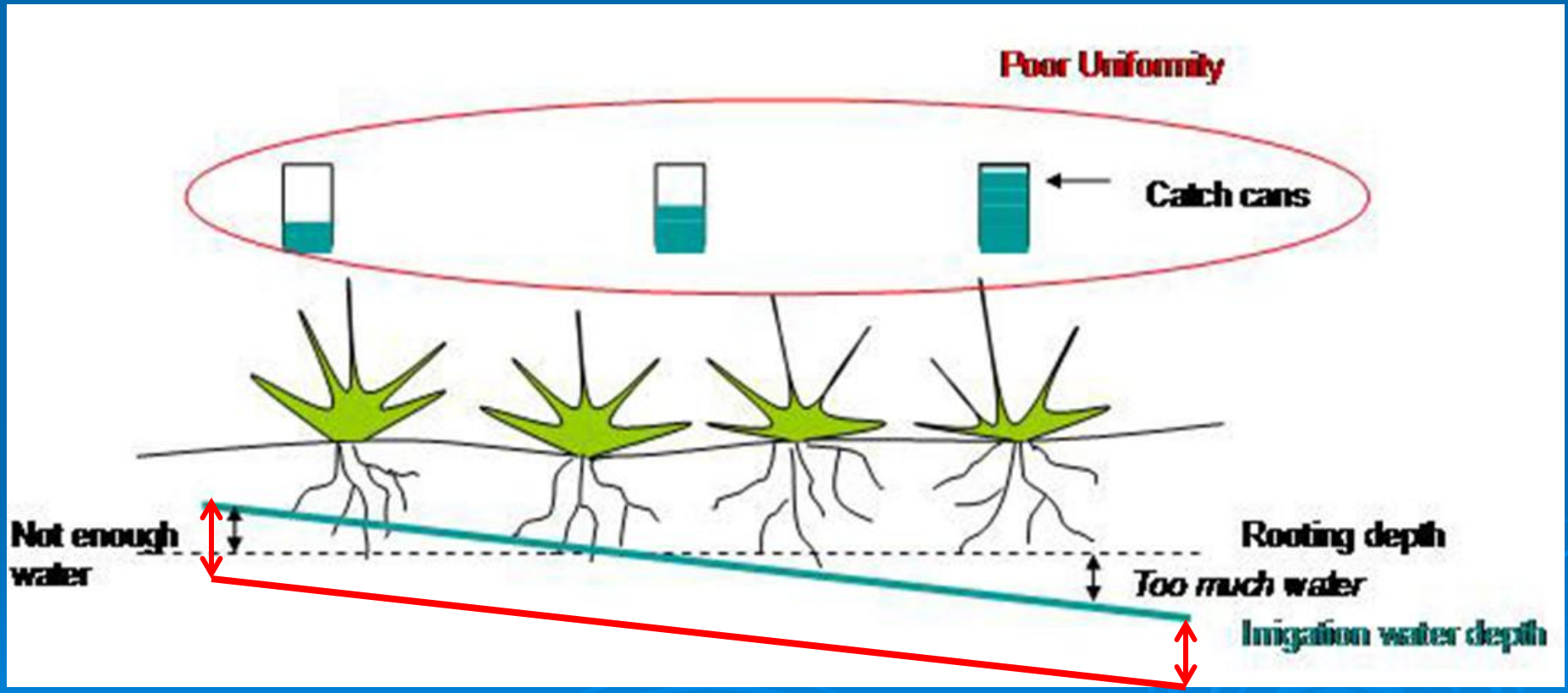
Distribution Uniformity - DU

- A measure of how even an irrigation system applies water to an area.
- Getting the system close to 100% is the goal.
- Lower DUs = increased irrigation water.
  - The lower the DU, the less efficient the distribution, and thus the more water that must be applied to meet the minimum requirement.

Good vs. Poor DU



Poor DU's = Over & Under Irrigation



Keys to achieving or maintaining high DUs (what works well)

- ✓ Balanced pressures
- ✓ Sprinkler types – must match
- ✓ Nozzle sizes – must match
- ✓ Maintenance
- ✓ Maintenance
- ✓ Maintenance

Pressure

Application Rate and Flow DU

This program calculates DU for 60 micro-system flow rates. To be used with Cal Poly ITRC's IWM software.

catch time (min):	5.0
# of emitters per plant:	6
space between rows:	22
space along rows:	15
Length of irrigation (hrs)	6

Location # 1

Enter ml's caught: Pressure=11

151	The flow rate for emitter #	1	was	0.48	gph.	The application rate was	0.014 in/hr.
162	The flow rate for emitter #	2	was	0.51	gph.	The application rate was	0.015 in/hr.
197	The flow rate for emitter #	3	was	0.62	gph.	The application rate was	0.018 in/hr.
212	The flow rate for emitter #	4	was	0.67	gph.	The application rate was	0.020 in/hr.
216	The flow rate for emitter #	5	was	0.68	gph.	The application rate was	0.020 in/hr.
237	The flow rate for emitter #	6	was	0.75	gph.	The application rate was	0.022 in/hr.
247	The flow rate for emitter #	7	was	0.78	gph.	The application rate was	0.023 in/hr.
247	The flow rate for emitter #	8	was	0.78	gph.	The application rate was	0.023 in/hr.
252	The flow rate for emitter #	9	was	0.80	gph.	The application rate was	0.023 in/hr.
265	The flow rate for emitter #	10	was	0.84	gph.	The application rate was	0.025 in/hr.
270	The flow rate for emitter #	11	was	0.86	gph.	The application rate was	0.025 in/hr.
283	The flow rate for emitter #	12	was	0.90	gph.	The application rate was	0.026 in/hr.
295	The flow rate for emitter #	13	was	0.94	gph.	The application rate was	0.027 in/hr.
297	The flow rate for emitter #	14	was	0.94	gph.	The application rate was	0.027 in/hr.
297	The flow rate for emitter #	15	was	0.94	gph.	The application rate was	0.027 in/hr.
307	The flow rate for emitter #	16	was	0.97	gph.	The application rate was	0.028 in/hr.

The average flow rate was 0.78 gph.
The average application rate was 0.023 in/hr.

The Flow DU for this location was 73.39 %

Location # 2

Enter ml's caught: Pressure= 7.5

270	The flow rate for emitter #	1	was	0.86	gph.	The application rate was	0.025 in/hr.
277	The flow rate for emitter #	2	was	0.88	gph.	The application rate was	0.026 in/hr.
282	The flow rate for emitter #	3	was	0.89	gph.	The application rate was	0.026 in/hr.
285	The flow rate for emitter #	4	was	0.90	gph.	The application rate was	0.026 in/hr.
290	The flow rate for emitter #	5	was	0.92	gph.	The application rate was	0.027 in/hr.
294	The flow rate for emitter #	6	was	0.93	gph.	The application rate was	0.027 in/hr.
296	The flow rate for emitter #	7	was	0.94	gph.	The application rate was	0.027 in/hr.
300	The flow rate for emitter #	8	was	0.95	gph.	The application rate was	0.028 in/hr.
300	The flow rate for emitter #	9	was	0.95	gph.	The application rate was	0.028 in/hr.
301	The flow rate for emitter #	10	was	0.95	gph.	The application rate was	0.028 in/hr.
303	The flow rate for emitter #	11	was	0.96	gph.	The application rate was	0.028 in/hr.
303	The flow rate for emitter #	12	was	0.96	gph.	The application rate was	0.028 in/hr.
304	The flow rate for emitter #	13	was	0.96	gph.	The application rate was	0.028 in/hr.
306	The flow rate for emitter #	14	was	0.97	gph.	The application rate was	0.028 in/hr.
308	The flow rate for emitter #	15	was	0.98	gph.	The application rate was	0.028 in/hr.
308	The flow rate for emitter #	16	was	0.98	gph.	The application rate was	0.028 in/hr.

The average flow rate was 0.94 gph.
The average application rate was 0.027 in/hr.

The Flow DU for this location was 94.27 %

Application Rate and Flow DU

Location # 3

Enter ml's caught: Pressure=3

0	The flow rate for emitter #	1	was	0.00	gph.	The application rate was	0.000 in/hr.
0	The flow rate for emitter #	2	was	0.00	gph.	The application rate was	0.000 in/hr.
34	The flow rate for emitter #	3	was	0.11	gph.	The application rate was	0.003 in/hr.
98	The flow rate for emitter #	4	was	0.31	gph.	The application rate was	0.009 in/hr.
106	The flow rate for emitter #	5	was	0.34	gph.	The application rate was	0.010 in/hr.
114	The flow rate for emitter #	6	was	0.36	gph.	The application rate was	0.011 in/hr.
117	The flow rate for emitter #	7	was	0.37	gph.	The application rate was	0.011 in/hr.
117	The flow rate for emitter #	8	was	0.37	gph.	The application rate was	0.011 in/hr.
118	The flow rate for emitter #	9	was	0.37	gph.	The application rate was	0.011 in/hr.
119	The flow rate for emitter #	10	was	0.38	gph.	The application rate was	0.011 in/hr.
119	The flow rate for emitter #	11	was	0.38	gph.	The application rate was	0.011 in/hr.
120	The flow rate for emitter #	12	was	0.38	gph.	The application rate was	0.011 in/hr.
121	The flow rate for emitter #	13	was	0.38	gph.	The application rate was	0.011 in/hr.
122	The flow rate for emitter #	14	was	0.39	gph.	The application rate was	0.011 in/hr.
122	The flow rate for emitter #	15	was	0.39	gph.	The application rate was	0.011 in/hr.
122	The flow rate for emitter #	16	was	0.39	gph.	The application rate was	0.011 in/hr.
122	The flow rate for emitter #	17	was	0.39	gph.	The application rate was	0.011 in/hr.
123	The flow rate for emitter #	18	was	0.39	gph.	The application rate was	0.011 in/hr.
123	The flow rate for emitter #	19	was	0.39	gph.	The application rate was	0.011 in/hr.
124	The flow rate for emitter #	20	was	0.39	gph.	The application rate was	0.011 in/hr.
124	The flow rate for emitter #	21	was	0.39	gph.	The application rate was	0.011 in/hr.
125	The flow rate for emitter #	22	was	0.40	gph.	The application rate was	0.012 in/hr.
125	The flow rate for emitter #	23	was	0.40	gph.	The application rate was	0.012 in/hr.
126	The flow rate for emitter #	24	was	0.40	gph.	The application rate was	0.012 in/hr.
126	The flow rate for emitter #	25	was	0.40	gph.	The application rate was	0.012 in/hr.
127	The flow rate for emitter #	26	was	0.40	gph.	The application rate was	0.012 in/hr.
127	The flow rate for emitter #	27	was	0.40	gph.	The application rate was	0.012 in/hr.
133	The flow rate for emitter #	28	was	0.42	gph.	The application rate was	0.012 in/hr.

The average flow rate was 0.35 gph.
The average application rate was 0.010 in/hr.

The Flow DU for this location was 30.26 %

The average flow rate for the entire system was 0.69 gph.
The average application rate for the system was 0.020 in/hr.

The Overall System Flow DU was 48.72 %.

An irrigation of 24 hrs will apply 0.481 gross inches of water.

Issues with this system

- Unbalanced pressures = mixed flow rates
- Likely plugging (maintenance)
- Pressure regulators rated to high for incoming pressure (design)

Sprinkler Types & Nozzles
What works well

- Use one type of sprinkler!
- Use one size of nozzle!
  - Small changes in sprinkler nozzles = large differences in flows
  - Follow manufacturer's specs

R10 Plate/Nozzle Options and Flow Performance in GPM and LPH

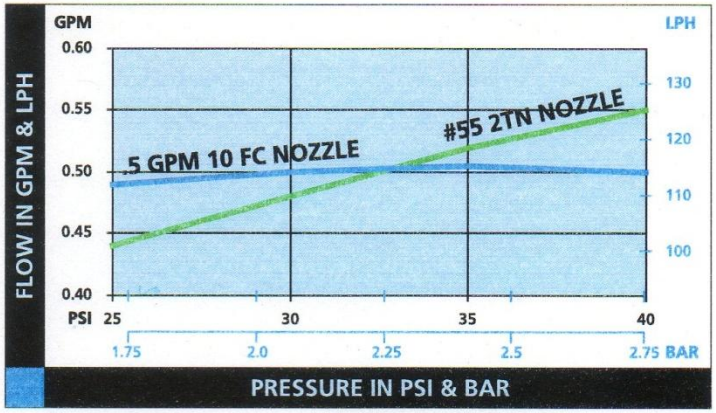
Plate Series	Plate Options	Recommended Nozzles	PSI 25	30	35	40	45	50	BAR 1.75	2	2.25	2.5	2.75	3	3.25
P2	P2 9° Red Radius 18-20' (5.5-6.1 m) Stream Ht.14-23" (36-58 cm)	Lt. Blue #40	—	—	.28	.30	.32	.34	—	—	61.4	64.7	68.0	71.3	74.6
		Lt. Purple #45	.29	.32	.35	.37	.39	.42	66.4	71.3	76.3	80.6	83.9	87.2	91.5
		Dk. Green #50	.36	.39	.43	.46	.48	.51	82.3	87.2	93.4	99.4	104	108	112
		.35 10FC	Within the recommended pressure range of 25-50 PSI (1.75-3.25 BAR), the .35 10 FC flow control nozzle is flow regulating within a flow range of no more than 0% greater and 10% less than the nominal flow of .35 GPM (79.5 LPH).												
P4	P4 9° White Radius 18-22' (5.5-6.7 m) Stream Ht. 14-24" (36-61 cm)	Dk. Green #50	—	—	.43	.46	.48	.51	—	—	93.4	99.4	104	108	112
		Lt. Yellow #55	.44	.48	.52	.55	.59	.62	101	107	114	120	125	131	137
		Lt. Red #60	.51	.56	.61	.65	.69	.73	117	125	133	141	147	154	161
	P4 15° Orange Radius: 23-25' (7.0-7.6 m) Stream Ht. 40-50" (102-127 cm)	.50 10FC	Within the recommended pressure range of pressure range of 25-50 PSI (1.75-3.25 BAR), the .5 10 FC flow control nozzle is flow regulating within a flow range of no more than 0% greater and 10% less than the nominal flow of .5 GPM (114 LPH).												

R10 Turbo Plate/Nozzle Options and Flow Performance in GPM and LPH

Plate Series	Plate Options	Recommended Nozzles	PSI 25	30	35	40	45	50	BAR 1.75	2	2.25	2.5	2.75	3	3.25
P6	P6 9° Blue R.20-22' (6.1-6.7 m) Stream Ht. 17-30" (43-76 cm)	Gray #65	.61	.67	.72	.77	.82	.86	140	150	158	166	175	183	190
		White #70	.70	.77	.83	.89	.94	1.00	160	172	182	192	202	210	219
		Dk. Blue #78	.88	.97	1.05	1.12	1.19	1.25	201	217	230	242	254	266	276
		.75 10FC	Within the recommended pressure range of 25 to 50 PSI (1.75-3.25 BAR), the .75 10 FC flow control nozzle is flow regulating within a flow range of no more than 0% greater and 10% less than the nominal flow of .75 GPM (170 LPH).												
	P6 15° Purple R. 25-26' (7.6-7.9 m) Stream Ht. 33-49" (84-124 cm)	1.0 10FC	Within the recommended pressure range of 30 to 50 PSI (2-3.75 BAR), the 1.0 10 FC flow control nozzle is flow regulating within a flow range of no more than 0% greater and 10% less than the nominal flow of 1.0 GPM (227 LPH).												
P8	P8 15° Gold R. 26-30' (7.9-9.1 m) Stream Ht. 38-58" (97-147 cm)	Orange #86	1.07	1.17	1.27	1.36	1.45	1.53	245	261	278	294	308	323	337
		Purple #94	1.27	1.39	1.50	1.61	1.70	1.80	290	311	329	347	365	380	396
		Yellow #102	1.50	1.64	1.78	1.90	2.02	2.13	343	366	389	411	431	451	469
		1.25 10FC	Within the recommended pressure range of 30 to 50 PSI (2-3.75 BAR), the 1.25 10 FC flow control nozzle is flow regulating within a flow range of no more than 3.5% greater and 8% less than the nominal flow of 1.25 GPM (284 LPH).												
	P8 24° Brown R. 27-33' (8.2-10.1 m) Stream Ht. 64-99" (163-251 cm)	1.5 10 FC	Within the recommended pressure range of 30 to 50 PSI (2-3.75 BAR), the 1.5 10 FC flow control nozzle is flow regulating within a flow range of no more than 3.5% greater and 8% less than the nominal flow of 1.5 GPM (341 LPH).												
		Dk. Blue #78 for use with P8 24° plate only	—	.97	1.05	1.12	1.19	1.25	—	217	230	242	254	266	276
		1.0 10FC for use with P8 24° plate only	Within the recommended pressure range of 30 to 50 PSI (2-3.75 BAR), the 1.0 10 FC flow control nozzle is flow regulating within a flow range of no more than 0% greater and 10% less than the nominal flow of 1.0 GPM (227 LPH).												

The performance data in this section has been recorded under ideal test conditions and may be adversely affected by poor hydraulic entrance conditions, slope, riser tilt, temperature, wind or other factors. **Always be sure to use the nozzle size that is recommended for the plate.** The operating pressure should be within the recommended range. Only the nozzle and plate combinations grouped together in the above chart are recommended. The absence of flow data on the above chart indicates the pressure is outside the recommended range.

10FC nozzle and 2TN nozzle flow rates with changes in pressure



Running a system with high DU

- Combine sprinkler models and types with proper nozzle size and corresponding pressures
  - Nozzle size dependent on sprinkler spacing, soil type, and crop
    - Newer systems with irrigation plans usually include nozzle size

Nozzle challenges

- When replacing nozzles always use the same size!!!
- Nozzles will wear out
- Check flows occasionally
- Have a scheduled maintenance plan to change out nozzles
  - Every 5-10 years

How to check pressures and flows

- Treat your irrigation system like a tractor!
  - With maintenance it will last longer and perform better

Maintenance tips

- Clean and flush filters regularly
- Flush lines on a regular basis
- For drip and micro check lines at least twice per season
  - Check for bacteria or calcium buildup around emitters and nozzles (especially when using surface water)

Infrequent hose flushing & lack of chemical injection

More challenges

Leaking

More challenges

Plugs

More challenges
More maintenance

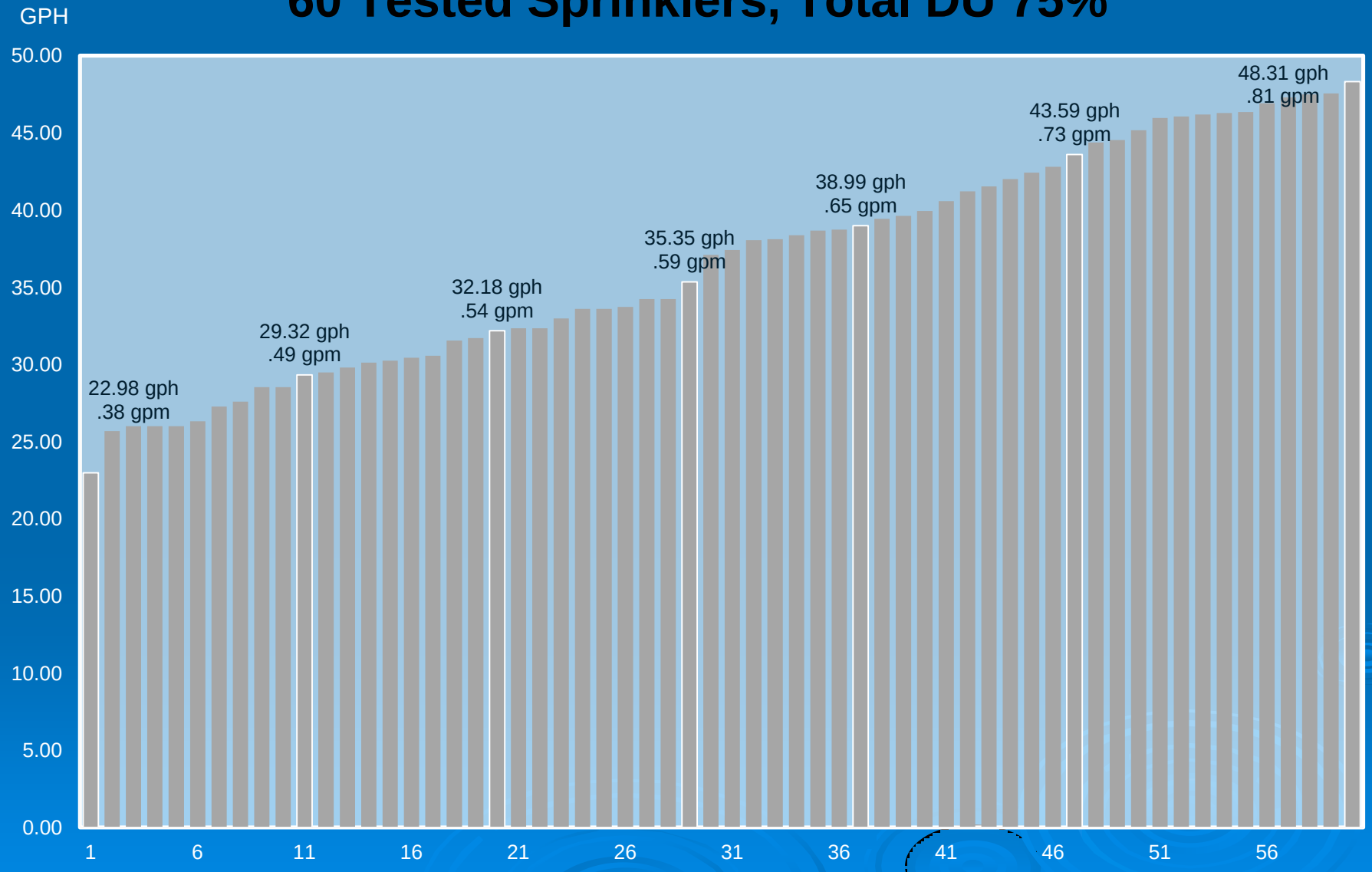
- Frequent system checks are encouraged
- Parts break or malfunction on a regular basis!

The Importance of DU

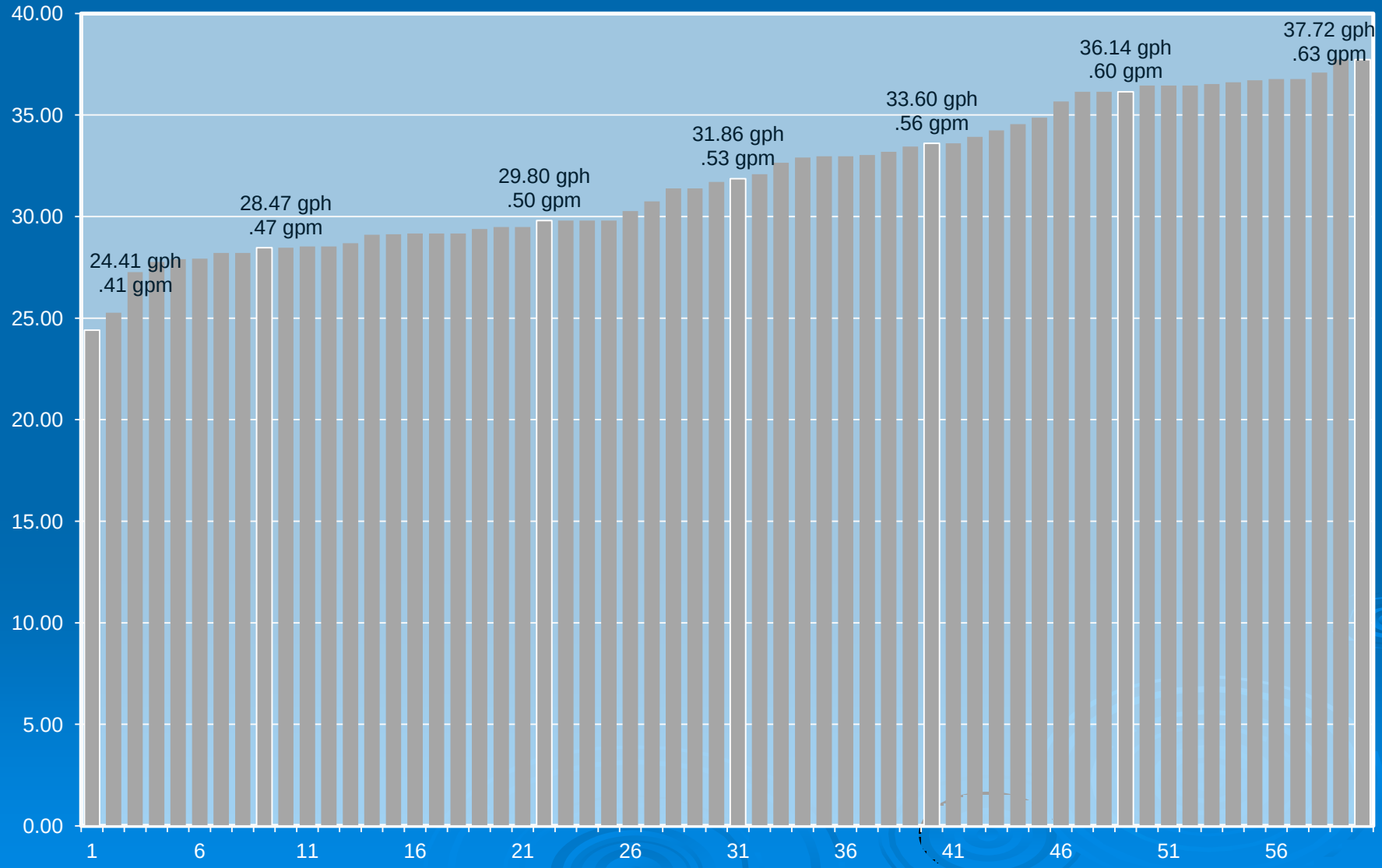
- Any combination of
  - Variations in pressure
  - Lack of maintenance
  - Mixing nozzles and sprinklers

  = Decrease in DU
- Poor DU = variations in sprinkler flow rates = lack of uniform water application across the crop = yields are not maximized!

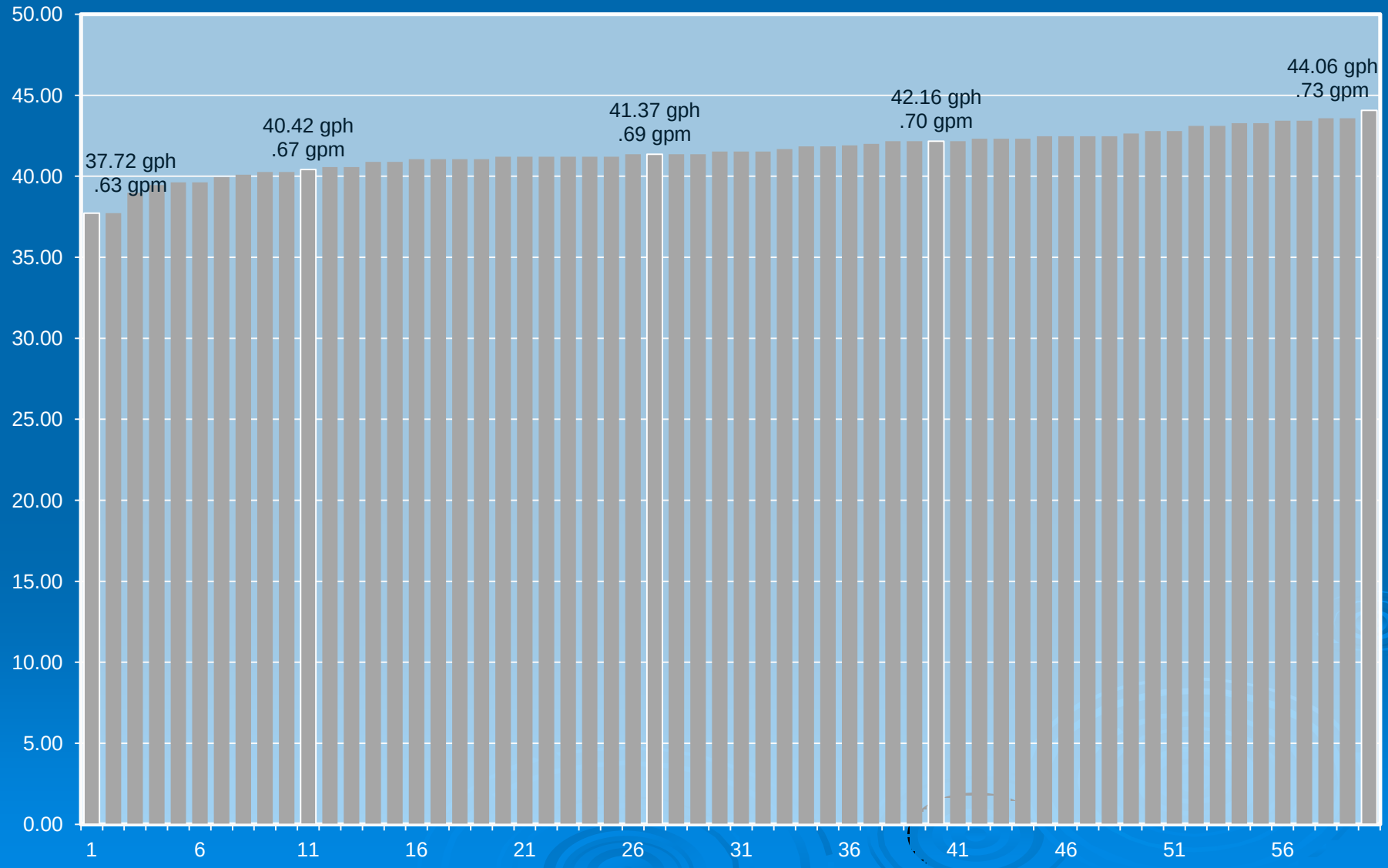
GPH Range on Micro Sprinklers
60 Tested Sprinklers, Total DU 75%



GPH Range on Micro Sprinklers
60 Tested Sprinklers, Total DU 87%



GPH Range on Micro Sprinklers
60 Tested Sprinklers, Total DU 96%



The Importance of DU

DU	Low	High	Difference	24 hour Total	15 Cycles	
75	22.98	48.31	25.33	608	9120	Gallons
87	24.41	37.72	13.31	319	4785	Gallons
96	37.72	44.06	6.34	152	2280	Gallons

My Contact Info

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