



Assessing Your Sprinkler Irrigation System

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Outline

1. Water Supply
2. System Sketch
3. Sprinkler spacing
4. Nozzle size and operating pressure
5. Pipe size
6. Application Rate
7. Effects of adding more sprinklers

Water Supply

- Surface water
 - Ditch, slough, river
 - Do you have a Water License?
- Do you have enough water?
 - Frost protection requires 10 times the flow rate of typical crop irrigation.
- Ground Water
 - Ground Water Protection Regulation

Pump Systems

- Centrifugal Pump



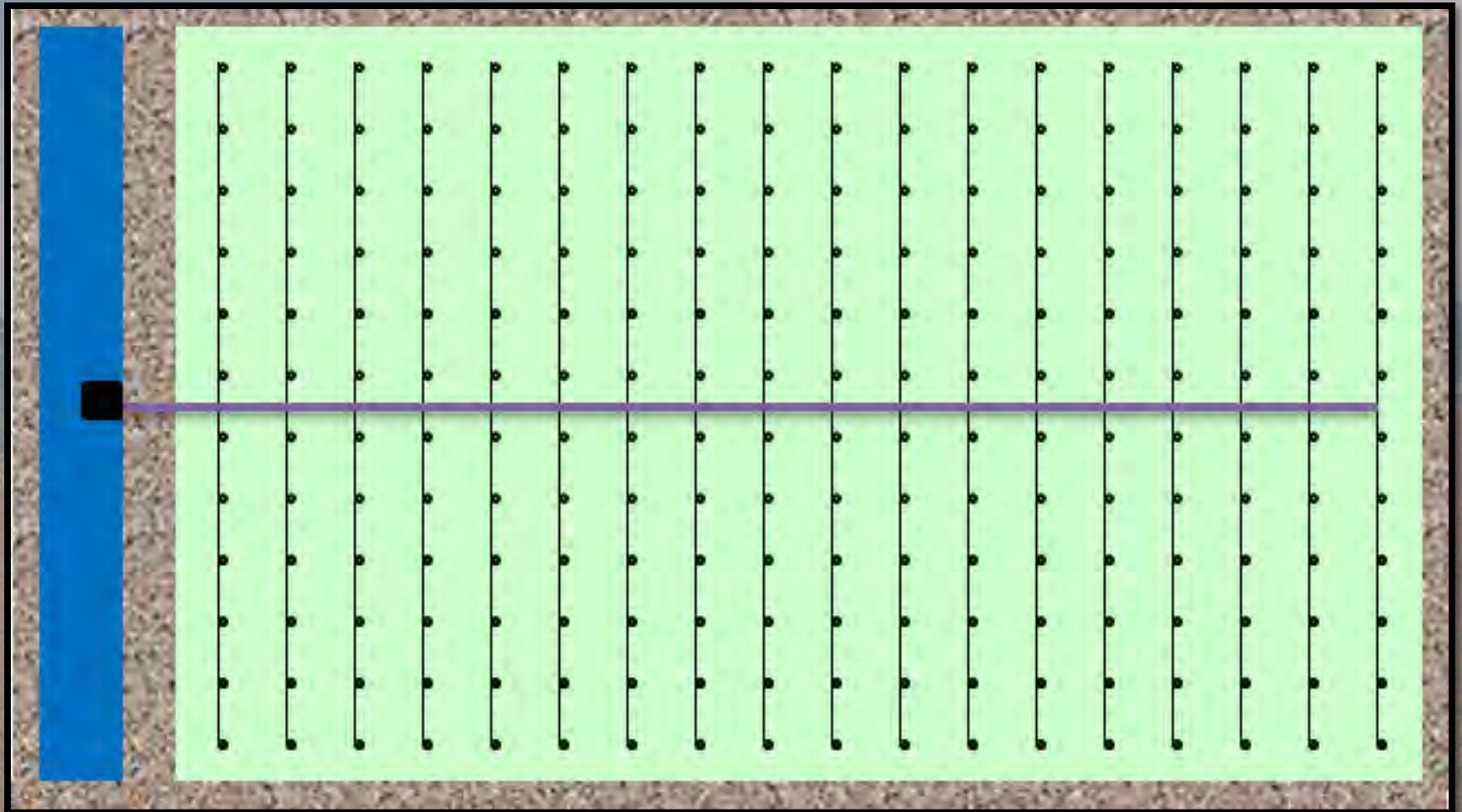
- Vertical Turbine Pump



- Pressure Gauge



System Sketch



Sprinkler and Lateral Spacing

- How far apart are the sprinklers?
- Are they the same distance apart?
- Are they the correct distance apart?
 - Proper design is **head to head** along lateral.



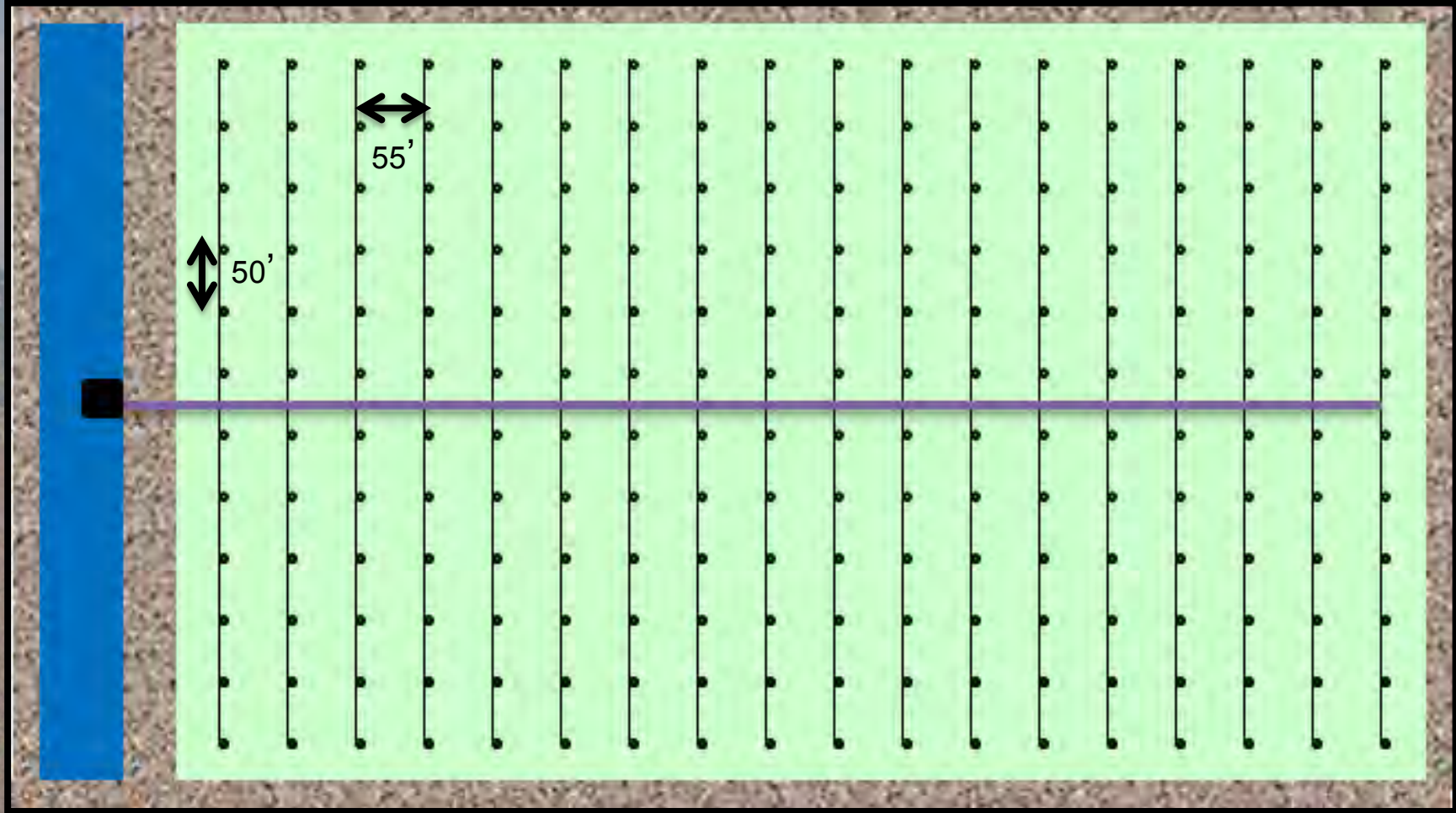
RECTANGULAR

TRIANGULAR

System Sketch

Example

Sprinkler Spacing 50 x Lateral Spacing 55



Sprinkler Nozzles

- What size?
- Are they the same size?
- When was the last time the orifice was checked or replaced?
- What pressure do they operate at?

Nozzle Flow Rate (q)

Pitot Tube

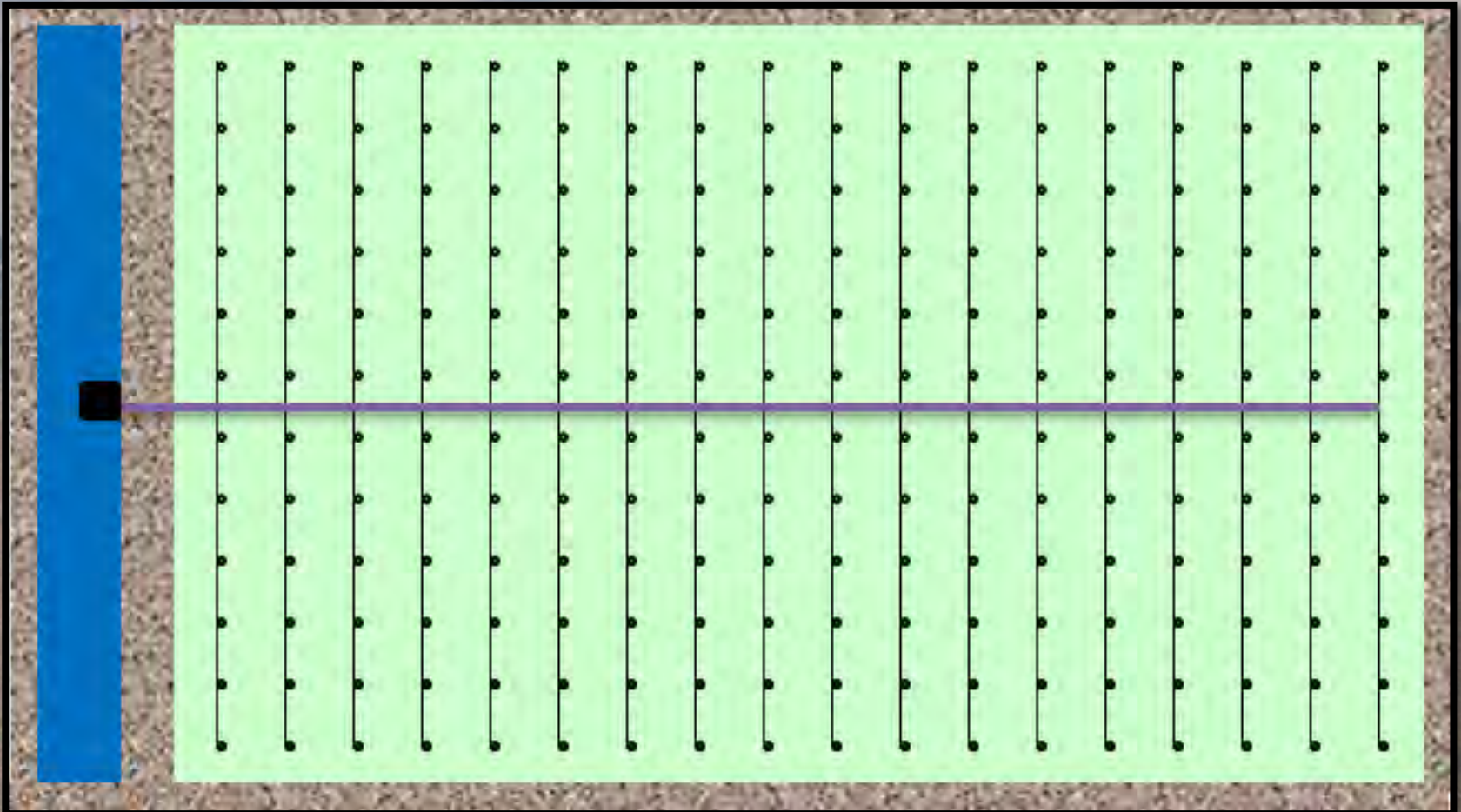


Nozzle Flow Rate (Usgpm)					
	Nozzle Size (in)				
PSI	7/64	1/8	9/64	5/32	11/64
25	1.73	2.26	2.90	3.50	4.30
30	1.90	2.48	3.10	3.90	4.70
35	2.05	2.68	3.40	4.20	5.10
40	2.19	2.86	3.60	4.50	5.40
45	2.32	3.03	3.80	4.70	5.70
50	2.45	3.20	4.10	5.00	6.10
55	2.57	3.35	4.20	5.20	6.30
60	2.68	3.50	4.40	5.50	6.50
65	-	-	4.60	5.80	6.90

System Sketch

Example

Spacing 50 x 55 with 9/64th @ 50 psi flowing 4.1 USgpm



Do you have enough water?

- One 4.1 US gpm Nozzle
 - In one hour = 246 us gal
 - In 15 hours = 3,690 us gal
- Per acre there is 17 sprinklers
 - Require 67,320 us gal
 - Or 9,000 ft³ per acre

Pipe Size

- What type of pipe?
- Is your pipe large enough?
- Maximum velocity should **NOT** exceed 5 ft/s
- Pipe size affects friction loss
- Flow increases 50 % - friction loss **doubles**

Pipe Size...

Example

$$Q = 4.1 \times 216 = 886 \text{ USgpm}$$

PIPE TYPE: PVC CLASS 160 Plastic Pipe						
Size	8		10		12	
ID	7.91		9.86		11.7	
gpm	Vel	Hf	Vel	Hf	Vel	Hf
600	3.91	0.25	2.52	0.09	1.79	0.04
650	4.24	0.29	2.73	0.10	1.94	0.04
700	4.57	0.33	2.94	0.11	2.09	0.05
750	4.89	0.38	3.15	0.13	2.24	0.06
800	5.22	0.42	3.36	0.14	2.39	0.06
850	5.54	0.47	3.57	0.16	2.53	0.07
900	5.87	0.53	3.78	0.18	2.68	0.08
950	6.20	0.58	3.99	0.20	2.83	0.09
1000	6.52	0.64	4.20	0.22	2.98	0.10
1100	7.18	0.76	4.62	0.26	3.28	0.11
1200	7.83	0.90	5.04	0.31	3.58	0.13
1300	8.48	1.04	5.46	0.36	3.88	0.15
1400	9.13	1.20	5.88	0.41	4.17	0.18
1500	9.79	1.36	6.30	0.46	4.47	0.20
1600	10.44	1.53	6.72	0.52	4.77	0.23
1700			7.14	0.59	5.07	0.25
1800			7.56	0.65	5.37	0.28

PIPE TYPE: PVC CLASS 125 Plastic Pipe						
Size	8		10		12	
ID	8.05		10.04		11.91	
gpm	Vel	Hf	Vel	Hf	Vel	Hf
600	3.78	0.23	2.43	0.08	1.73	0.03
650	4.09	0.27	2.63	0.09	1.87	0.04
700	4.41	0.30	2.83	0.10	2.01	0.05
750	4.72	0.35	3.04	0.12	2.16	0.05
800	5.04	0.39	3.24	0.13	2.30	0.06
850	5.35	0.44	3.44	0.15	2.45	0.06
900	5.67	0.48	3.64	0.17	2.59	0.07
950	5.98	0.54	3.85	0.18	2.73	0.08
1000	6.30	0.59	4.05	0.20	2.88	0.09
1100	6.93	0.70	4.45	0.24	3.17	0.10
1200	7.56	0.82	4.86	0.28	3.45	0.12
1300	8.19	0.96	5.26	0.33	3.74	0.14
1400	8.82	1.10	5.67	0.37	4.03	0.16
1500	9.45	1.25	6.07	0.43	4.32	0.19
1600			6.48	0.48	4.60	0.21
1700			6.88	0.54	4.89	0.23
1800			7.29	0.60	5.18	0.26

Pipe size...

- 20 % rule
 - Sprinkler should be within 20 % of supply pressure (flat ground)
- Supply Pressure
 - With sprinklers @ 50 psi pump needs to supply 63 psi

Pump

- For this example require
886 US gpm @ 63 psi
- 50 hp turbine with 2 impellers
886 US gpm @ 64 psi
- What happens if we add one lateral?

Expand existing system

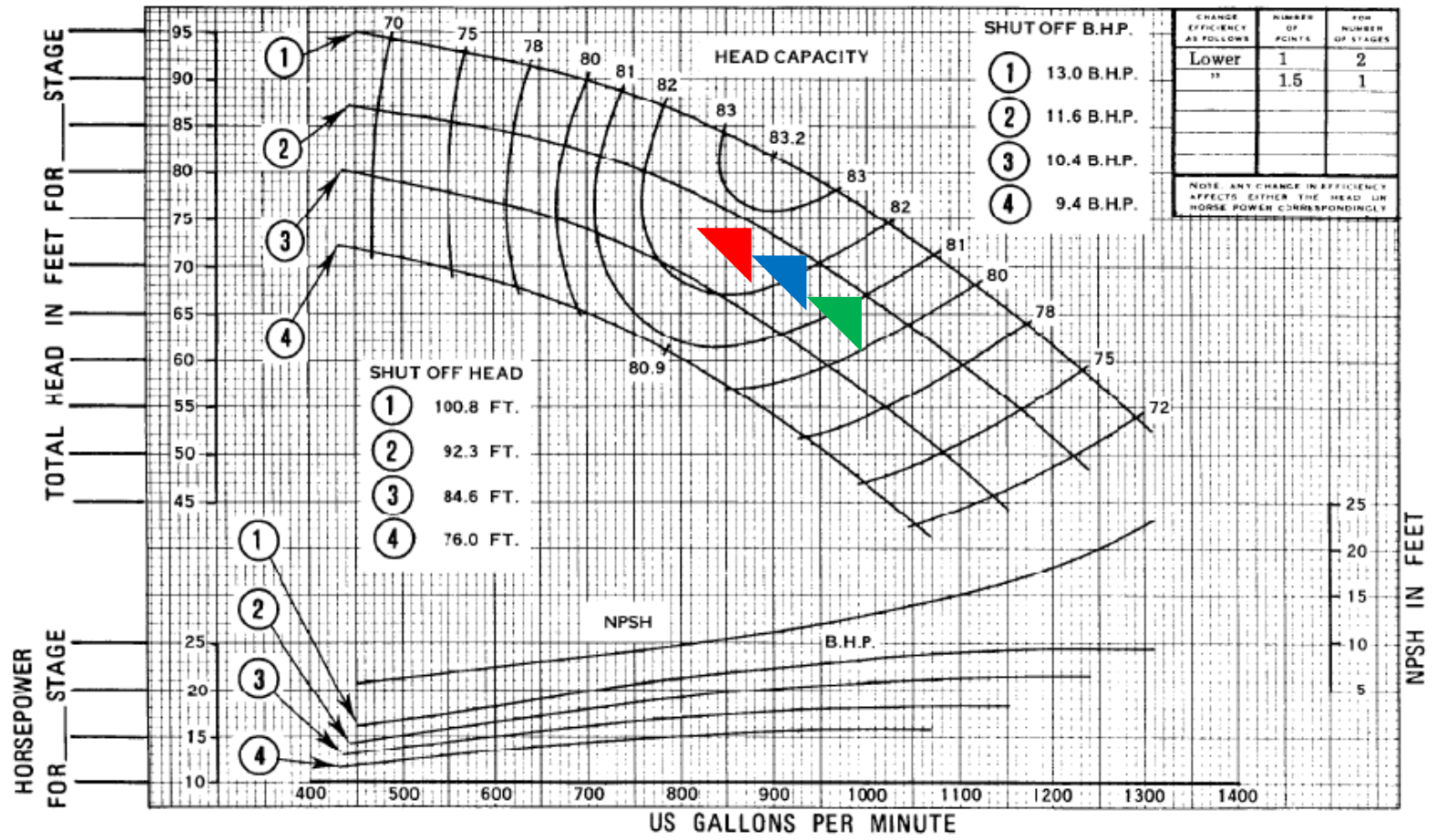
- Add 12 sprinklers at 4.1 US gpm (49 US gpm)
- Total flow = $886 + 49 = 935$
- Pump has to follow curve
(Unless using variable drive)



Peerless Pump Company
 Indianapolis, IN 46207-7026

VERTICAL TURBINE PUMPS
 Model 12LD - 1760 Rpm

SECTION 140
 Page 1760-41
 May, 1983



HYDRAULIC PERFORMANCE WARRANTY	CURVE NO.	IMPELLER NO.	IMPELLER DIA.	TAKEN FROM	Customer
	Guaranteed at designated point only, and contingent on: Proper flow to pump suction Proper submergence Fluid free of gas, air & abrasives Proper lateral setting of impeller	1	2634820	8 ¹⁹ / ₁₆ " x 9 ²³ / ₃₂ "	54628
	2	2634820	8 ⁵ / ₈ " x 9 ⁷ / ₁₆ "	54573	Item _____
	3	2634820	8 ¹ / ₂ " x 9 ⁵ / ₃₂ "	54601	Peerless Ref. No: _____
	4	2634820	7 ⁷ / ₈ " x 8 ²⁹ / ₃₂ "	54664	Laboratory Performance

SIZE	12LD	RPM	1760	BOWL	2634607 CIE
				CURVE	4805968

PUMP DESCRIPTION: Driver _____; Head _____; Column _____
 GUARANTEED BOWL PERFORMANCE: Capacity _____ gpm; Head _____ ft; Eff _____ %; BHP _____
 FIELD

Adding extra laterals

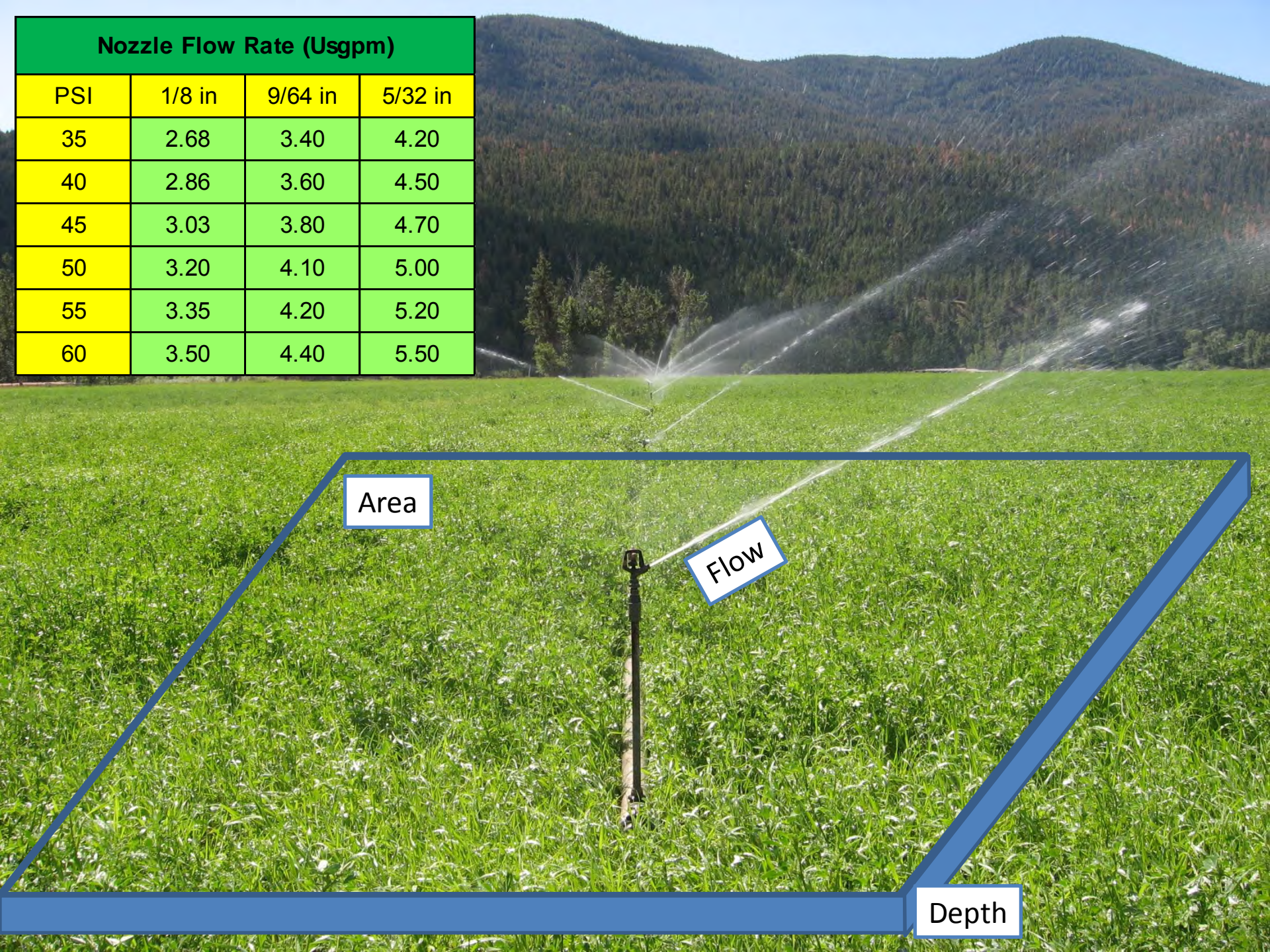
- For each added lateral
 - Pump move out on curve reduces pressure 2 psi
 - Friction loss goes up reduces pressure another 2 psi
 - Total pressure loss is 4 psi, compounds with more expansion

How much do you apply?

- We know the nozzle size.
- We know the sprinkler operating pressure.
- We know the sprinkler and lateral spacing.
- Need to calculate application rate.

Nozzle Flow Rate (Usgpm)

PSI	1/8 in	9/64 in	5/32 in
35	2.68	3.40	4.20
40	2.86	3.60	4.50
45	3.03	3.80	4.70
50	3.20	4.10	5.00
55	3.35	4.20	5.20
60	3.50	4.40	5.50



Area

Flow

Depth

Need to Calculate Depth

Application Rate, (AR)

$$AR = \frac{96.3 \times Q}{\text{Area}} = \frac{96.3 \times Q}{SS \times LS}$$

- AR = application rate (in/hr)
- Q = nozzle flow rate (USgpm)
- SS = sprinkler spacing (ft)
- LS = lateral spacing (ft)

Application Rate Example

9/64 @ 50 psi on a 50 x 55 ft spacing

$$\begin{aligned} \text{AR} &= \frac{96.3 \times Q}{\text{SS} \times \text{LS}} = \frac{96.3 \times 4.1}{50 \times 55} \\ &= 0.144 \text{ in/hr} \end{aligned}$$

- For frost protection require a minimum AR of 0.1 in/hr

Application Rate Ex

9/64 @ 46 psi on a 50 x 55

Nozzle Flow Rate (Usqpm)			
PSI	1/8 in	9/64 in	5/32 in
35	2.68	3.40	4.20
40	2.86	3.60	4.50
45	3.03	3.80	4.70
50	3.20	4.10	5.00
55	3.35	4.20	5.20
60	3.50	4.40	5.50

$$AR = \frac{96.3 \times Q}{SS \times LS} = \frac{96.3 \times 3.8}{50 \times 55}$$

$$1^{\text{st}} \text{ lateral added} = 0.133 \text{ in/hr}$$

$$2^{\text{nd}} \text{ lateral added} = 0.126 \text{ in/hr}$$

$$3^{\text{rd}} \text{ lateral added} = 0.116 \text{ in/hr}$$

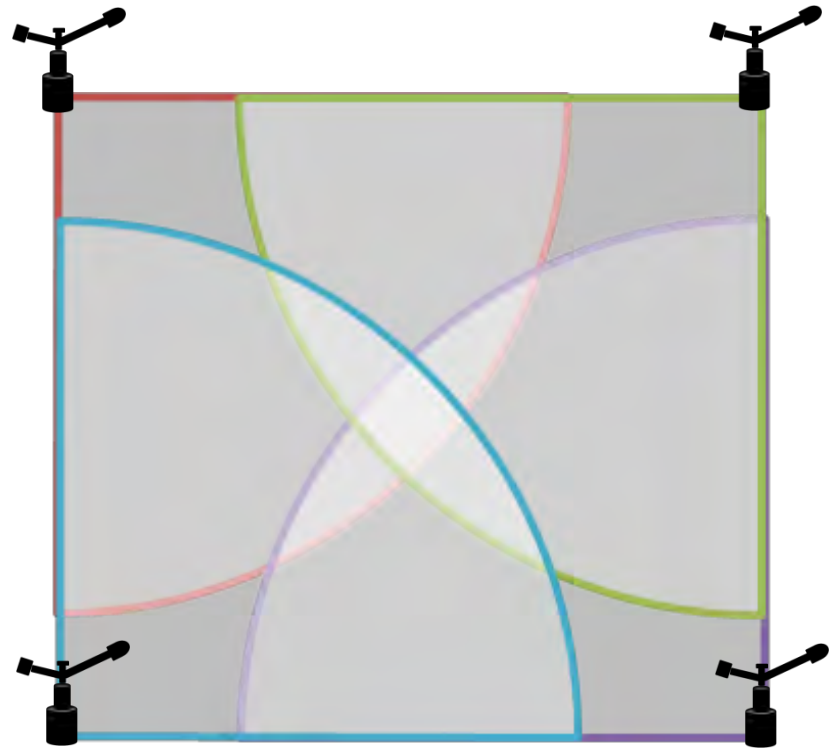
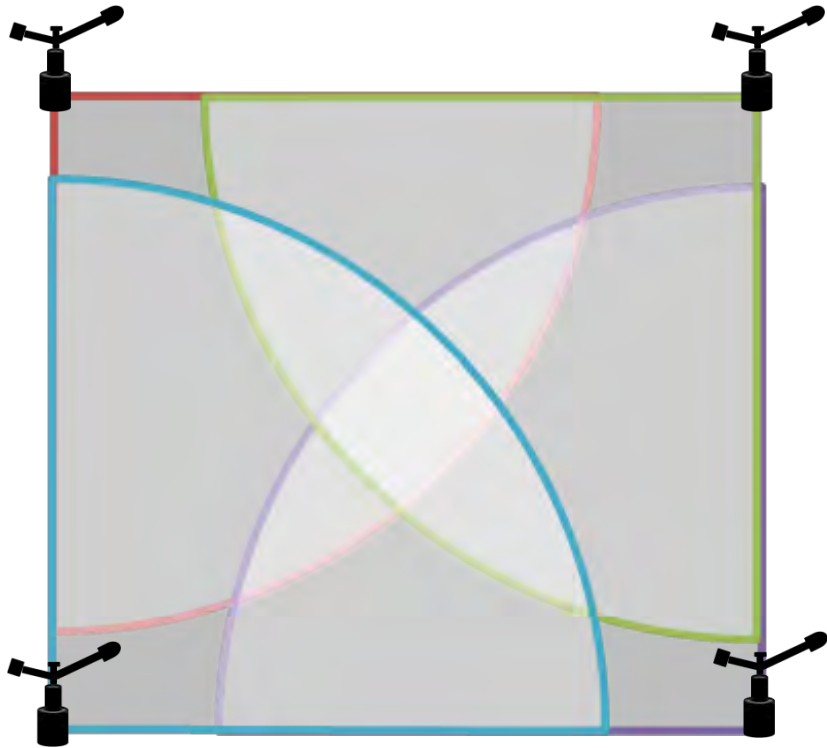
What else happens as we add sprinklers?

- Pressure at nozzle has dropped 4, 9, 15 psi.

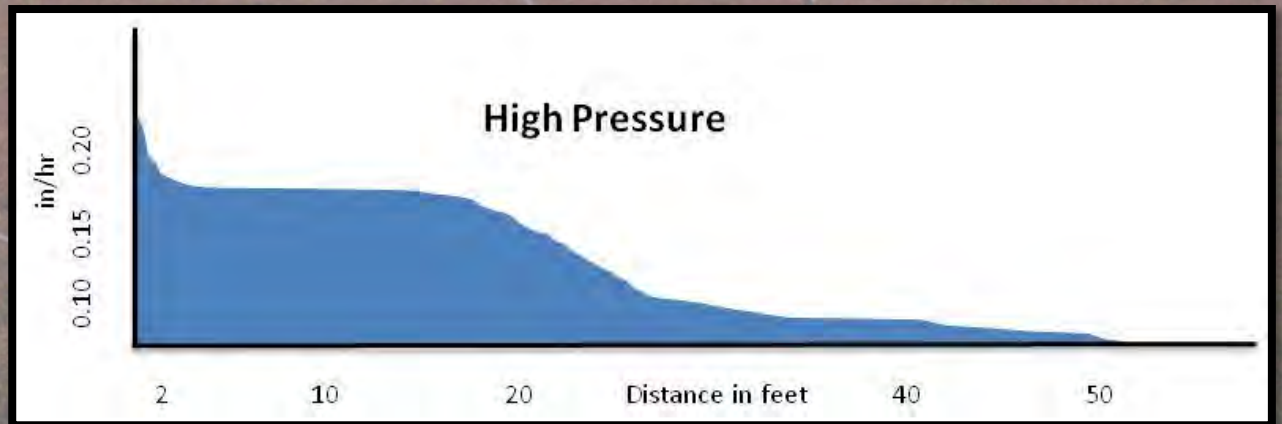
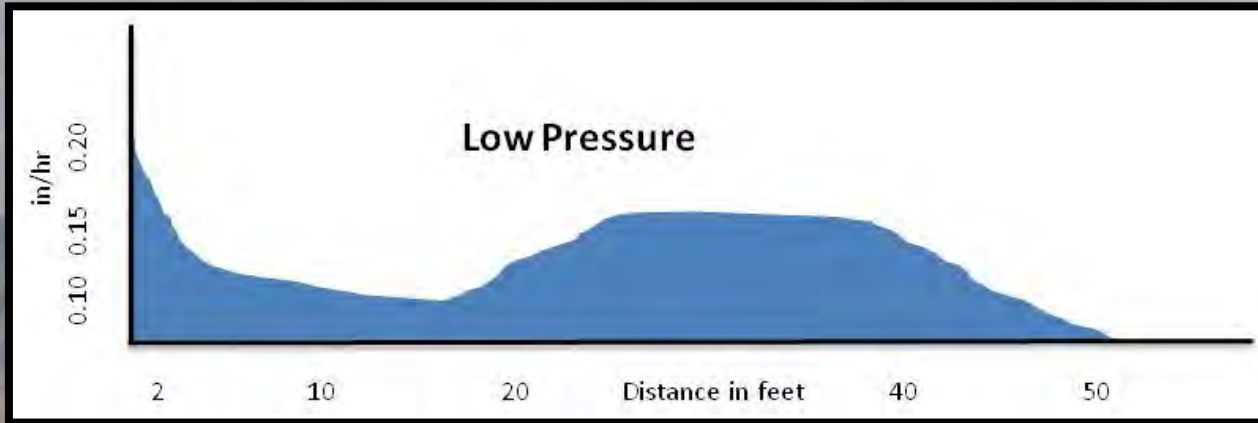
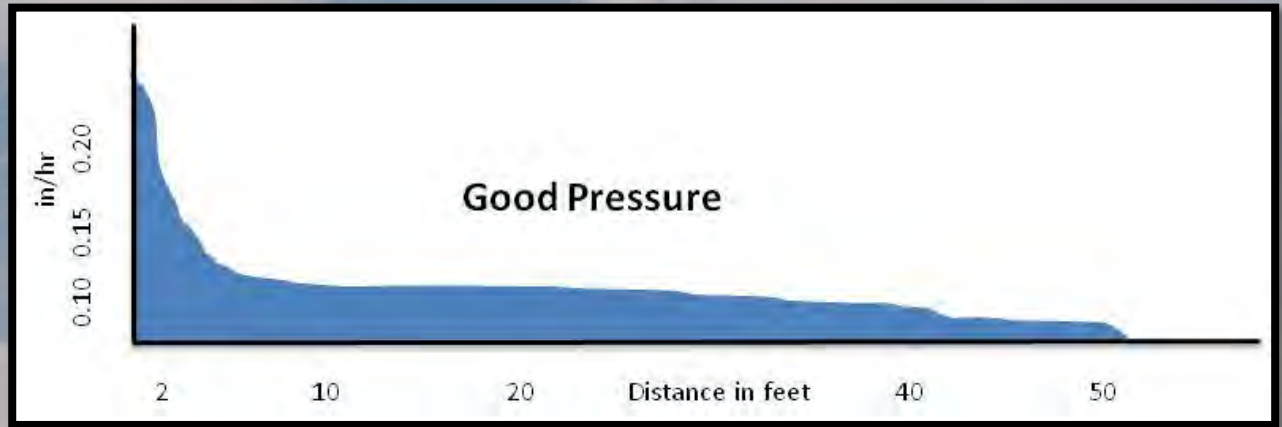
PSI @ Nozzle	NOZZLE SIZE US STANDARD							
	9/64"		5/32"		11/64"		3/16"	
	Rad.	GPM	Rad.	GPM	Rad.	GPM	Rad.	GPM
25	40	2.90	41	3.50	41	4.30	42	5.10
30	40	3.10	42	3.90	44	4.70	45	5.60
35	41	3.40	43	4.20	45	5.10	47	6.00
40	41	3.60	44	4.50	46	5.40	48	6.40
45	42	3.80	44	4.70	46	5.70	49	6.80
50	42	4.10	45	5.00	47	6.10	50	7.20
55	43	4.20	45	5.20	48	6.30	50	7.60
60	43	4.40	46	5.50	48	6.60	51	7.90
65	44	4.60	46	5.80	49	6.90	51	8.20
70	44	4.80	47	5.90	49	7.20	52	8.50
75	45	5.00	47	6.10	50	7.40	52	8.80
80	45	5.10	48	6.30	50	7.70	53	9.10

NOZ. PSI	9/64"		5/32"		11/64"	
	GPM	DIA. FT.	GPM	DIA. FT.	GPM	DIA. FT.
25	2.88	80	3.52	82	4.24	83
30	3.15	81	3.85	85	4.64	88
35	3.40	82	4.16	87	5.02	90
40	3.64	83	4.45	88	5.37	92
45	3.86	84	4.72	89	5.70	94
50	4.07	85	4.98	90	6.01	95
55	4.27	86	5.22	91	6.30	96
60	4.46	87	5.45	92	6.57	97
65	4.65	88	5.68	93	6.83	98
70	4.83	89	5.90	94	7.09	99
75	5.00	90	6.11	95	7.34	100
80	5.17	91	6.30	96	7.58	101

50' x 55' Loss of Radius



Effects of Pressure



Design Considerations

- Use a certified irrigation designer
- Head to Head down lateral
- 20% rule for pressure loss
- The goods:
 - Good operating pressure
 - Good spacing
 - Creates good uniformity
 - Produces a good crop

Spacing Considerations

- Field Edges
 - Chemical application
 - Over spray issues
 - Part circle heads
 - Reduce the nozzle size
 - Chemical wash out time

Irrigation System Design Manual

B.C. Sprinkler Irrigation Manual



IRRIGATION INDUSTRY ASSOCIATION
OF
BRITISH COLUMBIA

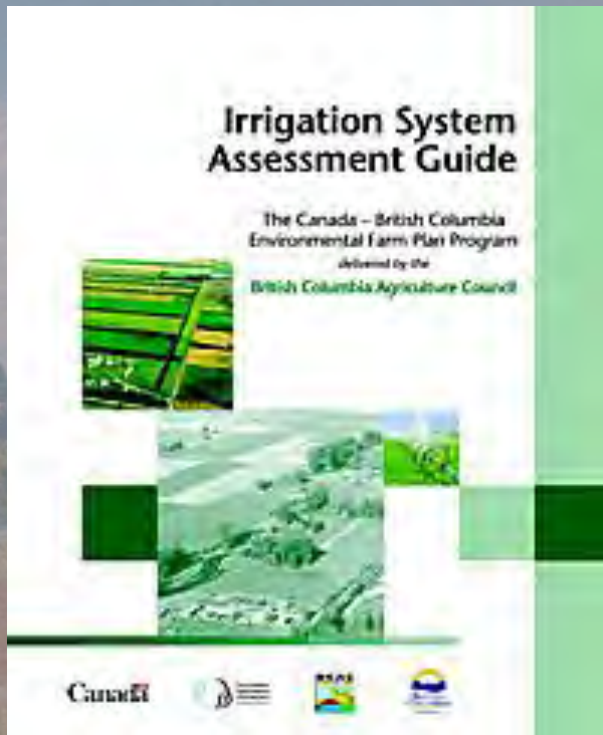


Province of British Columbia
Ministry of Agriculture and Fisheries
SOILS & ENGINEERING BRANCH

Available from the Irrigation
Industry Association of B.C.
(IIABC)

www.irrigationbc.com

B.C. Environmental Farm Plan



Irrigation System Assessment:

- | System peak flow rate check
- | Annual water use check
- | Water license check
- | Conveyance loss check
- | Screen area check
- | Irrigation water quality check

Available online at:

http://www.bcac.bc.ca/EFP_pages

Questions?



Exercise

- What is the application rate of your sprinkler?
- Nozzle Size = ?
- Nozzle Pressure = ?
- Sprinkler spacing = ?
- Lateral spacing = ?

Brass Impacts

PSI @ Nozzle	NOZZLE SIZE US STANDARD					
	9/64"		5/32"		11/64"	
	Rad.	GPM	Rad.	GPM	Rad.	GPM
25	40	2.90	41	3.50	41	4.30
30	40	3.10	42	3.90	44	4.70
35	41	3.40	43	4.20	45	5.10
40	41	3.60	44	4.50	46	5.40
45	42	3.80	44	4.70	46	5.70
50	42	4.10	45	5.00	47	6.10
55	43	4.20	45	5.20	48	6.30
60	43	4.40	46	5.50	48	6.60
65	44	4.60	46	5.80	49	6.90
70	44	4.80	47	5.90	49	7.20
75	45	5.00	47	6.10	50	7.40
80	45	5.10	48	6.30	50	7.70

NOZ. PSI	9/64"		5/32"		11/64"	
	GPM	DIA. FT.	GPM	DIA. FT.	GPM	DIA. FT.
25	2.88	80	3.52	82	4.24	83
30	3.15	81	3.85	85	4.64	88
35	3.40	82	4.16	87	5.02	90
40	3.64	83	4.45	88	5.37	92
45	3.86	84	4.72	89	5.70	94
50	4.07	85	4.98	90	6.01	95
55	4.27	86	5.22	91	6.30	96
60	4.46	87	5.45	92	6.57	97
65	4.65	88	5.68	93	6.83	98
70	4.83	89	5.90	94	7.09	99
75	5.00	90	6.11	95	7.34	100
80	5.17	91	6.30	96	7.58	101

Nelson R33

R33 / R33LP PERFORMANCE (U.S. UNITS)

R33LP PERFORMANCE RANGE 25-50 PSI

R33 PERFORMANCE RANGE 40-65 PSI




Pressure in PSI

Nozzle		25	30	35	40	45	50	55	60	65
9/64"	GPM	2.88	3.15	3.40	3.64	3.86	4.07	4.27	4.46	4.65
	RAD (ft.)	37	38	40	42 43	42 44	42 44	44	44	44
5/32"	GPM	3.52	3.85	4.16	4.45	4.72	5.00	5.22	5.45	5.68
	RAD (ft.)	38	40	42	43 45	43 45	44 45	46	47	46
11/64"	GPM	4.24	4.64	5.02	5.37	5.70	6.01	6.30	6.57	6.83
	RAD (ft.)	39	41	44	44 46	44 47	44 47	47	48	48
3/16"	GPM	5.00	5.50	5.96	6.38	6.78	7.16	7.52	7.85	8.18
	RAD (ft.)	41	43	45	46 49	46 49	46 50	50	50	50
13/64"	GPM	5.90	6.50	7.05	7.55	8.00	8.45	-	-	-
	RAD (ft.)	43	45	46	47 -	47 -	47 -	-	-	-

Measured indoors in no wind with plates mounted 18 inches above collection cups. The absence of data for a particular model/plate/nozzle combination is outside the recommended range.

Rainbird LF2400

LF2400

Nozzle	Stream Height (inch)	Flow Rates at Standard Pressures (gpm)							
		Throw Radius at Given Nozzle and Standard Pressure (feet)							
		25 psi	30 psi	35 psi	40 psi	45 psi	50 psi	55 psi	60 psi
Silver 9/64" .143" 11809809 	76-116	$\frac{2.99}{38}$	$\frac{3.27}{40}$	$\frac{3.54}{40}$	$\frac{3.78}{42}$	$\frac{4.01}{44}$	$\frac{4.23}{45}$	$\frac{4.43}{46}$	$\frac{4.63}{46}$
Brown 5/32" .156" 11809810 	78-118	$\frac{3.64}{38}$	$\frac{3.99}{40}$	$\frac{4.31}{42}$	$\frac{4.60}{44}$	$\frac{4.88}{44}$	$\frac{5.15}{45}$	$\frac{5.40}{46}$	$\frac{5.64}{46}$
Dark Grey 11/64" .172" 11809811 	80-120	$\frac{4.40}{40}$	$\frac{4.82}{42}$	$\frac{5.21}{44}$	$\frac{5.57}{47}$	$\frac{5.91}{48}$	$\frac{6.23}{48}$	$\frac{6.53}{48}$	$\frac{6.82}{50}$

Nelson R2000

Plate/Nozzle Options and Flow Performance in GPM and LPH

Plate Options*	Recommended Nozzles	PSI						BAR				
		40	45	50	55	60	65	2.75	3.0	3.5	4.0	4.5
Purple WF12  Radius: 35-39' (10.7-11.9 m)	#10 Blue** 	1.12	1.19	1.25	1.31	1.37	1.44	254	266	286	306	328
	#11 Orange 	1.36	1.45	1.53	1.61	1.68	1.76	308	323	350	375	401
	#12 Purple 	1.61	1.70	1.80	1.89	1.98	2.06	365	380	412	442	469
Green WF14  Radius: 38-40' (11.6-12.2 m)	#13 Yellow (13/128) 	1.90	2.02	2.13	2.23	2.34	2.45	431	451	487	521	558
	#14 Green (7/64) 	2.15	2.28	2.40	2.53	2.64	2.75	487	509	550	590	626
Red WF16  Radius: 39-41' (11.9-12.5 m)	#15 Tan (15/128) 	2.53	2.67	2.82	2.97	3.11	3.24	574	597	647	695	737
	#16 Red (1/8) 	2.89	3.07	3.23	3.40	3.54	3.68	655	685	739	792	837
Gold WF18  Radius: 41-42' (12.5-12.8 m)	#18 Gold (9/64) 	3.68	3.89	4.11	4.30	4.48	4.66	834	869	940	1001	1060
Dark Brown WF20  Radius: 42-45' (12.8 - 13.7 m)	#20 Dark Brown*** 	4.48	4.76	5.00	5.25	5.47	5.69	1016	1062	1144	1222	1295

FOR APPLICATIONS BETWEEN 25 AND 40 PSI (1.7 AND 2.8 BAR) PLEASE REFER TO THE R2000LP LITERATURE. *All plate options are high angle. 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. Always operate within the recommended pressure range. Only the nozzle and plate combinations grouped together in the above charts are recommended.

Frost Protection AR

APPLICATION RATE (in/hr)								
Spacing (ft)		Nozzle Flow Rate (USgpm)						
Spr.	Lat.	2	2.5	3	3.5	4	4.5	5
20	20	0.48	0.60	0.72	0.84	0.96	1.08	1.20
20	30	0.32	0.40	0.48	0.56	0.64	0.72	0.80
20	40	0.24	0.30	0.36	0.42	0.48	0.54	0.60
30	30	0.21	0.27	0.32	0.37	0.43	0.48	0.54
30	40	0.16	0.20	0.24	0.28	0.32	0.36	0.40
30	50	0.13	0.16	0.19	0.22	0.26	0.29	0.32
40	40	0.12	0.15	0.18	0.21	0.24	0.27	0.30
40	50	0.10	0.12	0.14	0.17	0.19	0.22	0.24
40	60	0.08	0.10	0.12	0.14	0.16	0.18	0.20
50	50	0.08	0.10	0.12	0.13	0.15	0.17	0.19
50	60	0.06	0.08	0.10	0.11	0.13	0.14	0.16
50	70	0.06	0.07	0.08	0.10	0.11	0.12	0.14