

Baking LEDs in Yuma: A One Year Update

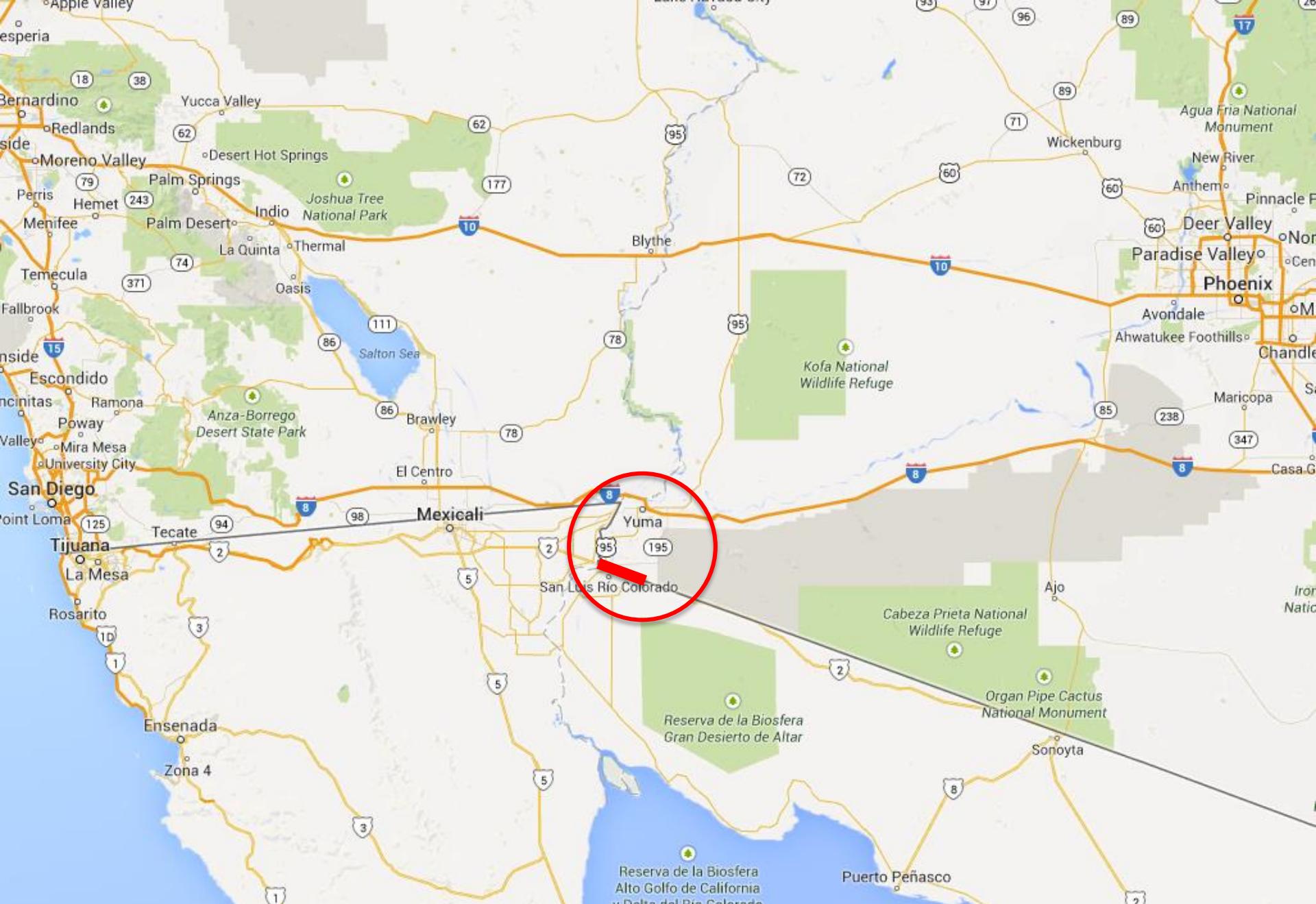


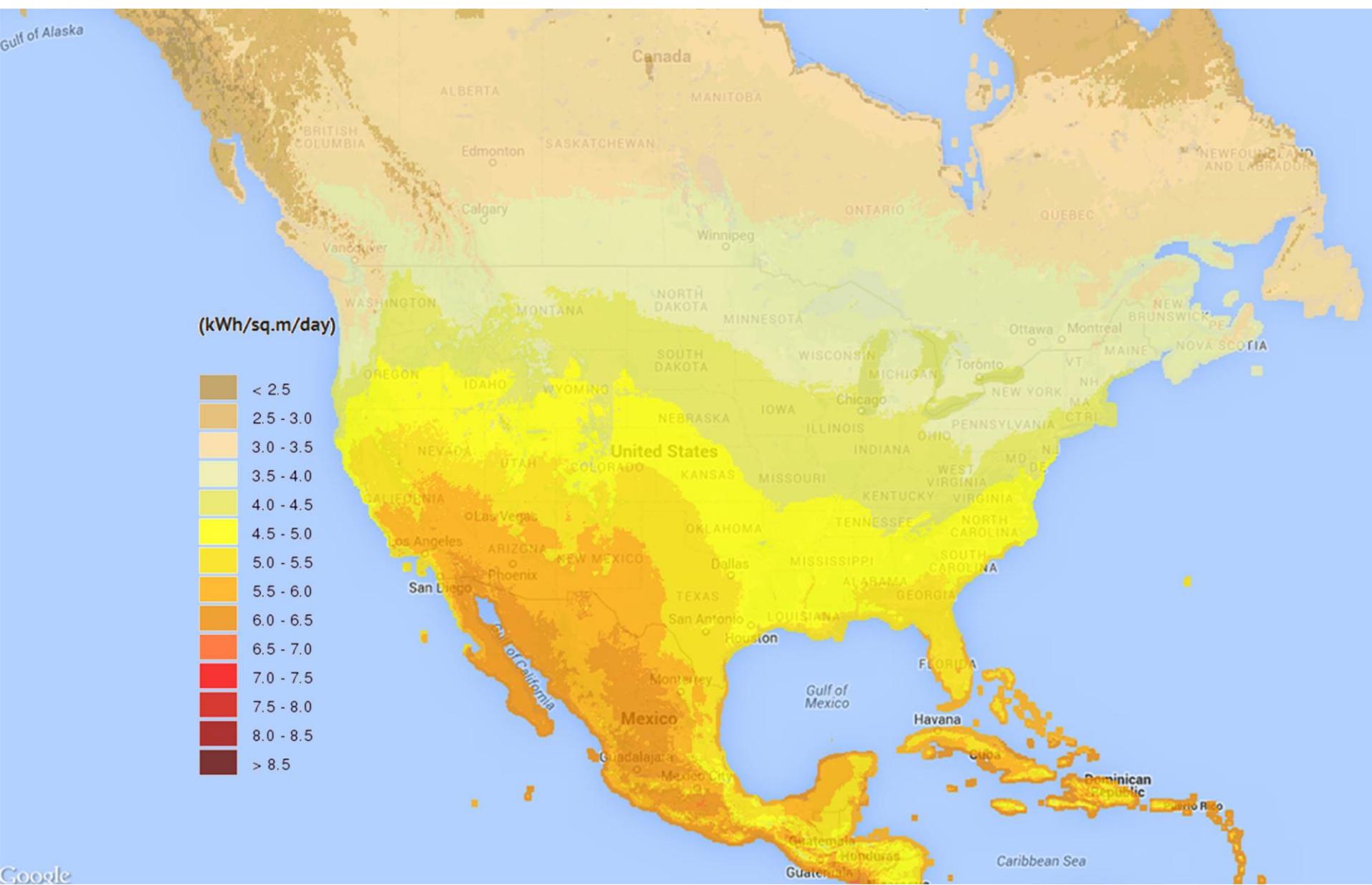
LIGHTFAIR International

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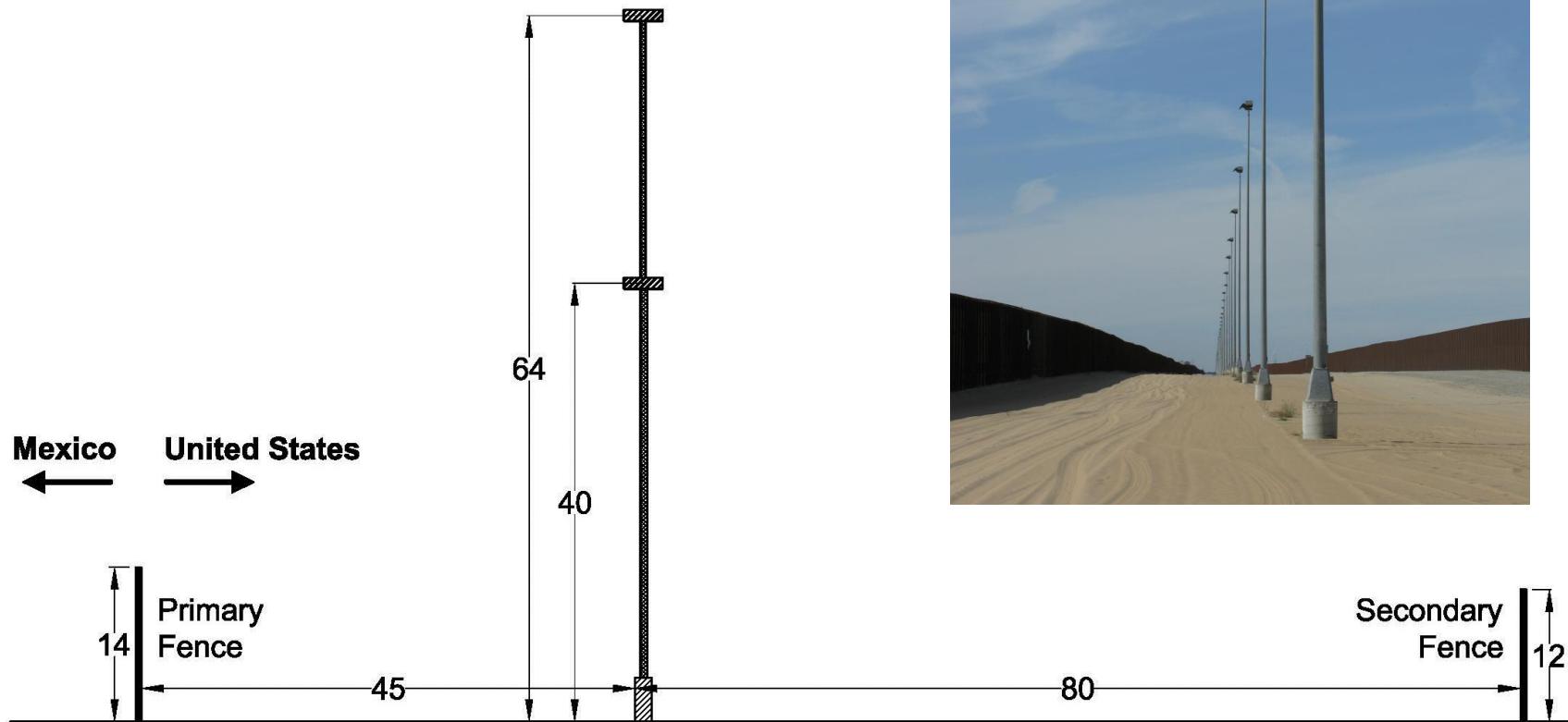


Background

- Three 1000 W metal halide fixtures installed
 - Two operating: 1080 W total power
 - 64 ft. height
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- Two 412 W LED fixtures installed
 - 40 ft. height



Background

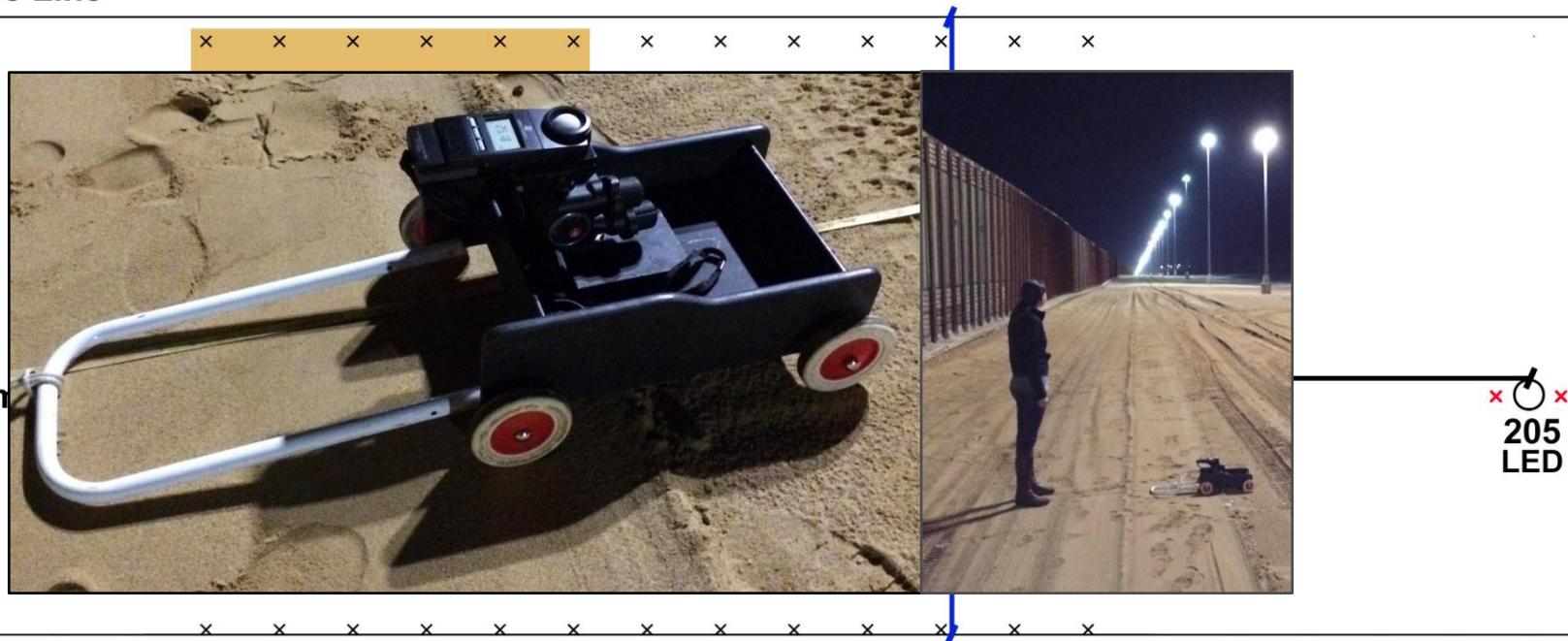


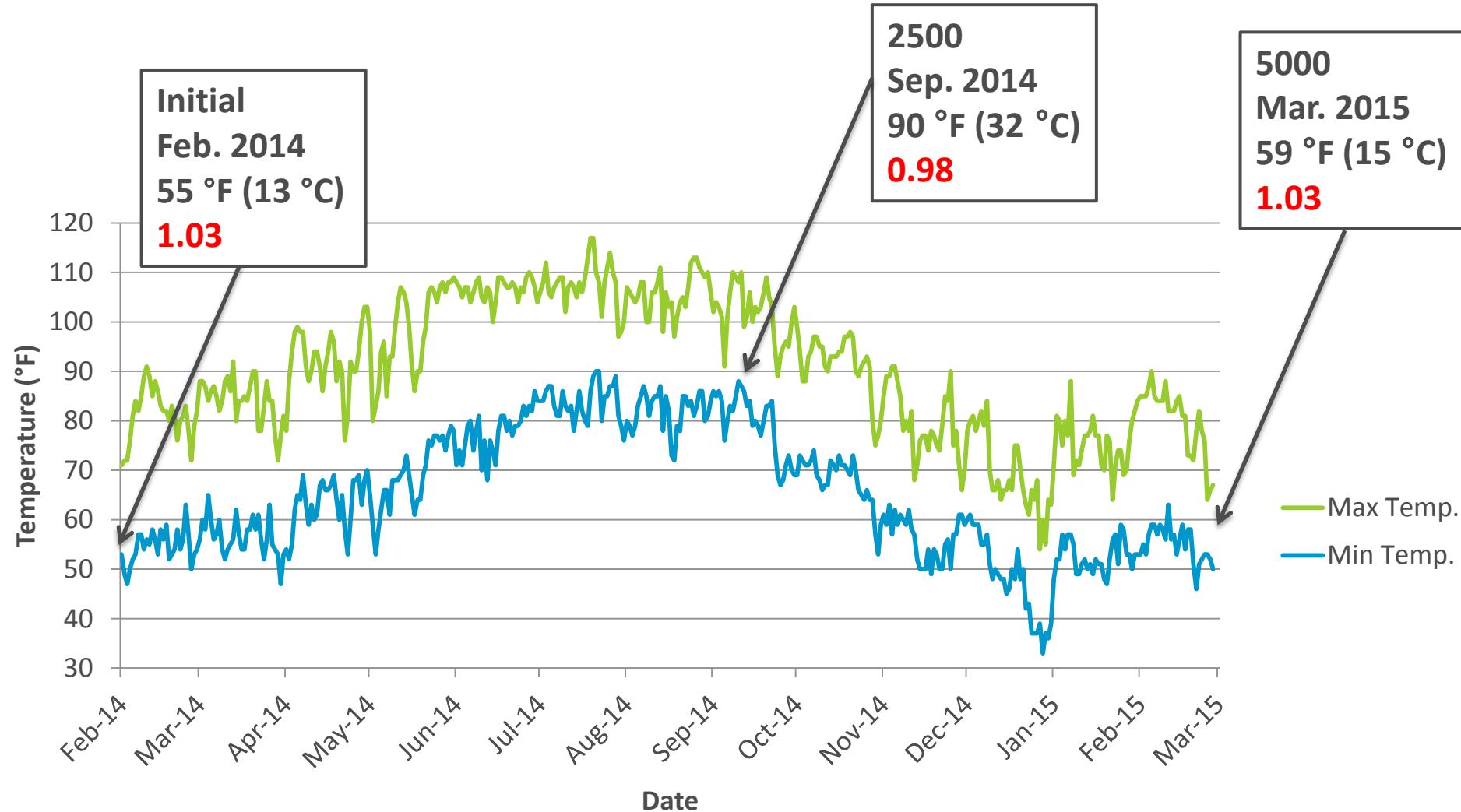
Measurement Methodology

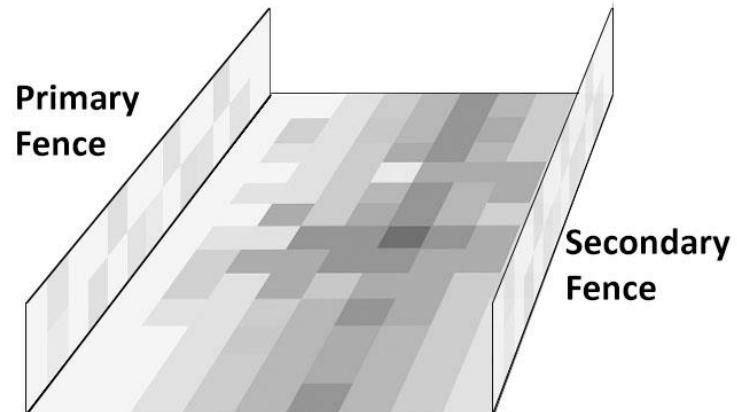
- 15 x 15 ft. grid
- 9.5 in. above the ground
- 4 ft. and 8 ft. along the fence



Secondary Fence Line







	Vertical		Horizontal								Vertical		
Primary	20.7	24.2	22.3	26.2	27.1	26.8	25.1	19.3	13.1	6.5	3.7	4.5	4.2
	22.8	25.4	23.0	26.8	27.7	28.6	25.8	20.7	13.1	6.5	3.8	4.6	4.2
	26.9	27.1	21.6	27.0	28.6	28.7	26.7	22.0	12.6	6.7	3.9	4.9	4.4
	31.4	28.2	21.3	27.0	29.7	30.7	27.2	22.0	12.9	6.8	4.0	5.5	4.8
	32.6	29.8	22.7	27.9	33.5	33.1	32.7	23.8	13.6	7.2	4.1	6.5	5.5
	35.3	32.0	23.2	29.2	37.7	36.3	38.8	25.4	14.7	7.6	4.3	7.2	6.3
	35.6	30.8	23.7	29.2	40.2	44.0	40.7	25.4	14.9	7.8	4.4	7.4	6.5
	35.3	31.1	24.1	29.7	38.0	36.3	38.8	25.4	14.7	7.6	4.3	7.4	6.5
	33.4	29.3	23.2	29.7	35.3	33.1	32.7	23.8	13.6	7.2	4.1	6.9	5.9
	30.9	25.8	21.8	28.1	32.2	30.7	27.2	22.0	12.9	6.8	4.0	6.0	5.0
	27.9	27.5	22.2	29.8	31.6	28.7	26.7	22.0	12.6	6.7	3.9	5.5	4.4
	22.6	25.2	22.0	28.9	29.8	28.6	25.8	20.7	13.1	6.5	3.8	5.4	4.4
	20.8	23.4	20.4	26.4	27.4	26.8	25.1	19.3	13.1	6.5	3.7	5.7	4.6

Secondary

→ N

	W90	W75	W60	W45	W30	W15	Pole	E15	E30	E45	E60	E75	E90	
8 ft	4.2	4.2	4.4	4.8	5.5	6.3	6.5	6.5	5.9	5.0	4.4	4.4	4.6	
4 ft	4.5	4.6	4.9	5.5	6.5	7.2	7.4	7.4	6.9	6.0	5.5	5.4	5.7	
Secondary Fence														
N75	3.7	3.8	3.9	4.0	4.1	4.3		4.4	4.3	4.1	4.0	3.9	3.8	3.7
N60	6.5	6.5	6.7	6.8	7.2	7.6		7.8	7.6	7.2	6.8	6.7	6.5	6.5
N45	13.1	13.1	12.6	12.9	13.6	14.7		14.9	14.7	13.6	12.9	12.6	13.1	13.1
N30	19.3	20.7	22.0	22.0	23.8	25.4		25.4	25.4	23.8	22.0	22.0	20.7	19.3
N15	25.1	25.8	26.7	27.2	32.7	38.8		40.7	38.8	32.7	27.2	26.7	25.8	25.1
Pole	26.8	28.6	28.7	30.7	33.1	36.3	44.0	36.3	33.1	30.7	28.7	28.6	26.8	
S15	27.1	27.7	28.6	29.7	33.5	37.7	40.2	38.0	35.3	32.2	31.6	29.8	27.4	
S30	26.2	26.8	27.0	27.0	27.9	29.2	29.2	29.7	29.7	28.1	29.8	28.9	26.4	
S45	22.3	23.0	21.6	21.3	22.7	23.2	23.7	24.1	23.2	21.8	22.2	22.0	20.4	
Primary Fence														
4 ft	24.2	25.4	27.1	28.2	29.8	32.0	30.8	31.1	29.3	25.8	27.5	25.2	23.4	
8 ft	20.7	22.8	26.9	31.4	32.6	35.3	35.6	35.3	33.4	30.9	27.9	22.6	20.8	
	W90	W75	W60	W45	W30	W15	Pole	E15	E30	E45	E60	E75	E90	

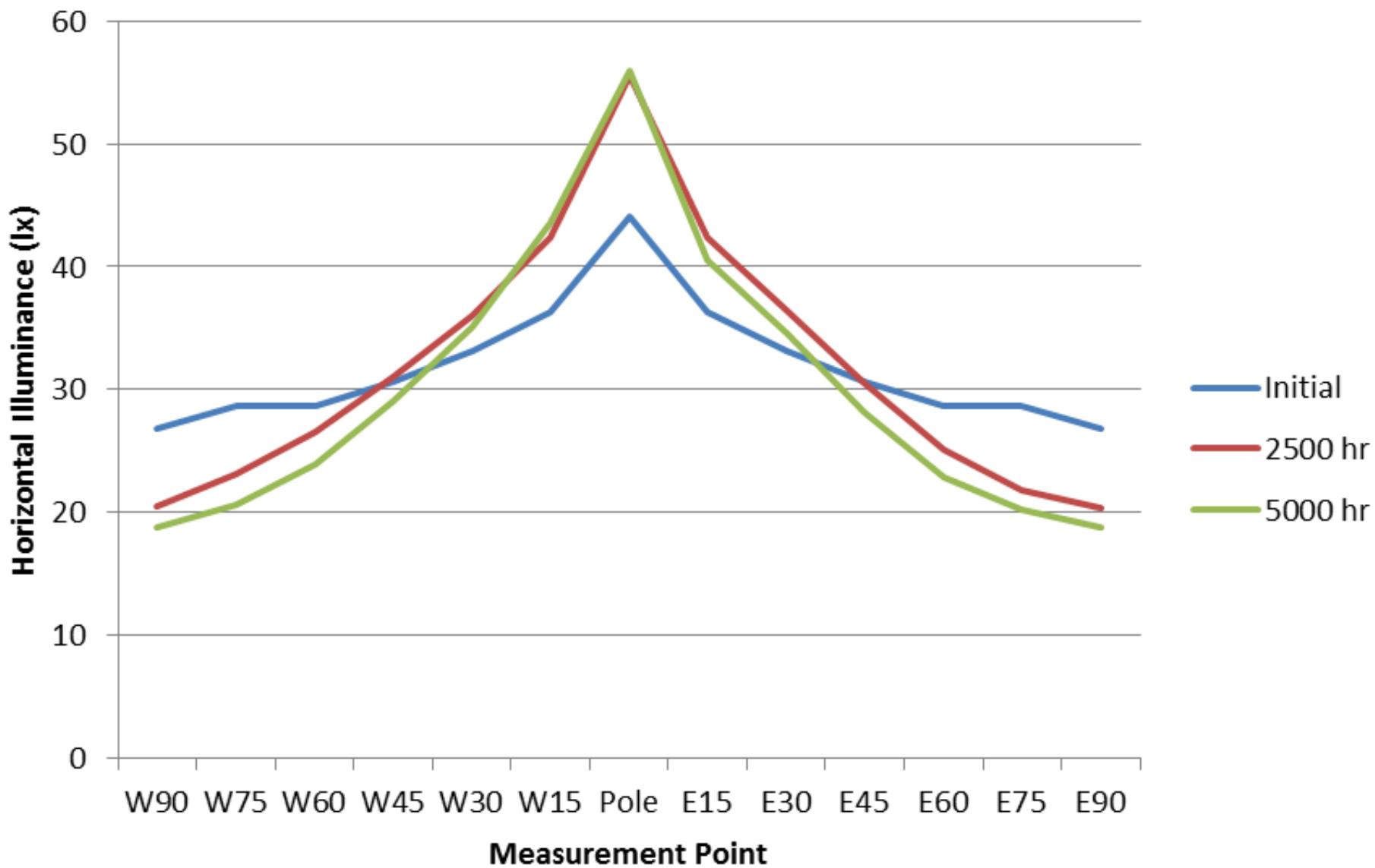


	W90	W75	W60	W45	W30	W15	Pole	E15	E30	E45	E60	E75	E90
8 ft	4.4	4.5	4.7	5.2	5.9	6.6	6.9	6.8	6.2	5.3	4.7	4.6	4.7
4 ft	4.8	4.9	5.2	5.9	6.9	7.6	7.8	7.8	7.2	6.3	5.7	5.5	5.6
Secondary Fence													
N75	2.5	2.8	3.2	3.5	4.0	4.2	4.0	4.0	4.0	3.7	3.5	3.4	3.4
N60	4.5	4.8	5.4	6.2	6.8	8.0	7.4	7.5	6.9	6.6	6.2	5.7	5.5
N45	8.7	9.2	10.0	11.5	13.8	15.5	14.7	15.4	13.9	12.3	11.3	11.2	10.6
N30	15.3	16.6	18.4	20.0	24.4	27.2	27.3	28.0	25.6	21.9	19.7	17.3	15.7
N15	19.2	21.2	23.0	27.8	35.9	43.5	45.8	44.8	36.5	28.1	24.1	20.9	19.7
Pole	20.5	23.1	26.5	31.1	36.1	42.3	55.6	42.3	36.5	30.5	25.1	21.8	20.4
S15	19.3	22.2	25.6	29.8	36.7	43.3	46.8	43.4	36.3	28.1	22.9	20.1	19.5
S30	17.6	20.0	22.6	25.1	28.2	30.6	31.1	29.4	25.6	21.1	18.8	17.5	17.5
S45	15.5	16.5	16.2	17.1	19.2	19.8	20.2	19.3	17.1	14.8	13.4	12.9	13.2
Primary Fence													
4 ft	16.4	18.7	20.0	21.2	23.9	27.3	26.5	25.7	22.5	19.7	17.8	15.9	15.3
8 ft	14.4	16.6	23.5	25.2	26.2	29.3	29.9	28.4	26.1	20.0	16.7	14.0	13.7
	W90	W75	W60	W45	W30	W15	Pole	E15	E30	E45	E60	E75	E90



	W90	W75	W60	W45	W30	W15	Pole	E15	E30	E45	E60	E75	E90
8 ft	4.1	4.2	4.5	4.9	5.7	6.5	6.7	6.7	6.1	5.1	4.6	4.4	4.6
4 ft	4.6	4.7	5.1	5.8	6.9	7.6	8.6	7.6	7.2	6.2	5.6	5.4	5.5
Secondary Fence													
N75	3.1	3.2	3.2	3.5	3.9	4.3	4.3	4.1	4.0	3.7	3.6	3.4	3.2
N60	4.8	5.1	5.3	6.0	6.9	7.9	8.0	7.8	7.1	6.4	5.9	5.4	5.0
N45	8.7	8.7	9.5	11.2	13.3	15.2	15.5	15.3	13.7	11.7	10.6	9.7	9.1
N30	14.1	14.7	16.6	19.3	24.0	27.1	28.0	27.7	24.7	20.6	17.8	15.1	13.4
N15	17.4	18.4	20.9	26.6	35.0	43.6	46.5	44.0	34.6	25.9	21.7	18.7	17.4
Pole	18.8	20.7	24.0	29.0	35.1	43.6	55.9	40.5	34.5	28.1	22.8	20.3	18.7
S15	17.9	19.8	23.0	27.4	34.4	42.0	45.3	40.2	32.8	25.6	22.1	19.6	18.5
S30	17.0	18.4	20.3	22.5	25.6	28.3	28.3	27.5	24.4	21.1	19.5	18.1	17.4
S45	14.8	15.5	15.4	16.9	19.1	20.5	20.8	20.2	18.2	16.1	15.1	14.3	13.9
Primary Fence													
4 ft	16.2	17.3	16.4	19.9	24.1	27.2	27.6	26.5	24.6	19.3	19.1	16.9	15.9
8 ft	13.5	15.5	18.0	22.6	26.7	30.2	30.6	29.6	25.8	21.3	18.3	15.2	13.9
	W90	W75	W60	W45	W30	W15	Pole	E15	E30	E45	E60	E75	E90





	W90	W75	W60	W45	W30	W15	Pole	E15	E30	E45	E60	E75	E90	
Vertical	8 ft	0.05	0.07	0.05	0.07	0.07	0.05	0.07	0.05	0.05	0.05	0.05	0.03	0.01
	4 ft	0.05	0.05	0.05	0.07	0.07	0.06	0.05	0.06	0.05	0.05	0.03	0.01	0.02
Secondary Fence														
Horizontal	N75						0.11	0.07	0.02	0.07	0.10	0.11	0.08	
	N60						0.05	0.01	0.03	0.02	0.07	0.12	0.15	
	N45						0.01	0.05	0.02	0.04	0.10	0.14	0.19	
	N30						0.07	0.10	0.08	0.00	0.10	0.16	0.19	
	N15						0.12	0.15	0.12	0.04	0.10	0.19	0.21	
Pole	0.24	0.19	0.08	0.01	0.09	0.17	0.26	0.17	0.10	0.01	0.13	0.24	0.24	
S15	0.29	0.20	0.11	0.00	0.10	0.15	0.16	0.14	0.03	0.13	0.27	0.33	0.29	
S30	0.33	0.25	0.16	0.07	0.01	0.05	0.06	0.01	0.14	0.25	0.37	0.39	0.34	
S45	0.31	0.28	0.25	0.20	0.16	0.15	0.15	0.20	0.26	0.32	0.40	0.41	0.36	
Primary Fence														
Vertical	4 ft	0.32	0.27	0.26	0.25	0.20	0.15	0.14	0.17	0.23	0.24	0.35	0.37	0.34
	8 ft	0.30	0.27	0.13	0.20	0.20	0.17	0.16	0.19	0.22	0.35	0.40	0.38	0.34
	W90	W75	W60	W45	W30	W15	Pole	E15	E30	E45	E60	E75	E90	



	W90	W75	W60	W45	W30	W15	Pole	E15	E30	E45	E60	E75	E90	
Vertical	8 ft	0.07	0.07	0.05	0.05	0.03	0.02	0.03	0.02	0.02	0.03	0.03	0.05	0.03
	4 ft	0.03	0.03	0.01	0.01	0.00	0.01	0.10	0.02	0.01	0.02	0.01	0.01	0.01
Secondary Fence														
Horizontal	N75	0.22	0.16	0.01	0.01	0.02	0.02	0.07	0.02	0.00	0.00	0.04	0.01	0.05
	N60	0.06	0.07	0.01	0.03	0.01	0.01	0.07	0.03	0.02	0.03	0.05	0.05	0.08
	N45	0.01	0.05	0.05	0.03	0.03	0.02	0.06	0.00	0.01	0.05	0.07	0.14	0.14
	N30	0.08	0.11	0.10	0.03	0.02	0.01	0.03	0.01	0.03	0.06	0.10	0.13	0.15
	N15	0.09	0.13	0.09	0.05	0.02	0.00	0.02	0.02	0.05	0.08	0.10	0.10	0.12
	Pole	0.08	0.11	0.10	0.07	0.03	0.03	0.01	0.04	0.05	0.08	0.09	0.07	0.08
	S15	0.07	0.11	0.10	0.08	0.06	0.03	0.03	0.08	0.10	0.09	0.04	0.02	0.05
	S30	0.04	0.08	0.10	0.10	0.09	0.07	0.09	0.07	0.05	0.00	0.04	0.03	0.01
	S45	0.04	0.06	0.05	0.01	0.00	0.03	0.03	0.05	0.06	0.09	0.13	0.10	0.05
Primary Fence														
Vertical	4 ft	0.01	0.07	0.18	0.06	0.01	0.00	0.04	0.03	0.10	0.02	0.07	0.06	0.04
	8 ft	0.07	0.06	0.23	0.10	0.02	0.03	0.02	0.04	0.01	0.06	0.10	0.08	0.02
	W90	W75	W60	W45	W30	W15	Pole	E15	E30	E45	E60	E75	E90	

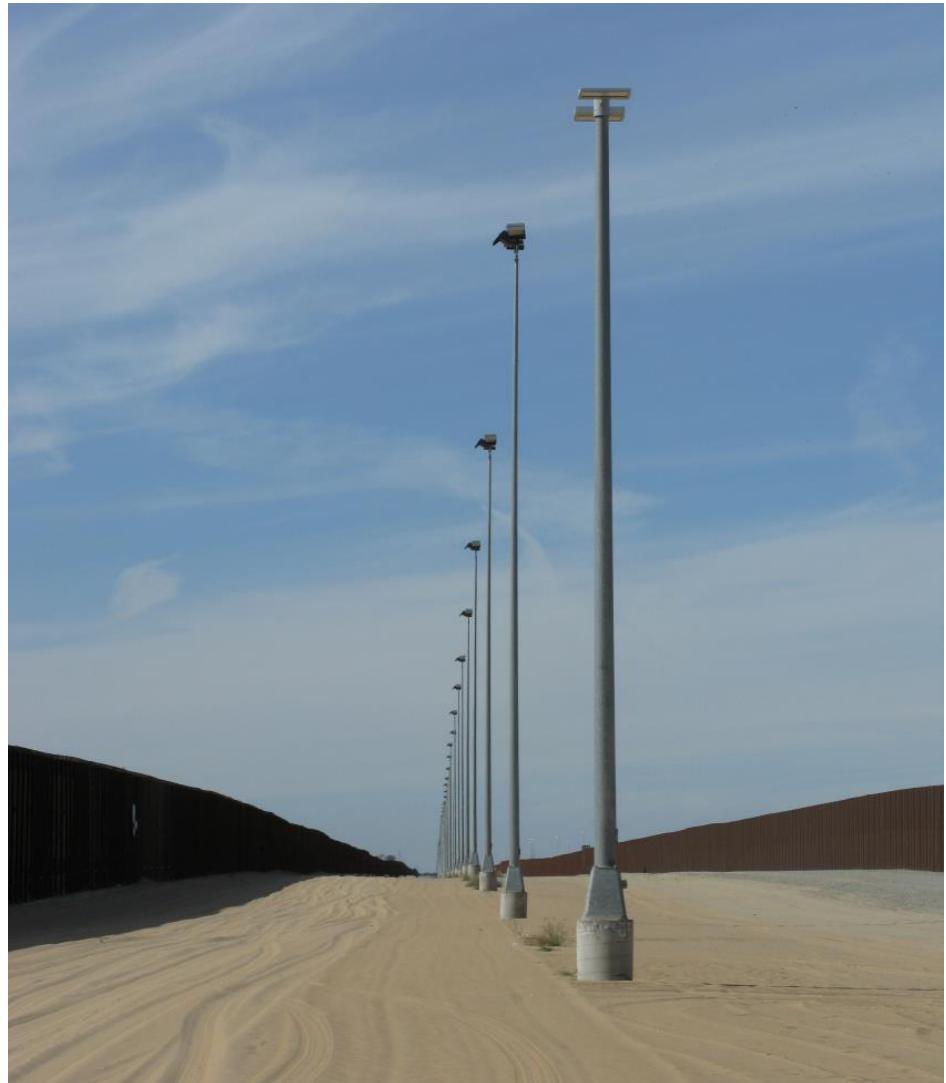


	W90	W75	W60	W45	W30	W15	Pole	E15	E30	E45	E60	E75	E90	
Vertical	8 ft	0.02	0.00	0.00	0.02	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02	
	4 ft	0.02	0.02	0.04	0.05	0.06	0.06	0.16	0.04	0.04	0.03	0.02	0.00	
Secondary Fence														
Horizontal	N75							0.04	0.04	0.02	0.07	0.07	0.10	0.13
	N60							0.02	0.02	0.01	0.05	0.11	0.16	0.22
	N45							0.04	0.04	0.00	0.09	0.16	0.26	0.30
	N30							0.10	0.09	0.04	0.06	0.19	0.27	0.31
	N15							0.14	0.14	0.06	0.05	0.19	0.28	0.31
Pole	0.30	0.28	0.17	0.05	0.06	0.20	0.27	0.12	0.04	0.08	0.21	0.29	0.30	
S15	0.34	0.28	0.20	0.08	0.03	0.11	0.13	0.06	0.07	0.20	0.30	0.34	0.32	
S30	0.35	0.31	0.25	0.17	0.08	0.03	0.03	0.08	0.18	0.25	0.35	0.37	0.34	
S45	0.34	0.33	0.28	0.21	0.16	0.12	0.12	0.16	0.21	0.26	0.32	0.35	0.32	
Primary Fence														
Vertical	4 ft	0.33	0.32	0.40	0.29	0.19	0.15	0.10	0.15	0.16	0.25	0.31	0.33	0.32
	8 ft	0.35	0.32	0.33	0.28	0.18	0.14	0.14	0.16	0.23	0.31	0.34	0.33	0.33
	W90	W75	W60	W45	W30	W15	Pole	E15	E30	E45	E60	E75	E90	



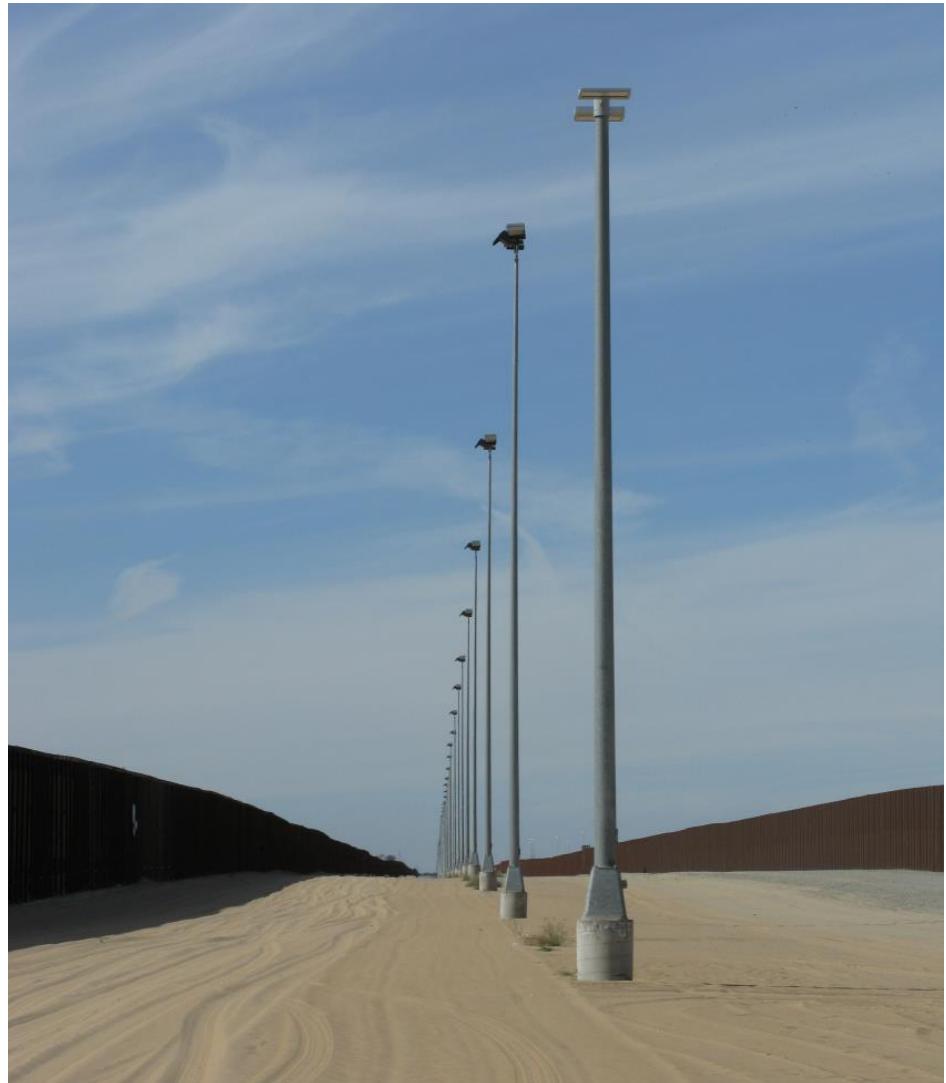
Discussion

- Dirt Depreciation
- LED Depreciation
- Lens Material
- Driver
- Measurement Error
- Orientation of Luminaires
- Electrical Changes



Next Steps

- Remove luminaires for further testing
- Install thermocouples
- Thermal simulations
- Continue data collection



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LIGHTFAIR International

May 2015

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