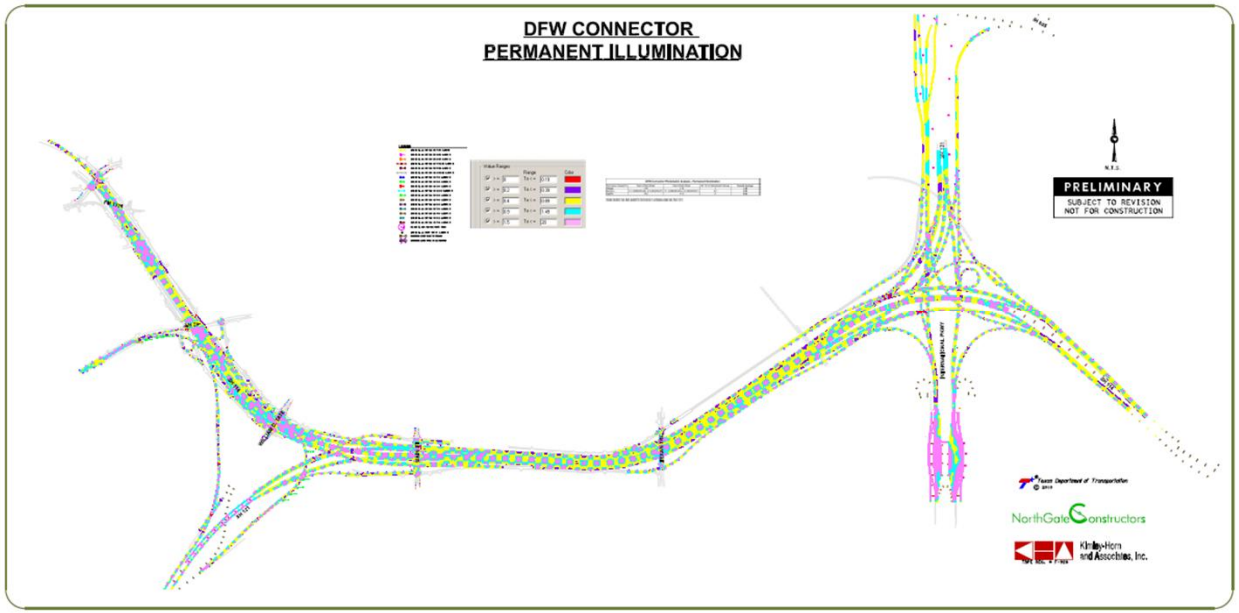
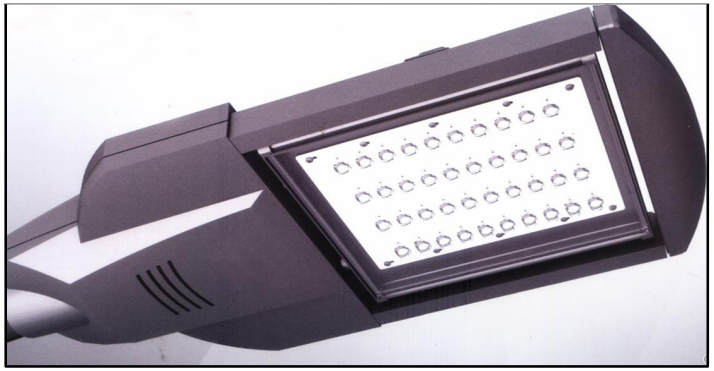
Roadway Illumination Design





Dhruva Lahon, P.E. (TX), PTOE

2016 TexITE Joint Meeting

July 15, 2016

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Outline

- Schematic development
- Photometric analysis
- LED lighting basics
- Electrical design

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Schematic Development

- Check illumination warrants
- Continuous lighting versus safety lighting
- Existing lighting system
  - Field visit; As-builts

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Schematic Development

- Preliminary pole placement
  - Avoid underground and overhead utilities
  - Check for proximity to airports (FAA flight path)
- Power provider coordination
  - Centrally located services

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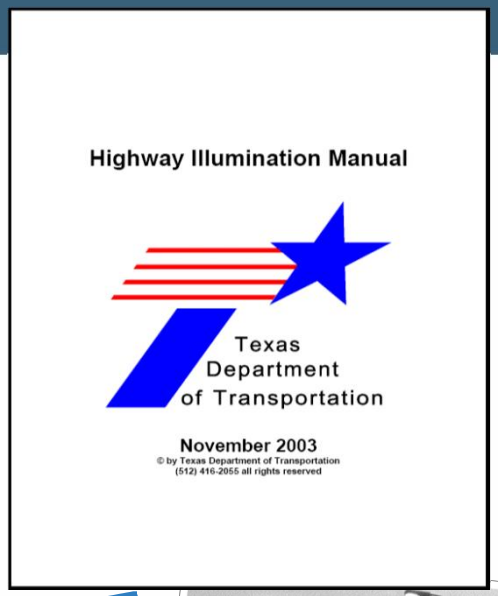
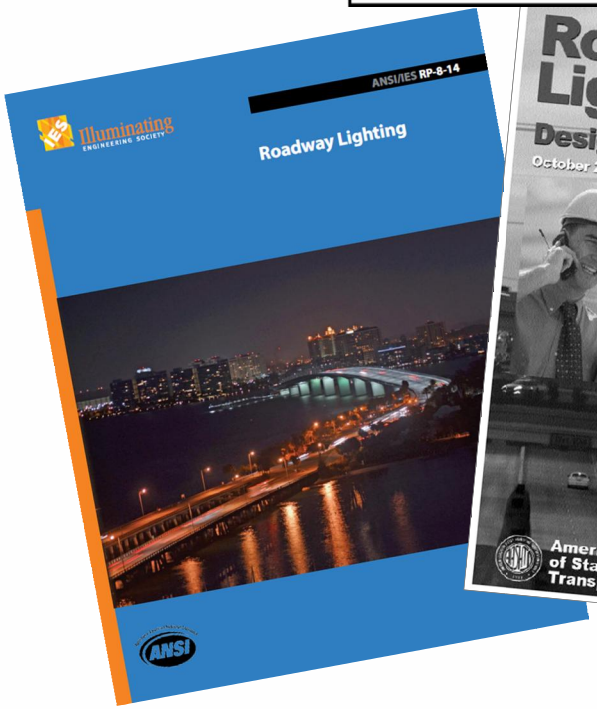
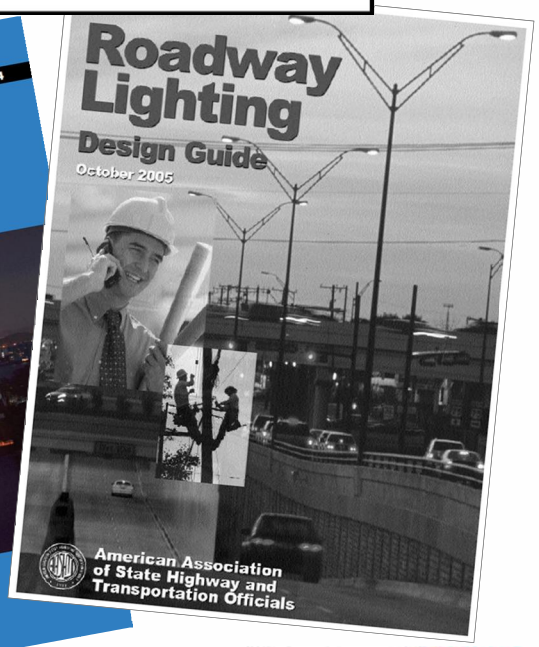
Design Guidelines

- TxDOT Highway Illumination Manual
- IESNA RP-8
- AASHTO Roadway Lighting Design Guide







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Photometric Analysis

- Lighting Level Calculations
- Pole spacing and placement
- Minimize light trespass

Roadway and Walkway Classification	Off-Roadway Light Sources	Illuminance Method					
		Average Maintained Illuminance				Minimum Illuminance	Illuminance Uniformity Ratio
		R1	R2	R3	R4		
	General Land Use	(foot-candles) (min)	(foot-candles) (min)	(foot-candles) (min)	(foot-candles) (min)	(foot-candles)	avg/min (max) (6)
Principal Arterials							
Interstate and other freeways	Commercial	0.6 to 1.1	0.6 to 1.1	0.6 to 1.1	0.6 to 1.1	0.2	3:1 or 4:1
	Intermediate	0.6 to 0.9	0.6 to 0.9	0.6 to 0.9	0.6 to 0.9	0.2	3:1 or 4:1
	Residential	0.6 to 0.8	0.6 to 0.8	0.6 to 0.8	0.6 to 0.8	0.2	3:1 or 4:1
Other Principal Arterials (partial or no control of access)	Commercial	1.1	1.6	1.6	1.4		3:1
	Intermediate	0.8	1.2	1.2	1.0		3:1
	Residential	0.6	0.8	0.8	0.8		3:1
Minor Arterials							

Source: AASHTO Roadway Lighting Design Guide

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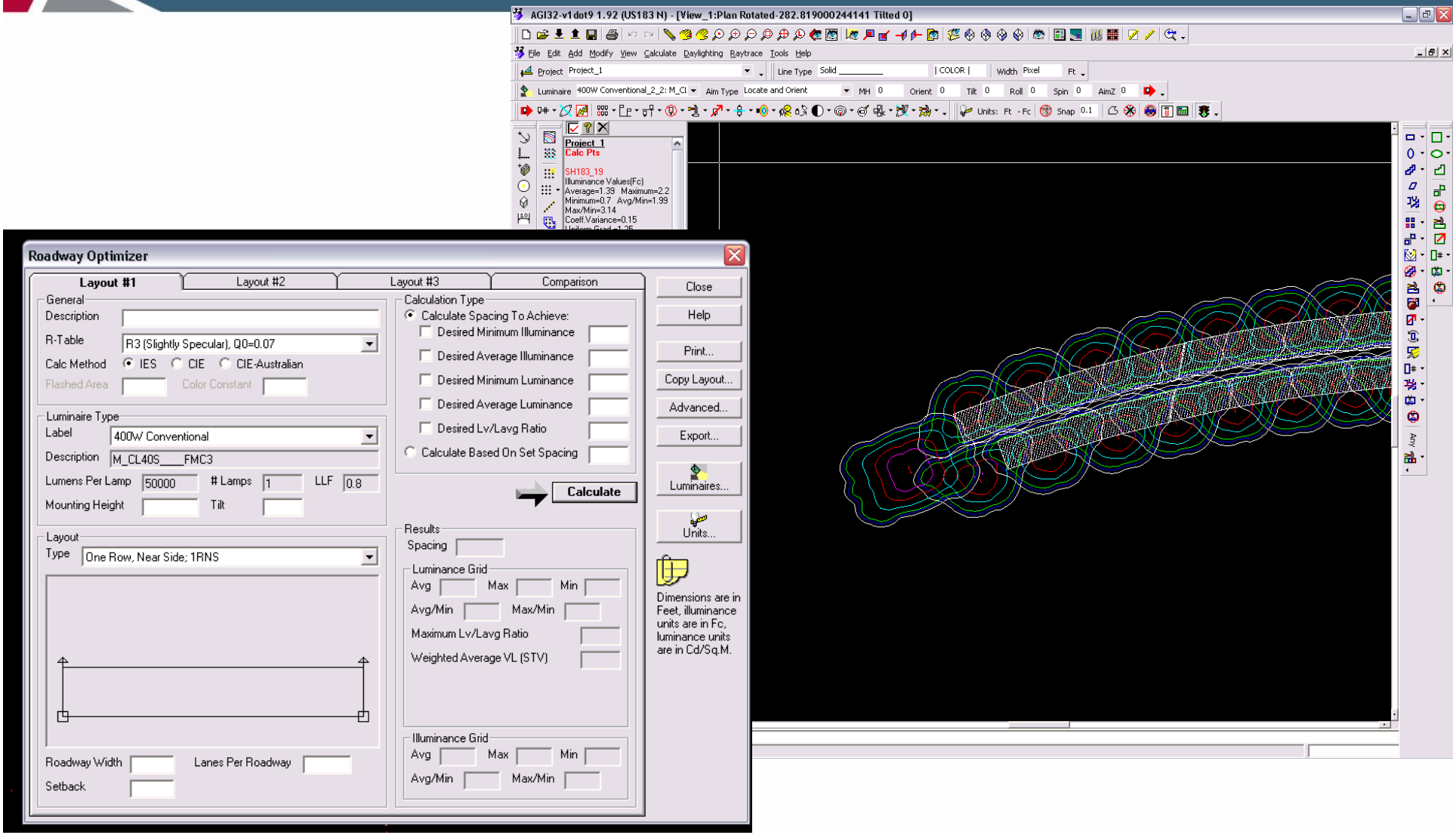
Photometric Analysis



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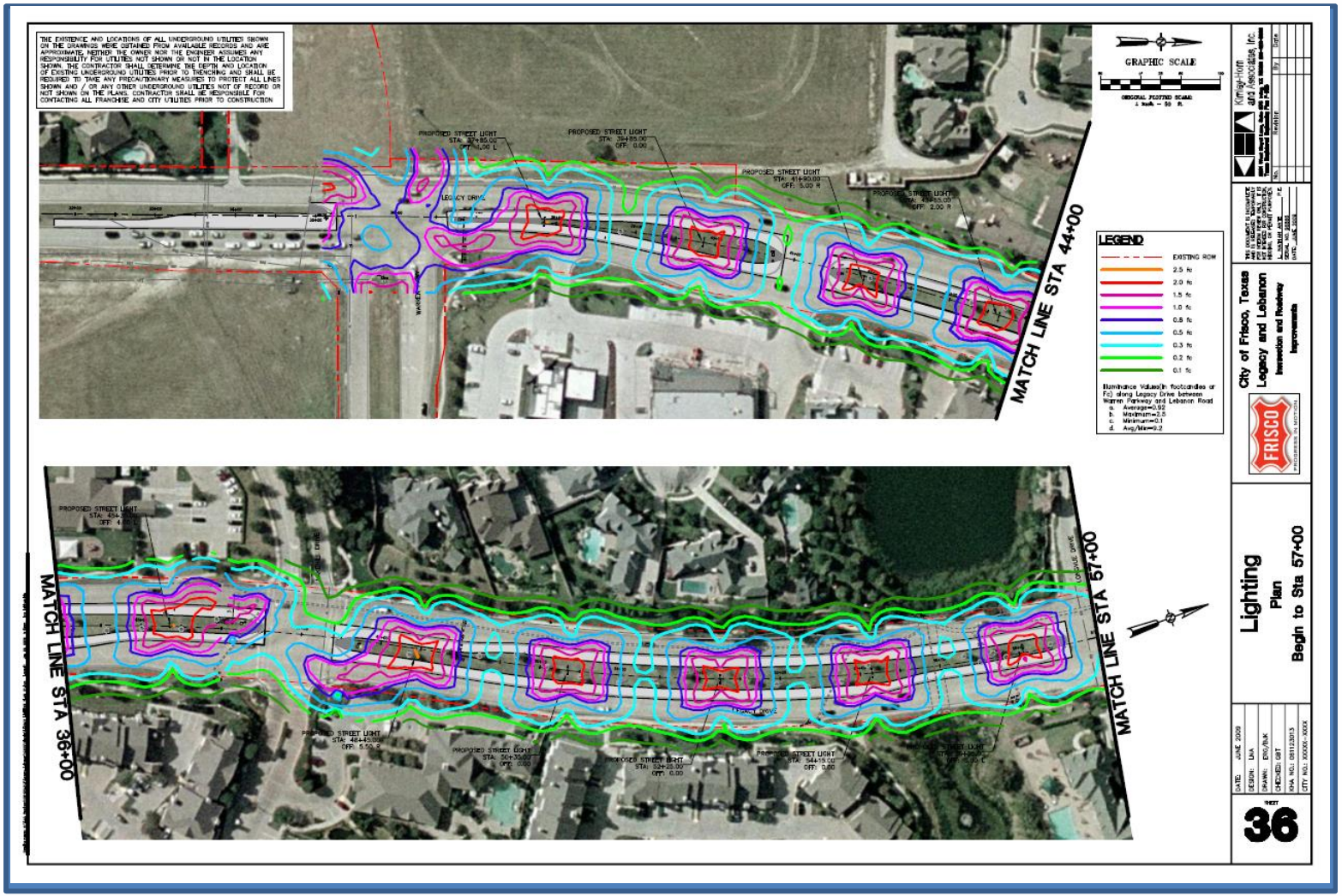
Photometric Analysis



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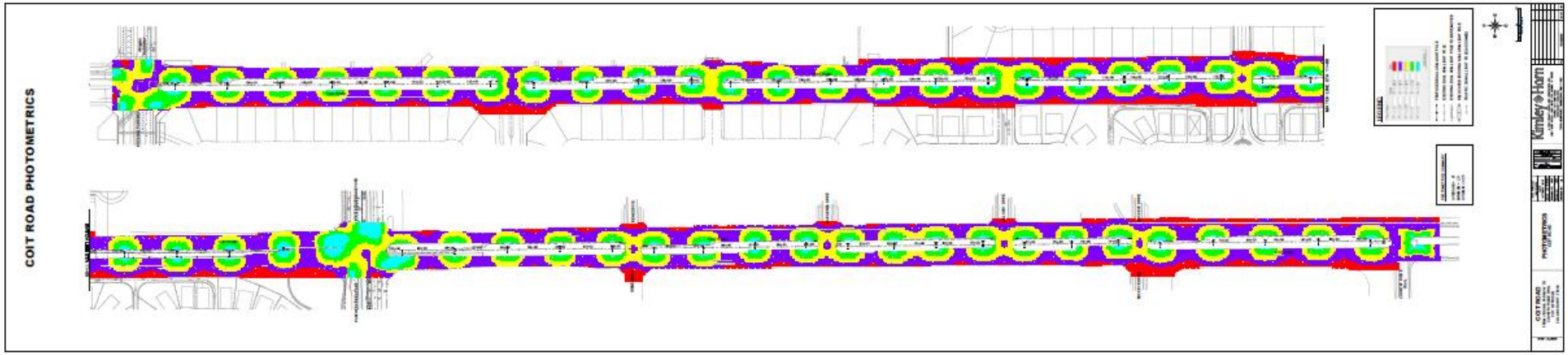
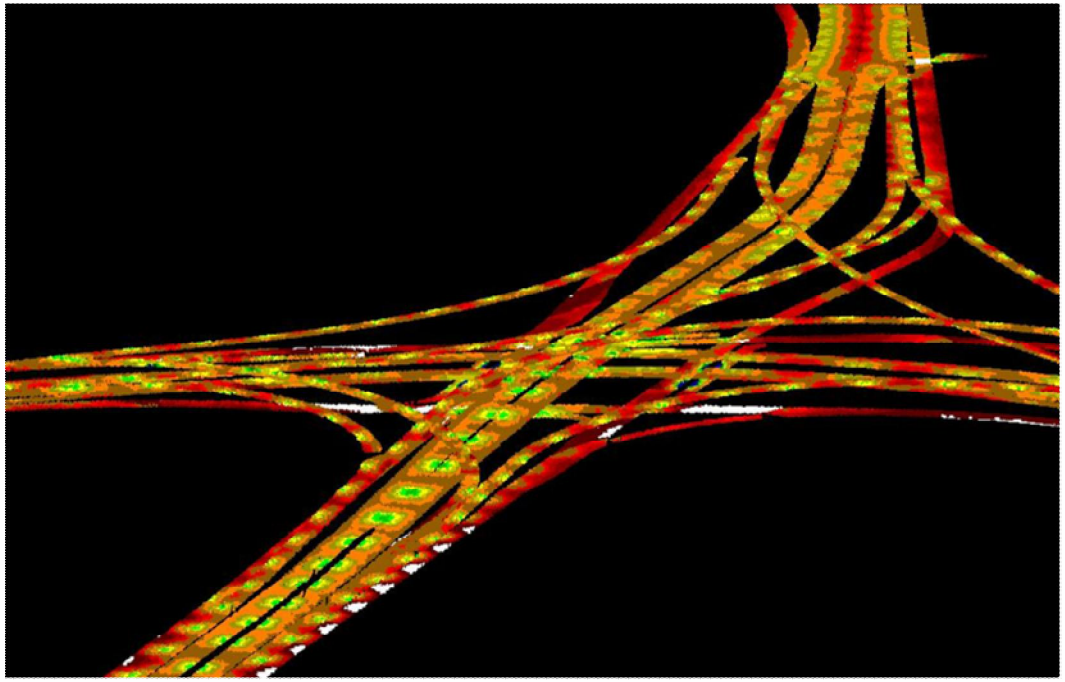
Photometric Analysis





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LED Lighting Basics

Source: GreenStar Products, Inc.

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LED - Advantages

- Longer life and less maintenance
- Higher efficacy with more lumens per watt
- More directed light so light trespass can be controlled
- Better light quality with cleaner, white light
- Better color rendering index
- Dimmable by using special driver within bulb
- Green, mercury free product
- Gradual failure, unlike the sudden burn out of incandescent bulbs
- Light up quickly to their full brightness
- Ideal for frequent on-off cycling applications

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LED - Disadvantages

- Higher initial cost
- Temperature dependent so needs heat dissipater arrangement for LED array
- Blue light pollution from blue light emitted

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Electrical Design

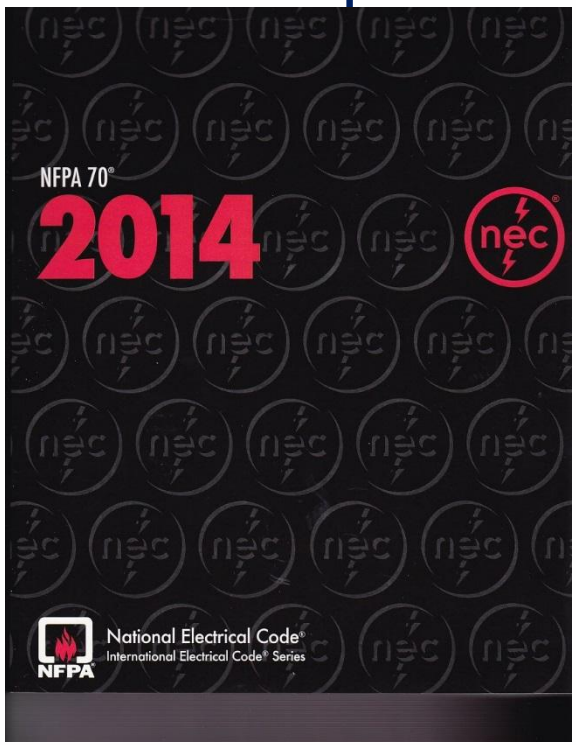
Design Amperes for Various Luminaires

Lamp Wattage and Type*	— Line Voltage —			LED Equivalent
	120 V	240 V	480 V	
100 W MV	1.2 A	0.6 A	0.3 A	
175 W MV	1.8 A	0.9 A	0.5 A	
100 W HPS	1.2 A	0.6 A	0.3 A	
150 W HPS	1.8 A	0.9 A	0.5 A	0.25 A
200 W HPS	2.4 A	1.2 A	0.6 A	
250 W HPS	3.0 A	1.5 A	0.75 A	0.40 A
400 W HPS	4.2 A	2.2 A	1.2 A	0.65 A
40 W F	0.37 A	n/a	n/a	
150 or 165 W IF	1.4 A	0.71 A	n/a	

Source: TxDOT highway Illumination Manual

Electrical Design

- Follow the National Electrical Code (NEC)
- Locate and Coordinate Electrical Service
  - Verify operating voltage with Electric Utility
  - Identify Utility Power drop location



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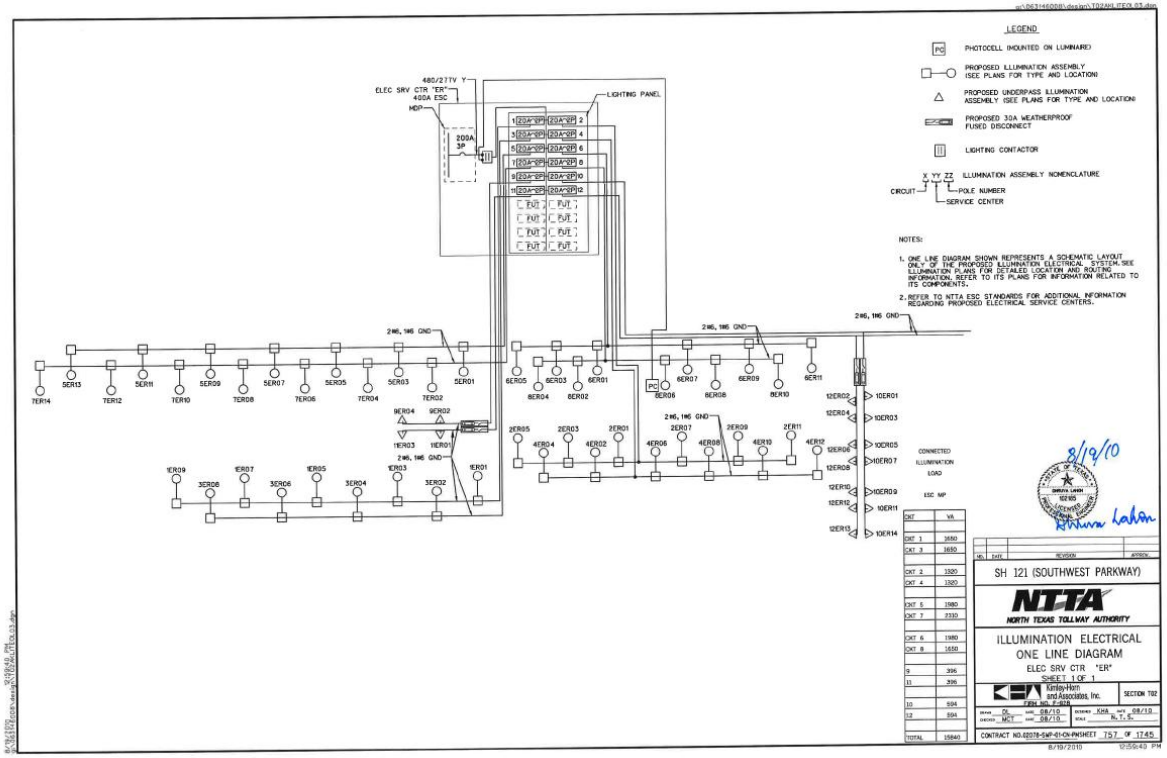
Electrical Design

- Circuit Routing
  - Minimize Total Length of Circuits (“H” layout pattern)
  - Minimize ‘backtracking’
  - Maintenance access



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Electrical Design

- Voltage Drop Calculations
  - Size wires
  - Smaller wire sizes away from the service
- Conduit fill calculations (40% max)

Elec. Service No.	Sheet No.	Electrical Service Description (see ED (5) - 14)	Service Conduit Size	Service Conductors No./Size*	Safety Switch Amps	Main Ckt. Bkr. Pole/Amp	Two-Pole Contactor Amps	Panelbd/ Loadcenter Amp Rating	Circuit No.	Branch Ckt. Bkr. Pole/Amps	Branch Circuit Amps	KVA Load
ES01** (EXISTING)	C8.04	ELEC SERV TY A(240/480)(060)(NS)AL(E)PS(U)	2"	3#6	N/A	2P/60	60	N/A	A	2P/20	13.0	11.0
									B	2P/20	10.0	
ES02	C8.08	ELEC SERV TY A(240/480)(060)(NS)AL(E)PS(U)	2"	3#6	N/A	2P/60	60	N/A	A	2P/20	7.0	22.1
									B	2P/20	7.0	
									C	2P/20	16.0	
									D	2P/20	16.0	

ALL ELECTRICAL SERVICES TO BE ALUMINUM (AL) WITH TRAFFIC BLACK (RAL 9017) POWDER COAT
*TO BE FURNISHED AND INSTALLED BY POWER COMPANY (SEE LAYOUT SHEETS FOR CONTACT INFORMATION)
**REFER TO COIT ROAD (NORTH OF ELDORADO) LIGHTING PLANS FOR MORE INFORMATION.

SUMMARY OF ILLUMINATION CONDUIT/CONDUCTOR - ES01 (EXISTING)

CIRCUIT	CONDUIT RUN #	PROPOSED CONDUCTOR COUNT/SIZE (USE/CUT B)	GROUND	BORED (B) TRENCH (T) PREPARE EXISTING CONDUIT (E)	2" PVC (SCHD 40)
B	3	2#4	#4	E	60
B	4	2#4	#4	E	100
B	7	2#4	#4	E	165
B	8	2#4	#4	E	160
B	9	2#4	#4	E	165
B	10	2#4	#4	E	110
B	11	2#4	#4	E	55
B	12	2#4	#4	E	160
B	13	2#4	#4	E	55
B	14	2#4	#4	E	100
B	15	2#4	#4	E	165
B	16	2#4	#4	E	120
B	17	2#4	#4	T	50
B	18	2#4	#4	T	215
B	19	2#4	#4	T	230
B	20	2#4	#4	T	230
B	21	2#4	#4	T	205
B	22	2#4	#4	T	45
B	23	2#4	#4	B	50
B	24	2#4	#4	T	45
B	25	2#4	#4	T	195
B	26	2#6	#6	T	200
B	27	2#6	#6	T	40
B	28	2#6	#6	B	105
B	29	2#6	#6	T	40
B	30	2#6	#6	T	195
B	31	2#6	#6	T	175
B	32	2#6	#6	T	195
B	33	2#6	#6	T	35
B	34	2#6	#6	B	100
B	35	2#6	#6	T	40
B	36	2#6	#6	T	205
B	37	2#6	#6	T	210
B	38	2#6	#6	T	200
B	39	2#6	#6	T	45
B	40	2#6	#6	B	85
B	41	2#6	#6	T	40
B	42	2#6	#6	T	220
B	43	2#6	#6	T	215
B	44	2#6	#6	T	210
B	45	2#6	#6	T	200
		TOTALS TRENCHED OR BORED CONDUIT (LF)			4,050

*THERE WILL BE NO EXTRA COMPENSATION IF CONTRACTOR CHOOSES TO BORE CONDUIT RATHER THAN TRENCH.
CONDUIT SHALL BE INSTALLED UNDER THE SUBGRADE SO THAT FUTURE GRADING AND PAVEMENT CONSTRUCTION DOES NOT DAMAGE THE CONDUIT. REFER TO PAVING PLANS FOR MORE DETAILS.
LIGHTING CONDUIT SHOWN IN THE PLANS IS SCHEMATIC. CONTRACTOR SHALL BE REQUIRED TO COORDINATE CONDUIT PLACEMENT WITH THE CITY OF FRISCO PRIOR TO INSTALLATION.
CONTRACTOR SHALL VERIFY* ULTIMATE CONDUIT LOCATION.

SUMMARY OF ILLUMINATION CONDUIT/CONDUCTOR - ES02 (PROPOSED)

CIRCUIT	CONDUIT RUN #	CONDUCTOR COUNT/SIZE	GROUND	BORED (B) TRENCH (T)	2" PVC (SCHD 80)	2" PVC (SCHD 40)
-	2SE	BY COSERV	BY COSERV	T		20
-	2SE-R	BY COSERV	BY COSERV	RISER	10	0
AB	38	4#6	#6	T		30
AB	39	4#6	#6	T		40
A	40	2#6	#6	T		45
A	41	2#6	#6	T		215
A	42	2#6	#6	T		215
A	43	2#6	#6	T		185
A	44	2#6	#6	T		160
A	45	2#6	#6	T		210
A	46	2#6	#6	T		215
A	47	2#6	#6	T		210
A	48	2#6	#6	T		160
A	49	2#6	#6	T		220
A	50	2#6	#6	T		215
A	51	2#6	#6	T		220
A	52	2#6	#6	T		215
A	53	2#6	#6	T		215
A	54	2#6	#6	T		215
B	61	2#6	#6	T		175
B	62	2#6	#6	T		215
B	63	2#6	#6	T		165
B	64	2#6	#6	T		210
B	65	2#6	#6	T		190
B	66	2#6	#6	T		185
B	67	2#6	#6	T		210
B	68	2#6	#6	T		170
B	69	2#6	#6	T		195
B	70	2#6	#6	T		210
B	71	2#6	#6	T		210
B	72	2#6	#6	T		210
B	73	2#6	#6	T		210
B	74	2#6	#6	T		180
		TOTALS (LF)			10	5,770

THERE WILL BE NO EXTRA COMPENSATION IF CONTRACTOR CHOOSES TO BORE CONDUIT RATHER THAN TRENCH.
CONDUIT SHALL BE INSTALLED UNDER THE SUBGRADE SO THAT FUTURE GRADING AND PAVEMENT CONSTRUCTION DOES NOT DAMAGE THE CONDUIT. REFER TO PAVING PLANS FOR MORE DETAILS.
LIGHTING CONDUIT SHOWN IN THE PLANS IS SCHEMATIC. CONTRACTOR SHALL BE REQUIRED TO COORDINATE CONDUIT PLACEMENT WITH THE CITY OF FRISCO PRIOR TO INSTALLATION.
CONTRACTOR SHALL VERIFY ULTIMATE CONDUIT LOCATION.

SUMMARY OF ILLUMINATION CONDUIT/CONDUCTOR - ES03 (EXISTING)

CONDUIT RUN #	CONDUCTOR COUNT/SIZE	GROUND	BORED (B) TRENCH (T) PREPARE EXISTING CONDUIT (E)	2" PVC (SCHD 40)
1	2#6	#6	E	420
		TOTALS (LF)		420

REFER TO WESTRIDGE PARKWAY LIGHTING PLANS FOR MORE INFORMATION.
CONTRACTOR SHALL BE REQUIRED TO COORDINATE WITH THE CITIES OF MCKINNEY AND FRISCO PRIOR TO BEGINNING WORK.

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WWW.KIMLEY-HORN.COM
TBPE - ID NUMBER F-928

1/15/2015
SHELLEY LAVEN 102195
LICENSED PROFESSIONAL ENGINEER

JOB No. 016-0271
DATE: 1/15/2015
SCALE: AS SHOWN
DESIGN BY: HBR
DRAWN BY: HBR
CHECK BY: CL

LIGHTING SUMMARIES

COIT ROAD & WESTRIDGE BLVD
CITY OF FRISCO
COLLIN COUNTY, TEXAS

SHEET NUMBER
C8.02

DATE
REVISIONS
NO.

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Electrical Design

- Electrical service and breaker size calculations

Elec. Service No.	Sheet No.	Electrical Service Description (see ED (5) - 14)	Service Conduit Size	Service Conductors No./Size*	Safety Switch Amps	Main Ckt. Bkr. Pole/Amp	Two-Pole Contactor Amps	Panelbd/ Loadcenter Amp Rating	Circuit No.	Branch Ckt. Bkr. Pole/Amps	Branch Circuit Amps	KVA Load
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(EXISTING)									B	2P/20	10.0	
ES02	C8.08	ELEC SERV TY A(240/480)060(NS)AL(E)PS(U)	2"	3/#6	N/A	2P/60	60	N/A	A	2P/20	7.0	22.1
									B	2P/20	7.0	
									C	2P/20	16.0	
									D	2P/20	16.0	

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Thank You

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