

# DENVER POLICE DPT. CRIME LAB

jackie eury

senior thesis presentation

lighting | electrical

15 april 2015



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lighting depth

lobby

south plaza

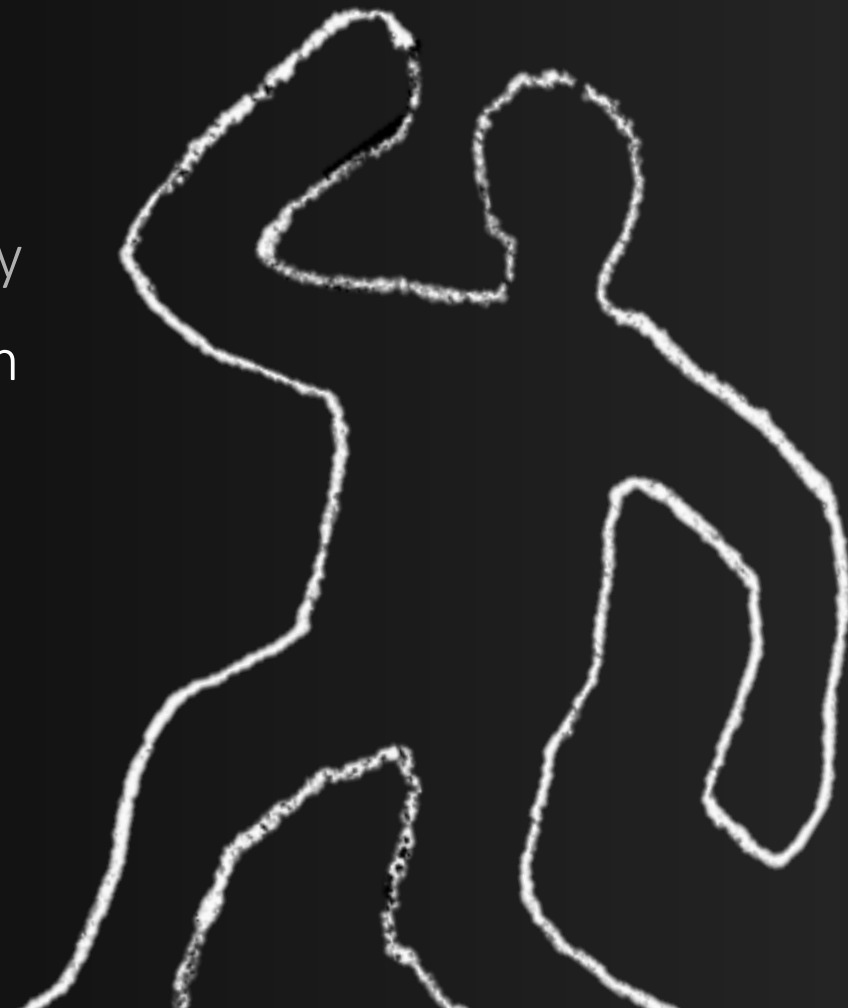
electrical depth

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construction breadth

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## building statistics

location | denver, colorado

occupant | denver police department

type | laboratory

size | 60,000 gsf

constructed | march 2011 – july 2012

actual cost | \$28 million

SMITHGROUP JJR



## building location



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# lighting depth



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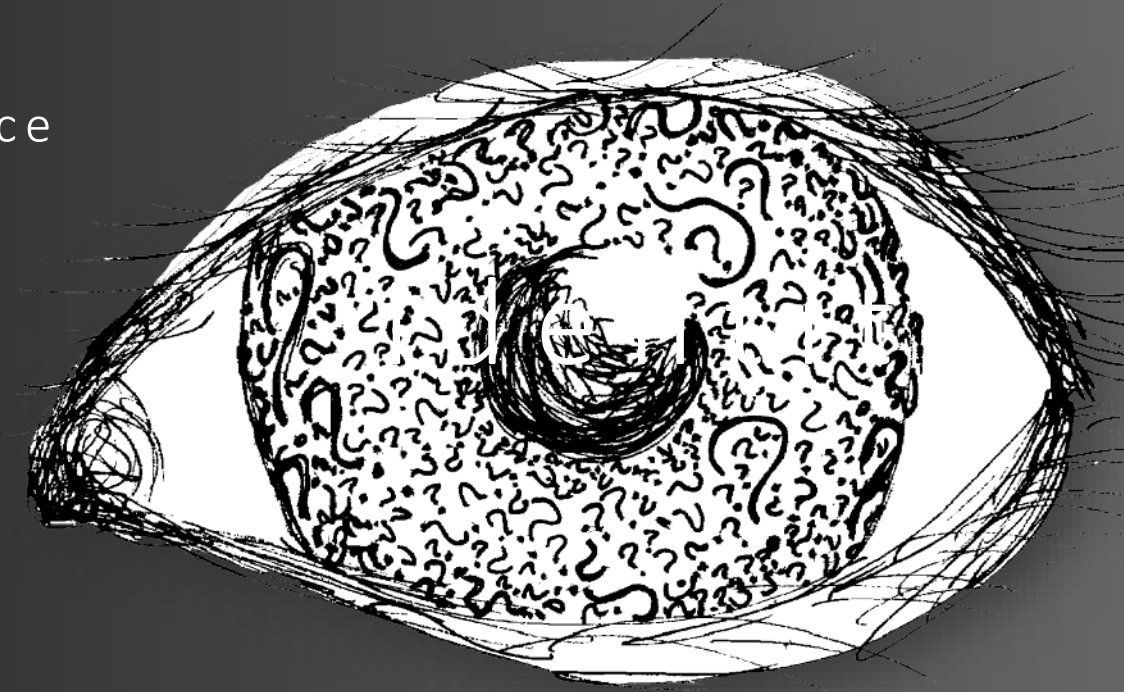
concept

investigation

research

justice

analysis



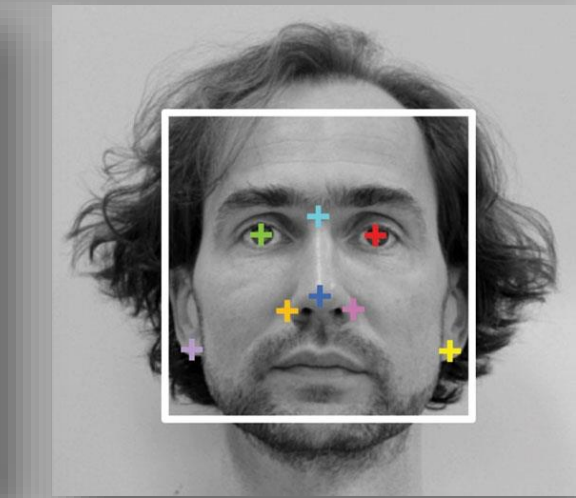
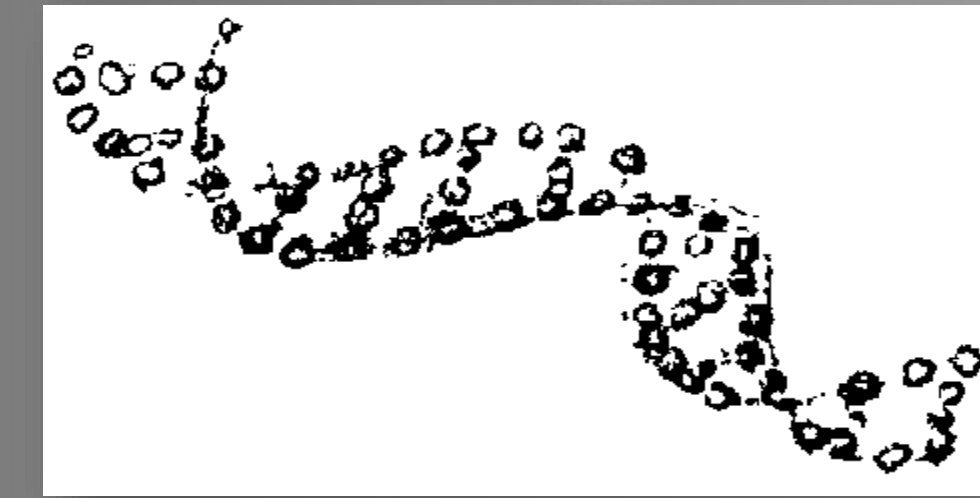
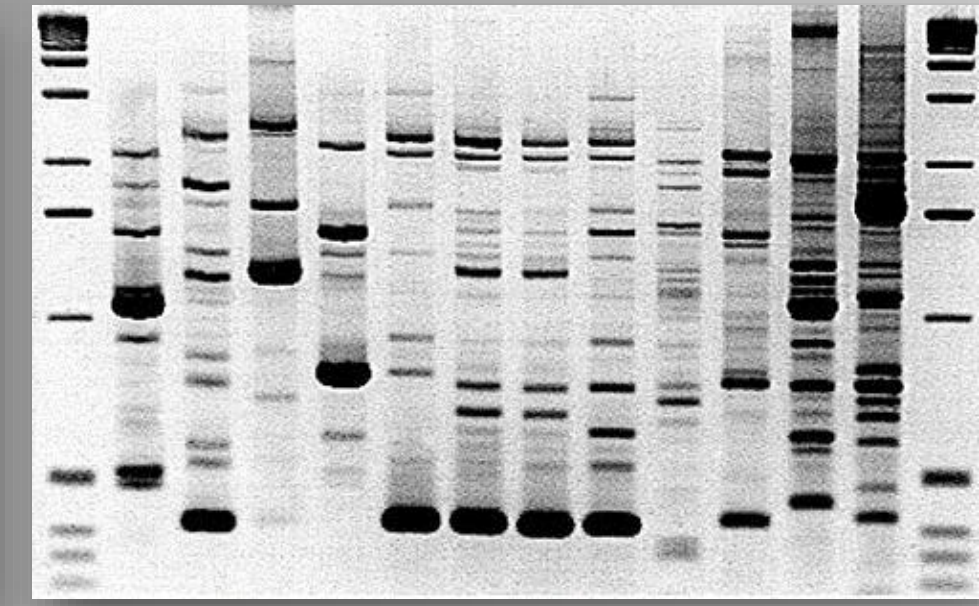
trials

teamwork

mystery

discovery

chemistry



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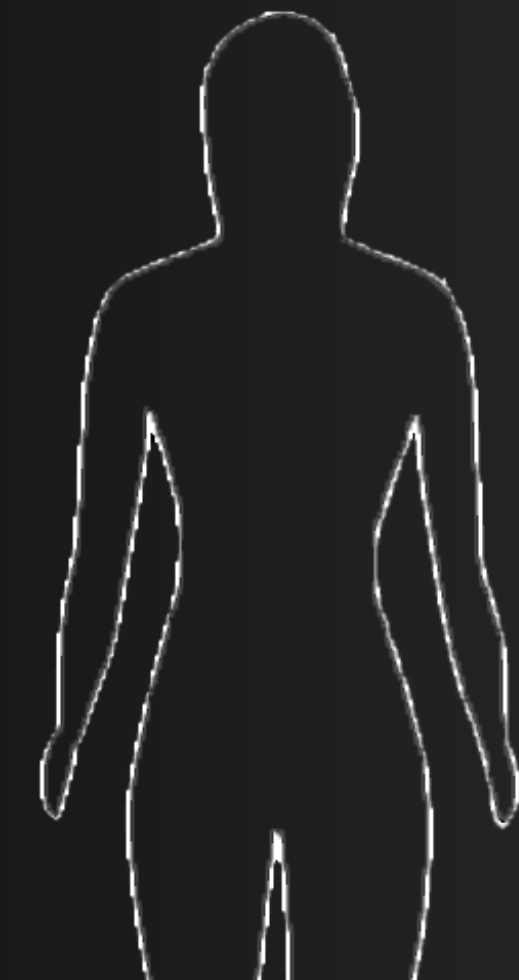
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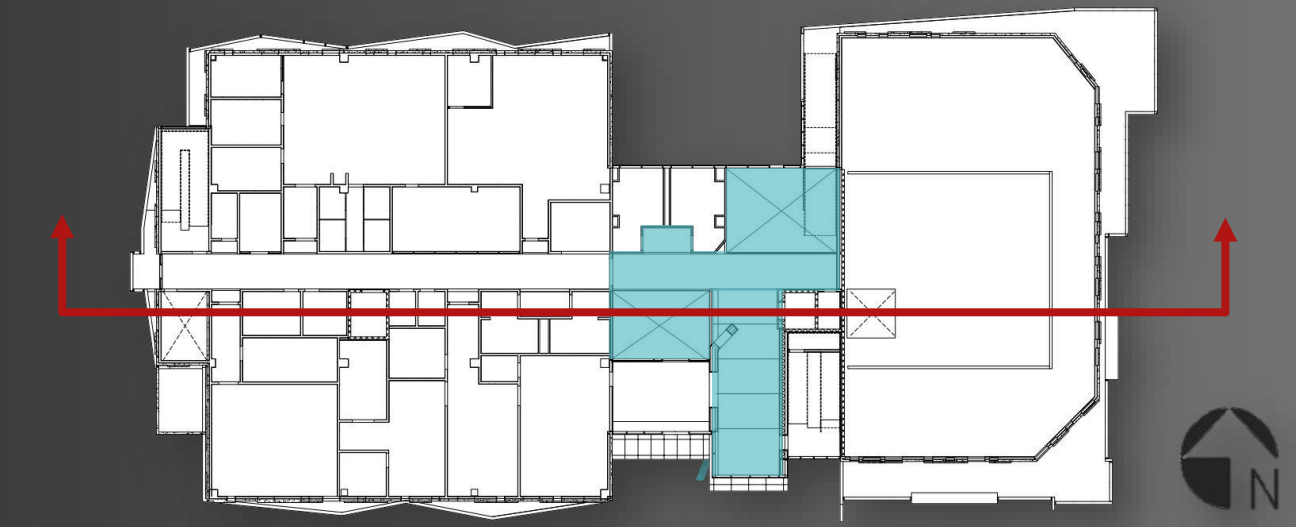
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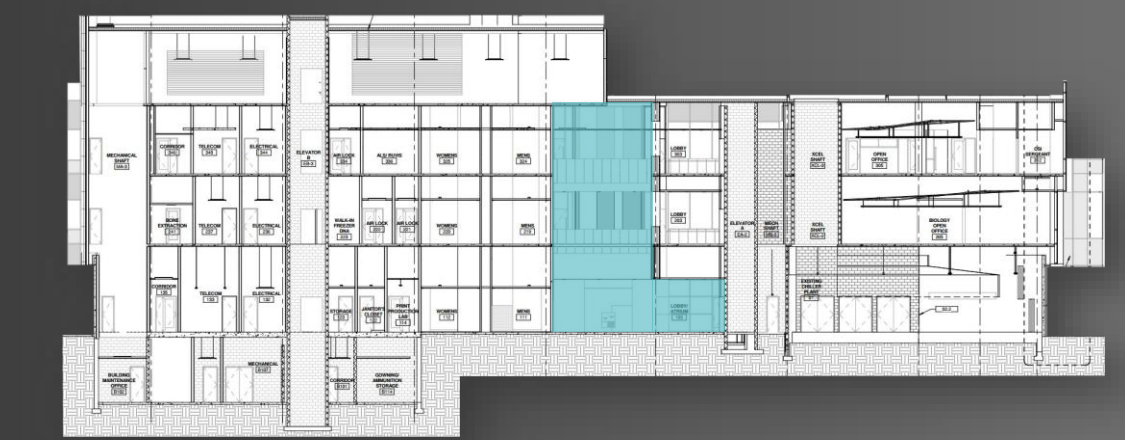


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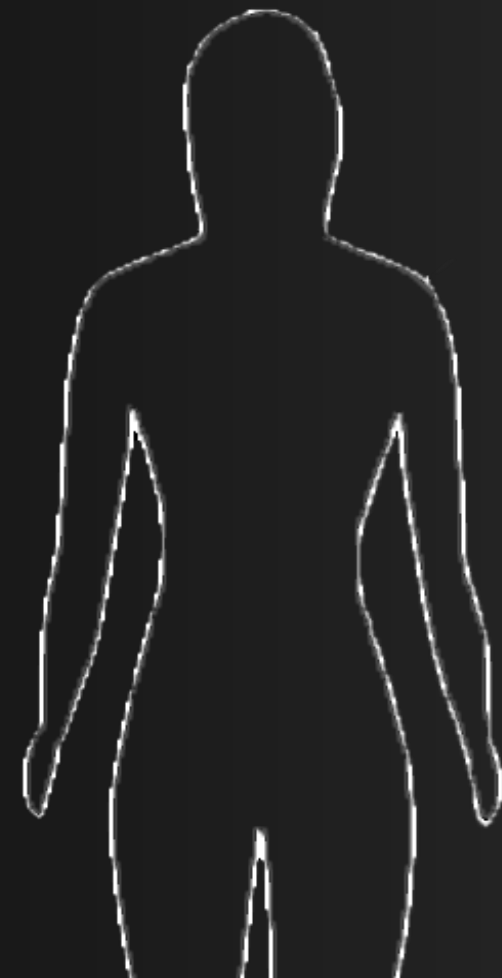
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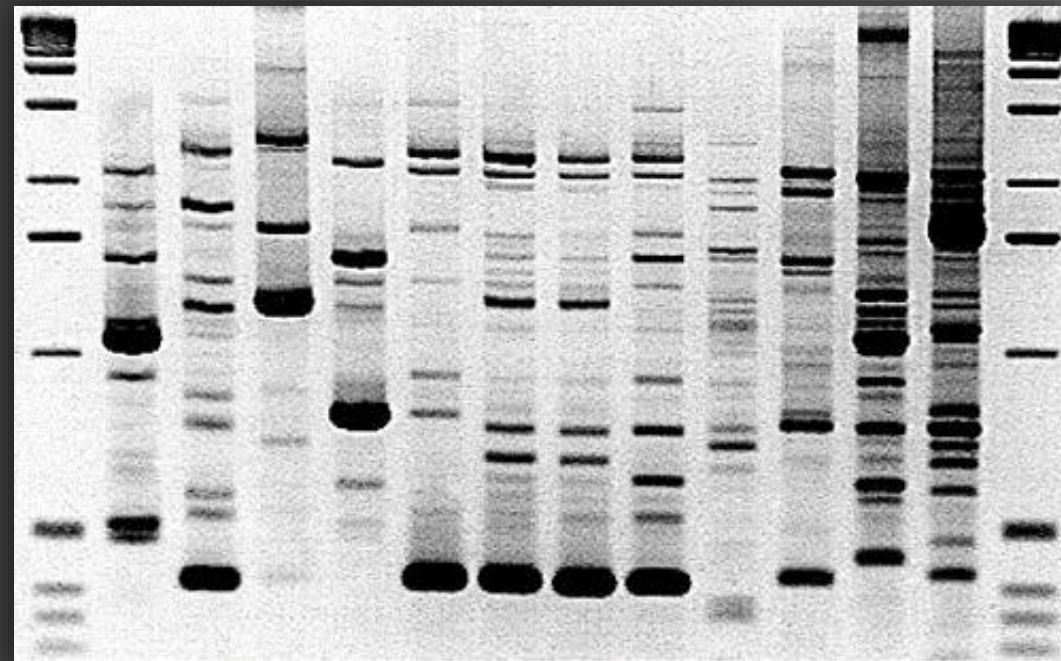


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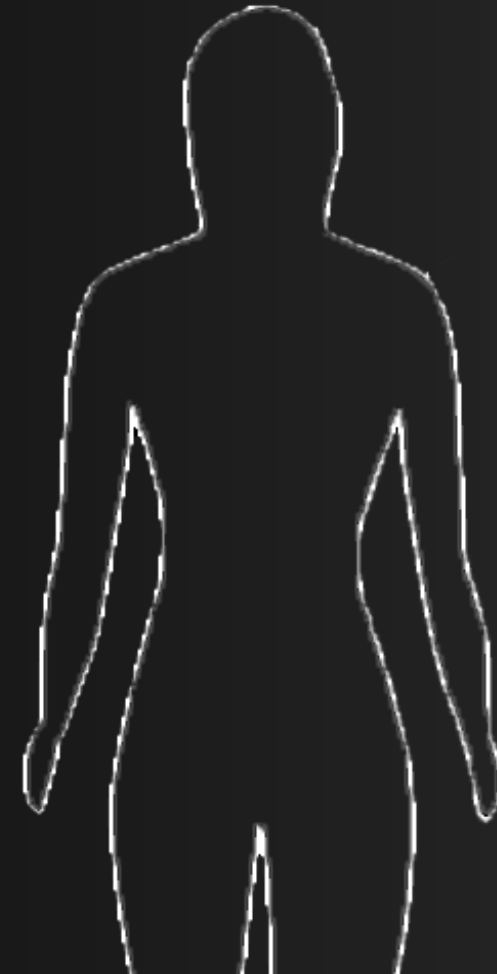
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qualitative criteria

aesthetics

transition

welcoming

bright

quantitative criteria

illuminance levels

Task	$E_h$ (lux)	Avg:Min
<b>Transition</b>	-	-
Day	100	4:1
Night	50	4:1
<b>Reception</b>	<b>150</b>	<b>4:1</b>
Lounge	150	2:1

lighting power density

Space	Allowance (W/ft <sup>2</sup> )
<b>Lobby</b>	<b>1.10</b>





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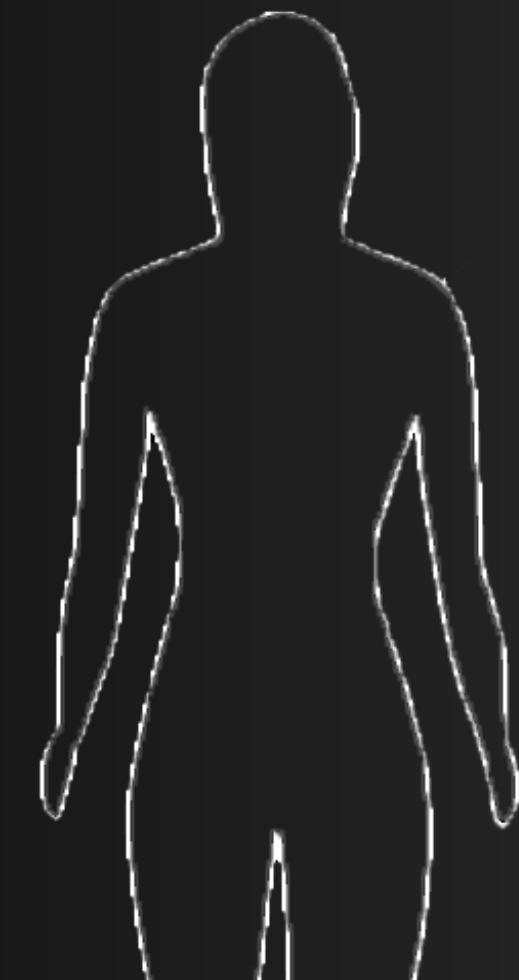
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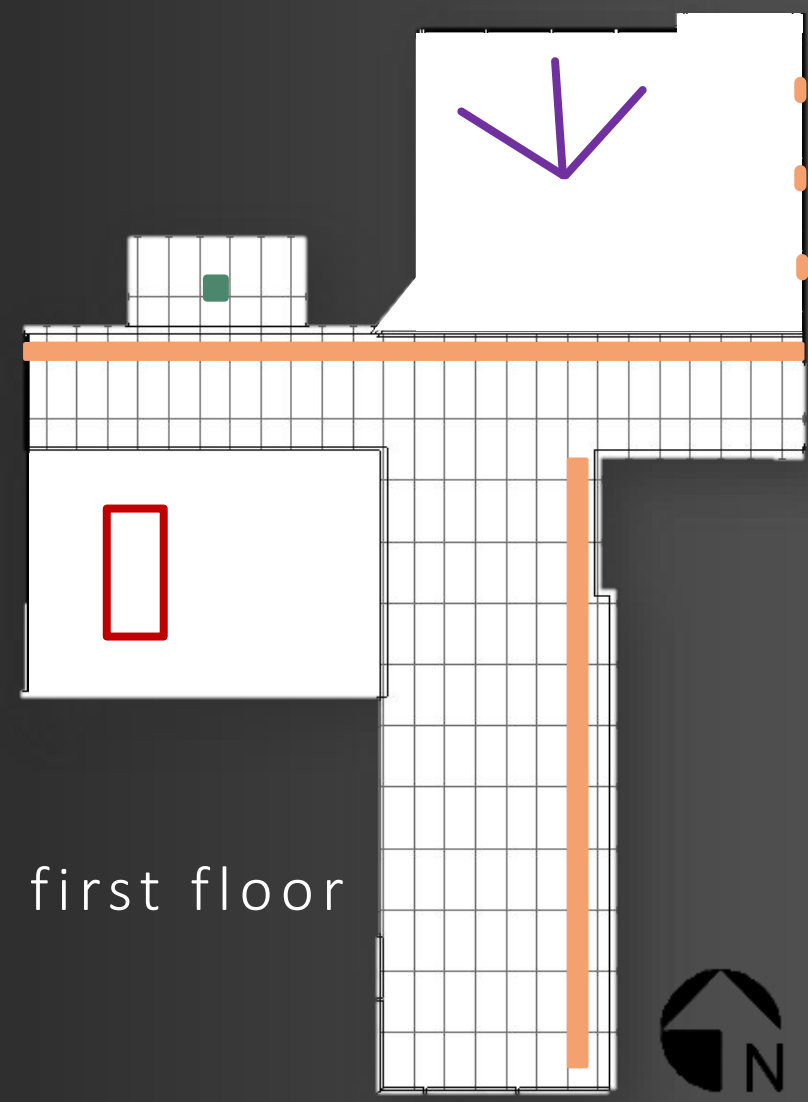
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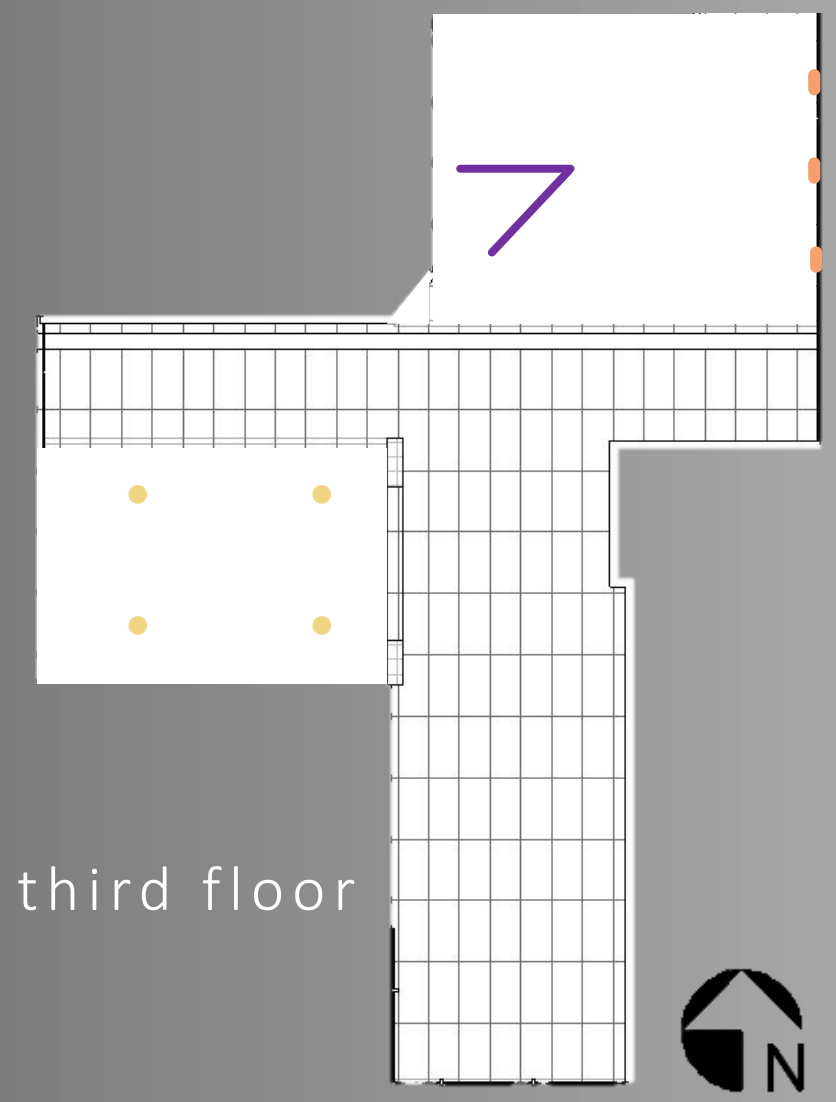
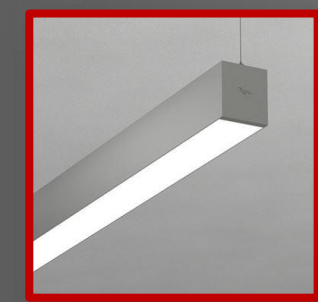
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# reflected ceiling plans



first floor



third floor



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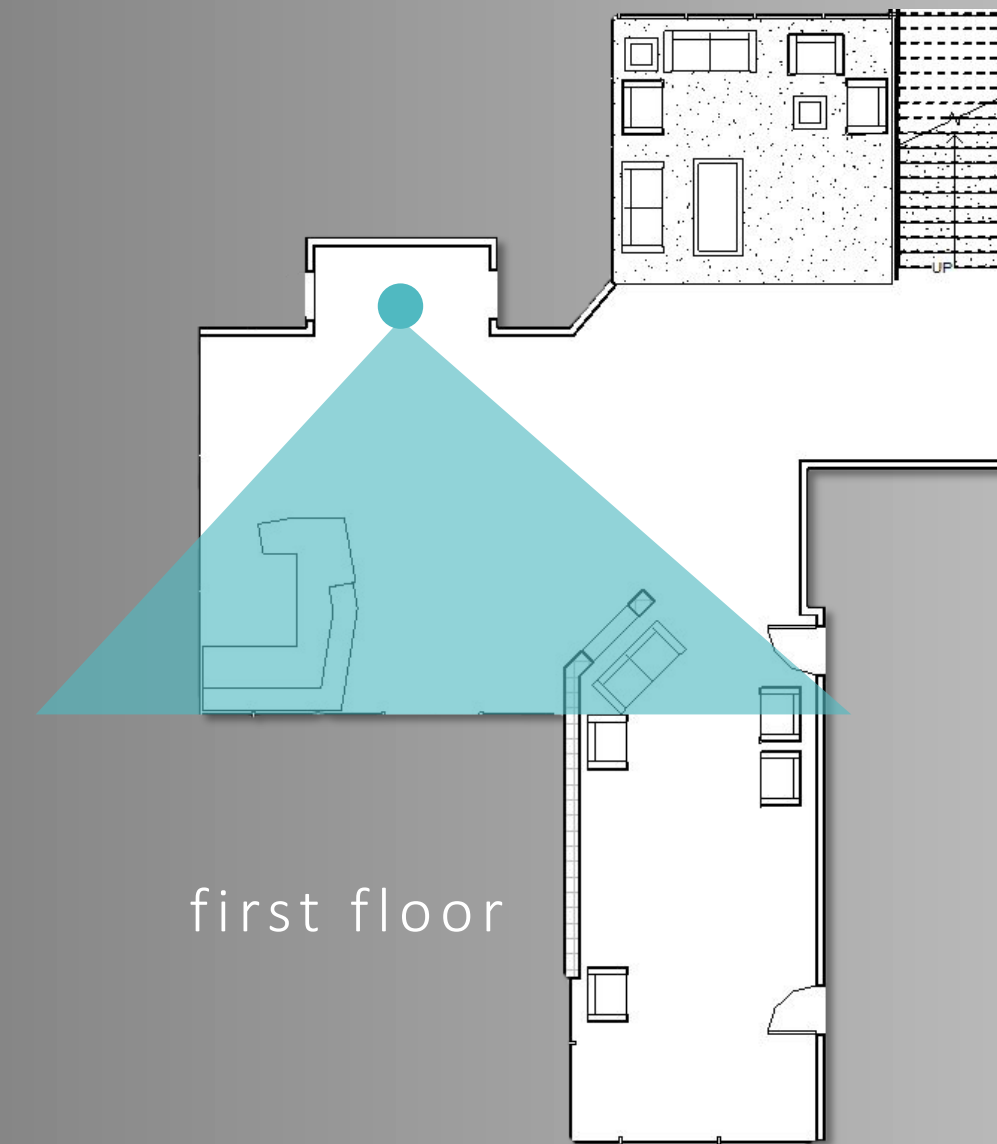
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renderings



plan view



first floor



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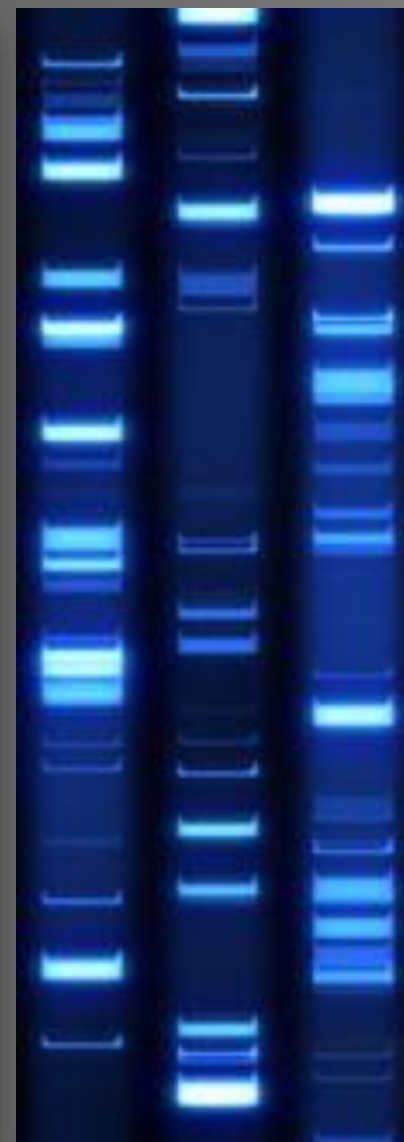
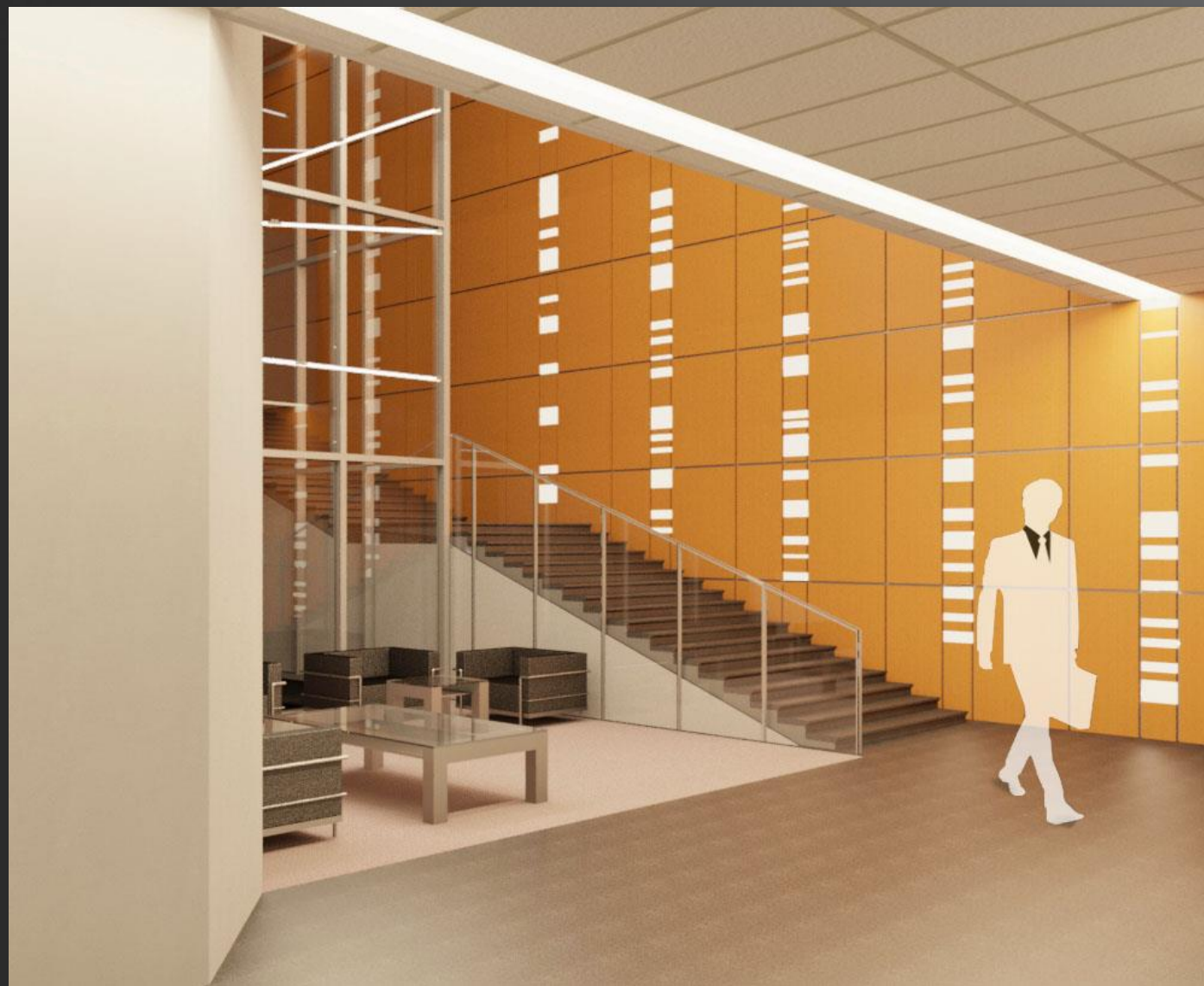
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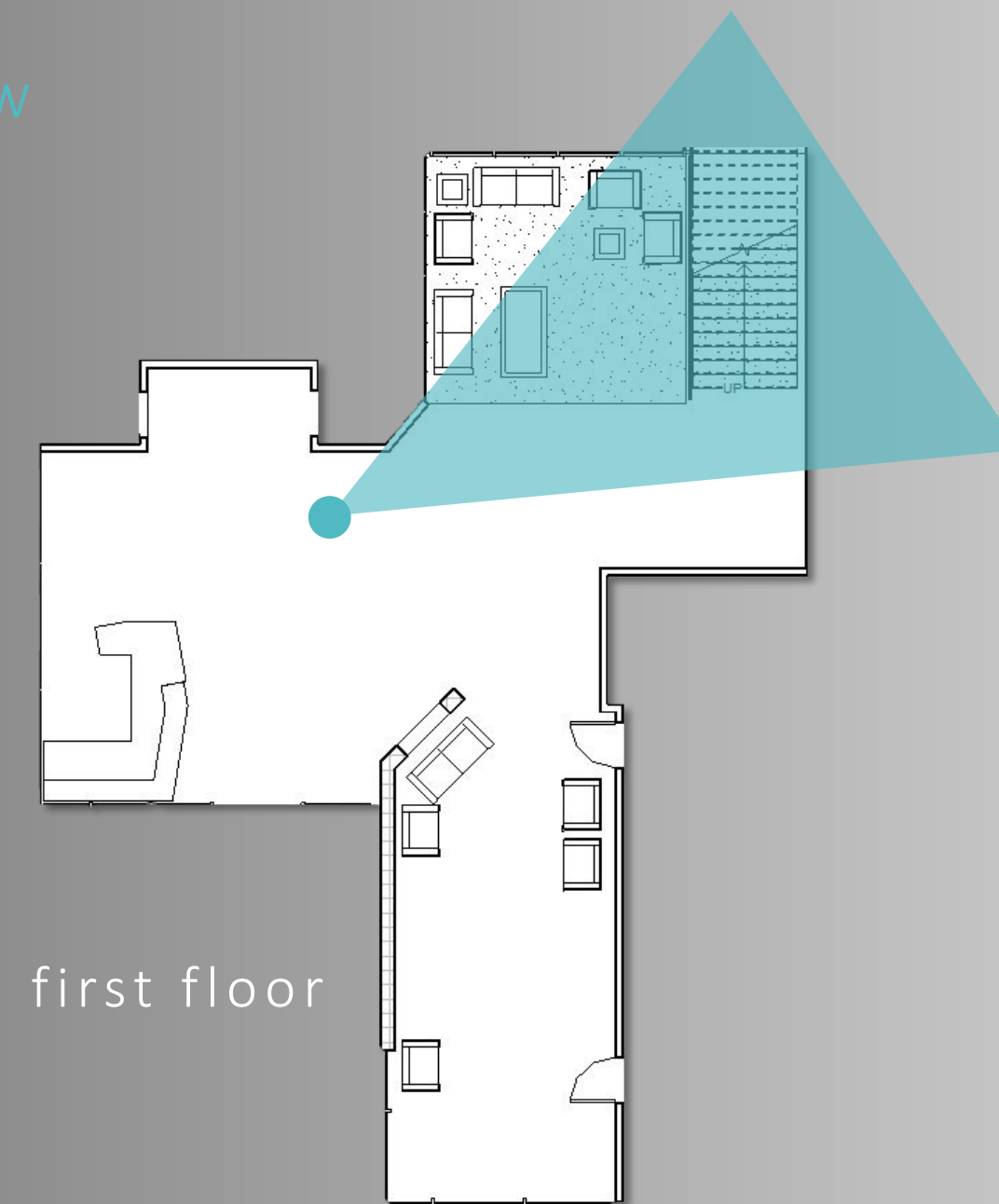
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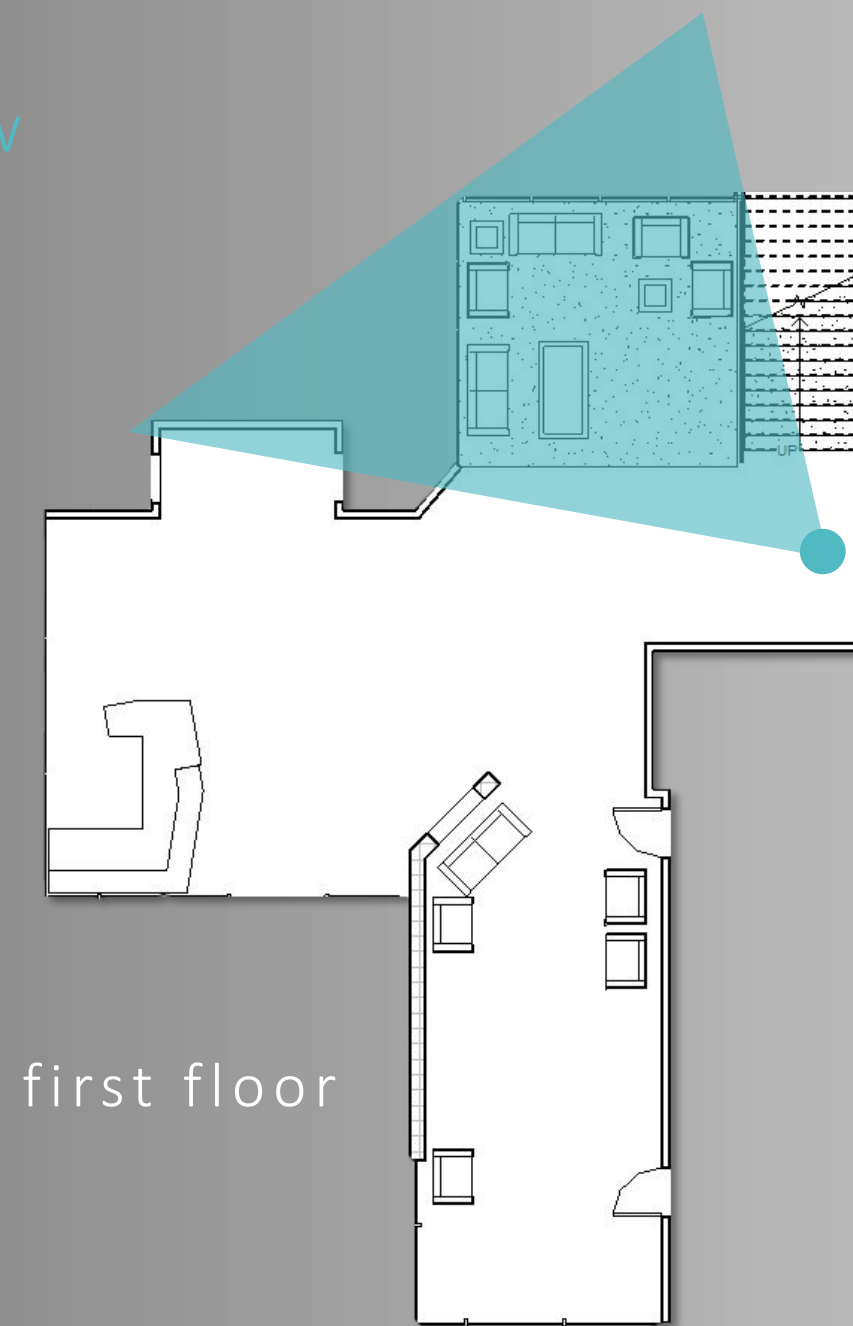
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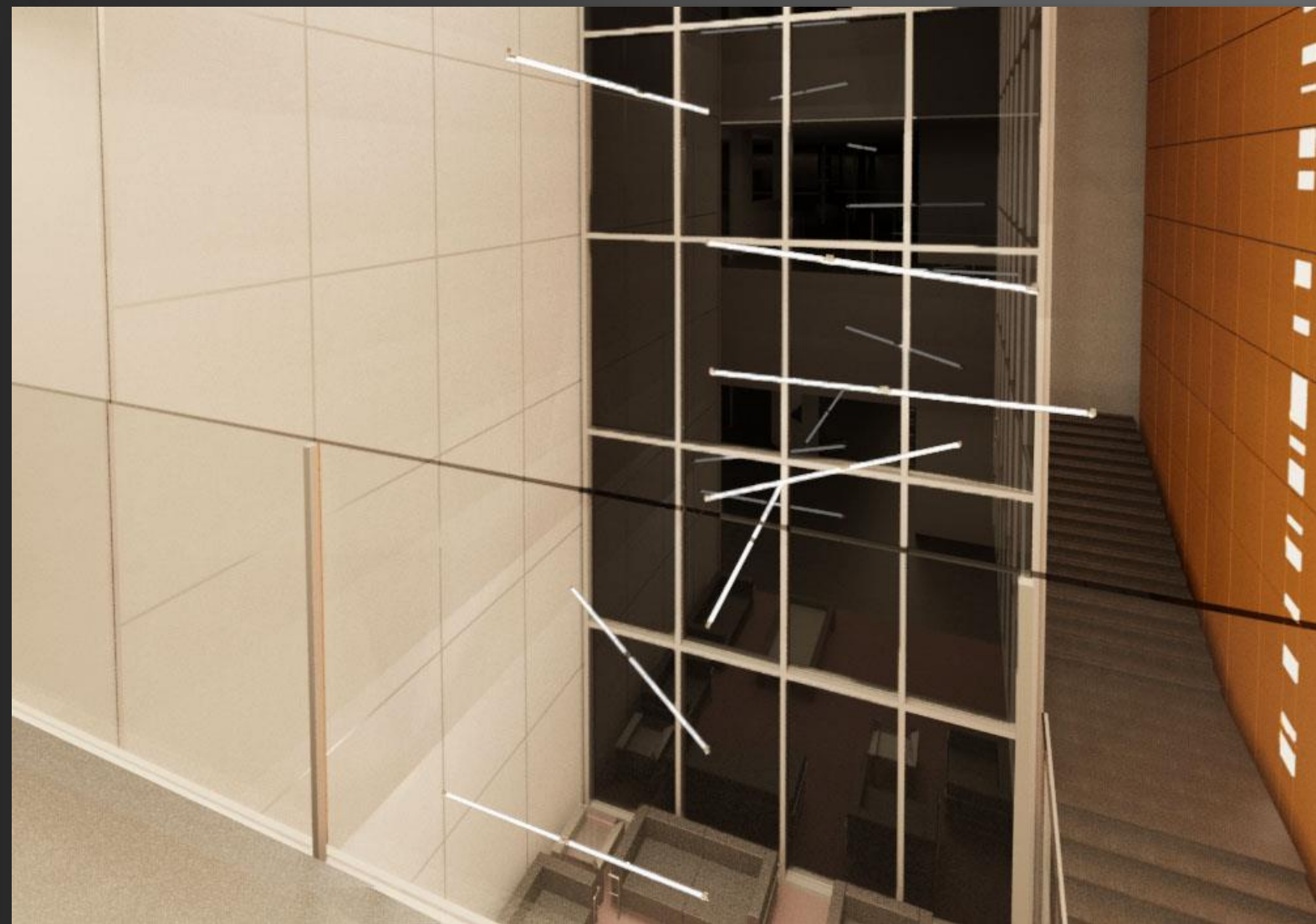
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structural breadth

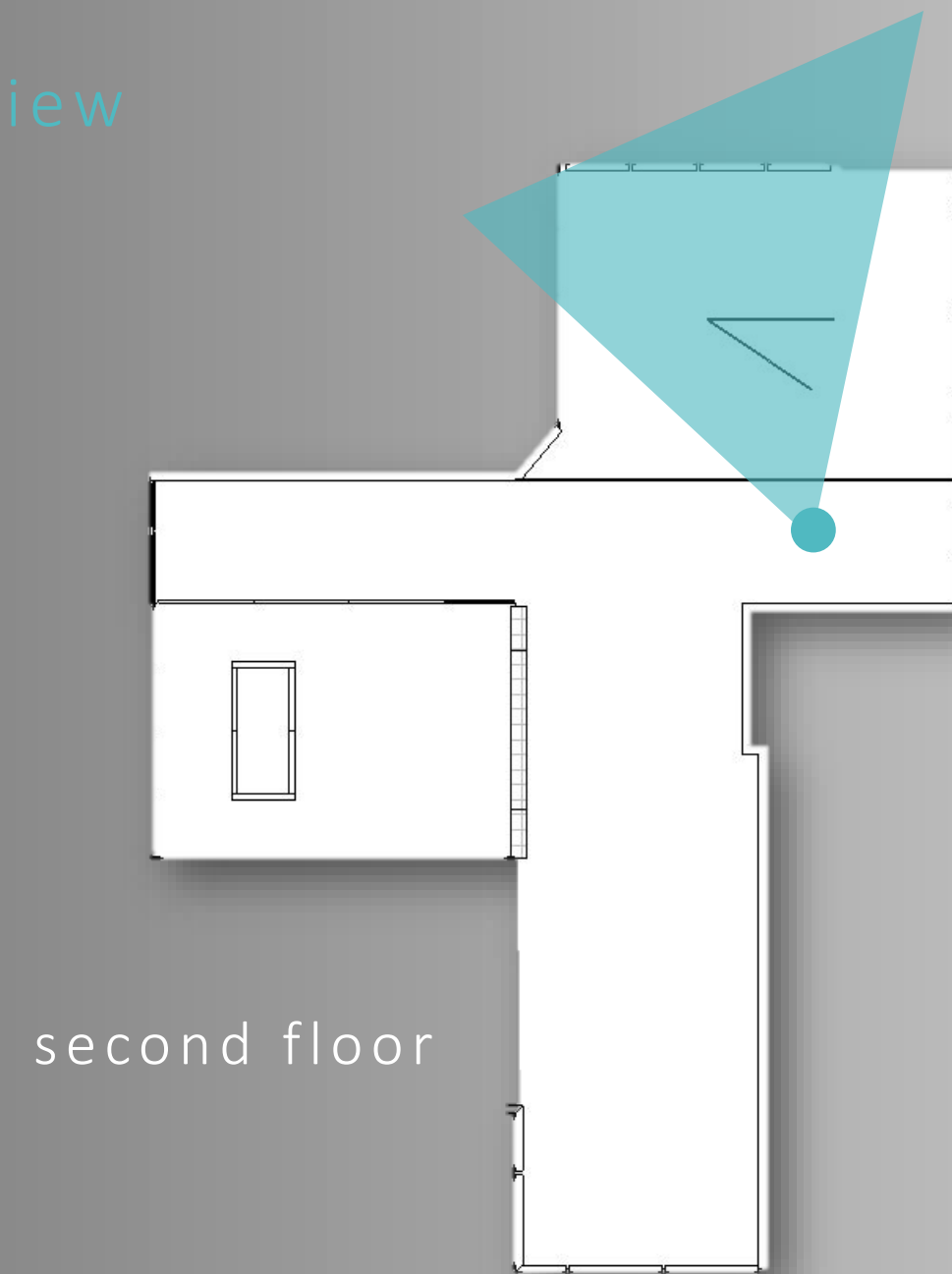
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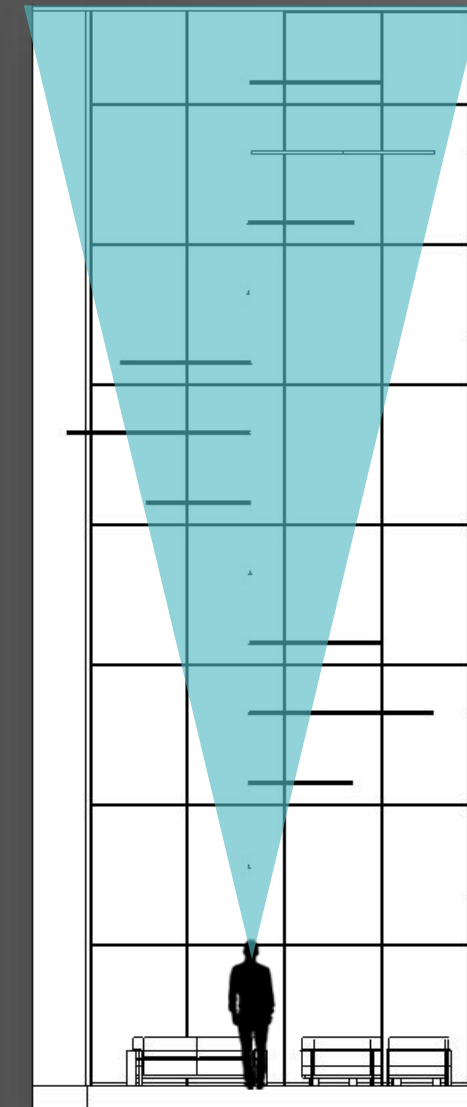
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structural breadth

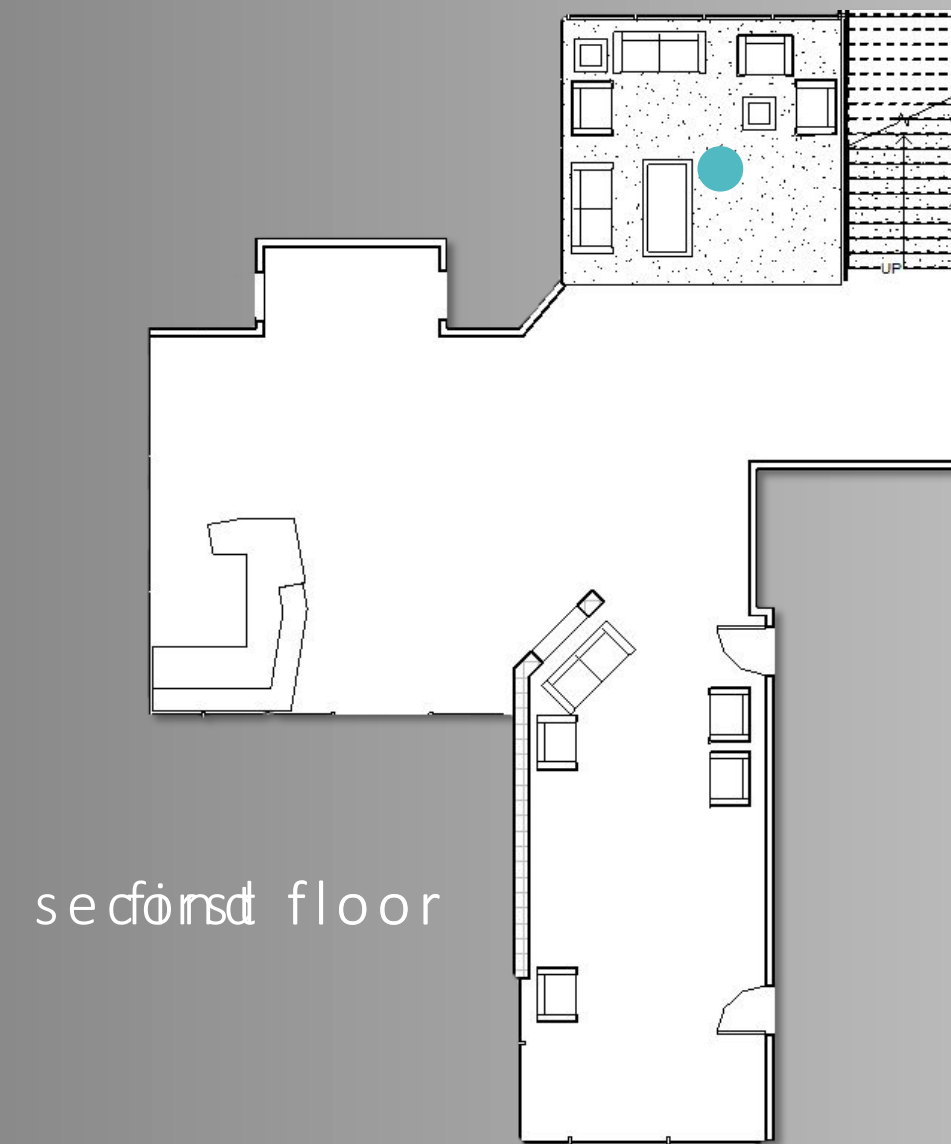
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second floor



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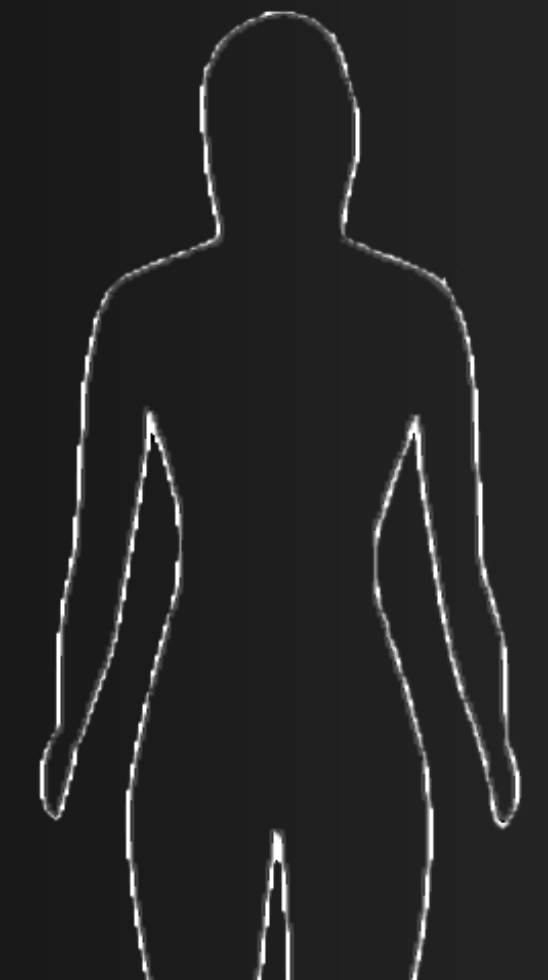
electrical depth

photovoltaic array

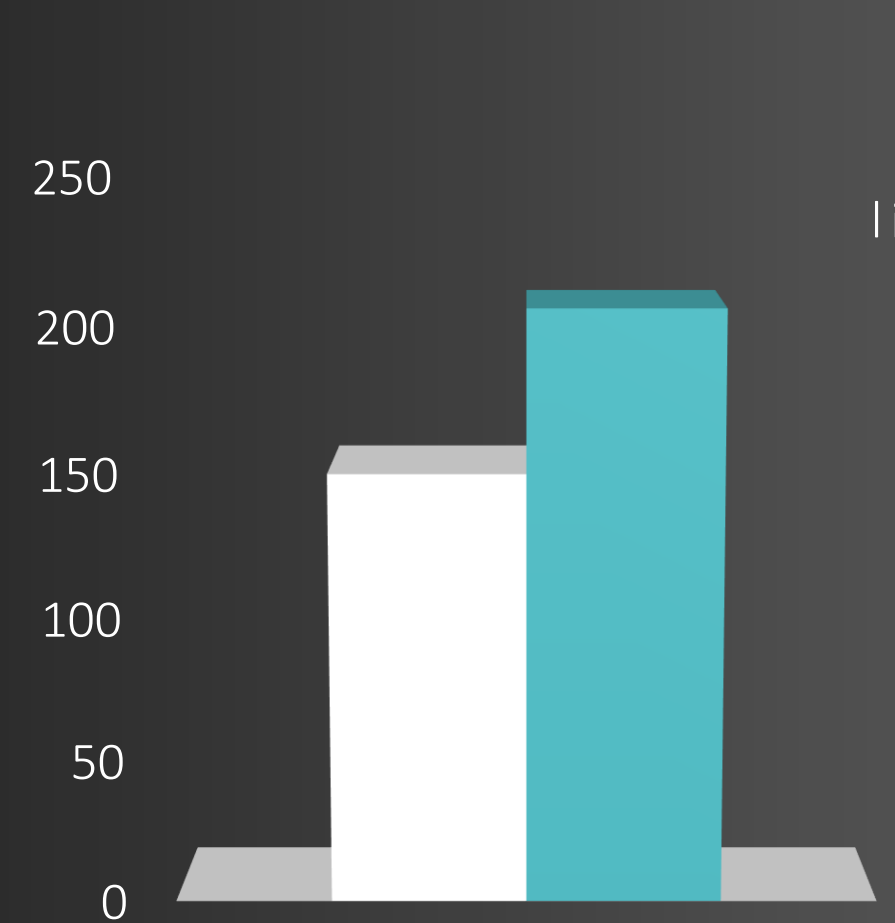
construction breadth

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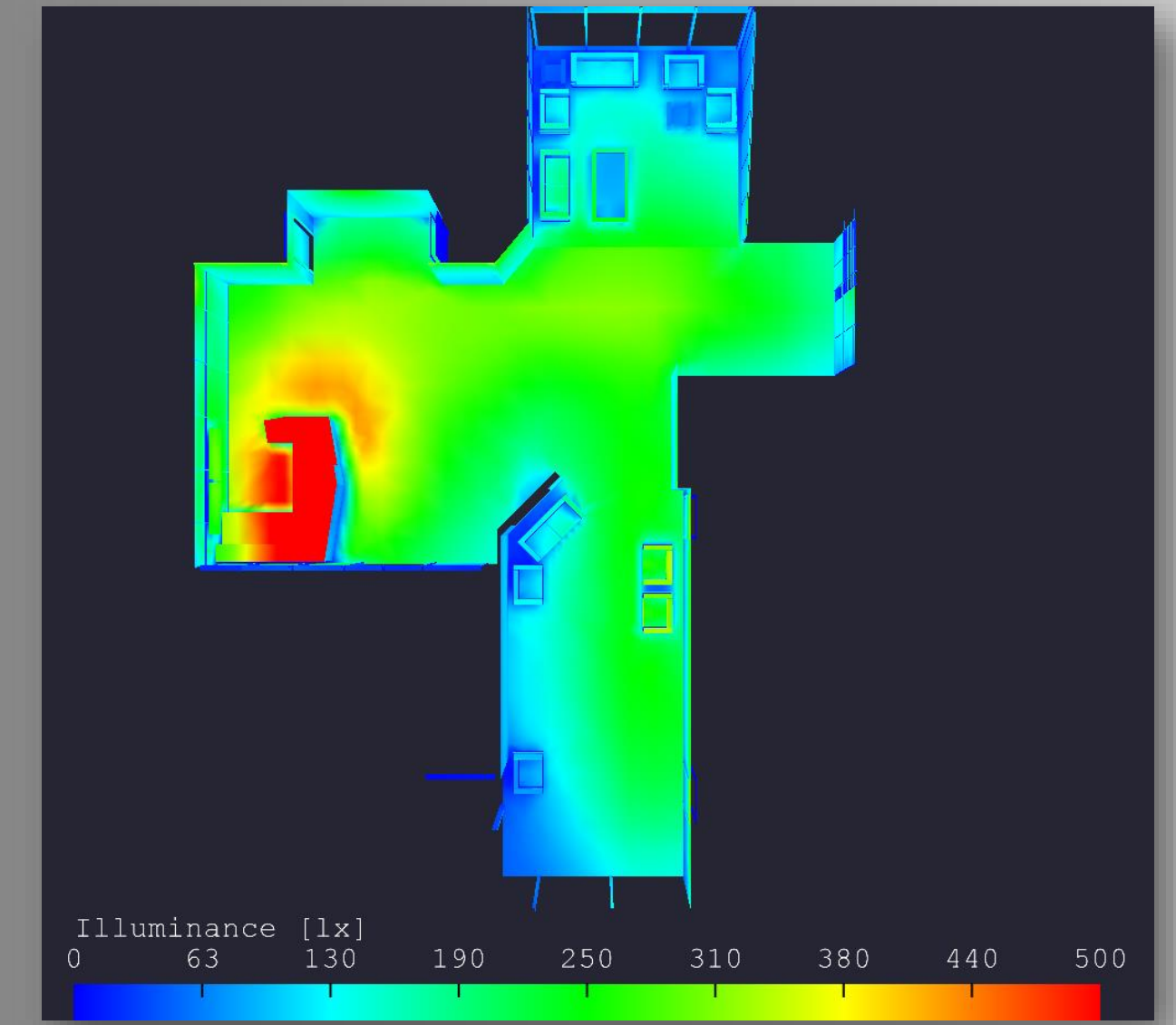
### quantitative data



■ Recommended ■ Achieved (Avg.)

Illuminance average | 206 lux  
 average/minimum | 3.7:1  
 lighting power density | 1.0 w/sf

### elumtools calculation



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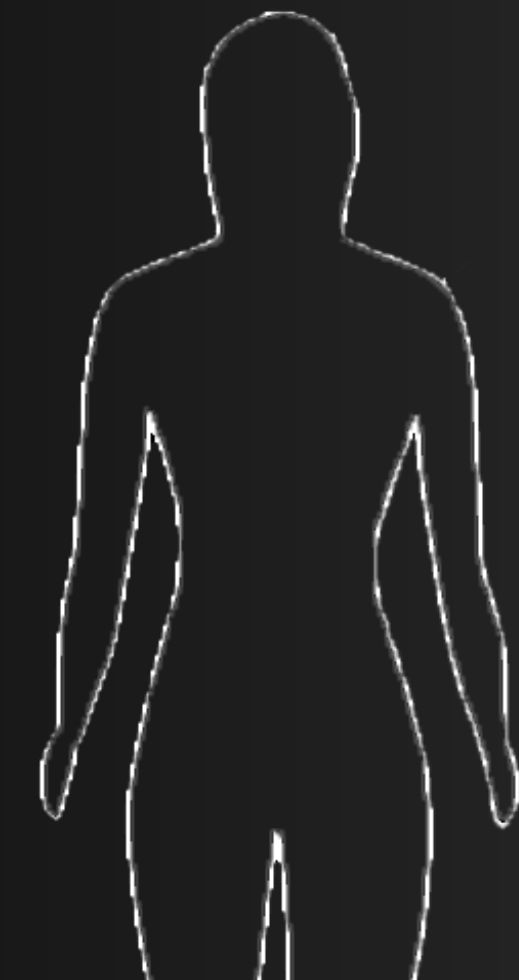
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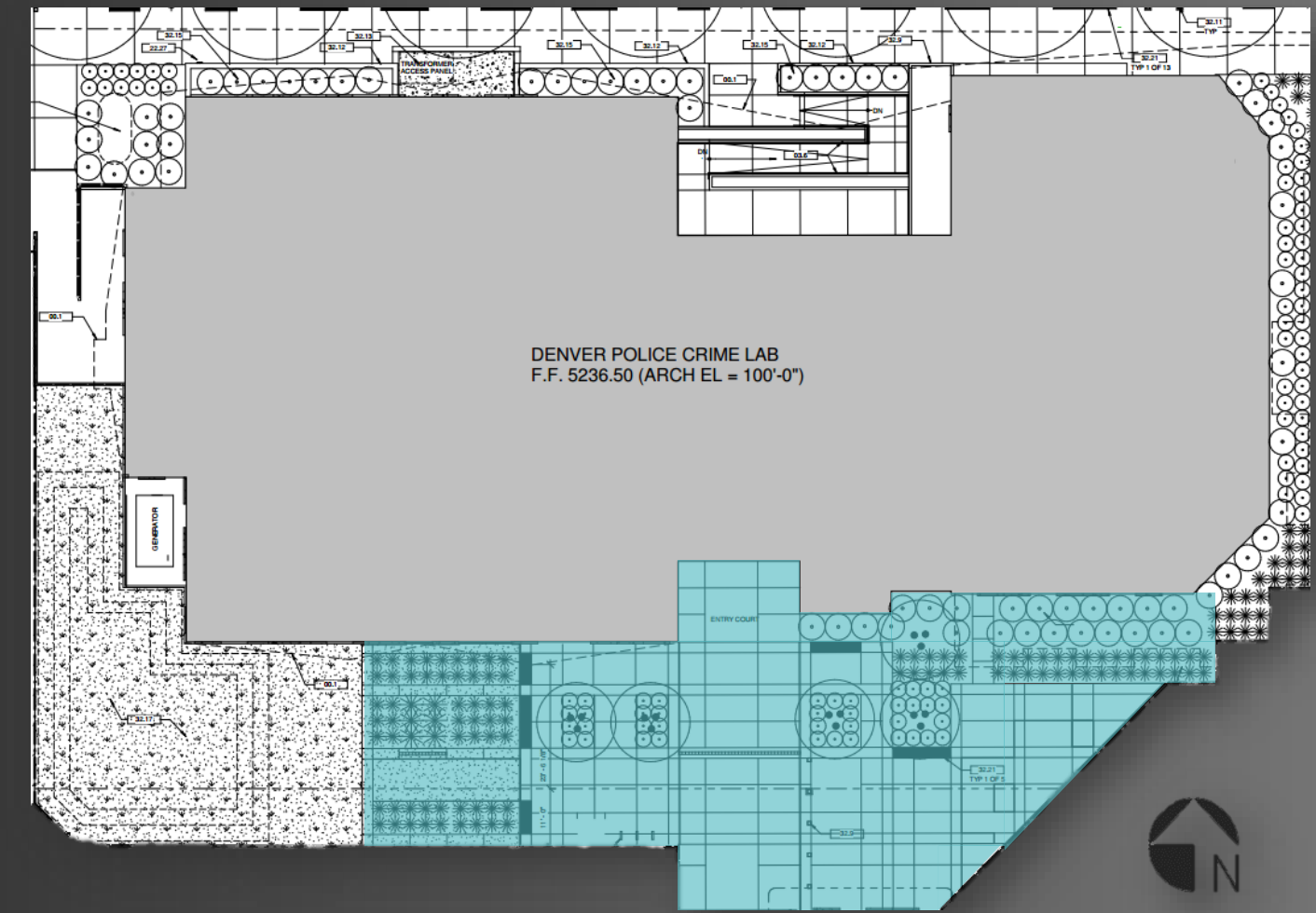
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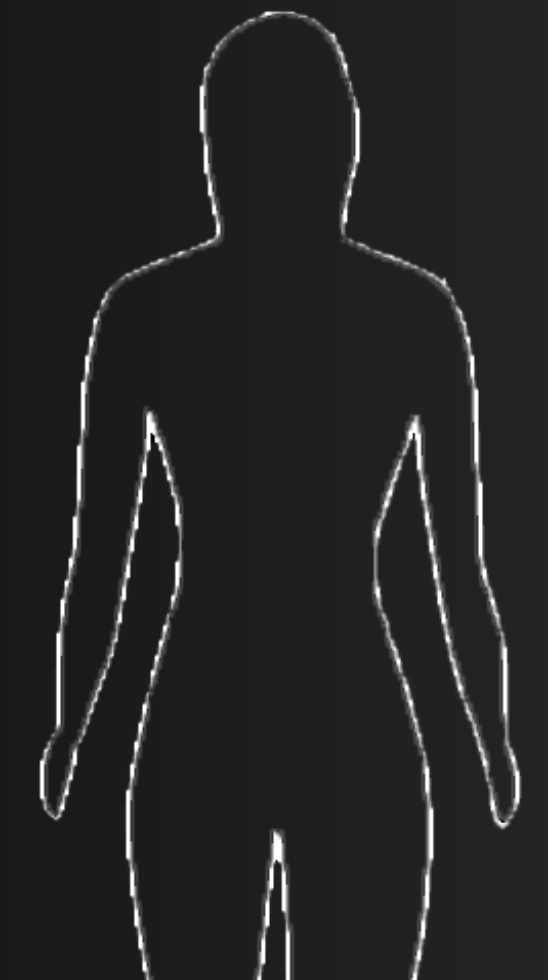
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concept

# fingerprint

individuality

one of a kind

uniqueness



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## qualitative criteria

relaxation

safety

## quantitative criteria

illuminance levels

Task	$E_h$ (lux)	$E_v$ (lux)	Avg:Min
Transition – Plaza	6	2	5:1

lighting power density

Space	Base Allowance (W)	Allowance (W/sf)	Square Footage	Total Allowance (W)
South Plaza	1300	0.2	5500	2400

model lighting ordinance

Space	Lighting Zone	Allowance (LM/sf)
South Plaza	LZ4	7.5



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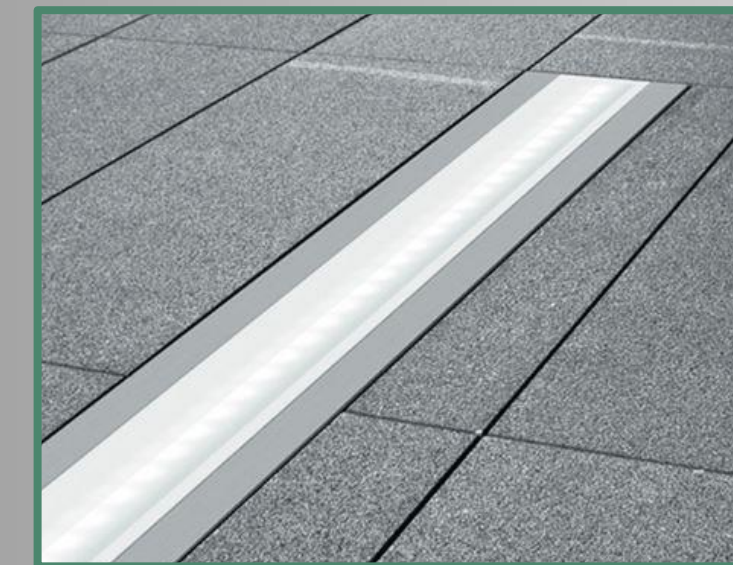
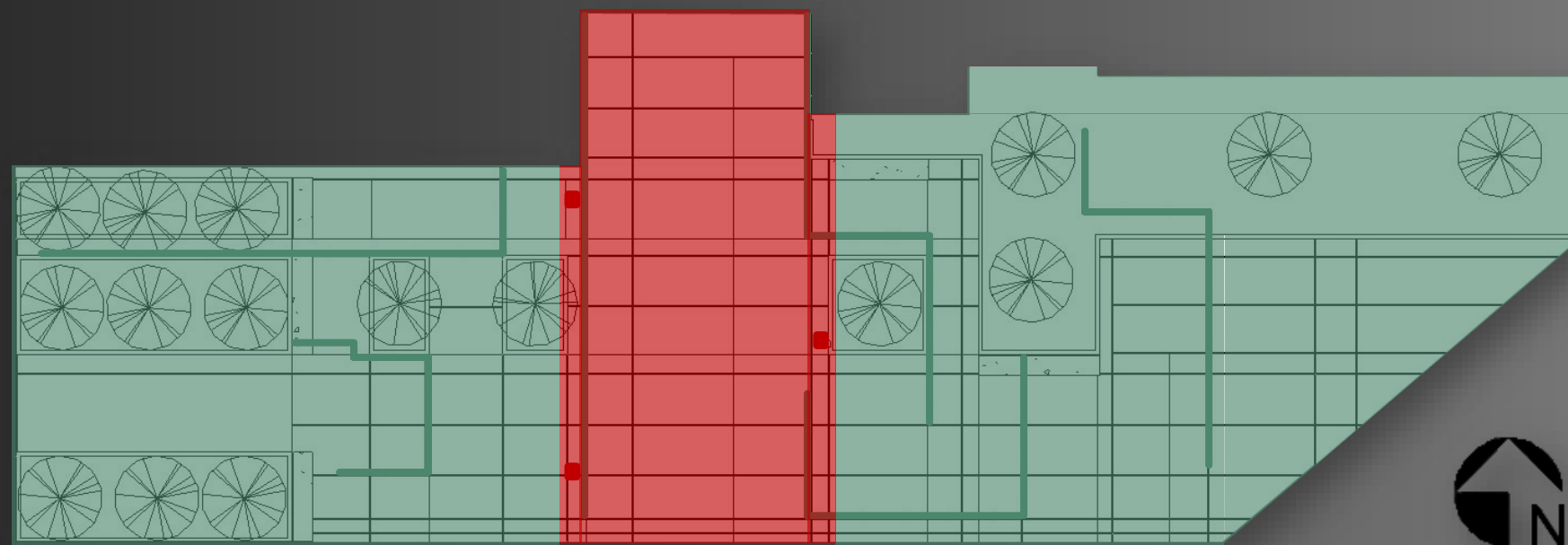
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site plan



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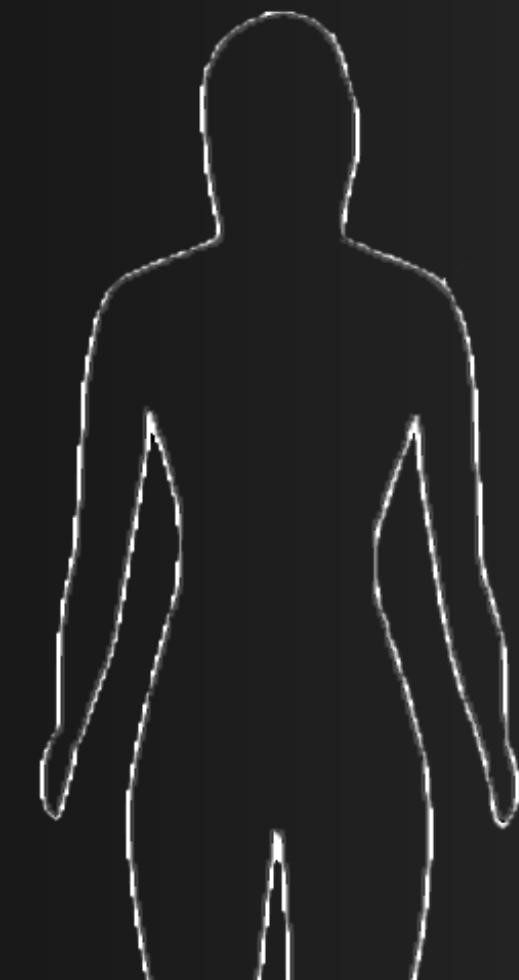
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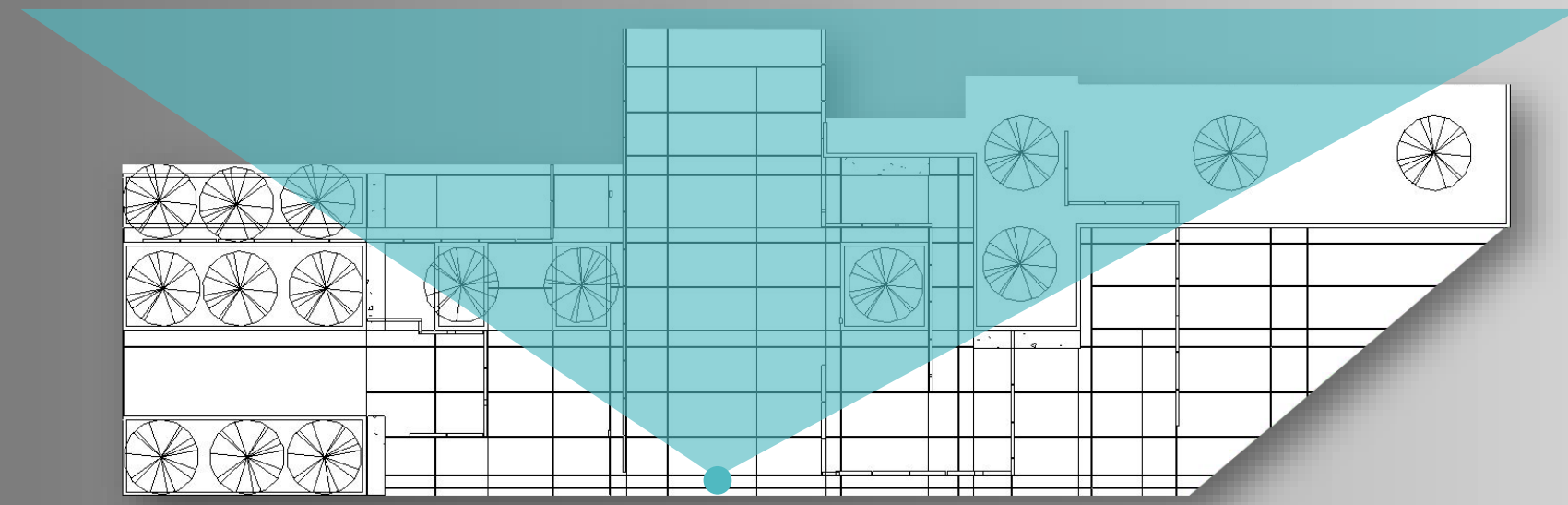
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plan view



site



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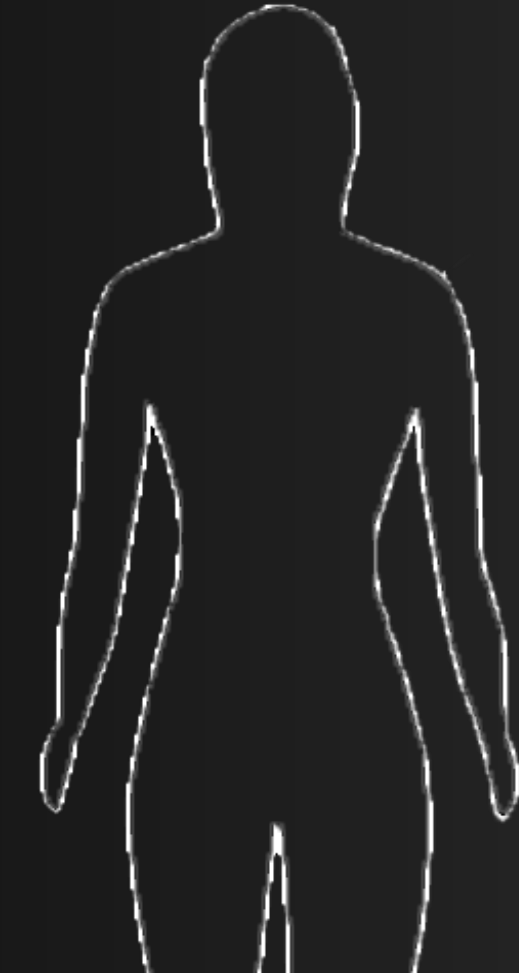
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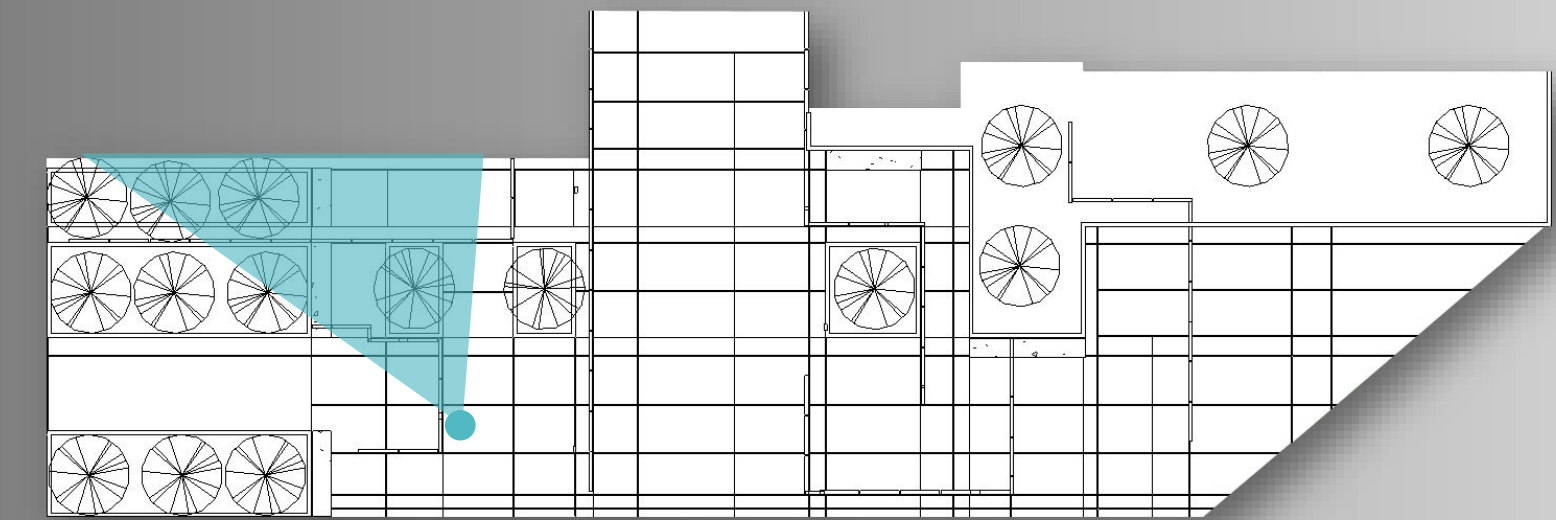
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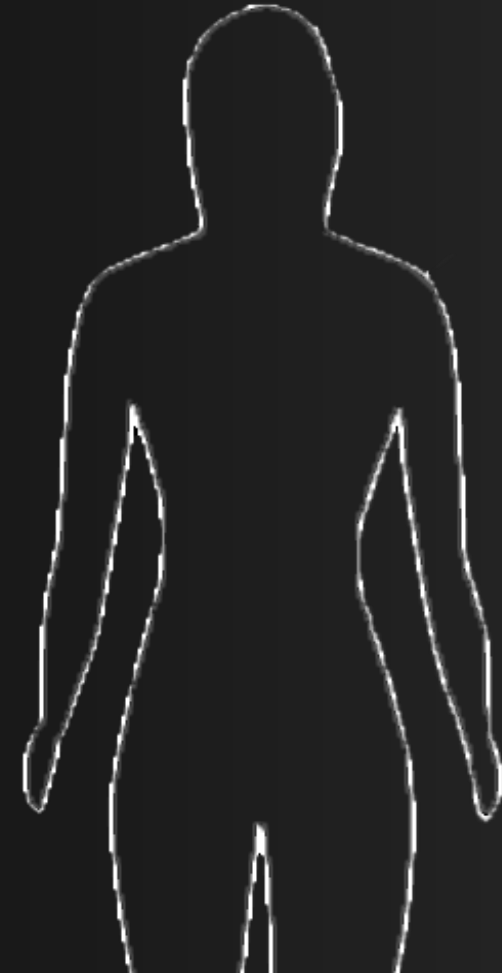
electrical depth

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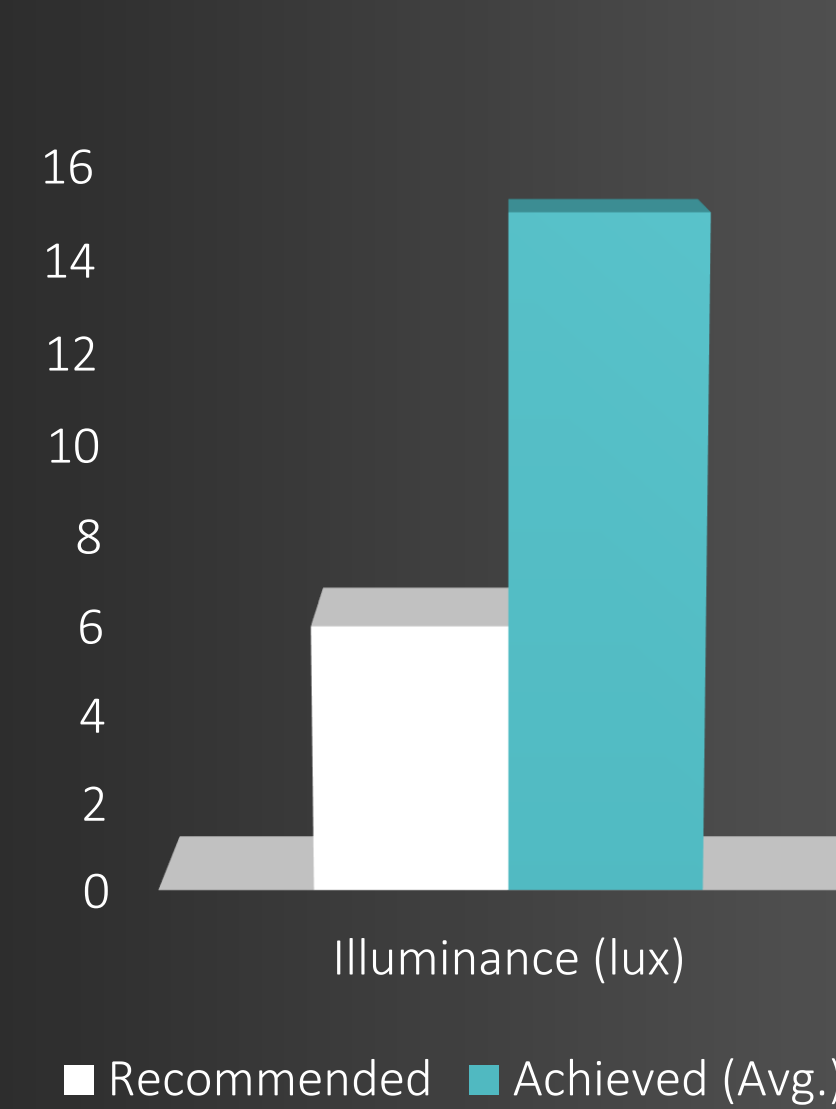
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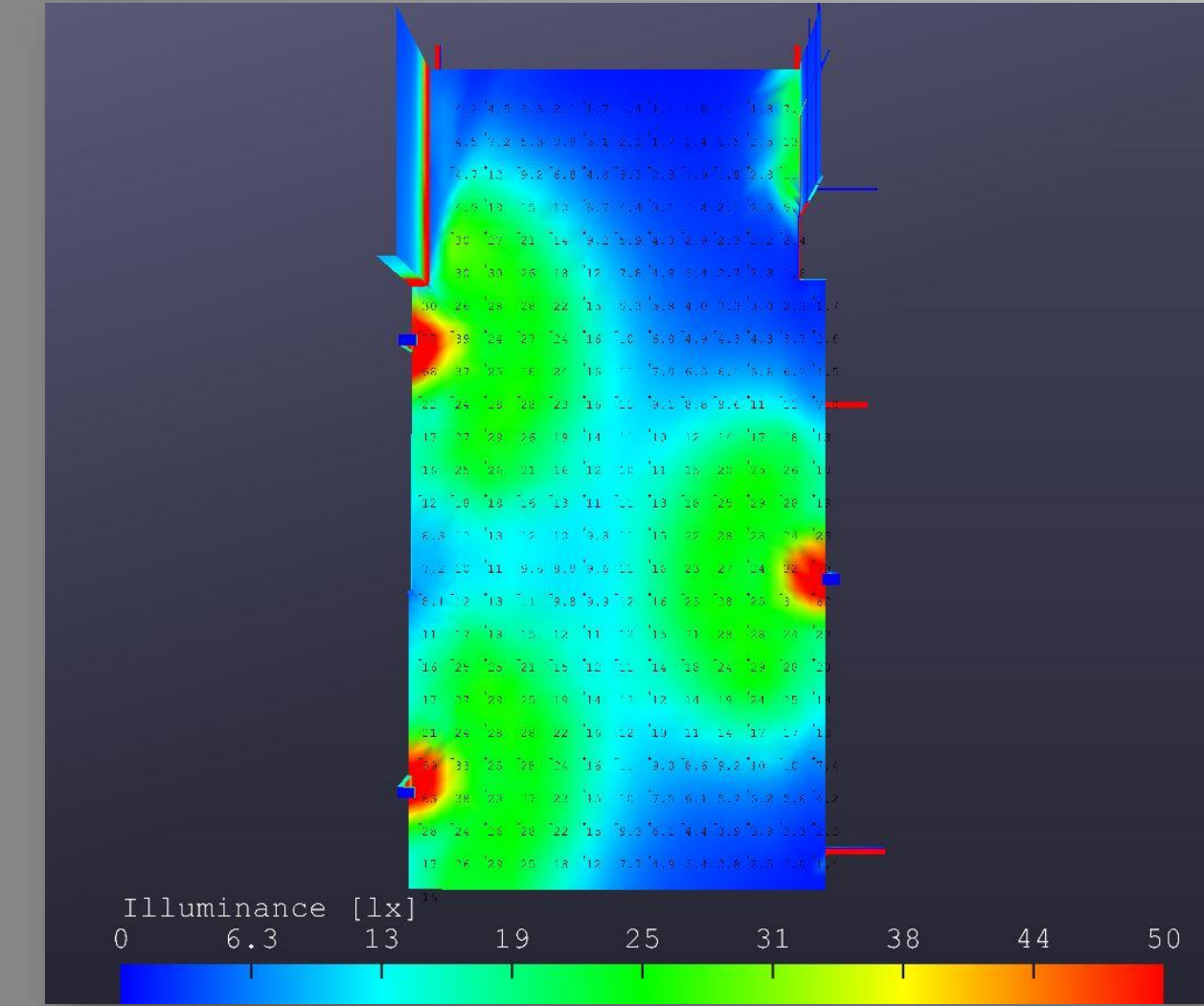


## quantitative data



Illuminance average | 15 lux  
average/minimum | 21:1  
total watts | 1848 W  
total site lumens | 18,552  
lumens/sf | 3.37

## elumtools calculation



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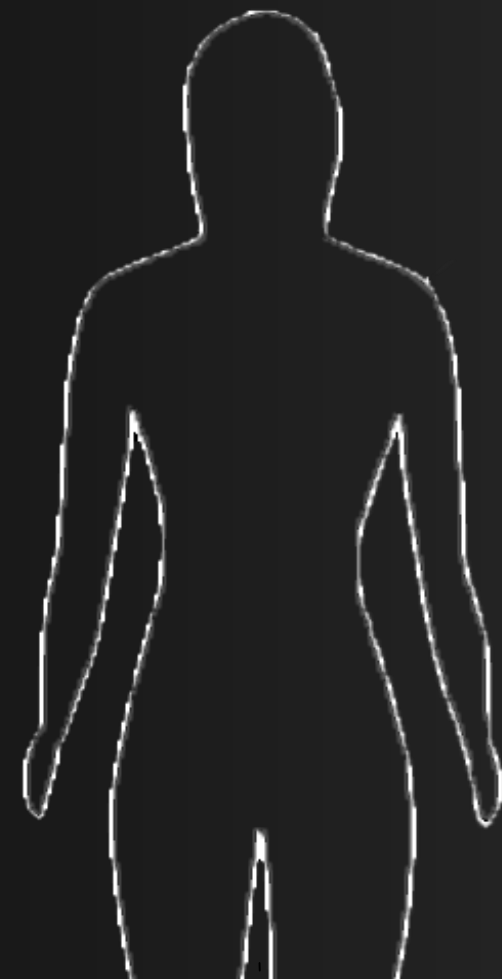
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# electrical depth



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## system advisor model (sam)

**System Sizing**

Specify desired array size       Specify modules and inverters

Desired array size:  kWdc  
 DC to AC ratio:

Modules per string:   
 Strings in parallel:   
 Number of inverters:

---

**Configuration at Reference Conditions**

Modules		Inverters	
Nameplate capacity	99.552 kWdc	Total capacity	100.000 kWac
Number of modules	240	Total capacity	104.208 kWdc
Modules per string	6	Number of inverters	1
Strings in parallel	40	Maximum DC voltage	600.0 Vdc
Total module area	518.9 m <sup>2</sup>	Minimum MPPT voltage	315.0 Vdc
String Voc	511.8 V	Maximum MPPT voltage	600.0 Vdc
String Vmp	437.4 V		

Sizing messages (see Help for details):

Voltage and capacity ratings are at module reference conditions shown on the Module page.

## modules

Manufacturer	SunPower
Nominal Efficiency	19.19%
Maximum Power	414.8 Wdc
Number of Cells	128
Length	7'-0"
Width	3'-3"
Number of Panels	240

## inverter

Manufacturer	Satcon Technology Corp.
CEC Weighted Efficiency	96.24%
Maximum Power (DC)	104 kWdc
Maximum Power (AC)	100 kWac
Nominal AC voltage	480 V
Number of Inverters	1





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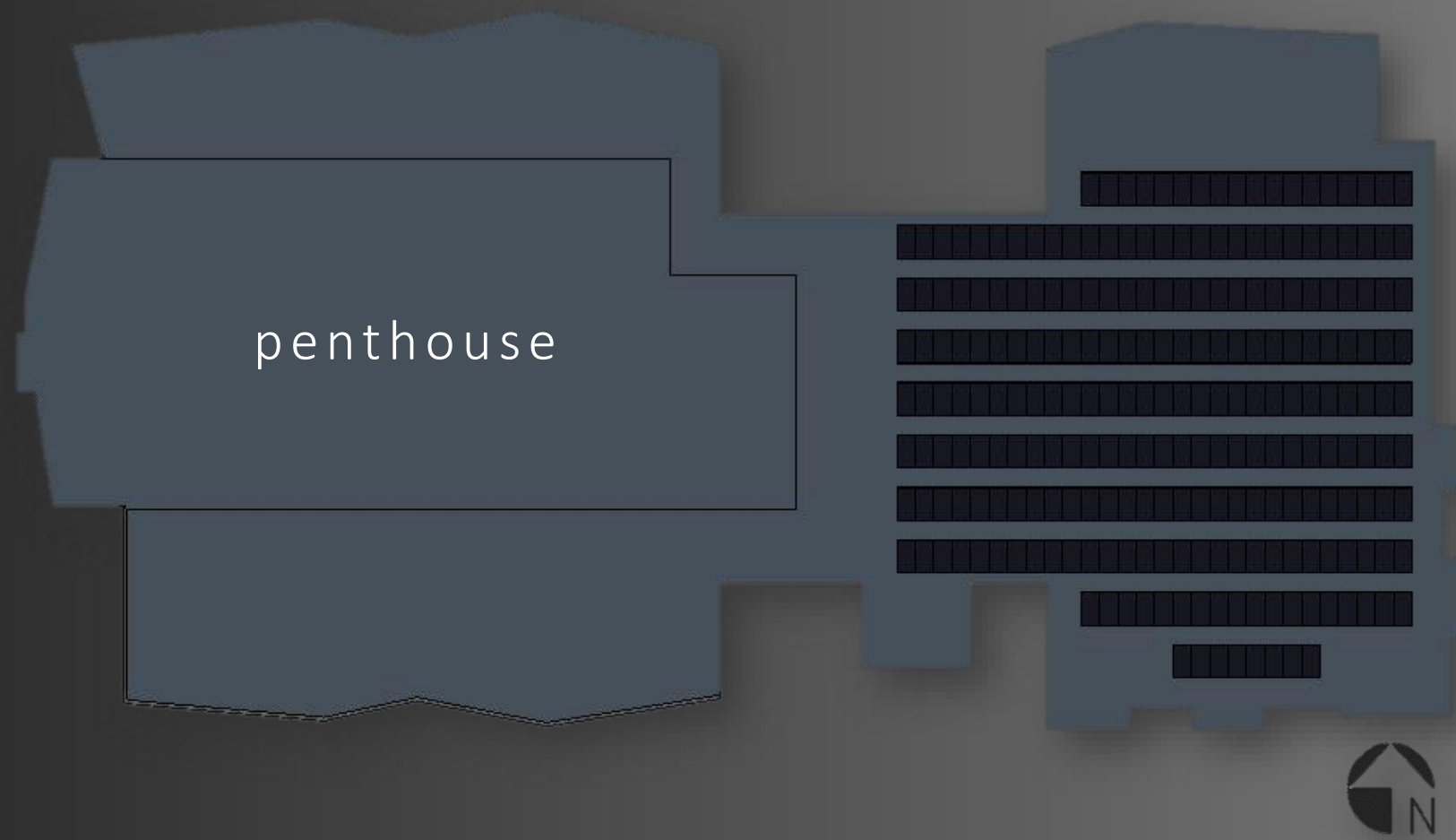
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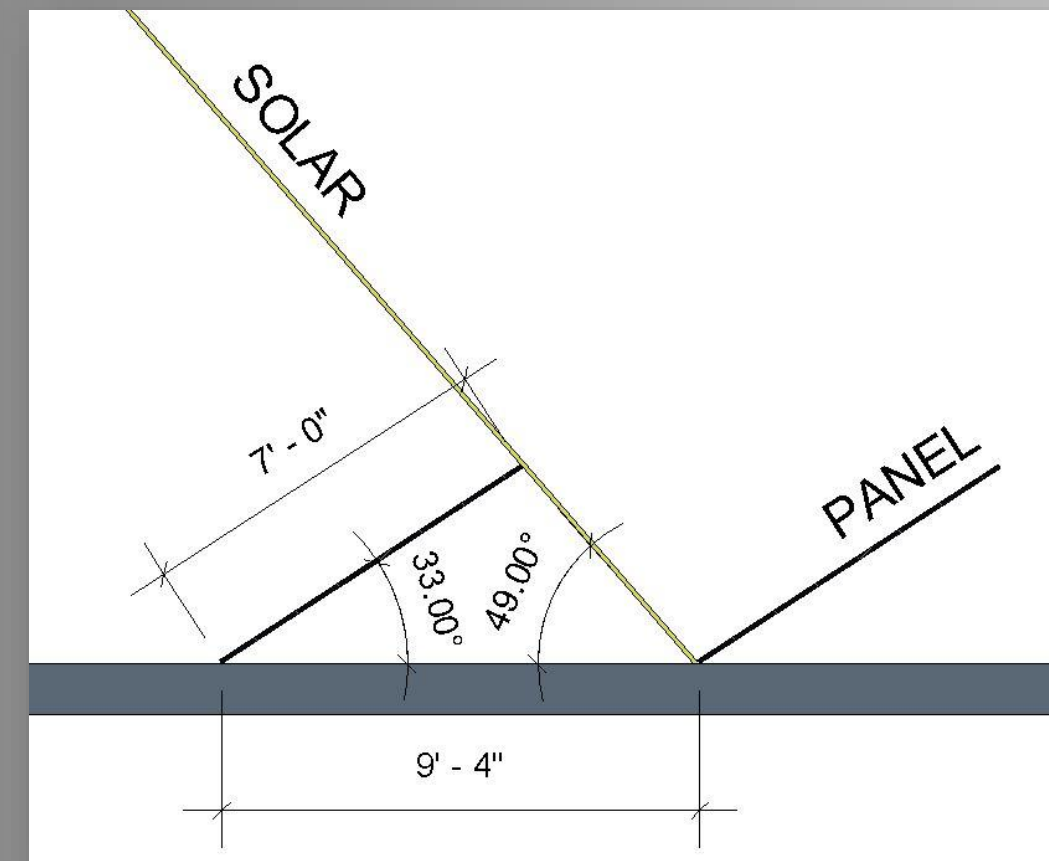
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analytical layout



solar angles



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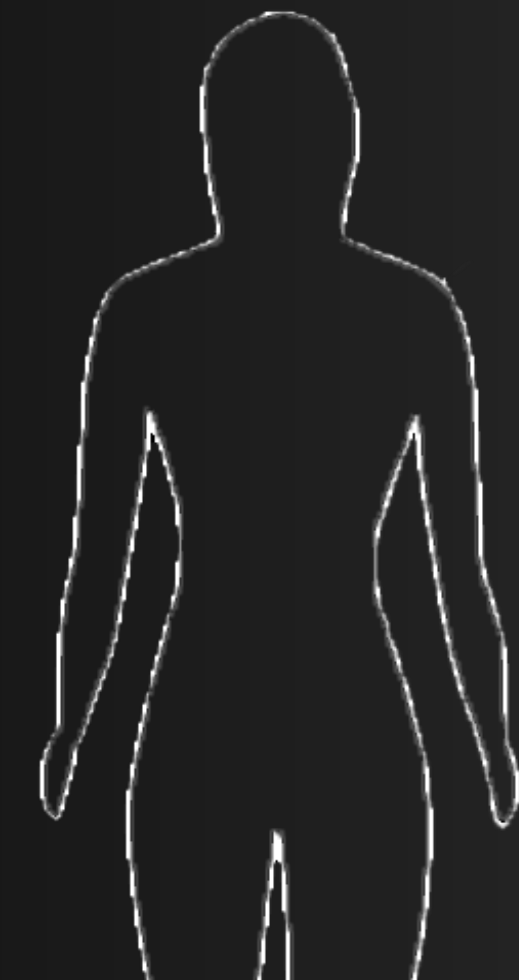
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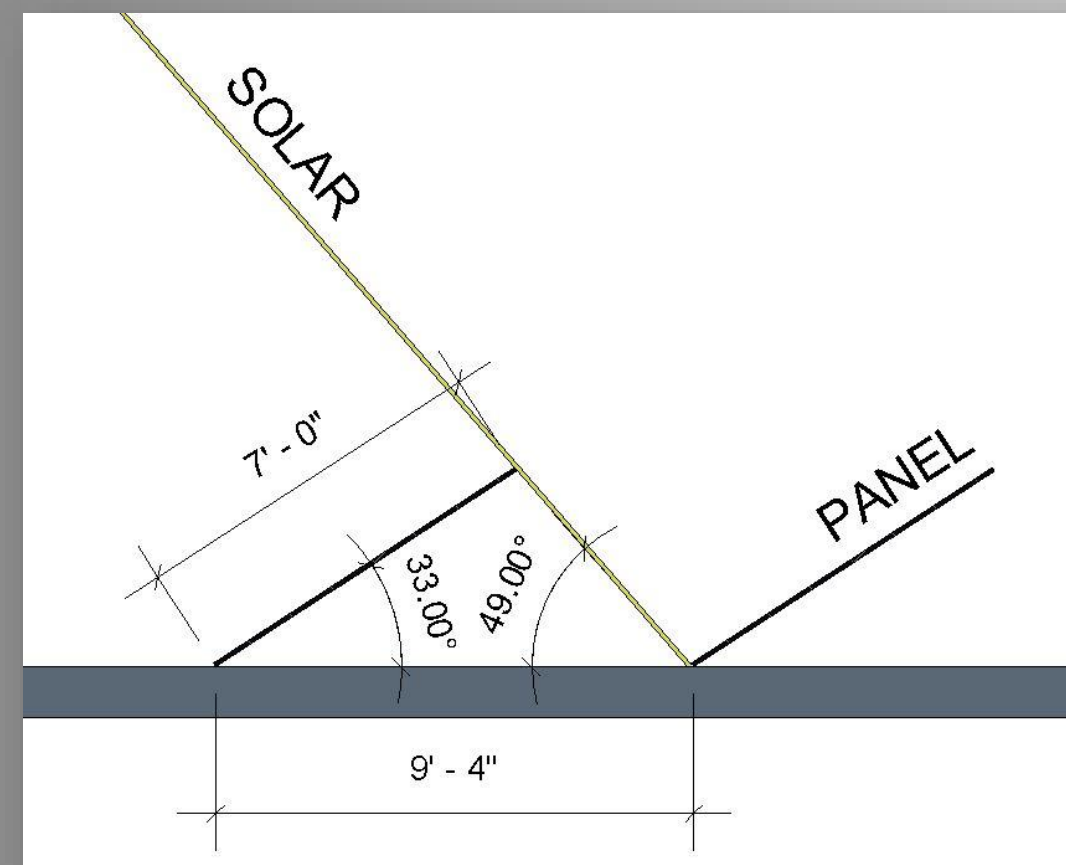


### array layout

Annual Energy Production	160,128 kWh
Performance ratio	0.86
Electricity Cost without system	\$92,605
Electricity Cost with system	\$77,440
Initial Cost	\$646,431
Payback Period	50 + Years
Number of Panels	240

total savings | \$15,165

### solar angles



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# construction breadth



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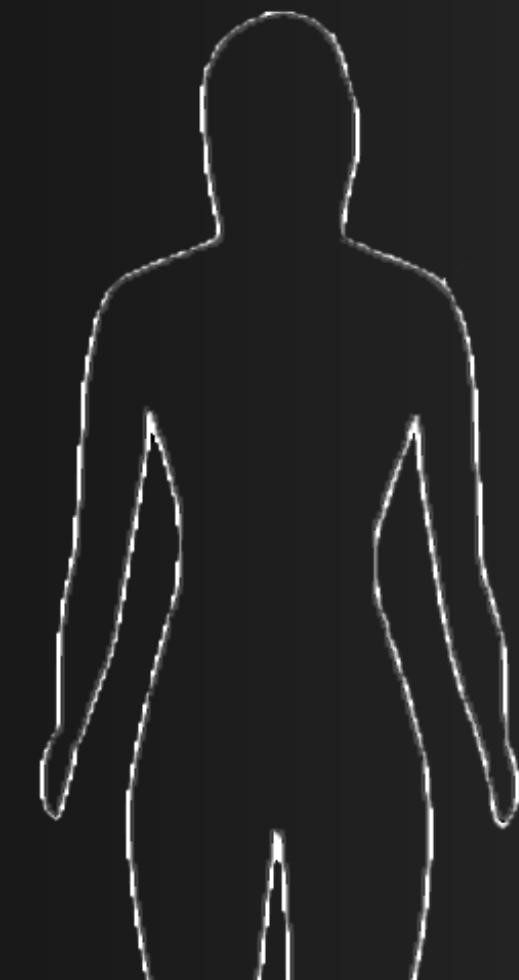
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### cost analysis

RS MEANS 2015 COST DATA						
ITEM	CREW	QUANTITY	2015 BARE COSTS			
			MATERIAL	LABOR	TOTAL	INCLUDING OVERHEAD & PROFIT
ALT. ENERGY SOURCE, SUNPOWER PHOTOVOLTAIC MODULE, 415 WATT, 73 VOLTS	2	240	1,785.00	109.00	454,560.00	522,744.00
SATCON CORP. DC TO AC INVERTER, 480 V, 100 KW	1	1	41,688.00	219.00	41,907.00	48,193.05
PV COMPONENTS, COMBINER BOX, NEMA 3R ENCLOSURE	1	1	191.00	109.00	300.00	345.00
FUSE, 15 A FOR COMBINER BOX	1	40	18.75	10.95	1,188.00	1,366.20
PV RACK SYSTEM, ROOF, NON-PENETRATING BALLAST, 1 PANEL	1	240	895.00	23.50	220,440.00	253,506.00

total cost | \$826,154.25

### schedule

ITEM	CREW	DAILY OUTPUT	LABOR HOURS	QTY.	HOURS	DAYS
ALT. ENERGY SOURCE, SUNPOWER PHOTOVOLTAIC MODULE, 415 WATT, 73 VOLTS	2	8	1	240	120	15.00
SATCON CORP. DC TO AC INVERTER, 480 V, 100 KW	1	2	4	1	4	0.50
PV COMPONENTS, COMBINER BOX, NEMA 3R ENCLOSURE	1	4	2	1	2	0.25
FUSE, 15 A FOR COMBINER BOX	1	40	0.2	40	8	1.00
PV RACK SYSTEM, ROOF, NON-PENETRATING BALLAST, 1 PANEL	1	30.5	0.525	240	126	15.75

schedule duration | 1 month



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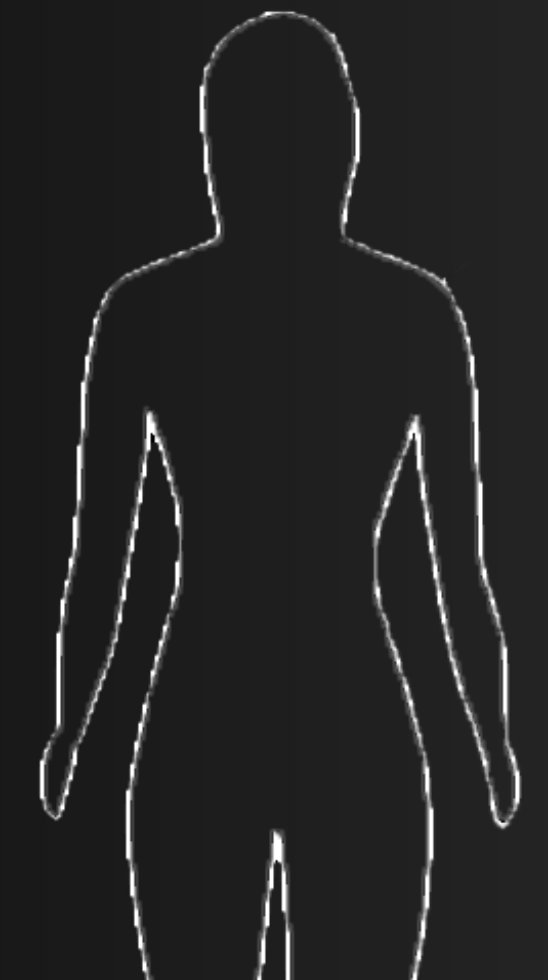
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cost analysis

schedule



total cost | \$826,154.25

schedule duration | 1 month



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# structural breadth



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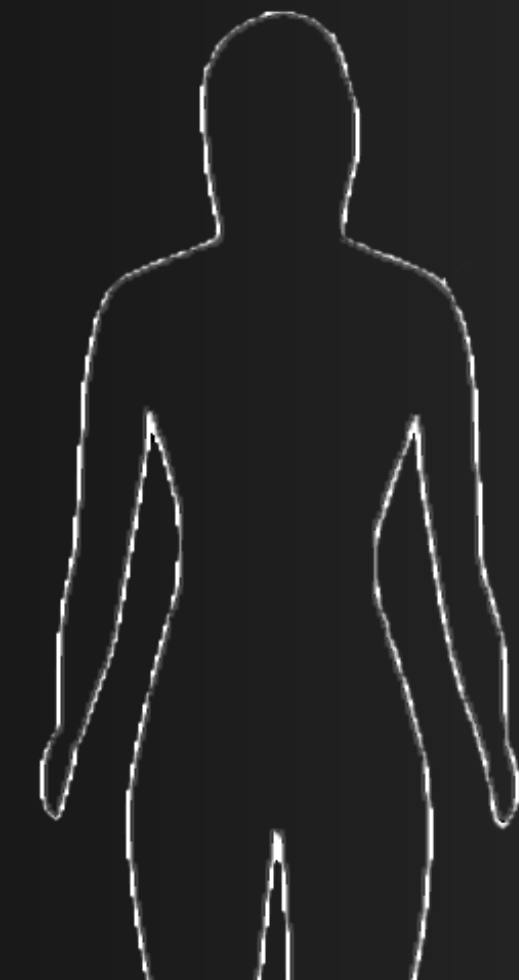
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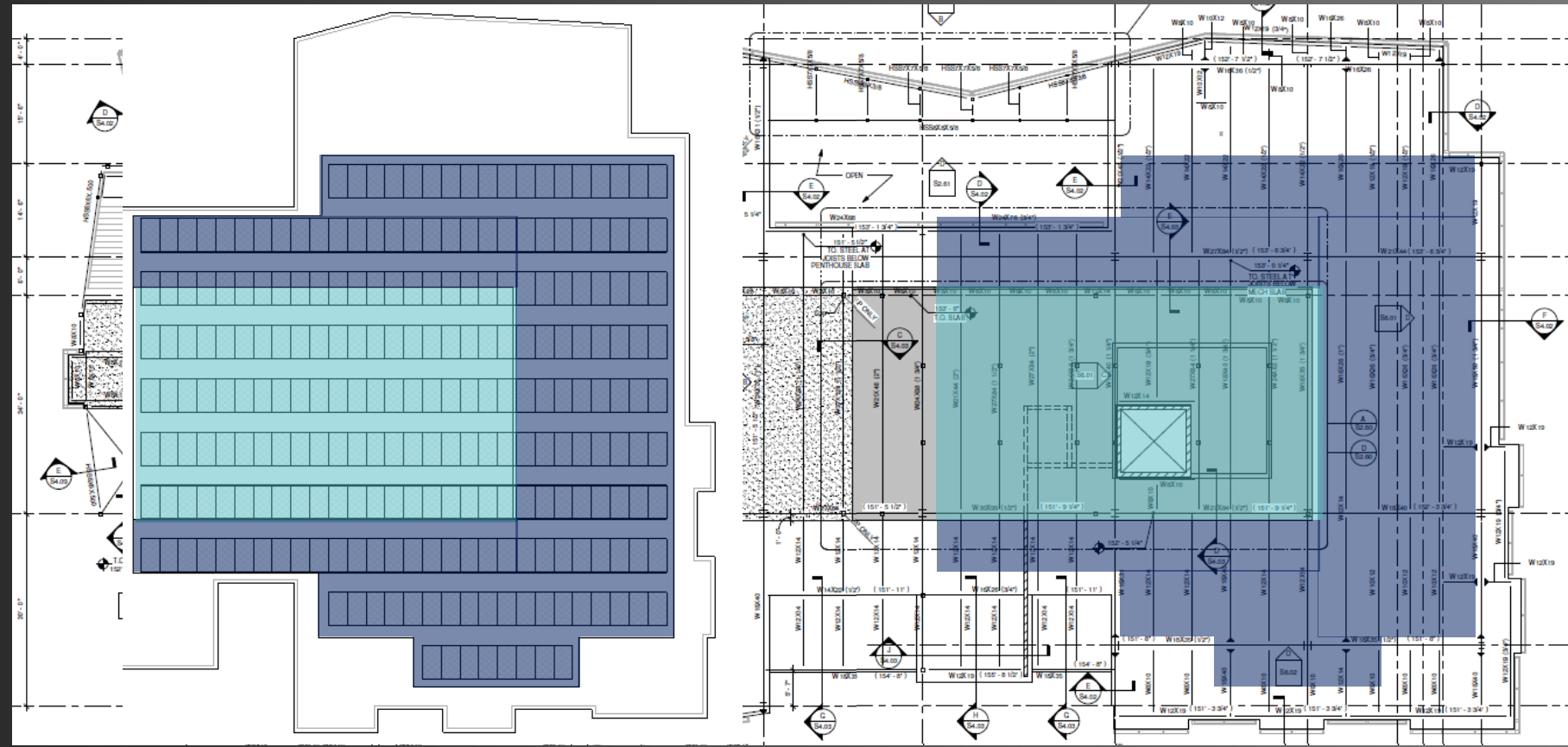
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# roof analysis



module layout

# deck type

composite | 2VLI20

roof | 1.5B20



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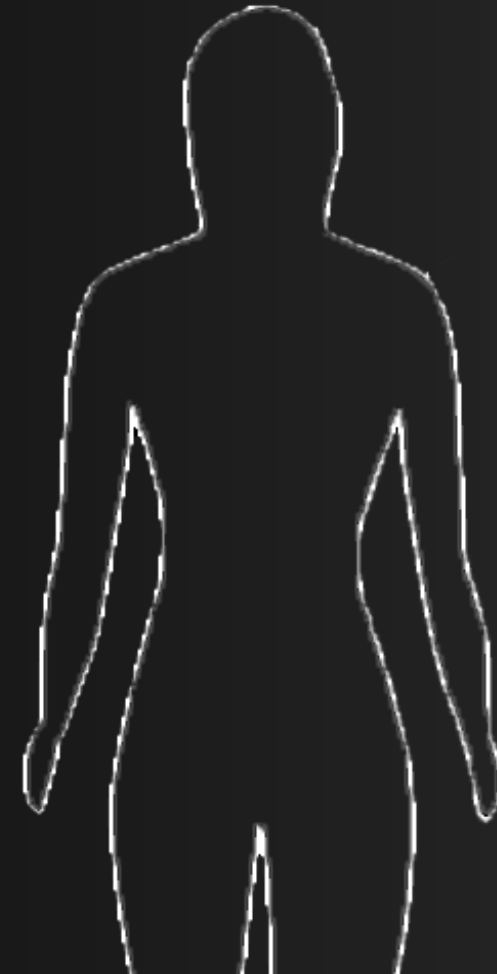
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## calculations

composite deck

$$W_{TL} = 30 \text{ psf} + 2 \text{ psf} + 10 \text{ psf} + 1.97 \text{ psf} + \frac{56 \text{ lbs.} \times 100 \text{ panels}}{2693 \text{ SF}}$$

snow load | 20 psf

$$W_{TL} = 46 \text{ psf} < 400 \text{ psf} \checkmark$$

roof deck

$$W_{TL} = 30 \text{ psf} + 2 \text{ psf} + 10 \text{ psf} + 2.14 \text{ psf} + \frac{56 \text{ lbs.} \times 140 \text{ panels}}{4600 \text{ SF}}$$

$$W_{TL} = 45 \text{ psf} < 111 \text{ psf} \checkmark$$

live

minimum live load | 30 psf

dead

rigid insulation | 2 psf

superimposed dead load | 10 psf

composite deck self-weight | 1.97 psf

roof deck self-weight | 2.14 psf

module weight | 56 lbs





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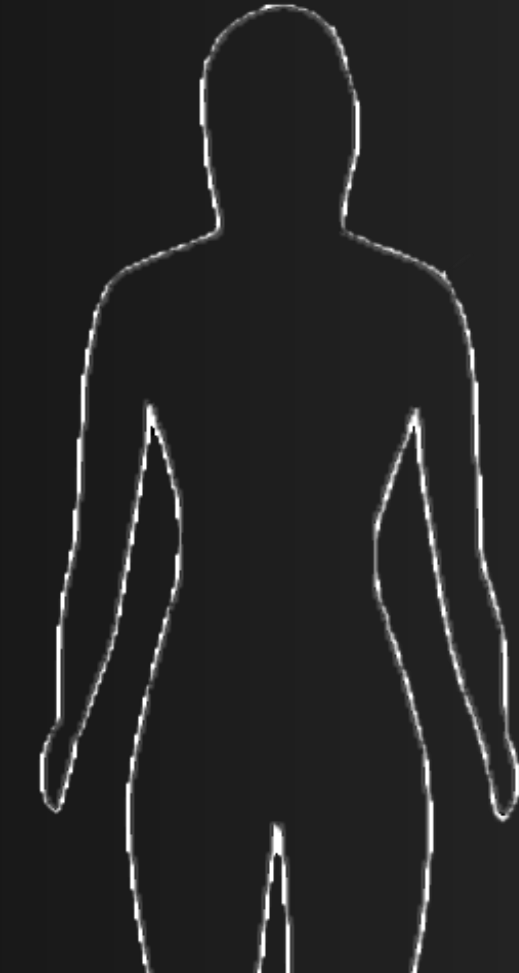
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thank you

a special thanks:

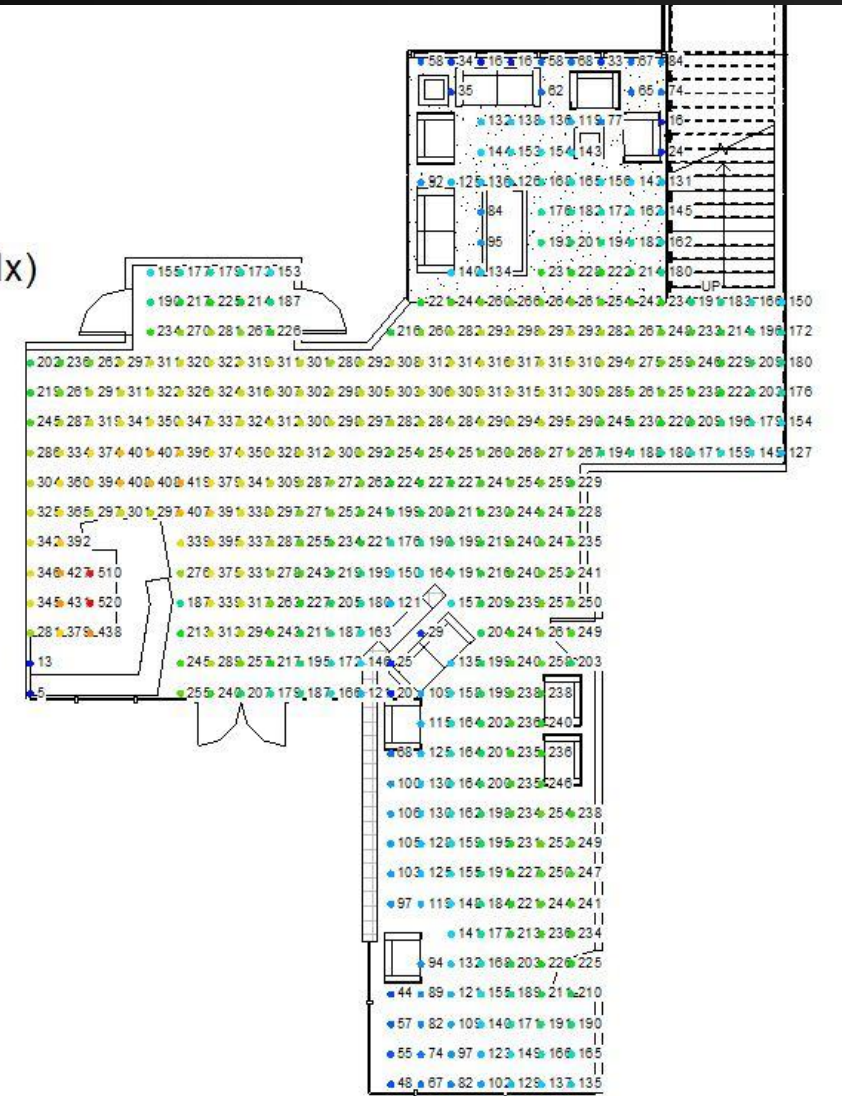
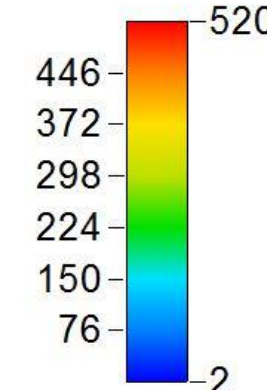
Mom & Dad  
SmithgroupJJR  
Denver Police Department  
Shawn Good  
AE Faculty & Staff  
Friends and Colleagues  
Nicolas Cage



denver crime lab

# support | lobby

## ElumTools Analysis (lx)



Space	Panel	Fixture Type	Input Watts	Number of Fixtures	Total Watts
Lobby	H1A	RL2A	2	79	158
	H1A	RL2B	2	48	96
	H1A	RL2C	3	33	99
	H1A	RL2D	20	1	756
	H1A	RL5	200	2	206.4
	H3A	PF1	63	12	400
	H3A	PL1	206.4	1	20
	H3A	DL1	44.8	4	179.2
<b>Total kVA</b>					<b>1.9</b>

Table 2.5 | Light Loss Factors

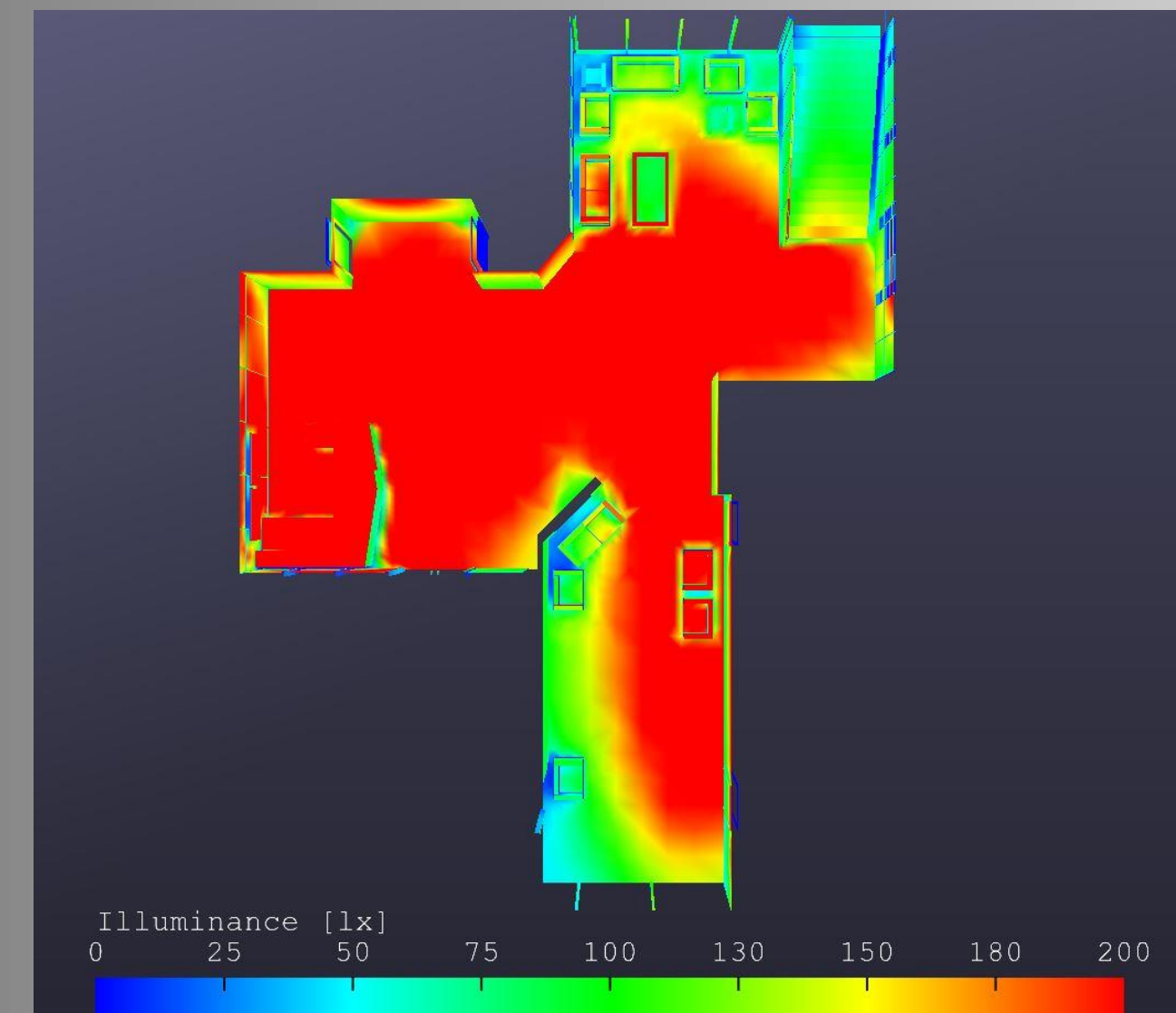
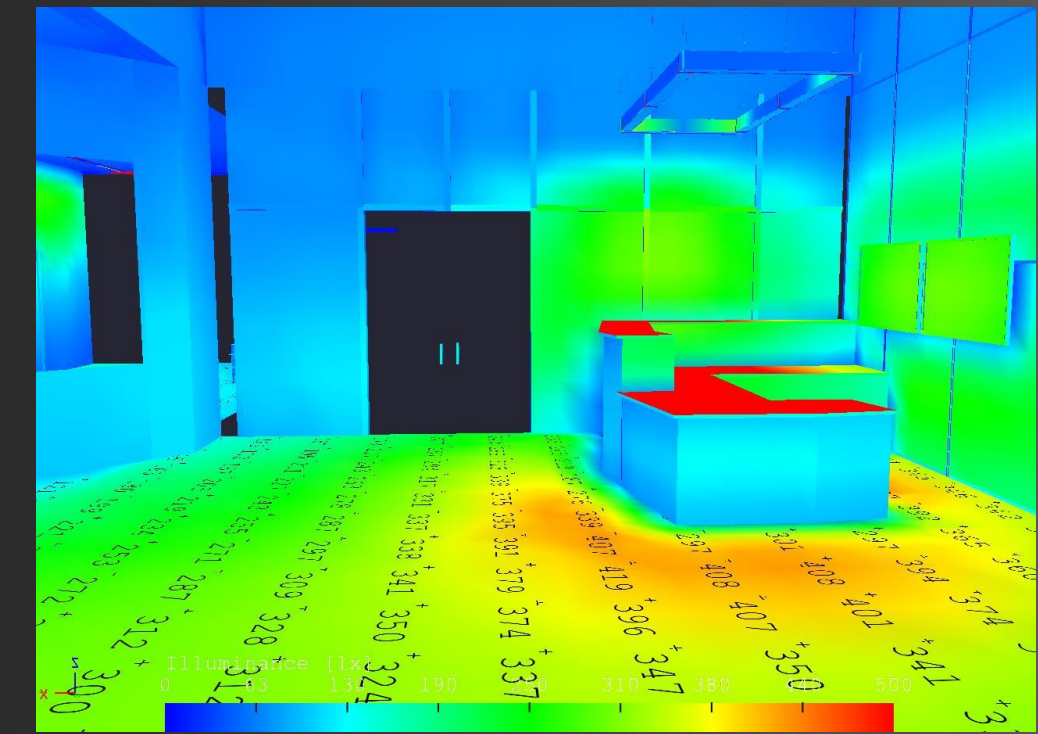
Luminaires	LLD*	LDD	BF**	LLF
DL1	0.7	0.89	-	0.62
PL1	0.7	0.94	-	0.66
RL2A	0.7	0.89	-	0.62
RL2B	0.7	0.89	-	0.62
RL2C	0.7	0.89	-	0.62
RL2A	0.7	0.94	-	0.66
PF1	0.93	0.89	1.0	0.83
RL3A	0.7	0.94	-	0.66

\*LLD for all LED fixtures has been determined as 0.7 per L70.

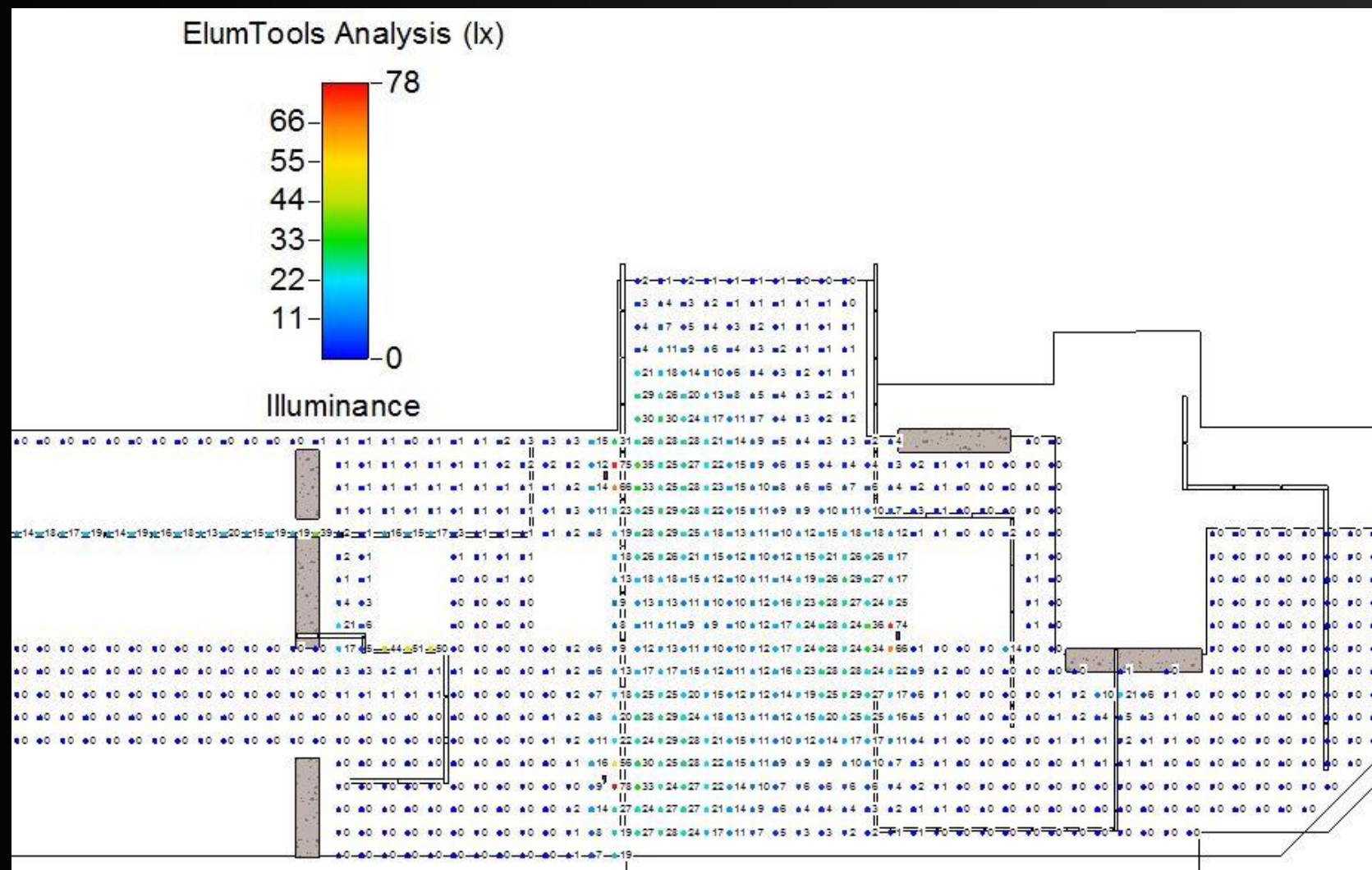
\*\*Ballast Factor information can be found in Appendix C.

Type	Tag	Description	Manufacturer	Model	Lamp	Input Wattage	Input Voltage	Notes
	DL1	LED 6" APERTURE DOWNLIGHT. 3200 LM OUTPUT.	ZUMTOBEL	BR6DLED2-N-46W-835-M5-DH2	LED 3500K, 85CRI	44.8 W	277 V	LUTRON HILUME A SERIES DRIVER.
	PL1	LINEAR LED DIRECT/INDIRECT 4'-0" PENDANTS. ARRANGED IN A 8'-0" BY 4'-0" RECTANGLE ABOVE RECEPTION.	AXIS LIGHTING	BBDILED-B3-640-320-40-SO-4-MR16LED-AP-277-D-1	LED 4000K, >80CRI	34.4 W	277 V	LUTRON HILUME DRIVER. WATTAGE FOR ENTIRE FIXTURE IS 206.4 W. BBPAT-REC-90-24-EX-LED-AP FOR CORNERS.
	RL2A	LUMISHEET LED LIGHT PANEL 12"x3." PART OF DNA WALL.	EVO-LITE	LLP12-12X3-NW-SFI-WL15-L1	LED 4100K, >80CRI	2 W	277 V	79 RL2A PANELS ARE USED WITHIN THE DNA WALL. DIMMABLE MAGNETIC TRANSFORMER.
	RL2B	LUMISHEET LED LIGHT PANEL 12"x5." PART OF DNA WALL.	EVO-LITE	LLP12-12X5-NW-SFI-WL15-L1	LED 4100K, >80CRI	2 W	277 V	48 RL2B PANELS ARE USED WITHIN THE DNA WALL. DIMMABLE MAGNETIC TRANSFORMER.
	RL2C	LUMISHEET LED LIGHT PANEL 12"x8." PART OF DNA WALL.	EVO-LITE	LLP12-12X8-NW-SFI-WL15-L1	LED 4100K, >80CRI	3 W	277 V	33 RL2C PANELS ARE USED WITHIN THE DNA WALL. DIMMABLE MAGNETIC TRANSFORMER.
	RL2D	LUMISHEET LED LIGHT PANEL 12" WIDE. RECESSED INTO METAL PANELS TO CREATE LINE OF LIGHT ALONG CORRIDOR.	EVO-LITE	LLP12-12X600-NW-SFI-WL15-L2	LED 4100K, >80CRI	200 W	277 V	RADIO FREQUENCY REMOTE CONTROLLED DIMMING.
	PF1	STICK T5 8'-0" BARE LAMP	DELRAY LIGHTING INC.	ST48228-2-DPB-SD8	2 (T5) 4100K, 85CRI	63 W	277 V	LUTRON HILUME DIMMING BALLAST
	RL3A	LIGHT FIELD LED RECESSED 1X1 FOOT FIXTURE. 1300 LM OUTPUT.	ZUMTOBEL	LFULED-11-20-K40-MP-DH2-WF	LED 4000K, 85CRI	20 W	277 V	LUTRON HILUME A SERIES DIMMING DRIVER

support | lobby



# support | plaza



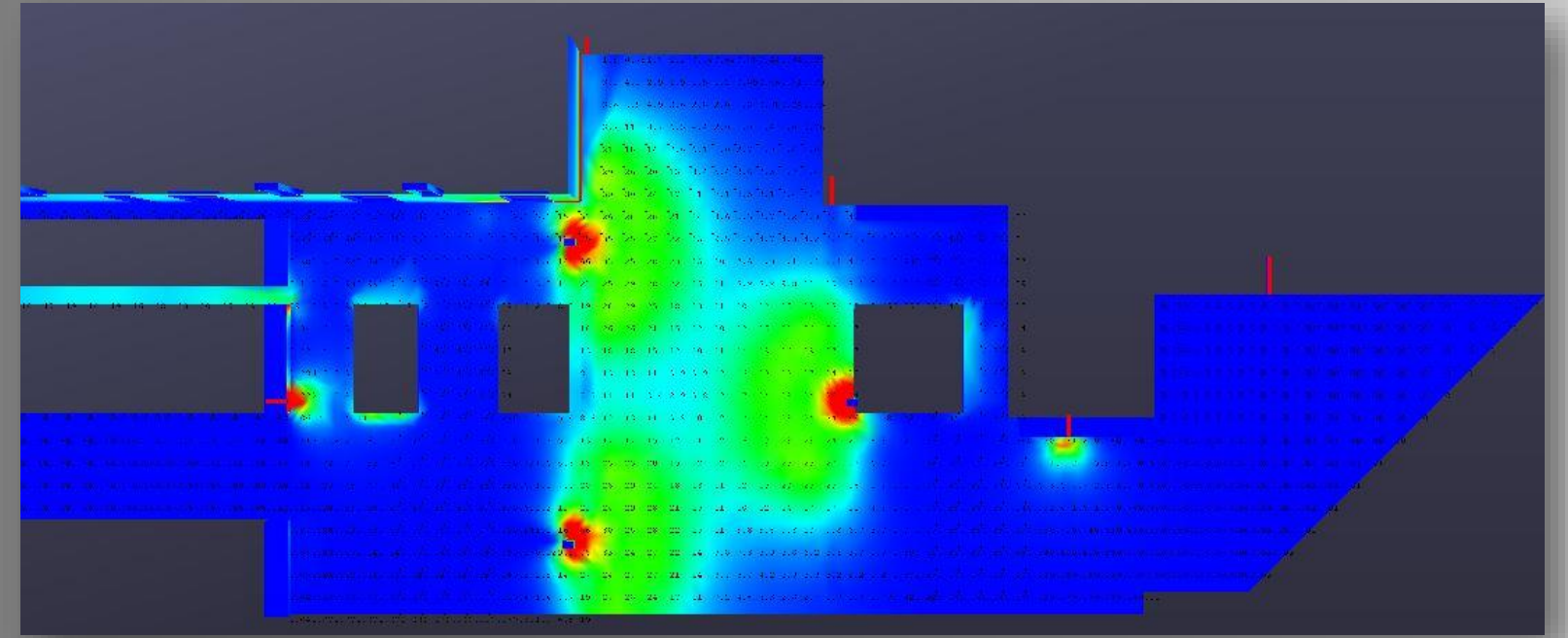
Type	Tag	Description	Manufacturer	Model	Lamp	Input Wattage	Input Voltage	Notes
	RL1	LUMENFACADE LED INGROUND. 55 LM/FT DIRECT VIEW.	LUMENPULSE	LOID-24V-48-40K-NO-ASL	LED 4000K, 80CRI	24 W	24 V	IP68 RATED. 6 W/FT. 0-10V DIMMING DRIVER.
	BL1	LINEA LED BOLLARD. 659 LM OUTPUT.	HESS	LN950-LED-NW-UNV-D-03SRA-SG-DIM	LED 4000K, 80CRI	16 W	277 V	0-10V DIMMING DRIVER.

Space	Panel	Fixture Type	Input Watts	Number of Fixtures	Total Watts
South Plaza	HBA	RL1	24	75	1800
	HBA	BL1	16	3	48
<b>Total kVA</b>					<b>1.8</b>

**Table 5.5 | Light Loss Factors**

Luminaires	LLD*	LDD	BF**	LLF
RL1	0.7	0.72	-	0.50
BL1	0.7	0.72	-	0.50

*\*LLD for all LED fixtures has been determined as 0.7 per L70.  
\*\*Ballast Factor information can be found in Appendix C.*



support | plaza

**Table B - Allowed Total Initial Lumens per Site for Non-residential Outdoor Lighting, Hardscape Area Method**

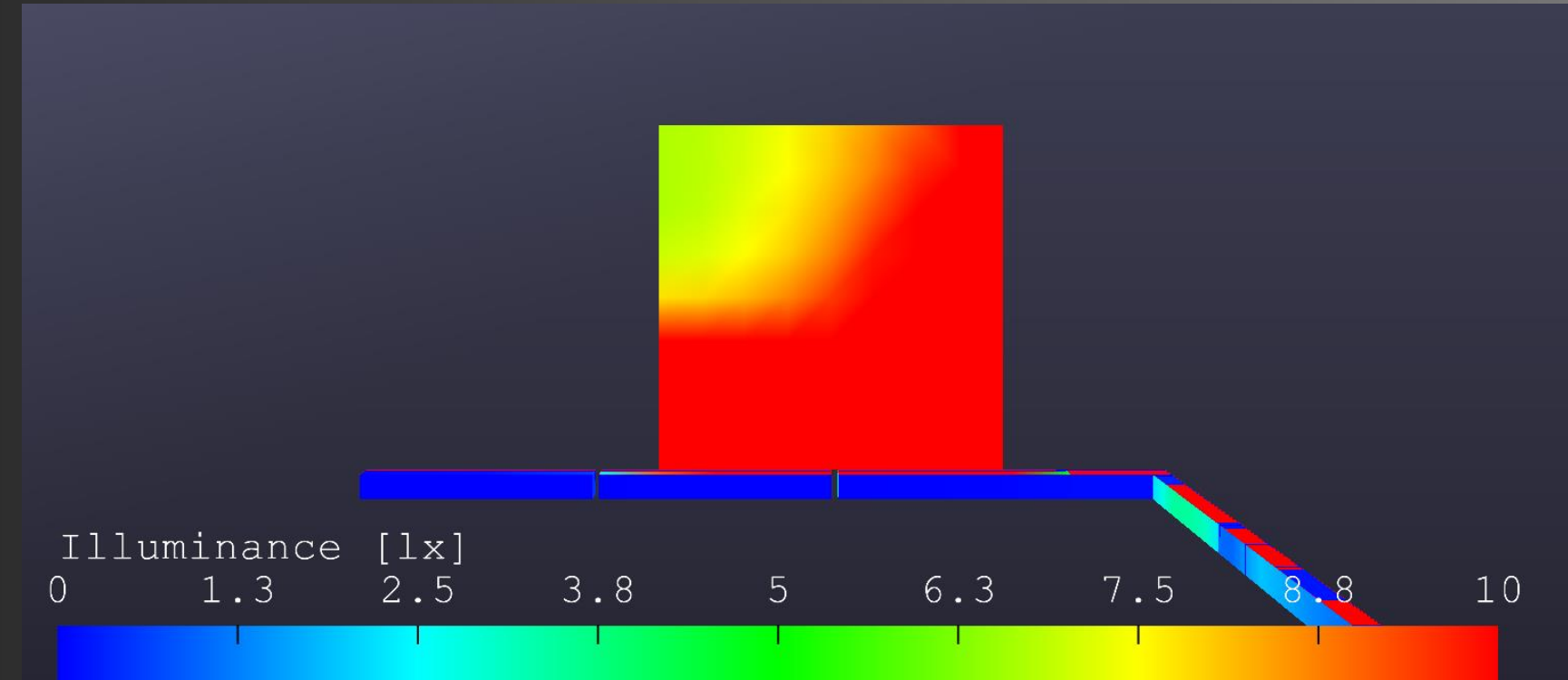
*May be used for any project. When lighting intersections of site drives and public streets or road, a total of 600 square feet for each intersection may be added to the actual site hardscape area to provide for intersection lighting.*

LZ-0	LZ-1	LZ-2	LZ-3	LZ-4
<b>Base Allowance</b>				
0.5 lumens per SF of Hardscape	1.25 lumens per SF of Hardscape	2.5 lumens per SF of Hardscape	5.0 lumens per SF of Hardscape	7.5 lumens per SF of Hardscape

**Table D Performance Method Allowed Total Initial Site Lumens**

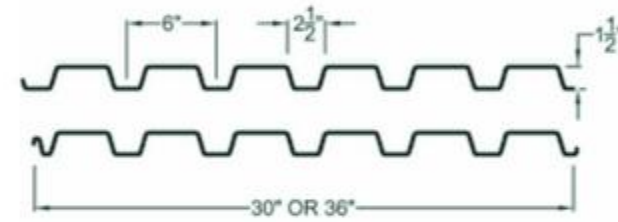
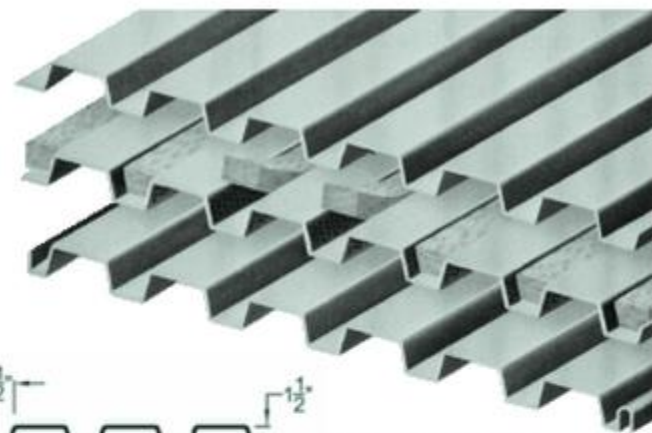
*May be used on any project.*

Lighting Zone	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
Allowed Lumens Per SF	0.5	1.25	2.5	5.0	7.5
Allowed Base Lumens Per Site	0	3,500	7,000	14,000	21,000



## 1.5 B, BI, BA, BIA, BSV

Maximum Sheet Length 42'-0"  
 Extra charge for lengths under 6'-0"  
 ICC ER-3415  
 FM Global Approved<sup>2</sup>



Interlocking side lap is not drawn to show actual detail.

### SECTION PROPERTIES

Deck type	Design thickness in.	W psf	Section Properties				V <sub>a</sub> lbs/ft	F <sub>y</sub> ksi
			I <sub>p</sub> in <sup>4</sup> /ft	S <sub>p</sub> in <sup>3</sup> /ft	I <sub>n</sub> in <sup>4</sup> /ft	S <sub>n</sub> in <sup>3</sup> /ft		
B24	0.0239	1.46	0.107	0.120	0.135	0.131	2634	60
B22	0.0295	1.78	0.155	0.186	0.183	0.192	1818	33
B20	0.0358	2.14	0.201	0.234	0.222	0.247	2193	33
B19	0.0418	2.49	0.246	0.277	0.260	0.289	2546	33
B18	0.0474	2.82	0.289	0.318	0.295	0.327	2870	33
B16	0.0598	3.54	0.373	0.408	0.373	0.411	3578	33

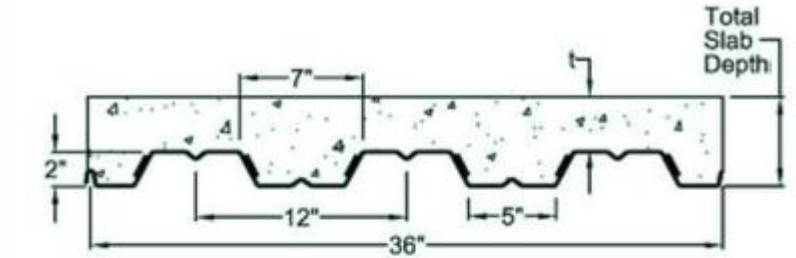
### VERTICAL LOADS FOR TYPE 1.5B

Batts are field installed and may require separation.

No. of Spans	Deck Type	Max. SDI Const. Span	Allowable Total (PSF) / Load Causing Deflection of L/240 or 1 inch (PSF)											
			Span (ft.-in.) ctr to ctr of supports											
			5-0	5-6	6-0	6-6	7-0	7-6	8-0	8-6	9-0	9-6	10-0	
1	B24	4'-8"	115 / 56	95 / 42	80 / 32	68 / 26	59 / 20	51 / 17	45 / 14	40 / 11	35 / 10	32 / 8	29 / 7	
	B22	5'-7"	98 / 81	81 / 61	68 / 47	58 / 37	50 / 30	44 / 24	38 / 20	34 / 17	30 / 14	27 / 12	25 / 10	
	B20	6'-5"	123 / 105	102 / 79	86 / 61	73 / 48	63 / 38	55 / 31	48 / 26	43 / 21	38 / 18	34 / 15	31 / 13	
	B19	7'-1"	146 / 129	121 / 97	101 / 75	86 / 59	74 / 47	65 / 38	57 / 31	51 / 26	45 / 22	40 / 19	36 / 16	
	B18	7'-8"	168 / 152	138 / 114	116 / 88	99 / 69	85 / 55	74 / 45	65 / 37	58 / 31	52 / 26	46 / 22	42 / 19	
	B16	8'-8"	215 / 196	178 / 147	149 / 113	127 / 89	110 / 71	96 / 58	84 / 48	74 / 40	66 / 34	60 / 29	54 / 24	
2	B24	5'-10"	124 / 153	103 / 115	86 / 88	74 / 70	64 / 56	56 / 45	49 / 37	43 / 31	39 / 26	35 / 22	31 / 19	
	B22	6'-11"	100 / 213	83 / 160	70 / 124	59 / 97	51 / 78	45 / 63	39 / 52	35 / 43	31 / 37	28 / 31	25 / 27	
	B20	7'-9"	128 / 267	106 / 201	89 / 155	76 / 122	66 / 97	57 / 79	51 / 65	45 / 54	40 / 46	36 / 39	32 / 33	
	B19	8'-5"	150 / 320	124 / 240	104 / 185	89 / 145	77 / 116	67 / 95	59 / 78	52 / 65	47 / 55	42 / 47	38 / 40	
	B18	9'-1"	169 / 369	140 / 277	118 / 213	101 / 168	87 / 134	76 / 109	67 / 90	59 / 75	53 / 63	48 / 54	43 / 46	
	B16	10'-3"	213 / 471	176 / 354	149 / 273	127 / 214	110 / 172	95 / 140	84 / 115	74 / 96	66 / 81	60 / 69	54 / 59	
3	B24	5'-10"	154 / 120	128 / 90	108 / 69	92 / 55	79 / 44	69 / 35	61 / 29	54 / 24	48 / 21	43 / 17	39 / 15	
	B22	6'-11"	124 / 167	103 / 126	87 / 97	74 / 76	64 / 61	56 / 50	49 / 41	43 / 34	39 / 29	35 / 24	31 / 21	
	B20	7'-9"	159 / 209	132 / 157	111 / 121	95 / 95	82 / 76	72 / 82	63 / 51	56 / 43	50 / 36	45 / 31	40 / 26	
	B19	8'-5"	186 / 250	154 / 188	130 / 145	111 / 114	96 / 91	84 / 74	74 / 61	65 / 51	58 / 43	52 / 37	47 / 31	
	B18	9'-1"	210 / 289	174 / 217	147 / 167	126 / 132	108 / 105	95 / 86	83 / 71	74 / 59	66 / 50	59 / 42	54 / 36	
	B16	10'-3"	264 / 369	219 / 277	185 / 214	158 / 168	136 / 135	119 / 109	105 / 90	93 / 75	83 / 63	74 / 54	67 / 46	

## 2 VLI

Maximum Sheet Length 42'-0"  
 Extra Charge for Lengths Under 6'-0"  
 ICBO Approved (No. 3415)



Interlocking side lap is not drawn to show actual detail.

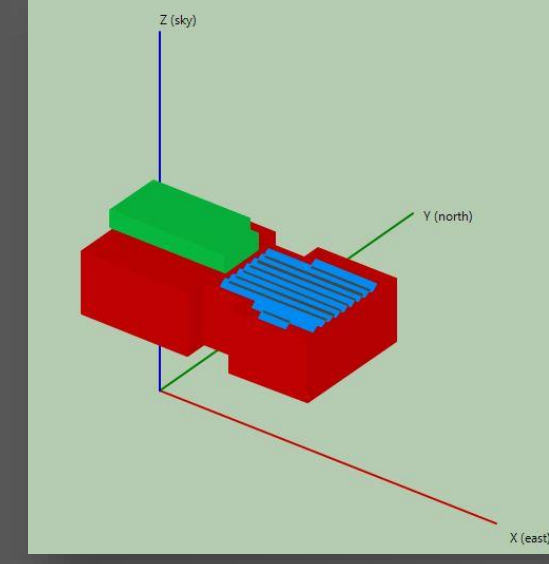
### STEEL SECTION PROPERTIES

Deck Type	Design Thickness in.	Deck Weight psf	Section Properties				V <sub>a</sub> lbs/ft	F <sub>y</sub> ksi
			I <sub>p</sub> in <sup>4</sup> /ft	S <sub>p</sub> in <sup>3</sup> /ft	I <sub>n</sub> in <sup>4</sup> /ft	S <sub>n</sub> in <sup>3</sup> /ft		
2VLI22	0.0295	1.62	0.324	0.263	0.321	0.266	1832	50
2VLI20	0.0358	1.97	0.409	0.341	0.406	0.346	2698	50
2VLI19	0.0418	2.30	0.492	0.420	0.489	0.426	3190	50
2VLI18	0.0474	2.61	0.559	0.495	0.558	0.504	3608	50
2VLI16	0.0598	3.29	0.704	0.653	0.704	0.653	3618	40

6.50 (t=4.50)	2VLI22	5'-11"	6'-11"	7'-11"	400	390	339	297	263	234	210	189	171	155	141	129	118	108	99
	2VLI20	6'-11"	8'-9"	9'-0"	400	400	400	337	297	264	237	213	193	175	159	145	133	122	112
69 PSF	2VLI19	7'-10"	9'-8"	10'-0"	400	400	400	400	374	293	262	236	213	193	176	161	147	135	124
	2VLI18	8'-7"	10'-5"	10'-11"	400	400	400	400	400	373	340	268	243	222	203	187	172	159	147
	2VLI16	8'-10"	10'-8"	11'-0"	400	400	400	400	400	400	387	309	280	256	234	215	198	183	169

support | electrical

shading loss



	5am	6am	7am	8am	9am	10am	11am	12pm	1pm	2pm	3pm	4pm	5pm	6pm
Jan	100	100	66.6262	41.4284	30.9819	26.1548	24.3441	24.0069	25.4262	31.477	43.3256	66.0323	100	100
Feb	100	100	38.6662	23.2976	17.1339	14.3545	13.1805	12.6909	13.6214	17.108	25.4686	43.101	73.5851	100
Mar	100	9.15711	4.28353	2.24689	1.49688	1.17057	0.832361	0.978999	0.923388	2.54405	7.19344	17.0431	57.1892	100
Apr	100	0	0	0	0	0	0	0	0	0.597934	4.19657	11.1939	29.4424	100
May	100	0	0	0	0	0	0	0	0	0.195979	3.21961	8.33564	21.2989	100
Jun	100	0	0	0	0	0	0	0	0	0.018403	2.41565	6.35199	15.5866	100
Jul	100	0	0	0	0	0	0	0	0	0.007914	2.28821	6.54035	15.3936	100
Aug	100	0	0	0	0	0	0	0	0	0.216182	3.30129	9.24263	21.5792	100
Sept	100	0	0	0	0	0	0	0	0	1.48456	5.83348	15.1104	60.0621	100
Oct	100	36.4335	18.6618	12.2612	9.63929	8.423	7.85318	8.19911	9.06049	14.0736	23.5467	47.9667	100	100
Nov	100	100	45.3173	30.6975	24.2614	21.5754	20.669	20.7049	23.4766	30.9598	45.2631	73.2618	100	100
Dec	100	100	65.4185	43.0801	33.367	29.0345	27.2614	27.3223	29.9461	37.6982	52.2935	79.0083	100	100





	EXISTING VERSUS NEW FIXTURES								
	Scheduled Hours (Weekly)	Existing Fixture	Number of Fixtures	LOAD (VA)	Existing Consumption (kWh)	Design Fixture	Number of Fixtures	LOAD (VA)	Design Consumption (kWh)
Lobby	168	SURFACE MOUNTED LED	14	50	118	6" LED DOWNLIGHT (DL1)	4	44.8	30
	168	LINEAR LED LIGHT STRIP	8	4	5	LINEAR LED PENDANT (PL1)	1	206.4	35
	168	RECESSED LINEAR FLUORESCENT	2	20	7	LED LIGHT PANEL (RL2A, RL2B)	127	2	43
	168	WALL MOUNTED FLUORESCENT	6	20	20	LED LIGHT PANEL (RL2C)	33	3	17
	168	RECESSED LINEAR FLUORESCENT	11	62	115	LED LIGHT PANEL (RL2D)	2	200	67
	168	COMPACT FLUORESCENT DOWNLIGHT	18	30	91	T5 BARE LAMP (PF1)	12	63	127
	168	WIDE APERTURE CFL DOWNLIGHT	8	187	251	RECESSED LED 1X1 (RL3A)	1	20	3
Main DNA Lab	100	FLUORESCENT PENDANT	15	124	186	RECESSED FLUORESCENT (RF1)	32	2	6
	100	FLUORESCENT PENDANT	3	62	19	RECESSED SYMMETRIC (RF2)	32	19	61
	100	-	0	0	0	FLUORESCENT PENDANT (PF2)	117	12	140
Multipurpose Room	55	RECESSED LINEAR FLUORESCENT	12	124	82	RECESSED LED 1X1 (RL3B)	7	24	9
	55	FLUORESCENT WALLWASHER	2	124	14	RECESSED LINEAR LED (RL4)	10	78	43
	55	CFL DOWNLIGHT	20	30	33	FLUORESCENT WALLWASHER (WW1)	20	17	19
	55	CFL DOWNLIGHT WALLWASHER	12	30	20	3.5" LED DOWNLIGHT (DL2)	5	16	4
	55	-	0	0	0	3.5" LED DOWNLIGHT WW (DL3)	1	16	1
South Plaza	91	CFL BOLLARD	9	30	25	LINEAR LED INGROUN (RL1)	75	24	164
	91	-	0	0	0	LED BOLLARD (BL1)	3	16	4
<b>Total Number of Fixtures:</b>			140	<b>Total kWh:</b>	984	<b>Total Number of Fixtures:</b>	482	<b>Total kWh:</b>	774
				<b>Annually:</b>	48213			<b>Annually:</b>	37903
				<b>Cost:</b>	\$ 2,892.75			<b>Cost:</b>	\$ 2,274.21

annual savings | \$600.00

annual kWh reduction | 10,000 kWh



## citations

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Vulcraft Manual

Revit 2015

RS Means Green Building 2015

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