SOUTH SALT LAKE

City of South Salt Lake

Lighting Master Plan

July 2018

Acknowledgements

City of South Salt Lake
Mayor Cherie Wood
Dennis Pay, Public Works Director
Sharen Hauri, Urban Design Director
Mike Florence, Community and
Economic Development Director
Alexandra White, City Planner
BJ Allen, GIS Specialist
Sgt. Bill Hogan, SSLC Police Department
Terry Addison, Deputy Fire Chief
Sharla Beverly, City Council
Ray deWolfe, City Council
Mark Kindred, City Council
Portia Mila, City Council
Ben Pender, City Council
Shane Siwik, City Council
Corey Thomas, City Council

Clanton & Associates
Nancy Clanton, CEO
Dane Sanders, Principal
Riley Rose, Engineer
Annie Kuczkowski, Engineer
Kevin Sisto, Engineer
Jon Ehnert, Production Manager
Travis Babcock, Senior CADD Technician

Table of Contents

List of Figures

List of Tables

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Section 1: Introduction and Executive Summary

Terms and Definitions
Lighting Goals
Lighting Improvements Strategies

1.1 Introduction & Goals

1.1.1 Purpose

The City of South Salt Lake is experiencing change and growth with new development and improvements in public roads, transit, and public spaces. Recent master plans in the Downtown, Streetcar, Creative Industry Zone, Riverfront, and Granite High areas set the framework for urban redevelopment that will attract new business opportunities and establish South Salt Lake as a destination. Street lighting and outdoor public space lighting have a considerable influence on the public perception of the City, both day and night. The street and pedestrian lights daytime appearance reinforce the design aesthetic and character of the neighborhood. At night, light is the essential medium for visual experience of the City. When designed with purpose and clear intent, lighting enhances the aesthetic character of the City as well as improves visibility, visual comfort, wayfinding, public safety, and security. When poorly designed, lighting can create adverse effects, such as glare, light trespass, and light pollution resulting in negative public opinion.

This Lighting Master Plan provides an actionable plan in four sections to improve street and public realm lighting throughout the City of South Salt Lake.

Section 1 Introduction and Executive Summary	**Section 1** • Introduces the reader to the Master Plan and defines lighting terminology used throughout. • Establishes lighting goals the Master Plan strives to accomplish and the strategies in which to do so.
Section 2 Existing Street Lighting Conditions	**Section 2** • Summarizes the existing lighting and equipment conditions in South Salt Lake City. • Provides strategies to improve the lighting throughout the City.
Section 3 Lighting Design Principles & Applications	**Section 3** • Describes lighting design principles and lighting applications applicable to South Salt Lake City. • Develops lighting character districts and their influence on the lighting design.
Section 4 The Lighting Design Process	**Section 4** • Walks the user through the street lighting design process to provide appropriate and efficient lighting in South Salt Lake City.

As one component of the urban design framework for the City of South Salt Lake, this Lighting Master Plan should be implemented along with the other urban design master plans and codes for the City, including:

- Creative Industry Master Plan (2017)
- Downtown South Salt Lake Master Plan (2015)
- Downtown South Salt Lake Zoning Ordinance & Design Standards (2016)
- East Streetcar Neighborhood Form-Based Code (2014)
- South Salt Lake Streetscape Handbook (2017)

This Lighting Master Plan refers to roadway lighting design guidelines issued by the Illuminating Engineering Society of North America (IES). The Illuminating Engineering Society (IES) was founded in 1906 and strives to improve the lighted environment by publishing recommended practices to guide lighting designers, architects, engineers, sales professionals, and researchers. The IES's *The Lighting Handbook* and *Recommended Practices* are the recognized authoritative reference on the science and application of lighting. The City of South Salt Lake is to adopt IES's *American National Standard Practice for Roadway Lighting* (Recommended Practice 8 [RP] Affirmed in 2014) with modifications approved by the City's Lighting Master Plan Criteria in the Standard Engineering Specifications.

Any deviations from this guide require special approval from the City of South Salt Lake.

1.1.2 Light Terms and Definition

The following terms are used throughout this Master Plan and in the lighting industry. Understanding these terms is essential to properly understanding and implementing this Lighting Master Plan.

Table 1.1.1: Lighting Terms and Definitions

Lighting Term	Unit	Definition
Backlight, Uplight, and Glare (BUG) Ratings (See *Chapter 4.4*)	B0 – B5 U0 – U5 G0 – G5	Luminaire Classification System for Outdoor Luminaires per IES TM-15 describing the amount of uplight, backlight and glare. The lower the rating (0) equates to the minimal amount of impact. • **B = backlight**, or the light directed behind the luminaire. • **U = uplight**, or the light directed above the horizontal plane of the luminaire. • **G = glare**, or the amount of light emitted from the luminaire at angles known to cause glare.
Color Rendering Index (CRI)	0 - 100	The color rendering index (CRI) is a developed metric on a scale of 0 to 100, to communicate the ability of the light to render an object's natural color
Continuous Lighting		A street lighting system made up of regularly spaced luminaires along the street. Criteria typically defines minimum and maximum illuminance or luminance values and overall uniformity along the lighted area.
Correlated Color Temperature (CCT)	Kelvin (K)	The color appearance of the light emitted by a lamp. The CCT rating for a lamp is a general "warmth" or "coolness" measure of its appearance. Fire has a CCT of 1850K and daylight is 6000K.
Glare		The visual sensation created by luminance (or brightness) that is significantly higher than the surrounding luminance that the eyes are adapted to, causing annoyance, discomfort, or loss in visual performance and visibility (disability glare).
Illuminance	Footcandle (Fc)	The density of light falling onto a surface. Commonly measured in the horizontal and vertical planes.
Illuminating Engineering Society (IES)		The IES strives to improve the lighted environment by publishing recommended practices to guide lighting designers, architects, engineers, sales professionals, and researchers. The IES's *The Lighting Handbook* and *Recommended Practices* are the recognized authoritative reference on the science and application of lighting.
Legacy Light Source		All non-LED light sources: incandescent, halogen, high pressure sodium, low pressure sodium, induction, and fluorescent.

Life Cycle Cost		An economic analysis of an investment that covers all the costs and benefits over the expected life of the equipment or system. Unlike a simple payback analysis, it accounts for maintenance and energy even after the system is paid for with projected savings.
Lifetime		The life value assigned to a light source. This is commonly a statistically determined estimated average or median operational life. For LED sources, it is the statistical time before the light output has reduced to 70% of its initial light output.
Light Pollution		Light emitted upward, directly from a luminaire or reflected from a surface, increasing skyglow. While the direct light is the largest contributor to light pollution, overlighting, resulting in ground reflected light, also increases this environmental impact.
Light Trespass		Light directed onto adjacent properties.
Lumen		The measure of visible light (luminous flux) emitted from a light source.
Luminaire		A complete electric light unit including light source, housing, optics, and driver.
Luminance	Candela per meter squared (cd/m^2)	The light source or surface brightness that people perceive.
Luminous Efficacy	Lumens per Watt (lm/W)	A measure of luminaire energy efficiency or the ratio of luminous flux to power.
Non-Continuous Lighting		A non-continuous street lighting system, lighting only conflict areas such as intersections, crosswalks, and other hazards.
Watt	(W)	A unit of power.

1.1.3 Lighting Goals to Creating a Quality Nighttime Visual Environment

Lighting plays a key role in how people view the exterior spaces in which they live, work, and play. Lighting helps residents understand the space they are in through visual cues and heightened awareness of their surrounding environment. Providing residents with spatial understanding increases comfort levels and encourages use of public spaces. The goal of this document is to aid the City of South Salt Lake in developing a quality nighttime visual experience through street, pedestrian, path, parking lot, park, and plaza lighting. While this Master Plan does not specifically address lighting of private property, it is important to recognize the impact that lighting from private properties has on the overall visual environment at night. Lighting of building facades, building entries, private plazas, and private parking lots can contribute significantly to creating a visually dynamic, attractive, and safe urban nighttime experience.

1.1.3.1 Lighting Design and Sustainability Goals

Visibility

Creating good visibility with street and public lighting depends on two metrics: illuminance (measured in footcandles – fc) is the amount of light falling on a surface, and luminance (measured in candela per square meter – cd/m^2) is the amount of light reflecting off a surface toward an observer. Most street lighting criteria is based on luminance, while pedestrian areas, such as crosswalks and sidewalks are based on illuminance. Sufficient visibility in the streetscape environment relies on sufficient luminance on pavement and vertical illuminance on pedestrians or any other objects on the road. The human eye identifies objects at night by the contrast between the object and its background. The street lighting criteria and strategies described in this Master Plan aim to improve the contrast on the roadway to provide the best possible visibility for drivers and pedestrians.

Design Aesthetics

Lighting enhances streetscapes and public spaces by rendering the form, texture, and color of surfaces and materials. Accent lighting for building facades, public art, landscape, and hardscape features establishes a depth of composition with multiple layers of light, encouraging people to relax and enjoy the space. The style of the luminaires reinforces the character of the neighborhood in creating a unique sense of place.

Light Pollution

Light pollution and sky glow are caused by light aimed directly up into the sky and by light reflected from the ground or objects. Any addition of light will add to light pollution. However, it is the direct component (rather than reflected) that is the most significant cause of light pollution. Unshielded luminaires are major contributors to sky glow. Overlighting, even with fully shielded or U0 luminaires, reflects unnecessary light into the atmosphere and adds to sky glow.

To minimize light pollution, first minimize the overall amount of light. Exterior lighting should be used only where and when it is needed. Define the lighting requirements of each street or public area and provide only the necessary lighting. Street and pedestrian lighting in residential areas should be dimmable and have house side shielding options to allow the City to proactively address specific complaints about light pollution or light trespass.

Light Trespass

Light trespass is defined as stray light that crosses a property boundary. The most obtrusive form of light trespass that may result in complaint calls from citizens is often caused by an excessively bright luminaire that is unshielded and distributes light into a bedroom window. Uncontrolled, non-shielded light sources are usually the cause of light trespass. However, even a controlled, fully shielded luminaire may cause light trespass if not properly located or oriented. In cases where the location of a light standard cannot be changed, additional shielding may be necessary to prevent light trespass.

Light Trespass Example at
133E Truman Ave, South Salt Lake

Light Only Where Needed

Lighting pathways, gathering areas, facades, structures, or landscape is necessary for safety and security. In some cases, large open areas may be left without light, minimizing energy use, maintenance costs, and impact on surrounding neighbors.

Light Only When Needed

Some accent and feature lighting perform an aesthetic function that does not need to be operating late at night. Lighting controls should turn off non-essential lighting after a curfew, while pathway lighting, entry lighting, plaza, and parking lot lighting remains on or is dimmed all night.

Roadway Safety

Street lighting should ensure the safety of both the drivers and pedestrians on the City right of way. Designers must consider the road type and pedestrian activity to ensure sufficient and appropriate roadway illumination. Not providing enough light on roadways reduces the driver's awareness and ability to identify objects in the road. However, too much light or too uniform light can also compromise visibility and safety. Direct glare can decrease drivers' visibility and too uniform of light diminishes the contrast between objects on the street and the street pavement, reducing visibility. Therefore, it is critical to follow lighting guidelines to provide the best visibility for improved safety.

Security

While there are studies that suggest that lighting may not directly reduce crime, it improves peoples sense of safety and security[1,2]. The resident's perception of an area is relevant and important to the success of that area. Quality lighting design will create more comfortable and appealing locations that attract people and improve perceived safety. Crime Prevention Through Environmental Design (CPTED)[3] is a commonly used approach to deterring criminal behavior by influencing a possible offender's choices before crimes are committed through natural surveillance, access control, and territorial reinforcement. Recommendations related to outdoor lighting are referred to in *Chapter 4: The Lighting Design Process*.

Modern video surveillance cameras are capable of capturing color video with as little as 0.2 Fc (or 2 lux) and can capture black and white video with virtually no light. Surveillance cameras located in any lighted area of the City should be capable of providing quality video recordings. When evaluating which surveillance camera is appropriate for a certain location in city, consider the lighting criteria for the space as well as the minimum lux capabilities of the camera. Darker areas in need of higher surveillance will require a camera with a lower minimum lux level.

Health and Wellbeing

The natural daily cycle of light and dark is directly linked to the healthy sleep/wake cycles, also known as circadian rhythm. Light is the primary stimulus that triggers the suppression of melatonin in humans. Darkness at night is needed to allow the production of melatonin for healthy and complete sleep. Exposure to blue spectrum light after sunset can delay the nighttime production of melatonin. Controlling light trespass and using light sources with warmer color (3000K or less) reduces the exposure to blue spectrum content of LED for street, pedestrian, and area lighting, improving the health and wellbeing of residents.

[1]Lighting, Crime and Safety. International Dark Sky Association
http://www.darksky.org/light-pollution/lighting-crime-and-safety/
[2]"Preventing Crime: What Works, What Doesn't, What's Promising." National Criminal Justice Reference Service, 1997, www.ncjrs.gov/works/.
[3]International CPTED Association

1.1.3.2 Operations and Maintenance Goals

Initial Costs

The initial cost will vary based on the amount of improvements being made and the strategy chosen in which to improve the lighting. Comprehensive improvements, such as lighting redesign, will have the highest initial costs, whereas 1-for-1 replacements of existing luminaires will have lower initial costs. In many areas throughout the City, major enhancements can be made with 1-for-1 replacements, but some areas do require more comprehensive improvements.

Long Term Life Cycle Costs

Changing to LED lighting will drastically reduce the life cycle and operating costs of the street lighting. LED lighting requires significantly less power than legacy sources, such as high-pressure sodium, greatly reducing the life cycle energy costs of the system. With a lifespan of up to 100,000 hours, LEDs need to be replaced significantly less often than legacy luminaires, reducing maintenance costs.

Maintenance

Proper maintenance is critical for the effectiveness of the lighting design. LEDs are known for their durability, longevity, and consistency in lighting, but quality components are essential to ensure this. The LED electronic driver will fail first if a low-quality luminaire is purchased. Planning and budgeting for high-quality luminaires ensures a longer lifespan with much less required maintenance. It is important to trim trees and bushes around luminaires to prevent the blocking of light and maintain the original design intent.

Another aspect of maintenance involves the dirt and dust that can accumulate inside or on the outside lenses of luminaires. Because street lighting will rarely, if ever, be cleaned, luminaires must have adequate ingress protection (IP) against dust and water. This IP rating shall be at least 65 for all street lighting luminaires. This rating means that the luminaire is dust-tight and water-tight.

Energy

Reducing energy use in South Salt Lake can be achieved by using energy efficient LED light sources, providing appropriate light levels without over-lighting, and reducing light levels after a curfew by dimming or turning off non-essential lighting.

1.1.4 Lighting Improvement Strategies

Throughout the City of South Salt Lake, there are various existing lighting conditions, which allows for various lighting improvement strategies. Improvement strategies range from minimal improvements, such as 1-for-1 replacements, to comprehensive improvements, such as complete lighting redesign. The strategy chosen to improve the lighting in certain areas will depend on the existing conditions as well as the need for improved lighting. Lighting improvements may also be prioritized by South Salt Lake's scheduled City improvements and goal to create multiple character districts throughout the City.

Minimal Improvements - 1-for-1 Luminaire Replacement

The most cost effective and quickest way to improve the lighting is 1-for-1 replacements. This should be implemented in areas that already have acceptable existing lighting. 1-for-1 replacements will lead to lower life cycle costs through reduced energy and maintenance. Updating High Pressure Sodium luminaires to LED will also improve color rendering and visibility on the streets while reducing glare and light pollution.

Supplemental Improvements – Adding New Light Locations

Supplemental improvements require adding light locations on streets with moderately acceptable or poor existing conditions. There are many areas throughout the City of South Salt Lake where street lights are spaced too far apart, resulting in less than acceptable lighting conditions. Adding poles between existing locations or adding lights to streets where there is minimal lighting can improve moderately acceptable and poor existing lighting conditions into acceptable lighting conditions.

Comprehensive Improvements - Lighting Redesign

Comprehensive improvements to the current conditions call for complete lighting redesign. This should be considered in areas of the City where the current lighting does not fit the character of the area or where streets do not have any lighting. Lighting plays a significant role in distinguishing the character of an area and should be considered in locations that are trying to make a distinct impression. Also, lighting design and effectiveness should be considered on streets with no current lighting or poor infrastructure where new lighting is being considered.

SECTION 2 EXISTING LIGHTING CONDITIONS

Existing Street Lighting Conditions
Existing Conditions Map

2.1 Existing Street Lighting Conditions

2.1.1 Purpose

To gain an understanding of the existing street lighting equipment and conditions in South Salt Lake, Clanton and Associates conducted surveys with city officials to evaluate the street lighting at various locations throughout the city, and Aptim Environmental and Infrastructure, Inc. surveyed the lighting equipment. The information and knowledge gained through these surveys will influence the improvement strategies used in the city.

2.1.2 Existing Street Lighting Equipment

The existing street lighting equipment was surveyed by Aptim Environmental and Infrastructure, Inc. in October of 2017. In their survey, they found the City of South Salt Lake currently has 1,364 light poles and 1,480 luminaires. Of the 1,480 luminaires, 95% of the luminaires were found to be in working condition, while only 1.9% were broken. This survey was conducted during the day and does not consider the number of lights burned out or failing due to wiring issues. Throughout the City, there are 10 different types of luminaires, shown in Table 2.1.1. The cobrahead luminaire type makes up approximately 71% of all luminaires.

There are currently six light sources being used in South Salt Lake fixtures:

- LED
- High Pressure Sodium
- Compact Fluorescent
- Linear Fluorescent
- Metal Halide
- Induction

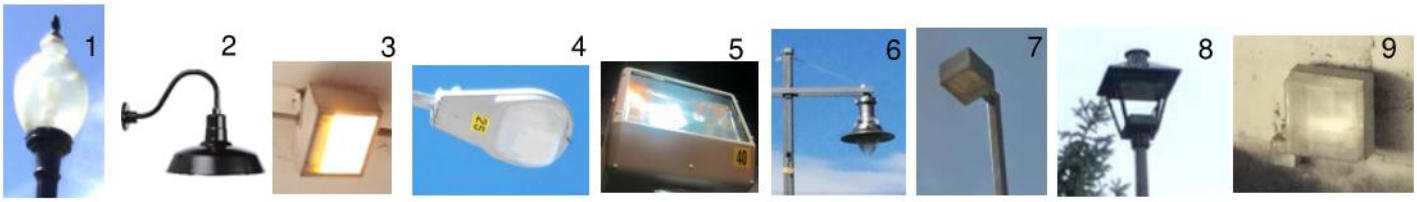
The wattage for the metal halide, compact fluorescent, and linear fluorescent lights is unknown, but estimated using the luminaire type, source type, and location.

In addition to luminaires, the City has a total of:

- 388 Pole Mounted Transformers
- 23 PAD Mounted Transformers
- 411 Total Transformers
- 25 Electric Meters
- Zero Lighting Control Centers

Table 2.1.1: Number of Fixtures by Luminaire and Pole Type

Luminaire	Area Light	Athletic Field Light	Parking Lot Light	Pedestrian Light-Plaza	Pedestrian Light-Sidewalk	Pedestrian Light-Trail	Streetlight	Underpass Light	Total
[1]Acorn					4		31		35
[2]Barn Light	4		1						5
[3]Ceiling Mount								29	29
[4]Cobra	17		5				1030		1052
[5]Flood Light	23	52	2				5		82
Other						8			8
[6]Pendant					24		143		167
[7]Rectilinear	6		25	9			3		43
[8]Traditional							29		29
[9]Wall Mount								30	30
Total	50	52	33	9	28	8	1241	59	1480



2.1.2.1 Lighting Power Consumption

It currently takes 257,682 watts to power the 1,480 luminaires in South Salt Lake. The lights are on an average of 12 hours a day, 365 days a year, consuming a total of 1,128,648 kilowatt-hours per year. The average American household uses approximately 10,766 kilowatt-hours in a given year, meaning that the street lights in South Salt Lake could power nearly 105 houses for a year. The number of luminaires by wattage used is displayed in Table 2.1.3.

Table 2.1.2: Wattage Summary

Wattage	Fixture Count	Total Wattage
50	16	800
70	1	70
92	2	184
100	715	71,500
137	2	274
150	82	12,300
200	1	200
250	130	32,500
400	144	57,600
1000	52	52,000
Undeterminded	332	30,254
No Pole / Fixture	3	-
Total	**1480**	**257,682**

Table 2.1.3: Wattage by Lamp Type

Lamp Type	Wattage	Luminaire Count	Total Wattage
LED	92	2	184
	137	2	274
	Undetermined	10	920
High Pressure Sodium	70	1	70
	100	715	71,500
	150	82	12,300
	250	130	32,500
	400	144	57,600
	1000	52	52,000
	Undetermined	2	200
Induction	50	16	800
	200	1	200
Other	Undetermined	323	29,134
Total		**1,480**	**257,682**

LED Light Source

High Pressure Sodium Light Source

Induction Light Source

Compact Fluorescent Source

Linear Fluorescent Source

Metal Halide Source

2.1.3 Existing Conditions Analysis

In September 2017, Clanton & Associates evaluated the current lighting conditions at eleven sites around the City to provide an understanding of the diversity of lighting conditions. The selected sites include industrial, commercial, residential, and primary pathways. Both horizontal and vertical illuminance (the amount of light reaching a surface, expressed in units of footcandles [fc]) measurements were taken along the pathways at each site. Luminance (the amount of light reflected from a surface that the eye perceives, expressed in units of candela per square meter [cd/m^2]) measurements were also taken to provide an understanding of surrounding surface brightness. These measured light levels are used to compare the existing light levels to the light level recommendations by the Illuminating Engineering Society (IES). Clanton & Associates also took high-dynamic-range (HDR) images as a visual representation of the perceived nighttime experience. Along with the lighting measurements taken, City officials completed a subjective survey assessing the lighted environment at each site. The whole existing conditions report along with all survey results and lighting measurements can be found in Appendix B.

Site #	Location	Lighting Quality
1	3300S 1000W	Poor
2	3300S State St.	Good
3	3335S State St.	Poor
3a	3745S 610E	Moderate
4	300E Welby Ave.	Moderate
5	Southgate Ave 300E	Moderate
6	Claybourne Ave. State St.	Moderate
7	2950S West Temple	Poor
8	2700S 300W	Poor
9	2100S 300W	Excellent
10	Bowers Way & Main St.	Poor

South Salt Lake City Survey Locations

2.1.3.1 Site Surveys

To obtain a better understanding of the perceived lighting at the eleven different sites throughout the City, four city officials took a nighttime tour of each site and completed a survey assessing the lighted environment. The survey is comprised of several subjective questions regarding the safety and aesthetics of each site. The survey includes, but was not limited to, the following questions:

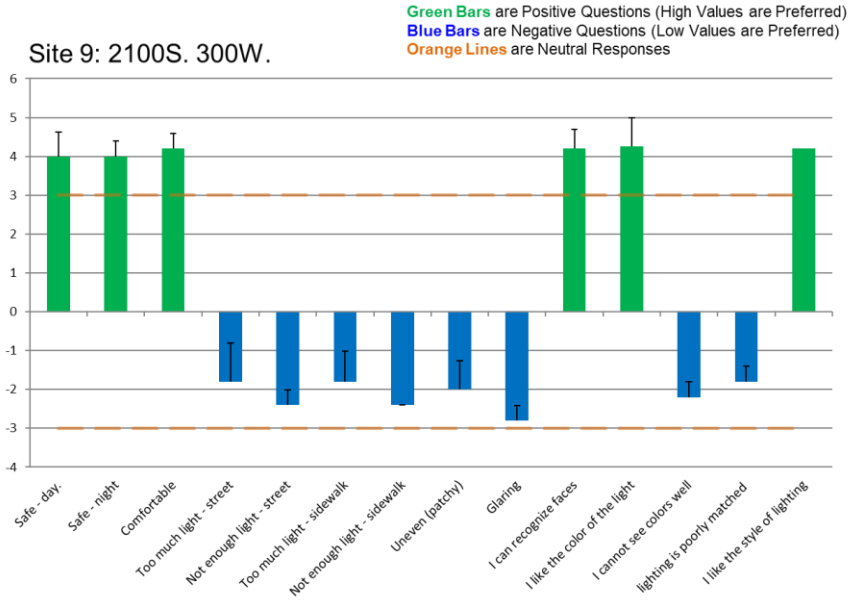
- It would be safe to walk here, alone, during daylight hours.
- It would be safe to walk here, alone, during darkness hours.
- The light is uneven (patchy).
- The light sources are glaring.

Participants answered each question with a ranking between Strongly Agree and Strongly Disagree. The answers to each question are combined to provide an understanding of each site. Participants surveyed eleven different sites featuring arterial, collector, and residential streets in industrial, commercial, and residential areas to gain the best understanding of the perception of lighting conditions throughout the City.

Example Site and HDR Photos

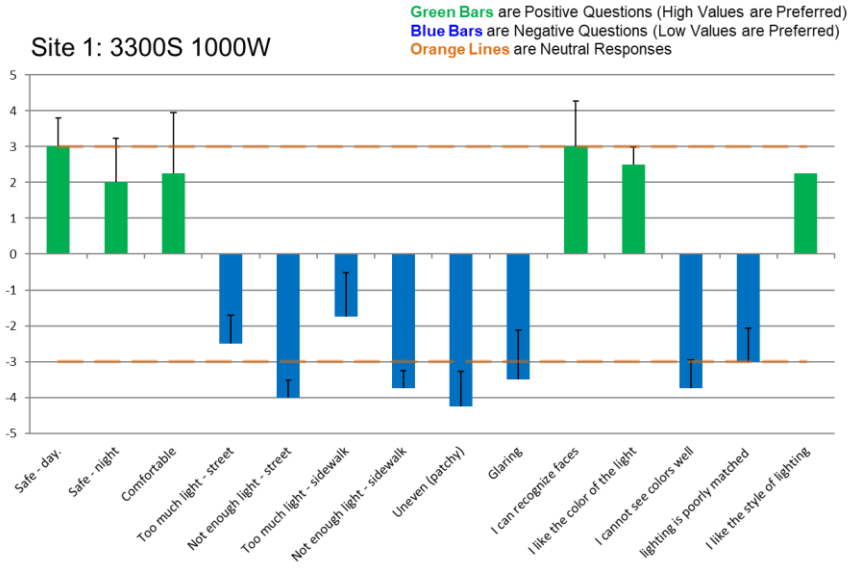
2.1.3.2 Survey Results

The survey results for each site is recorded and graphed to show the average subjection evaluation of the lighting environment. Of the eleven sites surveyed it is observed that five (5) sites have poor lighting, four (4) have moderate lighting, one (1) has good lighting and one (1) has excellent lighting. The poor lighting results are found mostly on arterial and collector streets in industrial and commercial areas. The moderate lighting conditions are found mostly in residential areas on local roads. Good lighting is found on 3300S where the street and sidewalk are sufficiently lighted by streets lights and private lighting from buildings and signs. The excellent lighting condition is found on 2100S where new LED lights are installed and there is pedestrian specific lighting.

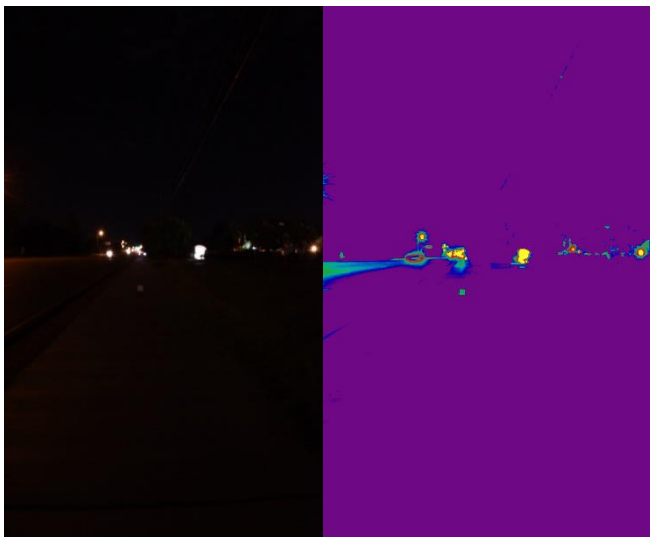


Survey Results for Excellent Conditions

Site Photo and HDR Image for Excellent Conditions



Survey Results for Poor Conditions



Site Photo and HDR Image for Poor Conditions

2.1.4 Development of Existing Conditions Map

To develop the existing lighting conditions map, data containing every street light in the City is analyzed based on luminaire spacing, wattage and street classification. By comparing existing data with calculated values at similar spacing and wattage, streets are determined to have acceptable, moderately acceptable, or poor lighting in accordance with the classification of the street. Using GIS software, a radius is drawn around each existing light to gauge appropriate spacing. Each block is then classified based on the spacing criteria in Table 2.1.4. The existing conditions map assumes all existing street lights are fully operational and only includes public streets.

Table 2.1.4 Luminaire Spacing Criteria

Street Classification	Luminaire Wattage (W)	Acceptable Spacing (ft)	Moderarely Acceptable Spacing (ft)	Poor Spacing (ft)
Major Arterial	400	200-300	300-350	350+
Minor Arterial	250	150-250	250-300	300+
Collector	200	150-250	250-300	300+
Local	100	Mid Block and Intersections	Intersections Only	No Lighting

Figure 2.1.1: Existing Conditions Development Example

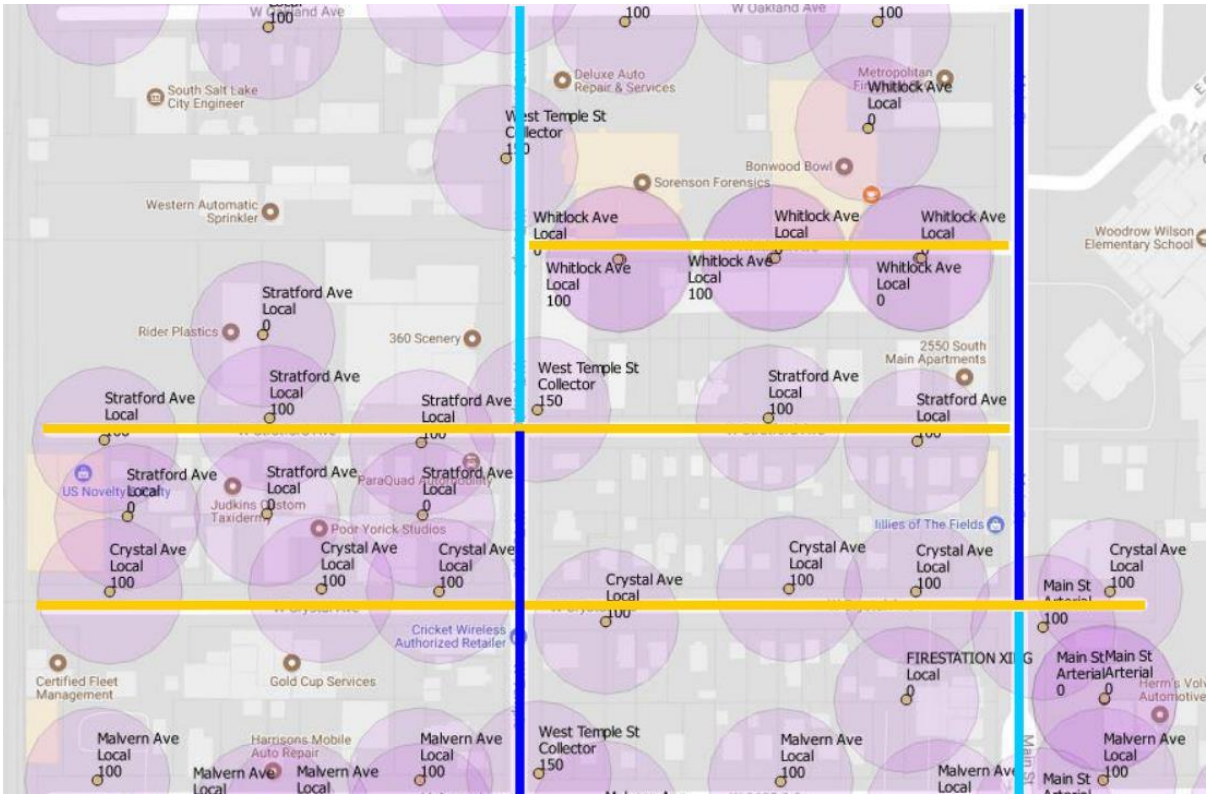
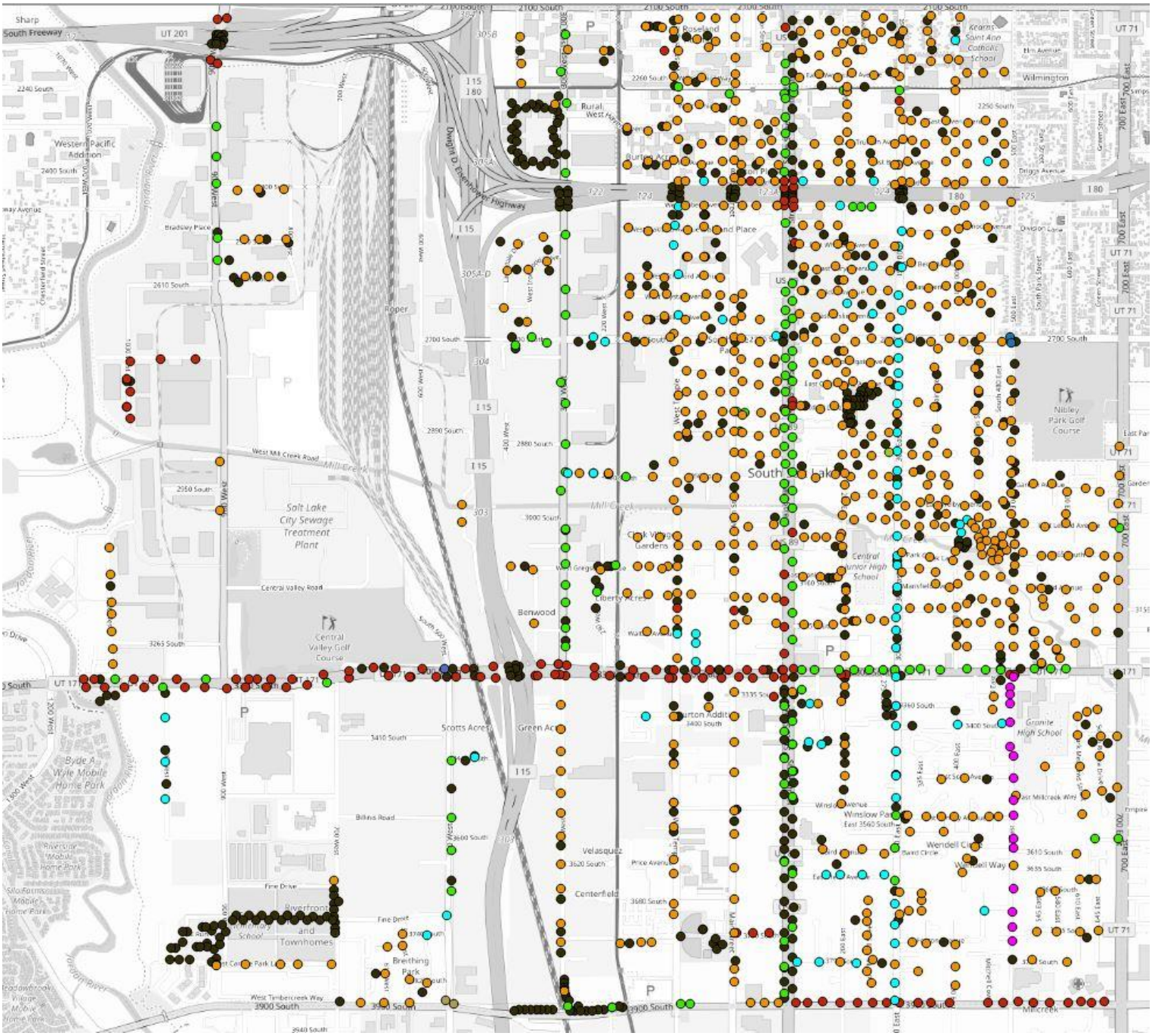


Figure 2.1.2: Existing Lights in the City of South Salt Lake



Existing Conditions Map

ACCEPTABLE CONDITIONS

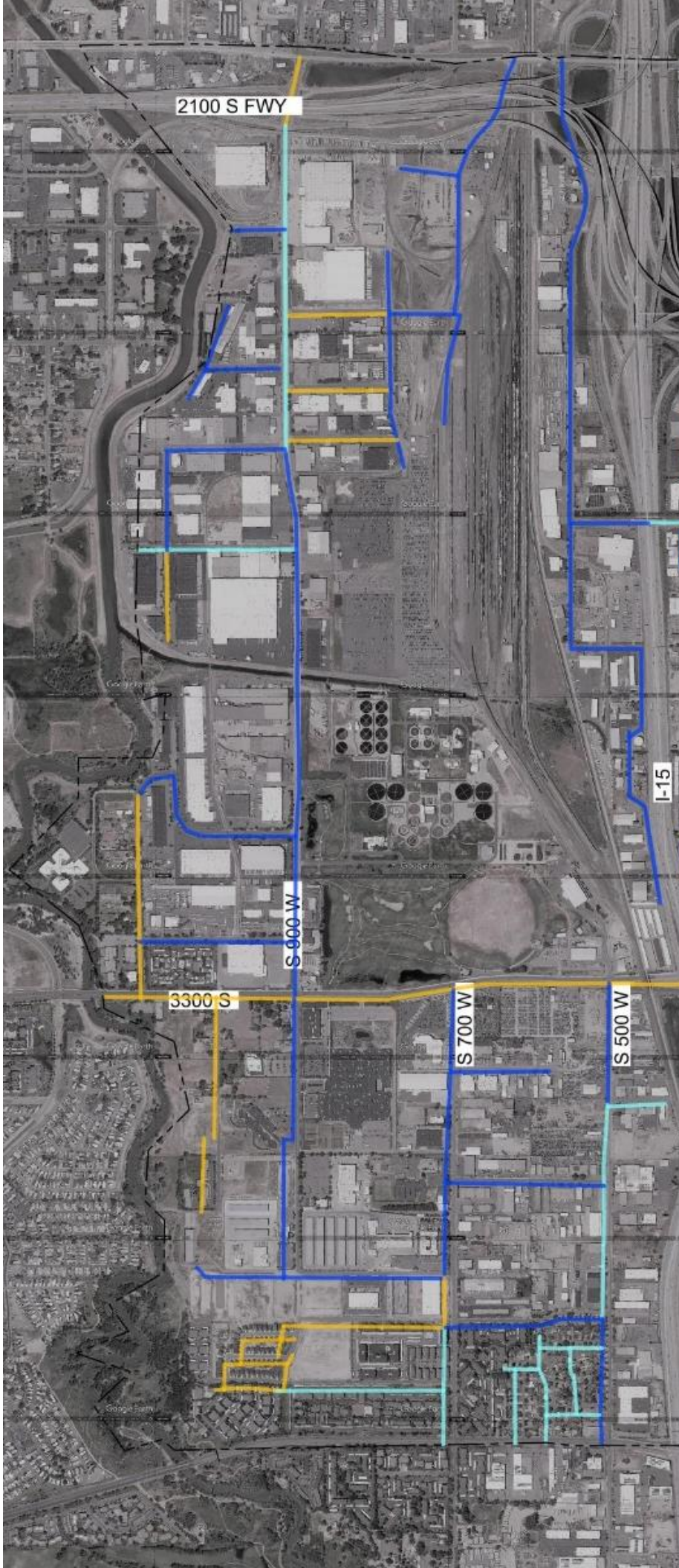
Improvement Strategy: 1-for-1 luminaire replacement on existing poles.

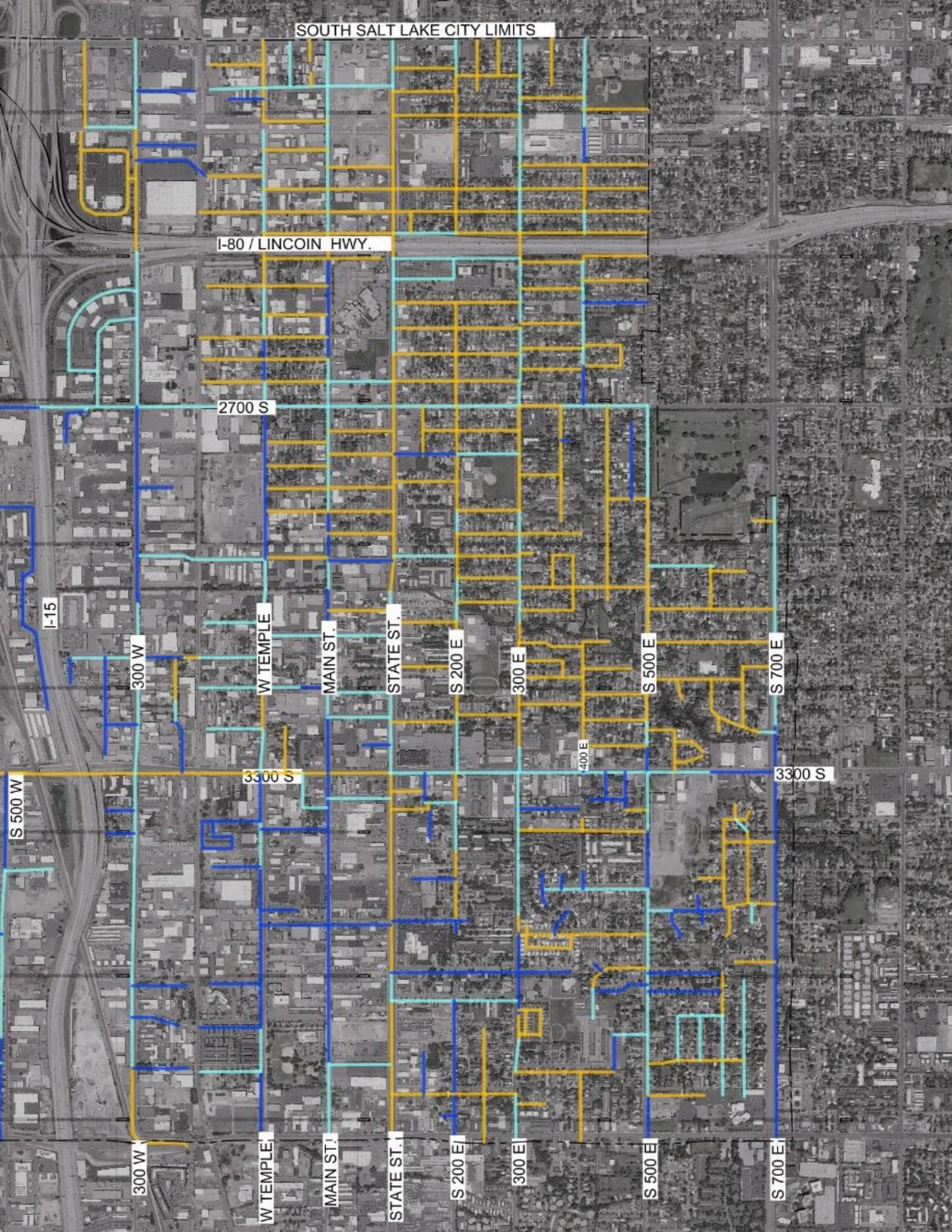
MODERATELY ACCEPTABLE CONDITIONS

Improvement Strategy: 1-for-1 replacement on existing poles and supplement with additional light poles.

POOR CONDITIONS

Improvement Strategy: Extensive additional lighting and electrical required.




SOUTH SALT LAKE CITY LIMITS
I-80 / LINCOIN HWY.
2700 S
I-15
300 W
W TEMPLE
MAIN ST.
STATE ST.
S 200 E
300 E
400 E
S 500 E
S 700 E
3300 S
S 500 W

2.1.5 Crime and Accident Data vs. Existing Conditions

The following maps show crime and accident data from the South Salt Lake police department overlaid onto the existing lighting conditions in South Salt Lake. The majority of incidents occur on arterial streets such as 3300S, 3900S, and State Street. The crime data shown on the map was reported between the hours of 9:00PM and 3:00AM between September 1st, 2017 and November 31st, 2017. The accident data was recorded between the hours of 8:00PM and 6:00AM between November 1st, 2016 and October 31st, 2017. Crime and accident data shown was recorded during nighttime hours to show the effects of existing street lighting conditions.

Figure 2.1.3: Accident Data Overlaid Existing Conditions Map

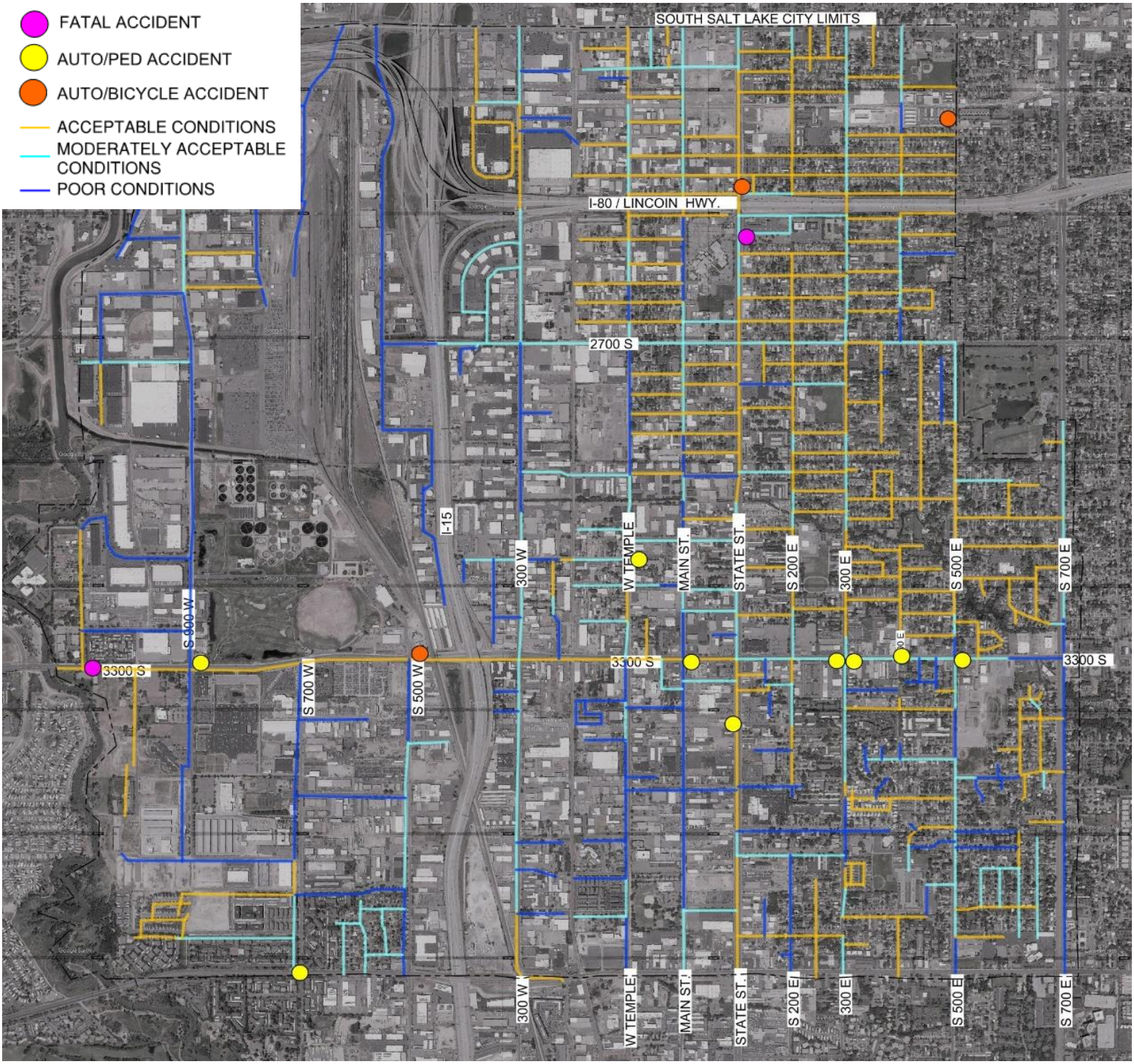
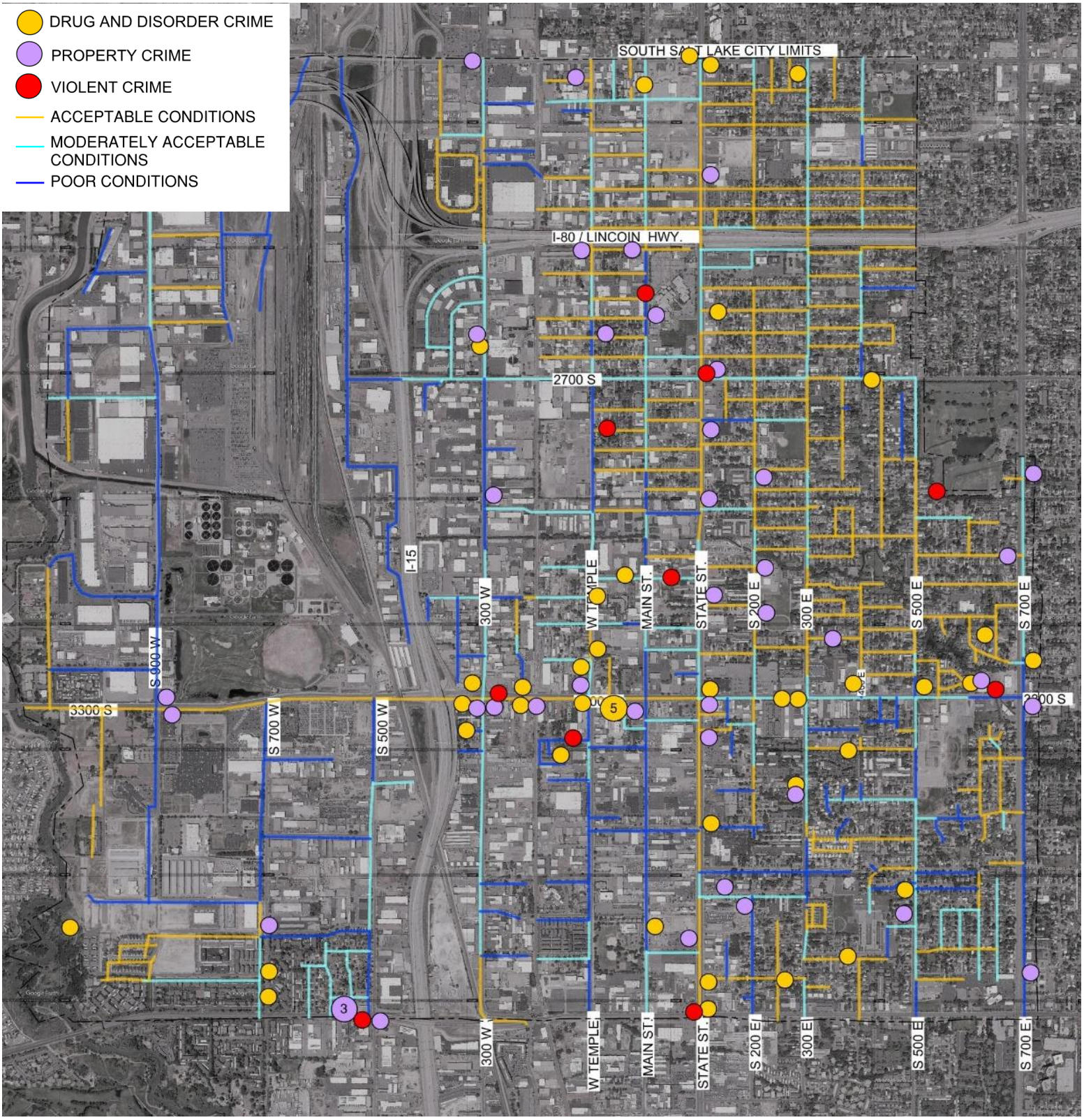


Figure 2.1.4: Crime Data Overlaid Existing Conditions Map



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SECTION 3 LIGHTING DESIGN STANDARDS

Lighting Design Principles and Applications
Lighting Character Districts

3.1 Lighting Design Principles & Applications

3.1.1 Purpose

This chapter clarifies what lighting is needed for quality street and pedestrian lighting and how to support beautiful and effective public spaces. These design principles for street lighting are intended to support a safe environment for both drivers and pedestrians. The design principles for public spaces include more aesthetic principles to support more dynamic and welcoming nighttime environments.

3.1.2 Street and Pedestrian Lighting

The following lighting design principles should be considered during lighting design for streets throughout South Salt Lake to support effective, safe, and comfortable street lighting.

3.1.2.1 Street and Pedestrian Lighting Principles

Color of Light

- White light improves visibility on roadways creating a safer and more comfortable commute.
- The color of a light source dictates the color rendering capabilities of that source. White light, from LED sources, reveals the color of an object improving nighttime visibility.
- All street lighting should have a color temperature no higher than 3000K.
- See *Luminaire Specification* for more information.

Wayfinding

- Creating focal points along pedestrian pathways improves pedestrian wayfinding and provides confidence to pedestrians who are unfamiliar with the area.
- Feature lighting creates visual interest and supports wayfinding by giving pedestrians a beacon in the lighted environment.

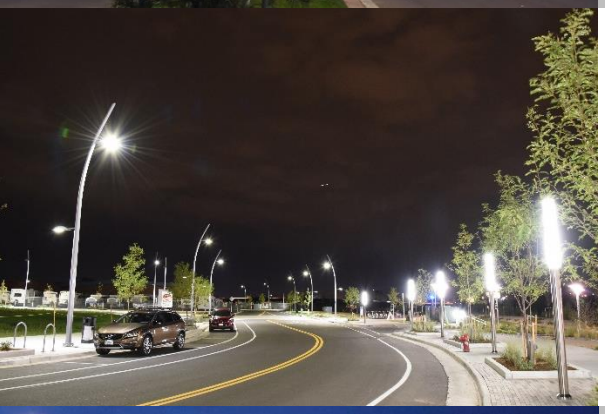
Low Glare

- Glare reduces nighttime visibility.
- Controlling glare, by using low B.U.G. ratings, reduces light pollution and light trespass.
- Specifying the correct luminaire based on street type and usage reduces over lit spaces and limits light pollution.
- The *Luminaire Spacing and Criteria* section guides the user in choosing the correct luminaire for various street types.

3.1.2.2 Street and Pedestrian Lighting Applications

Street Lighting

- Quality street lighting design is an extensive process where many variables are addressed. This Master Plan will guide the user through determining lighting warrants, luminaire spacing, and lighting criteria, as well as how to select a luminaire.
- Providing the proper amount of light based on street classification and pedestrian activity with minimal glare is the most effective way to create quality street lighting.
- Limiting the amount of light pollution, especially the amount of glare, will increase the appeal of the design and create more visually comfortable streets for residents and commuters.



Street and Pedestrian Lighting

- In areas of high pedestrian activity, pedestrian lighting, along with street lighting is needed. This will support a safer and more visually comfortable pedestrian environment.
- Pedestrian lights will need to be spaced closer together than street lights and will warrant their own layout and design.

Vertical Illumination in Crosswalks

- Proper crosswalk lighting in high traffic areas, such as the corridor commercial streets, will support a safer and more pedestrian friendly city.
- Lighting in the vertical plane will increase visibility in crosswalks and help to reduce vehicle-pedestrian accidents.
- See *Intersection & Crosswalk Lighting* for layout and spacing criteria.

Alley Lighting

- At a minimum, alleys should have lighting at the entrance and exit. If needed, a light should be placed at the midpoint.
- To support visual security, avoid creating dark spaces that is difficult to detect from adjacent streets.
- Improve lighting by trimming trees and bushes that block the light.

3.1.3 Lighting for Public Spaces

Unique public spaces in the City demand a different and more detailed set of lighting design principles than streetlighting. To highlight unique features, support safe and visually comfortable spaces, and enhance the appeal of public spaces, the following lighting design principles should be considered.

3.1.3.1 Lighting Principles for Public Spaces

Creating Layers of Light

- Ambient Light: Ambient light, provided by pedestrian luminaires, supports visual quality, allowing for increased pedestrians and cyclists visibility.
- Feature Lighting: Lighting the water features adds depth to the space with visual attractiveness.
- Tree Lighting: Lighting the trees highlights them as a landscape feature.
- Accent Lighting: The downlights that highlight the walls create visual interest by accenting architectural features while minimizing light pollution.

Subtle Contrast

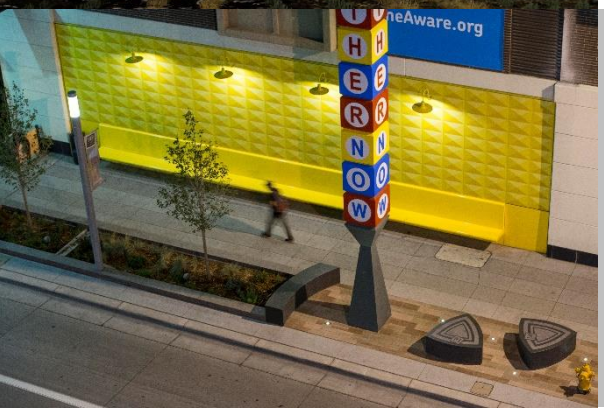
- Providing light along primary pathways acts as a visual guide for pedestrians and directs them along the intended path of travel.
- Illuminating stairs shows the intended path as well as highlights potential hazards.
- Providing varying light levels on the trees, ground, stairs, and walls creates a visually interesting exterior environment and adds more definition to the space.

Accent and Feature Lighting

- Accent Lighting: Grazing the surface of the building with light highlights the unique surfaces. Accent lighting improves the appeal of an area as well as increases visibility and comfort.
- Feature Lighting: The light feature supports visual interest around the building and supports wayfinding. Feature lighting can highlight an ordinary element and create distinctiveness.

Color of Light

- The color of light in public spaces can have a considerable influence on the overall perception of the area. Warmer light creates the feeling of intimacy and coziness, while cooler light may appear more public and bright.
- Designers should use the proper color of light based on the surrounding environment and health impacts as well as the intended perception of the area. Warmer colors should be used near residential properties.



Vertical Light Levels

- Lighting unique vertical surfaces highlights the building architecture and creates visually interesting surfaces.
- Lighting vertical surfaces along primary pathways improves vertical illumination levels, making it easier to identify faces and objects in the pathway.

3.1.3.2 Lighting Applications for Public Spaces

City Park Lighting

- Lighting in city parks should support visually comfortable and safe community gathering places.
- Lighting should enhance navigation for those walking and biking through the park, but should not encourage active recreation or play at night.
- Unique features in the park can have accent or feature lighting to separate and distinguish them from the rest of the City.
- See the *City Parks Character District* for more information.

Lighting for Pedestrian Plazas

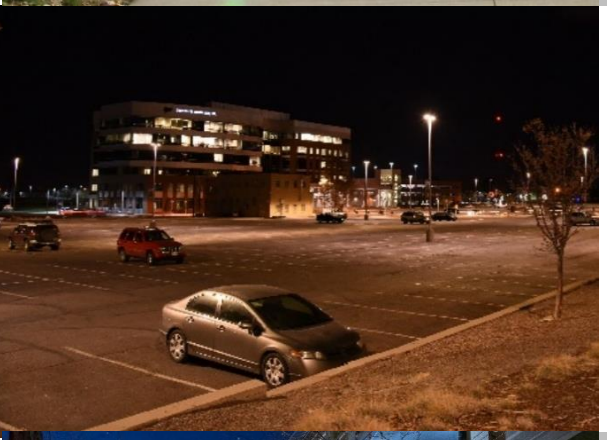
- Ambient light is essential for pedestrian comfort and proper navigation of the plaza. Warmer light can be used in pedestrian areas to create a more comfortable and intimate feeling.
- Adjustable aiming light sources can be used to allow for a more diverse space that will properly light daily activities but also have potential for festivities and events.
- Decorative lighting adds value to the space, creating a more interesting and inviting area.
- Feature lighting draws people toward the plaza, creates a unique experience, and heightens spatial awareness.
- Vertical illumination is important in pedestrian areas to enhance facial recognition and improve object detection.

Lighting for Historical Sites

- Lighting at historical sites throughout the City should reflect the historical significance of the building while also creating a welcoming and visually comfortable environment.
- Accenting unique building surfaces and providing feature light to any statues or artwork will help define the Historical Sites and draw attention of the residents.
- See the *Historical Sites Character District* for more information.

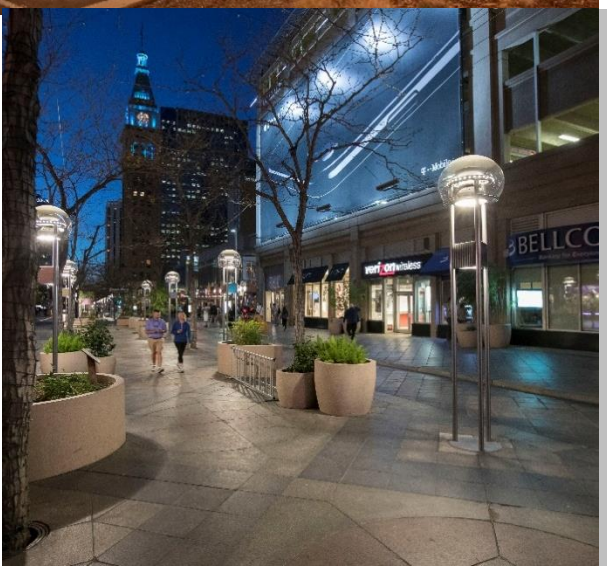
Lighting for Pedestrian Paths

- Providing proper illumination on pedestrian pathways is important in creating a visually comfortable and safe environment. Too much light will be glaring and affect the adaptation of pedestrians using the pathways.
- Pedestrian specific lighting along major roadways will create a more visually comfortable environment and increase pedestrian usage.
- Prioritizing vertical illumination on pedestrian pathways will improve facial recognition and object detection to improve safety and visual comfort.
- More information can be found in the *Pedestrian Lighting* section.



Parking Lot Lighting

- Parking lots should be lighted to IES criteria which will provide enough light for wayfinding, as well as supporting the sense of safety and security. This includes criteria for both horizontal and vertical illuminance.
- See *Parking Lot Lighting Chapter* for more information.



Lighting Recommendations from CPTED

- Avoid poorly placed lights that create blind-spots for observers. Ensure potential problem areas are well lighted: pathways, stairs, entrances/exits, parking areas, ATMs, phone kiosks, mailboxes, bus stops, children's play areas, recreation areas, pools, laundry rooms, storage areas, dumpster and recycling areas, etc.
- Avoid too-bright *security lighting* that creates blinding glare and/or deep shadows, hindering the view for observers. Eyes adapt to night lighting and have trouble adjusting to severe lighting disparities.
- Use fully shielded luminaires to control glare. Using low glare luminaires may require the use of more luminaires.
- Keep all lighting in working order. Proper maintenance shows the area is well attended. Trimming bushes and trees around light sources maintains the integrity of the design and reduces shadows.

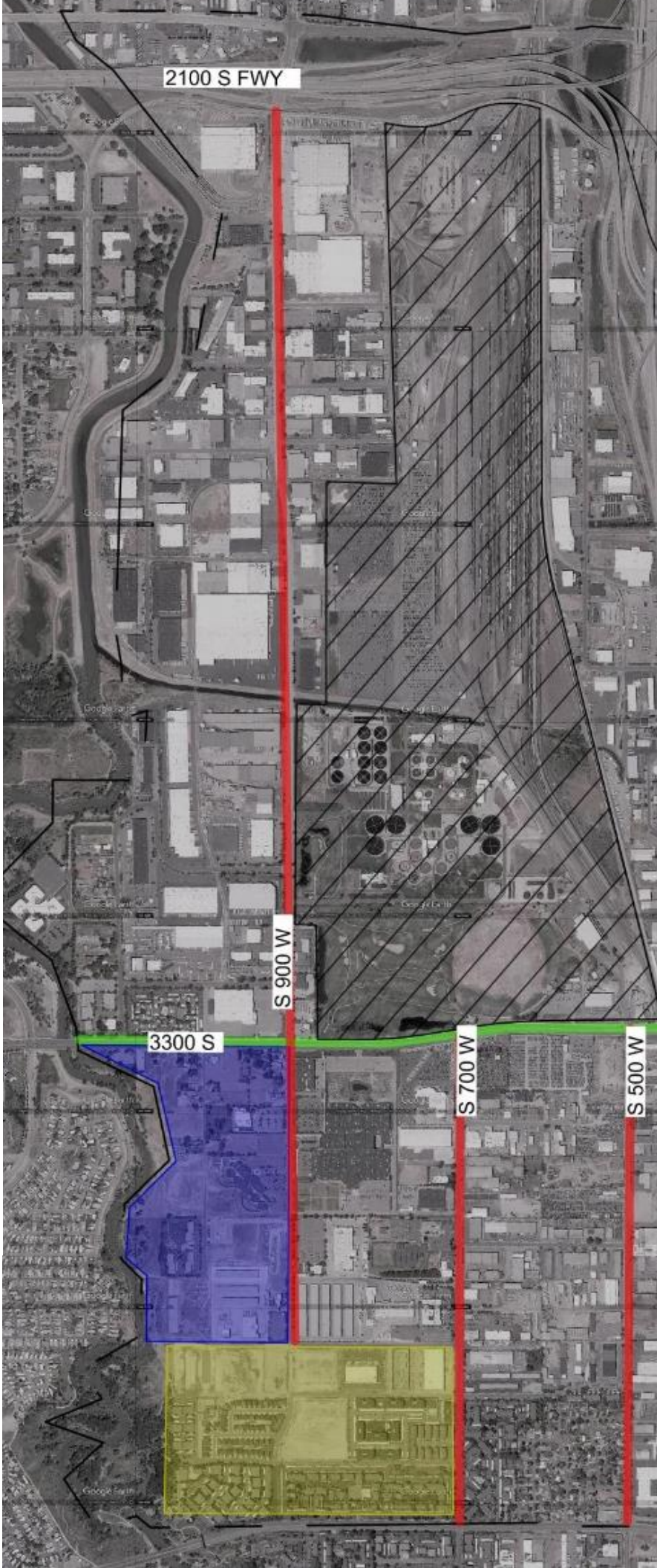
3.2 Lighting Character Districts

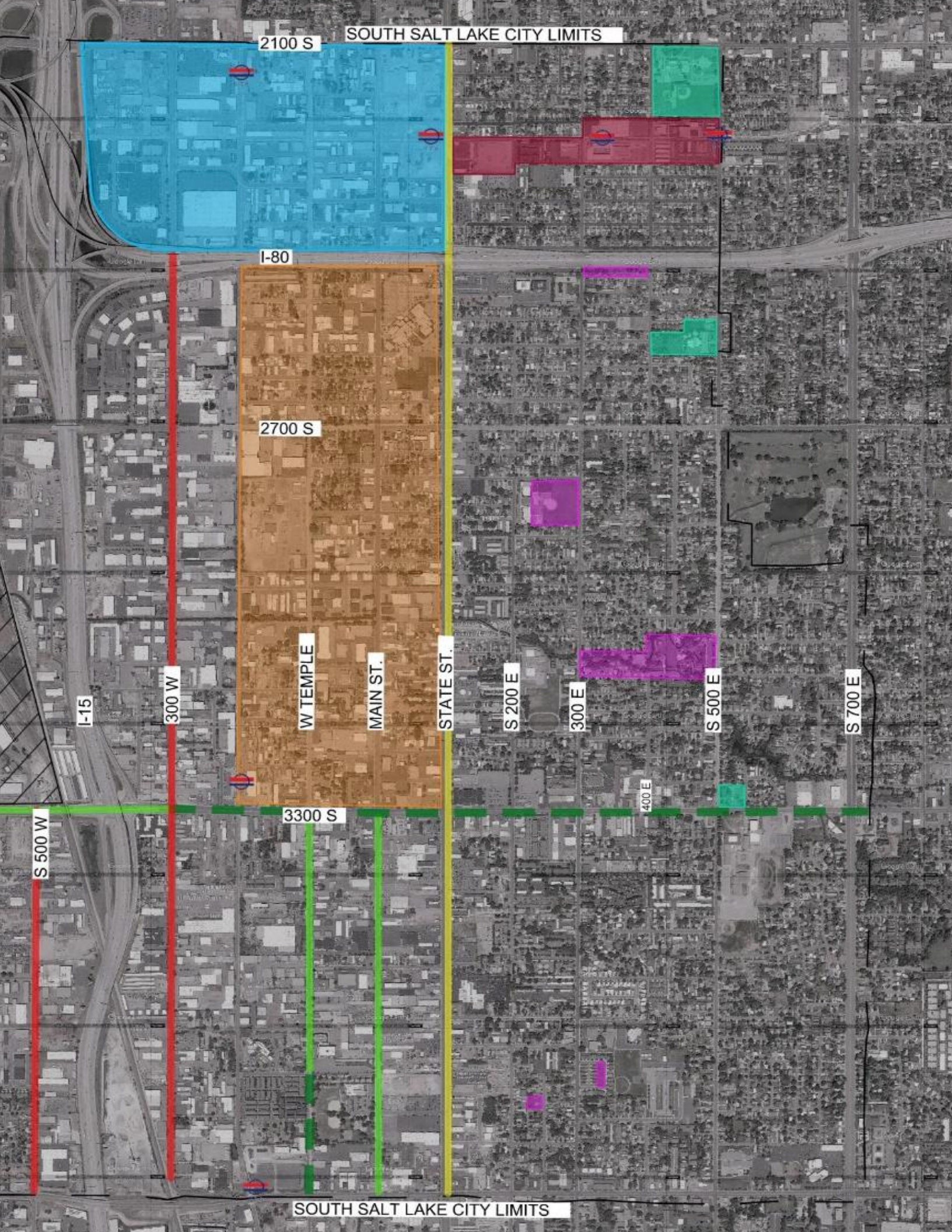
3.2.1 Purpose

Throughout the City of South Salt Lake, ten lighting character districts have been established based on typical usage in the area, pedestrian traffic, and foreseen City improvements. Each of the districts have varying levels of vehicle traffic, pedestrian traffic, and public transportation, which are primary considerations in the lighting design process. The lighting reinforces the unique function and aesthetic of each district. While some districts have primarily functional lighting, such as the Industrial District, others, like the Downtown District, utilize more layers of light and specific design aesthetics to create public outdoor spaces that encourage pedestrian use at night. Additional layers of light may include building façade lighting and lighting feature art work. Additional electrical infrastructure for holiday and event lighting may be desired in some areas. This chapter addresses the lighting intent and usage for each district to familiarize designers with the districts and aid in decision-making. A map of the character districts in the City can be found below.

Lighting Character Districts

- STATE STREET
- CORRIDOR COMMERCIAL
- CORRIDOR COMMERCIAL WITH PEDESTRIAN LIGHTING
- HEAVY TRAFFIC INDUSTRIAL
- DOWNTOWN
- EAST STREETCAR
- CREATIVE INDUSTRY
- RIVERFRONT NEIGHBORHOOD
- JORDAN RIVER GATEWAY
- CITY PARKS
- HISTORIC SITE
- PRIVATE PROPERTY
- TRAX/Streetcar STATION




SOUTH SALT LAKE CITY LIMITS
2100 S
I-80
2700 S
I-15
300 W
W TEMPLE
MAIN ST.
STATE ST.
S 200 E
300 E
S 500 E
S 700 E
400 E
3300 S
S 500 W
SOUTH SALT LAKE CITY LIMITS

3.2.2 Lighting Equipment

Each character district throughout the City serves different purposes and demographics. To best accomplish this, they require different lighting equipment. The table below guides the user in effectively lighting each character district based on the needs or the area and the desired aesthetic.

Table 3.2.1: Character District Design Guide

	Street Lighting	Pedestrian Lighting	Public Transportation	Accent Lighting	Feature Lighting	Luminaire/Style	Luminaire	Electrical Needs	Auxiliary Features
Downtown	✓	✓	☑ Bus Stops ☑ Rail Stations	✓	✓	Contemporary - Landscape Forms Torres		☑ Event Power ☑ Stage Power ☑ Holiday Receptades	☐ Flag Pole Mount ☑ Planters ☑ Banner Arms
East Streetcar	✓	✓	☑ Bus Stops ☑ Rail Stations	✓		Contemporary - Landscape Forms Leo		☐ Event Power ☐ Stage Power ☑ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☑ Banner Arms
State Street	✓		☑ Bus Stops ☐ Rail Stations			Historic - Holophane Esplanade		☐ Event Power ☐ Stage Power ☐ Holiday Receptades	☑ Flag Pole Mount ☐ Planters ☑ Banner Arms
Corridor Commercial	✓	✓	☑ Bus Stops ☐ Rail Stations			Industrial -Lumec RoadFocus Cobrahead & Hadco Pima Pendant		☐ Event Power ☐ Stage Power ☐ Holiday Receptades	☑ Flag Pole Mount ☐ Planters ☑ Banner Arms
Industrial	✓		☑ Bus Stops ☐ Rail Stations			Industrial -Lumec RoadFocus Cobrahead		☐ Event Power ☐ Stage Power ☐ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☐ Banner Arms
Creative Industry	✓		☑ Bus Stops ☐ Rail Stations			Hadco Pima Pendant		☐ Event Power ☐ Stage Power ☐ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☑ Banner Arms
Riverfront Neighborhood	✓		☐ Bus Stops ☐ Rail Stations			Philips - Swan		☐ Event Power ☐ Stage Power ☐ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☐ Banner Arms
Jordan River Gateway	✓		☑ Bus Stops ☐ Rail Stations			Industrial -Lumec RoadFocus Cobrahead		☐ Event Power ☐ Stage Power ☐ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☐ Banner Arms
City Parks		✓	☑ Bus Stops ☐ Rail Stations	✓		Match Existing Style		☐ Event Power ☐ Stage Power ☐ Holiday Receptades	☑ Flag Pole Mount ☐ Planters ☐ Banner Arms
Historical Sites		✓	☑ Bus Stops ☐ Rail Stations	✓		Historical - Match Existing		☐ Event Power ☐ Stage Power ☑ Holiday Receptades	☑ Flag Pole Mount ☐ Planters ☐ Banner Arms

3.2.2.1 Additional Features

Throughout the City, additional infrastructural elements can be added to street poles to support the City's unique identity. The *Character Districts Design Guide (Table 3.2.1)* shows what addition elements are recommended based on the character district. The City will approve which additional features may be used within each character district, street block, and on which light poles.

Auxiliary features include flag pole mounts, planters and banner arms. These items will be used to separate prominent blocks within character districts and create a more unique experience in the City.

Banner Arms

Flag Pole Mount

Planters

Additional electrical features include holiday receptacles, event power, and stage power. Holiday receptacles may be added in the bottom or top of the pole to provide power for holiday and decorative lighting. Holiday receptacles shall have in-use covers and be lockable where accessible to the public. Stage power requires larger electrical capacity and supports performances on temporary stages in the City. Event power is used for temporary electrical loads used for events and festivals throughout the City.

Decorative Lighting with Event Power

Stage Lighting

3.2.3 Downtown District

The City is building a downtown City Center to enhance the community and create a new destination in the Salt Lake Valley. Downtown will be a sustainable, vibrant, and active area with modern urban living, office spaces, and standalone retail. Working with the *Downtown South Salt Lake Zoning Ordinance and Design Standards*, the lighting in this district works to enhance the overall experience with quality illumination of roadways, plazas, pedestrian walkways, transit stations, and trails. Lighting contributes to a cleaner, safer, more inviting, and beautiful district of the City. The pedestrian experience is enhanced with quality lighted, walkable and bike-able areas, and transit stations. All of this helps to encourage public and active transportation.

The street and pedestrian lighting in the Downtown District is characterized by unique contemporary style luminaires that separate downtown from the rest of the City. Additional infrastructure, such as banner arms, planters and holiday receptacles on street poles, as well as supplying event and stage power in desired areas will enhance the downtown experience.

Contemporary Style Combined Street and Pedestrian Luminaire

3.2.3.1 Applying Lighting Design Principles to Downtown

The following lighting design principles contribute to creating a vibrant and active space throughout the Downtown District.

- **Layers of Light**: Ambient lighting provides necessary illumination for commuter and pedestrian traffic, while accent and feature lighting enhances the downtown experience.
- **Accent and Feature Lighting**: Highlighting artwork and unique building surfaces draws residents to downtown features and art, supporting a quality community environment.
- **Lighting Vertical Surfaces:** This will help improve facial recognition and the overall perception of brightness, creating a more comfortable and welcoming space for residents and commuters. Care should be taken to avoid light trespass into residential units when designing façade lighting.
- **Wayfinding:** Illuminating trails and pedestrian walkways attracts users and supports a more active visual environment. Quality lighting at transit stations and illuminating focal points encourages wayfinding, pedestrian activity and public transportation.
- **Lighting for Pedestrian Plazas:** Lighting in pedestrian plazas creates quality visual environments in community gathering areas. The lighting should be diverse, decorative, and unique providing heightened visual interest in pedestrian plazas.

3.2.3.2 Downtown Street Types

Throughout the Downtown District, there are twelve (12) different street and pedestrian path types: Boulevard, Avenue, Connector, Neighborhood, S-Line Transit, Transit Corridor, Lane, Alley, Parking Access, Parking Grid, and Paseo. Each of these twelve different street types has various lighting requirements and infrastructural options to optimize their visual performance. Table 3.2.2 addresses each street type's lighting and electrical needs, as well as any auxiliary features and Figure 3.1.1 shows a map of the downtown streets.

Table 3.2.2: Downtown Street Guide

Downtown Streets	Street Lighting	Pedestrian Lighting	Accent Lighting	Feature Lighting	Transit Stations	Electrical Needs	Auxiliary Features
Boulevard	✓	✓			Bus Stop	☐ Event Power ☐ Stage Power ☑ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☑ Banner Arms
Avenue	✓	✓	✓	✓	None	☐ Event Power ☐ Stage Power ☑ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☑ Banner Arms
Connector	✓	✓	✓	✓	Streetcar	☐ Event Power ☐ Stage Power ☑ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☑ Banner Arms
Neighborhood	✓	✓	✓		None	☐ Event Power ☐ Stage Power ☐ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☐ Banner Arms
S-Line Transit	✓	✓	✓		Streetcar	☐ Event Power ☐ Stage Power ☑ Holiday Receptades	☐ Flag Pole Mount ☑ Planters ☑ Banner Arms
Transit Corridor		✓	✓	✓	Streetcar & TRAX	☐ Event Power ☐ Stage Power ☐ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☐ Banner Arms
Festival Street	✓	✓	✓	✓	None	☑ Event Power ☑ Stage Power ☑ Holiday Receptades	☐ Flag Pole Mount ☑ Planters ☑ Banner Arms
Lane		✓	✓		None	☐ Event Power ☐ Stage Power ☑ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☑ Banner Arms
Alley	✓				None	☐ Event Power ☐ Stage Power ☐ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☐ Banner Arms
Parking Access		✓	✓	✓	None	☐ Event Power ☐ Stage Power ☐ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☐ Banner Arms
Parking Grid	✓	✓			None	☐ Event Power ☐ Stage Power ☐ Holiday Receptades	☐ Flag Pole Mount ☐ Planters ☐ Banner Arms
Paseo		✓	✓	✓	None	☑ Event Power ☑ Stage Power ☑ Holiday Receptades	☐ Flag Pole Mount ☑ Planters ☑ Banner Arms

Figure 3.1.1: Downtown Street Types

Refer to South Salt Lake City General Plan for street types.

3.2.4 East Street Car District

The East Street Car district blends both the past and the future of South Salt Lake while connecting the city to other areas throughout the Valley. A new emphasis on public transportation, biking, and walking will renew the neighborhood safety and appeal. The lighting will support visibility and comfort in this area with appropriate roadway, transit station, and pedestrian walkway illumination. New lighting will also help transit stations and pedestrian walkways will feel safer, cleaner, and more welcoming.

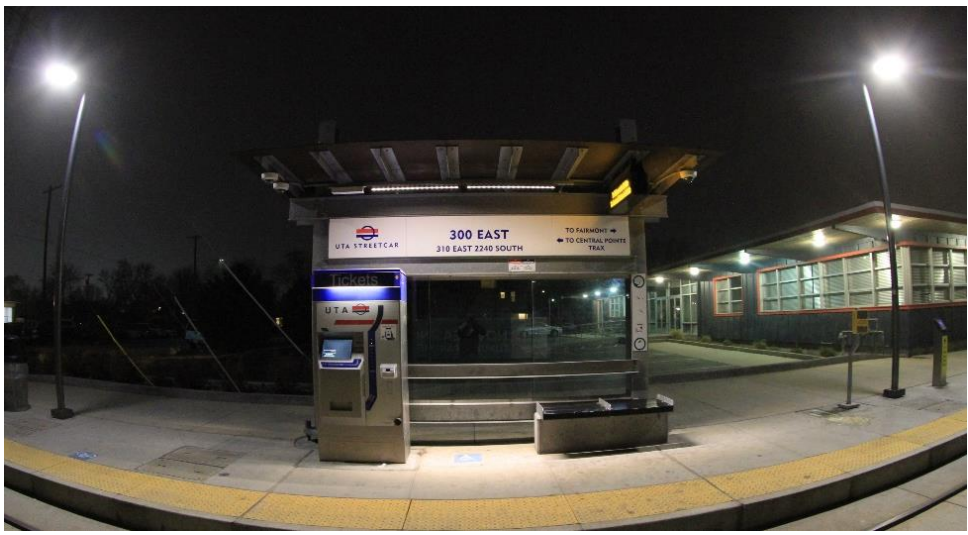
The lighting in this district is characterized by unique contemporary style luminaires with banner arms and holiday receptacles distinguishing the East Streetcar District and reinforcing the character of the area. Emphasis is placed on pedestrian and transit station lighting to encourage walking, biking, and public transportation.

Contemporary Style Street and Pedestrian Luminaire

3.2.4.1 Applying Lighting Design Principles to the East Streetcar District

Utilizing multiple lighting design principles throughout the East Street Car District will boost appeal of the area and create a more visually welcoming space.

- **Layers of Light:** Ambient light provides general illumination for commuters, walkers, and cyclists while accenting art work and other key features. It also distinguishes the unique visual nature of the East Street Car District.
- **Wayfinding:** Illuminating focal points, such as transit stations and pathways improves nighttime pedestrian navigation through the area. Quality lighting along trails and at transit stations encourages use and creates a quality visual environment.
- **Lighting Vertical Surfaces:** Illuminating vertical surfaces along pathways, such as Parley's Trail, aids in facial recognition which supports pedestrians in observing the intent of approaching pedestrians. This aids in identifying objects in the pathway, supporting the visual environment for cyclists and pedestrians.



3.2.5 State Street District

State Street is a 17.3-mile-long Boulevard running through the heart of the Salt Lake Valley, from the State Capitol to the Point of the Mountain. As it goes through the City, State Street provides access to I-80, City Hall, Granite School District's administrative building, and the S Line Streetcar. The lighting along State Street supports all forms of transportation and improves the visual environment. Quality lighting encourages nighttime walking, biking, and public transportation and enhances the commercial and retail visual environment along State Street.

3.2.5.1 Applying Lighting Design Principles to the State Street District

Street lighting will be the only form of public lighting along State Street and should provide enough light to sufficiently light the street and the sidewalk. The lighting character in this district is historic with banner arms and flag pole mounts on street poles to highlight and advertise events in South Salt Lake as residents and visitors commute through the City. Most of the lighting on State Street has been updated and additional improvements are planned to update all lighting in the corridor.

Historical Street Light

3.2.5.2 Suggested Improvements

Although this Lighting Master Plan does not consider private lighting ordinances, car dealership lighting along State Street should be addressed. There is no control of the light on these properties and the lights are far too bright. This causes light pollution and light trespass as well as glare for passing motorists. To improve the lighting along State Street, the light on the dealership properties should be shielded and dimmed to meet the guidelines in this Master Plan. This will reduce light pollution, light trespass, and glare, improving the current visual conditions along State Street and creating a higher quality visual environment for motorists and neighbors.

Lighting on State Street at Truman Ave with street light off.

3.2.6 Corridor Commercial District

Three principle arterial roads - 3300S, Main Street, and West Temple - are major corridors for commercial traffic and commuters through South Salt Lake. These main roads provide access to much of the City and are used for driving, walking, biking, and taking public transportation. The lighting in this district supports a quality visual environment aiding commuters along major paths of travel through the City.

3.2.6.1 Street Lighting

Street lighting emphasizes energy efficiency, minimal maintenance costs, and an increased lighting quality using cobrahead style luminaires. Banner arms and flagpole mounts distinguish these major corridors from the rest of the City.

Cobrahead Style Luminaire

3.2.6.2 Pedestrian Lighting

Along some sections of the arterial streets in the Corridor Commercial District are areas of heightened pedestrian usage. These areas border transit stations and are predominant pedestrian paths through the heart of the City. They include 3300S from 300W to 700E, and along West Temple from 3700S to 3900S. Along these sections of streets, a higher priority is placed on pedestrian lighting supporting a safer and more visually comfortable commute. The street lights are the same as the rest of the Corridor Commercial District and transitional style pedestrian lights are used. Lighting design in this area accommodates a pedestrian environment and considers pedestrian crossings as well as bike lanes to enhance the visual experience and support a safer commute in South Salt Lake.

Transitional Style Pedestrian Light

3.2.6.3 Applying Lighting Design Principles to the Corridor Commercial District

The following layers of light along corridor commercial streets, especially in high pedestrian environments, support a safer visual environment for drivers, cyclists, and pedestrians.

- **Lighting Vertical Surfaces**: Illuminating crosswalks in the vertical plane will help drivers identify pedestrians and other objects in the road to improve safety.
- **Wayfinding**: Illuminating pedestrian pathways, especially near transit stations, improves wayfinding and gives confidence to pedestrians who are unfamiliar with the area.

3.2.7 Industrial District

The City has a large, long standing industrial influence. The Industrial District focuses on providing enough light for large vehicle traffic in an energy efficient and cost-effective manner. The arterial streets that comprise the Industrial District are home to a diverse mix of industrial products and improved lighting will aid in increasing the overall visual appeal of these industrial areas.

The Industrial district is currently under served by street lighting, creating very dark streets. Street lighting improvements in this district will require new infrastructure in many areas to adequately improve the safety in the area. Cobrahead style lights will be used in the area to improve the street lighting in a cost-effective manner. Existing wooden utility poles for overhead power lines may be used for mounting additional street lighting to supplement the existing street lights. Wooden utility poles can only be used for lighting redesign where the pole spacing meets the spacing requirements for the applicable street classification .

Cobrahead Style Luminaire

3.2.7.1 Applying Lighting Design Principles to the Industrial District

Applying the following lighting design principles will support a safer and cleaner environment in the industrial district.

- **Color of Light:** Replacing the existing high pressure sodium lighting with white LED lights will increase the visibility where current street lights exist.
- **Street Lighting:** Providing the proper amount of light on the roadway with minimal glare is the most effective way to create quality street lighting. The *Luminaire and Spacing Criteria* section will aid in choosing the correct luminaire and spacing based on the road classification and pedestrian conflict.
- **Comprehensive Improvements:** Due to the current lack of street lighting, comprehensive improvements will need to be made. *Chapter 4.2* walks the user through the comprehensive improvement process to create quality and effective street lighting in underserved areas.

3.2.8 Creative Industry District

A Creative Industry Zone is being developed in South Salt Lake to support and welcome visitors, residents, and entrepreneurs. This zone offers unique spaces for residents to congregate and enjoy the local culture, food, art, and entertainment. Various small business with many different specialties are located in this district and make a significant contribution to the character of the area. The Creative Industry Lighting District reinforces the character of the area through style and quality illumination.

Transitional style luminaires are used to represent industrial history of the area, as well as the creative and entrepreneurial future. Banner arms may be used to separate the district from the rest of the City.

Transitional Style Street Light

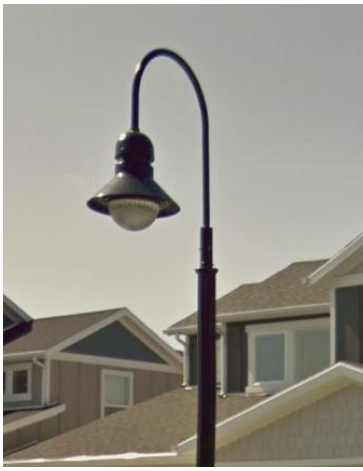
3.2.8.1 Applying Lighting Design Principles to the Creative Industry District

Applying the following lighting design principles will support a more inviting and safer environment in the Creative Industry District.

- **Street Lighting:** Providing the proper amount of light on the roadway and sidewalks with minimal glare is the most effective way to create quality street lighting. The *Luminaire and Spacing Criteria* section will aid in choosing the correct luminaire and spacing based on the road classification and pedestrian conflict.
- **Lighting Vertical Surfaces:** Lighting vertical surfaces increases visibility and pedestrian comfort. Light in the vertical plane aids in identifying people and objects to aid in a safer area for vehicles and pedestrians.

3.2.9 Riverfront Neighborhood District

The Riverfront Neighborhood is an emerging neighborhood in the south west corner of the City. The lighting in this area is transitional in style and is centered around the residential developments. Lighting should sufficiently illuminate streets and sidewalks supporting safe and visually comfortable environments in the area, while not creating light pollution or light trespass. This neighborhood is close to the Jordan River and should be sensitive to the natural area surrounding it.



Current Luminaire

Current street lights are causing light pollution and light trespass.

Preferred Flat Lens Luminaire

3.2.9.1 Applying Lighting Design Principles to the Riverfront Neighborhood District

Applying the following lighting design principles will aid in creating a more comfortable environment for the residents in this district.

- **Low Glare:** Reducing the amount of glare from the luminaires in residential neighborhoods limits the amount of light pollution and light trespass. Controlling glare can create a more comfortable nighttime environment in residential areas and reduce unwanted spill light.

3.2.10 Jordan River Gateway District

Jordan River Gateway will be home to the new homeless resource center in the City and includes the Salt Lake Valley Detention Center. New lighting in this area should provide essential illumination along roadways and sidewalks to increase nighttime visibility and support overall appeal of the area.

Street lighting emphasizes energy efficiency, low maintenance costs, and an increased lighting quality using cobrahead style luminaires. This district is in close proximity to the Jordan River trail and should be conscious of light pollution and light trespass to avoid disturbing the natural area.

Cobrahead Style Luminaire

3.2.10.1 Applying Lighting Design Principles to the Jordan River Gateway District

Applying the following lighting design principles will support a will lit and safer environment in the district.

- **Color of Light:** Replacing the existing high pressure sodium lighting with white LED lights will increase the visibility where current street lights exist.
- **Street Lighting:** Providing the proper amount of light on the roadway with minimal glare is the most effective way to create quality street lighting. The *Luminaire and Spacing Criteria* section will aid in choosing the correct luminaire and spacing based on the road classification and pedestrian conflict.
- **Comprehensive Improvements:** Due to the current lack of street lighting, comprehensive improvements will need to be made. *Chapter 4.2* walks the user through the comprehensive improvement process to create quality and effective street lighting in underserved areas.

3.2.11 City Parks

City Parks throughout South Salt Lake vary in purpose and style and support outdoor use. The lighting in the parks should enhance evening sense of safety and security, while also being durable and efficient. Park lighting will support walking through the park at night, but should not encourage active nighttime recreation or play.

The lighting style in each park will match the current luminaire styles and the character of the park. Emphasis is placed on lighting the pathways and pavilions using pedestrian style luminaires. In order to reduce vandalism and maintenance costs, no bollards are used in parks. Flag pole mounts in the parks aid in creating a unique space in the City.

3.2.11.1 Applying Lighting Design Principles to City Parks

Using the following lighting design principles in city parks enhance the overall visual appeal of the park, and enhances the sense park safe and enjoyment.

- **Wayfinding**: Pathways through parks are illuminated to guide walkers and cyclists and support a safer nighttime visual environment.
- **Accent Lighting**: Lighting distinctive features in the parks, such as pavilions, help create a more beautiful visual environment.

Accent Lighting - Central Park Pavilion

3.2.12 Historical Sites

There are multiple historical sites throughout South Salt Lake and the City would like to preserve and highlight their historical significance. These historical sites include St. Ann's Church and School, The Columbus Library, and the Historical Scott School. The lighting should draw residents toward these historical sites and distinguish them from the rest of the City. Acknowledging these sites allow residents to be more aware of the history within their city.

The lighting for historical areas is done site by site and matches the existing architecture and character of each site. Holiday receptacles and flag pole mounts enhance the lighting and identity of the area while also separating these historical sites from the rest of the City.

3.2.12.1 Applying Lighting Design Principles to Historical Sites

Multiple layers of light help boost appeal and recognition of Historical Sites throughout the City by creating distinct and inviting visual environments.

- **Layers of Light**: Ambient lighting provides quality illumination while feature and accent lighting highlights the unique visual nature of the various historical sites.
- **Accent and Feature Lighting**: Lighting any statues or art work located on Historical Sites and highlighting architectural features increases the visual appeal and attracts users.

The Historical Scott School (3300S 500W): Introducing general site lighting will create a more comfortable and welcoming environment. Changing the lighting on the walls to lights directed down will reduce glare and highlight architectural features to create a more inviting and comfortable space.

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SECTION 4 LIGHTING DESIGN PROCESS

4.1 The Lighting Design Process

4.1.1 Purpose

This Chapter outlines the street lighting design process and the necessary steps to developing quality street, pedestrian, parking lot, and bus stop lighting. The criteria used in the following section is a modification of the Illuminating Engineering Society of North America's (IES) *American National Standard Practice for Roadway Lighting* (RP-8-14).

4.1.2 How to Use This Design Guide

Included in Chapter 4.1 are the following diagrams and submittal forms to aid in the design process and guide the user in determining the proper lighting criteria, layout, and luminaire for various street types and pedestrian activity levels.

Street Lighting Design Process Diagram

The *Street Lighting Design Process* diagram will aid in the lighting design process for street and public space lighting by helping to determine street classification, lighting warrants, lighting layouts, and luminaire selection as well as meeting the lighting criteria. The following five chapters follow the step-by-step process shown in the diagram and will guide designers through the lighting design process.

Luminaire Submittal Forms

The street and pedestrian luminaire submittal forms found in Appendix A should be completed by the contractor to ensure that all luminaire criteria, set forth in *Chapter 4.4* as well as in the Luminaire Criteria Tables in *Chapter 4.2.3*, is met. These forms should be completed during the lighting design process and most of the information on the forms can be found in the luminaire specification sheet. These forms will aid the City in approving luminaire selection for construction.

Street Lighting Design Process

1. Determine Character District

2. Determine Existing Conditions

3. Determine Roadway Classification and Pedestrian Activity

4. Establish Lighting Warrants

5. Identify Influential Conditions
- Other Conflicts
- Real Existing Conditions

6. Determine Lighting Improvement Strategy

Comprehensive Improvements
Lighting Redesign (CH 8)

Determine Appropriate Lighting Layout and Criteria
- See Chapter 8 for Layouts and Criteria
- Evaluate Street Cross Section
- Select Appropriate Lighting Layout Based on Application Preferences

Design and Calculate Lighting Values
- Select Luminaire
- Set Geometry and Variables (Layout, Pole Height, Mast Arm Length, Spacing, Lumen Output and Distribution)
- Light Loss Factor (LLF) = 0.81
- Calculate with AGI32 or Comparable Program

Show Compliance with Criteria
(Compare Computer Model Results with Criteria)

Minimal Improvements
1-for-1 Replacement & Supplemental Improvements (CH 9)

Confirm Existing Conditions
- Pole Spacing
- Lighting Layout

Unacceptable Conditions
- Pole Spacing >2.5x Recommended
- Insufficient Single Sided Layout

Supplemental Improvements Needed
Pole Spacing Within 2.5x Recommended Value

Identify Where Light is Needed
- Identify Dark Spots
- Potential Luminaire Locations

Select Replacement Luminaire
- Lumen Output & Distribution

(Use Replacement Tables)

Existing Conditions Support 1-For-1 Luminaire Replacement

Select Replacement Luminaire
- Lumen Output & Distribution

(Use Replacement Tables)

6 Step Process for Evaluating the Lighted Environment

This chapter helps determine the appropriate lighting improvement strategy needed for each block in the City by identifying which character district improvements are being made in, existing conditions, whether lighting is warranted, and other conditions that may influence the lighting.

Step 1: Determine Character District Influence

Chapter 3.2 discusses the City's *lighting character districts* and how these character districts will influence the lighting designs. All new lighting in each district should match the character of the area and follow the *Character District Design Guide* (Table 3.2.1). Some character districts in the City, such as the Downtown area, may require lighting redesign, regardless of existing conditions, to meet the criteria set forth by the City. Other character districts, such as Heavy Traffic Industrial area, may only require a 1-for-1 replacement along certain blocks if the existing conditions permit. Areas not included in a character district will be lighted with cobrahead style luminaires and should meet the criteria and spacing based on road classification in *Chapter 4.2.3*.

Figure 4.1.1: Character District Map

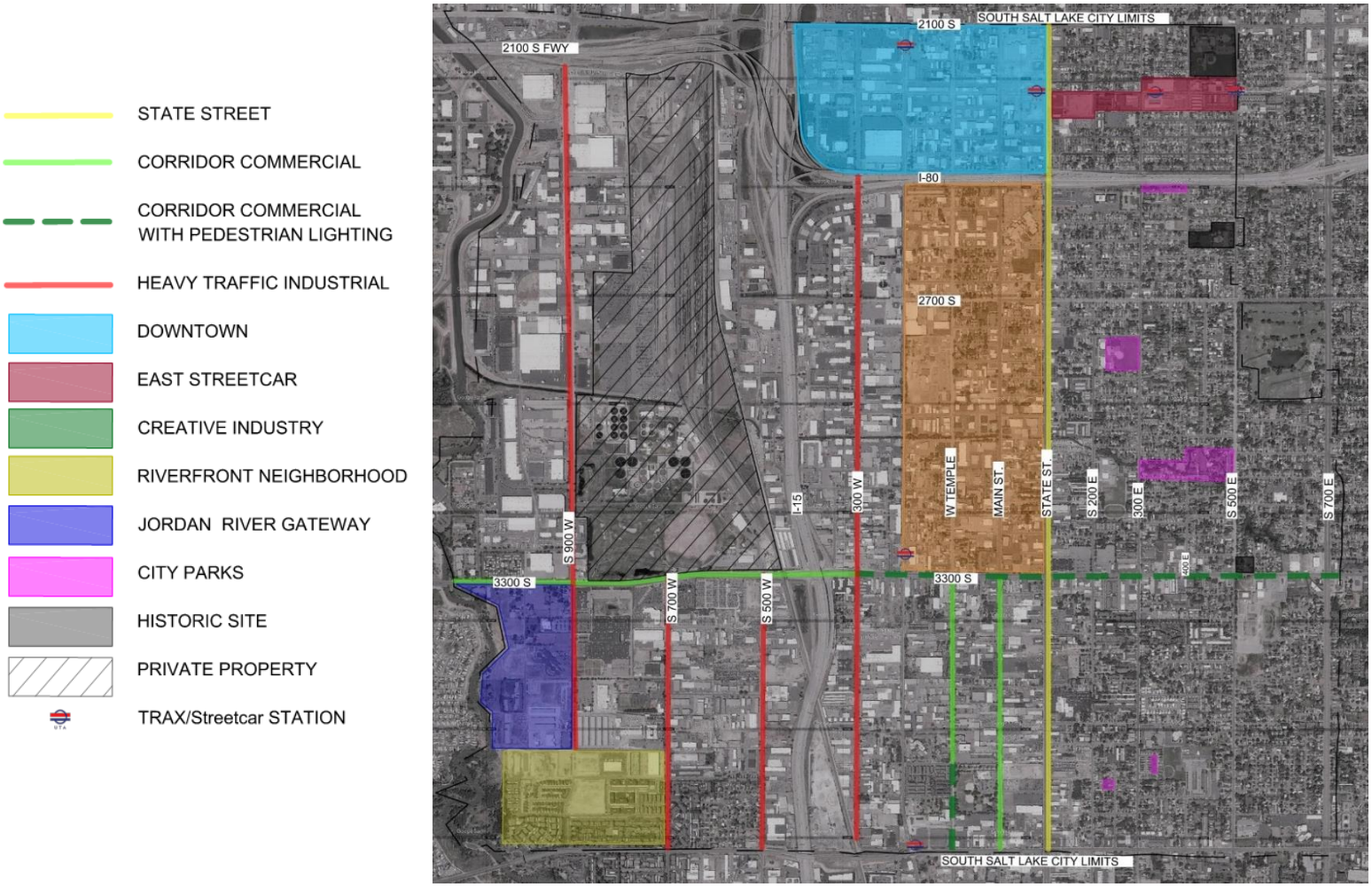
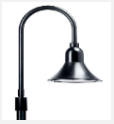


Figure 4.1.2: Character District Luminaire Schedule

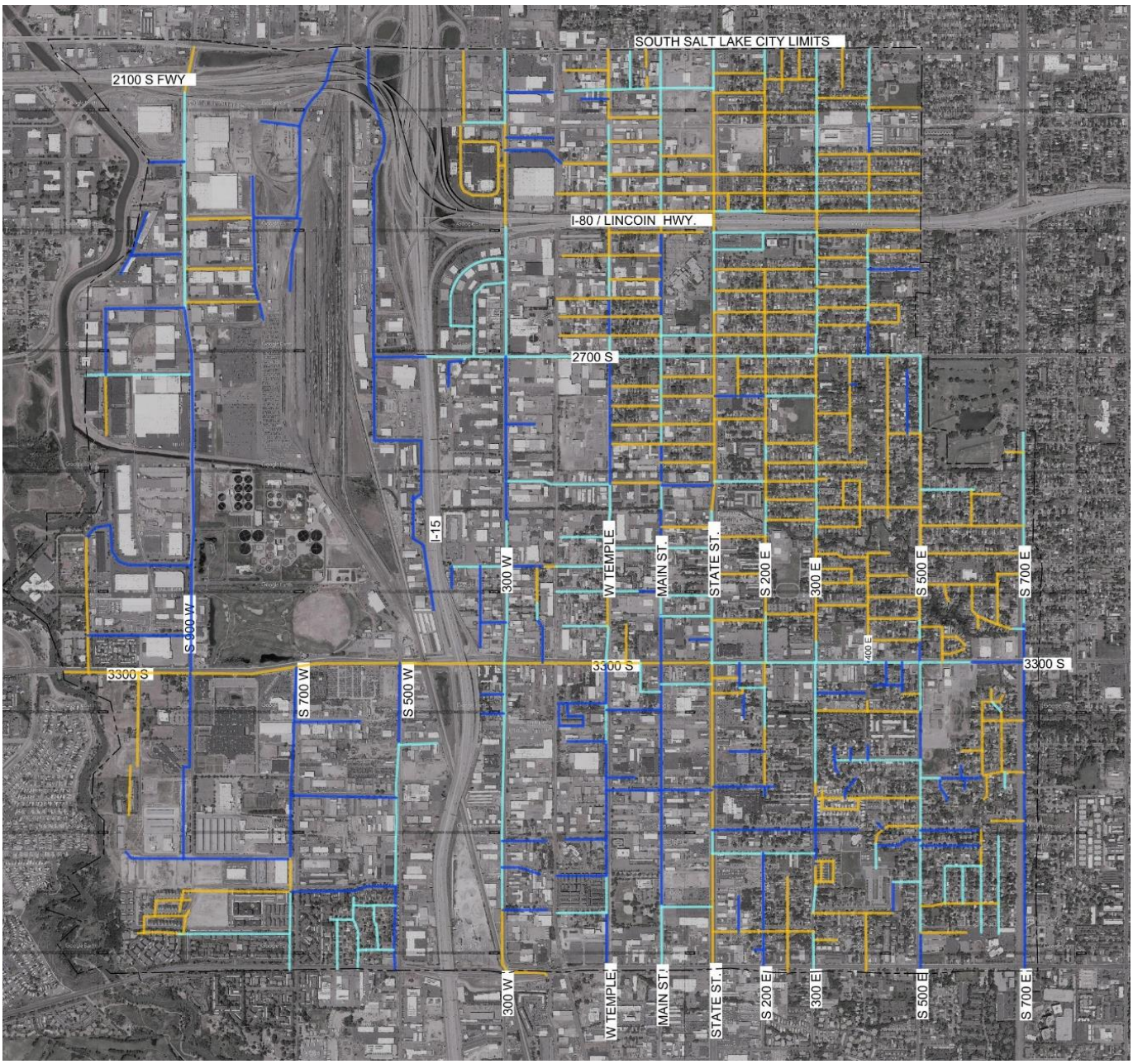
District		Luminaire Manufacturer	Luminaire Series	Luminaire Photo	Lumen Output	Color Temperature (Kelvin)	Distribution	BUG Rating	Mounting Height
Downtown	Street Luminaire	Landscape Forms	Torres		4,500 - 5,500	3000K	Type 2	B1-U0-G1	25
	Pedestrian Luminaire	Landscape Forms	Torres		2,500 - 3,500	3000K	Type 3	B1-U0-G1	12-15
East Street Car	Street Luminaire	Landscape Forms	Leo		6,500 - 7,500	3000K	Type 4	B1-U0-G2	25
	Pedestrian Luminaire	Landscape Forms	Leo		3,000 - 4,000	3000K	Type 4	B1-U0-G2	12-15
State Street	Street Luminaire*	Halothane	Esplanade		16,000 - 17,000	3000K	Type 3	B3-U3-G4*	30
Corridor Commercial	Street Luminaire	Lumec RoadFocus			11,000 - 17,000	3000K	Type 2	B3-U0-G2	35
	Pedestrian Luminaire	Hadco	Pima Pendant		2,500 - 4,000	3000K	Type 3	B1-U1-G1	15
Industrial	Street Luminaire	Lumec RoadFocus			11,000 - 17,000	3000K	Type 2	B3-U0-G2	35
Creative Industry	Street Luminaire	Hadco	Pima Pendant		6,000 - 9,000	3000K	Type 3	B2-U2-G1	25
Riverfront Neighborhood	Street Luminaire	Philips	Swan LED		4,000 - 6,000	3000K	Type 3	B1-U0-G1	20
Jordan River Gateway	Street Luminaire	Lumec RoadFocus			4,500 - 9,000	3000K	Type 3	B2-U0-G1	35
City Parks	Pedestrian Luminaire	Match Existing				3000K	Type 3	B1-U0-G1	12-15
Historical Sites	Pedestrian Luminaire	Must be Approved by City							
Outside of Character Districs	Street Luminaire	Lumec RoadFocus			Must meet luminaire specifications (Chapter 4.4) as well as spcing and lighting criteria based on street classification (Chapter 4.2.3).				

Step 2: Determine Existing Conditions

Throughout most of the City, the existing conditions will drive which lighting improvement strategy is used. The existing conditions and the improvement strategy they require are:

- **POOR** - Comprehensive improvements need to be made and extensive additional electrical and lighting infrastructure is required.
- **MODERATELY ACCEPTABLE** - Additional infrastructure will be needed to supplement the current lighting locations to minimize dark areas along the street. Existing luminaries can be replaced 1-for-1 by LED luminaires with additional LED luminaires installed where needed.
- **ACCEPTABLE** - 1-for-1 LED luminaire replacements are used.

Figure 4.1.3: Existing Lighting Conditions Map



Note: A larger version of this map can be found in *Section 2.1.4*.

Step 3: Determine Street and Pedestrian Classification

Purpose

When determining which criteria is appropriate for a given roadway within the City of South Salt Lake, designers must consider the size and traffic volume on the street as well as the number of pedestrians that typically use the street to commute. This step will guide designers in determining the appropriate street classification and pedestrian conflict level to use when evaluating which criteria to light the street to.

Step 3a: Determine Street Classifications

Street classification is used to determine the lighting warrants for a street, along with the surrounding environment and pedestrian conflict. The following street and roadway definitions are from IES RP-8-14:

Freeway:

A divided highway with full control of access. Oftentimes with great visual complexity and high traffic volumes. This roadway is usually found in major metropolitan areas in or near the central core and will operate at or near design capacity through some of the early morning or late evening hours of darkness.

Major (Arterial):

That part of the roadway system that serves as the principle network for through-traffic flow. The routes connect areas of principle traffic generation and important rural roadways entering and leaving the city. These routes are often known as "arterials". They are sometimes subdivided into primary and secondary; however, such distinctions are not necessary in roadway lighting. These routes primarily serve through traffic and secondarily provide access to abutting property.

Collector:

Roadways servicing traffic between major and local streets. These are streets used mainly for traffic movements within residential, commercial, and industrial areas. They do not handle long, through trips. Collector streets may be used for truck or bus movements and give direct service for abutting properties.

Local:

Local streets are used primarily for direct access to residential, commercial, industrial, or other abutting property. They make up a sizable percentage of the total street system, but carry a small proportion of vehicular traffic.

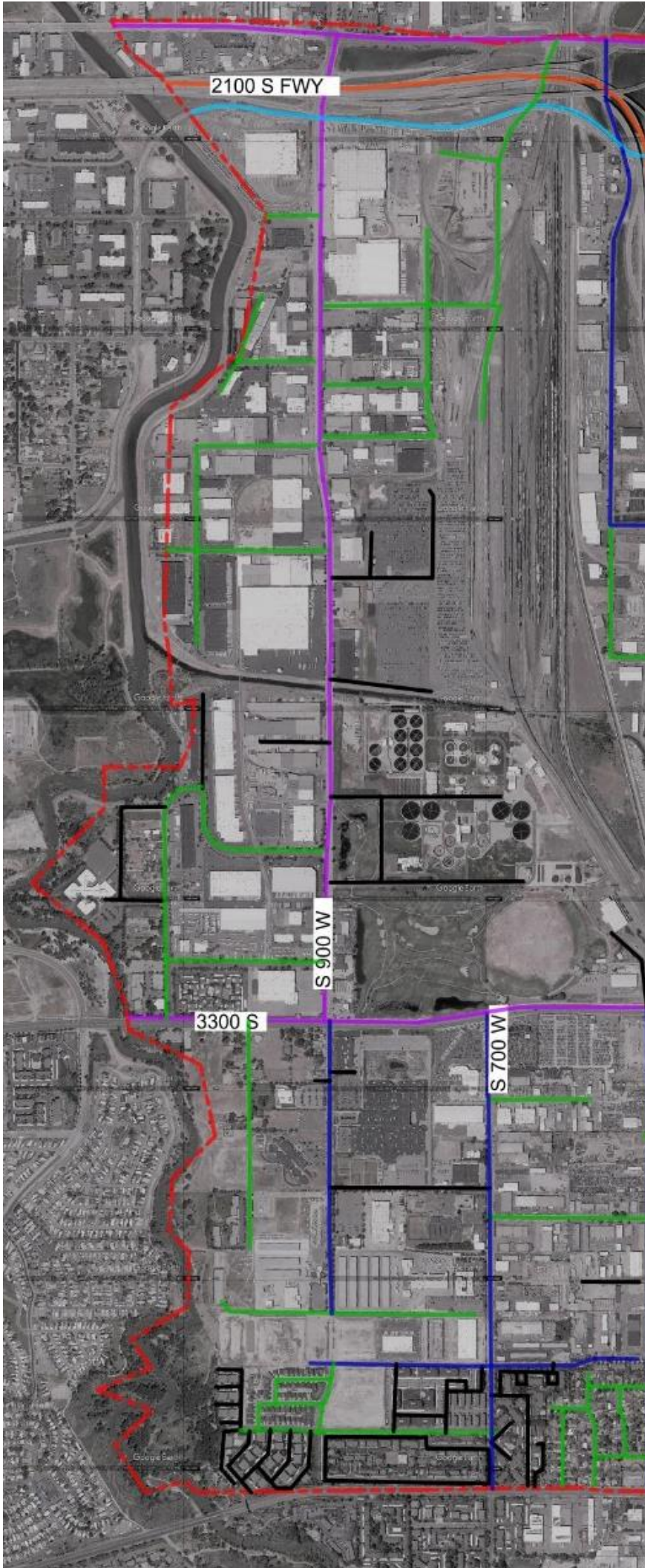
Intersections:

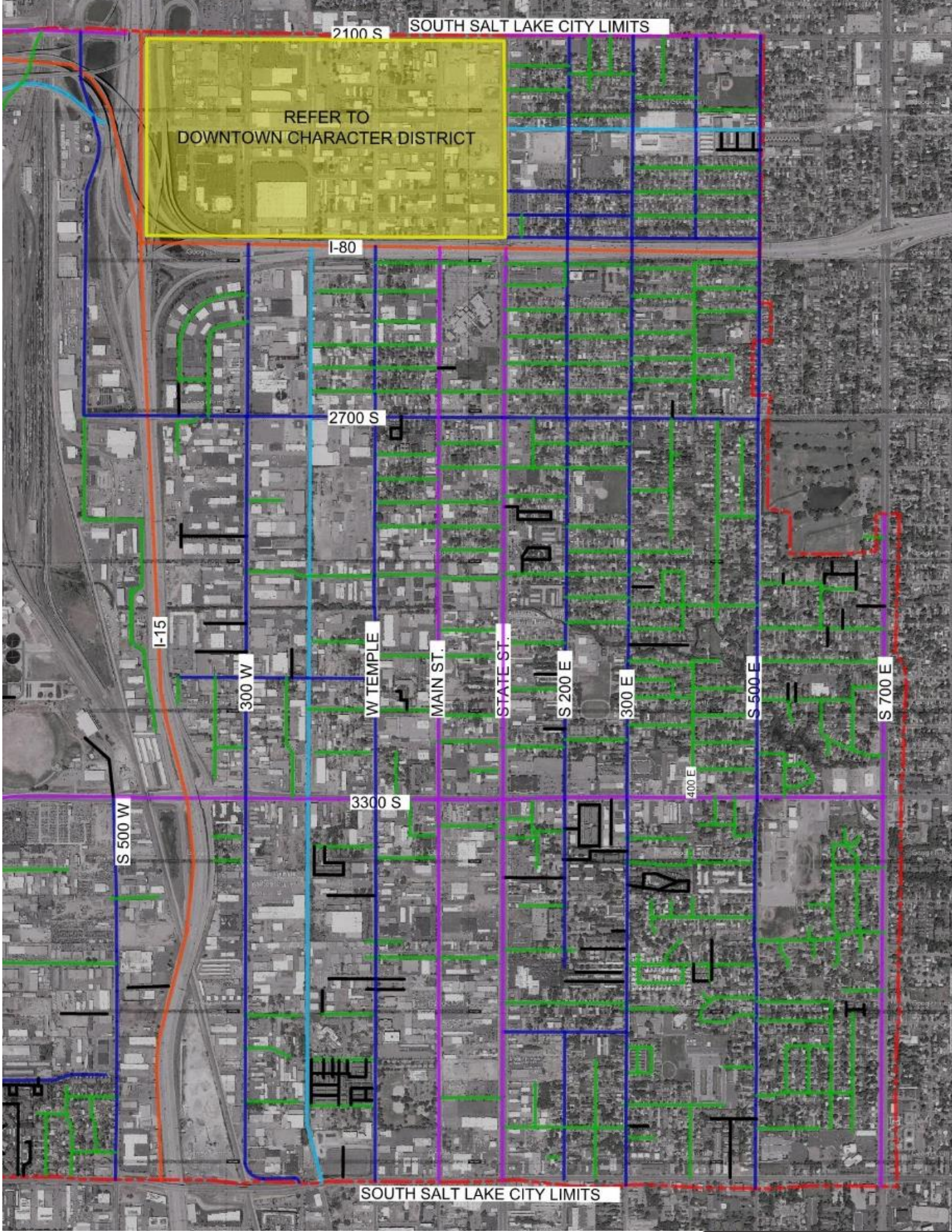
The traffic conflict area in which two or more streets join or cross at the same grade. The outside edge of pedestrian crosswalks defines intersection limits. If there are no pedestrian crosswalks, the stop bars define the intersection. If there are no stop bars, the intersection is defined by the radius return of each intersection leg. Intersection limits may also include the area encompassing channelized areas in which traffic is directed into definite paths by islands with raised curbing.

South Salt Lake Street Classifications*

: Freeway
: Arterial
: Collector
: Local
: Transit Line
: Private Street

*: Refer to the most recent South Salt Lake City General Plan for Street Classifications.




SOUTH SALT LAKE CITY LIMITS
2100 S
REFER TO
DOWNTOWN CHARACTER DISTRICT
I-80
2700 S
I-15
300 W
W TEMPLE
MAIN ST.
STATE ST.
S 200 E
300 E
S 500 E
S 700 E
400 E
3300 S
S 500 W
SOUTH SALT LAKE CITY LIMITS

Step 3b: Determine Pedestrian Activity Level Classification

The following are pedestrian classification definitions per IES RP-8-14. The pedestrian counts should be taken during darkness hours when the typical peak number of pedestrians are present. This typically occurs during early morning hours if a school or similar destinations are nearby. The lighting designer should determine what the typical peak hours are for each street.

High:

Areas with significant numbers (over 100 pedestrians an hour) of pedestrians expected to be on the sidewalks or crossing the streets during darkness. Examples are downtown retail areas, near theaters, concert halls, stadiums, and transit terminals. Areas of high pedestrian activity are rare in the City and using this criteria requires city approval.

Medium:

Areas where less numbers (10 to 100 pedestrians an hour) of pedestrians utilize the streets at night. Typical are downtown office areas, blocks with libraries, apartments, neighborhood shopping, industrial, parks, and streets with transit lines.

Low:

Areas with very low volumes (10 or fewer pedestrians per hour) of night pedestrian usage. A low pedestrian classification can occur in any street classifications but may be typified by suburban streets with single family dwellings, very low density residential developments, and rural or semi-rural areas.

Determining Pedestrian Activity Levels

IES pedestrian volumes represent the total number of pedestrians walking in both directions in a typical block or 660 foot section. Pedestrian counts and traffic studies take precedence over other references. To determine pedestrian count per IES RP-8-14: Take one hour of pedestrian counts during the first or last hour of darkness on some select days to establish the estimated pedestrian traffic count. One or two representative blocks, or a single block of unusual characteristics can be counted – such as a discharge from a major event.

Step 4: Establish Lighting Warrants

Using the roadway classification, pedestrian conflict levels, and adjacent land use, lighting warrants can be determined for streets throughout the City. Not all streets in the City will warrant continuous lighting, but all streets must meet the lighting criteria set forth by IES RP-8-14. Table 4.1.1 shows which streets based on street type, pedestrian conflict, and adjacent land use warrant continuous, non-continuous, and no lighting.

Table 4.1.1: Lighting Warrants

Road Classification	Adjacent Land Use	High Pedestrian Conflict Area	Medium Pedestrian Conflict Area	Low Pedestrian Conflict Area
Arterial	**Commercial**	**Continuous**	**Continuous**	**Non-Continuous**
	Industrial	**Continuous**	**Continuous**	**Non-Continuous**
	Residential	**Continuous**	**Non-Continuous**	**Non-Continuous**
	Open Space	**Continuous**	**Non-Continuous**	**Non-Continuous**
Collector	**Commercial**	**Continuous**	**Continuous**	**Non-Continuous**
	Industrial	**Continuous**	**Continuous**	**Non-Continuous**
	Residential	**Continuous**	**Non-Continuous**	**Non-Continuous**
	Open Space	**Non-Continuous**	**Non-Continuous**	**Not Warranted**
Local	**Commercial**	**Continuous**	**Non-Continuous**	**Non-Continuous**
	Industrial	**Continuous**	**Non-Continuous**	**Non-Continuous**
	Residential	**Non-Continuous**	**Non-Continuous**	**Non-Continuous**
	Open Space	**Non-Continuous**	**Non-Continuous**	**Not Warranted**

Step 5: Identify Influential Conditions

The most influential conditions when evaluating which lighting improvement strategy to implement are the existing conditions and proposed character district improvements. There may be other factors that will influence the lighting layout, lighting design, and improvement method selection such as character district influence.

Observed Existing Conditions

The existing conditions map in *Chapter 2.3* assumes all lights in the City are in working order, however that is not always the case. There may be lights that are damaged, nonoperational, or failing due to wiring issues. Before a lighting improvement strategy is selected, it is important that the site is surveyed, and the real existing conditions are documented. If the luminaire is damaged or nonoperational, a 1-for-1 replacement is sufficient to update the lighting. If the pole has been damaged or the wiring is failing, more comprehensive improvements are needed.

Other Conflicts

Other conflicts may exist along public streets in the City that influence the lighting layout and replacement strategy.

- Light standards cannot be installed in the immediate vicinity of overhead power lines. If overhead power lines are present, all street lighting must be mounted to the utility pole on the overhead power line side of the street. This will influence the lighting layout and may call for additional luminaires on the other side of the street.
- Dead end streets in the City warrant lighting at the termination of the roadway.

Lights Mounted to Power Poles where conflict exists.

Step 6: Determine Lighting Improvement Strategy

The appropriate lighting improvement strategy for each site should be determined using the first five steps of this chapter.

Comprehensive improvements should be made if:

- The existing lighting conditions, provided by the map or determined during site inspection, are poor.
- The site is in a character district that requires updated light fixtures or the addition of pedestrian lighting.
- There is not currently light where continuous lighting is warranted.

Supplemental Improvements should be made if:

- The existing lighting conditions, provided by the map or determined during site inspection, are moderately acceptable.
- Continuous lighting is warranted and existing conditions need to be supplemented to achieve this.

Minimal Improvements should be made if:

- The existing lighting conditions, provided by the map or determined during site inspection, are acceptable.

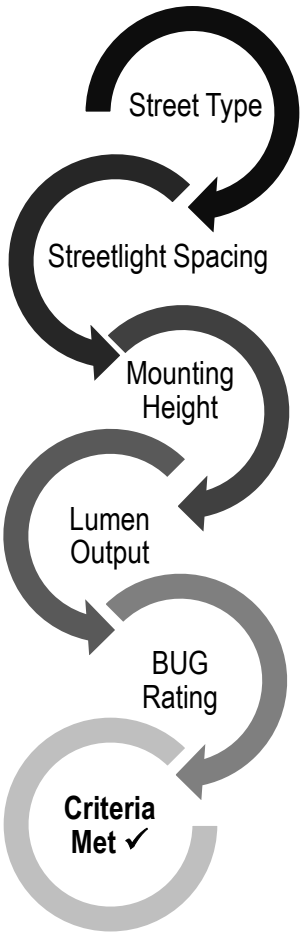
4.2 Comprehensive Improvements

4.2.1 Purpose

This chapter is used for new installations of public street and pedestrian lighting, either stand alone or on traffic signal installations, and modifications to existing street lighting installations that affect pole types or locations, excluding minor maintenance work. Refer to *Chapter 4.3: Minimal Improvements* for projects involving 1-for-1 luminaire replacement and supplemental improvements.

4.2.2 Lighting Design Process

Performing a lighting design for new installations of streetlights is an iterative process. This occurs because the lighting design is altered (spacing, arrangement, mounting height) until the target goal is met, per criteria set forth in this document, for the specific street. The most efficient method is to calculate luminance for straight streets or illuminance for intersections and non-straight streets, along with sidewalks and other pedestrian areas with varying luminaire parameters. The selected luminaire must comply with the lumen output, efficacy, BUG ratings, and other luminaire requirements specified in *Chapter 4.4*. Care should be taken, when selecting a luminaire to illuminate the surrounding sidewalks and public spaces without causing light trespass, or unwanted light spills onto surrounding properties and through residential windows. Instructions on setting up the lighting design calculations can be found in *Chapter 4.5.*



4.2.3 Luminaire Spacing and Criteria

The following pages describe the luminaire selection and lighting layout for each street classification. Designers should strive to meet the luminaire spacing that will provide the highest quality street lighting possible, but this is not always feasible. It is necessary to integrate lighting locations in correspondence to other improvements:

- Clearance from driveways (10 feet commercial and 5 feet residential).
- Clearance from fire hydrants (5 feet).
- Trees (centered in between trees or 20 feet from the tree trunk).

Place poles and luminaires near property lines wherever practical and avoid locations in front of doorways, windows, and lines of egress.

Based on a study by the Northwest Energy Efficiency Alliance (NEEA)[1], LED street lights provide the same, if not enhanced, visibility with less amount of light. This Master Plan reduces all IES roadway criteria by 20% when designing with LED street lights.

Intersections & Crosswalks

The same luminaires are to be used throughout the intersection. When an intersection is between two different street classifications, the higher street classification target criteria is used throughout the entire intersection. The recommended streetlight layout for an intersection is also dependent on whether the street classification calls for continuous or non-continuous lighting.

Table 4.2.1: Intersection & Crosswalk Target Horizontal Criteria per IES RP-8-14

Functional Classification	Average Horizontal Illuminance (fc) by Pedestrian Classification			Avg:Min Illuminance
	High[2]	Medium	Low	
Arterial/Arterial	3.4	2.6	1.8	3
Arterial/Collector	2.9	2.2	1.5	3
Arterial/Local	2.6	2.0	1.3	3
Collector/Collector	2.4	1.8	1.2	4
Collector/Local	2.1	1.6	1	4
Local/Local (>30mph)	1.8	1.4	1	6
Local/Local (<30mph)	n/a	n/a	n/a	n/a

Table 4.2.2: Intersection & Crosswalk Target Vertical Criteria

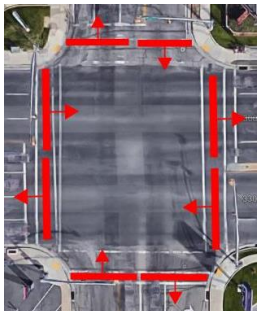
Functional Classification	Average Vertical Illuminance (fc) by Pedestrian Classification		
	High[2]	Medium	Low
Arterial/Arterial	1.4	0.9	0.5
Arterial/Collector	0.9	0.6	0.4
Arterial/Local	0.8	0.6	0.4
Collector/Collector	0.7	0.5	0.5
Collector/Local	0.6	0.5	0.3
Local/Local (>30mph)	0.5	0.4	0.2
Local/Local (<30mph)	n/a	n/a	n/a

[1] "Seattle LED Adaptive Lighting Study" Northwest Energy Efficiency Alliance *https://neea.org/docs/default-source/reports/seattle-led-adaptive-lighting-study.pdf?sfvrsn=4*

[2] A high pedestrian classification is not common in South Salt Lake. Use of this criteria requires City Engineer's approval.

Signalized/Continuous Lighting

For a signalized intersection, with continuous lighting, the typical streetlight arrangement is interrupted by placing streetlight signal poles. Another streetlight should be located along the approach to the crosswalk, installed half to one luminaire mounting height in front of the crosswalk. This is called out as "1/2 to 1 mounting height to centerline of crosswalk (Typical)" in Figure 4.2.1 and Figure 4.2.2 below. Vertical illuminance measurements are taken 5ft. above the roadway surface in the direction of oncoming traffic.



Crosswalk Meter Orientation

Figure 4.2.1: Typical Intersection Lighting Layout with Signals and Continuous Lighting

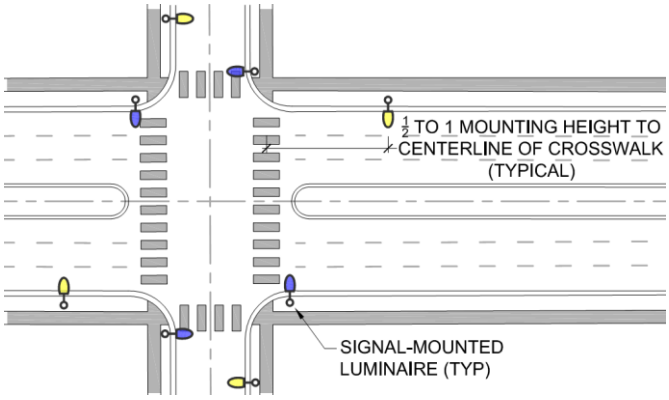
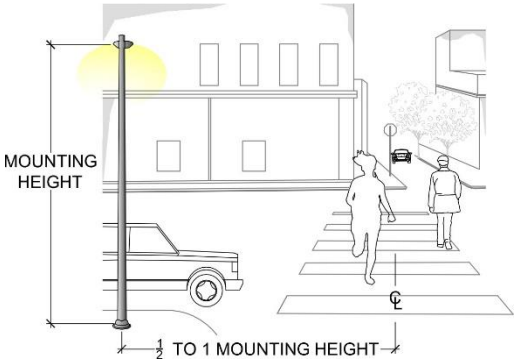


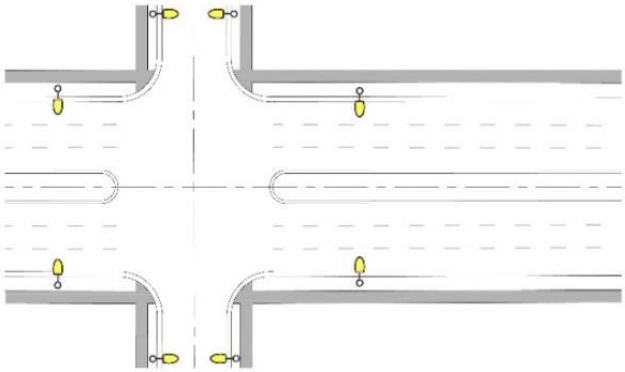
Figure 4.2.2: Streetlight Placement with Respect to Crosswalk



Non-Signalized/Continuous Lighting

For a non-signalized intersection with continuous lighting, the typical streetlight arrangement is continued through the intersection (see Figure 4.2.3). The streetlights should be located along the approach to the crosswalk, if it exists, installed half to one luminaire mounting height in front of the crosswalk, between approaching vehicles and pedestrians.

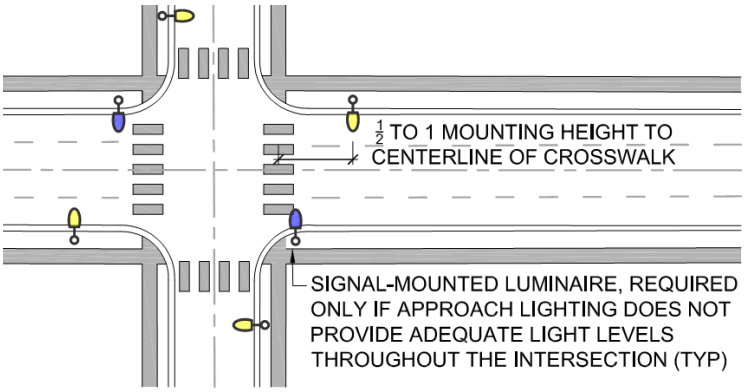
Figure 4.2.3: Typical Intersection Lighting Layout with No Signals and Continuous Lighting



Signalized/Non-Continuous Lighting

For signalized intersections with non-continuous lighting, luminaires are located half to one luminaire mounting height in front of the crosswalk, illuminating the approach to the intersection. If these four luminaires do not provide sufficient lighting throughout the entire intersection, two more additional luminaires may be used, to be mounted on the signals as shown in Figure 4.2.4.

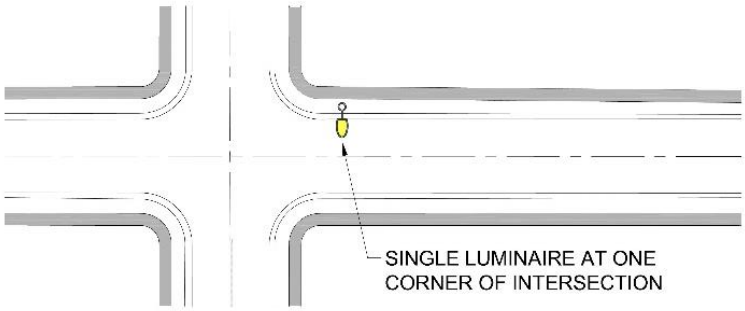
Figure 4.2.4: Typical Intersection Lighting Layout with Signals and Non-Continuous Lighting



Non-Signalized/Non-Continuous Lighting

For streets with non-continuous lighting and no signals, one luminaire is to be placed at each intersection, as shown in Figure 4.2.5. Refer to the *Local Street* chapter for more information.

Figure 4.2.5 Typical Intersection Lighting Layout with No Signals and Non-Continuous Lighting



Arterial Street – Six Lanes, Non-Median Mounted

The figures and tables below provide direction on the appropriate luminaire selection and non-median lighting layout when designing a six-lane arterial. Luminaires are to be placed in an opposite arrangement when not located at an intersection.

Figure 4.2.6: Typical Six Lane Arterial (non-median mounted) Lighting Layout

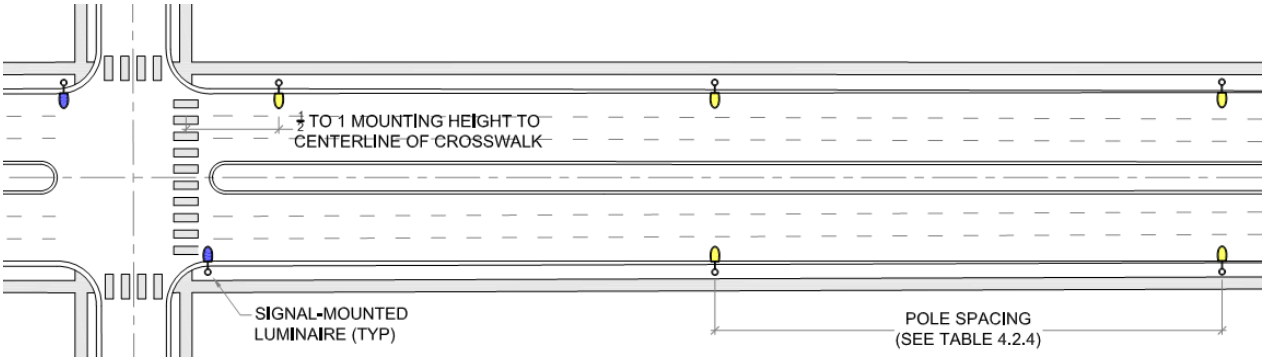


Figure 4.2.7: Typical Six Lane Arterial (non-median mounted) Street Cross Section

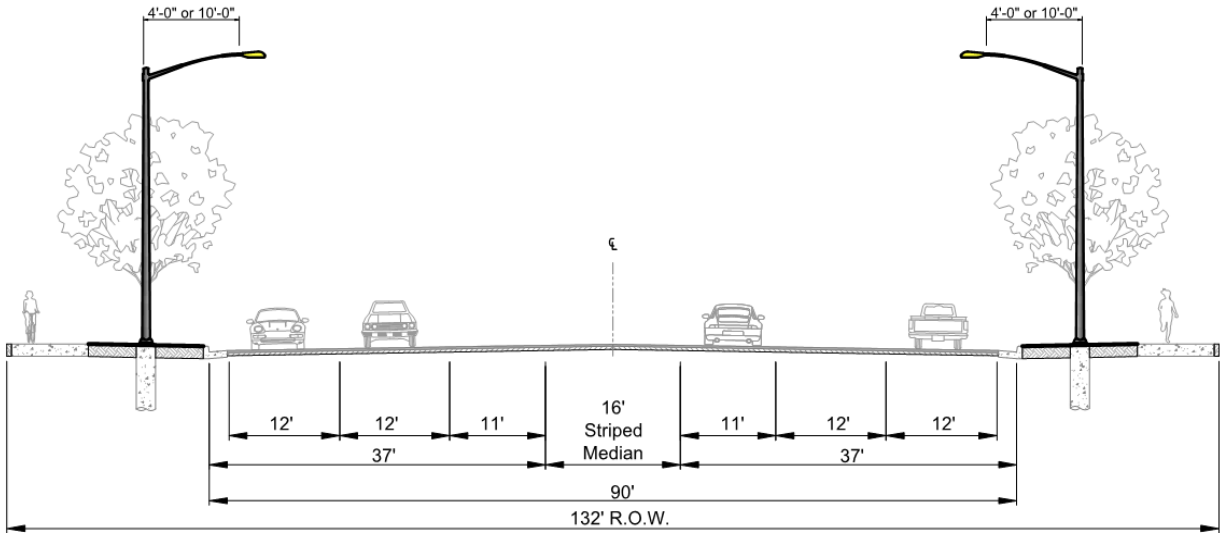


Table 4.2.3: Arterial Target Criteria 80% of IES RP-8-14

Pedestrian Activity	Roadway		Sidewalks
	Average Luminance (cd/m2)	**Luminance Avg:Min Ratio**	**Average Illuminance (fc)**
High[3]	**1.0**	**3.0**	**1.0[4]**
Medium	**0.7**	**3.0**	**0.5**
Low	**0.5**	**3.5**	**0.4**

Table 4.2.4: Recommended Six-Lane Arterial (non-median mounted) Luminaire & Pole Criteria

Pedestrian Activity	Pole Spacing (ft)	Pole Height (ft)	Lumen Output (lm)	Typical Photometric Distribution	Max. BUG Rating
High[3]	**150-250**	**35**	**15,000-20,000**	**Type II**	**B3-U0-G2**
Medium	**150-250**	**35**	**12,000-18,000**	**Type II**	**B3-U0-G2**
Low	**200-250**	**35**	**11,000-14,000**	**Type II**	**B2-U0-G2**

[3] High pedestrian classification is not common in South Salt Lake. Use of this criteria requires City Engineer's approval.
[4]Additional pedestrian lighting is warranted in high pedestrian activity zones.

Arterial Street – Four Lanes, Non-Median Mounted

The figures and tables below provide direction on the appropriate luminaire selection and non-median lighting layout when designing a four-lane arterial, when parking is not allowed along the street. Luminaires are to be placed in an opposite arrangement when not located at an intersection.

Figure 4.2.8: Typical Four Lane Arterial (non-median mounted) Lighting Layout

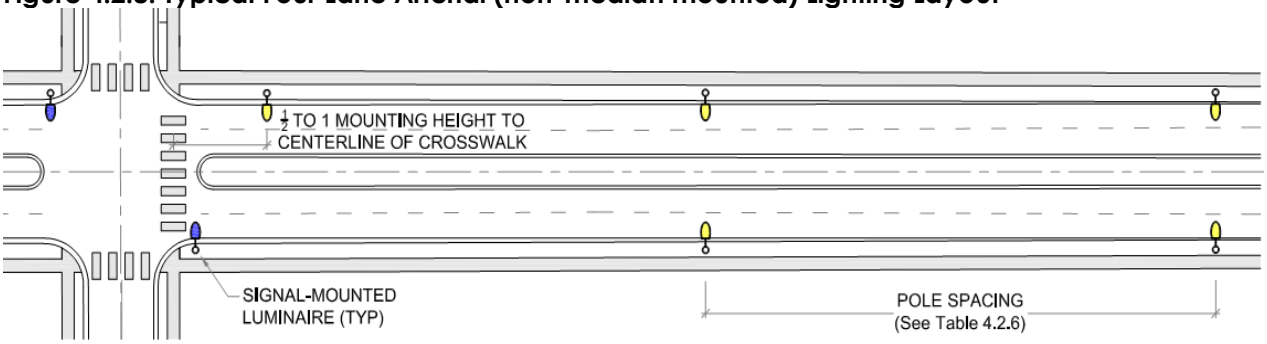


Figure 4.2.9: Typical Four Lane Arterial (non-median mounted) Street Cross Section

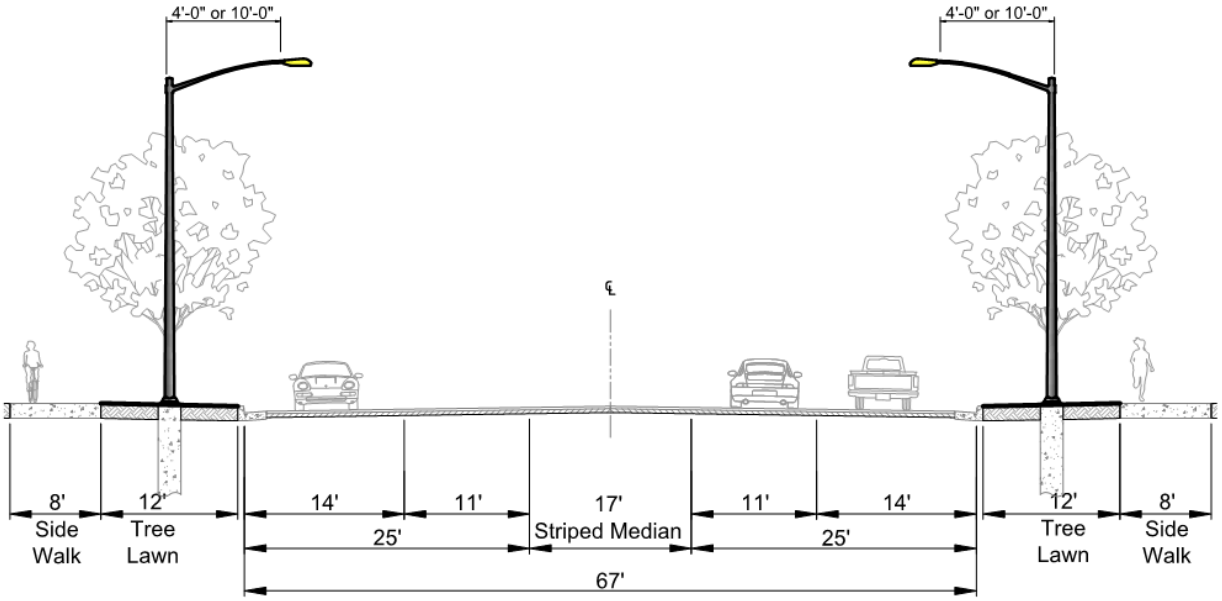


Table 4.2.5: Arteria Target Criteria 80% of IES RP-8-14

Pedestrian Activity	Roadway		Sidewalks
	Average Luminance (cd/m2)	**Luminance Avg:Min Ratio**	**Average Illuminance (fc)**
High[3]	**1.0**	**3.0**	**1.0[4]**
Medium	**0.7**	**3.0**	**0.5**
Low	**0.5**	**3.5**	**0.4**

Table 4.2.6: Recommended Four Lane Arterial (non-median mounted) Luminaire Criteria

Pedestrian Activity	Pole Spacing (ft)	Pole Height (ft)	Lumen Output (lm)	Typical Photometric Distribution	Max. BUG Rating
High[3]	**150-250**	**35**	**15,000-20,000**	**Type II**	**B3-U0-G2**
Medium	**150-250**	**35**	**12,000-18,000**	**Type II**	**B3-U0-G2**
Low	**200-250**	**35**	**11,000-14,000**	**Type II**	**B2-U0-G2**

[3] High pedestrian classification is not common in South Salt Lake. Use of this criteria requires City Engineer's approval.
[4]Additional pedestrian lighting is warranted in high pedestrian activity zones.

Arterial Street – Four Lanes with Parking, Non-Median Mounted

The figures and tables below provide direction on the appropriate luminaire selection and non-median lighting layout when designing a four-lane arterial, and parking is allowed along the street. Luminaires are to be placed in an opposite arrangement when not located at an intersection.

Figure 4.2.10: Typical Four Lane Arterial with Parking (non-median mounted) Lighting Layout

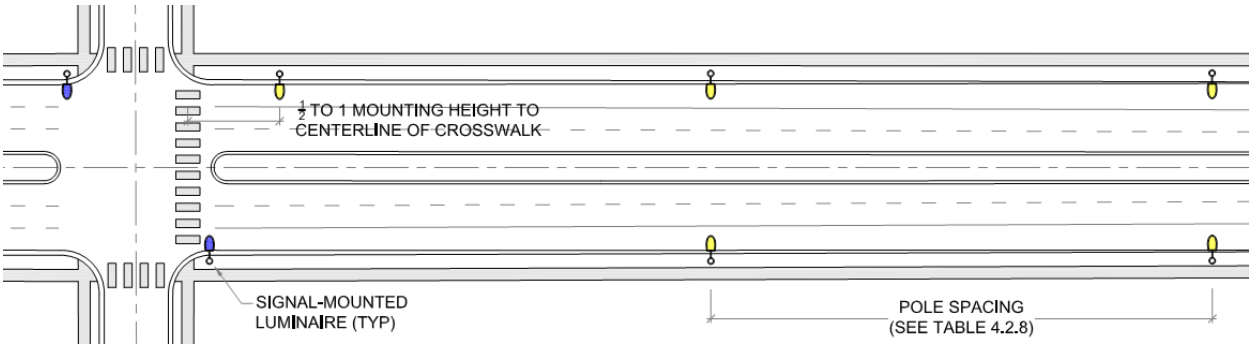


Figure 4.2.11: Typical Four Lane Arterial with Parking (non-median mounted) Street Cross Section

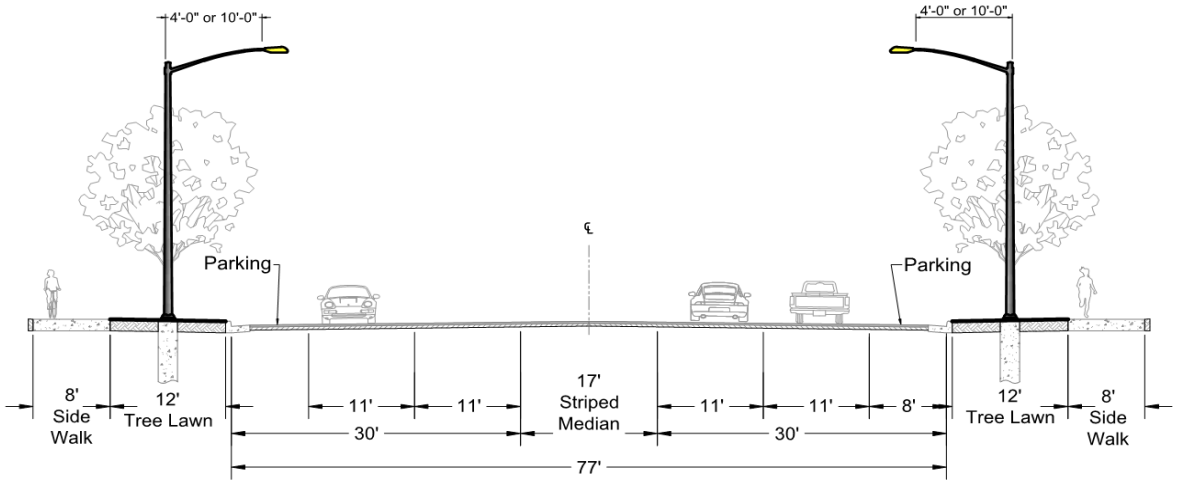


Table 4.2.7: Arterial Target Criteria 80% of IES RP-8-14

Pedestrian Activity	Roadway		Sidewalks
	Average Luminance (cd/m²)	**Luminance Avg:Min Ratio**	**Average Illuminance (fc)**
High[3]	**1.0**	**3.0**	**1.0[4]**
Medium	**0.7**	**3.0**	**0.5**
Low	**0.5**	**3.5**	**0.4**

Table 4.2.8: Recommended Four Lane Arterial with Parking (non-median mounted) Luminaire Criteria

Pedestrian Activity	Pole Spacing (ft)	Pole Height (ft)	Lumen Output (lm)	Typical Photometric Distribution	Max. BUG Rating
High[3]	**150-250**	**35**	**15,000-20,000**	**Type II**	**B3-U0-G2**
Medium	**150-250**	**35**	**12,000-18,000**	**Type II**	**B3-U0-G2**
Low	**200-250**	**35**	**11,000-14,000**	**Type II**	**B2-U0-G2**

[3] High pedestrian classification is not common in South Salt Lake. Use of this criteria requires City Engineer's approval.
[4]Additional pedestrian lighting is warranted in high pedestrian activity zones.

Boulevard Street (Downtown Character District Only)

Boulevard streets have both street and pedestrian lighting and are in the *Downtown Character District*. The figures and tables below provide direction on the appropriate luminaire selection and lighting layout when designing street and pedestrian lighting for Boulevards. Street and pedestrian lights will be combined on the same pole with supplemental pedestrian lights between the combination poles when needed to meet sidewalk lighting criteria. See Figure 4.2.14 for combination pole section.

Figure 4.2.12: Typical Four Lane Boulevard Street and Pedestrian Lighting Layout

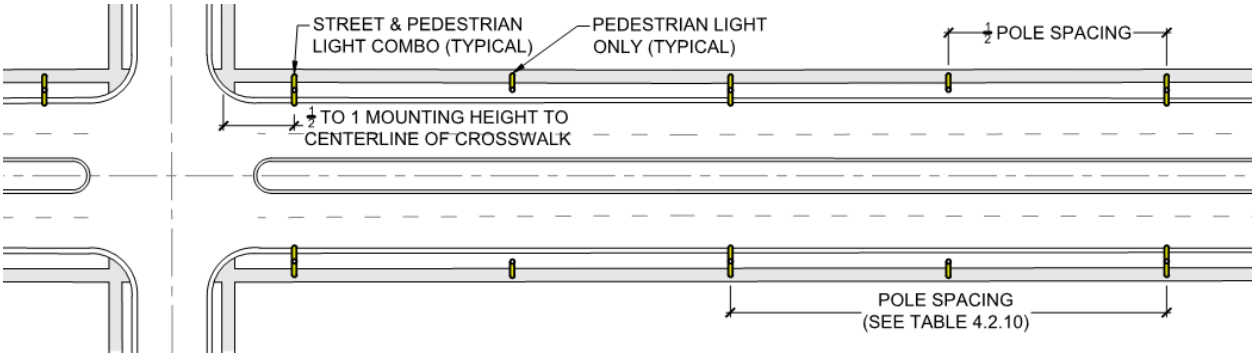


Figure 4.2.13: Typical Four Lane Boulevard Cross Section

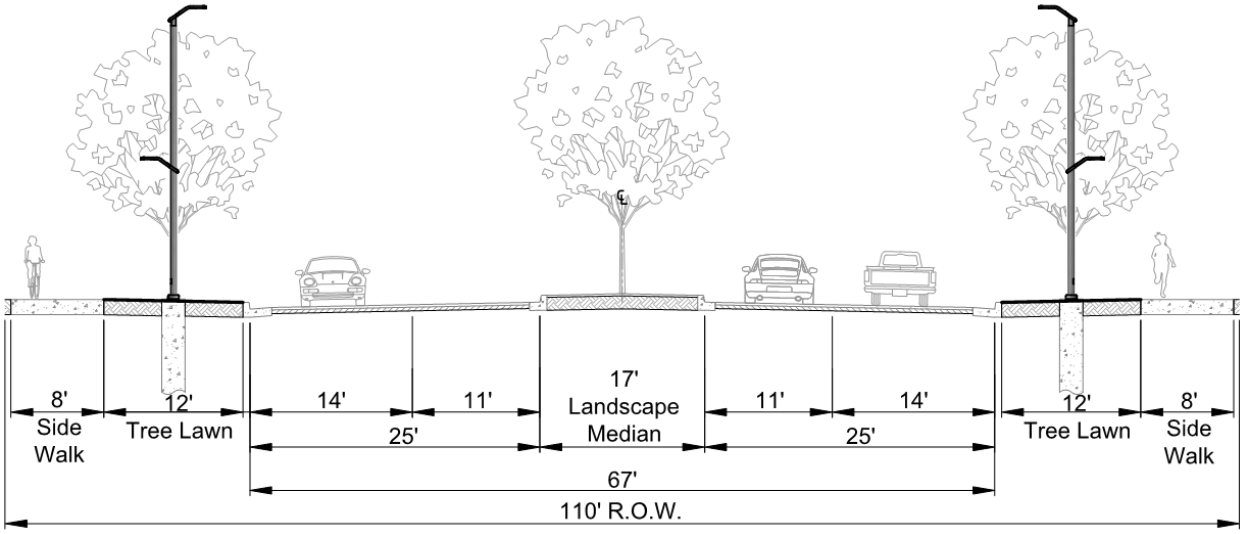


Table 4.2.9: Arterial Target Criteria 80% of IES RP-8-14

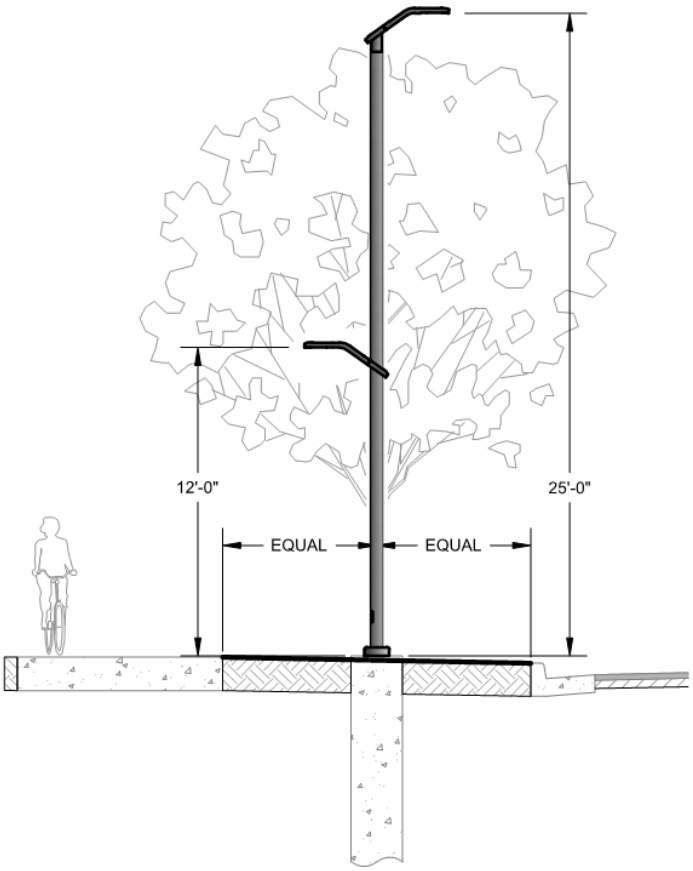
Pedestrian Activity	Roadway		Sidewalks
	Average Luminance (cd/m²)	**Luminance Avg:Min Ratio**	**Average Illuminance (fc)**
High[3]	**1.0**	**3.0**	**1.0[4]**
Medium	**0.7**	**3.0**	**0.5**
Low	**0.5**	**3.5**	**0.4**

[3] High pedestrian classification is not common in South Salt Lake. Use of this criteria requires City Engineer's approval.
[4]Additional pedestrian lighting is warranted in high pedestrian activity zones.

Table 4.2.10: Recommended Boulevard Luminaire Criteria and Spacing

Pedestrian Activity	Combination Pole Spacing (ft)	Street Luminaire Mounting Height (ft)	Pedestrian Luminaire Mounting Height (ft)	Street Luminaire Lumen Output (lm)	Pedestrian Luminaire Lumen Output (lm)	Street Luminaire Photometric Distribution	Pedestrian Luminaire Photometric Distribution	Max. BUG Rating
High[3]	**100**	**25**	**12**	**4,500-5,000**	**2,500-3,500**	**Type II**	**Type II**	**B3-U0-G2**
Medium	**100-120**	**25**	**12**	**4,500-5,000**	**2,500-3,500**	**Type II**	**Type II**	**B3-U0-G2**
Low	**120-180**	**25**	**12**	**4,500-5,000**	**2,500-3,500**	**Type II**	**Type II**	**B3-U0-G2**

Figure 4.2.14: Combination Pole Section



[3] High pedestrian classification is not common in South Salt Lake. Use of this criteria requires City Engineer's approval.
[4]Additional pedestrian lighting is warranted in high pedestrian activity zones.

Street Lighting with Pedestrian Lighting

In the *Corridor Commercial Character District*, certain areas with higher levels of pedestrian traffic will have pedestrian specific lighting. The figures below provide direction on the appropriate lighting layout when designing for street lighting with pedestrian lighting. The luminaire selection and lighting criteria will match the street classification. Street lights are to be placed in an opposite arrangement and pedestrian luminaires should comply with the recommended light levels for sidewalks based on pedestrian traffic.

Figure 4.2.15: Typical Arterial Street with Pedestrian Lighting Layout

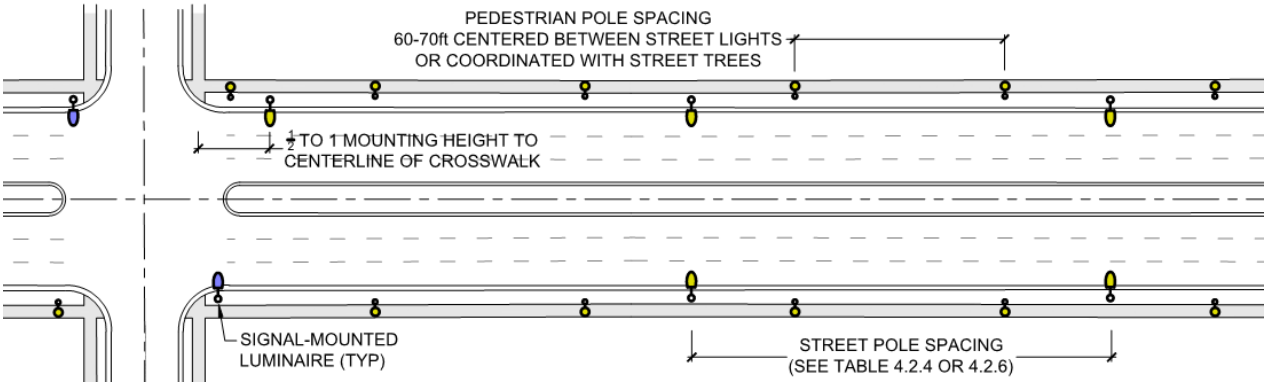


Figure 4.2.16: Typical Arterial Street with Pedestrian Lighting Section

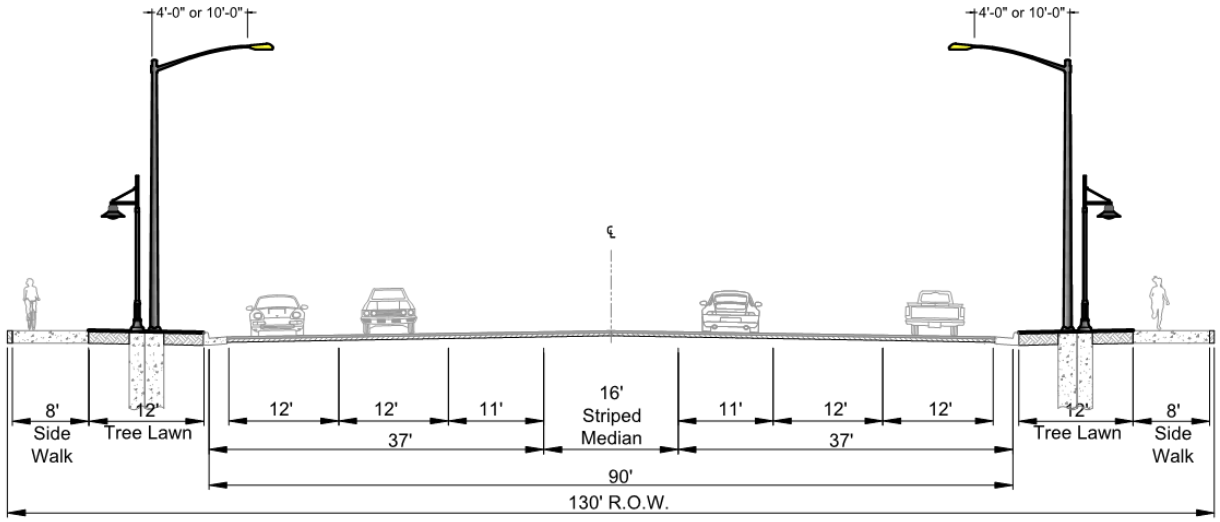


Table 4.2.11: Arterial Target Criteria 80% of IES RP-8-14

Pedestrian Activity	Roadway		Sidewalks
	Average Luminance (cd/m²)	**Luminance Avg:Min Ratio**	**Average Illuminance (fc)**
High[3]	**1.0**	**3.0**	**1.0[4]**
Medium	**0.7**	**3.0**	**0.5**
Low	**0.5**	**3.5**	**0.4**

Connector, S-Line Transit, and Festival Streets (Downtown Character District Only)

Connector and S-Line transit streets have both street and pedestrian lighting and are in the *Downtown Character District*. The figures and tables below provide direction on the appropriate luminaire selection and lighting layout for street and pedestrian lighting. Street and pedestrian lights will be combined on the same pole with supplemental pedestrian lights between the combination poles where needed to meet sidewalk illuminance criteria.

Figure 4.2.17: Typical S-Line Transit Street and Pedestrian Lighting Layout

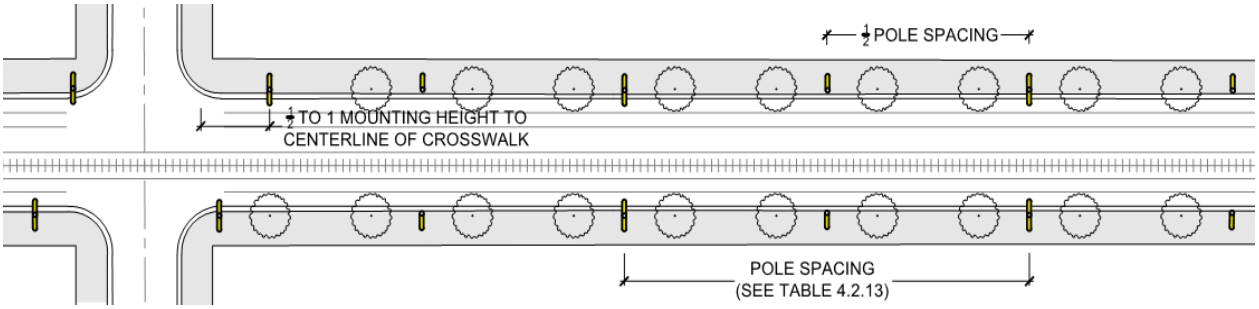


Figure 4.2.18: Typical S-Line Transit Street and Pedestrian Lighting Section

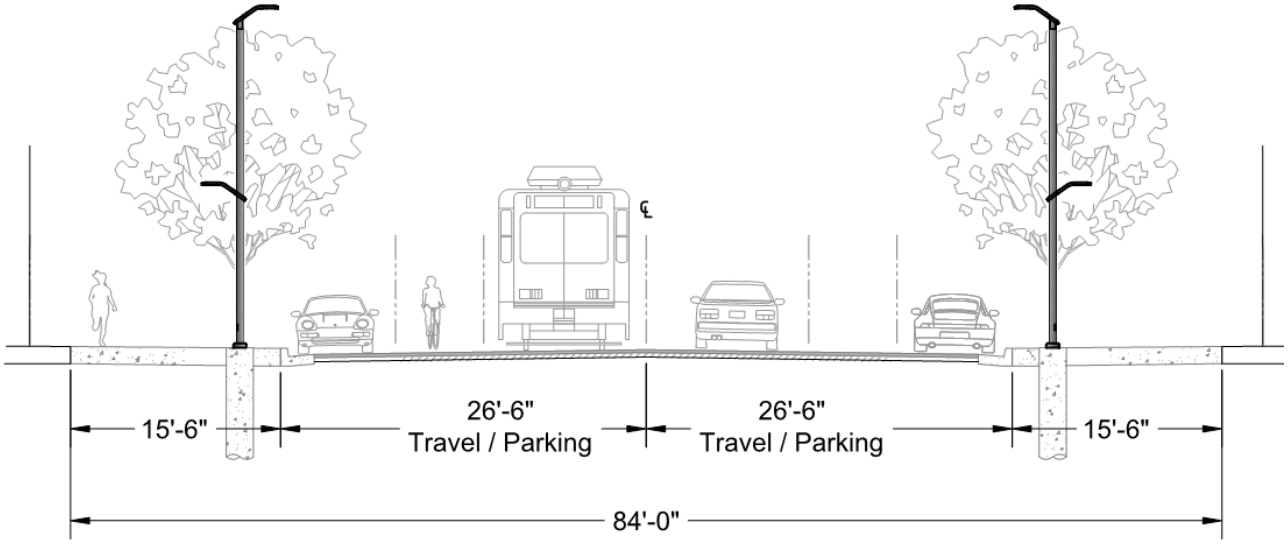


Table 4.2.12: Collector Target Criteria per 80% of RP-8-14

Pedestrian Activity	Roadway		Sidewalks
	Average Luminance (cd/m²)	**Luminance Avg:Min Ratio**	**Average Illuminance (fc)**
High[3]	**0.6**	**3.0**	**1.0[4]**
Medium	**0.5**	**3.5**	**0.5**

[3] High pedestrian classification is not common in South Salt Lake. Use of this criteria requires City Engineer's approval.
[4]Additional pedestrian lighting is warranted in high pedestrian activity zones.

Table 4.2.13: Recommended Connector and S-Line Luminaire Criteria and Spacing

Pedestrian Activity	Combination Pole Spacing (ft)	Street Luminaire Mounting Height	Pedestrian Luminaire Mounting Height	Street Luminaire Lumen Output (lm)	Pedestrian Luminaire Lumen Output (lm)	Street Luminaire Photometric Distribution	Pedestrian Luminaire Photometric Distribution	Max. BUG Rating
High[3]	**100-140**	**25**	**12**	**4,500-5,000**	**2,500-3,500**	**Type II**	**Type II**	**B2-U0-G2**
Medium	**140-180**	**25**	**12**	**4,500-5,000**	**2,500-3,500**	**Type II**	**Type II**	**B2-U0-G2**

[3] High pedestrian classification is not common in South Salt Lake. Use of this criteria requires City Engineer's approval.

Collector Street /Avenue

The figures and tables below provide direction on the appropriate luminaire selection and lighting layout for collector streets or avenue. Luminaires are to be placed in an opposite arrangement when not located at an intersection.

Figure 4.2.19: Typical Collector Lighting Layout

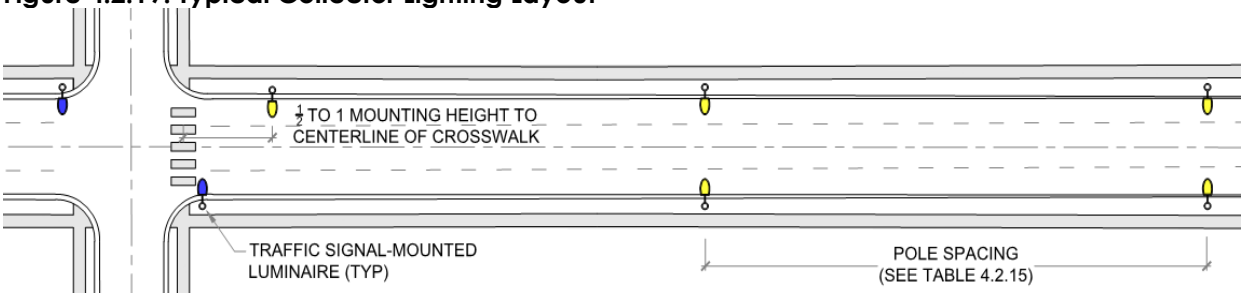


Figure 4.2.20: Typical Collector Street Cross Section

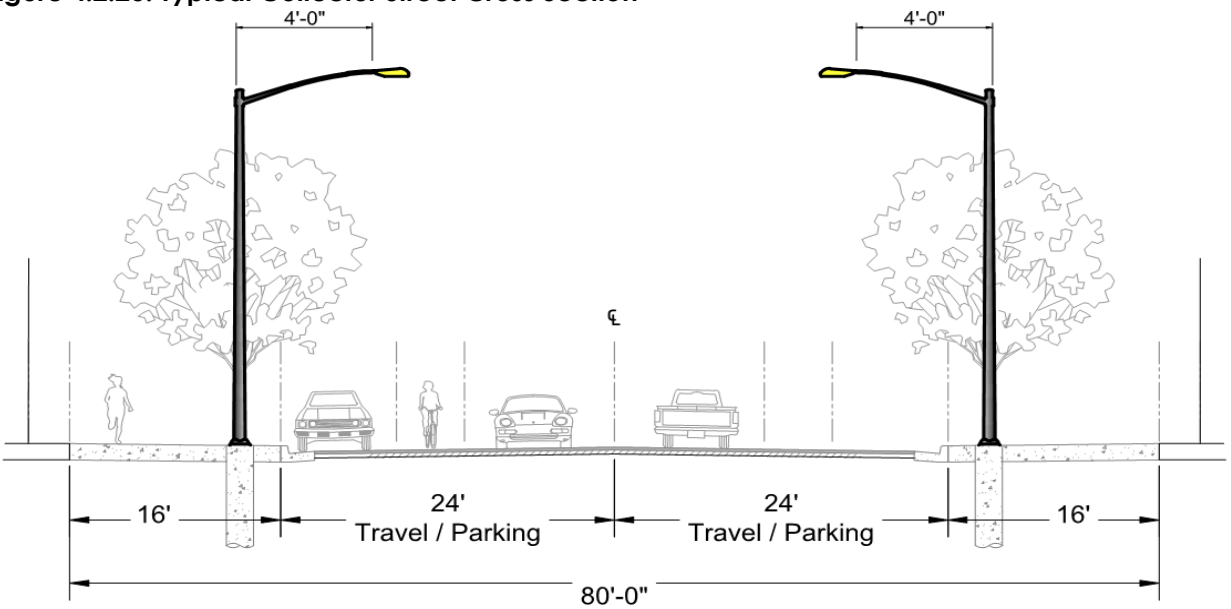


Table 4.2.14: Collector Target Criteria 80% IES RP-8-14

Pedestrian Activity	Roadway		Sidewalks
	Average Luminance (cd/m²)	**Luminance Avg:Min Ratio**	**Average Illuminance (fc)**
High[3]	**0.6**	**3.0**	**1.0[4]**
Medium	**0.5**	**3.5**	**0.5**
Low	**0.3**	**4.0**	**0.4**

Table 4.2.15: Recommended Collector Luminaire Criteria

Pedestrian Activity	Pole Spacing (ft)	Pole Height (ft)	Lumen Output (lm)	Typical Photometric Distribution	Max. BUG Rating
High[3]	**150-225**	**35**	**6,500-9,000**	**Type II Medium**	**B2-U0-G2**
Medium	**150-250**	**35**	**4,500-8,500**	**Type II Medium**	**B1-U0-G1**
Low	**175-300**	**35**	**4,000-5,500**	**Type II Medium**	**B1-U0-G1**

[3] High pedestrian classification is not common in South Salt Lake. Use of this criteria requires City Engineer's approval.
[4]Additional pedestrian lighting is warranted in high pedestrian activity zones.

Local/Neighborhood Street

The figures and tables below provide direction on the appropriate luminaire selection and lighting layout for local street.

Local streets are lighted with one light at each intersection and a light at the mid-block, for any street with speeds under 30 mph. If an alley is located along the street, the mid-block luminaire should be located adjacent to the alley entrance. If the length of the block is over 750 ft, an additional mid-block streetlight may be warranted to ensure that pedestrians feel visually comfortable when walking along the street.

Figure 4.2.21: Typical Local Lighting Layout for Road with Speeds Less Than 30 mph (<30 mph)

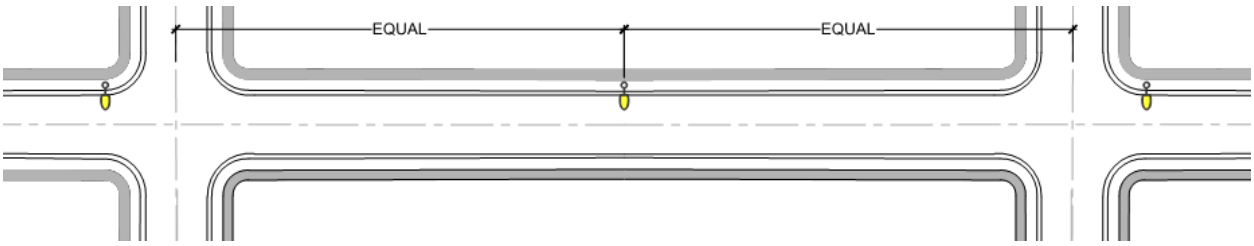


Figure 4.2.22: Typical Local Lighting Layout for Roads with Speeds of 30mph or Greater (≥30 mph)

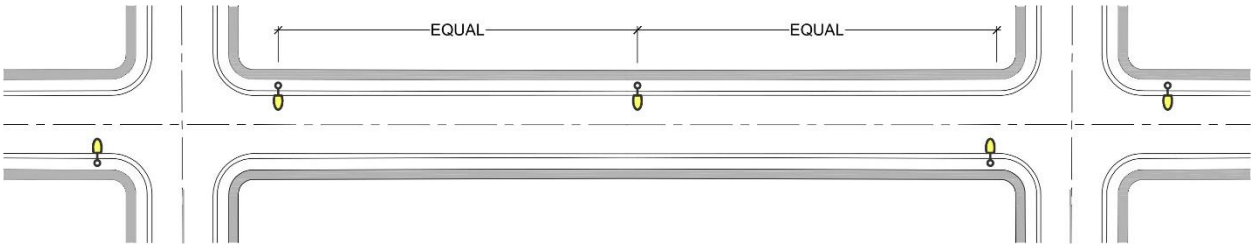


Figure 4.2.23: Typical Local Street Cross Section

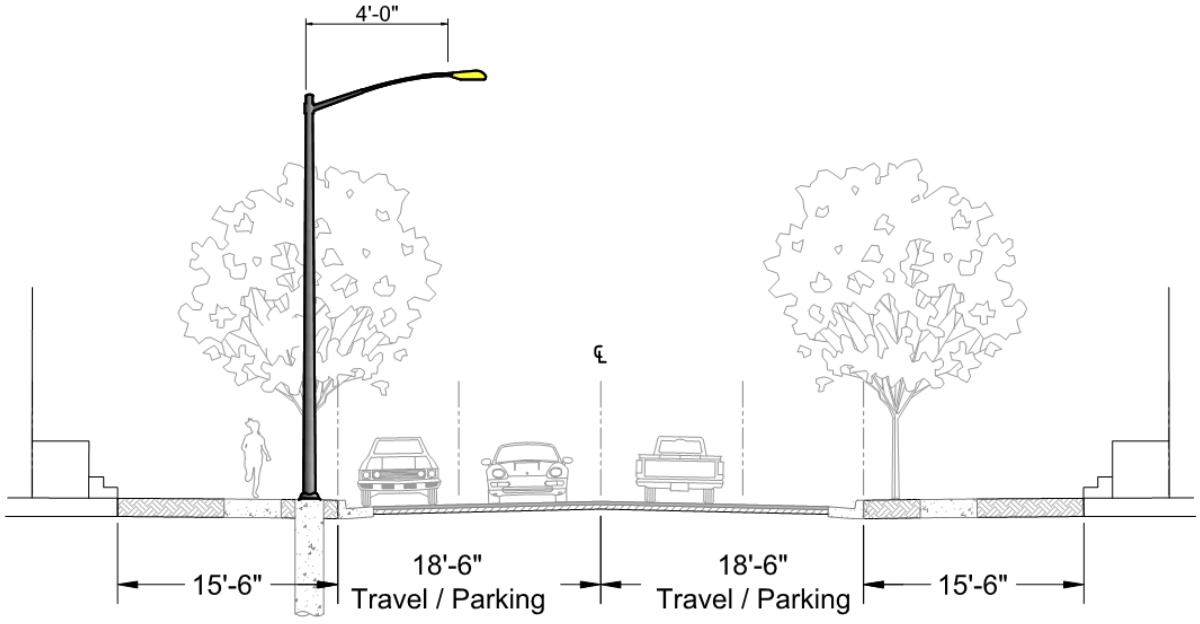


Table 4.2.16: Local Target Criteria 80% of IES RP-8-14

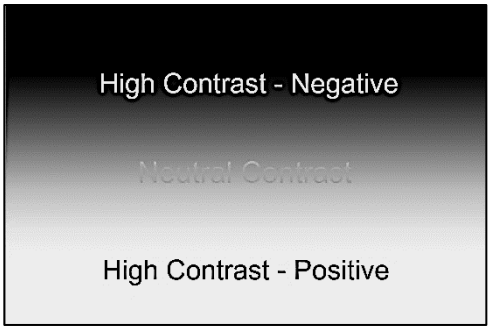
Pedestrian Activity	Roadway		Sidewalks
	Average Luminance (cd/m²)	**Luminance Avg:Min Ratio**	**Average Illuminance (fc)**
High[5]	**0.5**	**6.0**	**1.0**
Medium[5]	**0.4**	**6.0**	**0.5**
Low (≥ 30 mph)	**0.2**	**6.0**	**0.4**
Low (< 30 mph)	**N/A**	**N/A**	**N/A**

Table 4.2.17: Recommended Local Luminaire Criteria

Pedestrian Activity	Posted Speed	Pole Height (ft)	Lumen Output (lm)	Typical Photometric Distribution	Max. BUG Rating
High[5]	**All**	**25-30**	**2,000-5,000**	**Type II Medium**	**B1-U0-G1**
Medium[5]	**All**	**25-30**	**2,000-4,500**	**Type II Medium**	**B1-U0-G1**
Low	**≥ 30 mph**	**25-30**	**2,000-4,000**	**Type II Medium**	**B1-U0-G1**
Low	**< 30 mph**	**25-30**	**2,000-4,000**	**Type II Medium**	**B1-U0-G1**

[5]A high or medium pedestrian classification on a local road is unlikely and requires City Engineer's approval. Additional ambient lighting is required to properly light the sidewalks and other pedestrian areas.

4.2.4 Lighting Layouts

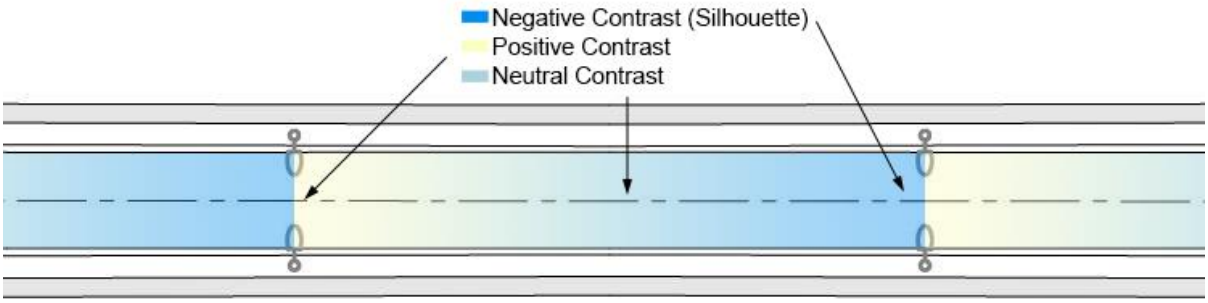


Negative, Neutral & Positive Contrast

An opposite lighting layout is recommended when designing a new streetlight installation to minimize neutral contrast occurrences. Neutral, vertical contrast occurs when an object is both positively contrasted (light strikes the front of the surface) and negatively contrasted (light strikes the back of the surface causing a silhouette). The equal levels of positive and negative contrast result in uniform lighting of the object, making it difficult to distinguish it from background surfaces. The difference between the object and the surrounding roadway luminance (brightness) is referred to as small target visibility (STV). Additional information on STV can be found in IES RP-8-14 Section A.8 *Calculation of Target Visibility*. A depiction of an opposite arrangement with neutral, vertical contrast is shown in Figure 4.2.24. Figure 4.2.25 shows an increased amount of neutral contrast areas using a staggered arrangement.

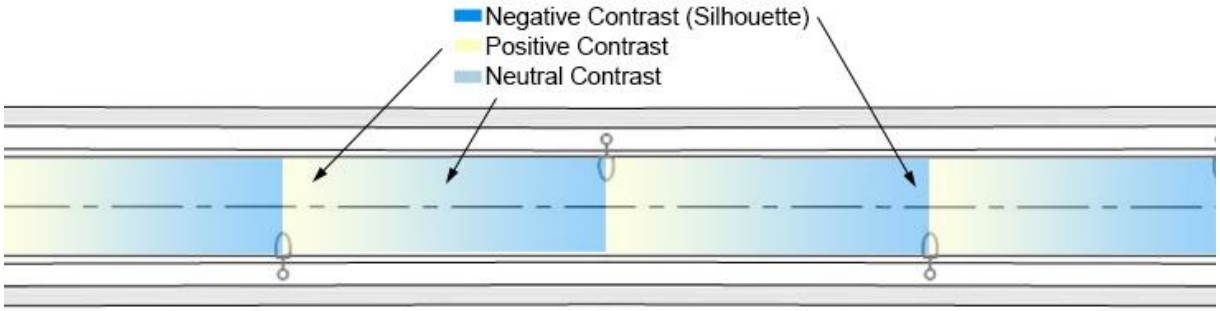
By locating the luminaires across from each other, the sections of roadway with neutral, vertical contrast are minimized. If an opposite arrangement is not possible due to how narrow the curb to curb width of the road is, then a single sided arrangement is recommended. Similar to an opposite arrangement, a single sided layout will minimize the neutral contrast along a roadway.

Figure 4.2.24: Opposite Arrangement



Many existing light layouts are staggered arrangement. This lighting arrangement results in a higher quantity of roadway sections with neutral, vertical contrast.

Figure 4.2.25: Staggered Arrangement



*Although not preferred, staggered arrangements are permitted when using a 1-for-1 replacement strategy.

4.2.5 Atypical Street Sections

Horizontal Curves

Streets that have a radius of 2,000 feet (600 meters) or less (measured from the center point to curb face) can use criteria for horizontal illuminance for straight streets. Streets that have a radius greater than 2000 feet rounded, to the nearest 100 feet, should be designed using luminance criteria.

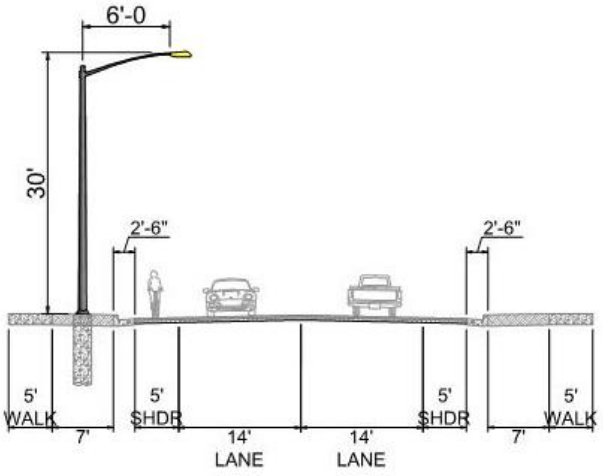
Additional design guidance is provided below:

- Sharper radius curves (less than 2000 feet, rounded to the nearest 100 feet) requires closer spacing of luminaires to provide higher pavement illuminance.
- Poles should be located behind guard rails (including the guardrail's expected deflection distance) or other natural barriers, and at a minimum of two feet behind the edge of the shoulder or three feet behind the face of curb.
- Place poles on the inside of curve where feasible, there is some evidence that poles are more likely to be involved in accidents if placed on the outside of curves.
- Aim luminaires with mast arm perpendicular to the centerline of the street.

Single-Sided Luminaire Arrangement

Where luminaires are proposed on one side of the street only, the luminance criteria from RP-8-14 should be applied individually to both the near side and the far side of the street and then averaged together.

Figure 4.2.26: Typical Single-Sided Cross Section



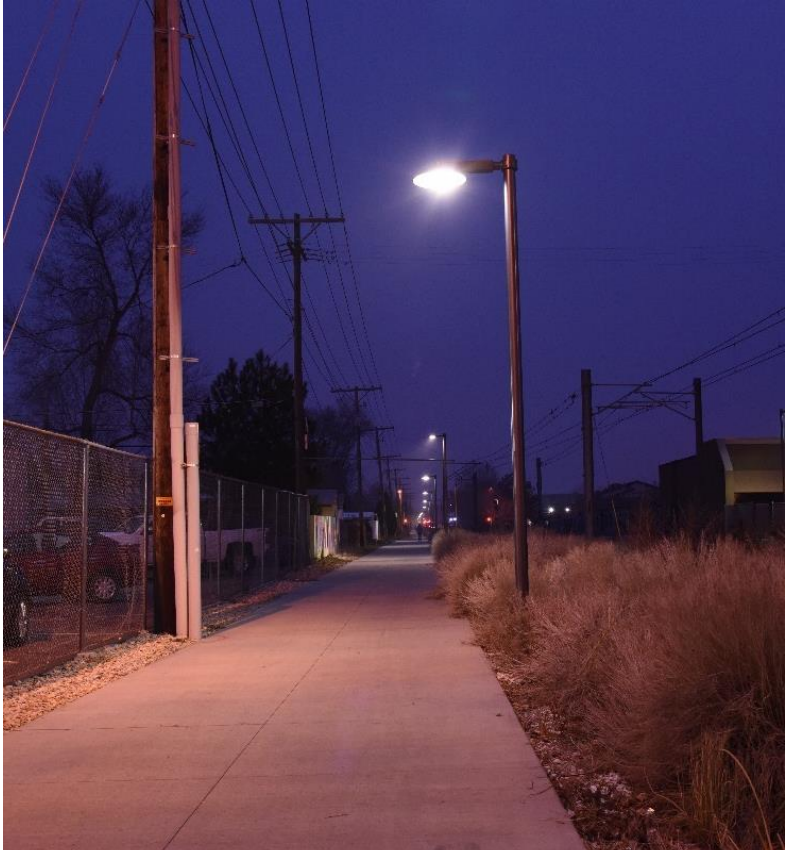
Dead End Streets

Dead end streets in the City warrant lighting at the termination of the roadway. Lighting the end of the street enhances visual safety and security as well as provides a visual cue for drivers.

4.2.6 Pedestrian Lighting

4.2.6.1 Sidewalk Lighting

In some cases, pedestrian light levels can be achieved with street lighting. In other cases, especially in higher pedestrian activity areas, additional lighting is warranted. Table 4.2.18 outlines the recommended average illuminance levels for pedestrian areas. Refer to *Chapter 4.1* for guidance on determining pedestrian activity classification. The average illuminance on the sidewalks should be determined using the calculation process as described *Chapter 4.5*. If the streetlights cannot meet the recommended average illuminance on the sidewalk, then pedestrian lights should be installed.



Pedestrian Lighting on the S-Line

Table 4.2.18: Sidewalk Lighting Criteria IES RP-8-14

Pedestrian Activity	Horizontal Illuminance (Avg. fc)	Vertical Illuminance (Avg. fc)	Uniformity Ratio (Avg:Min)	Maximum Lumen Output (lm)	Maximum BUG Rating
High	**0.8**	**0.4**	**4.0**	**5,500**	**B2-U2-G2**
Medium	**0.4**	**0.2**	**4.0**	**5,500**	**B2-U1-G1**
Low	**0.3**	**0.1**	**4.0**	**4,500**	**B1-U0-G1**

4.2.6.2 Walkway and Bikeway Path Lighting

Lighting along walkways and bikeways throughout the City is essential for the safety and enjoyment of those using the paths. Paths may be lighted continuously or non-continuously based on the usage and location of the path. Non-continuous lighting should illuminate intersections, curves, stairs, abrupt changes in elevation, and bridges. Continuous lighting along paths should meet the lighting and spacing criteria in Table 4.2.19.

Table 4.2.19: Walkway and Bikeway Pedestrian Luminaire Criteria

					Illuminance (fc)		
	Pedestrian Activity Level	Mounting Height (ft)	Spacing	Lumen Output	Horizontal Avg. fc	Horizontal Avg./Min	Vertical Avg. fc
Pedestrian Paths	High	12	60-80	1,500 - 3,000	0.8	6	0.4
		15	100-120	2,500 - 4,000	0.8	6	0.4
	Medium	12	60-80	1,200 - 2,500	0.4	4	0.2
		15	100-120	1,500 - 3,500	0.4	6	0.2
	Low	12	60-80	1,200 - 2,500	0.4	4	0.2
		15	100-120	1,500 - 3,500	0.4	6	0.2

Figure 4.2.27: Transit Corridor and Path Lighting Layout

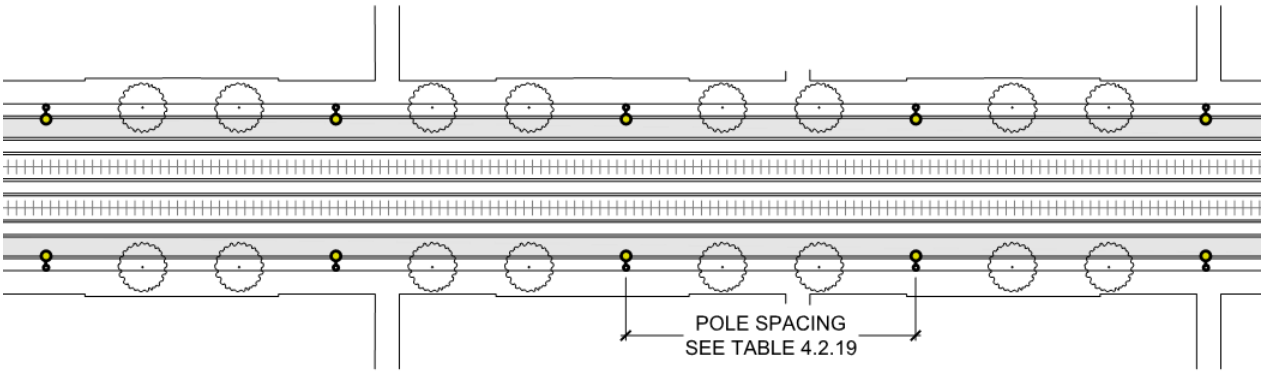


Figure 4.2.28: Transit Corridor and Path Lighting Section

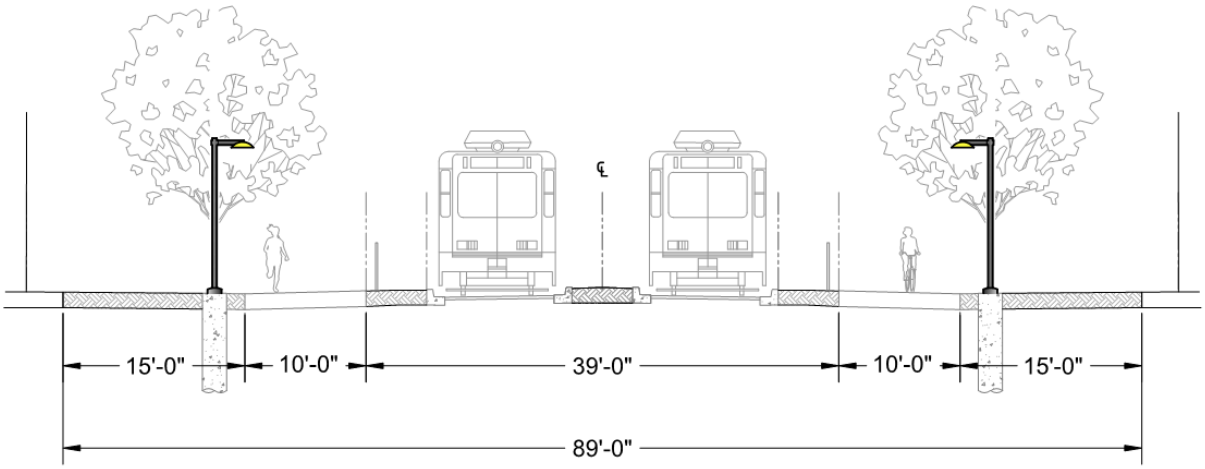


Table 4.2.20: Pathway Bollard Lighting Criteria

					Illuminance (fc)		
Pedestrian Paths	Pedestrian Activity Level	Mounting Height (ft)	Spacing	Lumen Output	Horizontal Avg. fc	Horizontal Avg./Min	Vertical Avg. fc
	High	3	20-30	150-250	0.8	6	0.4
	Medium	3	30-50	150-250	0.4	6	0.2
	Low	3	50-60	150-250	0.3	6	0.2

Figure 4.2.29: Bollard Lighting Layout

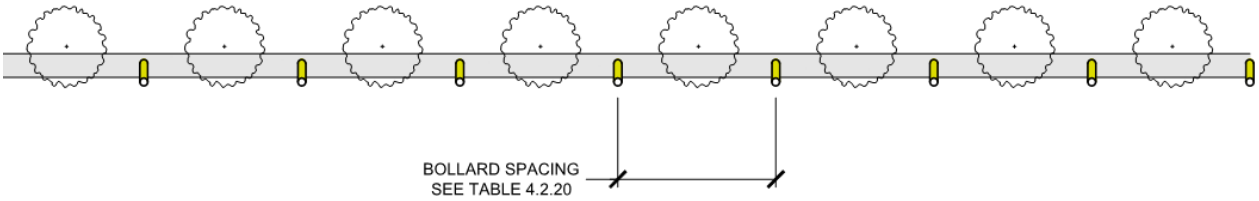
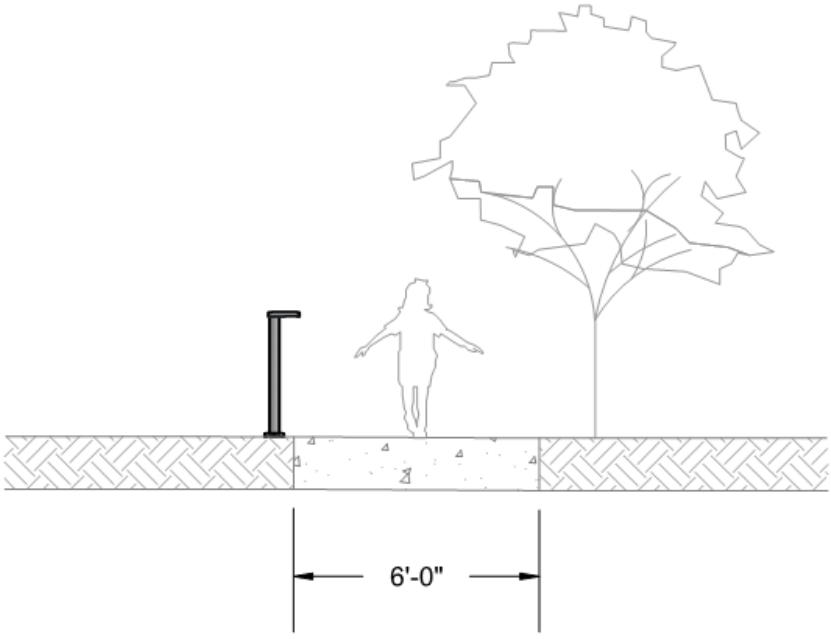


Figure 4.2.30: Bollard Lighting Section



4.2.7 Parking Lot Lighting

The purpose of this chapter is to provide methodology and criteria to be used for all city owned parking lots. The figures and tables below provide direction on the appropriate luminaire selection and lighting layouts. All lighting for public parking lots in the City of South Salt Lake shall comply with the lighting criteria in Table 4.2.21. Parking lot lighting should benefit the pedestrian, as they should have enough light to identify an obstacle, and motorists, who should have enough light to detect pedestrians and other vehicles.

Table 4.2.21: Parking Lot Criteria per IES RP-20-98

Parking Lot Criteria	Typical	Enhanced Security	Mounting Height
Minimum Horizontal Illuminance	0.2	0.5	20-30
Uniformity, Max./Min.	20:1	15:1	20-30
Minimum Vertical Illuminance	0.1	0.25	20-30

To reduce dark shadows and improve visibility, lights should be placed so that objects are illuminated from more than one direction. To do this, place lights along the perimeter and facing each other in larger parking lots. Lights should also be placed at the entrances to improve visibility for motorists entering and exiting.

Figure 4.2.31: Small Parking Lot Lighting Layout

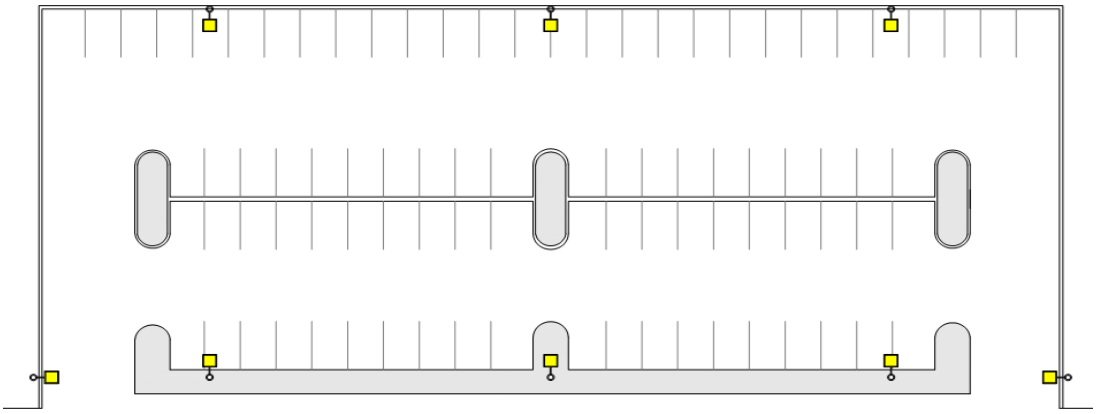
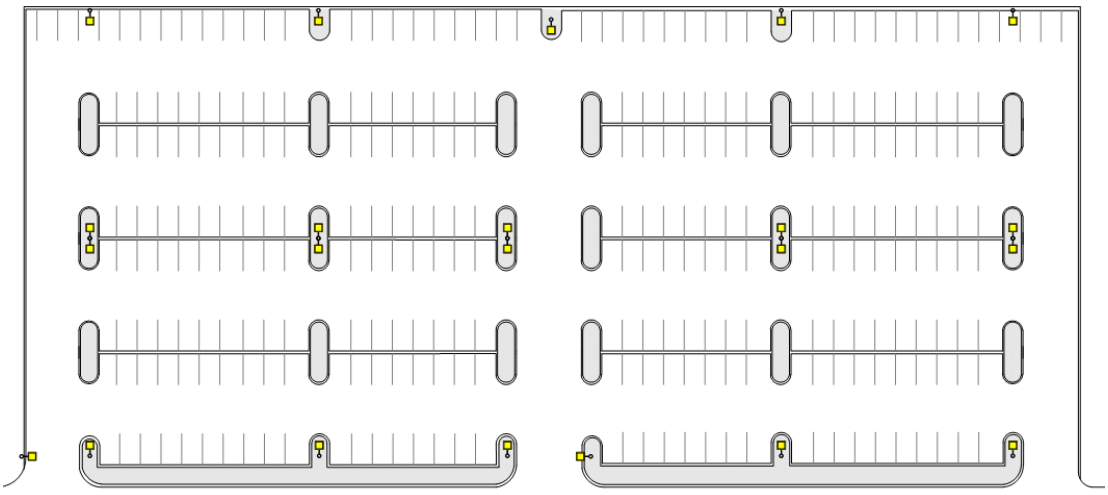


Figure 4.2.32: Large Parking Lot Lighting Layout

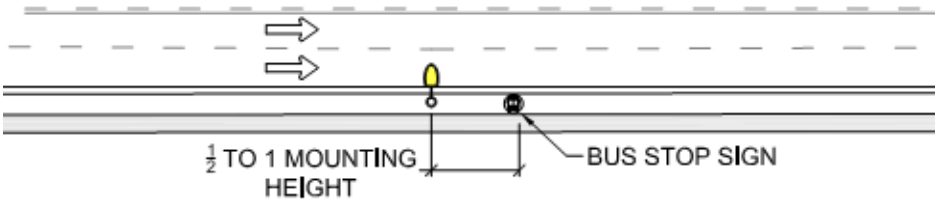


4.2.8 Bus Stop Lighting

4.2.8.1 Uncovered Bus Stop

Uncovered bus stops should be lit by a street luminaire positioned ½ to 1 mounting height from the bus stop in the direction of oncoming traffic. The illuminance at the bus stop shall meet the criteria in Table 4.2.22.

Figure 4.2.33: Uncovered Bus Stop Lighting Layout



4.2.8.2 Bus Shelters

Bus Shelters in the City shall meet the criteria in Table 4.2.22. Vertical illuminance aids in facial recognition and visible comfort and is to be measured 5 ft. above the ground. Bus Shelters shall be placed within 100ft of street luminaires to increase ambient light and visual comfort.

Figure 4.2.34: Covered Bus Stop Lighting Section

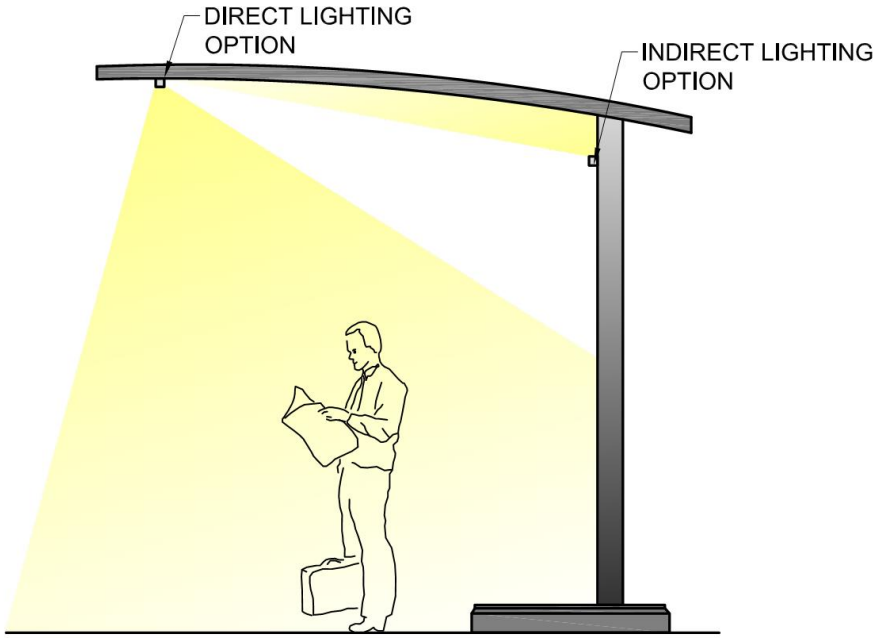


Table 4.2.22: Bus Stop Lighting Criteria

Bus Stop Criteria	Horizontal Illuminance (fc)	Vertical Illuminance (fc)
Uncovered Bus Stop	1.0	0.2
Covered Bus Stop	1.0	1.0

4.3 Minimal Improvements

4.3.1 Purpose

This chapter provides guidance on 1-for-1 luminaire replacements and supplemental lighting improvement strategies to improve the visibility and lighting conditions in areas throughout the City with moderately acceptable and acceptable existing street lighting conditions.

4.3.2 Confirm Existing Conditions

When beginning lighting improvement designs, the current existing conditions where improvements are being made should be evaluated. One-for-one replacements may only be made if the luminaires meet the spacing criteria in Table 4.3.1 and the necessary infrastructure, such as wiring, foundation, and poles are all in good condition. If the spacing is not met or there are infrastructural issues, supplemental improvements will also need to be made.

4.3.3 Supplemental Improvements

Supplemental improvements entail adding a limited quantity of new street light locations to the existing street light system to illuminate any dark areas on the street. If any of the following conditions exist, then the improvement area should follow the comprehensive improvement methodology:

- Spacing exceeds 2.5 times the recommended value based on street type and pedestrian conflict.
- Lighting only exists on one side of the street and does not sufficiently light the whole street.
- There are no existing lights on the block.

All luminaires used in supplemental improvements shall match the luminaires chosen for 1-for-1 replacements.

4.3.4 One-for-One Luminaire Replacement

The existing HID streetlights should be replaced with 3000K LED luminaires per the City of South Salt Lake's *Luminaire Specifications.* Care should be taken, when selecting a luminaire, to illuminate the surrounding sidewalks and public spaces without causing light trespass. Table 4.3.1 below provides LED replacement equivalents based upon lumen output range and maximum wattage for the various street classifications in the City to properly transition to LED luminaires.

Table 4.3.1: LED Lumen Replacement by Luminaire Spacing

Street Classification	Existing Luminaire Spacing (ft.)	LED Replacement Lumen Output Range	Minimum Luminaire Efficacy	Maximum LED Replacement Wattage	Maximum BUG Rating
Arterial	300-350	15,000 – 20,000[6]	100	220	B3-U0-G2
	200-300	10,000 – 16,000	100	175	B3-U0-G2
Collector	250-300	5,000-10,000	100	110	B2-U0-G2
	150-250	4,000 – 8,000	100	100	B2-U0-G2
Local	Mid-Block & Intersections	3,500 – 5,500	100	65	B1-U0-G1

[6] Greater lumen output may be warranted for special application but requires City Engineer's approval.

4.4 Luminaire Specification

4.4.1 Purpose

This chapter will guide the specification process for the luminaire, controls, and drivers. These luminaire specifications describe the minimum quality requirements for lighting equipment to minimize contribution to light trespass or light pollution and reduce on-going maintenance costs with quality equipment. All luminaires specified in South Salt Lake must meet the criteria stated in Table 4.4.1, Table 4.4.2, and Table 4.4.3 unless otherwise approved by the City.

4.4.2 Considerations when Specifying Luminaires

All light sources shall emit white light. All streetlights shall have a correlated color temperature (CCT) no greater than 3000K nominal in accordance with ANSI C78.277 (see Figure 4.4.1). All luminaires shall have a maximum lumen output and IES TM-15 BUG rating per Table 4.4.1 and Table 4.4.2 below. Detailed luminaire specifications can be found in Table 4.4.4.

Table 4.4.1: Cobrahead Luminaire Selection

Street Classification	Maximum CCT	Maximum Luminaire Lumen Output	Maximum BUG Rating	Minimum Efficacy Rating with Shielding (lm/W)	Minimum Efficacy Rating without Shielding (lm/W)
Arterial	**3000K**	**20,000**	**B3-U0-G2**	**80**	**100**
Collector	**3000K**	**10,000**	**B2-U0-G2**	**80**	**100**
Local	**3000K**	**5,800**	**B1-U0-G1**	**80**	**100**

Table 4.4.2: Decorative Luminaire Selection

Street Classification	Maximum CCT	Maximum Luminaire Lumen Output	Maximum BUG Rating	Minimum Efficacy Rating (lm/W)
Arterial	**3000K**	**15,000**	**B3-U2-G3**	**55**
Collector	**3000K**	**10,000**	**B2-U1-G2**	**55**
Local	**3000K**	**5,800**	**B1-U0-G1**	**55**

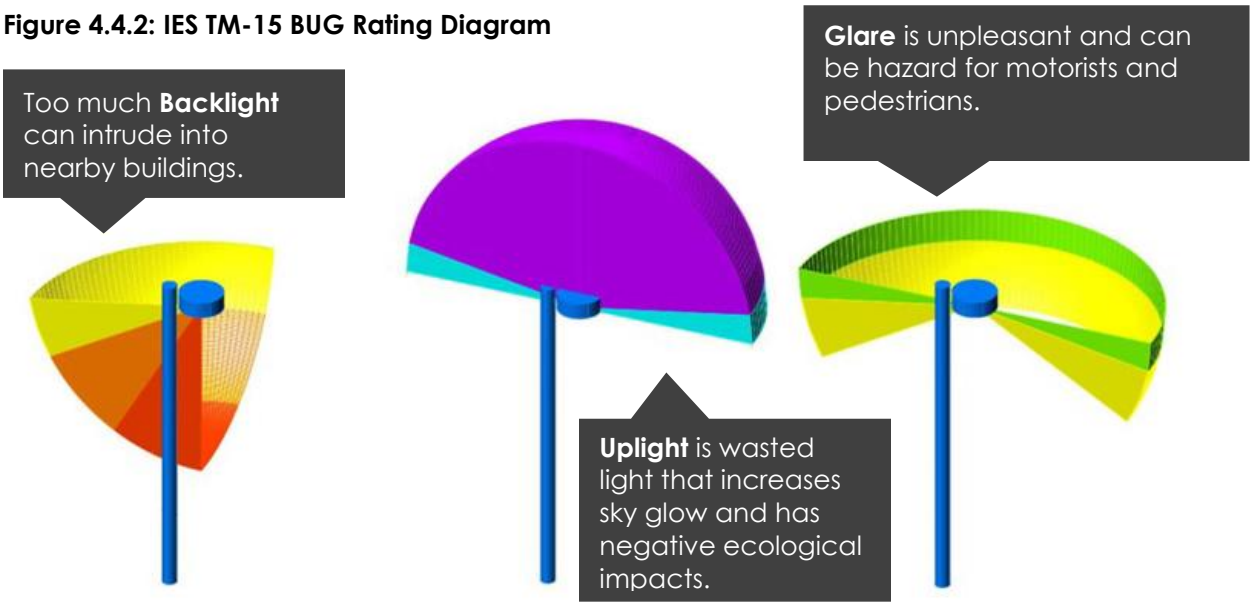
Figure 4.4.1: Color Temperature (CCT)

Temperature	Source
1,700 K	Match flame, low pressure sodium lamps (LPS/SOX)
1,850 K	Candle flame, sunset/sunrise
2,400 K	Standard incandescent lamps
2,700 K	Soft white compact fluorescent and LED lamps
3,000 K	Warm white compact fluorescent and LED lamps
3,200 K	Studio lamps, photofloods, etc.
4,100 – 4,150 K	Moonlight
5,000 K	Horizon daylight
5,500 – 6,000 K	Vertical daylight, electronic flash
6,500 – 9,500 K	LCD or CRT screen
15,000 – 27,000 K	Clear blue poleward sky

These temperatures are merely characteristic; considerable variation may be present.

All streetlights shall have a correlated color temperature (CCT) no greater than 3,000K.

Figure 4.4.2: IES TM-15 BUG Rating Diagram



4.4.3 Other Specifications

All luminaires shall meet the specifications stated in Tables 4.4.3 and 4.4.4.

Table 4.4.3: Specification Overview

Controls	Electrical System
All streetlights shall have integral 0-10V dimmable drivers in order to adjust light levels. All streetlights will be installed with an ANSI 7 pin photocell receptacle to be compatible with wireless controls in the future.	The electrical system voltage shall be single phase 120/240V.
Light Standard Specification	Light Standard Foundations
The light standard - also referred to as the pole - should be tapered, round galvanized steel with a 12-inch bolt circle. The head and arm shall match the color of pole. Replacement poles, heads, and/or arms shall be designed to match existing color and type of adjacent poles if appropriate and approved by the City in writing. Decorative or non-standard poles shall be approved by the City. Any pole that must be colored shall be painted over galvanized. Mast arms shall be 2, 6, or 10 feet for all new installations. The City must approve all poles with banner arms and power receptacles.	Precast concrete or poured-in-place light standard foundations shall be designed per the City standard. While the City accepts poured-in-place foundations, precast concrete foundations are preferred and should be installed whenever possible.

Table 4.4.4: Luminaire Specifications

Luminaire	Correlated Color Temperature (CCT)	3000K Maximum				
	Color Rendering Index (CRI)	≥70				
	Luminaire Lumen Range	The area surrounding each street classification should be taken into account when selecting luminaire lumen outputs. Arterial and collector lumen outputs, CCT, and BUG rating should be minimized in residential areas.				
		Street Classification	**Maximum CCT**	**Maximum Luminaire Lumen Output (lm)**	**Maximum BUG Rating***	**Minimum Efficacy Rating (lm/W)**
		Arterial	3000K	20,000	B3-U0-G2	100
		Collector	3000K	10,000	B2-U0-G2	100
		Local	3000K	5,800	B1-U0-G1	100
		High Lumen Output Roadways	3000K	> 20,000 by special application only	B3-U0-G3	100
		Decorative	3000K	See *Table 4.4.2*		55
		Pedestrian	3000K	4000	B1-U0-G2	55
		Parking Lot	3000K	7,000	B2-U0-G2	85
	Luminaire Finish	Die cast aluminum housing with fade and abrasion resistant polyester powder coat finish. Finish shall match existing color of luminaires along street.				
	Luminaire Warranty	10 years on luminaire and components.				
	Luminaire Warranty Period	Earliest warranty period allowed shall start on the date of receipt by City.				
	Luminaire Identification	Luminaire shall have an external label per ANSI C136.15, and an interior label per ANSI C136.22.				
	Operation and Storage Temperature	'-40°C to +40°C.				
	Frequency Vibration	'Luminaire shall withstand low and high frequency vibration, per ANSI C136.31, over the rated life of the light source.				
	Minimum Rated Life	70,000 hours minimum at 55°C, per IES TM-21				
	IP rating	IP65 or greater.				
	Voltage	120/277.				
	Control	All luminaires shall be dimmable and installed with ANSI 7 pin photo receptacle to be compatible with wireless controls in the future.				
	Cooling System	Passive utilizing heat sinks, convection, or conduction. Upper surfaces shall shed precipitation. Cooling fans are not allowed.				
	Photocontrol	Individual multi-contact 7-pin twist lock receptacle per ANSI C136.41. Or control module.				
	Electrical Immunity	Luminaire shall meet the performance requirements specified in ANSI C136.2 for dielectric withstand, using the DC test level and configuration.				

LED Drivers	Operating Voltage	120/277 Volt at 50/60 Hz and shall operate normally with input voltage fluctuations of ±10 percent, consistent with NEMA SSL-1, Electronic Drivers for LED Devices, Arrays, or Systems.
	Power Factor (PF)	Minimum of 0.9 at full input power.
	Total Harmonic Distortion (THD)	Maximum of 20 percent at full input power.
	Restriction of Hazardous Substances (RoHS)	Drivers shall be Restriction of Hazardous Substances (RoHS) compliant.
	Surge Protection	All LEDs shall be protected from all electrical surges with an elevated electrical immunity rating, including but not limited to lightning strikes and stray current in rebar and concrete. Surge protection shall be integral to the LED power supply. Luminaire shall meet the “Elevated" (10kV/10kA) requirements per IEEE/ANSI C62.41.2. Manufacturer shall indicate whether failure of the electrical immunity system can possibly result in disconnect of power to luminaire.
	Off State	Luminaire, including driver, shall consume no more than 4 watts in the off-state power.
	Electromagnetic interference	Electromagnetic interference: Shall comply with Federal Communications Commission (FCC) 47 Code of Federal Regulations (CFR) part 15 non-consumer radio frequency interference (RFI) and/or electromagnetic interference (EMI) standards.

4.5 LIGHTING CALCULATIONS

4.5.1 Purpose

Lighting design calculations for new installations is an iterative process. The use of lighting models to calculate the luminance and illuminance along streets is the most efficient and accurate way to design. This chapter will familiarize users with lighting models and the lighting design calculation process.

Lighting calculations are required for all comprehensive changes made to street and path lighting as well as all new construction in the City of South Salt Lake.

4.5.2 How to Set Up a Calculation

The following sections document the parameters and considerations when calculating street lighting levels.

IES Files

The first step in running a calculation is to find and download the photometric in IES file format for the specific luminaire being considered. This file is available on the manufacture's website and can be downloaded into any lighting calculation simulation software. The IES file will contain all information for the luminaire, such as lumen output, color temperature, wattage, distribution, and voltage.

Light Loss Factor for LED

A light loss factor should be applied to every luminaire considered, to ensure that the maintained light levels will meet the target criteria. Table 4.5.1, below, lists typical light loss factors for LEDs and legacy products found throughout the City of South Salt Lake.

Table 4.5.1: Typical Light Loss Factors

Light Source	Luminaire Dirt Depreciation (LDD)	Luminaire Lumen Depreciation (LLD)	Total Light Loss Factor (LLF)
LED	**0.9**	**0.9**[7]	**0.81**[8]
HPS	**0.9**	**0.9**	**0.81**
MH	**0.9**	**0.7**	**0.63**

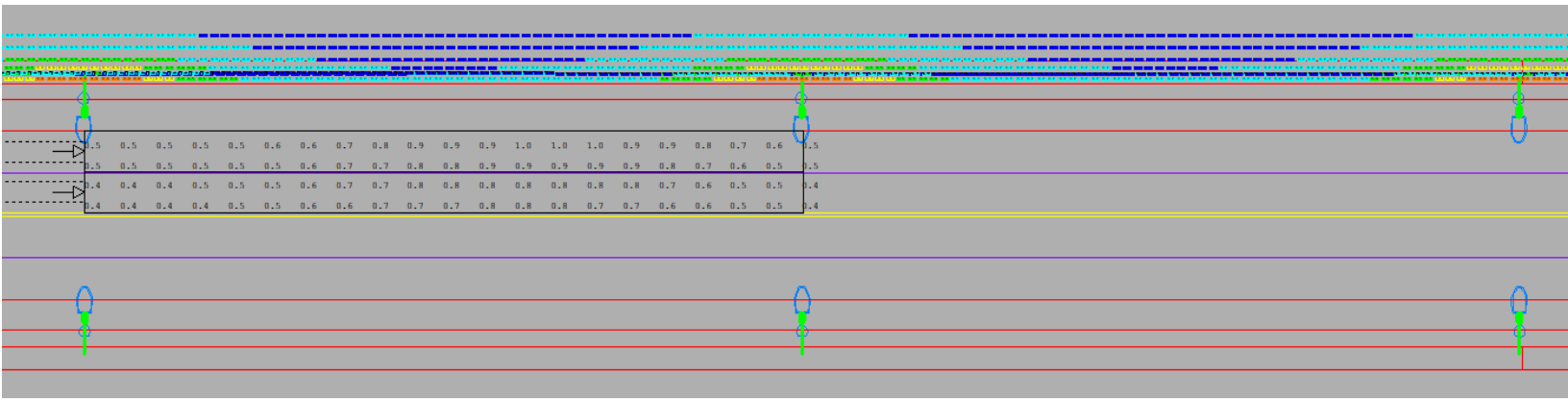
HPS: High Pressure Sodium
MH: Metal Halide

[7] Use 0.9 or LM value provided by the Manufacturer at 60,000 hours, if L70 is greater than 100,000 hours
[8] If using an LM value provided by the Manufacturer, the Total LLF is equal to 0.9 x LM60,000hr

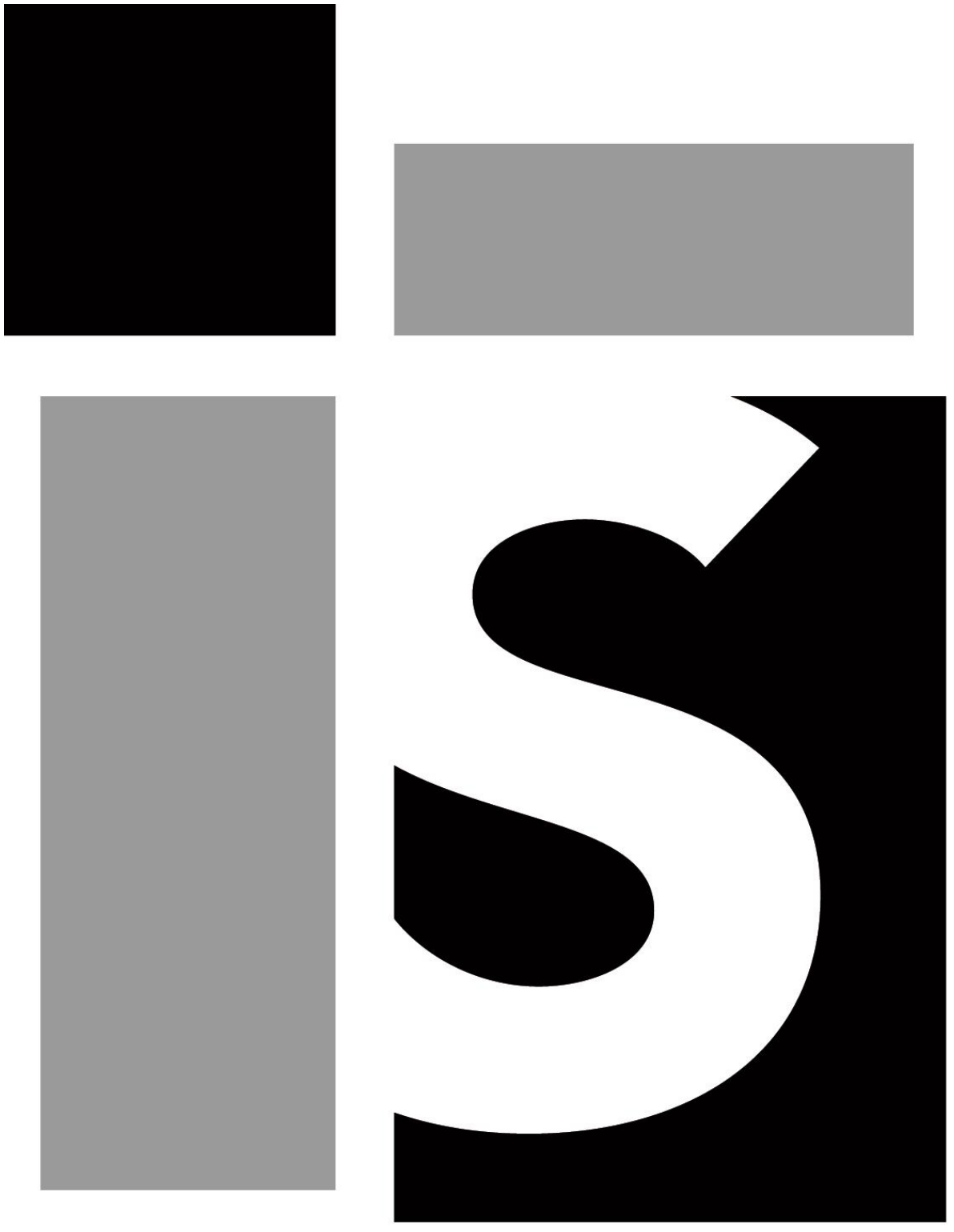
Calculation Process for Continuous Straight Streets

The design process for improving or installing street lighting should follow the outlined process below:

1. Determine the physical parameters of the new street, including: median width, luminaire setback, curb to curb width of the street, number of lanes in each direction, bike lane width, presence of on-street parking, and width of the shoulder.
2. Determine the street classification and level of pedestrian conflict for the street. If also determining the lighting for an intersection, determine the street classification of the intersecting street.
3. Determine the applicable lighting criteria, per IES RP-8-14 or appropriate industry standard, based upon the street classification and level of pedestrian conflict.
4. Select an appropriate luminaire based on the maximum lumen output, minimum efficacy, and maximum BUG ratings provided in Table 4.4.1.
5. Develop a model of the street with the design parameters in the lighting calculation simulation software such as AGi32, DIALux, or Visual.
6. Set up a luminance calculation grid for one cycle of luminaires in the travelled way. The travelled way is the number of vehicle lanes for the majority of the length of the roadway. Bike lanes, on street parking, and shoulder are not included in the travelled way. If irregular spacing is to be used, then the designer should consider extending the calculation area to include the whole street segment.
7. Begin by placing luminaires on the portion of the straight continuous lighted street. Evaluate the outcomes of varying street light arrangements to achieve an appropriate spacing. The streetlights should be arranged in an opposite layout to minimize neutral contrast, allowing for the greatest visibility. If an opposite arrangement is not possible due to how narrow the curb to curb width of the road is, then a single sided arrangement is recommended. Similar to an opposite arrangement, a single sided layout will minimize the neutral contrast along the street. A staggered arrangement should only be selected as a last resort for new construction projects. The staggered arrangement results in greater neutral contrast than other arrangements, which limits nighttime visibility. Although the luminance calculation grid includes only one cycle of luminaires (or stretch of street), include additional luminaires in each direction in the model if the luminaires have significant contribution.
8. Integrate lighting locations and revise lighting model in correspondence to other improvements, e.g. clearance from driveways (10 feet commercial and 5 feet residential), fire hydrants (5 feet), and trees (centered in between trees or 20 feet from the tree trunk). Place lights near property lines wherever practical and avoid locations in front of doorways, windows, and lines of egress.
9. If the calculated luminance meets the average target criteria luminance and uniformity ratio, then the luminaire is a viable option.
10. If necessary, adjust the luminaire spacing and/or lumen output and distribution. Repeat until the values meet the target criteria.



Typical arterial street calculation in AGI32 with opposite lighting layout. Street lighting luminance calculation points are located between the middle cycle of luminaries. Surrounding luminaires are included in the calculation since they have significant contribution to the calculated area. Illuminance calculation points are placed on the North sidewalk to evaluate the street lights sidewalk lighting effectiveness. This model can be adjusted by changing the luminaire spacing and evaluating different lumen outputs and distributions to meet criteria with the most efficient layout and efficacious luminaire.


SOUTH SALT LAKE

Appendix A: Luminaire Submittal Forms

Roadway Luminaire Submittal Form

Luminaire Manufacturer & Catalog Number	=		
Character District *See Step 1*	☐ Downtown	☐ East Street Car	☐ State Street
	☐ Corridor Commercial	☐ Industiral	☐ Creative Industry
	☐ Riverfront Neighborhood	☐ Jordan River Gateway	☐ City Parks
	☐ Historical Sites	☐ Other	
Street Classification *See Step 3*	☐ Arterial	☐ Collector/Avenue	☐ Local/Neighborhood
	☐ Boulevard	☐ Connector/S-Line Transit	
Pedestrian Activity Level *See Step 3*	☐ Low	☐ Medium	☐ High
Pedestrian Lighting	☐ Yes	☐ No	
Luminaire Characteristics	Initial Luminaire Lumen Output =	System Wattage =	Luminaire Efficacy (lm/W) =
Correlated Color Temperature (CCT)	=		
Color Rendering Index (CRI)	=		
BUG Rating (per IES TM-15)	Backlight =	Uplight =	Glare =
IES Photometric Data in .ies Format	☐ Yes	☐ No	☐ Other
LED Retrofit Luminaire	☐ Yes	☐ No	
Exterior Label (per ANSI C136.15) & Interior Label (per ANSI C136.22)	☐ Yes	☐ No	
Tool-Less Entry	☐ Yes	☐ No	
Luminaire Housing Finish	=		
Rated Life (IES TM-21)	=		
Ambient Temperature Range	Minimum Temperature=	Maximum Temperature=	
Vibration Rating (ANSI C136.31)	=		
UL Listing	☐ Wet Location	☐ Damp Location	IP Rating =
Passive Cooling System	☐ Yes	☐ No	
Upper Housing Surfaces Shed Precipitation	☐ Yes	☐ No	
LED Compatible 7-pin Receptacle (ANSI C136.41)	☐ Yes	☐ No	☐ Control Module
Internal Wiring and Quick Disconnects	=		
Operating Voltage	Voltage =	Frequency (Hz) =	
Power Factor	=		
Total Harmonic Distortion	=		
Restriction of Hazardous Substances (RoHS) Compliant	☐ Yes	☐ No	
Power Consumed in the Off State	=		
Surge Protection (IEEE C62.41.2)	=		
Electromagnetic Interference Complies with FCC 47 CFR part 15	☐ Yes	☐ No	
Warranty Period	=		
Warranty Start Date	=		
Other Submittals	=		

Pedestrian Luminaire Submittal Form

Luminaire Manufacturer & Catalog Number	=		
Character District *See Step 1*	☐ Downtown	☐ East Street Car	☐ State Street
	☐ Corridor Commercial	☐ Industiral	☐ Creative Industry
	☐ Riverfront Neighborhood	☐ Jordan River Gateway	☐ City Parks
	☐ Historical Sites	☐ Other	
Pedestrian Activity Level *See Step 3*	☐ High	☐ Medium	☐ Low
Path or Sidewalk Lighting	☐ Path	☐ Sidewalk	
Luminaire Characteristics	Initial Luminaire Lumen Output =	System Wattage =	Luminaire Efficacy (lm/W) =
Correlated Color Temperature (CCT)	=		
Color Rendering Index (CRI)	=		
BUG Rating (per IES TM-15)	Backlight =	Uplight =	Glare =
IES Photometric Data in .ies Format	☐ Yes	☐ No	☐ Other
LED Retrofit Luminaire	☐ Yes	☐ No	
Exterior Label (per ANSI C136.15) & Interior Label (per ANSI C136.22)	☐ Yes	☐ No	
Luminaire Housing Finish	=		
Rated Life (IES TM-21)	=		
Ambient Temperature Range	Minimum Temperature=	Maximum Temperature=	
Vibration Rating (ANSI C136.31)	=		
UL Listing	☐ Wet Location	☐ Damp Location	IP Rating =
Passive Cooling System	☐ Yes	☐ No	
Upper Housing Surfaces Shed Precipitation	☐ Yes	☐ No	
LED Compatible 7-pin Receptacle (ANSI C136.41)	☐ Yes	☐ No	☐ Control Module
Internal Wiring and Quick Disconnects	=		
Operating Voltage	Voltage =	Frequency (Hz) =	
Power Factor	=		
Total Harmonic Distortion	=		
Restriction of Hazardous Substances (RoHS) Compliant	☐ Yes	☐ No	
Power Consumed in the Off State	=		
Surge Protection (IEEE C62.41.2)	=		
Electromagnetic Interference Complies with FCC 47 CFR part 15	☐ Yes	☐ No	
Warranty Period	=		
Warranty Start Date	=		
Other Submittals	=		

SOUTH SALT LAKE

Appendix B
Existing Street Lighting Conditions

South Salt Lake City, Utah

Executive Summary

The City of South Salt Lake requested an evaluation of the existing street lighting conditions and a Master Plan to transition the street lighting from the existing high pressure sodium system to an LED system, with the intent to improve visibility and aesthetics while reducing energy and maintenance. The Master Plan develops new street lighting standards for retrofit and new construction. To obtain a comprehensive understanding of the existing lighting, Clanton & Associates surveyed eleven locations within the city, conducted nighttime surveys, and calculated the light levels along primary arterial, minor arterial, collector and local streets. From these evaluations, existing conditions were determined throughout the city which will inform the prioritization of the street lighting retrofit. By enhancing the street lighting, the city will promote a higher standard of well being as well as a more comfortable place for residents and commuters.

Evaluation of existing lighting conditions

In September 2017, Clanton & Associates evaluated the current lighting conditions at eleven sites around the city that provided an understanding of the diversity of lighting conditions. The selected sites included industrial, commercial, residential, and primary pathways. Both horizontal and vertical illuminance (the amount of light reaching a surface, expressed in units of footcandles [fc]) measurements were taken along the pathways at each site. Luminance (the amount of light reflected from a surface that the eye perceives, expressed in units of candela per square meter [cd/m^2]) measurements were also taken to provide an understanding of surrounding surface brightness. These measured light levels were used to compare the existing light levels to the light level recommendations by the Illuminating Engineering Society (IES). Clanton & Associates also took high-dynamic-range (HDR) images as a visual representation of the perceived nighttime experience. Along with the lighting measurements being taken, City officials completed a subjective survey assessing the lighted environment at each site. The survey results and lighting measurements can be found in this report.

Street lighting levels

To understand the street lighting throughout the entire city, Clanton & Associates calculated light levels on arterial, collector and residential streets. These calculations were based high pressure sodium luminaires with wattages typical to the type of street they were located on. Each street block was categorized into three levels of acceptability based on the calculations, lamp wattage, street type, luminaire spacing, and by comparing measure lighting levels to IES standards.

Acceptable: Road blocks that met the lighting standards based on street classification with high pressure sodium lamps and existing luminaire spacing. These areas would not require any lighting improvements beyond the LED retrofit assuming all current luminaires are operating properly.

Moderately Acceptable: Road blocks that do not meet lighting standards based on street classification with high pressure sodium lamps and existing luminaire spacing. Typically, these are blocks that have relatively small dark spaces between poles and would require minor improvements in order to meet lighting standards.

Poor: Road blocks that have very low, or no, light on the streets. These are blocks that typically do not have enough existing street lights and will most likely require significant investment in new lighting and electrical infrastructure to meet lighting standards.

Lighting improvements

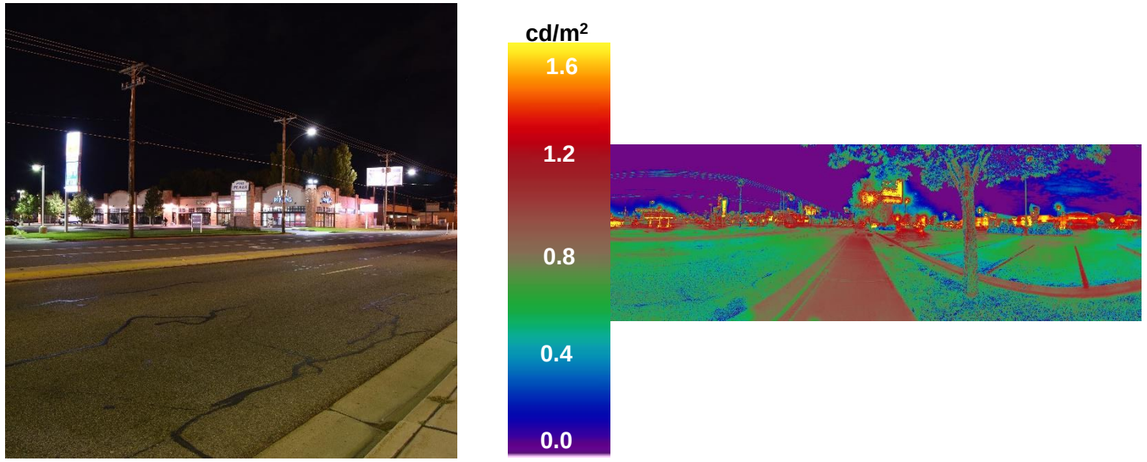
Lighting improvements in the City of South Salt Lake will enhance lighting on arterial, collector and residential streets by classifying each street, setting standards and investing in retrofits and new construction. Well lit streets will help to reduce vehicle accidents as well as pedestrian/vehicle conflicts. Various character districts have been designated throughout the city in order to provide cohesive and quality lighting based on the surrounding environment. Vertical light levels will also be increased to enhance pedestrian and object detection. LED luminaires consume significantly less energy and require far less maintenance than the current system resulting in a quick return on investment. By investing in evaluation of, and guidelines for street lighting, The City of South Salt Lake will be able to provide a safer and higher quality commute on their streets.

Existing Conditions Example

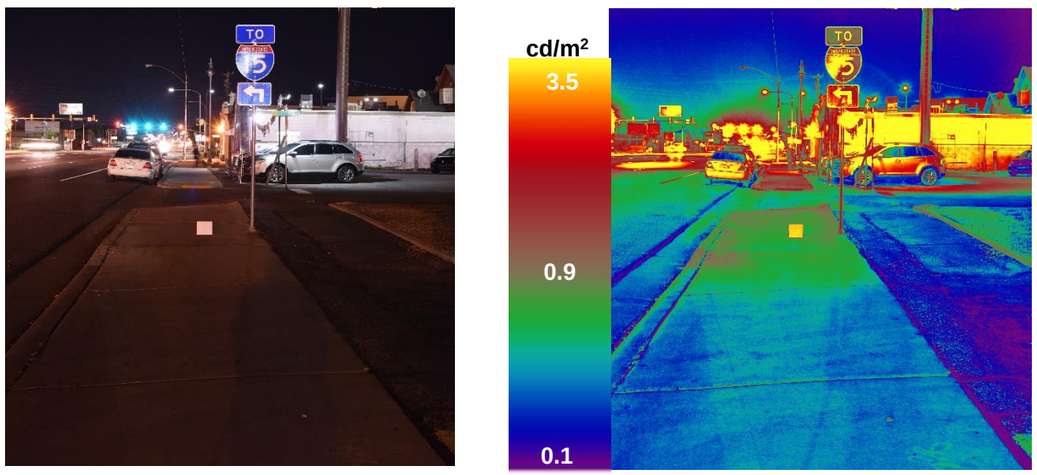
The following High Dynamic Range images (HDR) and measured illuminance levels were taken during the September 2017 site visit. An analysis of the eleven sites surveyed can be found in this report.

Measured Illuminance Levels

Criteria	Acceptance Level	Luminance Type (cd/m^2)	Street Luminance
Arterial Street Criteria	Acceptable	Average	0.9
2100S. 300W.	Acceptable	Average	0.51
3300S. State Street	Unacceptable	Average	0.32



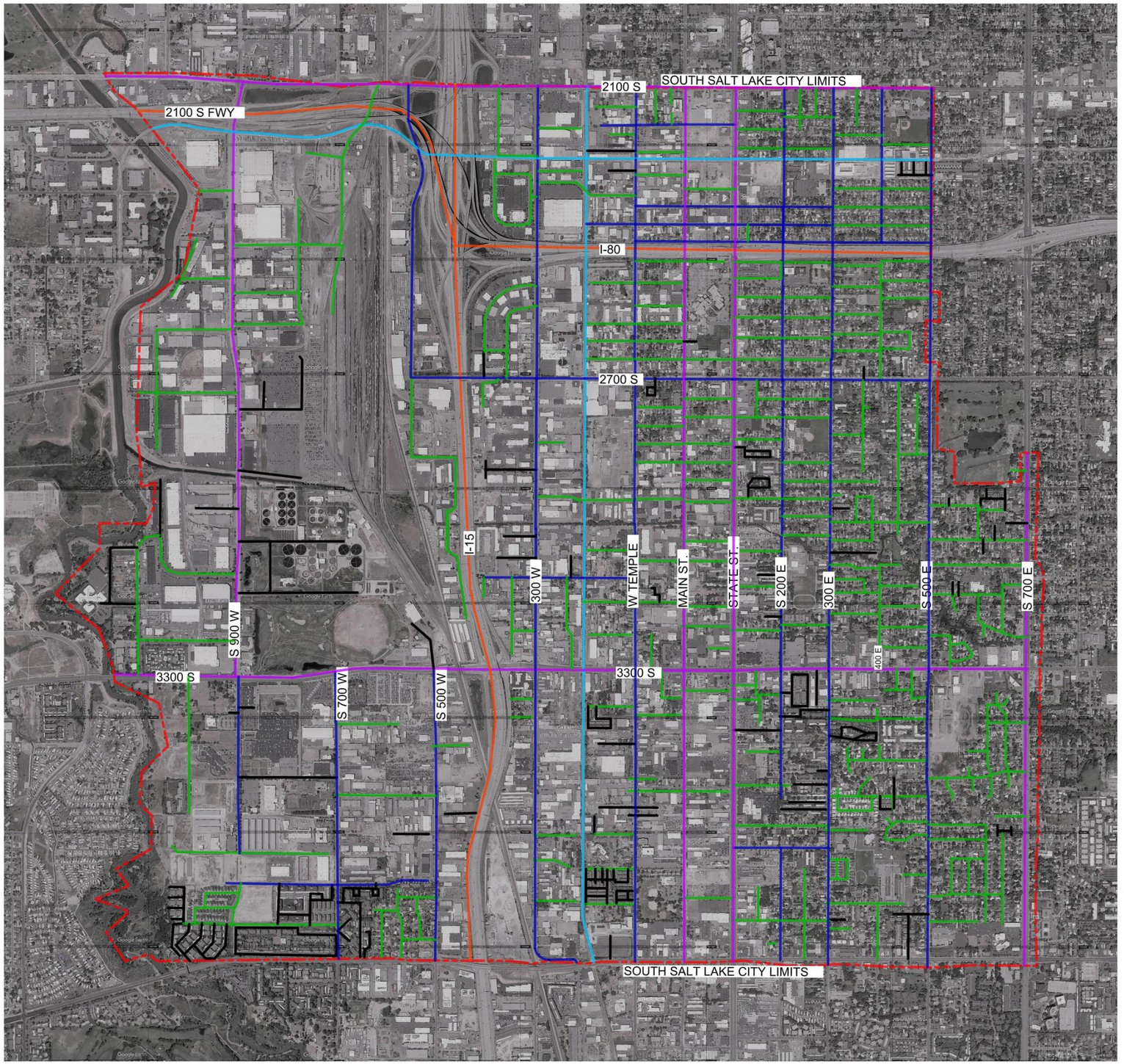
2700S 300W– Acceptable (0.7 average illuminance)



3300S. State Street– Unacceptable (0.2 average illuminance)

Street Classifications

- : Freeway
- : Arterial
- : Collector
- : Local
- : Transit Line
- : Private Street



Exterior lighting LED retrofit

The current street lighting in South Salt Lake is inconsistent, with acceptable lighting on some streets and poor lighting on others. To improve the consistency of street lighting throughout the city, the Lighting Master Plan will provide guidance for three basic lighting improvement strategies: (1) LED Luminaire Retrofit, (2) Additional Light Poles, and (3) Complete Lighting Redesign, which will be applied to certain streets throughout the city. Clanton & Associates will provide a document that summarizes the appropriate pole spacing and luminaire wattage based on street classification. Luminaire options from various manufacturers will also be provided that best suite the street classification and luminaire spacing. Clanton & Associates recommends purchasing a 3000K LED, the white light source improves color rending of objects and the warm color temperature creates a welcoming nighttime environment.

In order to provide proper suggestions for improving the lighting conditions throughout the city, Clanton and associates chose three different luminaires from three different manufacturers and ran calculations using AGi32. The luminaires varied in wattage, distribution and mounting height, were placed in staggered and opposite arrangements and at various distances between poles in order to determine the optimal lighting conditions for all street types and applications throughout the city.
The luminaire used were:

Manufacturer	Fixture
General Electric	Evolve LED Streetlight
Cree LED Lighting	XSP Series
Philips Lighting	Road Focus LED

To determine existing conditions, Clanton & Associates performed street lighting calculations with staggered and opposite layouts at various pole spacing using a high pressure sodium source with typical wattages found in the city. Comparing this information with GIS data of current light pole locations and luminaire wattages, Clanton & Associates was able to classify the lighting of each block in South Salt Lake as either Acceptable, Moderately Acceptable or Poor.

Street Classification	Luminaire Wattage (W)	Acceptable Spacing (ft)	Moderately Acceptable Spacing (ft)	Poor Spacing (ft)
Arterial	400	200-300	300-350	350+
Arterial	250	150-250	250-300	300+
Collector	200	150-250	250-300	300+
Local	100	Mid Block and Intersections	Intersections Only	No Lighting

Exterior lighting improvements
To improve the nighttime lighting conditions, Clanton & Associates recommends prioritizing the retrofits along the acceptable roadways. This will be the most economical improvement and ensures that existing infrastructure is properly used. Multiple arterial, collector and local streets in the city have proper infrastructure present, but are not meeting lighting criteria because of luminaire problems. These problems include but are not limited to existing luminaires malfunctioning, unnecessary glare, over lit areas and poor distribution.

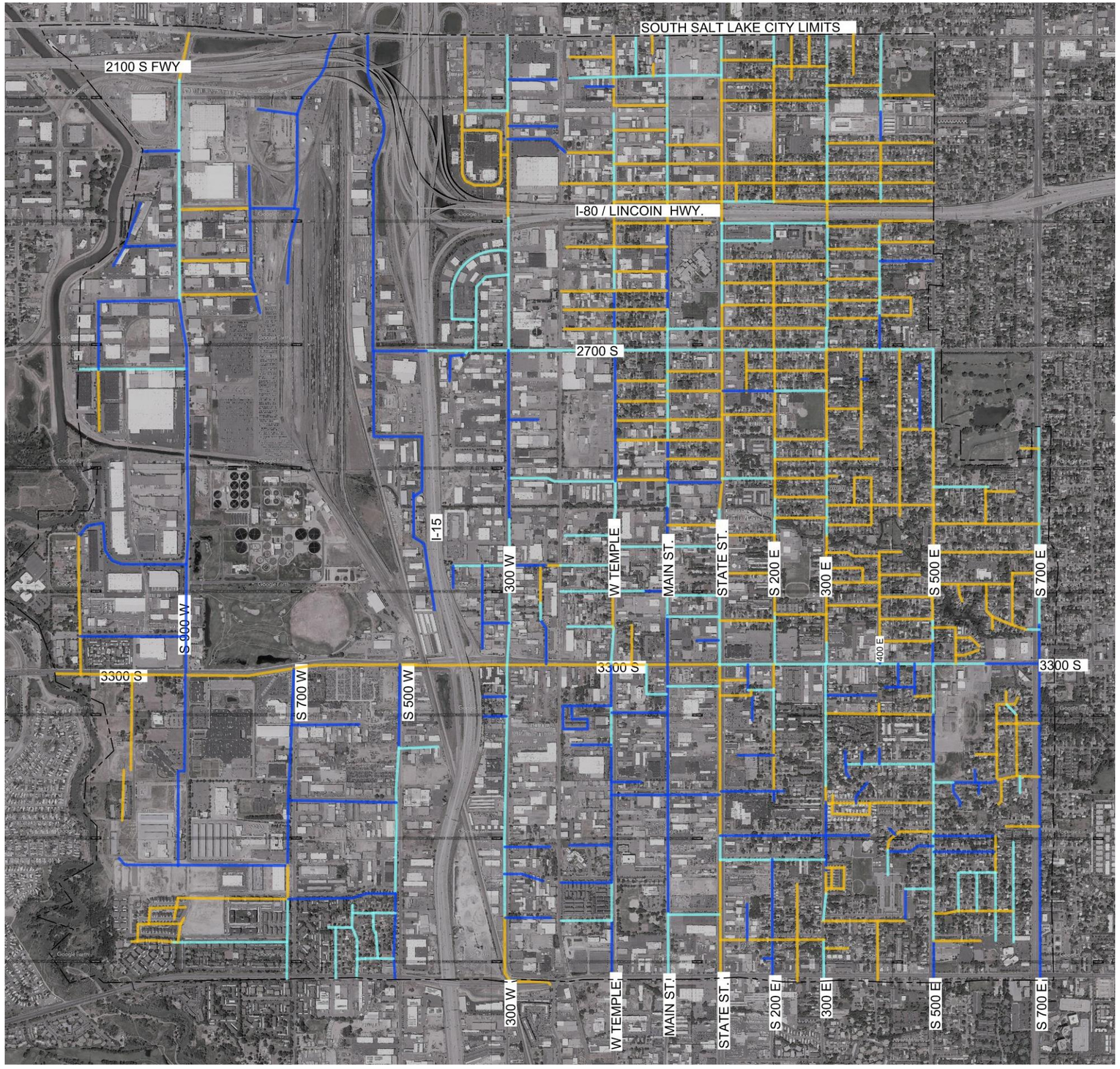
Further analysis of possible street lighting improvements should be completed before retrofits or new construction begins in order to confirm proper wattage, spacing and mounting heights. This will ensure that lighting criteria is being met and the proper design is being installed.

Existing Lighting Conditions

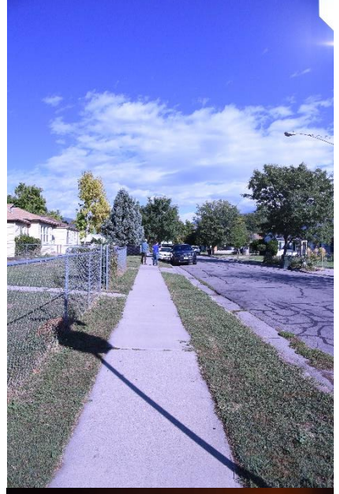
:ACCEPTABLE CONDITIONS

:MODERATELY ACCEPTABLE CONDITIONS

:POOR CONDITIONS

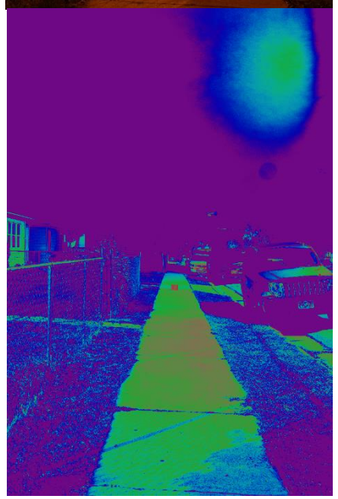


Street Lighting Surveys



300E. Welby Daytime Environment

300E. Welby Nighttime Environment



300E. Welby High-Dynamic Range

Site Observations

The City of South Salt Lake Lighting Study provides an understanding of the current street lighting in eleven different locations throughout the city. The sites were selected based on street type, arterial, collector, or residential, and on their surrounding environments in the city, industrial, commercial, transit or residential. The selected sites will help provide a collective understanding of the lighting and environmental conditions found throughout the city. The eleven site are:

- 3300S 1000W
- 3300S State St
- 3335S State St
- 3745S 610E
- 300E Welby
- 300E Southgate Ave.
- 2950S West Temple
- 2700S 300W
- 2100S 300W
- Bowers Way & Main St

While Clanton & Associates was in South Salt Lake, initial site observations were documented, and lighting measurements were taken. Both horizontal and vertical illuminance (the amount of light reaching a surface) measurements were taken along the sidewalk. Luminance (the amount of light on a surface that the eye perceives) measurements were taken along the roadway to provide an understanding of roadway brightness at each site. These measured light levels were used to compare the existing light levels to the light level requirements established by the IES. Clanton & Associates also took high-dynamic-range (HDR) images as a visual representation of the perceived nighttime experience. An example, of the images taken, is shown to the left.

The evening following the light measurements, four city representatives were taken on a nighttime tour of the selected sites and asked to complete a survey assessing the lighted environment. The survey was comprised of several subjective questions regarding the safety and aesthetics of each site. The survey includes, but was not limited to, the following questions:

- It would be safe to walk here, alone, during daylight hours.
- It would be safe to walk here, alone, during darkness hours.
- The light is uneven (patchy).
- The light sources are glaring.
- The lighting is poorly matched to the campus.

Participants answered each question with a ranking between Strongly Agree and Strongly Disagree. The answers to each question were combined to provide an understanding of each site. Participants surveyed eleven different sites featuring arterial, collector and residential streets in industrial, commercial and residential areas.

Establishing Levels of Acceptability

The site observations and study results were used to create four levels of acceptability: excellent, good, moderate and poor.

Excellent acceptability is obtained by meeting the IES standards based on roadway type, while providing adequate vertical illumination to allow for object detection and facial recognition. The lighting in this location will be relatively uniform, free of direct glare and properly illuminates the roadway and sidewalk.

Good acceptability indicates that the lighting in the area feels comfortable. In some cases, such as residential areas, the light level might be lower than the IES standard but the lack of glare and shadowing from surrounding landscaping, along with some surrounding surface brightness, creates a comfortable nighttime environment without light trespass.

A moderate level of acceptance is often seen in locations that do not provide enough light on the roadway or on the sidewalk. Although the light levels in these areas are only slightly lower than the IES standards, the color of the light is inconsistent and sources are often glary resulting in a uncomfortable space.

The lowest level of acceptance occurs when the luminaires are spaced too far apart to provide adequate light levels and uniformity or there are no luminaires on the street at all. These spaces are often characterized by industrial and commercial spaces without enough light for pedestrian comfort or driver safety.

These levels of acceptability provide an understanding of the nighttime environments found throughout the city. This allows a variety of lighting improvement options to be developed. These future lighting options will enhance the nighttime safety and security around the city. Each option will focus on improving light levels, uniformity, and wayfinding while reducing glare.

Example of Good Residential Lighting

Example of Poor Residential Lighting

Safety and Security

The safety and security of an area is created by the combination of several layers of lighting elements. The visibility of the immediate pathway and surrounding surface brightness are necessary to enhance the nighttime environment.

Layers of Light

Providing layers of ambient, accent, and feature lighting improves the surface brightness and uniformity of the lighted environment. Lighted building surfaces improve visibility, brightness perception, comfort and security.

Subtle Contrast

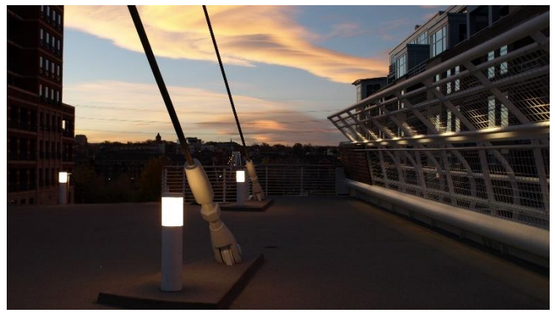
Some variation of light levels provides definition to exterior spaces. Brighter entrances and pathways draw pedestrians between spaces while pedestrians feel less inclined to walk through dimmer spaces.

Feature Lighting

Accent lighting of building architectural features, entrances, water features, and sculptures can improve the pedestrian experience. Surrounding surfaces that are appropriately lighted improves visibility, security, and perception of brightness.

Color of Light

White light sources improves color rendering, revealing rather than distorting colors. The warmth of the color of the light should be between a candle (1850K) and moonlight (4100K) to provide a comfortable nighttime environment.



Low Glare

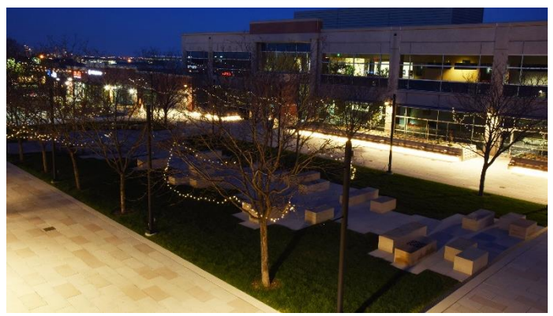
Glare destroys nighttime visibility. Minimize glare to improve visibility

Adaptation

Adapting from excessively bright interior spaces to non-lighted nighttime environments can take up to five minutes. Improving entry and immediate pathway nighttime light levels can improve adaptation.

Vertical Light Levels

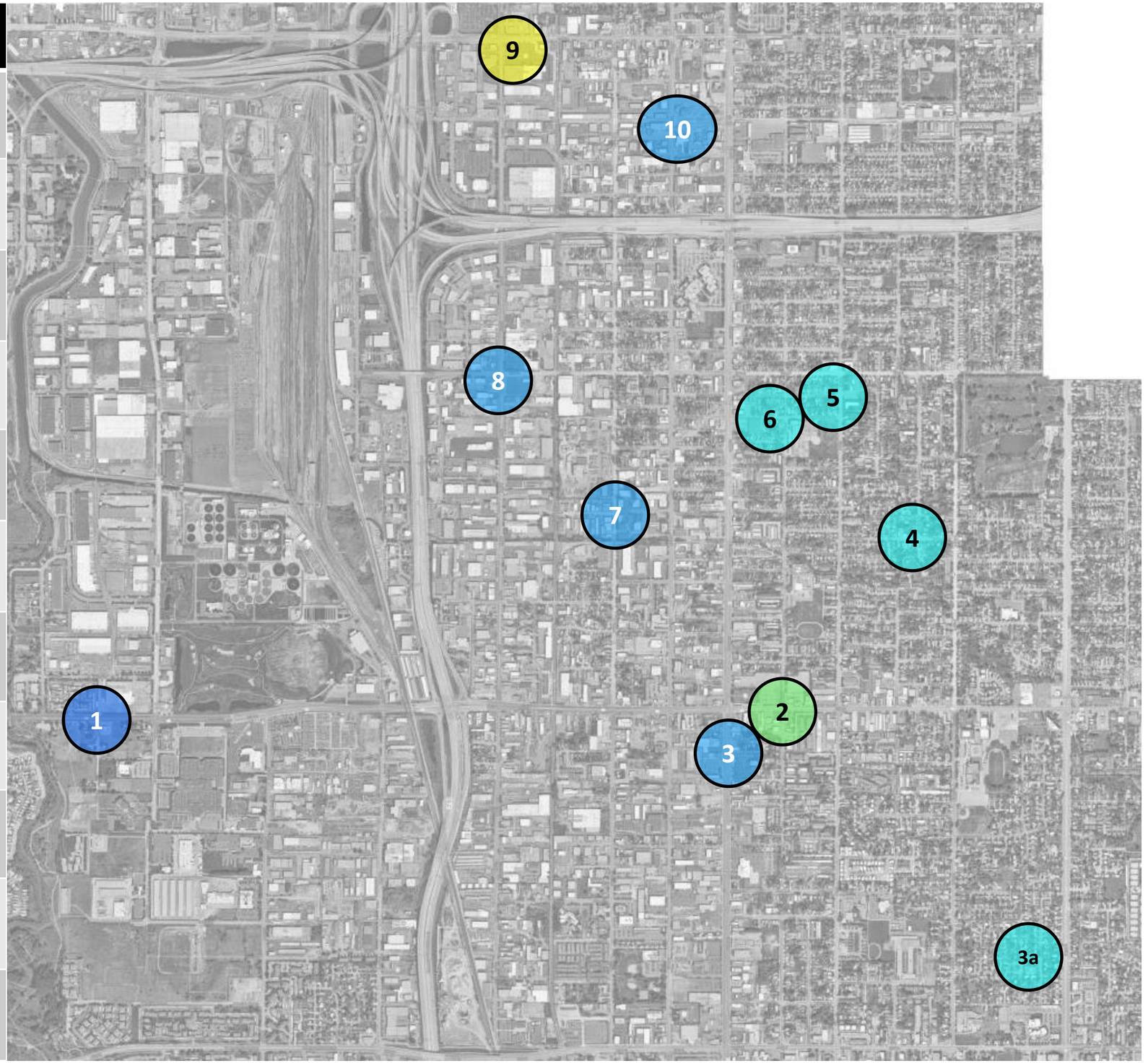
Lighting vertical surfaces enhances facial and object detection. Facial detection allows pedestrians to identify the intent of approaching pedestrians, or see objects in the pathway, and respond accordingly.

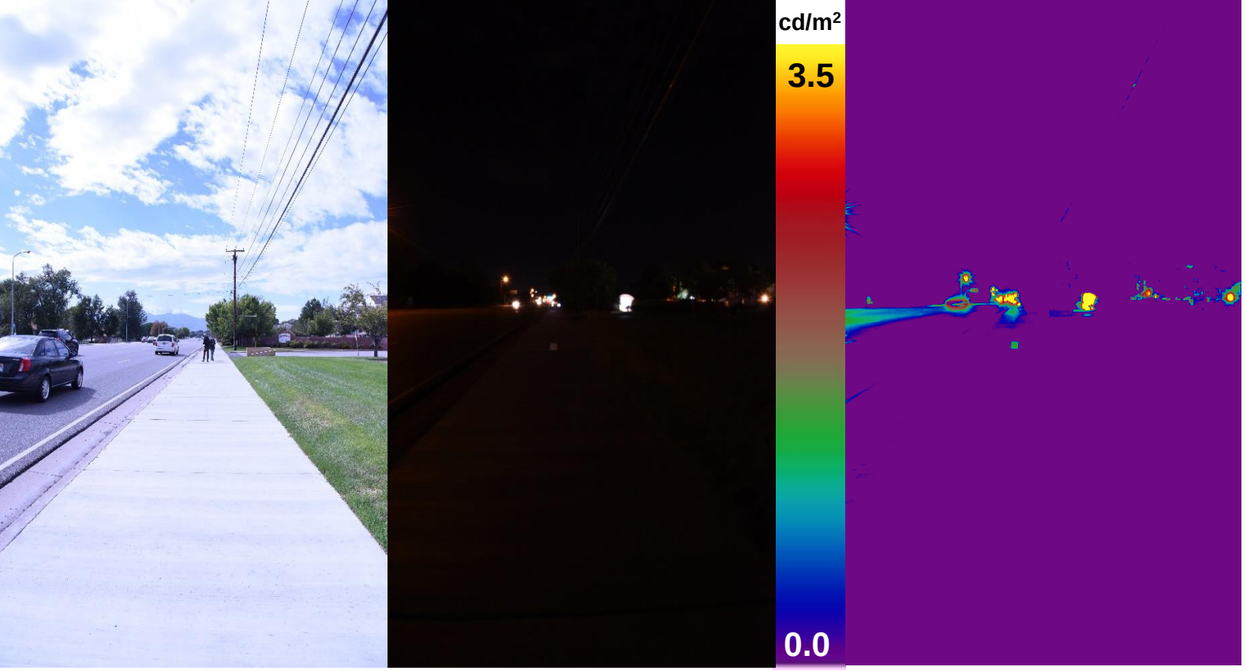


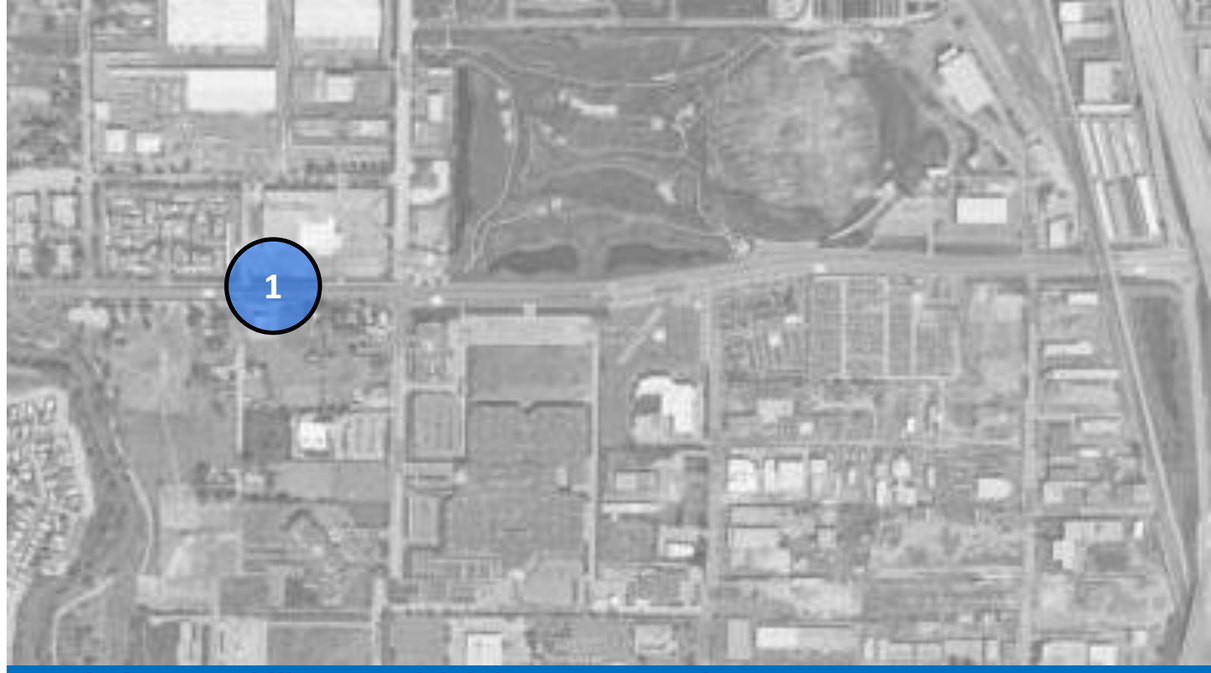
Wayfinding

Illuminating focal points such as entrances, architectural features, and key pathways improves navigation. Lighting that improves wayfinding provides confidence to pedestrians who are unfamiliar with the area.

Site #	Site Name	Street Classification	Existing Lighting
1	3300 South @ 1000 West	Arterial	**Poor** Maintenance issues
2	3300 South @ Edison St.	Arterial	**Good** Private lights dominate
3	State St. @ Spencer Ave.	Arterial	**Poor** New lights not on yet
3a	3745 South @ 610 East	Local	**Moderate** Lights too far apart
4	300 East @ Welby Ave.	Local	**Moderate** Glare & light trespass
5	300 East @ Southgate Ave.	Local	**Moderate** Glare & light trespass
6	Claybourne Ave. near State St.	Collector	**Moderate** Glary
7	2950 South @ West Temple	Local	**Poor** Lights too far apart
8	2700 South @ 300 West	Collector	**Poor** Lights too far apart
9	2100 South @ 300 West	Arterial	**Excellent** Public & private lights
10	Bowers Way @ Main Street	Collector	**Poor** No lighting on sidewalk



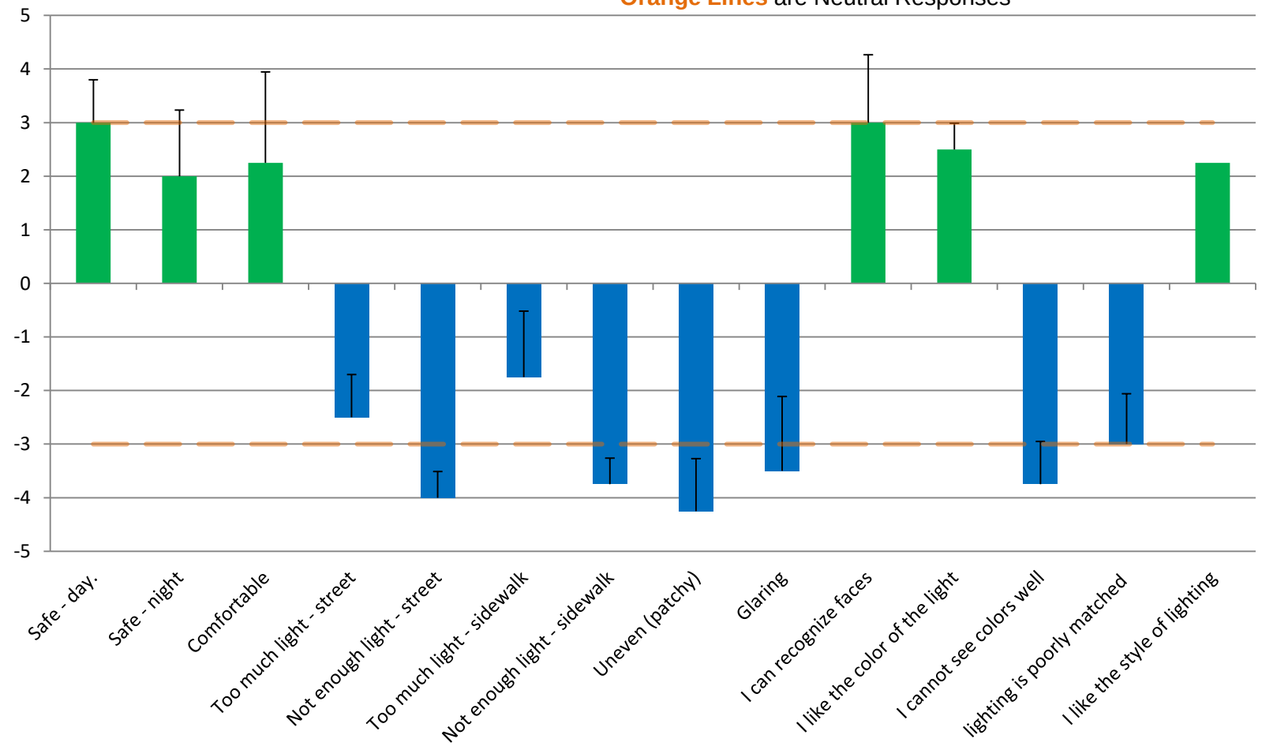




Level of Acceptability: Poor (LightingScore = -5.5)
3300S had the lighting infrastructure but due to maintenance issues, lights were not. operating

Site 1: 3300S 1000W

Green Bars are Positive Questions (High Values are Preferred)
Blue Bars are Negative Questions (Low Values are Preferred)
Orange Lines are Neutral Responses



Initial Site Observations
- This is a wide arterial road with heavy traffic from commuters and shipping.
- There is lighting infrastructure present at good spacing but lights are not operating due to maintenance issues.
- There are light sources from nearby buildings causing direct glare on the roadway.
- Lamp wattage and spacing is consistent and ideal for retrofit.

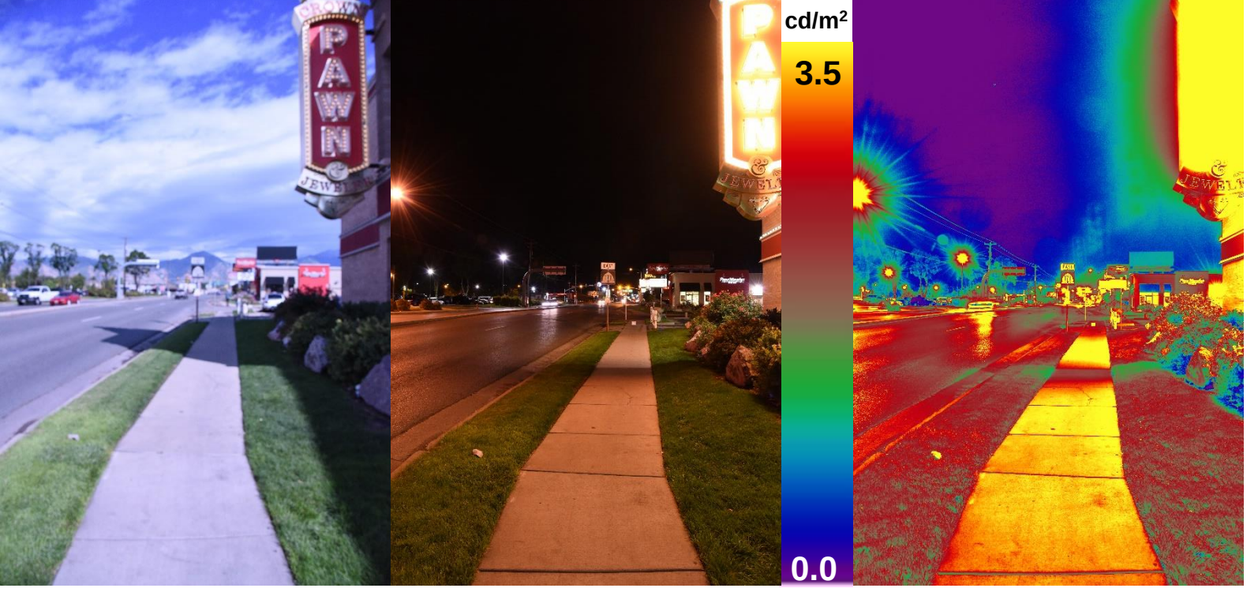
Lighting Measurements
- This street is dark and only lit by passing cars.

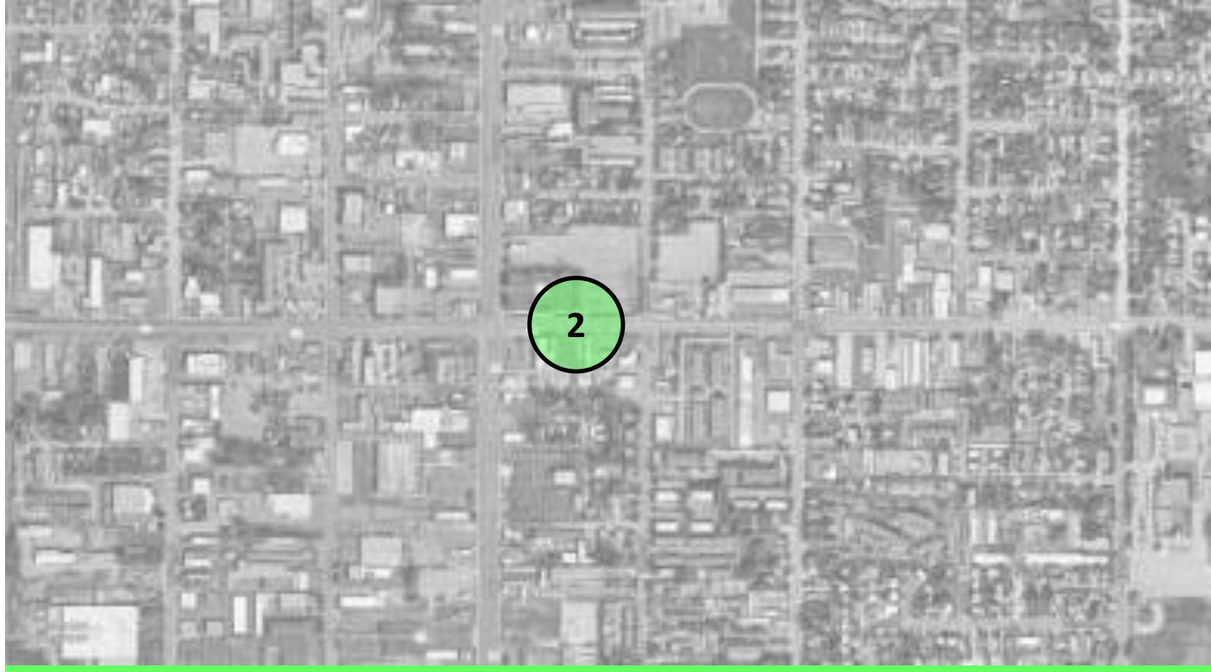
Participant Survey
- Participants felt neutral about the lighting in this location.
- The light kept coming off and on.
- Headlights from the busy road provide enough light to feel comfortable.
- Area is close to transient camps and the Jordan River.

		Sidewalk Illuminance (fc)		Roadway Luminance (cd/m^2)
		Horizontal	Vertical Min	
Arterial Criteria Low Conflict	Average	0.4	0.1	0.5
	Ave/Min	4	-	3.5
Site 1	Average	0.04	0.01	0.07
	Ave/Min	8	-	3.5

CLANTON & ASSOCIATES
LIGHTING DESIGN AND ENGINEERING

Site 1 : 3300S. 1000W.

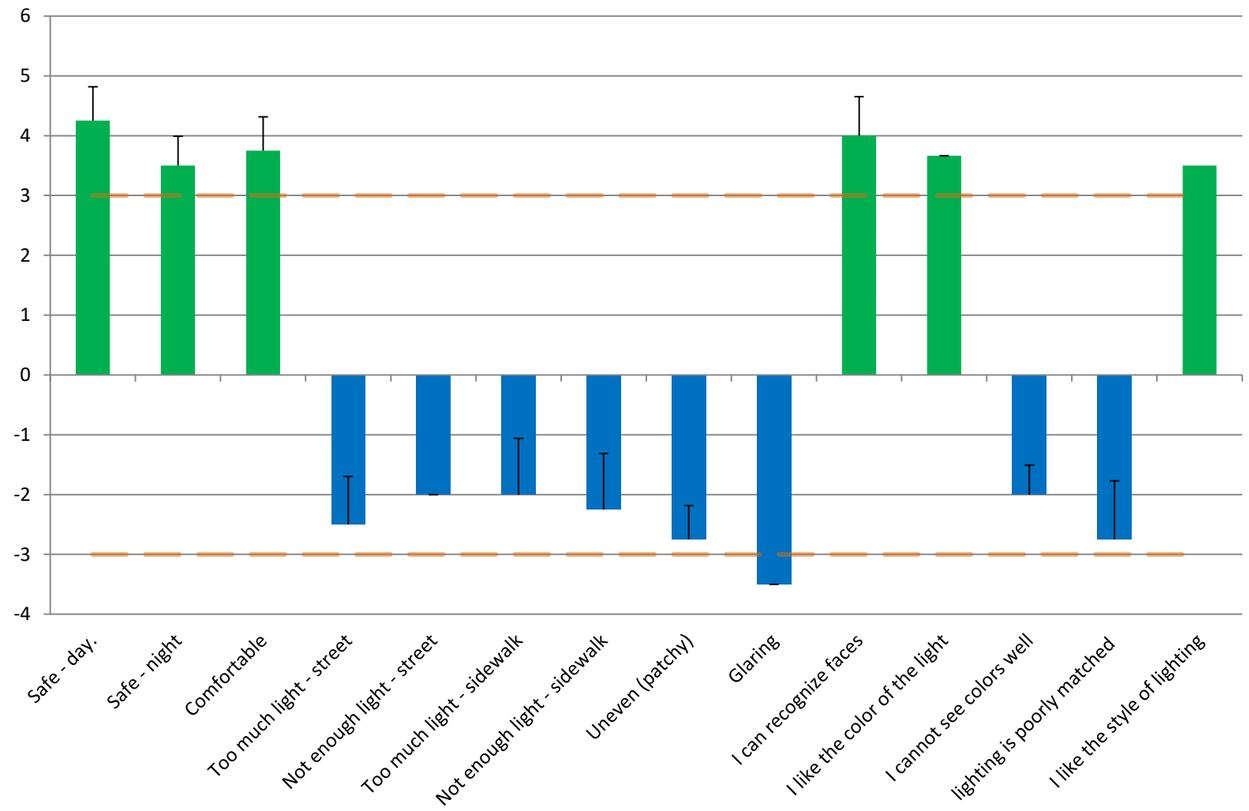




Level of Acceptability: Good (LightingScore = 8.9)
High vertical surface brightness improves visibility and comfort.

Site 2: 3300S. State St.

Green Bars are Positive Questions (High Values are Preferred)
Blue Bars are Negative Questions (Low Values are Preferred)
Orange Lines are Neutral Responses



Initial Site Observations

- Street and Sidewalk have sufficient light but a large percentage of the light is coming from nearby businesses.
- Direct glare coming from business signage.

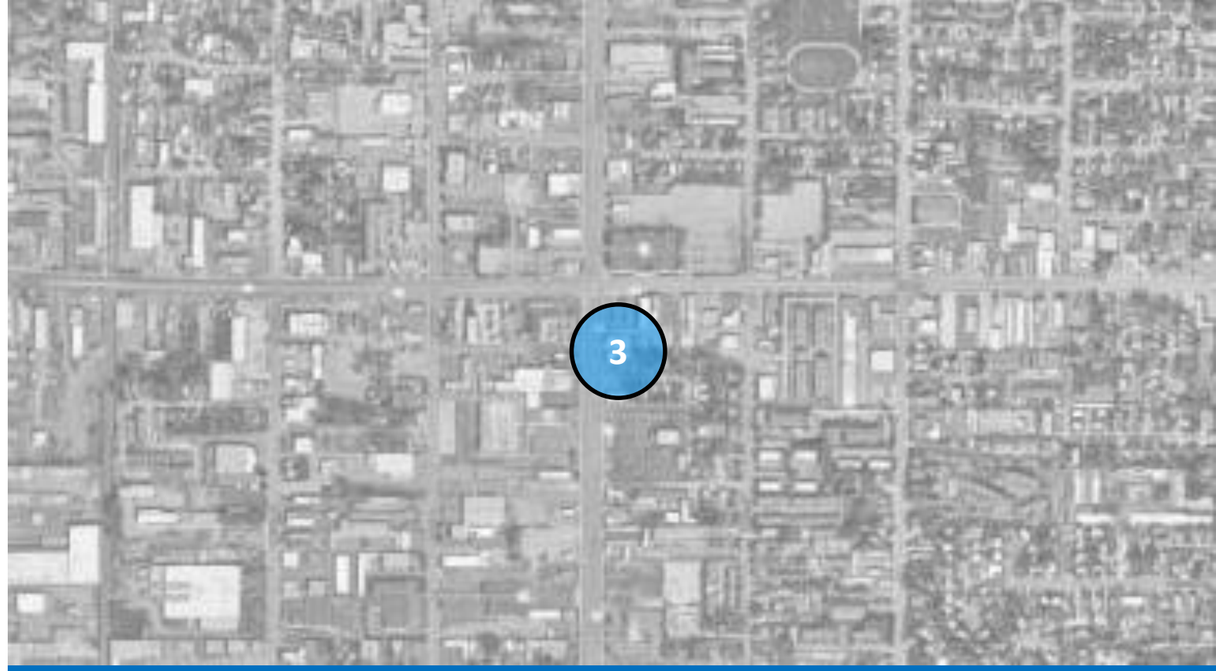
Lighting Measurements

- The street and sidewalk has sufficient lighting.
- Due to glaring signage, vertical illuminance on sidewalk is higher than lighting standards.

Participant Survey

- Participants felt safe and comfortable in this location and thought highly of the lighting
- Participants thought the bight light was suitable for the area.
- Participants note how the glaring lights could be distracting to drivers and pedestrians.

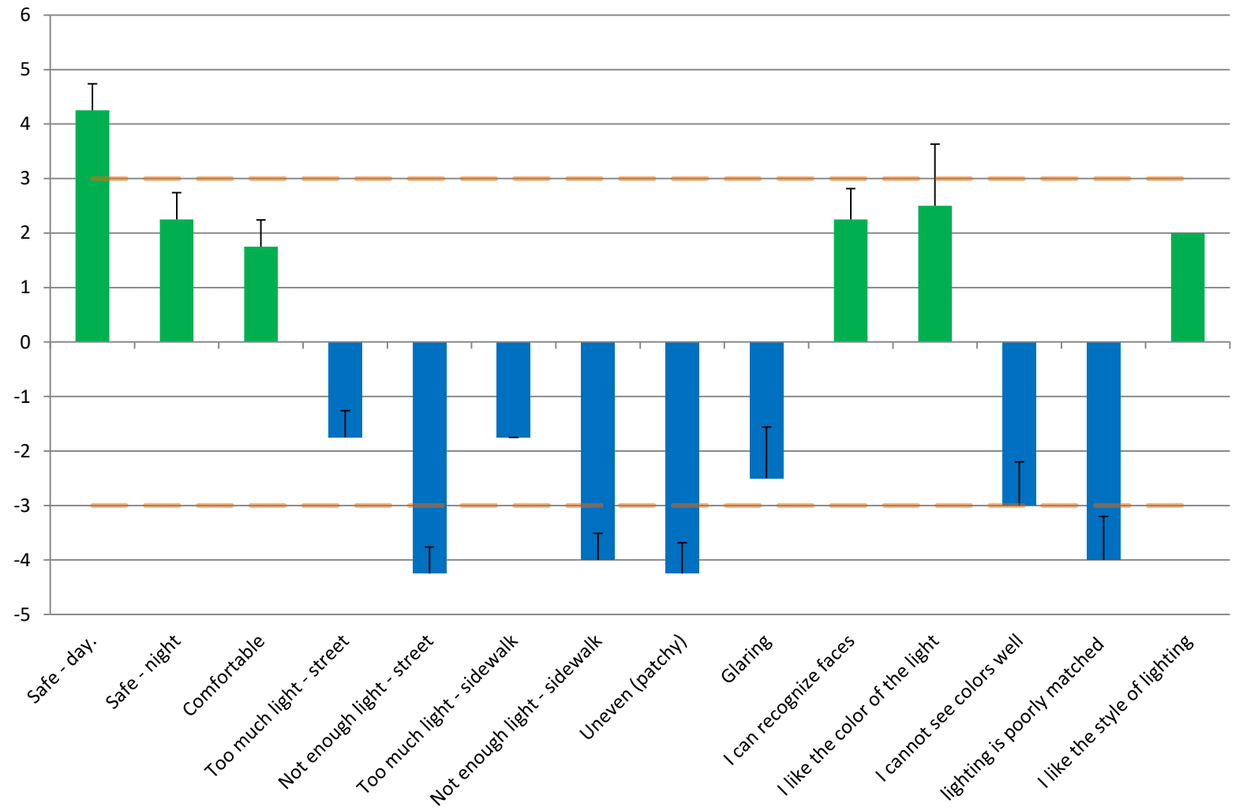
		Sidewalk Illuminance (fc)		Roadway Luminance (cd/m^2)
		Horizontal	Vertical Min	
Arterial Criteria Medium Conflict	Average	0.5	0.2	0.7
	Ave/Min	4	-	3.5
Site 2	Average	1.62	0.4	1.48
	Ave/Min	4.05	-	2.7



Level of Acceptability: Poor (LightingScore = -4.5)
Street lighting is not sufficient. Majority of light comes from local businesses.

Green Bars are Positive Questions (High Values are Preferred)
Blue Bars are Negative Questions (Low Values are Preferred)
Orange Lines are Neutral Responses

Site 3: 3335S. State St.



Initial Site Observations

- The majority of the lighting on the sidewalk and roadway comes from local businesses.
- Lighting from businesses is glary.
- New Holophane lights look good, but are not operating.

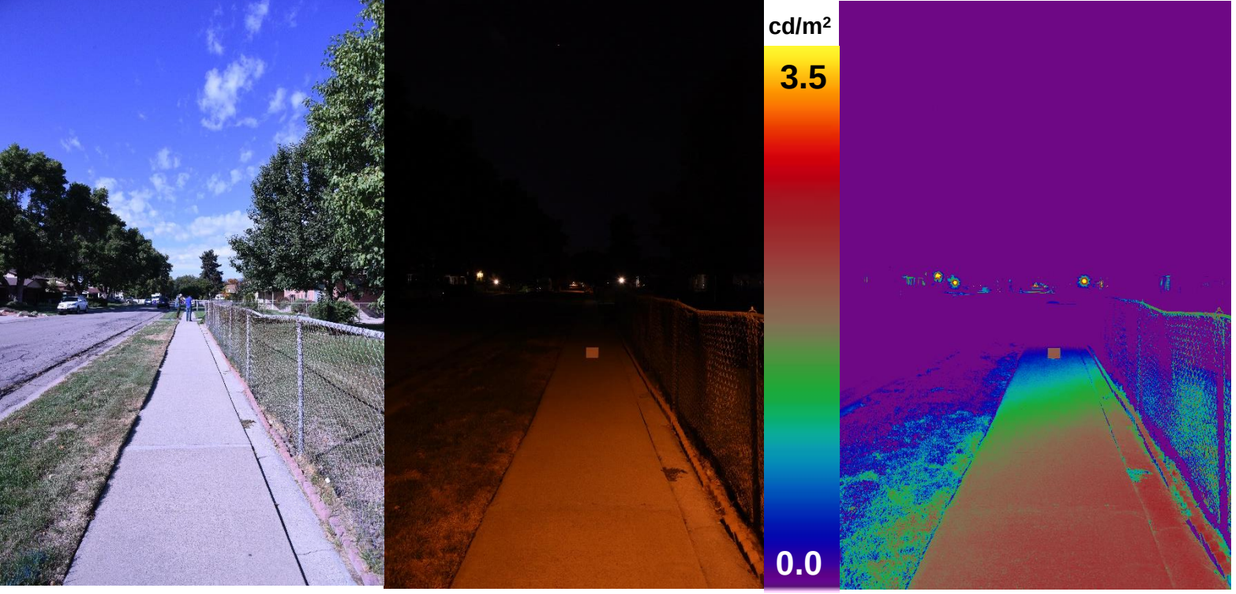
Lighting Measurements

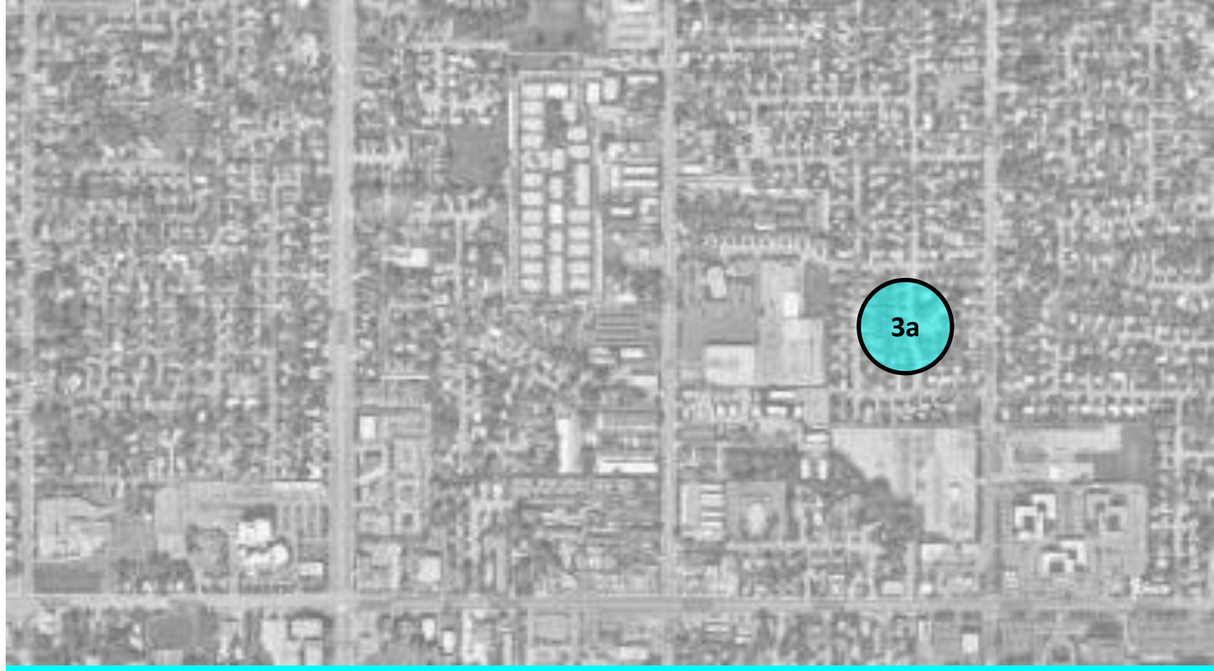
- Sidewalk illuminance is very low, except in areas directly under building lighting.
- Vertical illuminance is high in places due to glare.
- Street lighting is low and mostly comes from building lights.

Participant Survey

- Participants see this site as worse than the lighting in similar areas.
- Participants think that this is too dark for a commercial area.
- Participants found that most of the lighting is from private businesses.

		Sidewalk Illuminance (fc)		Roadway Luminance (cd/m^2)
		Horizontal	Vertical	
Arterial Criteria Medium Conflict	Average	0.5	0.2	0.7
	Ave/Min	4	-	4
Site 3	Average	0.65	0.2	0.32
	Ave/Min	3.8	-	1.78

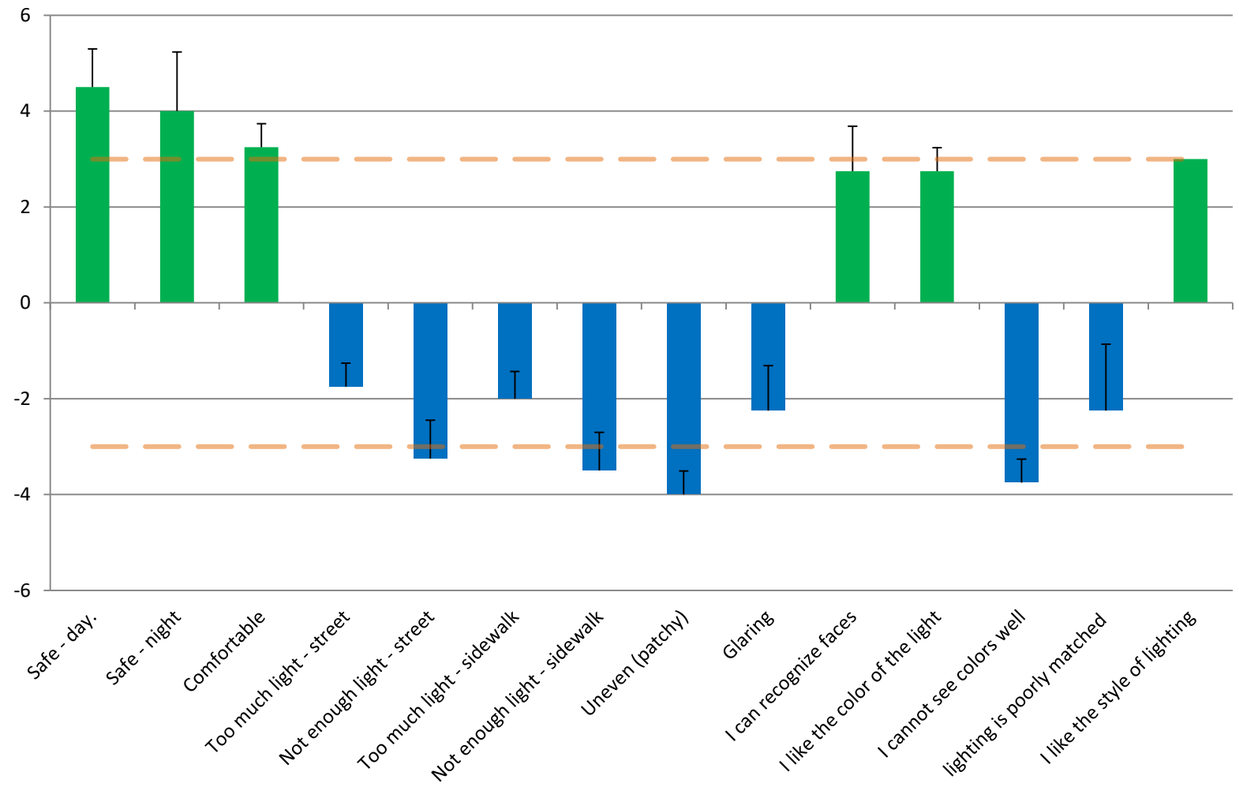




Level of Acceptability: Moderate (LightingScore = 3.5)
Light levels are lower than criteria, but fit the needs of the residential area well.

Green Bars are Positive Questions (High Values are Preferred)
Blue Bars are Negative Questions (Low Values are Preferred)
Orange Lines are Neutral Responses

Site 3A



Initial Site Observations

- There are street lights on street intersections and midblock. However, the streets blocks are long.
- Almost every residence has porch lighting, providing light onto the right of way.
- Overgrown trees are blocking some of the street lights.

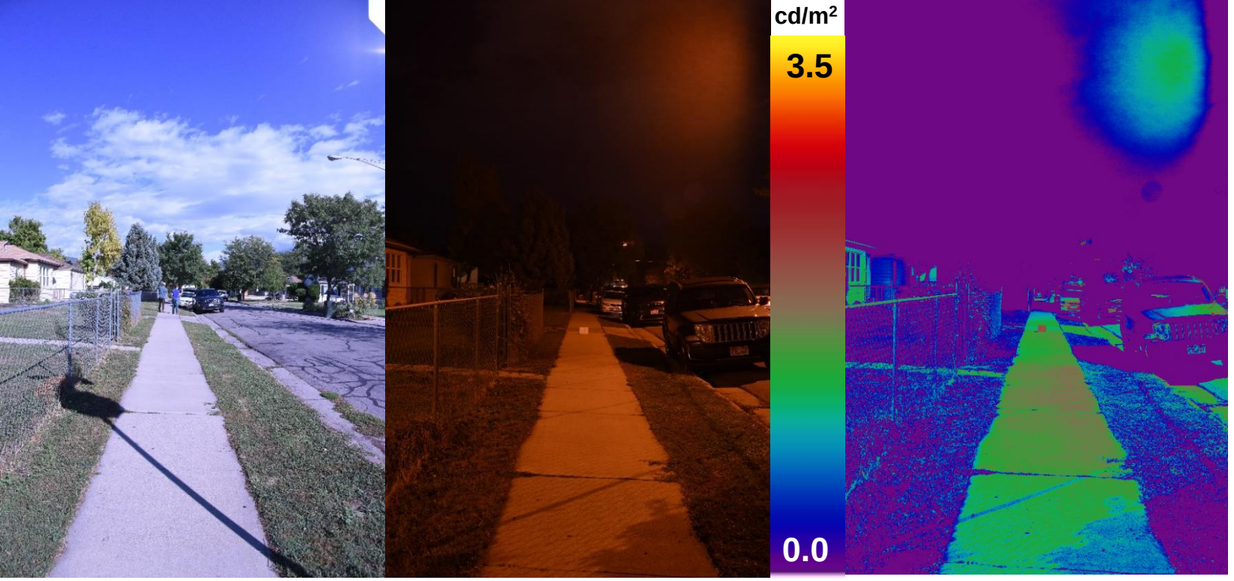
Lighting Measurements

- Vertical and horizontal illuminance measurements are peaked by porch lighting resulting in large ave/min ratio.
- Street luminance is low, but has good uniformity.

Participant Survey

- Participants see the lighting at this site as similar to the lighting in similar areas.
- Participants felt safe and comfortable in the space.
- Some participants liked the lower light levels in the neighborhoods and think that this provides sufficient light.
- Other participants would like to see more light on the sidewalks for pedestrians.

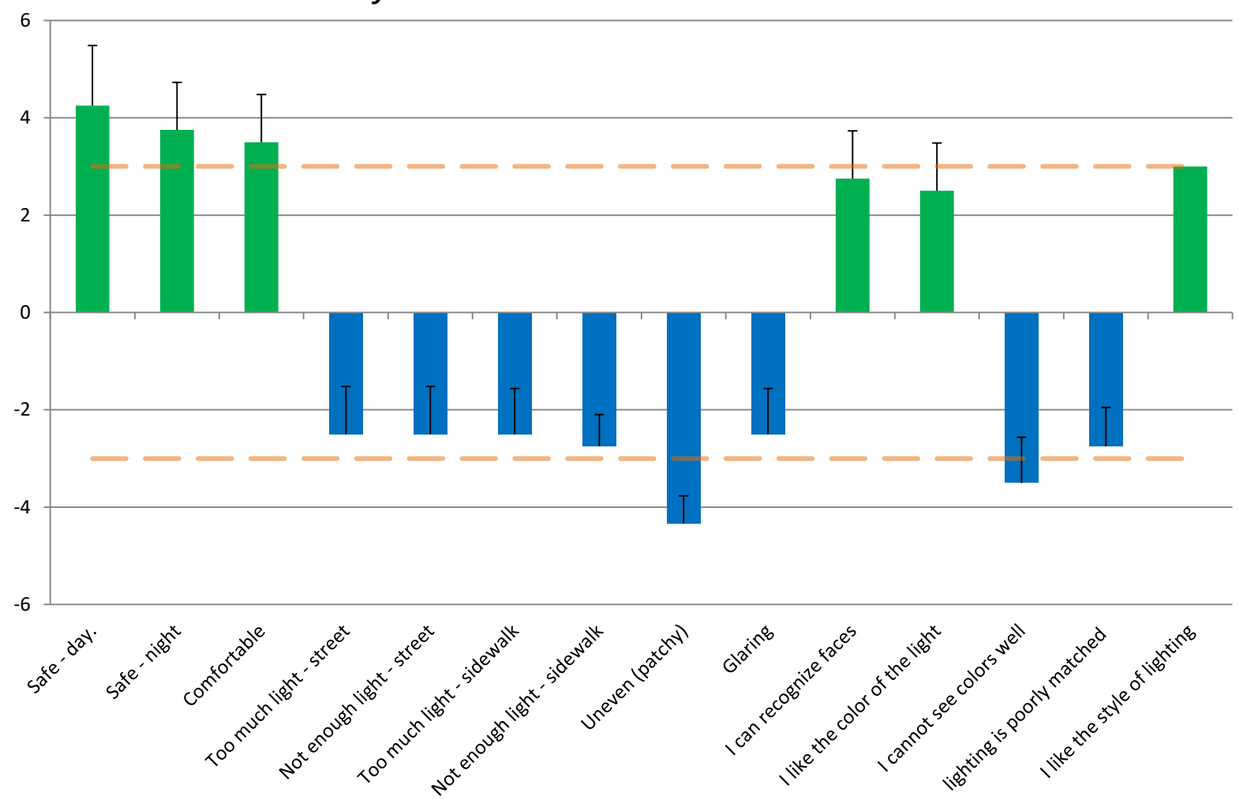
		Sidewalk Illuminance (fc)		Roadway Luminance (cd/m^2)
		Horizontal	Vertical Min	
Local Criteria Low Conflict	Average	0.4	0.08	0.2
	Ave/Min	4	-	6
Site 3A	Average	0.27	0.01	0.03
	Ave/Min	27	-	3



Level of Acceptability: Moderate (LightingScore = 2.4)
Light levels are adequate yet luminaires are glary and there is light trespass.

Green Bars are Positive Questions (High Values are Preferred)
Blue Bars are Negative Questions (Low Values are Preferred)
Orange Lines are Neutral Responses

Site 4: 300E. Welby Ave.



Initial Site Observations

- Light levels are adequate and spacing is appropriate.
- Light sources are glary and there is light from street lights entering private property.
- Sidewalks do not have sufficient light due to trees blocking street lights.

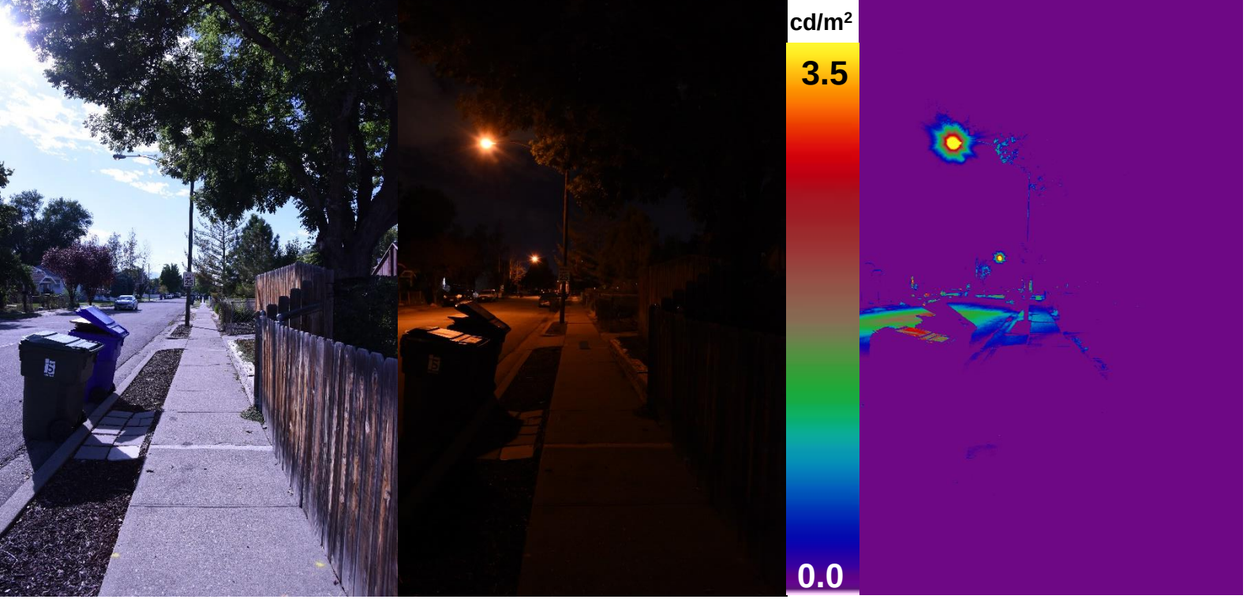
Lighting Measurements

- Light levels are adequate,
- Luminaires are glary. This hinders visibility into surrounding areas.
- There is light entering private property from street lights.

Participant Survey

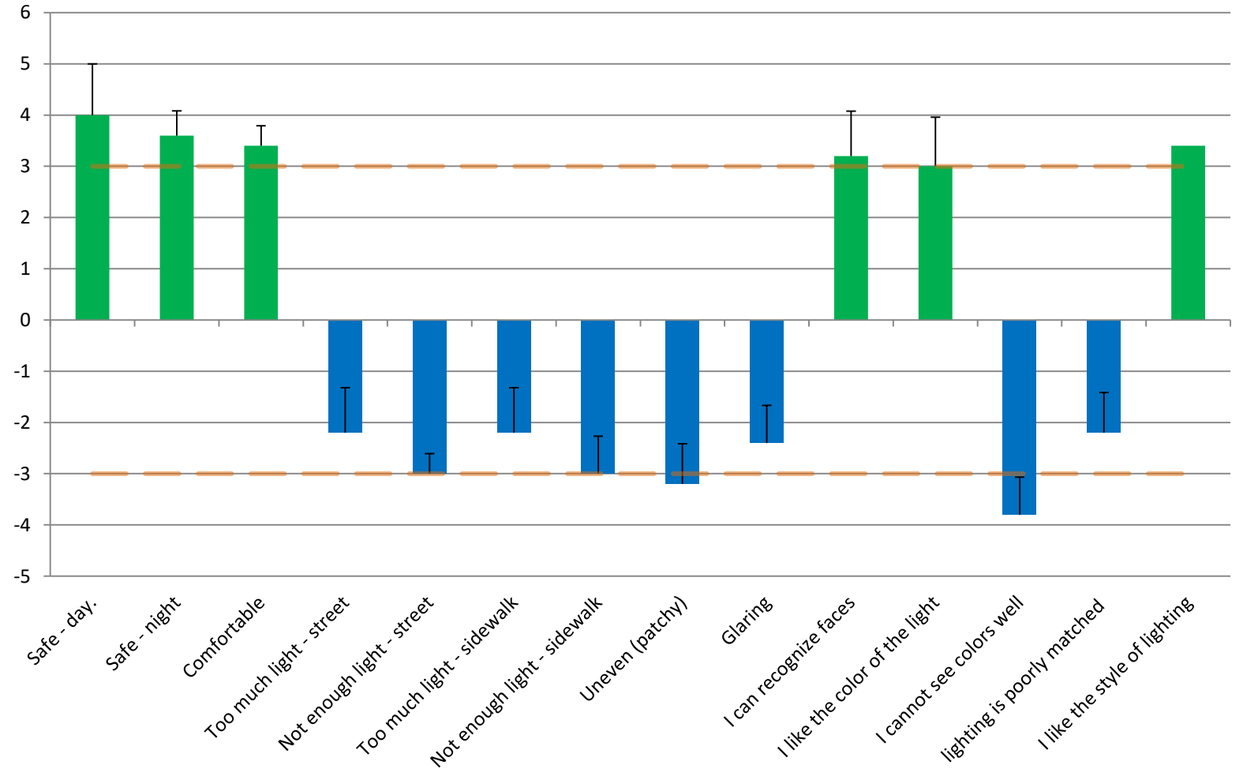
- Participants had varied responses on this street, from better than most to worse than most.
- One participant found the light levels appropriate but the glare makes it seem too bright.
- One Participant thinks that there enough light to feel comfortable.

		Sidewalk Illuminance (fc)		Roadway Luminance (cd/m^2)
		Horizontal	Vertical Min	
Local Criteria Low Conflict	Average	0.4	0.08	0.2
	Ave/Min	4	-	6
Site 4	Average	0.29	0.02	0.3
	Ave/Min	29	-	1.7



Site 5: 2700S. 300W.

Green Bars are Positive Questions (High Values are Preferred)
Blue Bars are Negative Questions (Low Values are Preferred)
Orange Lines are Neutral Responses



Level of Acceptability: Moderate (LightingScore = 4.6)
Light levels are adequate yet luminaires are glary and there is light trespass.

Initial Site Observations

- Light levels are adequate and spacing is appropriate.
- Light sources are glary and there is light from street lights entering private property.
- Sidewalks do not have enough light due to trees blocking street lights.

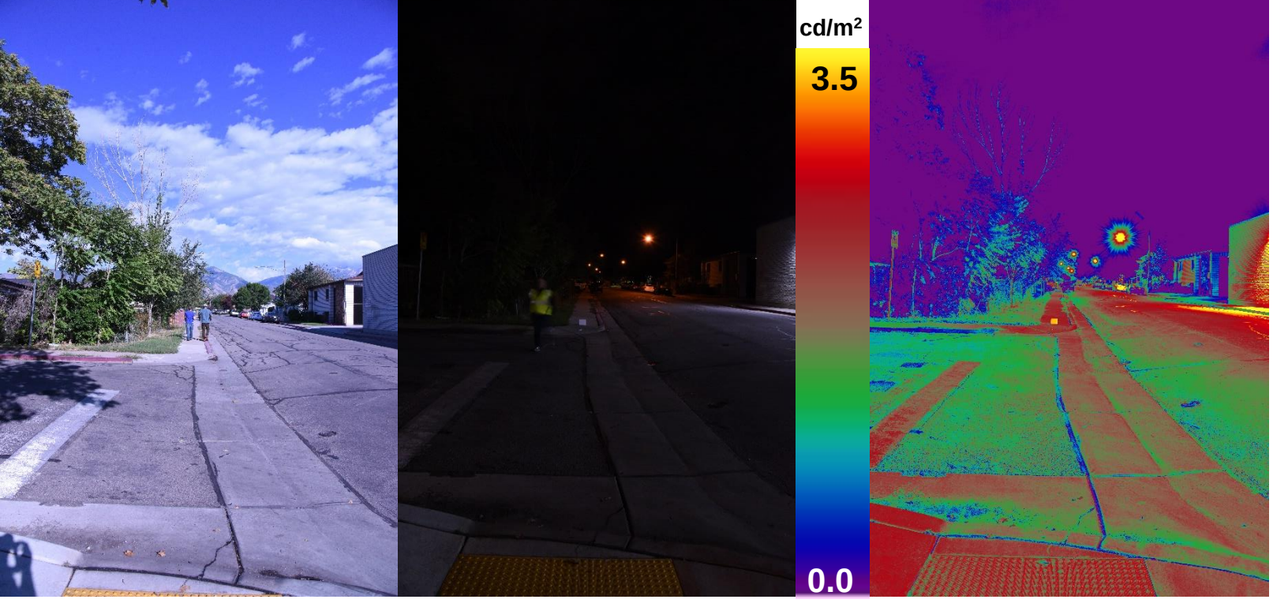
Lighting Measurements

- Roadway luminance is sufficient with quality spacing.
- Sidewalks are dark due to trees blocking street lights.
- Poarch lights are bright and a source of glare.

Participant Survey

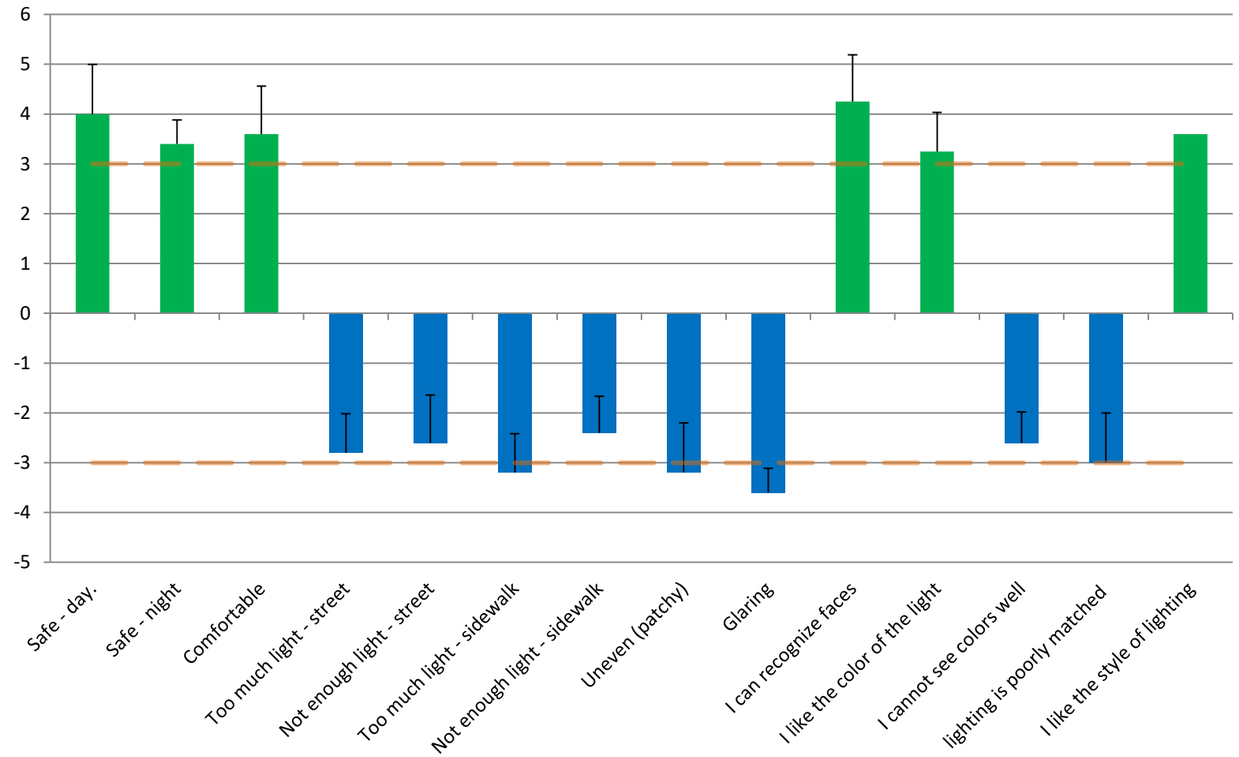
- Participants thought that the lighting was equivalent or better than similar areas throughout the city.
- Participants liked the light levels, but not the color of the light.
- Participants thought that the sources were too glary.
- Participants liked the lower light trespass levels.

		Sidewalk Illuminance (fc)		Roadway Luminance (cd/m^2)
		Horizontal	Vertical Min	
Local Criteria Low Conflict	Average	0.4	0.08	0.2
	Ave/Min	4	-	6
Site 5	Average	0.27	0.01	0.4
	Ave/Min	4.5	-	4



Green Bars are Positive Questions (High Values are Preferred)
Blue Bars are Negative Questions (Low Values are Preferred)
Orange Lines are Neutral Responses

Site 6: Claybourne Ave. State St.



Level of Acceptability: Moderate (LightingScore = 4.7)
Street lighting is adequate but nearby building lights are extremely glary.

Initial Site Observations

- The street lighting is adequate and pole spacing is appropriate.
- There are wall mount luminaires on a nearby building that are extremely glary.
- Sidewalk light levels are high near building lights and low away from them.

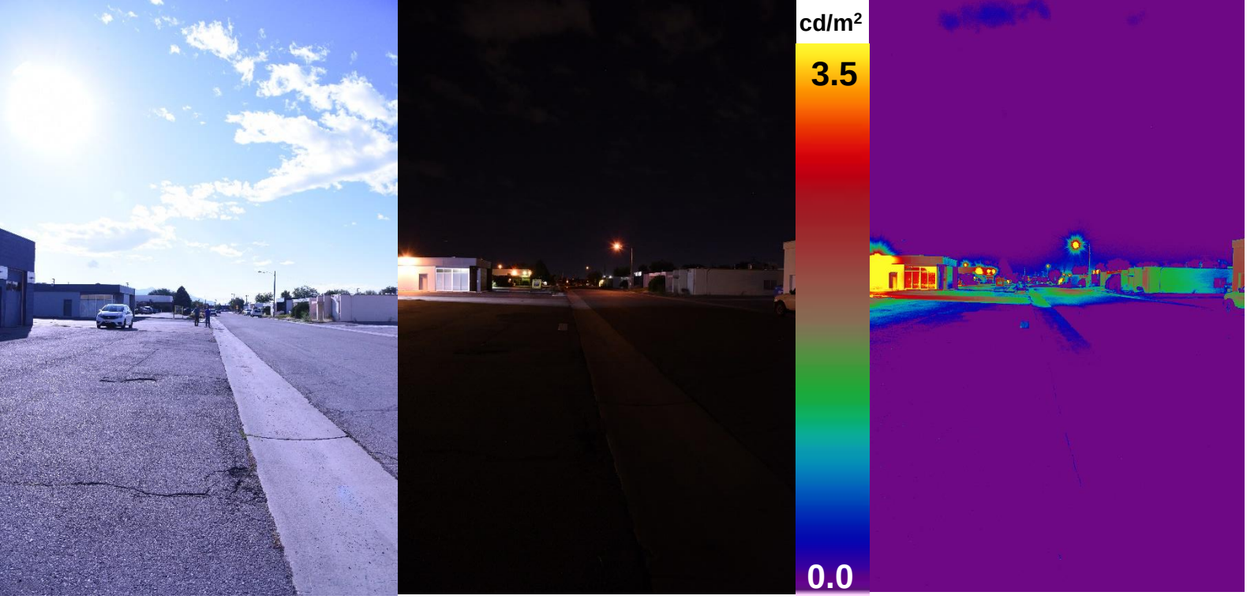
Lighting Measurements

- The roadway light levels are highest near building lights, but are sufficient along the street.
- Sidewalk vertical illuminance peaks near building due to glare.

Participant Survey

- Participants thought that lighting here was better than similar areas.
- Participants liked the street lighting
- Participants did not like the glare coming from nearby buildings.

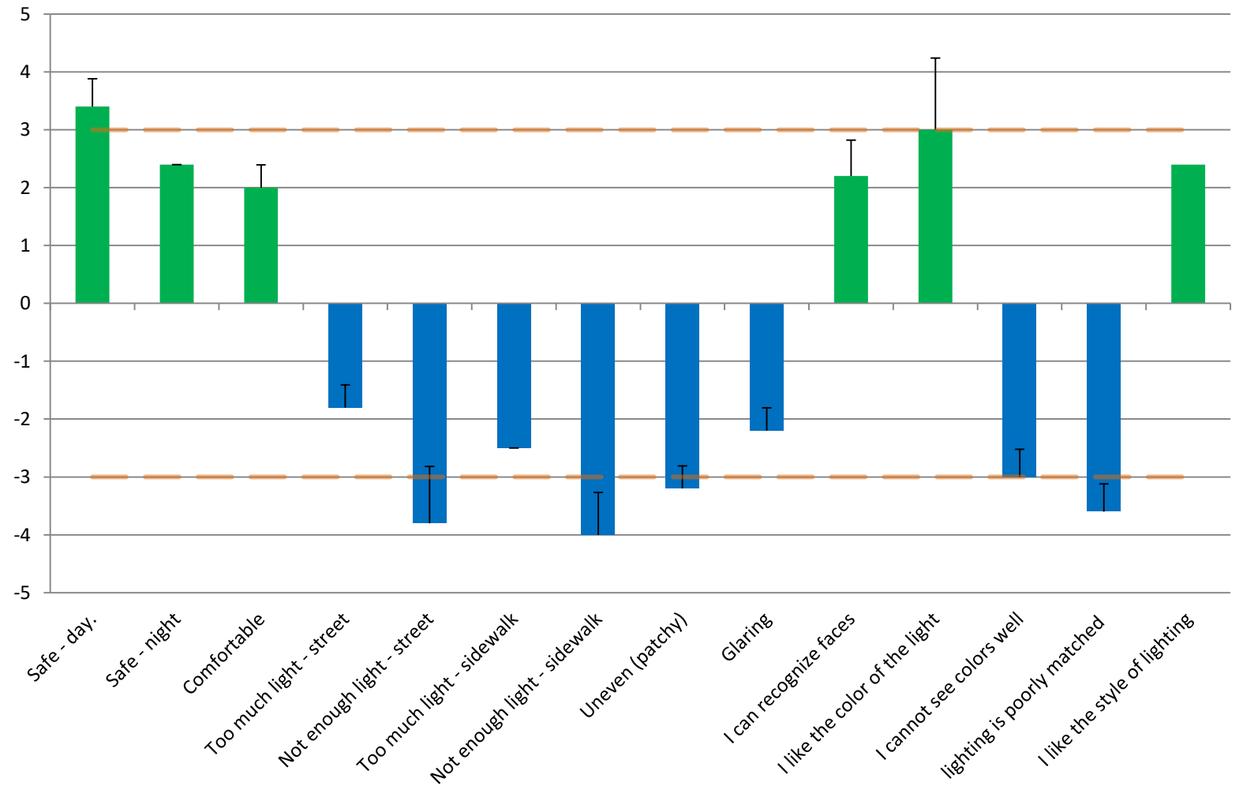
		Sidewalk Illuminance (fc)		Roadway Luminance (cd/m^2)
		Horizontal	Vertical Min	
Collector Criteria Medium Conflict	Average	0.5	0.2	0.5
	Ave/Min	4	-	6
Site 6	Average	0.29	0.2	0.42
	Ave/Min	1.45	-	1.4



Level of Acceptability: Poor (LightingScore = -2.7)
Luminaires are spaced too far apart to provide adequate light levels.

Green Bars are Positive Questions (High Values are Preferred)
Blue Bars are Negative Questions (Low Values are Preferred)
Orange Lines are Neutral Responses

Site 7: 2950S. 300W.



Initial Site Observations

- This area is dark and lights are placed too far apart to provide sufficient lighting.
- This is an industrial area without major traffic.
- There are many building lights that result in direct glare.

Lighting Measurements

- Lights need to be added in order to meet proper light levels.
- Vertical illuminance levels peak due to glare from building lights.
- Most light on streets comes from building lights.

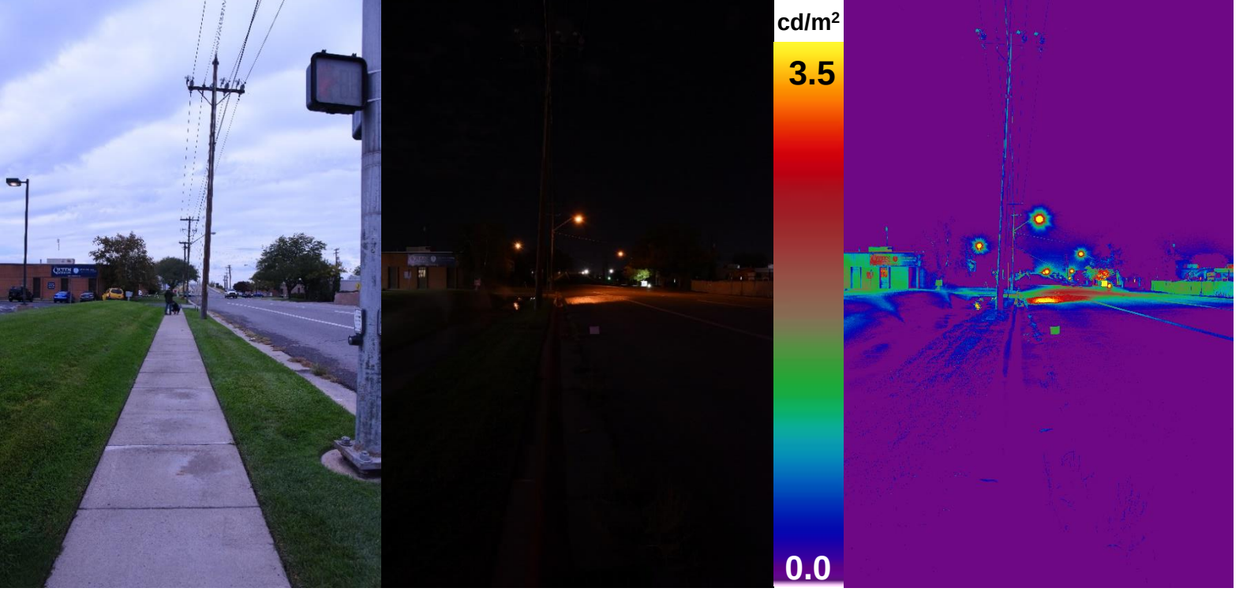
Participant Survey

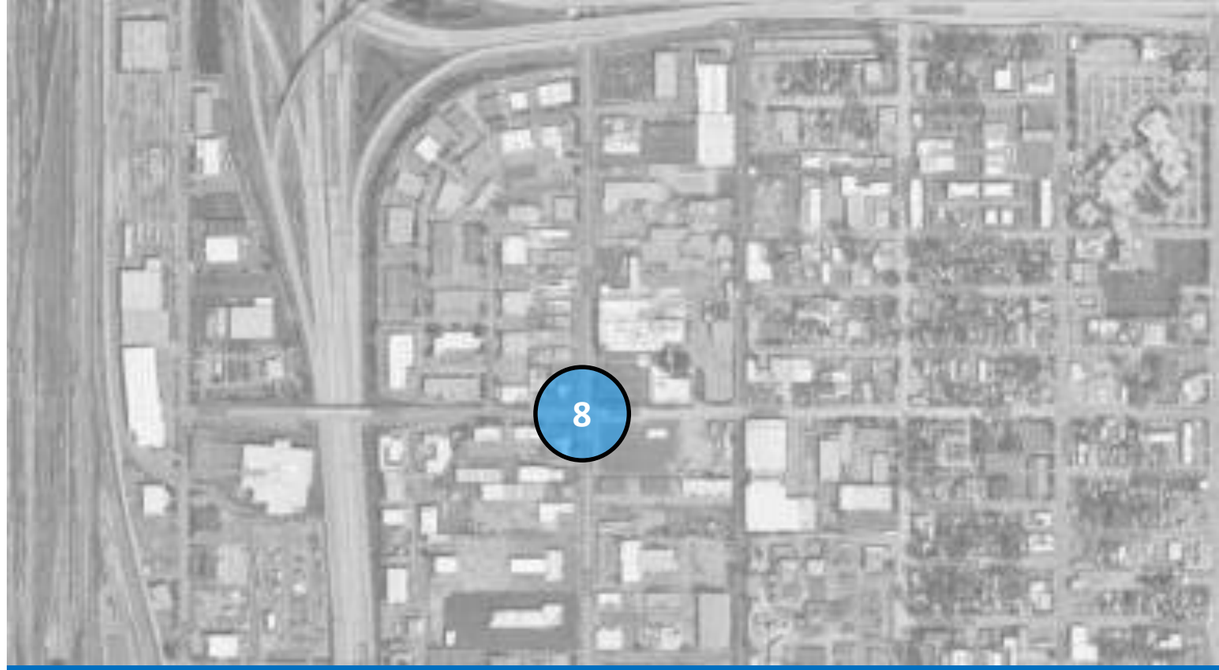
- Participants saw this street as having worse lighting than similar areas.
- Participants do not feel safe in this area.
- Participants observed that most of the light is coming from nearby buildings.

		Sidewalk Illuminance (fc)		Roadway Luminance (cd/m^2)
		Horizontal	Vertical Min	
Local Criteria Low Conflict	Average	0.4	0.08	0.2
	Ave/Min	4	-	6
Site 4	Average	0.13	0.02	0.1
	Ave/Min	6.5	-	5

CLANTON & ASSOCIATES
LIGHTING DESIGN AND ENGINEERING

Site 7: 2950S. West Temple

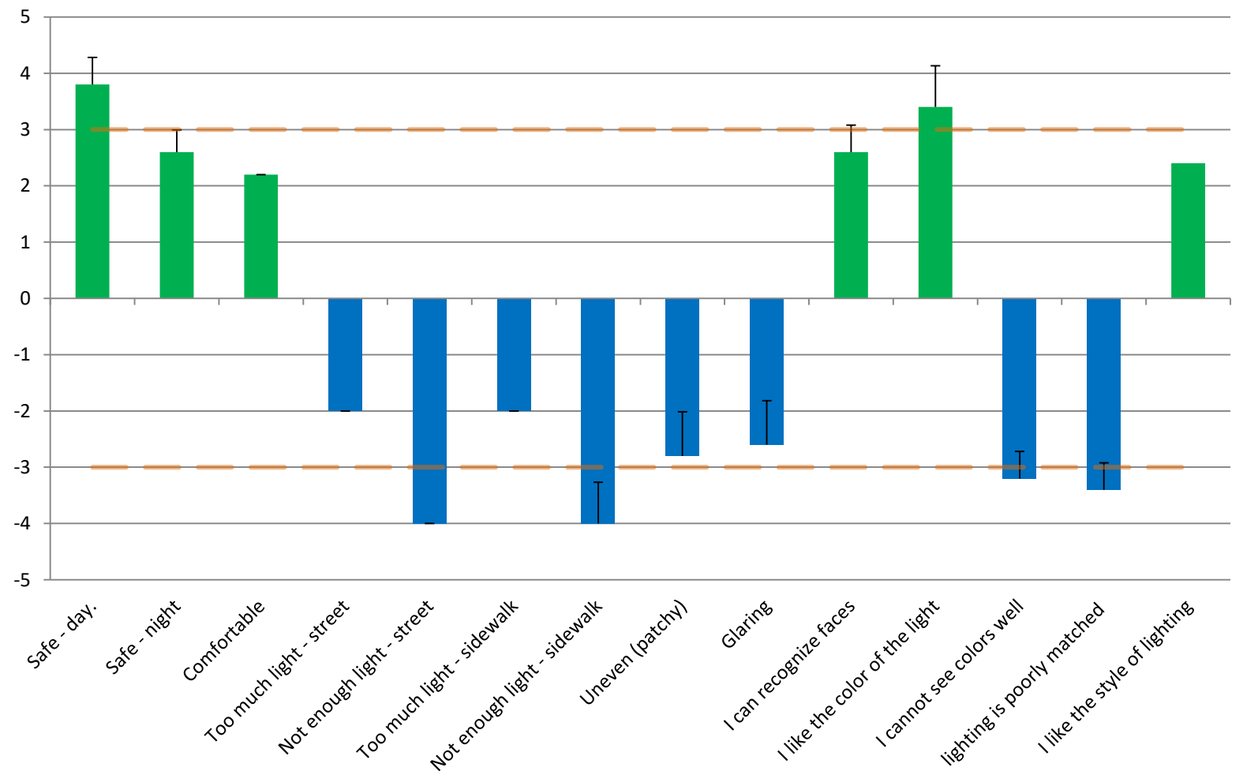




Level of Acceptability: Poor (LightingScore = -1)
Low light levels create a dangerous environment for pedestrians and vehicles near major intersection.

Site 8: 2700S. 300W.

Green Bars are Positive Questions (High Values are Preferred)
Blue Bars are Negative Questions (Low Values are Preferred)
Orange Lines are Neutral Responses



Initial Site Observations

- Major intersection with no nearby street lights.
- Site does not have sufficient lighting for sidewalks and crosswalks.
- Streets neighbor open land and large parking lots, minimal contribution from building lights.

Lighting Measurements

- Majority of roadway lighting comes from one street light far from intersection.
- Sidewalk and crosswalk is dark.
- Roadway is too dark looking away from the majority of buildings.

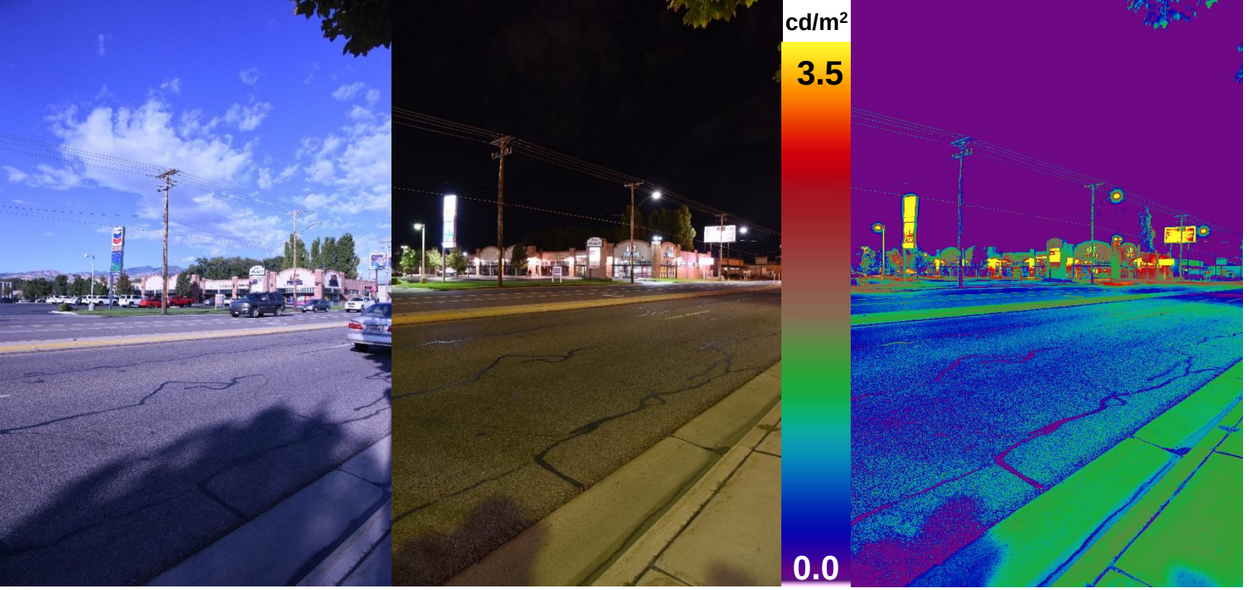
Participant Survey

- Participants found the space generally under lit.
- Participants were concerned with the lack of intersection lighting.
- Participants were comfortable but would prefer more light in the area.

		Sidewalk Illuminance (fc)		Roadway Luminance (cd/m^2)
		Horizontal	Vertical Min	
Collector Criteria Low Conflict	Average	0.4	0.1	0.3
	Ave/Min	4	-	4
Site 8	Average	0.11	0.02	0.17
	Ave/Min	3.67	-	3.4

CLANTON & ASSOCIATES
LIGHTING DESIGN AND ENGINEERING

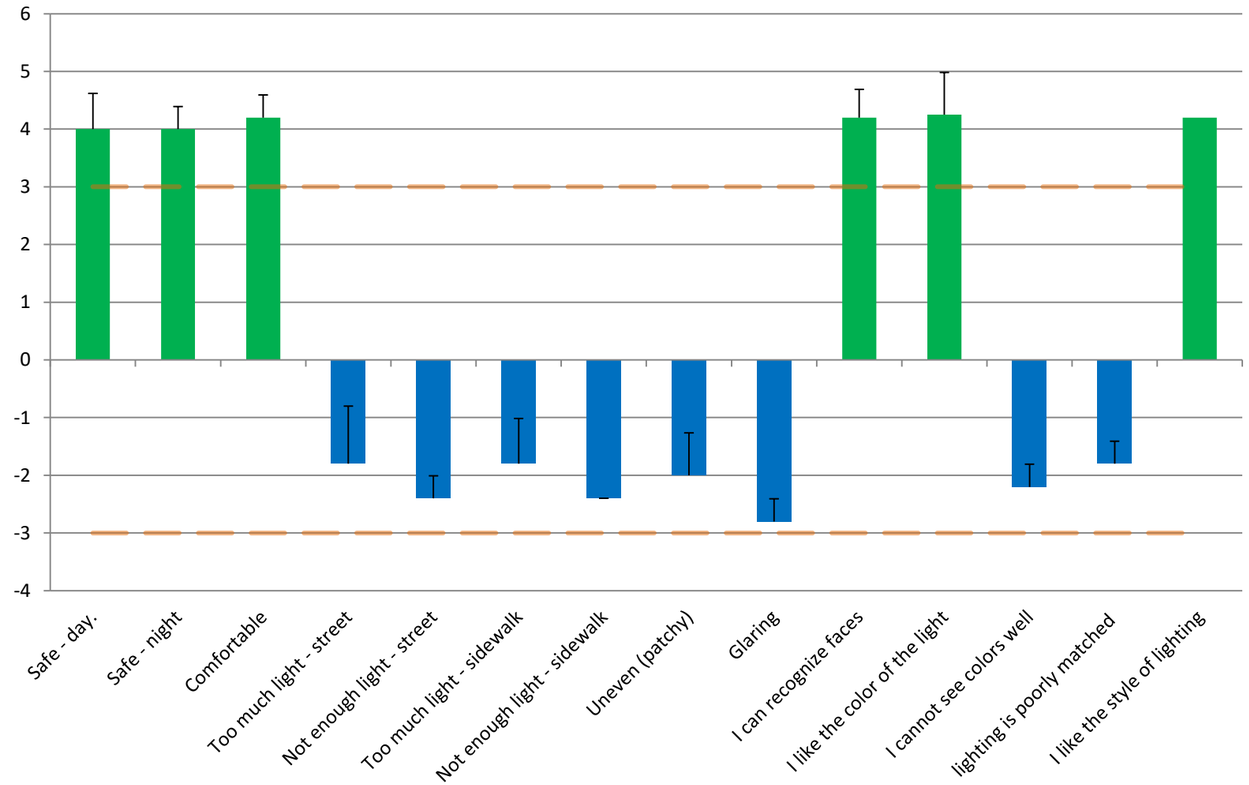
Site 8 : 2700S. 300W.



Level of Acceptability: Excellent (LightingScore = 13.65)
A combination of new LED street lighting and adequate parking lot lighting created a comfortable space.

Green Bars are Positive Questions (High Values are Preferred)
Blue Bars are Negative Questions (Low Values are Preferred)
Orange Lines are Neutral Responses

Site 9: 2100S. 300W.



Initial Site Observations

- The site is a high traffic area near on/off ramp to I-15.
- There is new LED street lighting along 2100s with good spacing and color.
- Pedestrian lighting along sidewalk is glary, but provides good light.

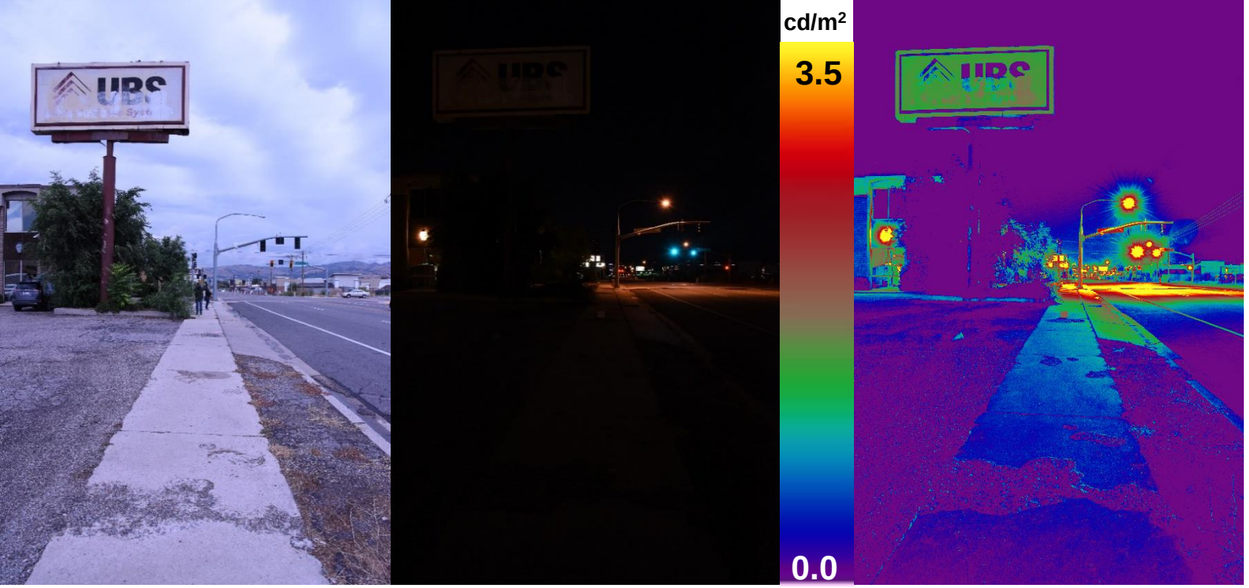
Lighting Measurements

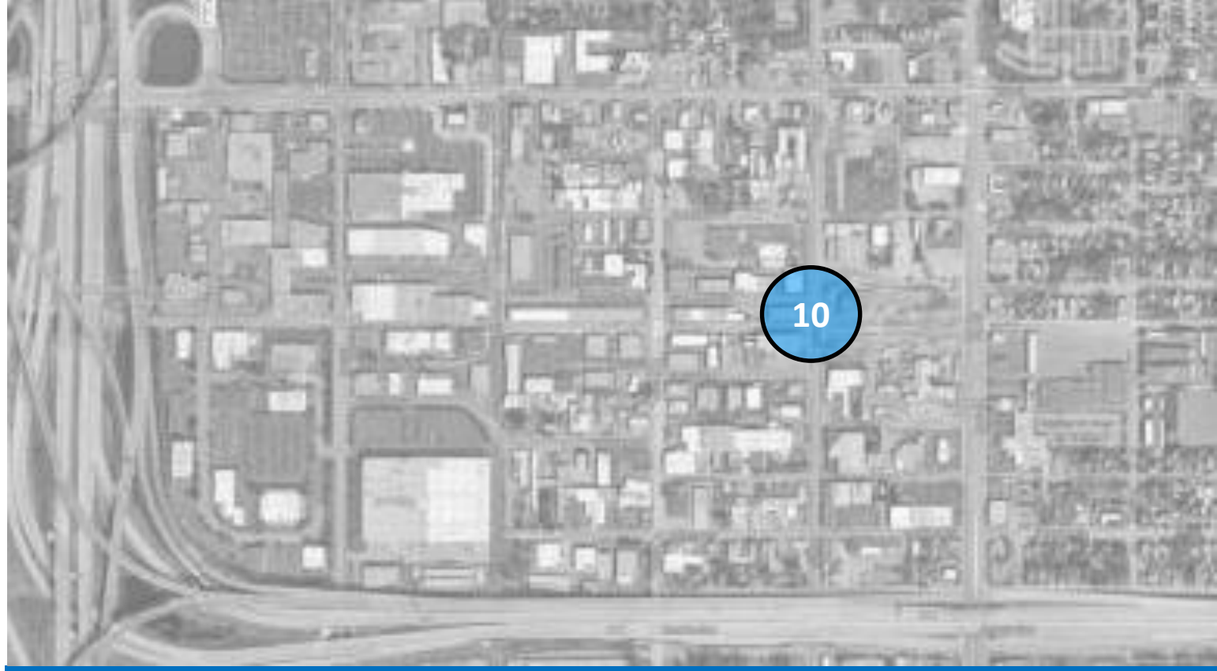
- Measurements meet lighting criteria.
- Even sidewalk lighting due to roadway, pedestrian and parking lot lights.
- Light from parking lot peaks vertical illuminance levels because of direct glare.

Participant Survey

- Participants found this location much better lit than other similar areas.
- Participants found parking lot lighting slightly excessive, but enjoyed the ambient light.
- Participants thought that the acorn pedestrian lighting was too glary, but provided nice light on the sidewalk.

		Sidewalk Illuminance (fc)		Roadway Luminance (cd/m^2)
		Horizontal	Vertical Min	
Arterial Criteria Medium Conflict	Average	0.5	0.2	0.7
	Ave/Min	4	-	3
Site 9	Average	0.98	0.5	0.51
	Ave/Min	3	-	1.8

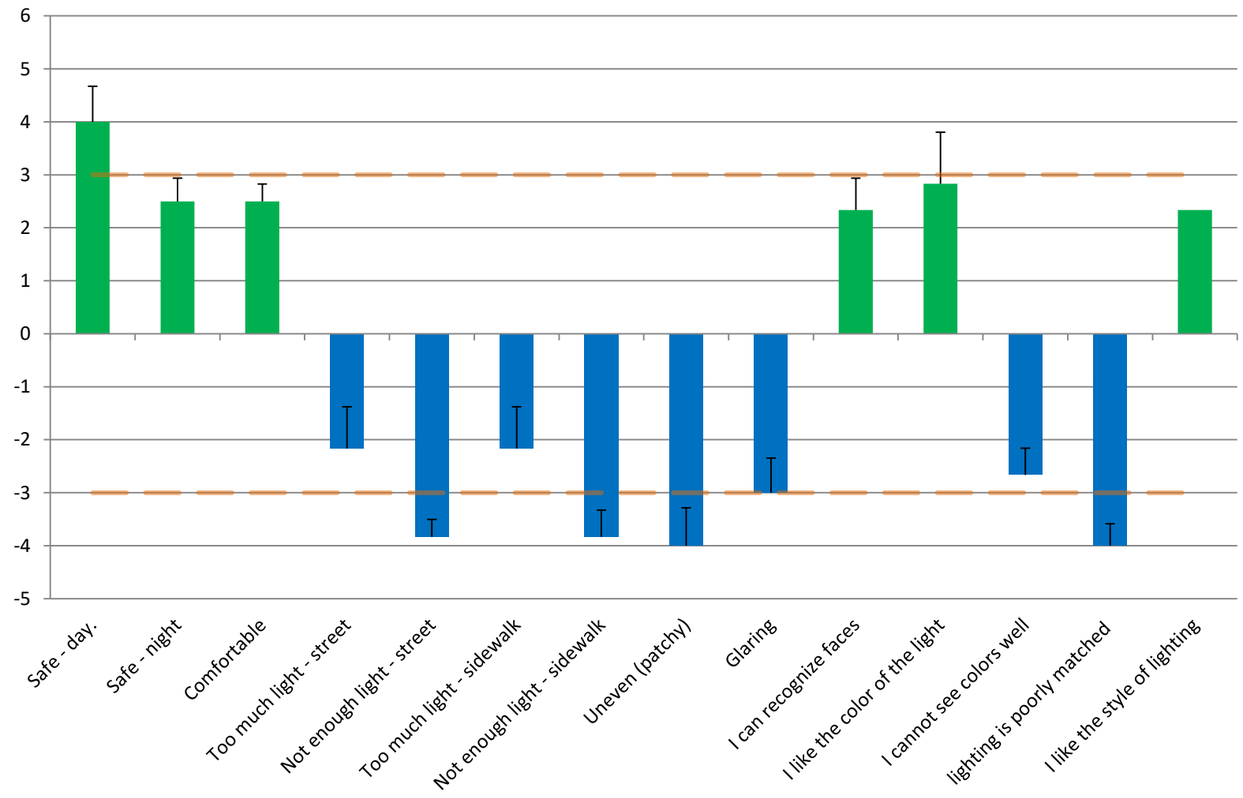




Level of Acceptability: Poor (LightingScore = -3.2)
A lack of ambient building light creates an uncomfortable nighttime environment.

Green Bars are Positive Questions (High Values are Preferred)
Blue Bars are Negative Questions (Low Values are Preferred)
Orange Lines are Neutral Responses

Site 10: Bowers Way Main St.



Initial Site Observations
- The site is close to street car station.
- The site is under lit, with the only lighting near the street car crossing.
- Industrial area with lighted signs and building wall pack lighting.

Lighting Measurements
- Measurement averages meet criteria, but are peaked by the rail crossing lights.
- Vertical illuminance is peak by building lights and lighted signs.

Participant Survey
- Participants found the lighting here worse than similar areas in the city.
- Participants wanted to see more light near the street car station and crossing.
- Participants noted how dark the area is and how most lighting is coming from nearby buildings.

		Sidewalk Illuminance (fc)		Roadway Luminance (cd/m^2)
		Horizontal	Vertical Min	
Collector Criteria Medium Conflict	Average	0.5	0.2	0.5
	Ave/Min	4	-	3.5
Site 10	Average	0.5	0.1	0.9
	Ave/Min	6.25	-	4.7