

MIAMI BEACH

// CITEMETRIX™ ANALYSIS

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SECTION I

EXECUTIVE SUMMARY

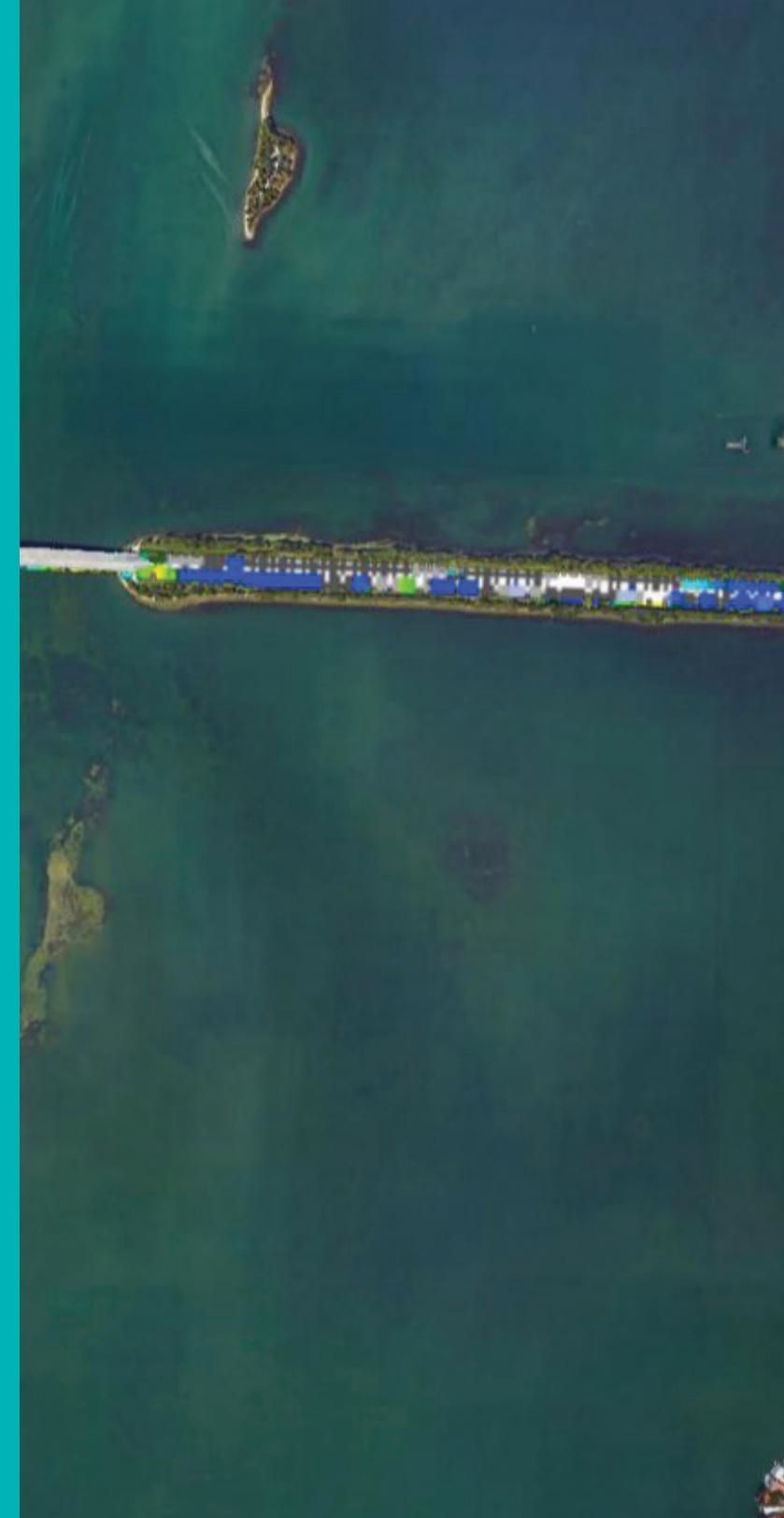
CITEMETRIX™ ANALYSIS

In mid-2015, Citelum approached the City of Miami Beach to propose the preparation of a Lighting Master Plan. The goal of such a plan is to ensure that the City has appropriate and desired lighting levels and lighting uniformity in accordance with its goals for tourism and public safety, among other things. Essentially, **the right light at the right place and the right time.**

Generally, such a process begins with assessing the City's current lighting by conducting a comprehensive inventory and analysis of lighting levels, i.e., a Citemetrix™ Analysis. Since the city has an existing, albeit somewhat dated GIS database of its street lights, it was decided that this database could be utilized for an initial analysis.

Citelum was advised that one of the City's main concerns at present is to analyze the current lighting in the city and assess its adequacy. Citelum was ultimately contracted to perform a photometric analysis of the City's street lights for this purpose.

Citelum sent a team of technicians to perform a city-wide photometric analysis for Miami Beach. Over the course of multiple weeks, the team drove and measured performance of all accessible roadways. This information was then mapped and analyzed by Citelum engineers in order to generate a top level understanding of lighting performance.





MEASUREMENT PROCEDURE

THE PHOTOMETRIC PATROL CAR & MUSE[®]

Citelum's Citemetrix™ Analysis is performed using our proprietary Computerized Maintenance Management System, MUSE[®], and tailor-made smart lighting vehicle, the Photometric Patrol Car.

MUSE[®] provides all software from route design to data integration, and from cross analysis to automatic reports.

The Photometric Patrol Car is equipped with an Illuminance meter (Konica Minolta T10-A), a GPS radio (BU-353) and a Control PC/Laptop. Through a CAN bus interface, the equipment also collects the location and odometer readings directly from the vehicle that are then factored in and recorded to the Control PC running the Photometric Module. LUX meter reading is recorded for every wheel rotation, in this case every 80 cm.

Equipment calibration is performed by external certified laboratories periodically. Additional information on the measurement tools may be found in Appendix C.



SOFTWARE DESCRIPTION

Citelum worked with the City of Miami Beach to gather as much existing data as possible to ensure a successful measurement. This included the GIS layer for street light locations as well as the street centerlines. This data was then imported into the MUSE® GIS platform as the basis for the creation of measurement routes, known as “itineraries.” The itineraries are generated as a method to systematically measure all roadway segments in an optimized manner.

After the itinerary segments have been created, patrols are scheduled and they are downloaded to the Control PC. The patrol team consists of a Driver and a Control PC Technician. The Technician acts as a navigator, providing required direction to the Driver to record measurements for each itinerary. The Control PC automatically indicates when the data has been acquired successfully. Also, itineraries are color coded so that roads to be patrolled are easily distinguishable from roads already patrolled. At the end of each patrol, data is reviewed and uploaded to the main database for additional quality control.

ACCESSIBILITY ISSUES

During the data collection of the Citemetrix™ Analysis in Miami Beach, specific street segments were not measured due to accessibility restrictions.

List of Inaccessible Streets:

Española	Drexel Ave.	Meridian Ave.
Lincoln Ave.	Lincoln Ln.	W. 63rd St.
Lincoln Rd.	N. Bay Rd.	34th St.
Lincoln Ct.	14th & Bay Rd.	87th Terrace
Euclid Ave.	Alton Ct.	Atlantic Way & 80th St.







THE PURPOSE OF A CITEMETRIX™ ANALYSIS IS TO TAKE THE FIRST STEP TOWARDS A FULLY DESIGNED LIGHTING MASTER PLAN.

HOW MUCH LIGHT IS THERE?
HOW MUCH LIGHT DOES THERE NEED TO BE?

**WHAT IS THE RIGHT LIGHT,
FOR THE RIGHT APPLICATION,
FOR EVERY LOCATION IN THE
CITY OF MIAMI BEACH?**

IMPORTATION & EVALUATION

DATA IMPORT / QUALITY ASSURANCE

After an itinerary has been completed, all measurements from that route are sent to the main database for quality assurance and control purposes. After all routes have been completed and quality-checked, reporting can be performed, as described in this report

For Miami Beach, we broke down the roadway segments by roadway type (accompanying chart 3c). The total numbers of segments, and their related distance are reflected in the accompanying chart:

NUMBER OF ROADWAY SEGMENTS (3a)

<i>Roadway Types</i>	<i>Sections</i>
COLLECTOR	10
EXPRESSWAY	12
LOCAL	1,775
MAJOR	379
TOTAL	2176

DISTANCE BREAKDOWN (MILES) (3c)



MILES OF ROADWAY MEASURED (3b)

<i>Roadway Types</i>	<i>Distance (Miles)</i>	<i>Distance Percentage</i>
COLLECTOR	1.46	1%
EXPRESSWAY	10.05	6%
LOCAL	124.40	73%
MAJOR	33.59	20%
TOTAL	169.49	100%

For reporting purposes, all results are segregated by roadway type, and in expressed distance instead of by number of street segments. This provides a better base of measurement, as roadway segments may vary in length.

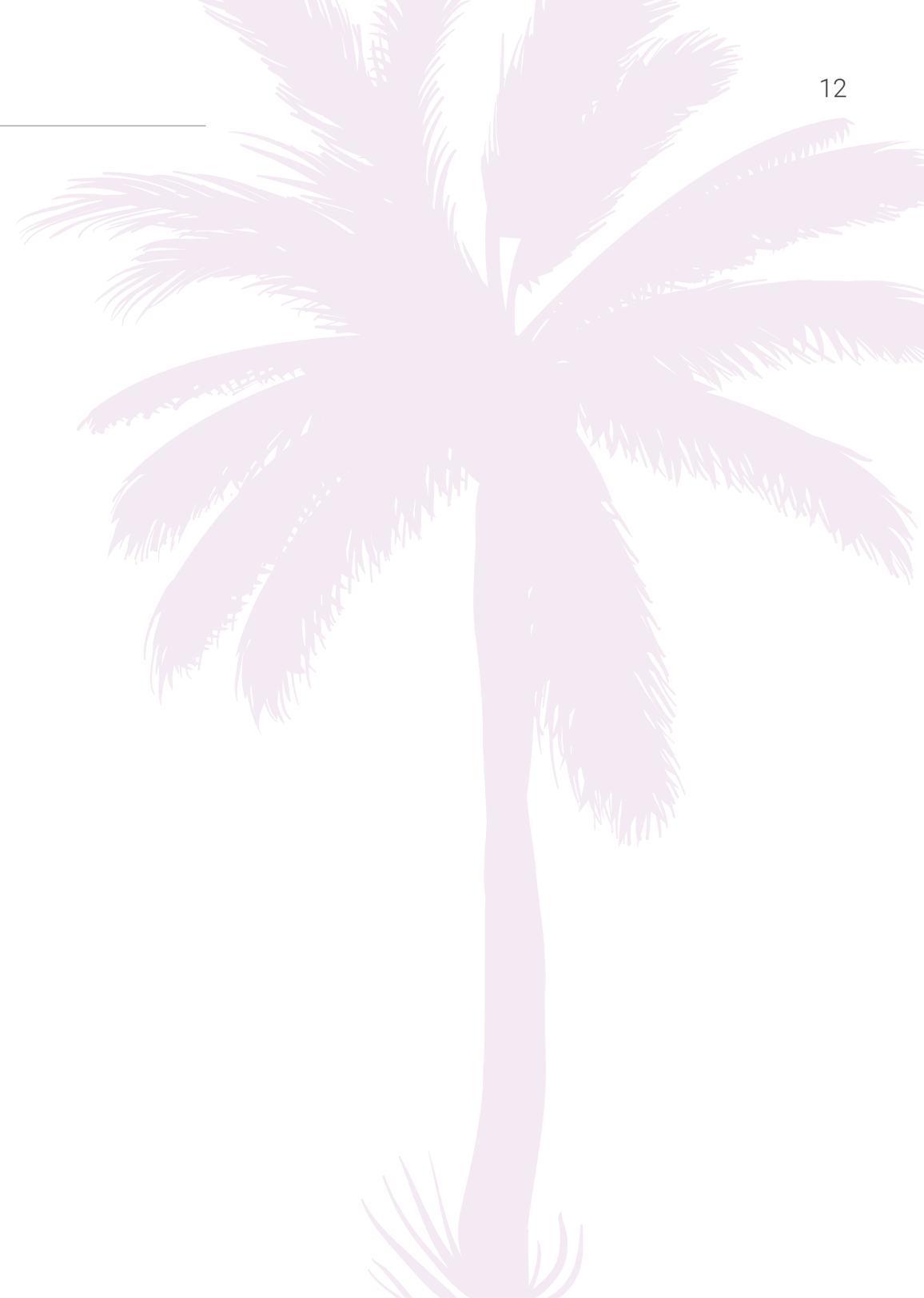


EVALUATION STANDARDS

After reviewing and providing quality control of the collected data, Citelum was able to begin the evaluation process. Our goal was to evaluate the measurements against accepted lighting standards, identify over lit and under lit areas, and calculate the uniformity of each roadway segment.

In order to evaluate the data collected and compare lighting levels to known standards, Citelum made specific assumptions.

- 1) **Citelum used the IESNA RP-8 Roadway Lighting standards to set the acceptable lighting level requirements**
- 2) **Within the RP-8 standard, lighting levels are outlined by roadway type, pavement classification, and pedestrian conflict level.**
 - a. Citelum assumed that the roadways measured all have a pavement classification of R2 or R3.
 - b. The roadway types defined in the RP-8 vary slightly from the City's roadway type definitions, and therefore, we made the following assumptions:



Miami Beach Roadway
Classification Nomenclature

RP-8 Equivalent
Nomenclature (*Assumed*)

Pedestrian Conflict
Area (*Assumed*)

RP-8 Recommended Illuminance
Level (f.c./LUX)

RP-8 Recommended Uniformity
Ratio (E_{AVE}/E_{MIN})

INTERSTATE	EXPRESSWAY	LOW	0.9/9.0	3.0
ARTERIAL	MAJOR	MEDIUM	1.3/13.0	3.0
RAMP	COLLECTOR	MEDIUM	0.9/9.0	4.0
RESIDENTIAL	LOCAL	MEDIUM	0.7/7.0	6.0
ALLEY	LOCAL	LOW	0.4/4.0	6.0
BEACH	LOCAL	HIGH	0.9/9.0	6.0

The photometric measurements taken were measured with a greater number of significant figures than normally factored into the RP-8 prescribed standards. Also, based on Citelum's previous experience, it would be highly unlikely to find any roadway segments adhering exactly to the strict standard. Therefore, Citelum included a safety factor to expand the standard values to be a range of values. For Illuminance, we factored in a $\pm 25\%$ allowable variance from standard and for uniformity, we factored in a $\pm 20\%$ allowable variance from standard.

GENERAL FINDINGS

OVERALL SUMMARY

The following values have been analyzed for photometric results:

- **Average lighting levels**
- **Lighting level compliance with standards**
- **Average uniformity**
- **Uniformity compliance with standards**

All results are broken down by roadway types, following the IESNA recommendations.

LIGHTING LEVELS (FULL RESULTS IN APPENDIX A)

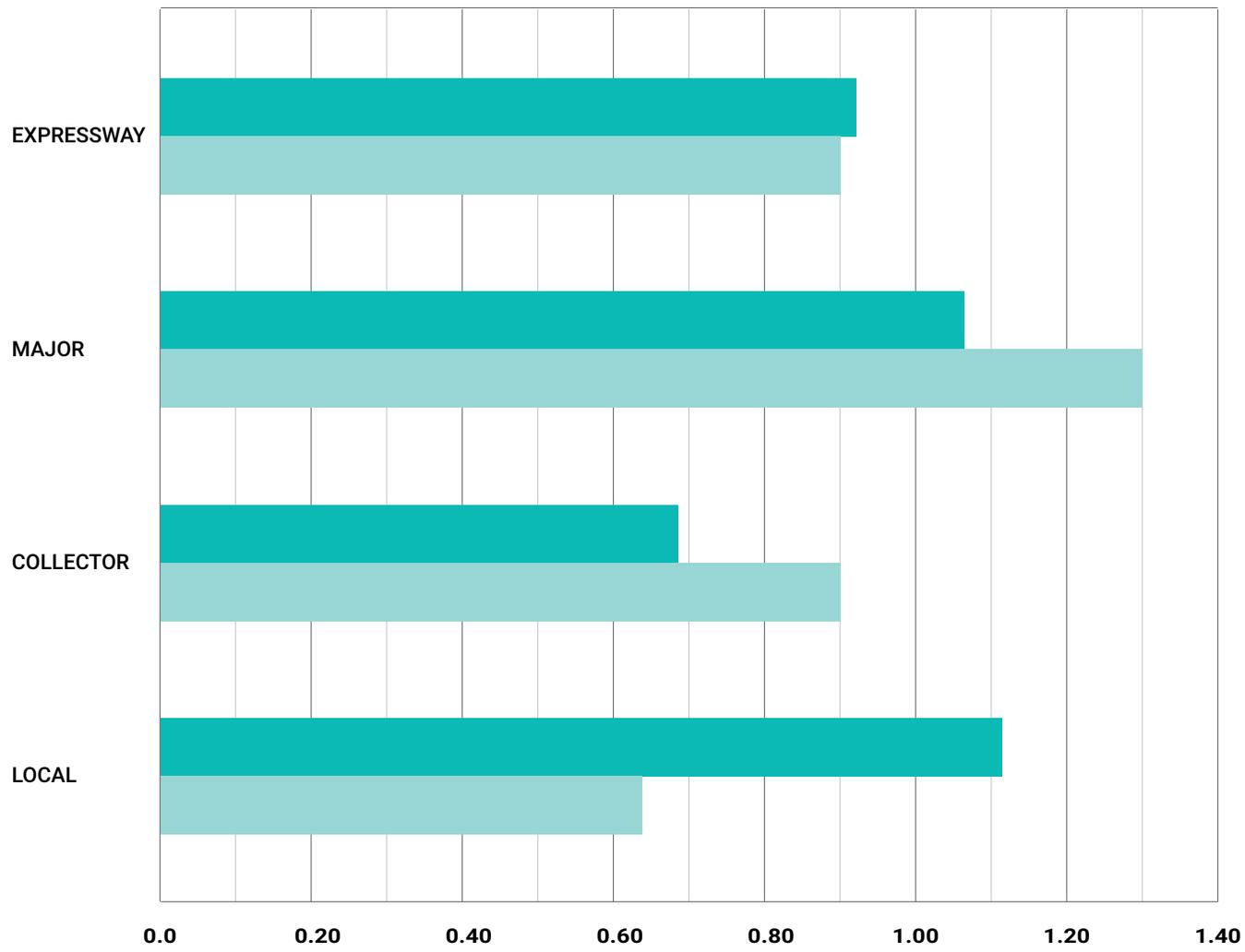
For each roadway segment, the average Illuminance has been calculated based on all measured values for this segment. The full results are available in Appendix A.

Then for each roadway type, the average Illuminance has been calculated and compared to the RP-8 standard values. Results below are displayed in foot-candles (fc), following the IESNA recommendations.

<i>Roadway Types</i>	<i>Average Illuminance (fc)</i>	<i>Standard Illuminance (fc)</i>
EXPRESSWAY	0.92	0.9
MAJOR	1.07	1.3
COLLECTOR	0.68	0.9
LOCAL	1.11	0.63*

*Standard Illuminance for local roadways can either be 0.4, 0.7 or 0.9 fc based on pedestrian conflict area factor.

Average Illuminance (fc) Standard Illuminance (fc)

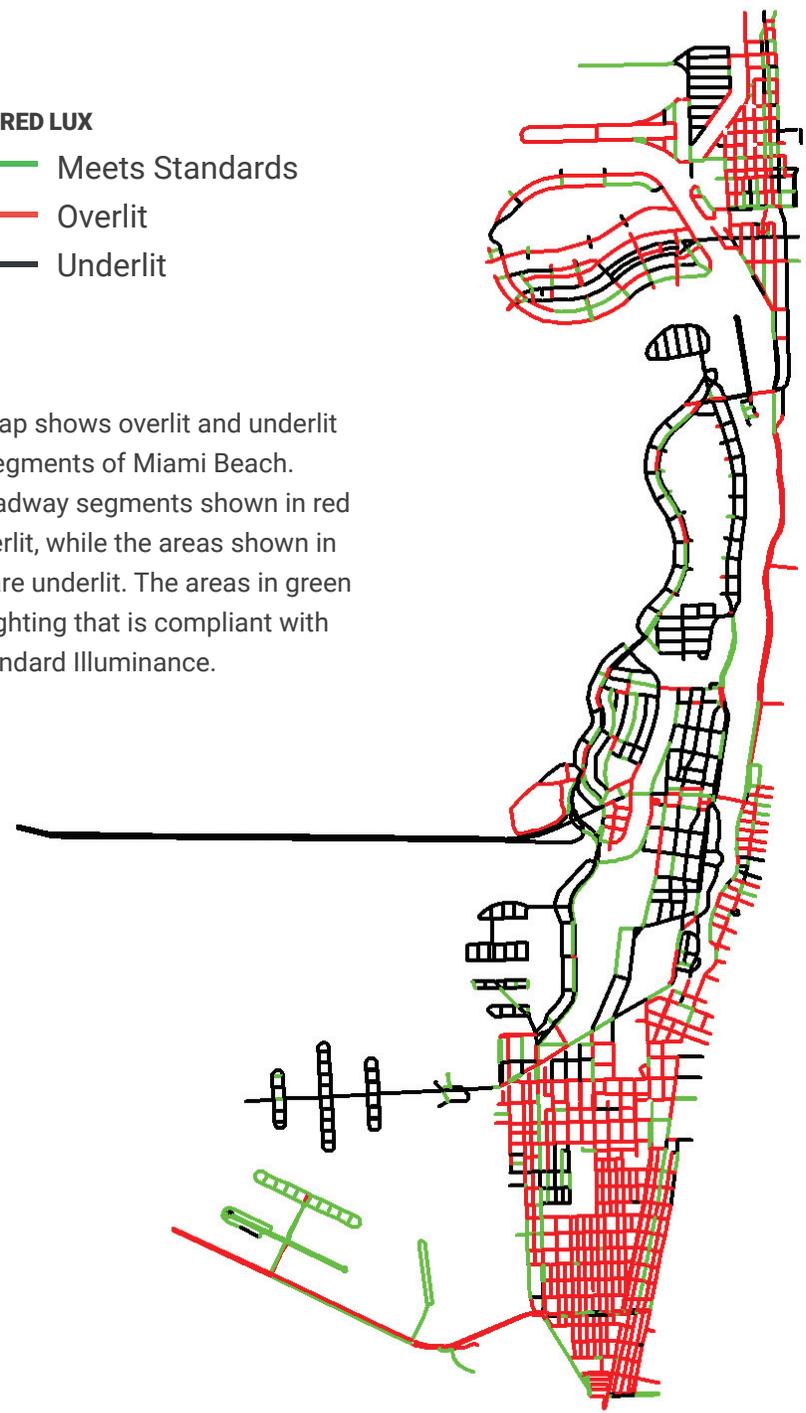


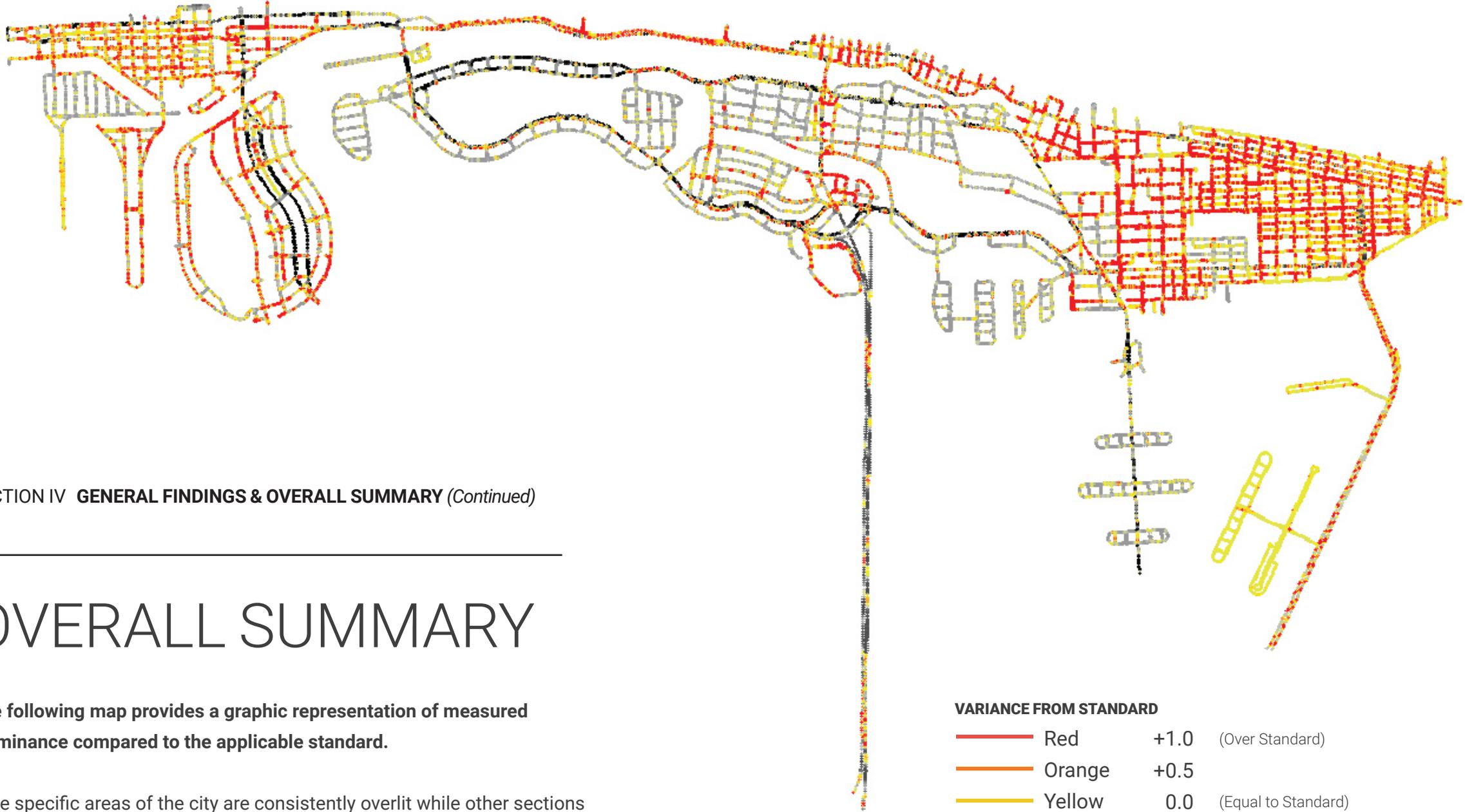
MEASURED LUX

- Meets Standards
- Overlit
- Underlit

RIGHT

This map shows overlit and underlit road segments of Miami Beach. The roadway segments shown in red are overlit, while the areas shown in black are underlit. The areas in green have lighting that is compliant with the standard Illuminance.





SECTION IV **GENERAL FINDINGS & OVERALL SUMMARY** *(Continued)*

OVERALL SUMMARY

The following map provides a graphic representation of measured **Illuminance compared to the applicable standard.**

Note specific areas of the city are consistently overlit while other sections are lit below standard. Further detail on measurements can be found in subsequent pages of this section.

VARIANCE FROM STANDARD

	Red	+1.0	(Over Standard)
	Orange	+0.5	
	Yellow	0.0	(Equal to Standard)
	Grey	-0.5	
	Black	-1.0	(Below Standard)



OVERALL SUMMARY

On average, expressway, major and collector roadways are lit below standards.

Local roadways, however, are highly above standards on average.

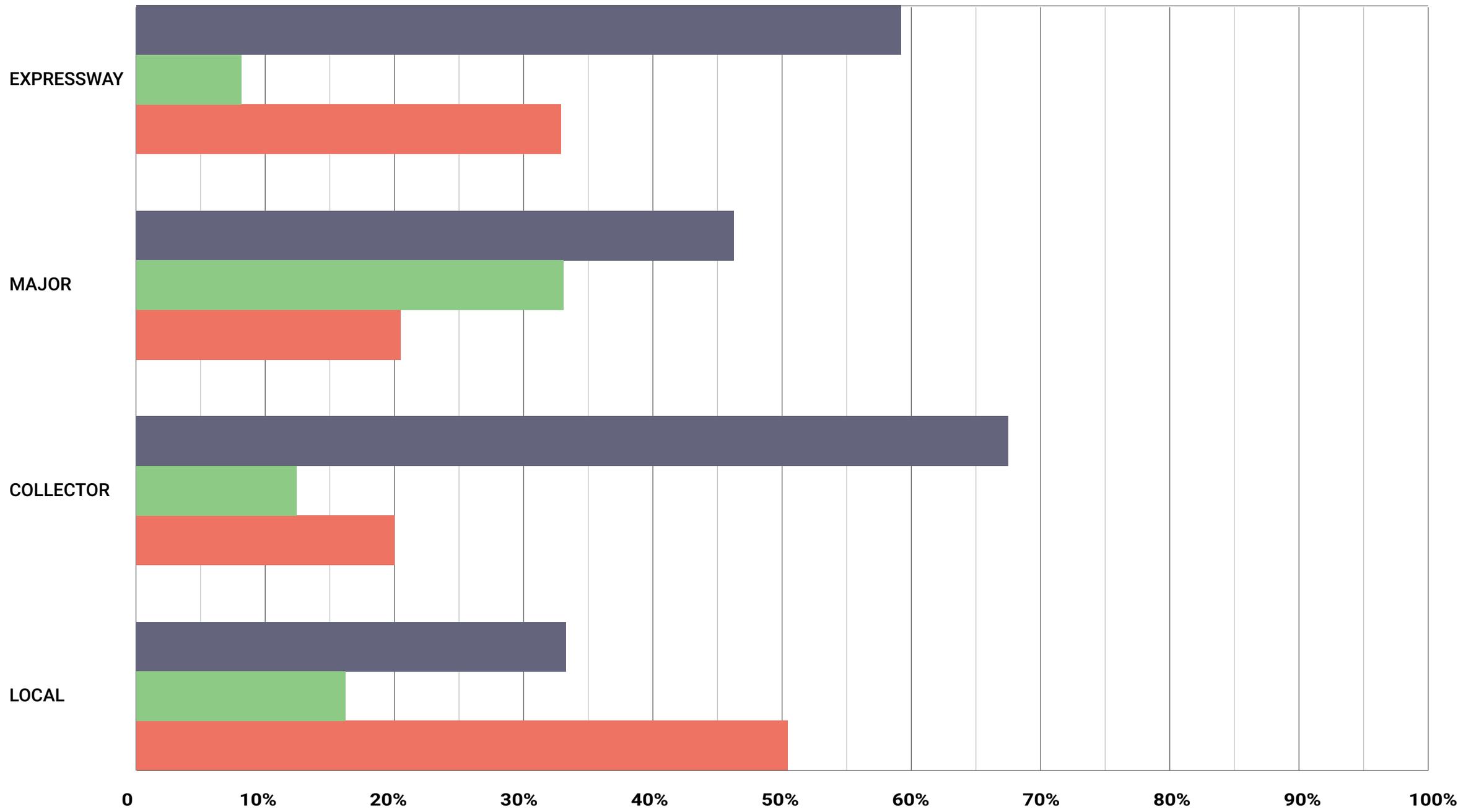
When we break down the results in terms of compliance with standards, a roadway type can appear close to standards, but individual street results are typically overlit or underlit, giving the incorrect impression of averaging near the recommended standards.

When comparing results to recommended standards, the average Illuminance by street segment can be deemed:

- **Compliant with standard (if included in a +/- 25% range)**
- **Underlit**
- **Overlit**

The results below are shown in percentage of the total distance in miles for each one of the four roadway types:

Roadway Type	Underlit	Compliant	Overlit	Grand Total
EXPRESSWAY	59.1%	8.1%	32.8%	100.0%
MAJOR	46.3%	33.1%	20.5%	100.0%
COLLECTOR	67.6%	12.4%	20.0%	100.0%
LOCAL	33.3%	16.2%	50.5%	100.0%
GRAND TOTAL	37.7%	19.0%	43.2%	100.0%



UNIFORMITY

CALCULATING UNIFORMITY

(FULL RESULTS IN APPENDIX B.)

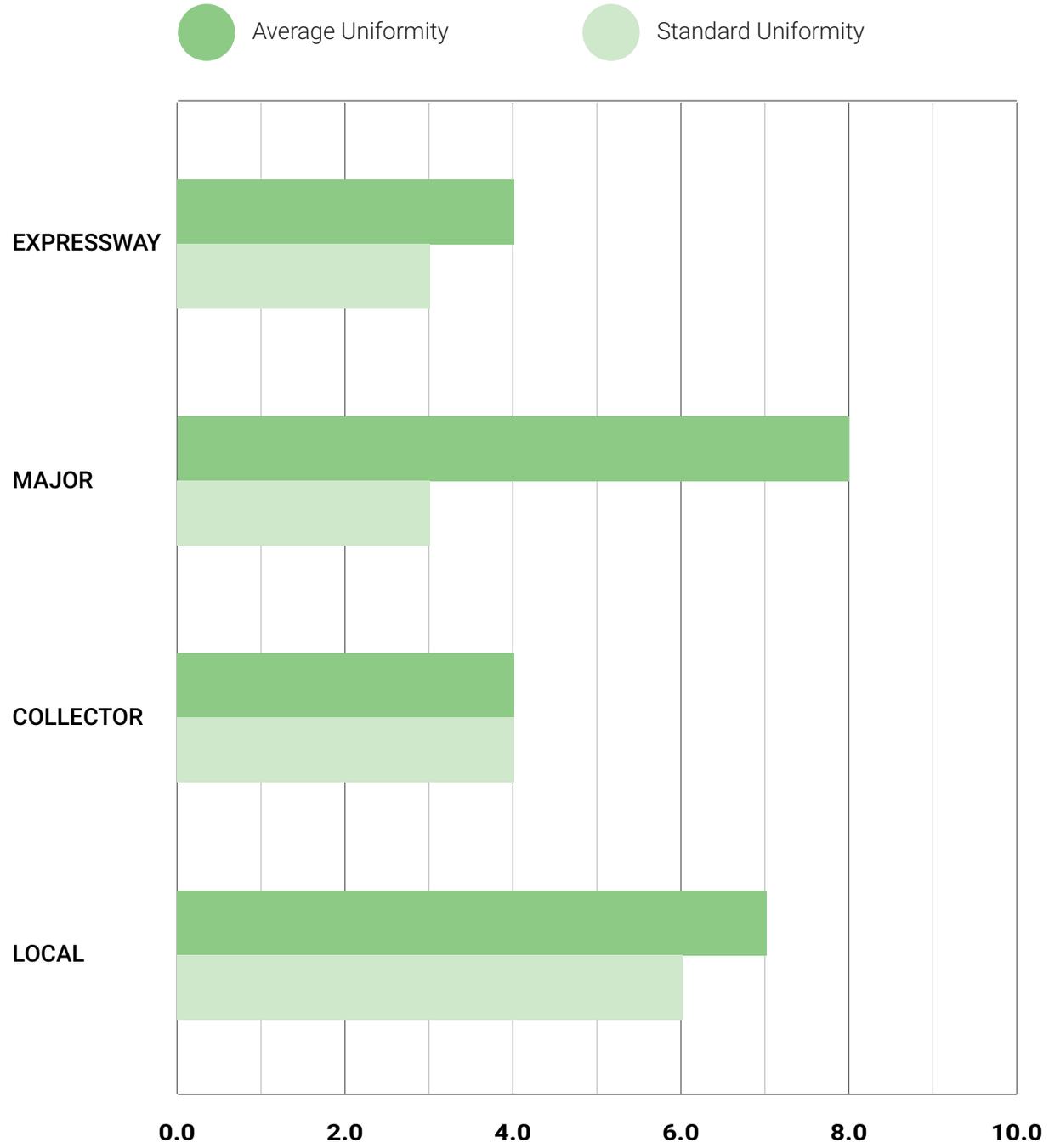
For each roadway segment, the average uniformity has been calculated based on all measured values for this segment, using the following formula:

AVERAGE ILLUMINANCE

MINIMUM ILLUMINANCE

Then for each roadway type, the average uniformity has been calculated and compared to the standard values, following the IESNA recommendations. **The results are below:**

<i>Roadway Types</i>	<i>Average Uniformity</i>	<i>Standard Uniformity</i>
EXPRESSWAY	4	3
MAJOR	8	3
COLLECTOR	4	4
LOCAL	7	6

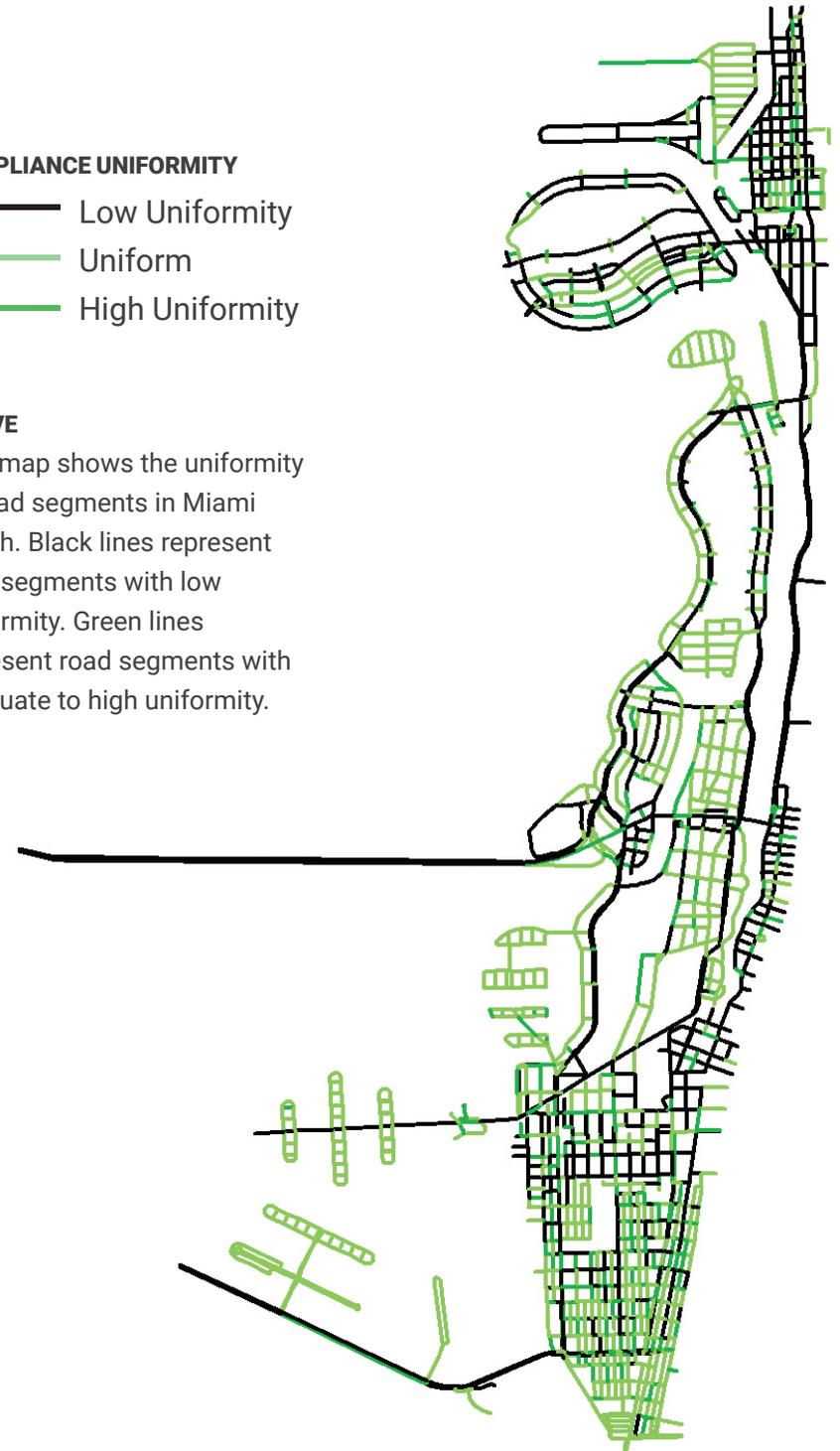


COMPLIANCE UNIFORMITY

- Low Uniformity
- Uniform
- High Uniformity

ABOVE

This map shows the uniformity of road segments in Miami Beach. Black lines represent road segments with low uniformity. Green lines represent road segments with adequate to high uniformity.



UNIFORMITY OVERVIEW

Uniformity is expressed as a ratio of Average Illuminance divided by the Minimum Illuminance, meaning a calculated value of 1 is “perfectly uniform” lighting. Roadways that are not uniform will exhibit bright and dark areas, meaning the ratio between the average and minimum lighting levels will be a larger number.

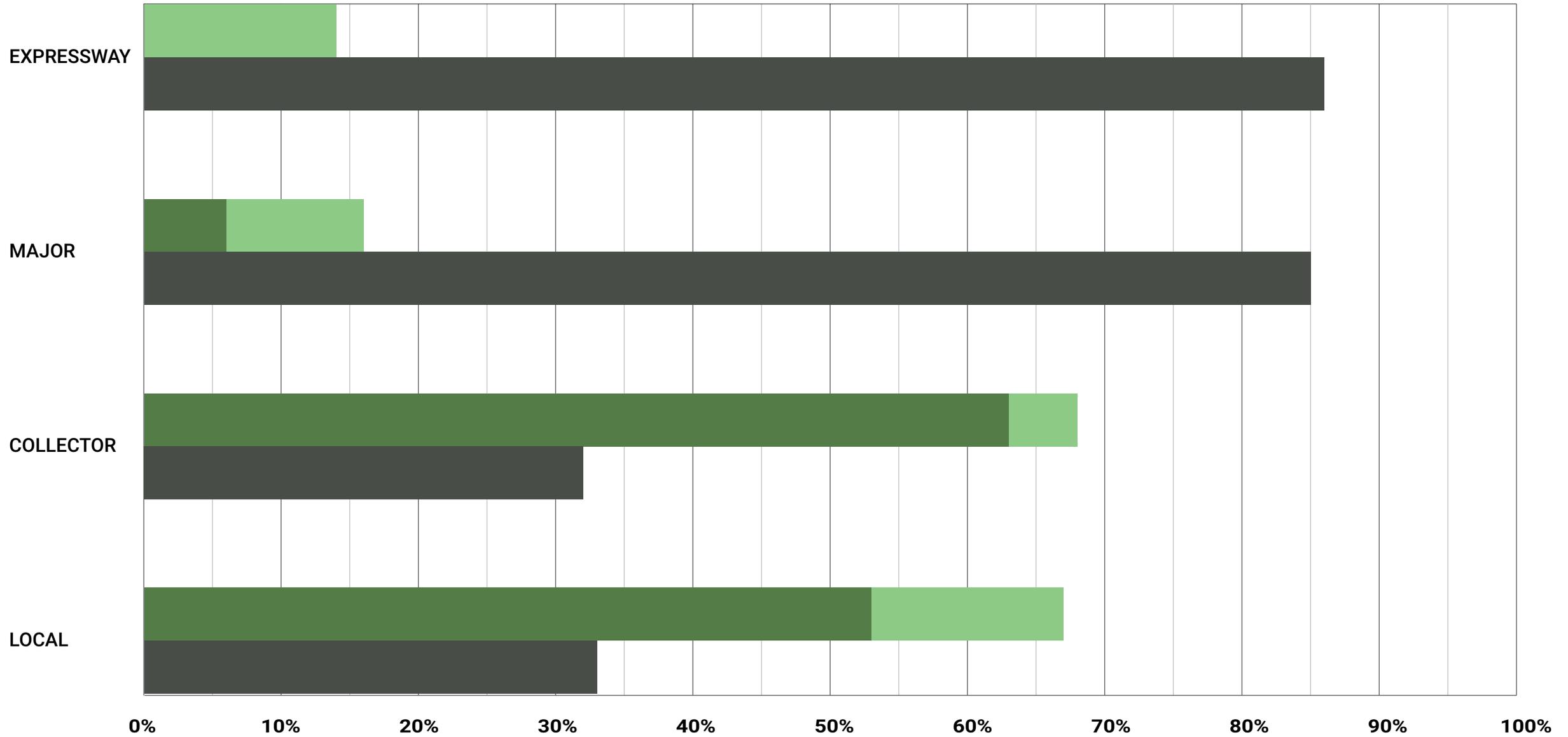
On average, expressways and major roadways exhibit low levels of uniformity (calculated value greater than standard). Both collectors and local roadways are generally uniform or exhibit greater uniformity than required, meaning the ratio is closer to “perfect uniformity” than required.

When comparing results to recommended standards, the average uniformity by street segment can be deemed:

- **Compliant with standard (if included in a +/- 20% range)**
- **High Uniformity (if uniformity is lower than 80% of the standard)**
- **Low Uniformity (if uniformity is higher than 120% of the standard)**

The results below are showed in percentage of the total distance in miles for each one of the four roadway types:

Roadway Type	Low Uniformity	Adequate Uniformity	Highly Uniformity	Grand Total
EXPRESSWAY	86%	14%	0%	100%
MAJOR	85%	10%	6%	100%
COLLECTOR	32%	5%	63%	100%
LOCAL	33%	14%	53%	100%
GRAND TOTAL	47%	13%	41%	100%





SOUTH

NEIGHBORHOODS INCLUDED

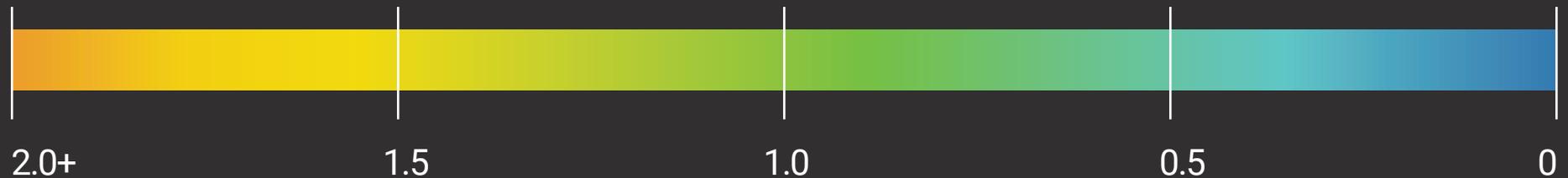
- South Point
- Flamingo/Lummus
- West Avenue
- Star Island
- Palm Island
- Hibiscus Island
- Venetian Islands

ILLUMINATION TRENDS

The South of Miami Beach is world renowned tourist destination. Currently, most of the area is brightly lit. While this may be more light than standards require, it could be a strategic choice to over light this area.

One exception is the area west of Flamingo Park, which is considerably darker and lit below standard.

LEGEND



(fc)



CENTRAL

NEIGHBORHOODS INCLUDED

Bayshore
City Center
Ocean Front
Nautilus

ILLUMINATION TRENDS

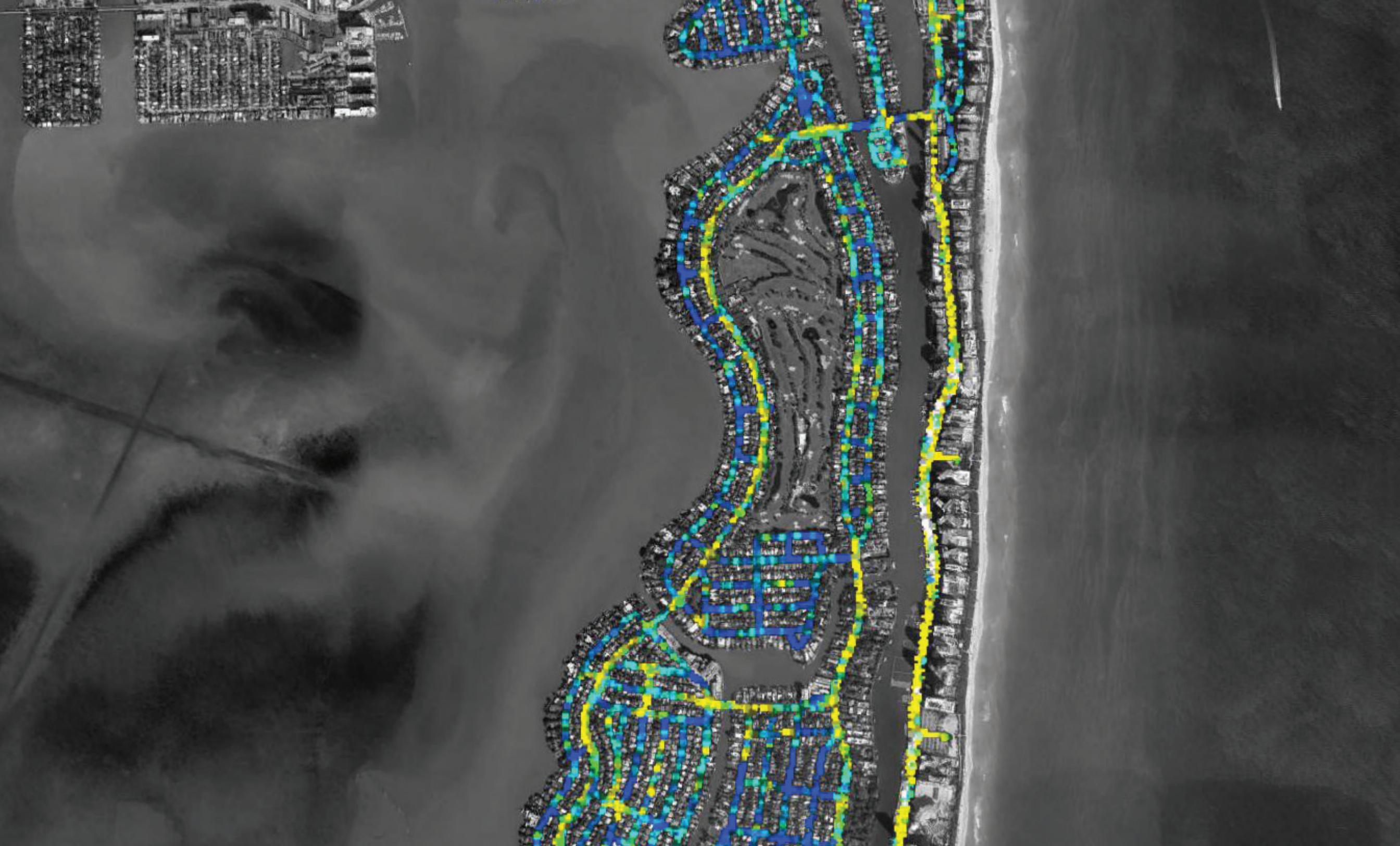
Central Miami Beach begins the transition from tourist mecca to residential area. With this known, lower lighting levels are seen and accepted. These local roadways are lit slightly below standards.

Major roadways, such as Alton Road or the Julia Tuttle Causeway, while lit to the same level of these residential neighborhoods, require greater levels of lighting and improvements may be required.

LEGEND



(fc)



BISCAYNE BAY

NEIGHBORHOODS INCLUDED

- Ocean Front
- Nautilus
- La Gorce

ILLUMINATION TRENDS

Similar to the trends exhibited in central Miami Beach, the area surrounding La Gorce are lit to a lower level, with major streets (Alton Road, W 63rd Street) lit below standards.

LEGEND



(fc)



NORTH

NEIGHBORHOODS INCLUDED

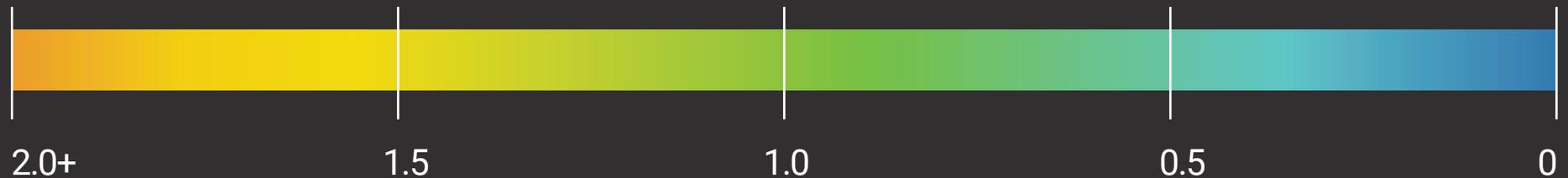
- North Shore
- Normandy Isle
- Normandy Shores
- La Gorce
- Biscayne Point

ILLUMINATION TRENDS

As the Miami Beach becomes more heavily trafficked in the North, lighting levels increase to those seen in the South portion. Again, this may be a strategic decision by the City.

The major difference is the existence of dark spots within the roadway network. On Collins Ave, poor uniformity leads to dark corners lit below standard. Also, Normandy Drive / 71st Street stand out from the surrounding streets with considerably lower lighting levels.

LEGEND



(fc)

OVERALL ASSESSMENT

In order to assess the overall compliance with standards, Citelum cross referenced the data collected for Illuminance and Uniformity.

The following table shows (*in miles of roadway*) how much of the overall system falls within the assumed acceptable range for Illuminance and Uniformity when compared to standards.

The portions of the data in grey represent the amount of roadway that is underlit, overlit, and/or not uniform.

This information is for all roadway types. The data can be parsed by roadway type, as described further in **Section 6, General Recommendations**.

18.2%
of roadways meet both Illuminance and Uniformity standards

Uniformity	Underlit	Compliant	Overlit	Grand Total
POORLY UNIFORM	17.8	14.0	47.1	79.0
UNIFORM	2.7	9.5	9.2	21.5
HIGHLY UNIFORM	43.4	8.7	16.9	69.0
GRAND TOTAL	63.9	32.3	73.3	169.5



SPECIFIC EXAMPLES - UNDERLIT

This is an example of a very dark/underlit intersection in an area of the city that is mostly underlit. Available street lighting is either not working or obstructed by overgrown trees. Additional maintenance may provide better service in this area. If the City elects to install new LED street lights, properly designed lighting can alleviate these issues.

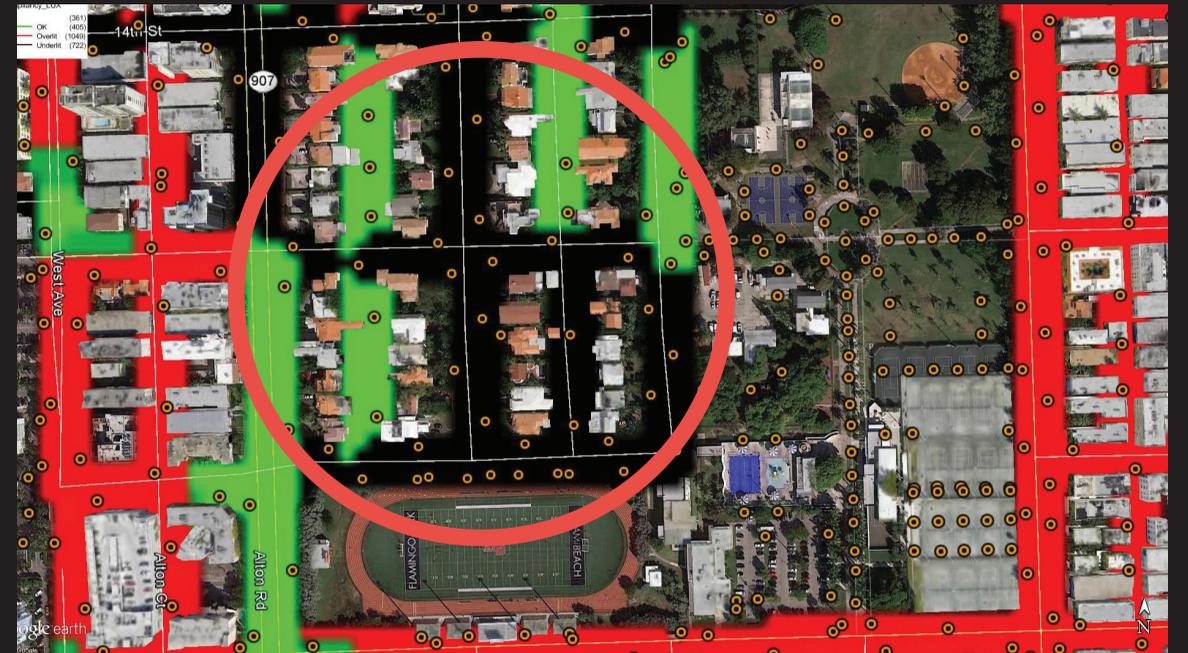
ILLUMINANCE



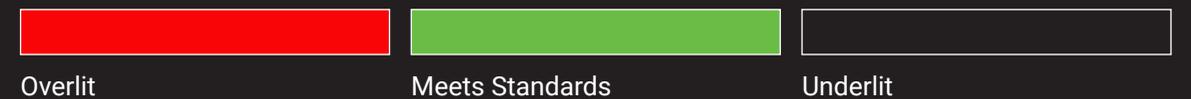
LEGEND



OVERLIT - UNDERLIT



LEGEND



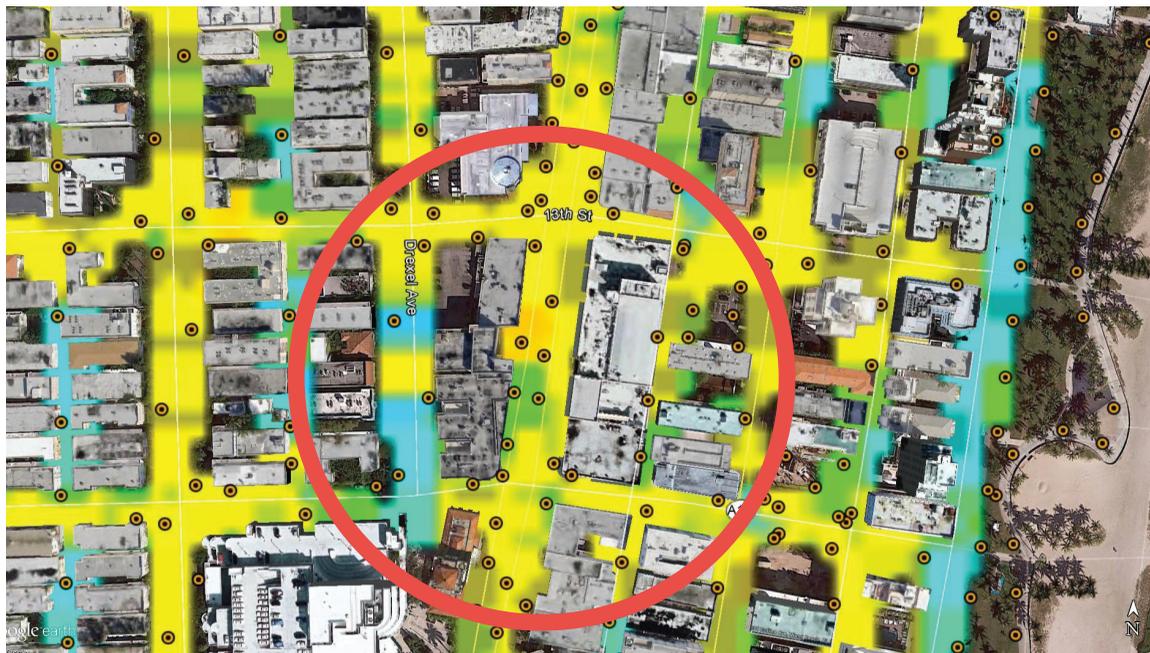


UNDERLIT INTERSECTION
13TH & LENNOX

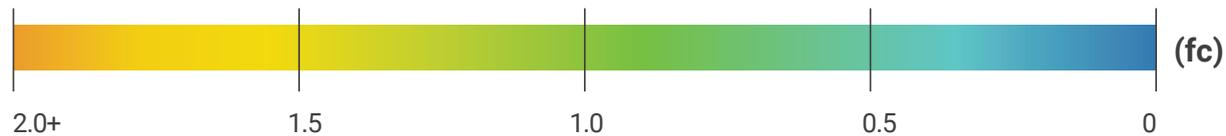
SPECIFIC EXAMPLES - OVERLIT

This shows an example of a technically overlit street. Given the location, land use, and pedestrian movement in the area, the City may elect to keep the lighting of the roadway at an elevated level for safety.

ILLUMINANCE



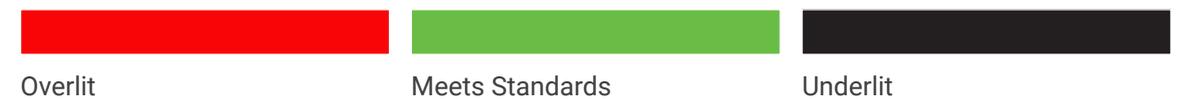
LEGEND



OVERLIT - UNDERLIT



LEGEND





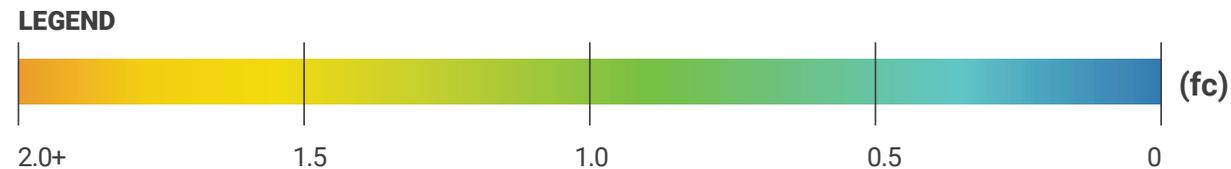
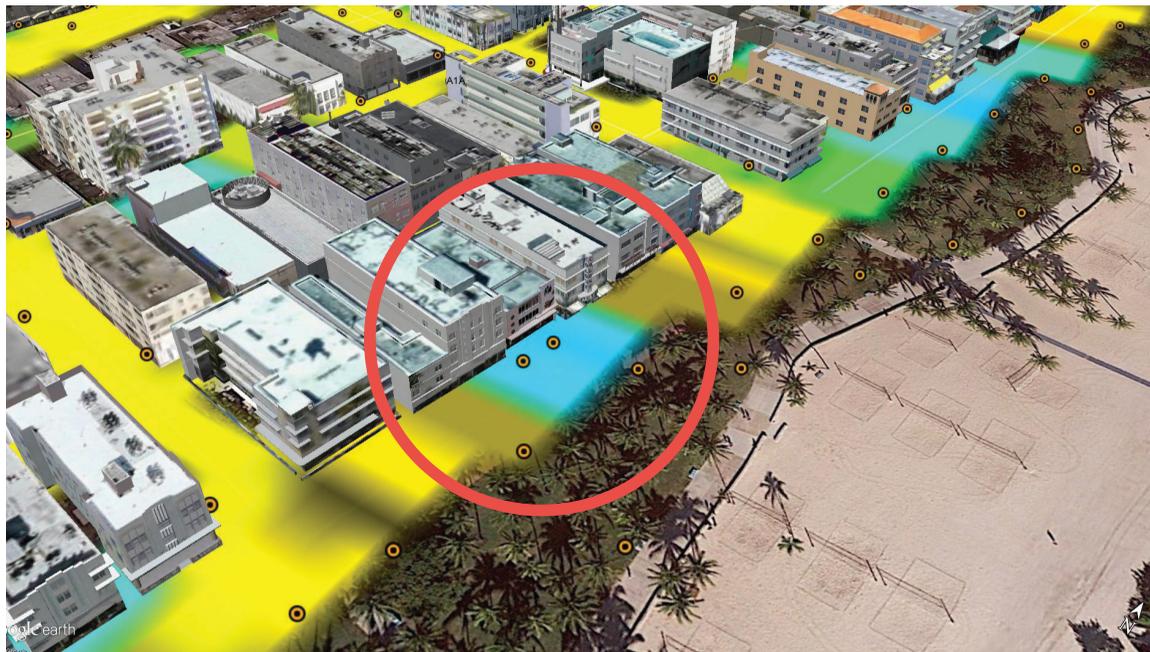
OVERLIT INTERSECTION

WASHINGTON AVE. (BETWEEN 12TH & 13TH)

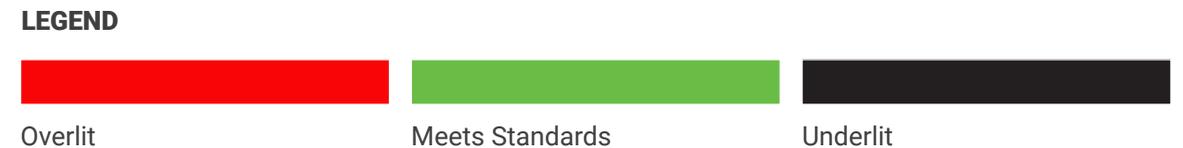
SPECIFIC EXAMPLES - POORLY UNIFORM

This major roadway provides a good example of the importance of uniformity and properly designed lighting. While the lighting level is close to standard, the lighting mid-block is measurably lower (approximately 1.0 fc) than the lighting at the intersections. This is most likely caused by the fixture type (Post Top) and location (offset from roadway) along Ocean Drive as compared to the cobra head fixtures used to illuminate the intersections. This poor uniformity can lead to drivers having issues adjusting their eyes to higher levels of glare when entering brighter spaces. On a roadway with heavy pedestrian traffic, like Ocean Drive, this can lead to safety issues.

ILLUMINANCE



OVERLIT - UNDERLIT





POORLY UNIFORM INTERSECTION
OCEAN DR. (BETWEEN 7TH & 8TH)

SUMMARY

After a thorough review of the lighting conditions in Miami Beach, Citelum has reached a few general conclusions:

- 1) **Only approximately 18.2% of the roadways (by mileage) fall within the assumed acceptable range for Illuminance and Uniformity when compared to standards**
- 2) **Expressways are either underlit or overlit, but in most cases display low uniformity**
- 3) **Major roadways can be underlit, compliant or overlit but in most cases the uniformity is low**
- 4) **The majority of surveyed collectors are underlit, however the uniformity is acceptable**
- 5) **A variety of issues can be observed on local roadways, with entire sections of the City that are overlit as well as specific underlit streets**



GENERAL RECOMMENDATIONS

Based on these findings, Citelum suggests the following:

- 1) **The City should update their existing inventory of street lights to account for any information that is more than 5 years out of date**
- 2) **The City should work with industry to develop a Lighting Master Plan. This plan will define the lighting goals of the City, as performing only to standard may not best the best option for specific regions. For example:**
 - a. The City may choose to continue to over light the main tourist and commercial centers of the city
 - b. The City should define a desirable lighting level for residential neighborhoods
 - c. Working with Police Department and the Emergency Services, the City should identify areas within the city that should be over lit with the goals of crime prevention and increased safety

- 3) **The City should improve the operation and maintenance services to address street light outages in proactive or preventative manner. This can be accomplished through a robust Computerized Maintenance Management System (CMMS), higher standards for O&M performance through Key Performance Indicators (KPIs), or the introduction of an advanced street light monitoring and control system**
- 4) **The City could include a remote control system on LED lights, setting a schedule for lighting levels. Specific areas can be kept bright when needed and adjusted during off-peak hours**
- 5) **The uniformity of street lighting within the City should be improved. This can be accomplished multiple ways:**
 - a. The city can investigate the possibility of adding additional street lights where needed and removing extraneous luminaires
 - b. The city can investigate upgrading the existing street lights to LED. LED fixtures provide directed light and with proper design (distribution types, low back-light and glare, etc.) uniformity issues can be corrected





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