



PREPARED FOR

CITY OF GOODYEAR

INVESTMENT GRADE AUDIT

JULY 9, 2020



AMERESCO
Green • Clean • Sustainable



CITY OF GOODYEAR

INVESTMENT GRADE AUDIT

July 9, 2020

PRESENTED BY

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ACRONYMS AND ABBREVIATIONS

\$/kWh	cost per kilowatt-hour
\$/SF	cost per square foot
°C	degrees Celsius
°F	degrees Fahrenheit
24/7	24 hours per day, 7 days a week
24/7/365	24 hours a day, 7 days a week, 365 days a year
A/P	accounts payable
AC	alternating current
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
CO ₂	carbon dioxide
DC	direct current
DOE	U.S. Department of Energy
ECI	energy cost index
ECM	energy and water conservation measure
EPA	U.S. Environmental Protection Agency
ESCO	energy service company
ESPC	energy savings performance contracting
EUI	energy utilization index
FPT	functional performance test
GHG	greenhouse gas
GPS	global positioning system
HID	high intensity discharge
HPS	High-pressure sodium
Hr or H	hour
Hz	hertz
IES	Illuminating Engineering Society of North America
IGA	Investment Grade Audit
IPMVP	International Performance Measurement and Verification Protocol
IT	information technology

kVA	kilovolt ampere
kW	kilowatt
kWh	kilowatt hour
LED	light-emitting diode
LEED	Leadership in Energy and Environmental Design
M&V	measurement and verification
MW	megawatt
MWh	megawatt hour
N/A	not applicable
NR	not recommended
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PM	project manager
PPA	power purchase agreement
PUA	Preliminary Utility Audit
PV	photovoltaic
REC	renewable energy credit
RFP	request for proposal
RFQ	request for qualifications
S&S	services and supplies
SCADA	supervisory control and data acquisition
SF	square foot
SOQ	statement of qualifications
SPM	senior project manager
TELP	tax-exempt lease purchase
TOU	time of use
VP	vice president

ES.0 EXECUTIVE SUMMARY

Ameresco, Inc. (Ameresco) developed this Investment Grade Audit (IGA) based on a 2018 survey of all of the street and intersection fixtures throughout the City of Goodyear (City), interviews with City representatives, review of the City streetlighting database, Arizona Public Service (APS) utility analysis, and energy savings calculations. This audit is intended to provide an overall representation of the potential for energy savings for the City of Goodyear. As a result of the data collected, Ameresco is confident that the implementation of this recommended energy conservation measure (ECM) will help the City reduce energy consumption, improve the dark skies lighting environment, and increase the life cycle of the streetlighting assets in the City of Goodyear. Ameresco would like to thank the outstanding staff (past and present) of the City of Goodyear including Luke Albert, Ron Siewwright, Hugh Bigalk, David Granata, David Luhan, and additional City of Goodyear personnel for their time in countless meetings, workshops, access to City GIS data, and overall engagement in the process.

ES.1 ENERGY CONSERVATION MEASURE

The ECM requested by the City of Goodyear is Light-Emitting Diode (LED) Streetlighting Conversion (ECM 1).

ES.2 FINANCIAL SUMMARY

The total guaranteed project energy savings from implementing this ECM is anticipated to be **\$311,621 per year (first year after installation)**. The total implementation cost for the project is \$2,941,128 for the installation of the streetlighting fixtures, without streetlight pole replacements. This cost includes performance and payment bonds, project implementation costs, and Arizona Transaction Privilege Taxes.

Table ES.0 presents the utility cost savings and construction costs for the measure.

Table ES.0. Energy Conservation Measure Selected for Implementation

Energy Conservation Measure	Guaranteed Electric Savings (\$)	Total Implementation Cost* (\$)	Simple Payback (years)
ECM 1: LED Streetlighting Conversion	\$311,621	\$2,941,128	9.4

*Note: The total implementation cost shown excludes ECM independent costs (i.e., audit fees, bonding costs)

In addition to cost savings, the project will deliver these additional strategic benefits to the City:

- Provide sustained, guaranteed energy savings for the term of the agreement
- Enhance reliability and quality of the streetlighting systems and operations, including extended material warranties on LED streetlight fixtures and photocells

- Provide long-term, non-obsolescent assets that continue to deliver cash flow and reliability benefits beyond the debt service term
- Due to the nature of the photocells that will be installed, this project will position the City as “smart city ready” in the event that the City desires to incorporate smart city applications in the future by connecting to these new photocells
- With the 3,000K color temperature fixtures recommended in this report, the City of Goodyear will be adhering to International Dark Sky recommendations, as well as American Medical Association (AMA) recommendations for appropriate lighting levels in a municipality; thus, bringing additional value to Goodyear residents for years to come

ES.3 ENVIRONMENTAL BENEFITS

By implementing the ECM audited and recommended by Ameresco, the City of Goodyear will accomplish the following:

- Reduce electricity consumption by over **4.5 million kilowatt-hours (kWh)** every year
- Reduce the production of **over 3,634 tons of carbon dioxide (CO₂), 24,223 pounds of sulfur dioxide, and 9,344 pounds of nitrogen oxides**

In terms of emission reductions, the environmental benefits associated with this energy conservation project are equivalent to...



annual greenhouse gas emissions from removing **691** passenger cars from the road

or



CO₂ emissions from **359,806** gallons of gasoline consumed annually

or



CO₂ emissions from the energy use of **369** typical American homes for 1 year

or



52,873 tree seedlings grown for 10 years

or



greenhouse gas emissions avoided by not landfilling **1,088** tons of waste

ES.4 CONCLUSION

By implementing an energy performance contract based on the results of this audit, the City of Goodyear will reduce energy consumption, save taxpayer money, enhance its operations and maintenance abilities, and upgrade aging streetlight assets.

Upon completion of the construction project, Ameresco will monitor the performance of this ECM for the duration of the contract, or for a shorter term if so desired by the City of Goodyear. The scope of work for the ongoing Measurement and Verification services is included in Section F.0.

Section I.0 provides additional details about the training services included in the scope of this project. Section J.0 includes details about the proposed Operations and Maintenance Plan.

PROJECT PROFORMA: CITY OF GOODYEAR LED STREETLIGHTING CONVERSION PROJECT – GE LUMINAIRES

Initial Project Costs:	
Investment Grade Audit	\$ 99,165
Performance and Payment Bond (if applicable), Permits	\$ 32,250
Implementation Costs	\$ 2,726,809
Taxes (5.37%)	\$ 182,089
Payment for Investment Grade Audit	\$ (99,165)
Total Ameresco Contract Amount	\$ 2,941,128
Financing Origination Cost	\$ -
3rd Party Engineering Review	\$ 10,000
Bond Counsel Cost	\$ -
Customer Contribution	\$ (2,951,128)
Net Project Costs	\$ -
Construction Period Interest	\$ -
Total Amount Financed	\$ -

Financial Assumptions	
Term of Project (years)	20.0 yrs
Term of Financing (years)	10.0 yrs
Estimated Financing Rate	2.50%
Payments per Year (frequency)	-
Discount Rate	2.50%
Energy Escalation Rates (annual)	Electricity 2.80%, Natural Gas 0%, Water and Sewer 0%
O&M Savings Escalation rate (annual)	0.00%
M&V Cost Escalation Rate (annual)	4.00%
O&M Cost Escalation Rate (annual)	0.00%
Project Simple Payback	9.4

Proforma		Year									
	Initial Values	1	2	3	4	5	6	7	8	9	10
1 Projected Annual Energy Cost Savings	\$ 336,520	\$ 346,245	\$ 356,252	\$ 366,548	\$ 377,141	\$ 388,040	\$ 399,255	\$ 410,793	\$ 422,665	\$ 434,880	\$ 447,448
2 Guaranteed Energy Cost Savings	\$ 302,868	\$ 311,621	\$ 320,627	\$ 329,893	\$ 339,427	\$ 349,236	\$ 359,330	\$ 369,714	\$ 380,399	\$ 391,392	\$ 402,703
3 O&M Savings	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
4 Utility Rebates (Note 4)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
5 Total Project Savings (Line 2 + Line 3 + Line 4)	\$ 302,868	\$ 311,621	\$ 320,627	\$ 329,893	\$ 339,427	\$ 349,236	\$ 359,330	\$ 369,714	\$ 380,399	\$ 391,392	\$ 402,703
6 Payments for Financing Equipment	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
7 Payments for Measurement and Verification Services	\$ 6,337	\$ 6,591	\$ 6,855	\$ 7,129	\$ 7,414	\$ 7,711	\$ 8,019	\$ 8,340	\$ 8,674	\$ 9,021	\$ 9,382
8 Payments for Operation and Maintenance Services	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
9 Total Payments	\$ -	\$ 6,591	\$ 6,855	\$ 7,129	\$ 7,414	\$ 7,711	\$ 8,019	\$ 8,340	\$ 8,674	\$ 9,021	\$ 9,382
10 Net Annual Benefit	\$ -	\$ 305,030	\$ 313,772	\$ 322,764	\$ 332,013	\$ 341,525	\$ 351,311	\$ 361,374	\$ 371,725	\$ 382,371	\$ 393,321
11 Cumulative Cash Flow	\$ 8,726,280	\$ 305,030	\$ 618,802	\$ 941,566	\$ 1,273,579	\$ 1,615,104	\$ 1,966,415	\$ 2,327,789	\$ 2,699,514	\$ 3,081,885	\$ 3,475,206
12 Net Present Value of Cash Flow	\$ 6,593,529										
13 Interest Rate	2.50%										
14 Discount Rate	2.50%										

Line #	Year										
	11	12	13	14	15	16	17	18	19	20	Totals
1 Projected Annual Energy Cost Savings	\$ 460,379	\$ 473,684	\$ 487,374	\$ 501,459	\$ 515,951	\$ 530,862	\$ 546,204	\$ 561,989	\$ 578,231	\$ 594,941	\$ 9,200,341
2 Guaranteed Energy Cost Savings											\$ 3,554,342
3 O&M Savings	\$ -										\$ -
4 Utility Rebates (Note 4)											\$ -
5 Total Project Savings (Line 2 + Line 3 + Line 4)	\$ 460,379	\$ 473,684	\$ 487,374	\$ 501,459	\$ 515,951	\$ 530,862	\$ 546,204	\$ 561,989	\$ 578,231	\$ 594,941	\$ 8,805,416
6 Payments for Financing Equipment	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
7 Payments for Measurement and Verification Services	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 79,136
8 Payments for Operation and Maintenance Services	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
9 Total Payments	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 79,136
10 Net Annual Benefit	\$ 460,379	\$ 473,684	\$ 487,374	\$ 501,459	\$ 515,951	\$ 530,862	\$ 546,204	\$ 561,989	\$ 578,231	\$ 594,941	\$ 8,726,280
11 Cumulative Cash Flow	\$ 3,935,585	\$ 4,409,269	\$ 4,896,643	\$ 5,398,102	\$ 5,914,053	\$ 6,444,915	\$ 6,991,119	\$ 7,553,108	\$ 8,131,339	\$ 8,726,280	

Notes:

- 1 This cash flow reflects an estimated tax exempt lease rate of 2.5%. The actual rate will increase or decrease based on market conditions and customer credit rating at the time of lease funding.
- 2 Energy Savings or revenues are based on current utility rate structures and usage information provided for purposes of this project.
- 3 The performance and payment bonds apply only to the installation portion of the contract and do not apply in any way to energy savings guarantees, payments or maintenance provisions, except that the performance bond shall guarantee that the installation will be free of defective materials and workmanship for a period of 12 months following completion and acceptance of the work.
- 4 The amount of the utility rebate(s) are not guaranteed. The final rebate amount will be determined by the utility company.

PROJECT PROFORMA: CITY OF GOODYEAR LED STREETLIGHTING CONVERSION PROJECT – GE LUMINAIRES

Initial Project Costs:	
Investment Grade Audit	\$ 99,165
Performance and Payment Bond (if applicable), Permits	\$ 32,250
Implementation Costs	\$ 2,726,809
Taxes (6.37%)	\$ 182,089
Payment for Investment Grade Audit	\$ (99,165)
Total Ameresco Contract Amount	\$ 2,941,128
Financing Origination Cost	\$ -
3rd Party Engineering Review	\$ 10,000
Bond Counsel Cost	\$ 20,000
Customer Contribution	\$ -
Net Project Costs	\$ 2,971,128
Construction Period Interest	\$ 37,333
Total Amount Financed	\$ 3,008,461

Financial Assumptions	
Term of Project (years)	20.0 yrs
Term of Financing (years)	10.0 yrs
Estimated Financing Rate	2.50%
Payments per Year (frequency)	2
Discount Rate	2.50%
Energy Escalation Rates (annual)	Electricity 2.89%, Natural Gas 0%, Water and Sewer 0%
O&M Savings Escalation rate (annual)	0.00%
M&V Cost Escalation Rate (annual)	4.00%
O&M Cost Escalation Rate (annual)	0.00%
Project Simple Payback	9.4

Proforma	Initial Values	Year									
		1	2	3	4	5	6	7	8	9	10
1 Projected Annual Energy Cost Savings	\$ 336,520	\$ 346,245	\$ 356,252	\$ 366,548	\$ 377,141	\$ 388,040	\$ 399,255	\$ 410,793	\$ 422,665	\$ 434,880	\$ 447,448
2 Guaranteed Energy Cost Savings	\$ 302,868	\$ 311,621	\$ 320,627	\$ 329,893	\$ 339,427	\$ 349,236	\$ 359,330	\$ 369,714	\$ 380,399	\$ 391,392	\$ 402,703
3 O&M Savings	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
4 Utility Rebates (Note 4)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
5 Total Project Savings (Line 2 + Line 3 + Line 4)	\$ 302,868	\$ 311,621	\$ 320,627	\$ 329,893	\$ 339,427	\$ 349,236	\$ 359,330	\$ 369,714	\$ 380,399	\$ 391,392	\$ 402,703
6 Payments for Financing Equipment	\$ -	\$ 301,398	\$ 310,140	\$ 319,132	\$ 328,381	\$ 337,894	\$ 347,679	\$ 357,742	\$ 368,093	\$ 378,739	\$ 389,690
7 Payments for Measurement and Verification Services	\$ 6,337	\$ 6,591	\$ 6,855	\$ 7,129	\$ 7,414	\$ 7,711	\$ 8,019	\$ 8,340	\$ 8,674	\$ 9,021	\$ 9,382
8 Payments for Operation and Maintenance Services	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
9 Total Payments	\$ -	\$ 307,989	\$ 316,995	\$ 326,261	\$ 335,795	\$ 345,605	\$ 355,698	\$ 366,082	\$ 376,767	\$ 387,760	\$ 399,072
10 Net Annual Benefit	\$ -	\$ 3,632	\$ 3,632	\$ 3,632	\$ 3,632	\$ 3,631	\$ 3,632	\$ 3,632	\$ 3,632	\$ 3,632	\$ 3,631
11 Cumulative Cash Flow	\$ 5,287,392	\$ 3,632	\$ 7,263	\$ 10,895	\$ 14,527	\$ 18,158	\$ 21,791	\$ 25,423	\$ 29,055	\$ 32,686	\$ 36,318
12 Net Present Value of Cash Flow	\$ 3,601,232										
13 Interest Rate	2.50%										
14 Discount Rate	2.50%										

Line #	Year										Totals
	11	12	13	14	15	16	17	18	19	20	
1 Projected Annual Energy Cost Savings	\$ 460,379	\$ 473,684	\$ 487,374	\$ 501,459	\$ 515,951	\$ 530,862	\$ 546,204	\$ 561,989	\$ 578,231	\$ 594,941	\$ 9,200,341
2 Guaranteed Energy Cost Savings	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3,554,342
3 O&M Savings	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
4 Utility Rebates (Note 4)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
5 Total Project Savings (Line 2 + Line 3 + Line 4)	\$ 460,379	\$ 473,684	\$ 487,374	\$ 501,459	\$ 515,951	\$ 530,862	\$ 546,204	\$ 561,989	\$ 578,231	\$ 594,941	\$ 8,805,416
6 Payments for Financing Equipment	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3,438,888
7 Payments for Measurement and Verification Services	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 79,136
8 Payments for Operation and Maintenance Services	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
9 Total Payments	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3,518,024
10 Net Annual Benefit	\$ 460,379	\$ 473,684	\$ 487,374	\$ 501,459	\$ 515,951	\$ 530,862	\$ 546,204	\$ 561,989	\$ 578,231	\$ 594,941	\$ 5,287,392
11 Cumulative Cash Flow	\$ 496,697	\$ 970,381	\$ 1,457,755	\$ 1,959,214	\$ 2,475,165	\$ 3,006,027	\$ 3,552,231	\$ 4,114,220	\$ 4,692,451	\$ 5,287,392	

Notes:

- 1 This cash flow reflects an estimated tax exempt lease rate of 2.5%. The actual rate will increase or decrease based on market conditions and customer credit rating at the time of lease funding.
- 2 Energy Savings or revenues are based on current utility rate structures and usage information provided for purposes of this project.
- 3 The performance and payment bonds apply only to the installation portion of the contract and do not apply in any way to energy savings guarantees, payments or maintenance provisions, except that the performance bond shall guarantee that the installation will be free of defective materials and workmanship for a period of 12 months following completion and acceptance of the work.
- 4 The amount of the utility rebate(s) are not guaranteed. The final rebate amount will be determined by the utility company.

A.0 INTRODUCTION

This Investment Grade Audit (IGA) is intended to provide an overall representation of the potential for energy savings for the City of Goodyear (City). Based on an audit of all of the street and intersection lighting fixtures throughout the City of Goodyear, interviews with City representatives, review of the City streetlight database, Arizona Public Service (APS) utility analysis, and energy calculations. Ameresco is confident that the implementation of the recommended energy conservation measure (ECM) will help the City reduce energy consumption, improve the dark skies lighting environment, and increase the life cycle value of the streetlight assets in the City of Goodyear.

A.1 PROJECT OVERVIEW

Ameresco developed a Streetlighting Conversion ECM for the City of Goodyear. The ECM includes upgrading the streetlighting systems with new light-emitting diode (LED) fixtures included in the scope of work. Implementing this ECM will provide the following benefits for the City:

- Decrease annual electrical energy consumption by **4,522,509 kWh**

The total potential guaranteed project savings resulting from implementing the ECM is projected to be \$311,621 per year.

In terms of pollution reduction, the project will avoid the production of over **3,634 tons of carbon dioxide (CO₂)**, **24,223 pounds of sulfur dioxide**, and **9,344 pounds of nitrogen oxides per year**¹. This reduction in carbon dioxide generation is the equivalent to removing **691 cars** from the road², or powering **369 homes** each year³. In addition, implementing this ECM will deliver strategic benefits to the City of Goodyear to include:

- Addressing the life cycle replacement needs for the streetlighting systems
- Providing long-term, non-obsolescent assets that continue to deliver cash flow and reliability benefits for the life of the fixtures
- Improving the environment by providing higher quality lighting and demonstrating the City's commitment to enhancing the lighting environment for both safety and reduced light pollution

¹ Calculated using 1,203 pounds of carbon dioxide reduction per 1,000 kilowatt hours based on the data provided by the EPA Greenhouse Gas Equivalencies Calculator.

² One car produces the equivalent of 5.3 tons of carbon dioxide per year (Source: U.S. Environmental Protection Agency).

³ The average home uses 1,000 kilowatt hours per month.

- Provide sustained, guaranteed energy savings for the term of the agreement
- Enhance reliability and quality of the streetlighting systems and operations, including extended parts warranties on LED streetlight fixtures and photocells
- Due to the nature of the photocells that will be installed, this project will position the City as "smart city ready" in the event that the City desires to incorporate smart city applications in the future by connecting to these new photocells
- By installing 3,000K color temperature fixtures recommended in this IGA, the City of Goodyear will adhere to International Dark Sky recommendations, as well as AMA recommendations for appropriate lighting levels in a municipality; thus, bringing additional value to Goodyear residents for years to come

The proposed ECM does not materially change the lighting system or pole design and is not anticipated to require construction drawings to be stamped by a licensed Professional Engineer.

Ameresco will perform measurement and verification (M&V) services upon completion of construction and annually every year thereafter for the 10-year performance period. Ameresco will provide training for the City of Goodyear personnel during commissioning and at the end of construction. (Please reference Section F.0 of the audit for more details regarding M&V services and Section I.0 for Ameresco's Training Plan for the City of Goodyear.)

A.2 FINANCIAL OVERVIEW

The costs and savings for the project with this financing structure are:

- Total project cost of \$2,941,128 (streetlight fixture replacement only)
- Total guaranteed annual energy savings of \$311,621 in Year 1 of the performance period

The LED Streetlighting Conversion proforma for the project is provided on the following pages.

PROJECT PROFORMA: CITY OF GOODYEAR LED STREETLIGHTING CONVERSION PROJECT – GE LUMINAIRES

Initial Project Costs:	
Investment Grade Audit	\$ 99,165
Performance and Payment Bond (if applicable), Permits	\$ 32,250
Implementation Costs	\$ 2,726,809
Taxes (5.37%)	\$ 182,089
Payment for Investment Grade Audit	\$ (99,165)
Total Ameresco Contract Amount	\$ 2,941,128
Financing Origination Cost	\$ -
3rd Party Engineering Review	\$ 10,000
Bond Counsel Cost	\$ -
Customer Contribution	\$ (2,951,128)
Net Project Costs	\$ -
Construction Period Interest	\$ -
Total Amount Financed	\$ -

Financial Assumptions	
Term of Project (years)	20.0 yrs
Term of Financing (years)	10.0 yrs
Estimated Financing Rate	2.50%
Payments per Year (frequency)	-
Discount Rate	2.50%
Energy Escalation Rates (annual)	Electricity 2.89%, Natural Gas 0%, Water and Sewer 0%
O&M Savings Escalation rate (annual)	0.00%
M&V Cost Escalation Rate (annual)	4.00%
O&M Cost Escalation Rate (annual)	0.00%
Project Simple Payback	9.4

Proforma		Year									
	Initial Values	1	2	3	4	5	6	7	8	9	10
1 Projected Annual Energy Cost Savings	\$ 336,520	\$ 346,245	\$ 356,252	\$ 366,548	\$ 377,141	\$ 388,040	\$ 399,255	\$ 410,793	\$ 422,665	\$ 434,880	\$ 447,448
2 Guaranteed Energy Cost Savings	\$ 302,868	\$ 311,621	\$ 320,627	\$ 329,893	\$ 339,427	\$ 349,236	\$ 359,330	\$ 369,714	\$ 380,399	\$ 391,392	\$ 402,703
3 O&M Savings	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
4 Utility Rebates (Note 4)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
5 Total Project Savings (Line 2 + Line 3 + Line 4)	\$ 302,868	\$ 311,621	\$ 320,627	\$ 329,893	\$ 339,427	\$ 349,236	\$ 359,330	\$ 369,714	\$ 380,399	\$ 391,392	\$ 402,703
6 Payments for Financing Equipment	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
7 Payments for Measurement and Verification Services	\$ 6,337	\$ 6,591	\$ 6,855	\$ 7,129	\$ 7,414	\$ 7,711	\$ 8,019	\$ 8,340	\$ 8,674	\$ 9,021	\$ 9,382
8 Payments for Operation and Maintenance Services	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
9 Total Payments	\$ -	\$ 6,591	\$ 6,855	\$ 7,129	\$ 7,414	\$ 7,711	\$ 8,019	\$ 8,340	\$ 8,674	\$ 9,021	\$ 9,382
10 Net Annual Benefit	\$ -	\$ 305,030	\$ 313,772	\$ 322,764	\$ 332,013	\$ 341,525	\$ 351,311	\$ 361,374	\$ 371,725	\$ 382,371	\$ 393,321
11 Cumulative Cash Flow	\$ 8,726,280	\$ 305,030	\$ 618,802	\$ 941,566	\$ 1,273,579	\$ 1,615,104	\$ 1,966,415	\$ 2,327,789	\$ 2,699,514	\$ 3,081,885	\$ 3,475,206
12 Net Present Value of Cash Flow	\$ 6,593,529										
13 Interest Rate	2.50%										
14 Discount Rate	2.50%										

Line #	Year											Totals
	11	12	13	14	15	16	17	18	19	20		
1 Projected Annual Energy Cost Savings	\$ 460,379	\$ 473,684	\$ 487,374	\$ 501,459	\$ 515,951	\$ 530,862	\$ 546,204	\$ 561,989	\$ 578,231	\$ 594,941	\$ 9,200,341	
2 Guaranteed Energy Cost Savings											\$ 3,554,342	
3 O&M Savings	\$ -										\$ -	
4 Utility Rebates (Note 4)											\$ -	
5 Total Project Savings (Line 2 + Line 3 + Line 4)	\$ 460,379	\$ 473,684	\$ 487,374	\$ 501,459	\$ 515,951	\$ 530,862	\$ 546,204	\$ 561,989	\$ 578,231	\$ 594,941	\$ 8,805,416	
6 Payments for Financing Equipment	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
7 Payments for Measurement and Verification Services	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 79,136	
8 Payments for Operation and Maintenance Services	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
9 Total Payments	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 79,136	
10 Net Annual Benefit	\$ 460,379	\$ 473,684	\$ 487,374	\$ 501,459	\$ 515,951	\$ 530,862	\$ 546,204	\$ 561,989	\$ 578,231	\$ 594,941	\$ 8,726,280	
11 Cumulative Cash Flow	\$ 3,935,585	\$ 4,409,269	\$ 4,896,643	\$ 5,388,102	\$ 5,914,053	\$ 6,444,915	\$ 6,991,119	\$ 7,553,108	\$ 8,131,339	\$ 8,726,280		

Notes:

- 1 This cash flow reflects an estimated tax exempt lease rate of 2.5%. The actual rate will increase or decrease based on market conditions and customer credit rating at the time of lease funding.
- 2 Energy Savings or revenues are based on current utility rate structures and usage information provided for purposes of this project.
- 3 The performance and payment bonds apply only to the installation portion of the contract and do not apply in any way to energy savings guarantees, payments or maintenance provisions, except that the performance bond shall guarantee that the installation will be free of defective materials and workmanship for a period of 12 months following completion and acceptance of the work.
- 4 The amount of the utility rebate(s) are not guaranteed. The final rebate amount will be determined by the utility company.

PROJECT PROFORMA: CITY OF GOODYEAR LED STREETLIGHTING CONVERSION PROJECT – GE LUMINAIRES

Initial Project Costs:	
Investment Grade Audit	\$ 99,165
Performance and Payment Bond (if applicable), Permits	\$ 32,250
Implementation Costs	\$ 2,726,809
Taxes (6.37%)	\$ 182,069
Payment for Investment Grade Audit	\$ (99,165)
Total Ameresco Contract Amount	\$ 2,941,128
Financing Origination Cost	\$ -
3rd Party Engineering Review	\$ 10,000
Bond Counsel Cost	\$ 20,000
Customer Contribution	\$ -
Net Project Costs	\$ 2,971,128
Construction Period Interest	\$ 37,333
Total Amount Financed	\$ 3,008,461

Financial Assumptions	
Term of Project (years)	20.0 yrs
Term of Financing (years)	10.0 yrs
Estimated Financing Rate	2.50%
Payments per Year (frequency)	2
Discount Rate	2.50%
Energy Escalation Rates (annual)	Electricity 2.89%, Natural Gas 0%, Water and Sewer 0%
O&M Savings Escalation rate (annual)	0.00%
M&V Cost Escalation Rate (annual)	4.00%
O&M Cost Escalation Rate (annual)	0.00%
Project Simple Payback	9.4

Proforma	Initial Values	Year									
		1	2	3	4	5	6	7	8	9	10
1 Projected Annual Energy Cost Savings	\$ 336,520	\$ 346,245	\$ 356,252	\$ 366,548	\$ 377,141	\$ 388,040	\$ 399,255	\$ 410,793	\$ 422,665	\$ 434,880	\$ 447,448
2 Guaranteed Energy Cost Savings	\$ 302,868	\$ 311,621	\$ 320,627	\$ 329,893	\$ 339,427	\$ 349,236	\$ 359,330	\$ 369,714	\$ 380,399	\$ 391,392	\$ 402,703
3 O&M Savings	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
4 Utility Rebates (Note 4)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
5 Total Project Savings (Line 2 + Line 3 + Line 4)	\$ 302,868	\$ 311,621	\$ 320,627	\$ 329,893	\$ 339,427	\$ 349,236	\$ 359,330	\$ 369,714	\$ 380,399	\$ 391,392	\$ 402,703
6 Payments for Financing Equipment	\$ -	\$ 301,398	\$ 310,140	\$ 319,132	\$ 328,381	\$ 337,894	\$ 347,679	\$ 357,742	\$ 368,093	\$ 378,739	\$ 389,690
7 Payments for Measurement and Verification Services	\$ 6,337	\$ 6,591	\$ 6,855	\$ 7,129	\$ 7,414	\$ 7,711	\$ 8,019	\$ 8,340	\$ 8,674	\$ 9,021	\$ 9,382
8 Payments for Operation and Maintenance Services	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
9 Total Payments	\$ -	\$ 307,989	\$ 316,995	\$ 326,261	\$ 335,795	\$ 345,605	\$ 355,698	\$ 366,082	\$ 376,767	\$ 387,760	\$ 399,072
10 Net Annual Benefit	\$ -	\$ 3,632	\$ 3,632	\$ 3,632	\$ 3,632	\$ 3,631	\$ 3,632	\$ 3,632	\$ 3,632	\$ 3,632	\$ 3,631
11 Cumulative Cash Flow	\$ 5,287,392	\$ 3,632	\$ 7,263	\$ 10,895	\$ 14,527	\$ 18,158	\$ 21,791	\$ 25,423	\$ 29,055	\$ 32,686	\$ 36,318
12 Net Present Value of Cash Flow	\$ 3,601,232										
13 Interest Rate	2.50%										
14 Discount Rate	2.50%										

Line #	Year										Totals
	11	12	13	14	15	16	17	18	19	20	
1 Projected Annual Energy Cost Savings	\$ 460,379	\$ 473,684	\$ 487,374	\$ 501,459	\$ 515,951	\$ 530,862	\$ 546,204	\$ 561,989	\$ 578,231	\$ 594,941	\$ 9,200,341
2 Guaranteed Energy Cost Savings	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3,554,342
3 O&M Savings	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
4 Utility Rebates (Note 4)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
5 Total Project Savings (Line 2 + Line 3 + Line 4)	\$ 460,379	\$ 473,684	\$ 487,374	\$ 501,459	\$ 515,951	\$ 530,862	\$ 546,204	\$ 561,989	\$ 578,231	\$ 594,941	\$ 8,805,416
6 Payments for Financing Equipment	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3,438,888
7 Payments for Measurement and Verification Services	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 79,136
8 Payments for Operation and Maintenance Services	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
9 Total Payments	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3,518,024
10 Net Annual Benefit	\$ 460,379	\$ 473,684	\$ 487,374	\$ 501,459	\$ 515,951	\$ 530,862	\$ 546,204	\$ 561,989	\$ 578,231	\$ 594,941	\$ 5,287,392
11 Cumulative Cash Flow	\$ 496,697	\$ 970,381	\$ 1,457,755	\$ 1,959,214	\$ 2,475,165	\$ 3,006,027	\$ 3,552,231	\$ 4,114,220	\$ 4,692,451	\$ 5,287,392	

Notes:

- 1 This cash flow reflects an estimated tax exempt lease rate of 2.5%. The actual rate will increase or decrease based on market conditions and customer credit rating at the time of lease funding.
- 2 Energy Savings or revenues are based on current utility rate structures and usage information provided for purposes of this project.
- 3 The performance and payment bonds apply only to the installation portion of the contract and do not apply in any way to energy savings guarantees, payments or maintenance provisions, except that the performance bond shall guarantee that the installation will be free of defective materials and workmanship for a period of 12 months following completion and acceptance of the work.
- 4 The amount of the utility rebate(s) are not guaranteed. The final rebate amount will be determined by the utility company.

A.3 BASELINE OVERVIEW

APS utility data from the City of Goodyear was used to establish the annual baseline energy consumption. The City provided utility summary data and sample copies of utility bills to verify the APS E-59 Rate. The annual baseline utility usage is based on the 12-month period from July 2019 to June 2020. A summary of the calculated baseline cost, energy consumption data, and associated energy profiles are provided in Tables A.0 and A.1.

Table A.0. Baseline Energy Consumption

Model	kWh (12 months)	Rate	Description
APS Billing – HPS Lighting Only	6,360,011	E-59	Streetlights

Table A.1. Baseline Energy Cost

Model	(\$) (12 months)	Rate	Description
APS Billing – HPS Lighting Only	\$473,219*	E-59	Streetlights

*Excludes light unit charges

A.4 COST SAVINGS OVERVIEW

Table A.2 provides a summary of the estimated costs and savings for this recommended ECM. Note that the electric savings are based on energy consumption reduction (kWh) only, given that the per fixture fixed charges will not change. The value of the savings is the energy costs associated with the fixtures and the associated assessments, adjustments, and taxes.

Table A.2. Estimated Costs and Savings

Energy Conservation Measure	Guaranteed Electric Savings (\$)	Total Implementation Cost* (\$)	Simple Payback (years)
ECM 1: LED Streetlighting Conversion	\$311,621	\$2,941,128	9.4

*Note: The total implementation cost shown excludes ECM independent costs (i.e., audit fees, bonding costs)

During implementation, progress payments are due by the City of Goodyear, based on the verified and accepted number of fixtures that have been installed. Final payment for fixture installation is due upon final acceptance of the project by the City of Goodyear.

A.5 ENERGY ESCALATION RATE

A 2.89 percent energy escalation rate has been used in the financial analysis for the project. This escalation rate forecast was vetted through discussions with the City and is based on information provided by the US Department of Commerce's National Institute of Standards and Technology (NIST) 2020 Energy Price Indices and Discount Factors Life Cycle Cost Analysis annual supplement. Table S-4 in the NIST publication provides projected fuel price indices with an assumed general price inflation rate of 2.89 percent. A copy of Table S-4 of the NIST publication is provided for reference in Appendix K.1.

A.6 RECOMMENDED MEASURE

The proposed ECM 1: LED Streetlight Conversion was evaluated to assess its potential for energy savings and to address life cycle issues. The following is an overview of this measure.

Ameresco proposes replacing the existing streetlighting with new LED technology. The proposed solution will reduce the energy and operational expense of the City's streetlighting systems. This measure includes the replacement of the existing high-pressure sodium (HPS) streetlight fixtures with LED lights for cobrahead and shoebox fixtures. New photocells will be included with the LED fixture conversion for ON/OFF operation of the lighting based on the ambient lighting levels. The new LED fixtures come with a 10-year factory warranty. In addition to this 10-year material warranty, this project includes a 1-year workmanship warranty. This retrofit will also reduce the amount of sky glare generated by lighting and will enable the City to better meet Dark Skies Association guidelines. Further, this ECM will reduce maintenance costs due to longer life and reduced number of LED fixtures that will require replacement in the future.

B.0 LIGHTING EQUIPMENT DESCRIPTIONS

The scope of the audit includes the light-emitting diode (LED) lighting conversion of the existing streetlighting systems throughout the City of Goodyear (City). Table B.0 lists the total number of streetlight fixtures included in the audit that Ameresco completed. A complete inventory of existing equipment is provided in Appendix K.2.

Table B.0. Existing Lighting Systems Summary

Lighting Location	Number of Fixtures
Streetlighting (cobrahead, shoebox)	9,390
Wall Pack Fixtures	52
Decorative and Specialty Fixtures (floodlight, post tops, pendants) (out of scope)	715
Private or Pedestrian Fixtures (out of scope)	1,789
Existing LED Lighting (existing to remain)	346
Existing HPS Intersection Lighting (existing to remain)	255
Total:	12,547

B.1 STREETLIGHTING

STREETLIGHTING DESCRIPTION

The existing streetlight fixtures surveyed are generally cobrahead and shoebox models, each containing different types of high-pressure sodium (HPS) and solid-state LED technology and are located throughout the City. The streetlights are controlled individually by means of dusk-to-dawn photocell sensors.

Table B.1 provides a summary of the existing streetlighting systems observed during the audit.

Table B.1. Existing Lighting Summary: Streetlighting

Model	Type	Wattage	Count
Cobrahead/Shoebox	HPS	100	5,481
Cobrahead/Shoebox	HPS	150	1,754
Cobrahead/Shoebox	HPS	250	2,066
Cobrahead/Shoebox	HPS	400	89
Wall Pack Fixtures	HPS	150	52
Decorative Pendant / Acorn / Post Top	HPS		715
Private/Pedestrian			1,789
Existing LED			346
Intersection	LED		255
Total:			12,547

Note that the paint colors for the new LED fixtures should be similar to the existing fixture colors; however, there may be a variance between the new and existing finish due to the discoloring by the effects of weather over time.

B.2 DECORATIVE AND SPECIALTY FIXTURES

STREETLIGHTING DESCRIPTION

The existing decorative light fixtures surveyed are post top and pendant models, consisting of mostly HPS lamps. The streetlights are typically controlled by dusk-to-dawn photocell sensors.

The decorative lighting throughout the City include screw-in type lamps. Table B.2 provides a summary of the existing decorative lighting systems observed during the audit. Note that only 40 of the decorative or specialty fixtures are to be replaced as a part of the LED Streetlighting Conversion project.

Table B.2. Existing Lighting Summary: Decorative and Specialty Lighting

Model	Type	Count
Decorative – Post Top	HPS	310
Decorative – Other	HPS	398
Decorative – Pendant	HPS	7
Total:		715

C.0 BASE YEAR UTILITY USAGE

The streetlighting baseline energy consumption and electric utility rate tariffs included in this project were established by combining data from the City of Goodyear (City), and Arizona Public Service (APS). The City and Ameresco collected historic utility data from APS. For the basis of this project, the City provided one year of historical electricity costs from APS, and copies of 12 monthly utility bills, which also include the electrical consumption. A summary of the utility data for all evaluated lighting accounts is provided in Appendix K.3.1. Copies of the APS electrical tariff sheets are provided in Appendix K.3.2.

C.1 ELECTRIC SERVICE

An audit was performed on the City's streetlights and intersection fixtures. The audit included a detailed field survey to verify the location, model, type, wattage, and other characteristics of each existing streetlight in the City of Goodyear inventory. The data included approximately 9,160 high-pressure sodium (HPS) streetlights (in-scope fixtures). In addition, the field survey sited and logged approximately the out-of-scope HPS streetlights, decorative streetlights, private or pedestrian lights, and the existing LED streetlights. The total number of streetlights within the surveyed was 12,547 lights.

The base year energy consumption data provided in this section is calculated from the fixture quantities, wattages, and run-time validated as part of the detailed field audit. The utility summary report data was used to establish the annual energy and cost baseline. The 12-month base year period that was used to establish the baseline energy usage as the basis of the audit for the streetlighting systems was from July 2019 to June 2020.

Electric energy is supplied to the City of Goodyear streetlights by APS under Rate Schedule E-59. All the dollar savings shown in this analysis are calculated by applying the actual rate codes during the audit to ensure that the projected dollar savings represents the actual billing reduction. Table C.0 lists the calculated annual cost and energy consumption for the existing streetlighting systems included in the scope of work (without light unit charges).

Table C.0. Annual Baseline Electricity Consumption and Expenditures

Location	Accounts	Energy (kWh)	Total Cost (\$)
APS Streetlights for City of Goodyear	ALL	6,360,011	\$473,219

*Excludes light unit charges

Table C.1 lists the electric energy-based charges for the APS rate tariff. The rate shown is the base power supply charge. This was selected since the energy charge (kWh) will be directly reduced by the fixture conversion, but the per fixtures charges will not be affected.

Table C.1. Energy Rate Charges

Rate Schedule	Energy Rate (\$/kWh)
E-59: Classified Service – Government Owned Streetlighting	\$0.07441

To calculate savings, Ameresco used the rate structure shown above, plus the associated fees and taxes for that account.

D.0 ENERGY CONSERVATION MEASURE

This section outlines the detailed recommendations for the light-emitting diode (LED) Streetlighting Conversion ECM developed in cooperation with the City of Goodyear (City). This audit includes a description of the existing conditions, the proposed changes as outlined in the energy savings analysis, a detailed scope of work, and documents the impact this measure will have on the City of Goodyear's streetlighting systems.

Table D.0. Proposed Energy Conservation Measure

Energy Conservation Measure
ECM 1: LED Streetlighting Conversion

The construction costs include the engineering design costs, permit costs, construction management fees, environmental fees, training, warranty, commissioning, and the individual contractor costs for the ECM, as well as for the project as a whole. These costs assume that the terms and conditions included within the contract are agreed on by all parties represented therein.

Section F.0 includes the Measurement and Verification (M&V) Plan. The baseline and proposed energy use have been outlined in detail and the savings algorithms are provided. Section G.0 includes the Commissioning Plan for this ECM.

ECM 1: LED STREETLIGHTING CONVERSION

STREETLIGHTING

GENERAL DESCRIPTION

ECM 1 proposes to replace the existing streetlight luminaires identified in the audit with new LED fixtures, as well as new photocells, throughout the entire City of Goodyear. The proposed project upgrades the existing fixtures and will greatly enhance the quality, consistency, and color rendering of the lighting system, thereby reducing the energy and operational expense of the streetlighting systems.

This strategy will reduce overall electricity consumption of the lighting systems throughout the City. Further, implementation of this ECM will reduce maintenance costs because of the longer life of LED lighting as compared to the City's existing HPS lighting. The LED fixtures come with a 10-year factory material warranty. Ameresco is providing a 1-year workmanship warranty as well. This retrofit will also reduce the amount of sky glare generated by lighting and enable the City to better meet Dark Skies Association guidelines.

EXISTING CONDITIONS

The City of Goodyear provided access to the streetlight inventory maintained by the City. A detailed fixture-by-fixture audit of the streetlighting system was performed by Ameresco to verify the streetlight inventory, as well as locating and documenting new, unknown, and privately-owned streetlights. Privately-owned streetlights are not included in the scope of this project.

The existing streetlight fixtures surveyed are cobrahead, shoebox, and post top models, each containing either a high-pressure sodium (HPS) or solid state LED technology. See Table D.1. for the existing streetlight fixture model, type, wattage, and count for the in-scope fixtures included in ECM 1. Note that Table D.1 below indicates the current wattage of each fixture. Table D.2 shows the final LED wattage for type of fixture. The values in Table D.1 and Table D.2 do not match since some of the HPS wattages will be converted to different LED wattages. For instance, there are 2,044 fixtures that are 250 watt in Table D.1, but only 1,669 fixtures will be converted to the equivalent 98 watt LED fixture. The remainder will be converted to 39 watt LED fixtures (100 watt HPS equivalent) or 71 watt LED fixtures (150 watt HPS equivalent) based on their installation location (i.e., the current HPS wattage is above the recommended wattage for the roadway type).

Table D.1. Existing Streetlighting Summary (In-Scope)

Model	Type	Wattage	Count
Cobrahead/Shoebox	HPS	100	5,261
Cobrahead/Shoebox	HPS	150	1,679
Cobrahead/Shoebox	HPS	250	2,044
Cobrahead/Shoebox	HPS	400	84
Wall Pack	HPS	150	52
Post Top	HPS	100	40
Total:			9,160

Recommended Modifications

Ameresco's approach is to standardize the proposed lighting system, whenever practical. Recommended modifications include replacing high energy consuming fixtures with more efficient fixtures where needed.



The proposed solution will help to reduce the energy and operational expense of the streetlighting systems by replacing the existing streetlighting with new LED technology for the cobrahead, post top, and shoebox fixtures.

All the fixtures proposed in this project will be 3000K color temperature and compliant with the Dark Skies Association guidelines. Table D.2 displays a complete list of the new fixture selections proposed for ECM 1. Note that not all existing fixture wattages convert directly to the same fixture for the new LED streetlights.

Table D.2. Proposed New Fixtures

New Fixture (GE)	Style	Input Watts	Lumens	Road Class	Count
ERL1-0-05-B3-30 3000K	Cobrahead	39	4,900	Local	5,481
ERL1-0-08-B3-30 3000K	Cobrahead	71	7,800	Collector	1,858
ERLH-0-11-C3-30 3000K	Cobrahead	98	11,000	Major/Arterial	1,669
ERL2-0-21-C3-30 3000K	Cobrahead	174	20,100	Major/Arterial	60
EWS3-H-D3-E1-30-1-DKBZ	Wall Pack	67	6,500	-	52
EPST-0-E3-30 3000K	Post Top	48	3,200	Local	40
Total:					9,160

Detailed Project Scope

The ECM 1 scope of work includes the upgrade of 9,160 streetlight fixtures located throughout the City of Goodyear. This measure will include the installation of the new fixtures and photocells needed for a complete retrofit.

The detailed fixture-by-fixture audit of the City's streetlight systems will be utilized to coordinate the installation of the new fixtures. Installation crews will use tablets to access the GIS mapping system in the field and to gather information on the existing luminaire, location, and new fixture model number for each streetlight for all City-owned streetlights.

The project scope of work includes:

- Surveying the existing streetlight infrastructure for pre-existing damage to the streetlight pole, mast arm, mounting hardware, and wiring
- Reporting any pre-existing damage to the City of Goodyear for correction
- Removal of the existing luminaire and photocell
- Installation of new luminaire and photocell
- Recycling of the old fixture
- Recycling of the old lamp
- Cleaning work area and disposing of any construction debris and removing debris from site
- Complying with applicable local, state, and federal codes at the point of installation of new fixtures

Exclusions to the scope of work include:

- Replacing any fixtures due to pole knock down
- Sampling, testing or removing asbestos, lead or other hazardous materials
- Repairing existing damaged or faulty electrical equipment and wiring, except as authorized by the City of Goodyear through change order
- Upgrading electrical distribution system to meet current electrical codes
- Creating, stamping, and signing engineering plans and specifications
- Installation of new junction boxes, except as authorized by the City of Goodyear through change order

Ameresco has included lamp recycling and disposal in the project scope of work. Recycling certificates and recycling revenue will be provided to the City for all recycled material.

Streetlight Fixture Retrofit Energy Savings Calculations

Detailed calculations for baseline and energy savings for this ECM are provided in Appendix K.4. Energy savings for the retrofits are determined by comparing the baseline existing energy consumption (kWh) with the proposed post-retrofit energy consumption (kWh). Total cost savings from the streetlight fixture upgrade is limited to energy consumption reductions only. No demand (kW) savings are claimed since the APS rate does not include any charges for demand.

$$\text{Electricity Savings} = \text{Lighting kWh Savings}$$

$$\text{Lighting kWh Savings} = \text{Base Lighting kWh} - \text{Post Lighting kWh}$$

$$\text{Base Lighting kWh} = \text{Base Light kW} \times \text{Hours}$$

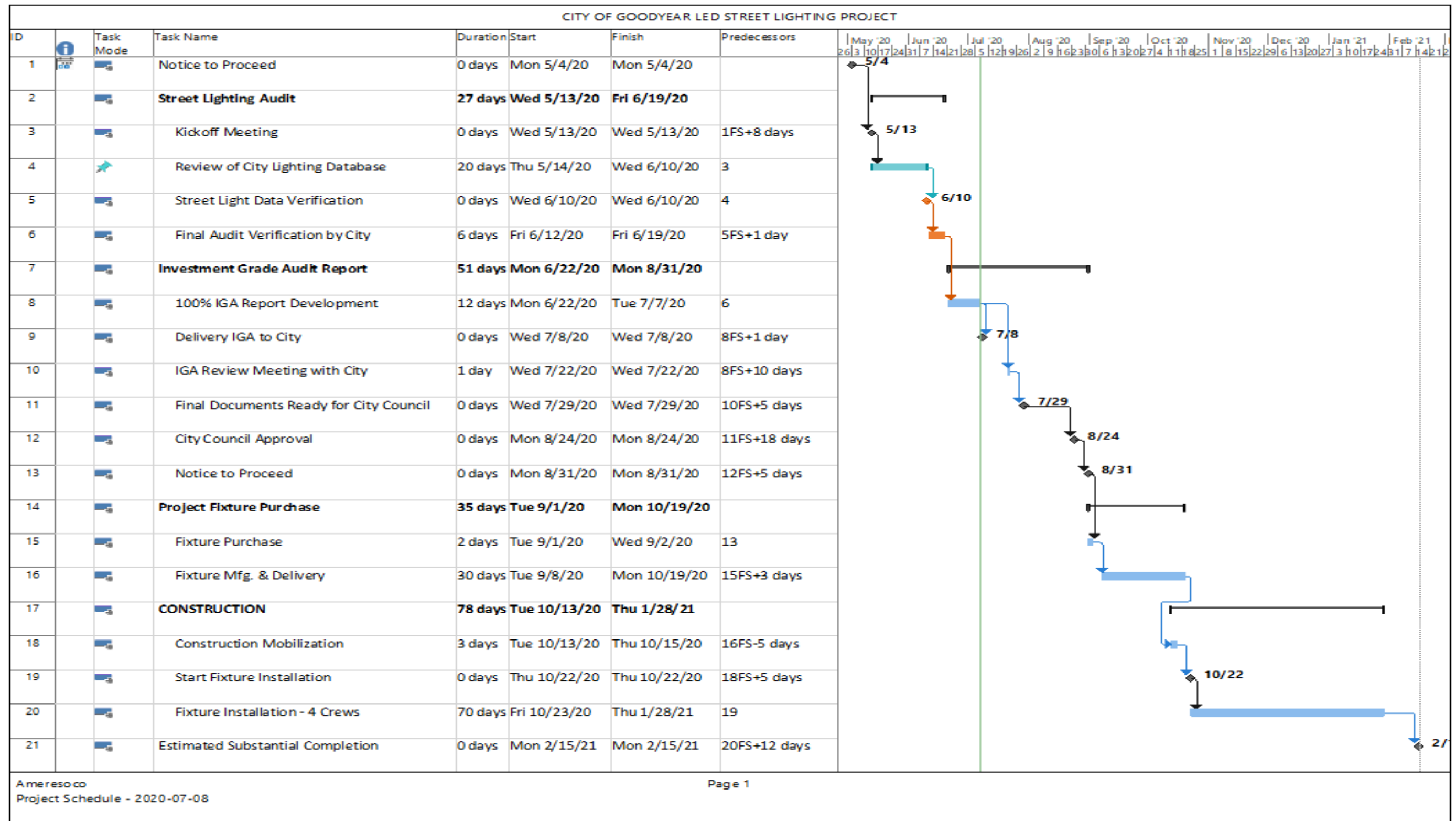
$$\text{Post Lighting kWh} = \text{Post Light kW} \times \text{Hours}$$

Existing energy usage for lighting is calculated from the number of existing streetlight fixtures and their rated wattages. The savings are determined on the same number of fixtures, as described in Appendix K.4. A summary of lighting run hours by fixture type is presented in the M&V Plan.

E.0 PROJECT SCHEDULE

A preliminary construction schedule for the project is provided herein. The total construction duration until project acceptance is estimated to be three months. Final completion and closeout of the project is expected to take three additional weeks including commissioning, final inspection, training, documentation, and any other final close-out procedures that may be required. The schedule tentatively anticipates construction beginning in September, based on a fixture order in early August 2020, although this date may change based on the needs and requirements of the City. It is estimated that it will take 12 – 14 weeks to install all the new fixtures once installation begins in the field.

PROPOSED CONSTRUCTION SCHEDULE: CITY OF GOODYEAR LED STREETLIGHTING CONVERSION PROJECT



F.0 MEASUREMENT AND VERIFICATION

The long-term success of any comprehensive energy efficiency program depends on the development of an accurate and successful Measurement & Verification (M&V) Plan which cost-effectively quantifies and verifies the performance of the ECM. For this reason, Ameresco subscribes to industry standard M&V protocols that have been developed in response to the need for reliable and consistent measurement practices. Ameresco used the International Performance Measurement and Verification Protocol (IPMVP) for the development of M&V procedures for this project.

The IPMVP protocol helps allocate various risks associated with achieving energy cost savings, reduces overall performance risk and facilitates better risk management. The protocols have several additional benefits:

- Define the role of verification in energy contracts and implementation
- Discuss procedures with varying levels of accuracy and cost for verifying baseline and project installation conditions and long-term energy savings performance
- Provide techniques for calculating whole-facility savings, individual technology savings, and stipulated savings
- Provide procedures that are consistent, industry-accepted, impartial, and reliable
- Provide procedures for the investigation and resolution of disagreements related to performance issues

The descriptions of the available M&V options provided in this section were developed by summarizing the IPMVP and contains an excerpt taken from that document.

The general approach to determining energy savings in these plans involves comparing the energy use of the system before installation of the ECM (baseline), and after installation of the ECM (post-retrofit). In general:

$$\text{Energy Savings} = \text{Baseline Energy Use} - \text{Post Retrofit Energy Use}$$

The IPMVP protocols define four M&V options (Options A through D) that meet the needs of a wide range of performance contracts and provide suggested procedures for baseline development and post-retrofit verification. These M&V options are flexible and reflect considerations such as complexity of the measure, potential interaction with other measures, and the level of projected savings versus the cost of the M&V services required by each option. The options are summarized in Table F.0.

Table F.0. Measurement and Verification Options

M&V Option	How Savings Are Calculated	Typical Applications
Option A: Partially Measured Retrofit Isolation		
<p>Savings are determined by partial field measurement of the energy use of the system(s) to which an ECM was applied, separate from the energy use of the rest of the facility. Measurements may be either short-term or continuous of the error they may introduce.</p> <p>Partial measurement means that some but not all parameter(s) may be stipulated, if the total impact of possible stipulation error(s) is not significant to the resultant savings. Careful review of ECM design and installation will ensure that stipulated values fairly represent the probable actual value. Stipulations should be shown in the M&V Plan along with analysis of the significance of the error they may introduce.</p>	<p>Engineering calculations using short term or continuous post-retrofit measurements and stipulations.</p>	<p>Lighting retrofit where power draw is measured periodically. Operating hours of the lights are stipulated.</p>
Option B: Retrofit Isolation		
<p>Savings are determined by field measurement of the energy use of the systems to which the ECM was applied, separate from the energy use of the rest of the facility. Short-term or continuous measurements are taken throughout the post-retrofit period.</p>	<p>Engineering calculations using short term or continuous measurements.</p>	<p>Application of controls to vary the load on a constant speed pump using a variable speed drive. Electricity use is measured by a kWh meter installed on the electrical supply to the pump motor. In the base year this meter is in place for a week to verify constant loading. The meter is in place throughout the post-retrofit period to track variations in energy use.</p>
Option C: Whole Facility (Bill Comparison)		
<p>Savings are determined by measuring energy use at the whole facility level. Short-term or continuous measurements are taken throughout the post-retrofit period.</p>	<p>Analysis of whole facility utility meter or sub-meter data using techniques from simple comparison to regression analysis.</p>	<p>Multifaceted energy management program affecting many systems in a building. Energy use is measured by the gas and electric utility meters for a 12-month base year period and throughout the post-retrofit period.</p>
Option D: Calibrated Simulation (Calibrated Building Modeling)		
<p>Savings are determined through simulation of the energy use of components or the whole facility. Simulation routines must be demonstrated to adequately model actual energy performance measured in the facility. This option usually requires considerable skill in calibrated simulation.</p>	<p>Energy use simulation calibrated with hourly or monthly utility billing data and/or end- use metering.</p>	<p>Multifaceted energy management program affecting many systems in a building but where no base year data are available. Post-retrofit period energy use is measured by the gas and electric utility meters. Base year energy use is determined by simulation using a model calibrated by the post-retrofit period utility data.</p>

Table F.1 summarizes the proposed M&V Plan for this project. A detailed description of the plan for this LED Streetlighting Conversion ECM subsequently follows. The results of the M&V services will be reported to the City of Goodyear (City) annually. All specific protocols in the plans must be explained to and accepted by the City of Goodyear before construction can begin.

Table F.1. Measurement and Verification Summary Matrix

ECM Description	IPMVP Option	M&V Requirements		Measurement and Metering	Stipulated Variables	Performance Period M&V Requirements
		Baseline	Post Retrofit			
ECM 1: LED Streetlighting Conversion	A	Existing fixture energy costs were provided through the baseline streetlighting utility billing and are based on stipulated fixture wattages and hours of operation.	Input power for a statistically significant sample of each retrofitted fixture (new fixture) will be measured at time of commissioning. Sixty-eight (68) fixtures are proposed for the post-installation measurements.	Operating hours from the audit will be used to calculate energy savings during the performance period. Post-installation wattages will be measured after retrofit installation. If measured values fall within 10 percent of the expected values, the retrofit will be deemed to be operating as expected.	Baseline and post-installation power draw will be stipulated for the term of the performance period after the power draw has passed the +/-10 percent measurement check. Operating hours of each usage group are stipulated as shown in the audit.	Ameresco will visually inspect a sample of fixtures to verify the types match those proposed in the audit and are operating as intended.

F.1 UTILITY RATE SUMMARY

Energy savings will be calculated using the applicable billing unit of kWh. Table F.2 summarizes the value of the utility savings that will be used to calculate dollar savings in each year of the M&V period based on the utility escalation factor.

The APS E-59 rate, plus the appropriate taxes, adjustments, and fees, is shown in Table F.2. This rate is then escalated at the annual escalation rate shown in the proforma. Note that these rates provide the basis of the savings calculation.

Table F.2. ECM 1: Streetlighting – APS Rate E-59

Year	Electricity (\$/kWh)
Construction	0.07441
Year 1	0.07656
Year 2	0.07877
Year 3	0.08105
Year 4	0.08339
Year 5	0.08580
Year 6	0.08828
Year 7	0.09083
Year 8	0.09346
Year 9	0.09616
Year 10	0.09894

F.2 MEASUREMENT AND VERIFICATION PLANS

ECM 1: LED STREET LIGHTING CONVERSION

The M&V protocol for ECM 1 – LED Streetlighting Conversion is based on the guidelines of the IPMVP Option A. Option A involves verifying that the measure has the potential to perform and to generate savings. Performance verification techniques include engineering calculations with one-time representative measured values, resulting in measured verification of performance. With the chosen method, hours of operation are agreed upon. Post installation fixture wattages will be determined from one-time post-retrofit spot measurements of representative fixture types.

Ameresco will perform equipment measurements to verify that the performance of the installed equipment will operate at the levels defined within the audit (power input at stated conditions). This will be established by measuring a percentage of fixtures of a defined group. If the lighting systems do not perform as proposed, Ameresco will either change the systems or compensate the City of Goodyear. Table F.3 shows the existing operating hours to be stipulated. The annual hours of operations vary from the information available from the U.S. Naval Observatory (Astronomical Applications Department, Washington D.C., Duration of Darkness for 2015, for Goodyear Arizona), however, 4,050 hours appears to be the hours used by the electric utility (APS).

Table F.3. Typical Operating Hours

Area Description	Total Annual Dark Hours of Operation
Typical Streetlighting	4,050

Table F.4 describes the existing high-pressure sodium (HPS) fixture input watts that are used in the savings calculations.

Table F.4. Existing Fixture Wattages

Description	Nameplate Wattage	HPS Input Wattage
100W HPS	100W	128W
150W HPS	150W	185W
250W HPS	250W	295W
400W HPS	400W	460W
100W Post Top	100W	128W

ENERGY SAVINGS CALCULATION METHODOLOGY

Savings Algorithms

The general savings calculation is defined as:

$$\text{Electricity Savings} = \text{Lighting kWh Savings}$$

Where:

$$\text{Electricity Savings} = \text{Total electric energy savings (kWh)}$$

$$\text{Lighting kWh Savings} = \text{Lighting system electric energy savings (kWh)}$$

Direct Savings

Energy savings for ECM 1 is generated directly by the wattage reduction of the new LED fixtures. The following was used to determine the annual energy savings for each fixture.

$$\text{Lighting kWh Savings} = \text{Base Lighting kWh} - \text{Post Lighting kWh}$$

$$\text{Base Lighting kWh} = \text{Base Light kW} \times \text{Hours}$$

$$\text{Post Lighting kWh} = \text{Post Light kW} \times \text{Hour}$$

$$\text{Lighting kWh Savings} = \text{Lighting system electric energy savings (kWh)}$$

$$\text{Base Lighting kWh} = \text{Base lighting equipment electric energy consumption (kWh)}$$

$$\text{Post Lighting kWh} = \text{Post lighting equipment electric energy consumption (kWh)}$$

SAMPLING PLAN FOR NEW STREETLIGHT FIXTURES

The base year energy consumption, provided in Section C.0 Base Year Utility Usage, is calculated from the fixture quantities and wattages determined as a part of the field audit. The utility billing summary report data provided by the City of Goodyear was used to verify the annual energy and cost baseline. The 12-month base year period used to establish the baseline is from July 2019 to June 2020 and was reviewed as the basis of the audit. Note that wall pack fixtures are not included in the sampling plan since they are 480V and generally on the AZDOT light circuits.

Ameresco will measure the fixture input power based on the Federal Energy Management Plan (FEMP) 80/20 accuracy level. The new fixtures will be measured according to Table F.5. To achieve the 80/20 level, Ameresco will measure 68 fixtures for the new LED fixtures. The electric utility accounts that form the basis of the audit can be found in the appendices.

Table F.5. New Street Fixture Sampling Plan

Fixture Model and Wattage	Type	Wattage	Quantity	Quantity to Measure
ERL1-0-05-B3-30 3000K	LED	39	5,481	28
ERL1-0-08-B3-30 3000K	LED	71	1,858	12
ERLH-0-11-C3-30 3000K	LED	98	1,669	12
ERL2-0-21-C3-30 3000K	LED	174	60	8
EPST-0-E3-30 3000K	LED	48	40	8
Total:			9,108	68

For the proposed retrofit power measurements, the measurement will occur at the time of installation (or immediately thereafter) and, if the total sample values are within +/- 10 percent of the audit values, no change will be made. If the total sample values are not within 10 percent, Ameresco will take corrective action for them to be within this limit or use the measured values.

No long-term term monitoring is included as part of this measure. The annual M&V report will be prepared based on the reconciliation reports performed at the end of construction and Ameresco's inspection. The M&V for this ECM allows for a high level of accuracy in the calculation of savings, while limiting the costs of verification.

G.0 COMMISSIONING PLAN

G.1 PERFORMANCE TESTING AND COMMISSIONING MATRIX

The performance testing and commissioning matrix for this project is provided in Table G.0. Pre-functional and functional reports will be modified during the design and construction phases based on actual system design and installation. Results of pre-functional and functional testing will be included in the Operations and Maintenance (O&M) manuals provided to the City of Goodyear (City) at the completion of the construction phase.

The commissioning process consists of two main steps: pre-functional check and functional testing. The pre-functional check is the verification process before, during and after construction to ensure the streetlights and photocells are installed according to the design intent. This process includes verification of installed equipment according to engineering specifications and submittals, verification of installation work according to manufacturers' specifications, inspections for equipment or installation flaws or inconsistencies, and other related inspection work. Pre-functional checks must be conducted before a full functional testing can be performed. Ameresco's installation subcontractor will be responsible for its own individual checks prior to installing the equipment. Ameresco will be responsible for the project-wide pre-functional checks during and after construction to ensure the system is installed as designed.

The functional test, the second step in the commissioning process, is the process of testing the installed systems to ensure that they operate as designed and can achieve the level of intended performance. In the functional test, operation of each piece of equipment, as well as its operation as part of a system, is verified, including power draw, dimming control (if applicable), etc. The functional test also includes testing system performance under various simulated conditions (e.g., to simulate peak internal fixture temperatures if the test is conducted in the summer). Results of the tests will be recorded, and any discrepancies in comparison to manufacturer's product data will be noted. Necessary modifications will be performed to rectify any performance levels that do not conform to design. Generally, Ameresco will be responsible for conducting and supervising the functional test with approved vendors and subcontractor representatives. Maintenance personnel are also encouraged to be involved in the process, as it will help the City understand any new operation and maintenance responsibilities or procedures.

Table G.0. Performance Testing and Commissioning Matrix

Energy Conservation Measure	Equipment/ Systems to be Performance Tested	Observations, Tests and Inspections During Construction (Pre-Functional)	Pre-Functional Responsibility	Observations, Tests and Inspections prior to Acceptance (Functional)	Functional Responsibility	Testing Documentation
ECM 1: LED Streetlighting Conversion	Lighting fixtures	Visually verify operation of all fixtures as completed.	Lighting Contractor	Measure power input at the switch or fixture for a statistically significant number of fixtures in locations mutually agreed by the City of Goodyear and Ameresco.	Installation Subcontractor and Ameresco	Lighting commissioning data sheets will be completed for the new fixtures that are tested (representative of the full project quantity of fixtures).

H.0 ACCEPTANCE PROCEDURES

Upon completion of the pre-functional testing and prior to the completion of the functional performance testing, Ameresco will submit Certificates of Substantial Completion for this energy conservation measure (ECM) that provide a performance and financial benefit to the City of Goodyear (City). Punch lists will accompany the Certificate of Substantial Completion. All punch list items that could directly affect the potential to generate energy cost savings must be completed prior to functional performance testing. Note that the warranty periods for equipment or systems that are in operation will begin upon execution of the Certificates of Substantial Completion for the ECM.

Functional performance tests will be conducted upon the completion of all punch list items that could potentially affect an ECM's ability to generate energy cost savings. Upon successful completion of these tests, the ECM is deemed to have the potential to achieve the estimated energy cost and maintenance savings. Ameresco will then formally request an inspection of the work completed from the City. A Certificate of Acceptance of Construction Completion and Inspection will accompany the formal inspection request. The Certificate of Acceptance of Construction Completion and Inspection formally acknowledges that the work has been completed, or a portion thereof, and is accepted by the City.

Some portions of the ECM may not be able to be completed at that time due to circumstances beyond Ameresco's control. In these instances, a percentage complete will be assigned to the ECM with a punch list of outstanding items. Because the functional performance test will have been completed prior to requesting the final inspection, these items will not typically have an impact on the savings or the potential to achieve savings. All outstanding punch list items will be completed as soon as possible.

Operations and Maintenance (O&M) manuals will be provided upon completion of all functional performance tests and upon completion of the as-built documentation. All necessary training will be provided as outlined in Section I.0.

Documentation to be provided will include O&M manuals, which (in printed form) will be contained in a sturdy binder printed on 8.5 x 11 sheets of paper and consist of the following sections and information:

- Section I: System Description
 - A detailed description of each system, including its major components and function
 - Procedures for the operation of every system, including all required emergency instructions and safety precautions
- Section II: Equipment Data Sheets
 - Corrected shop drawings, including product description, efficiency ratings, features, and options
 - Manufacturers' O&M manuals

- Manufacturers' spare parts lists
 - Name, address, and telephone number of the manufacturers' local representative(s) for each type of equipment for replacement parts and service
- Section III: Maintenance
 - This section will be modified for each project based on the maintenance requirements of the contract
- Section IV: Test Reports
 - Pre-functional reports: Equipment start-up reports and commissioning data sheets
 - Functional reports: System start-up reports and functional performance tests
 - Other reports, where applicable
- Section V: Warranties and Guarantees
 - A warranty for each system installed typewritten on company letterhead. The warranty will state the system and components covered, the duration of the warranty period, and emergency contact phone numbers for service and repair
 - Warranties or guarantees from subcontractors or equipment suppliers

I.0 TRAINING PLAN

Training and orientation on the systems installed will vary depending on the complexity of the specific equipment installed for each energy conservation measure (ECM). Training will be provided in the following levels:

- **Level 1:** For systems and equipment that are essentially direct replacements of existing equipment and where no additional specific skills will be required to perform operations and maintenance (O&M) functions, training will be limited to a general overview of the equipment installed and a review of the O&M manuals. Training will be directed to the City of Goodyear (City) facilities operations and maintenance personnel. The review of the O&M manuals will provide staff with familiarity of the equipment installed, manufacturer's recommended maintenance procedures and warranty information. Training will be provided at the completion of construction for the ECM.
- **Level 2:** For systems and equipment that are new to the site and require some general understanding as to their functions and operations, training will include a minimal amount of classroom time to provide an overview of the technology and any specific maintenance or operational requirements. Following the classroom training, a site tour will be conducted to view the installation and operation of the equipment. Training should occur at both the onset and completion of construction. Equipment cutsheets will be provided at the beginning of construction that provide a general description of the equipment, function, and operation. At the conclusion of construction, O&M manuals will provide parts lists and warranty information.
- **Level 3:** For systems and equipment that are new to the site and more complex in nature, training will be directed to both the facilities engineering and O&M personnel. In general, training will consist of classroom training followed by hands-on instruction in the field. Training will be provided through a complement of Ameresco personnel, design engineers, installation contractors and manufacturer's representatives, as necessary, and will be dictated by the complexity of the installation, participants' prior experience with the installed equipment, and contractual obligations.

In general, training will consist of the following:

- Explanation of the design concept
 - Design intent
 - Energy efficiency considerations
 - Emergency conditions and operation

- Systems operation
 - Operation of individual components, including instruction from authorized factory technicians, as required
 - Physical location of critical shut-off locations, fuses, and control panels
 - System operational procedures for all manual and automatic modes
- Service and maintenance
 - Use of the O&M manuals
 - Instruction from authorized factory technicians, as required
 - Troubleshooting and investigation of malfunctions
 - Recommended procedures for collecting, interpreting, and storing specific performance data

The types of training planned for this project has been listed in Table I.0. Training will be provided during the construction, commissioning, and acceptance.

Table I.0. Training Plan

Energy Conservation Measure	Training Level	Training (Hours)	
		Classroom	Field
ECM 1: LED Streetlighting Conversion	1	-	1

Training by a manufacturer's representative can be divided between classroom and field, as desired. The level of training will be based on access and clearances (i.e., highest level of training for primary operators, lowest level for field technicians, etc.).

J.0 OPERATIONS, MAINTENANCE AND WARRANTY PLAN

A well-designed and properly executed maintenance program is a crucial element to long-term ECM performance and savings. In order to maximize the energy savings and equipment performance, this ECM should be maintained under an ongoing, structured service program for the life of the contract, and ideally beyond. Ameresco has a vested interest in the equipment performance and maintenance required to realize all possible energy savings, which form the basis of our guarantee.

The primary point of contact for all maintenance, warranty, and monitoring operations will be Mr. Steve Croxton, Ameresco's Regional Energy Manager. Mr. Croxton will serve as the single point of contact for the City of Goodyear (City) throughout the entire operational phase of the project.

J.1 SCHEDULED PREVENTATIVE MAINTENANCE

Please reference Table J.0 for a summary of the operations and maintenance (O&M) plan for this project. A detailed description of the included scope for this ECM is presented in the section that follows.

Table J.0. Operations and Maintenance Matrix

ECM Description	Operations Responsibilities		Maintenance Responsibilities		Warranty
	Ameresco	City of Goodyear	Ameresco	City of Goodyear	
ECM 1: LED Streetlighting Conversion	None	Periodic inspections to verify proper operation.	Corrective warranty parts of LED fixtures for 10 years, as required. Corrective warranty labor for the new LED fixtures for 1 year.	The City of Goodyear will be first responder on all failure calls and notify Ameresco for warranty service and repairs. Preventive maintenance per manufacturer's recommendations at recommended intervals	The LED fixtures are covered by manufacturer-provided warranties for 10 years. The labor to make warranty repairs will be administered by Ameresco for 1 year. For warranty purposes, manufacturers may request the defective product be returned for analysis. Ameresco will retain all LED fixtures which fail prematurely and provide to the manufacturer upon request.

J.2 SERVICE DESCRIPTIONS

- **System Operation:** Ongoing, normal equipment adjustments necessary to satisfy the building occupants and assure the continued effective and efficient operation of equipment and systems.
- **Preventative Maintenance:** Periodic inspections, tests, calibrations, and adjustments needed for sustaining or restoring energy systems to the required level of performance.
- **Corrective Maintenance:** Services needed to replace, rebuild, or restore the level of specified performance of the systems and equipment that are in danger of failing or are otherwise inadequate.
- **Local Maintenance and Support:** The primary point of contact for service support.

J.3 SERVICE COORDINATION

Mr. Steve Croxton will be the point of contact for all warranty and service-related issues following the installation of the ECM. His familiarity with all aspects of the project will afford Mr. Croxton the ability to quickly diagnose system problems and implement any necessary corrective actions.

The scope of services for this ECM included with this performance contract or the program as a whole can be modified or fine-tuned at any time during the contract term. For example, where full coverage is not included, additional services can be provided on a time and materials basis based on pre-negotiated rates. Services can also be provided for equipment not replaced or modified as part of this performance contract.

J.4 WARRANTY SERVICES

The light-emitting diode (LED) luminaire and photocell manufacturers are providing a 10-year material warranty on the products. Ameresco will be providing warranty labor services for the materials for one (1) year only.

The City (or the City's designated streetlight O&M subcontractor) will be responsible for making an initial evaluation when a fixture is reported to be operating improperly from a citizen's report. The City will then contact Ameresco to investigate and repair any situations where there appears to be fixture failure. The City will be responsible for any repairs required that may be due to collisions, wiring infrastructure, lightning strikes, etc.

K.0 APPENDIX

The following reference materials have been included herein:

- K.1 NIST Energy Price Indices and Discount Factors
- K.2 Existing Lighting Equipment Summary
- K.3.0 Utility Account Summary
- K.3.1 Utility Consumption Data
- K.3.2 Electricity Rate Sheets
- K.4 Baseline & Savings Calculations
- K.5.0 New Streetlighting Cut-Sheets
- K.5.1 New Street Fixture Selection Summary

K.1 NIST ENERGY PRICE INDICES AND DISCOUNT FACTORS

Table S-4. Projected fuel price indices with assumed general price inflation rates of 2 %, 3 %, 4 %, and 5 %, by end-use sector and fuel type.

Census Region 4																
Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming																
Projected April 1 Fuel Price Indices (April 2020 = 1.00)																
Residential																
Year	Electricity Inflation Rate				Distillate Oil Inflation Rate				LPG Inflation Rate				Natural Gas Inflation Rate			
	2 %	3 %	4 %	5 %	2 %	3 %	4 %	5 %	2 %	3 %	4 %	5 %	2 %	3 %	4 %	5 %
2021	1.01	1.02	1.03	1.04	1.02	1.03	1.04	1.05	1.03	1.04	1.05	1.06	1.02	1.03	1.04	1.05
2022	1.02	1.04	1.06	1.08	1.07	1.09	1.11	1.13	1.08	1.10	1.12	1.14	1.02	1.04	1.06	1.09
2023	1.05	1.09	1.12	1.15	1.11	1.14	1.17	1.21	1.14	1.17	1.20	1.24	1.03	1.06	1.09	1.12
2024	1.09	1.13	1.18	1.22	1.16	1.20	1.25	1.30	1.20	1.24	1.29	1.34	1.04	1.08	1.12	1.17
2025	1.13	1.19	1.25	1.31	1.20	1.26	1.32	1.39	1.27	1.33	1.40	1.47	1.05	1.11	1.16	1.22
2026	1.18	1.25	1.33	1.41	1.25	1.32	1.40	1.48	1.35	1.43	1.52	1.60	1.09	1.16	1.22	1.30
2027	1.22	1.31	1.40	1.50	1.28	1.37	1.46	1.56	1.42	1.52	1.63	1.74	1.13	1.21	1.29	1.38
2028	1.25	1.35	1.46	1.58	1.32	1.43	1.54	1.66	1.49	1.61	1.74	1.88	1.17	1.26	1.36	1.47
2029	1.28	1.40	1.53	1.67	1.36	1.48	1.62	1.76	1.55	1.69	1.85	2.01	1.20	1.31	1.43	1.55
2030	1.32	1.45	1.60	1.76	1.40	1.54	1.70	1.87	1.64	1.81	1.99	2.19	1.33	1.47	1.62	1.78
2031	1.36	1.51	1.68	1.87	1.44	1.61	1.79	1.99	1.70	1.89	2.10	2.33	1.40	1.56	1.73	1.92
2032	1.39	1.57	1.76	1.97	1.48	1.67	1.87	2.10	1.74	1.96	2.20	2.46	1.43	1.61	1.81	2.03
2033	1.43	1.62	1.84	2.08	1.53	1.74	1.98	2.24	1.80	2.04	2.31	2.62	1.48	1.69	1.91	2.16
2034	1.47	1.68	1.93	2.20	1.58	1.81	2.08	2.37	1.85	2.13	2.43	2.78	1.53	1.75	2.01	2.29
2035	1.50	1.74	2.01	2.32	1.63	1.88	2.18	2.51	1.91	2.22	2.56	2.96	1.57	1.81	2.10	2.42
2036	1.53	1.79	2.09	2.44	1.68	1.96	2.29	2.67	1.98	2.31	2.70	3.15	1.60	1.87	2.19	2.55
2037	1.56	1.85	2.18	2.56	1.72	2.03	2.39	2.82	2.05	2.42	2.85	3.35	1.64	1.94	2.28	2.69
2038	1.60	1.90	2.27	2.69	1.77	2.11	2.51	2.98	2.12	2.52	3.00	3.57	1.68	2.00	2.39	2.83
2039	1.63	1.96	2.35	2.82	1.82	2.19	2.63	3.16	2.19	2.64	3.17	3.80	1.72	2.07	2.49	2.99
2040	1.66	2.02	2.45	2.96	1.87	2.27	2.75	3.33	2.26	2.75	3.34	4.04	1.76	2.14	2.60	3.14
2041	1.69	2.08	2.55	3.11	1.92	2.35	2.88	3.52	2.34	2.87	3.51	4.29	1.80	2.21	2.70	3.31
2042	1.73	2.15	2.65	3.28	1.98	2.45	3.03	3.74	2.41	2.99	3.70	4.57	1.84	2.28	2.82	3.48
2043	1.77	2.21	2.76	3.44	2.03	2.55	3.18	3.96	2.50	3.12	3.90	4.86	1.88	2.35	2.94	3.66
2044	1.80	2.28	2.87	3.62	2.09	2.64	3.33	4.19	2.58	3.26	4.11	5.17	1.93	2.43	3.07	3.86
2045	1.84	2.35	2.99	3.80	2.16	2.76	3.51	4.46	2.66	3.40	4.33	5.50	1.97	2.51	3.20	4.07
2046	1.88	2.43	3.12	4.00	2.22	2.86	3.67	4.71	2.75	3.54	4.55	5.84	2.02	2.60	3.34	4.29
2047	1.92	2.50	3.25	4.21	2.29	2.97	3.86	5.00	2.84	3.70	4.80	6.21	2.07	2.69	3.50	4.53
2048	1.96	2.58	3.38	4.41	2.36	3.10	4.06	5.31	2.94	3.86	5.06	6.61	2.12	2.79	3.65	4.78
2049	2.00	2.65	3.51	4.64	2.43	3.22	4.26	5.63	3.03	4.03	5.33	7.03	2.17	2.88	3.82	5.04
2050	2.04	2.73	3.65	4.86	2.49	3.34	4.46	5.94	3.13	4.20	5.61	7.47	2.23	2.99	3.99	5.32

K.2 EXISTING LIGHTING EQUIPMENT SUMMARY

Table K.2.0. Existing Lighting Summary: Streetlighting (from audit)

Model	Type	Wattage	Count
Cobrahead/Shoebox	HPS	100	5,481
Cobrahead/Shoebox	HPS	150	1,754
Cobrahead/Shoebox	HPS	250	2,066
Cobrahead/Shoebox	HPS	400	89
Decorative Pendant / Acorn / Post Top	HPS		715
Private/Pedestrian			1,789
Existing LED			346
Intersection	LED		255
Total:			12,547

K.3.0 UTILITY ACCOUNT SUMMARY

CITY OF GOODYEAR STREET LIGHT RATE ANALYSIS

Account Number: 5839730000 2019-2020

APS RATE CODE: E-59

\$ 0.07441 = Average Power Cost WITHOUT Light Charges

2020 Energy Charge (\$/kWh) = \$ 0.06563

Year Month kWh	2019 July	2019 August	2019 September	2019 October	2019 November	2019 December	2020 January	2020 February	2020 March	2020 April	2020 May	2020 June
	557,088	557,088	557,088	557,088	557,549	558,242	558,051	560,654	560,654	561,269	561,979	562,685
Energy Charge	\$ 36,561.69	\$ 36,561.69	\$ 36,561.69	\$ 36,561.69	\$ 36,591.94	\$ 36,637.43	\$ 36,624.89	\$ 36,795.72	\$ 36,795.72	\$ 36,836.09	\$ 36,882.69	\$ 36,929.02
Environmental Benefits Surcharge	\$ 658.68	\$ 658.68	\$ 658.68	\$ 658.68	\$ 632.37	\$ 633.05	\$ 632.87	\$ 635.42	\$ 635.42	\$ 636.03	\$ 636.72	\$ 637.42
Fed. Environmental Improvement Surcharge	\$ 140.94	\$ 140.94	\$ 140.94	\$ 140.94	\$ 141.06	\$ 141.24	\$ 141.19	\$ 141.85	\$ 141.85	\$ 142.00	\$ 184.89	\$ 185.12
Power Supply Adjustment	\$ 923.65	\$ 923.65	\$ 923.65	\$ 923.65	\$ 924.42	\$ 925.57	\$ 925.25	\$ (255.65)	\$ (255.65)	\$ (255.94)	\$ (256.26)	\$ (256.58)
Federal Trans. Cost Adjustment	\$ 255.70	\$ 255.70	\$ 255.70	\$ 255.70	\$ 255.92	\$ 256.23	\$ 256.15	\$ 257.34	\$ 257.34	\$ 257.62	\$ 257.95	\$ 177.81
Demand Side Mgmt. Adjustor Refund	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ (9,160.51)
Four-Corners Adjustment	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Tax Expense Adjustor	\$ (4,034.43)	\$ (4,034.43)	\$ (4,034.43)	\$ (4,034.43)	\$ (4,037.77)	\$ (4,695.37)	\$ (4,693.77)	\$ (4,715.65)	\$ (4,715.65)	\$ (4,720.83)	\$ (3,013.89)	\$ (3,017.68)
Light Unit Charges	\$ 27,729.00	\$ 27,729.00	\$ 27,729.00	\$ 27,729.00	\$ 27,774.00	\$ 27,795.00	\$ 27,789.21	\$ 28,061.19	\$ 28,061.19	\$ 28,140.00	\$ 28,248.00	\$ 28,338.00
Cost of Electricity Delivered =	\$ 62,235.23	\$ 62,235.23	\$ 62,235.23	\$ 62,235.23	\$ 62,281.94	\$ 61,693.15	\$ 61,675.79	\$ 60,920.22	\$ 60,920.22	\$ 61,034.97	\$ 62,940.10	\$ 53,832.60
Regulatory Assessment	\$ 98.46	\$ 126.46	\$ 126.46	\$ 126.46	\$ 126.56	\$ 125.36	\$ 125.33	\$ 123.79	\$ 123.79	\$ 124.02	\$ 127.89	\$ 109.39
State Sales Tax	\$ 3,560.50	\$ 3,562.10	\$ 3,562.10	\$ 3,562.10	\$ 3,564.77	\$ 3,531.07	\$ 3,530.08	\$ 3,486.83	\$ 3,486.83	\$ 3,493.40	\$ 3,602.44	\$ 3,081.17
County Sales Tax	\$ 445.06	\$ 445.26	\$ 445.26	\$ 445.26	\$ 445.60	\$ 441.35	\$ 441.26	\$ 435.85	\$ 435.85	\$ 436.68	\$ 450.31	\$ 385.15
City Sales Tax	\$ 1,589.51	\$ 1,590.22	\$ 1,590.22	\$ 1,590.22	\$ 1,591.42	\$ 1,576.38	\$ 1,575.93	\$ 1,556.62	\$ 1,556.62	\$ 1,559.55	\$ 1,608.23	\$ 1,375.52
Franchise Fee	\$ 1,246.67	\$ 1,247.23	\$ 1,247.23	\$ 1,247.23	\$ 1,248.17	\$ 1,236.37	\$ 1,236.02	\$ 1,220.88	\$ 1,220.88	\$ 1,223.18	\$ 1,261.36	\$ 1,078.84
Total Charges =	\$ 69,175.43	\$ 69,206.50	\$ 69,206.50	\$ 69,206.50	\$ 69,258.46	\$ 68,603.69	\$ 68,584.41	\$ 67,744.19	\$ 67,744.19	\$ 67,871.80	\$ 69,990.33	\$ 59,862.67
Total Cost per kWh =	\$ 0.1242	\$ 0.1242	\$ 0.1242	\$ 0.1242	\$ 0.1242	\$ 0.1229	\$ 0.1229	\$ 0.1208	\$ 0.1208	\$ 0.1209	\$ 0.1245	\$ 0.1064
Total Charges WITHOUT Light Unit Charges =	\$ 38,540.66	\$ 38,540.66	\$ 38,540.66	\$ 38,540.66	\$ 38,545.71	\$ 38,593.52	\$ 38,580.35	\$ 37,574.68	\$ 37,574.68	\$ 37,615.80	\$ 37,705.99	\$ 28,512.28
Est. Total of Assessment & Taxes (w/o Light Unit Charges) =	\$ 4,297.89	\$ 4,317.13	\$ 4,317.13	\$ 4,317.13	\$ 4,317.70	\$ 4,323.04	\$ 4,321.58	\$ 4,208.92	\$ 4,208.92	\$ 4,213.53	\$ 4,223.63	\$ 3,193.81
Estimated Total Charges WITHOUT Light Unit Charges =	\$ 42,838.54	\$ 42,857.78	\$ 42,857.78	\$ 42,857.78	\$ 42,863.42	\$ 42,916.56	\$ 42,901.93	\$ 41,783.60	\$ 41,783.60	\$ 41,829.33	\$ 41,929.62	\$ 31,706.09
Est. Energy Cost WITHOUT Light Unit Charges (\$/kWh) =	\$ 0.0769	\$ 0.0769	\$ 0.0769	\$ 0.0769	\$ 0.0769	\$ 0.0769	\$ 0.0769	\$ 0.0745	\$ 0.0745	\$ 0.0745	\$ 0.0746	\$ 0.0563

K.3.1 UTILITY CONSUMPTION DATA

ESTIMATED STREET LIGHT UNIT CHARGES					Estimated Operating Hours per SL Fixture		
Cost per Light = \$ 3.00					Monthly Hrs.	Annual Hrs.	Calc. Hours of Darkness
HPS Fixture Categories (from APS Bill)					337.50	4,050.0	4304.0
	Quantity	Cost	Watts	Calc. kWh			
16,000 HPS Arch.	1398	\$ 4,194.00	185	87,288			
16,000 HPS Cobrahead	433	\$ 1,299.00	185	27,035	1883	1,410,838	150W
16,000 Decorative Trans.	52	\$ 156.00	185	3,247			
30,000 HPS Arch.	1403	\$ 4,209.00	295	139,686	(Removed 10 fixtures to equalize with total billing)		
30,000 HPS Cobrahead	575	\$ 1,725.00	295	57,248	1993	2,381,137	250W
36,000 MH Arch.	2	\$ 6.00	295	199			
50,000 HPS Arch	57	\$ 171.00	460	8,849			
50,000 HPS Cobrahead	41	\$ 123.00	460	6,365	57	106,191	400W
8,000 FI Post Top Colonial	2	\$ 6.00	128	86			
9,500 HPS Acom	4	\$ 12.00	128	173			
9,500 HPS Arch.	3138	\$ 9,414.00	128	135,562	5175	2,682,720	100W
9,500 HPS Cobrahead	2018	\$ 6,054.00	128	87,178			
9,500 HPS Post Top	13	\$ 39.00	128	562	9,108	6,580,886	TOTAL ANNUAL KWH
30,000 Decorative Transit	13	\$ 39.00	295	1,294			
TOTAL =	9149	\$ 27,447.00		554,772	kWh (using June 2020 as an example)		

K.3.2 ELECTRICITY RATE SHEETS



**RATE SCHEDULE E-59
CLASSIFIED SERVICE
GOVERNMENT OWNED STREET LIGHTING SYSTEMS**

AVAILABILITY

This rate schedule is available for government owned outdoor lighting.

DESCRIPTION

This rate schedule is applicable for continuous lighting or dusk to dawn lighting of government owned street lighting systems.

The Customer will own, operate, and maintain the street lighting system including lamps and glass replacements but excluding distribution facilities installed by the Company to serve the lighting system.

TIME PERIOD

- Dusk: The time between sunset and full night when a photocontrol senses the lack of sufficient sunlight and turns on the lights.
- Dawn: The time between full night and sunrise when a photocontrol senses sufficient sunlight to turn off lights.

CHARGES

The monthly bill will consist of the following charges, plus adjustments:

Basic Service Charge	\$3.00	per installed lamp
Energy Charge	\$0.06563	per kWh

TRIP CHARGE

A \$100.00 trip charge per light will be charged when a Customer requests a disconnect or reconnect of service in order to accommodate the maintenance activities of the Customer or its designee(s) on their street lighting equipment.

ADJUSTMENTS

The bill will include the following adjustments:

1. The Renewable Energy Adjustment Charge, Adjustment Schedule REAC-1.
2. The Power Supply Adjustment charges, Adjustment Schedule PSA-1.
3. The Transmission Cost Adjustment charge, Adjustment Schedule TCA-1.
4. The Environmental Improvement Surcharge, Adjustment Schedule EIS.

ARIZONA PUBLIC SERVICE COMPANY
Phoenix, Arizona
Filed by: Charles A. Miessner
Title: Manager, Regulation and Pricing
Original Effective Date: November 18, 1997

A.C.C. No. 5939
Canceling A.C.C. No. 5845
Rate Schedule E-59
Revision No. 11
Effective: August 19, 2017



**RATE SCHEDULE E-59
CLASSIFIED SERVICE
GOVERNMENT OWNED STREET LIGHTING SYSTEMS**

5. The Demand Side Management Adjustment charge, Adjustment Schedule DSMAC-1.
6. The Lost Fixed Cost Recovery Adjustment charge, Adjustment Schedule LFCR.
7. The Tax Expense Adjustor Mechanism charge, Adjustment Schedule TEAM.
8. Direct Access Customers returning to Standard Offer service may be subject to a Returning Customer Direct Access Charge, Adjustment Schedule RCDAC-1.
9. Any applicable taxes and governmental fees that are assessed on APS's revenues, prices, sales volume, or generation volume.

SERVICE DETAILS

1. Billed energy is based upon the summation of the contracted energy rating of installed facilities specified in the street lighting contract.
2. The Customer's bill will not be reduced due to lamp, photocontrol, cable repair or cable replacement outages.
3. At the request of the Customer, Company will extend its standard street lighting system up to a distance of 300 feet for each additional lighting installation without cost. When the extension is underground the customer will provide earthwork as specified in the Company's Service Schedule 3, Conditions Governing Extensions of Electric Distribution Lines and Services; or, at the applicant's request, the Company will provide such earthwork and the applicant will be required to pay a non-refundable contribution in aid of construction equal to the cost of such earthwork. Any additional extension required (over and above the first 300 feet) will be provided by Company for a contribution in aid of construction equal to the cost of the additional extension.
 - a. Extensions to isolated areas requiring a substantial extension of the electric distribution system, as opposed to an extension of the street lighting system, will require a special study to determine the terms and conditions under which the Company will undertake such an extension.
4. APS provides electric service under the Company's Service Schedules. These schedules provide details about how the Company serves its Customers, and they have provisions and charges that may affect the Customer's bill. In addition, service may be subject to special terms and conditions as provided for in a Customer contract or service agreement.

CONTRACT PERIOD

The contract period for service under this rate schedule will be a fixed period of not less than 1 year and not more than 20 years, as agreed to by the Customer and as specified in the street lighting contract.

ARIZONA PUBLIC SERVICE COMPANY
Phoenix, Arizona
Filed by: Charles A. Miessner
Title: Manager, Regulation and Pricing
Original Effective Date: November 18, 1997

A.C.C. No. 5939
Canceling A.C.C. No. 5845
Rate Schedule E-59
Revision No. 11
Effective: August 19, 2017

K.4 BASELINE & SAVINGS CALCULATIONS

GOODYEAR STREET LIGHTING

Street Light Inventory & Baseline Energy Use

GE FIXTURES

Project No.: 73668
Calc. By: Scanlon
Revision: A1
Date: 6/23/2020

Hours of Darkness (Goodyear, AZ)

Summer Night =	1954	(Note 3)
Winter Night =	2350	(Note 3)
Daylight =	4456	
Total =	8760	

Fixture Summary

(12,547 Total Fixtures in City)

Watts	Count	Description	Baseline kW
100	2192	Private Fixtures (Out of Scope)	
150	138	Intersection (Out of Scope)	
100	715	Decorative Acorn & Pendant (Out of Scope)	
Varies	394	Existing LED (Out of Scope)	
3439	3439	SUBTOTAL (Out of Scope or Undercounted in APS Billing)	
APS Fixture Totals (From Billing) - Used for Baseline Energy Calculation			
128	5481	100W HPS + Post Top Colonial	701.57
128	40	100W Post Top	5.12
185	1858	150W HPS	343.73
295	1669	250W HPS	492.36
460	60	400W HPS + Metal Halide	27.60
Total HPS Fixtures =			9108
			(Note 1) 1,570.373 kW
			Annual Operating Hours (Note 2) = 4050.0
HPS Lighting Baseline Energy Usage =			6,360,011 kWh
2019-2020 Total HPS Fixture kWh (from billing) =			6,580,886 kWh
			96.64%

Fixture Summary and Hours of Darkness Notes:

- 1) The BASELINE kWh is based on the number of fixtures shown in the APS Billing Statements.
- 2) The hours used for billing the BASELINE ENERGY USAGE are determined on the Rate Analysis Worksheet, and are approx. 6% lower than the calculated hours of darkness for the City of Goodyear.
- 3) See Rate Analysis Worksheet for adjustment to the Hours of Darkness Calculation.

SUMMARY OF RESULTS

TOTAL Baseline Energy Usage =	6,360,011 kWh
Total Energy Savings =	4,522,509 kWh
Estimated Savings =	71.11%
Estimated Savings =	\$ 336,499

Utility Rates

APS E-59 Street Lighting Rate =	\$ 0.06563 \$/kWh
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Effective Energy Rate =	\$ 0.07441 \$/kWh
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(See Rate Analysis Sheet)

Energy Reduction Estimate - GE FIXTURES

HPS Input Watts	LED Input Watts	Count	Delta kW
128	39	5190	461.91
128	71	31	1.767
128	48	40	3.200
185	39	291	42.486
185	71	1388	158.232
295	71	439	98.336
295	98	1627	320.519
295	174	13	1.573
460	98	42	15.204
460	174	47	13.442
Subtotal =			9,108 1,116.669 kW
Annual Operating Hours =			4050.0
Estimated Energy Savings =			4,522,509 kWh
Estimated Savings (\$)			\$ 336,499

K.5.0 NEW STREETLIGHTING CUT-SHEETS



GE Evolve™

LED Roadway Lighting

ERL1-ERLH-ERL2



current
powered by GE



GE Evolve™ LED Roadway Lighting ERL1-ERLH-ERL2



The **Evolve** LED Roadway Luminaire is optimized for customers requiring a LED solution for local, collector and major roadways. GE's unique reflective optics are designed to optimize application efficiency and minimize glare. The modern design incorporates the heat sink directly into the unit for heat transfer to prolong LED life. This reliable unit has a 100,000 hour design life, significantly reducing maintenance needs and expense over the life of the fixture. This efficient solution lowers energy consumption compared to a traditional HID fixture for additional operating cost savings.

Features:

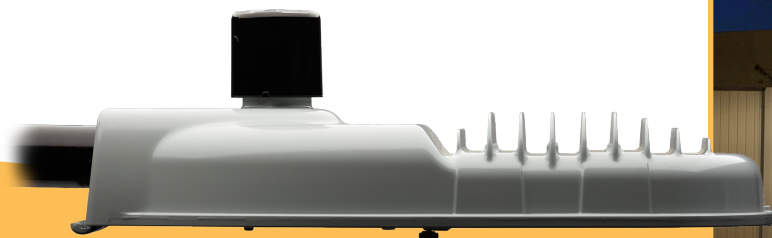
- Optimized roadway photometric distributions
- **Evolve**™ light engine consisting of reflective technology designed to optimize application efficiency and minimize glare
- 70 CRI at 2700K, 3000K and 4000K typical.
- -40°C to 50°C UL Ambient Typical.
- ULOR = 0 (zero uplight)
- Designed & Assembled in USA

Applications:

- Local Roadways
- Collector Roadways
- Major Roadway/Streets



Compatible with **LightGrid**™ Outdoor Wireless Control System



To learn more about **GE Evolve LED Roadway Lighting**, go to: www.currentbyge.com





Project name _____
Date _____
Type _____

Typical Specifications: ERL1-ERLH-ERL2

LED & Optical

- **Output Range:** 1900 – 30000 lm
- **Photometric Options:** Type II Narrow, Type II Wide, Type III, Type IV
- **System Efficacy:** 100 - 145 LPW
- **CCT:** 2700K, 3000K, 4000K; High brightness LEDs @ 70 CRI

Lumen Maintenance Tables

Projected Lxx per IES TM-21 at 25°C for reference:

ERL1 LUMEN OUTPUT CODES	LXX(10K)@HOURS		
	25,000 HR	50,000 HR	100,000 HR
02,03,04,05,06	L96	L95	L91
07,08,09	L95	L91	L84
10	L89	L80	L64

ERLH LUMEN OUTPUT CODES	LXX(10K)@HOURS		
	25,000 HR	50,000 HR	100,000 HR
10, 11	L97	L96	L94
13, 14	L95	L93	L88
15, 16	L94	L91	L85

ERL2 LUMEN OUTPUT CODES	LXX(10K)@HOURS		
	25,000 HR	50,000 HR	100,000 HR
16, 18, 19, 21, 23	L96	L94	L91
25, 27, 28	L95	L93	L88
30	L95	L93	L87

Note: Projected Lxx based on LM80 (10,000 hour testing). DOE Lighting Facts Verification Testing Tolerances apply to initial luminous flux and lumen maintenance measurements.

Electrical

- **Input Voltage:** 120-277 volt and 347-480 volt
- **Input Frequency:** 50/60Hz
- **Power Factor (PF)*:** >90%
- **Total Harmonic Distortion (THD)*:** <20%

*Power factor and THD tolerance exceptions: ERL1 "02" Lumen output: PF and THD within tolerances above only at 120 volt. ERL1 "03" Lumen output: @120 volt PF~0.89; @ 480 volt THD~26% ERL1 "04" Lumen output: @480 volt THD~22%

Ratings

- **Surge Protection:** per ANSI C136.2-2015: (Driver Internal):
 - 6kV/3kA "Basic: (120 Strikes)" - Standard on ERL1 (02-06)
 - 10kV/5kA "Enhanced: (40 Strikes)" - Standard on ERL1 (07 - 10), ERLH, ERL2
- **(Additional Separate Secondary SPD)**
 - 10kV/5kA "Enhanced: (40 Strikes)" - Option "R"
 - 20kV/10kA "Elevated" (40 Strikes) - Option "T"
- **Safety:** UL/cUL Listed. UL 1598 listed, suitable for wet locations (UL) (cUL)
- **Environmental:** Compliant with the materials restrictions of RoHS
- **EMI:** Title 47 CFR Part 15 Class A
- **Vibration:** 3G per ANSI C136.31-2010
- LM-79 testing in accordance with IESNA Standards
- Std. Optical enclosure rated per ANSI C136.25-2009:
 - ERL1/ERLH/ERL2 = IP65, Optional: IP66

Operating Temperature:

PRODUCT ID	LUMEN OUTPUT	AMBIENT READING
ERL1	02-10	-40°C to 50°C
ERLH	10-11	-40°C to 50°C
ERLH	13-16	-40°C to 45°C
ERL2	16-28	-40°C to 50°C
ERL2	30	-40°C to 45°C

Delayed start may be experienced < -35°C

Construction & Finish

- **Housing:**
 - Die Cast Enclosure
 - Casting-integral heat sink for maximum heat transfer
- **Lensing:** Impact resistant tempered glass, standard
- **Paint:** Corrosion resistant polyester powder painted, minimum 2.0 mil. thickness.
 - Standard Colors: Dark Bronze, Black, & Gray
 - RAL & custom colors available
 - Optional coastal finish available.
- **Weight:** 12.4lbs (5.6kg) – 24lbs (10.9kg)

Warranty

- **System Warranty:** 5 Year Standard, 10 Year Optional

Controls

- **Dimming:**
 - Standard: 0-10V; Optional: DALI (120-277V Only)
- **Sensors:**
 - Photo electric sensors (PE) available.
- LightGrid™ compatible

Mounting

- Slipfitter with +/- 5 degree of adjustment for leveling.
- Integral die cast mounting pipe stop.
- Adjustable for 1.25 in. or 2 in. mounting pipe.

Suggested HID Replacement Lumen Levels

- ~4,000–5,000 lumens to replace 100W HPS Cobra-head
- ~7,000–8,800 lumens to replace 150W HPS Cobra-head
- ~8,500–11,500 lumens to replace 200W HPS Cobra-head
- ~11,500–14,000 lumens to replace 250W HPS Cobra-head
- ~21,000–30,000 lumens to replace 400W HPS Cobra-head

Note: Actual replacement lumens may vary based upon mounting height, pole spacing, design criteria, etc.

PREVIOUS	DESCRIPTION	CURRENT	DESCRIPTION
A1, B1	Extra Narrow/Narrow Asymmetric	A3	Type II Narrow
C1, E1	Asymmetric Short/Medium	B3	Type II Wide
D1, G1	Asymmetric Forward/Extra Wide	C3	Type III
F1	Asymmetric Wide	D3	Type IV
		E3	Type II Enhanced Back Light

**The information above is designed to provide a guideline to select the correct luminaire for a roadway application. The best and most accurate way to ensure the proper design is do a lighting layout Utilizing AGI.

GE Evolve™

LED Roadway Lighting

ERL1-ERLH-ERL2



Project name _____
Date _____
Type _____

ERL 1

PROD. ID	VOLTAGE	LUMEN OUTPUT	DISTRIBUTION*	CCT	CONTROLS	COLOR	OPTIONS
E = Evolve R = Roadway L = Local 1 = Single Module	0 = 120-277V* 1 = 120 2 = 208 3 = 240 4 = 277 5 = 480 D = 347 H = 347-480* * Not available with Fusing. Must choose a discrete voltage with F option.	02* 03< 04< 05< 06 07 08 09 10 See Table *120V only, not compatible with 0-10V dimming. < See Note Under Controls Column	A3 = Type II Narrow B3 = Type II Wide C3 = Type III D3 = Type IV E3 = Type II Enhanced Back Light See Table *Nominal IES Type classing subject to typical variation, individual units may differ.	27 = 2700K 30 = 3000K 40 = 4000K < Select 2700K or 3000K CCT for IDA approved units.	A = ANSI C136.41 7-pin D = ANSI C136.41 7-pin with Shorting Cap E = ANSI C136.41 7-pin with non-Dimming PE Control.* *PE Control Only available for 120-277V or 480V Discrete. Not available for 347-480V or 347V Discrete. < If dimming the 03 - 05 lumen output using a control supplied from a source other than GE call 1-888-694-3533, then select Option 2 at the prompt for assistance. NOTE: Dimming controls wired for 0-10V standard unless DALI option "U" requested.	GRAY = Gray BLCK = Black DKBZ = Dark Bronze	A = 4 Bolt Slipfitter † F = Fusing G = Internal Bubble Level I = IP66 Optical L = Tool-Less Entry R = Secondary 10kV/5kA SPD U = DALI Programmable +^ X = Single Package # Y = Coastal Finish * XXX = Special Options † Contact manufacturer for Lead-Time. # "X" option provides single pack box per fixture. Std Packaging = 20 units per Magna pak container. * Recommended for installations within 750 ft. from the coast. Contact Factory for Lead-Time. ^ Compatible with LightGrid 2.0 nodes. + Not available in 347V, 480V or 347-480V for Lumen Output Levels 07, 08, 09, and 10.

LUMEN OUTPUT	DISTRIBUTION	TYPICAL INITIAL LUMENS			TYPICAL SYSTEM WATTAGE		BUG RATING			IES FILE NUMBER					
		4000K	3000K	2700K	120-277V	347-480V	4000K	3000K	2700K	120-277V	347-480V	120-277V	347-480V	120-277V	347-480V
02	A3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_02A340 -120VIES	N/A	ERL1_02A330 -120VIES	N/A	ERL1_02A327 -120VIES	N/A
	B3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_02B340 -120VIES	N/A	ERL1_02B330 -120VIES	N/A	ERL1_02B327 -120VIES	N/A
	C3	2000	1900	1900	14	N/A	B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_02C340 -120VIES	N/A	ERL1_02C330 -120VIES	N/A	ERL1_02C327 -120VIES	N/A
	D3						B0-U0-G1	B0-U0-G1	B0-U0-G1	ERL1_02D340 -120VIES	N/A	ERL1_02D330 -120VIES	N/A	ERL1_02D327 -120VIES	N/A
	E3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_02E340 -120VIES	N/A	ERL1_02E330 -120VIES	N/A	ERL1_02E327 -120VIES	N/A
03	A3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_03A340 -120-277VIES	ERL1_03A340 -347-480VIES	ERL1_03A330 -120-277VIES	ERL1_03A330 -347-480VIES	ERL1_03A327 -120-277VIES	ERL1_03A327 -347-480VIES
	B3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_03B340 -120-277VIES	ERL1_03B340 -347-480VIES	ERL1_03B330 -120-277VIES	ERL1_03B330 -347-480VIES	ERL1_03B327 -120-277VIES	ERL1_03B327 -347-480VIES
	C3	3000	2900	2800	22	26	B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_03C340 -120-277VIES	ERL1_03C340 -347-480VIES	ERL1_03C330 -120-277VIES	ERL1_03C330 -347-480VIES	ERL1_03C327 -120-277VIES	ERL1_03C327 -347-480VIES
	D3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_03D340 -120-277VIES	ERL1_03D340 -347-480VIES	ERL1_03D330 -120-277VIES	ERL1_03D330 -347-480VIES	ERL1_03D327 -120-277VIES	ERL1_03D327 -347-480VIES
	E3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_03E340 -120-277VIES	ERL1_03E340 -347-480VIES	ERL1_03E330 -120-277VIES	ERL1_03E330 -347-480VIES	ERL1_03E327 -120-277VIES	ERL1_03E327 -347-480VIES
04	A3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_04A340 -120-277VIES	ERL1_04A340 -347-480VIES	ERL1_04A330 -120-277VIES	ERL1_04A330 -347-480VIES	ERL1_04A327 -120-277VIES	ERL1_04A327 -347-480VIES
	B3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_04B340 -120-277VIES	ERL1_04B340 -347-480VIES	ERL1_04B330 -120-277VIES	ERL1_04B330 -347-480VIES	ERL1_04B327 -120-277VIES	ERL1_04B327 -347-480VIES
	C3	4000	3900	3800	31	34	B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_04C340 -120-277VIES	ERL1_04C340 -347-480VIES	ERL1_04C330 -120-277VIES	ERL1_04C330 -347-480VIES	ERL1_04C327 -120-277VIES	ERL1_04C327 -347-480VIES
	D3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_04D340 -120-277VIES	ERL1_04D340 -347-480VIES	ERL1_04D330 -120-277VIES	ERL1_04D330 -347-480VIES	ERL1_04D327 -120-277VIES	ERL1_04D327 -347-480VIES
	E3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_04E340 -120-277VIES	ERL1_04E340 -347-480VIES	ERL1_04E330 -120-277VIES	ERL1_04E330 -347-480VIES	ERL1_04E327 -120-277VIES	ERL1_04E327 -347-480VIES
05	A3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_05A340 -120-277VIES	ERL1_05A340 -347-480VIES	ERL1_05A330 -120-277VIES	ERL1_05A330 -347-480VIES	ERL1_05A327 -120-277VIES	ERL1_05A327 -347-480VIES
	B3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_05B340 -120-277VIES	ERL1_05B340 -347-480VIES	ERL1_05B330 -120-277VIES	ERL1_05B330 -347-480VIES	ERL1_05B327 -120-277VIES	ERL1_05B327 -347-480VIES
	C3	5000	4900	4700	39	43	B1-U0-G2	B1-U0-G2	B1-U0-G2	ERL1_05C340 -120-277VIES	ERL1_05C340 -347-480VIES	ERL1_05C330 -120-277VIES	ERL1_05C330 -347-480VIES	ERL1_05C327 -120-277VIES	ERL1_05C327 -347-480VIES
	D3						B1-U0-G1	B1-U0-G1	B1-U0-G1	ERL1_05D340 -120-277VIES	ERL1_05D340 -347-480VIES	ERL1_05D330 -120-277VIES	ERL1_05D330 -347-480VIES	ERL1_05D327 -120-277VIES	ERL1_05D327 -347-480VIES
	E3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_05E340 -120-277VIES	ERL1_05E340 -347-480VIES	ERL1_05E330 -120-277VIES	ERL1_05E330 -347-480VIES	ERL1_05E327 -120-277VIES	ERL1_05E327 -347-480VIES
06	A3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_06A340 -120-277VIES	ERL1_06A340 -347-480VIES	ERL1_06A330 -120-277VIES	ERL1_06A330 -347-480VIES	ERL1_06A327 -120-277VIES	ERL1_06A327 -347-480VIES
	B3						B1-U0-G2	B1-U0-G2	B1-U0-G2	ERL1_06B340 -120-277VIES	ERL1_06B340 -347-480VIES	ERL1_06B330 -120-277VIES	ERL1_06B330 -347-480VIES	ERL1_06B327 -120-277VIES	ERL1_06B327 -347-480VIES
	C3	6000	5800	5700	47	52	B1-U0-G2	B1-U0-G2	B1-U0-G2	ERL1_06C340 -120-277VIES	ERL1_06C340 -347-480VIES	ERL1_06C330 -120-277VIES	ERL1_06C330 -347-480VIES	ERL1_06C327 -120-277VIES	ERL1_06C327 -347-480VIES
	D3						B1-U0-G2	B1-U0-G2	B1-U0-G2	ERL1_06D340 -120-277VIES	ERL1_06D340 -347-480VIES	ERL1_06D330 -120-277VIES	ERL1_06D330 -347-480VIES	ERL1_06D327 -120-277VIES	ERL1_06D327 -347-480VIES
	E3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_06E340 -120-277VIES	ERL1_06E340 -347-480VIES	ERL1_06E330 -120-277VIES	ERL1_06E330 -347-480VIES	ERL1_06E327 -120-277VIES	ERL1_06E327 -347-480VIES
07	A3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_07A340 -120-277VIES	ERL1_07A340 -347-480VIES	ERL1_07A330 -120-277VIES	ERL1_07A330 -347-480VIES	ERL1_07A327 -120-277VIES	ERL1_07A327 -347-480VIES
	B3						B1-U0-G2	B1-U0-G2	B1-U0-G2	ERL1_07B340 -120-277VIES	ERL1_07B340 -347-480VIES	ERL1_07B330 -120-277VIES	ERL1_07B330 -347-480VIES	ERL1_07B327 -120-277VIES	ERL1_07B327 -347-480VIES
	C3	7000	6800	6600		58	B1-U0-G2	B1-U0-G2	B1-U0-G2	ERL1_07C340 -120-277VIES	ERL1_07C340 -347-480VIES	ERL1_07C330 -120-277VIES	ERL1_07C330 -347-480VIES	ERL1_07C327 -120-277VIES	ERL1_07C327 -347-480VIES
	D3						B1-U0-G2	B1-U0-G2	B1-U0-G2	ERL1_07D340 -120-277VIES	ERL1_07D340 -347-480VIES	ERL1_07D330 -120-277VIES	ERL1_07D330 -347-480VIES	ERL1_07D327 -120-277VIES	ERL1_07D327 -347-480VIES
	E3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_07E340 -120-277VIES	ERL1_07E340 -347-480VIES	ERL1_07E330 -120-277VIES	ERL1_07E330 -347-480VIES	ERL1_07E327 -120-277VIES	ERL1_07E327 -347-480VIES
08	A3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_08A340 -120-277VIES	ERL1_08A340 -347-480VIES	ERL1_08A330 -120-277VIES	ERL1_08A330 -347-480VIES	ERL1_08A327 -120-277VIES	ERL1_08A327 -347-480VIES
	B3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_08B340 -120-277VIES	ERL1_08B340 -347-480VIES	ERL1_08B330 -120-277VIES	ERL1_08B330 -347-480VIES	ERL1_08B327 -120-277VIES	ERL1_08B327 -347-480VIES
	C3	8000	7800	7600		71	B1-U0-G2	B1-U0-G2	B1-U0-G2	ERL1_08C340 -120-277VIES	ERL1_08C340 -347-480VIES	ERL1_08C330 -120-277VIES	ERL1_08C330 -347-480VIES	ERL1_08C327 -120-277VIES	ERL1_08C327 -347-480VIES
	D3						B1-U0-G2	B1-U0-G2	B1-U0-G2	ERL1_08D340 -120-277VIES	ERL1_08D340 -347-480VIES	ERL1_08D330 -120-277VIES	ERL1_08D330 -347-480VIES	ERL1_08D327 -120-277VIES	ERL1_08D327 -347-480VIES
	E3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_08E340 -120-277VIES	ERL1_08E340 -347-480VIES	ERL1_08E330 -120-277VIES	ERL1_08E330 -347-480VIES	ERL1_08E327 -120-277VIES	ERL1_08E327 -347-480VIES
09	A3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_09A340 -120-277VIES	ERL1_09A340 -347-480VIES	ERL1_09A330 -120-277VIES	ERL1_09A330 -347-480VIES	ERL1_09A327 -120-277VIES	ERL1_09A327 -347-480VIES
	B3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_09B340 -120-277VIES	ERL1_09B340 -347-480VIES	ERL1_09B330 -120-277VIES	ERL1_09B330 -347-480VIES	ERL1_09B327 -120-277VIES	ERL1_09B327 -347-480VIES
	C3	9000	8800	8500		84	B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_09C340 -120-277VIES	ERL1_09C340 -347-480VIES	ERL1_09C330 -120-277VIES	ERL1_09C330 -347-480VIES	ERL1_09C327 -120-277VIES	ERL1_09C327 -347-480VIES
	D3						B1-U0-G2	B1-U0-G2	B1-U0-G2	ERL1_09D340 -120-277VIES	ERL1_09D340 -347-480VIES	ERL1_09D330 -120-277VIES	ERL1_09D330 -347-480VIES	ERL1_09D327 -120-277VIES	ERL1_09D327 -347-480VIES
	E3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_09E340 -120-277VIES	ERL1_09E340 -347-480VIES	ERL1_09E330 -120-277VIES	ERL1_09E330 -347-480VIES	ERL1_09E327 -120-277VIES	ERL1_09E327 -347-480VIES
10	A3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_10A340 -120-277VIES	ERL1_10A340 -347-480VIES	ERL1_10A330 -120-277VIES	ERL1_10A330 -347-480VIES	ERL1_10A327 -120-277VIES	ERL1_10A327 -347-480VIES
	B3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_10B340 -120-277VIES	ERL1_10B340 -347-480VIES	ERL1_10B330 -120-277VIES	ERL1_10B330 -347-480VIES	ERL1_10B327 -120-277VIES	ERL1_10B327 -347-480VIES
	C3	9800	9600	9250		97	B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_10C340 -120-277VIES	ERL1_10C340 -347-480VIES	ERL1_10C330 -120-277VIES	ERL1_10C330 -347-480VIES	ERL1_10C327 -120-277VIES	ERL1_10C327 -347-480VIES
	D3						B1-U0-G2	B1-U0-G2	B1-U0-G2	ERL1_10D340 -120-277VIES	ERL1_10D340 -347-480VIES	ERL1_10D330 -120-277VIES	ERL1_10D330 -347-480VIES	ERL1_10D327 -120-277VIES	ERL1_10D327 -347-480VIES
	E3						B2-U0-G2	B2-U0-G2	B2-U0-G2	ERL1_10E340 -120-277VIES	ERL1_10E340 -347-480VIES	ERL1_10E330 -120-277VIES	ERL1_10E330 -347-480VIES	ERL1_10E327 -120-277VIES	ERL1_10E327 -347-480VIES

Photometrics:

Evolve™ LED Streetlight (ERL1)

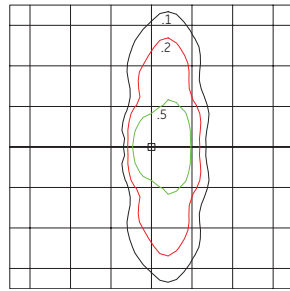
ERL1

Type II Narrow
(05A340)

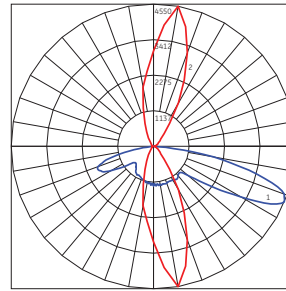
5,000 Lumens

4000K

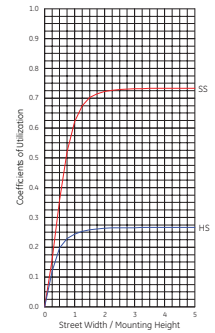
ERL1_05A340____.IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



— Vertical plane through horizontal angle of Max. Cd at 80°
— Horizontal cone through vertical angle of Max. Cd at 67°



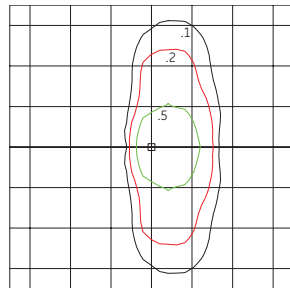
ERL1

Type II Wide
(05B340)

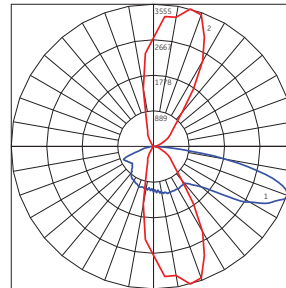
5,000 Lumens

4000K

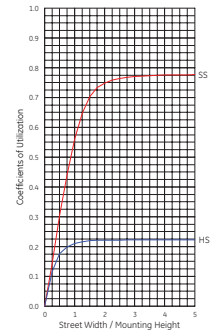
ERL1_05B340____.IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



— Vertical plane through horizontal angle of Max. Cd at 75°
— Horizontal cone through vertical angle of Max. Cd at 69°



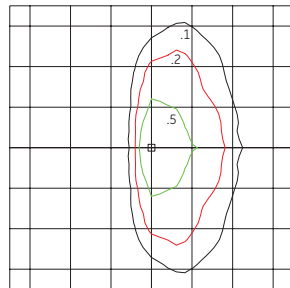
ERL1

Type III
(05C340)

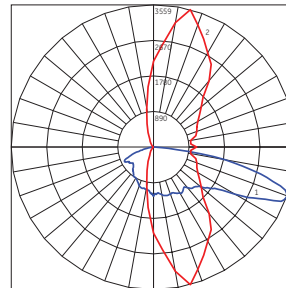
5,000 Lumens

4000K

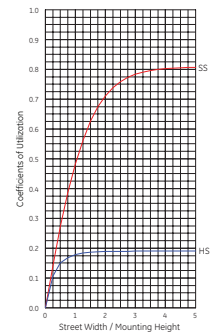
ERL1_05C340____.IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



— Vertical plane through horizontal angle of Max. Cd at 75°
— Horizontal cone through vertical angle of Max. Cd at 70°



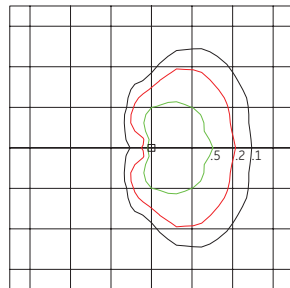
ERL1

Type IV
(05D340)

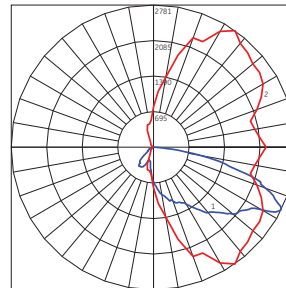
5,000 Lumens

4000K

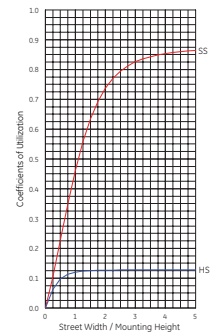
ERL1_(05D340)____.IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



— Vertical plane through horizontal angle of Max. Cd at 55°
— Horizontal cone through vertical angle of Max. Cd at 64°



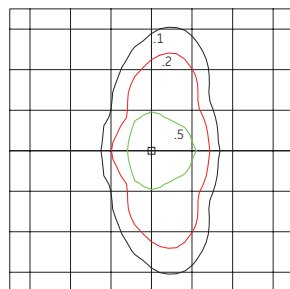
ERL1

Type II Enhanced Back Light
(05E340)

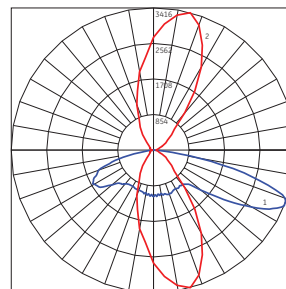
5,000 Lumens

4000K

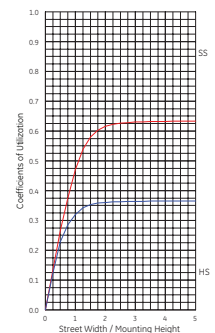
ERL1_(05E340)____.IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



— Vertical plane through horizontal angle of Max. Cd at 75°
— Horizontal cone through vertical angle of Max. Cd at 67°



GE Evolve™

LED Roadway Lighting

ERL1-ERLH-ERL2



Project name _____

Date _____

Type _____

ERLH

PROD. ID	VOLTAGE	LUMEN OUTPUT	DISTRIBUTION*	CCT	CONTROLS	COLOR	OPTIONS
E = Evolve R = Roadway L = Local H = High Output	0 = 120-277V* 2 = 208 3 = 240 4 = 277 5 = 480 D = 347 H = 347-480* * Not available with Fusing. Must choose a discrete voltage with F option.	10 11 13 14 15 16 See Table	A3 = Type II Narrow B3 = Type II Wide C3 = Type III D3 = Type IV E3 = Type II Enhanced Back Light See Table *Nominal IES Type classing subject to typical variation, individual units may differ.	30 = 3000K< 40 = 4000K < Select 3000K CCT for IDA approved units.	A = ANSI C136.41 7-pin D = ANSI C136.41 7-pin with Shorting Cap E = ANSI C136.41 7-pin with non-Dimming PE Control.* *PE Control Only available for 120-277V or 480V Discrete. Not available for 347-480V or 347V Discrete. NOTE: Dimming controls wired for 0-10V standard unless DALI option "U" requested.	GRAY = Gray BLCK = Black DKBZ = Dark Bronze	A = 4 Bolt Slipfitter † F = Fusing G = Internal Bubble Level I = IP66 Optical L = Tool-Less Entry R = Secondary 10kV/5kA SPD U = DALI Programmable +^ X = Single Package # Y = Coastal Finish * XXX = Special Options † Contact manufacturer for Lead-Time. # "X" option provides single pack box per fixture. Std Packaging = 20 units per Magna pak container. * Recommended for installations within 750 ft. from the coast. Contact Factory for Lead-Time. + Compatible with LightGrid 2.0 nodes. ^ Not available in 347V, 480V or 347-480V.

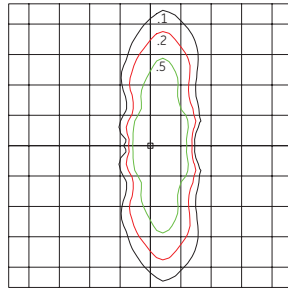
LUMEN OUTPUT	DISTRIBUTION	TYPICAL INITIAL LUMENS		TYPICAL SYSTEM WATTAGE		BUG RATING		IES FILE NUMBER	
		4000K	3000K	120-277V	347-480V	4000K	3000K	4000K	3000K
10	A3	10000	9600	82	82	B2-U0-G2	B2-U0-G2	ERLH_10A340	ERLH_10A330
	B3					B2-U0-G2	B2-U0-G2	ERLH_10B340	ERLH_10B330
	C3					B2-U0-G3	B2-U0-G2	ERLH_10C340	ERLH_10C330
	D3					B1-U0-G3	B1-U0-G2	ERLH_10D340	ERLH_10D330
	E3					B3-U0-G3	B3-U0-G3	ERLH_10E340	ERLH_10E330
11	A3	11500	11000	98	98	B3-U0-G3	B2-U0-G2	ERLH_11A340	ERLH_11A330
	B3					B3-U0-G3	B2-U0-G2	ERLH_11B340	ERLH_11B330
	C3					B2-U0-G3	B2-U0-G3	ERLH_11C340	ERLH_11C330
	D3					B1-U0-G3	B1-U0-G2	ERLH_11D340	ERLH_11D330
	E3					B3-U0-G3	B3-U0-G3	ERLH_11E340	ERLH_11E330
13	A3	13000	12500	111	111	B3-U0-G3	B3-U0-G3	ERLH_13A340	ERLH_13A330
	B3					B2-U0-G3	B2-U0-G3	ERLH_13B340	ERLH_13B330
	C3					B2-U0-G3	B2-U0-G3	ERLH_13C340	ERLH_13C330
	D3					B2-U0-G3	B2-U0-G3	ERLH_13D340	ERLH_13D330
	E3					B3-U0-G3	B3-U0-G3	ERLH_13E340	ERLH_13E330
14	A3	14000	13400	122	122	B3-U0-G3	B3-U0-G3	ERLH_14A340	ERLH_14A330
	B3					B2-U0-G3	B2-U0-G3	ERLH_14B340	ERLH_14B330
	C3					B2-U0-G3	B2-U0-G3	ERLH_14C340	ERLH_14C330
	D3					B2-U0-G3	B2-U0-G3	ERLH_14D340	ERLH_14D330
	E3					B3-U0-G3	B3-U0-G3	ERLH_14E340	ERLH_14E330
15	A3	15000	14400	136	136	B3-U0-G3	B3-U0-G3	ERLH_15A340	ERLH_15A330
	B3					B2-U0-G3	B2-U0-G3	ERLH_15B340	ERLH_15B330
	C3					B2-U0-G3	B2-U0-G3	ERLH_15C340	ERLH_15C330
	D3					B2-U0-G3	B2-U0-G3	ERLH_15D340	ERLH_15D330
	E3					B3-U0-G3	B3-U0-G3	ERLH_15E340	ERLH_15E330
16	A3	16000	15300	149	149	B3-U0-G3	B3-U0-G3	ERLH_16A340	ERLH_16A330
	B3					B3-U0-G3	B3-U0-G3	ERLH_16B340	ERLH_16B330
	C3					B2-U0-G3	B2-U0-G3	ERLH_16C340	ERLH_16C330
	D3					B2-U0-G3	B2-U0-G3	ERLH_16D340	ERLH_16D330
	E3					B3-U0-G3	B3-U0-G3	ERLH_16E340	ERLH_16E330

Photometrics: Evolve™ LED Streetlight (ERLH)

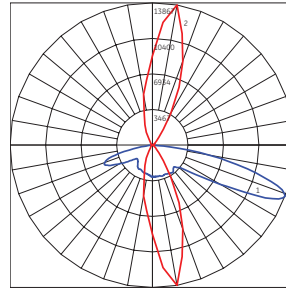
ERLH

Type II Narrow
(13A340)

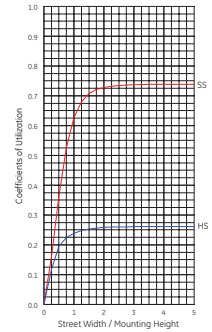
13,000 Lumens
4000K
ERLH_13A340__IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



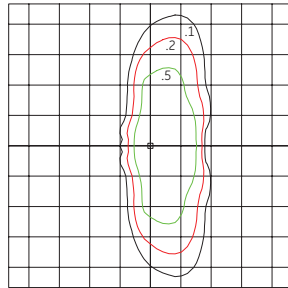
— Vertical plane through horizontal angle of Max. Cd at 80°
— Horizontal cone through vertical angle of Max. Cd at 69°



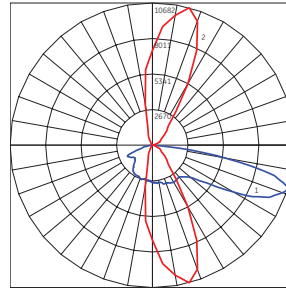
ERLH

Type II Wide
(13B340)

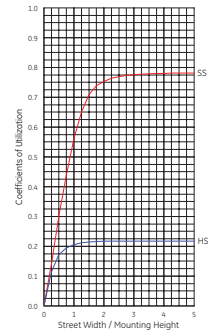
13,000 Lumens
4000K
ERLH_13B340__IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



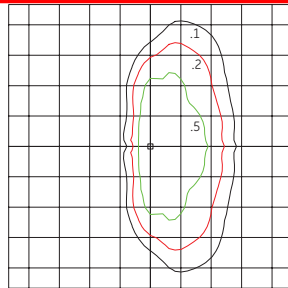
— Vertical plane through horizontal angle of Max. Cd at 75°
— Horizontal cone through vertical angle of Max. Cd at 72°



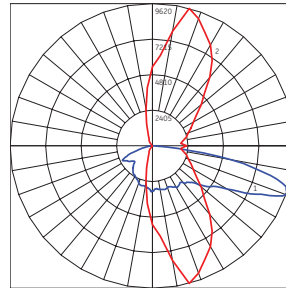
ERLH

Type III
(13C340)

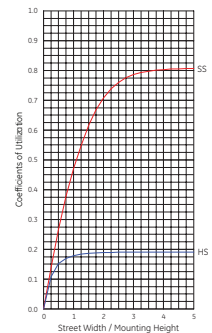
13,000 Lumens
4000K
ERLH_13C340__IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



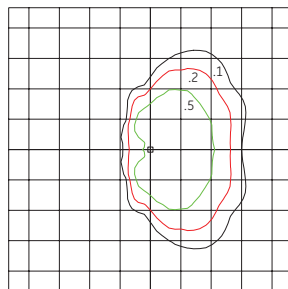
— Vertical plane through horizontal angle of Max. Cd at 75°
— Horizontal cone through vertical angle of Max. Cd at 71°



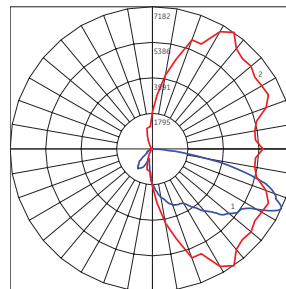
ERLH

Type IV
13D340

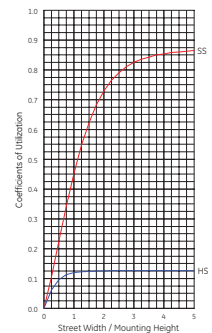
13,000 Lumens
4000K
ERLH_13D340__IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



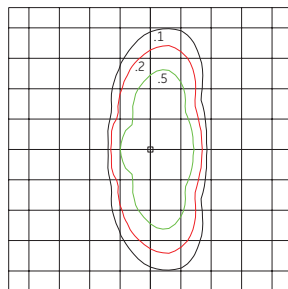
— Vertical plane through horizontal angle of Max. Cd at 55°
— Horizontal cone through vertical angle of Max. Cd at 65°



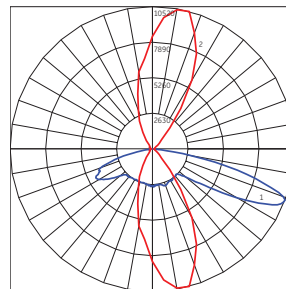
ERLH

Type II Enhanced Back Light
13E340

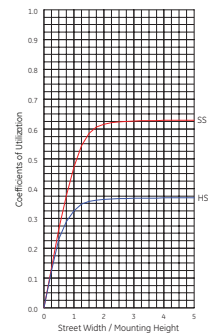
13,000 Lumens
4000K
ERLH_13E340__IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



— Vertical plane through horizontal angle of Max. Cd at 75°
— Horizontal cone through vertical angle of Max. Cd at 69°



GE Evolve™

LED Roadway Lighting

ERL1-ERLH-ERL2



Project name _____

Date _____

Type _____

ERL2

PROD. ID	VOLTAGE	LUMEN OUTPUT	DISTRIBUTION*	CCT	CONTROLS	COLOR	OPTIONS						
E = Evolve R = Roadway L = Local 2 = Double Module	0 = 120-277V* 1 = 160 2 = 208 3 = 240 4 = 277 5 = 480 D = 347 H = 347-480* * Not available with Fusing. Must choose a discrete voltage with F option.	16 18 19 21 23 25 27 28 30 See Table	A3 = Type II Narrow B3 = Type II Wide C3 = Type III D3 = Type IV E3 = Type II Enhanced Back Light See Table *Nominal IES Type classing subject to typical variation, individual units may differ.	30 = 3000K <> 40 = 4000K <> Select 3000K CCT for IDA approved units.	A = ANSI C136.41 7-pin D = ANSI C136.41 7-pin with Shorting Cap E = ANSI C136.41 7-pin with non-Dimming PE Control.* *PE Control Only available for 120-277V or 480V Discrete. Not available for 347-480V or 347V Discrete. NOTE: Dimming controls wired for 0-10V standard unless DALI option "U" requested.	GRAY = Gray BLCK = Black DKBZ = Dark Bronze	A = 4 Bolt Slipfitter † F = Fusing G = Internal Bubble Level I = IP66 Optical L = Tool-Less Entry R = Secondary 10kV/5kA SPD U = DALI Programmable ^ Y = Coastal Finish * XXX = Special Options † Contact manufacturer for Lead-Time. * Recommended for installations within 750 ft. from the coast. Contact Factory for Lead-Time. + Compatible with LightGrid 2.0 nodes. ^ Not available in 347V, 480V or 347-480V.						
LUMEN OUTPUT	DISTRIBUTION	TYPICAL INITIAL LUMENS		TYPICAL SYSTEM WATTAGE		BUG RATING		IES FILE NUMBER					
		4000K	3000K	120-277V	347-480V	4000K	3000K	120-277V	4000K	347-480V	120-277V	3000K	347-480V
16	A3	16000	15300	120	120	B3-U0-G3	B3-U0-G3	ERL2_16A340	.IES		ERL2_16A330	.IES	
	B3					B3-U0-G3	B3-U0-G3	ERL2_16B340	.IES	ERL2_16B330	.IES		
	C3					B2-U0-G3	B2-U0-G3	ERL2_16C340	.IES	ERL2_16C330	.IES		
	D3					B2-U0-G3	B2-U0-G3	ERL2_16D340	.IES	ERL2_16D330	.IES		
	E3					B3-U0-G3	B3-U0-G3	ERL2_16E340	.IES	ERL2_16E330	.IES		
18	A3	18000	17300	140	140	B3-U0-G3	B3-U0-G3	ERL2_18A340	.IES	ERL2_18A330	.IES		
	B3					B3-U0-G3	B3-U0-G3	ERL2_18B340	.IES	ERL2_18B330	.IES		
	C3					B2-U0-G3	B2-U0-G3	ERL2_18C340	.IES	ERL2_18C330	.IES		
	D3					B2-U0-G3	B2-U0-G3	ERL2_18D340	.IES	ERL2_18D330	.IES		
	E3					B3-U0-G3	B3-U0-G3	ERL2_18E340	.IES	ERL2_18E330	.IES		
19	A3	19000	18200	149	149	B3-U0-G3	B3-U0-G3	ERL2_19A340	.IES	ERL2_19A330	.IES		
	B3					B3-U0-G3	B3-U0-G3	ERL2_19B340	.IES	ERL2_19B330	.IES		
	C3					B3-U0-G3	B2-U0-G3	ERL2_19C340	.IES	ERL2_19C330	.IES		
	D3					B2-U0-G3	B2-U0-G3	ERL2_19D340	.IES	ERL2_19D330	.IES		
	E3					B3-U0-G3	B3-U0-G3	ERL2_19E340	.IES	ERL2_19E330	.IES		
21	A3	21000	20100	174	177	B3-U0-G3	B3-U0-G3	ERL2_21A340 -120-277V/IES	ERL2_21A340 -347-480V/IES	ERL2_21A330 -120-277V/IES	ERL2_21A330 -347-480V/IES		
	B3					B3-U0-G3	B3-U0-G3	ERL2_21B340 -120-277V/IES	ERL2_21B340 -347-480V/IES	ERL2_21B330 -120-277V/IES	ERL2_21B330 -347-480V/IES		
	C3					B3-U0-G4	B3-U0-G3	ERL2_21C340 -120-277V/IES	ERL2_21C340 -347-480V/IES	ERL2_21C330 -120-277V/IES	ERL2_21C330 -347-480V/IES		
	D3					B2-U0-G3	B2-U0-G3	ERL2_21D340 -120-277V/IES	ERL2_21D340 -347-480V/IES	ERL2_21D330 -120-277V/IES	ERL2_21D330 -347-480V/IES		
	E3					B3-U0-G3	B3-U0-G3	ERL2_21E340 -120-277V/IES	ERL2_21E340 -347-480V/IES	ERL2_21E330 -120-277V/IES	ERL2_21E330 -347-480V/IES		
23	A3	23000	22100	194	196	B3-U0-G3	B3-U0-G3	ERL2_23A340 -120-277V/IES	ERL2_23A340 -347-480V/IES	ERL2_23A330 -120-277V/IES	ERL2_23A330 -347-480V/IES		
	B3					B3-U0-G3	B3-U0-G3	ERL2_23B340 -120-277V/IES	ERL2_23B340 -347-480V/IES	ERL2_23B330 -120-277V/IES	ERL2_23B330 -347-480V/IES		
	C3					B3-U0-G4	B3-U0-G4	ERL2_23C340 -120-277V/IES	ERL2_23C340 -347-480V/IES	ERL2_23C330 -120-277V/IES	ERL2_23C330 -347-480V/IES		
	D3					B2-U0-G4	B2-U0-G4	ERL2_23D340 -120-277V/IES	ERL2_23D340 -347-480V/IES	ERL2_23D330 -120-277V/IES	ERL2_23D330 -347-480V/IES		
	E3					B4-U0-G4	B3-U0-G3	ERL2_23E340 -120-277V/IES	ERL2_23E340 -347-480V/IES	ERL2_23E330 -120-277V/IES	ERL2_23E330 -347-480V/IES		
25	A3	25000	24000	214	214	B3-U0-G3	B3-U0-G3	ERL2_25A340	.IES	ERL2_25A330	.IES		
	B3					B3-U0-G3	B3-U0-G3	ERL2_25B340	.IES	ERL2_25B330	.IES		
	C3					B3-U0-G4	B3-U0-G4	ERL2_25C340	.IES	ERL2_25C330	.IES		
	D3					B2-U0-G4	B2-U0-G4	ERL2_25D340	.IES	ERL2_25D330	.IES		
	E3					B4-U0-G4	B4-U0-G4	ERL2_25E340	.IES	ERL2_25E330	.IES		
27	A3	27000	25900	237	237	B3-U0-G3	B3-U0-G3	ERL2_27A340	.IES	ERL2_27A330	.IES		
	B3					B3-U0-G4	B3-U0-G4	ERL2_27B340	.IES	ERL2_27B330	.IES		
	C3					B3-U0-G4	B3-U0-G4	ERL2_27C340	.IES	ERL2_27C330	.IES		
	D3					B2-U0-G4	B2-U0-G4	ERL2_27D340	.IES	ERL2_27D330	.IES		
	E3					B4-U0-G4	B4-U0-G4	ERL2_27E340	.IES	ERL2_27E330	.IES		
28	A3	28000	26900	251	251	B3-U0-G3	B3-U0-G3	ERL2_28A340	.IES	ERL2_28A330	.IES		
	B3					B3-U0-G4	B3-U0-G4	ERL2_28B340	.IES	ERL2_28B330	.IES		
	C3					B3-U0-G4	B3-U0-G4	ERL2_28C340	.IES	ERL2_28C330	.IES		
	D3					B2-U0-G4	B2-U0-G4	ERL2_28D340	.IES	ERL2_28D330	.IES		
	E3					B4-U0-G4	B4-U0-G4	ERL2_28E340	.IES	ERL2_28E330	.IES		
30	A3	30000	28800	278	278	B4-U0-G4	B4-U0-G4	ERL2_30A340	.IES	ERL2_30A330	.IES		
	B3					B3-U0-G4	B3-U0-G4	ERL2_30B340	.IES	ERL2_30B330	.IES		
	C3					B3-U0-G4	B3-U0-G4	ERL2_30C340	.IES	ERL2_30C330	.IES		
	D3					B2-U0-G4	B2-U0-G4	ERL2_30D340	.IES	ERL2_30D330	.IES		
	E3					B4-U0-G4	B4-U0-G4	ERL2_30E340	.IES	ERL2_30E330	.IES		

Photometrics: Evolve™ LED Streetlight (ERL2)

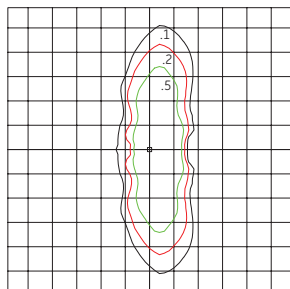
ERL2

Type II Narrow
(23A340)

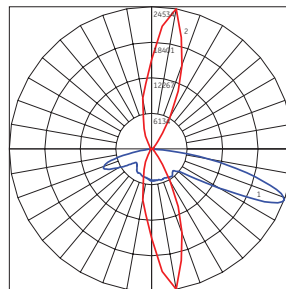
23,000 Lumens

4000K

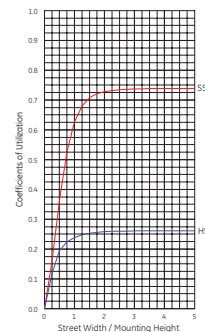
ERL2_23A340____.IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



— Vertical plane through horizontal angle of Max. Cd at 80°
— Horizontal cone through vertical angle of Max. Cd at 69°



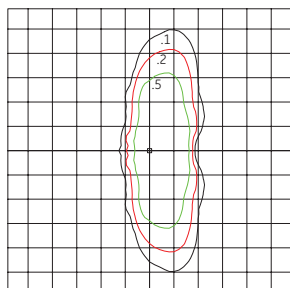
ERL2

Type II Wide
(23B340)

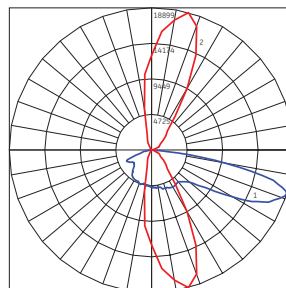
23,000 Lumens

4000K

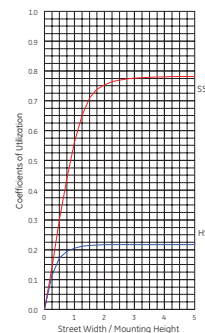
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Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



— Vertical plane through horizontal angle of Max. Cd at 75°
— Horizontal cone through vertical angle of Max. Cd at 72°



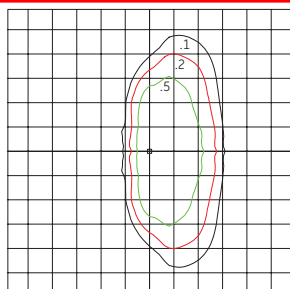
ERL2

Type III
(23C340)

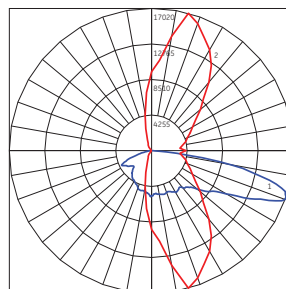
23,000 Lumens

4000K

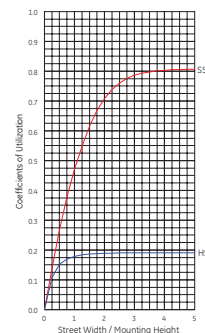
ERL2_23C340____.IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



— Vertical plane through horizontal angle of Max. Cd at 75°
— Horizontal cone through vertical angle of Max. Cd at 71°



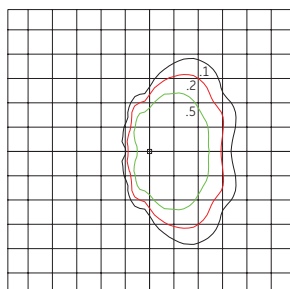
ERL2

Type IV
(23D340)

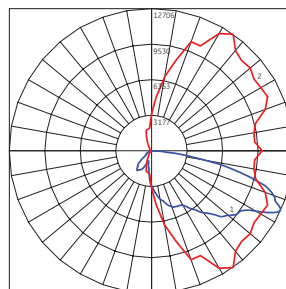
23,000 Lumens

4000K

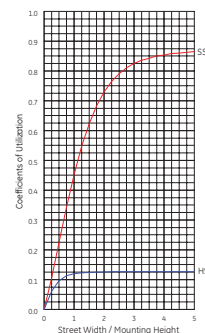
ERL2_23D340____.IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



— Vertical plane through horizontal angle of Max. Cd at 55°
— Horizontal cone through vertical angle of Max. Cd at 65°



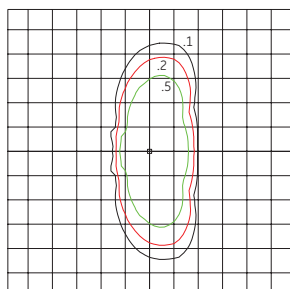
ERL2

Type II Enhanced Back Light
(23E340)

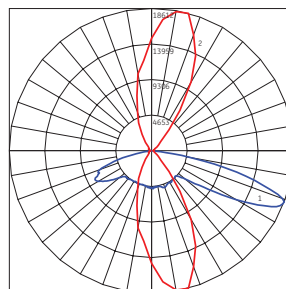
23,000 Lumens

4000K

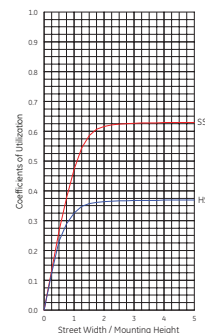
ERL2_23E340____.IES



Grid Distance in Units of Mounting Height at 30'
Initial Footcandle Values at Grade



— Vertical plane through horizontal angle of Max. Cd at 75°
— Horizontal cone through vertical angle of Max. Cd at 69°



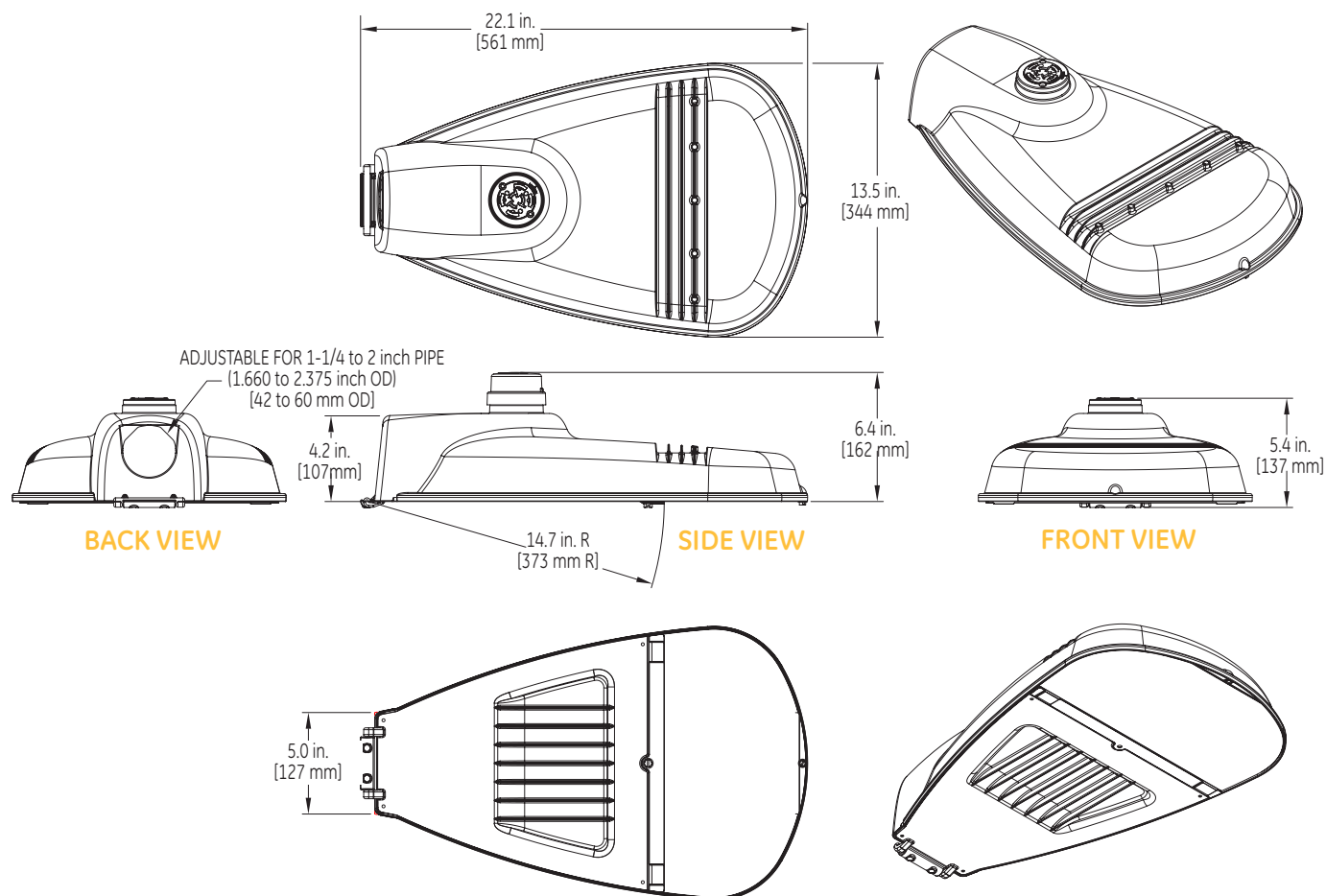
GE Evolve™

LED Roadway Lighting

ERL1-ERLH-ERL2

Product Dimensions:

Evolve™ LED Streetlight (ERL1)



DATA

- Approximate net weight: 12.4 lbs (5.6kgs) -15.5 lbs (7.0kgs) with XFMR
- Effective Projected Area (EPA): 0.5 sq ft max (0.046 sq m)

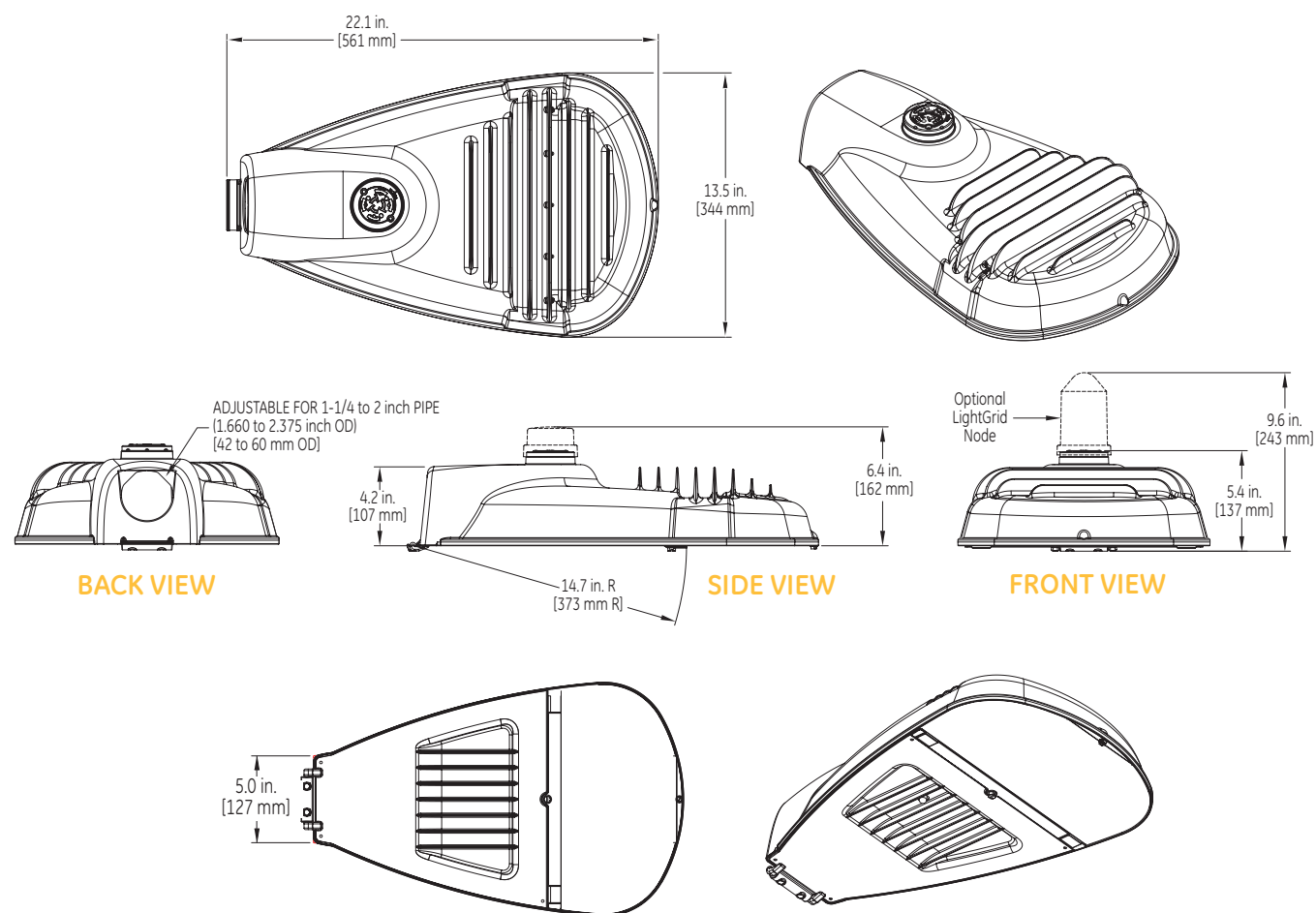
GE Evolve™

LED Roadway Lighting

ERL1-ERLH-ERL2

Product Dimensions:

Evolve™ LED Streetlight (ERLH)



DATA

- Approximate net weight: 15.15 lbs (6.9 kgs) - 2 Bolt Slipfitter
- Approximate net weight: 15.85 lbs (7.2 kgs) - 4 Bolt Slipfitter
- Effective Projected Area (EPA): 0.5 sq ft max (0.046 sq m)

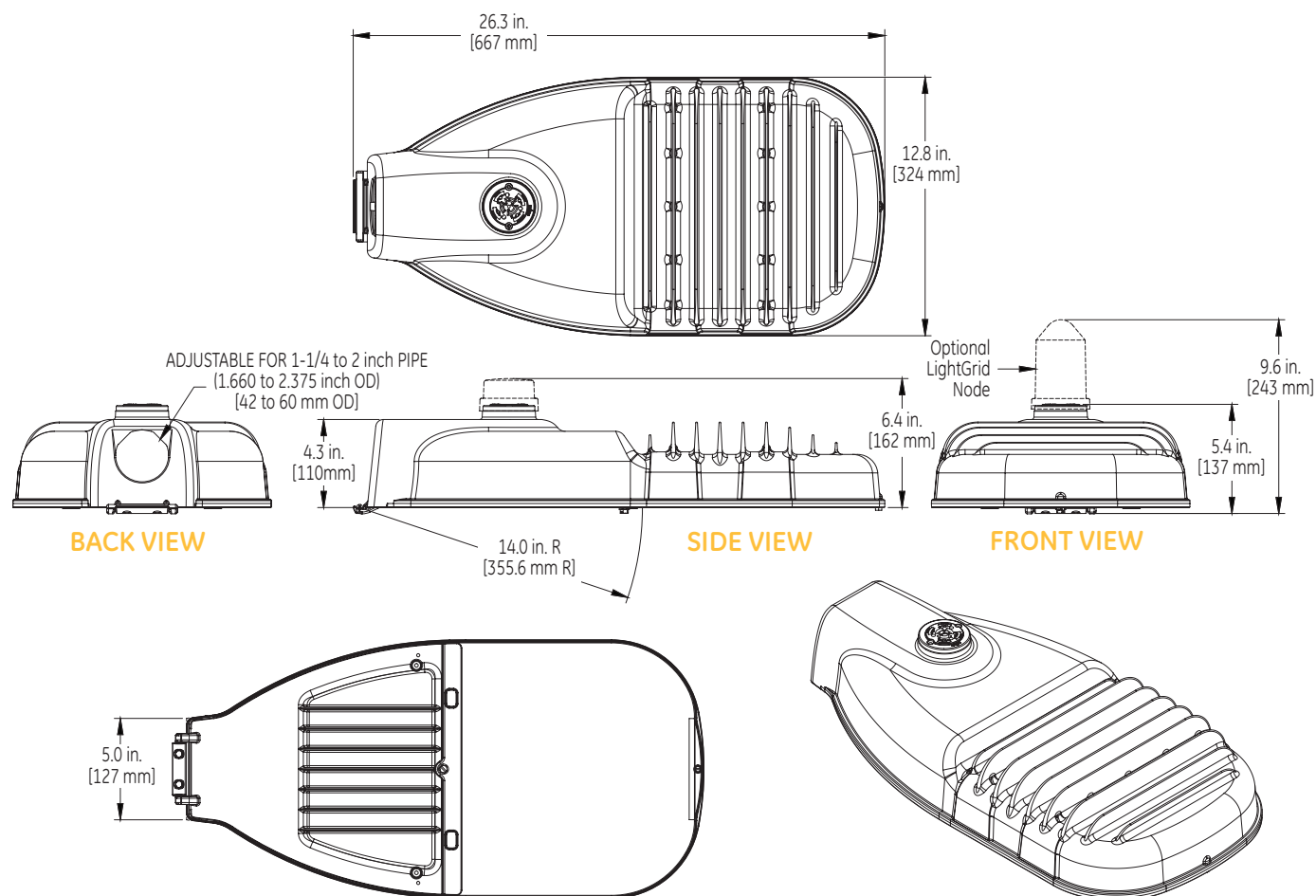
GE Evolve™

LED Roadway Lighting

ERL1-ERLH-ERL2

Product Dimensions:

Evolve™ LED Streetlight (ERL2)



DATA

- Approximate net weight: 24.0 lbs (10.9 kgs)
Contact manufacturer for specific configuration weight.
- Effective Projected Area (EPA): 0.57 sq ft max (0.053 sq m)

current
powered by GE

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TRS Series

Unsurpassed Features for Ultra Long Life



Unsurpassed construction, electrical, process, and environmental protections make the TRS Series the highest grade twistlock photocontrol on the market today. No aspect of design was overlooked, thus eliminating any potential weak point. It is designed to exceed the life expectancy of LED and Induction lights. The TRS is the best value photocontrol available.

Electrical

<u>Model Numbers:</u>	TRS-1: 105-130 VAC, 50/60 Hz - Nominal Voltage 120V	
<u>Operating Voltage Range</u>	TRS-2: 105-305 VAC, 50/60 Hz - Nominal Voltage 120/208/240/277V	
	TRS-1-FO: 105-130 VAC, 50/60 Hz - Nominal Voltage 120V <u>Fail OFF</u>	
	TRS-2-FO: 105-305 VAC, 50/60 Hz - Nominal Voltage 120/208/240/277V <u>Fail Off</u>	
<u>Load Rating</u>	1,000W/1,800 VA	15 Amp relay tested to 15,000 operations at 1,000 watts. AIR GAP load break has no voltage leakage
<u>Operating Temperature</u>	-40°C to +70°C	(-40°F to +158°)
<u>Surge Protection:</u>	40,000 Amps	640 Joule
<u>Power Consumption</u>	<0.5 Watts	@ 120 V
<u>Dielectric Strength</u>	5,000 Volts	Between current carrying parts

Mechanical

<u>Photocell</u>	Silicon Sensor in Glass and Metal Hermetic Enclosure	MIL STD202D, Method 112A Test Condition B
<u>Printed Circuit Board</u>	Glass Epoxy, Ionic Cleaning and Decontamination, Conformal Coated	MIL-1-24768/2/27-GEE, GEF MIL-PRF-55110F MIL-I-46058C
<u>Cover & Window</u>	Black Xenoy by Sabic	No. X5600WX-Series
<u>Base</u>	Polycarbonate 140°C	UL94HB Flame Class Rating
<u>Gasket</u>	Neoprene	ASTM D 1056
<u>Operating Light Levels</u>	Turn-on: 1.5 FC, 1.5:1 Off/On Ratio	+/- .25 FC, 3-5 Sec Turn-off Delay

K.5.1 NEW STREET FIXTURE SELECTION SUMMARY

City of Goodyear LED Street Light Fixture Summary

REV.: 1A

DATE: 6/19/2020

MAP SYMBOL COLOR	RGB	HALO	INPUT WATTS	GE FIXTURE PART NUMBER	SERVICE	IN-SCOPE FIXTURES
	0 / 205 / 0	None	39	ERL1-0-05-B3-30-A-GRAY-R (4900 Lumens)	Local	1282
	0 / 205 / 0		39	ERL1-0-05-B3-30-A-DKBZ-R (4900 Lumens)	Local	4199
	255 / 1 / 1	None	71	ERL1-0-08-C3-30-A-GRAY-R (7800 Lumens)	Collector	259
	255 / 1 / 1		71	ERL1-0-08-C3-30-A-DKBZ-R (7800 Lumens)	Collector	1599
	85 / 140 / 215	None	98	ERLH-0-11-C3-30-A-GRAY-R (11000 Lumens)	Arterial - Median	251
	85 / 140 / 215		98	ERLH-0-11-C3-30-A-DKBZ-R (11000 Lumens)	Arterial - Median	1418
	190 / 80 / 80	None	174	ERL2-0-21-C3-30-A-GRAY-R (20100 Lumens)	Arterial - Single/ Staggered	5
	190 / 80 / 80		174	ERL2-0-21-C3-30-A-DKBZ-R (20100 Lumens)	Arterial - Single/ Staggered	55
	205 / 100 / 255	None	48	EPST-0-E3-30-N-A-P-GRAY (3200 Lumens)	Post Top	40
	0 / 0 / 255		67	EWS3-H-D3-E1-30-1-DKBZ	Wall Pack	52
Wall Pack Brackets					Wall Pack Bracket	52
Small Shields (ELSF5-ERLC)					Shield	150
Large Shields (ELSHS-ERL2)					Shield	50
Photocells (Fisher TRS-2 Fail Off 7-Pin)					Photocell	9160

CONTACT OFFICE

AMERESCO INC.

2375 E. CAMELBACK ROAD

SUITE 400

PHOENIX, AZ 85018

T: 480.499.9200 | F: 480.499.9171

CITY OF GOODYEAR POINT OF CONTACT

DANIEL HUNTER, MBA, CEM, FMP

SENIOR ACCOUNT EXECUTIVE

T: 480.499.9155

E: DHUNTER@AMERESCO.COM

