Report to the Legislature

HB 1125 Sec. 201(2) (2023)

Street Lighting and Safety Study

Proviso Report

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Director
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Publication and Contact Information

A PDF version of this report is available for download on the Washington Traffic Safety Commission website at this link.

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Table of Contents

List of Figures

List of Tables

Glossary of Terms

Term	Definition
Dark-sky friendly	Dark-sky friendly refers to outdoor light fixtures designed to minimize glare, reduce light trespass, and eliminate night sky glow pollution.
Glare	Glare results from luminance within the visual field that exceeds what the eyes are adapted to, leading to discomfort or reduced visibility.
Illuminance	The measurement of the amount of light falling onto and spreading over a given surface area.
Illumination	The process of lighting up an area or space with artificial light sources.
Light trespass	Light trespass occurs when light crosses property boundaries, causing nuisance or loss of privacy.
Luminance	The amount of light emitted, passing through, or reflected from a surface.
Lumens	A measure of the perceived power of visible light emitted by a source.
Sky glow	The brightening of the night sky caused by the scattering of light in the atmosphere, with both natural and artificial components.

Executive Summary

The Washington Traffic Safety Commission's (WTSC) Street Lighting and Safety Study was funded by the state legislature in the 2023-2025 biennium to "conduct research pertaining to the issue of street lighting and safety, including a public input component and learning from counties, cities, the state, and other impacted entities." WTSC partnered with the Washington State Department of Transportation (WSDOT) to produce this study. This report and its attachments satisfy the requirements of this proviso.

During the summer and fall of 2024, the project team used multiple means to engage Tribes, local jurisdictions, public utilities, and emergency service providers to identify the needs and gaps in available resources related to street lighting. We heard four main themes among the public input gathered through an online survey, interviews, and a webinar:

1. Local jurisdictions feel like the technology required to adopt new approaches to pedestrian lighting is untested for their local context (i.e. land use, weather conditions).
2. Many local jurisdictions have not identified their local street lighting needs or lack a plan for long-term implementation.
3. Local jurisdictions lack sufficient funding to complete and maintain their desired street lighting networks.
4. Coordination with utility service providers can be complicated.

The engagement and research conducted as part of this study identified opportunities for Washington State and local partners to make roads safer for all under conditions of darkness. However, there are very few specific illumination guidelines for nonmotorized facilities, which can lead to under-illuminating or omitting lighting for bicycle and pedestrian facilities. The research components of this study were therefore conducted to better understand the guidance and technology available to improve lighting for these spaces. The research also reviewed case studies of funding programs and structures that could inform future funding opportunities in Washington State.

The recommendations identified for street lighting and safety are grouped based on who could act on each recommendation.

Table 1: Street Lighting and Safety Recommendations

Who	Topic	Recommendation
For the state legislature	Lighting funding	• Increase funding for lighting design, installation, maintenance, and operations.
For state agencies led by WSDOT Headquarters	Technical support	• Support local partners through trainings on how to build and maintain their systems. • Aggregate lighting resources, including technical guides, in a readily accessible location for local jurisdictions to understand their applicability to local contexts. • Incorporate new lighting technology resources into guidance and standards.
	Identify local needs	• Provide guidance on how communities can determine their own needs based on local context through planning work (e.g. comprehensive and safety planning).

		• Support a phased approach to implementation or the retrofit of recent projects to include pedestrian lighting in high priority areas
	Lighting funding	• Identify and promote opportunities to fund lighting design and installation as part of grant-funded projects and/or WSDOT capital projects.
For a WSDOT-led Working Group	Lighting funding	• Convene a working group to explore the feasibility of new funding sources such as levies, private development frontage improvements, and impact fees. • Identify and publicize non-transportation funding sources that can support lighting improvements, as provided in the two examples detailed below
	Coordination	• Provide support for coordination between local jurisdictions and public utilities. • Develop model memorandum of understanding (MOU) for collaborative approaches to maintenance and operations.

The Community Development Block Grant (CDBG) is a federal program that provides grants for community development activities, including funding for infrastructure and public services. This program is overseen by the Washington Department of Commerce. Washington Main Street is a WA Department of Archaeology and Historic Preservation program that offers technical and coordination assistance to help communities develop their own strategies to stimulate long term economic growth and civic pride. These are just two examples of non-transportation funding sources that can be used to support lighting improvements.

The success of these recommendations depends on a multilayered approach to each of these areas, such that they build on one another. WSDOT could provide an update on the recommendations listed above to the Washington Traffic Safety Commission and the state legislature as work progresses. Future recommendations to the legislature could include any legislative barriers identified by the working group. Supporting actions for the recommendations are further described in the Recommendations section of this study.

Introduction

During the 2023 session, Washington State legislators directed funding from the Cooper Jones[1] Active Transportation Safety Council account to conduct outreach and research on the issue of street lighting and safety (proviso language provided in Appendix A). This allocation followed a 2022 report from the council that found nearly half of all the state's serious injury and fatal crashes involving a pedestrian or bicyclist occurred after dark. In fact, just under 30 percent of pedestrian fatalities over the 10-year period from 2014-2023 occurred during daylight hours, while 70 percent occurred between dusk and dawn hours.

The council recommended the state conduct additional research that would include public outreach as well as further learning from counties, cities, the state, and other impacted entities. The outreach components of this study included an online survey, interviews with local agencies and utility service providers, and a webinar to share information on street lighting and safety. The research component of the plan included investigation of lighting technology, potential environmental impacts of different types of available lighting technology, design guidance, and case studies of funding strategies.

[1] The Cooper Jones Active Transportation Safety Council was created by the legislature to study and recommend ways to increase the safety of people who walk, bike, and roll. The council's name honors Cooper Jones, a 13-year-old boy who died after being struck from behind by a driver while participating in a Spokane County bicycle road race.

Approach

The project team conducted outreach across Washington and reviewed research on four major topic areas – design guidance, lighting technology, environmental impacts, and funding – to identify barriers to implementing street lighting in the state and to inform recommendations to address these barriers. The ultimate goal of the work is to improve lighting to reduce the likelihood of, exposure to, and severity of crashes, particularly those involving pedestrians and bicyclists.

Outreach and engagement

The project team sought input and feedback from local and regional jurisdictions, Tribes, public utilities, and emergency service providers across the state. These groups were engaged through an online survey, interviews, and an interactive webinar with audience participation to discuss preliminary findings from the study. Appendix B contains a complete summary of the engagement results.

Survey

An online survey was distributed to a sample group of local jurisdictions, Tribes, public utilities, and emergency service providers to understand the challenges respondents face regarding street lighting, and to identify areas where state resources, funding, or technical assistance could address critical gaps or challenges. Questions were specifically designed to elicit responses from staff who have experienced the benefits or shortcomings of current street lighting in their area, including maintenance crews, those responsible for street lighting, and those who see firsthand the impacts of inadequate or insufficient lighting.

The survey was opened to roughly 450 agencies on October 2, 2024, and ran for approximately three weeks. The survey received 276 responses representing 215 unique agencies and organizations across Washington. These came from Tribes, city and town governments, county governments, emergency service providers, public utilities, Regional Transportation Planning Organizations (RTPOs), Metropolitan Planning Organizations (MPO), and other organizations.

In-depth interviews

Nine interviews were conducted with 14 people who are responsible for or oversee street lighting; one interview was conducted with two emergency service providers. The 14 people included representatives from Tribes, local jurisdictions, and utilities. Figure 1 shows a map of the communities where survey respondents and interviewees were located. These interviews provided additional context, helped to further explain unique needs or challenges, and served to identify common themes across varying groups. Interviewees were identified through a survey question that asked whether respondents would like to be interviewed to expand on the needs and potential resources that could support street lighting improvements in their service areas.

> *A majority of our roadway incidents are on multi-lane roads and at intersections - proper lighting is important not just for the incidents, but for getting to the scene safely, finding needed resources, identifying hazards around the scene, etc. Having good overhead street lighting, there's really nothing that compares to it.*
>
> *– Emergency Service Provider*

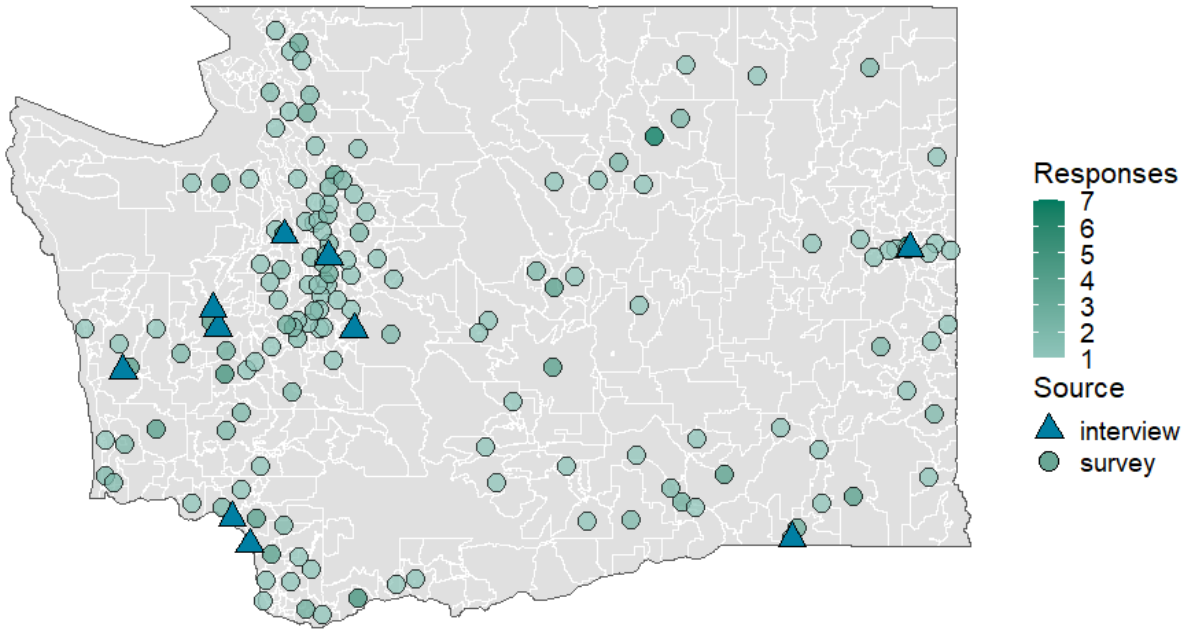


Figure 1: Location of survey respondents and interviewees

Webinar

A webinar was held on November 4, 2024, to share the study findings with invited state, regional, local, and community partners. Approximately 100 people registered for the 1.5-hour webinar. A questions and comments period followed the presentation, and over two dozen questions or comments were received.

Summary of Research

The project team conducted research to identify best practices for the four pedestrian lighting topic areas – design guidance, lighting technology, environmental impacts, and funding –that were identified as needing further study. This section summarizes the research findings and key takeaways to identify barriers to lighting implementation as well as provide tools to address them.

Design guidance and academic research

Design guidance for pedestrian lighting ranges from contextual information on bicycle and pedestrian networks and lighting theory to guidance on specific practices, such as lighting placement, markings, and illuminance levels. Some of the common themes in recent academic research include the effect of lighting glare and visibility on safety, drivers' perceived visibility compared to visual performance, the relationship between average lighting levels and nighttime crash risk, and cost efficient, effective lighting solutions. Additional research on the environmental impacts of lighting is discussed further below.

The *WSDOT Design Manual* (2024)[2] outlines WSDOT's general lighting guidelines and distinguishes between highway and pedestrian lighting requirements. Chapter 100 of the WSDOT Design Manual notes that its policies are developed primarily for use with WSDOT-owned transportation facilities on interstate and state highways (as defined by Revised Code of Washington [RCW] 47.17) and may not be suitable for projects on county roads or local streets. Chapter 100.05 also notes that "local jurisdictions are free to adopt this manual for their own local criteria or to develop specialized guidance for facilities not on state highway routes."

> *I would be willing to work with anyone to increase our lighting, especially as it relates to pedestrians and bicyclists... we've been trying to improve safety on the road that connects the two halves of our reservation - adding more safety features, including lighting is a major focus, especially for pedestrians and bicycles.*
>
> *–Tribal Government representative*

Still, the manual's lighting guidelines provide a framework for both general and specific lighting applications on WSDOT facilities, including in pedestrian areas. The extent of lighting depends on the type and features of the facility, but pedestrian lighting is covered under sections discussing walkways/sidewalks, shared-use paths, intersections, and crosswalks. The central aim of WSDOT lighting requirements for pedestrian facilities is to ensure that people walking can safely and comfortably navigate those facilities.

The WSDOT Design Manual offers flexibility in addressing unique or uncommon situations, but since it is intended for state highways, there are many lighting scenarios that are not specifically covered. It includes processes to document the rationale for design decisions made in such cases.

In addition to the WSDOT Design Manual, the most referenced lighting-specific design guidance and standards for streets, inclusive of pedestrian and bicycle facilities, are the following sources:

- AASHTO *Roadway Lighting Design Guide, Seventh Edition* (2018)
- ANSI/IES RP-8-22 *Recommended Practice: Lighting Roadway and Parking Facilities* (2022)
- AASHTO *Roadway Lighting Design Guide, Seventh Edition* (2018)
- FHWA *Pedestrian Lighting Primer* (FHWA-SA-21-087, 2022)
- FHWA *Lighting Handbook* (2023)

Appendix C includes additional references and academic research beyond the key sources summarized in this section.

[2] WSDOT. 2023. Design Manual. Chapter 1040, Illumination. Accessed October 2, 2024. https://wsdot.wa.gov/engineering-standards/all-manuals-and-standards/manuals/design-manual.

Lighting technologies

The scope of the study included research on current best practices related to lighting technology to confirm that WSDOT guidance aligns with these best practices. Key areas of lighting technology in Washington State include light-emitting diode (LEDs), adaptive lighting, and integration of smart lights. Appendix D includes the memorandum identifying best practices in lighting technology.

> *With so many proprietary intelligent light systems available, and each system using its own proprietary network, an agency looking to use intelligent light systems will be locked into one manufacturer. Development of standards for an open-source system at a state or federal level would alleviate this.*
>
> *- Survey response*

LED Lighting

The performance of traditional streetlights has been significantly enhanced since the emergence of energy-efficient LED lighting technology, which has become widely adopted since the early 2010s. LED lighting has become ubiquitous and is the dominant street lighting technology due to its efficiency, cost, long life, controls, and low material environmental impacts. They generally have higher color temperatures and offer a much greater selection of light distributions. Both of these additional features increase safety by enhancing the visibility of pedestrians and cyclists.

Adaptive Lighting

Adaptive lighting adjusts roadway light levels based on current travel patterns and pedestrian activity. This approach effectively mitigates issues such as skyglow[3], glare[4], and light trespass,[5] while also offering energy savings and reducing maintenance costs. In addition, it optimizes energy use by decreasing light levels to match activity levels during off-peak times. Although still considered an emerging technology, adaptive lighting has already proven its practical advantages. However, the adoption of networked adaptive lighting systems in the U.S. remains limited due to several challenges, ranging from high costs to the need for more reliable internet connections.

Smart Lighting

Lighting efficiency and responsiveness could be enhanced through the integration of advanced technologies such as adaptive lighting systems, smart lighting, and internet of things (IoT)-enabled solutions. Agencies typically rely on national standards and technical recommendations, and this influences the pace at which they adopt new technologies. One key barrier is the lack of comprehensive guidance from the Illuminating Engineering Society (IES), AASHTO, and FHWA, which creates liability concerns.

Environmental impacts of lighting

The purpose of this area of research is to assess the impact of using LED lights in roadway and pedestrian scale lighting and to provide information on the human and environmental effects of lighting. While pedestrian lighting is essential for safety and accessibility, it is also associated with environmental

[3] Skyglow is the brightening of the night sky caused by the scattering of light in the atmosphere, with both natural and artificial components. Street lighting is often cited as contributing to as much as 50% of the urban sky glow due to 95% of the light directed down toward the pavement being reflected upward at reflectance rates ranging from 6% for asphalt to 25% for concrete (IES 1985).

[4] Glare results from luminance within the visual field that exceeds what the eyes are adapted to, leading to discomfort or reduced visibility (IES 2021).

[5] Light trespass occurs when light crosses property boundaries, causing nuisance or loss of privacy.

concerns such as hazardous material disposal, carbon emissions, biological health risks for humans and wildlife, and light pollution.

Light pollution and light trespass are critical factors to consider in outdoor lighting designs. Lighting in pedestrian areas requires careful consideration of environmental impacts. Managing light pollution involves adopting dark-sky-friendly designs and careful planning.[6] Strategies such as shielding luminaires, controlling light trespass, and minimizing sky glow are essential to mitigating the effects of light pollution.

LED lighting is a beneficial solution for pedestrian lighting due to its energy efficiency, reduced carbon emissions, lower maintenance costs, and the ability to mitigate light pollution by providing better control of light direction and intensity. Its environmental advantages, including minimizing hazardous waste and reducing the carbon footprint of illumination, make LED lighting a sustainable option for both roadway and pedestrian areas. Appendix E includes the memorandum identifying the environmental impacts of lighting.

Funding case studies

The purpose of this section is to provide examples from other jurisdictions across the United States to inform implementation and funding of street lighting in Washington. The examples described below were selected because they describe programs that improve safety for roadway users by providing local jurisdictions with the funding tools necessary to build and maintain street lighting.

MnDOT Rural Intersection Lighting Program

The Minnesota Department of Transportation (MnDOT) Rural Intersection Lighting Program uses LED lights to enhance visibility and prevent crashes at high-risk rural intersections with a history of nighttime crashes. Detailed selection criteria help determine if intersections qualify for the program. This proactive approach uses lighting as a key tool in reducing traffic fatalities as part of Minnesota's Toward Zero Deaths initiative. Counties work with MnDOT to underwrite lighting improvements through various funding sources, complemented by contributions from local partners who help with installation and operational costs. This strategy ensures that rural communities can afford safety improvements despite potentially limited local budgets.

Rhode Island's Partnership for Rhode Island Streetlights Management program

The Partnership for Rhode Island Streetlights Management (PRISM) program also takes a statewide approach: the organization centralizes management of streetlight conversion as well as maintenance. This allows PRISM to leverage economies of scale to ease the process and the expense for cities transitioning to LED lighting. While focused primarily on LED conversion, it also operates a collective purchasing program and provides step-by-step guidance for participating municipalities; both of these efforts reduce the cost and barriers to involvement for local jurisdictions.

Delaware Valley Regional Streetlight Procurement Program

The Delaware Valley Regional Streetlight Procurement Program is a multicounty and multistate lighting program that encompasses the Greater Philadelphia region. The program unites municipalities to make informed decisions and efficiently purchase LED lighting solutions. By joining forces, municipalities access resources at competitive prices and follow a streamlined process to complete their projects. To

[6] "Dark-sky friendly" refers to outdoor light fixtures designed to minimize glare, reduce light trespass, and eliminate night sky glow pollution. DarkSky International is the leading advocacy organization for dark-sky friendly designs, including administering a certification program for lighting products, designs, and installations that reduce light pollution.

achieve this, the Delaware Valley Regional Planning Commission issues a request for proposals and contracts with one company to provide lighting design and pricing, as well as service costs during design and construction. The final contract locks in equipment specifications and pricing, project design details, and construction costs. Participants benefit from reduced costs for products and labor, a standardized project timeline, potential access to financing, and expert technical and legal support throughout the design and implementation phases.

Other examples reviewed from cities were identified due to their focus on pedestrian lighting and unique funding strategies. The complete list of examples reviewed is included in Appendix F.

Identification of Barriers

The project team identified barriers to implementation of street lighting in Washington State based on outreach and research. Barriers are broadly grouped into four areas: technical resources, local needs, funding, and coordination.

> *Technical support for transportation planning for the tribes could be very helpful. Getting support to work with me on design work could be hugely supportive for projects. Even helping with the planning - transportation and maintenance plans - we're a small shop, but WSDOT have a lot of staff with expertise in these areas, training from them could be really beneficial.*
>
> *- Tribal Government representative*

Access to technical resources

There are a number of technical resources available for the planning, design, and implementation of street lighting. A local jurisdiction or Tribe that does not have its own lighting policy may choose to adopt WSDOT Design Manual lighting policy for local streets. However, the WSDOT Design Manual currently lacks detailed lighting guidelines for bike lanes, pedestrian tunnels, and walkways separated from motor vehicles by a buffer such as a planter strip.

Guidance for pedestrian and bicycle facilities is available at the federal and state level, but some agencies do not have the staff or technical resources to fully utilize these resources. Respondents also identified potential liability as a concern for areas where WSDOT standards are lacking. Agencies interested in new technology may be hesitant to do so because new lighting approaches may be untested in their context. WSDOT's Complete Streets policy and other active transportation policies across the state aim to build out a complete network for people walking and biking. The lack of detailed illumination guidelines for these facilities and programs may lead to under-illuminating or even omitting lighting entirely in these areas.

Identifying local needs

Many agencies have implemented pedestrian/bicyclist safety programs or plans, but few have fully identified their comprehensive lighting needs or the specific lighting needs for pedestrian and bicyclist safety. Most survey respondents say that the current street lighting in their jurisdiction meets some but not all needs. While 21% say that the lighting meets or exceeds the needs of drivers, far fewer say the same for bicyclists (8%) or pedestrians (6%).

Not enough funding

Existing statewide roadway safety funding programs that could fund street lighting are popular and oversubscribed, and so can't support all of the lighting projects that Tribes and local jurisdictions have planned. However, the state does have a history of successful funding models created through partnerships with public utilities. The Transportation Improvement Board created the Relight Washington program in 2015.[7] Program eligibility is for cities with a population under 5,000 or with an assessed value below $2 billion. The purpose of the program is to underwrite the cost of converting streetlights to LEDs and reinvest the cost savings into transportation programs. Relight Washington has

[7] State of Washington Transportation Improvement Board. June 24, 2015. State of Washington, Puget Sound Energy and Avista Utilities to partner on LED Streetlight Program: Relight Washington. http://www.tib.wa.gov/media/newscontent/items/2015/Relight%20Washington%20Press%20Release.pdf

converted over 48,000 streetlights to LEDs, achieved over 91% agency participation, and invested $18.4 million in the program. The program has fulfilled its objective and Relight Washington will sunset in 2025.

Most survey respondents report difficulties with funding for installation (68%), followed by funding for maintenance (53%). Input from local jurisdictions indicated maintenance funds, including the costs for repairs needed to fix downed poles and respond to vandalism, is a significant need. As such, there is a need for recurring funding to support maintenance. Additionally, if more funding were available, most respondents (87%) say that improving pedestrian safety would be a top priority for their jurisdiction or service area.

> *The city pays all costs - both installation and operational expenses. We also have a property tax shortage - so the operational expense of adding lighting can be problematic. We have plans and ideas together to light more areas - but we don't have the money to do all of these projects.*
>
> *-City Government representative*

Coordination assistance

Based on the survey respondents, in most communities, public utility districts (PUDs) install and maintain standard pole-based streetlights. Responsibility for decorative or other types of lights more often falls to local governments. Cost arrangements for materials, installation, and maintenance of lighting equipment vary by PUD and local jurisdiction. Survey respondents from public utilities say they tend to partner with a wider variety of other organizations, with 75% selecting more than one type of partner organization. In contrast, 50% of respondents from government or planning organizations partner only with public utilities, with only 36% selecting more than one type of partner organization.

Recommendations

This section provides a summary of recommendations for improving street lighting. The project team developed these recommendations through preliminary discussions with state partners, review of existing policies and resources, public outreach, and research into similar efforts in other states. The success of these recommendations involves identifying local needs to inform the amount of funding required to build and maintain the system, including coordination with local utilities.

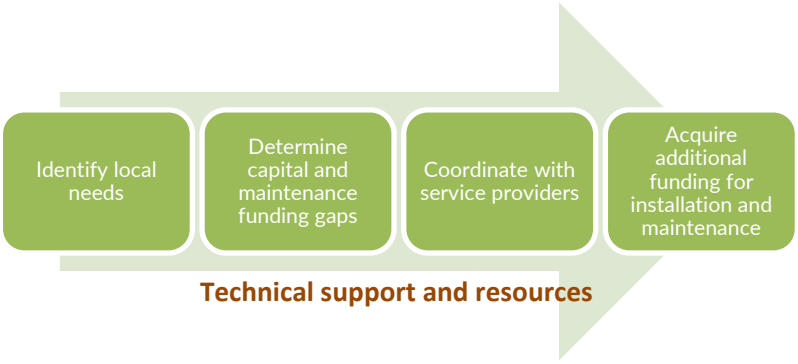


Figure 2: Overview of process to implement street lighting improvements for local jurisdictions

This effort identified the lighting needs of the state as well as emerging practices and guidance the state could adopt. The project team divided recommendations to address barriers to street lighting implementation and safety into three categories :

- Recommendations the state legislature can act on now
- Recommendations state agencies can act on now
- Recommendations for a working group to address outstanding barriers in the future

Recommendations for the state legislature to consider

The recommendations and supporting actions for the Washington State Legislature are provided in Table 2.

Table 2: Summary of recommendations and supporting actions for the state legislature

Recommendations for the Legislature to consider	**Supporting Actions**
Lighting funding	
Increase funding for lighting design, installation, maintenance, and operations.	• Encourage existing safety funding programs to prioritize some funding for lighting-specific projects, including needs studies. • Provide additional resources through existing funding programs for local jurisdictions to operate and maintain lighting.

Recommendations for WSDOT and partners

The project team recommends that WSDOT Headquarters take the lead on coordinating specific partners within various agencies to carry out the recommendations below. Possible partners include the Transportation Improvement Board, Washington Traffic Safety Commission, Washington

Department of Commerce, and Washington Utilities and Transportation Commission. The recommendations and supporting actions for state agencies are provided in Table 3.

Table 3: Summary of recommendations and supporting actions for state agencies

Recommendations for State Agencies	Supporting Actions
Technical support	
Support local partners with trainings on how to build and maintain their systems.	• Investigate opportunities to compile clear, specific guidance for assessing and implementing lighting for pedestrian and bicycle facilities across Washington State. • Provide technical support and design assistance tailored to local needs, such as providing tools, resources, and/or initial frameworks, that can help local jurisdictions develop their own local lighting standards.
Aggregate lighting resources, including technical guides, in a readily accessible location for local jurisdictions to understand their applicability to local contexts.	• Gather lighting resources, including technical guides, in a readily accessible location such as a web landing page, to consolidate information. Use the accessible location to share resources, including which ones are freely available vs. paid.
Incorporate new lighting technology resources into guidance and standards.	• Provide additional guidance on integration with Complete Streets requirements and appropriate lighting levels based on dusk and nighttime activity levels. • Summarize best practice guidelines published by national organizations and public agencies, including state, regional and local examples. • Incorporate new technology resources into future guidance to assess their application in local contexts.
Identify local needs	
Provide guidance on how communities can determine their own needs based on local context through planning work (e.g., comprehensive plans, safety planning).	• Provide support for agencies developing Needs Assessments, including standards for rural and urban contexts. • Support the inclusion of pedestrian and bicycle lighting as part of Comprehensive Plan updates and Safety Planning work, including Local Road Safety Plans.
Support a phased approach to implementation or allow retrofit of recent projects to include pedestrian lighting in high priority areas	• Emphasize importance of regular updates to local needs planning and assessments. • Once local needs are identified within communities, determine the amount of funding needed for implementation.
Lighting funding	
Increase funding for lighting design, installation, maintenance and operations.	• Encourage existing safety funding programs to prioritize some funding for lighting-specific projects.

Recommendations for a working group

The project team recommends that WSDOT Headquarters convene a working group to further understand how to address outstanding barriers. Possible working group representatives could include the Transportation Improvement Board, Washington Traffic Safety Commission, Washington Department of Commerce, and Washington Utilities and Transportation Commission.

Table 4: Summary of recommendations and supporting actions for a WSDOT-led working group

Recommendations for a WSDOT-led Working Group	Supporting Actions
Lighting funding	
Convene a working group to explore the feasibility of new funding sources such as levies, private development frontage improvements, and impact fees.	• Understand priority areas through the needs assessment to develop a comprehensive strategy with utilities. • Identify barriers to additional funding sources such as levies, private development frontage improvements, and impact fees. • Identify and publicize non-transportation funding sources that can support lighting improvements, such as Community Development Block Grants.
Coordination	
Provide templates and examples for cooperative maintenance agreements for utilities to fund operations and maintenance within local and regional jurisdictions.	• Assemble best practices for cooperative maintenance agreements between local jurisdictions and utilities, including electric, water and sewer districts. • Identify any additional legislative barriers to improve efficiency in coordination between public utilities and local jurisdictions.
Provide support for coordination between local jurisdictions and public utilities.	• Establish a point of contact at the state level to identify challenges to utility coordination and support improved coordination between local jurisdictions and public utilities.

Next steps

WSDOT could provide an update on the recommendations listed above to the Washington Traffic Safety Commission and the state legislature as the work progresses. Further recommendations to the legislature could include any possible legislative barriers identified by the working group.

Appendix A: Legislative Proviso for Street Lighting Safety Study

(2)(a) $235,500 of the Cooper Jones active transportation safety account—state appropriation is provided solely for the commission to conduct research pertaining to the issue of street lighting and safety, including a public input component and learning from counties, cities, the state, and other impacted entities. Research may include the following:

(i) Interviewing additional local and regional roads departments, water-sewer districts, and other utility services to gather a holistic data set or further input on which authority assumes primary responsibility for street illumination in various underserved areas throughout the state;

(ii) Systematically soliciting information from communities with poor street illumination and lighting to gather input as to whether this is an issue the community would like to see improved;

(iii) Conferring with regional and state-level police, fire, and emergency medical services to assess and document potential delays in emergency response times due to poor street illumination;

(iv) Further assessing the impact of using LED lights in roadway and pedestrian scale lighting in reducing carbon emissions and light pollution throughout the United States; and

(v) Subject to more in-depth findings, convening a meeting with appropriate state, regional, and local stakeholders and community partners.

(b) The commission must report research results and provide any recommendations for legislative or policy action to the transportation committees of the legislature by January 1, 2025.

Appendix B: Summary of Engagement

The complete engagement summary report is included in the following pages.

Street Lighting and Safety Study

Survey & Interview Final Report

October 2024

Table of Contents

Executive Summary

Project overview

Project goals

- Better understand the state of local street lighting, identified needs, and potential resources that may support street lighting improvements.
- Gather feedback from tribes and local jurisdictions, utility service providers, and emergency medical service (EMS) providers.
- Identify key findings and actionable recommendations to improve lighting practices across the state.

Research approach

This study uses a mixed-methods research approach, combining:

- **Survey data** from 276 respondents representing 215 unique organizations and agencies from across the state.
- **In-depth interviews** conducted with participants from 10 local, county, and regional agencies, tribal communities, public utilities, and emergency service providers.

Current lighting needs and gaps

- **Most areas have lighting where vehicles travel, but fewer have lighting on bike or pedestrian paths.** Most respondents (84%) report lighting along roadways and intersections in their jurisdictions and service areas. Fewer report lighting at on-street bike lanes (35%), shared-use paths (33%), or pedestrian walkways not adjacent to roadways (27%).
- **Current lighting meets some but not all needs, especially for pedestrians and bikers.** While 21% say that the lighting meets or exceeds the needs of drivers, fewer say the same for bicyclists (8%) or pedestrians (6%).
- **Poor visibility makes it difficult and dangerous for EMS providers to respond to emergencies.** Most say that poor visibility increases risk from other drivers (67%) and impacts their ability to operate at the location of the emergency (64%). About half (49%) say that street lighting impacts navigation and response times.

Current policies and programs

- **Most have implemented pedestrian/bicyclist safety programs.** 52% say that a Complete Streets policy or other similar plan has been implemented in their service area or jurisdiction.
- **Most are adopting new technologies.** 63% say their jurisdiction or service area has adopted or is considering adopting new technologies for street lighting.
- **Few have documented their lighting needs.** Among respondents who represent government, planning, or utility service providers, only 14% say their organization has documented lighting needs in a plan, study, memo, or other report. None of the EMS providers we heard from collect data on safety and street lighting.
- **Local government budgets are the most common way street lighting installation and maintenance is funded.**

Challenges and resources needed

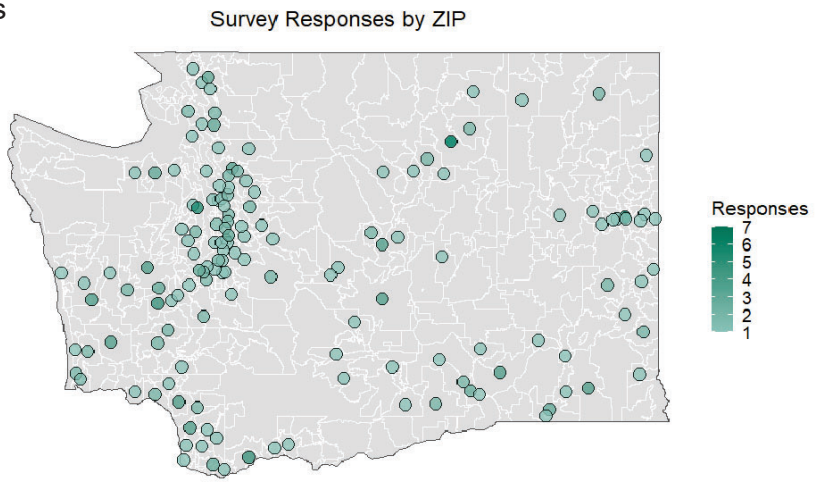
- **Lack of funding is the most common challenge agencies and organizations face.** Most report difficulties with funding for installation (68%), followed by funding for maintenance (53%) and lack of staffing or other resources (50%).
- **Funding and grants is the most helpful resource Washington State can provide to improve pedestrian and bicyclist safety.** When asked what state resources would be most helpful, government and utility respondents requested funding and grants for lighting installation or upgrades (83%) as well as for maintenance (71%). Emergency service respondents agree, with 68% saying that funding for local jurisdictions to improve lighting would be most helpful.
- **Some say that state model lighting standards would be helpful.** 62% of EMS respondents say that model lighting standards that consider the needs of emergency responders would be one of the most helpful resources the state could provide. In open-ended survey comments, some government respondents mention a need for state-wide standardized lighting standards and best practices.

Research Methods

Survey data provides a broad overview of needs and priorities across the state.

The online survey fielded from October 3rd to 21st, 2024. Over 500 individuals from government, utility, and emergency service agencies and organizations across Washington State were invited to participate in the survey.
The survey received 276 valid responses, representing 215 unique agencies and organizations across Washington State, including:

- 103 city or town governments
- 56 emergency service providers
- 26 county governments
- 14 utility service providers
- 4 Regional Transportation Planning Organizations (RTPOs)
- 3 tribal governments
- 1 Metropolitan Planning Organization (MPO)
- 9 other organizations



Number of survey responses received by zip code of the agency or organization's main office

Interviews add in-depth understanding of needs and priorities across the state.

10 interviews, each about 30 minutes in length, were conducted with 16 individuals with responsibility or oversight for street lighting. These included representatives from the following jurisdictions, tribes, and utilities:

- City of College Place
- City of Enumclaw
- City of Hoquiam
- City of Kalama
- Longview Fire Dept.
- Mason County PUD 3
- Puget Sound Energy
- Skokomish Tribe
- Spokane Regional Transportation Council
- Suquamish Tribe

These interviews were used to gather additional context, better understand unique needs or challenges, and identify common themes across these varying groups.

How to read this report

- There were two branches of the survey depending on the agency type. Emergency service providers were shown one set of questions, while all other respondents were shown the other. On each page is an icon to indicate the source of information.


Survey questions shown to all respondents


Survey questions and information gathered from local jurisdictions and other governmental organizations


Survey questions and information gathered from emergency service providers

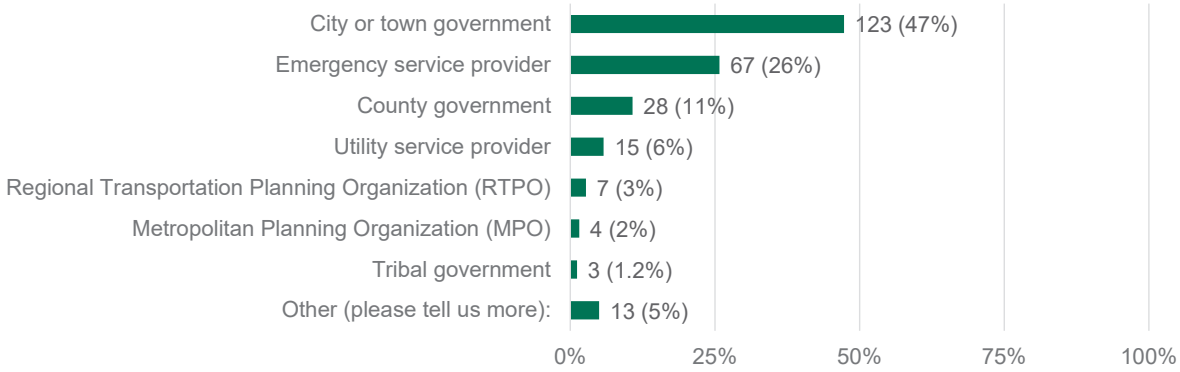

Information gathered from interviews

- The bottom of each slide contains the full question text and number of respondents for each survey question shown on the slide.
- Graphs show the percentage of respondents who selected each response option for each question. Percentages may not sum to 100% where questions allowed multiple selections.
- Interview bubbles contain statements from closely recorded notes. Interviews were not recorded or transcribed; statements should not be considered direct quotes.

Detailed Findings

Respondents represent a range of organizations and agencies.

Nearly half (47%) of survey respondents represent city or town governments from across the state. Overall, there were 155 responses from government or planning organizations (60%), 67 from emergency service providers (EMS) (26%), and 15 from utility service providers (6%).

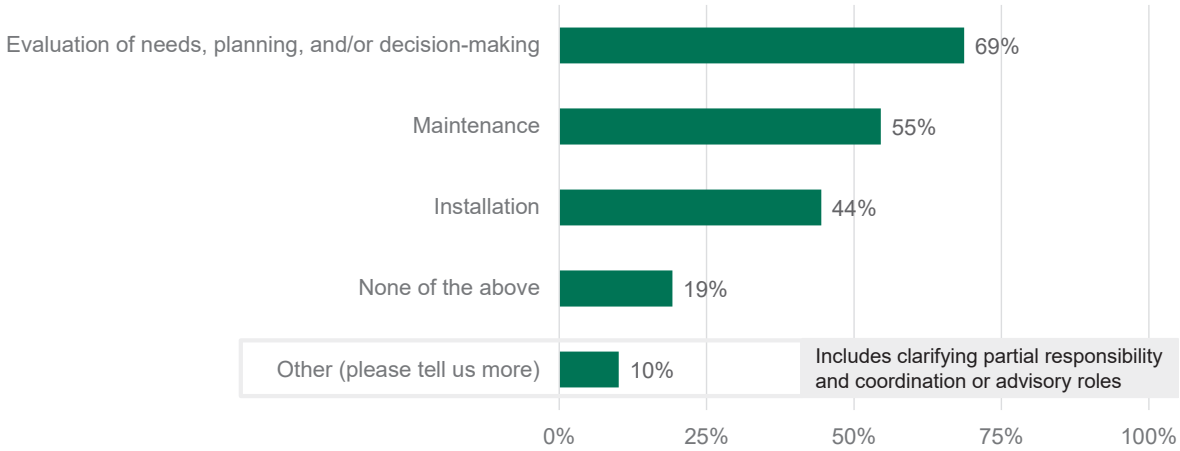


Out of the 67 responses from EMS providers, 27 selected “City or town government”, “County government”, or “Other”, but were identified as EMS providers based on the organization name they provided. While these respondents are categorized as EMS providers for analysis and reporting, they took the survey as government representatives and were not shown the questions intended for emergency service representatives. Their responses are included in the results from the government branch.

Q: Which of the following best describes your agency or organization? (n = 292)

Agencies and organizations have a range of responsibilities related to street lighting.

Most survey respondents represent agencies and organizations that are directly responsible for street lighting in their communities, including those responsible for planning and decision-making (69%), maintenance (55%), and installation (44%). About 30% were from organizations not directly or exclusively responsible for street lighting.



Q: Which of the following best describes your agency or organization's responsibilities related to street lighting? Please select all that apply. (n = 215)

Government and utility providers work together to provide street lighting.

Survey respondents from utility service providers tend to partner with a wider variety of other organizations, with 75% selecting more than one type of partner organization. In contrast, 50% of respondents from government or planning organizations partner only with utility service providers, with only 36% selecting more than one type of partner organization.

Partners with:	Government	Utility
Business Dist.	3%	21%
City or town government	15%	71%
County government	17%	71%
Federal government	3%	0%
Metropolitan Planning Organization (MPO)	1%	7%
Regional jurisdiction	2%	14%
Regional Transportation Planning Organization (RTPO)	2%	0%
State government	24%	43%
Tribal government	3%	21%
Utility service provider	73%	0%
Other (please tell us more)	2%	7%
My agency or organization does not partner with or share responsibilities with any others with regards to street lighting	11%	14%

Q: What other agencies or organizations, if any, do you partner with and/or share responsibilities with regarding street lighting? Please select all that apply. (n = 209)

Interviewees described partnerships in lighting responsibilities.

Many reported on the relationships between **local jurisdictions** and **public utilities**:

- In most jurisdictions, public utility districts (PUDs) install and maintain standard pole-based streetlights.
  - Responsibility for decorative or other types of lights more often falls to local governments .
- Cost arrangements for hardware, install, and maintenance of lights vary by PUD and jurisdiction

The majority of our mast lights are owned by our PUD - we pay a bulk rate for operating those… about $1,145/mo; after switching to LEDs the price has come down a little. That contract has worked very well for us. I think it's a great deal honestly; money wise it's the least of my worries. - City Government

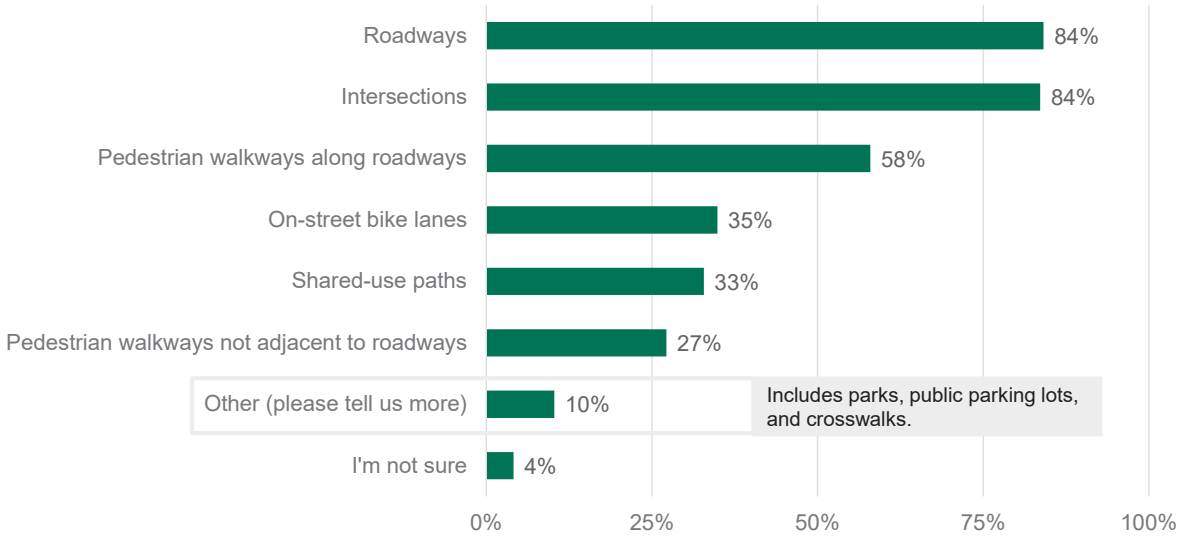
Tribes and jurisdictions also share lighting responsibilities with **WSDOT** who oversees state roads and infrastructure:

- Many said WSDOT lit roads meet high standards and are well lit.
- However, many also named intersections, bridges, or other state infrastructure where lighting is needed.

We do work with WSDOT when things are in their right of way, but we do most of these things on our own. We work with the state where we can - we used Safe Routes to School for a sidewalk and lighting project - it's nice when we're able to get funding. - Tribal Government

Most report vehicle-area lighting but less lighting exists on bike/pedestrian paths.

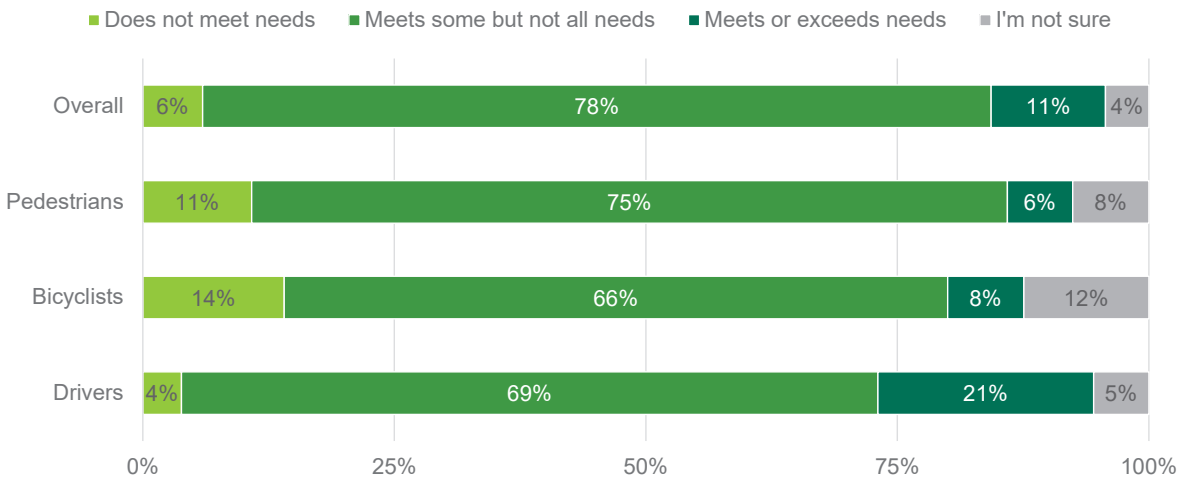
Most survey respondents (84%) report lighting along roadways and intersections in their jurisdictions and service areas. Fewer report lighting at on-street bike lanes (35%), shared-use paths (33%), or pedestrian walkways not adjacent to roadways (27%).



Q: Which of the following facilities in your jurisdiction or service area have lighting? Please select all that apply. (n = 209)

Current street lighting meets some but not all needs.

Most survey respondents say that the current street lighting in their jurisdiction meets some but not all needs. While 21% say that the lighting meets or exceeds the needs of drivers, fewer say the same for bicyclists (8%) or pedestrians (6%).



Q: How well does the street lighting in your jurisdiction or service area meet overall needs? (n = 197)
… the needs of pedestrians? (n = 197)
… the needs of bicyclists? (n = 195)
… the needs of drivers? (n = 194)

Most interviewees agreed that main roads were not their highest need areas.

Many told us street lighting tended to be best closer to **downtowns, intersections, and on state and major roads**.

Most identified **rural roads, and bike or pedestrian areas** as needing more lighting.

In my opinion, [lighting] is adequate. At the edge of the city, coverage can drop off a bit, but those tend to be less traveled areas. The city itself is well covered. – City Government

I would be willing to work with anyone to increase our lighting, especially as it relates to pedestrians and bicyclists... we've been trying to improve safety on the road that connects the two halves of our reservation - adding more safety features, including lighting is a major focus, especially for pedestrians and bicycles. – Tribal Government

We absolutely see a correlation between lighting and safety. We're working really hard to be a tree-city, and have other greenery, but these cut down on any natural lighting. We've been investing in pedestrian infrastructure to improve the safety in these areas, and especially improve the lighting. –City Government

Open-ended responses: Unmet needs

When asked what specific lighting needs are unmet in their jurisdiction or service area, most (86%) described gaps or lack of lighting, particularly for pedestrian and bicyclist infrastructure. Some also mentioned poor or inconsistent quality (spacing, lighting levels, aging infrastructure), insufficient or competing standards, concerns about excessive lighting or light pollution, and maintenance issues.

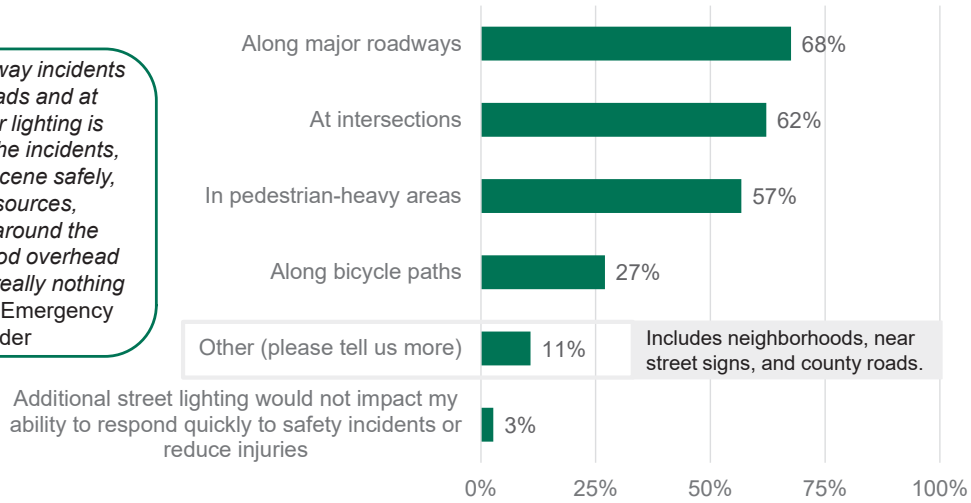
Gaps or lack of lighting		Other issues
"The major shared use paths in our city have no lighting and are separated enough from roadways that it makes them extremely dark."	"Many neighborhood streets don't have streetlights especially for areas annexed into the city."	"Many properties provide lighting through the PUD streetlight program […] PUD lights are not dark sky compliant."
"Pedestrian scale lighting lacks in residential areas, especially in areas with very established vegetation/ trees. Some intersections are not properly lit, including some state highway intersections with local roads."	"Lighting is mostly 'legacy' street lighting for motor vehicle use, and assumes headlights illuminate dark streets for drivers. Street lighting levels are not consistent in all areas of the city for pedestrians or bicyclists."	"Based on RP-8 there are deficiencies in existing streetlight spacing and lumens."
"Throughout the County, especially in rural environments, little to no lighting exists at various intersections, pedestrian crossings or bike routes."	"About 2/3 of the City currently has lighting, most of the gaps in residential areas. Most of our arterial streets have lighting, but many are on utility poles, which are not optimized for lighting."	"We don't have clear adopted standards, especially for pedestrian and bicycle lighting, to even measure needs against current lighting."
"Near-zero pedestrian scale lighting on existing sidewalks. Some existing crosswalks do not meet current lighting standards."	"The city and/or county need to be proactive and budget for additional lighting in older, established neighborhoods/intersections and high crime areas."	"Some complaints about too many lights in some streets, bright lights (new LEDs) and interest in promoting fewer lights for darker night sky."
		"We use IES, but other jurisdictions near us make up their own. It would be nice if there was a state standard so we are all consistent."

Q: Please describe what specific street lighting needs are unmet in your jurisdiction or service area. (n = 128)

Added lighting in specific areas could improve EMS response.

Most survey respondents say that additional street lighting along major roadways (68%), at intersections (62%), and in pedestrian-heavy areas (57%) would most help improve their ability to respond quickly to safety incidents and reduce injuries.

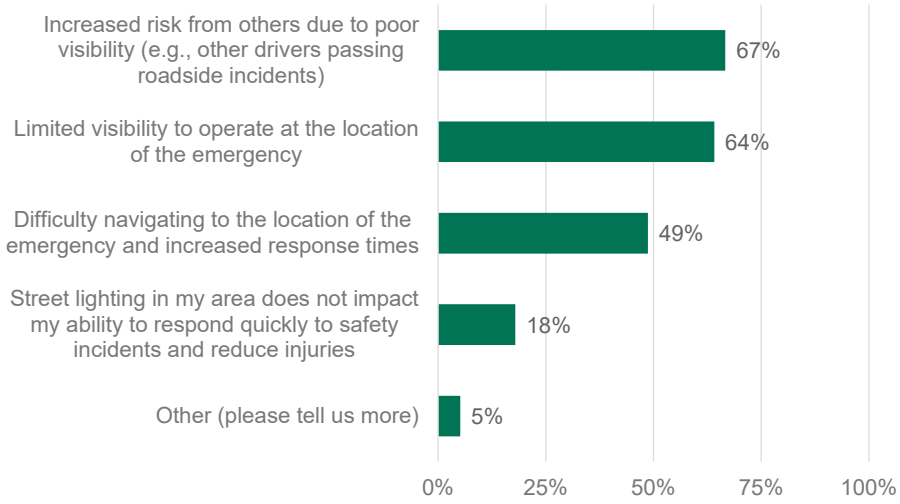
A majority of our roadway incidents are on multi-lane roads and at intersections - proper lighting is important not just for the incidents, but for getting to the scene safely, finding needed resources, identifying hazards around the scene, etc. Having good overhead street lighting, there's really nothing that compares to it. – Emergency Service Provider



Q: Where would additional street lighting most help improve your ability to respond quickly to safety incidents and reduce injuries? Please select all that apply. (n = 43)

Insufficient lighting contributes to dangerous conditions for EMS providers to respond to emergencies.

Most survey respondents indicated that poor visibility increases risk from others (67%) and their ability to operate at the location of the emergency (64%). About half (49%) say that street lighting impacts navigation and response times.

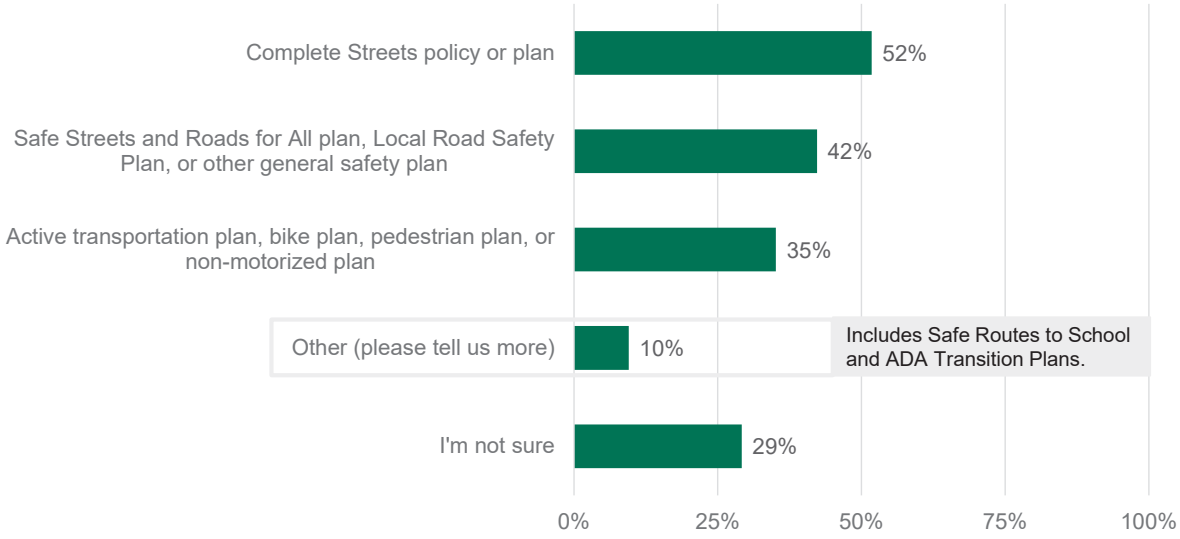


I can't tell you the number of times drivers say "I couldn't see them", even as a first responder, I can't tell you the number of near misses where we didn't see someone until the last minute while responding. – Emergency Service Provider

Q: How does street lighting or the lack of street lighting affect your ability to respond quickly to safety incidents and reduce injuries? Please select all that apply. (n = 47)

Most have implemented pedestrian/ bicyclist safety programs.

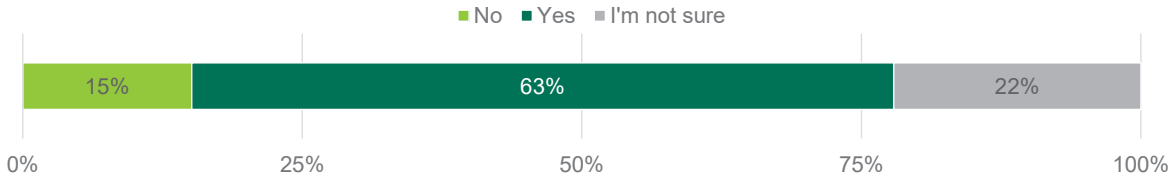
More than half of respondents (52%) say that a Complete Streets policy or plan has been implemented in their service area or jurisdiction. Many have also implemented a general safety plan (42%) or a non-motorized transportation plan (35%).



Q: What programs, policies, or facilities have been implemented in your jurisdiction or service area to improve pedestrian and/or bicyclist safety? Please select all that apply. (n = 175)

Most are adopting new technologies for street lighting.

Most respondents (63%) say their jurisdiction or service area has adopted or is considering adopting new technologies for street lighting. Only 15% say new technologies have not been adopted or considered, while another 22% are unsure.



Among the 118 respondents who specified what technologies are being implemented or considered, 88% said their jurisdiction or service area has implemented or is in the process of implementing **LED streetlights**. Other common responses include smart lighting, sensors, and dimmers or other dark sky compliance measures.

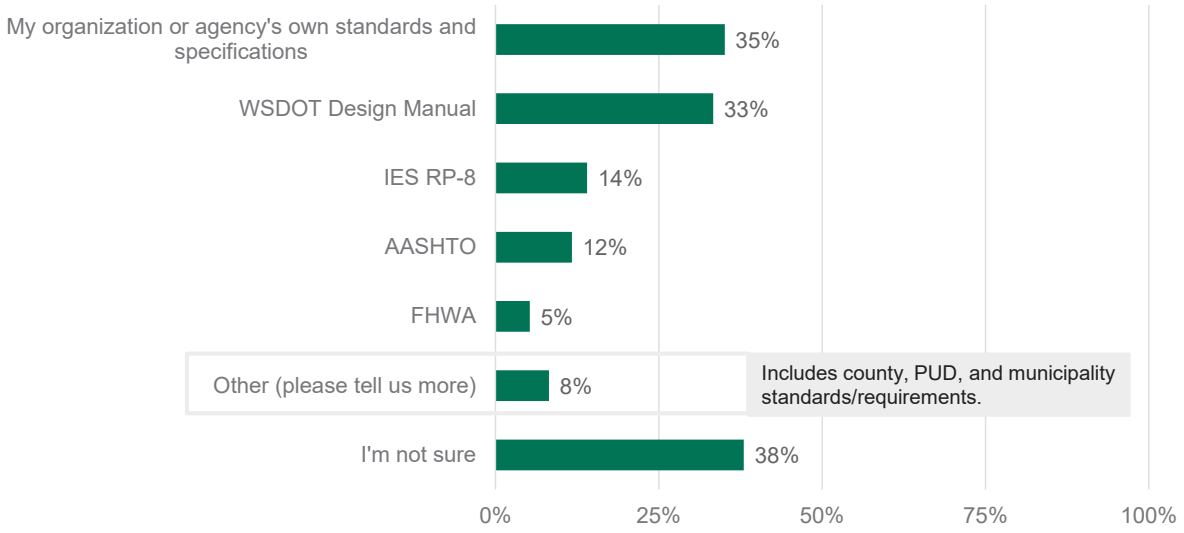
TIB had a program in the past for grants to replace lights with LEDs. Our electrical costs went down around 20% from the LED conversion. – City Government

We had a conversation with the city manager and police chief [about adaptive lighting]. They weren't in favor; I think there's a concern about security with lower lighting. – City Government

Q: Has your jurisdiction or service area adopted or is it considering adopting new technologies for street lighting (e.g., LED, smart lighting, motion sensors)? (n = 180)
(If "Yes" or "I'm not sure") Q: What technologies are being implemented or considered? (n = 118)

Street lighting standards vary across agencies and organizations.

Agencies and organizations use a variety of standards for street lighting, with some using their own standards and specifications (35%) and the WSDOT Design Manual (33%). Other standards are also used by some agencies, including IES RP-8 (14%), AASHTO (12%), FHWA (5%).



Q: What standards do you use for setting light levels, pole installation, lighting fixture selection, or others? Please select all that apply. (n = 178)

Some interviewees said that lighting standards have pros and cons.

Many said that where WSDOT does light roads, they tend to be very well-lit.

However, a few documented instances where strict standards created challenges or barriers.

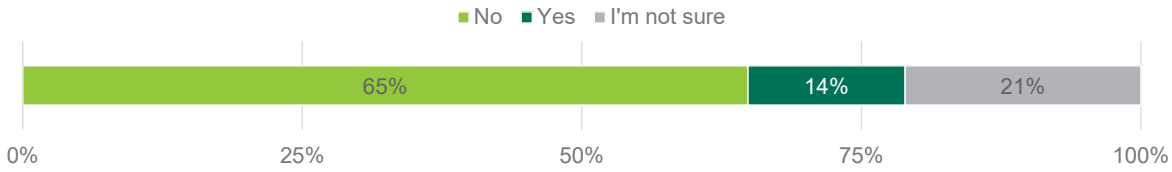
When DOT turns over roads to local agencies – things sometimes change. WSDOT has great standards to keep lighting standards and other things up to snuff, local agencies are less likely to keep up that high of standards. – Emergency Service Provider

We got denied for lighting under overpasses by WSDOT for lights - from the bridge department. Frustrating as it's a highly trafficked area, lots of ped traffic, and the I-5 exit 30 overpass is extremely dark - the intersections are covered - but not underneath. There seems to be a lack of willingness to work with local agencies - we have the lights and heads that match our area - but can't get permission to place them. Really seems to run counter to safe streets - lack of flexibility to meet needs and goals. Appreciate having the standards - but there should be ways to have a meaningful conversation about flexibility. – City Government

It'd be helpful if WSDOT had standards for local governments to use. One of our customers uses the WSDOT standard, but it really doesn't make sense on some of their local roads. The base requirements for their poles are really designed for highways and make it really challenging to put them in locally. – Utility Service Provider

Few participants have documented lighting needs.

Among respondents who represent government, planning, or utility service providers, **only 14% say their organization has documented lighting needs in a plan, study, memo, or other report.** Most (65%) say their organization has not documented lighting needs, while another 21% are not sure.



Among the 37 respondents who shared additional information about documentation:

- 9 (24%) described lighting assessments or specific research
- 4 (10%) mentioned a comprehensive plan or transit improvement plan that included streetlights
- 4 (10%) said they have public work or road standards that describe lighting needs, and
- 3 (8%) said they have a GIS inventory or map of streetlights

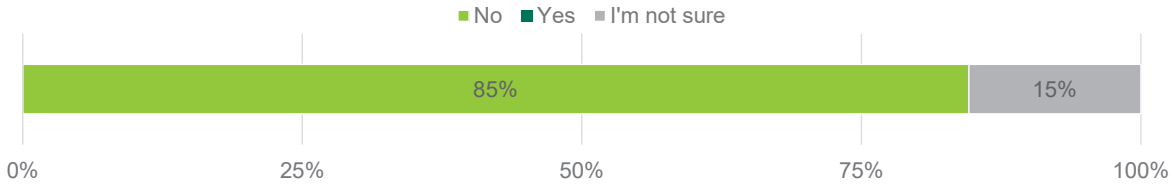
In addition, 9 (24%) said there is no documentation or they're not sure if there is any, and another 3 (8%) said this question was not applicable to their organization.

Several respondents (19%) said that while they have documentation of general lighting goals or standards, they do not have documentation of specific lighting needs.

Q: Have you documented your lighting needs in a plan, study, memo, or other report? (n = 198)
(If "Yes" or "I'm not sure") Q: Please tell us more about when, where, and how this documentation was collected, as well as any other information you would like to share. (n = 37)

Emergency service respondents do not collect data on safety and street lighting.

Among respondents who represent emergency service providers, **none say their organization collects data on pedestrian or traffic safety and its relationship to street lighting.**



Among the 6 who selected "I'm not sure":

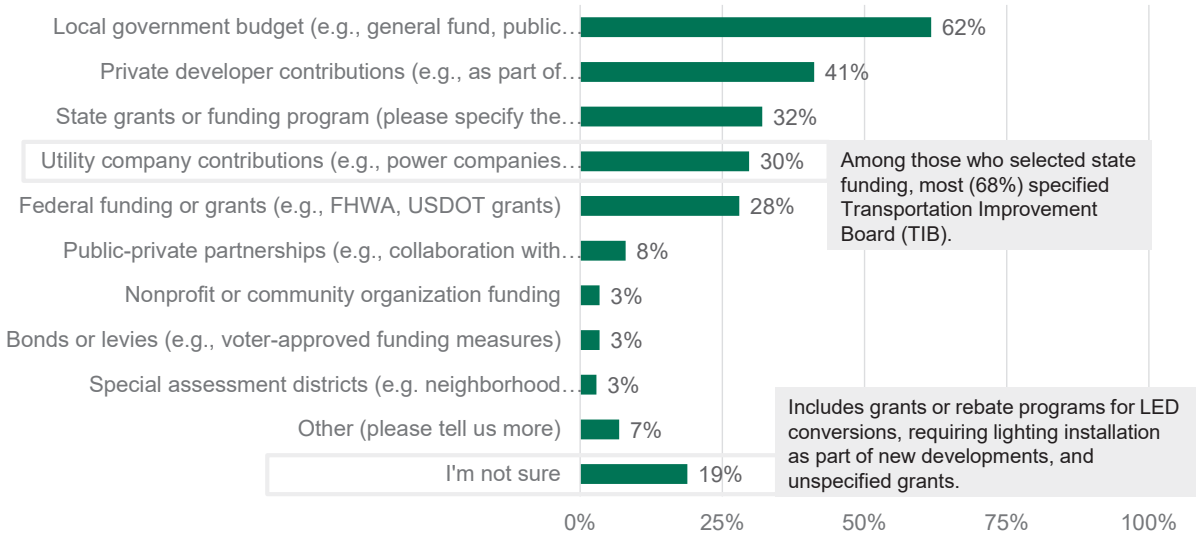
- 3 wrote that they were unsure
- 1 said they receive data from EPCR and fire reports
- 1 said they receive 911 call volume and call type data
- 1 said they receive data collected from Safe Streets USA

It would be good to have up-front and consistent connections with WSDOT to be able to relay data, near-misses, areas of need. etc. We tend to be adept at seeing patterns, including lighting, having clear lines of communication with WSDOT at the state or regional level, would be an improvement. More systems for tracking lighting and opportunities to share what's known would be really beneficial.
- Emergency Service Provider

Q: Do you currently collect data on pedestrian or traffic safety and its relationship to street lighting in your jurisdiction or service area (for instance, light levels at crash locations)? (n = 48)
(If "Yes" or "I'm not sure") Q: What types of data are collected and how is this data used? (n = 6)

Street lighting installation and maintenance is most commonly funded through local government budgets.

Other common funding sources include private developer contributions (41%), state funding (32%), utility company contributions (20%), and federal funding and grants (28%).



Q: If your jurisdiction or service area has street lighting, how has installation and maintenance been funded? Please select all that apply. (n = 183)

Interviewees shared information on lighting funding models.

Most said they fund operational costs from their general funds; however, the cost to install additional light can vary by PUD arrangement:

- Some PUDs will cover all upfront costs, and recoup these from jurisdictions though operating fees over time. This can make it less costly to add lights, but increase monthly/annual costs
- Other PUDs require local jurisdictions to pay costs upfront; they then only pay for electricity monthly. This can create a higher barriers to initial installs and require grants or other funding for major projects.

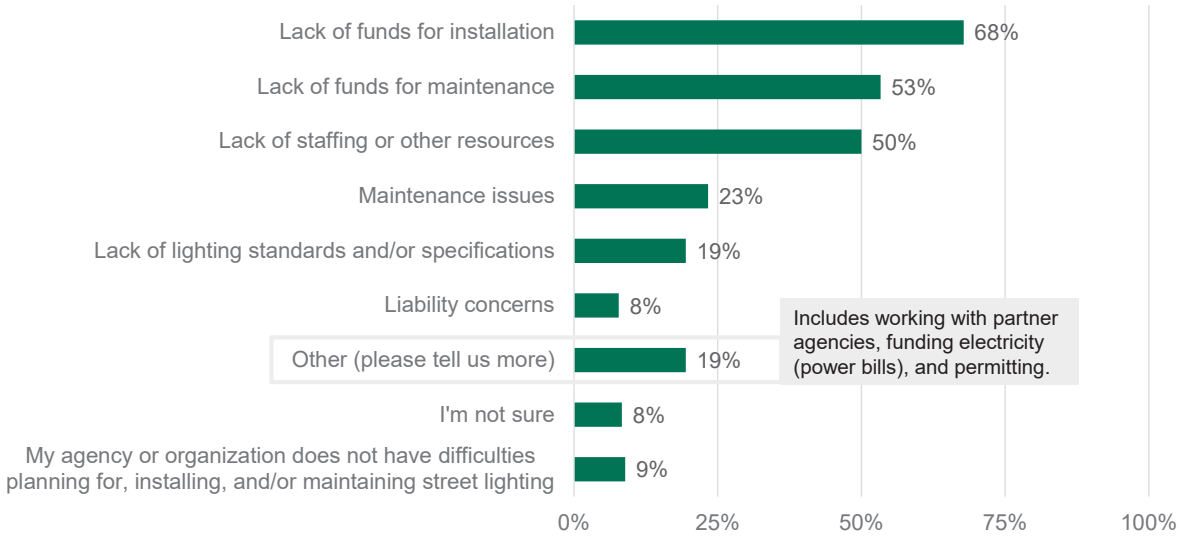
The city pays all costs - both installation and operational expenses. We also have a property tax shortage - so the operational expense of adding lighting can be a burden. We have plans and ideas together to light more areas - but we don't have the money to do all of these projects. – City Government

If it's a wood pole - a single add is not a big barrier. "One light costs about $15 a month" most folks are alright with that - but as that scales up it can be cost prohibitive. – Utility Service Provider

Operation and maintenance costs are an issues more than capital. Switching to LEDs reduced our electrical costs by about 20%, but we've had a bunch of people crash into poles. Our poles are expensive, and people who hit them don't always have insurance – City Government

Lack of funding and staff resources are the most common challenges.

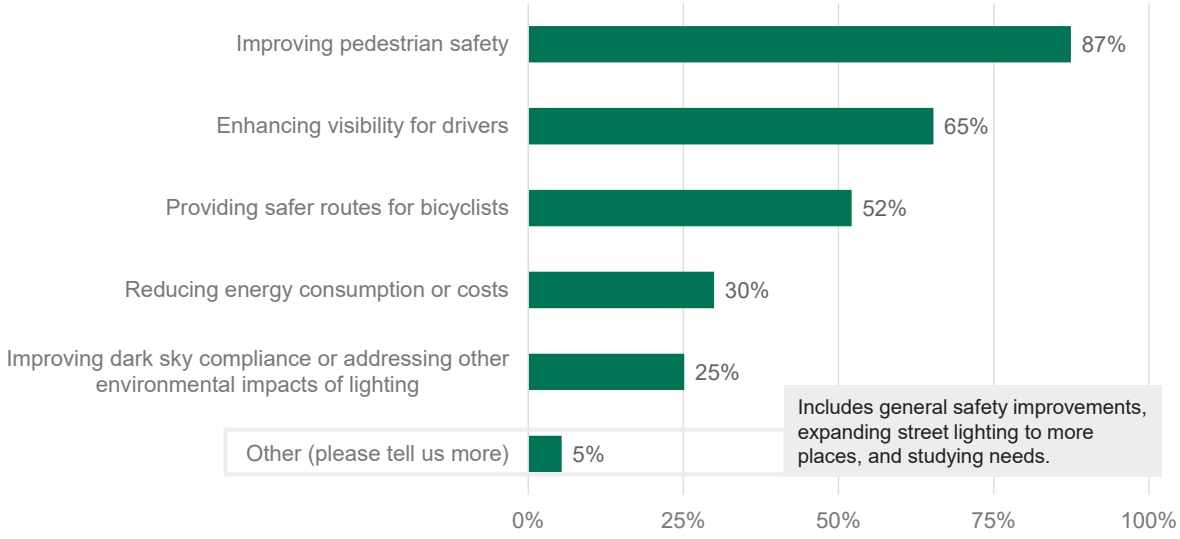
Most survey respondents report difficulties with funding for installation (68%), followed by funding for maintenance (53%) and lack of staffing or other resources (50%).



Q: Which of the following challenges, if any, make it difficult to plan for, install, and/or maintain adequate street lighting? Please select all that apply. (n = 191)

Improving pedestrian safety is a top priority for government respondents.

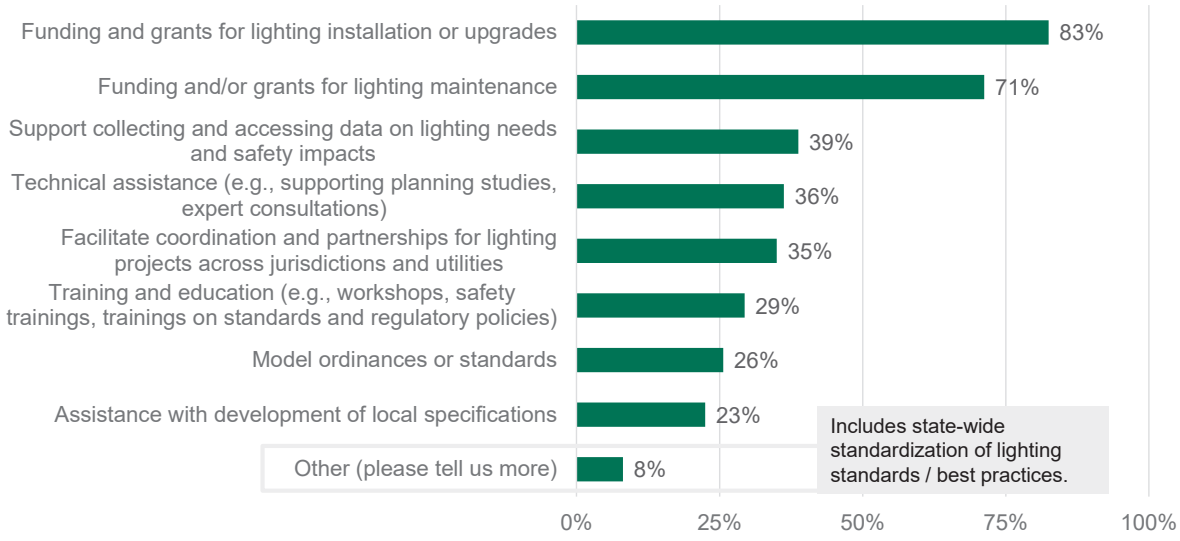
If more funding were available, most respondents (87%) say that improving pedestrian safety would be a top priority for their jurisdiction or service area. Other top priorities include enhancing visibility for drivers (65%) and providing safer routes for bicyclists (52%).



Q: If more funding were available, what would be the top street lighting priorities for your jurisdiction or service area? Please select all that apply. (n = 176)

Funding is the most helpful resource Washington state can provide.

When asked to select the top 5 most helpful resources, 83% selected funding and grants for lighting installation or upgrades (83%) as well as for maintenance (71%).



Q: Which of the following resources could Washington State provide to help your organization or agency install and maintain street lighting to improve pedestrian and bicyclist safety? Please select up to five (5) options that would be most helpful. (n = 165)

Interviewees said the state could improve support and share expertise.

Several from smaller jurisdictions and tribal governments said applying and competing for grants and support can create a barrier.

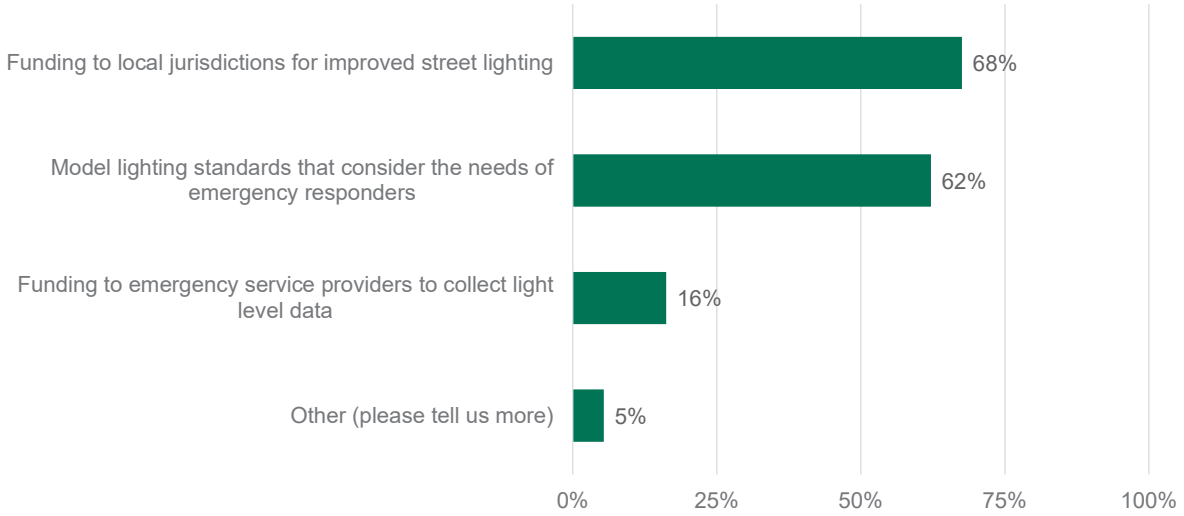
Many respondents said they could benefit from WSDOT sharing expertise of guidance.

Technical support for transportation planning for the tribes could be very helpful. Getting support to work with me on design work could be hugely supportive for projects. Even helping with the planning - transportation and maintenance plans - we're a small shop, but WSDOT have a lot of staff with expertise in these areas, training from them could be really beneficial. - Tribal Government

WSDOT Ped & Bike and Safe ways to school funds have helped, but it's been challenging to win those grants when competing with bigger cities, and I-5 areas, it sometimes feels like the further corridors are not getting much of that funding. Sometimes this is difficult because of the number of hoops and "rings of fire" required to jump through to access some funds - it takes a lot of resources to apply and build applications for many smaller municipal. – City Government

Emergency service providers agree that funding for local jurisdictions and model lighting standards would be most helpful.

Most say that funding to local jurisdictions for improved street lighting (68%) and model lighting standards that consider the needs of emergency responders (62%) are the most helpful resources the state could provide.



Q: Which of the following funding or resources related to street lighting could Washington State provide that would most improve your ability to respond quickly to safety incidents and reduce injuries in your jurisdiction or service area? Please select all that apply. (n = 43)

Open-ended responses: Additional comments

Among the 60 respondents who wrote additional comments, 21 shared requests or priorities, 11 provided additional context about their organization or operations, 10 discussed gaps or lack of lighting in general, and 17 did not have any additional feedback. Top requests include guidance, training, and funding:

- “We'd benefit from clearer guidance, especially for crosswalks. Funding would also help, as always.”
- “WSDOT standards are good, but expensive to implement.”
- “With so many proprietary intelligent light systems available, and each system using its own proprietary network, an agency looking to use intelligent light systems will be locked into one manufacturer. Development of standards for an open-source system at a state or federal level would alleviate this.”
- “Liability is a concern. Providing flexible standards and the ability to remove or reduce lighting levels would be helpful.”
- “Design training would be helpful - standards, design methods, specifications, etc.”
- “Finding training for maintenance crews to learn about the electrical components as well as setting light poles can be difficult to find. It would be great is there was state provided training on that.”
- “WSDOT offered electrical and lighting training a few years ago that was excellent.”
- “Some guidance and expertise on how to find the right kind of consultant, and how to work wit them to do a street lighting retrofit/upgrade would be helpful.”
- “Maintenance and replacing stolen wire is currently our biggest challenge to maintaining the current system. We cannot keep up with replacing stolen wire (copper) with aluminum wire.”
- “County residents often complain about LED road signs, flashing beacons, and anything else that introduces light to their area.”

Q: Is there anything else you would like us to know about street lighting and safety? (n = 60)

Appendix A: Participating organizations and agencies

Aberdeen Fire Dept.
Anacortes Fire Dept.
Avista
Ballard Ambulance
Ballard Services
Bellevue Fire Dept.
Benton County Fire Dist. 4
Benton Rural Electric Association
Burien Fire Dept.
Burlington Fire Dept.
Camas-Washougal Fire Dept.
Chelan County
City of Airway Heights
City of Anacortes
City of Arlington
City of Auburn
City of Battle Ground
City of Bellevue
City of Bellingham
City of Bingen
City of Black Diamond
City of Bremerton
City of Brewster
City of Bridgeport
City of Brier
City of Camas
City of Cashmere
City of Castle Rock
City of Centralia
City of Chehalis
City of Clarkston Fire Dept.
City of Cle Elum Fire Dept.
City of Colfax
City of College Place
City of Colville
City of Cosmopolis
City of Covington
City of Dayton
City of DuPont
City of Duvall
City of East Wenatchee
City of Edgewood
City of Edmonds
City of Ellensburg
City of Elma
City of Enumclaw
City of Everett
City of Federal Way
City of Fife
City of Fircrest Public Works
City of Hoquiam
City of Ilwaco
City of Issaquah
City of Kahlotus
City of Kalama
City of Kelso
City of Kenmore
City of Kent
City of Kirkland
City of Lacey
City of Lake Stevens
City of Langley
City of Liberty Lake
City of Marysville
City of Mercer Island
City of Mill Creek
City of Monroe
City of Montesano
City of Mount Vernon
City of Mountlake Terrace
City of Newcastle
City of Newport
City of Oak Harbor
City of Okanogan
City of Olympia
City of Omak
City of Orting
City of Pasco
City of Pasco Firefighters Union
City of Pateros
City of Port Townsend
City of Poulsbo
City of Pullman
City of Raymond
City of Renton
City of Richland
City of Ridgefield
City of Sammamish
City of Seattle
City of Selah
City of Sequim Public Works
City of Shelton
City of Spokane Valley
City of Stevenson
City of Sumner
City of Sunnyside
City of Tacoma
City of Tekoa
City of Toledo
City of Tonasket
City of Tukwila
City of Tumwater

Continued on next slide…

Appendix A: Participating organizations and agencies

City of Union Gap
City of Vancouver
City of Washougal
City of Waitsburg
City of Walla Walla
City of Wenatchee
City of White Salmon
City of Woodland
City of Yelm
Clallam County Fire Dist. 3
Clark County Fire Dist. 10
Clark County Public Works
Coastal Community Action Program
Columbia County Fire Dist. 3
Columbia REA
Cowlitz 2 Fire & Rescue
Cowlitz County Dept. of Public Works
Cowlitz County Fire Dist. 5
Cowlitz County Planning
Duvall-King County Fire Dist. 45
East Grays Harbor Fire & Rescue
Elmhurst Mutual Power & Light
Ferry County Public Works
Franklin County Emergency Management
Franklin County Public Hospital Dist. 1
Franklin County PUD
Grant County Sheriff's Office
Grays Harbor Council of Governments
Grays Harbor Fire Dist. 8
International Association of Fire Fighters - Local 1296
International Association of Fire Fighters - Local 29
King County
King County Dept. of Local Services
King County Roads
Kitsap County
Kitsap County Public Works
Kittitas County Public Works
Kittitas County PUD
Kittitas Valley Fire & Rescue
Klickitat County EMS Dist. 1
Lake Chelan EMS
Lewis County PUD
Lincoln County
Longview Fire Dept.
Mabton Fire Dept.
Marysville Fire Dist.
Marysville Fire Dist. Regional Fire Authority
Mason County Dept. of Public Works
Mason County PUD 3
Mclane Black Lake Fire Dept.
Mount Vernon Fire Dept.
Mukilteo Fire Dept.
Okanogan Council of Governments
Okanogan County Public Works
Pacific County
Pacific County Dept. of Public Works
Pacific County Economic Development Council
Pacific County Fire Dist. 1
Pacific County PUD 2
Peninsula Light Company
Peninsula Regional Transportation Planning Organization
Pierce County
Pierce County Planning and Public Works
Port of Woodland
Puget Sound Energy
Raymond Fire Dept.
Renton Regional Fire Authority
Richland Fire & Emergency Services
RiverCities Transit
Riverside Fire Authority
SE Thurston Fire Authority
Shoreline Fire
Skamania County
Skamania County Sheriff's Office
Skamania EMS & Rescue
Skokomish Indian Tribe
Snohomish County
Snohomish County Fire Dist. 4
Snoqualmie Indian Tribe
South Bend Police Dept.
South County Fire
South King Fire
South Kitsap Fire and Rescue
Spokane County
Spokane Fire Dept.
Spokane Regional Transportation Council
Stevens County Public Works
Suquamish Citizens Advisory Council
Suquamish Community Advisory Council
Suquamish Tribe
Tanner Electric Cooperative
Thurston County
Thurston County Public Works
Thurston Regional Planning Council
Town of La Conner
Town of Oakesdale
Town of Reardan
Town of South Cle Elum
Town of St John
Town of Starbuck
Town of Yacolt
Tumwater Fire Dept.
Vera Water & Power
Wahkiakum County
Washington State Dept. of Transportation
West Benton Fire Rescue
West Pierce Fire & Rescue
West Region EMS & Trauma Care Council
Whatcom Council of Governments
Whatcom County
Whatcom County PUD 1
White Swan Ambulance
Yakima County Fire Dist. 5

Appendix B: Survey instrument

The Washington State Department of Transportation is gathering feedback from tribes and local jurisdictions, utility service providers, and emergency service providers on the state of street lighting, any identified needs, and potential resources that could support street lighting improvements.

Your feedback will help Washington State Department of Transportation understand the challenges you face regarding street lighting and identify areas where state resources, funding, or technical assistance could provide the most support. By sharing your experiences and priorities, you contribute to the effort to make roads safer and more efficient for all users.

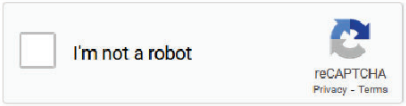
This survey takes about 10 minutes to complete. You can skip questions or choose to stop taking the survey at any time. Information you share will remain confidential and will be used only for research and planning purposes. Please complete the survey by October 16.

Please use the "Back" button at the bottom of each page to return to the previous page. Do NOT use the "Back" arrow in your browser because that will close the survey. If you are using a smartphone or tablet, please scroll all the way to the bottom to complete the full survey.

PRR has been hired to conduct this research. If you have any questions or concerns, please contact research@prrbiz.com

Thank you for your time and valuable input!

Please complete the CAPTCHA to continue:



Appendix B: Survey instrument

What agency or organization do you represent? Please provide the full name (without abbreviations).

What is the ZIP code of the main office of your agency or organization?

Which of the following best describes your agency or organization?

- ○ City or town government
- ○ County government
- ○ Tribal government
- ○ Utility service provider
- ○ Emergency service provider
- ○ Regional Transportation Planning Organization (RTPO)
- ○ Metropolitan Planning Organization (MPO)
- ○ Other (please tell us more):

If selected "Emergency service provider", skip to Slide 51

Which of the following best describes your agency or organization's responsibilities related to street lighting? Please select all that apply.

- ☐ Evaluation of needs, planning, and/or decision-making
- ☐ Installation
- ☐ Maintenance
- ☐ Other (please tell us more):
- ☐ None of the above

What other agencies or organizations, if any, do you partner with and/or share responsibilities with regarding street lighting? Please select all that apply.

- ☐ City or town government
- ☐ County government
- ☐ Regional jurisdiction
- ☐ Tribal government
- ☐ State government
- ☐ Federal government
- ☐ Utility service provider
- ☐ Regional Transportation Planning Organization (RTPO)
- ☐ Metropolitan Planning Organization (MPO)
- ☐ Business districts
- ☐ Other (please tell us more):
- ☐ My agency or organization does not partner with or share responsibilities with any others with regards to street lighting

Appendix B: Survey instrument

Which of the following facilities in your jurisdiction or service area have lighting? Please select all that apply.

- ☐ Roadways
- ☐ Shared-use paths
- ☐ Intersections
- ☐ Pedestrian walkways along roadways
- ☐ Pedestrian walkways not adjacent to roadways
- ☐ On-street bike lanes
- ☐ Other (please tell us more):
- ☐ I'm not sure

For the following questions, consider the street lighting that currently exists in your jurisdiction or service area.

How well does the street lighting in your jurisdiction or service area meet overall needs?

○ Does not meet needs ○ Meets some but not all needs ○ Meets or exceeds needs ○ I'm not sure

How well does the street lighting in your jurisdiction or service area meet the needs of pedestrians?

○ Does not meet needs ○ Meets some but not all needs ○ Meets or exceeds needs ○ I'm not sure

How well does the street lighting in your jurisdiction or service area meet the needs of bicyclists?

○ Does not meet needs ○ Meets some but not all needs ○ Meets or exceeds needs ○ I'm not sure

How well does the street lighting in your jurisdiction or service area meet the needs of drivers?

○ Does not meet needs ○ Meets some but not all needs ○ Meets or exceeds needs ○ I'm not sure

Please describe what specific street lighting needs are unmet in your jurisdiction or service area.

Have you documented your lighting needs in a plan, study, memo, or other report?

- ○ Yes
- ○ No
- ○ I'm not sure

If selected "Yes" or "I'm not sure":

Please tell us more about when, where, and how this documentation was collected, as well as any other information you would like to share.

Which of the following challenges, if any, make it difficult to plan for, install, and/or maintain adequate street lighting? Please select all that apply.

- ☐ Lack of funds for installation
- ☐ Lack of funds for maintenance
- ☐ Lack of lighting standards and/or specifications
- ☐ Maintenance issues
- ☐ Liability concerns
- ☐ Lack of staffing or other resources
- ☐ Other (please tell us more):
- ☐ I'm not sure
- ☐ My agency or organization does not have difficulties planning for, installing, and/or maintaining street lighting.

If your jurisdiction or service area has street lighting, how has installation and maintenance been funded? Please select all that apply.

- ☐ Local government budget (e.g., general fund, public works funding)
- ☐ State grants or funding program (please specify the program if known):
- ☐ Federal funding or grants (e.g., FHWA, USDOT rants)
- ☐ Utility company contributions (e.g., power companies covering installation or maintenance)
- ☐ Special assessment districts (e.g., neighborhood improvement districts, business improvement districts)
- ☐ Private developer contributions (e.g., as part of development agreements or impact fees)
- ☐ Public-private partnerships (e.g., collaboration with businesses or community groups)
- ☐ Bonds or levies (e.g., voter-approved funding measures)
- ☐ Nonprofit or community organization funding
- ☐ Other (please tell us more):
- ☐ I'm not sure

If more funding were available, what would be the top street lighting priorities for your jurisdiction or service area? Please select all that apply.

- ☐ Improving pedestrian safety
- ☐ Enhancing visibility for drivers
- ☐ Providing safer routes for bicyclists
- ☐ Reducing energy consumption or costs
- ☐ Improving dark sky compliance or addressing other environmental impacts of lighting
- ☐ Other (please tell us more):

Appendix B: Survey instrument

What programs, policies, or facilities have been implemented in your jurisdiction or service area to improve pedestrian and/or bicyclist safety? Please select all that apply.

- ☐ Active transportation plan, bike plan, pedestrian plan, or non-motorized plan
- ☐ Safe Streets and Roads for All plan, Local Road Safety Plan, or other general safety plan
- ☐ Complete Streets policy or plan
- ☐ Other (please tell us more):
- ☐ I'm not sure

Has your jurisdiction or service area adopted or is it considering adopting new technologies for street lighting (e.g., LED, smart lighting, motion sensors)?

- o Yes
- o No
- o I'm not sure

If selected "Yes" or "I'm not sure":

What technologies are being implemented or considered?

What standards do you use for setting light levels, pole installation, lighting fixture selection, or others? Please select all that apply.

- ☐ WSDOT Design Manual
- ☐ IES RP-8
- ☐ AASHTO
- ☐ FHWA
- ☐ My organization or agency's own standards and specifications
- ☐ Other (please tell us more):
- ☐ I'm not sure

Which of the following resources could Washington State provide to help your organization or agency install and maintain street lighting to improve pedestrian and bicyclist safety? Please select up to five (5) options that would be most helpful.

- ☐ Funding and grants for lighting installation or upgrades
- ☐ Funding and/or grants for lighting maintenance
- ☐ Model ordinances or standards
- ☐ Assistance with development of local specifications
- ☐ Technical assistance (e.g., supporting planning studies, expert consultations)
- ☐ Training and education (e.g., workshops, safety trainings, trainings on standards and regulatory policies)
- ☐ Facilitate coordination and partnerships for lighting projects across jurisdictions and utilities
- ☐ Support collecting and accessing data on lighting needs and safety impacts
- ☐ Other (please tell us more):

Appendix B: Survey instrument

Respondents who did not select "Emergency service provider" on slide 40, skip to slide 54.

How does street lighting or the lack of street lighting affect your ability to respond quickly to safety incidents and reduce injuries? Please select all that apply.

- ☐ Difficulty navigating to the location of the emergency and increased response times
- ☐ Limited visibility to operate at the location of the emergency
- ☐ Increased risk from others due to poor visibility (e.g., other drivers passing roadside incidents)
- ☐ Other (please tell us more):
- ☐ Street lighting in my area does not impact my ability to respond quickly to safety incidents and reduce injuries

Appendix B: Survey instrument

Do you currently collect data on pedestrian or traffic safety and its relationship to street lighting in your jurisdiction or service area (for instance, light levels at crash locations)?

- ○ Yes
- ○ No
- ○ I'm not sure

If selected "Yes" or "I'm not sure":

What types of data are collected and how is this data used?

Where would additional street lighting most help improve your ability to respond quickly to safety incidents and reduce injuries? Please select all that apply.

- ☐ At intersections
- ☐ Along major roadways
- ☐ In pedestrian-heavy areas
- ☐ Along bicycle paths
- ☐ Other (please tell us more):
- ☐ Additional street lighting would not impact my ability to respond quickly to safety incidents or reduce injuries

Which of the following funding or resources related to street lighting could Washington State provide that would most improve your ability to respond quickly to safety incidents and reduce injuries in your jurisdiction or service area? Please select all that apply.

- ☐ Funding to local jurisdictions for improved street lighting
- ☐ Model lighting standards that consider the needs of emergency responders
- ☐ Funding to emergency service providers to collect light level data
- ☐ Other (please tell us more):

Appendix B: Survey instrument

Is there anything else you would like us to know about street lighting and safety?

The research team may conduct additional post-survey interviews. Are you interested in sharing more about street lighting?

- o Yes, I am interested in participating in future research.
- o No, I am not interested at this time.

If selected "Yes, I am interested in participating in future research.":

Please provide your contact information below. This information will only be used to contact you for future research and will not be connected with your survey response.

First Name
Last Name
Title/Position
Organization/Agency
Email Address
Phone Number

Thank you for your feedback!

Appendix C: Interview Guide

WELCOME & INTRO

Key points:

- Introductions
- Purpose:
  - The Washington State Department of Transportation is gathering feedback from Washington's tribes and local jurisdictions, utility service providers, and emergency service providers on the state of local street lighting, identified needs, and potential resources that could support street lighting improvements in their service areas.
  - Report will include actionable recommendations to improve lighting practices across the state.
- Interview length: about 30 minutes, 40 max
- Notes/Recording:
  - Will not be recording
  - Will be taking notes, will mostly aggregate feedback
  - May attribute meaningful quotes

QUESTIONS

Roles & Responsibilities

1. I know that you're the (Role) at (Jurisdiction). Could you tell me a little about what responsibility you and your agency have for lighting in the area?
2. Many jurisdictions share responsibility with other agencies (the state, county, local public utility, etc.). Do you share responsibility for lighting with any other agencies?
   a. If so, does this cause any issues or differences in coverage? (For example, do you get calls about lighting issues on state roads? Or find that private roads are better/worse/inconsistently lit, compared to local roads, etc.)
3. EMS ALT – Does your agency participate in any decision-making regarding lighting in the jurisdiction?

Meeting Needs

In our statewide survey we saw that most folks say lighting meets "some but not all needs" in their jurisdiction. However, this varies by user… [numbers updated as survey results updated]

- Overall
  - 78% meets some needs
  - 11% meets or exceeds needs
- For Pedestrians
  - 75% say meets some needs
  - 7% say meets or exceeds needs
- For bicyclists
  - 66% say meets some needs
  - 8% say meets or exceeds
- For drivers
  - 69% say meets some needs
  - 21% say meets or exceeds needs

4. Do these general findings align with how you think about lighting in your community – that it most strongly meets the needs of drivers, somewhat less for pedestrians, and somewhat less than that meets the needs of bicyclists?
   a. Can you give some general examples of how these needs are being met at different levels?
   b. Do you have a sense of why these vary?
      i. Do lighting standards impact how these varying needs are met/privilege cars? Etc.
5. EMS ALT – Does your agency track trends regarding pedestrian, bicycle, or vehicle safety?
   a. Does any of this tracking include assessing lighting conditions?
   b. How does lighting impact how you do your work?

Appendix C: Interview Guide

Funding & Other Needs

More than two-thirds of survey respondents told us that funding is a barrier to installing more lighting, more than 50% said funding impacts maintenance and a similar number said staffing or other issues have similar impacts…

6. How is lighting funded in your community?
    a. Are there differences between how installation and maintenance are funded? Do you see the impacts of these differences?
7. Do you feel like funding is adequate? How do you think you would prioritize additional funds if they were made available?
8. Survey respondents told us they fund lighting from many different sources (local, state, and federal resources, private developers, utility companies, and to a lesser extent public-private arrangements, or non-profits.
    a. Do you feel like you/your jurisdiction has a good understanding of how each of these groups could support funding for lighting? Are there any sources you're surprised to see on this list and would be interested to learn more about working with?
9. Are there other resources, tools or forms of assistance that could be useful for meeting lighting needs in your community?
10. EMS ALT – What types of lighting improvements would you recommend that your jurisdiction prioritize? What do you think would be the impacts of adding or improving lighting in this way?

Closing Comments

11. Knowing that we're using what we hear in these interviews to help state leaders understand the lighting needs of local communities, and how the state can be more supportive, is there anything else you feel like leaders should know about lighting needs in your community or challenges you face, etc.?

Appendix C: Design Guidance Summary

The presence and effectiveness of street lighting significantly affects the safety of pedestrians and other vulnerable road users. Just as roadway design and operations are crucial for safe transportation systems, lighting criteria and guidance play an equally important role. Although many lighting-specific design guides and standards exist at the national and state levels, Tribes and local jurisdictions may not know of or have access to these documents. Washington State could address this gap by developing targeted guidance and enhancing access to existing resources for local jurisdictions.

Among the top three most referenced lighting-specific design guidelines for pedestrian and bicycle facilities, only the FHWA *Pedestrian Lighting Primer*[1] is publicly available online. In contrast, ANSI/IES RP-8-22 *Recommended Practice: Lighting Roadway and Parking Facilities*[2] and the AASHTO *Roadway Lighting Design Guide*[3] must be purchased at a high cost, limiting access for local jurisdictions with limited resources.

Even when local jurisdictions have access to these resources, significant staff time and effort are required to navigate them and identify the guidance most applicable to their specific needs. This challenge often limits the effective implementation of lighting standards, particularly in smaller local jurisdictions with constrained resources.

To support Tribes and local jurisdictions more effectively, Washington State could:

1. Develop a location for best practices and existing WSDOT resources, such as a web landing page.
2. Publish clear, specific guidelines for assessing and implementing lighting for pedestrian and bicycle facilities across Washington State. This would include guidance on how to establish evaluation criteria and processes for building, improving, and maintaining lighting.
3. Provide technical support and design assistance tailored to local needs.
4. Offer tools and resources that help local jurisdictions develop their own local lighting standards.

The remainder of this memorandum summarizes lighting-specific design guidance based on a review of lighting standards and recent journal publications for pedestrians and bicyclists. Additional references and recent publications beyond the key sources herein are summarized at the end of this memo.

Lighting Design Standards & Guidance

This section provides an overview of current practice, highlighting the most referenced lighting-specific design guidance for pedestrian and bicycle facilities, as well as new findings that have emerged in recent journal publications. Design guidance ranges from contextual information on bicycle and pedestrian networks and lighting theory to guidance on specific practices such as lighting placement, markings, and illuminance levels. Journal publications range from the effects of glare and visibility on safety to the relationship between average lighting levels and nighttime crash risk.

The most referenced lighting-specific design guidance and standards for pedestrian and bicycle facilities are the following sources:

- ANSI/IES RP-8-22 *Recommended Practice: Lighting Roadway and Parking Facilities* (2022)
- AASHTO *Roadway Lighting Design Guide*, Seventh Edition (2018)
- FHWA *Pedestrian Lighting Primer* (FHWA-SA-21-087, 2022)

Additionally, the *Multimodal Design Guide*[5] from the Ohio Department of Transportation provides a useful example of statewide lighting guidance, as it captures information from the forthcoming AASHTO *Guide for Development of Bicycle Facilities* (2024). Table 5 provides a summary of the type of lighting-specific design guidance and standards available in each of the primary resources reviewed herein, as well as the additional resources that can be used to supplement this guidance. The following section includes further detailed information on each resource.

Table 5: Summary of Lighting Design Guidance Resources

Resource	Planning Guidance	Illuminance Values/Criteria	Pedestrian Scale Lighting Guidance	Bicycle Lighting Guidance
Primary Lighting Resources				
ANSI/IES RP-8-22 Recommended Practice: Lighting Roadway and Parking Facilities (2022)		X	X	
AASHTO Roadway Lighting Design Guide, Seventh Edition (2018)		X		
FHWA Pedestrian Lighting Primer (FHWA-SA-21-087, 2022)		X	X	
Multimodal Design Guide, Ohio Department of Transportation (2023)			X	X
Design Manual, WSDOT (2024)		X	X	X
Lighting of Non-Motorized Facilities				
Roadway Visibility Research Needs Assessment, FHWA (2016)	X			
Guide for the Development of Bicycle Facilities, Fourth Edition, AASHTO (2012)			X	X
Urban Bikeway Design Guide, Second Edition, NACTO (2014)	X			
Integrated Solar Lighting for Pedestrian Crosswalk Visibility, Florida DOT (2016)			X	

Resource	Planning Guidance	Illuminance Values/Criteria	Pedestrian Scale Lighting Guidance	Bicycle Lighting Guidance
Other Design Guidance				
Active Transportation Programs Design Guide, WSDOT (2024)			X	X
Lighting Handbook, FHWA-SA-23-004 (2023)	X		X	X
Informational Report on Lighting Design for Midblock Crosswalks, FHWA (2008)		X	X	
Guide for the Design of Roadway Lighting, Transportation Association of Canada (2006)	X	X	X	X

ANSI/IES RP-8-22 Recommended Practice: Lighting Roadway and Parking Facilities (2022)

This ANSI/IES report provides some of the most detailed guidance on recommended lighting values (luminance, uniformity ratio, glare) for various facility types, including for walkways and bikeways. The document addresses the lighting needs of walkways and bikeways adjacent to roadways when the roadway is continuously illuminated. Other documents from IES, such as *ANSI/IES LP-2-20 Designing Quality Lighting for People in Outdoor Environments,* capture the needs of pedestrians away from the road.

- Local agencies and professionals turn to RP-8-22 as the primary standard for pedestrian-oriented illumination recommendations along roadways.
- RP-8-22 is a compilation of lighting design techniques and criteria used to help implement high quality roadway lighting solutions.
- The best practice is for each chapter not to be taken in isolation but used as a whole to design high quality lighting for roadways and other environments where vehicles are present, such as tunnels, intersections, and parking lots.
- Within RP-8-22, guidelines for walkways and bikeways are covered in *Chapter 11: Street Lighting*. This chapter serves "as the basis for the design of continuous fixed lighting for streets, adjacent bikeways, and pedestrian ways within the public right of way."[6]
    - *Section 11.2: Walkways and Bikeways in the Public Right of Way* notes "where walkways and bike lanes are located adjacent to the street, spillover light from the streetlights may contribute to the illumination of these areas. However, the lighting for the street may not produce the required lighting for pedestrians or cyclists, and additional lighting may be required."
    - *Section 11.6.1: Streets – General Recommendations* discusses luminance, illuminance, and small target visibility as the three methods for evaluating effective street lighting design.

    - *Section 11.6.2 Pedestrian Walkways and Bikeways – General Recommendations* explains that "the design criteria for lighting pedestrian walkways and bikeways are based on horizontal and vertical illuminance". The section goes on to discuss how to accomplish horizontal illuminance to provide visibility of bikeway and walkway surfaces and their boundaries.
    - Chapter 11 notes that guidance for lighting warrants[7] is provided in the AASHTO Roadway Lighting Design Guide and FHWA Lighting Handbook.
- *Chapter 12: Intersections, Roundabouts, and Crosswalks* also discusses vertical illumination at intersection and midblock crosswalks to improve pedestrian visibility.

AASHTO Roadway Lighting Design Guide, Seventh Edition (2018)

AASHTO's Roadway Lighting Design Guide is also a commonly referenced source for local agencies and professionals, as it provides recommended illuminance values for walkways and bikeways.

- *Chapter 3: Techniques of Lighting Design* includes *Section 3.4: Streets and Highways Other Than Freeways (Including Walkways and Bicycle Ways),* with sub sections for *Warning Conditions*, *Lighting Design Levels*, and *Other Considerations*.
    - "AASHTO has decided not to establish specific warrants for the installation of roadway lighting that satisfy all conditions. Other agencies such as the Federal Highway Administration (FHWA) and the Transportation Association of Canada (TAC), have published guidelines and methodologies for establishing warrants on most road types. Lighting designers and agencies should refer to these documents when establishing their own policies."[8]
- Suggested lighting design values for continuous lighting at non-intersections are provided in Tables 3-5a *Illuminance and Luminance Design Values (U.S. Customary)* and 3-5b *Illuminance and Luminance Design Values (Metric)*. These tables include values for adjacent but separated pedestrian and bike facilities. The tables note to use roadway design values if the walkways and bikeways are adjacent to a roadway.

Pedestrian Lighting Primer, FHWA-SA-21-087 (2022)

This document provides an overview of the lighting design process with guidance on lighting values. The primer states "lighting for pedestrian areas that do not cross and are not adjacent to or within a roadway" are not the focus of the primer as they are "designed to meet a different set of objectives and criteria, as no vehicle-to-pedestrian interaction is anticipated."[9]

- The primer is specifically geared toward lighting of pedestrian facilities and provides an overview of the lighting design process, guidance on lighting values, as well as a design example that details a typical scenario for assessing the lighting needs of a pedestrian facility.
- Regarding separated pedestrian walkways, "Lighting for pedestrian areas that do not cross and are not adjacent to or within a roadway are not the focus of this primer and are anticipated in other, upcoming informational resources."
- RP-8-22 does not reference the FHWA Pedestrian Lighting Primer FHWA-SA-21-087, though it does reference the FHWA Lighting Handbook FHWA-SA-11-22 012.

Multimodal Design Guide, Ohio Department of Transportation (2023)

The Ohio Department of Transportation's Multimodal Design Guide captures information from the forthcoming AASHTO Guide for Development of Bicycle Facilities (2023) and includes information about

street lighting and bicyclists' needs in the context of the streetscape. The Ohio DOT Multimodal Design Guide incorporates more lighting-specific information than NACTO's Urban Bikeway Design Guide and Urban Street Design Guide.

- Includes information on developing connected bicycle and pedestrian networks and addresses topics such as comfort and safety of facilities in different contexts.
- Includes illumination guidance in pedestrian facilities chapter.
- Chapter 3. Elements of Design, Section *3.7.2. Lighting* emphasizes the importance of lighting in perceived and real safety, and it's influence on people's decisions to walk or bike.
    - Notes that fixed-source lighting improves visibility and lists locations where a provision of lighting should be considered.
    - Outlines pedestrian-scale lighting characterization such as shorter light poles, lower levels of illumination, and closer spacing to address issues of social safety and visibility of people walking and biking.
    - Mentions placing light poles to provide horizontal and vertical clearance from walkways and bikeways.
    - Mentions light fixture compliance with "dark sky" guidelines and awareness of environmental disturbance.
    - Refers the reader to additional guidance in the AASHTO *Roadway Lighting Design Guide* and the Ohio Traffic Engineering Manual (TEM) *Section 1100.*
- Chapter 4. Pedestrian Facilities
    - Section *4.5.6 Illumination* references the Ohio Traffic Engineering Manual (TEM), *Section 11000* for *1103-6.3 Pedestrian Walkways* and *1140-4.6.4 Pedestrian Bridges*.
- Chapter 5. Shared Use Paths
    - Section *5.5 Path Amenities*: "Lighting should be provided at conflict points such as intersection or mid-block crossings, transit stops, and other areas based on land use context and expected user volumes. Lighting may also be needed along the lengths of shared use paths to improve safety and security for paths that are open during evening hours."[10]
- Chapter 10. Transit Facilities
    - Section *10.3.5 Bus Stop Amenities* discusses lighting considerations for bus stops and shelters.

Recent Journal Publications

While design guidance documents integrate some academic research, new findings continue to emerge in recent journal publications. These studies cover topics such as the effects of glare and visibility on safety, comparisons between drivers' perceived visibility and actual visual performance, the relationship between average lighting levels and nighttime crash risk, and cost-effective lighting solutions.

These publications are not referenced in ANSI/IES RP-8-22 *Recommended Practice: Lighting Roadway and Parking Facilities* (2022). Recent publications such as these could inform targeted updates to guidance, helping local jurisdictions incorporate the latest research into practical design improvements.

Roadway Lighting's Effect on Pedestrian Safety at Intersection and Midblock Crosswalks, Illinois Center for Transportation (2021)

- This study looked at three light levels and analyzed the visual performance of drivers at four different intersection lighting configurations and five midblock crosswalk lighting configurations, as well as intersections with rectangular rapid flashing beacons and flashing signs.
- The study found that the lighting design and light level influenced driver's nighttime visual performance at both types of crossings.
- The authors recommend specific average horizontal illuminance for several situations; for example, "when the exits of the intersection are illuminated, an average horizontal illuminance of 24 lux (2.2 fc) is needed to offset the disability glare from opposing vehicles."[11]

Modeling effects of roadway lighting photometric criteria on nighttime pedestrian crashes on roadway segments, Journal of Safety Research (2023)

- This study aimed to investigate the relationship between nighttime crash risk and average lighting level and uniformity in Florida roadway segments.
- The study concluded that by increasing average light levels on a roadway segment, the likelihood of nighttime pedestrian crashes on midblock segments tends to decrease.
- The authors developed more significant crash modification factors (CMFs) for average lighting levels, which were underestimated in previous studies. The CMFs can be used in nighttime pedestrian safety management and street lighting assessment.

Pedestrian Fatalities in Darkness: What Do We Know, and What Can Be Done? Transport Policy (2022)

- Seeks to understand the correlation between severe pedestrian injuries and darkness by evaluating data on pedestrian fatalities and serious injuries in California and pedestrian fatalities at a national level between 2012 and 2017.
- The authors found that variables related to roadway design and operations, rather than speeding, correlated with nighttime pedestrian fatalities and serious injuries.
- The study concludes that designs must specifically consider pedestrian safety at night, especially on high speed, multi-lane roads.

Additional Lighting Resources

This provides further lighting references, grouped by recent publications, bicycle-specific guidance, general design guidance and other resources.

Recent Publications

This section summarizes recent academic research and journal publications.

Examining the Impact of Different Street Lighting Schemes on Traffic Safety and Drivers' Behaviors at Unsignalized Intersections, Master's Thesis, Louisiana State University (2023)

- Failure to yield at roundabouts and stop-controlled intersections paired with a lack of lighting was a significant factor affecting the number of injuries and fatalities in nighttime crashes in Louisiana.
- Seventy two percent of states do not require lighting at stop-controlled intersections and 67% require lighting at roundabouts.
- The study concluded that lighting improves drivers' safety and behavior, and it is recommended that full lighting be provided at roundabouts and stop-controlled intersections.

- If this is not possible, the author recommends that low-cost countermeasures be implemented, referencing reflective pavement markings/markers and signage.

Effect of Intersection Lighting Design on Drivers' Perceived Visibility and Glare, TRB (2019)

- This study evaluated the effects of intersection lighting designs on perceived visibility and minimizing glare.
- Twenty-four participants (equal numbers of 18–25-year-olds and 65+ year olds) were exposed to different lighting designs in a realistic intersection and asked to indicate how much they agreed or disagreed with statements regarding the lighting levels (e.g. "The pedestrian is clearly visible" and "I experienced glare when approaching the intersection")[12]. Three intersection lighting designs were evaluated, a "Lighted Approach", "Lighted Box", and "Lighted Approach and Box". The lighting design that led to the highest levels of perceived visibility and the lowest level of glare was the "Lighted Box".
- The study concludes that there are benefits to illuminating the intersection box.

Study on Illumination for State Highways, WSDOT (2016)

- WSDOT's 2016 study evaluates how the department can reduce costs on illumination in the wake of budget pressures.
  - In particular, the study looks at the use of more efficient LED luminaire technology and implementing more judicious illumination.
- This study summarizes the design standards for City of Seattle, New York City DOT, CalTrans, Minnesota DOT, TxDOT, Transportation Association of Canada, Oregon DOT, Illinois DOT, and City of Los Angeles.

Drivers' Judgments of the Effect of Headlight Glare on Their Ability to See Pedestrians at Night, Journal of Safety Research (2015)

- Two experiments were conducted to understand how accurate or inaccurate drivers' judgements of pedestrian position were with different amounts of headlight glare.
  - Participants estimated how far away a person on the side of the road was, and then participants responded to a pedestrian on the side of the road.
- In both tests, participants overestimated conspicuity and their ability to see the pedestrian.
- The study concludes that motorists likely act in ways that increase the risk of nighttime collisions with pedestrians because motorists overestimate their ability to see pedestrians at night.

Drivers' Yielding Behavior at Crosswalks with Varying Treatments During the Day and Night, TRB (2017)

- This study analyzed the difference in driver yield rates at three types of crosswalks (marked crosswalk, marked crosswalk enhanced with pedestrian crossing signs, and marked crosswalk with pedestrian-activated overhead flashing beacon), under daytime and nighttime conditions.
  - This included recording speed and street illumination data.
- The authors found that drivers approach crosswalks at a faster speed at night than in daylight, and that the driver yield rate dropped significantly at night at all three types of crosswalks.

Lighting of Bicycle Facilities

This section summarizes publications that address lighting guidance and standards for bicycle facilities.

Roadway Visibility Research Needs Assessment, FHWA (2016)

- Reviews issues related to nighttime visibility and provides an assessment of the Federal Highway Administration (FHWA) Office of Safety's three safety program areas:
    1. roadway departure safety,
    2. intersection safety, and
    3. pedestrian and bicycle safety
- Considers how the programs address concerns for nighttime visibility, as well as a review of fatality data and a gap analysis for research needs.
- In addition to the assessment of the three program areas, this report provides a survey of practices and policies of highway design, traffic engineering, and highway safety that are based on daytime conditions and may neglect issues and concerns that arise from nighttime conditions.

Guide for the Development of Bicycle Facilities, Fourth Edition, AASHTO (2012)

- Provides guidance to designers and planners for how to accommodate bicycle travel and operations in most riding environments.
- Chapter 5 *Design of Shared Use* Paths, Section 5.2.12 *Lighting* includes recommendations for whether to light facilities based on permitted nighttime use. This section also discusses the use of pedestrian scale lighting instead of tall, highway-style lamps, as well as guidelines for light pole placement.

Urban Bikeway Design Guide, Second Edition, NACTO (2014)

- Provides contextual guidance for bikeway design and treatments, including chapters on bike lanes, cycle tracks, intersections, signals, signing and marking, and bicycle boulevards.
- Most of the treatments in this document are permitted under the Manual on Uniform Traffic Control Devices (MUTCD).
- 3rd edition to be released 1/14/2025.

Integrated Solar Lighting for Pedestrian Crosswalk Visibility, Florida DOT (2016)

- This report is written for the Florida Department of Transportation (FDOT) to aid in their assessment of the viability of solar-powered lighting of pedestrian crosswalks or other traffic bearing areas (such as parking lots, shared-use paths, multi-use trails) to enhance safety.
- The goal of solarized crosswalks is to provide power for luminaires and/or integrated lighting that can maintain service during power failures and in remote areas without nearby electrical utilities.

Design Guidance

This section summarizes lighting specific design guidance and other design guides that have specific lighting standards.

Lighting Design Guides

Active Transportation Programs Design Guide, WSDOT (2024)

- Summarizes guidance from the FHWA Lighting Primer relevant to pedestrian and bicyclists' illumination at intersections and along facilities.

Lighting Handbook, FHWA-SA-23-004 (2023)

- Provides detailed guidance on the different elements of lighting design.

- Includes warranting for pedestrian/bicycle facilities and a design example for a walkway/bikeway.
- It is not intended to be a detailed design guide but serves primarily as a resource for policy makers and designers to evaluate potential needs, benefits, and applicable references when considering a roadway or street lighting system.
- This is an update to the FHWA Lighting Handbook FHWA-SA-11-22 012.

Informational Report on Lighting Design for Midblock Crosswalks, FHWA (2008)

- Provides guidance on lighting placement and illuminance levels needed at midblock crossings.

Guide for the Design of Roadway Lighting, Transportation Association of Canada (2006)

- Provides guidance in the planning and design of roadway lighting and related outdoor lighting systems in Canada.
- The Fundamentals section contains information on lighting theory, obtrusive light, the planning and design process, standards and codes, calculations and the use of computer software in roadway design and maintenance.
- The Design section applies the principles and information presented in the first section to specific facilities that may require lighting (including pedestrian and bicycle pathways).

Other Resources

Design Manual, WSDOT (2024)

- Chapter 1040 *Illumination* outlines the responsibilities of WSDOT and local agencies when it comes to lighting, with Section 1040.08 *Pedestrian Facility Lighting* discussing lighting for walking and rolling.
- Where the local agency does not have light level or spacing requirements, WSDOT light level requirements are used; WSDOT does not provide illumination for separated pedestrian facilities such as isolated sidewalks or shared use paths with the exception of specific tunnels.

MUTCD 11th Edition (2023)

- Provides guidance on pavement markings: “Pavement markings on bicycle facilities that must be visible at night or in low-light conditions shall be retroreflective unless the markings are adequately visible under provided lighting.”[13]

Urban Street Design Guide, First Edition, NACTO (2013)

- Outlines design principles and strategies to design spaces for people, including international best practices and research in urban design, planning, and engineering.
- Includes chapters on streets & intersections, critical issues, and treatments & elements.

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Appendix D: Lighting Technology Summary

Introduction and Purpose

This memo provides a comprehensive evaluation of street lighting solutions to enhance the safety of pedestrians and other vulnerable road users. A central focus of the study is the impact of LED (light-emitting diode) lighting technology on both safety and sustainability.

The report is structured around a detailed assessment of national best practices in lighting technology, including examining advancements, effectiveness, and equipment longevity in lighting solutions. By exploring these components, the report seeks to provide actionable insights that can inform better lighting practices and contribute to a safer, more environmentally conscious urban infrastructure.

Lighting Technology

This section presents the findings from a comprehensive review of WSDOT guidelines and national best practices concerning lighting technology, with a specific focus on pedestrian and bicycle users. The subsequent sections provide an in-depth discussion of these best practices across various lighting technologies highlighting innovative approaches and effective solutions that set the standard for excellence in lighting design and implementation.

Current WSDOT Lighting Guidelines

The Washington State Department of Transportation (WSDOT) lighting guidelines provide a framework for both general and specific lighting applications on WSDOT facilities, including those relevant to pedestrian areas. This section includes comprehensive reviews of WSDOT's general lighting guidelines, whether they offer sufficient direction to support best practices in pedestrian lighting, and distinctions made between highway and pedestrian lighting requirements outlined in the WSDOT Design Manual (2023).

Chapter 100 of the WSDOT Design Manual notes that the policy within it is developed primarily for use with WSDOT-owned transportation facilities on interstate and state highways (as defined by Revised Code of Washington [RCW] 47.17) and may not be suitable for projects on county roads or city streets. Chapter 100.05 also notes that “local jurisdictions are free to adopt this manual for their own local criteria or to develop specialized guidance for facilities not on state highway routes.”

There are three common scenarios where local jurisdictions use the WSDOT Design Manual for lighting policy:

1. The WSDOT facility runs through a local jurisdiction; the local jurisdiction has its own lighting policy but due to the nature of the project, WSDOT Design Manual lighting policy supersedes.
2. The WSDOT facility runs through a local jurisdiction; the local jurisdiction relies on WSDOT Design Manual lighting policy.
3. The local jurisdiction does not have its own lighting policy and has adopted WSDOT Design Manual lighting policy.

The Design Manual offers flexibility in addressing unique or uncommon situations, but since it is intended for state highways there are many lighting scenarios that are not specifically covered. It includes processes for documenting the rationale behind design decisions made in such cases.

Local jurisdictions that do not adopt the WSDOT Design Manual for lighting policy, several other national lighting guidelines are often applied, such as:

- ANSI/IES RP-8-22 *Recommended Practice: Lighting Roadway and Parking Facilities* (2022)
- AASHTO *Roadway Lighting Design Guide, Seventh Edition* (2018)
- FHWA *Lighting Handbook* (2023)

By evaluating the WSDOT lighting guidelines alongside the various options available to local jurisdictions, this review aims to provide a nuanced understanding of how well these standards support the diverse needs of all roadway users, particularly in nonmotorized areas.

General Lighting Guidelines

WSDOT has developed a set of comprehensive lighting guidelines aimed at ensuring safety, visibility, and energy efficiency across various transportation environments (WSDOT 2023).

WSDOT is generally responsible for illumination on state highways except within the limits of an incorporated city or town. WSDOT is responsible for the illumination of all freeways and their interchanges, with cross street lighting management dependent upon additional factors related to jurisdiction and limited access.

WSDOT has outlined different sets of lighting requirements for conventional roadways, freeways or expressways, and other locations such as pedestrian facilities, parking lots, and work zone areas that are not covered by another design area (WSDOT 2023, Chapter 1040.10). Key elements of the general lighting requirements include:

- **Minimum light level** (footcandles [fc]). The lowest light intensity allowed within the design area must be at least 0.2 fc at any point.
- **Minimum average light level** (fc). This is the average light intensity across the entire design area.
- **Uniformity ratio** (unitless). This measures how even the light levels are throughout the area, and it is calculated by dividing the minimum average light level by the minimum light level. Any location with more than one light pole (source) is evaluated for uniformity.
- **Maximum veiling luminance ratio** (unitless). Average veiling luminance is used as a metric to evaluate and design lighting systems in a way that minimizes glare and enhances visibility for road users. The maximum veiling luminance ratio indicates the amount of disability glare produced by the lighting system, and it is calculated by dividing the maximum veiling luminance by the average luminance. Veiling luminance is not measured on sidewalks or roadway shoulders.

Requirements for these light levels vary based on roadway type and nighttime activity classification. Details are outlined in Exhibit 1040-44 through Exhibit 1040-46 in the WSDOT Design Manual.

The nighttime activity is categorized into three activity levels in the WSDOT Design Manual (2023):

- **High activity.** These are areas where more than 100 pedestrian crossings occur over a one-hour period during hours of darkness at any time of the year. These are typically urban core retail or event areas such as shopping districts, stadiums, concert venues, major transit centers, and their associated parking areas. This classification corresponds with ANSI/IES RP-8-18 High Pedestrian Conflict Areas.

- **Medium activity.** These are areas where 11 to 100 pedestrian crossings occur over a one-hour period during hours of darkness at any time of the year. Most basic urban and suburban areas with less dense commercial districts fall into this category. This category is the default standard unless justification can be provided for using the High or Low Activity classifications. This classification corresponds with ANSI/IES RP-8-18 Medium Pedestrian Conflict Areas.

- **Low activity.** These areas are where 10 or fewer pedestrian crossings occur over a one-hour period during hours of darkness at any time of the year. These are typically low density suburban or rural areas with low housing density, little retail activity, or farms. This classification corresponds with ANSI/IES RP-8-18 Low Pedestrian Conflict Areas. Lighting design areas with sidewalks or marked crosswalks cannot be classified as Low Activity Areas.

WSDOT's standard luminaires are LED cobra-head fixtures with IESNA[8] Type III distribution patterns. Although these are LED fixtures, they are classified based on their equivalent wattage to high-pressure sodium (HPS) lamps, with standard classifications of 200 W, 250 W, 310 W, and 400 W. Lighting analysis is performed using a benchmark luminaire for each wattage class, permitting any approved LED luminaire within that class.

WSDOT does not implement adaptive lighting systems because highway lighting is linear as opposed to a city grid system. Currently, to manage continuous lighting effectively, lighting needed to cover basic required lighting design areas must be installed on circuits separate from additional lighting. This setup allows the extra lighting beyond the basic required to be turned off as needed without affecting the minimum lighting levels (WSDOT 2023, Chapter 1040.11(3)(a)).

Application to Pedestrian Lighting

WSDOT lighting requirements include basic accommodations for pedestrians based on considerations such as the type of roadway and the pedestrian nighttime activity classification (WSDOT 2023, Chapters 1040.08 and 1040.10). Typically, WSDOT requires the roadway design area to be extended to cover the entire width of the adjacent sidewalk, or if there is no sidewalk, the full width of the roadway shoulder. WSDOT does not require isolated sidewalks or shared-use paths to be illuminated, except for specific tunnel conditions to address daytime light levels. If lighting is needed for these separate pedestrian facilities, it must be requested and managed by a local agency. Lighting of separated shared-use paths may be a topic considered in future phases of the cycle highways action plan currently under development under a separate proviso to WSDOT.

WSDOT Design Manual Chapter 1040 has some distinct lighting requirements for pedestrian facilities that align with ANSI/IES RP-8-22, and include the following:

- **Minimum average light level** (fc). The minimum average lighting level required for a pedestrian facility is 0.8 fc.
- **Uniformity ratio** (unitless). The required uniformity ratio is 4:1.

Additionally, crosswalks at roundabouts and midblock crossings must have a vertical average light level of 0.9 fc measured 5 feet above the roadway. This measurement should be taken at 1.5-foot intervals and oriented relative to oncoming traffic for each lane. Midblock crossings must be lit 50 feet before and 10 feet beyond the crosswalk in each direction. The lighting design area includes the full width of

[8] Illuminating Engineering Society of North America.

any median within the design area, and it covers shoulders, sidewalks, and the splitter island if present. Lights should be placed upstream on both sides to provide positive contrast lighting of pedestrians; avoid placement within 20 feet of the crosswalk centerline as this is generally the limit of effective positive contrast lighting (FHWA 2024).

WSDOT's lighting guidelines recognize different requirements for highway and pedestrian lighting:

- **Lighting requirements.** Highway lighting includes standards for light levels, uniformity, and glare control across road segments. Pedestrian lighting specifies light levels and uniformity with particular attention to pedestrian areas and crosswalks, as well as vertical illuminance at midblock crossings.
- **Coverage.** Highway lighting focuses on broad coverage to illuminate the entire roadway—including shoulders and adjacent areas—to ensure consistent visibility for drivers. Pedestrian lighting concentrates on sidewalks, roadway shoulders, and crosswalks to ensure focused and effective illumination for pedestrian safety.

Comparison of WSDOT Pedestrian Lighting Practices and Standards to National Best Practices

WSDOT lighting requirements for pedestrian facilities are tailored to address usability by pedestrians. The extent of lighting depends on the type and features of the facility. Section 0 includes information on the lighting design areas covered by the WSDOT Design Manual. The WSDOT Design Manual follows national best practices for pedestrian lighting:

- Recommended Practice: Lighting Roadway and Parking Facilities (Illuminating Engineering Society 2022).
- Roadway Lighting Design Guide (Seventh Edition; AASHTO 2018).
- Lighting Handbook (FHWA 2023).

Recommended Practice: Lighting Roadway and Parking Facilities, ANSI/IES RP-8-22

Pedestrian lighting is covered under sections discussing walkways/sidewalks, shared-use paths, intersections, and crosswalks. The recommendation requires specific levels of illuminance based on pedestrian activity during hours of darkness at any time of the year. ANSI/IES RP-8-22 recommends vertical illuminance criteria for midblock crossings, with lighting levels determined by pedestrian nighttime volume and activity (Table 11-2, ANSI/IES RP-8-22). Section 12.6.6 of the recommendation also provides a design example for midblock crosswalks. WSDOT aligns with ANSI/IES RP-8-22 by ensuring minimum lighting standards are met for all pedestrian facilities, including midblock crossings. WSDOT adds further requirements at these locations, such as ensuring lights are not within 20 feet of the crosswalk centerline to provide effective positive contrast lighting and improve visibility. However, ANSI/IES RP-8-22 offers slightly different guidance that places the fixtures 0.7 times the mounting height in advance of the crosswalk.

AASHTO Roadway Lighting Design Guide

AASHTO's Roadway Lighting Design Guide addresses pedestrian lighting primarily in the context of walkways, pedestrian ways, bicycle ways, intersections, and crossings (Table 3-5a, AASHTO 2018). Compared to WSDOT, AASHTO's approach is similar in terms of ensuring specific illumination levels and uniformity. However, AASHTO's lighting requirements are based on the general land use type (commercial, industrial, or residential) and road surface type (pavement reflectance) in contrast to WSDOT and ANSI/IES RP-8-22, which base their criteria on pedestrian volumes and activity during hours

of darkness. Additionally, WSDOT requires that lights be placed no closer than 20 feet from the crosswalk centerline to provide effective positive contrast lighting and improve visibility. AASHTO recommends the placement of fixtures 10 to 30 feet in advance of the crosswalk.

Federal Highway Administration Lighting Handbook

FHWA guidelines for pedestrian lighting design typically follow AASHTO and ANSI/IES RP-8-22 standards (FHWA 2023, Section 4.2.2). WSDOT guidelines generally align with FHWA's overall framework and key recommendations for pedestrian lighting design.

WSDOT Design Guideline Limitations and Recommended Updates

Limitations of the Design Guidelines

Advanced Technologies

In addition to the existing guidance, there is potential for enhancing lighting efficiency and responsiveness through the integration of advanced technologies such as adaptive lighting systems, smart lighting, and internet of things (IoT)-enabled solutions. Although current WSDOT practices do not use these technologies, their adoption could facilitate real-time adjustments to light levels based on actual conditions and vehicle or pedestrian activity, thereby improving both safety and energy efficiency.

WSDOT has opted to refrain from providing commentary on smart lighting technologies at this time due to the substantial differences between its typical lighting applications and those of other agencies per discussion with State Traffic Electrical Systems Engineer Flint Jackson. This strategic decision is aimed at avoiding unintended influence on other agencies' evaluations of these technologies, as certain solutions that may not be appropriate for WSDOT's specific requirements could still prove highly effective in different contexts. By maintaining this position, WSDOT ensures that other agencies remain open to considering smart lighting technologies that align with their own unique operational needs and conditions.

This neutral silence by WSDOT likely will not hinder larger, more sophisticated agencies from implementing their own systems; however, due to liability concerns many smaller agencies likely will not move forward with advanced technologies such as adaptive lighting without specific state guidance.

Specific Active Transportation Facilities Design Areas

The WSDOT Design Manual currently lacks detailed lighting guidelines for bike lanes, pedestrian tunnels, and walkways separated by a buffer such as a planter strips. According to the WSDOT Design Manual, design areas extend to the edge of pavement, which in many cases includes bike lanes. However, since bike lanes are not explicitly mentioned, there may be instances where bike lane illumination is overlooked or under-illuminated relative to the adjacent vehicle lanes.

In situations with bike lanes adjacent to vehicle lanes, it is typical for the average illuminance to be higher in the vehicle lane relative to a bike lane. The bike lane, which has more vulnerable roadway users, is likely to have a lower average illuminance than if it was broken out into a separate design area, especially when the bike lanes are positioned farther from the light sources.

With WSDOT's recently adopted Complete Streets requirement (RCW 47.04.035), bike lanes may be placed offset from vehicle lanes with a buffer or other physical separation. In these cases, WSDOT's

current policy of grouping the bike lane and vehicle lane together may lead to a less than desirable lighting design.

Additionally, the manual does not clearly define the buffer width at which a walkway, separated bike lane, or shared-use path should be considered a separate, dedicated facility.

This issue can arise where these facilities are separated from vehicle lanes by a landscape strip (possibly with street trees), on-street parking, or other amenity zones. This separation may put the facility outside of the WSDOT lighting design area, and it would then be up to a local jurisdiction to have illumination requirements that cover the area. Since many agencies do not have policies for this scenario, what may happen is the separated facilities area ends up not illuminated or light obstructions such as street trees are omitted from design.

WSDOT's Complete Streets policy and other active transportation policies across the state aim to build out a greater network for people walking and biking. The lack of specific illumination guidelines for these active transportation facilities may lead to omitting or under-illuminating these areas.

Nighttime Activity Levels

The WSDOT Design Manual notes that nighttime activity levels are evaluated over a one-hour period during hours of darkness at any time of the year. The recommended evaluation approach would be to conduct assessments during shorter winter days where activity is more likely during hours of darkness. Evaluations taking place during times of the year where daylight hours are longer may not appropriately identify needs.

Recommendations

A state policy that provides at least high-level guidance for advanced technologies, and more specifically for adaptive lighting, would be beneficial and could lead to greater adoption statewide, especially among smaller agencies that are concerned with the liability of implementing adaptive systems. Since this includes many areas outside of WSDOT jurisdiction, this may be best achieved through means other than the WSDOT Design Manual. A clear policy from the state would likely lead to quick adoption, and there is a high potential for energy savings among adopting agencies.

However, it is important to note that local agencies will require sufficient time, resources, and technical expertise to come into compliance with new state mandates. As evidenced by the engagement conducted for this report, many local agencies are interested in adopting new lighting technologies but lack the staffing and funding resources to evaluate and implement these technologies.

With a new emphasis on Complete Streets policy statewide, it is recommended that the WSDOT Design Manual incorporate the active transportation facility scenarios mentioned in the above section in greater detail to ensure adequate illumination for safety, visibility, and to make these spaces more inviting for all users. This includes separating bike lanes and other active transportation facilities into separate design areas and providing guidance for cases where facilities are not adjacent to vehicle lanes. Implementing comprehensive lighting standards will not only address these gaps but also enhance consistency and clarity in design practices across various types of infrastructure, ultimately improving safety.

For nighttime activity levels, a few changes are recommended to the WSDOT Design Manual. The first is to include additional context for time periods of low lighting, such as dusk or early morning hours, that extend beyond hours of darkness. The second is to provide clarification that bicyclists and other active transportation users are included in evaluating activity levels so that findings are not based solely on

pedestrians. It is also recommended that specific areas with the most vulnerable users—such as school zones—be explicitly defined as high pedestrian activity areas to maintain appropriate lighting levels during the winter months when darkness extends into daytime hours.

Adaptive Lighting

Adaptive lighting adjusts roadway light levels based on current traffic and pedestrian activity. This approach effectively mitigates issues such as skyglow, glare, and light trespass, while also offering energy savings and reducing maintenance costs. Although still considered an emerging technology, adaptive lighting has already proven its practical advantages. By adjusting light levels to match activity levels during off-peak times, it optimizes energy use. Adaptive lighting systems are particularly beneficial for continuous urban lighting setups where higher light levels and denser lighting networks are present (Illuminating Engineering Society 2022).

Luminance Selection

The key to implementing adaptive lighting effectively lies in selecting the appropriate lighting levels for different road types and pedestrian activity levels. According to the publication, Recommended Practice: Lighting Roadway and Parking Facilities (Illuminating Engineering Society 2021), lighting levels are determined based on three main categories: roadways, streets, and residential/pedestrian areas.

- Roadway lighting is used for freeways, expressways, and limited-access roads to help drivers stay on course.
- Street lighting is applied to major, collector, and local roads where pedestrians and cyclists are commonly present, enhancing visibility and safety for both road users and pedestrians.
- Residential and pedestrian area lighting focuses on pedestrian safety and security, typically in areas with lower driving speeds where vehicle headlights are sufficient for drivers.

Each of these categories has specific criteria for selecting the appropriate lighting levels (FHWA 2023). With an adaptive lighting system, appropriate luminance should be selected for each category to satisfy the required lighting levels as conditions change throughout the hours of darkness. For example, during the winter, pedestrian activity may be “high” during the morning and evening rush hours but drop to “low” in the middle of the night. Adapting the light levels from high to low to high through adaptive lighting could be financially and environmentally beneficial without sacrificing safety in this case. The key to implementing adaptive lighting is to have activity levels well documented to ensure minimum standards are met.

Adaptive Lighting Application

The adoption of networked adaptive lighting systems in the U.S. market remains limited due to several challenges. One key barrier is the lack of comprehensive guidance from the Illuminating Engineering Society (IES), AASHTO, and FHWA which leads to liability concerns. Agencies typically rely on national standards and technical recommendations, and this influences the pace of adoption. Cambridge, Massachusetts, stands out as one of the few U.S. cities that has piloted adaptive street lighting. The City's approach uses dimming technology to address lumen depreciation and reduces illumination levels by 50% during specific hours. This reduction is based on changes in road classification due to decreased vehicle and pedestrian traffic (Illuminating Engineering Society 2022, Section 6.10.2).

Given a standard 12-hour light cycle, with 4 hours of full illumination and 8 hours at 50% intensity, prior to installation Cambridge's adaptive LED system was projected to achieve an additional 53% energy use savings compared to the existing HPS system. In comparison, a typical LED retrofit without adaptive

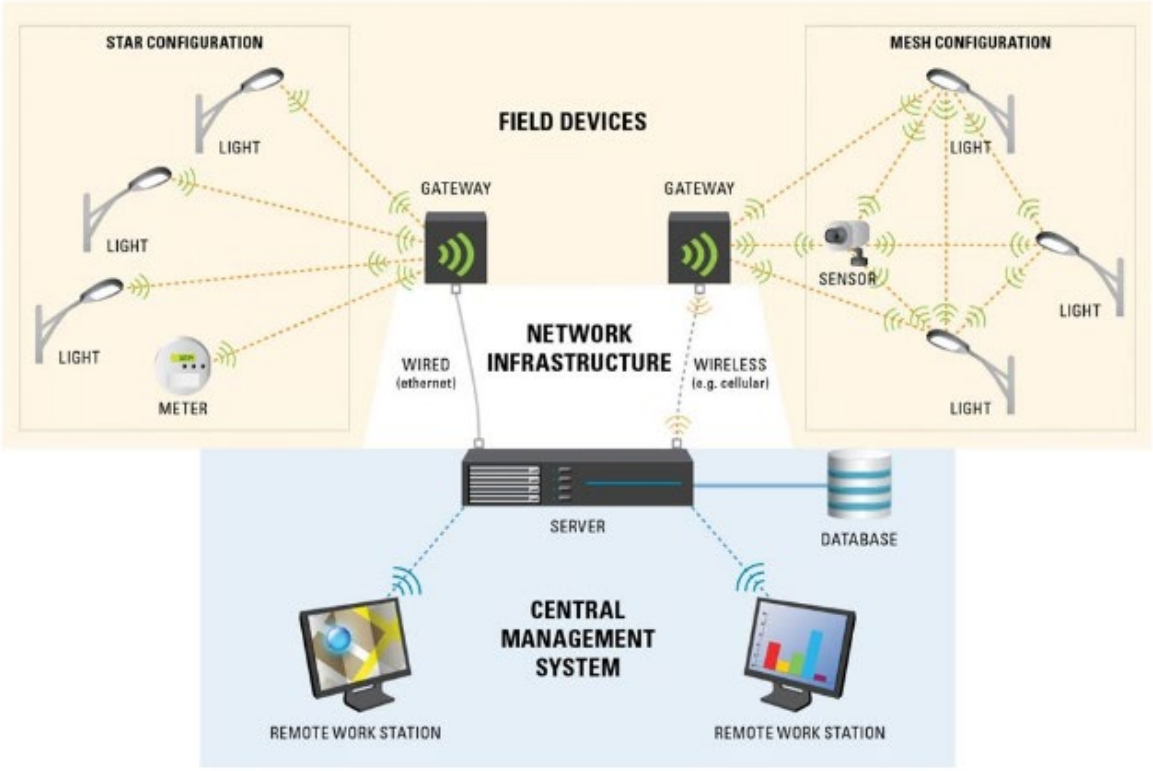

Figure 3: Major Components of a Typical Outdoor Lighting Control

Source: FHWA, 2023, Lighting Handbook.

controls would yield approximately 33% energy use savings. Thus, the integration of adaptive controls results in an estimated 75% reduction in energy consumption compared to an LED system without such controls. Following implementation of the adaptive system, Cambridge has reported a 75% initial energy use savings compared to its previous HPS installation. This demonstrates that incorporating adaptive controls and dimming can significantly amplify energy use savings beyond what is achieved with standard lighting practices (USDOE 2016). Figure 3 illustrates a typical adaptive control system.

Overall, adaptive lighting has demonstrated significant benefits in terms of energy savings by reducing lighting levels during periods of low traffic or pedestrian activity. However, there is a potential concern that dimming lights based on the assumption of lower pedestrian volumes during nighttime could lead to increased collisions, particularly if actual pedestrian activity is higher than expected or if the lighting is inadequate for unforeseen conditions. Despite this concern, current research does not provide significant evidence or studies indicating a widespread increase in collisions directly associated with the implementation of adaptive lighting systems. In certain applications, the use of supportive technologies such as motion sensors that temporarily boost light levels when pedestrians are detected could also be a potential solution to address this issue.

It is also important to note that while there may be significant energy use reductions with adaptive lighting system implementation, the cost reduction may or may not be substantial and would need to be determined on a project-specific basis. Utility rates and adaptive infrastructure costs play a key role in determining the extent of financial savings, and agencies should evaluate these factors as part of their decision-making.

Energy-Efficient Lighting Technologies

The performance of traditional streetlights has been significantly enhanced since the emergence of energy-efficient LED lighting technology, which has become widely adopted since the early 2010s. LED lighting has become ubiquitous and is the dominant street lighting technology due to its efficiency, cost, long life, controls, and low material environmental impacts. At this time, the only other energy-efficient lighting technology that can compete is plasma lighting; however, it is rarely used for roadway lighting (Delaware Valley Regional Planning Commission 2010). More detailed information on these technologies is provided in the following sections.

LED Lighting

LEDs are highly directional light sources with a small emission area, using lenses or reflective optics to diffuse the light. They offer high efficacy, with some top performance products currently reaching 220 lumens per watt (LedRise 2023). LEDs have long lifespans ranging from 25,000 to 100,000 hours. LEDs can provide various correlated color temperatures, with a typical range of 3,000 to 5,000 kelvins (K) being ideal for most roadway applications.

LEDs offer several advantages over traditional lighting sources. The extended lifespan of LED streetlights reduces the frequency of lamp replacements and lowers maintenance costs. These benefits contribute to the economic viability of street lighting projects, as the savings from reduced energy consumption and maintenance help offset the higher initial capital costs (Delaware Valley Regional Planning Commission 2010).

LEDs also have a much lower depreciation rate than HPS lamps and other types of lighting, which eliminates the need to over-illuminate areas at the outset to compensate for future light loss. This leads to more efficient and effective lighting design, minimizing energy use while maintaining optimal visibility and safety standards.

Additionally, the light distribution of LED fixtures is highly precise, allowing for better control over uniformity and pole spacing compared to traditional lighting options.

LEDs are fully dimmable, maintain their longevity even when dimmed, and they are not affected by frequent on-off cycling, making them well suited for use with lighting control systems (California Lighting Technology Center 2015). This dimming control leads to greater efficiency and reduced energy

Figure 4: High-Pressure Sodium Lights (left) versus LED Lights (right)

Source: Delaware Valley Regional Planning Commission, 2010, Energy Efficient Traffic Signals and Street Lights.

consumption and also limits excessive illumination. The ability to easily control and dim LED luminaires is one of their biggest advantages over other roadway lighting sources (FHWA 2023).

LED street lights offer significant benefits, but there is a potential environmental drawback to consider. The color temperature and spectrum of LED lights likely has different environmental impacts as compared to older technologies such as incandescent bulbs or HPS street lights. LED light sources typically fall more to the blue range of the visible light spectrum than other light sources. Bluer light is more often associated with daylight and other waking activities, whereas redder light is better associated with nighttime activities and is closer to natural darkness (see Figure 4). A shift toward bluer light can potentially impact sleep patterns, circadian rhythms, and nocturnal activity in nature. LED light manufacturers have worked to reduce these potential impacts by introducing more full-spectrum fixtures and offering lower color temperatures such as 3,000 K; 2,700 K; and lower. There is ongoing and emerging research on this subject, with the American Medical Association 2016 Report leading to much debate about environmental and health impacts related to LED street lights, color temperature, and spectrum.

Plasma Lighting

Plasma lamps are a type of electrodeless lamp energized by radio frequency or microwave power. They operate as gas-discharge lamps, generating light through the creation of plasma consisting of electrically charged particles. By 2013, plasma lighting had gained adoption in some industries but not in transportation. Compared to traditional high-intensity discharge lamps, such as metal halide or HPS lights, plasma lamps are more energy-efficient. This technology holds significant potential and is particularly worth considering for applications requiring higher high-intensity discharge wattages (400 W and above; Illuminating Engineering Society 2022).

Plasma lamps provide the highest level of brightness that can be perceived by the human eye in scotopic (low-light) conditions compared to other lighting solutions, effectively mimicking the natural light provided by the sun and sky during the daytime. This quality ensures that colors appear more natural, enhancing visual acuity and reducing the need for multiple fixtures and excessive energy consumption.

Additionally, plasma lamps are nontoxic as they do not contain mercury or other heavy metal toxins, either within the product or in their production process. With a bulb life that exceeds 50,000 hours, plasma lamps significantly reduce maintenance requirements, making them a sustainable and low-maintenance lighting option (PlasmaBright 2010).

However, the range of available wattages and voltages for plasma lighting is limited; only a few suppliers and luminaires offer these options. Additionally, plasma lights are designed for practical use primarily at higher light outputs (Illuminating Engineering Society 2022). Plasma lamps may also not be available in the lower color temperatures needed to reduce environmental impacts in outdoor applications.

Internet of Things

The integration of the IoT into street lighting systems represents a transformative advancement in urban infrastructure management. IoT-enabled or -supported streetlights can leverage sensors and connectivity to dynamically adjust brightness based on real-time factors such as traffic flow, weather conditions, and ambient light levels, which enhances energy efficiency and reduces operational costs. These systems can provide remote monitoring and control capabilities, allowing municipalities to quickly address issues, perform predictive maintenance, and optimize performance. Additionally, IoT technology can support public safety by enabling adaptive lighting for emergency situations and improving visibility, while also contributing to environmental sustainability through reduced energy consumption and minimized light pollution. However, it is important for agencies to evaluate IoT and other smart city applications (refer to the next section) to identify the specific features best suited to their needs and conditions, as not all solutions are universally beneficial. Overall, IoT in street lighting can lead to smarter, more responsive urban environments and substantial cost savings in the long term.

Smart City Applications

Smart city IoT platforms can upgrade traditional street lighting by integrating it into a network of connected digital devices to enhance safety, intelligence, and sustainability in neighborhoods. This transformation starts with installing intelligent nodes or smart nodes equipped with optical, acoustical, and environmental sensors that support edge computing and analytics. Edge computing helps reduce network bandwidth demands and addresses privacy and security issues. It also enables advanced capabilities such as computer-vision analytics, acoustical analytics, and artificial intelligence. Using application programming interfaces, smart city IoT platforms provide near-real-time data to optimize device and system performance. Smart nodes on light poles—such as thermal and laser-based sensors, video cameras, thermal cameras, and passive infrared sensors—can help cities monitor transportation, enhance public safety, improve pedestrian and bicycle flow, and track parking occupancy (Illuminating Engineering Society 2021).

Several cities in the United States, Europe, and Australia have started adopting smart technologies for pedestrian counting and environmental data collection. These technologies help city planners understand pedestrian activity trends, plan more effectively, and respond quickly to emergencies. For example, Auckland, New York, Dublin, and Barcelona have installed camera-based systems mounted on street poles. The collected data are transferred to a server and made available to the public via a website using a 3G communication box (Khemakhem and Krichen 2024).

Urbanization has powered a surge in connected devices. Cities are leveraging these connections to foster smarter, healthier, and more sustainable communities. However, navigating the growing range of technologies can be challenging for municipalities, potentially hindering the full benefits of connected devices. Digital master planning has emerged to help create cohesive strategies for integrating technologies, aiming to improve quality of life, economic development, and urban services. One key

strategy is the smart city digital twin approach, which links real-world sensors and controls with digital data to make informed decisions and manage applications such as adaptive lighting. This approach enhances control and adaptability, potentially enabling on-demand lighting. For network integration, smart city technologies need to fit into frameworks for autonomous and connected vehicles, with some authorities exploring data backhaul networks or bandwidth management for IoT devices. Engaging all interested parties in a needs assessment is crucial for successful implementation (FHWA 2023).

Lighting professionals should engage in IoT discussions early in the design process to ensure that lighting quality is maintained while integrating connectivity. IoT-based lighting design requires input from a broader team, including lighting designers, interested parties, and IT technicians, and it involves diverse project goals beyond traditional criteria. The decision-making process may also include collaborative financial analysis to balance costs and benefits (Illuminating Engineering Society 2021).

Smart or Networked Lighting Controls

Streetlights are often controlled using photocontrols that turn them off during the day to save energy and reduce costs. These photocontrols have internal photosensors that detect light levels and operate the lights accordingly. Modern advancements in street lighting technology include wireless controls and smart sensors that connect streetlights to a network, allowing for real-time data transmission. This connectivity enables better management of street lighting by enhancing visibility, safety, and infrastructure maintenance. With the integration of cameras and analytics, municipalities can monitor pedestrian movement, optimize lighting, and address issues more effectively. This smart infrastructure also supports municipal services such as law enforcement and environmental management, and it provides a foundation for future technological integrations. Data from these systems are used for monitoring, controlling, and sensing street lighting and facilitating functions such as energy analysis, maintenance planning, and adaptive lighting adjustments.

Networked control systems for street lighting involve three main components: field devices, network infrastructure, and a central management system (CMS). Field devices, including controllers and sensors, handle data collection and control functions, often communicating through gateways that connect to external networks or directly to the CMS via cellular links. The network infrastructure includes various communication methods such as wired, wireless, or powerline networks, with wireless systems using topologies such as mesh, star, and point-to-point. These topologies often rely on point-to-point connections for bridging between gateways or routers. Key limitations such as distance, line of sight, and information density are addressed through specific frequencies and communication protocols. Communication between gateways and the CMS may be hard-wired or cellular, with the entire system designed to maintain robust and redundant security and continuity. The CMS consolidates and stores data, provides a user interface for management, and enables remote control, ensuring efficient and secure operation of the street lighting system (FHWA 2023).

Vehicular and Infrastructure Communication Systems

Connected vehicle technology enables vehicles to exchange information with each other and infrastructure, which can be used to manage roadway lighting—such as adjusting brightness—or detecting pedestrians beyond sensor range. A pilot test by the Virginia Tech Transportation Institute showed a system that activated lighting as vehicles approached, thus enhancing safety without distracting drivers. Recently, the Federal Communications Commission reallocated spectrum from dedicated short-range communications to support cellular vehicle-to-everything (C-V2X) technology. While C-V2X offers potential for advanced communication between vehicles and infrastructure, including roadway lighting systems, it is still developing and requires further research (FHWA 2023).

Cybersecurity

Cybersecurity involves protecting systems, networks, and programs from digital attacks aimed at accessing, altering, or destroying sensitive information, extorting money, or disrupting business operations. As digital infrastructure and smart technologies become more interconnected, balancing the benefits with potential security risks is crucial. Connected networks are susceptible to various levels of cyber threats. In response, governments worldwide have issued guidance for implementing effective cybersecurity practices, such as the National Institute of Standards and Technology's framework, which emphasizes continuous real-time monitoring to detect and counter malicious code. Security measures are continuously evolving to address new threats and educating employees on using and updating security software is essential for maintaining protection against the latest cyber threats (FHWA 2023).

To enhance the security of IoT technologies and prevent breaches including data theft and unauthorized system control, additional measures are necessary. Key recommendations include incorporating firewalls with encryption features, connecting IoT devices to an independent network or a dedicated virtual local area network, and ensuring data encryption for all communications in addition to limiting physical access (Illuminating Engineering Society 2021).

Costs of Implementing IoT

Implementing IoT in street lighting offers significant long-term cost benefits including improved energy efficiency, reduced maintenance, and enhanced operational control. However, these benefits come with substantial upfront costs associated with hardware, installation, network setup, and integration which can make agencies hesitant to adopt this technology.

A study conducted by Philips Lighting over 5 years from 2012 to 2017 examined four smart city projects to explore different business models for entering the smart city market and assessed the budgets associated with each project.

In Amsterdam, with a budget exceeding €850,000 ($800,000), the focus was on making public spaces safer and more attractive through smart lighting to create a vibrant atmosphere, stimulate hospitality and the local economy, and link the area to other large spaces nearby. The focus area is called Hoekenrodeplein; it is a square between the shopping area ‘Winkelcentrum’ Amsterdam Poort, the Arena Boulevard, the Bijlmer railway station, and residential areas.

The Stratumseind project, with a budget over €500,000 ($470,000), aimed to use smart lighting to manage crowds and enhance safety. Stratumseind, Eindhoven's main entertainment area, faced high levels of aggression and incidents each weekend, impacting safety and reducing visitors. Following the development of the Urban Lighting Roadmap 2030, the municipality aimed to improve public safety and the area's appeal by using lighting to reduce aggressive behavior. They hoped this would attract more visitors, reduce costs, and increase property values and revenue for both Stratumseind and the city.

Eindhoven’s project, with a budget over €1 million ($950,000), adopted a joint approach to build a smart lighting grid with goals of stimulating the local economy, improving quality of life, and strengthening its reputation as the "City of Light." In 2011, a proposal was placed for replacing 21,000 streetlights in Eindhoven with LEDs to reduce CO_2 emissions and save costs. This led city officials to consider the long-term impact of LED technology and their innovation goals. As a result, Eindhoven developed a vision for urban lighting in 2030, emphasizing future-proof solutions and smart city initiatives. The city adopted this vision as policy in 2012 and began an innovative procurement process in 2013, engaging various interested parties in a competitive dialogue. Hence, Eindhoven aimed to create a smart lighting grid to

improve quality of life and stimulate economic growth through continuous innovation and new lighting solutions.

Finally, Veghel's initiative, funded by over €1.2 million ($1,130,000), created a unique lighting experience to revitalize the city center and attract visitors, incorporating joint value capture through recurring revenue from services (Brock et al. 2019).

Summary

While the WSDOT guidelines establish a foundational framework for lighting on state highways, their adequacy for pedestrian lighting varies. Local jurisdictions can adopt or adapt these guidelines, leading to distinct scenarios in their application. An analysis of the essential lighting requirements, including minimum light levels and uniformity ratios, alongside a review of WSDOT's pedestrian lighting practices compared to national standards, identified limitations and a lack of specific recommendations for active transportation facilities such as bike lanes and pedestrian tunnels.

To enhance safety and accessibility for all users, especially in active transportation spaces, the report recommends adopting advanced lighting technologies, providing clearer guidelines for these design areas, and better defining nighttime activity levels. These improvements can significantly strengthen WSDOT's lighting standards and create a safer, more inviting environment.

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- This paper provides an overview of LEDs and networked lighting control systems.

Delaware Valley Regional Planning Commission. 2010. Energy Efficient Traffic Signals and Streetlights. Accessed October 2, 2024. https://www.dvrpc.org/products/mit020.

- One of the sections of this reference discuss the emerging energy-efficient street lighting technologies, including LEDs, induction, and high-efficiency metal halide lights that enhance aesthetics and safety while reducing energy and maintenance costs. They provide better visibility and more even illumination, minimize glare, and often allow for fewer fixtures and improved control systems.

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→ This report shows the benefits of LEDs over other luminaires.

→

WSDOT. 2023. Design Manual. Chapter 1040, Illumination. Accessed October 2, 2024. https://wsdot.wa.gov/engineering-standards/all-manuals-and-standards/manuals/design-manual.

- This document contains WSDOT's lighting guidelines and requirements for conventional roadways, highways, and pedestrian areas.

Appendix E: Environmental Impacts Summary

Introduction and Purpose

This memo includes a comprehensive evaluation of street lighting solutions to enhance the safety of pedestrians and other vulnerable road users. A central focus of the study was the impact of LED lighting technology on both safety and environmental sustainability. The report delves into the efficacy of LED technology in roadway and pedestrian-scale lighting, with a particular focus on its potential to reduce carbon emissions and minimize light pollution.

The investigation was structured around a detailed assessment of research in the environmental impacts of lighting, including an analysis of the ecological footprint and sustainability of various lighting options. By exploring these components, the memo provides actionable insights that can inform better lighting practices and contribute to a more environmentally conscious urban infrastructure.

Existing WSDOT Lighting Guidelines Related to Environmental Impacts of LED Lighting

The Washington State Department of Transportation (WSDOT) Design Manual (Chapter 1040, Illumination; 2024) states that lighting design should balance its intended function against potential negative effects. These include light pollution, environmental impacts, energy usage, and maintenance requirements. The manual provides a few general guidelines for managing light pollution, but it does not provide specific guidelines regarding pedestrian lighting.

WSDOT has outlined three areas with guidelines for continuous lighting: open freeways, conventional roadways, and bridges. WSDOT guidance is structured to keep continuous lighting focused and minimal, limiting it to locations where it will be most effective. For freeways, this strategy is based on WSDOT's assessment that continuous lighting on open freeways, particularly those away from interchanges, offers minimal benefits. In addition, it leads to increased energy consumption, higher maintenance costs, and greater light pollution.

For conventional roadways, WSDOT requires that lighting be installed at the back of the sidewalk to remove the need for lighting to be cast away from the roadway, reducing the likelihood of light being cast out into the off-roadway environment.

Further, WSDOT mandates that where approved by the state transportation operations engineer, decorative lighting on bridge structures must adhere to specific guidelines. Light sources must not be visible to drivers (i.e., the bulb or LED source itself should not be seen), and the lighting must not be cast above the horizontal plane to prevent night sky light pollution. Additionally, lighting must not be projected off the structure to avoid environmental light pollution.

Although not part of WSDOT design guidelines, WSDOT Standard Specifications (Section 9-29.10, Luminaires) require that all LED luminaires have a correlated color temperature (CCT) of 3000 kelvins (K) nominal in an effort to limit the impacts of LED luminaire color temperature on the environment.

Environmental Impacts of Pedestrian Lighting

Lighting in pedestrian areas requires careful consideration of environmental impacts, as additional lighting beyond the roadway often results in more overall light in an area. Unlike roadway lighting, pedestrian lighting does not offer as much flexibility in how light is directed compared to roadway lighting which can result in light spilling in unwanted directions, causing light pollution, like glare or uplight.

The following sections delve into best practices for mitigating these impacts, offering insights into how various lighting technologies can be optimized for both environmental sustainability and efficiency.

Hazardous Material Disposal

When selecting lighting fixtures, it is important to consider their environmental impact especially regarding disposal. Many traditional lighting technologies—such as fluorescent lamps and incandescent lamps—contain hazardous materials such as mercury and require special handling during disposal. LED lamps/bulbs do not contain toxic materials, and LED fixtures generally have far fewer hazardous components in comparison to many conventional lighting technologies, making them safer for the environment and easier to dispose of.

In 2013, the U.S. Department of Energy reviewed of the life-cycle energy consumption of incandescent, compact fluorescent (CFL), and LED lamps. Figure 5 illustrates the findings. The plot indicates that LED technology performed significantly better than incandescent lamps and moderately better than CFLs. LEDs had the lowest environmental impact per unit of lighting service among the lamps considered.

When evaluated in 2013, the only area where LEDs were considered hazardous waste was in relation to their aluminum heat sinks. However, as LED efficacy has improved, aluminum heat sinks have decreased in size, thus reducing the environmental impact (U.S. Department of Energy 2013).

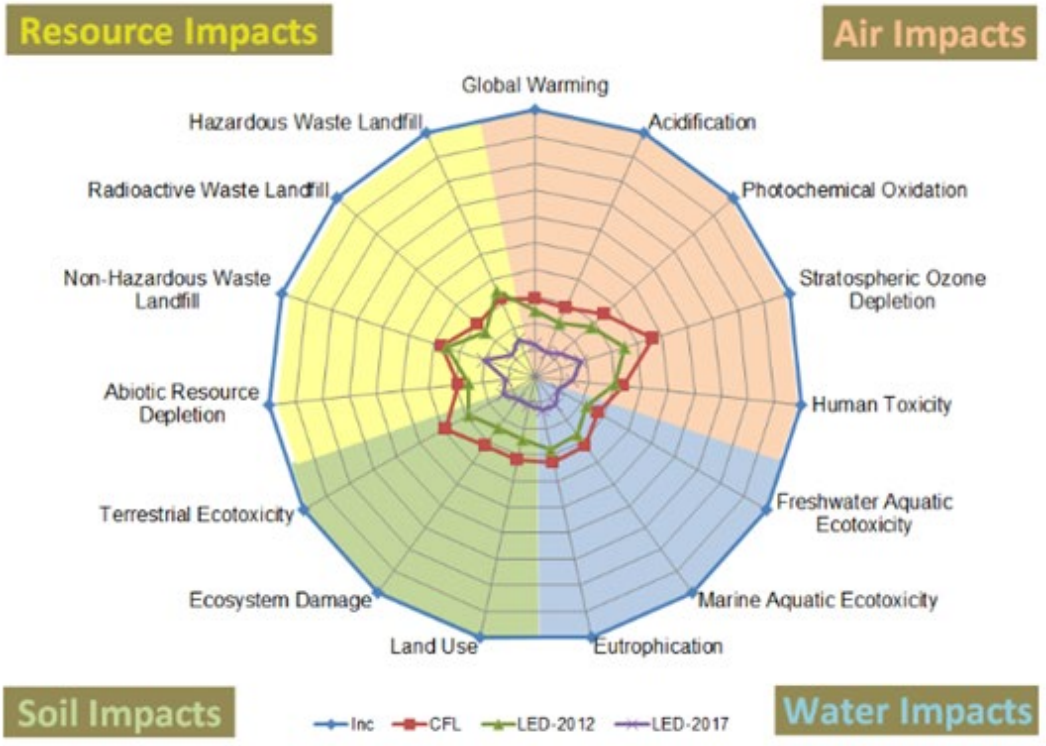

Figure 5: Life-Cycle Impacts Relative to Incandescent Lamps

Source: U.S. Department of Energy, 2013, Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products.

Impact of LED Lighting on Reducing Carbon Emissions

WSDOT lighting guidelines provide a framework for both general and specific lighting applications, including those relevant to pedestrian areas. A key factor in the effectiveness of these guidelines is the adoption of LED lighting, which plays a crucial role in reducing carbon emissions through enhanced energy efficiency. Compared to conventional light sources, LED fixtures offer substantial energy savings due to their higher efficacy. The increase in lumens per watt means that LEDs use considerably less power to produce the same amount of light, directly reducing energy consumption and associated carbon emissions.

Moreover, LEDs maintain their brightness far better over time unlike high-pressure sodium (HPS) lamps, which suffer from rapid lumen depreciation. As a result, areas illuminated by LEDs do not require over-illumination at installation to account for future light loss, further conserving energy. LED luminaires are also capable of more targeted and precise light distribution, ensuring that light is directed only where needed. Being able to target the lighting minimizes waste and avoids the over illumination that often occurs with broader, less-controlled lighting from HPS, CFL, or incandescent systems.

A detailed analysis of the LED manufacturing process, along with a comparative life-cycle assessment of other lamp technologies that considered a broader range of environmental impacts, confirmed that energy use during operation is the dominant environmental factor. In this analysis, 15-watt CFL and 12.5-watt LED lamps outperformed a 60-watt incandescent lamp. Figure 6 shows that although all three omnidirectional lamps produced approximately the same light output (~850 lumens), the environmental impacts of the incandescent lamp were significantly higher due to the energy consumed during its operational phase (U.S. Department of Energy 2013).

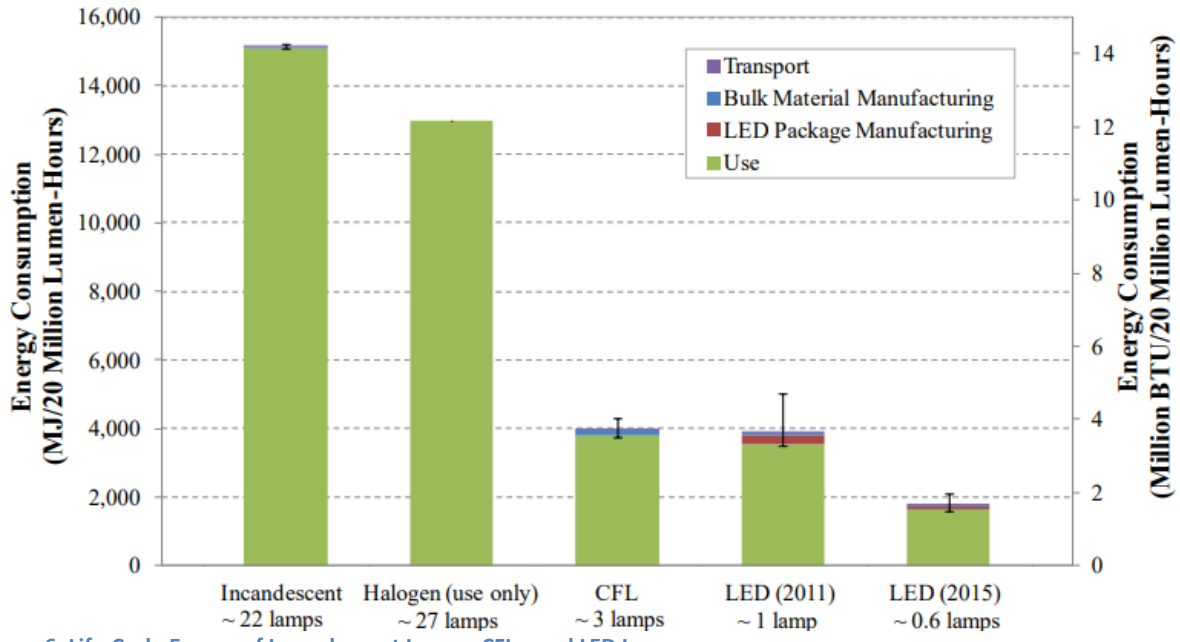

Figure 6: Life-Cycle Energy of Incandescent Lamps, CFLs, and LED Lamps

Source: US Department of Energy, 2013, Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products.

A report by the United Nations Environment Programme offers guidance on energy-efficient lighting solutions and highlights their potential to significantly reduce global carbon emissions. According to the report, lighting is responsible for over 2% of global greenhouse gas emissions. It further states that a global transition to energy-efficient LED technology could save more than 1,400 million tons of CO_2 and prevent the need for constructing 1,250 power stations (UNEP 2017).

LED products are highly beneficial for street and roadway lighting due to their excellent directionality, durability, and long lifetimes. Use often exceeds 50,000 hours—over three times that of many high-intensity discharge (HID) systems. These advantages make LEDs an attractive option, especially considering the long operating hours and the high maintenance costs associated with conventional lighting. Many local jurisdictions in the United States have begun transitioning to LED street and roadway lighting due to its advantages. By 2018, LED products accounted for approximately 48.6% of the total 49.7 million street and roadway installations, with a significant decline in HPS lighting since 2010. In 2018, there were 24.2 million LED installations, 2.1 million of which operated with connected lighting controls. This transition contributed to a 12% reduction in total energy consumption for street lighting, decreasing from 320 trillion British thermal units (tBtu) to 282 tBtu. LEDs saved an estimated 9.8 terawatt-hours (TWh) of site electricity (93.3 tBtu of source energy) in 2018, while connected systems saved an additional 3.4 tBtu. If all 49.7 million installations switched to the most efficient LED luminaires (138 lumens per watt), it could save 25.6 TWh of site electricity (245 tBtu of source energy), and with connected controls, the total savings could reach 302 tBtu (U.S. Department of Energy 2020). Figure 7 and Table 6 show the total LED installations and street/roadway LED energy savings summary in the United States in 2016 and 2018, respectively.

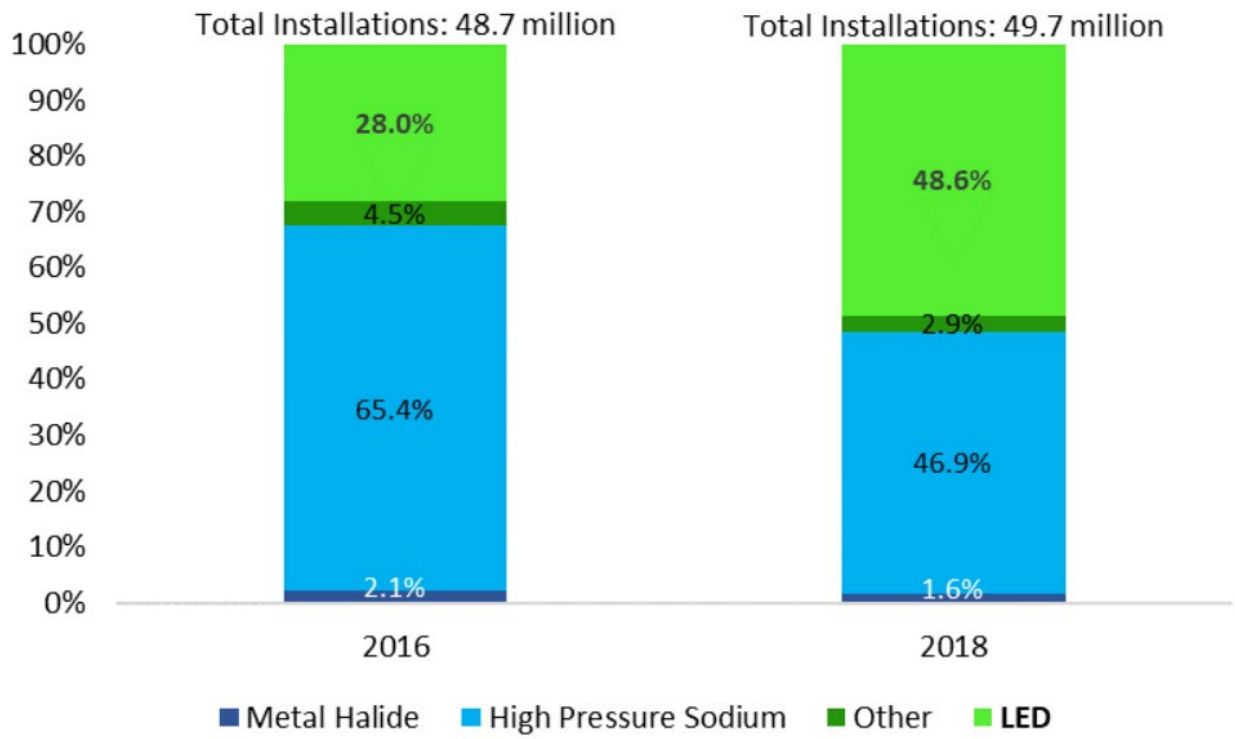

Figure 7: U.S. Street/Roadway Installed Stock Penetration from 2016 to 2018. LED products in street/roadway applications surged to become the most predominant lighting type in the US at 49% LED adoption.

Table 6: Street/Roadway LED Energy Savings Summary. Note: tBtu = trillion British thermal units.

Street/Roadway	2016 LED Adoption	2018 LED Adoption	2018 Technical - Potential
LED Installed Penetration	28.0%	48.6%	100%
LED Installed Base (millions of units)	13.7	24.2	49.7
LED Energy Savings (tBtu)	49.8	93.3	245
Connected Controls Energy Savings (tBtu)	1.2	3.4	57

Source: U.S. Department of Energy, 2020, Adoption of Light-Emitting Diodes in Common Lighting Applications.

Two region-specific examples of energy savings resulting from replacement of HPS fixtures with LED fixtures are noted below.

In 2014, WSDOT launched the US 101 Black Lake Boulevard LED Adaptive Lighting Pilot Project; 88 existing HPS lights were replaced with LEDs. Twenty-four lights were installed as basic illumination (on all night from dusk until dawn), while 64 lights were installed as additional illumination (turned off from 11 p.m. to 5 a.m.). The Traffic Management Center had the capability to turn on the lights remotely. During all hours of operation, the lights were dimmed to 70% lumen output (137 watts), with output increased by 2% each year to ensure design standards were maintained. The project was estimated to result in 51.5% energy savings from the HPS to LED conversion and 73.9% energy savings from dimming and on/off operation based on time of day (Calais 2014)

By maximizing efficiency and minimizing unnecessary power usage, LED lighting aligns well with WSDOT's goal of promoting sustainable and efficient transportation infrastructure. This targeted and energy-efficient approach to lighting not only enhances safety and visibility but also contributes to the broader aim of reducing carbon emissions in the state.

Biological Health Impacts

This section explores the broader effects of lighting beyond its influence on safety, noting that these effects can be either beneficial or detrimental. While safety typically remains the primary concern, these additional factors may also deserve attention during the lighting design process.

Human Health Impacts

In 2016, the American Medical Association (AMA) published a report titled Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting that highlights the disruptive effects of high levels of blue light from whiter, higher color-temperature LEDs (more than 4000K; AMA 2016). The AMA recommended using LEDs with color temperatures of 3000K or lower to reduce blue light exposure, aligning with the 2700K color temperature of traditional HPS streetlights (Falchi et al. 2016). The AMA also advised using proper shielding to minimize glare and dimming for off-peak periods. However, the Illuminating Engineering Society (IES) raised concerns, arguing that considering color temperature alone (CCT) is insufficient for assessing health effects and overlooks other factors such as light intensity and exposure duration (FHWA 2023).

Figure 3 provides a comparison of the color temperatures of three different lamps that produce a similar amount of light (lumens).

Figure 8: Color Temperature Comparison

Source: Wikimedia

Further, National Cooperative Highway Research Program Research Report 968 (National Academies of Sciences, Engineering, and Medicine 2021) examined the impact of LED roadway lighting on driver sleep health and alertness. Although LEDs contain more blue light than traditional HID light sources such as HPS (which can disrupt circadian rhythms and affect sleep), blue light also improves alertness and cognitive function and enhances nighttime traffic safety. The study found no significant differences among 4000K LED, 2100K HPS, and no lighting in terms of melatonin suppression or driver alertness. Additionally, melatonin suppression from consumer electronic devices was found to be higher than from 4000K LED roadway lighting, suggesting that at recommended light levels, CCT does not significantly affect human health or alertness (FHWA 2023).

The health impacts of blue spectrum light from LEDs are still being researched, and agencies should consider these potential effects as part of the lighting design process. While the AMA recommends limiting color temperature to 3000K to reduce health risks, the IES highlights the importance of considering light intensity and exposure duration. Research shows blue light can impact circadian rhythms but also enhances alertness and safety, with minimal health effects at recommended levels.

Wildlife Impacts

Lighting significantly influences the physiological and behavioral processes of organisms; it plays a vital role in the lives of many plants and animals. Artificial lighting has altered the nighttime environment for wildlife and has impacted species movement, reproduction, and migration over the past century (FHWA 2023).

Concerns about exterior lighting, including roadway lighting, often focus on its impact on animal species and their habitats. As a result, lighting regulations in sensitive areas are increasingly mandating wildlife-friendly lighting solutions (IES 2021).

Lighting Impacts on Plants

Plant photoreceptors enable plants to assess and respond to five key aspects of their lighting environment: light intensity, spectrum, direction, timing, and duration. Plants that rely on specific light periods for processes such as flowering, bud dormancy, or leaf aging may be negatively impacted by extended light exposure. To maintain their health, plants require sunlight during the day and darkness at night. (IES 2021)

Laboratory research in 2013 indicated that LEDs with higher blue light content can cause soybean plants to grow in a more compact form (Cope and Bugbee 2013). The effects of LED roadway lighting on soybean plant's growth and maturity have also been documented in a study conducted in Illinois, which concluded that roadway lighting adversely impacted plant growth near highways (IES 2021).

To minimize the impact of lighting, restricting light spills outside of the right-of-way is suggested. The recommended limits for vertical and horizontal illuminance at the property line to reduce lighting effects on soybeans are 0.17 foot-candles (fc; 1.8 lux) and 0.20 fc (2.2 lux), respectively (Palmer et al. 2017). While soybeans have been studied in detail, it is likely that many other plant species are also affected by artificial light exposure as these studies represent examples of the broader potential impacts of roadway lighting on plant health and development.

Lighting Impacts on Animals

Lighting affects various animal communities, from insects to large predators. It can either facilitate or hinder activities such as breeding, predation or avoidance of predators, migration, feeding, and communication or social interactions (IES 2021).

Lighting in environmentally sensitive areas should be minimized in duration, focused where necessary, and reduced in intensity to protect wildlife. For example, Witherington and Martin (1996) demonstrated that lighting adversely affects turtle hatching and shorebird nesting in Florida. Nearly 40% of the world experiences light levels above moonlight, impacting all animals with visual systems (Swaddle et al. 2015; Brüning et al. 2016). A notable example of nighttime lighting's impact is on sea turtles. Hatchlings instinctively follow starlight and moonlight to reach the ocean, but artificial light can lead them inland to roadways. In areas with street lighting, female turtles may be deterred from nesting, leading to dehydration, predation, unsuccessful nesting attempts and lower hatchling survival rates (Silva et al. 2017). Although further research is needed to fully understand optimal mitigation strategies, implementing sea-turtle-friendly lighting—such as amber or red LEDs with a spectral power distribution of 580 to 640 nanometers—is recommended and supported by conservation groups (Witherington and Bjorndal 1991). Additionally, roadway lighting disrupts animal habitats, disorients the animals, and disturbs their circadian rhythms (Van Bommel 2014).

Further, the Lake Washington/Cedar/Sammamish Watershed (WRIA[1] 8) Chinook Salmon Conservation Plan (2017) identifies artificial light pollution as a priority limiting factor to advance salmon recovery. Artificial nighttime lighting has posed several problems for juvenile salmon, particularly in WRIA 8 where only 9% to 11% of tagged juvenile Chinook migrating from the Cedar River and Bear Creek reached Puget Sound between 2014 and 2019. Lights disrupt migration patterns, slowing or stopping fish movement and making fish more vulnerable to predators. Studies show that direct lighting attracts

juvenile salmon and increases the predation risk significantly (Mazur & Beauchamp 2006). For example, predation by sculpins increases from 5% to 45% when juveniles are congregated beneath lights (Tabor et al. 2004). Sky glow further complicates this issue by extending predator feeding times into the night, resulting in a seven-fold increase in nighttime predation risk compared to historical conditions. The use of lights with blue-rich spectrum (with shorter blue wavelengths) increases light pollution and penetrates aquatic environments more deeply than warmer light sources; this ultimately undermines salmon survival efforts (Lake Washington/Cedar/Sammamish Watershed Salmon Recovery Council 2020).

The primary concerns regarding the effects of lighting on wildlife are the spectrum and dosage. While the spectrum can be tailored to an animal's sensitivity and the luminaire's spectral output, determining the appropriate dosage is more complex. Nocturnal species are highly sensitive to light levels as low as those from a full moon (~0.1 lux) or a clear starry sky (~0.001 lux). Since the levels of natural light are lower than those for roadway lighting (~6.5 to 13 lux), it is unlikely that any roadway lighting will fall below a threshold value for impacts at the roadway. Hence, unlike plants, setting a minimum lighting level to avoid effects on animals is difficult. Instead, managing wildlife exposure involves using luminaire optics to limit light trespass and sky glow and employing dimming or turning off lights during critical periods such as during mating, migration, or birth (FHWA 2023).

Light Pollution Impacts

The main elements of light pollution include light trespass, spill light, glare, and sky glow (see Figure 9). Light trespass occurs when light crosses property boundaries, causing nuisance or loss of privacy. Spill light refers to light outside the intended distribution of a light, and it is often used interchangeably with light trespass. Glare results from luminance within the visual field that exceeds what the eyes are adapted to, leading to discomfort or reduced visibility (IES 2021).

Light pollution and light trespass are critical factors to consider in outdoor lighting designs. As people become more aware of and value the beauty and benefits of the night, they are increasingly intolerant of excessive and intrusive lighting. Light trespass, particularly when it occurs around bedroom windows, can significantly impact individuals' sleep patterns and lead to disruptions in rest and overall well-being.

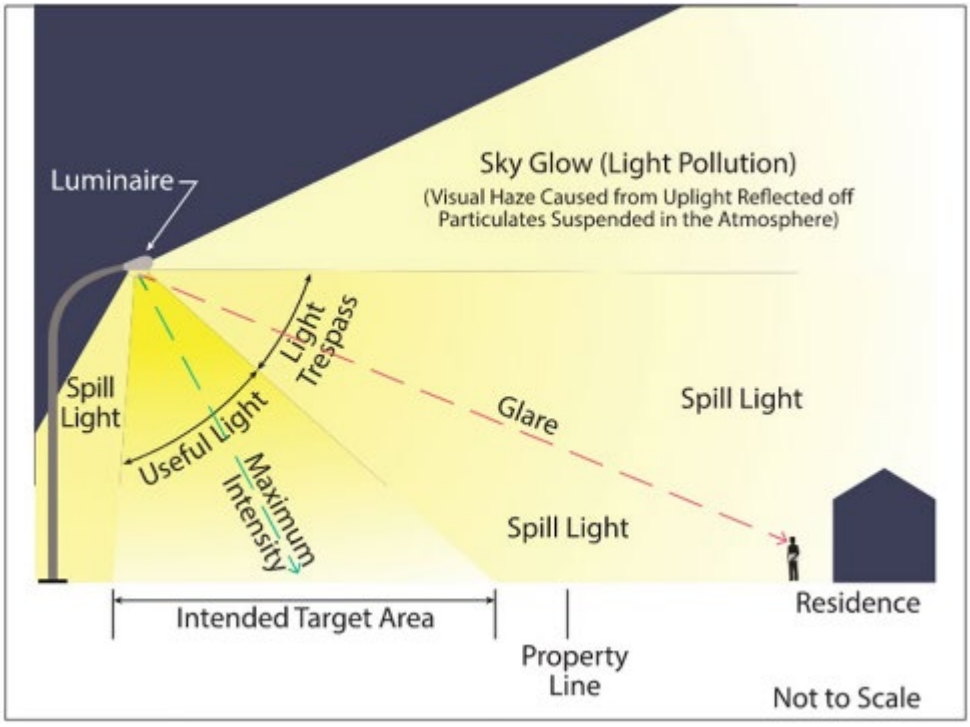

Figure 9: Spill Lighting, Glare, and Sky Glow for CFLs and LED Lamps

Source: FHWA, 2023, FHWA Lighting Handbook.

Addressing light pollution is important, but reducing light trespass must not come at the expense of roadway safety. Proper lighting in areas adjacent to roadways enhances peripheral vision; improves visibility at intersections, driveways, and sidewalks; and aids in detecting large animals that may pose safety hazards. A balanced, holistic approach is necessary to achieve both safety and environmental objectives. Luminaire shielding is an effective solution for reducing light trespass, including spill light and glare. Opting for luminaires with low backlight, uplight, and glare ratings will help reduce light trespass and glare both on and off the roadway, improving overall visibility (FHWA 2023).

Lighting Impacts on Dark Sky

Sky glow is the brightening of the night sky caused by the scattering of light in the atmosphere, with both natural and artificial components. Natural components include celestial sources such as the Moon, stars, Milky Way, airglow, and zodiacal light while the artificial sources include external electric lightings. Electric lighting enhances sky glow above natural levels through both direct and reflected light. Light directed above the horizontal contributes to this phenomenon. Light reflected from the ground or vertical surfaces can also add to sky glow, depending on the characteristics of the groundcover (IES 2021). Street lighting is often cited as contributing to as much as 50% of the urban sky glow due to 95% of the light directed down toward the pavement being reflected upward at reflectance rates ranging from 6% for asphalt to 25% for concrete (IES 1985).

As outdoor lighting continues shifting from HID sources such as HPS gas discharge bulbs to LED technology, there are opportunities to reduce sky glow. Over the past decade, efforts have focused on upgrading to LED fixtures that eliminate uplight and use color temperatures that minimize harm to biological systems. Additionally, a 2016 report, The New World Atlas of Artificial Night Sky Brightness (Falchi et al. 2016), states that 80% of the global population and more than 99% of the U.S. and

European populations lives under light-polluted skies, making it one of the most widespread forms of human-made environmental disruption. Natural lighting levels are determined by celestial sources such as the Moon, stars, Milky Way, airglow, and zodiacal light. Artificial light scattered in the atmosphere increases sky brightness and creates artificial sky glow, which is the most visible effect of light pollution. This not only disrupts astronomical observations but also alters the fundamental human experience of witnessing the natural beauty of the night sky including stars, the northern lights, and other celestial phenomena. Figure 10 shows the light pollution map of the US at night, which is a composite assembled from data acquired in April and October 2012.

Figure 10: USA Light Pollution Map

Source: City Lights of the United States 2012.(2012, December 25). In NASA Earth Observatory. https://earthobservatory.nasa.gov/images/79800/city-lights-of-the-united-states-2012

Sky glow, which is intensified by the short-wavelength content of exterior lighting, can be mitigated through the careful selection of luminaires. The three main factors influencing sky glow are spectral power distribution, total lumen output, and the distribution of light, especially the amount of uplight emitted. To minimize sky glow, lighting designers should use luminaires with cutoff optical systems and avoid over-lighting. An uplight rating of U02 is ideal for minimizing sky glow, while the lowest possible backlight rating should be chosen to achieve appropriate lighting levels for sidewalks and surrounding areas (FHWA 2023). All the LED luminaires in the WSDOT list of preapproved LED luminaires are dark-sky friendly with no uplight (WSDOT 2024).

Summary

While pedestrian lighting is essential for safety and accessibility, it is also associated with environmental concerns such as hazardous material disposal, carbon emissions, biological health risks for humans and wildlife, and light pollution.

LED lighting is identified as a beneficial solution for pedestrian lighting due to its energy efficiency, reduced carbon emissions, lower maintenance costs, and ability to mitigate light pollution by providing better control of light direction and intensity. Its environmental advantages, including minimizing hazardous waste and reducing the carbon footprint, make LED lighting a sustainable option for both roadway and pedestrian areas.

Pedestrian lighting requires careful consideration of the impact of additional lighting beyond roadway lighting to control light trespass. Managing light pollution involves adopting dark-sky-friendly designs and careful planning. Strategies such as shielding luminaires, controlling light trespass, and minimizing sky glow are essential to mitigate the effects of light pollution.

None of these challenges are insurmountable; an environmentally friendly pedestrian lighting system is both possible and achievable. By adopting sustainable lighting designs based on the latest LED technologies, agencies can balance safety, efficiency, and ecological preservation, addressing both known and emerging challenges associated with pedestrian lighting.

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Appendix F: Funding Case Studies Summary

The purpose of this memo is to provide examples for WSDOT to consider for implementation of a WSDOT lighting program if funding is made available. The examples were identified through a review of national resources to better understand programs that improve safety for roadway users by providing local agencies with the funding tools necessary to build and maintain street lighting. Washington state has recent experience partnering with public utilities and the Transportation Improvement Board for the Relight Washington program that began in 2015 (State of Washington Transportation Improvement Board, 2015). The examples described herein were selected to better understand programs that have innovative approaches to funding. The programs include:

- Minnesota Department of Transportation (MnDOT) Rural Intersection Lighting program,
- Delaware Valley Regional Streetlight Procurement program, and
- Rhode Island's Partnership for Rhode Island Streetlights Management (PRISM) program.

Other lighting programs from cities are included as examples due to their focus on pedestrian lighting and unique funding strategies. These programs include:

- Seattle, Washington Pedestrian Lighting Plan,
- Los Angeles, California Bureau of Street Lighting, and
- Brookline, Massachusetts Pedestrian-Friendly Lighting Report

These six programs emphasize strategic planning, agency collaboration, and diverse funding sources to implement effective lighting solutions that enhance safety, reduce costs, and support goals like economic development and energy efficiency. Key takeaways from these six programs include:

- **Targeted Safety Initiatives**: Programs like MnDOT's Rural Intersection Lighting and Rhode Island's PRISM use LED and solid-state lighting to reduce nighttime crashes and improve visibility.
- **Data-Informed Decisions**: Seattle and Brookline use data analytics and assessments to prioritize lighting needs, ensuring safety and accessibility while fostering economic growth.
- **Community Engagement**: Los Angeles and Seattle involve residents in lighting decisions, tailoring solutions to community needs through participatory funding models.
- **Phased Implementation:** Brookline balances immediate needs and long-term goals through phased upgrades, leveraging local budgets while seeking grants and partnerships for major changes.
- **Collaborative Cost Savings**: Delaware Valley's RSLPP and Rhode Island's PRISM show how pooling resources and regional collaboration can lower costs and streamline LED transitions.

These strategies provide a foundation for a tailored Washington State lighting program.

MnDOT Rural Intersection Lighting Program

Program Summary

The MnDOT Rural Intersection Lighting Program addresses safety at rural, unlit intersections by installing LED street lighting (Federal Highway Administration, 2023). The program focuses on intersections with a history of severe nighttime crashes, targeting these high-risk areas to improve visibility and reduce overall crashes. It is part of a larger effort to meet Minnesota's Toward Zero Deaths initiative by

decreasing roadway fatalities. This is a statewide program and spans across rural Minnesota, where many intersections lack sufficient lighting. MnDOT identified that rural intersections are often the site of severe crashes, especially at night, due to visibility issues. As a response, the state focused on installing proactive lighting systems to prevent crashes before they happen.

Funding Strategy

MnDOT shares costs with local agencies and counties, which are responsible for maintaining and operating the new lighting systems once installed. Collaboration is crucial as MnDOT partners with local governments to identify and prioritize intersections based on crash data and risk factors. Local governments play a critical role in implementing and maintaining the lighting infrastructure, and MnDOT actively encourages their participation by offering technical assistance, planning support, and partial funding coverage. Through collaboration, these entities ensure that improvements are both strategically planned and financially feasible for all parties involved. Counties work with MnDOT to fund lighting improvements. Any projects that meet the criteria and are located at an intersection of two connecting state highways are eligible for Highway Safety Improvement Program (HSIP) funding.

Funding Source

The program leverages HSIP for improvements at intersections on state routes. Counties work with MnDOT to fund lighting improvements through various funding sources, complemented by contributions from local agencies that help with installation and operational costs. This strategy ensures that rural communities can afford safety improvements despite potentially limited local budgets.

Collaboration with Local Agencies

Itasca County, Minnesota adopted an Intersection Street Lighting Policy to compliment and comply with MnDOT's Rural Intersection Lighting Program (Itasca County Department of Transportation, 2021). The policy states that the county will bear all costs for warranted intersections under its jurisdiction and that for intersections involving MnDOT-controlled segments, a formal agreement or permit will determine cost sharing. For unwarranted intersections on intersections that don't meet the criteria outlined in MnDOT's Rural Intersection Lighting Program, the local road authorities requesting lighting will be responsible for all costs.

Delaware Valley Regional Streetlight Procurement Program

Program Summary

The Delaware Valley Regional Street Lighting Procurement Program (RSLPP) unites municipalities in the Greater Philadelphia region to make informed decisions and purchase LED lighting solutions efficiently (Delaware Valley Regional Planning Commission, n.d.). By joining forces, municipalities can access resources at competitive prices and follow a streamlined process to complete their projects. To achieve this, DVRPC issued requests for proposals and contracts with one company to provide lighting design and pricing, as well as service costs during design and construction. The final contract locks in equipment specifications and pricing, project design details, and construction costs. Participants benefit from reduced costs for products and labor, a standardized project timeline, potential access to financing, and expert technical and legal support throughout the design and implementation phases.

Funding Strategy

The RSLPP offers municipalities a more efficient and cost-effective way to upgrade their street lighting. By pooling resources, municipalities can leverage their purchasing power. DVRPC had two rounds of the program, both of which operated differently. Round 1 used an Energy Performance Contracting aggregation program where the municipality has a contract with an energy services company (ESCO)

that allows the municipality to pay for a project that is developed and managed by the ESCO based on the project's future energy savings. Projects in Round 1 of the program were not considered capital projects because they are paid off over time through the operational savings and there was no upfront cost for municipalities. Round 2 used a Design-Bid-Build aggregation program. A Design-Bid-Build contracting approach has a contract between the municipality and the program-selected installation partner. DVRPC managed the Design-Bid-Build process for participating municipalities. The Request for Proposals for this project secured specific equipment and service costs prices and had a price per light for each project round. Projects in Round 2 required upfront costs from the local municipalities, but DVRPC supported local municipalities by arranging financing for municipalities that do not have upfront capital.

Funding Sources

DVRPC also evaluated supplemental funding sources. These sources include utility and ISO (International Organization for Standardization) rebates, along with state-level transportation funding allocations available to each municipality. In the DVRPC region, this included PECO (formerly Pennsylvania Energy Company) Smart Ideas rebates, PJM (Pennsylvania-New Jersey-Maryland) Capacity Market Rebates, and municipal Liquid Fuel Fund Allocations from Pennsylvania DOT.

Collaboration with Local Agencies

Over 61 municipalities in the Greater Philadelphia region participated in this program, two of which included Newtown Township and Haverford Township.

Newtown Township participated in Round 1 of the program and replaced 190 cobrahead streetlights and over 1,400 decorative colonial fixtures (The Reporter, 2024). The total cost of the conversion is $720,000 and Newtown Township is projected to save over $43,000 annually in operational and maintenance costs. The Energy Performance Contracting funding option allows Newtown Township to pay for the conversion through the operational and maintenance savings over time.

Haverford Township participated in Round 2 of the program and converted over 3,000 streetlights to LED fixtures (Haverford Township, 2021). This project cost approximately $1.8 million and provides an estimated savings of $180,000 a year. The costs of this project were included in the Township's capital budget for 2022. With the estimated annual savings, the project will become profitable in 10 years.

Partnership for Rhode Island Streetlights Management

Program Summary

Rhode Island's Washington County Regional Planning Council (WCRPC) drafted the Rhode Island Municipal Streetlight Investment Act, which removes the mandate that all street lighting be provided by the electric distribution company (Washington County Regional Planning Council, n.d.). This Act passed in 2014 and also established a purchasing process, determined how a purchase price was calculated, and encouraged regional collaborative maintenance programs. The PRISM (Partnership for Rhode Island Streetlights Management), a program originally based in WCRPC, was expanded as a formal statewide program to manage the delivery cost and maintenance of streetlights across municipalities in Rhode Island. PRISM coordinates the following tasks for municipalities: cost benefit analysis, purchase of streetlights, inventory capture and verification, purchase negotiations, and statewide maintenance contracts that include each community (Partnership for Rhode Island Streetlight Management, n.d.). Similar to Delaware Valley's RSLPP, PRISM takes advantage of economies of scale to both reduce the cost of streetlights and maintenance, but also to provide resources to municipalities to reduce hurdles to participation.

Funding Strategy

In 2016, the Rhode Island Office of Energy Resources (OER) collaborated with National Grid, a private energy provider in Rhode Island that owned most streetlights in Rhode Island prior to Rhode Island's Municipal Streetlight Investment Act, to create the Municipal LED Lighting Program (State of Rhode Island Office of Energy Resources, n.d.). This program provides financial incentives to Rhode Island municipalities to transition their street lighting to LED lighting and provides technical support that complements utility offerings. These initiatives have streamlined the process for municipalities to purchase and convert street lighting, significantly lowering project costs.

Funding Sources

The Municipal LED Lighting Program is funded through Rhode Island's participation in the Regional Greenhouse Gas Initiative totaling about $2.75 million. This funding has been instrumental in helping municipalities purchase and convert streetlights to energy-efficient LED technology. Through the efforts of PRISM and funding provided by OER, most Rhode Island municipalities have purchased and converted their streetlights to LED. As of 2020, twenty-nine municipalities were involved in the Municipal LED Lighting Program representing 80% of all streetlights in Rhode Island being converted to LED (State of Rhode Island Office of Energy Resources, 2020).

Collaboration with Local Agencies

PRISM allows municipalities to voluntarily join the program, giving local agencies the freedom to choose their level of involvement. Municipalities can become Associate Members by approving a participation agreement and paying a one-time fee, or Full Members by completing a three-year maintenance contract with PRISM. The Town of Portsmouth, RI, worked with PRISM to develop a tailored plan for streetlight acquisition and LED upgrade to apply for funding from the Municipal LED Lighting Program (Town of Portsmouth, 2021). This plan included a detailed inventory of existing streetlights, cost analysis, projected energy savings, and outlines the process for streetlight acquisition and LED upgrades.

Citywide Pedestrian Lighting Programs

Seattle, Washington Pedestrian Lighting Plan

Program Summary

Seattle's Pedestrian Lighting Program leverages data to strategically place pedestrian lighting, enhancing safety, security, economic development, and accessibility (Seattle Department of Transportation, 2012). Multiple funding sources are available, including the Pedestrian Lighting Program, Capital Improvement Program (CIP), Major Projects, Neighborhood Street Fund, and Complete Streets checklist.

Funding Strategy & Sources

Seattle Department of Transportation (SDOT) uses its data- informed approach to identify and prioritize locations of pedestrian lighting improvements. The Pedestrian Lighting Program allocates $100,000 annually to support 2-3 projects per year. Additionally, pedestrian lighting is often incorporated into larger Capital Improvement Program (CIP) projects and grant proposals, ensuring that it is considered as an essential component of broader infrastructure improvements. SDOT also incorporated pedestrian lighting needs into its Complete Streets policy, requiring a pedestrian lighting gap analysis for larger projects and requiring that pedestrian lighting is included in grant proposals based on the pedestrian lighting gap analysis. SDOT also empowers neighborhoods to identify and fund local lighting projects through the Neighborhood Street Fund.

Los Angeles, CA Bureau of Street Lighting

Program Summary

The Los Angeles Bureau of Street Lighting designs, constructs, and maintains all city-owned streetlights across the City of Los Angeles (City of Los Angeles, n.d.). Typically in Los Angeles, streetlights are installed through one of three ways: developers pay for them with new development projects, the community petitions the city to show community support in accordance with Proposition 218, or through assessment of new street lighting projects done by the city, which also requires the approval of property owners through a vote, in accordance with Proposition 218. [9]

Funding Strategy & Sources

Los Angeles' street lighting system's maintenance and operations is primarily funded through the Street Lighting Maintenance Assessment Fund, generated by property taxes. Installation of new lights is subsidized by the city's General Fund. The city has a history of both public and private installations, with community involvement playing a crucial role in new projects. Property owners bear the costs of installation and maintenance. The approval process for new installations or upgrades is governed by Proposition 218.

Brookline, Massachusetts Pedestrian-Friendly Lighting Report

Program Summary

The Pedestrian-Friendly Lighting Report for Brookline, completed in July 2021, outlines a comprehensive initiative to enhance nighttime safety and walkability throughout Brookline, Massachusetts (Town of Brookline, 2021). The program's primary objectives include improving pedestrian safety and comfort, increasing accessibility of streets and public spaces, supporting local businesses by encouraging foot traffic, and promoting energy efficiency while reducing light pollution. To achieve these goals, the town conducted a thorough assessment of existing lighting conditions, identifying areas needing improvement and developing targeted recommendations. This evaluation formed the foundation for a strategic implementation plan, which proposes a phased approach to lighting upgrades over short, medium, and long-term periods.

Funding Strategy & Sources

The town expects the primary source of funding for the pedestrian lighting improvements to come from the town's capital budget. Brookline sets annual appropriations for street lighting upgrades and allocates funds from the town's general fund. The plan also identifies potential external funding sources to supplement municipal funds. These include state grants, federal grants, and utility company programs that offer incentives or cost sharing programs. The report recommends exploring public-private partnerships to fund and implement lighting improvements through business improvement districts or requiring or incentivizing developers to include pedestrian-friendly lighting in new construction projects.

Brookline also updated its Complete Streets policy to explicitly require adequate lighting for sidewalks and crosswalks.

[9] Proposition 218 is a California constitutional amendment that restricts the ability of local governments to impose special taxes or assessments on property owners. It requires a majority vote of the affected property owners to approve any new special tax or assessment. This means that any new street lighting installations or upgrades must be approved by a vote of the property owners in the affected area.

Conclusion and Key Takeaways

These programs highlight the importance of strategic planning, collaboration with local agencies, and leveraging multiple funding sources to implement effective lighting solutions. They demonstrate how targeted lighting improvements can enhance safety, reduce costs, and support broader community goals such as economic development and energy efficiency. These examples could serve as a basis to develop a tailored lighting program that addresses specific needs within Washington State. Key takeaways from these examples include:

- **Targeted Safety Initiatives:** The MnDOT Rural Intersection Lighting Program focuses on high-risk rural intersections with a history of nighttime crashes, using LED lights to enhance visibility and prevent accidents. This proactive approach uses lighting as a key tool in reducing traffic fatalities as part of Minnesota's Toward Zero Deaths initiative. Rhode Island's PRISM program recognizes streetlights as an essential public safety resource and requires the inclusion of solid-state lighting (LED) and dimming controls, potentially contributing to better visibility and safety.

- **Data-Informed Decisions:** Seattle's Pedestrian Lighting Plan utilizes data analytics to identify where lighting improvements are most needed. This strategic approach not only enhances safety but also supports economic development by making neighborhoods more accessible and inviting. Brookline takes a similar approach by conducting a thorough assessment of existing lighting conditions, identifying areas needing improvement and developing targeted recommendations. This evaluation formed the foundation for a strategic implementation plan, which proposes a phased approach to lighting upgrades over short, medium, and long-term periods. MnDOT also uses data-informed selection criteria to determine where to prioritize lighting installation at rural intersections.

- **Community Engagement:** Los Angeles and Seattle leverage community involvement in its street lighting projects, allowing residents to petition for new installations. In Los Angeles, this participatory model ensures that lighting solutions reflect community needs while being funded through property taxes and city subsidies. In Seattle, community members can propose and vote on project ideas and the top voted projects are considered for final review and selection.

- **Phased Implementation for Long-Term Impact:** Brookline's Pedestrian-Friendly Lighting Report emphasizes a phased approach to lighting upgrades, balancing immediate needs with long-term goals. Because this program is funded primarily through the town's capital budget, this allows them to work towards lighting improvements within their budget, while exploring potential external funding from grants and partnerships for bigger long-term changes.

- **Collaborative Cost Savings:** The Delaware Valley Regional Streetlight Procurement Program (RSLPP) exemplifies how municipalities can pool resources to achieve significant cost reductions in LED upgrades. By participating in collective purchasing, towns can access competitive pricing and expert support, making the transition smoother and more affordable. Rhode Island's PRISM program encourages regional collaborative maintenance programs, which can lead to shared resources and reduced expenses. PRISM also established a purchase process and how the purchase price is calculated.

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