URBAN DESIGN COMMISSION APPLICATION

UDC

City of Madison
Planning Division
126 S. Hamilton St.
P.O. Box 2985
Madison, WI 53701-2985
(608) 266-4635

Complete all sections of this application, including the desired meeting date and the action requested.

If you need an interpreter, translator, materials in alternate formats or other accommodations to access these forms, please call the phone number above immediately.

FOR OFFICE USE ONLY:

Paid ______________ Receipt # ______________________

Date received ______________________________

Received by ______________________________

Aldermanic District ______________________________

Zoning District ______________________________

Urban Design District ______________________________

Submittal reviewed by ______________________________

1. Project Information

Address: 929 East Washington Avenue

Title: Archipelago Village

2. Application Type (check all that apply) and Requested Date

UDC meeting date requested April 24, 2019

- ☒ New development
- ☐ Alteration to an existing or previously-approved development
- ☐ Informational
- ☐ Initial approval
- ☒ Final approval

3. Project Type

- ☒ Project in an Urban Design District
- ☐ Project in the Downtown Core District (DC), Urban Mixed-Use District (UMX), or Mixed-Use Center District (MXC)
- ☐ Project in the Suburban Employment Center District (SEC), Campus Institutional District (CI), or Employment Campus District (EC)
- ☐ Planned Development (PD)
  - ☐ General Development Plan (GDP)
  - ☐ Specific Implementation Plan (SIP)
- ☐ Planned Multi-Use Site or Residential Building Complex

Signage

- ☐ Comprehensive Design Review (CDR)
- ☐ Signage Variance (i.e. modification of signage height, area, and setback)

Other

- ☐ Please specify ______________________________

4. Applicant, Agent, and Property Owner Information

Applicant name Curt Brink — Company Archipelago Village, LLC

Street address 701 E. Washington, Suite 105 — City/State/Zip Madison, WI 53703

Telephone (608) 575-4845 — Email curtbrink@hotmail.com

Project contact person Doug Hursh — Company Potter Lawson

Street address 749 University Row, Suite 300 — City/State/Zip Madison, WI 53705

Telephone (608) 274-2741 — Email dough@potterlawson.com

Property owner (if not applicant) Archipelago Village, LLC

Street address P.O. Box 512, 505 N. Carroll Street — City/State/Zip Madison, WI 53701

Telephone (608) 255-8633 — Email matt.carlson@carlsonblack.com

5. Required Submittal Materials

- ▣ **Application Form**
- ▣ **Letter of Intent**
  - If the project is within an Urban Design District, a summary of how the development proposal addresses the district criteria is required
  - For signage applications, a summary of how the proposed signage is consistent with the applicable CDR or Signage Variance review criteria is required.
- ▣ **Development plans** (Refer to checklist provided below for plan details)
- ▣ **Filing fee**
- ▣ **Electronic Submittal***

Each submittal must include fourteen (14) 11" x 17" collated paper copies. Landscape and Lighting plans (if required) must be full-sized. Please refrain from using plastic covers or spiral binding.

Both the paper copies and electronic copies must be submitted prior to the application deadline before an application will be scheduled for a UDC meeting. Late materials will not be accepted. A completed application form is required for each UDC appearance.

For projects also requiring Plan Commission approval, applicants must also have submitted an accepted application for Plan Commission consideration prior to obtaining any formal action (initial or final approval) from the UDC. All plans must be legible when reduced.

**Electronic copies of all items submitted in hard copy are required. Individual PDF files of each item submitted should be compiled on a CD or flash drive, or submitted via email to udcapplications@cityofmadison.com. The email must include the project address, project name, and applicant name. Electronic submittals via file hosting services (such as Dropbox.com) are not allowed. Applicants who are unable to provide the materials electronically should contact the Planning Division at (608) 266-4635 for assistance.*

6. Applicant Declarations

1. Prior to submitting this application, the applicant is required to discuss the proposed project with Urban Design Commission staff. This application was discussed with Janine Glaeser on January 4, 2019.
2. The applicant attests that all required materials are included in this submittal and understands that if any required information is not provided by the application deadline, the application will not be placed on an Urban Design Commission agenda for consideration.

Applicant name Curt Brink Relationship to property Developer

Authorized signature of **Property Owner** Curt Brink Date 4 / 17 / 2019

7. Application Filing Fees

Fees are required to be paid with the first application for either initial or final approval of a project, unless the project is part of the combined application process involving the Urban Design Commission in conjunction with Plan Commission and/or Common Council consideration. Make checks payable to City Treasurer. Credit cards may be used for application fees of less than $1,000.

Please consult the schedule below for the appropriate fee for your request:

- ☐ Urban Design Districts: $350 *(per §35.24(6) MGO)*.
- ☐ Minor Alteration in the Downtown Core District (DC) or Urban Mixed-Use District (UMX) : $150 *(per §33.24(6)(b) MGO)*
- ☐ Comprehensive Design Review: $500 *(per §31.041(3)(d)(1)(a) MGO)*
- ☐ Minor Alteration to a Comprehensive Sign Plan: $100 *(per §31.041(3)(d)(1)(c) MGO)*
- ☐ All other sign requests to the Urban Design Commission, including, but not limited to: appeals from the decisions of the Zoning Administrator, requests for signage variances (i.e. modifications of signage height, area, and setback), and additional sign code approvals: $300 *(per §31.041(3)(d)(2) MGO)*

A filing fee is not required for the following project applications if part of the combined application process involving both Urban Design Commission and Plan Commission:

— Project in the Downtown Core District (DC), Urban Mixed-Use District (UMX), or Mixed-Use Center District (MXC)

— Project in the Suburban Employment Center District (SEC), Campus Institutional District (CI), or Employment Campus District (EC)

— Planned Development (PD): General Development Plan (GDP) and/or Specific Implementation Plan (SIP)

— Planned Multi-Use Site or Residential Building Complex

URBAN DESIGN COMMISSION APPROVAL PROCESS

UDC

Introduction

The City of Madison's Urban Design Commission (UDC) has been created to:

- Encourage and promote high quality in the design of new buildings, developments, remodeling, and additions so as to maintain and improve the established standards of property values within the City.
- Foster civic pride in the beauty and nobler assets of the City, and in all other ways possible assure a functionally efficient and visually attractive City in the future.

Types of Approvals

There are three types of requests considered by the UDC:

- Informational Presentation. Applicants may, at their discretion, request to make an Informational Presentation to the UDC prior to seeking any approvals to obtain early feedback and direction before undertaking detailed design. Applicants should provide details on the context of the site, design concept, site and building plans, and other relevant information to help the UDC understand the proposal and provide feedback. (Does not apply to CDR's or Signage Variance requests)
- Initial Approval. Applicants may, at their discretion, request initial approval of a proposal by presenting preliminary design information. As part of their review, the Commission will provide feedback on the design information what should be addressed at Final Approval stage.
- Final Approval. Applicants may request Final Approval of a proposal by presenting all final project details. Recommendations or concerns expressed by the UDC in the initial approval must be addressed at this time.

Presentations to the Commission

Primarily, the UDC is interested in the appearance and design quality of projects. Emphasis should be given to the site plan, landscape plan, lighting plan, building elevations, exterior building materials, color scheme, and graphics.

When presenting projects to the UDC, applicants must fill out a registration slip provided in the meeting room and present it to the Secretary. Presentations should generally be limited to 5 minutes or as extended by motion by consent of the Commission. The Commission will withhold questions until the end of the presentation.

Applicants are encouraged to consider the use of various graphic presentation material including a locator map, photographs, renderings/model, scale drawings of the proposal in context with adjacent buildings/uses/signs, etc., as may be deemed appropriate to describe the project and its surroundings. Graphics should be mounted on rigid boards so that they may be easily displayed. **Applicants/presenters are responsible for all presentation materials, AV equipment and easels**.

URBAN DESIGN DEVELOPMENT PLANS CHECKLIST

UDC

The items listed below are minimal application requirements for the type of approval indicated. Please note that the UDC and/or staff may require additional information in order to have a complete understanding of the project.

1. Informational Presentation

- ☒ Locator Map
- ☒ Letter of Intent (If the project is within a Urban Design District, a summary of how the development proposal addresses the district criteria is required)
- ☒ Contextual site information, including photographs and layout of adjacent buildings/structures
- ☒ Site Plan
- ☒ Two-dimensional (2D) images of proposed buildings or structures.

Providing additional information beyond these minimums may generate a greater level of feedback from the Commission.

Requirements for All Plan Sheets

1. Title block
2. Sheet number
3. North arrow
4. Scale, both written and graphic
5. Date
6. Fully dimensioned plans, scaled at 1"= 40' or larger

*** All plans must be legible, including the full-sized landscape and lighting plans (if required)*

2. Initial Approval

- ☒ Locator Map
- ☒ Letter of Intent (If the project is within a Urban Design District, a summary of how the development proposal addresses the district criteria is required)
- ☒ Contextual site information, including photographs and layout of adjacent buildings/structures
- ☒ Site Plan showing location of existing and proposed buildings, walks, drives, bike lanes, bike parking, and existing trees over 18" diameter
- ☒ Landscape Plan and Plant List (*must be legible*)
- ☒ Building Elevations in both black & white and color for all building sides (include material callouts)
- ☐ PD text and Letter of Intent (if applicable)

Providing additional information beyond these minimums may generate a greater level of feedback from the Commission.

3. Final Approval

All the requirements of the Initial Approval (see above), **plus**:

- ☒ Grading Plan
- ☒ Proposed Signage (if applicable)
- ☒ Lighting Plan, including fixture cut sheets and photometrics plan (*must be legible*)
- ☒ Utility/HVAC equipment location and screening details (with a rooftop plan if roof-mounted)
- ☐ PD text and Letter of Intent (if applicable)
- ☐ Samples of the exterior building materials (presented at the UDC meeting)

4. Comprehensive Design Review (CDR) and Variance Requests (***Signage applications only***)

- ☐ Locator Map
- ☐ Letter of Intent (a summary of how the proposed signage is consistent with the CDR or Signage Variance criteria is required)
- ☐ Contextual site information, including photographs of existing signage both on site and within proximity to the project site
- ☐ Site Plan showing the location of existing signage and proposed signage, dimensioned signage setbacks, sidewalks, driveways, and right-of-ways
- ☐ Proposed signage graphics (fully dimensioned, scaled drawings, including materials and colors, and night view)
- ☐ Perspective renderings (emphasis on pedestrian/automobile scale viewsheds)
- ☐ Graphic of the proposed signage as it relates to what the Ch. 31, MGO would permit

600 Southgate Drive
Guelph ON Canada
N1G 4P6

Tel: +1.519.823.1311
Fax: +1.519.823.1316
E-mail: solutions@rwdi.com

MEMORANDUM

DATE:	2019-04-17	**RWDI Reference No.:** 1903089
TO:	Doug Hursh – Potter Lawson	**EMAIL:** dough@potterlawson.com
FROM:	Ryan Danks, P.Eng. - RWDI	**EMAIL:** ryan.danks@rwdi.com
	Jason Munn, P.Eng. - RWDI	**EMAIL:** jason.munn@rwdi.com
RE:	**Executive Summary of Solar Reflection Study Findings 929 East Washington Avenue Madison, WI**	

Dear Mr. Hursh,

RWDI was retained by Potter Lawson Architects Inc. to investigate how sunlight will reflect from the proposed 929 East Washington Avenue development ('Proposed Project'), and what impacts those reflections may have on people and property in the vicinity. RWDI has extensive experience in the study of urban reflections; having been involved in over 100 studies around the globe investigating issues ranging from simple nuisance reflections, to dangerous reflections distracting drivers and pilots, and even cases where reflections caused thermal damage and injury.

RWDI's detailed analysis and technical report (dated April 17, 2019) which was included with this memorandum, covers in detail, the methodology, results and conclusions of the analysis. This memorandum is intended to provide a high-level, non-technical summary of the salient findings.

Background

It is imperative to understand that *any* contemporary building will reflect light, most commonly from windows and other glazed elements. A critical task of modern architecture is to balance the positive aspects of a building's windows (i.e. providing natural light and views) with the need to control the sunlight reflected from them. Completely eliminating reflections from a building would result in either very little fenestration, or windows that are highly shaded, reducing views and natural light for the occupants.

It is also important to understand that the reflectivity of glass is *not* a fixed value. The reflectivity of glass increases as light strikes at more glancing angles. Depending on how the local street grid aligns with the path of the sun, situations can be created whereby reflections can affect drivers and pedestrians *regardless* of the type of glass that is used.

Experiencing a reflection from a building is a common experience in urban areas and typically represents no more than a momentary irritant which is quickly forgotten. In many cases a reflection coincides with times when the sun is already generally in the field-of-view and is therefore not as easily noticed due to the much more intense direct sunlight. The goal of RWDI's investigation was to quantify reflections from the Proposed Project in terms of their intensities, frequencies and durations throughout the year so that reflections can be understood holistically and in context.

Methodology

Currently, there are no universally accepted approaches for simulating and categorizing urban reflections. In this work, RWDI has used a proprietary computational tool[1] to simulate the reflections from the Proposed Project over the course of an entire year at one-minute increments. Based on an analysis of the results, we have used an internally developed set of metrics[2] to assign a level of visual and thermal impact to the reflections.

RWDI's approach is intentionally conservative to ensure that no potential reflections are missed. Most importantly, this analysis neglects the effects of trees (i.e. foliage) and cloud cover since these factors create inconsistent levels of shade. For context, according to the U.S. National Oceanic and Atmospheric Administration (NOAA), sunshine is possible in Madison on average 54% of the time on an annual basis[3]. We also note that many streets near the project have mature trees which in summer, would likely reduce the effect of some reflections. In winter however, the trees would likely provide little benefit. Given these conservatisms, we would expect the actual frequencies of reflections to be *lower* compared to what is predicted by RWDI's study.

Observations and Conclusions

Reflections are predicted to occur within the field-of-view of drivers on East Washington Ave. and North Brearly St. as they approach the Proposed Project. However, the potential for these reflections only exists in 11 to 31 hours in total per year. In other words, reflections which may affect drivers are possible in less than 0.7% of daytime hours.

Some of these impacts occur due to reflections occurring at glancing angles. As noted in the Background section herein, this naturally enhances the reflectivity of the glazing, meaning that these

[1] Danks, Ryan, and Joel Good. "Urban Scale Simulations of Solar Reflections in the Built Environment: Methodology and Validation." 2016 Proceedings of the Symposium on Simulation for Architecture and Urban Design. London. 2016.

[2] Danks, Ryan, Joel Good, and Ray Sinclair. "Assessing reflected sunlight from building facades: A literature review and proposed criteria." Building and Environment 103 (2016): 193-202.

[3] https://www1.ncdc.noaa.gov/pub/data/ccd-data/pctposrank.txt

impacts would occur regardless of the type of glass used in the Proposed Project. Further, many reflections on the streets occur when the sun would already be in a driver's field-of-view, making these reflections less impactful. This is because direct sunlight will dominate over any reflected light, and because drivers would expect glare at this time and would likely have already taken mitigative measures (i.e. sunglasses or lowering sun visors).

Reflections were also predicted to fall on 1002 East Washington Avenue for brief periods during a small fraction of the year. These reflections are possible in total between 36 and 133 hours per year, or 0.8% to 3% of daytime hours. We note that the most frequent impacts were seen on the lowest floors, which appear to be commercial rather than residential, and also that the trees on North Brearly Street may help reduce these impacts.

Reflections from the Proposed Project can also fall on Breese Stevens Field. This condition would be expected to occur for any glazed building at the location of the Proposed Project due to the orientation of the street grid and the site's proximity to the field. Reflections most commonly fall on the north corner of the field as well as on the north and northwest bleachers. These reflections occur between 44 to 111 hours per year, or 1% to 2.5% of the daytime annually. The majority of the bleachers are not predicted to be affected by reflections at all. At most the playing field is potentially exposed to reflections 40 hours per year in total (0.9% of the daytime annually). The street trees along East Washington Ave. are expected to help reduce the frequency of reflections reaching Breese Stevens Field.

RWDI's analysis also included an investigation of the potential for reflected solar energy to be focused or concentrated by the facetted northwest façade. The results indicate that while multiple reflections from this façade can converge, the maximum predicted intensity of these reflections was well below the peak intensity of naturally occurring sunlight.

In conclusion, it is RWDI's opinion that the solar reflection analysis of the Proposed Project does not indicate any significant potential for thermal impacts to people or property, and that the predicted visual impacts are typical of those seen in any urban environment.

Please do not hesitate to contact us if there are any further questions.

Yours truly,

ROWAN WILLIAMS DAVIES & IRWIN INC. (RWDI)

Ryan Danks, P.Eng
Senior Engineer/Associate

Jason Munn, P.Eng.
Senior Project Manager/Associate

REPORT

929 EAST WASHINGTON AVENUE

DETAILED SOLAR REFLECTION ANALYSIS

APRIL 17, 2019
PROJECT #1903089

SUBMITTED TO

Doug Hursh, AIA, LEED AP
Director of Design
dough@potterlawson.com

Potter Lawson Inc.
749 University Row, Suite 300
Madison, WI 53705
T: 608.274.2741

SUBMITTED BY

Nadine Soliman, B.A.Sc.
Technical Coordinator
Nadine.Soliman@rwdi.com

Ryan Danks, P.Eng.
Sr. Engineer/Associate
Ryan.Danks@rwdi.com

Jason Munn, P.Eng.
Sr. Project Manager/Associate
Jason.Munn@rwdi.com

RWDI
600 Southgate Drive,
Guelph, Canada, N1G 4P6
T: 519.823.1311
F: 519.823.1316

TABLE OF CONTENTS

INTRODUCTION

This report provides the computational modeling results of RWDI's reflected sunlight analysis from the proposed Project at 929 East Washington Avenue in Madison, WI. The proposed Project is located on East Washington Avenue, between South Patterson and South Brearly Streets (as shown in Figure 1). It is our understanding that the development will be surrounded by typical urban spaces such as parks, busy roadways and other buildings.

RWDI was retained to investigate the impact that solar reflections emanating from the proposed Project may have on the surrounding urban terrain.

A preliminary set of simulations was conducted to determine peak reflection intensities and the frequency of occurrence of reflections for a broad area around the development. This served to identify areas which may experience high intensity or very frequent reflections. This information informed the selection of 32 'receptor' points for a more detailed analysis. The receptor points represent drivers, pedestrians, and building façades. The detailed results allows for the quantification of the frequency, intensity and duration of glare events at the receptors, as well as the sources of those reflections.

Figure 1: Approximate Location of the Proposed Project (Blue Outline) (Map Credit: Google Earth)

Urban Reflections

While a common occurrence, solar reflections from buildings can lead to numerous visual and thermal issues.

Visual glare can:

- Impair the vision of motorists and others who cannot easily look away from the source;
- Cause nuisance to pedestrians or occupants of nearby buildings; and,
- Create undesirable patterns of light throughout the urban fabric.

Heat gain can:

- Affect human thermal comfort;
- Be a safety concern for people and materials, particularly if multiple reflections are focused in the same area; and
- Create increased cooling needs in conditioned spaces affected by the reflections.

The most significant safety concerns with solar reflections occur with concave facades (Figure 2) which act to focus the reflected light in a single area. The northwestern facade of this development is facetted in a slightly concave fashion. Therefore we have investigated the potential for focusing in greater detail.

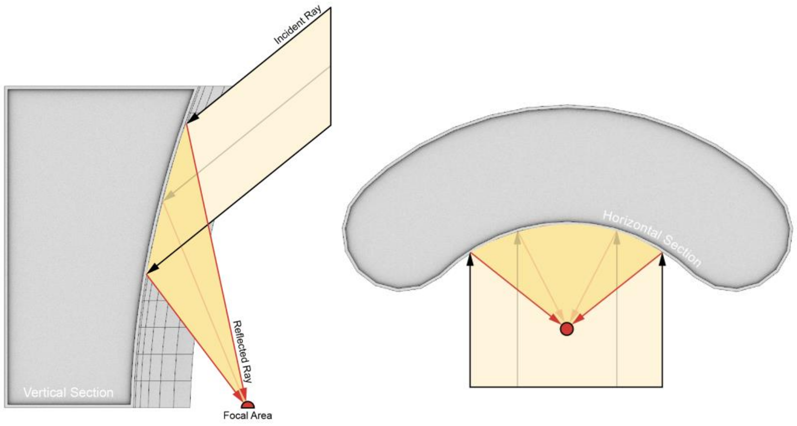


Figure 2: Illustration of Reflection Focusing Due to a Concave Facade

Methodology

RWDI assessed the potential for solar reflection using RWDI's in-house proprietary *Eclipse* software in two Phases per the steps outlined below:

1. The Phase 1 "Screening" assessment began with a 3D model of the area of interest (as shown in Figure 3). This model was then subdivided into many smaller triangular patches (see Figure 4).
2. For each hour in a year, the expected solar position was determined, and "virtual rays" were drawn from the sun to each triangular patch of the 3D model. Each ray that was considered to be "unobstructed" was reflected from the building surface and tracked through the surrounding area. The study domain included the entire pedestrian realm within approximately 1,000 feet of the proposed building.
3. The total reflected energy at a given hour from all of the patches was computed and its potential for visual and thermal impacts was assessed.
4. Finally, a statistical analysis was performed to assess the frequency, and intensity of the glare events occurring throughout the year within the nearby airspace. The Criteria used to assess the level of impact can be found in Appendix B of this report.

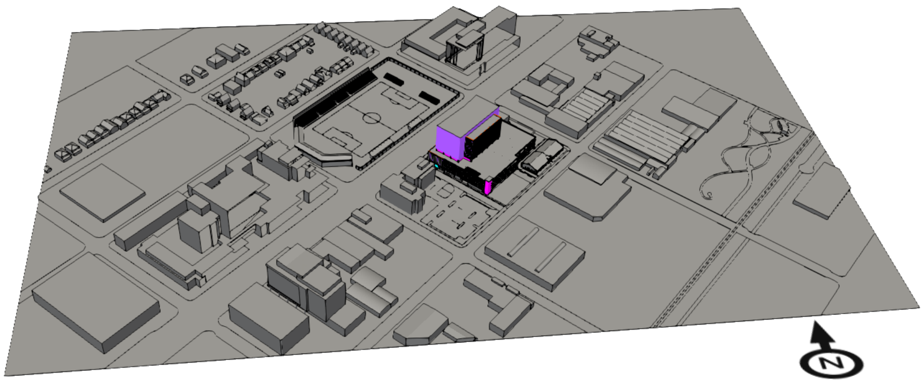


Figure 3: 3D Computer Model of the Proposed Development and Surrounding Context

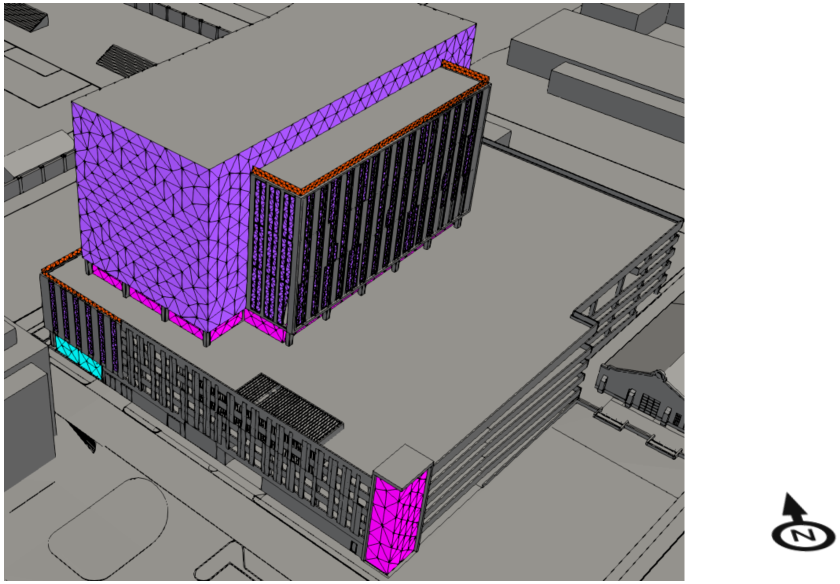


Figure 4: Close-up View of the Model, Showing Surface Subdivisions

Methodology (cont'd)

5. Based on the findings of the Phase 1 Screening analysis, 32 representative 'receptor points' were selected to undergo a more detailed, Phase 2 analysis.

6. The receptor points were chosen to understand in greater detail how reflections from the building will impact drivers, pedestrians and other buildings. These points are discussed further in the detailed analysis section this report.

7. The detailed analysis process is similar in the detailed phase of work, except reflections are analyzed at 1 minute increments for the entire year.

8. In addition to the frequency and duration of reflection impacts, the more detailed analysis allows for the prediction of when those impacts will occur, how long they occur for, and which building element is the source.

Assumptions and Limitations

Meteorological Data

This analysis used 'clear sky' solar data computed at the location of Dane County Regional Airport. This approach uses mathematical algorithms to derive solar intensity values for a given location, ignoring local effects such as cloud cover. This provides a 'worst case' scenario showing the full extent of when and where, glare could occur.

Radiation Model

RWDI's analysis is only applicable to the thermal and visual impacts of solar radiation (i.e. ultraviolet, visible and infrared wavelengths) on people and property in the vicinity of the development. It does not consider the impact of the building related to any other forms of radiation, such as cellular telephone signals, RADAR arrays, etc.

Potential reductions of solar reflections due to the presence of vegetation or other non-architectural obstructions were not included, nor are reflections from other buildings. Light that has reflected off several surfaces is assumed to have a negligible impact. As such, only a single reflection from the development was included in the analysis.

Study Building and Surrounds Models

The analysis was conducted based on a 3D model of the proposed Project and surrounding buildings provided by Potter Lawson to RWDI on April 5, 2019.

RWDI conducted a cursory examination of this model to confirm correct street orientations and approximate building massing, but otherwise the model has been implemented as it was supplied, without modification.

Assumptions and Limitations (cont'd)

Facade Material Reflectance

RWDI understands that the exact glazing units to be used in the proposed Project are still under consideration by the design team. For the purposes of this analysis, RWDI has assumed reflectivity characteristics for the glazing based on communication with Potter Lawson on April 5, 2019.

The glazing units included in this analysis range in visible reflectance (which relates to glare) from 10% to 26%. The studied glazing units range in full spectrum reflectance (which relates to heat gain) from 34% to 38%. The glass guardrails were also included in the analysis and assigned nominal visible and full spectrum reflectance values of 8% and 7%, respectively.

It is RWDI's understanding that all other façade elements will be matte in finish (or otherwise non-reflective) and thus have not been included as potential sources of reflections.

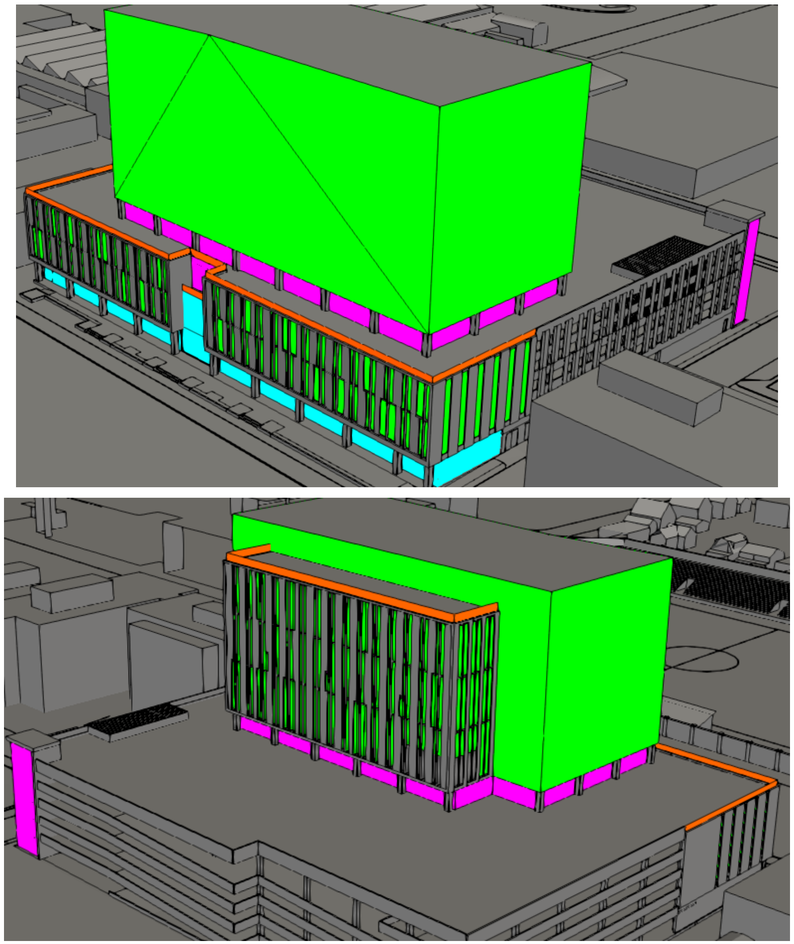
The reflectance properties of the reflective elements are summarized in Table 1. Figure 5 illustrates the location of the reflective materials on the facades.

Applicability of Results

The results presented in this report are highly dependent on the form and materiality of the facade. Should there be any substantial changes to the design of the building or surrounding road network, it is recommended that RWDI be contacted and requested to review their potential effects on the findings of this report.

This report has endeavored to provide a robust and suitably conservative analysis of the potential effects of reflected sunlight, contextualized based on current industry and academic research, and common best practices. Regulation and enforcement of performance requirements is the responsibility of the relevant regional regulatory authority.

Assumptions and Limitations (cont'd)



LEGEND

- NON-REFLECTIVE
- LAMINATED SAFETY GLASS
- VNE1-63
- VRE1-43
- VRE1-65

Table 1: Nominal Visible and Full Spectrum Reflectance Values of the Reflective Building Elements

Material Location	Material Specified	Visible Reflectance	Full Spectrum Reflectance
Guard Rails	Laminated Safety Glass	8%	7%
First Floor Retail	VNE1-63	10%	37%
Floors 2, 3, 5-11	VRE1-43	25%	38%
Floor 4 & South Corner	VRE1-65	26%	34%

Figure 5: Locations of Reflective Building Elements Facing East (top) and West (bottom)

Presentation of Results

This section presents the screening results pertaining to the solar impacts of the development on the surrounding urban area. The following plots are presented :

Peak Annual Reflected Irradiance
This plot displays the annual peak intensity of all reflections emanating from the development.

Two versions of this plot are included:

- **Visible Reflectance (Visual Glare):** These plots (Figures 6a and 6b) display the intensity of reflected visible light only. Depending on the ambient conditions, reflection intensities as low as 50 W/m² could be visible to people outdoors.

- **Full Spectrum Reflectance (Heat Gain):** These plots (Figures 6c and 6d) present the total intensity of a reflection, including both visible light and thermal energy. This relates to the risk of excessive heat gain. For full spectrum reflectance, RWDI considers 1500 W/m² as a short term thermal comfort threshold and reflections above 2500 W/m² as a human safety threshold (refer to Appendix B).

- **Frequency of Significant Visual Reflections:** These plots (Figures 6e and 6f) identify the locations of the most frequent and significant reflections emanating from the facades. In this context a 'significant' reflection is one that is at least 50% as intense as one that would cause after-imaging on a viewer (refer to Appendix B). As this criteria is visually based, the visible reflectance of the facades was used.

For all surfaces located in places where people could be present (i.e., grade level and the bleachers of Breese Stevens Field) the results are computed at typical eye height. For results on neighboring buildings, the results are plotted on the exterior of the building envelope and do not include any attenuation due to the façades. Additionally, it should be noted that since individual windows were not explicitly modeled, some reflections may be falling on opaque building elements.

In order to attain a complete understanding of the impact that reflections may have on people and property, other factors must be considered, including the duration of the reflections and when they occur. The following plots serve to illustrate the general characteristics of reflections from the development and inform the locations of the receptor points used in the detailed phase of work (Page 19) which analyzed these factors in greater detail.

Peak Annual Reflected Irradiance - Visible Reflectance (Visual Glare)

Reflections as low as 50 W/m² may be visible to people, depending on outdoor lighting levels.

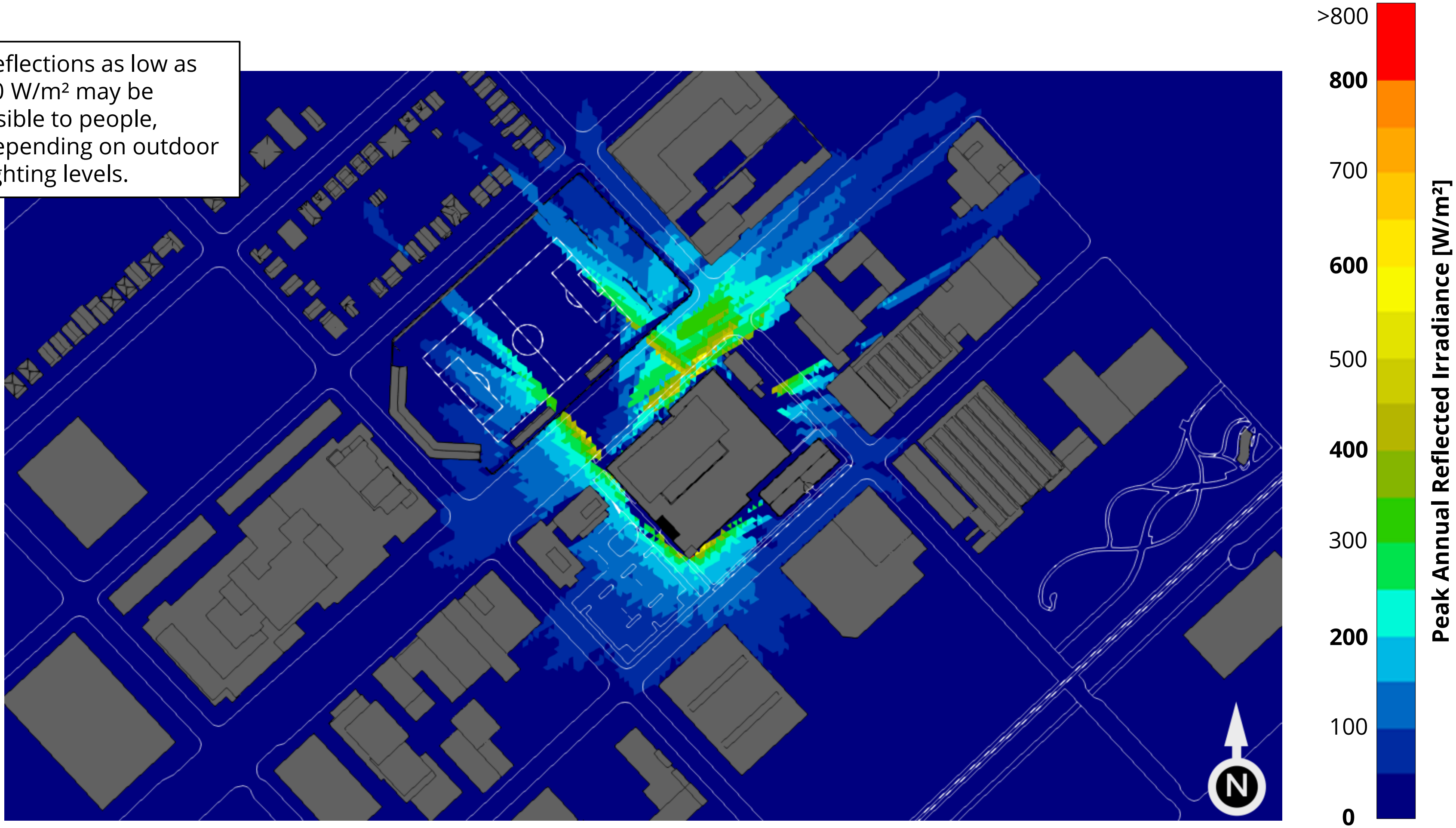


Figure 6a: Maximum Annual Intensity of Visible Reflections at Pedestrian Height

RWDI Project #1903089
April 17, 2019

Peak Annual Reflected Irradiance - Visible Reflectance (Visual Glare)

Reflections as low as 50 W/m² may be visible to people, depending on outdoor lighting levels.

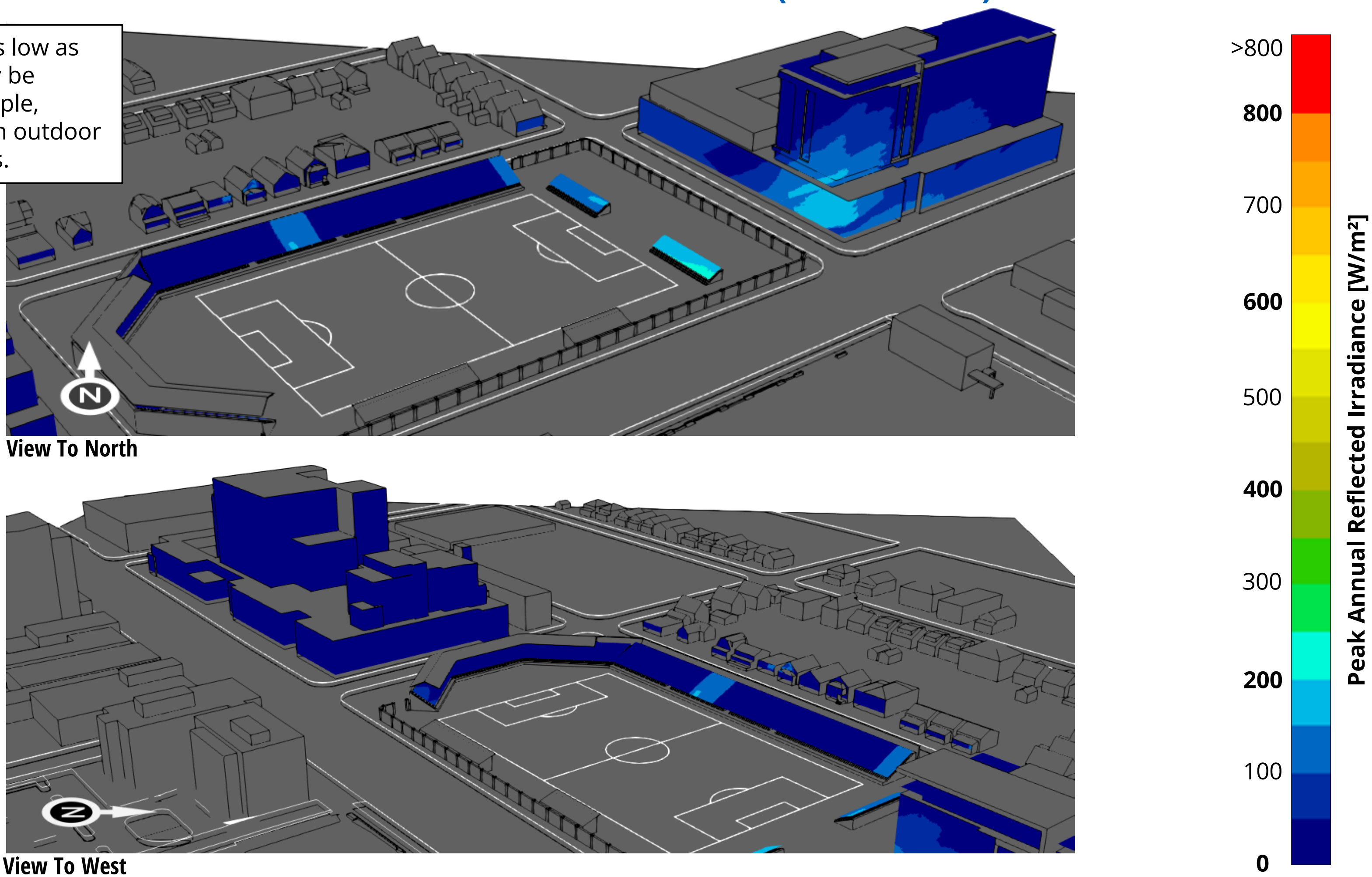


Figure 6b: Maximum Annual Intensity of Visible Reflections on Adjacent Facades (Proposed Project Removed for Clarity)

SCREENING ANALYSIS RESULTS

Peak Annual Reflected Irradiance - Full Spectrum Reflectance (Heat Gain)

800 W/m² represents a typical intensity for direct sunlight.

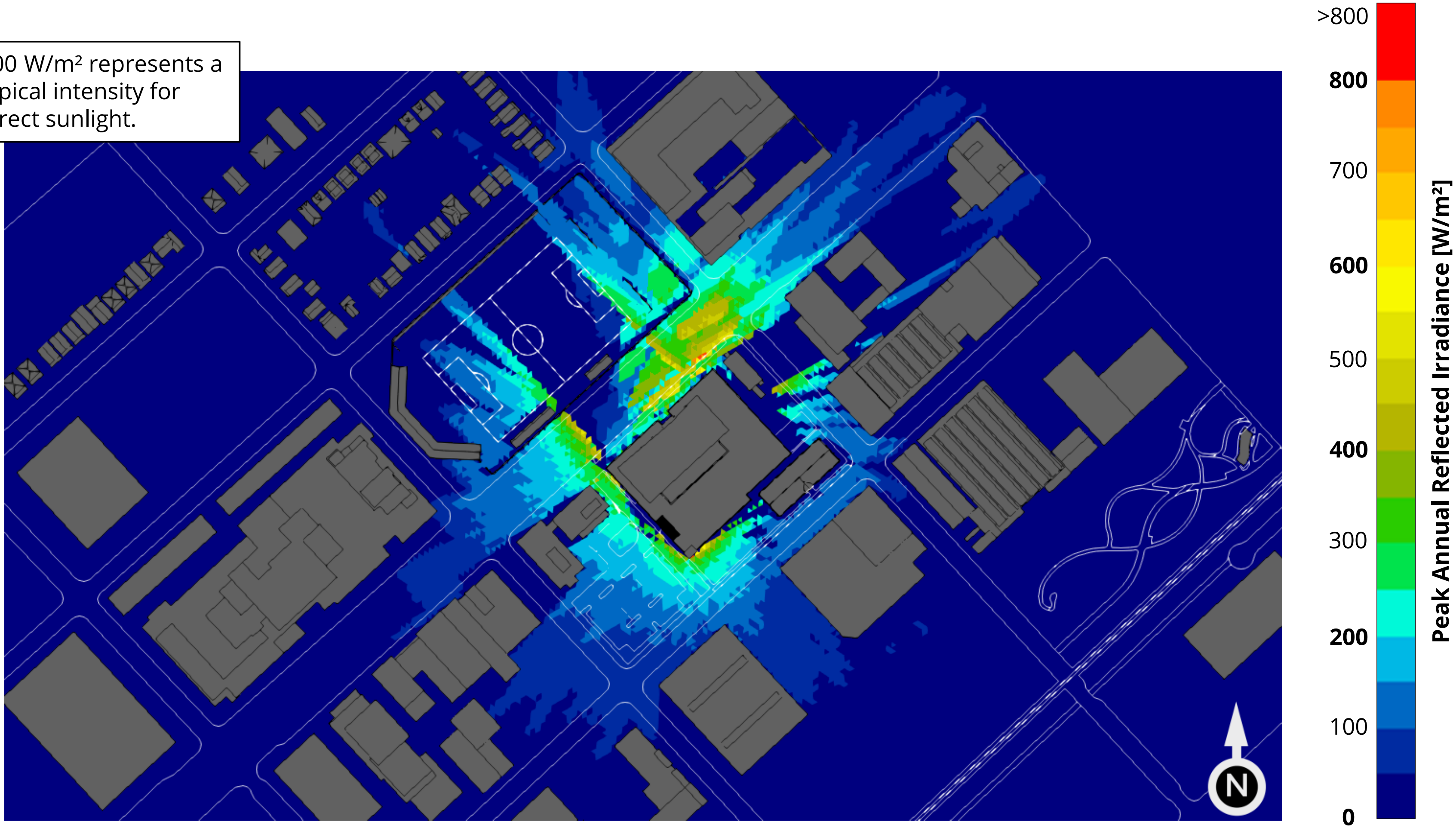


Figure 6c: Maximum Annual Intensity of Full Spectrum Reflections at Pedestrian Height

RWDI Project #1903089
April 17, 2019

Peak Annual Reflected Irradiance - Full Spectrum Reflectance (Heat Gain)

800 W/m² represents a typical intensity for direct sunlight.

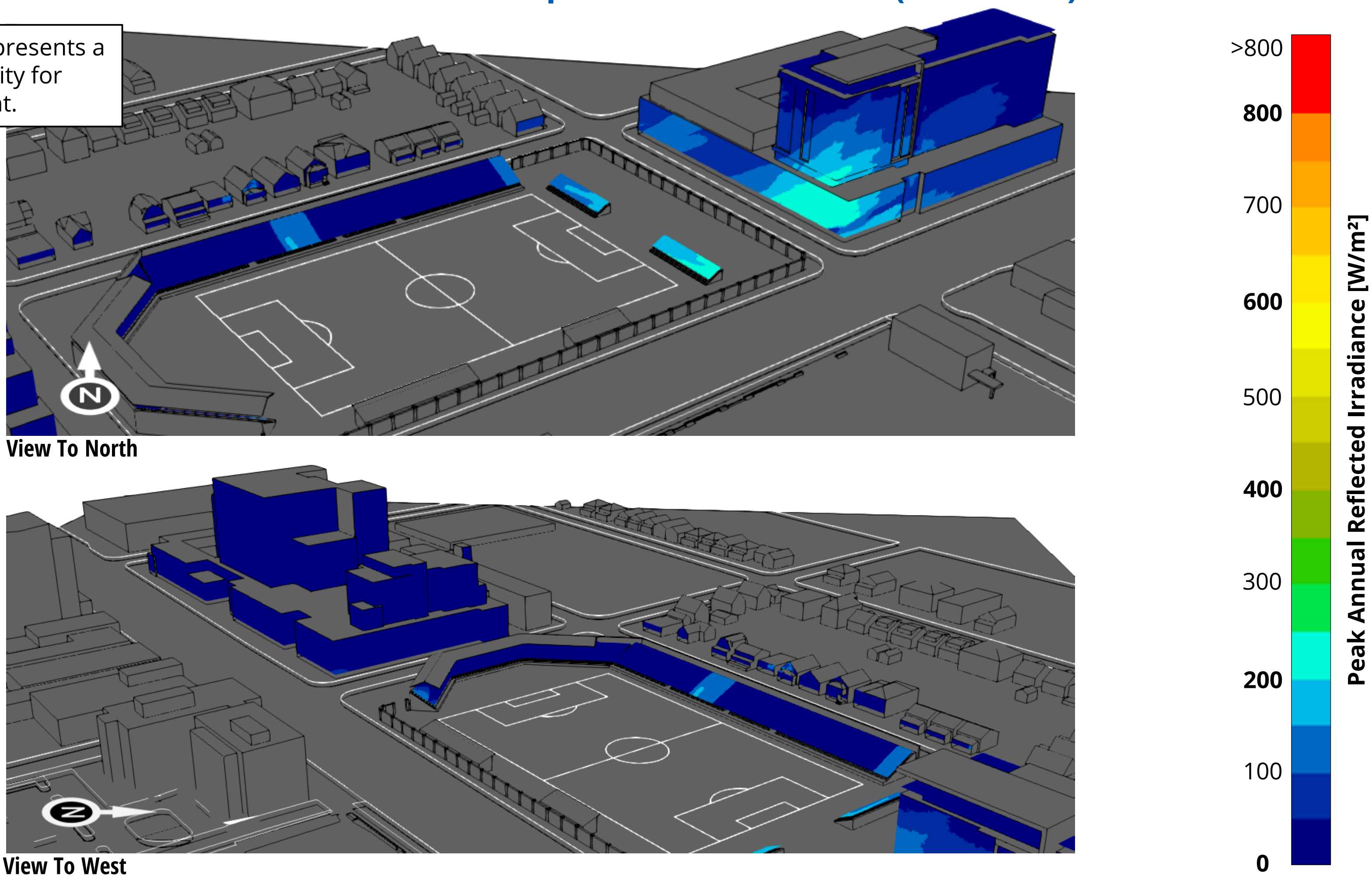


Figure 6d: Maximum Annual Intensity of Full Spectrum Reflections on Adjacent Facades (Proposed Project Removed for Clarity)

Frequency of Significant Visible Reflections

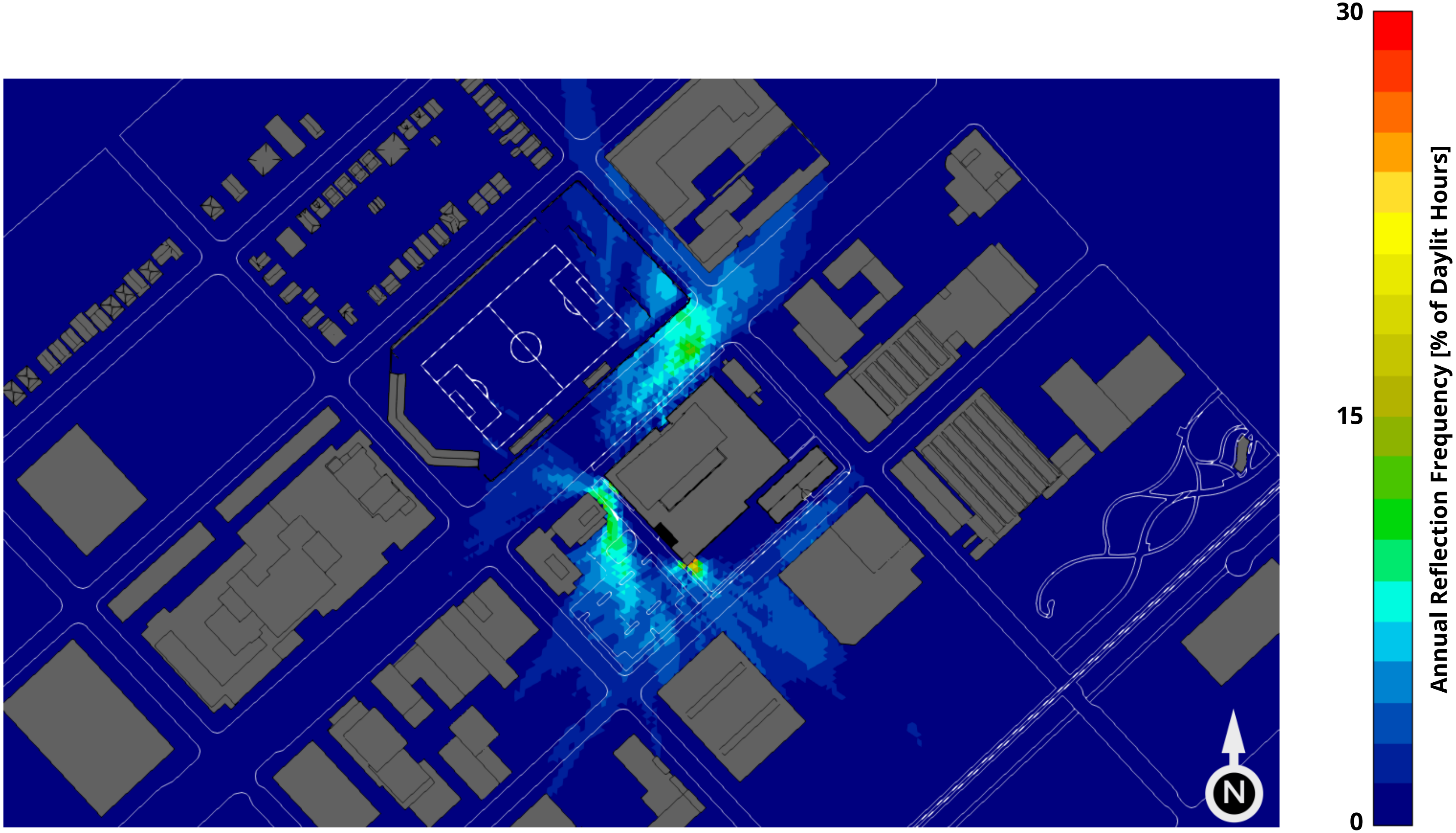


Figure 6e: Frequency (% of Daylit Hours) Where Significant Visible Reflections Can Occur

Frequency of Significant Visible Reflections

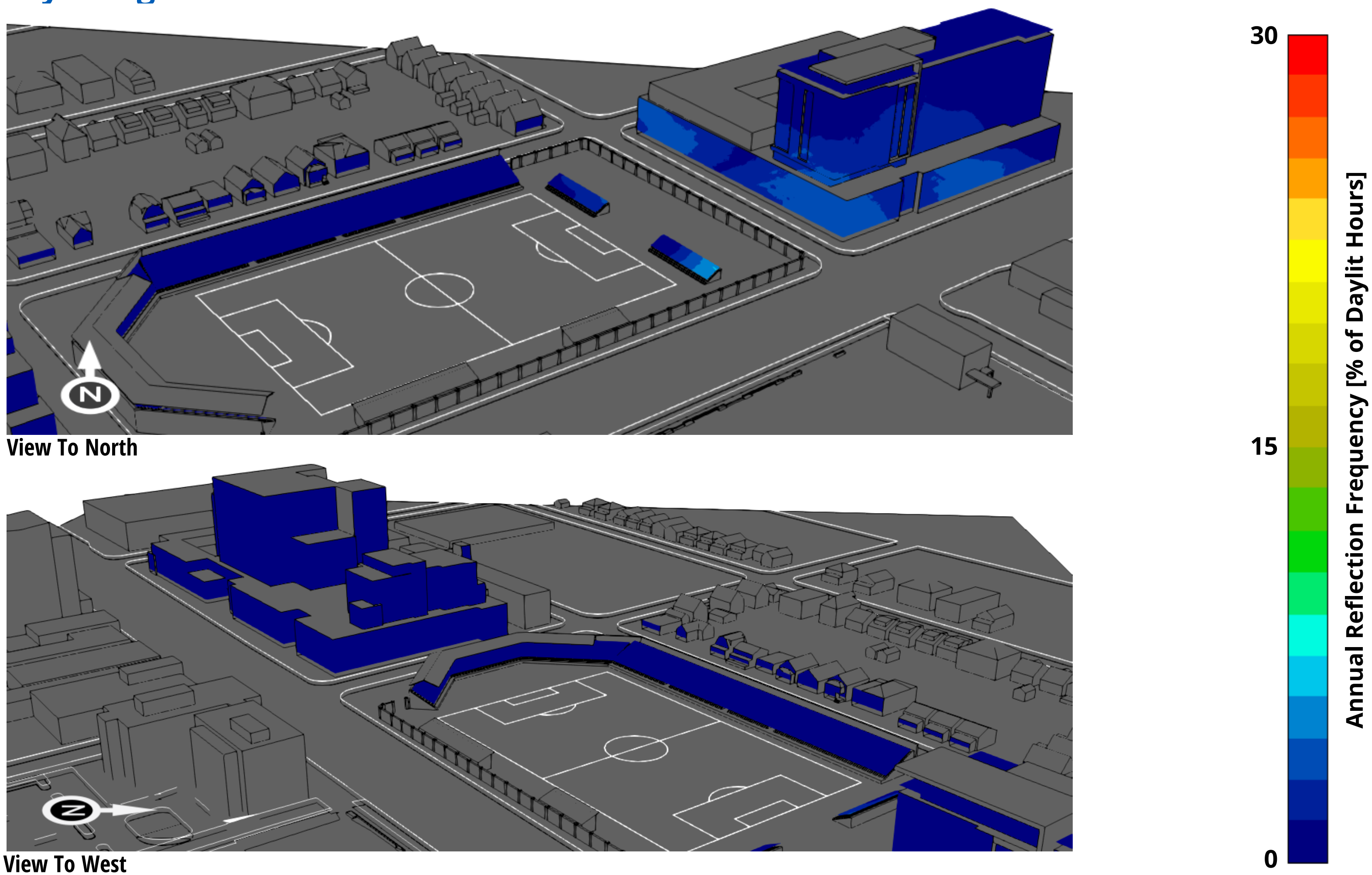


Figure 6f: Frequency (% of Daylit Hours) Where Significant Visible Reflections Can Occur on Adjacent Facades (Proposed Project Removed for Clarity)

SCREENING ANALYSIS OBSERVATIONS

1. Like any contemporary building, the reflective surfaces of the proposed Project are naturally causing solar reflections in the surrounding neighborhood and are generally confined to the area approximately 250 feet from the site.

2. The faceted nature of the north facade is predicted to create instances where multiple reflections converge. However, the maximum intensities of all reflections from the Project are predicted to be well below the maximum intensity of naturally occurring sunlight, as well as RWDI's intensity criteria. Further, the areas of highest peak reflection intensity do not correspond with the areas of the most frequent reflections, indicating that any solar concentration is highly transient. The areas of higher peak intensities are also generally on roadways, where people would not be expected to linger. Thus, RWDI does not expect any significant thermal impacts (i.e. risks to human safety or property damage) to occur either on the site of the development or in the surrounding neighborhood. The risk of heat gains within nearby buildings due to lower intensity but long duration reflections is further analyzed in the detailed analysis section of this report.

3. At pedestrian level, reflections are predicted to fall most frequently onto the area immediately south of the proposed Project and to a lesser extent, immediately north and west of it. The maximum frequency of glare occurrence found at pedestrian level is approximately 27% of daytime hours, which is typical of many projects RWDI has studied. That being said, the majority of spaces around the Project experience reflections less than 10% of the daytime annually.

4. These reflections are predicted to fall on East Washington Avenue, as well as on North Brearly Street. Not all of these reflections will align with a driver's field of view and may occur when the sun is already visible to a driver (which would lower the impact of any reflections). The exact durations and frequencies of these impacts are explored in the detailed analysis section of this report.

5. The occupants of the buildings located north and northwest of the Project, as well as people in some areas of Breese Stevens Field, are expected to experience visible reflections from the development. That being said, the reflections do not pose a risk to safety, and are likely a nuisance at worst, as the occupants can look away or close blinds. The exact durations and frequencies of these impacts are explored in the detailed analysis section of this report.

6. No significant impacts are expected on the rooftop terrace of 1002 East Washington Ave, McPike Park, nor on the envelope of the development to the west of the site (the block bounded by West Washington Avenue, East Mifflin Street, North Livingston Street and North Paterson Street).

DETAILED ANALYSIS RESULTS

Based on the findings of the Phase 1 - Screening Analysis and the risk levels associated with reflections effecting specific areas, 32 representative receptor points were selected for the Phase 2 - Detailed Analysis. These points are described in Table 2 and illustrated in Figure 7.

Table 2: Receptor Descriptions

Receptor Number	Receptor Description
D1-D5	North-eastbound drivers on East Washington Avenue
D6-D9	South-westbound drivers on East Washington Avenue
D10-D12	South-eastbound drivers on North Brearly Street
D13	South-eastbound drivers on North Paterson Street
F14-F17	Facade of 1002 East Washington Avenue (at approximately the 1st, 3rd, 5th and 7th floors)
F18	Facade of 102 North Brearly Street
F19	Facade of 994 East Mifflin Street
F20	Facade of 992 East Mifflin Street
F21	Facade of 920 East Mifflin Street
P22-P23	Pedestrians in the southeast corner of Breese Stevens field
P24-P29	Spectators in the bleachers of Breese Stevens field (facing approximately the center for the field)
P30-P32	Players on Breese Stevens field (facing approximately the center for the field)

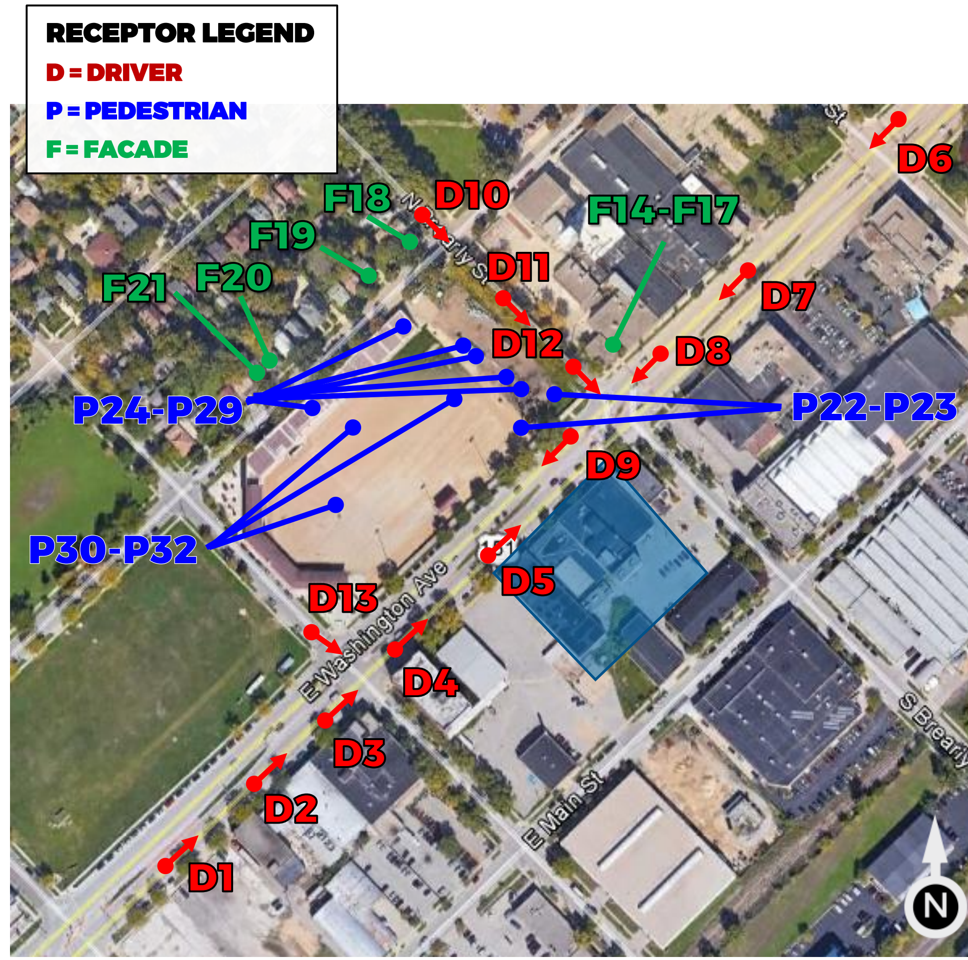


Figure 7: Receptor Locations (Map Underlay Credit: Google Earth)

DETAILED ANALYSIS RESULTS - CRITERIA

Table 3 summarizes the level of visual and thermal impact from the development's reflections at each of the studied points. For each category (visual impact, thermal impacts on people, thermal impacts on facades/property) the point is defined as experiencing one of three impact levels:

- **Low** impacts indicate that either no reflections reach the point, or that reflections which do reach the location are unlikely to lead to visual or thermal concerns.

- **Moderate** impacts indicate the potential for visual nuisance, minor thermal discomfort to people, or heating of materials. Moderate impacts do not indicate a significant safety risk and are common in urban areas. They represent effects such as intermittent visual glare on pedestrians or occupants of adjacent buildings which can be safely self-mitigated.

- **High** impacts indicate the potential for risks to safety, either through impairing the visual acuity of a vehicle operator or through reflection intensities high enough to cause injury or property damage. When the sun is also in a driver's field of view, we would expect that brightness of the sun to dominate over the less intense reflected light, likely reducing the perceived effect of high impact reflections. This situation is noted in Table 3 where applicable, as are notes on high impact reflection frequencies and durations.

The minute-by-minute results for each point are presented as "Annual Impact Diagrams" which distill an entire years worth of data into a single diagram. The diagrams for each of the receptor points as well as an explanation for how to read the diagrams are provided in **Appendix A**.

For further detail on RWDI's criteria refer to **Appendix B**.

The level of mitigation required (discussed further in the Overall Observations & Conclusions section of this report), is determined based on a combination of factors including the predicted level of impact, the frequency and duration of the impacts, and the risk level associated with activities likely to be engaged in at the location.

DETAILED ANALYSIS RESULTS

Table 3: Summary of Overall Predicted Impacts on Receptors

Receptor Number	Receptor Type	Assumed Activity Risk Level	Assumed Ability to Self-Mitigate	Peak Reflected Light Visual Impact	Sun in Field of View During High Impact Reflection	Duration / Number of Days with High Impact Reflection	Peak Reflected Solar Thermal Impact on People	Peak Reflected Solar Thermal Impact on Facade
D1	Driver	High	Low	***High*†***	***No***	Longest Duration: **15 minutes** Average Duration: **11 minutes** No. of days: **36**	***Low***	N/A
D2	Driver	High	Low	***High****	***No***	Longest Duration: **40 minutes** Average Duration: **27 minutes** No. of days: **66**	***Low***	N/A
D3-D5	Driver	High	Low	***Moderate***	N/A	N/A	***Low***	N/A
D6	Driver	High	Low	***High*†***	***Some***	Longest Duration: **11 minutes** Average Duration: **6 minutes** No. of days: **102**	***Low***	N/A
D7	Driver	High	Low	***High*†***	***Some***	Longest Duration: **23 minutes** Average Duration: **9 minutes** No. of days: **77**	***Low***	N/A
D8	Driver	High	Low	***High*†***	***No***	Longest Duration: **19 minutes** Average Duration: **7 minutes** No. of days: **49**	***Low***	N/A
D9	Driver	High	Low	***Moderate***	N/A	N/A	***Low***	N/A
D10	Driver	High	Low	***High*†***	***No***	Longest Duration: **16 minutes** Average Duration: **10 minutes** No. of days: **56**	***Low***	N/A
D11-D13	Driver	High	Low	***Moderate***	N/A	N/A	***Low***	N/A

***** High impact reflections are infrequent.

† High impact reflections are generally short in duration.

DETAILED ANALYSIS RESULTS

Table 3: Summary of Overall Predicted Impacts on Receptors (cont'd)

Receptor Number	Receptor Type	Assumed Activity Risk Level	Assumed Ability to Self-Mitigate	Peak Reflected Light Visual Impact	Sun in Field of View During High Impact Reflection	Duration / Number of Days with High Impact Reflection	Peak Reflected Solar Thermal Impact on People	Peak Reflected Solar Thermal Impact on Facade
F14-F20	Facade	Low	High	***Moderate***	N/A	N/A	N/A	***Low***
F21	Facade	Low	High	***Low***	N/A	N/A	N/A	***Low***
P22-P32	Pedestrian	Low	High	***Moderate***	N/A	N/A	***Low***	N/A

OVERALL OBSERVATIONS & CONCLUSIONS

Overall Impact of Reflections

1. Overall, we consider the impacts of the reflections from the Proposed Project to be typical of those we have studied in other urban spaces, that would not require mitigation.

Thermal Impacts on People

2. Given the low predicted intensities of reflected solar energy from the Project, RWDI does not expect any significant thermal impacts (i.e. risks to human safety or property damage) to occur either on the site of the development or in the surrounding neighborhood.

Visual Glare Impact on Drivers

3. As with the addition of any glazed building, drivers travelling in the vicinity of the proposed Project are expected to experience an increased level of visual glare impact. Some reflections with a high visual impact potential were noted. These impacts can alter a driver’s experience since the glare occurs at times when the sun would not be within a driver’s field-of-view. In particular, a driver’s experience could be altered when:
    A. Travelling northeast on an approximately 200 foot segment of East Washington Avenue between South Livingston Street and North Paterson Street (D1 and D2);
    B. Travelling southwest on East Washington Avenue between approximately North Ingersoll Street and South Brearly Street (D6-D8); and
    C. Travelling southeast on North Brearly Street at approximately East Mifflin Street (D10)

3. For north-eastbound drivers on East Washington Avenue the high impacts reflections are possible from mid-November through late-January between 2:30 pm and 3:30 pm CST. The impacts can persist in these locations up to 40 minutes per day but generally last between 11 and 27 minutes. This equates to high impact glare being possible less than 0.7% of the daytime annually (31 hours per year).

4. For south-westbound drivers on East Washington Avenue the high impacts reflections are possible from early October through early March between 3:30 pm and 4:30 pm CST. The impacts can persist in these locations up to 23 minutes per day but generally last between 6 to 9 minutes. This equates to high impact glare being possible less than 0.4% of the daytime annually, or 18 hours per year.

    Further, many (but not all) reflections in this area occur when the sun is already generally in a driver's field-of-view. We would expect the brightness of the sun to dominate over any reflected light, potentially reducing a driver’s perception of the reflection. Additionally, since the sun is already potentially creating glare during the times of high impact reflections, drivers are likely to have already taken mitigative action against it (e.g. putting on sunglasses, lowering sun visors, etc.), thus lowering the risk of reflections creating serious impacts.

Visual Glare Impacts on Drivers (cont'd)

5. For south-eastbound drivers on North Brearly Street at East Mifflin Street, the high impact reflections can occur from mid-January to mid-February and again from late October to late-November between 7:00 am and 8:30 am CST. The high impacts can last up to 16 minutes, but on average last for 10 minutes, equating to high impacts being possible in 0.25% of the daytime annually (11 hours per year). Similar to impacts noted in observation 4 , drivers would also be generally facing the sun during the times of high impact glare, potentially reducing the risk of reflections creating serious impacts.
6. For the remainder of the driver receptors, visual glare impacts are predicted to be moderate at worst, and therefore are not expected to pose a safety concern to drivers.

Visual Glare Impacts on Pedestrians and Facades

7. Moderate levels of visual impact are predicted to fall on all of the pedestrian and façade receptors studied in this analysis. This is not unusual for an urban environment and does not present a safety risk, but rather a temporary nuisance at worst which can be mitigated by briefly closing window treatments or looking away from the glare source.
8. Reflections reaching the 1002 East Washington Avenue (F14-F17) are possible during March, April, August and September twice per day. Morning reflections occur between 6:30 am CST and 7:45 CST and afternoon reflections are possible between 4:00 pm CST and 6:00 pm CST. These reflections last on average 16-25 minutes at a time and become less frequent with increased height above grade. Reflections are possible between 0.8% and 3.0% of the daytime annually, or between 36 and 133 hours per year.
9. Very brief and infrequent reflections are possible on certain homes on East Mifflin Street (F18-F20). These reflections last at most 13 minutes per day mainly between 8:30 am CST and 9:30 am CST from mid-November through January. This represents reflections being possible in at most 0.45% of the daytime annually (20 hours per year).
10. Moderate level glare can also reach the north corner of Breese Stevens Field (P22-P23), portions of the northeast (P24-P27) and northwest bleachers (P28-P29) as well as the playing field itself (P30-P32). For those standing in the north corner of the field or in the northern most bleachers (P22-P25), the reflections are expected to fall within a spectator's field-of-view only if they turn to face the proposed Project. This risk exists mainly between 4:30 pm CST and 5:30 PM CST from mid-April through August. This equates to less than 2.5% of the daytime annually (111 hours per year). Further, the sun could be in a spectators field of view during this time period, so experiencing solar impact may not be wholly unexpected.

OVERALL OBSERVATIONS & CONCLUSIONS

Visual Glare Impacts on Pedestrians and Facades (cont'd)

11. For those seated in the northwestern bleachers (P26 and P27) there is a potential for reflections to fall within a spectators field of view while facing the field. These reflections would also occur when the sun would **not** already be in their field of view. These reflections can occur mainly between 5:30 pm CST and 6:30 pm CST from May to July, or less than 1% of the daytime annually (44 hours per year).
12. For those seated in the western bleachers (P28 and P29) visual nuisance is highly unlikely outside of a very brief period between 9:00 am CST and 9:30 CST from November through January which is equivalent to 0.13% of the daytime. (6 hours per year)
13. For those playing on Breese Stevens field (P30 – P32), visual glare is possible for those facing the proposed project between 9:00 am CST and 10:00 am CST November through January and also between 5:30 pm CST and 6:30 CST from May through early August. This is less than 0.9% of the daytime (40 hours per year).

Thermal Impacts on Facades

14. The majority of reflected solar energy at the studied facade areas are of a low intensity (<250 W/m^2) and short duration. Hence, we would not expect these reflections to lead to a significant additional cooling load for a building. Should an individual choose to expose themselves to the reflected energy, they may feel warm however this would be a temporary experience and once which would easily be remedied by closing window treatments.

APPENDIX A

ANNUAL REFLECTION IMPACT DIAGRAMS

Presentation of Results

The frequency, duration, and intensity of glare events throughout the year is illustrated using “annual impact diagrams” (see Figure A1 below for the general layout of these plots). The color of the plot for a given combination of date and time indicates the relative impact of any glare sources found. The horizontal axis of the diagram indicates the date, and the vertical axis indicates the hour of the day.

We note that the referenced times are in local standard time, so in jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

The following pages present the impact categories for three types of Annual Impact Diagrams: Visual Impact, Thermal Impact on People, and Thermal Impact on Property. More information on RWDI’s criteria is available in Appendix B.

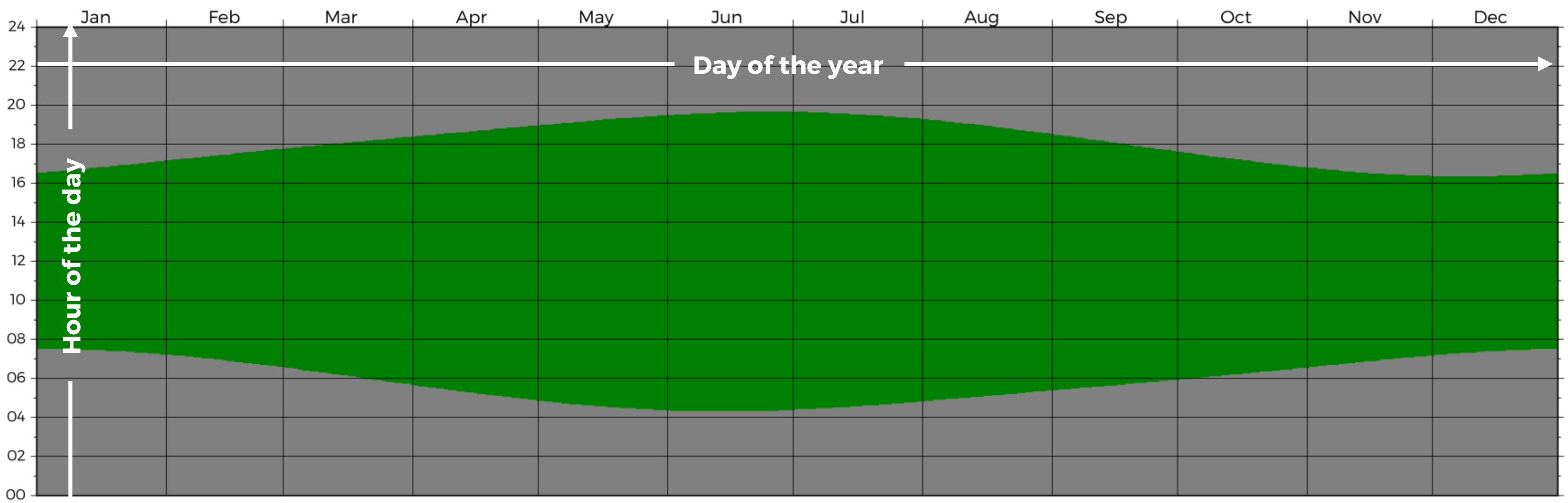


Figure A1: Layout of Annual Impact Diagram

Visual Impact Categories

Low: Either no significant reflections occur or the reflections will have a minimal effect on a viewer, even when looking directly at the source.

Moderate: The reflections can cause some visual nuisance only to viewers looking directly at the source.

High: The reflections can reduce visual acuity for viewers operating vehicles or performing other high-risk tasks who are unable to look away from the source, posing a significant risk of distraction.

Damaging: The brightest glare source is bright enough to permanently damage the eye for a viewer looking directly at the source.

Hatched areas indicate times and dates when the sun would also be in a driver's field of view.

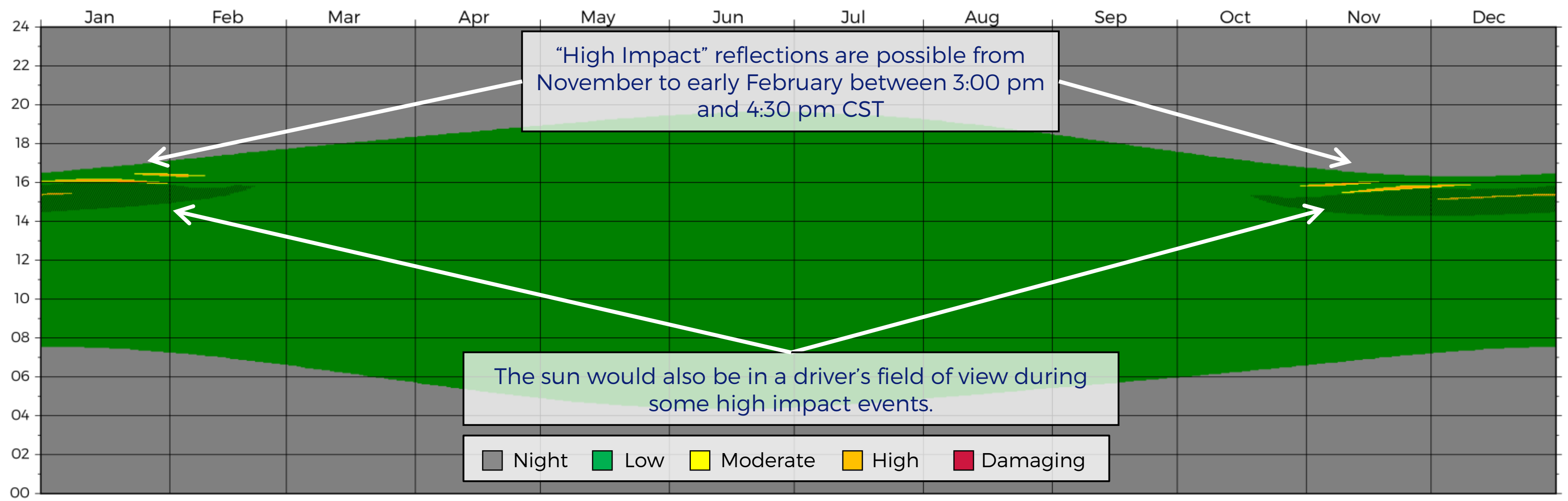


Figure A2: Example of Annual Visual Glare Impact Diagram – Receptor D6

Thermal Impact Categories for People

Low: Either no significant reflections occur or the reflection intensity is below the short-term exposure threshold of 1500 W/m².

Moderate: The reflection intensity is above the short-term exposure threshold of 1500 W/m² but below the safety threshold of 2500 W/m². Such reflections would quickly cause thermal discomfort in people.

High: The reflection intensity is above the safety threshold of 2500 W/m² but below 3500 W/m². This level of exposure to bare skin would lead to the onset of pain within 30 seconds.

Very High: Reflection intensity exceeds 3500 W/m². This level of exposure leads to second degree burns on bare skin within 1 minute.

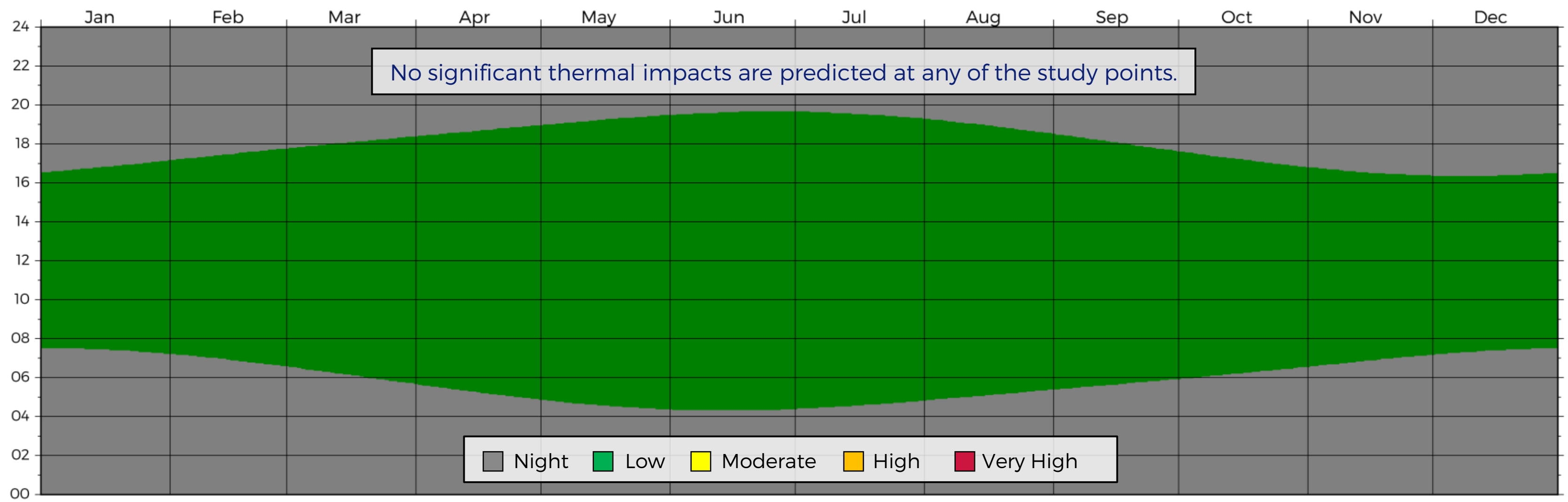


Figure A3: Example of Annual Pedestrian Thermal Impact Diagram – Receptor P22

Thermal Impact Categories for Property

A different scale is used to illustrate the reflected thermal energy on facades in order to provide further clarity on the potential for heat gain issues. The diagrams illustrate the irradiance levels of all predicted reflection events along with their frequency and duration.

The format of the diagram is similar to the diagrams described in the previous pages. The color of the plot for a given combination of date and time indicates the intensity of the reflected light at that point in time.

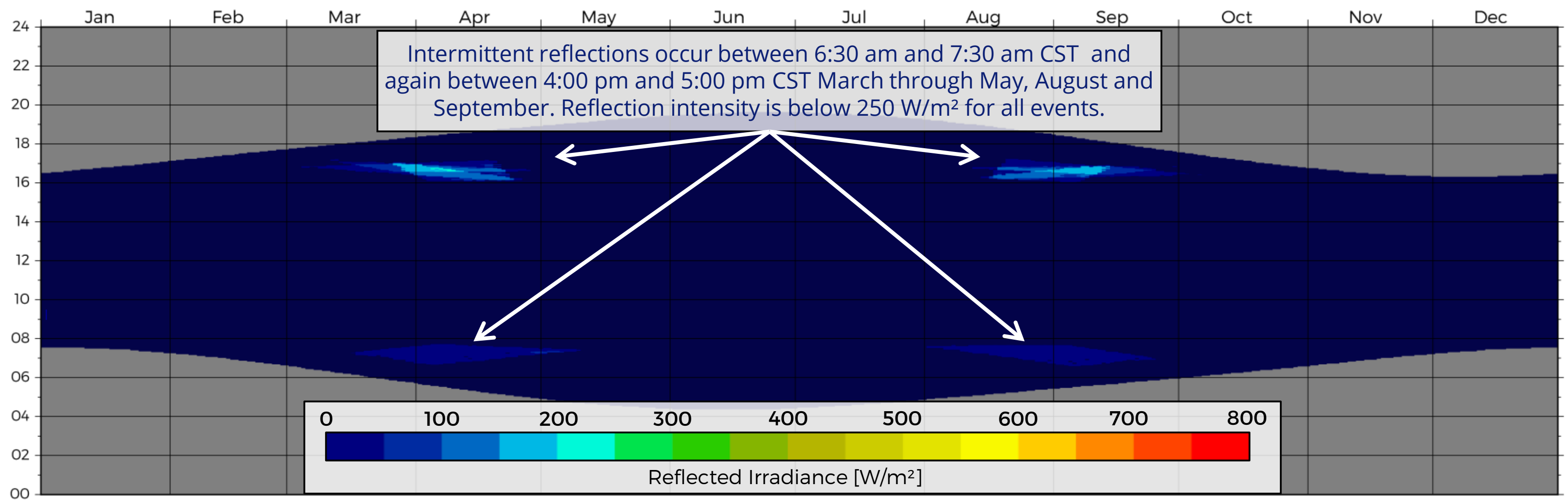


Figure A4: Example of Annual Property Thermal Impact Diagram – Receptor F14

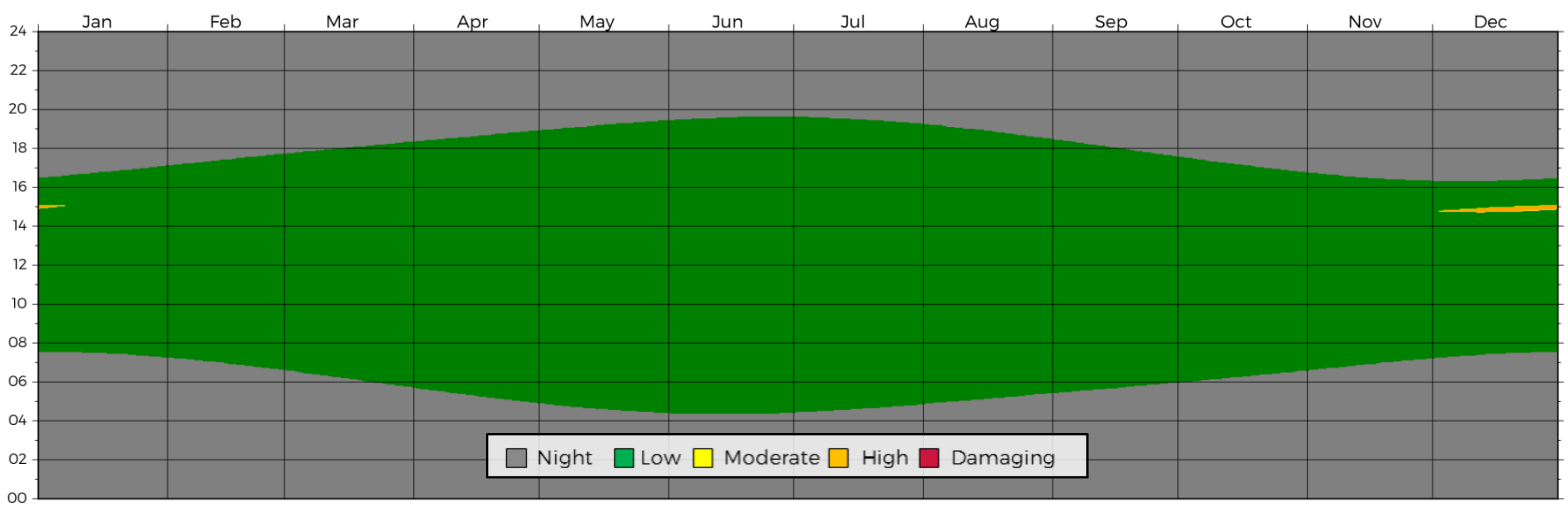
ANNUAL VISUAL IMPACT

Driver Receptor D1

Receptor D1 was chosen to assess the visual impact assocated with solar reflections affecting north-eastbound drivers on East Washington Avenue.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

Hatched areas on the plot indicate times when the sun is within a driver's field-of-view.

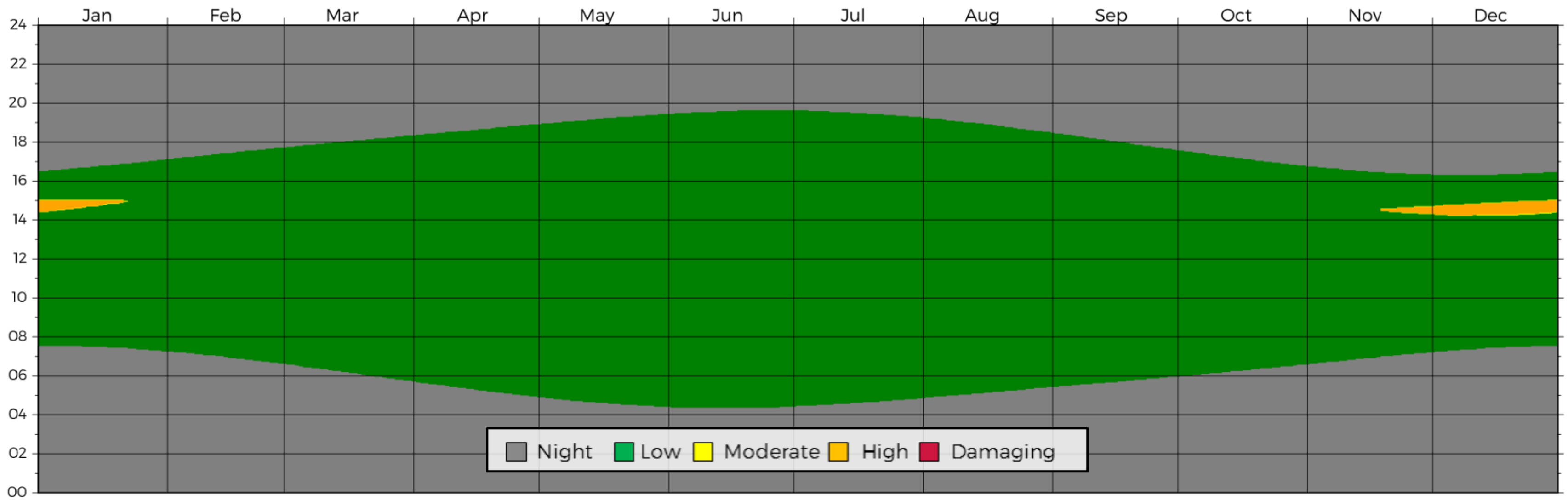


Driver Receptor D2

Receptor D2 was chosen to assess the visual impact assocated with solar reflections affecting north-eastbound drivers on East Washington Avenue.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

Hatched areas on the plot indicate times when the sun is within a driver's field-of-view.

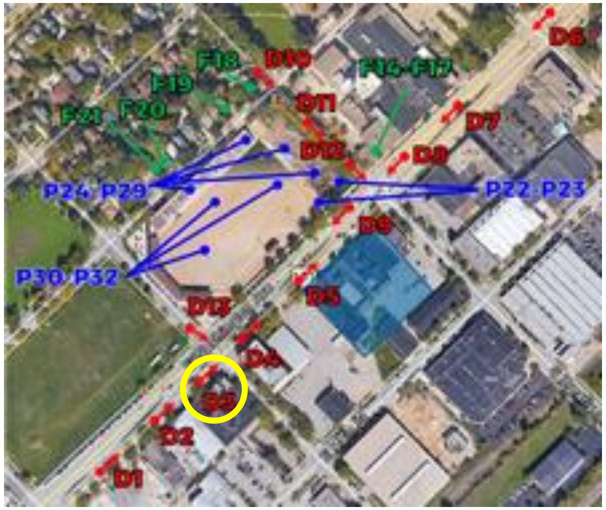


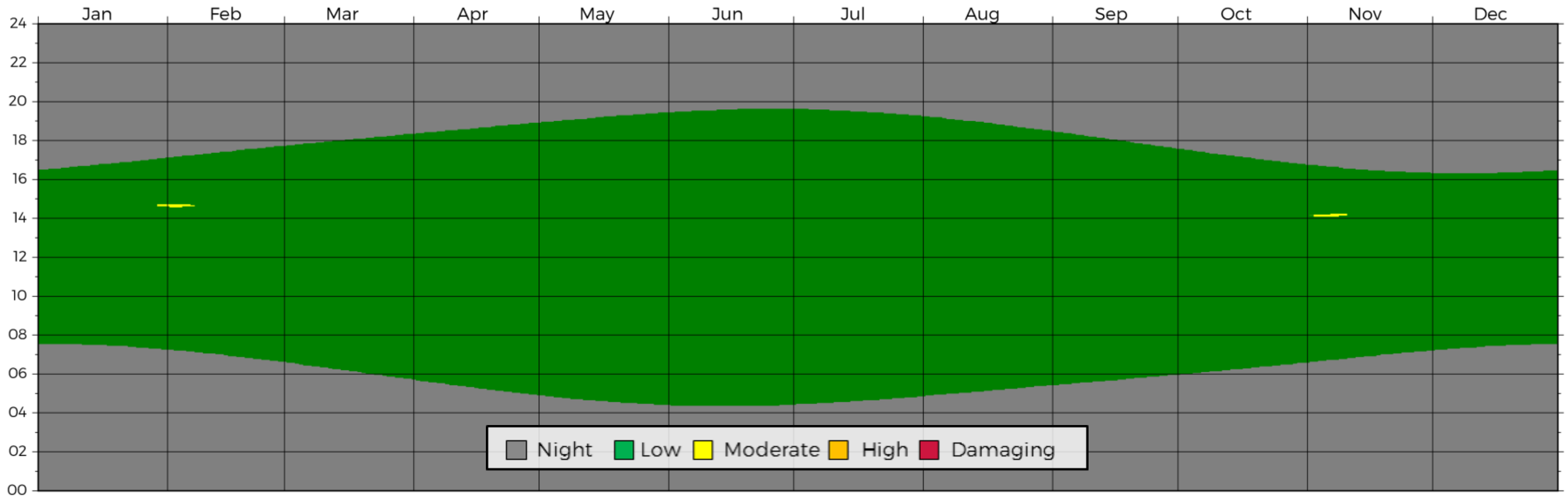
Driver Receptor D3

Receptor D3 was chosen to assess the visual impact assocated with solar reflections affecting north-eastbound drivers on East Washington Avenue.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

Hatched areas on the plot indicate times when the sun is within a driver's field-of-view.





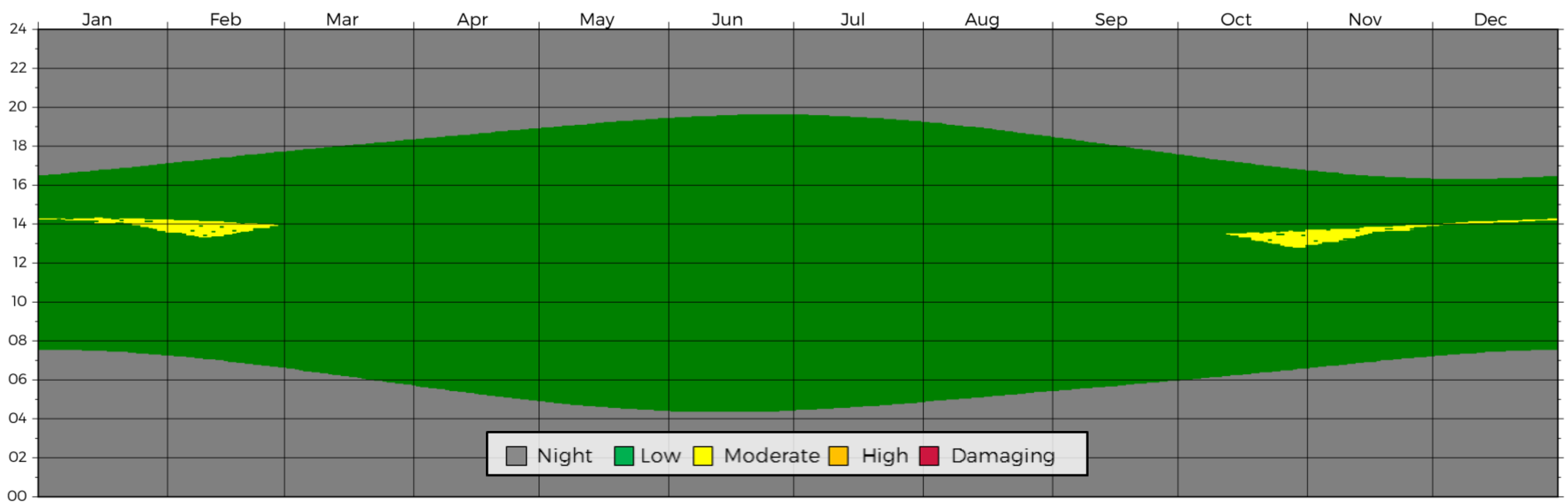
ANNUAL VISUAL IMPACT

Driver Receptor D4

Receptor D4 was chosen to assess the visual impact assocated with solar reflections affecting north-eastbound drivers on East Washington Avenue.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

Hatched areas on the plot indicate times when the sun is within a driver's field-of-view.

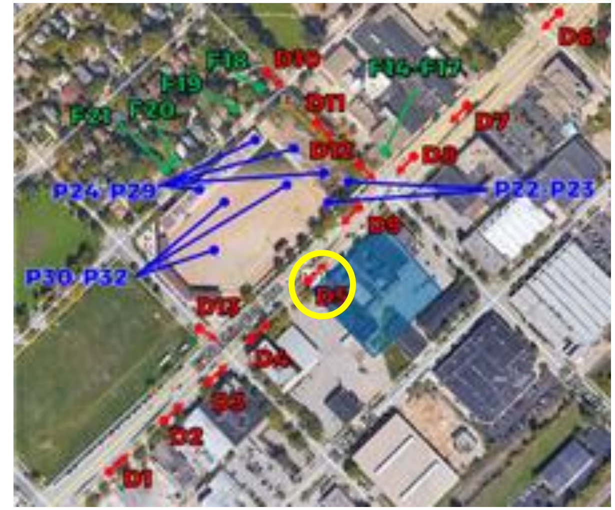


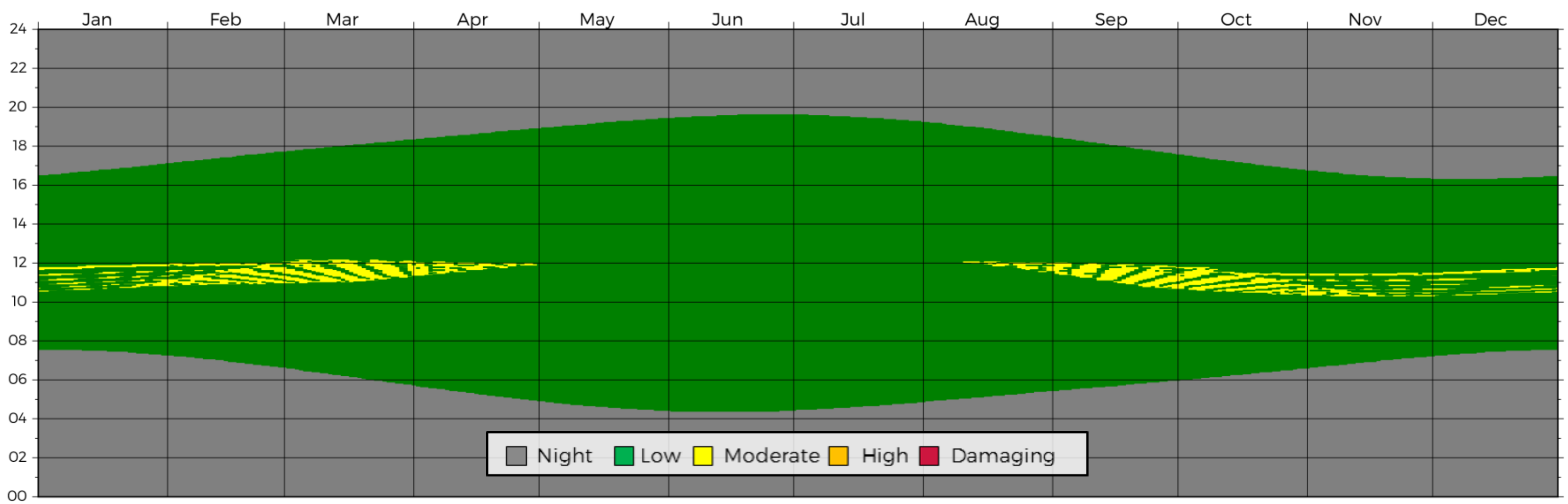
Driver Receptor D5

Receptor D5 was chosen to assess the visual impact assocated with solar reflections affecting north-eastbound drivers on East Washington Avenue.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

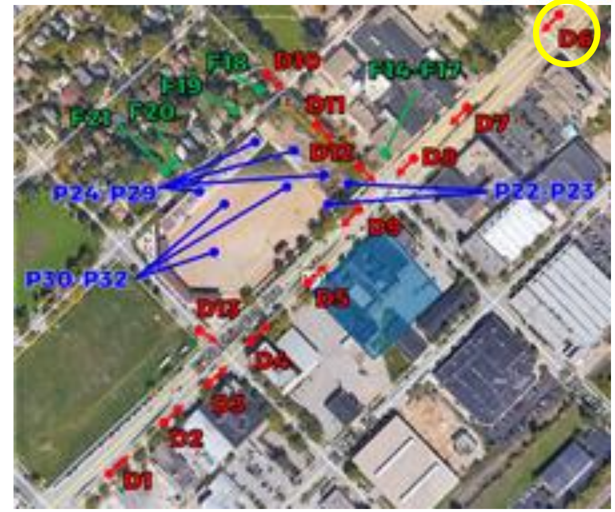
Hatched areas on the plot indicate times when the sun is within a driver's field-of-view.





ANNUAL VISUAL IMPACT

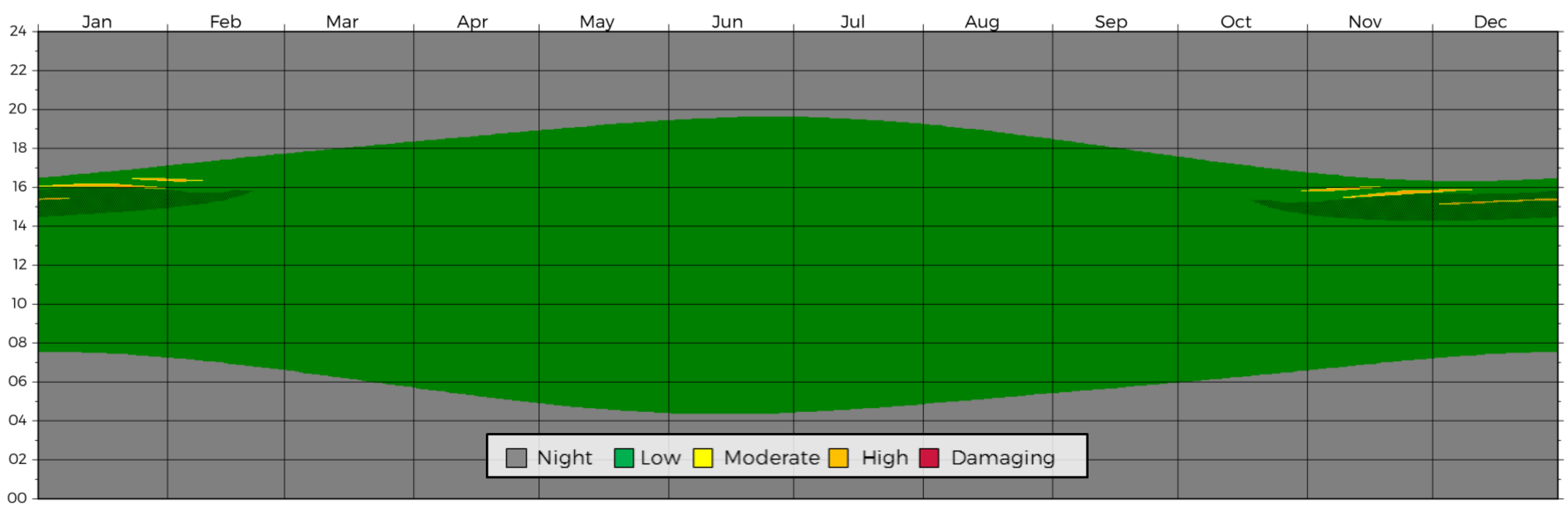
Driver Receptor D6



Receptor D6 was chosen to assess the visual impact assocated with solar reflections affecting south-westbound drivers on East Washington Avenue.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

Hatched areas on the plot indicate times when the sun is within a driver's field-of-view.

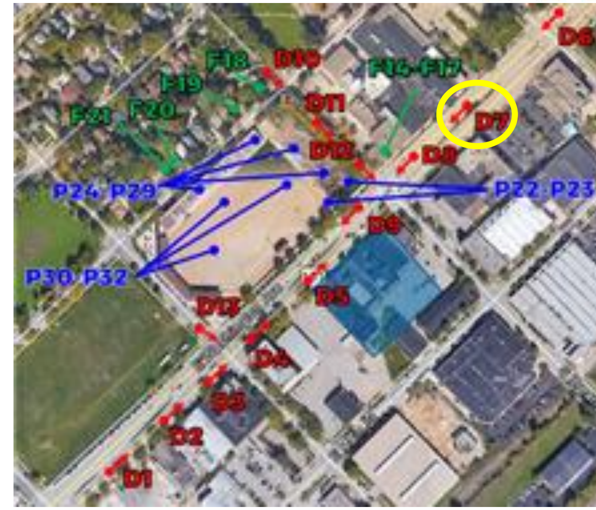


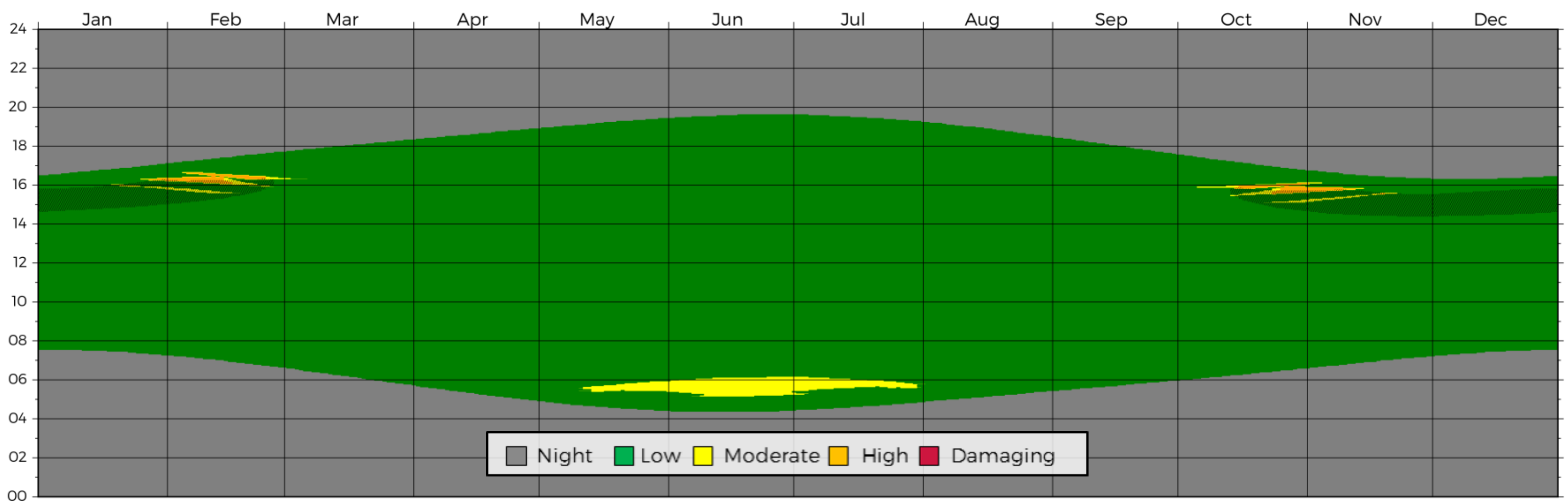
Driver Receptor D7

Receptor D7 was chosen to assess the visual impact assocated with solar reflections affecting south-westbound drivers on East Washington Avenue.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

Hatched areas on the plot indicate times when the sun is within a driver's field-of-view.



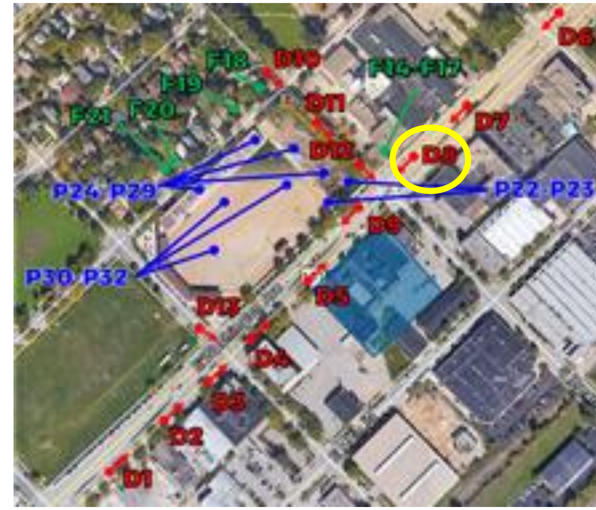


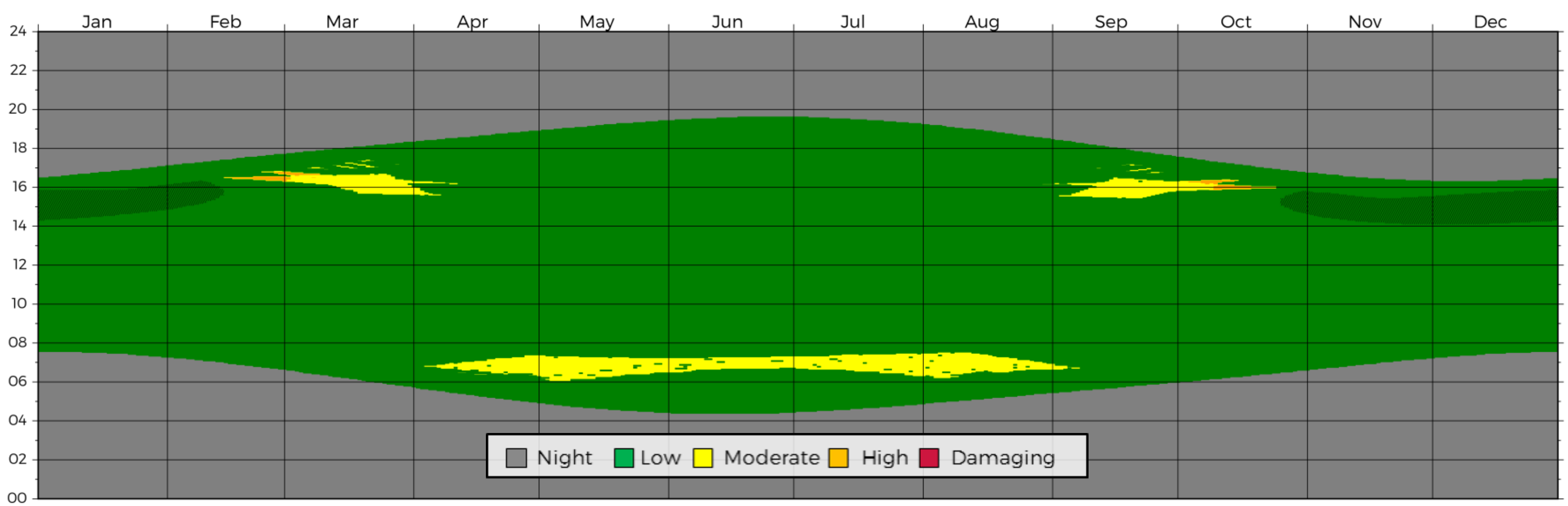
Driver Receptor D8

Receptor D8 was chosen to assess the visual impact assocated with solar reflections affecting south-westbound drivers on East Washington Avenue.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

Hatched areas on the plot indicate times when the sun is within a driver's field-of-view.





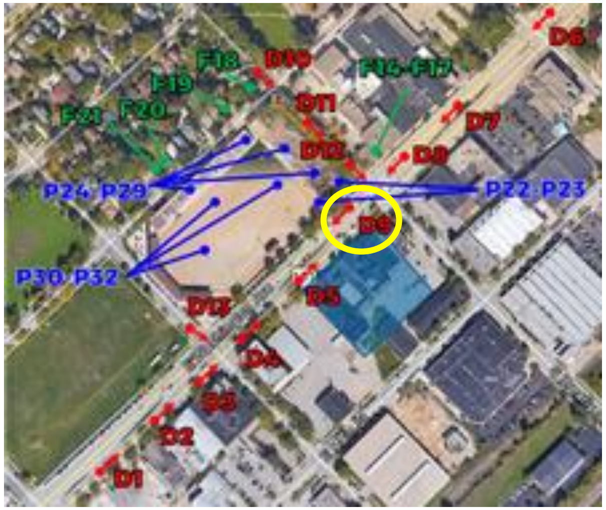
ANNUAL VISUAL IMPACT

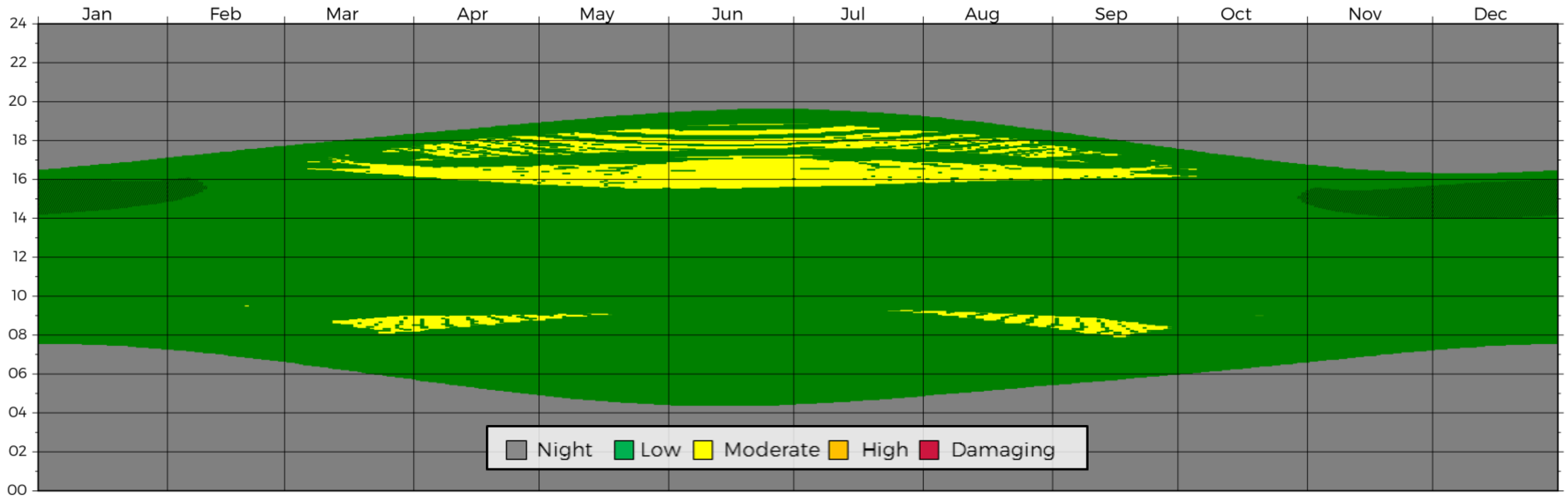
Driver Receptor D9

Receptor D9 was chosen to assess the visual impact assocated with solar reflections affecting south-westbound drivers on East Washington Avenue.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

Hatched areas on the plot indicate times when the sun is within a driver's field-of-view.





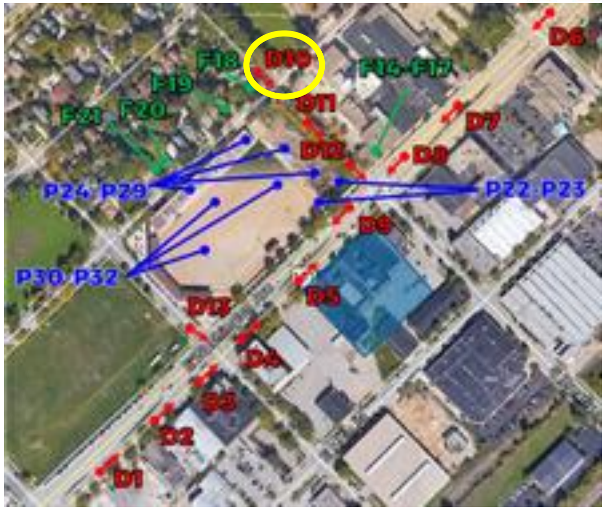
ANNUAL VISUAL IMPACT

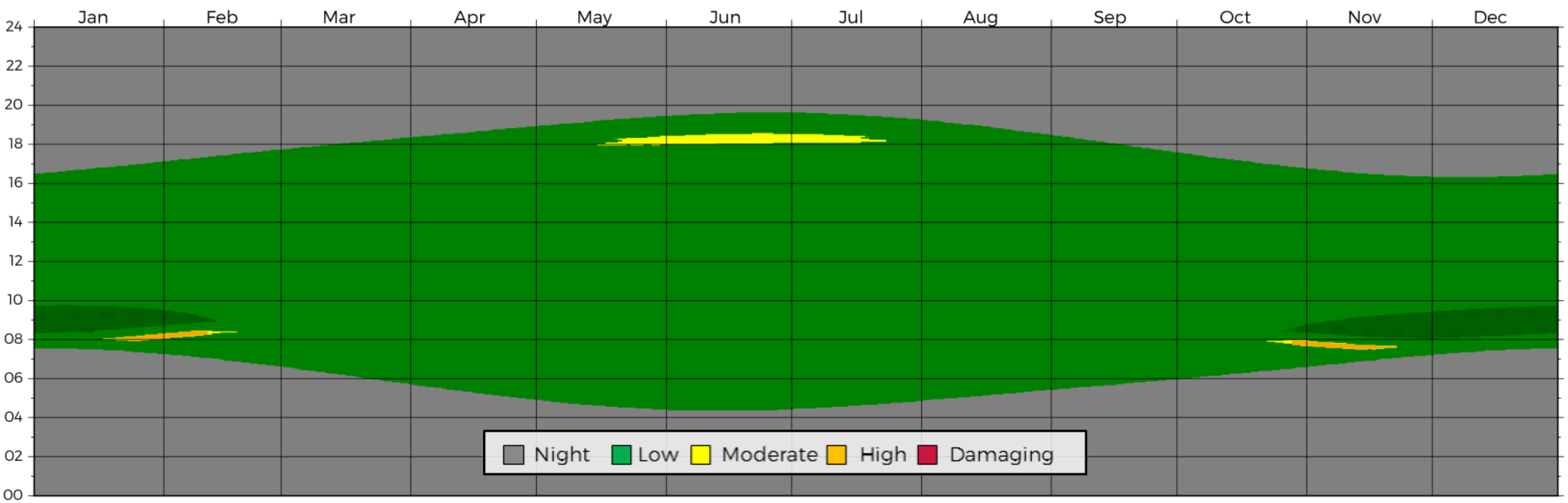
Driver Receptor D10

Receptor D10 was chosen to assess the visual impact assocated with solar reflections affecting south-eastbound drivers on North Brearly Street.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

Hatched areas on the plot indicate times when the sun is within a driver's field-of-view.



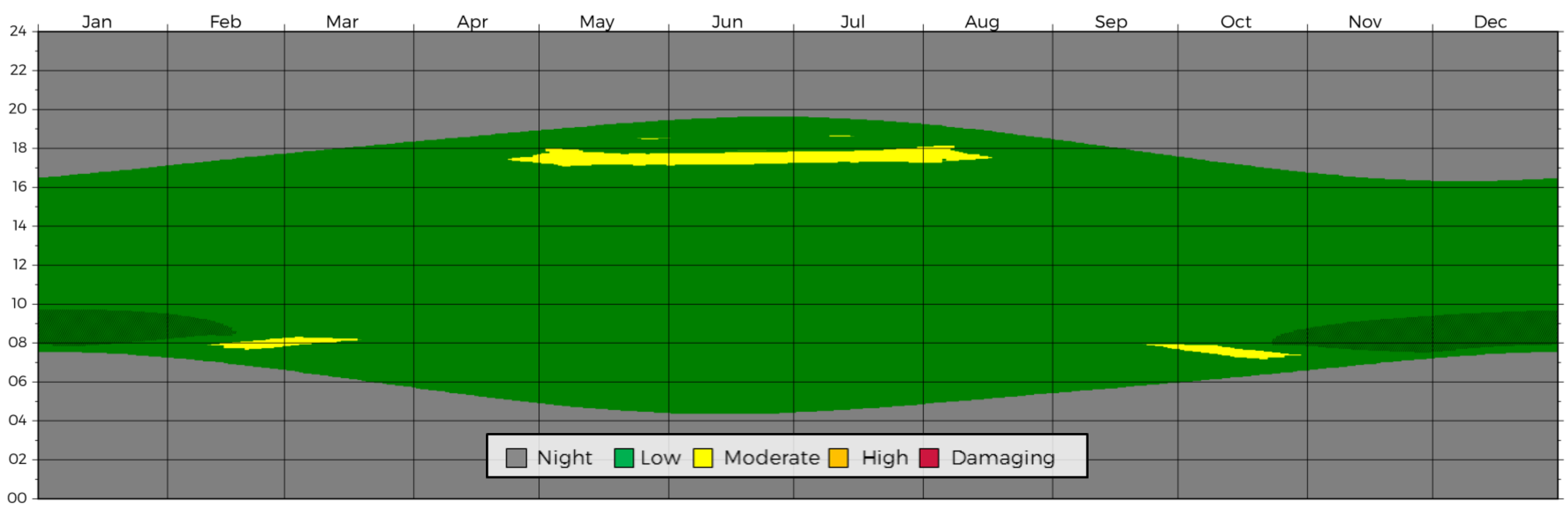


Driver Receptor D11

Receptor D11 was chosen to assess the visual impact assocated with solar reflections affecting south-eastbound drivers on North Brearly Street.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

Hatched areas on the plot indicate times when the sun is within a driver's field-of-view.

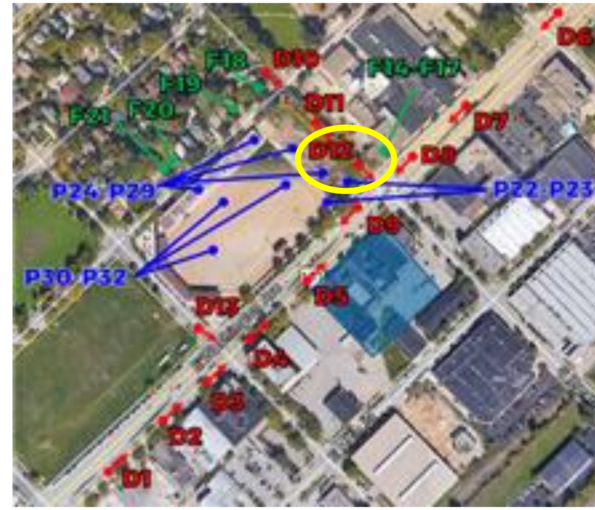


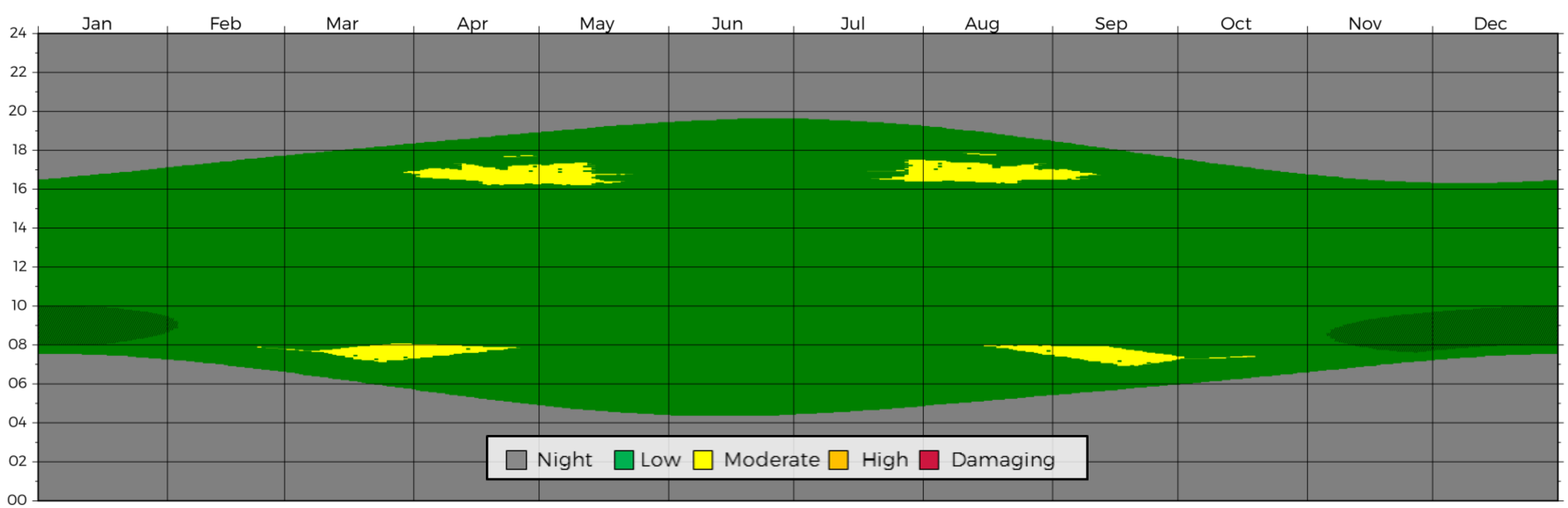
Driver Receptor D12

Receptor D12 was chosen to assess the visual impact assocated with solar reflections affecting south-eastbound drivers on North Brearly Street.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

Hatched areas on the plot indicate times when the sun is within a driver's field-of-view.





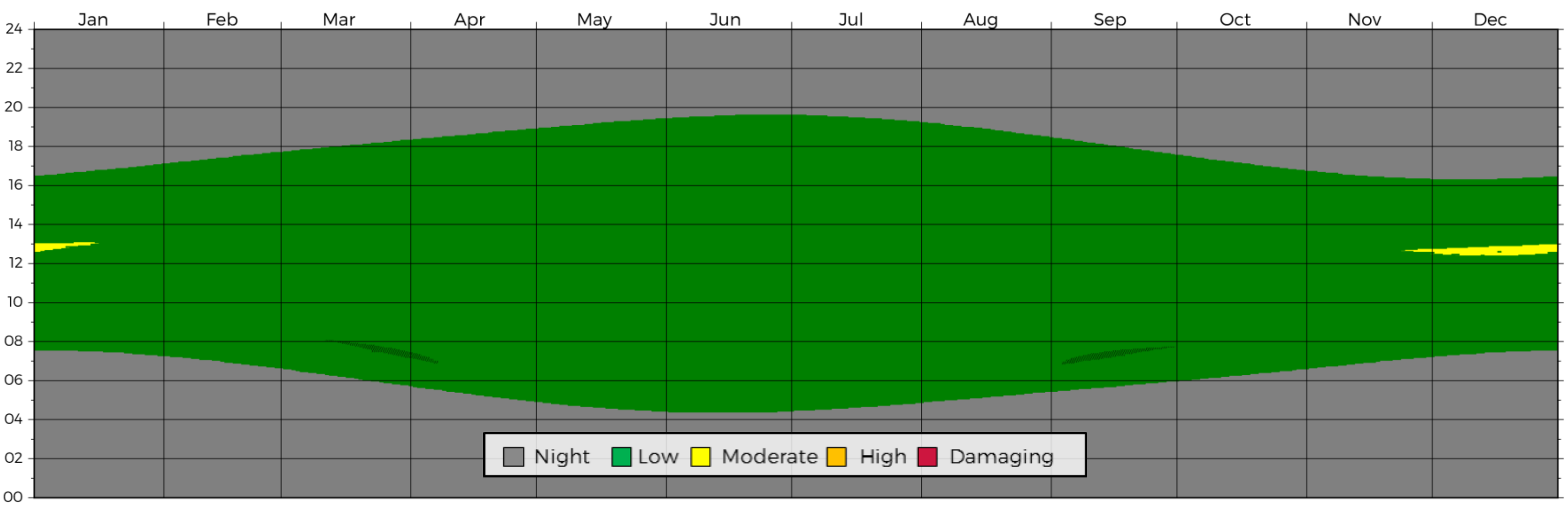
ANNUAL VISUAL IMPACT

Driver Receptor D13

Receptor D13 was chosen to assess the visual impact assocated with solar reflections affecting south-eastbound drivers on North Paterson Street.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

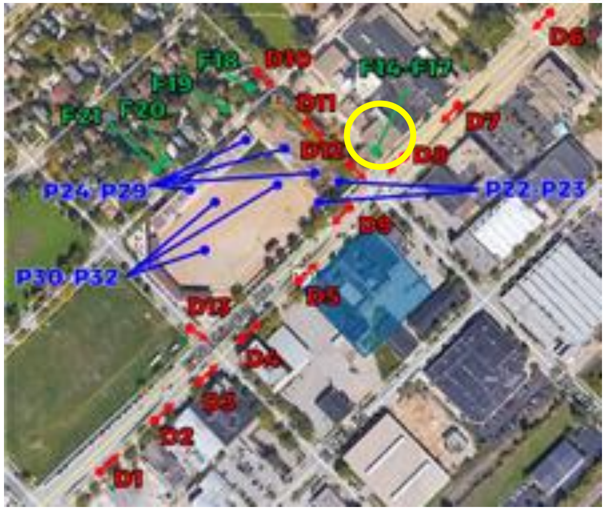
Hatched areas on the plot indicate times when the sun is within a driver's field-of-view.

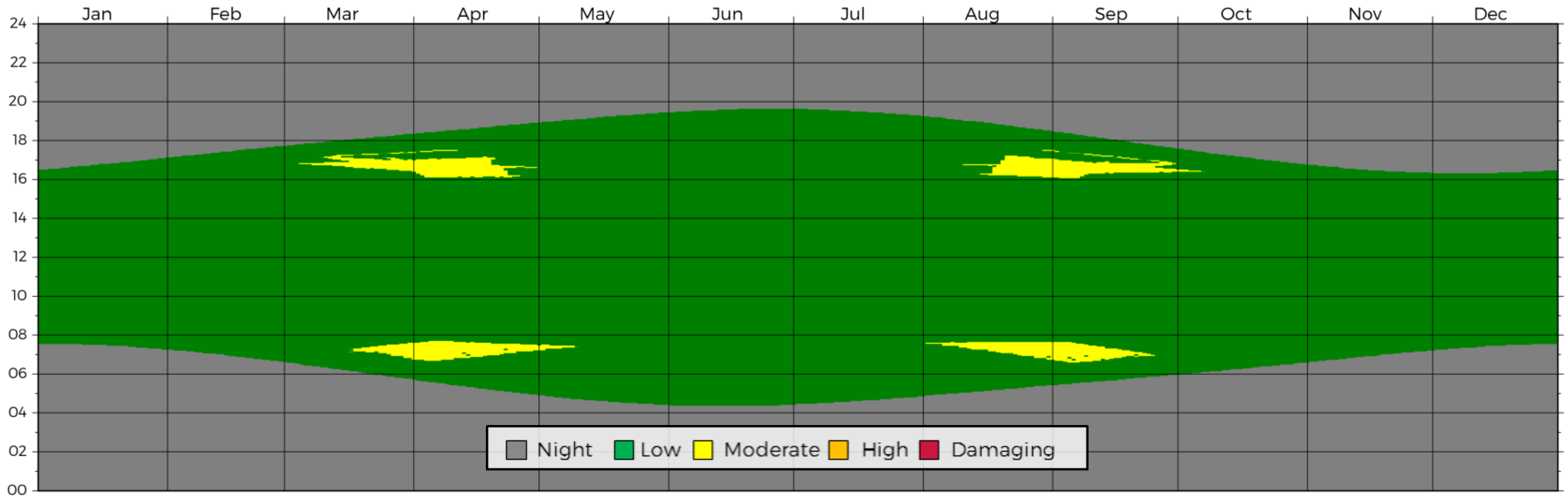


Facade Receptor F14

Receptor F14 was chosen to assess the visual impact assocated with solar reflections affecting occupants of 1002 East Washington Avenue (at approximately the 1st floor).

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

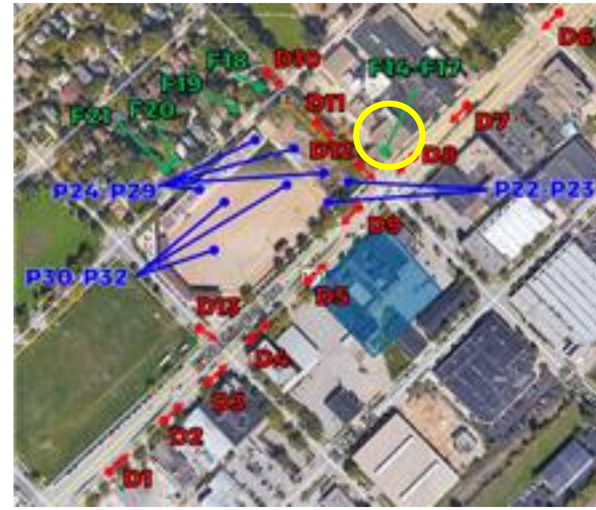


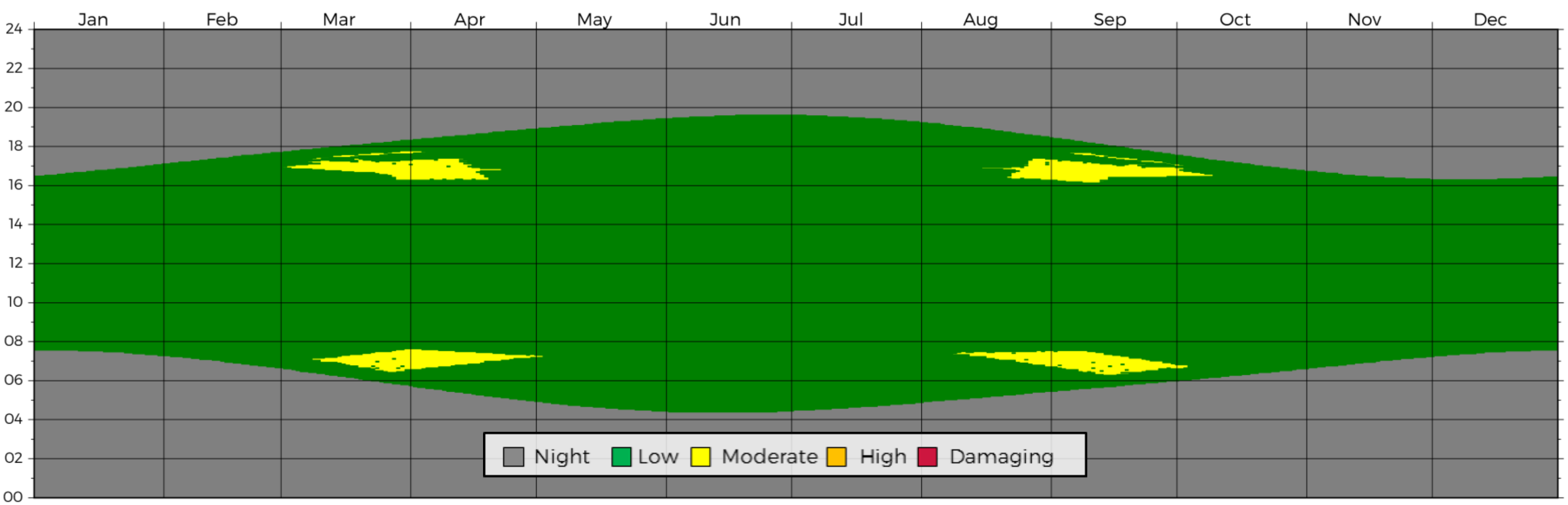


Facade Receptor F15

Receptor F15 was chosen to assess the visual impact assocated with solar reflections affecting occupants of 1002 East Washington Avenue (at approximately the 3rd floor).

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.



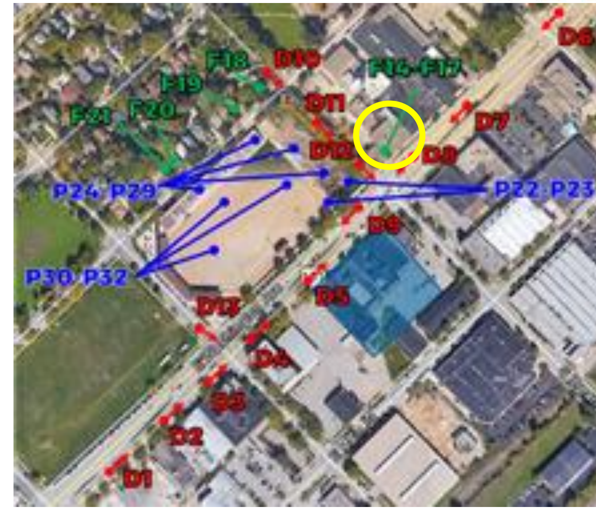


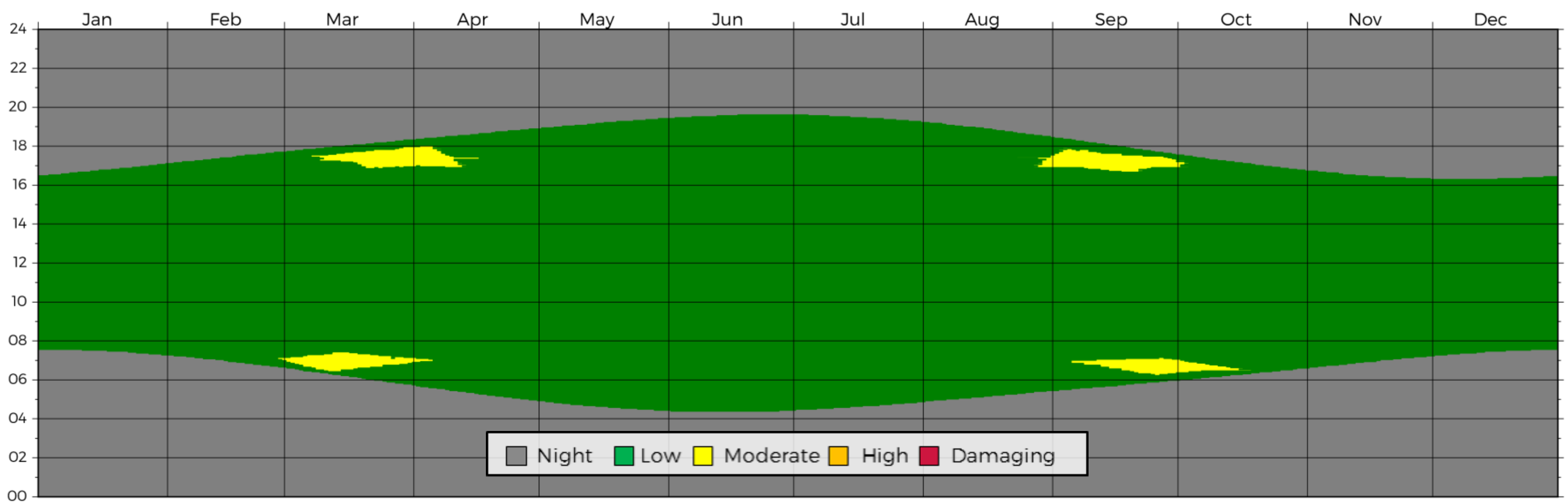
ANNUAL VISUAL IMPACT

Facade Receptor F16

Receptor F16 was chosen to assess the visual impact assocated with solar reflections affecting occupants of 1002 East Washington Avenue (at approximately the 5th floor).

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

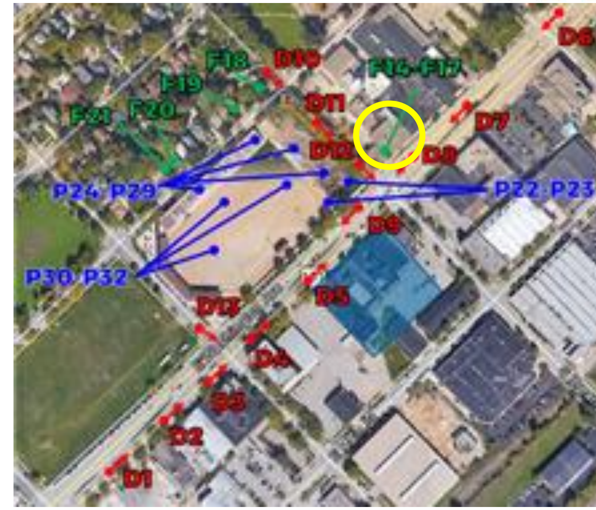


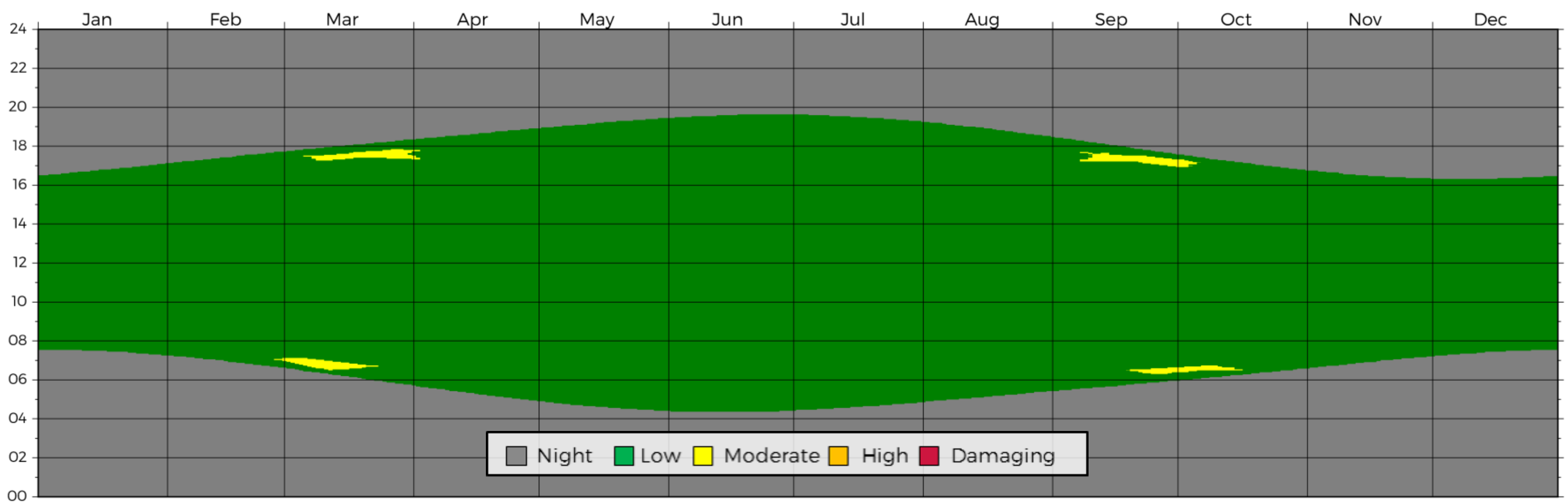


Facade Receptor F17

Receptor F17 was chosen to assess the visual impact assocated with solar reflections affecting occupants of 1002 East Washington Avenue (at approximately the 7th floor).

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

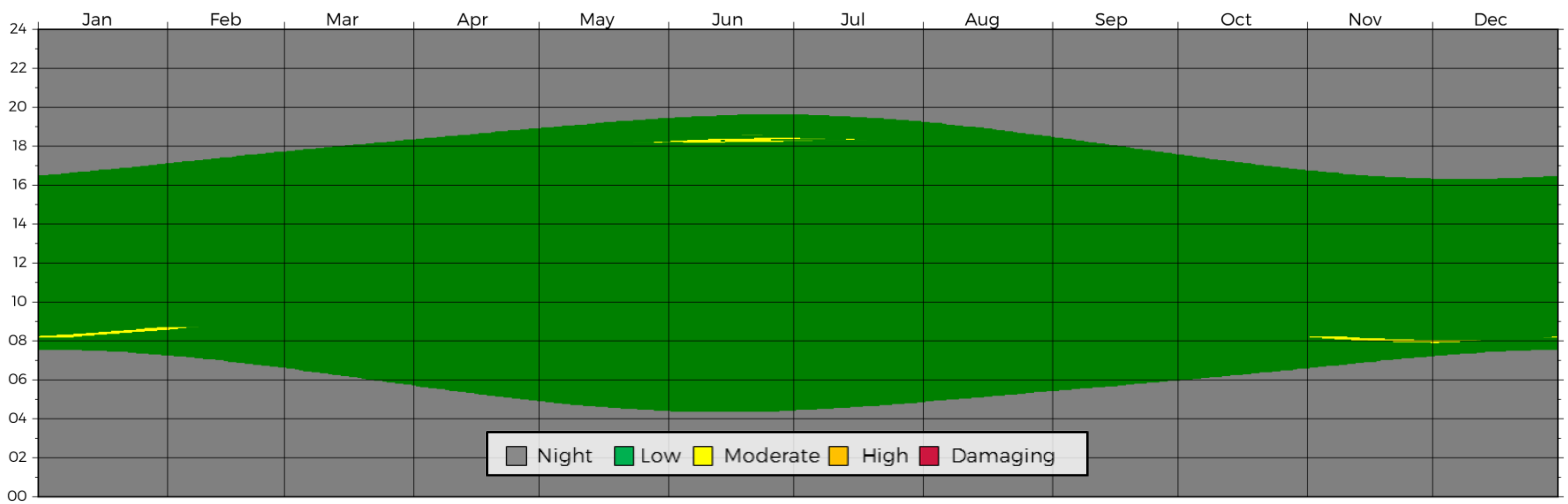




Facade Receptor F18

Receptor F18 was chosen to assess the visual impact assocated with solar reflections affecting occupants of 102 North Brearly Street.

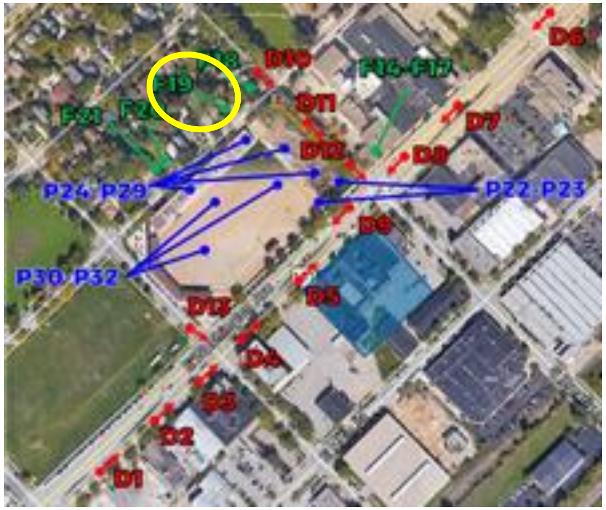
Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

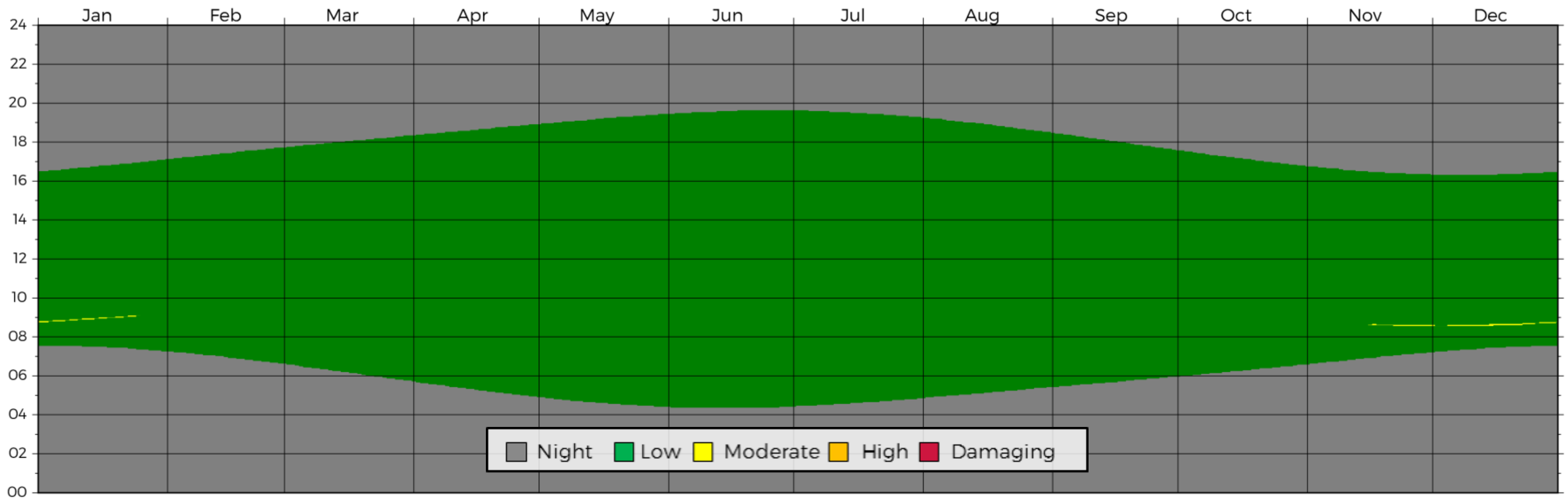


Facade Receptor F19

Receptor F19 was chosen to assess the visual impact assocated with solar reflections affecting occupants of 994 East Mifflin Street.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

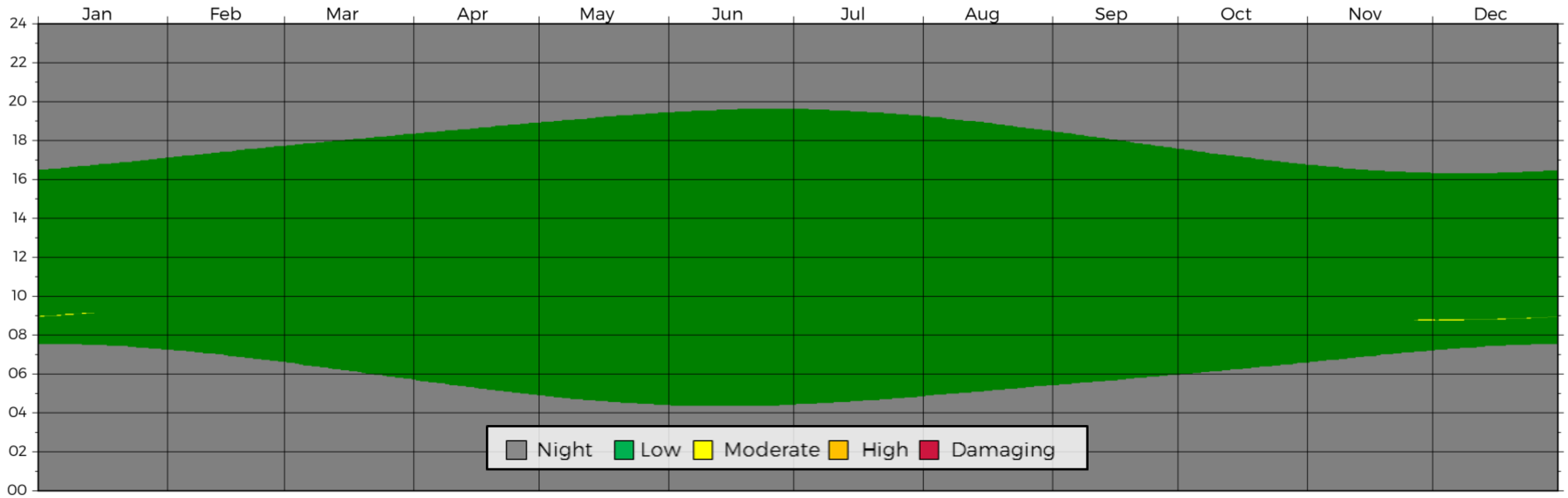




Facade Receptor F20

Receptor F20 was chosen to assess the visual impact assocated with solar reflections affecting occupants of 992 East Mifflin Street.

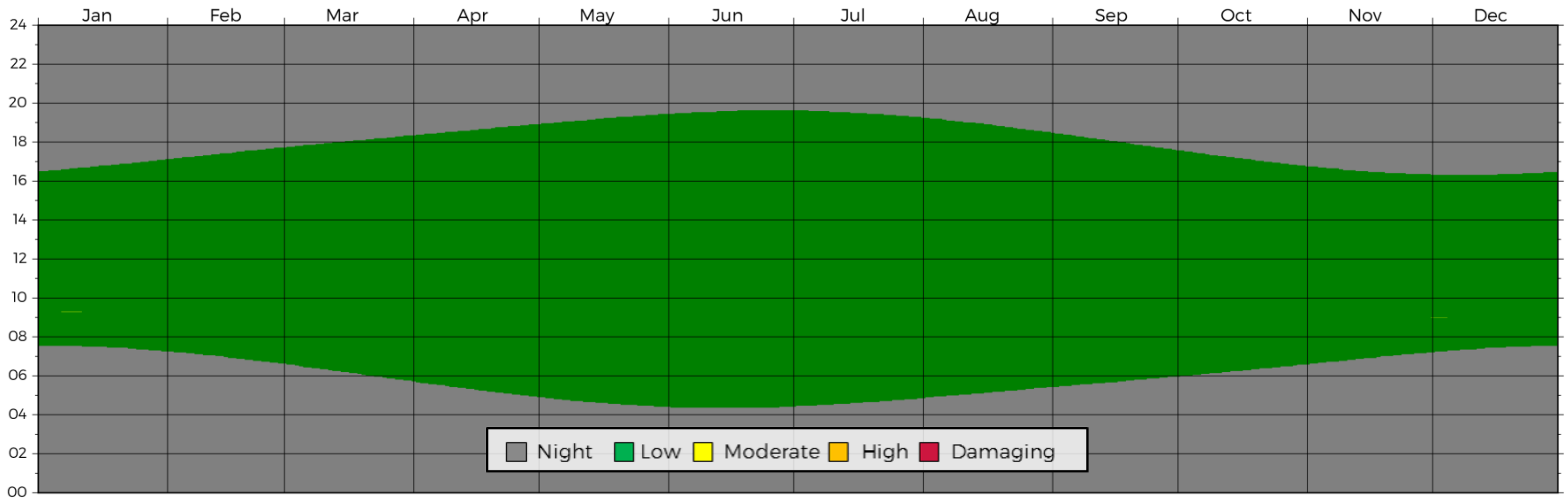
Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.



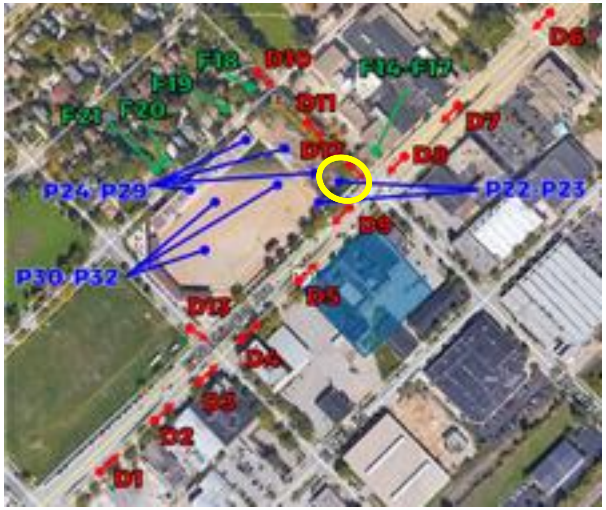
Facade Receptor F21

Receptor F21 was chosen to assess the visual impact assocated with solar reflections affecting occupants of 920 East Mifflin Street.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

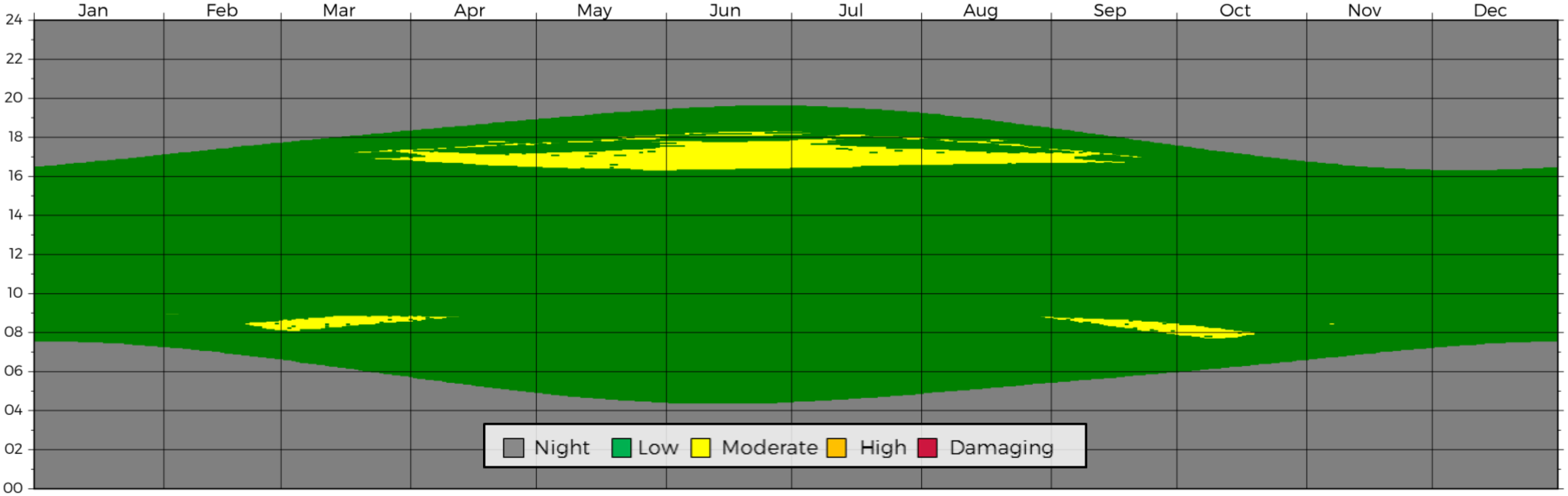


Pedestrian Receptor P22

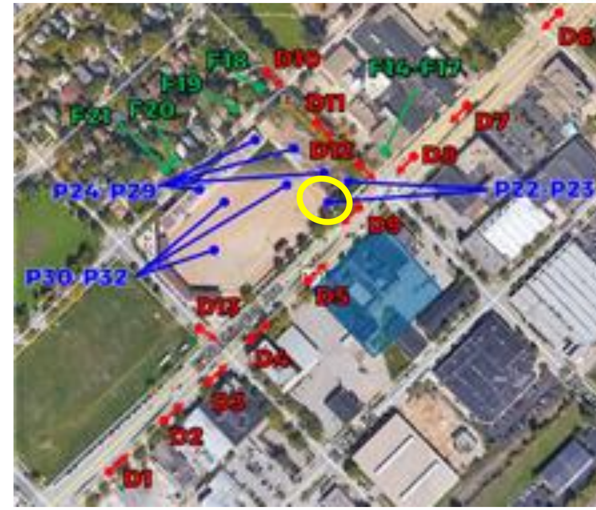


Receptor P22 was chosen to assess the visual impact assocated with solar reflections affecting pedestrians in the southeast corner of Breese Stevens field.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.



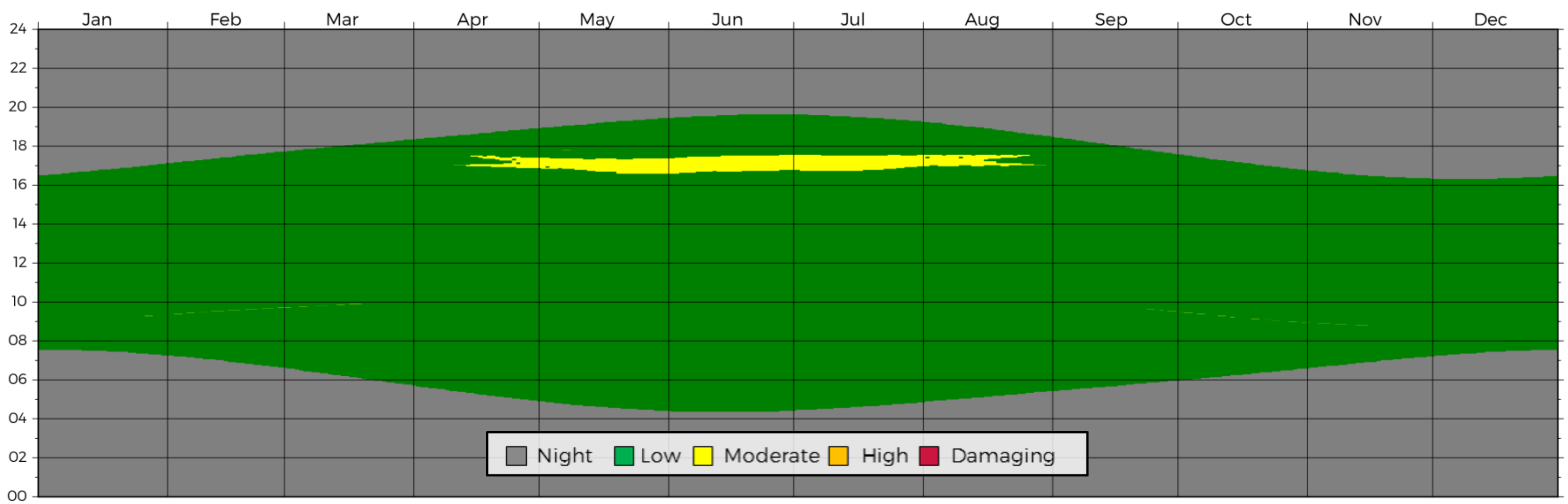
ANNUAL VISUAL IMPACT



Pedestrian Receptor P23

Receptor P23 was chosen to assess the visual impact assocated with solar reflections affecting pedestrians in the southeast corner of Breese Stevens field.

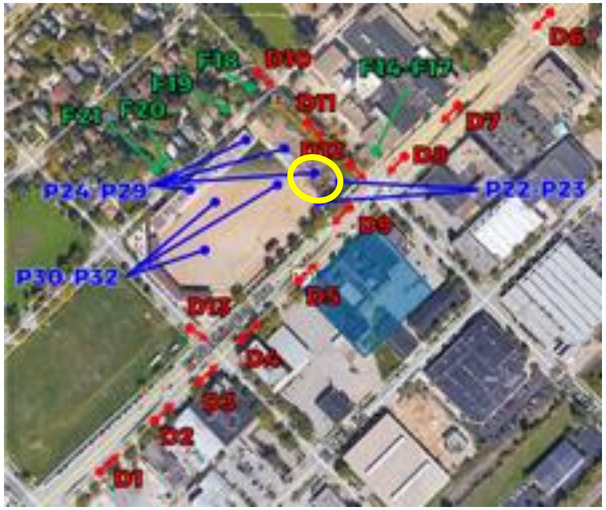
Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

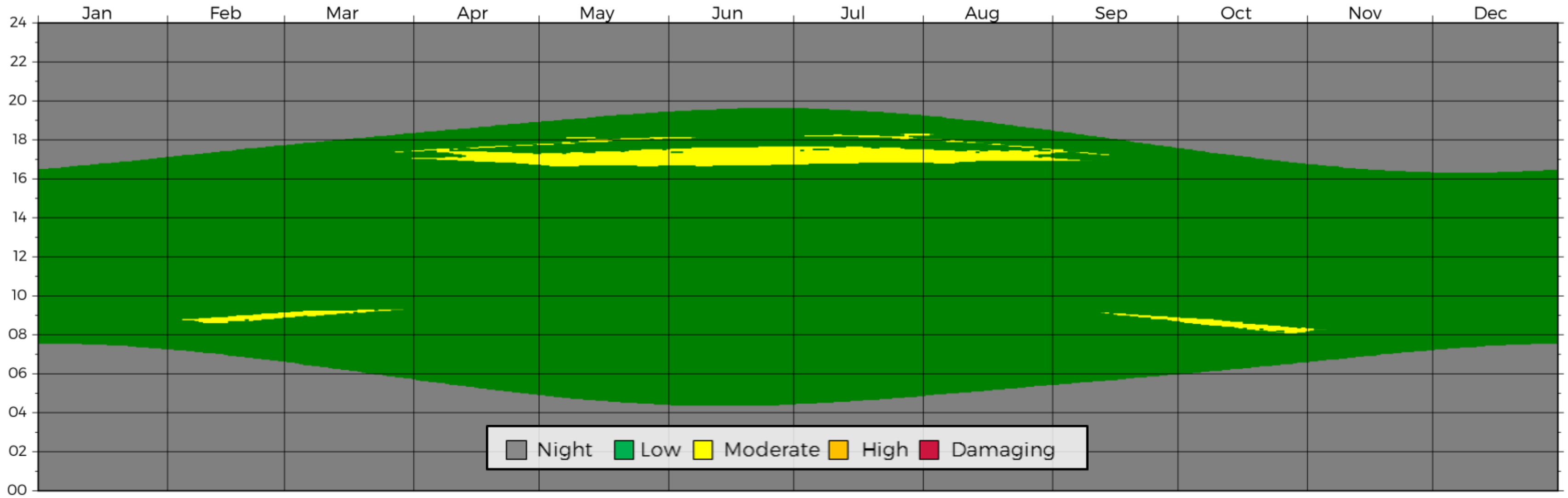


Pedestrian Receptor P24

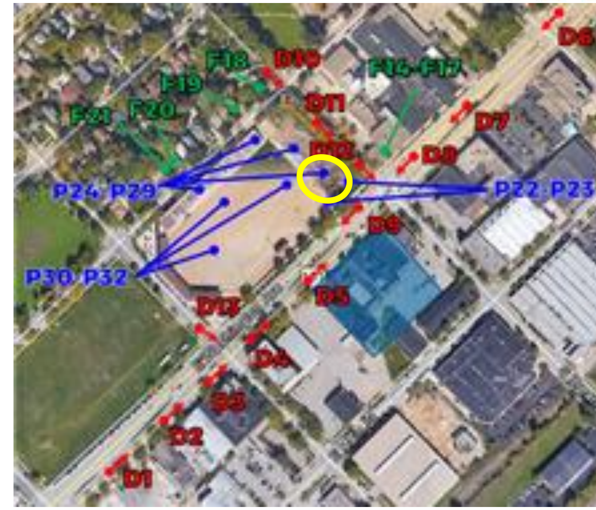
Receptor P24 was chosen to assess the visual impact assocated with solar reflections affecting spectators in the bleachers of Breese Stevens field (facing approximately the center for the field).

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.



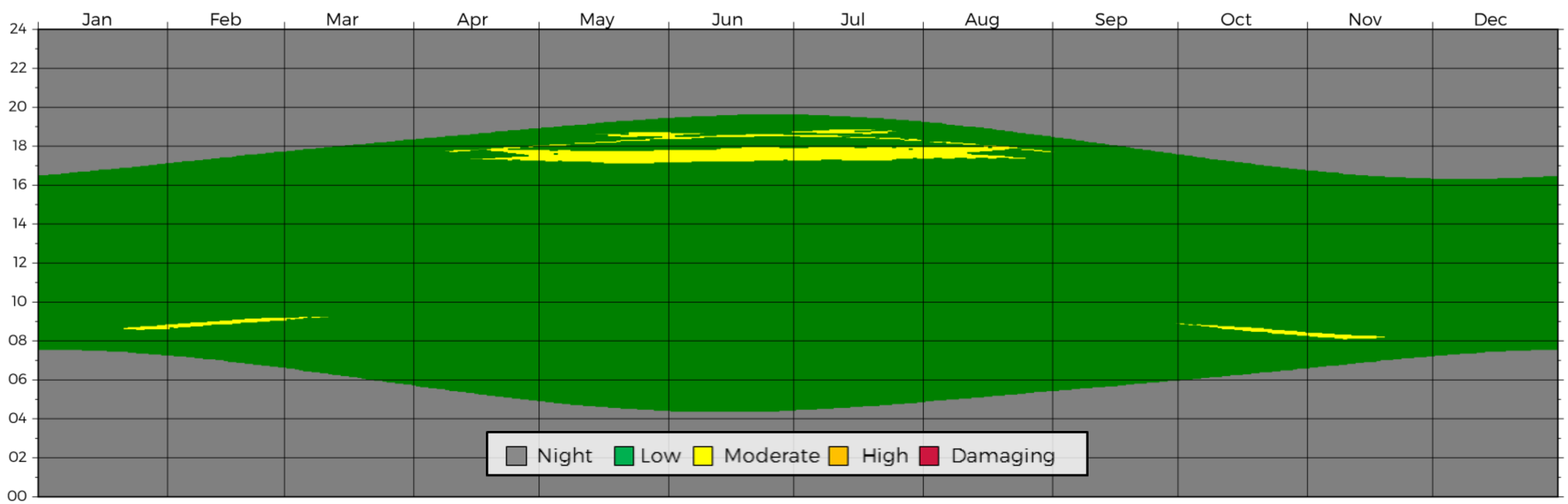


Pedestrian Receptor P25



Receptor P25 was chosen to assess the visual impact assocated with solar reflections affecting spectators in the bleachers of Breese Stevens field (facing approximately the center for the field).

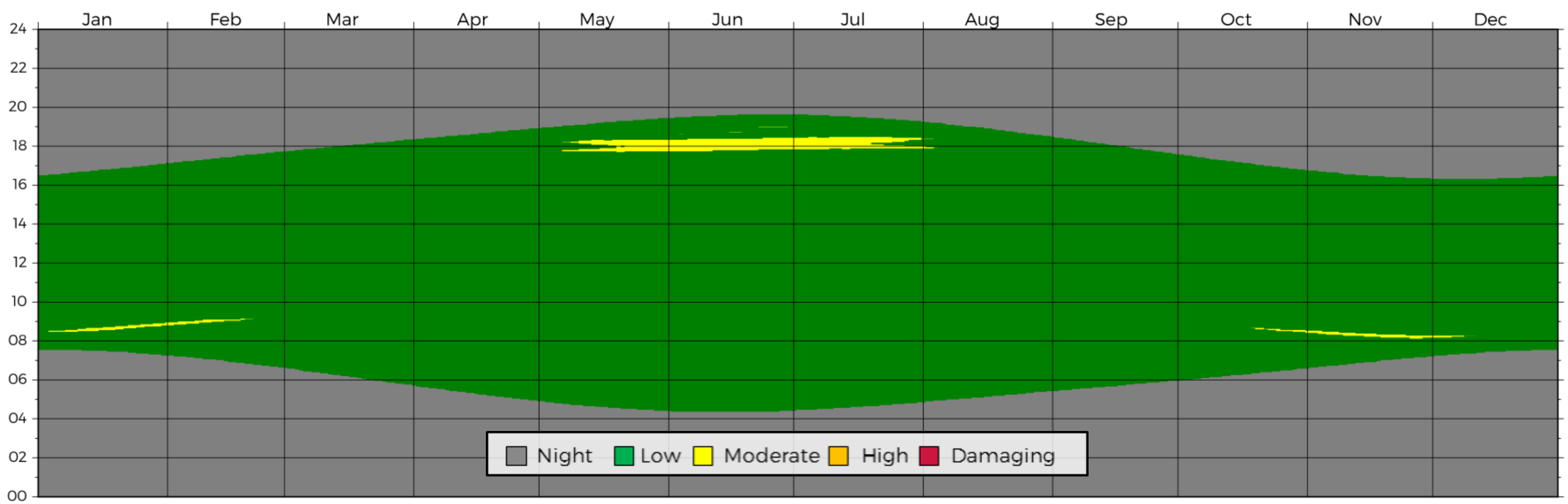
Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.



Pedestrian Receptor P26

Receptor P26 was chosen to assess the visual impact assocated with solar reflections affecting spectators in the bleachers of Breese Stevens field (facing approximately the center for the field).

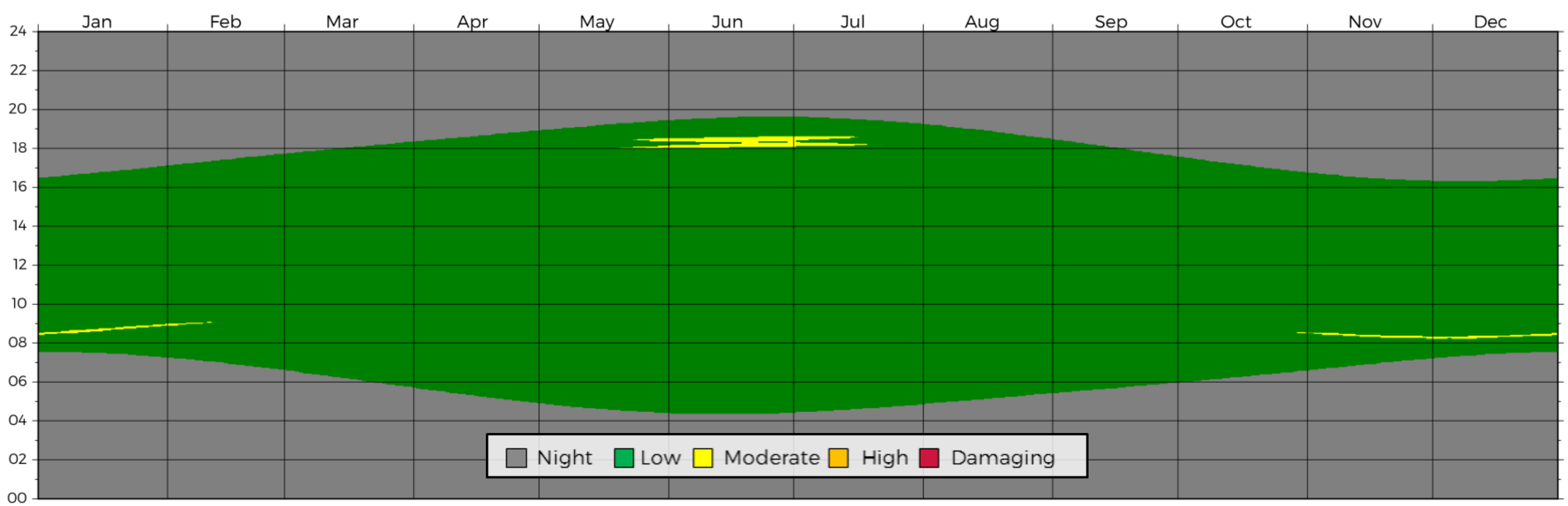
Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.



Pedestrian Receptor P27

Receptor P27 was chosen to assess the visual impact assocated with solar reflections affecting spectators in the bleachers of Breese Stevens field (facing approximately the center for the field).

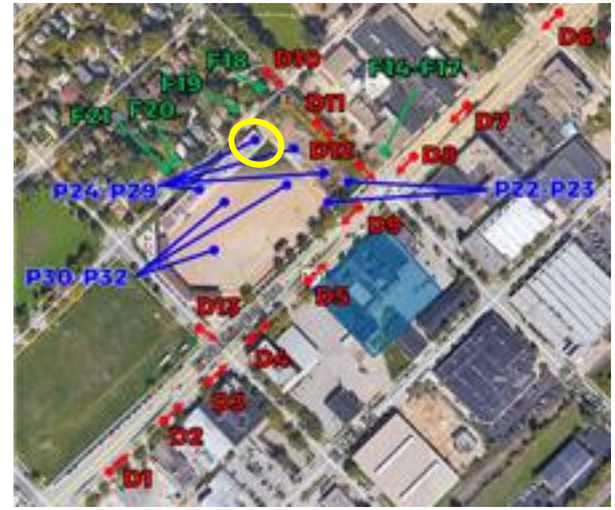
Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

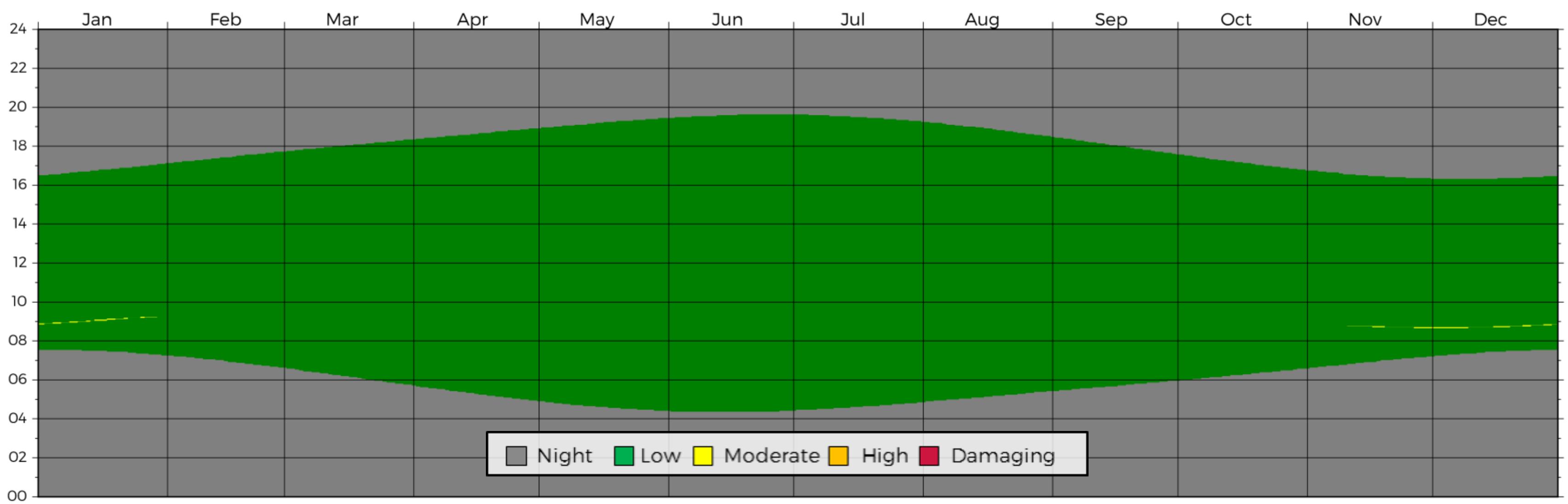


Pedestrian Receptor P28

Receptor P28 was chosen to assess the visual impact assocated with solar reflections affecting spectators in the bleachers of Breese Stevens field (facing approximately the center for the field).

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.



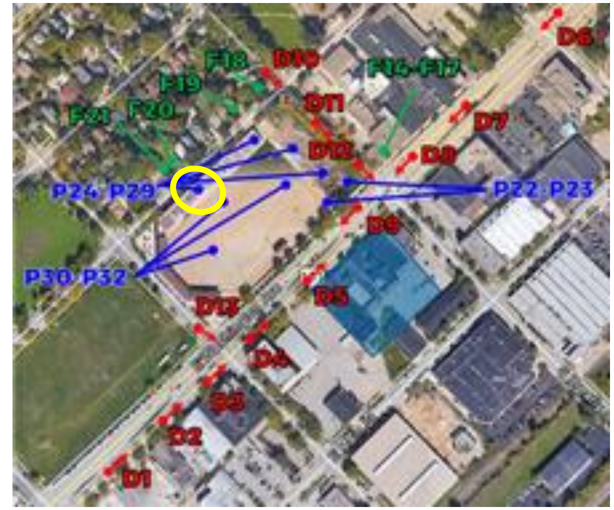


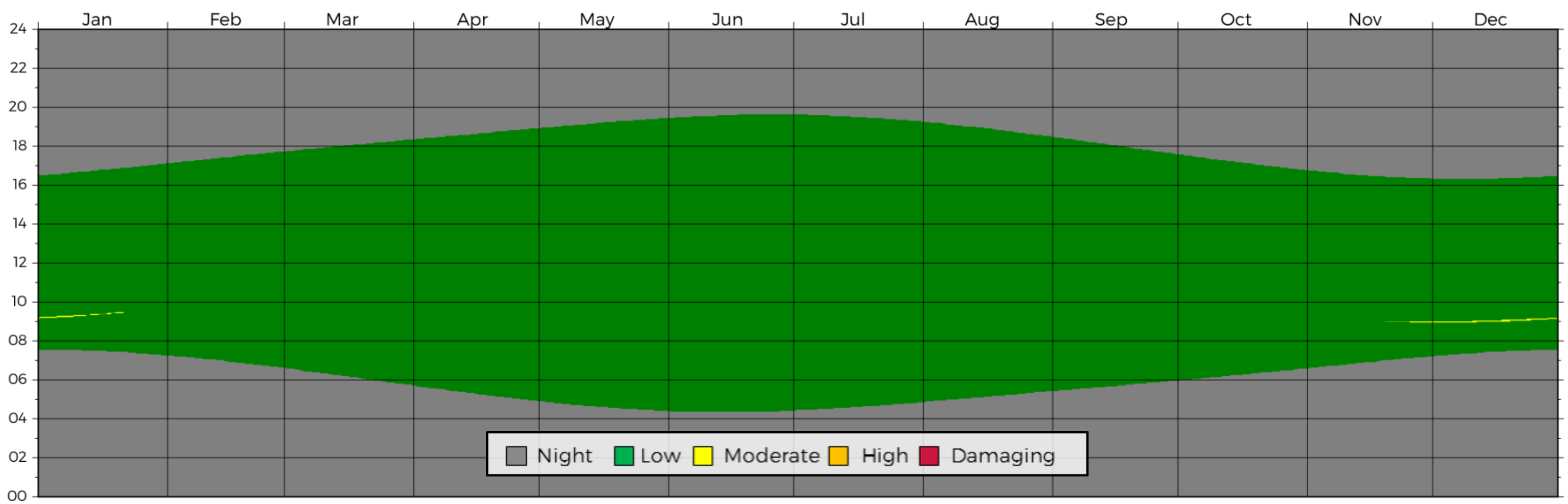
ANNUAL VISUAL IMPACT

Pedestrian Receptor P29

Receptor P29 was chosen to assess the visual impact assocated with solar reflections affecting spectators in the bleachers of Breese Stevens field (facing approximately the center for the field).

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

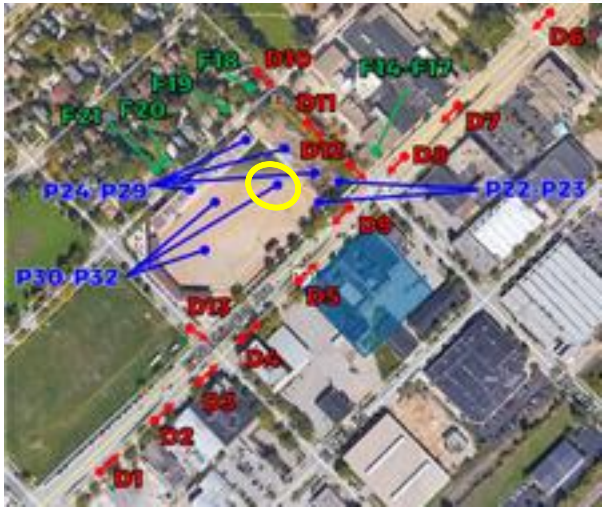


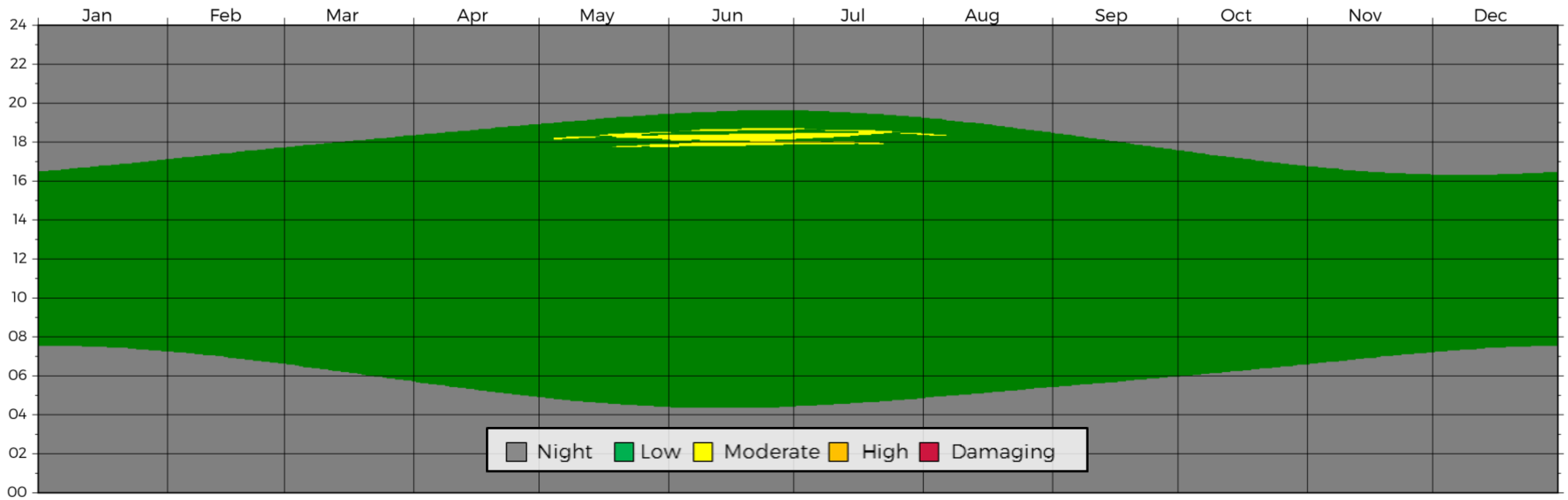


Pedestrian Receptor P30

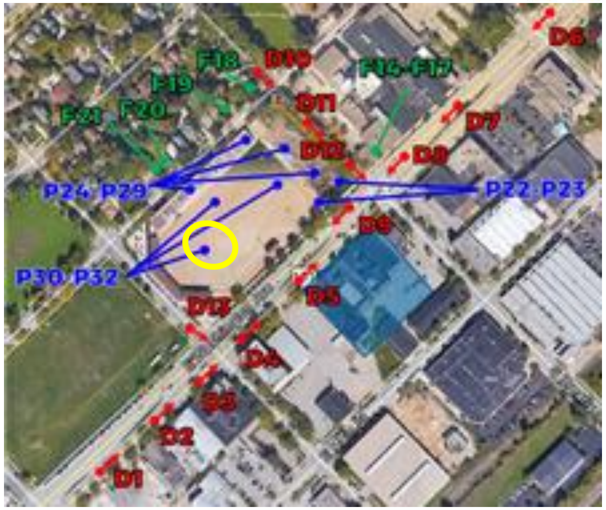
Receptor P30 was chosen to assess the visual impact assocated with solar reflections affecting players on Breese Stevens field (facing approximately the center for the field).

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.



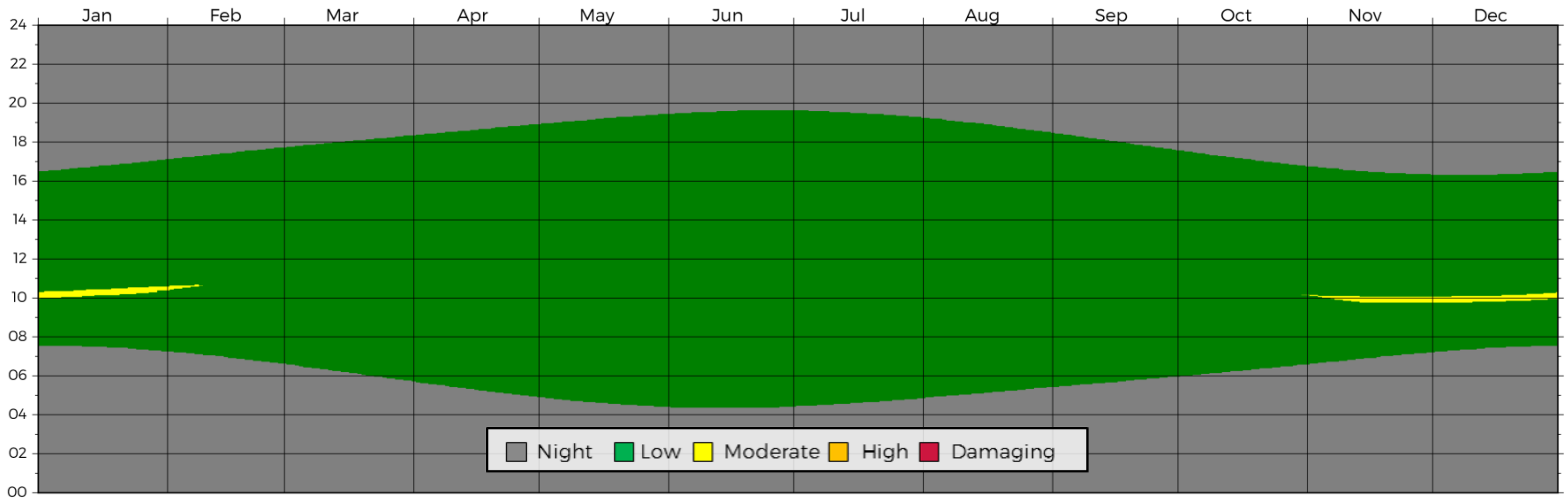


Pedestrian Receptor P31



Receptor P31 was chosen to assess the visual impact assocated with solar reflections affecting players on Breese Stevens field (facing approximately the center for the field).

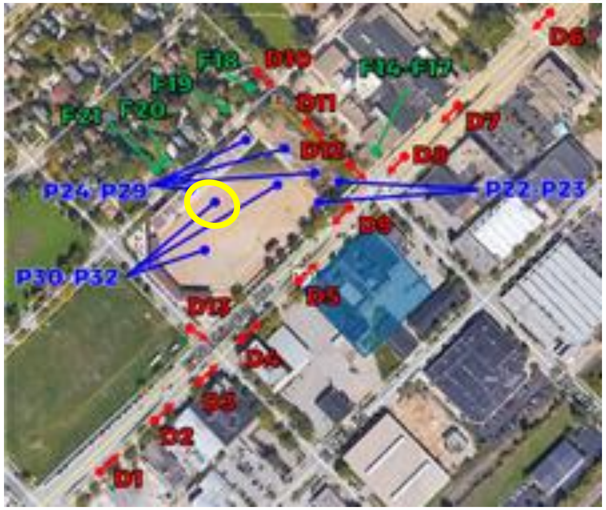
Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

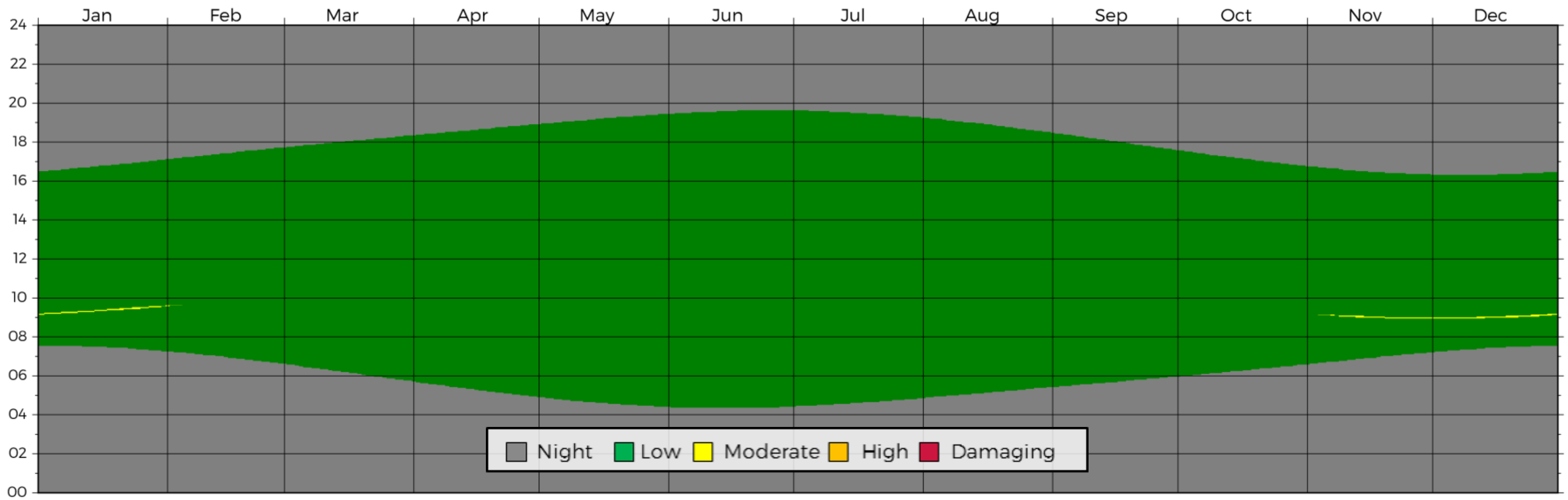


Pedestrian Receptor P32

Receptor P32 was chosen to assess the visual impact assocated with solar reflections affecting players on Breese Stevens field (facing approximately the center for the field).

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.



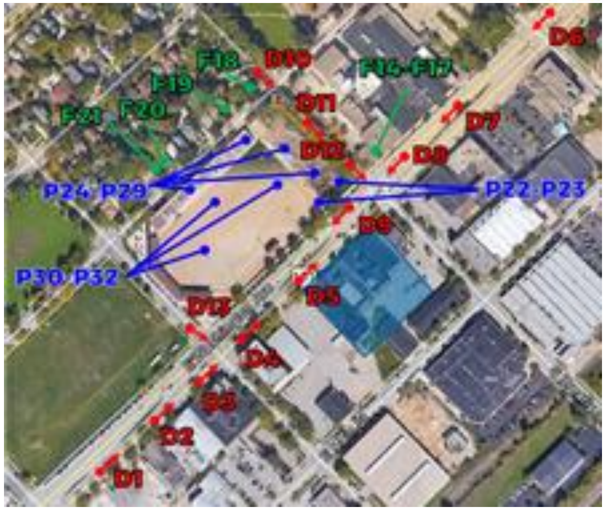


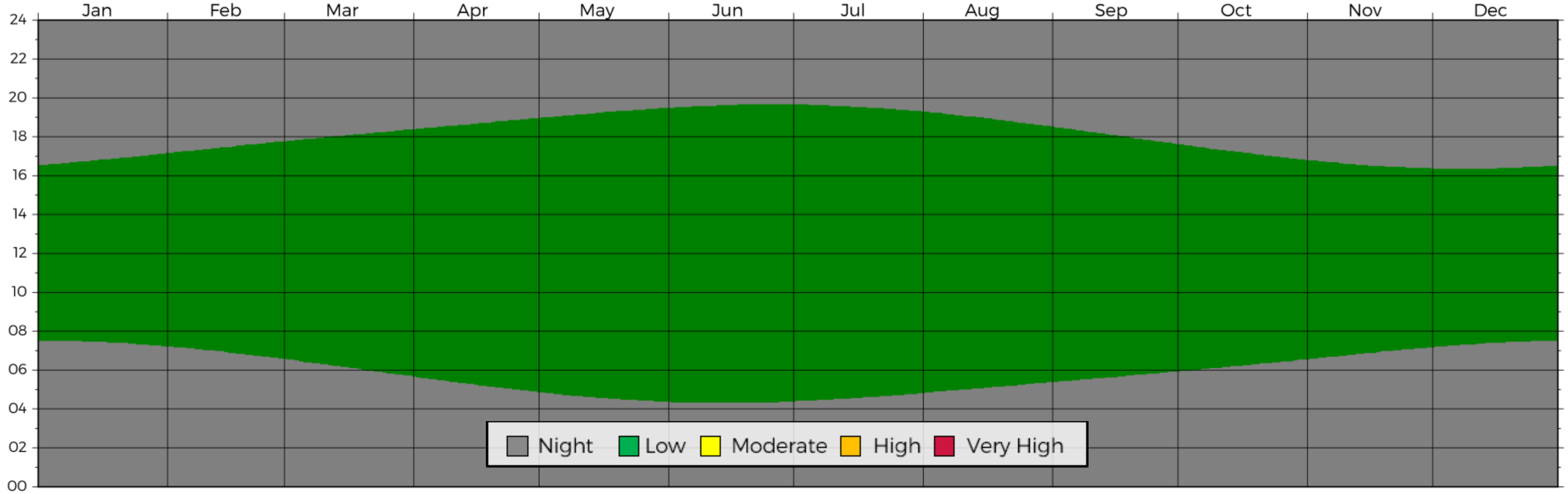
ANNUAL THERMAL IMPACT - PEOPLE

All Receptors

All reflection impacts at all receptors were found to have intensities below RWDI's short-term and human safety threshold values.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

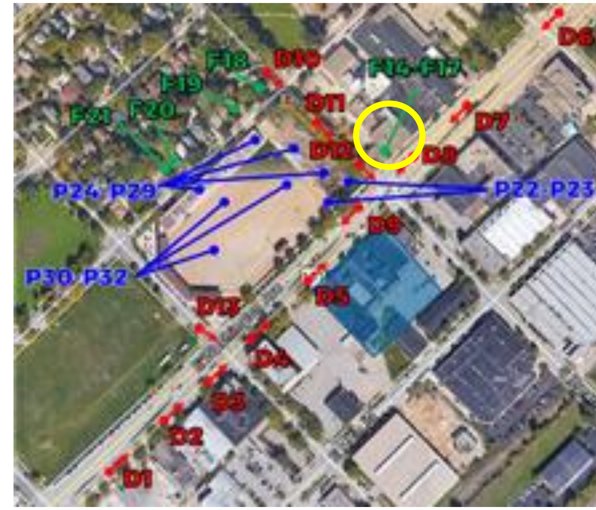


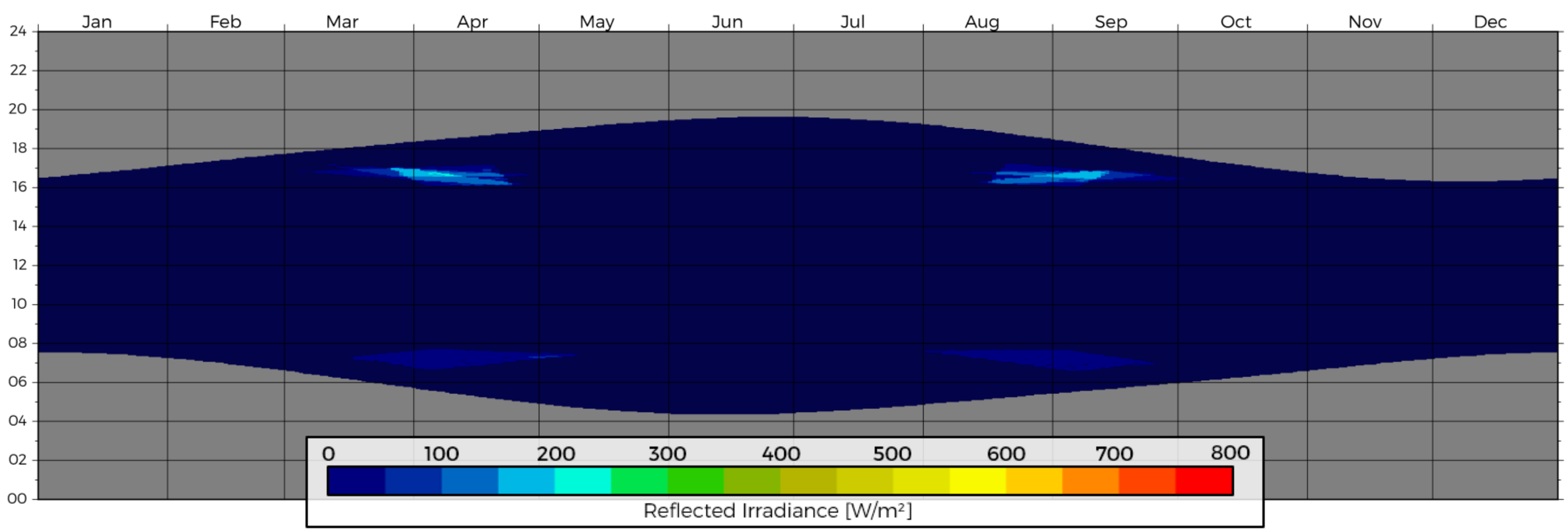


Facade Receptor F14

Receptor F14 was chosen to assess the thermal impact assocated with solar reflections affecting occupants of 1002 East Washington Avenue (at approximately the 1st floor).

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

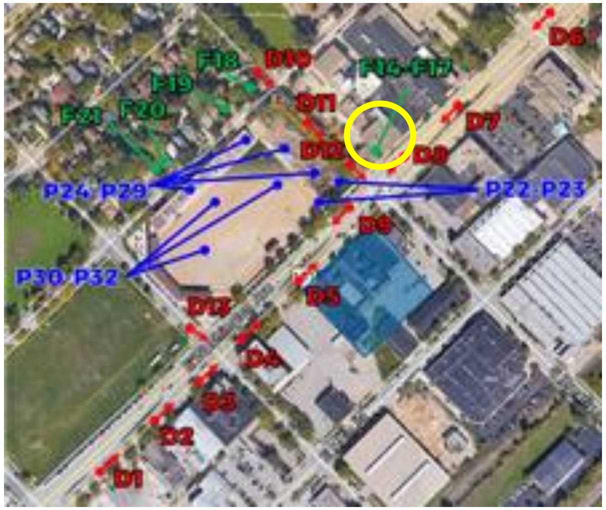


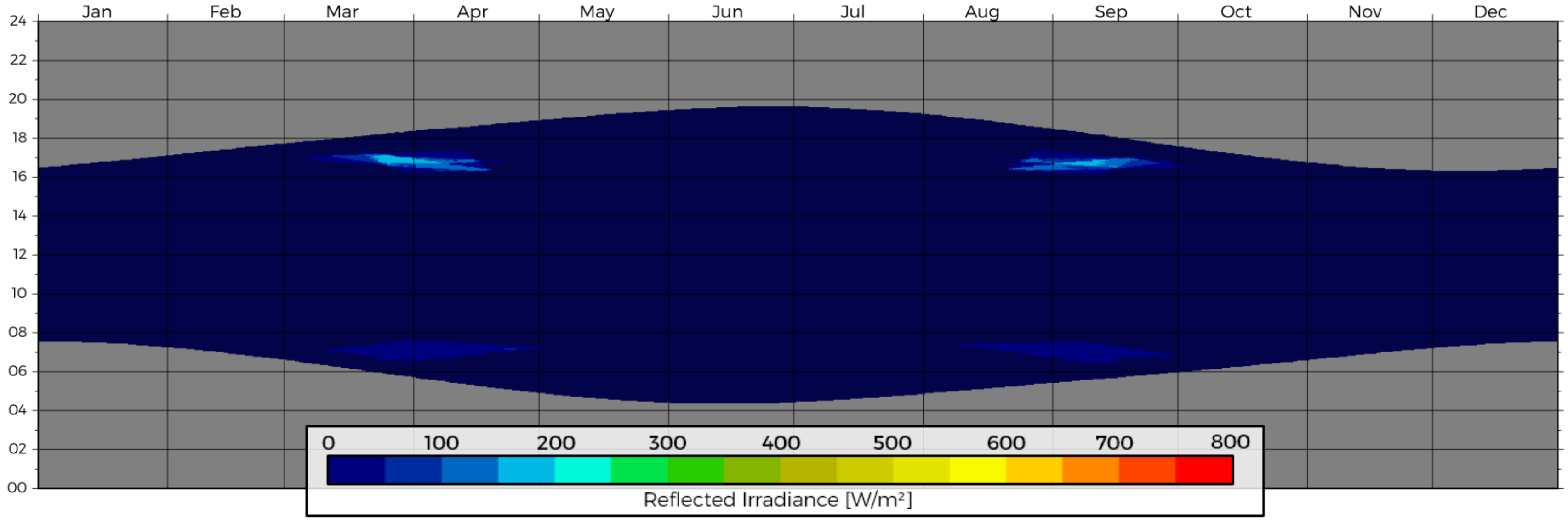


Facade Receptor F15

Receptor F15 was chosen to assess the thermal impact assocated with solar reflections affecting occupants of 1002 East Washington Avenue (at approximately the 3rd floor).

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

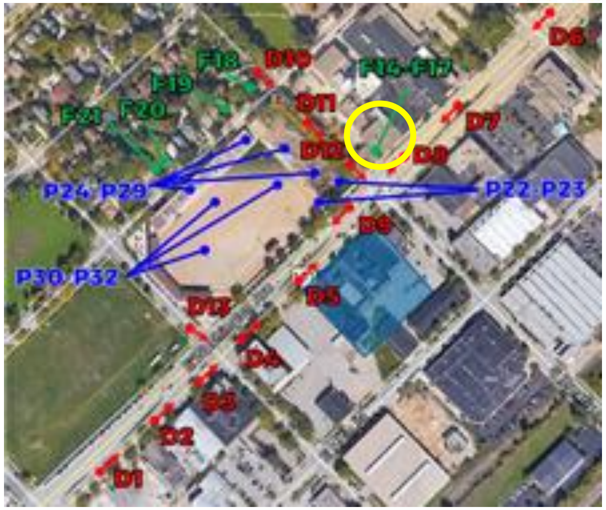


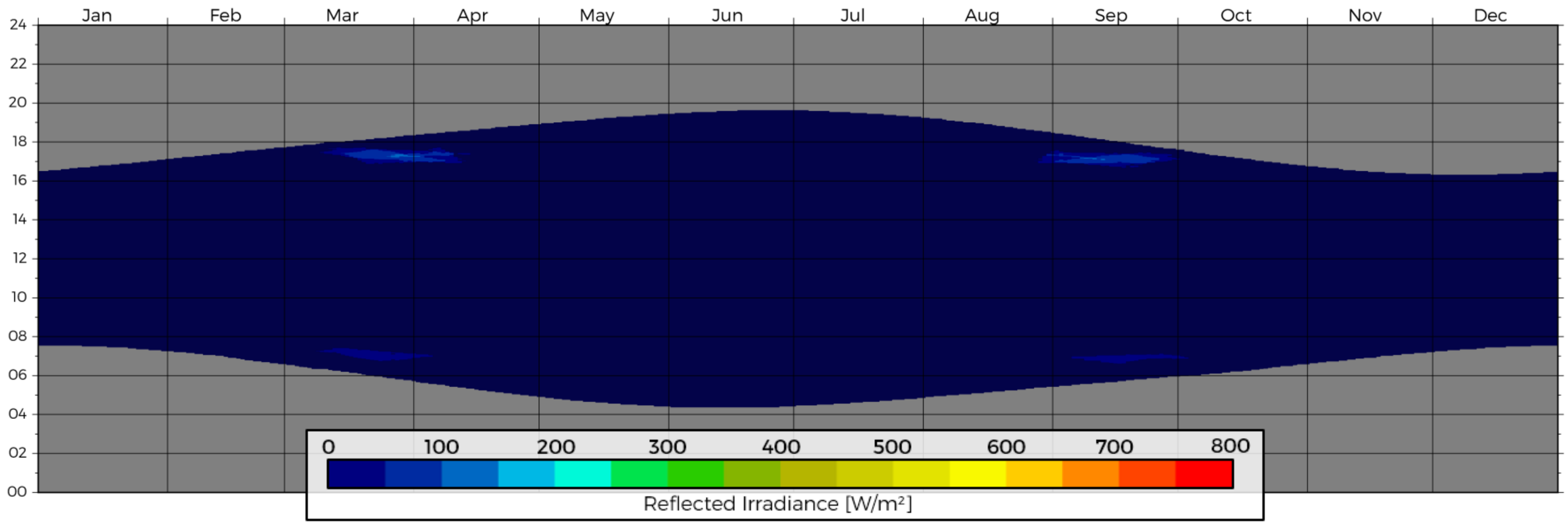


Facade Receptor F16

Receptor F16 was chosen to assess the thermal impact assocated with solar reflections affecting occupants of 1002 East Washington Avenue (at approximately the 5th floor).

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

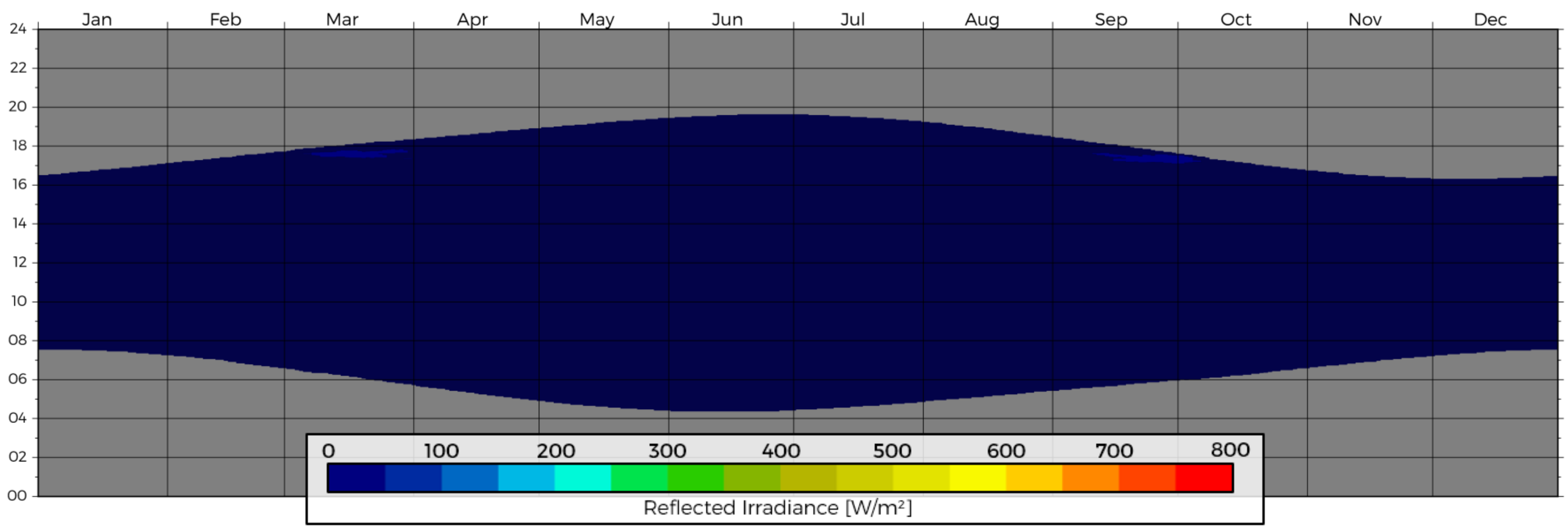




Facade Receptor F17

Receptor F17 was chosen to assess the thermal impact assocated with solar reflections affecting occupants of 1002 East Washington Avenue (at approximately the 7th floor).

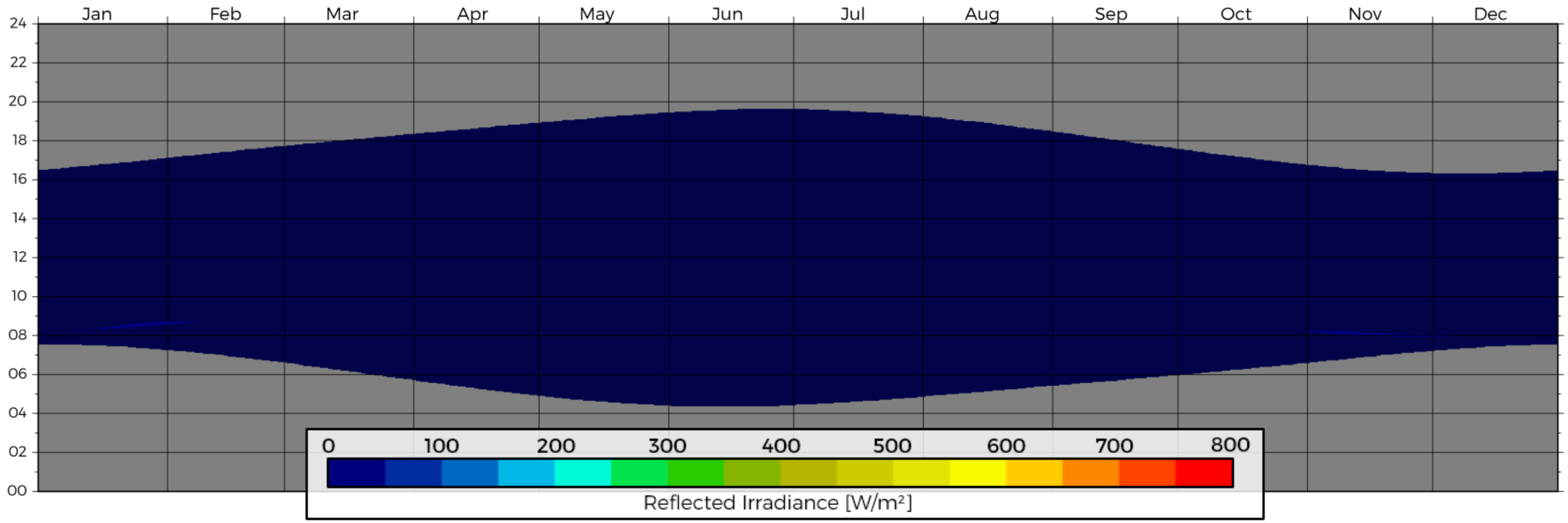
Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.



Facade Receptor F18

Receptor F18 was chosen to assess the thermal impact assocated with solar reflections affecting occupants of 102 North Brearly Street.

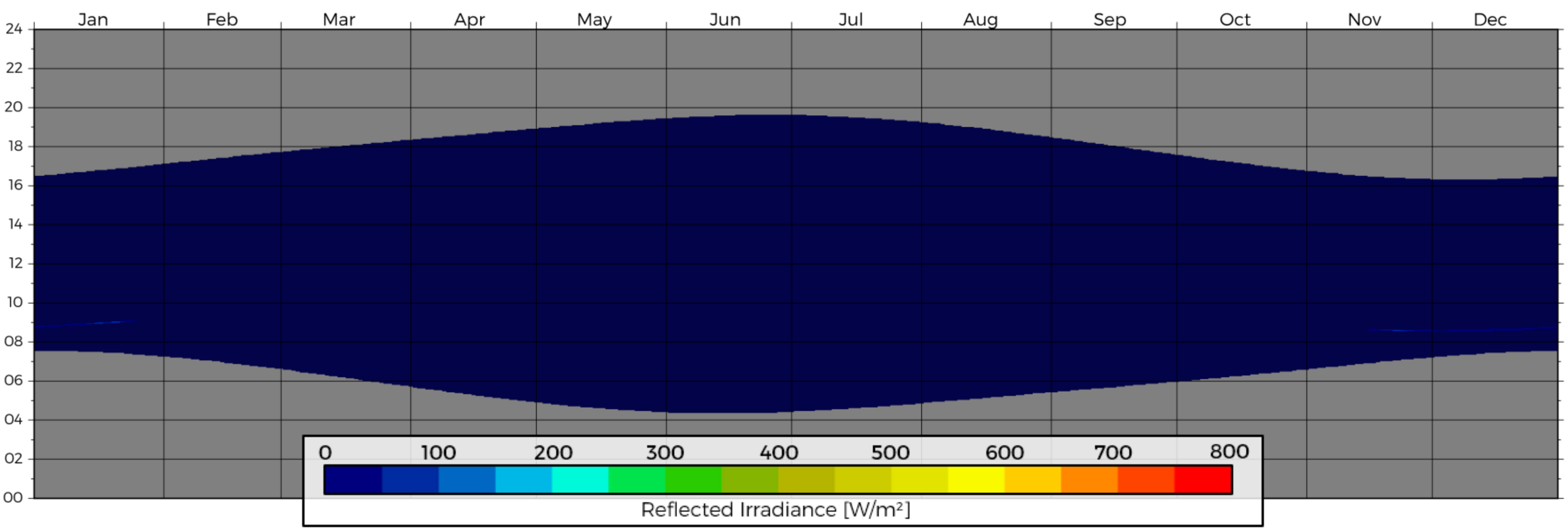
Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.



Facade Receptor F19

Receptor F19 was chosen to assess the thermal impact assocated with solar reflections affecting occupants of 994 East Mifflin Street.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

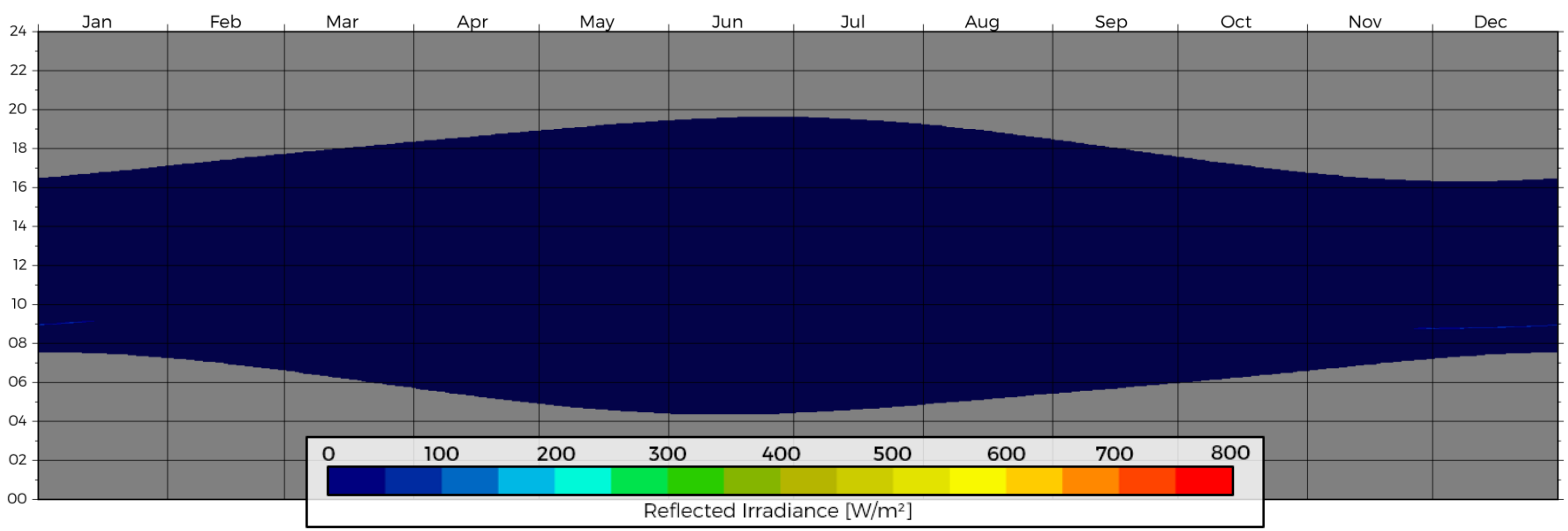


ANNUAL THERMAL IMPACT - PROPERTY

Facade Receptor F20

Receptor F20 was chosen to assess the thermal impact assocated with solar reflections affecting occupants of 992 East Mifflin Street.

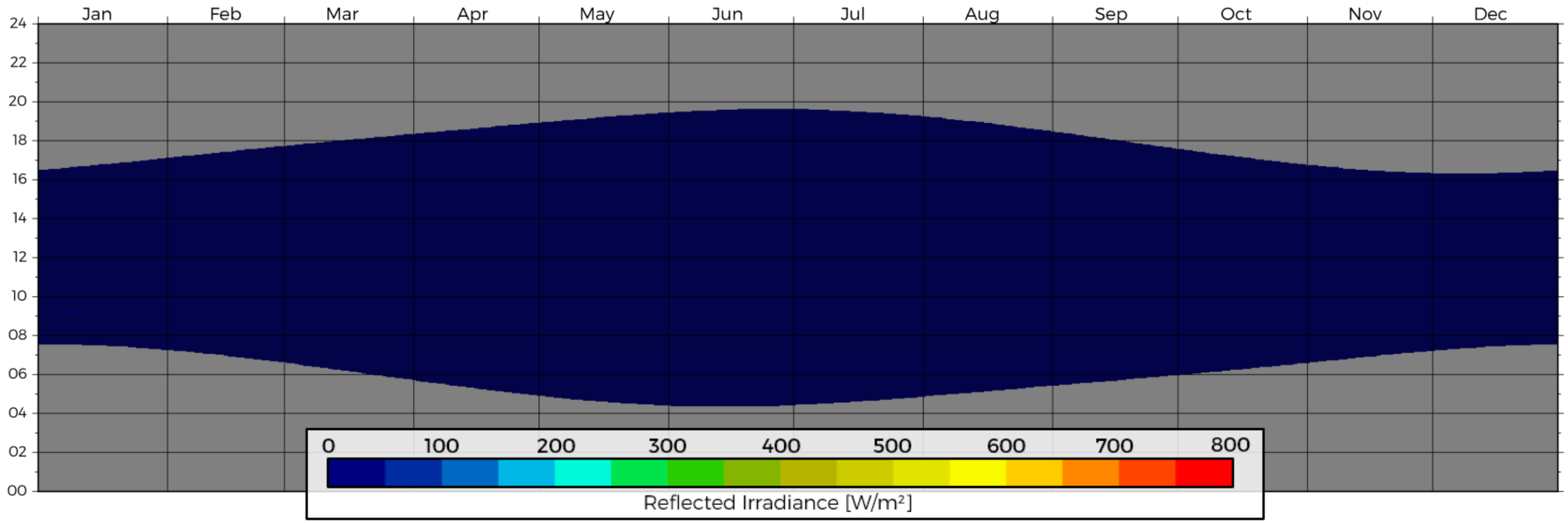
Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.



Facade Receptor F21

Receptor F21 was chosen to assess the thermal impact assocated with solar reflections affecting occupants of 920 East Mifflin Street.

Please note that the referenced times are in local standard time. In jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.



APPENDIX B

RWDI REFLECTION CRITERIA

Visual Glare

There are currently no existing criteria or standards that define an "acceptable" level of reflected solar radiation from buildings. RWDI has conducted a literature review of available scientific sources[1] to determine levels of solar radiation that could be considered acceptable to individuals from a visual standpoint.

Many glare metrics are designed for interior use and have been found to not correlate well with the glare impact humans perceive from direct sun or in outdoor environments. RWDI uses the methodology of Ho et al[2], which defines glare impact based on a physical reaction rather than on a preference based correlation.

Based on the intensity of the glare source and the size of the source in the field of view (Figure B1), the risk of that source causing temporary flash blindness (i.e. the after images visible after one is exposed to a camera flash in a dark room) faster than a person can reflexively close their eyes can be determined.

If this 'after-imaging' can occur faster than the human blink reflex, it presents an unavoidable effect on a person based on physiology rather than preference. This forms the basis of how we determine if a reflection is 'significant'.

This methodology has also been adopted by the United States Federal Aviation Administration (FAA) for determining the risk of glare to pilots and other airport staff under FAA Interim Policy 78 FR 63276.

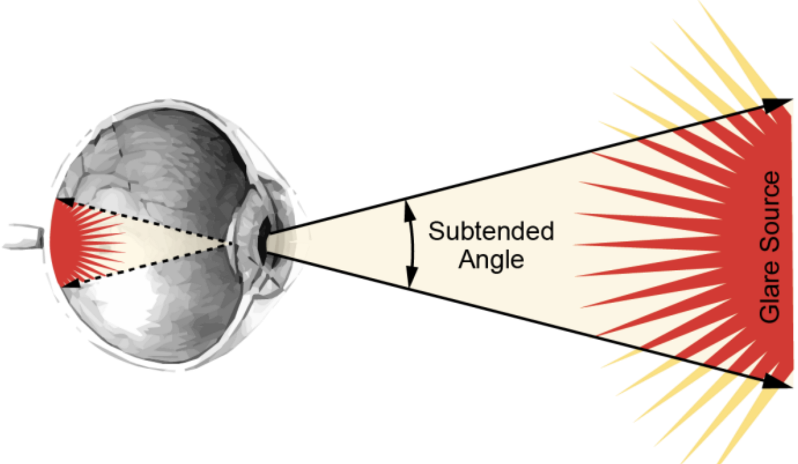


Figure B1: Schematic Illustrating the Subtended Angle of a Glare Source

Visual Glare (cont'd)

At the screening level, we conservatively take any reflections at least 50% of the intensity required to cause after-images as a "significant" reflection to be counted in the frequency analysis. In the detailed phase of work, we use the typical threshold level.

As a reference, point 1 on Figure B2 illustrates where looking directly at the sun falls in terms of irradiance on the retina (the back of the eye) and the size of the angle that the sun subtends in the sky. This puts it just at the border of causing serious damage before the blink reflex can close the eye.

The other points in Figure B2 correspond to the following:

2. Direct viewing of high-intensity car headlamp from 50 feet / 15 m
3. Direct viewing of typical camera flash from 7 feet / 2 m
4. Direct viewing of high-intensity car headlamp from 5 feet / 1.5 m
5. Direct viewing of frosted 60W light bulb from 5 feet / 1.5 m
6. Direct viewing of average computer monitor from 2 feet / 0.6 m

Note that the retinal irradiances described on this page are significantly higher than the irradiance levels discussed elsewhere in this report. This is because the human eye focuses the energy on to the retina. The magnitude of the increase is dependent on the geometry of the human eye and the source of the glare, both of which are computed per the Ho et al methodology.

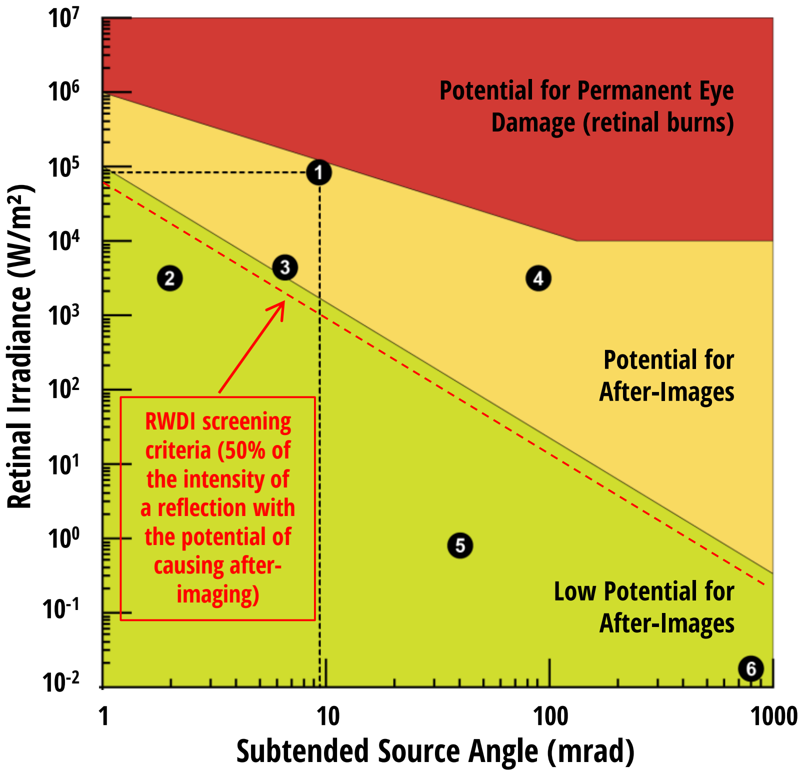


Figure B2: After-Imaging Potential From Various Glare Sources

Visual Glare (cont'd)

Significant glare impacts on the operators of vehicles or heavy equipment pose a particular risk to public safety due to operator distraction or reduction in their visual acuity. Thus, in the detailed analysis, RWDI assigns an assumed view direction to those engaged in "high-risk" activities (e.g. driving a car or flying a plane) as well as an assumed field of view.

The assigned directions and fields of view acknowledge that an operator is particularly sensitive to reflections emanating from the direction in which they are travelling (and therefore cannot safely look away from) and also that the opaque elements of the vehicle will act to obstruct reflections beyond a given angle.

For drivers the critical angle is taken to be 20° away from the direction of view[3]. Thus, any reflections emanating from within this 20° field of view are considered 'high' impacts, whereas reflections emanating from outside this cone are classified as 'moderate' impacts. This angle is adjusted as needed for impacts on other vehicles such as aircraft[4], trains[5], and other heavy equipment[6].

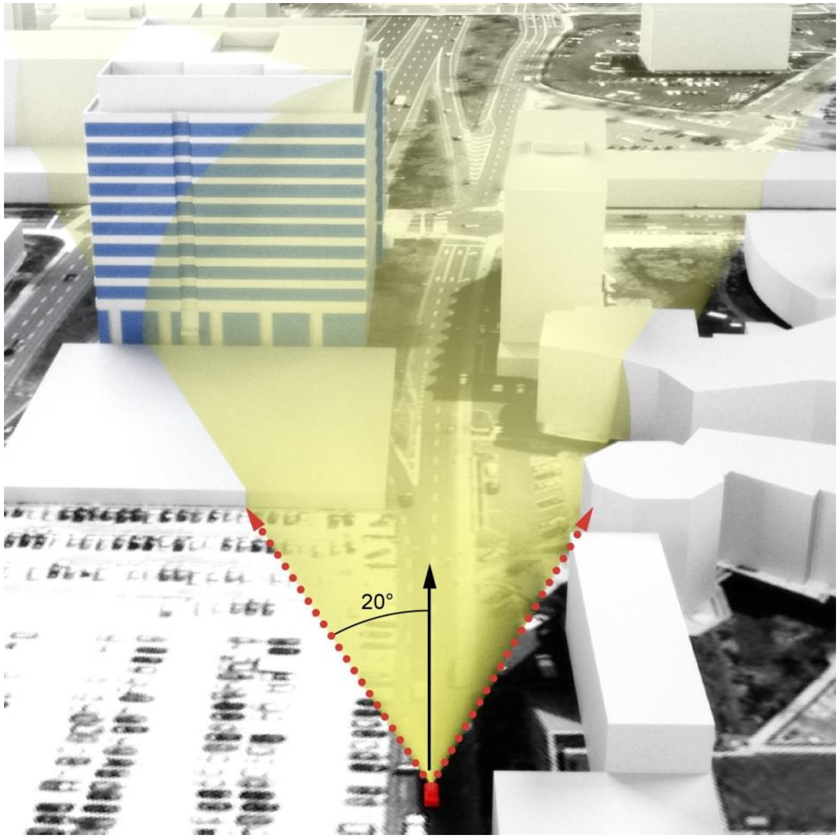


Figure B3: Illustration of a Driver's 20° Field of View

Thermal Impact (Heat Gain) on People

The primary sources for exposure limits to thermal radiation come from fire protection literature. The U.S. National Fire Protection Association (NFPA) defines 2,500 W/m² as an upper limit for a tenable egress environment[7]. That being said, while an individual could move through such an environment, they would not necessarily emerge unscathed. Both the British Standards Institution[8] and the U.S. Federal Energy Management Agency[9] indicate that individuals are likely to feel pain within 30 seconds at such exposure levels on bare skin. With second degree burns possible within minutes of exposure. Additionally, this level of additional heat flux can lead to rapid heating of exposed objects which could present a further risk to human safety.

It should be noted that these numbers are guideline values only, and that in reality many factors (skin color, age, clothing choice, etc.) influence how a person reacts to thermal radiation. **For our work RWDI has established 2,500 W/m² as a ceiling exposure limit which reflection intensity should not exceed for any length of time.**

Lower reflection intensities, while not posing as serious of a risk to human safety, can still negatively impact human comfort. There are no definitive guidelines or criteria with respect to this issue. We know this criterion should be less than 2,500 W/m² and greater than typical peak solar noon levels of 1,000 W/m² which people commonly experience. RWDI's opinion at this time is that a reasonable criterion is to limit reflected irradiance exposure to 1,500 W/m² or less. Based on our assessment, we believe at this level of irradiance most people would be able to tolerate it for several minutes before the onset of discomfort. Additionally reflections at this intensity level will heat surfaces more slowly.

Thus we feel reflections below 1,500 W/m² pose a reduced risk to people and should therefore be considered a short term exposure limit. We would conservatively define "short term" as 10 minutes or less which is slightly shorter than the standard 15 minute definition of short term used in the occupational safety context.

Thermal Impact (Heat Gain) on Property

The impact of solar irradiance on different materials is primarily based on the temperature gains to the material which can cause softening, deformation, melting, or in extreme cases, combustion. These temperature gains are difficult to predict as they are highly dependent on the convective heat transfer from air movement around the object and long-wave radiative heat transfer to the surroundings.

Generally, irradiance levels at or above 10,000 W/m² for more than 10 minutes are required to ignite common building and automotive materials in the presence of a pilot flame. That value increases to 25,000 W/m² when no pilot flame is present[10,11,12]. However, some materials like plastics and even some asphalts may begin to soften and deform at lower temperatures. For example, some plastics can deform at a temperature of 140°F (60°C), or lower if force is applied. The applied force typically comes from the thermal expansion of the material, the force of gravity acting on the material or an external mechanical force (i.e. someone or something pushing or pulling on it).

Aside from the risk of damage to the material itself, a hot surface poses a safety risk to any person who may come into contact with it. This is particularly important in an urban context as the individual may not expect the object to be heated. NASA[13] defines an upper limit of 111°F (44°C) for surfaces that require extended contact time with bare skin. Surface temperatures below this limit can be handled for any length of time without causing pain.

Because of the difficult nature of determining material temperatures, RWDI takes a conservative approach and uses a **threshold value of 1,000 W/m² which is approximately the peak intensity of natural sunlight that could be expected to occur over the course of a year**. Intensities beyond this value exceed the levels of irradiance that common exterior building materials are presumably designed for, and depending on the duration, may lead to deformation or damage. Though, as noted this would depend heavily on environmental conditions and the material properties of the exposed object or assembly.

References

1. Danks, R., Good, J., & Sinclair, R., "Assessing reflected sunlight from building facades: A literature review and proposed criteria." *Building and Environment*, 103, 193-202, 2016.

2. Ho, C., Ghanbari, C. and Diver, R., "Methodology to Assess Potential Glint and Glare Hazards From Concentrating Solar Power Plants: Analytical Models and Experimental Validation," *Journal of Solar Energy Engineering,* vol. 133, no. 3, 2011.

3. Vargas-Martin, F., and Garcia-Perez, M.A., "Visual fields at the wheel." *Optometry and Vision Science* 82, no. 8 (2005): 675-681.

4. Rogers, J.A., et al, "Evaluation of Glare as a Hazard for General Aviation Pilots on Final Approach." *Federal Aviation Administration* (2015).

5. Jenkins, D.P., et al, "A practical approach to glare assessment for train cabs." *Applied Ergonomics* 47 (2015): 170-180.

6. Hinze, J.W., and Teizer J., "Visibility-related fatalities related to construction equipment." *Safety Science* 49, no. 5 (2011): 709-718.

7. National Fire Protection Association. (2003). NFPA 130: standard for fixed guideway transit and passenger rail systems. NFPA.

8. The application of fire safety engineering principles to fire safety design of buildings – Part 6: Human Factors' PD 7974-6:2004, British Standards Institution 2004.

9. Federal Emergency Management Agency, U.S. Department of Transportation, and U.S. Environmental Protection Agency. 1988. Handbook of Chemical Hazard Analysis Procedures. Washington, D.C.: Federal Emergency Management Agency Publications Office.

10. Building Research Establishment: 'Fire spread in car parks' BD2552, Department of Communities and Local Government 2010

11. SFPE Handbook of Fire Protection Engineering 4th Edition NFPA/SPFE 2008 USA

12. V. Babrauskas 'Ignition Handbook' Fire Science Publishers + SFP , 2003

13. E Ungar, K Stroud 'A New Approach to Defining Human Touch Temperature Standards' National Aeronautics and Space Agency , 2010