



# Naval Observatory Lighting Study

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## Introduction



### **Main Points:**

- 1. Light pollution is significantly impacting the mission of the United States Naval Observatory (USNO)**
- 2. The USNO (Observatory) mission here is critical**
- 3. Light pollution can be reversed; Mission can be preserved**



## Introduction (Cont.)



Light trespass on the south side of Building 2 caused by the unshielded lighting fixtures to the south including security lights, building-mounted, interior and parking lot lighting.





## Survey Analysis Findings (continued)



General light pollution that can regularly be seen to the North of NSF USNO. Specific site has not been identified as a problem, but up-lighting adds to scatter and general sky glow.





## Survey Analysis Findings (continued)



Sky glow: View from roof of Building 2 looking South-Southeast







## Survey Analysis Findings (continued)



Sky glow: View of Building 2 looking East





## USNO Mission



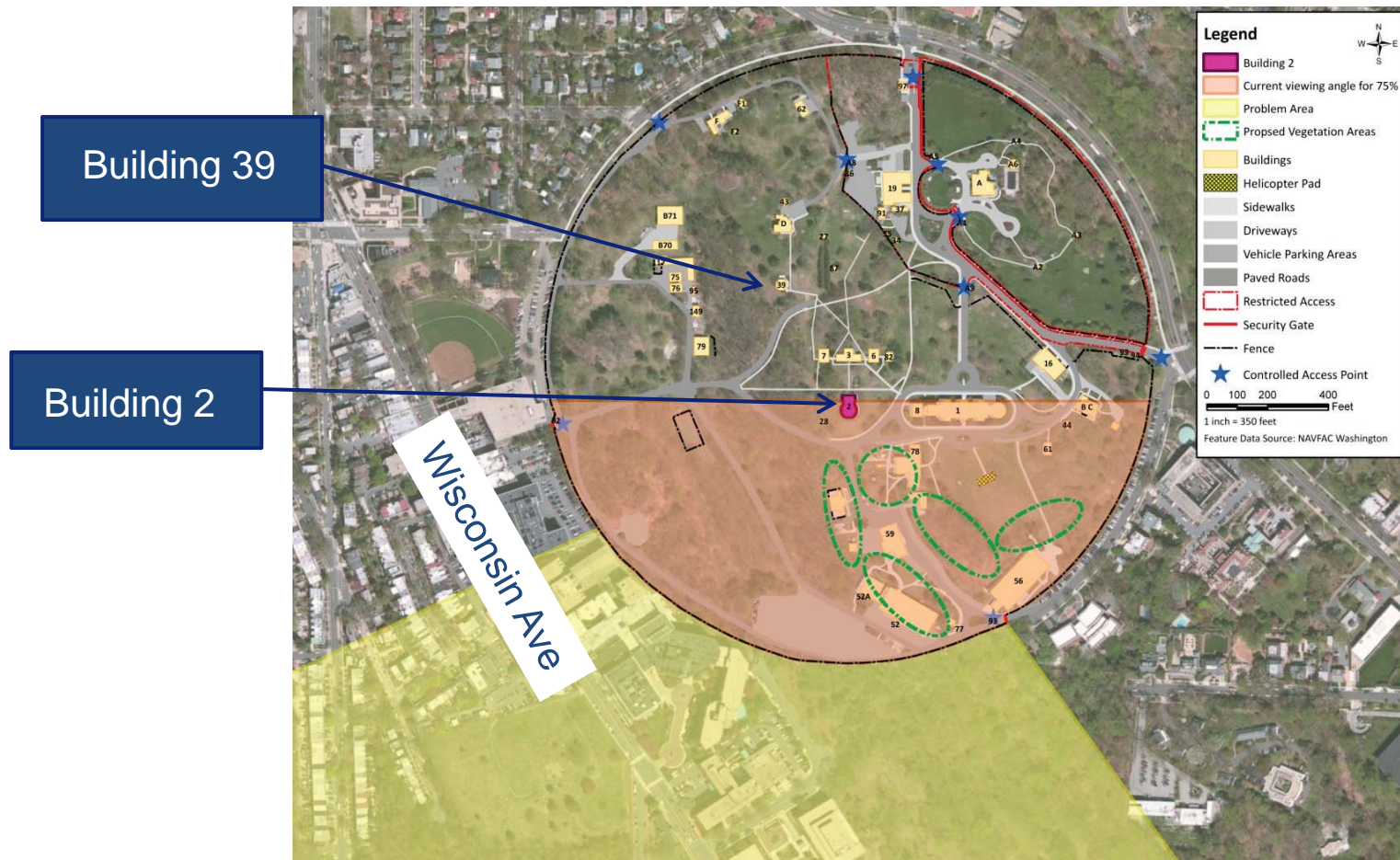
- The USNO, est. 1830, is one of the oldest scientific agencies in the United States
- Observations of earth orientation, astronomy and celestial objects frequently made
- Major authority in areas of precise time interval, Earth orientation, astronomy and celestial observation
- Produces positioning, navigation and timing for the US Navy and Department of Defense



## NSF USNO Background & USNO Mission (continued)



- Mission observations are frequently made from Buildings 2 and 39
- Indicates 75% viewing area (orange) and lighting issue area (yellow)







## NSF USNO Background & USNO Mission (continued)



- Naval Observatory (NO) Overlay District created in 1992
- 40 foot height restriction
- There are no lighting requirements within the overlay
- Overlay District does not cover primary viewing area
- **Modifications to Zoning needed**



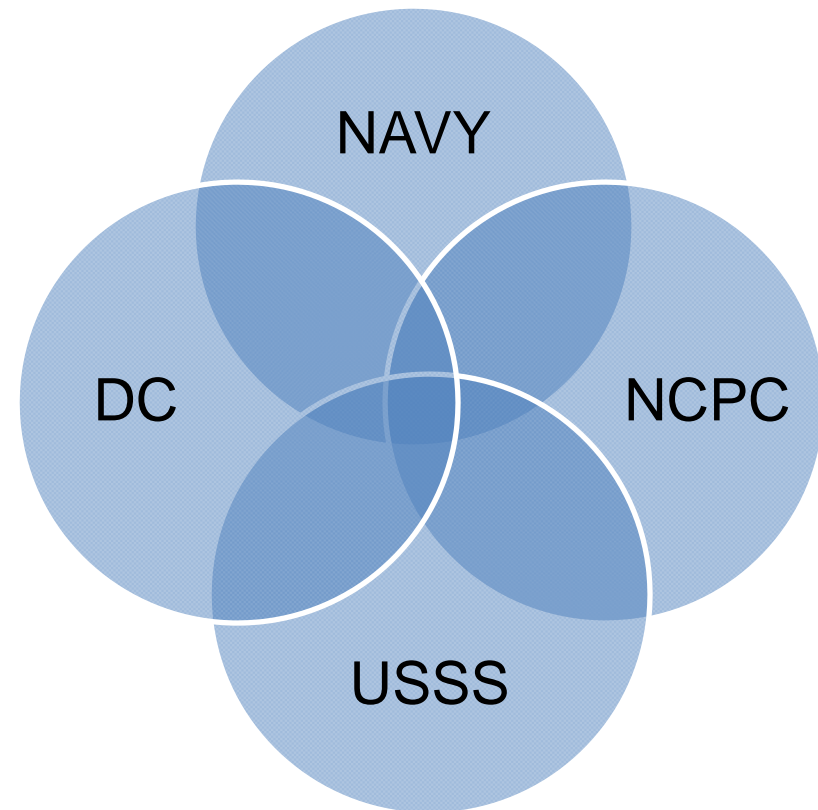
*NO Overlay District Boundaries*



## Study Information



- Direct result of mission degradation
- Collaborative effort with multiple agencies involved
- Identify lighting issues and potential solutions
- Goal: recommend viable solutions to preserve the Observatory's mission
- Extensive coordination with DDOT



Major Project  
Stakeholders



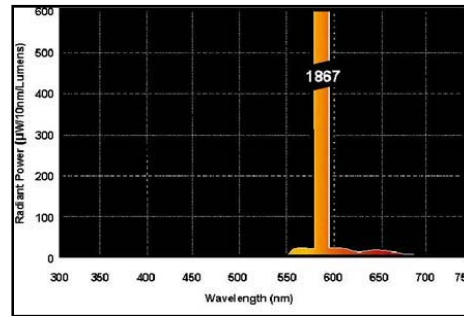
# Lighting Principles



## 1. Lighting spectrum

- Band spectrum light produces energy in only a few wavelengths

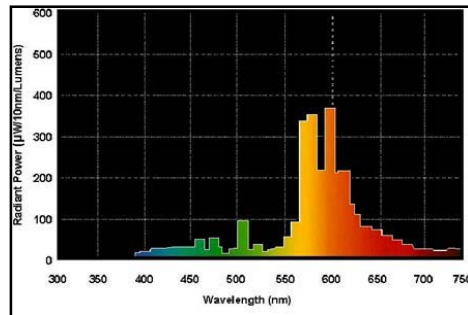
*Band Spectrum Light*



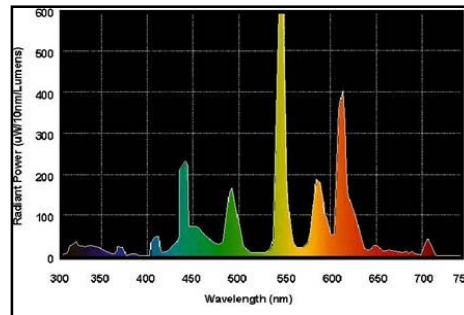
Low Pressure Sodium Lighting

- Broad spectrum light produces energy in all or many of the wavelengths

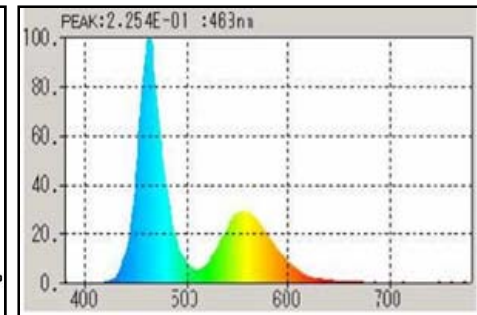
*Broad Spectrum Light*



High Pressure Sodium Lighting



Fluorescent Lighting



White LED Lighting

➤ Observatory scientists are unable to filter broad spectrum lighting sources



## Lighting Principles (continued)



### 2. Lamp Life

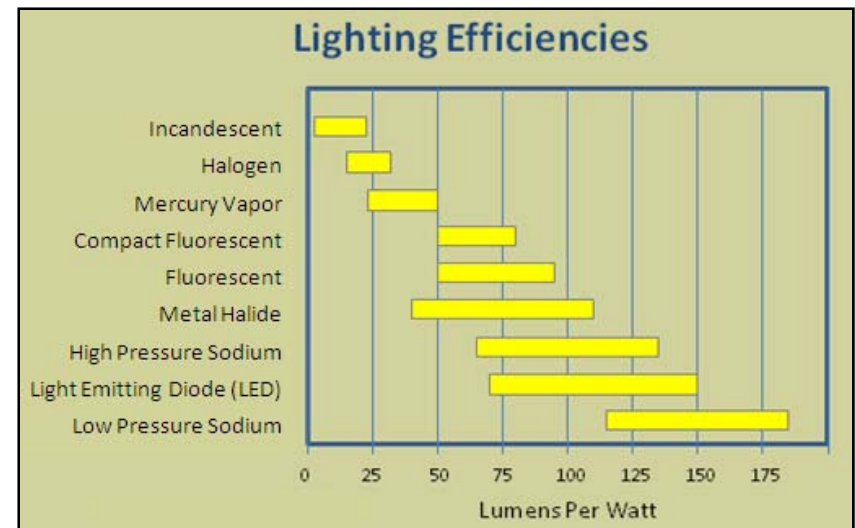
- Varies greatly between sources and directly affects maintenance and operating costs

### 3. Color Rendering Index (CRI)

- Measure of a lighting source's ability to reproduce colors of objects accurately in comparison with natural light
- Has an effect on security lighting: a person's ability to distinguish colors (i.e. vehicle color, skin tone, and clothing colors) decreases with low CRI.

### 4. Lighting Efficiency

- Low Pressure Sodium and Light Emitting Diode (LED) are the most efficient
- Halogen and Incandescent are the least efficient







## Lighting Principles (continued)



### Lighting Source Comparison Table

Light Source	CRI	Spectral Distribution Wavelength (nm)	Lighting Efficiency (Lumens per Watt)	Lamp Life (hours)
Fluorescent	80	400-700	82	20,000
High Pressure Sodium	22	380-480, 550-700	104	24,000
Light Emitting Diode (LED)	75	380-600	126	25,000
Low Pressure Sodium	5	590-600	150	18,000

Note: Table is based upon general data available for each lighting source.

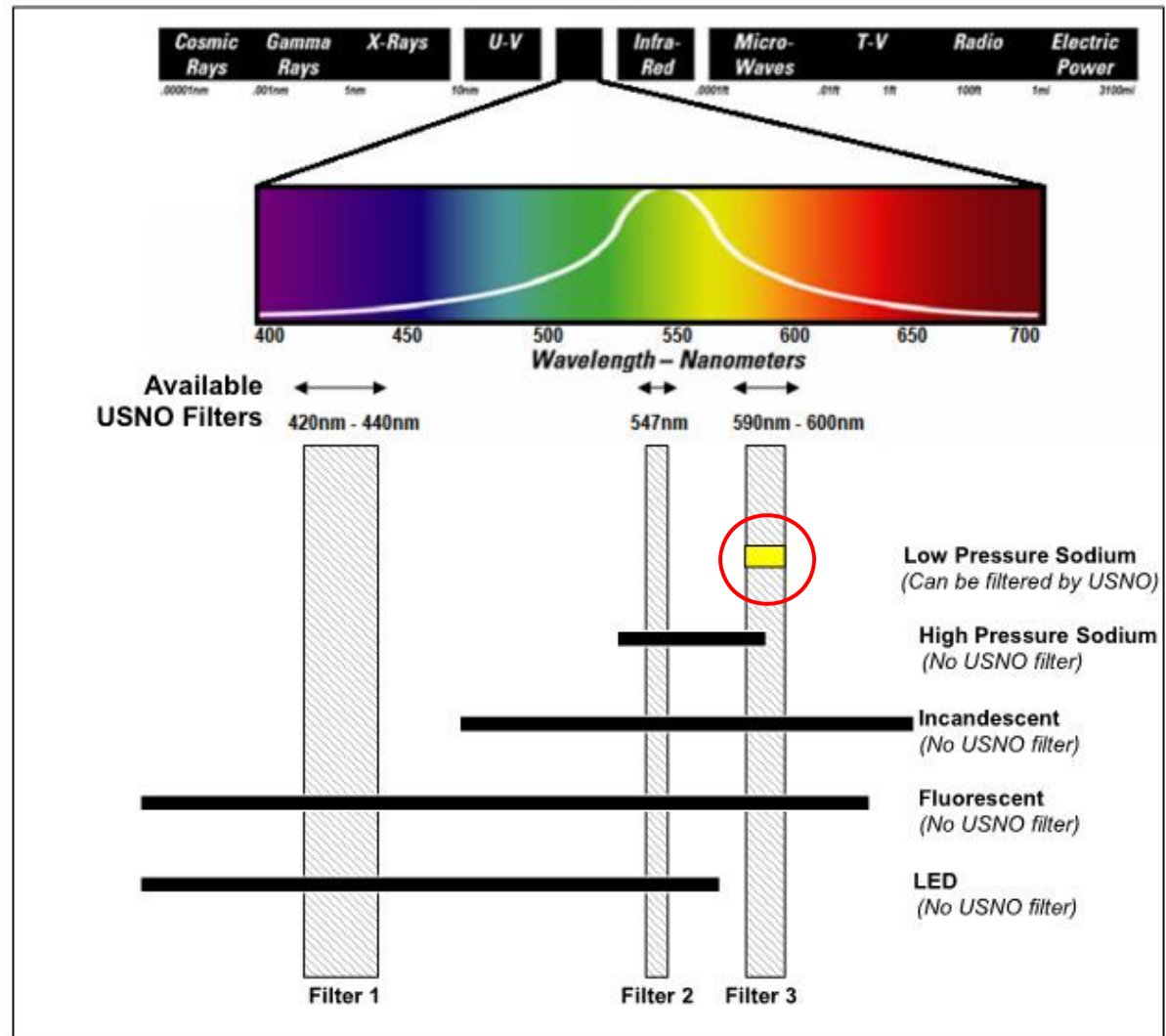


# USNO Lighting Requirements



➤ Reduce the amount of lighting in the blue/green spectrum

- Observatory has several filters that can be used to filter out light interference
- Only lighting source that is capable of being filtered by the Observatory scientists is Low Pressure Sodium





# Recommendations



## 1. Utilize Band Spectrum Lighting/Replacement of Broad Spectrum Lighting Sources with Low Pressure Sodium

- **Low Pressure Sodium is best!**
- For all exterior fixtures, with the exception of specialty lighting, including security areas
- Large projects, street and parking lot lighting

## 2. Ensure Light Directed Where Needed

- Manual adjustment of fixtures  $>10^\circ$  below horizontal plane
- Unshielded lighting fixtures should be replaced with fully shielded fixtures

## 3. Reduce Lighting Levels

- Use minimum lighting levels needed for the use. Walkways, parking lots, and street lighting should be designed to meet the Illuminating Engineering Society (IES) lighting recommendations



## Recommendations (continued)



### 4. Minimize interior light “bleed”

- Use of opaque building materials, shades and other light management techniques
- Occupancy sensors throughout buildings to control non-emergency lighting from dusk to dawn (~ 6:00pm and 6:00am)

### 5. Promote Use of Vegetation

- Increase tree cover and vegetation, especially evergreens

### 6. Enhance Interagency Collaboration

- Work collaboratively to increase education and awareness
- Scheduled meetings to identify potential impacts and integrate mission-sensitive measures

### 7. Adjust Naval Observatory Overlay District/Rezoning

- Expand coverage to the south for primary viewing area
- Incorporate Lighting requirements





## Conclusion



- 1. Light pollution is significantly impacting the mission**
- 2. Mission is critical**
- 3. Light pollution can be reversed**
  - A. Low Pressure Sodium is best
  - B. Best Lighting Practices
  - C. Public Education



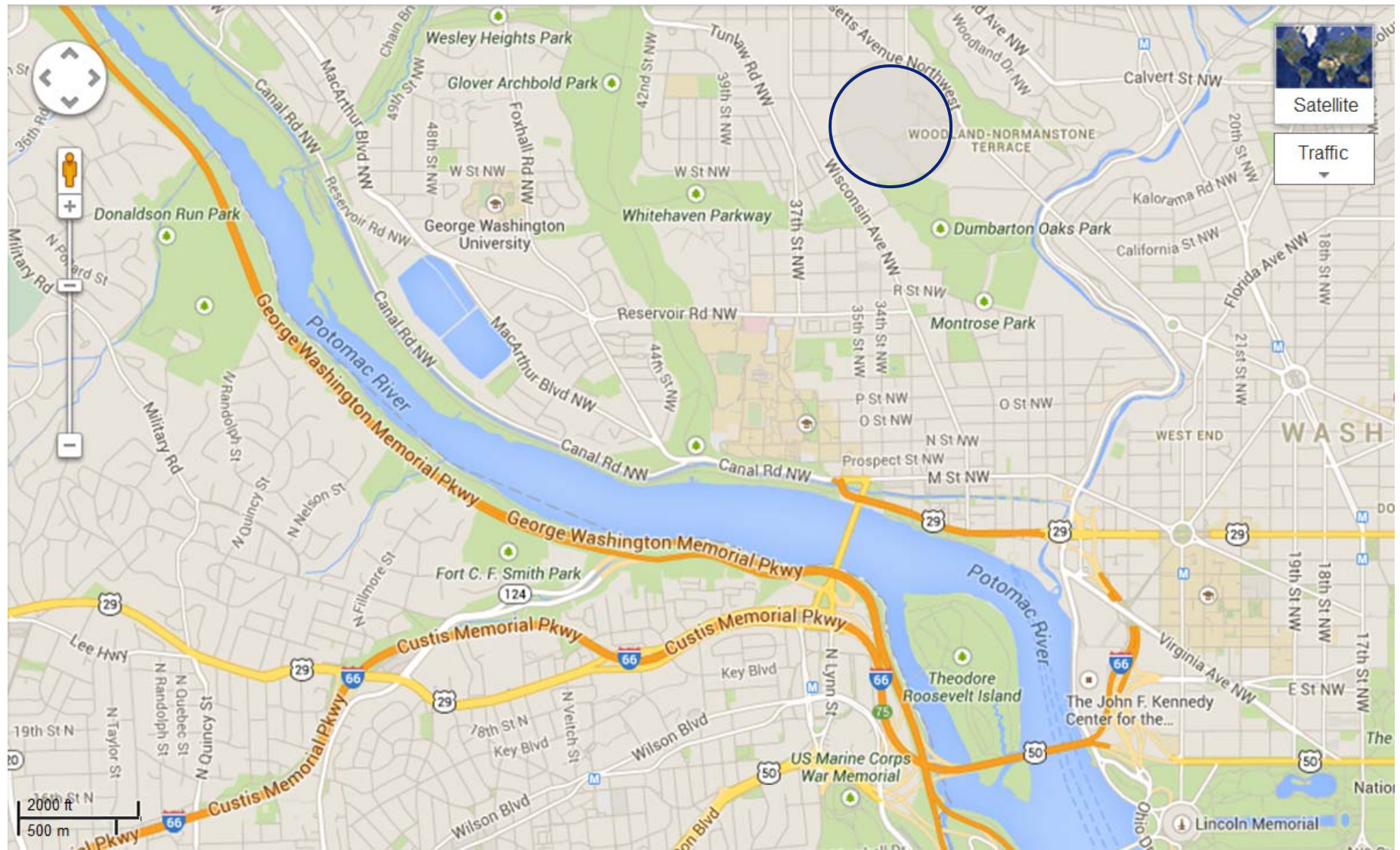
## Comments and Questions

Observatory tours: Bi-weekly on Mondays 8:30-10pm

<http://www.usno.navy.mil/USNO/tours-events/tour-information>



# Expanded Viewing Area





# Stakeholder Lighting Requirements



## ➤ Stakeholder Interviews

- US Navy
  - USNO
  - NSAW
- USSS
- District Department of Transportation (DDOT)
- DC Office of Planning (DCOP)
- District Department of the Environment (DDOE)
- The Commission of Fine Arts (CFA)
- DC Office of Historic Preservation (DC SHPO)
- National Capital Planning Commission (NCPC)

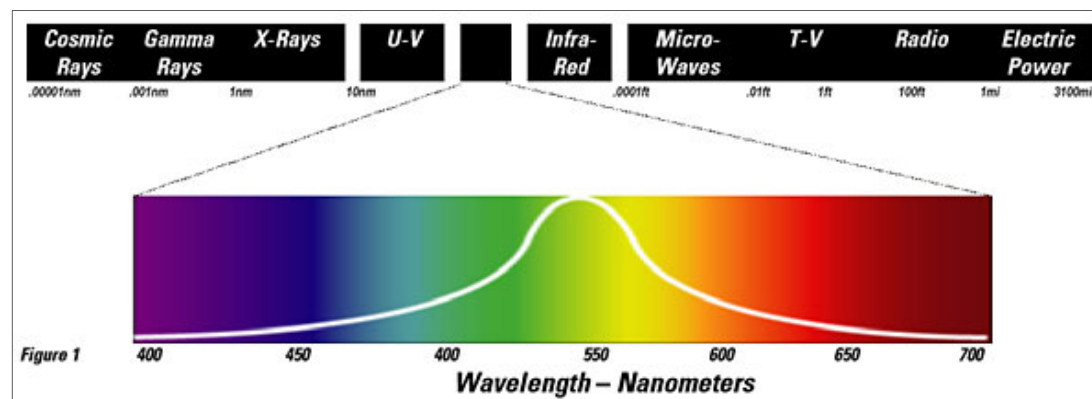




# Lighting Principles



- Light is defined as visually evaluated electromagnetic radiation
- Visible light occurs at wavelengths between 380 and 780 nanometers
- Lighting sources are assessed in terms of their electromagnetic spectrum wavelengths
- \*Study recommendations are based upon the wavelengths produced by lighting sources (e.g., LED, low pressure sodium) and the USNO scientist's ability to filter light at particular wavelengths



*Electromagnetic Spectrum of Visible Light*



## Recommendations – DDOT (continued)



### DDOT Recommendations – Lighting Fixture Replacement Scaled Recommendation Table for Option 1 & Option 2:

- Option 1 & Option 2 have been evaluated in terms of USNO mission compatibility, initial cost, energy consumption, and fixture lamp life.
- A ranking scale for each solution has been determined using fixture comparison data. Each evaluation is based on a ranked scale from 1 to 5, with 5 being the best and 1 being the worst.

Recommended Options	USNO Mission Compatibility	Initial Cost	Energy Consumption	Fixture Lamp Life
Option 1: Fully Shielded Low Pressure Sodium Fixtures	5	5	5	3
Option 2: Fully Shielded LED Fixtures	2	3	4	5

