



**CITY OF FLAGSTAFF**  
**International Dark Sky Association**  
**2016 Annual Report**



## INTRODUCTION

The City of Flagstaff and the northern Arizona region have achieved worldwide recognition for innovative leadership in the protection of dark skies. Beginning with Ordinance 400 in 1958 that addressed searchlights, over a half-century of policy decisions and implementations have fostered an astronomy industry that now includes Lowell Observatory, the U.S. Naval Observatory, the Navy Prototype Optical Interferometer, the National Undergraduate Research Observatory, the U.S. Geological Survey Astrogeology Center, and the new Discovery Channel Telescope. Public support for protection of the night sky for both general enjoyment and professional deep space research has become an established element of community and regional identity.

Zoning Codes that restricted the amount of light per acre in outdoor lighting installations were approved by both the City and the County in 1989, and since then the codes have been periodically updated and strengthened. On October 24, 2001, Flagstaff was recognized as the world's First International Dark Sky City for its pioneering work balancing preservation of our night sky natural resource with concerns about public safety and economic security. Rather than allow this significant economic and cultural inheritance to be degraded, the region's hard-won reputation and accomplishments are acknowledged as vital assets that must continue to be enhanced.

To remain one of the premiere astronomic sites in the world, to properly recognize preservation of naturally dark night skies as a persistent expression of community values, and to better-utilize a critical economic and tourism attractant, the region must implement evolving standards that proactively address problems associated with increased artificial light, air pollution, illuminated signage, and development - both adjacent to major scientific instruments and within the region.

## FLAGSTAFF REGIONAL PLAN 2030 GOALS AND POLICIES

*Goal E&C.5. Preserve dark skies as an unspoiled natural resource, basis for an important economic sector, and core element of community character.*

Policy E&C.5.1. Evaluate the impacts of the retention of dark skies regarding lighting infrastructure and regulatory changes, land use decisions or changes, and proposed transportation developments within the region.

Policy E&C.5.2. Encourage and incentivize voluntary reduction of "exempt" lighting that degrades night sky visibility, and work to prevent light trespass whenever possible in both public and private areas.

Policy E&C.5.3. Continue to enforce dark sky ordinances.

Policy E&C.5.4. Encourage uses within Lighting Zone 1 of the lighting codes of the City and County that do not require outdoor lighting, and discourage those which require all-night lighting.

The Flagstaff Regional Plan 2030 is available at: <http://www.flagstaff.az.gov/index.aspx?nid=2936>

## ZONING REGULATION OVERVIEW

The purpose of the zoning regulations is to help assure that dark skies remain a resource to be enjoyed by the Flagstaff community and its visitors, and to provide safe and efficient outdoor lighting regulations that protect Flagstaff's dark skies from careless and wasteful lighting practices. Dark starry nights, like natural landscapes, forests, clean water, wildlife, and clear unpolluted air, are valued in many ways by the residents of this community, and they provide the natural resource upon which our world-renowned astronomical industry depends.

The use of outdoor lighting is often necessary for adequate nighttime safety and utility, but common lighting practices can also interfere with other legitimate public concerns. Principle among these concerns is:

- The degradation of the nighttime visual environment by production of unsightly and dangerous glare;
- Lighting practices that produce excessive glare and brightness that interferes with the health and safety of Flagstaff's citizens and visitors;
- Unnecessary waste of energy and resources in the production of too much light or wasted light;
- Interference in the use or enjoyment of property that is not intended to be illuminated at night by light trespass, and the loss of the scenic view of the night sky due to increased urban sky-glow; and
- The impact of inappropriately designed outdoor lighting that disrupts nocturnal animal behavior, particularly migrating birds and other species.

The concerns of safety, utility, dark sky protection and aesthetic appearance need not compete. Good modern lighting practices can provide adequate light for safety and utility without excessive glare or light pollution. Careful attention to when, where, and how much night-time lighting is needed results in better lighting practices, darker skies and reduced energy use and costs.

It is therefore the intent of the zoning code to encourage lighting practices and systems which will:

- Minimize light pollution, glare, and light trespass;
- Conserve energy and resources while maintaining night time safety, utility, security, and productivity; and
- Curtail the degradation of the night time visual environment.

It is recognized that since topographic and atmospheric conditions surrounding the City are uniquely suited for astronomical observation and since observatories have been established in the City's vicinity, the City promotes the reduction of light pollution which interferes with the successful operation of these observatories.

The sensitivity of different areas to the different obtrusive impacts of outdoor lighting use depends on many factors, including the dominant use of the area (e.g. residential, industrial or commercial). Further, the effect of outdoor lighting on light pollution to the observatories is strongly dependent on the distance of those lights from the observatories. Therefore, three Lighting Zones are established, with varying standards designed to address the principal issues associated with the different areas. In addition the Flagstaff lighting standards identify a maximum lumen count per acre based on the use and provide standards for fixture and shielding types.

The Flagstaff lighting standards are found in the City Code, Title 10 Zoning Code, Division 10-50.70 Outdoor Lighting Standards. <http://www.codepublishing.com/AZ/Flagstaff/>

## **LIGHTING ENFORCEMENT EFFORTS**

Code Compliance investigates all reports of lighting violations. The program conducted a light audit in 2016 to confirm numerous violations and are presently working with non-conforming properties to bring

them into compliance. The City will continue to conduct annual audits to identify non-compliant properties and track progress.

## **DARK SKY SUMMIT, AUGUST 2014**

### Overview of Summit

The Dark Skies Summit held in Flagstaff, Arizona on August 18-20, 2014 was a great success. More than 150 people of diverse backgrounds participated in dynamic discussions about the future of lighting as LEDs (light emitting diodes) enter increasingly widespread outdoor use. An impressive mix of astronomers, traffic engineers, city and county planners, public lands managers, health officials, lighting industry professionals, and others learned the basics of lighting and shared the latest research on lighting impacts to health, astronomical pursuits, and traffic safety. This multi-disciplinary gathering then explored issues and defined actions related to supply of dark-sky-friendly lighting, demand for such lighting, and plans and policies to guide their use. Many agreed that “it will take a true expansive partnership to mindfully manage for dark skies.”

This catalytic event has already spurred important activities at all levels of government.

- An ordinance in southern Arizona, already in progress, was pushed across the finish line by a conference attendee.
- Flagstaff, a leader in dark sky protection, is convening local practitioners - most of whom attended the conference - to evaluate the range of lighting technologies and select its next generation of street lighting.
- Bureau of Land Management and National Park Service continue to work on a Colorado Plateau dark sky preserve

Service leaders, after finding common ground on the value of dark skies, are initiating internal conversations about policies for public lands under their care.

- Arizona State Parks will now be more effectively lobbied by a conferee to submit state parks for dark sky designation by the International Dark-Sky Association (IDA).

Further actions called for at the conference include:

- Coalition Building – the International Dark-Sky Association (IDA) (*Underway!*)
- The active and strategic pursuit of interconnected IDA designations, offering a large landscape scale system of IDA recognized dark sky resources across the Colorado Plateau.
- Model Lighting Ordinances options to choose from for Cities and Counties (*Underway!*)
- Developing a range of dark skies ordinances suited to a broad-array of needs
- Small cities and counties lacking significant resources for lighting analysis or implementation.
- Cities in close proximity to observatories that support lower lighting levels and a narrower light spectrum to support that industry.
- Larger cities and counties with resources to administer more sophisticated ordinances.
- Integrating mindfulness of dark skies across a full range of regulatory activities including NEPA, OSHA, MSHA, and FAA.

The Colorado Plateau was presented – and acknowledged by conferees – as a valuable dark-sky resource worthy of preservation, and with the potential for serving as a model across the Southwest and nation.

The Colorado Plateau Dark-Sky Cooperative is under development as an initial implementation of this model.

## **STREET LIGHTING TO ENHANCE DARK SKIES OVERVIEW**

The Street Lighting for Enhancing Dark Skies (SLEDS) project's primary objective is to find a solution to Flagstaff's current street lighting predicament while balancing dark skies, safety and maintenance/cost effectiveness objectives.

The SLEDS Project is the result of several years of discussions between the City and the local observatories (United States Naval Observatory – Flagstaff Station and Lowell Observatory) that started in May 2012. At that time, the City found itself in a lighting predicament as Low Pressure Sodium (LPS), the preferred lighting source since 1989, was becoming increasingly more expensive to purchase, quality replacement parts were becoming more difficult to acquire and the City was experiencing structural failures of the pole/mast arm connection due to the size and weight of the LPS fixture, especially in wind prone areas.

In June 2015, the Flagstaff City Council approved an Inter-Governmental Agreement (IGA) with the Arizona Department of Transportation (ADOT) to secure funding for the SLEDS Project. This was in the form of \$100K (FY16) to hire a Consultant Team (ultimately Monrad Engineering), \$200K (FY16) for test fixtures to support the Consultant Team's work, and \$370K (FY18) for the first phase of lighting replacements. All of the funding coming from the Flagstaff Metropolitan Planning Organization's (FMPO) Surface Transportation Program (STP) allocations.

The SLEDS Project is an opportunity for Flagstaff to demonstrate to other municipalities an innovative lighting solution for dark sky preservation with Light Emitting Diode (LED) technology that achieves municipal objectives for safety and cost effectiveness and astronomical objectives for maintaining dark skies and innovation that advances the industry or best practices for technology transfer that advances the purpose of preserving dark skies.

The Request for Proposals (RFP) for SLEDS defined the project's measures of effectiveness: "The City seeks cost effective replacement technologies that (1) maintain or approximate current lighting levels and (2) do not adversely impact the City's dark sky natural resource or the missions of the Lowell Observatory and the U.S. Naval Observatory. In consideration of cost effectiveness, the City seeks to utilize existing light pole infrastructure."

Measures of Effectiveness may include:

- Light uniformity
- (1) Brightness and (2) spectrum analysis from several perspectives including:
  - o On the street
  - o At the observatories
  - o General sky brightness
  - o Identification of ambient light levels (i.e. absence of streetlights)
- Color rendition
- Wind loading (Effective Projected Area)

- Public commentary on lighting levels and color rendition
- Life cycle costs including, but not limited to, initial capital expense, energy use, and maintenance”

In September 2015, the Consultant Team, led by Monrad Engineering, was awarded a \$100K contract to conduct applied research in order to develop a replacement strategy for the City’s increasingly obsolete LPS street lights with newer technology (LED).

The SLEDS Team has worked through several tasks to date:

- An assessment of the viability of continuing to use LPS
- A structural analysis of existing light pole/mast arm assembly and retrofit recommendation for existing poles/masts
- Pre-installation observations and measurements of “sky glow” of the Cheshire and arterial test areas have been completed through ground, aerial and satellite measuring techniques
- Test fixture recommendations have been divided into two categories:
  - o Arterials and selected Major Collectors
  - o Selected Major Collectors, Minor Collectors and Local Roads
- Developed specifications for the Minor Collector / Residential Narrow Band Amber Light Emitting Diode (NBALED) test fixtures and Arterial Hybrid Light Emitting Diode (HLED) 80% NBALED/20% 2700K LED test fixtures and Arterial 12,000 lumen NBALED test fixtures

SLEDS Project items that are currently in progress:

- Working with ADOT on SLEDS test fixture procurement
- SLEDS Team meetings to solidify the locations of the Arterial, Collector and Local roadway test strips

SLEDS Project next steps:

- Installation of test fixtures on various Arterial, Collector and Residential locations
- Solicit public feedback on the test installations
- SLEDS Team meetings to discuss results of the test areas and begin developing proposed new City Engineering Standards for Street Lighting for eventual Council Adoption
- Establish City Wide replacement scenarios
  - o Evaluate Life cycle costs for Alternatives including:
    - Initial capital expense
    - Energy use
    - Maintenance
  - o Evaluate citywide lumen output for Alternatives
- Finalize SLEDS Project Report

#### **NAVAL OBSERVATORY FLAGSTAFF STATION MISSION COMPATIBILITY LIGHT POLLUTION STUDY**

The Navy recently conducted a study to answer two questions:

1. What is the expected impact of development in the region on the Naval Observatory Flagstaff Station’s (NOFS) observing conditions?
2. Are the current lighting standards and patterns of expected development compatible with the long-term ability of the NOFS to fulfill Department of Defense mission requirements?

The study was completed in three phases. Phase one quantified the current sky brightness at the NOFS. An inventory and analysis was completed of the existing and potential land uses in the region. Which was followed by a quantitative prediction of sky brightness resulting from new development. The second phase defined the maximum sky brightness that will be compatible with NOFS mission. Phase three developed six mitigation strategies to preserve the NOFS mission and operational capabilities.

City and County staff have reviewed the findings and recommendations and will meet with the NOFS to review questions about the recommendations. Moving forward, it is anticipated that the findings and recommendations will be presented to the public and elected officials later in 2017.

## **JOINT LAND USE STUDY OVERVIEW**

The goal of the Joint Land Use Study (JLUS) is for local governments, stakeholders, and military installations to study, make recommendations, and provide a report that contains an implementation plan for compatible land use between the United States Naval Observatory Flagstaff Station (NOFS), the Arizona Army National Guard Camp Navajo while also supporting diverse community values. Additionally, the purpose of the JLUS is to prevent incompatible uses surrounding military installations that may interfere with the ability to complete the mission of the facility and to limit impacts of the installations on surrounding property owners. It is anticipated that lighting around the NOFS will be a significant consideration.

Coconino County is the local sponsor for the proposed \$479,430 grant to hire a consultant to complete the JLUS with a local match of \$53,270. In June 2016, the Policy Committee met for the first time. The Committee reviewed and approved membership and identified 23 voting members. The Policy Committee reviewed and adopted operating guidelines and reviewed the draft grant application, which identifies the project study area, desired outcome, and a detailed scope of work. The grant was submitted and has been funded. The next step is to prepare a request of qualifications and the Policy Committee will select a project consultant.

## **CITY FACILITY LIGHTING**

### Parks and Sports Complexes

Since, the implementation of the City of Flagstaff Dark Sky Ordinance in 2001 the Parks Section has been committed to compliance with this Ordinance. This was a multi-year effort to bring the Parks Section into compliance. These guidelines have been and will continue to be utilized with past and future designs of all Park projects.

Following is a list of the steps taken to bring the Parks Section into compliance with the ordinance:

- Parks Buildings (Thorpe Park, Continental Sports Complex, Joel Montalvo Park, Arroyo Park): All exterior non-compliant fixtures were replaced. This included the retro-fitting of unshielded and/or replacement of Mercury Vapor Light Fixtures with shielded Low Pressure Sodium light fixtures.
- Sports Field Lighting (Continental Sports Complex, Thorpe Park Sports Complex, Arroyo Park, Joel Montalvo Park): All unshielded fixtures were replaced with Musco SportsCluster-2 Total Light Control reflector system with Metal Halide 1500W lamps. In 2007, an automated lighting control system was implemented allowing both owner and user groups to remotely control the lighting.

- Sports field lighting have a curfew starting at 11 pm.
- A lighting inventory of Park facilities was created in 2005 and last updated in 2011. With the recent Bushmaster Park Improvements completed in 2016 the inventory is being updated.
- Light curfew is in place at all parks with walkway and parking lot lighting that follows the hours of operation at these facilities (Sun-Thursday 10 pm); (Fri-Sat. -12am). In 2013, an automated light control system was installed to control these lights.

## **COMMUNITY PARTNERS & RESOURCES**

### Flagstaff Dark Skies Coalition

Our Mission: To celebrate, promote, and protect the glorious dark skies of Flagstaff and Northern Arizona through successful dark sky practices.

The Flagstaff Dark Skies Coalition website includes information on the Flagstaff Dark Sky program, lighting products and technical information on the science of lighting.

<http://www.flagstaffdarkskies.org/>

### Lowell Observatory

Our mission is to pursue the study of astronomy, especially the study of our solar system and its evolution; to conduct pure research in astronomical phenomena; and to maintain quality public education and outreach programs to bring the results of astronomical research to the general public.

Lowell Observatory was founded in 1894 by Percival Lowell. Since then, Lowell astronomers have discovered Pluto, collected the first evidence of the expanding Universe, and measured the motions and properties of stars, among many other achievements. Today, Lowell Observatory continues to do research in all areas of astronomy and share our discoveries with all.

<https://lowell.edu/>

### United States Naval Observatory Flagstaff Station

The mission of the U.S. Naval Observatory, Flagstaff Station, is:

- To make, analyze, and interpret such astrometric and photometric dark sky observations as are required to fulfill the mission of the U.S. Naval Observatory.
- To conduct a research program to improve the observational methods and the accuracy of astronomical data required by the Navy and other components of the Department of Defense.
- To perform such other functions or tasks as may be directed by higher authority.

Established in 1955 a few miles west of Flagstaff, Arizona, the Flagstaff station is the US Naval Observatory's dark-sky site for optical and near-infrared astronomy. There are presently two USNO sites in the Flagstaff area: this station (NOFS) and the Navy Precision Optical Interferometer (NPOI), located some 15 miles south of the city.

<http://www.nofs.navy.mil/>