



CITY OF FLAGSTAFF
International Dark Sky Association
2017 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.

ZONING REGULATION OVERVIEW

The City was recognized as the world's first International Dark Sky City on October 24, 2001 for its pioneering work in the development and implementation of lighting codes that balance the need to preserve Flagstaff's dark sky resource with the need for safe lighting practices. 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 this Division 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.

LIGHTING ENFORCEMENT EFFORTS

Code Compliance investigates all reports of lighting violations. The Code team works 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.

STREET LIGHTING TO ENHANCE DARK SKIES OVERVIEW (no update since March 2017)

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

In response to various development proposals over the past several years, the Naval Observatory Flagstaff Station (NOFS) completed a Mission Compatibility study to evaluate mission impact from light pollution, present findings, and outline recommendations for consideration by the City of Flagstaff and Coconino County to minimize the impact to the Dark Sky and the NOFS military mission.

The study sought answers to 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. And finally 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.

On July 26, 2017 a meeting was held at Lowell Observatory to discuss the Mission Compatibility Study. Attendees included the United States Navy and Naval Observatory staff, Lowell Observatory, members of the Flagstaff Dark Sky Coalition, Coconino County and City of Flagstaff staff. An Executive Summary of the study was provided and is attached to this report. Attendees discussed the findings and recommendations. Some of the recommendations will require amendments to the current lighting standards. The City and County agreed that aligning our standards should be a priority as well as presenting the recommendations to the community and drafting the required amendments. The Executive Summary will be presented at a Joint City Council/Board of Supervisors meeting on November 6, 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, 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. 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.

A Request for Proposals was issued in the Springs of 2017 with the award granted to Makers, an architecture, planning and urban design consultant based in Seattle. Makers has assembled a team that includes specialists in public participation, transportation and engineering. A kickoff meeting was held on September 13, 2017 with the Policy Committee. The project schedule has stakeholder and public involvement beginning in November with installation and community tours. There will be a series of public meetings to discuss impacts of the installations and surrounding land use. A draft plan is anticipated in September 2018 with a final plan presented in December. Staff believes the lighting study completed by the Naval Observatory will go a long way to inform recommendations on future development around the facility.

CITY FACILITY LIGHTING

New Public Works Yard

The City worked with the local dark sky community and the Naval Observatory to receive a \$250,000 grant from the Military Installation Fund for dark sky compliant lighting at the new public works yard located on the west side of Flagstaff on Route 66. The new facility is located in Zone 1, the most restrictive zone located closest to the Naval Observatory. Zone 1 allows a maximum lumen allowance of 25,000 Lumens/Acre. The maximum allowable lumens for this 52-acre site is approximately 1.3 million lumens. A total of 796,582 lumens are proposed for the entire facility. The majority of lighting fixtures will use Narrow-Spectrum Amber LED (NSALED) light source. These fixtures will be a mix of 90% NSALED and 10% white LED. Approximately 10% of the facility's outdoor lighting will use a white LED light source.

PRIVATE DEVELOPMENT

Timber Sky

Timber Sky is a 1300 residential dwelling unit development with a mixture of high, medium, and single-family residential units combined with commercial service and open space on 197.58 acres. The development is located on West Route 66 in lighting zone 1, the most restrictive. An application to annex the site into the City and rezone the property was approved by City Council in November 2016. Working with the local dark sky community, the Timber Sky development committed to a series of strategies as part of their Development Agreement with the City of Flagstaff. The Developer is responsible for the enforcement of these provisions through their Covenants, Conditions & Restrictions.

- Lighting for each single family home developed within the R1, MR and HR zoning categories will be limited to a total of 1350 externally installed lumens, whether attached to the dwelling structure or installed elsewhere on the lot. This limit can be exceeded with the use of motion sensors on fixtures such that the non-motion sensor light fixtures do not exceed the 1350 lumens limit.
- Exterior lighting on single family and multi-family residential structures will be fully shielded fixtures to be installed under canopies or overhangs a minimum of five (5) feet from the nearest edge not attached to the structure. In situations where an overhang is not feasible or practical, a fully shielded fixture with motion sensor will be utilized.
- All common area property owned or managed by the master homeowner's association, or one of the sub-associations within a residential block, will be limited to security lighting and lighted entry monuments. For purpose of applying the City of Flagstaff lighting code, lighted entry monuments will be considered Class 1 Lighting, and security lighting will be considered Class 2 Lighting. Care must be given to minimize lumens and to direct light downward or be completely shielded for these applications.
- With the exception of lighting for single family residential, and lighting for multi-family residential all outdoor lighting will use "low-pressure sodium, narrow-spectrum amber LED, PC amber LED, or amber compact fluorescent or equivalent.
- Care should be given to selecting building colors and materials where external lighting will be installed to minimize reflectivity. Wall surfaces located below and within ten feet laterally of any external light fixture will have a "light reflectance value" (LRV) of 15 or less.
- For commercial development within Block 12, Table 10-50.70.050.D of the City's lighting code

requires outdoor lighting in Zone 1 to be turned off at 9:00 pm or no later than 30 minutes after the business closes, whichever is later. For any lighting fixtures exempted from this requirement in the lighting code, motion sensors will be utilized after 9:00 pm.

The City of Flagstaff has also approved a modification to development standards to not require street lighting on residential streets.

COMMUNITY OUTREACH AND EDUCATION

The City of Flagstaff presented a mobile workshop at the Arizona American Planning Association Fall Interlude in Flagstaff on October 27, 2016. Attendees included planners from all over the state of Arizona. City staff and Lowell Observatory Director Jeff Hall led the mobile workshop. We provided an overview of how lighting is regulated in Flagstaff including the three lighting zones, regulation of total lumens per acre, and amount of white light. We discussed the SLEDS project and how low pressure sodium lighting is being replaced with LED lights. We toured several locations to view new projects that comply with our current standards, and a non-conforming site to compare the differences. We walked West Street where the city installed a variety of street lights several years ago. Participants were able to compare LPS, with LED and narrow spectrum amber LED.

The city has prepared a PowerPoint that can be used for a variety of audiences to educate on the history of dark skies in Flagstaff and how we regulate lighting. This presentation is attached to this report.

MEDIA RELATIONS

The City of Flagstaff was featured in the May 2017 issue of Planning, the magazine of the American Planning Association. The article is attached to this report.

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/>

ATTACHMENTS