

## ATTACHMENT A

### CONTRACT FOR FMPO – STREET LIGHTING FOR ENHANCING DARK SKIES (SLEDS)

Contract No. 2015-69

This Contract is entered into this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_ by and between the City of Flagstaff, a political subdivision of the State of Arizona (“City”), and Monrad Engineering Inc (“Contractor”).

WHEREAS, the City of Flagstaff desires to receive, and Contractor is able to provide professional services;

NOW THEREFORE, in consideration for the mutual promises contained herein, the parties agree as follows:

#### SERVICES

Scope of Work: Contractor shall provide the professional services generally described as follows:

#### **FMPO – STREET LIGHTING FOR ENHANCING DARK SKIES (SLEDS)**

and as more specifically described in the scope of work attached hereto as **Exhibit A**.

Schedule of Services: Contractor shall perform all work pursuant to the schedule set forth in Exhibit A.

Standard Terms and Conditions: The City of Flagstaff Standard Terms and Conditions, attached hereto as **Exhibit B** are hereby incorporated in this Contractor by reference. Contractor hereby warrants that it has read and agrees to the same.

Key Personnel: Contractor’s Key Personnel and contact information are designated in Exhibit A. Key Personnel are those employees whose license number and signature will be placed on key documents and those employees who have significant responsibilities for completion of the services. The City Representative for this contract has the right to approve any proposed substitution of Key Personnel.

Subcontractors: Contractor’s subcontractors for this Contract are listed in Exhibit A.

Grants Provisions: The Grants Provisions are attached hereto as Exhibit D is hereby incorporated by reference in their entirety.

#### CITY RESPONSIBILITIES

City Representative: The City Representative is David Wessel, FMPO Manager, or his/her designee. All communications to the City shall be through the City Representative. City Representative is responsible for bringing any request for a contract amendment or price adjustment to the attention of the City Buyer.

City Cooperation: City will cooperate with Contractor by placing at its disposal all available information concerning the City, City property, or the City project reasonably necessary for Contractor's performance of this Contract.

## CONTRACT TERM

Contract Term: The Contract shall be effective as of the date signed by both parties. Performance shall commence within ten (10) days from the City's issuance of the Notice to Proceed, and shall be completed on or before August 30<sup>th</sup>, 2016 and consistent with the Schedule of Services. The term as defined by the Grant is for an initial one (1) year.

Renewal: This Contract may be renewed for up to two (2) additional one (1) year terms by mutual written consent of the parties. The City Manager or his designee (the Purchasing Director) shall have authority to approve renewal on behalf of the City.

Termination: This Contract may be terminated pursuant to the Standard Terms and Conditions attached hereto.

## PAYMENT

Compensation: Contractor shall be paid for all satisfactory performance of the work, in accordance with the Price Schedule attached hereto as Exhibit A. Except as expressly otherwise provided for and itemized in the Price Schedule, payment to Contractor shall be in full compensation for all of Contractor's work, and Contractor will not be entitled to reimbursement for any additional expenses, direct or indirect costs.

Price Adjustment: If price adjustments are permitted (see Exhibit A), any price adjustment must be approved by the City in writing, pursuant to a formal Contract Amendment. The City Council must approve the price adjustment if the annual contract price exceeds \$50,000; otherwise the City Manager or his designee (the Purchasing Director) shall have authority to approve a price adjustment on behalf of the City.

## DATA AND RECORDS

City Ownership of Document and Data: Any original documents prepared or collected by Contractor in performance of this Contract such as models, samples, reports, test plans, survey results, graphics, tables, charts, plans, maps, specifications, surveys, computations and other data shall be the property of City ("City's work product"), unless otherwise agreed by the parties in writing. Contractor agrees that all materials prepared under this Contract are "works for hire" within the meaning of the copyright laws of the United States and assigns all rights and interests Contractor may have in the materials it prepares under this Contract, including any right to derivative use of the material.

Re-Use. City may use City's work product without further compensation to Contractor; provided, however, City's reuse without written verification or adaption by Contractor for purposes other than contemplated herein is at City's sole risk and without liability to Contractor. Contractor shall not engage in any conflict of interest nor appropriate any portion City's work product for the benefit of Contractor or any third parties without City's prior written consent.

Delivery of Document and Data: Upon termination of this Contract in whole or part, or upon expiration if not previously terminated, Contractor shall immediately deliver to City copies of all City's work product and any other documents and data accumulated by Contractor in performance of this Contract, whether complete or in process.

INSURANCE

Insurance: Contractor shall meet insurance requirements of the City, set forth in **Exhibit C.**

MISCELLANEOUS

Notice. Any notice concerning this Contract shall be in writing and sent by certified mail and email as follows:

To the City:

Di Ann Butkay, Buyer  
Purchasing  
City of Flagstaff  
211 W. Aspen  
Flagstaff, Arizona 86001  
dbutkay@flagstaffaz.gov

To Contractor:

With a copy to:

David Wessel, FMPO Manager

With a copy to:

Authority. Each party warrants that it has authority to enter into this Contract and perform its obligations hereunder, and that it has taken all actions necessary to enter into this Contract.

CONTRACTOR

\_\_\_\_\_

Print name: \_\_\_\_\_

Title: \_\_\_\_\_

CITY OF FLAGSTAFF

\_\_\_\_\_

Print name: \_\_\_\_\_

Title: \_\_\_\_\_

Attest:

\_\_\_\_\_  
City Clerk

Approved as to form:

\_\_\_\_\_  
City Attorney's Office

Notice to Proceed issued: \_\_\_\_\_, 20\_\_\_\_

## EXHIBIT A

# Scope of Work

### STREET LIGHTING for ENHANCING DARK SKIES (SLEDS)

#### **PURPOSE**

The City of Flagstaff seeks a qualified research team to evaluate the impact of different street lighting applications on its dark skies, a resource highly valued by the City and the community.

#### **BACKGROUND**

Street lighting in Flagstaff

The city of Flagstaff was the first to be recognized by the International Dark Sky Association as an *International Dark Sky City*. Flagstaff earned this distinction, in part, by the establishment in 1989 of a lighting code and engineering standards specifying the use of low-pressure sodium (LPS) light fixtures for all roadway and parking lot lighting. Today, LPS lights are increasingly difficult to acquire as low demand has prompted many manufacturers and distributors to stop production. In addition, the use of the largest 180 watt LPS fixtures on the current poles and mast arms along arterial streets creates high wind loads. The City seeks proposals to partner on the application or development of an innovative light fixture technology to replace the current LPS technology and is particularly interested in narrow band amber LED, phosphor-coated amber LED, and various filtered LED options. The City seeks proposals that effectively and appropriately mitigate the impacts of these lighting options on the community's dark sky natural resource.

#### **LED lighting relative to LPS**

Flagstaff adopted LPS due to the very close proximity (2-10 miles from city limits) of major astronomical observatories established in 1894 (Lowell Observatory) and 1955 (the U. S. Naval Observatory). The low-pressure sodium spectrum covers 589-590 nm – only 1 nm spectral coverage. In contrast, the standard white LED spectrum has significant emission over more than 300 nm and filtered LEDs (FLED) over about 220 nm. Conversion of Flagstaff street lighting to 4100K CCT white LEDs has been estimated to increase sky glow by a factor of 7 relative to LPS, and conversion to FLED by a factor of 3.7, severely compromising the observatories' missions and greatly degrading the visual appearance of the night sky in the city.

Other LED options exist, however. Phosphor-coated amber LEDs (PCALED) have a narrower spectrum than FLED, cutting off at about 530 nm. True narrow band amber LEDs (NBALED) have only a 20nm bandpass centered near 590 nm; this is wider than LPS but entirely acceptable from an astronomical perspective. Filters that cut off the blue end of the spectrum at 550 nm (FLED550) create an LED option reasonably closely

resembling high-pressure sodium (HPS, with a roughly 120nm bandpass). True narrow band LED options are also available at slightly redder wavelengths than amber (about 620 nm rather than 590 nm). See Figure 1 for representative spectra of some of these options.

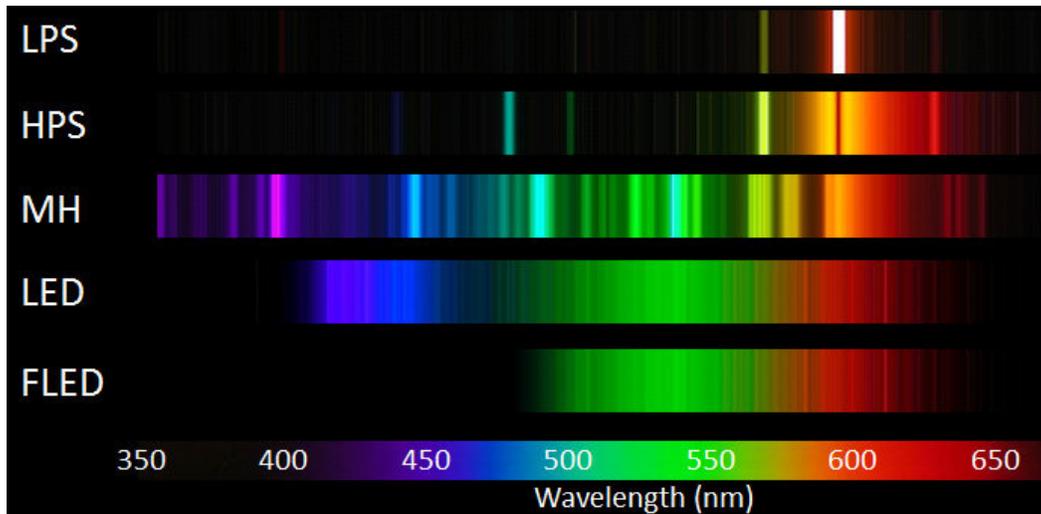


Figure 1. Representative lighting spectra. At present, Flagstaff is a mix of LPS and HPS, as over 50% of the city’s street lights have been replaced by LPS since adoption of the 1989 ordinance. Metal halide (MH), LED, and FLED all result in dramatically increased sky glow relative to LPS or even HPS. *(Figure of spectral distributions prepared by Jeffrey Hall, Lowell Observatory)*

### Challenges and opportunities presented by this RFP

At issue are the relative efficiencies of the lamps. NBALED is less efficient, at present, than FLED or white LED, making it less cost effective for citywide implementation. At the same time, it is the only LED option that preserves the current level of sky glow above the city. As an example scenario, if the City were to convert all its 180-watt LPS street lighting to NBALED and all of its HPS to FLED550, sky glow would be roughly conserved – but this solution would at present be extremely expensive.

We seek to identify how the City can effect a solution to this challenge. At the same time, we identify it as an opportunity for Flagstaff to demonstrate to other municipalities an innovative lighting solution for dark-sky preservation with LED technology. This entails:

- A cost effective solution to long-term street lighting needs that achieves municipal objectives for safety and cost effectiveness and astronomical objectives for maintaining dark skies.
- Innovation that advances the industry or best practices for technology transfer that advances the purpose of preserving dark skies.

## PARAMETERS FOR PROPOSERS

Available funds:

Through the Flagstaff Metropolitan Planning Organization, the City of Flagstaff has funding to (1) conduct innovative research and monitoring as well as (2) purchase new lighting technology. These funds are subject to federal requirements including compliance with procurement laws, Buy America, Civil Rights/Title VI, and the National Environmental Policy Act, among others.

The City will commit the following to the street lighting research collaborative:

- \$100,000 toward monitoring and research.\*
- \$200,000 toward the purchase of light fixtures.\*
  - It is the intent of the City to seek a phased approach to evaluating light fixture technologies by conducting small scale evaluations first to potentially eliminate some choices prior to purchases for the larger scale evaluations.
- \$11,000 of in-kind labor for installation of lighting technology (in-kind).\*

(\*The City's indirect cost allocation plan will be charged against all federal grant funding.)

General guidelines

- Proposals must support widespread applicability for the City's entire lighting inventory.
- Proposals must provide a clear plan and timeline for LPS to LED transition that maintains the City's dark-sky quality as new technology is implemented.
- Baseline data must be established across a range of measures of effectiveness.
- Proposals for modeling will not be accepted in the place of field testing, but existing evaluation or estimation software may be used for preliminary analysis during test designs and post-test estimates for city-wide impacts of new lighting recommendations.

The City is open to several ideas, including, but not limited to:

- Prototype – collaboration with a manufacturer to identify paths toward development of a cost-effective, narrow band LED replacement for a 180 Watt LPS fixture as the highest priority.
- Evaluation of selected corridors in the City for testing of one or multiple light sources.
- Proof of concept: Using available models to predict light levels on the streets and changes in sky glow and under different scenarios employing varying amounts of lumens emitted by different lamps and fixture arrangements.

## **Measures of Effectiveness (MOE)**

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:
  - on the street
  - at the observatories
  - general sky brightness
  - 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 expenses, energy use, and maintenance

## **Project description**

The project description must contain four sections in the order given below. These sections are designed to encourage a step-by-step evaluation of the evolution of an LED-based, dark-sky lighting solution in Flagstaff, and to create a roadmap for other communities that wish to embark on similar efforts. Proposers must source in the reference section all statements from the primary or secondary literature, case studies, and municipal codes and strategic plans.

## **Evaluation of lighting pole infrastructure in Flagstaff**

As stated above, the City desires to maintain existing lighting pole infrastructure in the interest of cost effectiveness. Proposers should provide a plan and timeline for assessment of this infrastructure. The City will provide the selected team with its lighting pole inventory documentation for the purposes of this evaluation. Critical questions include

- Where mast arm overloading by 180 watt LPS fixtures is of critical urgency
- Where poles themselves require engineering or replacement

## **Evaluation of LPS lighting technology**

Proposers must outline a plan to evaluate the state of low pressure sodium lighting in industry. This should include plans and a timeline to provide

- A review of LPS usage generally, showing usage trends and evolution of demand
- A projection for the future availability, cost, and efficiency of LPS lighting, to establish timescales on which LPS must be phased out in favor of LED

## **Evaluation of LED lighting options**

The proposal must provide a plan for evaluation of LED lighting technology. Options that must be explored include but are not limited to:

- FLED (500 nm cutoff)
- PCALED (530 nm cutoff)
- FLED550 (550 nm cutoff)
- NBALED (20 nm band width at 590 nm)
- Other NBALED-analogous options (e.g., narrow band centered at 620-630 nm)

## **Parameters that must be evaluated are:**

- Current efficiency
- Prospects and timescale for improvements in efficiency
- Cost implications to the City of implementation of the various options if it
  - Replaces 180-watt LPS fixtures in critical engineering areas identified in section 5.2.2.1 above
  - Replaces all current 180-watt LPS fixtures citywide
  - Replaces additional HPS fixtures citywide
- Examination of hybrid solutions for LPS/HPS replacement is acceptable and welcomed

## **Plan for transition of lighting in Flagstaff from LPS/HPS to LED**

Narrow band LED lighting preserves the viability and the missions of the local observatories. Proposers should describe a clear path to transitioning Flagstaff from LPS to dark-sky preserving LED. Elements of this plan should include, but are not limited to

- Maintenance of LPS through mechanical solutions (e.g., additional support of mast arms, removal of mast arms and attachment of fixtures directly to poles) while LED solutions are explored and implemented, and timescales for viability of such maintenance
- Temporary installation of broad-spectrum LED (e.g., FLED) in areas of critical urgency identified above while narrower band (PCALED, FLED550, NBALED, orange NBALED) options and improvements are explored
- Proposals for installation of the various types of LED options for public evaluation

- Timescale and limits of improvement in narrow band LED technology
- Plan for phased conversion of LPS and HPS streetlight fixtures to a mix of LED that maintains the dark sky standards in the city
- Projections for change in sky glow under the various scenarios presented

### **References cited**

All references included in the Project Description should be assembled in an alphabetical list. Proposers may use a citation style of their choosing, but they should be consistent throughout the reference list.

### **Project personnel**

Proposers should provide an explanation of the proposed personnel arrangements and the biographical data sheets for each of the main contributors to the project. The explanation should specify how many persons at what percentage of time and in what academic categories will be participating in the project. If the program is complex and involves people from multiple firms or institutions, the organization of the staff and the lines of responsibility must be made clear.

### **Budget and Budget Narrative**

Proposers should present a budget including the following line items.

- Effort level and salary or hourly rate for all personnel involved in the project (FTE levels expected for exempt personnel, hours to be invested for non-exempt personnel).
- Total fringe benefits.
- Direct costs including but not limited to
  - Travel and lodging
  - Computers, software, and software licenses
  - Equipment
  - Subcontracts and consultant fees
  - Supplies
  - Administrative costs
- Indirect costs, accompanied by documentation of negotiated rate as appropriate.
- A budget narrative of 1-2 pages should accompany the full budget.