COUNCIL AGENDA: 02-15-11
ITEM: 6.1

CITY OF SAN JOSE
CAPITAL OF SILICON VALLEY

Memorandum

TO: HONORABLE MAYOR AND CITY COUNCIL

FROM: Hans F. Larsen

SUBJECT: PUBLIC STREETLIGHT DESIGN GUIDE

DATE: 01-25-11

Approved | Date

COUNCIL DISTRICT: Citywide
SNI AREA: All

RECOMMENDATION

Adopt a resolution to:

1. Repeal Resolution No. 63396, adopted by the City Council on December 10, 1991, relating to design standards for the installation of public streetlights in new developments.

2. Approve San José Public Streetlight Design Guide, which includes three separate sections:
   a. "Public Streetlight Replacement Guide", which establishes design guidelines for replacing existing public streetlights in the City; and
   b. "Public Streetlight Installation Guide", which establishes design guidelines for installing new public streetlights in the City; and
   c. "Adaptive Street Lighting Design Guide", which establishes design guidelines for dimming public streetlights when reduced pedestrian and vehicular traffic in particular areas justify lower light levels.

3. Approve revisions to City Council Policy 4-2: Public Streetlights by removing references to "Streetlight Master Plan" and replace them with the term "Streetlight Design Guide" and to remove references to "lighting curfew" and replace them with "adaptive lighting.

OUTCOME

Approval of the recommended actions will allow City to implement City Policy 4-2: Public Streetlights by adopting guidelines for replacing existing and installing new streetlights that recognize the benefits of using energy-efficient, white light for roadway lighting and establish guidelines for when, where, and to what level streetlights may be dimmed during off peak hours.

The guidelines will allow the City convert to more energy-efficient lights that will reduce the City's operations and maintenance costs, energy consumption, and waste generation.

EXECUTIVE SUMMARY

In October 2007, the City of San José adopted its Green Vision, an ambitious, comprehensive plan that seeks to reduce the carbon footprint of the City by more than half in 15 years. The Green Vision committed the City to replace all of its streetlights with "smart" zero-emission lighting by 2022. In this context, "smart" refers to streetlights equipped with a remote monitoring and adaptive control system; "zero emission" is defined as streetlights powered exclusively by renewable energy. The first step to achieve this goal is improving the energy-efficiency of the City's streetlights.

In December 2008, the San José City Council adopted Resolution No. 74739 revising City Policy 4-2: Public Streetlights, to advance its Green Vision streetlight goal. The revised policy allows the City to take advantage of broad spectrum (white) street lighting technologies. These advanced technologies are more energy-efficient and longer-lasting than the streetlight technology stipulated in the previous policy: specifically low-pressure and high-pressure sodium (yellow-colored lights). The policy also permits the City to dim its streetlights in the late evening hours when reduced pedestrian and vehicular traffic justify lower light levels. Reducing the energy consumption of the City's streetlights will ultimately facilitate the City's efforts to power those lights with renewable energy. It will also help reduce the City's cost to power its 62,000 streetlights, currently approximately $4 million per year.

The Council conditioned implementation of the new public streetlight policy on the adoption of a streetlight design guide, termed "Master Plan" in the policy. Staff has completed the "Master Plan" for Council review and consideration.

The *Public Streetlight Design Guideline* is a 49-page technical report available on the City's website at:
http://www.sanjoseca.gov/transportation/SupportFiles/greenvision/Public_Streetlight_Design_Guide.pdf

It comprises three distinct sections:

1. The "Public Streetlight Replacement Guide" establishes design guidelines for replacing existing public streetlights.
2. The "Public Streetlight Installation Guide" establishes design guidelines for installing new public streetlights in the City.
3. The "Adaptive Street Lighting Design Guide" establishes design guidelines for dimming public streetlights when reduced pedestrian and vehicular traffic justify lower light levels.

The *Public Streetlight Design Guide* makes use of state-of-the-art lighting science and internationally and nationally recommended street lighting design practices to maintain if not

improve the quality of lighting on the City's streets; reduce energy consumption; and protect astronomical research.

BACKGROUND

In 1980, San José adopted the Streetlight Conversion Policy, which directed the City to replace all of its mercury vapor and incandescent streetlights with more energy efficient sodium vapor streetlights. The City installed primarily low-pressure sodium lights (LPS), which are more energy efficient than the more commonly employed high-pressure sodium (HPS). The narrow bandwidth of the yellow-colored LPS also confines the light pollution it generates to a limited area of the spectrum, preserving other portions of the spectrum for astronomical research by Lick Observatory.

Lick Observatory is located on Mt. Hamilton in the Diablo Range, east of San José, California. The world-class research astronomical research institution is part of the University of California. Using the telescopes on Mt. Hamilton, UC Observatory astronomers have contributed to virtually every area of optical and infrared astronomy. As the City has developed, San José has sought to balance its streetlighting goals with its desire to protect Lick's ability to conduct astronomical research.

In 1991, the City adopted a resolution establishing lighting design guidelines for the installation of public streetlights in new developments. Resolution No. 63396 referenced the "American Standard Practice for Roadway Lighting" issued by the Illuminating Engineering Society in 1964 that specifies the amount of light, or lumens, streetlights should cast on different types of roadways. Although not required by Resolution, where feasible the City has applied the guide to public capital projects. The design guide is used by staff to determine the wattage and spacing of streetlights.

In 2007, the City made a more substantive change in course. It adopted the *San José Green Vision*, a comprehensive plan to reduce the carbon footprint of the City by more than half in 15 years. The *Green Vision* committed the City to replace 100 percent of its 62,000 streetlights with "smart" zero emission streetlights by 2022.

To advance its streetlight goal, in December 2008 the City Council adopted Resolution No. 74739 revising City Policy 4-2: Public Streetlights ("Policy"). The revised policy allows the City to take advantage of new lighting technologies, such as light emitting diodes (LEDs), plasma and induction (a type of fluorescent) lights, which are more energy-efficient and longer-lasting than LPS and HPS streetlights. The policy also discusses dimming City streetlights in the late evening hours, when lower pedestrian and vehicular traffic warrant lower lighting levels. Both steps, replacing the City's streetlights with more efficient lights and dimming those lights, will reduce the City's energy consumption and facilitate its efforts to power its streetlights with renewable energy. Dimming will also reduce the impact of shifting to a broad-spectrum light on astronomical research.

The Council directed staff to develop a streetlight design guide (termed "Master Plan" in the Policy) for its approval before the Policy could be implemented. As a first step, San José installed some of the new streetlights around the City as part of various demonstration projects. Between 2009 and 2010, the City replaced approximately 270 LPS streetlights with "smart" LED streetlights in two neighborhoods: a residential neighborhood in East San José and an industrial area in North San José. The deployments helped the City better understand the capabilities and limitations of the new technologies, assist the City in development of the streetlight design guide, and seek public feedback.

In March 2010, the City hired a lighting design consultant, Clanton & Associates, to organize a two-day streetlight demonstration, complete a study involving different streetlight technologies and ascertain the public's response to those lights, and assist in the development of the streetlight design guide for Council review and consideration. One hundred and ten residents walked the demonstration site and completed a survey on the lights. Seventy-two people participated in a small target visibility study that analyzed how well people could see objects under the lights at different lighting levels. The latter research was led by Dr. Ron Gibbons, a lighting and visibility expert affiliated with Virginia Polytechnic Institute and State University. The study compared six different types of street lights, LPS, HPS and four white lights (one induction and three LED) at full brightness and dimmed approximately by half. The study helped establish the parameters for when, where and to what levels the City may dim its lights.

By switching to LED streetlights, the City will be able to reduce its Pacific Gas & Electric (PG&E) bill. In 2008 PG&E revised its non-metered streetlight tariff to include LED streetlights. All of the City streetlights are currently billed on a non-metered rate, like most cities in the nation. But to realize the financial benefit of dimming, San Jose will need to reach resolution with PG&E on how the data generated by its lighting control system might be used for billing purposes.

In October 2010, the City submitted testimony in PG&E's General Rate Case before the California Public Utility Commission. The testimony, which was filed on behalf of the City by the California City-County Street Light Association (CAL-SLA), recommended the creation of a new streetlight rate schedule that would utilize data generated by the City's control system for billing purposes. In the formal response PG&E filed in December 2010, the utility said it did not object to the creation of a new rate schedule and would be willing to discuss the issue. The legal proceeding on this is likely to be completed in early 2011.

Over the past two years, staff has coordinated progress reports on the LED Streetlight Conversion Program with the Transportation and Environment Committee. The most recent report was presented at the September 13, 2010 Committee meeting.

ANALYSIS

In the thirty years since the City switched to sodium vapor streetlights, lighting technology and science have measurably advanced. Today, there is widespread consensus among lighting scientists that vision in low-light situations, such as night-time driving, is significantly improved under white, broad spectrum light. The results of the City's March 2010 streetlight demonstration and study are consistent with this view. The study found that:

- Residents preferred the white lights (LED and induction) over the LPS lights. On a scale of 1 to 5 (strongly disagree to strongly agree), the mean score for the question "I like the color of the light" was 2.20 for LPS versus 3.67 on average for the white light sources. The response was similar for "I would like this style of lighting on my City streets": 2.07 for LPS and 3.37 on average for the white light sources.

- When the lights were dimmed approximately by half (unbeknownst to the participants), respondents thought the white streetlights were an improvement over existing conditions. In response to the question, "How does the lighting in this area compare with the lighting of similar San José City streets at night?" Where 2 is worse, 3 is about the same, and 4 is better, the average response for the white lights was 3.60, compared to 2.95 for LPS.

- Participants could detect target objects at a further distance under the white lights than the LPS, even when the white light output was reduced approximately by half. On the first night, when all the lights were at full power, participants saw the targets under the white light at a average distance of 64.5 meters compared to 58.9 meters for the LPS, a 5.6 meter or 9 percent difference. On the second night, when the white lights were dimmed approximately by half (and the LPS was at full power), the detection difference was greater: 56.8 meters compared to 47.9 meters, a difference of 8.9 meters or 16 percent. (Rain-wet roads on the first night may have elevated contrast and therefore the performance of the LPS on the first night, narrowing the difference).

- When the white lights were dimmed by approximately 50 percent, the detection distance for those lights decreased only 12 percent.

The study concluded that if San José replaced all of its streetlights with white (broad spectrum) lights it could reduce its energy consumption by 40 percent. If the lights throughout the City were dimmed in the late evening hours when pedestrian and vehicular traffic is minimal, the energy savings could be as much as 60 percent. Furthermore, the consultants concluded that these reductions could be accomplished "without compromising the lighting design characteristics recommended for streetlights."

Despite findings such as these, national and international lighting authorities have been slow to modify roadway lighting design guides. Consequently, San José has had to break new ground not only in its use of technology but also its application of lighting design advances.

Public Streetlight Replacement and Installation Guides

For several decades the international lighting community has discussed the need to revise photometric practice to recognize that the color of light has a significant effect on nighttime vision, particularly peripheral vision. As far back as 1978, a report by the International Commission on Illumination (abbreviated as CIE from its French title) noted that an area lit by mercury vapor (a white light) may appear twice as bright as a [High Pressure] sodium lamp with the same light output. But until recently, roadway design guides treated all light sources the same. That changed in April, 2009. After extensive deliberation, CIE adopted a methodology for valuing the greater efficacy of white light in outdoor, low-light conditions (called "mesopic" vision), such as night-time driving. CIE's *Recommended System for Mesopic Photometry Based on Visual Performance* (CIE 191:2010), quantifies the improved performance of white light through the use of "lumen effectiveness multipliers." The concluding result is that a higher wattage LPS or HPS can be replaced with a lower wattage white LED streetlight for equal or better visibility.

The U.S. lighting standards body, the Illuminating Engineering Society of North American (IESNA), has formed a mesopic committee to develop similar recommendations for its roadway lighting design guide *(*the *American National Standard Practice for Roadway Lighting).* The committee is chaired by Nancy Clanton, the Principal of Clanton & Associates (C&A). Until the IESNA adopts comparable guidelines, C&A recommends that San José employ CIE's methodology when replacing existing lights and designing new public streetlight installations. CIE's methodology is incorporated into the City's "Public Streetlight Replacement Guide" and "Public Streetlight Installation Guide."

The Public Streetlight Replacement Guide lays out the process by which the City can replace its existing sodium vapor streetlights with white (broad spectrum) light source streetlights. The City's lighting consultant specifically recommends that San Jose use LED streetlights to light the City's roadways due to the technology's greater efficiency from a lighting as well as energy perspective. The consultants made no recommendation on the lighting technology that should be used for pedestrian lights: the shorter lights used primarily for aesthetic reasons or to augment sidewalk lighting in areas with high pedestrian traffic. The pedestrian lights could be induction or LED. In conformity with standard lighting practice, replacements are intended to be equivalent in terms of lighting performance to the streetlights they replace. They are not designed to increase the level of visibility to current street lighting design goals. The replacement guide lays out the steps the City must take to determine equivalency.

The Public Streetlight Installation Guide describes how the City should perform a lighting design for new streetlight installations involving broad spectrum (white) streetlights. The document outlines the steps the City should take to calculate the base lighting levels required for a particular roadway, and then apply the luminance effectiveness multiplier. For both replacement and new lights, the greater efficiency offered by LEDs combined with the improved visibility of the white light results in an equivalent street light that is lower wattage than the streetlights the City would otherwise have installed.

To make use of CIE's mesopic photometry guide, the City will need to rescind Resolution 63396, which specifies that the City use the 1964 version of IESNA's roadway lighting design guide to install public streetlights in new developments. Since 1964, IESNA has changed its recommended method for measuring usable light in designing lighting systems. CIE's mesopic photometry system is predicated on this newer measurement system. Rescinding Resolution 63396 will allow the City to use the Public Streetlight Design Guide, which relies on the current (2005) version of the IESNA roadway design guide as the basis for its lighting design. The City may elect to employ successive editions of the design guide in the future.

Adaptive Street Lighting Design Guide

IESNA is also playing catch-up in another area of roadway lighting: adaptive lighting. Until recently, the conventional approach to roadway lighting design had been to light a street for the worst situation likely to be found on that roadway. That's because lighting levels were static once a light was installed. The advent of technologies such as LEDs, dimmable drivers (LED power supply), and remote monitoring and adaptive control systems capable of dimming lights, has changed that paradigm. Now cities have the ability to vary the lighting levels on their roadways as conditions on the ground change. If pedestrian and vehicular traffic predictably drops in the late evening hours, cities can program their streetlights to dim until traffic resumes in the early morning hours.

CIE adopted an adaptive streetlight design guide in 2007 that recognized this technological advancement, but IESNA has yet to do so. IESNA has created an adaptive lighting committee to develop recommendations for consideration, but they have not yet been adopted. In the interim, IESNA has indicated that its existing roadway lighting design can be used to determine when, where and to what extent streetlights might be safely dimmed.

The existing IESNA roadway lighting design guide establishes minimum lighting thresholds for what it classifies as high, medium and low pedestrian conflict levels for different categories of roads ranging from expressway to local streets. Depending on the degree to which vehicular and pedestrian activity declines during late night hours, a roadway could be reclassified from high to medium, or high to low, and lighting output correspondingly reduced 25 percent or 50 percent. The CIE adaptive lighting design guide uses a similar methodology that allows for lights to be dimmed as much as 60 percent.

A 50 percent reduction sounds like a dramatic reduction in light. But vision works on a logarithmic rather than a linear scale. In other words, a streetlight would need to be dimmed on a 3:1 scale (or about 67 percent) before the average person would be able to perceive that the lighting level had been reduced.

The adaptive lighting design guide stipulates how much the street lighting may be reduced on a particular category of roadway if traffic on that roadway declines by 25 percent or more. Roadway categories include minor and local streets, collector streets, and major arterial streets. The City plans to use a combination of vehicular traffic, transit ridership and land-use data to

ascertain peak and low traffic periods on different stretches of roadway, when the change occurs, and by what degree. The data will determine how much and when the City will program its streetlights to dim on those roadways. Should traffic levels change, the City will review the traffic data to determine if the dimming program should be modified.

Several cities in Canada and Europe have already instituted adaptive lighting and an increasing number of U.S. cities are investigating the possibility. More than 20 cities and utilities have joined a recently formed task force on remote monitoring and adaptive controls organized by the U.S. Department of Energy's Municipal Solid-State Street Lighting Consortium. San José staff was asked (and agreed) to chair the task force in large part due to its leadership in the nation on adaptive lighting.

Revisions to City Council Policy 4-2

A key element of the new streetlight policy was the development and approval of a "Streetlight Master Plan." As envisioned, the Master Plan would have included two documents: an adaptive (dimming) lighting design guide (termed "Lighting Curfew" in the policy) and guidelines for instituting an "energy cap" on public streetlights.

The energy cap would have established a limit on the amount of electricity that could be consumed by the City's streetlights. If a new light increased the City's electricity demand, the increase would need to be offset by replacing existing streetlights with more energy efficient fixtures or by paying an in lieu fee that would allow the City to do the same. Given the current economic downturn, staff is recommending that the City not pursue an energy cap at this time. (This is addressed more fully in the August 27, 2010 Transportation & Environment Committee memo "LED Streetlight Conversion Progress Report").

Staff is also recommending replacing the term "Master Plan" with "Streetlight Design Guide" and to replace the term "lighting curfew" with the more commonly used, and more easily understood, term "adaptive lighting." The term Master Plan has a specific meaning among planners. Its use in the streetlight policy created the expectation for a much more comprehensive and far-reaching document than the streetlight policy requires. Instead, staff recommends that the City adopt the *Public Streetlight Design Guide*, which comprises three documents: the adaptive street lighting design guide specified in the current streetlight policy plus two others, one for replacing existing streetlights and another for installing new public streetlights.

The *Public Streetlight Design Guide* is available on the City's website at http://www.sanjoseca.gov/transportation/SupportFiles/greenvision/Public_Streetlight_Design_Guide.pdf. The revised Council Policy 4-2 is attached.

Lick Observatory

Installing lower wattage LED streetlights and dimming those lights in the late evening hours will reduce the City's energy consumption, extend the lifetime of the lights, and maintain if not

improve lighting conditions on the ground. However, shifting to a white light will put more light into the sky in areas of the spectrum where Lick Observatory conducts its astronomical research.

Observatory scientists had initially asked if the City could employ a dual-color LED streetlight that would allow the City to shift from white to yellow light in the late night hours. While such lights are technically feasible, it would not be advisable to employ. A dual-color luminaire would require more LEDs to produce the same amount of light as a white-light only fixture. The product would also likely have a very limited market, which would drive up its price, as the City experienced with LPS. Lastly, shifting back to yellow light during off peak hours would void the improved visibility provided by white light for those driving late at night.

Alternatively, the Observatory asked if the City could reduce the light output of its streetlights at least by half during some specified period of the night. By making use of CIE's mesopic photometry guide and adaptive lighting, the City can satisfy Lick's request. The City is also adopting specifications recommended by IESNA that will ensure that the light generated by the City's streetlights is aimed down onto the street and sidewalk, rather than into the night sky.

The Observatory also asked that the City minimize wavelengths near the ultraviolet portion of the spectrum where the sky currently is fairly dark. Unfortunately, shifting to a broad spectrum light will by definition generate wavelengths across the visual spectrum. One strategy the City is pursuing to minimize this intrusion is to specify LED lights that produce less of the problem wavelengths in exchange for a modest decrease in energy efficiency.

"Cool" bluish-white LEDs are the most energy efficient, but they emit more blue wavelengths, which is a problem for Lick. "Warm" yellow-white LEDs, which produce far less of the problem wavelengths, are currently 15-20 percent less efficient than cool LEDs. Midway between are "neutral" LEDs, which are presently eight percent less efficient than cool LEDs. Over time, the efficiency of neutral and warm LEDs will improve. However, for the time being, the City intends to specify neutral LEDs balancing the desire to minimize blue wavelengths and maximize energy conservation. The City will continue to monitor advances in LED streetlights that might enable the City to more nearly achieve both goals.

Advancing the *Green Vision*

Lick Observatory has expressed support for the approach the City is taking to reduce its energy consumption while protecting astronomical research. The initial study conducted by the City's consultant concluded that the impact of converting the City's 62,000 streetlights to LED would have a "less than significant" impact on the Observatory.

At the same time, converting to LED streetlights would advance San José's *Green Vision* goals and more broadly its efforts to reduce greenhouse gas emissions. At a minimum, the conversion would reduce carbon dioxide emissions by 8,626 metric tons per year in the City, a 55 percent net reduction. The actual reductions would likely be much higher as the City's streetlight conversion will occur over a several years, allowing the City to take advantage of continuing LED efficiency gains. And, unlike the City's current LPS and HPS streetlights, LEDs are not a

hazardous waste. Similar to other electrical components, they can be recycled. Consequently, converting to LED streetlights will also advance San José's goal to become a zero waste city.

San Jose Downtown Street and Pedestrian Lighting Master Plan

The Redevelopment Agency's Downtown Street and Pedestrian Lighting Master Plan adopted in September 2003 established lighting guidelines for future development in the Greater Downtown. The guide specified the types of lighting technologies that should be used (specifically HPS and metal halide), fixture styles, light levels goals and where particular types of lights should be located. The Redevelopment Agency intends to revise its Master Plan to make it consistent with the City's Public Streetlight Design Guide. City staff will work with the Agency to assist them in revising the Redevelopment Agency's Downtown Street and Pedestrian Lighting Master Plan to have it consistent with the City's guide.

EVALUATION AND FOLLOW-UP

No additional follow-up actions with the City Council are expected at this time.

PUBLIC OUTREACH/INTEREST

☐ **Criterion 1:** Requires Council action on the use of public funds equal to $1 million or greater.
(Required: Website Posting)

☐ **Criterion 2:** Adoption of a new or revised policy that may have implications for public health, safety, quality of life, or financial/economic vitality of the City. **(Required: E-mail and Website Posting)**

☑ **Criterion 3:** Consideration of proposed changes to service delivery, programs, staffing that may have impacts to community services and have been identified by staff, Council or a Community group that requires special outreach. **(Required: E-mail, Website Posting, Community Meetings, Notice in appropriate newspapers)**

In compliance with the City's Community Engagement Process for Significant City Policy Actions, the City held three community meetings to seek input on its Streetlight Master Plan/Design guides. The first was the Streetlight Demonstration on March 3 and 4, 2010. The second, scheduled on April 7, 2010, reported the initial findings of the study and potential implications. The third meeting on July 21,2010, sought comment on the proposed streetlight Master Plan/design guides.

A public notice for the City Council meeting will be published in the *San José Mercury News*.

COORDINATION

The Transportation and Public Works departments collaborated on the development of the Public Streetlight Design Guide. An inter-departmental Streetlight Master Plan Task Force also provided valuable input into the design of the streetlight study and the development of the design guide. The Task Force, which was led by the Department of Transportation, included representatives from the City's Police Department; Redevelopment Agency; Environmental Services; Planning, Building and Code Enforcement; Parks, Recreation and Neighborhood Services; Public Works; and Information Technology.

This memorandum was coordinated with the City Attorney's Office, Planning, Building and Code Enforcement, Public Works, and the San José Redevelopment Agency.

FISCAL/POLICY ALIGNMENT

The recommended actions support implementation of Green Vision Goal 9 related to reducing energy consumption from the City's streetlights.

CEQA:

Exempt, File number PP11-002.

/s/
HANS F. LARSEN
Acting Director of Transportation

For questions please contact Laura Stuchinsky, DOT Sustainability Officer, at 408-975-3226.

Attachment