Street Lighting Evaluation and Improvements
Town of Chevy Chase, Maryland

Final Report

Prepared By:
Precision Systems, Inc.

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[1] Potomac Electric Power Company

EXECUTIVE SUMMARY

The Town of Chevy Chase, Maryland (hereafter referred to as "the Town") has commissioned Precision Systems, Inc. (PSI) to conduct a streetlight study to analyze the Town's current lighting system. PSI will also develop a lighting master plan, ensuring this system (whether owned by PEPCO or the Town) meets the following criteria:

- meets industry standards
- is energy and cost efficient
- provides for the security and safety of Town residents
- incorporates the principals of the Dark Sky Association in reducing trespass light
- respects the historic nature of the community
- can be operated and maintained with a manageable program

PSI conducted the following individual tasks to reach the project goals:

- survey of existing streetlight units
- assessment of lighting needs
- photometric analysis (using AGI 32 software to analyze lighting level)
- examination of existing PEPCO streetlight energy and maintenance bills and tariffs
- nationwide survey of lighting trends
- selection of three proposed options

PSI's study conclusion is that No. 3B (Induction lamps, and the Town owns and maintains the lighting system) of the proposed Town lighting options is preferred over the others.

This report summarizes PSI's study findings and presents the streetlight master plan.

I. Introduction

PSI was commissioned by the Town to conduct a streetlight study and to develop a streetlight master plan. Specifically, PSI was requested to conduct a survey of the existing lighting system, identify problems with this system, conduct an existing photometric analysis, investigate nationwide lighting trends, develop three lighting options with the associated construction and operating costs, and make recommendations to the Town through the Town's Public Services Committee.

Incorporated in 1918, the Town is a self-governing municipality located in Montgomery County, Maryland. The Town's boundaries extend to Bradley Lane on the south, Connecticut Avenue on the east, East-West Highway on the north, and 47th Street/46th Street/West Avenue on the west. The Town is entirely a residential area with minimal amounts of traffic volume and noise.

A five-member Town Council governs the Town. The council members are composed of and elected by Town residents. This Council also selects the Mayor. The Town Manager, appointed by the Council, enforces the regulations of the Town and is responsible for the day-to-day operations of the community.

After our investigation of the existing lighting system, PSI reached the conclusion that this system

- does not meet the national standards for roadway lighting,
- is not energy nor cost efficient,
- does not provide sufficient security and safety of Town residents, and
- does not meet the principals of the Dark Sky Association in reducing the trespass light.

PSI developed a manageable database system with basic parameters and photos for each streetlight in the Town. This database serves as a monitoring system and also a tool to update utility billing information. The data records from this database and the user manual are included in Attachments A and B of this report.

At the Town's request, PSI also examined the existing PEPCO streetlight energy usage, maintenance bills, and tariffs (summarized in Section III of this report). These data form the base condition for all proposed lighting options. As part of this task PSI also performed a life cycle cost analysis.

PSI conducted a nationwide survey of lighting trends (described in Section IV). During this task, PSI contacted lighting manufactures and their representatives concerning the projected trends in outdoor lighting for the next five to ten years. PSI also contacted city streetlight departments around the nation. PSI compared the pros and cons of the gathered lighting scenarios and used this comparison as a basis for proposing the three Town lighting options.

Based on the aforementioned existing condition data collection, analysis, cost, and industry lighting standards/trends, PSI proposed four Town street lighting options (each of the first three options was divided into sub-options a and b):

1A. maintain existing lighting system (PEPCO owns and maintains the system)

1B. maintain existing lighting system (Town purchases and maintains the system)

2A. add 70- and 100-Watt high pressure sodium (HPS) cutoff fixtures (PEPCO owns and maintains the system):

2B. add 70- and 100-Watt HPS cutoff fixtures (Town purchases and maintains the system):

3A. use Induction Lamps (PEPCO owns and maintains the system):

3B. use Induction Lamps (Town owns and maintains the system):

4. use LED lights (Town owns and maintains the system)

The details for these options are described in Section V of this report; calculations of the construction/maintenance costs are also presented.

The Town also requested that PSI develop a streetlight transitional scheme, i.e., the temporary streetlight system treatment in between the existing conditions and the long-term system. Section VI describes this transitional option.

Section VII summarizes the study results and presents the conclusions and Section VIII lists the references. The related study data are attached at the end of the report.

II. Analysis of Existing Streetlight System

SURVEY:

The first task PSI performed was to make a complete physical survey of all streetlights located within the Town boundaries. PSI collected information concerning each light, such as arm type and length, fixture type, light source, and wattage and pole ownership (see Attachment C for a copy of the Data Collection Form used). Pictures were taken of each streetlight and additional pictures were taken to show information such as tree branches. Our survey found a total of 307 lights, an increase of 26 units over the current PEPCO billing. The existing Mercury Vapor lights were converted to HPS ones between mid-June to mid-August in 2009. The reason for the change was that PEPCO no longer maintained Mercury Vapor lighting units and were converting them system wide.

During our survey PSI found many problems with the current lighting system:

1. Pole spacing and distance between lights:
   PSI found spacing between poles to be from 60-170 feet and between lights of up to 220 feet. This uneven distribution of lights causes areas of darkness between lights. PSI found in the review of citizen complaints that this was the biggest concern.

2. Lighting arm orientation:

   Instead of mounting the arms transverse to the roadway curb, which allows the illumination to stay within the roadway right of way, the utility company mounted some arms at an angle to the curb. In some areas, this irregular arm orientation puts the lighting into residents' front yards and against building walls. In most of the cases this occurrence is due to conflicts with existing wires and other pole hardware.

   At intersections, most arms are mounted at an angle. This orientation worked well when the luminaires put out light evenly in all directions (Type V distribution). However, the new high pressure sodium (HPS) luminaires that PEPCO recently installed distribute light into a "butterfly wing" shape (Type II or III). The orientation of some lighting arms at intersections should be adjusted.

3. Luminaire wattage:

   PSI found odd size luminaires, e.g., a 100-, 150-, or 250-Watt HPS luminaire on a street with mostly 70-Watt HPS ones. We believe these luminaires are irregularly installed due to PEPCO's maintenance practices. The PEPCO requirements include that during replacement of defective fixtures, if a maintenance crew did not have the proper size replacement they must use any available fixture to return the light to service.

After the survey was completed, all information collected was entered into a database (including all pictures). We have included a sample record illustrated in Figure 1. The database will allow the Town to add, remove, and change records in order to keep the database current. The database and instructional material have been supplied to the Town for their use.

PSI has also entered information on existing wood poles and streetlights (including arm length and orientation) into the mapping supplied by the Town. This mapping was used as a base for the photometric analysis, which is part of the supporting documentation in this report.

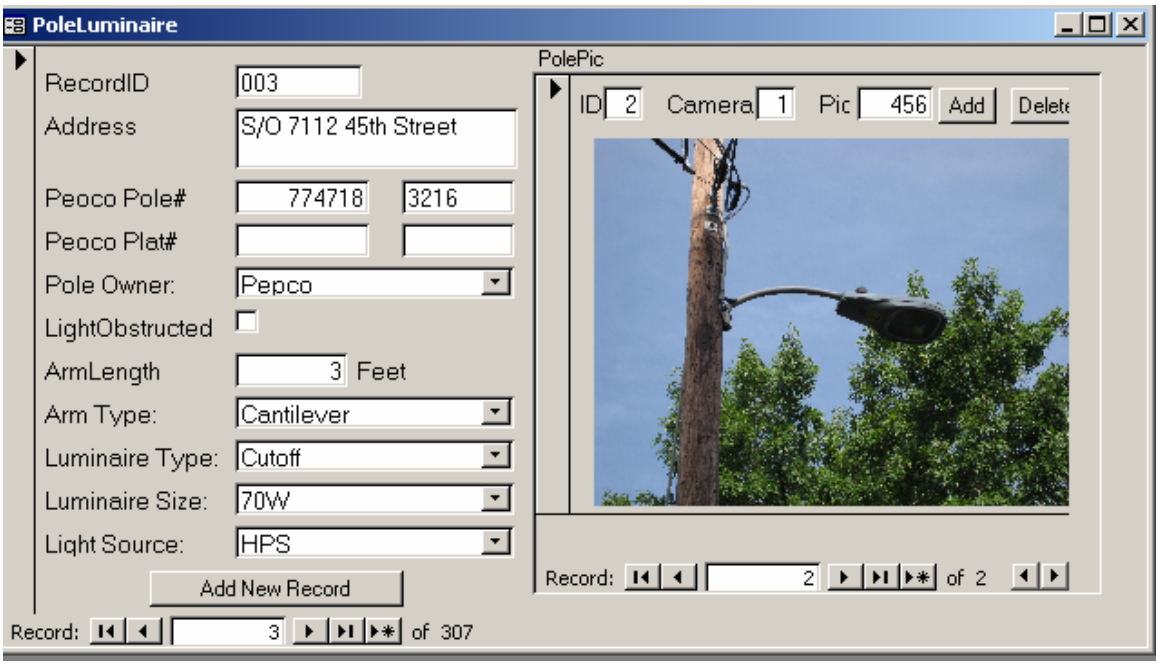

Figure 1. An example of a data record showing detailed information for an existing streetlight

PHOTOMETRIC ANALYSIS

PSI performed a photometric analysis of the existing lighting system using AGI 32 lighting analysis software (the results are shown in Attachment I of this report). This software is a tool in the lighting designer toolbox. This software has its limitations: the analysis is based on a flat surface and cannot take into account trees, transformer settings, or luminaire tilts. When conducting this analysis, we entered the type of fixture, lamp type, wattage, and a maintenance factor for each light. The program uses manufacturer's photometric data in a form approved by the Illuminating Engineering Society of North America (IES). This grogram produces a map showing the lighting patterns throughout the Town and also identifies dark spots. This map has been supplied to the Public Services Committee. With the analysis in hand the next step was to field verify the information at night.

NIGHTTIME FIELD VERIFICATION

Light meter readings were taken at night at each intersection and also in areas where the program identified dark spots (the readings are shown in Attachment H). These readings were done as a back check of the analysis program. During the course of this work, PSI also found that some lights shine in the front yard of some residents rather than on the roadway. A major reason for this problem is that the lighting poles are out of plumb and the supporting arms are not adjustable, so that the fixtures are tilted.

TREE TRIMMING

One of the major problems found during our survey was that some trees, either in public space or extending into public space from private properties, cover the lights. Figure 2 shows a tree trimming detail indicating the limits where tree limbs need to be cleared to allow for light to illuminate the street and sidewalk (see attachment L for tree trimming detail). The detail was approved by DC DOT Urban Forestry Administration.

III. Examination of PEPCO Streetlight Energy Usage, Maintenance Bills, and Tariffs

REVIEW OF CURRENT PEPCO BILLS:

The Town furnished PEPCO's recent 12 months of streetlight energy usage and maintenance bills to PSI. The Town, until June 1st, 2009, purchased both energy and maintenance for the Town's streetlights from the local utility PEPCO. After June 1st, Washington Gas Energy Services (WGES) became the Town's energy supplier. The Town's energy bill has dropped after this change. According to the Town's streetlight bills, there are a total of 281 streetlights and three attachments to Verizon wood poles. Table 1 shows the current yearly maintenance costs of the streetlights based on the energy supplied by WGES and PEPCO. The most recent PEPCO streetlight bill does not show the conversion that took place during June and July of this year.

						Attachment	Total
Size	100W	175W	250W	70W	100W		N/A
Source	MV	MV	MV	HPS	HPS		N/A
Sum	254	15	1	5	6	3	
KW/h	0.13	0.21	0.29	0.085	0.12		N/A
Burn Hours/Year	4200	4200	4200	4200	4200		N/A
Total KWH/Year	138684	13230	1218	1785	3024		
Cost/KWH	0.092	0.092	0.092	0.092	0.092		N/A
Dist/KWH	0.0324	0.0324	0.0324	0.0324	0.0324		N/A
Energy Cost/Year	$17,252.29	$1,645.81	$151.52	$222.05	$376.19		$19,647.86
Maintenance/ Month/Light	$4.08	$4.12	$4.69	$5.51	$5.97	$0.15	N/A
Maint. Cost/Year	$12,435.84	$741.60	$56.28	$330.60	$429.84	$5.40	$13,994.16
Total Cost/Year	$29,688.13	$2,387.41	$207.80	$552.65	$806.03	$5.40	$33,647.42

Table 1. Calculation of yearly cost base on June 2009 PEPCO bill (in 2009 US dollars)

PEPCO TARIFFS AND REGULATIONS

Streetlights installed by PEPCO or any other governmental agency, such as the Town, are governed by rates and tariffs established by PEPCO and approved by the Maryland Public Services Commission. These restrictions include the type of lights that can be installed, the wattages, and the lamp types. Because of these restrictions the proposed options in this report are limited. PSI has included the rates and tariffs in Attachment D.

IV. Nationwide Survey of Lighting Trends

Based on our experiences with the lighting industry, end users, and utility companies (these materials are presented in Attachment F), PSI has found one item in common: continued talk about the use of energy efficient (green) lighting. Besides the usage of induction lights, many cities are planning to, starting to, or are using light-emitting diode (LED) lighting. The reasons given were energy efficiency, the use of non-mercury light source, and it being a white light. It was also agreed that LED is a proven technology that is experiencing continual improvements. Currently the LED lighting efficiency is measured at about 70 Lumens per Watt of power used.

The industry data suggest that within the next five to ten years, the efficiency will be approaching 100 to 120 Lumens per Watt. High intensity discharge (HID) light sources such as Mercury Vapor, High Pressure Sodium Vapor, Metal Halide, and Induction all use some amount of mercury vapor inside the lamp. Except for Induction lights that have small amount of mercury, the disposal of the burned out lamps must be treated as hazardous waste and disposed of in an Environmental Protection Agency (EPA) approved manner.

The LED and Induction lights are rated for a minimum of 50,000 burning hours, against 25,000 for Mercury Vapor and HPS and 20,000 Hours for Metal Halide. The longer burning hours lead to fewer lamps used and less hazardous waste to dispose of. The use of induction and LED lamps has shown a 35% to 50% reduction in energy used. In addition, in most studies where Induction and LED lights replaced HID lights, higher wattage lamps (250- and 400-Watt) were replaced with lower wattage ones. A light source comparison is presented in Table 2.

OPTIONS	METHOD OF LIGHT PRODUCTION	ADVANTAGES	DISADVANTAGES
INCANDESCENT	LIGHT IS PRODUCED BY SENDING AN ELECTRICAL CURRENT THROUGH A FILAMENT	EXCELLENT COLOR RENDERING INTIAL COST LOW INSTANT ON NO DELAYED RESTART	SHORT LAMP LIFE, MUST BE RELAMPED TWICE A YEAR NO LONGER BEING INSTALLED
MERCURY VAPOR	GAS-DISCHARGE LAMP THAT USES ELECTRICAL CURRENT TO EXCITE MERCURY WITHIN A GLASS TUBE	INTIAL COST LOW 24,000+ HOUR LAMP LIFE	DELAYED HOT RESTART MUST BE DISPOSED OF PROPERLY NO LONGER BEING INSTALLED
METAL HALIDE	GAS-DISCHARGE LAMP THAT USES ELECTRICAL CURRENT TO EXCITE METAL HALIDE WITHIN A GLASS TUBE	EXCELLENT COLOR RENDERING WHITE LIGHT LIKE DAYLIGHT	DELAYED HOT RESTART EXPENSIVE LIGHT TO INSTALL & MAINTAIN ONLY PULSE START LAMPS CAN BE INSTALLED AFTER 2005 ENERGY ACT
HIGH PRESSURE SODIUM VAPOR	GAS-DISCHARGE LAMP THAT USES ELECTRICAL CURRENT TO EXCITE SODIUM VAPOR WITHIN A GLASS TUBE	24,000+ HOUR LAMP LIFE AVAILABLE IN WATTAGES FROM 50 TO 1000 WATT FIXTURE COST $150.00 TO $600.00	DELAYED HOT RESTART REQUIRES STARTER TO START LAMP
INDUCTION	HIGH FREQUENCY OSCILLATING CURRENT EXCITES A SMALL AMOUNT OF MERCURY VAPOR IN A TUBE	LONG LIFE 50,000 HOURS NO ELECTRODE TO BURN OUT GOOD COLOR RENDERING CHOICE OF COLOR TEMPERATURES WILL TAKE VIBRATION	CAN NOT BE DIMMED LAMP AND GENERATOR MUST BE REPLACED AT SAME TIME ($350.00 REPLACEMENT COST) FIXTURE COST $850 TO $1,100.00
LIGHT-EMITTING DIODE	SOLID-STATE DEVISE THAT PRODUCES LIGHT COLOR BASED ON SEMICONDUCTING MATERIAL USED CURRENT FLOWS ONLY ONE WAY	LONG LIFE 50,000 HOURS NO ELECTRODE TO BURN OUT CHOICE OF COLOR TEMPERATURES WILL TAKE VIBRATION CAN BE DIMMED INSTANT ON	NO RATE ESTABLISHED FOR THE TYPE OF LAMP THE WHOLE FIXTURE MUST BE REPLACED IF UNIT FAILS

Table 2. Lighting source comparison

ILLUMINATION STANDARDS

Two agencies determine the standards for roadway illumination: the IES and the American Association of State Highway and Transportations Officials (AASHTO). These national standards apply to all roadways in the United States. They were developed to

provide proper roadway lighting for all users of the roadways, including motorists, bicyclist, and pedestrians.

These standards are set up based on roadway classifications (from expressways to alleys) and are further broken down by abutting land use (such as commercial, mixed, and residential). Please refer to Table 3 for AASHTO and IES suggested maintained illumination values for roadways.

All streets within the Town are classified as local-residential, except East-West Highway and Connecticut Avenue, which are classified as major-mixed. The lighting standards for local streets indicated a horizontal average of 0.4 foot-candle, and a 6:1 average-to-minimum uniformity. The standards for mayor streets include a horizontal average of one (1) foot-candle, and a 4:1 average-to-minimum uniformity. These standards are one of the major criteria in determining whether the proposed Town lighting options are acceptable.

AASHTO and IES-Suggested Maintained Illuminance Values for Roadways

Roadway Classification		Average Illuminance Pavement Classification						Uniformity avg/min
		R1		R2 & R3		R4		
		Foot-candles	Lux	Foot-candles	Lux	Foot-candles	Lux	
Freeway Class A [a]		0.6	6	0.8	9	0.7	8	3:1
Freeway Class B [a]		0.4	6	0.6	6	0.5	5	
Expressway [b,c]	Commercial	0.9	10	1.3	14	1.2	13	3:1
	Intermediate	0.7	8	1.1	12	0.9	10	
	Residential	0.6	6	0.8	9	0.7	8	
Major [b]	Commercial	1.1	12	1.6	17	1.4	15	3:1
	Intermediate	0.8	9	1.2	13	1.0	11	
	Residential	0.6	6	0.8	9	0.7	8	
Collector [b]	Commercial	0.7	8	1.1	12	0.9	10	4:1
	Intermediate	0.6	6	0.8	9	0.7	8	
	Residential	0.4	4	0.6	6	0.5	5	
Local [b]	Commercial	0.6	6	0.8	9	0.7	8	6:1
	Intermediate	0.5	5	0.7	7	0.6	6	
	Residential	0.3	3	0.4	4	0.4	4	
Alleys [b]	Commercial	0.4	4	0.6	6	0.5	5	6:1
	Intermediate	0.3	3	0.4	4	0.4	4	
	Residential	0.2	2	0.3	3	0.3	3	
Sidewalks [b]	Commercial	0.9	10	1.3	14	1.2	13	3:1
	Intermediate	0.6	6	0.8	9	0.7	8	4:1
	Residential	0.3	3	0.4	4	0.4	4	6:1
Pedestrian Ways and Bicycle Lanes [d]		1.4	15	2.0	22	1.8	19	3:1

[a] Source: *The IESNA Lighting Standard Handbook, Ninth Edition*, IES, 2000. Illuminating Engineering Society of North America

[b] Source: *An Informational Guide for Roadway Lighting*, AASHTO, 1984.

[c] Both mainline and ramps. Expressways with full control of access are covered in the section on Freeways.

[d] This assumes a separate facility. Facilities adjacent to a vehicular roadway should use the illuminance or luminance levels for that roadway.

Table 3. AASHTO and IES suggested maintained illumination values for roadways

WHY NOT LED YET?

PSI noticed a number of citizen comments concerning the installation of LED streetlights. LED's are not part of the near-term Town lighting options for the following reasons:

1. There is no approved rate of tariff for the installation of LED's; they could only be installed as part of an underground metered-service.

2. LED suppliers claim that the lights will last for 100,000 hours, but the fixture manufacturers will only guarantee 60,000 hours with 70% of the LED modules still in operation, and this life length is still to be verified by field-testing.

3. There are no national standards for the manufacture and testing of LED fixtures; all other types of fixtures used in street lighting services are manufactured according to the nationally approved standards.

4. PSI found that to use LED lights the power usage would go up. However, the estimated maintenance cost would be 57% less than what the town currently pays PEPCO now with far fewer units installed.

V. Proposed Lighting Options

PEPCO PURCHASE OPTION

The purchase of the lighting system from PEPCO is a decision that the Town needs time to investigate; the purchase price is only a small part of the equation. The offer by PEPCO of $440.00 per lighting unit installed within the Town limits gave PSI the estimated cost of $135.080.00 for the 307 units identified during our physical survey. Legal documents will need to be prepared spelling out the rights of the Town to own, operate, maintain, install, and remove fixtures, supporting hardware, and wiring. The town would have to retain legal counsel to negotiate and draft such documents. Based on prior experience the minimum time required to complete the process is 18 months. Also, the cost of legal counsel was not included in the cost of the PEPCO purchase option.

What should be included in the system, at a minimum, is the fixture, lamp photocell, arm including the mounting hardware, cables to supply the power, PVC u-guard to protect the cables, and the grounding material to ground the arm to the pole grounding system. Wood poles that currently carry only a light-and-arm with no other utility attachment, or are used as "guy poles", should become part of the Town owned system.

The point where the Town and PEPCO systems meet will have to be agreed upon by both parties. When the District of Columbia purchased its lighting systems in 1985, that point was determined to be the splice point where the cables to the streetlight were connected to the secondary wire. Only PEPCO and its contractor could make or break that splice.

Contractors could perform work on the streetlight side of that splice, as long as PEPCO's requirements were met. Historically, PEPCO required insurance to be carried to protect it from contractor damages and outages. Attachment E of this report shows the PEPCO requirements for contractors.

When installing new streetlights on existing PEPCO wood poles, or new poles with streetlights outside of the PEPCO pole line, the contractor should be able to install all materials to within one or two feet from the secondary bus and leave the cables coiled for PEPCO to make the final connection.

For new poles outside of the PEPCO pole line, the contractor would install all materials including the pole, arm, fixture, and the span of triplex cable and leave it coiled on the side of the new pole. PEPCO would then attach it to their wood pole and make all connections to their system. PEPCO has stated that it requires a charge of $50.00 per connection.

During conversion from one light source to another, the Town's contractor could complete all work and the Town would have to send PEPCO the information on the existing and proposed fixture. The information needed would include light type and wattage, removal and installation of equipment, and the date of the conversion. Only light types and wattages from PEPCO approved tariffs could be installed.

The following section presents and compares the three proposed Town lighting options (each option is sub-divided into Options A and B: PEPCO or Town owns and maintains the system) respectively.

OPTION #1A MAINTAIN EXISTING LIGHTING SYSTEM (PEPCO OWNS AND MAINTAINS THE SYSTEM):

Under this option (details are shown in Table 4), the Town will continue paying WGES for energy and PEPCO for maintenance. No additional lighting units will be installed and there will be no changes to existing units. There will be no construction cost under this option.

					Total
Size	70W	100W	150W	250W	N/A
Source	HPS	HPS	HPS	HPS	N/A
Sum	265	35	3	4	307
KW/h	0.085	0.12	0.185	0.3	N/A
Burn Hours/Year	4200	4200	4200	4200	N/A
Total KWH/Year	94605	17640	2331	5040	119616
Cost/KWH	0.092	0.092	0.092	0.092	N/A
Dist/KWH	0.0324	0.0324	0.0324	0.0324	N/A
1 Year Energy Cost	$11,768.86	$2,194.42	$289.98	$626.98	$14,880.23
20 year Energy Cost	$235,377.20	$43,888.40	$5,799.60	$12,539.60	$297,604.80
Maintenance/ Month/Light	$5.51	$5.97	$6.15	$7.81	N/A
1 Year Maint. Cost	$17,521.80	$2,507.40	$221.40	$374.88	$20,625.48
20 Year Maint. Cost	$350,436.00	$50,148.00	$4,428.00	$7,497.60	$412,509.60

Table 4. Analysis of life cycle cost to the Town for proposed Option 1A (in 2009 dollars)

OPTION #1B MAINTAIN EXISTING LIGHTING SYSTEM (TOWN PURCHASES AND MAINTAINS THE SYSTEM):

Under this option (details are shown in Table 5), the Town would purchase the streetlights from PEPCO, but would continue paying WGES for energy. The Town would develop a streetlight and bid maintenance contract. No additional lighting units will be installed and there will be no changes to existing units. There will be no construction cost under this option.

					Total
Size	70W	100W	150W	250W	N/A
Source	HPS	HPS	HPS	HPS	N/A
Sum	265	35	3	4	307
KW/h	0.085	0.12	0.185	0.3	N/A
Burn Hours/Year	4200	4200	4200	4200	N/A
Total KWH/Year	94605	17640	2331	5040	119616
Cost/KWH	0.092	0.092	0.092	0.092	N/A
Dist/KWH	0.0324	0.0324	0.0324	0.0324	N/A
1 Year Energy Cost	$11,768.86	$2,194.42	$289.98	$626.98	$14,880.23
20 year Energy Cost	$235,377.20	$43,888.40	$5,799.60	$12,539.60	$297,604.80
Maintenance/ Month/Light	$4.00	$4.00	$5.00	$5.75	N/A
1 Year Maint. Cost	$12,720.00	$1,680.00	$180.00	$276.00	$14,856.00
20 Year Maint. Cost	$254,400.00	$33,600.00	$3,600.00	$5,520.00	$297,120.00

Table 5. Analysis of life cycle cost to the Town for proposed Option 1B (in 2009 dollars)

TOWN COST FOR NEW LIGHTING UNITS UNDER PEPCO OWNERSHIP OPTIONS

In all lighting options where PEPCO retains ownership of the system, PSI shows that the Town pays for the installation of the new lighting units. Under existing PEPCO tariffs all new construction cost is passed on to the town including the estimated taxes that PEPCO would be required to pay to the IRS.

OPTION #2A- ADD 70- AND 100-WATT HPS CUTOFF FIXTURES (PEPCO OWNS AND MAINTAINS THE SYSTEM)

Under this option (details are shown in Table 6), PSI recommends adding additional HPS luminaires and arms to poles that do not currently have lighting units installed. Also, the Town would add new wood poles with arms and luminaries as needed. PSI also recommends the installation of approximately 156 new HPS fixtures and 17 new wood poles. The energy supplier will remain the same and PEPCO would supply all maintenance services.

The calculations for the costs of the additional equipments/removal of existing equipment are shown below:

Connecticut Avenue and East-West highway

12- poles @ $4,000.00 Each =		$48,000.00
14- spans of wire @ $550.00 Each =		$ 7,700.00
16- arms & luminaries @ $1,200.00 Each =		$ 19,200.00
1- removal of existing arm & fixtures @ 550.00 Each =		$ 550.00
	TOTAL	**$75,450.00**

Within the Town PSI proposes to add five (5) new poles with arms and fixtures, and 135 new arms and fixtures on existing wood poles. All new luminaries will be 70-Watt.

5- poles @ $4,000.00 Each =		$ 20,000.00
5- spans of wire @ $550.00 Each =		$ 2,500.00
140-arms & fixtures @ $1200.00 Each =		$168,000.00
	TOTAL	**$ 190,500.00**

					Attachment	Total
Size	70W	100W	150W	250W	N/A	N/A
Source	HPS	HPS	HPS	HPS	N/A	N/A
Sum	402	53	3	4	3	461
KW/h	0.085	0.12	0.185	0.3	N/A	N/A
Burn Hours/Year	4200	4200	4200	4200	N/A	N/A
Total KWH/Year	143,514	26,712	2,331	5,040	N/A	177,597
Cost/KWH	0.092	0.092	0.092	0.092	N/A	N/A
Dist/KWH	0.0324	0.0324	0.0324	0.0324	N/A	N/A
1 Year Energy Cost	$17,853.14	$3,322.97	$289.98	$626.98	N/A	$22,093.07
20 year Energy Cost	$357,062.80	$66,459.40	$5,799.60	$12,539.60	N/A	$441,861.40
Maintenance/ Month/Light	$5.51	$5.97	$6.15	$7.81	$0.15	N/A
1 Year Maint. Cost	$26,580.24	$3,796.92	$221.40	$374.88	$5.40	$30,978.84
20 Year Maint. Cost	$531,604.80	$75,938.40	$4,428.00	$7,497.60	$108.00	$619,576.80

Table 6. Analysis of life cycle cost to the Town for proposed Option 2A (in 2009 dollars)[2]

[2] Cost for maintenance is based on current PEPCO tariffs and is subject to change.

OPTION #2B – ADD 70- AND 100-WATT HPS FIXTURES (TOWN PURCHASES AND MAINTAINS THE SYSTEM)

Under this option, fixtures and arms would be added to poles that do not currently have lighting units installed. Also, the Town would add new wood poles with arms and fixtures as needed. PSI recommends the installation of approximately 156 new HPS fixtures and 17 new wood poles.
The analysis will be the same as OPTION #2A. The Town would buy the system from PEPCO. The energy supplier will remain the same and the Town would contract out maintenance services. PSI estimates the purchase price to be approximately $135.080.00. PEPCO'S connection fee (per rates established by the Maryland PSC) is $50.00 per new connection. The increase in energy cost will be the same as Option 2A.

The calculations for the costs of the additional equipments/removal of existing equipment are shown below:

Connecticut Avenue and East-West highway

12- poles @ $1,500.00 Each =		$18,000.00
14- spans of wire @ $400.00 Each =		$ 5,600.00
16- arms & fixtures @ $600.00 Each =		$ 9,600.00
1- removal of existing arm & fixture @ 200.00 Each =		$ 200.00
16- PEPCO connections @ $50.00		$ 800.00
	TOTAL	**$34,200.00**

Within the Town PSI proposes to add five (5) new poles with arms and fixtures, and 135 new arms and fixtures on existing wood poles. All new fixtures will be 70-Watt.

5- poles @ $1500.00 Each =		$ 7,500.00
5- spans of wire @ $400.00 Each =		$ 2,000.00
140-arms & fixtures @ $600.00 Each =		$ 84,000.00
140-PEPCO connections @ $50.00		$ 7,000.00
	TOTAL	**$100,500.00**

					Total
Size	70W	100W	150W	250W	N/A
Source	HPS	HPS	HPS	HPS	N/A
Sum	402	53	3	4	462
KW/h	0.085	0.12	0.185	0.3	N/A
Burn Hours/Year	4200	4200	4200	4200	N/A
Total KWH/Year	143514	26712	2331	5040	144597
Cost/KWH	0.092	0.092	0.092	0.092	N/A
Dist/KWH	0.0324	0.0324	0.0324	0.0324	N/A
1 Year Energy Cost	$17,853.14	$3,322.97	$289.98	$626.98	$22,093.07
20 year Energy Cost	$357,062.80	$66,459.40	$5,799.60	$12,539.60	$441,861.40
Maintenance/ Month/Light	$3.00	$4.25	$4.25	$4.25	N/A
1 Year Maint. Cost	$14,472.00	$2,703.00	$153.00	$204.00	$17,532.00
20 Year Maint. Cost	$289,440.00	$54,060.00	$3,060.00	$4,080.00	$350,640.00

Table 7. Analysis of life cycle cost to the Town for proposed Option 2B (in 2009 dollars)

OPTION #3A USE INDUCTION LAMPS (PEPCO OWNS AND MAINTAINS THE SYSTEM)

Under this option (details are shown in Table 8), all existing HPS lighting units would be removed and replaced with new Teardrop fixtures. Connecticut Avenue and East-West Highway would remain 100-Watt HPS to meet Maryland State Highway Administration (MSHA) Standards; however, all cobra heads would be removed and replaced with Teardrop fixtures.

Additional units will be installed on existing PEPCO wood poles and additional poles will be added. All new lights will use induction lamps. PSI proposes to use 85-Watt lights for all streets and 55-Watt lights for the alleys. All Teardrops will be mounted 25 feet above the roadway.

The energy and maintenance suppliers will remain the same. (Note: The Town would have to furnish to PEPCO 85-Watt induction materials (initial and replacement fixtures, as well as replacement lamps and generators).

The calculations for the costs of the additional equipments/removal of existing equipment are shown below:

Connecticut Avenue and East-West Highway

12- poles @ $4000.00 Each =	$48,000.00
14- spans of wire @ $550.00 Each =	$ 7,700.00
16- arms & fixtures @ $1,600.00 Each =	$25,600.00
24- replace exist. Cobra head with Teardrop @ $1,500.00 Each=	$36,000.00
1- removal of existing arm & fixture @ 550.00 Each =	$ 550.00
TOTAL	**$117,850.00**

Within the Town PSI proposes to add five (5) new poles with arms and fixtures, and 135 new arms and fixtures on existing wood poles.

5- poles @ $4000.00 Each =	$20,000.00
5- spans of wire @ $550.00 Each =	$ 2,750.00
140-arms & fixtures @ $2,950.00 Each =	$413,000.00
3- replace exist. Cobra head w/ 55 Watt Teardrop @ $3,500.00 Each=	$10,500.00
279-replace exist. Cobra head with Teardrop @ $2,950.00 Each=	$823,050.00
TOTAL	**$1,269,300.00**

TOWN FURNISHED MATERIAL FOR PEPCO TO USE FOR INITIAL INSTALLATION

419- 85-Watt induction Teardrop Fixtures @ $1,050.00 Each = **$439,950.00**

(Note: PEPCO will furnish the 55-Watt units for the alley)

TOWN FURNISHED MATERIAL FOR PEPCO TO USE FOR MAINTENANCE

Town Cost (20 Year cost) (85-Watt Units Only)

43- replacement units @ $1,050.00 Each	$45,150.00
465-replacement Lamps & generators @ 360.00 Each	$167,400.00
TOTAL	**$212,550.00**

				Attachment	Total
Size	55W	85W	100W	N/A	N/A
Source	INDUCT	INDUCT	HPS	N/A	N/A
Sum	3	419	40	3	462
KW/h	0.055	0.085	0.12	N/A	N/A
Burn Hours/Year	4200	4200	4200	N/A	N/A
Total KWH/Year	693	149,583	20,160	N/A	170,436
Cost/KWH	0.092	0.092	0.092	N/A	N/A
Dist/KWH	0.0324	0.0324	0.0324	N/A	N/A
1 Year Energy Cost	$86.21	$18,608.13	$2,507.90	N/A	$21,202.24
20 year Energy Cost	$1,724.20	$372,162.60	$50,158.00	N/A	$424,044.80
Maintenance/ Month/Light	$4.04	$4.04	$5.97	$0.15	N/A
1 Year Maint. Cost	$145.44	$20,313.12	$2,865.60	$5.40	$23,329.56
20 Year Maint. Cost	$2,908.80	$406,262.40	$57,312.00	$108.00	$466,591.20

Table 8. Analysis of life cycle cost to the Town for proposed Option 3A (in 2009 dollars)

OPTION #3B USE INDUCTION LAMPS (TOWN OWNS AND MAINTAINS THE SYSTEM)

Under this option (details are shown in Table 9), all existing HPS units would be removed and replaced with new Teardrop fixtures. Connecticut Avenue and East-West Highway would have 100-Watt HPS Teardrops, which will match the units being installed on the opposite side by Chevy Chase Village.

Additional units will be installed on existing PEPCO wood poles in between the intersections. All new lights will use induction lamps. PSI proposes to use 85-Watt lights for all streets and 55-Watt lights for the alleys. All Teardrops will be mounted 25 feet above the roadway.

The Town would buy the system from PEPCO. The energy supplier will remain the same and the Town would contract out maintenance services. The maintenance program would have the HPS units re-lamped every five (5) years and the induction units every ten (10) years. All other maintenance services would be on an as-needed basis. PSI estimates the purchase price to be approximately $135,080.00.

The calculations for the costs of the additional equipment/removal of existing equipment are shown below:

Connecticut Avenue and East-West Highway

12- poles @ $1,500.00 Each =	$18,000.00
14- spans of wire @ $400.00 Each =	$ 5,600.00
16- arms &fixtures @ $1,100.00 Each =	$17,600.00
24- replace exist. Cobra head with Teardrop @ $950.00 Each=	$22,800.00
1- removal of existing arm & fixture @ 200.00 Each =	$ 200.00
16- PEPCO Connections @ $50.00 each	$ 800.00
TOTAL	**$65,000.00**

Within the Town PSI proposes to add five (5) new poles with arms and fixtures, and 135 new arms and fixtures on existing wood poles.

5- poles @ $1,500.00 Each =	$ 7,500.00
5- spans of wire @ $400.00 Each =	$ 2,000.00
140- arms & luminaries @ $1,500.00 Each =	$210,000.00
140- PEPCO Connections @ $50.00 each	$ 7,000.00
282- replace exist. Cobra head with Teardrop @ $1,100.00 each=	$310,200.00
TOTAL	**$536,700.00**

				Total
Size	55W	85W	100W	N/A
Source	INDUCT	INDUCT	HPS	N/A
Sum	3	419	40	461
KW/h	0.055	0.085	0.12	N/A
Burn Hours/Year	4200	4200	4200	N/A
Total KWH/Year	693	149,583	20,160	170,436
Cost/KWH	0.092	0.092	0.092	N/A
Dist/KWH	0.0324	0.0324	0.0324	N/A
1 Year Energy Cost	$86.21	$18,608.13	$2,507.90	$21,202.24
20 year Energy Cost	$1,724.20	$372,162.60	$50,158.00	$424,044.80
Maintenance/Month/Light	$3.00	$3.00	$4.25	N/A
1 Year Maint. Cost	$108.00	$15,084.00	$2,040.00	$17,232.00
20 Year Maint. Cost	$2,160.00	$301,680.00	$40,800.00	$344,640.00

Table 9. Analysis of life cycle cost to the Town for proposed Option 3B (in 2009 dollars)

OPTION #4 USE LED LIGHTS (TOWN OWNS AND MAINTAINS THE SYSTEM)

This option (details are shown in Table 10) is an example of what a proposed LED option would look like if PEPCO proposed and the Maryland Public Services Committee (PSC) approved rates for the use of this type of fixture. The energy costs were developed using the manufacturer's published input wattage for the fixture. The way PSI developed the maintenance cost is shown at the end of the option write up.

Under this option, all existing HPS units would be removed and replaced with new Teardrop luminaires. Connecticut Avenue and East-West Highway would have 100-Watt HPS Teardrops, which will match the units being installed on the opposite side by Chevy Chase Village.

Similar to Option No. 2B, additional units will be installed on existing PEPCO wood poles in between the intersections. All new lighting will use LED fixtures. Wattages will be 95-Watt for all streets and 60-Watt for the alleys. All Teardrops will be mounted at 25 feet above the roadway.

The town would buy the system from PEPCO. The energy supplier will remain the same and the town would contract out maintenance services. The maintenance program would have the HPS units re-lamped every five (5) years and the LED's would have photo controls replaced every five (5) years. All other maintenance services would be on an as needed basis. PSI estimates the purchase price to be approximately $135,080.00.

The calculations for the costs of the additional equipments/removal of existing equipment are shown below:

Connecticut Avenue and East-West Highway

12- poles @ $1,500.00 Each =	$18,000.00
14- spans of wire @ $400.00 Each =	$ 5,600.00
16- arms & luminaries @ $1,100.00 Each =	$17,600.00
24- replace exist. Cobra head with Tear Drop @ $,950.00 each=	$22,800.00
1- removal of existing arm & luminaire @ 200.00 Each =	$ 200.00
16- PEPCO Connections @ $50.00 each	$ 800.00
TOTAL	**$65,000.00**

Within the town PSI proposes to add 5 new poles with arms and luminaries, and 135 new arms and luminaries on existing wood poles.

5- poles @ $1,500.00 Each =	$ 7,500.00
5- spans of wire @ $400.00 Each =	$ 2,000.00
140-arms & luminaries @ $1,660.00.00 Each =	$232,400.00
140-PEPCO Connections @ $50.00 each	$ 7,000.00
282-rreplace exist. Cobra head with Tear Drop @ $1,360.00 each=	$383,520.00
TOTAL	**$632,420.00**

				Total
Size	60W	95W	100W	N/A
Source	LED	LED	HPS	N/A
Sum	3	419	40	462
KW/h	0.06	,095	0.12	N/A
Burn Hours/Year	4200	4200	4200	N/A
Total KWH/Year	756	156622	20160	177538
Cost/KWH	0.092	0	0	N/A
Dist/KWH	0.0324	0.0324	0.0324	N/A
1 Year Energy Cost	94.05	19483.8	2507.9	22085.75
20 year Energy Cost	$1,880.93	$389,676.03	$50,158.00	$441,715.04
Maintenance/Month/Light	$1.20	$1.30	$4.25	N/A
1 Year Maint. Cost	$43.20	$6,536.40	$2,040.00	8619.6
20 Year Maint. Cost	$864.00	$130,728.00	$40,800.00	$172,392.00

Table 10. Analysis of life cycle cost to the Town for proposed Option 4 (in 2009 dollars)

The maintenance cost for this option was developed using the following information:

1. 41- led fixtures would need to be replaced due to failures @ $1,275.00 each
$52,275.00
2. 5- led installations would need to be totally replaced @ $1,800.00
$ 9,000.00
3. 422- photocells would need to be replaced every 5 years @ $35.00 each
$44,310.00
Total $105,585.00

$105,585.00 ÷ 240 months ÷422 units = $1.04 x 124% = $1.2896 rounded off to $1.30 per month.

COMPARISON OF PROPOSED OPTIONS

Table 11 compares the proposed Town lighting options in terms of number of lights, system ownership, maintenance by, system purchase cost, 20-year energy Cost, 20-year maintenance cost, Town equipment cost, PEPCO construction cost, Town construction, and total 20-year cost.

OPTION #	1A	1B	2A	2B	3A	3B	LED
OPTION	MAINTAIN EXISTING	MAINTAIN EXISTING	ADD 70 & 100 W HPS	ADD 70 & 100 W HPS	100W HPS & 85 W INDUCTION	100W HPS & 85 W INDUCTION	100W HPS, 60 & 95 W LED
# OF LIGHTS	307	307	462	462	462	462	462
SYSTEM OWNERSHIP	PEPCO	TOWN	PEPCO	TOWN	PEPCO	TOWN	TOWN
MAINTENANCE BY	PEPCO	TOWN	PEPCO	TOWN	PEPCO	TOWN	TOWN
SYSTEM PURCHASE COST	$0	$135,080.00	$0	$135,080.00	$0	$135,080.00	$135,080.00
20 YR. ENERGY COST	$297,604.80	$297,604.80	$441,861.40	$441,861.40	$424,044.80	$424,044.80	$441,715.04
20 YR MAINT. COST	$412,509.60	$297,120.00	$619,576.80	$350,640.00	$466,591.20	$344,640.00	$172,392.00
TOWN EQUIP. COST	$0	$0	$0	$0	$652,500.00	$0	$0
PEPCO CONST. COST	$0	$0	$265,950.00	$0	$1,387,150.00	$0	$0
TOWN CONST. COST	$0	$0	$0	$134,700.00	$0	$601,700.00	$697,420.00
TOTAL 20 YR. COST	$710,114	$729,805	$1,327,388	$1,062,101	$2,930,286	$1,505,465	$1,446,607

Table 11. Comparison of the proposed Town street lighting options

COMMENTS ON PROPOSED TOWN STREET LIGHTING OPTIONS

Option 1A: no increase in cost; roadway lighting does not meet IES/AASHTO standards; citizen safety and dark areas not addressed.

Option 1B: the Town owns system; maintenance cost decreases; roadway lighting does not meet IES/AASHTO standards; citizen safety and dark areas not addressed.

Option 2A: 186% increase in cost; roadway lighting meets IES/AASHTO standards; roadway bright spots twice as bright as existing situation.

Option 2B: 149% increase in cost; roadway lighting meets IES/AASHTO standards; roadway bright spots twice as bright as existing situation.

Option 3A: 400% increase in cost; roadway lighting meets IES/AASHTO standards; roadway bright-spot illumination cut by 50% from existing situation.

Option 3B: 211% increase in cost; roadway lighting meets IES/AASHTO standards; roadway bright-spot illumination cut by 50% from existing situation.

Option 4: 211% increase in cost; but maintenance cost are only 41% of what the town current pays, roadway lighting meets IES/AASHTO standards; roadway bright-spot illumination cut by 50% from existing situation.

VI. Transitional Option

The Town requested that PSI look into what can be done to improve the existing lighting within the Town before the long-term lighting system is built. The first item that should be addressed is the trimming of trees, both inside public space and the private property trees that encroach within the public space.

During our survey, many streetlight units were found incorrectly installed; these cases include pole leaning, fixture not installed at level, or fixture tilted. Having fixtures tilted and not level allows the illumination from the unit to trespass onto private properties and is a cause of nightlight pollution. The Town should contact PEPCO to have these conditions corrected. PSI has included a database report identifying where these problems were found (shown in Attachment G). 55 fixtures and one leaning pole were found that needed to be corrected; the problem rate is 18.24%.

Since PEPCO will consider this work outside of the normal streetlight maintenance operations covered by the tariff, the Town would have to pay to have this work done. The estimated cost is approximately $500.00 to correct a leaning pole and $150.00 to correct problems with a fixture. Correcting these problems will allow the Town to benefit from the lighting currently installed and will take care of many of the light-trespass problems that currently exist.

In addition, Table 12 shows additional lighting units to be installed; areas were chosen based on pedestrian traffic patterns and the areas identified as being dark.

pepco plat	pole #	house #	street name	new light	new pole
		4202	LELAND STREET ON CENTER ISLAND		TRUE
774416	9612	4410	STANFORD STREET	TRUE	
774418	8931	4314	WILLOW LANE	TRUE	
774418	6420	7112	44TH STREET, S/O	TRUE	
775416	8477	6702	MAPLE AVENUE	TRUE	
775417	6227	6901	OAKRIDGE LANE	TRUE	
775417	8925	6902	MAPLE AVENUE	TRUE	
775417	'0243	4402	WALSH STREET	TRUE	
775418	4650	7208	OAKRIDGE LANE	TRUE	
775418	4017	4315	CURTIS ROAD	TRUE	
775419	5719	7500	LYNN DRIVE	TRUE	
776419	4115	7416	OAK LANE	TRUE	
777416	2575	4006	ROSEMARY STREET	TRUE	
777416	8083	3901	ROSEMARY ST S/O MEADOW LANE	TRUE	
777419	4122	3917	WOODBINE STREET	TRUE	
777420	'0105	7703	CHATHAM ROAD	TRUE	

Table 12. Proposed additional lighting units in Transitional Option

VII. Conclusion

The conclusion of this study is that without approved LED tariffs in place, the proposed Lighting Option 3B is preferred for a long-term lighting scheme for the Town. The reasons are the following:

- Option No. 3 fulfills the Town lighting needs, and meets the IES and AASHTO standards.
- Option No. 2 also meets the lighting standards, but it causes over lighting in certain areas of the Town.
- Option No. 3 cuts the current nighttime bright-spot illumination into half.
- Option No. 3 cuts the amount of hazardous waste (mercury) in the term of 20-year life cycle.
- Option No. 3 cuts down the maintenance contractor visits to the Town and traffic disruptions.

We conducted a case study (shown in Attachment J) to compare the photometric results amongst the proposed Town lighting options. The data show that Option No. 3 provides the best results.

We also performed a photometric analysis for the selected Option 3 scenario, and the results indicate that this lighting system meets all the requirements of the Town, as well as IES/AASHTO standards. Please refer to Attachment K for these results.

It should be pointed that PEPCO is currently testing LED fixtures. We believe that approved LED tariffs will be in place within the next three years. Once LEDs can be installed on PEPCO's system, the town should purchase the system and install LEDs as called for in the LED option. Currently the LED manufactures are finding and repairing problems with the current products; based on our prior experiences the price of the units will be reduced.

VIII. References

1. Town of Chevy Chase, Maryland, http://www.townofchevychase.org/index.php, accessed January 3, 2010
2. District of Columbia Department of Transportation, *District of Columbia Streetlight Grand Plan*, March 2005