Town of Colchester Comprehensive Street Lighting Plan

A guide to the costs and benefits of municipal ownership
of streetlighting infrastructure

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The Town of Colchester
Planning & Zoning Department
P.O. Box 55, 835 Blakely Road
Colchester, VT 05446

Contact: Sarah Hadd (802) 264-5602 shadd@town.colchester.vt.us

Researched and Written by:
Donna J. Leban of Light/Space/Design
7 Iris Lane, S. Burlington, VT 05403
(802)862-1901, lightspd@comcast.net
www.lightspacedesign.biz

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EXECUTIVE FINANCIAL SUMMARY

One of the goals of this project is to balance the need for a suitable new lighting system for growth centers with the simultaneous need to reduce overall town maintenance and energy costs. Overall, this is accomplished with the new streetlighting plan. Potential reductions in energy and maintenance costs for streetlighting of residential streets has the potential to balance the increases in those costs for the more dense General Development zones.

Higher initial equipment costs of the new streetlighting standards for R2 and R3 Residential are based on both the change to a more decorative standard luminaire and pole, but also on technology that will provide the town with lower maintenance and energy costs. There is no change to spacing for R2 and R3 zones. However, no part of the system will be owned by the electric utility company, saving the 36.25% income tax surcharge placed on contributions in aid of construction by GMP. Not including the cost of trenching and conduit, which would be equal for all underground utility systems, the current cost of $2500 per cobrahead light pole (or $1810 w/o the tax) compares roughly to $3625 per new decorative post top light pole. Energy and maintenance costs will be reduced annually by $154 per light pole in R3, and $332 in R2. With no change in spacing, this equates to annual energy and maintenance savings of $2032 per mile in R3 and $4382 per mile in R2.

Lower density R1, R5, and R10 Residential would see a reduction in costs due to a reduction in spacing from 400’ to 600’ o.c. for R1, and locations only at corners, intersections, and dead ends for R5 & R10. The new standard for bracket arm mounted cut-off fixtures and fiberglass poles, while similar to the existing, are only slightly more expensive than the existing standard and are expected to deliver better performance over time.

The General Development Zones 1-4 will use the new standard decorative luminaire and pole at a spacing that provides a pedestrian-friendly evening setting. The cost of lighting these streets will increase from $2500 to $3625 per pole. The change in spacing will increase initial costs by $191,750 per mile of new street in these districts where streetlights are on both sides of the street. The GD Districts are intended to be compact, high density developments with a high capacity for growth. While the cost per pole is reduced, the increased density adds $2724 per mile in annual maintenance and energy costs.

The Commercial Zone has an increase in lighting density for safety purposes, although the luminaire and pole type changes minimally. The change in spacing will increase initial costs by $45,000 per mile. The increased density adds $2,109 per mile in annual maintenance and energy costs. There is minimal change in lighting for the Industrial zones.

Conversion of existing streetlights to a town-owned system has the potential to save $18,600 in direct maintenance and energy costs compared with the existing utility owned system, although the indirect cost of managing and maintaining an 800 light system need to be considered. The largest potential savings are in the areas where decorative post top luminaires with maintenance saving induction lamps can be utilized. However, these are also the most costly initially. A long term plan of replacement by street or neighborhood will be needed to address this need.

SECTION 1 ISSUES WITH COLCHESTER STREETLIGHTING CURRENT STANDARDS AND GOALS OF ADOPTING NEW STANDARDS

Currently, Colchester provides approximately 750 street lights located along public roadways. A variety of different street luminaires and mounting configurations have been used over the years. These range from 100 to 250w mercury vapor and 70 to 150w high pressure sodium lamps. Mounting systems include utility owned pole infrastructure and 20' direct bury fiberglass tapered poles for bracket arm mounted cobraheads to 12' direct bury fiberglass poles with post top fixtures.

The town's current standard for new development is a cut-off cobrahead luminaire of 70w high pressure sodium on a 20' direct bury fiberglass tapered pole. Street lights are required at 400' intervals, as well as at dead end streets and intersections.

The Town is concerned with the effectiveness of the current system to provide vehicle and pedestrian safety, as well as the high cost of street lighting. There is no consideration of land use or road classification in the current Town lighting standards. Rural gravel roads require the same level of lighting as mixed use growth centers.

This study is intended to provide recommendations for different lighting packages according to Colchester zoning districts. New mixed use zones are a particular focus, as one goal of the revised lighting standard is to encourage a more pedestrian friendly environment in growth centers. Within the zoning districts, there may also be distinctions based on roadway type. Arterial roadways within zoning districts may be held to different standards, as they are generally state highways. State highways must meet VT Dept of Transportation requirements, which are not included in these recommendations. Also the state highway standards are not addressed in the attached lighting specifications.

Existing lighting guidelines such as AASHTO and IESNA Roadway Lighting RP-8 do not address many of the street lighting issues that exist in suburban and rural residential and small commercial areas which predominate in the Town of Colchester. Those frequently referenced guidelines are especially pertinent to higher traffic and urban areas, but do apply in suburban areas with a high level of traffic and adjacent commercial establishments with parking lot and building lighting. Therefore, guidelines of this nature must be based at least partially on what currently exists in the suburban development zones, as well as recent town safety and/or complaint records.

An effort is made to standardize on fixture and pole types for overall long term (life cycle) cost efficiency for the Town of Colchester. All recommended fixtures are selected to be cut-off type, to reduce light pollution and comply with the intent of Vermont HB.28 on outdoor lighting. The recommendations based on that legislation do not yet exist at the time of this writing.

These recommendations, while focused on requirements for new development, also would apply to retrofits of the current system, where and when that may occur. Suggestions for implementing street lighting standard throughout the community are addressed.

SECTION 2 STREET LIGHTING REQUIREMENTS BY ZONE WITH DISCUSSION OF CONTINUOUS AND NON-CONTINUOUS LIGHTING

The following Table 2.1 provides the streetlighting requirements by zoning district. Distinctions between zones include the type of light fixture and pole, as well as the spacing. Development in Residential Zones 2 and 3 and General Development Zones 1-3 will use a post top fixture selected specifically for its very low maintenance requirements as well as its cut-off optics and white light source. The utility style High Pressure Sodium cobrahead streetlight is the current standard for all zones, and will remain the standard for lower density and commercial/industrial zones. Generally, all new streetlighting system installations are fully paid for by the developer. Maintenance and energy costs only will be provided by the Town of Colchester once the development and its streets are turned over to the Town.

The streetlighting system managed by the Town of Colchester encompasses only local town roads, and not state-owned arterials or major thruways. The town's minor arterials and local roadways, with few exceptions, are not intended to have continuous lighting, as defined by IESNA (The Illuminating Engineering Society of North America) and AASHTO (American Association of State Highway Traffic Officials). Therefore, the guidelines as outlined by those organizations define an upper limit, but do not govern streetlighting as required under the new Colchester standard.

Continuous streetlighting is determined by the maintenance of an established level of average illuminance, measured in footcandles, and a maximum permitted level of contrast between the highest and lowest illuminance. This can be measured in horizontal or vertical illuminance. Nighttime vertical illuminance is the most important where the ability to see pedestrians and objects is critical to maintaining roadway safety. Both vertical and horizontal illuminance are negatively affected when pole spacing is increased, wattage is reduced, and pole height is decreased when using cutoff luminaires. The incidence of accidents between vehicles, or between vehicles and pedestrians, or the potential for such accidents determines where continuous street lighting is required.

Where accident incidence is low, such as on roadways with lower volume of vehicles, or where pedestrians are provided with separate sidewalks, the need for continuous lighting is reduced. In these locations, placing streetlights at intersections, dead ends of streets, and at longer intervals provides guidance for vehicles and pedestrians, but does not ensure that objects and pedestrians at all locations on the street will be visible. Current utility streetlighting, which is often at intervals of 300' spacing and greater, does not provide continuous lighting for the street (as defined by IESNA guidelines). Any streetlighting which is not by definition continuous, is non-continuous. Except for major street renovation projects such as downtown Winooski, Dorset Street and Shelburne Road in South Burlington, and major arterials entering Burlington, most Vermont roadways do not have continuous lighting.

Street lighting will be provided based on the following requirements, as defined by Zoning District. Exceptions to the recommendations are noted by Zoning District. These exceptions generally occur for one of the following reasons:

1. State highways within zoning districts may have different lighting requirements than Town streetlighting standards, particularly if the level of traffic and pedestrian activity is significantly different than that of the zoning district as a whole. As a guideline, state highways that have no adjacent commercial or institutional development, whether or not they are in a commercial district, may require streetlights only at vehicular and/or pedestrian intersections. If adjacent commercial or institutional facilities do or will soon exist, refer to the current IESNA RP-8 guidelines, and

request a review by the State of Vermont Agency of Transportation, which is the governing authority. However, in no case shall lighting requirements be higher than recommended by IESNA RP-8.

2. Continuous roadway lighting complying with the most current version of IESNA RP-8 "Recommendations for Roadway Lighting" will be required on any public roadway within 400 feet of a school property or other exceptions defined by zoning classification below.

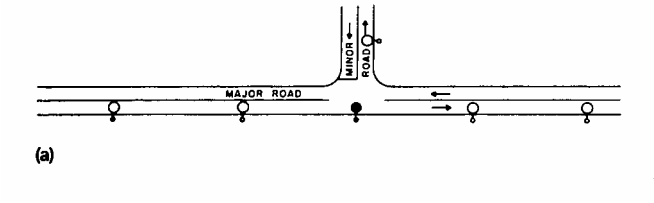
STREET LIGHTING REQUIREMENTS TABLE 2.1

Zoning District	Required lighting	Exceptions
R3 Residential – high density residential	85w Induction Post-Top on 14' pole, 400' o.c., at roadway intersections, pedestrian crosswalks, and dead ends	Modify spacing to 100' o.c. adjacent to and within 100' of school property
R2 Residential – medium density residential	55w Induction Post-Top on 12' pole, 400' o.c., at roadway intersections, pedestrian crosswalks, and dead ends	Modify spacing to 100' o.c. adjacent to and within 100' of school property
R1 Residential – low density single family residential	70w HPS bracket arm mounted cobrahead on 20' pole, 600' o.c., at roadway intersections, and at dead ends	Modify spacing to 100' o.c. adjacent to and within 100' of school property
R5 & R10 Residential – low density in rural and agricultural area	70w HPS bracket arm mounted cobrahead on 20' pole, intersections only.	
GD1 – General Development – Residential and compatible commercial	85w Induction Post-Top on 14' pole, stagger light poles at 140' o.c when sidewalks are on both sides of the street (70' o.c. from center line of street); 100' o.c. when sidewalks are on one side; at intersections; and at dead ends	
GD2 – General Development – Commercial and light industrial with multi-family residential	85w Induction Post-Top on 14' pole, stagger light poles at 140' o.c when sidewalks are on both sides of the street (70' o.c. from center line of street); 100' o.c. when sidewalks are on one side; at intersections; and at dead ends	

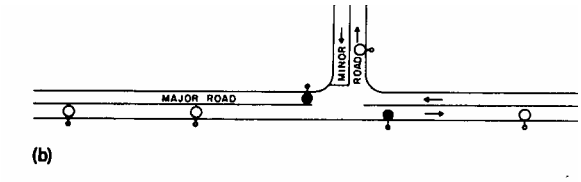
GD3 – High Density - Compact Mixed Use Development	85w Induction Post-Top on 14' pole, stagger light poles at 140' o.c when sidewalks are on both sides of the street (70' o.c. from center line of street); 100' o.c. when sidewalks are on one side; at intersections; and at dead ends	
GD4 – Higher Density – Mixed Use Development	85w Induction Post-Top on 14' pole, stagger light poles at 140' o.c when sidewalks are on both sides of the street (70' o.c. from center line of street); 100' o.c. when sidewalks are on one side; at intersections; and at dead ends	
COM – Commercial District	100w HPS bracked arm mounted cobrahead on 25' pole, at 280' o.c. when sidewalks are on both sides of the street; 140' o.c. when sidewalks are on one side, at intersections, and at dead ends.	
IND – Industrial District	70w HPS bracket arm mounted cobrahead on 25' pole, 400' o.c., at intersections, and at dead ends.	
AGR, FP, and CSVD Districts	No street lighting	70w HPS bracket arm mounted cobrahead on 20' pole, at intersections in areas with existing development

2A. DIAGRAMS OF STREETLIGHT LOCATIONS

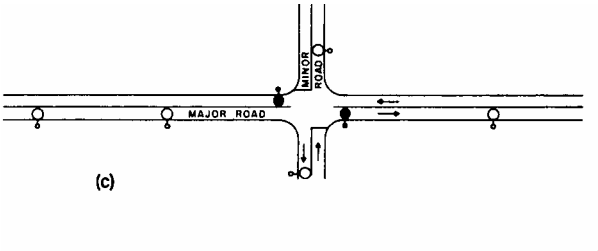
The streetlight shall typically be installed a distance of 3'-0" from the edge of pavement or outside edge of curb (if any). When there is a sidewalk or bicycle path adjacent to the roadway, the streetlight pole shall be located between the roadway and the pathway. Where a roadway dead-ends, the light pole shall be installed 3' from the edge of pavement and within 40' of the end of the roadway.



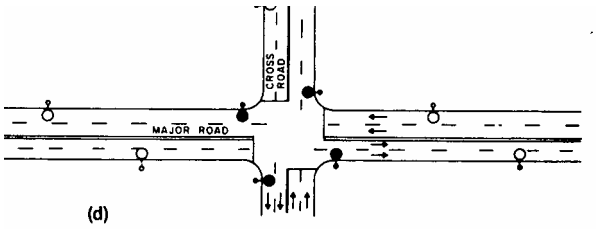
Where either a major, collector, or local road joins a local road at a T intersection in a low pedestrian area, a single pole mounted light directly across from the intersecting road is adequate. In the above and following diagrams, a solid symbol indicates a non-continuous roadway lighting application. The open symbols indicate the same instance in a continuous roadway lighting application.



This diagram shows the same roadway intersection as above, but with better lighting for a higher level of pedestrian activity. Install two light poles placed on opposing sides of the major as shown above, at 3'-0" from the edge of pavement. The function of street lighting in this case places greater emphasis on the crosswalks. As above, the solid symbol is for non-continuous lighting.



Where two 2-lane roads intersect, but there is no continuous lighting, two light poles suffice for a low or medium pedestrian activity area.



When two major 4-lane streets intersect, each corner requires a pole light.

Note for above diagrams from IESNA RP-8 Roadway Lighting Guidelines: Solid black street luminaire symbols are indicated for partial street lighting, ie, where only the intersection is illuminated. Open luminaire symbols indicate continuous lighting on street.

SECTION 3 TECHNICAL SPECIFICATIONS FOR NEW STREETLIGHTING STANDARDS

The following section includes detailed specifications for luminaires, lamps, poles, photosensors, and associated construction. Developers seeking plan approval must submit requested materials during Town site plan review to show compliance with the town streetlighting standards.

Details of the electrical installation must meet the requirements of the utility company providing the electrical service to the streetlights. The Town of Colchester will own the new streetlight system once a new street and utility system are completed and accepted by the town. Streetlights shall be installed for unmetered electrical service, with the provision of the utility required disconnect and meter socket. The disconnect shall be screened and located to be unobtrusive.

Where the utility does not provide unmetered service to streetlights, the streetlight shall be installed with a meter socket and meter in a screened and unobtrusive manner.

Materials used in the installation of streetlights shall meet the following specification. Any deviation from these specifications must be formally proposed to the Town of Colchester Department of Public Works during the plan review process, reviewed, and approved or rejected.

Replacement of existing luminaires and poles by the Town of Colchester shall also follow these specifications, with exceptions in the case that the town standard luminaire cannot be used on an existing type pole. In this case, a modification may be made to the replacement luminaire at the direction of the Public Works Director, but the wattage and lamp type are to be the same.

3A. STREETLIGHT LUMINAIRES, LAMPS, AND PHOTOSENSORS

DESCRIPTION AND SUBMITTALS.

Streetlighting luminaires and associated equipment installed shall meet the following specifications Prior to ordering the items, the contractor shall supply to the Town of Colchester for approval descriptive information for street lighting luminaires. The submittal shall contain at a minimum the following information:

Luminaires

(1) Manufacturer's detailed product specification sheet including:

a. Voltage rating.

b. Wattage and lamp type.

c. Ballast type.

d. Internal or external fuse specification

d. Photo cell specification

e. Weatherproofing and sealing

f. Weatherproof receptacles, if required.

(2) Photometric Data.

a. IES Distribution type.

c. Independent laboratory tested IES photometry report.

d. Mounting height factor.

WARRANTY

Warranty: Written manufacturer's warranty, agreeing to replace external parts of luminaires and poles exhibiting a failure of finish as specified below.

Protection of Metal from Corrosion: Warranty against perforation or erosion of finish due to weathering.

Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation.

Warranty Period: Not less than five years from date of Substantial Completion.

MOUNTING MATERIALS

Bracket arms, if required for luminaire type, shall be able to withstand a vertical load of 450 N (100 pounds) and a horizontal load of 225 N (50 pounds) without fracture or permanent deformation.

(1) Bracket Arms. Bracket arms shall be a single member elliptical-type. The main or wire-carrying member shall be ovalized at the shaft end. The shaft end of the arm shall have a cast aluminum fitting welded to it to permit attachment to the shaft. Single bracket arms shall be tapered, seamless tube conforming to the requirements of ASTM B 221M (ASTM B 221), Alloy 6063-T6 or Alloy 6061-T6. The bracket arm shall be provided with a 50 mm (2 inch) slip-fit mounting of sufficient length to accommodate the luminaire.

(3) Accessories. All screws, nuts, bolts, and other hardware including anchor bolts shall be stainless steel, unless otherwise specified.

LUMINAIRES

High Pressure Sodium, and Induction Luminaires. All luminaires, including lamps, ballasts, fuse, photoelectric control devices, and housings, shall include the latest design improvements available at the time the Contract is awarded. They shall include an aluminum housing with easy access to the ballast assembly, photoelectric control, internal fuse, sealed optical assembly, and regulator ballast for the appropriate voltage. The ballast and fusing shall be matched to its starting circuit. Wiring shall be neat, bundled, and kept away from excess heat. All required light distribution types shall be in accordance with the latest editions of the *American Standard Practice for Roadway Lighting* by the Illuminating Engineering Society (IES) and *An Informational Guide for Roadway Lighting* (AASHTO).

(1) Luminaires shall be weatherproof, meeting NEMA IP66 with a detachable reflector gasketed or permanently sealed to the lens and shall be optically sealed to prevent visible light leaks. Heat and cold resistant gaskets shall remain effective over the life of the luminaire or at least 20 years. Gasket seals shall be designed to prevent intrusion by insects and environmental contaminants. The glass lens shall be of tempered, heat-resistant glass. Housings shall be of die-cast aluminum, with a durable neutral color powder coat finish. The unit shall provide tool-free one-hand access to electrical components and replaceable ballast tray and UL/CSA recognized quick-disconnect polarized terminals.

(2) For cobrahead type luminaires, provide Universal slip-fitting for mounting onto a bracket 2" in diameter plus/minus ½". Effective Projected Area (EPA) of luminaire shall not exceed 1.6, and shall withstand 100 MPH wind gusts when mounted on a standard 6' aluminum mounting bracket arm without additional reinforcement.

(3) For post top mounted luminaires, provide Universal slip-fitting for mounting onto a 3"(76mm) OD by 4"(102mm) long tenon.

(4) Each luminaire shall have a standard NEMA tool-less bayonette mount photoelectric receptacle mount connected to the same voltage as unit. Internal fusing and line surge protection shall be provided. Luminaires shall have potential for UL listing for outdoor wet environments.

(5) The 120 volt or multi-tap ballast shall be ANSI regulated (constant wattage) type, internally mounted in a removable ballast tray in the luminaire. Ballasts shall regulate within ± 5 percent variation of the lamp wattage or a ± 10 percent variation in primary voltage. The ballast shall operate within the range of 5 percent voltage drop and have a guaranteed starting characteristic of -40 °C (-40 °F).

(6) Electrical components other than lamps, ballasts, and photosensors shall be warranted by the luminaire manufacturer for a minimum of 5 years. Ballasts shall be warranted by the ballast mfr for not less than two years.

HIGH INTENSITY DISCHARGE LAMPS

(1) High Pressure Sodium lamps

a. 70 watt universal operation HPS lamps

b. Mogul base lamps for use in enclosed fixtures

c. Low mercury, TCLP compliant. Lead free base.

d. 30,000 hour average lamp life.

e. CRI 21, Color Temperature 2100K

f. Lamps shall have end-of life indicator and non-cycling feature to protect ballasts from premature failure and aids in locating and replacing lamps at end of life.

g. Lamp manufacturer warranty of 1 year- replacement.

(2) Induction lamps

a. For 55 and 85 watt Induction lamps

b. For factory installation in qualified luminaires, consisting of discharge vessel (bulb), power coupler (induction coil and core), and HF generator (2.65 MHz).

c. Coated lamp CRI 80+, Color Temperature 4000K.

d. Average rated life not less than 100,000 hrs

E. Initial/Mean Lumens not less than 3500/2800 for 55 watt; 6000/4800 for 85 watt.

PHOTOELECTRIC CONTROL DEVICES.

A twist-lock type photoelectric control device shall be top accessible mounted to luminaire receptacle and shall comply with ANSI C136.10-1996 or latest revision.

Voltage shall be 120V. Surge protection shall be MOV, minimum 160 joules wired line to neutral. The load capacity of the photoelectric cell relays shall be a maximum of 1000 W. The photoelectric cells shall be suitable for operating a lighting system through load relays or oil switches.

The photoelectric cell circuitry shall be designed to be normally closed at night.

Silicon sulfide type photosesensors shall be factory set to

1) Turn on at 1.5 fc for horizontal facing controls. Location of photosensor shall be affected by no other lighting fixtures or building or reflected façade lighting.
2) Turn off at 1.5 fc.

The relay shall have a time delay to avoid operation due to lightning and transient light. In the event of a failure, the relay shall fail safe, that is, the lights are left on in the event of any failure in the electronic circuit.

The photocell shall be mounted above any visible light output from the luminaire, and oriented to the north sky, if possible. A lightning arrester shall be included as part of the unit.

Color shall be ANSI Standard black color for 120v horizontal facing controls.

The following shall appear on the base of the control: Month and year of manufacture; individual serial number; complete model description; operating voltage range, load rating, and provision for marking install and removal dates. Year of manufacture shall be permanently molded on cover.

Warranty: Four years minimum, one for one control replacement. Manufacturer: Thomas&Betts, Dark to Light, www.tnb.com/utility

SCHEDULE OF LUMINAIRES

A) High Pressure Sodium Roadway Lighting Luminaire – Full Cutoff Style
   1. IES Distribution Type Medium Cutoff 3 (MC3).
   2. High Pressure Sodium Lamp wattages: 70w, 100w
   3. Finish Color: BKTX Black Textured
   4. Acceptable Manufacturers/Models
      a. Lumec – Helios HBS-70HPS-ED23 ½ -MC3-120v-RC-FS (EPA 1.47 sq.ft.)
      b. Lumec – Helios HBS-100HPS-ED23 ½ - MC3-120v-RC-FS (EPA 1.47 sq.ft.)
   5. Alternate only for Town use as replacement luminaire where GE is existing luminaire
      a. GE Lighting Systems – M250A2 70w HPS Powr/Door with Cutoff Optics and flat glass

B) Induction Post Top Lighting Luminaire
   1. IES Distribution Type 5 Cutoff
   2. Induction wattages 55w, 85w
   3. Finish Color: BKTX Black Textured
   4. Acceptable Manufacturers/Models
      a. Lumec- Serenade S55C1-55QL-DSX5-120v-PH8-FS (EPA 2.25 sq ft)
      b. Lumec- Serenade S55C1-85QL-DSX5-120v-PH8-FS (EPA 2.6 sq ft)
   5. Alternate only for Town use as replacement luminaire
      a. GE Lighting Systems – Salem Cutoff with 70w induction lamping

2A. STREETLIGHT POLES AND FOOTINGS

DESCRIPTION AND SUBMITTALS

Prior to ordering the items, the Contractor shall submit for approval to the Colchester Planning Department manufacturer's drawings and specifications for street lighting poles, bracket arms, and prefabricated concrete footings. The submittal shall contain the following information.

1) Dimensioned drawing showing pole, ladder arms, and luminaire drawn to scale for each pole and luminaire combination. Show detail of method of luminaire attachment to pole or bracket arm.
2) Anchor-bolt templates keyed to specific fixture types and certified by manufacturer.
3) Manufacturer's literature and sizing of prefabricated concrete footings

Samples for Approval:

1) Finish and Color sample: For finished metal used in surface components.

WARRANTY

Warranty: Written manufacturer's warranty, agreeing to replace poles exhibiting a failure of finish as specified below.

Protection of Metal from Corrosion: Warranty against perforation or erosion of finish due to weathering.

Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation.

Warranty Period: Not less than five years from date of Substantial Completion.

LIGHT POLE STANDARDS

The shafts of all light standards shall be designed to withstand an equivalent wind gust of 160 km/h (100 miles per hr) velocity and when used with the listed bracket arm and luminaire, shall not produce an angular deflection of more than 70 minutes. The engineering design of light standards shall conform to the AASHTO *Standard Specifications for the Structural Supports for Highway Signs, Luminaires, and Traffic Signals.*

a) Delivery, Storage, and Handling of Poles

Package aluminum poles for shipping according to ASTM B 660.

Store poles on decay-resistant treated skids at least 6 inches (150 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

Retain factory-applied pole wrappings on metal poles until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

For fiberglass poles,

b) Installation of Poles and Electrical Service

Install all poles in compliance with Section 679 Street Lighting, of the State of Vermont Agency of Transportation Standard Specifications for Construction, 2001 or latest available edition. Light standards shall be erected on concrete bases at locations shown on plans.

Provide precast or site formed concrete footings for all pole types. Size and install as required for local soil conditions and pole type. Provide with anchor bolts installed to match bolt circle of specified pole. Ensure a minimum of 2" concrete cover at all anchor bolts. Neatly fill the space between the top of the concrete footing and metal base with Type IV mortar without blocking drain holes.

Install all electrical power service in compliance with requirements for underground electrical street lighting services by the local electric utility company for metered or unmetered electrical service. Unmetered service is required except where not available from the local utility.

Luminaires shall be installed simultaneously with the erection of light standards. All manufacturers instructions shall be adhered to in the installation of light standards and luminaires.

c) Decorative Aluminum Poles

1) Decorative Aluminum Poles Aluminum shafts shall consist of tapered round aluminum shaft welded over and inside of a larger section round extruded aluminum pole base, which is welded top and bottom to a cast aluminum anchor base. The entire shaft assembly is heat-treated. Construction to conform to current ASTM standards for Alloy 6063-T6. Minimum wall thickness shall be 3.2 mm (0.125 inch) for mounting heights of less than 6 m (20 feet) and 4.8 mm ((0.188 inch) for mounting heights of 6 m (20 feet) or more.

2) Finish Prepare for powder coating with hot dip chemical etching. Finish shall be Lumital thermoset polyester powder coat textured finish in a manufacturer's standard color. UV-resistant finish exterior finish shall comply with ASTM G7, and salt-spray resistant according to ASTM B117 testing procedures.

3) Base cover Made from two pieces of cast aluminum mechanically fastened to the base with stainless steel screws.

4) Breakaway Bolts A breakaway bolt system shall be provided for all aluminum poles. The breakaway bolt system shall consist of or be equal to Alcoa's Breakaway Support System. A breakaway bolt shield and bolt covers shall be provided and factory finished using the same method and color as the pole and base.

4) Ladder arms Ladder arms shall be cast aluminum and attached to the aluminum pole by means of a cast aluminum fitter, secured by stainless steel set point allen screws. Each of the two ladder arms installed per pole just below the luminaire mount shall be capable of withstanding a horizontal or vertical dead load of 500 lbs applied to any 1" of surface of the arms. Ladder arms shall be installed perpendicular to the adjacent street.

d) Fiberglass Roadway Poles

1) Fiberglass Pole Fiberglass reinforced plastic (FRP) light poles shall be constructed of polyester resin and fiberglass woven roving with more than 75% of the reinforcing fiberglass in the axial vertical plane. The pole shall be engineered and manufactured to have an EPA rating of not less than 7 in winds of 100 MPH with a gust factor of 1.3. The smooth tapered pole shall be round in section, with a satin brush acrylic finish.

2) Anchor Base The pole shall be an anchor based style with a tip outside diameter of 5.3", and a base diameter of 8.3". The anchor base shall be 6061-T6 cast aluminum with a 11-1/2" bolt circle. Four galvanized bolts, each with two hex nuts, two flat washers, lock nut and bolt cover will be provided.

3) Handhold The pole shall have a 4" x 6" handhole with aluminum door and vandalproof screws in a color to match pole.

4) Mast Arm The mast arm shall be made of 6063-T6 aluminum. It shall be 6' long with a rise of 15". The composite pole manufacturer will drill the mounting holes and supply stainless steel bolts, washers, and nuts for field installation of the mast arm. The pole shall be top-reinforced with an aluminum sleeve to support mast arm mount.

i. A special decorative bracket arm shall be used for the town owned roads at Water Tower Hill in the COM Zoning District. This bracket arm shall be the Lumec EQN type of equal, as determined by Colchester Planning and Zoning. Both standard and special mounting brackets shall position the flat glass diffuser of cobrahead type fixtures in the horizontal plane with no upward tilt.

SCHEDULE OF POLES

A) Fiberglass roadway type pole with single 6' bracket arm
   1. Shaft length: 18'-9", and 23'-9"
   2. Nominal luminaire mounting height: 20'-0", and 25'-0"
   3. Color: Black
   4. Acceptable Manufacturers/Models
      PLP Composite Technologies, 700 Series A720-M1/6, with EPA of 7 at 100MPH
      PLP Composite Technologies, 700 Series A725-M1/6, with EPA of 7 at 100MPH

B) Decorative aluminum post-top luminaire pole
   1. Shaft length: 12' or 14', as determined by luminaire wattage and location
   2. Color: BLTX Textured Black to match Lumec Serenade luminaire
   3. Acceptable Manufacturer/Model
      Lumec AM6F-12 BA, with EPA of 8.7 at 100mph
      Lumec AM6F-14 BA, with EPA of 4.7 at 100mph

SECTION 4 FINANCIAL EVALUATION OF THE CHANGE IN STREETLIGHTING STANDARDS

The following Table 4.1 and its associated assumptions listed below consider the combined financial effect to the Town of Colchester of various changes in the streetlight standards. The major changes include:

- Selection of a post top type luminaire that uses a very long-life QL type lamp, rated to last 100,000 hrs. While this fixture has a higher initial cost, the reduction in energy and maintenance costs will yield savings to the Town of Colchester. Energy costs and maintenance costs in Table 4.1 are provided on a per mile basis, with the total annual cost of energy and maintenance per mile summarized below. Table 4.1 includes a total annual cost which includes replacement costs.

For example:	Zoning	Old HPS Requirement	New QL Requirement
	R3 Residential	$932.97 per mile (70w)	$778.53 per mile (85w)
	R2 Residential	$932.97 per mile (70w)	$600.07 per mile (55w)

- Reduced or increased spacing between light poles in some zoning districts. The previous standard used 400' spacing of light poles for all zoning classification. In the new standard, light pole spacing increases in the lowest density zones due to low requirements for lighting. In higher density General Development zones, the new spacing of light poles decreases. This is in keeping with Colchester's desire to create more pedestrian friendly mixed use developments in selected areas of the town. The following shows the effect of increased spacing on maintenance and energy costs per mile.

For example:	Zoning	Old HPS Spacing	New HPS Spacing
	R1 Residential	$932.97 per mile @ 400'	$605.09 per mile @ 600'
	R5, R10 Residential	$932.97 per mile @ 400'	$275.04 per mile @ 1200'

- Contract for group relamping and other maintenance improvements on luminaires. Group relamping of streetlighting systems yields savings in the amount of time required for replacement of lamps(bulbs), photosensors, and cleaning of lenses to maintain greater lumen output. This service may be provided by the electric utility company or utility approved contractor at a time and materials rate to determine the actual savings.

  Many larger towns and utility companies who maintain their streetlighting through group relamping have found it not only to be more cost-effective than replacing lamps as they fail, but it also ensures the best light performance over time.

The QL type lamp is similar in appearance, although larger in size and with brighter output, when compared with compact fluorescent lamps. It's white light and excellent color rendering is a strong benefit for its use in residential and pedestrian/commercial areas. Due to its larger size and the diffuse nature of its light output, the QL lamp works best in luminaires that distribute light spherically. The selected post-top luminaire, with its special refractor optics that distribute less than 1% of the light above the horizontal plane, is well suited to this lamp. It meets the intent of regulations for outdoor lighting to be "cut-off", which means to control the amount of light above the horizontal plane to not more than 3%

of total luminaire output. Full cut-off refers to luminaires which control the light about the horizontal plane to not more than 1% of the total luminaire output.

However, in utility style "cobrahead" luminaires, the QL lamp will not provide cut-off distribution in any currently available luminaires. For this reason, the High Pressure Sodium Cobrahead type luminaire will continue to be used for bracket arm mounted fixtures for zones where the post top type fixture does not adequately meet the need for a longer street type distribution pattern. This longer distribution pattern, referred to as either Type II or Type III medium cutoff, works best with clear bulb, point source HID (high intensity discharge) lamps such as High Pressure Sodium and Metal Halide. Although Metal halide provides a clear, white light, it is not favored for many street lighting applications due to its shorter lamp life and consequent higher maintenance costs.

4A. ASSUMPTIONS USED IN MAINTENANCE COST COMPARISONS.

1. 70w High Pressure Sodium standard Sylvania Lumalux lamps have either an E17 Medium or ET23.5 Mogul base and a 24, 000+ hr lamp life. This means that 80% of lamps will have failed at this number of hours. Total lumen output 5550 and mean lumens; cost of $20 per lamp.
2. Mercury free 70w Sylvania Lumalux HGF lamps have an ET23.5 Mogul base; 24,000 hr avg life; and 5100 mean lumens. (not used in calculations)
3. Long-life, non-cycling 70w High Pressure Sodium Lumalux Plus/ECO lamp with an ET23.5 base have a 30,000 hr avg life; 5600 mean lumens.
4. Hours of annual usage for streetlights is 5110 hrs (14 hrs/day avg). This is as included in GMP rate filings.
5. A 30,000 hr lamp, derated by 10% as they begin to burn out at least 27,000 hrs, or 5.28 yrs.
6. A 24,000 hr lamp, derated by 10% to 21,600 hrs, or 4.22 yrs.
7. These are low-end estimates for annual cost of maintenance for group relamping. The non-cycling lamp would be less costly for labor if not group relamping. Regular HPS lamps are hard to find to replace since they still will burn some of the time and go out as they draw more current than is supplied by the ballast.
    a. Std HPS Lamp cost = $20 for lamp + $50 labor = $70 per relamping every 4 years = $17.50 per year.
    b. Mercury Free HPS cost = $40 lamp + $50 labor = $90 per relamping every 4 years = $22.50 per year.
    c. Non-cycling HPS cost = $45 lamp + $50 labor = $95 per relamping every 5 years = $19.00 per year.
8. Annual cost of maintenance (high estimate) for group relamping.
    a. Std HPS Lamp cost = $25 for lamp + $75 labor = $100 per relamping every 4 years = $25 per year.
    b. Mercury free HPS cost = $45 for lamp + $75 labor = $120 per relamping every 4 years = $30 per year.
    c. Non-cycling HPS cost = $55 for lamp + $75 labor = $130 per relamping every 5 years = $26 per year.
9. GMP maintenance cost under Rate 18 is $2.76/mo or $33.12 per year for replacement every 4 or 5 years. This cost includes replacement of photosensor and lamp, as well as replacement of broken fixtures that GMP owns. GMP assumes two linemen using a bucket truck for relamping.
10. The additional cost of replacing a photosensor is about $12 once every 10 years. This would include a high quality NEMA type twist-lock photosensor, not a button type. I don't add additional labor, since it would be easily replaced at the time of relamping.
11. The net present value (NPV) cost of replacing the electrode-less lamp and generator, including labor is assumed to be $350. I do not have any figures on how much labor would be required to replace these, so this cost could be higher or lower. The actual material costs would be around $150-$200 each.
12. Replacement of the electrodeless lamp and generator is assumed to be at 100,000 hrs, which is 19+ years.
13. The annual energy cost for 55w electrode-less lamp is not defined under Rate 18, but pro-rated it would be $28.38. Rate 18 annual energy charge for a 60w lamp is $30.96. This includes energy used by the ballast as well as the lamp.
14. The annual energy cost for 85w electrode-less lamp is also not defined by Rate 18. Pro-rated it would be $41.52. Rate 18 annual charge for a 100w lamp is $48.84.
15. Replacement of ballasts on HPS fixtures is assumed to occur at 20 years. Specified cobrahead type fixtures have replaceable ballast trays, making this a simple maintenance task. The cost of a replacement ballast tray is assumed to be $60, which would be replaced during a scheduled relamping.

16. At 85’ spacing between poles, there are 62 fixtures per mile.
17. At 100’ spacing between poles, there are 50 fixtures per mile.
18. At 130’ spacing between poles, there are 40 fixtures per mile.
19. At 200’ spacing between poles, there are 26 fixtures per mile.
20. At 400’ spacing between poles, there are 13.2 fixtures per mile.
21. At 600’ spacing between poles, there are 8.8 fixtures per mile.
22. At 800’ spacing between poles, there are 6.6 fixtures per mile.

23. Therefore, for a 70w light pole, mounted every 400’, the energy cost per mile (based on GMP rate 18 tariff) is $37.56 x 13.2 fixtures per mile = $495.80 per year. As a comparison, at one per every 600’, the energy cost per mile would be $37.56 x 8.8 = $330.53 per year.

24. Energy-only Rates for streetlights are per GMP Rate 18, revised in November 2005. 70w is $37.56 per year. 100w is $48.84 per year.

25. Replacement cost assumptions in Net Present Value:

	HPS Cobrahead (as per standard)	HPS Post top (not town standard)	Induction Post top (as per standard)
Fixture cost	$200.00	$800.00	$1100.00
Pole cost	$350.00	$900.00	$ 900.00
Fixture/pole install	$700.00	$700.00	$700.00
Electrical installation	$200.00	$200.00	$200.00
Total	$1450.00	$2600.00	$2900.00
OH&P (25%)	$ 360.00	$ 650.00	$ 725.00
Total pole and fixture replacement	$1810.00	$3250.00	$3625.00
Fixture replacement cost (for comparison with utility service)	$450.00	$1050.00	$1350.00

26. Replacement costs do not include trenching or conduit, as the original construction is assumed to be built to high quality standards. Replacement costs do include replacement of the pole, although poles, either fiberglass composite or aluminum, often last much longer than the luminaires. Therefore, it is unlikely that actual replacement costs would be this high.
27. Replacement costs per mile are calculated in the same fashion as the energy costs per mile, but using the figures from item 23.

TABLE 4.1 MAINTENANCE, ENERGY, AND REPLACEMENT COST COMPARISONS FOR HPS AND INDUCTION LIGHTING

(see next page)

SECTION 5. REPLACEMENT/UPGRADING OF EXISTING STREETLIGHTING

Why convert from a utility owned to a town owned streetlighting system?

Pro's for conversion:

- Reduced long term costs
- Improved quality of light and lighting system, including reducing glare and improved visibility where older lighting can be converted to newer cut-off type luminaires
- Increased energy efficiency and reduced energy costs by converting old mercury fixtures
- Improved maintenance of outdoor lighting through special contract with the utility or other qualified electrical contractor
- Reduced or eliminated use of uncontrolled lighting that unnecessarily lights up the night sky
- Less product waste, as town ownership justifies purchase of better quality, longer lasting light fixtures

Con's against conversion:

- Places potential risk of damage or vandalism to streetlighting system on town
- Eventual replacement of fixtures will be at the town's cost, so this cost must be built into the financial equation
- Payment for the undepreciated cost of a relatively new utility owned system can lessen financial payback to the town
- Town assumes administrative costs for products it purchases and maintains
- Responsibility for proper disposal of mercury containing lamps lies with the owner of the system. If maintenance work is contracted out, the contractor must maintain paperwork showing proper disposal.

In considering taking ownership of the streetlighting system, these specific issues must be addressed by the Town of Colchester.

- Are there actual cost savings to owning and maintaining the system with town crews or through a qualified contractor?
    - What is the source of funding to replace existing street lights? While there are cost savings in maintenance and energy costs from going to the new streetlight standards for new development, the replacement costs for the poles, and luminaires also must be considered. A source of interest free or very low interest capital is needed to fund replacement in order to achieve total cost savings. Some possible sources of revenue for this purpose will be considered in Section 5B.
    - Is taking over older decorative fixtures on underground service a worthwhile risk? Long term maintenance and/or replacement of underground service is a potentially costly undertaking. While new service is installed in conduit and inspected prior to acceptance, there is no guarantee that problems will not arise over time. This cost, which would be very difficult to estimate, has not been built into replacement costs used in this report. Current utility service also does not anticipate costs of underground conduit replacement.

- Does the town have the necessary staffing (internal or contracted) with the skills required to perform streetlight maintenance work? Maintenance of streetlights on utility poles will continue to be provided by the electric utility due to liability and safety concerns. However, systems with underground distribution on "decorative" light standards are less of a safety concern, although the 20' to 25' mounted fixtures will require at least a small bucket truck for safe access to the fixture for relamping.

- Does the town carry the necessary insurance coverage for damage to streetlights that it owns? Who will file the claims and provide support when damage does occur? Such damage due to traffic accidents, falling trees, and unusually high winds, ice, and storms is not uncommon. How long are residents willing to wait for replacement? Will the town stock replacement fixtures and poles as the utility does currently?

- How likely is it that vandalism will occur to streetlights and poles? How will this be handled?

- Who will track the maintenance of streetlights? Are GPS maps and assistance available to provide the necessary labeling and tracking of routine and less frequent major maintenance to the system?

- Does the town have a contract for disposal of mercury containing lamps, such as high pressure sodium, fluorescent, and mercury lamps? Lamps are considered hazardous waste, and must be disposed of properly.

All of these questions should be thoughtfully discussed and answers provided before agreeing to take over all or part of the existing 780 or so streetlights currently owned and serviced by Green Mountain Power. There are also lights in the northern part of Colchester which are supplied by CVPS and located on standard utility poles. CVPS is not currently permitting towns to own lights installed on the utility poles.

The following Table 5.1 provides a basic comparison of the cost of the current GMP provided streetlights with a scenario in which all of those lights were upgraded with no carry over of replacement cost in the form of financing.

5A. PROJECTED COSTS OF TOWN REPLACEMENT AND OWNERSHIP OF STREETLIGHTS

The cost of taking over and/or upgrading existing streetlights breaks down into several categories. Each needs to be looked at on its own merits.

1. Rate 16 MV lights on utility poles.

   Mercury vapor fixtures on utility poles should be upgraded to full cut-off type fixtures with High Pressure Sodium lamps for energy savings and the lowest maintenance cost. GMP does permit the town to own streetlights on its utility service poles, with GMP providing energy and maintenance service. CVPS does not provide this flexibility to towns.

   The majority of streetlights in Colchester are 100w Mercury Vapor, and replacement of lights on GMP poles is relatively easy to accomplish with GMP's crews performing the work. However, there may be some resistance by residents to the use of the gold colored HPS light in some residential areas. Planning for replacement will require outreach to the community not only to explain the need for the change, but also to gain support for the expenditure of resources in order to gain longer term savings.

2. Rate 16 MV lights including cobraheads and Town and Country luminaires on dedicated light poles/underground service.

   Assuming ownership of older underground serviced streetlights should be approached with caution. Testing should be done to ensure that the underground service is installed in conduit, and that the service is in proper order before the town decides to take over any of these lights.

   The poles themselves need to be looked at to determine their condition and whether they can be fitted with newer lights. This is a particular concern for the 12' poles with old "Town and Country" style luminaires. While the Lumec Serenade fixture may not be a good fit for this type of pole, GE makes the "Salem" style cutoff type lantern fixture with a Sylvania induction lamp that may be a better fit. This fixture is also a less costly fixture to purchase. See luminaire specifications for more information.

   If the capital resources can be raised, the induction (QL) type luminaire provides the greatest potential reduction in maintenance costs for the town. However, due to its high initial and replacement cost, as well as the potential cost of replacing existing poles, this replacement category also carries the highest financial burden.

3. Rate 18 MV or HPS lights on utility poles

   MV cobrahead fixtures should be replaced with the equivalent lumen output in HPS lamping. As with MV lights on rate 16, the long term cost benefits from a fixture retrofit would come if the town can assemble the needed capital for purchasing the luminaires directly. GMP would provide the replacement labor due to safety and security concerns. Plainfield, VT did such a replacement recently with the 50 light locations in its village. In that instance, most of the older lights were non-cutoff, and there was no charge required to write down GMP's fixed costs in the installation.

Newer HPS lights that are owned by GMP may be purchased, with cost determined by age of the luminaire. The purchase of these fixtures may be a lower priority since there are greater cost savings to be achieved in other categories.

4. Rate 18 MV or HPS lights on decorative poles

   MV fixtures should be changed over to HPS, if it is determined that the cost of taking over the underground distribution system would be advantageous to the town. This would have to be negotiated with GMP, and will involve some cost- depending on the age of the system. If the system is not being taken over, GMP should be asked to change all of the lights to HPS.

5B. SOURCES OF REVENUE FOR UPGRADING STREETLIGHTING

Several grant or incentive options may provide some revenue for streetlighting improvements, but it is unlikely that these would cover any significant percentage of the overall cost of conversion. Most of the grant options are conditional on meeting requirements that are unlikely to be met in Colchester without some change in the criteria for those grants.

1. Grant options

   a. Community Development Block Grant, Federal, administered by VT Dept of Housing & Community Affairs. Generally directed toward projects for low and moderate income.

   b. Vermont Housing & Community Affairs, Designated village center program for streetscapes. Applies only to designated village centers. Contact: Joss Bessy 828-5212

   c. Enhancement Grants – through VT Agency of Transportation, may not be extended beyond 2008. Contact: MPO Peter Keating 660-4071 x14 This program also focuses on designated downtown areas.

2. Bond issue

   Significant potential cost savings from streetlight improvements could make issuing a bond to cover the replacement costs worthwhile. However, the savings could be reduced or eliminated as a result of the interest costs. Also, the cost of total replacement of systems, including new underground distribution and poles, would be too high for the town to finance unless this is accompanied by significant increases in town revenues from such development.

3. Special tax assessments, or tax districts, to generate sufficient revenues for a multi-year replacement effort. Contact the VT League of Cities and Towns- the Municipal Assistance Center- to learn about Special Assessment Districts.

4. Allocation of funding from the town's operating revenues, is the most likely source for revenues that would be required over a number of years for replacement. Savings in maintenance and energy costs may be used to justify setting aside an annual budget for streetlight replacement. In the case of Plainfield, the town voted to allocate the resources needed for replacement of 50 lights

at one time. Replacing a set number of fixtures per year may yield the best contract savings both for equipment and labor, and allow for development of a planned replacement program.

5. Energy conservation incentives would be available, but not large enough to make a significant impact in the cost of replacement. Plainfield was provided with $30 for each fixture with a reduced wattage from the one it replaced.