

CORPORATION OF THE CITY OF BURLINGTON

STREET LIGHTING SPECIFICATIONS
AND DESIGN MANUAL

SPECIFICATION NO. SS-08

(Revised October 2019)

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1 Street Lighting Design and Installation Requirements

1.1 Glossary:

ANSI/IESNA RP-8-18 - Illuminating Engineering Society of North America's American National Standard Practice for Design and Maintenance of Roadway and Parking Facility Lighting, issued September 4 , 2018.

TAC -Transportation Association of Canada -Guide for the design of Roadway Lighting

ESA- Electrical Safety Authority

CSA – Canadian Standards Association- Photometric Performance of Street Lighting Luminaires

Luminance Design – a design based on the amount of light which is reflected from a surface and reaches the eye of the observer. It is based on the "light" the observer sees at a given point and is based on the reflectance of the surface and the angle and distance of the observer from the point observed. See RP-8-18, Chapter 3 for further information on luminance.

Illuminance Design - a design based on the amount of light which incident on a surface. Illuminance ignores the surface upon which the light falls. See RP-8-18, Chapter 3 for further information on illuminance.

Pedestrian Conflict (PC) Area Classification – Road classifications describe general conditions of vehicular traffic conflict in urban areas. A second type of conflict is the vehicular/pedestrian interaction. Pedestrian activity is nearly always related to the adjacent land uses. There are three levels of pedestrian conflict used by RP-8-18, high, medium and low. For the purposes of this manual, the pedestrian conflict level is assumed to be low for rural and low density urban areas. Medium for high density developments and adjacent to schools. Downtown locations are considered to be high density. High PC Areas are areas with significant numbers of pedestrians on the sidewalks or crossing the streets during darkness. Examples are downtown retail areas, areas near theatres, concert halls stadiums and transit terminals.

Medium PC Areas are areas where fewer pedestrians use the streets at night. Examples are downtown office areas, areas with libraries, apartments, neighborhood shopping and streets with transit lines. Low PC Areas are areas with low volumes of pedestrian traffic at night. Examples are suburban streets, low density developments and rural or semi-rural areas.

See RP-8-18 for further information on pedestrian conflict classifications.

Pavement Classifications – Luminance calculations require information about the directional surface reflectance of the pavement. There are four general pavement classifications given in RP-8-18 Table 3.1;

Class	Qo	Description	Mode of Reflectance
R1	0.10	Portland Cement concrete road surface. Asphalt road surface with a minimum of 12% of the aggregates composed of artificial brightener (e.g.synopal) aggregates. (Examples labradorite, quartzite)	Mostly diffuse
R2	0.07	Asphalt road surface with an aggregate composed of a minimum 60% gravel (size greater than 1cm) Asphalt road surface with 10 to 15% artificial brightener in aggregate mix. (Not normally used in North America)	Mixed (diffuse and specular)
R3	0.07	Asphalt road surface (regular and carpet seal) with dark aggregates (e.g tap rock, blast furnace slag); rough texture after some months of use (typical highways)	Slightly Specular
R4	0.08	Asphalt road surface with very smooth texture	Mostly specular

R3, is the typical road classification for roads and the pavement classification to be used in Burlington unless otherwise directed by the City,

1.2 General:

Street lighting design in the City of Burlington shall be generally based on ANSI/IESNA RP-8-18, or latest edition.

Street lighting design in Burlington must provide uniform lighting at a level that is adequate and comfortable for vehicular and pedestrian movement on the City's roads and sidewalks. All street lighting systems in the City of Burlington shall be designed by a qualified lighting designer using the illuminance and luminance methods as described in RP-8-18 (unless noted otherwise), and the Transportation Association of Canada TAC "Guide for the design of roadway lighting" as well as incorporating both the City's and Burlington Hydro's standards and specifications as given below. Street lighting design in Burlington must take into consideration all of the approved luminaires of a given type in order to allow interchangeability of luminaires during maintenance operations.

It is the responsibility of the street lighting designer to ensure they have the latest revisions of the City of Burlington's street lighting standards and specifications and a current list of approved suppliers prior to designing a street lighting system.

All street lighting design and construction is subject to Electrical Safety Authority (ESA) inspection and approval. All materials used for street lighting in the City of Burlington must meet CSA specifications.

If street lighting luminaires are to be installed on Burlington Hydro poles design shall meet Ontario Regulation 22/04 requirements. The documents and drawings prepared shall be stamped and sealed by a Professional Engineer and submitted to Hydro for approval.

Decorative street lighting may be used in the City only with the City's permission and in accordance with the City's requirements and specifications.

1.3 Replacement and Upgrade Policy:

New installations shall be designed and constructed in accordance with the specifications contained in this manual wherever possible. Where the designer wishes to use materials or specifications not contained in this manual, they must first contact the City to obtain their approval.

It is the policy of the City that damaged or destroyed street light poles, luminaires, etc. shall be replaced with materials in accordance with the current standards.

1.4 Downtown Lighting Policy:

The downtown area of the City is considered unique and requires special consideration. There is in general a high level of pedestrian activity in the downtown area, particularly during the numerous special events that occur in the summer months.

It is the policy of the City that all street and sidewalk lighting design shall be based on ANSI / IES RP-8-18.

The design criteria for pedestrian walkways shall include both horizontal and vertical illuminance. Vertical illuminance aids facial recognition.

All lighting designs for the downtown area must be submitted to the City for review. Including but not limited to illuminance design, cut sheets, shop drawings, lighting design photometric analysis data, cross sections, etc. The designer shall submit an appropriate road cross section(s) and the proposed road and pedestrian conflict classifications to the City for review. No design shall proceed without the City's approval of the road and pedestrian conflict classifications.

Lighting pole and luminaire combinations shall comply with the City's current Downtown streetscape Guidelines

2 Illuminance and Luminance Design Criteria

2.1 Introduction

The design requirements for luminance and illuminance shall be as detailed in ANSI/IES RP-8-18. The values given for luminance shall be used for all roadways. The values given for illuminance are for use in intersection and sidewalk designs. For the purposes of lighting design in the City of Burlington, it shall be assumed that the pedestrian conflict area classification with the exception of downtown area is low. All roads requiring a medium or higher pedestrian conflict designation will require the preparation and submission of a suitable design to the City for review.

Note 1 – Pedestrian Conflict Area Classification is as defined in ANSI/IES RP-8-18. The only standard exception to the low PCC used in lighting calculations the City is in school zones, where a medium PCC shall be used.

Note 2 – Pavement Classification is as defined in ANSI/IES RP-8-18.

2.2 Design Recommendations

(a) The street lighting system shall be designed to meet the average maintained luminance level, and to meet or exceed the uniformity ratio and meet the veiling luminance ratios for each type of roadway. The street lighting system shall also be designed to meet the

average maintained illuminance level, and to meet or exceed the uniformity for walkways.

(b) A roadway lighting system involves the systematic consideration of several practical aspects including;

- Safety
- Obtrusive or nuisance light trespass and glare -See Appendix A
- Sky glow
- Cost both capital and operational
- Optimization of lighting
- Aesthetics
- Environmental considerations
- Site conditions
- Collision data and investigations

(c) When locating street lighting poles, the Design Engineer shall follow standard Planning and design processes as detailed in RP-8-18.

(d) The design shall determine the determine the purpose of the lighting be that roadway, interchange, street or pathway and pay close attention to the recommended practice and methodology on RP-8-18 specifically Chapter 10 and 11.

(e) When determining lighting pole positions poles should first be placed at intersections and conflict areas and then in between using optimal spacing.

(f) The Design Engineer shall determine at the beginning of the design what restrictions are in place due to safety reasons or other physical restrictions. Utilities such as Gas and Hydro have regulations in place restricting pole placement within a certain off-set from the outer edges of pipes or conductors. Pole placement near overhead hydro lines is also governed by the Ontario Electrical Code based on the voltage present in the conductors

(g) A maximum off-set of 1.7 m shall be maintained between the face of the curb and the centre of the pole for all local roads with a 5.0 m or below boulevard. For roadways with 6.0 m or above boulevard, the off-set shall be a maximum of 2.5 m. pole locations shall always be within the road allowance, and take due consideration of underground utilities and obstructions. Guidance can be found in RP-8-18 in Chapter 6.

2.3 Lighting for Urban Intersections Roundabouts and Crosswalks

Illuminance calculations shall be used in the design of intersections. Intersections should be illuminated to a level equal to the sum of the recommended average illumination levels for each of the intersecting roads. These levels are given in Table 12-1 of Chapter 12 of RP-8-18.

2.4 ESA Lighting Design Requirements

ESA regulations are intended to separate the street lighting system from the Hydro electrical distribution system and to allow parties other than the local distribution company to maintain street lights.

There is specific guidelines which shall be adhered to in the ESA document "Guidelines for the Design, installation and operation and Maintenance of street lighting assets".

(Latest edition)

In order to accomplish this, a lighting designer must place a service entrance rated disconnect between the electrical distribution system and the street lighting system. The method approved by the City of Burlington at this time is to run an appropriately sized service cable to a street light pedestal (see City of Burlington Dwg. No. S-156) and from there to the individual street lighting circuits.

A maximum of a 5% voltage drop will be allowed in the street lighting cable from the transformer to the last light in the circuit.

All materials, including the secondary service to the disconnect switch, must be CSA approved and will be subject to ESA inspection and approval.

2.5 Cul-de-Sacs

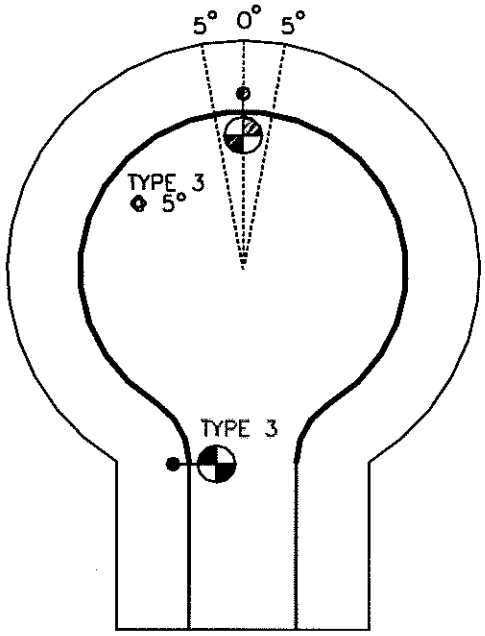
There are several design criteria to be addressed when designing lighting for the end (bulb) of cul-de-sacs. These are:

- The area to be lit is not readily adaptable to the standard luminaires used in Burlington;
- The space available for the placement of the luminaires/poles is generally quite limited due to the convergence of driveways in the boulevard areas; and
- Due to the basic assumptions inherent in luminance design and the methods used in its calculation, the use of luminance criteria at the ends of cul-de-sac (or any other "dead-end" arrangement) is not recommended. Illuminance method and calculations are recommended for use in the design of cul-de-sac as detailed in RP-8-18 Chapter 11, section 11.8.3

2.5.1 Lighting in Cul-de-Sacs

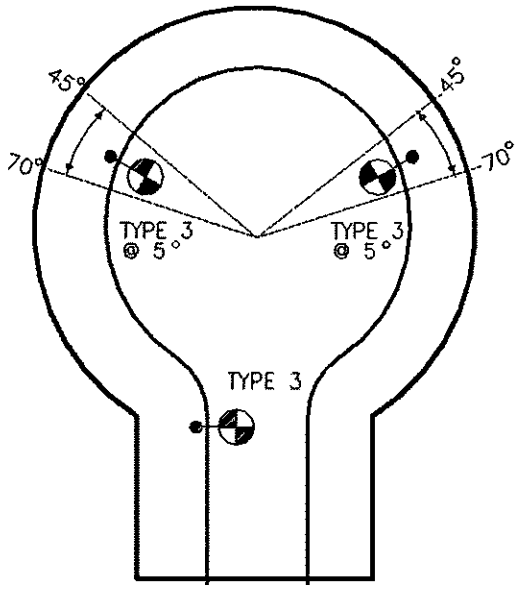
It is recommended that lighting in cul-de-sacs be arranged in accordance with the layouts given below.

Option A



Option A consists of a street light placed as close as possible to the neck of the bulb with two street lights tilted at 5° at the top of the bulb at an angle of 0° +/- 5° off the "north" line. The luminaire wattage and pole size are to match the luminaire/pole combination specified for the type of street.

Option B



Option B consists of a street light placed as close as possible to the neck of the bulb, with two street lights tilted at 5° at angles of 45° +/- to 70° +/- from the top center of the bulb. The luminaire wattage and pole size are to match the luminaire/pole combination specified for the type of street.

Designs for street lights using arrangements other than the standard locations given above shall be accompanied by a full set of lighting calculations for review and approval by the City.

3 Material Specifications

All street lighting equipment used in the City of Burlington must meet the current City of Burlington's street lighting standards and specifications. It is the responsibility of the street lighting designer to ensure they have the latest revisions of the City's street lighting specifications and list of approved suppliers prior to ordering any materials. All street lighting components are to be manufactured in strict accordance with the City's current requirements.

3.1 Street Light Poles

Street light poles used in the City of Burlington must be manufactured in accordance with the City's street light pole specifications as given below.

3.2 Standard Round Concrete Street Light Poles

9.45 meter (31.0 ft.) Class B Centrifugally Cast Round Concrete Pole

The 9.45 meter concrete street light pole shall be a direct buried Class B pre-stressed round concrete pole with provision for electrical ground, natural concrete finish and suitable for use with a 1.8 meter tapered aluminum bracket and manufactured in accordance with the City of Burlington Street Light Specification Drawing Number S-152

11.4 meter (37.5 ft) Class B Centrifugally Cast Round Concrete Pole

The 11.4 meter concrete street light pole shall be a direct buried Class B pre-stressed round concrete pole with provision for electrical ground, natural concrete finish and suitable for use with a 2.4 meter tapered aluminum bracket and manufactured in accordance with the City of Burlington Street Light Specification Drawing Number S-152

3.3 Decorative Black Concrete Street Light Poles

9.9 meter (32.5 ft) Class B Centrifugally Cast Black Octagonal Tapered Concrete Pole

The 9.9 meter black octagonal tapered concrete street light pole shall be a direct buried Class B pre-stressed concrete pole with provision for electrical ground, black eclipse polished finish a side mount decorative bracket and luminaire, manufactured in accordance with the City of Burlington Street Light Specification Drawing Number S-153

10.7 meter (35.0 ft) Class B Centrifugally Cast Black Octagonal Tapered Concrete Pole

The 10.7 meter black octagonal tapered concrete street light pole shall be a direct buried Class B pre-stressed concrete pole with provision for electrical ground, black eclipse polished finish a side mount decorative bracket and luminaire, manufactured in accordance with the City of Burlington Street Light Specification Drawing Number S-153 (latest revision).

3.4 Decorative Aluminum Poles (Downtown Locations)

The 3.8m or 4.6m tall decorative poles shall be Aluminum, one-piece construction. The 500mm fluted cast aluminum base shall be constructed with a 150-100 mm dia tapered aluminum shaft. The pole shall be UL/CSA approved.

The base shall be designed with 12 curved flutes and teardrop decorations and be made of heavy wall 356 grade alloy cast aluminum. The base shall have a 25mm thick floor cast as an integral part of the base. The shaft shall be double circumferentially welded internally and externally.

The shaft shall be tapered fluted extruded and be made of ASTM 6063 extruded aluminum and tempered to T6 condition.

The pole shall be provided with four 20mm dia galvanized "L" type anchor bolts. Each anchor bolt shall be equipped with double nuts. A door shall be provided for wiring and anchor bolt access. It shall be secured with tamper proof stainless steel hardware. A ground lug shall be installed in the pole handhole, manufactured in accordance with the City of Burlington Street Light Specification Drawing Number S-155.

The City may from time to time deviate from this standard of decorative pole in special circumstances or locations and will generally follow the Street Scape Guidelines document. Any proposed poles should be approved by the Street Lighting department.

The shaft and base shall be powder coated Black.

Options

- GFI Receptacle
- Flag pole holder
- Single banner arm
- Double banner arm

- Planter, hanging basket arm
- Wreath mount hooks

3.5 Brackets

All street light brackets used in the City of Burlington must be manufactured in accordance with the City of Burlington's specifications as given below (latest revision).

3.5.1 Tapered Elliptical Aluminum Brackets

Standard street light brackets for use with "cobra-head" luminaires must be manufactured in accordance with "ANSI C136.1", latest revision.

The brackets shall be a 1.8 m or 2.4 m tapered elliptical aluminum bracket. The brackets for mounting on wooden hydro poles shall be 1.8 m long with 2.1 m rise ("high-rise") tapered elliptical aluminum brackets.

3.5.2 Decorative Brackets

Decorative street light brackets must be manufactured in accordance with "ANSI C136.1", latest revision with the changes necessary to apply to arms for decorative fixtures.

The brackets shall be a 1.5 m or a 1.8 m nominal curved bracket with a decorative scroll below the bracket.

The City may from time to time deviate from this standard of decorative bracket in special circumstances or locations and will generally follow the Street Scape Guidelines document. Any proposed brackets should be approved by the Street Lighting department.

3.6 Luminaires

All luminaires used in the City of Burlington must be manufactured in accordance with the City of Burlington's Street lighting luminaire standards.

3.6.1 "Cobra Head" LED Luminaires

In general, streets may be lighted by means of "Cobra head" style luminaires designed specifically for street lighting applications and having the following design characteristics:

a. Designed to mount on a pole using a horizontal bracket arm;
b. An aluminum top housing containing the light source, associated control gear and mounting mechanism
c. An optical aperture that is either open or enclosed with a flat lens
d. Mounted in a fixed position;
e. Provided with a photometric file tested to IES LM-79-08 (LED Light Sources) using type C photometry per IES LM-75-01.

The methodology used for shortlisting approved luminaires is that the LED luminaires meet the specifications required in the City of Burlington Luminaire Standards document and performance with respect to RP-8-18, the Unit Power Density and the energy saving criteria and then the luminaires that have met these criteria are investigated for their economic performance and shortlisted as shown below.

See Also Appendix B

Manufacturer	Model reference
Philips/Signify	Road Focus
Cooper	Arch
GE	Evolve
LED Roadway	NXT

3.6.2 Decorative Coach LED Luminaires

A "Traditional Coach light" style luminaire intended for lighting streets that serve a decorative function in addition to providing optical performance that delivers street lighting appropriate for the street and pedestrian usage. It will have a coach light appearance, and will have the following design characteristics:

a. Designed to mount on a pole using a bracket arm or vertical tenon;
b. An aluminum top housing containing the light source, associated control gear and mounting mechanism, and with or without translucent side panels;
c. An optical aperture that is either open or enclosed with a flat lens;
d. Mounted in a fixed position;
e. Provided with a photometric file tested to IES LM-31-95 (HID Light Sources) or IES LM-79-08 (LED Light Sources) using type C photometry per IES LM-75-01.

See Standard detail Drawing S-155A.

Approved Decorative Coach LED Luminaires

Manufacturer	Model reference
Philips/Signify	L40U
Cooper	UTLD Traditionaire
Holophane	AEL Georgian
King Luminaire	K600 Series

The City may from time to time deviate from this standard list of decorative fixtures in special circumstances or locations and will generally follow the City's Street Scape Guidelines document. Any proposed fixture should be approved by the Street Lighting department.

3.7 Photo-Electric Controllers

Photo-electric controllers for the City of Burlington shall be electronic twist lock photo controllers with:

A filtered (human eye spectral response) silicon light sensor with infrared blocking filter

MOV surge protection

Rated for 120 volts

Load rating: 1000 watts, 1800vA ballast

Turn on level at 1.5 FC and turn off at 1.5 times turn on

Operating temperature range from -40^{0}C to 70^{0}C

20 year life span

Photo-electric controllers must be manufactured using non-hazardous materials.

3.8 Lamps

See LED specifications, Appendix B

3.9 Load centers/Pedestals

The City requires the ESA mandated disconnect for any street lighting system. The disconnect is provided by means of a service entrance rated loadcentre (i.e. pedestal type for underground systems, and pole-mounted unit for overhead systems) with weather proof enclosure, and complete with:

60 amp, 22 kAIC, 120 V / 240 V double-pole line side main breaker, and 40 amp, 120 V single-pole load side breakers (quantity: up to 8).

Note: Only 120 volt street lighting systems are approved by the City, hence only single pole 120 volt loadside breakers are permitted.

City of Burlington Street Light Specification Drawing Number S-156

3.10 Street Light Conduit

Street light conduit shall be 50 mm (2") Type II PVC, direct buried or directional bore conduit duct meeting CAN/CSA-C22.2 NO. 227.1-97 (latest revision).

3.11 Street Light Wiring from the Pole or Handhole to the Luminaire (riser cable)

Street light wiring from the handhole to the luminaire shall be 2 - #12 copper NMWU with ground.

3.12 Street Light Distribution Cable from Load center to Street Light Poles (Load-side Circuits)

The street light cable from load center to luminaire and from luminaire to luminaire shall be 3 - #6 copper RWU 600 volt single insulated conductor (red/black/white/green).

3.13 Street Light Power Supply Cable from Hydro Transformer to Load center (Line-side Circuits)

The street light supply cable feed from Hydro transformer to load center shall be 3 - #4 copper RWU 600 volt (black/red/white/green), as per latest Burlington Hydro standards.

3.14 Grounding Rods and Plates

Ground rods shall be solid steel, 19 mm diameter, 3 m long, copper clad for the full length and shall be according to CSA C22.2 No 41.

Ground plates shall present not less than 0.2 m^2 of surface to exterior soil and be not less than 6 mm thick as per the Electrical Code. The plates shall be made of hot dip galvanized solid steel. Steel shall be according to CAN/CSA G40.20/G40.21, Grade 230G and shall be galvanized according to CAN/CSA G164.

All wiring circuits are required by code to be protected with overcurrent devices such as circuit breakers or fuses, which are located in the lighting distribution cabinet. In addition, luminaire circuits should be protected with an inline fuse or terminal block located within the pole handhole, or the nearest junction box or luminaire.

4 Adaptive Lighting

The City currently does not utilize Adaptive Lighting control but may consider it in the future.

Adaptive lighting is a design methodology in which the light output of a system is adjusted as traffic conditions change. More specifically, roadway lighting illumination levels are adjusted based on the needs of the roadway's users. The level of lighting can be reduced or dimmed when traffic and pedestrians on roads, sidewalks, or both is reduced.

Dimming the lighting level while maintaining the lighting configuration will not affect the uniformity of the lighting or an object's contrast; however, contrast thresholds will increase, resulting in longer detection times.

Luminaires installed in new lighting designs often exceed the requirements of the lighting design. Over time, the system will meet or exceed the design level even as the lamps age and dirt accumulates on lenses. Adjusting the output of luminaires so the system meets the design level throughout the service life of the lamps can also save on energy costs and eliminate periods of over-lighting.

The overall objective of adaptive lighting is to reduce or increase lighting levels on roadways During Periods of reduced or increased Traffic and pedestrian Density. Some of the issues to consider are:

- Optimal times and conditions for adapting lighting.
- Appropriate lighting levels for various roads and road features.
- Appropriate approaches for reducing lighting.
- Energy savings and reduction in greenhouse gases that may result from reducing lighting.
- Potential legal issues related to reducing lighting, including the development of such.

Recommendations are detailed in RP-08-18 in Chapter 6, and specifically section 6.10.3.

5. Installation Specifications

5.1 General

The contractor shall ensure that the construction and installation of a street lighting system shall in accordance with the latest revisions of the specifications, standards and drawings of the City of Burlington.

Street lights shall be located on the boulevard in accordance with the City of Burlington's standard cross sections and as shown on the trenching plans and typical road sections, while maintaining proper clearances from fire hydrants, driveways, transformers, switching units and trees or any other services.

The street lighting power is to be supplied to each streetlight load center in accordance with Burlington Hydro U/G electrical distribution specs.

The entire street light installation is subject to inspection and approval by the ESA. The contractor is responsible for applying and obtaining said inspection. Burlington Hydro will make the connections inside the transformer or Hydro system once the following steps have been fulfilled:

- Approval has been given by the ESA, and a Connection Authorization has been received by Burlington Hydro. City Engineering Inspection will also require a copy of the ESA authorization for the City's records.
- The contractor has arranged for a Megger testing of the system, and a copy of the successful test report has been submitted to the City Engineering Inspector and the Supervisor of Traffic Operations.
- The Supervisor of Traffic Operations has sent a request for connection letter to Burlington Hydro.

Burlington Hydro will notify the City Engineering Inspector and the Street light Coordinator once the street light system connection at the transformer has been completed. The City Engineering Inspector shall then energize the streetlight system at the load center and inspect the system operation. Any deficiencies shall be reported by the Inspector to the contractor for rectification.

5.2 Cable

Street light cables shall be installed in conformity with Burlington Hydro's Underground Electrical Distribution specifications. The cable shall be installed in 50 mm Type II PVC, direct buried or directional bore conduit with a minimum of 600 mm cover. As per the Electrical Code, a 150mm wide red plastic warning tape is to be installed with black lettering stating "ELECTRIC LINE BURIED BELOW". This warning tape is required to be installed midway between the topmost conductor and final grade above all conductors within the trench.

Where the street light poles are not in place at the time of the cable installation, the end of the cable shall be coiled and staked at the intended pole location in a similar manner to the secondary service cables except that at least 3 m of cable shall be left above grade. Where the cable is to continue onto another street light, the cable shall be looped and not cut, and at least 6 m in total shall be left above grade.

Cables are to be inserted into poles via the cable access ports and the ground wire shall be connected to the internal ground lug at the hand hole by means of a #6 AWG compression connector lug.

All connections to ground and to the luminaire conductors are to be made at the hand hole and taped or otherwise insulated after installation.

All connections inside the transformer shall be made by Burlington Hydro.

5.3 Street Light Conduit

In general, the ducts shall be placed in accordance with Burlington Hydro's underground electrical distribution system specifications. In general, the street light duct shall be placed in the common trench on the same level as the secondary and/or communication cables, and on the road side of the trench, with a minimum of 600 mm cover.

When street light ducts are placed under driveways, the top 300 mm of the backfill shall be compacted to 100% Standard Proctor Density with granular "A".

Street light duct placed under roadways shall be installed in accordance with City of Burlington Standard Drawing S-150 (latest revision) and S-151.

A ¼" Polypropylene fish rope is to be pulled into each duct.

5.4 Street Lighting Handholes

Street light handholes shall be installed where cables and conduit cross intersections and roadways, to define a change in conduit direction and shall be installed to conform with finished grade. Hand holes shall be installed in accordance with Burlington Standard detail drawing S-339

5.5 Street Lighting Power Pedestal

Street light power pedestals shall be installed where hydro cables terminate and a separated, protected dedicated street lighting circuit begins. They shall be made of galvanized steel mounted on a concrete base. Inside there shall be a panel with main breaker for Hydro and load breakers for street lighting circuits.

Power Pedestals shall be installed in accordance with Burlington Standard detail drawing S-156

5.6 Poles

Installation of street light poles is to be in accordance with the City of Burlington Standard Drawings S-152, S-153, S-154 or S-155 and the manufacturer's requirements.

In general, poles are to be installed in augured or vaccuumed (high pressure water evacuation method) holes to the depths given in the above referenced drawings. The bottom of the hole must be cleaned of loose material before placing the pole.

The Contractor shall take care to ensure that no damage occurs to the electrical or street lighting system or other utilities during the installation of street light poles.

5.7 Luminaires, Brackets and Photo Controllers

Installation of street light luminaires and brackets shall be in accordance with the manufacturer's requirements. In general, luminaires and brackets are to be installed and wired prior to the pole being erected.

The photo-electric controller shall be positioned to face north.

The Contractor shall take care to ensure that no damage occurs to the pole, luminaire, bracket or wiring during their assembly and erection.

5.8 Grounding

Two ground rods must be installed adjacent to the street light pedestal, at least 0.3 m below final grade and connected to the bonded neutral block of the service entrance and must be spaced no less than 3 m apart in accordance with the Electrical Code requirements.

Alternatively, a ground plate must be installed adjacent to the street light pedestal at least 0.6 m below final grade level and connected to the bonded neutral block of the service entrance.

A ground rod/plate shall also be installed at the last street light pole of every circuit and bonded to the pole's internal ground.

Either system is acceptable providing the installation conforms to the Electrical ESA Code requirements.

APPENDIX A

SPILL LIGHT/ GLARE

Lighting Zones

The IES and IDA have defined maximum levels of spill light within given areas of ambient brightness, known as lighting Zones (LZ's) these area classifications are being recognized and utilized by professional organizations and adopted in lighting ordinances.

Areas are classified into one of five LZ's ranging from LZ-0 the most restrictive to LZ-4 the least restrictive as shown in table 4.1 of RP-08-18.

Lighting Zones	Ambient Brightness	Locations	Land Use
LZ-0	Dark	Undeveloped areas of open space, wilderness parks and preserves, areas near astronomical observatories, environmentally Sensitive Areas	Wilderness areas, parks, preserves and undeveloped rural areas, or designated environmentally sensitive areas.
LZ-1	Low	Single residential communities, rural town centers, commercial and industrial storage areas with limited night time activity.	Rural, Residential areas, Agricultural or Open Spaces
LZ-2	Moderate	Multifamily residential areas, institutional residential uses, schools, churches, hospitals, hotels, commercial areas with night time activity	Light commercial business districts and high density mixed use residential
LZ-3	Moderately-high	Commercial corridors, high intensity suburban commercial areas, town centers, mixed use areas, industrial uses, shipping and rail yards with high night time activity. High use recreation and playing fields, regional shopping malls, car dealerships, gas stations.	Large Cities and business districts
LZ-4	Very High	High Density entertainment districts, heavy industrial uses	Commercial, Industrial, and high density business or industrial zone districs

Obtrusive Light

Obtrusive light is defined by three major interrelated elements, each considered separately;

- Light trespass
- Glare
- Light Pollution

Light Trespass

Light trespass is light that strays from its intended purpose and can become a visual annoyance or even temporarily disabling. The term light trespass is sometimes called spill light or stray light to describe this effect.

Spill light can be mitigated, but not eliminated, through careful photometric analysis, using a process of experimenting with various mounting heights and luminaires with various lumen outputs, light distribution and shielding options. Computerized lighting design means that this type of experimental process can be carried out using desktop modelling before getting to site. Every effort of the lighting designer should be tried and tested before installation.

Discomfort and disability Glare

Surveys carried out by researchers indicate that in outdoor lighting applications, the light trespass complaints do not necessarily point to objectionable levels of light on their properties. The majority of the complaints seem to describe an annoying brightness from light sources in the visual field.

This subjective condition is called "nuisance glare" or "discomfort glare". Studies have shown that this condition does not create visual disability and is not a safety issue; however, it can cause annoyance and discomfort. Therefore, reducing spill light levels along the property line may not necessarily resolve residents' concerns regarding the perceived brightness/glare of the highway lighting.

Disability glare is another aspect of a lighting system. Disability glare reduces the effectiveness of a driver to see objects or pedestrians in or near the roadway and should be addressed by the recommended practices associated with the specific application.

Glare can often be mitigated by shielding the view of bright light sources from the observer, this can include adjusting mounting heights, decreasing lumen output using external shielding or diffusers or dimming.

Light Pollution

Light pollution is possibly the easiest form of pollution to prevent since it is easily controlled through proper fixture design. Additionally, much of it, such as street lights, is directly under the control of the public sector or is subject to regulations.

Light pollution is defined as excessive and ineffective light, such as light coming from an exposed bulb. Sky glow describes the large scale brightening of the night sky due to the cumulative effect of the illumination of street lights, outdoor advertising, buildings, parking lots, airports, and other sources bouncing off of microscopic particles suspended in the air that is then reflected back to Earth.

Sky Glow

Sky glow prevents a clear view of the night sky landscape for hundreds of millions in urbanized areas around the world and can be seen from outer space. Night light pollution is problematic on a number of fronts, none more serious than its impact on human and ecosystem health. Night light pollution:

- disrupts ecosystems and natural ecological processes such as migration
- affects human circadian rhythms
- wastes energy
- reduces the visibility of stars
- threatens astronomical research

Sky glow has two effective components: The upward light component from the luminaire itself and the reflected light component from the ground. The limitation of upward light component is controlled by the optical characteristics of the luminaire. The reflected light component depends on the amount of light incident on the ground and the reflection characteristics of the surface.

Sky glow can be mitigated and controlled using full cut-off luminaires. No light should be permitted beyond the horizontal line of the fixture.

Limiting Design Criteria for Spill Light

The limiting design criteria for spill light and perceived brightness is a function of Lighting Zones. Illuminance values for spill light may be specified as vertical illuminance

Light Trespass	Proposed Design Criteria				
	Maximum initial Vertical illuminance, lux (foot candles)				
	LZ-0	**LZ-1**	**LZ-2**	**LZ-3**	**LZ-4**
ANSI/IES	0.5 (0.05)	1(0.1)	3 (0.3)	8 (0.7)	15 (1.4)

APPENDIX B
LED LUMINAIRE SPECIFICATIONS

Light Distribution – Photometric data per IESNA LM-79-08 and formatted per IESNA LM-63-02 as an .ies file.

Lumen Maintenance - Luminaire lumen depreciation data derived from Luminaire in-situ temperature measurement testing[4] under UL1598 environments and directly correlated to LED package manufacturers IESNA LM-80-08 data.

Predicted Luminaire Lumen Depreciation Limits[4] (% depreciation @50,000 hours of operation and 15°C[1] operating ambient) as follows:

- < 15% @ 350mA Drive Current
- < 20% @ 525mA Drive Current
- ≤ 30% @ 700mA Drive Current

Lumen Depreciation (LD) Performance Data Sets – LED Luminaire Lumen Depreciation Data Sets to be created from correlated in-situ luminaire test methods[4]. The T_S temperature is to be correlated directly to the LED chip package manufacturer's LM-80-08 data to form data sets predicting luminaire lumen depreciation for the following luminaire average ambient operating conditions: 5°C, 10°C, 15°C, 20°C, 25°C and for the following operating durations: 25,000, 50,000 and 100,000 hours.

LED Life Rating (L_{70}) – Defined as time of operation (in hours) to 30% lumen depreciation (i.e. 70% lumen maintenance), derived from Luminaire in-situ temperature measurement testing[4] under UL1598 environments and directly correlated to LED package manufacturers IESNA LM-80-08 data.

Predicted L_{70} Limits (@ 25°C luminaire ambient operating environment) as follows:

- > 100,000 hours @ 350mA Drive Current
- > 65,000 hours @ 525mA Drive Current
- > 45,000 hours @ 700mA Drive Current

Luminaire Operating Ambient Range – (-40°C – +40°C)[2]

Mechanical – Luminaire housing components to be low copper aluminum, with high performance heat sink(s) designed specifically for LED luminaires. No active cooling features (Fans, etc.). Luminaire configuration must allow for modular upgradability and/or field repair of all electrical components (i.e. LED modules, Driver(s), etc.).

A. Utilizes terminal block for power input suitable for #6 AWG wire

B. Designed to mount on 1.25" IP and / or 2" IP horizontal tenon and is adjustable +/- 5 degrees to allow for fixture leveling

Lighting Controls Options – Provisions for compatibility with wireless (radio frequency, mesh network, etc.) and power line carrier lighting control protocols as follows:

- Tool-less access to LED Driver compartment
- Tool-less removal of existing or standard LED driver and/or control gear
- Tool-less installation of alternate LED driver and/or control gear

Factory installed options

- Ingress Protection (IP) Rating – IP66
- Internal Fusing
- NEMA photo control 7 pin receptacle
- Backlight Cut-Off Shielding

Finish – Finish includes cleaning and preparing metal surface, electro-deposited epoxy primer and baked-on ultra-durable power coat. Salt fog test data to validate corrosion residence performance to be provided in accordance with the ASTM B 117 standard @ 5,000 hours.

Correlated Colour Temperature (CCT) and Colour Rendering Index (CRI)

- CCT = 3000K ± 500K (other CCTs available upon request)
- CRI ≥ 70

Warranty – 7 years on the LEDs, 7 years on the driver, 10 years on the paint finish

Electrical Safety – cUL and UL listed for Wet Location, ENEC, CE, ROHS and EMI. Class 1 rated. Internal surge protection – ≥9kV

Driver Specification

1. Electronic
2. Input Voltage range 120-277 ±10% (347-480V +/- 10% optional)
3. Output Current 0.35 A dc (+/- 5%), 0.53 A dc (+/- 5%), 0.70 A dc (+/- 5%)
4. Input Frequency 50/60 Hz
5. Power Factor >90% at full load
6. THD at full load is < 10% at 120V, <20% at 277V or 347V
7. Load regulation: +/- 1% from no load to full load
8. Output ripple <10%
9. Output should be isolated
10. Case temperature: rated for -40°C through +80°C
11. Overheat protection, self-limited short circuit protection and overload protected
12. Primary fused

13. Driver Life Rating: less than 0.5% failure rate at 150,000 operating hours (@ full rated power and a minimum fixture operating ambient of 22°C)[3]

[1] A 15°C ambient condition conservatively represents the nighttime average ambient conditions for the mildest climate zones of Canada.

[2] Active thermal monitoring and control circuitry will reduce drive current to protect the LED system components from exposure to elevated ambient conditions, above the rated luminaire ambient operating temperature limit.

[3] Represented by accelerated life testing and electronic industry accepted component modelin

[4] LED chip package temperature (T_S) measurement obtained with the LED chip package operating in given luminaire and in a given stabilized ambient environment.

APPENDIX C
US DOE LED SPECIFICATIONS

PART 1 – GENERAL

References

The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by their basic designation only. Versions listed shall be superseded by updated versions as they become available.

American National Standards Institute (ANSI)

- C136.2-2004 (or latest), American National Standard for Roadway and Area Lighting Equipment—Luminaire Voltage Classification
- C136.10-2010 (or latest), American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacle Physical and Electrical Interchangeability and Testing
- C136.15-2011 (or latest), American National Standard for Roadway and Area Lighting Equipment – Luminaire Field Identification
- C136.22-2004 (R2009 or latest), American National Standard for Roadway and Area Lighting Equipment – Internal Labeling of Luminaires
- C136.25-2009 (or latest), American National Standard for Roadway and Area Lighting Equipment – Ingress Protection (Resistance to Dust, Solid Objects and Moisture) for Luminaire Enclosures
- C136.31-2010 (or latest), American National Standard for Roadway Lighting Equipment – Luminaire Vibration
- C136.37-2011 (or latest), American National Standard for Roadway and Area Lighting Equipment - Solid State Light Sources Used in Roadway and Area Lighting

American Society for Testing and Materials International (ASTM)

- B117-09 (or latest), Standard Practice for Operating Salt Spray (Fog) Apparatus
- D1654-08 (or latest), Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
- D523-08 (or latest), Standard Test Method for Specular Gloss
- G154-06 (or latest), Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

Council of the European Union (EC)

- RoHS Directive 2002/95/EC, on the restriction of the use of certain hazardous substances in electrical and electronic equipment

Federal Trade Commission (FTC)

- Green Guides, 16 CFR Part 260, Guides for the Use of Environmental Marketing Claims

Illuminating Engineering Society of North America (IESNA or IES)

- DG-4-03 (or latest), Design Guide for Roadway Lighting Maintenance
- HB-10-11 (or latest), IES Lighting Handbook, 10th Edition
- LM-50-99 (or latest), IESNA Guide for Photometric Measurement of Roadway Lighting Installations

- LM-61-06 (or latest), IESNA Approved Guide for Identifying Operating Factors Influencing Measured Vs. Predicted Performance for Installed Outdoor High Intensity Discharge (HID) Luminaires
- LM-79-08 (or latest), IESNA Approved Method for the Electrical and Photometric Measurements of Solid-Sate Lighting Products
- LM-80-08 (or latest), IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources
- RP-8-00 (or latest), ANSI / IESNA American National Standard Practice for Roadway Lighting
- RP-16-10 (or latest), ANSI/IES Nomenclature and Definitions for Illuminating Engineering
- TM-3-95 (or latest), A Discussion of Appendix E - "Classification of Luminaire Lighting Distribution," from ANSI/IESNA RP-8-83
- TM-15-11 (or latest), Luminaire Classification System for Outdoor Luminaires
- TM-21-11 (or latest), Projecting Long Term Lumen Maintenance of LED Light Sources

Institute of Electrical and Electronics Engineers (IEEE)

- IEEE C62.41.2-2002 (or latest), IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits
- ANSI/IEEE C62.45-2002 (or latest), IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits

National Electrical Manufacturers Association (NEMA)

- ANSI/NEMA/ANSLG C78.377-2008 (or latest), American National Standard for the Chromaticity of Solid State Lighting Products

National Fire Protection Association (NFPA)

- 70 – National Electrical Code (NEC)

Underwriters Laboratories (UL)

- 1449, Surge Protective Devices
- 1598, Luminaires
- 8750, Light Emitting Diode (LED) Equipment for Use in Lighting Products

1.1. Related Documents

Contract Drawings and conditions of Contract (including General Conditions, Addendum to the General Conditions, Special Conditions, Division 01 Specifications Sections and all other Contract Documents) apply to the work of this section.

See the separate Specification for Adaptive Control and Remote Monitoring of LED Roadway Luminaires for additional driver performance and interface requirements.

1.2. Definitions

Lighting terminology used herein is defined in IES RP-16. See referenced documents for additional definitions.

1. Exception: The term "driver" is used herein to broadly cover both drivers and power supplies, where applicable.

2. Clarification: The term "LED light source(s)" is used herein per IES LM-80 to broadly cover LED package(s), module(s), and array(s).

1.3. Quality Assurance

Before approval and purchase, Owner may request luminaire sample(s) identical to product configuration(s) submitted for inspection. Owner may request IES LM-79 testing of luminaire sample(s) to verify performance is within manufacturer-reported tolerances.

After installation, Owner may perform IES LM-50 field measurements to verify performance requirements outlined in Appendix A, giving consideration to measurement uncertainties outlined in IES LM-61.

1.4. Lighting System Performance

Energy Conservation

Connected Load

- Luminaires shall have maximum nominal luminaire input wattage as specified for each luminaire type in Appendix A.

Lighting Controls

- See separate controls specification identified in section 1.2 above, if applicable.
- See section 2.1-B below for driver control interface and performance requirements.

- See section 2.1-K below for photocontrol receptacle requirements.

Photometric Requirements

Luminaires shall meet the general criteria provided in the body of this specification and the particular criteria for each luminaire type defined in Appendix A.

1.5. Required Submittals for Each Luminaire Type Defined in Appendix A

General submittal content shall include

1. Completed Appendix E submittal form
2. Luminaire cutsheets
3. Cutsheets for LED light sources
4. Cutsheets for LED driver(s) - If dimmable LED driver is specified, provide diagrams illustrating light output and input power as a function of control signal.
5. Cutsheets for surge protection device, if applicable
6. Instructions for installation and maintenance
7. Summary of luminaire recycled content and recyclability per the FTC Green Guides, expressed by percentage of luminaire weight

LM-79 luminaire photometric report(s) shall be produced by the test laboratory and include

1. Name of test laboratory (The test laboratory must hold National Voluntary Laboratory Accreditation Program (NVLAP) accreditation for the IES LM-79 test procedure or must be qualified, verified, and recognized through the U.S. Department of Energy's CALiPER program. For more information, see

http://ts.nist.gov/standards/scopes/eelit.htm or www.ssl.energy.gov/test_labs.html.)

2. Report number
3. Date
4. Complete luminaire catalog number - Provide explanation if catalog number in test report(s) does not match catalog number of luminaire submitted.
    - Clarify whether discrepancy does not affect performance, e.g., in the case of differing luminaire housing color.
    - If nominal performance of submitted and tested products differs, submit additional LM-79 report(s) and derivation as indicated in Appendix C.
5. Description of luminaire, LED light source(s), and LED driver(s)
6. Goniophotometry
7. Colorimetry (the next item may be deleted if mesopic multipliers are disallowed)- If a scotopic/photopic (S/P) ratio is not reported, a spectral power distribution table adequate for accurate calculation of the ratio shall be included.

Calculations and supporting test data per Appendix B indicating a lumen maintenance life of not less than 36,000 operating hours

Computer-generated point-by-point photometric analysis of maintained photopic light levels as per Appendix A

1. Calculations shall be for maintained values, i.e. Light Loss Factor (LLF) < 1.0, where LLF = LLD x LDD x LATF, and
    - Lamp Lumen Depreciation (LLD)
        - Shall be 0.70 (L_{70}) for all luminaires as per IES HB-10.
        - Shall be the percentage of initial output calculated in section 1.6-C.
    - Luminaire Dirt Depreciation (LDD) = 0.90, as per IES DG-4 for an enclosed and gasketed roadway luminaire installed in an environment with less than 150 $\cdot \text{um}^3$ airborne particulate matter and cleaned every four years
    - Luminaire Ambient Temperature Factor (LATF) = 1.00
2. Use of IES HB-10 mesopic multipliers
    - Shall be disallowed herein, by assuming an S/P ratio of 1.00 for all luminaires.
    - Shall only be permitted for luminaire types indicated in Appendix A for use in 25 mph speed zones, using nominal S/P ratio and bilinear interpolation. Mesopic multiplier(s) used shall be clearly indicated in the calculations.
3. Calculation/measurement points shall be per IES RP-8.

Summary of Joint Electron Devices Engineering Council (JEDEC) or Japan Electronics and Information Technology Industries (JEITA) reliability testing performed for LED packages

Summary of reliability testing performed for LED driver(s)

Written product warranty as per section 1.7 below

Safety certification and file number - Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratory).

1. Manufacturers listed on the current NEMA Listing of Companies Offering Outdoor Luminaires Manufactured in U.S.A. for Recovery Act Projects need only provide a copy of the document (http://www.nema.org/gov/economic-stimulus).
2. Other manufacturers shall submit documentation as per the DOE Guidance on Documenting Compliance with the Recovery Act Buy American Provisions (http://www1.eere.energy.gov/recovery/buy_american_provision.html).

1.6. Warranty

Provide a minimum five-year warranty covering maintained integrity and functionality of

- Luminaire housing, wiring, and connections
- LED light source(s) - Negligible light output from more than 10 percent of the LED packages constitutes luminaire failure.
- LED driver(s)

Warranty period shall begin 90 days after date of invoice, or as negotiated by owner such as in the case of an auditable asset management system.

PART 2 – PRODUCTS

2.1. Luminaire Requirements

General Requirements

1. Luminaires shall be as specified for each type in Appendix A.
2. Luminaire shall have an external label per ANSI C136.15

3. Luminaire shall have an internal label per ANSI C136.22.
4. Nominal luminaire input wattage shall account for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.
5. Luminaires shall start and operate in -20°C to +40°C ambient.
6. Electrically test fully assembled luminaires before shipment from factory.
7. Effective Projected Area (EPA) and weight of the luminaire shall not exceed the values indicated in Appendix A.
8. Luminaires shall be designed for ease of component replacement and end-of-life disassembly.
9. Luminaires shall be rated for the ANSI C136.31 Vibration Level indicated in Appendix A.
10. LED light source(s) and driver(s) shall be RoHS compliant.
11. Transmissive optical components shall be applied in accordance with OEM design guidelines to ensure suitability for the thermal/mechanical/chemical environment.

Driver

1. Rated case temperature shall be suitable for operation in the luminaire operating in the ambient temperatures indicated in section 2.1-A above.
2. Shall accept the voltage or voltage range indicated in Appendix A at 50/60 Hz, and shall operate normally for input voltage fluctuations of plus or minus 10 percent.
3. Shall have a minimum Power Factor (PF) of 0.90 at full input power and across specified voltage range.
4. Control signal interface

- Luminaire types indicated "Required" in Appendix A shall accept a control signal as specified via separate controls specification referenced in section 1.2 above, e.g., for dimming.
- Luminaire types indicated "Not Required" in Appendix A need not accept a control signal.

Electrical immunity

Luminaire shall meet the "Basic" requirements in Appendix D. Manufacturer shall indicate on submittal form (Appendix E) whether failure of the electrical immunity system can possibly result in disconnect of power to luminaire.

1. Luminaire shall meet the "Elevated" requirements in Appendix D. Manufacturer shall indicate on submittal form (Appendix E) whether failure of the electrical immunity system can possibly result in disconnect of power to luminaire.

Electromagnetic interference

1. Shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
2. Shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.

Electrical safety testing

1. Luminaire shall be listed for wet locations by an OSHA NRTL.
2. Luminaires shall have locality-appropriate governing mark and certification.

Painted or finished luminaire components exposed to the environment

1. Shall exceed a rating of six per ASTM D1654 after 1000hrs of testing per ASTM B117.
2. The coating shall exhibit no greater than 30% reduction of gloss per ASTM D523, after 500 hours of QUV testing at ASTM G154 Cycle 6.

Thermal management

1. Mechanical design of protruding external surfaces (heat sink fins) for shall facilitate hose-down cleaning and discourage debris accumulation.
2. Liquids or other moving parts shall be clearly indicated in submittals, shall be consistent with product testing, and shall be subject to review by Owner.

IES TM-15 limits for Backlight, Uplight, and Glare (BUG Ratings) shall be as specified for each luminaire type in Appendix A.

1. Calculation of BUG Ratings shall be for initial (worst-case) values, i.e., Light Loss Factor (LLF) = 1.0.
2. If luminaires are tilted upward for calculations in section 1.6-D, BUG Ratings shall be calculated for the same angle(s) of tilt.

Minimum Color Rendering Index (CRI): **60.**

Correlated Color Temperature (CCT)

1. If nominal CCT specified in Appendix A is listed in Table 1 below, measured CCT and Duv shall be as listed in Table 1.

Table 1. Allowable CCT and Duv
(adapted from NEMA C78.377)

Manufacturer-Rated Nominal CCT (K)	Allowable LM-79 Chromaticity Values	
	Measured CCT (K)	Measured Duv
2700	2580 to 2870	-0.006 to 0.006
3000	2870 to 3220	-0.006 to 0.006
3500	3220 to 3710	-0.006 to 0.006
4000	3710 to 4260	-0.005 to 0.007
4500	4260 to 4746	-0.005 to 0.007
5000	4745 to 5311	-0.004 to 0.008
5700	5310 to 6020	-0.004 to 0.008
6500	6020 to 7040	-0.003 to 0.009

2. If nominal CCT specified in Appendix A is not listed in Table 1, measured CCT and Duv shall be as per the criteria for Flexible CCT defined in NEMA C78.377.

The following shall be in accordance with corresponding sections of ANSI C136.37

1. Wiring and grounding - All internal components shall be assembled and pre-wired using modular electrical connections.
2. Mounting provisions - Specific configurations are indicated in Appendix A
3. Terminal blocks for incoming AC lines
4. Photocontrol receptacle
5. Latching and hinging
6. Ingress protection

2.2. Product Manufacturers

Any manufacturer offering products that comply with the required product performance and operation criteria may be considered.

2.3. Manufacturer Services

Manufacturer or local sales representative shall provide installation and troubleshooting support via telephone and/or email.

Estimating LED Lumen Maintenance

IES TM-21 allows for extrapolation of expected lumen maintenance from available test data. The extent of such extrapolation is limited by the duration of testing completed and the number of samples used in the testing. The TM-21 methodology shall be used by the manufacturer to determine lamp lumen depreciation (LLD) at end of lumen maintenance life per section 1.6-C.

The applicant may estimate lumen maintenance in one of two ways:

Option 1: Component Performance

Under this compliance path, the applicant must submit calculations per TM-21 predicting lumen maintenance at the luminaire level using In Situ Temperature Measurement Testing (ISTMT) and LM-80 data. To be eligible for the Component Performance option, ALL of the conditions below must be met. If ANY of the conditions is not met, the component performance option may not be used and the applicant must use Option 2 for compliance.

1. The LED light source(s) have been tested according to LM-80.
2. The LED drive current specified by the luminaire manufacturer is less than or equal to the drive current specified in the LM-80 test report.
3. The LED light source(s) manufacturer prescribes/indicates a temperature measurement point (T_S) on the light source(s).
4. The T_S is accessible to allow temporary attachment of a thermocouple for measurement of in situ temperature. Access via a temporary hole in the housing, tightly resealed during testing with putty or other flexible sealant is allowable.
5. For the hottest LED light source in the luminaire, the temperature measured at the T_S during ISTMT is less than or equal to the temperature specified in the LM-80 test report for the corresponding drive current or higher, within the manufacturer's specified operating current range.
    - The ISTMT laboratory must be approved by OSHA as a Nationally Recognized Testing Lab (NRTL), must be qualified, verified, and recognized through DOE's CALiPER program, or must be recognized through UL's Data Acceptance Program.
    - The ISTMT must be conducted with the luminaire installed in the appropriate application as defined by ANSI/UL 1598 (hardwired luminaires), with bird-fouling appropriately simulated (and documented by photograph) as determined by the manufacturer.

Option 2: Luminaire Performance

Under this compliance path, the applicant must submit TM-21 calculations based on LM-79 photometric test data for no less than three samples of the entire luminaire. Duration of operation and interval between photometric tests shall conform to the TM-21 criteria for LED light sources. For example, testing solely at 0 and 6000 hours of operation would not be adequate for the purposes of extrapolation.

Between LM-79 tests, the luminaire test samples must be operated long-term in the appropriate application as defined by ANSI/UL 1598 (hardwired luminaires). The test laboratory must hold NVLAP accreditation for the LM-79 test procedure or must be qualified, verified, and recognized through the U.S. Department of Energy (DOE)'s CALiPER program. The extent of allowable extrapolation (either 5.5 or 6 times the test duration) depends on the total number of LED light sources (no less than 10 and preferably more than 19) installed in the luminaire samples, as per TM-21.

This compliance path poses a greater testing burden to luminaire manufacturers but incorporates long-term testing of other components in the system, such as drivers.

Under either compliance path, values used for extrapolation shall be summarized per TM-21 Tables 1 and 2. Submitted values for lumen maintenance lifetime and the associated percentage lumen maintenance shall be "reported" rather than "projected" as defined by TM-21. Supporting diagrams are requested to facilitate interpretation by Owner.

APPENDIX D

PRODUCT FAMILY TESTING LM-79 AND ISTMT

It is recognized that due to the time and cost required for product testing, it would not be realistic to expect manufacturers offering a multitude of unique luminaire configurations to test every possible configuration. Therefore, the "product families" method may be utilized for LM-79 and ISTMT, whereby manufacturers identify a set of representative products for which test data can be used to demonstrate the accuracy of interpolated or extrapolated performance of product configurations lacking test data. Precedent for this approach can be found in LM-80.

If the particular luminaire configuration submitted has not been tested, the performance may be conservatively represented by test data for another luminaire configuration having:

- The same intensity distribution (typically only applies to LM-79)
- The same or lower nominal CCT
- The same or higher nominal drive current
- The same or greater number of LED light source(s)
- The same or lower percentage driver loading and efficiency
- The same or smaller size luminaire housing.

A more accurate estimate of performance can be obtained by linear interpolation between two or more tests differing in terms of the six parameters listed above. For example, consider a hypothetical luminaire offered in a single size housing, and having the following parameters:

- Three intensity distributions: IES Type II, III, or IV
- Three CCTs: 4000, 5000, and 6000K
- Three drive currents: 350, 525, and 700 mA
- Four LED quantities: 20, 40, 60, or 80 LEDs.

Table C.1 illustrates a set of tests which could allow for accurate interpolation between tested configurations, given a single luminaire housing size and essentially constant driver efficiency; these 10 tests may provide representative data for the 108 possible product configurations. Note that normalized intensity distribution must not be affected by the other three parameters.

Table C.1. Representative testing of a single luminaire housing size

Tests	Intensity distribution (IES Type)	CCT (K)	Drive current (mA)	# of LEDs
1, 2, 3	II, III, IV	4000	700	80
4, 5	IV	5000, 6000	700	80
6, 7	IV	4000	325, 525	80
8, 9, 10	IV	4000	700	20, 40, 60

For example, the manufacturer could detail interpolation as shown in Table C.2, applying the following multipliers to the base test #2 to model a configuration with Type III intensity distribution, 5000K CCT, 525 mA drive current, and 40 LEDs:

- Ratio of test #4 lumens to test #3 lumens

- Ratio of test #7 lumens to test #3 lumens
- Ratio of test #9 lumens to test #3 lumens.

Table C.2. Multipliers for Test #2 to yield: Type III , 5000K, 525mA, 40 LEDs

Test #	Intensity distribution (IES Type)	CCT (K)	Drive current (mA)	# of LEDs	Multiplier (lumens ratio)
2	III	4000	700	80	n/a
3	IV	4000	700	80	n/a
4	IV	5000	700	80	#4 / #3
7	IV	4000	525	80	#7 / #3
9	IV	4000	700	40	#9 / #3

Interpolation between minimal LM-79 and ISTMT data is more difficult if housing size increases with increasing wattage; it may not be clear whether the lowest-wattage configuration would be expected to "run cooler" than the highest-wattage configuration. In these circumstances, the adequacy of submitted data is subject to Owner approval.

At this time, the "successor" method cannot be used; luminaires tested must utilize the LED light source(s) characterized by the submitted LM-80 report.

APPENDIX E

ELECTRICAL IMMUNITY

Test Procedure

Electrical Immunity Tests 1, 2 and 3, as defined by their Test Specifications, shall be performed on an entire powered and connected luminaire, including any control modules housed within the luminaire, but excluding any control modules mounted externally, such as a NEMA socket connected photo-control. A shorting cap should be placed across any such exterior connector.

The luminaire shall be connected to an AC power source with a configuration appropriate for nominal operation. The AC power source shall have a minimum available short-circuit current of 200A. The luminaire shall be tested at the nominal input voltage specified in Appendix A, or at the highest input voltage in the input voltage range specified in Appendix A.

Electrical Immunity test waveforms shall be superimposed on the input AC power line at a point within 6 inches (15cm) of entry into the luminaire using appropriate high-voltage probes and a series coupler/decoupler network (CDN) appropriate for each coupling mode, as defined by ANSI/IEEE C62.45-2002. The test area for all tests shall be set up according to ANSI/IEEE C62.45-2002, as appropriate.

Prior to electrical immunity testing a set of diagnostic measurements shall be performed, and the results recorded to note the pre-test function of the luminaire after it has reached thermal equilibrium. These measurements should include at a minimum:

- For all luminaires, Real Power, Input RMS Current, Power Factor and THD at full power/light output
- For luminaires specified as dimmable, Real Power, Input RMS Current, Power Factor and THD at a minimum of 4 additional dimmed levels, including the rated minimum dimmed level

Tests shall be applied in sequential order (Test 1, followed by Test 2, followed by Test 3). If a failure occurs during Test 3, then Test 3 shall be re-applied to a secondary luminaire of identical construction.

Following the completion of Tests 1, 2, and 3, the same set of diagnostic measurements performed pre-test should be repeated for all tested luminaires, and the results recorded to note the post-test function of the luminaire(s).

A luminaire must function normally and show no evidence of failure following the completion of Test 1 + Test 2 + Test 3 (for a single tested luminaire), or the completion of Test 1 + Test 2 on a primary luminaire and Test 3 on a secondary luminaire. Abnormal behavior during testing is acceptable.

A luminaire failure will be deemed to have occurred if any of the following conditions exists following the completion of testing:

- A hard power reset is required to return to normal operation

- A noticeable reduction in full light output (e.g. one or more LEDs fail to produce light, or become unstable) is observed
- Any of the post-test diagnostic measurements exceeds by ±5% the corresponding pre-test diagnostic measurement.
- The luminaire, or any component in the luminaire (including but not limited to an electrical connector, a driver, a protection component or module) has ignited or shows evidence of melting or other heat-induced damage. Evidence of cracking, splitting, rupturing, or smoke damage on any component is acceptable.

Test Specifications

NOTE: L1 is typically "HOT", L2 is typically "NEUTRAL" and PE = Protective Earth.

Test 1: Ring Wave:

The luminaire shall be subjected to repetitive strikes of a "C Low Ring Wave" as defined in IEEE C62.41.2-2002, Scenario 1, Location Category C. The test strikes shall be applied as specified by Table D.1. Prior to testing, the ring wave generator shall be calibrated to simultaneously meet BOTH the specified short circuit current peak and open circuit voltage peak MINIMUM requirements. Note that this may require that the generator charging voltage be raised above the specified level to obtain the specified current peak. Calibrated current probes/transformers designed for measuring high-frequency currents shall be used to measure test waveform currents.

Test waveform current shapes and peaks for all strikes shall be compared to ensure uniformity throughout each set (coupling mode + polarity/phase angle) of test strikes, and the average peak current shall be calculated and recorded. If any individual peak current in a set exceeds by

±10% the average, the test setup shall be checked, and the test strikes repeated.

Table D.1: 0.5 µS – 100Hz Ring Wave Specification

Parameter	Test Level/Configuration
Short Circuit Current Peak	0.5 kA
Open Circuit Voltage Peak	6 kV
Source Impedance	12 Ω
Coupling Modes	L1 to PE, L2 to PE, L1 to L2
Polarity and Phase Angle	Positive at 90° and Negative at 270°
Test Strikes	5 for each Coupling Mode and Polarity/Phase Angle combination
Time between Strikes	1 minute
Total Number of Strikes	= 5 strikes x 4 coupling modes x 2 polarity/phase angles = 40 total strikes

Test 2: Combination Wave:

The luminaire shall be subjected to repetitive strikes of a "C High Combination Wave" or "C Low Combination Wave", as defined in IEEE C62.41.2-2002, Scenario 1, Location Category C. The test strikes shall be applied as specified by Table D.2. The "Low" test level shall be used for luminaires with **Basic** Electrical Immunity requirements, while the "High" test level shall be used for luminaires with **Elevated** Electrical Immunity requirements. Prior to testing, the combination wave generator shall be calibrated to simultaneously meet BOTH the specified short circuit current peak and open circuit voltage peak MINIMUM requirements. Note that this may require that the generator charging voltage be raised above the specified level to obtain the specified current peak. Calibrated current probes/transformers designed for measuring high-frequency currents shall be used to measure test waveform currents.

Test waveform current shapes and peaks for all strikes shall be compared to ensure uniformity throughout each set (coupling mode + polarity/phase angle) of test strikes, and the average peak current shall be calculated and recorded. If any individual peak current in a set exceeds by ±10% the average, the test setup shall be checked, and the test strikes repeated.

Table D.2: 1.2/50µS – 8/20 µS Combination Wave Specification

Parameter	Test Level/ Configuration
1.2/50 µS Open Circuit Voltage Peak	Low: 6 kV High: 10kV
8/20 µS Short Circuit Current Peak	Low: 3 kA High: 10kA
Source Impedance	2Ω
Coupling Modes	L1 to PE, L2 to PE, L1 to L2
Polarity and Phase Angle	Positive at 90° and Negative at 270°
Test Strikes	5 for each Coupling Mode and Polarity/Phase Angle combination
Time Between Strikes	1 minute
Total Number of Strikes	= 5 strikes x 4 coupling modes x 2 polarity/phase angles = 40 total strikes

Test 3: Electrical Fast Transient (EFT):

The luminaire shall be subjected to "Electrical Fast Transient Bursts", as defined in IEEE C62.41.2 -2002. The test area shall be set up according to IEEE C62.45-2002. The bursts shall be applied as specified by Table D.3. Direct coupling is required; the use of a coupling clamp is not allowed.

Table D.3: Electrical Fast Transient (EFT) Specification

Parameter	Test Level/ Configuration
Open Circuit Voltage Peak	3 kV
Burst Repetition Rate	2.5 kHz
Burst Duration	15 mS
Burst Period	300 mS
Coupling Modes	L1 to PE, L2 to PE, L1 to L2
Polarity	Positive and Negative
Test Duration	1 minute for each Coupling Mode and Polarity combination
Total Test Duration	= 1 minute x 7 coupling modes x 2 polarities = 14 minutes

PRODUCT SUBMITTAL FORM

Luminaire Type[1]		
Manufacturer		
Model number		
Housing finish color		
Tenon nominal pipe size (inches)		
Nominal luminaire weight (lb)		
Nominal luminaire EPA (ft^2)		
Nominal input voltage (V)		
ANSI vibration test level	❒ Level 1 (Normal)	☐ Level 2 (bridge/overpass)
Nominal BUG Ratings		
Make/model of LED light source(s)		
Make/model of LED driver(s)		
Dimmability	☐ Dimmable	❒ Not dimmable
Control signal interface		
Upon electrical immunity system failure	☐ Possible disconnect	☐ No possible disconnect
Thermal management	☐ Moving parts	❒ No moving parts
Lumen maintenance testing duration (hr)		
Reported lumen maintenance life (hr) [2]		
Warranty period (yr)		
Parameter	Nominal value	Tolerance (%)
Initial photopic output (lm)		
Maintained photopic output (lm)		
Lamp lumen depreciation		
Initial input power (W)		
Maintained input power (W)		
Initial LED drive current (mA)		
Maintained LED drive current (mA)		
Drive current used		
In-situ LED T_c (°C)		
CCT (K)		
S/P ratio		
Additional product description		

[1] See Appendix A, and attach supporting documentation as required.

[2] Value shall be no less than as specified in section 1.6-C, and shall not exceed six times the testing duration indicated in the row above. Value shall be consistent with values submitted in the rows below for maintained light output, maintained input power, and maintained drive current.

APPENDIX F

STANDARD DETAIL DRAWINGS

APPROVED

DIRECTOR OF ENGINEERING

DATE: April 28/08

CITY OF BURLINGTON

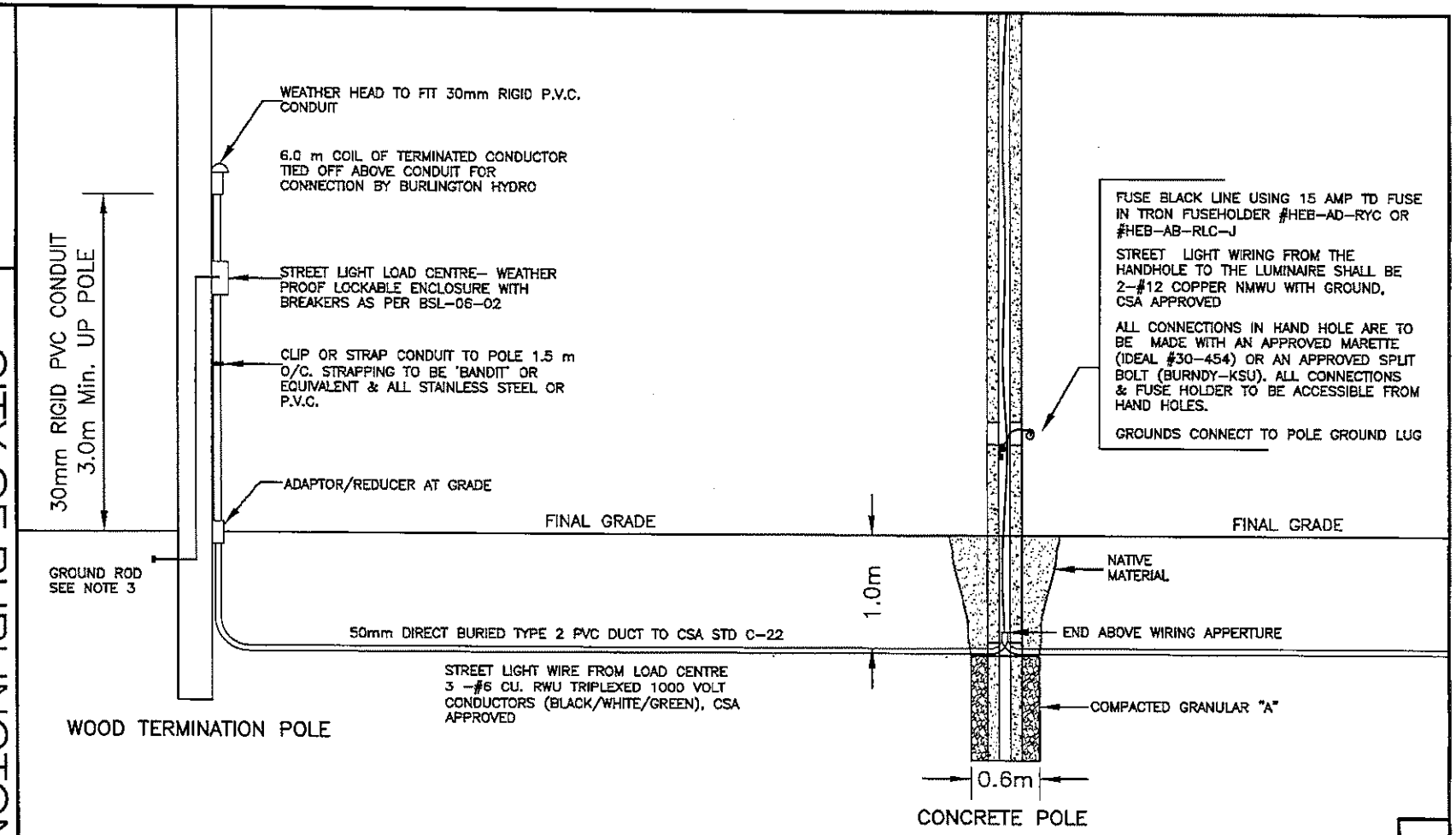
ENGINEERING DEPARTMENT

STREETLIGHT POLE INSTALLATION
DUCTED SYSTEM

METRIC

SCALE: N.T.S.

DWG. NO.
S-151

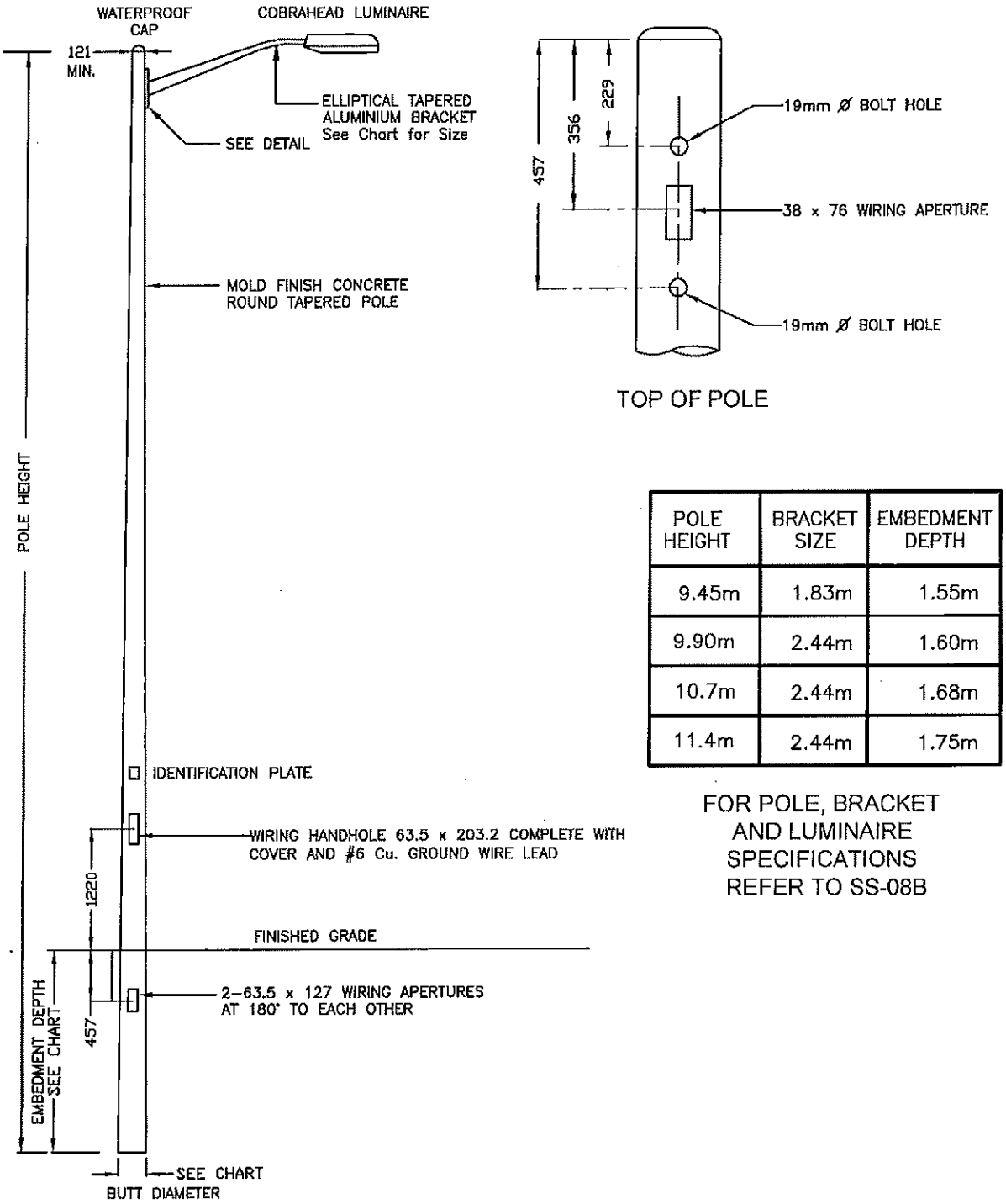


NOTES

1. ALL CIRCUITS MUST BE IDENTIFIED BY THE CONTRACTOR WITH BRADY TAPE OR APPROVED EQUIVALENT ADHESIVE MARKER MATERIAL
2. CONTACT CITY INSPECTOR FOR MOUNTING HEIGHT UP POLE
3. THE #6 GREEN STREET LIGHT WIRE SHALL BE ATTACHED WITH A CLAMP TO THE GROUNDING SYSTEM. THE GROUNDING SYSTEM SHALL BE AS DESCRIBED IN SS08B-3.17. THE GROUND WIRE SHALL BE ATTACHED TO THE GROUND BOLT IN THE STREET LIGHT POWER PEDESTAL OR LOAD CENTRE.

DATE: APRIL/08

DATE: APRIL/08



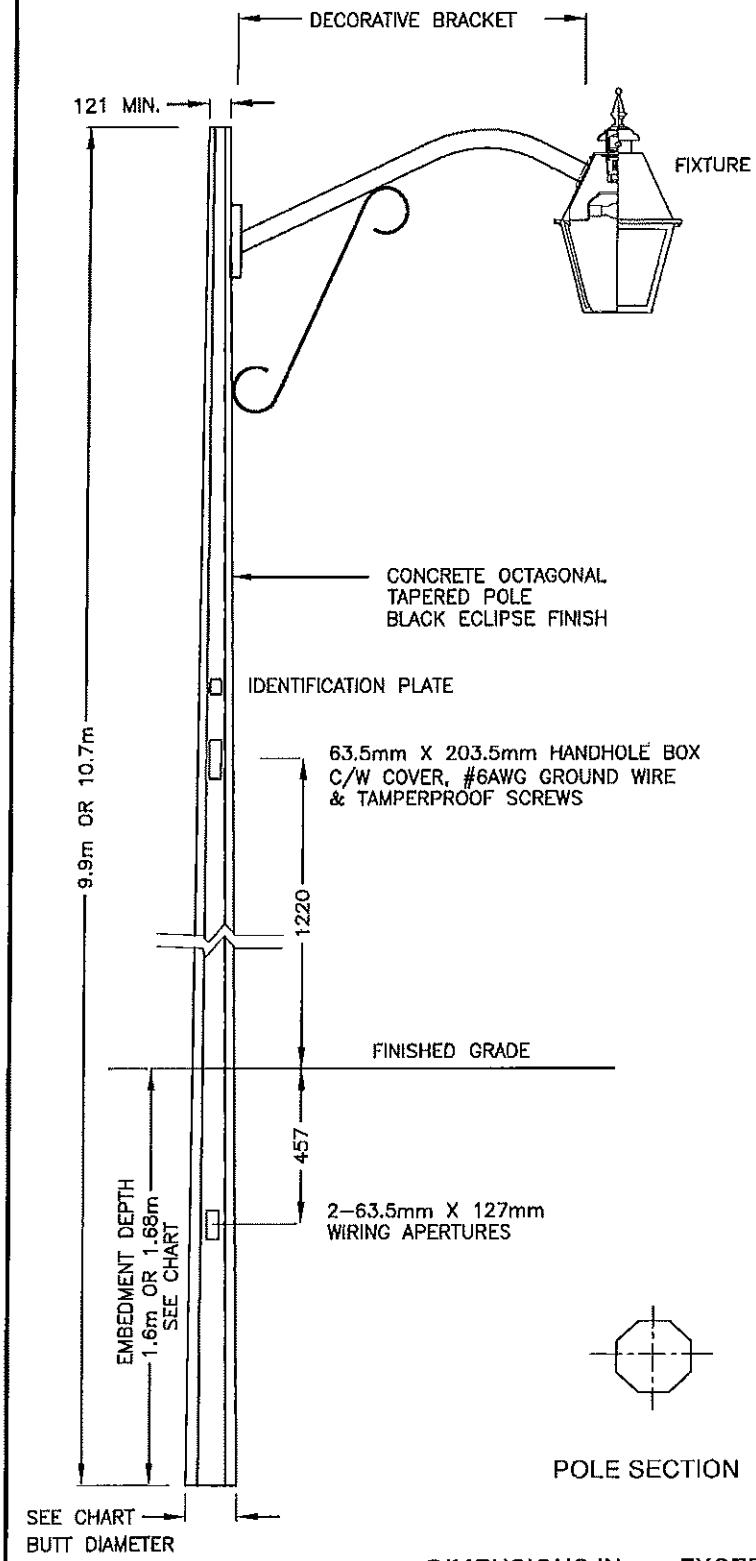
POLE HEIGHT	BRACKET SIZE	EMBEDMENT DEPTH
9.45m	1.83m	1.55m
9.90m	2.44m	1.60m
10.7m	2.44m	1.68m
11.4m	2.44m	1.75m

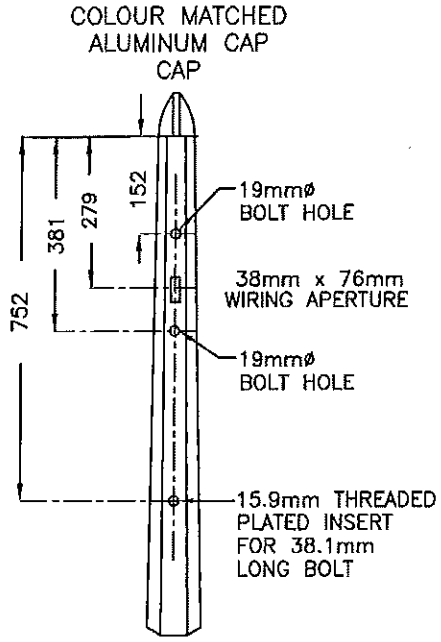
FOR POLE, BRACKET AND LUMINAIRE SPECIFICATIONS REFER TO SS-08B

DIMENSIONS IN mm EXCEPT AS NOTED

APPROVED T. Edwardson DIRECTOR OF ENGINEERING DATE: April 28/08	CITY OF BURLINGTON ENGINEERING DEPARTMENT	METRIC SCALE: N.T.S.
	DIRECT BURIED CONCRETE STREET LIGHT POLE	DWG. NO. S-152

DATE: APRIL/08





TOP OF POLE

POLE HEIGHT	BRACKET SIZE	EMBEDMENT DEPTH
9.9m	1.52m	1.60m
10.70m	1.83m	1.68m

FOR POLE, BRACKET AND LUMINAIRE SPECIFICATIONS REFER TO SS-08B

POLE SECTION

DIMENSIONS IN mm EXCEPT AS NOTED

APPROVED

DIRECTOR OF ENGINEERING

DATE: April 28/08

CITY OF BURLINGTON

ENGINEERING DEPARTMENT

METRIC

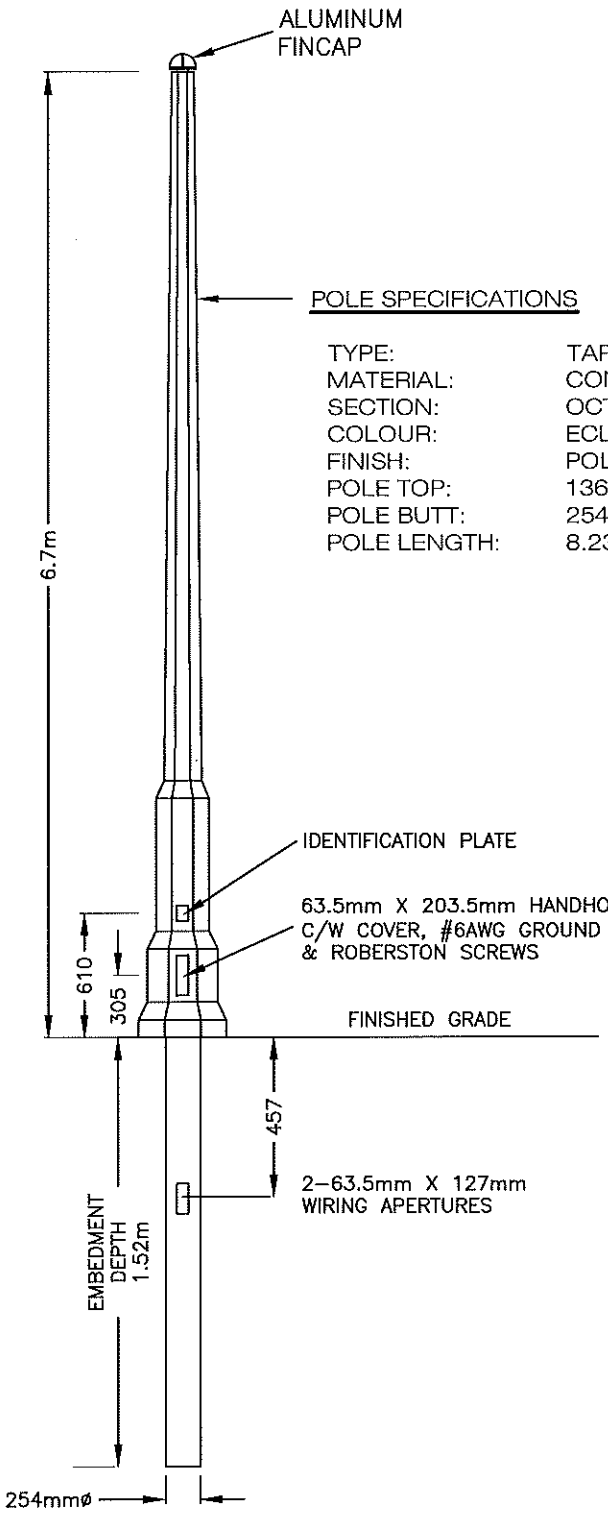
SCALE: N.T.S.

DIRECT BURIED DECORATIVE CONCRETE STREETLIGHT POLE

DWG. NO.

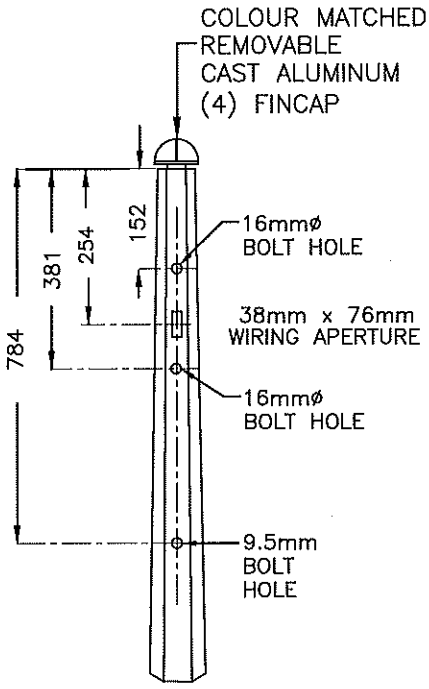
S-153

DATE: FEB/19



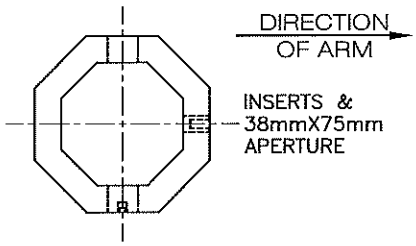
POLE SPECIFICATIONS

TYPE:	TAPERED POLE
MATERIAL:	CONCRETE
SECTION:	OCTAGONAL
COLOUR:	ECLIPSE, S11 (BLACK)
FINISH:	POLISHED
POLE TOP:	136.5mm FL. TO FL.
POLE BUTT:	254mm DIA.
POLE LENGTH:	8.23m

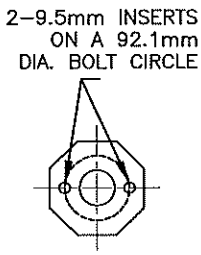


TOP OF POLE

FOR POLE, BRACKET AND LUMINAIRE SPECIFICATIONS REFER TO SS-08B



TYPICAL POLE SECTION

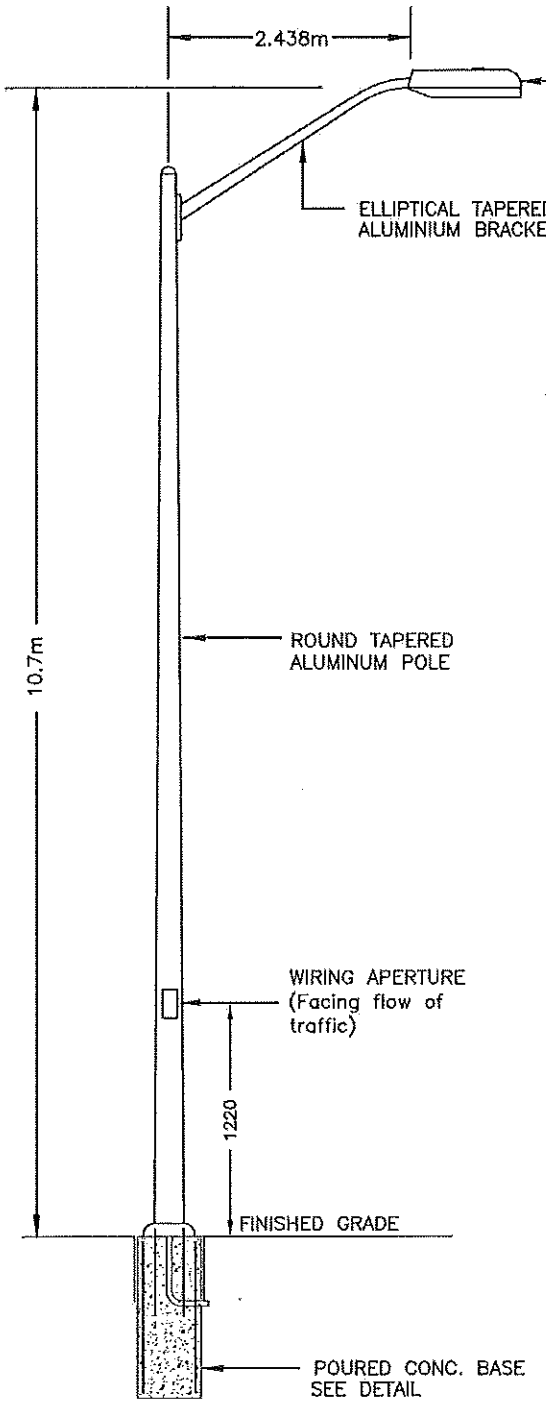


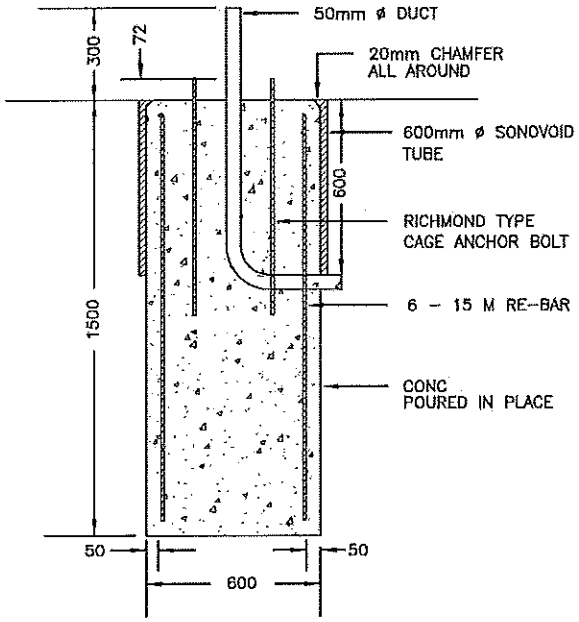
POLE TOP DETAIL

DIMENSIONS IN mm EXCEPT AS NOTED

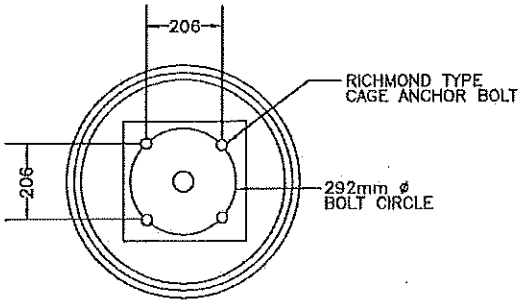
APPROVED MANAGER OF DESIGN & CONSTRUCTION DATE:	CITY OF BURLINGTON CAPITAL WORKS DEPARTMENT DIRECT BURIED DECORATIVE CONCRETE STREETLIGHT POLE	METRIC SCALE: N.T.S. DWG. NO. S-153A

DATE: MAY/12	REV 1





POLE BASE SECTION



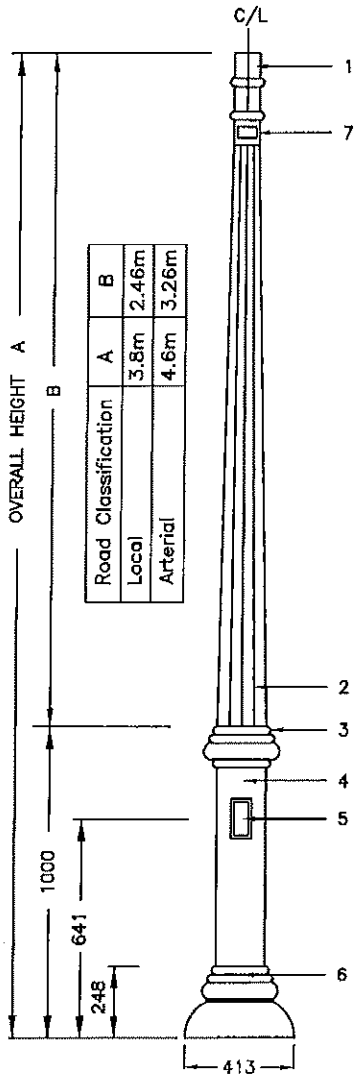
POLE BASE PLAN

Notes:
1) CONCRETE AS PER C-2 (ITEM 11-CONCRETE)
CITY OF BURLINGTON AMENDMENTS TO OPSS

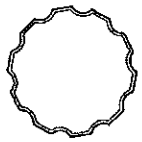
DIMENSIONS IN mm EXCEPT AS NOTED

APPROVED	CITY OF BURLINGTON	METRIC
DIRECTOR OF ENGINEERING DATE: June 5/12	ENGINEERING DEPARTMENT	SCALE: N.T.S.
	BASE MOUNTED ALUMINUM STREETLIGHT POLE	DWG. NO. S-154

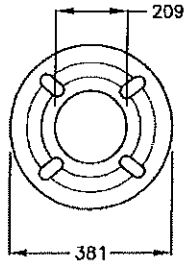
DATE: APRIL/08



Road Classification	A	B
Local	3.8m	2.46m
Arterial	4.6m	3.26m

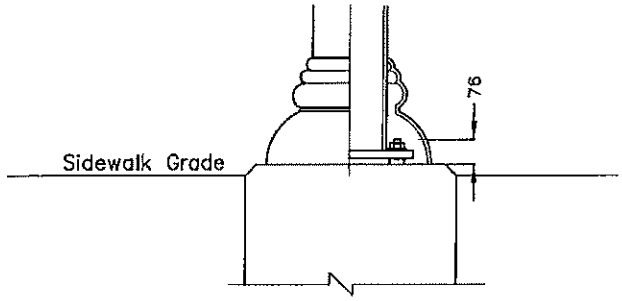


TAPERED
POLE SECTION



B.C. 292 Ø
CAST ALUMINUM

ANCHOR PLATE



BASE DETAILS
BOLT
PROJECTION

DESCRIPTION OF COMPONENTS:

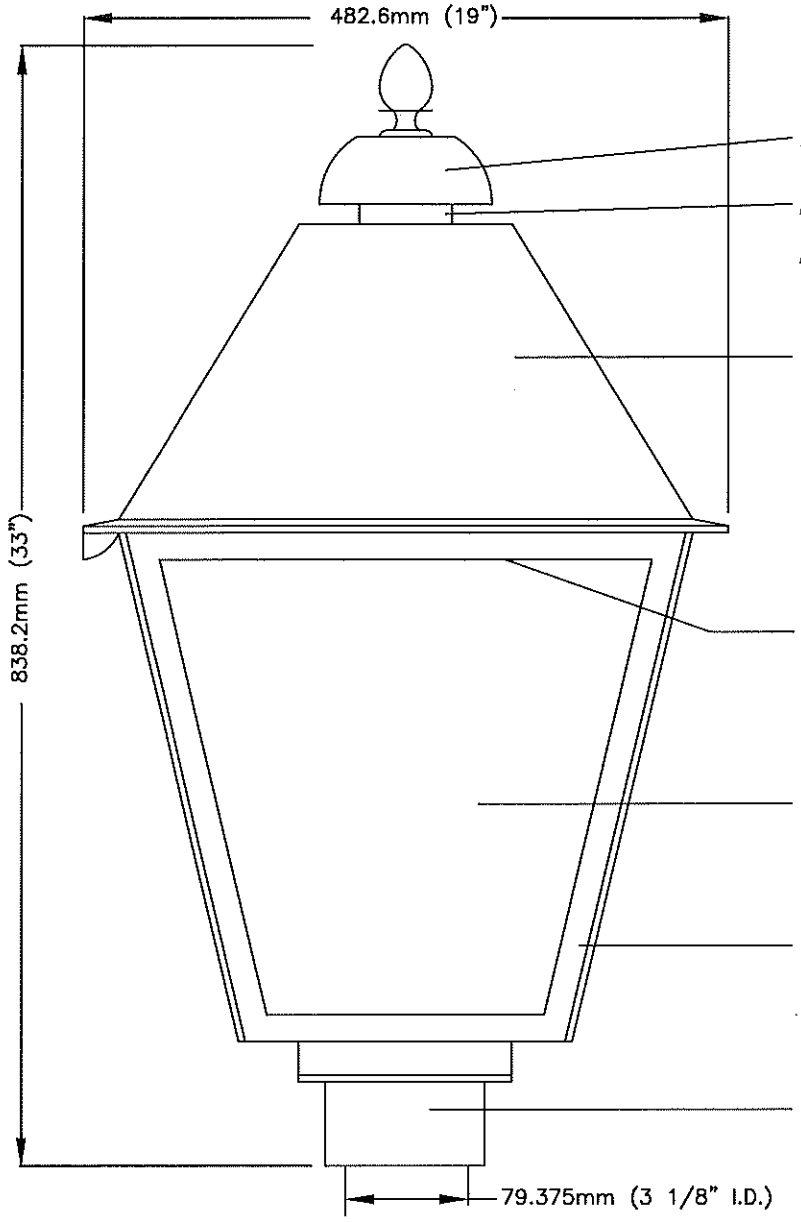
1. *TENON*: Made of Aluminum, 76mmO.D.x89mm long, mechanically secured.
2. *POLE*: Made of cast aluminum, A-356, tapered, 10 flutes, welded to the base.
3. *DECORATIVE COVER*: Made of cast aluminum, mechanically secured to the pole.
4. *BASE*: Made of aluminum, 219mO.D., 5mm wall thickness, welded to the anchor plate.
5. *ACCESS DOOR*: Made of aluminum, covering an opening of 143mmx181mm, giving access to a ground lug, c/w city name.
6. *BASE COVER*: Made of a two-piece cast aluminum component, mechanically secured.
7. *RECEPTACLE*: Duplex receptacle, 15A, 120volt, c/w weatherproof cover.

GASKETING: Neoprene and silicone gasketing is applied.
HARDWARE: All exposed screws will be stainless steel.
FINISH: Finished surface of the pole shall be free of pitting, streaking, burrs and any other surface imperfections or the pole will not be accepted. An application of a thermosetting polyester powder coat paint with a rust inhibitive process applied by means of an electrostatic process should be applied to the pole, colour to be black. This finish will have a minimum 10 year warranty to provide protection against corrosion, peeling, cracking and fading of not more than 20% of the original gloss.

DIMENSIONS IN mm EXCEPT AS NOTED

APPROVED T. Eichenbaum DIRECTOR OF ENGINEERING DATE: April 28/08	CITY OF BURLINGTON ENGINEERING DEPARTMENT	METRIC SCALE: N.T.S.
	ALUMINUM DECORATIVE STREETLIGHT POLE	DWG. NO. S-155

DATE: FEB/19



FOR POLE TYPE SEE STD. S–155

FINIAL Made of spun aluminum, mechanically secured.

PHOTOELECTRIC CONTROL (PEC)

DRIVER Universal dimmable driver, class 2. 120-277v greater than 0.9 power factor with standard surge protector.

HOOD Made of cast aluminum, integral hinges, quick release captive hood fastener, fully gasketed perimeter.

LED ENGINE Solid state high power, LED using SMT technology circuit boards, mounted to high performance heat sink.

OPTICS HighPrecision refractive lenses mounted above the LED. Optimum upward light control, horizontal light distribution to IESNA Type II, III, IV or V

LENS Optional, Polycarbonate or Acrylic, Clear

CAGE Made of cast aluminum.

SLIPFITTER
Made of cast aluminum, will accept a 3" (76mm) O.D., by 4" (102mm) long tenon and mechanically secured, mounting hardware should be included. Mounting options for post top, side mount or pendant.

NOTES

WIRING Included, 203.2mm (8") minimum exceeding from luminaire c/w quick disconnect plug.

GASKETTING Neoprene and silicone gasketting will be applied to keep out dirt and moisture.

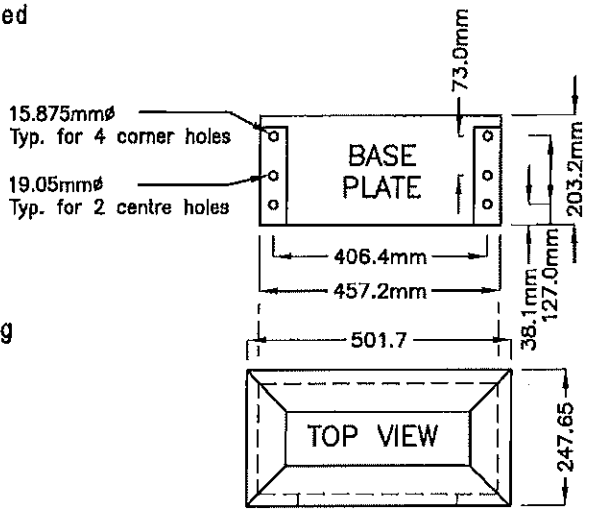
HARDWARE All exposed screws will be stainless steel.

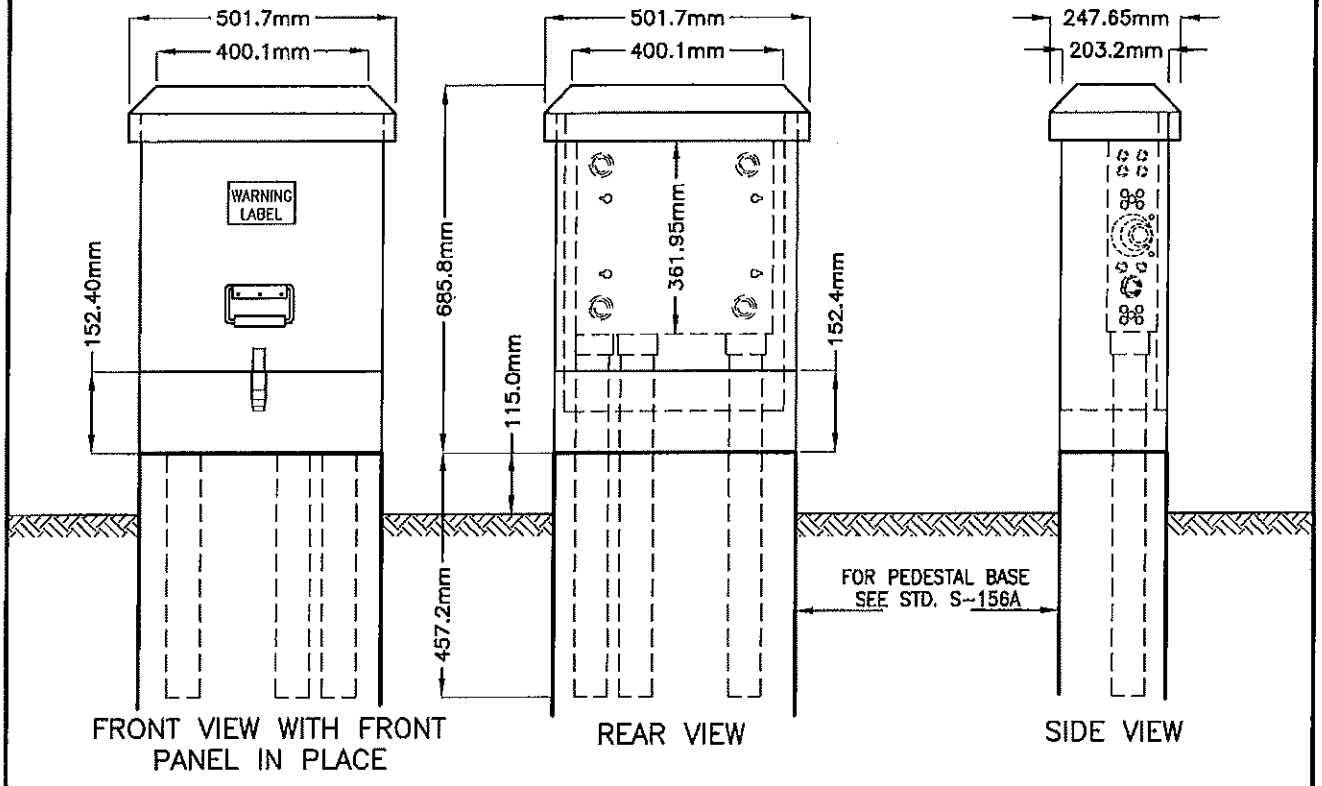
FINISH The finished surface of the luminaire will be free of pitting, streaking, burrs and any other surface imperfections or the luminaires will not be accepted. An application of a thermosetting polyester powder coat paint with a rust inhibiting process applied by means of an electrostatic process, colour to be black textured. This finish will have a minimum of a 10 year warranty which will provide protection against corrosion, peeling, cracking and fading of not more than 20% of the original gloss.

APPROVED MANAGER OF DESIGN AND CONSTRUCTION DATE:	CITY OF BURLINGTON CAPITAL WORKS DEPARTMENT	METRIC SCALE: N.T.S.
	COACH STYLE LUMINAIRE	DWG. NO. S-155A

DATE: APRIL/08

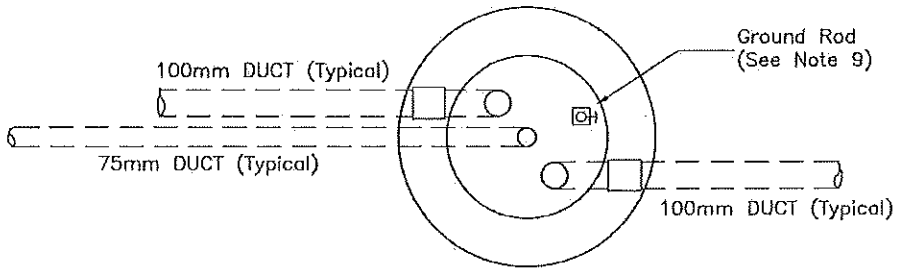
Enclosure Material - 14 gauge (2.1mm) thick zinc coated (galvanized) sheet metal
Paint Colour - Byers-Bush Jet Kote BB510GR Electrostatic powder coat finish
Panel - Square D cat# CQO112M100C60 12 cct. 2p 3w Combination service entrance panel
Main Breaker - Square D cat# QOM1-60 60amp 2pole Wire range #12-2/0 Al/Cu 22KA rating
Load Breakers - Square D cat# QO140. 40amp 1pole Wire range #14-#2 Al/Cu 10KA rating
Main Neutral Lug - Wire range #4-2/0 Al/Cu
Load Neutral Lugs - Wire range 1 lug #4-2/0 Al/Cu
3 lugs #14-1/0 Al/Cu
8 lugs #14-#6 Al/Cu
Fasteners - 4-Plated hex head bolts 12.7mm x 330.2mm x 50.8mm Grade 2 or better
4-Plated 50.8mm Flat washers
4-Plated 50.8mm Lock washers
for mounting into concrete mounting base



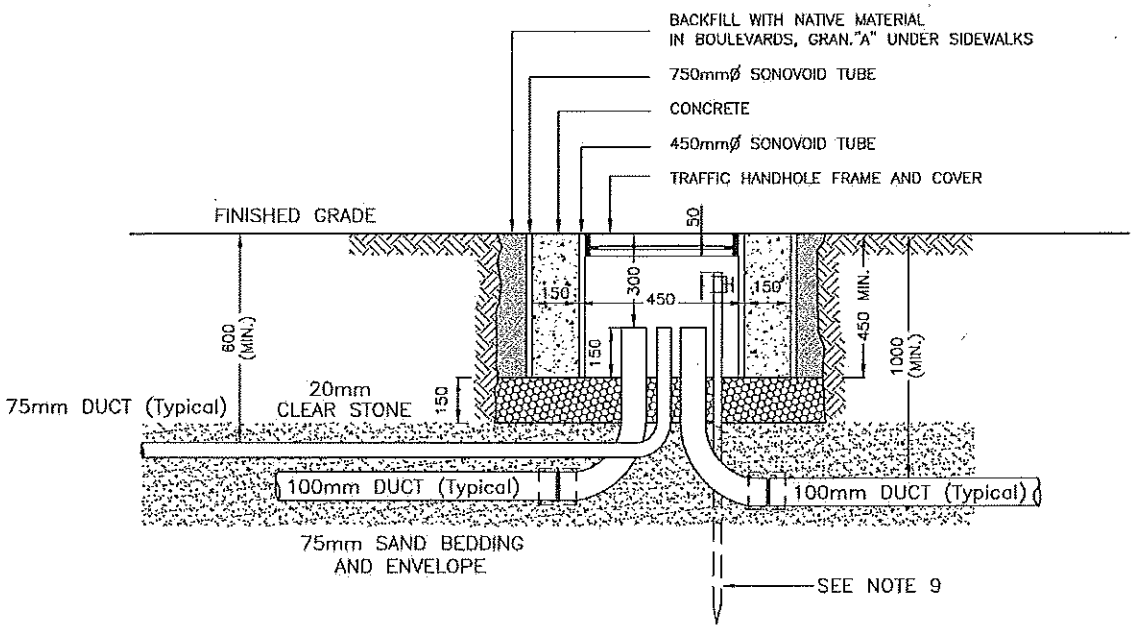


APPROVED T. Eidsvoog DIRECTOR OF ENGINEERING DATE: April 28/08	CITY OF BURLINGTON ENGINEERING DEPARTMENT	METRIC SCALE: N.T.S.
	STREETLIGHT POWER PEDESTAL	DWG. NO. S-156

DATE: MAY/12	REV. 5



PLAN



SECTION

NOTES

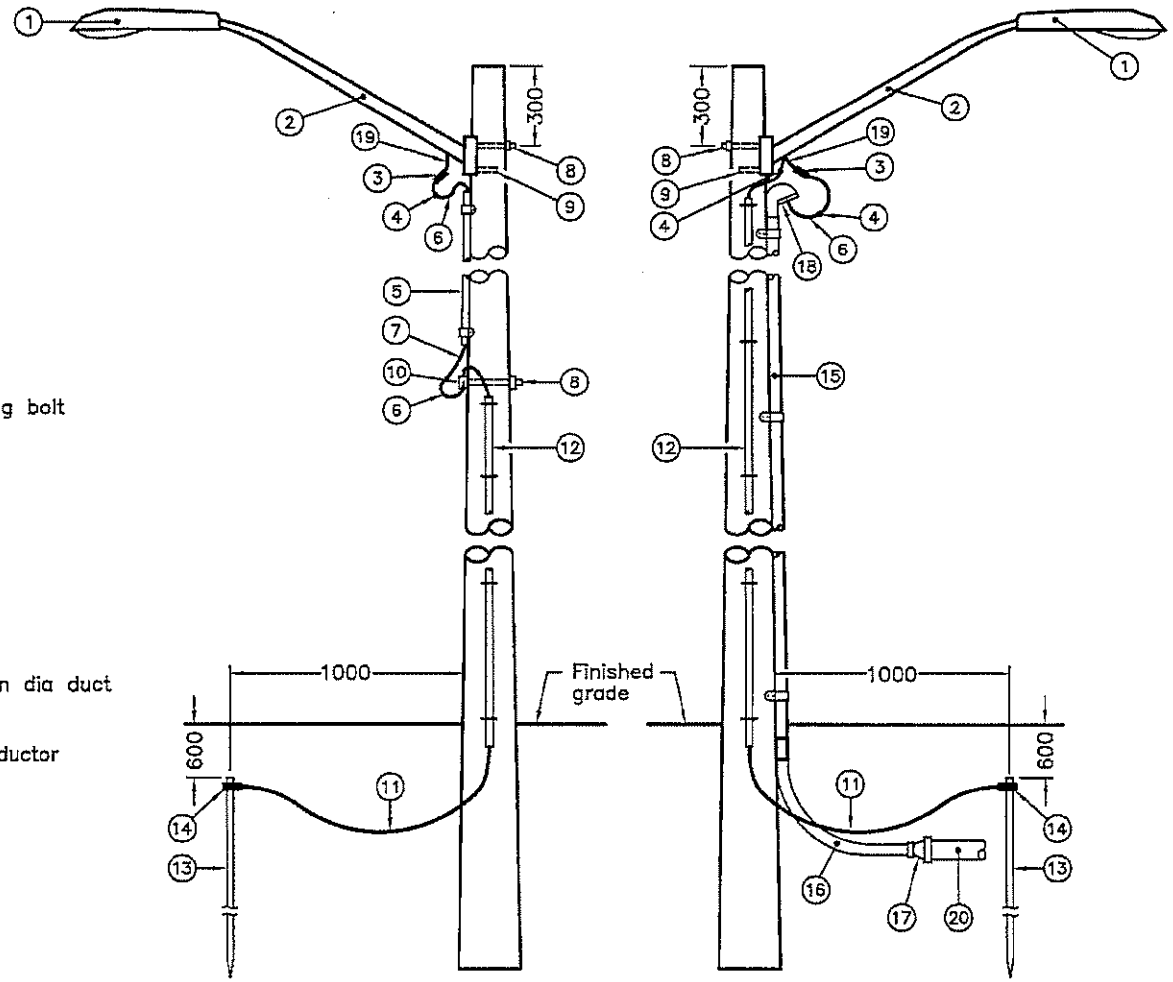
1. HANDHOLE & COVER SHALL CONFORM TO FINISHED GRADE.
2. ALL DUCTS TO BE PLACED IN 75mm SAND ENVELOPE.
3. ALL DUCTS TO BE "SCEPTER" RIGID P.V.C. CONDUIT.
4. END OF ALL DUCTS MUST BE CAPPED UNTIL WIRES PULLED.
5. CONDUITS FROM HANDHOLES TO CONTROLLER TO BE 100mm Ø RIGID CONDUIT.
6. BACKFILL UNDER ROADS AND ISLANDS TO BE GRANULAR.
7. BACKFILL IN BOULEVARD TO BE SELECTED EXCAVATED MATERIAL AS SPECIFIED IN SUPPLEMENTARY SPECIFICATIONS.
8. CONTRACTOR TO SUPPLY & PLACE 5mm POLYPROPLENE FISH ROPE IN ALL CONDUITS.
9. GROUND ROD TO BE A 20mm x 3000mm COPPER CLAD GROUND ROD (SLATER CAT. No. 9450 OR EQUAL) & MUST INCLUDE A U-STRAP GROUND WIRE CONNECTOR (SLATER CAT. No. 22151 OR EQUAL). GROUND ROD AND CONNECTOR SHALL BE SUPPLIED AND INSTALLED BY THE CONTRACTOR.
10. ALL DUCTS MUST BE CLEAN AND FREE OF ALL DEBRIS AND OBSTRUCTIONS (DIRT, STONES, ETC.)
11. CONCRETE AS PER C-2 (ITEM 11-CONCRETE) CITY OF BURLINGTON AMENDMENTS TO OPSS.

DIMENSIONS IN mm EXCEPT AS NOTED

APPROVED DIRECTOR OF ENGINEERING DATE: JUNE 5/12	CITY OF BURLINGTON ENGINEERING DEPARTMENT	METRIC SCALE: N.T.S.
	CAST IN PLACE CONCRETE SIGNAL HANDHOLE	DWG. NO. S-339

MATERIALS:

1. Luminaire
2. Single or double elliptical bracket
3. 600V, 15A in line type fuse holder, complete with insulating boots
4. Compression connectors with insulating covers
5. 25mm rigid PVC conduit with PVC pipe straps
6. 150mm drip loop
7. Secondary aerial bus, 2–#12 AWG low voltage cables and #12 AWG ground conductor
8. 16mm dia galvanized through bolt, complete with 50x50mm square washer, lock washer, and nut
9. 12mm dia x 150mm long galvanized square head lag bolt
10. Spool and clevis with secondary aerial cable
11. #6 AWG ground conductor
12. Protective moulding stapled to pole
13. Ground rod
14. Ground rod connection
15. 32mm dia rigid PVC conduit with PVC pipe straps
16. 32mm dia rigid PVC 90° bend
17. Coupling from 32mm dia rigid PVC conduit to 50mm dia duct
18. Entrance fitting
19. #12 AWG low voltage cables and #12 AWG ground conductor
20. 50mm dia duct



NOTES:

A Connect #12 AWG ground conductor to luminaire ground stud and secondary aerial bus.

B Length of wood pole and pole setting depth as specified.

C All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING

WOOD POLE WITH ELLIPTICAL BRACKET

OVERHEAD AND UNDERGROUND CIRCUITS

Nov 2006 | Rev 2

ONTARIO STANDARDS · MUNICIPAL – PROVINCIAL · OPS

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