APPENDIX 9.4-A
Roberts Bank Terminal 2
Light Assessment Study

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ROBERTS BANK TERMINAL 2
TECHNICAL REPORT
Light Assessment

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TECHNICAL REPORT/TECHNICAL DATA REPORT DISCLAIMER

The Canadian Environmental Assessment Agency determined the scope of the Project and the scope of the assessment in the Final Environmental Impact Statement Guidelines (EISG) issued January 7, 2014. The scope of the Project includes the project components and physical activities to be considered in the environmental assessment. The scope of the assessment includes the factors to be considered and the scope of those factors. The Environmental Impact Statement (EIS) has been prepared in accordance with the scope of the Project and the scope of the assessment specified in the EISG. For each component of the natural or human environment considered in the EIS, the geographic scope of the assessment depends on the extent of potential effects.

At the time supporting technical studies were initiated in 2011, with the objective of ensuring adequate information would be available to inform the environmental assessment of the Project, neither the scope of the Project nor the scope of the assessment had been determined.

Therefore, the scope of supporting studies may include physical activities that are not included in the scope of the Project as determined by the Agency. Similarly, the scope of supporting studies may also include spatial areas that are not expected to be affected by the Project.

This out-of-scope information is included in the Technical Report (TR)/Technical Data Report (TDR) for each study, but may not be considered in the assessment of potential effects of the Project unless relevant for understanding the context of those effects or to assessing potential cumulative effects.

EXECUTIVE SUMMARY

The Roberts Bank Terminal 2 Project (RBT2 or Project) is a proposed new three-berth marine terminal at Roberts Bank in Delta, B.C. that could provide 2.4 million TEUs (twenty-foot equivalent units) of additional container capacity annually. The Project is part of Port Metro Vancouver's Container Capacity Improvement Program, a long-term strategy to deliver projects to meet anticipated growth in demand for container capacity to 2030.

Port Metro Vancouver has retained Golder Associates Ltd. (Golder) to assess the potential changes in environmental light levels attributable to the proposed Project light emissions. The potential light emissions from RBT2 were assessed in accordance with the Commission Internationale de l'Eclairage (CIE)[1] guidelines and the limits previously used in literature (Narisada and Schreuder 2004).

The CIE guidelines are addressed in this report for RBT2, and specifically those relating to the potential changes attributable to the Project on light trespass and sky glow at the surrounding receptor sites. Light trespass and sky glow are the parameters used to assess the potential changes in light levels attributable to the Project.

Golder measured the existing light trespass and sky quality levels at 12 Point(s) of Reception (POR[s]) in the area surrounding the Roberts Bank terminals during site visits between March 27 and April 2, 2014 and on August 27, 2014. Using the existing light levels and light fixture photometric data from manufacturers, light trespass and sky glow levels associated with the Project operation were predicted at the PORs. The predictive analysis indicates that Project-related light emissions are expected to change the current CIE light trespass environmental light classifications at one of the PORs, and also change the current CIE sky glow zone classification at one of the 12 PORs.

[1] Translation: International Commission on Illumination

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LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation	Term
CIE	Commission Internationale de l'Eclairage
IESNA	Illuminating Engineering Society of North America
PORs	Point(s) of Reception
UTM	Universal Transverse Mercator

GLOSSARY OF TERMS

Term	Description
Astronomical twilight	The time when the centre of the sun is between 12° and 18° below the horizon. From the end of astronomical twilight in the evening to the beginning of astronomical twilight in the morning, the sky (away from urban light pollution) is dark enough for all astronomical observations
Candela	The luminous intensity of a lighting source and is measured in candelas (cd = lm/steradian)
Illuminance / illumination level	The total luminous flux incident on a surface, per unit area (i.e. lumens per m^2). It is a measure of the intensity of the incident light, wavelength-weighted by the luminosity function to correlate with human brightness perception and is the standard metric for lighting levels, measured in Lux
Indicators	Specific characteristics of the environment that can be measured, qualified or determined in some way
Magnitude per square arc second	A relative measure of the brightness of the sky. The natural background is 21.6, and the smaller the number the brighter the sky or celestial object. One magnitude level of difference corresponds to a factor of 2.5 change in brightness
Limiting magnitude	The brightness in mag/arcsec^2 of the weakest star visible as seen with some viewing device, such as a telescope, binoculars, or the naked eye. Here wherever the term is used, it refers to the naked eye limiting magnitude. This value depends on many factors, including the viewer's age and observation experience
Lumen	The unit of luminous flux produced by a source
Luminaire	A lighting fixture
Luminance	The perceived brightness of an object which has been illuminated by a source. The luminance of an object depends on its material characteristics and reflectance and is measured in cd/m^2
Point of reception	A location where measurements or predictions of light levels are made
Zenith	An imaginary point directly "above" a particular location, on the imaginary celestial sphere. "above" means in the vertical direction opposite to the apparent gravitational force at that location

LIST OF UNITS

Abbreviation	Term
%	Percent
cm	Centimetre
km	Kilometre
lux	lux (measured in lumens per metre squared)
m	Metre
mag/arcsec^2	Magnitude per square arc second
mlux	millilux (measured in one thousandth of a lumen per metre squared)
mm	Millimetre

1.0 INTRODUCTION

This section provides Project background information, an overview of the Light Assessment, and a review of available literature and data.

1.1 PROJECT BACKGROUND

The Roberts Bank Terminal 2 Project (RBT2 or Project) is a proposed new three-berth marine terminal at Roberts Bank in Delta, B.C. that could provide 2.4 million TEUs (twenty-foot equivalent units) of additional container capacity annually. The Project is part of Port Metro Vancouver's Container Capacity Improvement Program, a long-term strategy to deliver projects to meet anticipated growth in demand for container capacity to 2030.

Port Metro Vancouver has retained Golder Associates Ltd. (Golder) to assess the potential changes in environmental light levels attributable to the proposed Project light emissions. This technical report describes the results of the Light Assessment.

1.2 LIGHT ASSESSMENT OVERVIEW

A review of available information and state of knowledge was completed for the Light Assessment to identify key data gaps and areas of uncertainty related to light within the general RBT2 area. This technical report describes the study findings for key components identified from this gap analysis.

Light trespass and sky glow are the parameters that were used to assess the potential changes in light levels attributable to the Project. Light trespass can be described as the effect of the light or **illuminance** that strays from its intended purpose onto neighbouring areas. Sky glow is the result of stray light being scattered in the atmosphere, brightening the natural sky background level and reducing star visibility. The Commission Internationale de l'Eclairage (CIE)[2] guidelines are addressed in this report; specifically those relating to the potential Project-related changes on light trespass and sky glow at the surrounding locations.

The specific locations at which light levels are assessed are referred to as Point(s) of Reception (POR[s]). Golder measured the existing light trespass and sky quality levels at 12 PORs in the area surrounding the Roberts Bank terminals during site visits between March 27 and April 2, 2014 and on August 27, 2014. Using the measured light levels at the PORs, and photometric data (i.e., light fixture emission characteristics) from the light fixture manufacturers, light trespass and sky glow levels were predicted for the Project operation at each of the PORs, labelled as POR1 to POR12 on **Figure 1**.

[2] Translation: International Commission on Illumination

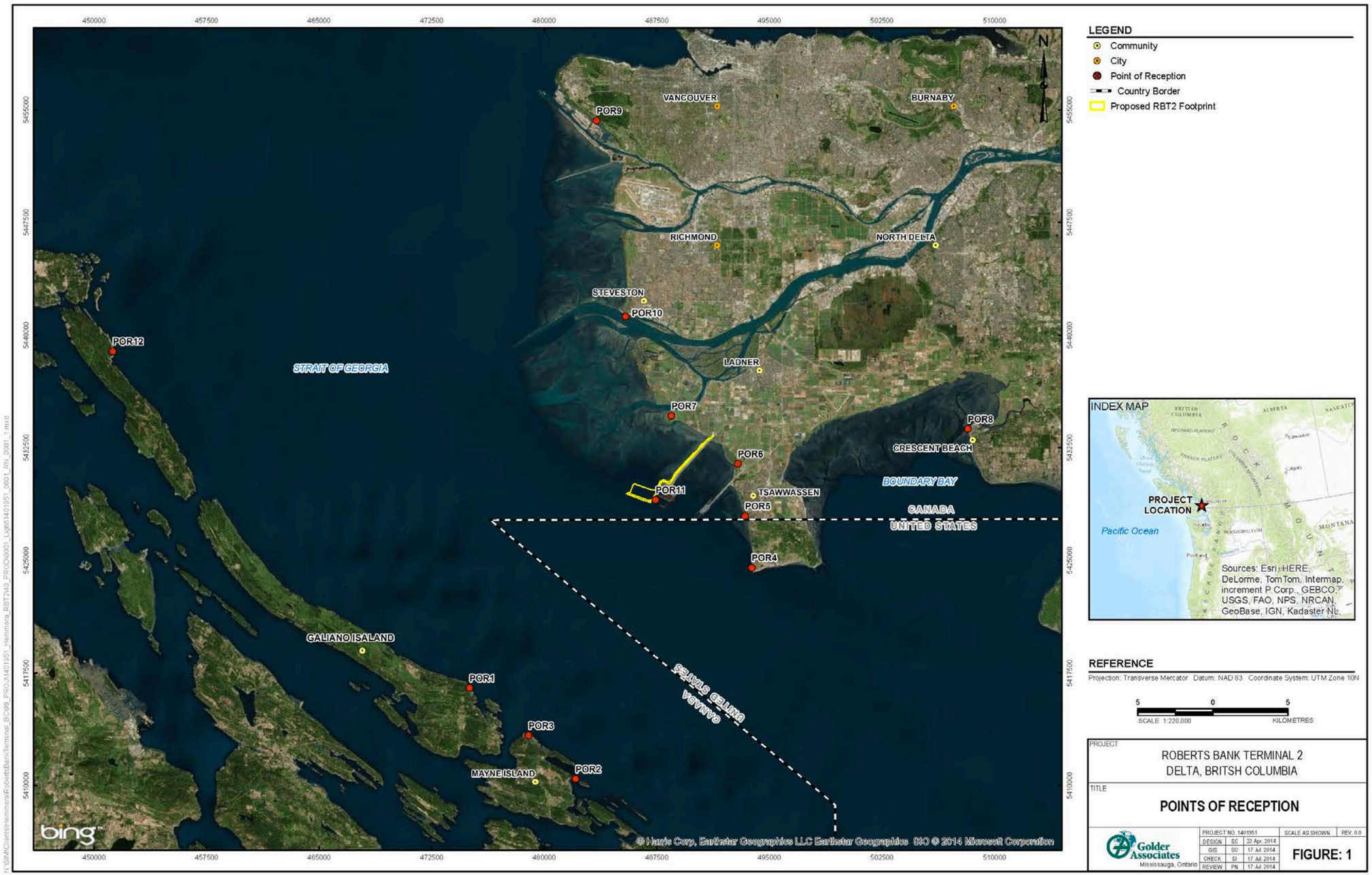
The following is a brief overview of the objectives of the assessment:

- Light Trespass objectives:
  - Measure the existing light trespass level at each of the PORs in the area surrounding the RBT2 to establish the current (year 2014) light trespass levels;
  - Determine the current light trespass CIE classification at each of the PORs;
  - Predict future (year 2025) light trespass levels at the PORs due to the Project; and
  - Determine whether the future light trespass level at each POR changes from the current CIE classification.
- Sky Glow objectives:
  - Measure existing sky quality level at each of the PORs in the area surrounding the RBT2 to establish the current (year 2014) sky glow levels;
  - Determine the current sky glow CIE classification at each of the PORs;
  - Predict future (year 2025) sky glow levels at the PORs due to the Project; and
  - Determine whether the future sky glow level at each POR changes from the current CIE classification.

1.3 REVIEW OF AVAILABLE LITERATURE AND DATA

There are no existing data sources summarising the current light trespass and sky glow levels in the vicinity of the Project. Assessments for the Deltaport Third Berth Project (Vancouver Port Authority 2005) and the Deltaport Terminal Road and Rail Improvement Project (Hemmera 2012) were both reviewed for the purposes of this assessment. However, the assessments were qualitative and did not include quantitative analysis of existing or predicted light trespass or sky glow levels. Therefore, field studies were carried out to collect the requisite data where appropriate, to characterise the existing conditions.

Figure 1 Points of Reception



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2.0 METHODS

Descriptions of the spatial and temporal scopes of the Light Assessment Study, as well as the study methods and data analysis are provided below.

2.1 STUDY AREA

The Light Assessment study area is comprised of 12 PORs. These POR locations were selected to represent the light conditions in the Lower Mainland and some Gulf Islands. The Aboriginal and federal lands and communities surrounding the Project are represented by the selected PORs.

In assessing the changes due to the Project on current light levels, this assessment has expanded on the typical definition of a POR representing an area of human habitation to include specific locations (POR 7 and POR 8) near the Project identified through consultation with the Canadian Wildlife Service (CWS), in order to enable the assessment of effects of light on coastal birds. The effects of light on coastal birds will be assessed in the Coastal Birds Section of the RBT2 Environmental Impact Statement (EIS). One location (POR12) was identified through consultation with Aboriginal groups.

POR1, POR2 and POR3 are located to the southwest; POR4 and POR5 are located to the southeast; POR6 and POR8 are located to the east; POR7, POR9 and POR10 are located to the north; POR11 is located at the existing Roberts Bank terminals; and POR12 is located to the northwest of the RBT2. **Table 1** summarises each POR.

Table 1 Points of Reception

POR ID	Location	UTM Coordinates (Zone 10U)		Distance from the Project (km)
		Easting (m)	Northing (m)	
POR1	Galiano Island	475019	5416523	17.3
POR2	Mayne Island	482086	5410465	19.3
POR3	Mayne Island	478949	5413361	17.7
POR4	Point Roberts	493819	5424530	8.4
POR5	Tsawwassen	493381	5427976	6.7
POR6	Tsawwassen First Nation Land	492897	5431451	6.5
POR7	Brunswick Point	488475	5434643	5.7
POR8	Crescent Beach	508223	5433767	21.9
POR9	Lookout location near the University of British Columbia	483486	5454294	25.3
POR10	Steveston Village	485416	5441259	12.2
POR11	Existing Roberts Bank terminals	487421	5429047	0.6
POR12	Valdes Island (Lyackson First Nation)	451275	5438934	37.0

2.2 TEMPORAL SCOPE

The Light Assessment is intended to summarise the current (2014) levels of light trespass and sky glow at the PORs surrounding Roberts Bank terminals using measured data, and to predict potential future levels of light trespass and sky glow during the operational phase of the Project. In assessing the potential changes in light levels attributable to the Project, the works and activities associated with each Project phase were reviewed to determine which phase would result in the greatest changes. Based on the number of light fixtures and the total light output during the operational phase of the Project, the operational phase was determined to result in the greatest changes on light levels.

A lighting layout representing the light emissions during the construction phase of the Project was not available. However, light sources and emissions during the construction phase are anticipated to vary according to construction requirements, and are expected to be lower than those during the operation phase (based on available information about anticipated construction equipment types and usage). The operational phase is therefore, assessed as the worst case scenario, intended to represent both construction and operational phases. The representative year for the operation phase is 2025, when RBT2 is anticipated to be operating at maximum sustainable capacity of 2.4 million TEUs per year.

2.3 STUDY METHODS

Light measurements were taken at each POR (**Figure 1**) between March 27 and April 2, 2014 and on August 27, 2014. Galiano Island (POR1) measurements were collected on the night of March 27, when the sky was mainly cloudy. Mayne Island measurements (POR2 and POR3) were collected on the night of March 28 under partly cloudy skies. Measurements in Point Roberts (POR4), Tsawwassen (POR5) and Tsawwassen First Nation Land (POR6) were collected on the night of March 30 under mainly cloudy skies. On the night of March 31, measurements at Steveston Village (POR10) were collected from a chartered vessel close to the shore under partly cloudy skies and windy weather conditions. The sky was mainly clear on the night of April 1, during which measurements were collected from a chartered vessel at the existing Roberts Bank terminals (POR11). Measurements were also collected on April 1 at Brunswick Point (POR7), Crescent Beach (POR8), and at a lookout location near the University of British Columbia (POR9) under mainly clear skies. Measurements were collected under clear skies on Valdes Island on the night of August 27, 2014. Both light trespass and sky quality measurements were collected at each POR with the exception of POR9 where only sky quality was measured. All measurements were taken after **astronomical twilight**. More specifically, measurements were collected each night after 9:30 p.m. and before 2:00 a.m. the next morning.

2.3.1 Light Trespass

Light trespass measurements were carried out using a Solar Light PMA2100 photometer and a PMA2131 scotopic detector (see **Appendix A** for the calibration certificate). This unit has a precision of 0.001 lux (or 1 mlux, comparable to the light trespass of a moonless clear night sky). The measurements were made at each identified location following best practices as per CIE guidelines (CIE 2003). At each location, measurements were made on a vertical plane towards the Project site. To account for slight variations in direction and emissions, four measurements with the same orientation were taken at each location and averaged. The rationale behind the selection of the measurement locations are explained in **Section 2.1**.

2.3.2 Sky Glow

Two methods were used for gathering information on existing sky glow. The first approach used a Unihedron Sky Quality Meter (SQM), which provides sky quality measurements in mag/arcsec^2. Sky quality is a measure of sky brightness, which is used to calculate sky glow level. The sky quality measurements were taken facing the **zenith** and at 45° from the zenith in the direction of the centre of the proposed terminal footprint. To account fo**r** any variability in the measurements, four readings were taken at each location, and averaged to obtain a more representative sky quality measurement. SQM has a precision of ±0.10 mag/arcsec^2.

The second approach provides a visual description of the existing sky glow and involves recording high resolution digital images of the night sky. In this regard, photographs were taken at 45° from the zenith in the direction of the centre of the proposed terminal footprint using a Nikon D700 dSLR with a Sigma 24 mm F1.8 wide-angle lens. This configuration provides high resolution images with low digital noise.

The number of stars captured in the resulting image far exceeds those visible to the naked eye. The images can be adjusted to obtain an accurate representation of what an average observer would see. The sky quality measurement from the SQM is used to determine the faintest star that could be seen by an average naked-eye observer (i.e., the **limiting magnitude** stars) from a particular location. The image is then compared to a star chart showing all the stars fainter than the limiting magnitude at that particular location, time, and date, and then adjusted to remove those stars too faint to be seen. Existing sky quality measurements were taken at all PORs listed in **Table 1** above.

2.4 DATA ANALYSIS

2.4.1 Light Trespass Predictive Modelling

Light trespass from the Project on the PORs was modelled using the AGi32 lighting software, which uses well established light propagation algorithms. This model allows for the incorporation of the following environmental factors that can result in noticeable changes in light levels:

- attenuation due to distance between the source and PORs;
- light fixture characteristics (e.g., shielding); and
- reflections off of building and ground surfaces.

Using the inverse square law, the AGi32 lighting software was used to calculate the aggregate illuminance from all significant light sources at the PORs identified in **Table 1**. The lighting model was developed based on the lighting layout provided for the Project. The proposed lighting for the Project includes high mast lighting, flood lighting, road lighting and crane lighting on the terminal, and road lighting on the causeway. The preliminary lighting layout includes more than 900 fixtures (**Table 2**). The layout (**Appendix B**) includes the locations and types of light fixtures proposed for the terminal and causeway structures. The types, luminous output and quantities of light fixtures used in modelling are listed in **Table 2**. The layout and **luminaire** information for the light fixtures identified with "type IDs" A, F, S, PL7, PL8 and PL9 can be found in **Appendix B**. The light fixtures photometric data is provided in **Appendix C**.

Table 2 Light Fixture Summary

Type ID	Brand	Model	IES Photometric Filename	Description	Lumens per Lamp	Quantity
A	Cooper Lighting	HMC91SXX4D	HMC91SXX4D.ies	High Pressure Sodium High-mast light fixture, (lighting layout description: HMC91SXX4D)	140,000	462
F	GE Lighting	GE LU250	ge453647_tcm201-56139.ies	High Pressure Sodium Flood lighting (lighting layout description: AMF-X-250-HPS-XX-44)	28,000	82
S	LED Roadway Lighting	SAT 96M 0XT3 450	SAT-96M-450mA-T3.IES	Road LED lighting (lighting layout description: SAT-96M-450mA-T3)	12,148	61
PL7	Holophane	PLLED 7 4K 10A 66	PLLED_7_4K_10A _66.ies	Predator large LED lighting	25441	48
PL8	Holophane	PLLED 8 4K 10A 45	PLLED_8_4K_10A _ 45.ies	Predator large LED lighting	26378	96
PL9	Holophane	PLLED 9 4K 10A 44	PLLED_9_4K_10A _ 44.ies	Predator large LED lighting	29432	192

The illuminance from the light sources was used to establish the level of light trespass at the PORs. The inverse square law is described as follows:

$$E = \frac{I}{D^2}(\cos\theta)$$

Where:

- E = illuminance at the point of interest (lm/m^2 = lux);
- I = luminous intensity (**candelas** [cd]);
- D = distance to POR (m); and
- θ = angle between the light ray and the normal to the surface of interest (degrees).

The PORs were assumed to be vertical walls facing in the direction of the majority of lights at the existing Roberts Bank terminals. This is the Illuminating Engineering Society of North America (IESNA) and CIE recommended approach (IESNA 2000, CIE 2003). The precise orientation of each POR was varied to determine the highest light trespass.

2.4.2 Sky Glow Predictive Modelling

Modelling for sky glow was carried out using a computer program based on a model developed by Garstang (1986, 1989) that predicts the night sky brightness caused by a city or large industrial facility at an observer location inside or outside the city for various zenith distances. The model accounts for molecular scattering, aerosol scattering, reflectivity of the ground, distance, and the fraction of light radiated above the horizontal. The model is based on an observer located at position O at a distance D from an illuminated area centred at C with radius R presented on **Figure 2** (obtained from Garstang 1986).

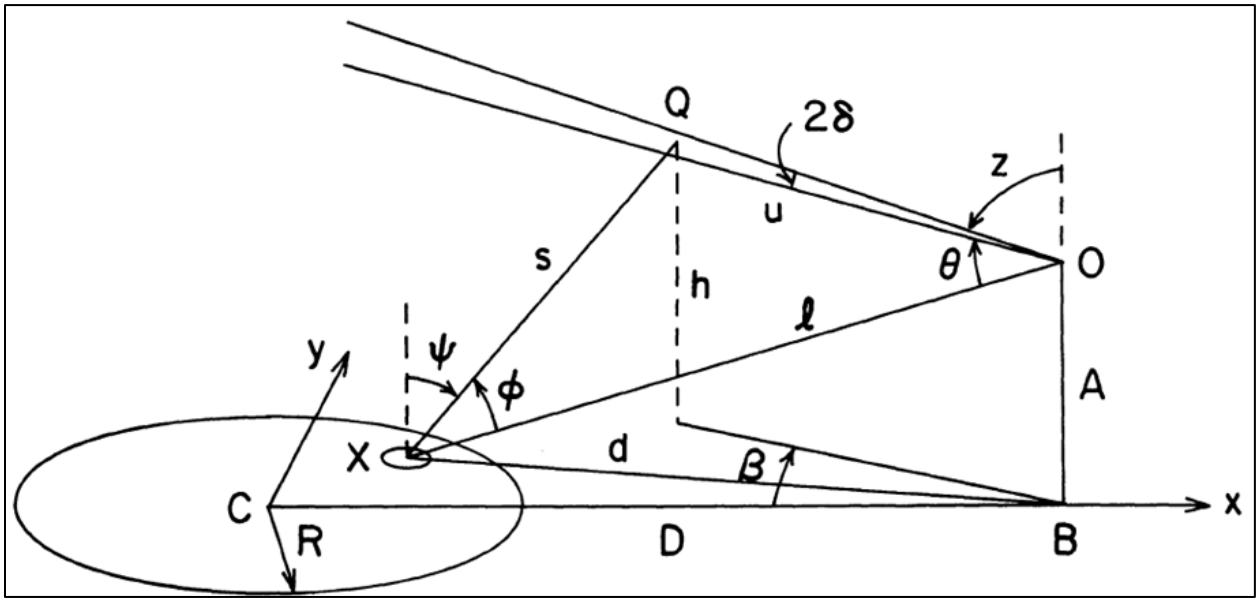


Figure 2 Sky Glow Model

The model predicts sky brightness using the following equation:

$$b = \pi N_m \sigma_R \exp(-cH) \iint (dxdy / \pi R^2) \int_0^\infty du \times I_{up} s^{-2} (EF)_{XQ} (EF)_{QO} (DS) \times \left\{ \exp(-ch) 3(1 + \cos^2[\theta + \phi]) / (16\pi) + \exp(-ah) 11.11 K f(\theta + \phi) \right\}$$

Where:

- b = the sky brightness;
- N_m = the particle density of the atmosphere at sea level;
- σ_R = 4.6 x 10^{-27} cm^2;
- c = 0.104 km^{-1};
- H = elevation of facility above sea level (m);
- I_{up} = luminous intensity in the direction of ψ;
- $(EF)_{QO}$ and $(EF)_{XQ}$ = extinction factor (the fractional reduction of light intensity with distance) from Q to O and from X to Q, respectively;
- DS = the double scattering correction;
- K = air clarity parameter (ratio of aerosol to molecular N_σ at ground level); and
- $f(\theta+\Phi)$ = scattering function.

The total predicted Project-related lumens were obtained from the light trespass model and applied to the sky glow model (i.e., light trespass and sky glow models used the same input information). Lighting fixture layout and the number of lumens each light fixture produces were exported from the light trespass model and imported into the sky glow model. The total sky glow amount at each POR was then predicted.

2.4.3 Light Trespass Assessment Criteria

Light trespass is the unintended direct illumination of nearby off-site locations by the light sources from the Project. Illuminance, measured in lux, has been selected as the **indicator** to represent the light trespass levels for this study. In order to put the illuminance levels from the Project into perspective, it is important to recognise the illuminance levels associated with common well known sources. **Table 3** provides a list of illuminance levels for some familiar light sources.

Table 3 Summary of Illumination Levels Associated with Common Sources

Example Illuminance Source	Illuminance (lux)
Moonless overcast night sky[1]	0.0001
Moonless clear night sky[1]	0.002
Full moon on a clear night[1]	0.27
Family living room[2]	50
Hallway[3]	80
Office lighting[4]	320-500
Overcast day[1]	1,000
Full daylight (not direct sun)[1]	10,000-25,000

Sources:
1 Schlyter (2009)
2 Pears (1998)
3 Australian Greenhouse Office (2005)
4 US Department of Labour (2010)

Light trespass limits attributable to the Project light sources may be determined based on the CIE environmental light classifications for the area. The CIE light classification system consists of a set of illuminance zones, identified as E1 to E4, ranging from intrinsically dark landscapes to areas of high ambient brightness (CIE, 2003; Narisada & Schreuder, 2004). The CIE light classification limits and their descriptions are provided in **Table 4**. The selection of a CIE environmental light classification for light trespass at each POR is based on the measured current light levels. As an example, measured existing light levels that are greater than 1 lux and less than 2 lux at a POR would result in an E3 classification.

Table 4 Environmental Light Classification

CIE Environmental Light Classification	Description of Environmental Light Classification	Maximum Recommended Light Trespass Limits (lux)
E1	Area with intrinsically dark landscapes	0
E2	Areas of low ambient brightness	1
E3	Areas of medium ambient brightness	2
E4	Areas of high ambient brightness	5

2.4.4 Sky Glow Assessment Criteria

Sky glow is the illumination of the night sky due to the scattering and reflection of light rays radiated in directions above the horizontal or reflected from the ground and buildings by aerosols present in the night sky. This results in a loss of contrast which reduces the number of visible stars, and produces a visible glow in the direction of the Project. One metric that can be used to describe sky glow is determining the change in sky brightness. Sky quality has been selected as the indicator representing sky brightness. **Table 5** provides a list of reference sky quality and corresponding sky glow levels.

Table 5 Summary of Commonly Seen Sky Glow in Percent above Natural Dark Sky Background

Example	Sky Quality[1] (Mag/arcsec^2)	Sky Glow[2] (%)
Standard natural background (zero sky glow)	21.6	0
Limit for astronomical site of international standing	21.5	10
Limit for dark sky site for most astronomers	21.2	40
Full moon night sky	18	3,000
Common densely populated area in North America	17	7,000
Clear sky 30 minutes after sunset	15	43,000
Heavily overcast sky	8	2.7×10^7
Clear daytime sky	3	2.7×10^9

Note: [1] Sky quality is a measure of sky brightness.
[2] Sky glow defined as percent brightness above natural dark sky background is obtained by converting sky quality values into units of luminance. Luminance for 21.6 mag/arcsec^2 set as 0% sky glow; luminance for 21.5 mag/arcsec^2 is 10% greater and yields 10% sky glow, etc.

Similar to the CIE environmental light classifications for light trespass, classifications have been established for sky glow. The sky glow zone classifications are based on limits recommended in the literature (Narisada and Schreuder 2004). The zones are defined in **Table 6** and are determined by sky glow levels in terms of percentage brightness above natural dark sky background. The sky glow limit for zone G1 – areas of outstanding natural beauty or protected landscapes is 20%. Zone G2 – areas of low district brightness are typically rural landscapes and have a sky glow limit of 100%. Sky glow limit of 200% for zone G3, suburban residential areas, is conservatively based on Narisada and Schreuder 2004 recommendations. Narisada and Schreuder 2004 recommend a sky glow limit for zone G4, areas of high district brightness, in multiple thousands; a limit was not set for zone G4 in **Table 6**.

Table 6 CIE Zone Classifications for Sky Glow

CIE Zone Classification[1] for Sky Glow	Description of the Zone	Sky Glow (% Brightness above Natural Dark Sky)
G1	Areas of outstanding natural beauty, protected landscapes	0 % < x ≤ 20 %
G2	Areas of low district brightness	20 % < x ≤ 100 %
G3	Suburban residential area	100 % < x ≤ 200 %
G4	Areas of high district brightness	x > 200 %

Note: [1] CIE (1997) classifies the zones as E1 through E4, however, to avoid confusion with light trespass classifications (**Table 4**), the zones have been re-labelled G1 through G4.

3.0 RESULTS

This section presents the main findings of the study, and briefly describes data gaps, potential biases and incidental observations.

3.1 FIELD STUDY INCIDENTAL OBSERVATIONS

Light trespass and sky quality measurements were collected at eleven locations surrounding the Project. The following provides a qualitative description of the PORs:

- POR1 to POR3 are representative of the Gulf Islands located to the west of the Project. There is no street lighting on the islands and the only lights observed on the islands were home and building outdoor lighting.
- POR4 is representative of the small suburban community of Point Roberts located southeast of the Project. There is no street lighting at this suburban community and the only lights observed were outdoor home lighting. The existing Roberts Bank terminals were visible from this location.
- POR5 is representative of the suburban community of Tsawwassen. Streets are brightly lit throughout this community including along the waterfront. This location had the greatest level of ambient light out of all the locations investigated.
- POR6 is representative of Tsawwassen First Nation Land. Streets within Tsawwassen First Nation Land were not as brightly lit as the suburban community of Tsawwassen. The light measurements were collected roughly at the midpoint between two consecutive street lights.
- POR7 is located at Brunswick Point to the north of the Project. Activities associated with Roberts Bank terminals were the only observed light source from this location.
- POR8 is at a Crescent Beach public park located approximately 20 km to the east of the Project. The area had very little ambient lighting.
- POR9 is at a lookout location next to a busy roadway representative of the University of British Columbia. There was no street lighting in this area.
- POR10 is on the water to the north of the Project near the shore of Steveston Village. This POR is representative of the mouth of the Fraser River south arm.
- POR11 is on the water near the existing Roberts Bank terminals.
- POR12 is representative of the Gulf Islands (Valdes Island) located northwest of the Project.

The activities at the existing Roberts Bank terminals are visible from all of the 12 PORs with the exception of POR8 and POR12.

In **Section 3.2**, the existing light trespass levels are used to classify each POR location according to light trespass environmental light classifications listed in **Table 4** and in **Section 3.3**, the existing sky glow levels are used to classify each POR location according to sky glow zones listed in **Table 6**.

3.2 MEASUREMENTS OF EXISTING LIGHT TRESPASS

The measured illuminance levels at the identified POR locations are summarised in **Table 7**. The illuminance levels range from 0.005 to 0.571 lux and are all above 0 and under 1 lux. Based on the existing illuminance levels, all of the 11 PORs are classified as E2.

Table 7 Existing Illuminance Levels at the Identified Measurement Locations and the Corresponding Light Classification

POR ID	Location	Illuminance (lux)	CIE Environmental Light Classification
POR1	Galiano Island	0.005	E2
POR2	Mayne Island	0.010	E2
POR3	Mayne Island	0.006	E2
POR4	Point Roberts	0.032	E2
POR5	Tsawwassen	0.571	E2
POR6	Tsawwassen First Nation Land	0.058	E2
POR7	Brunswick Point	0.030	E2
POR8	Crescent Beach	0.013	E2
POR9[1]	Lookout location near the University of British Columbia	0.013	E2
POR10	Steveston Village	0.031	E2
POR11	Existing Roberts Bank terminals	0.226	E2
POR12	Valdes Island	0.004	E2

Note: [1] Property access was not possible for light trespass measurements at POR9. The lighting environment at POR9 is similar to POR8 and therefore, measurements taken at POR8 were used.

3.3 MEASUREMENTS OF EXISTING SKY GLOW

The measured average sky quality levels at the identified POR locations facing the centre of the proposed terminal footprint at 45° from the zenith are summarised in **Table 8**. Each POR zone is classified based on the sky quality measurements and the corresponding sky glow.

Table 8 Existing Sky Quality Levels at the Identified Measurement Locations

POR ID	Measured Sky Quality (mag/arcsec^2)	Existing Sky Glow (% Brightness above Natural Background)	CIE Zone Classification for Sky Glow
POR1	20.88	95	G2
POR2	20.82	105	G3
POR3	20.53	167	G3
POR4	18.34	1909	G4
POR5	17.46	4440	G4
POR6	17.19	5735	G4
POR7	19.21	804	G4
POR8	19.47	613	G4
POR9	18.80	1218	G4
POR10	19.33	711	G4
POR11	18.33	1932	G4
POR12	20.63	144	G3

3.4 MODELLING RESULTS

This section summarises light trespass and sky glow modelling results.

3.4.1 Light Trespass

Light trespass predictions for the Project generated by AGi32 lighting software are summarised in **Table 9**. A discussion of results is provided in **Section 3.5.1**.

Table 9 Summary of Predicted Results for Light Trespass

POR ID	Location	Light Trespass (lux) Attributable to the Project
POR1	Galiano Island	0.000
POR2	Mayne Island	0.000
POR3	Mayne Island	0.000
POR4	Point Roberts	0.003
POR5	Tsawwassen	0.004
POR6	Tsawwassen First Nation Land	0.005
POR7	Brunswick Point	0.010
POR8	Crescent Beach	0.000
POR9	Lookout location near the University of British Columbia	0.000
POR10	Steveston Village	0.001
POR11	Existing Roberts Bank terminals	1.621
POR12	Valdes Island	0.000

3.4.2 Sky Glow

Sky glow prediction results for the Project are summarised in **Table 10**. A discussion of results is provided in **Section 3.5.2.**

Table 10 Summary of Predicted Results for Sky Glow

POR ID	Sky Glow (% Brightness above Natural Dark Sky)
POR1	121
POR2	124
POR3	192
POR4	2093
POR5	4753
POR6	6086
POR7	1307
POR8	626
POR9	1,226
POR10	794
POR11	13343
POR12	146

3.5 DISCUSSION OF KEY FINDINGS

A discussion of the major results arising from the Light Assessment is provided below.

3.5.1 Light Trespass

Based on measurements of existing levels of light trespass (i.e., > 0 lux ≤ 1 lux) at the PORs, the CIE environmental light classification E2 as described in **Section 2.4.3** is representative of the identified PORs. The maximum illuminance corresponding to the environmental light classification of E2 is 1 lux. Beyond this maximum illuminance, CIE light classification would change to E3 for trespass levels greater than 1 lux but less than 2 lux. Light trespass levels greater than 2 lux would result in an E4 classification. **Table 11** provides a comparison of the existing and predicted light trespass levels to the existing CIE classification maximum illuminance. The predicted illuminance levels with the Project result in a change of the CIE light classification for POR 11. The greatest increase of 1.621 lux in light trespass levels occurs at POR11. This increase yields a predicted future light trespass level of 1.847 lux at POR11 which is over 1 lux. This prediction is to be expected because of the proximity of POR11 to RBT2.

Table 11 Predicted Changes in Light Trespass Levels

Point of Reception	Existing Illuminance [lux]	Project Prediction [lux]	Existing + Project Illuminance [lux]	Maximum Illuminance for the Existing CIE Classification (lux)
POR1	0.005	0.000	0.005	1
POR2	0.010	0.000	0.010	1
POR3	0.006	0.000	0.006	1
POR4	0.032	0.003	0.035	1
POR5	0.571	0.004	0.575	1
POR6	0.058	0.005	0.063	1
POR7	0.030	0.010	0.040	1
POR8	0.013	0.000	0.013	1
POR9	0.013	0.000	0.013	1
POR10	0.031	0.001	0.032	1
POR11[1]	0.226	1.621	**1.847**	1
POR12	0.004	0.000	0.004	1

Note: [1] Predicted light trespass at POR11 is greater than the threshold of 1 lux.

3.5.2 Sky Glow Assessment

The sky glow CIE zone classifications for the PORs as described in **Section 2.4.4** were determined based on measurements of existing levels of sky quality at the PORs. The existing sky glow along with the corresponding CIE zone, and the future sky glow along with the corresponding future CIE zone classification at the PORs are presented in **Table 12**. The predicted future sky glow level (with the Project) at POR1 of 121% is greater than the sky glow limit of 100% for CIE zone G2 as defined in **Table 6**. The sky glow level of 121% falls in between 100% and 200% which is classified as zone G3. Hence, CIE zone classification at POR1 is expected to change from G2 to G3. The existing CIE zone classification does not change for any of the remaining PORs.

Table 12 Predicted Changes in Sky Glow

Point of Reception	Existing Sky Glow (% Brightness above Natural Background)	Existing Sky Glow CIE Zone Classification	Existing + Project Sky Glow (% Brightness above Natural Background)	Existing + Project Sky Glow CIE Zone Classification
POR1[1]	95	G2	**121**	G3
POR2	105	G3	124	G3
POR3	167	G3	192	G3
POR4	1909	G4	2093	G4
POR5	4440	G4	4753	G4
POR6	5735	G4	6086	G4
POR7	804	G4	1307	G4
POR8	613	G4	626	G4
POR9	1218	G4	1,226	G4
POR10	711	G4	794	G4
POR11	1932	G4	13343	G4
POR12	144	G3	146	G3

Note: [1] Predicted sky glow at POR1 is greater than the threshold of 100%.

The potential changes related to sky glow are presented as a visual aid in **Figure 3** and **Figure 4** for POR2. **Figure 3** shows the existing sky glow and **Figure 4** is an image that has been processed to represent the predicted future sky glow, which includes the changes associated with the Project. Based on a predicted change from 105% to 124% in sky glow, the brightness of the stars does not appear to change noticeably.

Figure 3 Photo of the Existing Sky at POR2

Figure 4 Photo of the Predicted Sky at POR2

3.6 DATA GAPS AND LIMITATIONS

The following assumptions and/or limitations were made/encountered in the Light Assessment:

- The IES photometric data obtained from lighting manufacturers was assumed to be current and correct, and were selected based on the catalog numbers indicated in the lighting schedule;
- When no manufacturer information was available for luminaires, Golder selected IES photometric data that seemed most appropriate for the luminaires in question;
- If information on physical barriers was not available, barriers were not included, leading to a conservative estimate;
- Ground reflectivity used was assumed to be 8% based on site observations;
- Light output above 90° from downwards was considered uplight;
- Light loss factors were not considered (i.e., the lights were considered to be 'new', with perfect ballasts, clean, and perfect input voltage). Older lights with varying input voltage, dirt and ballasts can reduce lumen output; and
- Light changes were modelled using the assumption that expected conditions would be the same as existing conditions. The plan to replace lights at Deltaport Terminal with LED lights prior to commencement of Project construction introduces some uncertainty to predicted future conditions with the Project.

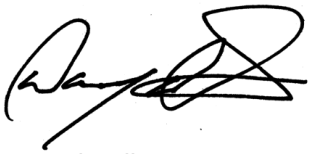
4.0 CLOSURE

Major authors and reviewers of this technical data report are listed below, along with their signatures.

Report prepared by:
Golder Associates Ltd.

Esen Cintosun, PhD, P.Eng.

Report peer reviewed by:
Golder Associates Ltd.



Danny da Silva, B.Sc., B.A.Sc., P.Eng.
Principal

5.0 REFERENCES

Pears. A. 1998. Appliance technologies and scope for emission reduction. Chapter 7 in Australian Green House Office. Strategic study of household energy and greenhouse issues.

Australian Greenhouse Office. 2005. Assessing lighting savings. Chapter 5 in Working Energy Program Resource and Training kit – Lighting. Available at: http://web.archive.org/web/20070415151053/www.greenhouse.gov.au/lgmodules/wep/lights/training/training9.html Accessed July 2014.

Commission Internationale de l'Eclairage (CIE). 1997. Technical report: guidelines for minimizing sky glow. CIE 126:1997, ISBN 978 3 900734 83 1. Vienna, Austria.

CIE. 2003. Technical report: guide on the limitation of the effects of obtrusive light from outdoor lighting installations. CIE 150:2003, ISBN 9788 3 901906 19 0. Vienna, Austria.

Garstang, R. H. 1989. Night-sky brightness at observatories and sites. Publications of the Astronomical Society of the Pacific 101:306-329.

Garstang, R. H. 1986, Publications of the Astronomical Society of the Pacific 98:364-375.

Hemmera. 2012. Environmental assessment report: Deltaport Terminal Road and Rail Improvement Project. Prepared for Port Metro Vancouver, Vancouver, B.C.

IESNA. 2000. Light trespass: research, results, and recommendations, IESNA TM-11-2000. Prepared by the Obtrusive Light Subcommittee of the IESNA Roadway Lighting Committee. New York: Illuminating Engineering Society of North America.

Narisada, K., and D. Schreuder. 2004. Light pollution handbook. Springer: Dordrecht, The Netherlands.

Schlyter, P. 2009. Radiometry and photometry in astronomy. Archived from the original on Dec 7, 2013. Available at http://stjarnhimlen.se/comp/radfaq.html. Accessed July 2014.

U.S. Deptartment of Labor. 2010. Illumination. Regulations (Standards - 29 CFR). Occupational Safety and Health Administration. Available at https://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=standards&p_toc_level=1&p_keyvalue=construction.

Vancouver Port Authority. 2005. Environmental assessment application for the Deltaport Third Berth Project. Vancouver, B.C.

APPENDIX A
Calibration Certificates

SOLAR®
LIGHT

CERTIFICATE OF CALIBRATION

CUSTOMER	Golder Associates, Ltd. Mississauga, ON, Canada	**PROJECT NUMBER**	15055
P.O. NUMBER	Verbal	**INSTRUMENT DESC.**	Photopic Detector
RANGE	0 – 1500 Lux	**INSTRUMENT MODEL**	PMA2130L
SENSITIVITY	380 – 780 nm, CIE Photopic weighted	**INSTRUMENT SN**	15922
SPECTRUM TO WHICH CALIBRATED	Quartz-halogen tungsten filament	**DATE CALIBRATED**	10/11/2013
		PREV. CALIBRATED	10/08/2012
REFERENCE PLANE	Leading edge of detector	**CALIBRATION FREQUENCY**	Annual
TEMPERATURE	25.5 °C	**REFERRING STANDARD**	Mfg Spec
HUMIDITY	44 %	**CALIBRATION METHOD**	Spectroradiometric
		EXPANDED UNCERTAINTY	±5%, k=2

The above instrument has been calibrated traceable to the National Institute of Standards and Technology (NIST). Solar Light Company's quality system is compliant with ANSI/NCSL Z540-1-1994. Unless otherwise specified, the tolerance limits are equal to the expanded uncertainty. This report may not be reproduced, except in full, without the written approval of Solar Light Company.

EQUIPMENT USED

- Optronic Laboratories Model OL220M 200W quartz-halogen, coiled-coil tungsten filament lamp S/N M1313
- Optronic Laboratories Model 65DS precision current source S/N 84473
- Vishay Model VFP4 shunt resistor S/N NA
- Fluke Model 189 multimeter S/N 82290282
- Schott NG-5 1mm Thick Filter Melt: 135047
- Solar Light PMA Detector Programming Interface S/N LAB
- Solar Light Model PMA2100 Radiometer S/N 10822

CALIBRATION METHOD

The spectral irradiance of the lamp is known and traceable to NIST.

The spectral irradiance of the lamp is weighted by the CIE Photopic Luminous Efficiency Function and 683 Lumens/Watt then integrated over the effective wavelength range (380-780nm) to give the photopic illuminance. The transmittance of the neutral density filter is then applied to the illuminance. The PMA2130L detector is calibrated to the photopic illuminance of the lamp at a distance of 50cm with neutral density filter in place.

RESULTS

Lamp Illuminance:	1091.3 [Lux]				
As Found:	1063.7 [Lux]	Error:	-2.5%	Condition:	In Tolerance
As Left:	1063.7 [Lux]	Error:	-2.5%	Condition:	In Tolerance

NOTES

PRINT DATE October 14, 2013
CALIBRATION CERTIFIED BY

Christopher Voth
Metrologist

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SOLAR®
LIGHT

CERTIFICATE OF CALIBRATION

CUSTOMER	Golder Associates, Ltd. Mississauga, ON, Canada	**PROJECT NUMBER**	15055
P.O. NUMBER	Verbal	**INSTRUMENT DESC.**	Scotopic Detector
RANGE	0 – 200 Lux	**INSTRUMENT MODEL**	PMA2131
SENSITIVITY	380 – 780 nm, CIE Scotopic weighted	**INSTRUMENT SN**	15960
SPECTRUM TO WHICH CALIBRATED	Quartz-halogen tungsten filament	**DATE CALIBRATED**	10/11/2013
		PREV. CALIBRATED	10/08/2012
REFERENCE PLANE	Leading edge of detector	**CALIBRATION FREQUENCY**	Annual
TEMPERATURE	25.9 °C	**REFERRING STANDARD**	Mfg Spec
HUMIDITY	43 %	**CALIBRATION METHOD**	Spectroradiometric
		EXPANDED UNCERTAINTY	±5%, k=2

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EQUIPMENT USED

- Optronic Laboratories Model OL220M 200W quartz-halogen, coiled-coil tungsten filament lamp S/N M1313
- Optronic Laboratories Model 65DS precision current source S/N 84473
- Vishay Model VFP4 shunt resistor S/N NA
- Fluke Model 189 multimeter S/N 82290282
- Edmund Optics neutral density filter, 3.2% transmittance
- Solar Light PMA Detector Programming Interface S/N LAB
- Solar Light Model PMA2100 Radiometer S/N 10822

CALIBRATION METHOD

The spectral irradiance of the lamp is known and traceable to NIST.

The spectral irradiance of the lamp is weighted by the CIE Scotopic Luminous Efficiency Function and 1754 Lumens/Watt then integrated over the effective wavelength range (380-780nm) to give the scotopic illuminance. The transmittance of the neutral density filter is then applied to the illuminance. The PMA2131 detector is calibrated to the scotopic illuminance of the lamp at a distance of 50cm with neutral density filter in place.

RESULTS

Lamp Illuminance:	107.28 [Lux]				
As Found:	100.33 [Lux]	Error:	-6.5%	Condition:	Out of Tolerance
As Left:	107.28 [Lux]	Error:	0.0%	Condition:	In Tolerance

NOTES

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CERTIFICATE OF CALIBRATION

CUSTOMER	Golder Associates, Ltd. Mississauga, ON, Canada	**PROJECT NUMBER**	15055
P.O. NUMBER	Verbal	**INSTRUMENT DESC.**	Radiometer
RANGE	0 – 5 Volts	**INSTRUMENT MODEL**	PMA2100
REFERRING STANDARD	Mfg Spec	**INSTRUMENT SN**	15833
CALIBRATION METHOD	Transfer	**DATE CALIBRATED**	10/14/2013
TEMPERATURE	25.5 °C	**PREV. CALIBRATED**	10/08/2012
HUMIDITY	36 %	**CALIBRATION FREQUENCY**	Annual
		EXPANDED UNCERTAINTY	±0.5%, k=2

The above instrument has been calibrated traceable to the National Institute of Standards and Technology (NIST). Solar Light Company's quality system is compliant with ANSI/NCSL Z540-1-1994. Unless otherwise specified, the tolerance limits are equal to the expanded uncertainty. This report may not be reproduced, except in full, without the written approval of Solar Light Company.

EQUIPMENT USED

- Fluke Model 189 multimeter S/N 85500008
- Maxim Model MAX677 precision 5.0000 volt reference S/N NA

CALIBRATION METHOD

The above instrument was calibrated by transfer from the Fluke 189 multimeter measuring the MAX677 precision voltage reference.

The precision voltage reference is applied to each the left and right detector connector of the PMA2100 for calibration. The high range calibration factor for each connector and the common low range calibration factor are stored in the PMA2100. Any PMA21xx series detector can interface to either connector.

RESULTS

	Low Range	High Left	High Right	Units
Reference:	0.3307	3.0000	3.0000	[Volts]
As Found:	0.3307	2.9992	2.9991	[Volts]
As Found Error:	0.00	-0.03	-0.03	[%]
As Found Condition:	In Tolerance	In Tolerance	In Tolerance	
As Left:	0.3307	3.0000	3.0000	[Volts]
As Left Error:	0.00	0.00	0.00	[%]
As Left Condition:	In Tolerance	In Tolerance	In Tolerance	

NOTES

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CALIBRATION CERTIFIED BY

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APPENDIX B

Lighting Layout

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TITLE BLOCK: DL-TB.dwg

LUMINAIRE LOCATION SUMMARY

LUM NO	LABEL	ORIENT	TILT
1	A	0	0
2	A	0	0
3	A	0	0
4	A	0	0
5	A	0	0
6	A	0	0
7	A	0	0
8	A	0	0
9	A	0	0
10	A	0	0
11	A	0	0
12	A	0	0
13	A	0	0
14	A	0	0
15	A	0	0
16	A	0	0
17	A	0	0
18	A	0	0
19	A	0	0
20	A	0	0
21	A	0	0
22	A	0	0
23	A	0	0
24	A	0	0
25	A	0	0
26	A	0	0
27	A	0	0
34	A6	0	0
35	A6	0	0
36	A6	0	0
37	A6	0	0
38	A6	0	0
39	A6	0	0
40	A6	0	0
41	A6	0	0
42	A6	0	0
43	A	0	0
44	A	0	0
45	A	0	0
46	A	0	0
47	A	0	0
48	F	260	80
49	F	260	80
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51	F	260	80
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54	F	260	80
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79	F	260	80
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82	F	260	80
83	F	260	80
84	F	260	80
85	F	260	80
86	F	260	80
87	F	260	80
88	F	260	80
93	A	0	0

LUMINAIRE LOCATION SUMMARY

LUM NO	LABEL	ORIENT	TILT
94	A6	200.837	0
95	A6	253.54	0
96	F	280	80
97	F	280	80
98	F	280	80
99	F	280	80
100	F	280	80
101	F	280	80
102	F	280	80
103	F	280	80
104	F	280	80
105	F	280	80
106	F	280	80
107	F	280	80
108	F	280	80
109	F	280	80
110	F	280	80
111	F	280	80

LUMINAIRE LOCATION SUMMARY

LUM NO	LABEL	ORIENT	TILT
120	F	280	80
121	F	280	80
122	F	280	80
123	F	280	80
124	F	280	80
125	F	280	80
126	F	280	80
127	F	280	80
128	F	280	80
129	F	280	80
130	F	280	80
131	F	280	80
132	F	280	80
133	F	280	80
134	F	280	80
135	F	280	80
136	F	280	80

LUMINAIRE SCHEDULE

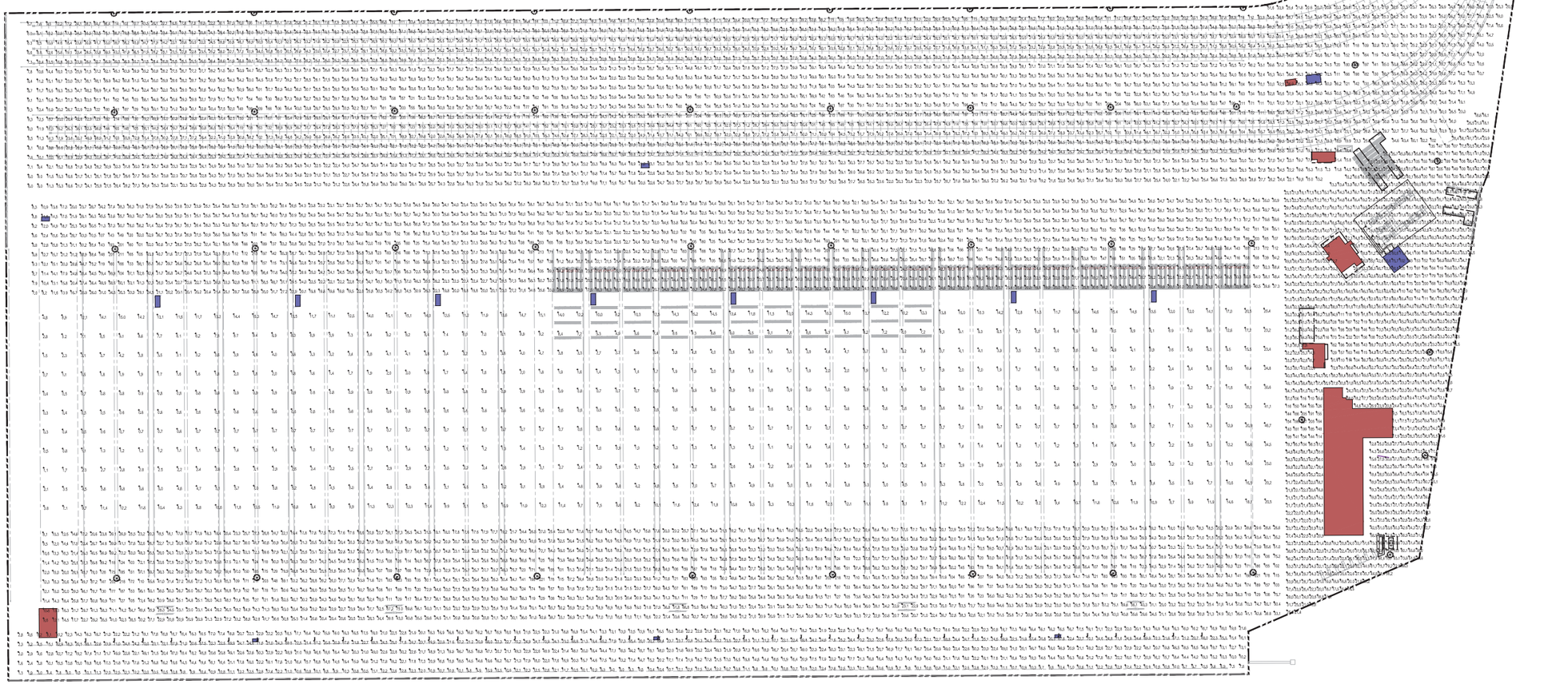
SYMBOL	QTY	LABEL	ARRANGEMENT	TOTAL LAMP LUMENS	LLF	DESCRIPTION
	33	A	12 @ 30 DEGREES	140000	0.770	12xHMC91SXX4D
	11	A6	GROUP	N.A.	0.770	6xHMC-91S-X-4D
	82	F	SINGLE	28000	0.770	AMF-X-250-HPS-XX-44

CALCULATION SUMMARY

LABEL	CALC TYPE	UNITS	AVG	MAX	MIN	AVG/MIN	MAX/MIN
BUILDINGS AREA	ILLUMINANCE	LUX	51.50	232	9.5	5.42	24.37
CAISSON WHARF AREA	ILLUMINANCE	LUX	22.21	71.6	1.3	17.08	55.08
CONTAINER YARD	ILLUMINANCE	LUX	5.13	46.7	0.3	17.10	155.67
CONTAINER YARD 50LX AREA NORTH	ILLUMINANCE	LUX	52.49	216	7.0	7.50	30.84
CONTAINER YARD 50LX AREA SOUTH	ILLUMINANCE	LUX	51.00	223	8.1	6.30	27.49
RAILS	ILLUMINANCE	LUX	43.85	221	0.3	146.17	736.33

DRAWING INFORMATION:
FIXTURE MOUNTING HEIGHT: TYPE A AND A6 - 35m;
TYPE F - 5.5m
ARM'S LENGTH: 2.5m;
BUILDINGS' HEIGHT: 7m

DISCLAIMER: THIS ANALYSIS IS A MATHEMATICAL MODEL OF A REAL LIFE SITUATION. THE CALCULATIONS ARE BASED ON THE DATA PROVIDED BY THE CLIENT, AS STATED ON THE DESIGN. ACTUAL VALUES MAY VARY FROM DESIGN DUE TO SITE CONDITIONS, OBSTRUCTIONS AND HIGH OBJECTS, LIKE SHELVES, DUCTS ETC, NOT SHOWN ON THE DESIGN, MAY REDUCE LIGHT LEVELS ADDITIONALLY.



LUMINAIRE LOCATION SUMMARY

LUM NO	LABEL	ORIENT	TILT
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113	F	280	80
114	F	280	80
115	F	280	80
116	F	280	80
117	F	280	80
118	F	280	80
119	F	280	80

PRELIMINARY
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DATE: 2013/07/23 - 11:10am
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Ref.No.	REFERENCE

AECOM

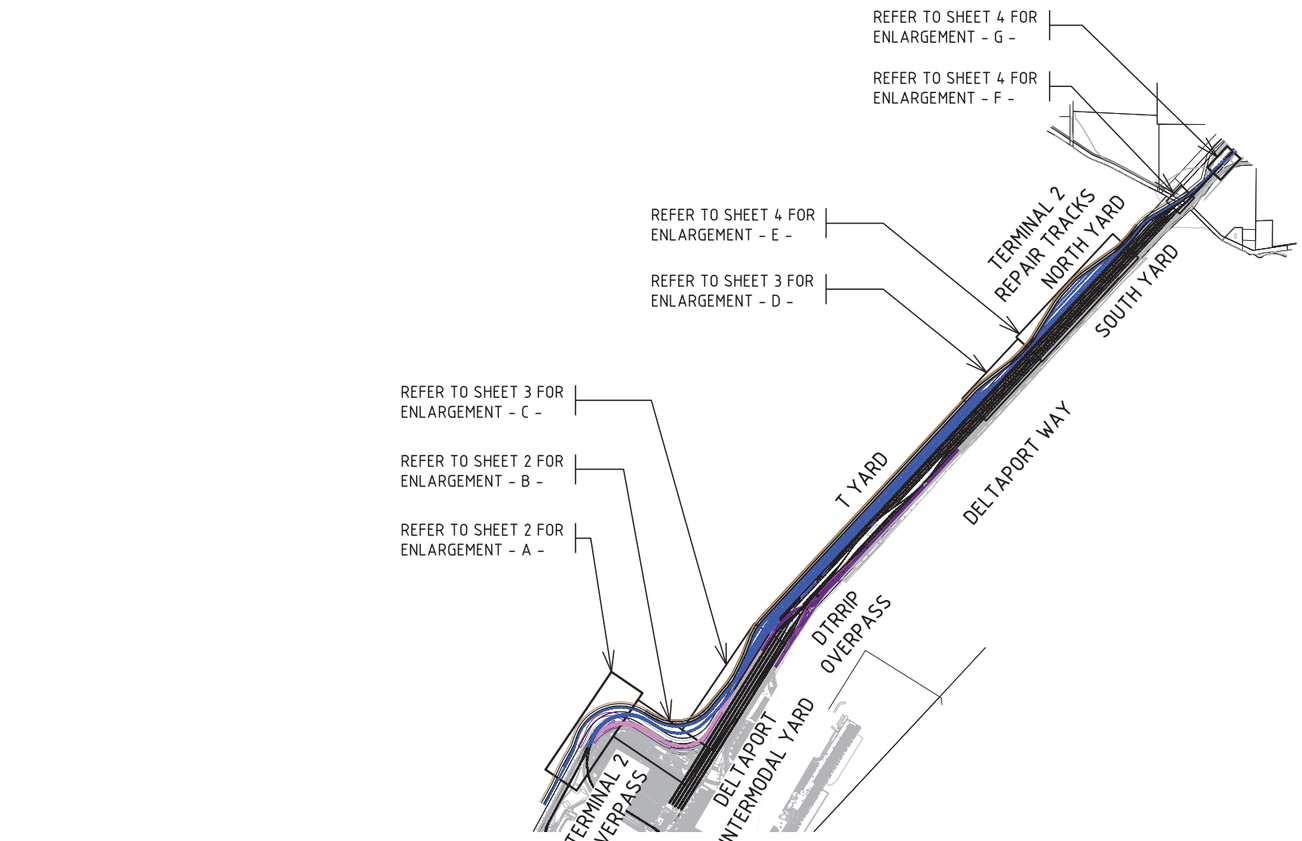
No.	Date	REVISION	Dr'n	Ch'd
B	22-Jul-13	Project Description Issue	JB,EC	BB
A	27-Jun-13	Issued for Review	JB,EC	BB

PORT METRO vancouver
VANCOUVER FRASER PORT AUTHORITY
ENGINEERING DEPARTMENT

DESIGN BY B.Kellie/B.Boyes
DRAWN BY J.Beldo/B.Kellie
APPROVED
DATE
SCALE 1:2500
PMV SITE

CONTAINER CAPACITY IMPROVEMENT PROGRAM
RBT2 - PRELIMINARY DESIGN
SITE WIDE LIGHTING AND LUX VALUES
PLAN

SIZE D | DWG. 60287593-EL-840 | SHEET 1 of 1 | REV. B



KEYPLAN
N.T.S.

CONCEPTUAL DESIGN
DO NOT USE FOR CONSTRUCTION
Last Saved: Jun. 20/14 10:17am

		CONSULTANT					
		DMD & Associates Ltd.					
		#12-17358 104A Avenue, Surrey, BC, Canada V4N 5M3					
		www.dmdeng.com 604/589-9010					
		office@dmdeng.com Fax 604/589-9012					
		DMD PROJECT No. 4124-13-01 of 06					
Ref.No.	REFERENCE						
		1	JUN/2014	REVISED TO SUIT PMV COMMENTS	AM	.	
		No.	Date	REVISION	Dr'n	Ch'd	

PORT METRO vancouver
VANCOUVER FRASER PORT AUTHORITY
ENGINEERING DEPARTMENT

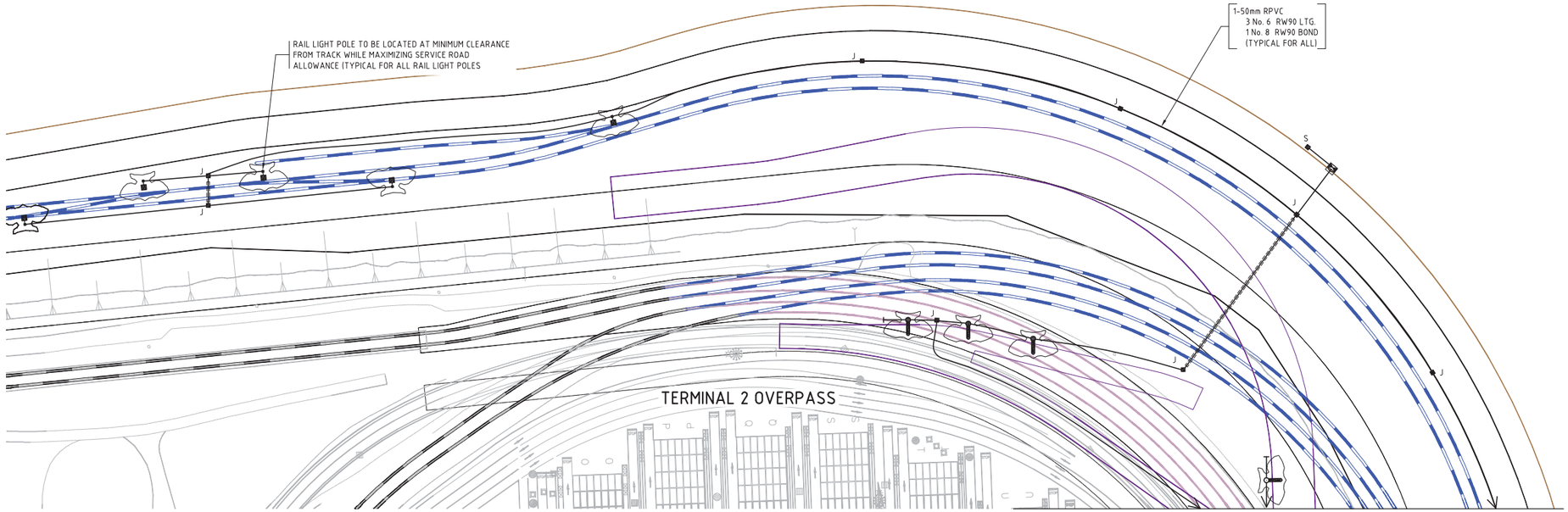
DESIGN BY	DONATO SPEIDEL
DRAWN BY	BOB KELLIE
APPROVED	
DATE	MAY 09/2013
SCALE	SHOWN
PMV SITE	34

CONTAINER CAPACITY IMPROVEMENT PROGRAM
KEY PLAN
FOR RAIL SWITCH LIGHTING
ROBERTS BANK TERMINAL 2

SIZE	DWG.	SHEET	REV.
D	34-347-EL-4000	1 of 6	1

RAIL LIGHT POLE TO BE LOCATED AT MINIMUM CLEARANCE FROM TRACK WHILE MAXIMIZING SERVICE ROAD ALLOWANCE (TYPICAL FOR ALL RAIL LIGHT POLES

1-50mm RPVC
3 No. 6 RW90 LTG.
1 No. 8 RW90 BOND
(TYPICAL FOR ALL)



ENLARGEMENT - A -

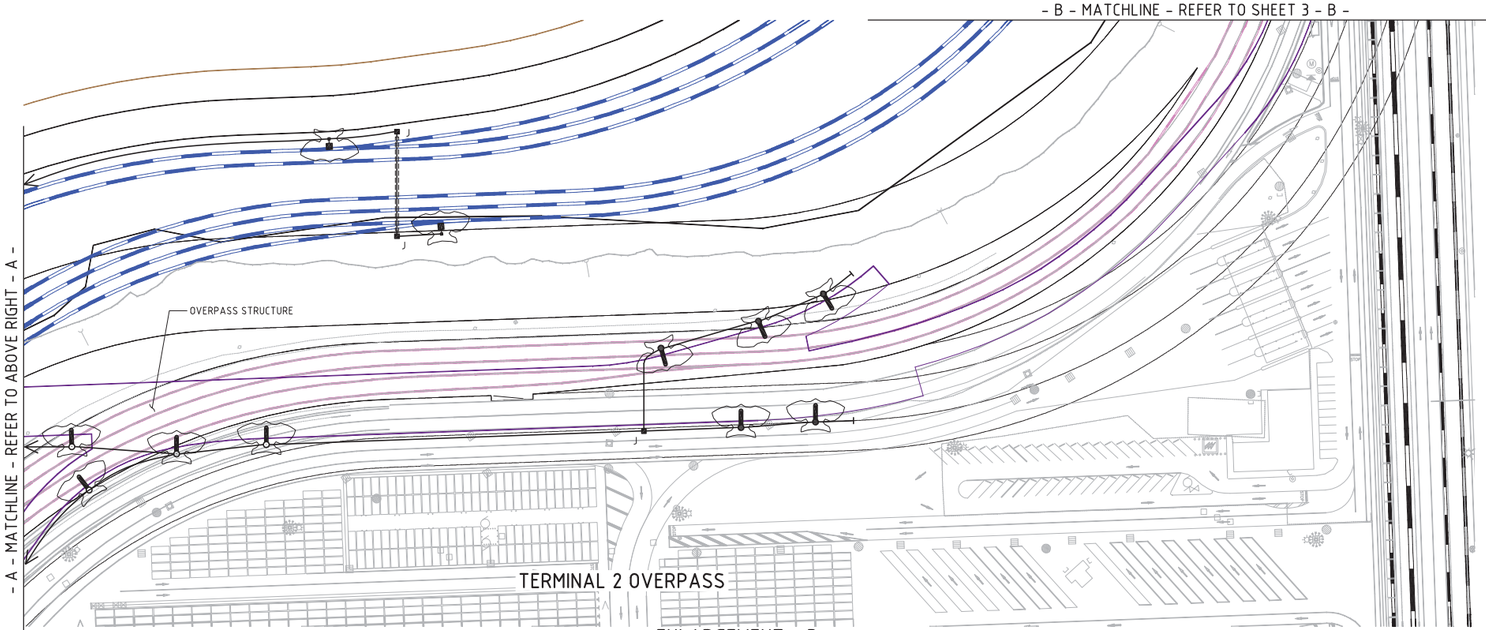
m 0 10 20 30 40 50 m

1:1000

- A - MATCHLINE - REFER TO BELOW LEFT - A -

- B - MATCHLINE - REFER TO SHEET 3 - B -

- A - MATCHLINE - REFER TO ABOVE RIGHT - A -



ENLARGEMENT - B -

m 0 10 20 30 40 50 m

1:1000

LEGEND

- PROPOSED 9.0m DAVIT ROADWAY LIGHT POLE C/W LED STREET LIGHT FIXTURE INSTALLED ON BRIDGE DECK. REFER TO SHEET 08 FOR DETAILS
- PROPOSED 9.0m DAVIT ROADWAY LIGHT POLE C/W LED STREET LIGHT FIXTURE ON AN MMCD TYPE C2 CONCRETE BASE. REFER TO SHEET 08 FOR DETAILS
- PROPOSED 8.0m STRAIGHT SQUARE STEEL LIGHT POLE C/W A SINGLE LED STREET LIGHT FIXTURE ON AN MMCD TYPE C CONCRETE BASE. REFER TO SHEET 08 FOR DETAILS
- PROPOSED 8.0m STRAIGHT SQUARE STEEL LIGHT POLE C/W TWO LED STREET LIGHT FIXTURES ON AN MMCD TYPE C CONCRETE BASE. REFER TO SHEET 08 FOR DETAILS
- REMOVED LIGHT STANDARD
- 20 LUX ISOLUX LINE (FOR CALCULATION PURPOSES)
- J ■ PROPOSED JUNCTION BOX.
- J □ EXISTING JUNCTION BOX.
- S ■ ASSUMED BC HYDRO SERVICE BOX LOCATION (347/600V)
- PROPOSED 50mm RPVC CONDUIT AND CONDUCTORS
- EXISTING CONDUIT AND CONDUCTORS
- CO PROPOSED CONDUIT STUB OUT
- PROPOSED RAIL TRACK
- EXISTING RAIL TRACK
- EXISTING RAIL TRACK TO BE REMOVED
- PROPOSED 50mm RPVC CONDUIT CONCRETE ENCASED
- PROPOSED SERVICE KIOSK (347/600V)
- EXISTING SERVICE KIOSK
- ASSUMED BC HYDRO SERVICE POLE LOCATION (347/600V)

CONCEPTUAL DESIGN
DO NOT USE FOR CONSTRUCTION
Last Saved: Jun. 19/14 5:06pm

Ref.No.	REFERENCE

CONSULTANT
DMD & Associates Ltd.
#12-17358 104A Avenue, Surrey, BC, Canada V4N 5M3
www.dmdeng.com 604/589-9010
office@dmdeng.com Fax 604/589-9012
DMD PROJECT No. 4124-13-02 of 06

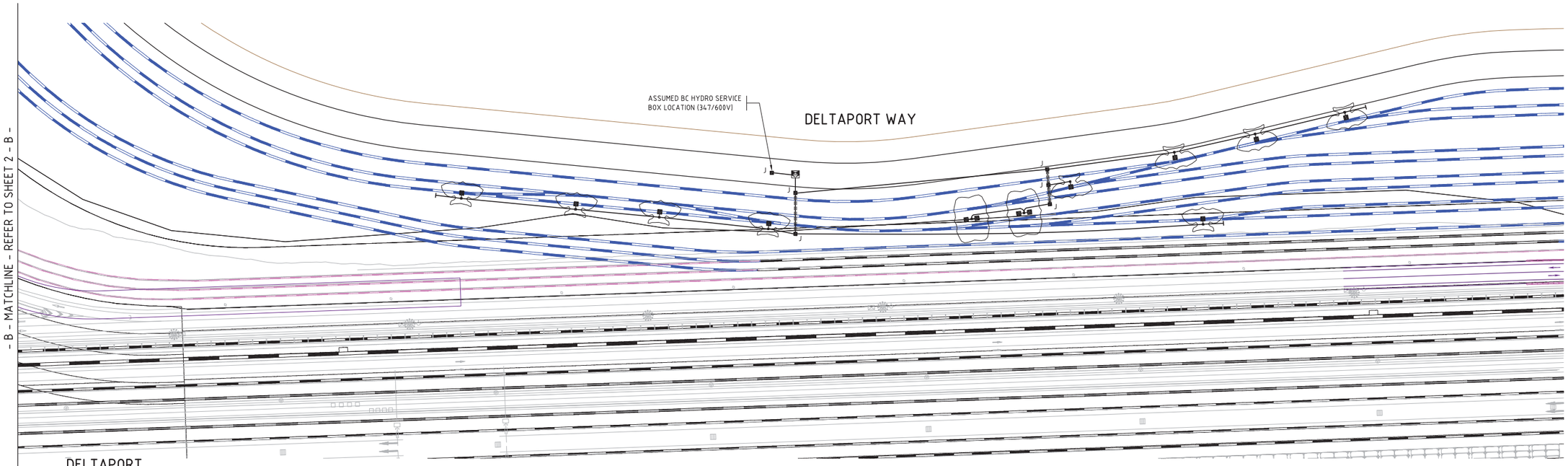
No.	Date	REVISION	Dr'n	Ch'd
1	JUN/2014	REVISED TO SUIT PMV COMMENTS	AM	.

PORT METRO vancouver
VANCOUVER FRASER PORT AUTHORITY
ENGINEERING DEPARTMENT

DESIGN BY	DONATO SPEIDEL
DRAWN BY	BOB KELLIE
APPROVED	
DATE	MAY 09/2013
SCALE	SHOWN
PMV SITE	34

CONTAINER CAPACITY IMPROVEMENT PROGRAM
LIGHTING LAYOUT
FOR RAIL SWITCH LIGHTING
ROBERTS BANK TERMINAL 2

SIZE	DWG.	SHEET	REV.
D	34-347-EL-4001	2 of 6	1



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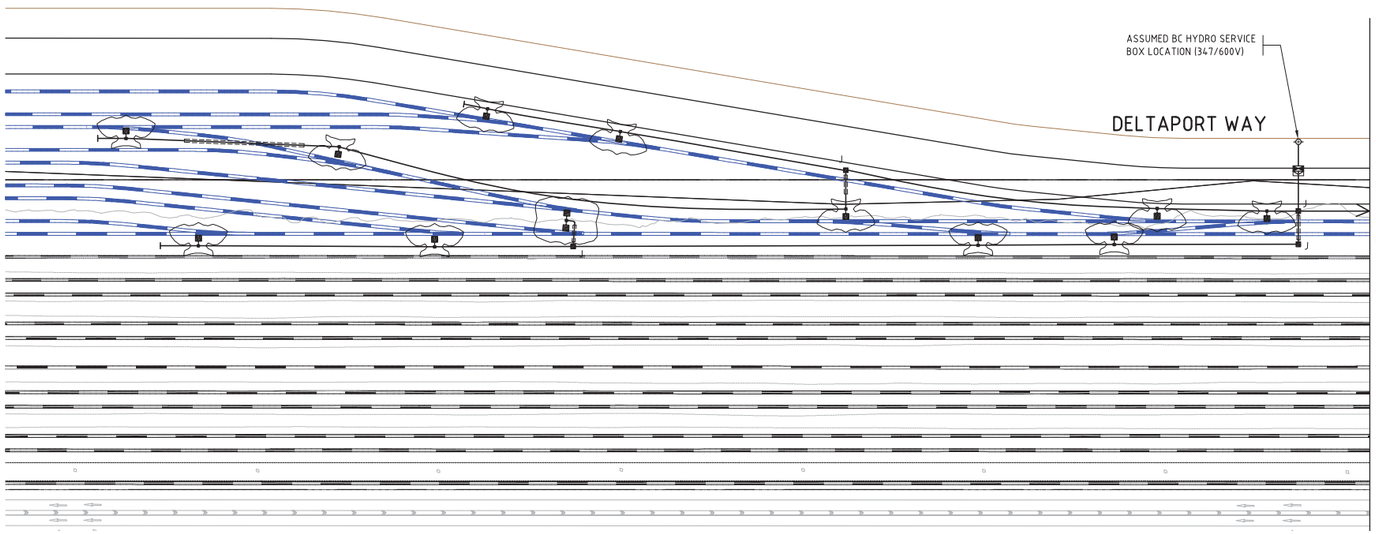

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CONCEPTUAL DESIGN
DO NOT USE FOR CONSTRUCTION
Last Saved: Jun. 19/14 5:06pm

Ref.No.	REFERENCE

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office@dmdeng.com Fax 604/589-9012
DMD PROJECT No. 4124-13-03 of 06

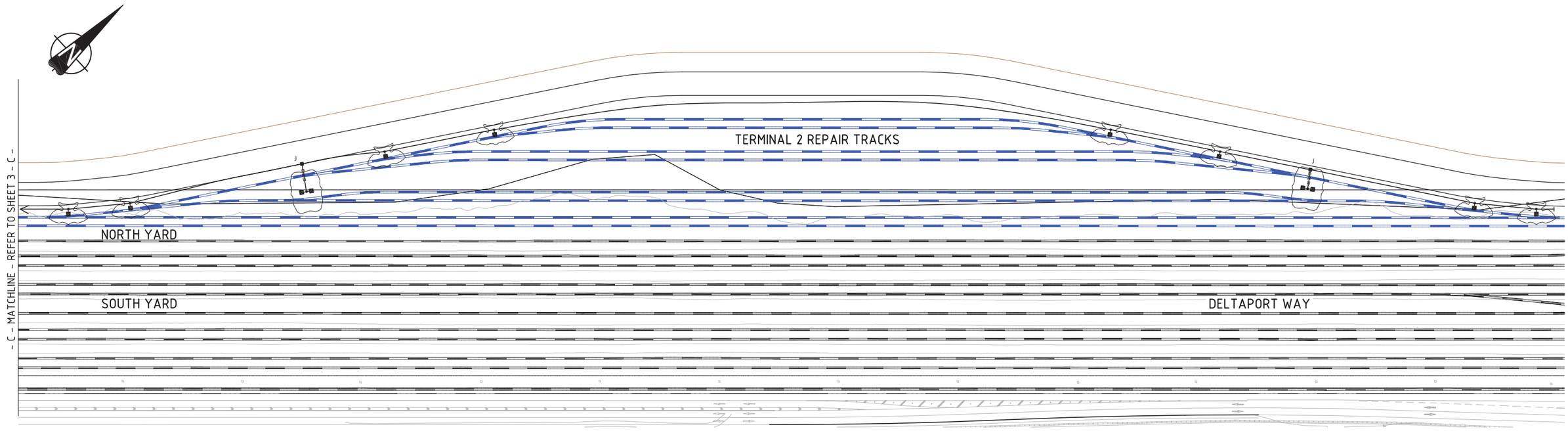
No.	Date	REVISION	Dr'n	Ch'd
1	JUN/2014	REVISED TO SUIT PMV COMMENTS	AM	.

PORT METRO vancouver
VANCOUVER FRASER PORT AUTHORITY
ENGINEERING DEPARTMENT

DESIGN BY	DONATO SPEIDEL
DRAWN BY	BOB KELLIE
APPROVED	
DATE	MAY 09/2013
SCALE	SHOWN
PMV SITE	34

CONTAINER CAPACITY IMPROVEMENT PROGRAM
LIGHTING LAYOUT
FOR RAIL SWITCH LIGHTING
ROBERTS BANK TERMINAL 2

SIZE	DWG.	SHEET	REV.
D	34-347-EL-4002	3 of 6	1



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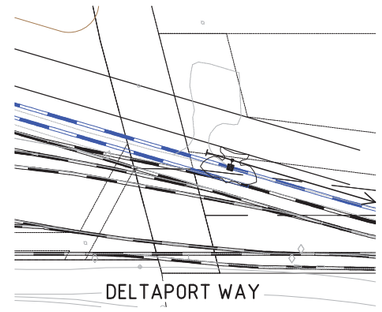

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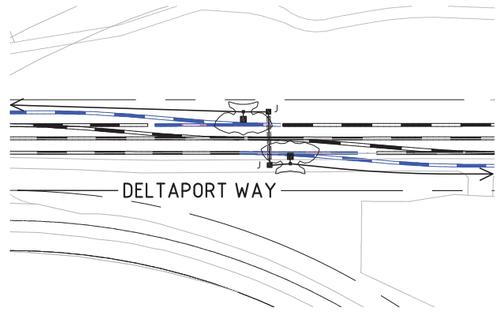

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1:1000

CONCEPTUAL DESIGN
DO NOT USE FOR CONSTRUCTION
Last Saved: Jun. 19/14 5:06pm

Ref.No.	REFERENCE

CONSULTANT

DMD & Associates Ltd.
#12-17358 104A Avenue, Surrey, BC, Canada V4N 5M3
www.dmdeng.com 604/589-9010
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DMD PROJECT No. 4124-13-04 of 06

No.	Date	REVISION	Dr'n	Ch'd
1	JUN/2014	REVISED TO SUIT PMV COMMENTS	AM	.

PORT METRO vancouver

VANCOUVER FRASER PORT AUTHORITY
ENGINEERING DEPARTMENT

DESIGN BY	DONATO SPEIDEL
DRAWN BY	BOB KELLIE
APPROVED	
DATE	MAY 09/2013
SCALE	SHOWN
PMV SITE	34

CONTAINER CAPACITY IMPROVEMENT PROGRAM
LIGHTING LAYOUT
FOR RAIL SWITCH LIGHTING
ROBERTS BANK TERMINAL 2

SIZE	DWG.	SHEET	REV.
D	34-347-EL-4003	4 of 6	1

TITLE BLOCK: DL-TB.dwg

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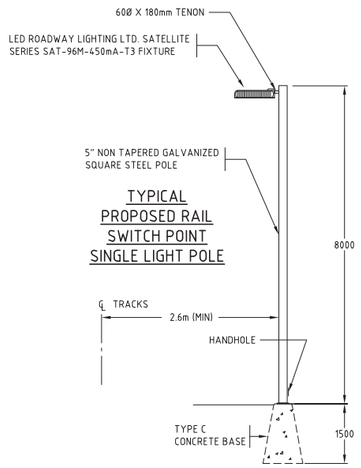

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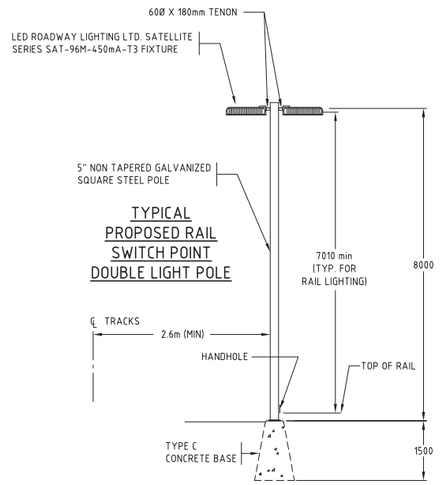

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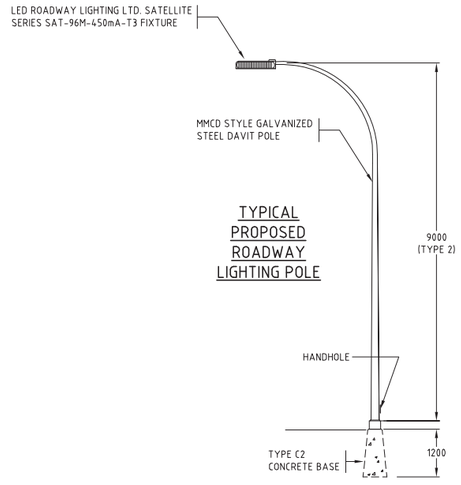

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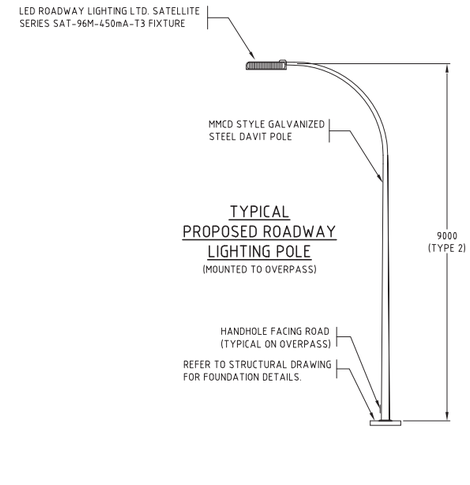
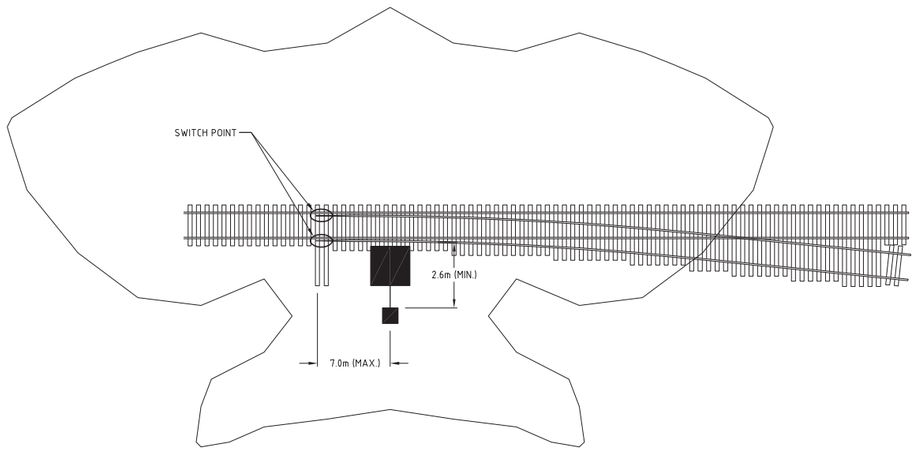


ELEVATIONS

m 0 1 2 3 4 5 m

1:75



ILLUMINATION ALIGNMENT DETAIL

N.T.S.

CONCEPTUAL DESIGN
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office@dmdeng.com Fax 604/589-9012

DMD PROJECT No. 4124-13-05 of 06

No.	Date	REVISION	Dr'n	Ch'd
1	JUN/2014	REVISED TO SUIT PMV COMMENTS	AM	.

PORT METRO vancouver

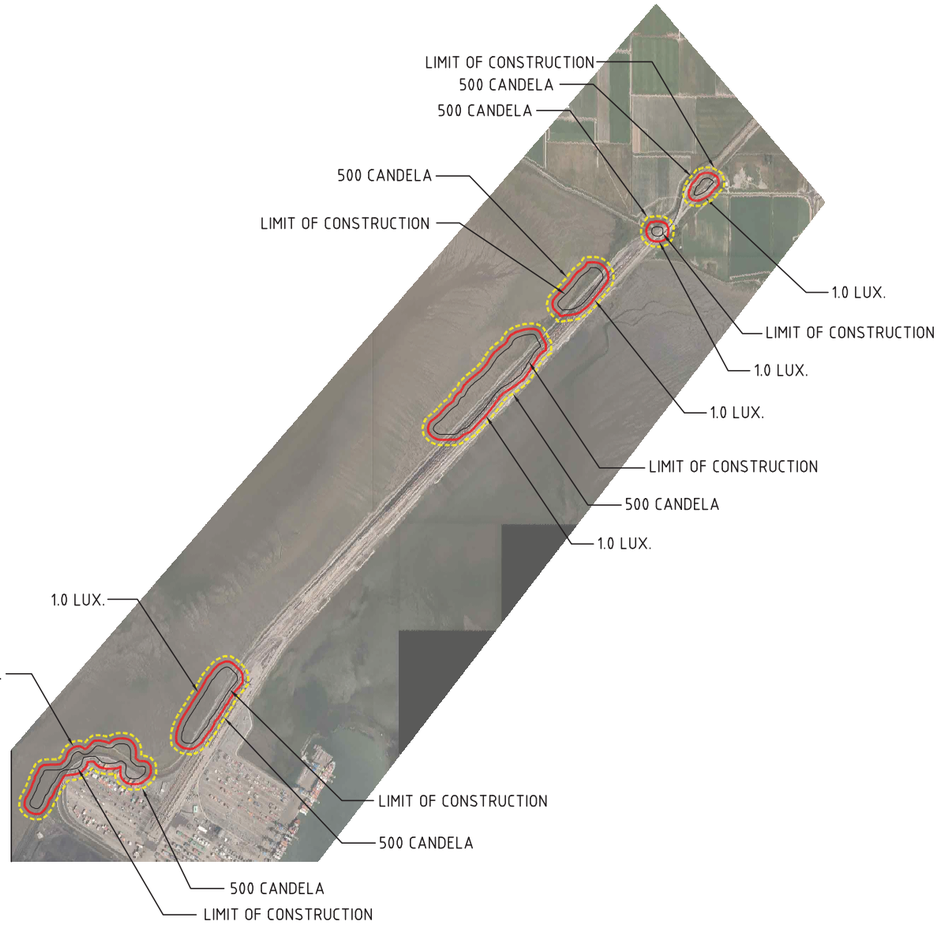
VANCOUVER FRASER PORT AUTHORITY
ENGINEERING DEPARTMENT

DESIGN BY	DONATO SPEIDEL
DRAWN BY	BOB KELLIE
APPROVED	
DATE	MAY 09/2013
SCALE	SHOWN
PMV SITE	34

CONTAINER CAPACITY IMPROVEMENT PROGRAM
LIGHTING LAYOUT
FOR RAIL SWITCH LIGHTING
ROBERTS BANK TERMINAL 2

SIZE	DWG.	SHEET	REV.
D	34-347-EL-4004	5 of 6	1

DATE: 2014/06/20 - 10:24am
PATH: P:\Projects\Jobs 4100-4199\4124-13 (ST LTG - T2 Deltaport)\CAD Drawings\4124-13-02 to 05.dwg



CONCEPTUAL DESIGN
DO NOT USE FOR CONSTRUCTION
Last Saved: Jun. 20/14 10:01am

Ref.No.	REFERENCE

CONSULTANT

DMD & Associates Ltd.
#12-17358 104A Avenue, Surrey, BC, Canada V4N 5M3
www.dmdeng.com 604/589-9010
office@dmdeng.com Fax 604/589-9012

DMD PROJECT No. 4124-13-06 of 06

No.	Date	REVISION	Dr'n	Ch'd
1	JUN/2014	REVISED TO SUIT PMV COMMENTS	AM	.

PORT METRO vancouver
VANCOUVER FRASER PORT AUTHORITY
ENGINEERING DEPARTMENT

DESIGN BY	DONATO SPEIDEL
DRAWN BY	BOB KELLIE
APPROVED	
DATE	MAY 09/2013
SCALE	SHOWN
PMV SITE	34

CONTAINER CAPACITY IMPROVEMENT PROGRAM
LIGHTING LAYOUT
FOR RAIL SWITCH LIGHTING
ROBERTS BANK TERMINAL 2

SIZE	DWG.	SHEET	REV.
D	34-347-EL-4005	6 of 6	1

TITLE BLOCK: DL-TB.dwg
DATE: 2014/06/20 - 10:25am
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REV.	DATE	DESCRIPTION	INT

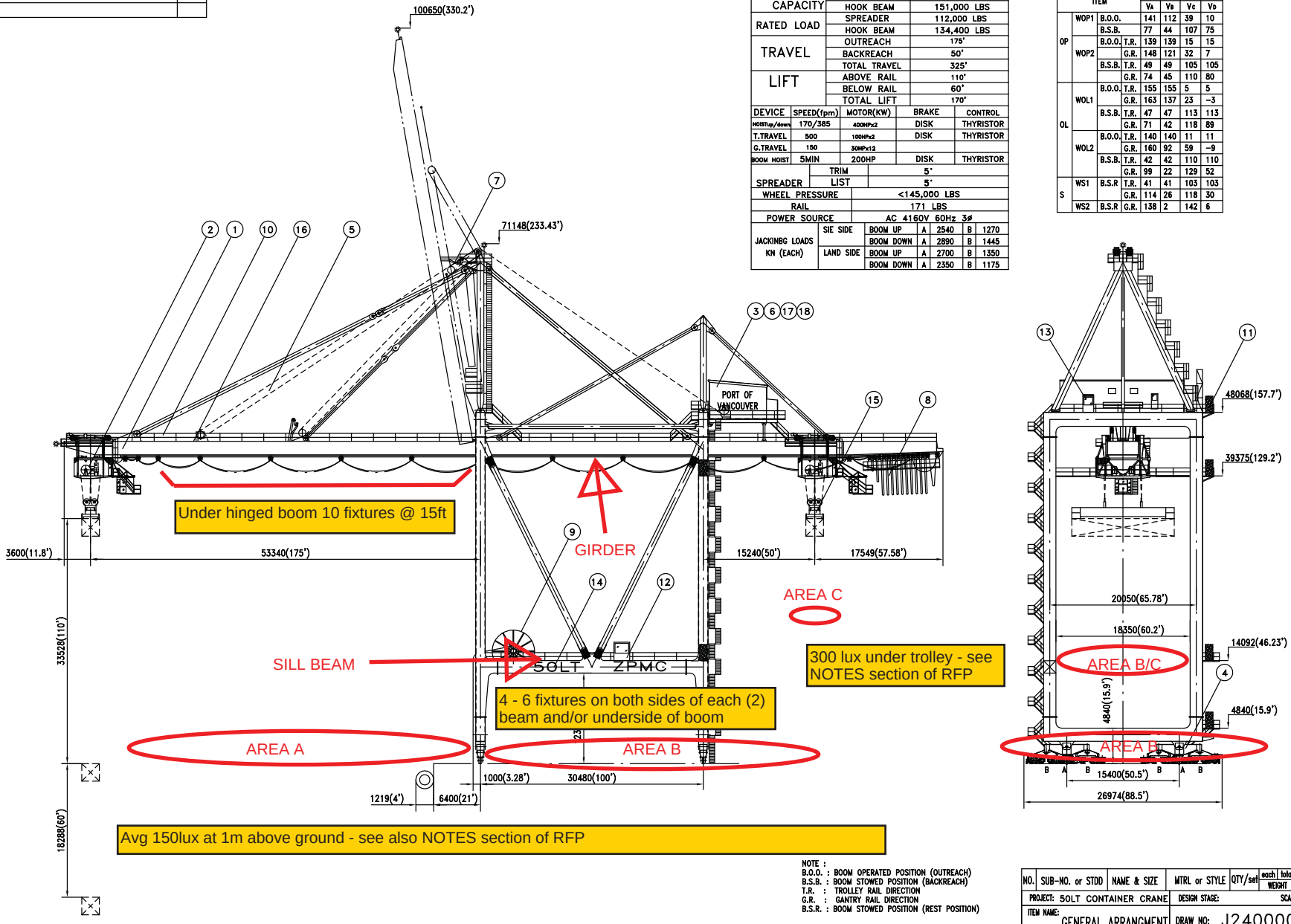
PARTICULARS		
LIFTING CAPACITY	SPREADER	143,500 LBS
	HOOK BEAM	151,000 LBS
RATED LOAD	SPREADER	112,000 LBS
	HOOK BEAM	134,400 LBS
TRAVEL	OUTREACH	175'
	BACKREACH	50'
	TOTAL TRAVEL	325'
LIFT	ABOVE RAIL	110'
	BELOW RAIL	60'
	TOTAL LIFT	170'

DEVICE	SPEED(fpm)	MOTOR(KW)	BRAKE	CONTROL
HOIST up/down	170/385	400HPx2	DISK	THYRISTOR
T.TRAVEL	500	100HPx2	DISK	THYRISTOR
G.TRAVEL	150	30HPx12		
BOOM HOIST	5MIN	200HP	DISK	THYRISTOR

SPREADER	TRIM	5'
	LIST	5'
WHEEL PRESSURE		<145,000 LBS
RAIL		171 LBS
POWER SOURCE		AC 4160V 60Hz 3ø

JACKINBG LOADS KN (EACH)						
	SIE SIDE	BOOM UP	A	2540	B	1270
		BOOM DOWN	A	2890	B	1445
	LAND SIDE	BOOM UP	A	2700	B	1350
		BOOM DOWN	A	2350	B	1175

TABLE FOR WHEEL LOADS (KIPS)						
ITEM				SIE SIDE		LAND SIDE
				Va	Vb	Vc	Vd
OP	WOP1	B.O.O.		141	112	39	10
		B.S.B.		77	44	107	75
	WOP2	B.O.O.	T.R.	139	139	15	15
			G.R.	148	121	32	7
		B.S.B.	T.R.	49	49	105	105
			G.R.	74	45	110	80
OL	WOL1	B.O.O.	T.R.	155	155	5	5
			G.R.	163	137	23	-3
		B.S.B.	T.R.	47	47	113	113
			G.R.	71	42	118	89
	WOL2	B.O.O.	T.R.	140	140	11	11
			G.R.	160	92	59	-9
		B.S.B.	T.R.	42	42	110	110
			G.R.	99	22	129	52
S	WS1	B.S.R	T.R.	41	41	103	103
			G.R.	114	26	118	30
	WS2	B.S.R	G.R.	138	2	142	6



NOTE :
B.O.O. : BOOM OPERATED POSITION (OUTREACH)
B.S.B. : BOOM STOWED POSITION (BACKREACH)
T.R. : TROLLEY RAIL DIRECTION
G.R. : GANTRY RAIL DIRECTION
B.S.R. : BOOM STOWED POSITION (REST POSITION)

NO.	SUB-NO. or STDD	NAME & SIZE	MTRL or STYLE	QTY/set	each	total	NOTE
					WEIGHT		

PROJECT: 50LT CONTAINER CRANE | DESIGN STAGE: | SCALE: 1:250

ITEM NAME: GENERAL ARRANGMENT | DRAW NO: J240000

ZPMC

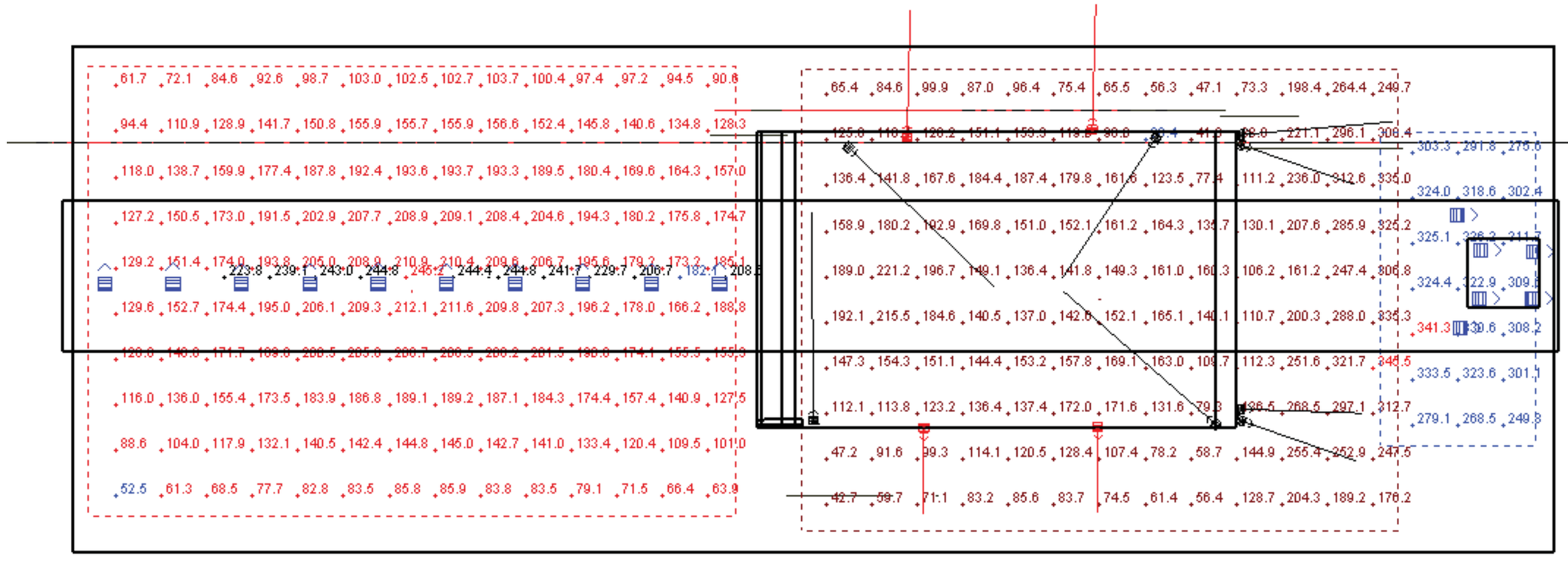
DSGN				TRACE			APP.	
DRAW				CHCK			Q'TY/SET	
CHCK				VER.			SET/CRANE	~1050 T

Luminaire Schedule

Symbol	Label	Quantity	Manufacturer	Catalog Number	Description	Lamp	Number Lamps	Filename	Lumens Per Lamp	Light Loss Factor	Wattage
	A	16	Holophane	PLLED 9 4K 10A XX 44 XX	PREDATOR LARGE LED	360W 4000K LED ARRAY	1	PLLED_9_4K_10A_XX_44_XX.ies	-1	0.82	360
	B	4	Holophane	PLLED 7 4K 10A 66	Predator Large LED with 7 COBs, 4000K Color Temperature , 1050mA Drive Current , 6X6 Distribution	LED	1	PLLED_7_4K_10A_66.ies	-1	0.82	280
	C	8	Holophane	PLLED 8 4K 10A XX 45 XX	PREDATOR LARGE LED	330W 4000K	1	PLLED_8_4K_10A_XX_45_XX.ies	-1	0.82	323.4

Statistics

Description	Symbol	Avg	Max	Min	Max/Min	Avg/Min	Avg/Max
AREA A	+	151.4 lux	212.1 lux	52.5 lux	4.0:1	2.9:1	0.7:1
AREA B	+	157.6 lux	345.5 lux	38.4 lux	9.0:1	4.1:1	0.5:1
AREA C	+	308.2 lux	341.3 lux	249.8 lux	1.4:1	1.2:1	0.9:1
Vertical	+	229.5 lux	245.2 lux	182.1 lux	1.3:1	1.3:1	0.9:1



Current View

TSI TERMINALS
Option 2

Designer

Date
1/13/2014

Scale
Not to Scale

Drawing No.

Summary

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APPENDIX C
Photometric Data

STREETWORKS™ energy solutions

DESCRIPTION

The HMC Large Area Luminaire's asymmetric optics can be oriented by rotating the optical assembly 360° making this high mast fixture ideal for use on interstate highways mounted at 100' in a series of four or more fixtures. U.L. listed for wet location.

Catalog #		Type
Project		
Comments		Date
Prepared by		

SPECIFICATION FEATURES

Construction
HOUSING: Die-cast aluminum housing and cover. DOOR: Die-cast aluminum door with tempered convex glass lens and silicone rubber gasket.

Optical
OPTICS: Anodized spun aluminum outer reflector housing. Light pattern can be oriented by rotating optical assembly (360°). A degree indicator is provided to identify the aiming position. REFLECTOR: Inner hydroformed and anodized reflector.

Mounting
Clamp type slipfitter for 2-3/8" O.D. pipe.

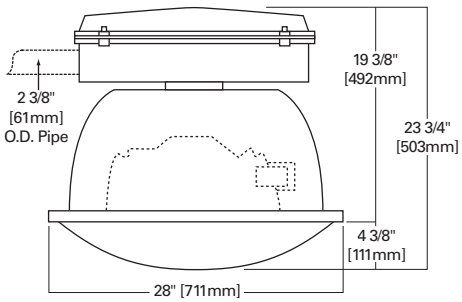
Finish
Standard bronze polyester powder coat finish. Other finish colors available. Consult your Streetworks Representative.

HMC
HIGH MAST LUMINAIRE

400 - 1000W
Pulse Start Metal Halide
High Pressure Sodium
Metal Halide

LARGE ROADWAY LUMINAIRE

DIMENSIONS



Horizontal Lamp Configuration

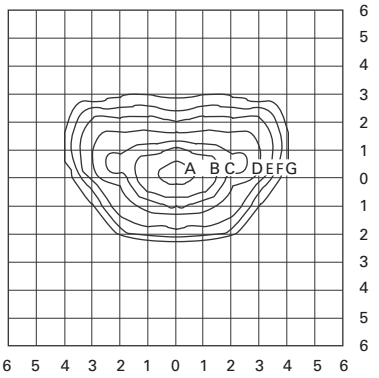
EPA
Effective Projected Area:
1.46 Square Feet

SHIPPING DATA
Approximate Net Wt:
68 lbs. (30 kgs.)

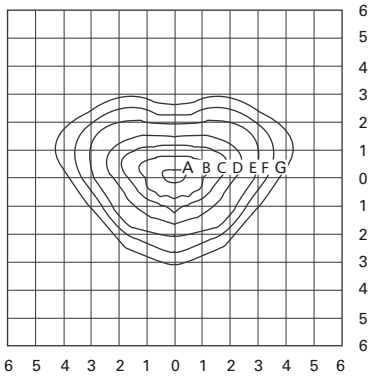
COOPER Lighting
www.cooperlighting.com

ADW082622
2010-03-10 10:27:53

PHOTOMETRICS (Complete IES files available at www.cooperlighting.com)



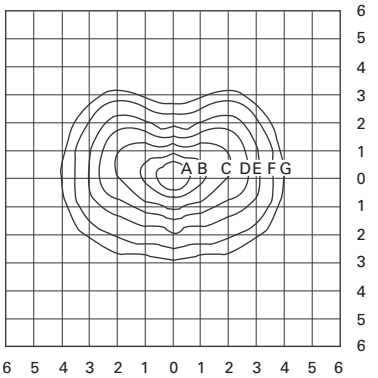
HMC40S3D
400-Watt HPS
50,000-Lumen Clear Lamp



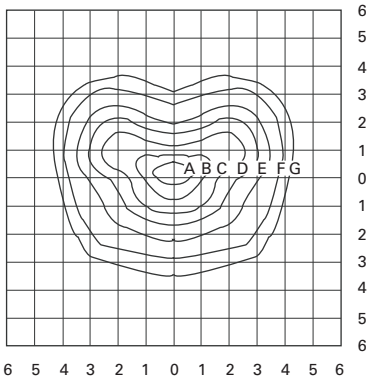
HMC91S3D
1000-Watt HPS
140,000-Lumen Clear Lamp

Footcandle Table
Select mounting height and read across for footcandle values of each isofootcandle line. Distance in units of mounting height.

Mounting Height	Footcandle Values for Isofootcandle Lines						
	A	B	C	D	E	F	G
HMC40S3D / HMC91S3D							
80'	0.78	0.31	0.16	0.08	0.03	0.02	0.008
100'	**0.50**	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.005**
120'	0.35	0.14	0.07	0.03	0.01	0.007	0.003



HMC40M3A
400-Watt MH
36,000-Lumen Clear Lamp



HMC91M3A
1000-Watt MH
110,000-Lumen Clear Lamp

Footcandle Table
Select mounting height and read across for footcandle values of each isofootcandle line. Distance in units of mounting height.

Mounting Height	Footcandle Values for Isofootcandle Lines						
	A	B	C	D	E	F	G
HMC40M3A / HMC91M3A							
80'	1.56	0.78	0.31	0.16	0.08	0.03	0.02
100'	**1.00**	**0.50**	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**
120'	0.69	0.35	0.14	0.07	0.03	0.01	0.007

ORDERING INFORMATION

Sample Number: HMC40SC23E

Product Family
HMC=High Mast Luminaire

Lamp Wattage
Pulse Start Metal Halide
40=400W
91=1000W
High Pressure Sodium
40=400W
91: 1000W
M (Probe Start) [1]
40: 400W
91: 1000W

Lamp Type [2]
P=Pulse Start Metal Halide
S=High Pressure Sodium
M=Metal Halide

Ballast Type [2]
C=CWI
W=CWA
K: CWA Extended[3] Life
M: Mag. Reg.[4]

Voltage [2]
2=120V
0=208V
4=240V
7=277V
8=480V
9=347V
W=Multi-Tap wired 120V
V=Multi-Tap wired 240V
N=Multi-Tap wired 277V

Optical Package
1=Type I
2=Type II
3=Type III

Distribution
A=SCO
D=MCO
E=MSCO
L=LMCO

Options
CEC=California Title 20 Compliant Ballast (Applies to 400W Pulse Start MH only)
1=Single Fuse (120, 277 or 347V)
2=Double Fuse, (208, 240, or 480V)
4=NEMA Photocontrol Receptacle
AP: Grey
B: Two Position Terminal Block
F: Flat Glass
3: Four-Stage Air Filter
M: MOV Lightning Surge Protectors

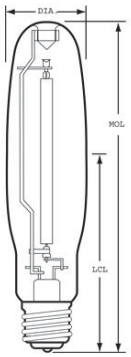
Accessories
OA/RA1016=NEMA Photocontrol - Multi-Tap
OA/RA1027=NEMA Photocontrol - 480V
OA1153=External Cutoff Shield (.90 EPA)

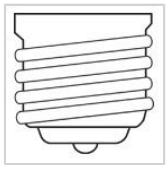
Notes: **1** Probe Start Metal Halide available for non-US markets only (400-1000W).
2 Refer to the technical section for lamp/ballast voltage compatibility.
3 1000W HPS only.
4 Not available in 1000W.

44047 - LU250

GE Lucalox® High Pressure Sodium ED18

This product is no longer manufactured.





CAUTIONS & WARNINGS

Caution

- Risk of Burn
  - Allow lamp to cool before handling.
  - Do not turn on lamp until fully installed.
- Lamp may shatter and cause injury if broken
  - Dispose of lamp in a closed container.
  - Do not use excessive force when installing lamp.
  - Do not use lamp if outer glass is scratched or broken.
  - Wear safety glasses and gloves when handling lamp.

Warning

- Contains sodium – chemical burn risk
  - Avoid skin contact with broken pieces.
- Risk of Electric Shock
  - Do not use where directly exposed to water or outdoors without an enclosed fixture.
  - Turn power off before inspection, installation or removal.
- Risk of Fire
  - Keep combustible materials away from lamp.
  - Use in fixture rated for this product.
- Unexpected lamp rupture may cause injury, fire, or property damage
  - Do not exceed rated voltage.
  - Do not store flammable materials near/below lamp.
  - Do not turn on lamp until fully installed.
  - Do not use lamp if outer glass is scratched or broken.
  - Do not use where directly exposed to water or outdoors without an enclosed fixture.
  - Use only properly rated ballast.

GRAPHS & CHARTS

Graphs_Spectral Power Distribution

GENERAL CHARACTERISTICS

Lamp Type	High Intensity Discharge - High Pressure Sodium
Bulb	ED18
Base	Mogul Screw (E39)
Bulb Finish	Clear
Rated Life (MIN)	24000.0 h
Bulb Material	Hard glass
Lamp Enclosure Type (LET)	Open or enclosed fixtures
Mercury Content (NOM)	16.4 mg
Picograms of Mercury (NOM)	27.1 pg

PHOTOMETRIC CHARACTERISTICS

Initial Lumens (NOM)	28000.0
Mean Lumens (NOM)	25200.0
Nominal Initial Lumens per Watt (NOM)	112.0
Color Temperature (NOM)	2100.0 K
Color Rendering Index (CRI) (NOM)	22.0
Effective Arc Length (NOM)	2.64 in

ELECTRICAL CHARACTERISTICS

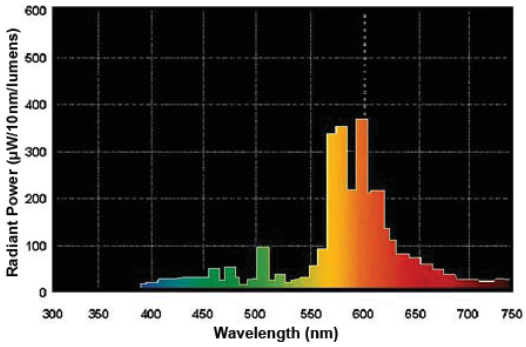
Wattage (NOM)	250.0
Burn Position	Universal burning position
Open Circuit Voltage (RMS lag ballast) (MIN)	198.0 V
Warm Up Time to 90% (MIN)	3.0 min
Warm Up Time to 90% (MAX)	4.0 min
Hot Restart Time to 90% (MAX)	1.0 min

DIMENSIONS

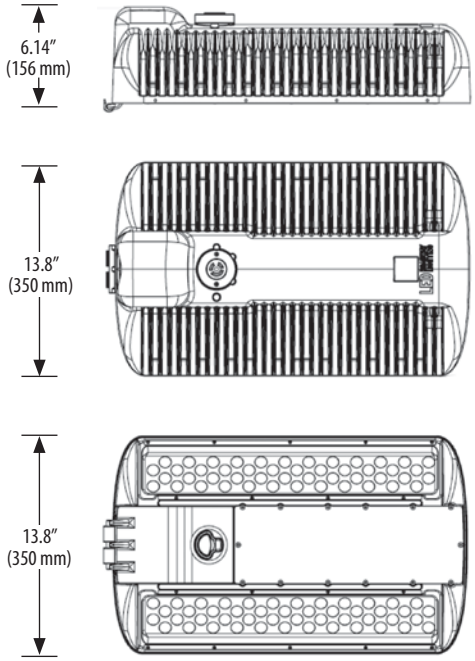
Maximum Overall Length (MOL) (NOM)	9.750 in(247.6 mm)
Nominal Length (NOM)	9.750 in(247.6 mm)
Bulb Diameter (DIA) (NOM)	2.250 in(57.2 mm)
Light Center Length (LCL) (NOM)	5.750 in(146.0 mm)

PRODUCT INFORMATION

Product Code	44047
Description	LU250
ANSI Code	S50
Standard Package	Case
Standard Package GTIN	10043168440476
Standard Package Quantity	12
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	12
UPC	043168440479


Radiant Power (µW/10 nm/lumens)
600
500
400
300
200
100
0
300
350
400
450
500
550
600
650
700
750
Wavelength (nm)

SATELLITE™ SERIES LUMINAIRE: SPECIFICATIONS



Housing:	Single piece, die-cast A360 aluminum
Operating Temperature:	-40°C to +60°C (-40°F to +140°F)
Mounting:	1.625" - 2.375" (42 - 60 mm) O.D. Tenons
Weight:	25 lb (11.4 kg)
EPA Rating:	<0.699 ft^2 (< 0.065 m^2)
Lens Material:	Acrylic
Finish:	Durable polyester powdercoat topcoat
Available Colors:	GRAY (RAL 7035) · BRONZE (RAL 7022) · BLACK (RAL 9005)

ARRA COMPLIANT

ELECTRICAL	SAT-72M (72 LEDs)					SAT-96M (96 LEDs)				
Currents (mA)	280 mA	350 mA	450 mA	525 mA	600 mA	280 mA	350 mA	450 mA	525 mA	600 mA
Power Consumption* (W)	65 W	83 W	107 W	131 W	150 W	86 W	110 W	143 W	175 W	200 W
Input Voltage (V)	Universal Driver 120 - 240V AC, 50 Hz or 60 Hz; 277V, 347V, 480V, and 12 - 24V DC drivers available upon request.									
Surge Protection	20kV/10kA per ANSI C62.41.2-2002									
Power Factor	>0.90									
OPTICS & PERFORMANCE	**SAT-72M (72 LEDs)**					**SAT-96M (96 LEDs)**				
Photometry (Distribution Types)	Type II, Type II Medium, Type II Wide, Type II U, Type III, European Wide, European Narrow, European Long, European Medium									
Color Temperature (CCT)	5000K (Standard), 4000K & 4500K (Optional)									
Color Rendering Index (CRI)	~70 (±5%)									
Drive Currents (mA)	280 mA	350 mA	450 mA	525 mA	600 mA	280 mA	350 mA	450 mA	525 mA	600 mA
Fixture Efficacy (Lm/W)*	97 Lm/W	93 Lm/W	87 Lm/W	84 Lm/W	80 Lm/W	96 Lm/W	92 Lm/W	86 Lm/W	81 Lm/W	78 Lm/W
Fixture Output (Lm)*	6,200 Lm	7,500 Lm	9,300 Lm	10,800 Lm	11,800 Lm	8,250 Lm	10,000 Lm	12,250 Lm	14,100 Lm	15,500 Lm
LED L70 (Hours)	> 100,000 hours (@ 350mA)									
PHOTOCELL & CONTROLS	**SAT-72M (72 LEDs)**					**SAT-96M (96 LEDs)**				
Photocell Options	20-Year Life Photocell with NEMA Twist-Lock (Standard)									
Control & Monitoring	Available with integrated Streetlight Intelligence™ System.									

NOTES: * VALUES SHOWN ARE BASED ON "TYPE II" LM-79 TESTING AND ARE SUBJECT TO ±5% TOLERANCE. ILLUSTRATED ABOVE: SAT-96M IN GRAY (RAL 7035). ALL INFORMATION PROVIDED IS SUBJECT TO CHANGE WITHOUT NOTICE.

LED ROADWAY LIGHTING
Leading the LED technology wave

115 Chain Lake Drive, Halifax, Nova Scotia, B3S 1B3 Canada
Toll-Free Phone: +1 (877) 533.5755 Toll-Free Fax: +1 (888) 533.5755 info@ledroadwaylighting.com www.ledroadwaylighting.com

LRL_SATELLITE_SAT-M_SPEC_ORDER_2013_09_04

SATELLITE™ SERIES LUMINAIRE: ORDERING GUIDE sat-m

SERIES (A)	LED'S/BODY SIZE (B)	VOLTAGE (C)	PHOTOCELL CONTROL (D)	OPTICS (E)	DRIVE CURRENT (F)
SAT Satellite	72M Medium 96M Medium	0 120V-240V Universal 6 277V-347V Universal 7 480V 8 12V-24V DC (Solar Applications)	R c/w NEMA Photocell Receptacle S Solid Casting (No Photocell Receptacle) Photocells and shorting caps ordered separately.	T2 Type II TW Type II Wide TM Type II Medium TU Type II U T3 Type III EW Euro Wide EN Euro Narrow EL Euro Long EM Euro Medium	280 280 mA 350 350 mA 450 450 mA 525 525 mA 600 600 mA

FINISH (G)	COLOR/TEMPERATURE (CCT) (H)	LENS TYPE (I)	CERTIFICATION (J)	CONTROL OPTIONS (K)
GY Gray (RAL 7035) BK Black (RAL 9005) BZ Bronze (RAL 7022) ____ 4 Digit RAL# (Custom Finish)	1 5000K (Standard/Default) 2 4500K (Optional) 3 4000K (Optional) Other color temperatures available. Please contact factory for details.	A Acrylic	NS USA/Canada (QPS) (Standard/Default) CE European NM NOM-Mexico CT C-TICK (Australia) UL USA (120-240V only)	XX TBA

SAMPLE CATALOG NUMBER: | SAT (A) | 96M (B) | 0 (C) | R (D) | T2 (E) | 450 (F) | GY (G) | 1 (H) | A (I) | NS (J) | XX (K) |

A= Satellite™ Series **B=** 96 LEDs (Medium Body Fixture) **C=** 120V - 240V **D=** NEMA Photocell Receptacle **E=** Type II Distribution **F=** 450mA Drive Current **G=** Gray Finish **H=** 5000K CCT **I=** Acrylic Lens **J=** CDN/US QPS Certification **K=** No Control Option Specified

ORDER CONFIRMATION	COMMENTS
PROJECT NAME:	
QUANTITY:	
APPROVED BY:	
DATE:	

(For standard finishes insert 2 digit code. For custom finishes, insert 4 digit RAL number)

CATALOG NUMBER: SAT (A) | _ _ _ (B) | _ (C) | _ (D) | _ _ (E) | _ _ _ (F) | _ _ _ _ _ (G) | _ (H) | A (I) | _ _ (J) | XX (K) |

By completing the Order Confirmation above, I certify that I am authorized to sign the confirmation on behalf of the company. Information provided is subject to change without notice.

LED ROADWAY LIGHTING
Leading the LED technology wave

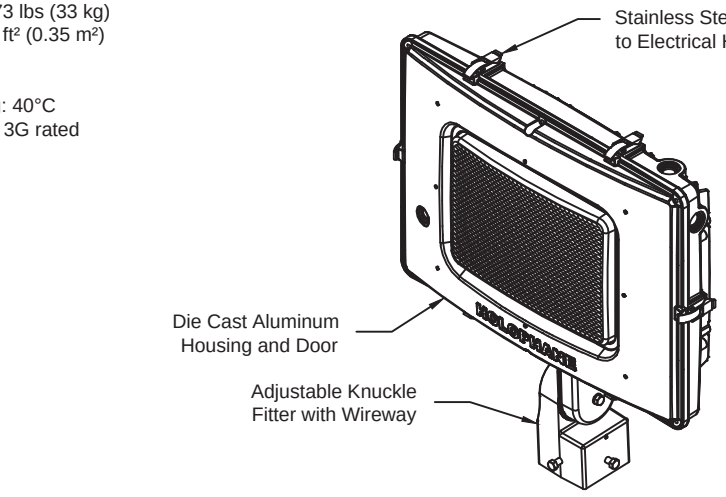
115 Chain Lake Drive, Halifax, Nova Scotia, B3S 1B3 Canada
Toll-Free Phone: +1 (877) 533.5755 Toll-Free Fax: +1 (888) 533.5755 info@ledroadwaylighting.com www.ledroadwaylighting.com

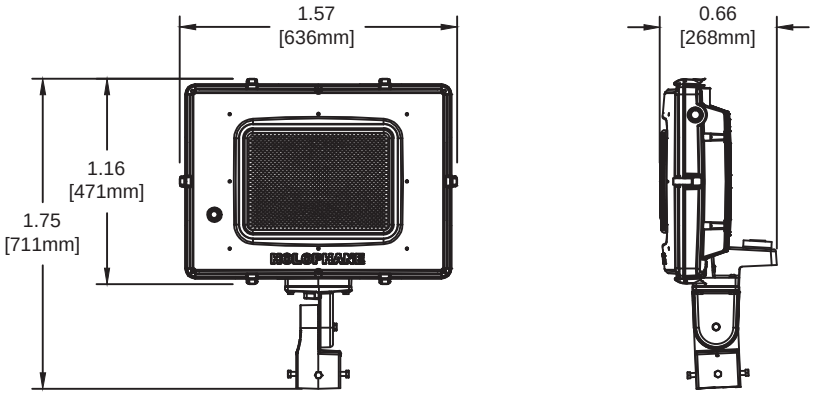
LRL_SATELLITE_SAT-M_SPEC_ORDER_2013_09_04

Predator® Large LED

Infrastructure Specialty

Max Weight = 73 lbs (33 kg)
Max EPA = 3.8 ft² (0.35 m²)
UL Listed
Wet Location
Ambient Rating: 40°C
ANSI C136.31: 3G rated





KNUCKLE MOUNT

Customer Preferred: (Most Frequently Ordered Catalog Numbers)
PLLED95K10AAS551KGP

ORDERING INFORMATION:

PLLED

Series
Predator Large LED

Number of LED'S
7 = 7 Modules
8 = 8 Modules
9 = 9 Module

Color Temperature
4K = 4,000K CCT
5K = 5,000K CCT

Drive Current
10A = 1050 mA Driver
07A = 700mA Driver

Voltage
AS = Auto-sensing Voltage (120 thru 277)
AH = Auto-sensing Voltage (347 thru 480)

Beam pattern
44 = 4x4 (prismatic glass)
45 = 4x5 (prismatic glass)
55 = 5x5 (prismatic glass)
56 = 5x6 (prismatic glass)
66 = 6x6 (prismatic glass)

Mounting
1 = Tenon Slipfitter Knuckle
3 = Yoke Stainless Steel
4 = Yoke Galvanized

UL Category
K = Wet Locations
[1] L = Marine

Color
BP = Black Superdurable with Epoxy Primer
GP = Grey Superdurable with Epoxy Primer
HP = Graphite Superdurable with Epoxy Primer
WP = White Superdurable with Epoxy Primer
ZP = Bonze Superdurable with Epoxy Primer

Cord Length Option
04 = 4 ft Cord Length
05 = 5 ft Cord Length
06 = 6 ft Cord Length
08 = 8 ft Cord Length
10 = 10 ft Cord Length
12 = 12 ft Cord Length
15 = 15 ft Cord Length
20 = 20 ft Cord Length
25 = 25 ft Cord Length
30 = 30 ft Cord Length

Cord Type
63 = 16 Gage, 3 Conductor
43 = 14 Gage, 3 Conductor
23 = 12 Gage, 3 Conductor

Options
See Sheet 2

Accessories
See Sheet 2

HOLOPHANE
LEADER IN LIGHTING SOLUTIONS
An AcuityBrandsCompany

ORDER #:	
TYPE:	
DRAWN:	CEA
DATE:	8/18/14
DWG #:	LUM_PLLED

Options and Accessories

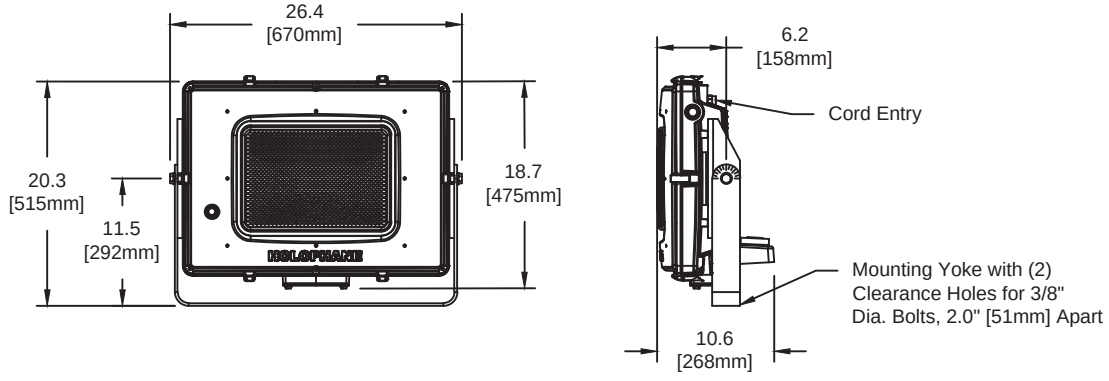
Options

DE = ROAM Concierge/Enterprise 120-277V
DE34 = ROAM Concierge/Enterprise 347V
DE48 = ROAM Concierge/Enterprise 480V
DM = 0-10V Dimmable Driver
F1 = Single Fusing
F2 = Double Fusing
NL = NEMA Label
PCL1 = DLL Photocontrol 120V
PCL2 = DLL Photocontrol 208-277V
PCL3 = DLL Photocontrol 347V
PCL4 = DLL Photocontrol 480V
PCSS = DSS Photocontrol 120-277V
[2] P3 = Standard 3-Pin Photocontrol Receptacle
[2] P5 = 5-Pin Photocontrol Receptacle
[2] P7 = 7-Pin Photocontrol Receptacle
SH = Shorting Cap
TL - Tool-less Entry with Latches
VE = ROAMVIEW 120-277V
VE34 = ROAMVIEW 347V
VE48 = ROAMVIEW 480V

Notes:
1. Only available with SS Yoke (3).
2. Not available with Marine (L).

Accessories

PLLED FV-BP = Full Visor, Black
PLLED FV-GP = Full Visor, Gray
PLLED FV-HP = Full Visor, Graphite
PLLED FV-WP = Full Visor, White
PLLED FV-ZP = Full Visor, Bronze
PLLED UBV-BP = Upper/Bottom Visor, Black
PLLED UBV-GP = Upper/Bottom Visor, Gray
PLLED UBV-HP = Upper/Bottom Visor, Graphite
PLLED UBV-WP = Upper/Bottom Visor, White
PLLED UBV-ZP = Upper/Bottom Visor, Bronze
PLLED VG = Vandal Guard
PLLED WG = Wire Guard
08657-BP = Yoke to 2.375" OD Tenon Adaptor, Black
08657-GP = Yoke to 2.375" OD Tenon Adaptor, Gray
08657-HP = Yoke to 2.375" OD Tenon Adaptor, Graphite
08657-WP = Yoke to 2.375" OD Tenon Adaptor, White
08657-ZP = Yoke to 2.375" OD Tenon Adaptor, Bronze
08775-BP = Yoke to 2.375" OD Tenon Adaptor with Photocontrol Receptacle, Black
08775-GP = Yoke to 2.375" OD Tenon Adaptor with Photocontrol Receptacle, Gray
08775-HP = Yoke to 2.375" OD Tenon Adaptor with Photocontrol Receptacle, Graphite
08775-WP = Yoke to 2.375" OD Tenon Adaptor with Photocontrol Receptacle, White
08775-ZP = Yoke to 2.375" OD Tenon Adaptor with Photocontrol Receptacle, Bronze



YOKE MOUNT

Predator® Large LED

Infrastructure Specialty

HOLOPHANE® LEADER IN LIGHTING SOLUTIONS
An AcuityBrandsCompany

ORDER #:	
TYPE:	
DRAWN:	CEA
DATE:	8/18/14
DWG #:	LUM_PLLED

Performance Specification

Optical

Performance of the PLLED is to replace 400 -1000 watt HID product. The optical system utilizes state of the art chip on board technology with 4000K and 5000K color temperature choices with a 70 CRI minimum color temperature. The luminaire uses a highly specular internal reflector designed for superior field to beam ratios, uniformity and spacing. NEMA beam pattern choices of 4X4, 4X5, 5X5, 6X5, and 6X6 are available. Optional shielding is available to control uplight and light trespass. The optical enclosure is a borosilicate prismatic glass lens.

Electrical

Long Life: LED light engines are rated > 100,000 hours at 25C, L70. Electronic driver has a rated life of 100,000 hour at a 25C ambient.

Surge protection device provides IEEE/ANSIc62.4 Category C (10kV/5kA) level of protection .

Mechanical

Rugged low copper A360 alloy die cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convection cooling. The die cast aluminum housings are painted with a super durable polyester paint finish over an epoxy primer pretreat yields a finish that achieves a scribe creepage of 8 after 5,000 hours exposure to salt spray providing durability and corrosion resistance.

The luminaire is available in either knuckle mount or yoke mount. The knuckle mount is adjustable and is designed to fit 2.375 inch to 2.875 inch tenons. The yoke mount is available in either galvanized steel or stainless steel. The luminaire comes standard prewired eliminating the lineman from opening the unit during installation. The knuckle version is pre-wired to the wiring chamber at the fitter. The yoke mount has provision for a pre-wired cord drop to specified length in the ordering information.

The luminaire comes standard with the door frame bolted to the housing. Optional tool less stainless steel latches are available to allow easy access to LED drivers, surge protection, and optional terminal block.

The optical enclosure is sealed and gasketed to an IP66 rating. All luminaire mountings are 3G vibration rated per ANSI C136.

Controls

The NEMA three pin locking-style photocontrol receptacle and an optional five pin receptacle is available.

Dimming version (available with DE and VE option) uses proprietary Acuity Brands components to enable continuous 0-10V dimming down to 10% output via the ROAM smart controls system. (sold separately)

Photocontrol for solid -state lighting meets ANSI C136.10 criteria

Warranty & Standards

Rated for -40C to 40C ambient

UL 1598 A wet location, UL 1598A Marine Outside Type(Salt Water)

Predator® Large LED

Infrastructure Specialty

HOLOPHANE® LEADER IN LIGHTING SOLUTIONS

An AcuityBrandsCompany

ORDER #:
TYPE:
DRAWN: CEA
DATE: 8/18/14
DWG #: LUM_PLLED

Operating Characteristics

PLLED	Distribution	Lumens 4K	Input operating Amps 120V	208V	240V	277V	347V	480V	Input Watts (AS)	Input Watts (AH)	LPW (AS)	LPW (AH)
07 07A			1.541	0.898	0.799	0.719	0.538	0.400				
	44	16,852							185	185	91	91
	45	16,835							185	185	91	91
	55	18,161							185	185	98	98
	65	18,447							185	185	100	100
	66	18,417							185	185	100	100

PLLED	Distribution	Lumens 4K	Input operating Amps 120V	208V	240V	277V	347V	480V	Input Watts (AS)	Input Watts (AH)	LPW (AS)	LPW (AH)
08 07A			1.746	1.012	0.896	0.804	0.608	0.448				
	44	19,129							210	210	91	91
	45	19,110							210	210	91	91
	55	20,615							210	210	98	98
	65	20,940							210	210	100	100
	66	20,905							210	210	100	100

PLLED	Distribution	Lumens 4K	Input operating Amps 120V	208V	240V	277V	347V	480V	Input Watts (AS)	Input Watts (AH)	LPW (AS)	LPW (AH)
09 07A			1.949	1.127	0.993	0.886	0.677	0.497				
	44	21,224							233	233	91	91
	45	21,203							233	233	91	91
	55	22,873							233	233	98	98
	65	23,233							233	233	100	100
	66	23,195							233	233	100	100

PLLED	Distribution	Lumens 4K	Input operating Amps 120V	208V	240V	277V	347V	480V	Input Watts (AS)	Input Watts (AH)	LPW (AS)	LPW (AH)
07 10A			2.343	1.375	1.207	1.074	0.859	0.680				
	44	23,279							280	316	83	74
	45	23,299							280	316	83	74
	55	25,088							280	316	90	79
	65	25,483							280	316	91	81
	66	25,441							280	316	91	81

PLLED	Distribution	Lumens 4K	Input operating Amps 120V	208V	240V	277V	347V	480V	Input Watts (AS)	Input Watts (AH)	LPW (AS)	LPW (AH)
08 10A			2.646	1.547	1.361	1.20	0.968	0.754				
	44	26,355							317	353	83	75
	45	26,378							317	353	83	75
	55	28,403							317	353	90	80
	65	28,850							317	353	91	82
	66	28,803							317	353	91	82

PLLED	Distribution	Lumens 4K	Input operating Amps 120V	208V	240V	277V	347V	480V	Input Watts (AS)	Input Watts (AH)	LPW (AS)	LPW (AH)
09 10A 4K			2.949	1.719	1.515	1.326	1.077	0.828				
	44	29,432							354	390	83	75
	45	29,456							354	390	83	76
	55	31,718							354	390	90	81
	65	32,218							354	390	91	83
	66	32,164							354	390	91	82

WARRANTY
Limited warranty located at
www.acuitybrands.com/CustomerResources/Terms and conditions.aspx

NOTE
Specifications subject to change without notice.

Actual performance may differ as a result of end-user environment and application.

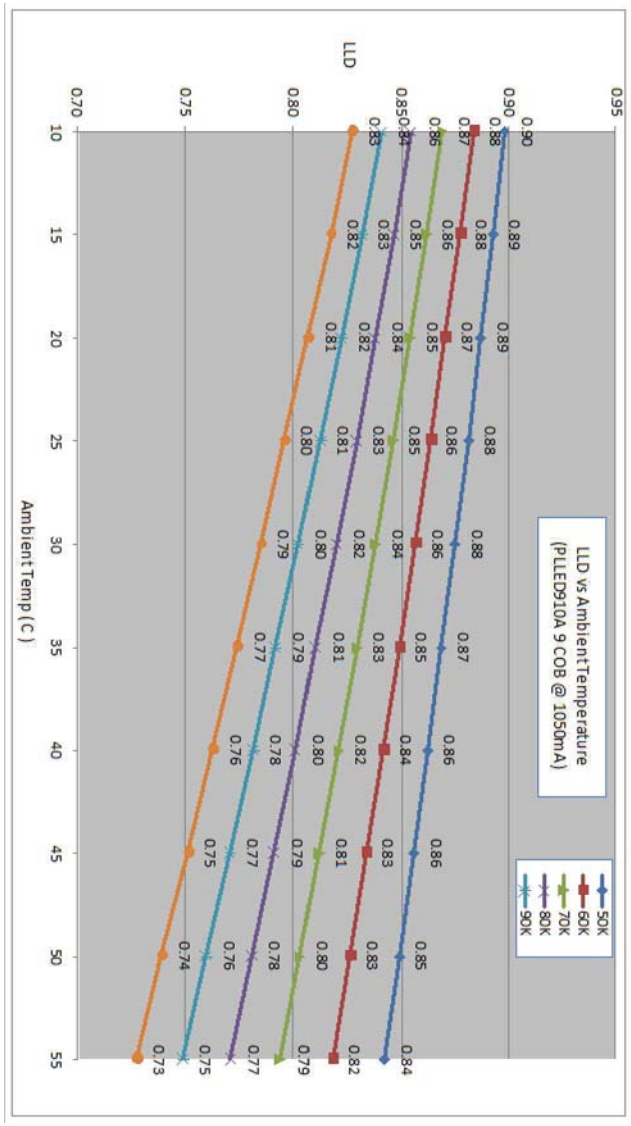
Actual wattage may differ by +/- 8% when operating at nominal input voltage +/- 10%.

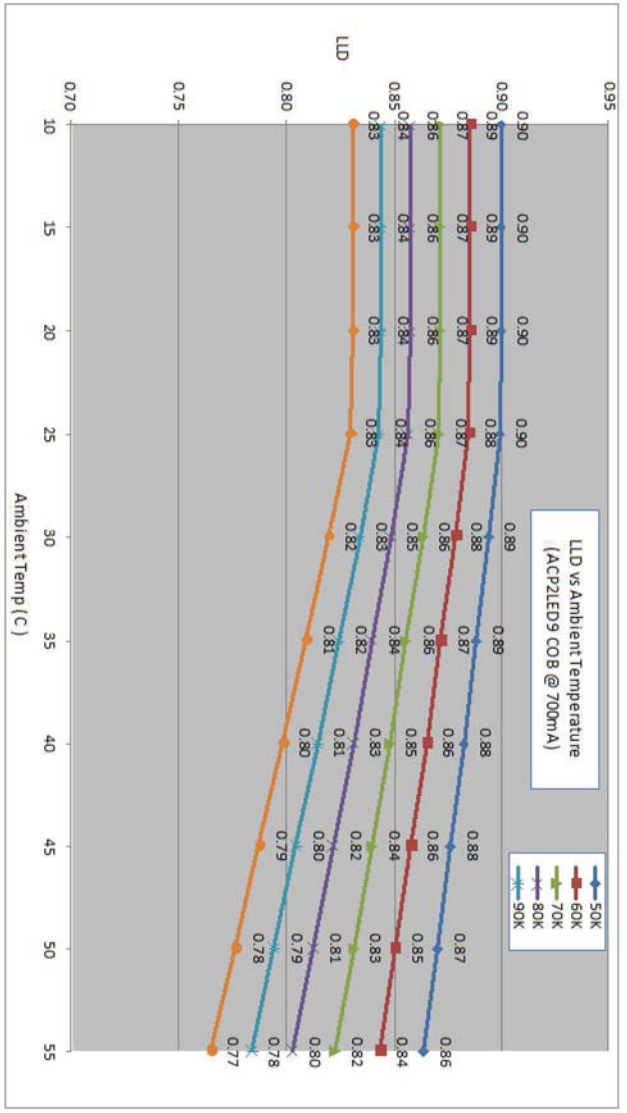
Predator®
Large LED

Infrastructure
Specialty

HOLOPHANE®
LEADER IN LIGHTING SOLUTIONS
An AcuityBrands Company

ORDER #:
TYPE:
DRAWN: JRM
DATE: 2/11/14
DWG #: LUM_PLLED





5 of 5	ORDER #:	THIS DRAWING, WHEN APPROVED, SHALL BECOME THE COMPLETE SPECIFICATION FOR THE MATERIAL TO BE FURNISHED BY HOLOPHANE ON THE ORDER NOTED ABOVE. A UNIT OF SIMILAR DESIGN MAY BE SUPPLIED, BUT ONLY AFTER APPROVAL BY THE CUSTOMER IN WRITING. ON POLE ORDERS AN ANCHOR BOLT TEMPLATE PRINT WILL BE SUPPLIED WITH EACH ANCHOR BOLT ORDER TO MATCH THE POLE PROVIDED. THIS PRINT IS THE PROPERTY OF HOLOPHANE AND IS LOANED SUBJECT TO RETURN UPON DEMAND AND UPON EXPRESS CONDITION THAT IT WILL NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO OUR INTERESTS, AND ONLY IN CONNECTION WITH MATERIAL FURNISHED BY HOLOPHANE.	HOLOPHANE® LEADER IN LIGHTING SOLUTIONS An AcuityBrandsCompany	Infrastructure Specialty	Predator® Large LED
	TYPE:				
	DRAWN: JRM				
	DATE: 2/11/14				
	DWG #: LUM_PLLED				

APPENDIX 9.4-B

Rationale for Exclusion of Other Certain and Reasonably Foreseeable Projects and Activities in the Light Assessment of Cumulative Change

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Appendix 9.4-B Rationale for Exclusion of Other Certain and Reasonably Foreseeable Projects and Activities in the Light Assessment of Cumulative Change

The assessment included consideration of the potential for an interaction between potential Project-related changes to light and the changes resulting from other certain and reasonably foreseeable projects and activities on light. **Table 9.4-B1** presents the rationale for exclusion of each certain and reasonably foreseeable project and activity identified in **Section 8.0 Effects Assessment Methods, Table 8-8 Project and Activity Inclusion List**, from the assessment of cumulative change for light. All future projects are expected to meet CIE and IESNA guidelines for limiting light trespass and sky glow.

Table 9.4-B1 Rationale for Exclusion of Other Certain and Reasonably Foreseeable Projects in the Light Assessment of Cumulative Change

Other Certain and Reasonably Foreseeable Project /Activity	Rationale for Exclusion
Project	
BURNCO Aggregate Project, Gibsons, B.C.	Located too far away from the Project to be relevant for light assessment.
Centerm Terminal Expansion, Vancouver, B.C.	Located too far away from the Project to be relevant for light assessment.
Fraser Surrey Docks Direct Coal Transfer Facility, Surrey, B.C.	Located too far away from the Project to be relevant for light assessment.
Gateway Pacific Terminal at Cherry Point and associated Burlington Northern Santa Fe Railway Company Rail Facilities Project, Blaine, Washington	There is a lack of relevant publicly available information.
Gateway Program – North Fraser Perimeter Road Project, Coquitlam, B.C.	Located too far away from the Project to be relevant for light assessment.
George Massey Tunnel Replacement Project, Richmond and Delta, B.C.	There is a lack of relevant publicly available information.
Kinder Morgan Pipeline Expansion Project, Strathcona County, Alberta to Burnaby, B.C.	Located too far away from the Project to be relevant for light assessment.
Lehigh Hanson Aggregate Facility, Richmond, B.C.	There is a lack of relevant publicly available information.
Lions Gate Wastewater Treatment Plant Project, District of North Vancouver, B.C.	Located too far away from the Project to be relevant for light assessment.
North Shore Trade Area Project – Western Lower Level Route Extension, West Vancouver, B.C.	Located too far away from the Project to be relevant for light assessment.
Pattullo Bridge Replacement Project, New Westminster and Surrey, B.C.	There is a lack of relevant publicly available information.
Southlands Development, Delta, B.C.	There is a lack of relevant publicly available information.

Other Certain and Reasonably Foreseeable Project /Activity	Rationale for Exclusion
Vancouver Airport Fuel Delivery Project, Richmond, B.C.	There is a lack of relevant publicly available information.
Woodfibre LNG Project, Squamish, B.C.	Located too far away from the Project to be relevant for light assessment.
Activity	
Incremental Road Traffic Associated with RBT2	Mobile sources of light not relevant for light assessment.
Incremental Train Traffic Associated with RBT2	Mobile sources of light not relevant for light assessment.
Incremental Marine Vessel Traffic Associated with RBT2	Mobile sources of light not relevant for light assessment.