City of Richmond

Report to Committee

To:	Parks, Recreation and Cultural Services Committee	**Date:**	June 15, 2023
From:	Todd Gross Director, Parks Services	**File:**	06-2400-20-RAIL1/Vol 01
Re:	**Potential Enhancements to the Railway Greenway**		

Staff Recommendation

That a public consultation and engagement process be initiated to determine community preferences for lighting along the Railway Greenway, as outlined in the staff report titled "Potential Enhancements to the Railway Greenway," dated June 15, 2023, from the Director, Parks Services.

Todd Gross
Director, Parks Services
(604-247-4942)

Att. 1

REPORT CONCURRENCE		
ROUTED TO:	**CONCURRENCE**	**CONCURRENCE OF GENERAL MANAGER**
Engineering	☑	
Sustainability & District Energy	☑	
Transportation	☑	
SENIOR STAFF REPORT REVIEW	**INITIALS:**	**APPROVED BY CAO**

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Staff Report

Origin

At the October 19, 2022, Public Works and Transportation Committee meeting, Richmond resident Kevin Krygier presented concerns about user safety after dark along the Railway Greenway. A petition to "install lighting and integrate other safety enhancements that are consistent with CPTED, pedestrian, and cyclist safety standards" with fifty-six signatures was also submitted. Staff received the following referral:

> *Refer presentation and the petition on the railway greenway to staff for review of CPTED principles and other relevant City of Richmond strategies and report back to Committee with an implementation plan.*

The purpose of this report is to respond to the referral and outline recommended next steps.

This report supports Council's Strategic Plan 2022-2026 Focus Area #2 Strategic and Sustainable Community Growth:

> *2.4 Enhance Richmond's robust transportation network by balancing commercial, public, private and active transportation needs.*

This report supports Council's Strategic Plan 2022-2026 Focus Area #3 A Safe and Prepared Community:

> *Community safety and preparedness through effective planning, strategic partnerships and proactive programs.*
>
> *3.4 Ensure civic infrastructure, assets and resources are effectively maintained and continue to meet the needs of the community as it grows.*

This report supports Council's Strategic Plan 2022-2026 Focus Area #6 A Vibrant, Resilient and Active Community:

> *6.2 Enhance the City's network of parks, trails and open spaces.*

Background

Crime Prevention Through Environmental Design

Crime Prevention Through Environmental Design (CPTED) is a conceptual framework that was developed by American criminologist C. Ray Jeffery in the 1970s. It is based on the notion that the quality and character of the built environment has a significant influence on public health, safety, and wellness, and is regularly cited by urban planners and design professionals. The CPTED principle of "natural surveillance" is most relevant to this discussion. Its premise is that a greater degree of visibility for a given public space, i.e., with clear sightlines, will deter criminal activity and instill a greater sense of security for users.

The City's Parks Services Department strives to create and maintain good visibility and clear sightlines in all new and existing park spaces through its planning, design, construction and maintenance practices.

Railway Greenway Overview

In 2010, the City purchased the Canadian Pacific Railway (CPR) corridor adjacent to Railway Avenue between Granville Avenue and Garry Street. The goal to develop a trail/greenway for pedestrians, cyclists, and other wheeled users was established in the 1979 Trails Plan and the subsequent 2010 Trails Strategy. In 2012, Council approved the Phase 1 Implementation Plan of the Railway Corridor Greenway following an extensive public consultation process. The associated report to committee "Railway Corridor Greenway – Phase 1 Implementation Plan," dated November 6, 2012, outlined the initial priorities, intended future enhancements and community engagement results. While the report noted resident requests for lighting at bus stop connections, lighting along the multi-use path (MUP) was not indicated as a current or future priority. Since the initial implementation phase, subsequent enhancements to realize the original vision have occurred; these include extending the greenway north to River Road, planting trees and shrubs, installing site furnishings, improving crossings and bus stop connections, and creating new amenities such as picnic areas, community gardens and a bike park.

Today, the Railway Greenway is an established linear City park that provides important ecosystem services as an ecological corridor, while concurrently serving as a corridor for various modes of active transportation. The MUP serves as one of Richmond's busiest cycling routes; Eco-Counter data from 2020 and 2021 indicated average daily cycling trips ranging from approximately 700 to 1,000 for the months of April through August.

There is an existing on-road bicycle lane on both the east and west sides of Railway Avenue, which runs parallel to the Railway Greenway between Garry Street and Granville Avenue that is illuminated by roadway lighting.

Relevant City Strategies

The Council-approved Enhanced Accessibility Design Guidelines and Technical Specifications aim to improve accessibility in public facilities and open spaces; they include references to outdoor lighting. Section 4.14 'Outdoor Recreational Facilities' notes "on paths, install lighting, waste receptacles, benches, drinking fountains, trees and shrub plantings, and other pedestrian path elements, in a location adjacent and not encroaching on the accessible path." Section 4.16 'Outdoor Lighting Considerations' notes that "artificial lighting and natural light… should provide a glare-free evenly distributed light where required, at outdoor working areas, on accessible path routes, at areas of potential hazard, and at building entrances and places of outdoor amenity." 'Outdoor Lighting Principles' note that "illumination along an accessible route should not create any dark or shadowy areas."

The provision of lighting in parks occurs on a site-specific basis, and is commensurate with park amenities and community need, e.g., sport fields and urban environments where lighting is deemed necessary to ensure safe passage or access to amenities that operate after dark; in these cases, lights typically operate on a sensor or timer from dawn to dusk. The Parks and Open

Space Strategy (POSS) Implementation Plan does refer to lighting: Outcome #2 "The system is inviting, accessible, and safe, enabling residents and visitors to feel comfortable and connected to the community;" and Priority Action #5 "Provide lighting for those locations intended for night time use, primarily urban places where there are adjacent, complementary uses."

The Community Wellness Strategy does not specifically refer to lighting; however, Focus Area #4 is to "Facilitate supportive, safe and healthy natural and built environments." Its key actions include references to improving accessibility and addressing barriers to using existing pedestrian and cycling routes.

Finally, the Community Energy & Emissions Plan 2050 includes Action 5.2.1 (Expand existing walking and rolling connectivity within and between neighbourhoods) to "review development requirements and urban design guidelines as necessary to ensure streets, lanes, and walk/roll infrastructure are accessible, and easy to navigate for all ages and abilities."

Analysis

Existing Conditions

In response to the referral received, staff procured the services of a qualified electrical engineer, PBX Engineering Ltd. (PBX), to study lighting levels along the Railway Greenway, from Garry Street to Westminster Highway, and prepare a report summarizing its findings; refer to Attachment 1 – PBX Engineering Technical Report, Railway Greenway Lighting Study. As there are no established City Park lighting standards, the City's current Engineering Design Specifications for Roadway Lighting were used. These specifications are based on the Illuminating Engineering Society (IES) standards and can be applied to off-street pathways as well as roadways.

The final report from PBX reached the following conclusions with respect to existing conditions:

- Existing lighting levels for almost the entirety of the Railway Greenway do not meet IES standards; the exception being areas with close proximity (< 30 metres) to lit intersections;
- Spillage from existing roadway lighting is insufficient to light the Railway Greenway to IES standards;
- Segment 1 – from Garry Street to Steveston Highway (approximately 470 metres in length) – had the best lighting levels, due to nearby BC Hydro lease lights; and
- Segment 6 – from Granville Avenue to Westminster Highway (approximately 786 metres in length) – had the worst lighting levels, due to the absence of parallel roads to provide light spillage.

Potential Lighting Strategy

As a reporting deliverable, PBX outlined a lighting strategy that would meet City illumination targets along the Railway Greenway. Based on their lighting assessment and computer simulations, PBX noted that the installation of 166 light poles with a height of 4.57 metres, spaced at 30 metres on centre, with lamp and fixtures that correspond to City Engineering design specifications, would be expected to meet City lighting standards. A Class D cost estimate for

this design was provided, with a projected cost of $1,367,000. The costs were broken down per segment, and ranged from $144,000 to $254,000 – refer to Table 1.

Table 1: Cost Estimate for PBX Lighting Design

Segment	Poles per Segment	Segment Length	Cost per Segment
Steveston Highway Quarter	16	470 m	$ 144,000
Williams Road Quarter	27	800 m	$ 231,000
Francis Road Quarter	31	800 m	$ 254,000
Blundell Road Quarter	28	785 m	$ 230,000
Granville Avenue Quarter	32	786 m	$ 254,000
Westminster Highway Quarter	32	786 m	$ 254,000
Total	**166**	**4,427 m**	**$ 1,367,000**

Alternative Lighting Solutions

PBX also provided input on alternative lighting approaches, including solar lights, photoluminescent aggregate and bollards.

PBX raised caution with the use of solar lights for this application due to the limited availability of sunlight throughout much of the year, battery maintenance and potential theft, placement limitations for optimal sunlight capture and a higher upfront cost.

Photoluminescent aggregate is a type of material that is applied to the pathway itself and can absorb and store light energy from natural or artificial light sources and then emit that energy in the form of visible light in darkness. When mixed with concrete or asphalt, photoluminescent aggregate can be used to provide pathway illumination for pedestrian walkways, paths and trails. PBX did not recommend the use of photoluminescent aggregate in this application due to the limited duration of emitted light, limited brightness and extent of illumination, maintenance requirements and costs required to replace existing paving.

Bollards, short vertical posts often used to control vehicle and pedestrian traffic, can be designed with integrated lighting. PBX did not recommend the use of bollards in this application due to their limited height, poor illumination coverage, and cost; they noted that bollards might be more appropriate for decorative or ambient lighting.

Considerations

To determine whether lighting is appropriate for the Railway Greenway, there are a number of factors that should be considered.

Community Impact

The Railway Greenway passes through a number of predominantly single-family home residential neighbourhoods, in some cases with limited visual screening, e.g., tree or shrub planting, between the pathway and adjacent homes. The introduction of pathway lighting could

lead to unintended light trespass, and may have a perceived negative effect on adjacent residents. This will be carefully considered and included in the public consultation process.

While the petition received indicates a number of Richmond residents are in favour of lighting implementation to address safety concerns, staff recommend that this preference should be verified through consultation with the broader community.

Ecological Impact

In addition to providing a MUP for various modes of active transportation, the Railway Greenway serves as an ecological corridor, as noted in the City's Ecological Network Management Strategy. It is an important piece of green infrastructure that offers ecosystem services, including but not limited to stormwater management, provision of food and wildlife habitat, reducing the urban heat island effect, etc. It enhances the City's ecological network by creating a continuous green linkage between the south and middle arm of the Fraser River that facilitates the movement of animals, nutrients and energy.

If lighting is implemented along the Railway Greenway, staff will assess and bring forward measures to mitigate negative effects on wildlife and ensure the continued provision of habitat and ecosystem services within the corridor.

Associated Costs

As noted above, PBX has developed a cost estimate for approximately $1.37 million to implement the recommended lighting approach along the Railway Greenway. Opportunities for phased implementation, and/or the use of a combination of lighting alternatives can be explored, however in any case a capital funding request would need to be submitted for Council consideration.

Local Precedents

City of Vancouver Outdoor Lighting Strategy

In 2019, the City of Vancouver adopted an Outdoor Lighting Strategy to provide direction on outdoor lighting on streets, public spaces and private properties across the city. Its stated intents are to:

- Improve public safety;
- Provide accessible and inviting outdoor spaces;
- Reduce light pollution;
- Reduce energy usage and cost; and
- Minimize ecological impacts.

One of its specified goals is to "Provide accessible and inviting spaces," noting "An improved public lighting network can help those who feel vulnerable to harassment and violence feel more secure by making outdoor spaces more visible and inviting."

Arbutus Greenway Solar-Powered Lighting

The Arbutus Greenway is an 8.8-kilometre paved pathway on a former rail line that runs between the Fraser River and False Creek in Vancouver. In 2019, the City implemented a solar photovoltaic lighting system along a 900-metre long section of the pathway with limited ambient lighting. Thirty solar-powered LED light poles, spaced at approximately 30 metres on centre, were installed between West 37th Avenue and West 33rd Avenue on the Arbutus Greenway.

The cost for supply, installation and commissioning was approximately $400,000 (roughly $13,500 per unit). The lights have been operated in 'dimmed' mode to provide adequate lighting while minimizing light spillage and conserving energy stored in the batteries, and the fixtures have shrouds to further manage light spillage. Field reviews demonstrated that there are no significant light trespass issues. The supplier, Urban Solar, noted that the lights could operate at these levels for over 20 days without solar recharge.

Further development of the Arbutus Greenway, including expansion of the lighting program, has not been realized to date. However, this project has been cited as a successful local example of off-grid solar lighting along an active transportation corridor.

While PBX raised caution with the use of solar lighting to meet City illumination targets, successful local precedents such as the Arbutus Greenway indicate that it may be a viable approach and warrants further study.

Next Steps

Staff are seeking endorsement from Council to proceed with public consultation, engagement and ecological assessments to determine community preferences and potential impacts for introducing lighting along the Railway Greenway. For an initiative of this magnitude with significant associated costs, and the potential to affect adjacent residents, pathway users and wildlife, it is paramount to consult with subject matter experts and Richmond residents while exploring opportunities to expand use of the Railway Greenway.

A public consultation process would adhere to the City's standard practices and consist of a combination of a Let's Talk Richmond online engagement process and in-person events. In addition to local residents, stakeholders would include those with expertise in accessibility, active transportation, and environmental impacts of lighting.

In the meantime, staff will work to ensure routine pruning and preservation of sightlines through existing planted areas to the degree possible.

Financial Impact

There is no financial impact at this time.

Conclusion

In response to the referral, staff procured the services of a qualified electrical engineer, PBX Engineering Ltd., to study existing lighting levels along the Railway Greenway (Garry Street to Westminster Highway) and provide a lighting strategy that would meet IES standards.

Staff recommend conducting a comprehensive public consultation and engagement process to determine community preferences and the ecological impact of lighting along the Railway Greenway. Once completed, staff would report back to Council with the results to inform next steps.

Kevin Fraser
Research Planner 2
(604-233-3311)

Att. 1: PBX Engineering Technical Report, Railway Greenway Lighting Study, City of Richmond

PBX ENGINEERING

TECHNICAL REPORT

Railway Greenway Lighting Study

City of Richmond

PBX Engineering Ltd.
131 Water St #300
Vancouver, BC V6B 4M3
pbxeng.com
Permit to Practice Number: 1000208

Prepared by:
T: 1.604.408.7222 | E: delainey.sampson@pbxeng.com

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Revision	Description	Date
1.0	First Submission	March 24, 2023
2.0	Final Submission	April 14, 2023
3.0	Updated Final Submission	May 12, 2023

1 Executive Summary

The City of Richmond retained PBX Engineering (PBX) to provide a lighting level assessment and lighting analysis report for the Railway Greenway ("The Greenway") from Garry Street to Westminster Highway. It is understood that the Greenway is a multi-use path (MUP) along the westside of Railway Avenue with multiple at-grade street crossings. PBX assumes the area to have medium pedestrian activity based on surrounding land use. The intention of this assignment is to identify the need for additional lighting to meet the recommended lighting levels of a MUP.

This report describes the methodology and findings of the lighting assessment for all segments of the Greenway. In this report there are two main parameters that are considered as follows:

- Illuminance is the amount of light hitting on a given surface and is a measure of the density of light incident on a surface. The number of lumens incident on a surface (real or imaginary) is divided by the area of the surface to obtain the average illuminance over that area. The unit for illuminance is lux (lx).
- Uniformity may be expressed as the ratio of the average level of illuminance to the minimum level. A high degree of uniformity of lighting has traditionally been accepted as desirable. The closer the uniformity ratio is to 1:1 the more evenly distributed the light with fewer bright spots or dark shadows in the calculation area.

Based on IESNA RP-8-21 Roadway Lighting Table 11-2 and City of Richmond standards the evaluation criteria utilized in this assessment include:

- Minimum maintained average horizontal illuminance 5 lux
- Average vertical illuminance at 1.5m above the pavement 2 lux
- Uniformity ratio 5:1

The lighting assessment survey was conducted on the Railway Greenway on March 14th, 2023. The assessment started after Evening Civil Twilight (7:48pm) when all nearby roadway fixtures would be illuminated. The light readings were attained where lighting levels changed significantly and the lighting of roadway intersections and crosswalks were not collected as they are outside the scope of this report

Of the segments that have been assessed, it has been determined that the Steveston Highway Quarter is currently the most lit segment with an average of 4 lux, and the Westminster Highway Quarter is the least lit segment, with an average of 1 lux.

During winter months, little to no foliage is on the trees along the Greenway. As this site visit occurred during this time, the noted values were taken during the best-case scenario for light levels. As the summer months approach, and the leaves return to the trees, there will be more blockage between the roadway lighting and the Greenway, decreasing the values even further.

Based on these findings, PBX designed a lighting solution for the Greenway using City of Richmond recognized products. To meet the evaluation criteria, 166 poles spaced at approximately 30 meters on centre would be required to light the Greenway.

Several alternative lighting options were explored including solar lighting, photoluminescent aggregate and illuminated bollards. PBX does not recommend use of these solutions for this location.

It is estimated the total cost to complete these upgrades will be $1,367,000.

Table of Contents

List of Tables

List of Figures

2 Introduction

The City of Richmond has contracted PBX Engineering to perform a lighting assessment of the Railway Greenway ("The Greenway") corridor from Garry Street to Westminster Highway and provide possible solutions for improvement. A field review was completed on March 14th, 2023. For the purposes of this study, the Greenway was divided into segments as shown below:

Table 1: Greenway Segments

#	Segment Name	Start	End	Length
1	Steveston Highway Quarter	Garry Street	Steveston Highway	470m
2	Williams Road Quarter	Steveston Highway	Williams Road	800m
3	Francis Road Quarter	Williams Road	Francis Road	800m
4	Blundell Road Quarter	Francis Road	Blundell Road	785m
5	Granville Avenue Quarter	Blundell Road	Granville Avenue	786m
6	Westminster Highway Quarter	Granville Avenue	Westminster Highway	786m

3 Lighting Standards

The Illuminating Engineering Society (IES) has established standards and best practices that have been adopted by the City of Richmond. These standards have been applied to this assessment in order to inform recommendations. In this report there are two main parameters that are considered as follows:

- Illuminance is the amount of light hitting on a given surface and is a measure of the density of light incident on a surface. The number of lumens incident on a surface (real or imaginary) is divided by the area of the surface to obtain the average illuminance over that area. The unit for illuminance is lux (lx).
- Uniformity may be expressed as the ratio of the average level of illuminance to the minimum level. A high degree of uniformity of roadway lighting has traditionally been accepted as desirable. The closer the uniformity ratio is to 1:1 the more even evenly distributed the light with fewer intense bright spots or dark shadows in the calculation area.

For the purposes of this report, the recommended lighting level for the Greenway is noted in the following table:

Table 2: Lighting Design Criteria

PEDESTRIAN USAGE AT NIGHT	MINIMUM MAINTAINED AVERAGE HORIZONTAL ILLIMNANCE (E_{AVG}, LUX)	AVERAGE VERTICAL ILLUMINANCE AT 1.5M ABOVE THE PAVEMENT (E_{VAVG}, LUX)	UNIFORMITY RATIO (E_{AVG}/E_{MIN})
MEDIUM PEDESTRIAN ACTIVITY	5 lux	2 lux	5

This table is based on IESNA RP-8-21 Roadway Lighting Table 11-2

4 Methodology

4.1 Field Measurements

The lighting assessment survey was conducted along the Greenway on March 14th, 2023 and was started after Evening Civil Twilight (7:48pm) when all nearby roadway fixtures would be illuminated. Evening Civil Twilight is defined as when the geometric center of the sun is 6 degrees below the horizon. This start time also ensures that there is a minimal level of ambient light.

On March 14th, 2023, the weather was overcast on site. The cloud cover was high in the atmosphere and did not obstruct the existing lighting infrastructure but did filter out moonlight.

A Minolta Illuminance Meter model T-10 was employed to record the field measurements. The lighting sensor was attached to a tripod at a height of 1.5m to ensure consistent sensor reading.

The survey points were chosen based on the size of the survey areas to ensure that a reasonable representation of the area was captured. Due to the large stretches of complete darkness the survey points were attained where lighting levels changed significantly. The lighting of roadway intersections and crosswalks was not collected as it is outside the scope of this report.

4.2 Lighting Design Simulation

To find a possible lighting solution Agi32 was used as it is widely accepted industry standard lighting design software. It was used to determine the luminaire mounting height and spacing required to meet the lighting design criteria mentioned in Section 3.
The following should also be noted:

- A light loss factor (LLF) of 0.82 was used for the evaluation.
- The American Electric Lighting (AEL) Autobahn fixture (ATBMic-P101-MVOLT-R3L-3K HSS) was used for the proposed fixture.
- IES files for fixtures were downloaded from the AEL website.
- Where possible, pedestrian lights were positioned on the West side of the Greenway, with luminaire arms facing East towards Railway Avenue

5 Findings

5.1 Observations

The following sections describe in detail what was observed on site, and potential changes that could occur in the surrounding environment due to seasonal changes.

Table 3: Site Observations

#	SEGMENT	EXISTING NEARBY LIGHTING	FOLIAGE
1	Steveston Highway Quarter	-BC Hydro lease lights along Greenway facing Railway Avenue. City of Richmond street lights along far side of Railway Avenue -Single davit luminaire at midblock crosswalk -Approximately 100m South of Steveston Highway crossing a Hydro lease light burnt out. The effect of this light missing reduces the lighting levels from near recommended level to not meeting.	Sparsely treed for majority of trail
2	Williams Road Quarter	-City of Richmond street lights along far side of Railway Avenue. Impact of street lights minimal due to distance from trail -Single davit luminaire facing Railway Avenue at midblock crosswalk	Heavily treed on one side of the Greenway for majority of the trail
3	Francis Road Quarter	-BC Hydro lease light at the crossing of Railway and Princeton Avenue -City of Richmond street lights along far side of Railway Avenue. Impact of street lights minimal due to distance from trail -City of Richmond street lights along far side of Geal Road. Impact of street lights minimal due to distance from trail -Single davit luminaire facing Railway Avenue at Woodwards Road crosswalk	Heavily treed on one side of the Greenway for majority of the trail
4	Blundell Road Quarter	-City of Richmond street lights along far side of Railway Avenue. Impact of street lights minimal due to distance from trail	Heavily treed for majority of the trail
5	Granville Avenue Quarter	- BC Hydro lease lights along far side of Railway Avenue. Impact of street lights minimal due to distance from trail -BC Hydro lease lights along McCallan Road. Impact of lights minimal due to distance from trail. -Single davit luminaire facing Railway Avenue at Colbeck Road crosswalk.	Heavily treed for majority of the trail
6	Westminster Highway Quarter	-Downlights at JN Burnett Secondary School but the impact is minimal due to distance from trail. Single BC Hydro lease light 20m South of Westminster Highway crossing	Sparsely treed for majority of the trail

For the purpose of this report, a condensed set of the total lighting measurements were used to evaluate the illuminance against the recommended levels. It is assumed that the area is large enough that these points would represent a suitable average for the segments in question without performing an impractical amount of data collection. To that end, the specific point values, and not the average of the entire zone is used as a reference. The summary of the measured lighting levels using a handheld light meter can be found in Appendix A.

5.2 Seasonal Affect

During winter months, little to no foliage is on the trees along the Greenway. As this site visit occurred during this time, the noted values were taken during the best-case scenario for lighting levels. As the summer months approach, and the leaves return to the trees, there will be more blockage between the roadway lighting and the Greenway, decreasing the values even further.

6 City of Richmond Pathway Lighting Design

The design for additional lighting along the Greenway using City of Richmond approved products, includes a 4.57m (15 ft) Side Mounted Luminaire pole with an American Electric Lighting Autobahn ATBMic 20W luminaire fixture. To meet the recommended lighting levels, 166 poles with an average spacing of 30m per pole would be required to complete this design sufficiently. The breakdown of the design per segment can be seen in the table below, (refer to Appendix B for a Class D summary of costs):

Table 4:Lighting Design

SEGMENT	POLES PER SEGMENT	SEGEMENT LEGNTH	COST PER SEGEMENT
Steveston Highway Quarter	16	470m	$144,000
Williams Road Quarter	27	800m	$231,000
Francis Road Quarter	31	800m	$254,000
Blundell Road Quarter	28	785m	$230,000
Granville Avenue Quarter	32	786m	$254,000
Westminster Highway Quarter	32	786m	$254,000
TOTAL	166	4.4km	$1,367,000

6.1 Lighting Calculations

The following table identifies the theorical lighting levels for the proposed lighting design of the Greenway using the AGI32 lighting analysis software. All calculations were completed using the American Electric Lighting Autobahn fixture, ATBMicro 20W Type 3 Long Throw. The detailed results of the lighting calculations can be found in Appendix C.

Table 5: Software Calculations (AGI32)

SEGMENT	ILLUMINANCE	VERTICAL ILLUMINANCE	UNIFORMITY (LAVG/LMIN)
Steveston Highway Quarter	7.99 lux	7.23 lux	4.70
Williams Road Quarter	7.96 lux	7.42 lux	4.98
Francis Road Quarter	8.30 lux	7.59 lux	4.91
Blundell Road Quarter	8.25 lux	5.43 lux	4.58
Granville Avenue Quarter	9.44 lux	8.11 lux	4.72
Westminster Highway Quarter	9.45 lux	6.24 lux	4.50

7 Alternative Lighting Options

7.1 Solar Lighting

Solar street lights would not be suitable for this design, based on the following considerations:

- Limited Availability of Sunlight: One of the main challenges with solar street lights is that they require high amounts of sunlight to function properly. In Metro Vancouver's rainy climate, solar panels may not function at full capacity. This could result in reduced lighting or a shorter lifespan for the street lights. Due to the location of this project, these lights would not be able to provide consistent lighting year-round.
- Battery Maintenance & Theft: Solar street lights rely on batteries to store energy, and these batteries require maintenance to ensure they function correctly. If the batteries are not properly maintained, they may fail, resulting in insufficient lighting. Furthermore, battery banks have been identified as attractive targets for theft.
- Placement Limitations: Depending on the location and orientation of the street lights, it may be difficult to position the solar panels in an optimal position to capture sunlight. This can impact the efficiency and effectiveness of the street lights. Considering the many trees shading the Greenway and the number of lights required to meet the given lighting criteria, shading due to trees is likely and will result in reduced efficiency of the lights.
- Cost: Solar Street lights have a higher upfront cost per pole than traditional grid-connected street lights. However, they save money in cost for trenching and conduit between poles. The linear cost per metre is $920/metre.

Ultimately, the decision to use solar street lights depends on a variety of factors, including the location, lighting requirements, and budget.

7.2 Photoluminescent Aggregate

Photoluminescent aggregate is a type of material that can absorb and store light energy from natural or artificial light sources and then emit that energy in the form of visible light in darkness. When mixed with concrete or asphalt photoluminescent aggregate can be used to provide pathway illumination for pedestrian walkways, paths and trails.

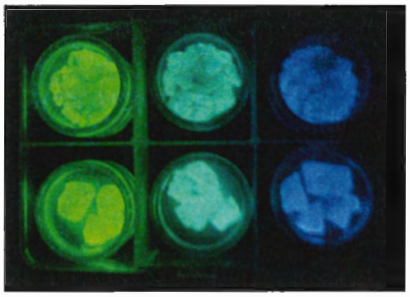

Figure 1: Photoluminescent Aggregate

PBX does not recommend the use of photoluminescent aggregate in this application for the following reasons:

- Limited Duration: The duration of the emitted light from photoluminescent aggregate is limited by the amount of light energy it can absorb and store. Once the stored energy is depleted, the material will no longer emit light, which means it may not be effective in situations where sunlight is limited for extended periods of time.
- Limited Brightness: The intensity of the light emitted by photoluminescent aggregate is often much lower than that of other lighting sources, which means it may not be bright enough to provide adequate visibility in all situations.
- Maintenance Requirements: Photoluminescent aggregate requires periodic maintenance to ensure that it remains functional, including snow clearing. Over time, the material can become dirty or damaged, which can reduce its ability to absorb and emit light.
- Facial Lighting: Photoluminescent aggregate would not be an equivalent to traditional pathway lighting as it would only provide the ability to see the pathway, and not what is in the surrounding area.
- Replacement of Existing Pavement: This product would require an entire replacement of the existing functional pavement on the greenway.
- Cost: Adding photoluminescent aggregate is an additional cost to asphalt or concrete pour and is more expensive than traditional materials. The linear cost per metre is $2,300/metre.

7.3 Illuminated Bollards

Bollards, which are short vertical posts often used to control vehicle and pedestrian traffic, can be designed with lighting features. However, they may not be suitable for functional lighting for several reasons:

- Limited height: Bollards are typically low to the ground, which means that the light they emit may not reach far enough to adequately illuminate an area. This can make them less effective for providing functional lighting, particularly in larger spaces.
- Limited coverage: Bollard lights are often designed to cast light in a specific direction or pattern, which may not be sufficient to provide full coverage of an area. This can create dark spots or shadows that can be hazardous, particularly in areas where people are walking or riding.
- Cost: Due to the limited height and coverage additional bollards are required to reach the same lighting levels as street lights. The linear cost per metre is $1,370/metre.

For these reasons, bollards may be better suited for decorative or ambient lighting rather than functional lighting. PBX does not recommend the use of Illuminated bollards to provide sufficient trail lighting.

8 Conclusions & Recommendations

8.1 Conclusions

The following conclusions were made while conducting this study:

- Existing lighting levels for almost the entirety of the Greenway are insufficient and do not meet City-adopted lighting standards, the only readings that met the recommended lighting criteria were less than 30m from the closest intersection.

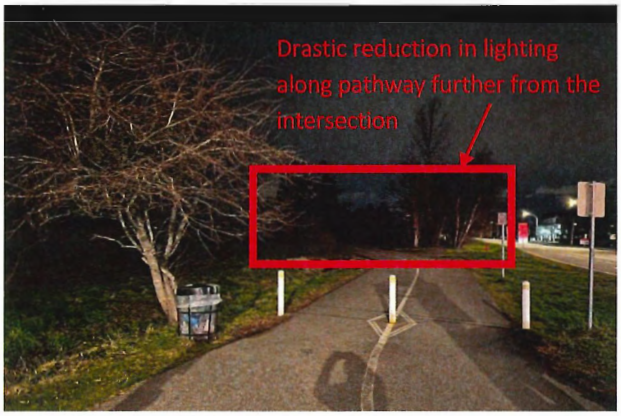

Figure 2: Lighting at the Francis Rd. Intersection

- Spillage from roadway lighting is insufficient to light the Greenway. Overall Segment 1, the Steveston Highway Quarter, does not meet lighting recommendations but has the best lighting (much of the trail had a rating of 4 lux) due to the nearby BC Hydro lease lights. Segment 6, the Westminster Highway Quarter, has the worst lighting as there are no roads parallel to the path to provide light spillage. An average of 0.5 lux was not uncommon.
- In order to meet recommended lighting levels along the Greenway, additional poles along the Greenway are required.
- Solar lighting, photoluminescent aggregate and bollards are not suggested for this design.

8.2 Recommendations

Based on the findings summarized in the previous sections, a list of recommendations has been provided. The recommendations below are based on the calculated values from the computer simulation:

- Installation of 166 additional 4.57m light poles to meet recommended lighting levels along the Greenway. This installation can be completed over several years.
- The ATBMic-P101-MVOLT-R3L-3K HSS fixture is recommended.
- Poles should be spaced about 30 m apart to meet lighting criteria.

9 Closure

This document has been prepared based upon the information referenced herein and on-site findings. It has been prepared in a manner consistent with good engineering judgement. Should new information come to light, PBX Engineering Ltd. requests the opportunity to review this information and our conclusions contained in this report. This document has been prepared for the exclusive use of the City of Richmond, and there are no representations made by PBX Engineering Ltd. to any other party. Any use that a third party makes of this document, or any reliance on or decisions made based on it, are the responsibility of such third parties.

Prepared By:

Delainey Sampson E.I.T.
Design Engineer
p. 1.604.408.7222
e. delainey.sampson@pbxeng.com
Permit to Practice Number: 1000208

Reviewed By:

Kara Imhof P.Eng
Project Engineer
p. 1.604-789-1784
e. Kara.Imhof@pbxeng.com
Permit to Practice Number: 1000208

Appendix A – Field Survey

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Rev.	DATE		DESN	QC	QA
1	23MAR10	FIELD SURVEY RESULTS–DRAFT REPORT	DS	KI	KI

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TITLE

CITY OF RICHMOND
MUP LIGHTING – SITE PLAN
SEGMENT 1 – GARRY ST TO STEVESTON HWY

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E001	1

Rev.	DATE		DESN	QC	QA
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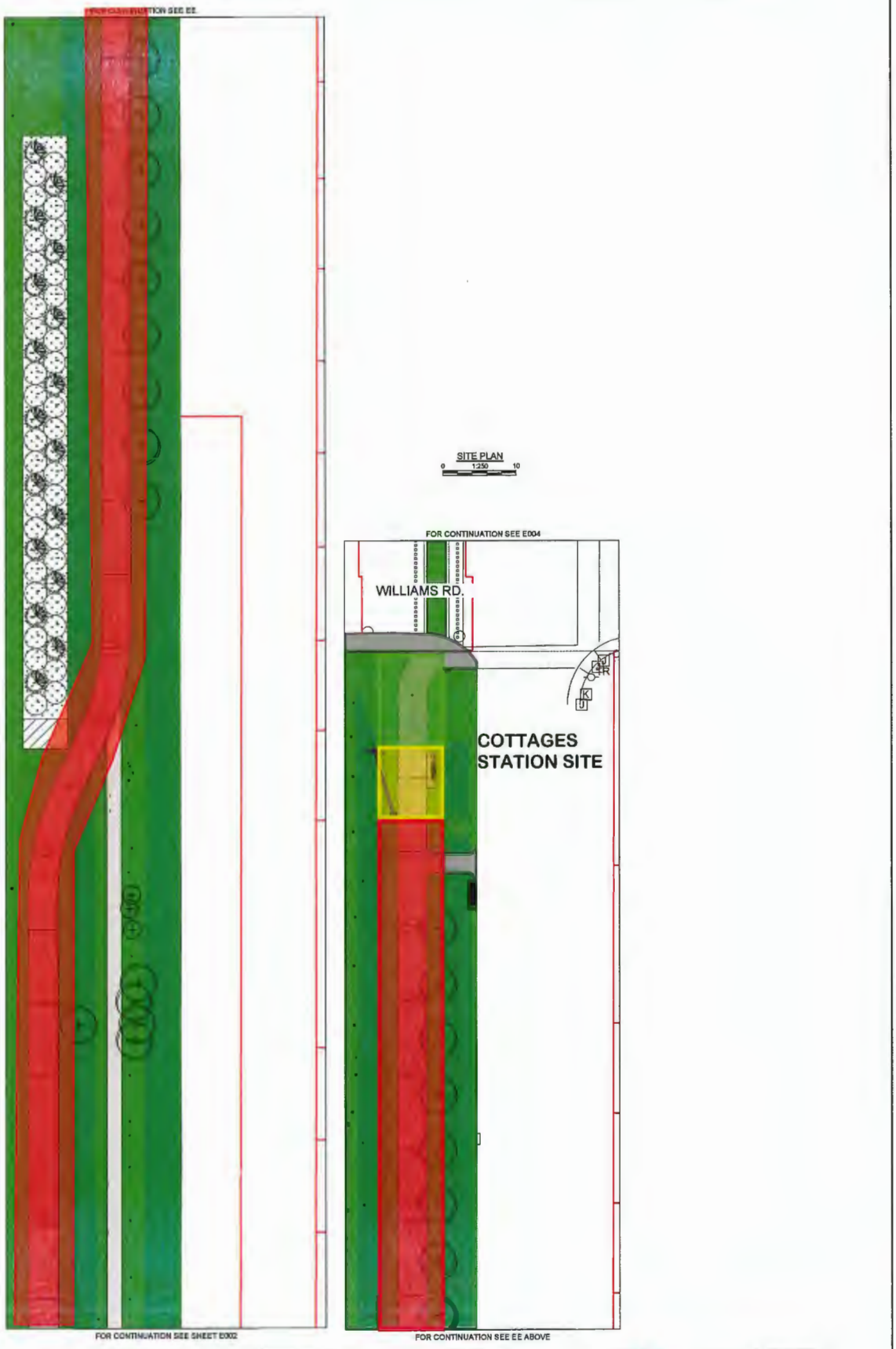
TITLE

CITY OF RICHMOND
MUP LIGHTING – SITE PLAN
SEGMENT 2 – STEVESTON HWY TO WILLIAMS RD

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E002	1



Rev.	DATE		DESN	QC	QA
1	23MAR10	FIELD SURVEY RESULTS–DRAFT REPORT	DS	KI	KI

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MUP LIGHTING – SITE PLAN
SEGMENT 2 – STEVESTON HWY TO WILLIAMS RD

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
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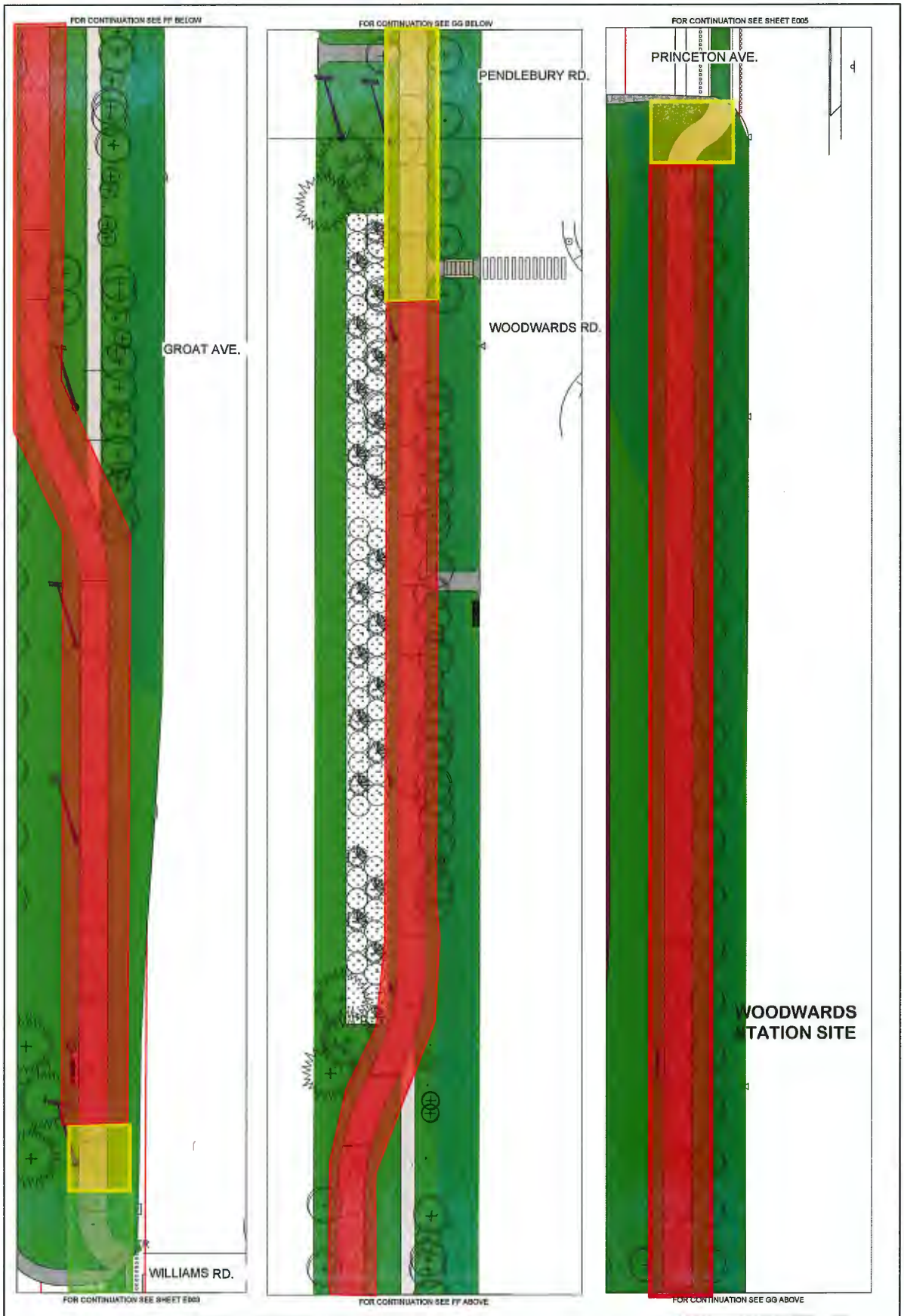

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1	23MAR10	FIELD SURVEY RESULTS–DRAFT REPORT	DS	KI	KI

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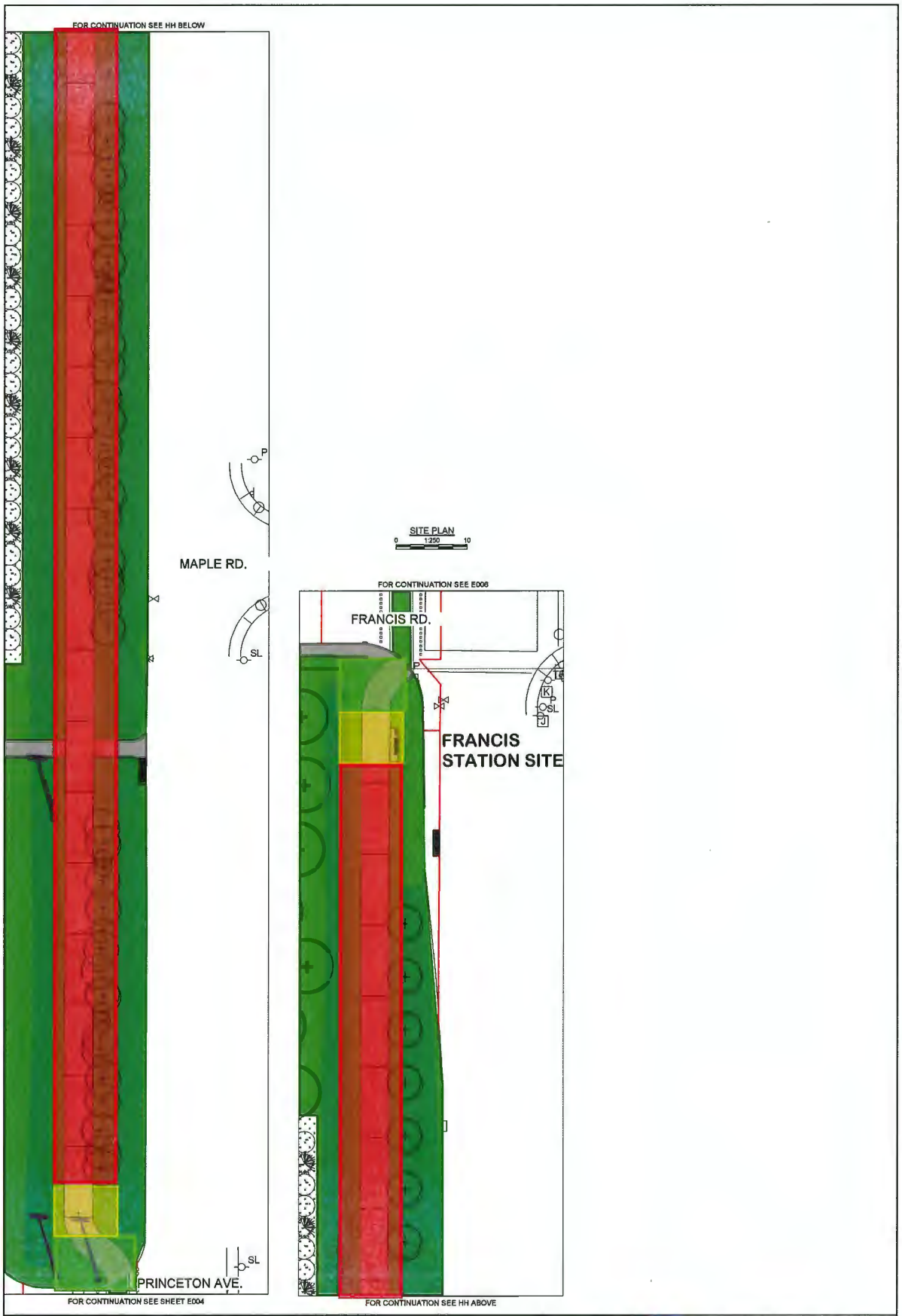
CITY OF RICHMOND
MUP LIGHTING – SITE PLAN
SEGMENT 3 – WILLIAMS RD TO FRANCIS RD

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E004	1



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MUP LIGHTING – SITE PLAN
SEGMENT 3 – WILLIAMS RD TO FRANCIS RD

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
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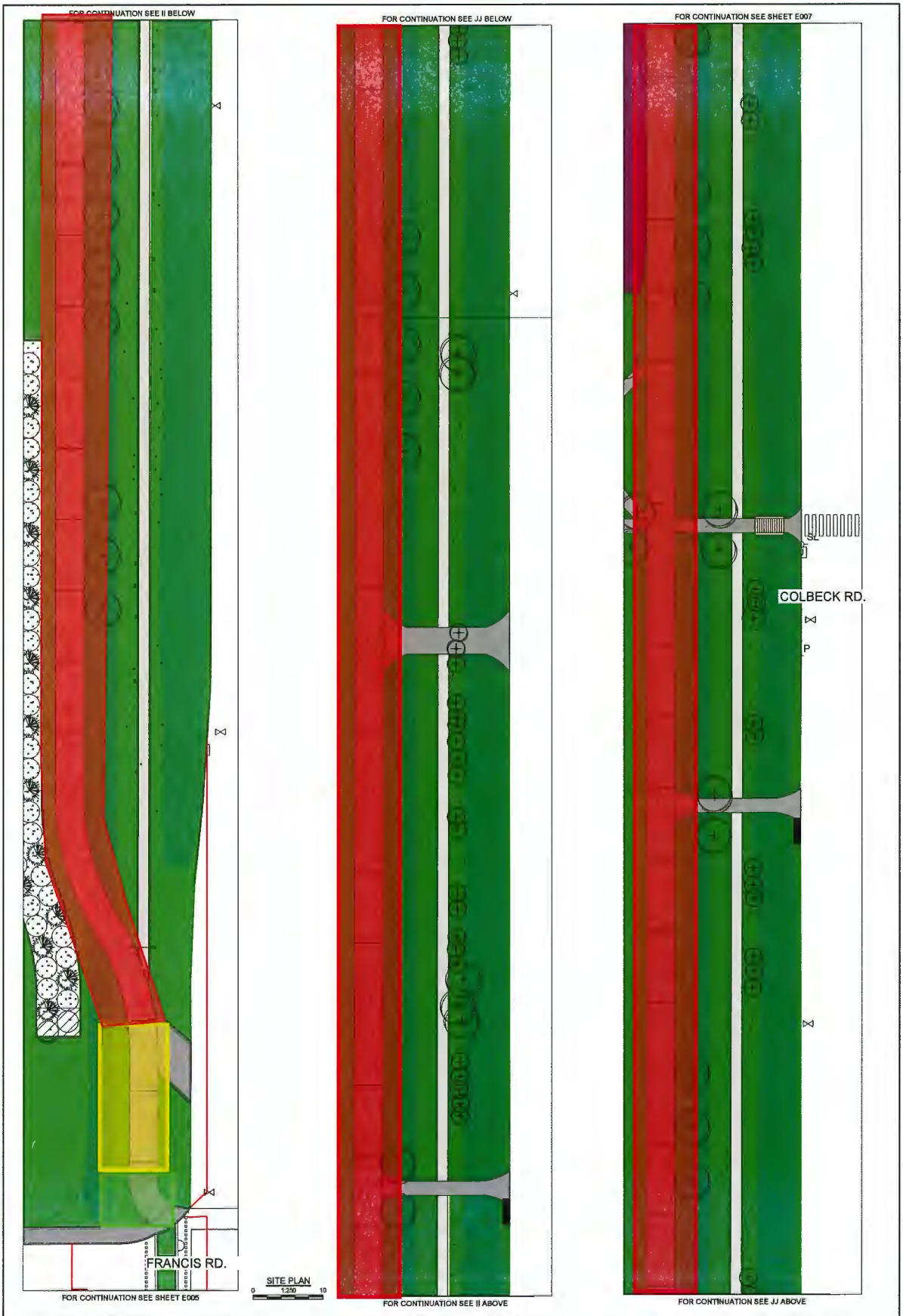

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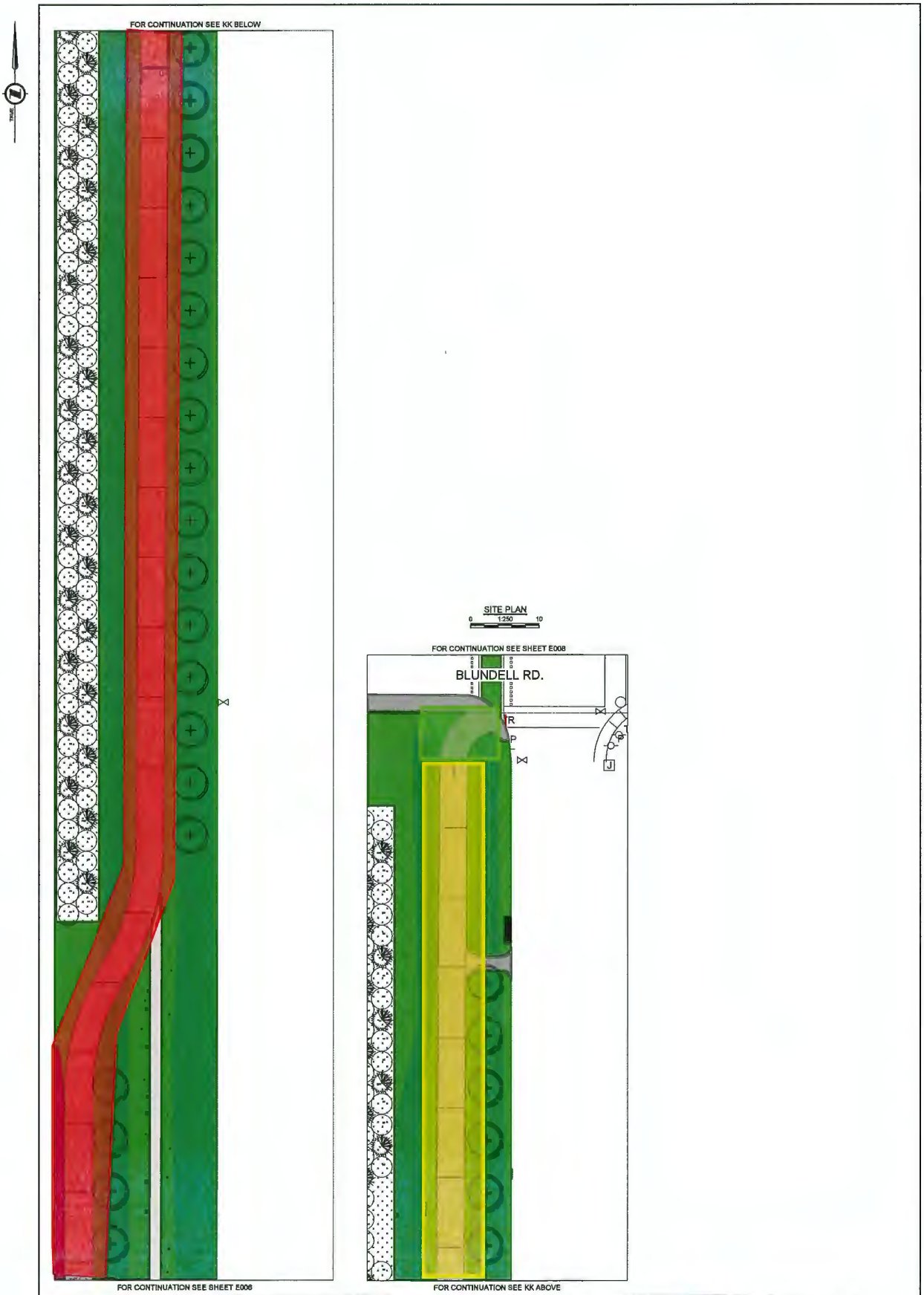
CITY OF RICHMOND
MUP LIGHTING – SITE PLAN
SEGMENT 4 – FRANCIS RD TO BLUNDELL RD

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E006	1



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CITY OF RICHMOND
MUP LIGHTING – SITE PLAN
SEGMENT 4 – FRANCIS RD TO BLUNDELL RD

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E007	1

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SITE PLAN
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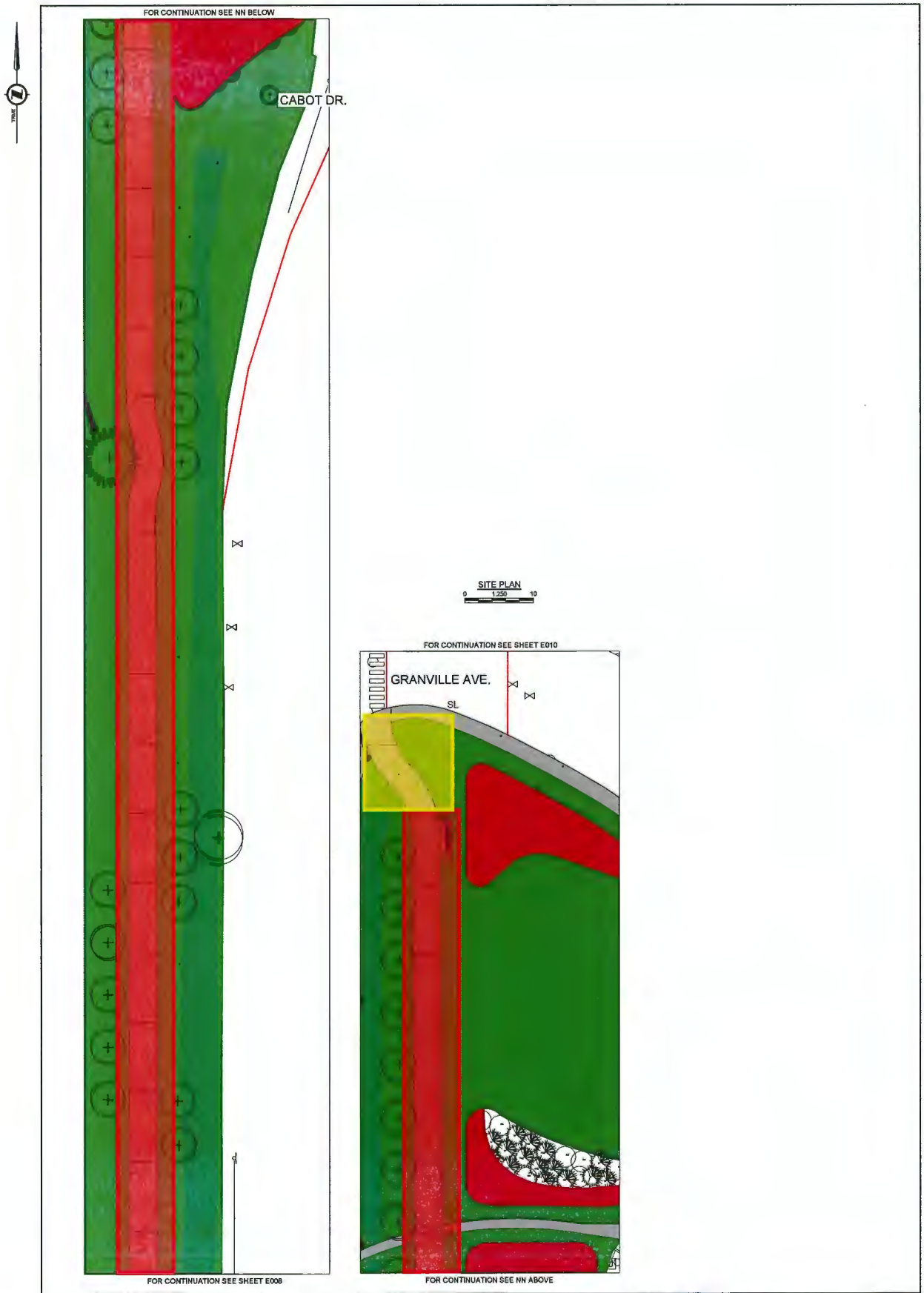
CITY OF RICHMOND
MUP LIGHTING – SITE PLAN
SEGMENT 5 – BLUNDELL RD TO GRANVILLE AVE

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E008	1



Rev.	DATE		DESN	QC	QA
1	23MAR10	FIELD SURVEY RESULTS–DRAFT REPORT	DS	KI	KI

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CITY OF RICHMOND
MUP LIGHTING – SITE PLAN
SEGMENT 5 – BLUNDELL RD TO GRANVILLE AVE

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
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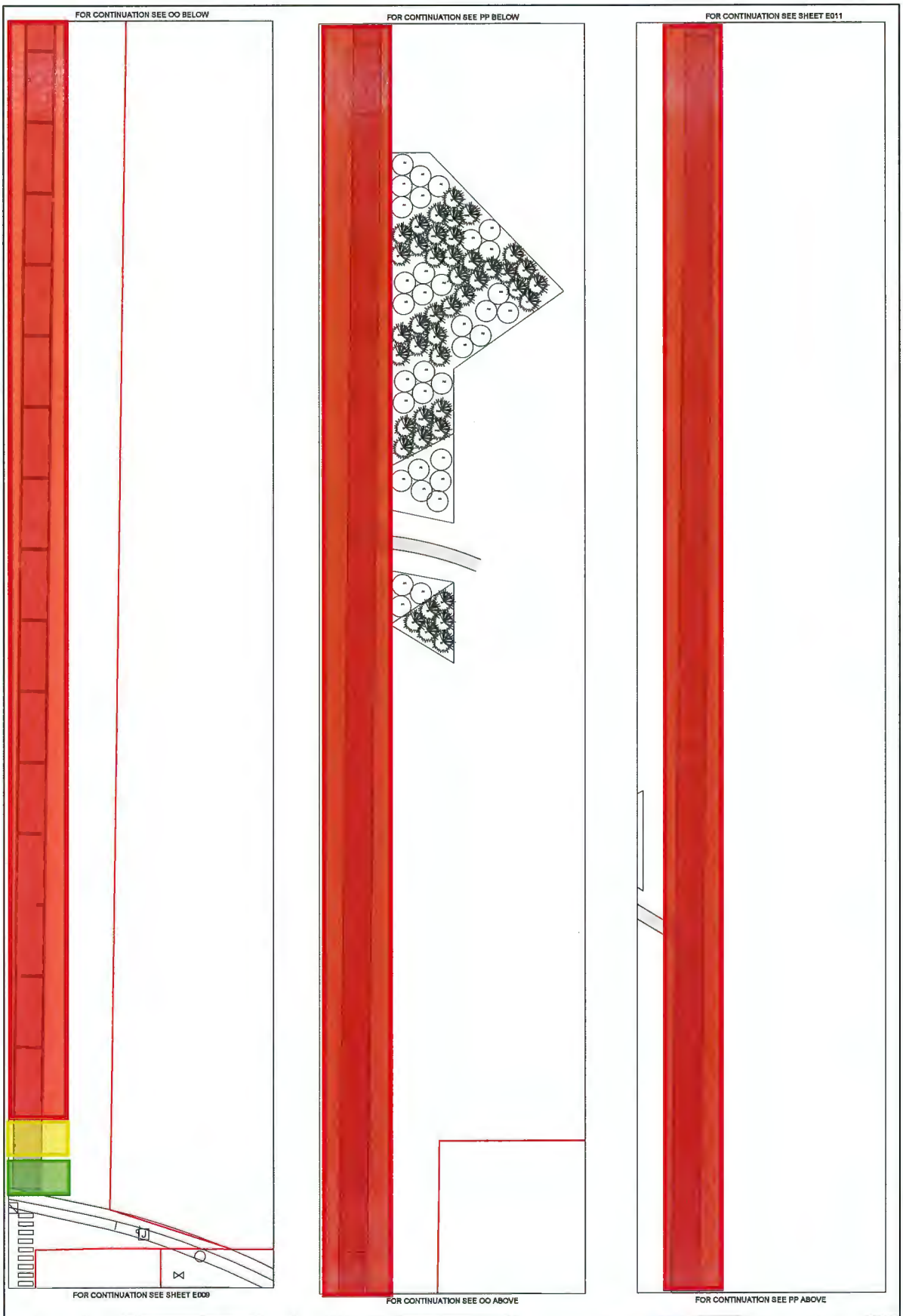

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1	23MAR10	FIELD SURVEY RESULTS–DRAFT REPORT	DS	KI	KI

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TITLE

CITY OF RICHMOND
MUP LIGHTING – SITE PLAN
SEGMENT 6 – GRANVILLE AVE TO WESTMINSTER HWY

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E010	1

SITE PLAN
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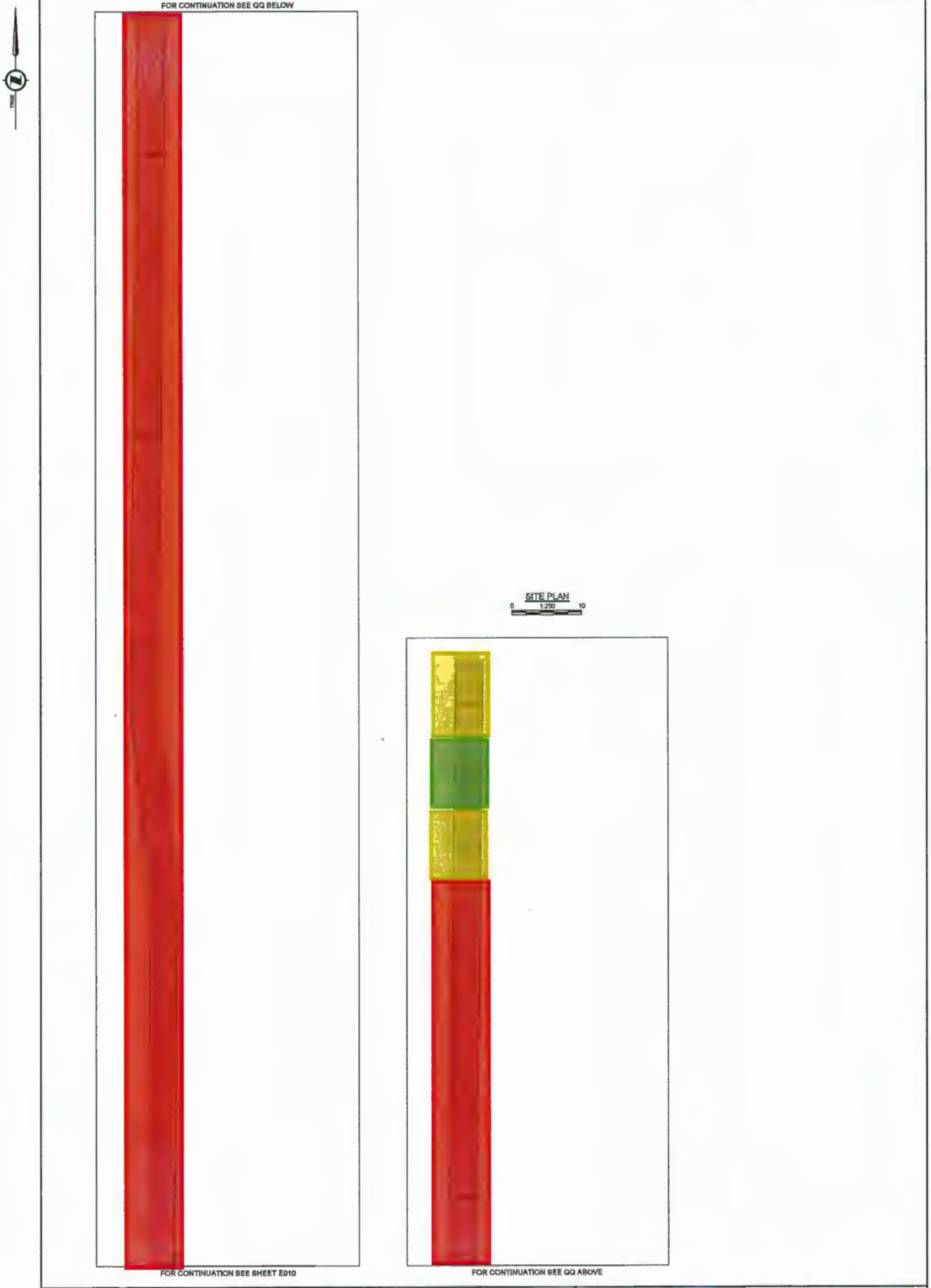

Rev.	DATE		DESN	QC	QA
1	23MAR10	FIELD SURVEY RESULTS–DRAFT REPORT	DS	KI	KI

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TITLE

CITY OF RICHMOND
MUP LIGHTING – SITE PLAN
SEGMENT 6 – GRANVILLE AVE TO WESTMINSTER HWY

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E011	1

Appendix B – Class D Cost Estimate

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City of Richmond Railway Greenway Lighting - Steveston Highway Quarter

Description		Unit	Qty	Material Cost	Total Material	Labour	Total Labour	Equipment	Total Equipment	Line Totals	TOTALS
1	**Street Lighting**										
1.01	CoR Type S1 Concrete Base	ea.	16	$ 1,000.00	$ 16,000.00	6.00	$ 8,640.00	$ -	$ -	$ 24,640.00	
1.02	35mm RPVC Conduit	m	470	$ 15.00	$ 7,050.00	0.04	$ 1,692.00	$ -	$ -	$ 8,742.00	
1.03	Trenching and Backfill (Gravel)	m	458	$ 60.00	$ 27,480.00	0.00	$ -	$ -	$ -	$ 27,480.00	
1.05	Trenching and Backfill (Asphalt)	m	12	$ 600.00	$ 7,200.00	0.00	$ -	$ -	$ -	$ 7,200.00	
1.06	Laneway 4.57m Luminaire Pole, Galv & Powder Coated, RICHMOND	ea.	16	$ 581.00	$ 9,296.00	6.00	$ 8,640.00	$ -	$ -	$ 17,936.00	
1.07	ATBMic-P101-MVOLT-R2-3K	ea.	16	$ 220.00	$ 3,520.00	2.00	$ 2,880.00	$ -	$ -	$ 6,400.00	
1.08	No. 6 RW90	m	1410	$ 5.31	$ 7,487.10	0.00	$ -	$ -	$ -	$ 7,487.10	
1.08	No. 8 RW90	m	470	$ 3.51	$ 1,649.70	0.00	$ -	$ -	$ -	$ 1,649.70	
1.10	BC Hydro Disconnect and New Service Dip	LS	1	$ 10,000.00	$ 10,000.00	0.00	$ -	$ -	$ -	$ 10,000.00	
Subtotal					$ 79,682.80		$ 21,852.00		$ -		$ 101,534.80
2	**General Site Costs**										
2.00	Mobilization	LS	1	$ 5,000.00	$ 5,000.00	0.00	$ -	$ -	$ -	$ 5,000.00	
Subtotal					$ 5,000.00		$ -		$ -		$ 5,000.00
TOTAL											$ 106,534.80
CONTINGENCY (35%)											$ 37,287.18
GRAND TOTAL											$ 143,821.98

City of Richmond Railway Greenway Lighting - Williams Road Quarter

Description		Unit	Qty	Material Cost	Total Material	Labour	Total Labour	Equipment	Total Equipment	Line Totals	TOTALS
1	**Street Lighting**										
1.01	CoR Type S1 Concrete Base	ea.	27	$ 1,000.00	$ 27,000.00	6.00	$ 14,580.00		$ -	$ 41,580.00	
1.02	35mm RPVC Conduit	m	800	$ 15.00	$ 12,000.00	0.04	$ 2,880.00	$ -	$ -	$ 14,880.00	
1.03	Trenching and Backfill (Gravel)	m	796	$ 60.00	$ 47,760.00	0.00	$ -	$ -	$ -	$ 47,760.00	
1.05	Trenching and Backfill (Asphalt)	m	8	$ 600.00	$ 4,800.00	1.00	$ 720.00	$ -	$ -	$ 5,520.00	
1.06	Laneway 4.57m Luminaire Pole, Galv & Powder Coated, RICHMOND	ea.	27	$ 581.00	$ 15,687.00	6.00	$ 14,580.00	$ -	$ -	$ 30,267.00	
1.07	ATBMic-P101-MVOLT-R2-3K	ea.	27	$ 220.00	$ 5,940.00	2.00	$ 4,860.00	$ -	$ -	$ 10,800.00	
1.08	No. 6 RW90	m	2400	$ 5.31	$ 12,744.00	0.00	$ -	$ -	$ -	$ 12,744.00	
1.09	No. 8 RW90	m	800	$ 3.51	$ 2,808.00	0.00	$ -	$ -	$ -	$ 2,808.00	
1.10	BC Hydro Disconnect and New Service Dip	LS	1	$ 10,000.00	$ 10,000.00	0.00	$ -	$ -	$ -	$ 10,000.00	
Subtotal					$ 128,738.00		$ 37,620.00		$ -		$ 166,358.00
2	**General Site Costs**										
2.00	Mobilization	LS	1	$ 5,000.00	$ 5,000.00	0.00	$ -	$ -	$ -	$ 5,000.00	
Subtotal					$ 5,000.00		$ -		$ -		$ 5,000.00
TOTAL											$ 171,359.00
CONTINGENCY (35%)											$ 59,975.65
GRAND TOTAL											$ 231,334.65

City of Richmond Railway Greenway Lighting - Francis Road Quarter

Description		Unit	Qty	Material Cost	Total Material	Labour	Total Labour	Equipment	Total Equipment	Line Totals	TOTALS
1	**Street Lighting**										
1.01	CoR Type S1 Concrete Base	ea.	31	$ 1,000.00	$ 31,000.00	6.00	$ 16,740.00		$ -	$ 47,740.00	
1.02	35mm RPVC Conduit	m	800	$ 15.00	$ 12,000.00	0.04	$ 2,880.00	$ -	$ -	$ 14,880.00	
1.03	Trenching and Backfill (Gravel)	m	784	$ 60.00	$ 47,040.00	0.00	$ -	$ -	$ -	$ 47,040.00	
1.05	Trenching and Backfill (Asphalt)	m	16	$ 600.00	$ 9,600.00	1.00	$ 1,440.00	$ -	$ -	$ 11,040.00	
1.06	Laneway 4.57m Luminaire Pole, Galv & Powder Coated, RICHMOND	ea.	31	$ 581.00	$ 18,011.00	6.00	$ 16,740.00	$ -	$ -	$ 34,751.00	
1.07	ATBMic-P101-MVOLT-R2-3K	ea.	31	$ 220.00	$ 6,820.00	2.00	$ 5,580.00	$ -	$ -	$ 12,400.00	
1.08	No. 6 RW90	m	2400	$ 5.31	$ 12,744.00	0.00	$ -	$ -	$ -	$ 12,744.00	
1.09	No. 8 RW90	m	800	$ 3.51	$ 2,808.00	0.00	$ -	$ -	$ -	$ 2,808.00	
1.10	BC Hydro Disconnect and New Service Dip	LS	1	$ 10,000.00	$ 10,000.00	0.00	$ -	$ -	$ -	$ 10,000.00	
Subtotal					$ 140,023.00		$ 43,381.00		$ -		$ 183,403.00
2	**General Site Costs**										
2.00	Mobilization	LS	1	$ 5,000.00	$ 5,000.00	0.00	$ -	$ -	$ -	$ 5,000.00	
Subtotal					$ 5,000.00		$ -		$ -		$ 5,000.00
TOTAL											$ 188,403.00
CONTINGENCY (35%)											$ 65,941.05
GRAND TOTAL											$ 254,344.05

Notes:

1. Civil Works beyond trenching and backfilling are not included in this estimate.
2. Applicable taxes are not included.

City of Richmond Railway Greenway Lighting - Blundell Road Quarter

Description		Unit	Qty	Material Cost	Total Material	Labour	Total Labour	Equipment	Total Equipment	Line Totals	TOTALS
1	**Street Lighting**										
1.01	CoR Type S1 Concrete Base	ea.	28	$ 1,000.00	$ 28,000.00	6.00	$ 15,120.00		$ -	$ 43,120.00	
1.02	35mm RPVC Conduit	m	765	$ 15.00	$ 11,775.00	0.04	$ 2,626.00	$ -	$ -	$ 14,601.00	
1.03	Trenching and Backfill (Gravel)	m	761	$ 60.00	$ 46,860.00	0.00	$ -	$ -	$ -	$ 46,860.00	
1.05	Trenching and Backfill (Asphalt)	m	4	$ 600.00	$ 2,400.00	1.00	$ 360.00	$ -	$ -		
1.06	Laneway 4.57m Luminaire Pole, Galv & Powder Coated, RICHMOND	ea.	28	$ 581.00	$ 16,268.00	6.00	$ 15,120.00	$ -	$ -	$ 31,388.00	
1.07	ATBMic-P101-MVOLT-R2-3K	ea.	28	$ 220.00	$ 6,160.00	2.00	$ 5,040.00	$ -	$ -	$ 11,200.00	
1.08	No. 6 RW90	m	2355	$ 5.31	$ 12,505.05	0.00	$ -	$ -	$ -	$ 12,505.05	
1.09	No. 8 RW90	m	765	$ 3.51	$ 2,755.35	0.00	$ -	$ -	$ -	$ 2,755.35	
1.10	BC Hydro Disconnect and New Service Dip	LS	1	$ 10,000.00	$ 10,000.00	0.00	$ -	$ -	$ -	$ 10,000.00	
Subtotal					$ 126,723.40		$ 38,466.00		$ -		$ 165,189.40
2	**General Site Costs**										
2.00	Mobilization	LS	1	$ 5,000.00	$ 5,000.00	0.00	$ -	$ -	$ -	$ 5,000.00	
Subtotal					$ 5,000.00		$ -		$ -		$ 5,000.00
TOTAL											$ 170,189.40
CONTINGENCY (35%)											$ 59,566.29
GRAND TOTAL											$ 229,755.69

City of Richmond Railway Greenway Lighting - Granville Ave Quarter

Description		Unit	Qty	Material Cost	Total Material	Labour	Total Labour	Equipment	Total Equipment	Line Totals	TOTALS
1	**Street Lighting**										
1.01	CoR Type S1 Concrete Base	ea.	32	$ 1,000.00	$ 32,000.00	6.00	$ 17,280.00		$ -	$ 49,280.00	
1.02	35mm RPVC Conduit	m	766	$ 15.00	$ 11,790.00	0.04	$ 2,629.60	$ -	$ -	$ 14,619.60	
1.03	Trenching and Backfill (Gravel)	m	740	$ 60.00	$ 44,400.00	0.00	$ -	$ -	$ -	$ 44,400.00	
1.05	Trenching and Backfill (Asphalt)	m	18	$ 600.00	$ 9,600.00	1.00	$ 1,440.00	$ -	$ -	$ 11,040.00	
1.06	Laneway 4.57m Luminaire Pole, Galv & Powder Coated, RICHMOND	ea.	32	$ 581.00	$ 18,592.00	6.00	$ 17,280.00	$ -	$ -	$ 35,872.00	
1.07	ATBMic-P101-MVOLT-R2-3K	ea.	32	$ 220.00	$ 7,040.00	2.00	$ 5,760.00	$ -	$ -	$ 12,800.00	
1.08	No. 6 RW90	m	2358	$ 5.31	$ 12,520.98	0.00	$ -	$ -	$ -	$ 12,520.98	
1.09	No. 8 RW90	m	766	$ 3.51	$ 2,758.66	0.00	$ -	$ -	$ -	$ 2,758.66	
1.10	BC Hydro Disconnect and New Service Dip	LS	1	$ 10,000.00	$ 10,000.00	0.00	$ -	$ -	$ -	$ 10,000.00	
Subtotal					$ 138,701.64		$ 44,509.60		$ -		$ 183,291.44
2	**General Site Costs**										
2.00	Mobilization	LS	1	$ 5,000.00	$ 5,000.00	0.00	$ -	$ -	$ -	$ 5,000.00	
Subtotal					$ 5,000.00		$ -		$ -		$ 5,000.00
TOTAL											$ 188,291.44
CONTINGENCY (35%)											$ 65,902.00
GRAND TOTAL											$ 254,193.44

City of Richmond Railway Greenway Lighting - Westminster Highway Quarter

Description		Unit	Qty	Material Cost	Total Material	Labour	Total Labour	Equipment	Total Equipment	Line Totals	TOTALS
1	**Street Lighting**										
1.01	CoR Type S1 Concrete Base	ea.	32	$ 1,000.00	$ 32,000.00	6.00	$ 17,280.00		$ -	$ 49,280.00	
1.02	35mm RPVC Conduit	m	786	$ 15.00	$ 11,790.00	0.04	$ 2,829.60	$ -	$ -	$ 14,619.60	
1.03	Trenching and Backfill (Gravel)	m	782	$ 60.00	$ 46,920.00	0.00	$ -	$ -	$ -	$ 46,920.00	
1.05	Trenching and Backfill (Asphalt)	m	12	$ 600.00	$ 7,200.00	1.00	$ 1,080.00	$ -	$ -	$ 8,280.00	
1.06	Laneway 4.57m Luminaire Pole, Galv & Powder Coated, RICHMOND	ea.	32	$ 581.00	$ 18,592.00	6.00	$ 17,280.00	$ -	$ -	$ 35,872.00	
1.07	ATBMic-P101-MVOLT-R2-3K	ea.	32	$ 220.00	$ 7,040.00	2.00	$ 5,760.00	$ -	$ -	$ 12,800.00	
1.08	No. 6 RW90	m	2358	$ 5.31	$ 12,520.98	0.00	$ -	$ -	$ -	$ 12,520.98	
1.09	No. 8 RW90	m	786	$ 3.51	$ 2,758.86	0.00	$ -	$ -	$ -	$ 2,758.86	
1.10	BC Hydro Disconnect and New Service Dip	LS	1	$ 10,000.00	$ 10,000.00	0.00	$ -	$ -	$ -	$ 10,000.00	
Subtotal					$ 151,821.84		$ 44,229.60		$ -		$ 196,051.44
2	**General Site Costs**										
2.00	Mobilization	LS	1	$ 5,000.00	$ 5,000.00	0.00	$ -	$ -	$ -	$ 5,000.00	
Subtotal					$ 5,000.00		$ -		$ -		$ 5,000.00
TOTAL											$ 188,051.44
CONTINGENCY (35%)											$ 65,818.00
GRAND TOTAL											$ 253,869.44

Notes:

1. Civil Works beyond trenching and backfilling are not included in this estimate.
2. Applicable taxes are not included.

Appendix C – Lighting Calculations

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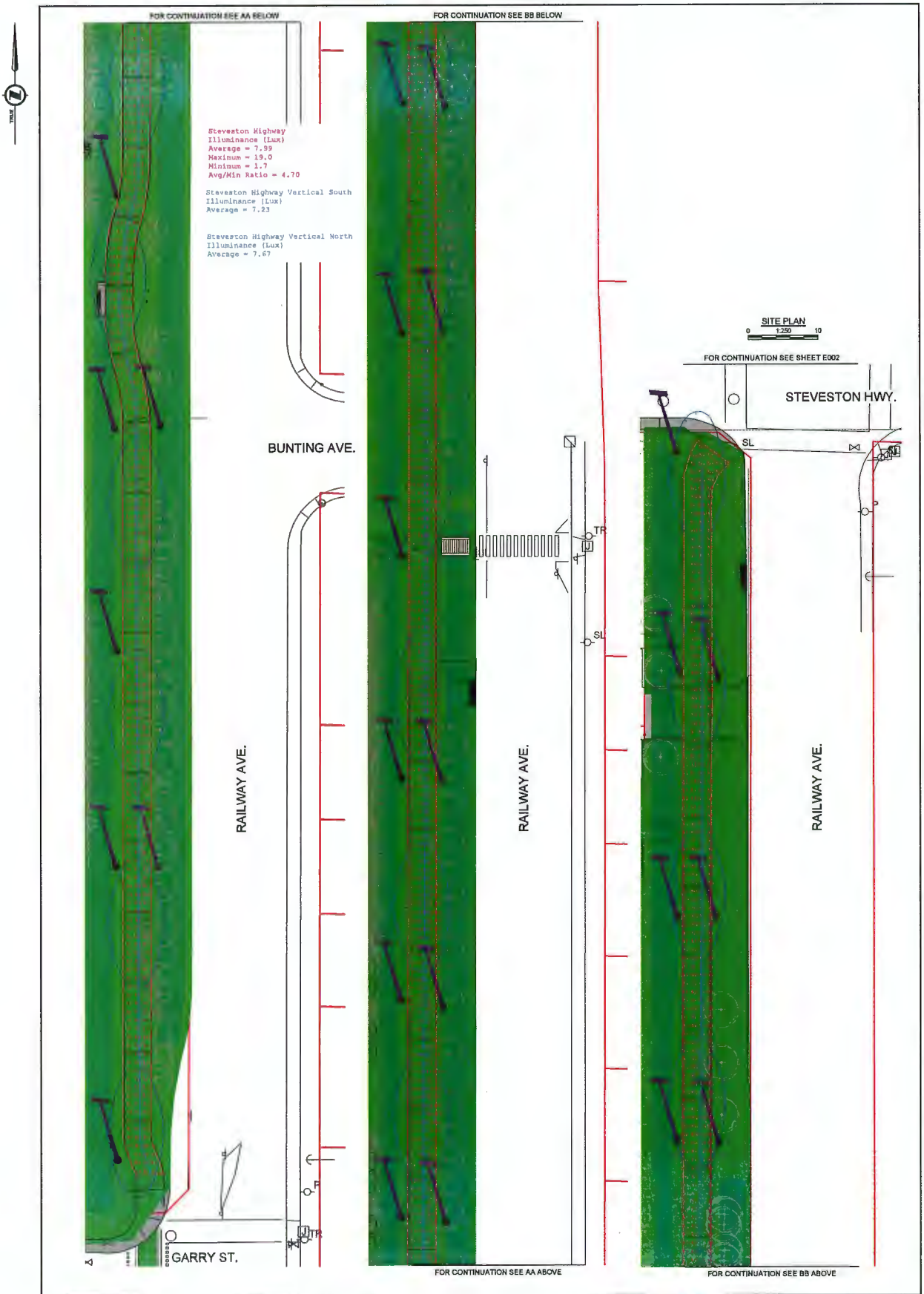

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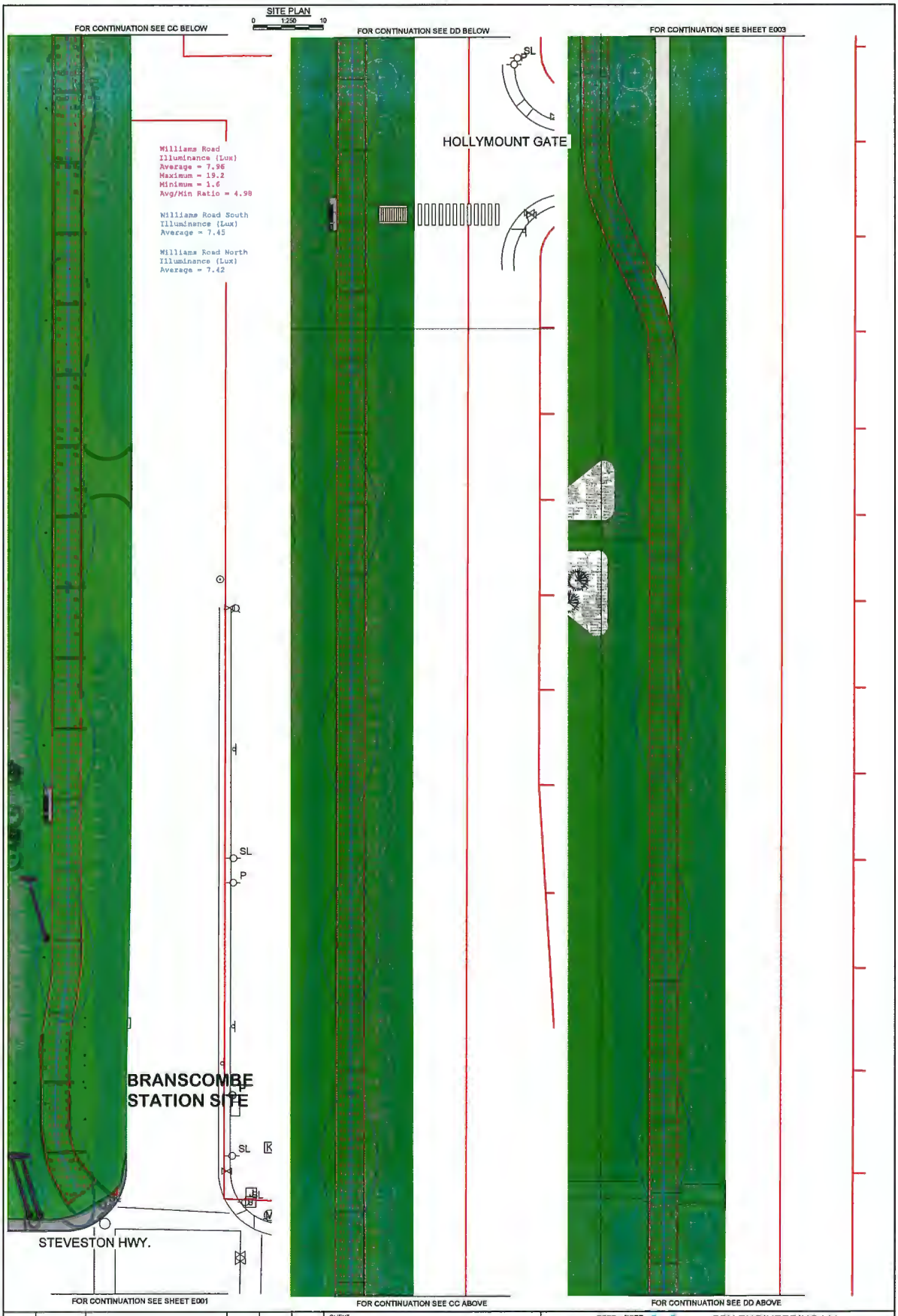
www.pbxeng.com

TITLE

CITY OF RICHMOND
MUP LIGHTING CALCULATION
SEGMENT 1 – GARRY ST TO STEVESTON HWY

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	ED01	1



Rev.	DATE		DESN	QC	QA
1	23MAR10	LIGHTING CALCULATION–DRAFT REPORT	DS	KI	KI

CLIENT

PROJECT

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Tel 604.408.7222
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TITLE

CITY OF RICHMOND
MUP LIGHTING CALCULATION
SEGMENT 2 – STEVESTON HWY TO WILLIAMS RD

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E002	1

Rev.	DATE		DESN	QC	QA
1	23MAR10	LIGHTING CALCULATION–DRAFT REPORT	DS	KI	KI

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TITLE

CITY OF RICHMOND
MUP LIGHTING CALCULATION
SEGMENT 2 – STEVESTON HWY TO WILLIAMS RD

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E003	1

Rev.	DATE		DESN	QC	QA
1	23MAR10	LIGHTING CALCULATION-DRAFT REPORT	DS	KI	KI

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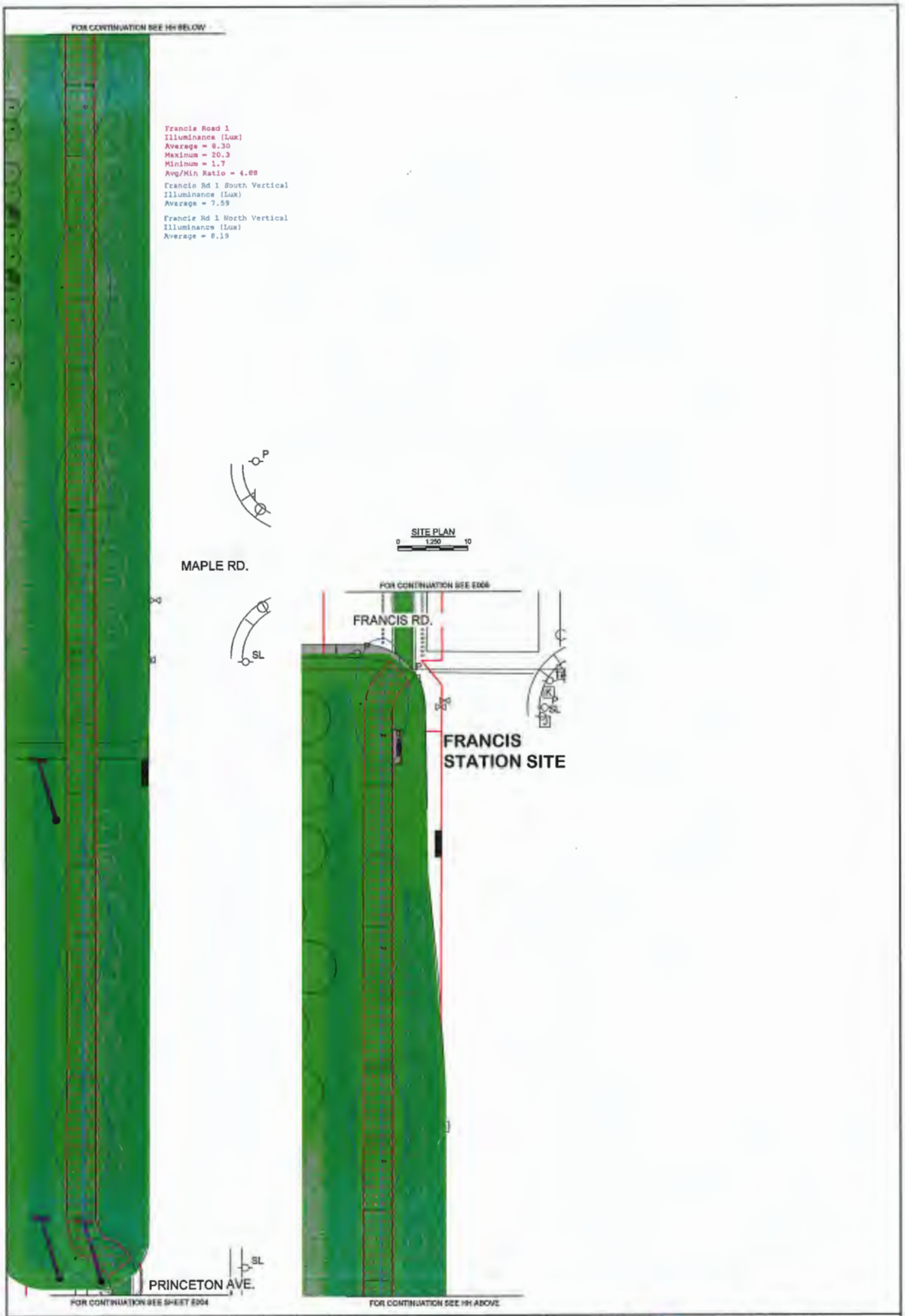
TITLE

CITY OF RICHMOND
MUP LIGHTING CALCULATION
SEGMENT 3 – WILLIAMS RD TO FRANCIS RD

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E004	1



Rev.	DATE		DESN	QC	QA
1	23MAR10	LIGHTING CALCULATION-DRAFT REPORT	DS	KI	KI

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TITLE

CITY OF RICHMOND
MUP LIGHTING CALCULATION
SEGMENT 3 – WILLIAMS RD TO FRANCIS RD

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E005	1

Rev.	DATE		DESN	QC	QA
1	23MAR10	LIGHTING CALCULATION–DRAFT REPORT	DS	KI	KI

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Tel 604.406.7222
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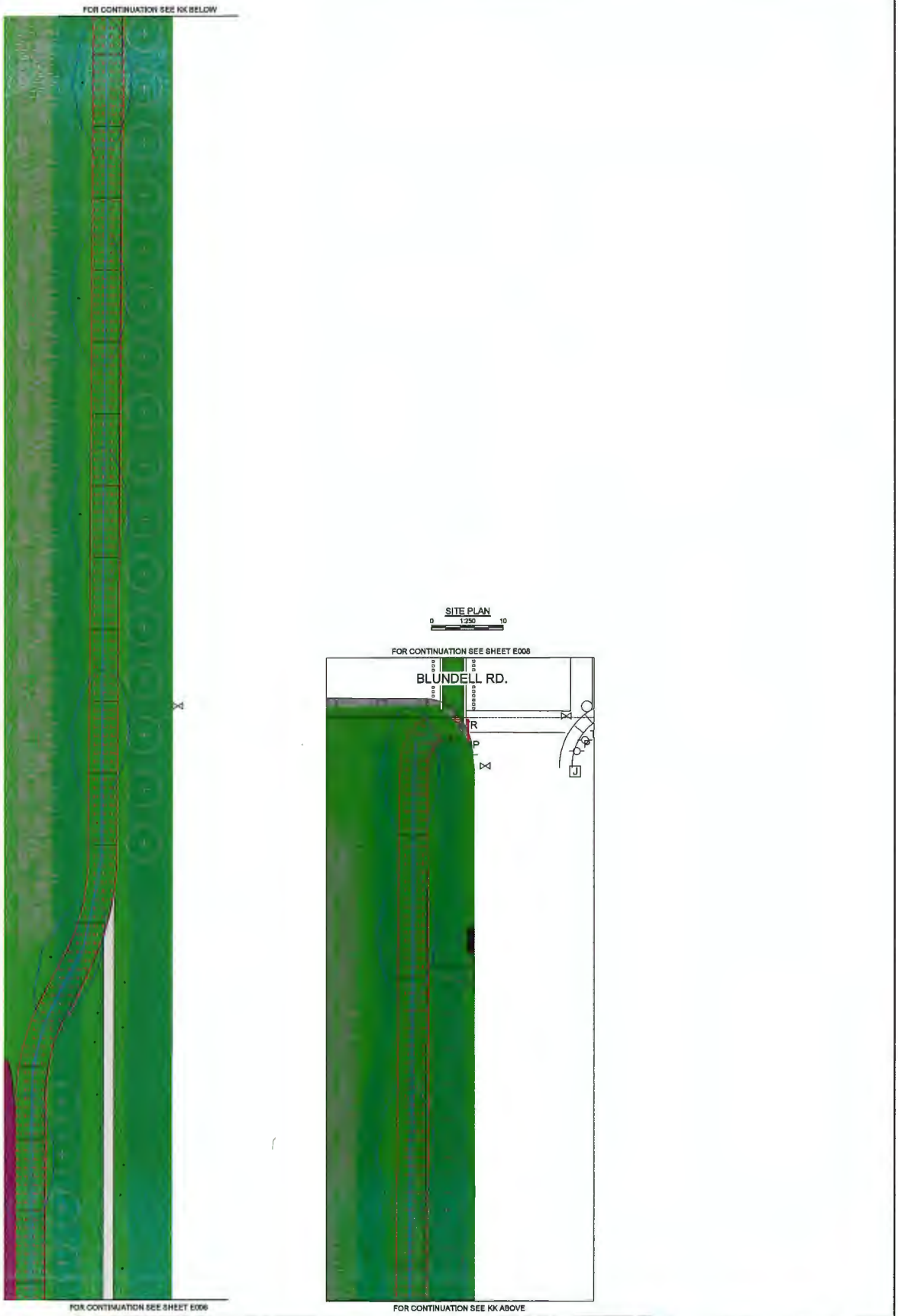
TITLE

CITY OF RICHMOND
MUP LIGHTING CALCULATION
SEGMENT 4 – FRANCIS RD TO BLUNDELL RD

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E008	1



Rev.	DATE		DESN	QC	QA
1	23MAR10	LIGHTING CALCULATION–DRAFT REPORT	DS	KI	KI

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TITLE

CITY OF RICHMOND
MUP LIGHTING CALCULATION
SEGMENT 4 – FRANCIS RD TO BLUNDELL RD

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E007	1

Rev.	DATE		DESN	QC	QA
1	23MAR10	LIGHTING CALCULATION-DRAFT REPORT	DS	KI	KI

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PROJECT

SITE PLAN
0 125 50

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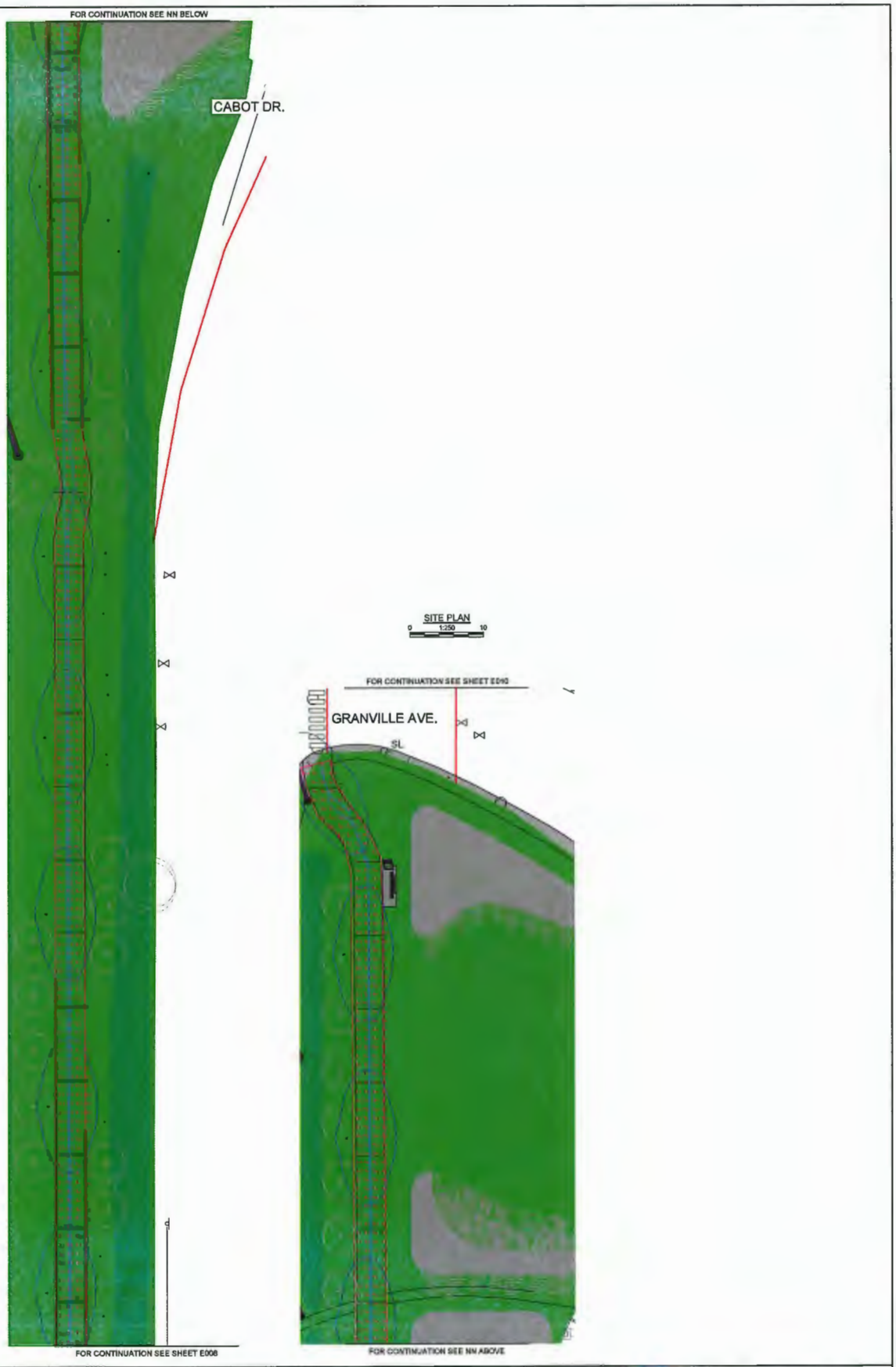
TITLE

CITY OF RICHMOND
MUP LIGHTING CALCULATION
SEGMENT 5 – BLUNDELL RD TO GRANVILLE AVE

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E008	1



Rev.	DATE		DESN	QC	QA
1	23MAR10	LIGHTING CALCULATION-DRAFT REPORT	DS	KI	KI

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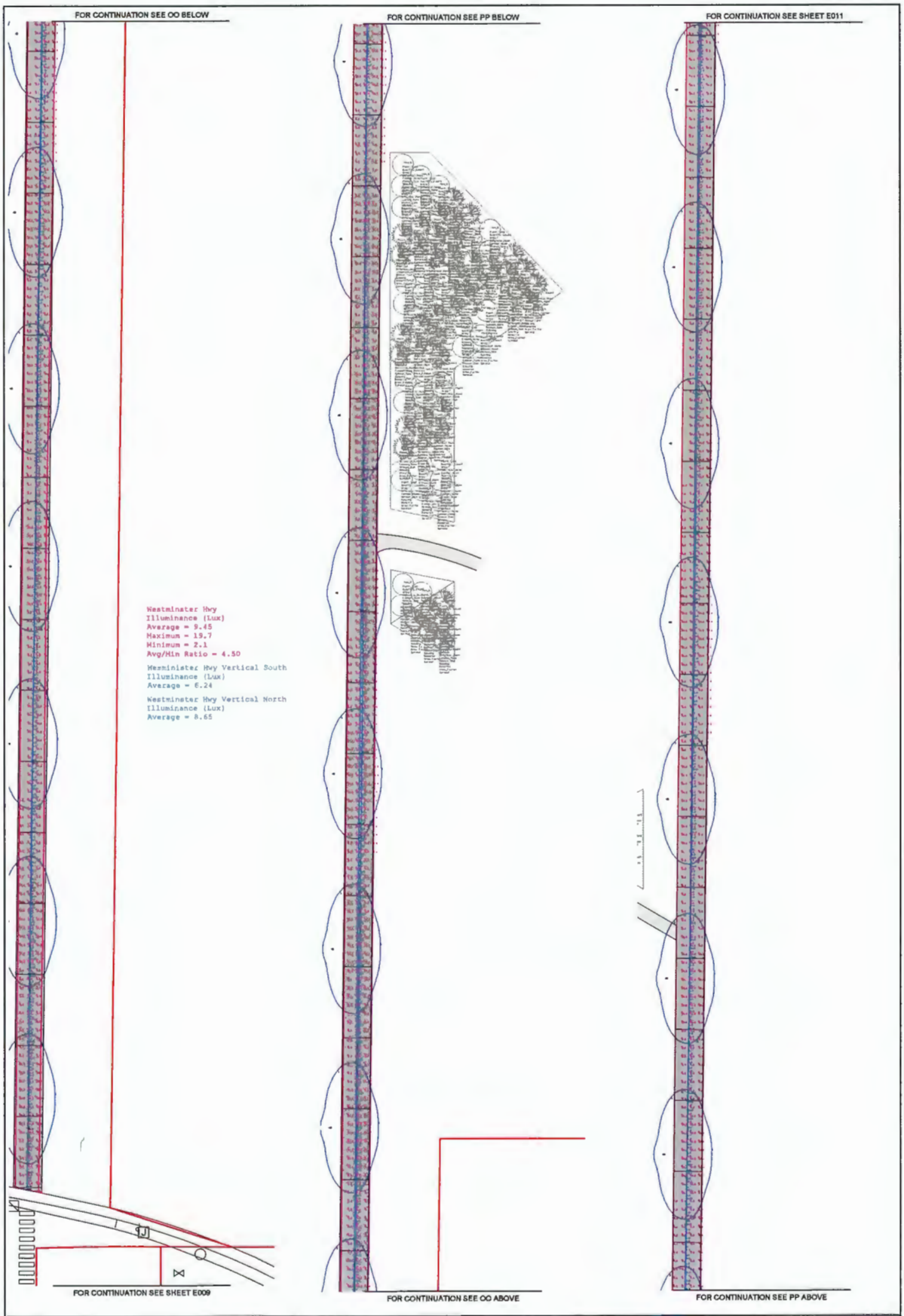
TITLE

CITY OF RICHMOND
MUP LIGHTING CALCULATION
SEGMENT 5 – BLUNDELL RD TO GRANVILLE AVE

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E009	1



Rev.	DATE		DESN	QC	QA
1	23MAR10	LIGHTING CALCULATION-DRAFT REPORT	DS	KI	KI

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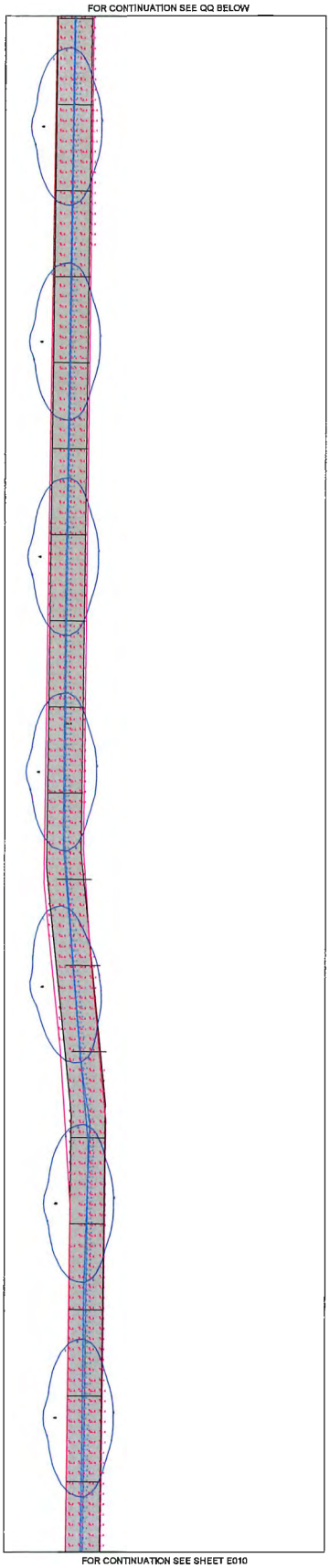
TITLE

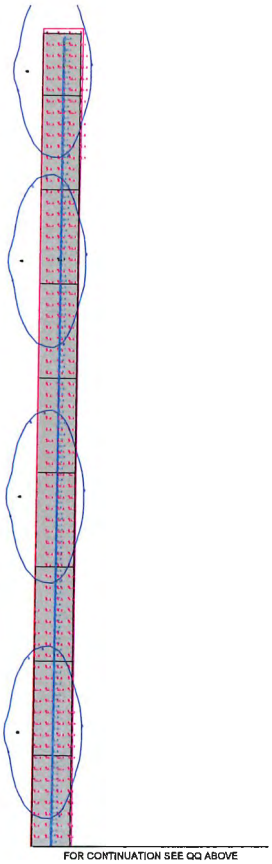
CITY OF RICHMOND
MUP LIGHTING CALCULATION
SEGMENT 6 – GRANVILLE AVE TO WESTMINSTER HWY

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E010	1

SCALE 1:250



SITE PLAN
0 1:250 10



Rev.	DATE		DESN	QC	QA
1	23MAR10	LIGHTING CALCULATION-DRAFT REPORT	DS	KI	KI

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TITLE

CITY OF RICHMOND
MUP LIGHTING CALCULATION
SEGMENT 6 – GRANVILLE AVE TO WESTMINSTER HWY

SCALE	PROJECT NUMBER	DRAWING NUMBER	REV.
NTS	230054	E011	1