PROPOSED MEADOW WALK DEVELOPMENT

Lynnfield, Massachusetts

LIGHTING PEER REVIEW

April 10, 2008

PRELIMINARY
DRAFT SUBMISSION

Bartlett Design

LIGHTING & ELECTRICAL ENGINEERING

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LIGHTING PEER REVIEW SCOPE

Project Application:
Proposed Meadow Walk Development
Applicant:
National Development
Newton Lower Falls, Massachusetts

The objective of this lighting peer review is to determine conformance of the proposed lighting systems contained in the subject application to the design and implementation criteria contained in the Lynnfield 40R Planned Village Development District Design Standards and Procedures (PVDD). Additionally, where elements of the proposed lighting system are found to be in non-compliance with the Town's PVDD Design Standards, such elements will be identified and the exact nature of the non-compliance will be described. The following proposed lighting systems elements will be reviewed:

- Guiding Principles for Lighting
- Lighting Fixtures
- Lamp Sources
- Lighting Poles
- Lighting Controls
- Lighting Equipment Placement
- Lighting Performance

EXECUTIVE SUMMARY OF LIGHTING REVIEW

In general, the proposed application meets the design standards for lighting as contained in Section 5.F of the 40R Planned Village Development District. There are a number of instances where the exact illuminance values contained in the 40R Design Standards are not met by the applicant. The calculation of illuminance is dependent on many variables that make exact calculation impossible. It is the reviewer's opinion that, although there are minor discrepancies in a few instances between the applicant's calculation results and the 40R Standards, these discrepancies are sufficiently insignificant so as to be ignored.

The items relating to site lighting which require further attention by the applicant are limited to the following issues:

- The applicant should be required to coordinate locations of lighting poles with the final landscaping plan to assure that light is not obscured by trees.
- The applicant should provide specific information on how exterior light timing will be achieved for reduced lighting levels in commercial parking areas after commercial facilities are closed.
- The applicant should provide illuminance calculations showing lighting levels for periods when reduced lighting is provided for commercial parking areas.
- Extended height house side shields should be provided for all Perimeter Loop lighting fixtures.

- A house side shield should be provided for the Type EI-6 lighting pole at the property line adjacent to Building 1000.

The only element of complete non-conformance with the 40R PVDD Design Standards is that the applicant has elected to provide lighting poles continuously along the Perimeter Loop road instead of only at loop road intersections as is specified in the 40R standards.

LIGHTING SUBMISSION INFORMATION

The following lighting information was reviewed as part of the Project Application. All application lighting information was prepared and submitted by *J & M Lighting Design, Inc*. of Kennebunkport, Maine.

- *Lighting Plans*

Dwg. No. LR-8.0	Overall Photometric Plan	dated 03-13-08
Dwg. No. LR-8.1	Area One Photometric Plan	dated 03-13-08
Dwg. No. LR-8.2	Area Two Photometric Plan	dated 03-13-08
Dwg. No. LR-8.3	Area Three Photometric Plan	dated 03-13-08
Dwg. No. LR-8.4	Area Four Photometric Plan	dated 03-13-08
Dwg. No. LR-8.5	Area Five Photometric Plan	dated 03-13-08

- *Written Reports*

Lighting Calculations and Luminaire Selections (vol. 1)	dated 03-13-08
Lighting Calculations and Luminaire Selections (vol. 2)	dated 03-13-08

LIGHTING REVIEW METHODOLOGY

The following tasks have been performed as part of the peer lighting review.

- *Review of Lighting Equipment Details*
  Submission materials describing proposed lighting fixtures lamps and lighting poles have all been reviewed for conformance to the 40R Design Standards. Photometric reports, as published in the application materials, have been reviewed for each lighting fixture type to confirm consistency with actual manufacturer's data and to confirm the stated optical distribution classification as full cut-off. In addition, the proposed lighting fixture controls have been reviewed to determine conformance with the 40R design Standards requirements for reduced lighting levels during evening hours when commercial facilities are closed.
- *Review of Lighting Equipment Locations*
  The proposed lighting fixture heights have been reviewed by area within the District to confirm conformance with Table X as listed in the 40R Design Standards. Lighting pole locations have been reviewed to evaluate the proposed spacing and coordination with street trees.
- *Review of Calculated Illuminance Results*
  The calculated illuminance levels have been reviewed for each area within the District to confirm conformance with the 40R Design Standards for illuminance. Illuminance levels have been calculated for representative areas across the site (using the same computer design software that the applicant used in preparing the application submission) to confirm the accuracy of the calculation figures that have been submitted.
- *Review of Potential Lighting Impact Off-Site*
  A review of landscape buffering, as proposed by the applicant to shield lighting from being

seen outside the District, has been conducted to assess its effectiveness in blocking lighting fixture brightness. An analysis of illuminance levels received at the wetland areas adjacent to Walnut Street was conducted to determine the degree of impact from the project's site lighting. Calculated illuminance levels along the property line have been reviewed to determine conformance to the 40R Design Standards for limitation of light beyond the project property.

GUIDING PRINCIPLES FOR LIGHTING

40R PVDD Design Standards – General Guidelines

The general guidelines for outdoor lighting are contained in paragraph 5.F.

> **5.F.**
> Guiding Principles. Outdoor lighting should be designed to ensure safety, functionality and convenience through illumination of the Transportation Network and open spaces while conserving energy and limiting the visibility of the lighting outside the District. Development permitted within the District should not unreasonably interfere with the use and enjoyment of property within the District and surrounding areas. Design features should be incorporated into exterior luminaires in order to minimize the effect of lighting on abutting areas and the night sky to the maximum extent possible. Lighting fixtures should be chosen based on scale, style and performance to enhance the traditional design goals within the District. Lighting should be scaled appropriately to their function such that lighting fixtures serving Sidewalks and Paths are pedestrian scale, while lighting fixtures serving vehicular Traveled Ways and parking areas may be taller. Low-level lighting of landscaped areas within the District is encouraged. Every consideration should be given to decreasing pole height to less than the required maximum while balancing the light level, uniformity of light, pole height, and quantity of poles.

Application Proposed Design – General Guidelines

There are essentially six principles of design that are contained in the 40R PVDD Design Standards.

1. Lighting shall ensure safety, function and convenience.
2. Lighting shall conserve energy.
3. Visibility of lighting from outside the District shall be limited.
4. Lighting shall not intrude on abutting properties nor on the night sky.
5. Lighting styles shall enhance the District's traditional design goals.
6. Lighting shall be appropriately scaled to be consistent with the lighting task, with minimal heights and quantities.

In general, the proposed lighting design has met all six of the guiding principles. Specifics relating to lighting equipment and lighting performance are described in this report under the various report sections that address each lighting element.

1. Lighting shall ensure safety, function and convenience.
   The standards of safety and function are addressed in the 40R PVDD in the criteria that list illuminance performance standards (paragraphs 5.F.7.a(i) and 5.F.7a(ii)). For most of the project areas, the applicant has been directed through the 40R Design Standards to provide minimum illuminance levels as well as acceptable illuminance uniformity in terms of maximum-to-minimum illuminance ratios. These deign metrics are directed at achieving a level of lighting quality that will promote pedestrian and vehicular safety. Where the 40R PVDD does not include specific design criteria for minimum illuminance or illuminance uniformity, the applicant has chosen to follow standards as published by the *Illuminating Engineering Society of North*

America (IESNA).
The applicant's lighting design generally meets the governing principles of safety, function and convenience.

2. Lighting shall conserve energy.
   The applicant has selected lighting fixtures that utilize metal halide lamps in various wattages. The efficacy of these lamps ranges between 61.1 and 81.5 initial lumens delivered per watt of electricity consumed. Paragraph 5.F.3a in the 40R PVDD Standards precludes the use of high pressure sodium lamps, which characteristically have higher efficacies. Accordingly, the proposed metal halide lamps are the most efficient lamp sources allowable. Furthermore, the applicant has selected pulse-start type metal halide lamps for many of the lighting fixtures. Pulse-start lamps have efficacies in the upper end of the range of efficacy ratings for metal halide lamps.
   The applicant's lighting design generally meets the governing principle of energy efficiency.
3. Visibility of lighting from outside the District shall be limited.
   The proposed design incorporates three measures that are directed at limiting the visibility of lighting from outside the District. All of the proposed lighting fixtures are classified as having full cut-off optical distribution, as defined by the *IESNA*. This means that no luminaire has a lighting distribution pattern that emits more than 10% of its light (candelas per lumen) at vertical angles between 80 degrees and 90 degrees; and no light will be emitted at angles of 90 degrees or higher. This designation significantly limits fixture brightness that might otherwise be viewed at great distances from the site. The second measure that has been employed in the lighting design to shield lighting from off-site views is that lighting pole heights have been kept below a maximum height of twenty-five feet. In all cases, lighting pole heights are in conformance with the maximum pole heights allowed by the 40R Design Standards, and in several instances, the proposed pole heights are lower than are allowed. The third element that is included as a shielding means is that of the use of landscape buffering. The berm along the side of the property that connects with Walnut Street, for example, has been proposed to include 10-foot high vegetation to serve as a visual screen for the property.
   The applicant's lighting design generally meets the governing principle of limiting the visibility of lighting from outside the district.
4. Lighting shall not intrude on abutting properties nor on the night sky.
   The potential for astronomic light pollution has been greatly mitigated by the applicant's use of lighting fixtures that have full cut-off optical distribution, and by limiting pole heights. The cut-off classification means that the proposed lighting fixtures will emit all of the light towards the ground plane and not skyward. The limitation of pole heights helps to minimize the affect of particulates in the air (water, dust, etc.) that tend to scatter light resulting in "sky glow". The 40R Design Standards include specific illuminance criteria regarding the allowable levels of spill light at property lines (paragraph 5.F.7.b). For the vast majority of locations, the applicant has met the spill light restrictions.
   The applicant's lighting design generally meets the governing principle of limiting sky brightness and spill light onto abutting properties.
5. Lighting styles shall enhance the District's traditional design goals.
   The 40R Design Standards call for a character that evokes a "traditional New England village" (paragraph 5.B). The choice of lighting fixtures that has been made by the applicant includes a variety of lighting fixture styles with decorative motifs. A decorative lighting fixture/pole style styles has been proposed to help differentiate the Gateway Entrances, Main Street and the Village Green from surrounding parking areas and the Perimeter Loop roadway. Additionally, a separate lighting fixture/pole style has been selected for residential roadways and residential parking areas to help identify these spaces from other commercial spaces.

The applicant's lighting design generally meets the governing principle of addressing lighting styles to enhance the District's daytime image.

6. Lighting shall be appropriately scaled to be consistent with the lighting task, with minimal heights and quantities.

   The 40R Design Standard specifically identifies permitted lighting pole heights per area within the District (Table X). The applicant has met these height restrictions and in several areas, has elected to propose shorter than allowed pole heights. The tallest pole heights are reserved for commercial surface parking areas and for the Perimeter Loop road. Shorter lighting poles are proposed for the Gateway Entrances, Main Street at the Village Green, residential roadways and residential parking areas. Pedestrian height lighting poles are proposed for residential walkways and pass-through walkways.

   The applicant's lighting design generally meets the governing principle of providing appropriately scaled lighting fixtures and poles.

LIGHTING FIXTURES

40R PVDD Design Standards – Lighting Fixtures

Standards for lighting fixtures are contained in the following paragraphs:

5.F.1

All outdoor lighting in the District shall comply with the following shielding provision: Direct light emitted by exterior luminaire shall not emit directly by a lamp, off a reflector, or through a refractor above a horizontal plane (90 degrees) through the fixture's lowest light-emitting part.

5.F.2.e

Street poles and lighting fixtures shall be dark in color to reduce light reflectivity.

5.F.3.d

The operation of searchlights is prohibited.

5.F.3.e

Cobra head light fixtures are prohibited.

Application Proposed Design – Lighting Fixtures

In response to the 40R Design Standards requirement for lighting fixture shielding, the applicant has proposed that all lighting fixtures be provided with full cut-off optics.
The applicant's proposed lighting fixtures meet the requirements of paragraph 5.F.1 without exception.

The applicant has proposed that all lighting fixtures be either black or dark bronze in color.
The applicant's proposed lighting fixtures meet the requirements of paragraph 5.F.2.e without exception.

The applicant has not proposed any searchlight luminaires.
The applicant's proposed lighting fixtures meet the requirements of paragraph 5.F.3.d without exception.

The applicant has not proposed any cobra head style roadway luminaires.
The applicant's proposed lighting fixtures meet the requirements of paragraph 5.F.3.e without exception.

LAMP SOURCES

40R PVDD Design Standards – Lamp Sources

Standards for lighting fixture lamp sources are contained in the following paragraphs:

5.F.2.g
All light fixtures shall emit a steady and constant light and shall not emit a flashing or irregular light, unless specifically required by Federal, State, or municipal authorities.
5.F.3.a
Mercury vapor, low pressure sodium, high pressure sodium, and high wattage quartz lamps over 100 watts are prohibited.
5.F.3.b
Laser source light. The use of laser source light or any similar high-intensity light for outdoor advertising, when projected above the horizontal, is prohibited.
5.F.3c
Neon or other edge-glowing sources, including cold cathode are prohibited

Application Proposed Design – Lamp Sources
The applicant has not proposed any flashing lamp sources.
The applicant's proposed lamp sources meet the requirements of paragraph 5.F.2.g without exception.

The applicant has proposed only metal halide lamps for lighting fixtures.
The applicant's proposed lamp sources meet the requirements of paragraph 5.F.3.a without exception.

The applicant has not proposed any laser light sources.
The applicant's proposed lamp sources meet the requirements of paragraph 5.F.3.b without exception.

The applicant has not proposed any neon or cold cathode lamp sources.
The applicant's proposed lamp sources meet the requirements of paragraph 5.F.3.c without exception.

LIGHTING POLES

40R PVDD Design Standards – Lighting Poles
Standards for lighting fixtures are contained in the following paragraphs:

5.F.2.a
Maximum height requirements for each area within the District as defined in Table X.
5.F.2.b
The height of a light fixture shall be measured from the ground to the light emitting flat glass of the luminaire; pole height may be higher than this light-emitting height.
5.F.2.e
Street poles and lighting fixtures shall be dark in color to reduce light reflectivity.
5.F.2.f
Light fixtures may include an option for brackets (either single- or double-sided) to attach banners and other temporary graphic elements.

Application Proposed Design – Lighting Poles
Table X in the 40R Design Standards lists the maximum allowable heights for lighting fixtures. A summary of the height criteria in comparison to the applicant's proposed pole heights is listed below:

Area	*Max. Allowed Lighting Fixture Height*	*Proposed Lighting Fixture Height*
Traditional Main Street	18 Feet	16 Feet
Perimeter Loop	25 Feet	25 Feet

Area	*Max. Allowed Lighting Fixture Height*	*Proposed Lighting Fixture Height*
Residential Traveled Way	18 Feet	18 Feet
Pass-Through Walkway	18 Feet	12 Feet
Paths	18 Feet	12 Feet
Gateway	25 Feet	18 Feet
Village Green	18 Feet	16 Feet
Surface Parking	25 Feet	25 Feet

The applicant's proposed lighting fixture heights meet the requirements of paragraph 5.F.2.a with only a single exception. The proposed lighting design includes lighting poles along the entire length of the Perimeter Loop road, rather than lighting poles at intersections, and reflectors between intersections.
REVIEWER'S COMMENT: The purpose of roadway lighting is to promote nighttime visibility for motorists and pedestrians. Where the potential exists for conflict between pedestrians and vehicles, roadway lighting is required. For sections of roadways that are remote from pedestrians, and where such roadways can be adequately illuminated by vehicle headlights, it may not be necessary to provide roadway lighting. In these cases, it may be possible to use reflectors (such as are identified in the 40R Design Standards) to simply mark roadway edges. There is some question, however, as to whether the Perimeter Loop road can be considered as being remote from pedestrians, and/or, whether the Perimeter Loop road can be adequately lighted by vehicle headlights. A secondary purpose of roadway lighting is to provide a visual identity and directive focus for motorists who are unfamiliar with a roadway layout. Lighting poles can provide both a daytime as well as nighttime visual means of organization that helps to identify primary travel routes.

The proposed lighting fixture poles have been selected to provide lighting fixture heights that are listed in the Table above, as measured from the ground to the flush, flat diffuser lens of each light fixture. In some cases, the poles themselves extend above the lighting fixture height. The applicant's proposed lighting fixture heights meet the requirements of paragraph 5.F.2.b without exception.

The applicant has proposed that all lighting poles be either black or dark bronze in color.
The applicant's proposed lighting fixtures meet the requirements of paragraph 5.F.2.e without exception.

The applicant has not proposed any lighting pole bracket arms for banners or other graphic elements.
The applicant's proposed lighting poles meet the requirements of paragraph 5.F.2.f without exception.

LIGHTING CONTROLS

40R PVDD Design Standards – Lighting Controls
Standards for lighting controls are contained in paragraph 5.F.4:

> **5.F.4**
> Exterior lighting shall be controlled by a photo sensor or time switch that automatically reduces light levels, decreasing light levels during nighttime hours (when commercial facilities are closed) while still maintaining necessary security lighting.

Application Proposed Design – Lighting Controls
The application states the following:

> "The double headed luminaires in the parking areas shall have two circuits for control; one to

each luminaire. Exact method of control shall be developed during the construction documentation phase."

The applicant has not explained specifically how the control will be implemented. The applicant should provide specific information regarding the proposed means and method of lighting control as part of the application process to demonstrate conformance to 40R Design Standards paragraph 5.F.4.

LIGHTING EQUIPMENT PLACEMENT

40R PVDD Design Standards – Lighting Equipment Placement

Standards for lighting equipment placement are contained in the following paragraphs:

5.F.2.c

If the sidewalk includes street trees, locate streetlights between the trees so that the tree canopy does not interfere with illumination coverage.

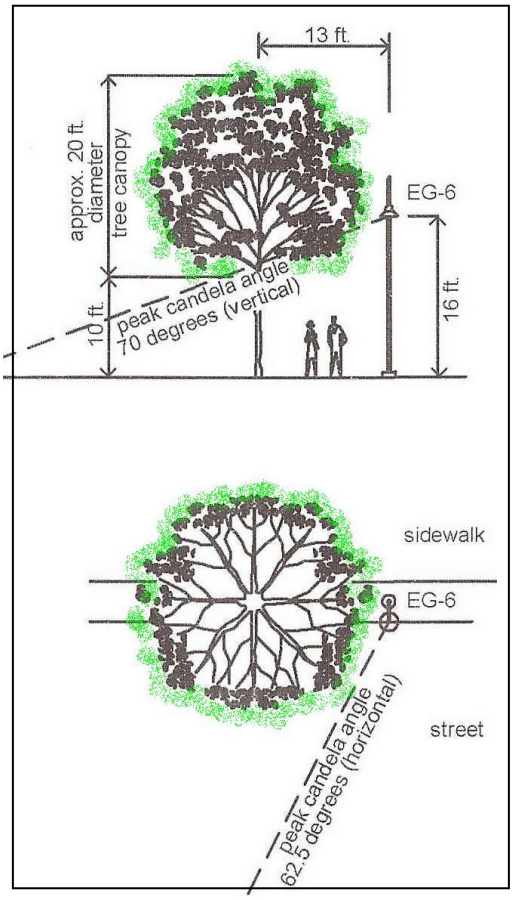
5.F.5

Perimeter Loop Lighting. Reflectors shall be used in lieu of light poles along the outside edge of the Perimeter Loop, provided, however, that additional lighting for safety and wayfinding purposes may be required at intersections with key parking corridors, Gateways, and Residential Traveled Ways.

Application Proposed Design – Lighting Equipment Placement

Lighting poles that are located along Main Street are generally positioned as to avoid sidewalk tree wells. Table X in the 40R Design Standards calls for trees to be located along Main Street, at the Village Green, and along Residential Streets at 50-feet on center. Lighting poles have been designed to be located at a varied spacing to provide the lighting illuminance criteria that is stipulated in the Design Standards. Accordingly, there are a number of locations on the lighting plans where lighting poles are indicated to be located immediately beside a street tree.

The lighting fixture/pole types that are indicated to be installed along Main Street are listed in the application as Type EG-6. These lighting fixtures are mounted at a height of 16-feet. The photometric distribution for these light fixtures is such that the peak intensity of light in candelas is emitted at a vertical angle of 70 degrees (based on 0 degrees being straight down) and at a horizontal angle of 62.5 degrees (based on 0-180 degrees being parallel to the street curb). To assure that the maximum intensity angle is not obscured by street tree foliage, the type EG-6 lighting poles should be installed no closer than 13-feet from the center of any street tree. The applicant should be required to coordinate all lighting pole locations with the final landscaping plan to assure that the light is not obscured by trees to demonstrate conformance to 40R Design Standards paragraph 5.F.2.c



The applicant has proposed the installation of lighting poles around the entire length of the Perimeter Loop road. The applicant has offered the following justification for lighting the Loop road:

> "Project Team felt that illumination of the Perimeter Loop should be accomplished by more than the reflectors for way-finding and safety. Luminaires proposed on the exterior of the Perimeter Loop shall have additional house side shields to better restrict the light to the Perimeter Loop road."

The proposal for lighting fixtures between intersections along the Perimeter Loop road does not meet the requirement of 40R Design Standard paragraph 5.F.5.

REVIEWER'S COMMENT: The Board should consider the applicant's request for additional lighting along the Perimeter Loop road by weighing the merits of better visual organization for way-finding as well as increased lighting for safety, versus the potential negative impact of lighting at adjacent wetlands and off-site. This issue is further discussed under the report section where Illuminance Performance is addressed.

There are a number of instances where the applicant has located type EN lighting fixtures on the back sides of buildings that front Main Street. When these buildings are executed, it should be a condition of their approval that the specified Type EN lights be installed where shown in this application, or if an alternate lighting solution is proposed based on the construction details of these buildings, the illuminance from any alternate lighting fixtures should be calculated and shown to be in conformance with the 40R Design Standards.

LIGHTING PERFORMANCE

40R PVDD Design Standards – Lighting Performance

Standards for illuminance performance are contained in the following paragraphs:

5.F.7.a

Light levels shall meet or exceed the minimum design guidelines defined by the Illuminating Engineering Society of North America (IESNA). Light levels shall be designed to meet a ratio of maximum to minimum footcandle (FC) levels, with required minimum levels at the boundaries of the District. Specifically, light levels shall be designed to the following standards:

5.F.7.a(i)

Lighting when commercial facilities are closed:
Minimum of 0.2 FC
Maximum to minimum ratio of FC in the District of 20:1

5.F.7.a(ii)

Lighting when commercial facilities are open:
Minimum of 0.6 FC
Maximum to minimum ratio of 15:1 FC in the District

5.F.7.b

At the District boundary, the light level shall not exceed 0.20 footcandles at any time to ensure that no light is emitted outside the District. The two Gateways and the southern boundary of the District which borders Interstate-95/Route 128 are exempt from this minimum requirement but are still included when calculating compliance with District-wide Light Level design requirements.

Application Proposed Design – Lighting Performance

Parking Areas

The applicant has provided illuminance grid statistics on the lighting plans as well as in the written report for each parking area. The statistics are for all lighting on at full intensity.

CALCULATED ILLUMINANCE RESULTS AS SUBMITTED BY THE APPLICANT

Area	*Illuminance in Footcandles* *Average*	*Maximum*	*Minimum*	*Uniformity (max : min)*
Whole Foods Parking	4.18	10.88	0.52[1]	20.92 : 1[2]
South Parking[5]	2.48	8.86	0.45[1]	19.69 : 1[2]
Southwest Parking[5]	4.24	9.12	0.40[1]	27.80 : 1[4]
West Parking	4.37	9.59	0.44[1]	21.80 : 1[2]
Northwest Parking	4.44	9.16	0.69	13.28 : 1
Northeast Parking[5]	4.89	9.40	0.60	15.67 : 1[2]
East Parking South	3.95	10.16	0.52[1]	19.54 : 1[2]
East Parking North	4.73	9.37	0.53[1]	17.68 : 1[2]
Residential West Parking	1.31	4.12	0.23	17.91 : 1
Residential East Parking	1.42	3.85	0.29	13.28 : 1
BSC North Parking	1.72	5.78	0.18[3]	32.11 : 1[4]
BSC Northwest Parking	2.72	5.36	0.49	10.94 : 1
BSC Southwest Parking	1.91	4.26	0.23	18.52 : 1
BSC East Parking	1.87	3.62	0.17[3]	21.29 : 1[4]

1 *Calculated minimum illuminance does not meet the 40R Design Standard of 0.6 footcandles for commercial parking areas when commercial facilities are open (par. 5.F.7.a(ii).*

2 *Calculated maximum-to-minimum illuminance uniformity exceeds the 40R Design Standard of 15 : 1 for commercial parking areas when commercial facilities are open (par. 5.F.7.a(II).*

3 *Calculated minimum illuminance does not meet the 40R Design Standard for conformance to IESNA lighting standards. IESNA recommended minimum for parking areas is 0.2 footcandles (par. 5.F.7.a).*

4 *Calculated maximum-to-minimum illuminance uniformity does not meet the 40R Design Standard for conformance to IESNA lighting standards. IESNA recommended maximum-to-minimum uniformity for parking areas is 20 : 1 or less (par. 5.F.7.a).*

5 *The illuminance figures that are published in the applicants written report differ slightly from the figures that are listed on the lighting plans. The figures contained here are taken from the lighting plans, which are correct.*

- Whole Foods Parking Area
  There is only a single point within this parking area whose illuminance level is less than the 40R Design Standard of 0.6 footcandles. This point is located at the extreme out edge of the parking lot. Furthermore, there is only a single point whose illuminance exceeds 9.0 footcandles. When this single point is discounted, the illuminance uniformity for the parking lot conforms to the 40R design Standard of 15 : 1.
  In the reviewer's opinion, this parking area conforms to 40R Design Standard paragraph 5.F.7.a(ii).
- South Parking Area
  There are only three points within this parking area whose illuminance level is less than the 40R Design Standard of 0.6 footcandles. These points occur at the north entrance to the parking lot. It is entirely possible that building mounted lighting that may be provided as part of the construction of Building 100 could make up for the relatively small area that does not

meet the Design Standard minimum illuminance. When these three points are discounted, the illuminance uniformity for the parking lot conforms to the 40R design Standard of 15 : 1.
In the reviewer's opinion, this parking area conforms to 40R Design Standard paragraph 5.F.7.a(ii).

- Southwest Parking Area
  There is only a single point within this parking area whose illuminance level is less than the 40R Design Standard of 0.6 footcandles. This point is located immediately adjacent to the south end of Building 300. Furthermore, there is only a single point whose illuminance exceeds 9.0 footcandles. When this single point is discounted, the illuminance uniformity for the parking lot conforms to the 40R design Standard of 15 : 1.
  In the reviewer's opinion, this parking area conforms to 40R Design Standard paragraph 5.F.7.a(ii).
- West Parking Area
  There are only two points within this parking area whose illuminance level is less than the 40R Design Standard of 0.6 footcandles. These points are located at the lot entrance that is adjacent to Building 700. Furthermore, there is only a single point whose illuminance exceeds 9.0 footcandles. When this single point is discounted, the illuminance uniformity for the parking lot conforms to the 40R design Standard of 15 : 1.
  In the reviewer's opinion, this parking area conforms to 40R Design Standard paragraph 5.F.7.a(ii).
- Northwest Parking Area
  This parking area conforms to 40R Design Standard paragraph 5.F.7.a(ii).
- Northeast Parking Area
  There is only a single point within this parking area whose illuminance level exceeds 9.0 footcandles. When this single point is discounted, the illuminance uniformity for the parking lot conforms to the 40R design Standard of 15 : 1.
  In the reviewer's opinion, this parking area conforms to 40R Design Standard paragraph 5.F.7.a(ii).
- East Parking South Area
  There are only two points within this parking area whose illuminance level is less than the 40R Design Standard of 0.6 footcandles. These points are located just inside the entrance to the lot off the Loop road. Furthermore, there is only a single point whose illuminance exceeds 9.0 footcandles. When this single point is discounted, the illuminance uniformity for the parking lot conforms to the 40R design Standard of 15 : 1.
  In the reviewer's opinion, this parking area conforms to 40R Design Standard paragraph 5.F.7.a(ii).
- East Parking North Area
  There is only a single point within this parking area whose illuminance level is less than the 40R Design Standard of 0.6 footcandles. This point is located just inside the south entrance to the lot off the Loop road. Furthermore, there is only a single point whose illuminance exceeds 9.0 footcandles. When this single point is discounted, the illuminance uniformity for the parking lot conforms to the 40R design Standard of 15 : 1.
  In the reviewer's opinion, this parking area conforms to 40R Design Standard paragraph 5.F.7.a(ii).
- Residential West Parking Area
  This parking area conforms to 40R Design Standard paragraph 5.F.7.a.
- Residential East Parking Area
  This parking area conforms to 40R Design Standard paragraph 5.F.7.a.
- BSC North Parking Area

The applicant has designed this parking area according to IESNA illuminance standards, rather than according to the 40R Design Standards for commercial parking.
REVIEWER'S COMMENT: The Board should consider the appropriateness of the applicant's decision not to classify this lot as a commercial parking area.
There are only four points within this parking area whose illuminance level is less than 0.2 footcandles. Furthermore, there are only four points within the lot whose illuminance level is significantly above 4.0 footcandles. When these relatively few points are discounted, the illuminance uniformity for the parking lot conforms to the IESNA standard of 20 : 1.
In the reviewer's opinion, this parking area conforms to 40R Design Standard paragraph 5.F.7.a. If, however, the Board feels that this parking lot should be designed to 40R design Standards for commercial parking, the applicant should provide a revised lighting design that conforms to paragraph 5.F.7.a(ii).

- BSC Northwest Parking Area
  The applicant has designed this parking area according to *IESNA* illuminance standards, rather than according to the 40R Design Standards for commercial parking.
  REVIEWER'S COMMENT: The Board should consider the appropriateness of the applicant's decision not to classify this lot as a commercial parking area.
  This parking area conforms to 40R Design Standard paragraph 5.F.7.a. If, however, the Board feels that this parking lot should be designed to 40R design Standards for commercial parking, the applicant should provide a revised lighting design that conforms to paragraph 5.F.7.a(ii).
- BSC Southwest Parking Area
  The applicant has designed this parking area according to *IESNA* illuminance standards, rather than according to the 40R Design Standards for commercial parking.
  REVIEWER'S COMMENT: The Board should consider the appropriateness of the applicant's decision not to classify this lot as a commercial parking area.
  This parking area conforms to 40R Design Standard paragraph 5.F.7.a. If, however, the Board feels that this parking lot should be designed to 40R design Standards for commercial parking, the applicant should provide a revised lighting design that conforms to paragraph 5.F.7.a(ii).
- BSC East Parking Area
  The applicant has designed this parking area according to IESNA illuminance standards, rather than according to the 40R Design Standards for commercial parking.
  REVIEWER'S COMMENT: The Board should consider the appropriateness of the applicant's decision not to classify this lot as a commercial parking area.
  There are only two points within this parking area whose illuminance level is less than 0.2 footcandles. When these relatively few points are discounted, the illuminance uniformity for the parking lot conforms to the IESNA standard of 20 : 1.
  In the reviewer's opinion, this parking area conforms to 40R Design Standard paragraph 5.F.7.a. If, however, the Board feels that this parking lot should be designed to 40R design Standards for commercial parking, the applicant should provide a revised lighting design that conforms to paragraph 5.F.7.a(ii).

In the written report that was submitted with the project application, the applicant has described the approach to providing reduced illuminance at commercial parking areas. Paragraph 5.F.7.a(i) in the 40R Design Standards requires that illuminance levels in commercial parking areas be reduced to 0.2 footcandles, minimum, with a maximum-to-minimum uniformity ratio not to exceed 20 : 1, during periods when commercial facilities are closed. The applicant has not provided illuminance calculations to confirm that the proposed design will meet the specified illuminance criteria. The applicant should

submit additional lighting calculations showing predicted illuminance levels at commercial parking areas when reduced lighting is in effect.
REVIEWER'S COMMENT: Since the requirements for lighting after-hours are not the same as when the District is serving the general public, the strict adherence to the specified illuminance criteria does not necessarily need to be held as rigorously for after-hours lighting. Consideration might be given by the Board to having only representative areas calculated for reduced lighting levels.

Street Lighting
The applicant has provided illuminance statistics in the written report for Main Street.

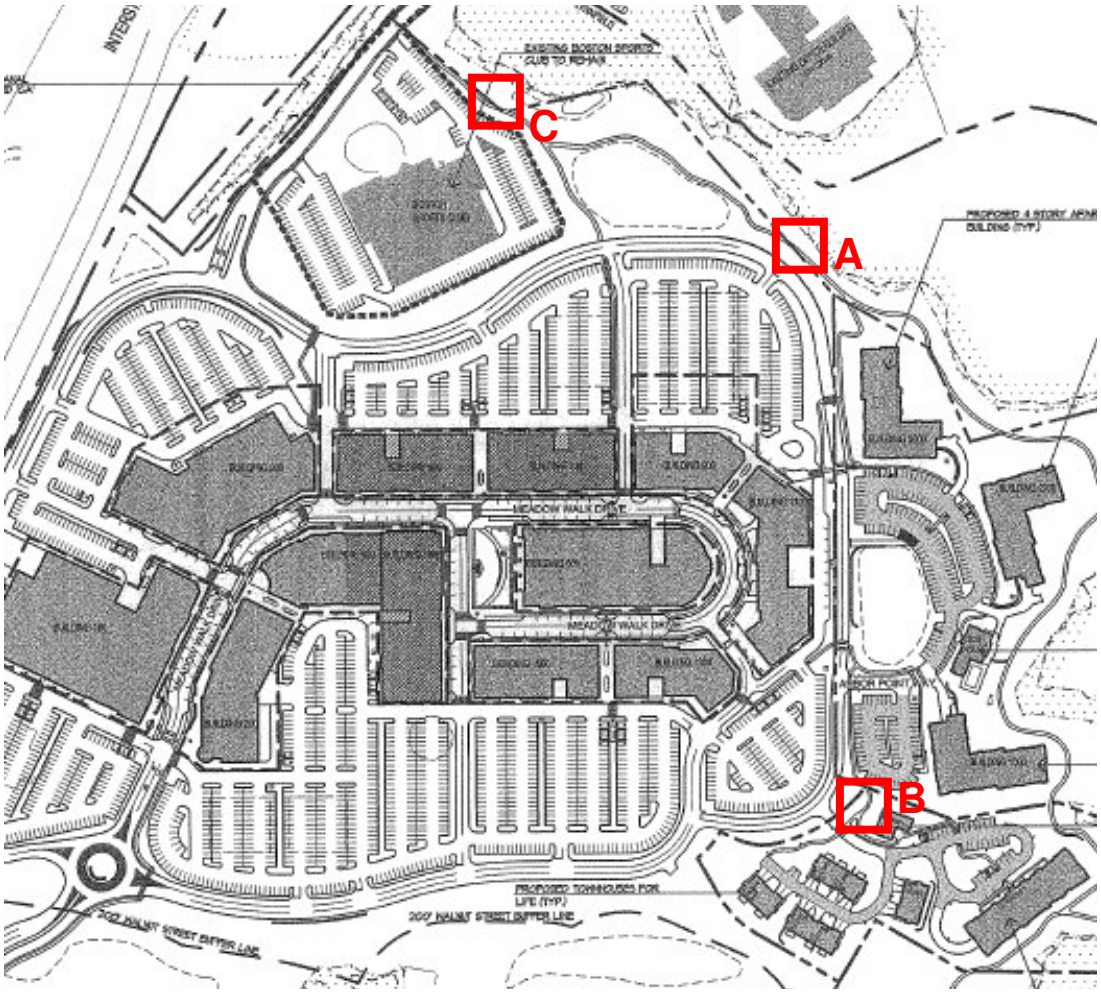
CALCULATED ILLUMINANCE RESULTS AS SUBMITTED BY THE APPLICANT

	Illuminance in Footcandles			
Area	*Average*	*Maximum*	*Minimum*	*Uniformity (max : min)*
Main Street[1]	2.51	5.46	0.69	7.91 : 1

1 *The illuminance figures that are published in the applicant's written report differ slightly from the figures that are listed on the lighting plans. The figures contained here are taken from the lighting plans, which are correct.*

The *IESNA* publishes illuminance recommendations for a range of roadway types. Recommendations for roadways are included in the *IESNA* publication RP-8-00 Roadway Lighting. The recommendations are based on classification of road use, the potential for pedestrian/vehicle conflict, and pavement type. For the PVDD, there are three roadway use classifications that apply. Main Street would be classified as a Collector Roadway with a high incidence of pedestrian/vehicle conflict. The *IESNA* recommendations for this classification of roadway are at least 1.2 footcandles, average, with an average-to-minimum illuminance uniformity of 4 : 1 or lower. The Perimeter Loop road would be classified as a Collector Roadway with a low incidence of pedestrian/vehicle conflict. . The *IESNA* recommendations for this classification of roadway are at least 0.6 footcandles, average, with an average-to-minimum illuminance uniformity of 4 : 1 or lower. The Residential roads would be classified as Local Roadways with a medium incidence of pedestrian/vehicle conflict. . The *IESNA* recommendations for this classification of roadway are at least 0.7 footcandles, average, with an average-to-minimum illuminance uniformity of 6 : 1 or lower.
It should be noted that the section of roadway that leads into the garage at Building 3000 is relatively under lighted. The relative proximity of the property line makes this roadway difficult to light with pole lights without exceeding 0.2 footcandles at the property line. Main Street, the Perimeter Loop road and the Residential roadways all conform to 40R Design Standard paragraph 5.F.7.a.
REVIEWER'S COMMENT: It is likely that supplemental light could be provided for this section of road by means of wall mounted fixture(s)at the end of Building 3000.

District Boundary Lighting
The applicant has included calculated illuminance levels along the District property line on the lighting plans. Illustrated below are areas where the calculated illuminance exceeds the 0.2 maximum footcandle level allowed under 40R Design Stander 5.F.7.b.



Area A: Calculated Illuminance Greater than 0.2 Footcandles

- Eight points at 0.3 footcandles
- Three points at 0.4 footcandles

Area B: Calculated Illuminance Greater than 0.2 Footcandles

- Four points at 0.3 footcandles
- Three points at 0.4 footcandles
- Three points at 0.5 footcandles
- Two points at 0.8 footcandles
- One point at 1.0 footcandle
- One point at 1.1 footcandle
- One point at 1.4 footcandle

Area C: Calculated Illuminance Greater than 0.2 Footcandles

- One point at 0.3 footcandles
- One point at 0.4 footcandles
- Two points at 0.5 footcandles
- One point at 0.6 footcandles

REVIEWER'S COMMENT: The grade slopes away from the property line at locations A and C. The illuminance calculations have been prepared at the elevation at the property line. Therefore, the actual

illuminance readings at grade would be less than that indicated. Additionally, the property line includes landscape vegetation that will serve as a shield. This landscaping is not included in the illuminance calculation.

The illuminance across the property line at location B which exceeds 0.2 footcandles is the result of the type EI-6 lighting pole being positioned right at the property line. To mitigate the high illuminance levels at this location, the applicant should be directed to provide a house side shield for this lighting fixture. With this condition, it is the reviewer's opinion that the lighting meets the requirements of 40R design Standard paragraph 5.F.7.b.

GENERAL OBSERVATIONS AND RECOMMENDATIONS

The overall project selection of lighting fixtures does a good job of directing light to the ground surfaces without introducing excessive fixture brightness. Furthermore, the proposed landscape vegetation that is proposed for the perimeter earth berms will greatly help in limiting brightness as seen beyond the District property lines. Nevertheless, given the sensitivity of wetland areas that are immediately adjacent to the Perimeter Loop road, it is recommended that consideration be given by the Board to requiring the applicant to provide extended house side shields for the lighting fixtures along the Perimeter Loop. These lighting fixtures are specified by the applicant to include house side shields to be installed on the back side of the lighting fixtures. The proposed lighting fixture manufacturer offers two type of house side shields for the specified lighting fixtures at the Perimeter Loop road. One manufacturer's option is for a shield that is 2.4" tall. A second option is 10.9" tall. Consideration should be given to requiring the 10.9" (min) high house side shields for the Perimeter Loop lighting fixtures.

Lighting associated with exterior signage has been excluded from the submitted lighting calculations. In addition, building mounted lighting (other than type EN lights) has not been considered in the illuminance calculations. When a design is developed for these elements, consideration should be given to having the lighting calculations updated to confirm compliance with the 40R design Standards.

The applicant has used specific manufacturer's data in the preparation of the illuminance calculations for the project. If the Developer elects to select lighting equipment other than what has been proposed, the applicant should be required to submit updated illuminance calculations to confirm compliance with the 40R Design Standards.

EXTERIOR LIGHTING ELEMENTS OF COMPLIANCE/NON-COMPLIANCE WITH 40R PVDD DESIGN STANDARDS			
40R Par. No.		**Application in Compliance**	**Reviewer's Comments**
5.F.1	All outdoor lighting in the District shall comply with the following shielding provision: Direct light emitted by exterior luminaire shall not emit directly by a lamp, off a reflector, or though a refractor above a horizontal plane (90 degrees) through the fixture's lowest light-emitting part.	YES	
5.F.2.a	Maximum height requirements for each area within the District as defined in Table X.	YES	
5.F.2.b	The height of a light fixture shall be measured from the ground to the light emitting flat glass of the luminaire; pole height may be higher than this light-emitting height.	YES	
5.F.2.c	Spacing of street lights should provide for uniformity of light, with the distance depending on the minimum illumination levels required.	YES	
5.F.2.d	If the sidewalk includes street trees, locate street lights between the trees so that the tree canopy does not interfere with illumination coverage.	CONDITIONAL	The applicant should be required to coordinate locations of lighting poles with the final landscaping plan to assure that light is not obscured by trees.
5.F.2.e	Street poles and lighting fixtures shall be dark in color to reduce light reflectivity.	YES	
5.F.2.f	Light fixtures may include an option for brackets (either single-or double-sided) to attach banners and other temporary graphic elements.	YES	
5.F.2.g	All light fixtures shall emit a steady and constant light and shall not emit a flashing or irregular light, unless specifically required by Federal, State, or municipal authorities.	YES	
5.F.3.a	Mercury vapor, low pressure sodium, high pressure sodium, and high wattage quartz lamps over 100 watts are prohibited.	YES	
5.F.3.b	Laser source light. The use of laser source light or any similar high-intensity light for outdoor advertising, when projected above the horizontal is prohibited.	YES	
5.F.3.c	Neon or other edge-glowing sources, including cold cathode are prohibited.	YES	
5.F.3.d	Searchlights. The operation of searchlights is prohibited.	YES	
5.F.3.e	Cobra head light fixtures are prohibited.	YES	
5.F.4	Exterior Light Timing. Exterior lighting shall be controlled by a photo sensor or time switch that automatically reduces light levels, decreasing light levels during nighttime hours (when commercial facilities are closed) while still maintaining necessary security lighting.	CONDITIONAL	The applicant should provide specific information on how exterior light timing will be achieved.

EXTERIOR LIGHTING ELEMENTS OF COMPLIANCE/NON-COMPLIANCE WITH 40R PVDD DESIGN STANDARDS			
5.F.5	Perimeter Loop Lighting. Reflectors shall be used in lieu of light poles along the outside edge of the Perimeter Loop, provided, however, that additional lighting for safety and way finding purposes may be required at intersections with key parking corridors, Gateways, and Residential Traveled Ways.	NO	The applicant has elected to provide lighting poles continuously around the Perimeter Loop road. In lieu of reflectors as dictated by this paragraph.
5.F.6	Holiday Lighting. Holiday lighting may be used on a seasonal or festive basis. Such lighting shall not contribute to footcandles along the boundary of the District, with the exception of the two Gateways and the southern portion of the District which borders Interstate-95/Route 28. At all locations, the potential for seasonal lighting shall be included when calculating compliance with District-wide Light Level design requirements.	YES	
5.F.7.a	Light levels shall meet or exceed the minimum design guidelines defined by the Illuminating Engineering Society of North America (IESNA). Light levels shall be designed to meet a ratio of maximum to minimum footcandle (FC) levels, with required minimum levels at the boundaries of the District. Specifically, light levels shall be designed to the following standards:	YES	
5.F.7.a (i)	Lighting when commercial facilities are closed: Minimum of 0.2 FC Maximum to minimum ratio of FC in the District of 20:1	CONDITIONAL	The applicant should provide illuminance calculation information showing illuminance levels for periods when reduced lighting is provided for commercial parking areas.
5.F.7.a (ii)	Lighting when commercial facilities are open: Minimum of 0.6 FC Maximum to minimum ratio of 15:1 FC in the District.	YES	The board should consider if the commercial parking standards for lighting apply to the BSC parking areas.
5.F.7.b	At the District boundary, the light level shall not exceed 0.20 footcandles at any time to ensure that no light is emitted outside the District. The two Gateways and the southern boundary of the District which borders Interstate-95/Route 128 are exempt from this minimum requirement but are still included when calculating compliance with District-wide Light Level design requirements.	CONDITIONAL	Extended height house side shields should be provided for all Perimeter Loop lighting fixtures. A house side shield should be provided for the Type EI-6 lighting pole at the property line adjacent to Building 1000.