Appendix J
Ecological Impacts of Lighting Tech Memo
(Golder - December 2017)

DATE December 21, 2017 **PROJECT No.** 1541774

TO Wes Paetkau, MCIP, RPP, Senior Planner
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CC Berend Jan Velderman

FROM Gwendolyn Weeks **EMAIL** gweeks@golder.com

RECOMMENDATIONS FOR REDUCING ECOLOGICAL IMPACTS OF LIGHTING ON THE PROPOSED KINGSTON THIRD CROSSING BRIDGE, KINGSTON, ONTARIO.

This technical memorandum has been prepared by Golder Associates Ltd. (Golder) in response to agency comments on the Draft Detailed Impact Assessment (DIA) Report (J.L. Richards and Associates, 2017). Comments were received from Parks Canada and Fisheries and Oceans Canada relating to the potential impact of artificial lighting of the proposed bridge on wildlife in the study area. These agencies requested that recommendations made in the DIA to "Use minimal lighting to reduce the impact on nocturnal wildlife, while still meeting safety requirements and aesthetic goals" be elaborated on to include more specific recommendations.

Potential Impacts to Wildlife from Artificial Lighting

Impacts of night-time artificial lighting on wildlife has been widely studied. These studies have identified negative effects on migration, feeding behaviours and success, predation, distribution of animals within habitats, reproduction, and stress to wildlife in general (Navara and Nelson, 2007; Rich and Longcore, 2006). Based on the literature reviewed for this memorandum, effects to wildlife from artificial lighting are generally influenced by three main factors:

- **Intensity**: Intensity can relate to the intensity of the source itself (e.g. brightness of the bulb), but also whether the light is directly pointed at the wildlife / habitat or scattered through indirect glare (i.e. 'sky glow' or light trespass).
- **Colour / Spectral Composition**: Some studies have identified varying responses to different wavelengths of light by different species groups.
- **Duration**: Duration of lighting exposure can correspond to the impact on wildlife (e.g. longer exposure can correspond to greater stress and disruption).

These three areas of potential impact were considered in designing a recommended lighting strategy for the proposed bridge. Also considered were the existing regulatory requirements for lighting roadways and bridges as it relates to public safety, as advised by J. L. Richards and Associates.

Review of Potential Impacts and Best Practices

Deck Lighting

Intensity

The direction of artificial lighting has varying effects on wildlife in adjacent natural areas, for example, lighting that is pointed upward, horizontally or near-horizontal increases the visibility of the light source from a distance, and significantly increases the illuminated area (producing more 'sky glow' and light trespass) which correlates to increased disturbance to wildlife in adjacent areas (Gaston et al., 2012). Therefore, lighting on the proposed bridge should be positioned low on the structure, and be pointed downward directly onto the decking by using full cut-off light fixtures.

In the absence of artificial light, full moonlight under clear skies gives an illumination of 0.1–0.3 lux (a standardized measure of the brightness as perceived by the human eye) (Rich & Longcore, 2006 as referenced in Gaston et al., 2012). Typical incandescent, fluorescent or high-intensity discharge (HID) street lighting gives rise to street-level illumination of between 10 and 60 lux (Gaston et al., 2012), while standard white LED lights can produce significantly more but, unlike traditional lighting, may be dimmed. To reduce the impacts on adjacent natural areas, the lighting source should provide the lowest illumination possible, while still meeting safety requirements. Further, the lights on the proposed bridge should be linked to motion-sensors which would dim the lights to moonlight levels when no traffic (pedestrian or vehicle) is present. This would further reduce the intensity of artificial lighting impacts on surrounding natural areas for a portion of the night, and is a practice that has been advocated by the City of Toronto (2017).

Colour / Spectral Composition

Different types of light sources produce light across different ranges of the light spectrum, and similarly, different groups of wildlife are sensitive to different wavelengths of light pollution. For instance, studies have shown that bats may be attracted to blue and white light because their prey are attracted to the wavelengths these lights emit, while red lights have been shown to have no effect on bat activity (Sploestra et al., 2017). Conversely, red lights have been shown to interact with the navigational abilities of migrating birds, while blue / green lighting had no effect (Poot et al., 2008). Lighting of all wavelengths have been shown to cause stress in birds nesting near lit areas, with white light being the most disruptive (Kumar et al., 2000). All wavelengths have been shown to supress nocturnal melatonin production (hormone which controls sleep and wake cycles) in fish, with blue light being the least disruptive (Bruning et al., 2015). It is inferred that light which produces a narrow spectrum of light, such as low-pressure sodium, may have less ecological impact compared to broader spectrum (white) light sources (Gaston et al., 2012).

Recently, Ameland Island in the Netherlands, which is within a dark-sky preserve, has incorporated current research on ecological impacts of artificial lighting into the lighting design for the entire island. Among other initiatives, the island has installed "ClearSky Technology" LED lighting in public places and along roadways. This newer technology emits a subtle blue-green light that provides sufficient light for human safety while reducing impacts to nocturnal and crepuscular wildlife (Leeming, 2017; http://www.clearsky.lighting/en/), particularly migrating birds.

Based on this information, LED lighting specifically designed to produce a narrow spectrum, preferably blue/green if readily available, is recommended.

Duration

The majority of nocturnal and crepuscular wildlife activity occurs in the hours immediately after dusk and immediately before dawn, which coincides with the times when artificial lighting is most likely needed (i.e. commuter traffic). Considering safety requirements, turning lights off outside these peak hours is not feasible. However, reducing the duration of lighting seems likely to have positive ecological benefits (Gaston et al., 2012), therefore it is recommended that the lighting on the proposed bridge be linked to solar sensors which will turn the lights off as soon as natural lighting is of sufficient brightness to meet safety requirements.

As noted, the lights on the proposed bridge should be linked to motion-sensors which would dim the lights to moonlight levels when there is no traffic (pedestrian or vehicle). This would reduce the duration that adjacent natural areas are subject to higher levels of artificial light.

Accent Lighting

Accent lighting of the bridge, to highlight the v-pier design and steel arch, is proposed. The v-pier accent lighting will be installed just below the bridge deck and point downwards along the v-piers. To minimize scatter onto the water surface below the bridge, the lights should be narrowly focused and point towards the v-piers rather than parallel with them. Two lights will illuminate each side of each v-pier, for a total of eight lights. Also proposed are upward pointing lights along the steel arches. These upward pointing lights include four lights per side of the bridge, for a total of eight lights. As noted, upward pointing lighting can impact wildlife and adjacent habitats, however, lighting the arches from above would increase light cast onto the water surface, which is not recommended. To minimize effects to wildlife, the v-pier and upward pointing arch accent lights will follow these recommendations: minimizing the duration of accent lighting (i.e. full shut-off during the middle of the night); lighting at the lowest intensity possible; and using narrow spectrum (blue/green if possible) LED lighting.

Summary

Based on the information reviewed for this memorandum, the following recommendations with respect to the lighting design for the proposed bridge include:

- Use of low-mounted, downward pointing, full cut-off lighting fixtures only to reduce or eliminate light trespass on adjacent natural areas and ‘sky glow’.
- Use of solar and motion-sensors to reduce lighting duration and intensity to the minimum feasible.
- Selection of narrow-spectrum blue-green LED lighting sources of the lowest brightness feasible.
- Accent lighting should follow as many of the recommendations listed in this memorandum for deck lighting as feasible.

We trust that this information meets your needs. If you have any questions or would like to discuss, please contact Gwendolyn Weeks at 613-592-9600.

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