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February 16, 2018

## **Background on Optical Measurements and Calculations**

Watchfire Signs has manufactured outdoor electric signs since 1932 and led signs since 1996. We have more than 50,000 led signs in operation worldwide.

Incandescent signs were commonly measured using illuminance measurements, partly because the light bulb is ideally a point source of light, illuminating equally in all directions, and illuminance meters are commonly available and inexpensive. Foot-candle measurements are made at a defined distance from the sign and the magnitude depends on the physical size of the sign.

LED signs are highly directional however, which is an advantage in an urban setting since the light can be directed more precisely to the intended audience. Luminance measurements have been used to specify LED signs by the industry. The candela per square meter (NITs) unit allows a specification that does not depend on size or viewing distance.

The study done on the sign adjacent to a residential area used actual lab measurements made on modules using an illuminance meter. These measurements and extrapolations are then scaled up to the size of the sign and the distance corrections are made using the inverse square law.

Watchfire adopted brightness standards set forth by both the ISA (International sign Association) and OAAA (Outdoor Advertising Association of America). The standards used are based on the studies of Dr. Lewin and the IESNA (Illuminating Engineering Society of North America).

Below is a list of some of the measurement equipment used by Watchfire engineers.

### **Equipment used by Watchfire engineers to make lighting measurements:**

Foot-candles/Lux - Minolta Illuminance Meter T-10

NITs/candela/sq. m – Minolta Luminance Meter LS-100

Sign Calibration – Minolta CS-1000 Spectra radiometer

## SIGN LIGHTING STUDY

### Sign Details

**Size:** 14x48 Digital Billboard

**Location:** **13100 Brooks Drive, Irwindale, CA**

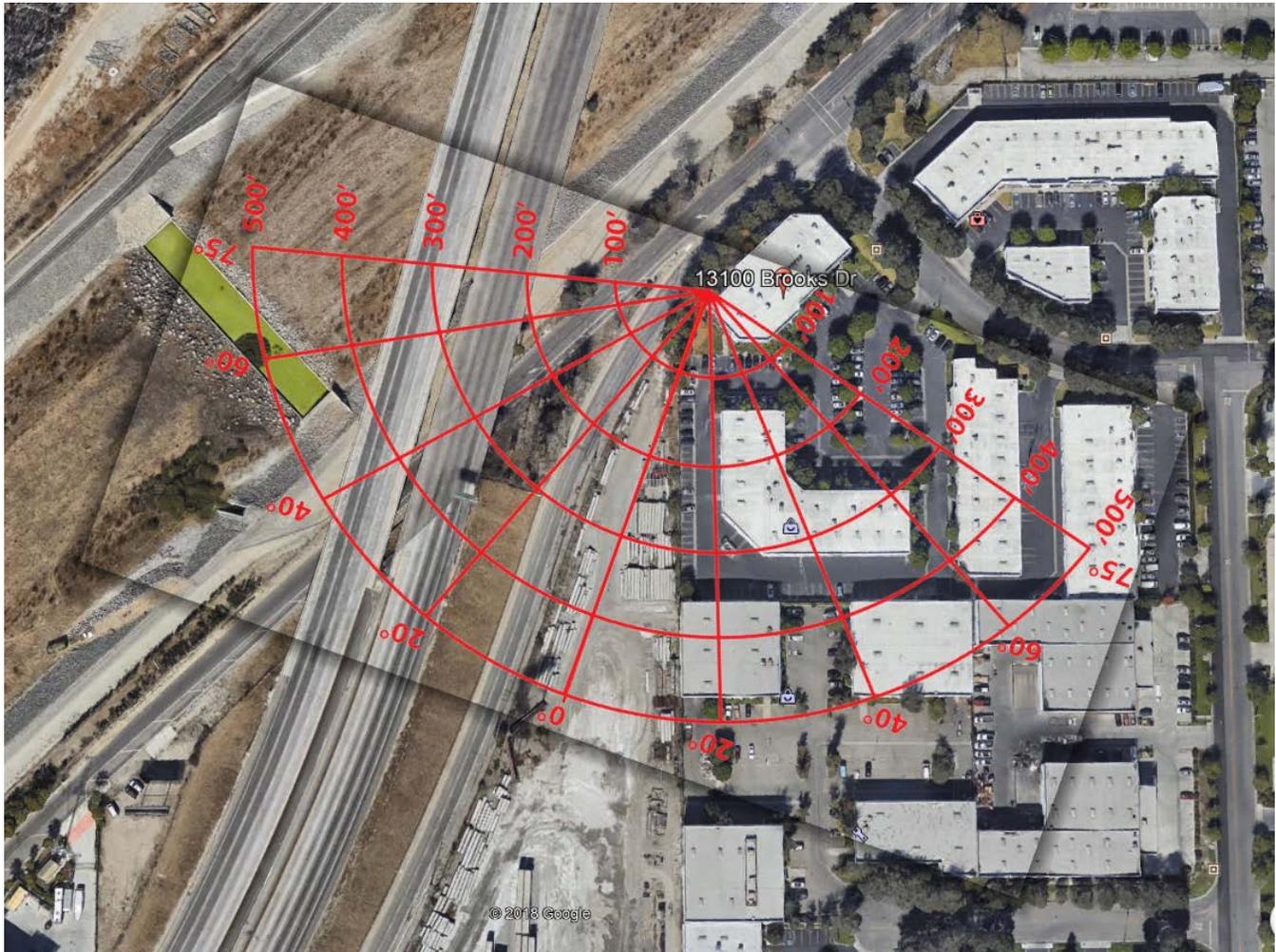
*Light measurements are completed in foot-candles. A foot-candle is the amount of light produced by a single candle when measured from 1 foot away. For reference, a 100-watt light bulb produces 137 foot-candles at 1 foot away, .0548 foot-candles at 50 feet and .0137 foot-candles at 100 feet.*

The table represents the total increase in ambient light produced by the sign under normal or typical operation at night. The ambient light increases will be less than shown in the chart since they fail to consider any objects blocking the line of site to the sign. Obstructions such as trees would further reduce real world overall ambient light increases. In addition to obstructions any existing light within the viewing cone will further diminish any light increase.

|      | 0 degrees | 20 degrees | 40 degrees | 60 degrees | 90 degrees |
|------|-----------|------------|------------|------------|------------|
| 100' | 0.6814    | 0.5621     | 0.3795     | 0.1717     | 0.0341     |
| 200' | 0.1703    | 0.1405     | 0.0949     | 0.0429     | 0.0085     |
| 300' | 0.0757    | 0.0625     | 0.0422     | 0.0191     | 0.0038     |
| 400' | 0.0426    | 0.0351     | 0.0237     | 0.0107     | 0.0021     |
| 500' | 0.0273    | 0.0225     | 0.0152     | 0.0069     | 0.0014     |

Light values in foot-candles at night under typical operation





## Conclusion

Given the above comparisons and measurements, the area will see an almost undetectable difference in ambient light after installation of a billboard. Ambient light levels are more heavily impacted by street, building, and landscape lights than the increases produced by a billboard.

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