Memorandum

TO: Plan Commission
FROM: Greg Keil, CDD GK
DATE: September 7, 2012
RE: Digital Billboards

The following materials are attached for your information/consideration relative to criteria and standards that may be applicable to digital billboards.

- Proposed ordinance language- Next Media
- Existing size and location of NextMedia billboards
- Typical dimensions of electronic billboards
- WisDOT 2010 Traffic Counts
- City of Menasha Billboard Location drawing
- WisDOT USH10/114 Recommended Alternative - drawing
- White Paper- Illinois Coalition for Responsible Outdoor Lighting
- White Paper – Digital LED Billboard Luminance Recommendations – Luginbuhl, et.al.

Upon review of these materials and other relevant information, I would make the following recommendations:

- Location – Limit digital billboards to an area north and west of the STH 441 ROW and within 200 feet thereof. May not be placed within 300 feet of a residential use or residential zoning district
- Spacing – Not less than 500 feet from an interchange and not less than 800 feet between signs, irrespective of the political jurisdiction the signage is located in
- Height – Not more than 30 feet above natural grade
- Brightness - Day time not more than 5,000 nits, night time not more than 150 nits. Sign permitee should be responsible for annually certifying signage is operated within these parameters using a methodology approved by the city
- Message duration- not less than 8 seconds, transition time -1 second or less
- Movement of Image- No scrolling, animation, flashing, blinking or motion video
- Mitigation –two square feet of sign face should be eliminated for each square foot of digital display permitted. (If, due to the dimensional characteristics of the signage to be mitigated the strict application of this ratio is impractical, the Plan Commission should have the authority to consider an alternative ratio).
- The entire sign, including all structural support members should be removed. The signs to be mitigated are at the discretion of the city.

NOTE: THESE PROVISIONS ARE PROPOSED BY NEXT MEDIA

Proposed City of Menasha Off-Premise Ordinance Language

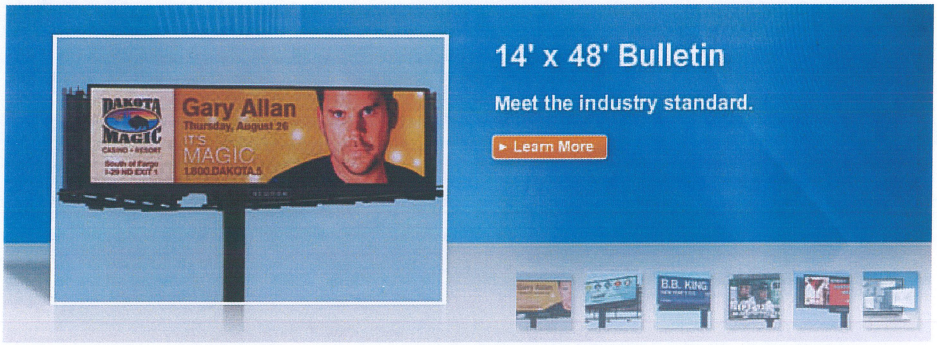
1. Billboards/Off-Premise Advertising.
    a. Purpose. The purpose of this section is to provide minimum standards to protect the life, health, safety, property, welfare, convenience and enjoyment of the general public by regulating and controlling the location, use and maintenance of outdoor advertising signs and sign structures. The provisions of this section are intended to mitigate the aesthetic impact on a neighborhood that affects the visual environment, to contribute to the development and maintenance of an attractive visual environment for the community while facilitating the communication of messages to the public.
    b. Existing Signs. Off-Premise signs in existence prior to September 1, 2012 shall be considered a legal non-conforming use and shall represent the maximum number of off-premise signs permitted in the City of Menasha.
    c. Relocation of Signs. Off-Premise signs located on the City's streets may be relocated to the Highway 441 corridor as long as:
        i. The spacing on Highway 441 meets the State of Wisconsin spacing requirements of 500 linear feet between signs.
        ii. The equivalent square footage of the sign being built on Highway 441 must have been removed from the city streets.
        iii. The zoning on Highway 441 is either Industrial or Commercial.
    d. Multiple Message Signs. Shall be only be permitted on the Highway 441 corridor and shall meet all regulations of this section and applicable State of Wisconsin regulations, including the following:
        i. Signs shall not exceed 700 square feet per face.
        ii. Spacing between Multiple Message signs shall be 1000 linear feet for signs facing the same direction.
        iii. The time the message remains fixed in a position shall be eight (8) seconds or more before changing to the next message.
        iv. The transition time, or the time it takes to change a message, shall be one second or less.
        v. No sign shall interfere with the visibility or the operation of any traffic signal or railroad control device.
        vi. Movement, flashing, blinking, scrolling and/or animation is prohibited.
        vii. Audio speakers and all forms of pyrotechnics are prohibited.
        viii. All multiple message signs shall be equipped with automatic dimming capability, and light produced by such signs shall not exceed 0.3 foot candles over ambient light levels.
        ix. The mitigation credit for a multiple message face shall be the removal of two (2) existing sign faces on the city streets.

EXISTING NEXTMEDIA SIGNAGE

Sign #	Desription	Face Size	# of Faces	Height	AREA PER FACE	TOTAL AREA
3M03	1215 N Racine St N/O Airport Rd ES	12' x 24'	4	30'	288	1152
3M15	Hwy 10-114 750' E/O Oneida St NS	12' x 24'	2	35'	288	576
3M18	1800 S Hwy 47 350' S/O Valley Rd WS	12' x 24'	2	30'	288	576
3M20	S Oneida St 200' N/O Hwy 10-114 ES	10'6" x 22'9"	3	20'	239	717
? 3M75	Hwy 441 .1 mi N/O Midway Rd	14' x 48'	2	70'	672	1344
3M76	Hwy 441 .5 mi W/O Appleton Rd	12' x 24'	4	30'	288	1152
3M77	Hwy 441 @ Novak WS	14' x 48'	2	30'	672	1344
3N77	221 Washington Ave @ Menasha	10'6" x 36'	2	30'	378	756

Digital Billboards

- Sizes & Specifications
  - 14' X 48' Bulletin
  - 11' X 22' Poster
  - 10'6" X 36' Jr. Bulletin
  - 20' x 60' Spectacular
  - Additional Sizes
- Features
- Installation
- Technology Types
- Display Management
- Billboard Advertising
- Services
- Support
- Resources
- FAQ
- Request Info & E-list
- What's New
- Top 5 Reasons to Invest



Outdoor LED Digital Billboards Sizes & Specifications

Built To Fit Any Application

We offer several digital billboard specification options from our popular standard billboard sizes to totally customized displays, we can help you select the digital signage that will fit your needs. Choose from our many digital billboard specifications and sizes.

14' X 48' Bulletin

15 MM • 16 MM • 20 MM

Bulletins are the most common freeway billboard structure used today. The Bulletin is considered the industry standard for outdoor digital billboards.

Learn More

11' X 22' Poster

15 MM • 16 MM • 20 MM

Posters are the perfect outdoor digital billboard for viewing by pedestrians or people in automobiles. Posters deliver fantastic exposure.

Find Out More

10'6" X 36' Jr. Bulletin

15 MM • 16 MM • 20 MM

Jr. Bulletins are the most common outdoor digital billboard used on freeways. High-traffic locations use Jr. Bulletins for a sharp view.

View More

20' X 60' Spectacular

15 MM • 16 MM • 20 MM

Spectacular outdoor digital billboards are often used in areas with visibility to several major highways at the same time.

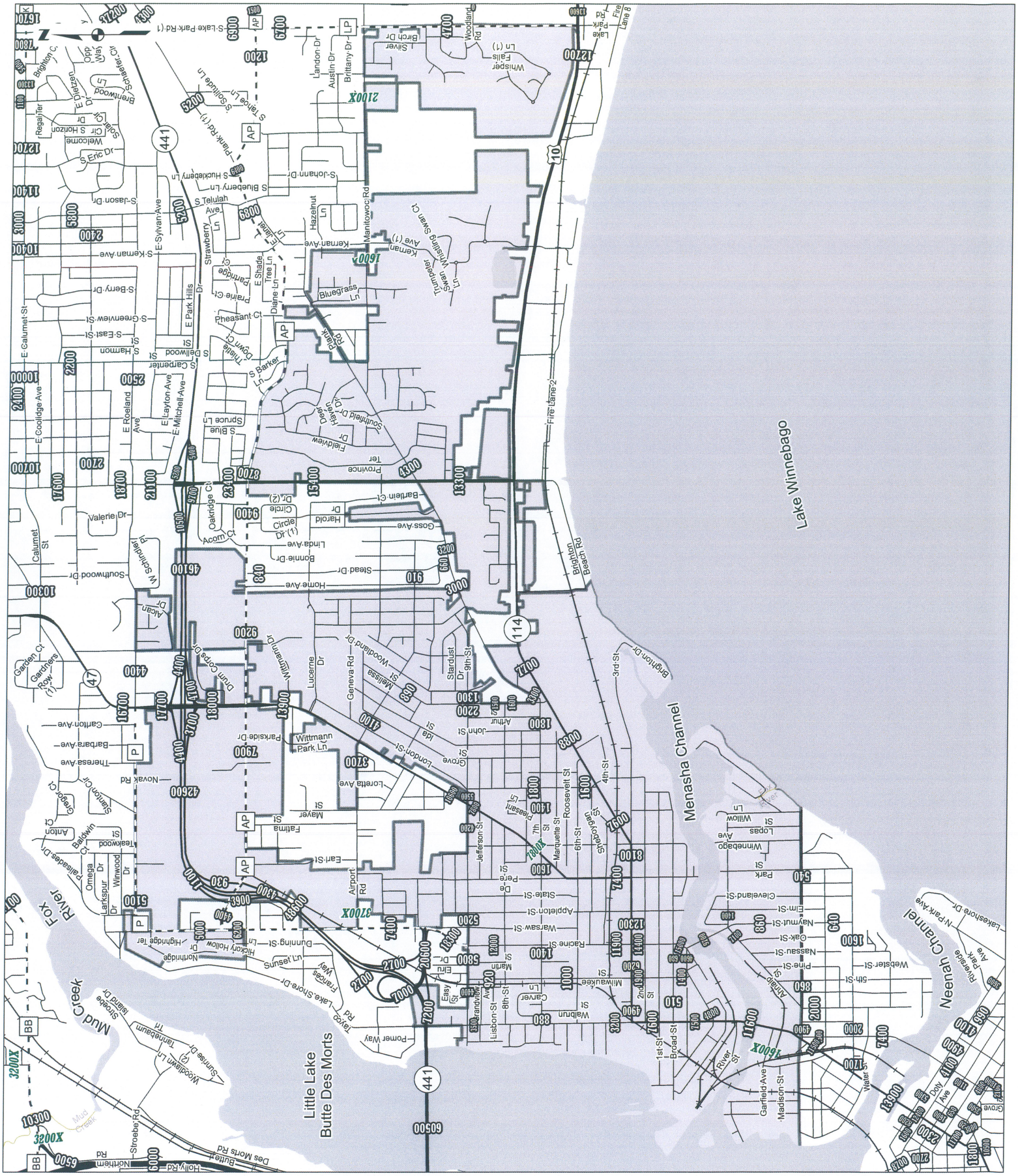
Learn More

Additional Sizes

We understand that not every billboard application fits the above sizes. We can build a digital billboard to fit any location, but here are some examples that are common in the industry. Our additional sizes include:

10' X 20' • 10' X 30' • 14' X 28'

View More



2010
City of MENASHA
WINNEBAGO County

9999 = 2010

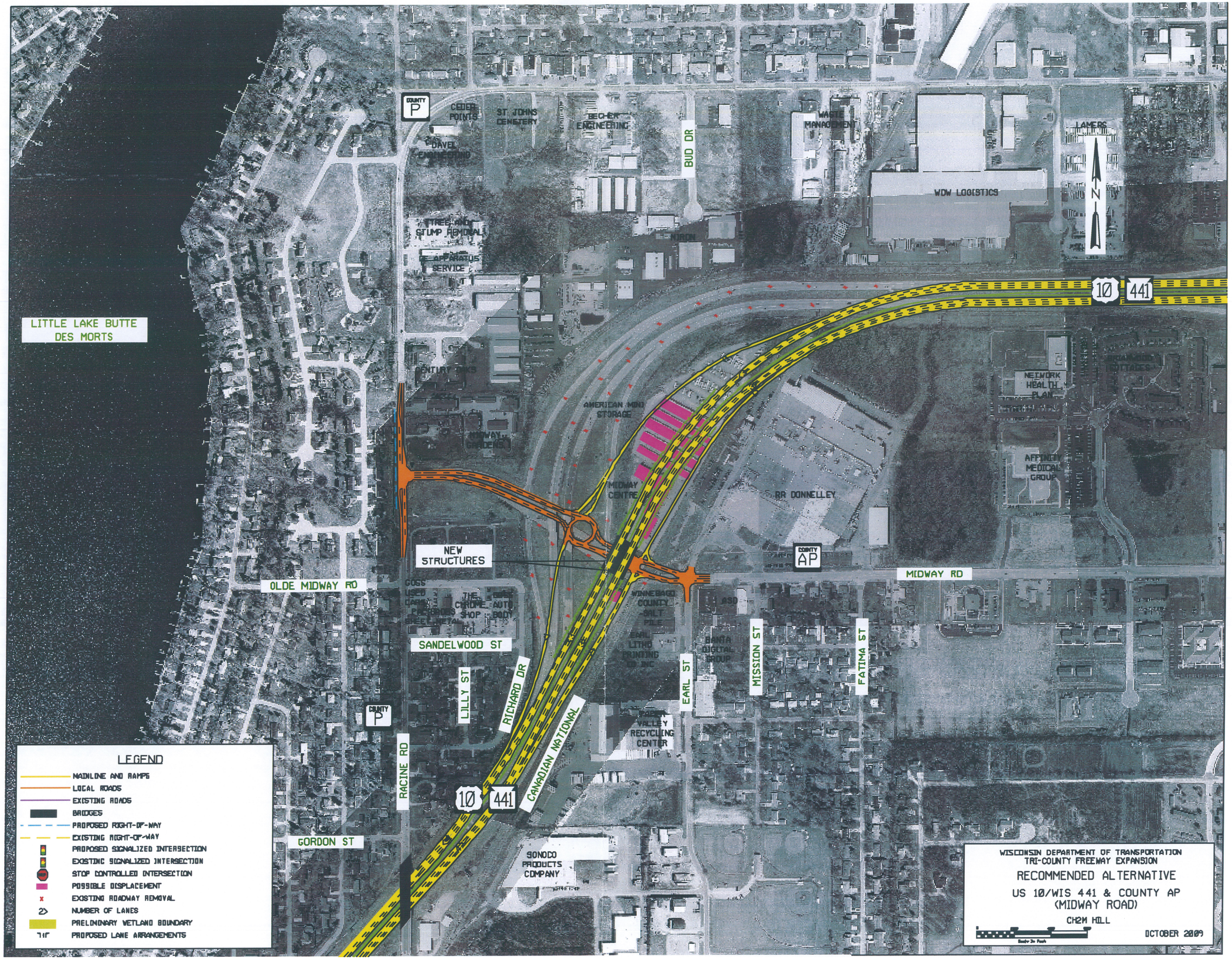
9999# = 2009
9999* = 2008
9999@ = 2007
9999^ = 2006
9999~ = 2005
9999x = 2004 or older

- Character following count value designates the year the count was taken
- AADT lie perpendicular to road
- Ramp counts lie parallel to road

Legend

- IH
- USH
- STH
- CTH
- Local Roads
- Railroads

CITY OF MENASHA, BILLBOARD LOCATIONS


LITTLE LAKE BUTTE DES MORTS
COUNTY P
CEDER POINTS
ST JOHNS CEMETERY
BECHER ENGINEERING
BUD DR
WASTE MANAGEMENT
WDW LOGISTICS
LAMERS
N
TREE AND STUMP REMOVAL
APPARATUS SERVICE
10
441
CENTURY TRUCKS
AMERICAN MINI STORAGE
MIDWAY GARDENS
MIDWAY CENTRE
NEIWORK HEALTH PLAN
AFFINITY MEDICAL GROUP
RR DONNELLEY
NEW STRUCTURES
COUNTY AP
MIDWAY RD
OLDE MIDWAY RD
GOSS USED CARS
THE CHROME SHOP
AUTO BODY
WINNEBAGO COUNTY SALT PILE
ASD
SANDELWOOD ST
EARL LITHO PRINTING
BANTA DIGITAL GROUP
LILLY ST
RICHARD DR
EARL ST
MISSION ST
FATIMA ST
COUNTY P
FOX VALLEY RECYCLING CENTER
RACINE RD
CANADIAN NATIONAL
10
441
GORDON ST
SONOCO PRODUCTS COMPANY
LEGEND
MAINLINE AND RAMPS
LOCAL ROADS
EXISTING ROADS
BRIDGES
PROPOSED RIGHT-OF-WAY
EXISTING RIGHT-OF-WAY
PROPOSED SIGNALIZED INTERSECTION
EXISTING SIGNALIZED INTERSECTION
STOP CONTROLLED INTERSECTION
POSSIBLE DISPLACEMENT
EXISTING ROADWAY REMOVAL
NUMBER OF LANES
PRELIMINARY WETLAND BOUNDARY
PROPOSED LANE ARRANGEMENTS
WISCONSIN DEPARTMENT OF TRANSPORTATION
TRI-COUNTY FREEWAY EXPANSION
RECOMMENDED ALTERNATIVE
US 10/WIS 441 & COUNTY AP
(MIDWAY ROAD)
CH2M HILL
OCTOBER 2009

Working toward legislation to curb light pollution in Illinois.

Illinois Coalition for Responsible Outdoor Lighting

www.illinoislighting.org
site menu

Manual Site Directory

current page:
Lighting Practices>
Articles & Studies>
Digital Billboards

May, 2010

Digital Billboards: New Regulations for New Technology

State, county, and municipal leaders across the U.S. are finding themselves with a new issue on their agendas: the latest generation of outdoor advertising signage, the digital billboard. Also known as LED or electronic billboards, dynamic signage, constantly variable signs, and other names, these signs are a whole new ballgame in outdoor advertising.

The digital technology features two major changes from the old "static" signage, which is graphics painted or printed on a surface. The image in the digital sign is displayed by a myriad of colored "lightbulbs" (light-emitting diodes, or LEDs, actually). So while the static sign is visible from daylight reflecting off it (or artificial lighting at night), the digital image shines out, akin to a television set. In the digital signs, the image is supplied to the sign by a computer; the image can be varied at will, right up to functioning as a Hi-Def television display. These two properties -- potential for both intense surface brightness and motion -- pose questions to safety and esthetics issues beyond those raised by the old static signs, and require new analysis by agencies tasked with regulating outdoor advertising.

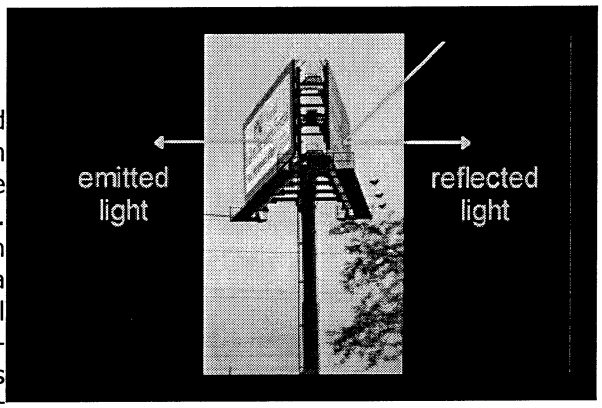
Digital display technology (as in this artist's conception) allows for much greater surface brightness than old "static" signage, and sudden changes in display.

It makes sense to start off this discussion by addressing the topic of digital billboards and the future. The large outdoor advertising companies have embraced this technology as the replacement for static signage; in their book, it is the technology which is here to stay. To quote a promotional video from the Trans-Lux company, *"Nothing's as eye-catching as an electronic LED display. The brightly-lit text and graphics can be seen from hundreds of feet away, drawing the attention of everyone within view."* Space on the electronic signs is marketed as being superior to that on static signs; it can cost as much or more to run your company's sign on the digital billboard as to rent a static one, even

though your sign may only be shown a small percentage of the time on the digital display, alternating with as many as eight or more others. While the investment in a digital sign is a large one (often quoted as $250,000 - $500,000), the anticipated return is great. Overhead costs are also cut for the advertising companies; when signs are designed, they no longer need to be printed, and then installed by a crew in the field; at the click of a computer mouse, the sign graphic is wired or radioed to the digital billboard for display. The companies in the multi-billion-dollar outdoor advertising field have a large financial incentive to change most outdoor signage from static to digital over the coming years.

Why is our coalition for responsible outdoor lighting discussing the subject of digital billboards? There are a few issues which directly involve questions of illumination which we address. The signs emit light into the nocturnal environment, potentially including residential and natural areas and the sky; they consume large amounts of electricity; their presence can affect public safety, most commonly by distracting drivers (which, after all, is the signs' precise intent and purpose). To understand these issues, and consider ordinances which should regulate the placement and operation of these signs, we need to understand the details of how the various effects are measured. Unfortunately, this is not common knowledge; state and local managers may not be familiar with principles and metrics which apply. Our intent in this paper is to provide some practical definitions, and cite sensible, logical and defensible levels of regulation.

LUMINANCE



Luminance is a measure of the perceived brightness of a surface. This differs from *illuminance*, which is a measure of the amount of light falling onto a surface. Luminance is a key measurement when analyzing surfaces which emit light, like a computer or television screen, or a digital billboard. Luminance, with this sort of light-emitting device, is controlled by the settings of the device itself. Illuminance is what allows us to see items which don't emit light; light (illumination) coming from other sources reflects off the object, rendering it visible to us; illuminance is determined by the brightness and location of the external light source(s). But any object which we can see has a specific level of surface brightness or luminance. A computer screen turned up to high brightness puts out more light per square inch of its surface than when it is set to low; a piece of paper in the full sun reflects more light per square inch than one in candlelight. The two billboards in the photo above each present a certain surface brightness to the observer's eye, whether they emit light like the digital one on the left, or reflect light like the "static" one on the right.

Illuminance (illumination) is usually measured in units of foot-candles or lux; *luminance* (surface brightness) is most often measured in *nits* or *candela per square meter* (cd/m^2), which are equivalent. (For further discussion of these units or any other technical terms used in this paper, see our website's Encyclopedia of Terms page.)

Luminance plays a critical role in how a sign like a billboard interacts with the environment around it. During the daytime, a static billboard lit by the natural daylight will appear to the eye to have a brightness which "fits in" with its surroundings; it will not cause excessive distraction because of an unusual level of luminance. (Perception studies show that having something in our field of vision which is either much brighter or darker than its surroundings causes an involuntarily shift of our vision to the object.) A digital sign which is set to a luminance level higher than that of the other objects around it, which are lit by daylight alone, can potentially draw a driver's eyes to the sign when they

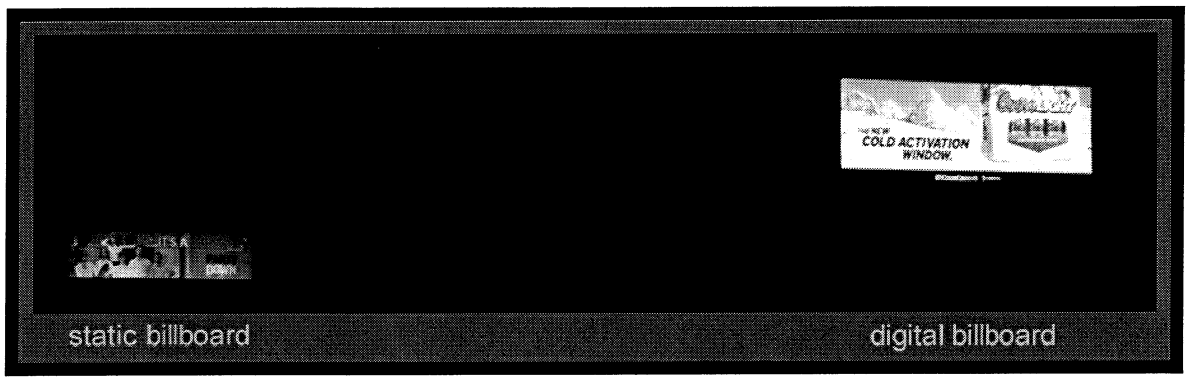
need to be looking elsewhere to safely operate their vehicle; levels can even be so high as to cause vision-disturbing glare.

The luminance level which a digital sign needs to be set at to be visible in the daylight is far above that needed at dusk or night. This effect can be seen with other luminous displays, such as on cellphones and laptop computers; brightness levels which seem high indoors are totally inadequate outside in the much brighter direct sunlight. The eye of the driver at night compensates for lower light levels by becoming more sensitive to light; it is even more easily distracted, dazzled, and even disabled by an overly luminous object than the daytime eye is.

SAFE AND SENSIBLE LIMITS FOR LUMINANCE

While an advertiser's desire might be to draw everyone's attention, for as long as possible, in the most potent methods possible, logic dictates that it is not in our best interest to have people who are at the moment operating motor vehicles (and hopefully practicing defensive driving, monitoring all the other vehicles and activity around, ahead, and behind their vehicle) be inordinately distracted from that task by advertising or anything else not related to safe driving. While this goal does not in itself dictate specific limits to the luminance level of electronic signs, it suggests a logical course for deriving such limits.

For daylight hours, the maximum luminance level for digital signage should be similar to what the luminance of an identical sign would be if it was printed out and installed on a static billboard. In other words, the digital sign would appear no brighter, no more intense, that the printed sign next to it, or the landscape surrounding it. In practice, setting a limit of 5000 nits (setting the sign's intensity so that an area on it displaying full -brightness white has no higher luminance than that figure) ends up delivering a surface brightness similar to landscape illuminated by sunlight.



At dusk and nighttime, a logical conclusion would be that new digital billboards do not need to operate at higher surface brightness than the static ones which they are replacing. The outdoor advertising industry has not, for decades, been telling its customers that their nighttime advertising is ineffective; quite the contrary. So, what could be the rationale for setting nighttime luminance limits which are higher than the brightness of the existing static signs? However, if such limits are not set, it seems that the advertising industry will be pushing the envelope out further and further, increasing the distractive effects of the digital signs, the potential disruption of visual perception, and the flooding of the surrounding neighborhoods with excess light. The single photograph in the frame above, taken May 24, 2010, shows two adjacent billboards; the one in back (left) a static sign, lit from below by metal halide luminaires, which obviously has a lower surface brightness that the one in front (right), which is digital.

From independent surveys of static billboards, we have a good summary of levels of surface brightness that those signs are currently commonly operated at. A 2009 survey of

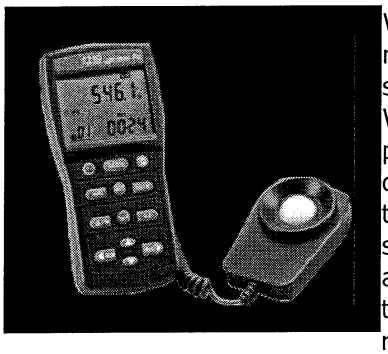
static billboards in Arizona found that, out of 565 measured, 98% had a luminance of less than 150 nits, and 83% measured below 100 nits. A smaller 2008 survey[1] in New York State found an average nighttime luminance of 124 nits for static billboards.

The IESNA Lighting Handbook[2] recommends for "illuminated billboards and other large advertising panels", illuminating such signs at night with 1000 lux in bright locations, and 500 lux for ones in dark surroundings. Assuming that a static billboard has a white face with a reflectance of 0.8, the luminance of such a billboard would be 250 nits in the setting (1000 lux) for brightly illuminated surroundings, and 125 nits in the low-light setting (500 lux illumination). Many digital billboards are mounted on tall masts, above the driver/viewer, so they appear to "hang in the sky"; at night, this would place them against that dark background, making the darker-surroundings setting appropriate.

MEASURING LUMINANCE

The Outdoor Advertising Association of America (the trade group of the billboard industry) hired Dr. Ian Lewin, CEO of Lighting Sciences, Inc. to write a report on "Digital Billboard Recommendations and Comparisons to Conventional Billboards"[3]. The report proposes both a set of sign brightness limits, and a methodology for estimating sign brightness. The report is widely cited by the billboard industry as the be-all, end-all of expert opinion on the matter of sign brightness and safety, but we find it to be notably flawed in several aspects.

Luminance can be directly measured with a special instrument called a luminance meter. It works much like a camera, focusing on the surface which one is determining the brightness of, and measuring that surface's light output per angular degree of area. Lewin suggests that these meters, which may cost several thousand dollars, are too expensive for local sign installers and regulators to obtain. Therefore, instead of direct measurement with a luminance meter (like the one shown on the right), he suggests obtaining an approximate measurement by using a more common, generally less expensive *illuminance* light meter (as shown below). While the cost savings suggestion is laudable, the proposed indirect method contains several flaws when applied to real-world situations, leaving it, in our opinion, too lacking to use anywhere outside of the theoretical laboratory. Lewin's method involves positioning the observer with the light meter a known distance in front of the sign in question, and taking one measurement of all the light falling on the light meter while the sign is illuminated, and another reading while the sign is turned off. The difference between the two measurements should be the contribution of illuminance from the sign, and if you know the exact overall size of the sign, and just how far from the sign the measurements were taken, you can compute the approximate average surface brightness of the sign.



With a luminance meter, surface brightness can be measured from any (unspecified) distance, as long as the surface to be measured fills the field of view of the meter. With the indirect method, you need to know the distance precisely, and to use Lewin's "easy" table of calculation, the distance has to be a pre-set value, like 200 or 250 feet. In the real world, billboards are often located in hard to reach spots; 200' in front might be a private property, a highway, a pond, etc. To measure the distance in most situations, a tape measure would not be practical; either a laser rangefinder or a precise GPS unit would be needed; purchasing that equipment would notably reduce the cost difference between the luminance and illuminance meters.

With the luminance meter, the brightness measurement can be taken in any condition of ambient light -- bright or cloudy day, dusk, or night. With the illuminance method, daytime light levels will overpower the light readings; separating out the contribution from the sign will be next to impossible to do to any level of accuracy. Finding this flaw in Lewin's proposal is not surprising, because he does not address the subject of limiting luminance during the daylight hours. When discussing digital billboard technology, this is a glaring omission (no pun intended). Current production models of LED displays can achieve surface brightness of over 13,000 nits[4]; this is intensly bright in the daylight, especially on overcast days. (As a comparison, the bright blue daytime sky ranges from around 5,000 to 7,000 nits in luminance.) We need to set limits for daytime sign luminance, too, and to be able to measure that performance.

With the luminance meter, the apparent surface brightness can be measured at any angle; this includes taking measurements directly from whatever areas of roadway where the sign will be in view. If the Lewin measurement is taken from the ground in front of the sign, that will often place the observer notably below the sign (billboards along roadways often being mounted high off the ground, especially those installed along elevated highways). The light emanating from digital billboards is somewhat directional; it is notably more intense along an axis extending out perpendicularly from the sign's face, and drops off in intensity as the angle away from that axis increases. The observer at ground level, often 30 feet or more below the lower edge of sign, will not be intercepting the most intense output of light.

The Lewin method requires manipulating the sign display, to take one reading with the sign on, and one with it off. This precludes the ability to independently measure sign luminance for code enforcement, because the sign operators will be choosing the luminance settings during the test. With a luminance meter, any sign can be checked for compliance at any time, without requiring the involvement of the sign owner/operator.

LIGHT TRESPASS

Light trespass is an issue related to the luminance of a light source, but it is generally measured in a different way. Instead of considering the surface brightness of the source (which needs to be regulated separately, as described above), trespass is looked at in terms of the level of illumination (illuminance) which the light source on one property shines onto another property. So for this value, we do look at foot-candles (or lux) of illuminance, generally at the property line of the property being trespassed upon; we do measure it directly with the illuminance light meter. (Illuminance trespass can also be calculated during engineering with computer modeling, by inputting the light output levels and pattern of the light source(s), and the physical layout of the properties involved.)

In his paper, Lewin uses the term "light trespass," but not in the way which it has normally been addressed in outdoor lighting regulation. He posits a set of distances away from the billboards at which to measure illuminance levels, rather than using the fairly standardized concept of property boundaries. His measurement points (at as far as 350' from the sign) might end up being on the same parcel which the sign in question is located on, or the next one over, or one beyond that. This points out a major difference between sign illumination and most other outdoor illumination; the later generally serves the purpose of illuminating the property it is installed on; the former (signs) are often intended expressly to illuminate (be seen from) adjoining properties, or across entire neighborhoods.

So, comparing the Lewin proposal for limiting "trespass" to the traditional concept of limiting light trespass is difficult. He arrives (through, I might add, what seems to be an elaborate use of cherry-picked logic) at a figure of 0.3 foot-candles as his recommended limit for nighttime trespass at his table of random distances out in front of various billboard sizes. This shouldn't be mistakenly equated with the location of a neighboring

property; if there was 0.3 f.c. at 350', but a house was only 175' away, the trespass level to that house would be four times higher.

Trespass should be measured to property lines. Admittedly, this puts billboards at a disadvantage; it is not uncommon for them to be located on parcels which are barely larger than the footprint of the signs themselves. But why should they be allowed to light up adjacent properties any more than any other form of artificial illumination?

Some municipalities, townships, counties and states have light trespass regulations. For trespass on to properties with any residential class of zoning, a limit of 0.1 foot-candles is not uncommon. In Illinois, some jurisdictions which have the 0.1 f.c. limit include Barrington Hills, Crystal Lake, Elk Grove, Homer Glen, Mt. Prospect, Mt. Vernon, Naperville, Palatine, Park Ridge, Springfield, Urbana, and even Scott Air Force Base.

MOTION & DISTRACTION

Digital signs have the ability to display anything which a television or computer monitor can, including "moving images". It is obvious that a Panavision movie playing along side a highway would constitute a grossly unsafe distraction hazard for vehicle operators. The Outdoor Advertising Association of America has accepted that concept, and in its Code of Industry Practice now states that full-sized billboards should not feature animation, flashing lights, scrolling, or full-motion video. This self-imposed code of conduct is laudable, but is missing (at least) two key points.

First, they limit their suggestion to not use moving images to full-sized billboards only. It is fine with them if "street-sized" signs along the roadways in our busy towns and cities feature any sort of animation or television-like video. Apparently, they believe that roadway accidents caused by distraction only occur on highways.

Second, when one image changes to another on a sign within a person's field of view, the viewer's visual system perceives that change as motion, even though the two images themselves were "static." (This is how motion pictures operate; they present the viewer a series of static images, and the mind "sees" motion.) If there is one sign ahead of us, and it turns into another, what we perceive is a flash, and/or movement. So, paradoxically, the billboard companies say they won't operate flashing or moving billboards, but they cannot avoid those effects if they change the displayed images while we are watching. They also display ads which continue on multiple "frames," encouraging the viewer to stare at the sign for a prolonged time to see the next installment.

OTHER REAL-WORLD CONCERNS

In addressing the issue of ***sky glow*** (the "light pollution" which emptied the nighttime sky of most of its stars over our towns and cities over the past few decades), Lewin notes that most digital billboard units feature a set of louvers which limit the amount of light they project upwards. In reality, those louvers are installed to shade the light-emitting diodes from sunlight, to increase the contrast of the signs during the day and reduce solar heating. But, they do reduce the amount of light shining "up."

However, the light projection at lower angles above the horizontal is not impeded by the louvers. As described in the seminal paper "Lighting and Astronomy" by Luginbuhl, Walker & Wainscoat[5], light emitted between the horizontal and just 20° above it contributes much more to skyglow than light emitted at higher angles, and that low-angle light's effects are visible over a much broader area. So, the sunshade louvers built into many digital signs do little to minimize their impact on the night sky.

The outdoor advertisers like to point out some studies (most of which they commissioned) which show negligible ***traffic safety*** problems related to existing digital signage. But this is new technology; we don't have enough real-world data to make

accurate judgments yet. There are vast numbers of billboards in the U.S. (the OAAA estimates 450,000), and only a tiny fraction have been converted to digital. Short-term analysis of that small percentage will not address the safety effect that large-scale, long term installation will have. Picture an Illinois highway which already has a bewildering display of billboards, like stretches of I-294 and I-55 near Chicago, with all of those signs converted to digital, changing displays. Now picture it with all those displays turned up to excessive brightness. Many of us can discern that such a situation would pose increased driving hazards, without the need for a study, or for the accidents, injuries and fatalities which might occur during the study period.

The big "selling point" which the outdoor advertising companies use is that the digital signs may be used for posting ***Amber Alerts*** in real-time. This is a genuine public service, and is lauded by many in law enforcement. However, operating roadside signs every day and night at levels of brightness which makes them too highly distracting could negate the public safety positives of Amber Alerts by increasing everyone's risk of accident and injury in the vicinity.

We have heard some people suggest that there are ***other distraction hazards*** on the roads which pose greater dangers, like drivers talking on cell phones, text messaging, eating, reading, etc. Yes, those are obvious real hazards. But their existence does not somehow make it logical that we should add even more distractions on the roadways of this country. Over thirty thousand people die each year here in traffic accidents; this is a horrible epidemic, and we need to be figuring out how to combat it, rather than shrugging off safety concerns.

In the real world, once digital billboards are installed, most local regulatory agencies will find it ***virtually impossible to ever remove them***. If they were allowed by existing regulations (or lack thereof) to be installed, even removal called for by a change in those regulations will generally require condemnation procedures to be instituted; that will entail the governmental body purchasing each offending sign from its owner. At a quarter to a half of a million dollars per sign, this cost is not affordable to most local governments, no matter how objectionable they or the citizens of the area have found the signs to end up being, how the land usage in the areas around the signs has changed over time, or if signs need to be removed because of road widening or other civic projects.

SUMMARY

Our organization is not "anti-billboards". We believe that the residents of each jurisdiction should decide what sort of outdoor advertising should be allowable in their neighborhoods.

We are also not beholden in any way to the outdoor advertising industry, or any related trades; we accept no contributions of any sort from these industries. Nor does our organization or any of its board members stand to gain or lose anything of monetary value based on the successes or failures of the outdoor advertising industry.

Our charter, as explained elsewhere across this website, is to speak as independent advocates for safe, environmentally responsible outdoor illumination practices, including a focused look at energy conservation. Filling that charter, we have studied the potential real-world ramifications of digital sign technology, including a focus on practical engineering (rather than vague theory) and on precedents which can be derived from other, well-established technology. Our recommendations for ordinances to govern the installation and operation of digital signage include the following:

- All digital signage visible from roadways (not just billboard-sized signs) should only be allowed to display non-animated images, and each image must be displayed ("dwell") for a minimum of ten seconds. Longer delay times should be

set by local regulation as is needed in specific installations where distraction hazards are especially high.

- All self-luminous outdoor signs should be subject to surface luminosity limits, both during the daytime and nighttime hours. During the daytime, based on normal daylight illumination, a maximum limit of 5,000 nits will keep luminous signage balanced with the surrounding landscape. During the nighttime hours, a luminosity limit of 150 nits will provide a surface brightness for digital signs which is comparable to the nighttime signage which is widespread across this nation, and is in line with the sign illumination level recommendations of the Illuminating Engineering Society of North America (IESNA). If the nighttime luminance setting and limit is based on the sign in question being set to display full white, full brightness field, a limit as high as 200 nits for this method of calibration and testing is suitable. Incremental luminance limits between the nighttime limit and the full sunlight limit may also be specified for overcast or foggy days, or for dusk; or regulations may require an automatic control of sign luminance based on the ambient lighting condition, to throttle the sign luminance between the sunny-day and night maximums.
- Surface luminosity measurements should be made directly with a calibrated luminosity meter, following the instrument manufacturer's instructions. Readings should be taken from the area (generally of roadway) where the sign in question will be visible from, and which is closest to being directly in front of the sign (where the luminosity output is most focused).
- Outdoor signage should obey light trespass regulations. Into areas zoned for any type of residential occupation (including parks and preserves so zoned), a trespass limit of 0.1 foot-candles should be enforced, at the property line.

Considering the effect which large-scale outdoor signage may have on property values and quality of life issues, regulatory bodies should require public notification and allow public comment when sign permits are applied for, including requests to convert existing static billboards to digital.

Currently, some outdoor advertising companies are offering local regulators a "swap-out plan", where they will remove more than one square foot of existing static billboards for each square foot of replacement digital billboard. From an environmental perspective, such an overall reduction in illuminated signage could be an advance. But ***that only true if the new signage is no brighter, per square foot, than what it is replacing!*** Without regulation to enforce those operating parameters, digital signage may generate negative environmental and safety impacts many orders of magnitude worse than the old signage it is poised to replace.

UPDATES:

Since this article was written, some good additional resources have become available. The article "Digital Signage and Philadelphia's Green Future" by Gregory Young provides an excellent overview of digital signage, and focuses in depth on the substantial energy consumption by such signs -- tens of times larger than that of conventionally illuminated "static" signs.
An initial draft of the study "Digital LED Billboard Luminance Recommendations: How Bright Is Bright Enough?" by Luginbuhl, Israel, Scowen, Polakis & Polakis has been made available here for distribution; it covers many of the same issues addressed in this article, and includes

substantial real-world measurement of existing sign illumination to provide a baseline in the discussion of brightness needs and limits.

[1] "Evaluation of Billboard Sign Luminances", Lighting Research Center, Rensselaer Polytechnic Institute, March, 2008 [2] "IESNA Lighting Handbook, Ninth Edition, July 2000, Mark Stanley Rea, ed. [3] "Digital Billboard Recommendations and Comparisons to Conventional Billboards", Ian Lewin Ph.D., FIES, L.C., Lighting Sciences, Inc., 2009 [4] "P20 Outdoor Full Color LED Display", Shenzhen Only Optoelectronic Technology Co., Ltd. website, June, 2011 [5] "Lighting and Astronomy", Luginbuhl, Walker & Wainscoat, Physics Today, December 2009

Home

About Us

Find us on Facebook

Lighting Practices

Our Proposals

What You Can Do

Resources

Return to Page Top

This page available as an Adobe Acrobat document Here

light pollution Illinois Chicago Cook County DuPage County Will County Springfield energy enviromnent global warming anti light pollution legislation lighting ordinances

Digital LED Billboard Luminance Recommendations
How Bright Is Bright Enough?

DRAFT

Christian B. Luginbuhl, U.S. Naval Observatory Flagstaff Station
Howard Israel, Phoenix, Arizona
Paul Scowen, Arizona State University
Jennifer and Tom Polakis, Tempe Arizona
9 November 2010

Summary

Careful and sensible control of the nighttime brightness of digital LED signage is critical. Unlike previous technologies, these signs are designed to produce brightness levels that are visible during the daytime; should too large a fraction of this brightness be used at night serious consequences for driver visibility and safety are possible. A review of the lighting professional literature indicates that drivers should be subjected to brightness levels of no greater than 10 to 40 times the brightness level to which their eyes are adapted for the critical driving task. As roadway lighting and automobile headlights provide lighting levels of about one nit, this implies signage should appear no brighter than about 40 nits. Standard industry practice with previous technologies for floodlit billboards averages less than 60 nits, and rarely exceeds 100 nits. It is recommended that the new technologies should not exceed 100 nits.

Introduction

Illuminated signage, for both advertising and informational purposes, has been a fixture of the modern nighttime environment since at least the invention of electric lighting. Until recently, the principal use of artificial lighting has been to make signs legible at night: ambient lighting, including skylight and sunlight, has been considered adequate for daytime visibility. With the advent of digital LED billboards, however, this is no longer true. Digital LED billboards must generate brightness sufficient to make them legible during the daytime as well as at night. The brightness necessary to make a sign legible during a full sunlit day can be many thousands of candela per square meter (also called nits); products available on the digital LED billboard market commonly advertise maximum luminances between 6500 and 7500 nits. This creates the potential risk of a blinding nighttime brightness should an inappropriate adjustment for nighttime conditions be made. Thus, the question arises of an appropriate limit to the brightness of a sign at night, whether a digital LED billboard or any other kind of sign.

Background: Sign Brightness, Drivers, and Visibility

The principal safety and regulatory concerns for drivers viewing signage from a roadway is that 1) the sign, by its very nature, is seeking to attract the gaze of the driver, i.e. the advertiser intends the driver to look directly at the sign (and away from the roadway) for a period of time sufficient to discern the sign's message or messages. Besides the obvious issue of a driver taking his or her eyes from the driving task, viewing the sign leads to the second problem, 2) the eye adapting toward the brightness level of the sign. Thus, when the driver returns his gaze back to the roadway, in all cases illuminated to a much lower brightness than the sign, for some period of time the driver's vision is no longer optimally adapted to seeing objects on the roadway. This changing visual adaptation when brightness levels change is

referred to in the technical literature as "transient adaptation." Drivers that have their visibility reduced for objects on the roadway, even momentarily, will be at greater risk for accidents.

The Illuminating Engineering Society of North America (IESNA) recognizes this issue in numerous places in its literature. The *IESNA Lighting Handbook* (9th edition, page 3-9) states:

> "If the change in [brightness] lies completely within the range of operation of the cone photoreceptors [i.e., daytime vision], *a few minutes* is sufficient for adaptation to occur. ... As for direction of change... changes to a higher [brightness] can be achieved much more rapidly than changes to a lower [brightness]." [*emphasis added]*

This last sentence says that the eye will adapt much more quickly when moving from the dimly lighted roadway to the bright sign, but much more slowly when returning to the dim roadway.

Design brightness levels for illuminated roadways are in the range of one nit (varying from about 0.3 to 1.2 nits, depending on roadway type (IESNA RP-8-00, 2000)). Thus, a driver viewing a billboard illuminated to (for example) 100 nits, and then returning his gaze to the roadway, must adapt his eyes to a brightness range of about 100:1.

What then is an acceptable ratio for transient adaptation, such that a driver's vision will not be hampered when viewing both more brightly and less brightly illuminated areas while driving? *IESNA RP-33-99, Lighting for Exterior Environments* (page 42) states:

> "If... roadways are lighted to a base level, [adjacent] areas should be no brighter than ten times that level. Additional brightness will not attract more attention, and may present a hazard to motorists on adjacent roadways."

Further, in *IESNA RP-20-98 Lighting for Parking Facilities*, we find (page 2):

> "It is intended that a driver (or pedestrian) looking at the brightest spot in the field of view will also be able to detect an object in the dark areas within the field of view. This detection can occur only if the maximum-to-minimum illuminance is limited to a range that the human eye can see."

This is followed by the numerical recommendations (page 3, Table 1) of 15-20:1. In other words, the brightest area should appear no more than 20 times as bright as the faintest to assure that the brightness remains within a range that the human eye can see.

In *IESNA RP-2-01, Lighting Merchandise Areas* (page 58), we find:

> "... luminance ratios between the lighted retail area and its surroundings should not exceed 20:1. Increasing the lighting level does not add to merchandise attraction, and may create a hazard to motorists on adjacent roadways or a nuisance for neighbors. A value of 10 times the average surrounding task luminance is a maximum that should be utilized for the focus merchandise. This will provide merchandise appeal without producing hazards or creating conflicts with other nighttime events."

The IESNA recommendations for advertising sign brightness (*IESNA Lighting Handbook, 9th edition*, page 17-26) are inconsistent with all recommendations noted above. Brightnesses between 250 and 1400 nits are listed in the table titled "Recommended Luminous Background Sign Luminances." These recommendations, if visible to highway drivers, will subject drivers' eyes to a brightness ratio of 250-1400:1. According to their own recommendations this ratio is unsupportable and will lead to compromised visibility and safety on public roadways. From the maximum ratio of 20:1, and assuming roadways are illuminated to about one nit, signs should be no brighter than 20 nits. It is perhaps telling that nowhere in the discussion of recommended advertising sign brightnesses is transient adaptation or the vision of drivers mentioned.

Lighting for Conventional Floodlit Billboards

A series of measurements made for this report in August 2009 (55 billboards, Phoenix metro area), Novembr 2010 (3 billboards, Chicago area), as well as deduced from data supplied for Tucson billboards by M. Mayer, give an idea of brightness levels commonly seen in usual floodlit signs. These signs were constructed and illuminated in most cases without any restrictions on sign brightness. It seems reasonable to assume that the signs are illuminated to a brightness considered satisfactory by the industry; if they were not, in most cases there were no regulations preventing them from increasing the lighting levels.

Tucson Metro Billboards. A lighting inventory undertaken by M. Mayer lists the areas, number and types of lamp used for illumination for 510 billboard faces located throughout the Tucson metropolitan area. Since no direct luminance measures were made for this survey, we deduced approximate luminances using a set of assumptions describing the physical characteristics of the sign lighting installation[1]. These assumptions allow the conversion of total initial lamp lumens and area of the signs to the maintained luminance values shown in Figure 1.

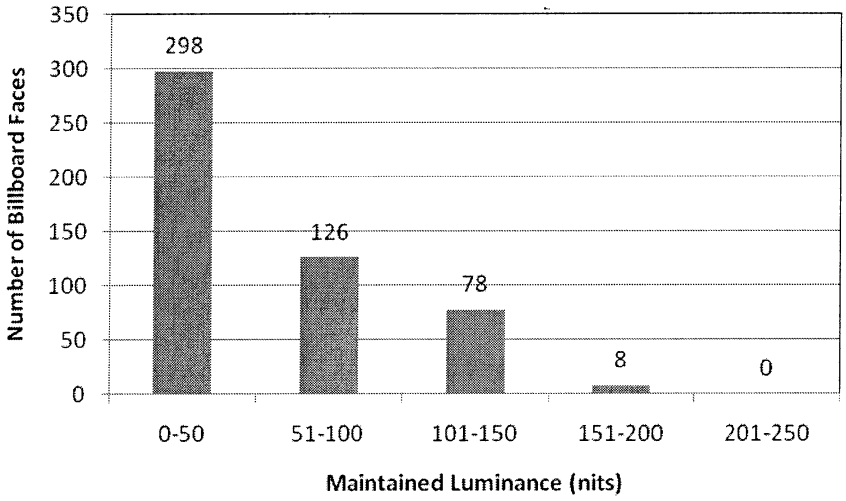


Figure 1. Number of billboard faces with indicated predicted maintained luminances in the Tucson metropolitan area.

[1] Initial lamp lumen outputs from the manufacturer's literature; Light Loss Factor (LLF) = 0.60; Application coefficient of utilization = 0.30; Diffuse reflectance of white vinyl sign surface = 0.70

Phoenix and Chicago Metro Billboards. Measures of white surfaces on 55 floodlit billboards in the Phoenix metropolitan area were made in August and November, 2009 using a Minolta LS-100 luminance meter. An additional 3 billboards were measured in th Chicago area in Novmber, 2010. All of these billboards are located in an urban environment. The results are presented in Figure 2; the data are presented in Appendix A.

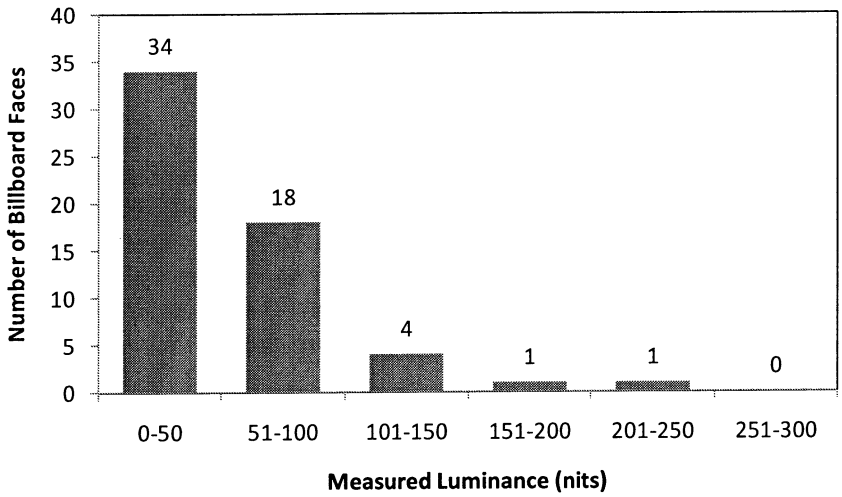


Figure 2. Number of billboard faces with indicated measured luminances in the Phoenix and Chicago metropolitan areas.

Of the total 510 billboard faces inventoried in the Tucson metropolitan area, the estimated average luminance is 59 nits; 83% (424/510) are estimated at 100 nits or less, and 98% (502/510) at 150 nits or less. The Phoenix and Chicago sample shows quite similar results, with an average luminance of 54 nits, and 90% (52/58) measured at 100 nits or less, and 97% (56/58) under 150 nits.

Toward a Sensible Standard

Following the most conservative information concerning contrast ratios and transient adaptation, it appears that the maximum luminance for signs visible to drivers on typically illuminated roadways should not exceed approximately 20 nits. This follows directly from the commonly cited maximum contrast ratio of 20:1 appearing in the IESNA literature and roadway luminances of approximately 1 nit.

Twenty nits is considerably below the brightness proposed by the OAAA report, and even below the typical floodlit sign visible to drivers today. Yet IESNA references concerning brightness ratios and transient adaptation, when discussed in any context other than that of signage (see below), indicate that choosing a value higher than 20 nits may have visibility consequences for drivers.

When discussing lighting recommendations for signs directly, IESNA recommendations begin at 20 nits but range higher, in one case much higher. *IESNA RP-19-01 Recommended Practice for Roadway Sign Lighting* recommends that roadway signs be designed with luminances between 20 and 80 nits. The lower value, 20 nits, is consistent with the value deduced from recommended maximum contrast ratios and typical roadway luminances. The higher value, 80 nits, will present drivers with a contrast ratio of

about 80:1, yet is approximately comparable to typical practice for floodlit billboards. In The IESNA Lighting Handbook (9th edition), Figure 17-37 Recommended Luminances for Poster Panels, Painted Bulletins, and Other Advertising Signs recommends illumination levels that are consistent with luminances of 45 – 111 nits[2].

Thus, we suggest that a regulated maximum luminance for any type of sign visible from a roadway, digital LED billboard or other, should not exceed 100 nits in an urban environment. Though it can be easily argued that this value is too high, this limit would be consistent with the vast majority of commercial floodlit billboards in use today, and at least would not increase potential degradation of drivers' vision above levels experienced with current floodlit billboards. As the adaptation state of drivers' eyes is generally dominated by the luminance level of the roadway illuminated by headlights, that is around one nit, it may not be necessary to require lower sign luminances in darker surroundings.

The Outdoor Advertising Association of America Report and Recommendation

To formulate its own recommendations for sign luminance limits, the Outdoor Advertising Association of America commissioned a study (Lewin, 2008; hereafter referred to as the OAAA report). This report describes "a method for specification of luminance limits for digital billboards based on accepted practice by the Illuminating Engineering Society of North America (IESNA)." Based ultimately on considerations of "light trespass," as developed in another report *(IESNA TM-11-00 Light Trespass: Research, Results and Recommendations)*, a recommended "brightness" limit and measurement technique is presented. The technique uses an illuminance meter ("footcandle" meter) held at a height of 5 feet above the ground and a distance of between 150 and 350 feet from the sign under consideration, depending on the size of the sign, and aimed at the sign. The illuminance level with the sign lighting on is compared with a measure made with the sign off: if the value differs by 0.3 foot candles or less the author proposes that the sign brightness is at an acceptable level. Though direct luminance measures or limits are not suggested in this proposed regulatory strategy, the report indicates that this method effectively limits the luminance of signage to 300-350 nits.

Issues with the OAAA Report

The OAAA proposed luminance levels are too high, about ten or more times as bright as recommended in most IESNA recommended practices, and three or more times as bright as current accepted practice reflected in billboard floodlighting. They would present drivers with contrast ratios of 300:1 or more. This is unnecessary for advertising effectiveness and unnecessarily risks roadway safety. Further, the OAAA recommendations are consistent with only the highest values gleaned from the IESNA literature, and inconsistent with IESNA recommendations for roadway signs and maximum contrast ratios to minimize transient adaptation problems.

Besides potentially serious practical issues associated with the measurement procedure proposed in the OAAA report (e.g. the location for the suggested measurement may often lie within roadways; determining compliance requires switching the sign on-and-off), there is a fundamental conceptual error in the approach used to develop the strategy and limits.

---

[2] IESNA recommended illuminance of 200-500 lux for light copy in dark-light surrounds combined with assumed diffuse sign reflectance of 0.70.

The details of *IESNA TM-11-00* are critical to understand if the results of that study are being appropriately applied to the problem of determining maximum sign luminances. In the study, a group of observers was presented with a variety of very brightly illuminated (2000 to 7500 nits) panels and asked to judge whether or not the panels seemed too bright. An in-depth review is beyond the scope of this discussion, but the following point is critical: the observers were asked only to rate how "objectionable" they found the illuminated panels to appear; no evaluation of visual performance - the ability to see objects or read signs - was attempted. This alone brings into serious question the applicability of theTM-11-00 study to the question of appropriate sign brightnesses, and their potential impact on driver safety.

The fundamental approach of the OAAA report has confused lighting that has been judged to cause an acceptable level of light trespass or even just an "objectionable" sensation with the much more vital issue of sign lighting that compromises the vision and therefore safety of drivers. The ability to see and light trespass/objectionability are essentially unrelated. The OAAA report recognizes this, stating "Digital billboards are not the form of lighting that TM-11-00 was developed to limit." Yet the OAAA report does just that.

Transient adaptation, and not light trespass, or "objectionability," is the overriding concern for public safety with regard to the brightness of signage.

References

IESNA, *RP-20-98 Lighting for Parking Facilities,* 1998

IESNA, *RP-33-99 Lighting for Exterior Environments, An IESNA Recommended Practice,* 1999

IESNA, *IESNA TM-11-00 IESNA Technical Memorandum on Light Trespass: Research, Results and Recommendations*

IESNA, *The IESNA Lighting Handbook, 9th Edition,* M. Rea (ed.), 2000

IESNA, *ANSI/IESNA RP-8-00 American National Standard Practice for Roadway Lighting,* 2000

IESNA, *IESNA RP-19-01 IESNA Recommended Practice for Roadway Sign Lighting,* 2001

Lewin, I., *Report to: Outdoor Advertising Association of America; Subject: Digital Billboard Recommendations,* Lighting Sciences Inc., Scottsdale, Arizona, 2008

Appendix A

Floodlit billboard luminance measurements presented in this report.

Number	Advertisement	Location	AddressLocation	Luminance (nits)	Notes
1	Miracle Auto Painting	Tempe, AZ	Tempe Marketplace	103	1
2		Chandler, AZ	202 @ McClintock Dr.	235	1
3	ClearChannel	Ahwatukee, AZ	I-10 between Ray and Chandler	114	1
4	Naumann Hobbs	Phoenix, AZ	I-10 & 43rd St.	174	2
5	Fry's	Tempe, AZ	Tempe Marketplace	124	2
6	Bankruptcy/Divorce	Phoenix, AZ	2511 W Indian School	82	2
7	Hastings & Hastings	Phoenix, AZ	I-10 & 42nd St.	42	2
8	Cox Cable	Phoenix, AZ	I-10 & 40th St.	23	2
9	Dare to Compare	Phoenix, AZ	Broadway & 40th St.	19	2
10	Select 55 Lightest Beer	Phoenix, AZ	Elwood & 40th St.	103	2
11	Recession 101	Phoenix, AZ	I-10 & 40th St.	100	2
12	100% USDA Fry's	Phoenix, AZ	Illini & 38th St.	71	2
13	MHM Inc.	Phoenix, AZ	I-10/7th St.	33	3
14	The Experts	Phoenix, AZ	I-10/7th St.	63	3
15	WhataBurger	Phoenix, AZ	I-10/Central Ave.	26	3
16	Univ. of Arizona	Phoenix, AZ	I-10/Central Ave.	40	3
17	Cricket	Phoenix, AZ	I-10/Central Ave.	44	3
18	Run Wild	Phoenix, AZ	I-10/Central Ave.	10	3
19	Kimberly-Clark	Phoenix, AZ	I-10/7th Ave.	75	3
20	Alcock	Phoenix, AZ	I-10/7th Ave.	70	3
21	Flying J	Phoenix, AZ	I-10/7th Ave.	60	3
22	Thirst – McDonalds	Phoenix, AZ	I-10/7th Ave.	30	3
23	Univ. of Arizona	Phoenix, AZ	I-10/7th Ave.	70	3
24	Arizona Heart Inst.	Phoenix, AZ	Durango Curve	53	3
25	Bud Select	Phoenix, AZ	Durango Curve	10	3
26	Park University	Phoenix, AZ	Durango Curve	57	3
27	Geico	Phoenix, AZ	Durango Curve	28	3
28	Michelob	Phoenix, AZ	Durango Curve	73	3
29	Cabella	Phoenix, AZ	22nd Ave. – I-10	24	3
30	Location	Phoenix, AZ	22nd Ave. – I-10	48	3
31	Burger King	Phoenix, AZ	22nd Ave. – I-10	25	3
32	AAA	Phoenix, AZ	16th Ave. - I-10	6	3
33	Buick	Phoenix, AZ	16th Ave. - I-10	45	3
34	Lowes	Phoenix, AZ	16th Ave. - I-10	50	3
35	AZ Lottery	Phoenix, AZ	16th Ave. - I-10	32	3
36	Landshark	Phoenix, AZ	16th Ave. - I-10	70	3
37	Qwest Espanol	Phoenix, AZ	11th Ave - I-10	30	3
38	Dex	Phoenix, AZ	11th Ave - I-10	15	3
39	Ronald McDonald	Phoenix, AZ	11th Ave - I-10	18	3
40	Coors Light	Phoenix, AZ	11th Ave - I-10	45	3
41	Senior Care	Phoenix, AZ	7th Ave. – I-10	30	3

42	KTAR	Phoenix, AZ	7th Ave. – I-10	35	3
43	Cancer	Phoenix, AZ	7th Ave. – I-10	40	3
44	Geico	Phoenix, AZ	Central – I-10	36	3
45	St. Lukes Espanol	Phoenix, AZ	Central – I-10	60	3
46	L4D	Phoenix, AZ	Central – I-10	10	3
47	Run Wild	Phoenix, AZ	Central – I-10	16	3
48	Easy Street	Phoenix, AZ	Central – I-10	42	3
49	PHX Zoo	Phoenix, AZ	Central – I-10	50	3
50	Left 4 Dead	Phoenix, AZ	7th St. – I – 10	6	3
51	Bud Light	Phoenix, AZ	7th St. – I – 10	60	3
52	Mc Donalds	Phoenix, AZ	7th St. – I – 10	60	3
53	U of Phx Espanol	Phoenix, AZ	7th St. – I – 10	46	3
54	Chipotle	Phoenix, AZ	7th St. – I – 10	56	3
55	Droid	Phoenix, AZ	16th St. – I-10	46	3
56		Plainfield, IL	12040 Aero Dr.	76	4
57		Plainfield, IL	12501 S Rte. 59	46	4
58		Naperville, IL	3004 111th St.	68	4

Notes: 1 measured by P. Scowen; 2 measured by J. and T. Polakis; 3 measured by H. Israel; 4 B. Radner, Assistant Director, Will County Land Use Department, Memorandum 1 November 2010