Night Time Satellite Image
2012 Annual Average

Map shows the Urban Growth Boundaries of Bend, Redmond, La Pine and Sisters

Notes: Night time satellite images taken between 1:30 AM – 2:30 AM show the lighted areas. This image is an average of all night time images for 2012. Compare with the next image that shows the average night time situation in 2020.
Night Time Satellite Image
2020 Annual Average

Map shows the Urban Growth Boundaries of Bend, Redmond, La Pine and Sisters

Radiance Measured
nanowatts/cm²/steradian

0
.25
.50
.75
1.00

Notes: This image is an average of all night time images for 2020. Compare with the previous image that shows the average night time situation in 2012. Night time satellite images are used to calculate the skyglow expected from the lit up areas. IDA Oregon contracted with a specialist company, Night Sky Metrics LLC, to calculate the skyglow expected. See the next two slides.
Notes: This is the “All-Sky Average Light Pollution Ratio” map for 2012. The colors and contours represent the ratio between a light polluted and pristine night sky. Ratio values higher than 2.00 are considered to represent “ruined sky”. Ratio values lower than 0.25 are considered good, starry night sky. In between those two contours, the night sky is considered threatened or compromised.
Notes: This is the “All-Sky Average Light Pollution Ratio” map for 2020. The light pollution has spread by comparison to 2012 – compare with the previous slide. The 2.00 contour now encompasses more area. The 0.25 contour has moved outward. The patch of pristine night sky in the lower right of the 2012 map has gone away.
Compare 2012 and 2020 Models

Notes: The light pollution ratio contours from both 2012 and 2020 are displayed on a Google Earth background. The 0.25 contour has expanded about 4 miles outward over 8 years, about one-half mile per year, extending the zone of threatened sky.
The skyglow calculations are conservative – the reality is worse because:

Reality #1  Satellite doesn’t see the blue in the spectrum of white lights
  • Many lights such as white LEDs emit a significant amount of blue light in their spectrum
  • Blue light scatters more than green, yellow and red parts of the visible spectrum
  • However, the satellite does not see the blue visible light from each lamp

Reality #2  Satellite pixels are large and will not pick up sparse lights
  • There are many widely separated lights in rural areas which contribute to skyglow
  • The satellite looks with large pixels – about 500 meters x 500 meters
  • The satellite may not be sensitive enough to see the widely separated lights

Reality #3  Satellite images exclude cloudy nights, but clouds multiply the skyglow
  • Cloudy nights are excluded from the satellite images
  • Clouds reflect back downward the artificial light at night coming up from the ground
  • Glow downward from clouds is 10x or more brighter than skyglow during clear nights
These Skyglow Models -

Are based on

• All-Sky light pollution - not just at the zenith, but entire hemisphere, down to horizon
• Cloud-free night time satellite images from NASA’s VIIRS Sensor
• Model of light scattering by the atmosphere
• Atmosphere characteristic of Western US desert areas
• Distance to light sources calculated via Geographic Information System
• No topographic blocking or highlighting
• Calibration by National Park Service measurements of hemispheric sky luminance and zenith sky luminance measurements

\[
\text{ALR} = \frac{\text{Sky Luminance} - \text{Pristine Sky Luminance}}{\text{Pristine Sky Luminance}}
\]

\[
\text{ALR} = \frac{\text{Sky Luminance} - 250 \text{ micro Candelas/meter squared}}{250 \text{ micro Candelas/meter squared}}
\]

The method is described in this publication: “A simplified model of all-sky artificial sky glow derived from VIIRS Day/Night band data”, 2018.

How can we minimize light pollution? -- Adopt the Five Principles for Responsible Outdoor Lighting

**LIGHT TO PROTECT THE NIGHT**  
Five Principles for Responsible Outdoor Lighting

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
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| **USEFUL** | ALL LIGHT SHOULD HAVE A CLEAR PURPOSE  
Before installing or replacing a light, determine if light is needed. Consider how the use of light will impact the area, including wildlife and the environment. Consider using reflective paints or self-luminous markers for signs, curbs, and steps to reduce the need for permanently installed outdoor lighting. |
| **TARGETED** | LIGHT SHOULD BE DIRECTED ONLY TO WHERE NEEDED  
Use shielding and careful aiming to target the direction of the light beam so that it points downward and does not spill beyond where it is needed. |
| **LOW LIGHT LEVELS** | LIGHT SHOULD BE NO BRIGHTER THAN NECESSARY  
Use the lowest light level required. Be mindful of surface conditions as some surfaces may reflect more light into the night sky than intended. |
| **CONTROLLED** | LIGHT SHOULD BE USED ONLY WHEN IT IS USEFUL  
Use controls such as timers or motion detectors to ensure that light is available when it is needed, dimmed when possible, and turned off when not needed. |
| **COLOR** | USE WARMER COLOR LIGHTS WHERE POSSIBLE  
Limit the amount of shorter wavelength (blue-violet) light to the least amount needed. |

Notes: These five principles are the cornerstone of responsible outdoor lighting. They emphasize outdoor lighting for safety and quality of life – by preventing light trespass, by eliminating over-lighting which produces sharp dark shadows and glare, by encouraging smart lighting and warm colored light which is more beneficial to the ecosystem than blue-rich white light. Deschutes County can improve night time safety and quality of life by adopting these principles.