



The Patagonia Mountains are an area of great natural beauty with abundant habitat for wildlife. They attract many visitors interested in birding and astrotourism. The oldest science, Astronomy, has been practiced for decades at many sites in Santa Cruz County. We must be forward thinking and protect this patrimony for future generations.

Mining activity will unavoidably disturb the environment. It must be managed by mitigating its impacts and pursuing sustainability. The operations at South32 Hermosa could be detrimental to human activity, ranging from visitors to astronomical research, unless measures are implemented to protect the night sky.

Below we provide comments on the MPO text that refer to dark sky. We then provide a description of the impact of the current impact of the mine operations that started before the NEPA process. Finally we describe the likely future impacts of the mine operations, and ways to minimize them.

Comments on the MPO text

Dark sky is paid only cursory attention in the MPO. Below are comments on the two sections of the MPO that refer to dark sky.

p. 3.11:

SR7 – Outdoor lighting plan. *Hermosa Hermosa will develop and implement an outdoor lighting plan to reduce impacts from artificial night lighting, reducing illumination levels where appropriate while still meeting MSHA requirements for lighting sufficient to provide safe working conditions.*

Without a detailed plan for all the outdoor lighting from the mine, it is impossible to estimate its impacts on the brightness of the night sky. The plan must indicate what measures will be taken by the mine to mitigate these impacts. Such a plan must be developed and made public before the MPO is accepted by the Forest Service.

p. 3.14:

FW9 – Biodiversity management. *South32 Hermosa manages biodiversity by evaluating potential impacts to biodiversity and identifying controls and best management practices to*

avoid, minimize, rehabilitate, and offset those impacts and work to achieve South32 Hermosa's goal of preventing long-term loss of biodiversity values and ecosystem services. Additionally, South32 Hermosa complies with relevant federal, state, and local environmental regulations, including but not limited to the Endangered Species Act, the National Forest Management Act, the Clean Water Act, the Migratory Bird Treaty Act, the Arizona Native Plant Law, and Arizona Department of Agriculture regulations regarding noxious weeds. Measures implemented pursuant to this plan to avoid or minimize impacts to sensitive fish and wildlife resources include:

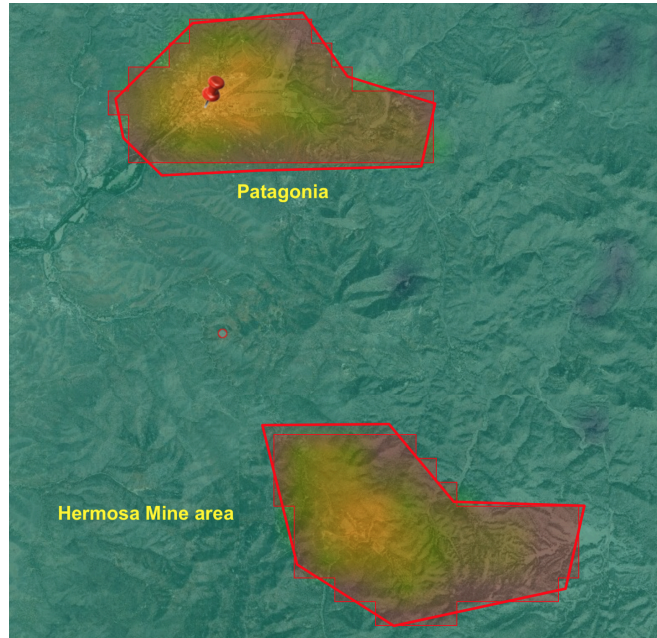
- ***FW9C – Low impact design.*** *Infrastructure improvements incorporate design features that promote biodiversity plan goals by minimizing impacts to sensitive wildlife species or populations. Examples include: dark sky measures to reduce or minimize artificial night lighting to reduce impacts to migrating birds, bats, and moths; design considerations of bridges and culverts that can maintain habitat connectivity and reduce wildlife-vehicle collisions; fencing designed to address wildlife concerns; and avian protection measures included in the design, construction, and maintenance of overhead electric transmission and distribution lines that can minimize or eliminate impacts to avian birds of prey (raptors).*
- This is the only place where “dark” is mentioned in the MPO. The EIA requires a detailed plan rather than generalities, otherwise the impacts cannot be ascertained. The MPO must provide a complete lighting plan designed by an expert designer.
- The MPO is not explicit, but from its Figure 2-1, by counting the triangle symbols for drilling sites, there will be 26 such sites, each with a light plant. To determine the impact of these lights on the night sky brightness the MPO must include the type of lights, the type of luminaires, which must be fully shielded, the initial lumens of these lights, and their color temperature.
- FW9: “values” and “services” are vague concepts. The MPO does not state what South32 will actually do. The MPO states that South32 will evaluate impacts and identify controls and best management practices. Regarding dark sky, these controls and management practices are well known. It also avoids stating that it will IMPLEMENT these controls and practices and how. Stating it will comply with regulations is an empty promise as no specifics are given. For example, this section should list what should be an essential management practice: what strategies will be used to avoid areas with high biodiversity value or critical habitats and specify these areas in the MPO.

South32 Hermosa lighting impact since 2017

The outdoor lighting in use for current South32 Hermosa operations is already having an impact in the area surrounding the Patagonia Mountains. We extracted data acquired by the VIIRS/DNB satellite, which covers the earth each night. It measures the light emitted (radiance) upward at visual wavelengths. Figure 1 depicts the town of Patagonia and the Hermosa Mine

areas. The red outlines are the areas where we extracted the satellite data I show below. The yellow color indicates significant light emission.

Figure 1



The plot in Figure 2 shows the light emitted (radiance) from the town of Patagonia between 2013 and mid-2024. Each point in the plot is a monthly average. Over this period, the radiance from the town decreased from 60 to about 50 nW/cm²/sr.

Figure 2: Town of Patagonia

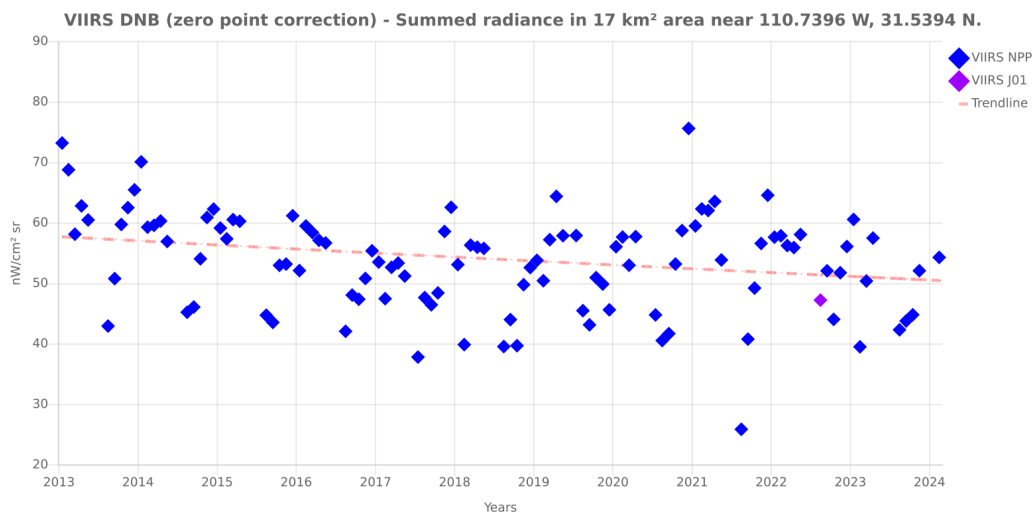
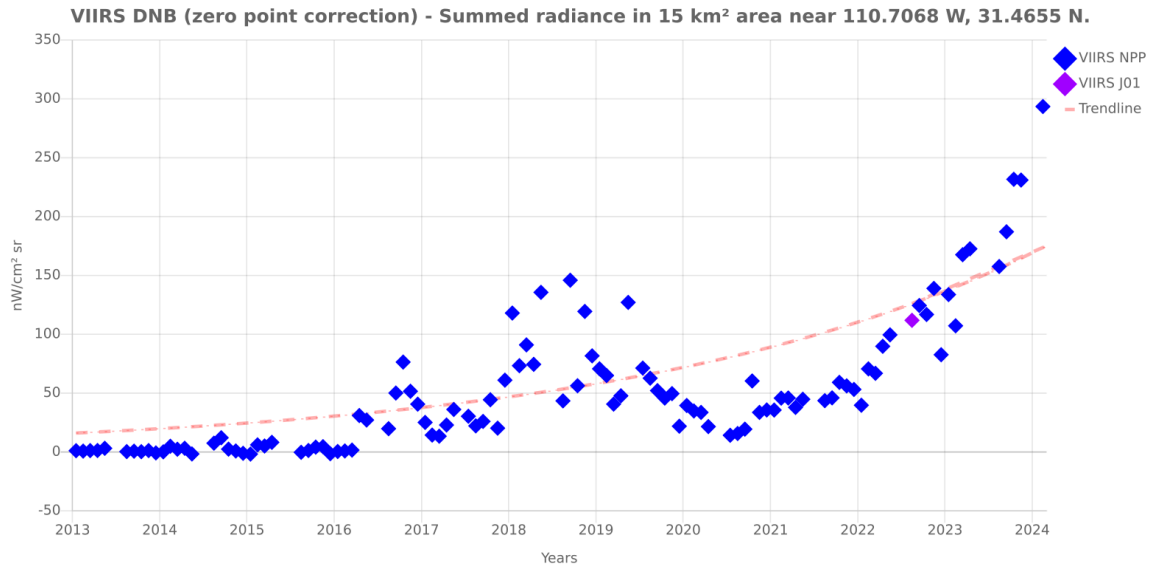


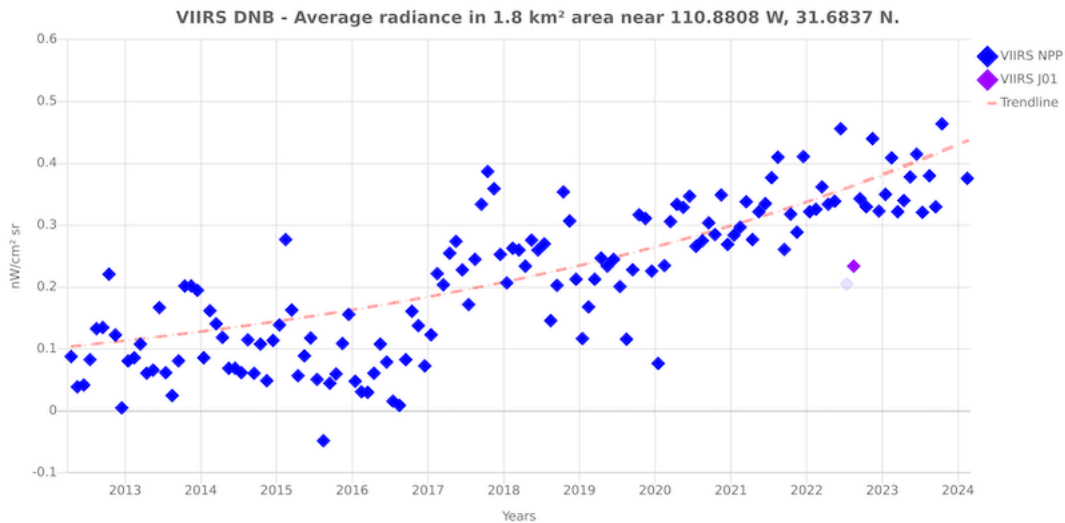
Figure 3 plots the radiance from the mine area shown in Figure 1 between 2013 and mid-2024. Each point in the plot is a monthly average.

Figure 3: South32 Hermosa Mine area



From Figure 3, the radiance from the mine area was small until mid-2016, when it suddenly surged, then it surged to twice its previous peak, then it decreased to a still significant level in 2020 and finally it ramped up by a factor of 15, to about 6 times the current radiance for the whole town of Patagonia.

Figure 4: F. L. Whipple Observatory



From Figure 4, due to its proximity to the mine site, the Smithsonian Astrophysical Observatory's F. L. Whipple Observatory (FLWO) on Mt Hopkins appears impacted by these lights. The radiance at FLWO started low, as befits a dark site for astronomy. However, in mid-2016, the radiance rose sharply, just as South32 Hermosa started exploration operations, and as its radiance started increasing (Figure 3). The radiance remains fairly low, but it has

grown so far by an alarming factor of 4. There are no other sources of light near FLWO that brightened by as much as the mine area, so it appears that the light from the mine operations is the cause of this brightening.

Lighting impacts: the environment and the economy

Light pollution from artificial light at night has wide-ranging environmental and social consequences,¹ impacting wildlife, energy consumption, and public safety, especially in disadvantaged communities.² Despite the advent of highly energy-efficient lighting technologies, much of the outdoor light at night we use is wasted.³ These are some of its consequences:

- Disruption of Ecosystems
 - Wildlife Behavior: Many animals rely on natural light cycles for their behavioral patterns. For example, nocturnal animals become disoriented and more vulnerable to predators when exposed to artificial light. Artificial light with excess blue is most disruptive to wildlife behavior.⁴
 - Insect Populations: Artificial lights attract and often kill insects, disrupting food webs because insects are key pollinators and a crucial food source for many other species.
 - Migratory Patterns: Birds and other migratory species are confused by artificial lights, leading them off course or causing collisions with illuminated structures. This is no small matter: the Cornell Lab of Ornithology estimates that about 15 million birds migrated across Santa Cruz County so far this year.
 - Photoperiodism: Plants rely on the length of day and night to regulate their life cycles. Artificial light interferes with these processes, affecting flowering, seed germination, and growth cycles.
 - Ecosystem Imbalances: Changes in plant behavior due to artificial light have cascading effects on entire ecosystems, affecting herbivores and the predators that depend on them.
- Human Health and Well-being
 - Circadian Rhythms: Artificial light disrupts human circadian rhythms, leading to sleep disorders, stress, and other health issues. This also affects productivity and overall well-being.
 - Mental Health: There is growing evidence linking exposure to artificial light, particularly blue light from screens, to mental health issues like depression and anxiety.

¹ For a comprehensive evidence summary, see DarkSky International, "[Artificial Light at Night: State of the Science 2023](#)"

² Nadybal, S.M., Collins, T.W. and Grineski, S.E. (2020). [Light pollution inequities in the continental United States: A distributive environmental justice analysis](#). *Environmental Research* (Vol. 189, p. 109959).

³ DarkSky International estimates that at least 30 percent of outdoor light at night in the U.S. is wasted, worth at least \$4.5 billion per year.



⁴ [Longcore \(2023\)](#) shows that many animals are most sensitive to blue, shorter wavelengths of light.

- Energy Waste
 - Carbon Footprint: Excessive use of artificial light consumes excess energy, leading to excess carbon emissions and environmental degradation.
 - Resource Depletion: Generating the required electricity for artificial lighting generally involves the burning of fossil fuels, which depletes natural resources and contributes to pollution and climate change.
- Aquatic Environments
 - Freshwater Systems: Light pollution affects the behavior of fish and other aquatic organisms, potentially altering predator-prey dynamics and ecosystem health.
- Economic Activity
 - Santa Cruz County: a choice birding and astrotourism destination for visitors from all over the world, owing to its still nearly pristine dark skies. Protecting the night sky by managing all lighting is essential to maintaining and promoting these activities.

Among the different forms of pollution, light pollution is the easiest one to control. The consequences listed above can be mitigated by following five principles that DarkSky International and the Illuminating Engineering Society advocate:

Five Lighting Principles for Responsible Outdoor Lighting




Responsible outdoor lighting is	1 Useful	<p>Use light only if it is needed</p> <p>All light should have a clear purpose. Consider how the use of light will impact the area, including wildlife and their habitats.</p>	
	2 Targeted	<p>Direct light so it falls only where it is needed</p> <p>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.</p>	
	3 Low Level	<p>Light should be no brighter than necessary</p> <p>Use the lowest light level required. Be mindful of surface conditions, as some surfaces may reflect more light into the night sky than intended.</p>	
	4 Controlled	<p>Use light only when it is needed</p> <p>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.</p>	
	5 Warm-colored	<p>Use warmer color lights where possible</p> <p>Limit the amount of shorter wavelength (blue-violet) light to the least amount needed.</p>	

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