Fact Sheet: Solar and Surface Water Quality

GREAT PLAINS INSTITUTE

Ground-mounted solar arrays challenge our traditional understanding of the relationship between impervious surfaces and stormwater management practices; over 90 percent of a solar farm is vegetated ground cover despite almost half the land being covered by solar panels. Research shows that engineered stormwater infrastructure may not be needed under some site conditions and solar site designs. When sited on farmland, utility-scale solar farms have the potential to provide local water quality benefits. With the correct design standards, solar frequently improves watershed function relative to conventional agriculture.

What is stormwater management?

Stormwater management is the practice of slowing, infiltrating, or storing surface water runoff to limit localized flooding, reduce erosion, and protect surface water quality. Impervious surfaces (e.g., parking lots, roofs) are used as a metric to measure the impact of development on local waterbodies and to design appropriate standards and regulations.

Key things to know:

- Solar farms can improve local surface water quality, serving as "green infrastructure" (e.g., rain gardens, native ground cover, etc.), when they are properly designed and replace certain land uses (e.g., conventional agriculture).
- Four primary factors affect water quality on solar sites: (1) soil compaction, (2) soil depth, (3) ground cover, and (4) disconnection (i.e., spacing of solar arrays).
- Communities or state agencies can capture the water quality co-benefits of solar and provide transparent and predictable permitting by attending to these factors in stormwater regulation and site design.

Example: Utility-scale solar as a surface water quality solution in agricultural communities

Stormwater runoff can pose significant risks to local surface water quality by carrying nutrients such as fertilizers. Non-point pollution, such as runoff, is the primary reason for diminished water quality in both urban and rural areas.

In rural areas, replacing conventional agriculture land uses with solar arrays and native, deep-rooted perennial vegetation can reduce phosphorus loads to nearby rivers and lakes by 75–95 percent[1] and sediment export by 90–98 percent.[2]

Not recognizing this potential in stormwater permitting processes can lead to higher costs for developers and result in the use of farmland to construct unneeded stormwater infrastructure.[3]

[1] Clean Wisconsin, *Local Environmental Benefits of Solar Farming in Wisconsin* (Clean Wisconsin, 2025), 14.
[2] Leroy J. Walston et. al, "Modeling the ecosystem services of native vegetation management practices at solar energy facilities in the Midwestern United States," *Ecosystem Services* 47 (2021).
[3] Brian Ross, Aaron Hanson, David Mulla, et al., *Best Practices: Photovoltaic Stormwater Management Research and Testing (PV-SMaRT)* (Great Plains Institute, January 2023), 4.

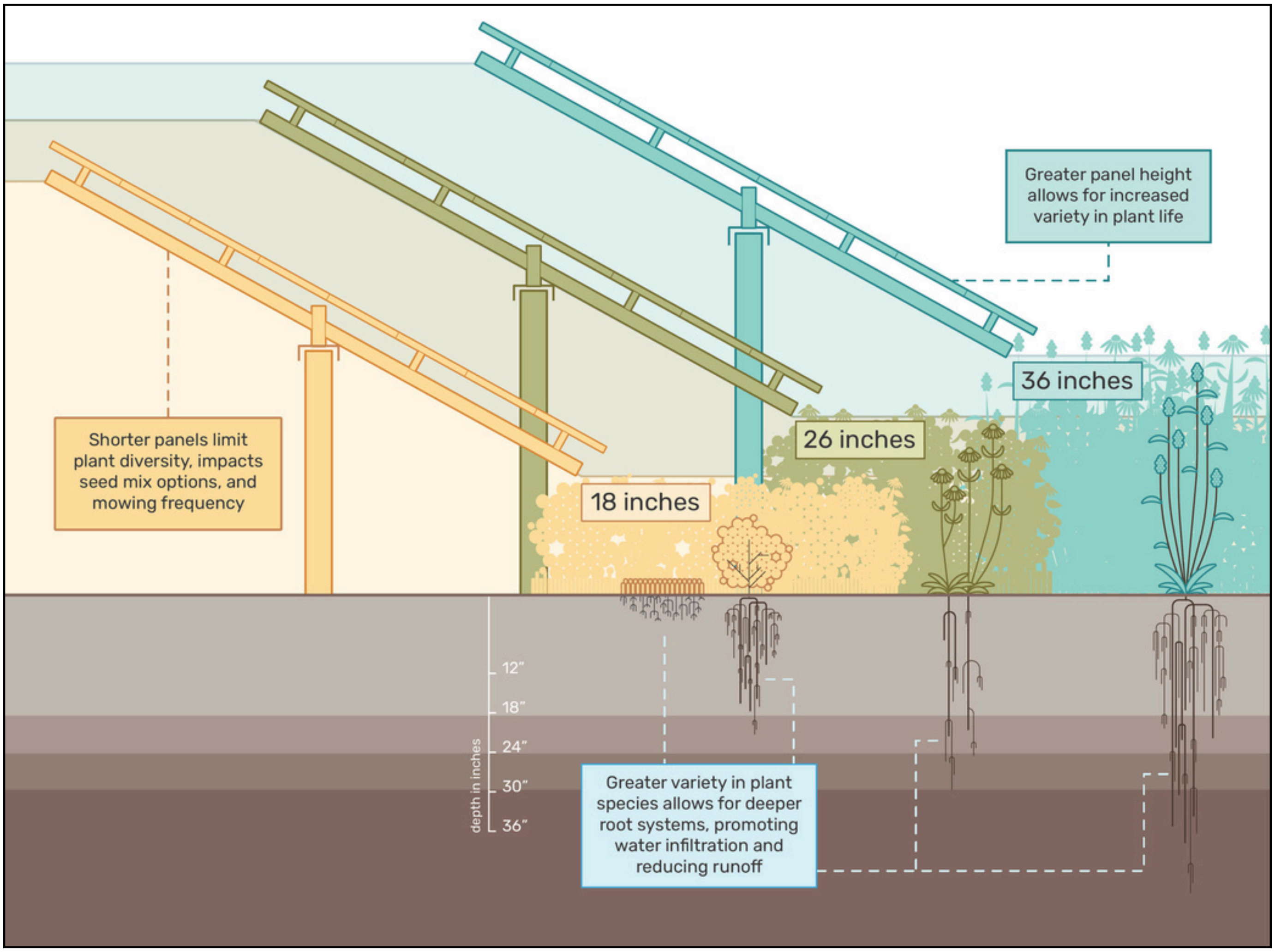

Figure 1. Solar panel height impact on vegetation. Illustration by Kay Rossback, reprinted from Ross, *Best Practices: Photovoltaic Stormwater Management Research and Testing (PV-SMaRT)*, 12. Increasing panel height allows for a wider range of deep-rooted vegetation to grow, slowing runoff and improving infiltration.

Four primary factors for water quality on solar sites

Extensive fieldwork and modeling performed by the Photovoltaic Stormwater Management Research and Testing (PV-SMaRT) project identified the following factors as influencing water quality on solar sites:

1. **Soil compaction.** Compacted soil between arrays can double the amount of runoff. Looser soil increases infiltration and improves the establishment of vegetation.
2. **Soil depth.** Depth of the "rooting zone" for plants indicates the site's ability to absorb and hold water. Half a meter of soil depth has 78 percent more runoff than a soil depth of 1.5 meters.
3. **Ground cover.** The type of vegetation and vegetation maintenance used on a site greatly impacts local water quality. Vegetation with shallow roots or intermittent density (e.g., mowed turf grass or poorly managed row crops) has 38 percent greater runoff compared to well-established, native vegetation. Native ground cover also provides co-benefits such as habitat, visual interest, and pollination services for agricultural fields.
4. **Disconnection.** Disconnection accounts for the space between rows of arrays. The larger the disconnection (i.e., distance) between solar arrays, the greater the infiltrative capacity of a site.[5]

[4] Ross et al., *Best Practices: Photovoltaic Stormwater Management Research and Testing (PV-SMaRT)*, 6-12.

Resources on solar and surface water quality

- **PV-SMaRT best practices guide for stormwater management at ground-mounted solar PV sites**: https://betterenergy.org/wp-content/uploads/2023/01/PV-SMaRT-Best-Practice.pdf
- **National Renewable Energy Laboratory (NREL) PV-SMaRT website:** https://www.nrel.gov/solar/market-research-analysis/pv-smart
- **PV-SMaRT stormwater-runoff calculator for solar PV sites** (University of Minnesota): https://license.umn.edu/product/pv-smart-solar-runoff-calculator-version-30
- **Webinar summarizing PV-SMaRT work, including a demonstration of how to use the stormwater-runoff calculator** (Fresh Energy): https://www.youtube.com/watch?v=bfwL_2inbpY

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