Appendix L - Quantifying Pollutant Credits for Solar Farms

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Large-scale solar arrays have gained popularity amongst energy utilities in recent years due to multiple technological and cultural factors. Arrays are often grouped together in large installations that can cover several hundred acres or more. Installations are typically set in rural locations on land previously used for agriculture – giving rise to the term "solar farm." From a hydrologic perspective, solar farms can be best characterized as disconnected impervious areas surrounded by vegetation. The solar panels can be either fixed or tilt at varying angles to track the sun's position. As for a pollutant load associated with total phosphorus (TP) or total suspended solids (TSS), the principal pollutant source on a solar panel is air deposition. This is similar to a residential roof source area in the model WinSLAMM (http://www.winslamm.com/). TP and TSS sources include runoff from vegetated areas, any areas with active erosion, and impervious areas associated with access roads and other infrastructure that may be present at the site.

Agricultural land may be taken out of traditional row cropping agriculture to establish a solar farm and realize other environmental benefits. A WPDES permit is required covering the construction of the solar farm as well as outlining the post construction requirements to comply with both chs. NR 216 and NR 151, Wis. Adm. Code.

1.1 Challenges Quantifying Runoff and Pollutant Loads

Solar farms neither fit into traditional urban land use definitions nor can they be characterized as undeveloped due to the impervious area associated with the solar panels and any supporting infrastructure including access roads, buildings, or parking. Two models typically used to simulate either urban or agricultural areas offer potential assistance.

SnapPlus (https://snapplus.wisc.edu/) can simulate agricultural land and land in perennial vegetation such as prairies. It can account for the soil type, slopes, vegetation management, and nutrient concentration of the soil. It is unable to account for the impervious area associated with the solar farm.

WinSLAMM can simulate the impervious areas and could approximate the impervious area associated with the solar panels. The model can simulate turf grass but is unable to directly simulate prairie plants or other vegetation types. Soils are limited to three main classes (sandy, silty, and clayey) and the erosion process cannot be simulated. The nutrient concentration of the soil is fixed.

1.2 Modeling Options

For areas of the site not covered by the WPDES permit (i.e. areas not graded, disturbed, or used for solar panels and supporting infrastructure), credits can be calculated by comparing the existing land use to the final land use condition. In most cases it is anticipated that this will entail converting agricultural land to some sort of perennial vegetation. The baseline level of pollution loading for an agricultural setting can be calculated using SnapPlus. The pollutant loading associated with a perennial vegetation scenario can also be calculated with SnapPlus. The difference between the two scenarios' pollutant loading can be used as a pollution reduction and can be eligible for generating water quality trading credits.

For areas covered under the WPDES permit, credits are generated by reducing pollutant loads below levels that would otherwise occur when meeting the WPDES permit requirements. This potential reduction may be quantified by using SnapPlus to model baseline compliance with permit requirements to define the applicable credit threshold.

Solar Panels: The impervious areas created by solar panels are not accounted for in the SnapPlus model. However, by adequately disconnecting the impervious area created by the solar panels, the cumulative effect of imperviousness can be minimized. This is possible because the impervious area of the solar array directly discharges to a vegetated pervious area underneath the next-downslope panel.

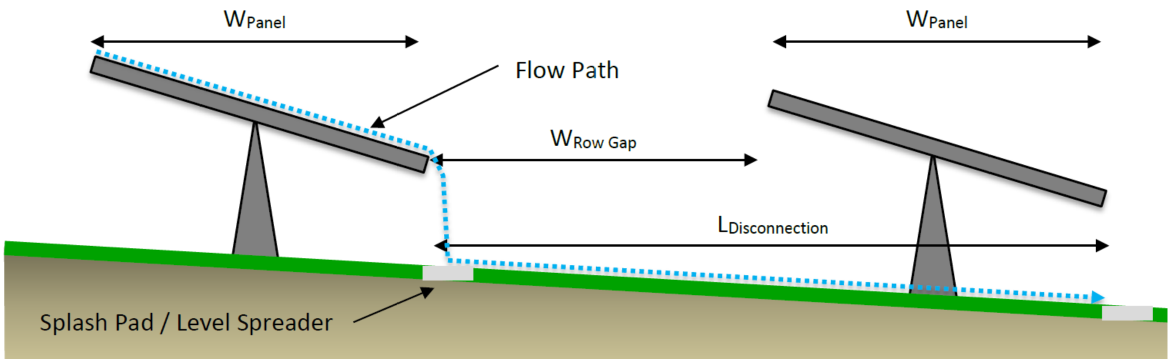

FIGURE L1: PROFILE OF SOLAR PANEL ARRAY PROVIDING IMPERVIOUS AREA DISCONNECTION (OHIO EPA, GUIDANCE ON POST-CONSTRUCTION STORM WATER CONTROLS FOR SOLAR PANEL ARRAYS)

Several measures must be taken at solar installations to minimize the cumulative effect of impervious surfaces to maintain applicability of SnapPlus modeling:

- Adequate panel spacing: Maintain row gaps consistent with WDNR permitting guidance.
- Panel orientation: panels should be oriented perpendicular to any slope to adequately disperse runoff.
- Infiltration below panels: Runoff from up-slope panels should be able to infiltrate under the next down-slope row.
- Maintain sheet flow: Concentrated flow paths are not modeled by SnapPlus, therefore, any concentrated flow that occurs may cause pollutant loading beyond what the modeling can quantify. The drip line of each row should be adequately protected to prevent formation of depressions, gullies, or mobilization of sediment. A splash pad or level spreader may be employed to diffuse water along each row’s drip edge.
- Limit the footprint of other infrastructure: Impervious roads and buildings will create runoff beyond what SnapPlus can quantify. These features should not be located on fields that are being modeled in SnapPlus.

1.3 Calculating the Credit Threshold

As previously mentioned, the baseline pollutant loading for a solar farm is compliance with WPDES permit requirements. Pollution reductions that occur due to measures that go beyond compliance are eligible to generate water quality trading credits. Therefore, a pollutant loading value associated with compliance must be calculated.

The assumed minimum vegetative cover to maintain WPDES compliance is turf grass. Therefore, existing agricultural field parameters should be entered into SnapPlus (slopes, soil test results, etc.) with cropping practice changed to ongoing grass as “Sod, established”. Once the model is populated, run the “P Trade Report” to obtain annual pollution loading values.

The same field parameters should be used to complete a second model run, but with the trade-related enhanced conditions in place of “Sod, established” cropping practices. In most cases, this is expected to be perennial prairie vegetation. Select the management status (harvested vs. not harvested) consistent with the management activities planned for the site. Run the “P Trade Report” to obtain pollution loading values from the proposed site conditions. These values can be compared to the compliance-based credit threshold values generated previously based on “Sod, established” to determine the pollution reduction eligible to generate credits.

1.4 Trade Agreement Structure

Section 283.84(1) Wis. Stats., sets forth trade agreement requirements for all water quality trades. Practices that generate credits for water quality trade agreements must be adopted under a valid trade agreement with a credit user or clearinghouse. In many cases, the pollution reduction must occur after the trade agreement has been established. Trade agreements may include provisions for compensation, other resources to support the pollution reducing practices, and provisions for annual maintenance and inspection required by a credit user’s discharge permit.

1.5 Vegetation Requirements

Native prairie vegetation should be established to ensure site conditions are enhanced beyond the credit threshold associated with ch. NR 151, Wis. Adm. Code, compliance. Prairie seed mixtures are available from a number of vendors across the state. When establishing vegetation, follow WI NRCS 327 technical standard. Tables 2 – 7 contain specific seed mix examples that meet species composition requirements.

References

Several references exist outlining methodologies for determining the quantity of storm water retained at various solar panel projects. It should be noted that these references focus more on storm water quantity and not as much on quality.

1. Minnesota Stormwater Manual:
   https://stormwater.pca.state.mn.us/index.php?title=Stormwater_management_for_solar_projects_and_determining_compliance_with_the_NPDES_construction_stormwater_permit

2. Hydrologic Response of Solar Farms:
   “Hydrologic Response of Solar Farms”; Lauren M. Cook, S.M. and Richard H. McCuen, Journal of Hydrologic Engineering, Vol. 18, No. 5, May 1, 2013. © ASCE, ISSN 1084-0699/2013/5-536-541

3. Great Plains Institute "Photovoltaic Stormwater Management Research and Testing (PV-SMaRT) Potential Stormwater Barriers and Opportunities": https://www.betterenergy.org/wp-content/uploads/2021/10/PV-SMaRT-Barriers-and-Best-Practices.pdf