BUREAU OF WATERSHED MANAGEMENT
PROGRAM GUIDANCE

WATERSHED MANAGEMENT TEAM
Storm Water Runoff Management Program

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Post-Construction Storm Water Management for Ground-Mounted Solar

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This document is intended solely as guidance and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

APPROVED:

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Jill Schoen, Acting Director Date
Bureau of Watershed Management

A. Introduction/Statement of Problem Being Addressed

Ground-mounted solar installation projects are becoming increasingly frequent, creating a need for an approach to post-construction storm water management that meets the post-construction performance standards in ss. NR 151.122 to 151.124, Wis. Adm. Code that reflects the unique hydrological conditions created by large areas of ground-mounted solar and is simple to implement.

B. Objectives

This guidance identifies the conditions under which the vegetation under and around ground-mounted solar arrays may be considered a storm water management practice sufficient to satisfy post-construction performance standards. Other approaches to demonstrating compliance with ss. NR 151.121 to 151.124, Wis. Adm. Code, may be used but are likely to require additional documentation and review.

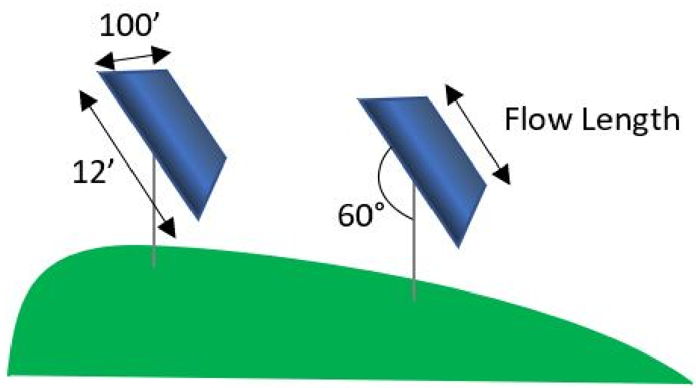
C. Background and Definitions

Ground mounted solar array installations have become increasingly common as a means of power generation in Wisconsin and elsewhere in the country. The size of ground-mounted solar array areas range from a few acres to over 1,000 acres. The area under the solar arrays is generally vegetated, creating a landscape that is a combination of meadow and impervious surface. The former land use associated with newly sited solar array installations is often row crops. Emerging research on the hydrologic response of solar installations has confirmed a reduction in runoff from predevelopment to post-development conditions; however, the research was limited in scope to fixed panel installations and evaluation of only one or two rows parallel to topographical contours.

Current tools used to estimate runoff and pollution control such as P8 and WinSLAMM are tailored to assess the effects of impervious surfaces from classic urban development, while other tools such as SnapPlus are able to better assess pervious areas and different types of vegetation, but are unable to simulate impacts of impervious surfaces.

Post-construction storm water management practices must satisfy the applicable performance standards in ss. NR 151.121 to 151.128, Wis. Adm. Code. The DNR has developed technical standards to assist in the design of practices that meet the performance standards. This guidance is developed specifically to address the performance standards in ss. NR 151.122 to 151.124, Wis. Adm. Code, which cover Total Suspended Solids (TSS), peak flow, and infiltration performance standards for ground-mounted solar arrays and associated gravel access roads. Compliance with the post-construction performance standards must be demonstrated separately for other associated land uses such as parking lots, driveways, and substations.

The conditions in this guidance are based on WinSLAMM modeling of a series of pitched roof source areas in series with vegetated buffer strips and TR-55 hydrologic modeling methodology.



The test case was assumed to be a tracked solar array consisting of two 6’x100’ solar modules (12’x100’ per row) mounted on piles and oriented parallel to topographic contours. The panels were assumed to be oriented at 60 degrees, which is a typical ‘storm stow’ position (i.e., a position in which the panels are oriented to reduce the chance of damage from adverse weather events). One 20-foot-wide by 100-foot-long gravel access road that sheet flows to a 20-foot-wide vegetated area was also included.

Based on a 2010 USGS rain garden study (Selbig et. al., 2010), deep rooted native prairie plantings are associated with measured soil infiltration rates that are 2-3 times that of traditional turf grass. In the modeling used to support development of this guidance, areas planted with deep rooted native prairie were assumed to infiltrate at a rate of twice the design infiltration rate listed in Table 2 of Technical Standard 1002 Site Evaluation for Infiltration for each soil textural class.

The differences between turf and prairie were analyzed for the purpose of defining scenarios with and without pollutant trading with the assumption that prairie will be used in all cases. For information on native prairie plantings, please refer to the following websites and publications:

- https://dnr.wisconsin.gov/topic/endangeredresources/nativeplants.html
- Publication NH 936: *Wisconsin Native Plants - Recommendations for Landscaping and Natural Community Restoration*

Wisconsin DOT, Minnesota DOT, and NRCS have prairie seed mix specifications which may need to be modified depending on the requirements of the solar development. There are also commercially available native seed mixes for Wisconsin from local restoration nurseries and distributors designed to meet solar height requirements.

D. Guidance Content

Satisfy the post-construction performance standards for the vegetation under, between, and around ground-mounted solar arrays within ss. NR 151.122 to 151.124, Wis. Adm. Code, by demonstrating that the following conditions are met:

1. The area under and between the modules is vegetated per DNR Technical Standard “Vegetative Buffer For Construction Sites” (1054).
2. The distance between the lowest point of any panel and the ground is less than 10 feet.
3. Seasonally high groundwater is at least 12 inches below the proposed grade.
4. The ground slope is no steeper than 20%.
5. Flow from the panels is delivered as sheet flow from the solar panels to a well-vegetated prairie planting area. The solar array rows are aligned, to the extent practicable, parallel to topographic contours to limit the potential for concentrated flow along the drip lines. If a drip line will be more than 45 degrees off parallel from topographic contours, implement one of the following measures:
    a. Establish prairie vegetation before module installation. Any erosion observed along the dripline is promptly repaired using erosion control mat per DNR Technical Standard “Non-Channel Erosion Mat” (1052) in conjunction with grading and seeding.
    b. For tracked installations, establish prairie vegetation between module installation and commissioning. Once vegetation is established on one side, rotate the module to allow vegetation to establish under the drip line on the other side prior to commissioning. Any erosion observed along the dripline is promptly repaired. Use Technical Standard 1052 in conjunction with grading and seeding where needed.
    c. Prevent formation of concentrated flow and eroded channels at the dripline. Technical Standard 1052 provides information on the use and installation of turf reinforcement mats, which may be used for this purpose. Technical Standard 1054 provides information on level spreaders.
6. Address soil compaction in the aisles as described in section V.G of DNR Technical Standard “Vegetated Swale” (1005).
7. Meet the peak flow performance standards in s. NR 151.123, Wis. Adm. Code. This may be demonstrated in the following ways:
    a. Compare predevelopment and post-development curve numbers and time of concentration. In determining the post-construction curve number, the procedure for calculating a curve number for disconnected impervious surfaces in TR-55 may be used. Predevelopment runoff curve numbers must not exceed the maximums provided in s. NR 151.123, Wis. Adm. Code for the respective hydrologic soil group. For example, the predevelopment curve number of cover type “woodland” may not exceed a value of 55 for hydrologic soil group B based on the values provided in Table 2 of s. NR 151.123(1), Wis. Adm. Code.

b. Hydrologic modeling assuming the panels are disconnected impervious surfaces shows that the peak discharge from the 1- and 2-year, 24-hour storm events does not exceed the corresponding predevelopment peak discharge.

Note: Turf grass should be assumed for modeling purposes sites where pollutant trading credit generation is planned; however, prairie vegetation is the preferred permanent vegetation.

8. Limit runoff from areas outside solar array areas to the maximum extent practicable. Excess runoff can limit the amount of pollution control provided by the vegetation. A permanent stabilized diversion swale may be needed to keep off-site water from entering the solar array field consistent with DNR Technical Standard "Vegetated Swale" (1005).
9. Include in the materials submitted with the Notice of Intent (NOI): panel length, width, spacing of solar panels, mounting height, and orientation. For panels on tracking systems, please indicate the range of positions including night stow position and storm stow position. If a final decision on panels and tracking systems has not been made at the time of permit application, provide the requested information for all products currently under consideration.
10. Include the vegetation under and around the solar array area as a storm water best management practice in a long-term maintenance agreement per s. NR 216.47(5), Wis. Adm. Code. The maintenance agreement specifies the actions needed to maintain the vegetation in good condition during facility operation including repair of any eroded areas consistent with DNR Technical Standard "Seeding" (1059).
11. The layout of the facility uses one or more of the approaches below based on soil type present in the solar array areas.
    a. The solar array area and buffer area downgradient are planted in deep rooted native prairie species maintained at 6" minimum height. This practice does not generate Pollutant trading credit as the prairie is needed to meet post-construction performance standards. Refer to Table 1: Post-Construction Options for No Pollutant Trading Credit Generation.
    b. Use vegetation to generate pollutant trading credits for areas outside of the prairie buffer areas. Such areas are modeled as turf grass maintained at 4" minimum height. Refer to Table 2: Post-Construction Options for Pollutant Trading Credit Generation.
    c. The solar array area is served by a best management practice designed per the post-construction technical standards. Model the solar array area to demonstrate performance standards are being met. https://dnr.wisconsin.gov/topic/Stormwater/standards/postconst_standards.html
    d. Additional considerations:
        i. Maintain existing drainage patterns or create a series of swales to serve every 100' of slope length for HSG D soils. Design swales based on

the recommendations provided in DNR Technical Standard "Vegetated Swale" (1005).

ii. Protect existing drainage patterns from erosion and/or sediment buildup by ensuring vegetation is established in the surrounding areas.

Table 1: Post-Construction Options for No Pollutant Trading Credit Generation

Hydrologic Soil Group	Minimum Aisle Width	Max % impervious (excluding substations)	Minimum Vegetated Buffer Width downslope of the solar array	Maximum flow length between interception swales for slopes >1%
A	1.0 times module flow length	50%	Minimum Aisle Width	None
B	1.1 times module flow length	25%	Minimum Aisle Width	None
C	1.2 times module flow length	21%	25 feet (ground slope ≤5%) 30 feet (ground slope >5% to <15%) 35 feet (ground slope ≥ 15% to ≤20%)	200 feet
D	1.3 times module flow length	20%	30 feet (ground slope ≤5%) 35 feet (ground slope >5% to ≤20%)	100 feet

Note: Distances provided above are based on WinSLAMM modeling of typical projects.

Table 2: Post-Construction Options for Pollutant Trading Credit Generation

Hydrologic Soil Group	Minimum Aisle Width	Max % impervious (excluding substations)	Minimum Vegetated Buffer Width downslope of the solar array	Maximum flow length between interception swales for slopes >1%
A	1.0 times module flow length	50%	10 feet	None
B	1.1 times module flow length	25%	10 feet (ground slope ≤5%)	300 feet
C	1.2 times module flow length	21%	35 feet (ground slope ≤5%) 40 feet (ground slope >5% to ≤20%)	200 feet
D	1.3 times module flow length	20%	35 feet (ground slope ≤5%) 40 feet (ground slope >5% to ≤20%)	100 feet

Note: Distances provided above are based on WinSLAMM modeling of typical projects.

Modeling may be used to demonstrate compliance with post-construction performance standards for the solar array areas that do not meet the conditions listed above. Department staff are available to discuss proposed modelling approaches.

E. References

Cook, Lauran M., McCuen, Richard H., 2013. Hydrologic Response of Solar Farms. Journal of Hydrologic Engineering. Vol. 18, p. 536-541. American Society of Civil Engineers.

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Wisconsin Department of Natural Resources, *Channel Erosion Mat*, Technical Standard (1053), 2004, http://dnr.wi.gov/topic/stormWater/documents/dnr1053-ChannelErosionMat.pdf.

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Watershed Management Team approved on TBD, 2022.