Storm Water Measures for Ground Mounted Solar

Amy Minser

Samantha Whitens

April 10, 2024

Webinar Outline

- Introductions
- Goals and objectives
- Webinar logistics
- Part 1: Post-Construction Performance Standards presentation
- Q & A
- Part 1: Construction Standards presentation
- Q & A
- Closing and follow-up

Webinar Introductions

- Shannon Haydin, Stormwater Runoff Section Manager
- Amy Minser, Stormwater Engineer
- Samantha Whitens, Stormwater Engineer
- Ron Binzley, Air Management Stationary Source Modeling Section Manager
- Greg Moeller, Drinking Water and Groundwater Water Supply Specialist
- Ben Callan, Waterways Program Director

Webinar Goals and Objectives

Provide background and training to solar developers on the Bureau of Watershed Management's guidance titled Post-Construction Storm Water Management Options for Ground-Mounted Solar Array Areas.

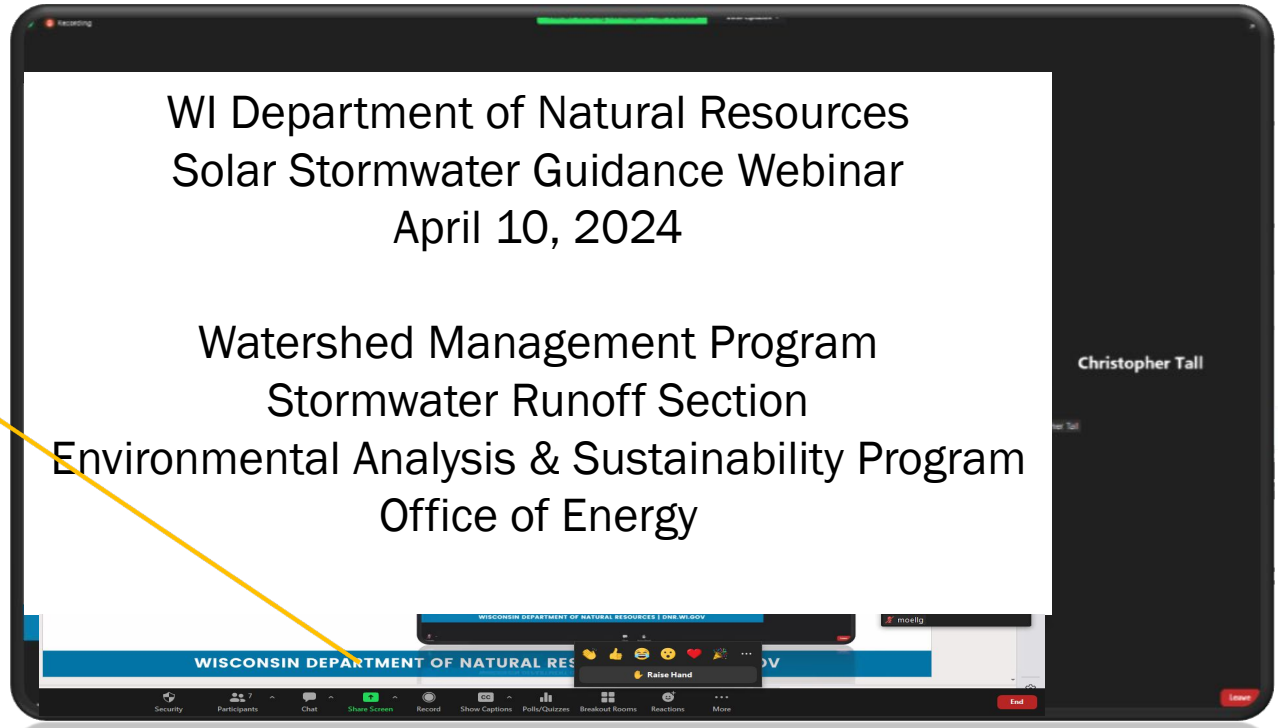
Provide construction best practices and lessons learned on utility-scale solar sites.

Recorded training will also be available for interested stakeholders.

Webinar Logistics

For *technical assistance* with Zoom Webinar:

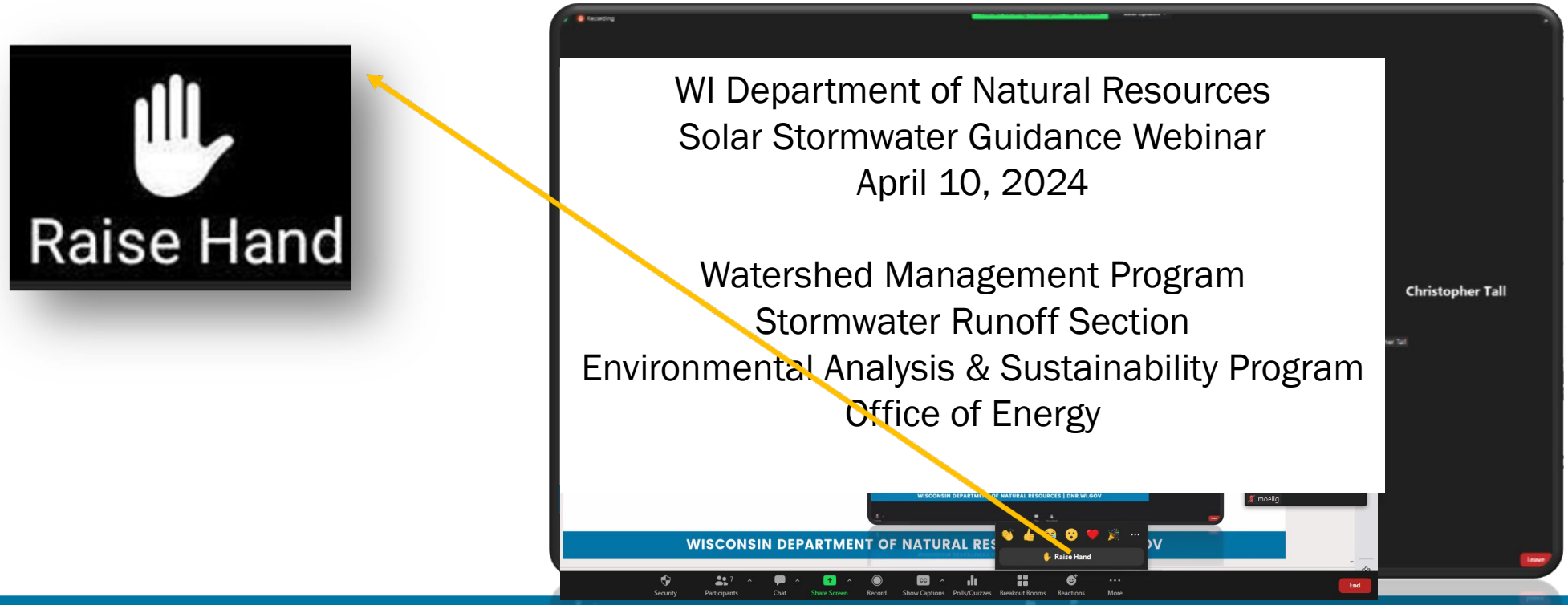
- Use the **CHAT** button to connect with DNR support staff



Webinar Logistics

For *questions* on the Zoom Webinar presentation:

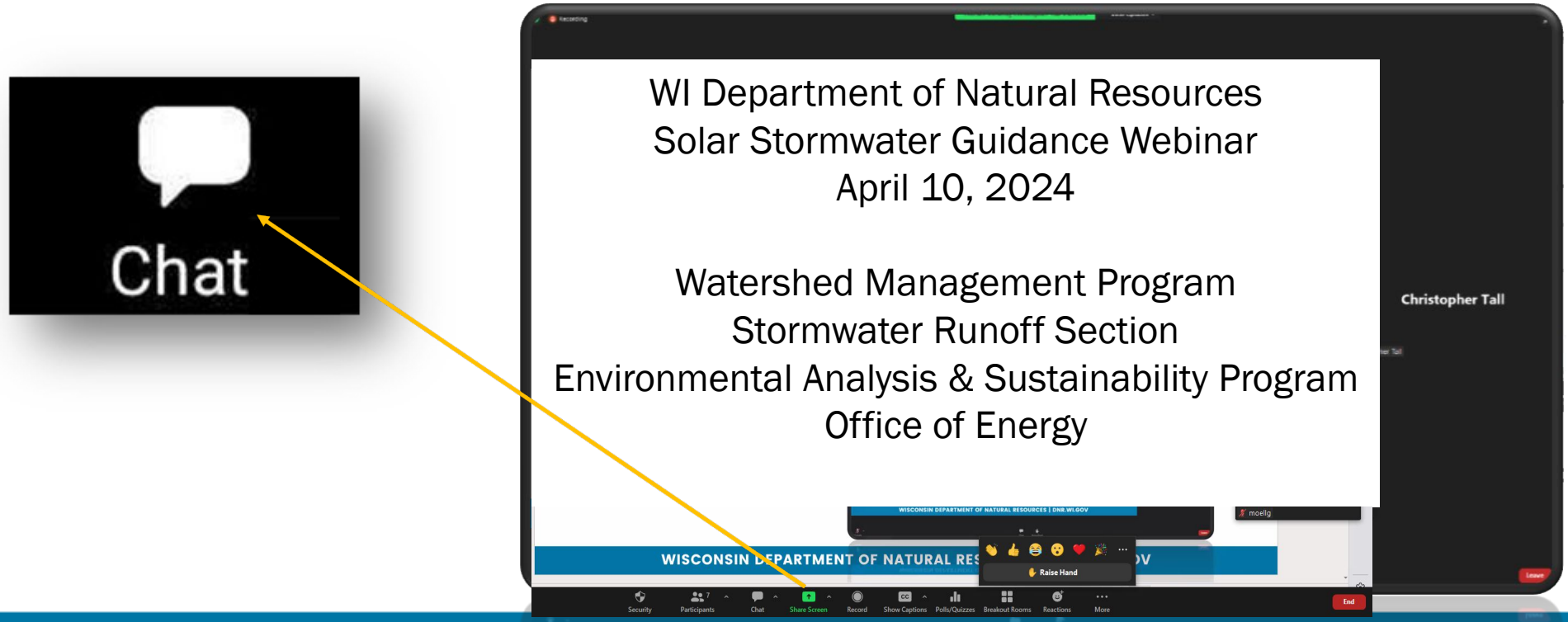
1. Use the **RAISE HAND** option under the **REACTIONS** button, OR



Webinar Logistics

For *questions* on the Zoom Webinar presentation:

2. Type your question into the **CHAT** button.

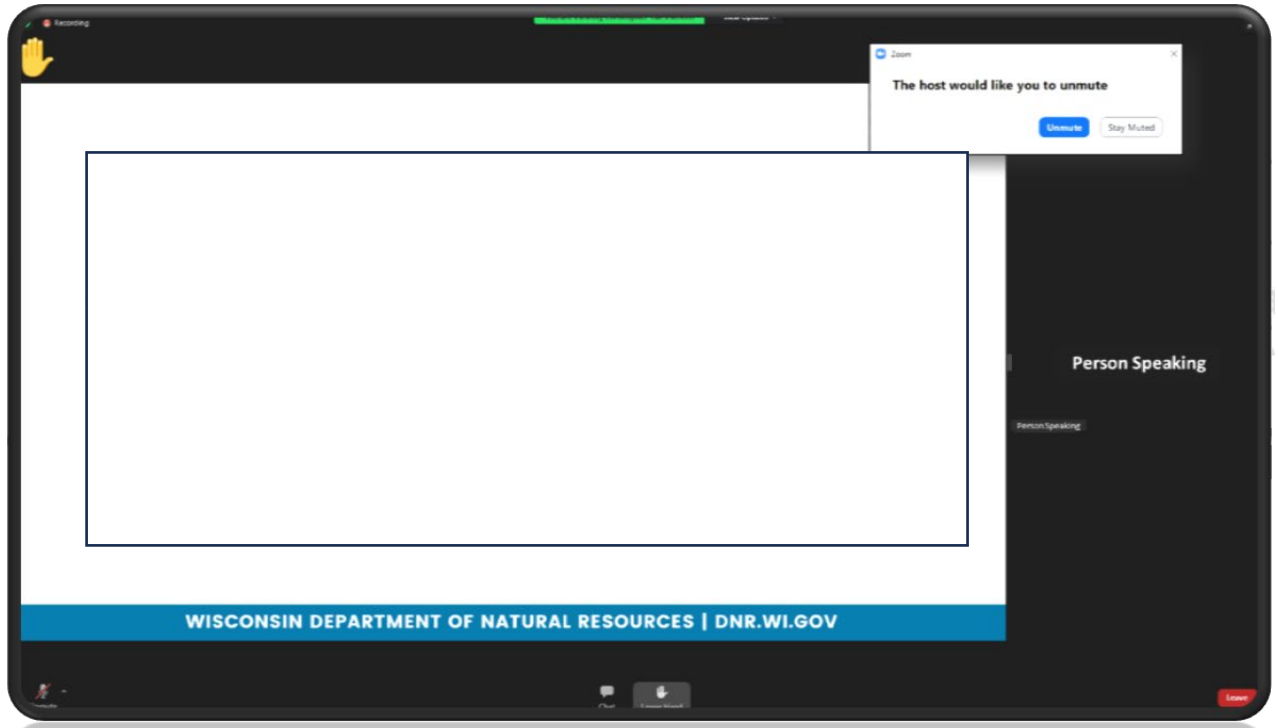


Webinar Logistics

Questions will be addressed during the **Q & A.** The host will:

1. Ask you to unmute to offer your question (**RAISE HAND**), or
2. Read your question (**CHAT**).

*When you're done speaking, please remember to **re-mute**.*



Storm Water Measures for Ground Mounted Solar Part 1-Post-Construction

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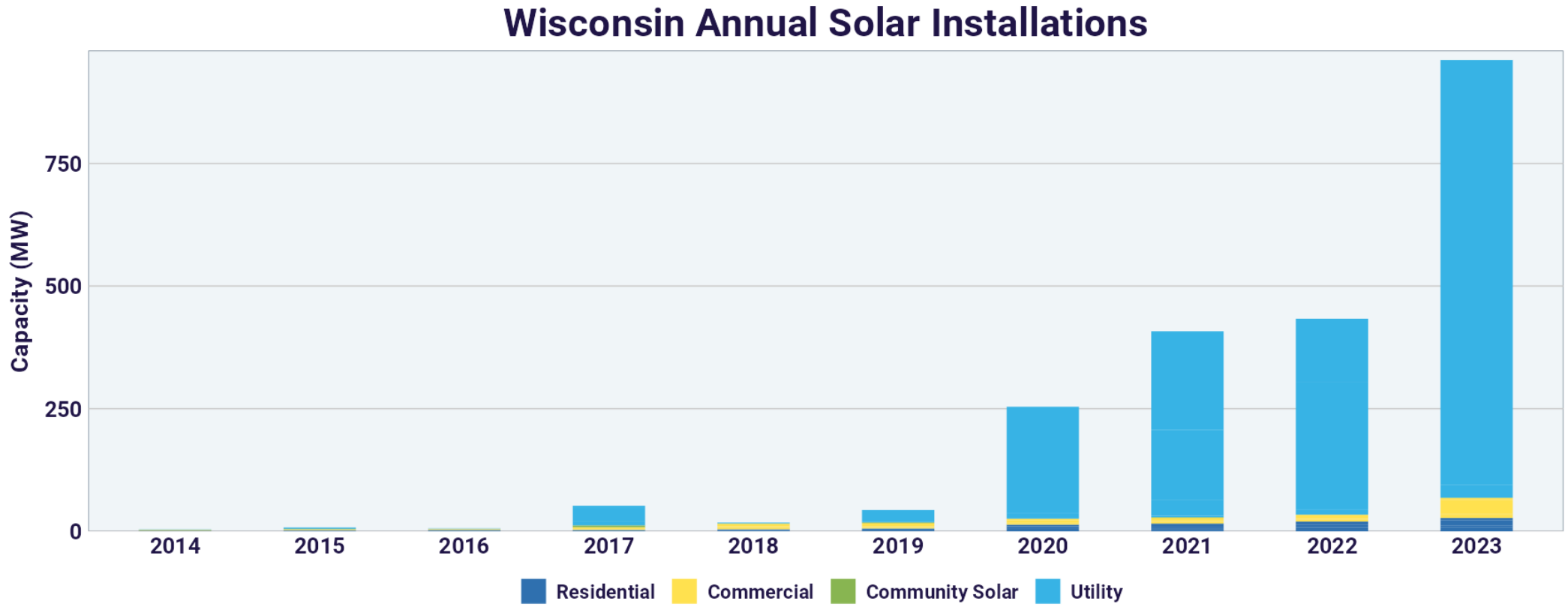


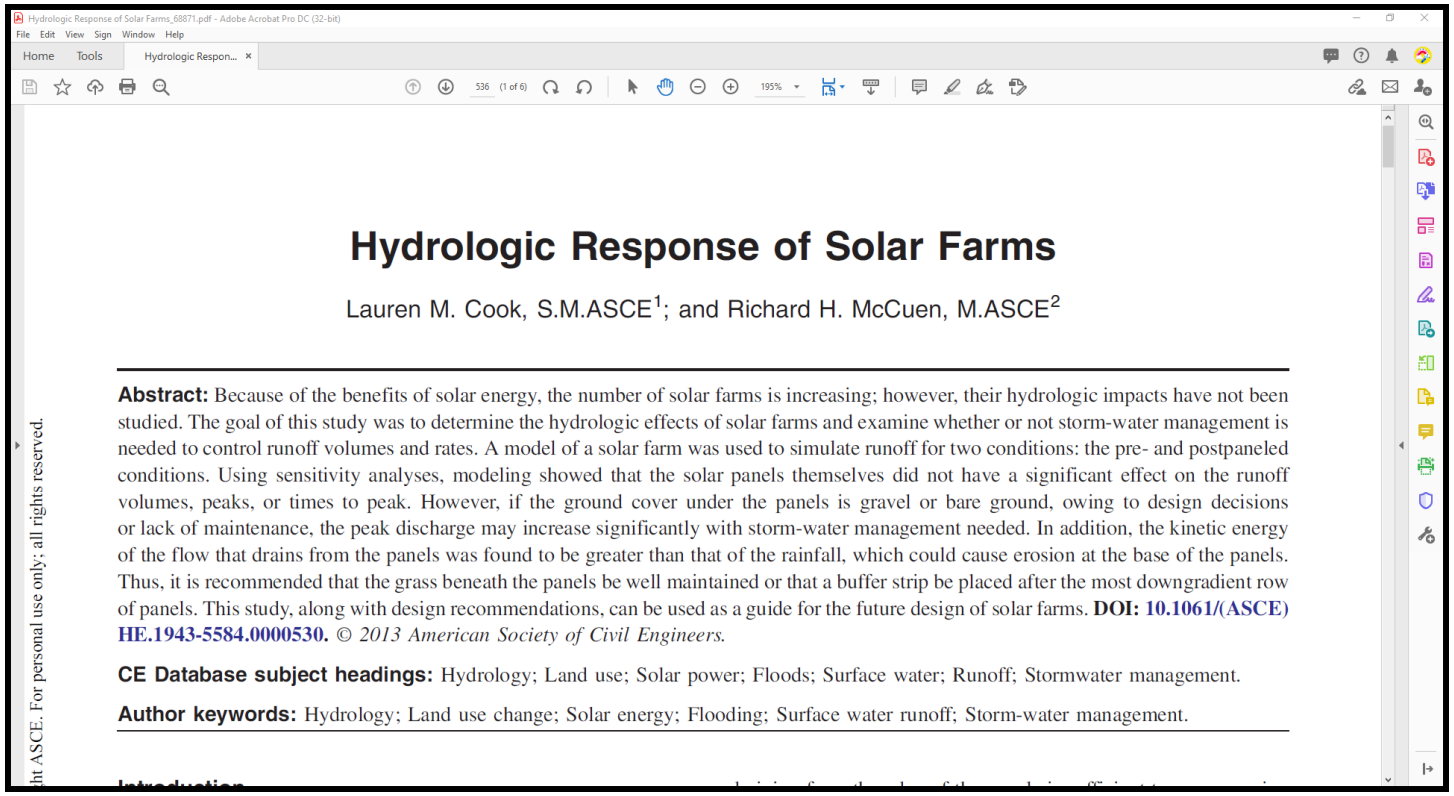
According to the Solar Energy Industries Association, Wisconsin can expect an additional 3,805 MW over the next 5 years

https://www.seia.org/state-solar-policy/wisconsin-solar

Background

- 1-9,000 acre sites
- Often located in former row crop fields
- Typically panels sheet flow to vegetation under and around pile-mounted panels
- Many applicants unfamiliar with Wisconsin Storm Water regulations

Limited Research



Hydrologic Response of Solar Farms

Lauren M. Cook, S.M.ASCE[1]; and Richard H. McCuen, M.ASCE[2]

Abstract: Because of the benefits of solar energy, the number of solar farms is increasing; however, their hydrologic impacts have not been studied. The goal of this study was to determine the hydrologic effects of solar farms and examine whether or not storm-water management is needed to control runoff volumes and rates. A model of a solar farm was used to simulate runoff for two conditions: the pre- and postpaneled conditions. Using sensitivity analyses, modeling showed that the solar panels themselves did not have a significant effect on the runoff volumes, peaks, or times to peak. However, if the ground cover under the panels is gravel or bare ground, owing to design decisions or lack of maintenance, the peak discharge may increase significantly with storm-water management needed. In addition, the kinetic energy of the flow that drains from the panels was found to be greater than that of the rainfall, which could cause erosion at the base of the panels. Thus, it is recommended that the grass beneath the panels be well maintained or that a buffer strip be placed after the most downgradient row of panels. This study, along with design recommendations, can be used as a guide for the future design of solar farms. **DOI: 10.1061/(ASCE) HE.1943-5584.0000530.**

CE Database subject headings: Hydrology; Land use; Solar power; Floods; Surface water; Runoff; Stormwater management.

Author keywords: Hydrology; Land use change; Solar energy; Flooding; Surface water runoff; Storm-water management.

- Assumes row-crop for predevelopment
- Assumes pervious under, between, and around the panels
- Only looks at a single row
- Based on modeling
- Vegetation the primary Best Management Practice (BMP)

s. NR 151.003 (3) The amount of credit the department may give a BMP…is limited to the treatment capability of the BMP

PV-SMaRT

(Photovoltaic Stormwater Management Research and Testing)

- Runoff calculator designed for solar
- 5 test sites across US
- Findings:
  - Decompaction
  - Root depth
  - Panel spacing
- Waiting for additional research, peer reviewed papers

Post-Construction

Solar panels, other above-ground equipment and gravel or paved access roads are considered impervious surfaces under s. NR 151.002 (17).

Most solar installations do not meet the exemption in s. NR 151.121 (2) (a) for sites with <10% connected imperviousness AND < 1 acre total imperviousness.

Quality Performance Standards

- Multiple paths
- Common goal
- By design
- Mostly quantified using modeling

Post-Construction Performance Standards

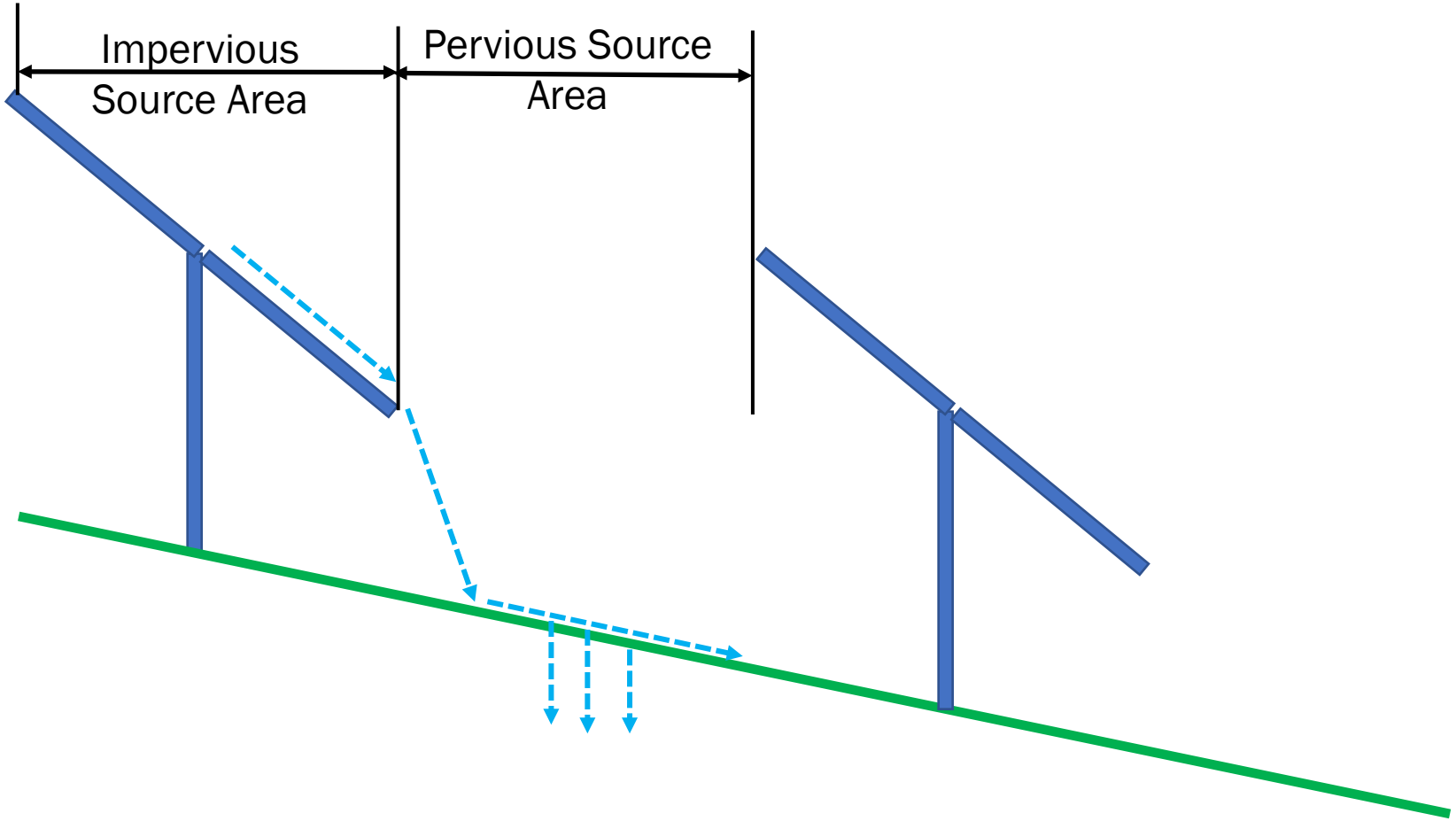
- Found in Wisconsin Administrative Code
- NR 151.121-Applicability and exemptions
- **NR 151.122-Total Suspended Solids Performance Standards**
- **NR 151.123-Peak Discharge Performance Standards**
- **NR 151.124-Infiltration Performance Standards**
- NR 151.125-Protective Area Performance Standards
- NR 151.126-Fueling and Vehicle Maintenance Areas
- NR 151.127-Location
- NR 151.128-Timing

Wisconsin Nuances

Performance Standard	Base Condition
TSS Control	Post Construction without Storm Water Controls
Peak Flow Control	Pre-construction condition
Infiltration	Pre-construction condition
Protective Area	Edges of delineated wetland or ordinary high-water mark for waterbody

Vegetation as Storm Water Treatment

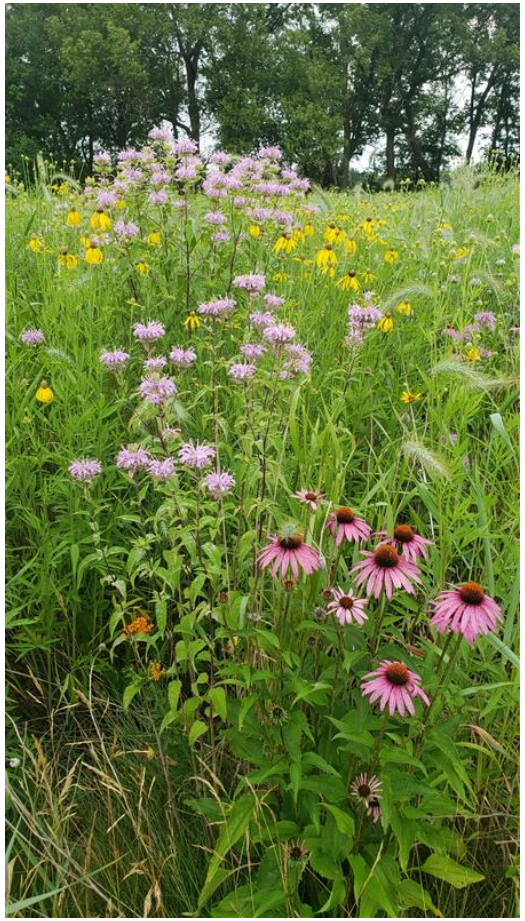
- Limited filtering due to resuspension concerns
- Primary mechanism is infiltration
- Requires maintenance



General Approach

- Leverage existing guidance
- Leverage typical design elements in recent NOIs
- Model a portion of a typical layout
- Source areas and filter strips in series
- Include disconnected gravel access
- Provide an option in which, if the sideboards are met, water quality modeling is not needed
- All other options for demonstrating compliance are still allowed
- Substations, parking, driveways, etc. evaluated separately

Vegetation Types



Native/Prairie/ Pollinator

- Deep rooted-higher infiltration rates
- Adapted to climate
- After initial establishment, lower maintenance

- Turf Grass
  - Not preferred
  - Short roots-Lower long-term infiltration
  - Higher long-term maintenance

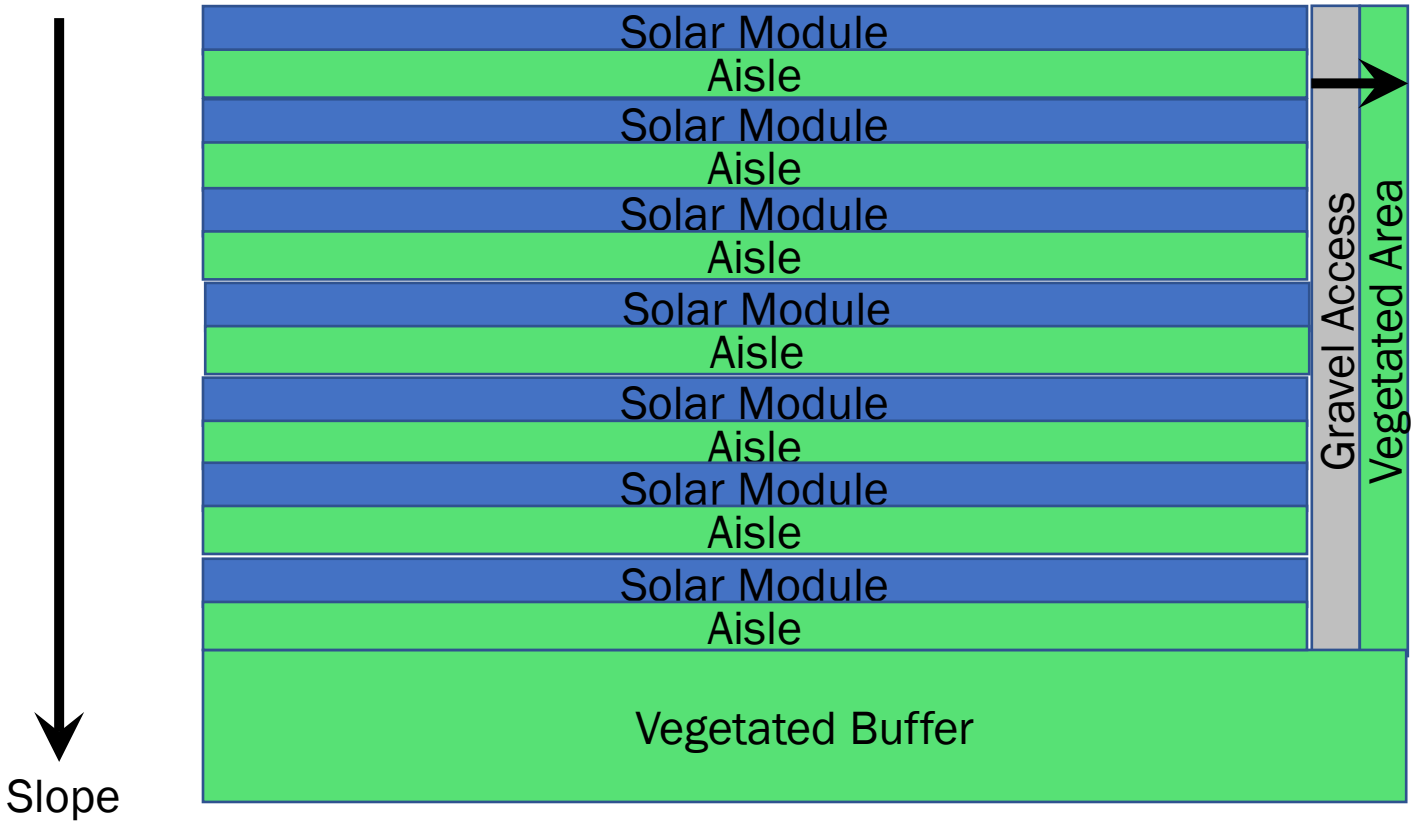
Appendix A

- Sample Seed Mixes
- Provided in response to comment
- Not required mixes
- Actual mix from a past project

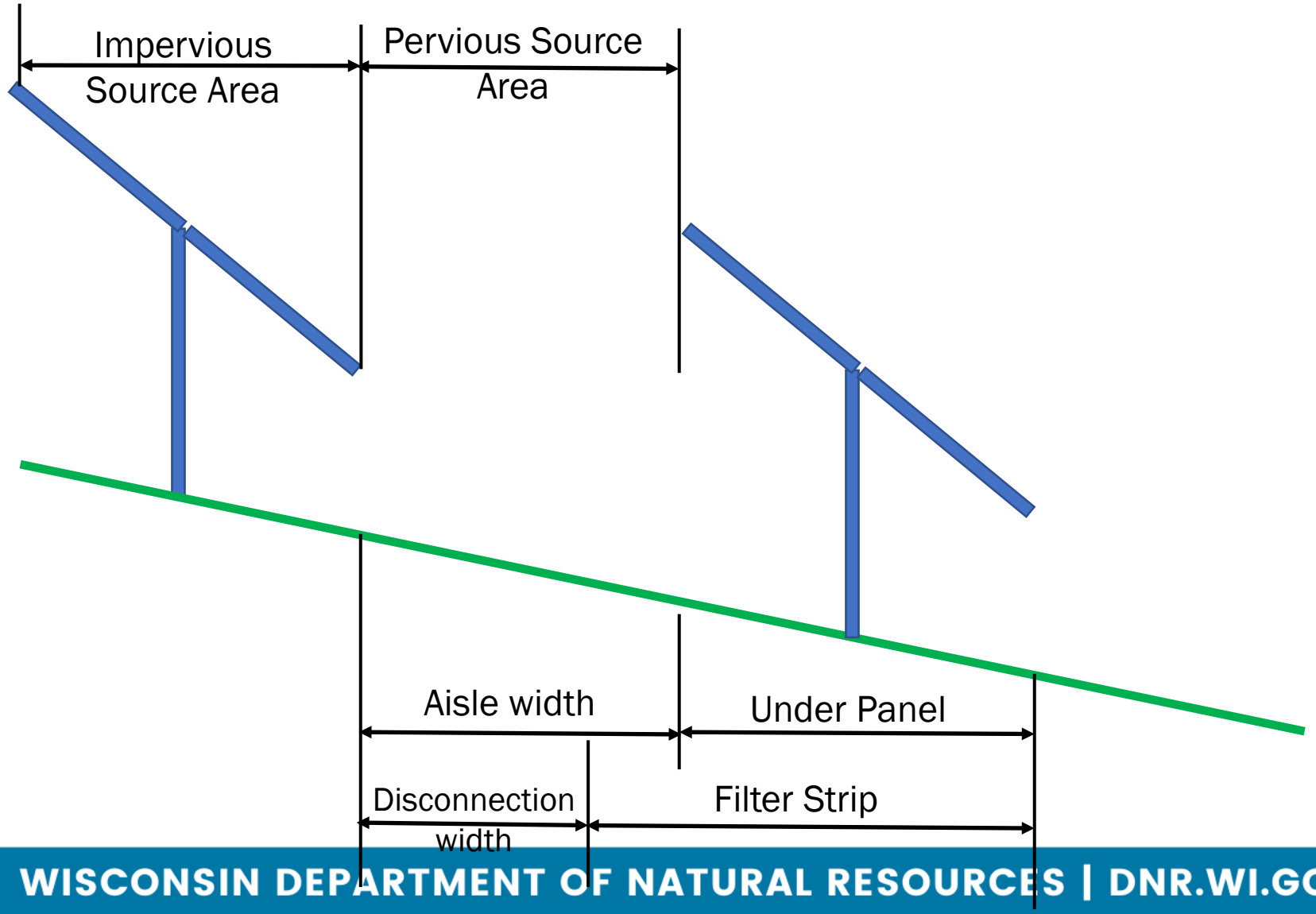
***Appendix A: Considerations for native plant species with typical height range 1-6'**

GRASSES, SEDGES, RUSHES	COMMON NAME	HEIGHT	PERCENT OF MIX
Sporobolus cryptandrus	Sand Dropseed	1-3'	2.6
Bouteloua curtipendula	Side Oats Grama	1-3'	12.2
Elymus canadensis	Canada Wild Rye	3-5'	1.7
Elymus trachycaulus	Slender Wheatgrass	2-3'	1.6
Elymus virginicus	Virginia Wild Rye	3-5'	1.2
Panicum virgatum	Switchgrass	4-6'	7.0
Schizachyrium scoparium	Little Bluestem	2-3'	29.7
Total			**56.0**
WILDFLOWERS	**COMMON NAME**	**HEIGHT**	**PERCENT OF MIX**
Achillea millefolium	Native Yarrow	1-3'	4.2
Agastache foeniculum	Lavender Hyssop	2-4'	0.7
Amorpha canescens	Leadplant	1-3'	0.3
Asclepias incarnata	Marsh (Red) Milkweed	3-5'	0.1
Asclepias syriaca	Common Milkweed	2-4'	0.1
Asclepias tuberosa	Butterfly Weed	2-3'	0.1
Astragalus canadensis	Canada Milk Vetch	1-3'	0.3
Chamaecrista fasciculata	Partridge Pea	1-3'	0.2
Dalea candida	White Prairie Clover	1-2'	0.3
Dalea purpurea	Purple Prairie Clover	1-2'	2.1
Desmodium canadense	Canada Tick Trefoil	2-5'	0.2
Heliopsis helianthoides	Early Sunflower	3-5'	0.5
Hypericum pyramidatum	Great St. John's Wort	4-6'	7.0
Aster azureus	Sky Blue Aster	1-3'	0.5

Modeling Approach



Modeling Approach



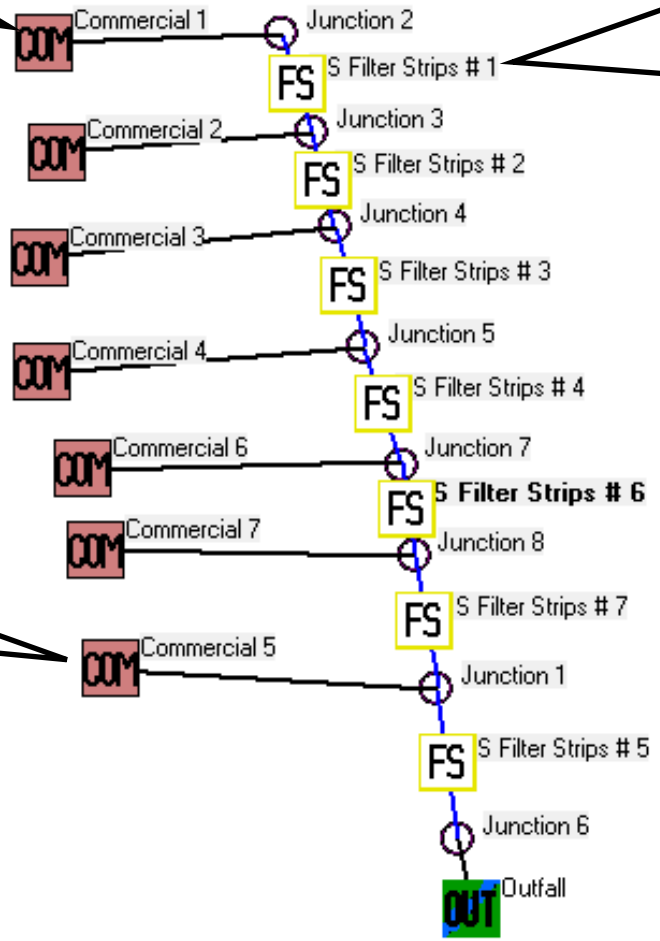
Modeling Approach

Solar panels plus landscape area

Flow length under downstream panel plus aisle width

Disconnected gravel access road

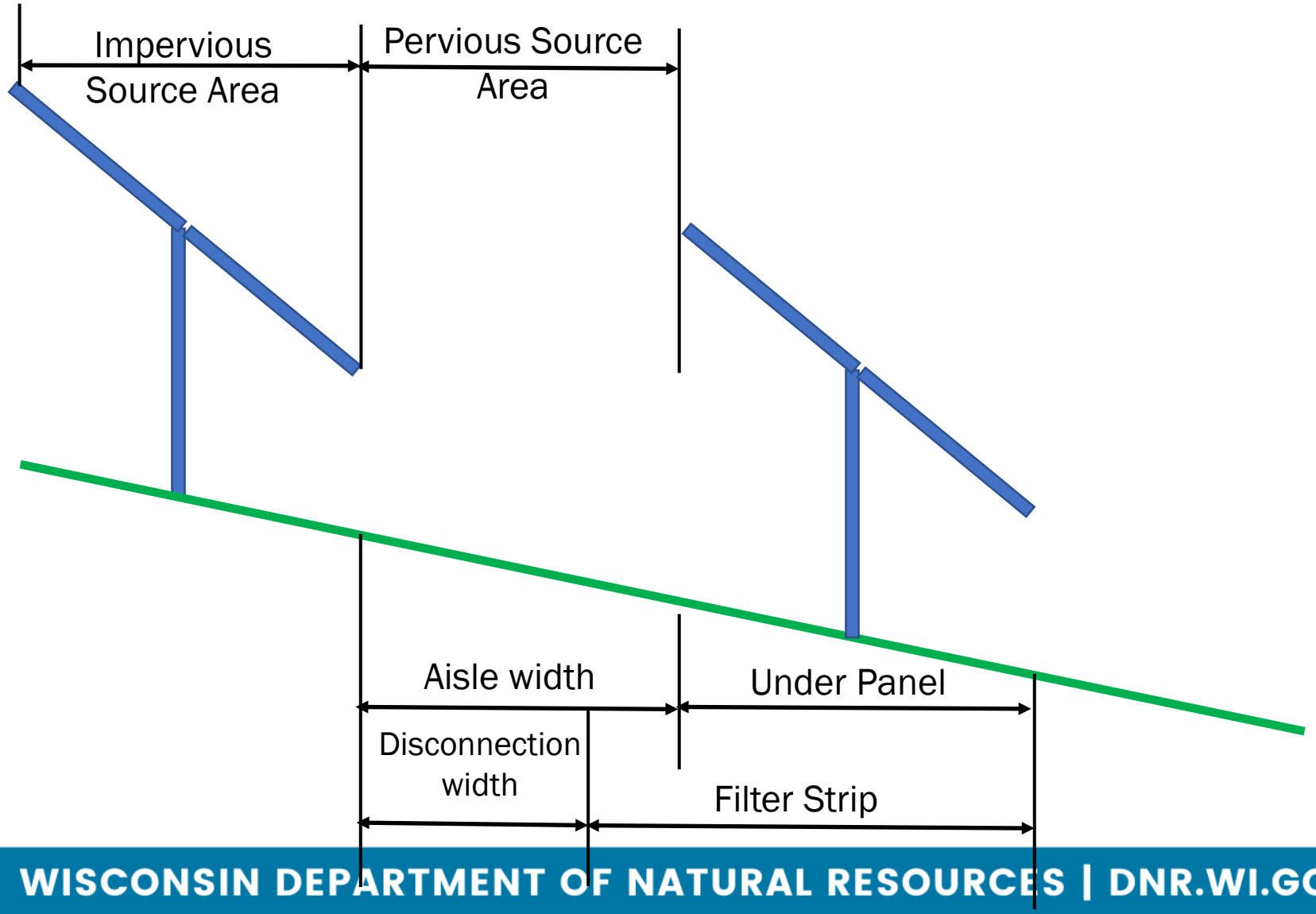
Buffer Strip



Sideboards

- Site Characteristics
  - Slope considerations
  - Soil types
  - Ground water > 12” or > 12” to drain tile
- Design Elements
  - Maintain hydrology
  - Sheet flow over vegetation
  - Minimum dimensions-relation to maximum anticipated panel dimensions
- Construction Elements
  - Compaction mitigation
  - Provisions for long-term maintenance

Minimum Dimensions



Interpreting Table 1

Table 1: Post-Construction Design Parameters

Hydrologic Soil Group-Vegetation Type-Slope[1]	Minimum Aisle Width[2]	Max panel area + other array area % impervious (excluding substations)	Minimum Vegetated Buffer Width downslope of the solar array[3]	Maximum flow length between interception swales for slopes >4%
A-Native Vegetation Ground Slope <20%	1.0 x L but not less than 10 feet	50%	Same as Minimum Aisle Width	None
A- Native Vegetation with Pollutant Credit Generation Desired Ground Slope <20%	1.0 x L but not less than 10 feet	50%	Same as Minimum Aisle Width	None
B- Native Vegetation Ground Slope <20%	1.1 x L but not less than 10 feet	25%	Same as Minimum Aisle Width	None
B- Native Vegetation with Pollutant Credit Generation Desired Ground Slope <20%	1.1 x L but no less than 10 feet	25%	1P: 10’ 2P: 15’	300 feet

Interpreting Table 1-Part 2

Hydrologic Soil Group-Vegetation Type-Slope[1]	Minimum Aisle Width[2]	Max panel area + other array area % impervious (excluding substations)	Minimum Vegetated Buffer Width downslope of the solar array[3]	Maximum flow length between interception swales for slopes >4%
C- Native Vegetation Ground slope ≤5%:	1.2 x L but no less than 10 feet	21%	1P: 20' 2P: 25'	200 feet
Ground slope >5% and < 15%	1.2 x L but no less than 12 feet		1P: 20' 2P: 30'	
Ground Slope ≥15%			1P: 25' 2P: 35'	
C- Native Vegetation with Pollutant Credit Generation Desired	1.2 x L but no less than 12 feet	21%	Ground slope ≤5%: 1P: 25' 2P: 35'	200 feet
			Ground slope >5% 1P: 30' 2P: 40'	
D- Native Vegetation	1.3 x L but no less than 12 feet	20%	Ground slope ≤5%: 1P: 25' 2P: 30'	100 feet
			Ground slope >5% 1P: 30' 2P: 35'	
D- Native Vegetation with Pollutant Credit Generation Desired	1.3 x L but no less than 12 feet	20%	Ground slope ≤5%: 1P: 25' 2P: 35'	100 feet
			Ground slope >5% 1P: 35' 2P: 40'	

Maintenance Agreement

Required for long-term maintenance of storm water features

- Vegetation beneath and within array area
- Basins/ponds

Maintenance Agreement Goals

- Vegetation density of 90%
- Maintenance of desired vegetation
  - Mowing frequency
- Address vegetation damage
- Manage erosion
- Pond/basin cleanout schedule

Notice of Intent Information Needed

- Identify which areas on the site meet the sideboards
- Provide sufficient dimensions and topography
- Provide a plan for compaction mitigation
- Provide a signed maintenance agreement

Storm Water Management Report

- Explain how the post-construction performance standards met
- Attach hydrology and hydraulic modeling reports to document peak flow inputs and outputs
- If traditional post-construction measures included, attach pollution control modeling inputs and outputs (typically P-8 or WinSLAMM)
- Identify any unique features or unusual approaches

Traditional Post-Construction Measures

Post-construction standards	Number	Effective date
Bioretention for infiltration [PDF]	1004	Oct-14
Compost [PDF]	S100	Oct-17
Infiltration basin [PDF]	1003	Oct-04
Infiltration trench [PDF]	1007	May-12
Permeable pavement [PDF] Tech note [PDF]	1008	Jun-21
Proprietary storm water filtration devices [PDF] Tech note [PDF] Filter efficiency adjustment spreadsheet [XLSX]	1010	Sep-20
Proprietary storm water sedimentation devices [PDF]	1006	Apr-09
Rain Garden [PDF]	1009	Sep-18
Site evaluation for stormwater infiltration [PDF]	1002	Dec-22
Vegetated swale [PDF]	1005	Dec-17
Wet detention pond Part 1 [PDF], Part 2 [PDF]	1001	Oct-07

https://dnr.wisconsin.gov/topic/Stormwater/standards/postconst_standards.html

Questions

Storm Water Measures for Ground Mounted Solar Part 2-Construction

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Permitting Issues-Land Disturbance

What counts as land disturbance?

- Vehicle access/rutting
- Grubbing
- Fine Grading
- Mass Grading
- Trenching
- Seedbed Preparation
- Haul roads/temporary access/laydown

Usually, the entire area within the project's limit of disturbance will have some type of disturbance

Solar Construction – Permitting Issues

- How much time does it take to get permit coverage?
- Can I get an early start permit? Is after the fact permitting an acceptable option?
- Is silt fence sufficient sediment control?

Construction Technical Standards

CONSTRUCTION SITE EROSION & SEDIMENT CONTROL STANDARDS

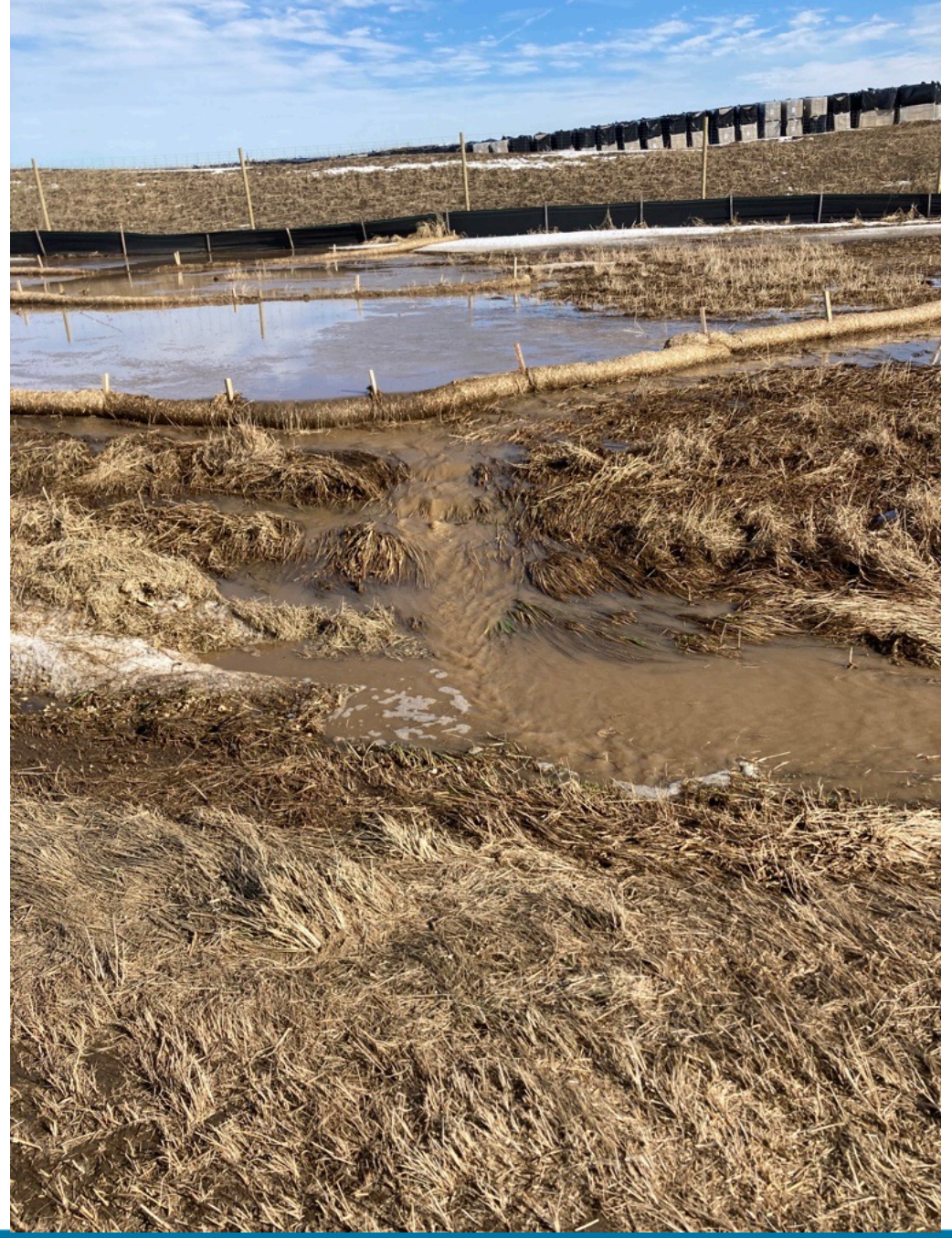
Erosion and Stabilization Practices	Number	Effective Date
Channel Erosion Mat [PDF]	1053	Nov-18
Construction Site Diversion [PDF]	1066	Mar-06
Ditch Checks [PDF]	1062	Nov-22
Dust Control [PDF]	1068	Nov-17
Land Application of Additives for Erosion Control [PDF]	1050	Dec-15
Mulching for Construction Sites [PDF]	1058	Jun-03
Non-channel Erosion Mat [PDF]	1052	Nov-18
Seeding [PDF]	1059	Nov-03
Trackout Control Practices [PDF]	1057	Jul-18
Grading Practices for Erosion Control - Temporary [PDF]	1067	Mar-04
Vegetative Buffer for Construction Sites [PDF]	1054	May-03

Construction Technical Standards

Sediment Control Practices	Number	Effective Date
Dewatering Practices for Sediment Control [PDF]	1061	Apr-20
Sediment Bale Barrier [PDF]	1055	Aug-03
Sediment Basin [PDF]	1064	Mar-06
Sediment Trap [PDF]	1063	Oct-14
Silt Curtain [PDF]	1070	Sep-05
Perimeter Sediment Control and Slope Interruption [PDF]	1056	Nov-22
Storm Drain Inlet Protection For Construction Sites [PDF]	1060	Jan-22
Turbidity Barriers [PDF]	1069	Sep-05
Water Application of Additives for Sediment Control [PDF]	1051	Dec-15
Horizontal Directional Drilling [PDF] • Approved Horizontal Directional Drilling Products List [PDF]	1072	

Solar Construction – Erosion Control

- Source control vs. ‘end of pipe’ treatment
- Work areas and Phasing
- Compaction
- Priority items
- Winter stabilization- "We would rather have the sediment basin water used for irrigation than go into winter with unstable ground."



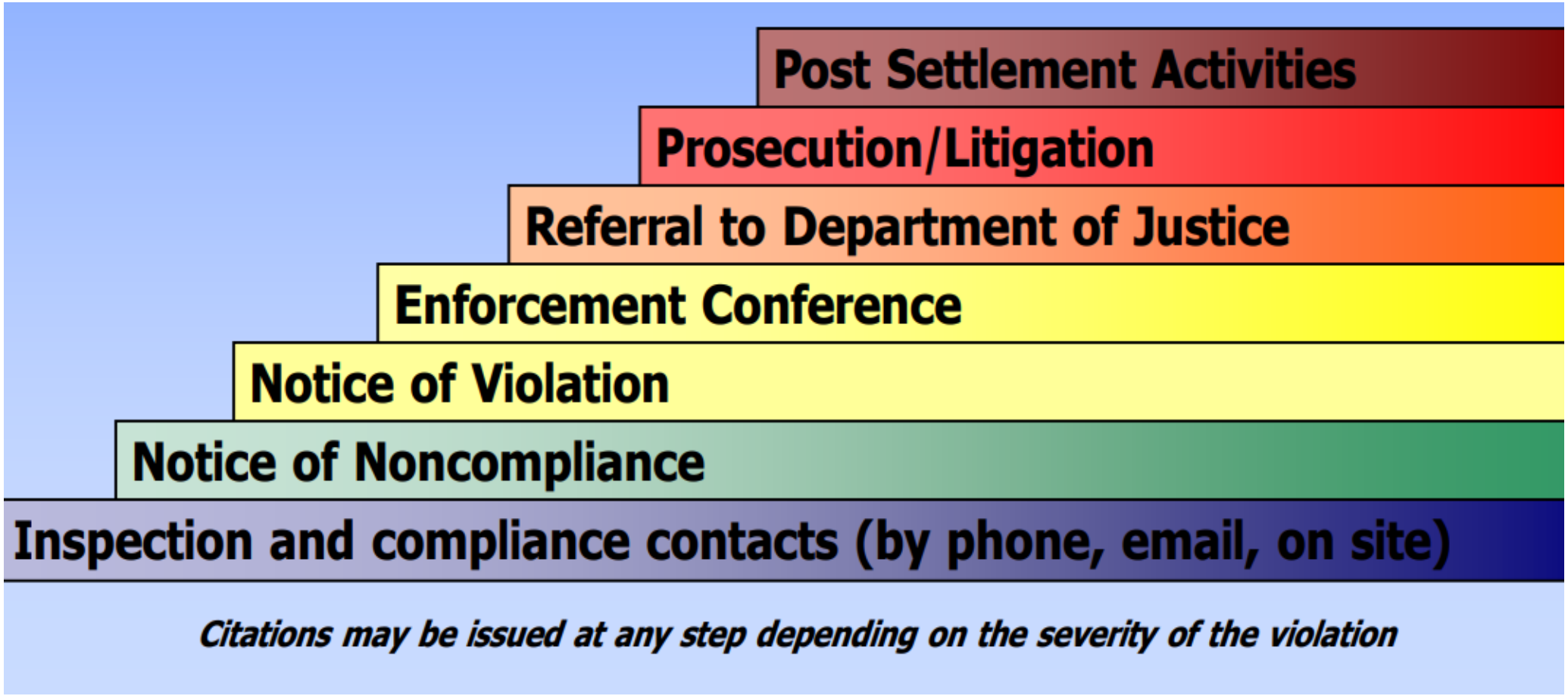
Solar Construction – Sediment Control

- Sediment basins
- Water applied additives
- Slope interruption
- Perimeter control

Other Solar Concerns

- Seeding too late
- Inadequate winter stabilization
- BMP maintenance in frozen conditions
- Too much area disturbed at one time

Solar Construction – Stepped Enforcement



Complaints

Contact local warden — DNR Staff Directory

Contact me

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samantha.whitens@wisconsin.gov
(608) 301-6110
(Email preferred)

Anonymous

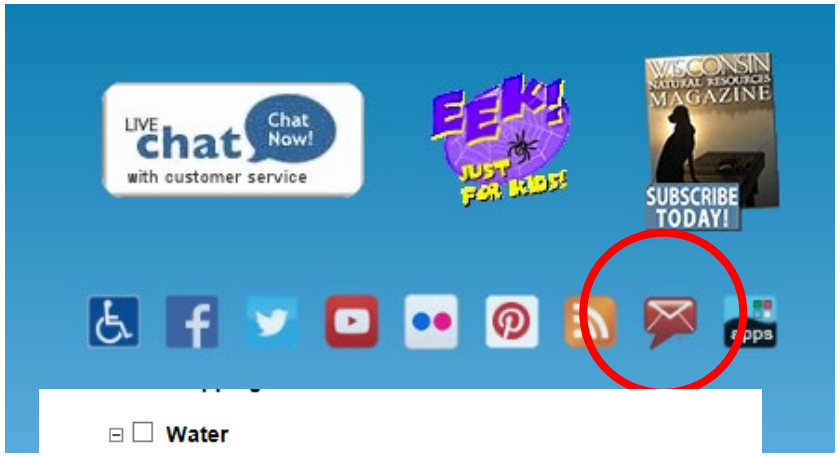
EROSION CONTROL COMPLAINTS
should be reported to the WDNR Tip Line at
1-800-TIP-WDNR (1-800-847-9367)

Final Thoughts

https://dnr.wisconsin.gov/topic/Sectors/SolarInstallations

Questions

GovDelivery Sign-up



- **Water**
  - Aquatic Pesticide Pollutant Discharge Permits
  - Dam Information
  - [x] Impaired Waters
  - Golden Sands Dairy CAFO
  - Piers, Docks, Wharves
  - Wetland Mitigation
  - Shoreland Zoning
  - Wetland Regulations
  - Floodplains
  - [x] Municipal Separate Storm Sewer System (MS4)
  - [x] Construction Site Storm water
  - [x] Industrial Storm Water
  - Phosphorus Implementation

- **Announcements & News**
  - Air Management Study Group
  - Air News
  - Ask the Expert Online Chats
  - Central Sands Strategic Analysis
  - Citizen-based Monitoring
  - Clean Air Tip of the Week
  - Council on Recycling
  - DNR Land Sales
  - DNR Weekly News
  - Electronics Recycling
  - Enbridge Sandpiper-Line 3 Project
  - Natural Heritage Conservation News and Events
  - Gogebic Taconite Updates
  - Jobs
  - Hazardous Waste Decoded
  - MacKenzie Center Updates
  - Natural Area Spotlight
  - Natural Heritage Quiz of the Week
  - Outdoor Report
  - Pharmaceutical Waste News
  - Recycling Updates
  - [x] Proposed DNR Program Guidance
  - Small Business Advisor
  - Stewardship Grant News
  - The Compost Post
  - Warden Wire
  - Solid Waste News
  - Nonmetallic Mining News

CONNECT WITH US

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