Appendix A

Atlas 14 Rainfall Data

NOAA Atlas 14, Volume 2, Version 3
Location name: Ottawa, Ohio, USA*
Latitude: 41.0908°, Longitude: -84.1305°
Elevation: 727.25 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.340** (0.306-0.378)	**0.404** (0.365-0.449)	**0.483** (0.436-0.537)	**0.547** (0.491-0.606)	**0.627** (0.561-0.693)	**0.689** (0.614-0.761)	**0.751** (0.666-0.828)	**0.814** (0.718-0.897)	**0.899** (0.786-0.990)	**0.960** (0.834-1.06)
10-min	**0.528** (0.476-0.588)	**0.631** (0.570-0.701)	**0.751** (0.677-0.834)	**0.844** (0.759-0.935)	**0.959** (0.858-1.06)	**1.05** (0.931-1.15)	**1.13** (1.00-1.25)	**1.22** (1.07-1.34)	**1.32** (1.16-1.46)	**1.40** (1.21-1.54)
15-min	**0.647** (0.583-0.721)	**0.772** (0.697-0.857)	**0.922** (0.831-1.02)	**1.04** (0.933-1.15)	**1.19** (1.06-1.31)	**1.29** (1.15-1.43)	**1.40** (1.25-1.55)	**1.51** (1.33-1.66)	**1.65** (1.44-1.82)	**1.75** (1.52-1.93)
30-min	**0.856** (0.771-0.953)	**1.03** (0.932-1.15)	**1.26** (1.14-1.40)	**1.44** (1.30-1.60)	**1.67** (1.50-1.85)	**1.85** (1.65-2.04)	**2.03** (1.80-2.24)	**2.21** (1.95-2.43)	**2.44** (2.14-2.69)	**2.62** (2.27-2.89)
60-min	**1.05** (0.942-1.16)	**1.27** (1.14-1.41)	**1.59** (1.43-1.76)	**1.84** (1.65-2.03)	**2.17** (1.94-2.40)	**2.44** (2.17-2.69)	**2.71** (2.41-2.99)	**2.99** (2.64-3.30)	**3.38** (2.96-3.72)	**3.68** (3.19-4.06)
2-hr	**1.22** (1.10-1.36)	**1.48** (1.34-1.65)	**1.86** (1.68-2.07)	**2.17** (1.95-2.40)	**2.59** (2.31-2.87)	**2.93** (2.61-3.24)	**3.29** (2.91-3.64)	**3.66** (3.22-4.05)	**4.19** (3.65-4.64)	**4.61** (3.98-5.11)
3-hr	**1.30** (1.18-1.45)	**1.57** (1.43-1.75)	**1.97** (1.79-2.19)	**2.30** (2.07-2.55)	**2.75** (2.47-3.03)	**3.12** (2.78-3.44)	**3.51** (3.11-3.87)	**3.92** (3.45-4.32)	**4.50** (3.92-4.96)	**4.97** (4.28-5.48)
6-hr	**1.53** (1.39-1.70)	**1.84** (1.67-2.04)	**2.30** (2.08-2.55)	**2.68** (2.42-2.96)	**3.22** (2.90-3.54)	**3.67** (3.28-4.03)	**4.16** (3.69-4.56)	**4.68** (4.11-5.12)	**5.44** (4.71-5.95)	**6.06** (5.18-6.62)
12-hr	**1.77** (1.61-1.96)	**2.12** (1.94-2.34)	**2.64** (2.40-2.91)	**3.07** (2.79-3.38)	**3.70** (3.33-4.05)	**4.21** (3.77-4.61)	**4.77** (4.24-5.21)	**5.37** (4.73-5.86)	**6.24** (5.42-6.81)	**6.96** (5.98-7.59)
24-hr	**2.07** (1.94-2.22)	**2.48** (2.32-2.66)	**3.06** (2.87-3.28)	**3.53** (3.30-3.78)	**4.21** (3.92-4.49)	**4.75** (4.41-5.08)	**5.33** (4.92-5.68)	**5.93** (5.44-6.33)	**6.77** (6.17-7.24)	**7.45** (6.74-7.99)
2-day	**2.39** (2.25-2.55)	**2.86** (2.69-3.05)	**3.50** (3.30-3.73)	**4.02** (3.78-4.28)	**4.74** (4.44-5.04)	**5.33** (4.97-5.67)	**5.94** (5.51-6.31)	**6.58** (6.07-7.00)	**7.45** (6.82-7.96)	**8.15** (7.41-8.73)
3-day	**2.57** (2.43-2.74)	**3.07** (2.90-3.27)	**3.74** (3.53-3.98)	**4.29** (4.04-4.55)	**5.03** (4.73-5.35)	**5.64** (5.28-5.99)	**6.27** (5.84-6.65)	**6.91** (6.41-7.34)	**7.80** (7.17-8.31)	**8.50** (7.77-9.09)
4-day	**2.76** (2.61-2.93)	**3.29** (3.11-3.49)	**3.99** (3.77-4.23)	**4.55** (4.30-4.83)	**5.33** (5.01-5.65)	**5.95** (5.58-6.31)	**6.59** (6.16-6.99)	**7.24** (6.74-7.69)	**8.14** (7.52-8.67)	**8.85** (8.12-9.44)
7-day	**3.23** (3.07-3.42)	**3.85** (3.65-4.06)	**4.64** (4.40-4.90)	**5.28** (5.00-5.56)	**6.15** (5.81-6.48)	**6.85** (6.45-7.22)	**7.56** (7.09-7.97)	**8.30** (7.74-8.77)	**9.31** (8.61-9.87)	**10.1** (9.28-10.8)
10-day	**3.69** (3.50-3.89)	**4.37** (4.16-4.61)	**5.22** (4.96-5.50)	**5.89** (5.59-6.21)	**6.82** (6.45-7.18)	**7.54** (7.11-7.95)	**8.28** (7.78-8.73)	**9.03** (8.45-9.54)	**10.1** (9.33-10.7)	**10.8** (10.0-11.5)
20-day	**5.07** (4.83-5.33)	**5.98** (5.70-6.28)	**7.01** (6.68-7.37)	**7.83** (7.45-8.23)	**8.92** (8.46-9.37)	**9.76** (9.24-10.3)	**10.6** (10.0-11.1)	**11.4** (10.7-12.0)	**12.5** (11.7-13.2)	**13.3** (12.4-14.1)
30-day	**6.29** (6.02-6.59)	**7.40** (7.09-7.75)	**8.57** (8.21-8.98)	**9.47** (9.06-9.92)	**10.6** (10.2-11.1)	**11.5** (11.0-12.0)	**12.3** (11.7-12.9)	**13.2** (12.5-13.8)	**14.2** (13.4-14.9)	**14.9** (14.0-15.7)
45-day	**8.11** (7.77-8.47)	**9.50** (9.11-9.93)	**10.9** (10.4-11.4)	**12.0** (11.4-12.5)	**13.3** (12.7-13.9)	**14.3** (13.6-14.9)	**15.2** (14.5-15.9)	**16.1** (15.3-16.8)	**17.2** (16.3-18.0)	**18.0** (17.0-18.9)
60-day	**9.83** (9.42-10.3)	**11.5** (11.0-12.0)	**13.1** (12.6-13.7)	**14.3** (13.7-14.9)	**15.8** (15.1-16.5)	**17.0** (16.2-17.7)	**18.0** (17.1-18.8)	**19.0** (18.0-19.8)	**20.2** (19.1-21.1)	**21.0** (19.9-22.1)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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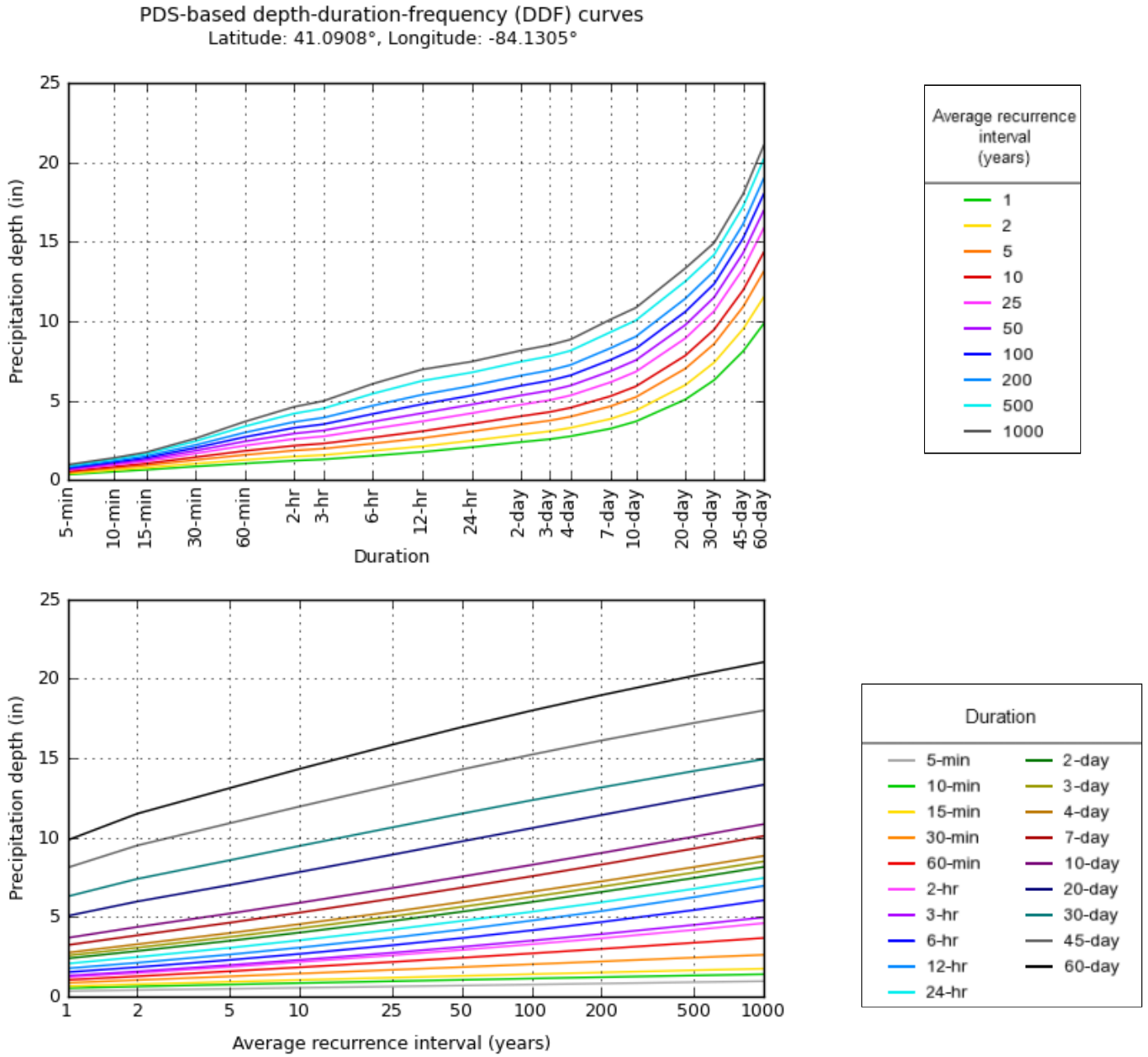
PF graphical



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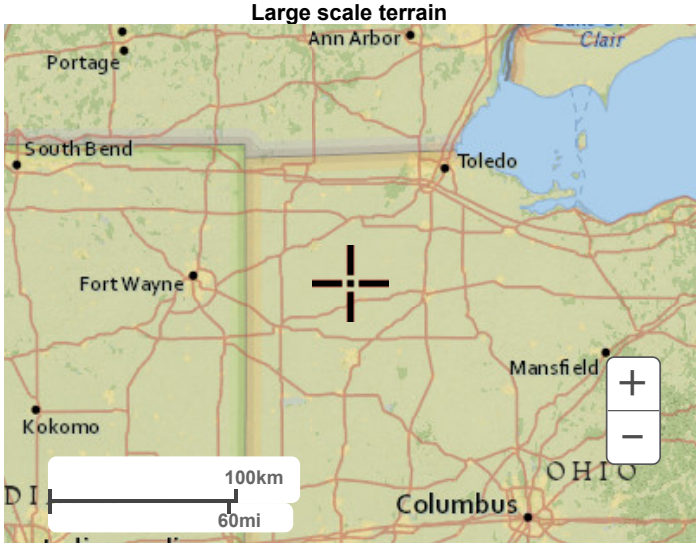
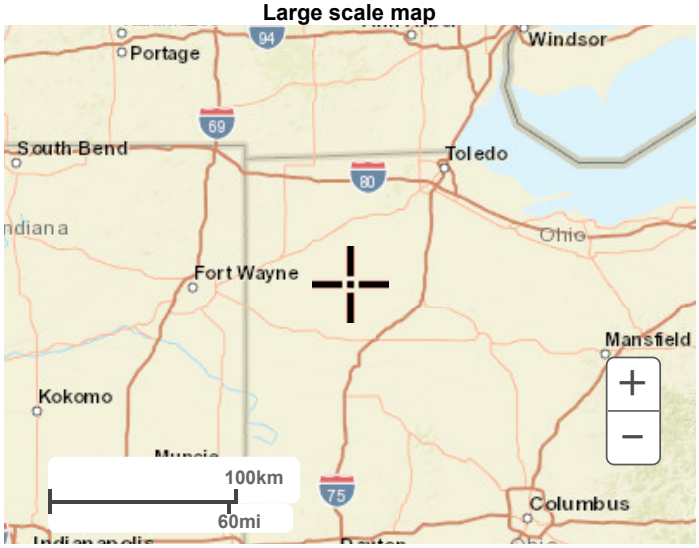
Maps & aerials

Small scale terrain

Large scale terrain



Large scale map



Large scale aerial

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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix B

Curve Number Table

Table 1. Standard Curve Numbers

Class	Value	Classification Description [NLCD 2006]	Curve Number				
			Soil Type*				
			A	B	C	D	W
Water	11	Open Water - areas of open water, generally with less than 25% cover of vegetation or soil.	98	98	98	98	100
	12	Perennial Ice/Snow - areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.	98	98	98	98	100
Developed	21	Developed, Open Space - areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.	46	65	77	82	100
	22	Developed, Low Intensity - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.	61	75	83	87	100
	23	Developed, Medium Intensity – areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.	77	85	90	95	100
	24	Developed High Intensity -highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.	89	92	94	95	100
Barren	31	Barren Land (Rock/Sand/Clay) - areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.	77	86	91	94	100
Forest	41	Deciduous Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.	43	55	70	77	100
	42	Evergreen Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.	43	55	70	77	100
	43	Mixed Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.	43	55	70	77	100
Shrubland	51	Dwarf Scrub - Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.	43	48	65	73	100
	52	Shrub/Scrub - areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.	43	48	65	73	100
Herbaceous	71	Grassland/Herbaceous - areas dominated by gramanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.	43	58	71	78	100
	72	Sedge/Herbaceous - Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.	43	58	71	78	100
	73	Lichens - Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation.	43	48	65	73	100
	74	Moss - Alaska only areas dominated by mosses, generally greater than 80% of total vegetation.	43	48	65	73	100
Planted/Cultivated	81	Pasture/Hay – areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.	43	58	71	78	100
	82	Cultivated Crops – areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.	67	78	85	89	100
	83	Small Grains	63	75	83	87	100
Wetlands	91	Woody Wetlands - areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.	45	66	77	83	100
	92	Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.	45	66	77	83	100

*A/D, B/D and C/D soils lumped as D soils, W denotes water

**Curve Numbers for NLCD Codes 41-81 have been increased from 30 to 43 as many of these areas are partially grazed Woods-grass combination.

Appendix C

Ohio EPA Post-Construction Storm Water Controls For Solar Arrays

Guidance on Post-Construction Storm Water Controls for Solar Panel Arrays

Background

Although the area under and between ground-mounted solar panel arrays may be covered in vegetation (normally considered pervious), the elevated panels alter the volume, velocity and discharge pattern of storm water runoff and associated pollutants and therefore do require post-construction storm water management under OHC00005 (Part III.G.2.e, pp. 19-27). Paved or gravel roads and support buildings associated with the solar panel array as well as any gravel surfaces under or around the panel arrays must also include post-construction storm water management.

Post-Construction Storm Water Management Options

There are several factors that determine the entire installation's effect on runoff and feasible storm water management options. In some cases, runoff from roads, buildings and the solar panels can be managed through the standard post-construction practices listed in tables 4a and 4b of the CGP. For many facilities, storm water runoff from the solar panels can be simply managed by disconnection to the vegetated ground surface under and between the elevated panels provided 1) an ungraded, uncompacted soil profile exists, 2) dense and healthy vegetation can be maintained over the entire surface, and 3) runoff from the panels can be managed as non-erosive, sheet flow. The disconnection length ($L_{Disconnection}$) provided depends upon the width of the row of solar panels (W_{Panel}) and the width of the open gap width between the panel rows ($W_{Row\ Gap}$) as shown in Figure 1 below.

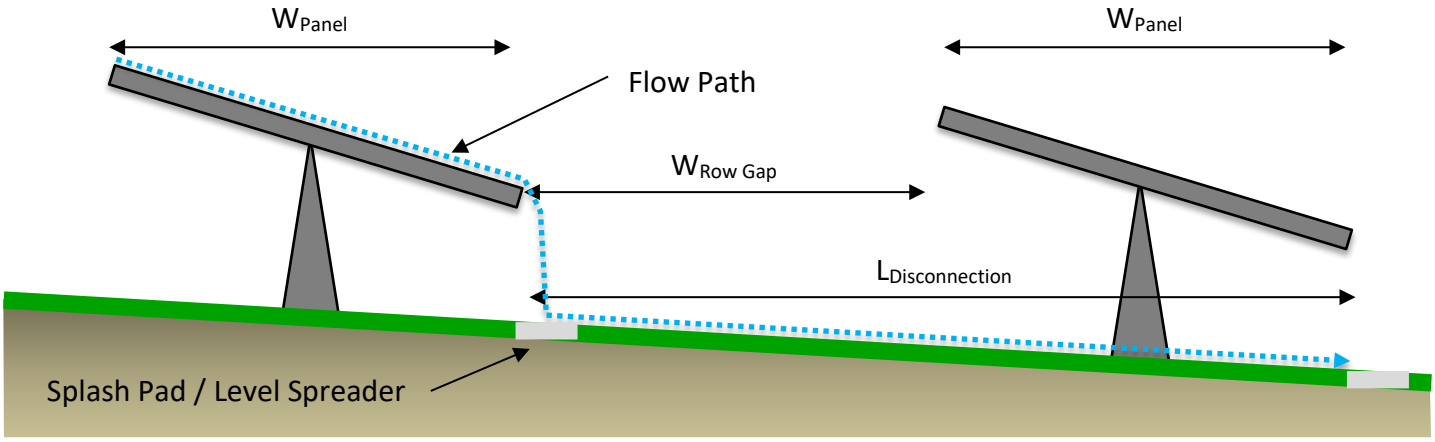

Figure 1: Schematic profile of solar panel array providing impervious area disconnection.

Runoff Reduction Spacing

The Runoff Reduction credit values for impervious area disconnection can be used to determine the $L_{Disconnection}$ needed based upon the W_{Panel}. Where the entire panel area is grass, this can be viewed as a needed ratio of W_{Panel} to $W_{Row\ Gap}$ for the entire length of the panel row.

For panel arrays on Hydrologic Soil Group (HSG) A or B soils and on soils that have been functionally restored, the disconnection length required is two times the solar panel width on a horizontal plane, which equates to a 1:1 spacing ratio. On HSG C or D soils without restoration, the disconnection length required is 3.5 times the solar panel width on a horizontal plane, or a 2.5:1 spacing ratio.

General Permit OHC000005: Guidance on Post-Construction Storm Water Controls for Solar Panel Arrays

Other Design Considerations

- Gravel or paved access roads and equipment pads as well as solar panels that drain onto to them may require traditional practices if impervious disconnection is not feasible.
- This guidance assumes the ground support structure and foundation are minimal (less than five percent of the area), will allow vegetation, and will not disrupt sheet flow. Otherwise, the area underneath the panels may not be included in the disconnection area.
- To limit erosion at the drip edge, it is recommended the panel drip edge be no more than 10 feet above the ground.
- If the panel position is fixed, a narrow stone drip pad may be used to protect the ground surface from erosion and promote sheet flow.
- If the panels track or rotate, the disconnection length shown in the previous diagram will vary and must be shown to be acceptable in all panel positions.
- The Storm Water Pollution Prevention Plan (SW3P) should include typical drawings and calculations for large panel arrays. Specific controls for access roads and other infrastructure must also be detailed.
- Utilize low- and slow-growing grass varieties to reduce compaction and damage from frequent mowing. Include cool-season, warm-season, shade-resistant, and legumes as necessary to develop a dense, year-round groundcover.

References

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Ohio Environmental Protection Agency. 2018. *General Permit Authorization for Storm Water Discharges Associated with Construction Activity under the National Pollutant Discharge Elimination System*. Ohio EPA Permit Number OHC000005. April 23, 2018.

Pennsylvania Department of Environmental Protection, Bureau of Clean Water. 2019. *Chapter 102 Permitting for Solar Panel Farms, Frequently Asked Questions*. January 2, 2019.

Contact

For more information, contact Michael Joseph at ***michael.joseph@epa.ohio.gov*** or (614) 644-2001.

Summary: Application Exhibit G - Hydrology Study (Part 4 of 4) electronically filed by Teresa Orahood on behalf of Dylan F. Borchers