4.4 Recommended Changes to Post-Development Stormwater Model

In addition to the use of more updated precipitation values, we also recommend that the Curve Number selected for use in the Atlantic post-development HydroCAD model be modified to a more conservative value. In our opinion the Atlantic post-development model underestimates the runoff that the Site will generate once the panels have been installed because of the Curve Numbers selected for land cover. HW modified the Atlantic post-development model and created a new post-development model that makes the following assumptions:

1. **No change to drainage area size or type of cover.**
2. **No change to Time of Concentration for any drainage area.**
3. **No change to Curve Number for wooded areas.**
4. **Change Curve Number for grass areas: The grass areas were classified as "good" condition. Based on recent Rhode Island Department of Environmental Management (RIDEM) guidance for solar facilities (see below), the grass will be "fair" condition. Curve numbers were therefore increased to reflect this condition.**

RIDEM has recently published guidance for the design and permitting of ground-mounted solar arrays (RIDEM, 2021). While this project does not fall under RIDEM jurisdiction, this document provides current best practices for ground-mounted solar arrays in the region. The RIDEM guidance states that "In order for modeled ground cover to be considered in "good" hydrologic condition, at least 6" of loam cover must be provided." Based on field observations and a review of the plans, HW was unable to confirm that 6" of topsoil would be provided throughout the site. In addition, as currently proposed, the panels vary between 12-14 feet in width with ten feet of spacing between the rows. RIDEM guidance recommends a minimum spacing between rows of panels equal to the width of the panels to provide sufficient light for the groundcover. Therefore, HW believes the grass will be in "fair" condition as the project is currently proposed.

When compared to HW's edited pre-development model, the HW post-development model, created based on the above-listed assumptions, results in up to a 56% increase in peak flow and a 50% increase in total runoff volume exiting the Site under proposed versus existing conditions (Table 11). Therefore, the stormwater basins are undersized to manage the modeled increase in runoff as currently designed. — Concurred w/ in Patrick Garner's assessment using Cornell + NRCC

Speaking with Mr. Price at Conservation, he said The NPDES Stormwater management for solar projects was the reference source he and he used.
Attached — for spacing to "make" impervious pervious.

Atlantic
DESIGN ENGINEERS, INC.

June 16, 2022

Kenneth Buckland
Director of Planning and Community Development
Town of Wareham Planning Board
54 Marion Road
Wareham, MA 02571

RE: Response to Recommendations from Horsley Witten Group, Inc. Hydrogeologic and Hydrologic Study, May 2022
91 and 101 Fearing Hill Road Solar Project – Wareham, MA
ADE Job #3055.02

Dear Mr. Buckland:

This response letter addresses the recommendations made in Horsley Witten Group's Hydrogeologic and Hydrologic Study dated May 2022 for the above-referenced project. Please note that Horsley Witten's recommendations are italicized, and our responses follow in bold text:

Recommendations:

Due to the projected increases in stormwater runoff from the proposed Site, and the existing conditions high water level concerns of nearby neighbors, we recommend that the Applicant consider some elements of redesign for Site layout and stormwater management.

- *While the Site compliance with current Massachusetts guidance for ground-mounted solar facilities is uncertain, it does not meet all the newer guidance standards of the Rhode Island guidance. Significantly, the current Rhode Island guidance calls for a minimum spacing between rows of panels of at least equal to the width of those panels, and the proposed Site development does not meet that criterion. This is important because a wider spacing between panels would better allow for a healthy grass or meadow ground cover to establish. While a healthy meadow still allows for more runoff than does an intact forest, it would reduce the volume and rate of runoff generated from the proposed development relative to the current design. The Site is obviously not in Rhode Island and, as such, we mention this newer Rhode Island guidance as information for Town consideration.*

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Page Content

Stormwater management for solar projects and determining compliance with the NPDES construction stormwater permit

Construction projects need to have consideration of the quantity of stormwater retained at the construction site. Estimating stormwater retained for a photovoltaic solar farm project can be challenging because the panels are impervious but the area beneath the panels is often pervious. The following methodology and guidelines are recommended for determining the quantity of stormwater retained at these types of solar panel projects.

Link to Excel calculator for computing volumes: File:Solar panel calculator feb 2021.xlsx

Contents

Description of hydrologic processes at solar panel projects

support of the MIDS performance goal development (Barr, 2011) was modified to represent watersheds with varying impervious to pervious ratios and hydrologic soil types of A, B, C, and D. See the link above for more detailed discussion.

Since the entire solar array is not a continuous impervious surface, the MPCA has chosen to modify the calculations to account for infiltration for a single panel. Total volumes can be calculated by multiplying the results for a single panel by the number of panels being considered. To make the calculation, the following information is needed.

- Soil type - Hydrologic Soil Group A, B, C, or D
- Area of impervious surface, which is the same as the area of a solar panel. This will equal the average horizontal distance of the panel, Z, multiplied by the width of the panel.
- Area of pervious surface - this equals the distance (Y + Z) times the width of the panel

Calculations can be made using this Excel file: File:Solar panel calculator feb 2021.xlsx

This last output on this calculator will show the remaining water quality volume to be treated for an individual panel. This may be accomplished using more traditional stormwater management methods including but not limited to:

- Constructed shallow depresions for Infiltration (with or without an underdarin)
- Natural depressions on the landscape that infiltrate
- Stormwater retention ponds
- Vegetated swales
- Swales with check dams to create storage and promote infiltration

Assumptions and guidance

The following are assumptions or recommended practices for applying the above methodology.

- Projects must minimize earth disturbance and grading activities where natural vegetation cover is preserved and/or restored. Utilizing low impact construction techniques is encouraged. Projects that are unable to minimize disturbance or grading activities may employ soil/landscape restoration and soil amendment (http://stormwater.pca.state.mn.us/index.php/Alleviating_compaction_from_construction_activities). Vegetation cover has 90 percent or better uniform coverage.
  - A meadow condition is preferable, particularly for slopes between 5 and 10 percent.
  - Mowed areas, where approvable, should be kept to 4 inch minimum height.
  - Vegetated areas will not be subject to chemical fertilization or herbicides/pesticides except for those applications that are necessary to get vegetation established and which follow an approved Erosion and Sediment Pollution Control Plan.
- Individual photovoltaic panels within an array are arranged in a fashion that
  - allows the passage of runoff between each module thereby minimizing the creation of concentrated runoff and
  - allows the growth of vegetation beneath and between arrays.
- Structures/foundations for ground mounted solar panels should be included as impervious surfaces.
- The lowest vertical clearance of the solar array is at an elevation of 10 feet or less from the ground, but is also at an adequate height to promote vegetative growth below the array. If elevation is greater

- The runoff depth from pervious areas, equal to 5.7 inches for a B soil
- The redirected runoff from a solar panel. The calculator automatically calculates the impervious to pervious ratio (I/P ratio), which for this example is 0.379. Using the figure in the spreadsheet (also shown to the right), the runoff from redirected impervious must be interpolated since the curve shows a value of 6.8 inches for an I/P ratio of 0.5 and 6.1 inches for an I/P ratio of 0.2. Assuming a linear curve, the resulting redirected runoff from a solar panel is 6.52 inches. **NOTE this term is also called average annual runoff depth.**
- Runoff depth from the solar panel equal to 22.5 inches
- Performance goal equals 1 inch (for compliance with the Construction Stormwater General Permit)

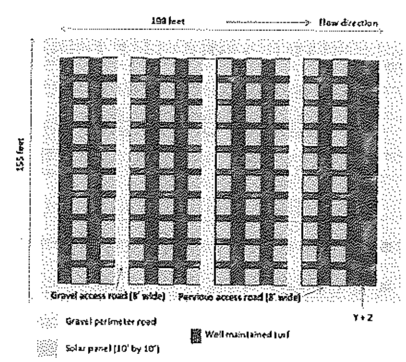
The performance goal, considering a single panel, is 5.69 cubic feet. The volume credit for this scenario is 3.86 cubic feet, meaning 67.8 percent of the performance goal is achieved. The remaining volume to be treated is 1.83 cubic feet.

Considering the entire site (100 panels plus gravel roads), the remaining volume to be treated is equal to the runoff from the impervious gravel roads plus runoff from all 100 solar panels. Runoff from the panels is 100 times 1.83 cubic feet per panel, for a volume of 183 cubic feet. For a performance goal of 1 inch, runoff from the gravel roads is 882.5 cubic feet (two 15 foot wide, 155 foot long gravel roads, and two 15 foot wide, 198 foot long gravel roads). The remaining volume to be treated is therefore 183 + 882.5 cubic feet, or 1065.5 cubic feet.

Note that if this example was for an A soil, 82.1 percent of the performance goal would have been achieved (4.68 cubic feet treated toward the performance goal of 5.73 cubic feet). If the example was for a C soil, 66.3 percent of the performance goal would have been achieved (a credit of 3.79 cubic feet toward the performance goal of 5.73 cubic feet). If the example was for a D soil, 57.3 percent of the performance goal would have been achieved (a credit of 3.28 cubic feet toward the performance goal of 5.73 cubic feet).

Example 2

A solar farm consists of a 10 by 10 array of solar panels (100 total panels). Each panel is 10 feet long by 10 feet wide. The entire area, excluding perimeter gravel roads and three interior gravel access roads, is well-maintained turf. The gravel roads are considered to be impervious. The area between each column of panels consists either of an 8 foot wide turf access area, when the panels are in a horizontal position, or an 8 foot wide impermeable gravel area. The perimeter of the solar farm consists of 15 foot wide gravel roads. The soil is Hydrologic Group B (SM), having an infiltration rate of 0.45 inches per hour.



Schematic used for Example 2.

The initial calculation is made for 1 solar panel. However, two calculations must be made separately for solar panels adjacent to turf access areas and panels adjacent to gravel access roads. Each panel is assumed to rotate between 30 and 60 degrees, giving an average length of each panel of 6.83 feet. For panels adjacent to turf access areas, and using the dimensions shown in the figure to the right, the length Z is the length beneath each solar panel, or 6.83 feet. The length Y is the width of the access road (8 feet) plus the difference between the horizontal and average lengths of the solar panels (10 minus 6.83 feet or 3.17 feet), for a length of 11.17

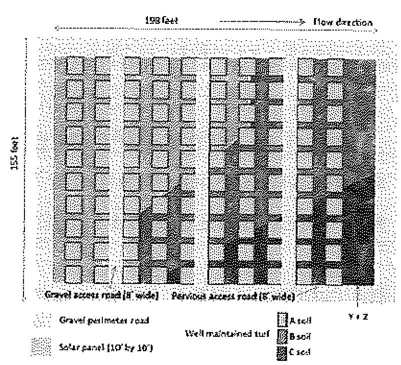
To compute the remaining volume requiring treatment, the number of panels adjacent to turf access roads or gravel access roads must be known.

- There are 70 panels adjacent to turf access roads. 70 panels times 1.83 cubic feet per panel = 128.1 cubic feet.
- There are 30 panels adjacent to gravel access roads. 30 panels times 5.53 cubic feet per panel = 165.9 cubic feet.

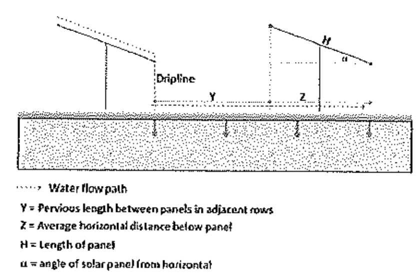
Adding these values up gives 294 cubic feet. For a performance goal of 1 inch, runoff from the perimeter gravel roads is 882.5 cubic feet (see Example 1 (https://stormwater.pca.state.mn.us/index.php?title=Stormwater_management_for_solar_projects_and_determining_compliance_with_the_NPDES_construction_stormwater_permit#Example_1)). Thus, the total volume needing treatment is 294 + 882.5 = 1176.5 cubic feet.

Example 3

A solar farm consists of a 10 by 10 array of solar panels (100 total panels). Each panel is 10 feet long by 10 feet wide. The entire area, excluding perimeter gravel roads and three interior gravel access roads, is well-maintained turf. The gravel roads are considered to be impervious. The area between each column of panels consists either of an 8 foot wide turf access area, when the panels are in a horizontal position, or an 8 foot wide impermeable gravel area. The perimeter of the solar farm consists of 15 foot wide gravel roads. Three soils occur on the site, including Hydrologic Soil Groups A, B, and C.



Schematic used for Example 3.



Schematic illustrating dimensions for a solar panel that discharges to a pervious turf access road.

The initial calculation is made for 1 solar panel. However, six calculations must be made separately for solar panels adjacent to turf access areas (A, B, and C soils) and panels adjacent to gravel access roads. Each panel is assumed to rotate between 30 and 60 degrees, giving an average length of each panel of 6.83 feet. For panels adjacent to turf access areas, and using the dimensions shown in the figure to the right, the length Z is the length beneath each solar panel, or 6.83 feet. The length Y is the width of the access road (8 feet) plus the difference between the horizontal and average lengths of the solar panels (10 minus 6.83 feet or 3.17 feet), for a length of 11.17 feet. The pervious length is Z + Y or 18 feet. Note that if the entire area between panels is pervious, the pervious length is simply the distance between panels when horizontal (Y) plus the width of each panel (H), or 10 + 8 = 18 feet. For panels adjacent to gravel access roads, the width of the gravel road must be counted as impervious surface rather than pervious surface. So the impervious length is Z (6.83 feet) plus the width of the road (8 feet) or 14.83 feet. The pervious length is the average width of the solar panel (6.83 feet), plus the distance between panels when the panels are at their average rotation (11.17 feet), minus the width of the gravel road (8 feet), for a total pervious length of 10 feet. Note that the pervious length can also be calculated simply as the width of a solar panel, plus the distance between solar panels that are in the horizontal position, minus the width of the gravel road (10 + 8 - 8 = 10 feet).