Stormwater Management Narrative

Wilson Hill Road Solar Array

469 Wilson Hill Road

Town of Hoosick

Rensselaer County, New York

Applicant:

Wilson Hill Solar, LLC

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Boston, MA 02110

JUNE 2023

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Prepared By:

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1.0 Introduction

Wilson Hill Solar, LLC is proposing the development of a solar farm on an existing parcel of land totaling approximately 99.52± acres located on the northern side of Wilson Hill Road in the Town of Hoosick, New York. The proposed site development includes a solar farm which consists of approximately 7.00± acres of solar panels spaced 30.0± feet center to center and the construction of approximately 2,300± linear feet (LF) of access road, stormwater management areas, and eight-foot-high perimeter fencing. The total area of proposed disturbance is approximately 25.1± acres and 7.60± acres of impervious area will be added to the site.

A stormwater management system has been designed to provide pollutant removal, reduce channel erosion, prevent overbank flooding, and safely control extreme flood events in accordance with the NYS Stormwater Management Design Manual (Design Manual). The NYS Department of Environmental Conservation (NYSDEC) issued specific guidance in April 2018 relative to stormwater management design considerations for solar panel installations. The temporary erosion control measures and post-construction stormwater management systems for this project have been designed in accordance with those guidelines and subsequent discussions with the NYSDEC relative to their guidelines. Section 7.0 of this report addresses specific solar panel application guidance.

The proposed stormwater management system for the project will include roadside swales, attenuation ponds, bioretention areas, and a wet pond designed to convey runoff from the proposed gravel stormwater access roads, solar panels, and the solar equipment pad. Runoff from the impervious access road and solar panels is directed into vegetated swales that discharge into bioretention areas or a wet pond. Additional roadside swales are proposed to direct stormwater runoff from the solar panel array into attenuation ponds to protect against washouts.

This narrative presents a review of the design concepts and parameters of the stormwater management system for the proposed increased impervious areas, in accordance with NYSDEC solar application guidance, including the access roads and the equipment pads. The purpose of the stormwater management narrative is to assure that changes in the surface runoff characteristics, as a result of the proposed construction, will not adversely impact adjacent or downstream properties. On-site stormwater management will be implemented in accordance with the Design Manual and NYSDEC solar application guidance to accommodate both additional stormwater runoff and to provide water quality treatment according to the green infrastructure standards.

2.0 Redevelopment Justification

Redevelopment Activity is defined as "…the disturbance and reconstruction of existing impervious area, including impervious areas that were removed from a project site within five (5) years of preliminary project plan submission to the local government (i.e. site plan,

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subdivision, etc.)", according to the NYSDEC SPDES General Permit GP-0-20-001 for Stormwater Discharges from Construction Activity.

The proposed solar facility will be constructed on an abandoned farm field. As part of the proposed development a section of an existing impervious roadway will be improved. Therefore, this project is considered a redevelopment project.

The Design Manual states several of the challenges encountered during redevelopment projects include "…the need to tie in to the existing drainage infrastructure… …the presence of underground utilities, incompatible surrounding land usages, highly compacted soils that are not suitable for infiltration, and contaminated soils that require mitigation."
Due to these constraints, the Design Manual offers "alternative sizing criteria" which differs from the standards and sizing criteria listed in other portions of the manual. These standards include:

- Water Quantity: Analyzing how redevelopment and new development activities change the existing hydrology and discharge rates from the project site.
- Channel Protection: Channel protection is known as stream channel protection, designed to protect stream channels from erosion. It is accomplished by providing 24-hour extended detention of the one-year, 24-hour storm event. For redevelopment projects, channel protection is not required if the post-construction 1-year 24-hour discharge rate and velocity is less than or equal to the pre-construction discharge rate.
- Water Quality: Water quality volumes must be treated for redevelopment projects by implementing conventional treatment standards, alternative treatment standards, or a combination of both.

The proposed redevelopment meets the alternative sizing criteria put forth in the Design Manual; more detail will be provided in Section 6 of this report.

3.0 Existing Conditions

The site generally consists of a farm field with small patches of wooded areas. The topography of the land consists of drainage from northeast to southwest. The typical slopes in the area of proposed development range from 10% to 20%, with localized areas over 30%. Elevations at the site vary between 734 and 1087 feet above sea level.

3.1 Soil and Groundwater Conditions

The USDA Natural Resources Conservation Service Soil Survey identifies the soils on the site, in the area of proposed development, to consist of sandy to silty loams, which range from somewhat poorly drained to moderately well drained, and which are predominantly classified as Hydrologic Soil Group (HSG) C/D. The results from the USDA Natural Resources Conservation Soil Survey (Soil Survey) are included in Section 6 of the SWPPP.

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4.0 Predevelopment Stormwater Analysis

The existing hydrologic conditions, in the area to be disturbed as a result of the proposed construction, were analyzed using Applied Microcomputer Systems' "HydroCAD" computer modeling program. The HydroCAD stormwater modeling program employs the United States Department of Agriculture's Soil Conservation Service (SCS) Technical Release 20 (TR-20) method for stormwater analysis. Using this modeling technique, the site is divided into "subcatchments" that represent specific areas contributing stormwater runoff to an existing, or proposed drainage feature. The subcatchments typically flow through "reaches" (i.e., swales, channels, or pipes) that convey the stormwater to storm basins or discharge areas.

A hydrologic model of the existing site was prepared using the Hydrocad program. Four (4) subcatchments were used to represent the existing drainage condition, see Figure 2.

The existing parameters of topography, vegetation, slope and soil type are all incorporated into the predevelopment model.

Table 1 presents a summary of the pre-development stormwater peak discharge for the 1 year, 10 year and 100-year design storm events at the respective Design Points. As will be discussed in subsequent sections, the post development stormwater discharge rate has been limited to the predevelopment discharge rate for the 1-year, 10-year, and 100-year storm events.

Table 1: Pre-Development Runoff Rates

Storm Event	Design Point Discharge (cfs)				Total Discharge offsite (cfs)
	OFF#1	OFF#2	OFF#3	OFF#4	
1-Year (2.19")	7.92	13.92	0.56	0.83	23.23
10-Year (3.63")	24.66	42.14	1.92	2.56	71.28
50-Year (5.18")	40.17	68.00	3.20	4.16	115.53
100-Year (6.05")	47.36	79.94	3.80	4.90	136.00

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The pre-development Curve Numbers (CN) for the existing ground covers are listed in Table 2.

Table 2: Pre-Development Ground Cover

Pre-Development Ground Cover Description	Curve Number
Gravel Surface, HSG C/D	96
Meadow non-grazed, HSG D	78
Meadow non-grazed, HSG C	71
Woods, Fair HSG D	79

The weighted CN for the pre-development conditions for the site is approximately 79. The HydroCAD model results for the pre-development conditions are included within Attachment B.

Design Point OFF#1 conveys flows to the neighboring property to the south. Design Point OFF#2 conveys flows to a low point off the property in the southeastern direction. Design Point OFF#3 includes runoff from the existing gravel access drive that flows to the south into a roadside ditch. Design point OFF#4 consists of a filed draining into a roadside ditch along Wilson Hill Road.

5.0 Stormwater Management Planning and Practice Selection

The site layout and stormwater design for this project was completed while taking into consideration the potential impacts on the existing site and downstream hydrology. Stormwater runoff from the existing site predominately sheet flows to areas to the south of the site. The stormwater management system will replicate similar practices.

Stormwater from impervious areas on the site is designed to be treated with bioretention areas with underdrains and a wet pond. This design method was considered ideal on this site given the steep topography which eliminates the possibility of using a majority of other treatment practices. Bioretention areas are considered standard stormwater management practices with runoff reduction volume capacity and wet ponds are only considered standard stormwater management practices.

The total disturbance for the project will be on the order of 25.1± acres. The proposed redevelopment will result in an increase of impervious cover by 7.60± acres.

6.0 Post-Development Stormwater Analysis

The post-development conditions were analyzed using the HydroCAD computer modeling program.

Twelve (12) subcatchments were used to represent the post development drainage conditions of the site in the areas of the proposed development. Site improvements to the property will

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consist of a solar farm which will include 7.00± acres of solar panels, approximately 2,700± LF of access road, a solar electrical equipment pad, and chain link fencing. Also included, as permanent elements of the development, are the on-site stormwater management areas. Stormwater management practices have been designed to provide storage, treatment, and attenuation of stormwater runoff from the proposed impervious surfaces on the site.

Stormwater runoff from the proposed impervious access road, solar panels, and solar electrical equipment pads will flow into vegetated swales which will convey flows to five (5) stormwater management areas, designed as bioretention areas and a wet pond.

Runoff from the undeveloped site perimeter, outside of the stormwater management areas, will sheet flow off site, which is similar to predevelopment drainage patterns. In areas with slopes greater than 5% where solar panels will be installed, overland flow dispersion devices will be installed on 100-foot intervals. The overland flow dispersion devices will maintain sheet flow patterns similar to predevelopment conditions.

The post-development ground cover Curve Numbers (CN) are listed in Table 3.

Table 3: Post-Development Ground Cover

Post-Development Ground Cover Description	Curve Number
Meadow, non-grazed, HSG D	78
Meadow, non-grazed, HSG C	71
Gravel Access Road	96
Improved Entrance Road, Equipment Pad	98
Woods, Fair HSG D	79

The weighted CN for the post-development conditions for the site is approximately 78. The HydroCAD model results for the post-development conditions are included within Attachment B. The contributing area to each stormwater management area is identified on Figure 3.

6.1 Stormwater Management Areas #1 through #4 – Bioretention Areas

Stormwater Management Areas (SMA) #1 through #4 are designed as bioretention areas with underdrains. They will provide detention and treatment of stormwater runoff from the improved access road, solar panels, and equipment pad.

Stormwater runoff contributing to SMA #1 and #2 will sheet floe from the existing slope into forebays that will distribute into bioretention areas. Runoff contributing to SMA #3 and #4 will be collected in swales located adjacent to the roadway.

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Stormwater runoff contributing to SMA #1 through #4 will receive pretreatment through the forebays that convey flows to the proposed SMAs. According to the Design Manual, a minimum pretreatment volume of 10% of the WQv must be provided.

6.2 Stormwater Management Area #5 – Wet Pond

Stormwater Management Area (SMA) #5 is designed as a wet pond. It will provide the primary detention and treatment of stormwater runoff from the solar panels.

Stormwater runoff contributing to SMA #1 will be collected in vegetated swales located adjacent to the solar panels and will receive pretreatment through the sediment forebays within the wet pond. According to the Design Manual, a minimum pretreatment volume of 10% of the WQv must be provided.

6.3 Redevelopment Criteria

Chapter 9 of the Design Manual states specific sizing criteria for water quantity, channel protection, and water quality volume as described below in the following sections.

6.3.1 Water Quantity

In accordance with Chapter 9 of the Design Manual, if the redevelopment results in no change to hydrology that increases the discharge rate from the project site, the 10-Year and 100-Year criteria do not apply.

The 1-Year, 10-Year, and 100-Year storm events were analyzed using HydroCAD under the post-development conditions shown in Figure 3. The following table presents the pre-development and post development discharge rates for discharges off the site. As indicated, the post development discharge rate is less than the predevelopment rate, and therefore, no additional water quantity controls are required.

Table 4: Water Quantity Summary

Storm Event	Predevelopment Runoff (CFS)	Post development Runoff (CFS)	Runoff Reduction (CFS)
1-Year (2.19")	23.23	7.50	15.73
10-Year (3.63")	71.28	44.16	27.12
50-Year (5.18”)	115.53	80.91	34.62
100-Year (6.05")	136.00	97.42	38.58

6.3.2 Channel Protection

For redevelopment projects, channel protection is not required if there are no changes to hydrology that increase the discharge rate from the project site. But as shown in the HydroCAD

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analysis the bioretention areas and wet pond attenuate a 1-year 24-hour storm for at least 24 hours.

6.3.3 Water Quality (WQ_v)

Chapter 9 of the Design Manual lists several options for providing water quality treatment on a redevelopment project. These options include the following:

1. Reduce the existing impervious cover by a minimum of 25% of the total disturbed, impervious area.
2. Treat at least 25% of the Water Quality Volume (WQ_v) from the disturbed, impervious area through the implementation of standard stormwater management practices or by reduction through the implementation of green infrastructure techniques.
3. Propose the use of alternative SMPs to treat at least 75% of the WQ_v from the disturbed impervious area, as well as any additional runoff from tributary areas that are not within the disturbed, impervious area.
4. Use a combination of impervious cover reduction and standard alternative SMPs that provide a weighted average of at least two of the above methods using the following formula: %WQv treatment by Alternative Practice = (25 – (% IC Reduction + % WQv treatment by Standard Practice + % Runoff Reduction))*3

The proposed development uses Option 2 to meet the Water Quality Treatment requirements but the bioretention areas and wet pond are sized to treat 100% of all disturbed impervious areas on the site. The Design Manual allows for a runoff reduction equivalent to the water quality volume associated with this practice.

The runoff reduction for the bioretention area is on the order of 6,532 CF. Attachment A contains the WQv and RRv calculations for the bioretention areas.

The proposed solar farm includes both redevelopment and new development activities. As such, the new development portions of the project have been designed in accordance with the sizing criteria in Chapter 4 of the Design Manual.

In general, small storm events and the initial runoff from larger storm events are an environmental concern as this stormwater runoff typically contains roadway pollutants and thermal energy stored by the asphalt. In accordance with the Design Manual, this initial runoff is designated as the Water Quality Volume (WQ_v) and special attention is given to this volume of runoff to meet water quality objectives.

The water quality storage volume, WQ_v, is calculated as follows:

$$WQ_v = \frac{P \cdot R_v \cdot A}{12}$$

Where: WQ_v = water quality volume (acre-feet)

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P = 90% rainfall event number

R_v = 0.05+0.009(I), where I is percent impervious cover excluding 75% of redevelopment impervious area (Option 2 above)

A = site area (acres), impervious area used with I = 100%

Table 6 below lists the required water quality volume for each stormwater management area in the areas of new development.

Table 6: Required Water Quality Volume

SMA I.D.	P	R_v	A (SF)	Required WQ_v (cf)	Provided WQv (cf)
SMA#1	1.1	0.41	23,086	860	860
SMA#2	1.1	0.56	24,393	1,262	1,262
SMA#3	1.1	0.37	506,603	17,056	17,056
SMA#4	1.1	0.36	211,266	7,042	7,042
SMA#5	1.1	0.40	180,774	6,614	6,614
TOTAL				32,835	32,835

6.3.4 Runoff Reduction Volume (RRv)

The Design Manual specifies that runoff shall be reduced by 100% of the site WQv using standard SMPs with RRv capacity and green infrastructure techniques. The proposed project area is approximately 25.1± acres with a total proposed impervious area on the order of 7.60± acres. The resulting WQv for the site coverage is computed as 32,835± CF.

Site constraints, including poor soils and steep topography prohibit the ability to meet 100% of the RRv reduction. The minimum RRv for the site has been calculated as 6,089 CF. See Attachment A for the minimum RRv calculations.

6.3.4.1 Green Infrastructure Practices

The proposed impervious area on the site will be treated through a combination of SMA's #1 through #5. The SMA's have been designed to increase the time of concentration and reduce the peak discharge. The runoff reduction for the SMA's is on the order of 6,532 CF. Attachment A contains WQv and RRv calculations for this Green Infrastructure Practice. Attachment A contains the WQv and RRv calculations for this green infrastructure practice. Table 7 provides a summary of the runoff reduction provided.

Table 7: Runoff Reduction Volume Summary

Runoff Reduction Technique	RRv (cf)

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B1 (Bioretention Area)	378
B2 (Bioretention Area)	624
B3 (Bioretention Area)	2,851
B4 (Bioretention Area)	2,678
Total Site Reduction	**6,532**
Minimum RRv	**6,089**
% of Min. RRv	**107%**

Many of the green infrastructure practices recommended in the Design Manual were not applied to the stormwater management design on this site due to either site restrictions or the use of more feasible green infrastructure or standard SMP techniques in place of more restrictive and/or maintenance intensive practices. The following table discusses why the unused green infrastructure practices were not feasible.

Table 8: Non-Feasible Green Infrastructure Practices

Green Infrastructure Practice	Reason use is not feasible
Conservation of Natural Areas	Existing natural areas on site will be conserved to the greatest extent possible, solar facilities are considered temporary in nature, however the added reduction is minimal.
Porous Pavement	Porous Pavement is not economically feasible on this site.
Tree Planting/Tree box	Trees will be saved on the site as possible to conserve the natural areas. Trees will also be planted to maintain a buffer from the roadway and viewshed to the proposed site, though the resulting runoff reduction value for adding additional trees is minimal.
Disconnection of Rooftop Runoff	No structures are proposed within the project area
Stream Daylighting	No streams exist on the project site.
Rain Gardens	Rain gardens are not recommended for commercial applications as well as not economically feasible.
Green Roofs	Rooftops are not present on the site.
Stormwater Planters	The proposed practices were deemed more economically feasible and effective as opposed to stormwater planters. Additionally, they require less maintenance.
Rain Barrels/Cisterns	Rain Barrels/Cisterns would require the ability to use the water between storm events which is not feasible for this project type.

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7.0 NYSDEC Solar Panel Construction Guidance Stormwater Analysis

Due to the increase in solar projects throughout New York State, the Department of Environmental Conservation (NYSDEC) released guidance for solar panel stormwater permitting and stormwater pollution prevention plans (SWPPP) in April 2018. The NYSDEC Solar Panel Construction Guidance (SPCG) classifies solar projects under two separate "Scenarios". Scenario 1 Solar Projects are considered *"…Land clearing and grading for the purposes of creating vegetated open space…"*. These projects typically require a SWPPP that only addresses erosion and sediment controls. Solar projects are categorized as Scenario 1 if they are designed and constructed in accordance with a specific set of six criteria. Solar projects that aren't designed and constructed to meet these six (6) criteria are classified as Scenario 2 and require a SWPPP that addresses post-construction stormwater management practices which are designed in accordance with the sizing criteria in the Designed Manual. Table 9 provides an analysis of the six (6) criteria provided by the NYSDEC SPCG as they pertain to the Northern Gateway Renewables, LLC Solar Farm:

Table 9: NYSDEC Solar Panel Criteria

Scenario 1 Criteria	Proposed Solar Farm Design
1. Solar panels are constructed on post or rack systems and elevated off the ground surface.	Solar panels will be installed on mechanically driven posts with approximately 36 inches between the bottom of the panel and existing grade.
2. The panels are spaced apart so that rain water can flow off the down gradient side of the panel and continue to sheet flow across the ground surface*.	Panels are spaced 30± feet from center to center with 15.9± feet between the panel rows (adjacent edge of panel to adjacent edge of panel). The typical width of a solar panel rack is 14.1± feet. The panel spacing is the larger than the panel width, therefore, sheet flow is maintained.
3. For solar panels constructed on slopes, the individual rows of solar panels are generally installed along the contour so rain water sheet flows down slope*.	Panels are constructed generally along the contours to maintain sheet flow. In locations where panels are not along contours, and slopes are greater than 5%, overland flow dispersion devices are spaced at 100 ft apart are proposed to maintain sheet flow down slope in accordance with discussions with NYSDEC.
4. The ground surface below the panels consist of a well-established vegetative cover.	All ground surface below the panels will have well-established vegetative cover in accordance with the "Final Stabilization" noted in Appendix A of the SPDES Construction General Permit (see Section 4 of the SWPPP).
5. The project does not include the construction of any traditional imperious areas.	The proposed project does contain a solar equipment pad and a gravel road, both of which are considered impervious. **This project therefore falls under Scenario 2.**
6. Construction of the solar panels will not alter the hydrology from pre-to post	Based on the analysis performed in this report, the project will create minor disturbance, and add impervious area however, the

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development conditions.	pre-to post development hydrology will be maintained.

Criteria 5 of the NYSDEC SPCG is not met as traditional impervious area will be added to the site, therefore, this project falls under Scenario 2 and will require post-construction stormwater management controls for impervious areas of the project (gravel access road and equipment pads). This interpretation is also included in the **Notes- Item 5 portion of the NYSDEC SPCG.

*The NYSDEC SPCG also references the Maryland Department of the Environment's (MDE) "Stormwater Design Guidance - Solar Panel Installations" memo for further guidance on panel installation. The MDE's memo provides guidance using two examples of solar panels to provide direction; Example 1 references solar panels which are installed on average slopes less than 5% and Example 2 references solar panels which are installed on average slopes between 5% and 10%.

<u>Example 1- Using Non-Rooftop Disconnection Where the Average Slope ≤ 5%</u>

MDE states that in order for solar panels to qualify as non-rooftop disconnect, the disconnection length must be greater than or equal to the solar panel width. The proposed solar panel project uses a rack system with a width of 14.1± feet and a disconnection length of 15.9± feet. The spacing between the panel rows is greater than the width of the solar racks, therefore, the solar panels meet the MDE requirements for runoff treatment under non-rooftop disconnection.

<u>Example 2- Using Non-Rooftop Disconnection Where the Average Slope ≥ 5% but ≤ 10%</u>

In this example, the MDE advises the use of level spreaders along the drip edge of the panels to maintain sheet flow and dissipate energy in addition to maintaining a disconnection length greater than or equal to the solar panel width. Areas where slopes are ≥ 5%, overland flow dispersion devices are proposed which are parallel to contours in ±100-foot intervals in accordance with the New York State Standards and Specifications for Erosion and Sediment Control (Blue Book) requirements for level spreaders and discussions with NYSDEC representatives regarding the application of the NYSDEC SPCG for use with tracker style systems.

In accordance with the aforementioned guidance, post-construction stormwater management is required for all new impervious areas on the project site. Therefore, SMA #1 through SMA #3 have been designed in accordance with the Design Manual to treat the proposed gravel access road and solar equipment pad. Since this project has been designed in accordance with Criteria 1 through Criteria 4 of the NYSDEC SPCG Criteria, the WQv and RRv requirements for the solar panels do not need to be addressed.

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8.0 Summary

Development of the proposed project site will alter the stormwater drainage characteristics of the site; impervious area will be added in the form of a compacted gravel access road, solar panels, and a solar equipment pad. Changes to the stormwater drainage characteristics of the site have been evaluated in accordance with the Design Manual. The proposed stormwater management system has been designed to comply with the recommendations in the Design Manual and the NYSDEC SPCG as it relates to maintaining sheet flow, providing water quality/runoff reduction/channel protection volume, overbank flood control and extreme flood control for new development projects.

The proposed stormwater management system has been designed to attenuate and treat the stormwater runoff generated from the contributing areas for storm events to the pre-development rates, up to and including the 100-Year design storm event. The proposed stormwater management design includes the use of bioretention areas and attenuation ponds. Stormwater modeling results indicate the ability to reduce the overall post-development discharge rate from the site as summarized in Table 10.

Table 10: Post Development Stormwater Peak Discharge Rates

Peak Discharge Rates in cfs	1-Year Storm	10-Year Storm	50-Year Storm	100-Year Storm
Pre-Development	23.23	71.28	115.53	136.00
Post-Development	7.5	44.16	80.91	97.42
Overall Reduction (cfs)	15.73	27.12	34.62	38.58

Through the implementation of acceptable stormwater management practices, recommended by the NYS Stormwater Management Design Manual, the proposed project will not adversely affect adjacent or downstream properties.

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Figures

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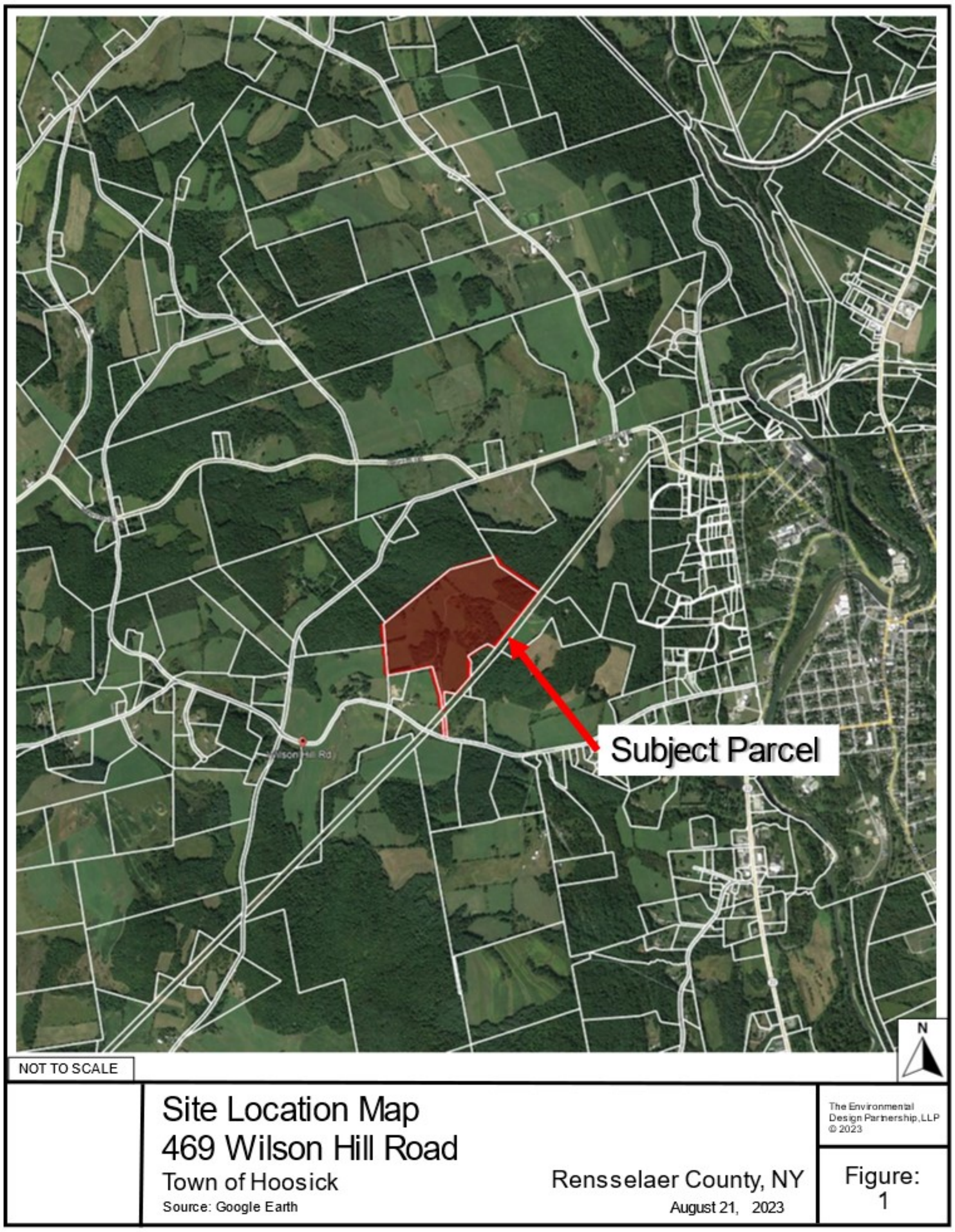

Figure 1: Site Location Map

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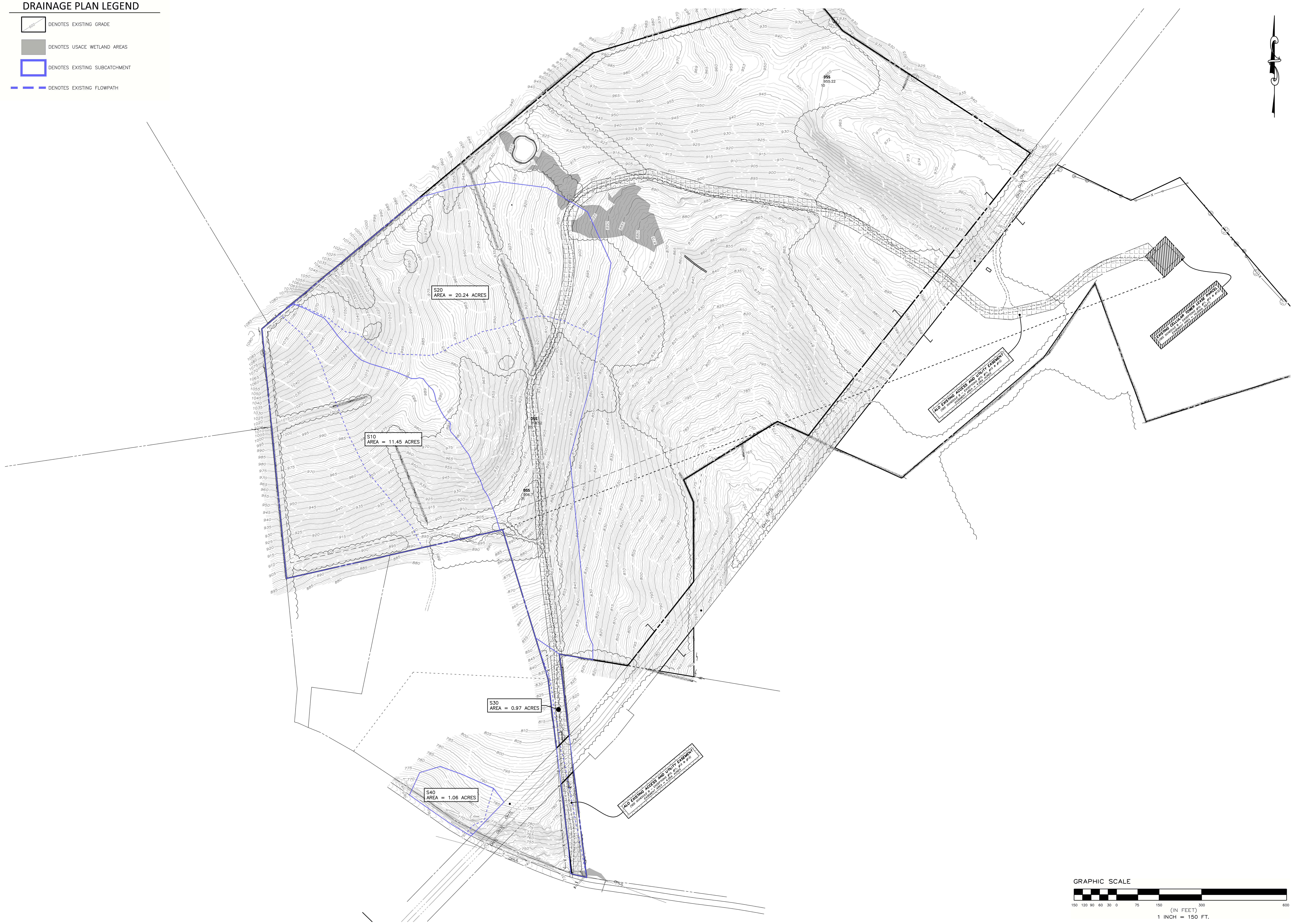
DRAINAGE PLAN LEGEND

- DENOTES EXISTING GRADE
- DENOTES USACE WETLAND AREAS
- DENOTES EXISTING SUBCATCHMENT
- DENOTES EXISTING FLOWPATH



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Rev	Issued For	Date
A	PRELIM PLAN SET	5/22/2023
B	INTERNAL COMMENTS	8/10/2023

P.E. seal/Consultant:

NOT FOR CONSTRUCTION

Project:

WILSON HILL SOLAR

469 Wilson Hill Road
Hoosick Falls, NY 12090

Drawing Title:

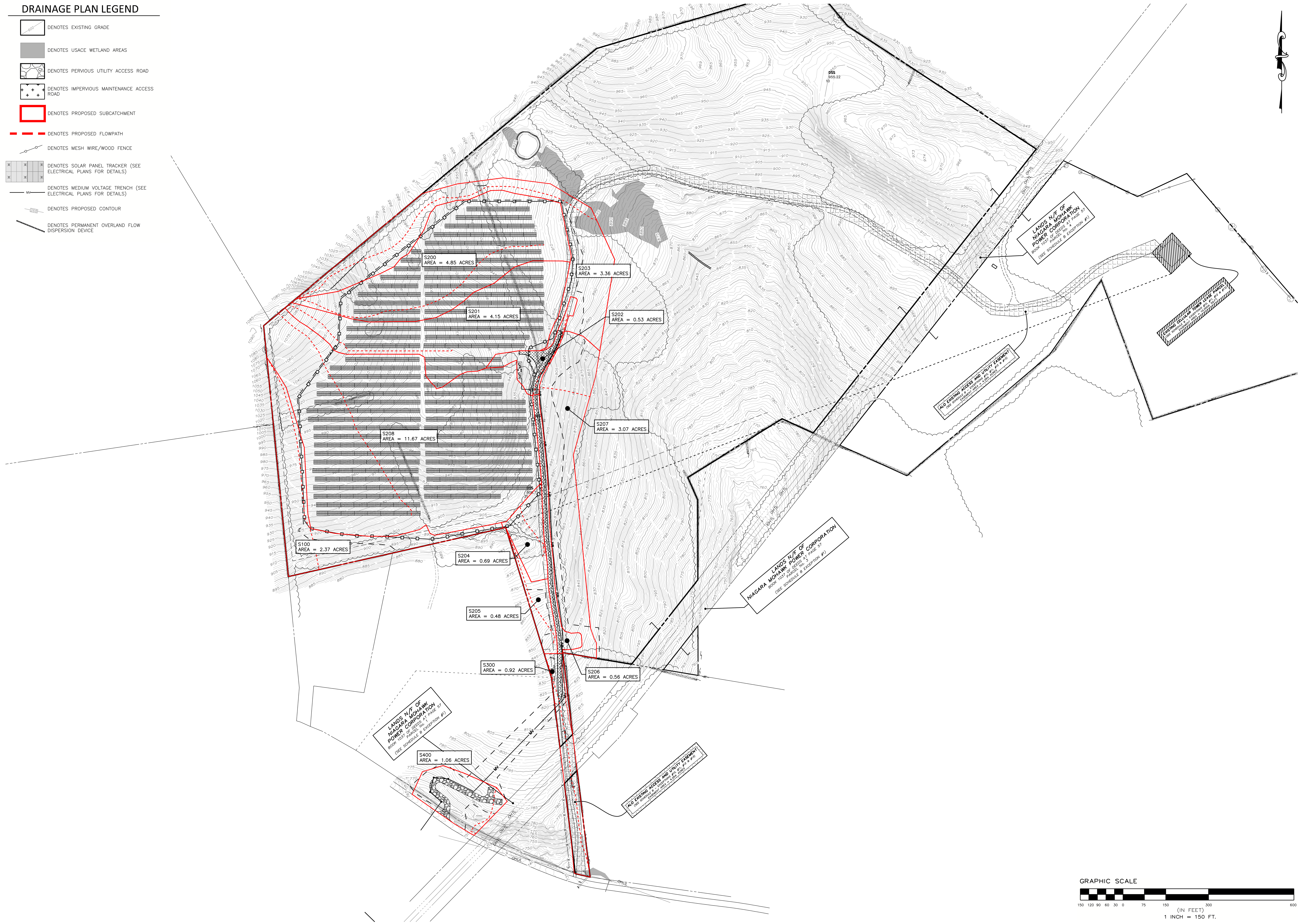
EXISTING DRAINAGE MAP

Drawn by: BMW Scale: As Shown Approved by: STA

Dwg No:	Size: D	Sheet Rev:
1 OF 2		B

DRAINAGE PLAN LEGEND

- DENOTES EXISTING GRADE
- DENOTES USACE WETLAND AREAS
- DENOTES PERVIOUS UTILITY ACCESS ROAD
- DENOTES IMPERVIOUS MAINTENANCE ACCESS ROAD
- DENOTES PROPOSED SUBCATCHMENT
- DENOTES PROPOSED FLOWPATH
- DENOTES MESH WIRE/WOOD FENCE
- DENOTES SOLAR PANEL TRACKER (SEE ELECTRICAL PLANS FOR DETAILS)
- DENOTES MEDIUM VOLTAGE TRENCH (SEE ELECTRICAL PLANS FOR DETAILS)
- DENOTES PROPOSED CONTOUR
- DENOTES PERMANENT OVERLAND FLOW DISPERSION DEVICE



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Rev	Issued For	Date
A	PRELIM. PLAN SET	5/22/2023
B	INTERNAL COMMENTS	8/10/2023
C	INTERNAL COMMENTS	9/15/2023

P.E. seal/Consultant: NOT FOR CONSTRUCTION

Project: WILSON HILL SOLAR
469 Wilson Hill Road
Hoosick Falls, NY 12090

Drawing Title: PROPOSED DRAINAGE MAP

Drawn by: BMW Scale: As Shown Approved by: STA

Dwg No: 2 OF 2 Size: D Sheet Rev: C

Attachment A

Water Quality Calculation

Runoff Reduction Calculation

900 Route 146, Clifton Park, New York 12065
phone (518) 371-7621

Version 1.8 Total Water Quality Volume Calculation
Last Updated: 11/09/2015 WQv(acre-feet) = [(P)(Rv)(A)] /12

Is this project subject to Chapter 10 of the NYS Design Manual (i.e. WQv is equal to post-development 1 year runoff volume)?...		No
Design Point:	A	
P=	1.10	inch

Manually enter P, Total Area and Impervious Cover.

Breakdown of Subcatchments						
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Description**
1	0.53	0.21	40%	0.41	860	Bioretention
2	0.56	0.32	57%	0.56	1,262	Bioretention
3	11.63	4.10	35%	0.37	17,056	Wet Pond
4	4.85	1.69	35%	0.36	7,042	Bioretention
5	4.15	1.61	39%	0.40	6,614	Bioretention
6						
7						
8						
9						
10						
Subtotal (1-30)	21.72	7.93	37%	0.38	**32,835**	**Subtotal 1**
Total	21.72	7.93	37%	0.38	**32,835**	**Initial WQv**

Identify Runoff Reduction Techniques By Area			
Technique	**Total Contributing Area** *(Acre)*	**Contributing Impervious Area** *(Acre)*	**Notes**
Conservation of Natural Areas	0.00	0.00	*minimum 10,000 sf*
Riparian Buffers	0.00	0.00	*maximum contributing length 75 feet to 150 feet*
Filter Strips	0.00	0.00	
Tree Planting	0.00	0.00	*Up to 100 sf directly connected impervious area may be subtracted per tree*
Total	**0.00**	**0.00**	

Recalculate WQv after application of Area Reduction Techniques					
	Total Area *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Runoff Coefficient Rv**	**WQv** *(ft^3)*
"<<Initial WQv"	21.72	7.93	37%	0.38	32,835
Subtract Area	0.00	0.00			
WQv adjusted after Area Reductions	**21.72**	**7.93**	37%	0.38	32,835
Disconnection of Rooftops		0.00			
Adjusted WQv after Area Reduction and Rooftop Disconnect	21.72	7.93	37%	0.38	**32,835**
WQv reduced by Area Reduction techniques					0

Total Water Quality Volume Calculation

WQv(acre-feet) = [(P)(Rv)(A)] /12

All Subcatchments						
Catchment	**Total Area** *(Acres)*	**Impervious Cover** *(Acres)*	**Percent Impervious** *%*	**Runoff Coefficient** *Rv*	**WQv** *(ft^3)*	**Description**
1	0.53	0.21	0.40	0.41	860.49	Bioretention
2	0.56	0.32	0.57	0.56	1,262	Bioretention
3	11.63	4.10	0.35	0.37	17056.10	Wet Pond
4	4.85	1.69	0.35	0.36	7041.66	Bioretention
5	4.15	1.61	0.39	0.40	6614.40	Bioretention
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

Runoff Reduction Volume and Treated volumes						
	Runoff Reduction Techiques/Standard SMPs		**Total Contributing Area**	**Total Contributing Impervious Area**	**WQv Reduced (RRv)**	**WQv Treated**
			(acres)	**(acres)**	**cf**	**cf**
Area/Volume Reduction	Conservation of Natural Areas	RR-1	0.00	0.00		
	Sheetflow to Riparian Buffers/Filter Strips	RR-2	0.00	0.00		
	Tree Planting/Tree Pit	RR-3	0.00	0.00		
	Disconnection of Rooftop Runoff	RR-4		0.00		
	Vegetated Swale	RR-5	0.00	0.00	0	
	Rain Garden	RR-6	0.00	0.00	0	
	Stormwater Planter	RR-7	0.00	0.00	0	
	Rain Barrel/Cistern	RR-8	0.00	0.00	0	
	Porous Pavement	RR-9	0.00	0.00	0	
	Green Roof (Intensive & Extensive)	RR-10	0.00	0.00	0	
Standard SMPs w/RRv Capacity	Infiltration Trench	I-1	0.00	0.00	0	0
	Infiltration Basin	I-2	0.00	0.00	0	0
	Dry Well	I-3	0.00	0.00	0	0
	Underground Infiltration System	I-4				
	Bioretention & Infiltration Bioretention	F-5	10.09	3.83	6532	9247
	Dry swale	O-1	0.00	0.00	0	0
Standard SMPs	Micropool Extended Detention (P-1)	P-1				
	Wet Pond (P-2)	P-2	11.63	4.10		17056
	Wet Extended Detention (P-3)	P-3				
	Multiple Pond system (P-4)	P-4				
	Pocket Pond (p-5)	P-5				
	Surface Sand filter (F-1)	F-1				
	Underground Sand filter (F-2)	F-2				
	Perimeter Sand Filter (F-3)	F-3				
	Organic Filter (F-4	F-4				
	Shallow Wetland (W-1)	W-1				
	Extended Detention Wetland (W-2	W-2				
	Pond/Wetland System (W-3)	W-3				
	Pocket Wetland (W-4)	W-4				
	Wet Swale (O-2)	O-2				
	Totals by Area Reduction	→	0.00	0.00	0	
	Totals by Volume Reduction	→	0.00	0.00	0	
	Totals by Standard SMP w/RRV	→	10.09	3.83	6532	9247
	Totals by Standard SMP	→	11.63	4.10		17056
	Totals (Area + Volume + all SMPs)	→	21.72	7.93	6,532	26,303

Minimum RRv

Enter the Soils Data for the site		
Soil Group	Acres	S
A		55%
B		40%
C	0.78	30%
D	**31.54**	20%
Total Area	32.316	
Calculate the Minimum RRv		
S =	**0.20**	
Impervious =	7.93	*acre*
Precipitation	1.1	*in*
Rv	0.95	
Minimum RRv	**6,089**	***ft3***
	0.14	af

Bioretention Worksheet

(For use on HSG C or D Soils with underdrains)

Af=WQv*(df)/[k*(hf+df)(tf)]

Af	Required Surface Area (ft2)
WQv	Water Quality Volume (ft3)
df	Depth of the Soil Medium (feet)
hf	Average height of water above the planter bed
tf	Volume Through the Filter Media (days)
k	The hydraulic conductivity [ft/day], can be varied depending on the properties of the soil media. Some reported conductivity values are: ***Sand*** - 3.5 ft/day (City of Austin 1988); ***Peat*** - 2.0 ft/day (Galli 1990); ***Leaf Compost*** - 8.7 ft/day (Claytor and Schueler, 1996); ***Bioretention Soil*** (0.5 ft/day (Claytor &

Design Point: **A**

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
1	0.53	0.21	0.40	0.41	860.49	1.10	Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops		0.00	40%	0.41	860	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.					0	*ft^3*	
Soil Information							
Soil Group		D					
Soil Infiltration Rate		0.00	*in/hour*	*Okay*			
Using Underdrains?		Yes	*Okay*				
Calculate the Minimum Filter Area							
				Value		Units	Notes
WQv				860		*ft^3*	
Enter Depth of Soil Media			*df*	2.5		*ft*	*2.5-4 ft*
Enter Hydraulic Conductivity			*k*	0.5		*ft/day*	
Enter Average Height of Ponding			*hf*	0.5		*ft*	*6 inches max.*
Enter Filter Time			*tf*	5		*days*	
Required Filter Area			***Af***	**287**		***ft^2***	
Determine Actual Bio-Retention Area							
Filter Width		9	*ft*				
Filter Length		35	*ft*				
Filter Area		315	*ft^2*				
Actual Volume Provided		945	*ft^3*				
Determine Runoff Reduction							
Is the Bioretention contributing flow to another practice?			No	Select Practice			
RRv		378					
RRv applied		**378**	***ft^3***	***This is 40% of the storage provided or WQv whichever is less.***			
Volume Treated		482	*ft^3*	*This is the portion of the WQv that is not reduced in the practice.*			
Volume Directed		0	*ft^3*	This volume is directed another practice			
Sizing √		OK		*Check to be sure Area provided ≥ Af*			

Bioretention Worksheet

(For use on HSG C or D Soils with underdrains)

Af=WQv*(df)/[k*(hf+df)(tf)]

Af	Required Surface Area (ft2)
WQv	Water Quality Volume (ft3)
df	Depth of the Soil Medium (feet)
hf	Average height of water above the planter bed
tf	Volume Through the Filter Media (days)
k	The hydraulic conductivity [ft/day], can be varied depending on the properties of the soil media. Some reported conductivity values are: ***Sand*** - 3.5 ft/day (City of Austin 1988); ***Peat*** - 2.0 ft/day (Galli 1990); ***Leaf Compost*** - 8.7 ft/day (Claytor and Schueler, 1996); ***Bioretention Soil*** (0.5 ft/day (Claytor & Schueler, 1996)

Design Point:	**A**						
Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
2	0.56	0.32	0.57	0.56	1261.99	1.10	Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops			57%	0.56	1,262	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.						*ft^3*	
Soil Information							
Soil Group		D					
Soil Infiltration Rate		0.00	*in/hour*	*Okay*			
Using Underdrains?		Yes	*Okay*				
Calculate the Minimum Filter Area							
				Value		Units	Notes
WQv				1,262		*ft^3*	
Enter Depth of Soil Media			*df*	2.5		*ft*	*2.5-4 ft*
Enter Hydraulic Conductivity			*k*	0.5		*ft/day*	
Enter Average Height of Ponding			*hf*	0.5		*ft*	*6 inches max.*
Enter Filter Time			*tf*	2		*days*	
Required Filter Area			***Af***	**1052**		***ft^2***	
Determine Actual Bio-Retention Area							
Filter Width		26	*ft*				
Filter Length		50	*ft*				
Filter Area		1300	*ft^2*				
Actual Volume Provided		1560	*ft^3*				
Determine Runoff Reduction							
Is the Bioretention contributing flow to another practice?			No	Select Practice			
RRv		624					
RRv applied		**624**	***ft^3***	***This is 40% of the storage provided or WQv whichever is less.***			
Volume Treated		638	*ft^3*	*This is the portion of the WQv that is not reduced in the practice.*			
Volume Directed		0	*ft^3*	This volume is directed another practice			
Sizing √		OK		*Check to be sure Area provided ≥ Af*			

Bioretention Worksheet

(For use on HSG C or D Soils with underdrains)

Af=WQv*(df)/[k*(hf+df)(tf)]

Af	Required Surface Area (ft2)
WQv	Water Quality Volume (ft3)
df	Depth of the Soil Medium (feet)
hf	Average height of water above the planter bed
tf	Volume Through the Filter Media (days)
k	The hydraulic conductivity [ft/day], can be varied depending on the properties of the soil media. Some reported conductivity values are: ***Sand*** - 3.5 ft/day (City of Austin 1988); ***Peat*** - 2.0 ft/day (Galli 1990); ***Leaf Compost*** - 8.7 ft/day (Claytor and Schueler, 1996); ***Bioretention Soil*** (0.5 ft/day (Claytor &

Design Point:	**A**

Enter Site Data For Drainage Area to be Treated by Practice

Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
4	4.85	1.69	0.35	0.36	7041.66	1.10	Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops		0.00	35%	0.36	7,042	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.					0	*ft^3*	

Soil Information

Soil Group	D		
Soil Infiltration Rate	0.00	*in/hour*	*Okay*
Using Underdrains?	Yes	*Okay*	

Calculate the Minimum Filter Area

		Value	Units	Notes
WQv		7,042	*ft^3*	
Enter Depth of Soil Media	*df*	2.5	*ft*	*2.5-4 ft*
Enter Hydraulic Conductivity	*k*	0.5	*ft/day*	
Enter Average Height of Ponding	*hf*	0.5	*ft*	*6 inches max.*
Enter Filter Time	*tf*	2	*days*	
Required Filter Area	***Af***	**5868**	***ft^2***	

Determine Actual Bio-Retention Area

Filter Width	33	*ft*
Filter Length	180	*ft*
Filter Area	5940	*ft^2*
Actual Volume Provided	7128	*ft^3*

Determine Runoff Reduction

Is the Bioretention contributing flow to another practice?		No	Select Practice
RRv	2,851		
RRv applied	**2,851**	***ft^3***	***This is 40% of the storage provided or WQv whichever is less.***
Volume Treated	4,190	*ft^3*	*This is the portion of the WQv that is not reduced in the practice.*
Volume Directed	0	*ft^3*	This volume is directed another practice
Sizing √	OK		*Check to be sure Area provided ≥ Af*

Bioretention Worksheet

(For use on HSG C or D Soils with underdrains)

Af=WQv*(df)/[k*(hf+df)(tf)]

Af	Required Surface Area (ft2)
WQv	Water Quality Volume (ft3)
df	Depth of the Soil Medium (feet)
hf	Average height of water above the planter bed
tf	Volume Through the Filter Media (days)
k	The hydraulic conductivity [ft/day], can be varied depending on the properties of the soil media. Some reported conductivity values are: ***Sand*** - 3.5 ft/day (City of Austin 1988); ***Peat*** - 2.0 ft/day (Galli 1990); ***Leaf Compost*** - 8.7 ft/day (Claytor and Schueler, 1996); ***Bioretention Soil*** (0.5 ft/day (Claytor &

Design Point:	**A**						
Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
5	4.15	1.61	0.39	0.40	6614.40	1.10	Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops		0.00	39%	0.40	6,614	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.					0	*ft^3*	
Soil Information							
Soil Group		D					
Soil Infiltration Rate		0.00	*in/hour*	*Okay*			
Using Underdrains?		Yes	*Okay*				
Calculate the Minimum Filter Area							
				Value		Units	Notes
WQv				6,614		*ft^3*	
Enter Depth of Soil Media			*df*	2.5		*ft*	*2.5-4 ft*
Enter Hydraulic Conductivity			*k*	0.5		*ft/day*	
Enter Average Height of Ponding			*hf*	0.5		*ft*	*6 inches max.*
Enter Filter Time			*tf*	2		*days*	
Required Filter Area			***Af***	**5512**		***ft^2***	
Determine Actual Bio-Retention Area							
Filter Width		31	*ft*				
Filter Length		180	*ft*				
Filter Area		5580	*ft^2*				
Actual Volume Provided		6696	*ft^3*				
Determine Runoff Reduction							
Is the Bioretention contributing flow to another practice?			No	Select Practice			
RRv		2,678					
RRv applied		**2,678**	***ft^3***	***This is 40% of the storage provided or WQv whichever is less.***			
Volume Treated		3,936	*ft^3*	*This is the portion of the WQv that is not reduced in the practice.*			
Volume Directed		0	*ft^3*	This volume is directed another practice			
Sizing √		OK		*Check to be sure Area provided ≥ Af*			

Bioretention Worksheet

Total RRv Applied	6,531.60
Total Area	10.09
Total Impervious Area	3.83
Total Volume Treated	9,246.94
Rooftop Disconnect Impervious Area Total	0.00

Attachment B

Stormwater Modeling Calculations

900 Route 146, Clifton Park, New York 12065
phone (518) 371-7621