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Virginia Pollinator-Smart Solar Industry

POLLINATOR–SMART
Comprehensive Manual

DCR
Virginia Department of Conservation & Recreation

DEQ
Virginia Department of Environmental Quality

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Acknowledgements

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Virginia Pollinator-Smart Solar Industry: At a Glance…

The Virginia Department of Environmental Quality (DEQ) and Department of Conservation and Recreation (DCR) have developed an ecologically-responsible program to encourage pollinator-friendly solar energy developments throughout the Commonwealth of Virginia. The program is referred to as the Virginia Pollinator-Smart Solar Industry (paraphrased hereafter as "Pollinator-Smart program").

A Pollinator-Smart solar facility is one that meets performance standards outlined in the most current release of the Virginia Pollinator Smart/Bird Habitat Scorecard ("Scorecard"). There are two versions of the Scorecard for different scenarios: 1) Proposed or Retrofit Solar Sites (i.e., sites where a Pollinator-Smart re-vegetation program is planned); and 2) Established Solar Sites (i.e., sites where a Pollinator-Smart management program has already been implemented). Solar sites that meet the minimum requirement of 80 points on the Scorecard are considered "Certified Virginia Pollinator-Smart"; those that score 100 or more points are considered "Gold Certified Virginia Pollinator-Smart".

The details of the Pollinator-Smart program are provided in the Comprehensive Manual, which is the document that follows this introductory section. The purpose of this At a Glance… section is to provide a "snapshot view" of the steps involved in getting a solar site certified – and keeping it certified – through this program.

STEP 1: THE SITE

» Certification through the Pollinator-Smart program starts with the site. At this stage, stakeholders (in most cases, a solar developer or a solar site operator/owner) will review the site to determine suitability for a Pollinator-Smart re-vegetation program.

» Site suitability analysis, which includes review of the existing conditions (e.g., topography, hydrology, soils, existing vegetation, infrastructure, etc.), should be performed by a qualified professional (as used in this program, a qualified professional has experience in site feasibility, management planning, installation, vegetation monitoring, and/or permitting for re-vegetation activities consistent with the Pollinator-Smart program).

STEP 2: VEGETATION MANAGEMENT PLAN (OPTIONAL)

» Based on the site suitability analysis, a Vegetation Management Plan is developed that outlines the re-vegetation program for the site.

» A Vegetation Management Plan is technically not required to complete the Scorecard, but it is strongly recommended because it will satisfy most of the required supplemental information in the Scorecard submittal process (as long as the Vegetation Management Plan is prepared in the format outlined below). Further, as a blueprint for Pollinator-Smart re-vegetation activities, the information in the Vegetation Management Plan can be used to streamline the remaining steps in the program (e.g., installation and monitoring).

» It is recommended that the plan be prepared by a qualified professional with expertise in establishing and/or monitoring native vegetation communities in various landscape settings.

» The Vegetation Management Plan should provide the following elements:

- Goals and objectives of the plan
- Outline of the regulatory context for the plan
- Summary of existing conditions (from the site suitability analysis)
- Proposed vegetation management methods (including species selections for seed mixes to be used on the site with seed suppliers/sources identified)
- Monitoring methods
- Schedule of vegetation management activities
- Reporting format for monitoring years
- Supporting documentation such as site plans, representative site photographs, site suitability analysis data, and regulatory support documents

STEP 3: SCORECARD

» For Proposed or Retrofit Solar Sites, the most current Version A of the Scorecard is completed and submitted through the Virginia Pollinator-Smart Solar Industry web portal, along with supporting documentation (for most purposes, a Vegetation Management Plan will include all required supporting documentation; in addition, if a research collaboration is proposed, documentation of that arrangement should be submitted) [Note: The Virginia Pollinator-Smart Solar Industry web portal is under development. In the interim, Scorecards and supporting documentation should be emailed to pollinator.smart@dcr.virginia.gov].

» Submitted Scorecards and supporting documentation are reviewed by the Virginia Pollinator-Smart Solar Industry Review Board ("Review Board"). There is a 21-day review period from the date that a complete application is received. The Review Board makes the determination of whether an application is complete and will notify the applicant if more information is needed.

» If approved by the Review Board, a solar site that scores at least 80 points on the Scorecard is Certified Virginia Pollinator-Smart. A solar site that scores 100 points or more on the Scorecard is Gold Certified Virginia Pollinator-Smart.

STEP 4: INSTALLATION

» The next step in the process is installation, which involves solar developers and/or operators/owners executing the re-vegetation program on their site. It is recommended that installation is performed or at least overseen by a qualified professional with relevant expertise in establishing native plant communities in various landscape settings. For most sites, installation will include the following steps:

- Site preparation
- Seed mix/seeding
- Integrated vegetation management (IVM; as defined in the comprehensive manual)
- Establishment and maintenance

STEP 5: MONITORING

» Annual monitoring is recommended on all Pollinator-Smart solar sites. Annual monitoring typically includes vegetation sampling and invasive species mapping.

» For Certified or Gold Certified Virginia Pollinator-Smart solar sites, biennial (once every 2 years) monitoring is required to maintain the certification. Starting from the date of the initial Pollinator-Smart certification, biennial monitoring occurs in Years 2, 4, 6, 8, and 10.

» Biennial monitoring should follow the Virginia Pollinator-Smart Solar Industry Monitoring Plan. It is recommended that biennial monitoring be performed by a qualified professional.

» Based on the monitoring results, the most current Version B of the Scorecard (for Established solar sites) is completed and submitted along with supporting documentation (same information submitted with Scorecard A, along with monitoring report). Submissions are made and reviewed as noted above. If approved, Certified or Gold Certified Virginia Pollinator-Smart solar sites retain their certification status for two years (until Year 10, see below).

STEP 6: REMEDIATION (IF NEEDED)

- If an Established Site does not satisfy the minimum standards on Version B of the Scorecard in any subsequent monitoring year, re-vegetation remediation will be required to rectify the issues and re-establish Pollinator-Smart conditions on the site. Remediation methods should be prescribed and completed by a qualified professional.
- After site-level remediation has been finalized, a new Version B of the Scorecard (for Established solar sites) documenting remediation activities must be completed, submitted, and reviewed following the Scorecard submittal process outlined above.

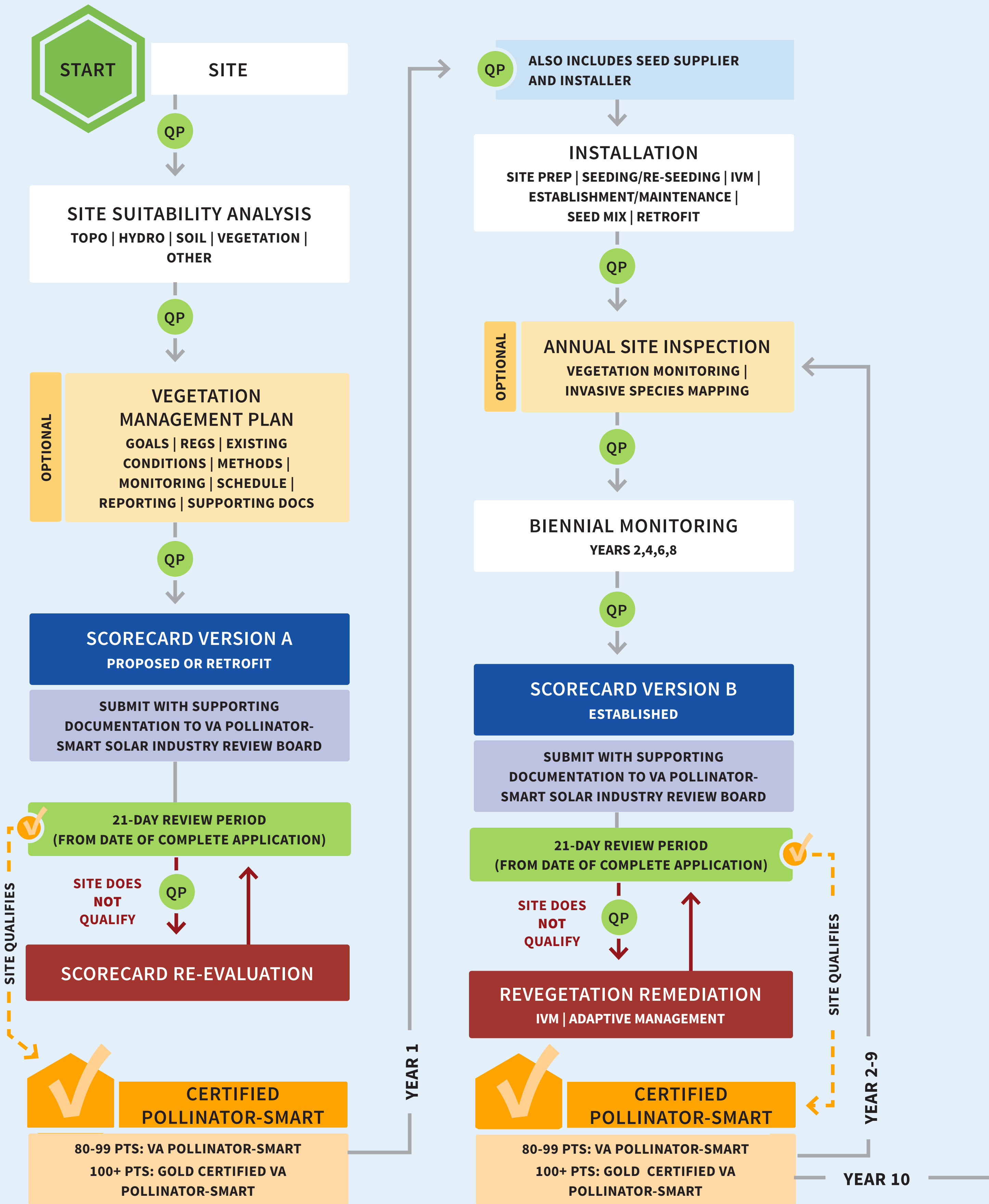
STEP 7: LONG-TERM VEGETATION MANAGEMENT PLAN

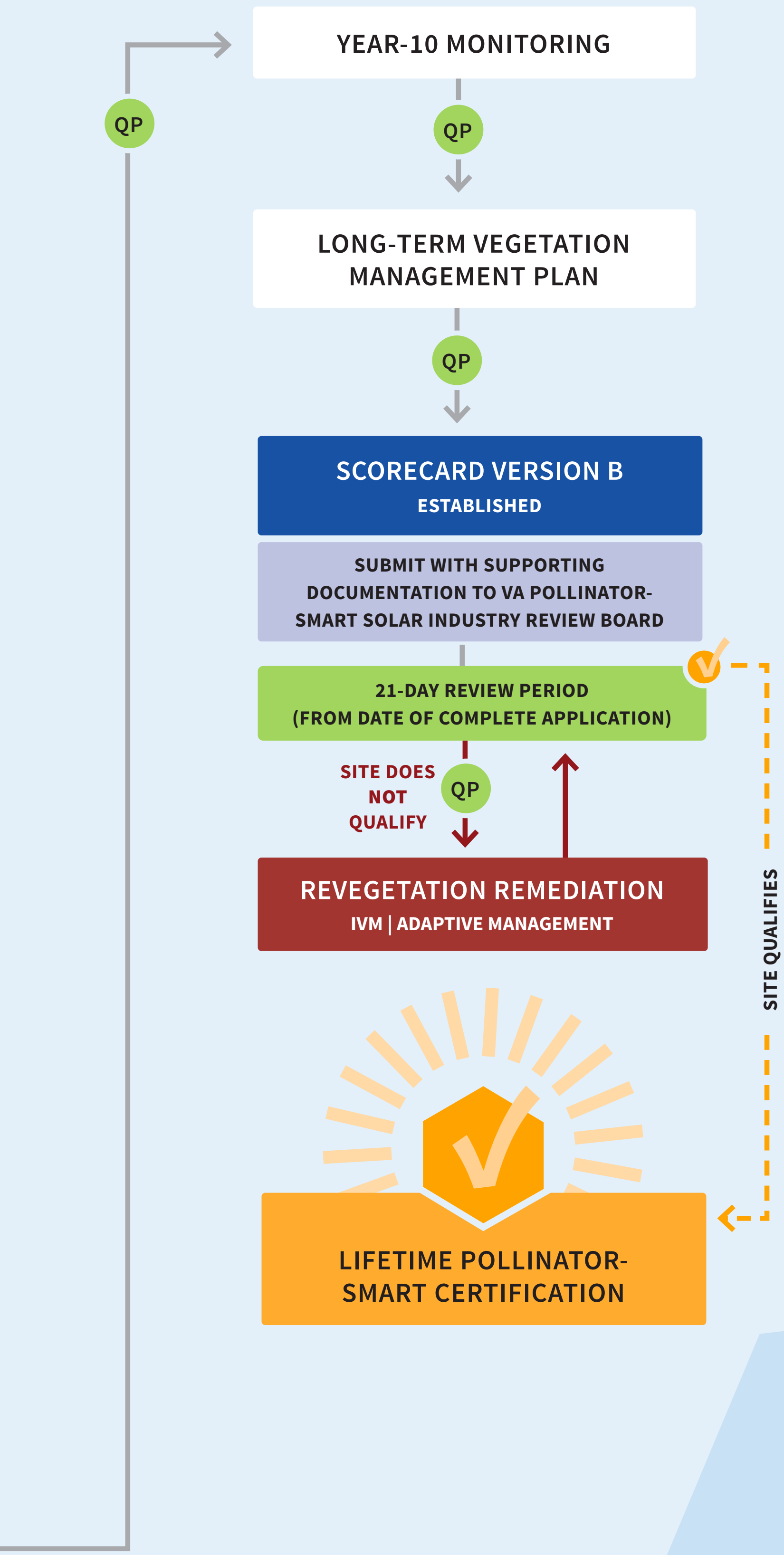
- Provided that a site has retained its Certified or Gold Certified Virginia Pollinator-Smart status throughout the 10-year monitoring period, a final Scorecard B is submitted in Year 10 along with a Long-Term Vegetation Management Plan. The Long-Term Plan should demonstrate a commitment to the management principles applied in the first 10 years of the project, and it should address both IVM goals and Adaptive Management for the operational life of the facility beyond the first 10 years (or for retrofit sites, beyond the first decade following implementation of Pollinator-Smart re-vegetation practices). It is recommended that the Long-Term Vegetation Management Plan be prepared by a qualified professional.
- A site in Year 10 that is approved by the Review Board as meeting Scorecard B requirements and having a viable Long-Term Vegetation Management Plan is released from further monitoring requirements and is considered Certified or Gold Certified Virginia Pollinator Smart for the life of the project.

FLOWCHART

LEGEND: QP QUALIFIED PROFESSIONAL

Virginia Pollinator-Smart Solar Industry ***At a Glance...***





QP
YEAR-10 MONITORING
QP
LONG-TERM VEGETATION MANAGEMENT PLAN
QP
SCORECARD VERSION B
ESTABLISHED
SUBMIT WITH SUPPORTING DOCUMENTATION TO VA POLLINATOR-SMART SOLAR INDUSTRY REVIEW BOARD
21-DAY REVIEW PERIOD
(FROM DATE OF COMPLETE APPLICATION)
SITE DOES NOT QUALIFY
QP
REVEGETATION REMEDIATION
IVM | ADAPTIVE MANAGEMENT
SITE QUALIFIES
LIFETIME POLLINATOR-SMART CERTIFICATION

1 INTRODUCTION

The Virginia Department of Environmental Quality (DEQ) and Department of Conservation and Recreation (DCR) have developed an ecologically-responsible program to encourage Pollinator-Smart solar energy developments throughout the Commonwealth of Virginia. The program is referred to as the **Virginia Pollinator-Smart Solar Industry** (paraphrased hereafter as “Pollinator-Smart program"), and its goal is to create self-sustaining, high-quality pollinator landscapes that require minimal maintenance in the long term.

RFP number [18-KW-01]

Therefore, in Virginia, a “Pollinator-Smart” solar facility is one that meets the goals and objectives of the Pollinator-Smart program. This determination is made through completion of the Virginia Pollinator-Smart/Bird Habitat Scorecard (**“Scorecard”**), and the Scorecard also serves as the program’s mode-of-entry for solar facilities. Details surrounding the Scorecard concept, including its inception and use in the solar industry, the science behind its development, the states that pioneered its use and functionality, and Virginia’s approach to the concept, are provided below under the heading “Pollinator-Smart Criteria – the Scorecards.”

This document is referred to as the **“Comprehensive Manual”**, and ultimately its purpose is to cover all important aspects of program participation. Any stakeholder – whether it be an energy buyer, solar developer, energy provider, native seed vendor, landscape/environmental contractor, scientist, or governmental or non-profit organization – should be able to understand the details of their participation in the Pollinator-Smart program from these pages. The Commonwealth of Virginia has also developed summary documents on key aspects of the program (e.g., Monitoring Plan, Business Plan), as well as downloadable, form-fillable versions of the Scorecards, and an interactive website for the Virginia **Solar Site Native Plant Finder** (defined below). Those resources can be found at https://www.dcr.virginia.gov/natural-heritage/Pollinator-Smart.

PROGRAM OVERVIEW

The Pollinator-Smart program was established in October 2019 in response to the anticipated increase in land used for photovoltaic solar energy generation in Virginia. This increase is based in part on rapidly declining costs for solar as well as Virginia’s commitment to renewable energy over the coming years, as outlined below.

The Virginia Governor’s Executive Order Number 43 (2019) directs several state agencies to “develop a plan of action to produce thirty percent of Virginia’s electricity from renewable energy sources by 2030 and one hundred percent of Virginia’s electricity from carbon-free sources by 2050.”

REGULATORY FRAMEWORK

In 2009, the Virginia General Assembly enacted the Small Renewable Energy Projects Act (Chapters 808 and 854) directing DEQ to develop "permit by rule" (PBR) regulations for the construction and operation of renewable energy projects. A second PBR specifically addressing the review of solar projects went into effect on July 18, 2012. The PBR requirements for a complete application to construct and operate a solar facility of a certain size (between 5MW and 150 MW) are explicitly identified under the regulation rather than being developed on a case-by-case basis. Qualifying facilities can obtain authorization from DEQ by agreeing to comply with all the construction and operating requirements of the PBR. Smaller facilities (<5MW) are permitted by-right and are not subject to the purview of the PBR. Larger facilities (>150MW) are subject to the permitting requirements of the State Corporation Commission (SCC).

Statewide renewable energy goals and the current Virginia regulatory context are summarized in the following statement taken from the Commonwealth of Virginia's 2018 Energy Plan:

Virginia is slated to embark on a period of accelerated renewable energy development. This will increase the obligations of local governments and state agencies tasked with land use, permitting and environmental decision-making. To streamline permitting, the Commonwealth currently uses a [PBR] managed by DEQ to permit wind, solar and biomass-based generation resources with a nameplate capacity less than 150 MW (Virginia DMME 2018).

Currently, participation in the Pollinator-Smart program is not a requirement of the PBR review process or state-level regulatory approvals. Therefore, solar projects adopting the Pollinator-Smart approach to facility establishment or retrofit will do so voluntarily, or under motivation of other factors that will emerge as the program evolves. However, program participation and, most importantly, certification through the Pollinator-Smart program review process carry several benefits for stakeholders as described under "Program Benefits" below. In addition, as noted in the 2018 Energy Plan, it is anticipated that local governments will respond to the growing demand for permitting of solar facilities by developing review processes tailored to solar projects, and those counties and cities will be looking to the state's Pollinator-Smart program for guidance on portions of their solar-specific review policies. As of October 2019, ordinances addressing solar development have already been established for some localities within the Commonwealth.

SOLAR ENERGY GENERATION IN VIRGINIA

On the heels of the 2012 PBR, the solar portion of Virginia's renewable energy portfolio saw an immediate response, and the current status of solar development in Virginia is moving rapidly. For instance, one solar PBR was issued by DEQ in 2015, six in 2016, ten in 2017, and nine in 2018. The 26 PBR applications approved through 2018 represent more than 881 megawatts (MW) of permitted solar power, with more than 11 projects and 357 MW in operation. As of spring 2019, sixty-two Notices of Intent to construct and operate were in the queue, representing a total of approximately 4,500 MW sited on more than 46,000 acres (it should be noted that this acreage does not include solar facilities approved by the State Corporation Commission (SCC), which adds several thousand acres to this total).

Figure 1-1: Aerial view of solar facility.

On January 10, 2018, Dominion Energy – the largest energy provider in Virginia – announced its intent to invest $1 billion in solar development in Virginia and

North Carolina. As of mid-year 2019, Dominion Energy has 14 solar generating facilities, either in operation or under development, producing 474 MW and sited on nearly 6,500 acres. The company has indicated that it could add at least 5,200 MW (40,000-50,000 acres) of solar over the next 25 years. In addition, American Electric Power (AEP) – another provider in Virginia – intends to invest $1.8 billion in new renewable generation between 2018 and 2020. On December 12, 2017, Appalachian Power, an AEP subsidiary, announced plans for their first solar project, the 15 MW Depot Solar Center in Campbell County. Adding to the momentum, AEP issued a Request for Proposal (RFP) on November 15, 2018 for up to 200 MW of solar energy projects in Virginia to reduce customer costs and further diversify its electric generation portfolio. This is a commitment that will bolster Virginia industry in the near term by requiring facilities to be operational at end-of-year 2021, and also requiring local goods and services to be sourced from Virginia businesses.

SOLAR LANDSCAPES

The demand for solar energy generation will stimulate an equally significant demand for facilities management on the thousands of Virginia acres that solar installations will occupy over the coming years. In particular, vegetation management will be a critical-path issue for the industry, owing mostly to the fact that: 1) solar facilities must be adequately vegetated to meet stormwater and erosion/sedimentation control guidelines; 2) solar facilities are subject to state and local ordinances with regard to spread of noxious and invasive plant species; and, 3) it is an industry best-practice to ensure that solar panels are not shaded by plants. Equally challenging is the fact that short-term "cost-cutting" assumptions can result in panels built within 24 inches of the ground surface that are then "in the way," making it very difficult and expensive to use traditional vegetation management techniques such as mowing, brush-hogging, or weed-whacking. For these reasons, and the fact that projects often change owners between the design and build stages, vegetation management on solar facilities has often favored short-term, reactive approaches rather than proactive solutions with long-term benefits.

As a result, current landscape management practices on solar facilities do not promote healthy ecosystems, are often unsustainable, and risk imposing water quality issues on downstream aquatic resources within the Commonwealth's watersheds (see Importance of Pollinators below). Recognizing the potential to promote environmental stewardship and reduce long-term maintenance costs on solar installations over time, the Commonwealth is taking a proactive step in developing the Pollinator-Smart program to increase ecologically-sustainable and climate-resilient landscapes using Virginia native species.

POLLINATOR-SMART CRITERIA – THE SCORECARDS

Throughout the U.S., habitat assessment has been a mainstay of regulatory programs focused on natural resources (Schaefer et al. 2015). The concept of using a metric-based point system to evaluate the relative ecological health of sites dates back as least as far as the early 1980s, with most systems categorized under the heading "biotic integrity" (Karr 1981). However, the use of a point system to evaluate solar facilities for pollinator habitat is a relatively new idea. Minnesota was the first state to develop a program around this concept, and since the publication of their 2016 "Solar Site Pollinator Habitat Assessment Form" (MN-DNR 2017), several states have followed suit. As of mid-year 2019, twelve states have either finalized or are in the process of developing an assessment form for evaluating pollinator habitat on solar installations, including Wisconsin (UWM 2019), New York (NYDEC 2016), Maryland (MD-DNR 2018), Vermont (PFSIV 2018), Pennsylvania (Penn State 2019), North Carolina (Rob Davis, Center for Pollinators in Energy, pers. comm.; Eskew 2018), Illinois (Illinois DNR 2019), Michigan (MSU 2019), Florida (Rob Davis, Center for Pollinators in Energy, pers. comm.), Ohio (OPHI 2018), South Carolina (SC General Assembly 2018), and Virginia. Developed in close consultation with several of the nation's expert entomologists including MacArthur Fellow honoree Dr. Marla Spivak and Presidential Medal of Honor recipient Dr. May Berenbaum, these scorecards constitute an incremental change in solar facility vegetation design and operation that results in meaningful benefits for pollinator species (Kalland and Andeck 2018; Rob Davis, Center for Pollinators in Energy, pers. comm.).

The Virginia Scorecards, shown in Figures 1-2a and 1-2b below , were developed through extensive research conducted over a nine-month period by an interdisciplinary team of specialists with expertise in plant and pollination ecology, horticulture, land management, environmental policy, and the solar energy industry. In addition, and perhaps most importantly, the Virginia team included specialists instrumental in the development of the Minnesota assessment form, as well as every state scorecard since. As part of this process, the Virginia team conducted a detailed review of all available scorecards associated with other state programs.

Figure 1-2a: Version A of the Scorecard.

The Virginia Scorecard focuses on three vegetation

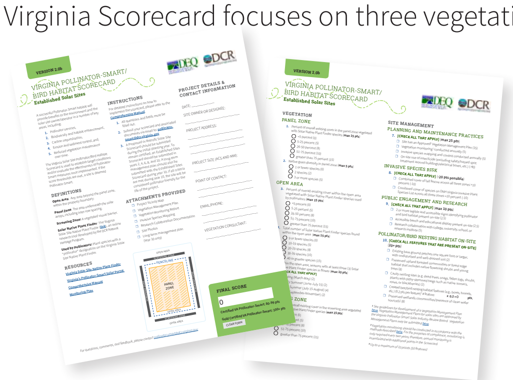


Figure 1-2b: Version B of the Scorecard.

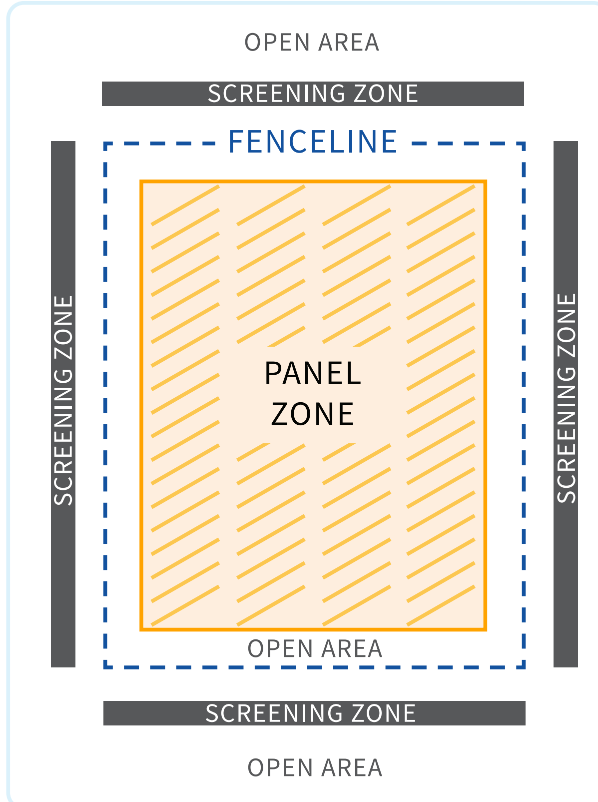


Figure 1-3: Panel Zone, Open Area, and Screening Zone.

management zones (Figure 1- 3):

Panel Zone: The area underneath the solar arrays, including inter-row spacing.

Open Area: Any area beyond the Panel Zone within the property boundary.

Screening Zone: A vegetated visual barrier.

In addition, Virginia has established two versions of the Scorecard to be used in the following scenarios (Appendix A):

Version A: New solar facilities planned as Pollinator-Smart sites, or existing solar facilities planned to be retrofitted as Pollinator-Smart sites

Version B: Established solar facilities already approved as Pollinator-Smart sites and being monitored for continued compliance with the Pollinator-Smart program

For the purposes of determining compliance with performance standards, established sites that have already been designated as Pollinator-Smart must be monitored using methods that will document site-specific conditions and generate the data required to complete Version B of the Scorecard. Recommended monitoring procedures are outlined in Chapter 6 and in the **Pollinator-Smart Monitoring Plan** (Appendix B).

The metrics in the Scorecard can be subdivided into two general categories: Vegetation Metrics and Site Management Metrics. Below is a list of the metric headings describing the types of information required to complete both versions of the Scorecard. Note that some of the metrics are based on the use of the Virginia Solar Site Native Plant Finder, which is described in detail in the next section. Also note that the questions on Version A of the Scorecard refer to species that will be seeded or planted, whereas those on Version B refer to established on-site vegetation.

Vegetation Metrics

Panel Zone

1. Percent with Solar Site Native Plant Finder species
2. Native grass diversity

Open Area

3. Percent with Solar Site Native Plant Finder species
4. Total number of Solar Site Native Plant Finder species
5. Seasons with at least three (3) Solar Site Native Plant Finder species in flower

Screening Zone

6. Percent with Solar Site Native Plant Finder species

Site Management Metrics

Planning and Maintenance

7. Site Planning and Maintenance Practices

Invasive Species Cover

8. Invasive species risk

Public Engagement and Research

9. Public engagement and research

Pollinator Habitat Features

10. Observed and created pollinator/bird habitat on-site

A detailed review of the questions and approaches to answering each metric for both Scorecards is provided in the **Scorecard User's Guide** (Appendix A). Under both Scorecards, a solar site meets the minimum standards to be **Certified Virginia Pollinator-Smart with a score of 80 points or greater.** The program also designates a **Gold Certified Virginia Pollinator-Smart level for sites that reach 100 points or greater.**

VIRGINIA SOLAR SITE NATIVE PLANT FINDER

The Virginia Solar Site Native Plant Finder is a web-based tool developed and maintained by DCR Natural Heritage to aid solar energy stakeholders in creating technical re-vegetation specifications for solar projects. The Virginia Solar Site Native Plant Finder is built on a robust database of native plant species generated from the Flora of Virginia (Weakley et al. 2012), the state's comprehensive manual of vascular flora. In its current version, the Virginia Solar Site Native Plant Finder can be queried based on the parameters listed below.

When searching for a single species, the user can enter either:

» species common name

» species scientific name

When searching for a list of species, the user can select from the following:

» light requirements (sun, part, shade)

» moisture requirements (water, wet, moist, dry)

» pollinator species (yes/no options) (i.e., a native plant species pollinated by animals)

» maximum height (i.e., maximum reported height for the species in Virginia)

» locality (i.e., county or city in Virginia)

» plant type (growth habit) and phenology

» commercially available (yes/no options; note that the default query is commercially available species)

Figure 1-4: Solar Site Native Plant Finder.

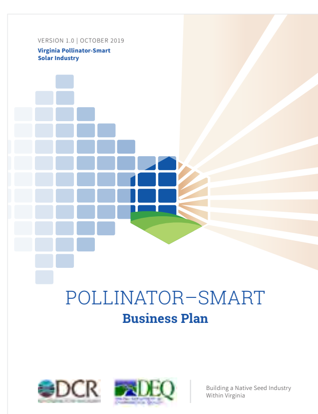
Figure 1-4 shows the current Virginia Solar Site Native Plant Finder, which is located at https://www.dcr.virginia.gov/natural-heritage/solar-site-native-plants-finder.

Assuming that the user is basing the Virginia Solar Site Native Plant Finder selections above on project-specific conditions for a proposed or retrofit solar facility, the query will return a list of commercially available native species from the overall database that meet those criteria and could be considered viable options for the project. A seed mix based on a list of species generated from the Virginia Solar Site Native Plant Finder that meet certain criteria (see "Pollinator-Smart Seed Mix" in the Glossary), therefore, would be deemed “Pollinator-Smart”. As noted above, the Virginia Solar Site Native Plant Finder is used to define the concept of "native species" in developing a Pollinator-Smart vegetation community on solar sites, so this tool is an integral part of the Pollinator-Smart program.

FLORA OF VIRGINIA AND NATIVE SEED SUPPLY

Over the last half century there has been a wealth of research into the native flora of Virginia (Weakley et al. 2012, Virginia Botanical Associates 2019), resulting in a robust understanding of the potential native plant species that can be employed in the development of Pollinator-Smart solar installations. Concurrently, there has been a great deal of knowledge developed regarding the cultivation of native plants and techniques that can be employed for site restoration and planting (Priest and Epstein 2011, Brandt et al. 2015, Kuzovkina et al. 2016).

It is widely recognized that ecosystem service benefits including carbon sequestration, sedimentation and erosion reduction, provision of pollinator services, and provision of wildlife habitat are enhanced when a site is planted using native plant species (Moore-O’Leary et al. 2017, Semeraro et al. 2018).



Even with this increase in knowledge, action has not yet been taken by Virginia or local governments to require use of native seed; thus, commercial-scale cultivation has not taken place. However, several counties have already indicated a preference for native plantings and it is

anticipated that the demand for native seed sources will quickly rise over the course of the next few years. Currently wholesale Virginia-sourced native seeds and plants are extremely limited, though some Virginia native species with ranges that overlap adjacent states can be sourced from material grown in those states. With interagency coordination, collection and cultivation of Virginia plant and seed material can be achieved over several years to meet the anticipated need of providing expansive native pollinator habitat on solar sites and other lands in Virginia. As part of the Virginia Pollinator-Smart program, DEQ and DCR have created a Business Plan to undergird the development of a viable native seed industry in Virginia (Virginia Pollinator-Smart Solar Industry Business Plan 2019).

IMPORTANCE OF POLLINATORS

For years landowners have structured their landscapes to attract pollinators, for the dual aesthetic quality of the wildflowers they grow and the charismatic butterflies, bees, and hummingbirds they draw to their property. But in the overall context of pollinator influence, aesthetics plays a minor role in comparison to other benefits.

For example, from an economic and food security viewpoint, studies estimate that 35% of US crops rely exclusively on animal pollination (U.S. Klein et al. 2006), and that the value of pollinators in agriculture reached $179 billion in 2005, representing nearly 9.5% of the industry's gross capital (Gallai et al. 2009). From an ecological perspective, pollinators facilitate the reproduction of nearly 90% of the world's flowering plant species (Ollerton et al. 2011) and are therefore responsible for fostering plant community structure and diversity in numerous ecosystems, which in turn provide habitat and forage for our nation's wildlife (National Research Council 2007, Wojcik and Buchmann 2012).

THREATS TO POLLINATORS

As with most symbiotic relationships, the co-evolution of insect pollinators and the plants they pollinate has resulted in a pollinator-plant co-dependency (National Research Council 2007). In biological systems, this mutualism requires healthy ecosystems to sustain the co-dependency – i.e., to ensure that pollinators have sufficient host plant populations as a resource, and that the host plants have sufficient pollinators to ensure reproduction. This balance is threatened when one or both mutualists are disrupted. For pollinators, habitat fragmentation and habitat loss have been cited as important contributors to their global decline (Winfree et al. 2007, Potts et al. 2010, Pollinator Health Task Force 2015). Additional threats such as climate change, broad-scale pesticide application, and non-native or otherwise increasingly prevalent parasites and pathogens also play major roles in decreasing pollinator numbers and diversity (Hegland et al. 2009, González-Varo et al. 2013, Vanbergen 2013). While there is not a single cause for global pollinator decline, maintaining native, pollinator-friendly plant communities through conservation practices is a necessary step toward securing the ecosystem values afforded by pollinators into the future.

POLLINATOR COMMUNITY INTRODUCTION

Common insect pollinators include members of the family Apidae (bees), order Lepidoptera (moths/butterflies), and family Syrphidae (hoverflies) (National Research Council 2007). Avian pollinators are also important, and although few bird species develop the type of co-dependency that certain insects have with plants, their function in pollination is widespread (Kremen et al. 2007, Wojcik and Buchmann 2012).

Many of these organisms rely on a specific set of native plants for foraging, nesting, and as larval hosts, but disruption of native plant communities and the introduction of functional barriers to pollinator dispersal have led to dramatic reductions in availability of pollinator habitats and resources (Ricketts 2001). Pollinator habitat restoration is one important approach to recovering the ecological landscapes lost to human land use, but the sheer diversity of plants and insect pollinators makes defining a single restoration target challenging – there is no "catch-all" pollinator habitat design (Stout and Tiedeken 2017). However, carefully considered, constructed, and maintained ecosystems can provide the ecological structure required to recruit and sustain pollinators and, most importantly, these approaches can be sited within or adjacent to existing or proposed land uses such as solar installations for mutual benefit. Important considerations include:

- Neighboring habitat types and distance from viable populations of pre-existing pollinator species
- Expected maintenance activities (mowing, chemical application, vehicle traffic, etc.)
- Environmental conditions post-construction (moisture regime, temperature, light availability)
- Overall size of functionally-contiguous habitats

Depending on how these factors are incorporated into a pollinator habitat restoration project, they can either limit or augment the types of plant species and pollinators likely to succeed in a given area (Schultz and Crone 2005, Winfree et al. 2007, Zurbuchen et al. 2010, Wojcik and Buchman 2012, USDA and USDOI 2015). One approach to restoration is to maintain habitat diversity by incorporating areas with varying levels of moisture, shade, and cover, which has been shown to promote greater diversity for native plants and the pollinators they support (USDA and USDOI 2015). Likewise, the direct incorporation of native plantings specific to desirable pollinators promotes active use by target organisms and, in many cases, these restored habitats can support pollinators with wide home ranges on the order of kilometers (Greenleaf et al. 2007, Winfree 2010, Williams et al. 2015). Documentation of tightly-bound plant/pollinator relationships is prevalent in the scientific literature (Stebbins 1981) allowing some specific tailoring of plant communities to attract and sustain certain pollinators and facilitate further vegetation development toward natural and sustainable ecosystem structure.

As discussed in Chapter 5, disturbance in resource-rich environments like post-agricultural landscapes – a landscape type where solar facilities are commonly sited in Virginia – risks introduction of noxious and invasive plant species, which can have lasting effects. Invasive plants can functionally overlap with desirable species and reduce the overall rate of interaction between pollinators and host plants. Evidence suggests that, over time, these shared interactions can reduce reproductive success for desirable plant species and diminish habitat quality for pollinators whose life cycles rely on those species (Morales and

Traveset 2009). Discouraging the initial establishment of invasive plants is a key aspect of ensuring long-term stability in pollinator habitat restoration.

Despite the marked decline in pollinator numbers throughout the late 20th and early 21st centuries, hope endures for the re-stabilization of pollinator populations (Helmer 2019). Rates of diversity decline have slowed in some areas (Carvalheiro et al. 2013), and experts point to increased awareness about pollinator-friendly practices as a potential stimulant for recovery. On the basis of ecosystem services alone, opportunities for continued growth toward sustainable interactions between environmental change, human development, and pollinator diversity are worth pursuing using targeted, science-based methodologies. Virginia intends to do its part to ensure a legacy of pollinator recovery for future Virginians, and the Pollinator-Smart program is one step toward that goal.

POLLINATOR-SMART PROGRAM BENEFITS

ECONOMIC BENEFITS

In addition to the important agricultural link to global economies for pollinators (Garibaldi et al. 2013), land management activities that support pollinator habitat through native species plantings can provide economic benefits that have just recently been evaluated in managed landscapes (Barton et al. 2005, Lundholm et al. 2010, Gunawardena et al. 2017). Numerous cost-reducing benefits have been identified in association with native species plantings in right-of-ways (ROWs) and within solar facilities, including reduction in maintenance associated with mowing and dust suppression, avoidance of fines and litigation costs associated with perceived environmental impacts, and beneficial dissipation of heat leading to increased solar panel longevity (Barton et al. 2005; Shashua-Bar et al. 2006, Glicksman 2011, Macknick et al. 2013; Kuzovkina et al. 2016). On the latter point, recent research has demonstrated that planting forbs (broad-leaved plants) under solar panels promotes cooler temperatures due to the thermal buffering capacity of the plants via transpiration, which translated into a 3% measured increase in energy generation during the summer months, and a 1% increase averaged over the entire year (Barron-Gafford et al. 2019). The ability of denser vegetation to mitigate negative effects of heat will be increasingly important over time due to anticipated changes in regional climate such as increasing temperatures (Peters and Buonassisi 2019, Siegner 2019).

Reduction in Operation and Maintenance Costs Over Time

One of the greatest perceived benefits in moving to a Pollinator-Smart approach on solar installations is the reduction in operation and maintenance (O&M) costs over the life of the project. Conceptually, these cost savings are realized by replacing monotypic turfgrass cover types with a diverse mix of native herbaceous species selected for a maximum height that would not overreach the panels. In doing so, solar site developers/owners would be reducing the number of mobilizations required to mow the vegetation on an annual basis by selecting for a self-sustaining community of native meadow-type plant species that would out-compete aggressive weeds and undesirable woody plants, thus reducing the amount of other vegetation management techniques needed to keep the panels shade-free (e.g., herbicide, bush-hogging, etc.; see Chapter 5 Integrated Vegetation Management).

The pollinator-friendly approach to landscape maintenance on solar sites is a recent advancement, so information on the extent of solar-specific cost savings over time is limited. However, there are reliable estimates from similar landscape settings such as linear transportation corridors, where mowing costs are tracked on an annual basis and can reach over $400 per acre (Indiana Department of Transportation 2019). Translating these costs to a solar installation setting, when the additional labor required to mow

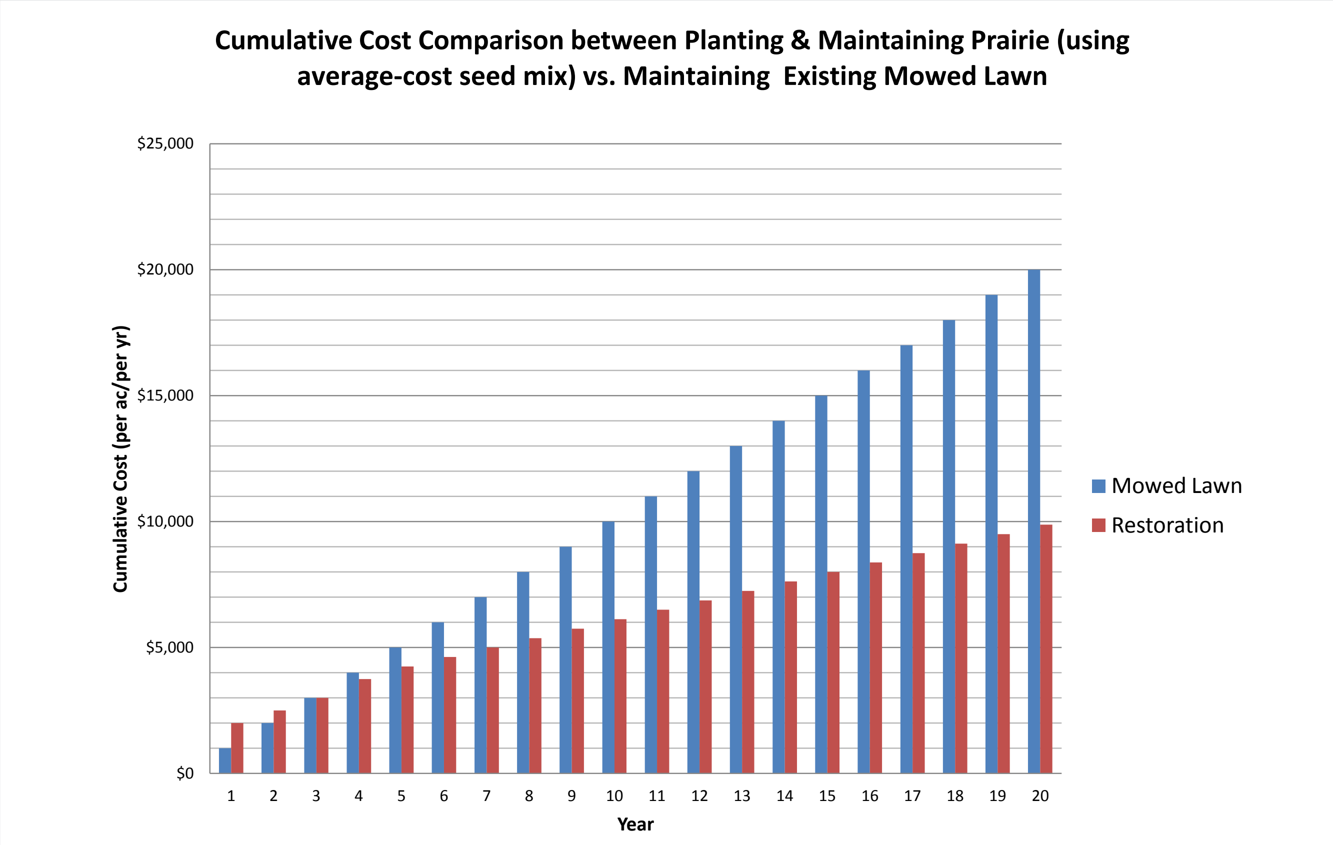


Figure 1-5: From Tiller (2013), a medium-diversity native seed mix results in cost savings on maintenance over traditional turfgrass, with a break-even point at Year 3. For high-diversity seed mixes, the break-even point is around Year 7-8 (Applied Ecological Services, Inc., used with permission).

under and around ground-mounted solar panels is factored in, as well as impacts associated with equipment damage to the panels (e.g., severed cables, cracked panels from collisions or mower-thrown projectiles, etc.), the annual turfgrass maintenance costs on solar sites can be excessive. In transportation corridors where turfgrass has been replaced by native species, agencies have experienced noticeable cost savings as well as additional benefits. For example, a recent Federal Highways Administration study in Florida demonstrated an annual savings of $1,000/mile and a seven-fold reduction in mobilized labor required to maintain a segment of interstate ROW corridor after conversion from turfgrass to naturally colonizing native plants (Hopwood et al. 2015).

In addition to cost savings, the Florida study reported an increase in desirable pollinator-support species, aesthetically-pleasing wildflowers within the visual corridor of the highway, soil stabilization benefits, and an herbaceous cover type that did not interfere with normal highway operations. Given the potential savings on just the annual mowing and maintenance mobilizations alone, the up-front costs associated with installation and early maintenance of a Pollinator-Smart solar site (see Installation Process chapter) could be recovered in the first five to ten years of O&M, resulting in a net savings over the life of a typical solar project (e.g., 25-30 years). This has been demonstrated recently in a study on several hundred sites in the Midwest, where projects using native meadow species for open spaces showed a financial break-even point of 3-8 years over costs of traditional turfgrass lawn maintenance (Tiller 2013; Figure 1-5).

Finally, benefits of native herbaceous plantings have also been quantified for stormwater control, with 30% reductions in stormwater runoff recorded even at low densities (Hernandez-Santana et al. 2013). This represents a potential savings for solar installations experiencing chronic erosion and sedimentation issues, particularly in the Mid-Atlantic region where turfgrass species have been recently failing on solar sites due to extreme environmental conditions such as excessive wetness or drought. These scenarios can lead to delays in local, state, and federal government approvals, as well as enforced remediation practices that frequently require re-grading, temporary best management practice (BMP) design and installation, and additional mobilizations to establish the vegetative cover required to meet erosion and sedimentation control standards. All of these factors can increase costs dramatically and, most importantly, suspend the effective operational date of the facility, which ultimately delays the revenue-generating capacity of a solar project until the environmental issues are resolved.

VIRGINIA POLLINATOR-SMART CERTIFICATION

The Virginia Pollinator-Smart program is a voluntary certification for solar projects implementing the techniques outlined in this document at a level sufficient to satisfy the Scorecard standards. Although participation in the program is non-mandatory, certification carries several advantages for solar developers and owners within the Commonwealth. Program benefits are outlined below.

- **Reduced O&M costs:** The tangible benefits related to time-averaged cost savings for projects adopting Pollinator-Smart practices are discussed in detail under Economic Benefits above.
- **Reduced stormwater costs/remediation:** The well-documented stormwater management benefits of a Pollinator-Smart program are addressed under Economic Benefits above.
- **Brand and reputation enhancement/public relations:** The Virginia Pollinator-Smart program is built on a model that is increasing in public approval and popularity across the U.S. The “pollinator-friendly” paradigm is becoming the new norm for projects like solar installations – the benefits are well-documented, and it is only a matter of time before native plantings become the customary site preparation standard in the solar energy industry. The Virginia Pollinator-Smart program gives solar developers/owners an opportunity to “take credit” for their commitment to a practice that will ultimately save money and enhance ecosystem functions – a win-win for any solar stakeholder in Virginia, and an opportunity to reap the benefits of positive public relations and general reputation enhancement, particularly for Virginia’s solar developers and owners.
- **Accelerated permit approval:** Several counties have already indicated a preference for native plantings and Pollinator-Smart approvals in their site plan approval process. By standardizing the state’s approach to this program, DEQ and DCR are providing Virginia’s cities and counties the tools to give developers, designers, and owners/operators clear direction on expectations for re-vegetation on solar projects using the Virginia Pollinator-Smart program as a guideline. To date, several local government programs are providing tacit approvals for projects certified under the Virginia Pollinator-Smart program, and the opportunities for expedited review at the locality level are expected to increase as solar development continues in Virginia.
- **Resilient landscaping/reduced risk of extreme environmental effects:** Nearly all solar projects in Virginia have a vegetative cover requirement to meet erosion and sedimentation control standards, and many carry a vegetative screening requirement. By using Pollinator-Smart native species adapted to local

Figure 1-6: Community stakeholder engagement during development of the Pollinator-Smart program.

environmental conditions, solar developers will be introducing plants that not only provide aesthetic and visual screening benefits, but also species with ecological tolerances attuned to variations in ecological thresholds for survival. A robust native planting program is a reliable strategy for resilient landscaping that takes advantage of species' genotypic adaptations to conditions specific to physiographic regions.

» **Community support:** One of the biggest obstacles to successful solar energy implementation within a geographic area is local community opposition. Local residents often express concerns about the visual impact of solar panels constructed over several acres on landscapes that historically have been agricultural, rural, or pastoral. By adopting a Pollinator-Smart program, solar developers/owners will be taking an important step toward engendering community advocacy, particularly if the program will provide multifaceted benefits such as pollinator support, native plant species diversity, erosion and sedimentation control benefits, and perhaps most importantly, the aesthetic benefits of native flowering plants. Local governments will be provided all relevant materials and information to educate their communities on the benefits of a Pollinator-Smart approach to site management. In addition, "public engagement and research" is a component of the certification process, so community support is already factored into the Pollinator-Smart model and, as such, should be viewed as a potential benefit of the program. Community support was evident during stakeholder engagement as DEQ and DCR were developing the Pollinator-Smart program (Figure 1-6).

» **Soil benefits:** A Pollinator-Smart program can provide measurable benefits in the form of erosion and sedimentation control as addressed under Economic Benefits above. In addition, several pollinator-support species supply nutrient subsidies [e.g. nitrogen-fixing species in the legume family (Fabaceae)], an ecosystem function that a turfgrass cover crop would not be able to deliver.

» **Enhanced solar energy performance:** The potential for increased energy generation efficiency at the level of the solar panels is a quantifiable benefit to adoption of a Pollinator-Smart approach on solar installations, a topic that is addressed in more detail under Economic Benefits above.

2

SITE SUITABILITY AND PLANNING

In theory, all solar installations built on soil can be managed for Pollinator-Smart plant communities. However, the decision to implement a Pollinator-Smart landscape on a solar facility should be informed by a site suitability analysis. Ideally, site suitability is addressed early in the planning process, and includes data gathered on the site prior to construction. Important site suitability factors are addressed below.

TOPOGRAPHY

Topography is an important consideration in Pollinator-Smart solar installations. This is particularly true of a state like Virginia where the landform changes from the flat landscapes of the Coastal Plain to the rolling hills of the Piedmont to the steep slopes of the Blue Ridge, Ridge and Valley, and Appalachian Plateau physiographic provinces (Figure 2-1). Although many solar sites in Virginia are established on relatively level ground, there are some cases where site conditions require panels to be erected on sloping terrain. The direction that the slope is facing is referred to as its aspect, and slope aspect is an important factor in species selection for native plantings. For example, species that are adapted to cooler and moister conditions are more likely to occur on north- and east-facing slopes, which are exposed to the sun's rays at an oblique angle and/or during the morning hours when solar radiation is less intense. By contrast, drought-tolerant species are more inclined to occupy south- and west-facing slopes, which experience the hotter and drier conditions of higher-intensity solar radiation during the afternoon hours.

Relative slope severity is an additional topographic consideration that will factor into the selection of planting methods. For example, on sloping sites with greater than 5% gradient, planting the site using broadcast techniques (i.e., only distributing the seed

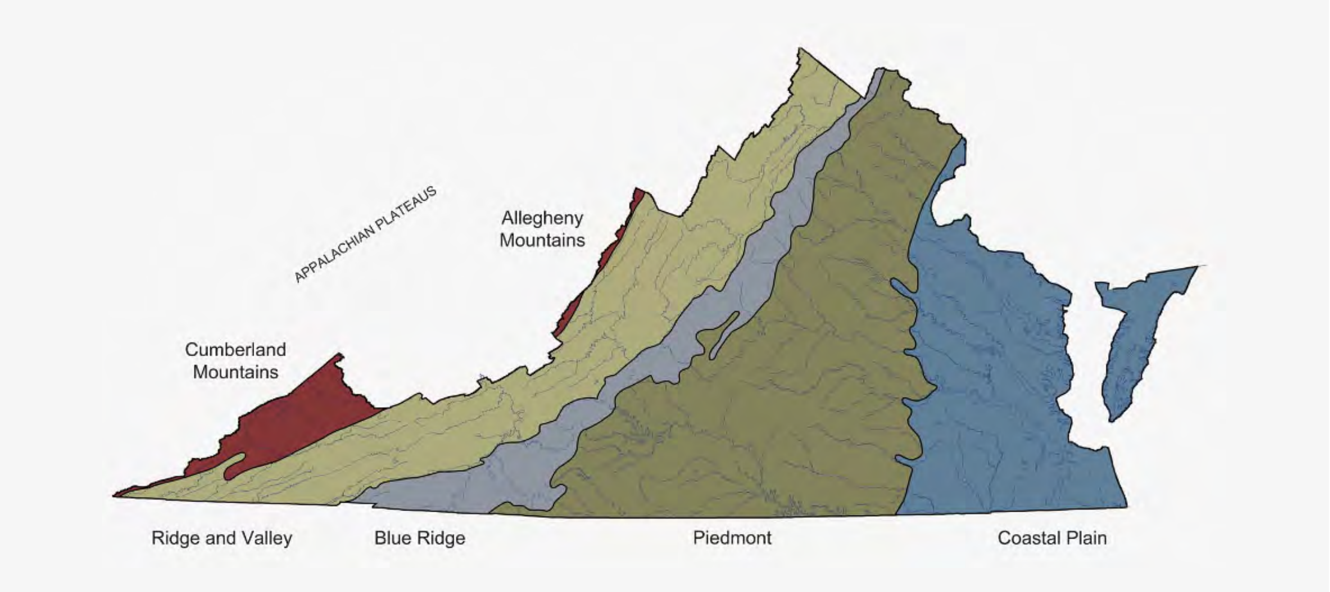


Figure 2-1: Physiographic provinces in Virginia (from Fleming 2012).

on the surface of the soil) would likely increase the risk that the seed would migrate downhill during surface runoff events following rainstorms or during periods of high winds. For sloping sites, techniques like seed drilling will ensure that the seed is buried and decrease the potential for seed loss from these factors.

Site suitability analysis for topography should include review of the design plans for the project. For most solar installations in Virginia, the construction drawings for the site will include topographic contours that demonstrate the pre-existing and post-construction conditions. Aspect should be apparent from the topographic data in the plans but can also be confirmed by post-construction site reconnaissance and, if necessary, by relative elevation mapping using standard ground survey techniques.

HYDROLOGY

Hydrology is, by definition, the sum total of the properties, distribution, and circulation of water on a site (Environmental Laboratory 1987). In Virginia, site hydrology is a major consideration during the civil engineering design of solar installations, as all sites are required to comply with state stormwater management regulations. Just as important to the site design is the need to keep water from pooling under the panels or shedding across the site in areas that could concentrate and cause erosion.

HYDROLOGY REGIME AND SUITABILITY FOR PLANTING

Hydrology is an important consideration for planting specifications. Native plants for Pollinator-Smart installations exhibit a broad range of tolerances for site hydrology. Some plants require dry conditions, whereas other species are more adapted to wet sites. The overall moisture environment on a site is referred to as its hydrology regime, and in Virginia's temperate climate the hydrology regime is generally bimodal – i.e., wetter conditions normally coincide with the winter and spring months, and drier conditions occur during the summer and fall.

On a typical upland site, water infiltrates into the ground or sheds off the site via surface runoff even during the wetter months. In these conditions, species selections from the Solar Site Native Plant Finder (see above) for a seed mix could be in the range of "dry" or "moist" in combination with the topographic data from above. There are places on the Virginia landscape, however, that stay wet nearly year-round such as valley bottoms, floodplains, depressions, seepage slopes, and flats. These areas are frequently defined as wetlands both ecologically and legally. Those areas that meet the legal definition of wetlands in Virginia are protected under Section 404 of the Clean Water Act and analogous State Water Control Law. During the site feasibility or planning stages, most solar sites will have had a wetland delineation prior to the design phase, which will show areas of the site that meet the legal definition of wetlands and, in most cases, exhibit prolonged periods of surface soil saturation or shallow inundation. To the extent that on-site wetlands may be designated for Pollinator-Smart planting, the wetland delineation for the solar site will be useful during the site suitability analysis since the distribution of wetlands will affect planting considerations. For example, in wetlands, species with a "wet" attribute in the Solar Site Native Plant Finder will be more appropriate for Pollinator-Smart seed mixes.

There are some sites in Virginia that exhibit a bimodal hydrology regime consistent with the "winter wet/summer dry" climatic conditions described above, making species choices for Pollinator-Smart seed mixes somewhat more challenging. Such sites may experience prolonged soil saturation or flooding during the winter and early spring months, only to dry up later in the growing season during the summer and early fall. These sites are often affected by a confining layer in the soil that prevents downward infiltration of surface water, creating a perched water table near the soil surface (Figure 2-2). This scenario, and related site suitability considerations, are described in more detail under Soil Conditions.

Figure 2-2: Example of surface water ponding on poorly-drained and compacted soil at a solar facility during construction.

HYDROLOGY AND E&S

All sites subjected to land disturbing activities are required to meet erosion and sedimentation (E&S) control standards, which in Virginia are administered by local governments (counties and cities). At the local E&S review level, sites are required to have a permanent vegetative cover sufficient to inhibit erosion. As discussed above, the hydrology regime on a site plays an important role in decisions about which species to select for a permanent vegetative cover, as does the timing of construction. When sites are constructed during the wetter winter months, establishing a permanent vegetative cover can be challenging, particularly if a site is compacted or poorly drained and is subject to surface water ponding during rain events (see Soil Conditions below). Winter planting of native species is also limited by germination requirements, which for many Virginia natives means warmer temperatures and germination later in the growing season. By contrast, sites constructed during the late summer months will be challenged by drought stress on seedlings imposed by dry conditions, or the potential for favorable germination times to have already passed.

In these cases, solar sites are still required to meet their E&S standards by establishing a permanent vegetative cover. Knowledge of hydrology regime during site suitability analysis can help inform decisions about how to prepare a site for a Pollinator-Smart planting strategy (e.g., drainage solutions, tilling to reduce compaction, etc.), and also species selections to maximize E&S control as well as achieve a permanent cover of plants that support pollinators.

SOIL CONDITIONS

Soils analysis should include assessment of basic soil fertility and other factors that can affect plant development such as compaction. The Virginia Cooperative Extension (2000) and state soil testing lab at Virginia Tech (Maguire and Heckendorn 2019) recommend the following:

SOIL SAMPLING

» Acquire soil information sheets and soil testing boxes from a local Cooperative Extension office.

» Divide the site into separate soil sampling areas based on differences in landscape setting (e.g., ridge, valley, slope, etc.), vegetative cover type (e.g., agricultural field, fallow field, regenerative-growth scrub-shrub, upland forest, wetland, etc.), moisture regime and/or drainage conditions (e.g., dry vs. wet conditions, presence of functioning drainage system via drain tiles or ditching, etc.), and soil type. The latter may be researched through the Natural Resources Conservation Service (NRCS) Web Soil Survey at https://websoilsurvey.nrcs.usda.gov/app/.

» Obtain a representative soil sample from each sampling area. A sample area is considered to be relatively uniform, so the soil "sample" is actually a composite of several "sample units" or soil cores spread out across the sample area. Sampling a soil core typically involves extracting a small volume of soil down to approximately 6 inches (15 cm) using an auger or soil probe. Virginia Cooperative Extension (2000) suggests 20 or more cores for each sample area and recommends spreading them out using a "zig-zag" approach across the sample area. Once the cores have been collected, they are mixed

Figure 2-3: Sampling soils during site suitability analysis.

thoroughly (composited) in a container, and about ½ pint of the soil mixture is extracted for analysis.

» Place the soil sample in a soil sample box and fill out a soil information sheet for each sample. The information sheet includes important owner and site identification data as well as site history information (e.g., fertilizer history, crop history, etc.), and desired soil tests. The sample and information sheet are then sent to the soil lab for analysis.

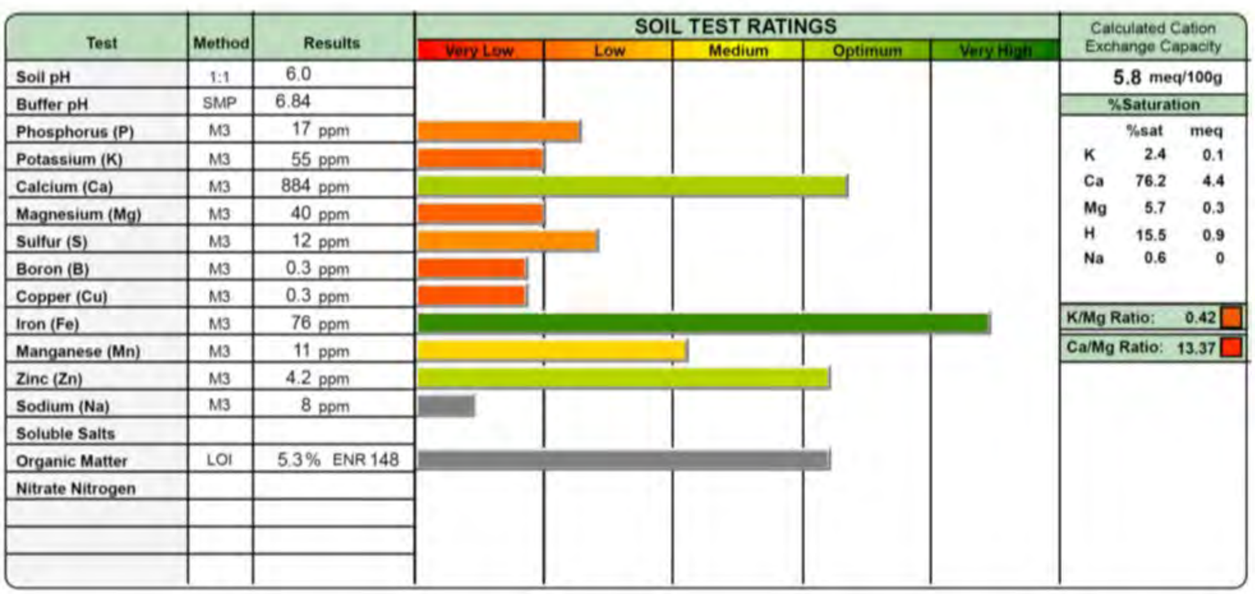
LAB ANALYSIS

» For most agronomic applications, a standard Mehlich extraction will provide the basic suite of important soil chemicals as well as pH. Organic matter content and soluble salt content are also recommended tests.

» Most soil sampling labs will provide an analysis of the data along with recommendations for the proposed planting regime (Figure 2-4).

SOIL PHYSICAL PROPERTIES

Although there are lab tests that can evaluate the physical properties of soil from a sample (e.g., bulk density, particle size distribution), these tests are not routine for agronomic purposes, are typically labor-intensive, and are locality-specific (i.e., not generalizable to entire sample areas or fields). More importantly, tests of soil condition before a solar site is constructed are only indirectly related to the physical condition of the soil after construction. This is due to the fact that soil conditions like compaction will more directly reflect the methods of construction, the equipment used, and the amount of grading



Test	Method	Results
Soil pH	1:1	6.0
Buffer pH	SMP	6.84
Phosphorus (P)	M3	17 ppm
Potassium (K)	M3	55 ppm
Calcium (Ca)	M3	884 ppm
Magnesium (Mg)	M3	40 ppm
Sulfur (S)	M3	12 ppm
Boron (B)	M3	0.3 ppm
Copper (Cu)	M3	0.3 ppm
Iron (Fe)	M3	76 ppm
Manganese (Mn)	M3	11 ppm
Zinc (Zn)	M3	4.2 ppm
Sodium (Na)	M3	8 ppm
Soluble Salts		
Organic Matter	LOI	5.3% ENR 148
Nitrate Nitrogen		

Calculated Cation Exchange Capacity: 5.8 meq/100g

%Saturation

	%sat	meq
K	2.4	0.1
Ca	76.2	4.4
Mg	5.7	0.3
H	15.5	0.9
Na	0.6	0

K/Mg Ratio: 0.42

Ca/Mg Ratio: 13.37

Figure 2-4: Example of soil lab analysis data for one soil sample (courtesy of Waypoint Analytical, Inc., used with permission).

required to meet the design specifications for the project (Figure 2-5). Likewise, there are methods to measure post-construction compaction (e.g., soil penetrometer), but these tests are also labor-intensive and are subject to sampling error.

SOIL TEXTURE

» For the purposes of site suitability analysis, a qualitative visual assessment of soil physical properties by a qualified professional will be sufficient for most Pollinator-Smart installations (see Glossary for definition of qualified professional).

» Recommendations for soil amendments are typically based on broad texture categories such as “coarse”, “medium”, and “fine”, so field estimates of soil texture using the “feel test” (Ritchey et al. 2015) are adequate for a summary of pre-construction physical properties.

» These observations can be used in combination with soil mapping and soil series descriptions available on the NRCS Web Soil Survey to make soil texture generalizations at the level of a soil sample area.

SOIL COMPACTION

» Analysis of compaction can be done on a qualitative basis by sampling the post-construction soil profile at various locations throughout the installation.

» Most qualified professionals will understand how to diagnose compaction in surface soils by evaluating soil secondary structure. Compacted soil will exhibit a platy structure type, or a soil that has a rectangular secondary structure with long horizontal dimension.

CONFINING LAYERS

» There are many soil types in Virginia that develop a confining layer at depth. A confining layer is a zone of soil or bedrock that inhibits downward infiltration of water and other

Figure 2-5: Example of soil compacted by heavy equipment, with minimal vegetation growth due to the surface soil compaction.

mineral constituents and can also inhibit plant root penetration. Confining layers can come in the form of high bulk density clay horizons, fragipans, shallow bedrock, or other subsurface phenomena that restrict downward movement of water or plant roots (Figure 2-6).

» Confining layers are important because they can cause water to perch in the surface soils during the wet season (winter/spring), which can result in severe erosion and sedimentation issues if site construction activities coincide with wetter times. Also, because shallow confining layers impede deep root penetration, it becomes very difficult to establish a robust stand of herbaceous species anchored with deep roots. A shallow-rooted herbaceous cover type such as tall fescue will be more susceptible to erosion, a problem that has been noted on recently-constructed solar installations in Virginia.

» Confining layers can also inhibit establishing cover crops or native plant species from seed, particularly when the perched conditions result in standing water on the site. Standing water prevents positive soil-seed contact and, as a result, seed applied using broadcast methods during the wet season has a tendency to resuspend during storm events and wash off the site.

» A confining layer can typically be diagnosed by boring an auger hole to a depth of 3-5 feet and describing the soil texture, structure, and/or depth to bedrock. As noted above, this information can be used in combination with soil mapping and series descriptions in the NRCS Web Soil Survey to evaluate the potential for a confining layer at the level of a field or soil sample area.

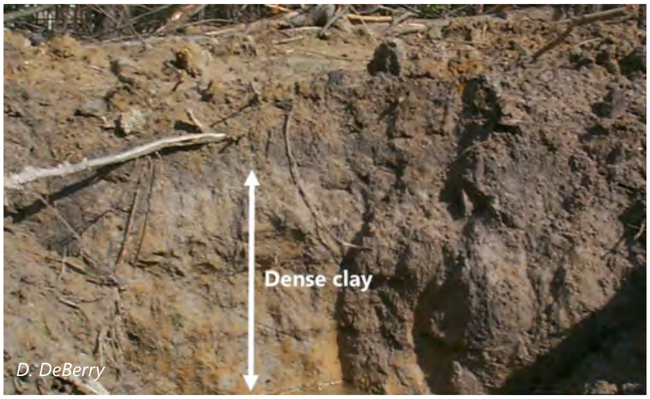


Figure 2-6: Soil pit showing an accumulation of dense clay in subsurface horizons, which can function as a confining layer restricting downward infiltration of water and also potentially inhibiting root penetration.

USING SOIL DATA FOR POLLINATOR-SMART INSTALLATIONS

For most Pollinator-Smart installations on solar projects, soil amendments will not be required. This means that typical agronomic soil enrichment practices such as fertilizer applications or organic amendments would not be needed. Although this may seem counterintuitive when establishing a vegetative community from seed, such soil amendments will increase the potential for weedy or invasive species to colonize. The theoretical basis for this is described under Integrated Vegetation Management (Chapter 5).

EXTREME SOIL CONDITIONS

Notwithstanding the comments above, there are certain rare circumstances in which soil data will reveal an extreme condition that is outside of the normal habitat range for native species, and such conditions may necessitate soil amendments. For example, in some places in Virginia, low pH soils are a naturally-occurring phenomenon, particularly when deeper, sulfide-bearing stratigraphic layers are suddenly exposed to the atmosphere and oxidize to acid sulfate (Onrdorff and Daniels 2004). These problematic soils can occur on construction sites where the soil is being excavated or re-worked, and they will often have a pH <3.5. In this condition, very few plants could survive the extreme acidic stress, which inhibits normal nutrient uptake functions in root cells and can lead to systemic effects such as aluminum toxicity (Delhaize and Ryan 1995). Examples of other extreme soil conditions include high concentrations of soluble salts and heavy metal toxicity. High soluble salts can occur in soils that have been heavily fertilized for years and can negatively affect plants by creating an osmotic stress that can lead to water loss, wilting, and eventually cell death. High concentrations of heavy metals can interfere with cellular functions like enzyme synthesis, and metal ions can compete with essential nutrients at cation exchange sites within the cell (Chibuike and Obiora 2014).

In cases of extreme soil conditions, amendments such as lime fertilizer for low pH soils (Orndorff and Daniels 2004), irrigation for high soluble salt content, or in situ stabilization of heavy metals using additives (Usman et al. 2006) or phytoremediation (Chibuike and Obiora 2014) will be necessary to improve the soil conditions and promote native vegetation establishment. Application rates or phytoremediation techniques should follow recommendations from the soil testing lab, Agricultural Extension agent, or a qualified professional with experience in prescriptive soil amendments. The application rate should be based on reaching the low optimum levels for Conservation Reserve Program (CRP) plantings or warm season grasses.

SOIL COMPACTION AND CONFINING LAYERS

When site suitability analysis reveals a physical soil constraint such as post-construction compaction or a confining layer, the surface soils may need to be reworked by tilling to produce a more friable condition (i.e., soil that is easily crumbled). Reworking soils within the Panel Zone will require additional care to avoid buried cables or other solar infrastructure within the installation (see Chapter 4 Installation Process).

For confining layers such as bedrock, clay horizons, or fragipans that occur at depth (i.e., layers that start at a depth greater than 12 inches in the profile), plowing the surface soils will not resolve the issue. In such circumstances, a more prudent approach may be to accept that the physical constraint exists and work with the condition by adjusting the seed mix that will be used on-site. This can be accomplished by selecting a diversity of species with broad ecological tolerances for the seasonal wet/dry conditions that can be imposed by a confining layer as described above.

VEGETATION ASSESSMENT

For Pollinator-Smart installations, one of the most important criteria to review during site suitability analysis is the existing vegetation on a proposed or retrofit solar site. A reconnaissance-level survey of the community types and the distribution of dominant plant species on-site will provide an invaluable bank of information for planning purposes. The reasons for this are three-fold: 1) a planning-level vegetation survey will help identify species that could remain in the seedbank after site construction and potentially compete with native plantings; 2) a vegetation survey can help to identify the relative risk of incursion from non-native invasive species; and, 3) community mapping and preliminary analysis of species distribution and abundance can help to identify areas of the site that may already have native Pollinator-Smart species.

A standard approach is to walk all portions of the site and document plant assemblages using a zonation classification based on dominant cover types. Within each zone, a cumulative list of species can be tracked during site reconnaissance, and relative abundance values for each species can be estimated using broad cover class categories designed for rapid assessment. Examples of cover classes include: dominant (>20% cover); common (5-20% cover); scattered (1-5% cover); and, occasional (<1% cover). Although standard field mapping would suffice, vegetation zones can also

Figure 2-7: Documenting vegetation on a potential solar site in Virginia.

be mapped using mobile technology that would allow polygons to be uploaded to a GIS platform or equivalent mapping application.

One other advantage to a pre-construction, planning-level vegetation survey is that adjacent habitats can be characterized, and the data collected can be used to evaluate the potential for pollinator habitat in perimeter landscapes surrounding a solar site. This would include observations such as woody plants with pollinator value (e.g., flowering shrubs and trees) and native plants with pithy stems that provide cavity nesting habitat. In addition, reconnaissance-level review of the perimeter landscape will identify areas that could serve as potential sources of non-native invasive or weedy species, and these areas could be addressed proactively using Integrated Vegetation Management techniques (see Chapter 5).

On a retrofit site, a reconnaissance-level vegetation survey is a must, since the existing vegetation will most likely need to be removed and replaced with Pollinator-Smart plantings.

Without a preliminary understanding of the dominant species, community types, and relative risk of invasion, a Pollinator-Smart retrofit program should not even be contemplated. As discussed below, this is due to the fact that a retrofit design requires initial site preparation steps that cannot be executed without knowledge of the existing vegetation cover.

OTHER SITE CHARACTERISTICS

Practitioners aspiring to establish a sustainable, Pollinator-Smart vegetation community on a solar installation should also take note of the following during the site suitability analysis phase.

LANDSCAPE FEATURES

- Presence of wetlands and/or open water sources on-site
- Proximity to other pollinator habitat on the landscape
- Presence of pollinator/bird nesting habitat on-site
    - habitat for ground-nesting pollinator insects, including bare ground patches one square foot or larger in undisturbed, well-drained soil (Figure 2-8)
    - opportunities for preservation of upland forested communities or forest edge habitat that includes native flowering shrubs and young trees
    - cavity nesting sites (e.g., dead trees, snags, fallen logs, woody plants with pithy-stemmed twigs such as native sumacs, roses, and blackberries)

SITE DESIGN

- Elements of the solar site design such as underground cables, wires hung between panels, or other infrastructure that would preclude standard site preparation techniques such as mowing, seed drilling, or tilling
- Panel dimensions such as inter-panel spacing distance and panel height – both of which will be important determinants of the equipment that can be used to implement Pollinator-Smart practices within the Panel Zone, and the species that can be included in seed mix specifications
- Access points from major roadways, and potential staging areas for equipment

NEIGHBORHOOD/COMMUNITY

- Potential to engage adjacent landowners as stakeholders
- Potential for vandalism or theft of habitat features, signage, and other displays

Figure 2-8: Examples of suitable habitat for ground-nesting pollinator insects.

3

VEGETATION MANAGEMENT PLAN

A Vegetation Management Plan is a critical element of a successful re-vegetation project. If prepared properly, it expresses in clear terms the goals and objectives of the re-vegetation program and the regulatory context for the management plan. It also includes information on existing site conditions and methods to be used in site preparation, establishment, and maintenance over time. A Vegetation Management Plan should also include a review of monitoring methods, an overall schedule of vegetation management activities, and reporting requirements and deadlines. It should explain how Integrated Vegetation Management (IVM) techniques will be applied on the project, and how adaptive management will be used to meet goals and objectives. Finally, a Vegetation Management Plan should include scaled figures depicting the site in plan view with vegetation management zones clearly identified.

For the Pollinator-Smart program, an approved Vegetation Management Plan is an important component of the Scorecard solar site evaluation process. Below is an outline of the typical components of a Vegetation Management Plan that would be appropriate for a Virginia solar installation. For a plan to be approved by the Virginia Pollinator-Smart Solar Industry Review Board, it should adequately address all of the elements listed below.

VEGETATION MANAGEMENT PLAN – COMPONENTS

SECTION 1: GOALS AND OBJECTIVES

Clearly state the goals and objectives of the re-vegetation project.

- Goals should be expressed in terms of: 1) the desired ecological communities to be established on-site; 2) the desired outcome of a Certified Pollinator-Smart application review (i.e., “Certified” or “Gold Certified”); and, 3) the desired operation and maintenance benefits provided by following the Vegetation Management Plan (e.g., reduced long-term maintenance costs, inventory of invasive species for retrofit facilities, and efficient management of invasive and otherwise undesirable species, etc.).

SECTION 2: REGULATORY COMPLIANCE

State the regulatory context for the Vegetation Management Plan.

- For most solar installations, this will include satisfying the vegetation cover requirements at the state and local level with regards to the E&S and stormwater review process.
- This will also include satisfying the conditions of the Virginia Pollinator-Smart certification program.

State any other conditions of approval for successful execution of the Vegetation Management Plan.

- In Virginia, any individual using herbicide for vegetation management in a commercial context is required to hold a Pesticide Applicator Certification. This section should clearly state the project’s intent to honor all such licensures and requirements in executing the Vegetation Management Plan and speak to any special conditions that may be required based on work to be conducted on either public or private lands.

SECTION 3: EXISTING CONDITIONS

Summarize existing conditions on the site relevant to the Vegetation Management Plan.

» This should include, at a minimum, a summary of information garnered during the site suitability analysis described above such as topography, hydrology, soils, existing vegetation (including invasive species as identified on the most current DCR Invasive Plant Species List), and other relevant site conditions. This information should focus on site conditions that will dictate the vegetation management methods used on-site. Any on-site investigations that have been conducted to date and are relevant to the Vegetation Management Plan should also be included, as necessary (e.g., soils analysis).

SECTION 4: VEGETATION MANAGEMENT METHODS

Describe the methods to be used in the installation phase of the project.

» This should include a summary of the details described under Installation Process (see Chapter 4), for example site preparation techniques, seed mix (include seed specification tables and identify sources), invasive species pre-treatment, and seeding techniques.

Describe the methods to be used in the establishment and maintenance phase of the project.

» This should include information such as anticipated mowing and spraying frequency and intensity, or other vegetation management techniques to be used such as mechanical removal (see Installation Process below).

Differentiate management methods by vegetation management zone if applicable.

» At a minimum, project management approaches should be differentiated by Panel Zone, Screening Zone, and Open Area. These zones should be clearly defined and depicted on site mapping. On larger sites, it may be beneficial to subdivide management zones based on site layout and other factors such as equipment accessibility and existing conditions (e.g., known pre-existing issues such as invasive species dominance in localized areas of the site).

SECTION 5: MONITORING

Explain the monitoring methods to be used in evaluating whether the goals and objectives of the re-vegetation project are being achieved.

» Monitoring methods for most sites will follow the approaches outlined under Monitoring Plan (see Chapter 6). Any additional or alternative approaches to site monitoring should be explained in this section.

» Describe techniques for monitoring invasive species.

SECTION 6: PROJECT SCHEDULE

Provide an anticipated schedule of vegetation management activities with important milestones identified.

» A timeline showing the proposed vegetation management strategy laid out over the lifespan of the project is one of the most useful elements of a Vegetation Management Plan.

» The project schedule should include all vegetation management activities from site suitability analysis to final monitoring and reporting.

» For sites anticipating participation in the Pollinator-Smart program, a project schedule should be provided for the first 10 years of the vegetation management program (the target release date for a site meeting Pollinator-Smart criteria in all monitoring years).

SECTION 7: REPORTING

Explain the format of the information to be submitted for approval under the regulatory compliance criteria (Section 2 above).

- For Pollinator-Smart certification, this will most likely follow the format described under Monitoring Plan (Chapter 6, and Appendix B) and should include Version B of the Scorecard.
- Information submitted to demonstrate compliance with state/local E&S and stormwater requirements should follow the recommended format for the respective regulating authority in which the solar project is sited.

ATTACHMENTS

At a minimum, the following attachments should be provided:

- **ATTACHMENT 1:** A scaled site plan showing proposed/existing solar facility (including panel arrays and infrastructure), vegetation management zones per scorecard (if applicable, see above), locations of specific vegetation management practices (if appropriate), vegetation sampling design for monitoring purposes, location of photostations, and mapped invasive inventory (if applicable).
- **ATTACHMENT 2:** Representative photographs from permanent photostations and other vantage points on the site.
- **ATTACHMENT 3:** Supporting site documentation (e.g., tabular data representing summary information under Existing Conditions above; examples include checklists of existing vegetation, soil analysis tables, etc.)
- **ATTACHMENT 4:** Regulatory compliance documentation [e.g., agency correspondence, E&S documentation, copy of completed Scorecard (if applicable), etc.].

LONG-TERM VEGETATION MANAGEMENT PLAN

As stated in Version B of the Scorecard, if a solar site is satisfying Pollinator-Smart certification criteria (i.e., 80+ points on the Scorecard) in all assessment years (Years 2, 4, 6, 8, and 10), then that site can be reviewed for a Lifetime Pollinator-Smart Certification. A Long-Term Vegetation Management Plan is a submission requirement (along with the Scorecard) in Year 10 for a site to be officially released from monitoring requirements under the Pollinator-Smart program. The Long-Term Plan should demonstrate a commitment to the management principles applied in the first 10 years of the project, and it should address both IVM goals and Adaptive Management for the operational life of the facility beyond the first 10 years after initial Pollinator-Smart Certification. In addition to the Pollinator-Smart certification benefits of a Long-Term Plan, solar owners/operators will benefit from having a plan in place for long-term vegetation maintenance to protect the investment already made in ecosystem enhancement, and also to protect the photovoltaic integrity of the facility [i.e., by keeping undesirable vegetation from shading panels, and to continue the benefits of energy generation efficiency (see Program Benefits under Chapter 1 above)].

The Long-Term Vegetation Management Plan should be prepared in a format similar to the Vegetation Management Plan described above, with appropriate adjustments for management techniques, site inspections, overall schedule, and milestones projected out over the life of the facility. Upon approval of a Long-Term Vegetation Management Plan by the Virginia Pollinator-Smart Solar Industry Review Board, there will not be a Scorecard submission requirement under the Pollinator-Smart program; however, owners/operators are encouraged to continue monitoring vegetation performance through routine site inspections to determine if/when IVM techniques should be implemented in subsequent years.

INSTALLATION PROCESS

This section summarizes the basic sequence of techniques used to establish Pollinator-Smart solar installations in Virginia. As with any ecological restoration or re-vegetation program, each site presents its own unique set of attributes and challenges and, as such, there is no "one-size-fits-all" prescription for a Pollinator-Smart installation. Instead, what is provided here is best considered a laundry list of approaches that can be tailored to suit the specific needs of a project site.

SITE PREPARATION

» Use IVM techniques to remove aggressive competitors, noxious weeds, and invasive species from the site (see IVM discussion below).

» Soil amendments are not recommended unless the site has soil fertility conditions in extreme ranges (see Soil Conditions discussion above).

- For extreme soil conditions (e.g., excessively low or high pH, high soluble salts, heavy metals, etc.), implement a soil amendment or remediation technique to attenuate the problem (Figure 4-1).

» Remediate compacted soils by tilling.

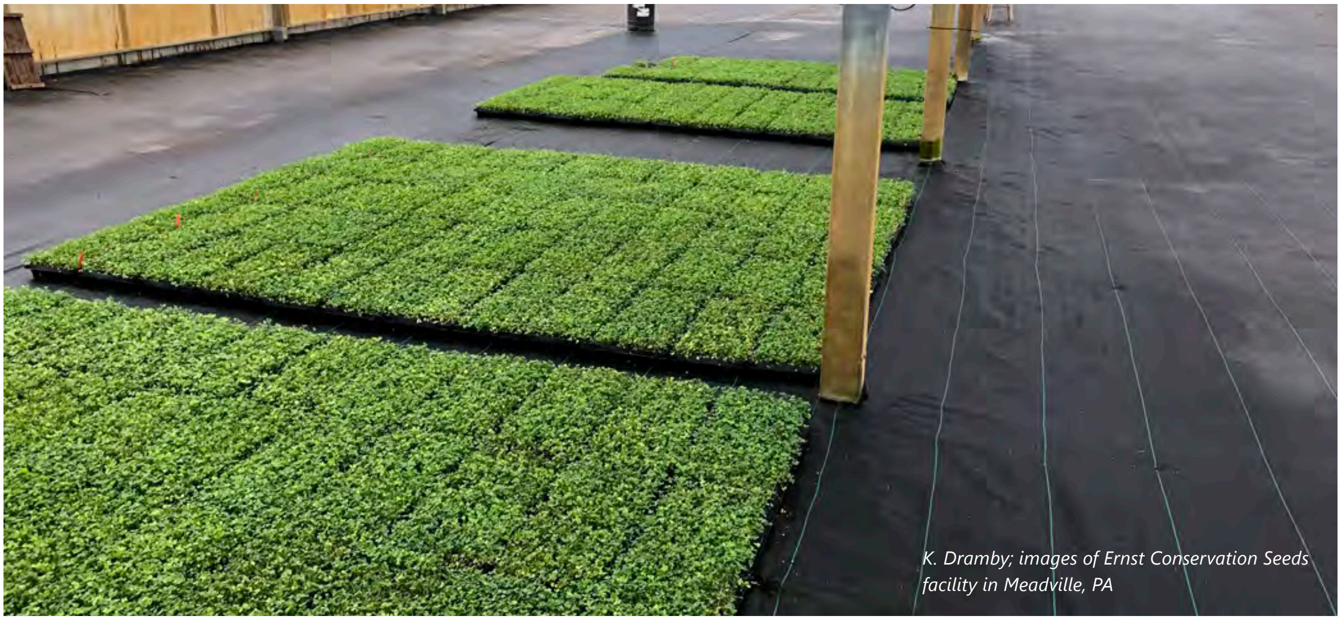
- Lightly compacted soils should be tilled to a depth of 3-4 inches. Recommended equipment includes a rototiller or notched coulter disk plow with adjustable gang angles, typically two passes (Figure 4-2). Care should be taken in the Panel Zone to ensure that all buried cables are marked beforehand.
- Severely compacted soils should be tilled to a depth of 6-8 inches. Tilling severely compacted soils typically requires a chisel plow to break up the soil, followed by a single pass with a disk plow to break up larger fragments.

» Friable soils are considered ideal for plant root development. However, for planting native seed, there is such a thing as overly-friable soils – i.e., soils that are so easily crumbled that they create issues with seed placement and reduce the potential for good soil-seed contact.

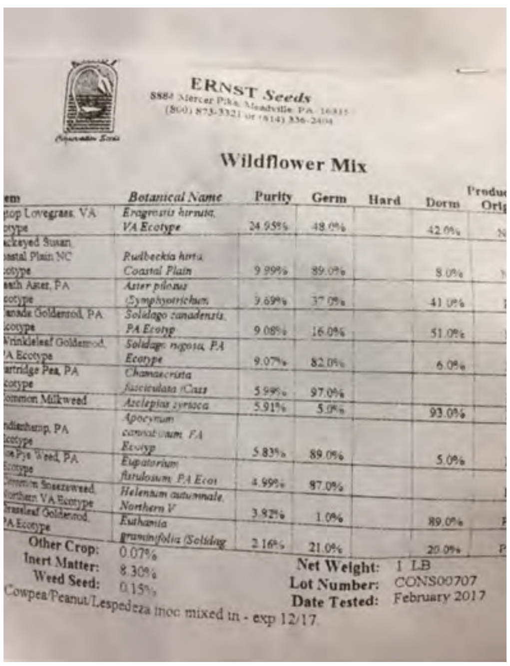
- Overly-friable soils may require rolling prior to seeding to improve the substrate condition for positive seed-soil contact.

Figure 4-1: Amendments being incorporated into the surface soils on a re-vegetation project.

Figure 4-2: Example of disk plowing methods.



K. Dramby; images of Ernst Conservation Seeds facility in Meadville, PA



ERNST Seeds
8884 Mercer Pike, Meadville, PA 16335
(800) 873-3321 or (814) 336-2404

Wildflower Mix

em	Botanical Name	Purity	Germ	Hard	Dorm	Produc Orig
op Lovegrass, VA otype	Eragrostis hirsuta, VA Ecotype	24.95%	48.0%		42.0%	
ckeyed Susan, astal Plain NC otype	Rudbeckia hirta Coastal Plain	9.99%	89.0%		8.0%	
ath Aster, PA cotype	Aster pilosus (Symphyotrichum	9.69%	37.0%		41.0%	
anada Goldenrod, PA cotype	Solidago canadensis, PA Ecotyp	9.08%	16.0%		51.0%	
Vrinkleleaf Goldenrod, A Ecotype	Solidago rugosa, PA Ecotype	9.07%	82.0%		6.0%	
artridge Pea, PA cotype	Chamaecrista fasciculata (Cass	5.99%	97.0%			
ommon Milkweed	Asclepias syriaca	5.91%	5.0%		93.0%	
ndianhemp, PA cotype	Apocynum cannabinum, PA Ecotyp	5.83%	89.0%		5.0%	
e Pye Weed, PA cotype	Eupatorium fistulosum, PA Ecot	4.99%	87.0%			
ommon Sneezeweed, orthern VA Ecotype	Helenium autumnale, Northern V	3.82%	1.0%		89.0%	
rassleaf Goldenrod, A Ecotype	Euthamia graminifolia (Solidag	2.16%	21.0%		20.0%	

Other Crop: 0.07%
Inert Matter: 8.30%
Weed Seed: 0.15%
Net Weight: 1 LB
Lot Number: CONS00707
Date Tested: February 2017
Cowpea/Peanut/Lespedeza inoc mixed in - exp 12/17.

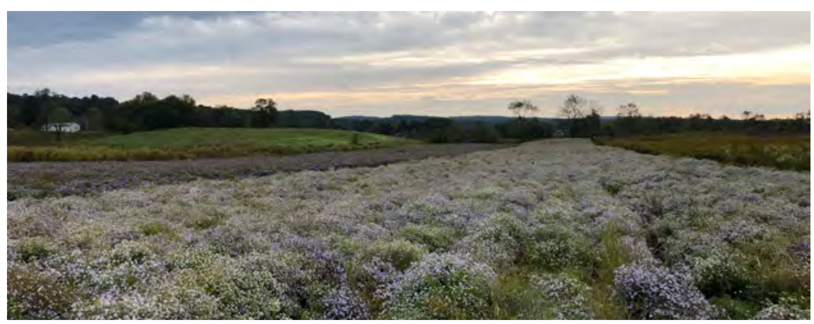


Figure 4-3: Native seed supplier (inventory, storage, equipment, fields, etc.).

SEED MIX

- Develop and purchase a **Pollinator-Smart seed mix** (see definition in Glossary) based on the Solar Site Native Plant Finder. The selection of species for the seed mix should be informed by the site suitability analysis. Important considerations include:
  - Physiographic region (ecotype)
  - Commercial availability
  - Panel height
  - Planned vegetation zones (e.g., Panel Zone, Open Area, Screening Zone)
  - Soil conditions/soil type
  - Hydrology regime
  - Topography and aspect
  - Cover (full sun, partial shade, full shade)
  - Pure live seed (PLS) ratio from the provider (i.e., amount of seed in a given seed lot capable of germinating and developing into seedlings)
  - Species richness and relative abundance within the seed mix based on Scorecard designations
  - Seed should be purchased from a reputable seed company with a background in native seed production and full seed tag documentation, including Association of Official Seed Analysts (AOSA) testing and approvals
- Note that the amount of seed purchased will be based on seeding rates and site size. Rate recommendations will be made by the provider dependent on the specific seed mix, typically in pounds per acre or seeds per square foot. The latter rate is species-specific and is typically expressed in PLS seeds per square foot. For seed drilling applications in the Mid-Atlantic Region, 50 PLS seeds per square foot is a standard target application rate, and for broadcast applications, 75 PLS seeds per square foot is recommended.
- **Note also that a healthy site will contain not only a diversity of pollinator-support species, but also several native species of grasses as identified on the Solar Site Native Plant Finder, which will promote long-term site health.**

EROSION & STABILIZATION SEED MIX CONSIDERATIONS

Some invasive species, such as sericea lespedeza (*Lespedeza cuneata*), crown vetch (*Securigera varia*), and shrubby bushclover (*Lespedeza bicolor*), are commonly used in erosion and stabilization seed mixes. There are many native species that can serve the same purpose and will benefit pollinators. The following list contains examples of some native species to consider:

- big bluestem (*Andropogon gerardii*)
- indiangrass (*Sorghastrum nutans*)
- side-oats grama (*Bouteloua curtipendula*)
- little bluestem (*Schizachyrium scoparium*)
- beaked panic grass (*Coleataenia anceps*)
- switchgrass (*Panicum virgatum*)
- purpletop (*Tridens flavus*)
- broomsedge (*Andropogon virginicus*)
- autumn bentgrass (*Agrostis perennans*)
- round-headed lespedeza (*Lespedeza capitata*)
- partridge pea (*Chamaecrista fasciculata*)
- yellow wild indigo (*Baptisia tinctoria*)
- Maryland wild senna (*Senna marilandica*)
- nodding wild rye (*Elymus canadensis*)
- Virginia wild rye (*Elymus virginicus*)

SEEDING

- **In most circumstances, a cover crop will be necessary to establish an herbaceous community for E&S compliance in advance of a native Pollinator-Smart seed application.**
  - Native cover crop species are preferred, but in some cases a non-native species may be required due to difficult planting scenarios or time-of-year requirements.
- For permanent seeding, November to May is the recommended planting window, with dormant season planting preferred due to the benefits of in situ cold stratification.
  - Permanent seed may be applied separate from the cover crop (if used) or with the cover crop depending on time of year.
- Seed drill is the recommended application method (Figure 4-4).
  - Calibration of the drill depth is important, with a maximum recommended planting depth of ¼ inch.
  - Calibration of the drill application rate is also important – here it is best to set the application rate in accordance with the seeding specifications, but also to ensure that the drill is executing with good soil-seed contact.
- Broadcast methods may be used but are not preferred over drill seeding (Figure 4-4).
  - Light rolling should be used with broadcasting to ensure soil-seed contact.
- Hydroseeding (i.e., seed in liquid slurry with a surfactant design to "stick" the seed to the soil) is a technique that is used quite frequently in the industry, but it is not recommended for native seed applications due to the potential for poor seed-to-soil contact.

Figure 4-4: Field examples of drill seeding and broadcast seeding methods.

*Figure 4-5a: Native wildflower meadow re-vegetation project, Year 1. Partridge pea (*Chamaecrista fasciculata*) in flower.*

*Figure 4-5b: Native wildflower meadow re-vegetation project, Year 2. Narrow-leaf tick-trefoil (*Desmodium paniculatum*) featured in foreground.*

*Figure 4-5c: Native wildflower meadow re-vegetation project, Year 3. Frost aster (*Symphyotrichum pilosum*) in flower.*

RE-SEEDING

» Re-seeding may be needed in areas where the original seed application was unsuccessful or resulted in low germination.
  - The determination of whether to re-apply seed in specified areas on-site should be part of the approved Vegetation Management Plan for the site, with a clearly-defined threshold for the decision.
  - Re-seeding may be applied by broadcast or drill seeding.

ESTABLISHMENT AND MAINTENANCE

» Year 1 – expect to mow vegetation to a height of approximately 10 inches at least twice and possibly three times.

» Year 2 – same as Year 1.

» Year 3 – mowing should only be needed outside of the growing season to control woody volunteers, with the blade set high enough to prevent scalping of native species.

» Mechanical means should be used to ensure proper mowing heights (e.g., gauge chains, depth gauge).

» At any point spot spraying or mechanical removal of invasive or otherwise undesirable vegetation (e.g., tree saplings) may be needed to meet the IVM goals explained below.

WHAT TO EXPECT…

In the chronology of a Pollinator-Smart installation, the first three years of vegetation establishment are the most critical to project success. Below is a year-by-year summary of expectations for plant establishment during those first few years.

» **YEAR 1** – Within the first growing season, a Pollinator-Smart solar installation should have a well-established cover crop providing

adequate soil stabilization to meet E&S requirements (Figure 4-5a). Although pollinator-support species will have been planted, it is possible that only a few species will be flowering at this time; however, seedlings and first-year growth of a diversity of native forbs and perennial grasses should be evident. Annual forbs should have set seed within the first growing season.

» **YEAR 2** – By the second growing season, the relative abundance of the Year 1 cover crop should be diminished or non-existent over most of the site, giving way to an increase in relative dominance of the native species established on-site (Figure 4-5b). Some perennial forbs may not reach full reproductive maturity at this time, but most native grasses should be reproducing and approaching full stand density.

» **YEAR 3** – Within the third growing season, the majority of native forbs should reach full reproductive maturity and produce flowers for maximum pollinator support (although some native forbs may require up to five years for maturity) (Figure 4-5c). Native grasses will be at full maturity, stand density, and height.

In subsequent years, a well-established, self-sustaining Pollinator-Smart installation will undergo variation in the relative dominance of native plant species on-site but should sustain a species-rich community with upwards of 40 to 50 species per habitat area (Bazzaz 1996, Tracy and Sanderson 2000, Sluis 2002). Changes in the relative dominance of species is a natural phenomenon that accords with localized variations in environmental conditions and habitat specificity as the site matures. The extent to which proactive intervention is needed in these first few years will depend on site conditions and the potential risk of issues such as incursion by undesirable plants. The techniques used to maintain sites during these critical first few years are addressed under IVM below.

Figure 4-6: This site, which did not use a Pollinator-Smart approach to vegetation management, was originally planted in a cultivar of tall fescue and by spring of the first growing season is already dominated with a mix of post-agricultural weeds requiring frequent mowing.

RETROFIT SITES

When implementing a retrofit Pollinator-Smart installation, the techniques will be largely the same as a new facility because the same challenges and opportunities exist as when an undeveloped site is being evaluated for a Pollinator-Smart installation. The primary differences are as follows:

- A retrofit will be an existing facility presumably in operation as a ground-mounted PV array, so it is likely to have an increase in the number of obstacles to work around for the planting contractors (e.g., panels and infrastructure such as cables, inverters, transformers, fencing, stormwater facilities, access roads, etc.). By contrast, although a new site will also have much of this already in place, the planting contractor will have the advantage of working with the construction crews while the site is being developed to schedule site prep activities and take advantage of the ability to access the site and stage equipment/materials while the facility is an active construction site.
- In a retrofit scenario, the planting contractor will not have the ability to take advantage of the soil having been reworked during construction. This could create additional mobilization and equipment access issues if it is determined that part of the retrofit program will require soil manipulation (e.g., tilling, excavation, rolling, etc.).
- A retrofit site is likely to have been planted with a turf-type grass species such as tall fescue (*Schedonorus arundinaceus*, or cultivars thereof such as Kentucky 31), which is an undesirable species in Virginia. In addition, retrofit sites are more likely to harbor other undesirable plant species such as agricultural weeds, volunteer woody species, or invasive plants, either in the existing vegetative community or in the seedbank (Figure 4-6).

The above issues put a premium on IVM techniques on the front end of the retrofit, which will add cost and time to the Pollinator-Smart implementation. Costs will be incurred mostly in the additional land management requirements, including purchase of herbicide, mobilizations to treat undesirable species or rework soils, additional activities required to “re-set” the site to a condition similar to a new construction, and any post-establishment mobilizations that may be required to treat for undesirable plants.

5

INTEGRATED VEGETATION MANAGEMENT

Creating a self-sustaining herbaceous community composed of native pollinator species in Virginia is a challenging endeavor.

Figure 5-1: Solar facility in Virginia constructed on a prior agricultural field. This site did not use a Pollinator-Smart approach to vegetation management and, as a result, is dominated with aggressive weeds that are already overtopping the panels even before the first growing season is over.

Without active management, regenerating sites in this region will almost always follow a pattern of ecological succession directed toward some variant of an eastern deciduous hardwood forest (Monette and Ware 1983, Weakley et al. 2012) or mixed pine-hardwood forest (Ware 1970). This phenomenon is well-known to land managers in the Mid-Atlantic Region who are tasked with maintaining vegetation in a low-canopy or meadow-like condition, which is often the preferred cover type on sites like utility rights-of-way (ROW). For ROW managers, the primary objective is to keep trees from growing under powerlines or over buried utilities to promote safety and to avoid compromising the lines (Nowak et al. 1992). Land management concepts in ROW corridors can be directly applied to solar installations, because the goal in both cases is to promote a natural herbaceous cover type (perhaps with some interspersion of shrubs in the Open Area) that will ultimately inhibit tree regeneration and/or other undesirable plant species (Nowak and Ballard 2005). In landscape settings that have been heavily managed for various human activities such as agriculture, this is an even more difficult challenge due to the biotic and abiotic legacy effects of prior land uses, as well as recruitment from non-native weedy plants that abound in disturbed landscapes (Hobbs and Walker 2007, Cramer et al. 2008) (FIgure 5-1). Given the exposure of many Virginia solar installations to these pressures, the task of creating a natural, self-sustaining, Pollinator-Smart meadow at these facilities is a challenging endeavor.

What scientists and managers have learned from applied research in these scenarios is that an Integrated Vegetation Management (IVM) approach is the most practical way to achieve short-term and long-term goals, reduce costs, and ultimately promote successful re-vegetation projects (Nowak et al. 1992, USEPA 2017). This approach is based on the assumption that proactive vegetation management using targeted herbicide treatment and/or mechanical removal is an activity that not only controls pest species, but also minimizes its own use over time (Nowak and Ballard 2005). This is true of tree control in settings where management has promoted a dense herbaceous cover that reduces tree regeneration through competition (Bramble et al. 1996). The approach will also work to control weedy grasses and forbs in combination with activities that help to establish a diversity of native species (such as drill seeding), thereby reducing potential for non-native, aggressive species to colonize during the establishment phase on young sites (Kennedy et al. 2002). Finally, IVM uses the concept of adaptive management to modify the prescriptive approaches as the site develops, with the assumption that the need for active intervention should wane over time. These factors should reduce operation and management costs over the life of a re-vegetation project. Adaptive management is a process of managed learning that steers strategic action to achieve desired endpoints in complex ecosystems (Foxcroft 2004). The benefit of this approach is that it recognizes that every project is different, and therefore avoids the pitfalls of setting unrealistic targets and thresholds for project milestones by using direct feedback from project performance to guide management decisions.

IVM AND INVASION ECOLOGY ON SOLAR SITES

IVM is informed by invasion ecology, a relatively new science that has received increasing attention in the past few decades (Lockwood et al. 2013). Although scientific opinion differs as to the most important factors that make species invasive (Blossey and Notzold 1995, Galatowitsch et al. 1999, Maron and Vilà 2001, Callaway and Ridenour 2004), prevailing theory on invasion ecology suggests a few consistent trends that render a site invadable. These are summarized below by the following three conditions:

- Sites that are both recently disturbed and high in resource availability are most likely to be susceptible to invasion by aggressive, undesirable species (Alpert et al. 2000, Zedler and Kercher 2004).
- Sites exposed to propagules of invasive species in nearby locations are more likely to be invaded than sites that are isolated from invasive populations (Zedler and Kercher 2004, Lockwood et al. 2013) (a propagule is any part of plant that can be detached and used to generate a new plant, such as such as a seed, root fragment, stem section, vegetative bud, or spore).
- Sites that have conditions that are minimally stressful to plants are more likely to be invaded (Alpert et al. 2000, Lockwood et al. 2013).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To understand the above criteria, it is important to differentiate between "disturbance" and "stress" in plant ecology. From a plant-centric perspective, disturbance means any anomaly or change that is outside the normal range of conditions for a species and results in the destruction or removal of biomass (Hobbs and Huenneke 1992, Craine 2009). By contrast, stress is defined as any aberrant change in physiological processes due to one or more environmental or biological factors that results in a reduction in fitness or growth (Craine 2009). Disturbance includes human-induced modifications of the landscape such as clearing, tilling, grading, mowing, herbicide treatment, etc., but it can also include naturally-occurring events such as storm damage (e.g., high winds, flooding, erosion, ice damage, etc.) or beaver impacts from tree removal and flooding (Hobbs and Huenneke 1992, Clewell and Aronson 2013). In contrast with disturbance, stress does not directly result in destruction or removal of biomass, but rather involves a condition in the environment that affects an organism systemically such as nutrient limitation, drought, salt stress, shading, or heavy metal toxicity (Craine 2009).

Unfortunately, almost all utility-scale solar installations in Virginia are in the first category of invadable conditions, with a combination of site disturbance and high resource availability. This owes mostly to the siting of these facilities on post-agricultural landscapes, but can also result from tree clearing/removal and forest fragmentation. The "disturbance half" of the equation in this case is related to construction of the site, which meets the definition because it results in direct removal of biomass. On the other hand, the "high resource availability half" is related to the post-agricultural setting: a site that has been continuously farmed for a commodity crop is likely to have been fertilized on an annual basis, making the surface soils a resource-rich environment for plants. The combination of disturbance and nutrient-rich soils in post-agricultural landscapes makes them a prime target for invasive species by "opening up" the habitat to aggressive species colonization and providing a resource-rich environment that favors plants adept at converting nutrients into biomass quickly and efficiently. These species become established and rapidly outcompete desirable native species.

Although it seems counterintuitive, in most cases a somewhat stressful condition will promote higher species richness in herbaceous communities. This is most easily visualized by the model proposed by Alpert et al. (2000) which shows how the disturbance and stress regimes on-site might influence risk of invasion (Figure 5-2). As the model indicates, a high-disturbance, low-stress (nutrient-rich) environment like a solar site is theoretically prone to invasion.

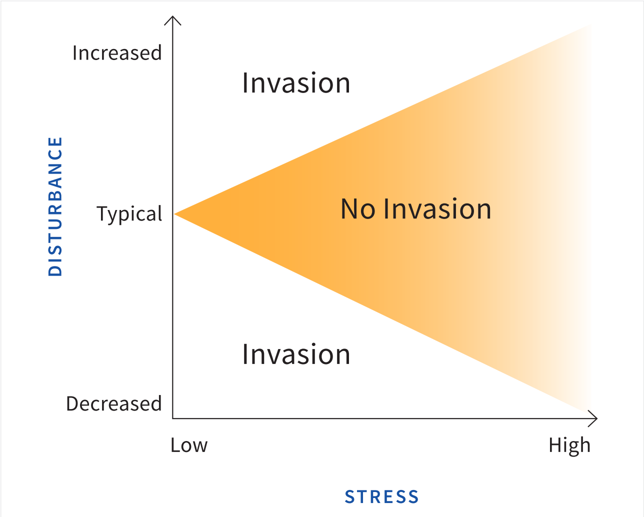


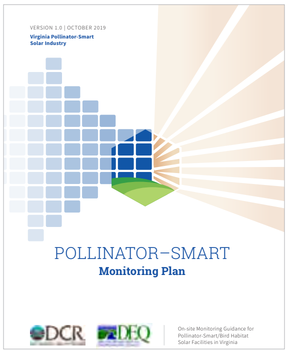
Figure 5-2: Model showing the relationship between stress, disturbance, and invasion (based on Alpert et al. 2000).

For these reasons, it is important to adopt a proactive management strategy that anticipates at least some incursion from weedy, invasive, or otherwise undesirable species. IVM techniques accommodate this goal by targeting these species early and adopting the following management practices:

- Avoid soil amendments that will increase nutrient availability, such as fertilizer or organic amendments, which will favor aggressive or weedy plants and increase the risk of invasion.
- Conduct mid-season site inspections to determine the potential management needs over the latter portion of the growing season. A mid-season site inspection should include mapping of "trouble spots" where undesirable species may have colonized. These spots can be monitored later in the season to determine if the populations are expanding and would therefore merit herbicide treatment or mechanical removal.
- Schedule mid- and late-season mobilizations to treat undesirable species. In Virginia, herbicide applications will need to be performed by a professional contractor with a pesticide applicator license, and any product chosen for this purpose should be rated as safe for use near waterbodies.
- Overseeding with native species may be beneficial as a follow-up to targeted treatment of undesirable plants.
- Mowing to reduce aboveground biomass will be prudent during the first few years of vegetation establishment. Unlike traditional turf-type landscapes that require mowing on a frequent basis throughout the growing season, an IVM approach would be to schedule mowing only during the dormant-season or occasionally at strategic times during the growing season as determined by a qualified professional.

MONITORING ESTABLISHED SITES

This chapter summarizes the recommended monitoring procedures for assessing Pollinator-Smart solar facilities in Virginia. A more detailed review of the Pollinator-Smart monitoring program is provided in the Pollinator-Smart Monitoring Plan (Appendix B). For established sites, the test for continued compliance with the Pollinator-Smart program is the most current version of the Established Solar Sites Scorecard. Appendix A includes the Scorecard as well as a Scorecard User's Guide.



At a minimum, the following data will need to be collected on established sites in order to complete the Scorecard:

1. **Vegetation Monitoring**
   - » Identity, species richness, percent cover, and reproductive phenology of plant species from vegetation sampling plots within each of the planting zones on-site
     - a. Panel Zone
     - b. Open Area
     - c. Screening Area
2. **Site Management Monitoring**
   - » Documentation of management activities and planning-level documents completed to promote Pollinator-Smart habitats on-site
     - a. Planning and Maintenance
       - i. Vegetation Management Plan
       - ii. Annual vegetation monitoring
       - iii. Annual invasive species mapping and control efforts
       - iv. Banned use of insecticides on-site
     - b. Invasive Species Cover
       - i. Percent of site covered with tall fescue
       - ii. Percent of site covered with listed invasive species
     - c. Public Engagement and Research
       - i. Signage, educational displays and benches
       - ii. Research collaboration with institution
     - d. Pollinator Habitat Features
       - i. Ground-nesting bee habitat
       - ii. Amount of edge habitat in buffer with flowering native species
       - iii. Cavity nesting sites
       - iv. Constructed pollinator/bird habitat
       - v. On-site water source(s)

MONITORING METHODS

The recommended methodology described below will provide the data necessary to fill out the current version of the Established Solar Sites Scorecard in a given monitoring year. A detailed review of the methods summarized below is provided in the Pollinator-Smart Monitoring Plan (Appendix B).

1 DETERMINE SIZE OF SAMPLING PLOTS

In Herbaceous Spaces: A 1 m^2 (10.8 ft^2) square quadrat is recommended for sampling herbaceous communities.

In Forested or Scrub-shrub Spaces: For forested or scrub-shrub sampling in the Open Area or Screening Zone, a plot size of 100 m^2 (1076 ft^2) is recommended. The radius for a 100 m^2 (1076 ft^2) circle would be approximately 5.6 m (18.5 ft).

2 DETERMINE NUMBER OF SAMPLE PLOTS

In Herbaceous Spaces: For homogeneous cover types, the minimum sample area recommended for herbaceous communities is 25 m^2, or 25 plots at 1 m^2 per plot (Mueller-Dombois and Ellenberg 1974). This density would likely result in oversampling for smaller sites (e.g., < 5ac); therefore, a recommended plot density for smaller sites is to sample 5 plots per acre for sites up to 5 acres in size. At this point, the 25 m^2 minimum sample area is achieved. Provided that the sample effort does not cross a community boundary, 25 plots should provide a baseline sample for homogeneous cover types of any size greater than 5 acres, at which time the data should be evaluated to confirm sample adequacy and determine if additional sampling is needed (see Step 5 below). A list of minimum plots per acre of sample area is provided in Table 6-1.

Table 6-1. Minimum number of plots per herbaceous sample area size.

Sample Area (ac.)	Number of Plots
1	5
2	10
3	15
4	20
5+	25

In Forested or Scrub-shrub Spaces: The minimum sample area recommendations for forests is around 500 m^2 (Mueller-Dombois and Ellenberg 1974). At a plot size of 100 m^2, this equates to 1 plot per acre up to 5 acres, at which point the recommended minimum sample area of 500 m^2 is achieved, and the data collected can be assessed to confirm sample adequacy and determine if additional sampling is required (see Step 5 below).

3 DETERMINE LOCATION OF SAMPLING PLOTS

The recommended technique for vegetation monitoring is to use a stratified-random approach. This involves initially dividing solar sites into the three management zones defined in Chapter 1: Panel Zone, Open Area, and Screening Zone. Each zone will be considered one "sample area," but zones may be further subdivided into unique community types if necessary (see discussion on sample adequacy in Step 5 below). Plot locations are then determined using a randomization approach. Examples of randomization procedures are provided below.

RANDOMIZATION PROCEDURE #1 – BASELINE/TRANSECT APPROACH

1. Within each sample area, establish a baseline along one edge. Subdivide the baseline into equal segments (a second "stratification"). The segments may be any size but should be spaced in a manner that will allow the minimum number of plots to be sampled (see discussion on minimum plot number above)
2. Within each segment, locate a single random point along the baseline. Random points are determined using a random numbers generator and setting the minimum value at 1 and the maximum value at the overall width of the segment.
3. From the random baseline point, establish a sampling transect perpendicular to the baseline and extending across the width of the sample area.
4. Along each transect within each segment, determine the locations of sampling plots using the same randomization procedure described above but taking the overall transect length as the maximum value for the random numbers generator. The number of plots per transect will vary depending on the overall length of each transect and the total minimum number of plots required for the site.

RANDOMIZATION PROCEDURE #2 – GIS

1. Once the site has been stratified into separate vegetation zones, most GIS-based applications have a random point generator function that allows users to establish a pre-determined number of random points within a polygon or feature in GIS. Taking this approach, determine the number of points needed within each zone (stratum) and have the GIS application randomly select locations for the points.
2. The GIS technique carries the risk that the randomization procedure will inadvertently cluster sampling points without having plots "spread out" across the zone as in the baseline/transect approach above. One solution to this problem is to subdivide the zone into equal segments as describe above and subject each segment to the GIS random point routine.

Using either approach outlined above, investigators can complete a desktop assignment of random plots within a selected area prior to fieldwork. This information can be incorporated into a data collection platform using mobile technology coupled with GPS receivers, which can then be used to wayfind to the location of each point while sampling. This type of approach allows investigators to accommodate a stratified-random sampling design while alleviating the need to physically lay out baselines and transects. An example of a stratified-random approach is provided in the Pollinator-Smart Monitoring Plan (Appendix B).

Once the plots have been laid out, sampling proceeds based on a predetermined minimum plot density, and sample adequacy is assessed (see Step 5 below). If the sample for each zone is determined to be inadequate, plots are added until sample adequacy is achieved.

4 SAMPLE EACH PLOT

TIME OF YEAR AND SAMPLING LEVEL-OF-EFFORT

It is recommended that vegetation sampling be performed during peak growing season, which corresponds to the mid- to late-summer months in the Mid-Atlantic Region (DeBerry and Perry 2004). The benefit of a peak growing season sampling window is that it allows reviewers to observe the site when aboveground biomass accumulation and plant species richness are expected to be highest. One concern is that certain spring-flowering species could be missed during a mid- to late-summer site visit; however, in most cases, early flowering species are identifiable from vegetative organs (e.g., leaves, stems, roots), and many of Virginia's spring-flowering species have persistent fruits that may be used for identification later in the summer (Weakley et al. 2012).

Using the 1 m^2 plot size in combination with a cover class scale, the average time to estimate cover for all species within a plot should be less than 10 minutes, which would allow a qualified professional to complete approximately 6+ plots per hour or around 50 plots per day. In addition, experience has shown that even though the woody species plots are larger, the time investment is approximately the same. Alternatively, we estimate that a team of two or more qualified professional could increase sampling efficiency by 25-50%.

VEGETATION DATA

All species present within plots should be identified to species level (or subspecific taxon, if applicable). It is recommended that species nomenclature follow the Flora of Virginia (Weakley et al. 2012), the most current version of which is available in the Flora of Virginia App. For each species in the plot, **percent cover** will be estimated and recorded. For this purpose, **a cover class scale** is recommended, because it allows percent cover to be estimated based on ranges of cover values that are easily perceived in the context of a square herbaceous plot or a circular woody species plot. Using this approach, the midpoints of the classes are recorded for analysis (for non-integer midpoints, cover classes are rounded to the nearest whole integer). **Cover estimates are then averaged across the zone** to develop relative cover values (i.e., the percentage of the total cover across the entire zone that each species comprises; see example provided in the Monitoring Plan, Appendix B). Once this is calculated, questions on the Scorecard that relate directly to percentage may be answered based on the composition of the species and the relative cover values. Qualified professionals conducting the analysis should also treat "bare ground" (if present) as a cover value for each plot. Bare ground would include any area of exposed soil within the plot.

A simple cover class scale that would be appropriate for herbaceous vegetation is shown in Table 6-2 below.

Table 6-2. Modified Daubenmire Cover Class Scale (Mueller-Dombois and Ellenberg 1974).

Cover Class ID	Percent Cover Range (%)	Cover Class Midpoint (%)
1	0-1%	1
2	1-5%	3
3	5-25%	15
4	25-50%	38
5	50-75%	63
6	75-95%	85
7	95-100%	98

In addition to species identification, plot cover estimates, and relative cover calculations, qualified professionals conducting the sampling will need to document the following characteristics of each species encountered on-site in order to complete the vegetation community questions on the Scorecard:

1. Solar Site Native Plant Finder classification status, if applicable (i.e., pollinator species, warm-season grass, etc.);
2. native/non-native status;
3. invasive/nuisance species status; and,
4. reproductive phenology (seasonal timing of flowering).

Information on all of these characteristics can be researched on the Solar Site Native Plant Finder. For ease of use, a Virginia Pollinator-Smart Rapid Assessment Form has been developed and is available in the Pollinator-Smart Monitoring Plan (Appendix B), along with an example of a completed vegetation data table.

5 CONFIRM SAMPLING ADEQUACY HAS BEEN REACHED

Once the initial plot sampling has been completed, sample adequacy should be evaluated using an approach that demonstrates adequate coverage of the vegetative community, such as a **species-area curve** (Scheiner 2003). To construct a species-area curve, cumulative species richness (total number of species) is plotted on the Y-axis of a simple coordinate grid, and cumulative area sampled is plotted on the X-axis (which can be approximated by cumulative number of plots). The curve generated by this approach is an example of a species-area curve, and it is considered to be stabilized when the curve flattens out toward the top right-hand side (as if to approach an upper asymptote). In practice, the inflection point of the curve is used to approximate an adequate sample size for vegetation research (McCune and Grace 2002). During sampling, scientists create a species-area curve after the initial sampling effort (the initial number of plots can be estimated from the literature; see Step 2 above). By entering cumulative species richness and plot number into a simple graphing program (Excel, etc.), a species-area curve can be generated “on the fly” as a simple scatterplot/trendline graph and interpreted in the field, and scientists can add plots as necessary until the curve stabilizes. An example of a species-area curve generated for data collected on a Mid-Atlantic region native meadow restoration project in is provided in the Pollinator-Smart Monitoring Plan (Appendix B).

If the Curve Doesn't Stabilize: On sites with high species richness, it is possible that the species-area curve will not flatten out to the right after completing the minimum number of sample plots. When this occurs, random plots should be added to each stratum (zone or subdivision) until the curve levels off.

"Stairstep" Curves: In other cases, the species-area curve may produce a "stairstep" pattern. A stairstep pattern typically means that the species-area phenomenon has been tracked across community boundaries. When this occurs, qualified professionals conducting the sampling should re-stratify the site into discrete, homogeneous cover types and re-sample using the stratified-random approach described above. In most cases, plots already sampled may be retained in the data sets for the remapped community types.

6 ESTABLISH PERMANENT PHOTOSTATIONS AND PHOTO-DOCUMENT SITE

Permanent photostations should be established within each of the three zones, and representative photographs of the developing vegetation should be taken in each monitoring year. For smaller vegetation zones, one photostation per acre is recommended up to 5 acres. For larger zones, a minimum of five photostations should be established across the zone, distributed in a manner that will allow adequate spatial coverage. Photographs should be taken from the same height and direction for year-to-year comparisons.

7 CONDUCT SITE MANAGEMENT MONITORING

Most of the site management documentation required to complete the Scorecard can be compiled as management activities are completed on-site. Records and photographic evidence of the re-vegetation implementation sequence including site prep, initial planting, supplemental overseeding, habitat enhancement, public engagement and research, and invasive or nuisance species management can be recorded in the form of activity logs and/or site photographs. These documents can be sourced from the planting contractor, the solar site manager, or an environmental consultant.

8 MAP INVASIVE AND/OR NUISANCE SPECIES

In addition to site management documentation, invasive and/or nuisance species mapping is recommended annually. This includes documenting any dominant zones of non-native invasive species listed on the Virginia Invasive Plant Species List (Heffernan et al. 2014), as well as any site-specific nuisance species identified during the site suitability analysis or vegetation management planning phases of the project. The distribution of invasive/nuisance species should be shown on a scaled, spatially-correct plan view map of the site, with the total area for each species expressed in acres and percentage of the total study area.

REPORTING

Because the site-level documentation is ultimately intended to support completion of the Scorecard, reporting should be considered supplemental information to the Scorecard and should be concise and easily searchable. The format presented in the Pollinator-Smart Monitoring Plan (Appendix B) is recommended. At a minimum, the report should include:

- Executive Summary
- Mapping
- Vegetation data
- Representative photographs
- Site management documentation

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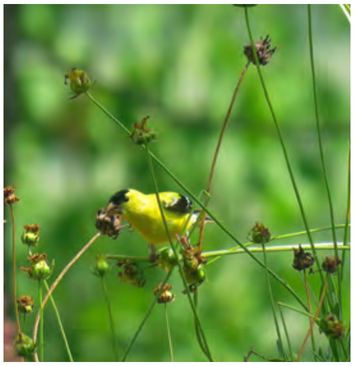


REVIEW AND APPROVAL OF MONITORING REPORTS

Monitoring reports will be submitted as supporting documentation for the Established Solar Sites Scorecard via the Virginia Pollinator-Smart Solar Industry web portal. Monitoring reports carry a 21-day review process, at the end of which the Pollinator-Smart Solar Industry Review Board will respond by either: 1) approving the monitoring report in writing; or, 2) submitting comments and requesting a revised report. [Note: The Virginia Pollinator-Smart Solar Industry web portal is under development. In the interim, Scorecards and supporting documentation should be emailed to pollinator.smart@dcr.virginia.gov.]

7

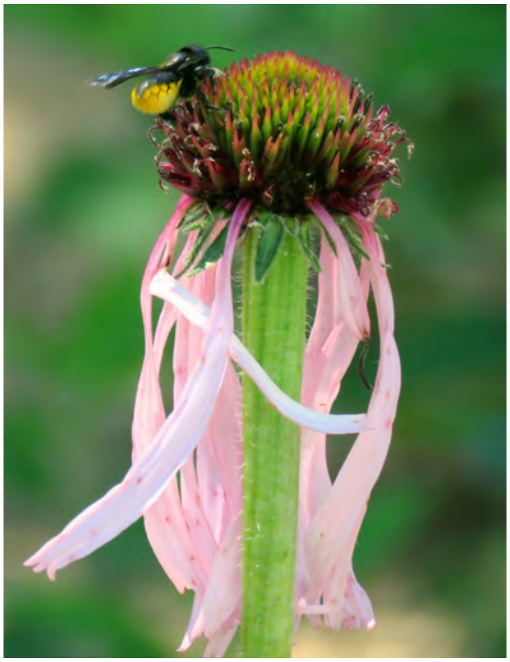
THE FUTURE OF POLLINATOR-SMART SOLAR LANDSCAPES IN VIRGINIA

The emerging solar power industry holds in its hands an extraordinary opportunity as decision-makers, engineers, and designers consider the impacts of their facilities on the landscape. Expertly crafted mixes of native plants can transform a solar facility into a thriving ecosystem that supports pollinator species, birds, and other wildlife, while also potentially enhancing the economic efficiency of a facility. As Virginia moves ahead with firm commitments to meet its renewable energy portfolio, the demand for co-location of solar facilities with other beneficial land uses will continue to expand. The goal of this Program – to facilitate self-sustaining, high quality pollinator landscapes that require minimal maintenance in the long term – is aimed directly at the confluence of these ideas.

Our motivations are ecological *and* economic. Traditional land management approaches to solar development such as planting turfgrass not only impact ecosystem functions, but also increase and extend the burden of maintenance over the life of a solar facility and increase potential for site-level problems such as failing erosion and sedimentation controls. These issues translate into financial burdens that are borne not only by the owners and operators, but ultimately by the rate payers as well. Based on the research outlined in this document, there are numerous potential long-term cost reducing benefits of a Pollinator-Smart approach such as reduction in maintenance associated with mowing and dust suppression, as well as heat dissipation leading to increased solar panel longevity. Further, the ability of denser vegetation to mitigate negative effects of heat will be increasingly important over time due to anticipated changes in regional climate.

Virginia's Pollinator-Smart program is designed to provide tools for the solar industry to adopt a native plant strategy that will address soil and water control regulations, community needs, and the needs of our biosphere. With a net savings potential for companies that embrace and master it, Pollinator-Smart Solar for Virginia is an opportunity to create clean energy landscapes with benefits to air, water, and wildlife – a future with an enduring legacy for generations of Virginians to come.

R. Davis, Fresh Energy



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GLOSSARY

Agricultural Extension agent: individual who presents information about industry advances that may positively impact farmers and livestock producers. Agricultural Extension agents travel throughout their region or district to provide the latest industry information to farmers, ranchers, community groups, and youth groups.

agronomic: of or related to agronomy, the science of soil management and crop production.

annual plant: a plant species that completes its life-cycle in one growing season.

biomass: the total weight of all living organisms in a biological community; in vegetation science, usually the total weight of all above-ground plant parts.

broadcast seeding: a technique of sowing seeds by scattering them on the surface of the soil, either by hand or through machines designed to distribute seed in this manner.

carbon sequestration: a natural or artificial process by which carbon dioxide is removed from the atmosphere and held in solid or liquid form.

cation exchange: the process whereby positively charged ionic forms of nutrients bound to negatively charged soil particles are released into the soil solution and are thereby available for plant uptake; in plants, cation exchange sites can refer to the sites in root cells where cations are taken up in exchange for hydrogen ions.

co-evolution: evolution involving successive changes in two or more ecologically interdependent species (as of a plant and its pollinators) that affect their interactions.

commodity crop: any crop that is traded.

confining layer: a layer of low-permeability soil or rock that restricts downward movement of water in the soil profile.

cultivar: plant variety that has been produced in cultivation by selective breeding; cultivars nomenclature typically follows the style Scientific name “Cultivar Name” (e.g., P*anicum virgatum* “Alamo”).

dominant plant species: a plant species that by its size, abundance, or coverage exerts considerable influence on a community's biotic and abiotic conditions.

ecological tolerance: the range of environmental conditions over which an organism is able to survive and persist in a given habitat area; plants typically have ecological tolerances for environmental factors such as moisture, soil chemistry (nutrients, pH, etc.), salinity, sunlight exposure, shade, elevation, temperature, and exposure to potentially damaging environmental conditions like wind, waves, ice, and currents.

ecosystem: a complete interacting system of organisms and their environment, applicable at any spatial scale.

ecotype: in reference to plants, a sub-specific category representing a genetically distinct geographic variety, population, or race of a species that survives as a distinct group through environmental selection; ecotypes are generally considered to be adapted to the environmental conditions found within a specific region.

entomologist: a scientist who studies or is an expert in the branch of zoology concerned with insects.

enzymes: molecules produced by living organisms that are used to as catalysts to hasten biochemical reactions.

evapotranspiration: transfer of water from the soil or land surface to the atmosphere as water vapor via the combined effects of evaporation and transpiration by plants.

forb: a broad-leaved herbaceous plant (contrast with "graminoid").

fragipan: a soil horizon with altered subsurface soil layers that restrict water flow and root penetration due to reversible cementation (i.e., hard and impermeable in dry state, brittle and permeable in moist state).

friable: of soil, a crumbly texture ideal for plant growth.

genotypic: of or related to genotype, the genetic makeup of an organism. Genotypic is often used in reference to groups of genetically-related organisms, and also in reference to a trait or set of traits of interest.

germination: the sprouting of a plant from a seed or spore after a period of dormancy.

graminoid: a grass or grass-like herbaceous plant (contrast with "forb").

homogeneous cover: vegetative cover type typically composed of a community of plants that does not vary appreciably in terms of relative species abundance and distribution over a given land area.

host plants: as used in this document, plants that serve as pollinator hosts.

hydrology regime: variations in the state and characteristics of soil wetness or standing water in a given area that are typically repeated in time and space and pass through phases such as seasons.

hydroseeding: a technique of distributing seeds on land surfaces by using a specialized apparatus designed to spray a mixture of water and seeds simultaneously; hydroseeding often uses a chemical surfactant to hold the seed in place once distributed and can also include a mulch component in the slurry.

in situ: situated in the place of origin.

infiltration: the process by which water on the ground surface enters the soil and percolates downward through the soil profile.

inter-panel spacing: the spacing between solar panel rows.

invasive species: of plants, species that are intentionally or accidentally introduced, usually by human activity, into a region in which they did not evolve, typically with negative consequences for natural resources, economic activity, or human health.

lime: a soil additive made from pulverized limestone or chalk (calcium carbonate), the purpose of which is to increase the pH of acidic soil; also provides a source of calcium and magnesium for plants.

Mehlich extraction: a standard laboratory-based soil analysis test that provides data on essential nutrients important to plant growth and overall soil fertility.

microtopography: fine-scale variation in topography within a habitat; e.g., the pattern of small mounds and recesses around vegetation clumps in a meadow.

mobile technology: use of hand-held devices for data collection during fieldwork.

mutualism: a relationship between two organisms or species that benefits both; e.g., in pollination support, wildflowers provide nectar as a food resource for bees which, in the process of nectar foraging, distribute pollen to other wildflowers to promote cross-pollination.

native plant: plants indigenous to a given area; although this concept is typically defined in terms in geologic time, for practical purposes a native Virginia plant is one that currently lives in the state and is known to have been present prior to European (human) colonization of North America. For the purposes of Scorecard evaluation, a species is considered native if it appears within the Virginia Solar Site Native Plant Finder.

Open Area: any area beyond the Panel Zone excluding the Screening Zone within the property boundary.

organic amendments: any material of plant or animal origin that can be added to the soil to improve its physical or chemical properties, such as water retention, permeability, water infiltration, drainage, aeration, structure, pH, and nutrient content.

osmotic stress: a sudden change in the solute concentration around a cell, causing a rapid change in the movement of water across the cell membrane; osmotic stress typically results from the solute concentration being higher outside the cell than inside, which results in a net loss of water from the cell; plants growing in soils with high salt content are usually exposed to osmotic stress.

overseeding: process of spreading seed over an existing landscape for the purposes of increasing vegetation; typically used as a supplemental planting technique after an initial planting has been completed.

Panel Zone: the area underneath the solar arrays, including inter-row spacing.

perched water table: an aquifer that occurs above the regional water table due to an impermeable layer of rock or soil that prevents downward infiltration of water.

perennial: a plant species with a life-cycle that lasts at least two growing seasons.

permanent vegetative cover: a community of plants composed of trees, shrubs, or perennial grasses, legumes, or shrubs with an expected life span of at least 5 years.

Permit by Rule (PBR): permit approved by administrative rule for activities deemed to meet the requirements of the provisions set forth therein.

pH: a figure expressing the acidity or alkalinity of a solution; on a pH scale, 7 is equivalent to neutral, values lower than 7 are acidic, and values higher than 7 are basic (alkaline).

physiographic province: a geographic region with characteristic landform, environmental conditions, and often geology. From east to west, physiographic provinces in Virginia include the Coastal Plain, Piedmont, Blue Ridge, Ridge and Valley, and Appalachian Plateau.

phytoremediation: a technique used to remediate hazardous materials in water, soil, or sediments with plants and/or microorganisms as the remediating agent.

pithy stems: woody plants with extensive cavity space in the pith or central area of the stem (e.g., native sumacs, roses, and blackberries); pithy stems provide nesting habitat for certain species of insects.

plant community: a multi-species group of plants occurring together in a particular habitat area.

pollination: the transfer of pollen from a male part of a plant to a female part of a plant, later enabling fertilization and the production of seeds; pollination is most often facilitated by an animal or by wind.

pollinator habitat: an area with a variety of flowering plants that provide food and nesting space for organisms that facilitate pollination.

Pollinator-Smart seed mix: seed mix that includes native Virginia ecotypes and conforms with the Virginia Solar Native Plant Finder, with species richness, relative percentage, and species composition sufficient to rate the highest score on the Vegetation questions in Version A of the Scorecard.

Pure Live Seed (PLS): measure used by the seed industry to describe the percentage of a quantity of seed that will germinate; obtained by multiplying the purity percentage by the percentage of total viable seed, then dividing by 100.

qualified professional: a person knowledgeable in the principles and practices of a particular discipline though active participation in that discipline; as used in this program, a qualified professional has experience in site feasibility, management planning, installation, vegetation monitoring, and/or permitting for re-vegetation activities related to the Pollinator-Smart program.

relative abundance values: the percent composition of a species of plant relative to the total number of plants in the area.

relative dominance: measure of the relative importance of a plant species with respect to the degree of influence that the species exerts on other components of a natural community.

reproductive phenology: the timing of reproduction events in plants and animals.

retrofit site: an existing solar facility on which some type of vegetative cover other than a Pollinator-Smart plant community has been established, and to which Pollinator-Smart practices will be implemented.

re-vegetation: the process of establishing a new or enhanced vegetation community on a landscape area from which vegetation has been removed or altered, or in an area where an undesirable plant community exists.

Screening Zone: a vegetated visual barrier.

seed drill: a device that sows the seeds by positioning them in the soil and burying them to a specific depth; seed drills typically can be adjusted for different seeding rates and depths; seed drilling (the process of sowing seed using a seed drill) is considered advantageous because it ensures seed burial which helps to prevent seed loss from wind, water, or animal consumption, and also ensures proper seed-soil contact.

seed mix: a commercially available blend of seeds from two or more plant species combined in specific ratios to encourage a desired vegetative community when planted or sown.

seedling: a very young plant that recently germinated from seed.

slope aspect: the direction of a slope relative to the ambient sunlight, which can influence local climate, temperature, and moisture; in Virginia, north- and east-facing slopes tend to be cooler and moister, whereas south- and west-facing slopes tend to be warmer and drier.

soil amendments: materials added to the soil to improve physical structure and/or chemical conditions relative to plant growth.

soil fertility: the overall condition of the soil as a medium to support biological organisms, particularly plant life.

Solar Site Native Plant Finder: the Virginia Solar Site Native Plant Finder, a web-based research tool developed and maintained by the Virginia Department of Conservation and Recreation Division of Natural Heritage to aid solar energy stakeholders in creating technical re-vegetation specifications for solar projects. The Solar Site Native Plant Finder is built on a robust database of native plant species generated from the Flora of Virginia (Weakley et al. 2012), the state's comprehensive manual of vascular flora.

species-area curve: the relationship between the area of a habitat, or of part of a habitat, and the number of species found within that area, expressed graphically as a curve with species ; larger areas tend to contain larger numbers of species, and empirically, the relative numbers seem to follow systematic mathematical relationships.

species composition: the identity of the species present within a given area.

species diversity: a measure of the variety of species present within a given area that considers both the total number of species present (species richness) and the evenness of species distribution across the area.

species richness: total number of species present within a given area.

stakeholders: a party with a vested interest in a program, organization, entity, or outcome of an undertaking.

stormwater runoff: that portion of precipitation that is discharged across the land surface or through conveyances to one or more waterways.

turf-type grass: a landscaping and lawn gardening term for the grass used on a lawn; in contrast with ornamental grasses (taller, with bunch-type growth habit) and native grasses (highly variable).

used by pollinators: plant species with a "pollinator" designation on the Virginia Solar Site Native Plant Finder.

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Appendix A

Scorecards and Scorecard User's Guide

VERSION 2.0a

VIRGINIA POLLINATOR-SMART/ BIRD HABITAT SCORECARD

Proposed or Retrofit Solar Sites

A successful Pollinator-Smart habitat will provide benefits to the environment and the solar site owner/operator in a number of key areas, including:

1. Pollinator services,
2. Biodiversity and habitat enhancement,
3. Carbon sequestration,
4. Erosion and sediment control, and;
5. Reduced vegetation maintenance over time.

The Virginia Solar Site Pollinator/Bird Habitat Scorecard is used to establish target conditions and/or evaluate the effectiveness of Pollinator-Smart measures once implemented. If the score thresholds are met, a site is deemed Pollinator-Smart provided the activities described herein are implemented **over at least 10% of the project area**.

DEFINITIONS

Open Area: Any area beyond the panel zone, within the property boundary.

Panel Zone: The area underneath the solar arrays, including inter-row spacing.

Project Area: Open Area + Panel Zone + Screening Zone.

Screening Zone: A vegetated visual barrier.

Solar Native Plant Finder: The Virginia Solar Site Native Plant Finder (link), an online research tool developed by the DCR Natural Heritage Program.

Virginia Pollinator-Smart Seed Mix: A seed mix that includes native local ecotypes and conforms with the Solar Native Plant Finder.

RESOURCES

Virginia Solar Site Native Plant Finder

Virginia's Pollinator-Smart Solar Portal

Comprehensive Manual

Monitoring Plan

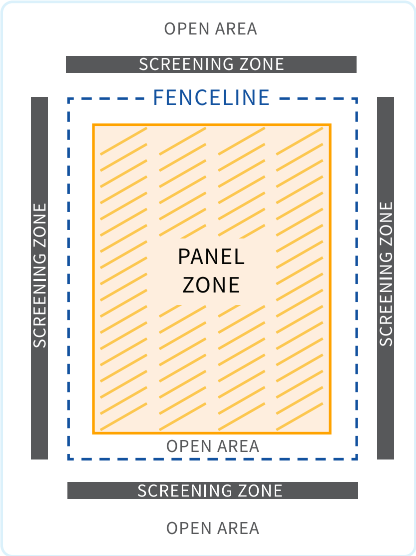
INSTRUCTIONS

For detailed instructions on how to implement the scorecard, please refer to the Comprehensive Manual.

1. All questions and fields must be filled out.
2. Submit your scorecard and associated documents via email to: pollinator.smart@dcr.virginia.gov
3. A Proposed or Retrofit Solar Site Scorecard should be submitted during the initial planting year. To remain certified, an Established Sites Scorecard should be submitted in years 2, 4, 6, 8, and 10. A long-term management plan should also be submitted with the Established Sites Scorecard during year 10. If all criteria are met during year 10, the site will be considered pollinator-friendly for the life of the project.

ATTACHMENTS PROVIDED

- ☐ Project Vicinity Map/Planting Plan
- ☐ Seed Mix and Seeding Rates
- ☐ Vegetation Management Plan
- ☐ Vegetation Monitoring Plan
- ☐ Invasive Species Mapping
- ☐ Research Collaboration Documentation
- ☐ Site Photos



PROJECT DETAILS & CONTACT INFORMATION

DATE: ____________

SITE OWNER OR DESIGNEE:

____

PROJECT ADDRESS:

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____

____

PROJECT SIZE (ACS AND MW):

____

POINT OF CONTACT:

____

____

EMAIL/PHONE:

____

____

VEGETATION CONSULTANT:

____

SEED SUPPLIER (IF KNOWN):

____

TARGET SEEDING DATE:

____

FINAL SCORE

0

Certified VA Pollinator-Smart: 80-99 pts

Gold Certified VA Pollinator-Smart: 100+ pts

CLEAR FORM

For questions, comments, and feedback, please contact pollinator.smart@dcr.virginia.gov

VERSION 2.0a

VIRGINIA POLLINATOR-SMART/ BIRD HABITAT SCORECARD

Proposed or Retrofit Solar Sites

VEGETATION

PANEL ZONE

1. Percent of panel zone to be planted with a seed mix of native species developed using the Solar Native Plant Finder (**max 15 pts**)
   - ◯ <5 percent (0)
   - ◯ 5-25 percent (5)
   - ◯ 26-50 percent (8)
   - ◯ 51-75 percent (10)
   - ◯ greater than 75 percent (15)
2. Planned native grass diversity in panel zone (**max 5 pts**)
   - ◯ 1 or fewer species (0)
   - ◯ 2 species (2)
   - ◯ 3 or more species (5)

OPEN AREA

3. Percent of open area to be planted with Virginia Pollinator-Smart Seed Mix developed using the Solar Plant Finder (**max 15 pts**)
   - ◯ <5 percent (0)
   - ◯ 5-25 percent (5)
   - ◯ 26-50 percent (8)
   - ◯ 51-75 percent (10)
   - ◯ greater than 75 percent (15)
4. Total *number* of Solar Native Plant Finder species in the seed mix to be used within the open area (**max 15 pts**)
   - ◯ 4 or fewer species (0)
   - ◯ 5-9 species (5)
   - ◯ 10-14 species (8)
   - ◯ 15-19 species (10)
   - ◯ 20 or greater species (15)
5. For the seed mix to be used within the open area, seasons with at least three (3) Solar Native Plant Finder species in flower (**max 10 pts**) **[CHECK ALL THAT APPLY]**
   - ☐ Spring (March-May) (2)
   - ☐ Early Summer (June-July 15) (2)
   - ☐ Late Summer (July 15-August) (4)
   - ☐ Fall (September-November) (2)

SCREENING ZONE

6. Within the screening zone, percent to be planted with Solar Native Plant Finder species (**max 15 pts**)
   - ◯ <5 percent (0)
   - ◯ 5-25 percent (5)
   - ◯ 26-50 percent (8)
   - ◯ 51-75 percent (10)
   - ◯ greater than 75 percent (15)

SITE MANAGEMENT

PLANNING AND MAINTENANCE PRACTICES

7. **[CHECK ALL THAT APPLY]** (**max 25 pts**)
   - ☐ Site has an Approved[1] Vegetation Management Plan (15)
   - ☐ Vegetation monitoring[2] is proposed annually (5)
   - ☐ Invasive species mapping and control proposed annually (5)
   - ☐ Planned on-site use of insecticide or pre-planting seed/plant insecticide treatment (excluding buildings/electrical boxes, etc.) (-40)

INVASIVE SPECIES RISK

8. **[CHECK ALL THAT APPLY]** (**-20 pts possible**)
   - ☐ Combined cover of tall fescue across all three zones planned to be >10 percent (-10)
   - ☐ Combined cover of species on DNH Virginia Invasive Plant Species List across all three zones planned to be >10 percent (-10)

PUBLIC ENGAGEMENT AND RESEARCH

9. **[CHECK ALL THAT APPLY]** (**max 10 pts**)
   - ☐ 2 or more legible and accessible signs identifying pollinator and bird habitat proposed on-site (2.5)
   - ☐ Accessible bench and educational display proposed on-site (2.5)
   - ☐ Research collaboration with college, university, school, or research institute (5)

POLLINATOR/BIRD NESTING HABITAT ON-SITE

10. **[CHECK ALL FEATURES THAT ARE PRESENT ON-SITE]** (**20+ pts**)
    - ☐ Existing bare ground patches one square foot or larger, with undisturbed and well-drained soil (2)
    - ☐ Preserved upland forested communities or forest edge habitat that includes native flowering shrubs and young trees (8)
    - ☐ Cavity nesting sites (e.g. dead trees, snags, fallen logs, shrubs, plants with pithy-stemmed twigs such as native sumacs, roses, blackberries) (2)
    - ☐ Created bee/bird nesting habitat features (e.g., boxes, tunnels, etc.) (0.2 pts per feature)[3] # features: **x 0.2 =** 0 **pts.**
    - ☐ Preserved wetland communities/presence of clean water source(s) (8)

[1] See guidelines for development of a Vegetation Management Plan here. Vegetation Management Plans for solar sites are approved by the Virginia Pollinator-Smart Solar Industry Review Board. Vegetation Management Plans may be submitted here.

[2] Vegetation monitoring should be conducted in accordance with the methods described here. For the purposes of compliance, monitoring is only required every two years; therefore, annual monitoring is incentivized with additional points in the Scorecard.

[3] Up to a maximum of 10 points (50 features)

VERSION 2.0b

VIRGINIA POLLINATOR-SMART/ BIRD HABITAT SCORECARD

Established Solar Sites

A successful Pollinator-Smart habitat will provide benefits to the environment and the solar site owner/operator in a number of key areas, including:

1. Pollinator services,
2. Biodiversity and habitat enhancement,
3. Carbon sequestration,
4. Erosion and sediment control, and;
5. Reduced vegetation maintenance over time.

The Virginia Solar Site Pollinator/Bird Habitat Scorecard is used to establish target conditions and/or evaluate the effectiveness of Pollinator-Smart measures once implemented. If the score thresholds are met, a site is deemed Pollinator-Smart.

DEFINITIONS

Open Area: Any area beyond the panel zone, within the property boundary.

Panel Zone: The area underneath the solar arrays, including inter-row spacing.

Screening Zone: A vegetated visual barrier.

Solar Native Plant Finder: The Virginia Solar Site Native Plant Finder (link), an online research tool developed by the DCR Natural Heritage Program.

Used by Pollinators: Plant species with a "pollinator" designation on the Virginia Solar Site Native Plant Finder.

RESOURCES

Virginia Solar Site Native Plant Finder

Virginia's Pollinator-Smart Solar Portal

Comprehensive Manual

Monitoring Plan

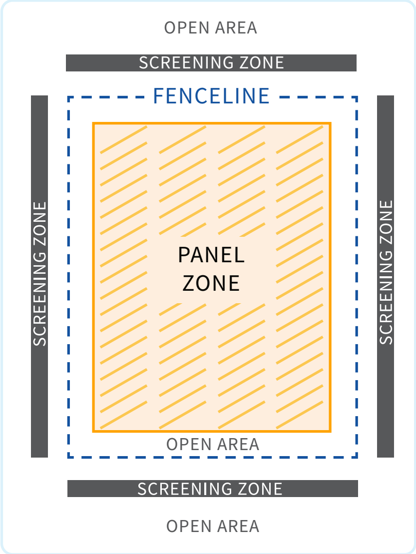
INSTRUCTIONS

For detailed instructions on how to implement the scorecard, please refer to the Comprehensive Manual.

1. All questions and fields must be filled out.
2. Submit your scorecard and associated documents via email to: pollinator.smart@dcr.virginia.gov
3. A Proposed or Retrofit Solar Site Scorecard should be submitted during the initial planting year. To remain certified, an Established Sites Scorecard should be submitted in years 2, 4, 6, 8, and 10. A long-term management plan should also be submitted with the Established Sites Scorecard during year 10. If all criteria are met during year 10, the site will be considered pollinator-friendly for the life of the project.

ATTACHMENTS PROVIDED

- ☐ Project Vicinity Map
- ☐ Vegetation Management Plan
- ☐ Vegetation Monitoring Report
- ☐ Invasive Species Mapping
- ☐ Research Collaboration Documentation
- ☐ Site Photos
- ☐ Long-term management plan (Year 10 only)



PROJECT DETAILS & CONTACT INFORMATION

DATE: ____________

SITE OWNER OR DESIGNEE:

____

PROJECT ADDRESS:

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PROJECT SIZE (ACS AND MW):

____

POINT OF CONTACT:

____

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EMAIL/PHONE:

____

____

VEGETATION CONSULTANT:

____

FINAL SCORE

0

Certified VA Pollinator-Smart: 80-99 pts

Gold Certified VA Pollinator-Smart: 100+ pts

CLEAR FORM

For questions, comments, and feedback, please contact pollinator.smart@dcr.virginia.gov

VERSION 2.0b

VIRGINIA POLLINATOR-SMART/ BIRD HABITAT SCORECARD

Established Solar Sites

VEGETATION

PANEL ZONE

1. Percent of overall existing cover in the panel zone vegetated with Solar Native Plant Finder species (**max 15 pts**)
   - ◯ <5 percent (0)
   - ◯ 5-25 percent (5)
   - ◯ 26-50 percent (8)
   - ◯ 51-75 percent (10)
   - ◯ greater than 75 percent (15)
2. Native grass diversity in panel zone (**max 5 pts**)
   - ◯ 1 or fewer species (0)
   - ◯ 2 species (2)
   - ◯ 3 or more species (5)

OPEN AREA

3. Percent of overall existing cover within the open area vegetated with Solar Native Plant Finder species used by pollinators (**max 15 pts**)
   - ◯ <5 percent (0)
   - ◯ 5-25 percent (5)
   - ◯ 26-50 percent (8)
   - ◯ 51-75 percent (10)
   - ◯ greater than 75 percent (15)
4. Total *number* of Solar Native Plant Finder species found within the open area (**max 15 pts**)
   - ◯ 9 or fewer species (0)
   - ◯ 10-19 species (5)
   - ◯ 20-29 species (8)
   - ◯ 30-39 species (10)
   - ◯ 40 or greater species (15)
5. Within the open area, seasons with at least three (3) Solar Native Plant Finder species in flower (**max 10 pts**) **[CHECK ALL THAT APPLY]**
   - ☐ Spring (March-May) (2)
   - ☐ Early Summer (June-July 15) (2)
   - ☐ Late Summer (July 15-August) (4)
   - ☐ Fall (September-November) (2)

SCREENING ZONE

6. Percent of overall existing cover in the screening area vegetated with Solar Native Plant Finder species (**max 15 pts**)
   - ◯ <5 percent (0)
   - ◯ 5-25 percent (5)
   - ◯ 26-50 percent (8)
   - ◯ 51-75 percent (10)
   - ◯ greater than 75 percent (15)

SITE MANAGEMENT

PLANNING AND MAINTENANCE PRACTICES

7. **[CHECK ALL THAT APPLY]** (**max 25 pts**)
   - ☐ Site has an Approved[1] Vegetation Management Plan (15)
   - ☐ Vegetation monitoring[2] conducted annually (5)
   - ☐ Invasive species mapping and control conducted annually (5)
   - ☐ On-site use of insecticide (excluding safety/hazard spot treatment around buildings/electrical boxes, etc.) (-40)

INVASIVE SPECIES RISK

8. **[CHECK ALL THAT APPLY]** (**-20 pts possible**)
   - ☐ Combined cover of tall fescue across all three zones >10 percent (-10)
   - ☐ Combined cover of species on DNH Virginia Invasive Plant Species List across all three zones >10 percent (-10)

PUBLIC ENGAGEMENT AND RESEARCH

9. **[CHECK ALL THAT APPLY]** (**max 10 pts**)
   - ☐ 2 or more legible and accessible signs identifying pollinator and bird habitat present on-site (2.5)
   - ☐ Accessible bench and educational display present on-site (2.5)
   - ☐ Research collaboration with college, university, school, or research institute (5)

POLLINATOR/BIRD NESTING HABITAT ON-SITE

10. **[CHECK ALL FEATURES THAT ARE PRESENT ON-SITE]** (**20+ pts**)
   - ☐ Existing bare ground patches one square foot or larger, with undisturbed and well-drained soil (2)
   - ☐ Preserved upland forested communities or forest edge habitat that includes native flowering shrubs and young trees (8)
   - ☐ Cavity nesting sites (e.g. dead trees, snags, fallen logs, shrubs, plants with pithy-stemmed twigs such as native sumacs, roses, or blackberries) (2)
   - ☐ Created bee/bird nesting habitat features (e.g., boxes, tunnels, etc.) (0.2 pts per feature)[3] # feature: x **0.2 =** 0 **pts.**
   - ☐ Preserved wetlands communities/presence of clean water source(s) (8)

[1] *See guidelines for development of a Vegetation Management Plan here. Vegetation Management Plans for solar sites are approved by the Virginia Pollinator-Smart Solar Industry Review Board. Vegetation Management Plans may be submitted here.*

[2] *Vegetation monitoring should be conducted in accordance with the methods described here. For the purposes of compliance, monitoring is only required every two years; therefore, annual monitoring is incentivized with additional points in the Scorecard.*

[3] *Up to a maximum of 10 points (50 features)*

Scorecard User's Guide

INTRODUCTION

The Virginia Pollinator-Smart program uses two Scorecards to assess pollinator habitat: the Proposed/Retrofit Solar Sites Scorecard and the Established Solar Sites Scorecard. The Proposed/Retrofit Solar Sites Scorecard is used up front to establish target conditions on-site, while the Established Solar Sites Scorecard is intended to evaluate the effectiveness of the measures once implemented.

This **Scorecard User's Guide** is intended to explain all facets of both Scorecards, including timelines, requirements, review processes, and how to accurately assess all questions. If you have any questions about the Scorecards, how to complete them, or how to submit, please contact: pollinator.smart@dcr.virginia.gov.

CERTIFICATION

In order to be considered a Pollinator-Smart solar facility, a site must implement Pollinator-Smart practices over at least 10% of the project area AND pass the points threshold designated on the Scorecard.

There are two levels of certification that can be reached with this program: Certified Virginia Pollinator-Smart (80-99 points) and Gold Certified Virginia Pollinator-Smart (100+ points).

LEVEL 1

CERTIFIED VIRGINIA POLLINATOR-SMART (80-99 POINTS)

LEVEL 2

GOLD CERTIFIED VIRGINIA POLLINATOR-SMART (100+ POINTS)

THE SCORECARD TIMELINE AND APPROVAL PROCESS

Solar sites should be evaluated for Pollinator-Smart status using the following timeline:

YEAR	RECOMMENDED TIMING OF SUBMITTAL	SCORECARD TO USE
0	At least a month prior to intended seeding date.	Proposed/ Retrofit Solar Sites Scorecard
2	September - December	Established Solar Sites Scorecard
4	September - December	Established Solar Sites Scorecard
6	September - December	Established Solar Sites Scorecard
8	September - December	Established Solar Sites Scorecard
10	September - December	Established Solar Sites Scorecard & Long-Term Vegetation Management Plan
11+		

ADDITIONAL NOTES

Year 0: Consider submitting as early in the planning process as possible to allow time to address potential issues. In order to be considered Pollinator-Smart, a site must pass the Scorecard AND Pollinator-Smart practices must be implemented over 10% of the project area.

Year 2,4,6,8: Site monitoring should be conducted in mid to late-summer.

Year 10: Site monitoring should be conducted in mid to late-summer. A Long-Term Vegetation Management Plan should be submitted at this time.

Year 11+: If the Long-Term Vegetation Management Plan in Year 10 is accepted, the site will be considered Pollinator-Smart for the life of the project.

SUBMITTAL

Completed Scorecards should be submitted, with all accompanying attachments, via the Virginia Pollinator-Smart Solar Industry web portal. [Note: The Virginia Pollinator-Smart Solar Industry web portal is under development. In the interim, Scorecards and supporting documentation should be emailed to pollinator.smart@dcr.virginia.gov].

Each Scorecard will be reviewed by the Pollinator-Smart Solar Industry Review Board, who will ultimately decide if a site will be considered certified at either the Pollinator-Smart Virginia Certified or Pollinator-Smart Virginia Gold Certified levels.

The Review Board is committed to reviewing and providing comments to completed Scorecards within 21 days of receiving a complete application. All questions and required fields must be filled out, and all required attachments must be provided for a Scorecard to be considered complete.

Applicants will be notified once a submittal has been determined to be complete, at which time the 21-day review period begins. If you do not receive comments within the 21-day review period and your site passed the Scorecard certification thresholds, it is considered Certified.

WHO IS THE POLLINATOR-SMART INDUSTRY REVIEW BOARD?

The board is made up of members of the following organizations:

» Virginia Department of Environmental Quality
» Virginia Department of Conservation and Recreation
» Virginia Department of Game and Inland Fisheries
» The College of William & Mary

Scorecards should be submitted every two calendar years from the initial year in which the Proposed/ Retrofit Solar Sites Scorecard was submitted. If a Scorecard is not received during the appropriate calendar year, the site can no longer be considered Pollinator-Smart. If your project is delayed or encounters unforeseen circumstances, contact pollinator.smart@dcr.virginia.gov to organize a modified timeline as needed.

ATTACHMENTS

The Scorecard asks for many types of attachments, most of which are required for the Scorecard to be considered complete. Below is a table that details the type of attachment, the year(s) in which it should be submitted, whether it is a requirement, and any additional details that may help with Scorecard completion.

If you have completed a Vegetation Management Plan in accordance with the guidelines provided in the Virginia Pollinator-Smart Comprehensive Manual, then most of these attachments will already be prepared. A Vegetation Management Plan is technically not required to complete the Scorecard, but it is strongly recommended.

Attachment	Years	Status	Notes
Project Vicinity Map	All	Required	Provide acreages for the Panel Zone, Open Area, and Screening Zone on the map.
Planting Plan	0	Required	--
Seed Mix and Seeding Rates	0	Required	--
Vegetation Management Plan	All	Strongly Recommended	Required if selected in Question 7.
Vegetation Monitoring Plan	All	Required	A site can gain points on the Scorecard for monitoring annually (optional); sites must be monitored biennially.
Invasive Species Mapping	All	Strongly Recommended	Required if selected in Question 7.
Research Collaboration Documentation	All	Optional	Required if selected in Question 9.
Site Photos	All	Required	--
Vegetation Monitoring Report	2, 4, 6, 8, & 10	Required	--
Long-term Management Plan	10	Strongly Recommended	If provided and approved in Year 10, and site passes Scorecard that year, the site is considered Pollinator-Smart for the life of the project.

PROJECT DETAILS & CONTACT INFORMATION

The following must be filled out on the first page of the Scorecard:

» Date

» Site Owner or Designee

» Project Address

- GPS coordinates in Decimal Degrees is also acceptable

» Project Size (acres and MW)

- Consider also providing the total size of the Pollinator-Smart portion of the site.

» Point of Contact

- The Pollinator-Smart Solar Industry Review Board will contact this person with comments and approval of the Scorecard.

» Email/Phone

» Vegetation Consultant

- If known, please provide the name of the company. If not yet decided, please write "Undetermined".

» Seed Supplier

- Proposed/Retrofit Solar Sites Scorecard only
- If known, please provide the name of the company. If not yet decided, please write "Undetermined".

» Target Seeding Date

- Proposed/Retrofit Solar Sites Scorecard only
- We recognize that dates are subject to change due to changes in the project schedule. Please contact pollinator.smart@dcr.virginia.gov if the seeding date significantly changes (6+ or more months) or moves into a different calendar year, as this may ultimately affect the timeline established for re-certification of your solar site.

Proposed/Retrofit Solar Sites Scorecard Evaluation

The metrics in the Proposed/Retrofit Solar Sites Scorecard can be subdivided into two general categories: Vegetation and Site Management. Note that the Vegetation metrics section relies heavily on the Virginia Solar Site Native Plant Finder.

VEGETATION

Before evaluating the Vegetation section, consider working through the provided worksheets, which will enable you to quickly evaluate the Scorecard once completed. These sheets do not have to be included as part of any submittal and are provided solely for your use and convenience.

Prior to filling out the Proposed/Retrofit Solar Sites Scorecard, you should identify the seed mix you intend to use on-site. This will require contact with a qualified professional with experience in seed provision and/or installation, who will provide a proposed Pollinator-Smart Seed Mix using the guidance in the Comprehensive Manual. If you elect to work through the provided sheets, begin by transferring the proposed seed mix to the appropriate tables below.

Due to the differing constraints associated with each zone (Panel Zone, Open Area, and Screening Zone), it is possible that multiple seed mixes and planting plans will be used on-site. If this is the case, work through each sheet individually. If the same seed mix is being used across zones, consider adapting the most inclusive worksheet to avoid redundancy.

SITE MANAGEMENT METRICS

Site management metrics will usually require at least one site visit to assess prior to completing the Scorecard. Please see the Site Suitability and Planning chapter of the Comprehensive Manual for specific details on what should be covered during an initial site visit.

WHAT DEFINES A POLLINATOR-SMART SEED MIX?

A mix of seeds composed of species found on the Virginia Solar Site Native Plant Finder, with species richness, relative percentage, and species composition sufficient to rate the highest score on questions 2, 4, and 5. When available, Virginia local ecotypes are used in the seed mix.

This means a Pollinator-Smart Seed Mix has:

3 or more Solar Site Native Plant Finder grass species in the seed mix

20 or more Solar Site Native Plant Finder species total

At least three Solar Site Native Plant Finder species in flower during all four time periods (spring, early summer, late summer, fall)

PANEL ZONE SEED MIX

	SCIENTIFIC NAME	IN SOLAR SITE NATIVE PLANT FINDER?	NATIVE GRASS?	NOTES
1.				
2.				
3.				
4.				
5.				
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.				
TOTAL				

PANEL ZONE SEED MIX CONT.

	SCIENTIFIC NAME	IN SOLAR SITE NATIVE PLANT FINDER?	NATIVE GRASS?	NOTES
31.				
32.				
33.				
34.				
35.				
36.				
37.				
38.				
39.				
40.				
41.				
42.				
TOTAL				

OPEN AREA SEED MIX

	SCIENTIFIC NAME	IN SOLAR SITE NATIVE PLANT FINDER?	FLOWERING SEASON	NOTES
1.				
2.				
3.				
4.				
5.				
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.				
TOTAL				

OPEN AREA SEED MIX CONT.

	SCIENTIFIC NAME	IN SOLAR SITE NATIVE PLANT FINDER?	FLOWERING SEASON	NOTES
31.				
32.				
33.				
34.				
35.				
36.				
37.				
38.				
39.				
40.				
41.				
42.				
TOTAL				

SCREENING ZONE PLANTING PLAN AND/OR SEED MIX

	SCIENTIFIC NAME	IN SOLAR SITE NATIVE PLANT FINDER?	# BEING PLANTED
1.			
2.			
3.			
4.			
5.			
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.			
TOTAL			

SCREENING ZONE PLANTING PLAN AND/OR SEED MIX CONT.

	SCIENTIFIC NAME	IN SOLAR SITE NATIVE PLANT FINDER?	# BEING PLANTED
31.			
32.			
33.			
34.			
35.			
36.			
37.			
38.			
39.			
40.			
41.			
42.			
TOTAL			

WORKSHEET 2-ACREAGES

1. What is the total size (in acres) of the Panel Zone? ________
2. How many acres of the Panel Zone will be planted with Solar Site Native Plant Finder Species? ________
3. What is the total size (in acres) of the Open Area? ________
4. How many acres of the Open Area will be planted with Solar Site Native Plant Finder Species? ________
5. What is the total size (in acres) of the Screening Zone? ________
6. How many acres of the Screening Zone will be planted with Solar Site Native Plant Finder Species? ________
7. What is the total size (in acres) of the project area? ________
8. __________________ **+** __________________ **+** __________________ **=** ______________
   # Acres in Question 2 | # Acres in Question 4 | # Acres in Question 5 | TOTAL ACRES OF NATIVE SPECIES
9. _____________________ **/** __________________ **x 100 =** _________________________
   Total Acres in Question 8 | Acres in Question 7 | % of Site Implementing Pollinator-Smart Practices
10. Is the % of site implementing Pollinator-Smart practices greater than 10% of the total project area?

    ❑ **YES** | ❑ **NO**

    a. If **YES**, your site has met the first threshold required for Pollinator-Smart Certification. Begin to evaluate each question of the Scorecard!

    b. If **NO**, this site cannot be considered Pollinator-Smart as-is. Please consider expanding your pollinator habitat implementation in order to meet the first requirement.

ANSWERING THE QUESTIONS

VEGETATION

Panel Zone

1 Percent of Panel Zone to be planted with a seed mix of native species developed using the Solar Site Native Plant Finder (max 15 points)

- ☐ <5 percent (0)
- ☐ 5-25 percent (5)
- ☐ 26-50 percent (8)
- ☐ 51-75 percent (10)
- ☐ Greater than 75 percent (15)

Divide the acreage of the Panel Zone that is to be planted with native species by the total acreage of the Panel Zone, and multiply by 100.

The Virginia Pollinator-Smart program defines native species as any species that can be found in the Solar Site Native Plant Finder. Not every seed mix will contain all native species. When evaluating this question, you do not have to pro-rate your acreage by the percent of native species within the seed mix as long as the top three dominant species in the seed mix AND the majority (i.e., greater than 50 percent) of the species within the seed mix can be found on the Solar Site Native Plant Finder.

2 Planned native grass diversity in Panel Zone (max 5 pts)

- ☐ 1 or fewer species (0)
- ☐ 2 species (2)
- ☐ 3 or more species (5)

Grasses are in the Family Poaceae. *Agrostis, Andropogon, Elymus, Dichanthelium, Panicum*, and *Poa* are common commercially available grass genera. The Solar Site Native Plant Finder indicates which species are grasses under the "Plant Type" field.

Open Area

3 Percent of Open Area to be planted with Virginia Pollinator-Smart Seed Mix developed using the Solar Site Native Plant Finder (max 15 pts)

- ☐ <5 percent (0)
- ☐ 5-25 percent (5)
- ☐ 26-50 percent (8)
- ☐ 51-75 percent (10)
- ☐ Greater than 75 percent (15)

Divide the acreage of the Open Area to be planted with the Pollinator-Smart Seed Mix by the total acreage of the Open Area, and multiply by 100.

A Virginia Pollinator-Smart Seed Mix contains 3 or more species of native grasses, 20 or greater native species overall, and at least three flowering native species in each of the following time periods: spring (March-May), early summer (June-July 15), late summer (July 15-August), and fall (September-November). The best way to determine this is by using the provided worksheet, which guides you through each item. Provided here is a quick overview of how to determine each parameter:

- » Overall number of native species – Use the species search in the Solar Site Native Plant Finder to determine native status for each species in the seed mix. If the species appears in the Solar Site Native Plant Finder, then it is considered native. If it does not appear in the Solar Site Native Plant Finder, then it is non-native.
- » Native grasses – The Solar Site Native Plant Finder indicates which species are grasses under the "Plant Type" field.
- » Seasons – Flowering seasons can be found for each species in the Virginia Solar Site Native Plant Finder. Some species will flower across multiple seasons and can be counted towards each.

WHAT IF MY SPECIES IS NOT IN THE VIRGINIA SOLAR SITE NATIVE PLANT FINDER?

A Note on Synonyms...

Scientific names for plant species are not immutable. As botanists discover new relationships based on genetic analysis and other classification approaches, scientific names must change to reflect the new information or, in some cases, to recognize the authority of an old name. This can create issues for practitioners, for example, who might be trying to develop a native seed mix using information from different sources with different names for the same plant (e.g., a database like the Virginia Solar Site Native Plant Finder vs. a seed supplier catalog). The good news is that all legitimate scientific names - both old and new - are easily cross-referenced using the **synonymy** for a species. The Virginia Solar Site Native Plant Finder is based on the *Flora of Virginia*, so it uses the names in that reference as reflected in the current version of the Flora of Virginia App. **Synonyms** for scientific names are provided in the Flora and can also be researched using other tools like the Digital Atlas of the Virginia Flora. So, if a species name from a seed supplier doesn't come up on the Virginia Solar Site Native Plant Finder, be sure to check the synonymy...it's entirely possible that your species has a new name.

RARITY and UNCERTAIN STATUSES

Non-native species are not included in the Virginia Solar Site Native Plant Finder. Additionally, species with uncertain native statuses are also excluded from consideration.

State rare native species are the only native species truly not included in the Virginia Solar Site Native Plant Finder. These species have an S1, S2, or S3 state ranking through the Natural Heritage Program and are not included due to their rarity throughout the state. These species should not be included in proposed seed mixes and do not count on the Proposed/Retrofit Solar Sites Scorecard. Rare species can be included in the Established Solar Sites Scorecard evaluation if occurring naturally on the site (i.e., not introduced) and recorded during monitoring.

If your seed mix for the Open Area is not Pollinator-Smart, then no points can be received for this question. If your seed mix is Pollinator-Smart, then divide the acreage of the Open Area to be planted by the total acreage of the Open Area, and multiply by 100.

By definition, a Pollinator-Smart seed mix will qualify for maximum points in both Question 4 and in Question 5.

4 Total number of Solar Site Native Plant Finder species in the seed mix to be used within the Open Area (max 15 pts)

- ☐ 4 or fewer species (0)
- ☐ 5-9 species (5)
- ☐ 10-14 species (8)
- ☐ 15-19 species (10)
- ☐ 20 or greater species (15)

By definition, a Pollinator-Smart Seed Mix will have 20 or greater species and will qualify for the maximum points available. If the seed mix is not Pollinator-Smart, simply sum the number of Solar Site Native Plant Finder species that are within the seed mix for the Open Area.

5 For the seed mix to be used within the Open Area, seasons with at least three (3) Solar Site Native Plant Finder species in flower (max 10 pts) [CHECK ALL THAT APPLY]

- ☐ Spring (March-May) (2)
- ☐ Early Summer (June-July 15) (2)
- ☐ Late Summer (July 15-August) (4)
- ☐ Fall (September-November) (2)

See comments under Question 3 concerning approaches for determining flowering seasons for each species. Once this determination has been made, sum the total number of species in each time period. For each time period that contains at least three native species, check the box. By definition, a Pollinator-Smart Seed Mix will score maximum points on this question.

SCREENING ZONE

6 Within the Screening Zone, percent to be planted with Solar Site Native Plant Finder species (max 15 pts)

- ☐ <5 percent (0)
- ☐ 5-25 percent (5)
- ☐ 26-50 percent (8)
- ☐ 51-75 percent (10)
- ☐ Greater than 75 percent (15)

Divide the total number of plants that are native by the total number of plants being planted, and multiply by 100.

Since the Screening Zone is defined as a vegetated visual barrier, the extent of the zone is defined by extent of the area being planted. In most cases, the Screening Zone will consist of woody plant species and a seed mix is not used. Therefore, the methods used to calculate this question are slightly different than when using a seed mix. Start by identifying which species in the planting plan are native using the Solar Site Native Plant Finder and list the number of woody stems being installed. Divide the total number of stems that are native by the total number of stems being planted, and multiply by 100.

If a seed mix is being used in the Screening Zone, follow the methods described in Question 1.

SITE MANAGEMENT

Planning and Maintenance Practices

7 [CHECK ALL THAT APPLY] (max 25 pts)

- ☐ Site has an Approved Vegetation Management Plan (15)
- ☐ Vegetation monitoring is proposed annually (5)
- ☐ Invasive species mapping and control proposed annually (5)
- ☐ Planned on-site use of insecticide or pre-planting seed/plant insecticide treatment (excluding buildings/electrical boxes, etc.)(-40)

Please refer to the Vegetation Management Plan chapter of the Comprehensive Manual for guidelines on how to create and execute a proper plan. If you choose to complete a Vegetation Management Plan for your site (highly recommended) and you follow the guidelines in the Comprehensive Manual, you may assume that it is Approved. Select the "Site has an Approved Vegetation Management Plan" box and submit your Vegetation Management Plan alongside the Scorecard as part of the complete Pollinator-Smart application. The Pollinator-Smart Solar Industry Review Board will review the plan and provide comments to the plan and Scorecard (if necessary).

Vegetation monitoring is required biennially (every two years) as described in the Established Solar Sites Scorecard. Annual monitoring, though not required, is highly recommended because it enables proactive treatment, IVM, and corrective methods on Pollinator-Smart plantings prior to the critical recertification years. If you choose to monitor the site annually, please explicitly state this in your Vegetation Management Plan.

Invasive species mapping and control is not required but is highly recommended. Annual monitoring and treatment of invasive species can prevent Pollinator-Smart planting failures and can proactively reduce cover of any established invasive species prior to the critical recertification years (Years 2, 4, 6, 8, and 10) where cover of greater than 10% results in a 10-point reduction on the Scorecard. If you choose to map and control invasive species annually, please explicitly state this in your Vegetation Management Plan.

Insecticide is incompatible with the goals of a Pollinator-Smart facility. However, things like wasp nests on buildings, electrical boxes, and other structural elements of a solar site can pose significant health and safety risks to technicians who need to access these areas of the site for routine operation and maintenance activities. If insecticide is only being applied in highly localized areas of the site to address specific scenarios such as these, then its use is within the approved parameters of the Pollinator-Smart program. If insecticide is planned to be broadcast across portions of the site, please check the box. Some seeds and plants come with insecticide treatment already in place. Make sure that any material being planted on-site has not been pre-treated; if it has, please check the box.

Invasive Species Risk

8 **[CHECK ALL THAT APPLY] (-20 pts possible)**

- ❐ Combined cover of tall fescue across all three zones planned to be >10 percent (-10)
- ❐ Combined cover of species on DNH Virginia Invasive Plant Species List across all three zones planned to be >10 percent (-10)

Tall fescue – especially cultivars like Kentucky-31 – is widely planted as a forage and erosion control plant. Although it is easy to grow and relatively cheap, the presence of tall fescue reduces biological diversity "on the level of soil organisms, insects, plants, birds, and mammals" (NRCS 2001). Tall fescue is allelopathic (Buta and Spaulding 1989), meaning that it releases its own chemicals into the environment that reduce the ability for other plant species to grow and thrive where it is established. This makes tall fescue a species that is incompatible with the goals of a Pollinator-Smart facility.

There are two ways in which tall fescue can be "planned" to be present on a facility. The first is if tall fescue is going to be installed in areas of the site that are not planned to be Pollinator-Smart; for example, if tall fescue is slated to be planted underneath the arrays of the Panel Zone, while a Pollinator-Smart seed mix is installed within the Open Area. If this is the case:

Divide the acreage of the area to be planted with tall fescue by the acreage of the project area, and multiply by 100.

If your value is greater than 10 percent, please check the box. The second way tall fescue can be "planned" to be on a facility is if it already exists on-site and will not be removed during construction or treated with herbicide prior to a Pollinator-Smart planting. If this is the case, refer to the Vegetation Assessment section of the Site Suitability and Planning chapter of the Comprehensive Manual. Using the guidelines within the Comprehensive Manual, you will get an estimate of the overall cover of tall fescue on-site. If the assessment indicates >10% cover, check the box.

An important note is that there are several synonyms for tall fescue (*Schedonorus arundinaceus*), including:

Lolium arundinaceum, Festuca arundinacea, Festuca eliator, and *Festuca elatior* var. *arundinacea*, and *Festuca pratensis* (see comments above concerning scientific names and synonyms). Additionally, this question specifically targets tall fescue, and species such as red fescue (*Festuca rubra*) and cluster fescue (*Festuca paradoxa*) should not be included.

Invasive plants are defined as species that are intentionally or accidentally introduced, usually by human activity, into a region in which they did not evolve, typically with negative consequences for natural resources, economic activity, or human health. For a thorough discussion of why the presence of invasive species is incompatible with Pollinator-Smart plantings, please refer to the Integrated Vegetation Management chapter of the Comprehensive Manual. The Virginia Invasive Plant Species List contains species that are established (or potentially will establish) within the Commonwealth. If a species is included on this list, there is evidence that it can negatively impact Virginia's natural resources, including forests, grasslands, wetlands, or waterbodies. This list also ranks invasive species by risk of invasion (low, medium, high). Regardless of invasiveness rank, any species on this list should be evaluated for this question.

Similar to the tall fescue discussion, there are two ways in which invasive species may be "planned" to be on a solar facility. The first is if an invasive species is planned to be included in a seed mix that will be installed on-site. Examples of invasive species used for erosion control and stabilization include Chinese lespedeza (*Lespedeza cuneata*), crown vetch (*Securigera varia*), and shrubby bushclover (*Lespedeza bicolor*). If this is the case:

Divide the acreage of the area to be planted with the invasive species by the acreage of the project area, and multiply by 100.

If an invasive species is part of a seed mix, regardless of the percent composition that the species makes up within the mix, evaluate this question using the entire acreage of the area to be planted (i.e., do not pro-rate your acreage by the percentage of invasive species within a mix). If your value is greater than 10 percent, please check the box.

The second way in which an invasive species can be "planned" to be on a solar facility is if it already exists on-site and the invader(s) will not be removed during construction or treated with herbicide prior to a Pollinator-Smart planting. If this is the case, refer to the Vegetation Assessment section of the Site Suitability and Planning chapter of the Comprehensive Manual. Using the guidelines within the Comprehensive Manual, you will get an estimate of the overall cover of the invasive species on-site. Examples of some commonly encountered invasive species with generally high cover include: kudzu (*Pueraria montana var. lobata*), Japanese honeysuckle (*Lonicera japonica*), Japanese stiltgrass (*Microstegium vimineum*), common reed (*Phragmites australis ssp. australis*), and porcelainberry (*Ampelopsis brevipedunculata*). It is possible that several invasive species will be established on a solar site with existing vegetation simultaneously. Assess the cover of invasive species cumulatively for this question. If the assessment indicates >10% cover of all invasive species on-site, check the box.

Public Engagement and Research

9 **[CHECK ALL THAT APPLY] (max 10 pts)**

- ❒ 2 or more legible and accessible signs identifying pollinator and bird habitat proposed on-site (2.5)
- ❒ Accessible bench and educational display proposed on-site (2.5)
- ❒ Research collaboration with college, university, school, or research institute (5)

Signage identifying Pollinator-Smart plantings can be placed on the outskirts of facilities either mounted within the Screening Zone or hung on fences (when local ordinances allow). The Virginia Pollinator-

Smart program is in the process of designing sample signage and wording, but the use of these samples is optional. Ultimately, content and display are left to the applicant's discretion. Signage is not always feasible for solar sites, especially on larger utility-scale facilities where the public accessing the site could pose significant safety risks. If including signage at your facility, submit an example of the design for the sign along with your Scorecard.

An accessible bench and educational display will not be feasible for most utility-scale solar facilities where public accessibility may cause safety risks. Smaller installations intended in part for educational use (such as sites adjacent to schools, public buildings, etc.) may want to consider the value of adding a bench and display at their site. The Virginia Pollinator-Smart program is in the process of designing a sample display for planning purposes; however, the final content/presentation of the educational display is left to the applicant's discretion. If including an educational display at your site, provide an example of the design for the display along with your Scorecard.

A research collaboration with a college, university, school, or research institute is a great way to engage the public while also increasing knowledge of the benefits of Pollinator-Smart plantings. This question is deliberately broad to allow for many types of projects to qualify. If you are collaborating with a college, university, school, or research institute, please submit documentation of the partnership along with your Scorecard. Name, affiliation, and contact information should be included as well as a conceptual outline of the research subject and the proposed methodology.

10 **[CHECK ALL FEATURES THAT ARE PRESENT ON-SITE] (20+ pts)**

- ☐ Existing bare ground patches one square foot or larger, with undisturbed and well-drained soil (2)
- ☐ Preserved upland forested communities or forest edge habitat that includes native flowering shrubs and young trees (8)
- ☐ Cavity nesting sites (e.g., dead trees, snags, fallen logs, shrubs, plants with pithy-stemmed twigs such as native sumacs, roses, blackberries) (2)
- ☐ Created bee/bird nesting habitat features (e.g. boxes, tunnels, etc.) (0.2 pts per feature)
- ☐ Preserved wetland communities/presence of clean water source(s) (8)

This final Scorecard question is meant to incentivize preserving natural habitat on-site. Only the project area physically controlled by solar site owner, operator, or developer can be assessed for this question; points cannot be given for habitat located on adjacent properties. An initial site visit will be required to analyze these questions. Refer to the Site Suitability and Planning chapter of the Comprehensive Manual for details on what to investigate.

Existing bare ground patches provide habitat for native ground nesting bees, the most common of which is the polyester bee (*Colletes inaequalis*), which has a strong preference for sandy soils. A well-drained soil in Virginia will be uncompacted, free of confining layers, and composed primarily of sand or loam. Refer to the soil physical properties section of the Site Suitability Planning chapter of the Comprehensive Manual for additional details. If suitable bare ground patches are identified on-site, please document and provide as part of the site photos.

Upland forested communities and edge habitat should have a prevalence of native flowering shrubs and young trees in order to be considered. Plants do not need to be flowering at the time of assessment in order to qualify for this question. Multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), wineberry (*Rubus phoenicolasius*), or Chinese privet (*Ligustrum sinense*), are common non-native invasive species that may be encountered along forest edges; they will not qualify for this question. Common native edge species that may be encountered include sumacs (*Rhus* spp.), blackberries (*Rubus* spp.), viburnums (*Viburnum* spp.), hollies (*Ilex* spp.), dogwoods (*Cornus* spp.), and beautyberry (*Callicarpa americana*). It is possible (and highly likely) that there is a mix of non-native and native species within a forest stand. As long as there are no dominant non-native or invasive species present within the forest stand or edge habitat, you will still qualify for this question. If this habitat is present on-site, please document and provide as part of the site photos.

Dead trees, snags, fallen logs, shrubs, plants with pithy-stemmed twigs (e.g., native sumacs, roses, blackberries) provide potential nesting sites for all types of pollinators. In order to qualify for this question, the features should be natural, i.e. installing logs on-site will qualify for the “created bee/bird nesting habitat features” option and not the “cavity nesting sites” option. Multiple cavity nesting features should be located within the project area in order to qualify. If these features are present, please provide representative photos of the identified habitat as part of the site photos.

Bird houses and bee nest shelters with artificial nesting holes can be installed throughout a site (specifically in the Open Area and the Screening Zone) to provide the opportunity for pollinators to inhabit areas on-site. Beehives do not qualify for this question, as they promote habitat for the European honeybee (*Apis mellifera*), which is a species that is non-native to Virginia. Up to 50 features can be installed on-site for a total of 10 additional points. If bee/bird features are installed on-site, provide representative images as part of the site photos.

Wetlands or waterbodies (such as streams, ponds, or other open waterbody features) that are present on-site and have not been impacted as part of the construction process should be considered for the “preserved wetland communities/presence of clean water source(s)” question. Manmade features such as BMPs and non-jurisdictional ditches should not be considered for this question. Water quality (i.e., “clean water”) should be assessed qualitatively in areas where standing water is present. Signs of excess nutrients such as algae blooms or heavy macrophyte growth, the presence of large amounts of trash, or an oil sheen on the water surface may indicate that water quality is low. To receive points on the scorecard for preserved habitats that are owned or controlled by the solar development/developer they must be included in the Vegetation Management Plan for the project.

Established Solar Sites Scorecard Evaluation

As with the Proposed/Retrofit Scorecard, the metrics in the Established Solar Sites Scorecard are subdivided into Vegetation Metrics and Site Management Metrics. The Vegetation Metrics should continue to be evaluated in reference to the Virginia Solar Site Native Plant Finder.

Biennial monitoring must be conducted in order to complete this Scorecard. It is recommended that monitoring be conducted by a qualified professional (for a definition of “qualified professional”, see the Comprehensive Manual Glossary). Refer to the Monitoring Plan for detailed methods on how to monitor a Pollinator-Smart facility. Monitoring and Established Solar Site Scorecard submission should occur in Years 2, 4, 6, 8, and 10.

VEGETATION

Percent cover of native species, number of native species, number of native grass species, percent cover of invasive species, and flowering phenologies are examples of information that will be needed in order to complete the Scorecard. Refer to Appendix C of the Monitoring Plan for an example of how to organize the monitoring data into a table that will provide most of the Scorecard answers. This table should be provided as part of the Monitoring Report, which is to be submitted as part of the complete Scorecard package.

SITE MANAGEMENT METRICS

Following Steps 6, 7, and 8 of the Monitoring Plan will provide the appropriate documentation needed to fill out questions 7 through 10 of the Established Solar Sites Scorecard.

ANSWERING THE QUESTIONS

VEGETATION

Panel Zone

1 Percent of overall existing cover in the Panel Zone vegetated with Solar Site Native Plant Finder species (max 15 points)

- ☐ <5 percent (0)
- ☐ 5-25 percent (5)
- ☐ 26-50 percent (8)
- ☐ 51-75 percent (10)
- ☐ Greater than 75 percent (15)

Sum the total percent cover of native species from each sampling plot within the Panel Zone and divide by the total cover of all species in all plots within the Panel Zone. Multiply by 100.

The Virginia Pollinator-Smart program defines native species as any species that can be found in the Solar Site Native Plant Finder. Sampling plots will not always contain 100% native species. When evaluating this question, only take the cover of native species into account.

2 Native grass diversity in Panel Zone (max 5 pts)

- ☐ 1 or fewer species (0)
- ☐ 2 species (2)
- ☐ 3 or more species (5)

Sum the total number of native grasses in the Panel Zone.

Grasses are in the family Poaceae. The Solar Site Native Plant Finder indicates which species are grasses under the "Plant Type" field. Monitoring data should indicate which species are grasses.

Open Area

3 Percent of overall existing cover within the Open Area vegetated with Solar Site Native Plant Finder species used by pollinators (max 15 pts)

- ☐ <5 percent (0)
- ☐ 5-25 percent (5)
- ☐ 26-50 percent (8)
- ☐ 51-75 percent (10)
- ☐ Greater than 75 percent (15)

Sum the total percent cover of native species used by pollinators across all plots in the Open Area and divide by the total cover of all species in all plots in the Open Area. Multiply by 100.

The Virginia Pollinator-Smart program defines native species as any species that can be found in the Solar Site Native Plant Finder. The Solar Site Native Plant Finder also has an additional designation of "Pollinator?". This subset of native species is pollinated by animals. Not every sampling plot will contain 100% native species, and not every native species will be "used by pollinators". When evaluating this question, only take the cover of native species that are also present in the "Pollinator" category in the Solar Site Native Plant Finder into account.

4 Total number of Solar Site Native Plant Finder species found within the Open Area (max 15 pts)

- ☐ 9 or fewer species (0)
- ☐ 10-19 species (5)
- ☐ 20-29 species (8)
- ☐ 30-39 species (10)
- ☐ 40 or greater species (15)

Sum the number of unique native species identified within the Open Area across all plots.

There will be species overlap across sampling plots within the Open Area. Only take into account the number of unique species that occur across the Open Area, not how frequently they appear across plots.

5 Within the Open Area, seasons with at least three (3) Solar Site Native Plant Finder species in flower (max 10 pts) [CHECK ALL THAT APPLY]

- ☐ Spring (March-May) (2)
- ☐ Early Summer (June-July 15) (2)
- ☐ Late Summer (July 15-August) (4)
- ☐ Fall (September-November) (2)

Because vegetation monitoring is only required once biennially, a species does not have to be in flower at the time of survey to count towards this question. To determine typical flowering times for a species, refer to Solar Site Native Plant Finder. Some species will flower across multiple seasons and can be counted towards more than one category for this question. Sum the total number of species in each time period. For each time period that contains at least three native species, check the box.

Screening Zone

6 Percent of overall existing cover in the Screening Zone vegetated with Solar Site Native Plant Finder species (max 15 pts)

- ☐ <5 percent (0)
- ☐ 5-25 percent (5)
- ☐ 26-50 percent (8)
- ☐ 51-75 percent (10)
- ☐ Greater than 75 percent (15)

Sum the total percent cover of native species from each sampling plot within the Screening Zone and divide by the total cover of all species in all plots within the Screening Zone. Multiply by 100.

Since the Screening Zone is defined as a vegetated visual barrier, the extent of the zone is defined by extent of the area that was originally planted. The Virginia Pollinator-Smart program defines native species as any species that can be found in the Solar Site Native Plant Finder. Not every sampling plot will contain 100% native species. When evaluating this question, only take the cover of native species into account.

SITE MANAGEMENT

Planning and Maintenance Practices

7 [CHECK ALL THAT APPLY] (max 25 pts)

- ☐ Site has an Approved Vegetation Management Plan (15)
- ☐ Vegetation monitoring conducted annually (5)
- ☐ Invasive species mapping and control conducted annually (5)
- ☐ On-site use of insecticide (excluding safety/ hazard spot treatment around buildings/ electrical boxes, etc.) (-40)

If a Vegetation Management Plan was submitted along with the Proposed/Retrofit Solar Sites Scorecard in Year 0 and was approved, please continue to provide the same plan alongside each Scorecard submittal. If there are updates to the Vegetation Management Plan based on IVM or other Adaptive Management approaches, please inform the Pollinator-Smart Solar Industry Review Board that the plan will need to be reapproved. If revisions were completed in accordance with the guidelines in the Comprehensive Manual, you may assume that the revised plan is approved. The Review Board will provide comments to the plan and Scorecard if necessary during the 21-day review period.

If you did not create a Vegetation Management Plan during the Proposed/Retrofit (Year 0) phase of your Pollinator-Smart planting but choose to create one for your site during Years 2-10, if you follow the guidelines in the Vegetation Management Plan chapter of the Comprehensive Manual you may assume that it is approved. Select the "Site has an Approved Vegetation Management Plan" box and submit your Vegetation Management Plan alongside the Scorecard as part of the complete Pollinator-Smart application. The Pollinator-Smart Solar Industry Review Board will review the plan and provide comments to the plan and Scorecard (if necessary).

Annual monitoring is voluntary but highly recommended because it enables proactive treatment, IVM, and corrective methods on Pollinator-Smart plantings prior to the critical recertification years. If the site was monitored during an odd year (Year 1, 3, 5, 7, or 9), please provide the Monitoring Report as part of the Scorecard submittal.

Invasive species mapping and control is not required but is highly recommended. Annual monitoring and treatment of invasive species can prevent Pollinator-Smart planting failures and can proactively reduce cover of any established invasive species prior to the critical recertification years (2, 4, 6, 8, and 10) where cover of greater than 10% results in a 10-point reduction on the Scorecard. If you choose to map and control invasive species annually, please provide a spatially-correct plan view map of the site showing the location of dominant zones of non-native invasive species listed on the Virginia Invasive Plant Species List, with the total area for each species expressed in acres and percentage of the total project area. Two maps should be provided: a map from the odd year (1, 3, 5, 7, or 9) and a map from the submittal year (2, 4, 6, 8, or 10). Additionally, evidence of invasive species control on-site should be provided as either an activity log or before-and-after site photos.

Insecticide is incompatible with the goals of a Pollinator-Smart facility. However, things like wasp nests being formed on buildings, electrical boxes, and other structural elements of a solar facility can pose significant health and safety risks to technicians who need to access these areas of the site for routine operation and maintenance activities. If insecticide is only being applied in highly localized areas of the site to address specific scenarios such as these, then its use is within the approved parameters of the Pollinator-Smart program. If insecticide is broadcast across portions of the site, please check the box.

Invasive Species Risk

8 [CHECK ALL THAT APPLY] (-20 pts possible)

- ❒ Combined cover of tall fescue across all three zones >10 percent (-10)
- ❒ Combined cover of species on DNH Virginia Invasive Plant Species List across all three zones >10 percent (-10)

Tall fescue – especially cultivars like Kentucky-31 – is widely planted as a forage and erosion control plant. Although it is easy to grow and relatively cheap, the presence of tall fescue reduces biological diversity "on the level of soil organisms, insects, plants, birds, and mammals" (NRCS 2001). Tall fescue is allelopathic (Buta and Spaulding 1989), meaning that it releases its own chemicals into the environment that reduce the ability for other plant species to grow and thrive where it is established. This makes tall fescue a species that is incompatible with the goals of a Pollinator-Smart facility.

An important note is that there are several synonyms for tall fescue (*Schedonorus arundinaceus*), including: *Lolium arundinaceum, Festuca arundinacea, Festuca eliator*, and *Festuca elatior* var. *arundinacea,* and *Festuca pratensis* (see comments above concerning scientific names and synonyms). Additionally, this question specifically targets tall fescue, and species such as red fescue (*Festuca rubra*) and cluster fescue (*Festuca paradoxa*) should not be included.

Combine the total percent cover of tall fescue in all sampling plots across the site and divide by the total cover of all species in all plots across the entire site. Multiply by 100.

Invasive plants are defined as species that are intentionally or accidentally introduced, usually by human activity, into a region in which they did not evolve, typically with negative consequences for natural resources, economic activity, or human health. For a thorough discussion of why the presence of invasive species is incompatible with Pollinator-Smart plantings, please refer to the Integrated Vegetation Management chapter of the Comprehensive Manual. The Virginia Invasive Plant Species List contains species that are established (or potentially will establish) within the Commonwealth. If a species is included on this list, there is evidence that it can negatively impact Virginia's natural resources, including forests, grasslands, wetlands, or waterbodies. This list also ranks invasive species by risk of invasion (low, medium, high). Regardless of invasiveness rank, any species on this list should be evaluated for this question.

Sum the total percent cover of all invasive species across all plots and divide by the total cover of all species in all plots. Multiply by 100.

Public Engagement and Research

9 [CHECK ALL THAT APPLY] (max 10 pts)

- ☐ 2 or more legible and accessible signs identifying pollinator and bird habitat present on-site (2.5)
- ☐ Accessible bench and educational display present on-site (2.5)
- ☐ Research collaboration with college, university, school, or research institute (5)

Signage identifying Pollinator-Smart plantings can be placed on the outskirts of facilities either mounted within the Screening Zone or hung on fences (when local ordinances allow). The Virginia Pollinator-Smart program is in the process of designing sample signage and wording, but the use of these samples is optional. Ultimately, content and display are left to the applicant's discretion. Signage is not always feasible for solar sites, especially on larger utility-scale facilities where the public accessing the site could pose significant safety risks. If including signage at your facility, submit an example of the design for the sign along with your Scorecard.

An accessible bench and educational display will not be feasible for most utility-scale solar facilities where public accessibility may cause safety risks. Smaller installations intended in part for educational use (such as sites adjacent to schools, public buildings, etc.) may want to consider the value of adding a bench and display at their site. The Virginia Pollinator-Smart program is in the process of designing a sample display for planning purposes; however, the final content/presentation of the educational display is left to the applicant's discretion. If including an educational display at your site, provide an example of the design for the display along with your Scorecard.

A research collaboration with a college, university, school, or research institute is a great way to engage the public while also increasing knowledge of the benefits of Pollinator-Smart plantings. This question is deliberately broad to allow for many types of projects to qualify. If you are collaborating with a college, university, school, or research institute, please submit documentation of the partnership along with your Scorecard. Name, affiliation, and contact information should be included as well as a conceptual outline of the research subject and the proposed methodology.

10 [CHECK ALL FEATURES THAT ARE PRESENT ON-SITE] (20+ pts)

- ☐ Existing bare ground patches one square foot or larger, with undisturbed and well-drained soil (2)
- ☐ Preserved upland forested communities or forest edge habitat that includes native flowering shrubs and young trees (8)
- ☐ Cavity nesting sites (e.g. dead trees, snags, fallen logs, shrubs, plants with pithy-stemmed twigs such as native sumacs, roses, blackberries) (2)
- ☐ Created bee/bird nesting habitat features (e.g. boxes, tunnels, etc.) (0.2 pts per feature)
- ☐ Preserved wetland communities/presence of clean water source(s) (8)

This final Scorecard question is meant to incentivize preserving natural habitat on-site. Only the project area physically controlled by solar site owner, operator, or developer can be assessed for this question; points cannot be given for habitat located on adjacent properties. An initial site visit will be required to analyze these questions. Refer to the Site Suitability and Planning chapter of the Comprehensive Manual for details on what to investigate.

Existing bare ground patches provide habitat for native ground nesting bees, the most common of which is the polyester bee (*Colletes inaequalis*), which has a strong preference for sandy soils. A well-drained soil in Virginia will be uncompacted, free of confining layers, and composed primarily of sand or loam. Refer to the soil physical properties section of the Site Suitability Planning chapter of the Comprehensive Manual for additional details. If suitable bare ground patches are identified on-site, please document and provide as part of the site photos.

Upland forested communities and edge habitat should have a prevalence of native flowering shrubs and young trees in order to be considered. Plants do not need to be flowering at the time of assessment in order to qualify for this question. Multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), wineberry (*Rubus phoenicolasius*), or Chinese privet (*Ligustrum sinense*), are common non-native invasive species that may be encountered along forest edges; they will not qualify for this question. Common native edge species that may be encountered include sumacs (*Rhus* spp.), blackberries (*Rubus* spp.), viburnums (*Viburnum* spp.), hollies (*Ilex* spp.), dogwoods (*Cornus* spp.), and beautyberry (*Callicarpa americana*). It is possible (and highly likely) that there is a mix of non-native and native species within a forest stand. As long as there are no dominant non-native or invasive species present within the forest stand or edge habitat, you will still qualify for this question. If this habitat is present on-site, please document and provide as part of the site photos.

Dead trees, snags, fallen logs, shrubs, plants with pithy-stemmed twigs (e.g., native sumacs, roses, blackberries) provide potential nesting sites for all types of pollinators. In order to qualify for this question, the features should be natural, i.e. installing logs on-site will qualify for the “created bee/bird nesting habitat features” option and not the “cavity nesting sites” option. Multiple cavity nesting features should be located within the project area in order to qualify. If these features are present, please provide representative photos of the identified habitat as part of the site photos.

Bird houses and bee nest shelters with artificial nesting holes can be installed throughout a site (specifically in the Open Area and the Screening Zone) to provide the opportunity for pollinators to inhabit areas on-site. Beehives do not qualify for this question, as they promote habitat for the European honeybee (*Apis mellifera*), which is a species that is non-native to Virginia. Up to 50 features can be installed on-site for a total of 10 additional points. If bee/bird features are installed on-site, provide representative images as part of the site photos.

Wetlands or waterbodies (such as streams, ponds, or other open waterbody features) that are present on-site and have not been impacted as part of the construction process should be considered for the “preserved wetland communities/presence of clean water source(s)” question. Manmade features such as BMPs and non-jurisdictional ditches should not be considered for this question. Water quality (i.e., “clean water”) should be assessed qualitatively in areas where standing water is present. Signs of excess nutrients such as algae blooms or heavy macrophyte growth, the presence of large amounts of trash, or an oil sheen on the water surface may indicate that water quality is low.

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Appendix B

Monitoring Plan

VERSION 1.1 | DECEMBER 2019

Virginia Pollinator-Smart Solar Industry

POLLINATOR–SMART

Monitoring Plan

Virginia Department of Conservation & Recreation

Virginia Department of Environmental Quality

On-site Monitoring Guidance for Pollinator-Smart/Bird Habitat Solar Facilities in Virginia

At a Glance...

This document outlines the recommended monitoring procedures for assessing "Pollinator-Smart" solar facilities in Virginia.

A Pollinator-Smart solar facility is one that meets performance standards established in the Virginia Pollinator-Smart Solar Industry program ("Pollinator-Smart program"), with joint oversight from the Virginia Department of Environmental Quality (DEQ) and the Virginia Department of Conservation and Recreation (DCR).

Performance standards are given in the most current version of the Established Solar Sites Virginia Pollinator Smart/Bird Habitat Scorecard, ("Scorecard"), and monitoring data will be collected on established solar sites to determine continued compliance with Pollinator-Smart performance standards. This includes sites that were either: 1) established as approved Pollinator-Smart solar facilities when constructed; or, 2) retrofitted as approved Pollinator-Smart solar facilities. The approval process is outlined in the **Virginia Pollinator-Smart Solar Industry Comprehensive Manual**. In all cases, for new sites or retrofits the mode of entry for the Pollinator-Smart program is the **Proposed or Retrofit Solar Sites Scorecard**; likewise, for established sites, the test for continued compliance with the Pollinator-Smart program is the **Established Solar Sites Scorecard**.

At a minimum, the following data will need to be collected on established sites in order to complete the Established Solar Sites Scorecard:

1. **Vegetation Monitoring**
   a. Identity, species richness, percent cover, and reproductive phenology of plant species from vegetation sampling plots within each of the planting zones on-site
      ii. Panel Zone
      iii. Open Area
      iv. Screening Area
2. **Site Management Monitoring**
   a. Documentation of management activities and planning-level documents completed to promote Pollinator-Smart habitats on-site
      ii. Planning and Maintenance
         1. Vegetation Management Plan
         2. Annual vegetation monitoring
         3. Annual invasive species mapping and control efforts
         4. Banned use of insecticides on-site
      iii. Invasive Species Cover
         1. Percent of site covered with tall fescue
         2. Percent of site covered with listed invasive species
      iv. Public Engagement and Research
         1. Signage, educational displays and benches
         2. Research collaboration with institution
      v. Pollinator Habitat Features
         1. Ground-nesting bee habitat
         2. Edge habitat in with flowering native species
         3. Cavity nesting sites
         4. Constructed pollinator/bird nesting habitat
         5. On-site wetlands or water source(s)

A site that continues to meet the standards for a Pollinator-Smart solar facility in Virginia will be vegetated with a predominance of native species listed on the Solar Site Native Plant Finder and will have adequate documentation of site management activities focused on pollinator habitat.

Reporting requirements are minimal and include the following baseline components: executive summary; site map; vegetation data tables; representative photographs; and, site management documentation.

Table of Contents

Definitions

The Pollinator-Smart program employs a set of terms, methods, and plans that are specific to the solar industry in Virginia. A detailed list of definitions is provided in the Comprehensive Manual; however, there are certain terms used throughout this Monitoring Plan that merit definition because of their unique relevance to the Scorecard. For convenience, definitions for these terms are provided below:

Open Area: Any area beyond the Panel Zone, within the property boundary.

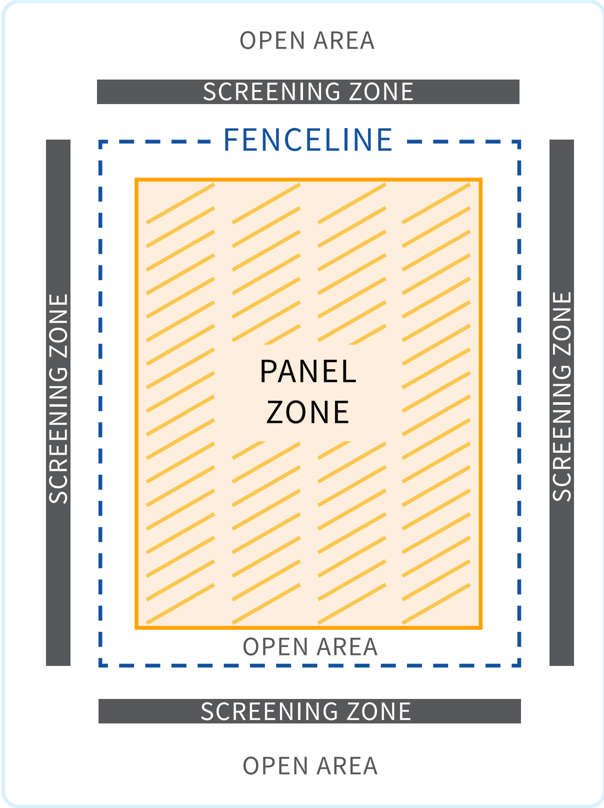
Panel Zone: The area underneath the solar arrays, including inter-row spacing.

Screening Zone: A vegetated visual barrier.

Qualified Professional: A person trained in plant identification, vegetation sampling, and vegetation assessment techniques.

Solar Native Plant Finder: The Virginia Solar Site Native Plant Finder, an online research tool developed by the DCR Natural Heritage Program (link).

Used by Pollinators: Plant species with a "pollinator" designation on the Virginia Solar Site Native Plant Finder.



Introduction

The Virginia Department of Environmental Quality (DEQ) and Department of Conservation and Recreation (DCR) have developed an ecologically-responsible program to encourage pollinator-smart solar energy developments throughout the Commonwealth of Virginia. The program is referred to as the **Virginia Pollinator-Smart Solar Industry** (paraphrased hereafter as "Pollinator-Smart program"), and its overall motivation and purpose are described in detail in the Virginia Pollinator-Smart Solar Industry Comprehensive Manual ("Comprehensive Manual"). For a more concise description, readers can visit the program website at Virginia's Pollinator-Smart Solar Portal.

In Virginia, a "Pollinator-Smart" solar facility is one that meets the goals and objectives of the Pollinator-Smart program. This determination is made through completion of the Virginia Pollinator Smart/Bird Habitat Scorecard ("**Scorecard**"), and the Scorecard also serves as the program's mode-of-entry for solar facilities. Details surrounding the Scorecard concept, including its inception and use in the solar industry, the science behind its development, the states that pioneered its use and functionality, and Virginia's approach to the concept, are provided in the Comprehensive Manual.

Virginia has established two versions of the Scorecard to be used in the following scenarios:

Proposed of Retrofit Solar Sites (Version A)
New solar facilities planned as Pollinator-Smart sites, or existing solar facilities planned to be retrofitted as Pollinator-Smart sites (link)

Established Solar Sites (Version B)
Established solar facilities already approved as Pollinator-Smart sites and being monitored for continued compliance with the Pollinator-Smart program (link)

For the purposes of determining compliance with performance standards, *established sites that have already been designated as Pollinator-Smart must be monitored using methods that will document site-specific conditions and generate the data required to complete the Established Solar Sites Scorecard*. This report outlines the recommended procedures for accomplishing this task in a given monitoring year.

The conceptual framework for the monitoring approach described herein was developed with four concurrent goals in mind: 1) ease of use; 2) repeatability; 3) scientific validity; and, 4) consistency with ecological sampling practice. Other state programs were consulted for general concepts, and these are outlined in the Comprehensive Manual. For field methods specific to documenting vegetation composition and relative dominance, ideas from existing programs within the State of Virginia were incorporated (notably, the DCR Natural Communities of Virginia, the "Mitigation Banking Instrument Template" jointly authored by DEQ and the U.S. Army Corps of Engineers, Norfolk District, and the DCR Rapid Assessment Field Survey for Ecological Community Groups within Proposed Wind Energy Project Areas). Other references used to develop practical monitoring concepts and procedures are cited where appropriate below.

Performance Standards

For *established sites that are being monitored to determine compliance with the Pollinator-Smart program*, ten performance metrics are rated in accordance with the most current version of the Established Solar Sites Scorecard as outlined below. Six of the metrics evaluate establishment of native vegetation communities, and four metrics evaluate site management practices that affect pollinator habitat.

VEGETATION METRICS

PANEL ZONE

1. Percent of overall existing cover in the Panel Zone vegetated with Solar Native Plant Finder species (15 points total)
2. Native grass diversity in Panel Zone (5 points total)

OPEN AREA

3. Percent of overall existing cover within the Open Area vegetated with Solar Native Plant Finder species that are used by pollinators (15 points total)
4. Total number of Solar Native Plant Finder species found within the Open Area (15 points total)
5. Within the Open Area, seasons with at least three (3) Solar Native Plant Finder species in flower (10 points total)

SCREENING ZONE

6. Percent of overall existing cover in the screening area vegetated with Solar Native Plant Finder species (15 points total)

SITE MANAGEMENT METRICS

PLANNING AND MAINTENANCE

7. Site planning and maintenance practices (25 points total)

INVASIVE SPECIES COVER

8. Invasive species risk (-20 points total)

PUBLIC ENGAGEMENT AND RESEARCH

9. Public engagement and research (10 points total)

POLLINATOR HABITAT FEATURES

10. Pollinator/bird nesting habitat on-site (20+ points total)

For facilities already established as Pollinator-Smart sites, performance standards are set by the overall score on the most current version of the Established Solar Sites Scorecard. **A minimum score of 80 must be achieved for a Pollinator-Smart designation, and 100+ points must be reached for Gold Certification.**

Monitoring Methods

The recommended methodology described below will provide the data necessary to fill out the Established Solar Sites Scorecard in a given monitoring year. Methods are divided into two categories: 1) vegetation monitoring; and, 2) site management monitoring. The approaches described under vegetation monitoring are based on existing programs within the Commonwealth as well as ecological sampling principles for vegetation assessment from the scientific literature. The approaches provided for site management involve adequate documentation of re-vegetation management practices used on-site throughout the year.

SAMPLING DESIGN

VEGETATION MONITORING

1 DETERMINE SIZE OF SAMPLING PLOTS

In Herbaceous Habitats: One of the most commonly used plot sizes in herbaceous community sampling is the 1 m^2 (10.8 ft^2) square sampling frame (Mueller-Dombois and Ellenberg 1974, Krebs 1999, Kindt and Coe 2005), although a variety of plot sizes and shapes may be used to assess herbaceous vegetation (Mueller-Dombois and Ellenberg 1974, Krebs 1999). One concern is that the use of smaller plot sizes on larger sites risks higher sample variances, perhaps to the point that an excessively large number of plots would need to be sampled to capture the overall community variability and minimize sample error (Krebs 1999). Alternatively, use of larger plots sizes could minimize this effect with fewer plots, but would require longer search times to adequately evaluate all species within the plot (Kenkel et al. 1989, Kenkel and Podani 1991). For this reason, vegetation ecologists over the years have sought a tradeoff between high variance for small plots and longer sampling times for larger plots. Based on the literature, the **1 m^2 (10.8 ft^2) square quadrat** represents a reasonable compromise for **herbaceous communities**, allowing for cover estimates to be evaluated relatively quickly in the field and still maintain statistical rigor.

In Forested or Scrub-shrub Habitats: In cases where the area is dominated by forested or scrub-shrub species (most often, this will be encountered in the Screening Zone), larger plots will need to be sampled to assess the additional structural complexity of the community. For **forested or scrub-shrub sampling** in the Open Area or Screening Zone, a plot size of **100 m^2 (1076 ft^2)** is recommended based on the standardization of this size in accepted protocols such as the North Carolina Vegetation Survey (Peet et al. 1998) and the National Wetland Condition Assessment (USEPA 2016). In terms of sampling efficiency for woody species (trees and shrubs/saplings), **circular plots** are easiest to lay out in the field (only one reference point is needed at the center), and circles minimize the number of edge decisions because they have the lowest perimeter-to-area ratio. The **radius** for a 100 m^2 (1076 ft^2) circle would be approximately **5.6 m (18.5 ft)**. While a circular plot is the preferred sampling method, if the area to be sampled is not wide enough to accommodate a 37-foot-wide circle, then the plot can be modified into a rectangular shape as long as it still encompasses a 100 m^2 area.

RECOMMENDED PLOT SIZES

Herbaceous Plots: 1 m^2 (10.8 ft^2) quadrat

Woody Plots: 5.6 m (18.5 ft) radius circular plots

2 DETERMINE NUMBER OF SAMPLING PLOTS

To initiate sampling, qualified professionals conducting the sampling must determine *a minimum number of plots* that will provide an initial sample upon which to evaluate sample adequacy (see Step 5 below). Several authors recommend establishing a minimum sample area as a baseline for determining initial plot number (Mueller-Dombois and Ellenberg 1974, Krebs 1999, Gardener 2017).

In Herbaceous Habitats: For homogeneous cover types, the minimum sample area recommended for herbaceous communities is 25 m^2, or 25 plots at 1m^2 per plot (Mueller-Dombois and Ellenberg 1974). This density would likely result in oversampling for smaller sites (e.g., < 5ac); therefore, a recommended plot density for smaller sites is to sample **5 plots per acre for sites up to 5 acres** in size. At this point, the 25 m^2 minimum sample area is achieved. Provided that the sample effort does not cross a community boundary, **25 plots should provide a baseline sample for homogeneous cover types of any size greater than 5 acres**, at which time the data should be evaluated to confirm sample adequacy and determine if additional sampling is needed (see Step 5 below). A list of minimum plots per acre of sample area is provided in Table 1.

Table 1. Minimum number of plots per herbaceous sample area size.

Sample Area (ac.)	Number of Plots
1	5
2	10
3	15
4	20
5+	25

In Forested or Scrub-shrub Habitats: The minimum sample area recommendations for forests is around 500 m^2 (Mueller-Dombois and Ellenberg 1974). At a plot size of 100 m^2, this equates to 1 plot per acre up to 5 acres, at which point the recommended minimum sample area of 500 m^2 is achieved, and the data collected can be assessed to confirm sample adequacy and determine if additional sampling is required (see Step 5 below).

3 DETERMINE LOCATION OF SAMPLING PLOTS

The recommended technique for vegetation monitoring is to use a stratified-random approach. A stratified-random sampling design is one in which the study area is divided into a number of non-overlapping subdivisions (or strata) and samples are randomly selected from each subdivision (Manly 2015, Henderson and Southwood 2016). The benefit of this approach is that investigators are able to sample the plant community in a non-biased manner (due to the randomization component) while also ensuring that the sampling effort adequately covers the entire study site (due to the stratification component) (Mueller-Dombois and Ellenberg 1974, Tiner 2016, Henderson and Southwood 2016).

SAMPLING DEFINED, SAMPLE UNITS, AND ECOLOGICAL SAMPLING THEORY

For most scientific measurements of vegetation communities, a sample is defined as a collection of sample units (SU), the latter of which can be defined as discrete portions of an aggregate (i.e., community) from which repeatable observations can be made (Pielou 1984, Ludwig and Reynolds 1988, Krebs 1999). Sampling is therefore defined as the collection and analysis of data from SUs to make informed assumptions about the overall community (Ludwig and Reynolds 1988).

Ultimately, the purpose of sampling vegetation communities is to develop summary data about the sample based on statistics calculated from measurements or observations of the SUs (e.g., "central-tendency" statistics like arithmetic mean, etc.). Although these summary data represent the sample, they are assumed to also be representative of the overall community as long as certain assumptions of ecological sampling theory are upheld. The most important of these are listed below (Krebs 1999):

1. All SUs should have an equal chance of being selected.
2. The sample (collection of SUs) should not cross community boundaries (i.e., the sample should be taken from a relatively homogeneous cover type).
3. Sample adequacy should be demonstrated (see discussion below).

If the above assumptions are met, a sample (and its associated statistical derivations) can be said to represent the underlying community with respect to the measurements or observations collected in the field. Vegetation sampling strategies are conformable to the above criteria as long as locations of SUs are randomized, the site is "stratified" (i.e., divided) by planting zone or community type with respect to sample area (see Stratification), and sample adequacy is evaluated via the species-area relationship or equivalent technique (see discussion below).

STRATIFICATION

Using a stratified-random sampling technique on Pollinator-Smart solar sites in Virginia, sites are initially divided into the three zones based on the definitions provided above: Panel Zone, Open Area, and Screening Zone. Each zone will be considered one "sample area," but zones may be further subdivided into unique community types if necessary (see discussion on sample adequacy in Step 5 below).

Plot locations are then determined using a randomization approach. Examples of randomization procedures are provided below.

Randomization Procedure #1 – Baseline/ Transect Approach

1. Within each sample area, establish a baseline along one edge. Subdivide the baseline into equal segments (a second "stratification"). The segments may be any size but should be spaced in a manner that will allow the minimum number of plots to be sampled (see discussion on minimum plot number above), taking into account the plot size and shape.
2. Within each segment, locate a single random point along the baseline. Random points are determined using a random numbers generator and setting the minimum value at 1 and the maximum value at the overall length of the segment.
3. From the random baseline point within each segment, establish a sampling transect perpendicular to the baseline extending across the width of the sample area.
4. Along each transect within each segment, determine the locations of sampling plots using the same randomization procedure described above but taking the overall transect length as the maximum value for the random numbers generator. The number of plots per transect will vary depending on the overall length of each transect and the total minimum number of plots required for the site.

Randomization Procedure #2 – GIS

1. Once the site has been stratified into separate vegetation zones, most GIS-based applications have a random point generator function that allows users to establish a pre-determined number of random points within a polygon or

feature in GIS. Taking this approach, determine the number of points needed within each zone (stratum) and have the GIS application randomly select locations for the points.

2. The GIS technique carries the risk that the randomization procedure will inadvertently cluster sampling points without having plots "spread out" across the zone as in the baseline/transect approach above. One solution to this problem is to subdivide the zone into equal segments as describe above and subject each segment to the GIS random point routine.

Using either approach outlined above, investigators can complete a desktop assignment of random plots within a selected area prior to fieldwork. This information can be incorporated into a data collection platform using mobile technology coupled with GPS receivers, which can then be used to wayfind to the location of each point while sampling. This type of approach allows investigators to accommodate a stratified-random sampling design while alleviating the need to lay out baselines and transects. An example of a stratified-random approach is provided in Appendix A.

Once the plots have been laid out, sampling proceeds based on a predetermined minimum plot density, and sample adequacy is assessed (see Step 5 below). If the sample for each zone is determined to be inadequate, plots are added until sample adequacy is achieved.

4 SAMPLE EACH PLOT

TIMING OF YEAR AND SAMPLING LEVEL-OF-EFFORT

It is recommended that vegetation sampling be performed during peak growing season, which corresponds to the mid- to late-summer months in the mid-Atlantic region (DeBerry and Perry 2004).

The benefit of a peak growing season sampling window is that it allows reviewers to observe the site when aboveground biomass accumulation and plant species richness are expected to be highest. One concern is that certain spring-flowering species could be missed during a mid- to late-summer site visit; however, in most cases, early flowering species are identifiable from vegetative organs (e.g., leaves, stems, roots), and many of Virginia's spring-flowering species have persistent fruits that may be used for identification later in the summer (Weakley et al. 2012).

Using the 1 m^2 plot size in combination with a cover class scale, the average time to estimate cover for all species within a plot should be less than 10 minutes, which would allow a professional to complete approximately 6+ plots per hour or around 50 plots per day. In addition, experience has shown that even though the woody species plots are larger, the time investment is approximately the same. Alternatively, we estimate that a team of two or more professionals could increase sampling efficiency by 25-50%.

VEGETATION MONITORING

All species present within plots should be identified to species level (or subspecific taxon, if applicable). It is recommended that species nomenclature follow the *Flora of Virginia* (Weakley et al. 2012), the most current version of which is accessible via the Flora of Virginia App. For each species in the plot, **percent cover** will be estimated and recorded. For this purpose, a **cover class scale** is recommended, because it allows percent cover to be estimated based on ranges of cover values that are easily perceived in the context of a square herbaceous plot or a circular woody species plot. Using this approach, the midpoints of the classes are recorded for analysis (for non-integer midpoints, cover classes are rounded to the nearest whole integer). **Cover estimates are then averaged across the zone** to develop relative cover values (i.e., the percentage of the total cover across the entire zone that each species comprises; see example,

Appendix C). Once this is calculated, questions on the scorecard that relate directly to percentage may be answered based on the composition of the species and the relative cover values. Qualified professionals conducting the analysis should also treat any area of exposed soil within the plot as "bare ground" and assign a cover value.

A simple cover class scale that would be appropriate for herbaceous vegetation is shown in Table 2 below.

Table 2. Modified Daubenmire Cover Class Scale (Mueller-Dombois and Ellenberg 1974).

Cover Class ID	Percent Cover Range (%)	Cover Class Midpoint (%)
1	0-1%	1
2	1-5%	3
3	5-25%	15
4	25-50%	38
5	50-75%	63
6	75-95%	85
7	95-100%	98

In addition to species identification, plot cover estimates, and relative cover calculations, qualified professionals conducting the sampling will need to document the following characteristics of each species encountered on-site in order to complete the vegetation community questions on the Scorecard:

1. Virginia Solar Site Native Plant Finder classification status, if applicable (i.e., pollinator species, warm-season grass, etc.);
2. native/non-native status;
3. invasive/nuisance species status; and,
4. reproductive phenology (seasonal timing of flowering).

Information on all of these characteristics is anticipated to be made available on the Solar Native Plant Finder, with portions currently under development. Solar Native Plant Finder classification status is already available online. Native/non-native status (and species-by-county distribution) can also be found in the Flora of Virginia (available hard copy or digital app) or on the Digital Atlas of the Virginia Flora. A list of invasive species that occur in Virginia is provided on the Virginia Natural Heritage Program website. Reproductive phenology is in the Flora of Virginia. For ease of use, a Virginia Pollinator-Smart Rapid Assessment Form has been developed and is available in Appendix B. In addition, an example of a completed vegetation data table is provided in Appendix C.

5 CONFIRM SAMPLING ADEQUACY HAS BEEN REACHED

Once the initial plot sampling has been completed, sample adequacy should be evaluated using an approach that demonstrates adequate coverage of the vegetative community. Sample adequacy is most frequently evaluated using the species-area relationship (Scheiner 2003), though other methods can be used (e.g., standard error ≤ 10% of the mean, McCune and Grace 2002). In species-area analyses, the cumulative total number of species is tracked as plots are sampled, and professionals conducting the sampling develop a graph with cumulative species richness (total number of species) on the Y-axis and cumulative area sampled on the X-axis (which can be approximated by cumulative number of plots). The curve generated by this approach is an example of a "**species-area curve**," and it is considered to be stabilized when the curve flattens out toward the top right-hand side (as if to approach an upper asymptote). In practice, the inflection point of the curve is used to approximate an adequate sample size for vegetation research (McCune and Grace 2002). During sampling, scientists create a species-

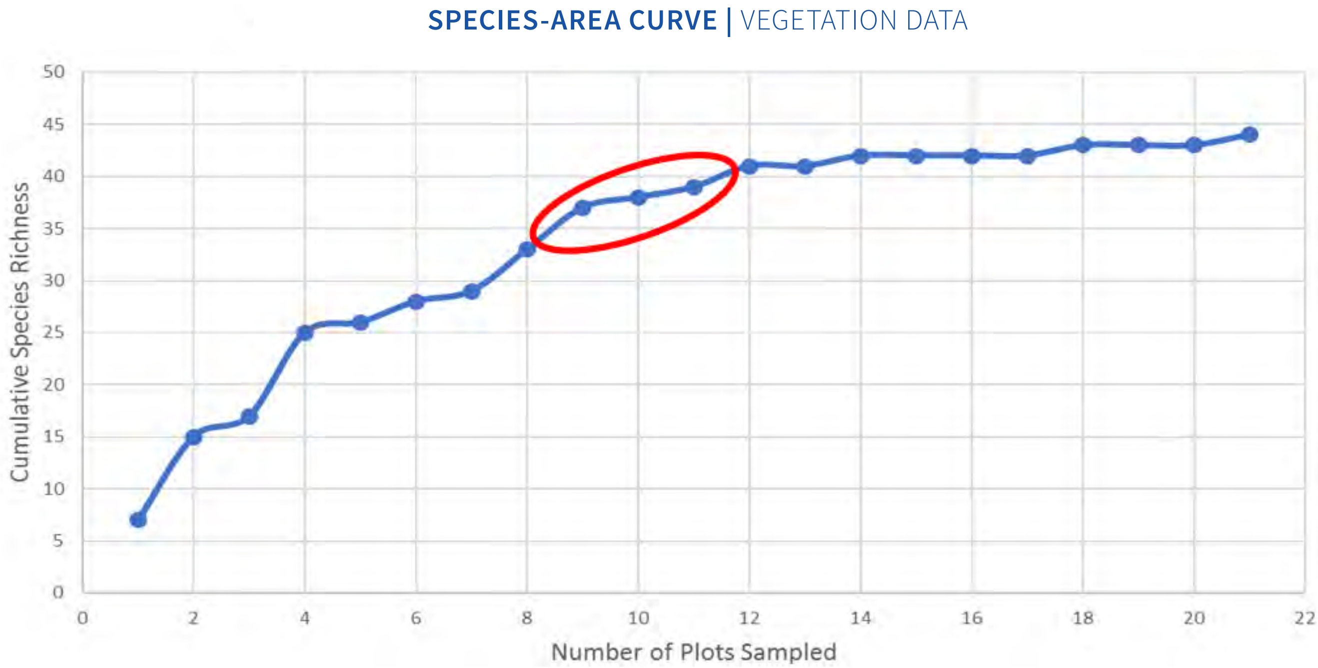


Figure 1. Species-area curve plotted on a simple line graph with markers created in Excel. This graph is easily interpreted as leveling off in the upper half, suggesting that a sample size of 9-11 plots represents the minimum adequate number of sample units for this site (corresponding to the inflection point on the graph shown by the red circle).

area curve after the initial sampling effort (the initial number of plots can be estimated from the literature; see Initial Plot Density below). By entering cumulative species richness and plot number into a simple graphing program (Excel, etc.), a species-area curve can be generated "on the fly" as a simple scatterplot/trendline graph and interpreted in the field, and scientists can add plots as necessary until the curve stabilizes. An example of a species-area curve generated for data collected on a mid-Atlantic region native meadow restoration project is shown in Figure 1.

If the Curve Doesn't Stabilize: On sites with high species richness, it is possible that the species-area curve will not flatten out to the right after completing the minimum number of sample plots. When this occurs, random plots should be added to each stratum (zone or subdivision) until the curve levels off.

"Stairstep" Curves: In other cases, the species-area curve may produce a "stairstep" pattern such as the one show in Figure 2. A stairstep pattern typically means that the species-area phenomenon has been tracked across community boundaries. When this occurs, professionals conducting the sampling should re-stratify the site into discrete, homogeneous cover types and re-sample using the stratified-random approach described above. In most cases, plots already sampled may be retained in the data sets for the remapped community types.

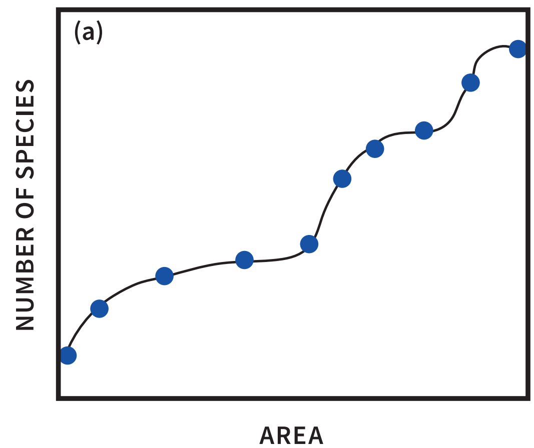


Figure 2: "Stairstep" species-area curve. From Scheiner (2003).

6 ESTABLISH PERMANENT PHOTO STATIONS AND PHOTO-DOCUMENT SITE

Permanent photostations should be established within each of the three zones, and representative photographs of the developing vegetation should be taken in each monitoring year. For smaller vegetation zones, one photostation per acre is recommended up to 5 acres. For larger zones, a minimum of five photostations should be established across the zone, distributed in a manner that will allow adequate spatial coverage. Photographs should be taken from the same height and direction for year-to-year comparisons.

7 CONDUCT SITE MANAGEMENT MONITORING

Most of the site management documentation required to complete the Established Solar Sites Scorecard can be compiled as management activities are completed on-site. Records and photographic evidence of the re-vegetation implementation sequence including site prep, initial planting, supplemental overseeding, habitat enhancement, public engagement and research, and invasive or nuisance species management can be recorded in the form of activity logs and/or site photographs. These documents can be sourced from the planting contractor, the solar site manager, or an environmental consultant.

8 MAP INVASIVE AND/OR NUISANCE SPECIES

In addition to site management documentation, invasive and/or nuisance species mapping is recommended annually. This includes documenting any dominant zones of non-native invasive species listed on the Virginia Invasive Plant Species List (Heffernan et al. 2014) as well as any site-specific nuisance species identified during the site suitability analysis or vegetation management planning phases of the project. The distribution of invasive/nuisance species should be shown on a scaled, spatially-correct plan view map of the site, with the total area for each species expressed in acres and percentage of the total study area.

Reporting

Because the site-level documentation described in this monitoring plan is ultimately intended to support completion of the Established Solar Sites Scorecard, reporting should be considered supplemental information to the Scorecard and should be concise and easily searchable. The format presented in Appendix C is recommended for the vegetation data. At a minimum, the report should include:

☑ **Executive Summary**

Short (1-page) narrative summarizing monitoring results

☑ **Map**

Scaled, spatially-correct plan view of the site showing the following:

- Project boundary
- Vegetation zones (acres identified)
- Vegetation plot locations (including transects, if used in plot layout)
- Permanent photostations
- Invasive/nuisance species polygons (acres and percentage identified)
- Pollinator habitat features (if relevant)

☑ **Vegetation data**

Presented in tabular format

☑ **Representative photographs**

☑ **Site management documentation**

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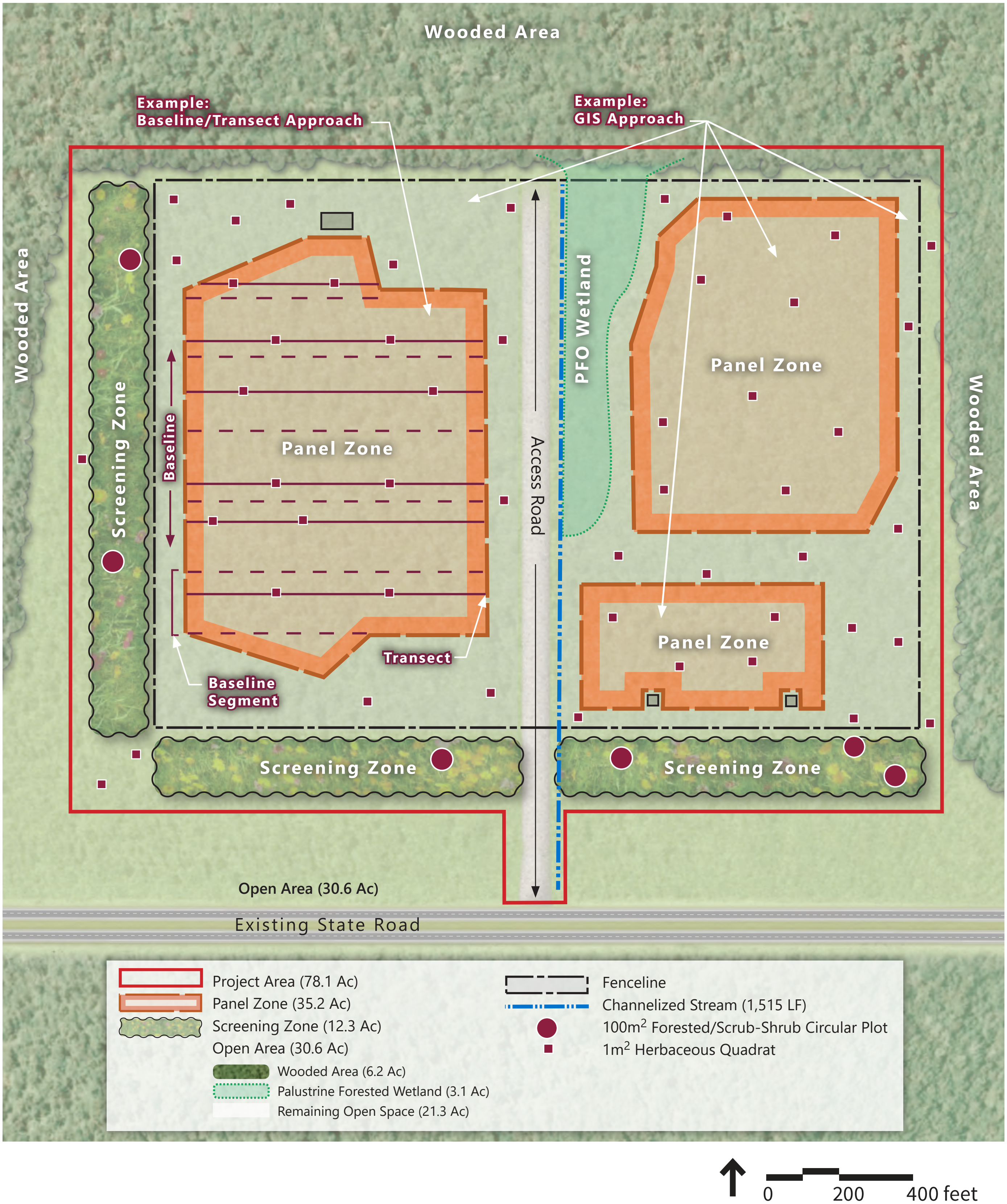
Appendix A

Example of Stratified-Random Study Design

Virginia Pollinator-Smart Solar Industry

EXAMPLE OF STRATIFIED-RANDOM STUDY DESIGN



Appendix B

Virginia Pollinator-Smart Rapid Assessment Form

COMPLETE THIS PAGE FOR EACH SAMPLING PLOT

GENERAL INFORMATION

Plot Code/Identifier:	Project:
Zone:	Surveyors:
Date:	

COMMUNITY NAME

OBSERVATION AREA *[100 m² circular plot recommended for woody plants; 1 m² plot recommended for herbaceous species]*

Circle of radius m; or m by m; or area =

PLOT DOCUMENTATION	GPS DATA *[Decimal Degrees]*
# of Photos: ☐ No Photos Taken	GPS Unit: GPS Datum:
Photo Descriptions:	LAT: LONG:

GENERAL NOTES

USE THIS PAGE TO ASSESS SAMPLING ADEQUACY ON-THE-FLY

SPECIES AREA CURVE

NUMBER OF PLOTS SAMPLED

CUMULATIVE SPECIES RICHNESS

SPECIES COMPOSITION AND ABUNDANCE

List all plant species within your observation area and indicate relative abundance.

PLOT ID:

Zone: *[P = Panel, S = Screen, O = Open Area]*														
Habitat: *[H = herbaceous, SS = scrub-shrub, F = forested, W = wetland, O = other*]*														
Ground														
% Bare Ground														
% Rock														
Taxon														

SPECIES COMPOSITION AND ABUNDANCE

List all plant species within your observation area and indicate relative abundance.

PLOT ID:

Zone: *[P = Panel, S = Screen, O = Open Area]*														
Habitat: *[H = herbaceous, SS = scrub-shrub, F = forested, W = wetland, O = other*]*														
Ground														
% Bare Ground														
% Rock														
Taxon														

Appendix C

Completed Vegetation Data Table

VEGETATION MONITORING DATA

Sample Solar Site Facility | Establishment Year 2 (2019)

					PANEL ZONE														
SCIENTIFIC NAME	COMMON NAME	SPF?	FLOWERING PERIOD*	INV SPP	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
Bare Ground						15.0										0.5			
Achillea millefolium	Common Yarrow	Y	S, ES, LS, F						15.0										
Amaranthus hybridus	Slender Pigweed	N	N/A																
Ambrosia artemisiifolia	Annual Ragweed	Y	LS, F		15.0	63.0	38.0			63.0	38.0	3.0	38.0	85.0	15.0	63.0	15.0	38.0	38.0
Andropogon virginicus	Broom-Sedge	Y	N/A			38.0			38.0		0.5	15.0		3.0					63.0
Apocynum cannibinum	Indian Hemp	Y	S, ES, LS																
Bromus racemosus	Bald Brome	N	N/A																
Cirsium arvense	Canadian Thistle	N	N/A	✓		15.0													
Conyza canadensis	Horseweed	Y	ES, LS, F		15.0		63.0	15.0			63.0	3.0	15.0	38.0	15.0	38.0	38.0	38.0	
Dactylis glomerata	Orchard Grass	N	N/A		0.5														38.0
Daucus carota	Queen Anne's-Lace	N	N/A																
Dichanthelium clandestinum	Deer-Tongue Rosette Grass	Y	N/A																
Dichanthelium dichotomum	Cypress Rosette Grass	Y	N/A														38.0		
Digitaria ciliaris	Southern Crab Grass	N	N/A																
Digitaria ischaemum	Smooth Crabgrass	N	N/A			15.0													
Eragrostis hirsuta	Big-top Lovegrass	Y	N/A				3.0												
Eragrostis spectabilis	Purple Lovegrass	Y	N/A																
Eupatorium capillifolium	Dog-Fennel	Y	LS, F						3.0		38.0					3.0	3.0		
Juncus effusus	Lamp Rush	Y	N/A																
Juncus tenuis	Lesser Poverty Rush	Y	N/A						3.0			0.5							
Lespedeza cuneata	Chinese Bush-Clover	N	N/A	✓			15.0		15.0										
Lespedeza frutescens	Shrubby Lespedeza	Y	ES, LS, F						15.0										
Lespedeza procumbens	Trailing Lespedeza	Y	ES, LS, F						63.0										15.0
Lespedeza repens	Creeping lespedeza	Y	S, ES, LS, F																
Lobelia inflata	Indian-tobacco	Y	ES, LS, F																
Lonicera japonica	Japanese Honeysuckle	N	N/A	✓								0.5							
Oxalis stricta	Upright Yellow Wood-Sorrel	Y	S, ES, LS, F			3.0											3.0		
Panicum virgatum	Wand Panic Grass	Y	N/A							38.0									
Persicaria longiseta	Bristly Lady's Thumb	N	N/A	✓															
Physalis heterophylla	Clammy Ground-Cherry	Y	S, ES, LS												3.0				
Phytolacca americana	American Pokeweed	Y	S, ES, LS, F																
Plantago lanceolata	English Plantain	N	N/A									3.0					0.5		
Potentilla indica	Indian-Strawberry	N	N/A																
Pseudognaphalium obtusifolium	Sweet Everlasting	Y	LS, F											3.0		3.0	3.0	3.0	
Rubus flagellaris	Whiplash Dewberry	Y	S, ES																
Rubus pensilvanicus	Pennsylvania Blackberry	Y	S, ES						3.0			0.5						3.0	
Rudbeckia hirta	Black Eyed-Susan	Y	S, ES, LS						0.5	3.0	3.0								
Schedonorus arundinaceus	Tall False Rye Grass	N	N/A																

VEGETATION MONITORING DATA *CONT...*

Sample Solar Site Facility | Establishment Year 2 (2019)

SCIENTIFIC NAME	COMMON NAME	SPF?	FLOWERING PERIOD*	INV SPP
Solanum carolinense	Carolina Horse-Nettle	Y	S, ES, LS	
Solanum ptycanthum	Eastern Black Nightshade	Y	S, ES, LS, F	
Solidago altissima	Tall Goldenrod	Y	LS, F	
Solidago rugosa	Rough-leaved Goldenrod	Y	LS, F	
Stellaria media	Common Chickweed	N	N/A	✓
Symphoricarpos orbiculatus	Coral-Berry	Y	N/A	
Symphyotrichum lateriflorum	Farewell-Summer	Y	LS, F	
Taraxacum officinale	Common Dandelion	N	N/A	
Thlaspi arvense	Field Pennycress	N	N/A	
Tridens flavus	Tall Redtop	Y	N/A	
Trifolium arvense	Rabbit-foot Clover	N	N/A	
Trifolium repens	White Clover	N	N/A	
Ulmus rubra	Slippery Elm	Y	N/A	
Verbascum thapsus	Great Mullein	N	N/A	
Verbena brasiliensis	Brazilian Vervain	N	N/A	

SCIENTIFIC NAME	PANEL ZONE														
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
Solanum carolinense								15.0			38.0				
Solanum ptycanthum															
Solidago altissima				38.0	3.0			15.0				15.0			
Solidago rugosa															
Stellaria media															
Symphoricarpos orbiculatus															
Symphyotrichum lateriflorum															
Taraxacum officinale	7.5														
Thlaspi arvense								0.5						15.0	
Tridens flavus			38.0												
Trifolium arvense										15.0					
Trifolium repens	63.0		38.0	38.0		15.0	15.0	38.0	86.0	15.0	63.0	3.0	63.0	38.0	
Ulmus rubra	0.5	15.0		0.5	0.5								0.5	3.0	
Verbascum thapsus			15.0					38.0		3.0			15.0		
Verbena brasiliensis				63.0								15.0			

% Cover of Solar Native Plant Finder Species	**99.6**
Total Number of Native Plant Finder Species	**20**
Total Number of Native Grass Species	**5**
% Cover of Invasive Species	**3**
% Cover of Fescue	**0**
Flowering Phenologies	**S= 6, ES=9, LS=11, F=9**

***S=Spring, ES=Early Summer, LS=Late Summer, F=Fall**

VEGETATION MONITORING DATA *CONT...*

		OPEN AREA									SCREENING ZONE											
SCIENTIFIC NAME	**COMMON NAME**	**O1**	**O2**	**O3**	**O4**	**O5**	**O6**	**O7**	**O8**	**O9**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**
Bare Ground																			15.0			
Achillea millefolium	Common Yarrow												0.5						3.0			
Amaranthus hybridus	Slender Pigweed										63.0	63.0										
Ambrosia artemisiifolia	Annual Ragweed	15.0			38.0	63.0	38.0	38.0	63.0	38.0											15.0	
Andropogon virginicus	Broom-Sedge	3.0				3.0	15.0		15.0	15.0			15.0		15.0					3.0		15.0
Apocynum cannibinum	Indian Hemp						15.0															
Bromus racemosus	Bald Brome						0.5		3.0	38.0												
Cirsium arvense	Canadian Thistle																		15.0		15.0	
Conyza canadensis	Horseweed	85.0	15.0	63.0	63.0	38.0		38.0	15.0					63.0	38.0	63.0	63.0	63.0	63.0		38.0	
Dactylis glomerata	Orchard Grass						15.0								15.0			15.0				15.0
Daucus carota	Queen Anne's-Lace												15.0									
Dichanthelium clandestinum	Deer-Tongue Rosette Grass																15.0					
Dichanthelium dichotomum	Cypress Rosette Grass															3.0	3.0					
Digitaria ciliaris	Southern Crab Grass										63.0											
Digitaria ischaemum	Smooth Crabgrass					38.0	15.0		38.0	63.0												
Eragrostis hirsuta	Big-top Lovegrass			38.0								15.0										
Eragrostis spectabilis	Purple Lovegrass								15.0													
Eupatorium capillifolium	Dog-Fennel				3.0	0.5							0.5	15.0				15.0	3.0	3.0		38.0
Juncus effusus	Lamp Rush																			38.0		
Juncus tenuis	Lesser Poverty Rush			3.0	3.0				0.5												3.0	15.0
Lespedeza cuneata	Chinese Bush-Clover																					
Lespedeza frutescens	Shrubby Lespedeza																					
Lespedeza procumbens	Trailing Lespedeza																					
Lespedeza repens	Creeping lespedeza												15.0			3.0					3.0	
Lobelia inflata	Indian-tobacco			3.0										15.0								
Lonicera japonica	Japanese Honeysuckle												38.0									
Oxalis stricta	Upright Yellow Wood-Sorrel					3.0	0.5		3.0													15.0
Panicum virgatum	Wand Panic Grass																					
Persicaria longiseta	Bristly Lady's Thumb				15.0																	
Physalis heterophylla	Clammy Ground-Cherry																					
Phytolacca americana	American Pokeweed										38.0						38.0					
Plantago lanceolata	English Plantain																	15.0				
Potentilla indica	Indian-Strawberry																		15.0			
Pseudognaphalium obtusifolium	Sweet Everlasting				15.0					15.0										3.0	15.0	
Rubus flagellaris	Whiplash Dewberry												15.0			15.0	15.0					
Rubus pensilvanicus	Pennsylvania Blackberry	15.0																	0.5			
Rudbeckia hirta	Black Eyed-Susan														63.0						15.0	
Schedonorus arundinaceus	Tall False Rye Grass									15.0			38.0									

VEGETATION MONITORING DATA *CONT...*

		OPEN AREA									SCREENING ZONE											
SCIENTIFIC NAME	**COMMON NAME**	**O1**	**O2**	**O3**	**O4**	**O5**	**O6**	**O7**	**O8**	**O9**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**
Solanum carolinense	Carolina Horse-Nettle												3.0				38.0					3.0
Solanum ptycanthum	Eastern Black Nightshade	38.0																				
Solidago altissima	Tall Goldenrod											15.0		15.0			15.0					
Solidago rugosa	Rough-leaved Goldenrod		15.0			0.5	38.0															
Stellaria media	Common Chickweed	63.0																				
Symphoricarpos orbiculatus	Coral-Berry						15.0															
Symphyotrichum lateriflorum	Farewell-Summer	15.0																				
Taraxacum officinale	Common Dandelion					3.0				3.0		3.0		15.0				3.0			15.0	
Thlaspi arvense	Field Pennycress																					
Tridens flavus	Tall Redtop				0.5				15.0						15.0							15.0
Trifolium arvense	Rabbit-foot Clover																					
Trifolium repens	White Clover	15.0	98.0	38.0	85.0			85.0		38.0		15.0		15.0	15.0					85.0	15.0	38.0
Ulmus rubra	Slippery Elm							3.0	15.0													
Verbascum thapsus	Great Mullein	18		3.0	15.0			15.0								15.0		3.0	38.0		3.0	
Verbena brasiliensis	Brazilian Vervain																					
% Cover of Solar Native Plant Finder Species		**105.4**									**84.3**											
Total Number of Native Plant Finder Species		**18**									**22**											
Total Number of Native Grass Species		**4**									**5**											
% Cover of Invasive Species		**8.7**									**5.7**											
% Cover of Fescue		**1.7**									**3.2**											
Flowering Phenologies		**S= 3, ES=6, LS=10, F=9**									**S= 8, ES=10, LS=11, F=10**											

***S=Spring, ES=Early Summer, LS=Late Summer, F=Fall**

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