

Critical Review of the Dewberry Report

Vasilis Fthenakis

December 12, 2018

The Dewberry Engineers Inc. memo to Ms. Wanda Parrish, AICP, Director, County of Spotsylvania, dated November 2018, report cites several of my studies but some of its conclusions contradict the cited studies. Below I highlight these contradictions.

I. On setback distances

The Dewberry report recommends 350 ft setbacks from the properties of Fawn Lake and they state that such is “matching the results in reference (3)”. Ref 3 is a paper I wrote “Analysis of the Potential for a Heat Island Effect in Solar Farms”ⁱ but I did not mention anything about necessary setbacks. Perhaps Dewberry misinterpreted the field data I listed indicating that the heat build-up from the plant would have been effectively dissipated within a distance of 100 m (328 ft) from the perimeter of a large solar farm, as temperature at such distance has approached the ambient within 0.45 C (1 °F). However, these data corresponded to maximum mean temperature differences that may occur for only a few hours. Also the Sarnia solar farm, from where I obtained the data, did not have any trees in its perimeter, whereas the proposed Spotsylvania solar farm would have a buffer zone with trees and bushes that would enhance heat dissipation and will result to a faster temperature decline around the perimeter of the plant. Overall I do not believe that there is a justification for a 350 ft setback distance from residential properties. Another misinterpretation of my paper in the Dewberry report is the quotation that “temperatures return to ambient at 60 ft (18.7 m) above the panels”. Again, this corresponds to a maximum; actually my simulations showed that the thermal energy emitted from the panels completely dissipates to the environment at heights of 5 m to 18 m. In addition, the Dewberry report did not site my major conclusion that ‘analysis of 18 months of detailed data showed that in most days, the solar array was completely cooled at night and is unlikely that a heat island effect could occur’. In summary, I have not offered any suggestions for setbacks; for such I am referring to Solar Ordinance Guides that specify setbacks of up to 100 ft. For example, the comprehensive Georgia Solar Ordinance Guide “Best practices for setbacks from large and intermediate systems”ⁱⁱ specifies:

- 15-50 feet setbacks from property lines or roads for solar energy systems in commercial, industrial, and agricultural districts;
- 15-100 feet setbacks from property lines or roads for solar energy systems in residential districts;
- Specify larger setbacks from residences, ranging between 50-100 feet; (p. 45).

It is noted that the Georgia Solar Model is a most recent (2018) Guide of Solar Zoning Ordinance and it references Solar Ordinances in the States of California, Delaware, Massachusetts, Minnesota, North Carolina, Florida, New Jersey, New York, Texas, Utah and Virginia (pp. 3-4). None of these Ordinances requires setbacks larger than 100 ft from property lines in residential districts.

II. On the potential for a heat island effect

The Dewberry report cites six research papers on the heat island effect; five of them showed that solar farms do not cause a heat island effect whereas one showed an effect. I discuss the later in the last section of this report.

As discussed in my initial report for sPower, based on my studies and the review of other studies, I believe that a “heat island effect” would not happen in the considered north Virginia solar installation. Heat build-up quickly dissipate with height and distance from a solar park, and would not be felt at the surrounding community.

In essence the Dewberry report agrees with my assessment as shown from statements quoted below:

“Panels have low thermal mass as compared to soils, meaning that they do not retain heat very well. They will lose heat quickly, so a prolonged sense of heat will not be carried out into the evening and night time. This will not create a consistent increase in temperature of the area which would suggest a micro-climate.”

“Dewberry previously conducted a study on the impact of a solar farm on local heating on a project in Washington, NJ. The following was observed: Temperatures were several degrees higher directly above the panels within the solar farm. Temperature decreased to ambient at the perimeter of the solar farm.”

III. On decommissioning at the end-of-life

I feel that a decommissioning and recycling plan is imperative for the sustainability of large PV growth, as recycling of the materials from PV modules and the balance of system (BOS) not only protects the environment but would also result to recovery of valuable materials (e.g., Ag, Te, In, Al, glass). However, I think that requiring a fine level of detail (e.g., type of equipment, storing locations, etc.) is both unreasonable and illogical as so many conditions and options would have changed in 30-35 years when decommissioning would be needed. Any decommissioning plan requirement should have a built-in flexibility. For example, the Georgia Model Solar Zoning Ordinance Guide (2018)ⁱⁱ, offers the following insights regarding decommissioning. “When a decommissioning plan is required, it should not be extensive. A few pages answering the required considerations may be sufficient. The Georgia Model Solar Ordinance requires a decommissioning plan that identifies who is responsible for decommissioning, when decommissioning must happen, the structures to be removed, how materials will be recycled or reused, how the land will be restored, and the timeline for decommissioning.” (pp. 62-63)

The same Ordinance Guide states that “A county or city should avoid requiring decommissioning bonds. But, if a county or city feels strongly otherwise, the bond should only be required for the largest solar energy systems and the county or city should consider not requiring the bond be posted until at least 5 or 10 years after the start of the system” (p.44).

IV. On CdTe PV modules

The Dewberry reports states: “Cadmium telluride drawbacks: 1. Lower efficiency levels: Cadmium telluride solar panels currently achieve an efficiency of 10.6%, which is significantly lower than the typical efficiencies of silicon solar cells. 2. Tellurium supply”.

It seems that Dewberry used 10 yrs old numbers for panel efficiency. The efficiency of current generation CdTe is 17.5 %, much higher than the stated 10.6%. Also although Te is not abundant, copper production generates enough Te to reach two million MW (2 TW) cumulative deployment by mid-century^{iii, iv}.

V. Comments on documents cited by Dewberry.

- a) Dr. Clinton Andrews Memos dated 9/9/2012 and 9/25/2012 (Ref. 6 in Dewberry report). I completely agree with Dr. Andrews assessment. He noted that grasses thrive underneath solar panels during hot summer months and that solar panels have a very small thermal mass and, therefore, they do not retain heat for long, as urban structures do. He took temperature measurement during a sunny summer afternoon in the middle and at the edges of a solar farm in New Jersey and performed standard heat transfer and engineering calculations. Based on his observations, measurements and calculations, he concluded that “a solar farm is unlikely to cause significant local heating that may adversely affect neighboring households or farms”.
- b) Barron- Gafford et al. (2016) (Ref. 2 in Dewberry report) temperature measurements within the University of Arizona (UA) Science and Technology Park Solar Zone (latitude of 32° N) that contrasted all other studies; I reached out to them about a year ago asking for background information, but I did not receive any response. At this point I can only hypothesize that the differences between their findings and those of all other investigators enact from the very dry and low wind conditions in their bare ground location that is surrounded by buildings, not plants. I note that the climate in Tucson, AZ is very different than that of Spotsylvania, Virginia and that the Solar Zone in the UA lacks vegetation, is exposed to high ambient temperatures and dry air, all conditions that do not allow effective cooling.

ⁱ Fthenakis V. and Yu Y., Analysis of the Potential for a Heat Island Effect in Solar Farms”, 39 IEEE PV Specialists Conference, 3362-33226, 2013.

ⁱⁱ The Georgia Model Solar Zoning Ordinance Guide, Version 1.0, July 2018 http://www.energy.gatech.edu/sites/default/files/documents/2018-07-30_mso_guide_final.pdf

ⁱⁱⁱ Fthenakis V.M., Sustainability of photovoltaics: The case for thin-film solar cells, Renewable and Sustainable Energy Reviews, 13, 2746-2750, 2009.

^{iv} Fthenakis V.M., Sustainability metrics for extending thin-film photovoltaics to terawatt levels. MRS Bulletin, 37(4), 425-430, 2012



INITIAL PROJECT DECOMMISSIONING AND SITE RESTORATION PLAN
Spotsylvania Solar Energy Center
12/13/18

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1.0 INITIAL PROJECT DECOMMISSIONING AND SITE RESTORATION PLAN

1.1 Introduction

The Spotsylvania Solar Energy Center (Project) is a 500-Megawatt (MW) photovoltaic (PV) solar project located in western Spotsylvania County, Virginia. The Project Site consists of three non-contiguous boundaries that encompass approximately 6,350 acres, of which approximately 3,500 acres are developed for the Project. The Project is anticipated to operate for 35 years.

The Project will operate under a Special Use Permit with Spotsylvania County. Following the life of the Project, a decision would be made to extend the life of the Project or to decommission the Project. If the Project is decommissioned, Sustainable Power Group (sPower) or its successor in interest will be responsible for the removal, recycling, and disposal of all solar arrays, inverters, transformers and other structure on the Project site, depending upon the proposed future use of the Project site. sPower anticipates using the best available recycling measures at the time of decommissioning.

1.2 Existing Land Use

The current and historic land use for the Project Site is silviculture. The area surrounding the Project site also include silviculture with limited agriculture and scattered single-family residences.

1.3 Proposed Land Use

The Project is being developed to provide clean, renewable energy to corporate off-takers. The Project consists of a 3,500-acre, 500 MW alternating current (AC) solar energy facility. All parcels within the Project site will be purchased by sPower or its Transferee.

The Project will involve installation of various facilities, such as ground-mounted solar arrays, switchyard, inverters, electrical conduits, foundations, and an operations and maintenance facility. The majority of the foundations and electrical conduits will be located underground.

1.4 Objectives

This Decommissioning Plan was developed per Section 23-4.5.7 of Spotsylvania County Ordinance No. 23-173. The Decommissioning Plan ensures that if the Project is decommissioned, the site restoration will be accomplished in a way this is environmentally sound, safe, and protects the public health and safety. Decommissioning is a general term used to describe a formal process to remove something from active status whereas restoration objectives aspire to return the land to some degree of its former state, after some process has resulted in its disturbance.

Future conditions that could affect decommissioning are largely unknown at this time; however, the best available technologies and management practices will be deployed to ensure successful project decommissioning and site restoration.

To ensure that decommissioning will be completed in a manner that is environmentally sound, safe, and protects public health and safety, sPower or its successor in interest will submit a Final

Plan for Project Decommissioning to Spotsylvania County for review and approval before the Project's decommissioning begins. Overall, the plan will include a discussion of:

- Proposed decommissioning activities for the Project and all appurtenant facilities that were constructed as part of the Project;
- The activities necessary to restore the Project site if the plan requires removal of equipment and appurtenant facilities; and
- Decommissioning alternatives at the time of final decommissioning.

Satisfying the above requirements should serve as a safeguard, even in the unlikely event that the Project is abandoned.

1.5 Project Decommissioning

When the Project reaches the end of its operational life, the component parts will be dismantled and recycled. All waste resulting from the decommissioning of the facility will be transported by a certified and licensed contractor and taken to a landfill/recycling facility in accordance with all local, State, and federal regulations.

The Initial Project Decommissioning Plan for the project site will include the following:

- The facility will be disconnected from the utility power grid.
- Individual PV panels will be disconnected from the on-site electrical system.
- Project components will be dismantled and removed using conventional construction equipment and recycled or disposed of safely.
- Individual PV panels will be unbolted and removed from the support frames and carefully packaged for collection and return to a designated recycling facility for recycling and material re-use.
- Electrical interconnection, transmission, and distribution cables will be removed and recycled offsite by an approved recycling facility.
- PV Panel support steel and support posts will be removed and recycled off-site by an approved metals recycler.
- Electrical and electronic devices, including inverters, transformers, panels, support structures, lighting fixtures, and their protective shelters will be recycled off-site by an approved recycler.
- Any hazardous materials will be removed and disposed in accordance with the current regulations.

- All concrete that is removed from the switchyard and on-site distribution system will be recycled off-site by a concrete recycler or crushed on site and used as fill material.
- Fencing will be removed and recycled off-site by an approved metals recycler.
- Soil erosion and sedimentation control measures will be re-implemented during the decommissioning period and until the site is stabilized.
- Only minimal grading is expected to be required.

1.6 Site Restoration

Restoration activities will return the Project site to a land use consistent with the surrounding land uses at the time of decommissioning. The Initial Site Restoration Plan for the Project Site will include the following:

- Existing wells or pumps located on the periphery of the Project Site will be maintained in place. Any ditches used for temporary water transport within the Project Site will be removed for the Project. These irrigation works will be restored if appropriate or necessary.
- Restoration activities would entail one of the following measures:
 - If land is to be used for silviculture use, the nutrient content of the soil would be restored to pre-construction concentration levels (if degraded) and the land would be tilled regularly to ensure aeration of soils and proper weed management; or
 - If the land is to be converted for another purpose, soil stabilization techniques would be deployed to prevent topsoil erosion. Conversion to another use consistent with applicable land use regulation in effect at that time.
- All permits related to restoration would be obtained where required

1.7 Estimated Costs

sPower or Transferee will provide financial security for the performance of its decommissioning and restoration obligations based on the Initial Decommissioning and Site Restoration Plan. A decommissioning cost estimate was prepared and is included as Attachment A. The cost estimate will be used to determine the value of the Performance Bond to ensure that the funds will be available for decommissioning and site restoration (see Section 3.0).

**2.0 FINAL PROJECT DECOMMISSIONING AND SITE RESTORATION PLAN **

2.1 Final Project Decommissioning and Site Restoration Plan

Ninety days (90) prior to decommissioning the Project Site, sPower will submit a Final Project Decommissioning and Site Restoration Plan (Final Plan) to the County for its approval, which approval will not be unreasonably withheld. The Final Plan may contain measures to decommission the Project and restore the Project Site different than the Initial Plan, provided that sPower explains in sufficient detail the reasons for any new or substantially different measures.

2.2 Decommissioning and Restoration: Scope and Timing

2.2.1 Scope of Decommissioning

Decommissioning the Project will involve removal of the Project's components as necessary for reuse of the site, including; the solar panels, panel trackers, anchors, supports and mounts, inverter buildings, electrical conductors, electrical cables, and substation components, other structures and the re-grading, backfilling, and re-stabilizing of any areas significantly impacted by the removal of any components. It is anticipated that internal roads will be left in place to facilitate the future landowner's use after decommissioning. Landscaped vegetative buffers will be left in place as part of the decommissioning.

Noise impacts from decommissioning activities are expected to be less than the impacts described in the submitted noise study for the construction phase due to the absence of multiple construction activities and associated equipment, such as grading, but most notably the largest noise impact: pneumatic pile-driving. Additionally, the decommissioning will meet the required noise standards located in Chapter 14, Article II of the county code of Spotsylvania.

2.2.2 Decommissioning Work Hours

Decommissioning of the Project will adhere to the work hours and time of day considerations applicable for construction described in the Spotsylvania County Ordinances in effect at that time. Typical work week would be Monday-Friday 7:00-5:00pm.

2.2.3 Decommissioning Phasing Plan

A phasing plan for site decommissioning and restoration can be developed once the final site layout is determined during the site planning stage. The plan will include phasing, material staging locations, truck routes, and information regarding recycling and disposal activities. It is not anticipated that PV materials will be stored on site between decommissioning and removal from the site to the end-user as decommissioned panels are removed by hand and go from the array to the export truck. Panels would typically be exported by trucks including covered semi-trailer trucks and semi-flatbed cargo trucks. Other material, such as metal post and wiring may be transported by semi-trucks or refuse trucks for recycling. Vehicles would utilize all legal access points and would utilize Orange Plank Rd, Old Plank Rd, West Catharpin Rd and Post Oak Rd. Access and routes are indicated in the GDPs for Site A, B and C.

2.2.4 Site Restoration

Restoration of the Project Site will be to a reasonable approximation of its original condition prior to construction

The site restoration will not include the removal of gravel access roads/paths or stream crossings.

Removal of existing, fully permitted access roads would create additional land and wetlands disturbance that is not required nor recommended by any regulatory agencies. All crossings will be permitted and will remain in place.

Site decommissioning will utilize existing roadway for the solar equipment removal and will not cause heavy traffic outside the roadway that will compact soils. Furthermore, it would not be prudent to destabilize the site and create potential erosion issues on the land. At the time of decommissioning sPower reserves the right to develop the land as desired and in compliance with current zoning and development regulations.

If existing underground conduits are removed, the ground will be restored to the existing topography and ground cover re accordance with any applicable permitting requirements.

2.2.5 Timing, Exemptions, and Extension

sPower or any Transferee, as the case may be, will decommission the Project and restore the Project Site within twelve (12) months following project termination. The twelve-month period to perform the decommissioning and restoration may be extended for one additional twelve-month period if there is a delay caused by forces beyond the control of sPower including, but not limited to, inclement weather conditions, planting requirements, equipment failure, wildlife considerations or the availability of equipment or personnel to support decommissioning.

2.2.6 County Access and Reporting

The County will be granted access to the Project Site during decommissioning of the Project for purposes of inspecting any decommissioning work or to perform decommissioning evaluations. County personnel must provide a 5-day pre-notification for site access on the Project Site and must observe all current owner safety standards and protocols. If requested by the County, sPower will provide monthly status reports until this decommissioning work is completed.

Documentation (manifests) will be provided from the recycling and disposal sites which shall include descriptions and quantities of materials delivered.

2.2.7 Solar Panel End-of-Life Use and Recycling

Studies show the value of the recovered materials can cover the expense of decommissioning and recycling making recycling of PV at the end of their useful life a profitable enterprise. Furthermore, studies of large-scale penetration of PV into global electricity grids show that recycling of PV modules is imperative for maintaining a secondary source of materials¹.

¹ -Fthenakis V.M., Sustainability metrics for extending thin-film photovoltaics to terawatt levels. MRS Bulletin, 37(4), 425-430, 2012

End-of-life disposal of solar products in the US is governed by the Federal Resource Conservation and Recovery Act (RCRA), and state policies that govern waste. Panels removed from the site will be recycled according to the means, methods, and regulations at the time of decommissioning. Presently, there are numerous companies that recycle solar panels including First Solar, Dynamic Life Cycle Innovations, Cleanlites Recycling, and Clean Harbors.

It is also worth noting that the panels pass the Environmental Protection Agency (EPA) Toxicity Characterization Leachate Profile (TCLP), which characterizes the leaching potential of metals in landfills. This means, should panel recycling options be unavailable in the future for whatever reason, traditional, non-hazardous landfills would be an option for disposal.

3.0 RESPONSIBLE DECOMMISSIONING PARTY CONTACTS

Points of contact for Project Decommissioning:

Contact	Group	Title	Phone	Email
Daniel Menahem	sPower	Project Developer	202.390.7772	daniel.menahem@spower.com
Tony Archibald	sPower	Project Manager	801.913.0780	tony.archibald@spower.com

The above contact person(s) should be reviewed and re-evaluated every two (2) years along with the Initial Plan to assure they are up to date, relevant, and appropriate to serve as points of contact regarding decommissioning.

4.0 DECOMMISSIONING AND RESTORATION FUNDING AND SECURITY

4.1 Decommissioning and Restoration Obligations

sPower or a Transferee, as the case may be, will post a Performance Bond as described in 3.2 below to ensure the availability of funds to cover sPower decommissioning and restoration obligations. sPower will deliver the Performance Bond to Spotsylvania County after receipt of the Conditional Use Permit and prior to the start of construction. The Initial Plan, to be completed by sPower will include the estimated costs for the Project’s potential decommissioning and restoration obligations. The Initial Plan also will provide that such estimated costs will be re-evaluated by sPower at the conclusion of construction of the Project and every two (2) years thereafter from the date of Substantial Completion to ensure sufficient funds for decommissioning and restoration and, if deemed appropriate at that time, the amount of the Performance Bond will be adjusted accordingly.

4.2 Performance Bond

sPower or Transferee, as the case may be, will provide financial security for the performance of its Decommissioning and Restoration obligations assuming the Project Site is restored to silviculture use through a Performance Bond issued by a surety registered with the Virginia Commissioner of Insurance and is, at the time of delivery of the bond, is on the authorized insurance provider list published by the Commissioner. The Performance Bond will be in an

amount equal to 100% of the estimated costs for sPower decommissioning and restoration obligations provided in the Initial Plan. The Performance Bond will be for a term of one (1) year, and will be continuously renewed, extended, or replaced so that it remains in effect for the remaining term of the agreement or until the secured decommissioning obligations are satisfied, whichever occurs later.

5.0 PROJECT DECOMMISSIONING AND SITE RESTORATION COST ESTIMATE

The estimated costs for the decommissioning and restoration associated with the Spotsylvania Solar Energy Center project are shown below:

Description	Duration	Labor, Equipment, Materials	Net Recycling	Total Cost
SWPPP & Dust Control Measures	30.6	\$428,328	\$0	\$428,328
Removal of Equipment	26.8	\$16,499,447	(\$21,981,586)	(\$5,482,139)
Site Demolition	8.2	\$605,830	(\$394,865)	\$210,965
Site Reclamation	7.6	\$3,987,671	\$0	\$3,987,671
Contingency, Escalation, PM, Insurance, Fees		\$15,184,385	(\$3,356,468)	\$11,827,918
Opinion of Probable Gross Decommissioning Cost		\$36,705,641	(\$25,732,919)	\$10,972,743

Attachment A

Conceptual Cost Estimate

sPower Group
Conceptual Cost Estimate
for
Decommissioning Highlander
a
647,735.1kW (STC) PV System

November 15, 2018

Prepared for: Daniel Menahem
Senior Project Manager

Documents include: ❖ Executive Summary
❖ Summary
❖ Basis of Estimate
❖ Crew Wage Detail

Prepared Under the Review of:
Brian Ewing, Project Manager
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SWINERTON
RENEWABLE ENERGY



sPower Group
Decommissioning Highlander
Executive Summary

Conceptual Cost Estimate
November 15, 2018

Description	Duration (weeks)	Labor/ Equip/Mat	Net Recycling	Total Cost
SWPPP & Dust Control Measures	30.6	\$428,328	\$0	\$428,328
Removal of Equipment	26.8	\$16,499,447	(\$21,981,586)	(\$5,482,139)
Site Demolition	8.2	\$605,830	(\$394,865)	\$210,965
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sPower Group
Decommissioning Highlander
Summary

Conceptual Cost Estimate
November 15, 2018

Item Description	Qty	Unit	Labor/ Equip/Mat	Net Recycling	Total Cost
<u>SWPPP & Dust Control Measures</u>					
1 Stabilized Construction Entrances	1	EA	\$3,266		\$3,266
2 Perimeter Silt Fencing	52,040	LF	\$25,293		\$25,293
3 Spill Kits (Emergency Equipment Cleanup)	1	EA	\$305		\$305
4 Street Wash Down (Water Truck)	195	DA	\$129,652		\$129,652
5 Dust Control Watering (Water Truck)	195	DA	\$129,652		\$129,652
6 Mobilization/DeMobilization	1	EA	\$140,160		\$140,160
Subtotal SWPPP & Dust Control Measures			\$428,328		\$428,328
<u>Removal of Equipment</u>					
7 Remove & Recycle Substation Step Up Transformer	6	EA	\$39,251	\$1,800	\$41,051
8 Remove & Recycle Substation Disconnect Switches	12	EA	\$19,347	\$720	\$20,067
9 Remove & Recycle Substation Circuit Breakers	12	EA	\$19,179	\$3,600	\$22,779
10 Remove & Recycle Substation Pedestals	18	EA	\$114,251	(\$441)	\$113,810
11 Remove & Recycle AC Conductor	518,189	LF	\$212,725	(\$652,918)	(\$440,193)
12 Remove & Recycle Conduit	77,730	LF	\$22,582	(\$97,940)	(\$75,358)
13 Remove & Recycle Switchgear Assemblies	1	LS	\$24,126	\$12	\$24,137
14 Remove & Recycle Inverters & Xfmrs	169	LS	\$110,293	\$15,654	\$125,946
15 Remove & Recycle DC Conductor	9,694,572	LF	\$1,136,098	(\$446,340)	\$689,758
16 Remove & Recycle Photovoltaic Modules	1,615,762	EA	\$11,016,129	(\$8,175,756)	\$2,840,373
17 Remove & Recycle Support Assemblies	23,588	EA	\$1,560,052	(\$9,075,893)	(\$7,515,841)
18 Remove & Recycle W6 x 7 x 11' Foundations	214,585	EA	\$1,550,959	(\$2,284,311)	(\$733,352)
19 Remove & Recycle W6 x 9 x 11.5' Foundations	45,148	EA	\$326,317	(\$646,017)	(\$319,700)
20 Remove & Recycle W6 x 12 x 9' Foundations	22,574	EA	\$163,158	(\$337,052)	(\$173,894)
21 Remove & Recycle W6 x 20 x 11' Foundations	2,704	EA	\$19,544	(\$82,242)	(\$62,698)
22 Remove & Recycle W6 x 7 x 11' Foundations	19,235	EA	\$147,595	(\$204,761)	(\$57,166)
23 Remove SCADA and Met Stations	25	EA	\$17,841	\$300	\$18,141
Subtotal Removal of Equipment			\$16,499,447	(\$21,981,586)	(\$5,482,139)
<u>Site Demolition</u>					
24 Remove & Recycle 6' Chain Link Fence	349,570	LF	\$601,640	(\$393,354)	\$208,286
25 Remove & Recycle Gates	1196	LF	\$4,190	(\$1,511)	\$2,679
Subtotal Site Demolition			\$605,830	(\$394,865)	\$210,965
<u>Site Reclamation</u>					
29 Scarify & Blend ~40% of Site (Depth = 6")	1,230	AC	\$1,429,651		\$1,429,651
30 Seed Mixture across ~40% of Site (@ 25 LB/AC)	1,230	AC	\$2,558,020		\$2,558,020
Subtotal Site Reclamation			\$3,987,671		\$3,987,671
<u>Contingency, Escalation, PM, Insurance, Fee</u>					
31 Subcontractor Bonding	0.75%		\$170,101		\$170,101
32 General Contingency (% of Labor/Equip/Mat)	2.00%		\$453,603		\$453,603
33 Labor & Equip. Escalation (2% per Year for 25 Years)	50.0%		\$11,340,083		\$11,340,083
34 Recycled Material Escalation (0.6% per Year for 25 Years)	15.0%			(\$3,356,468)	(\$3,356,468)
35 Construction Management (% of Labor/Equip/Mat)	5.10%		\$1,156,688		\$1,156,688
36 Permits, Inspection & Fees (% of Labor/Equip/Mat)	3.25%		\$737,105		\$737,105
37 Liability Insurance (% of Labor/Equip/Mat)	0.97%		\$219,998		\$219,998
38 Overhead & Profit (% of Labor/Equip/Mat)	4.75%		\$1,077,308		\$1,077,308
39 County Administration Costs (Full-time for Contract Duration)			\$29,499		\$29,499
Subtotal Contingency, Escalation, PM, Insurance, Fee			\$15,184,385	(\$3,356,468)	\$11,827,918
Opinion of Probable Decommissioning Cost			\$36,705,641	(\$25,732,919)	\$10,972,743

Basis of Estimate
Assumptions ❖ Exclusions ❖ Qualifications
for Decommissioning a
647,735.1kW (STC) PV System

This Opinion of Probable Cost is based on professional experience and interpretation of project documents, and is based on Swinerton resource data, current in-house information and estimators' judgment regarding this type of product.

Please notify Swinerton of any errors or omissions in this estimate within ten (10) days of receipt.

General Assumptions

- 1 - Permitting NTP: 09/24/44
- 2 - Mobilization: 11/23/44
- 3 - Total Decommission Duration: 34.5 weeks.
- 4 - Completion Date: 07/22/45
- 5 - This estimate includes zero days of weather delay contingency.
- 6 - Overall Permit, Demolition & Close-out: 9.9 months
- 7 - This PV array is assumed de-energized and ready for demolition.
- 8 - Pricing valid for (60) sixty days from date of release. [01/14/19]
- 9 - Swinerton cannot control the actual conditions of the Project or the market, and as such, this Opinion of Probable Cost is not a guarantee of pricing, but a reasonable estimating tool based upon the assumptions, exclusions, and qualifications contained herein.
- 10 - Labor rates based on Spotsylvania, VA prevailing wages per the Wage Determinations website. *WDOL.gov is part of the Integrated Acquisition Environment, one of the E-Government initiatives in the President's Management Agenda. It is a collaborative effort of the Office of Management and Budget, Department of Labor, Department of Defense, General Services Administration, Department of Energy, and Department of Commerce.*
- 11 - Labor productivity metrics have been based on RSMeans Construction Cost Databases.
- 12 - We have escalated labor, equipment and material by 2% APR for the assumed (25) year life of this PV power plant.
- 13 - Material and salvage unit costs have been based on historical data for this type and size of project, and RSMeans Construction Cost Databases modified for scale and location.

Estimating Methodology

This Opinion of Probable Cost was developed based on material take-off quantities generated from current project data. Customized Excel workbooks were the primary estimating tools used to generate this cost estimate.

Basis of Estimate
Assumptions ❖ Exclusions ❖ Qualifications
for Decommissioning a
647,735.1kW (STC) PV System

Site Assumptions

Modules

(1,615,762) - 427.5w FirstSolar S-6 & 360w Jinko

Inverters

(169) -Power Electronics FS3000MU

DAS & Extras

Inverter-level monitoring and (25) weather stations

Racking Systems

ATI v3

Foundations

W6 x 7 x 11'

W6 x 9 x 11.5'

W6 x 12 x 9'

W6 x 20 x 11'

W6 x 7 x 11'

Interconnection

Allowance for Substation decommissioning and demolition has been included.

Sitework

Demolish all fencing, foundations, housekeeping pads, structures of any kind.

Remove and salvage gravel access aisles.

Restoration after decommission and demolition:

Apply Manure Compost (@ 24 CY/AC)

Scarify & Blend ~40% of Site (Depth = 6")

Seed Mixture across ~40% of Site (@ 25 LB/AC)

General Requirements

Included are SWPPP/Erosion control, dust control, safety equipment, dumpsters, chemical toilets & hand / eye wash stations, and lift equipment.

General Conditions represent costs for job-site staff and direct support are calculated against project scope and duration.

N.B., General Requirements and Conditions have been captured in the Construction Management line.

Basis of Estimate
Assumptions ❖ Exclusions ❖ Qualifications
for Decommissioning a
647,735.1kW (STC) PV System

Labor Rate Assumptions

Fully burdened prevailing wages for demolition and electrical demolition crews based on www.wdol.gov rates from General Decision Number: VA180176 01/05/2018 VA176.

County Administration wage based on Spotsylvania, VA County Administrative Analyst.

Indirect Costs

Sales Tax

Sales Tax at the rate of 5.30% has been included for all material and equipment.

Building Permits, Inspection and Fees

Building or construction permits are documents that grant the holder approval to construct their project in accordance with the permit and construction documents approved by the appropriate government agency. One or more permits may be required depending the type of project and the government agency's established requirements. Fees may include testing & inspection (soils, etc). This Conceptual Cost Estimate includes 3.25% against labor, equipment & material costs for building permits, inspection and fees.

Subcontractor Bonding

This Opinion of Probable Cost includes Contractor Default Insurance against loss incurred as the direct result of a subcontractor or supplier default.

Public Liability and/or Property Damage:

This estimate includes Public Liability and Property Damage. This insurance provides protection against the financial risk of being found liable for death or injury, loss or damage of property or pure economic loss, and is factored against the non-residential portions of the project.

Contractor Contingency:

This Opinion of Probable Cost includes Contractor Contingency of 2.00% against labor, equipment & material costs.

Contractor's Overhead & Profit:

This Opinion of Probable Cost includes Contractor's Overhead & Profit Overhead of 4.75% against labor, equipment & material costs.

Exclusions

- 1 Premium for off-hours work or accelerated schedule.

Basis of Estimate
Assumptions ❖ Exclusions ❖ Qualifications
for Decommissioning a
647,735.1kW (STC) PV System

Qualifications

- 1 Costs for waste management/recycling verification programs are unknown at this time and may need to be added if required by the Authority Having Jurisdiction.
- 2 A direct cost allowance of \$3,410,488 has been included for E-waste handling, abatement and disposal (including escalation). Any costs incurred in excess of this allowance shall be deemed a compensable change order.
- 3 Production rates based on 8 hour shifts.
- 4 Timeline is based on a (5) day work week.
- 5 Recycle definition: material will be reconstituted into a new product.
- 6 Salvage definition: material will be reused in its current configuration or format.
- 7 Disposal definition: material will be disposed of at licensed waste dispose facility. Material still may be recycled or salvaged at the sole discretion of the waste disposal facility.
- 8 Estimate is based on a current recycled steel value of \$276.5 per ton.
- 9 Estimate is based on a current 'clean' recycled aluminum value of \$0.455 per pound.
Clean aluminum is free of fasteners, insulation, and other minor debris.
- 10 Estimate is based on a current 'dirty' recycled aluminum value of \$0.32 per pound.
Dirty aluminum includes fasteners, insulation, and other minor debris.
- 11 Estimate is based on a current recycled copper value of \$1.465 per pound.
- 12 Estimate is based on a recycled glass value of \$0.07 per pound.
- 13 Estimate is based on a electronic disposal waste fee of \$0.30 per pound.

Blended Crew Rates

Based on www.wdol.gov rates for Spotsylvania, VA

General Decision Number: VA180176 01/05/2018 VA176

DEMO, non-Electrical	Crew	Rate*	Total	Designation No.
Laborers	4	\$20.62	\$82.48	SUVA2013-050 01/11/2016
Operators	2	\$32.20	\$64.40	SUVA2013-050 01/11/2016
Foremen	1	\$40.25	\$40.25	RSMeans Metric
Weighted Average		\$26.73	\$187.13	

DEMO, Electrical	Crew	Rate*	Total	Designation No.
Electricians	4	\$47.52	\$190.07	SUVA2013-050 01/11/2016
Operators	2	\$32.20	\$64.40	SUVA2013-050 01/11/2016
Foremen	1	\$40.25	\$40.25	RSMeans
Weighted Average		\$42.10	\$294.72	

* Fully burdened

Spotsylvania Solar Energy Center Landscape, Revegetation and Management Plan

December 14, 2018

1.0 Purpose

The purpose of the Landscape, Revegetation and Management Plan is to establish sPower's general guidelines and approach for landscaping, revegetation and required maintenance at the Spotsylvania Solar Energy Center (Project) located in Western Spotsylvania County, Virginia. Landscaping and revegetation for the Project will be used to enhance aesthetics, attract native pollinators, provide erosion and sediment control, and screen visibility of the Project from adjacent properties during the operational lifetime of the Project. sPower's Operations and Maintenance (O&M) staff will maintain landscaping during the lifetime of the Project. A final Landscaping and Revegetation Plan will be approved during the building permit process and be in general conformance with the guidelines established in this plan.

Landscape enhancements, buffers, and berms are proposed where the Project Site is adjacent to high density residential neighborhoods or high visibility corridors. Areas that are not immediately adjacent to the solar facility will be stabilized as necessary, and natural vegetation will be permitted to grow back. The Landscape and Revegetation Plan also discusses the installation of berms in locations where the Project abuts high density residential areas. sPower consulted with professional biologists and arborists in preparing this Landscape and Revegetation Plan.

2.0 Guidelines

The Landscape and Revegetation Plan considers the following guidelines regarding plant species:

1. Plant and tree species will be selected based on their ability to provide the desired screening after 2 years of growth.
2. A variety of plants shall be used based on availability and are expected to include evergreens and deciduous trees as appropriate.
3. Plant and tree species shall be environmentally friendly, native species (preferably) and compatible with local wildlife.
4. Plants and trees shall be installed as early as possible following establishment of erosion and stormwater management controls, provided they do not inhibit construction of the facility.
5. Plants and trees, once established, will require little maintenance and grow under natural precipitation conditions.
6. Understory vegetation and seeding, if necessary, shall conform with the County approved seed list (Exhibits A and C).

3.0 Buffer Types

Buffers and landscaping will be installed in accordance with the final GDP Landscape and Buffer Area Plan. All landscaping is subject to final site plan approval and will follow the guidelines outlined in Section 2.0 above.

3.1 Berms

sPower is proposing to construct berms comprised of mulched leftover timber slash and logging debris at the Project Site. These berms will reduce the amount of burning required on site, the number of delivery trucks exiting the site to export excess mulch, and reduce the amount of earthwork and heavy equipment required to construct earthen berms. If natural topography limits the viewshed corridor, a berm may not be necessary and natural vegetation may be present to adequately screen the facility.

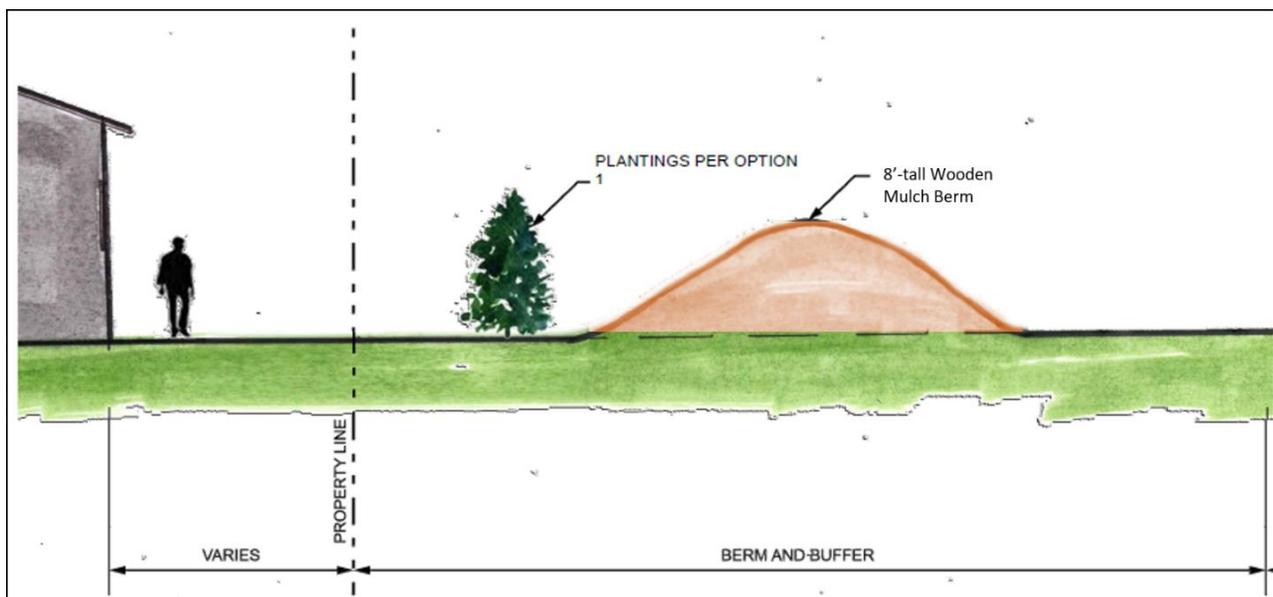


Figure 1. Drawing of proposed mulch berm for visual screening.

3.2 Supplemental Plantings

Some buffer areas may require additional screening through supplemental plantings. These plantings will be in conformance with landscaping guidelines in the Spotsylvania Design Standards Manual Article 6.

Trees and Shrubs

Based on the Section 2.0 guidelines above and consultations with certified biologists and arborists, sPower generated a list of potential plant species that could be used at the Project Site, depending on availability at the time of planting. sPower intends to use a combination of evergreen trees with low-lying, evergreen shrubs (Exhibit A).

Planting Criteria

These plantings will be in general conformance with landscaping guidelines in the Spotsylvania Design Standards Manual Article 6, or in conformance with the following guidelines from the County Staff Report:

A minimum of one (1) evergreen tree with a minimum height of six (6) feet every ten (10) feet, one (1) large deciduous tree with a minimum trunk caliper of two (2) inches at breast height (DBH) every fifteen (15) feet, one (1) understory deciduous tree with a minimum trunk caliper of two (2) inches measured diameter at breast height (DBH) every fifteen (15) feet, one (1) evergreen shrub with a minimum height of four (4) feet every ten (10) feet.

3.3 Revegetation

Allowing the naturally occurring vegetation to replenish itself provides a fast growing, thick, and effective visual screen. Examples of natural regrowth already present on the Project Site following the year's timber harvest are located below in Figure 2 and in Exhibit D.



Figure 2. Example of natural revegetation on Site C

3.4 Preservation

Throughout the facility, there are locations where existing areas were not logged along property boundaries as shown in Figure 3. These buffer areas provide outstanding natural visual screening.



Figure 3. Example of Preserved buffer along West Catharpin Rd.

4.0 Buffer and Landscaping Options

4.1 Buffers Not Adjacent to Residences

1. Maintain existing 50ft vegetated buffer as shown in Section 3.4 where they have been preserved, or...
2. Allow for 50ft natural revegetation as shown in Section 3.3. where the timber companies have harvested the existing buffer.

4.2 Buffers Adjacent to Residences

Option 1: Install 8ft-tall logging mulch berm with supplemental plantings of large evergreens 20ft on center in front of berm and natural regrowth behind the berm. Total vegetated buffer width of 100ft. Berm and evergreens provide immediate visual screening and time for natural regrowth to completely screen panels. Utilizing logging waste to create the berm will dramatically reduce the need to burn logging debris on site.

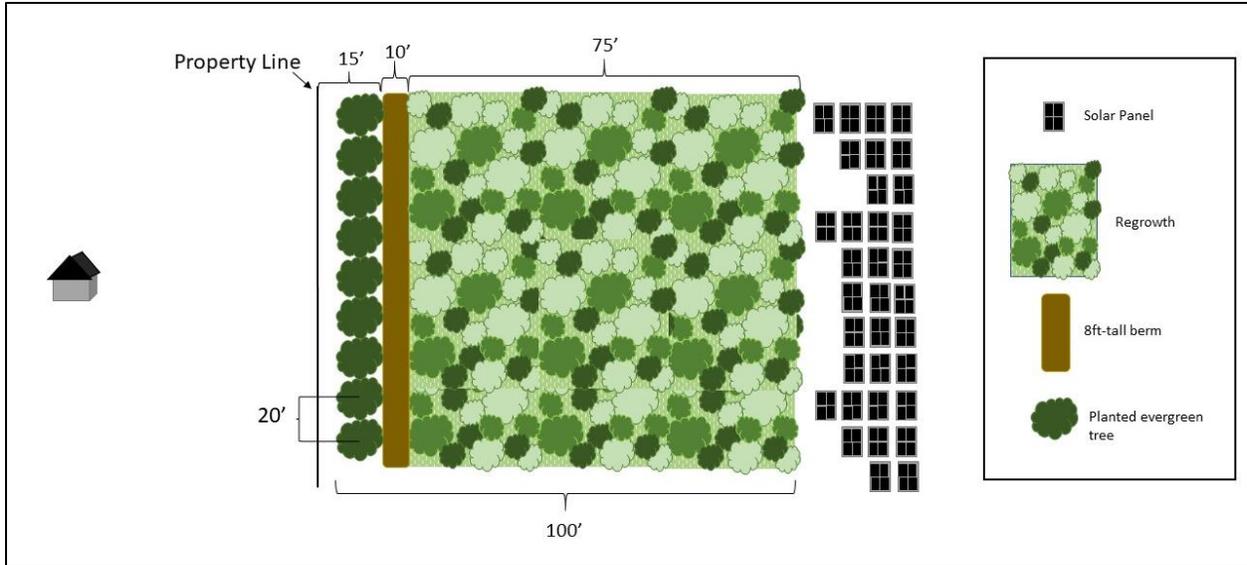


Figure 4. Drawing of Proposed Visual Screening and Buffering Option 1.

Option 2: Install supplemental plantings at residential property boundaries with natural regrowth behind. Total vegetated buffer width of 100ft. Supplemental plantings will be in general accordance with Spotsylvania Design Standards Manual Article 6 or planting criteria noted above (Section 3.0).

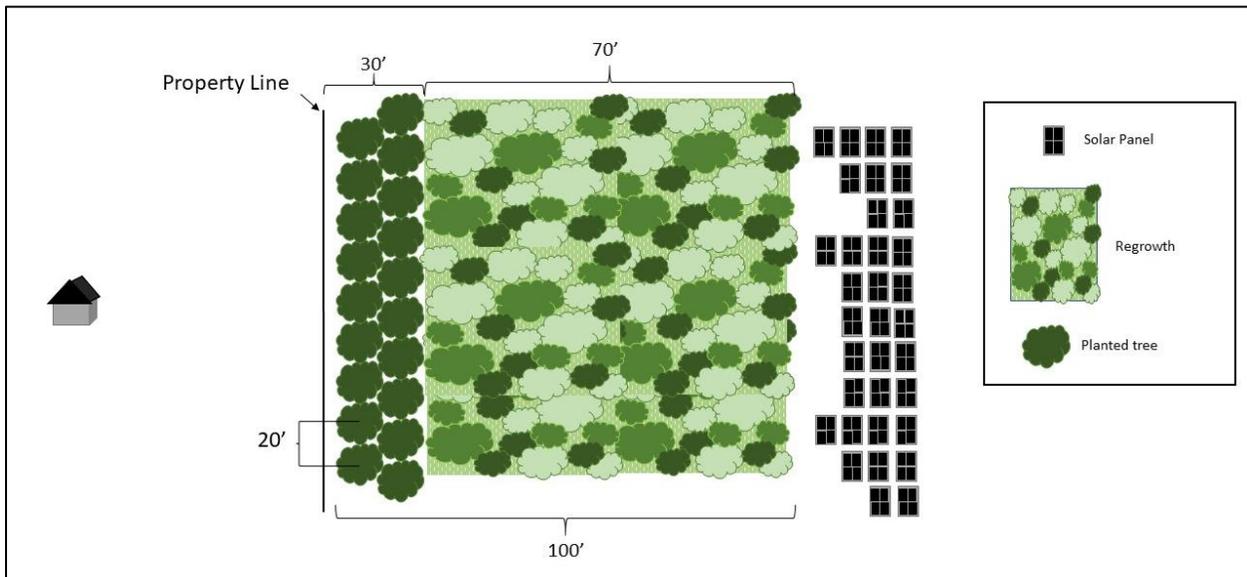


Figure 5. Drawing of Proposed Visual Screening and Buffering Option 1.

5.0 Maintenance – Planting, Watering and Cutting

sPower intends to begin planting in Fall of 2019 with a means of watering during the first year of construction or until the plants have established (whichever comes first). Natural precipitation will

be the sole source of watering after plants have established. Final placement and landscape design will be coordinated with the County to provide adequate screening for the project site.

Grass Mowing

Low maintenance and low growing grasses will be utilized to minimize the mowing requirements. Grasses near the solar panels will be kept maintained at no higher than 24 inches.

Firebreak and access roads will consist of mainly graveled areas and low growing vegetation. Any low growing vegetated firebreaks will consist of year-round green grasses kept less than 24 inches high.

Herbicides and Pesticides

sPower has not identified any proposed herbicides or pesticides for use during construction and operation. If their use is required, sPower will use herbicides and pesticides that conform with EPA guidelines for use and with application that applies with Federal, State and Local regulations. Additionally, selective herbicides and pesticides would be favored over broad-based applications.

6.0 Dominion Easement

sPower will install hedges along a Dominion Easement along the north side of West Catharpin Road (refer to Exhibit A). Dominion has provided the following list of approved evergreen shrubs to be planted in this location:

Species	Height (ft)	Width (ft)
Northern Bayberry	9	9
Sweet Osmanthus	10	8
Dwarf Burford Holly	6	6
Emerald Green Arborvitae	15	4

Species and plant spacing will be determined based on availability and will be approved by Dominion prior to installation.

The depiction and images below show the detail of the Dominion easement plantings and a visual simulation of the Dominion easement.

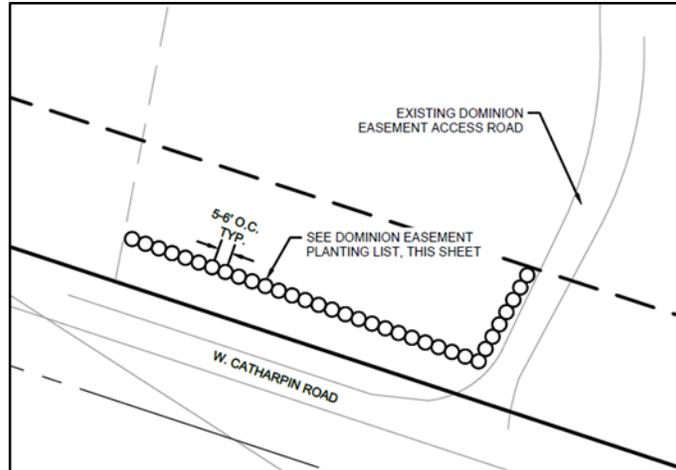


Figure 6. Dominion easement detail.



Figure 7. Dominion easement, existing condition.



Figure 8. Dominion easement, future simulation.



Figure 9. Dominion easement, future simulation with plantings.

7.0 Invasive Species Management

See Exhibit B for the Invasive Species Management Plan.

8.0 Seed Mixtures

sPower will use two types of seed mixes:

During Construction

For temporary and permanent stabilization during construction, sPower will follow the guidelines in the Virginia Erosion and Sediment Control Handbook Tables 3.31-B Temporary Seeding and Table 3.32-D Permanent Seeding. sPower will select the seed mixture that is low maintenance and low growing to minimize or eliminate mowing, fertilizer and herbicide usage.

Pollinator

sPower will plan to utilize the VADGIF recommended seed mixtures (Exhibit C) at various locations throughout the facility. If the seed mix is not available, sPower will seek alternatives that are appropriate for the geographic location. Final location of the pollinator planting locations will be determined once the panel layout and site plans are finalized. Potential areas for the pollinators will be identified in the site plan. Additionally, existing native pollinator communities will be located in approximately 3500 acres of conserved areas such as RPAs, visual setbacks/buffers, and other undeveloped areas and will include the following species: orange jewel weed, morning glory, Turk's-cap lily, Cardinal Flower, Maryland Golden Aster, etc.

Exhibit A

Plant and Tree Species

Species	Description	Image
Evergreen Trees		
Norway Spruce	Tall timber tree with dark green evergreen needles on dense branches. Medium to fast growth rate at 13 to 25 inches per year. Reaches 40 to 60 ft. tall and 25 to 30 ft. wide.	
White Spruce	Pendulous branches covered with short, densely packed needles. Medium growth rate at 13 to 24 inches per year. Reaches 40 to 60 ft. tall, 10 to 20 ft. wide.	
Nellie R Stevens Holly	Vigorous growing with a broad pyramidal tree-like form, dense branching, and lustrous, dark green, leathery foliage. An excellent hedge, screen, or specimen. Quickly reaches 15 to 25 ft. tall, 10 to 15 ft. wide. Both male and female plants are proposed for this species.	

<p>Eastern Red Cedar</p>	<p>Evergreen tree with reddish wood that has a spreading canopy. Medium rate at 13 to 24 inches per year. Reaches up to 40 to 50 ft. tall, 8 to 20 ft. wide.</p>	
<p>American Holly</p>	<p>Considered both an evergreen and ornamental tree that keeps foliage year-round. Slow to medium growth rate at 12 to 24 inches per year. Reaches up to 40 to 50 ft. tall, 18 to 40 ft. wide. Both male and female plants are proposed for this species.</p>	
<p>Evergreen Shrubs</p>		
<p>Southern Wax Myrtle</p>	<p>Shrub with clusters of waxy, bluish gray berries that tends to develop multiple stems. Medium growth rate that can reach to 12 ft. tall and 8 to 10 ft. wide.</p>	

<p>Rose Azalea</p>	<p>Semi-evergreen foliage with rose-red blossoms. Medium growth rate that can reach 2 to 4 ft. tall and 3 to 5 ft. wide.</p>	
<p>Swamp Azalea</p>	<p>Multi-stemmed shrub with abundant white flowers. Medium growth rate that can reach 5 to 8 ft. tall and wide.</p>	

DOMINION EASEMENT

Species	Description	Image
<p>Northern Bayberry</p>	<p>Fragrant, dense foliage in a compact form. Medium growth rate that reaches 9 ft. tall with equal width.</p>	
<p>Sweet Osmanthus</p>	<p>Large evergreen shrub with broad upright form that is densely branched and covered with finely toothed, dark foliage. Slow growth rate that reached 10 ft. tall, 6 to 8 ft. wide.</p>	

<p>Dwarf Burford Holly</p>	<p>Evergreen shrub with large, bright red berries. Slow growth rate that reaches 4 to 6 ft. tall with equal width.</p>		
<p>Emerald Green Arborvitae</p>	<p>A narrow, pyramidal evergreen with dense, emerald green foliage that holds its color throughout winter. Medium growth rate that reaches 15 ft. tall, 3 to 4 ft. wide.</p>		

Exhibit B

Invasive Species Management Plan

Invasive Species Management Plan

1.0 INTRODUCTION

Sustainable Power Group (sPower) has prepared this Invasive Species Management Plan (Plan) in support of the Spotsylvania Solar Energy Center (Project) located in western Spotsylvania County, Virginia. The Plan provides guidelines for managing and preventing the spread and propagation of noxious and invasive species and weeds during construction and operation of the Project.

1.1 Project Description

The Project is a 500-megawatt (MW) solar energy facility that consists of three non-contiguous project sites (Site A, B, and C) that total approximately 6,350 acres, of which approximately 3,500 acres will be developed for the Project. The remaining 2,850 acres will be set aside as open space. The Project will utilize photovoltaic (PV) panels installed on single-axis trackers. Electricity will be delivered via transmission lines that will run from the Project to the adjacent Spotsylvania Switching Station owned by the Virginia Electric and Power Company.

1.2 Invasive Species

An invasive species is defined as a non-native species to an ecosystem whose introduction causes economical, medical, and/or environmental harm. The ability for non-native species to establish themselves and become invasive is incredibly difficult as they are usually not as well adaptive to the surroundings as native species and usually require a “leg-up” usually in the form of a disturbance event. Invasive spread is generally categorized into 5 stages:

1. Introduction
2. Colonization
3. Establishment
4. Dispersal
5. Invasive Spread

The best strategy for managing invasive is to 1) minimize their introduction and 2) foster and support native species which will naturally out-compete non-native species and prevent them from colonizing (stage 2). The following management plan is designed to accomplish both those objectives.

2.0 BEST MANAGEMENT PRACTICES

2.1 Prevention Measures

Preventing introduction of non-native species is often the most effective way of managing invasive species for a project. These prevention practices can also limit the spread of non-native species that may have already been present to new areas, both inside and outside of the project site.

2.1.1 Worker Environmental Training

Mandatory site environmental instruction for the Construction and Operations Teams, contractors, or related personnel entering the site during operation of the Project will include weed management awareness training. Personnel involved will include the Construction and Operations Teams, contractors, subcontractors, construction managers, construction personnel, and individuals bringing vehicles or equipment onto the Project Site. Proposed measures to prevent the spread of weeds in areas currently not infested, and controls on their proliferation when already present, will also be explained.

2.1.2 Rumble Strip Stations

Equipment and vehicles that have been cleaned prior to being staged on the Project Site require no further cleaning to prevent the spread of weeds. In the event of large-scale maintenance activities that require heavy vehicles and equipment to access the Project Site, the Construction and Operations Teams will set up rumble strip stations at ingress and egress locations to remove mud and dirt from vehicles and equipment. This will prevent the spread of weed seeds; trucks with mud and dirt containing seeds is one of the most common ways weed seeds are spread to new environments. Heavy equipment entering the Project Site on trailers during large-scale maintenance activities will also require cleaning prior to entering the Project Site. The Construction and Operations Teams will ensure that vehicles and equipment are free of soil and debris capable of transporting weed seeds, roots, or rhizomes before the vehicles and equipment are allowed to use access roads and enter the Project Site.

2.1.3 Site Soil Management

Prior to operations, contractors will stabilize disturbed areas of the Project Site utilizing ground stabilization methods such as application of mulch or hydro-mulch containing a native seed mix. Application of a pre-emergent, EPA-approved herbicide, designed to prevent weed growth without affecting existing vegetation, may also be included and would be applied per Federal, County and State regulations.

During the Operations Phase, the Operations and Maintenance Team will limit the amount of soil disturbance to the absolute minimum necessary.

2.1.4 Site Mowing

Mowing will primarily be used as a method to maintain vegetation height for fire safety concerns, rather than weed management. Mowing will prevent maturation (“going to seed”) of unwanted species that may be present and limits their dispersal. During mowing activities, the Construction and Operations Teams will avoid transporting soil within the Project Site to avoid any dispersal of unwanted species.

2.1.5 Revegetation and Plantings

All revegetation products shall use seeding, seedling, and sapling material native to the region. All preventative measures as outlined in this Plan shall be implemented during revegetation activities and after during operation and maintenance phase of the Project.

3.2 Noxious Weed Control Methods

3.2.1 Physical Removal

Physical control methods range from manual hand pulling of weeds to the use of hand tools to provide enough leverage to pull out the entire plant and associated root systems. Hand or power tools can also be used to uproot, girdle, or cut plants. For localized weed control, this is the most effective method. Employees during both the Construction and Operation phases will be encouraged to use this method during the training mentioned in section 2.1.1.

3.2.2 Chemical Removal

Herbicide application is a widely used, effective control method for removing invasive weed species. Prior to application of herbicide, contractors will be required to obtain required permits from state and local authorities. Permits may contain additional terms and conditions that go beyond the scope of this Plan. Only a State of Virginia and federally certified contractor will be permitted to perform herbicide applications. Should their use be deemed necessary, herbicides will be applied in accordance with applicable laws, regulations, and permit stipulations.

5.0 DURATION

Implementation of this Plan will be required during the both the construction phase and the operational phase of the Project.

Exhibit C

VDGIF Seed Mix

Species #	Common Name	Scientific Name	Native to East	VA Native	Annual/Biennial / Perennial	Warm Season / Cool Season	Seeds per pound	Seeds per SF at 1 pound of pure live seed (PLS) per acre	Pounds of Pure Live Seed (PLS) per Acre to Deliver 3 Seeds per SF	Seed Cost per Pound (Ernst, 9/2017)	Cost per Acre of 3 Seeds per SF	Cost per Acre of 4.5 Seeds per SF
Potential Pollinator Mix with Plants 2 Feet or Shorter for Solar Farms in the Southern Piedmont on Well-drained Soils												
2013	Deertongue	<i>Dichanthelium clandestinum</i>	✓	✓	Perennial	Warm Season	350,000	8.03	0.37	18.00	6.72	10.08
2020	Lovegrass, Purple	<i>Eragrostis spectabilis</i>	✓	✓	Perennial	Warm Season	1,058,100	24.31	0.12	180.00	22.21	33.31
2079	Pea, Partridge	<i>Chamaecrista fasciculata</i>	✓	✓	Annual	Warm Season	65,000	1.49	2.01	16.00	32.17	32.17
2125	Coneflower, Pale Purple	<i>Echinacea pallida</i>	✓	No	Perennial	Warm Season	106,000	2.43	1.23	84.00	103.56	155.34
2127	Coneflower, Purple	<i>Echinacea purpurea</i>	✓	No	Perennial	Warm Season	115,664	2.66	1.13	36.00	40.67	61.01
2129	Coreopsis, Lanceleaf	<i>Coreopsis lanceolata</i>	✓	No	Perennial	Warm Season	221,000	5.07	0.59	20.00	11.83	17.74
2139	Goldenrod, Gray	<i>Solidago nemoralis</i>	✓	✓	Perennial	Warm Season	1,008,000	23.14	0.13	360.00	46.67	70.01
2151	Indian Blanket	<i>Gaillardia pulchella</i>	✓	No	Perennial	Warm Season	238,144	5.47	0.55	30.00	16.46	24.69
2178	Primrose, Showy Evening	<i>Oenothera speciosa</i>	✓	No	Perennial	Warm Season	3,039,069	69.77	0.04	50.00	2.15	3.23
2190	Spiderwort, Ohio	<i>Tradescantia ohioensis</i>	✓	✓	Perennial	Warm Season	1,750,000	40.17	0.07	210.00	15.68	23.52
2191	Spiderwort, Virginia	<i>Tradescantia virginiana</i>	✓	✓	Perennial	Warm Season	1,750,000	40.17	0.07	400.00	29.87	44.80
										Total	327.99	475.90
Alternative Pollinator Mix Species 2 Feet or Shorter for Solar Farms in the Southern Piedmont on Well-drained Soils												
2073	Indigo, Wild Yellow	<i>Baptisia tinctoria</i>	✓	✓	Perennial	Warm Season	300,000	6.89	0.44	600.00	261.36	392.04
2075	Lespedeza, Roundhead	<i>Lespedeza capitata</i>	✓	✓	Perennial	Warm Season	174,000	3.99	0.75	108.00	81.11	121.67
2078	Milkvetch, Canada	<i>Astragalus canadensis</i>	✓	✓	Perennial	Warm Season	270,500	6.21	0.48	80.00	38.65	57.97
2086	Alexander, Golden	<i>Zizia aurea</i>	✓	✓	Perennial	Warm Season	121,800	2.80	1.07	240.00	257.50	386.25
2115	Blue-eyed Grass, Narrowleaf	<i>Sisyrinchium angustifolium</i>	✓	✓	Perennial	Warm Season	757,000	17.38	0.17	160.00	27.62	41.43
2120	Butterflyweed	<i>Asclepias tuberosa</i>	✓	✓	Perennial	Warm Season	70,000	1.61	1.87	136.00	253.89	380.84
2123	Columbine, Wild	<i>Aquilegia canadensis</i>	✓	✓	Perennial	Warm Season	515,616	11.84	0.25	300.00	76.03	114.05
2152	Indian Paintbrush	<i>Castilleja coccinea</i>	✓	✓	Perennial	Warm Season	325,000	7.46	0.40	490.00	197.03	295.54
2176	Poppymallow, Purple	<i>Callihoe involucreata</i>	✓	✓	Perennial	Warm Season	600,000	13.77	0.22	180.00	39.20	58.81
2200	Susan, Black-eyed	<i>Rudbeckia hirta</i>	✓	✓	Biennial	Warm Season	1,575,760	36.17	0.08	20.00	1.66	2.49
Seed Density for Wildlife and Pollinator Seed Mixes at Best Dates: 30 seeds per SF drilled, 45 seeds per SF broadcast												
Seed Density for Wildlife and Pollinator Seed Mixes before Best Dates: 45 seeds per SF drilled, 70 seeds per SF broadcast												
Wildlife Mix: no more than 50% native grass by seeds per SF												
Pollinator Mix: 2 native grasses and 9 native legumes and forbs												
Pollinator Mix: no more than 20% native grass by seeds per SF												

Exhibit D

Natural Regrowth at SSEC



Site C - 1 year regrowth, winter



Site A – 1.5 years regrowth



Site A – 1.5 years regrowth



Site A – 1 years regrowth

Spotsylvania Solar Energy Center
Proposed Soil Testing and Remediation Plan
Operations Phase

1.0 Introduction

The purpose of this plan is to describe a Cadmium Telluride soil screening program, its methodology, protocols, and reporting procedures for the Spotsylvania Solar Energy Center proposed by sPower. The creation of this plan was proposed by Dewberry Engineers Inc. in their review of sPower cases SUP18-001, -002, and -003 dated November 26, 2018, for Spotsylvania County Staff.

1.1 Dewberry's Findings

In the November 26, 2018 review document submitted to Spotsylvania County Staff, Dewberry found:

Based upon our review of the above referenced documents, there is little evidence to suggest that CdTe based solar panels present risk to the population or environment. If they are handled properly during all phases of construction and disposal, they will not emit any toxicity into the environment.

According to "Environmental Life Cycle Assessment of Cadmium Telluride Solar Cells: Cd Emissions", emissions of Cd can only happen during an accidental fire. Experiments have been conducted with fire and almost none of the Cd (0.04%) was actually released into the environment.

Below are some risks associated with everyday life, where risks are prevalent.

Some common uses of Cd that pose a risk include:

- *Ni-Cd batteries – these batteries use Cd, which is less stable than CdTe.*
- *Coal & Petroleum – Coal and petroleum both contain Cd and it is emitting during burning.*
- *Plastic – Cd is used as a stabilizer and for pigments in plastics.*

According to "The Health Risks of Cadmium in Cigarette Smoke":

- *Cadmium is present in water and foods because it is naturally occurring in water and soils.*
- *Per the EPA, a safe level of Cadmium in drinking water is 5 ppb (parts per billion).*
- *Cadmium occurs naturally in food: it is highest in vegetables, potatoes, meats, shellfish*
- *Most foods in US contain 2 to 40 ppb.*
- *Single cigarettes contain 1-2 mcg (micrograms) of Cadmium and produce 1,000 – 3,000 ppb in the smoke that is emitted. For each pack of cigarettes, the body will absorb approximately 1-3 mcg of cadmium.*
- *It is estimated that the average person also ingested 30 mcg of Cadmium per day. The body only retains about 1-3 mcg of what it ingests.*

These findings support sPower's own findings regarding Cadmium Telluride panels and are in accordance with the assertion the panels present no risk to human or environmental health and safety.

1.2 Purpose

The purpose of the following protocol is to establish baseline levels of cadmium present at the proposed Spotsylvania Solar Energy Center site and monitor those levels through the life of the project. The protocol also outlines remediation action in the event baseline levels rise to quantities greater than environmental and human health and safety standards as a result of solar panel-related activities as per Virginia DEQ Tier II Screening Levels, and EPA Region 3 Residential Screening Levels.

2.0 Soil Testing

2.1 Baseline Sample Collection

2.1.1 *Sample Collection Methodology*

Soil samples collected during the geotechnical engineering effort will be analyzed for background (anthropogenic or naturally occurring) cadmium using the analyses described in Section 2.3 below. Samples will be collected from 1-2 feet below ground surface (bgs) and located in the area where CdTe panels will be used. A total of five (5) samples will be collected at random to define baseline conditions in these areas: 3 random locations within Site A, 1 location within Site B, and 1 location within Site C.

2.2 Operations Phase Sample Collection

2.2.1 *Sample Collection Methodology*

Sampling procedure shall be the following, derived from the Virginia Department of Environmental Quality Storage Tank Program Technical Manual 4th edition, section Z.5.1.1 “Collecting soil samples with a soil auger or a soil probe”:

1. Advance a clean, decontaminated hand auger into the area of concern [5ft bgs] until the one auger bucket of material has been collected.
2. Don clean latex gloves and remove the first centimeter (approximately) from the bit end of the auger and discard that soil.
3. Remove the soil from the bit end and place that soil in the sampling containers that are appropriate for the analyses to be performed.
4. Label the sample containers.
5. Record information about soil texture, odor, color, and other soil characteristics.
6. Place soil remaining in the auger after sample collection back in the excavation.
7. Decontaminate the auger using a detergent solution and deionized water before another soil sample is collected.

Samples will be collected at 1-2 feet (bgs) using the auger methodology described above and collected at the frequency described in section 2.2.2 below.

2.2.2 *Sample Location and Frequency*

The potential for Cadmium Telluride to be released into the environment is extremely unlikely as noted in the Dewberry report (2018). sPower staff will collect 5 samples, samples in the CdTe panel arrays and at any operational facility where CdTe panels are stored: 3 samples within Site A, 1 sample within Site B, and 1 sample within Site C. During each sampling event, at least one sample should be taken from outside the solar array to serve as a control and document possible changes in the anthropogenic or naturally occurring baseline levels. Sample event frequency will be once every five (5) years. If requested, sPower will provide County Staff with at least 48-hour advance notice of all sampling events should the County wish to provide oversight of the sampling activity.

2.3 Sample Analysis

All samples collected in sections 2.1 and 2.2 will be sent to an Environmental Laboratory Program (ELAP) certified laboratory for analysis. Samples will be analyzed for Cadmium by USEPA Method 6020, or equivalent. Analysis results will be screened against the background levels as per Virginia DEQ Tier II Screening Levels, and EPA Region 3 Residential Screening Levels.

2.4 Reporting

sPower or their engineers will generate sampling reports for each sample event. Each report will contain at a minimum:

- sample location(s) map
- copy of the laboratory sample chain of custody
- laboratory analytical results
- summary report

Reports will be provided to the County via electronic copy and will be retained by the applicant for the life of the facility.

3.0 Remediation

In the event that the laboratory analysis indicates Cadmium levels above the Virginia DEQ Tier II Screening Levels, and EPA Region 3 Residential Screening Levels when compared against the control, sPower shall contact Spotsylvania County Staff within 24 hours of receiving the laboratory results. sPower and County Staff will then coordinate and determine next steps regarding further characterization and remediation of the sampled area, including, but not limited to: additional sampling and soil removal.

Spotsylvania Solar Energy Center Traffic Mitigation Plan

December 13, 2019

The following Traffic Mitigation Plan (TMP) describes various policies for the management of traffic for the duration of construction of the proposed Spotsylvania Solar Energy Center. These strategies will address school bus avoidance, on-site and off-site parking and ridesharing programs, haul route pavement maintenance, temporary traffic control measures, safety and deliveries. sPower and the general contractor will work closely with Spotsylvania County and the Virginia Department of Transportation (VDOT) to ensure the safe and efficient movement of local traffic throughout the anticipated 18-month construction period.

School Bus Avoidance

Spotsylvania County Schools bus stops exist along Orange Plank Road, West Catharpin Road, Post Oak Road, and along various connecting side streets in the vicinity of the project area. These stops serve eleven different local area elementary, middle and high schools. The school year begins in early August and ends in late May.

sPower is prepared to take steps to ensure that students are kept safe and minimal interaction occurs between construction traffic and school bus operations. This will be achieved through a combination of the following strategies:

- Wide-load deliveries will be restricted between 6:10 AM and 8:40 AM and between 2:45 PM and 4:30 PM during the school year. sPower will educate drivers on school bus pickup hours and locations.
- Employees will be encouraged to participate in ridesharing programs to reduce commuter traffic to the site (see Parking and Ridesharing).
- Reduced speed limits during the school year near bus stop locations will be a suggested traffic calming measure to VDOT. Speed limits will be communicated via temporary signage along construction traffic routes and through driver education.
- Installation of temporary signage informing drivers of a school bus stop ahead and hours of operation for those stops along construction haul routes (Orange Plank Road, West Catharpin Road, and Post Oak Road).
- Informational handouts will be prepared and distributed to students and parents in coordination with Spotsylvania County Schools. These handouts will describe the truck routes, hours of operation, and construction schedule and duration, as well as basic safety precautions for walkers and students waiting at bus stops.
- Potential “high-risk” bus stops will be identified in coordination with Spotsylvania County Schools. These locations will be considered for temporary relocation or enhanced safety measures, such as signage to indicate safe waiting areas and warn of heavy truck traffic.

Parking and Ridesharing

On-Site Parking

On-site parking will be provided adjacent to construction entrances within the project. Open space free of solar panels and other infrastructure has been made available to allow for adequate parking on site. Parking area size will fluctuate based on the construction phasing and number of workers needed at each entrance. Construction parking areas will be set back a minimum of 500 feet from any adjoining residential structure.

The contractor will utilize multiple seat vehicles/shuttle buses/vans to transport employees to and from various construction areas within the site to reduce the number of vehicle trips between sites and optimize the use of parking areas around the project.

Off-Site Parking

The following off-site parking opportunities in the greater Fredericksburg area and along the I-95 corridor are under consideration:

- **Park and Ride and Virginia Railway Express (VRE) Parking Lots** – VDOT manages six park and ride lots for a combined total of over 5,000 parking spaces in the greater Fredericksburg area. sPower will work with VDOT representatives to identify lots with excess capacity.
- **Private Parking Lots** – Private parking lots with excess capacity during regular business hours may be considered for agreements for temporary parking. Potential locations could include the Spotsylvania Town Center, local churches, or other commercial shopping centers.

Based on the available off-site parking capacity, sPower and the contractor will identify one or more locations as hubs for employees to meet and utilize the encouraged ridesharing opportunities. The following strategies are under consideration to facilitate and promote ridesharing among employees:

- **Shuttle Service/Vanpool** – Shuttle and vanpool services may be contracted during construction. These services require established pick-up/drop-off areas and pre-scheduled departure times, which may be on a limited schedule. Potential shuttle and vanpool services for this project have been researched based on anticipated use, rental cost for vehicles and parking lot space, lost productivity due to increased travel times has concluded that shuttle service may not be logistically and financially viable. Additionally, there are safety concerns with site accessibility in the event of an emergency to provide employees with timely access to their vehicles.
- **App-Based Carpool Programs** – A number of app-based carpool programs, such as Scoop, RideAmigos, iCarpool, and Waze Carpool, currently offer employer partnership packages. These platforms facilitate carpooling by connecting users, optimizing commute routes, and tracking usage for incentive programs. In some cases, carpooling also allows for direct pick-up from residences, reducing the need for off-site parking. Carpooling allows greater flexibility for employees than shuttles or vanpools while still reducing the number of single occupancy vehicles on the road. sPower and the contractor will educate employees on the selected program and encourage them to utilize the resource to help mitigate traffic.

- **Carpool Promotional Materials** – sPower and the contractor will provide employees with brochures and other informational materials on the benefits of carpooling, such as lower stress, transportation cost savings, and reduced wear-and-tear on private vehicles.

Pavement Maintenance along Haul Routes

Portions of the surrounding public roadways will be designated as haul routes for deliveries during construction. The following procedures will be set in place for the assessment and maintenance of haul route pavements before, during, and after construction.

1. Prior to construction, representatives from Spotsylvania County, VDOT, sPower, and the contractor will coordinate to drive the designated haul routes to collect observations and video footage of current pavement conditions. The pre-construction pavement conditions will be documented for future reference.
2. At the conclusion of construction, representatives from Spotsylvania County, VDOT, sPower, and the contractor will coordinate to drive the designated haul routes to collect observations and video footage of current pavement conditions. The post-construction pavement conditions will be documented and compared to pre-construction conditions.
3. At project completion, sPower will restore road damage determined to be caused by construction vehicle negligence in coordination with Spotsylvania County and to the satisfaction of VDOT as permitted.
4. If pavement along a haul route becomes damaged due to construction traffic, as confirmed with VDOT, to the point where it has become unsafe for use, sPower will repair the damage at their expense within 48 hours upon notice from the County's transportation planner and/or VDOT.

Temporary Traffic Control Measures

Temporary traffic control measures will be implemented in accordance with the most recent version of the Virginia Work Area Protection Manual (WAPM). Traffic control for construction activity within the public right-of-way will be implemented in accordance with typical traffic control applications. Necessary construction activity within the public right-of-way will be identified as construction documents are prepared and traffic control plans will be included in the construction documents as necessary.

Traffic control measures will also be installed at active construction entrances. These will include but are not limited to the following:

- advanced warning signs
- flaggers at the entrance location to facilitate truck turns for wide-load deliveries
- If sight distance is limited on the approach to a construction entrance, additional warning signs will be installed.
- temporary traffic signals
- reduced speed limits
- Additional construction traffic warning signage
- channelizing devices



These VDOT-approved measures may be implemented as needed and will be addressed during the site plan process and the VDOT permitting process.

Deliveries

Deliveries shall occur between the hours of 9:00 AM and 2:45 PM during the months of August through May to the extent practical to avoid school bus activity. Deliveries shall occur between the hours of 8:00 AM and 6:00 PM during all other months.

Delivery instruction shall be provided to all suppliers and contractors.

Trained employees shall assist when deliveries are accessing the Project Site.

Banksmen shall ensure the safe passage of pedestrians and vehicular traffic when vehicles are being loaded and unloaded.

Delivery vehicles shall not wait or stack on County roads.

Suppliers and contractors shall utilize primary delivery routes identified in this Construction Traffic Plan to the extent possible. In the event delivery routes are not feasible, new routes shall be identified and coordinated with Spotsylvania County staff.

sPower and its contractor shall issue maps to suppliers identifying primary delivery routes.

Identification of surrounding truck stops shall be identified prior to construction to ensure that trucks can stage overnight prior to scheduled deliveries.

sPower and its contractor shall coordinate a daily delivery schedule for suppliers and provide, via electronic distribution, to Spotsylvania County and nearby residents when available.

Permits for oversized or overweight loads, if any, on primary delivery routes shall be obtained from VDOT and coordinated with Spotsylvania County. Such permit loads shall be subject to the conditions of the permit at the time of issuance.

Safety

Speed limit signs of 15 mph shall be clearly displayed at all ingress and egress points, as well as throughout the Project Site.

At least two weeks prior to construction, residents, schools, and businesses along primary delivery routes shall be notified of the construction activities.

A 24-hour contact shall be provided to Spotsylvania County staff and residents for both the contractor and sPower. The contact shall be responsible for responding to inquiries or concerns of surrounding residents and businesses, as well as the general public.

Where necessary, flagmen with communication devices shall be used to coordinate delivery and hauling activities at the Project Site.

General construction signs shall be placed in pre-approved areas along primary delivery routes in the vicinity of the Project Site to notify residents of construction delivery locations.