Methodology Creation for Understanding Stressors of Solar Farm Development in Agricultural Wet-Meadows Type Wetlands

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I. Project Background

The arrival of industrial solar occurred on a widespread basis circa 2014 in Vermont. With the advent of this new industry came increased demand for land resources. Agricultural fields became an attractive option for siting solar projects because of the relative lack of tree clearing and site grading needed. In our observation as consultants, farmers and landowners began offering their wet agricultural lands to solar developers while retaining their "dry land" for continued agriculture. As a result, there was a flood of requests to permit development of solar projects on these wet agricultural lands.

Over the past 5 years, there has been ongoing discussion and debate about whether solar development in agricultural wetlands has an adverse impact on the significant functions and values of these wetlands. This project provides the opportunity to develop and implement a scientifically rigorous monitoring protocol to analyze and answer this question.

II. Project Overview

The Project components included developing and implementing a monitoring methodology for soils, hydrology and vegetation in wet meadow type wetlands associated with solar facilities. The Project consisted of three distinct phases: literature review, methodology development, and methodology implementation. The Project was conducted over an approximately two and a half year period with the literature review completed in the fall and early winter of 2017/2018, draft methodology completed in the spring of 2018, first year of monitoring in the summer of 2018, methodology revisions in the fall and winter of 2018/2019, second year of monitoring in the summer of 2019 and final methodology completed in the winter of 2020.

The first phase of the project was to conduct a literature review. We conducted a comprehensive review of the current scientific literature on topics related to solar development in agricultural wetlands. The goal of the literature review was two-fold: First, to identify the broader scientific research that has been conducted and review whether any conclusions have been drawn from this research regarding the impacts of solar development on wetland functioning. We sought out the current knowledge and substantive findings as well as any methodological contributions to the topic. Secondly, we evaluated the effectiveness of past methodologies used in Vermont to monitor the effects of solar projects on wetlands. The findings of the literature review and existing methodology review helped inform the development of a revised and more comprehensive methodology for the current project. The results of the literature review are presented in our report: Literature Review of Monitoring Methodology and Wetland Impacts from Solar Facilities (February 9, 2018).

The second phase of the project was to develop a scientific methodology to evaluate whether solar development impairs wet meadow wetland function and value in agricultural settings. When this particular wetland type is considered to be significant, it typically performs the functions of water quality protection and flood storage. These wetlands can also perform the function of erosion control when surface water features are present (i.e. streams). The methodology was designed to incorporate monitoring of vegetation, hydrology and soils parameters to specifically assess impacts to these three functions and values. The methodology was developed to be a flexible and adaptable method for future use beyond this project, considering the wide range of site characteristics.

The third phase of the project was to identify five existing solar development sites and to implement the monitoring methodology. AE and FEA worked with the Vermont Wetlands Program to screen potential sites and ultimately select the sites for this study. The selection process focused on choosing sites with a

variety of environmental and physical conditions. Factors such as soil type, slope, land-use history (row crop vs hay/pasture) and whether the site has been graded or not, went into the selection process. The goal of the site selection was to include as much variability as possible so that the methods could be tested and used in a wide variety of conditions.

A comprehensive Quality Assurance Project Plan (QAPP) was developed for the implementation of the Methodology and approved by EPA. The QAPP is a separate document prepared for VTDEC Wetlands Program Staff following site selection and site-specific methods refinement. The document includes specific site monitoring and sampling details and describes all sample collection methods, field and laboratory analyses, safety precautions, and statistical methods selected for the project, following guidance from USEPA. A list of all personnel assigned to sample collection, data analysis, project management, and QA/QC oversight are provided. The QAPP includes a draft sampling scheme overlain on aerial site imagery and draft versions of all field data collection sheets.

Monitoring was conducted for two years at each of the 5 solar sites. In addition to the collection of data, another goal of the monitoring task was to assess the methodology. Once the 2018 site sampling was completed, the techniques and methods for each of the primary and secondary parameters was reviewed. This review included assessing the efficacy and repeatability of each of the data collection methods. This review resulted in the recommendation to modify the methodology to better meet project goals and was outlined in the Year 1 Analysis Memo (5/30/19). Changes to the methodology were discussed with DEC staff and implemented for the 2019 field season. A second round of methodology review was conducted after the 2019 monitoring with resulting Year 2 Analysis Memo (12/30/20) and final revisions to the methodology.

In summary, the project involved the following key components:

- Phase 1: Literature Review (Literature Review of Monitoring Methodology and Wetland Impacts from Solar Facilities, February 9, 2018).
- Phase 2: Methodology Development (Draft 2017/2018 and Final 2020) and Quality Assurance Project Plan (QAPP)
- Phase 3: Implementation of Methodology at Five Select Solar Sites (2018 and 2019)

The focus of this report is documenting the development of the final methodology in terms of efficacy and repeatability of the protocols outlined and presentation of the results of the monitoring at the five selected solar sites.

III. Monitoring Methodology

A. Background

The purpose of the monitoring methodology as stated by the Vermont DEC is to create a scientifically sound methodology for sampling potential effects and stressors solar farms have on wetlands and what effects they may have on State protected wetland functions and values. DEC intends to continue collecting and analyzing data at permitted solar facilities and reviewing program policy. The intended result will be a better understanding of impacts from solar projects to inform permitting decisions for DEC, the solar community, and other regulatory agencies.

This comprehensive methodology incorporates analysis of vegetation as well as hydrologic, chemical and physical parameters. The identification of specific parameters that, when monitored, provide a quantifiable measure of change in site conditions is core to determining if solar development adversely

impacts agricultural wetlands. In addition to a detailed quantitative assessment, the methodology also includes a qualitative assessment to gather broader site data.

B. Preliminary Review and Site Base Mapping

The first step in the monitoring methodology is to conduct a preliminary site visit and develop a base map. The purpose of the preliminary review and site base mapping is to document existing site features. For un-developed sites, this will consist of two steps. The first step will be the preliminary review to identify pre-construction site conditions (wetland boundaries, hydrological features, erosion, bare soils, etc.) and the second step will be the follow up review to identify and develop the post-construction as-built survey of the solar arrays (development area, height and angle of arrays). For developed sites, the process will entail one step to identify existing site conditions and develop the as-built survey of the solar arrays.

We conducted pre-design base mapping at each of the selected 5 solar sites. This work included collection of all relevant existing GIS data including soils, high-resolution lidar-based topography (as available), existing wetland delineation data (as possible) and location of surface waters. New high-resolution aerial orthophotography was collected for each site utilizing a UAS (drone) which provides current imagery and digital surface models of the as-built conditions on-site. Arrowwood has an FAA licensed UAS pilot on staff who planned and conducted all base mapping flights fully in compliance with current regulations and best practices. This high-resolution imagery as a foundation for full site mapping, provided many capabilities including hydrologic pathway modeling, shadow analysis and monitoring plot design.

C. Shadow Analysis and Monitoring Plot Layout

The base map can be used to conduct a shading analysis of the solar arrays if an engineering analysis is not available from the solar project. We collected solar array height and slope data at each of the 5 sites during the preliminary site review and used this data in combination with the drone imagery to conduct a shading analysis. The purpose of the shading analysis is to determine zones of full sun and full shade which are used to establish the experimental sampling areas. Sampling areas are located within reference and impacted locations. The impacted locations consist of both full sun and full shade plots.

Locations of the sampling plots were randomly generated within both the reference and impacted study zones. Sub-meter GPS units and a printed base map were used to establish the plots in the field. We determined that minor in-field adjustments to plot layout may need to be made on a site by site basis, for instance to avoid a post obstruction. We also found that shifting of plot locations may be necessary to ensure placement in full sun and/or full shade zones as defined by the shading analysis. Critical to successful establishment of the plots was the combined use of the GPS unit with generated plot location and sun/shade zones with a printed out base map with same information.

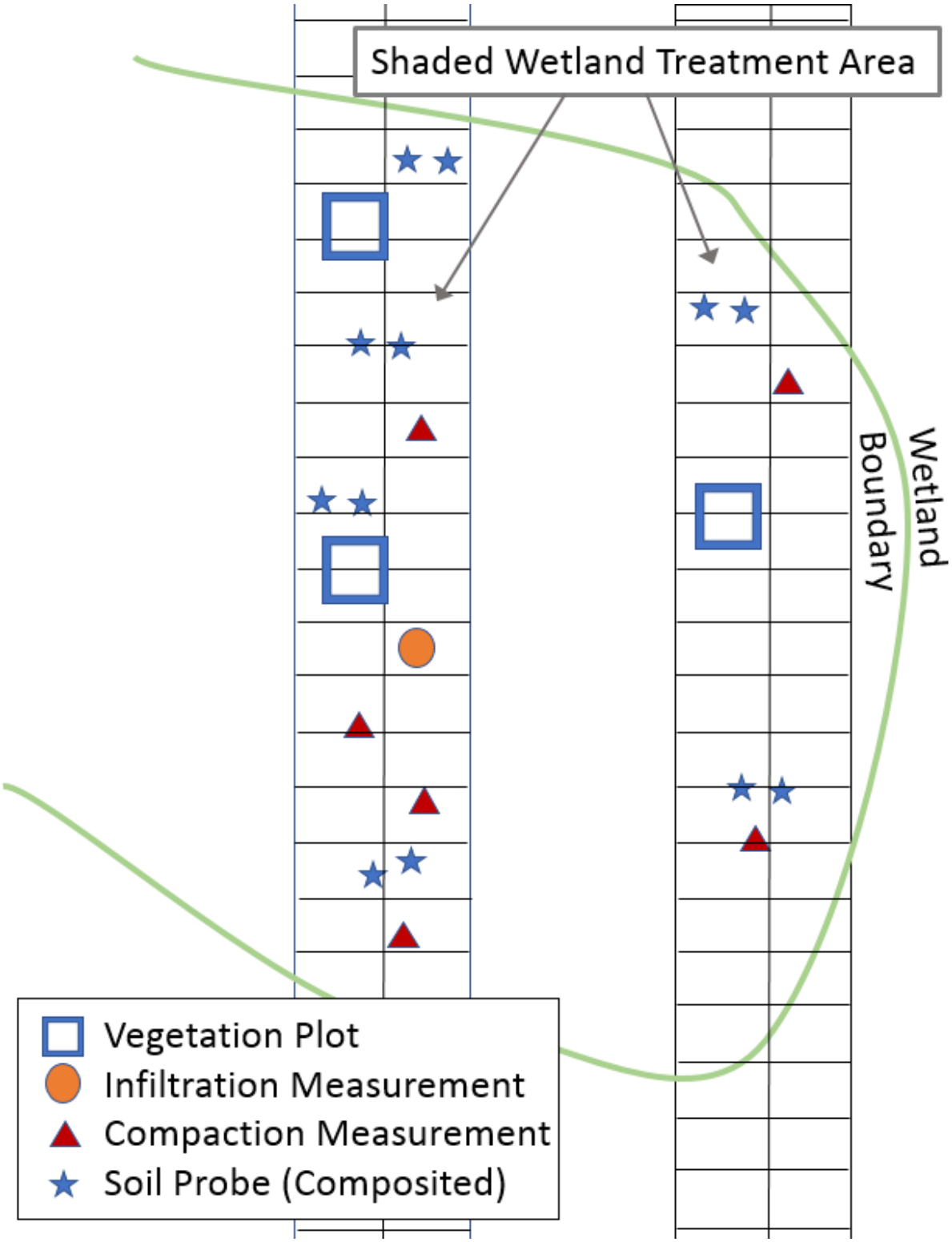


Figure 1 Example of sample collection locations randomly generated for the shaded (under panel) treatment areas within a solar array. A similar sampling distribution is utilized to characterize the rows between the panels for the full sun treatment areas.

D. Annual Qualitative Assessment

The purpose of the Qualitative Assessment is to document areas of erosion, bare soil, problematic vegetation or disrupted hydrology. A Qualitative Observations Data Form has been developed and was utilized during the 2018 and 2019 field season to document baseline conditions at the sites and identify and track problematic areas that may not be addressed by the quantitative sampling methods (discussed below). For the purposes of the 5 sites that were monitored for this study, the Qualitative Data Form coupled with photo documentation was sufficient to document and monitor problem areas. A Disturbance Tracking Data Form has been developed for this purpose and incorporated into the final methodology.

The methodology was revised to include the creation of a site plan map for each site which shows all sampling locations as well as any problem areas. This was not conducted during the current study due to time constraints. In addition, most of the sites are stable and problem areas did not differ significantly from 2018 to 2019. For sites that have recently been constructed, an annually updated site map for use in the field during monitoring would be beneficial. Maps were compiled upon completion of the current 2 year study and are presented in Appendix 1.

E. Vegetation Monitoring

The first step in the vegetation monitoring methodology is to physically set up the monitoring plots at each of the site locations. We established nine study plots at each of the 5 solar sites. Six plots are within the impacted sampling area: three plots in a Wetland Shade Treatment below the panels and three plots in the Wetland Sun Treatment in between the panels. The remaining three plots are located in the reference vegetation plots. The methodology provides clear instructions on the size and configuration of the plots. The added provisions to ensure year after year field identification of the plots is effective. The combination of a recorded GPS location, a strict north-south plot orientation, rebar set at the northwest corner and blue survey whiskers at all four plot corners resulted in ease of locating the monitoring plots in Year 2 of the monitoring effort.

The vegetation plots were set up at each of the 5 sites prior to the first year of monitoring by a qualified botanist. Combining the set up with the actual monitoring may be difficult to accomplish in a single day and would likely require two people.

The methodology calls for conducting the vegetation monitoring within a specified sampling window (June 15th-August 31st) and repeating annually within two weeks of the initial sampling date in order to have comparable data. However, it should be noted that site mowing is largely out of the control of the researcher. Therefore, there may be some years where vegetation data needs to be collected on recently mowed plots. For the most part, we do not find that this should not be a significant issue, especially if the previous year's data can be used to aid in identification of recently mowed vegetation.

We developed and revised vegetation monitoring field forms over the course of the two year study to collect consistent data on species composition, percent cover, plant height, and plant density. The vegetation data forms were filled out at each monitoring plot during both the 2018 and 2019 field seasons. These data forms collect sufficient data and are repeatable in subsequent years. The Year 1 Analysis Memo addressed the issue of inconsistent data from the sub-plots and this data collection was discontinued for the 2019 field survey. Specifically, we determined in 2018 that conducting stem counts in the sub-plots is often very difficult because most of the species present are graminoids and most of these are sterile. Sterile graminoids are very difficult to identify to species or (in some cases) genus. We also determined that trailing species which root at the nodes are difficult to count and a standard should be developed for these circumstances. Ultimately because it is unclear what meaningful analysis can be performed on stem counts since plant form is so widely variable (e.g. a single stem of goldenrod is not easily compared to a single stem of bluegrass), the collection of stem-count data in the sub-plots was discontinued.

Vegetation Data

Numerous factors of the vegetation data were included in the analysis, including total vegetation cover, species diversity, presence of Non-Native Invasive Species (NNIS), and plant form. Total plant cover is taken as a categorical data using the Braun-Blanquet cover categories. For analysis purposes, this categorical data must be converted to continuous data using the mid-points of each of the cover categories. Simpson's Index of Diversity (SID) was used to assess species diversity in the plots. This index takes into account not only the number of species present but also species abundance and evenness in the samples.

The presence and abundance of Non-Native Invasive Species (NNIS) in the different plot types was also analyzed. For the purposes of this study, a NNIS is a species that is a Class A or B noxious weed on the Vermont Department of Agriculture Noxious Weed Quarantine List. Species on the Vermont Invasive Species Watch List can also be tracked. However, analysis was not conducted on reed canary grass (*Phalaris arundinacea*) since this species is often planted as an agricultural crop and data on its presence/abundance may not therefore be related to solar development.

In addition to the above factors, the abundance of different plant forms was analyzed across all sites. This analysis was conducted to determine if shading from the solar arrays shifts the dominance from one plant form to another. Each species was categorized into its major plant form. The common plant form types

present at solar sites include: Graminoid (grasses/sedges/rushes), Woody (trees and shrubs), Forb (herbaceous), Liana (vines), and Ferns/Allies (ferns/clubmosses). The midpoints of the percent cover values of those plant forms was then used for the analysis.

A single-factor One-Way Analysis of Variance (ANOVA) was used to determine if there was a significant difference in a factor (e.g. plant cover, SID) between the three plot types. If the ANOVA test determined that there is at least one significant difference in the factor between plot types, the Tukey's HSD (honest significant difference) post-hoc test was used to determine which plot types were significantly different.

F. Hydrology Monitoring

The hydrology monitoring methods are comprised of primary and secondary parameters. Primary parameters are those that can be measured at any site, such as hydrologic pathways and erosion. Secondary parameters are those that may be suitable at certain sites, such as runoff monitoring and water quality sampling.

The location, size, and severity of surface runoff and erosion features were documented at all sites. These observations were collected during the October/November site visits for soil, compaction, and infiltration sampling. A new "Qualitative Observations Data Form" was developed for 2019 and was completed for each site. The new form coupled with photo documentation was sufficient to document and monitor problem areas. The five monitoring sites in this current study were not suitable for measurement of secondary parameters due to absence of concentrated runoff.

G. Soils Monitoring

Soils data collection included soil compaction testing, modified Philip-Dunne Soil Infiltration testing, composite soil sampling for nutrient analysis, metals analysis, and soil structure and texture characterization. The soil data collection field forms were used to provide consistent analysis across sites.

Soil Compaction

Soil compaction readings were simple and quick to obtain, with six (6) readings collected at each of the five sites to characterize soil compaction throughout each of the reference and impacted areas. Additional soil compaction measurements may also be used to define the boundaries of any distinct compacted areas (i.e., heavy vehicle traffic areas). Each compaction reading was entered into a field form and the location was logged with a sub-meter GPS.

Soil compaction was directly measured with a Dickey John Soil Compaction Tester. Other comparable compaction meters are available and should provide comparable results for readings up to 300psi. Soil compaction measurements were collected when the soils were moist or at field capacity (roughly 24-hours after a prolonged soaking rain), but not dry or saturated. Soil moisture was recorded at each sampling location using an Extech Soil Moisture Meter (Model MO750). All compaction measurements were collected by a single member of the Project Team to ensure sampling consistency. The compaction tester, fitted with the $^{3}/_{4}$" tip, was slowly pushed into the soil (ASAE 4E. S313.2, 1999). The maximum pressure (psi) was recorded for each 3" interval to a total depth of 24". The exact depth of any reading exceeding 300psi was recorded. Refusal due to rocky soils was recorded.

Soil Infiltration

The Modified Philip Dunne Infiltrometer (MPD) was used to conduct soil infiltration testing (ASTM Method D8152-16). This method uses the field-measured soil infiltration rates to interpolate saturated hydraulic conductivity. We constructed four (4) MPD samplers for this project, consisting of a 24-inch tall 4-inch wide PVC standpipe. Each standpipe was fitted with a 1" diameter clear PVC water level indicator. A ruler with millimeter graduations was attached to the water level indicator. The MPD sampling protocol is described below:

- A 4" diameter steel or rigid plastic ring is hammered 2" into the soil and carefully removed to create a pilot hole ring to minimize disturbance when the MPD is installed.
- The MPD is pounded 2" into the soil using a wooden block and a rubber mallet across the top of the standpipe.
- Soil moisture readings are collected in four (4) locations approximately 10" from the base of the MPD (not inside the MPD).
- Once the standpipe is installed, a 4" diameter piece of high porosity filter material may be placed on the ground surface within the standpipe if necessary to reduce soil disturbance.
- The standpipe is filled to a depth of at least 30cm (based on water level within the indicator tube)
- The time required for the first 1cm drop in water level is recorded. This time determines the recommended measurement interval for the remaining samples, see Table 1 below (modified from ASTM Method D8152-16 to have a maximum testing interval of 10 minutes).

- A minimum of twelve additional water level readings are collected at the determined interval.
- A modified (variable) sampling interval may be used to allow for concurrent sampler deployment.
- Time of reading (hr:min:sec) must be recorded for each reading.
- A final soil moisture reading is promptly collected after draining the sampler, from inside the sampler area.

The water level and time interval measurements (or variable time readings) along with the soil moisture data were entered into an infiltration rate and hydraulic conductivity calculation spreadsheet developed at the St. Anthony Falls Laboratory at the University of Minnesota. At least one MPD measurement was collected within each reference and impacted area. When infiltration rates dictated testing intervals of at least 4-6 minutes, multiple MPD samplers were concurrently deployed within a reference or impact area. It is important to note that the spreadsheet uses advanced calculations to interpolate the hydraulic conductivity once the soil has reached "saturation". The pre and post soil moisture readings are important for interpolating the results at saturation. As a result, the hydraulic conductivity values do not necessarily align with a visual representation of the infiltration rate over the duration of the sample collection.

Table 1 Recommended measurement time interval for the MPD infiltrometer test

Time to drop 1cm	<10 sec	10 sec	20 sec	40 sec	1 min	2 min	>5 min
Testing Interval	30 sec	40 sec	1 min	2 min	4 min	6 min	10 min

Soil Sampling

Representative composite soil samples were collected within each reference and impacted area. Soils were sampled using an AMS step-probe to collect a pair of cores (7/8" diameter) in 6 different locations within each reference or impacted area (at least 12 cores total). A sub-meter GPS was used to locate the sampling areas. The top 6" of soil (below the O horizon) was placed into a clean bucket and thoroughly mixed. Approximately 1 cup of the composite sample was bagged and labeled for analysis. Soil samples were submitted to the UVM Agricultural & Environmental Testing Laboratory. The "basic nutrient analysis" was completed on all samples to determine pH, available P, K, Ca, Mg, S, micronutrients, cation exchange, and organic matter. Metals analysis (Pb, Cu, Zn, Ca, Ni) was also completed on all samples. Replicate samples were submitted for 10% of the collected soil samples. Replicates were collected from the same bucket of composited soil cores to test for variability within the soil sample collection and laboratory analyses.

Soil structure and texture were described for at least two of the soil core locations within each reference and experimental area. An Edelman soil auger was used to collect soil cores to 24" of depth. Features such as rooting depth, hydric soil indicators, mineral horizon locations, and soil texture were described and photographed.

Soils Data

The soil sampling procedures were primarily used for method development and testing. The soil sampling and soil infiltration/saturated hydraulic conductivity methods yielded a single value for each sampling area within a site. The sample sizes are too small for any analysis within sites. Therefore, these results can only be assessed qualitatively and used for general interpretation of trends within and between sites.

IV. Site Monitoring and Data Analysis

The monitoring methodology was implemented at five existing solar facilities in 2018 and 2019. The sites are located in Clarendon, Ferrisburgh, Hinesburg, Middlebury and Sudbury. Data from each of the five sites is discussed and analyzed separately. A final analysis of trends across all sites is also presented. The five sites represent a range of conditions, including size (1 acre to 36 acres), power generation (7.46 kW to 2MW), array module type (fixed and tracker), and construction dates (circa 2010 to 2016).

A. Clarendon Solar

The Clarendon Solar site is a 2 MW generation facility that occupies ~36 acres, located at the intersection of Vermont Route 103 and Vermont Route 7. Details of the facility are presented in Table 2.

Table 2 Clarendon Solar Site Information

Date of Construction	2014
Type of Foundation	Concrete
Type of Modules	Fixed
Height of Panels	18" to 8'
Distance Between Panel Rows	15'

The Clarendon site map (Appendix 1) shows existing site conditions from UAS drone imagery taken on May 9, 2018. Overlaid on this map is the wetland boundary and monitoring locations. The reference wetland area is located outside of the fence to the south of the facility. The reference wetland is part of the same wetland that exists within the solar array and appears to be managed in the same manner.

1. Clarendon Solar Qualitative Observations

Wetland Hydrology and Soils

The wetland at the Clarendon Solar site contains unsaturated soils in the drier areas and much wetter, saturated soils in the low areas, especially in the southern end of the site. The site drains west to an emergent wetland which also receives runoff from Route 7 and Route 103. Areas of standing water were observed along the western portions of the solar array during field visits following rainfall events. Deep ruts from mowing were observed in the low areas in the western portion of the array. These ruts did not appear to change in degree or extent from 2018 to 2019. They are not located along any flow paths and are not expected to have a significant water quality impact.

A few small areas of exposed soils are present in the wetland and buffer, mostly between the panels. Though there was no excessive soil disturbance in the wetland or buffer that would negatively influence hydrology.

Wetland Vegetation

Overall, the wetland vegetation at the site is dominated by a mixture of wetland species such as sensitive fern (*Onoclea sensibilis*) and fox sedge (*Carex annectans*) and upland pasture species such as timothy (*Phleum pretense*) and bedstraw (*Galium mollugo*). The invasive species purple loosestrife (*Lythrum salicaria*) is present at the site at low (<5%) cover. During 2018 and 2019, mowing of the vegetation had occurred just previous to vegetation monitoring.

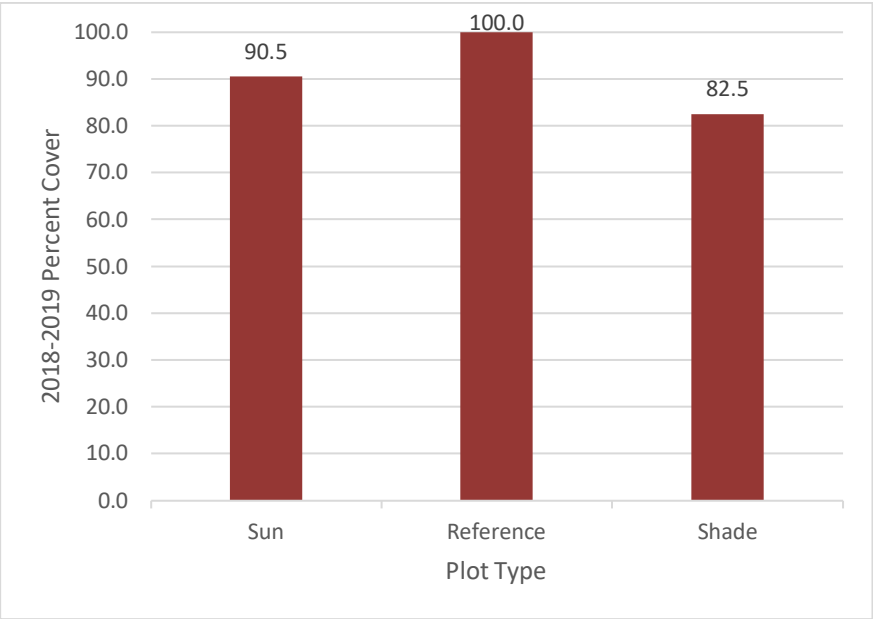
2. Clarendon Solar Quantitative Observations

Vegetation Monitoring

The vegetation monitoring occurred on August 28, 2018 and August 28, 2019. Data on species presence and abundance is presented in Appendix 2.

Percent cover of vegetation in all plot types was high in both 2018 and 2019 (greater than 87% on average for both years) and is presented in Figure 2.

Figure 2 Clarendon Average Percent Vegetation Cover



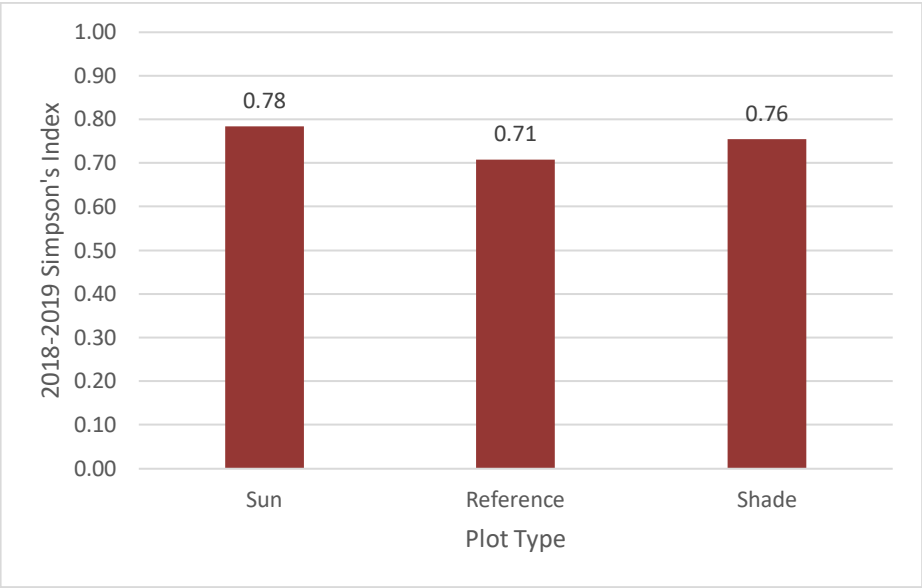
A single-factor ANOVA analysis was conducted on the percent cover data shown in Figure 2. Since this analysis focused on comparison of the different plot types, percent cover data from both 2018 and 2019 was averaged for this test and found to be significant at the p=.05 level (ANOVA(F(2,15))=7.38,p=.0058). A post-hoc Tukey HSD test was conducted to determine which plots had significantly different mean percent covers. This test determined that the Shade Plots (M=82.5, SD=11.7) had significantly lower mean percent cover than the Reference Plot (M=100, SD=0). Other plots showed no significant differences in percent cover.

Given the lack of pre-construction data, or data immediately following construction, interpretation of these results can only be speculative at this point. If the shade from the arrays was the only factor responsible for the lower percent cover, the results would be significant between the Shade and the Sun Plots. However, since these means are not significantly different other factors are likely involved. One possible factor is that the construction of the solar facility negatively impacted the percent cover within the arrays. While the Sun Plots have recovered from this disturbance since construction, the Shade Plots have not.

An analysis to determine abundance of non-native invasive species (NNIS) in the different plots was also conducted for this site. The only noxious weed that was present in the vegetation monitoring plots at this site was purple loosestrife (*Lythrum salicaria*). Using the mid-points of the percent cover categories, a single factor ANOVA analysis was conducted to determine if any of the plots had significantly different mean percent cover of purple loosestrife at the p=.05 level. Though the Shade Plots had higher percent cover of the noxious weed, the results fall just short of statistical significance, ANOVA(F(2,15))=3.425,p=0.059.

Finally, an analysis of species diversity was conducted of the plots using Simpson's Diversity Index. Like the percent cover data, the species diversity data for both 2018 and 2019 was compiled for this between-plot comparison and is shown in Figure 3. A single-factor ANOVA analysis was conducted on this data and no significant differences in mean index values was found, ANOVA(F(2,15))=1.52,p=0.249).

Figure 3 Clarendon Solar Plant Diversity



Soils Monitoring

Soil Compaction

Soil compaction measurements were collected for the Clarendon Solar site on 11/5/2018 and 10/14/2019. Rocky subsoils were encountered throughout the study area resulting in incomplete measurements of the soil profile. Probe refusal was encountered at almost all sampling locations at depths ranging from 6 to 21 inches. As a result, the soil compaction measurements from the Clarendon site are not sufficient for analysis or interpretation. Two sampling points (Shade 3 and Shade 4) were the only locations both years where we were able to complete the soil compaction measurement.

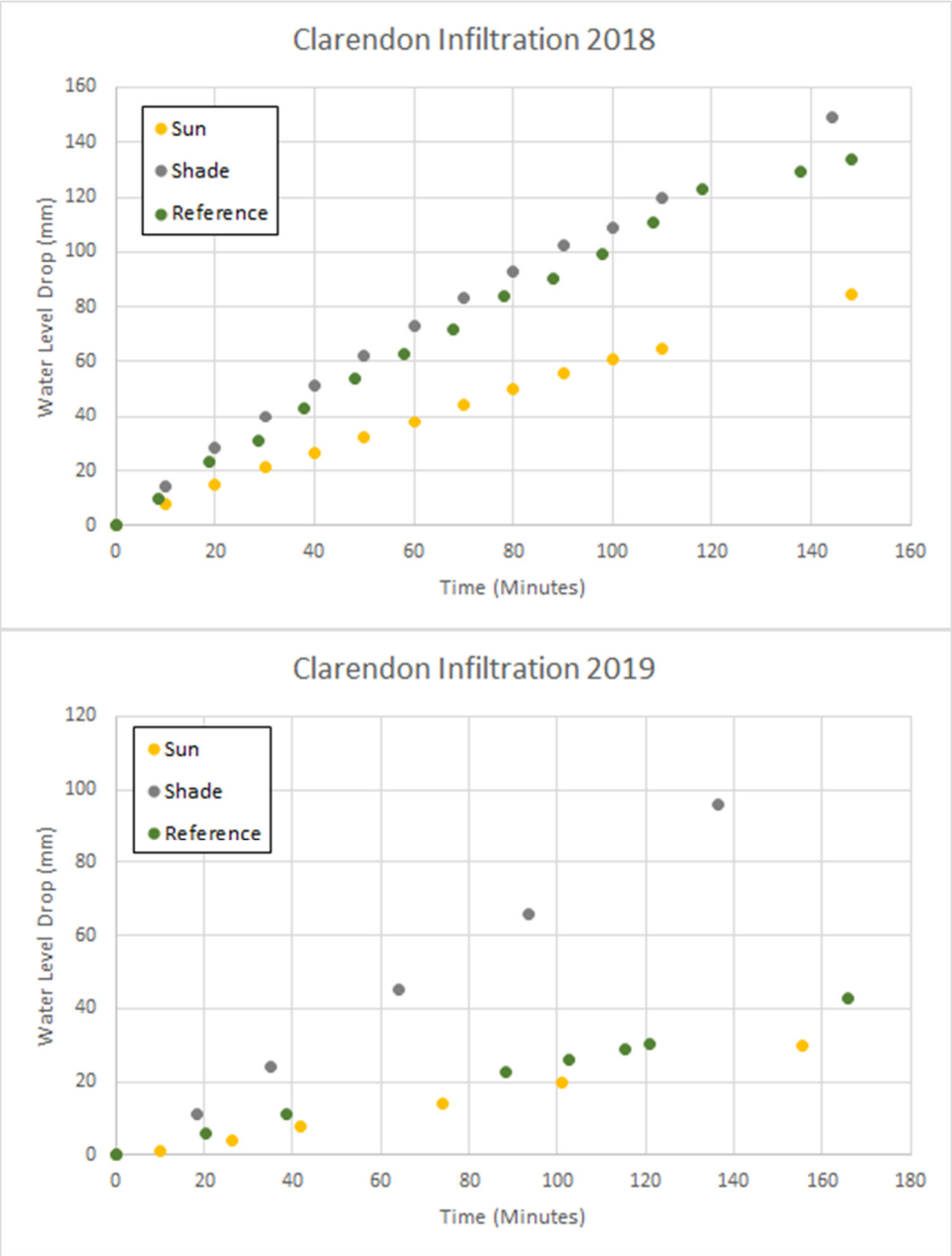
Soil Infiltration

Soil infiltration measurements were collected for the Clarendon Solar site on 11/5/2018 and 10/14/2019. Soil moisture conditions were consistent for both years across all sites, ranging from 15% to 24%. The calculated hydraulic conductivity rates are shown in Table 3. The Reference samples had the highest infiltration/conductivity both years and the Sun samples had the lowest. The low infiltration rates for the "Sun" samples-located in the open spaces between arrays, may be indicative of soil compaction due to ongoing maintenance activities and potentially from heavy equipment used during the installation of the array.

Table 3 Hydraulic conductivity rates (in/hr)

	2018	2019
Sun	0.84	0.04
Shade	0.12	0.13
Reference	0.24	0.05

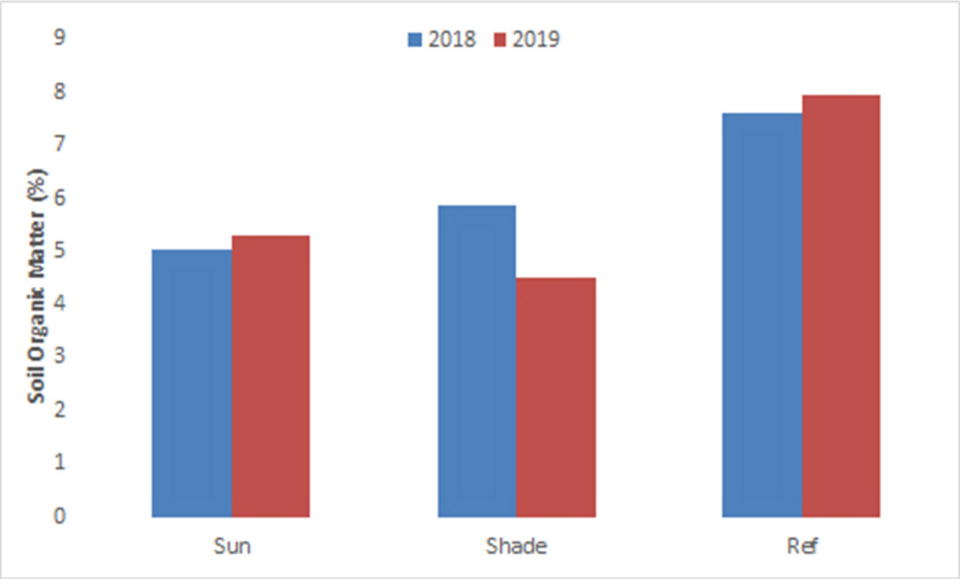
Figure 4 Clarendon Solar Soil Infiltration Rates



Soil Sampling

Soil samples were collected for the Clarendon site on 8/7/2018 and 10/14/2019. Overall, soil sampling results were variable with no apparent trends for most of the parameters included in the suite of soil analyses. We observed that organic matter was 20-50% higher in the reference areas compared to the impacted areas for both sampling years (Figure 5). Increased mowing frequency within the array may decrease primary productivity, reducing organic matter.

Figure 5 Clarendon Solar Soil Organic Matter



B. Ferrisburgh Solar

The Ferrisburgh Solar facility is located along Route 7, just north of the junction with Route 22A in the town of Ferrisburgh. This 7.46 kW generating facility occupies approximately 1 acre of land. Facility details are presented in Table 4.

Table 4 Ferrisburgh Solar Facility Details

Date of Construction	2013
Type of Foundation	Post
Type of Modules	Fixed
Height of Panels	18” to 6’
Distance Between Panel Rows	20’

The Ferrisburgh site map (Appendix 1) shows existing site conditions from UAS drone imagery taken on May 9, 2018. Overlaid on this map is the wetland boundary and monitoring locations. The Reference Wetland is located to the southwest of the facility across a managed hay field.

1. Ferrisburgh Solar Qualitative Observations

Wetland Hydrology and Soils

The wetland soils at the Ferrisburgh site consists mostly of unsaturated soils, at least at the time of the field visits. In 2019, there was some evidence of recent flow through the middle of panel rows with some localized saturated soils along the flow path. No areas of standing water were present in the wetland.

The Reference Wetland contains small hummocks of vegetation, though no saturated soils or standing water were present. The Reference Wetland is generally drier than the wetland within the array and has no visible surface flow paths. There are not areas of excessive soil disturbance in the wetland or buffer that may influence hydrology. Some small areas of exposed soils are present in the shaded areas beneath the arrays.

Wetland Vegetation

The wetland at this site is dominated by a mixture of wetland species such as reed canary grass (*Phalaris arundinacea*) and dark green bulrush (*Scirpus atrovirens*) and upland species such as timothy (*Phleum pretense*) and bird's foot trefoil (*Lotus corniculatus*). The only NNIS present is the watchlist species reed canary grass. Mowing of the vegetation occurs once per year. During the 2018 vegetation monitoring, the yearly mowing had not yet been conducted on the site. During the 2019 field season, vegetation monitoring was conducted when the mowing between the rows had been completed but the mowing beneath the solar panels had not yet been done.

2. Ferrisburgh Solar Quantitative Observations

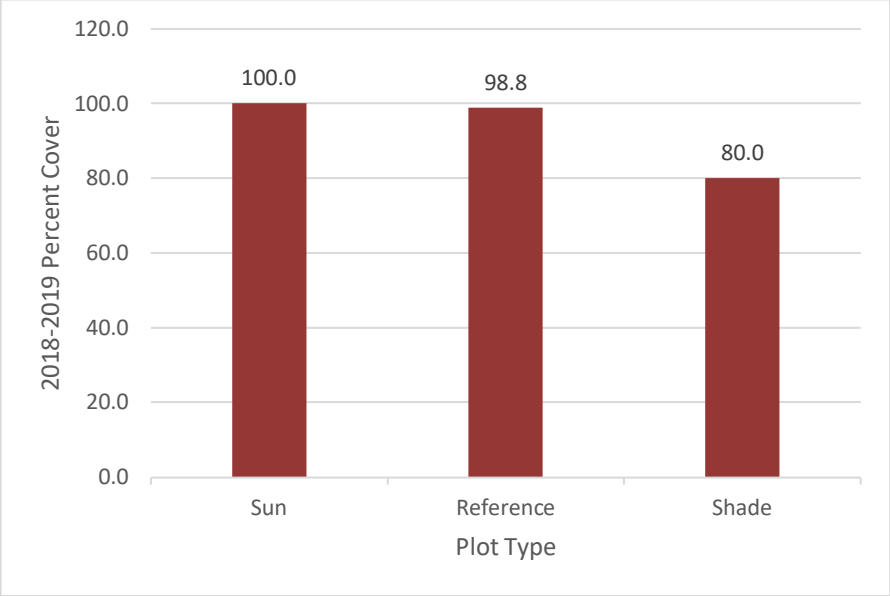
Vegetation Monitoring

The vegetation monitoring occurred on August 27, 2018 and August 26, 2019. Data on species presence and abundance is presented in Appendix 2.

Percent cover of vegetation in all plot types is presented in Figure 6. A single-factor ANOVA analysis was conducted on the percent cover data shown in Figure 6. Since this analysis focused on comparison of the different plot types, percent cover data from both 2018 and 2019 was averaged for this test and found to be significant at the p=.05 level (ANOVA(F(2,15))=4.68,p=.026). A post-hoc Tukey HSD test was conducted to determine which plots had significantly different mean percent covers. This test determined that the

Shade Plots (M=80, SD=21.9) had significantly lower mean percent cover than both the Reference Plots (M=100, SD=2.0) and the Sun Plots (M=100,SD=0).

Figure 6 Ferrisburgh Solar Average Percent Vegetation Cover

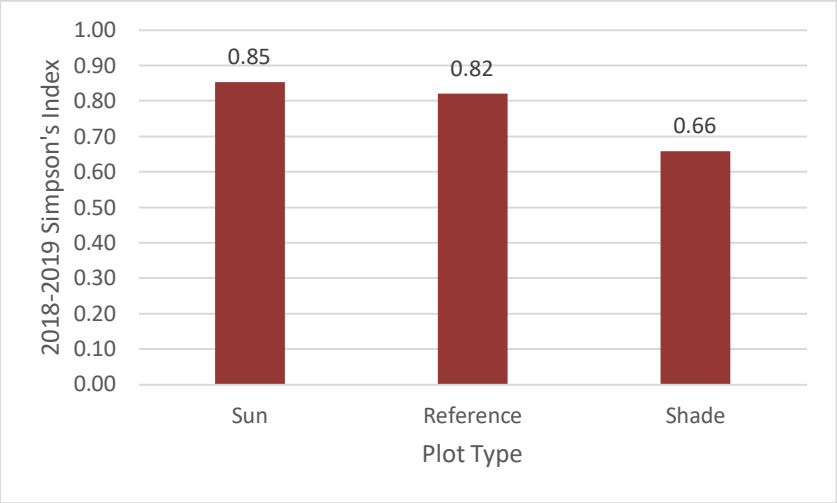


The lower percent cover in the Shade Plots compared to the Sun and Reference Plots suggests that, at this site, the solar arrays are having a statistically significant impact on percent cover of vegetation. As noted above, small areas of bare soil are present in the shaded areas beneath the arrays. However, no areas of significant soil erosion, or other disturbance that would impact wetland function appears to be associated with this decrease in percent cover. Data collection in subsequent years may provide more insight into this issue.

There were no NNIS other than reed canary grass documented within the plots at this site.

Finally, an analysis of species diversity was conducted using Simpson's Diversity Index. This data is shown in Figure 7. Though the Shade Plots show lower Diversity Index scores, there was no statistically significant difference between group means as determined by ANOVA($F(2,15)=3.23, p=0.068$).

Figure 7 Ferrisburgh Solar Plant Diversity



Soils Monitoring

Soil Compaction

Soil compaction measurements were collected for the Ferrisburgh site on 10/30/2018 and 10/10/2019. Rocky subsoils were encountered at the lowest measurement interval (24 inches) for 5 readings in 2018 and at 18 inches for one reading in 2019. The Shade sampling locations have consistently lower compaction readings than both the Sun and Reference locations throughout the vertical sampling profile. These findings likely indicate moderate soil compaction from the farm equipment used on the hay field. The reduced mowing frequency within the Sun sampling area (once per year) may result in minor soil compaction, when compared to the Shade areas.

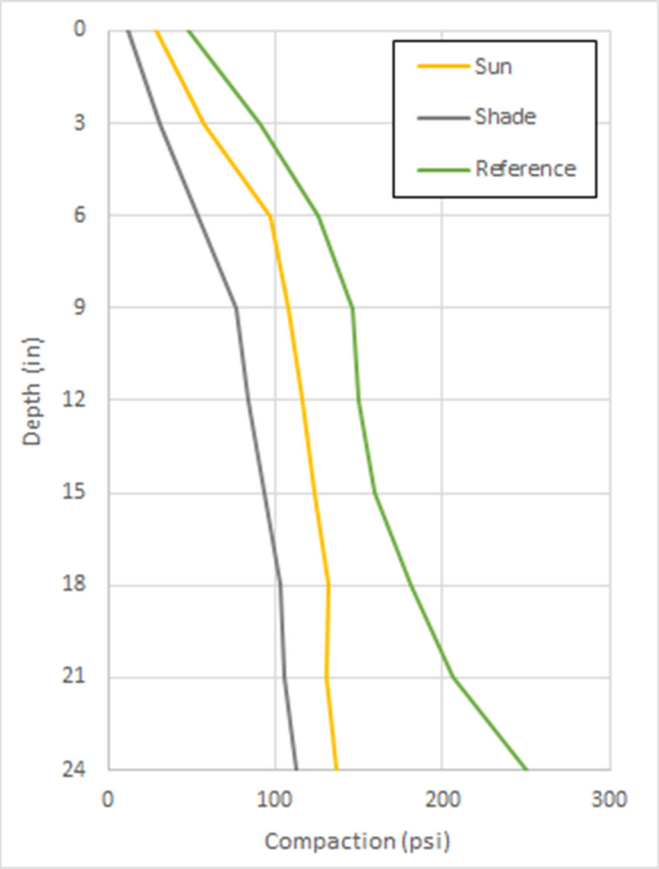


Figure 8 Ferrisburgh Soil Compaction

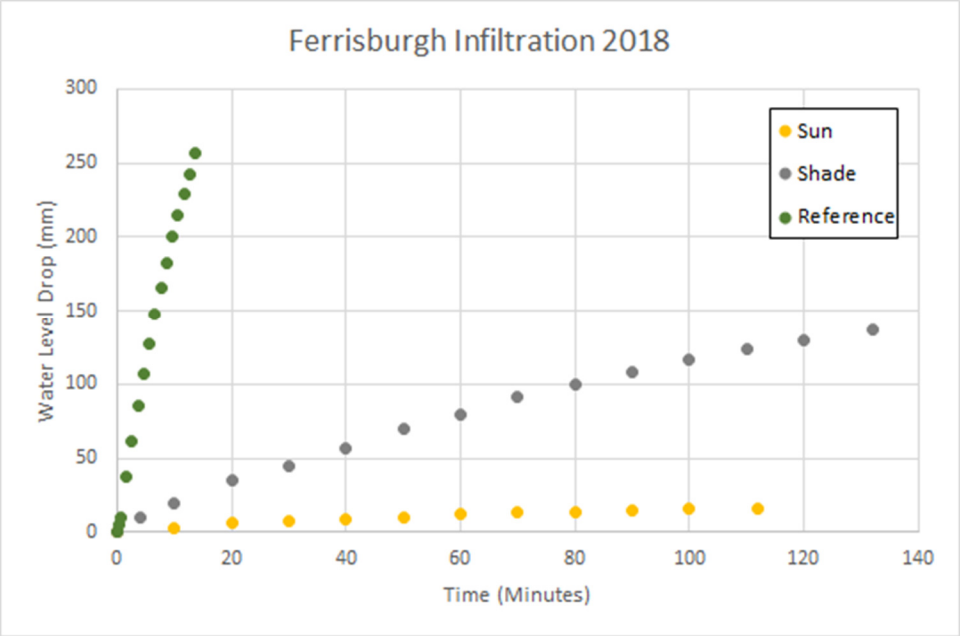
Soil Infiltration

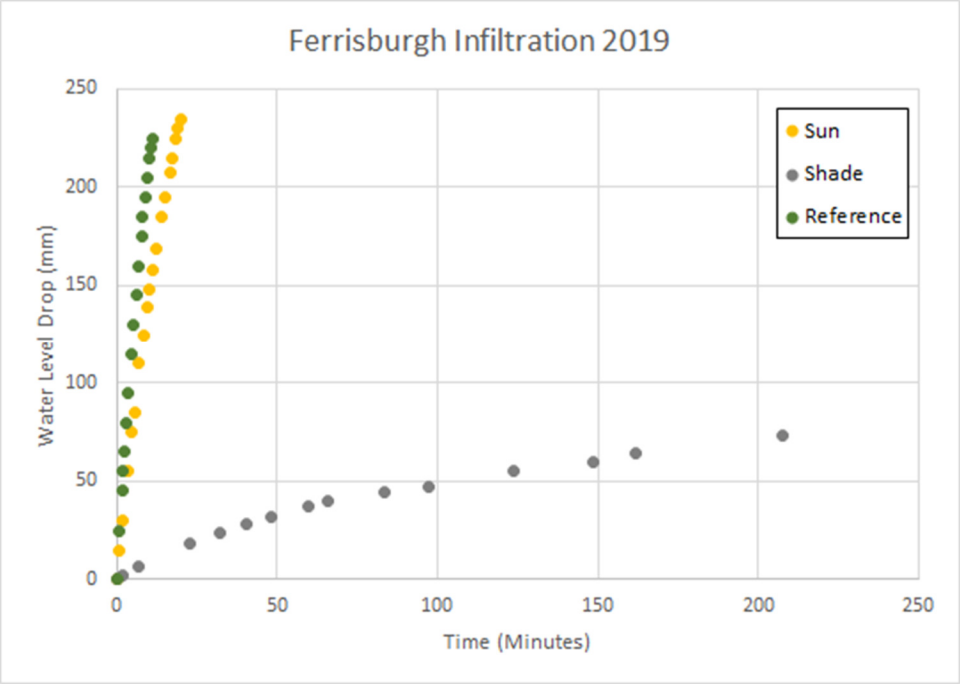
Soil infiltration measurements were collected for the Ferrisburgh Solar site on 10/30/2018 and 10/10/2019. Soil moisture conditions were consistent for both years across all sites, ranging from 16% to 26%. The calculated hydraulic conductivity rates are shown in Table 5. The Reference samples had the highest infiltration/conductivity both years. The variability in the Sun samples is not due to soil moisture. The MPD sampler can read an artificially high infiltration rate if there are soil macropores present in the sampling location. It is possible that the 2018 sampler was installed in a location that was affected by localized compaction, however we suspect that the 2019 reading was affected by macropores or other soil drainage features that were not visible during sample collection. We observed increased compaction throughout the Reference area based on the soil penetrometer readings, therefore the increased infiltration rate is likely due to site topography and drier subsoils.

Table 5 Hydraulic conductivity rates (in/hr)

	2018	2019
Sun	0.02	8.99
Shade	1.51	0.73
Reference	7.92	16.20

Figure 9 Ferrisburgh Solar Soil Infiltration





Soil Sampling

Soil samples were collected for the Ferrisburgh site on 8/9/2018 and 10/10/2019. Overall, soil sampling results were variable with no apparent trends for most of the parameters included in the suite of soil analyses.

C. Hinesburg Solar

The Hinesburg Solar site is a 143.6 kW generation tracker facility that occupies approximately 1.4 acres in an old field off of Mechanicsville Road just north of Hinesburg village. Vegetation management (mowing) occurs at this site on a 5-year rotation.

Table 6 Hinesburg Solar Array Site Information

Date of Construction	Circa 2010
Type of Foundation	Post
Type of Modules	Tracker
Height of Panels	4’
Distance Between Panel Rows	40’

The Hinesburg site map (Appendix 1) shows existing site conditions from UAS drone imagery taken on May 9, 2018. Overlaid on this map is the wetland boundary and monitoring locations. The Reference Wetland is located to the east of the solar arrays and is part of the same wetland as the Sun and Shade Plots and is managed in the same manner. During the 2018 field sampling, the vegetation had not been mowed. During the 2019 field sampling, the vegetation had been mowed approximately 3 weeks prior to vegetation sampling.

3. Hinesburg Solar Qualitative Observations

Wetland Hydrology and Soils

The site is bordered by Patrick Brook to the East and an unnamed tributary to the LaPlatte River to the north, west, and south. Large beaver dams on the tributary to the north of the site have created a large wetland complex with large areas of standing water in the spring. The wetland in the study area consists of poorly drained soils which prevent drainage and aids in development of wetland conditions. No standing water was present at the time of sampling in 2018 and 2019, though it is apparent that standing water does occur for some periods during the growing season. There are minor hummocks from sedges in the wetter areas of the wetland, and these areas typically have saturated soils. Hydric soil indicators were present throughout the mapped wetland, however we observed very dry soil conditions within the solar array during both the 2018 and 2019 sampling period. Soils in the Reference wetland area were wetter both years.

There are no exposed soils present in the wetland/buffer within the Project area. There are some ruts present but these do not appear to significantly impact wetland hydrology. We observed rock chips and less pronounced layering within the soil profile for the sampling areas under the tracker panels. This suggests that fill soils may have been incorporated, or that deeper subsoils may have been disturbed and brought to the surface during installation of the anchoring posts.

Wetland Vegetation

The flora of this site is relatively diverse. Dominant species include Canada golden rod (*Solidago canadensis*), sedges (*Carex annectans* and *Carex spp*.), and joe-pye-weed (*Eutrochium maculatum*). Non-native species meadow parsnip (*Pastinaca sativa*) and reed canary grass (*Phalaris arundinacea*) are present with 10% and 5% cover, respectively.

4. Hinesburg Solar Quantitative Observations

Vegetation Monitoring

The vegetation monitoring occurred on August 27, 2018 and August 26, 2019. Data on species presence and abundance is presented in Appendix 2.

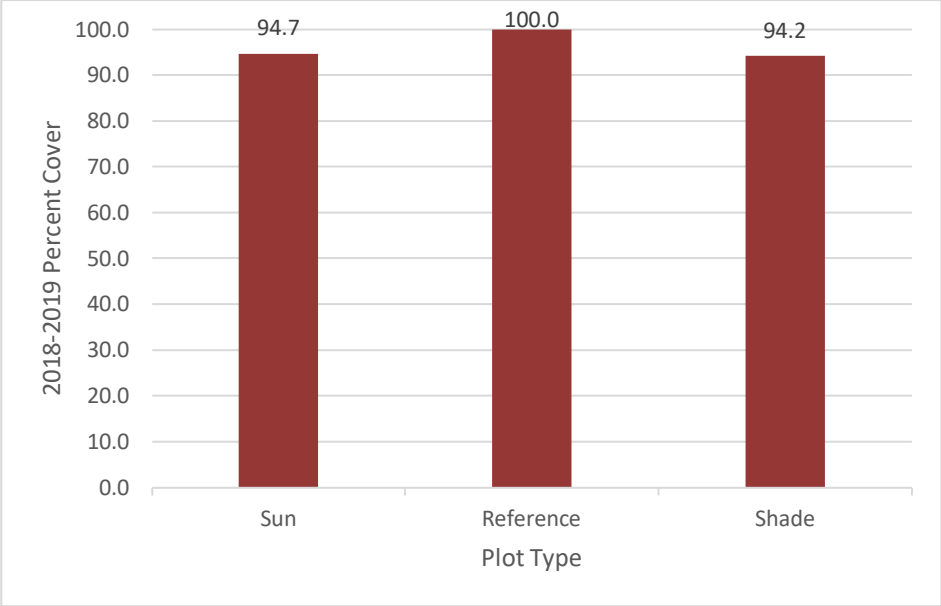
Percent cover of vegetation in all plot types was fairly high in both 2018 and 2019 (greater than 80% on average for both years) and is presented in Figure 10.

A single-factor ANOVA analysis was conducted on the percent cover data shown in Figure 10. Since this analysis focused on comparison of the different plot types, percent cover data from both 2018 and 2019 was averaged for this test and found to be significant at the p=.05 level (ANOVA(F(2,15))=3.70,p=.049). A post-hoc Tukey HSD test was conducted to determine which plots had significantly different mean percent covers. This test determined that the Reference Plots (M=100, SD=0) had significantly higher mean percent cover than both the Sun Plots (M=94.7, SD=5.2) and the Shade Plots (M=94.1,SD=4.9).

The definitive reason for these differences is not currently known. The reference area is observed to be wetter than the array area. Since vegetation in both areas is managed the same, difference in management is not the cause. Impacts from construction could also explain these differences, assuming that no construction machinery was used in the reference area.

It should be noted that percent cover in the Sun and Shade plots is still quite high. While the differences with the Reference plots are statistically significant, they may not be ecologically significant.

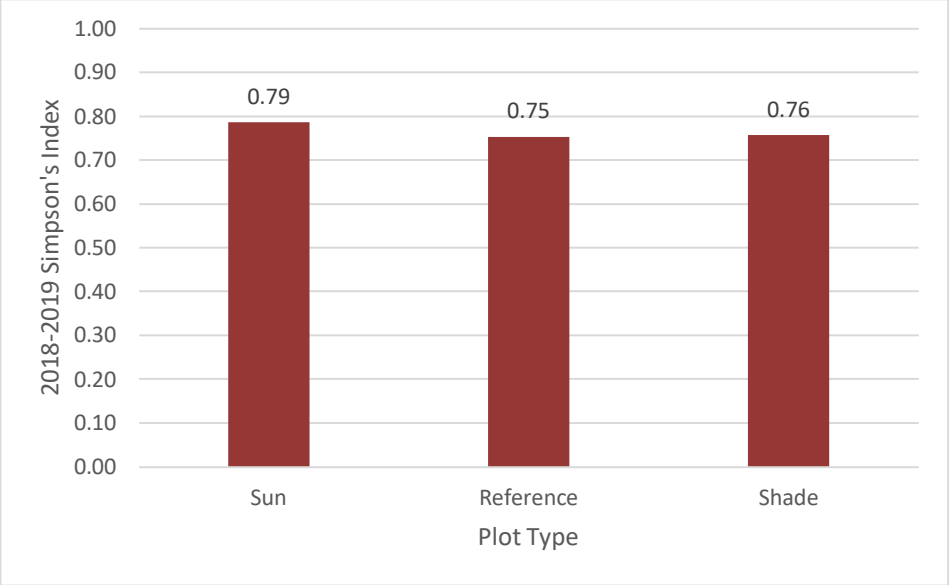
Figure 10 Hinesburg Solar Average Percent Cover



An analysis to determine abundance of NNIS in the different plots was also conducted for this site. There were no "Noxious Weeds" present in the vegetation monitoring plots at this site. The only "Watch List" species present, other than reed canary grass, was meadow parsnip. No statistical analysis could be conducted on this data because in both the Reference and Sun plots, there were only single occurrences of meadow parsnip.

Finally, an analysis of species diversity was conducted using Simpson's Index of Diversity. This data is shown in Figure 11. There was no statistically significant difference between group means as determined by ANOVA(F(2,15))=0.33,p=0.73).

Figure 11 Hinesburg Solar Plant Diversity



Soils Monitoring

Soil Compaction

Soil compaction measurements were collected for the Hinesburg site on 10/30/2018 and 10/10/2019. Rocky subsoils were encountered in all sampling locations within the solar array and some of the reference sampling locations. The depth to rocky soils was variable, with refusal typically encountered between 9 and 15 inches. As a result, the soil compaction measurements at the Hinesburg site are not suitable for interpretation or analysis.

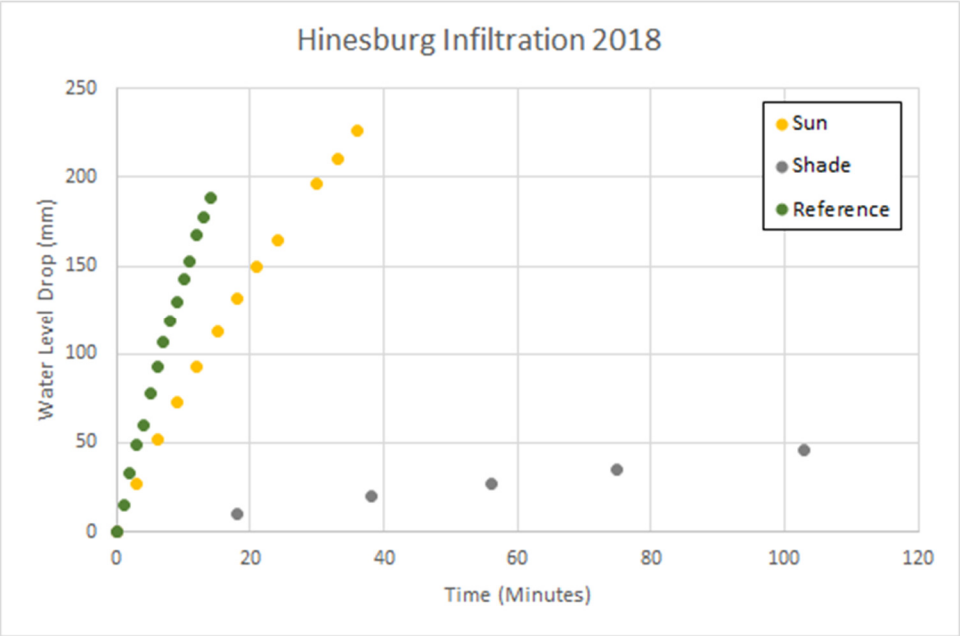
Soil Infiltration

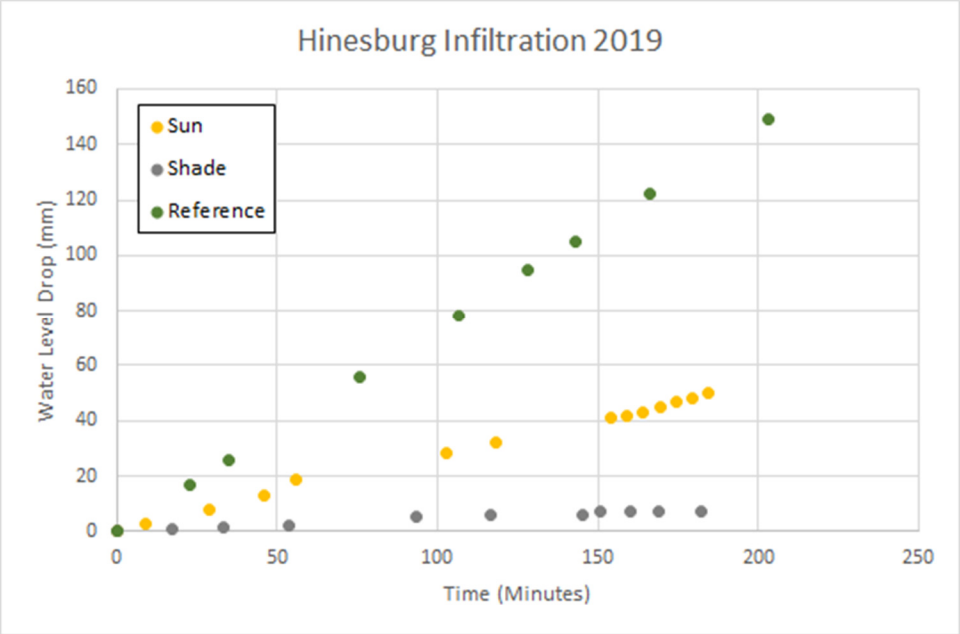
Table 7 Hydraulic conductivity rates (in/hr)

	2018	2019
Sun	3.54	0.39
Shade	0.82	0.004
Reference	7.74	0.10

Soil infiltration measurements were collected for the Hinesburg Solar site on 10/30/2018 and 10/10/2019. Soil moisture conditions were drier than other sites, ranging from 2% to 11%. Soils were driest in the Sun sampling area both years and wettest in the Reference area. The calculated hydraulic conductivity rates are shown in **Error! Reference source not found.**. The Shade samples had the lowest infiltration/conductivity both years. We observed rock chips and a loss of visible layering in the soil profile in several of the soil samples collected under the tracker arrays. Fill soils may have been incorporated into the native soil to improve anchoring of the tracker posts. We also observed higher compaction readings at 6 inches of depth under some of the panels, compaction close to the surface would decrease infiltration rates.

Figure 12 Hinesburg Solar Soil Infiltration





Soil Sampling

Soil samples were collected for the Hinesburg site on 8/9/2018 and 10/10/2019. While the sample size is too low for statistical analysis of results between the Reference area and the sample sites within the solar array (Sun and Shade), we observed trends for most of the analyzed soil parameters. For both years of the study, the Shade samples had lower concentrations for organic matter and for most of the nutrients included in the analysis (calcium, magnesium, boron, manganese, and iron). In addition, the Shade samples had higher values for all of the reported heavy metals (lead, nickel, cadmium, and chromium) and for aluminum and zinc. The reduced nutrient concentrations may be a result of fill soils or the

incorporation of deeper nutrient-poor subsoils during the construction process. The increased metal levels may indicate minor wash off of metals from the galvanized solar tracker hardware.

D. Middlebury Solar

The Middlebury Solar facility is located along Route 125 just west of the Middlebury College campus. This 143 kW generation facility occupies approximately 1.5 acres of land managed as a mowed lawn. There is a managed recreation path that goes through the solar facility.

Table 8 Middlebury Solar Site Information

Date of Construction	2011
Type of Foundation	Post
Type of Modules	Tracker
Height of Panels	5' - 20'
Distance Between Panels	30'- 40'

The Middlebury site map (Appendix 1) shows existing site conditions from UAS drone imagery taken on May 9, 2018. Overlaid on this map is the wetland boundary and monitoring locations. Since this area is managed as a mowed lawn, vegetation is kept at a height below 3" and appears to be mowed weekly. The Reference Wetland is located to the west of the solar facility in an agricultural field. This wetland is managed for hay production. In 2018, the portions of the Reference Plots had been recently mown for hay; the parts that had not been mowed were mowed earlier in the season. In 2019, the field was not mowed as far to the east, perhaps due to the presence of wooden grade stakes marking the corners of the vegetation sampling plots. As a result, the vegetation plots and several of the soil sampling and soil compaction locations were not mowed in 2019.

1. Middlebury Solar Qualitative Observations

Wetland Hydrology/Soils

The site is located at the confluence of three perennial streams managed as agricultural ditches, all draining into unnamed tributary to Otter Creek, flowing northeast along the western boundary of the solar array. Site saturation conditions vary seasonally with ponded water and saturated soils present in numerous sampling locations in the fall. There are only very small areas of exposed soils present in the wetland/buffer, the result of mowing activity and herbicide application.

Wetland Vegetation

The Middlebury Solar facility is under a routine vegetation management regimen. Dominant species include Kentucky blue grass (*Poa pratensis*), timothy (*Phleum pretense*), common dandelion (*Taraxicum officinale*) and common plantain (*Plantago major*). Non-native species reed canary grass in found at the site. The Reference Wetland is managed as a hay field, though has been variably mowed/unmowed during vegetation sampling.

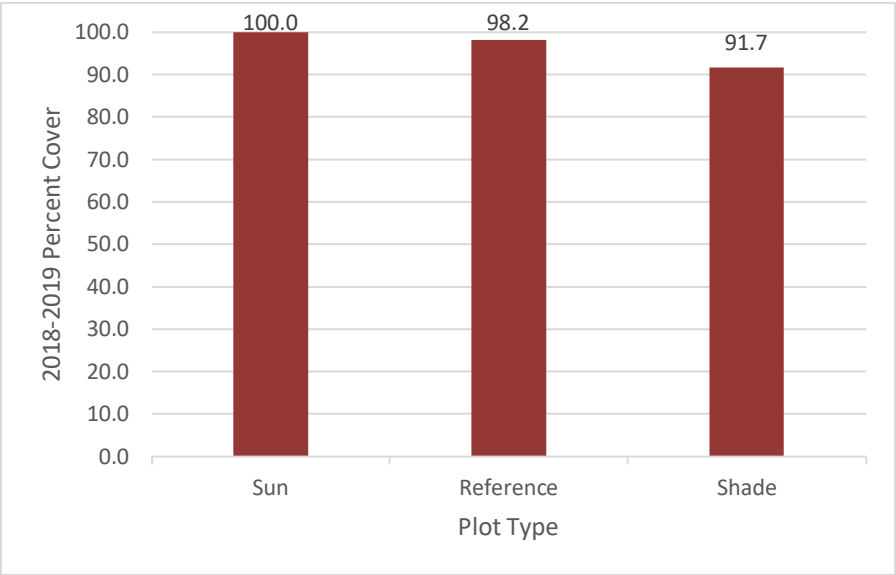
2. Middlebury Solar Quantitative Observations

Vegetation Monitoring

The vegetation monitoring at the Middlebury Solar site occurred on August 28, 2018 and September 6, 2019. Data on species presence and abundance is presented in Appendix 2. Percent cover of vegetation in all plot types was fairly high in both 2018 and 2019 (greater than 90% on average for both years) and is presented in Figure 13.

A single-factor ANOVA analysis was conducted on the percent cover data shown in Figure 13. Since this analysis focused on comparison of the different plot types, percent cover data from both 2018 and 2019 was averaged for this test and found to be significant at the p=.05 level (ANOVA(F(2,15))=5.39,p=.017). A post-hoc Tukey HSD test was conducted to determine which plots had significantly different mean percent covers. This test determined that the Shade Plots (M=91.7, SD=7.5) had significantly lower mean percent cover than both the Sun Plots (M=100, SD=0) and the Reference Plots (M=98.2,SD=2.7).

Figure 13 Middlebury Solar Average Percent Cover



Like the Ferrisburgh site, the lower percent cover in the Shade plots compared to the Sun and Reference Plots suggests that, at this site, the solar arrays are having a statistically significant impact on percent cover of vegetation. No areas of significant soil erosion, or other disturbance appears to be associated with this decrease in percent cover. Data collection in subsequent years may provide more insight into this issue.

There were no NNIS other than reed canary grass documented within the plots at this site.

Figure 14 Middlebury Solar Plant Diversity

Finally, an analysis of species diversity was conducted using Simpson's Diversity Index. This data is shown in Figure 14 and the means found to be significantly different at the p=.05 level (ANOVA(F(2,15))=15,p=0.0003). A post-hoc Tukey HSD test was conducted to determine which plots had significantly different mean diversity indices. This test determined that the Reference Plots (M=.36, SD=.13) had significantly lower diversity indices than both the Sun Plots (M=.75, SD=.07) and the Shade Plots (M=.62,SD=.15).

The reason for these differences may be the result of the different management employed at the Reference Plots. The Reference Plots consist of forage species and the area managed for hay production, while the Sun and Shade Plots were planted to turf grasses and managed as lawn.

Soils Monitoring

Soil Compaction

Soil compaction measurements were collected for the Middlebury site on 10/30/2018 and 11/18/2019. Soil compaction readings were fairly consistent across all sampling locations. One sampling location (Shade 4 in 2019) had a reading over 300psi, however this was due to rocky subsoil, not excessive compaction. We did observe some measurements that suggested compaction from hay harvesting equipment, and possibly compaction from maintenance/mowing within the solar array. ***Figure 15*** shows the mean soil compaction at each depth reading for the Sun, Shade, and Reference sampling areas, and includes 2 additional profiles of single measurements which suggest soil compaction from tractor and mower/maintenance vehicle activity within the sampling areas. Compaction at these depths is less likely to be reduced through natural activities such as freezing/thawing and plant roots[1]. It is important to note that both of these sampling locations (Sun 3 and Reference 2) did not show increased compaction for the other monitoring year. Given the depth of the compaction it is more likely that the year to year variation is due to the variation in measurement location than from a change in the soil compaction profile over a relatively short time period.

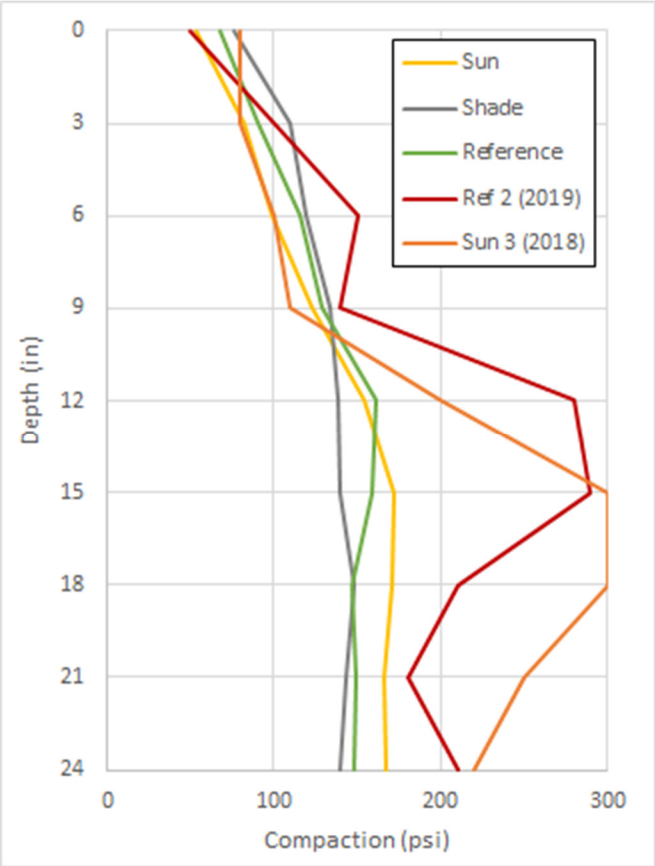


Figure 15 Middlebury Solar Soil Compaction

[1] Raper, R. L. (2005). Agricultural traffic impacts on soil. In Journal of Terramechanics. https://doi.org/10.1016/j.jterra.2004.10.010

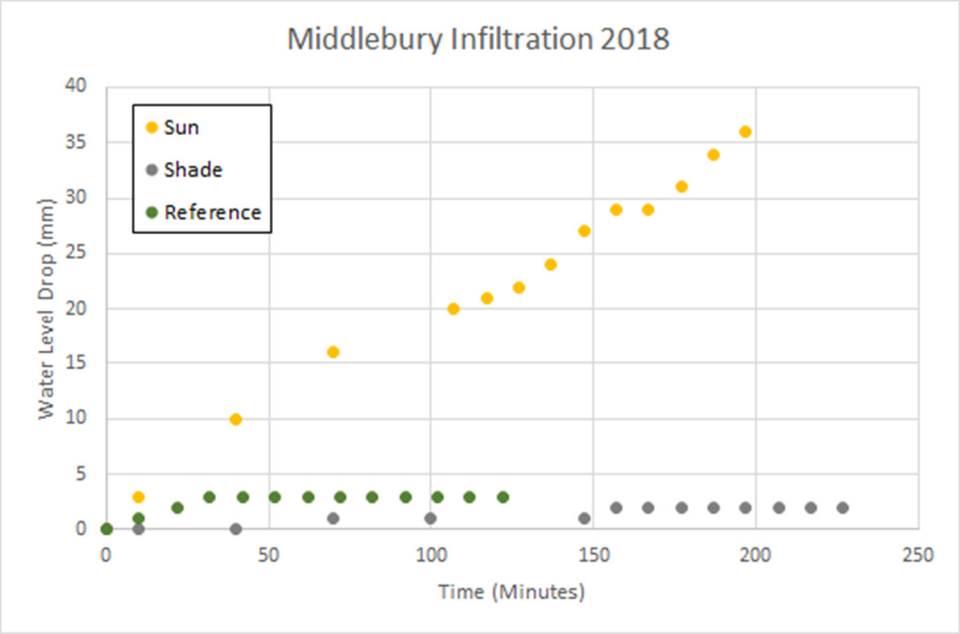
Soil Infiltration

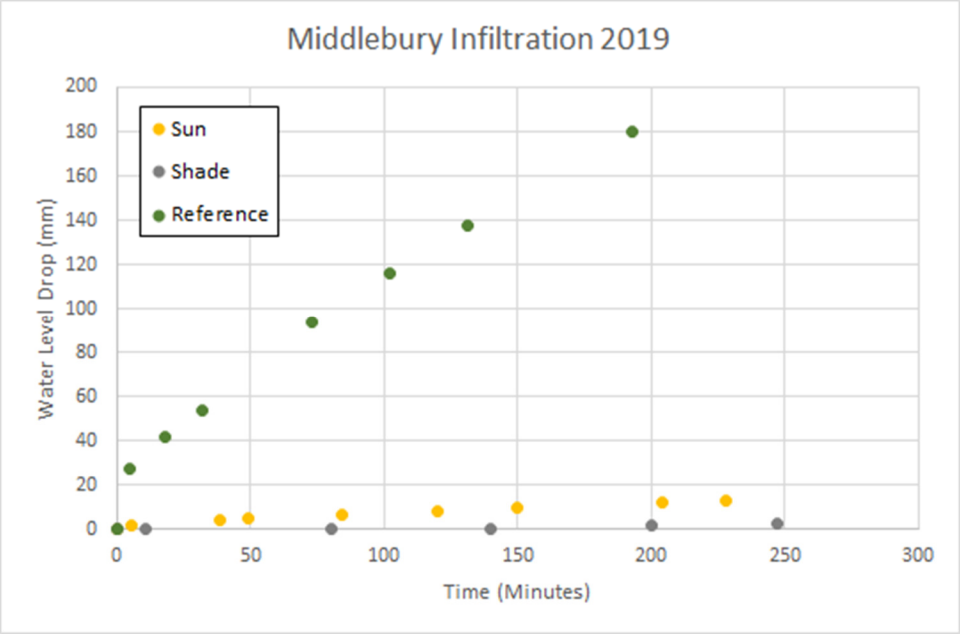
Soil infiltration measurements were collected for the Middlebury Solar site on 11/6/2018 and 11/18/2019. Soil moisture conditions were highly variable between the sampling areas both years. Saturated soils (>50%) were recorded at the Sun sampling location both years and at the Shade location in 2018. The Reference sampling area had moderately wet soils both years (20-25% saturation). Hydraulic conductivity rates were very low for all locations, with almost no infiltration at the sites with saturated soil conditions. The differences in hydraulic conductivity are more likely due to soil moisture and are not a result from different land management practices between the solar array and the hayfield.

Table 9 Hydraulic conductivity rates (in/hr)

	2018	2019
Sun	0.26	0.014
Shade	0.01	0.005
Reference	0.02	0.59

Figure 16 Middlebury Solar Soil Infiltration

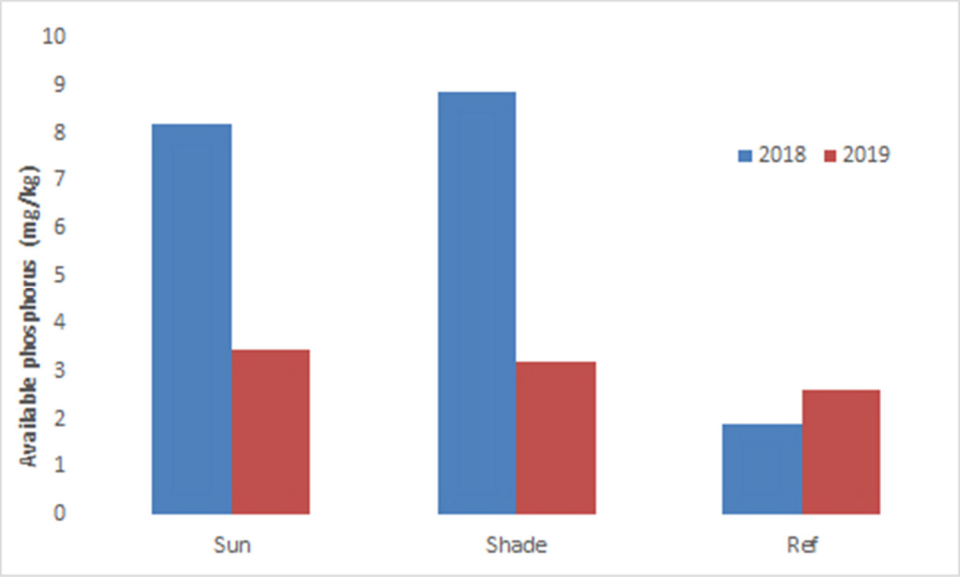




Soil Sampling

Soil samples were collected for the Middlebury site on 8/7/2018 and 11/18/2019. Overall, soil sampling results were variable with no apparent trends for most of the parameters included in the suite of soil analyses. We observed that available phosphorus concentrations were elevated for the Sun and Shade samples within the solar array in 2018. The values 8.2 and 8.9ppm respectively are slightly higher than the optimal agronomic soil concentration of 4-7ppm. These values are also approximately double the next highest concentration for all sites over the two years of sampling. We suspect that a lawn fertilizer may have been recently applied within the solar array.

Figure 17 Middlebury Solar Available Phosphorus



E. Sudbury Solar

The Sudbury Solar facility is located along Route 30, just north of the junction with Route 73 in Sudbury, Vermont. This 2 MW solar facility occupies approximately 15 acres of former hay field and is accessed from a locked gate off of Route 30. It consists of a larger array field on the western end and a smaller array field on the eastern side. These are separated by a marsh wetland and connected by an upgraded old farm access road.

Table 10 Sudbury Solar Site Information

Date of Construction	2016
Type of Foundation	Post
Type of Modules	Fixed
Height of Panels	2' – 8'
Distance Between Panel Rows	20'

The Sudbury site map (Appendix 1) shows existing site conditions from UAS drone imagery taken on May 9, 2018. Overlaid on this map is the wetland boundary and monitoring locations. The Reference Wetland is located in the wetland which sits between the two arrays. The Reference plots are located in the northern part of this wetland. The vegetation in the wetland consists of dense reed canary grass and is not managed.

1. Sudbury Solar Qualitative Observations

Wetland Hydrology/Soils

There are saturated soils throughout most of the site, though no hummock/hollow development has taken place. While there is no evidence of recent runoff or flow paths, there are small pockets of bare soil present beneath the panels throughout the site. Some ruts from mowing were observed but exposed soil associated with these ruts has been minimal. There are not excessive areas of soil disturbance in the wetland or buffer that may influence hydrology. The herbicide treatment conducted beneath the solar panels in 2019 have resulted in a thick thatch of dead plant matter covering bare soil. There has been no erosion present at this site but unknown what will occur in the spring of 2020 due to herbicide treatment in 2019.

Wetland Vegetation

The wetland vegetation at this site is overwhelmingly dominated by reed canary grass with smaller amounts of red clover (*Trifolium pratense*), foxtail sedge (*Carex annectans*) and marsh bluegrass (*Poa palustris*). Herbicide treatment was conducted beneath the solar panels in 2019 resulting in the killing of nearly all the reed canary grass and allowing for other species to colonize the area.

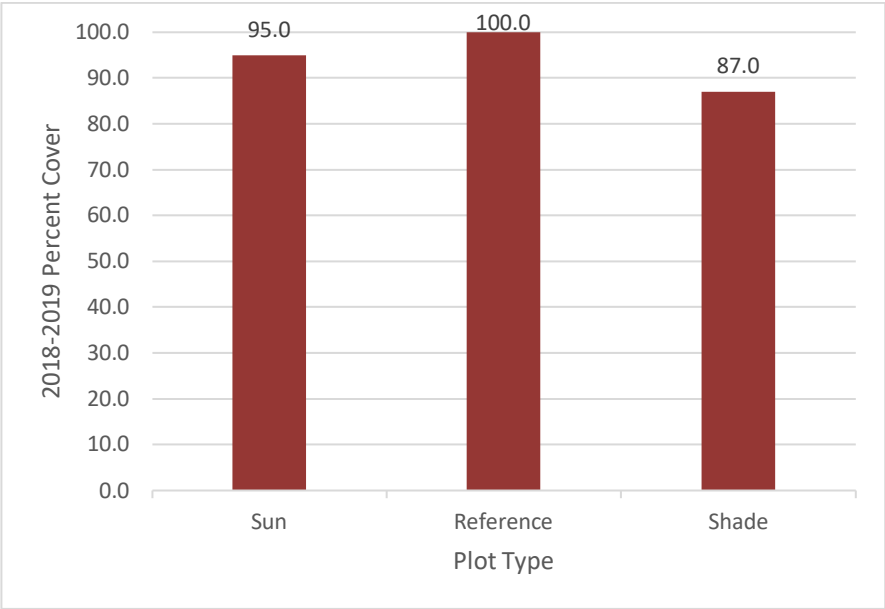
2. Sudbury Solar Quantitative Observations

Vegetation Monitoring

The vegetation monitoring at the Sudbury site occurred on August 28, 2018 and August 28 and September 6, 2019. Data on species presence and abundance is presented in Appendix 2.

Percent cover of vegetation in all plot types is presented in Figure 18. A single-factor ANOVA analysis was conducted on the percent cover data shown in Figure 18. Since this analysis focused on comparison of the different plot types, percent cover data from both 2018 and 2019 was averaged for this test and found to be significant at the p=.05 level (ANOVA(F(2,15))=5.03,p=.021). A post-hoc Tukey HSD test was conducted to determine which plots had significantly different mean percent covers. This test determined that the Shade Plots (M=87, SD=9.1) had significantly lower mean percent cover than the Reference Plots (M=100,SD=0) but not the Sun Plots (M=95,SD=8.4).

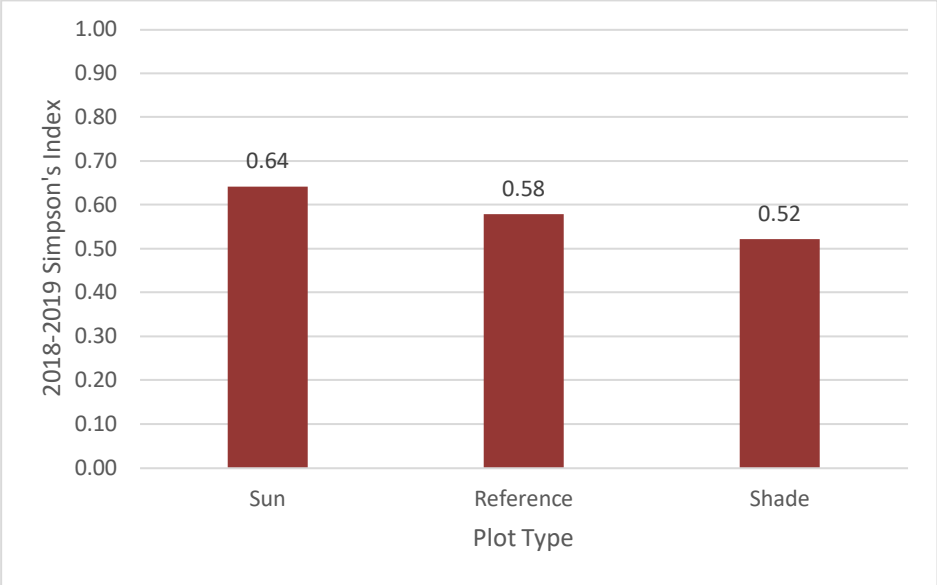
Figure 18 Sudbury Solar Average Percent Cover



The Reference wetland is characterized by a very dense, nearly monotypic growth of reed canary grass. As such, percent cover was 100% in each plot in both 2018 and 2019. The Shade Plots, while significantly lower cover than the Reference Plots, are not significantly different than the Sun Plots. The use of herbicide beneath the arrays in 2019 is not likely a factor in these differences since the 2018 mean cover (M=85.7,SD=14) is actually lower than the 2019 mean cover (M=88.3,SD=2.9).

There were no NNIS other than the Watch List species reed canary grass documented within the plots at this site.

Figure 19 Sudbury Solar Plant Diversity



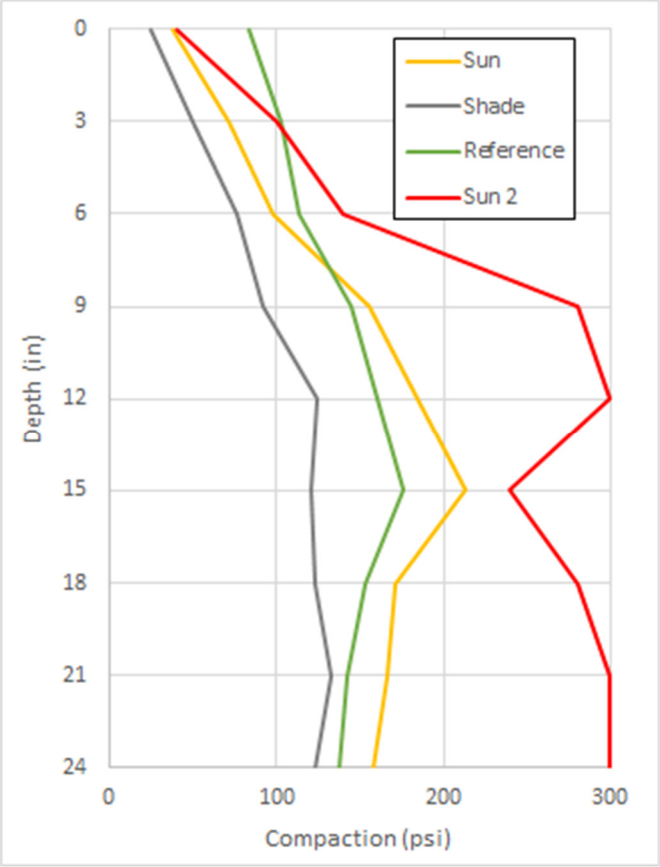
Finally, an analysis of species diversity was conducted using Simpson's Diversity Index. This data is shown in Figure 19. There was no statistically significant difference between group means as determined by ANOVA(F(2,15))=0.48,p=0.63).

Soils Monitoring

Soil Compaction

Soil compaction measurements were collected for the Sudbury site on 11/15/2018 and 10/14/2019. Soil compaction readings were variable across the sampling locations with some apparent trends. Several measurements within the solar array had compaction readings greater than 300psi, however most of these were likely due to rocky subsoils. Overall soil compaction was lowest in the "Shade" sampling areas and higher in the "Sun" areas. Several of the Sun measurements were collected on wheel tracks that were likely from a maintenance pickup truck. We did observe several compaction measurements within the Sun sampling area that indicated deep compaction, likely due to maintenance activities.

Figure 20 Sudbury Solar Soil Compaction



Soil Infiltration

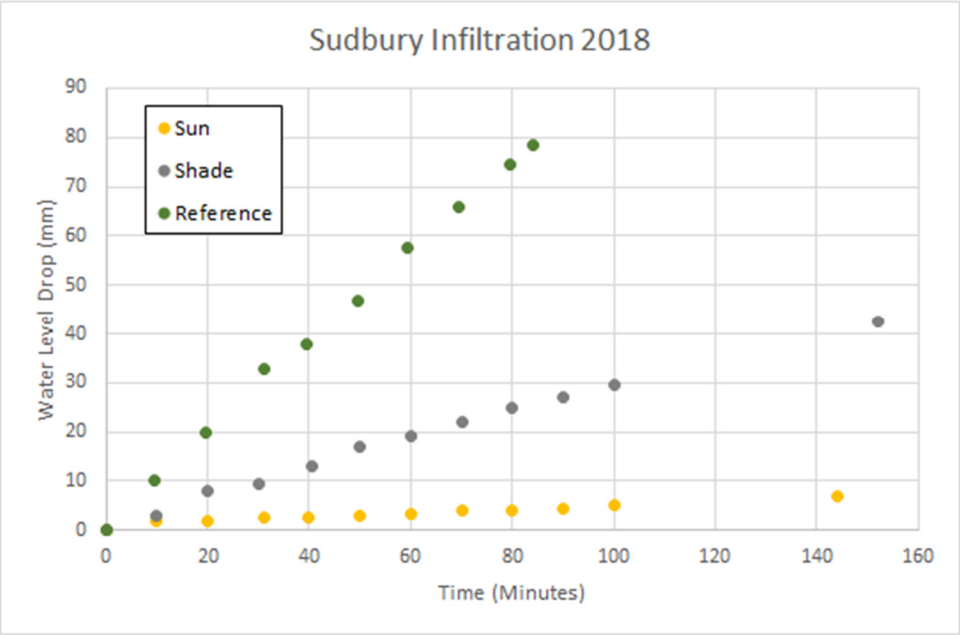
Soil infiltration measurements were collected for the Sudbury Solar site on 11/5/2018 and 10/14/2019. Soil moisture conditions were consistent between the sampling areas for both years (20-30%). The saturated hydraulic conductivity rates were similar for the Shade samples. The Sun and Reference samples differed substantially between the two sampling years. Both the Sun and Reference sampling points were near wheel tracks, it is possible that the 2018 samplers were installed in areas with localized compaction.

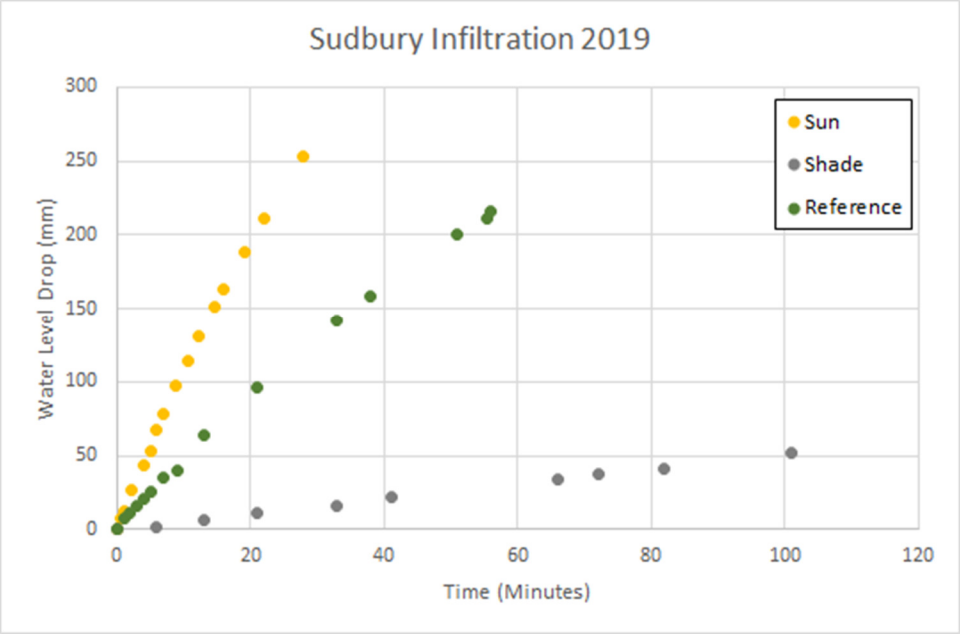
The sampling points were located with a sub-meter GPS both years, therefore the actual sampling locations likely vary by 0 to 3 feet between the two years of data collection.

Table 11 Hydraulic conductivity rates (in/hr)

	2018	2019
Sun	0.01	3.29
Shade	0.76	0.53
Reference	0.52	2.65

Figure 21 Sudbury Solar Plant Diversity





Soil Sampling

Soil samples were collected for the Sudbury site on 8/9/2018 and 10/14/2019. Overall, soil sampling results were variable with no apparent trends for most of the parameters included in the suite of soil analyses.

F. Trends across 5 Sites from 2 years monitoring data

1. Qualitative Analysis

The purpose of the Qualitative Assessment is to document areas of erosion, bare soil, problematic vegetation or disrupted hydrology. The methodology was revised to include the creation of a site plan map for each site which shows all sampling locations as well as any problem areas. Maps were compiled upon completion of the current 2 year study and are presented in the attachment.

Overall, the five monitoring sites are stable with no significant areas of erosion identified. The majority of the sites have small areas of bare soil and rutting, with site maintenance identified as the primary cause. The sites with permanently or seasonally saturated soils have ruts from the mowing equipment. The drier sites, such as Ferrisburgh did not have ruts present. It was determined that the limited degree of rutting even on the wetter sites was not causing water quality impacts or significantly altering wetland hydrology. The problem areas did not differ significantly from 2018 to 2019.

All of the sites had varying degrees of either Noxious (Meadow parsnip) or Watch List (reed canary grass and meadow parsnip) non-native invasive species present. The following table provides a summary of the NNIS species present at each solar site as well as presence in reference wetlands.

Table 12 Non-native Invasive Species Presence at the Study Sites

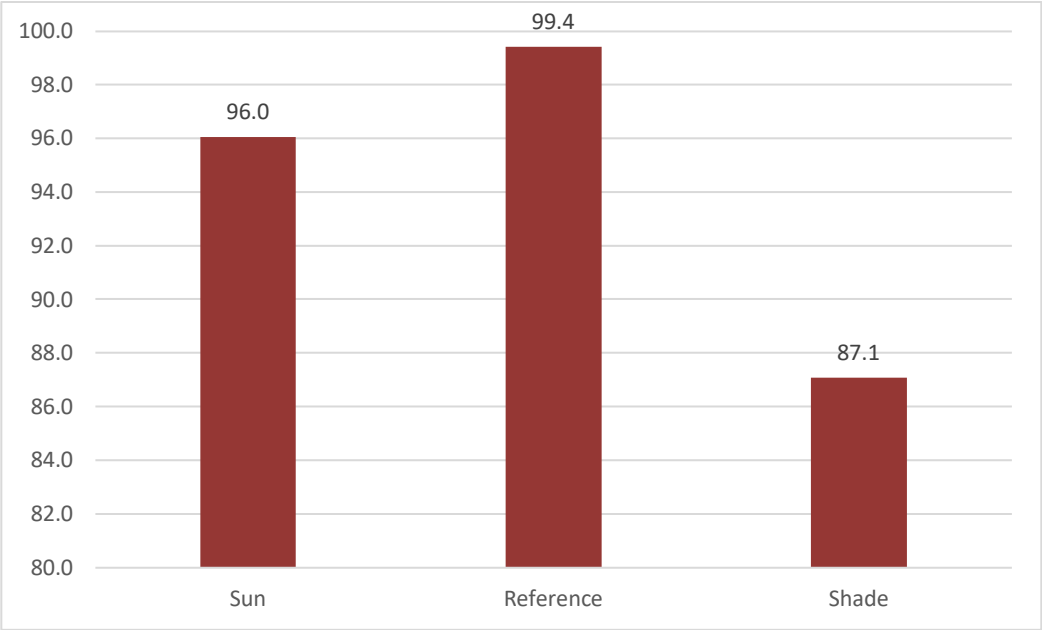
	Clarendon		Ferrisburgh		Hinesburg		Middlebury		Sudbury	
Species	Array	Ref	Array	Ref	Array	Ref	Array	Ref	Array	Ref
Purple loose strife	x	x								
Reed Canary Grass		x	x	x	x	x	x	x	x	x
Meadow Parsnip					x	x				

As can be seen from Table 12, both the array areas and reference wetlands generally had the same NNIS species present. Lacking pre-construction survey data makes it difficult to definitively conclude whether the solar projects provided the venue for introduction of the NNIS at these 5 study sites.

2. Vegetation Monitoring

As mentioned above, the 5 solar sites differ from one another in many ways, making comparisons between the sites difficult. However, some similarities do exist between the sites, and general trends regarding these similarities can be analyzed. For this analysis, the data from all the sites was combined and analyzed as a single dataset. Figure 22 shows this combined percent cover data for all sites.

Figure 22 Average Percent Cover Across All Sites

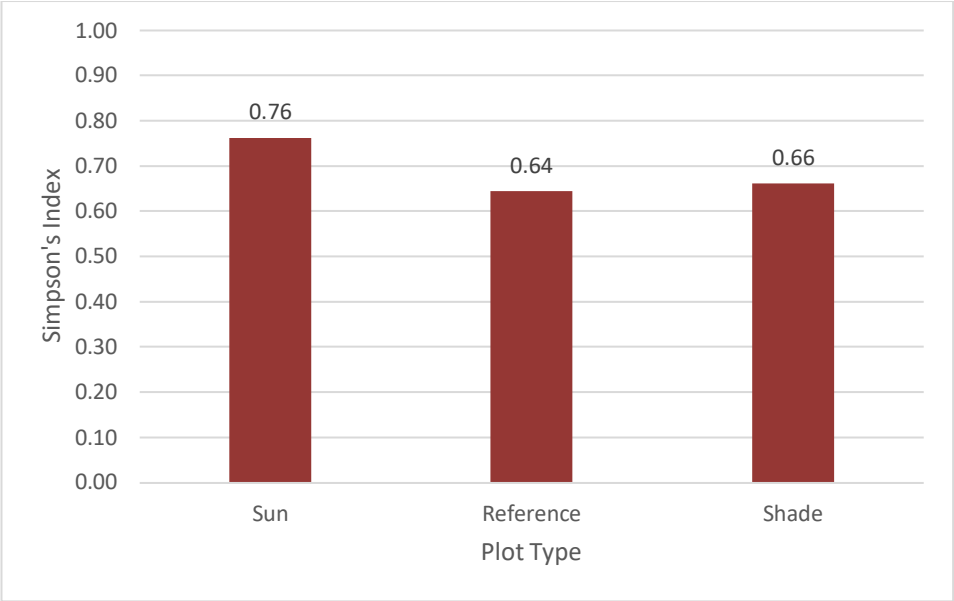


As can be seen from this data, average percent cover is lower in the shade plots than in any other plot type. The single-factor ANOVA analysis performed on this compiled percent cover data determined that these differences were statistically significant at the p=.05 level (ANOVA(F(2,87))=17.8,p=3.3E-07). A post-hoc Tukey HSD test confirmed that these differences were between the Shade plots and the other two plot types [Reference Plots (M=99.4, SD=1.6); Sun Plots (M=96.0, SD=6.2); Shade Plots (M=87.1,

SD=12.8)]. Across all sites, therefore, the Shade Plots show significantly lower percent cover than the Reference or Sun Plots.

In addition to total percent cover in the plots, data on species diversity (calculated as Simpson's Index of Diversity) can be compiled for all of the sites to determine if the different plot types impact diversity. The mean SID ranks for each plot type are shown in Figure 23.

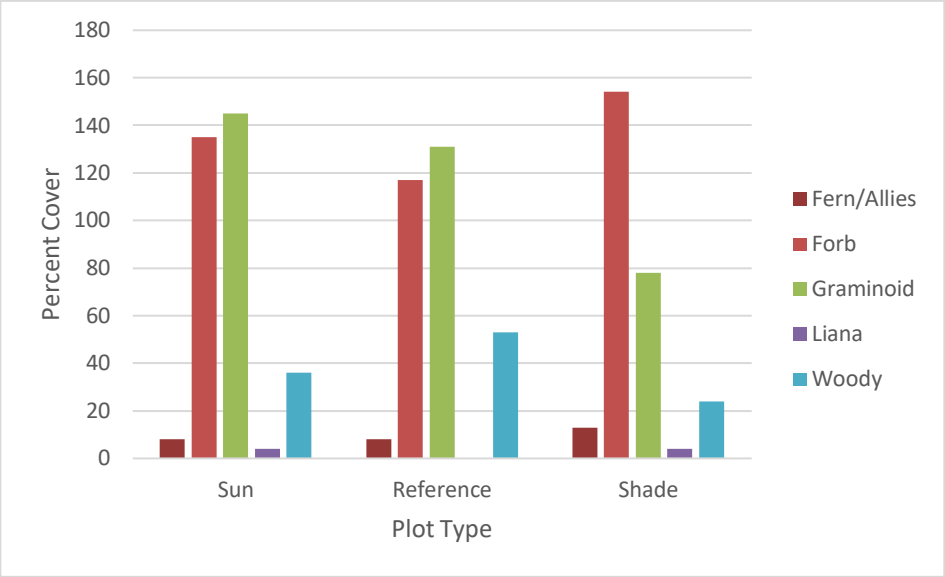
Figure 23 Plant Diversity Across All Sites



The single-factor ANOVA analysis performed on this compiled SID data determined that there is at least one statistically significant difference at the p=.05 level (ANOVA(F(2,87))=4.14,p=.02). A post-hoc Tukey HSD test determined that these differences were between the Reference plots (M=.64,SD=.18) and the Sun Plots (M=.76, SD=.09). It is unclear why the Reference Plots would have lower plant diversity than the Sun Plots but not the Shade Plots. It was expected, however, that plant diversity in the shade plots did not differ from diversity in the Sun Plots, since none of the sites individually showed any significant differences in this regard.

Finally, an analysis was conducted to determine if the presence of the solar arrays had an impact on plant form at the sites. Each plant documented in the plots was categorized according to it major plant form and the average cover of each plant form type in each plot type was analyzed. A graph of this data is shown in Figure 24.

Figure 24 Plant Form Across All Sites



A single-factor ANOVA test was conducted for all of the plant form categories. This test revealed that there were no significant differences for any of these plant forms between the different plot types. The presence of the solar arrays does not, therefore, have a significant effect on plant form at the five study sites.

3. Soils Monitoring

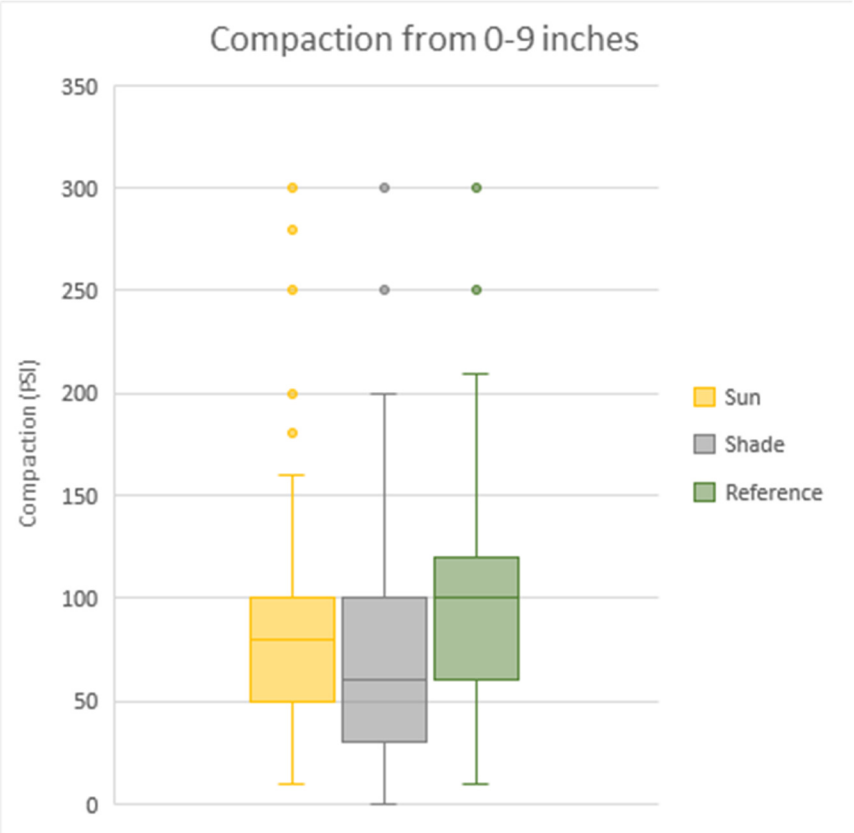
Soil Compaction

Soil compaction measurements were the only soil monitoring dataset with sufficient sample size to detect trends across all sites. The rocky subsoils present at the Hinesburg and Clarendon sites limited analysis across all sites to shallower depths within the compaction profile. These depths (0-9") also coincide with the typical rooting depth observed within the soil profiles. We analyzed mean soil compaction readings for all sites within the upper 9 inches of the soil profile (Table 13 and Figure 25). The differences between each sampling area were pronounced. These results suggest that the compaction from equipment used in the reference areas (hay cutting) is contributing to a higher level of shallow soil compaction than the maintenance and mowing equipment used in the "Sun" areas. The "Shade" areas do not have any ongoing equipment traffic in the fixed solar arrays, mowing and maintenance equipment may still access the areas under the tracker panels (Hinesburg and Middlebury).

Table 13 Soil Compaction Statistical Summary Across All Sites

Groups	*Count*	*Sum*	*Average*	*Variance*
Sun	239	20,235	84.7	2288.3
Shade	239	16,370	68.5	2761.6
Reference	237	23,940	101.0	2553.2

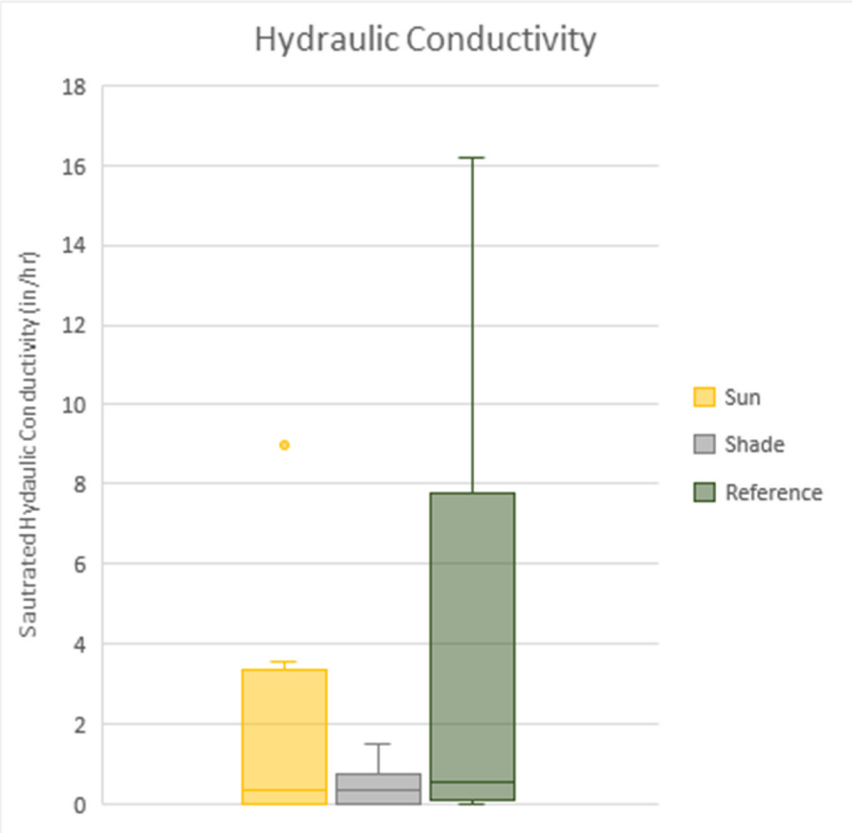
Figure 25 Soil Compaction Across All Sites



Soil Infiltration

Soil infiltration measurements (saturated hydraulic conductivity) were highly variable between sites, sampling years, and between the reference areas and impacted areas. Antecedent soil moisture conditions were similarly variable and likely explain some of the observed differences within and between sites. The infiltration rates for each sampling area (Sun, Shade, Reference) are not significantly different.

Figure 26 Hydraulic Conductivity Across All Sites



Soil Sampling

The soil sampling results were variable, and we did not observe any trends between the impacted and reference areas that were consistent across the sites.

G. Method Efficacy for Future Studies

1. Vegetation Monitoring

Overall, the vegetation monitoring methodology that was developed does a good job of categorizing the vegetation on the site. The Qualitative Data form is important for characterizing vegetation on the site as a whole. This form will play a more valuable role when used on newly constructed sites because it will enable the researcher to detect problem areas that need to be addressed, such as areas lacking sufficient revegetation or areas with NNIS.

The quantitative plot data provides two main metrics for analyzing impacts from solar development: cover of vegetation and species diversity. Since this is plot-based data that can be re-visited multiple years, tracking potential changes over time can occur if sampling is conducted in subsequent years. This will allow not only for comparisons to be made between solar sites, but more valuable data can be obtained within a particular site as changes occur over time. Tracking these changes over time can be especially valuable if pre-construction data can be obtained.

2. Soil Monitoring

Soil Compaction

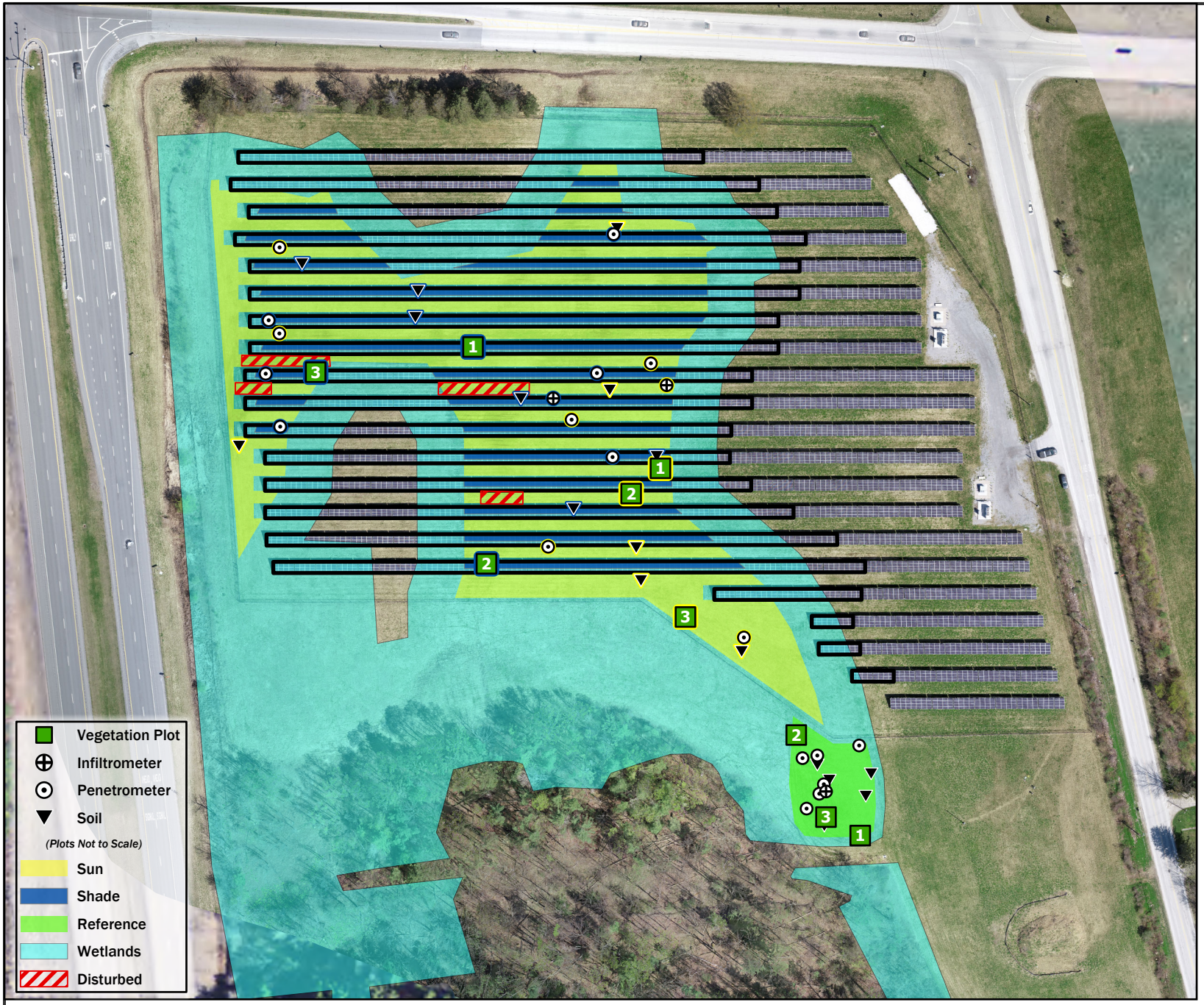
The soil compaction measurements are easy to collect and can quickly characterize compaction within a 24 inch deep soil profile. Based on our results, soil compaction does not appear to be a significant impact associated with solar arrays, and that conversion of marginal agricultural fields to solar arrays may result in an overall reduction in soil compaction. Due to the localized sources of compaction within a solar array, a more detailed compaction study could be a useful tool for tracking and quantifying impacts associated with installation and maintenance of commercial solar arrays. Compaction measurements would also be a useful tool for monitoring compliance with the Vermont Construction General Permit.

Soil Infiltration

The Modified Philip-Dunne (MPD) infiltrometer is a useful tool for measuring soil infiltration rates and it can be used to calculate the saturated hydraulic conductivity in a relatively short time period (compared to other accepted methods). Based on our study, infiltration/hydraulic conductivity rates do not appear to be significantly affected by solar development. A larger data set would be important to better assess the efficacy of this method; however, this would require a significant sampling effort. We suspect that some of the variability in our hydraulic conductivity results was caused by soil macropores or other preferential flow paths in the upper portion of the soil profile. The MPD sampler is suitable for use at the soil surface, however most of the hydraulic conductivity measurements collected for stormwater applications are taken in the subsoil, where preferential flow paths are less likely. Assuming that soil type and texture are relatively consistent within a solar array, compaction would be the primary factor altering hydraulic conductivity in underlying soils. Based on our study, soil compaction measurements are a far more efficient method for documenting these potential impacts.

Soil Sampling

The soil sampling results from our study did not identify any consistent trends within or between sites. We initially hypothesized that the changes in vegetation richness and density between the reference and impacted sampling areas (particularly Shade sites) may result in changes to soil chemistry. The Shade sites were found to have significantly lower plant cover; however, this did not result in any detectable changes to soil chemistry. We also did not observe any consistent trends in heavy metals, which could be associated with the array mounting hardware. Overall, the soil samples are relatively easy to collect, however we did not observe any potential trends suggesting an impact due to solar development.



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Vegetation	43.53968	-72.95579
Vegetation	43.53874	-72.955
Vegetation	43.54003	-72.95705
Vegetation	43.53932	-72.95557
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Soil	43.53889	-72.95504
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Infiltrometer	43.53996	-72.9561

Site: Clarendon

Background imagery Arrowwood Environmental UAS flight: 5/9/2018

Soil Samples: 18
Plant Plots: 9

Penetration Samples: 18
Infiltration Samples: 3

Thursday, April 30, 2020 File: DECSolar
Prepared By: A Worthley

0 15 30 60 90 120 Feet

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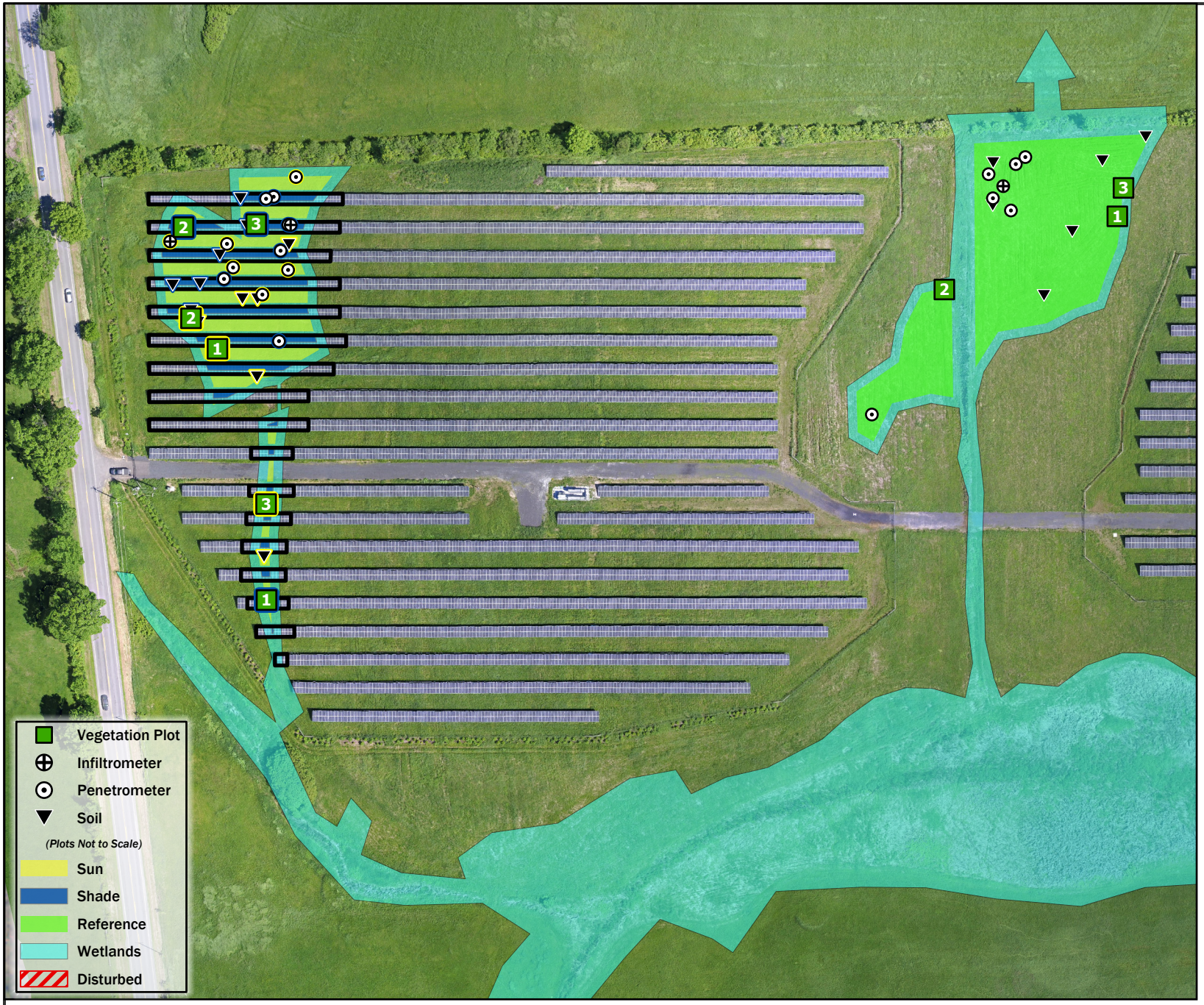

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Vegetation	43.83343	-73.19317
Vegetation	43.83261	-73.19312
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Soil	43.83342	-73.1932
Soil	43.83298	-73.19316
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Site: Sudbury

Soil Samples: 18
Plant Plots: 9

Penetration Samples: 18
Infiltration Samples: 3

Background imagery Arrowwood Environmental UAS flight: 5/9/2018

Thursday, April 30, 2020 File: DECSolar
Prepared By: A Worthley

0 15 30 60 90 120 Feet

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Type	Lat	Long
Vegetation	44.00969	-73.18724
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Vegetation	44.01012	-73.18571
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Soil	44.00952	-73.18772
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Site: Middlebury

Soil Samples: 18
Plant Plots: 9
Penetration Samples: 18
Infiltration Samples: 3

Background imagery Arrowwood Environmental UAS flight: 5/9/2018

Thursday, April 30, 2020 File: DECSolar
Prepared By: A Worthley

0 12.525 50 75 100 Feet

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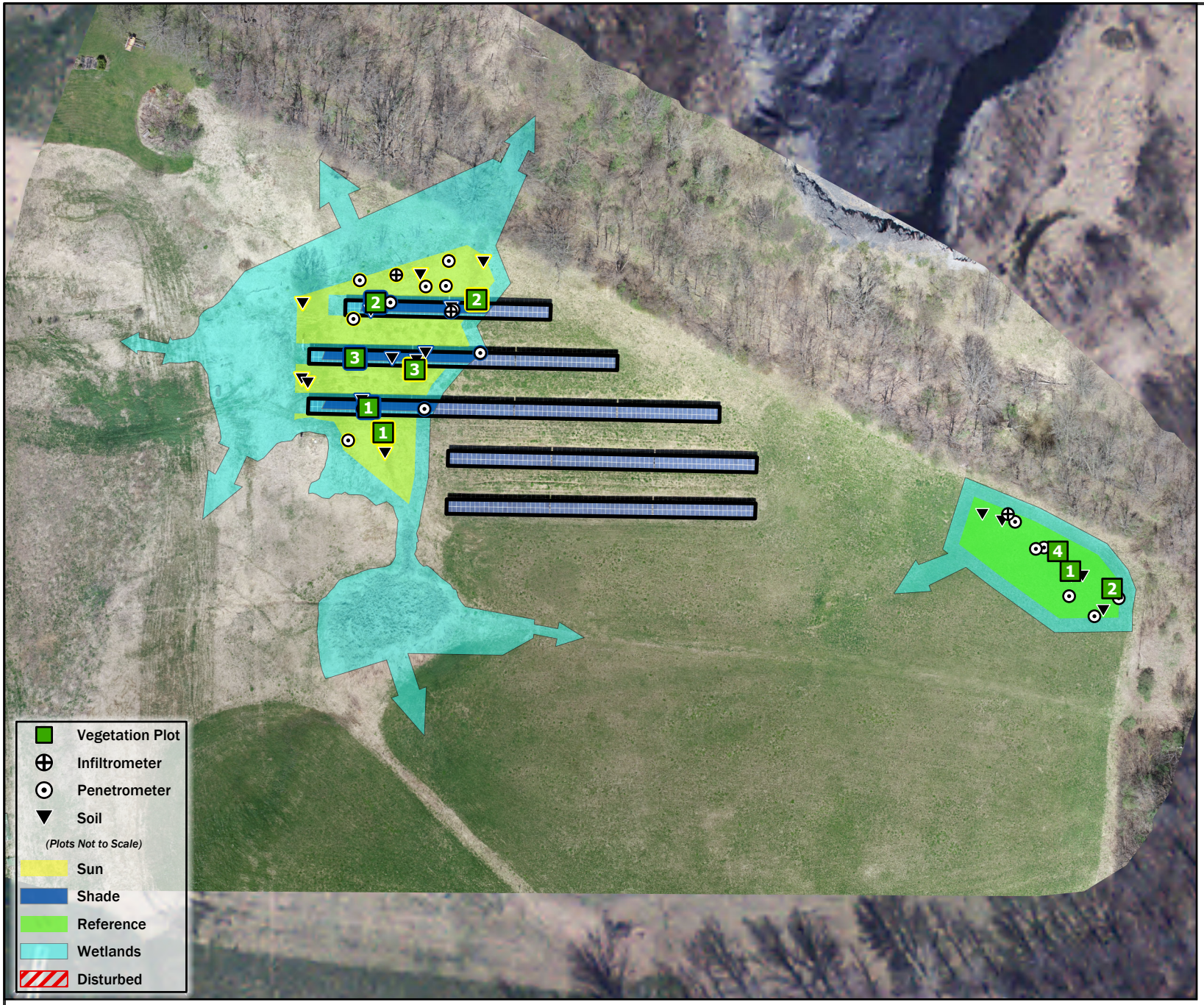

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Vegetation	44.18735	-73.24322
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Site: Ferrisburgh

Soil Samples: 18
Plant Plots: 9

Penetration Samples: 17
Infiltration Samples: 3

Background imagery Arrowwood Environmental UAS flight: 5/9/2018

Thursday, April 30, 2020 File: DECSolar
Prepared By: A Worthley

0 12.525 50 75 100 Feet

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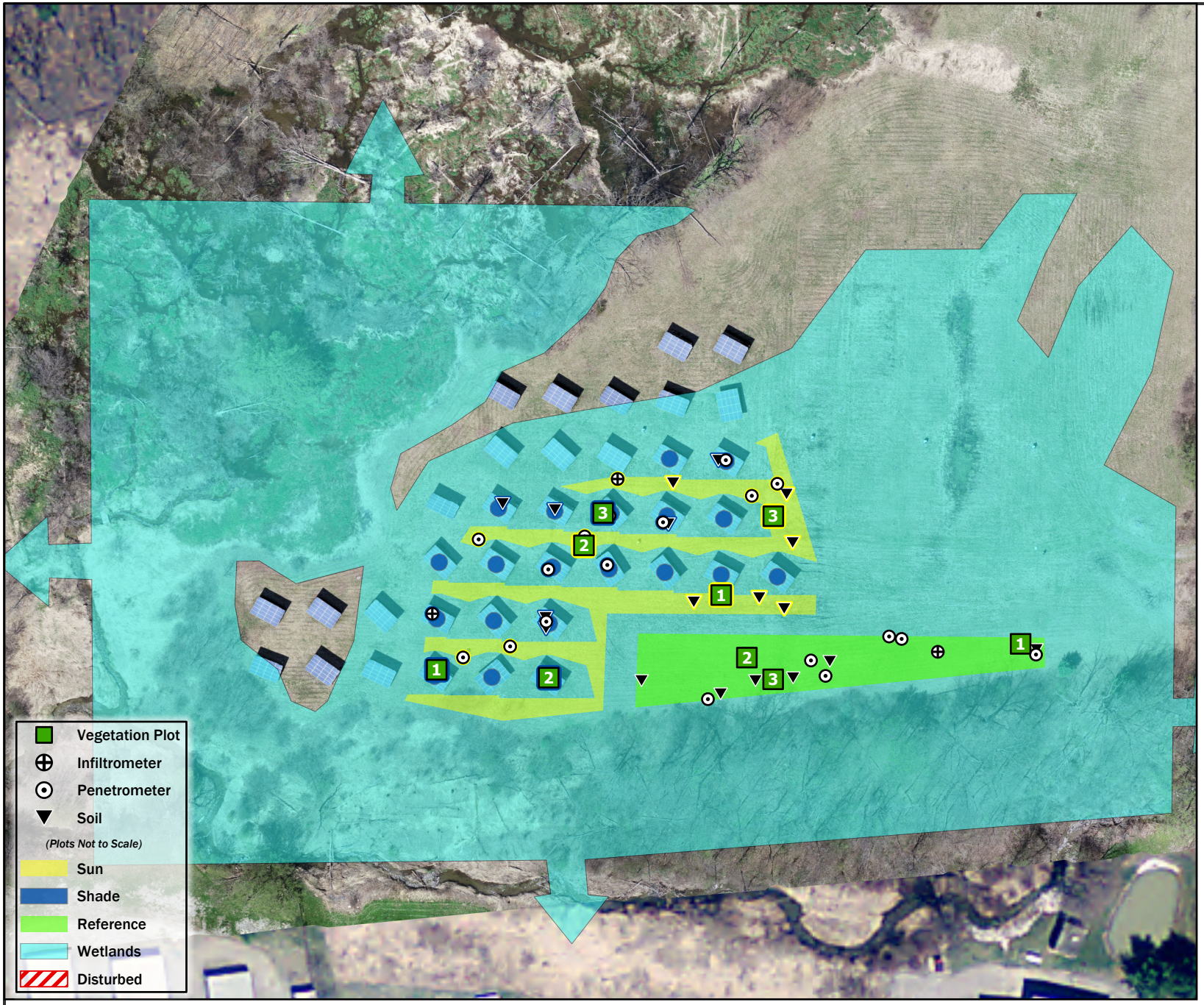

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Site: Hinesburg

Soil Samples: 18
Plant Plots: 9
Penetration Samples: 18
Infiltration Samples: 3

Background imagery Arrowwood Environmental UAS flight: 5/9/2018

Thursday, April 30, 2020 File: DECSolar
Prepared By: A Worthley

0 12.525 50 75 100 Feet

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Qualitative Observations Data Form v6

Observer: *Michael Lew-Smith*	Site Name: *Clarendon*	Date: 8/28/19

Solar Facility Notes

Height of panels (off ground): *18" to 8'*	Distance between panel rows: *15'*
This is a pre-construction survey __	Type of foundation: Post ____ Concrete _X__ Other ____
This is a post-construction survey X_	Type of modules: Trackers ____ Fixed Mount __X_
Notes / Other Vegetation Mgmt:	Date of Annual Mowing: Unk

None

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

No standing water at time of site visit. Some saturated soils. No surface waters

Notes:	Are Hummock/Hollows Present?	Yes ___	No _X_

Shaded plots seem a little wetter than sun plots?

Are any exposed soils present in the wetland/buffer within Project Area?			Yes _X_	No ___
Explain and map:	Unique ID		Photo #	

Only a few small areas of bare soil, mostly beneath panels. Ruts noted in 2018 still present to same extent in 2019

Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?			Yes ___	No X__
Explain and map:	Unique ID		Photo #	

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Phleum pretense	*60*	*Lythrum salicaria*	*4*
Onoclea sensibilis	*40*		
Carex annectans	*20*		
Galium mollugo	*20*		
Total Cover	*95*	Total Cover	*4*

Notes: *Veg recently mowed, otherwise overall similar to 2018. Yearly mowing appears to keep the Lythrum salicaria controlled, though it is still present.*

Are there areas in the wetland/buffer with disturbed vegetation?			Yes ___	No _X_
Describe and Map:	Unique ID		Photo #	

NA

If yes, does this impact wetland function/value?	Yes ___	No _X_

Explain:

NA

Clarendon Solar Site

8/28/19

ID #1 Ruts in soil. Same location and extent as 2018.

Clarendon Solar Site

8/28/19

ID #2 Ruts in soil. Same location and extent as 2018.

Clarendon Solar Site

8/28/19

ID #3 Ruts in soil. Same location and extent as 2018.

Clarendon Solar Site

8/28/19

ID #4 Ruts in soil. Same location and extent as 2018.

Qualitative Observations Data Form v6

Observer: *Joe Bartlett*	Site Name: *Clarendon*	Date: 10/14/2019

Solar Facility Notes

Height of panels (off ground):	Distance between panel rows:
This is a pre-construction survey __	Type of foundation: Post ____ Concrete ____ Other ____
This is a post-construction survey __	Type of modules: Trackers ____ Fixed Mount ____
Notes / Other Vegetation Mgmt:	Date of Annual Mowing:

Site was recently mowed

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

Some ponded water along the western edge of the array, slowly draining to the wetlands along Route 4.

Notes:	Are Hummock/Hollows Present?	Yes _ _ _	No _ X__

Are any exposed soils present in the wetland/buffer within Project Area?			Yes __X_	No _ __
Explain and map:	Unique ID		Photo #	

Several deep ruts were observed in the Sun zones in the western portion of the array. The ruts are not located along any flow paths and are not expected to have a significant water quality impact.

Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?			Yes ___	No _X__
Explain and map:	Unique ID		Photo #	

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Total Cover		Total Cover	

Notes:

Are there areas in the wetland/buffer with disturbed vegetation?			Yes ___	No ___
Describe and Map:	Unique ID		Photo #	

If yes, does this impact wetland function/value?	Yes ___	No ___

Explain:

DEC Solar Vegetation Monitoring Plots

Reference Clarendon

CREF1

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	2-18 in	6-66 in
Average Veg. Height:	12 in	24 in

Species	Non-native	species % Cover	species % Cover
Anthoxanthum odoratum	✔	-	6-10%
Carex annectens		-	11-25%
Eleocharis sp.		76-100%	26-50%
Equisetum arvense		<1%	6-10%
Galium mollugo	✔	1-5%	-
Galium sp.		<1%	<1%
Phalaris arundinacea		76-100%	76-100%
Plantago lanceolata	✔	<1%	-
Ranunculus acris	✔	1-5%	-
Stellaria sp.		<1%	-
Taraxacum officinale	✔	1-5%	1-5%
Trifolium pratense	✔	6-10%	11-25%
Vicia cracca	✔	<1%	1-5%
Species Richness:		11	9
Species Diversity*:		0.6	0.71

2018 Plot Comments: Sterile plants in subplot cf Eleocharis.

2019 Plot Comments: Plot is 1/2 recently mowed and 1/2 unmowed

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Reference Clarendon

CREF2

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	3-12 in	3-24 in
Average Veg. Height:	8 in	5 in

Species	Non-native	species % Cover	species % Cover
Anthoxanthum odoratum	✔	-	6-10%
Carex annectens		6-10%	1-5%
Eleocharis sp.		6-10%	26-50%
Equisetum arvense		1-5%	11-25%
Galium mollugo	✔	76-100%	51-75%
Glyceria striata		-	1-5%
Phleum pratense	✔	11-25%	6-10%
Plantago lanceolata	✔	6-10%	-
Ranunculus acris	✔	<1%	-
Schedonorus pratensis	✔	-	6-10%
Scirpus atrovirens		-	6-10%
Symphyotrichum lanceolatum		6-10%	-
Taraxacum officinale	✔	1-5%	1-5%
Trifolium pratense	✔	76-100%	51-75%
Vicia cracca	✔	<1%	-
Species Richness:		11	11
Species Diversity*:		0.71	0.8

2018 Plot Comments: Dominated mostly by non-hydric vegetation. Dense veg and saturated soils.

2019 Plot Comments: Plot mostly mowed. NE 1/4 unmowed. No standing water.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Reference Clarendon

CREF3

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	2-12 in	4-30 in
Average Veg. Height:	8 in	10 in

Species	Non-native	species % Cover	species % Cover
Carex annectens		-	6-10%
Daucus carota	✔	6-10%	1-5%
Eleocharis palustris		-	1-5%
Eleocharis sp.		76-100%	76-100%
Equisetum arvense		-	1-5%
Galium sp.		-	1-5%
Juncus brevicaudatus		<1%	1-5%
Lythrum salicaria	✔	-	1-5%
Phalaris arundinacea		11-25%	11-25%
Phleum pratense	✔	6-10%	6-10%
Ranunculus acris	✔	6-10%	6-10%
Schedonorus pratensis	✔	-	11-25%
Scirpus atrovirens		26-50%	6-10%
Solidago canadensis		-	1-5%
Taraxacum officinale	✔	-	1-5%
Trifolium pratense	✔	1-5%	-
Trifolium repens	✔	-	6-10%
Species Richness:		8	16
Species Diversity*:		0.67	0.76

2018 Plot Comments: Saturated soils. Standing water nearby outside plot. Recent rains. Well vegetated.

2019 Plot Comments: Most of plot was recently mowed. NE 1/4 unmowed. No standing water.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Clarendon

CSHD1

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	70%	90%
Rock Cover:	0%	0%
Soil Cover:	0%	10%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	1-16 in	2-12 in
Average Veg. Height:	6 in	8 in

Species	Non-native	species % Cover	species % Cover
Carex annectens		11-25%	1-5%
Epilobium coloratum		11-25%	11-25%
Equisetum arvense		1-5%	1-5%
Galium mollugo	✔	-	11-25%
Galium tinctorium		26-50%	-
Lysimachia nummularia	✔	1-5%	-
Persicaria hydropiper	✔	-	6-10%
Persicaria maculosa		11-25%	-
Phleum pratense	✔	6-10%	11-25%
Plantago major	✔	-	1-5%
Poa palustris		-	11-25%
Ranunculus acris	✔	1-5%	-
Rumex sp.		6-10%	1-5%
Species Richness:		9	9
Species Diversity*:		0.82	0.84

2018 Plot Comments: Standing water in plot and throughout area. Some moss (Campylium spp). Recent rains. Many small galium seedlings.

2019 Plot Comments: Very wet, saturated soils. 20% moss cover.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Clarendon

CSHD2

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	80%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	3-10 in	3-16 in
Average Veg. Height:	6 in	12 in

Species	Non-native	species % Cover	species % Cover
Acalypha rhomboidea		-	<1%
Carex annectens		11-25%	-
Cerastium fontanum	✔	<1%	-
Epilobium coloratum		1-5%	-
Galium mollugo	✔	26-50%	6-10%
Lythrum salicaria	✔	-	11-25%
Oxalis stricta		-	<1%
Persicaria hydropiper	✔	11-25%	26-50%
Phleum pratense	✔	76-100%	76-100%
Ranunculus acris	✔	<1%	1-5%
Taraxacum officinale	✔	-	1-5%
Species Richness:		7	8
Species Diversity*:		0.65	0.62

2018 Plot Comments: Recently mowed. Some grass clippings in plot. Soils saturated and soft. Bare soil present outside of plot, but no in plot.

2019 Plot Comments: Plot mowed; veg matted. Dense graminoids. Some bare soil beneath thatch.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Clarendon

CSHD3

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	70%	85%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	10%
Veg Height Range:	1-6 in	- in
Average Veg. Height:	4 in	in

Species	Non-native	species % Cover	species % Cover
Calystegia sepium		6-10%	1-5%
Epilobium coloratum		1-5%	<1%
Equisetum arvense		-	1-5%
Galium mollugo	✔	26-50%	26-50%
Lythrum salicaria	✔	11-25%	6-10%
Onoclea sensibilis		26-50%	26-50%
Oxalis stricta		1-5%	1-5%
Persicaria hydropiper	✔	-	11-25%
Phleum pratense	✔	<1%	6-10%
Poa palustris		-	6-10%
Poa sp.		1-5%	-
Ranunculus acris	✔	<1%	1-5%
Solanum dulcamara	✔	-	<1%
Sonchus arvensis	✔	1-5%	6-10%
Symphyotrichum lanceolatum		-	<1%
Symphyotrichum lateriflorum		1-5%	-
Trifolium repens	✔	<1%	-
Species Richness:		12	14
Species Diversity*:		0.77	0.83

2018 Plot Comments: Recently mowed, some sensitive fern thatch. Regrowing well. Small amount of bare soil present. Soils saturated and soft.

2019 Plot Comments: Saturated soils. Moss cover appx 20%. Very small hummocks/hollows.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Clarendon

CSUN1

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	85%	83%
Rock Cover:	0%	0%
Soil Cover:	0%	2%
Mulch Cover:	0%	0%
Thatch Cover:	0%	15%
Veg Height Range:	2-8 in	3-8 in
Average Veg. Height:	4 in	6 in

Species	Non-native	species % Cover	species % Cover
Anthoxanthum odoratum	✔	26-50%	11-25%
Carex annectens		1-5%	6-10%
Galium mollugo	✔	-	26-50%
Juncus tenuis		26-50%	-
Onoclea sensibilis		11-25%	11-25%
Oxalis stricta		1-5%	-
Phleum pratense	✔	11-25%	26-50%
Plantago lanceolata	✔	26-50%	1-5%
Prunella vulgaris		1-5%	-
Ranunculus acris	✔	-	1-5%
Taraxacum officinale	✔	1-5%	1-5%
Trifolium pratense	✔	-	11-25%
Trifolium repens	✔	1-5%	-
Species Richness:		10	9
Species Diversity*:		0.82	0.82

2018 Plot Comments: Recently mowed. Some areas of bare ground, likely from mowing. Some mulch on plot from mowing. Plant id difficult.

2019 Plot Comments: Recently mowed All veg very short, though growing back. Some mulch from mowing. No standing water.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Clarendon

CSUN2

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	95%	85%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	15%
Veg Height Range:	2-8 in	4-36 in
Average Veg. Height:	6 in	10 in

Species	Non-native	species % Cover	species % Cover
Carex annectens		1-5%	11-25%
Carex scoparia		6-10%	-
Epilobium sp.		1-5%	-
Galium mollugo	✔	26-50%	6-10%
Galium sp.		1-5%	-
Lythrum salicaria	✔	-	<1%
Onoclea sensibilis		76-100%	26-50%
Oxalis stricta		<1%	-
Phleum pratense	✔	6-10%	6-10%
Plantago lanceolata	✔	1-5%	-
Poa pratensis		-	<1%
Poa sp.		<1%	-
Ranunculus acris	✔	<1%	1-5%
Solanum dulcamara	✔	11-25%	6-10%
Trifolium pratense	✔	-	1-5%
Trifolium repens	✔	<1%	-
Vicia cracca	✔	1-5%	<1%
Species Richness:		14	10
Species Diversity*:		0.69	0.75

2018 Plot Comments: Recently mowed, plant id difficult. Growing back well. No bare ground, well vegetated. Dense, young sensitive fern

2019 Plot Comments: Recently mowed but growing back well. Area around wooden stake not mowed. Some bare ground beneath thatch.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Clarendon

CSUN3

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	95%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	1-16 in	3-30 in
Average Veg. Height:	6 in	12 in

Species	Non-native	species % Cover	species % Cover
Anthoxanthum odoratum	✔	-	6-10%
Calystegia sepium		1-5%	6-10%
Carex annectens		26-50%	6-10%
Carex conoidea		1-5%	-
Carex echinata		26-50%	26-50%
Carex sp.		<1%	-
Galium mollugo	✔	11-25%	11-25%
Lythrum salicaria	✔	-	1-5%
Onoclea sensibilis		<1%	-
Oxalis stricta		-	1-5%
Phleum pratense	✔	26-50%	51-75%
Plantago lanceolata	✔	11-25%	-
Poa pratensis		-	6-10%
Ranunculus acris	✔	1-5%	1-5%
Schedonorus pratensis	✔	-	6-10%
Stellaria graminea		-	<1%
Symphyotrichum lateriflorum		<1%	<1%
Taraxacum officinale	✔	-	1-5%
Trifolium pratense	✔	-	1-5%
Species Richness:		11	15
Species Diversity*:		0.81	0.81

2018 Plot Comments: Dense graminoids. Recently mowed, plant id difficult. Saturated soils.

2019 Plot Comments: Recently mowed with thick thatch layer of dead plant material. Area around stake not mowed.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

2019 Clarendon Solar Vegetation Plot Photo Log

Reference Plot 1

Reference Plot 2

2019 Clarendon Solar Vegetation Plot Photo Log

Reference Plot 3

Sun Plot 1

2019 Clarendon Solar Vegetation Plot Photo Log

Sun Plot 2

Sun Plot 3

2019 Clarendon Solar Vegetation Plot Photo Log

Shade Plot 1

Shade Plot 2

Shade Plot 3

Soil Compaction		
Site	Date	Personel
Clarendon	10/14/2019	EHB JHB

GPS Point Label	Sun 1
Soil Moisture (%)	16.1
Depth (in)	Max (psi)
Surface	50
3	80
6	120
9	>300
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	7

Notes: rock

GPS Point Label	Sun 2
Soil Moisture (%)	17.2
Depth (in)	Max (psi)
Surface	40
3	80
6	60
9	80
12	120
15	180
18	>300
21	
24	
Depth to readings over 300psi	
	17

Notes: rock

GPS Point Label	Sun 3
Soil Moisture (%)	18.1
Depth (in)	Max (psi)
Surface	40
3	40
6	80
9	100
12	>300
15	
18	
21	
24	
Depth to readings over 300psi	
	14

Notes: might be compaction

GPS Point Label	Sun 4
Soil Moisture (%)	21
Depth (in)	Max (psi)
Surface	80
3	60
6	80
9	100
12	>300
15	
18	
21	
24	
Depth to readings over 300psi	
	11

Notes: rock

GPS Point Label	Sun 5
Soil Moisture (%)	15.2
Depth (in)	Max (psi)
Surface	50
3	80
6	120
9	150
12	130
15	200
18	270
21	>300
24	
Depth to readings over 300psi	
	20

Notes: rock

GPS Point Label	Sun 6
Soil Moisture (%)	21.9
Depth (in)	Max (psi)
Surface	60
3	80
6	40
9	130
12	100
15	200
18	>300
21	
24	
Depth to readings over 300psi	
	18

Notes:rock

GPS Point Label	Shade 1
Soil Moisture (%)	18.4
Depth (in)	Max (psi)
Surface	0
3	10
6	10
9	30
12	100
15	>300
18	
21	
24	
Depth to readings over 300psi	
	13

Notes: rock not compaction

GPS Point Label	Shade 2
Soil Moisture (%)	8.3
Depth (in)	Max (psi)
Surface	30
3	80
6	50
9	100
12	>300
15	
18	
21	
24	
Depth to readings over 300psi	
	11

Notes: rock

GPS Point Label	Shade 3
Soil Moisture (%)	13.9
Depth (in)	Max (psi)
Surface	0
3	30
6	40
9	40
12	100
15	180
18	160
21	150
24	150
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 4
Soil Moisture (%)	24.8
Depth (in)	Max (psi)
Surface	0
3	0
6	10
9	30
12	100
15	200
18	250
21	180
24	240
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 5
Soil Moisture (%)	14.3
Depth (in)	Max (psi)
Surface	0
3	10
6	30
9	30
12	50
15	80
18	200
21	>300
24	
Depth to readings over 300psi	
	20

Notes: rock

GPS Point Label	Shade 6
Soil Moisture (%)	17.2
Depth (in)	Max (psi)
Surface	0
3	0
6	20
9	50
12	100
15	200
18	280
21	300
24	
Depth to readings over 300psi	
	21

Notes: rock

GPS Point Label	Ref 1
Soil Moisture (%)	28.7
Depth (in)	Max (psi)
Surface	20
3	40
6	40
9	80
12	>300
15	
18	
21	
24	
Depth to readings over 300psi	
	10

Notes:rock

GPS Point Label	Ref 2
Soil Moisture (%)	11.5
Depth (in)	Max (psi)
Surface	120
3	100
6	150
9	150
12	200
15	150
18	>300
21	
24	
Depth to readings over 300psi	
	16

Notes:rock

GPS Point Label	Ref 3
Soil Moisture (%)	17.8
Depth (in)	Max (psi)
Surface	60
3	100
6	150
9	>300
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	8

Notes: rock

GPS Point Label	Ref 4
Soil Moisture (%)	23.4
Depth (in)	Max (psi)
Surface	80
3	100
6	100
9	>300
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	8

Notes: rock

GPS Point Label	Ref 5
Soil Moisture (%)	16.2
Depth (in)	Max (psi)
Surface	80
3	80
6	120
9	100
12	>300
15	
18	
21	
24	
Depth to readings over 300psi	
	11

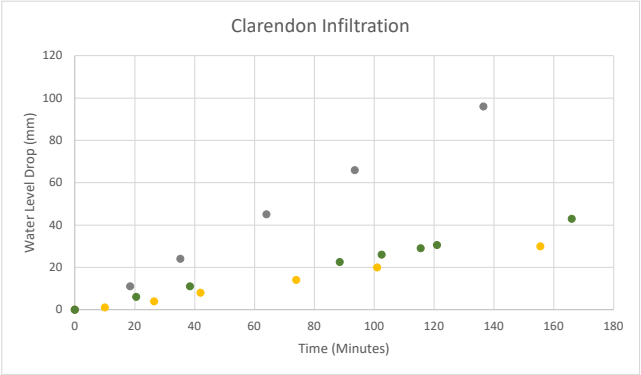
Notes: rock

GPS Point Label	Ref 6
Soil Moisture (%)	18
Depth (in)	Max (psi)
Surface	80
3	100
6	120
9	>300
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	8

Notes: rock

MPD Infiltration Testing		
Site	Date	Personel
Clarendon	10/14/2019	JHB & EHB

	Sampler 1					Sampler 2					Sampler 3				
GPS Point	Sun 1-1					Shade 2-1					Ref 1-1				
Pre-Soil Moisture (%)	19.9	22	22.7	18.6		15	14.8	14.7	15.8		23.7	24.2	23.8	24	
Pre-Average Soil Moisture (%)	20.8					15.075					23.925				
		Stop Watch Time	**Time from start**	**Depth (mm)**	**Drop (mm)**		**Stop Watch Time**	**Time from start**	**Depth (mm)**	**Drop (mm)**		**Stop Watch Time**	**Time from start**	**Depth (mm)**	**Drop (mm)**
		21	0	86	0		29.5	0	86	0		13.5	0	75	0
		31	10	87	1		48	19	97	11		34	21	81	6
		47	27	90	4		64.7	35	110	24		52	39	86	11
		63	42	94	8		93.5	64	131	45		102	89	97.5	23
		95	74	100	14		123	94	152	66		116	103	101	26
		122	101	106	20		166	137	182	96		129	116	104	29
		176	156	116	30							134.5	121	105.5	31
												179.5	166	118	43
Post-Soil Moisture Center (%)	19.8					17					24.6				



Soil Description

Site	Clarendon	Sampling Area	Sun. Shade, Reference
Date	10/14/2019	Personnel	JHB EHB

Sampling Area	Sun		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 5	Primary 4	
Depth (in)	Description	Depth (in)	Description
1	O horizon loose soil dense roots	2	O horizon wet
0 to 11	Fine sand silt loam 10YR 3/3, roots to 9, redox at 8	0 to 10	10YR 3/1 vf sandy loam, heavy redox. Coarse roots to 6
11 to 20+	Depleted sand matrix 2.5Y 8/2 heavy redox	10-16+	Sand with moderate redox 2.5Y 5/4

Sampling Area	Shade		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 5	Primary 6	
Depth (in)	Description	Depth (in)	Description
1	O horizon	0.5	O horizon
0 to 11	sandy loam 10YR 2/2, roots to 4, redox at 4	0 to 8	VF sandy loam 10YR 3/3
11 to 15	10YR 4/2 with redox	8 to 12	Sity sand 10YR 5/2 lots of orange redox
15-18	VF sand 10YR 5/8 no redox	12 to 18+	VF sand, heavy redox 2.5 Y 6/3
18+	Rocky		

Sampling Area	Reference		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 6	Primary 5	
Depth (in)	Description	Depth (in)	Description
2	O horizon loose soil dense roots	2	O horizon
0 to 8	Fine silt loam 10YR 3/2 some redox at 6 roots to 6	0 to 7	Fine silt loam some roots some redox at 5, 10YR 3/2
8+	Rocky	7 to 12	10YR 6/5 light brown VF sand with some redox
		12+	Rocky

Soil Test Results

Site	Date	Location	pH	OM_Pct	Avail_P	K	Ca	Mg	Zn	B	Mn	Cu	Fe	Al	Na	S	Exch_Acid	ECEC	A_Base_Sa	G_Base_S	K_Base_Sa	Pb	Ni	Cd	Cr
				%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Clarendon	10/14/2019	Sun	6.72	5.33	1.7	33	1843	272	0.9	0.2	6.5	0.05	3.8	22	37	12	0.07	11.57	79.16	19.47	0.73	0.55	0.35	0.1	0.1
Clarendon	10/14/2019	Shade	6.75	4.511	1.3	28	1765	249	0.35	0.25	3.3	0.05	2.4	18	14	6	0.00	10.97	80.43	18.91	0.65	0.45	0.35	0.1	0.1
Clarendon	10/14/2019	Ref	6.71	7.969	1.8	28	2065	317	0.35	0.3	4.4	0.05	3.4	11	80	9	0.62	13.04	75.61	19.35	0.53	0.45	0.25	0.1	0.1
		Average:	6.73	5.94	1.6	30	1891	279	0.53	0.25	4.7	0.05	3.2	17	44	9	0.23	11.86	78.40	19.24	0.64	0.48	0.32	0.10	0.10
Clarendon	8/7/2018	Ref	6.94	7.605	1.05	16	1683	302	0.25	0.25	1.3	0.15	1.5	7	71	5	0.00	10.97	76.69	22.94	0.37	0.3	0.40	0.05	0
Clarendon	8/7/2018	Shade	7	5.876	1.20	20	1627	267	0.40	0.25	1.4	0.05	1.3	8	16	5	0.00	10.41	78.14	21.37	0.49	0.3	0.55	0.05	0
Clarendon	8/7/2018	Sun	6.94	5.057	0.80	17	1385	234	0.20	0.15	1.6	0.10	1.5	10	31	8	0.00	8.92	77.65	21.86	0.49	0.4	0.35	0.05	0
		Average:	6.96	6.179	1.02	18	1565	268	0.28	0.22	1.4	0.10	1.4	8	39	6	0.00	10.10	77.49	22.06	0.45	0.3	0.43	0.05	0

2018 Clarendon Solar Qualitative Data

Observer: *Michael Lew-Smith*	Site Name: *Clarendon*	Date: *8/28/18*

Solar Facility Notes

Height of panels (off ground): *18" to 8'*	Distance between panel rows: *15'*
This is a pre-construction survey __	Type of foundation: Post ____ Concrete _X__ Other ____
This is a post-construction survey _X	Type of modules: Trackers ____ Fixed Mount __X_
Notes / Other Vegetation Mgmt:	Date of Annual Mowing: ?

None

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

Standing water present in lower part of project after recent heavy rain. Low areas with ruts. Other areas of wetland exhibit saturated soils. No drainages visible.

Notes:	Are Hummock/Hollows Present?	Yes ___	No _X_

A few minor sedge/rush hummocks but no well-established hummock-hollow complex.

Are any exposed soils present in the wetland/buffer within Project Area?	Yes _X_	No ___
Explain and map:	Photo #	

Some minor areas of exposed soil beneath panels throughout wetland. Mainly on lower side of panels. Appx 1-2% of area beneath panels with bare soil

Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?	Yes ___	No _X_
Explain and map:	Photo #	2231

A few ruts with standing water. Well-vegetated. Don't appear to be significantly impacting hydrology. Photo shows the worst area, a few other minor areas.

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Phalaris arundinacea	*60*	*Phalaris arundinacea*	*60*
Carex annectans	*40*	*Lythrum salicaria*	*3*
Onoclea sensibilis	*20*		
Galium mollugo	*20*		
Total Cover	*90*	Total Cover	*63*

Notes: *In general, site is well-vegetated*

Are there areas in the wetland/buffer with disturbed vegetation?	Yes ___	No _X_
Describe and Map:	Photo #	
If yes, does this impact wetland function/value?	Yes ___	No _X_

Explain:

2018 Clarendon Solar Vegetation Plot Data

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Clarendon	DATE: 08-28-2018		
Plot: REF1	Height: 2"-18" Avg:12"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phalaris arundinacea	75-100%	70	est
Trifolium pratense	6-10%	3	ct
Vicia cracca	<1%	0	0
Eleocharis sp.	75-100%	150	sample
Stellaria sp.	<1%	0	0
Galium sp.	<1%	2	0
Ranunculus acris	1-5%	0	0
Galium mollugo	1-5%	0	0
Taraxacum officinale	1-5%	0	0
Plantago lanceolata	<1%	0	0
Equisetum arvense	<1%	1	ct
2018 Notes: Sterile plants in subplot cf Eleocharis.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Clarendon	DATE: 08-28-2018		
Plot: REF2	Height: 3"-12" Avg: 8"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Trifolium pratense	75-100%	60	ct
Galium mollugo	75-100%	35	ct
Equisetum arvense	1-5%	3	ct
Phleum pratense	11-25%	31	ct
Plantago lanceolata	6-10%	0	0
Symphyotrichum lanceolatum	6-10%	0	0
Taraxacum officinale	1-5%	0	0
Ranunculus acris	<1%	0	0
Vicia cracca	<1%	0	0
cf Eleocharis sp.	6-10%	60	sample
Carex annectens	6-10%	4	ct
2018 Notes: Dominated mostly by non-hydric vegetation. Dense vegetation and saturated soils.			

2018 Clarendon Solar Vegetation Plot Data

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Clarendon	DATE: 08-28-2018		
Plot: REF3	Height: 2"-12" Avg: 8"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Scirpus atrovirens	25-50%	5	ct
Phalaris arundinacea	11-25%	9	ct
Ranunculus acris	6-10%	4	ct
Daucus carota	6-10%	23	ct
Trifolium pratense	1-5%	1	ct
cf Eleocharis sp.	75-100%	180	ct
Phleum pratense	6-10%	0	0
Juncus brevicaudatus	<1%	0	0
2018 Notes: Saturated soils. Standing water nearby outside plot. Recent rains. Well vegetated.			

	2018		
Name: Michael Lew-Smith	Total % Cover 85%		
Site: Clarendon	DATE: 08-28-2018		
Plot: SUN1	Height: 2"-8" Avg: 4"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Plantago lanceolata	25-50%	5	ct
Onoclea sensibilis	11-25%	18	ct
Trifolium repens	1-5%	1	ct
Oxalis stricta	1-5%	8	ct
Prunella vulgaris	1-5%	0	0
Trifolium hybridum	<1%	0	0
Taraxacum officinale	1-5%	0	0
Juncus tenuis	25-50%	0	0
Phleum pratense	11-25%	9	ct
Unknown graminoid, thin lvs	25-50%	100	sample
Carex annectens	1-5%	0	0
2018 Notes: Recently mowed. Some areas of bare ground, likely from mowing. Some mulch on plot from mowing. Plant id difficult.			

2018 Clarendon Solar Vegetation Plot Data

	2018		
Name: Michael Lew-Smith	Total % Cover 95%		
Site: Clarendon	DATE: 08-28-2018		
Plot: SUN2	Height: 2"-8" Avg: 6"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Onoclea sensibilis	75-100%	94	ct
Galium mollugo	25-50%	0	0
Plantago lanceolata	1-5%	1	ct
Vicia cracca	1-5%	0	0
Ranunculus acris	<1%	0	0
Epilobium sp.	1-5%	0	0
Oxalis stricta	<1%	0	0
Carex annectens	1-5%	0	0
Phleum pratense	6-10%	12	ct
Galium sp.	1-5%	0	0
Solanum dulcamara	11-25%	0	0
Carex scoparia	6-10%	0	0
Trifolium repens	<1%	1	ct
cf Poa sp.	<1%	3	ct
2018 Notes: Recently mowed, plant id difficult. Growing back well. No bare ground, well vegetated. Dense, young sensitive fern			

	2018		
Name: Michael Lew-Smith	Total % Cover 95%		
Site: Clarendon	DATE: 08-28-2018		
Plot: SUN3	Height: 1"-16" Avg: 6"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Calystegia sepium	1-5%	0	0
Plantago lanceolata	11-25%	0	0
Galium mollugo	11-25%	3	ct
Phleum pratense	25-50%	65	ct
Onoclea sensibilis	<1%	0	0
Symphyotrichum lateriflorum	<1%	0	0
Carex annectens	25-50%	22	ct
Carex sp.	<1%	0	0
Ranunculus acris	1-5%	1	ct
Carex sp. -thin lvs	25-50%	200	sample
Carex conoidea	1-5%	1	ct
2018 Notes: Dense graminoids. Recently mowed, plant id difficult. Saturated soils.			

2018 Clarendon Solar Vegetation Plot Data

	2018		
Name: Michael Lew-Smith	Total % Cover 70%		
Site: Clarendon	DATE: 08-28-2018		
Plot: SHADE1	Height: 1"-16" Avg: 6"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Galium cf tinctorum	25-50%	80	sample
Rumex sp.	6-10%	1	ct
Epilobium coloratum	11-25%	0	0
Carex annectens	11-25%	9	ct
Phleum pratense	6-10%	17	ct
Equisetum arvense	1-5%	0	0
Ranunculus acris	1-5%	0	0
Lysimachia nummularia	1-5%	0	0
Persicaria maculosa	11-25%	0	0
2018 Notes: Standing water in plot and throughout area. Some moss (Campylium spp). Recent rains. Many small galium seedlings.			

	2018		
Name: Michael Lew-Smith	Total % Cover 80%		
Site: Clarendon	DATE: 08-28-2018		
Plot: SHADE2	Height: 3"-10" Avg: 6"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phleum pratense	75-100%	31	ct
Persicaria hydropiper	11-25%	11	ct
Galium mollugo	25-50%	36	ct
Cerastium fontanum	<1%	0	0
Ranunculus acris	<1%	0	0
Epilobium coloratum	1-5%	0	0
Ostrya virginiana	<1%	0	0
Carex annectens	11-25%	13	ct
2018 Notes: Recently mowed. Some grass clippings in plot. Soils saturated and soft. Bare soil present outside of plot, but not in plot.			

	2018		
Name: Michael Lew-Smith	Total % Cover 70%		
Site: Clarendon	DATE: 08-28-2018		
Plot: SHADE3	Height: 1"-6" Avg: 4"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Onoclea sensibilis	25-50%	17	ct
Galium mollugo	25-50%	23	ct
Calystegia sepium	6-10%	0	0
Lythrum salicaria	11-25%	0	0
Sonchus arvensis	1-5%	0	0
Symphyotrichum lateriflorum	1-5%	0	0
Phleum pratense	<1%	0	0
Epilobium coloratum	1-5%	6	ct
Oxalis stricta	1-5%	2	ct
cf Poa sp.	1-5%	0	0
Trifolium repens	<1%	1	ct
Ranunculus acris	<1%	1	ct
2018 Notes: Recently mowed, some sensitive fern thatch. Regrowing well. Small amount of bare soil present. Soils saturated and soft.			

Ruts in between solar panels (#2231)

Clarendon Solar

8/28/18

Reference Plot 1

Clarendon Solar

8/28/18

Reference Plot 2

Clarendon Solar

8/28/18

Reference Plot 3

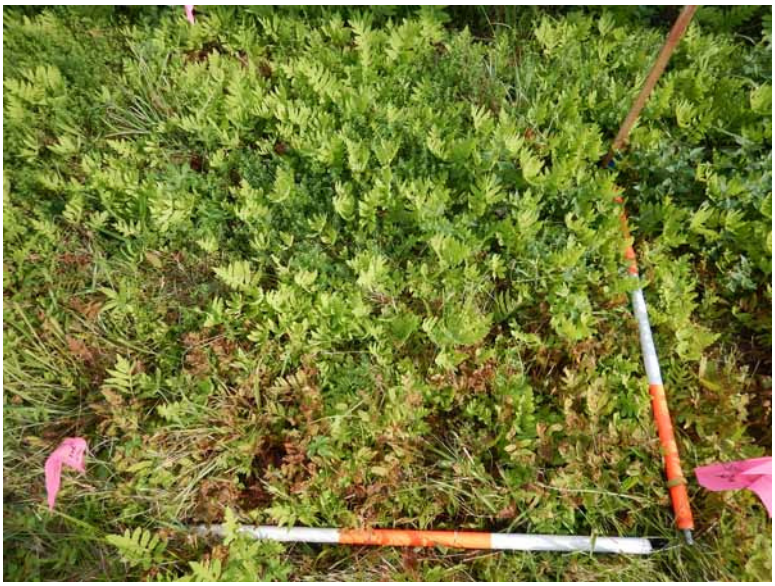
Clarendon Solar

8/28/18

Sun Plot 1

Clarendon Solar

8/28/18



Sun Plot 2

Clarendon Solar

8/28/18

Sun Plot 3

Clarendon Solar

8/28/19

Shade Plot 1

Clarendon Solar

8/28/18

Shade Plot 2

Clarendon Solar

8/28/18

Shade Plot 3

Clarendon Solar

8/28/18

Soil Compaction		
Site	Date	Personel
Clarendon	11/5/2018	JHB & EHB

GPS Point Label	Sun 1
Soil Moisture (%)	21
Depth (in)	Max (psi)
Surface	30
3	70
6	90
9	180
12	210
15	260
18	
21	
24	
Depth to readings over 300psi	
	17

Notes:

GPS Point Label	Sun 2
Soil Moisture (%)	17
Depth (in)	Max (psi)
Surface	70
3	90
6	110
9	200
12	260
15	300
18	
21	
24	
Depth to readings over 300psi	
	15

Notes:

GPS Point Label	Sun 3
Soil Moisture (%)	18.8
Depth (in)	Max (psi)
Surface	40
3	70
6	100
9	100
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	11

Notes:

GPS Point Label	Sun 4
Soil Moisture (%)	26.7
Depth (in)	Max (psi)
Surface	30
3	40
6	90
9	100
12	300
15	
18	
21	
24	
Depth to readings over 300psi	
	11

Notes:

GPS Point Label	Sun 5
Soil Moisture (%)	16.3
Depth (in)	Max (psi)
Surface	40
3	100
6	180
9	
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	7

Notes:

GPS Point Label	Sun 6
Soil Moisture (%)	22.5
Depth (in)	Max (psi)
Surface	20
3	30
6	40
9	60
12	200
15	220
18	300
21	
24	
Depth to readings over 300psi	
	18

Notes:

GPS Point Label	Shade 1
Soil Moisture (%)	18.4
Depth (in)	Max (psi)
Surface	0
3	0
6	20
9	300
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	9

Notes:

GPS Point Label	Shade 2
Soil Moisture (%)	9.2
Depth (in)	Max (psi)
Surface	0
3	20
6	80
9	170
12	250
15	280
18	300
21	
24	
Depth to readings over 300psi	
	18

Notes:

GPS Point Label	Shade 3
Soil Moisture (%)	14.7
Depth (in)	Max (psi)
Surface	0
3	30
6	50
9	100
12	110
15	90
18	150
21	160
24	250
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 4
Soil Moisture (%)	26.8
Depth (in)	Max (psi)
Surface	0
3	0
6	10
9	60
12	200
15	280
18	290
21	200
24	200
Depth to readings over 300psi	

Notes: 5" of standing water

GPS Point Label	Shade 5
Soil Moisture (%)	14.5
Depth (in)	Max (psi)
Surface	0
3	0
6	40
9	200
12	200
15	250
18	
21	
24	
Depth to readings over 300psi	
	16

Notes:

GPS Point Label	Shade 6
Soil Moisture (%)	19.4
Depth (in)	Max (psi)
Surface	0
3	30
6	60
9	200
12	200
15	
18	
21	
24	
Depth to readings over 300psi	
	14

Notes:

GPS Point Label	Ref 1
Soil Moisture (%)	>50
Depth (in)	Max (psi)
Surface	50
3	60
6	90
9	110
12	150
15	250
18	
21	
24	
Depth to readings over 300psi	
	16

Notes:

GPS Point Label	Ref 2
Soil Moisture (%)	16.7
Depth (in)	Max (psi)
Surface	60
3	80
6	110
9	80
12	120
15	140
18	
21	
24	
Depth to readings over 300psi	
	17

Notes:

GPS Point Label	Ref 3
Soil Moisture (%)	22.6
Depth (in)	Max (psi)
Surface	80
3	40
6	60
9	150
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	10

Notes:

GPS Point Label	Ref 4
Soil Moisture (%)	24.8
Depth (in)	Max (psi)
Surface	120
3	40
6	60
9	90
12	200
15	
18	
21	
24	
Depth to readings over 300psi	
	13

Notes:

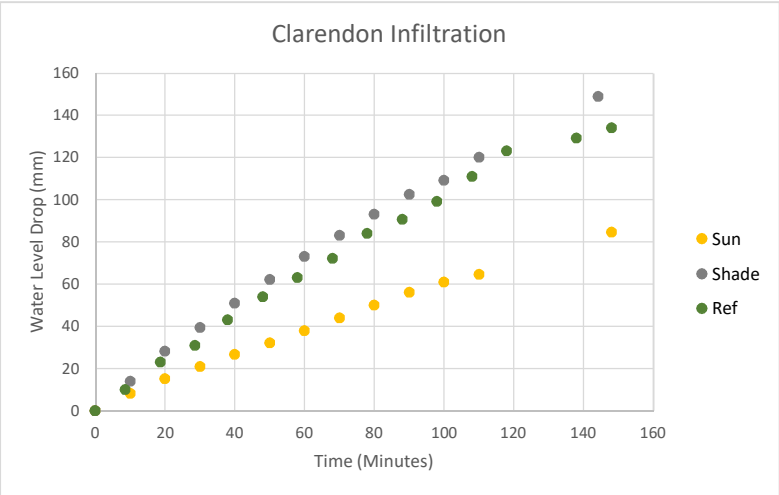
GPS Point Label	Ref 5
Soil Moisture (%)	20.1
Depth (in)	Max (psi)
Surface	60
3	60
6	
9	
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	6

Notes:

GPS Point Label	Ref 6
Soil Moisture (%)	21.7
Depth (in)	Max (psi)
Surface	60
3	90
6	150
9	
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	7

Notes:

MPD Infiltration Testing															
Clarendon	11/5/2018	JHB & EHB													
	Sampler 1					Sampler 2					Sampler 3				
GPS Point	Sun 1-1					Shade 2-1					Ref 1-1				
Pre-Soil Moisture (%)	20.5	21.5		21	18.7	16.9	16.6		15.8	17.6	24.3	24.9		23.3	24
Pre-Average Soil Moisture (%)	20.425					16.725					24.125				
Time to drop 1cm															
Sampling Interval	10					10					10				
		Time (min)		Depth (mm)			Time (min)		Depth (mm)			Time (min)		Depth (mm)	
		0	0	65	65		0	0	43	43		0	0	62	62
		10	10	73	73		10	10	57	57		8.66	9	72	72
		20	20	80	80		20	20	71	71		18.66	19	85	85
		30	30	86	86		30	30	82.5	83		28.66	29	93	93
		40	40	91.5	92		40	40	94	94		38	38	105	105
		50	50	97	97		50	50	105	105		48	48	116	116
		60	60	103	103		60	60	116	116		58	58	125	125
		70	70	109	109		70	70	126	126		68	68	134	134
		80	80	115	115		80	80	136	136		78	78	146	146
		90	90	121	121		90	90	145.5	146		88	88	152.5	153
		100	100	126	126		100	100	152	152		98	98	161	161
		110	110	129.5	130		110	110	163	163		108	108	173	173
		148	148	149.5	150		144.3	144	192	192		118	118	185	185
												138	138	191	191
												148	148	196	196
Post-Soil Moisture (%)	21.5	20.4		20.4	20.2	15.2	14.8		17.7	17.8	25.1	24		24.4	23.5
Post-Soil Moisture Center (%)	18.8					16.1					23.5				
Post-Average Soil Moisture (%)	20.625					16.375					24.25				



Soil Description

Site	Clarendon	Sampling Area	Sun. Shade, Reference
Date	8/9/2018	Personnel	JHB, AK

Sampling Area	Sun		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 5	Primary 3	
Depth (in)	Description	Depth (in)	Description
1	O horizon loose soil dense roots	1	O horizon
0 to 5	Dark gray brown silt loam	0 to 4	light brown silt loam
5 to 7	dark gray brown silt loam redox, roots to 6	4 to 10	light brown silt loam some redox roots to 6
7 to 10+	stripped with very fine sand, heavy redox	10 to 12	heavy redox some pebbles
		12+	stripped layer light gray very fine sand loam

Sampling Area	Shade		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 1	Primary 3	
Depth (in)	Description	Depth (in)	Description
0.5	O horizon	0.5	O horizon
0 to 6	dark silt clay, roots to 4	0 to 8	light brown silt loam roots to 2
6 to 10	light brown silt loam some redox	8 to 12	minor redox, old roots, light brown silt loam
10 to 15	heavy dark brown soil with mottling	12+	rocky
15+	very fine sand loam w/ pebbles, some redox		

Sampling Area	Reference		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 3	Primary 4	
Depth (in)	Description	Depth (in)	Description
0.5	O horizon loose soil dense roots	0.5	O horizon
0 to 2	dark silt loam	0 to 6	dark silt loam some redox, roots to 5
2 to 10	dark silt loam with redox	6 to 10	stripped silt loam heavy redox
10 to 14	stripped silt heavy redox	10 to 13	fine gravel
14+	rocky	13+	rocky

Qualitative Observations Data Form v6

Observer: *Michael Lew-Smith*	Site Name: *Ferrisburg*	Date: 8/26/19

Solar Facility Notes

Height of panels (off ground): *18" to 6'*	Distance between panel rows: *20'*
This is a pre-construction survey __	Type of foundation: Post __X_ Concrete ____ Other ____
This is a post-construction survey X_	Type of modules: Trackers ____ Fixed Mount __X_
Notes / Other Vegetation Mgmt:	Date of Annual Mowing: Unk

Stockpiled soil and grade stakes present in area near reference plots. New landowner may be developing area ?

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

No standing water or saturated soils at time of site visit.

Notes:	Are Hummock/Hollows Present?	Yes ___	No _X_

NA

Are any exposed soils present in the wetland/buffer within Project Area?			Yes _X_	No ___
Explain and map:	Unique ID		Photo #	

Small areas of exposed soils present beneath arrays.

Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?			Yes ___	No _X_
Explain and map:	Unique ID		Photo #	

NA

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Phalaris arundinacea	*30*	*Phalaris arundinacea*	*30*
Phleum pretense	*20*		
Lotus corniculata	*5*		
Scirpus atrovirens	*5*		
Total Cover	*100*	Total Cover	*30*

Notes: *Areas in between panels mowed, areas beneath panels not mowed.*

Are there areas in the wetland/buffer with disturbed vegetation?			Yes ___	No _X_
Describe and Map:	Unique ID		Photo #	

NA

If yes, does this impact wetland function/value?	Yes ___	No X__

Explain:

NA

Qualitative Observations Data Form v6

Observer: *Joe Bartlett*	Site Name: *Ferrisburgh*	Date: 10/10/2019

Solar Facility Notes

Height of panels (off ground):	Distance between panel rows:
This is a pre-construction survey __	Type of foundation: Post ____ Concrete ____ Other ____
This is a post-construction survey __	Type of modules: Trackers ____ Fixed Mount ____
Notes / Other Vegetation Mgmt:	Date of Annual Mowing:

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

Evidence of recent surface flow through middle of panel rows, some saturated soils along flow path, otherwise site is dry

Notes:	Are Hummock/Hollows Present?	Yes __X_	No ___

Some small hummocks are present in the reference area

Are any exposed soils present in the wetland/buffer within Project Area?			Yes ___	No _X__
Explain and map:	Unique ID		Photo #	
Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?			Yes ___	No _X__
Explain and map:	Unique ID		Photo #	

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Total Cover		Total Cover	

Notes:

Are there areas in the wetland/buffer with disturbed vegetation?		Yes ___	No ___
Describe and Map:	Unique ID	Photo #	
If yes, does this impact wetland function/value?		Yes ___	No ___

Explain:

DEC Solar Vegetation Monitoring Plots

Reference Ferrisburg

FREF1

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	100%	98%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	2%
Veg Height Range:	2-48 in	3-20 in
Average Veg. Height:	24 in	116 in

Species	Non-native	species % Cover	species % Cover
Agrostis gigantea	✔	6-10%	-
Carex annectens		6-10%	-
Carex laxiflora	✔	-	1-5%
Carex pellita		1-5%	-
Carex sp.		1-5%	26-50%
Daucus carota	✔	6-10%	6-10%
Fraxinus americana		1-5%	1-5%
Galium mollugo	✔	1-5%	11-25%
Juncus tenuis		6-10%	-
Lotus corniculatus	✔	1-5%	-
Phalaris arundinacea		76-100%	26-50%
Phleum pratense	✔	11-25%	6-10%
Poa pratensis		-	6-10%
Prunella vulgaris		6-10%	1-5%
Ranunculus acris	✔	1-5%	1-5%
Scirpus atrovirens		1-5%	-
Symphyotrichum lanceolatum		1-5%	-
Symphyotrichum lateriflorum		-	1-5%
Taraxacum officinale	✔	1-5%	1-5%
Trifolium pratense	✔	6-10%	11-25%
Vicia cracca	✔	-	1-5%
Species Richness:		17	14
Species Diversity*:		0.74	0.85

2018 Plot Comments: Dense, thick mat of vegetation. Counts in subplot are estimates only, dense sterile graminoids difficult to distinguish.

2019 Plot Comments: Mowed earlier in season. All graminoids sterile. Agrostis gigantea may be present? All Carex cover lumped

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Reference Ferrisburg

FREF2

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	2-24 in	3-24 in
Average Veg. Height:	24 in	10 in

Species	Non-native	species % Cover	species % Cover
Agrostis gigantea	✔	26-50%	6-10%
Asclepias syriaca		11-25%	11-25%
Carex laxiflora	✔	-	1-5%
Carex pallescens		1-5%	-
Carex sp.		1-5%	6-10%
Dactylis glomerata	✔	11-25%	6-10%
Fraxinus americana		1-5%	1-5%
Galium mollugo	✔	11-25%	26-50%
Geum sp.		1-5%	-
Juncus tenuis		1-5%	-
Lotus corniculatus	✔	6-10%	-
Phleum pratense	✔	51-75%	26-50%
Plantago lanceolata	✔	<1%	-
Poa pratensis		1-5%	-
Prunella vulgaris		<1%	-
Scirpus atrovirens		11-25%	1-5%
Symphyotrichum lanceolatum		6-10%	-
Symphyotrichum lateriflorum		6-10%	11-25%
Taraxacum officinale	✔	<1%	1-5%
Trifolium pratense	✔	1-5%	6-10%
Vicia cracca	✔	1-5%	1-5%
Species Richness:		20	13
Species Diversity*:		0.86	0.85

2018 Plot Comments: Dense graminoids. No bare ground. Sterile graminoids in subplot difficult to distinguish.

2019 Plot Comments: Mowed earlier in the season. Some thatch. Carex spp cover lumped. May be missing some graminoids. Difficult to get ID and cover.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Reference Ferrisburg

FREF3

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	100%	95%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	5%
Veg Height Range:	3-36 in	3-16 in
Average Veg. Height:	24 in	12 in

Species	Non-native	species % Cover	species % Cover
Agrostis gigantea	✔	6-10%	6-10%
Asclepias syriaca		11-25%	1-5%
Carex annectens		76-100%	51-75%
Carex pellita		6-10%	-
Dactylis glomerata	✔	6-10%	-
Daucus carota	✔	1-5%	1-5%
Fraxinus americana		6-10%	6-10%
Galium mollugo	✔	11-25%	26-50%
Lotus corniculatus	✔	11-25%	<1%
Phleum pratense	✔	26-50%	11-25%
Potentilla simplex		-	1-5%
Prunella vulgaris		1-5%	-
Ranunculus acris	✔	1-5%	6-10%
Scirpus atrovirens		1-5%	-
Symphyotrichum lateriflorum		1-5%	<1%
Taraxacum officinale	✔	1-5%	1-5%
Trifolium pratense	✔	6-10%	11-25%
Vicia cracca	✔	1-5%	<1%
Species Richness:		17	14
Species Diversity*:		0.82	0.8

2018 Plot Comments: Area may have been mowed in recent past. Seems only marginally wet (pretty dry). Dense graminoids, difficult to distinguish cover of spp.. Estimates only in subplot

2019 Plot Comments: Eastern part of plot was recently mowed. Entire plot mowed earlier in summer.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Ferrisburg

FSHD1

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	40%	100%
Rock Cover:	0%	0%
Soil Cover:	30%	0%
Mulch Cover:	0%	0%
Thatch Cover:	30%	0%
Veg Height Range:	2-24 in	5-55 in
Average Veg. Height:	12 in	50 in

Species	Non-native	species % Cover	species % Cover
Asclepias syriaca		11-25%	1-5%
Bidens vulgata		-	76-100%
Carya cordiformis		-	11-25%
Cirsium arvense	✔	6-10%	-
Daucus carota	✔	6-10%	-
Epilobium coloratum		11-25%	51-75%
Galium mollugo	✔	6-10%	1-5%
Galium tinctorium		-	1-5%
Phleum pratense	✔	<1%	-
Schedonorus sp.		1-5%	-
Sonchus arvensis	✔	6-10%	1-5%
Symphyotrichum lateriflorum		-	1-5%
Taraxacum officinale	✔	<1%	-
Species Richness:		9	8
Species Diversity*:		0.84	0.65

2018 Plot Comments: 60% unvegetated. 30% bare ground and 30% duff layer (graminoid thatch). Looks like may have been trampled by deer.

2019 Plot Comments: Unmowed plot. Tall, dense Bidens and Epilobium but bare soil beneath that layer (appx 30%). Soft soils

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Ferrisburg

FSHD2

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	90%	90%
Rock Cover:	0%	0%
Soil Cover:	10%	5%
Mulch Cover:	0%	0%
Thatch Cover:	0%	5%
Veg Height Range:	2-48 in	2-28 in
Average Veg. Height:	12 in	2 in

Species	Non-native	species % Cover	species % Cover
Bidens vulgata		51-75%	51-75%
Calystegia sepium		76-100%	6-10%
Cirsium arvense	✔	1-5%	-
Epilobium coloratum		6-10%	-
Galium mollugo	✔	1-5%	<1%
Symphyotrichum lateriflorum		6-10%	-
Species Richness:		6	3
Species Diversity*:		0.61	0.21

2018 Plot Comments: Sprawling Calystegia covers most of the plot, bare ground beneath.

2019 Plot Comments: Recently mowed. Dense Bidens, much mowed and laid down flat. % cover as if it were erect.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Ferrisburg

FSHD3

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	70%	90%
Rock Cover:	0%	0%
Soil Cover:	20%	10%
Mulch Cover:	0%	0%
Thatch Cover:	10%	0%
Veg Height Range:	2-36 in	4-36 in
Average Veg. Height:	24 in	20 in

Species	Non-native	species % Cover	species % Cover
Acalypha rhomboidea		<1%	26-50%
Carex gracillima		1-5%	1-5%
Circaea canadensis		1-5%	-
Daucus carota	✔	<1%	-
Epilobium coloratum		-	1-5%
Fraxinus americana		11-25%	11-25%
Galium mollugo	✔	<1%	1-5%
Onoclea sensibilis		-	6-10%
Oxalis stricta		11-25%	26-50%
Persicaria pensylvanica		-	6-10%
Persicaria sp.		11-25%	-
Phleum pratense	✔	1-5%	1-5%
Poa pratensis		1-5%	-
Symphyotrichum lateriflorum		1-5%	6-10%
Urtica dioica		26-50%	26-50%
Vicia cracca	✔	-	1-5%
Species Richness:		12	12
Species Diversity*:		0.8	0.84

2018 Plot Comments: 30% unvegetated. Thin layer of duff over bare soil- some exposed. Sparsely vegetated.

2019 Plot Comments: Unmowed. Ground soft.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Ferrisburg

FSUN1

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	2-48 in	10-48 in
Average Veg. Height:	36 in	36 in

Species	Non-native	species % Cover	species % Cover
Asclepias syriaca		-	11-25%
Carex annectens		26-50%	51-75%
Carex conoidea		1-5%	1-5%
Carex cristatella		-	11-25%
Daucus carota	✔	1-5%	-
Galium mollugo	✔	6-10%	11-25%
Juncus tenuis		6-10%	11-25%
Lotus corniculatus	✔	26-50%	51-75%
Phleum pratense	✔	26-50%	26-50%
Ranunculus acris	✔	<1%	6-10%
Schedonorus pratensis	✔	1-5%	-
Scirpus atrovirens		11-25%	11-25%
Taraxacum officinale	✔	<1%	-
Trifolium pratense	✔	<1%	-
Species Richness:		12	10
Species Diversity*:		0.81	0.85

2018 Plot Comments: Dense reed canary grass, matted down. Galium seedlings in subplot. Graminoids difficult to distinguish in subplot.

2019 Plot Comments: Dense mat of unmowed vegetation. Undisturbed.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Ferrisburg

FSUN2

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	2-48 in	8-48 in
Average Veg. Height:	24 in	36 in

Species	Non-native	species % Cover	species % Cover
Calystegia sepium		<1%	1-5%
Carex annectens		11-25%	11-25%
Carex cristatella		26-50%	26-50%
Carex sp.		-	1-5%
Daucus carota	✔	6-10%	1-5%
Galium mollugo	✔	1-5%	1-5%
Inula helenium	✔	11-25%	11-25%
Lotus corniculatus	✔	26-50%	1-5%
Oxalis stricta		1-5%	-
Persicaria sp.		<1%	-
Phalaris arundinacea		11-25%	51-75%
Phleum pratense	✔	1-5%	-
Poa pratensis		-	6-10%
Ranunculus acris	✔	<1%	-
Scirpus atrovirens		6-10%	6-10%
Sonchus arvensis	✔	6-10%	11-25%
Stellaria longifolia		-	1-5%
Stellaria sp.		<1%	-
Symphyotrichum lanceolatum		6-10%	-
Symphyotrichum lateriflorum		-	6-10%
Taraxacum officinale	✔	1-5%	1-5%
Trifolium pratense	✔	1-5%	-
Species Richness:		18	15
Species Diversity*:		0.87	0.84

2018 Plot Comments: Densely vegetated, mostly by graminoids. Counts in subplot estimates only, difficult to distinguish, mostly sterile.

2019 Plot Comments: Unmowed. Tall, dense vegetation. Undisturbed plot.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Ferrisburg

FSUN3

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	6-36 in	8-48 in
Average Veg. Height:	30 in	24 in

Species	Non-native	species % Cover	species % Cover
Ambrosia artemisiifolia		<1%	6-10%
Carex annectens		11-25%	26-50%
Carex conoidea		1-5%	6-10%
Carex laxiflora	✔	-	6-10%
Carex sp.		6-10%	-
Elymus repens	✔	11-25%	-
Galium mollugo	✔	26-50%	11-25%
Juncus tenuis		11-25%	1-5%
Phalaris arundinacea		<1%	-
Phleum pratense	✔	26-50%	26-50%
Poa pratensis		11-25%	6-10%
Ranunculus acris	✔	1-5%	<1%
Rumex sp.		1-5%	-
Schedonorus pratensis	✔	51-75%	6-10%
Scirpus atrovirens		1-5%	11-25%
Stellaria longifolia		-	<1%
Symphyotrichum lanceolatum		6-10%	-
Symphyotrichum lateriflorum		-	26-50%
Taraxacum officinale	✔	1-5%	6-10%
Trifolium pratense	✔	6-10%	6-10%
Species Richness:		17	15
Species Diversity*:		0.87	0.88

2018 Plot Comments: Dense sedges and forbs. Nice undisturbed plot. Difficult to distinguish graminoids in sub-plot.

2019 Plot Comments: Undisturbed plot, unmowed. Dense mat of vegetation, mostly graminoids.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

2019 Ferrisburg Solar Vegetation Plot Photo Log

Reference Plot 1

Reference Plot 2

2019 Ferrisburg Solar Vegetation Plot Photo Log

Reference Plot 3

Sun Plot 1

2019 Ferrisburg Solar Vegetation Plot Photo Log

Sun Plot 2

Sun Plot 3

2019 Ferrisburg Solar Vegetation Plot Photo Log

Shade Plot 1

Shade Plot 2

Shade Plot 3

Soil Compaction		
Site	Date	Personel
Ferrisburg	10/10/2019	EHB JHB

GPS Point Label	Sun 1
Soil Moisture (%)	23.7
Depth (in)	Max (psi)
Surface	40
3	40
6	80
9	100
12	120
15	120
18	130
21	140
24	140
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 2
Soil Moisture (%)	>50
Depth (in)	Max (psi)
Surface	20
3	50
6	80
9	100
12	100
15	115
18	140
21	150
24	170
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 3
Soil Moisture (%)	24.5
Depth (in)	Max (psi)
Surface	50
3	100
6	120
9	140
12	140
15	110
18	110
21	120
24	120
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 4
Soil Moisture (%)	48.3
Depth (in)	Max (psi)
Surface	10
3	30
6	100
9	100
12	110
15	130
18	130
21	110
24	120
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 5
Soil Moisture (%)	30.4
Depth (in)	Max (psi)
Surface	10
3	30
6	80
9	90
12	120
15	110
18	100
21	120
24	150
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 6
Soil Moisture (%)	26.8
Depth (in)	Max (psi)
Surface	20
3	30
6	80
9	100
12	110
15	110
18	110
21	130
24	130
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 1
Soil Moisture (%)	46.1
Depth (in)	Max (psi)
Surface	10
3	20
6	50
9	80
12	90
15	90
18	100
21	120
24	120
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 2-2
Soil Moisture (%)	>50
Depth (in)	Max (psi)
Surface	0
3	20
6	40
9	50
12	50
15	80
18	100
21	120
24	150
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 3
Soil Moisture (%)	47.2
Depth (in)	Max (psi)
Surface	10
3	20
6	30
9	50
12	50
15	70
18	80
21	80
24	80
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 2-1
Soil Moisture (%)	23.9
Depth (in)	Max (psi)
Surface	10
3	30
6	50
9	100
12	120
15	150
18	150
21	110
24	110
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 5
Soil Moisture (%)	35.5
Depth (in)	Max (psi)
Surface	10
3	30
6	80
9	120
12	110
15	120
18	110
21	100
24	100
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 6
Soil Moisture (%)	27.1
Depth (in)	Max (psi)
Surface	20
3	40
6	80
9	80
12	90
15	110
18	110
21	100
24	100
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 1
Soil Moisture (%)	23.1
Depth (in)	Max (psi)
Surface	30
3	150
6	150
9	180
12	110
15	180
18	180
21	150
24	200
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 2
Soil Moisture (%)	23.5
Depth (in)	Max (psi)
Surface	50
3	90
6	120
9	150
12	180
15	190
18	180
21	190
24	220
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 3
Soil Moisture (%)	23.5
Depth (in)	Max (psi)
Surface	60
3	100
6	120
9	130
12	160
15	180
18	>300
21	
24	
Depth to readings over 300psi	

Notes: rock

GPS Point Label	Ref 4
Soil Moisture (%)	27.7
Depth (in)	Max (psi)
Surface	50
3	80
6	120
9	140
12	140
15	140
18	180
21	200
24	250
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 5
Soil Moisture (%)	22.8
Depth (in)	Max (psi)
Surface	100
3	150
6	160
9	160
12	180
15	190
18	230
21	250
24	250
Depth to readings over 300psi	

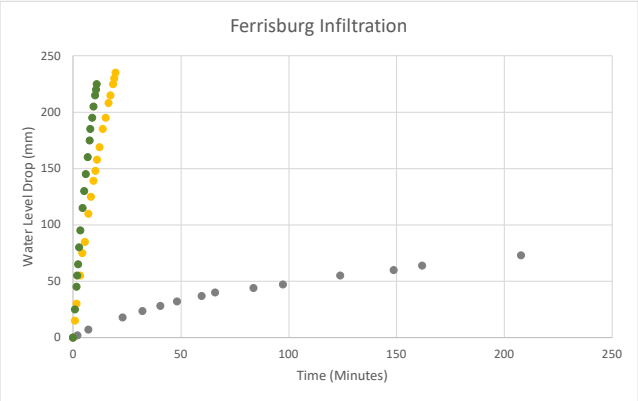
Notes:

GPS Point Label	Ref 6
Soil Moisture (%)	24
Depth (in)	Max (psi)
Surface	60
3	30
6	130
9	150
12	180
15	190
18	200
21	200
24	200
Depth to readings over 300psi	

Notes:

MPD Infiltration Testing		
Site	Date	Personel
Ferrisburg	10/10/2019	EHB JHB
Used the penetrometer for Sampler 2 and Sampler 3.		

	Sampler 2					Sampler 1					Sampler 3				
GPS Point	Sun 1					Shade 1					Ref 1				
Pre-Soil Moisture (%)	20.2	22.8	20	22.5		24.3	25.7	28.6	28.2		20.6	22.2	21.9	19.3	
Pre-Average Soil Moisture (%)	21.375					26.7					21				
		Stop Watch Time	**Time from start**	**Depth (mm)**	**Drop (mm)**		**Stop Watch Time**	**Time from start**	**Depth (mm)**	**Drop (mm)**		**Stop Watch Time**	**Time from start**	**Depth (mm)**	**Drop (mm)**
		1.2	0	85	0		2	0	70	0		109.7	0	75	0
		2	0.8	100	15		4	2	72	2		110.5	0.8	100	25
		2.8	1.6	115	30		9	7	77	7		111.2	1.5	120	45
		4.4	3.2	140	55		25	23	88	18		111.5	1.8	130	55
		5.5	4.3	160	75		34	32.2	93.5	23.5		112	2.3	140	65
		6.6	5.4	170	85		42	40.5	98	28		112.5	2.8	155	80
		8.2	7	195	110		50	48.1	102	32		113	3.3	170	95
		9.4	8.2	210	125		61	59.6	107	37		114.1	4.4	190	115
		10.7	9.5	224	139		68	65.9	110	40		114.9	5.2	205	130
		11.5	10.3	233	148		85	83.7	114	44		115.6	5.9	220	145
		12.3	11.1	243	158		99	97.3	117	47		116.5	6.8	235	160
		13.4	12.2	254	169		126	123.9	125	55		117.3	7.6	250	175
		15	13.8	270	185		150	148.6	130	60		117.6	7.9	260	185
		16.2	15	280	195		164	161.8	134	64		118.6	8.9	270	195
		17.6	16.4	293	208		210	207.8	143	73		119.2	9.5	280	205
		18.5	17.3	300	215							119.9	10.2	290	215
		19.7	18.5	310	225							120.3	10.6	295	220
		20.3	19.1	315	230							120.6	10.9	300	225
		20.9	19.7	320	235										
		21.6	20.4	325	240										
Post-Soil Moisture Center (%)	25					46.2					24.5				



Soil Description

Site	Ferrisburg	Sampling Area	Sun. Shade, Reference
Date	10/10/2019	Personnel	JHB EHB

Sampling Area Sun

Core Location GPS Points: Primary 1-6

Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 2	Primary 1	
Depth (in)	Description	Depth (in)	Description
1	O horizon, coarse	1	O horizon
0 to 4	10YR 3/2 coarse roots to 4	0 to 4	friable silt loam 10YR 3/3 lots of roots
4 to 9	10YR 4/2 moderate redox	4 to 9	fine roots 10YR 2/2 no redox
9 to 17+	light gray silt moderate redox 10YR 6/2	9 to 14	Med gray with redox some roots, 10YR 3/2
		14+	Light gray silt clay heavy redox 10YR 5/2

Sampling Area Shade

Core Location GPS Points: Primary 1,3,4,6,Alt1, Alt2 - Skipped 2 and 5 because they were behind inverter racks

Lab Duplicate	Y	Metals Analysis	Y

Soil Description

Sampling area	Alt #2	Primary 4	
Depth (in)	Description	Depth (in)	Description
1	O horizon	2	O horizon
0 to 4	loose silt loam some roots 10YR 3/4	0 to 4	wet silt no roots, minor redox 10YR 4/1
4 to 12	10YR 5/2 some redox	4 to 16+	10YR 6/1 silt light redox
12 to 18+	10YR 6/1 mod redox silty clay		

Sampling Area Reference

Core Location GPS Points: Primary 1-6

Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 1	Primary 2	
Depth (in)	Description	Depth (in)	Description
2	O horizon loose soil dense roots	2	O horizon
0 to 4	10YR 3/3 lots of fine roots, silt loam	0 to 4	10YR 3/2 some redox silt loam
4 to 9	10YR 3/3 fewer roots, siltier	4 to 10	10YR 4/1 moderate redox
9 to 18	10YR 6/2 silt, no redox	10 to 16+	10YR 5/2 fine sand silt loam, some redox
18+	10YR 6/2 silt, some redox		

Soil Test Results

Site	Date	Location	pH	OM_Pct	Avail_P	K	Ca	Mg	Zn	B	Mn	Cu	Fe	Al	Na	S	Exch_Acid	ECEC	A_Base_Sa	G_Base_S	K_Base_Sa	Pb	Ni	Cd	Cr
				%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Ferrisburgh	10/10/2019	Sun	7.29	7.787	2.9	243	3085	628	0.95	0.65	6.7	0.15	5.4	19	73	20	0.00	21.28	72.48	24.59	2.93	0.25	0.55	0.1	0.2
Ferrisburgh	10/10/2019	Shade	7.29	8.606	3	240	3075	772	1.05	0.8	6.2	0.1	3	15	72	16	0.00	22.42	68.57	28.69	2.74	0.2	0.5	0.1	0.2
Ferrisburgh	10/10/2019	Ref	7.29	6.786	2.45	149	3082	394	0.65	0.5	4.3	0.05	1.8	18	29	8	0.00	19.08	80.78	17.21	2.00	0.1	0.5	0.1	0.15
Ferrisburgh	10/10/2019	Shade 2	7.47	7.787	4.3	257	3022	686	1.05	0.85	8.1	0.15	6.1	16	87	22	0.00	21.49	70.33	26.61	3.07	0.25	0.3	0.05	0
		Average:	7.34	7.74	3.2	222	3066	620	0.93	0.70	6.3	0.11	4.1	17	65	17	0.00	21.07	73.04	24.28	2.69	0.20	0.46	0.09	0.14
Ferrisburgh	8/9/2018	Ref 1	7.31	7.605	1.55	111	4449	323	0.40	0.50	2.6	0.15	1.0	6	20	6	0.00	25.22	88.20	10.67	1.13	0.2	0.20	0.05	0
Ferrisburgh	8/9/2018	Ref 2	7.27	8.606	1.60	118	4794	355	0.45	0.55	3.2	0.15	1.0	7	23	7	0.00	27.23	88.03	10.86	1.11	0.4	0.20	0.05	0
Ferrisburgh	8/9/2018	Shade	7.27	9.698	1.85	160	4754	656	0.80	0.70	1.9	0.10	1.0	6	66	11	0.00	29.65	80.18	18.44	1.38	0.2	0.20	0.05	0
Ferrisburgh	8/9/2018	Sun	7.57	8.242	3.40	176	4207	549	0.95	0.65	3.2	0.15	2.0	8	77	20	0.00	26.06	80.71	17.55	1.73	0.3	0.25	0.05	0
		Average:	7.39	8.538	2.10	141	4551	471	0.65	0.60	2.7	0.14	1.3	7	47	11	0.00	27.04	84.28	14.38	1.34	0.3	0.21	0.05	0

2018 Ferrisburg Solar Qualitative Data

Observer: *Michael Lew-Smith*	Site Name: *Ferrisburg*	Date: *8/27/18*

Solar Facility Notes

Height of panels (off ground): *18" to 6'*	Distance between panel rows: *20'*
This is a pre-construction survey __	Type of foundation: Post _X_ Concrete ____ Other ____
This is a post-construction survey _X	Type of modules: Trackers _X__ Fixed Mount ____
Notes / Other Vegetation Mgmt:	Date of Annual Mowing: ?

Some planted shrubs in between panels which get maintained.

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

No standing water or saturated soils at time of site visit. No visible hydrologic sources.

Notes:	Are Hummock/Hollows Present?	Yes ___ No _X_

Are any exposed soils present in the wetland/buffer within Project Area?	Yes _X_	No ___
Explain and map:	Photo #	

< 1% unvegetated, some bare areas under panels, very rare. See plot SHADE1

Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?	Yes ___	No _X_
Explain and map:	Photo #	

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Lotus corniculatus	*10*	*Phalaris arundinacea*	*30*
Phalaris arundinacea	*30*		
Scirpus atrivirens	*15*		
Symphiotrichum lanceolatum	*5*		
Total Cover	*100*	Total Cover	*30*

Notes: *Variable vegetation, generally well vegetated; Phalaris throughout*

Are there areas in the wetland/buffer with disturbed vegetation?	Yes ___	No _X_
Describe and Map:	Photo #	
If yes, does this impact wetland function/value?	Yes ___	No _X_

Explain:

2018 Ferrisburg Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Ferrisburg	DATE: 08-27-2018		
Plot: REF1	Height: 2"-4' Avg: 3'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phalaris arundinacea	75-100%	8	ct
Daucus carota	6-10%	3	ct
Trifolium pratense	6-10%	0	0
Taraxacum officinale	1-5%	0	0
Galium mollugo	1-5%	18	ct
Prunella vulgaris	6-10%	3	ct
Lotus corniculatus	1-5%	0	0
Fraxinus americana	1-5%	1	ct
Carex annectens	6-10%	33	est
Phleum pratense	11-25%	0	0
Agrostis gigantea	6-10%	0	0
Carex (laxiflorae group)	1-5%	1	ct
Carex pellita	1-5%	0	0
Juncus tenuis	6-10%	0	0
Ranunculus acris	1-5%	0	0
Symphyotrichum lanceolatum	1-5%	1	ct
Scirpus atrovirens	1-5%	1	ct
2018 Notes: Dense reed canary grass, matted down. Galium seedlings in subplot. Graminoids difficult to distinguish in subplot.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Ferrisburg	DATE: 05-27-2018		
Plot: REF2	Height: 2"-4' Avg: 2'		
Plant Species	**Plot % Cover**	**Subplot Stem Count**	**Subplot Count Type**
Phleum pratense	50-75%	12	est
Asclepias syriaca	11-25%	0	0
Galium mollugo	11-25%	35	ct
Dactylis glomerata	11-25%	2	ct
Lotus corniculatus	6-10%	0	0
Vicia cracca	1-5%	1	ct
Trifolium pratense	1-5%	5	ct
Agrostis gigantea	25-50%	30	est
Symphyotrichum lateriflorum	6-10%	0	0
Scirpus atrovirens	11-25%	3	0
Taraxacum officinale	<1%	0	0
Plantago lanceolata	<1%	0	0
Juncus tenuis	1-5%	0	0
Symphyotrichum lanceolatum	6-10%	0	0
Geum sp.	1-5%	0	0
Carex pallescens	1-5%	0	0
Carex spp (sect Laxiflorae)	1-5%	1	ct
Poa pratensis	1-5%	10	est
Fraxinus americana	1-5%	1	0
Prunella vulgaris	<1%	0	0
2018 Notes: Densely vegetated, mostly by graminoids. Counts in subplot estimates only, difficult to distinguish, mostly sterile.			

2018 Ferrisburg Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Ferrisburg	DATE: 08-27-2018		
Plot: REF3	Height: 6"-3' Avg: 2.5'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Asclepias syriaca	11-25%	0	0
Dactylis glomerata	6-10%	3	ct
Galium mollugo	11-25%	13	ct
Fraxinus americana	6-10%	1	ct
Agrostis gigantea	6-10%	22	ct
Carex annectens	75-100%	12	ct
Lotus corniculatus	11-25%	0	0
Daucus carota	1-5%	0	0
Trifolium pratense	6-10%	14	ct
Symphyotrichum lateriflorum	1-5%	0	0
Vicia cracca	1-5%	0	0
Taraxacum officinale	1-5%	2	ct
Ranunculus acris	1-5%	0	0
Prunella vulgaris	1-5%	0	0
Carex pellita	6-10%	0	0
Phleum pratense	25-50%	13	ct
Scirpus atrovirens	1-5%	2	ct
2018 Notes: Dense sedges and forbs. Nice undisturbed plot. Difficult to distinguish graminoids in subplot.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Ferrisburg	DATE: 08-27-2018		
Plot: SUN1	Height: 2"-4' Avg: 2'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Scirpus atrovirens	11-25%	0	0
Lotus corniculatus	25-50%	0	0
Carex annectens	25-50%	45	ct
Juncus tenuis	6-10%	8	ct
Schedonorus pratensis	1-5%	0	0
Galium mollugo	6-10%	0	0
Phleum pratense	25-50%	30	ct
Daucus carota	1-5%	0	0
Taraxacum officinale	<1%	0	0
Carex conoidea	1-5%	0	0
Ranunculus acris	<1%	0	0
Trifolium pratense	<1%	2	ct
2018 Notes: Dense, thick mat of vegetation. Counts in subplot are estimates only, dense sterile graminoids difficult to distinguish.			

2018 Ferrisburg Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Ferrisburg	DATE: 08-27-2018		
Plot: SUN2	Height: 2"-2' Avg: 2'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Daucus carota	6-10%	0	0
Phalaris arundinacea	11-25%	0	0
Lotus corniculatus	25-50%	10	ct
Taraxacum officinale	1-5%	0	0
Sonchus arvensis	6-10%	0	0
Symphyotrichum lanceolatum	6-10%	0	0
Inula helenium	11-25%	0	0
Carex cristatella	25-50%	0	0
Galium mollugo	1-5%	0	0
Trifolium pratense	1-5%	0	0
Scirpus atrovirens	6-10%	3	0
Carex annectens	11-25%	0	0
Oxalis stricta	1-5%	0	0
Stellaria sp.	<1%	0	0
Ranunculus acris	<1%	0	0
Persicaria sp.	<1%	0	0
Calystegia sepium	<1%	1	0
Phleum pratense	1-5%	3	0
2018 Notes: Dense graminoids. No bare ground. Sterile graminoids in subplot difficult to distinguish.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Ferrisburg	DATE: 08-27-2018		
Plot: SUN3	Height: 3"-3' Avg: 2'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Galium mollugo	25-50%	80	est
Symphyotrichum lanceolatum	6-10%	0	0
Rumex spp.	1-5%	0	0
Phalaris arundinacea	<1%	0	0
Taraxacum officinale	1-5%	1	ct
Elymus repens	11-25%	0	0
Ambrosia artemisiifolia	<1%	0	0
Scirpus atrovirens	1-5%	0	0
Juncus tenuis	11-25%	5	ct
Phleum pratense	25-50%	0	0
Carex conoidea	1-5%	?	0
Schedonorus pratensis	50-75%	0	0
Trifolium pratense	6-10%	0	0
Carex spp. (sect Laxiflorae)	6-10%	6	0
Ranunculus acris	1-5%	2	0
Carex annectens	11-25%	4	0
Poa pratensis	11-25%	30	0
2018 Notes: Area may have been mowed in recent past. Seems only marginally wet. Dense graminoids, difficult to distinguish cover of spp.. Estimates only in subplot.			

2018 Ferrisburg Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 40%		
Site: Ferrisburg	DATE: 08-27-2018		
Plot: SHADE1	Height: 2"-2' Avg: 1'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Daucus carota	6-10%	0	0
Asclepias syriaca	11-25%	0	0
Epilobium coloratum	11-25%	17	ct
Taraxacum officinale	<1%	0	0
Galium mollugo	6-10%	2	ct
Cirsium arvense	6-10%	0	0
Schedonorus spp.	1-5%	0	0
Sonchus arvensis	6-10%	0	0
Phleum pratense	<1%	1	ct
2018 Notes: 60% unvegetated. 30% bare ground and 30% duff layer (graminoid thatch). Looks like may have been trampled by deer.			

	2018		
Name: Michael Lew-Smith	Total % Cover 90%		
Site: Ferrisburg	DATE: 08-27-2018		
Plot: SHADE2	Height: 2"-4' Avg: 1'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Bidens vulgata	50-75%	6	ct
Calystegia sepium	75-100%	2	ct
Cirsium arvense	1-5%	3	ct
Epilobium coloratum	6-10%	0	0
Galium mollugo	1-5%	0	0
Symphyotrichum lateriflorum	6-10%	0	0
2018 Notes: Sprawling Calystegia covers most of the plot, bare ground beneath.			

	2018		
Name: Michael Lew-Smith	Total % Cover 70%		
Site: Ferrisburg	DATE: 08-27-2018		
Plot: SHADE3	Height: 2"-3' Avg: 2'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Oxalis stricta	11-25%	0	0
Urtica gracilis	25-50%	1	ct
Fraxinus americana	11-25%	0	0
Persicaria sp.	11-25%	1	ct
Circaea canadensis	1-5%	0	0
Galium mollugo	<1%	2	ct
Phleum pratense	1-5%	4	ct
Acalypha rhomboidea	<1%	0	0
Poa pratensis	1-5%	0	0
Symphyotrichum lateriflorum	1-5%	0	0
Carex gracillima	1-5%	0	0
Daucus carota	<1%	0	0
2018 Notes: 30% unvegetated. Thin layer of duff over bare soil-some exposed. Sparsely vegetated.			

Reference Plot 1

Ferrisburg Solar

8/27/18

Reference Plot 2

Ferrisburg Solar

8/27/18

Reference Plot 3

Ferrisburg Solar

8/27/18

Sun Plot 1

Ferrisburg Solar

8/27/18

Sun Plot 2

Ferrisburg Solar

8/27/18

Sun Plot 3

Ferrisburg Solar

8/27/18

Shade Plot 1

Ferrisburg Solar

8/27/18

Shade Plot 2

Ferrisburg Solar

8/27/18

Soil Compaction		
Site	Date	Personel
Ferrisburg	10/30/2018	JHB & AK

GPS Point Label	Sun 1
Soil Moisture (%)	21
Depth (in)	Max (psi)
Surface	30
3	80
6	130
9	130
12	130
15	110
18	110
21	120
24	120
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 2
Soil Moisture (%)	21
Depth (in)	Max (psi)
Surface	20
3	50
6	60
9	100
12	120
15	110
18	110
21	110
24	130
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 3
Soil Moisture (%)	22
Depth (in)	Max (psi)
Surface	40
3	100
6	120
9	100
12	110
15	200
18	220
21	120
24	100
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 4
Soil Moisture (%)	23
Depth (in)	Max (psi)
Surface	40
3	70
6	120
9	130
12	130
15	150
18	170
21	210
24	
Depth to readings over 300psi	
22	300

Notes:

GPS Point Label	Sun 5
Soil Moisture (%)	20
Depth (in)	Max (psi)
Surface	20
3	50
6	100
9	100
12	100
15	120
18	140
21	120
24	120
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 6
Soil Moisture (%)	18
Depth (in)	Max (psi)
Surface	40
3	60
6	90
9	100
12	100
15	100
18	110
21	120
24	200
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 1
Soil Moisture (%)	21
Depth (in)	Max (psi)
Surface	20
3	50
6	50
9	60
12	80
15	60
18	110
21	120
24	120
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade Alt. 1
Soil Moisture (%)	21
Depth (in)	Max (psi)
Surface	10
3	40
6	60
9	60
12	60
15	70
18	80
21	90
24	140
Depth to readings over 300psi	

Notes: Shade 2 & 4 were behind racks so used alternative sample

GPS Point Label	Shade 3
Soil Moisture (%)	19
Depth (in)	Max (psi)
Surface	10
3	20
6	40
9	70
12	60
15	60
18	80
21	110
24	130
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade Alt. 2
Soil Moisture (%)	20
Depth (in)	Max (psi)
Surface	10
3	40
6	60
9	90
12	100
15	120
18	120
21	120
24	120
Depth to readings over 300psi	

Notes: Shade 2 & 4 were behind racks so used alternative sample

GPS Point Label	Shade 5
Soil Moisture (%)	20
Depth (in)	Max (psi)
Surface	10
3	30
6	50
9	70
12	90
15	90
18	90
21	90
24	100
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 6
Soil Moisture (%)	22
Depth (in)	Max (psi)
Surface	20
3	40
6	60
9	90
12	110
15	100
18	100
21	100
24	80
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 1
Soil Moisture (%)	16
Depth (in)	Max (psi)
Surface	40
3	80
6	120
9	160
12	180
15	150
18	150
21	180
24	300
Depth to readings over 300psi	
24	300

Notes:

GPS Point Label	Ref 2
Soil Moisture (%)	16.9
Depth (in)	Max (psi)
Surface	30
3	60
6	120
9	160
12	120
15	80
18	140
21	200
24	300
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 3
Soil Moisture (%)	14
Depth (in)	Max (psi)
Surface	30
3	90
6	110
9	120
12	110
15	130
18	150
21	200
24	280
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 4
Soil Moisture (%)	14
Depth (in)	Max (psi)
Surface	60
3	120
6	140
9	140
12	160
15	180
18	220
21	250
24	
Depth to readings over 300psi	
23	300

Notes:

GPS Point Label	Ref 5
Soil Moisture (%)	16
Depth (in)	Max (psi)
Surface	30
3	70
6	100
9	120
12	120
15	140
18	160
21	200
24	rock
Depth to readings over 300psi	

Notes:

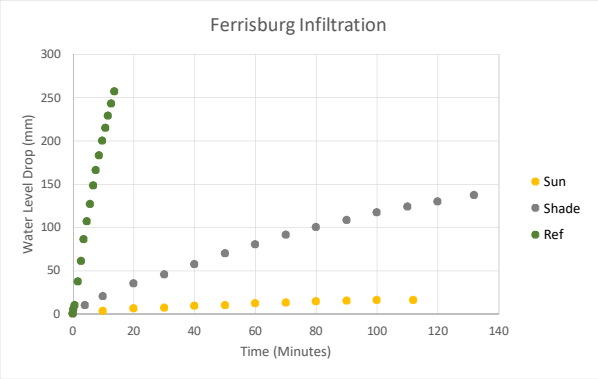
GPS Point Label	Ref 6
Soil Moisture (%)	17
Depth (in)	Max (psi)
Surface	40
3	80
6	120
9	150
12	160
15	170
18	200
21	250
24	
Depth to readings over 300psi	
22	300

Notes:

MPD Infiltration Testing															
Ferrisburg	10/30/2018	JHB & AK													
Used the penetrometer for Sampler 2 and Sampler 3.															
	Sampler 2					Sampler 1					Sampler 3				
GPS Point	Sun 1					Shade 1					Ref 1				
Pre-Soil Moisture (%)	21.4	22.8		21.4	23.3	25.5	24.6		27.7	24	16.9	15.8		15.8	17.1
Pre-Average Soil Moisture (%)	22.225					25.45					16.4				
Time to drop 1cm	Very slow so, doing same interval as Sampler 1.					4 minutes					Started slow and sped up over time.				
Sampling Interval	10 minutes					Changed from 6 minutes to 10 minutes because was moving slow.					Changed from 15 minutes to every 1 minute.				
		Time (min)		Depth (mm)			Time (min)		Depth (mm)			Time (min)		Depth (mm)	
		20	20	36	36		0	0	45	45		0	0	85	85
		30	30	39	39		4	4	55	55		0.25	0.25	90	90
		40	40	42	42		10	10	65	65		0.66	0.66	95	95
		50	50	43	43		20	20	80	80		1.66	1.66	122	122
		60	60	45	45		30	30	90	90		2.66	2.66	146	146
		70	70	46	46		40	40	102	102		3.66	3.66	171	171
		80	80	48	48		50	50	115	115		4.66	4.66	192	192
		90	90	49	49		60	60	125	125		5.66	5.66	212	212
		100	100	50	50		70	70	136	136		6.66	6.66	233	233
		110	110	51	51		80	80	145	145		7.66	7.66	251	251
		120	120	52	52		90	90	153	153		8.66	8.66	268	268
		132	132	52	52		100	100	162	162		9.66	9.66	285	285
							110	110	169	169		10.66	10.66	300	300
							120	120	175	175		11.66	11.66	314	314
							132	132	182	182		12.66	12.66	328	328
												13.66	13.66	342	342
Post-Soil Moisture (%)	24	22.4		24	22.3	47.7	37.1		25.2	24.5	16.5	16.7		16	16
Post-Soil Moisture Center (%)	25.2					>50%					20.4				
Post-Average Soil Moisture (%)	23.175					33.625					16.3				

Penetrometer	
	30
	100
	140
	140
	160
	200
	220
	200
	300 @ 23

Penetrometer	
	40
	90
	150
	200
	300



Soil Description

Site	Ferrisburg	Sampling Area	Sun. Shade, Reference
Date	8/9/2018	Personnel	JHB, AK

Sampling Area	Sun		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 2	Primary 1	
Depth (in)	Description	Depth (in)	Description
1	O horizon loose soil dense roots	1.5	O horizon
0 to 4	Dark brown loose, dense roots	0 to 5	dark brown silt loam
4 to 7	firm dark brown silt	5 to 8	light brown with moderate redox
7 to 10	light brown slit loam w/ redox, very firm	8 to 12+	depleted layer silt to clay, heavy redox
10 to 12+	light brown moderate redox		

Sampling Area	Shade		
Core Location GPS Points: Primary 1,3,4,6,Alt1, Alt2 - Skipped 2 and 5 because they were behind inverter racks			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Alt #2	Primary 1	
Depth (in)	Description	Depth (in)	Description
0.5	O horizon	0.5	O horizon
0 to 3	Loose medium brown silt	0 to 3	Very loose dark brown loam
3 to 5	clay silt, no redox	3 to 7	dark brown silt loam
5 to 8	light brown clay silt, some redox, hydric	7 to 9	light brown clay silt, moderate redox
8 to 12+	Silty clay, heavy redox, chroma 1/2	9 to 12+	depleted layer, clay silt with heavy redox

Sampling Area	Reference		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	Y	Metals Analysis	Y

Soil Description

Sampling area	Primary 5	Primary 2	
Depth (in)	Description	Depth (in)	Description
1	O horizon loose soil dense roots	0.5	O horizon
0 to 3	Dark brown loose, dense roots	0 to 4	dark brown loose
3 to 5	dark brown with some redox	4 to 7	dark brown loose
5 to 9	redox increases	7 to 12+	stripped light brown silt loam with heavy redox
9 to 11	light brown with moderate redox		
11+	Depleted soil with heavy redox		

Qualitative Observations Data Form v6

Observer: *Michael Lew-Smith*	Site Name: *Hinesburg*	Date: 8/26/19

Solar Facility Notes

Height of panels (off ground): *4'*	Distance between panel rows: *40'*
This is a pre-construction survey __	Type of foundation: Post __X_ Concrete ____ Other ____
This is a post-construction survey X_	Type of modules: Trackers __X_ Fixed Mount ____
Notes / Other Vegetation Mgmt:	Date of Annual Mowing: Unk

Mowing on a 5 year rotation

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

Poorly drained soils prevents drainage and aids in development of wetland conditions. No standing water at time of this site visit.

Notes:	Are Hummock/Hollows Present?	Yes _X_	No ___

Minor hummocks from sedges, mostly outside of sampling area

Are any exposed soils present in the wetland/buffer within Project Area?		Yes ___	No _X_
Explain and map:	Unique ID	Photo #	

NA

Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?		Yes ___	No _X_
Explain and map:	Unique ID	Photo #	

Some ruts present, though these don't appear to significantly impact wetland hydrology.

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Solidago canadensis	*20*	*Pastinaca sativa*	*10*
Phalaris arundinacea	*5*	*Phalaris arundinacea*	*5*
Carex spp.	*20*		
Eutrochium maculatum	*10*		
Total Cover	*100*	Total Cover	*15*

Notes: *Fairly diverse flora, only dominants listed above. Recently mowed.*

Are there areas in the wetland/buffer with disturbed vegetation?		Yes ___	No _X_
Describe and Map:	Unique ID	Photo #	

NA

If yes, does this impact wetland function/value?	Yes ___	No ___

Explain:

NA

Qualitative Observations Data Form v6

Observer: *Joe Bartlett*	Site Name: *Hinesburg*	Date: 10/10/2019

Solar Facility Notes

Height of panels (off ground):	Distance between panel rows:
This is a pre-construction survey __	Type of foundation: Post ____ Concrete ____ Other ____
This is a post-construction survey __	Type of modules: Trackers ____ Fixed Mount ____
Notes / Other Vegetation Mgmt:	Date of Annual Mowing:

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

Some saturated soils in low areas between the reference and sun/shade areas, no standing water or saturated soils within the sampling areas.

Notes:	Are Hummock/Hollows Present?		Yes __X_	No ___
Some small hummocks are present in the reference area				
Are any exposed soils present in the wetland/buffer within Project Area?			Yes ___	No _X__
Explain and map:	Unique ID		Photo #	
No erosion visible along flow paths from sampling area to adjacent wetlands				
Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?			Yes ___	No _X__
Explain and map:	Unique ID		Photo #	

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Total Cover		Total Cover	

Notes:

Are there areas in the wetland/buffer with disturbed vegetation?			Yes ___	No ___
Describe and Map:	Unique ID		Photo #	
If yes, does this impact wetland function/value?			Yes ___	No ___

Explain:

DEC Solar Vegetation Monitoring Plots

Reference Hinesburg

HREF1

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	6-48 in	3-36 in
Average Veg. Height:	24 in	12 in

Species	Non-native	species % Cover	species % Cover
Agrostis gigantea	✔	26-50%	26-50%
Anthoxanthum odoratum	✔	51-75%	26-50%
Carex annectens		1-5%	6-10%
Elymus repens	✔	6-10%	6-10%
Oxalis stricta		1-5%	<1%
Pastinaca sativa	✔	6-10%	-
Persicaria sagittata		<1%	-
Poa pratensis		-	11-25%
Potentilla simplex		<1%	1-5%
Schedonorus arundinaceus	✔	6-10%	11-25%
Solidago canadensis		51-75%	26-50%
Symphyotrichum lateriflorum		1-5%	6-10%
Trifolium pratense	✔	-	1-5%
Vicia cracca	✔	<1%	-
Species Richness:		12	11
Species Diversity*:		0.76	0.85

2018 Plot Comments: Agostis is the main wide-lvd graminoid in subplot. Anthoxanthum, the main narrow-lvd one. Difficult to tell % cover of sterile plants. No bare ground, some leaf litter from nearby trees. Tall goldenrod over dense graminoids

2019 Plot Comments: Recently mowed, in part. Most veg mowed or matted. Graminoids difficult to identify, dense.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Reference Hinesburg

HREF2

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	3-48 in	3-8 in
Average Veg. Height:	24 in	5 in

Species	Non-native	species % Cover	species % Cover
Agrostis gigantea	✔	6-10%	-
Carex annectens		6-10%	-
Carex pellita		11-25%	-
Carex scoparia		1-5%	-
Carex sp.		6-10%	26-50%
Eutrochium maculatum		11-25%	-
Hypericum perforatum	✔	<1%	-
Juncus effusus		6-10%	-
Onoclea sensibilis		-	11-25%
Persicaria sagittata		-	<1%
Phalaris arundinacea		76-100%	76-100%
Poa palustris		11-25%	1-5%
Poa pratensis		1-5%	-
Schedonorus arundinaceus	✔	1-5%	-
Scirpus cyperinus		6-10%	-
Solidago canadensis		51-75%	51-75%
Solidago rugosa		6-10%	-
Symphyotrichum lateriflorum		1-5%	-
Vicia cracca	✔	<1%	<1%
Species Richness:		17	7
Species Diversity*:		0.82	0.7

2018 Plot Comments: No bare ground. Tall goldenrod over dense graminoids. Plants indicate that this is wetter than REF1.

2019 Plot Comments: Recently mowed. All veg mowed or matted. Graminoids difficult to identify and distinguish. Dense thatch layer from mowed veg.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Reference Hinesburg

HREF3

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	4-48 in	3-12 in
Average Veg. Height:	24 in	8 in

Species	Non-native	species % Cover	species % Cover
Carex annectens		1-5%	-
Carex pellita		1-5%	-
Carex scoparia		<1%	-
Carex sp.		-	6-10%
Eutrochium maculatum		11-25%	11-25%
Onoclea sensibilis		11-25%	11-25%
Persicaria sagittata		<1%	-
Phalaris arundinacea		76-100%	51-75%
Poa palustris		6-10%	6-10%
Solidago canadensis		11-25%	6-10%
Solidago rugosa		1-5%	6-10%
Vicia cracca	✔	1-5%	<1%
Species Richness:		11	8
Species Diversity*:		0.67	0.72

2018 Plot Comments: Dense reed canary grass, appears to shade out other species. Some sensitive fern senescing. Thick thatch layer.

2019 Plot Comments: Recently mowed. All veg either mowed or matted. Thick dead thatch layer.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Hinesburg

HSHD1

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	90%	95%
Rock Cover:	0%	0%
Soil Cover:	10%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	5%
Veg Height Range:	3-42 in	3-24 in
Average Veg. Height:	12 in	12 in

Species	Non-native	species % Cover	species % Cover
Anthoxanthum odoratum	✔	11-25%	6-10%
Carex annectens		6-10%	-
Carex pellita		1-5%	-
Carex scoparia		1-5%	-
Carex sp.		-	6-10%
Doellingeria umbellata		1-5%	-
Dryopteris intermedia		1-5%	-
Euthamia graminifolia		1-5%	-
Galium sp.		1-5%	-
Galium tinctorium		-	1-5%
Onoclea sensibilis		76-100%	76-100%
Pastinaca sativa	✔	11-25%	11-25%
Persicaria sagittata		6-10%	1-5%
Phalaris arundinacea		11-25%	6-10%
Poa pratensis		<1%	6-10%
Potentilla simplex		-	1-5%
Solidago rugosa		1-5%	-
Symphyotrichum lateriflorum		6-10%	1-5%
Thymus pulegioides	✔	-	1-5%
Ulmus rubra		<1%	-
Veronica sp.		<1%	-
Species Richness:		17	11
Species Diversity*:		0.75	0.65

2018 Plot Comments: Mostly sensitive fern- a few senesced. Some unvegetated areas (10%) but covered by ferns and graminoid thatch. A few large parsnip plants.

2019 Plot Comments: Recently mowed, though sensitive fern recovering nicely. Thatch from mowing.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Hinesburg

HSHD2

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	100%	90%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	10%
Veg Height Range:	2-30 in	4-20 in
Average Veg. Height:	18 in	10 in

Species	Non-native	species % Cover	species % Cover
Acer negundo		-	1-5%
Agrostis gigantea	✔	26-50%	-
Ambrosia artemisiifolia		-	<1%
Amphicarpaea bracteata		1-5%	26-50%
Anthoxanthum odoratum	✔	11-25%	-
Cerastium fontanum	✔	<1%	-
Cornus sericea		1-5%	-
Daucus carota	✔	-	1-5%
Geum sp.		-	1-5%
Juncus effusus		11-25%	11-25%
Onoclea sensibilis		11-25%	26-50%
Pastinaca sativa	✔	26-50%	26-50%
Persicaria sagittata		51-75%	6-10%
Phalaris arundinacea		11-25%	1-5%
Poa palustris		1-5%	6-10%
Poa pratensis		-	1-5%
Ranunculus acris	✔	-	6-10%
Ranunculus sp.		<1%	-
Schedonorus arundinaceus	✔	1-5%	-
Scirpus atrovirens		6-10%	6-10%
Symphyotrichum lateriflorum		<1%	1-5%
Symphyotrichum novae-angliae		1-5%	-
Viburnum nudum		<1%	1-5%
Species Richness:		17	16
Species Diversity*:		0.86	0.86

2018 Plot Comments: No bare ground. Stable veg and soils. Some graminoids sterile, difficult to distinguish.

2019 Plot Comments: Recently mowed. All veg mowed or matted down from mowing.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Hinesburg

HSHD3

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	100%	90%
Rock Cover:	0%	0%
Soil Cover:	0%	5%
Mulch Cover:	0%	0%
Thatch Cover:	0%	5%
Veg Height Range:	2-48 in	3-12 in
Average Veg. Height:	36 in	8 in

Species	Non-native	species % Cover	species % Cover
Ambrosia artemisiifolia		-	6-10%
Carex scoparia		51-75%	-
Carex sp.		-	51-75%
Epilobium coloratum		-	<1%
Fragaria sp.		-	6-10%
Oxalis stricta		-	1-5%
Persicaria sagittata		11-25%	26-50%
Poa palustris		<1%	-
Poa sp.		-	26-50%
Potentilla simplex		6-10%	1-5%
Schedonorus arundinaceus	✔	1-5%	-
Solidago rugosa		76-100%	6-10%
Symphyotrichum lateriflorum		1-5%	6-10%
Taraxacum officinale	✔	-	<1%
Species Richness:		7	11
Species Diversity*:		0.64	0.78

2018 Plot Comments: Not very divese plot. Dense goldenrod with depauperate Carex scoparia beneath, mostly sterile and sprawling.

2019 Plot Comments: Recently mowed. Some bare ground from mowing activity. Difference in veg from last year may be from mowing.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Hinesburg

HSUN1

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	100%	90%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	10%
Veg Height Range:	5-36 in	3-10 in
Average Veg. Height:	12 in	6 in

Species	Non-native	species % Cover	species % Cover
Acalypha rhomboidea		<1%	<1%
Agrostis gigantea	✔	1-5%	-
Carex annectens		26-50%	-
Carex pellita		6-10%	-
Carex scoparia		51-75%	-
Carex sp.		-	51-75%
Cornus sericea		<1%	-
Equisetum arvense		1-5%	-
Eupatorium perfoliatum		6-10%	-
Galium tinctorium		6-10%	26-50%
Juncus effusus		26-50%	6-10%
Lycopus uniflorus		<1%	-
Oxalis stricta		1-5%	1-5%
Persicaria sagittata		1-5%	1-5%
Phalaris arundinacea		<1%	<1%
Pilea pumila		-	<1%
Poa palustris		26-50%	11-25%
Scirpus cyperinus		<1%	6-10%
Scutellaria sp.		-	<1%
Solidago gigantea		<1%	1-5%
Stellaria graminea		-	<1%
Symphyotrichum lanceolatum		-	6-10%
Symphyotrichum lateriflorum		26-50%	-
Vicia cracca	✔	1-5%	1-5%
Species Richness:		19	15
Species Diversity*:		0.85	0.76

2018 Plot Comments: Low-growing veg, but very diverse plot. No bare ground. Mostly graminoids. Counts of graminoids in subplot estimates only, many sterile individuals.

2019 Plot Comments: Sterile graminoids difficult to distinguish; Carex spp. cover lumped

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Hinesburg

HSUN2

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	90%	98%
Rock Cover:	0%	0%
Soil Cover:	10%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	2%
Veg Height Range:	1-42 in	3-16 in
Average Veg. Height:	30 in	12 in

Species	Non-native	species % Cover	species % Cover
Carex annectens		11-25%	-
Carex scoparia		26-50%	-
Carex sp.		-	51-75%
Juncus effusus		26-50%	1-5%
Onoclea sensibilis		26-50%	76-100%
Persicaria sagittata		-	1-5%
Phalaris arundinacea		-	11-25%
Phleum pratense	✔	1-5%	1-5%
Pilea pumila		-	<1%
Poa sp.		-	6-10%
Scirpus atrovirens		11-25%	-
Scirpus sp.		-	1-5%
Solidago canadensis		26-50%	6-10%
Solidago rugosa		6-10%	-
Symphyotrichum lateriflorum		11-25%	1-5%
Symphyotrichum puniceum		<1%	-
Trifolium pratense	✔	-	<1%
Vicia cracca	✔	6-10%	6-10%
Species Richness:		11	13
Species Diversity*:		0.87	0.72

2018 Plot Comments: Small area of bare ground (10%) covered by graminoid thatch. Some sensitive fern senescing. Near walking path? Graminoid counts in subplot estimates only, mostly sterile plants.

2019 Plot Comments: Recently mowed. Carex spp. cover lumped, all sterile. Some thatch from mowing

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Hinesburg

HSUN3

	2018	2019
Survey Date:	8/27/2018	8/26/2019
Total Vegetative Cover:	100%	90%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	10%
Veg Height Range:	2-48 in	3-8 in
Average Veg. Height:	24 in	4 in

Species	Non-native	species % Cover	species % Cover
Acalypha rhomboidea		<1%	<1%
Agrostis gigantea	✔	26-50%	11-25%
Carex annectens		26-50%	-
Carex scoparia		6-10%	-
Carex sp.		6-10%	76-100%
Galium tinctorium		1-5%	1-5%
Juncus effusus		11-25%	6-10%
Mentha arvensis	✔	11-25%	11-25%
Oxalis stricta		<1%	-
Pastinaca sativa	✔	<1%	6-10%
Persicaria sagittata		6-10%	<1%
Phalaris arundinacea		-	1-5%
Poa palustris		-	6-10%
Poa pratensis		1-5%	6-10%
Potentilla norvegica	✔	-	1-5%
Solidago canadensis		76-100%	1-5%
Symphyotrichum lateriflorum		1-5%	-
Vicia cracca	✔	1-5%	6-10%
Species Richness:		15	14
Species Diversity*:		0.8	0.72

2018 Plot Comments: Undisturbed plot. Some graminoid tussocks. No bare grounds. Thatch layer present. Graminoid counts in subplot estimates only, mostly sterile plants.

2019 Plot Comments: Recently mowed. Distinction between the Poas is an estimate

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

2019 Hinesburg Solar Vegetation Plot Photo Log

Reference Plot 1

Reference Plot 2

2019 Hinesburg Solar Vegetation Plot Photo Log

Reference Plot 3

Sun Plot 1

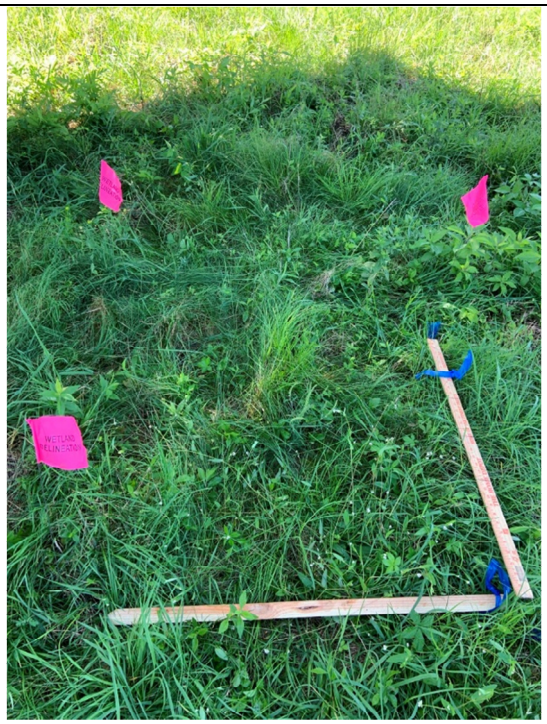
Sun Plot 2

Sun Plot 3

2019 Hinesburg Solar Vegetation Plot Photo Log

Shade Plot 1

Shade Plot 2



Shade Plot 3

Soil Compaction		
Site	Date	Personel
Hinesburg	10/10/2019	EHB JHB

GPS Point Label	Sun 1
Soil Moisture (%)	12.8
Depth (in)	Max (psi)
Surface	15
3	50
6	60
9	90
12	180
15	200
18	>300
21	
24	
Depth to readings over 300psi	
	15

Notes: rocks

GPS Point Label	Sun 2
Soil Moisture (%)	9.4
Depth (in)	Max (psi)
Surface	30
3	50
6	130
9	200
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	10

Notes: rocks

GPS Point Label	Sun 3
Soil Moisture (%)	12
Depth (in)	Max (psi)
Surface	20
3	80
6	100
9	150
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	10

Notes: rocks

GPS Point Label	Sun 4
Soil Moisture (%)	12
Depth (in)	Max (psi)
Surface	20
3	60
6	80
9	100
12	250
15	250
18	
21	
24	
Depth to readings over 300psi	
	16

Notes: rocks

GPS Point Label	Sun 5
Soil Moisture (%)	12.2
Depth (in)	Max (psi)
Surface	20
3	60
6	100
9	250
12	>300
15	
18	
21	
24	
Depth to readings over 300psi	
	10

Notes: rocks

GPS Point Label	Sun 6
Soil Moisture (%)	12
Depth (in)	Max (psi)
Surface	50
3	50
6	80
9	90
12	>300
15	
18	
21	
24	
Depth to readings over 300psi	
	9

Notes: rocks

GPS Point Label	Shade 1
Soil Moisture (%)	4.4
Depth (in)	Max (psi)
Surface	20
3	80
6	80
9	120
12	>300
15	
18	
21	
24	
Depth to readings over 300psi	
	12

Notes: rocks

GPS Point Label	Shade 2
Soil Moisture (%)	9.8
Depth (in)	Max (psi)
Surface	10
3	50
6	80
9	100
12	200
15	250
18	>300
21	
24	
Depth to readings over 300psi	
	17

Notes: rocks

GPS Point Label	Shade 3
Soil Moisture (%)	11.2
Depth (in)	Max (psi)
Surface	10
3	30
6	80
9	120
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	10

Notes: rocks

GPS Point Label	Shade 4
Soil Moisture (%)	8.1
Depth (in)	Max (psi)
Surface	20
3	80
6	60
9	120
12	>300
15	
18	
21	
24	
Depth to readings over 300psi	
	10

Notes: rocks

GPS Point Label	Shade 5
Soil Moisture (%)	11.2
Depth (in)	Max (psi)
Surface	30
3	80
6	100
9	160
12	160
15	200
18	>300
21	
24	
Depth to readings over 300psi	
	18

Notes: rocks

GPS Point Label	Shade 6
Soil Moisture (%)	9.7
Depth (in)	Max (psi)
Surface	50
3	60
6	120
9	200
12	>300
15	
18	
21	
24	
Depth to readings over 300psi	
	12

Notes: rocks

GPS Point Label	Ref 1
Soil Moisture (%)	11.4
Depth (in)	Max (psi)
Surface	20
3	30
6	60
9	90
12	120
15	150
18	150
21	160
24	220
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 2
Soil Moisture (%)	11.7
Depth (in)	Max (psi)
Surface	20
3	30
6	60
9	90
12	150
15	250
18	200
21	200
24	170
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 3
Soil Moisture (%)	14
Depth (in)	Max (psi)
Surface	50
3	60
6	120
9	250
12	200
15	210
18	200
21	200
24	300
Depth to readings over 300psi	
	24

Notes:

GPS Point Label	Ref 4
Soil Moisture (%)	16.1
Depth (in)	Max (psi)
Surface	10
3	50
6	90
9	120
12	160
15	180
18	190
21	220
24	>300
Depth to readings over 300psi	
	22

Notes: rocks?

GPS Point Label	Ref 5
Soil Moisture (%)	19.1
Depth (in)	Max (psi)
Surface	30
3	50
6	80
9	120
12	150
15	180
18	150
21	180
24	180
Depth to readings over 300psi	

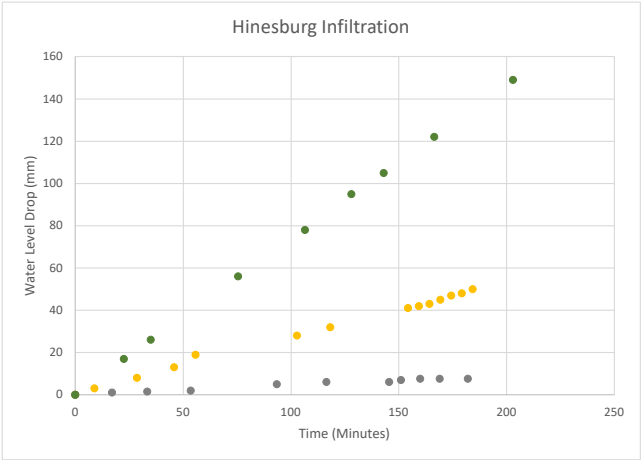
Notes:

GPS Point Label	Ref 6
Soil Moisture (%)	10.1
Depth (in)	Max (psi)
Surface	30
3	90
6	100
9	120
12	180
15	250
18	300
21	
24	
Depth to readings over 300psi	
	17

Notes: rocks?

MPD Infiltration Testing		
Site	Date	Personel
Hinesburg	10/10/2019	EHB JHB

GPS Point	Sampler 2 Sun 1					Sampler 3 Shade 1					Sampler 1 Ref 1				
Pre-Soil Moisture (%)	7.4	7.3	8.2	7.2		8.5	9.2	8.5	7.3		11.3	11.5	11.3	11.2	
Pre-Average Soil Moisture (%)	7.525					8.375					11.325				
		Stop Watch Time	**Time from start**	**Depth (mm)**	**Drop (mm)**		**Stop Watch Time**	**Time from start**	**Depth (mm)**	**Drop (mm)**		**Stop Watch Time**	**Time from start**	**Depth (mm)**	**Drop (mm)**
		8.7	0	90	0		19	0	90	0		1.5	0	70	0
		17.5	8.8	93	3		36	17	91	1		24	22.5	87	17
		37.3	28.6	98	8		52.4	33.4	91.5	1.5		36.5	35	96	26
		54.5	45.8	103	13		72.5	53.5	92	2		77	75.5	126	56
		64.5	55.8	109	19		112.5	93.5	95	5		108	106.5	148	78
		111.5	102.8	118	28		135.5	116.5	96	6		129.5	128	165	95
		127	118.3	122	32		164.5	145.5	96	6		144.5	143	175	105
		163	154.3	131	41		170	151	97	7		168	166.5	192	122
		168	159.3	132	42		179	160	97.5	7.5		204.5	203	219	149
		173	164.3	133	43		188	169	97.5	7.5					
		178	169.3	135	45		201	182	97.5	7.5					
		183	174.3	137	47										
		188	179.3	138	48										
		193	184.3	140	50										
		199	190.3	141											
Post-Soil Moisture Center (%)	9					9.3					13.1				



Soil Description

Site	Hinesburg	Sampling Area	Sun. Shade, Reference
Date	10/10/2019	Personnel	JHB EHB

Sampling Area	Sun		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 2	Primary 5	
Depth (in)	Description	Depth (in)	Description
2	O horizon loose soil dense roots	1	O horizon
0 to 6	10YR 5/2 some redox at 4	0 to 5	10YR 5/3 silt loam, heavy redox
6 to 12	10YR 5/1 silty	5 to 18+	10YR 5/2
12 to 16+	10YR 7/1 heavy redox, silt clay		

Sampling Area	Shade		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 2	Primary 3	
Depth (in)	Description	Depth (in)	Description
1	O horizon	1	O horizon
0 to 10	silt loam 10YR 4/4	0 to 8	loam 10YR 4/4 some gravel
10 to 18+	Silt loam 10YR 6/1 heavy redox	8 to 10	loam 10YR 4/3 some redox
		10 to 15+	pebbly loam 10YR 5/2 some redox

Sampling Area	Reference		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description **All soil cores are bone dry**

Sampling area	Primary 5	Primary 4	
Depth (in)	Description	Depth (in)	Description
0.5	O horizon	0.5	O horizon
0 to 3	10YR 3/4 silt with dense roots	0 to 5	silt loam dense roots 10YR 3/3
3 to 11	10YR 5/1 roots with med redox	5 to 12	silt loam 10YR 5/3 roots to 10
11 to 18+	10YR 5/1 heavy redox	12 to 16	heavy redox 10YR 5/2
		16+	10YR 5/1 saturated silt loam

Soil Test Results

Site	Date	Location	pH	OM_Pct	Avail_P	K	Ca	Mg	Zn	B	Mn	Cu	Fe	Al	Na	S	Exch_Acid	ECEC	A_Base_Sa	G_Base_S	K_Base_Sa	Pb	Ni	Cd	Cr
				%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Hinesburg	10/10/2019	Sun	5.28	5.876	1.4	115	1140	284	1.3	0.3	18.4	0.25	46.1	160	25	11	5.23	8.36	41.92	17.41	2.17	0.95	1.3	0.1	0.25
Hinesburg	10/10/2019	Shade	5.25	3.874	0.95	74	618	95	1.7	0.15	10.1	0.2	24.4	198	13	11	5.06	4.07	33.84	8.67	2.08	1.2	1.65	0.1	0.2
Hinesburg	10/10/2019	Ref	5.35	5.421	1.4	121	946	217	1.15	0.25	10.3	0.25	34.1	126	16	9	4.78	6.85	40.67	15.55	2.67	0.8	1.05	0.1	0.25
		Average:	5.30	5.06	1.3	103	901	199	1.38	0.23	12.9	0.23	34.9	161	18	10	5.03	6.43	38.81	13.87	2.30	0.98	1.33	0.10	0.23
Hinesburg	8/9/2018	Ref	5.26	6.058	1.00	112	893	212	1.15	0.20	9.9	0.20	32.5	103	15	8	5.11	6.52	38.41	15.20	2.47	0.4	0.50	0.05	0.1
Hinesburg	8/9/2018	Shade	5.12	4.511	0.70	108	592	97	1.95	0.10	9.0	0.20	15.2	188	19	9	5.56	4.05	30.83	8.42	2.88	0.9	1.00	0.05	0.1
Hinesburg	8/9/2018	Sun 1	5.24	6.24	0.90	128	1007	262	2.05	0.15	19.7	0.25	31.5	122	22	10	5.28	7.55	39.25	17.02	2.56	0.7	0.65	0.10	0.1
Hinesburg	8/9/2018	Sun 2	5.22	5.876	0.90	118	993	257	1.65	0.15	16.0	0.20	28.1	110	22	10	5.22	7.41	39.31	16.96	2.40	0.6	0.55	0.05	0.1
		Average:	5.20	5.671	0.88	117	871	207	1.70	0.15	13.7	0.21	26.8	131	20	9	5.29	6.38	36.95	14.40	2.58	0.6	0.68	0.06	0.10

2018 Hinesburg Solar Quantitative Vegetation Data

Observer: *Michael Lew-Smith*	Site Name: *Hinesburg*	Date: 8/27/18

Solar Facility Notes

Height of panels (off ground): *4'*	Distance between panel rows: *Appx 40'*
This is a pre-construction survey __	Type of foundation: Post __X_ Concrete ____ Other ____
This is a post-construction survey _X	Type of modules: Trackers __X_ Fixed Mount ____
Notes / Other Vegetation Mgmt:	Date of Annual Mowing: ?

Mowed every few years, not mowed this year. No other vegetation management.

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

Hummocks and hollows present in wettest areas only (mostly not where arrays are located). Minor sedge hummocks. Hollows appear to hold water, but none at time of site visit. Saturated soils present.

Notes:	Are Hummock/Hollows Present?	Yes _X_	No ___
Are any exposed soils present in the wetland/buffer within Project Area?		Yes ___	No _X_
Explain and map:		Photo #	
Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?		Yes ___	No _X_
Explain and map:		Photo #	

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Solidago canadensis	*30*	*Pastinaca sativa*	*15*
Carex annectans	*30*	*Phalaris arundinadea*	*5*
Onoclea sensibilis	*20*		
Eutrochium maculatum	*5*		
Total Cover	*100*	Total Cover	*20*

Notes: *Very floristically diverse. Varying from very wet to dry microhabitats. Not mowed.*

Are there areas in the wetland/buffer with disturbed vegetation?	Yes ___	No _X_
Describe and Map:	Photo #	
If yes, does this impact wetland function/value?	Yes ___	No _X_

Explain:

2018 Hinesburg Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Hinesburg	DATE: 08-27-2018		
Plot: REF1	Height: 6"-4' Avg: 2'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Solidago canadensis	50-75%	9	ct
Carex annectens	1-5%	0	0
Agrostis gigantea	25-50%	12	ct
Oxalis stricta	1-5%	1	ct
Symphyotrichum lateriflorum	1-5%	2	ct
Anthoxanthum odoratum	50-75%	80	sample
Persicaria sagittata	<1%	0	0
Elymus repens	6-10%	0	0
Vicia cracca	<1%	1	0
Potentilla simplex	<1%	0	0
Schedonorus arundinaceus	6-10%	0	0
Pastinaca sativa	6-10%	0	0
2018 Notes: Agrostis is the main wide-lvd graminoid in subplot. Anthoxanthum, the main narrow-lvd one. Difficult to tell % cover of sterile plants. No bare ground, some leaf litter from nearby trees. Tall goldenrod over dense graminoids			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Hinesburg	DATE: 08-27-2018		
Plot: REF2	Height: 3"-4' Avg: 2'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Solidago canadensis	50-75%	8	ct
Agrostis gigantea	6-10%	0	0
Juncus effusus	6-10%	0	0
Eutrochium maculatum	11-25%	0	0
Phalaris arundinacea	75-100%	10	ct
Scirpus cyperinus	6-10%	0	0
Poa palustris	11-25%	2	ct
Carex pellita	11-25%	24	ct
Vicia cracca	<1%	0	0
Carex cf scoparia	1-5%	2	ct
Schedonorus arundinaceus	1-5%	0	0
Carex annectens	6-10%	0	0
Solidago rugosa	6-10%	0	0
Symphyotrichum lateriflorum	1-5%	2	ct
Poa pratensis	1-5%	0	0
Carex sp.	6-10%	15	ct
Hypericum perforatum	<1%	0	0
2018 Notes: No bare ground. Tall goldenrod over dense graminoids. Plants indicate that this is wetter than REF1.			

2018 Hinesburg Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Hinesburg	DATE: 08-27-2018		
Plot: REF3	Height: 4"-4' Avg: 2'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phalaris arundinacea	75-100%	38	ct
Eutrochium maculatum	11-25%	0	0
Poa palustris	6-10%	10	ct
Solidago canadensis	11-25%	0	0
Onoclea sensibilis	11-25%	2	ct
Solidago rugosa	1-5%	0	0
Vicia cracca	1-5%	0	0
Carex annectens	1-5%	0	0
Persicaria sagittata	<1%	0	0
Carex scoparia	<1%	0	0
Carex pellita	1-5%	4	ct
2018 Notes: Dense reed canary grass, appears to shade out other species. Some sensitive fern senescing. Thick thatch layer.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Hinesburg	DATE: 08-27-2018		
Plot: SUN1	Height: 5"-3' Avg: 1'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Eupatorium perfoliatum	6-10%	0	0
Symphyotrichum lateriflorum	25-50%	8	ct
Juncus effusus	25-50%	24	ct
Vicia cracca	1-5%	0	0
Carex scoparia	50-75%	12	ct
Carex annectens	25-50%	8	ct
Poa palustris	25-50%	46	ct
Persicaria sagittata	1-5%	1	ct
Galium cf tinctorum	6-10%	58	ct
Carex pellita	6-10%	8	ct
Equisetum arvense	1-5%	0	0
Oxalis stricta	1-5%	1	ct
Cornus sericea	<1%	1	ct
Acalypha rhomboidea	<1%	0	0
Lycopus uniflorus	<1%	0	0
Agrostis gigantea	1-5%	0	0
Solidago gigantea	<1%	0	0
Scirpus cyperinus	<1%	1	ct
Phalaris arundinacea	<1%	1	ct
2018 Notes: Low-growing veg, but very diverse plot. No bare ground. Mostly graminoids. Counts of graminoids in subplot estimates only, many sterile individuals.			

2018 Hinesburg Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 90%		
Site: Hinesburg	DATE: 08-27-2018		
Plot: SUN2	Height: 1"-3.5' Avg: 2.5'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Solidago canadensis	25-50%	0	0
Phleum pratense	1-5%	8	ct
Carex scoparia	25-50%	12	ct
Juncus effusus	25-50%	21	ct
Symphyotrichum lateriflorum	11-25%	3	ct
Vicia cracca	6-10%	2	ct
Scirpus atrovirens	11-25%	2	ct
Carex annectens	11-25%	30	ct
Solidago rugosa	6-10%	0	0
Onoclea sensibilis	25-50%	7	ct
Symphyotrichum puniceum	<1%	0	0
2018 Notes: Small area of bare ground (10%) covered by graminoid thatch. Some sensitive fern senescing. Near walking path? Graminoid counts in subplot estimates only, mostly sterile plants.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Hinesburg	DATE: 08-27-2018		
Plot: SUN3	Height: 2"-4' Avg: 2'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Solidago canadensis	75-100%	1	ct
Agrostis gigantea	25-50%	20	ct
Carex annectens	25-50%	14	ct
Mentha arvensis	11-25%	4	ct
Vicia cracca	1-5%	0	0
Persicaria sagittata	6-10%	3	ct
Carex sp. (Ovales)	6-10%	0	0
Galium tinctorium	1-5%	31	ct
Symphyotrichum lateriflorum	1-5%	0	0
Juncus effusus	11-25%	0	0
Poa pratensis	1-5%	0	0
Pastinaca sativa	<1%	0	0
Carex scoparia	6-10%	0	0
Acalypha rhomboidea	<1%	1	ct
Oxalis stricta	<1%	2	ct
2018 Undisturbed plot. Some graminoid tussocks. No bare grounds. Thatch layer present. Graminoid counts in subplot estimates only, mostly sterile plants.			

2018 Hinesburg Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 90%		
Site: Hinesburg	DATE: 08-27-2018		
Plot: SHADE1	Height: 3"-3.5' Avg: 1'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Pastinaca sativa	11-25%	3	ct
Onoclea sensibilis	75-100%	10	ct
Persicaria sagittata	6-10%	0	0
Phalaris arundinacea	11-25%	0	0
Solidago rugosa	1-5%	0	0
Symphyotrichum lateriflorum	6-10%	0	0
Euthamia graminifolia	1-5%	0	0
Carex annectens	6-10%	0	0
Galium spp	1-5%	0	0
Carex pellita	1-5%	0	0
Ulmus rubra	<1%	0	0
Dryopteris intermedia	1-5%	0	0
Carex scoparia	1-5%	0	0
Poa pratensis	<1%	0	0
Doellingeria umbellata	1-5%	0	0
Anthoxanthum odoratum	11-25%	0	0
Veronica sp.	<1%	0	0
2018 Notes: Mostly sensitive fern- a few senesced. Some unvegetated areas (10%) but covered by ferns and graminoid thatch. A few large parsnip plants.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Hinesburg	DATE: 08-27-2018		
Plot: SHADE2	Height: 2"-2.5' Avg: 1.5'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Pastinaca sativa	25-50%	2	ct
Onoclea sensibilis	11-25%	5	ct
Persicaria sagittata	50-75%	2	ct
Phalaris arundinacea	11-25%	0	0
Cornus sericea	1-5%	0	0
Symphyotrichum novae-angliae	1-5%	0	0
Symphyotrichum lateriflorum	<1%	0	0
Ranunculus sp.	<1%	0	0
Juncus effusus	11-25%	0	0
Agrostis gigantea	25-50%	0	0
Viburnum nudum	<1%	2	ct
Amphicarpaea bracteata	1-5%	2	ct
Scirpus atrovirens	6-10%	0	0
Schedonorus arundinaceus	1-5%	11	ct
Anthoxanthum odoratum	11-25%	50	sample
Poa palustris	1-5%	0	0
Cerastium fontanum	<1%	0	0
2018 Notes: No bare ground. Stable veg and soils. Some graminoids sterile, difficult to distinguish.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Hinesburg	DATE: 08-27-2018		
Plot: SHADE3	Height: 2"-4' Avg: 3'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Solidago rugosa	75-100%	7	ct
Persicaria sagittata	11-25%	4	ct
Potentilla simplex	6-10%	1	ct
Carex cf scoparia	50-75%	130	sample
Schedonorus arundinaceus	1-5%	0	0
Symphyotrichum lateriflorum	1-5%	0	0
Poa palustris	<1%	0	0
2018 Notes: Not very divese plot. Dense goldenrod with depauperate Carex scoparia beneath, mostly sterile and sprawling.			

Hinesburg Solar Site

8/27/18

Reference Plot 1

Hinesburg Solar

8/27/18

Reference Plot 2

Hinesburg Solar

8/27/18

Reference Plot 3

Hinesburg Solar

8/27/18

Sun Plot 1

Hinesburg Solar

8/27/18

Sun Plot 2

Hinesburg Solar

8/27/18

Sun Plot 3

Hinesburg Solar

8/27/18

Shade Plot 1

Hinesburg Solar

8/27/18

Shade Plot 2

Hinesburg Solar

8/27/18

Shade Plot 3

Hinesburg Solar

8/27/18

Soil Compaction		
Site	Date	Personel
Hinesburg	10/30/2018	JHB & AK

GPS Point Label	Sun 1
Soil Moisture (%)	1
Depth (in)	**Max (psi)**
Surface	30
3	80
6	60
9	120
12	
15	
18	
21	
24	
Depth to readings over 300psi	
11	>300

Notes: Gravel

GPS Point Label	Sun 2
Soil Moisture (%)	2
Depth (in)	**Max (psi)**
Surface	20
3	80
6	80
9	160
12	250
15	
18	
21	
24	
Depth to readings over 300psi	
13	>300

Notes: Gravel

GPS Point Label	Sun 3
Soil Moisture (%)	9
Depth (in)	**Max (psi)**
Surface	40
3	80
6	80
9	200
12	250
15	
18	
21	
24	
Depth to readings over 300psi	
14	>300

Notes: Gravel

GPS Point Label	Sun 4
Soil Moisture (%)	4
Depth (in)	**Max (psi)**
Surface	30
3	100
6	110
9	200
12	150
15	200
18	
21	
24	
Depth to readings over 300psi	
17	>300

Notes: Stopped because hit gravel.

GPS Point Label	Sun 5
Soil Moisture (%)	6
Depth (in)	**Max (psi)**
Surface	40
3	120
6	180
9	110
12	220
15	
18	
21	
24	
Depth to readings over 300psi	
14.5	300

Notes: Gravel

GPS Point Label	Sun 6
Soil Moisture (%)	6
Depth (in)	**Max (psi)**
Surface	50
3	40
6	40
9	140
12	150
15	
18	
21	
24	
Depth to readings over 300psi	
14	>300

Notes: Stopped because hit gravel.

GPS Point Label	Shade 1
Soil Moisture (%)	11
Depth (in)	**Max (psi)**
Surface	40
3	140
6	200
9	200
12	
15	
18	
21	
24	
Depth to readings over 300psi	
11	>300

Notes: Gravel

GPS Point Label	Shade 2
Soil Moisture (%)	3
Depth (in)	**Max (psi)**
Surface	10
3	40
6	80
9	120
12	180
15	200
18	
21	
24	
Depth to readings over 300psi	
18	>300

Notes: Gravel

GPS Point Label	Shade 3
Soil Moisture (%)	7
Depth (in)	**Max (psi)**
Surface	40
3	80
6	100
9	150
12	250
15	
18	
21	
24	
Depth to readings over 300psi	
13	>300

Notes:

GPS Point Label	Shade 4
Soil Moisture (%)	8
Depth (in)	**Max (psi)**
Surface	20
3	60
6	100
9	120
12	220
15	
18	
21	
24	
Depth to readings over 300psi	
13	>300

Notes: Gravel

GPS Point Label	Shade 5
Soil Moisture (%)	6
Depth (in)	**Max (psi)**
Surface	30
3	60
6	80
9	100
12	200
15	
18	
21	
24	
Depth to readings over 300psi	
13	>300

Notes: Gravel

GPS Point Label	Shade 6
Soil Moisture (%)	6
Depth (in)	**Max (psi)**
Surface	60
3	180
6	250
9	
12	
15	
18	
21	
24	
Depth to readings over 300psi	
8	>300

Notes: Gravel

GPS Point Label	Ref 1
Soil Moisture (%)	8
Depth (in)	**Max (psi)**
Surface	40
3	90
6	150
9	170
12	300
15	
18	
21	
24	
Depth to readings over 300psi	
12	

Notes:

GPS Point Label	Ref 2
Soil Moisture (%)	7
Depth (in)	**Max (psi)**
Surface	20
3	80
6	60
9	210
12	150
15	180
18	200
21	200
24	200
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 3
Soil Moisture (%)	13
Depth (in)	**Max (psi)**
Surface	20
3	40
6	160
9	200
12	160
15	220
18	300
21	
24	
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 4
Soil Moisture (%)	9
Depth (in)	**Max (psi)**
Surface	40
3	80
6	150
9	160
12	140
15	200
18	250
21	
24	
Depth to readings over 300psi	
20	300

Notes: Gravel

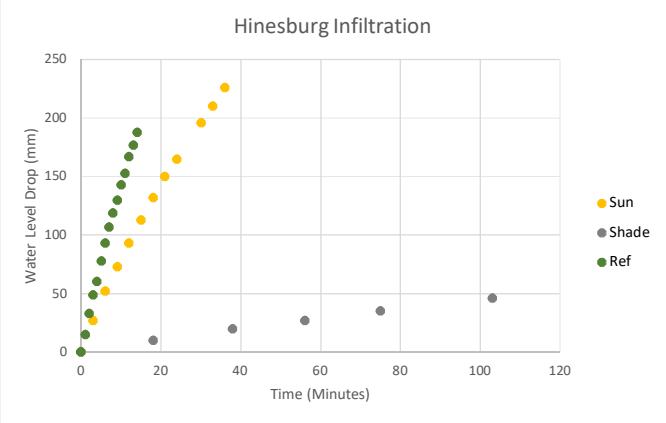
GPS Point Label	Ref 5
Soil Moisture (%)	6
Depth (in)	**Max (psi)**
Surface	20
3	50
6	100
9	150
12	160
15	160
18	180
21	300
24	
Depth to readings over 300psi	
21	

Notes:

GPS Point Label	Ref 6
Soil Moisture (%)	10
Depth (in)	**Max (psi)**
Surface	100
3	130
6	120
9	150
12	150
15	
18	
21	
24	
Depth to readings over 300psi	
13	300

Notes: Gravel

MPD Infiltration Testing																			
Site	Date	Personel																	
Hinesburg	10/30/2018	JHB & AK																	
	Sampler 2					Sampler 3					Sampler 1					Sampler 4			
GPS Point	Sun 1					Shade 1					Ref 1					Shade 2			
Pre-Soil Moisture (%)	1.6	2.8		4.1	2.7	5	5.1		5.9	6.3	11	12.3		11.8	11.6	12.9	9.9	12	13
Pre-Average Soil Moisture (%)	2.8					5.575					11.675					11.95			
Time to drop 1cm	56 seconds					Very Slow					28 seconds					Very Slow			
Sampling Interval	3 minutes					Random					1 minute					Random			
		Time (min)		Depth (mm)			Time (min)		Depth (mm)			Time (min)		Depth (mm)			Time (min)	Depth (mm)	
		4	0	78	0		9	0	54	0		1.5	0	73	0		39	5.2	
		7	3	105	27		27	18	64	10		2.5	1	88	15		57	6.4	
		10	6	130	52		47	38	74	20		3.5	2	106	33		94	7.9	
		13	9	151	73		65	56	81	27		4.5	3	122	49		121	9	
		16	12	171	93		84	75	89	35		5.5	4	133	60				
		19	15	191	113		112	103	100	46		6.5	5	151	78				
		22	18	210	132							7.5	6	166	93				
		25	21	228	150							8.5	7	180	107				
		28	24	243	165							9.5	8	192	119				
		31	27									10.5	9	203	130				
		34	30	274	196							11.5	10	216	143				
		37	33	288	210							12.5	11	226	153				
		40	36	304	226							13.5	12	240	167				
												14.5	13	250	177				
												15.5	14	261	188				
Post-Soil Moisture (%)	7.1	5.5		5.6	6.2	7.1	6		7.4	7.2	12.5	12.3		11.9	12.1	12.4	12.5	13.2	13.1
Post-Soil Moisture Center (%)	8.9					7.2					13.3					13.5			
Post-Average Soil Moisture (%)	6.1					6.925					12.2					12.8			



Soil Description

Site	Hinesburg	Sampling Area	Sun. Shade, Reference
Date	8/9/2018	Personnel	JHB, AK

Sampling Area	Sun		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	Y	Metals Analysis	Y

Soil Description

Sampling area	Primary 5	Primary 3	
Depth (in)	Description	Depth (in)	Description
1	O horizon loose soil dense roots	1	O horizon
0 to 4	Fine sand loam, light brown dense roots	0 to 4	medium brown loam
4 to 5	Light gray with moderate redox	4 to 6	redox, roots to 6
5 to 10	light gray with heavy redox, very dry	6 to 9	loam with light gray depleted matrix, moderate redox
10+	gravel, can't core	9 to 12+	loam with light gray depleted matrix, moderate redox

Sampling Area	Shade		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 5	Primary 1	
Depth (in)	Description	Depth (in)	Description
0.5	O horizon	0.5	O horizon
0 to 3	medium brown loam	0 to 3	roots to 3, medium brown silt loam some gravel
3 to 4	medium brown loam roots to 4	3 to 9	medium brown silt loam some gravel
4 to 7	loam with moderate redox	9 to 12+	striped matrix with heavy redox
8+	mostly chroma 3 with moderate redo		

Sampling Area	Reference		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description **All soil cores are bone dry**

Sampling area	Primary 5	Primary 1	
Depth (in)	Description	Depth (in)	Description
0.5	O horizon loose soil dense roots	0.5	O horizon
0 to 4	loose light brown soil	0 to 4	light brown soil, loose, dense roots
4 to 6	redox starts, roots to 6	4 to 8	redox starts, loamy, roots to 6
6 to 12+	depleted matrix with heavy redox	8 to 10	Chroma 2 moderate redox
		10 to 12+	depleted matrix

Qualitative Observations Data Form v6

Observer: *Michael Lew-Smith*	Site Name: *Middlebury*	Date: 9/6/19

Solar Facility Notes

Height of panels (off ground): *5' to 20'*	Distance between panel rows: *NA*
This is a pre-construction survey __	Type of foundation: Post _X__ Concrete ____ Other ____
This is a post-construction survey X_	Type of modules: Trackers __X_ Fixed Mount ____
Notes / Other Vegetation Mgmt:	Date of Annual Mowing: Unk

Regularly mowed (weekly ?)

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

No surface waters present. Some saturated soils. Standing water in a few ruts.

Notes:	Are Hummock/Hollows Present?	Yes ___	No _X_

NA

Are any exposed soils present in the wetland/buffer within Project Area?			Yes _X_	No ___
Explain and map:	Unique ID		Photo #	

Ruts with standing water exhibit some bare soils. Small areas near the base of tower also show some bare soils, likely from mowing (esp in Shade Plot 3)

Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?			Yes ___	No _X_
Explain and map:	Unique ID		Photo #	

NA

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Poa pratensis	*50*		
Phleum pretense	*30*		
Taraxisum officinale	*30*		
Plantago major	*10*		
Total Cover	*100*	Total Cover	

Notes: *Area with plots is mowed regularly (weekly ?)*

Are there areas in the wetland/buffer with disturbed vegetation?			Yes _X_	No ___
Describe and Map:	Unique ID		Photo #	

Area mowed regularly. Reference site was mowed hayfield in 2018. Presence of wooden plot stakes appeared to prevent mowing in 2019. Reference plots with tall vegetation.

If yes, does this impact wetland function/value?	Yes _X_	No ___

Explain:

Mowed lawn has little to no function. Though it does have value as recreation with walking path through the arrays. Part of the Trail Around Middlebury (TAM) trail network.

Middlebury Solar Site

9/6/19

ID#1 Bare soil from mower beneath solar panel

Middlebury Solar Site

9/6/19

ID#2 Bare soil from mower

Middlebury Solar Site

9/6/19

Ruts beneath solar panel

Qualitative Observations Data Form v6

Observer: *Joe Bartlett*	Site Name: *Middlebury*	Date: 11/18/2019

Solar Facility Notes

Height of panels (off ground):	Distance between panel rows:
This is a pre-construction survey __	Type of foundation: Post ____ Concrete ____ Other ____
This is a post-construction survey __	Type of modules: Trackers ____ Fixed Mount ____
Notes / Other Vegetation Mgmt:	Date of Annual Mowing:

The reference hayfield was not managed as far to the east as in 2018. The hayfield ended approximately 60 feet west of the 2018 extent, several of the reference sampling plots were located outside of the hayfield area with dense herbaceous vegetation.

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

Ponded and frozen water was present along the northwestern edge of the solar panels, saturated soils observed in numerous sampling locations.

Notes:	Are Hummock/Hollows Present?	Yes __ _	No _X__
Are any exposed soils present in the wetland/buffer within Project Area?		Yes ___	No _X__
Explain and map:	Unique ID	Photo #	
Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?		Yes ___	No _X__
Explain and map:	Unique ID	Photo #	

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Total Cover		Total Cover	

Notes:

Are there areas in the wetland/buffer with disturbed vegetation?		Yes ___	No ___
Describe and Map:	Unique ID	Photo #	
If yes, does this impact wetland function/value?		Yes ___	No ___

Explain:

DEC Solar Vegetation Monitoring Plots

Reference Middlebury

MREF1

	2018	2019
Survey Date:	8/29/2018	9/6/2019
Total Vegetative Cover:	93%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	3-18 in	3-48 in
Average Veg. Height:	12 in	36 in

Species	Non-native	species % Cover	species % Cover
Elymus repens	✔	76-100%	76-100%
Phalaris arundinacea		-	11-25%
Silene vulgaris	✔	<1%	-
Taraxacum officinale	✔	1-5%	6-10%
Trifolium pratense	✔	11-25%	1-5%
Trifolium repens	✔	6-10%	-
Species Richness:		5	4
Species Diversity*:		0.41	0.41

2018 Plot Comments: Mowed nearby but not in plot. Dense timothy 16"-18" tall. No hydric plants.

2019 Plot Comments: Unmowed. Very dense Elymus repens and thick thatch chokes out most other species. Soils not saturated.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Reference Middlebury

MREF2

	2018	2019
Survey Date:	8/29/2018	9/6/2019
Total Vegetative Cover:	98%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	2-16 in	8-48 in
Average Veg. Height:	12 in	38 in

Species	Non-native	species % Cover	species % Cover
Ambrosia artemisiifolia		<1%	-
Elymus repens	✔	76-100%	76-100%
Oxalis stricta		<1%	-
Setaria pumila	✔	<1%	-
Taraxacum officinale	✔	1-5%	6-10%
Trifolium pratense	✔	11-25%	-
Trifolium repens	✔	11-25%	-
Species Richness:		7	2
Species Diversity*:		0.5	0.15

2018 Plot Comments: Plot partially mowed. Western 1/3 mowed. Hayfield, cut recently taken.

2019 Plot Comments: Unmowed. Dense Elymus repens and thick thatch chokes out most other vegetation.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Reference Middlebury

MREF3

	2018	2019
Survey Date:	8/29/2018	9/6/2019
Total Vegetative Cover:	98%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	3-14 in	4-38 in
Average Veg. Height:	10 in	24 in

Species	Non-native	species % Cover	species % Cover
Artemisia vulgaris	✔	-	1-5%
Chenopodium album	✔	<1%	-
Elymus repens	✔	76-100%	76-100%
Setaria pumila	✔	1-5%	-
Taraxacum officinale	✔	6-10%	6-10%
Trifolium pratense	✔	11-25%	-
Trifolium repens	✔	1-5%	1-5%
Species Richness:		6	4
Species Diversity*:		0.44	0.25

2018 Plot Comments: Recently mowed in vicinity but not in plots. Veg largely non-hydric. Dense timothy. Field looks fertilized.

2019 Plot Comments: Unmowed. Dense Elymus repens, most other species choked out. Lodged, thick thatch.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Middlebury

MSHD1

	2018	2019
Survey Date:	8/29/2018	9/6/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	2-4 in	2-6 in
Average Veg. Height:	3 in	3 in

Species	Non-native	species % Cover	species % Cover
Cerastium fontanum	✔	26-50%	<1%
Galium sp.		-	<1%
Oxalis stricta		<1%	-
Phleum pratense	✔	11-25%	26-50%
Plantago major	✔	1-5%	-
Poa pratensis		26-50%	51-75%
Potentilla simplex		1-5%	-
Stellaria longifolia		-	<1%
Taraxacum officinale	✔	76-100%	26-50%
Trifolium repens	✔	26-50%	26-50%
Species Richness:		8	7
Species Diversity*:		0.76	0.74

2018 Plot Comments: Mowed lawn. Fully in shade of panel. No bare soil. Very difficult to get accurate count on clover stems (small, mowed and fragile)

2019 Plot Comments: Saturated soils.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Middlebury

MSHD2

	2018	2019
Survey Date:	8/29/2018	9/6/2019
Total Vegetative Cover:	90%	80%
Rock Cover:	0%	0%
Soil Cover:	0%	20%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	1-6 in	2-8 in
Average Veg. Height:	4 in	3 in

Species	Non-native	species % Cover	species % Cover
Carex annectens		1-5%	1-5%
Cerastium fontanum	✔	<1%	-
Galium sp.		<1%	<1%
Persicaria maculosa		<1%	-
Phleum pratense	✔	51-75%	11-25%
Plantago major	✔	11-25%	-
Poa pratensis		51-75%	26-50%
Scirpus atrovirens		6-10%	1-5%
Taraxacum officinale	✔	6-10%	1-5%
Trifolium repens	✔	1-5%	-
Species Richness:		10	6
Species Diversity*:		0.7	0.59

2018 Plot Comments: Some bare ground, likely from mower. Some ruts in area. Dense canary grass meadow nearby (unmowed). Subplot includes area of bare ground.

2019 Plot Comments: Area of bare soil from mower. Soils saturated. Poa ma include both P. pretensis and P.palustris

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Middlebury

MSHD3

	2018	2019
Survey Date:	8/29/2018	9/6/2019
Total Vegetative Cover:	90%	90%
Rock Cover:	0%	0%
Soil Cover:	10%	10%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	1-4 in	2-6 in
Average Veg. Height:	3 in	3 in

Species	Non-native	species % Cover	species % Cover
Carex sp.		<1%	-
Galium mollugo	✔	<1%	-
Oxalis stricta		<1%	-
Phleum pratense	✔	6-10%	1-5%
Poa pratensis		76-100%	76-100%
Taraxacum officinale	✔	26-50%	11-25%
Trifolium repens	✔	6-10%	1-5%
	Species Richness:	7	4
	Species Diversity*:	0.55	0.36

2018 Plot Comments: Dense bluegrass. Some bare ground (10%), may be from mower.

2019 Plot Comments: Saturated soils. Some bare soils from mower.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Middlebury

MSUN1

	2018	2019
Survey Date:	8/29/2018	9/6/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	1-5 in	1-3 in
Average Veg. Height:	2 in	2 in

Species	Non-native	species % Cover	species % Cover
Carex annectens		-	<1%
Carex laxiflora	✔	-	1-5%
Cerastium fontanum	✔	<1%	-
Cirsium vulgare	✔	1-5%	-
Galium mollugo	✔	1-5%	<1%
Phalaris arundinacea		-	<1%
Phleum pratense	✔	11-25%	11-25%
Plantago major	✔	1-5%	-
Poa pratensis		76-100%	76-100%
Taraxacum officinale	✔	51-75%	26-50%
Trifolium pratense	✔	11-25%	6-10%
Trifolium repens	✔	26-50%	11-25%
Species Richness:		9	9
Species Diversity*:		0.75	0.68

2018 Plot Comments: Mowed lawn.

2019 Plot Comments: Edge of mowed lawn. Most diversity is in small area that is unmowed. Soils saturated.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Middlebury

MSUN2

	2018	2019
Survey Date:	8/29/2018	9/6/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	1-4 in	2-5 in
Average Veg. Height:	2 in	3 in

Species	Non-native	species % Cover	species % Cover
Carex annectens		-	<1%
Carex laxiflora	✔	-	1-5%
Phleum pratense	✔	11-25%	11-25%
Plantago major	✔	-	<1%
Poa pratensis		26-50%	26-50%
Taraxacum officinale	✔	76-100%	6-10%
Trifolium pratense	✔	6-10%	-
Trifolium repens	✔	11-25%	11-25%
Species Richness:		5	7
Species Diversity*:		0.66	0.72

2018 Plot Comments: Mowed lawn. Bluegrass mowed very short (not growing back as much as timothy). Difficult to get good count in subplot.

2019 Plot Comments: Mowed lawn. Saturated soils.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Middlebury

MSUN3

	2018	2019
Survey Date:	8/29/2018	9/6/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	2-5 in	2-36 in
Average Veg. Height:	3 in	3 in

Species	Non-native	species % Cover	species % Cover
Acalypha rhomboidea		<1%	-
Carex annectens		11-25%	11-25%
Cerastium fontanum	✔	<1%	-
Echinochloa crus-galli	✔	<1%	-
Phalaris arundinacea		-	6-10%
Phleum pratense	✔	51-75%	26-50%
Plantago major	✔	1-5%	-
Poa pratensis		6-10%	11-25%
Prunella vulgaris		1-5%	-
Scirpus atrovirens		-	1-5%
Stellaria longifolia		6-10%	<1%
Symphyotrichum lateriflorum		1-5%	11-25%
Taraxacum officinale	✔	26-50%	6-10%
Trifolium pratense	✔	11-25%	1-5%
Trifolium repens	✔	11-25%	11-25%
Verbena hastata		1-5%	1-5%
Species Richness:		14	11
Species Diversity*:		0.81	0.85

2018 Plot Comments: Mowed lawn. Northern and western end of plot a little wetter. More diverse than other SUN plots.

2019 Plot Comments: One-half of plot is regularly mowed, the other half is not. Very different flora in each half. Saturated soils. Poa palustris may be mixed in with P. pratensis.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

2019 Middlebury Solar Vegetation Plot Photo Log

Reference Plot 1

Reference Plot 2

2019 Middlebury Solar Vegetation Plot Photo Log

Reference Plot 3

Sun Plot 1

2019 Middlebury Solar Vegetation Plot Photo Log

Sun Plot 2

Sun Plot 3

2019 Middlebury Solar Vegetation Plot Photo Log

Shade Plot 1

Shade Plot 2

Shade Plot 3

Soil Compaction		
Site	Date	Personel
Middlebury	11/18/2019	JHB

GPS Point Label	Sun 1
Soil Moisture (%)	25.5
Depth (in)	Max (psi)
Surface	50
3	100
6	120
9	160
12	180
15	160
18	160
21	160
24	160
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 2
Soil Moisture (%)	24.8
Depth (in)	Max (psi)
Surface	30
3	70
6	70
9	100
12	120
15	150
18	140
21	140
24	140
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 3
Soil Moisture (%)	49
Depth (in)	Max (psi)
Surface	80
3	80
6	100
9	110
12	200
15	300
18	300
21	250
24	220
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 4
Soil Moisture (%)	>50
Depth (in)	Max (psi)
Surface	80
3	60
6	120
9	120
12	120
15	140
18	120
21	120
24	120
Depth to readings over 300psi	
	12

Notes:

GPS Point Label	Sun 5
Soil Moisture (%)	24.5
Depth (in)	Max (psi)
Surface	60
3	80
6	100
9	120
12	220
15	250
18	200
21	200
24	200
Depth to readings over 300psi	
	11

Notes:

GPS Point Label	Sun 6
Soil Moisture (%)	25.4
Depth (in)	Max (psi)
Surface	50
3	80
6	100
9	150
12	260
15	250
18	220
21	200
24	200
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 1
Soil Moisture (%)	25
Depth (in)	Max (psi)
Surface	100
3	150
6	140
9	140
12	150
15	150
18	150
21	150
24	150
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 2
Soil Moisture (%)	24.7
Depth (in)	Max (psi)
Surface	80
3	100
6	120
9	120
12	150
15	150
18	150
21	150
24	150
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 3
Soil Moisture (%)	24.2
Depth (in)	Max (psi)
Surface	120
3	130
6	130
9	130
12	130
15	130
18	130
21	130
24	130
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 4
Soil Moisture (%)	21.4
Depth (in)	Max (psi)
Surface	100
3	150
6	100
9	250
12	>300
15	
18	
21	
24	
Depth to readings over 300psi	
	11

Notes:Did not feel like rocks

GPS Point Label	Shade 5
Soil Moisture (%)	24.4
Depth (in)	Max (psi)
Surface	100
3	80
6	120
9	150
12	200
15	160
18	160
21	140
24	140
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 6
Soil Moisture (%)	30.5
Depth (in)	Max (psi)
Surface	40
3	100
6	120
9	120
12	120
15	120
18	120
21	120
24	120
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 1
Soil Moisture (%)	20.4
Depth (in)	Max (psi)
Surface	50
3	80
6	100
9	120
12	250
15	200
18	160
21	160
24	140
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 2
Soil Moisture (%)	40
Depth (in)	Max (psi)
Surface	250
3	120
6	130
9	100
12	100
15	100
18	100
21	80
24	80
Depth to readings over 300psi	

Notes:Not part of hayfield in 2019

GPS Point Label	Ref 3
Soil Moisture (%)	49
Depth (in)	Max (psi)
Surface	20
3	40
6	90
9	120
12	120
15	100
18	100
21	100
24	100
Depth to readings over 300psi	

Notes: Edge of field in 2019

GPS Point Label	Ref 4
Soil Moisture (%)	22.1
Depth (in)	Max (psi)
Surface	120
3	100
6	140
9	120
12	120
15	120
18	120
21	120
24	120
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 5
Soil Moisture (%)	24.6
Depth (in)	Max (psi)
Surface	20
3	60
6	60
9	80
12	80
15	60
18	60
21	60
24	60
Depth to readings over 300psi	

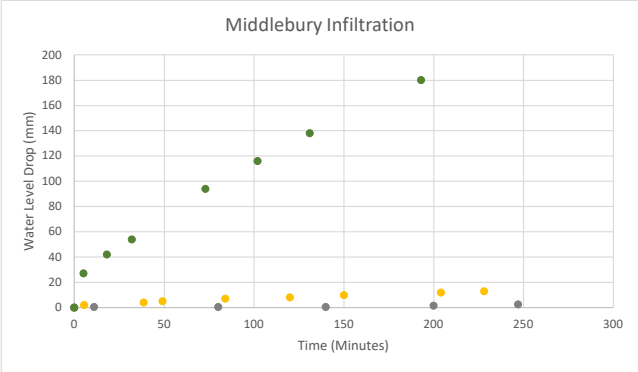
Notes: Not part of hayfield in 2019

GPS Point Label	Ref 6
Soil Moisture (%)	21.9
Depth (in)	Max (psi)
Surface	80
3	80
6	100
9	120
12	140
15	140
18	140
21	140
24	140
Depth to readings over 300psi	

Notes:

MPD Infiltration Testing		
Site	Date	Personel
Middlebury	11/18/2019	JHB

	Sampler 1					Sampler 2					Sampler 3				
GPS Point	Sun1					Shade 1					Ref 1				
Pre-Soil Moisture (%)	>50	>50	>50	>50		34.6	38.8	26.4	28.8		20.4	21.8	22	19.5	
Pre-Average Soil Moisture (%)	>50					32.15					20.925				
		Stop Watch Time	**Time from start**	**Depth (mm)**	**Drop (mm)**		**Stop Watch Time**	**Time from start**	**Depth (mm)**	**Drop (mm)**		**Stop Watch Time**	**Time from start**	**Depth (mm)**	**Drop (mm)**
		17	0	83	0		0	0	51.5	0		31	0	39	0
		22.5	6	85	2		11	11	52	1		36	5	66	27
		55.5	39	87	4		80	80	52	1		49	18	81	42
		66	49	88	5		140	140	52	1		63	32	93	54
		101	84	90	7		200	200	53	2		104	73	133	94
		137	120	91	8		247	247	54	3		133	102	155	116
		167	150	93	10							162	131	177	138
		221	204	95	12							224	193	219	180
		245	228	96	13										
Post-Soil Moisture Center (%)	>50					>50					22.8				



Soil Description

Site	Middlebury	Sampling Area	Sun. Shade, Reference
Date	11/18/2019	Personnel	JHB

Sampling Area	Sun		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 4	Primary 5	
Depth (in)	Description	Depth (in)	Description
2	O horizon loose soil dense roots	1	O horizon
0 to 12	10 YR 5/2 roots to 8 silt with some vf sand	0 to 8	10YR 4/2
12 to 16	10YR 6/2 with redox	8 to 15	10yr 4/2 some dark redox, roots to 10
16+	10YR 6/1 with heavy redox	15+	10YR 6/1 heavy redox

Sampling Area	Shade		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 3	Primary 6	
Depth (in)	Description	Depth (in)	Description
1	O horizon	1	O horizon
0 to 6	10YR 3/3 silt with some VF sand	0 to 8	10YR 3/4 roots to 8
6 to 14	10YR 4/2 some redox, roots to 10	8 to 12	10YR 4/2 some redox, silty
14+	10YR 5/1 heavy redox	12+	10YR 5/1 moderate redox, some clay

Sampling Area	Reference		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 4	Primary 3	
Depth (in)	Description	Depth (in)	Description
0.5	O horizon loose soil dense roots	0.5	O horizon
0 to 14	10YR 3/1 with coars roots to 8 and fine roots to 14	0 to 12	10YR 4/3 silt with dense roots to 12
14-16+	10YR 3/1 with redox, more clay	12 to 18	10YR 4/2 some redox
		18+	10YR 5/1 heavy redox

Soil Test Results

Site	Date	Location	pH	OM_Pct	Avail_P	K	Ca	Mg	Zn	B	Mn	Cu	Fe	Al	Na	S	Exch_Acid	ECEC	A_Base_Sa	G_Base_S	K_Base_Sa	Pb	Ni	Cd	Cr
				%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Middlebury	11/18/2019	Sun	7.65	6.968	3.45	111	2852	796	0.85	0.75	15.1	0.1	6.4	12	968	25	0.00	21.18	67.33	31.32	1.34	0.65	0.15	0.05	0.1
Middlebury	11/18/2019	Shade	7.37	7.15	3.2	156	2845	1010	1.7	0.9	31.8	0.15	10.6	14	563	16	0.00	23.04	61.74	36.53	1.74	0.8	0.3	0.05	0.15
Middlebury	11/18/2019	Ref	7.22	5.057	2.6	162	3054	758	0.6	0.65	8.8	0.15	5.2	29	159	13	0.00	22.00	69.40	28.71	1.89	0.35	0.45	0.05	0.15
		Average:	7.45	6.39	3.1	143	2917	855	1.05	0.77	18.6	0.13	7.4	18	563	18	0.00	22.07	66.16	32.19	1.66	0.60	0.30	0.05	0.13
Middlebury	8/7/2018	Ref	7.48	6.24	1.90	90	3914	559	0.80	0.80	2.7	0.15	1.9	9	298	11	0.00	24.46	80.01	19.05	0.94	0.8	0.35	0.05	0
Middlebury	8/7/2018	Shade	7.83	5.057	8.85	181	4093	715	1.90	0.80	4.7	0.20	1.9	8	176	12	0.00	26.89	76.11	22.16	1.73	2.0	0.35	0.05	0
Middlebury	8/7/2018	Sun	7.72	6.24	8.20	135	3182	739	2.65	0.85	3.6	0.30	3.4	7	252	17	0.00	22.41	70.98	27.47	1.54	1.0	0.30	0.10	0.05
		Average:	7.70	5.846	6.32	135	3730	671	1.78	0.82	3.7	0.22	2.4	8	242	13	0.00	24.59	75.70	22.89	1.40	1.3	0.33	0.07	0.02

2018 Middlebury Solar Qualitative Data

Observer: *Michael Lew-Smith*	Site Name: *Middlebury*	Date: 8/28/18

Solar Facility Notes

Height of panels (off ground): *5' to 20'*	Distance between panel rows: *NA*
This is a pre-construction survey __	Type of foundation: Post __X_ Concrete ____ Other ____
This is a post-construction survey _X	Type of modules: Trackers _X__ Fixed Mount ____
Notes / Other Vegetation Mgmt:	Date of Annual Mowing: ?

Mowing conducted every two weeks. Herbicide may be sprayed at base of trackers.

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

Soils very dry at time of site visit. No standing water, saturated soils or other hydric indicators present.

Notes:	Are Hummock/Hollows Present?	Yes ___	No __X
Are any exposed soils present in the wetland/buffer within Project Area?		Yes _X_	No ___
Explain and map:		Photo #	*2251*

A few small areas from herbicide spraying at base of trackers and from mowing where mower cut into ground.

Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?	Yes ___	No _X_
Explain and map:	Photo #	

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Poa pratensis	*40*		
Phleum pretense	*30*		
Taraxicum officinale	*30*		
Plantago major	*10*		
Total Cover	*100*	Total Cover	

Notes: *Mowed lawn. Does not exhibit wetland characteristics or have hydric vegetation.*

Are there areas in the wetland/buffer with disturbed vegetation?	Yes ___	No _X_
Describe and Map:	Photo #	
If yes, does this impact wetland function/value?	Yes ___	No ___

Explain:

This wetland does not appear to be functioning at all, managed as a mowed lawn.

2018 Middlebury Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 93%		
Site: Middlebury	DATE: 08-29-2018		
Plot: REF1	Height: 3"-18" Avg: 12"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phleum pratense	75-100%	150	sample
Trifolium pratense	11-25%	0	0
Taraxacum officinale	1-5%	6	ct
Trifolium repens	6-10%	6	ct
Silene vulgaris	<1%	0	0
2018 Notes: Mowed nearby but not in plot. Dense timothy 16"-18" tall. No hydric plants.			

	2018		
Name: Michael Lew-Smith	Total % Cover 98%		
Site: Middlebury	DATE: 08-29-2018		
Plot: REF2	Height: 2"-16" Avg: 12"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phleum pratense	75-100%	70	sample
Trifolium pratense	11-25%	3	ct
Trifolium repens	11-25%	12	ct
Ambrosia artemisiifolia	<1%	0	0
Setaria pumila	<1%	3	ct
Taraxacum officinale	1-5%	5	ct
Oxalis stricta	<1%	0	0
2018 Notes: Plot partially mowed. Western 1/3 mowed. Hayfield, cut recently taken.			

2018 Middlebury Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 98%		
Site: Middlebury	DATE: 08-29-2018		
Plot: REF3	Height: 3"-14" Avg: 10"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phleum pratense	75-100%	160	sample
Trifolium pratense	11-25%	11	ct
Taraxacum officinale	6-10%	0	0
Setaria pumila	1-5%	0	0
Trifolium repens	1-5%	10	ct
Chenopodium cf album	<1%	0	0
2018 Notes: Recently mowed in vicinity but not in plots. Vegetation largely non-hydric. Dense timothy. Field looks fertilized.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Middlebury	DATE: 08-29-2018		
Plot: SUN1	Height: 1"-5" Avg: 2"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Trifolium pratense	11-25%	2	ct
Taraxacum officinale	50-75%	15	ct
Phleum pratense	11-25%	7	0
Poa pratensis	75-100%	300	sample
Galium mollugo	1-5%	0	0
Cirsium vulgare	1-5%	0	0
Cerastium fontanum	<1%	0	0
Plantago major	1-5%	0	0
Trifolium repens	25-50%	11	ct
2018 Notes: Mowed lawn.			

2018 Middlebury Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Middlebury	DATE: 08-29-2018		
Plot: SUN2	Height: 1"-4" Avg: 2"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Trifolium pratense	6-10%	0	0
Taraxacum officinale	75-100%	27	ct
Trifolium repens	11-25%	14	ct
Phleum pratense	11-25%	33	ct
Poa pratensis	25-50%	200	sample
2018 Notes: Mowed lawn. Bluegrass mowed very short (not growing back as much as timothy). Difficult to get good count in sub-plot.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Middlebury	DATE: 08-29-2018		
Plot: SUN3	Height: 2"-5" Avg: 3"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Taraxacum officinale	25-50%	1	ct
Trifolium repens	11-25%	18	ct
Trifolium pratense	11-25%	0	0
Phleum pratense	50-75%	100	sample
Poa pratensis	6-10%	80	sample
Stellaria cf longifolia	6-10%	0	0
Plantago major	1-5%	0	0
Verbena hastata	1-5%	4	ct
Echinochloa crus-galli	<1%	0	0
Symphyotrichum lateriflorum	1-5%	0	0
Carex annectens	11-25%	0	0
Prunella vulgaris	1-5%	0	0
Acalypha rhomboidea	<1%	0	0
Cerastium fontanum	<1%	1	ct
2018 Notes: Mowed lawn. Northern and western end of plot a little wetter. More diverse than other SUN plots.			

2018 Middlebury Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Middlebury	DATE: 08-29-2018		
Plot: SHADE1	Height: 2"-4" Avg: 3"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Taraxacum officinale	75-100%	16	ct
Trifolium repens	25-50%	37	sample
Cerastium fontanum	25-50%	0	0
Potentilla simplex	1-5%	0	0
Oxalis stricta	<1%	0	0
Plantago major	1-5%	0	0
Poa cf pratensis	25-50%	45	sample
cf Phleum pratense	11-25%	8	ct
2018 Notes: Mowed lawn. Fully in shade of panel. No bare soil. Very difficult to get accurate count on clover stems (small, mowed and fragile)			

	2018		
Name: Michael Lew-Smith	Total % Cover 90%		
Site: Middlebury	DATE: 08-29-2018		
Plot: SHADE2	Height: 1"-6" Avg: 4"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Taraxacum officinale	6-10%	4	ct
cf Scirpus atrovirens	6-10%	5	ct
Phleum pratense	50-75%	80	sample
Trifolium repens	1-5%	0	0
Plantago major	11-25%	3	ct
Poa pratensis	50-75%	120	sample
Cerastium fontanum	<1%	0	0
Galium sp.	<1%	0	0
Persicaria maculosa	<1%	0	0
Carex annectens	1-5%	3	ct
2018 Notes: Some bare ground, likely from mower. Some ruts in area. Dense canary grass meadow nearby (unmowed). Sub-plot includes area of bare ground.			

	2018		
Name: Michael Lew-Smith	Total % Cover 90%		
Site: Middlebury	DATE: 08-29-2018		
Plot: SHADE3	Height: 1"-4" Avg: 3"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Poa pratensis	75-100%	300	sample
Taraxacum officinale	25-50%	23	ct
Trifolium repens	6-10%	0	0
Phleum pratense	6-10%	25	ct
Oxalis stricta	<1%	0	0
Carex sp.	<1%	5	ct
Galium mollugo	<1%	4	ct
2018 Notes: Dense bluegrass. Some bare ground (10%), may be from mower.			

Middlebury Solar Site (#2251)

8/28/18

Middlebury Solar Site

Bare soil beneath tracker from herbicide application

8/28/18

Reference Plot 1

Middlebury Solar Site

8/28/18

Reference Plot 2

Middlebury Solar Site

8/28/18

Reference Plot 3

Middlebury Solar Site

8/28/18

Sun Plot 1

Middlebury Solar Site

8/28/18

Sun Plot 2

Middlebury Solar Site

8/28/18

Sun Plot 3

Middlebury Solar Site

8/28/18

Shade Plot 1

Middlebury Solar Site

8/28/18

Shade Plot 2

Middlebury Solar Site

8/28/18

Shade Plot 3

Middlebury Solar Site

8/28/18

Soil Compaction		
Site	Date	Personel
Middlebury	10/30/2018	JHB & AK

GPS Point Label	Sun 1
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	60
3	90
6	110
9	110
12	90
15	120
18	120
21	120
24	150
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 2
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	60
3	80
6	100
9	140
12	150
15	150
18	150
21	120
24	120
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 3
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	50
3	80
6	100
9	100
12	120
15	120
18	180
21	220
24	200
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 4
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	30
3	110
6	90
9	80
12	120
15	120
18	140
21	140
24	150
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 5
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	60
3	80
6	90
9	180
12	150
15	150
18	160
21	160
24	180
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 6
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	30
3	80
6	90
9	100
12	120
15	150
18	160
21	160
24	160
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 1
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	60
3	90
6	80
9	80
12	80
15	120
18	150
21	150
24	150
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 2
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	60
3	100
6	120
9	100
12	100
15	100
18	120
21	120
24	120
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 3
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	30
3	90
6	70
9	100
12	110
15	140
18	140
21	140
24	130
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 1
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	60
3	90
6	80
9	80
12	80
15	120
18	150
21	150
24	150
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 5
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	100
3	90
6	110
9	180
12	200
15	200
18	250
21	180
24	160
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 6
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	40
3	80
6	120
9	120
12	160
15	140
18	140
21	140
24	140
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 1
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	50
3	90
6	110
9	130
12	140
15	180
18	220
21	220
24	210
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 2
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	50
3	100
6	150
9	140
12	280
15	290
18	210
21	180
24	210
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 3
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	40
3	100
6	110
9	140
12	160
15	160
18	170
21	160
24	160
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 4
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	40
3	90
6	120
9	120
12	200
15	200
18	160
21	160
24	260
Depth to readings over 300psi	

Notes:

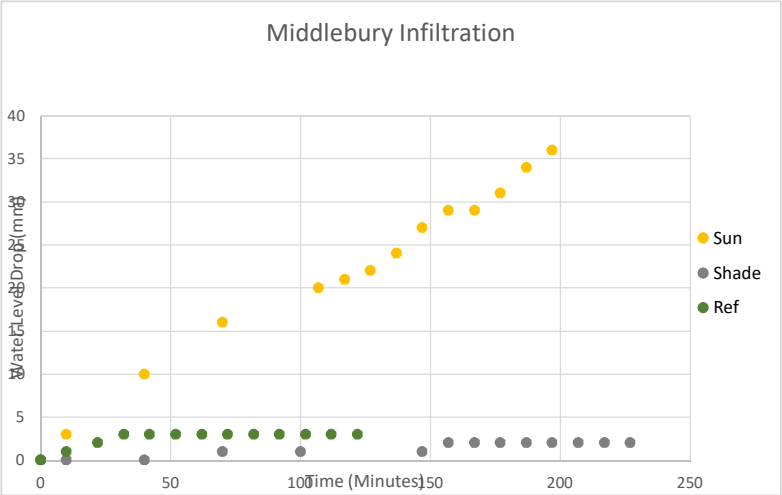
GPS Point Label	Ref 5
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	40
3	120
6	120
9	180
12	160
15	160
18	160
21	160
24	150
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 6
Soil Moisture (%)	
Depth (in)	**Max (psi)**
Surface	50
3	100
6	160
9	180
12	180
15	190
18	160
21	250
24	
Depth to readings over 300psi	
23	300

Notes:

MPD Infiltration Testing															
Middlebury	11/6/2018	APK													
	Sampler 1					Sampler 2					Sampler 3				
GPS Point	Sun1					Shade 1					Ref 1				
Pre-Soil Moisture (%)	>50	>50		>50	>50	47.2	>50		>50	>50	24	24.3		23.3	25
Pre-Average Soil Moisture (%)	>50					>50					24.15				
Time to drop 1cm															
Sampling Interval	10					10					10				
		Time (min)		Depth (mm)			Time (min)		Depth (mm)			Time (min)		Depth (mm)	
		0	0	53	53		0	0	32	32		0	0	45	45
		10	10	56	56		10	10	32	32		10	10	46	46
	12:08	40	40	63	63		40	40	32	32		22	22	47	47
	12:38	70	70	69	69	11:47	70	70	33	33		32	32	48	48
	1:15	107	107	73	73	12:19	100	100	33	33		42	42	48	48
	1:25	117	117	74	74	1:06	147	147	33	33		52	52	48	48
	1:35	127	127	75	75	1:16	157	157	34	34		62	62	48	48
	1:45	137	137	77	77	1:26	167	167	34	34		72	72	48	48
	1:55	147	147	80	80	1:36	177	177	34	34		82	82	48	48
	2:05	157	157	82	82	1:46	187	187	34	34		92	92	48	48
	2:15	167	167	82	82	1:56	197	197	34	34		102	102	48	48
	2:25	177	177	84	84	2:06	207	207	34	34		112	112	48	48
	2:35	187	187	87	87	2:16	217	217	34	34		122	122	48	48
	2:45	197	197	89	89	2:26	227	227	34	34					
Post-Soil Moisture (%)	>50	>50		>50	>50	46.1	>50		>50	>50	25.6	24		24.1	24
Post-Soil Moisture Center (%)	>50					>50					7.3				
Post-Average Soil Moisture (%)	>50					>50					24.425				



Soil Description

Site	Middlebury	Sampling Area	Sun. Shade, Reference
Date	8/7/2018	Personnel	JHB, AK

Sampling Area	Sun		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 2	Primary 1	
Depth (in)	Description	Depth (in)	Description
1	O horizon loose soil dense roots	1	O horizon
0 to 4	Medium gray brown silt loam, roots to 4	0 to 3	gray brown silt loam some redox
4 to 9	medium gray brown silt loam	3 to 11	light gray brown with moderate redox, roots to 8
9 to 12+	Stripped matrix, gray with heavy redox	11	thin layer of wood chips
		11+	Stripped layer with heavy redox

Sampling Area	Shade		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 1	Primary 3	
Depth (in)	Description	Depth (in)	Description
0.5	O horizon	0.5	O horizon
0 to 3	medium brown gravel silt loam dense roots	0 to 1.5	Medium brown with dense roots
3 to 5	Medium brown gravel silt loam some roots	1.5 to 6	Medium brown silt loam
5 to 8	redox starts, roots to 6	6 to 10	Redox and stripped matrix
8 to 14+	stripped matrix with more silt	10 to 14+	stripped matrix light gray silt loam

Sampling Area	Reference		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 4	Primary 3	
Depth (in)	Description	Depth (in)	Description
0.5	O horizon loose soil dense roots	0.5	O horizon
0 to 6	light brown silt loam, dense roots to 4, roots to 6	0 to 4	medium brown silt loam with roots to 4
6 to 10	light brown silt loam	4 to 9	medium brown silt loam
10 to 12+	stripped layer with moderate redox	9 to 12+	stipped layer with heavy redox, increasing clay

Qualitative Observations Data Form v6

Observer: *Michael Lew-Smith*	Site Name: *Sudbury*	Date: 9/6/19

Solar Facility Notes

Height of panels (off ground): *2' to 8'*	Distance between panel rows: *17'*
This is a pre-construction survey __	Type of foundation: Post __X_ Concrete ____ Other ____
This is a post-construction survey X_	Type of modules: Trackers ____ Fixed Mount __X_
Notes / Other Vegetation Mgmt:	Date of Annual Mowing: Unk

Herbicide used beneath solar arrays prior to vegetation monitoring.

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

Saturated soils throughout most of site.

Notes:	Are Hummock/Hollows Present?	Yes ___	No _X_

NA

Are any exposed soils present in the wetland/buffer within Project Area?			Yes _X_	No ___
Explain and map:	Unique ID		Photo #	

Small pockets of bare soils are present throughout the site beneath the solar panels.

Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?			Yes ___	No _X_
Explain and map:	Unique ID		Photo #	

NA

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Phalaris arundinacea	*80*	*Phalaris arundinacea*	*80*
Trifolium pretense	*15*		
Vicia cracca	*5*		
Carex annectans	*10*		
Total Cover	*100*	Total Cover	*80*

Notes: *Dense reed canary grass.*

Are there areas in the wetland/buffer with disturbed vegetation?			Yes _X_	No ___
Describe and Map:	Unique ID		Photo #	

Herbicide was used to control vegetation beneath solar panels. Reed canary grass mostly dead, other species colonizing area. Thick thatch of dead plant matter covering bare soil.

If yes, does this impact wetland function/value?	Yes ___	No _?_

Explain:

Fairly good growth of other vegetation. Though bare soils may be present in spring? Unknown if this will impact function or result in soil erosion. No erosion evident at time of site visit.

Sudbury Solar Site

9/6/19

Herbicide use beneath solar panels

Qualitative Observations Data Form v6

Observer: *Joe Bartlett*	Site Name: *Sudbury*	Date: 10/14/2019

Solar Facility Notes

Height of panels (off ground):	Distance between panel rows:
This is a pre-construction survey __	Type of foundation: Post ____ Concrete ____ Other ____
This is a post-construction survey __	Type of modules: Trackers ____ Fixed Mount ____
Notes / Other Vegetation Mgmt:	Date of Annual Mowing:

Site was recently mowed

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

No evidence of recent runoff or flow paths. Saturated soils were found in low points in the Sun and Shade sampling areas.

Notes:	Are Hummock/Hollows Present?	Yes _ _ _	No _ X__
Are any exposed soils present in the wetland/buffer within Project Area?		Yes __X_	No _X__
Explain and map:	Unique ID	Photo #	

Some mowing ruts were observed in the Sun zone but exposed soil was minimal.

Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?		Yes ___	No _X__
Explain and map:	Unique ID	Photo #	

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Total Cover		Total Cover	

Notes:

Are there areas in the wetland/buffer with disturbed vegetation?		Yes ___	No ___
Describe and Map:	Unique ID	Photo #	
If yes, does this impact wetland function/value?		Yes ___	No ___

Explain:

DEC Solar Vegetation Monitoring Plots

Reference Sudbury

SREF1

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	6-48 in	4-72 in
Average Veg. Height:	36 in	60 in

Species	Non-native	species % Cover	species % Cover
Ambrosia artemisiifolia		-	<1%
Carex annectens		1-5%	1-5%
Carex sp.		<1%	-
Cerastium fontanum	✔	-	<1%
Oxalis stricta		1-5%	1-5%
Phalaris arundinacea		76-100%	76-100%
Poa palustris		1-5%	6-10%
Stellaria longifolia		-	<1%
Symphyotrichum lanceolatum		-	26-50%
Symphyotrichum lateriflorum		26-50%	-
Taraxacum officinale	✔	-	<1%
Trifolium repens	✔	-	1-5%
Vicia cracca	✔	11-25%	1-5%
Species Richness:		7	11
Species Diversity*:		0.6	0.58

2018 Plot Comments: Dense meadow of reed canary grass, most of it lodged (fallen over). Undisturbed. Soils not saturated.

2019 Plot Comments: Dense, tall reed canary grass. Undisturbed plot, soils not saturated

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Reference Sudbury

SREF2

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	8-52 in	4-72 in
Average Veg. Height:	48 in	66 in

Species	Non-native	species % Cover	species % Cover
Carex annectens		11-25%	6-10%
Carex lurida		1-5%	-
Galium sp.		<1%	6-10%
Phalaris arundinacea		76-100%	76-100%
Poa palustris		1-5%	6-10%
Scirpus sp.		-	1-5%
Symphyotrichum lanceolatum		-	11-25%
Symphyotrichum lateriflorum		26-50%	-
Trifolium repens	✔	-	1-5%
Vicia cracca	✔	<1%	6-10%
Species Richness:		7	8
Species Diversity*:		0.59	0.6

2018 Plot Comments: Dense reed canary grass thicket. Tall veg and thick thatch layer. Undisturbed.

2019 Plot Comments: Dense reed canary grass. Undisturbed. Tall veg.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Reference Sudbury

SREF3

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	48-48 in	6-72 in
Average Veg. Height:	48 in	60 in

Species	Non-native	species % Cover	species % Cover
Acalypha rhomboidea		-	<1%
Carex annectens		6-10%	1-5%
Carex grisea		<1%	-
Carex scoparia		-	1-5%
Carex sp.		1-5%	-
Galeopsis tetrahit	✔	<1%	1-5%
Lotus corniculatus	✔	-	1-5%
Oxalis stricta		1-5%	1-5%
Phalaris arundinacea		76-100%	76-100%
Poa palustris		1-5%	6-10%
Symphyotrichum lateriflorum		11-25%	6-10%
Symphyotrichum puniceum		1-5%	11-25%
Trifolium repens	✔	-	1-5%
Vicia cracca	✔	-	1-5%
Species Richness:		9	12
Species Diversity*:		0.5	0.6

2018 Plot Comments: Dense reed canary grass meadow, tall veg.

2019 Plot Comments: Dense, tall reed canary grass. Soils not saturated. Undisturbed

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Sudbury

SSHD1

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	90%	90%
Rock Cover:	0%	0%
Soil Cover:	0%	10%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	48-48 in	3-24 in
Average Veg. Height:	48 in	16 in

Species	Non-native	species % Cover	species % Cover
Carex annectens		1-5%	1-5%
Epilobium coloratum		-	6-10%
Erechtites hieraciifolius		-	6-10%
Persicaria pensylvanica		-	51-75%
Phalaris arundinacea		76-100%	1-5%
Phleum pratense	✔	-	1-5%
Poa palustris		1-5%	11-25%
Ranunculus acris	✔	1-5%	<1%
Rumex sp.		-	26-50%
Taraxacum officinale	✔	-	1-5%
Trifolium pratense	✔	-	51-75%
Trifolium repens	✔	<1%	6-10%
Species Richness:		5	12
Species Diversity*:		0.18	0.8

2018 Plot Comments: Unmowed. Dense reed canary grass, most lodged. Thick thatch layer, no bare ground. More sparse than sun plots, though % cover measure may not show that.

2019 Plot Comments: Plot under drip line from panels. Looks like herbicide treatment beneath panels earlier in season, dense thatch of dead vegetation

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Sudbury

SSHD2

	2018	2019
Survey Date:	8/28/2018	9/6/2019
Total Vegetative Cover:	70%	85%
Rock Cover:	0%	0%
Soil Cover:	5%	10%
Mulch Cover:	0%	0%
Thatch Cover:	25%	5%
Veg Height Range:	36-36 in	3-18 in
Average Veg. Height:	36 in	10 in

Species	Non-native	species % Cover	species % Cover
Ambrosia artemisiifolia		-	<1%
Equisetum arvense		-	<1%
Lactuca canadensis		-	1-5%
Phalaris arundinacea		76-100%	-
Poa palustris		-	6-10%
Rumex crispus	✔	-	26-50%
Taraxacum officinale	✔	-	1-5%
Trifolium pratense	✔	-	51-75%
Trifolium repens	✔	-	6-10%
Species Richness:		1	8
Species Diversity*:		0	0.64

2018 Plot Comments: Dense reed canary grass meadow. Nearly all laying down. % cover difficult to determine what is living and dead material. 5% area bare ground.

2019 Plot Comments: Herbicide treatment earlier in season, dense thatch of dead reed canary grass. Soils soft and saturated.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Shade Sudbury

SSHD3

	2018	2019
Survey Date:	8/28/2018	9/6/2019
Total Vegetative Cover:	97%	90%
Rock Cover:	0%	0%
Soil Cover:	0%	2%
Mulch Cover:	0%	0%
Thatch Cover:	3%	8%
Veg Height Range:	24-48 in	4-36 in
Average Veg. Height:	36 in	14 in

Species	Non-native	species % Cover	species % Cover
Acalypha rhomboidea		-	6-10%
Carex annectens		1-5%	1-5%
Equisetum arvense		-	6-10%
Helianthus tuberosus		-	1-5%
Lactuca canadensis		-	1-5%
Oxalis stricta		-	6-10%
Phalaris arundinacea		76-100%	6-10%
Poa palustris		26-50%	1-5%
Ranunculus acris	✔	-	1-5%
Solanum dulcamara	✔	26-50%	11-25%
Taraxacum officinale	✔	-	11-25%
Trifolium pratense	✔	-	11-25%
Vicia cracca	✔	-	<1%
Species Richness:		4	13
Species Diversity*:		0.62	0.89

2018 Plot Comments: Unmowed. Reed canary grass, overgrown and laying down. Thick thatch layer covering bare ground (no bare ground visible).

2019 Plot Comments: Herbicide treatment earlier in season, thatch of dead reed canary grass. Soils soft and saturated

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Sudbury

SSUN1

	2018	2019
Survey Date:	8/28/2018	9/6/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	3-16 in	4-24 in
Average Veg. Height:	12 in	8 in

Species	Non-native	species % Cover	species % Cover
Ambrosia artemisiifolia		-	11-25%
Carex annectens		51-75%	26-50%
Eleocharis sp.		-	1-5%
Lactuca canadensis		-	1-5%
Phalaris arundinacea		76-100%	76-100%
Poa palustris		26-50%	<1%
Taraxacum officinale	✔	-	1-5%
Trifolium pratense	✔	-	11-25%
Species Richness:		3	8
Species Diversity*:		0.64	0.67

2018 Plot Comments: Dense graminoids. Mowed recently, though thick thatch is matted down. Soils not saturated.

2019 Plot Comments: Mowed previously in season, vegetation growing back. Some thatch from previous mowing.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Sudbury

SSUN2

	2018	2019
Survey Date:	8/28/2018	9/6/2019
Total Vegetative Cover:	100%	100%
Rock Cover:	0%	0%
Soil Cover:	0%	0%
Mulch Cover:	0%	0%
Thatch Cover:	0%	0%
Veg Height Range:	3-54 in	4-28 in
Average Veg. Height:	12 in	10 in

Species	Non-native	species % Cover	species % Cover
Carex annectens		51-75%	26-50%
Echinochloa crus-galli	✔	-	<1%
Eleocharis sp.		-	6-10%
Epilobium coloratum		-	<1%
Phalaris arundinacea		76-100%	26-50%
Poa palustris		26-50%	11-25%
Taraxacum officinale	✔	-	<1%
Trifolium pratense	✔	-	26-50%
Species Richness:		3	8
Species Diversity*:		0.64	0.77

2018 Plot Comments: Very similar in every way to SUN1. Recently mowed in part. Northern edge of plot not mowed. Soils not saturated.

2019 Plot Comments: Mowed earlier in season, some thatch created from that mowing.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

DEC Solar Vegetation Monitoring Plots

Sun Sudbury

SSUN3

	2018	2019
Survey Date:	8/28/2018	8/28/2019
Total Vegetative Cover:	90%	80%
Rock Cover:	0%	0%
Soil Cover:	0%	5%
Mulch Cover:	0%	0%
Thatch Cover:	10%	15%
Veg Height Range:	4-10 in	- in
Average Veg. Height:	6 in	in

Species	Non-native	species % Cover	species % Cover
Carex annectens		51-75%	26-50%
Galium sp.		-	<1%
Phalaris arundinacea		76-100%	76-100%
Poa palustris		26-50%	6-10%
	Species Richness:	3	4
	Species Diversity*:	0.64	0.49

2018 Plot Comments: Recently mowed. Mulch thick on remaining veg. Soils not saturated. Dense reed canary grass. Very similar to other SUN plots.

2019 Plot Comments: Recently mowed. Thatch layer of dead veg covering bare soil. Soils saturated. NE corner of plot not mowed.

*Simpson's Index of Diversity, calculated n as range median and N as total of all medians.

2019 Sudbury Solar Vegetation Plot Photo Log

Reference Plot 1

Reference Plot 2

Reference Plot 3

Sun Plot 1

2019 Sudbury Solar Vegetation Plot Photo Log

Sun Plot 2

Sun Plot 3

2019 Sudbury Solar Vegetation Plot Photo Log

Shade Plot 1

Shade Plot 2

Shade Plot 3

Soil Compaction		
Site	Date	Personel
Sudbury	10/14/2019	EHB JHB

GPS Point Label	Sun 1
Soil Moisture (%)	>50
Depth (in)	Max (psi)
Surface	40
3	60
6	80
9	120
12	150
15	250
18	120
21	120
24	60
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 2
Soil Moisture (%)	15.1
Depth (in)	Max (psi)
Surface	50
3	80
6	80
9	120
12	150
15	250
18	200
21	200
24	300
Depth to readings over 300psi	

Notes: Definitely compaction, measurement was on a wheel

GPS Point Label	Sun 3
Soil Moisture (%)	>50
Depth (in)	Max (psi)
Surface	50
3	80
6	80
9	100
12	150
15	180
18	160
21	160
24	150
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 4
Soil Moisture (%)	48.4
Depth (in)	Max (psi)
Surface	20
3	60
6	80
9	120
12	250
15	250
18	180
21	160
24	130
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 5
Soil Moisture (%)	22.8
Depth (in)	Max (psi)
Surface	50
3	80
6	120
9	180
12	>300
15	
18	
21	
24	
Depth to readings over 300psi	
	12

Notes: Definitely compaction, measurement was on a wheel

GPS Point Label	Sun 6
Soil Moisture (%)	>50
Depth (in)	Max (psi)
Surface	20
3	30
6	50
9	80
12	80
15	150
18	100
21	100
24	80
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 1
Soil Moisture (%)	>50
Depth (in)	Max (psi)
Surface	10
3	10
6	30
9	30
12	50
15	50
18	110
21	80
24	30
Depth to readings over 300psi	

Notes: rocks at 18

GPS Point Label	Shade 2
Soil Moisture (%)	>50
Depth (in)	Max (psi)
Surface	30
3	50
6	80
9	100
12	150
15	150
18	150
21	150
24	150
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 3
Soil Moisture (%)	29
Depth (in)	Max (psi)
Surface	20
3	40
6	80
9	110
12	110
15	180
18	160
21	140
24	140
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 4
Soil Moisture (%)	23.5
Depth (in)	Max (psi)
Surface	40
3	80
6	100
9	90
12	120
15	>300
18	
21	
24	
Depth to readings over 300psi	
	14

Notes:Might be compaction, feels sandy

GPS Point Label	Shade 5
Soil Moisture (%)	20.4
Depth (in)	Max (psi)
Surface	40
3	80
6	80
9	110
12	160
15	>300
18	
21	
24	
Depth to readings over 300psi	
	13

Notes:Might be compaction, feels sandy

GPS Point Label	Shade 6
Soil Moisture (%)	22.5
Depth (in)	Max (psi)
Surface	20
3	50
6	80
9	80
12	100
15	100
18	110
21	100
24	100
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 1
Soil Moisture (%)	18.9
Depth (in)	Max (psi)
Surface	120
3	80
6	100
9	150
12	150
15	150
18	150
21	150
24	130
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 2
Soil Moisture (%)	23.8
Depth (in)	Max (psi)
Surface	80
3	120
6	100
9	180
12	>300
15	
18	
21	
24	
Depth to readings over 300psi	
	12

Notes:

GPS Point Label	Ref 3
Soil Moisture (%)	31
Depth (in)	Max (psi)
Surface	150
3	120
6	100
9	120
12	120
15	100
18	100
21	100
24	100
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 4
Soil Moisture (%)	31
Depth (in)	Max (psi)
Surface	130
3	100
6	90
9	150
12	220
15	220
18	200
21	160
24	140
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 5
Soil Moisture (%)	23.5
Depth (in)	Max (psi)
Surface	30
3	80
6	100
9	120
12	130
15	300
18	200
21	200
24	180
Depth to readings over 300psi	
	15

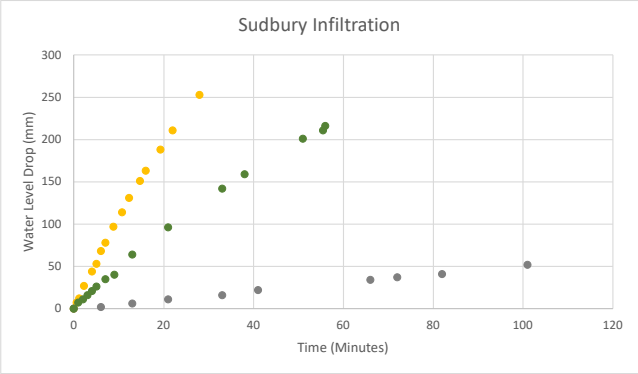
Notes: Definitely compaction

GPS Point Label	Ref 6
Soil Moisture (%)	17.1
Depth (in)	Max (psi)
Surface	50
3	150
6	100
9	180
12	200
15	200
18	250
21	200
24	200
Depth to readings over 300psi	

Notes:

MPD Infiltration Testing		
Site	Date	Personel
Sudbury	10/14/2019	JHB & EHB

	Sampler 2					Sampler 1					Sampler 3				
GPS Point	Sun 1					Shade 1					Ref 1				
Pre-Soil Moisture (%)	25.2	25	31	24.2		38.8	26.1	25.6	31.2		23.1	24.5	22.4	22.5	
Pre-Average Soil Moisture (%)	26.35					30.425					23.125				
		Stop Watch Time	**Time from start**	**Depth (mm)**	**Drop (mm)**		**Stop Watch Time**	**Time from start**	**Depth (mm)**	**Drop (mm)**		**Stop Watch Time**	**Time from start**	**Depth (mm)**	**Drop (mm)**
		12.5	0	54	0		14	0	78	0		17	0	66	0
		13.1	0.6	61	7		20	6	80	2		18	1	73	7
		13.7	1.2	66	12		27	13	84	6		19	2	77	11
		14.75	2.25	81	27		35	21	89	11		20	3	82	16
		16.5	4	98	44		47	33	94	16		21	4	87	21
		17.5	5	107	53		55	41	100	22		22	5	92	26
		18.5	6	122	68		80	66	112	34		24	7	101	35
		19.5	7	132	78		86	72	115	37		26	9	106	40
		21.3	8.8	151	97		96	82	119	41		30	13	130	64
		23.2	10.7	168	114		115	101	130	52		38	21	162	96
		24.8	12.3	185	131							50	33	208	142
		27.2	14.7	205	151							55	38	225	159
		28.5	16	217	163							68	51	267	201
		31.75	19.25	242	188							72.5	55.5	277	211
		34.5	22	265	211							73	56	282	216
		40.5	28	307	253										
Post-Soil Moisture Center (%)	27.8					26.6					25.3				



Soil Description

Site	Sudbury	Sampling Area	Sun. Shade, Reference
Date	10/14/2019	Personnel	JHB EHB

Sampling Area	Sun		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 4	Primary 2	
Depth (in)	Description	Depth (in)	Description
1	O horizon loose soil dense roots	0.5	O horizon
0 to 6	10YR 5/3	0 to 12	silty clay 10YR 5/2 redox to surface, some fine roots to 8
6 to 16	10YR 4/2 dense roots to 8 some redox	12 to 18+	Silty clay heavy redox 10YR 6/1
16 to 20+	10YR 5/2 depleted matrix		

Sampling Area	Shade		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	Y	Metals Analysis	Y

Soil Description

Sampling area	Primary 3	Primary 6	
Depth (in)	Description	Depth (in)	Description
0.5	O horizon	0.5	O horizon
0 to 15	VF sandy loam, redox at 4, 10YR 4/2 fine roots to 6	0 to 12	10YR 4/2 VF sandy loam redox at 4 fine roots to 6
15 to 18+	VT sand 2.5Y 4/5	12-18+	VF sand 10YR 5/1 base, 10YR 6/6 redox

Sampling Area	Reference		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 1	Primary 5	
Depth (in)	Description	Depth (in)	Description
2	O horizon loose soil dense roots	1	O horizon
0 to 6	Silty clay 10YR 4/2 some redox, roots to 3	0 to 6	silty clay loam 10YR 3/2 redox at 2, roots to 4
6 to 16	10YR 4/1 frequent redox	6 to 12	Silty clay 10YR3/1 more redox
16 to 22+	10YR 4/1 heavy redox with 10YR 5/1 sand pockets	12 to 18	silty clay 10 YR5/1 more redox
		18 to 22+	Same as above but with sand deposits 10YR 6/1

Soil Test Results

Site	Date	Location	pH	OM_Pct	Avail_P	K	Ca	Mg	Zn	B	Mn	Cu	Fe	Al	Na	S	Exch_Acid	ECEC	A_Base_Sa	G_Base_S	K_Base_Sa	Pb	Ni	Cd	Cr
				%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sudbury	10/14/2019	Sun	7.37	5.239	2.1	134	3059	583	0.45	0.4	9.8	0.1	2.8	25	567	31	0.00	20.50	74.62	23.70	1.68	0.25	0.4	0.1	0.2
Sudbury	10/14/2019	Shade	7.19	3.146	1.75	74	2541	346	0.45	0.35	5	0.05	2	16	340	8	0.00	15.78	80.52	18.27	1.20	0.25	0.45	0.05	0.15
Sudbury	10/14/2019	Ref	7.38	3.874	1.8	109	2425	1081	0.3	0.35	4.5	0.1	4.6	26	123	15	0.00	21.41	56.62	42.07	1.31	0.4	0.35	0.05	0.2
Sudbury	10/14/2019	Shade 2	7.3	3.783	2.05	86	2721	337	0.5	0.4	5.7	0.15	2.1	15	462	10	0.00	16.63	81.79	16.88	1.33	0.25	0.15	0.05	0
		Average:	7.32	4.09	1.9	106	2675	670	0.40	0.37	6.4	0.08	3.1	22	343	18	0.00	19.23	70.59	28.02	1.39	0.30	0.40	0.07	0.18
Sudbury	8/9/2018	Ref	6.9	6.24	1.15	89	2176	719	0.95	0.30	2.3	0.10	2.1	10	76	15	0.00	17.10	63.63	35.04	1.33	0.3	0.35	0.05	0.05
Sudbury	8/9/2018	Shade	7.18	4.784	1.60	66	2654	328	1.40	0.45	3.4	0.15	1.0	7	329	10	0.00	16.17	82.05	16.90	1.05	0.2	0.40	0.05	0
Sudbury	8/9/2018	Sun	7.44	6.331	1.40	90	3495	418	1.00	0.40	5.7	0.15	1.3	11	518	23	0.00	21.19	82.47	16.44	1.09	0.2	0.35	0.05	0.05
		Average:	7.23	5.785	1.38	82	2775	488	1.12	0.38	3.8	0.13	1.5	9	308	16	0.00	18.15	76.05	22.79	1.16	0.2	0.37	0.05	0.03

2018 Sudbury Solar Qualitative Data

Observer: *Michael Lew-Smith*	Site Name: *Sudbury*	Date: *8/28/18*

Solar Facility Notes

Height of panels (off ground): *2' to 8'*	Distance between panel rows: *17'*
This is a pre-construction survey __	Type of foundation: Post __X_ Concrete ____ Other ____
This is a post-construction survey _X	Type of modules: Trackers ____ Fixed Mount __X_
Notes / Other Vegetation Mgmt:	Date of Annual Mowing: ?

Wetland Hydrology / Soils

List Hydrologic Sources (seeps, drainages, streams, standing water, saturated soils):

No surface drainage features visible. No saturation at time of site visit.

Notes:	Are Hummock/Hollows Present?	Yes ___	No _X_
Are any exposed soils present in the wetland/buffer within Project Area?		Yes ___	No _X_
Explain and map:		Photo #	
Are there areas of excessive soil disturbance in the wetland or buffer that may influence hydrology?		Yes ___	No _X_
Explain and map:		Photo #	

Wetland Vegetation

Dominant Species		Invasive Species	
Species	% Cover	Species	% Cover
Phalaris anundinacea	*80*	*Phalaris anundinacea*	*80*
Carex annectans	*30*		
Poa palustris	*10*		
Total Cover	*100*	Total Cover	*80*

Notes: *Areas between panels have been mowed, areas beneath panels have not. Overall vegetation is very uniform. Getting here before mowing would be good, but may not make much difference, most species can be identified.*

Are there areas in the wetland/buffer with disturbed vegetation?	Yes ___	No _X_
Describe and Map:	Photo #	
If yes, does this impact wetland function/value?	Yes ___	No _X_
Explain:		

2018 Sudbury Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Sudbury	DATE: 08-28-2018		
Plot: REF1	Height: 6"-4" Avg: 3"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phalaris arundinacea	75-100%	23	ct
Symphyotrichum lateriflorum	25-50%	0	0
Vicia cracca	11-25%	1	ct
Oxalis stricta	1-5%	0	0
cf Poa palustris	1-5%	2	ct
Carex annectens	1-5%	3	ct
Carex sp.	<1%	1	ct
2018 Notes: Dense meadow of reed canary grass, most of it lodged (fallen over). Undisturbed. Soils not saturated.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Sudbury	DATE: 08-28-2018		
Plot: REF2	Height: 8"-4.5' Avg: 4'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phalaris arundinacea	75-100%	8	ct
Carex annectens	11-25%	8	ct
Symphyotrichum lateriflorum	25-50%	4	ct
Galium sp.	<1%	0	0
Vicia cracca	<1%	0	0
Carex cf lurida	1-5%	0	0
cf Poa palustris	1-5%	6	ct
2018 Notes: Dense reed canary grass thicket. Tall vegetation and thick thatch layer. Undisturbed.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Sudbury	DATE: 08-28-2018		
Plot: REF3	Height: 4'-4' Avg: 4'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phalaris arundinacea	75-100%	34	ct
Symphyotrichum lateriflorum	11-25%	0	0
Galeopsis tetrahit	<1%	0	0
Poa palustris	1-5%	0	0
Carex annectens	6-10%	16	ct
Oxalis stricta	1-5%	0	0
Carex sp.	1-5%	3	ct
Symphyotrichum puniceum	1-5%	3	ct
Carex grisea	<1%	1	ct
2018 Notes: Dense reed canary grass meadow, tall vegetation.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Sudbury	DATE: 08-28-2018		
Plot: SUN1	Height: 3"-16" Avg: 12"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phalaris arundinacea	75-100%	18	ct
Carex annectens	50-75%	40	ct
cf Poa palustris	25-50%	120	sample
2018 Notes: Dense graminoids. Mowed recently, though thick thatch is matted down. Soils not saturated.			

	2018		
Name: Michael Lew-Smith	Total % Cover 100%		
Site: Sudbury	DATE: 08-28-2018		
Plot: SUN2	Height: 3"-4.5' Avg: 12"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phalaris arundinacea	75-100%	32	ct
Carex annectens	50-75%	36	ct
Poa cf palustris	25-50%	24	ct
2018 Notes: Very similar in every way to SUN1. Recently mowed in part. Northern edge of plot not mowed. Soils not saturated.			

2018 Sudbury Solar Quantitative Vegetation Data

	2018		
Name: Michael Lew-Smith	Total % Cover 90%		
Site: Sudbury	DATE: 08-28-2018		
Plot: SUN3	Height: 4"-10" Avg: 6"		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phalaris arundinacea	75-100%	58	ct
Carex annectens	50-75%	100	sample
cf Poa palustris	25-50%	60	sample
2018 Notes: Recently mowed. Mulch thick on remaining veg. Soils not saturated. Dense reed canary grass. Very similar to other SUN plots.			

	2018		
Name: Michael Lew-Smith	Total % Cover 90%		
Site: Sudbury	DATE: 08-28-2018		
Plot: SHADE1	Height: 4'-4' Avg: 4'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phalaris arundinacea	75-100%	52	ct
Carex annectens	1-5%	0	0
Ranunculus acris	1-5%	0	0
Trifolium repens	<1%	0	0
cf Poa palustris	1-5%	1	ct
2018 Notes: Unmowed. Dense reed canary grass, most lodged. Thick thatch layer, no bare ground. More sparse than sun plots, though % cover measure may not show that.			

	2018		
Name: Michael Lew-Smith	Total % Cover 70%		
Site: Sudbury	DATE: 08-28-2018		
Plot: SHADE2	Height: 3'-3' Avg: 3'		
Plant Species	**% Cover**	**Stem Count**	**Count Type**
Phalaris arundinacea	75-100%	20	ct
2018 Notes: Dense reed canary grass meadow. Nearly all laying down. % cover difficult to determine what is living and dead material. 5% area bare ground.			

	2018		
Name: Michael Lew-Smith	Total % Cover 97%		
Site: Sudbury	DATE: 08-28-2018		
Plot: SHADE3	Height: 2'-4' Avg: 3'		
Plant Species	**Plot % Cover**	**Sub-Plot Stem Count**	**Sub-Plot Count Type**
Phalaris arundinacea	75-100%	12	ct
Solanum dulcamara	25-50%	0	0
cf Poa palustris	25-50%	35	ct
Carex annectens	1-5%	6	ct
2018 Notes: Unmowed. Reed canary grass, overgrown and laying down. Thick thatch layer covering bare ground (no bare ground visible).			

Sudbury Solar Site

8/28/18

Sudbury Solar Reference Area

8/28/18

Reference Plot 1

Sudbury Solar

8/28/18

Reference Plot 2

Sudbury Solar

8/28/18

Reference Plot 3

Sudbury Solar

8/28/18

Sun Plot 1

Sudbury Solar

8/28/18

Sun Plot 2

Sudbury Solar

8/28/18

Sun Plot 3

Sudbury Solar

8/28/18

Shade Plot 1

Sudbury Solar

8/28/18

Shade Plot 2

Sudbury Solar

8/28/18

Shade Plot 3

Sudbury Solar

8/28/18

Soil Compaction		
Site	Date	Personel
Sudbury	11/5/2018	JHB & EHB

GPS Point Label	Sun 1
Soil Moisture (%)	>50
Depth (in)	Max (psi)
Surface	50
3	100
6	110
9	150
12	180
15	220
18	150
21	100
24	100
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 2
Soil Moisture (%)	13.9
Depth (in)	Max (psi)
Surface	40
3	100
6	140
9	280
12	300
15	240
18	280
21	300
24	300
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 3
Soil Moisture (%)	25.5
Depth (in)	Max (psi)
Surface	30
3	80
6	110
9	110
12	180
15	150
18	150
21	160
24	140
Depth to readings over 300psi	

Notes:

GPS Point Label	Sun 4
Soil Moisture (%)	24.4
Depth (in)	Max (psi)
Surface	50
3	90
6	100
9	300
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	12

Notes:

GPS Point Label	Sun 5
Soil Moisture (%)	21.2
Depth (in)	Max (psi)
Surface	30
3	50
6	140
9	180
12	
15	
18	
21	
24	
Depth to readings over 300psi	
	11

Notes:

GPS Point Label	Sun 6
Soil Moisture (%)	>50
Depth (in)	Max (psi)
Surface	30
3	50
6	90
9	120
12	220
15	230
18	200
21	200
24	160
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 1
Soil Moisture (%)	>50
Depth (in)	Max (psi)
Surface	20
3	30
6	30
9	60
12	90
15	90
18	90
21	90
24	90
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 2
Soil Moisture (%)	>50
Depth (in)	Max (psi)
Surface	20
3	70
6	120
9	110
12	110
15	110
18	120
21	130
24	130
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 3
Soil Moisture (%)	29.8
Depth (in)	Max (psi)
Surface	20
3	50
6	90
9	100
12	100
15	120
18	150
21	160
24	160
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 4
Soil Moisture (%)	19.4
Depth (in)	Max (psi)
Surface	20
3	50
6	80
9	100
12	150
15	
18	
21	
24	
Depth to readings over 300psi	
	14

Notes:

GPS Point Label	Shade 5
Soil Moisture (%)	20.3
Depth (in)	Max (psi)
Surface	40
3	60
6	100
9	110
12	150
15	140
18	140
21	200
24	160
Depth to readings over 300psi	

Notes:

GPS Point Label	Shade 6
Soil Moisture (%)	21.7
Depth (in)	Max (psi)
Surface	20
3	30
6	50
9	110
12	200
15	150
18	80
21	140
24	150
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 1
Soil Moisture (%)	21
Depth (in)	Max (psi)
Surface	120
3	120
6	200
9	200
12	240
15	200
18	150
21	130
24	130
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 2
Soil Moisture (%)	24.5
Depth (in)	Max (psi)
Surface	110
3	120
6	120
9	150
12	150
15	220
18	120
21	110
24	110
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 3
Soil Moisture (%)	23
Depth (in)	Max (psi)
Surface	30
3	60
6	80
9	80
12	110
15	120
18	120
21	120
24	120
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 4
Soil Moisture (%)	49.4
Depth (in)	Max (psi)
Surface	100
3	120
6	160
9	180
12	180
15	160
18	160
21	160
24	160
Depth to readings over 300psi	

Notes:

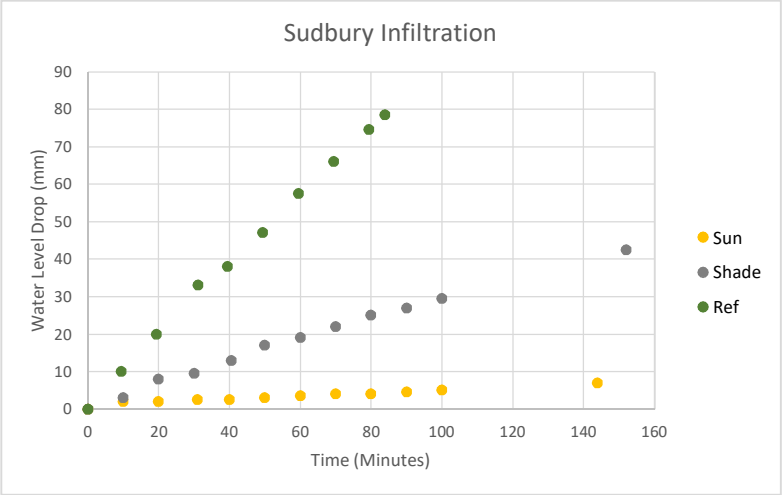
GPS Point Label	Ref 5
Soil Moisture (%)	21.9
Depth (in)	Max (psi)
Surface	30
3	80
6	100
9	100
12	120
15	120
18	110
21	110
24	110
Depth to readings over 300psi	

Notes:

GPS Point Label	Ref 6
Soil Moisture (%)	20.4
Depth (in)	Max (psi)
Surface	50
3	90
6	110
9	120
12	140
15	140
18	130
21	130
24	130
Depth to readings over 300psi	

Notes:

MPD Infiltration Testing															
Sudbury	11/5/2018	JHB & EHB													
	Sampler 2					Sampler 1					Sampler 3				
GPS Point	Sun 1					Shade 1					Ref 1				
Pre-Soil Moisture (%)	21.1	20.6		21.1	19.3	22.2	22.4		21.8	21.7	22.9	22.3		21.1	21.5
Pre-Average Soil Moisture (%)	20.525					22.025					21.95				
Time to drop 1cm											9.5				
Sampling Interval	10					10					10				
		Time (min)		Depth (mm)			Time (min)		Depth (mm)			Time (min)		Depth (mm)	
		4.5	4.5	57	57		0	0	52	52		0	0	68	68
		14.5	14.5	59	59		10	10	55	55		9.5	9.5	78	78
		24.5	24.5	59	59		20	20	60	60		19.5	19.5	88	88
		35.5	35.5	59.5	59.5		30	30	61.5	61.5		31.2	31.2	101	101
		44.5	44.5	59.5	59.5		41	40.5	65	65		39.5	39.5	106	106
		54.5	54.5	60	60		50	50	69	69		49.5	49.5	115	115
		64.5	64.5	60.5	60.5		60	60	71	71		59.5	59.5	125.5	125.5
		74.5	74.5	61	61		70	70	74	74		69.5	69.5	134	134
		84.5	84.5	61	61		80	80	77	77		79.5	79.5	142.5	142.5
		94.5	94.5	61.5	61.5		90	90	79	79		84	84	146.5	146.5
		104.5	104.5	62	62		100	100	81.5	81.5					
		148.5	148.5	64	64		152	152	94.5	94.5					
Post-Soil Moisture (%)	21.9	20.4		22	21.5	21	22.9		22.7	21.5	22	22.3		22	21.8
Post-Soil Moisture Center (%)	21.3					22.3					24				
Post-Average Soil Moisture (%)	21.45					22.025					22.025				



Soil Description

Site	Sudbury	Sampling Area	Sun. Shade, Reference
Date	8/9/2018	Personnel	JHB, AK

Sampling Area	Sun		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 2	Primary 3	
Depth (in)	Description	Depth (in)	Description
0.5	O horizon loose soil dense roots	1	O horizon
0 to 4	Medium brown silt loam	0 to 2	medium brown silt loam
4 to 5	white sandy deposits with redox	2 to 8	medium brown silt loam with some redox
5 to 9	light brown silt loam, redox	8 to 12+	depleted silt clay loam with moderate redox, roots to 9
9 to 12+	silt clay laom chroma 2 with more redox, coarse organic fragments indicate tillage		

Sampling Area	Shade		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 1	Primary 4	
Depth (in)	Description	Depth (in)	Description
0.5	O horizon	1	O horizon
0 to 2	light brown gray silt loam roots to 2	0 to 6	light brown gray silt clay loam, some pebbles
2 to 10	light brown gray silt loam with redox	6 to 10	light brown gray silt clay loam chroma 2, some redox
10-14+	stripped matrix heavy redox	10 to 12+	Straight clay light brown gray

Sampling Area	Reference		
Core Location GPS Points: Primary 1-6			
Lab Duplicate	N	Metals Analysis	Y

Soil Description

Sampling area	Primary 2	Primary 1`	
Depth (in)	Description	Depth (in)	Description
1.5	O horizon loose soil dense roots	1	O horizon
0 to 4	light brown silt loam dense roots to 4	0 to 4	loose light brown soil
4 to 8	light brown silt loam with some redox	4 to 7	light brown with redox, roots to 7
8 to 10	heavy redox, roots to 10	7 to 12+	depleted matrix silt clay
10 to 12+	depleted matrix		