Guidelines for the NEON Soil Characterization Effort

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1. Background and rationale for sampling strategies for distributed soil sampling at NEON sites

The National Ecological Observatory Network (NEON, www.neoninc.org) is an NSF-funded project aimed at "understanding and forecasting the impacts of climate change, land use change, and invasive species on continental-scale ecology by providing infrastructure and consistent methodologies to support research and education in these areas". It is a large-scale, multifaceted, long-term research project that encompasses a network of terrestrial and aquatic field sites across the United States and monitors ecosystems at multiple spatial temporal, and taxonomic scales.

The goals of the NEON soil characterization effort are two-fold: First, to characterize the physical and geochemical properties of soils; and second, to capture the *variability* in soil characteristics across the NEON sites. Rather than simply a generalized interpretation of geomorphic and soils at the landscape scale, NEON would like to determine the range of soil conditions across the sampling locations (e.g. plots), and to determine how well the sampling locations represent the overall site characteristics (i.e. what are we missing?).

In order to address long-term ecological questions, NEON determined terrestrial sampling locations using a randomized design that was stratified by vegetation type. This approach imposes certain constraints on soil characterization, and NRCS soil scientists will need to adhere to the sampling protocols and locations established by NEON.

2. Pre-analysis of soil potential sample locations

2.1. The main goal for soil sampling on NEON sites is to characterize the physical and geochemical properties of soils and evaluate soil variability at each site. A pre-analysis is done to select which, and how many, of the pre-selected NEON plots to sample for adequate characterization. The pre-analysis also helps guide the site summary, which is completed after plot description and sampling. Example pre-analyses can be found in Appendix 2.

2.2. NEON reviews the NRCS plot selection and obtains approval for sampling the selected plots. A pre-analysis plan may be approved as selected or modified. NEON prefers that NRCS follow a consistent approach for pre-analysis which can also complement the Site Summary document. Each NEON site is in a different soil landscape. Hence, the most important plot selection variables at a specific site can vary. Relief, landforms, slope position, parent materials, and aspect are the important parameters in the analysis. The number and distribution of soil map units should reflect these properties and can be employed in the pre analysis.

2.3. NEON provides 34 pre-selected sample plots within each site and a minimum of 10 plots must be sampled. It should be pointed out that soil survey or soil landscape relationships were <u>not</u> the primary consideration when NEON identified the 34 pre-selected plots. Therefore, some map units within the site may not have any of the pre-selected plots located within them, regardless of the proportionate extent of the map units on the site. If this is the case make note

of this in the pre-analysis and include in the site summary. Also, given the difference in mapped detail of soil surveys across the nation, we recognize the need to integrate additional ancillary data layers where existing soil maps do not provide sufficient detail needed to guide plot selection.

2.4. There may be instances when a primary selected plot is rejected for sampling. We therefore recommend selecting back-up plots if field conditions preclude sampling at the selected plots. These alternate plots should allow the sampling plan to achieve its original objectives in terms of number of plots sampled and representativeness of soil types across the site. Depending on NEON site and anticipated soil conditions, we recommend identifying 10% to 20% back-up plots. Back-ups plots can be selected using various rationale. For example, if it's anticipated that soils will be difficult to sample because of stone cover or high rock fragment content, it might be prudent to select a back-up plot. In some situations it could be desirable to have a duplicate of a more common soil/landscape/vegetation combination if there are unforeseen access problems not identified during the pre-analysis. Another example might be the desire to ensure that under-represented soil components are sampled. Regardless of the rationale, the back-up plots must be clearly identified in the pre-analysis. If it is determined, while in the field, that a plot cannot be sampled, the field crew must contact the domain manager and/or NEON POC as soon as possible and sampling a back-up plot should only occur once confirmation is provided by the POC.

2.5. Example Pre-analyses

2.6. Two example pre-analyses are provided in Appendix 2. The approaches are similar but employ slightly different selection criteria because mapping detail differs, as well as the soil landscape complexity. The Dead Lake example is map unit-centered in part because the site is relatively homogenous. The SCBI example employs a combination of soil, geology, landform, and vegetation to obtain the major repeating landforms. Note that a number of soil map units at this site do not contain any of the pre-selected plots.

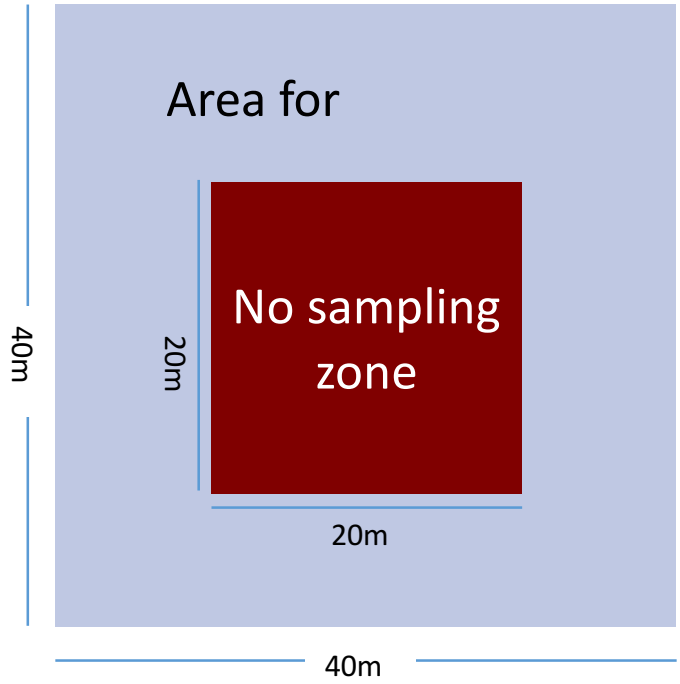


Figure 1. Diagram of the layout of plots for soil sampling. Note that sampling for soil characterization may take place in the 10m outer perimeter of each plot. The central 20x20m region is designated for plant diversity measurements and is very sensitive to disturbance. Please avoid this inner plot area.

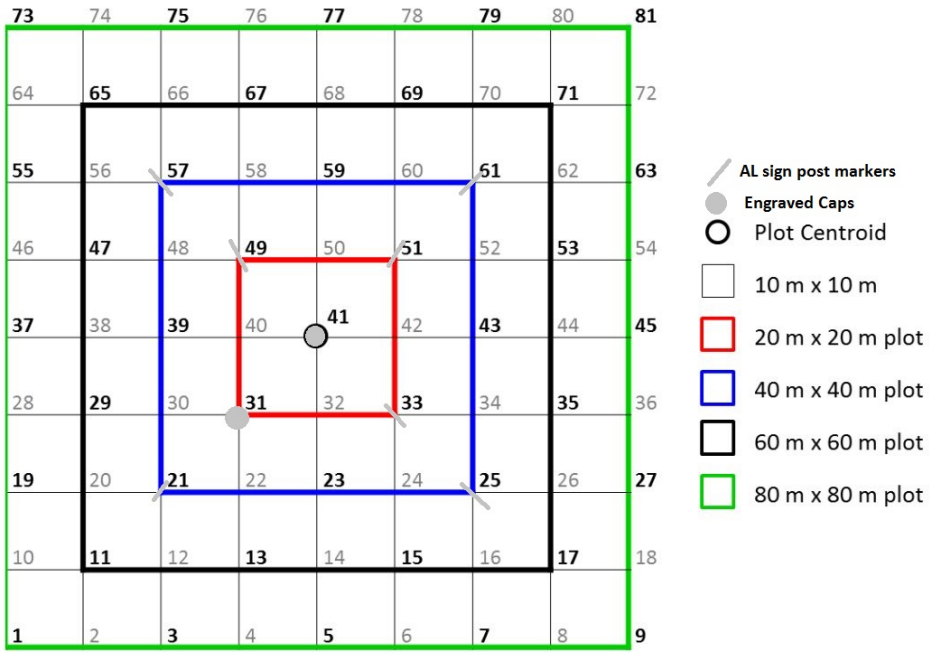


Figure 2. General layout for all of NEON's distributed plots (tower plots may vary). NEON plots vary in size from 20x20 m to 80x80 m, depending on sampling protocol. Each corner of the 40x40 m (blue) plot is typically marked with an aluminum post. A round, engraved metal cap is typically used to mark the SW corner of the inner (20x20 m, red) plot, which is excluded from soil sampling and is designated for plant diversity measurements. The plot center is also marked with an engraved cap.

3. Sampling methodologies

3.1. Soil characterization will occur within 40x40m soil plots, which are distributed throughout the site and are used for various monitoring purposes, including beetle sampling and plant diversity surveys (Figure 1). Soil sampling is prohibited from the central 20x20m region within each plot. Coordinates are provided for the plot marker located at the SW corner of the 40x40m plot. NEON has a standardized approach to installing plot markers, as outlined in Figure 2. However, some sites may deviate from this general schema: it is up to the contractor to discuss site-specific differences during the pre-visit meeting with the Domain Manager. The sampling guidelines are as follows:

3.2. Sampling may occur in the outer 10m band of the 40x40 m plots (Figure 1). These plots are the only locations where soil sampling (and disturbance) is permitted. The precise location(s) for soil sampling and characterization to occur is up to the expertise of NRCS soil scientists. NEON will communicate the permitted soil sampling method to be used at each site (see Figure 3).

3.3. All efforts should be made to avoid disturbing vegetation and soil surface surrounding the sample locations. This may most effectively be done using tarps to collect excavated material and facilitate replacement by horizon when sampling is complete. It is recommended that tarps be placed outside of the plot area to minimize damage to surface vegetation.

Sampling via pit excavation

3.3.1. Where permitted, a 1mx1mx1m pit will be dug, pending authorization by NEON Permitting Team and as specified in the "Sample Type" column in "Summary" worksheet in current ***Schedule.xlsx*** document on the SharePoint site hosted by NEON (Table 1). The site host must give approval to the NEON permitting team for pit excavations to be allowed.

Sampling via bucket auger or similar

3.3.2. Where permission for a 1mx1mx1m pit is not received, sampling will be conducted using a bucket auger via 10 cm bore holes. More than one auger hole may be excavated to achieve the mass of soil needed for laboratory analyses (~500-700g). Soil cores are the **only** sampling available in the following circumstances:

3.3.2.1. At the four tower plots (denoted as "tower" in the column "Plot_Type" for each site-specific spatial data .csv file). These plots are located near the tower sensors and cannot incur disturbance from digging pits;

3.3.2.2. Anywhere outside of the SHPO compliant area, which varies from site to site. For sites with SHPO boundary concerns, this information will be provided prior to initiating work (i.e., pre-visit analysis described in Step 3.2) for a site;

3.3.2.3. Any plot location that is not authorized by the site host.

3.3.3. In all cases where a bucket auger is to be used, fill soil may be required to be carried in by NRCS staff to replace the soil taken for sample and laboratory analyses. Typically, this would be sterile sand, but inquire with the Domain Manager for any site-specific instructions for fill material. In cases were sampling via bucket auger will not suffice (i.e., presence of coarse fragments or skeletal soils), NRCS should contact the ARS point of contact (Table 2) for further guidance.

3.4. Specific soil sampling guidelines are provided below:

3.4.1. **Coarse Fragments**: Soil descriptions for pit and auger sample locations should include volume estimates for coarse fragments. The volume estimates should be made by standard size classes – 2-5, 5-20, 20-75, and >75 mm. For core sample locations, it may be difficult to obtain a large view area for coarse fragment estimate. In this situation, use existing map unit information, field observations, and your professional judgment to estimate coarse fragments. A volume estimate of the total coarse fragment content (> 2 mm) is the minimum required. Where observation area is limited (i.e. core), it may not be feasible to make reliable estimates on all coarse fragment classes.

3.4.2. **Sample Size**: A minimum ~500 g air-dry < 2 mm (fine earth) material is needed (~ 1,000 g if saturated paste (salts) is required). A quart is approximately ~600g of air-dry < 2 mm material. Note the 500 g sample excludes all coarse fragments (> 2 mm). If the sample contains coarse fragments (2-20 mm), a minimum of 500 g < 2 mm must still be obtained. No fragments > 20 mm should be included in the sample bag.

3.4.3. **Bulk density samples**: At NEON approved pit sample locations, the goal is to collect clod samples from the major horizons described. For some horizons it may not be feasible to obtain clods (e.g., thin, granular structure, coarse fragments, roots, etc.). Use your professional judgement to obtain clods where it is feasible. If a horizon cannot be sampled for clods, the frame bulk device may be used for surface or near surface horizons. If clods are not feasible, obtain just the bulk sample. At NEON sites that are approved only for auger sampling collect bulk samples only.

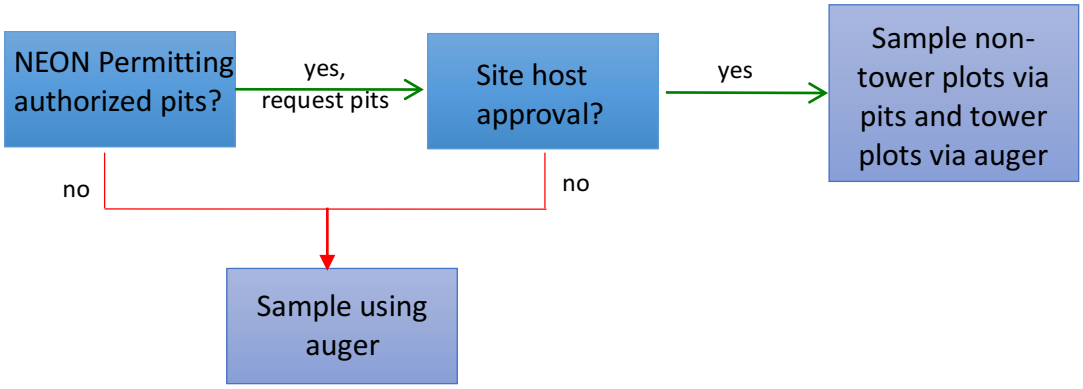


Figure 3. Flowchart for determining the sampling methodology to be used at a site. Note that plots located within the tower airshed (e.g. "tower" plots) cannot be sampled by digging a pit; for these plots a soil auger is the only allowable method. Pits denote excavated areas of 1mx1m to a depth of 1m.

Data recording and reporting

3.5. Soil sample locations must be noted via distance (to nearest 0.01 m) and compass bearing from the southwest corner (or closest corner) of the 40x40m plot. If NRCS personnel have access to a GPS capable of high spatial accuracy (e.g., Trimble Geo 7 series unit), sample locations may be noted this way additionally. Record the location of the reference marker that is used to denote soil sampling location (e.g. 3.5 m at a compass bearing of 45 degrees from the SW plot marker).

3.5.1. The point location for a pit or core is the center of the excavated area (not the pit face). The aspect (compass direction) of the described and sampled pit face, in degrees, will be noted (e.g. if the north pit face is sampled, direction will be 0 degrees).

3.6. NEON has strict data entry requirements and has worked extensively with NRCS database management staff to develop an efficient electronic workflow for submitting, receiving and validating data for this project.

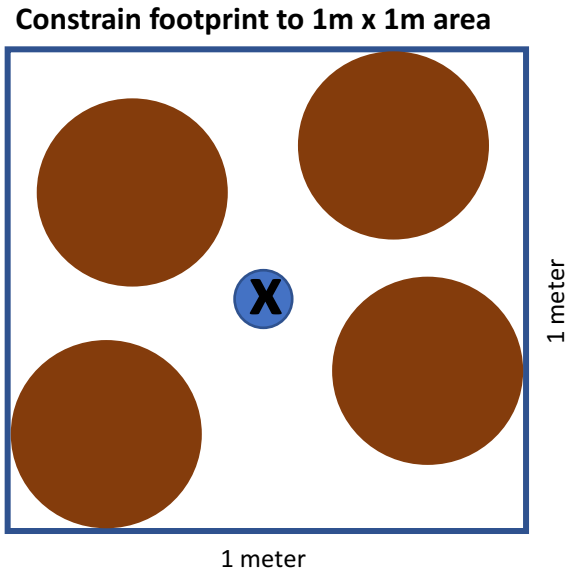
3.6.1. NEON must track the exact locations of every sample collected within the NEON plots. In general, it is assumed that the total disturbed area is limited in surface footprint to the 1x1m surface area of a pit.

3.6.1.1. Spatial data (bearing and distance to reference point) are to be compiled in an Excel spreadsheet, which is located on the NEON Sharepoint site as "NEON_Plot_Location_Datasheet.Rev". Once completed, email to Doug Wysocki.

3.6.1.2. In the event that the footprint of sampling exceeds a 1x1m square of disturbance, every coring location must be separately recorded (see Fig 4).

3.6.1.3. For questions related to data entry in this data sheet or into NASIS, contact Doug Wysocki or Dave Kingsbury.

3.6.2. It is advised that NRCS staff also record the sample location (i.e., area of soil disturbance from NEON's perspective) using a handheld GPS unit for NASIS data entry. A physical marker may also be placed at the center of the pit or core if requested and provided by NEON Domain Manager. NEON will have the southwest plot corner marked; exceptions to this are NEON locations where the site hosts or logistical considerations (e.g., cultivated lands) preempt plot markers. Plot marker details will be conveyed to NRCS staff during the pre-site discussion (i.e., Pre-visit coordination meeting described in Step 3.4) with the Domain Manager.



- Sample up to 16 cores within a plot, but never within the center 20x20m exclusion zone. Collect only as many as required to obtain sufficient material for analysis.
- Whenever possible, keep all core locations within the 1m x 1m square and record the distance and compass bearing from the center of the square (marked with an X in the diagram).
- If *any* core location goes outside of the 1m x 1m square, you *must* record the distance and compass bearing to the nearest reference marker of each core individually.
- Example: You sample 4 cores within a 1m x 1m footprint, but a fifth core location is outside of the footprint. You must enter a distance and compass bearing for all 5 core locations. You cannot treat the 4 core locations within a 1m x 1m footprint as one point.

Figure 4. Guidelines for sampling and data recording when sampling by coring.

4. Distributed Soil Characterization Standard Operating Procedure

4.1. Review the schedule for your site. This information will be available in the "Site schedule.xlsx" document and will be kept up to date by the Key Contract Personnel. **COMMENT:** Step 4.2 may occur before Step 4.1 in some instances, however, do not proceed to Step 4.3 until your site has been released to begin work by the NRCS Point of Contact (Jon Hempel).

4.2. Choose plot locations to sample. The plot locations for each site are provided in the folder: *NEON spatial data*. This folder contains .csv files for each site with plot coordinates, as well as geospatial layers located in the *Boundary and tower shapefiles* folder. The boundary shape files correspond to the boundaries for each NEON site. NRCS soil scientists may choose the best method for selecting the number of plots and which plots to sample in order to assess the range of soil characteristics across the NEON site. To the extent possible, the chosen plots should capture the variability in soil characteristics across the NEON site, which can range in size and complexity. These methods may include examination of available geospatial data

layers (i.e., digital soil maps, digital elevation models, etc.), geology, and satellite image data to target the plots for sampling. Once the soil scientists have evaluated a site and are satisfied with the number of plots and which plots they selected, submit this information (including the data used and sources of those data) to the NRCS POC (Wysocki) who forwards selected sample location to NEON (Lee Stanish) and ARS (Dawn Browning) POCs.

4.3. Once the targeted plots have been approved by NEON POC, the next step is for NRCS staff to contact (via email) the NEON POC to ensure the permits are in process and to notify the Permitting Specialist they are the NRCS staff to be contacted if the site hosts seek information or technical details from NEON.

The permitting specialist will:

4.3.1. Facilitate conversations with the site host. This will determine the allowable method for soil sampling. The permitting team will initiate a request for digging pits, if all other permits are in place (refer to Figure 2). If the site host refuses the proposal to dig pits, sampling with a sharpshooter may be proposed. Otherwise, a borehole via auger will be dug; and

4.3.2. Complete research permits at sites where it is required. NRCS soil scientists should be prepared to provide general information, such as the names and contact information for the field crew, and the expected dates of field work. Each site differs in its requirements, but in general **expect a 3-4 week lag time between initiating this process and beginning fieldwork**.

4.4. Contact the Domain Manager to arrange a Pre-visit Coordination Meeting. The Domain Manager is responsible for managing site activities, such as the regular field sampling, and it is important to coordinate your field activities so as to minimize disturbance to other field activities. Other important questions to ask during the pre-site discussion related to Environmental protection are listed in Section 5.

4.4.1. The Domain Manager will update the Field Calendar on Sharepoint once sampling dates are determined by NRCS staff and the DM.

4.5. **Environmental Health & Safety compliance**. All non-NEON staff who visit a NEON site must comply with the NEON EH&S plan. As an additional resource, NEON has developed comprehensive site-specific plans for each site, which are located in the folder *EHS site specific plans*. These documents contain useful site information that may help field staff when planning a visit, or in case of an emergency.

Table 1. Key documents and resources related to the distributed soils characterization contract are housed on a SharePoint site hosted by NEON. The root file structure is as follows:

Document name	Description	Document Location
Soil Characterization Guidelines.pdf	The guiding document for the soils characterization effort. Describes the contract purpose, sampling methods, standard operating procedures, and contact information for key	NEONsoils/General Information

	personnel.	
Schedule.xlsx	Tracks the schedule for all contract-related activities. This document will be updated regularly by key contract personnel.	NEONsoils/General Information
NEON spatial data/Boundary and Tower Shapefiles/	Folder containing geospatial data for currently constructed NEON sites. New sites will be added periodically.	NEONsoils (root directory)
NEON spatial data/Site information/	Folder containing .csv files of plot coordinates for all current NEON sites. New plot information will be added periodically as new sites complete plot establishment.	NEONsoils (root directory)
NEON Site Specific Information/	Folder containing other site-specific information	Remove or restructure to contain all folders with site specific data (i.e., EH&S). See comment above.
Soils_site-specific_permitting_information.xlsx	Includes site-specific contact information for permitting and domain staff, general permit requirements, and estimated timelines for gaining access to a site.	NEONsoils/General Information
EHS site specific plans/	Folder containing detailed environmental health and safety information for each site.	NEONsoils/NEON site specific information
NEON site evaluation approvals/	Contains formal NEON approval document for proposed sampling plan. For documentation purposes only.	NEONsoils/NEON site specific information

5. NEON site level summary

A narrative summary of soils occurring on the NEON site is to place the sampled soils in the broader context of the soils and geomorphology for the entire NEON site. This is the provide NEON the basis for understanding the variability of soils at the NEON site as well as the representativeness of sampled soils as mentioned in the Task 1 of the Statement of Work. An example of the NEON Site Level Plot Summary for the SCBI site is provided in Appendix 1 of this document.

6. Environmental protection

Rare, threatened, and endangered (RTE) species may occur at NEON sites. Currently available information regarding the likelihood of encountering RTE species at a site will be provided. Additionally, NRCS staff are advised to inquire with the Domain Manager as to the existence of RTE species during their pre-site discussion. Plants and ground-dwelling birds are the most commonly encountered RTE species. Please avoid sampling on or near bird nesting sites or any RTE plant species.

Depending on the time of year, some NEON plots may be inundated with water, which will prevent sampling. Inquire with the Domain Manager during your pre-site discussion as to the current plot conditions and the likelihood of flooding during your anticipated field work.

Appendix 1. NEON Site Level Plot Summary SCBI

Site Background

- The Smithsonian Conservation Biology Institute (SCBI) site is near Front Royal Virginia. The site is in MLRA 130A – Northern Blue Ridge Mountains, near the boundary of MLRA 147 – Ridge and Valley Province. The site consists of 2966 acres and is located in the foothills of the Blue Ridge Mountains.

Site Information

- Elevation ranges from approximately 800 feet to 2000 feet above sea level.
- The parent materials at the SCBI site are residuum, colluvium, and local alluvium derived from Cambrian age crystalline rocks including meta-basalt, greenstone, and gabbro.
- Land use is dominated by forest land, with a few areas cleared for pasture, hay, or other agricultural or general use.
- Plant communities are dominated by oak-hickory forest. Several plots contained Japanese stilt grass.
- Major soil series on the site include Hawksbill, Lew, Montalto, Myersville, Catoctin, and Thurmont.
- Landforms that these soils occur on are residual ridgetops, shoulder slopes, and back slopes, colluvial foot slopes, fans, and benches, and low stream terraces.

P**lot analysis and for Sampling**

Soil map unit, geology, landform, and major vegetative communities were four features identified for each plot during the pre-analysis. Each unique combination of these four features was labeled as a landform setting. The landforms identified on the SCBI site were residual ridgetops, shoulder slopes, and back slopes; colluvial foot slopes, fans, and benches; and low stream terraces. Soil mapping consisted of 19 different map units (including water), but the pre-selected sampling plots occurred in only 10 of the map units. The analysis resulted in 18 plots being selected for field description, field sampling, and lab characterization. The 16 plots not sampled either occurred in non-typical settings or were duplicates of one of the 18 chosen plots.

- Roughly 9 percent of the Neon site area (47% of the site's total map units) at SCBI consisted of map units that were not sampled. These include:

Mapunit Sym	Mapunit Name	% Total Site Area
11E	Chester-Manor complex, 25 to 60 percent slopes, very stony	0.23
20B	Hawksbill very cobbly loam, 2 to 7 percent slopes, occasionally flooded	0.22
31C	Myersville-Catoctin silt loams, 7 to 15 percent slopes, very stony	0.44
31E	Myersville-Catoctin silt loams, 25 to 65 percent slopes, very stony	5.79
37D	Rigley-Weikert-Berks complex, 15 to 25 percent slopes, very stony	1.08
3C	Buchanan fine sandy loam, 7 to 15 percent slopes	0.17
8D	Cataska channery silt loam, 15 to 25 percent slopes	0.46
8E	Cataska channery silt loam, 25 to 65 percent slopes	0.06

W	Water		0.08
		Total	8.53

- Sampled map units represent approximately 91 percent of the Neon site area (53% of the site's total map units):

Mapunit Sym	Mapunit Name		% Total Site Area
32C	Myersville and Montalto soils, 7 to 15 percent slopes, very stony		2.78
32D	Myersville and Montalto soils, 15 to 25 percent slopes, very stony		11.69
32E	Myersville and Montalto soils, 25 to 65 percent slopes, very stony		18.55
31D	Myersville-Catoctin silt loams, 15 to 25 percent slopes, very stony		8.39
21D	Lew channery loam, 7 to 25 percent slopes		1.87
22E	Lew loam, 25 to 65 percent slopes, very stony		20.48
29C	Montalto loam, 7 to 15 percent slopes		6.50
30C	Myersville silt loam, 7 to 15 percent slopes		8.67
30D	Myersville silt loam, 15 to 25 percent slopes		7.70
19B	Hawksbill cobbly loam, 2 to 7 percent slopes, occasionally flooded		4.83
		Total	91.47

The selected sample plots are representative of the map units in which they occur. They fall within the Range in Characteristics (RIC) of the individual major component with the exception of a few outliers (noted below). The random plot selection method missed several landform positions within map units, and missed much of the colluvium and alluvium on the site. Although these areas are of minor extent to the overall site they are important for establishing the variability of the soils at the SCBI location.

Plot Findings

The eighteen pedons sampled represent 10 soil map units. The major components are Montalto, Myersville, Lew, Catoctin, and Hawksbill. Most of the plots sampled were forested (73%). Secondary land use was pasture or grassland (27%).

Landforms – Plots SCBI_004, 005, 006, 011, 013, 014, 017, 019, 021, 034, 035, and 037 consist of soil formed in residuum, Plots SCBI_002, 008, 010, 022, and 043 formed in colluvium. Plots SCBI_007 formed in alluvium over colluvium. Sampled plots were 67% residuum, 28% colluvium and 5% alluvium.

Soils –

The soils sampled under forest cover generally had organic horizons that were very thin. These horizons ranged from 1 to 5 cm in thickness. The multiple O horizons are not accounted for in the aggregated NASIS data. They were sampled for organic matter and bulk density following normal protocols where surface stoniness allowed.

Sampled soils were dominantly Myersville (10 samples) on the residual ridgetops and side slopes (SCBI_006, 011, 013, 014, 017, 019, 021, 022, 034, 035). These soils developed in residuum and are 1 to 1.5 meters to bedrock. These soils have an increase in clay content in the subsoil (i.e. an argillic horizon) and are fine-loamy, with field estimated clay content ranging from about 24 to 39 percent.

Of the pedons sampled as Myersville two stand out as being outside the normal range in characteristics of the series. SCBI_019 is moderately well drained as opposed to being well drained. SCBI_014 is a taxadjunct to the series (classifies differently) because it contains more rock fragments than a normal Myersville. Additionally, one of the Myersville samples came from a minor component position in a Lew map unit (SCBI_022).

The second most common soil series was Lew (5 samples) on colluvial side slopes (SCBI_005, 007, 008, 010, 043). These soils developed in colluvium and are greater than 1.5 meters to bedrock. Lew soils have an increase in clay content in the subsoil and are loamy-skeletal (rock fragments generally comprise more than 35 % of the subsoil). Field estimate clay content ranges from 17 to 30% in the subsoil and the volume of rock fragments increases with depth. Two of the Lew samples came from map units that did not have Lew as a major component. One came from a Myersville – Catoctin complex map unit (SCBI_005) and one came from a Hawksbill cobbly loam map unit (SCBI_007). Plot SCBI_007 has a lithologic discontinuity since there is a significant color change between the Bt1 and 2Bt2 horizons that could indicate older parent material in the C horizon. This does not affect the use and management of the soil. SCBI_008 has a lithologic discontinuity since there is a distinct rock fragment volume and fragment size increase in the C horizon. This does not affect the use and management of the soil. SCBI_005 has a lithologic discontinuity in that there is a clay increase from 23% to 38% clay in the 2Bt horizon.. The argillic horizon in this pedon begins at greater depth than is typical in Lew. The lower clay content of the upper horizons of SCBI_005 will impact water holding capacity, available water, and fertility of the soil. It should be pointed out that lithologic discontinuities are somewhat common in soils forming from colluvium in this area.

Two samples of Montalto were collected on residual ridgetops and side slopes (SCBI_004, 007). These soils develop in residuum and are greater than 1.5 meters to bedrock. These soils have an increase in clay content in the subsoil and are fine, with field estimated clay content ranging 35 to 43 percent in the subsoil. SCBI_037 has an increase in rock fragments that is higher than the normal range for Montalto. SCBI_004 falls within the RIC for the Montalto soil series.

One of the plots (SCBI_007) fell within a Hawksbill cobbly loam, 2 to 7 percent slopes, occasionally flooded map unit, but the soil identified was Lew. Lew differs from Hawksbill in that it is deeper and more acidic than Hawksbill. Lew soils form mainly in colluvium weathered from greenstone, while Hawksbill soils form mainly in colluvium or alluvium weathered from greenstone, sandstone, and phyllite.

One plot (SCBI_002) was located in a Lew loam, 25 to 65 percent slopes, very stony map unit, but was identified as a Thurmont soil. Thurmont is a very deep well drained soil, fine-loamy soil. Thurmont soils form in alluvium and colluvium from mixed metamorphic rocks. Depth to bedrock is greater than 1.5 meters. Field estimated clay content increased with depth, ranging from 20% in the surface horizon to 30% in the Bt2 horizon. Redoximorphic features occur in the Bt horizon due to prolonged saturation in the profile. This pedon is a good representation of Thurmont and falls within the RIC of the series.

Appendix 2: Example NEON plot evaluations.
Note that the tables have been truncated to reduce space.

Example #1: Smithsonian Conservation Biology Institute (SCBI) Pre-Analysis

This NEON site has relatively high relief, distinct landforms, uniform geology, and relatively detailed soil mapping. The SCBI site is within MLRA 130A (Northern Blue Ridge Mountains) in northern Virginia and consists of 2966 acres. Parent materials consist of residuum, colluvium, and local alluvium weathered or derived from Cambrian age crystalline rocks including meta-basalt, greenstone, and gabbro.

The pre-analysis was conducted utilizing available soils, geology, landform, and vegetative community information. These four features were identified for each plot. Each unique combination of these four features was labeled as a 'setting'. Plots that represented a unique setting were identified and chosen for sampling. Where multiple plots occurred in the same setting, plot access (a logistically-based factor) was considered to choose the sample plot.

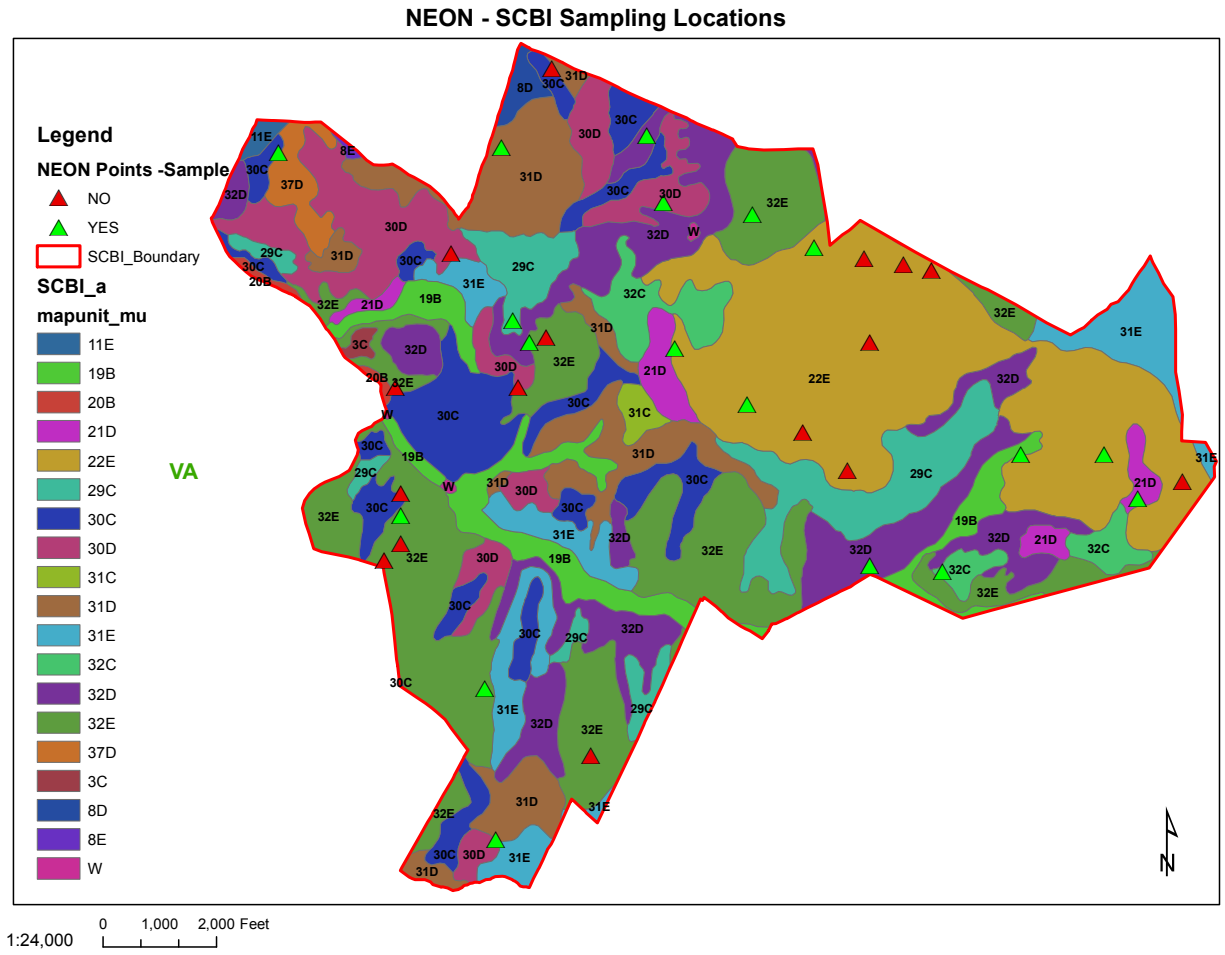
Supporting information used in the pre-analysis included NRCS Official Series Descriptions (OSD); the local soil survey report; 2014 FSA NAIP Ortho Imagery; NRCS 2015 Web Soil Survey data and maps; Digital Raster Graphic image from USGS topographic maps; USGS Geologic information of the Front Royal Quadrangle; hillshade derived from USGS 10m DEM data; and the NEON Site Boundary and NEON plot locations provided by NEON. Since USGS geologic mapping was coarse (less detailed), this layer provided little differentia for decision-making.

Landforms identified on the SCBI site were residual ridgetops, shoulder slopes, and back slopes; colluvial foot slopes, fans, and benches; and low stream terraces. Soil mapping consisted of 19 different map units (including water), but the pre-selected sampling plots were located in only 11. The attached SCBI documents (spreadsheet and pdf's) provide examples of this process.

The analysis resulted in 18 plots being selected for sampling. The 16 plots not chosen for sampling either occurred in non-typical settings or were adequately represented in one of the 18 chosen plots.

Additional plots were selected (about 15 to 20% of the total) as backup plots in the event that on-site difficulties were encountered. These backup plots were selected for settings where less represented components were located since an on-site plot rejection for one of these plots might completely remove that component from the sampling plan. The backup plots also help ensure that the minimum number

of plots required per site (e.g. 10) are sampled in instances when some of the primary plots cannot be sampled (ARS/NEON may question why fewer plots were sampled than planned).



Plot ID	Plot Type	mu	mapunit__1	Acres	Sample YES/NO	Reasoning
SCBI_007	Dist	19B	Hawksbill cobbly loam, 2 to 7 percent slopes, occasionally flooded	107.241246	YES	We selected sample points by mapunit. Within each mapunit we selected major vegetation types. Within each mapunit and vegetation type we selected the major landforms: ex: Footslope vs sideslope or shoulder vs summit. These selected points will capture the variability of the overall site. Any points marked no were rejected because they replicate a site that will be sampled, or are on a nonrepresentative landform position for the soil series.
SCBI_022	Dist	21D	Lew channery loam, 7 to 25 percent slopes	13.301272	YES	
SCBI_002	Dist	22E	Lew loam, 25 to 65 percent slopes, very stony	607.48525	YES	
SCBI_008	Dist	22E	Lew loam, 25 to 65 percent slopes, very stony	607.48525	YES	
SCBI_010	Dist	22E	Lew loam, 25 to 65 percent slopes, very stony	607.48525	YES	
SCBI_043	Dist	22E	Lew loam, 25 to 65 percent slopes, very stony	607.48525	YES	
SCBI_037	Dist	29C	Montalto loam, 7 to 15 percent slopes	42.960922	YES	
SCBI_019	Dist	30C	Myersville silt loam, 7 to 15 percent slopes	9.010203	YES	
SCBI_006	Dist	30D	Myersville silt loam, 15 to 25 percent slopes	34.149679	YES	
SCBI_014	Dist	30D	Myersville silt loam, 15 to 25 percent slopes	10.988806	YES	
SCBI_049	Tower	22E	Lew loam, 25 to 65 percent slopes, very stony	607.48525	NO	
SCBI_067	Tower	22E	Lew loam, 25 to 65 percent slopes, very stony	607.48525	NO	
SCBI_016	Dist	30C	Myersville silt loam, 7 to 15 percent slopes	8.772763	NO	Sample plot crosses soil boundary
SCBI_040	Dist	30C	Myersville silt loam, 7 to 15 percent slopes	16.019639	NO	Sample plot crosses soil boundary
SCBI_039	Dist	30D	Myersville silt loam, 15 to 25 percent slopes	111.800348	NO	

SCBI_012	Dist	32E	Myersville and Montalto soils, 25 to 65 percent slopes, very stony	26.486341	NO	
SCBI_018	Dist	32E	Myersville and Montalto soils, 25 to 65 percent slopes, very stony	100.314751	NO	
SCBI_033	Dist	32E	Myersville and Montalto soils, 25 to 65 percent slopes, very stony	41.412985	NO	Sample plot crosses soil boundary
SCBI_042	Dist	32E	Myersville and Montalto soils, 25 to 65 percent slopes, very stony	185.854069	NO	

Example #2: Dead Lake (DELA) Pre-Analysis

This NEON site is an area with broad landforms and fairly uniform geology. Soils were fairly homogenous (i.e. not highly variable). The DELA site is MLRA 133A (Southern Coastal Plains) Hale County, Alabama and consists of 1010 acres. Parent material consists of recent and older alluvium along the Alabama River with elevations ranging from 68 to 72 meters. The Alabama River geology is labeled as "Low Stream Terrace and Alluvium."

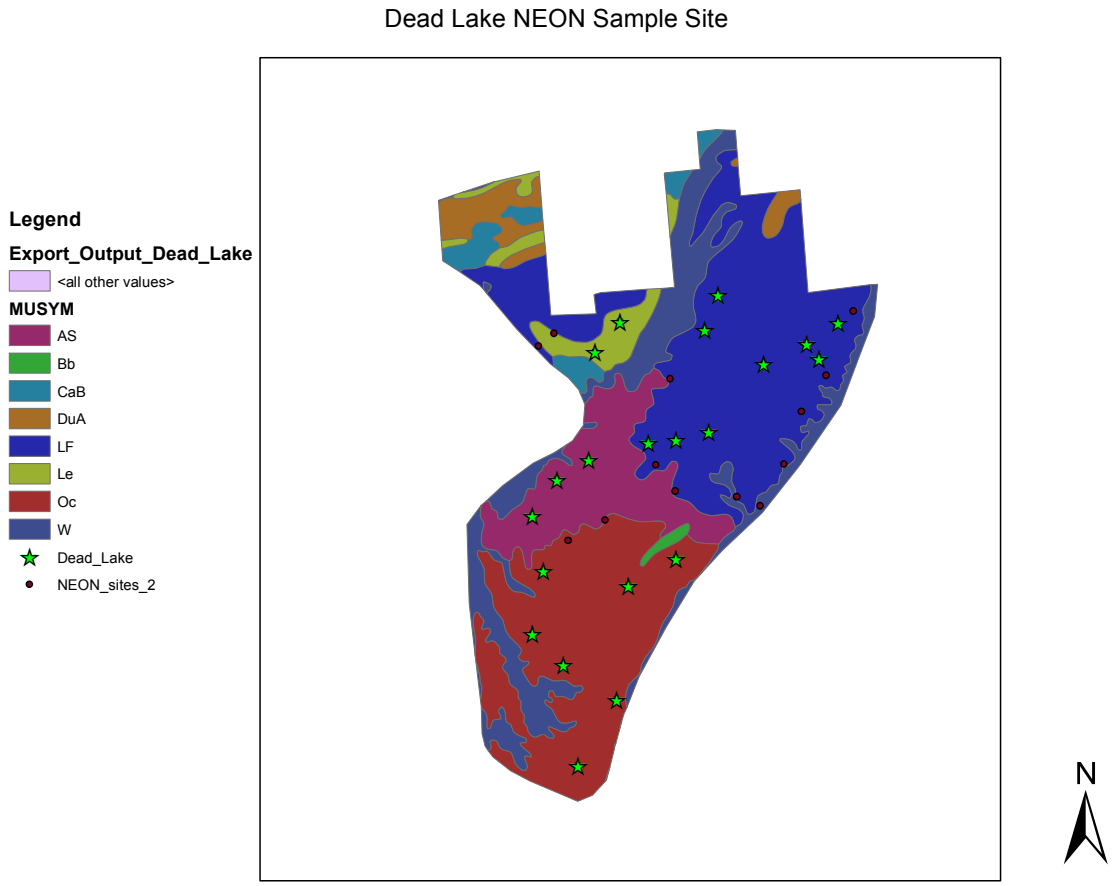
In this example, the number of plots sampled per map unit was based on the percentage of the map unit within the NEON site. For example, if the map unit acreage equals 40 percent of the site, then roughly 40 percent of the sample plots were selected from that map unit.

Plot locations were generally chosen to be representative of map unit delineations and to ensure relatively even plot distribution across the site. To accomplish this, spatial analysis of plot distribution was conducted. This analysis improves the likelihood of sampling soils that are more representative of the map unit delineations.

The number of plots selected for sampling should be enough to adequately represent the map units or map unit components that were included in the 34 pre-selected plot locations (i.e. fewer plots may be sufficient to represent map units of smaller proportionate extent). The provided example (I.e., Dead_Late_Pre_Analysis.xlsx) illustrates this. The table below the individual plots provides a summary of map units represented, map unit proportionate extent, and total numbers of plots selected for each

map unit. A spatial representation of the sample plots is provided (i.e., Dead_Lake_Spatial.pdf). For the DELA site, 21 sample plots were selected.

Also, if map units of moderate or large extent were not included in the pre-selected plots, then plots representing the same component, or similar component, may be favored in the sampling plan.



Plot_ID	Plot_Type	Latitude	Longtitude	MU	Sample YES/NO
DELA_002	distributed	32.532316	-87.818742	AS	YES
DELA_003	distributed	32.534774	-87.81525	AS	YES
DELA_009	distributed	32.53395	-87.817159	AS	YES
DELA_008	distributed	32.539922	-87.814338	LE	YES
DELA_038	tower	32.542134	-87.80701	LF	YES
DELA_040	tower	32.538631	-87.804742	LF	YES
DELA_010	distributed	32.540283	-87.800284	LF	YES
DELA_020	distributed	32.538651	-87.801547	LF	YES
DELA_014	distributed	32.529612	-87.818398	OC	YES

DELA_029	distributed	32.529662	-87.810731	OC	YES
DELA_019	distributed	32.536207	-87.802803	LF	NO
DELA_001	distributed	32.531859	-87.80564	W	NO
DELA_017	distributed	32.532392	-87.806922	W	NO
DELA_022	distributed	32.54099	-87.816584	LE	NO

MU SYM	Acres	Percent Total Acres	Sites per MU	Minimum # of sites to sample	Sites Selected to sample
LF	355	35	17	6.0	9
Oc	258	26	9	2.3	7
AS	129	13	3	0.4	3
Le	41	4	3	0.1	2
Water	157	16	2	0.3	0
Bb	3	0	0	0.0	0
CaB	29	3	0	0.0	0
DuA	38	4	0	0.0	0
Total	1010		34		