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## National Wetland Condition Assessment 2021

# Field Operations Manual

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## Notice

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The objective of the National Wetland Condition Assessment (NWCA) 2021 project is to describe the ecological condition of the nation's wetlands and stressors commonly associated with poor condition. The complete documentation of overall project management, design, methods, and standards is contained in companion documents, including:

National Wetland Condition Assessment 2021: Quality Assurance Project Plan (EPA 843-B-21-004)  
National Wetland Condition Assessment 2021: Laboratory Operations Manual (EPA 843-B-21-003)  
National Wetland Condition Assessment 2021: Site Evaluation Guidelines (EPA 843-B-21-001)

This document (Field Operations Manual) contains a brief introduction to the project and procedures to follow at the base location (i.e., a Field Crew's home base of operation) and on-site at the field sampling location, including methods for sampling vegetation, soils, hydrology, water chemistry (including chlorophyll-*a*), microcystin, and physical alterations. Methods described in the National Wetland Condition Assessment: Field Operations Manual (FOM) are to be used specifically in work related to the National Wetland Condition Assessment (NWCA). Mention of trade names or commercial products in the document does not constitute endorsement or recommendation for use.

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## Acronyms/Abbreviations

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AA	Assessment Area
AV	Assistance Visit
WCHL	chlorophyll-a sample
CPR	cardiopulmonary resuscitation
CRAM	California Rapid Assessment Method
CWA	Clean Water Act
DBH	diameter at breast height
DI	deionized
DNA	deoxyribonucleic acid
DO	dissolved oxygen
DOC	dissolved organic carbon
EMAP	Environmental Monitoring and Assessment Program
EPA	U.S. Environmental Protection Agency
ETOH	ethyl alcohol
FLC	Field Logistics Coordinator
FOM	Field Operations Manual
GIS	geographic information system
GPS	global positioning system
GRTS	Generalized Random Tessellation Stratified (survey)
HDPE	high density polyethylene
HGM	Hydrogeomorphic
H <sub>2</sub> S	hydrogen sulfide
HQ	Headquarters
IM	Information Management
LRR	Land Resource Regions
LOM	Lab Operations Manual
MICX	microcystin sample
MLRA	Major Land Resource Area
NARS	National Aquatic Resource Surveys
NH <sub>4</sub>	ammonium
NO <sub>2</sub>	nitrite
NO <sub>3</sub>	nitrate
NRCS	Natural Resources Conservation Service
NWCA	National Wetland Condition Assessment
NWI	National Wetland Inventory
PDOP	Position Dilution of Precision
QA	quality assurance
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QRG	Quick Reference Guide
SDSC	Standard Depth Soil Core
SEG	Site Evaluation Guidelines
SHBD	soil horizon bulk density sample
SHCH	soil horizon chemistry sample
SISO	Soil isotope sample
SOP	Standard Operating Procedure
S&T	U.S. Fish and Wildlife Service's Wetland Status and Trends
TES	Threatened, Endangered and Sensitive Species

TN	total nitrogen
TP	total phosphorus
VEGQ	QA plant sample
VEGU	unknown plant sample
USFWS	U.S. Fish and Wildlife Service
USDA	United States Department of Agriculture
USGS	United States Geological Survey

## Chapter 1 Overview

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### 1.1 Background

This manual describes field protocols and daily operations for the National Wetland Condition Assessment (NWCA). The NWCA is one in a series of statistically valid National Aquatic Resource Surveys (NARS) conducted by the U.S. Environmental Protection Agency (EPA) to provide the public with a comprehensive assessment of the condition of the Nation's waters. In addition to wetlands, these NARS sample coastal waters, lakes, and flowing waters in a revolving sequence.

EPA will collaborate with state, tribal, federal, and other partners to implement the NWCA to meet three goals:

1. Estimate the current condition of the nation's wetlands with known statistical confidence using selected ecological indicators.
2. Identify the relative importance of key stressors.
3. Assess changes and trends in the condition of wetlands between NWCA 2011 and 2016.

NWCA is also designed to help expand and enhance state monitoring programs. Through these assessments, states and tribes have the opportunity to collect data which can be used to supplement their existing monitoring programs or to begin development of new programs. Development of the NWCA builds on the accomplishments of the U.S. Fish and Wildlife Service (USFWS) and their production of national reports on status and trends in wetland acreage. When taken together, the results from the NWCA and the USFWS *Wetland Status and Trends (S&T)* will be used to measure progress toward attainment of the national goal to increase the quantity and quality of the Nation's wetlands. These complementary studies can influence how wetlands are managed at local, state, and national scales (Scozzafava et al. 2007).

### 1.2 Survey Design

#### 1.2.1 Target Population

The target population for NWCA 2021 is tidal and nontidal wetlands of the conterminous U.S., including certain farmed wetlands not currently in crop production. The wetlands have rooted vegetation and, when present, open water less than 1 meter deep. A wetland's status under state or federal regulatory programs does not affect a site's status as target for the purposes of NWCA.

#### 1.2.2 Sample Frame

Wetland sampling locations were chosen through a survey design consisting of two components: 1) sites from the prior NWCA survey in 2016; and; 2) new sites drawn from a sample frame utilizing USFWS National Wetland Inventory (NWI) digitized maps of wetland types and locations (<http://www.fws.gov/wetlands/>), or state-provided wetland maps comparable to NWI (MN, MT). NWCA processed the NWI data by assigning wetland polygons to states and within each state assigning them to the NARS nine aggregated ecoregions. In addition, the detailed wetland classes were categorized into seven wetland types of interest to NWCA:

- E2EM- Estuarine Intertidal Emergent.

- E2SS- Estuarine Intertidal Forest or Shrub.
- PEM-Palustrine Emergent.
- PSS- Palustrine Shrub.
- Pf- Palustrine Farmed.
- PFO- Palustrine Forested.
- PUBPAB- Palustrine Unconsolidated Bottom/ Palustrine Aquatic Bed.

and five wetlands types not included:

- EOTH – Estuarine Other Wetlands.
- M1M2 – Marine Wetlands.
- LOTH – Lacustrine Other Wetlands.
- POTH – Palustrine Other Wetlands.
- ROTH – Riverine Other Wetlands.

The former are included as they are likely to result in sites that would meet the NWCA target population and the latter are excluded as they are unlikely to result in sites that would meet the NWCA target population. Cowardian wetland classes were assigned to each NWCA wetland type by two wetland ecologists.

### *1.2.3 Selection of Sampling Locations*

Sites were randomly selected from the NWCA sample frame using a spatially balanced Generalized Random Tessellation Stratified (GRTS) survey design for an area resource, with each point having a known probability of being sampled (Stevens and Olsen 2004). The GRTS design ensures the sample is representative of wetland resources at national and regional scales. Using this approach, 904 wetland assessment locations were selected from across the conterminous U.S., consisting of 269 resample sites from NWCA 2016 and 635 new sites. Ninety-six of the 904 sites are sampled twice within the index period to quantify variability in sampling; these sites are referred to as revisit sites. In addition, a pool of oversample sites was selected for use as replacements if any of the 904 assessment locations are not sampleable. The selected sites are distributed across seven target wetland types defined for the NWCA (see NWCA Target Wetland Types, below and Table 1-1) and 10 geographic areas (see Reporting Units, below and Figure 1-1). In addition, some states invest resources to supplement the NWCA survey design by adding sites to allow state-scale reporting of wetland quality.

### *1.2.4 NWCA Target Wetland Types*

For the 2021 NWCA, the seven target wetland types are described in Table 1-1. The NWCA Target Wetland Types are based on specific S&T wetland categories and NWI wetland classes from the sample frame that fall under the NWCA Target Population. Table 1-1 also provides a crosswalk among the codes for NWCA Target Wetland Types (used in design documents and in forms and field App), S&T wetland categories, and NWI classes.

**Table 1-1. NWCA Target Wetland Types and crosswalk to US Fish & Wildlife Service (USFWS) Status & Trends (S&T) wetland categories and USFWS National Wetland Inventory (NWI) wetland classes (Ref Card AA-3, Side A).**

<b>NWCA Target Wetland Type (Design Code)</b>	<b>NWCA Target Wetland Type (Form/App Code)</b>	<b>NWCA Target Wetland Type Description</b>	<b>S&amp;T Wetland Categories*<sup>1</sup></b>	<b>Included NWI Classes: Systems/Subsystems<sup>2</sup></b>
<b>E2EM</b>	<b>EH</b>	Estuarine Emergent	<i>E2EM</i> - Estuarine Intertidal Emergent	<i>Emergent and Aquatic Bed Classes in Estuarine/Intertidal Subsystems</i>
<b>E2SS</b>	<b>EW</b>	Estuarine Shrub/Forest	<i>E2SS</i> - Estuarine Intertidal Forest or Shrub	<i>Forested and Scrub-Shrub Classes in Estuarine/Intertidal Subsystems</i>
<b>PEM</b>	<b>PRL-EM</b>	Palustrine, Riverine, and Lacustrine - Emergent	<i>PEM</i> - Palustrine Emergent	<i>Emergent Classes in Palustrine Systems; Shallow Riverine/Tidal, Lower Perennial, Upper Perennial, or Intermittent Subsystems; and Shallow Lacustrine/Littoral Subsystems</i>
<b>PUBPAB</b>	<b>PRL-UBAB</b>	Palustrine, Riverine, and Lacustrine - Unconsolidated Bottom/Aquatic Bed	<i>PUB</i> - Palustrine Unconsolidated Bottom  <i>PAB</i> - Palustrine Aquatic Bed	<i>Unconsolidated Bottom, Aquatic Bed Unconsolidated Shore, Rock Bottom, and Rocky Shore Classes in Palustrine Systems; Shallow Riverine/Tidal, Lower Perennial, Upper Perennial, or Intermittent Subsystems; and Shallow Lacustrine/Littoral Subsystems</i>
<b>Pf</b>	<b>PRL-f</b>	Palustrine, Riverine, and Lacustrine - Farmed	<i>Pf</i> - Palustrine farmed	<i>Farmed Modifier in Palustrine Systems; Shallow Riverine/Tidal, Lower Perennial, Upper Perennial, or Intermittent Subsystems; and Shallow Lacustrine/Littoral Subsystems</i>
<b>PSS</b>	<b>PRL-SS</b>	Palustrine, Riverine, and Lacustrine - Shrub/Scrub	<i>PSS</i> - Palustrine Shrub	<i>Scrub-Shrub Classes in Palustrine Systems; Shallow Riverine/Tidal, Lower Perennial, Upper Perennial, or Intermittent Subsystems; and Shallow Lacustrine/Littoral Subsystems</i>
<b>PFO</b>	<b>PRL-FO</b>	Palustrine, Riverine, and Lacustrine - Forested	<i>PFO</i> - Palustrine Forested,	<i>Forested Classes in Palustrine Systems; Shallow Riverine/Tidal, Lower Perennial, Upper Perennial, or Intermittent Subsystems; and Shallow Lacustrine/Littoral Subsystems</i>
<p><b>*IMPORTANT NOTE:</b> Status and Trends (S&amp;T) category names DO NOT precisely equate to National Wetland Inventory (NWI) Codes for wetland type. S&amp;T categories often aggregate multiple NWI types.</p> <p><sup>1</sup>Dahl TE, Bergeson MT (2009) Technical procedures for conducting status and trends of the Nation's wetlands. U.S. Fish and Wildlife Services, Division of Habitat and Resource Conservation, Washington, D.C., p 74.</p> <p><sup>2</sup>US Fish and Wildlife Service, National Wetlands Inventory, Wetland Classification Codes. <a href="https://www.fws.gov/wetlands/Data/Wetland-Codes.html">https://www.fws.gov/wetlands/Data/Wetland-Codes.html</a>. Accessed November 2020.</p>				

### 1.2.5 Reporting Units

NWCA 2021 is based on 17 reporting units associated with 10 geographic areas. Inland wetland regions are based on nine NARS aggregated ecoregions where the Upper Midwest and Northern Appalachians are combined to form the North Central East region and the Northern Plains and Southern Plains are combined to form the Great Plains region. Estuarine wetland coastal regions are the Pacific Coast, Gulf and Florida Coast, and the Atlantic Coast. The inland reporting regions are then divided by herbaceous and woody wetland types. The survey design allows EPA to report on national conditions for all wetlands in the target population by NWCA wetland group (estuarine, inland herbaceous, inland woody), by NWCA geographic area (Figure 1-1), and by reporting unit (Table 1-2). It may also be possible to report on other geographically derived assessment units, yet to be determined, or by other classifications, such as Hydrogeomorphic (HGM) wetland class (Brinson 1993). In addition, states and tribes that are able to invest additional resources will have the opportunity to leverage EPA design and logistical support to produce a state or tribal-scale assessment.

## 2021 National Wetland Condition Assessment Design

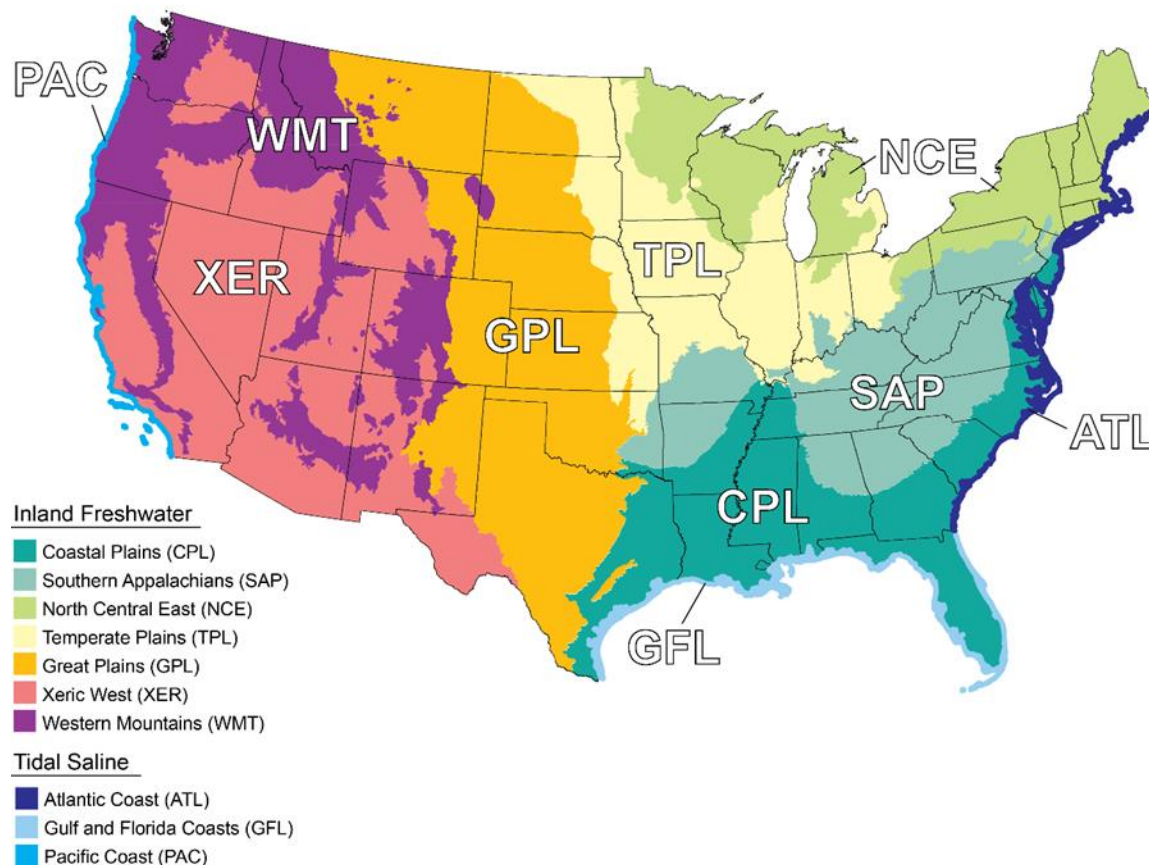


Figure 1-1. Ten geographic areas used in survey design and for reporting on wetland condition in NWCA

**Table 1-2. Description of the 17 reporting units incorporated into the survey design for NWCA**

<b>NWCA Reporting Unit Code</b>	<b>NWCA Reporting Unit Description</b>
<b>CPL-PRLH</b>	<i>Coastal Plains - Palustrine, Riverine, and Lacustrine (PRL) Herbaceous Wetlands</i>
<b>CPL-PRLW</b>	<i>Coastal Plains - Palustrine, Riverine, and Lacustrine (PRL) Woody Wetlands</i>
<b>GPL-PRLH</b>	<i>Great Plains - Palustrine, Riverine, and Lacustrine (PRL) Herbaceous Wetlands</i>
<b>GPL-PRLW</b>	<i>Great Plains - Palustrine, Riverine, and Lacustrine (PRL) Woody Wetlands</i>
<b>NCE-PRLW</b>	<i>North Central East - Palustrine, Riverine, and Lacustrine (PRL) Herbaceous Wetlands</i>
<b>NCE-PRLH</b>	<i>North Central East - Palustrine, Riverine, and Lacustrine (PRL) Woody Wetlands</i>
<b>SAP-PRLW</b>	<i>Southern Appalachians - Palustrine, Riverine, and Lacustrine (PRL) Herbaceous Wetlands</i>
<b>SAP-PRLH</b>	<i>Southern Appalachians - Palustrine, Riverine, and Lacustrine (PRL) Woody Wetlands</i>
<b>TPL-PRLH</b>	<i>Temperate Plains - Palustrine, Riverine, and Lacustrine (PRL) Herbaceous Wetlands</i>
<b>TPL-PRLW</b>	<i>Temperate Plains - Palustrine, Riverine, and Lacustrine (PRL) Woody Wetlands</i>
<b>WMT-PRLH</b>	<i>Western Mountains - Palustrine, Riverine, and Lacustrine (PRL) Herbaceous Wetlands</i>
<b>WMT-PRLW</b>	<i>Western Mountains - Palustrine, Riverine, and Lacustrine (PRL) Woody Wetlands</i>
<b>XER-PRLH</b>	<i>Xeric West - Palustrine, Riverine, and Lacustrine (PRL) Herbaceous Wetlands</i>
<b>XER-PRLW</b>	<i>Xeric West - Palustrine, Riverine, and Lacustrine (PRL) Woody Wetlands</i>
<b>ATL_EST</b>	<i>Estuarine Wetlands occurring across the Atlantic coastal regions of the conterminous US</i>
<b>GFL_EST</b>	<i>Estuarine Wetlands occurring across the Gulf and Florida coastal regions of the conterminous US</i>
<b>PAC_EST</b>	<i>Estuarine Wetlands occurring across the Pacific coastal regions of the conterminous US</i>



### 1.3 Overview of Indicators

Multiple indicators will be assessed in the NWCA to maximize the potential of detecting anthropogenic stress and describing its potential effect on wetland condition across multiple spatial scales. The choice of NWCA field methods and indicators was influenced by considerations of timing and resources, such as the need to complete travel and sampling for each site in one day. The indicators to be evaluated will include:

- vegetation;
- physical alterations;
- hydrology;
- soils;
- surface water chemistry; and
- algae.

A summary of each indicator and its relation to wetland condition is provided below.

**Vegetation** will be characterized by collecting plant data in five 100-m<sup>2</sup> Vegetation Plots systematically placed across the Assessment Area (AA). Vegetation is a major component of biodiversity found in wetlands and is habitat for a myriad of organisms. The composition and abundance of plant species both reflects and influences the hydrology, water chemistry, and soil characteristics of a wetland. Plants respond to and reflect physical, chemical, or biological disturbances and stressors (Selinger-Looten et al. 1999, Rayamajhi et al. 2006). The presence and abundance of alien plant species often reflect degraded or declining wetland quality. In addition, plant data can be used to derive numerous metrics or indicators that are useful descriptors of ecological integrity or stress (e.g., USEPA 2002b, Bourdaghs et al. 2006, Magee et al. 2008, Mack and Kentula 2010, USEPA 2016, Magee et al. 2019a, b). Examples of the types of vegetation data to be collected are:

- species composition and abundance;
- native species;
- alien species;
- floristic quality;
- guild composition;
- community composition; and
- vegetation structure.

**Physical alteration** data will be collected within the entire AA and at twelve 100-m<sup>2</sup> Buffer Sample Plots laid out along four, 145-m cardinal transects that begin at the AA CENTER and cross into the buffer at the AA boundary. The Buffer Sample Plots are arranged so that they can be given weights for proximity analysis. Human-mediated *physical alterations*, defined as modifications or damage caused directly by humans or consequentially from anthropogenic activities (e.g., raising livestock) or human pressures (e.g., land use encroachment, fire suppression), may occur in the Assessment Area (AA) and/or in the surrounding buffer. In the case of the NWCA, the *buffer* is a prescribed measurement area or discrete zone (e.g., riparian buffer or GIS buffer) that surrounds the perimeter of the AA. The buffer may encompass wetland or upland, natural vegetation cover, or human land uses. Information about what surrounds the AA and the degree of physical alteration is important for characterizing the POINT and associated AA. Observations of physical alterations that affect the vegetation, hydrology, and soil in both the AA and in the buffer indicate disturbances and possible stress to the wetland ecosystem. These data

are necessary for an assessment of wetland condition to place the AA on a gradient of disturbance relative to a reference standard. Examples of the types of physical alteration data to be collected in the AA and buffer are:

- vegetation removal;
- vegetation replacement;
- water addition and/or subtraction;
- flow obstruction;
- soil hardening; and
- surface modification.

**Soils** data will be collected in a 3-meter diameter Soil Plot and include a soil profile description and collection of soil samples for laboratory analysis of physical and chemical properties. Soils cycle nutrients, mediate groundwater movement and storage, and serve as a growth medium or habitat for plants, microbes, and macroinvertebrates. Soil physical and chemical characteristics can be indicative of hydrology, past and present land uses, and the health and condition of the soil (which impacts its ability to perform important ecosystem services). Examples of the types of soils data to be collected are:

- soil morphological and physical characteristics (soil profile description);
- soil chemistry (including isotopes) and bulk density;
- hydric soil field indicators; and
- depth to water table.

**Hydrology** data will include an assessment of hydrologic sources and connectivity, indirect evidence of hydroperiod, and estimates of hydrologic fluctuations. Wetland hydrology is the primary driver of wetland formation and persistence. Hydrology impacts soil geochemical dynamics, plant productivity, nutrient cycling, and accretion and erosion of organic and inorganic materials in wetlands (Mitsch and Gosselink 2007, Tiner 1999). Examples of the types of hydrology data to be collected are:

- hydrologic sources and connectivity; and
- evidence of saturation and inundation.

**Surface water** conditions will be recorded and **water chemistry** samples collected (where possible) to assess general surface water conditions, various chemical analytes, and evidence of disturbance. Total nitrogen (TN) and phosphorus (TP) reflect the trophic state of the wetland, providing crucial information on possible eutrophication (Keddy 1983). Anthropogenic disturbances such as hydrologic modifications and land use changes are known to alter water chemistry variables (Lane and Brown 2007; Reiss and Brown 2005).

**Chlorophyll-*a*** and **microcystin** samples will be collected from water (planktonic samples) if surface water is present. Algae respond rapidly to ecological change in wetlands and have been widely used as indicators of wetland condition because of their rapid reproduction rates, short life cycles, and broad distribution (McCormick and Cairns 1994). More notably, because nutrients such as nitrogen and phosphorus are limiting factors to most types of algae, they respond quickly to excess nutrients. The samples collected will provide data on the presence of microcystin (a class of toxins produced by bluegreen algae) toxins and algal productivity (based on chlorophyll-*a* levels).

## 1.4 NWCA Reference Documents

The complete documentation of overall project management, design, methods, rationale, and standards for the NWCA is contained in several companion documents.

### 1.4.1 Quick Reference Guide

Field Crews will receive an NWCA 2021 Quick Reference Guide (QRG) containing tables and figures summarizing field activities and protocols from the NWCA 2021 FOM. The QRG is meant to be used in the field to give Field Crews a list of the required sampling protocols at each site. While comprehensive, the steps contained in this QRG are not as detailed as the descriptions found within the FOM. The user is assumed to have attended Field Training and completely read and understood the FOM before using this QRG at a field site. This waterproof handbook will be a field reference used by Field Crews after completing a required field training session. The Field Crews are also required to keep the FOM available in the field for reference and for possible protocol clarification.

### 1.4.2 Site Evaluation Guidelines

The NWCA 2021 Site Evaluation Guidelines (SEG) outline the process to compile the final list of candidate wetland sites for sampling. The process includes locating a candidate site, evaluating the site to determine if it meets the criteria for inclusion in the target population and is accessible for sampling, and, if not, replacing it with an alternate site.

### 1.4.3 Quality Assurance Project Plan

Large-scale and/or long-term monitoring programs such as those envisioned for national surveys and assessments require a rigorous Quality Assurance (QA) program that can be implemented consistently by all participants throughout the duration of the monitoring period. QA is a required element of all EPA-sponsored studies that involve the collection of environmental data (USEPA 2002a). Field crews will be provided a copy of the NWCA 2021 Quality Assurance and Project Plan (QAPP). The QAPP contains more detailed information regarding QA/Quality Control (QC) activities and procedures associated with general field operations, sample collection, measurement data collection for specific indicators, and data reporting activities. For more information on the project level QA procedures, refer to the NWCA 2021 QAPP.

### 1.4.4 Lab Operations Manual

The methods used for the laboratory sample analysis are available in the NWCA 2021 Lab Operations Manual (LOM).

### 1.4.5 NWCA Fact Sheets

Fact sheets providing basic information on the NWCA for landowners or other individuals requesting such information will be made available to crews. Crews should consider printing copies of these fact sheets to have with them in the field to help explain the assessment to interested parties.

## Chapter 2 Base Location Activities and Summary of Field Operations

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### 2.1 Introduction

This chapter aids in structuring the field season and each sampling day by providing the following information:

- Contacts for logistic and technical support (Section 2.2).
- Description of site information, data forms, equipment, and sample tracking (Section 2.3).
- Field Crew responsibilities (Section 2.5).
- Pre-sampling Base Location activities – Preparation for field sampling (activities essential for staging field work and for accurate data and sample collection) (Section 2.6).
- Determining sampling index period (Section 2.6.1) and sampling order for sites (Section 2.6.2).
- Developing weekly itineraries for sampling and compiling site information (Section 2.6.3).
- Instrument checks and calibration, equipment and supply preparation, and vehicle maintenance (Section 2.6.4).
- Equipment and supply preparation (Section 2.6.5).
- Field day activities (Section 2.7).
- Health and safety (Section 2.7.1).
- Protocols for recording data (Section 2.7.2).
- Overview of sampling tasks (AA establishment; data and sample collection for buffer, vegetation, soils, hydrology, water, chlorophyll-*a*, and microcystin) (Section 2.7.3).
- Field protocols used in multiple NWCA indicators (Section 2.7.4).
- Post-sampling Base Location activities (Section 2.8).
- Equipment maintenance and clean-up (Section 2.8.1).
- Sample shipping and tracking (Section 2.8.2).
- Handling and transmittal of completed data (Section 2.8.3).

### 2.2 Logistic and Technical Support for the NWCA

Effective communication between Field Crews, EPA coordinators, and NWCA contractor support staff is essential for the survey to proceed with maximum efficiency and to ensure collection of high-quality data. This section provides: 1) a general description of the roles of key NWCA personnel in providing logistical and technical support to the Field Crews, 2) the flow of communication between Field Crews and these individuals (i.e., *who to call for specific types of questions or support needs*) (Table 2-1), and 3) their contact information (Table 2-2).

The **EPA Headquarters (HQ) Project Management Team** consists of the Project Manager, Alternate Project Manager, Logistics Coordinator, and NARS Team Lead. The EPA HQ Team is responsible for overseeing all aspects of the project and ensuring technical and QA requirements are properly carried out. The Team is the final authority on all decisions regarding field sampling, site evaluation, site replacement, and laboratory analysis.

The **EPA Regional Coordinators** are the primary EPA point of contact for Field Crews operating in their Region. Field Crews should direct all technical and logistical questions to their EPA Regional Coordinator, who will work with the EPA HQ Team to resolve the issue. Field Crews should also work with their EPA

Regional Coordinator to schedule an **Assistance Visit (AV)** to occur within the first two weeks of field sampling. An AV is part of the QA component of the NWCA QAPP. To meet the requirements of the QAPP, each Field Crew will allow an EPA employee or contractor to observe that crew sampling one entire site (typically one day of sampling). The AV is used to confirm that the protocols are implemented as intended and to suggest corrective actions to the Field Crew’s sampling approach if necessary.

The **Information Management (IM) Coordinator** generates the label packets which will be included in the site kit for each site to be sampled, manages the Field Crews’ data submissions via the NWCA App, and tracks the location of each NWCA sample that is collected. Field crews are responsible for requesting site kits via the fillable PDF Request Form before sampling occurs and submitting all pertinent data via the NWCA App after each site visit. Backup paper field forms will be supplied to the Field Crews prior to the start of the field season in the event the NWCA App cannot be used.

The **Field Logistics Coordinator (FLC)** is responsible for tracking the Field Crew’s sampling schedules and whereabouts, providing site kits and base kits with supplies and equipment, and assisting Field Crews with questions concerning field logistics, equipment, and supplies as they arise during the field season.

**Table 2-1. Personnel to call for specific types of questions and support needs.**

<b>Personnel</b>	<b>Call</b>
EPA Regional Coordinators	<ul style="list-style-type: none"> <li>- First, to ask any questions about the NWCA, including questions on the field protocols</li> <li>- To ask questions about your CWA Section106 grant</li> <li>- To schedule a field Assistance Visit</li> </ul>
EPA HQ Project Management Team  (Comprised of the Project Manager, Alternate Project Manager, Logistics Coordinator, and NARS Team Lead)	<ul style="list-style-type: none"> <li>- If you can’t reach the EPA Regional Coordinator, IM Coordinator, or Field Logistics Coordinator</li> <li>- If you are unsure of who to call</li> <li>- To ask questions about site access, site evaluation, and site replacement</li> <li>- To ask questions about the field methods</li> <li>- To ask questions about the survey design</li> <li>- To ask questions about the quality assurance procedures</li> <li>- To ask questions about the laboratory methods</li> </ul>
Field Logistics Coordinator	<ul style="list-style-type: none"> <li>- To order more site kits, base kits, or miscellaneous consumable supplies</li> <li>- To ask questions about the shipping contract, shipping locations, or to order more shipping forms</li> <li>- To ask questions about sample handling procedures</li> <li>- To ask questions about the field methods</li> <li>- If an EPA Regional Coordinator directs you to contact them</li> <li>- If you can’t reach an EPA HQ or Regional Coordinator, and you have an urgent question</li> </ul>
<b>Personnel</b>	<b>ONLY Call</b>
Information Management Coordinator	<ul style="list-style-type: none"> <li>- If an EPA Regional Coordinator, HQ Team member of Field Logistics Coordinator directs you to contact them</li> </ul>

**Table 2-2. Contact Information for Logistic and Technical Support for the NWCA**

Title	Name	Contact Information
<b>EPA HQ NWCA Project Manager</b>	Gregg Serenbetz, OW	Serenbetz.Gregg@epa.gov, 202-566-1253
<b>EPA HQ Logistics Coordinator</b>	Brian Hasty	Hasty.Brian@epa.gov; 202-564-2236
<b>EPA HQ NARS Team Lead</b>	Sarah Lehmann, OW	Lehmann.Sarah@epa.gov, 202-566-1379
<b>Contract Field Logistics Coordinator</b>	Chris Turner, Great Lakes Environmental Center, Inc.	cturner@glec.com; 715-829-3737
<b>Information Management Coordinator</b>	Michelle Gover, GDIT	gover.michelle@epa.gov, 541-754-4793
<b>EPA Regional Coordinators</b>	Beth Alafat, Region 1 Tom Faber, Region 1	Alafat.Beth@epa.gov, 617-918-1399 Faber.Tom@epa.gov, 617-918-8672
	Emily Nering, Region 2 Jaclyn Woollard, Region 2	Nering.Emily@epa.gov, 732-321-6764 Woollard.Jaclyn@epa.gov, 212-637-3832
	Christine Mazzarella, Region 3 Bill Richardson, Region 3	Mazzarella.Christine@epa.gov, 215-814-5756 Richardson.William@epa.gov, 215-814-5675
	Elizabeth McGuire Smith, Region 4 Christopher McArthur, Region 4 Elizabeth Belk, Region 4 Diana Woods, Region 4	Smith.Elizabeth@epa.gov, 404-562-8721 mcarthur.christopher@epa.gov, 404-562-9391 Belk.Elizabeth@epa.gov, 404-562-9377 Woods.Diana@epa.gov, 404-562-9404
	Kerryann Weaver, Region 5 Mari Nord, Region 5	weaver.kerryann@epa.gov, 312-353-9483 Nord.Mari@epa.gov, 312-886-3017
	Robert Cook, Region 6	Cook.Robert@epa.gov, 214-665-7141
	Eliodora Chamberlin, Region 7	Chamberlin.Eliodora@epa.gov, 913-551-7945
	Nolan Hahn, Region 8 Tom Johnson, Region 8 Liz Rogers, Region 8	hahn.nolan@epa.gov, 303-312-6486 Johnson.Tom@epa.gov, 303-312-6226 Rogers.Liz@epa.gov, 303-312-6974
	Matt Bolt, Region 9 Jennifer Siu, Region 9	Bolt.Matthew@epa.gov, 415-972-3578 Siu.Jennifer@epa.gov, 415-972-3983
	Annie Whitley, Region 10 Charissa Bujak, Region 10 Lil Herger, Region 10	Whitley.Annie@epa.gov, 206-553-0058 Bujak.Charissa@epa.gov, 208-378-5754 Herger.Lillian@epa.gov, 206-553-1074

### 2.3 Overview of Key Information and Materials

Prior to going to an NWCA site to conduct sampling, the site’s suitability for sampling will have been evaluated using a desktop evaluation, and in many cases an on-site evaluation (see NWCA SEG and FOM

Chapter 3). Each site selected for sampling is identified in a site list and a single set of coordinates are provided for each site. The coordinates in the site list are referred to as the POINT, and will determine the location of all sampling associated with the site. Site evaluation includes locating the NWCA POINT and confirming that the wetland at the POINT is an NWCA target wetland type.

In addition, a variety of other kinds of information important for planning and conducting sampling must be gathered and reviewed before going into the field. These activities are often conducted from a **base location**. The base location is the location from which NWCA activities are organized and staged (e.g., a state or tribal office, field lodgings, or a campsite).

For efficient sampling, it is critical to keep site information, data forms, sampling equipment, and gear needed for data and sample collection at each NWCA site organized and readily available. Likewise, managing completed data forms and the water, chlorophyll-*a*, microcystin, soil, and plant samples after collection is critical to data quality and sample tracking. For the NWCA, there are standard methods to organize and handle the equipment needed to conduct sampling as well as the data and samples gathered at each site. Key terms and steps for this organization process are defined or introduced in this section.

## 2.4 Site Packet

A **Site Packet** contains information key to the planning and preparation for visiting and sampling a particular NWCA site. Development of Site Packets are initiated during site evaluation and reconnaissance. However, the Field Crew (or other state, tribe, or organization personnel) may need to gather additional information for the Site Packet during preparation for the sampling visit to a site. ***It is the responsibility of the Field Crew (or other state, tribe, or organization personnel) to obtain access permissions and any needed permits as part of developing the Site Packet.***

**Prior to the Field Crew traveling to an NWCA site for sampling, the information for the Site Packet must be gathered and reviewed.**

### Site Packet Components

- **Label Packet:** (See Section 2.4.1)
- **Applicable Site Maps, Aerial Photos, and Geospatial Information:**
  - **NWCA Site Maps, Imagery, and Geospatial Data** (See Section 2.4.2) – Maps and aerial photos for the NWCA sites in each state are provided upon request by the EPA HQ Project Management Team. Geospatial data (e.g., shapefiles, KMZ files) depicting locations and other information for each NWCA Site are also provided by the NWCA EPA Headquarters Project Management Team for use by states and contractors who wish to create their own maps or images from desktop geospatial software such as ArcMap and Google Earth.
  - **Other Maps, Imagery, or Geospatial Data** – Any other maps, aerial photos, geospatial data, or sources of information compiled by Field Crews and/or their partners that could be helpful to sampling the NWCA sites.
- **Soil Survey Information** (See Section 2.4.2.1): Soil maps and soil survey information pertinent to the site.
- **Information on the timing and duration of the peak growing season**

- **Land Ownership Status, Requirements, and Permissions for Access:**
  - Landowner identity and contact information.
  - Results of communication with landowners.
  - Documentation of permission to access private land.
  - Permissions for crossing private lands to reach sites located on public lands.
  - For public land, response of relevant agency to notification that the Field Crew will be accessing a site, and, if needed, permissions to do so.
- **Threatened or Endangered Species Information:** If applicable and per Field Crew's Standard Operating Procedures (SOP), include information on federal or state listed species that may occur at the site, how to avoid them, and actions to be taken if they are encountered.
- **Permits:** Any permits or documentation required for site access, or for data collection activities or sample/specimen collection.
- **Information for Accessing the Site:**
  - Contact information for landowners.
  - Notes about whether landowner(s) want to be informed when Field Crew is on site.
  - Contact information for individuals who must be available to open gates or allow entry to a site, and the time and location for meeting them.
  - Notes on locked gates, pets, livestock, or other things that could impede access.
  - Notes about active hunting, farming, mining, or other activities on or near the site.
  - Notes about current conditions that could prevent access (e.g., high water, forest fires).
- **Site Evaluation Notes** (should already be in the Site Packet prepared by the Field Crew):
  - Site Evaluation notes, annotated aerial photos, and completed **Point Verification Form (PV-1)** in the App if a field evaluation was conducted, which can aid with planning for accessing or sampling a site.
- **Driving and Hiking Routes to the Site:**
  - Detailed driving directions may be obtained from the NWCA Google Earth files.
  - Results from the Site Evaluation may include driving directions and notations about site access or logistically challenging conditions on the site, which can be useful in shifting the site or helpful in anticipating special circumstances.
- **Preliminary Plan for Assessment Area (AA) and Buffer Plot Establishment:** As part of the base location activities to prepare for field work, the Field Crew will review aerial photos and maps of the site and make a plan for laying out the AA based on rules in Chapter 3. If appropriate (i.e., location of AA is fairly certain), Global Positioning System (GPS) coordinates of the centers of the buffer plots could be determined and entered into a GPS unit for ease in navigating to the plots. This plan should be included in the Site Packet.
- **Any other site specific information useful to the Field Crew**

#### 2.4.1 Label Packet

The **Label Packet** for each site is composed of:

- Complete set of NWCA sample/specimen labels and tags. The sample labels will be pre-printed with sample identification numbers which will all occur with the same sample ID series. Any Label Packet can be used at any site, but only a single label packet should be used at any one site and sample labels from multiple label packets should not be mixed. Note: Soil Horizon Chemistry and Bulk Density sample tags will be supplied, upon request, at the beginning of the field season



(along with soil sample bags). Field crews will need to request additional tags and bags as needed during the field season.

A Label Packet for each site will be included in each Site Kit and can be added to the Site Packet prior to going in the field.

#### *2.4.2 NWCA Site Maps, Aerial Photos, and Geospatial Data*

Site maps for each NWCA site will be produced upon request by the EPA to provide imagery to assist in conducting sampling. The maps include:

- An aerial image of each site at a scale appropriate to view wetland and land features present in the AA and buffer surrounding the POINT.
- A United States Geological Survey (USGS) topographic map illustrating the location of the site, at a scale appropriate to view roads and including topographic features in the vicinity of the site, to provide information on site access.

For those with access to ArcGIS software, an ArcMap Template containing a layer with NWCA shapefiles is provided by EPA to assist with site evaluation. The template and shape files link to publicly available online data that may be useful in planning sampling activities at each site. These data include the USFWS NWI Online Mapper; the National Hydrography Dataset feature service; and imagery, topographic maps, and a soil data layer from ESRI's online geographic information system (GIS) server. The NWCA shapefiles also include a layer that contains all of the NWCA sites, with additional attribute information pulled from national databases of protected areas, counties, and Natural Resources Conservation Service (NRCS) soil survey information.

For those with access to Google Earth, there is a Google Earth KMZ file containing all of the sites in the NWCA. Opening this file should automatically load the sites into Google Earth. Clicking on a POINT with your mouse should cause a pop-up box to appear with basic attributes about the site. NWI data can be added to the map by downloading a KMZ file available at <http://www.fws.gov/wetlands/Data/Data-Download.html>. Soil survey data can be added to the map by downloading a KMZ file at <http://www.gelib.com/soilweb.htm> or <http://casoilresource.lawr.ucdavis.edu/soilweb-apps/>.

The NWCA Site Maps, the NWCA ArcMap template and NWCA shapefiles, and the NWCA Google Earth KMZ file should all have been made available to you. If, for any reason, you have not received these files, they can be obtained from the EPA NARS SharePoint Site. For more information on how to access this site, contact Kendra Forde at [forde.kendra@epa.gov](mailto:forde.kendra@epa.gov), 202-566-0417.

##### *2.4.2.1 Soil Survey Information*

Site specific information about soils on each NWCA site will be useful in planning for sampling, as well as providing background information that may aid in generating soil profile descriptions during data collection. Soil Survey information can provide insight into the soil types that might be expected at a particular NWCA site and may help the Field Crew anticipate likely site conditions and the tools that may be needed for soil sampling. Soil Survey information for NWCA sites can easily be downloaded from the U.S. Department of Agriculture, NRCS (<http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm>). In addition, a state or local soil scientist may be able to offer useful insights into what tools may be particularly useful for sampling soils in your area.

### *2.4.3 Coordination with the Natural Resources Conservation Service (NRCS) Soil and Plant Science Division*

NWCA Field Crews may be able to receive assistance with soil sampling at specific sites from a NRCS state soil scientist (a list of current State soil scientists with contact information is available at [https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2\\_053951](https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951)). Field crews desiring assistance must contact and coordinate with NRCS Soil and Plant Science Division prior to the start of the sampling season to facilitate possible field assistance by a NRCS state soil scientist. Assistance is not guaranteed; but, when possible, a NRCS state soil scientist may be able to accompany the NWCA sampling crew to assist with soil sampling, provide further training, and ensure sampling protocols are being followed accurately.

### *2.4.4 Other Information Resources*

For each field sampling trip, you will carry a variety of resources (listed below) in addition to the Site Packets for the site(s) to be sampled. These resources should be organized for easy access and kept in the field vehicle or carried in the field, as appropriate, by the Crew Leader or relevant Crew Member (See Section 2.5).

- The State, Tribe, or organization approved **Health and Safety Plan** (See Section 2.7.1), which should include:
  - detailed health and safety protocols for field work;
  - contact information and locations for emergency and medical services nearest to each site being sampled; and
  - emergency contact information for supervisors and personnel health care representatives of the Field Crew.
- NWCA logistics and research support contact information (See Section 2.2).
- Floras and field guides appropriate to the region of study (See also Floristic Resources **8.7Appendix C**).
- Any available, regional or site specific plant species lists or wetland plant species lists that can be helpful in plant identification (See discussion in Chapter 5, Section 5.2.3.1).
- Soil reference books in addition to those that are part of the field equipment.

### *2.4.5 Equipment and Supplies*

Organizing and maintaining NWCA equipment is discussed in Section 2.7 and a master checklist for field equipment and supplies is provided in Section 2.9.

#### *2.4.5.1 Master Equipment List*

The state, tribe, or other organization will provide some of this equipment; however, some consumable supplies and some durable equipment will be provided by the EPA Office of Water. Items that are provided by EPA are included in the Site Kit or in the Base Kit (see below), which will be delivered to the Field Crews by the FLC. See the **Master Equipment List** (Section 2.9) for specific items that will be provided in the Site Kits or the Base Kit. It is also important that each Field Crew reviews the **Master Equipment List** to determine what additional pieces of equipment may need to be gathered or purchased by the Field Crew's organization prior to the field season.

#### 2.4.5.2 *Site Kit*

A **Site Kit** contains the subset of consumable supplies (i.e., used up during sampling or requiring replacement after use) provided by EPA through the FLC. A new Site Kit is provided, upon request, for each site sampled. See the **Master Equipment List** for the consumable items that will be provided by EPA (e.g., cubitainers, sample bags, plastic bottles, nitrile gloves, Label Packet, etc.).

#### 2.4.5.3 *Base Kit*

The Base Kit is comprised of the subset of durable equipment and supplies needed for NWCA sampling that is provided by EPA through the FLC. One Base Kit is provided to each Field Crew and contains some of the equipment that is used throughout the field season. See the **Master Equipment List** for a list of the items provided by EPA in the Base Kit (e.g., laser rangefinder, plant presses, Munsell Soil Color book, etc.). Crews that have sampled in a previous NWCA may have already received a Base Kit and therefore may not need some of the Base Kit items. Each Field Crew will be contacted by the FLC to determine their equipment needs.

#### 2.4.6 *NWCA App (Data E-Forms)*

Fill in NWCA App forms while sampling the site. Fill in as much as possible within the App while in the field and save often. Sample tracking will be completed and submitted within the App.

#### 2.4.7 *NWCA App Tracking Forms*

The tracking form in the App describes the status and location of all samples and specimens collected during the sampling of an NWCA site and is transmitted electronically to the IM Team at specified times. When samples are shipped to the lab, a packing slip is included in the shipping container to convey to the lab which samples are included in the shipment. These packing slips (which are pre-printed with the same sample IDs as the individual sample labels) are included in the Label Packet with each Site Kit.

The tracking form is divided into several shipping groups, each labelled with a shipping group number (e.g., T-1, T-2, T-3, etc.). Sample labels, packing slips, and FedEx shipping labels also carry these shipping group numbers to help Field Crews group correct items together for shipping. See below and 8.7Appendix A for more details.

##### 2.4.7.1 *Immediately Shipped Samples*

**Immediately Shipped Samples** are any NWCA samples that are required to be shipped within 24 hours of collection (i.e., the same day as sampling or the following day). Samples that are immediately shipped are water chemistry, chlorophyll-*a*, soil isotope, and microcystin. These samples are kept cool on blue or wet ice or refrigerated until they are shipped, and then are shipped on wet ice (See Section 2.8.2 and 8.7Appendix A). The water chemistry and chlorophyll-*a* samples will be shipped overnight to a national or state lab for analysis. The soil isotope and microcystin samples (collectively referred to as 'daily chilled samples') will be shipped overnight to the Batch Lab, where they will be frozen and sent to the processing labs in batches.

##### 2.4.7.2 *Batch Shipped Samples*

**Batch Shipped Samples** are NWCA samples that are collected and held by the Field Crew for later shipping. Samples from several sites can be shipped together in a "batch" to a designated lab for analysis (See Section 2.8.2 and 8.7Appendix A). Unknown and QA voucher plant specimens, and soil horizon chemistry, bulk density, and standard depth soil core samples are all shipped in batches.

## 2.5 Field Crew Responsibilities

The NWCA Field Crews are responsible for collecting all field data and samples. Field Crews will also need to conduct a number of activities at their base location (e.g., a state office, a laboratory, camping site, or motel) that must be completed both before departure to the wetland site and after return from the field.

### Field Crew tasks will include:

- 1) gathering information for the Site Packet and obtaining permits and permissions for site access or sample collection, if not previously completed (Section 2.4);
- 2) reviewing the Site Packet (Section 2.4) prior to going to an NWCA site and making a preliminary plan for establishing the AA (Chapter 3);
- 3) organizing equipment, supplies, and the field vehicle prior to traveling to the field sites and after sampling has been completed (Sections 2.6 and 2.8);
- 4) conducting NWCA data and sample collection at field sites (Section 2.7; Chapter 3, Chapter 4, Chapter 5, Chapter 6, Chapter 7, Chapter 8);
- 5) post-sampling handling, shipping, and tracking of samples and submission of data via the NWCA App (Sections 2.8.2 and 2.8.3, Chapter 5, Chapter 6, Chapter 8); and
- 6) cleaning and maintaining equipment (Section 2.8.1).

The Field Crew is comprised of the **Vegetation (Veg) Team** and the **Assessment Area-Buffer (AB) Team**, each with two members. The Veg Team is composed of a Botanist/Ecologist and a Botanist Assistant. The AB Team is composed of a Soil Specialist and a Field Technician. See the NWCA 2021 QAPP for a complete description of Field Crew duties and qualifications (QAPP, Section 1.6.1). One of the Field Crew Members will serve as **the Crew Leader** and will have responsibilities for planning field logistics and sampling, and confirming that all data and samples have been collected and submitted.

### Veg Team – Primary field sampling responsibilities are:

- locating the NWCA POINT and establishing the AA (Chapter 3) in tandem with the AB Team; and
- collecting Vegetation data and plant specimens (Chapter 5).

### AB Team – Primary field sampling responsibilities are:

- locating the NWCA POINT and establishing the AA (Chapter 3) in tandem with the Veg Team;
- collecting physical alteration data in the AA and Buffer (Chapter 4);
- collecting soils data and samples (Chapter 6);
- collecting hydrology data (Chapter 7); and
- collecting water chemistry, chlorophyll-*a*, and microcystin samples (Chapter 8).

### Crew Leader – Primary responsibilities are:

- developing or participating in the development of sampling schedules (See Section 2.6.2); then ensuring the FLC and the Field Crew's local supervisor(s) have the sampling schedules;
- keeping the FLC and local supervisors updated about any sampling schedule changes that may occur;
- developing field itineraries and preparing for sampling; identifying field accommodations and making lodging reservations; and checking that needed supplies, equipment, and data forms are available to conduct the planned work;
- organizing the Field Crew's daily field activities and pre- and post-sampling base location activities;

- overseeing the Field Crew's sampling activities and reviewing data and App forms;
- double checking that all data and samples have been collected before leaving a site;
- ensuring all samples are shipped to designated locations within the correct timeframes; and
- ensuring NWCA App data are submitted to the IM Team in a timely manner.

The number of NWCA sites a Field Crew will be able to sample per week is likely to vary depending upon ease of access, relative proximity of sites to one another and to the Field Crew's base location, and on sampling challenges posed by various site conditions. An effective approach to sampling might be for a Field Crew to sample two or three sites per week on average, using additional days as needed for travel, reviewing forms, managing plant specimens, identifying unknown plant species, sample packaging and shipment, confirming site access permission, equipment cleanup, equipment repair, lodging logistics, and restocking field supplies, forms, and crew essentials (e.g., food).

## 2.6 Pre-Sampling Base Location Activities

This section focuses on base location activities that must be completed prior to going into the field to sample an NWCA site. Procedures for these activities are described in detail in the subsections below and summarized in **Reference Card OPS-1** (Figure 2-1). Section 2.8 describes base location activities that must be conducted post field sampling.

### 2.6.1 *Sampling Index Period*

Field sampling for the NWCA should take place during peak growing season when most vegetation at a sample site is fully leafed and in flower or fruit. If sampling cannot take place during the peak growing season, crews should still plan to sample near the peak growing season such that vegetation is identifiable. Sampling at or near the peak of the growing season minimizes phenological, biomass, and cover variability and enhances plant species identification accuracy, particularly of difficult species such as grasses and sedges. This sampling index period optimizes characterization of the vegetation. It is expected that the Botanist/Ecologist on the crew will be familiar with the timing of peak flowering for the wetland types and wetland plant communities in the state or region that they are responsible for sampling. The overall index period for sampling across the conterminous US can range from April to early September, but for an individual sample site will likely fall into a much narrower range depending on a variety of factors. It is critical that Field Crews sample each location during the site-appropriate period.

Timing and duration of the peak growing season for each sample site will vary depending on wetland type, geographic location, and elevation, and on the precipitation, temperature, and hydrological patterns prevailing in a given year. Note that within a state or region, NWCA sites occurring at lower elevations or in drier, warmer locations are likely to be ready to sample earlier in the index period, and sites at higher elevations or in wetter, cooler locations are likely to be at peak growing season later in the index period. Sampling schedules need to take into account the appropriate time to sample sites based on the vegetation within the broader index period.



### Reference Card OPS-1: Site Evaluation and Pre-Sampling Base Location Activities

#### Site Evaluation (See NWCA Site Evaluation Guidelines)

- 1) Desk evaluation of each NWCA site – Determine if site is sampleable and part of the NWCA target population
- 2) Obtain permission to access and sample site, any necessary permits for data and sample collection
- 3) On-site field evaluation of individual NWCA sites
- 4) Assemble Site Packet for each site

#### Site Packet Components:

- Label Packet (shipped with site kit)
- NWCA site maps, aerial photos, and other imagery
- Soil survey information
- Land ownership and requirements or permissions for access
- Permits for site access and/or data and sample collection
- Information for accessing the site
- Driving and hiking routes to the site
- Site Evaluation results
- Preliminary plan for establishing the AA
- Any other site specific information useful to the crew

#### Sampling Index Period and Recommended Approach for Determining Site Sampling Order

- 1) Determine the best sampling index period for each site.
- 2) Develop a schedule for the sampling order of the NWCA sites that incorporates index period and geographic proximity of the individual sites. Be sure to schedule two site visits for the revisit sites (two per state).
- 3) Once in the field, if a site must be dropped because it is unsampleable, follow the instructions in the Field Operations Manual and Site Evaluation Guidelines to obtain an alternate site. Contact your EPA Regional Coordinator or the EPA HQ Team to confirm that the correct alternate site is selected.

#### Planning Field Itineraries and Preparing for a Sampling Trip

- 1) Determine which NWCA sites will be sampled during the sampling trip.
- 2) Organize and confirm lodging for the trip.
- 3) Assemble Site Packets (including Label Packet) for all sites to be sampled and ensure that all packets are complete.
- 4) Review all pertinent information sources about sites to be sampled (e.g., Site Evaluation results, soil survey, maps, plant species lists, site access requirements, etc.). Consult with NRCS Soil Scientists for advice about likely soil conditions and sampling methods at specific NWCA sites. Develop a plan for sites with special conditions (e.g., tidal wetlands, difficult of complex sites, difficult to sample soils).
- 5) Review aerial photos, maps, and other imagery to develop a preliminary plan for AA establishment
- 6) Address logistical issues, including navigation routes to sites, contact landowners, make any necessary arrangements to obtain access to sites, coordinate with NRCS Soil Scientist if they will be participating in site visit.
- 7) Ensure safety information and emergency contact information is correct, complete, and is always with the crew.
- 8) Inform Logistics Coordinator, Information Management Coordinator, and local supervisors of your sampling schedule
- 9) Check supplies and equipment.

#### Field Instrument Checks and Calibration – test and calibrate field instruments prior to departure

- 1) Laser Rangefinder check
- 2) GPS battery check
- 3) Camera battery and supply check
- 4) iPad battery and back-up battery check (if applicable)
- 5) Ensure iPad is loaded with current version of NWCA App
- 6) Multi-probe meter performance test (if applicable)

#### Equipment and Supply Preparation –

- 1) Inventory supplies and equipment prior to departure using the NWCA 2021 Master Equipment List. The Master Equipment List identifies supplies provided by the state, tribe, or other organization or provided by EPA Office of Water.
- 2) The Field Logistics Coordinator will provide some durable sampling equipment in the Base Kit at the beginning of the field season, and will provide Site Kits (upon request) that contain a label packet and consumable supplies for each NWCA site.
  - NOTE: Soil bags and soil horizon tags (for SHBD and SHCH samples) will **not** be included in the Site Kit. Crews will be provided a supply of bags and tags at the beginning of the season, and will need to order more as needed. Be sure to pack a sufficient number of bags and tags so all samples can be collected at each site.
- 3) Identify additional pieces of equipment to be gathered or purchased by the Field Crew's organization prior to sampling.

#### Vehicle Maintenance

Follow state, tribe, or other organization approved guidelines for maintaining and operating field vehicles.

Figure 2-1. Reference Card OPS-1. Preparation for Field Sampling of NWCA Sites (Tasks are conducted by Field Crew unless otherwise indicated. Note other personnel listed may be the same as the Field Crew at times.)

## 2.6.2 Determining Sampling Order and Selecting Alternate POINTS

For many states the Field Crew, Site Evaluation Team, and the group who schedules the timing and order for sampling sites may be comprised of the same individuals. In other cases, a different set of personnel from the relevant state, tribe, or organization associated with the Field Crew may handle this task and communicate the schedule for sampling to the Field Crew. This will likely be the case where multiple crews are operating in one state. **It is vitally important that all people involved in scheduling or coordinating field sampling communicate with one another to ensure the most efficient sampling approach and to eliminate any chance of either double sampling of the same sites or skipping sites.**

The sampling order for NWCA sites should allow for the most efficient data collection and most favorable travel logistics while coinciding with peak (or near peak) growing season incorporating the appropriate index period for each site. A recommended procedure for developing a plan for sampling order for the NWCA sites in the state(s) where you are working is outlined below.

- 1) Begin by examining the state specific NWCA 2021 Site Evaluation Spreadsheet distributed electronically by EPA to states, tribes, and contractors conducting field sampling for NWCA 2021. The spreadsheet contains a list of base and oversample POINTS in the state for three separate stratum (ReSamp\_2016, Estuarine, and Inland). The POINTS are listed on the spreadsheet in the order in which they were randomly selected. The first two base POINTS in each state are designated as revisit sites and each revisit POINT is sampled on two separate occasions at least two weeks apart during the NWCA index period. The other POINTS designated as base sites are sampled once. The order of the sites on the list MUST BE maintained, but they can be sampled in any order the crew chooses. **All base POINTS (Panel Use = Base21\_16RVT2, Base21\_16, and Base21\_21) must be evaluated and should be sampled unless they are determined to be non-target or non-sampleable** (See Site Evaluation Guidelines, USEPA 2021c).
  - **Base Site** – A base site is a POINT that was randomly selected during the development of the survey design. Base sites in NWCA 2021 are further distinguished by whether they are revisit sites (“Base21\_16RVT2”), NWCA 2016 resample sites (“Base21\_16”), or new sites (“Base21\_21”).
  - **Revisit Site (Base21\_16RVT2)** – A revisit site is a base site that is sampled twice during the same field season to gather information on the quality and noisiness of data collected in the NWCA.
    - If a revisit site cannot be sampled, refer to the Site Evaluation Guidelines for the proper steps to replace it.
    - The second sampling visit (Visit #2) to a revisit site should occur as far apart as possible within the index period for the site, but at a minimum 2 weeks, after the initial sampling visit (Visit #1).
    - All the same data and samples are collected for both Visit #1 and Visit #2.
  - **Resample Site (Base21\_16)** – A resample site is a base site that was sampled and/or evaluated in the 2016 NWCA survey.
    - Every attempt should be made to sample the exact location as in NWCA 2016, using the same Assessment Area layout and AA CENTER coordinate.
  - **New Site (Base21\_21)** – Base sites that are new randomly selected POINTS in NWCA 2021.
  - **Oversample Site** – An oversample site is a randomly selected POINT that can be used as a replacement for an unsampleable base site.

- Oversample POINTS are used as alternate base sites **in the order** they are listed on the Site Evaluation Spreadsheet for a state.
  - **If an oversample site on the list is skipped (i.e., it is not evaluated and either sampled or determined to be non-target or non-sampleable), it creates a data gap that invalidates all data from sampled sites that occur below the skipped site and affects the validity of the survey design.**
- 2) During Site Evaluation it is likely that some POINTS in your state were found to be non-target or unsampleable. The Site Evaluation Team, working with the EPA HQ Project Management Team, will have used the following rules to select alternate sites from the Site Evaluation Spreadsheet for your state (See Site Evaluation Guidelines (USEPA 2021c)).

Base sites that are determined to be non-target or non-sampleable are replaced within their respective Stratum (Stratum = ReSamp\_2016, Estuarine, and Inland) following Figure 2-2.



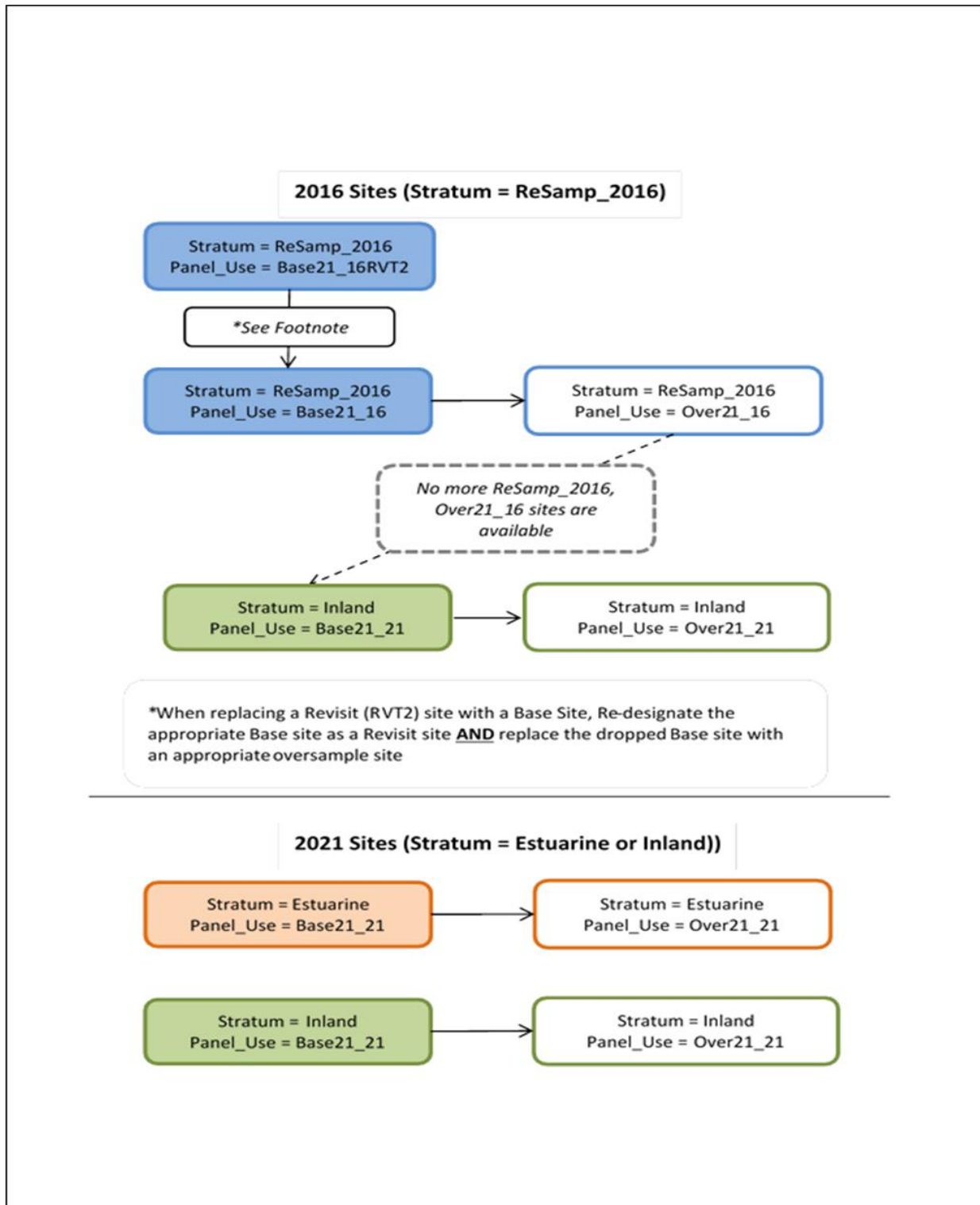


Figure 2-2 NWCA 2021 Site Replacement Plan (primary and alternate). Base Panels in shaded cells, oversample panels in unshaded cells.

As POINTS are determined to be non-target or non-samplable, evaluators will continue to work with the Designated EPA Contact to replace them with oversample POINTS by selecting the next available site on the list within that stratum, irrespective of NWCA wetland type. **It is imperative for**

**crews to fill the site evaluation spreadsheet for each evaluated site regardless of whether it was sampled.**

- 3) After Site Evaluation has been completed, you will have a final list of sites to sample, which includes two revisit sites, all base sites not dropped during Site Evaluation, and the alternate sites (oversample sites from the site list for your state) that replaced any sites dropped because they were determined to be non-target or non-sampleable (See Site Evaluation Guidelines, USEPA2021c).
- 4) After reviewing the final list of NWCA sites to be sampled, determine the best index period for each of these sites (See Section 2.6.1).
- 5) Develop a schedule for the order and timing for sampling the sites that incorporates specific index periods and geographic proximity of NWCA sites. Prioritize sampling date order by:
  - index period that is most appropriate for each site;
  - geographic proximity of sites to one another; and
  - proximity of field lodging and/or shipping locations to sites.

This procedure will minimize travel time, maximize in-field time, and allow sampling of individual NWCA sites as closely as possible to peak growing season.

- 6) Occasionally upon arrival at a site, you may discover that it is no longer sampleable (See Chapter 3) because:
  - only a Desktop Site Evaluation was completed and conditions on the ground do not match the information used in the evaluation;
  - it became non-target in the interval since Site Evaluation (e.g., was developed and is no longer a wetland, was put into active crop production, etc.);
  - access permission or sampling permits have been revoked or could not be obtained;
  - conditions on the site are hazardous or the site is completely inaccessible; or
  - an AA could not be established on the site.

If this occurs, follow the instructions below (also found in the Site Evaluation Guidelines) for selecting a new site.

- 7) If a site must be dropped in the field and there is only one Field Crew working in a state, determine the correct alternate site with which to replace the dropped site (see Figure 2-2).

If there are multiple Field Crews working in a state, then the individual who is coordinating the sampling schedule for the Field Crews will select any needed alternate sites and communicate their location and when to sample them to the appropriate Field Crew. If the Field Crews are from different organizations, the communications should be facilitated through the FLC.

Information on POINTS determined to be non-sampleable and the selection of alternate POINTS to replace them is reported to EPA and the NWCA FLC throughout the period of site evaluation and field sampling. EPA and the FLC will review the information to:

- confirm that the correct process was used to select the alternate POINT;
- confirm which Field Crew is responsible for sampling the alternate POINT (if multiple organizations are sampling within state boundaries); and

- report the replacement of revisit and base POINTS with oversample POINTS to appropriate Field Crew(s) and agencies AND to the EPA Project Team.

Once the alternate sample site is confirmed, the person coordinating the sampling schedule for the Crew(s) and/or the FLC will determine which Field Crew is responsible for sampling the alternate POINT (if multiple organizations are sampling within state boundaries).

Finally, the sampling order plan is modified to include the new alternate site into the schedule based on its appropriate index period (e.g., peak growing season) and geographic proximity to other NWCA sites. If the peak growing season for the alternate site has already passed, it should be sampled as soon as practicable based on logistic considerations.

Repeat this process whenever a site must be dropped in the field.

### *2.6.3 Planning Field Itineraries and Preparation for Sampling*

The Field Crew Leader, with assistance from the other Field Crew Members, will develop an itinerary for each sampling trip; the length of which may vary from 1 or 2 days, a week, or longer time period depending on distances to sites and number of sites sampled. The itinerary includes the sampling schedule and locations of NWCA sites to be completed during the trip, lodging locations and contact information, FedEx shipping locations, and other important information. Some important steps in developing the itinerary and preparing for the sampling trip are listed below.

- Determine which NWCA sites will be sampled based on the sampling plan and the order for sampling sites based on the index period, geographic proximity of sites to one another, and access logistics (See Section 2.6.2).
- Address logistical issues:
  - Review routes for navigating to and accessing each site.
  - Call the landowners or local contacts to confirm access permission and notify them regarding the timing of the sampling visit.
  - If necessary, arrange rendezvous locations and times with individuals who must provide access to a site (e.g., open gates, provide any keys to gates, or accompany the Field Crew, etc.).
  - If needed, arrange consultation or field meetings with a local soil scientist.
  - Determine the best locations for field lodging during the sampling trip, make needed reservations, and confirm lodging plans.
  - Identify your nearest FedEx drop off location or arrange a pickup for immediately shipped samples.
- Ensure the Site Packets for each scheduled site are complete before leaving to travel to the sites (See Section 2.4):
  - Confirm that a complete Label Packet is included in the Site Packet for each site.
  - When multiple sites are to be sampled, keep extra Site Kits in the vehicle.
- Locate and review any special information resources (e.g., soil surveys, plant species lists) that would be helpful to conducting sampling (See Section 2.4.3).
- Work with other Crew members to review the aerial photos in the Site Packet for each site to gain an overview of the area in the vicinity of the POINT and to develop a preliminary plan for the

location, layout, and establishment of the AA (See Chapter 3). Preplanning is critical to maximize the actual onsite time available to collect data and samples at the site.

- Ensure that the safety manual and emergency contact information is always with the Field Crew so it is available if needed.
- Important communications:
  - Inform your local supervisors and personal emergency contacts of the field schedule, the Site IDs for sites to be sampled, where the Field Crew is going each day, and the expected time of return to the field lodging or camp. It is critical for safety reasons that the location of the Field Crew is known by someone able to respond quickly in the event of an emergency.
  - Inform the FLC of the basic field schedule and the Site IDs for the sites to be sampled (through the submission of updated Site Evaluation Spreadsheets). The FLC will communicate the Field Crew's start date and general schedule to the appropriate persons.
  - Contact the FLC directly about any issues related to NWCA data or tracking submissions, etc.
  - Requests for supplies should be made using the **NWCA 2021 Request Form**. If needed, interact directly with the FLC, who will provide assistance to the Field Crews regarding needs for additional supplies or shipping containers, etc.
  - Contact your Regional EPA Coordinator if you have technical questions regarding the field protocols, design, or site replacement procedures. The Regional EPA Coordinator will work with the EPA HQ Project Management Team to provide a response directly to the Field Crew in a timely manner.
  - Contact any member of the EPA HQ Project Management team if you have a time sensitive question and cannot get in contact with the IM Team, FLC, or Regional EPA Coordinator.
  - Contact your NRCS soil contact to coordinate sampling activities if this is one of the designated sites NRCS is sampling in conjunction with NWCA.
- Planning for special circumstances:
  - **Tidal wetlands** – Check tide tables for all tidal wetlands and schedule arrival and departure to and from the site to maximize the time available for sampling. For example, arrive on-site as the tide is going out so that you can begin work on the landward side of the site and work toward the seaward side as the tide recedes. This allows work to be continued until the tide begins coming in again and flooding lower areas. Note that the timing of flooding and exposure of areas within the AA may require some modification of the normal sampling order to complete all sampling tasks.
  - **Difficult soils** – Review of information in the Site Packet may indicate that collection of soil samples at a particular site could be problematic. If difficult-to-sample soils are anticipated, the local NRCS soil scientist may have useful advice or may be able to lend you tools to aid in the collection of soil samples.
  - **Difficult or complex sites** – Sites that require long travel or hike-in distances, particularly those with complex topography or sites with high plant species diversity, may take more than one day to sample. In these rare instances, the Field Crew will need to plan for camping on site and to determine how to handle the extra gear and food required. For sites that take more than one day to sample, but which are located near lodging or a developed campground, the Field Crew will want to plan for what can remain in the field (e.g., AA, Veg Plot, and Soil Plot marker) for the next sampling day in order to expedite data and sample collection.
  - **Listed Species** - Field Crews have the potential to encounter federally listed species and critical habitats that are protected under the Endangered Species Act (ESA) while conducting

field sampling. Crew Leaders are expected to have an understanding of the federally listed species and their critical habitats and state species of concern that have the potential to occur at or near a given sampling site, including habitats that will be used to access the sampling site. Crew Leaders are responsible for making their crew members aware of potential occurrences of listed species and their critical habitat. Efforts should be made to minimize risks to listed species and their critical habitats and avoid the take of listed species while implementing the NWCA field protocols. For example, crews are expected to:

- allow a listed species to naturally move away from the sampling area (do not herd or harass);
- immediately release listed taxa if they are unintentionally collected); and
- implement additional limitations that may be established in the scientific sampling permits.

These best practices are not an exhaustive list of requirements for Field Crews. Regulations and guidelines provide useful risk minimization practices when sampling in areas that may have listed species. Field Crews are expected to be aware of the recommendations and guidelines that apply in a given state and for a given species.

#### *2.6.4 Field Instrument Checks and Calibration*

Each Field Crew must test and calibrate field instruments prior to sampling. Field instruments include a laser rangefinder, a GPS receiver, a camera, and an optional multi-parameter sonde for measuring temperature, dissolved oxygen (DO), conductivity, and pH in water. Ideally, Field Crews will have access to backup instruments in case any instruments fail the manufacturer performance tests or calibrations prior to a field trip. Field Crews should carry extra batteries for all instruments used in the field.

##### *2.6.4.1 Laser Rangefinder*

Follow the instructions in the user's manual for operating and maintaining your laser rangefinder. Before traveling to the first field site, run through the procedures for operating the rangefinder until you are comfortable with its operation. Throughout the field season, make any recommended periodic maintenance checks suggested in the user's manual.

##### *2.6.4.2 Global Positioning System*

Turn on the GPS receiver and check the batteries prior to departure. Replace batteries immediately if a battery warning is displayed. Ensure that extra batteries are carried in the field. Complete any calibration requirements described in the GPS manual. GPS uses many alternative mathematical models to describe the spherical shape of the earth and each is a separate Datum. **The NWCA standard Datum will be NAD83. GPS units should be switched to this datum as part of their pre-field set up. Use True North bearings for all locational recording and the metric system for any distance measurements.**

##### *2.6.4.3 Camera Battery*

Turn on the digital camera and check the batteries prior to departure from the base location. Replace batteries immediately if a battery warning is displayed. Carry extra batteries in the field. For rechargeable batteries, make certain to keep a charged battery in the camera and another battery in the charger. Ensure that the camera memory card has sufficient space for the photos to be captured during the week. If needed, carry an additional memory card or a camera-specific cable/adaptor for downloading images. Keep lens paper, or cloths, and lens cleaning solution in the camera case for easy

access in the field. Refer to 8.7 Appendix D for photography guidelines and a list of required photos to take at each NWCA site.

#### 2.6.4.4 *Electronic Data Capture Device Battery Check*

When using the iPad for data collection in the field, turn on the device and check the battery prior to departure. Charge overnight to ensure enough battery for a full field day. Battery packs are often available for these devices if battery life is a concern. Putting the iPad into airplane mode or turning off Wi-Fi and other communications can help extend the life of the battery while in the field.

#### 2.6.4.5 *Multi-parameter Sonde Performance Test (if applicable)*

Multi-parameter sondes are not required for completion of NWCA protocols, but some crews may elect to use them to record in situ measurements of existing surface water. If a multi-parameter sonde is to be used, Field Crews should test and calibrate the sonde prior to departure from the base site, following either the SOP developed for the instrument or the manufacturer's calibration and maintenance procedures. Field crews should perform a periodic QC check of the pH and conductivity meters (where applicable).

**Table 2-3. Instrument checks and calibration**

Equipment	Preparation
Laser Rangefinder	Check batteries prior to departure Perform manufacturer checks as necessary to ensure accuracy
GPS Unit	Check the batteries prior to departure Ensure map datum is set to NAD83 Perform manufacturer checks as necessary to ensure accuracy
Camera	Check batteries prior to departure Check memory card capacity to ensure enough memory for additional photos
Electronic Data Capture Device (iPad)	Check the battery prior to departure Ensure NWCA App is installed and functioning
Multi-parameter Sonde (Optional)	Calibrate per manufacturer guidelines (Dissolved Oxygen to be calibrated as close to the site as possible) Check the batteries prior to departure Perform QC Check as directed by manufacturer and/or lab protocols

#### 2.6.5 *Equipment and Supply Preparation*

Field Crews must inventory supplies and equipment prior to departure for each trip using the **Master Equipment List** provided in Section 2.9 to avoid forgetting any item(s) whose absence could preclude collecting data or samples at a field site. This task can be divided between the Veg and AB Teams, with each focusing on the gear and supplies that their team requires. Pack equipment, supplies, and any samples carried in the vehicle such that physical shock and vibration are minimized during transport. Keep personal field gear, equipment, and samples in the same locations in the vehicle for each trip so that packing becomes routine and omissions are easier to spot. The Crew Leader should confirm that everything needed is present before departing for the field.

The FLC will provide some durable sampling equipment in the Base Kit at the beginning of the field season and will provide a Site Kit (upon request) that contains consumable supplies for each NWCA site,

including a Label Packet. Other equipment and supplies are provided by your state, tribe, or other organization. See the **Master Equipment List** (Section 2.9) and Section 2.4.5 for details.

You will use a couple of chemical solutions as part of the sampling or clean-up protocols for the NWCA, including magnesium carbonate and bleach. Magnesium carbonate solution will be part of the Base Kit provided by the FLC. You will need to prepare bleach solution or appropriate disinfecting solution for cleaning gear and equipment. If necessary, before going into the field, prepare stock solutions as described in Table 2-4. When preparing solutions, follow appropriate safety protocols, (e.g., see your state, tribe, or other organization approved safety plan and procedures).

**Table 2-4. Stock solutions, uses, and methods for preparation**

Solution	Use	Preparation
<b>Bleach (10%)</b> <i>if used</i>	Clean waders, shovels, dipper, and other gear.	Add 400mL laundry bleach to 3,600mL water.
<b>MgCO<sub>3</sub> (Magnesium Carbonate)</b>	Buffer for Chlorophyll- <i>a</i>	Dissolve 1g MgCO <sub>3</sub> per 100ml distilled water

### Vehicle Maintenance

Follow your state, tribe, or other organization approved guidelines for maintaining and operating your field vehicle.

In addition, it is important to clean the vehicle when traveling to different geographic areas (e.g., at the end of a sampling trip or at intervals during the sampling trip if traveling long distances between sites) to remove propagules of invasive plant species or other non-native biotic hitchhikers. For example, the vehicle might be routinely taken through a car wash at specified intervals.

## 2.7 Daily Field Activities

This section presents an overview of the sampling activities that a four-person Field Crew conducts during a typical one-day visit to a site, and it also presents details of protocols that pertain to the entire sampling day or to multiple individual indicator protocols.

- Safety and health considerations and guidelines related to field operations are described in Section 2.7.1.
- Guidelines for recording data are presented in Section 2.7.2.
- An overview and flowchart (**Reference Card OPS-2, Side A and Side B**) Figure 2-4 describing how to structure the field day to accomplish all sampling tasks is provided in Section 2.7.3.
- NWCA protocol tasks that apply to data collection for multiple wetland indicators are found in Section 2.6.4 including gathering information on site and sample status, guidelines for GPS use, post-sampling review of forms and samples, cleanup, and final checks.

Major sample and data collection tasks for the Veg and AB Teams are listed below in Table 2-5, along with estimated times required for their completion at sites of varying complexity.

**Table 2-5. Estimated time ranges for field activities depending on site complexity. It is anticipated that most sites will fall in the middle of these ranges. Estimates do not include travel to and from the site.**

Task	Veg Team – Hours to Complete			AB Team – Hours to Complete		
	Number of People	Range		Number of people	Range	
		Easy Site	Highly Complex Site		Easy Site	Highly Complex Site
AA - Site verification/POINT & CENTER Location/ AA establishment	2 people	0.50	1.00	2 people	0.50	1.00
Vegetation – Plot layout, Data and specimen collection	2 people	2.50	8.00			
Buffer – Transect location and data collection				1-2 people	1.00	2.50
Soil – Plot location, data and sample collection				2 people	2.00	4.00
Hydrology – Data collection				1 person	0.25	1.00
Microcystin – Sample collection and processing				1 person	0.50	0.50
Water – Sample collection				1 person	0.25	0.50
Sample/Specimen Handling and Tracking	1-2 people	1.00	2.00	1-2 people	1.00	1.50
<b>Sample Day Length = Total Hours/Site</b>		4.00	11.00		5.50	11.00
<b>Estimated Mean Sample Day Length<sup>1</sup> = ~ 8 to 9 hrs</b>						
<sup>1</sup> Estimated mean sample day length based on combined estimated minimum times for easy sites and maximum times highly complex for tasks for each team.						

### 2.7.1 Health and Safety

Collection and analysis of samples can involve risks to personal safety and health, and **the safety of the Field Crew must always be the primary consideration during sampling.** This section describes general safety considerations, some safety equipment, and safety guidelines for field operations.

**This section does not substitute for an official Health and Safety Plan. The Crew MUST ALWAYS carefully follow the protocols in their Health and Safety Plan for the NWCA field work that was approved by the state, tribe, or other organization with which the Field Crew is affiliated. A copy of this approved Health and Safety plan must be carried in the field.**

Basic health and safety considerations for field work are presented in Table 2-6. It is the responsibility of the group safety officer (state, tribe, or other organization) to ensure that necessary safety courses are taken by all field personnel and all safety policies and procedures are followed. Each state, tribe, or other organization must have a specific safety plan for the NWCA sites they sample, including a communications plan that addresses safety and emergency situations. The plan should have a daily check-in procedure for field personnel, and emergency contacts for police, ambulance, fire departments, hospitals, and search and rescue personnel.

In wetlands, a potential hazard is water overlying soft sediments. Care should be taken in situations where shallow water overlies deep soft sediments to avoid falling or becoming mired. In these situations, it is important for people to work in pairs so that one person can assist someone who is stuck in the mud. For example, a long-handled shovel can be used to help pull a person from the mud while a



second person stays on firmer ground. This is also a case where the plastic snow sled recommended in the soils protocol can be used as a platform to distribute a person's weight and enable them to crawl out of a dangerous area. This is particularly important in tidal situations. The NWCA recognizes these safety issues; a sampleable wetland AA can have no more than 10% of its area with water greater than 1-m deep or a combination of water and soft sediment that may be hazardous.

Some hazards lie out of sight beneath the surface of wetland waters or their associated ponds, rivers, and streams. Broken glass or sharp pieces of metal embedded in the substrate can cause serious injury if care is not exercised when walking or working with the hands in such environments. Infectious agents and toxic substances that can be absorbed through the skin or inhaled may also be present in the water or sediment. Personnel who may be exposed to water known or suspected to contain human or animal waste that may carry pathogens must be immunized against tetanus, hepatitis, typhoid fever, and polio. Other types of biological organisms can also be a threat (e.g., viruses, bacteria, fungi, amoebae, or parasites).

If boats are used to access sampling sites (e.g., for tidally influenced sites or wetlands fringing bodies of water), personnel must be trained in operating the type of boat in use and must consider and prepare for hazards associated with the operation of motor vehicles, boats, winches, tools, and other incidental equipment. Boat operators should be familiar with U.S. Coast Guard rules and regulations for safe boating contained in a pamphlet, *Federal Requirements for Recreational Boats*, available from a local U.S. Coast Guard Director or Auxiliary or State Boating Official and online (U.S. Coast Guard, <http://uscgboating.org/content/about.php>). Some states also require that boat operators attend a state-specific safety training program to be allowed to operate boats. All boats with motors must have fire extinguishers, boat horns, life jackets or flotation cushions, and flares or communication devices.

Field Crew members should be familiar with hazards associated with the use of sampling equipment and establish appropriate safety practices prior to their use. They must ensure that all equipment is in safe working condition. Proper field clothing should be worn to prevent hypothermia, heat exhaustion, sunstroke, or other dangers. For boat accessed sites, field personnel should be able to swim, and personal flotation devices must be worn. Chest waders made of rubberized or neoprene material, and suitable footwear should be worn with a belt to help prevent them from filling with water in case of a fall. Appropriate safety apparel such as waders, gloves, safety glasses, etc. must be available and used when necessary. First aid kits, fire extinguishers, and blankets must be readily available. Cellular or satellite telephones and/or portable radios should be carried by Field Crews working in remote areas for use in an emergency. Supplies, such as anti-bacterial soap and an adequate supply of clean water or ethyl alcohol (ETOH), must be available for cleaning exposed body parts that may have been contaminated by pollutants in the water.

Wetlands and surrounding landscapes can be home to dangerous organisms. Field Crews should take care to minimize contact with biting insects, bees, poisonous snakes and dangerous animals. Insect repellent and protective clothing will help to limit exposure. At the end of each field day, workers should inspect their bodies for ticks. Any person allergic to bee stings, other insect bites, or plants (i.e., poison ivy, poison oak, poison sumac, etc.) should take proper precautions and have any needed medications on hand. In addition, Field Crew members should always be aware of their surroundings to protect themselves from dangerous animals, such as alligators, mountain lions, bears, and wolves.

Personnel participating in field activities on either a regular or infrequent basis should be in sound physical condition and have a physical examination annually or in accordance with regional, state, tribe,

or organizational requirements. All surface waters and sediments should be considered potential health hazards due to potential toxic substances and/or pathogens.

During field research activities, it is possible that Field Crews may observe violations of environmental regulations, may discover improperly disposed hazardous materials, or may observe an accidental spill or release of hazardous materials. If this occurs, it is important that the proper actions be taken and field personnel do not expose themselves to something harmful. The following guidelines apply:

- 1) ***First and foremost, protect the health and safety of all personnel.*** Take any necessary steps to avoid injury or exposure to hazardous materials. If you have been trained to take a particular action (e.g., cleaning up a minor fuel spill during fueling of a boat), do so. However, you should always err on the side of personal safety when considering any action.
- 2) Field personnel should never disturb or retrieve improperly disposed hazardous materials from the field to bring back to a facility for "disposal". To do so may increase impact, incur personal liability or liability for the Crew Members and their respective organizations, cause personal injury, or cause unbudgeted expenditure of time and money for proper treatment and disposal of the material.
- 3) It is important not to ignore environmental incidents. Notify the proper authorities of any incident involving hazardous materials so they can take the necessary response actions. For most environmental incidents, the following emergency telephone numbers should be provided to all Field Crews: state or tribal department of environmental quality or protection, U.S. Coast Guard, and the EPA regional office. If a Field Crew is unsure about who to contact, they should call their Designated EPA Coordinator. In the event of a major environmental incident, the National Response Center may need to be notified at 1-800-424-8802.

#### ***2.7.1.1 COVID Precautions***

Safety is the number one concern for all personnel. In implementing the NWCA, crews should follow their agencies' guidance on maintaining social distance, use of personal protective equipment, travel restrictions, sanitizing equipment, vehicles and boats, and if necessary, hotel rooms. NWCA training and assistance visits will be implemented in a manner that considers Covid-19 safety requirements and restrictions.

**Table 2-6. Basic health and safety considerations for field work**

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**Recommended Training:**

- First aid
- Cardiopulmonary resuscitation (CPR)
- Vehicle safety (e.g., operation of 4-wheel drive vehicles)
- Boating and water safety (if boats are required to access sites)
- Field safety (weather, personal safety, orienteering, site reconnaissance prior to sampling)
- Equipment design, operation, and maintenance
- Handling of chemicals and other hazardous materials that might be encountered

**Communications:**

- Check-in schedule
- Sampling itinerary (vehicle used, description and license plate number, time of departure & return, travel route)
- Contacts for police, ambulance, hospitals, fire departments, search and rescue personnel
- Emergency services available near each sampling site and base location
- Cell phone or satellite phone
- Carry your Health and Safety plan and locate the nearest hospital/emergency center before you start sampling

**Personal Safety:**

- Field clothing and other protective gear (including lifejackets for boat accessed sites) for all Crew Members
- Medical and personal information (allergies, personal health conditions)
- Personal contacts (family, telephone numbers, etc.)
- Physical exams and immunizations
- Persons allergic to bee stings, other insect bites, or plants (i.e., poison ivy, poison oak, poison sumac, etc.) must take proper precautions and have any needed medications available

**General Safety Guidelines for Field Operations:**

- Two persons must be present during all sampling activities; **no one should be left alone while in the field**
- Minimize exposure to wetland water and sediments. Use gloves, if necessary, and clean exposed body parts after contact
- All electrical equipment should bare the Underwriters Laboratories approval seal and be properly grounded
- Use appropriate protective equipment (e.g., gloves, safety glasses) when handling and using any chemicals
- Handle and dispose of chemical wastes properly; do not dispose of any chemicals in the field
- Persons working in areas where venomous snakes or spiders may be encountered should check with the local Drug and Poison Control Center for recommendations on what should be done in case of a bite.
- Persons working where large predatory animals, e.g., as bears, cougars, wolves, or alligators are known, should be familiar with and take appropriate precautions for avoiding encounters that could lead to aggressive behavior or attacks
- Field personnel should protect themselves against tick bites because of potential risk of acquiring pathogens that cause Rocky Mountain spotted fever, Lyme disease or ehrlichiosis
- Where mosquitoes or other biting insects are prevalent (particularly where they are known to potentially transmit diseases such as West Nile virus), minimize exposure to bites by wearing long sleeve shirts and long pants and, as appropriate, by wearing mosquito nets or using insect repellent
- Be familiar with the symptoms of hypothermia and know what to do in case symptoms occur. Hypothermia can kill a person at temperatures much above freezing (up to 10°C or 50°F) if he or she is exposed to wind or becomes wet

**Precautions to Prevent Heat/Sun Stroke:**

- Field personnel should be familiar with the symptoms of heat/sun stroke and be prepared to move a suffering individual into cooler surroundings, hydrate immediately, and seek medical help. Some symptoms include:
    - **Heat Stroke:** Extremely high body temperature (above 103°F); red, hot, and dry skin (no sweating); rapid, strong pulse; throbbing headache; dizziness; nausea; confusion; unconsciousness
    - **Heat Exhaustion:** Heavy sweating; paleness; muscle cramps; tiredness; weakness; dizziness; headache; nausea or vomiting; fainting
  - Carry a portable shade device for areas where little shade is expected
  - Set a daily high temperature ceiling above which you should stop sampling for the day
  - Review the CDC Emergency Preparedness and Response Guidance on extreme heat (<http://www.bt.cdc.gov/disasters/extremeheat/faq.asp>).
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## 2.7.2 Procedures for Recording Data

The NWCA App data and tracking forms are formatted so that the data you record can be submitted electronically immediately after sampling. For the NWCA, there will be over 4 million data fields entered, reviewed, assured, and stored in perpetuity. The legacy of this study starts with the IM Team's ability to capture what you are communicating via the NWCA App. Thus, it is important that field data and sample information are recorded completely, accurately, and consistently. It is recommended that all field data be submitted via the NWCA app as soon as possible after sampling. Revisions can be made to the data at any time, and each new App submission automatically updates the IM Database.

### 2.7.2.1 NWCA App Forms

Detailed instructions for completing specific App forms are provided in each major indicator chapter. Some key points for completing all forms are discussed below and **standard guidelines that must be followed for recording field data are presented in Table 2-7**. . Back up paper forms will be provided to all Field Crews in the event the iPad or App fails.

**Site ID and Visit Number** – Correctly recording the Site ID and Visit number is vital to data quality. If this information is incorrect or omitted, it may be impossible to connect data or samples to a particular site, resulting in lost data. Thus, it is critical to:

- carefully select the correct State, Site ID, and Visit number as you access the initial menu selections in the App;
- enter the correct sampling date for the site into the **AA Establishment Form (AA-1)**; if a site is sampled over multiple days, use the first day of sampling as the official sampling date; the date entered on the **AA-1 form** will populate to other form headers as well, but those can each be changed manually if needed;
- enter the correct water chemistry ID into the App tracking form to allow the App to display the other sample IDs; and
- ensure that you accurately fill out the sample labels and tags for each site with the correct Site ID, Visit number, and date.

**Form Instructions** – Carefully follow all instructions on each electronic data form. Consult the appropriate protocol chapter for more detail about how to record data on a particular form.

**Data Comments** – There is space on all electronic forms to “flag” data by adding comments about samples or data that may need additional information or explanation. See Table 2-7, and Section 5.2.3.1 for examples of how to correctly comment on data.

**Table 2-7. Guidelines for recording field data and tracking information**

ACTIVITY	GUIDELINES
<b>Field Measurements</b>	
<b>Data Recording</b>	<ul style="list-style-type: none"> <li>Record observations and measurement values <b><u>only in the official NWCA App</u></b> (provided on EPA owned iPads for all regional, state, and tribal crews)</li> <li>If you make an error when recording data and changes are required, it is best to enter the new value and resubmit that electronic form.</li> <li>Use the correct crew ID assigned during field training.</li> <li>Use the units and formats specified on individual data forms for recording data.</li> <li>For any sample or data where additional explanation is needed, use the provided comment bubble adjacent to the data</li> </ul>
<b>Sample Collection</b>	
<b>Sample Labels and Tags</b>	<ul style="list-style-type: none"> <li>Use a writing instrument that leaves clear, dark text (e.g., a No. 2 pencil for tags or a waterproof and smear proof fine-point indelible marker for labels) to record information on all labels and tags.</li> <li>Use the sample-type appropriate adhesive labels or tags with preprinted Sample ID numbers for each sample. Record the Site ID, Visit number, and date sampled. Be sure to fill in any requested information about the sample on the sample label or tag, and affix it to the outside of the sample container. Cover completed labels and tags with clear tape if the label/tag is expected to get wet.</li> <li>Complete the requested information on the adhesive plant specimen sample tag and affix it to the newsprint in which the specimen is pressed.</li> <li>Completely fill out the detailed sample labels for soil chemistry and bulk density samples or plant specimens. Attach the soil chemistry or bulk density sample label to the correct soil sample bag. Place the plant specimen label inside the newsprint holding the plant specimen.</li> </ul>
<b>Sample Collection Information</b>	<ul style="list-style-type: none"> <li>Enter the water chemistry sample ID (also referred to as the anchor ID) into the tracking form in the App. Doing so will allow the app to automatically populate the other sample IDs in their respective forms.</li> <li>Record that each sample has been collected on the appropriate electronic data form.</li> <li>When targeted samples are not collected, use the sample-specific comment bubble to provide a brief explanation why the sample was not collected.</li> </ul>

ACTIVITY	GUIDELINES
<b>QA and Tracking</b>	
<b>Before Leaving Site:</b> Review of Data Forms and Comparison of Sample Labels, Data Forms, and Tracking Form	<ul style="list-style-type: none"> <li>Review all data forms for accuracy and completeness.</li> <li>Review all sample labels/tags for accuracy, completeness, and legibility.</li> <li>Verify that the information recorded on the sample labels and tags is consistent with all Sample IDs listed on the App tracking form.</li> </ul>
<b>Before Shipping Samples:</b> Review of Sample Labels and Tracking Forms	<ul style="list-style-type: none"> <li>Complete all tracking forms required for all samples being shipped. Review tracking forms for consistency and correctness.</li> <li>Compare labels and tags on samples with the Sample IDs recorded on the tracking form for accuracy and completeness before shipping samples.</li> </ul>
<b>Review of Data Forms</b>	<ul style="list-style-type: none"> <li>The Field Crew Leader should review the completed forms in the NWCA App as soon as is practicable to ensure they are complete and all data forms are consistent and correct</li> <li>Confirm that the forms have been reviewed by selecting the reviewed bubble in the App for each electronic data form.</li> <li>If any revisions are made, re-submit the updated form(s) as soon as possible to update the IM Database.</li> <li>After each submission, a data summary email will be sent to the email address which submitted the data. This data summary contains a list of the data forms and their most recent submissions date/time as well as a list of the most critical data points collected at the site. The Field Crew Leader should review this data summary to ensure that the data forms were successfully received and that critical values are present and correct.</li> </ul>

### 2.7.3 Daily Sampling Scenario (suggested sampling routine)

Field methods for the NWCA are designed to be completed in one field day at a site. Depending on the time needed for both the sampling and traveling for that day, an additional day may be needed for pre-departure and post-sampling activities (e.g., cleaning equipment, repairing gear, shipping samples, and traveling to the next site). Remote wetlands with lengthy or difficult approaches may require extended time to gain access to the wetland, and Field Crews will need to plan accordingly.

Details of all sampling protocols are described in Chapter 3 through Chapter 8 of this manual. Several other sampling tasks that cross multiple chapters are detailed in Section 2.7.4. Most chapters include reference cards that summarize key protocols required for sampling specific NWCA indicators. These reference cards are also compiled together in the in the Quick Reference Guide (QRG). The QRG is intended as a field tool to rapidly access key information; however, the full manual should always be available so that it can be consulted whenever questions about specific sampling activities emerge.

A suggested daily field sampling scenario showing how the workload may be split between the Field Crew members over the day is presented in **Reference Card OPS-2. Side A** of the Reference Card

outlines tasks for the Veg Team (Figure 2-3) and **Side B** outlines tasks for the AB Team (Figure 2-4). The entire Field Crew should be familiar with all the tasks that need to be completed in the sampling day so that they can assist one another if one Team finishes earlier than the other.

To organize field activities efficiently, each Field Crew should define roles and responsibilities for each Crew Member. Minor modifications to the sampling scenario may be made by Field Crews; however the general sequence of sampling events presented in **Reference Card OPS-2, Side A** and **Side B** should not be changed because it is based on the need to protect some types of samples from potential contamination and to minimize holding times once samples are collected.



**Reference Card OPS-2, Side A: Vegetation Team Sampling Day Activities**

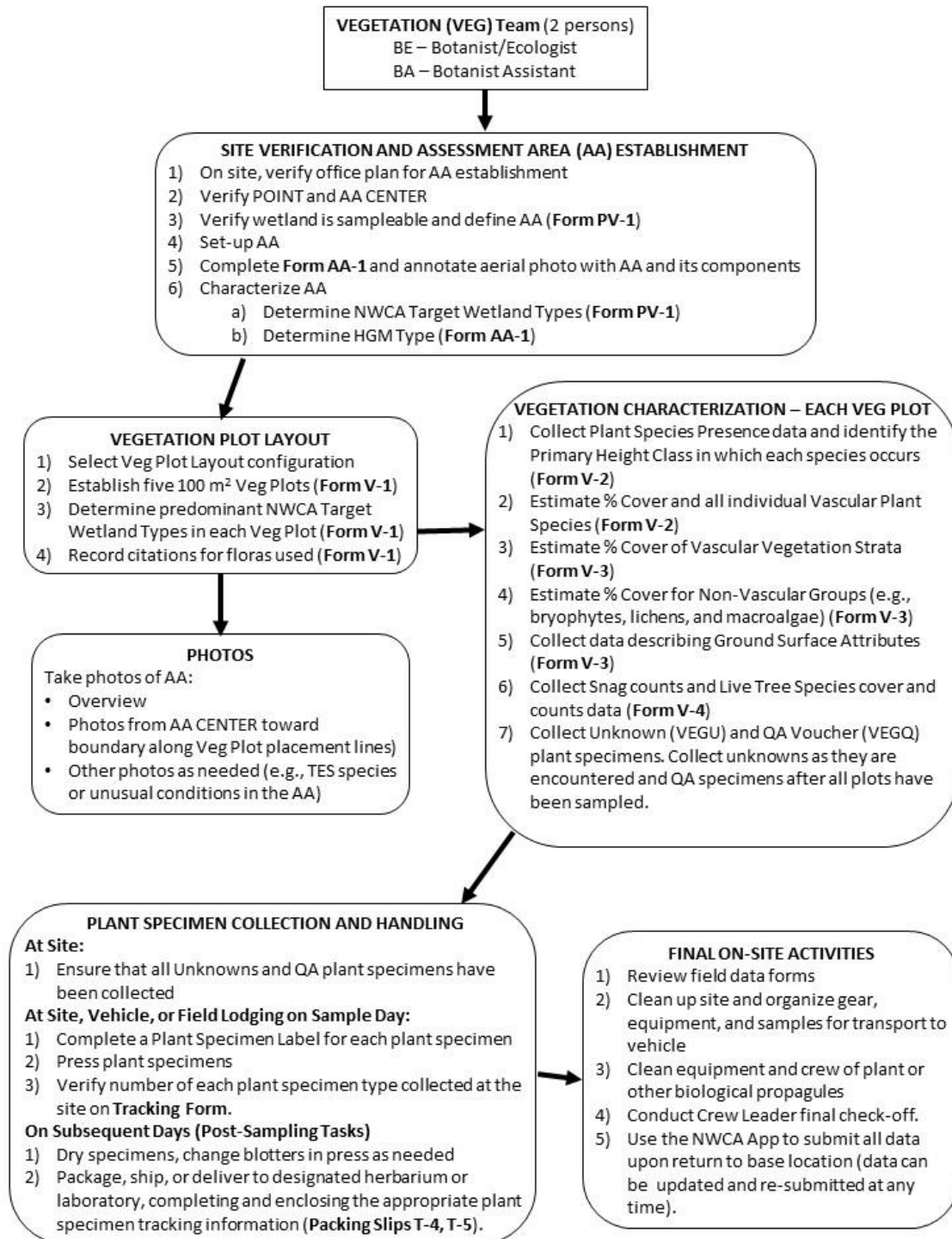


Figure 2-3. Reference Card OPS-2, Side A. Vegetation Team sampling day activities.



### Reference Card OPS-2, Side B: Assessment Area-Buffer (AB) Team Sampling Day Activities

NOTE: This guide provides a general outline of the order of activities, however, some modifications may be needed to adapt to site specific conditions (e.g., tides, site complexity).

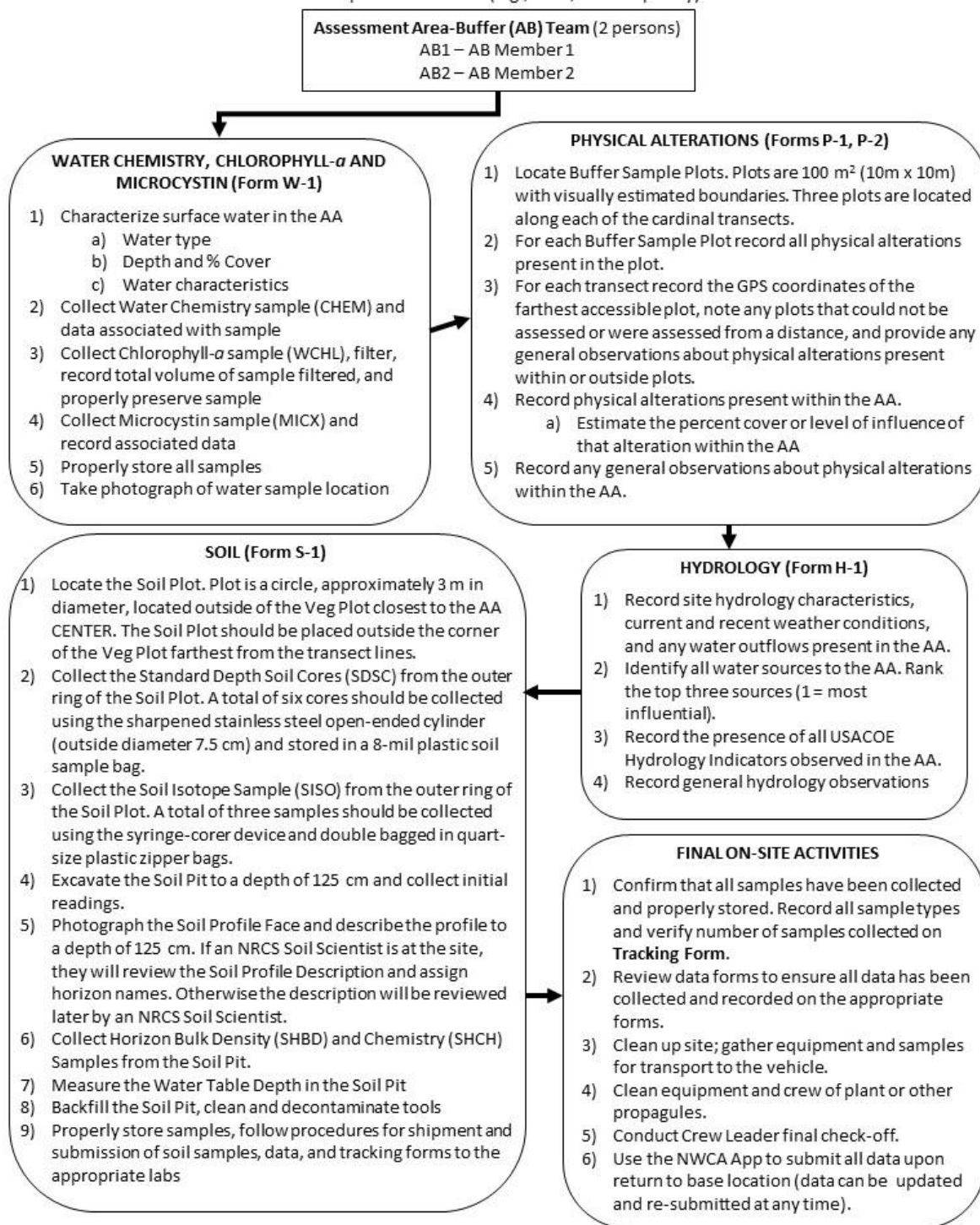


Figure 2-4. Reference Card OPS-2, Side B. Assessment Area-Buffer Team sampling activities

## 2.7.4 *Sampling Activities and Forms Applicable to Multiple Indicators or Tasks*

Sampling activities that span multiple protocols are:

- determining site and sample status (Section 2.7.4.1);
- photography (Section 2.7.4.2 and 8.7Appendix D);
- use of GPS (Section 2.7.4.3); and
- post-sampling review of the NWCA App and samples (See **Reference Card OPS-2**, Sides A and B).

The **NWCA 2021 Tracking Form** is used to track shipped samples and is discussed in Sections 2.7.4.1 and 2.8.2 of this chapter and other aspects are discussed in Chapter 5, Chapter 6, and Chapter 8.

Adhesive sample labels for several sample types (e.g., water chemistry, chlorophyll-*a*, microcystin, standard depth soil core, and soil isotope) are printed together on one label sheet for each site (Section 2.9). Each sample label is preprinted with the sample type and a unique Sample ID. Specifics of these labels are discussed with their relevant sample types in other chapters.

### 2.7.4.1 *Determining Site and Sample Status*

The **Point Verification Form (PV-1)** must be filled out for every NWCA site that is visited with the intent to sample. In some cases, this form may be partially completed during a field recon visit and then finalized by the sampling crew. It provides several key types of information:

- Point location and accessibility – This section includes directions to the site as well as any other difficulties in accessing the site. It also contains information about how the site was verified.
- Site status – Completing this section of the form indicates whether the site was sampled or not. If the site was sampled, additional information such as whether the original point needed to be shifted and the target wetland type are recorded here. If the site was not sampled, reasons for not sampling are recorded in this section of the form.

### 2.7.4.2 *Photography*

For the NWCA field work, a series of digital photographs will be taken to characterize the AA (See Chapter 3), document the presence of any threatened, endangered, or sensitive (TES) plant species (Chapter 5), and illustrate soil profiles. In addition, if the Field Crew finds something of interest that they believe should be documented, photos may be taken of these situations. See 8.7Appendix D for details on how to take and frame the photographs, how to label and track the photos, and how to upload and to save the photos and their location and identification information.

### 2.7.4.3 *Guidelines for Global Positioning System (GPS) Use*

A GPS unit is used to locate the POINT and to establish the AA at NWCA Sites (Chapter 3). It is also used to determine the coordinates of a subset of the Buffer Plots (Chapter 4), the Soil Plot (Chapter 6), and water sample location (Chapter 8). Therefore, it is imperative that the Field Crew understands how to operate their GPS unit.

GPS uses signals sent from multiple orbiting satellites to a ground-based sensor in order to fix a position on the earth. Position accuracy depends on the Position Dilution of Precision (PDOP) which is a measure of the geometry of the satellite spread over the location of the observer. Low PDOP values are typically conveyed to the user as a measure of accuracy or precision and represent more advantageous satellite geometry and therefore less locational error. For NWCA, crews should regularly monitor the accuracy

reading on their GPS and should record coordinates only after achieving the lowest amount of error possible.

GPS uses many alternative mathematical models to describe the spherical shape of the earth and each is a separate datum. Commonly used datums include NAD27 CONUS, NAD83, and WGS84. Each represents a different interpretation of the shape of the earth. The NWCA standard is NAD83. **Thus, all GPS units should be switched to this standard as part of their pre field-use set up.** Crews should confirm that the NAD83 datum is being used when the GPS is turned on prior to data collection.

GPS devices use a variety of units for position designation based on an imaginary latitude and longitude coordinate grid system laid across the earth (degrees, minutes, seconds, or degrees and decimal minutes, and UTM's (a metric system)). **The NWCA standard is decimal degrees for reporting all GPS positions.**

Refer to the GPS user's manual to provide specific instructions on setting the datum, coordinate system, and units to NWCA standards.

#### *2.7.4.4 Site, Crew, and Equipment Check and Cleanup*

Once all sampling is completed at a site, gather all equipment, remove all flagging, and return the site to as close to its original condition as possible. If the site is a revisit site, leave the flagging marking the POINT and the AA CENTER if it is different from the POINT. Before leaving the site, check that all equipment, gear, samples, and data are accounted for and ready to be carried back to the vehicle. Make a final sweep of the site to ensure nothing has been left behind.

#### **Zero Taxa Transport**

Before leaving the site, implement the Zero Taxa Transport protocol. Increases in invasive and noxious alien species are occurring throughout all regions of the U.S., with many deleterious effects on ecosystem services. Thus, it is imperative that all NWCA Field Crews employ a decontamination protocol with the goal of Zero Taxa Transport to new sites. The Site Packet or other resources that you reviewed before traveling to the site may have information about areas of the sample region known or suspected to be infested with invasive, nonnative species. If any specific invasive species are known to occur in the sample area, take species-specific precautions against transporting them. However, all sites should be treated with equal caution to minimize the spread of invasive taxa. Stringent decontamination procedures will help to prevent the spread organisms via NWCA field work.

#### **The protocol for the Zero Taxa Transport Goal has two elements:**

- procedures conducted on site or at the field location of the vehicle (this section); and
- procedures conducted from the field lodgings or base location (See Sections 2.7.4.4 and 2.8.1).

Every effort must be made to limit the potential for transport of mature and immature life stages of invasive plant and animal species, and of pathogens that may affect native plants or animals. Take precautions to avoid transporting seeds or vegetative propagules, pollen, pathogens, fungi, eggs, any small organisms, invertebrates, fish, or other animals.

**While still onsite**, before leaving to hike to the vehicle, conduct the following decontamination measures to clean off personal clothing, gear, and field equipment:

- Remove visible plants, seeds, mud and animals from equipment, gear, clothing, raingear, boots, and waders through brushing and shaking.
- Use a small scrub brush to clean the lace area and soles of boots.
- Rinse personal protective equipment including raingear, waders and wading boots if water is available on the site to remove all visible dirt, mud, and plant seeds and fragments.
- In instances where mud is clinging to gear and equipment, but no standing water is present at or very near the site; remove as much mud as possible.
- If a spray bottle with a 10% bleach solution or other approved biological disinfectant solution (See Table 2-4) is available at the site, spray down boots, waders, and soil sampling equipment before leaving the site.
- If a boat was used to access the site, prior to leaving, drain all bilge water in the boat.

**At the staging area for the site (where the vehicle is parked):**

- Repeat the on-site protocol prior to departure for base location. The initial cleaning and wipe-down at the field site by Crew Members before returning to the vehicle should minimize the potential for the road edge becoming an invasive species locus or vector.
- Ideally, a hand pressurized sprayer filled with clean water or 10% bleach solution or other approved biological disinfectant solution should be kept in the vehicle and used to rinse all gear of water from the site and to finish rinsing mud from gear.
- When site access has necessitated travel on an unimproved road, remove any vegetation debris that may have accumulated on accessible areas of the vehicle with a whisk broom before leaving the area.
- If the vehicle has collected packed mud and detritus in the wheel wells and undercarriage, run the vehicle through a car wash at the earliest opportunity, and if at all possible, before visiting another site.

## 2.8 Post-Field Sampling Base Location Activities

This section describes activities that are completed after field sampling and back at the base location. These activities are the critical final elements to complete the NWCA sampling and data collection and include:

- post-Sampling Equipment Clean-up and Maintenance (Section 2.8.1);
- sample Shipping and Tracking (Section 2.8.2); and
- data Submission (Section 2.8.3).

No reference card summarizes these tasks specifically, but many of them are noted in other protocols, reference cards, or checklists. Information on sample shipping and tracking is summarized on **Reference Card ST-1, Side A** (Figure 2-5, NWCA Sample Packaging and Shipping Flowchart), **Reference Card ST-1, Side B** (NWCA Summary of Sample Collection, Handling, and Shipping Procedures), and Reference Card ST-2, Sides A-D (NWCA Sample Shipping Guidance) from 8.7Appendix A.

### 2.8.1 Post Sampling Base Location Equipment Clean-Up and Maintenance

Once back at the base location (or at the field lodgings, if needed), complete the following clean-up and maintenance tasks.

- 1) Inspect all equipment, the vehicle, and the boat (if used) and clean off any plant propagules or fragments and animal material that were missed in the on-site clean-up procedures (Section 2.7.4.4).
- 2) Disinfect all equipment, personal gear, and boat (if used) with 10% bleach solution or other approved disinfectant solution to prevent spread of nonnative and/or invasive taxa.
- 3) Rinse and dry equipment and gear prior to storage or repacking for the next sampling trip:
  - a) Rinse waders, boots, and other personal protective gear with tap water.
  - b) Rinse chlorophyll-*a* filtration chambers three times with de-ionized (DI) water after each use.
  - c) Rinse long handled dipper three times with DI water after each use.
  - d) Rinse vegetation quadrat frames with tap water.
  - e) Rinse soil plot sampling gear (e.g., shovels, corers, augers) with tap water.
  - f) Rinse coolers with water to clean off any dirt or debris on the outside and inside.
- 4) Inventory equipment and supply needs and relay orders to the FLC or to the IM Team using the **Request Form**.
- 5) Before moving to the next site, if a commercial car wash facility is available, wash vehicle (and boat, and trailer, if used) and thoroughly clean with a hot water pressurized rinse with no soap.

## 2.8.2 Sample Shipping and Tracking

All samples are processed following specific protocols described in each indicator chapter (Chapter 5, Chapter 6, and Chapter 8). The Field Crew ships time-sensitive samples, known as immediately shipped samples (water chemistry, chlorophyll-*a*, soil isotope, and microcystin), to the designated analytical laboratories within 24 hours of collection (i.e., same day as sampling or following day) to ensure sample quality and data integrity. Other samples, called batch samples (unknown and QA plant specimens, soil horizon bulk density and chemistry samples, and standard depth soil cores) are held by the Field Crew for 1 or 2 weeks (or longer is the case of some pressed plant samples), then shipped or delivered in batches to the appropriate laboratories (See Figure 2-5 and 8.7Appendix A).

All samples must be shipped with the pertinent packing slip, which includes the site where samples were collected, the Visit number, the sample IDs of all included samples, and the date of collection. In addition to the completed packing slip included in the shipping container, shipping details for each shipment are recorded in the **Tracking Form** in the NWCA App and submitted at the time of shipping.

More detail on shipping and tracking is provided in 8.7Appendix A.

### 2.8.2.1 Shipping Groups

In order to streamline sample shipping from the field and entry of shipping details, a number of shipping groups have been designated. These groups are signified with a T# which can be found in the App tracking form, sample labels, FedEx shipping labels, and on packing slips.

Two sample groups contain samples which are time-sensitive and need to be shipped to the designated analytical laboratories within 24 hours of collection (i.e., same day as sampling or following day). Those two shipping groups are:



- T-1: Water Chemistry Samples (water chemistry and chlorophyll-*a*); and
- T-2: Daily Shipped Samples (soil isotope and microcystin).

Several kinds of samples are collected and held for up to 1 or 2 weeks. These samples, from one to several sites, are then shipped in batches by sample type to designated laboratories as one of the following shipping groups.

- T-3: Soil Samples (soil horizon bulk density and chemistry samples, and standard depth soil cores).
- T-4: Unknown Plant Samples.
- T-5: QA Plant Samples.

See Figure 2-5 and 8.7 Appendix A for shipping destinations, addresses, and packing specifications. Follow the procedures, outlined in Section 2.8.2.1, for: 1) submitting the **Tracking Form** to the IM Team for each site with samples being shipped, and 2) including the packing slip from each site in shipping boxes with samples. There should be one packing slip for each set of samples in each shipping container sent to a laboratory (i.e., if samples from multiple sites are shipped together, then multiple packing slips will be included in the shipping container).

Details on how to complete the tracking forms for individual sample types, and additional guidelines for packing samples, are covered in the relevant indicator chapters.

### **2.8.3 Data Submittal**

#### **2.8.3.1 Electronic Data**

For crews utilizing the NWCA App, after the Field Crew Leader has reviewed form content at the end of your sampling day, click the SUBMIT menu button and choose the form(s) that you wish to submit. After you have chosen which form to submit, click the green submit button at the bottom of the form list. An email will pop up on your device addressed to NARSFieldData@epa.gov. Copy yourself and any other crew members or managers and click send. To ensure that the email was sent, check the SENT mailbox on your email App and look for the recent email containing the data. If the email is not in the SENT mailbox, it was not sent and you should try again after verifying an internet connection.

After each submission, a data summary email will be sent to the email address which submitted the data. This data summary contains a list of the data forms and their most recent submission date/time as well as a list of the most critical data points collected at the site. The Field Crew Leader should review this data summary to ensure that the data forms were successfully received and that critical values are present and correct.

At any point, if it is determined that data needs to be revised or updated, crews should feel free to do so in the App and re-submit any edited data forms using the steps above. Newly revised data will supersede previous data. It is not necessary to re-submit data forms that were unchanged.

#### **2.8.3.2 Data and Tracking Reminders**

It is very important to submit the data and tracking forms immediately after every sampling event. Prompt submissions allow the FLC to closely track sampling progress. More importantly, it enables

NARS IM to track samples that were collected at each site versus those that were not, and to immediately track the shipment of the time-sensitive samples after each sampling event.

The Field Crews must promptly report any field sampling problems to the FLC and sample tracking or data reporting problems to IM Team. The FLC and IM Team will relay these issues to the EPA HQ Team throughout the sampling period, as necessary.



Figure 2-5. Reference Card ST-1 Side A. NWCA sample packaging and shipping flowchart by sample type. See Appendix A for more details



## 2.9 Master Equipment, Tracking Forms, and Sample Label Lists

### MASTER EQUIPMENT CHECKLIST

#### Base Kit

Base Kit Item (some items supplied as-needed)	Quantity	Protocol(s)
Adapter for filter funnel to stopper	3	Chlorophyll filtration
Aluminum foil or foil squares (to wrap Chlorophyll-a sample vial)	25	Chlorophyll filtration
Black plastic sheets for laying out soil slabs/cores or spoil at Soil pit (6 mil thick, roughly 4' by 5' each)	2	Soil pit
Blotter paper for plant presses	150	Veg
Box of nitrile gloves (box of 100)	1	Water collection Chlorophyll filtration
Bypass pruner	1	Veg
Cardboard ventilators for plant presses	75	Veg
Cargo Box (Rubbermaid action packer)	1	General
Centrifuge tube with screw cap type (for Chlorophyll-a filter) in bag, 50-mL - spare	2	Chlorophyll filtration
Chaining Pins	11	Veg
Chaining Pin quiver	1	Veg
Clear tape strip packs for covering labels (Packs of 25)	6	Sample labels
Clip-on weight for flexible tape measure	1	Soil Profile
Compasses	2	AA Setup Buffer plots Veg
Cubitainer, 1 Liter - spare	1	Water Chemistry Sample
Diameter measuring tape (cm)	1	Buffer Plots Veg
Disposable flat forceps - spares	2	Chlorophyll filtration
Electrician's tape for sealing sample caps	1	Shipping
Fiberglass fabric tape measure (60 inches/152 cm long) with metric scale	1	Soil Profile
Filter funnel for chlorophyll-a (250mL , reusable)	5	Chlorophyll filtration
File Folder (expandable)	1	Shipping Labels (spares)
Folding ruler (with metric markings)	1	Soil Profile Water depth measurements
Frame backpack (Teton Sport Scout 3400 cubic inch internal frame)	1	General
Garden transplanter trowel	1	Veg
Golf tees for marking soil horizons (pk of 20)	1	Soil Profile
Graduated cylinder (PPE, 250-mL)	1	Chlorophyll filtration
Hand lenses (Doublet Magnifier), 10X	1	Veg
Hand water pump (Beckson; extracting water in soil pit)	1	Soil pit
Hand-operated vacuum pump with tubing	1	Chlorophyll filtration
Heavy duty staples (Box of 5,000)	1	Soil Samples
Heavy-duty hand operated stapler (for soil sample bags)	1	Soil Samples
King Sampler	1	Soil profile

<b>Base Kit Item (some items supplied as-needed)</b>	<b>Quantity</b>	<b>Protocol(s)</b>
Laminated Quick Reference Guide	1	General
Laser rangefinder (Nikon 6x20 Prostaff 1000)	1	AA Setup Buffer plots
Magnesium Carbonate (MgCO <sub>3</sub> ) saturated solution in dropper bottle	1	Chlorophyll filtration
Metal flashing 10" tall for supporting/sealing earthen coffer dam built from Soil Pit spoils for inundated soils (10' rol)	1	Soil Pit
Munsell Color X-Rite Soil Color Charts	1	Soil profile
Open Reel Fiberglass tape measure, 100-m	2	AA Setup Buffer plots Veg
Packing tape rolls	2	Shipping
Packing tape with dispenser	1	Shipping
Plant press with straps	2	Veg
Plastic amber bottle (for Chlorophyll-a collection), 1 Liter	1	Chlorophyll collection
Plastic bottle with screw lid (microcystin bottle), 125-mL - Spare	1	Microcystin sample
Putty knife (to shear off excess core), 1 ½ inch	1	Soil Samples
PVC pole (1-m) with 90 degree coupler for 1-m <sup>2</sup> quadrat	2	Veg
PVC pole for 1-m <sup>2</sup> quadrat (1-m with no coupler)	4	Veg
Quart-size zipper plastic bags - spare	10	Soil Isotopes
Rope (30-m, marked at 10 and 20 meters) for marking outer edges of Veg Plots	1	Veg
Rope for inside edges of 10-m <sup>2</sup> quadrat, 6.32-m, marked in the middle	2	Veg
Rubber stopper with hole for filter funnel to attach to flask	2	Chlorophyll filtration
Ruler with metric markings for measuring plant parts during field keying, 6-inch	1	Veg
Sharpie® or comparable fine-point, permanent, silver marker	2	AA Setup
Sidearm filter flask, 500-mL	1	Chlorophyll filtration
Small envelopes (Glassine) for loose plant parts	50	Veg
Small scoop for bailing water from pit (measuring cup)	1	Soil Pit
Small, soft-sided cooler	1	Soil Isotopes Water chemistry Microcystin Chlorophyll-a
Soil bulk density core (3" OD)	3	Soil Samples
Spray bottle (8 oz)	1	Soil Profile
Squirt bottle for DI water, 1 Liter	1	Chlorophyll filtration
Stake flags (5" x 8" flag, 36" wire stakes) - pack of 100 (red)	1	AA Setup Buffer plots Veg
Stake flags (5" x 8" flag, 36" wire stakes) - pack of 100 (blue)	1	AA Setup Buffer plots Veg
Stylus with tether for use with iPad	2	General
Surveyor's flagging tape rolls (red)	2	AA Setup Buffer plots Veg

Base Kit Item (some items supplied as-needed)	Quantity	Protocol(s)
Surveyor's flagging tape rolls (blue)	2	AA Setup Buffer plots Veg
Syringe core sampler (60-mL plastic syringe with end cut off) - spare	2	Soil Isotopes
Tote (3 gallon Rubbermaid; packed with smaller items)	1	General
Twist-ties for attaching Tyvek tags (In bag)	50	Veg
Tyvek tags for marking unknown plant species (In bag)	50	Veg
U-shaped pins/stakes (landscape staples)	1	Veg
Water dipper assembly with extendable handle	1	Water collection
Whatman GF/F 0.7 µm glass fiber filter (47-mm diam.) (Box of 100)	1	Chlorophyll filtration
White bags for consolidating plant collection bags, 13-gallon (box)	1	Veg

### Site Kit

Site Kit Item	Quantity	Protocol(s)
Label Pack with sample labels and packing slips <i>Arrives in separate FedEx package with one label pack per ordered site kit</i>	1	Sample labeling and shipping
Quart-size zipper plastic bags	2	Soil Isotope Samples
Small cooler for daily shipped samples (with liner)	1	Sample shipment
Medium Cooler for water shipment (if requested) with liner	1	Sample shipment
Collapsible 1-liter cubitainer for surface water sample	1	Water Chemistry Sample
125-mL plastic bottle with screw lid	1	Microcystin sample
60-mL syringe core sampler (soil isotope samples)	1	Soil Isotope Samples
50-mL Centrifuge tube with screw cap in zip-top bag (for holding Chlorophyll-a filter)	1	Chlorophyll-a
Disposable flat blade forceps	2	Chlorophyll-a
Nitrile gloves, disposable (Pair)	1	Water Collections Chlorophyll filtration
Shipping supplies (FedEx shipping airbills, handle tags, zip ties, FedEx envelope, APHIS Soil isotopes permit)	-	Sample shipment

### Crew Supplied Items

Crew Supplied Items	Quantity	Protocol(s)
Plant species lists pertinent to the site and/or region (wetland species, alien species, threatened and endangered species)		Veg
Binoculars	1	Buffer Plots
Blue ice to fit soft sided cooler (or wet ice)		Water Samples Soil Isotopes
Bucket auger with interchangeable extension handles and appropriate head(s) for anticipated soil conditions (regular, mud, sand, dutch, etc.). A ratchet handle crossbar may often be useful.	1	Soil Pit
De-ionized water		Chlorophyll filtering
Digital camera with batteries and memory card	1	AA Setup
Dissecting tools (e.g., single edge razor blades, forceps, and dissecting needles)		Veg
Extra batteries for range finder		AA Setup Buffer plots

<b>Crew Supplied Items</b>	<b>Quantity</b>	<b>Protocol(s)</b>
Field clipboards	2	General
GPS unit loaded with coordinates for the POINT, manual, extra battery pack	1	General
Indelible markers to write on flagging	2	AA Setup
Lengths of marked rope for measuring and laying out Veg Plots (size and number at crew's discretion)	1 to 4	Veg
Paper towels		General
Pencils	Multiple	General
Permanent marker (Fine-tip for labels)	2	Sample labels
Regional floras		Veg
Sharp knife shaving soil slices to expose fresh surface, for cutting out bulk density samples in difficult soils (e.g., peat, or saturated soils extracted with the King tub extractor method).	1	Soil Pit
Site packet with maps with POINT marked, directions to the POINT, access information		General
Small flashlight for viewing <i>in situ</i> soil profile in Soil Pit	1	Soil Profile
Sprayer and disinfectant for decon of equipment	1	General
Tiling or Sharpshooter style shovel	1	Soil Pit
Waterproof boots (waders, hip boots, or knee boots as site conditions dictate)		General
Waterproof field notebook	2	General
<b>OPTIONAL ITEMS</b>		
2-way hand-held radios (with extra batteries or charger)	2	General
3.16 m PVC poles to mark the 10 m <sup>2</sup> veg plot quadrat	2	Veg
Appropriate size leak-proof, screw-cap containers (e.g., Nalgene) for additional calibration solutions		Optional water quality parameters
Basic tools (assorted screwdrivers, Allen wrenches)		General
Board for laying across steel soil corer or King sampler to facilitate using a hammer		Soil Samples
Calibration cup with removable cove, DO membranes, backup probes and spare parts (o-rings, etc)		Optional water quality parameters
Field Meter calibration kit (can be contained in a good quality, plastic box, e.g. tackle box) and should contain:		Optional water quality parameters
Field vest to carry tools and small equipment		General
Hammer or mallet for driving steel soil corer or King sampler		Soil Samples
Metal shears for cutting coffer dam flashing material	1	Soil Pit
Multi-Probe Field Meter (dissolved oxygen, pH, conductivity, temperature)	1	Optional water quality parameters
pH buffers		Optional water quality parameters
Plastic sled (for soil sampling)	1	Soil Pit
Stainless steel soil probe (approximately 7/8" diameter) - alternate collection device for soil isotope samples		Soil Isotopes
Thermometer		Optional water quality parameters

Other Items (Ordered as Needed)

<b>Other as needed items</b>	<b>Protocol (s)</b>
Herbarium folders with zip-top bags	Shipping
Plant shipping box*	Shipping
Large cooler with liner for shipment of soil samples†	Shipping
Soil bags with horizon tags (pack of 15 each)	Soil Samples

\* Plant shipping boxes will come with a T-4/T-5 FedEx shipping label for use with unknown and/or QA plant samples going to the nationally contracted lab.

† Soil coolers will come with a T3 FedEx shipping label for shipment of soil samples to the NRCS soil lab

**SAMPLE LABELS AND TAGS**

- Water Chemistry Sample Label
- Chlorophyll-*a* Sample Label
- Chlorophyll-*a* Outer Bag Label
- Microcystin Sample Label
- Soil Isotope Sample Label
- Standard Depth Soil Core Label
- Standard Depth Soil Core Tag
- Soil Horizon Chemistry Label
- Soil Horizon Bulk Density Label
- Soil Horizon Chemistry/Bulk Density Tag
- Unknown/QA Plant Specimen Label
- QA Plant Folder Label
- Unknown Plant Folder Label

**PACKING SLIPS**

- T1: NWC21 Daily Water Chemistry Sample Tracking
- T2: NWC21 Daily Chilled Tracking
- T3: NWC21 Soil Chemistry & Bulk Density Sample Tracking
- T4: NWC21 Unknown Plant Tracking
- T5: NWC21 QA Plant Tracking

**FIELD FORMS IN THE APP**

- NWCA 2021 Point Verification Form (PV-1)
- NWCA 2021 Assessment Area Establishment (AA-1)
- NWCA 2021 Assessment Area Hydrology (H-1)
- NWCA 2021 Assessment Area Water (W-1)
- NWCA 2021 Assessment Area Physical Alterations (P-1)
- NWCA 2021 Buffer Area Physical Alterations (P-2)
- NWCA 2021 Soil Data (S-1)
- NWCA 2021 Vegetation Plot Establishment (V-1)
- NWCA 2021 Vascular Species Presence and Cover (V-2)
- NWCA 2021 Vegetation Types / Ground Surface Attributes (V-3)
- NWCA 2021 Snag and Tree Counts and Tree Cover (V-4)
- NWCA 2021 Sample Tracking Form

## Chapter 3 Establishing the Assessment Area

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The Assessment Area (AA) represents the POINT. The POINT is the location defined by the coordinates generated by the NWCA sample draw. Proper placement of the AA is crucial because it defines the area where most of the data collection for the NWCA occurs. The principles guiding AA establishment are:

- 1) the NWCA sampling protocols are designed to produce an assessment of the ecological condition of wetland area at the POINT. This approach assumes that condition can change spatially, especially in a large wetland;
- 2) the area sampled is large enough to accurately characterize the wetland area at the POINT using rapid (Level 2) or comprehensive (Level 3) assessment methods (e.g., see Wardrop et al. 2007a, b) but is small enough to be sampled in one day (Kentula and Cline 2004, Fennessy et al. 2008);
- 3) the POINT has been evaluated according to the procedures in the NWCA 2021 SEG and was determined to be sampleable; and
- 4) the boundaries of the AA encompass the POINT.

### 3.1 Develop a Plan for AA Establishment (In Office) and Verify (In Field)

A Desktop Evaluation as described in the NWCA 2021 Site Evaluation Guidelines is conducted for all POINTs to begin the process of determining if they are sampleable. The determination of whether the AA is sampleable starts with an analysis in the office and is completed in the field. If the site can be definitively determined as non-sampleable in the Desktop Evaluation, follow the instructions in the Site Evaluation Guidelines to document this observation and select an alternate site. Often, a field reconnaissance will also be conducted to confirm that a site is sampleable and to aid in developing an AA establishment plan.

Once the Desktop Evaluation and any field reconnaissance have been completed, an AA Establishment Plan is developed for the potentially sampleable sites. Note, it is possible that a site that appears sampleable in the office or on a reconnaissance visit may ultimately have obstacles to sampling upon arrival at the site on the scheduled sampling date.

For each potentially sampleable POINT, a plan for AA establishment (Section 3.1.1) is developed in the office. The protocol for verifying the plan for AA establishment (Section 3.1.2) is completed as part of Field Evaluation described in the Site Evaluation Guidelines or, if that is not possible, as part of the AA establishment as described in this protocol. The details of the plan for AA establishment, including any information on the site obtained during Field Reconnaissance (e.g., **Point Verification Form (PV-1)** in the App, completed during reconnaissance), are added to the materials in the Site Packet.

#### 3.1.1 Develop Plan in the Office

Develop a plan for AA establishment using the aerial photos in the Site Packet, other supporting information, and the general procedures below.

- 1) Determine whether a field reconnaissance was conducted and directions to the POINT were developed and recorded in the **Point Verification Form (PV-1)** of the App. If a field reconnaissance

was not conducted, use the materials in the Site Packet to develop directions and record them in the *Directions to POINT* field on the **Point Verification Form (PV-1)** to be used for accessing the site.

If the site is tidally influenced, consider stage of tide in scheduling sampling of the POINT. The best way to maximize time in the field is to plan to arrive at the site at or slightly before the time that it is exposed at low tide.

- 2) Annotate the aerial photo encompassing the POINT with the details of the plan for AA establishment. Other photos and supporting material (e.g., wetland maps) may be needed to confirm details depicted on the aerial photo chosen.
- 3) Use the key on **Reference Card AA-1** to determine the appropriate AA layout. See Section 3.2 to determine how the selected layout will likely encompass the POINT, and for details on laying out the AA in the field. See examples of the possible AA layout types on **Reference Card AA-1** (Figure 3-1 and Figure 3-2) and in Figure 3-6 to Figure 3-9.
- 4) Determine if the AA is sampleable. The criteria for what is sampleable is detailed in **Reference Card AA-2, Side A** (Figure 3-3). See **Reference Card AA-2, Side B** (Figure 3-4) for examples of Hydrogeomorphic (HGM) boundaries or types to avoid crossing or mixing within an AA. The process of determining if the AA is sampleable starts with the analysis in the office then is completed or verified in the field.
- 5) Begin the AA establishment plan by annotating the aerial photo to clearly indicate the following:
  - True North.
  - POINT.
  - AA CENTER.
  - AA boundaries.
  - Bearings and estimates of important distances (e.g., Figure 3-8).
  - Other information as useful.

See examples of the possible AA types and annotations of the photos in Figure 3-6 to Figure 3-9. In our experience, a Sharpie® (or similar) fine-point, permanent, silver marker that can be purchased at many retail stores works well to annotate the photo. Alternatively, crews can create a digital map and annotate electronically or print and annotate in the field.

- 6) Indicate the photo was annotated by filling in the bubble on of **AA Establishment Form (AA-1)** under *Annotated Aerial Photo or Map* and place all materials in the Site Packet. This annotated photo or map will be submitted via SharePoint by the Field Crew.

Reference Card AA-1: Assessment Area Establishment, Side A

**Key to Assessment Area (AA) Layouts**

**1a** Sampleable area contains POINT (original or shifted) and is  $\geq 0.5$  hectares (ha) ..... **2**

**2a** Sampleable area can contain a circular area with a diameter of 80m ..... **3**

**3a** POINT is at the center of sampleable area ..... **Standard Circular AA (Plate 1)**

**3b** POINT (original or shifted) is not at the center of sampleable area ..... **Standard Circular AA-Shifted (Plate 1)**

**2b** Sampleable area contains POINT (original or shifted) but ranges from minimum width 20m (length 250m) to maximum width of 79.5m (length 63m) ..... **Polygon AA (Plate 2)**

**1b** Sampleable area contains POINT (original or shifted) and is  $< 0.5$ ha but  $\geq 0.1$ ha ..... **Wetland Boundary AA (Plate 3)**

**Sampleable Area:** No more than 10% of the AA can contain upland, non-target wetland, standing water greater than 1m deep, or soft substrate that is unsafe or impossible to sample.

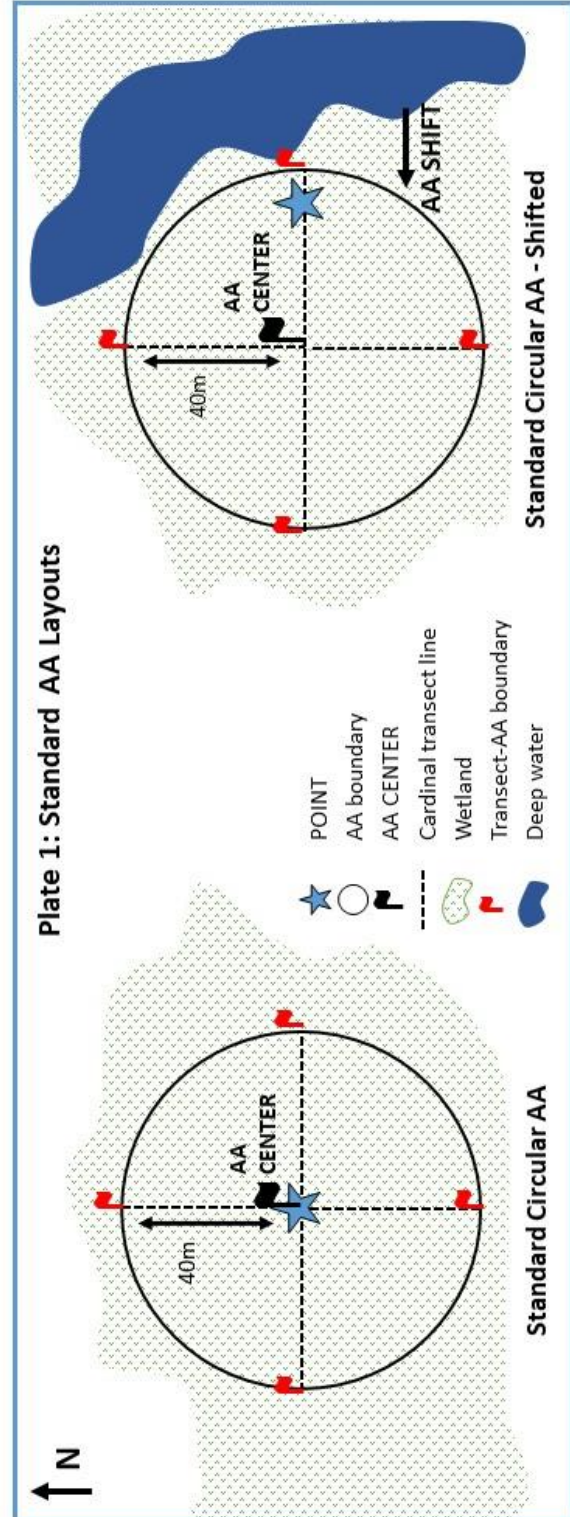


Figure 3-1. Reference card AA-1 Side A



# Reference Card AA-1: Assessment Area Establishment, Side B

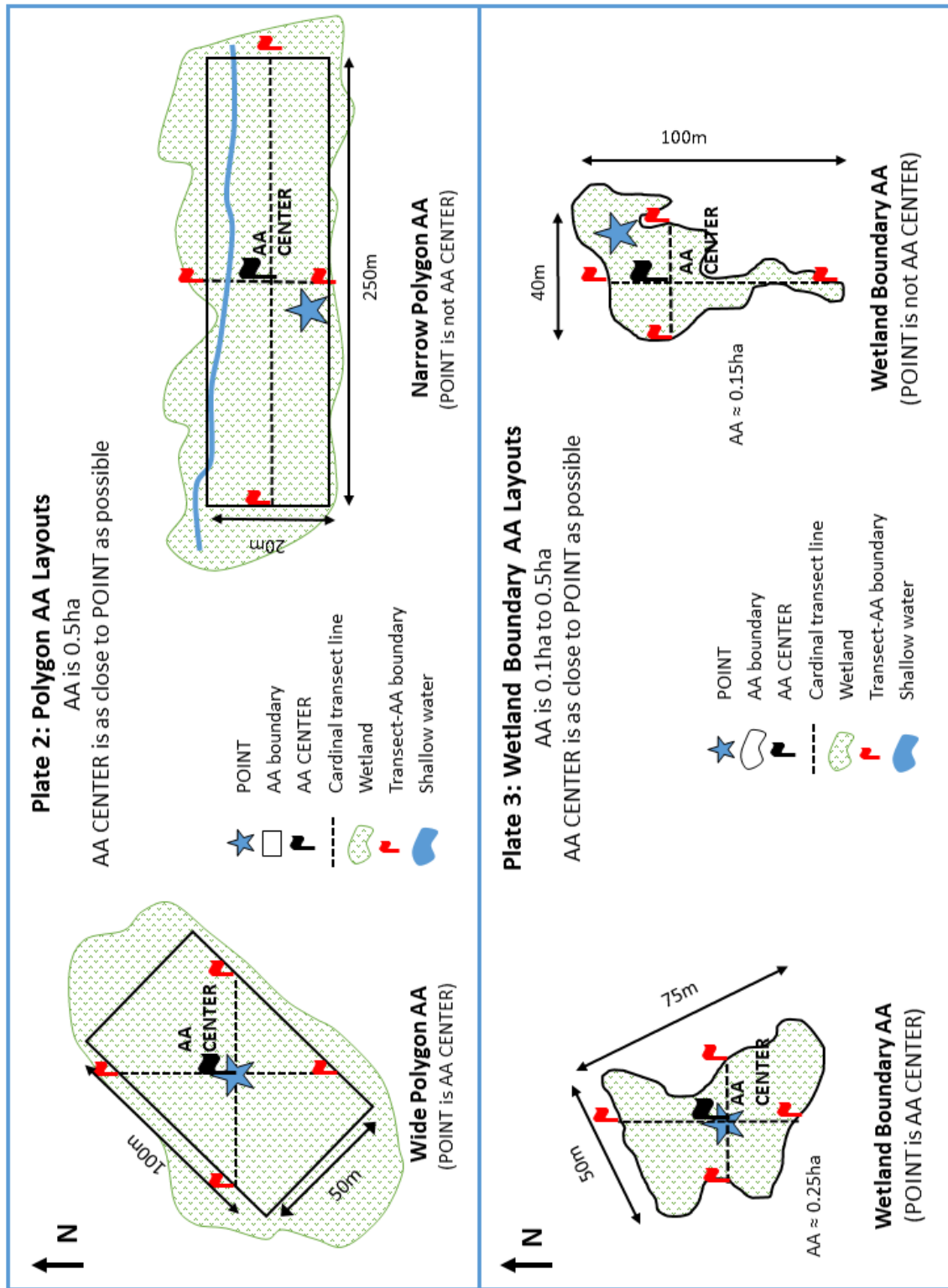


Figure 3-2. Reference card AA-1 Side B

### 3.1.2 Verify Plan in the Field

Any plan for AA establishment developed prior to the date of sampling is checked in the field to assure that it fits the situation on-the-ground. Ideally, plan verification is done as part of the Field Evaluation as described in the NWCA 2021 Site Evaluation Guidelines.

- 1) Prior to sampling, the Field Crew reviews the plan for AA establishment (Section 3.1.1).
- 2) After travelling to the vicinity of the POINT, one person from the Field Crew should review the annotated maps and assess the best way to approach the POINT while the other crew members wait outside the likely AA boundaries.
- 3) A Field Crew member uses a GPS to navigate to the POINT and marks it with flagging labeled "POINT." If there are obstacles to getting to the POINT (e.g., deep water), flagging is placed as close to the POINT as possible and labeled with the approximate distance and direction to the POINT's actual location (e.g., 5 m, 120° from the flagging to the POINT). Always use True North bearings for all directional references.
- 4) Begin filling out **Point Verification (PV-1) and AA Establishment (AA-1) Forms** :
  - When accessing the data forms in the App, be sure to select the correct State, Site ID, and Visit Number. Visit #1 is the primary sampling event; Visit #2 is the second sampling visit to a revisit site.
  - Enter field sampling date by hitting the "Today" button on the **AA Establishment Form (AA-1)**. If sampling occurs over multiple days, enter the first date of sampling here and manually change dates on other forms as needed.
  - Complete the *Field Crew Personnel* section in the **AA Establishment Form (AA-1)**.
  - Provide the requested information in the *POINT Location and Accessibility* section on the **Point Verification Form (PV-1)**.
- 5) Complete the **Point Verification Form (PV-1)** – Determine whether the POINT is sampleable (See **Reference Card AA-2, Side A** (Figure 3-3)) and indicate this under the 'POINT SAMPLE INFORMATION' Section on the **Point Verification Form (PV-1)** by selecting the YES or NO check box, as appropriate. Once one of the check boxes is selected, an additional window will open to allow additional data entry (see below):

**If YES:**

- Fill in the bubble identifying whether the '*original POINT is sampleable*' OR the '*POINT could be shifted less than or equal to 60m*'.
  - The Field Crew, from their respective vantage points (the vicinity of the POINT and outside the likely AA boundary), should work together to identify the predominant wetland type at the POINT and determine whether it is part of the *target population* (e.g., *NWCA Target Wetland Type*; see **Reference Card AA-3, Side A** (Table 1-1) and **Reference Card AA-4** (Figure 3-5)). After determining the predominant wetland type, document it under the 'POINT SAMPLE INFORMATION' section on the **Point Verification Form (PV-1)**. Target wetland types are listed under the YES category, while various reasons for not sampling (including non-target wetland type) are listed under the NO category.
  - *If the wetland type is excluded from the NWCA target population, do not sample the*

site. Instead, follow the procedures in Section 2.6.2 and in the SEG for selecting an alternate POINT (i.e., an alternate NWCA site).

**If NO:** select the reason by filling in the appropriate bubble under one of four non-sampleable categories on **Point Verification Form (PV-1)**, including:

- Non-Sampleable – On This Visit;
- Non-Sampleable – No Access Categories;
- Non-Sampleable – AA Cannot Be Established; or
- Non-Sampleable – Non-Target Categories.

**Provide Comments**, if needed, regarding reasons for non-sampleability, or factors related to accessing the site, in the pertinent *Comment* bubble(s) on the **Point Verification Form (PV-1)**. Use the **General Assessment Comments** to record any additional information and observations of the POINT or surrounding area.

- 6) **Recording Data on AA Establishment Form (AA-1)** – Determine whether an AA that contains the original POINT can be established at the site. Document by selecting the appropriate data bubble, Yes or No, under the 'AA ESTABLISHMENT' section of the **AA Establishment Form (AA-1)**. Doing so will reveal additional data fields specific to that selection.

**If YES:** Continue with establishing the AA (Section 3.2).

**If No:** Proceed to the '*Can an AA be established if the POINT is shifted  $\leq$  60m of the ORIGINAL POINT?*' field and answer Yes or No by selecting the appropriate bubble.

- **If Yes**, document the reasons for shifting the POINT in the *Point Establishment Comments area* in the AA ESTABLISHMENT section and follow the directions for shifting the POINT in Section 3.2.3, AND record the GPS coordinates (in decimal degrees using NAD83) for the Shifted POINT.
- **If No**, document the reasons in the *Point Establishment Comments area* of the **AA Establishment Form (AA-1)**. Then, follow the procedures for selecting an alternate POINT (i.e., an alternate NWCA site) in the Site Evaluation Guidelines.

**The AA is sampleable if ALL of the following criteria are met:**

- The AA contains the POINT (original design or shifted) and ranges in size from 0.1ha to 0.5ha.
- The AA is at least 20m wide<sup>b</sup> to accommodate the vegetation plots (see Chapter 5).
  - <sup>b</sup> It is allowable for the AA to fall below the width of 20m in some locations, as long as Veg Plots can be placed adequately.
- No more than 10% of the area of the AA:
  - has water greater than 1m deep<sup>d</sup>;
  - has standing water or soft substrate that is unsafe or impossible to sample effectively; and/or
  - has upland or non-target wetland type (see definition of wetland below).
- <sup>d</sup> One meter is the minimum water depth sampled in the National Lakes Assessment and, thus sets the boundary between open water and fringing wetlands used in the National Aquatic Resource Surveys.
- The sampleable area contains one or more of the NWCA Target Wetland types representing the NWCA target population. See Reference Card AA-3, Side A for a list of target wetland types.

The **NWCA Target Population** is defined as: *Tidal and nontidal wetlands of the conterminous U.S., including certain farmed wetlands not currently in crop production. The wetlands have rooted vegetation and, when present, open water less than 1 meter deep.*

The NWCA defines wetlands using the classification system described by Cowardin et al. (1979) and established as a Federal Geographic Data Committee (FGDC) standard for classification of wetlands:

*Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following three attributes:*

- 1) *at least periodically, the land supports predominantly hydrophytes;*
- 2) *the substrate is predominantly undrained hydric soil, and*
- 3) *the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year (FGDC 2013).*

Examples of characteristics that could be used in the field to identify whether the AA is wetland include:

- predominance of hydrophytic vegetation;
  - presence of plants with morphological or structural adaptations for growing in wetland soils, e.g., buttressed tree trunks, multiple trunks, pneumatophores, adventitious roots, hypertrophied lenticels, polymorphic leaves;
  - visual observation of soil saturation and/or inundation;
  - presence of undrained hydric soil;
  - presence of indicators of wetland hydrology. e.g., drift lines, watermarks, sediment deposits; and
  - geomorphic boundaries such as the active floodplain or flood-prone width.
- The AA does not cross any Hydrogeomorphic boundaries (see Side B).

Figure 3-3. Reference Card AA-2 Side A.

### Reference Card AA-2, Side B. Hydrogeomorphic Boundaries and Human Altered Types

#### Examples of Hydrogeomorphic Boundaries or Mixes of Types to Avoid in Establishing the AA

The AA should not include:

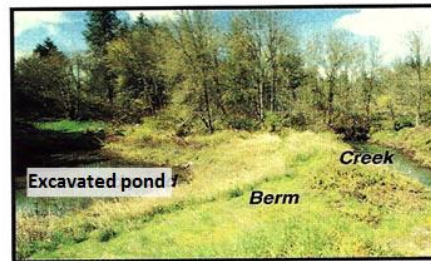
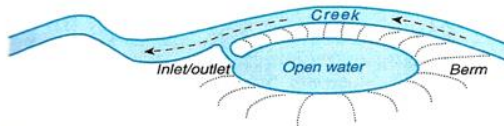
- A mix of tidal and nontidal wetlands;
- A tributary to the river or stream associated with the POINT; or
- A combination of lacustrine fringe or riverine wetlands and the seeps or springs (i.e., slope wetlands) upslope from them, in other words, the hydrogeomorphic (HGM) types are distinct (excluding any transition zone).

Alternatively, an AA can include a mosaic of HGM types (see Riverine Complex on **Reference Card AA-3, Side B**) or drainage channels typical in tidal and lacustrine fringing wetlands.

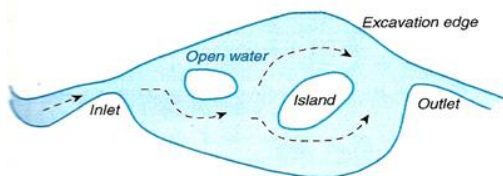
#### Examples of Human Altered Hydrogeomorphic Types

Alteration of the hydrogeomorphic (HGM) class of a site that has been altered or disturbed may change the class or create a hybrid HGM class. To avoid these problems, the site should be placed in the “human” class associated with the original HGM type (see **Reference Card AA-3, Side B**).

##### Riverine – Human Altered



##### Riverine – Human Altered



##### Slope – Human Altered

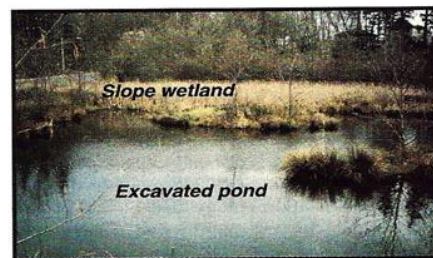
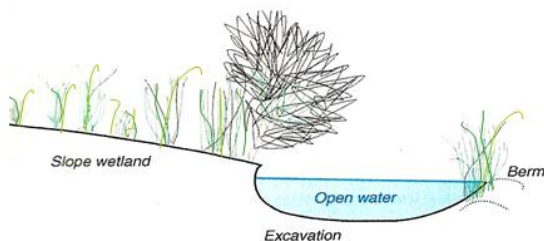
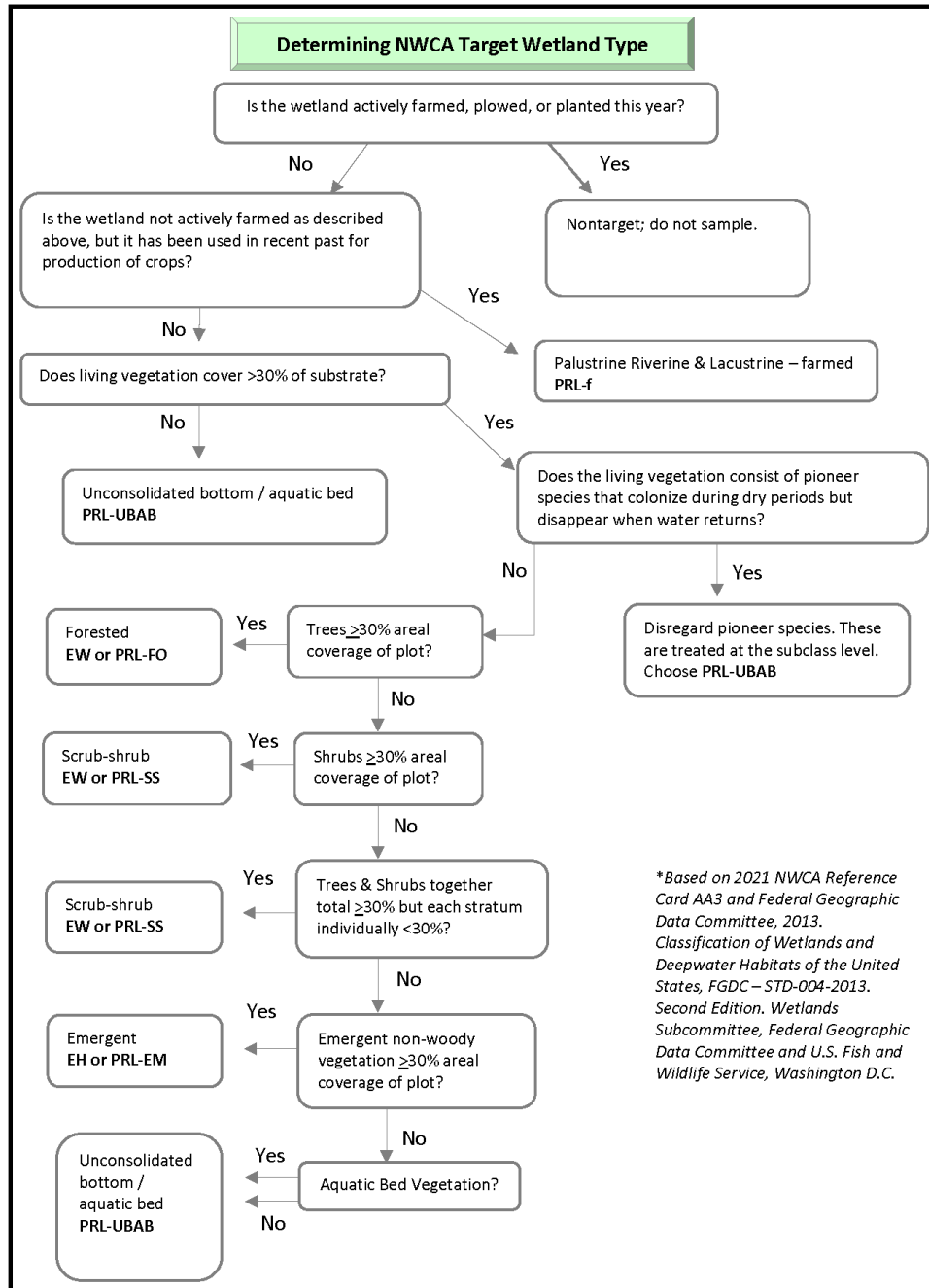


Figure 3-4. Reference Card AA-2 Side B.

Reference Card AA-4. Flowchart for Determining NWCA Target Wetland Type



Refer to 2021 NWCA-Field Operations Manual – Chapter 3,5 for detail on protocols summarized on this card.

Figure 3-5. Reference Card AA-4. Flowchart for determining NWCA target wetland type.

### 3.2 Establish the AA

In many cases, using a GPS while walking the AA boundary will be the most efficient way to establish the AA and calculate its area. Alternative strategies may be required depending on site conditions and



satellite availability. A laser rangefinder, meter tapes, and ropes of appropriate lengths may also be useful. For example, it may be easier to use a rangefinder or meter tape than a GPS for an open wetland with low vegetation, especially for a Standard Circular AA. Two-way radios or cell phones (assuming reception) would facilitate communication between the people setting up the AA.

The Field Crew should minimize trampling of the AA, especially prior to sampling vegetation. This can be accomplished by taking efforts to avoid the areas where the Vegetation Plots will be located, by maneuvering around patches of vegetation (as feasible), and by walking in single file on the same path.

### 3.2.1 Standard AA Layouts

There are two standard AA layouts—a circular AA or a circular AA that is shifted to allow the AA to fit in wetland space at the site.

#### 3.2.1.1 Standard Circular AA

The Standard Circular AA is a circular plot with a 40-m radius (80-m diameter) centered on the POINT (Figure 3-6 and **Reference Card AA-1, Plate 1**).

In the field, for sites that are fairly open, it may be easiest to use a laser rangefinder or tape to set up the AA. For example, the Field Crew member at the POINT locates the AA boundary by using the rangefinder to determine a distance of 40 m by sighting on a metal clipboard or other reflective object carried by the Field Crew member walking the AA boundary. This Field Crew member flags the boundary as often as site conditions warrant and works with the person at the POINT to place labeled flags where the cardinal compass directions from the POINT cross the AA boundary.

Complete the *AA Layout Used* field in the AA ESTABLISHMENT section of the **AA Establishment Form (AA-1)** by selecting *Standard Circular AA* from the drop-down list, 0.5 ha auto-populates for the area of the AA, and *POINT is the AA CENTER* auto-selects from the *Location of AA CENTER* drop-down list. Record the GPS coordinates (in decimal degrees using NAD83) for the AA CENTER

Once the cardinal directions are marked at the AA boundaries, the Veg and AB Teams can proceed their other sampling activities.

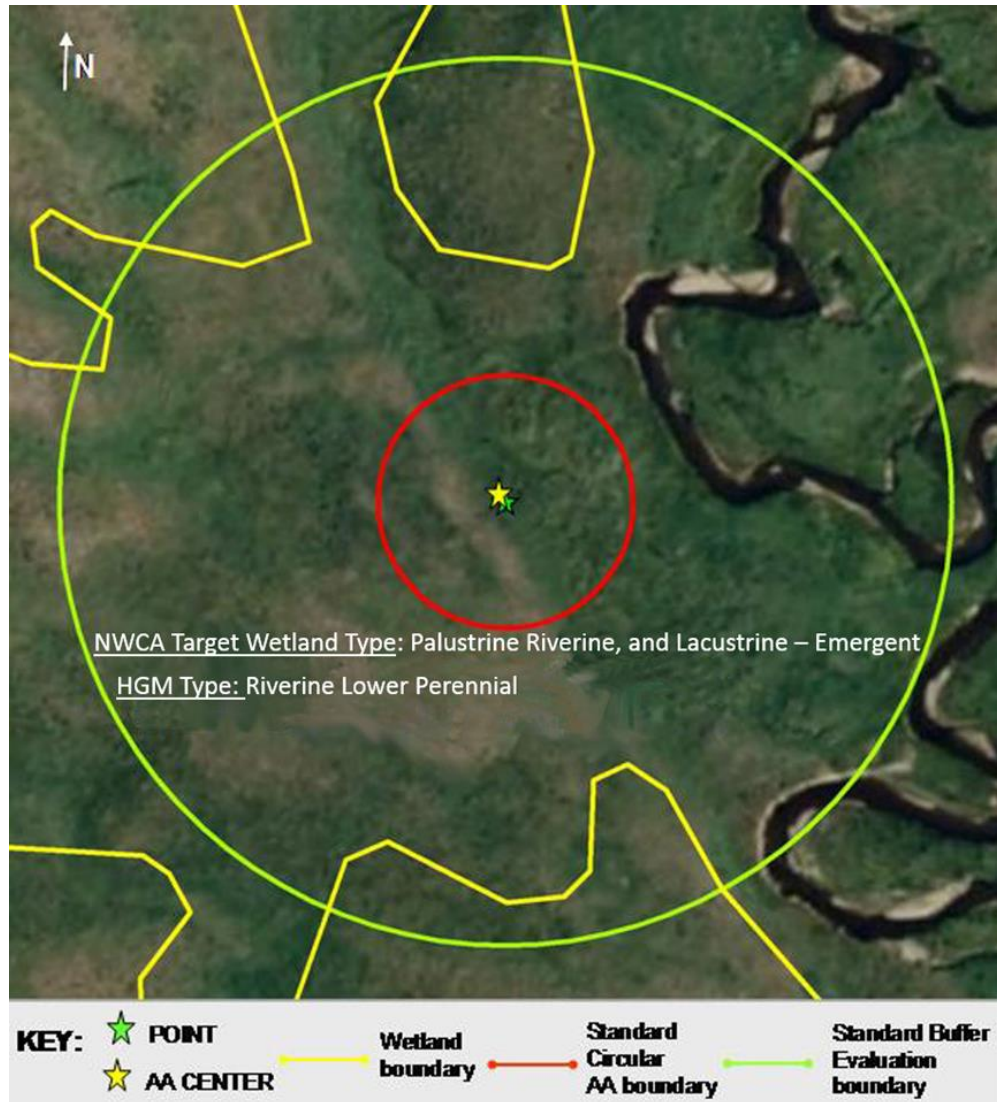


Figure 3-6. The Standard Circular AA layout with the standard boundary for buffer evaluation is depicted on an example annotated aerial photo (note that in a true standard circular layout the POINT and AA CENTER would be in the same spot; they are slightly askance in order to depict both on this example map).

### 3.2.1.2 Standard Circular AA-Shifted

The Standard Circular AA-Shifted is used when a 0.5 ha circular plot with a 40-m radius (80-m diameter) can be established but the POINT is not the AA CENTER (Figure 3-7 and **Reference Card AA-1, Plate 1** (Figure 3-1)). Use this layout at sites with a 0.5 ha or more sampleable area in the vicinity of a POINT located close to the wetland boundary or other unsampleable area, e.g., deep water or upland.

#### Prior to going to the site:

- Use the aerial photo from the Site Packet to evaluate the setting at the POINT and determine the distance and bearing from the POINT to the prospective location of the AA CENTER. Note this information on the photo (See Figure 3-7).



- The distance from the POINT to the AA CENTER should not exceed 40 m. If the distance exceeds 40 m, do not continue planning the AA layout. Use the procedures in Section 3.2.3 to determine whether the POINT can be shifted or an alternate POINT (i.e. alternate site) is needed).

**In the field on the sampling day:**

Verify and modify the AA establishment plan as ground conditions dictate.

- The Veg Team, in tandem with the AB Team, proceeds with AA establishment. For sites that are fairly open, it may be easiest to use a laser rangefinder or tape to set up the AA. For example, the Team member at the CENTER uses a laser rangefinder to locate the AA boundary (a distance of 40 m) by sighting on a metal clipboard or reflector carried by the second member of the Team walking the AA boundary. This Team member flags the AA boundary as often as site conditions warrant and works with the person at the CENTER to place labeled flags where the cardinal compass directions cross the AA boundary.
- The Field Crew member at the POINT uses bearing and distance information from the AA layout plan to navigate to the location of the CENTER of the shifted AA and places a labeled flag at the CENTER. If there are obstacles to getting to the CENTER (e.g., deep water), place flagging as close to the CENTER as possible and label flagging with the approximate distance and direction to the CENTER's actual location (e.g., 5 m, 120° from the flagging to the CENTER). Always use True North bearings for all directional references.
- Complete the *AA Layout Used* field in the AA ESTABLISHMENT section of the **AA Establishment Form (AA-1)** by selecting *Standard Circular AA- Shifted* from the drop-down list, 0.5 ha auto-populates for the area of the AA, and *POINT is not the AA CENTER* auto-selects from the *Location of the AA CENTER* drop-down list. Record the GPS coordinates (in decimal degrees using NAD83) for the AA CENTER
- In the *Point Establishment Comment* section of **AA Establishment Form (AA-1)**, describe why the AA was shifted.
- Once the cardinal directions are marked at the AA boundaries, the Veg and AB Teams can proceed with their other sampling activities.

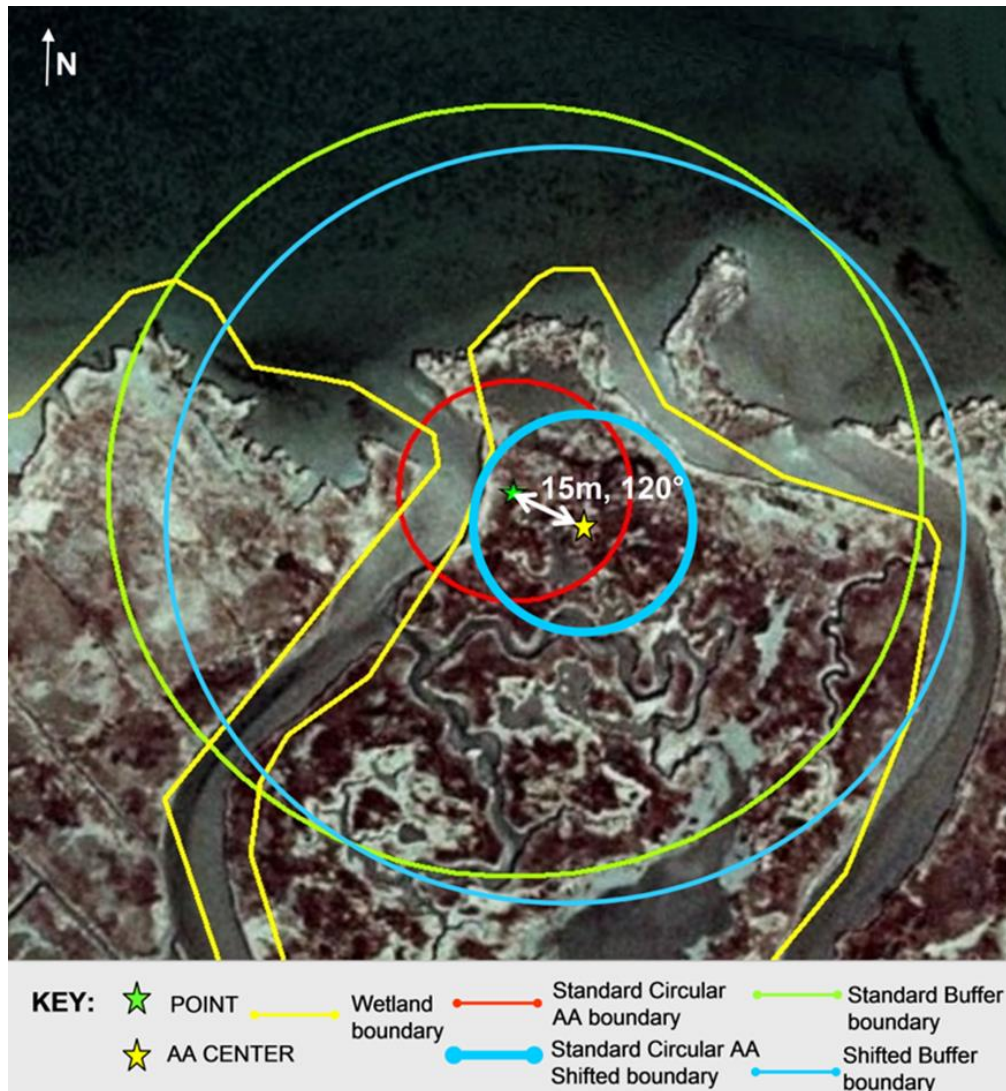


Figure 3-7. Example of a Standard Circular AA –Shifted Layout depicted on an example annotated aerial photo. Distance and bearing from the POINT to the AA CENTER are indicated. The Standard Circular AA layout and the standard Buffer evaluation boundary are shown for comparison.

### 3.2.2 Alternate AA Layouts

An Alternate Layout is used in situations where a 0.5 ha circular AA encompassing the POINT will not fit the sampleable area. The Polygon AA layout is used when a non-circular, 0.5 ha AA is possible at the POINT; the Wetland Boundary layout applies when the AA would be <0.5 ha but at least 0.1 ha in size.

#### 3.2.2.1 Polygon AA

The Polygon AA is used to establish a 0.5 ha AA at sites where the wetland is >0.5 ha, but has dimensions <80 m in at least one direction and could not, therefore, accommodate a circle with an 80 meter diameter). The AA CENTER is as close to the POINT as possible (**Reference Card AA-1, Side B, Plate 2** Figure 3-2).

**Prior to going to the site:**

- Use an aerial photo to evaluate the setting at the POINT and determine the distance and bearing from the POINT to the location of the AA CENTER. Note this information on the photo (See Figure 3-8).
- Use tools available in your desktop software (i.e., Google Earth, ArcGIS) to approximate the boundary of the AA. Alternatively, use the scale of the photo to estimate the average width of the area and use it to estimate the length needed to get 0.5 ha (See calculations in Figure 3-8).
- In cases where the site has bends or is oddly shaped, break the AA into sections and estimate the area for each (See Figure 3-8).

**In the field on the sampling day:**

Verify and modify the AA establishment plan as ground conditions dictate.

- Locate the AA CENTER using the information on the annotated photo. Select *Polygon* from the Area Layout Used drop-down list in the AA ESTABLISHMENT section of the **AA Establishment Form (AA-1)**. Record the GPS coordinates of the AA CENTER (in decimal degrees using NAD83) and indicate whether or not the POINT is the AA CENTER by selecting the appropriate choice in the *Location of the AA CENTER* drop-down list.
- In most situations in the field, using a GPS will be the most efficient way to establish the AA boundary and calculate the AA area. Turn on the “Area Calculation” function on the GPS and walk the perimeter of the AA, using the vegetation and other indicators to identify the wetland boundary (See **Reference Card AA-1, Side B** and Figure 3-2).
- At open sites with mostly low vegetation one could effectively use a rangefinder or meter tape to lay out a rectangular AA. For example, if the wetland in Figure 3-8 had been dominated by emergent vegetation, one could set up a rectangular AA (30 m X 167 m) centered on the AA CENTER by sighting on a Team member walking the AA boundary (See second example on **Reference Card AA-1, Side B, Plate 2** and Figure 3-2).
- Complete the *AA ESTABLISHMENT section* of the **AA Establishment Form (AA-1)** by entering the area of the AA as 0.5 ha. If the area of the AA as initially bounded is too small or too large, area can be added or subtracted from either end of the AA to equal 0.5 ha.

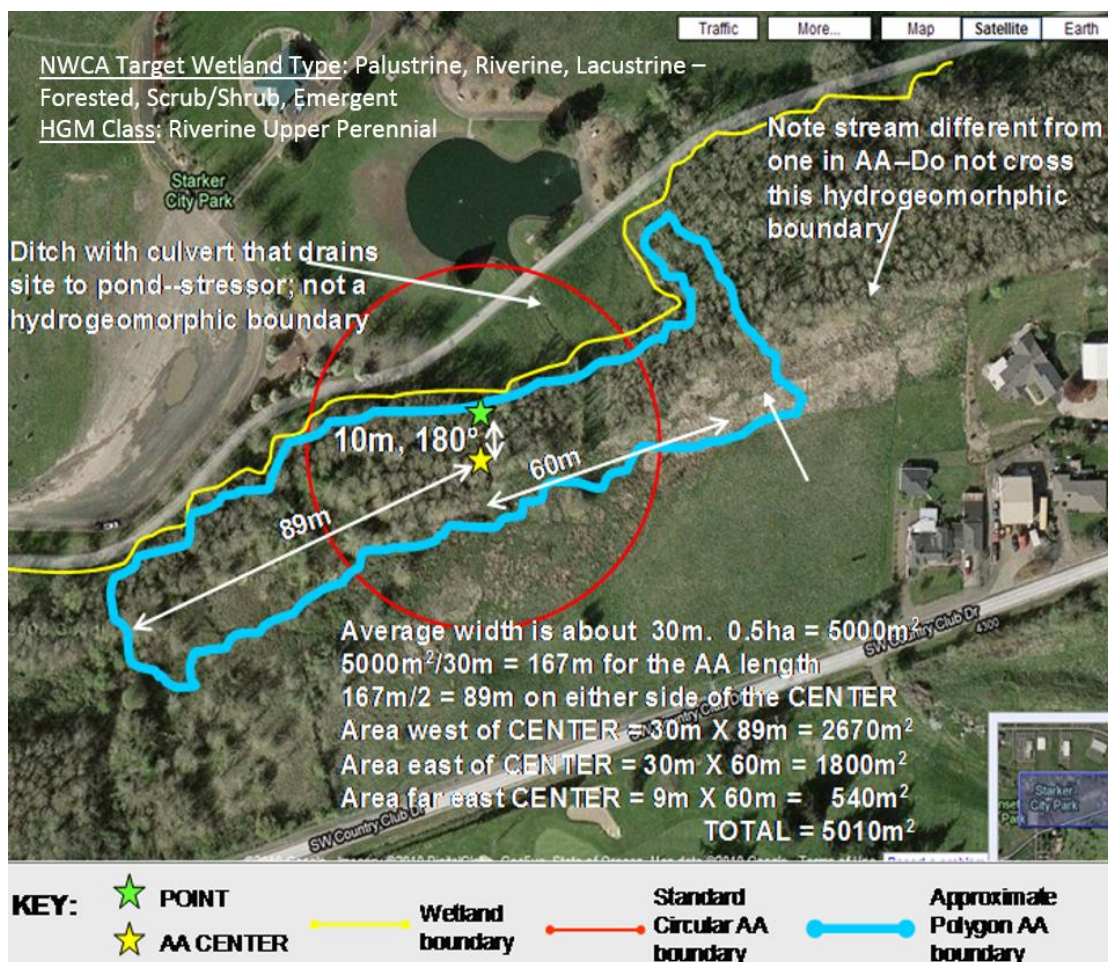


Figure 3-8. Example of a Polygon AA layout depicted on an example annotated aerial photo. Distance and bearing from the POINT to the AA CENTER and notes on likely dimensions of the AA are shown. A hydrogeomorphic boundary (a tributary stream), a stressor (ditch with culvert), and a stream in the vicinity of the POINT are illustrated to show features that should be considered in determining AA layout and in conducting the assessment. A Standard Circular AA is shown for comparison.

**Note:** the AA in this figure contains three of the NWCA Target Wetland Types. The AA is predominantly Palustrine, Riverine, and Lacustrine-Forested, and has elements of two other target wetland types.

### 3.2.2.2 Wetland Boundary AA

The Wetland Boundary AA is used when the sampleable area at the POINT is smaller than 0.5 ha, but is at least 0.1 ha, and is at least 20 m wide so that vegetation plots can be established (See Chapter 5). In this case, the AA boundary coincides with the wetland boundary, i.e., the entire area of the wetland will be sampled (Figure 3-9, **Reference Card AA-1**, **Plate 3** Figure 3-2).

#### Prior to going to the site:

- Use an aerial photo to identify the likely AA boundary. Sketch the AA boundary on the aerial photo. Determine the bearing and distance from the POINT to the CENTER and add this information to the sketch (Figure 3-9).

**In the field on the sampling day:**

Verify and modify the AA establishment plan as ground conditions dictate.

- Locate the AA CENTER using the information on the annotated photo. Select *Wetland Boundary* from the Area Layout Used drop-down list in the AA ESTABLISHMENT section of the **AA Establishment Form (AA-1)**. Record the GPS coordinates of the AA CENTER (in decimal degrees using NAD83) and indicate whether the POINT is or is not the AA CENTER by selecting the appropriate choice in the *Location of the AA CENTER* drop-down list.
- The preferred method for establishing the AA is to use a GPS to determine the boundary and calculate the area. Turn on the “Area Calculation” function on the GPS and walk the perimeter of the AA, using the vegetation and other indicators to identify the wetland boundary (See **Reference Card AA-1, Side B, Plate 3** Figure 3-2).
- Complete the *AA ESTABLISHMENT section* of the **AA Establishment Form (AA-1)** by entering the area of the AA to the nearest 0.1 ha.





Figure 3-9. Example of a Wetland Boundary AA layout depicted on an example annotated aerial photo. Distance and bearing from the POINT to the AA CENTER are indicated. The Standard Circular AA layout and the Standard Buffer Evaluation boundary are shown for comparison.

### 3.2.3 Shifting the POINT

During POINT verification, if the original POINT cannot be sampled because the POINT is inaccessible, falls in a non-target category, or an AA cannot be established (due to issues with size, HGM classes, or proximity to another NWCA site), determine if the POINT can be shifted to a sampleable wetland that lies within 60 meters of the original POINT. Sixty meters was chosen to establish a new sample POINT because it is the distance that would encompass a roughly  $\pm 1$  second latitude/longitude degree mapping or GPS error in the location of the POINT. The following steps document the procedures to accomplish this task:

**Step 1** -- Navigate to the nearest spot that is the same NWCA wetland type listed for the original POINT where a sampleable AA can be established. Using a range finder, GPS, or measuring tape, determine if this is within 60 meters of the original POINT. If it is, access the AA ESTABLISHMENT section of the **AA Establishment Form (AA-1)**, select the *NO* bubble in response to the question “Can an AA that contains the POINT be established” and the *YES* bubble in the resulting section to indicate the POINT can be shifted  $\leq 60$  meters from the original POINT. Record the GPS coordinates for the shifted POINT. Take a

digital picture to further document the prevailing conditions at the shifted POINT using photography protocols in 8.7Appendix D. Make notes in the Point Establishment Comments section explaining why the POINT was shifted.

**Step 2** -- If there is not a wetland of the same NWCA type listed for the original POINT within 60 meters, navigate to the nearest spot that is a wetland in the NWCA target population where a sampleable AA can be established. Using a range finder, GPS, or measuring tape determine if this is within 60 meters of the original POINT. If it is, access the AA ESTABLISHMENT section of the **AA Establishment Form (AA-1)**, select the *NO* bubble in response to the question “*Can an AA that contains the POINT be established*” and the *YES* bubble in the resulting section to indicate the POINT can be shifted  $\leq 60$  meters from the original POINT. Record the GPS coordinates for the shifted POINT. Take a digital picture to further document the prevailing conditions at the shifted POINT using photography protocols in 8.7Appendix D. Make notes in the Point Establishment Comments section explaining why the POINT was shifted and the need for changing to a wetland type other than the type listed for the original POINT.

**Step 3** -- If there is not a wetland in the target population within 60 meters of the original POINT, access the AA ESTABLISHMENT section of the **AA Establishment Form (AA-1)**, select the *NO* bubble in response to the question “*Can an AA that contains the POINT be established*” and the *NO* bubble in the resulting section to indicate the POINT cannot be shifted  $\leq 60$  meters from the original POINT. Also document this conclusion on the **Point Verification Form (PV-1)** by indicating that the site is non-sampleable and selecting the appropriate non-target category. Follow the procedures for selecting an alternate POINT (i.e., alternate site) in Section 2.6.2.

### 3.3 Initial Characterization of the AA

The Veg Team previously identified the predominant NWCA Target Wetland Type on the **Point Verification Form (PV-1), Reference Card AA-3, Side A** (Table 1-1). Next, HGM types found in the AA are recorded in the AA ESTABLISHMENT section of the **AA Establishment Form (AA-1)**. Use the key to HGM types (**Reference Card AA-3, Side B** (Figure 3-10)) to make HGM determinations. A single Class and Subclass should be indicated for the AA.

The Veg Team takes the following digital photos after establishing the Veg Plots (Chapter 5):

- Overview of the setting around the POINT.
- Overview of the setting around the AA CENTER, if in a different location than the POINT.
- View from the AA CENTER along each of the four plot placements lines extending from the CENTER in each direction (if possible, capture flagging for Veg Plots in the photo).
- Important features the Field Crew feels must be recorded, e.g., threatened and endangered species.

The protocol for photography is found in 8.7Appendix D. Be sure to include location information in the photo descriptions, e.g., the direction of the plot placement lines.

**Reference Card AA-3, Side B. Key to Hydrogeomorphic (HGM) Classes and Subclasses**

*In the following key, the all-capitalized HGM Class is separated by a dash (–) from an associated HGM Subclass. For the Depression HGM Class, modifiers to the HGM Subclass are described after a comma (,). Start with 1 in the key, and for each set of choices that are grouped by the same number, select the statement that best describes the AA. Follow the key until the HGM Class and Subclass are identified.*

1. Wetland is naturally under influence of tides.....	2
2. Water is typically saline or brackish with predominantly salt-tolerant vegetation communities present in a wetland commonly called ‘salt marsh’.....	<b>TIDAL – Naturally Occurring</b>
2. Water is typically freshwater with predominantly salt-intolerant vegetation communities present in a wetland commonly called ‘freshwater tidal’.....	<b>RIVERINE – Tidal</b>
1. Wetland is not naturally under influence of tides.....	3
3. Wetland would be under influence of tides if not for human actions, e.g., diked.....	4
4. Water is typically saline or brackish with predominantly salt-tolerant vegetation communities present in a wetland commonly called ‘salt marsh’.....	<b>TIDAL – Human Altered<sup>a</sup></b>
4. Water is typically freshwater with predominantly salt-intolerant vegetation communities present in a wetland commonly called ‘freshwater tidal’.....	<b>RIVERINE – Human Altered<sup>b</sup></b>
3. Wetland is topographically flat and precipitation is a dominant source of water.....	4
4. Wetland has a mineral soil.....	<b>FLATS – Mineral Soil</b>
4. Wetland has an organic soil.....	<b>FLATS – Organic Soil</b>
4. Either of the above with hydrology altered by human actions, e.g., ditching.....	<b>FLATS – Human Altered<sup>b</sup></b>
3. Wetland is not topographically flat and precipitation is not a dominant source of water.....	5
5. Wetland is associated with a nontidal stream channel, floodplain, or terrace.....	6
6. Stream is 1st or 2nd order and found in the upper watershed.....	<b>RIVERINE – Upper Perennial</b>
6. Stream is 3rd order or higher and found in the lower watershed.....	<b>RIVERINE – Lower Perennial</b>
6. Wetland is part of a mosaic of streams, floodplain features (former channels, depressions) and/or slope wetlands (supported by groundwater).....	<b>RIVERINE – Complex</b>
6. Wadeable stream channel has been impounded by beaver activity.....	<b>RIVERINE – Beaver Impounded</b>
6. Wadeable stream channel has been excavated and deepened, the active floodplain has been excavated and/or isolated from overbank flows from the channel.....	<b>RIVERINE – Human Altered<sup>b</sup></b>
6. Stream is constrained by a graminoid-dominated wetland supported primarily by groundwater.....	10
5. Wetland is not associated with a nontidal stream channel, floodplain, or terrace.....	7
7. Wetland is fringing a lake or reservoir.....	8
8. Wetland inundation controlled by relatively natural hydroperiod.....	<b>LACUSTRINE – Naturally Occurring</b>
8. Wetland inundation controlled by dam releases.....	<b>LACUSTRINE – Artificially Flooded</b>
7. Wetland is not fringing a lake or reservoir.....	9
9. Wetland is primarily supported by ground water.....	10
10. Water source is ground water discharged to the surface on the side of a hill due to a geologic feature, e.g., a confining layer.....	<b>SLOPE – Stratigraphic</b>
10. Water source is ground water discharged at the toe-of-slope.....	<b>SLOPE – Topographic</b>
10. Slope wetland excavated to increase depth/amount of surface water.....	<b>SLOPE – Human Altered<sup>b</sup></b>
9. Wetland is associated with a topographic depression.....	11
11. Topographic depression without surface water inlets, outlets or other connections.....	12
12. Wetland is a naturally occurring feature of the landscape.....	<b>DEPRESSION – Closed</b>
12. Closed Depression impounded by beaver activities.....	<b>DEPRESSION – Closed, Beaver Impounded</b>
12. Closed Depression impounded by human activities.....	<b>DEPRESSION – Closed, Human Impounded</b>
12. Closed Depression excavated by human activities.....	<b>DEPRESSION – Closed, Human Excavated</b>
12. Closed Depression excavated and impounded by human activities.....	<b>DEPRESSION – Closed, Human Excavated and Impounded</b>
11. Topographic depression with surface water inlets, outlets, or other connections.....	13
13. Wetland is a naturally occurring feature of the landscape.....	<b>DEPRESSION – Open</b>
13. Open Depression impounded by beaver activities.....	<b>DEPRESSION – Open, Beaver Impounded</b>
13. Open Depression impounded by human activities.....	<b>DEPRESSION – Open, Human Impounded</b>
13. Open Depression excavated by human activities.....	<b>DEPRESSION – Open, Human Excavated</b>
13. Open Depression is excavated and impounded by human activities.....	<b>DEPRESSION – Open, Human Excavated and Impounded</b>

<sup>a</sup> Adapted from Smith et al. (1995), Brooks et al. (2011), and personal experience of M.E. Kentula, USEPA.

<sup>b</sup> For examples of human altered hydrogeomorphic types, see Reference Card AA-2, Side B.

**Figure 3-10. Reference Card AA-3, Side B.**



### 3.4 Listed Species Considerations

Field crews have the potential to encounter federally listed species and critical habitats that are protected under the Endangered Species Act (ESA) while conducting field sampling. Field crew leads are expected to have an understanding of the federally listed species and their critical habitats and state species of concern that have the potential to occur at or near a given sampling site, including habitats that will be used to access the sampling site. Crew leads are responsible for making their crew members aware of potential occurrences of listed species and their critical habitat. Efforts should be made to minimize risks to listed species and their critical habitats and avoid the take of listed species while implementing the NWCA field protocols. For example, crews are expected to:

- understand the circumstances when it would be necessary to avoid sampling due to the presence of a listed species;
- allow a listed species to naturally move away from the sampling area (do not herd or harass);
- immediately release listed taxa if they are unintentionally collected while implementing the sediment or vegetation protocols (do not preserve); and
- implement additional limitations that may be established in the scientific sampling permits.

These best practices are not an exhaustive list of requirements for Field Crews. Field crews are expected to be aware of the recommendations and guidelines that apply in a given state and for a given species.

### 3.5 General Comments

The bottom of **AA Establishment Form (AA-1)** – General Assessment Comments, is a section for a Field Crew to capture general comments about the field site. If there are features of the assessment area that are unique to the site that may influence data they need to be recorded here.

### 3.6 Data Handling

See Chapter 2 for protocols on submitting completed data and tracking forms to the Information Management Team via the NWCA App. See 8.7Appendix D for information on transmitting the image files of the photos taken.

### 3.7 Reference Cards

Reference Card AA-1, Side A and B: Assessment Area Establishment

Reference Card AA-2, Side A: Criteria for Sampleable Area

Reference Card AA-2, Side B: Hydrogeomorphic Boundaries and Human Altered Types

Reference Card AA-3, Side A: NWCA Target Wetland Types

Reference Card AA-3, Side B: Key to Hydrogeomorphic Classes

Reference Card AA-4: Flowchart for Determining NWCA Target Wetland Type

The Assessment Area Reference Cards are compiled (with all other NWCA 2021 Reference Cards) in the Quick Reference Guide.

## 3.8 Equipment and Forms List and Data Forms

### EQUIPMENT AND SUPPLIES

- 50-m or 100-m measuring tape with reel and/or other measuring devices (such as marked rope) for situations where GPS or rangefinder does not work
- 2-way hand-held radios
- Compass
- iPads with NWCA app
- Reference cards
- Digital camera with batteries and memory card
- Field clip boards
- Pencils
- GPS loaded with coordinates for the POINT, manual, extra battery pack
- Indelible markers to write on flagging
- Laser rangefinder with extra batteries (optional)
- Sharpie® or comparable fine-point, permanent, silver marker
- Site packet with maps with POINT marked, directions to the POINT, access information
- Surveyor's flagging tape to mark the AA boundary
- Pin flags for occasional use

### DATA FORMS (in the NWCA APP):

- NWCA 2021 Point Verification Form (PV-1)
- NWCA 2021 AA Establishment Form (AA-1)

## Chapter 4 Human-Mediated Physical Alterations

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### 4.1 Introduction

Anthropogenic activities have resulted in the loss of nearly 50 percent of the wetlands across the US since pre-settlement, with losses of some wetland types continuing to increase in the last three decades (Dahl 1990, Dahl 2000, Dahl 2005, Dahl 2011). However, in many cases, anthropogenic activities do not result in the complete loss of a wetland, but instead, an impairment of wetland functions and diminished ecological condition (Hemond & Benoit 1988, Faulkner 2004, Fennessy et al. 2004, Kirwan & Megonigal 2013). Thus, observations of physical alterations to the wetland are important for indicating the degree of disturbance to a wetland, and, ultimately, to its condition.

Human-mediated *physical alterations*, defined as modifications or damage caused directly by humans or consequentially from anthropogenic activities (e.g., raising livestock) or human pressures (e.g., land use encroachment, fire suppression), may occur in the Assessment Area (AA) and/or in the surrounding buffer. In the case of the NWCA, the *buffer* is a prescribed measurement area or discrete zone (e.g., riparian buffer or GIS buffer) that surrounds the perimeter of the AA. The buffer may encompass wetland or upland, natural vegetation cover, or human land uses. Regardless of what the buffer encompasses, information about what surrounds the AA and the degree of physical alteration is important for characterizing the POINT and associated AA. Observations of physical alterations that affect the vegetation, hydrology, and soil in both the AA and in the buffer indicate disturbances and possible stress to the wetland ecosystem. These data are necessary for an assessment of wetland condition to place the AA on a gradient of disturbance relative to a reference standard.

This chapter provides the procedures to identify, survey, and record physical alteration data within the entire AA and in twelve Buffer Sample Plots by the Assessment Area and Buffer (AB) Team. Collecting physical alteration data for the NWCA involves recording observations of 48 physical alterations. In the AA, an assessment of the percent cover or level of influence of observed physical alterations is recorded. In the twelve Buffer Sample Plots, only the presence of physical alterations is recorded.

The list of 48 physical alterations compiled on the field forms (**Assessment Area Physical Alterations Form (P-1)** and **Buffer Area Physical Alterations Form (P-2)**) evolved from the those used in previous NWCA surveys, which contained elements from multiple sources, including the California Rapid Assessment Method (CRAM) for Wetlands and Riparian Areas (Collins et al. 2006), Gulf of Mexico Coastal Wetlands Condition Assessment (Heitmuller 2008), Delaware Comprehensive Assessment Procedure (Jacobs et al. 2008), Delaware Rapid Assessment Procedure (Jacobs 2007), USEPA Environmental Monitoring and Assessment Program (EMAP) Stream Survey (Kaufmann et al. 1999, Peck et al. 2006), and Ohio Rapid Assessment Method for Wetlands (Mack 2001).

To avoid impairing data collection for Vegetation (Chapter 5), AB Team members will avoid stepping into areas that might be delineated as Vegetation Plots, by waiting until the Plots are marked (or at least their general area is known) before entering the AA. Assessment of physical alterations occurring in Vegetation Plots must be done from plot peripheries to avoid trampling vegetation in the plots.

## 4.2 Sampling Procedure

The protocols for the NWCA physical alteration sampling are:

- 1) Setting up Buffer Sample Plots
- 2) Identification of Physical Alterations
  - a. In the entire AA
  - b. In twelve 100-m<sup>2</sup> Buffer Sample Plots

### 4.2.1 Buffer Sample Plot Layout

The AB Team records physical alterations within the entire AA and at twelve 100-m<sup>2</sup> Buffer Sample Plots laid out along four, 145-m cardinal transects (marked N, S, E, and W on figures) that begin at the AA CENTER and cross into the buffer at the AA boundary. For all cardinal transects, ensure that true N is being used. The Buffer Sample Plots are arranged so that they can be given weights for proximity analysis. Follow the instructions for locating Buffer Sample Plots given below and, as needed, refer to the description of the Standard AA circular and shifted layouts in Chapter 3. The buffer protocol is also summarized on **Reference Card P-1, Side A**.

Regardless of the AA layout, crews should always place three buffer plots per cardinal transect. Each buffer plot is placed such that the distances between each buffer plot and the distance from the edge of the AA to the first buffer plot along a transect are all equal.

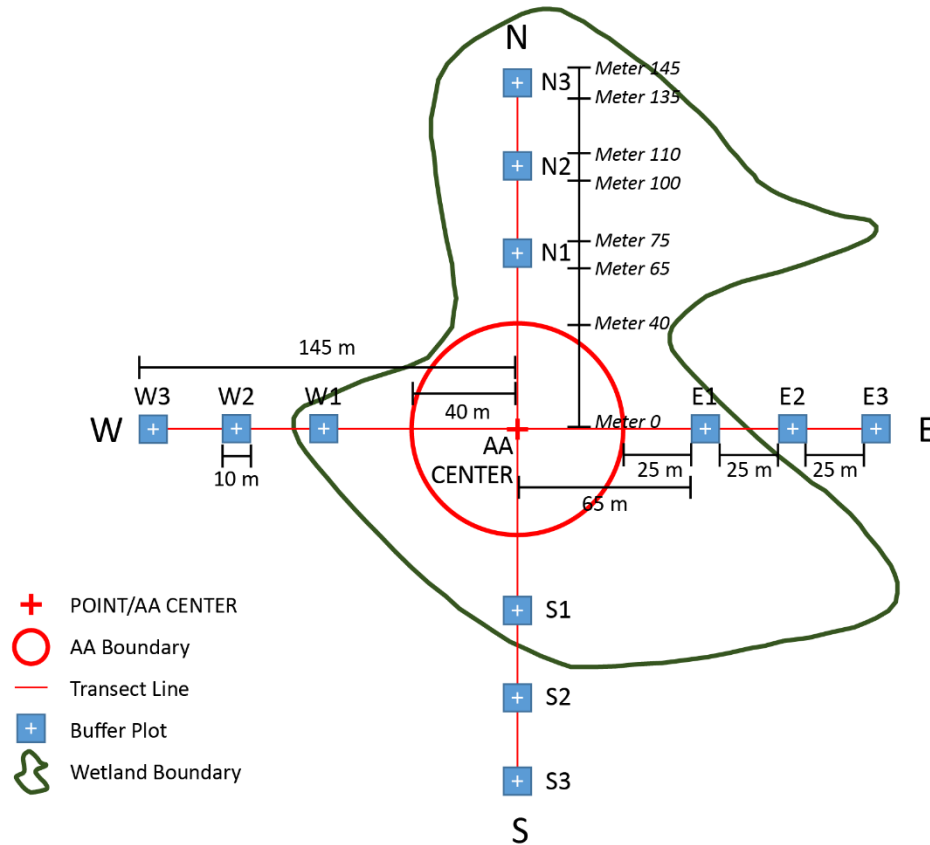
#### 4.2.1.1 Buffer Sample Plot Layout – Standard AAs (Circular and Shifted)

**Figure 4-1** shows a Standard Circular AA layout where the three Buffer Sample Plots are equally spaced along the portion of each cardinal transect within the buffer. The cardinal transects begin at Meter 0 (the AA CENTER) and end at Meter 145, with Meter 40 marking the AA boundary. Transects and plots do not have to be sampled in any particular order as long as the sample plots are identified correctly and data are placed in the appropriate areas of each data form.

Buffer Sample Plots have an area of 100 m<sup>2</sup>, with a length of 10 m; thus, each Buffer Sample Plot will span 10 m along the cardinal transect with a distance of 25 m between the end of one plot and the beginning of the next. **Table 4-1** describes the location of the Buffer Sample Plots along the cardinal transects. Buffer Sample Plots N1, E1, S1, and W1 begin 25 meters outside the AA boundary, with the plots spanning the 10 m located between Meter 65 – 75 along the transect. Buffer Sample Plots N2, E2, S2, and W2 begin 25 meters away from the end of the first Buffer Sample Plots, spanning the 10 m located between Meter 100 – 110 along the transect. Buffer Sample Plots N3, E3, S3, and W3 begin 25 meters away from the end of the second Buffer Sample Plots, spanning the 10 m located between Meter 135 – 145 along the transect.

**Table 4-1. Location of Assessment Area, spacing, and Buffer Sample Plots along a 145-m cardinal transect for a Standard AA.**

	TOTAL LENGTH	LOCATION ALONG TRANSECT FROM AA CENTER	DISTANCE FROM AA CENTER TO BUFFER PLOT CENTER
<b>ASSESSMENT AREA (AA)</b>	40 m	Meter 0 to 40	-
<i>SPACING BETWEEN AA BOUNDARY AND BEGINNING OF BUFFER SAMPLE PLOT 1</i>	25 m	Meter 40 to 65	-
<b>BUFFER SAMPLE PLOT 1</b>	<b>10 m</b>	<b>Meter 65 to 75</b>	<b>70</b>
<i>SPACING BETWEEN END OF BUFFER SAMPLE PLOT 1 AND BEGINNING OF BUFFER SAMPLE PLOT 2</i>	25 m	Meter 75 to 100	-
<b>BUFFER SAMPLE PLOT 2</b>	<b>10 m</b>	<b>Meter 100 to 110</b>	<b>105</b>
<i>SPACING BETWEEN END OF BUFFER SAMPLE PLOT 2 AND BEGINNING OF BUFFER SAMPLE PLOT 3</i>	25 m	Meter 110 to 135	-
<b>BUFFER SAMPLE PLOT 3</b>	<b>10 m</b>	<b>Meter 135 to 145</b>	<b>140</b>



**Figure 4-1. Buffer Sample Plots placed relative to a Standard Circular AA Layout. Note, in this example, all the Buffer Sample Plots on the N transect and plots E1, S1, and W1 fall within the wetland. The remaining plots occur in upland locations surrounding the wetland.**

The following protocol is used to establish the Buffer Sample Plots for a Standard Circular AA Layout:

- 1) Once the intersection of the AA boundary and the first cardinal transect has been located, the AB Team begins locating Buffer Sample Plots along the transect.
- 2) Starting at the AA CENTER, use a tape measure, GPS, a rangefinder and compass, or other means to measure the distance along the transect to the beginning of Buffer Sample Plot 1, located **65 m** away from the AA CENTER. Measure or estimate 5 m to the left and right of the transect line, flagging the front corners of the square buffer plot, if necessary.
- 3) Walk 10 m away from the AA CENTER along the transect line to the end Buffer Sample Plot 1, ending at **75 m** away from the AA CENTER. Measure or estimate 5 m to the left and right of the transect line, flagging the back corners of the square buffer plot, if necessary, and finalizing the establishment of the first 100 m<sup>2</sup> Buffer Sample Plot.
- 4) From the beginning of Buffer Sample Plot 1, walk the 10 m from **Meter 65 – 75** along the transect, making careful observations within a distance of 5 m to your left and 5 m to your right, thus visually sampling a square, 100 m<sup>2</sup>-plot.
- 5) Record data for Buffer Sample Plot 1 on the **Buffer Area Physical Alterations Form (P-2)** as described in **Section 4.2.4**.

- 6) From the end of Buffer Sample Plot 1, walk 25 m away from the AA CENTER along the cardinal transect to Buffer Sample Plot 2, beginning at **100 m** away from the AA CENTER. Repeat the process described in steps 2, 3 and 4, appropriately adjusting the distances (designated by bold text) to establish and sample Buffer Sample Plot 2. Record data on **Form P-2** as described in **Section 4.2.4**.
- 7) Walk another 25 m away from the end of Buffer Sample Plot 2 to reach Buffer Sample Plot 3, beginning at **135 m** away from the AA CENTER. Repeat the process described in steps 2, 3 and 4, appropriately adjusting the distances (designated by bold text) to establish and sample Buffer Sample Plot 3. Record data on **Form P-2** as described in **Section 4.2.4**.
- 8) Proceed to each of the remaining three transects and repeat steps 2–7. Select the appropriate tab on **Form P-2** for each Buffer Transect (N, S, E, W). For special situations, use the ‘*Select if plot(s) observed from outside plot boundaries (i.e., from a distance) and comment*’ bubble or the ‘*Select if plot(s) not sampled and comment*’ bubble at the top of **Form P-2** as described in **Section 4.2.4** (steps 3a and 3b).
- 9) Alternately, crews may choose to travel to the center of each Buffer Sample Plot and measure or estimate a 10x10 meter plot around them. To do so, measure the distance from the AA CENTER to the center of each Buffer Sample Plot along a cardinal transect with the most appropriate means (tape measure, rangefinder, GPS, etc.). Distances for a standard circular AA are 70, 105 and 140 meters (see Table 4-1).

#### 4.2.1.2 Buffer Sample Plot Layout - Alternate AAs (Polygon and Wetland Boundary)

If a wetland is not large enough to accommodate a 40-m radius circle, an alternate AA layout is used. Chapter 3 presents instructions for laying out alternate AAs. Once the AA layout is established, four, 145-m cardinal transects from the AA CENTER can be established due N, E, S, and W of the AA CENTER (use true N). The transect lines will be used to measure distances between the AA CENTER, the AA boundary, and the end of the transect in each cardinal direction – information necessary for the Field Crew to establish the Buffer Sample Plots.

The distances between Buffer Sample Plots along the cardinal transects will vary depending on the distance between the AA CENTER and AA boundary and on the shape and orientation of the AA (**Figure 4-2**). The procedure for locating Buffer Sample Plots on transects of varying lengths appears below and is summarized on **Reference Card P-1, Side A**.

The farthest edge of the most distant Buffer Sample Plot on a transect line (i.e., Buffer Sample Plots N3, E3, S3, and W3) is 145 m away from the AA CENTER regardless of the AA layout. By measuring the distances between the AA CENTER and the intersection of the AA boundary with the cardinal transect lines, the first Buffer Sample Plots (e.g., N1, E1, S1, and W1) and the middle Buffer Sample Plots (e.g., N2, E2, S2, and W2) can be established using equal spacing. The space between each of these 100 m<sup>2</sup>-plots is determined using the following **FORMULA**:

$$\frac{(115 - D)}{3} = S$$

Where:

- **115** is the length of the cardinal transect (145 meters) – the total Buffer Sample Plot lengths (10x3 or 30 meters)
- **D** is the **distance** (in meters) from the AA CENTER to the AA boundary along the cardinal transect
- **S** is the **spacing** (in meters) between the AA boundary and the first Buffer Sample Plot **AND** is the **spacing** between the remaining Buffer Sample Plots along the cardinal transect

**NOTE:** If a narrow AA (like in a riparian area) is aligned directly along the E-W or N-S transects, it may be necessary to extend the cardinal transect length to accommodate three Buffer Sample Plots. That is, if a buffer transect length is too short, such that the distance between the Buffer Sample Plots would be <10 m (i.e., the transect length is less than 60 m from the AA boundary), the transect length is extended to allow the plots to be at least 10 m apart.

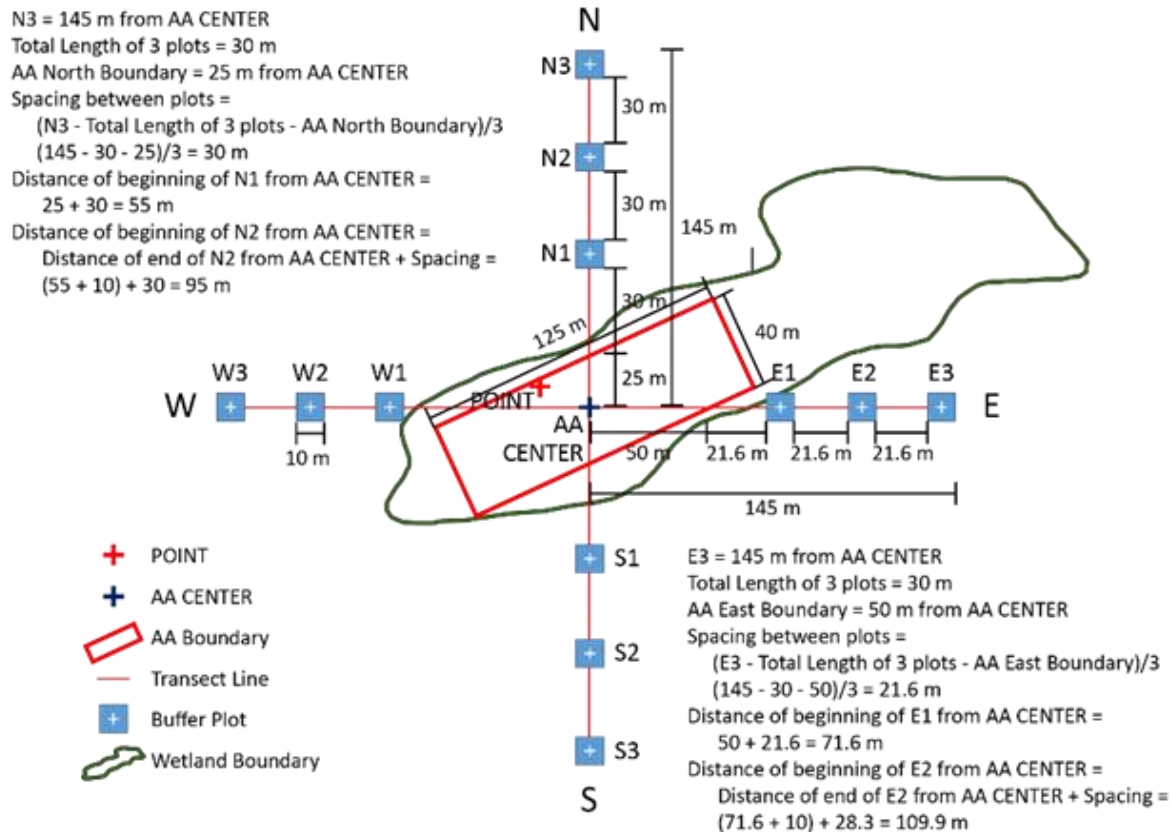


Figure 4-2. Alternate AA with an area of ½ ha. The shape and orientation of the AA determines the distance of plots N1, E1, S1, and W1 from the AA CENTER as well as the distance between Buffer Sample Plots on each transect.

The following protocol is used to establish the Buffer Sample Plots for an Alternate (Polygon or Wetland Boundary) AA Layout:



- 1) Once the intersection of the AA boundary and the first cardinal transect has been located, the AB Team begins locating Buffer Sample Plots along the transect.
- 2) Starting at the AA CENTER, use a tape measure, GPS, a rangefinder and compass, or other means to measure and take note of the distance along the cardinal transect from the AA CENTER to the AA boundary.
- 3) Knowing that the end of Buffer Sample Plot 3 should be 145 m away from the AA CENTER (exception: see NOTE above), use the **FORMULA** above to locate the beginning of Buffer Sample Plot 1. Measure or estimate 5 m to the left and right of the transect line, flagging the front corners of the square buffer plot, if necessary.
- 4) Walk 10 m away from the AA CENTER along the transect line to the end of Buffer Sample Plot 1. Measure or estimate 5 m to the left and right of the transect line, flagging the back corners of the square buffer plot, if necessary, and finalizing the establishment of the first 100 m<sup>2</sup> Buffer Sample Plot.
- 5) From the beginning of Buffer Sample Plot 1, walk the 10 m length along the transect away from the AA CENTER, making careful observations to a distance of 5 m to your left and 5 m to your right, thus visually sampling a square, 100 m<sup>2</sup>-plot.
- 6) Record data for Buffer Sample Plot 1 on **Form P-2** as described in **Section 4.2.4**.
- 7) From the end of Buffer Sample Plot 1, walk the calculated distance away from the AA CENTER along the cardinal transect to the beginning of Buffer Sample Plot 2, using the **FORMULA** above. Repeat the process described in steps 3, 4 and 5 to establish and sample Buffer Sample Plot 2. Record data on **Form P-2** as described in **Section 4.2.4**.
- 8) From the end of Buffer Sample Plot 2, walk the calculated distance away from the AA CENTER along the cardinal transect to the beginning of Buffer Sample Plot 3, using the **FORMULA** above. Repeat the process described in steps 3, 4 and 5 to establish and sample Buffer Sample Plot 2. Record data on **Form P-2** as described in **Section 4.2.4**.
- 9) Proceed to each of the remaining three transects and repeat steps 2–8. Select the appropriate tab on **Form P-2** for each Buffer Transect (N, S, E, W). For special situations, use the ‘*Select if plot(s) observed from outside plot boundaries (i.e., from a distance) and comment*’ bubble or the ‘*Select if plot(s) not sampled and comment*’ bubble at the top of **Form P-2** as described in **Section 4.2.4** (steps 3a and 3b).
- 10) Alternately, crews may choose to travel to the center of each Buffer Sample Plot and measure or estimate a 10x10 meter plot around them. To do so, measure the distance from the AA CENTER to the center of each Buffer Sample Plot along a cardinal transect with the most appropriate means (tape measure, rangefinder, GPS, etc.). Distances for alternate layouts must be calculated based on the dimensions of the AA (see **FORMULA** above) and the center of each plot will be 5 meters farther from the AA CENTER than the beginning edge of the plot.

#### 4.2.2 Identification of Physical Alterations

The objective of the Physical Alteration protocol is to assess human-mediated physical alterations to the AA and buffer. Observations of physical alterations are recorded in the field using the **Assessment Area Physical Alterations Form (P-1)** and **Buffer Area Physical Alterations Form (P-2)**. These two forms include the same list of 48 physical alterations, equally divided among three categories: Vegetation, Hydrology, and Soil – the three components that define wetlands. Each of the three categories is

subdivided into subcategories totaling six. A summary of each physical alteration may be found on the double-sided **Reference Card P-2: Physical Alteration Definitions**. The following list of physical alterations includes descriptions, definitions, examples, and considerations for observations. Note that any examples provided in the following list are meant to be illustrative and not exhaustive.

### **Vegetation Removal**

**Forest Clear Cut** – Logging practice in which all or most of the trees in an area are cut down leaving stumps, debris, and, if any, only few snags or wildlife/seed trees across the landscape.

**Forest Selective Cut** – Logging practice in which selected trees are removed, leaving a canopy of scattered or uniformly spaced trees that cover at least 30% of the area. This also includes shelterwood cutting (Note: for areas with less than 30% of the trees remaining after a cut, see *Forest Clear Cut*).

**Vegetation Damage from Insects** – Evidence of vegetation damage or herbivory (e.g., crown or branch dieback, leaf or bark damage, boring) from insects (native and nonnative), e.g., Emerald Ash Borer, Gypsy Moth, Asian Longhorn Beetle, Willow Borers.

**Herbicide/Pesticide Use** – Evidence of herbicide or pesticide use, including (but not limited to) yellowing or browned foliage, spray residues, or a strong chemical smell.

**Shrub/Tree Browsing** – Evidence of livestock (e.g., cows, horses, goats, sheep) or feral animals (e.g., pigs) stripping leaves, bark, fruit, or green stems from shrubs and trees, or evidence of excessive browsing (causing damage to the plant community) by native animals (e.g., deer, elk). Note: *Browsing Type*, indicating whether *Livestock/Feral*, *Native Overbrowsing*, or *Both* are doing damage, must be provided.

**Grass/Forb Grazing** – Evidence of livestock (e.g., cows, horses, goats, sheep), feral animals (e.g., pigs), or native animals (e.g., deer, elk) eating grasses or other forbs, or evidence of excessive grazing (causing damage to the plant community) by native animals (e.g., deer, elk). Note: *Grazing Type*, indicating whether *Livestock/Feral*, *Native Overgrazing*, or *Both* are doing damage, must be provided.

**Mowing/Pruning/Clearing** – Mowing or shrub cutting/clearing, often to maintain ease of access for a right-of-way or easement (i.e., utility, agriculture, property).

**Human-Altered Fire Regime** – Evidence of intense fires or fire suppression; indicators include blackened forest canopy, charred/mineralized soil/peat surface, and/or absence of fire-dependent plant species.

### **Vegetation Replacement**

**Abandoned Crop Field/Historical Cultivation** – Abandoned crop field or evidence of historical cultivation where the land is now revegetated with volunteer forbs, grasses, shrubs, or trees.

**Recent Fallow/Resting Crop Field** – Recent fallow or resting crop field, evident by, for example, dead corn stalks, crop debris, or bare soil.

**Lawn/Park/Cemetery/Golf Course** – Area of maintained grass/turf with or without landscaping/gardens, such as in a lawn, park, cemetery, or golf course.

**Silviculture/Tree Plantation/Orchard/Nursery** – Planted and cultivated trees for harvesting timber, fruit, or another product of the tree; actively, intensively managed forest plantations are included. Note: Secondary growth forests on a natural, successional trajectory are excluded.

**Active Row or Field Crop** – Presence of any type of row or field crop, including corn, soybean, alfalfa, hay, wheat, lettuce, cover crops, table vegetables, berries, etc.

**Range** – Rangelands, used for livestock grazing, tend to have natural vegetation but also may have introduced plant species.

**Pasture** – Pastures have forage that is adapted for livestock and managed by seeding, mowing, fertilization, and irrigation.

**Nonnative Pest Plants** – Pest plant species that are entirely nonnative (e.g., Japanese Honeysuckle, Himalayan Blackberry, Multiflora Rose, Kudzu) or partially-nonnative/cryptogenic (e.g., Reed Canarygrass, Cattail, Common Reed). Refer to **Appendix B Example Nonnative Plant Species** for examples of commonly encountered nonnative pest plants. Note: these examples are not exhaustive and there may be numerous nonnative species encountered (consult the site Botanist/Ecologist if questions arise).

### **Water Addition/Subtraction**

**Ditch/Channelized Stream** – Ditches (inflowing, outflowing, or dry) or a natural stream that has been intentionally channelized by humans for routing water from the site.

**Culvert** – Culvert, which may be circular corrugated pipe, concrete arch or box, or other types.

**Point Source/Pipe** – Point source pipe for routing effluent, sewer outfall, or stormwater to site.

**Tile Drainage/Drain Tiles** – Presence or evidence of tile drainage (or drain tiles), typically used to drain and move water from agricultural fields.

**Irrigation** – Any type of irrigation that adds water to the site.

**Water Withdrawal Pump** – Any type of water withdrawal pump.

**Impervious Surface Input** – Sheetflow into the AA or buffer plot from the presence of an impervious surface, such as roads or concrete pads.

**Human-mediated Shallow Channels** – Shallow channels that act as flow paths created by, for example, vehicle ruts, human, livestock, or feral animal trails or trampling, eroded foot paths, etc.

### **Flow Obstruction**

***Dike/Berm/Levee*** – Artificially-raised banks (typically constructed parallel to the direction of flow) that obstruct flooding.

***Dam*** – A barrier constructed by humans, or a barrier constructed by beavers against a human-made structure (e.g., weir, culvert), that is perpendicular to the direction of flow, holding back water and raising the water level.

***Wall/Riprap*** – Wall or riprap (e.g., boulders, concrete blocks, shot rock) used to armor a shoreline or stabilize a bank from erosion.

***Trash/Soil/Gravel/Spoil/Organic Debris Heap*** – Human-deposited trash, soil, gravel, spoil, and organic debris heaps (including slash or lawn waste) that impede or redirect water flow.

***Road/Railroad/Walkway*** – Artificially-raised road, railroad, or walkway (e.g., boardwalk) above low ground.

***Water Level Control Structure*** – Any type of water level control structure, including weirs, tide/flood gates, and flashboard riser structures.

***Pond/Retention Basin/Quarry*** – Ponds/lagoons created by humans for watering cattle, collecting wastewater or stormwater, holding irrigation water, recreational use (fishing, swimming), etc.

***Silvicultural/Agricultural Mounding of Soil*** – Mounding of soil for silviculture (e.g., tree bedding) or for agriculture that results in impediment or redirection of water flow.

### **Soil Hardening**

***Oil/Gas/Utility Wells/Drilling/Pipeline*** – Presence of oil or gas wells, oil/gas/utility pipeline (above or below ground), or active/historic drilling.

***Soil Compaction/Pugging/Wallows*** – Compacted soil or pugging as a result of trampling, rooting, or wallowing by livestock, domesticated, or feral animals, or humans and human activities, such as hiking and camping.

***Non-Paved Trail*** – Non-paved trails or matted vegetation created by livestock, domesticated or feral animals, or humans.

***Vehicle Rut/Off-road Vehicle Damage*** – Vehicle ruts or off-road vehicle damage to the soil surface. Note: unpaved dirt roads are excluded and should be captured using *Unpaved Road*.

***Unpaved Road*** – Unpaved road, including gravel, aggregate, dirt, grass, sand, and other semi-permeable surface types.

***Paved Road*** – Paved road, including asphalt, concrete, chip and seal, and other impervious surface types.

**Other Impervious Surface** – Buildings, housing structures, parking lots, driveways, sidewalks, and other surfaces that have impervious footprints (i.e., concrete, asphalt, pavement). Note: paved roads are excluded and should be captured using *Paved Road*.

**Pilings/Utility Pole/RR Track** – Impervious footprint from the presence of pilings (e.g., dock pilings, fence posts, raised boardwalk posts) a utility pole, or a railroad track.

### **Surface Modification**

**Conspicuous Trash/Dumping** – Clearly visible trash or dumping either deposited directly by humans (e.g., individuals, social camps) or indirectly by tides or wind.

**Soil/Gravel/Spoil/Organic Debris Heap** – Soil, gravel, spoil, and organic debris heaps (including slash and lawn waste) created by humans.

**Landfill** – Presence of an active or historic landfill.

**Excavation/Dredging** – Active or historic excavation or dredging, including gravel pits and transport channels.

**Mine** – Presence of an active or historic, surface or underground mine.

**Soil Deposition/Sedimentation** – Freshly deposited soil or sediment as a result of human activities.

**Soil Erosion/Oxidation/Subsidence** – Soil loss from erosion, oxidation, or human-mediated subsidence (e.g., human restriction of sediment delivery to a wetland, removal of soil-stabilizing vegetation, etc.), or evidence thereof, such as root exposure.

**Soil Tilling/Plowing/Disking/Harrowing** – Soil tilling, plowing, disking, or harrowing, typically from agricultural practices.

### **4.2.3 Considerations for Assessing Physical Alterations**

Crew Members making the observations are best situated (as opposed to the Data Analysis Team) to assess the type of impact or impacts the physical alteration may have on the site. When assessing an observation of a physical alteration at a site, there are several key questions that should be used to guide which bubble to fill in:

- 1) Am I observing a human-mediated physical alteration?
- 2) What impact is the physical alteration having on the vegetation, hydrology, and/or soil of the AA?
- 3) Which listed physical alteration best characterizes the observation? Note: There is no option to choose 'Other' in the **P-1** or **P-2** forms. Choose the category that most closely matches the alteration and use the adjacent comment bubble to add further information if necessary.
- 4) **For Physical Alterations Observed in the AA Only:** What is the percent cover or level of influence of the physical alteration within the AA?

These questions are outlined in the decision flow chart in Figure 4-3. Field crews should be acutely aware of the following considerations, which expound upon the above key questions, when assessing Physical Alterations within the AA and the Buffer Plots.

#### *4.2.4 Physical Alterations Focus on Human-Mediated Impacts*

While there are many naturally occurring physical alterations that impact wetlands and their surroundings, this protocol is specifically focused on human-mediated physical alterations to the AA and Buffer Plots. The 48 physical alterations are meant to focus only on human-mediated impacts; thus, it may be necessary to examine the sites for other possible indicators that may help distinguish human-mediated physical alterations from naturally occurring ones.

For example, freshly deposited sediment with evidence of water marks on nearby trees or debris in vegetation is likely an indicator of a flooding event (i.e., naturally occurring, and therefore, no bubble should be filled in for this). On the other hand, freshly deposited sediment with visible, active construction upslope is likely an indicator of a human-mediated impact, and, at the least, the '*Soil Deposition/Sedimentation*' bubble should be filled in.

### Physical Alteration Decision Flow Chart

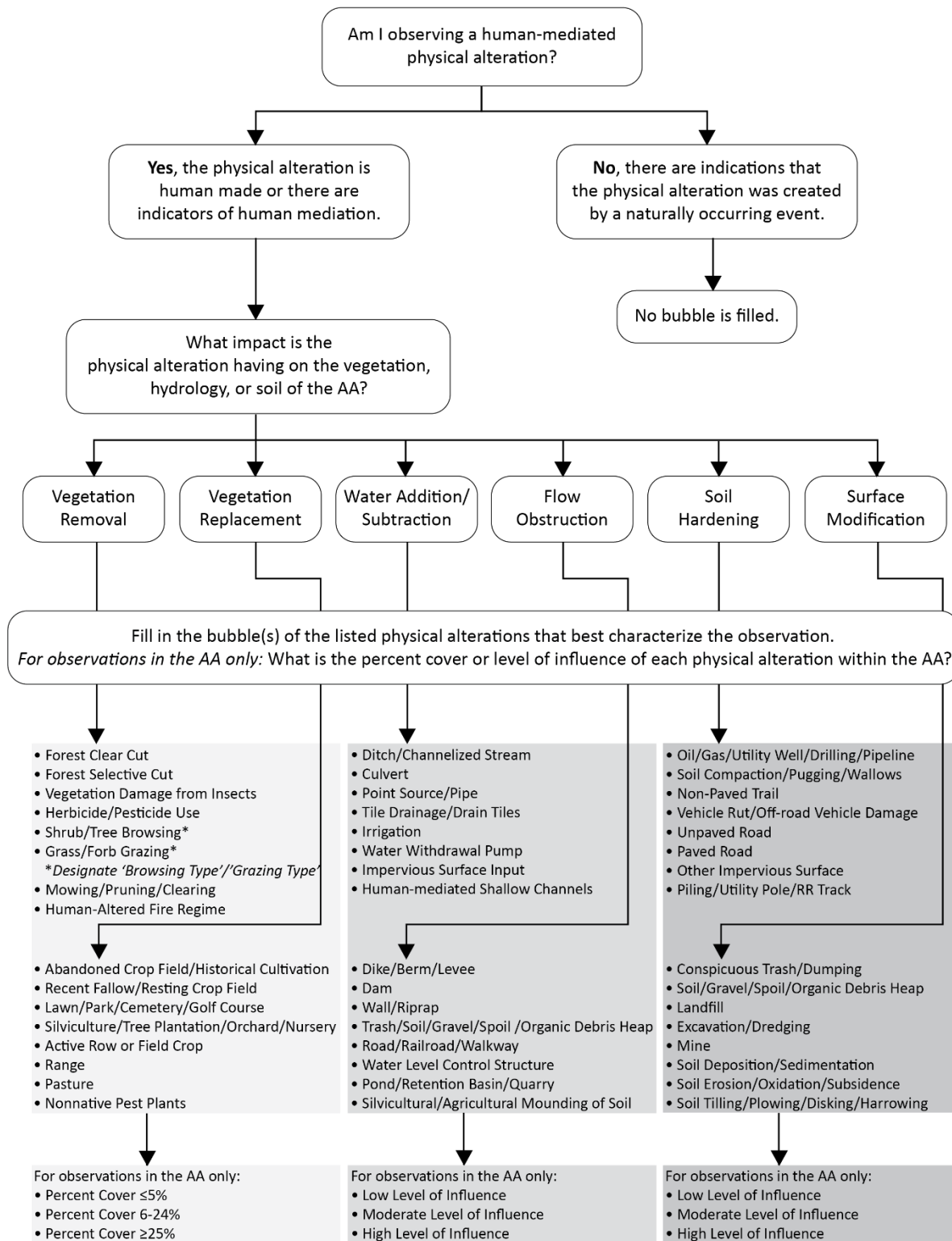


Figure 4-3. Physical Alteration decision flow chart

#### 4.2.5 *The Impact of the Physical Alteration Needs to be Identified*

The most important consideration in filling out the form is to capture the impact of the observed physical alteration to the AA or buffer plot. Therefore, the most appropriate physical alteration bubble within the category that most closely aligns with the observation should be filled in.

Note: For observations of *'Shrub/Tree Browsing'* and *'Grass/Forb Grazing'* under the *'Vegetation Removal'* category, *'Browsing Type'* or *'Grazing Type'* must also be provided by selecting one of three options:

- *'Livestock/Feral'* if there is evidence of any livestock or feral animal browsing/grazing.
- *'Native Overbrowsing'* or *'Native Overgrazing'* if there is evidence of excessive browsing/grazing, (causing damage to the plant community), which can occur when native animal population densities are high.
- *'Both'* if there is evidence of both livestock/feral animal browsing/grazing and native animal overbrowsing/overgrazing.

Alternatively, on paper forms, crews should check one or both of the *'Livestock/Feral'* or *'Native Overbrowsing'/'Native Overgrazing'* boxes, with both boxes checked designating that both livestock/feral animal browsing/grazing and native animal overbrowsing/overgrazing are observed.

For observations of *'Shrub/Tree Browsing'* and *'Grass/Forb Grazing'* alterations in the Buffer Sample Plots, the *'Browsing Type'* or *'Grazing Type'* information should be collected once to cumulatively describe all three plots on a transect. For example, if there is evidence of cow grazing in one plot and deer overgrazing in two plots, *'Both'* should be selected for *'Grazing Type'*.

Observations of physical alterations are limited to the list of 48, with no option for writing in additional observations that do not exactly fit the description of one of the listed 48 physical alterations. While as many physical alterations were broadly captured as possible, it is certainly possible that other human-mediated physical alterations will be observed that were not anticipated. The Field Crew should fill out the most appropriate physical alteration bubble (even if the description is not exact) within the category that most closely aligns with the observation. For example, for an observation of a duck blind, which is not specifically named as a physical alteration, the primary impact is likely to be soil hardening from the posts; thus, the bubble for *'Piling/Utility Pole/RR Track'* under the *'Soil Hardening'* category may be filled in. Evidence of compaction around the duck blind may also be present, necessitating a second bubble to be filled in for *'Soil Compaction/Pugging/Wallows'* under the *'Soil Hardening'* category. If the entry merits a comment (e.g., explanation or clarification), use the adjacent comment bubble to provide additional information.

#### 4.2.6 *A Physical Alteration Can Have More Than One Impact*

It is possible that an observed physical alteration has more than one impact on the vegetation, hydrology, and soil of the site. This is reflected on the Physical Alteration Forms, where there are similarly named physical alterations listed under two different categories (note that the definitions of these physical alterations are also different). Thus, crews should be careful to avoid filling in a bubble for a physical alteration without confirming that the category under which the physical alteration is listed describes the impact. The following examples illustrate how an observation may have multiple impacts, necessitating more than one bubble to be filled in.

*Example 1:* Consider a human-made pile of gravel. It is certainly impacting the soil surface, thus the bubble for *'Soil/Gravel/Spoil/Organic Debris Heap'* under the *'Surface Modification'* category can be



filled in. However, depending on its position in relation to the flow of water, it may also be affecting the hydrology by acting as a barrier. If this second case is true, a second bubble should also be filled in for *'Trash/Soil/Gravel/Spoil/Organic Debris Heap'* under the *'Flow Obstruction'* category.

*Example 2:* Consider a herd of cows. The cows themselves are not a physical alteration, thus there is not a specific bubble for livestock; however, cows are associated with human activities and make physical alterations to the site themselves. Depending on what physical alterations can be observed, bubbles may be filled out for *'Grazing/Browsing'* under the *'Vegetation Removal'* category if there is evidence of grazing, *'Soil Compaction/Pugging/Wallows'* under the *'Soil Hardening'* category if there is visible compaction or pugging from the cow hooves, and/or *'Soil/Gravel/Spoil/Organic Debris Heap'* under the *'Surface Modification'* category if there are cow patties.

*Example 3:* Consider a boardwalk that is only six inches higher than the surface of the soil, with vegetation debris accumulated on one side of the boardwalk piles and some fine sediment on the surface of the boardwalk. The boardwalk piles require that the bubble for *'RR Track/Utility Pole/Piling'* under the *'Soil Hardening'* category is filled in. The low height of the boardwalk, the vegetation debris accumulated on one side of the piles, and the fine sediment on the surface of the boardwalk all indicate that the boardwalk was flooded and that it has obstructed the flow of water. Thus, the bubble for *'Road/Railroad/Walkway'* under the *'Flow Obstruction'* category should also be filled in.

#### 4.2.7 Percent Cover or Level of Influence within the AA

In the AA only, the presence of a physical alteration is documented on Form P-1 with additional information about the magnitude of the physical alteration within the AA. For each physical alteration observed, the Crew Member must choose and fill in one of three bubbles that corresponds to the relevant estimated percent cover or level of influence the impact of the physical alteration has within the AA.

Percent cover is used to characterize the magnitude of physical alterations under the two Vegetation categories, *'Vegetation Removal'* and *'Vegetation Replacement'*. The cover classes are  $\leq 5\%$ , 6-24%, and  $\geq 25\%$ . When a vegetation removal alteration or vegetation replacement alteration is observed, the Crew Member should visually estimate the cover class that best describes the magnitude of the alteration. It may be helpful to visualize percent cover in terms of spatial areas within the AA. For a standard 0.5 ha (5000 m<sup>2</sup>) AA, 300 m<sup>2</sup> (roughly a 17x17-m block) is equivalent to 6% of the AA, and a 35x35-m block is about 25% of the area of the AA. The cover classes are intentionally broad so Field Crews do not need to spend a lot of time deliberating over which bubble to fill in.

**NOTE:** The  $\geq 25\%$  cover class bubble for some physical alterations, such as *'Active Row or Field Crop'*, should never be filled in, as this cover class is above the 10% areal limit that disqualifies a site as sampleable (see Chapter 3, **Reference Card AA-2, Side A**).

Level of influence is used to represent the magnitude of physical alterations under the four Hydrology and Soil categories, *'Water Addition/Subtraction'*, *'Flow Obstruction'*, *'Soil Hardening'*, and *'Surface Modification'*. The three level of influence classes are low, moderate, and high. When a physical alteration under one of these four categories is observed, the Crew Member should consider the overall influence or impact on the AA. While the estimation of level of influence does involve best professional judgement, consideration of the size, percent cover, and/or position of the physical alteration within the AA will help guide the decision to assign *'Low'*, *'Moderate'*, or *'High'* level of influence. The following

examples illustrate how the size, percent cover, and/or position of different physical alterations within the AA can be used to help estimate of the level of influence.

*Example 1:* Consider a ditch. A small, 0.5 m wide ditch that runs across the corner of the AA probably has a low influence on the hydrology of the AA. In contrast, a 5 m wide ditch that runs through the middle of the AA likely has a high influence on the hydrology of the site. Perhaps a small, 0.5 m wide ditch that runs through the center of the AA, clearly shunting a high volume of water as evidenced by deep scouring, has a moderate level of influence on the site.

*Example 2:* Consider a large, 3 m diameter culvert that freely allows large amounts of water to flow through it, compared to a small, 0.25 m diameter culvert that restricts water flow (which may be evidenced by debris above and around the culvert or elevated water levels). The first scenario with the large culvert is likely to have little (i.e., low) influence over the hydrology of the site, whereas the second scenario with the small, restrictive culvert may have moderate or high influence over the hydrology of the site. Perhaps there are several undersized culverts within a site; this would warrant high level of influence.

*Example 3:* Consider a raised boardwalk. The posts are thin, tall, and well-spaced, and the boardwalk does not pose an issue for water obstruction. However, the posts themselves are still considered a 'Piling/Utility Pole/RR Track' physical alteration under 'Soil Hardening' category. Unless there is a large number of posts within the AA, the surface area of the site that the posts are impacting is probably low, so the 'Low' bubble can be filled in. In contrast, a railroad track that runs through the AA is wide and graveled, so depending on the length of the track within the AA, this could pose a larger impact than the boardwalk posts.

#### 4.2.8 Recording Physical Alterations on the AA Form

Key information, including the Site ID and sampling date, and physical alteration data for the AA is recorded on the **Assessment Area Physical Alterations Form (P-1)**. To document the human-mediated physical alterations within the entire AA, the AB Team members will survey the entire AA, avoiding Vegetation Plots by assessing the area within from the plot peripheries to avoid trampling vegetation.

- 1) Verify that the header information at the top of **Form P-1** contains the correct Site ID and visit number in the designated spaces.
- 2) Walk the entire AA to identify the presence of physical alterations within the boundaries of the AA.
- 3) If there is an observed human-mediated physical alteration, consider the impact(s) and fill in the most appropriate physical alteration bubble(s) within the category that most closely aligns with the observation.
- 4) For each physical alteration, estimate the percent cover or level of influence of that alteration within the AA and fill in the corresponding bubble on **Form P-1**. Note: if there is more than one observation of the same physical alteration, consider the cumulative percent cover or level of influence of the observations and select the appropriate bubble.
- 5) If the entry merits a comment (e.g., explanation or clarification), use the adjacent comment bubble to provide additional information.
- 6) There will likely be many unfilled bubbles on the form, indicating absence of a physical alteration.  
**IMPORTANT: If none of the eight physical alterations under a category are observed, the Field**

**Crew must affirm that the physical alterations contained on the field form have been evaluated by filling in the 'No [Physical] Alterations Present' bubble that corresponds with the category.** If no physical alterations are found within the AA, all six 'No [Physical] Alterations Present' bubbles (one for each category) should be filled in.

- 7) The bottom of **Form P-1** may be used to record any additional information and observations of physical alterations found within the Assessment Area that may be useful for data interpretation.

#### 4.2.9 Recording Physical Alterations on the Buffer Form

Physical alteration data for all Buffer Sample plots are recorded on the **Buffer Area Physical Alterations Form (P-2)**. The AB Team members will document the human-mediated physical alterations within twelve buffer sample plots (established using the protocol discussed in **Section 4.2.1**). Additional information that identifies Buffer Sample Plot spatial locations (Plot Coordinates) is also collected.

Procedures for collecting and recording the key information and physical alteration data are detailed below. These procedures are repeated for transects N, W, S, and E using a *separate* tab on **Form P-2** for each buffer transect.

- 1) Verify that the header information at the top of **Form P-2** contains the correct Site ID and visit number in the designated spaces.
- 2) Select the appropriate tab (N, S, E, W) at the top of **Form P-2** to designate the transect for which data are being collected.
- 3) Three Buffer Sample Plots (1, 2, and 3) are sampled along each transect, with data recorded for all three plots on the same tab of **Form P-2**. All three plots must be sampled if possible, beginning with Plot 1 and ending with Plot 3. For the Buffer Sample Plot being sampled, identify the presence of physical alterations within the 100 m<sup>2</sup>-boundary of the plot by walking the 10 m-length of the plot and observing 5 m to both the left and right. For special situations, see protocol provided in 3a and 3b.

3a) If AB Team members are not able to access a Buffer Sample Plot due to open water, thick brush, fencing, or some other impediment, approach as close to the plot as possible and visually observe from afar or use binoculars to observe and record the presence of physical alterations within the sample plot. If this occurs and a Buffer Sample Plot is estimated from outside the plot boundaries, fill in the '*Select if plot(s) observed from outside plot boundaries (i.e., from a distance) and comment*' bubble at the top of **Form P-2** for the relevant Plot Number. Use the adjacent comment bubble to provide additional information about why the plot was assessed from a distance.

3b) If one or more of the three Buffer Sample Plots along the transect is not able to be accessed or observed from outside the plot boundaries, e.g., when physical obstacles or dangerous conditions occur, or when there are access issues related to land ownership boundaries, fill in the '*Select if plot(s) not sampled and comment*' bubble at the top of **Form P-2** for the relevant Plot Number. Use the adjacent comment bubble to provide additional information about why the plot(s) were not sampled. List the Plot Number with the reason in the comment section.

- 4) If there is an observed human-mediated physical alteration, consider the impact(s) and find the most appropriate physical alteration bubble(s) within the category that most closely aligns with the observation. Be sure to fill in the correct bubble corresponding to the Plot Number that is being observed.

- 5) If the entry merits a comment use the adjacent comment bubble to provide additional information.
- 6) Repeat steps 3–5 for Buffer Sample Plot 2 and Buffer Sample Plot 3, using the appropriate Plot Number bubbles to collect data.
- 7) There will likely be many unfilled bubbles on the form, indicating absence of a physical alteration. **IMPORTANT: If none of the eight physical alterations under a category are observed in any of the Buffer Plots along a transect, the Field Crew must affirm that the physical alterations contained on the field form have been evaluated by filling in the ‘No [Physical] Alterations Present’ bubble that corresponds with the category for each transect**
- 8) The bottom of **Form P-2** may be used to record any additional information and observations of physical alterations found within the Assessment Area that may be useful for data interpretation.
- 9) In the ‘*Buffer Plot Coordinates*’ section near the top of **Form P-2**, provide the GPS coordinates (latitude and longitude in decimal degrees (NAD83)) for the center of the Buffer Sample Plot at the end of each transect, i.e., farthest from the AA CENTER (typically Buffer Plot 3). For special situations, see protocol provided in 9a.  
  
9a) If any of the outermost Buffer Sample Plots (e.g., N3, S3, E3, or W3) cannot be accessed, record the plot coordinates at the center of the farthest accessible Buffer Sample Plot **along the transect**.
- 10) Indicate which Plot (N3, S3, E3, or W3) the coordinates represent by filling in the applicable bubble in the ‘*Location of Coordinates*’ field. Alternatively, i.e., if plot coordinates were measured from a location other than Buffer Sample Plot 3, fill in the ‘*Farthest accessible plot*’ bubble and use the ‘*Comments*’ field to indicate the Plot Number at which the coordinates were taken and why.
- 11) Record the plot coordinates.
- 12) Repeat steps 1–11 for the remaining transects using the appropriate tab on **Form P-2** for each buffer transect.

#### 4.2.10 Data Handling

Review **Form P-1** and **Form P-2** to check that all sections have been completed. See Chapter 2 for protocols on submitting data to the Information Management Team via the App.

### 4.3 Reference Cards

Reference Card P-1, Side A: Buffer Sample Plot Layouts  
Reference Card P-1, Side B: Completing Form P-1 and Form P-2  
Reference Card P-2: Physical Alteration Definitions

The Buffer Reference Cards are compiled (with all other NWCA 2021 Reference Cards) in the Quick Reference Guide.

## 4.4 Equipment List and Data Forms

### PHYSICAL ALTERATION EQUIPMENT CHECKLIST

- 50 or 100 Meter tape or other measuring device
- Aerial photo for each site from the site packet
- Binoculars
- Clipboard
- Compass to locate cardinal directions
- Field forms
- GPS
- Laser Rangefinder (optional)
- Pin flags for occasional use
- Surveyor's flagging tape (if necessary)

### PHYSICAL ALTERATION FORMS

Form P-1: NWCA Assessment Area Physical Alterations

Form P-2: NWCA Buffer Sample Plot Physical Alterations

## 4.5 References

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## Chapter 5 Vegetation

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### 5.1 Introduction

Wetland plant species represent diverse adaptations, ecological tolerances, and life history strategies; effectively integrating environmental conditions, species interactions, and human-caused disturbance. Data describing plant species composition and abundance and vegetation structure are powerful, robust, and relatively easy to gather. They can be used to derive myriad metrics or indicators that are useful descriptors of ecological integrity or stress (e.g., Lopez and Fennessy 2002, USEPA 2002b, Pino et al. 2005, Bourdaghs et al. 2006, Quétier et al. 2007, Magee et al. 2008, Magee et al. 2010, Mack and Kentula 2010). NWCA collects data on plant species composition and abundance, on vegetation structural attributes, and on ground surface attributes within vegetation plots at each sample site. These vegetation data collected by Field Crews are later used during analysis to calculate numerous metrics in a variety of categories that inform the development of Vegetation Multimetric Indices that serve as indicators of wetland vegetation condition (USEPA 2016, Magee et al. 2019a, b). Thus, the vegetation data collected in the field by the Vegetation Team are central to the key descriptors of ecological condition for the NWCA. The field data and metrics can also be used to characterize vegetation across the NWCA target wetland population or subpopulations.

The NWCA vegetation sampling methods were designed to address NWCA objectives, while meeting logistical constraints of the study. Vegetation protocols were informed by evaluating numerous existing sampling approaches and through discussions with many wetland scientists. Several existing applications of flexible-plot methods in wetland and upland vegetation types, as well as other wetland sampling approaches, were particularly useful in developing the NWCA vegetation methods, and we gratefully acknowledge these efforts (Magee et al. 1993, Peet et al. 1998, Mack 2007, Rocchio 2007, FGDC 2008, Jennings et al. 2008, Lee et al. 2008).

Protocols in this chapter document the methods for vegetation sampling. A **Vegetation Team (Veg Team)** comprised of a **Botanist/Ecologist** and a **Botanist Assistant** collects the vegetation data. Field sampling for the NWCA takes place during peak growing season when most vegetation is in flower or fruit to optimize plant species identification and characterization of species abundance (see Chapter 2 for further description of sampling index periods). Vegetation data collection in each Assessment Area (AA) is typically completed in one day. Collection and pressing of plant specimens is also usually conducted during the sampling day for each AA. Other activities such as keying and identification of unknown species, drying plant specimens, completing plant specimen tracking forms, and shipping specimens to appropriate herbaria (Section 5.3) may be initiated during the field sampling day, but will often be continued and completed as non-field day or laboratory activities (USEPA 2011b).

Vegetation Protocols are outlined in the flowchart in **Reference Card V-1** (Figure 5-1), and summarized in other Reference Cards and the Vegetation Protocol Checklist. Reference Cards illustrate major protocol steps for Vegetation sampling tasks. All Reference Cards are located in the Quick Reference Guide for easy access, but are also presented, as figures, near the text for the applicable protocol. The Vegetation Equipment List, examples of Data Forms from the NWCA App, and Plant Specimen Labels are in Section 5.5. It will be useful to consult these materials when reading the protocols.



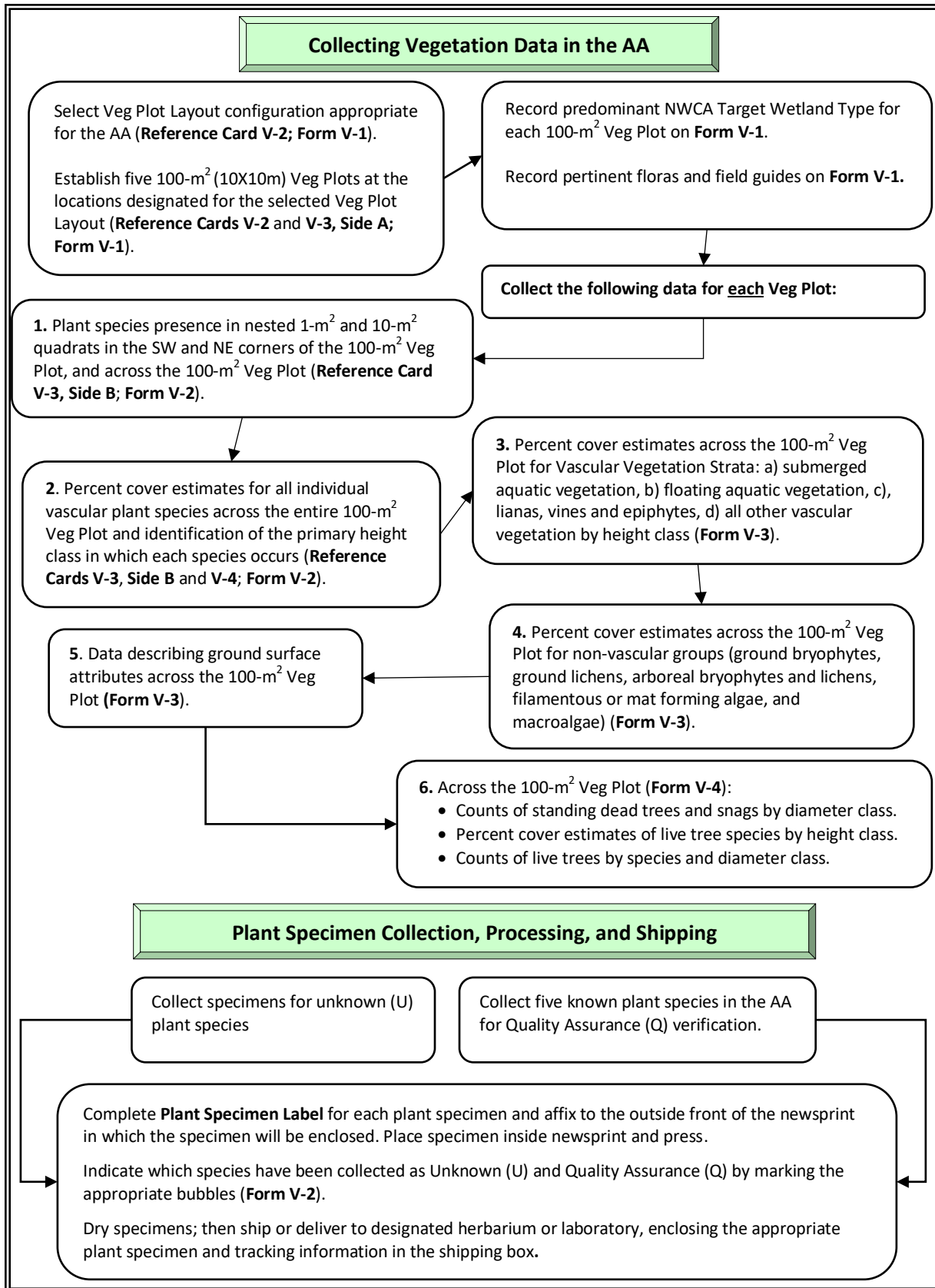


Figure 5-1. Reference Card V-1. Flowchart of Vegetation Protocol Tasks

## 5.2 Sampling Procedures

Vegetation data describing vegetation structure, and individual plant species presence and percent cover, are collected in five 100-m<sup>2</sup> Vegetation (Veg) Plots placed systematically in the AA. Data describing the cover of various biotic and abiotic surface materials are also collected in each Veg Plot. Detailed protocols for collecting each kind of data and instructions for filling out data forms are found in this section. Protocols for plant specimen collection and processing are in Section 5.3. In this manual, vegetation data collection and recording procedures are described for use of the NWCA Data Collection Application (App) and iPad. **It is required that data be submitted using the App.** If there is a malfunction of the iPad or App, data can be collected using paper forms that will be *available for emergency situations*. Protocols and procedures for filling out paper forms can be found in the 2016 version of the NWCA Field Operations Manual (USEPA 2016). Data collected on paper forms must be transcribed and submitted via the App.

Prior to beginning field work for the day, ensure the iPad is charged and the NWCA App is up to date and organize the equipment needed for vegetation data collection activities (See Chapter 2). The vegetation equipment checklist, examples of App data forms, plant specimen labels, and tracking forms are provided in Section 5.5.

### 5.2.1 Placement of Vegetation Plots

The Veg Team identifies the locations of the five 100-m<sup>2</sup> Veg Plots within the AA using guidelines for plot placement provided in this section and summarized on **Reference Card V-2, Sides A** (Figure 5-3) and **B** (Figure 5-4).

Begin by identifying the appropriate Veg Plot Layout configuration for the AA being sampled using the key below.

<b>Key for Selecting Veg Plot Layout Configuration within the Assessment Area (AA)</b>	
<b>1a</b> AA type, any; no obstacles to Veg Plot placement.....	<b>2</b>
<b>2a</b> AA is a ½-ha circle.....	<b>Standard Veg Plot Layout – Circular AA</b> (Veg Plots on Two Axes) Section 5.2.1.2; Reference Card V-2, Plate 1
<b>2b</b> AA is not a circle or is < ½ha.....	<b>Alternate Veg Plot Layouts</b> go to..... <b>3</b>
<b>3a</b> AA is a ½-ha polygon.....	<b>4</b>
<b>4a</b> AA width and length > 30m.....	<b>Wide Polygon AA Veg Plot Layout</b> (Veg Plots on Two Axes) Section 5.2.1.3; Reference Card V-2, Plate 2
<b>4b</b> AA is ≤ 30m wide .....	<b>Narrow Polygon AA Veg Plot Layout</b> (Veg Plots on One Axis) Section 5.2.1.4; Reference Card V-2, Plate 3
<b>3b</b> AA < ½ ha, but > 0.1ha; a polygon equaling wetland boundary.....	<b>Wetland Boundary AA Veg Plot Layout</b> (Veg Plots Distributed) Section 5.2.1.5; Reference Card V-2, Plate 4
<b>1b</b> AA type, any; obstacles (deep water; wide, deep channels; cliffs; other physical barriers; etc.) to Veg Plot placement.....	<b>Obstacle Veg Plot Layout</b> (Veg Plots Distributed) Section 5.2.1.6; Reference Card V-2, Plate 5

Figure 5-2. Key for selecting Veg Plot Layout configuration.

Veg Plot Layout configurations are designed to provide an unbiased characterization of the vegetation of the AA surrounding the POINT in a manner that can consistently be applied by numerous Field Crews across the country.

- Locations of the Vegetation (Veg) Plots within circular 0.5-ha Standard AAs are systematically determined using the Standard Veg Plot Layout.
- Veg Plot locations for Alternate AA Layouts are identified using the Veg Plot Layout key above to select the appropriate Alternate Veg Plot Layout configurations. Alternate Veg Plot Layouts are used only when the Standard Veg Layout will not fit into the AA.
- The Obstacle Veg Plot Layout is applied only when there are obstacles preventing the placement of a Veg Plot in its designated location within any particular Veg Plot Layout type.

#### *5.2.1.1 Key Concepts for All Veg Plot Layout Configurations*

Wetlands can be fragile ecosystems. Minimize foot traffic to limit crushing vegetation and compacting soils and to avoid trampling the AA prior to sampling.

- Before beginning Veg Plot establishment, make a plan for limiting the number of traverses across the AA as work is conducted.
- The AA CENTER is a focal location for Veg Plot Layout so some trampling at the CENTER is unavoidable; however, limit the disturbance radius as much as possible.
- In most AAs, Veg Plots are placed at specified distances along **plot placement lines** extending outward from the CENTER of the AA (see illustrations on **Reference Card V-2** (Figure 5-3 and Figure 5-4). These plot placement lines are typically defined using ropes or meter tapes; however, if woody vegetation is dense, they may be represented by imaginary lines with flagging placed at intervals.
- The plot placement lines receive considerable foot traffic during Veg Plot set-up and sampling. Veg Plots are typically placed immediately to the left side of plot placement lines (when facing the AA boundary from the CENTER) so crews are encouraged to limit their foot travel to the right side of the plot placement lines to avoid walking in the Veg Plots prior to sampling. In non-standard layouts, orient foot travel to avoid Veg Plots as much as possible.

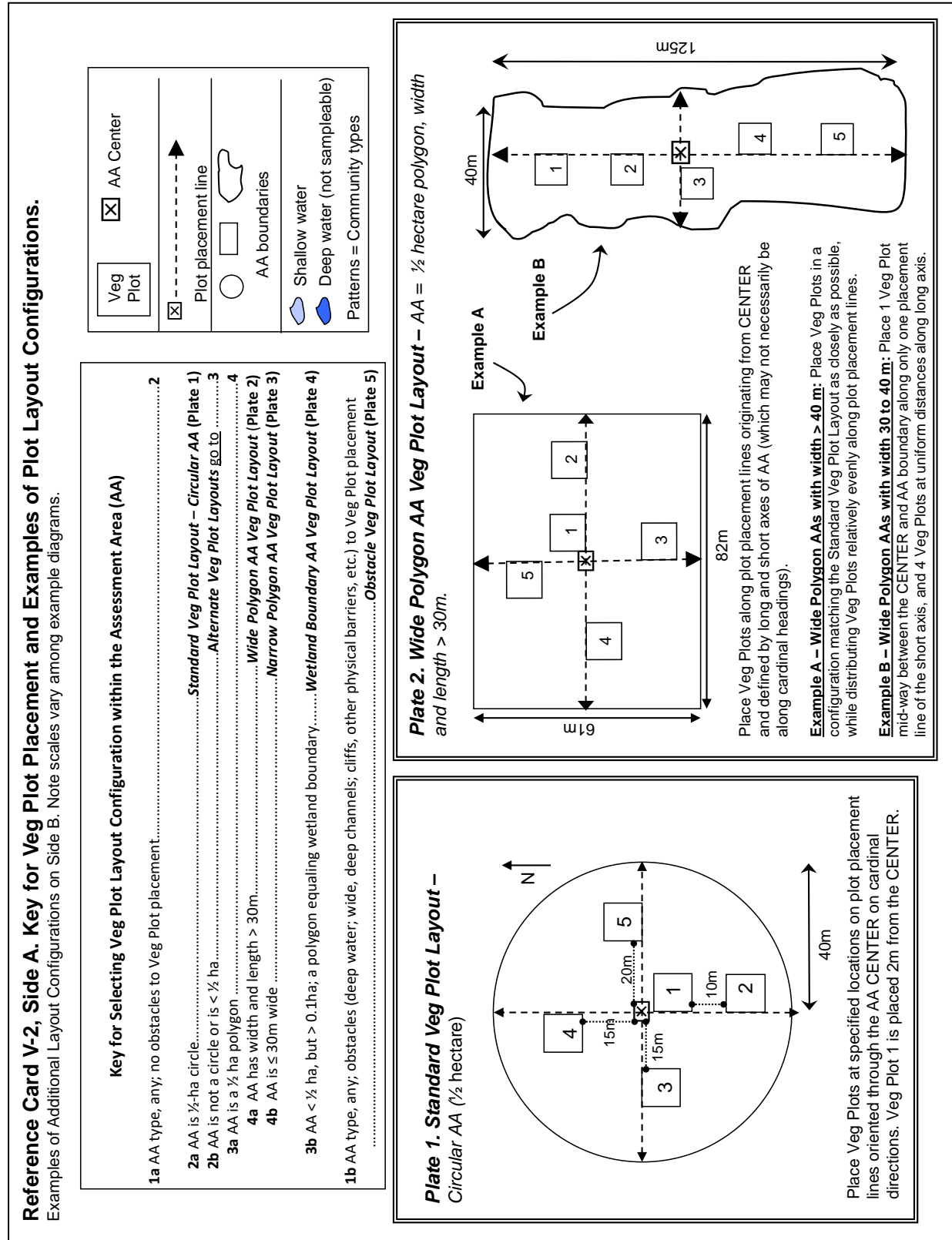


Figure 5-3. Reference Card V-2, Side A.

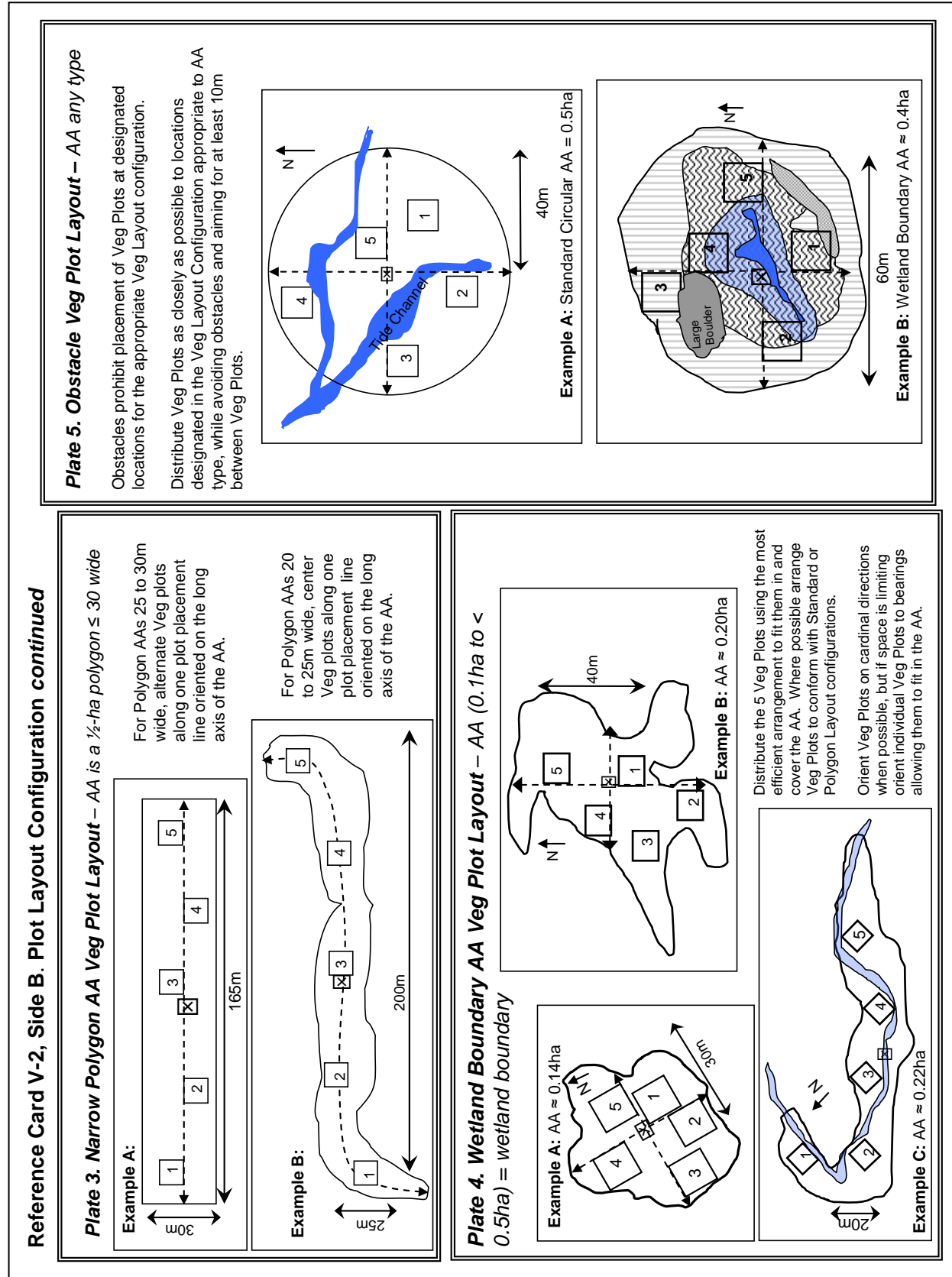


Figure 5-4. Reference Card V-2, Side B.

### 5.2.1.2 *Standard Veg Plot Layout – Veg Plots on Two Axes in a 0.5-ha Circular AA*

In the Standard AA, five 100-m<sup>2</sup> Veg Plots are distributed as depicted in the Standard Veg Plot Layout (see **Reference Card V-2** (Figure 5-3), **Plate 1**). Position Veg Plots along the four cardinal directions (north, east, south, west) from the CENTER of the AA. Number Veg Plots in clockwise order from Veg Plot 1 near the AA CENTER to Veg Plot 5 along the eastern plot placement line.

- To avoid the trampled area at the AA CENTER, place Veg Plot 1 to the east side of the south placement line with its northern edge 2 m from the AA CENTER as indicated in **Reference Card V-2** (Figure 5-3), **Plate 1**.
- Place Veg Plot 2 to the east side of the south plot placement line with its northern edge 22 m from the AA CENTER (i.e., 10 m south of the southern edge of Veg Plot 1).
- Place Veg Plot 3 to south side of the west plot placement line 15 m from the AA CENTER.
- Place Veg Plot 4 to west side of the north plot placement line 15 m from the AA CENTER.
- Place Veg Plot 5 to north side of the east plot placement line 20 m from the AA CENTER.

### 5.2.1.3 *Wide Polygon AA Veg Plot Layout – Veg Plots on Two Axes in a 0.5-ha Polygon AA with Width and Length > 30m*

If the wetland in which the POINT occurs is greater than or equal to 0.5 ha, but has dimensions <80 m in at least one direction, the AA will be configured as a polygon. Recall that the Polygon AA may be a rectangle, may have more than four sides, or may have sinuous edges paralleling the wetland boundary depending on conditions at the study site (see Chapter 3).

If the Polygon AA is greater than 30 m in width and length, use the Wide Polygon AA Veg Plot Layout to determine Veg Plot locations (see **Reference Card V-2** (Figure 5-3), **Plate 2**) along plot placement lines that are oriented on the long and short axes of the AA and intersecting the AA CENTER.

#### **Polygon AA > 40m wide** (see **Reference Card, Plate 2** (Figure 5-3) - **Example A**)

- Place the Veg Plots in a configuration matching as closely as possible the Standard Veg Plot Layout, while distributing plots evenly along plot placement lines. Note distances from the AA CENTER to each Veg Plot may have to be lengthened or contracted compared to the Standard Veg Plot Layout based on the distance from the AA CENTER to its edge.
- Locate each Veg Plot to the left side of the plot placement line when looking from the AA center to the AA edge. Number Veg Plots in clockwise order with Veg Plot 1 nearest the AA center.

#### **Polygon AA width 30 to 40m** (see **Reference Card V-2, Plate 2** (Figure 5-3) - **Example B**)

- Place one Veg Plot along one of the plot placement lines making up the short axis of the AA so that the plot is mid-way between the CENTER and the AA boundary. Locate the Veg Plot on the left side of the plot placement line, when looking from the AA CENTER to its edge.
- Evenly distribute the other four Veg Plots along the long axis of the AA, placing plots to left side of the plot placement lines when looking from the AA CENTER to its edge.
- Number Veg Plots consecutively from one end of the long axis of the AA to the other.

### 5.2.1.4 *Narrow Polygon AA Veg Plot Layout – Veg Plots along One Axis in ½-ha Polygon AA ≤30m Wide*

The Narrow Polygon AA Veg Plot Layout (**Reference Card V-2** (Figure 5-4), **Plate 3**) is used for 0.5-ha Polygon AAs that are ≤ 30m wide. AAs of this type might occur in long narrow riparian areas bordering small streams or along lake or pond shorelines. AAs < 20m wide are not sampleable (Chapter 3).

### All Polygon AAs ≤ 30m wide

- The plot placement line is oriented on the long axis of the AA and passes through the AA CENTER. The plot placement line may be:
  - a straight line, as in the case of a narrow rectangle (see **Reference Card V-2**, (Figure 5-4) **Plate 3 - Example A**); or
  - a sinuous line that parallels the shape of an AA with its width defined by a wetland edge (see **Reference Card V-2**, (Figure 5-4) **Plate 3 - Example B**).
- Evenly distribute Veg Plots along the plot placement line and number them in sequence along the long axis of the AA.

### Polygon AA width 25 to 30 m

- Place Veg Plots alternately on opposite sides of the plot placement line (see **Reference Card V-2**, (Figure 5-4) **Plate 3 - Example A**).

### Polygon AA width > 20 up to 25 m

- Center Veg Plots on the plot placement line (see **Reference Card V-2**, (Figure 5-4) **Plate 3 - Example B**). Take care to avoid trampling in the middle of the plots while moving around the AA.

#### 5.2.1.5 Wetland Boundary AA Veg Plot Layout – Veg Plots Distributed Across Entire Small Wetland (< 0.5ha but > 0.1ha)

When the wetland in which the POINT occurs is smaller than 0.5 ha but greater than or equal to 0.1 ha, the AA equals the wetland boundary. Wetlands that are smaller than 0.1 ha or less than 20 m wide are not sampleable (See Chapter 3).

Use the Wetland Boundary AA Veg Plot Layout (**Reference Card V-2** (Figure 5-4), **Plate 4**) to distribute Veg Plots over small (< ½ha) Wetland Boundary AAs.

- Distribute the five Veg Plots using the most efficient arrangement to fit them within the AA and evenly cover the AA area.
- Wherever feasible, arrange Veg Plots so they mirror as closely as possible the plot placement patterns used in the Standard or Polygon Veg Plot Layout configurations.
- When possible, orient individual Veg Plots on cardinal directions or along the long and short axis of the AA (perpendicular to one another). However, if the configuration of the AA prevents this, orient individual Veg Plots along bearings that allow them to fit in the AA.

#### 5.2.1.6 Obstacle Veg Plot Layout – Veg Plots Distributed around Obstacles in any AA type

Occasionally a Veg Plot cannot be placed at its designated location for a particular Veg Plot Layout configuration because of the presence of an obstacle creating unsafe or unsampleable conditions. In such situations, use the Obstacle Veg Plot Layout (see **Reference Card V-2** (Figure 5-4), **Plate 5**) to select a new location for the plot. The Obstacle Veg Plot Layout can be applied to any AA type; however, Veg Plots should be relocated only when absolutely necessary, and should be done in a way that aims for at least 10 m between plots. If a Veg Plot must be relocated, position it as close to the original location designated by the AA-appropriate Veg Plot Layout as possible.

A Veg Plot may be moved if it cannot be sampled because more than 10% of the space in which it would fall is obstructed by unsafe or unsampleable conditions. An individual Veg Plot may be moved to an alternate location to:



- avoid areas of deep (> 1 m) water, water < 1m deep but underlain by soft sediments posing safety hazards, water < 1 m deep but moving rapidly enough to pose safety hazards, or water likely to have widely varying depths during the sample period such as wide, deep tide channels;
- avoid large patches of upland in the AA. However, the plot should not be moved when there are microtopographic upland inclusions (e.g., hummocks or mounds); or
- avoid other obstacles such as very large boulders (e.g., glacial erratics), cliffs, or other physical barriers that would occupy a large portion of the Veg Plot.

### 5.2.2 *Establishing the Vegetation Plots and Completing Veg Plot Establishment. Form (V-1)*

After determining the appropriate Vegetation Plot Layout for the AA, set-up the Veg Plots and complete the **Veg Plot Establishment Form (V-1)** (see Figure 5-5 through Figure 5-7 for a completed example of this Form in the NWCA App). Establish the Veg Plots in the AA as close as possible to their designated locations in the selected Veg Plot Layout configuration (Section 5.2.1, **Reference Card V-2** (Figure 5-3 and Figure 5-4)).

#### 5.2.2.1 *Establishing Veg Plots*

- 1) Lay out all five 100-m<sup>2</sup> Veg Plots before vegetation sampling begins so the Assessment Area-Buffer (AB) Team can avoid trampling the Veg Plots as they work.
- 2) Double check the header information on the top of the **Veg Plot Establishment Form (V-1)** (Figure 5-5). Ensure the site ID and Visit number that you have chosen matches the site and visit being sampled. Verify or enter the sampling date by using the today button of the date selection wheel. It is very important the date be entered in the correct format (MM/DD/YYYY).
- 3) Document which Veg Plot Layout configuration is used for sampling the AA by selecting the appropriate bubble in the Vegetation Plot Layout section of **Veg Plot Establishment Form (V-1)** (Figure 5-5).
- 4) Establish Veg Plots in whatever order is most convenient and causes the least disturbance to the AA. Take care to avoid walking in the interior of a plot. Set-up each Veg Plot as illustrated and described on **Reference Card V-3, Side A** (Figure 5-9). Crews should use a compass while laying out the plots to ensure that each plot is square. A variety of approaches may be used to demarcate the edges of a Veg Plot:
  - Often the easiest method is to use four 10-m lengths of durable (e.g., nylon) rope or cord on which the 5-m point is marked with brightly colored, waterproof tape. This method offers high flexibility for use in open to dense vegetation types and the rope is compact and lightweight for carrying into the field.
  - Use the four ropes to measure the boundaries of each Veg Plot and then clearly mark boundaries with flagging, pin flags, chaining pins, or other type marker. Once the Veg Plot boundary is marked, the rope can be removed and used to measure the boundary of the next Veg Plot.
  - Only one set of four 10-m ropes or cords needs to be carried in the field. However, if desired, for sites near a road and with open vegetation, five sets of the four 10-m cord lengths can be carried in the field so the rope can be left in place at Veg Plot to clearly demarcate its edges during sampling. Alternatively, crews can roughly flag each plot initially

to identify its general location and then use one set of ropes to lay out and demarcate the plot which is being sampled.

- Other alternatives that some Field Crews prefer are using two 20-m lengths of rope, one 30-m length of rope with the 10 and 20-m points marked (the fourth side of the plot is marked by the plot placement line in this case), one 40-m length with the 5 and 10-m points marked, or a 50-m tape. Note that ropes are more durable and easier to handle than a meter tape. Some situations may call for a compass and rangefinder to be used to mark the corners of the plots.
- 5) Number Veg Plots, 1 through 5, using conventions illustrated on **Reference Card V-2** (Figure 5-3 and Figure 5-4). Place a flag with the Veg Plot number in the SE corner of each plot to clearly identify the plots for all Field Crew Members. For Veg Plots that are laid out using the Standard Veg Plot Layout, it is not necessary to record their GPS coordinates on the **Veg Plot Establishment Form (V-1)**, Figure 5-5).
  - 6) For Non-Standard Veg Plot Layouts, including any Veg Plot that was moved due to an obstacle, record Veg Plot locations using the GPS coordinates of the Plot corner that is closest to the AA CENTER in the space provided on **Veg Plot Establishment Form (V-1)** (Figure 5-5). For Alternate Veg Plot Layouts this will include coordinates for all five Veg Plots. For a Standard Layout that includes the Obstacle Veg Plot Layout (see next), only coordinates for plots moved from their standard locations need to be recorded.
  - 7) If an obstacle to Veg Plot placement occurs and one or more Veg Plots must be moved from their normally designated locations in the selected Veg Plot Layout configuration, also select the Obstacle Veg Plot Layout Used bubble on **Veg Plot Establishment Form (V-1)** (Figure 5-5) and indicate the obstacle type.
    - For example, in the situation where a Standard Veg Plot Layout is used and an obstacle necessitates moving a single Veg Plot, select the bubbles for both *Standard Veg Plot Layout* and the *Obstacle Veg Plot Layout Used*.
      - Also, indicate the obstacle type by selecting the appropriate bubble on the **Veg Plot Establishment Form (V-1)** (Figure 5-5). If the obstacle type is not listed, fill in the bubble for 'Other' and type in a short (e.g., one to three word) description of the obstacle. Highlight the obstacle on the aerial photo or map used to document AA establishment.
    - Record any pertinent notes about the general veg plot layout, the vegetation or environment of the AA, and/or any specific observations about any of the veg plots (including additional information regarding the need to move a veg plot from its standard location) in the pertinent text fields (Figure 5-6).

10:16 AM Sun Apr 11
63%

Menu
TEST-OR-10005, Visit: 1  
Version 2.3
SAVE

NWCA 2021 VEGETATION PLOT ESTABLISHMENT (V-1)

✘ This form has been thoroughly reviewed and is ready for submission

Date:

Today

**VEGETATION PLOT LAYOUT**

Fill in the bubble for the Vegetation Plot Layout configuration:

Standard Veg Plot Layout - 1/2 ha Circular AA

**Alternate Veg Plot Layouts (remember to enter coordinates below)**

Wide Polygon AA Veg Plot Layout - 1/2 ha Polygon AA with width and length >30m

Narrow Polygon AA Veg Plot Layout - 1/2 ha Polygon AA ≤ 30m wide

Wetland Boundary AA Veg Plot Layout - AA <1/2 ha polygon equal to wetland boundary

For alternate or obstacle vegetation plot layouts only: [Enter coordinates for plot corner closest to AA center]

	Latitude North (Decimal Degrees)	Longitude West (Decimal Degrees)
<input checked="" type="radio"/> Obstacle Veg Plot Layout Used		
(Fill bubble if obstacles prevent placement of plot(s) as designated by selected layout)		
<b>Obstacle Type (mark all that apply):</b>		
<input type="radio"/> Deep Water		
<input checked="" type="radio"/> Tide Channel		
<input type="radio"/> Safety Hazard		
<input type="radio"/> Other: <input style="width: 150px;" type="text"/>		
Plot 1:	<input type="text" value="XX.XXXXXX"/>	<input type="text" value="-XXX.XXXXXX"/>
Plot 2:	<input type="text" value="XX.XXXXXX"/>	<input type="text" value="-XXX.XXXXXX"/>
Plot 3:	<input type="text" value="XX.XXXXXX"/>	<input type="text" value="-XXX.XXXXXX"/>
Plot 4:	<input type="text" value="44.91776"/>	<input type="text" value="-124.007777"/>
Plot 5:	<input type="text" value="XX.XXXXXX"/>	<input type="text" value="-XXX.XXXXXX"/>

**Figure 5-5. Example of completed upper section Veg Plot Establishment Form (V-1). Data depicted on this figure are imaginary and for illustration only.**

VEGETATION PLOT NOTES	
<p>Add veg plot locations to the annotated aerial photo. Number veg plots 1 through 5 using guidelines on Reference Card V-2. If needed, elaborate on plot layout or make notes about unique features or gradients in the vegetation or environment below.</p>	
<p>Veg Plot Layout Notes:</p>	
<p>Standard veg plot layout; Plot 4 to avoid the channel greater than 1 m deep at high tide</p>	
<p>Vegetation or Environment of AA Notes:</p>	
<p>Low saltmarsh incised by tide channels. Slight elevation rise from seaward to inland side of AA. Dead/dying scattered shrubs on inland edge of AA.</p>	
<p>Plot 1 Notes:</p>	
<p>Plot 2 Notes:</p>	
<p>Plot 3 Notes:</p>	
<p>Shallow tide channel over corner of plot (less than 10% of plot area).</p>	
<p>Plot 4 Notes:</p>	
<p>Plot 5 Notes:</p>	
<p>Dead clump of my Myrica Gale, SE corner of plot. Increase in salt water flooding?</p>	

Figure 5-6. Example of completed middle section Veg Plot Establishment Form (V-1). Data depicted on this figure are imaginary and for illustration only.

### PREDOMINANT NWCA TARGET WETLAND TYPE

**Definitions:**  
EH - Estuarine Emergent  
EW - Estuarine Shrub/Forest  
PRL-EM - Palustrine, Riverine, and Lacustrine Emergent  
PRL-SS - Palustrine, Riverine, and Lacustrine Scrub/Shrub  
PRL-FO - Palustrine, Riverine, and Lacustrine Forested  
PRL-UBAB - Palustrine, Riverine, and Lacustrine Unconsolidated  
PRL-f - Palustrine, Riverine, and Lacustrine Farmed (not actively farmed)

Plot 1:    
Plot 2:    
Plot 3:    
Plot 4:    
Plot 5:

### PLANT SPECIES NOMENCLATURE

Record citations for Floras/Field Guides/Databases used for plant identification. List citations in order of importance with 1 being primary guide.

Citation 1:    
Citation 2:    
Citation 3:    
Citation 4:    
Citation 5:


 Online

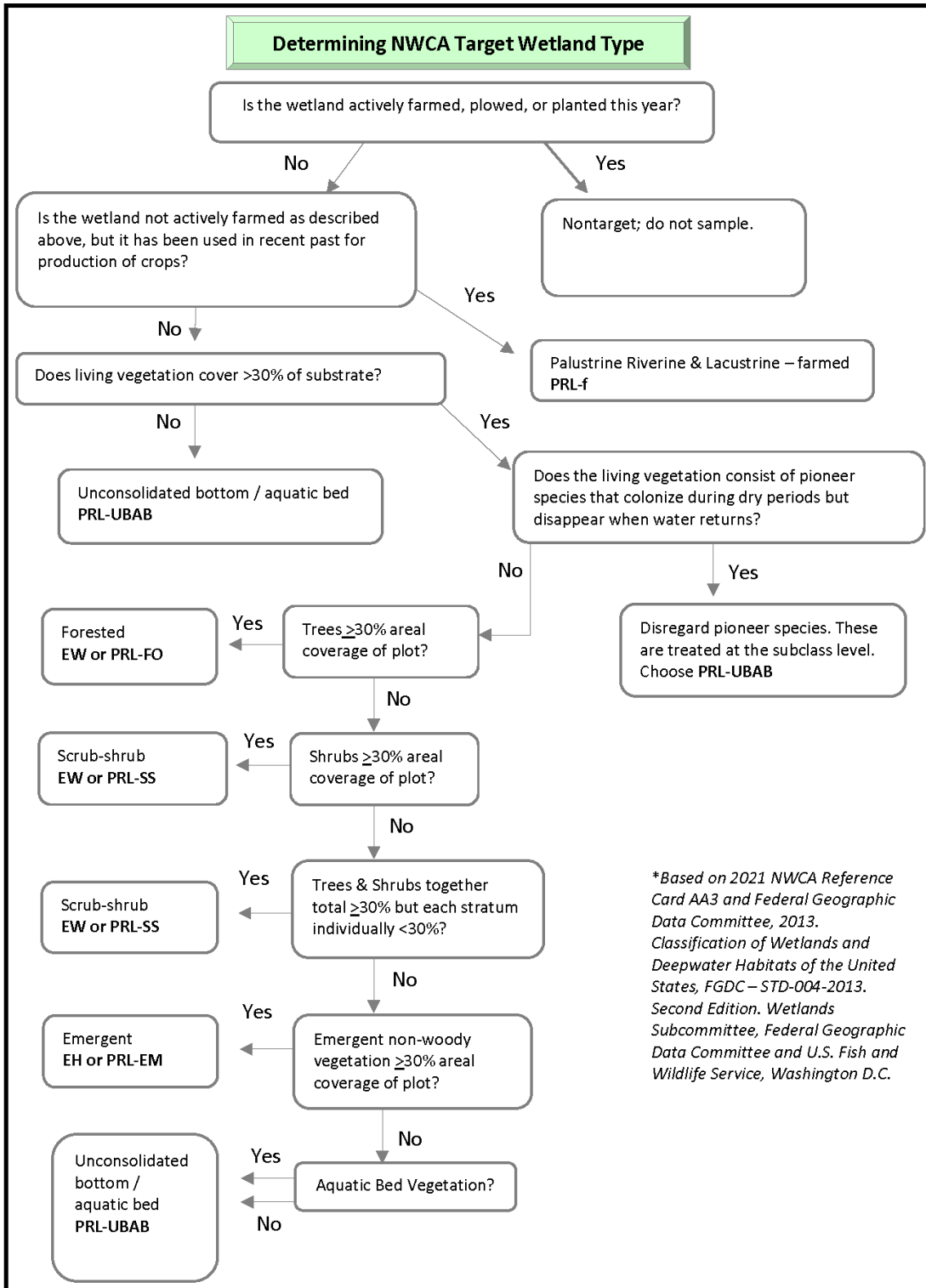
Figure 5-7. Example of completed lower section Veg Plot Establishment Form (V-1). Data depicted on this figure are imaginary and for illustration only.

#### 5.2.2.2 NWCA Target Wetland Type by Veg Plot

Identify the predominant NWCA Target Wetland Type best representing each Veg Plot and record on the **Veg Plot Establishment Form (V-1)** (Figure 5-7). See **Reference Card AA-3, Side A** (Figure 5-9) and Chapter 3 for definitions of NWCA Target Wetland Types. See **Reference Card AA-4** (Figure 5-8) for the Flowchart for Determining NWCA Target Wetland Type. Each AA will represent an overall dominant NWCA Target Wetland Type. However, within the AA, there may be areas or inclusions that have different vegetation structure.

Most often, the same NWCA wetland type will occur across all five Veg Plots. However, there may be instances where some Veg Plots are dominated by different vegetation structure. For example, at a given AA, some Veg Plots may be characterized by forest, while others may be largely shrub dominated. Similarly, some plots within an AA might be represented by emergent vegetation, while others could be shrub dominated. Differences and similarities among the Veg Plots can provide information on the heterogeneity of the AA.

**Reference Card AA-4. Flowchart for Determining NWCA Target Wetland Type**



Refer to 2021 NWCA-Field Operations Manual – Chapter 3,5 for detail on protocols summarized on this card.

Figure 5-8. Flowchart for Determining NWCA Target Wetland Type

**Reference Card V-3. Side A – Vegetation Plot Establishment**

**1) Select Veg Plot Layout Configuration**

**2) Complete Form V-1:** Enter Veg Plot Layout information, annotate aerial photo with Veg Plot locations, enter NWCA Target Wetland Types for each Veg Plot, provide plant nomenclature sources, and if needed, add any explanatory notes to the Vegetation Plot Notes Section.

**3) Setting up Veg Plots**

- Use a compass and measuring device to delineate the outside edges of each Veg Plot. A convenient way to do this is with four 10m lengths of durable (e.g., nylon) rope or cord on which the 5m interval is marked with brightly colored waterproof tape.
- If leaving the ropes in place to bound the Veg Plot, pin them using U-shaped pins, tent stakes, or surveyor's arrows (also called chaining pins).
- When stretching tapes or lines along a compass bearing, there will occasionally be some drift related to obstacles and slope. Some drift is acceptable, but try to keep the Veg Plot relatively square and constant in area. The following steps can help align the square when laying out the sides of the plot:
  - 1) Mark out one 10m edge.
  - 2) Mark out one perpendicular edge, 90 degrees from the first.
  - 3) Return to first edge and mark opposing perpendicular edge.
  - 4) Check square by laying fourth rope between the far ends of the perpendicular edges.

Mark corners and mid-points of each side of the plot with different colored flagging or pin flags, e.g., fluorescent pink or red for corners, blue for mid-points of the plot edges.

- If removing the rope lines (e.g., only one set of ropes is available for measuring all plots), use additional flagging as needed to ensure Veg Plot boundaries are easily visible during sampling, particularly where vegetation is dense with shrubs or trees.

Refer to NWCA 2021 Field Operations Manual (Chapter 5. Vegetation) for more detail on protocols summarized on this card.

Figure 5-9. Reference Card V-3. Side A. Vegetation Plot Establishment.



### 5.2.2.3 Identifying and Recording Taxonomic Sources Used in the AA

Prior to the beginning of the field season, each Vegetation Team will have been requested to provide the NWCA Project Team with the list of floras/field guides/floristic databases they plan to use during the field season for plant identification and taxonomic designation. Citations for these floristic resources are included in 8.7Appendix C, along with others appropriate for use in specific states or regions. The resources are listed by state in 8.7Appendix C and each resource is referenced by a Short Citation (for ease of communication) and a Long (i.e., complete) Citation. The short citation typically includes the author(s) and the publication year or a brief description of the flora. Resources are classed as primary (most applicable and comprehensive for that state) or supplementary (covering only some kinds of plants or limited portions of the state). For some states or regions no current manual of the flora may exist. In such cases, floras from one or more adjacent states/regions may be applicable to various geographies within that state.

Note: 8.7Appendix C is not necessarily an exhaustive list, but it includes many primary resources and a variety of secondary resources for each state. Other resources or newly published floras absent from Appendix C may also be considered for use. If you use a resource not listed in Appendix C, it must be cited as described below.

To ensure the highest quality taxonomic data, **it is critical** that the floristic references used by each crew are pertinent to the state and ecoregion being sampled. It is **also important** to use range maps to ensure that identified species are within their ranges, or examined in more detail if out of their known range. Range maps or descriptions of species distributions are provided in most floras. In addition, range maps for plant species across North America can be found on the USDA-NRCS PLANTS Database website (<https://plants.sc.egov.usda.gov/>) and on the Biota of North America Program website ([www.bonap.org](http://www.bonap.org)). The PLANTS database maps include ranges for species, subspecies, and varieties, while BONAP maps provides some finer detail about native and introduced distributions for at the species level. Also, many states have plant atlases or ongoing flora projects with state-level plant species distribution maps that are accessible online. It is a good idea to investigate whether a state-level plant atlas is available for the state or states in which you are sampling.

For accurate plant identification in the field or lab, it is necessary to use state or regional floras, field guides, and range maps. However, plant nomenclature will vary across these different floristic resources and standardized names are critical for comparisons of species composition across the national scale. For the NWCA, taxonomic standardization is based on the nomenclature of the PLANTS Database (USDA, NRCS 2021, <https://plants.sc.egov.usda.gov/>), hereafter PLANTS). To provide consistent taxonomy across the NWCA sampled sites, it is essential to reconcile the plant names recorded by each Field Crew during sampling to the nomenclature of the PLANTS Database. This taxonomic reconciliation is not the Field Crew's responsibility; rather, it will be done during data review and analysis by the NWCA analysis team. For this reason, crews should not cite USDA PLANTS as a taxonomic source.

Both to facilitate quality assurance evaluation of the collected species data and for nomenclatural reconciliation, **IT IS CRITICALLY IMPORTANT** that the floristic resources used at each AA are recorded on the **Veg Plot Establishment Form (V-1)** under the '**Floristic Resources Used**' heading (Figure 5-7). Procedures for recording citations in this section of the form using the NWCA Data Collection App are outlined below:

- Space is provided for recording citations for up to eight floristic references (Citation 1 through Citation 8).
- Use the drop-down list (click on the arrow) next to each Citation space to display the list of Short

Citations and select the relevant Short Citation for each floristic resource used at the site. Refer to Appendix C as needed to ensure that you are selecting the correct short citation for the reference you are citing.

- Selecting the Short Citation from the drop-down lists ensures consistent spelling and formatting, which is important for data consistency and facilitates data review.
  - Record Short Citation for the primary flora used for plant identification at the site, as Citation Number 1.
  - Record secondary floras or field guides used at the site under Citations 2 through 5+ in order of importance.
- If you are using a reference that is not included in 8.7 Appendix C and the **V-1 Form** drop-down list, then record a citation that is as complete as possible (e.g., author(s), publication date, title, and publisher). Do not use the drop-down menus in the App, type directly in the blank field using the following citation as an example. Once the data for this site are submitted, you will be contacted by NWCA to set a consistent short citation for this reference.
  - Magee, D.W. and H.E. Ahles. 2007. Flora of the Northeast: A Manual of the Vascular Flora of New England and Adjacent New York. University of Massachusetts Press.

#### 5.2.2.4 *Documentation of Veg Plot Locations and Characteristics*

Complete Veg Plot Establishment activities by annotating the AA aerial photo with Veg Plot and Soil Plot locations (Chapter 6) and provide any needed explanatory notes on the **Veg Plot Establishment Form (V-1)** (Figure 5-7).

- Draw the plot placement lines and Veg Plot locations on the aerial photo (examples: Figure 5-10 and Figure 5-11) that was previously annotated in the office (see Chapter 2) or during AA establishment (Chapter 3). Annotations may be sketched in the field and finalized electronically in the office. Alternatively, a Sharpie® (or similar) fine-point, permanent, silver marker works well for annotating the photo.
- Once the AB Team designates the water sampling and Soil Plot location, record and label both positions on the aerial photo.
- *If needed*, elaborate on reasons for plot layout selection and make notes about unique features or gradients in the vegetation or environment in the *Notes* section of **Veg Plot Establishment Form (V-1)**, Figure 5-7. The Notes section is divided into several areas by topic to organize comments and make them easy to search during data analysis. It is not required to fill in information for all of these categories. The space is available to highlight observations that the Veg Team considers key for later analysis and interpretation.

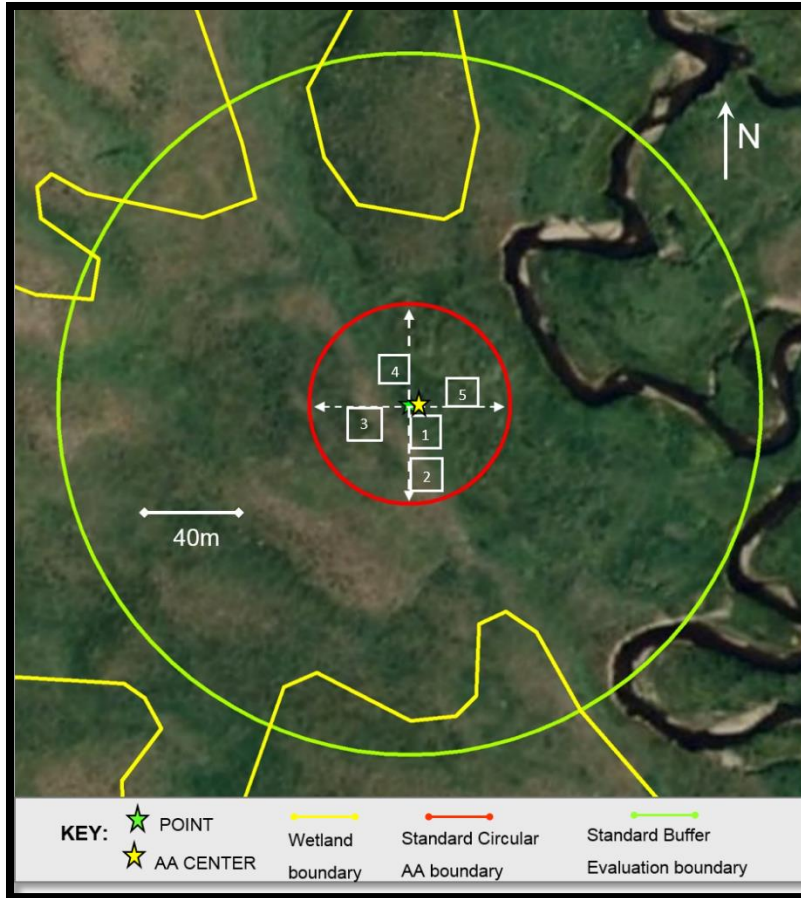


Figure 5-10. Annotated aerial photo illustrating a Standard AA Layout and Veg Plot (white squares) locations and plot placement lines (dashed white arrows) for a Standard AA Veg Plot Layout.

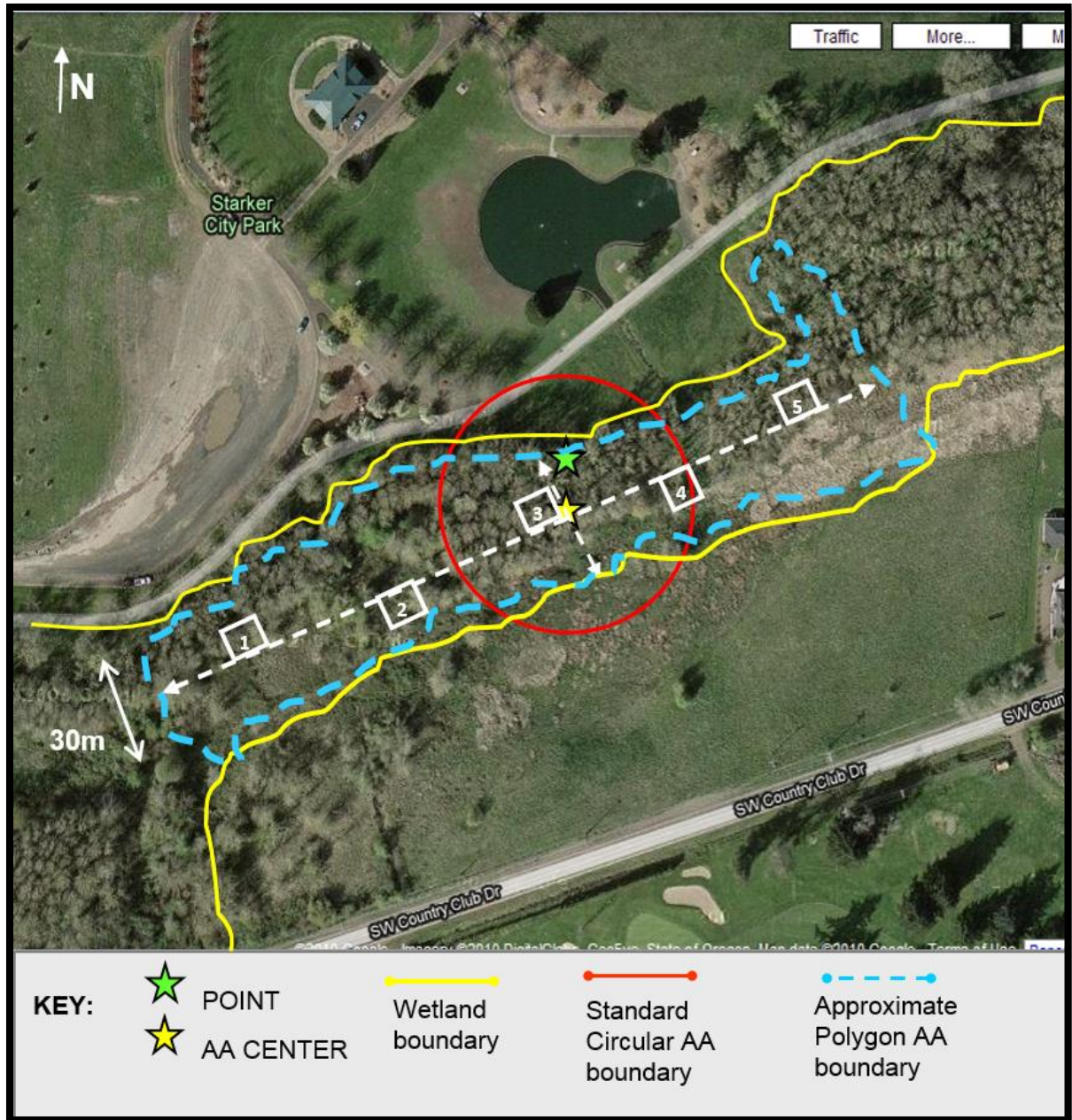


Figure 5-11 Annotated aerial photo showing Veg Plots (white squares) locations and plot placement lines (dashed white arrows) for a Wide Polygon AA Veg Plot Layout. Note the boundary of the Standard AA Layout (red) and the actual Polygon AA (blue).



### 5.2.3 Vegetation Data Collection (Forms V-2, V-3, and V-4)

Vegetation data collection activities are summarized in **Reference Card V-3, Side B** (Figure 5-12), and the configuration for the 100-m<sup>2</sup> Veg Plots used for data collection is illustrated. Several kinds of vegetation data (presence, cover, counts, and categorical), and data describing ground surface attributes (cover, depth, and categorical) are collected in each Veg Plot. Additional presence data by plant species are collected in nested quadrats at the SW and NE corners of each Veg Plot. Vegetation data are collected using three forms (Form V-2, Form V-3, and Form V-4) in the NWCA App.

At each AA, data describing the identity, presence, cover, and height of all vascular plant species are recorded on the **Vascular Species Presence and Cover Form (V-2)**, Figure 5-13. In addition, tree species are specifically noted on Form V-2 to automatically add the tree name to a row on the **Snag and Tree Counts and Tree Cover Form (V-4)**, where additional data describing tree species are recorded. This connection between Forms V-2 and V-4 ensures all observed tree taxa will appear on both Forms V-2 and V-4 and the name used for each tree taxon will be exactly the same across both forms, something that is essential to data quality. Tree cover and count data can be entered either on **Form V-4** or in the resulting “Enter Tree Data” popup window on **Form V-2**. The data on these two forms are linked, so entering and saving data on one automatically updates the other. Note, however, that these data are all plot-specific, so be sure the correct plot tab (on **Form V-2**) or row (on **Form V-4**) is chosen.

At the top of the **Vascular Species Presence and Cover Form (V-2)**, there are five *Plot* tabs, one for each Veg Plot. This allows the user to enter specific data elements for each vascular plant species observed in each individual Veg Plot, including name, presence (Section 5.2.3.2), height (Section 5.2.3.4), and percent cover (Section 5.2.3.3). Each row on a *Plot* tab represents data for an individual plant species. Note that when a species name is entered into any *Plot* tab on Form V-2 in the App, that name is displayed across all five *Plot* tabs for the site. New species can be added from any of *Plot* tab as they are observed. The number of rows completed for each site will depend on how many unique species are observed across the five plots. On Form V-2, you must record for each species observed in a Veg Plot, at minimum, four data elements: 1) Presence in the NE nested quadrat, 2) Presence in the SW nested quadrat, 3) representative Height, and 4) Percent Cover. If a species is not observed in a specific plot, please indicate by recording 0 for percent cover.

Data describing vertical vegetation structure (Section 5.2.3.5) and nonvascular groups (5.2.3.6), as well as a variety of ground surface attributes (Section 5.2.3.7) are recorded on the **Vegetation Types/Ground Surface Attributes Form (V-3)** (Figure 5-20 and Figure 5-22). There are five *Plot* tabs, one for each Veg plot, in Form V-3. Evaluate all attributes, listed on Form V-3, for a plot and record the appropriate numeric value or character value for each item. A value is required for all data items and if an item is not present, record 0.

The **Snag and Tree Counts and Tree Cover Form (V-4)** (Figure 5-23) is used to collect counts of dead trees and snags, and detailed information for living trees by species (cover by height class and counts by diameter at breast height (DBH) class). Once all observations for these items are made and their values are recorded, the remaining empty cells should be populated with zeros. This may be done manually or with “Fill Zeros” button in the App which auto fills zeros for cells in which no snags or trees were observed and recorded.

All vegetation data are typically collected for a single Veg Plot before moving on to sample the next Veg Plot. An efficient approach to collecting vegetation data is for the Botanist Assistant to record data as the Botanist/Ecologist makes observations. When using the NWCA App for data collection, this is likely to be the best method. If using paper data forms (in the event of App or iPad failure) or if both Botany Team members have iPads with the NWCA App, it may be more efficient for the Botanist/Ecologist and Botanist Assistant to collect different kinds of data independently, with the Botanist Assistant consulting the Botanist/Ecologist as needed on issues related to plant identification. For example, the Botanist/Ecologist might collect all data requiring identification or cover estimation for individual plant species (all data on Form V-2 and Form V-4), while the Botanist Assistant write notes related to plot establishment (Form V-1) or collects data on cover of vegetation strata, ground surface attributes, and groups of non-vascular taxa, Form V-3). Because Forms V-2 and V-4 are linked, the same iPad should be used to collect data for both forms.

#### *5.2.3.1 Global Activities and Conventions Key to Vegetation Data Collection*

Several kinds of sampling activities are conducted, and several types of plant data are recorded throughout the sampling day. Careful adherence to specific protocols is essential to ensure data quality and management. In addition, there are a number of activities and conventions that apply to data collection and recording across all vegetation protocols.

**Form Instructions** – Carefully follow all instructions on how to record data on each data form in the NWCA App and refer to the NWCA Field Operations Manual for clarification of sampling protocols whenever necessary.

**Confirm Site and Visit Number** – Check to ensure that the Site and Visit Number for the App forms you have selected match the Site and Visit Numbers at your sample location. Site and Visit Number are automatically included at the top of each form.

**Date** – On each form, verify or record the date when sampling is initiated for the current visit to the site. In the NWCA App, tap the ‘Today’ button to autofill the date.

**Reference Card V-3, Side B – Veg Plot Configuration and Data Collection Summary**

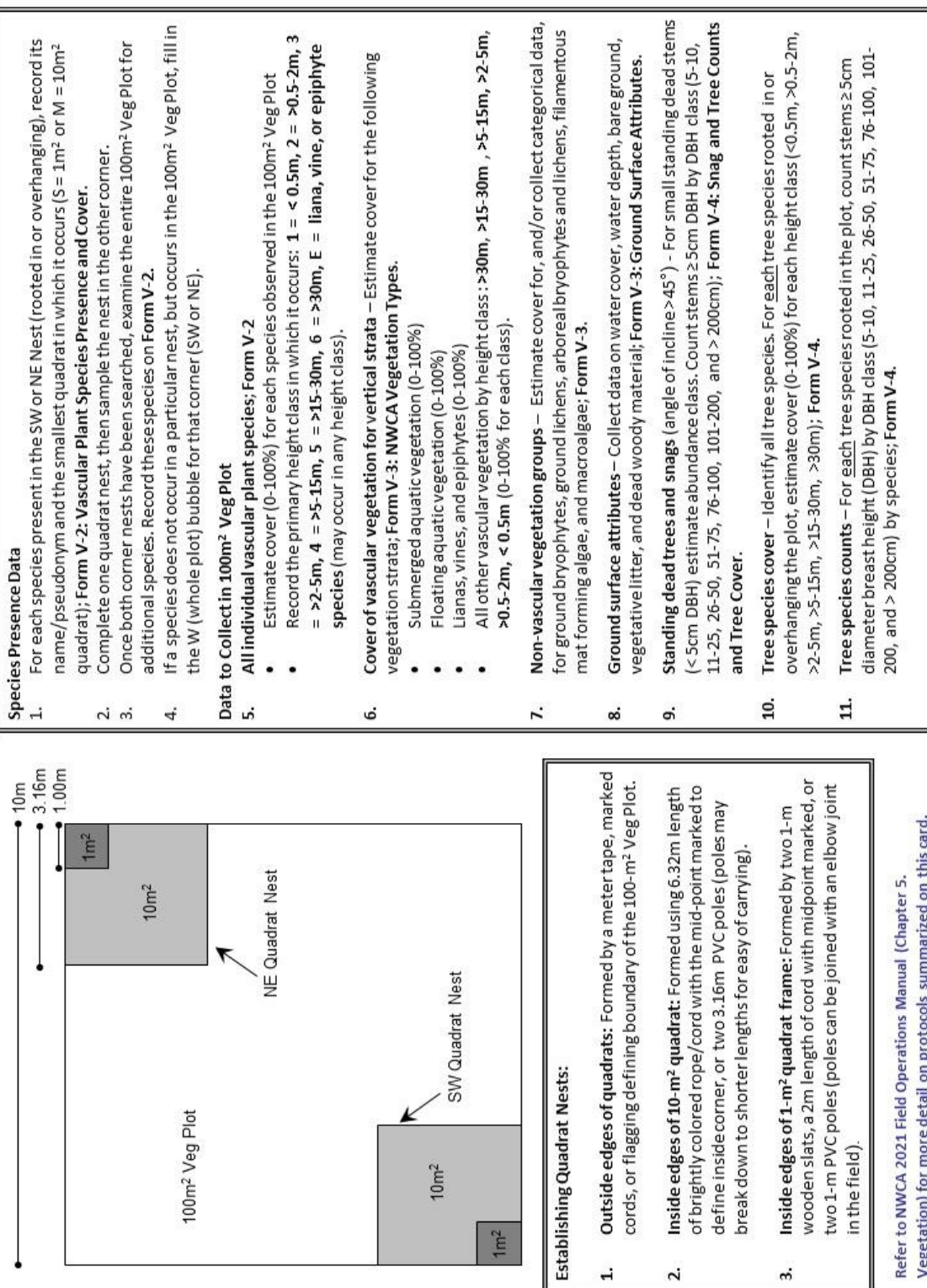




Figure 5-12. Reference Card V-3, Side B. Veg Plot configuration and data collection summary



**Indicate if any Veg Plots Have Not Been Sampled** – Normally 5 Veg Plots are sampled at each site. Only on **RARE** occasions will site conditions (e.g., safety issues, rising tide, alligator) or weather events (e.g., dangerous thunderstorm, hurricane causing early departure from a site) result in fewer than 5 Veg Plots being sampled. If it is possible to return to the site, the unsampled Veg Plots would ideally be completed the next day or as soon as logistics allow. If, due to hazards, a particular Veg Plot cannot be sampled for V-2 or V-3 data, check the ‘*This plot was not sampled box*’ at the top of the relevant Plot tab on the **Vascular Species Presence and Cover Form (V-2)** or on the **Vegetation Types/Ground Surface Attributes Form (V-3)**. Finally, using the comment bubble next to the ‘*This plot was not sampled box*’, add the reason why this plot could not be sampled. If data for the **Snag and Tree Counts and Tree Cover Form (V-4)** were not collected in a particular plot, add a comment indicating why these data were not collected. In this case, blank fields indicate not assessed.

**Data Comments** – There are comment bubbles on all vegetation data forms in the App to “flag” or comment on data for which additional information or explanation may be needed. In some cases, the comment bubbles are located in areas to allow them to refer to entire sections of data, while in other cases the comment is specific to an individual data point. In both cases, an empty comment bubble (  ) indicates the presence of an available comment field. Tapping the bubble opens a text field that allows the user to type the pertinent comment. Once the comment is saved, the comment bubble now appears filled in (  ) to indicate that a comment has been recorded.

**Floristic Resources** –State and regionally appropriate floras and field guides for use in plant identification are listed in 8.7Appendix C.

**Regional or Site-Specific Species Lists** – Ideally, a complete state-level species list that mirrors the primary flora being used for plant identification by the crew for the state(s) where they are sampling will be included as the species checklist embedded in **Form V-2** of the NWCA App. In addition, it may be helpful to consult existing plant species lists for similar habitats in the region of the AA you are sampling. If such lists are available, keep an electronic copy available on your field tablet or computer, include hardcopies in the Site Packet for the AA (see Chapter 2), or in the vehicle with your other floristic resources.

**Species Not Included in Floristic Resources Used at a Site** -- Occasionally species might occur that are not included in the flora or field guides used by the Vegetation Team. This might happen when a recently described native species or a recently introduced nonnative species is observed. Use the comment bubble for this species on the **Vascular Species Presence and Cover Form (V-2)** to record the botanical authority for the species, and if possible, for newly described species, provide a nomenclatural citation. For example, see the comments for *Kalmiopsis fragrans* illustrated in the example data in Figure 5-13:

- KALMIOPSIS FRAGRANS MEINKE & KAYE, SP. NOV.
- Meinke and Kaye. 2007. Jour. of Botanical Research Institute of Texas 1:9-19.

**Recording Plant Names on Data Forms** – Species names and pseudonyms are recorded in all capital letters (ALL CAPS), because this is the default data format for analysis. The drop-down species lists uploaded into the **Vascular Species Presence/Cover Form (V-2)** will provide names in ALL CAPS. Please use this drop-down list when the taxon name you need is available; this prevents spelling and formatting errors. When you must enter scientific names not included in the App list or pseudonyms for unknowns, please, do so by typing in ALL CAPS.

**Correcting Plant Species Names on Data Forms**— At times corrections to plant species names for a particular site may need to be made to the **Vascular Species Presence/Cover Form (V-2)** during data collection, or before or after submission of data forms to the Information Management Team. Edit the species name on **Form V-2** by selecting the cell containing the name to be changed and selecting the new genus and species from the drop-down menus. If the species is a tree species, save the newly edited name into the **V-4 Form** by selecting the “Enter Tree Data” button on **Form V-2** and select the SAVE button in the resulting pop-up window. Species names are not directly editable in the **V-4 Form**. During data collection, it is likely that (a) some taxa not initially recognized will later be identified, or (b) a species initially misidentified will be later corrected. Corrections may be made to species names at any time, and the data submitted or resubmitted. See training material information for the App.

**Deleting Plant Species Names on Data Forms**— If you wish for a row of data on the V-2 Form to be disregarded, type the word DELETE in the full genus/species name box and save it. This can happen when 2 rows of data contained the same species and the information is consolidated into a single row, or when an unknown species is later found to be the same as a plant species already listed. All data associated with this row will be removed from the IM Database at a later date, therefore other data associated with the row can be removed in the App if desired, but it is not critical to do so.

**Plant Specimen Collection**—Specimens are collected for observed species of unknown identity for later identification. In addition, five randomly selected species of known identity (quality assurance (QA) voucher specimens) are collected for taxonomic confirmation (See Section 5.3 for selection procedure for QA specimens). Plant specimen collection and handling procedures are detailed in Section 5.3. A brief overview is provided here:

#### ***Unknown Specimens***

- Unknown plant specimens may be collected over the sampling day as they are encountered.
- Collect all unknown species (see Section 5.3.1) that are mature and have diagnostic elements needed for keying and identifying specimens (e.g., leaves, stems, flowers and/or fruits) **regardless of cover**.
- For immature or senescent unknown species with key parts missing (e.g., grasses or sedges with only leaf blades and no flowers or fruits; forbs that are seedlings, have unremarkable leaf shapes, or missing flowers), do the following:
  - If the species has > 5% cover, **collect it anyway**. It is possible that a regional expert may be able to identify the species even it is incomplete.
  - If the species has < 5% cover, record a pseudonym and estimate cover as usual, but **collecting a specimen is optional**. If there are only a few such species, collecting them is encouraged.
- For each **collected** unknown taxon listed on Form V-2 select the U circle. The collection number is automatically assigned by the App.
- See **Reference Card V-5**, Side B for the Flowchart for Collecting Unknown Plant Specimens.

#### ***QA Specimens***

- Using procedures defined in Section 5.3.1, select five known (identified by the Botanist/Ecologist during the sampling day) plant species to collect for QA verification (See Section 5.3.1 for selection procedure for QA specimens).
- For each QA specimen that is collected fill in the Q circle. The collection number is automatically

assigned by the App.

### ***Collecting Plant Material***

- For each species collected, place enough fresh plant material for a complete specimen (see Section 5.3.1) into a plastic bag (e.g., 1-gallon zipper-lock or larger bag, if necessary). Write the Site ID, Visit Number, and the Collection Number for the specimen on the outside of the bag with a waterproof marker or on a slip of waterproof paper placed inside the bag. Bagging plants individually helps keep plant parts together and prevents mixing different species.
- However, if it is easier, multiple species can be placed into larger bags. If more than one specimen is included in a single bag, be sure they can be easily distinguished from one another and related to their collection numbers from the **Vascular Species Presence and Cover Form (V-2)**. For example, tag individual species by bundling plant material by the stems with masking tape, a strip of flagging, or wire and labeling with the collection number.
- Keep specimen collection bags out of the sun and cool during the sampling day. If a cooler with ice is available, place bags in the cooler until pressed.

### ***Pressing Plant Specimens***

- Press plant specimens as soon as possible (Sections 5.2.4 and 5.3.1), usually at the end of the sampling day.
- Make sure to complete a **Plant Specimen Label** and affix it to the outside of the newsprint for each specimen (Section 5.3.3).

### ***Sensitive Plant Species***

Do not collect plant species that are listed as THREATENED, ENDANGERED, or SENSITIVE (TES), or are easily destroyed if collected (e.g., many orchid species). Become familiar with national and state TES species lists relevant to the state in which you are working and with wetland TES species in particular. Photograph TES species using the guidance in 8.7 Appendix D. Toggle the “TES plant species” button on (it will turn from grey to green) and add a comment to the data recorded for this species on the **Vascular Species Presence and Cover Form (V-2)** indicating its state or federal TES status. See example comment for *Corydalis aquae-gelidae*, an Oregon sensitive species, illustrated on Figure 5-13.

10:27 AM Sun Apr 11  
Menu TEST-OR-10005, Visit: 1 Version 2.3 SAVE

**NWCA 2021 VASCULAR SPECIES PRESENCE AND COVER (V-2)**

This form has been thoroughly reviewed and is ready for submission

Date:  Today

**Plot 1** Plot 2 Plot 3 Plot 4 Plot 5

This plot was not sampled

**Row 1**  Collection Number:  Q  U  
 SW:  S  M  W NE:  S  M  W Height Class:  Percent Cover:   
 Is this a tree species?    
 TES plant species:

**Row 2**  Collection Number:  Q  U  U2  
 SW:  S  M  W NE:  S  M  W Height Class:  Percent Cover:   
 Is this a tree species?    
 TES plant species:

**Row 3**  Collection Number:  Q  U  
 SW:  S  M  W NE:  S  M  W Height Class:  Percent Cover:   
 Is this a tree species?    
 TES plant species:

**Row 4**  Collection Number:  Q  U  
 SW:  S  M  W NE:  S  M  W Height Class:  Percent Cover:   
 Is this a tree species?    
 TES plant species:

**Row 5**  Collection Number:  Q  U  
 SW:  S  M  W NE:  S  M  W Height Class:  Percent Cover:   
 Is this a tree species?    
 TES plant species:

**Row 6**  Collection Number:  Q  U  
 SW:  S  M  W NE:  S  M  W Height Class:  Percent Cover:   
 Is this a tree species?    
 TES plant species:

**Row 7**  Collection Number:  Q  U  Q7  
 SW:  S  M  W NE:  S  M  W Height Class:  Percent Cover:   
 Is this a tree species?    
 TES plant species:

Cancel **Add Comment** Save

**1\_1\_COMMENT**  
SPECIES PRESENCE

TES Oregon sensitive species.  
Photo taken

---

Select from Existing Items

Outside knownrange, on rock outcrop.  
KALMIOPSIS FRAGRANS Meinke and  
Kaye SP. NOV. Meinke and Kaye. 2007.  
Jour. of Botanical Research Institute of  
Tex

TES Oregon sensitive species.  
Photo taken

Figure 5-13. Example of completed Vascular Species Presence and Cover Form (V-2). All data depicted are imaginary and for illustration only.

### 5.2.3.2 Collecting Vascular Plant Species Presence Data and Creating Species List

Plant species presence data are recorded on the **Vascular Species Presence and Cover Form (V-2)**, Figure 5-13, and are collected before other vegetation data to begin building the species list for the Veg Plot and to prevent trampling of the quadrats before the presence data are obtained. Species presence data are collected at multiple scales; from *nested quadrats* (1-m<sup>2</sup> and 10-m<sup>2</sup>), located in the SW and NE corners of each 100-m<sup>2</sup> Veg Plot (**Reference Card V-3, Side B**, Figure 5-12), and from the entire Veg Plot. Presence for a given species in smaller sample units implicitly includes its presence in larger sample units. The process of collecting presence information aids in building an initial species list for the entire Veg Plot. Species presence data are collected in both the 1-m<sup>2</sup> and 10-m<sup>2</sup> quadrats of one nest, then in both quadrats of the other corner nest, followed by the area represented by the entire 100-m<sup>2</sup> Veg Plot.

**Establish Quadrat Nests** – Each nest is comprised of a 1-m<sup>2</sup> and a 10-m<sup>2</sup> quadrat and can be set-up in a variety of ways (Figure 5-12):

- Outside edges of the 1-m<sup>2</sup> and 10-m<sup>2</sup> quadrats are formed by the edges of the 100-m<sup>2</sup> Veg Plot demarcated during Veg Plot establishment (Section 5.2.2).
- Interior sides of the 1-m<sup>2</sup> quadrat may be defined using (a) two 1-m PVC poles, (b) two 1-m long wooden slats, or (c) a 2-m length of rope with the mid-point marked.
- The interiors of the 10-m<sup>2</sup> quadrat can be set-up using (a) two 3.16-m segmented PVC poles, or (b) a 6.32-m length of rope with the mid-point marked.
- Any of the items used for the inside quadrat edges can be placed on the ground in open or herbaceous vegetation, or threaded through or over the top of shrubby vegetation. If obstacles prevent leaving these materials in place, measure the distance to the quadrat corners and mark quadrat edges with flagging.

**Double check the header information** on the top of the **Vascular Species Presence and Cover Form (V-2)** (Figure 5-13). Ensure the Site ID and Visit number that you have chosen matches the site and visit being sampled. Verify or enter the sampling date by using the *today* button of the date selection wheel. It is very important the date be entered in the correct format (MM/DD/YYYY), so using one of these methods will ensure the correct format.

**Indicate if any Veg Plots Have Not Been Sampled** – Normally all 5 Veg Plots must be sampled. If on a rare occasion, due to hazards, a particular Veg Plot cannot be sampled, check the '*This plot was not sampled box*' at the top of the relevant Plot tab. Also, using the comment bubble, add the reason why this plot could not be sampled.

**Create the Plant Species List** – Select one of the nested corners, SW or NE, in which to begin collecting presence data. As each species is *observed*, enter its name by selecting the *Enter New Species* box on the **Vascular Species Presence and Cover Form (V-2)** (Figure 5-13) and use the resulting drop-down lists of plant names to select the scientific name for that taxon (Figure 5-14).

- Begin to develop a species list for the plot by recording the names of all species encountered in 1-m<sup>2</sup> and 10-m<sup>2</sup> quadrats of the first nested corner sampled.
- If the species identity is known, record the *scientific name* (e.g., genus and species, subspecies or variety if applicable) using the drop-down lists. The full scientific name will populate into the *Full Genus/Species Name* box. Click the *SAVE* button to populate the species name into Form V-2.

- If the taxon's identity is unknown, give it a descriptive *pseudonym* (See **Assigning Pseudonyms for Unknown Plant Species**, below) by typing the pseudonym directly into the *Full Genus/Species Name* box and clicking the SAVE button.
- If only the family or genus is known, these higher-level taxa can be selected from the drop-down list and will appear in the *Full Genus/Species Name* box. Annotate the family or genus name to distinguish the taxon from other partially identified taxa in the same family or genus. Click the SAVE button. For instructions on annotating the family or genus name, see **Assigning Pseudonyms for Unknown Plants Species** below.
- If at any point the name needs to be changed (e.g., the plant is found to be a different species than first thought or an unknown plant is identified), the species name can easily be updated in the App. On **Vascular Species Presence and Cover Form (V-2)**, clicking the box that contains the species name will reopen its pop-up window. The species name can easily be changed either by using the genus and species drop-down lists to overwrite the previously saved name or by adding/editing the text directly in the *Full Genus/Species Name* box.

For each plot, if the taxon is a tree species, click the "Enter Tree Data" button next to the question on Form V-2 'Is this a tree species?' and it will automatically add the tree species to **Snag and Tree Counts and Tree Cover Form (V-4)** for this Veg Plot. The resulting pop up window can be populated now or at a later time, or the tree cover and count data can be entered on **Form V-4**. The data on these two forms are linked, so entering and saving data on one automatically updates the other.

- Continue adding species to **Vascular Species Presence and Cover Form (V-2)** as they are encountered during collection of species presence in the 1-m<sup>2</sup> and 10-m<sup>2</sup> quadrats of the second nested corner.
- Once both corner nests have been searched, examine the entire 100-m<sup>2</sup> Veg Plot for additional species. Add these species to the V-2 Form as well and finishing recording presence data for the whole Veg Plot.

**Assigning Pseudonyms for Unknown Plant Species (Reference Card V-4, Side A, Figure 5-15)** – The Botanist/Ecologist makes pseudonym assignments for unknown plant species using the following rules:

- If the plant's genus is known, but its species is not, then a number and short description of identifying characteristics is substituted for the specific epithet (see Figure 5-15). Numbers indicate how many unknowns occur in a single genus and should be included even if there is only one unknown species in the genus.
- In the App, a user can select a genus and then edit or amend the text in the Full Genus/Species Name box to create the applicable epithet.
- Where neither genus nor species names are known, devise a descriptive name reflecting growth habit, microhabitat, or some distinctive morphological feature (see Figure 5-15).
- It is often useful to carry examples of unknown plants, in small individual '*tagged bouquets*', to keep pseudonyms straight; particularly when there are several unknown species in a single genus.

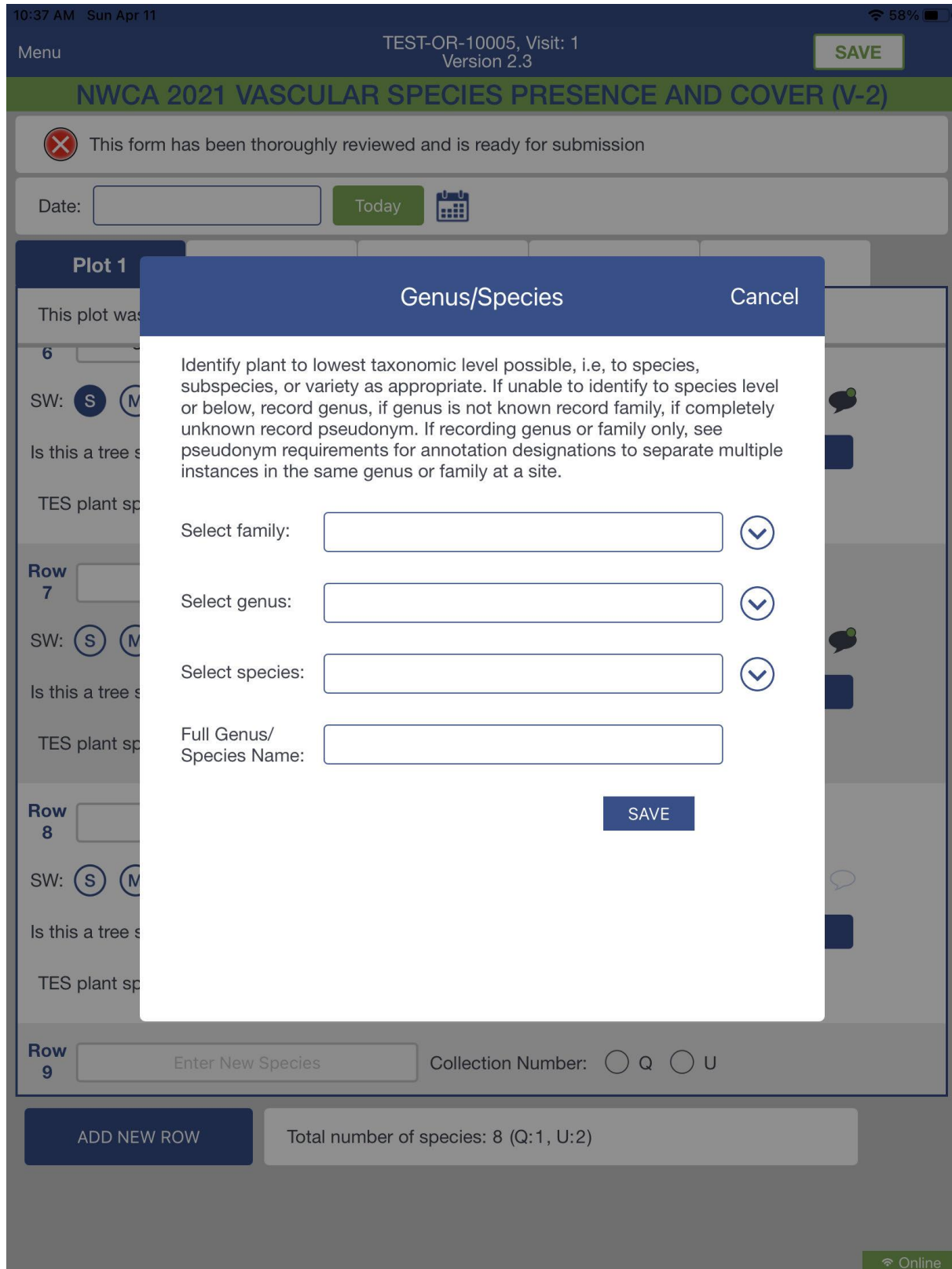


Figure 5-14. Genus/Species Selection Window on Vascular Species Presence and Cover Form (V-2).



The Botanist/Ecologist makes pseudonym assignments for unknown plant species using the following rules:

- ❖ If the genus name is known, but the species name is not, then a number and short description of identifying characteristics is substituted for the species epithet. For example:
  - Carex 1 – winged stem
  - Carex 2 – tussock
  - Carex 3 – bidentate perigynia
  - Carex 4 – striped scale
  - Salix 1 – acuminate leaf
  - Salix 2 – hairy under-leaf.
  
- Numbers indicate how many unknowns occur in a single genus at a site and should be included even if there is only one unknown in the genus.
  
- ❖ Where neither the genus nor species names are known, devise a descriptive name that reflects growth habit, microhabitat, or some distinctive morphological feature. For example:
  - bunchgrass 1
  - pinnate-lf. aquatic herb
  - decid. low shrub simple lin. lf.
  
- ❖ Where numerous unknown taxa occur, it may be useful to carry examples of the plants, in small individual ‘tagged bouquets’, to keep pseudonyms straight. This is especially relevant if a single genus has several unknown representatives on the site.

Figure 5-15. Reference Card V-4, Side A. Assigning Pseudonyms.

**Collecting the Species Presence Data** – For the NWCA, a plant species is *present* if it is rooted in or overhangs the sample unit (quadrat or Veg Plot). *Make sure to look up when working in nested corners, as species overhanging the plot may be above your head.*

For each plant species present in a Veg Plot, always fill in one bubble (S, M or W) for the SW corner and one bubble for the NE corner data field on the **Vascular Species Presence and Cover Form (V-2)** (Figure 5-13). Fill in the bubble that represents the smallest area in which the plant is found.

- If a plant species on the V2 list is not present in a plot, indicate that by recording 0 for percent cover.

**Guidance for recording presence data (see Figure 5-16):**

For each species encountered, record the smallest quadrat size (S = 1-m<sup>2</sup> or M = 10-m<sup>2</sup>) in which a plant species is observed by filling in the appropriate data bubble (S or M) in the field for the SW or NE quadrat nest on the **Vascular Species Presence and Cover Form (V-2)**.

If a species does not occur in a particular nest, but occurs in the 100-m<sup>2</sup> Veg Plot, fill the W (whole plot = 100-m<sup>2</sup>) bubble for that corner (Figure 5-13). For example, a single plant in the SW small or medium plot is, by default in the whole plot for the NE corner (See Example A in Figure 5-16).

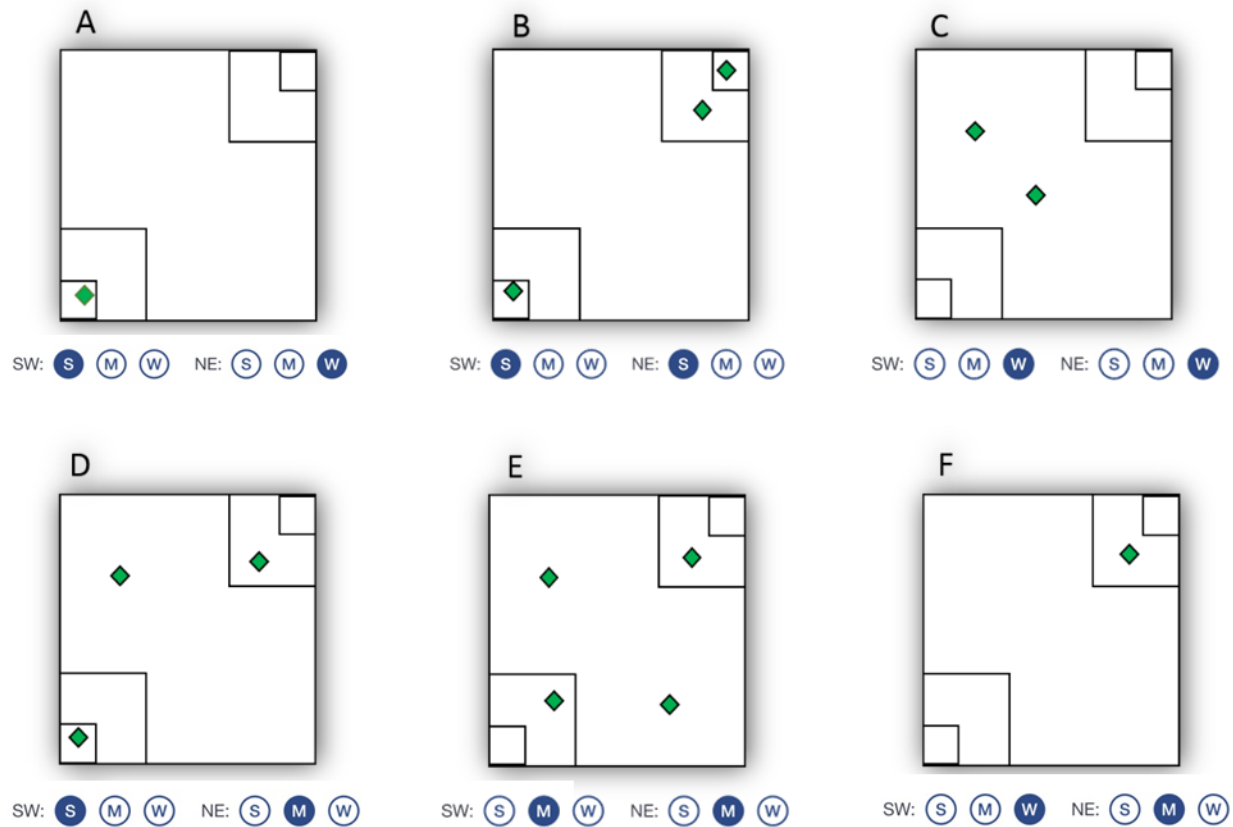


Figure 5-16. Guidance for recording species presence data on the Vascular Species Presence and Cover Form (V-2). Letters A-F represent hypothetical Veg Plots with nested quadrats at SW and NE corners. Green diamonds represent the presence of a particular plant species. SW and NE column diagrams illustrate which data bubbles (S = 1-m<sup>2</sup> quadrat, M=10-m<sup>2</sup> quadrat, and W=whole plot) should be filled based on the location of the plant species.

### 5.2.3.3 General Cover Estimation Procedures

Percent cover within each 100-m<sup>2</sup> Veg Plot is used to assess abundance for individual vascular plant species (Section 5.2.3.4), vertical strata of vascular vegetation (Section 5.2.3.5), non-vascular taxonomic groups (Section 5.2.3.6), and individual tree species by height class (Section 5.2.3.8). Percent cover data are also collected for some ground surface attributes (Section 5.2.3.7). Methods for cover estimation are essentially the same across all these groups.

Cover estimates for individual plant species, vegetation height strata, non-vascular groups, and trees are made for organisms rooted in or overhanging a Veg Plot. For these entities, cover is estimated as the *percentage of the ground area in a sampling unit overlain by the outline of the canopies (e.g., leaves, branches, stems, and space) describing the circumference for individual plants or clumps of organisms*. Cover for ground surface attributes is estimated based the area of the sampling unit overlain by a specific ground surface type.

Cover estimation methods are detailed below and summarized in **Reference Card V-4, Side B** (Figure 5-17):

- 1) **Estimating Percent Cover** – Cover is estimated directly as the percentage (0 to 100%) of the plot area covered by the species or vegetation group under consideration. Use the continuous range of values from 0 to 100% when estimating cover for a species or other entity within the 100-m<sup>2</sup> Veg Plot. For values < 1%, record 0.1%.

Cover determinations for a particular entity of interest (species, taxonomic group, vegetation layer, ground surface type) are made by estimating the percentage of ground space in the 100-m<sup>2</sup> Veg Plot overlain by the outline of the canopies or footprint of all individuals or patches of that entity.

**Note:** The space over which a plant exerts influence is approximated by the area of its undisturbed canopy, since the plant's root system typically spreads at least as extensively in the horizontal direction as does its aboveground parts. Thus, gaps in the canopy created by spaces among leaves are ignored and are not subtracted from the cover estimate.

- 2) **Recognizing the Limits of Estimate Precision** – Note when making cover value assignments, *do not deliberate extensively over values for cover estimates* (e.g., for small values choosing between 1 or 3%, for higher values choosing between 77% or 85%).

Remember your assessments of cover are estimates and it is not appropriate to agonize over small differences because this precision would exceed the accuracy of our ability to detect cover differences over the area of the Veg Plot.

- 3) **Viewing Veg Plot to Make Cover Estimations** – View the Veg Plot from several vantage points to be sure that all patches of each entity have been detected, while taking care to limit trampling of the vegetation as much as possible.
- 4) **Noting Horizontal and Vertical Distribution of Cover across Veg Plot** – When estimating cover, remember the pattern of distribution of a particular species or entity might be aggregated or dispersed across a 100-m<sup>2</sup> Veg plot (**Reference Card V-4, Side B**, Figure 5-17). Take care to detect low cover, widely dispersed taxa. Similarly, plant species or vegetation strata vary in height, and it is

common for the canopies of species or vegetation layers to be distributed vertically, but overlie the same horizontal space.

- 5) **Assigning cover values** – It is helpful to visualize percent cover in terms of spatial areas within the 100-m<sup>2</sup> Veg Plot, and to use this information to guide cover estimations for a particular species or entity. In a 10×10-m Veg Plot, 1 m<sup>2</sup> is equivalent to 1% cover, a 3×3-m block equals 9% cover, and a 5×5-m block represents 25% of the area of the Veg Plot. **Reference Card V-4, Side B** (Figure 5-17) provides examples of cover estimates reflecting different distributions and abundances for an individual entity (e.g., a species, a vegetation layer, a taxonomic group, or ground surface type) within a 100-m<sup>2</sup> Veg Plot.

#### 5.2.3.4 Height and Cover Data for Vascular Plant Species (Form V-2)

Height and percent cover data collected for each vascular plant species occurring in a 100-m<sup>2</sup> Veg Plot are recorded on the **Vascular Species Presence and Cover Form (V-2)**. For each species, data describing the primary height class in which it occurs, and its percent cover should be collected concurrently. (See **Reference Cards V-3, Side B** (Figure 5-12) and **V-4, Side B** (Figure 5-17)).

- 1) **Species Identity** – Recall that during collection of species presence data (Section 5.2.3.2), you recorded, on the **Vascular Species Presence and Cover Form (V-2)**, the names or pseudonyms of the species so far observed in each 100-m<sup>2</sup> Veg Plot (e.g., Figure 5-13). As you collect data on height class and estimate cover for each species in a Veg Plot, add any newly detected taxa you encounter in a new row using the *Enter New Species* box on the V-2 Form.
- 2) **Species Height Class** – Estimate the predominant height class in which each species occurs across each Veg Plot. Record the height class by selecting from the drop-down list on the **Vascular Species Presence and Cover Form (V-2)** for the Veg Plot under consideration (Figure 5-18). Height class choices are displayed below. Note that **E** is a life form class that encompasses all vascular liana, vine, or epiphyte species, and which may occur in any height class.

Height Classes (except E, which may occur in any vertical stratum)	
1	< 0.5m
2	>0.5 to 2m
3	>2 to 5m
4	>5 to 15m
5	>15 to 30m
6	>30m
E	Liana, vine, or epiphyte species

**Reference Card V-4, Side B. Cover Estimation Procedures**

- Estimating Cover in 100-m<sup>2</sup> Veg Plots**
- Cover estimates for various entities (individual plant species, vegetation height strata, non-vascular taxonomic groups, and ground surface attributes) are made in all five 100-m<sup>2</sup> Veg Plots in an AA. Cover data are recorded on **Forms V-2, Forms V-3, and Forms V-4**.
  - Cover estimates for individual plant species, vegetation height strata, and non-vascular groups are made for organisms rooted-in or over-hanging a Veg Plot.
  - Cover determinations for a particular entity of interest are made by estimating the percentage of ground space in a 100-m<sup>2</sup> Veg Plot overlain by the canopies or footprints of all individuals or patches of that entity.
  - Cover values may range from 0 to 100% for a particular individual species or entity. Because species or other entities often overlie one another vertically, the combined cover for all species or entities may often exceed 100%.
  - Estimate cover directly as the percentage (0 to 100%) of the plot area covered by the species or entity under consideration. Cover may be estimated in 1% increments, however, do not deliberate excessively over values for cover estimates. For values < 1%, record 0.1%.
  - The figure to the right illustrates some examples of different levels of percent cover across 100-m<sup>2</sup> Veg Plots.

Refer to **NWCA 2021 Field Operations Manual (Chapter 5. Vegetation)** for more detail on protocols summarized on this card.

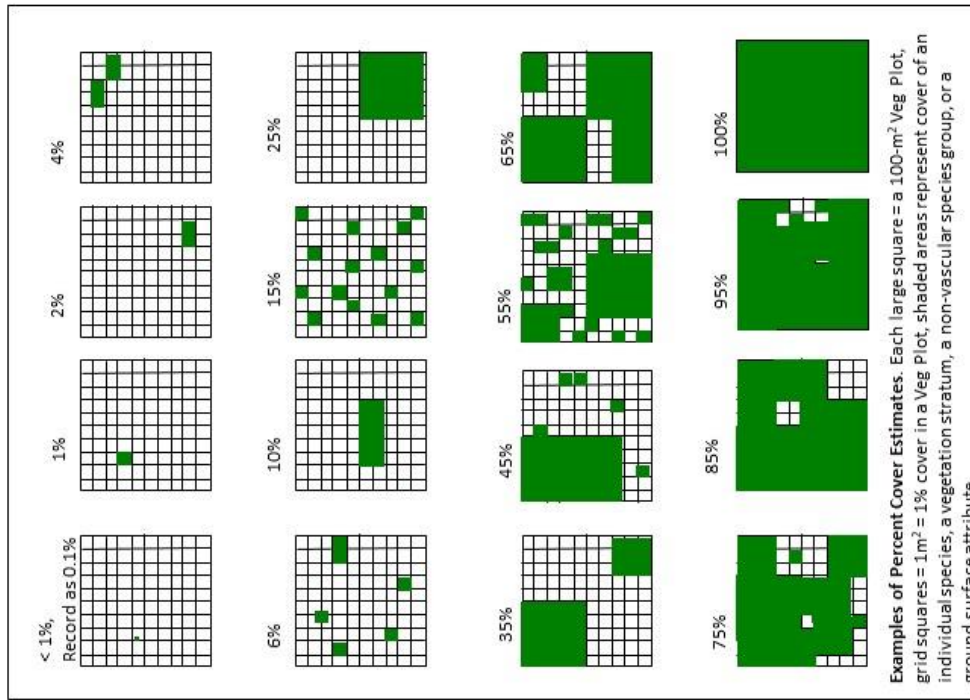


Figure 5-17. Reference Card V-4, Side B. Cover Estimation procedures.

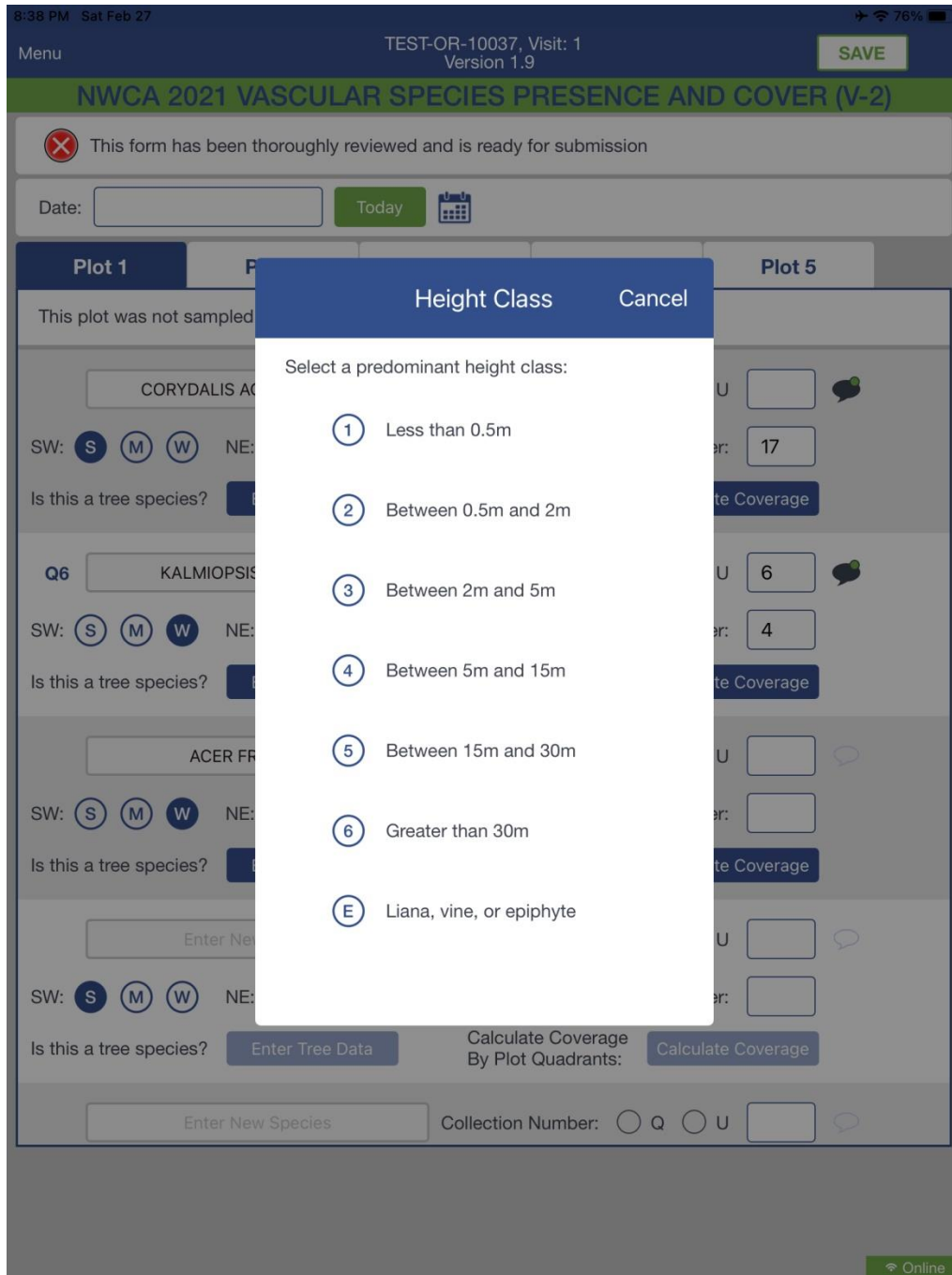


Figure 5-18. Height Class Selection Window on Vascular Species Presence and Cover Form (V-2).



- 3) **Species Cover** – Estimate percent cover for each species observed in each Veg Plot and record this data in the *Percent Cover* field for the appropriate plot on the **Vascular Species Presence and Cover Form (V-2)** (Figure 5-13). Use the following general guidelines, based on the complexity of the vegetation, to estimate cover for the plant species occurring in the 100-m<sup>2</sup> Veg Plot.
- Cover for any individual plant species observed in a Veg Plot can range from 0 to 100%. However, because of vertical stratification of plant species within communities, the sum of the covers of all observed species often substantially exceeds 100%.
  - View and search the Veg Plot from several vantage points (e.g., from several points outside the plot and from the plot center) to detect and make cover estimates for all species that are present.
  - When estimating cover of tall species (i.e., tall shrubs and trees) care should be taken to try to visually project the Veg Plot boundaries upwards to frame the vertical sample area and identify the edges of the Veg Plot.
  - Where species diversity is high, vegetation is patchy, or species are widely distributed across a Veg Plot, it may be helpful to make preliminary estimates of cover for different patches of a particular species in different parts of the Veg Plot (e.g., Species 1 may occur in patches of the following sizes: 1 m<sup>2</sup> = 1%, 7 m<sup>2</sup> = 7%, 25 m<sup>2</sup> = 25%). Once all patches of the species in the Veg Plot are observed, the preliminary estimates can be combined to obtain the total percent cover for the species (e.g., continuing with the example above, Species 1 = 33%), which is then recorded in the *Percent Cover* field.
  - If a Veg Plot is structurally complex or has high species richness, it will be useful to employ a systematic procedure by using the 'Optional Cover Calculator' button to calculate preliminary estimates (Figure 5-19) that is available in **Form V-2** of the NWCA App.
    - Visually divide the 100-m<sup>2</sup> Veg Plot into four 25-m<sup>2</sup> quarters. In each quarter of the Veg Plot, search for all species occurring in that quarter.
    - Estimate the approximate percent area of the Veg Plot (remember 1 m<sup>2</sup> = 1%) occupied by each plant species present in each quarter. Keep in mind that maximum cover possible for an individual species in a given quarter plot is 25% (i.e., 25 m<sup>2</sup> = 25% of the entire 100-m<sup>2</sup> Veg Plot). For a particular species in a particular Veg Plot, click on 'Optional Cover Calculator' and a grid with four cells representing the four quarters of the 100-m<sup>2</sup> Veg Plot will pop-up (Figure 5-x). This grid can be used to estimate the percent cover for an individual species in an individual quarter of the Veg Plot by entering the appropriate value (0.1 to 25%).
    - Select SAVE and you will be returned to the main part of **Form V-2** and you can move on to a new species. When you finish estimating percent cover for all the species in one quarter of the Veg Plot, move on to the next quarter. Once again, open the grid for each species and record and SAVE its cover for that quarter. Repeat for all species in all four quarters in the Veg Plot. As cover for each quarter is entered, the cover for the species observed so far is summed in the *Percent coverage for plot* box.



- Once preliminary cover estimates for all four quarters of the Veg Plot are completed, the preliminary estimates for each species are summed to obtain the total percent cover of that species in the Veg Plot. Summing is done automatically in the 'Optional Cover Calculator' feature. You can then record this final total percent cover value for each species (or the value may automatically fill) in the *Percent Cover* box on the main page of the **V-2 Form** (see examples in Figure 5-13)).

#### 4) **IMPORTANT: Connection of Form V-2 to Snag and Tree Counts and Tree Cover Form (V-4)**

- Names for tree taxa occurring in specific Veg Plots can only be added to **Form V-4** via the **V-2 Form**. To add a name to **Form V-4** for a particular tree species and Veg Plot from the **V-2 Form**, click on the *Enter Tree Data* button next to the question '*Is this a tree species?*'. An additional window will pop up showing the relevant plot and tree name. Click SAVE to retain the tree name on **Form V-4**. This process populates the tree name into the appropriate Plot on the **V-4 Form** and ensures that the name for each tree species is the same on both forms.
- As you are collecting cover data for all vascular species on the **V-2 Form** and are evaluating a particular tree species in a particular plot, you may find that it is efficient to also collect the **V-4 Form Live Trees Cover and Counts** data for that tree species at the same time. To do this, for a particular plot and tree species click on the *Enter Tree Data* button next to the question '*Is this a tree species?*' on the **V-2 Form**. This will open the relevant window and you can enter the data pertaining to the relevant tree species and plot. When you have done so, click SAVE to save the data you have just entered. If you need to update this data, you can simply repeat the process. The data on these two forms are linked, so entering and saving data on one automatically updates the other.
- See Section 5.2.3.8 (Standing Dead/Snag Tree Counts and Live Tree Species Count and Cover Data) for detailed protocols for collecting the data required for the **Snag and Tree Counts and Tree Cover Form (V-4)**.

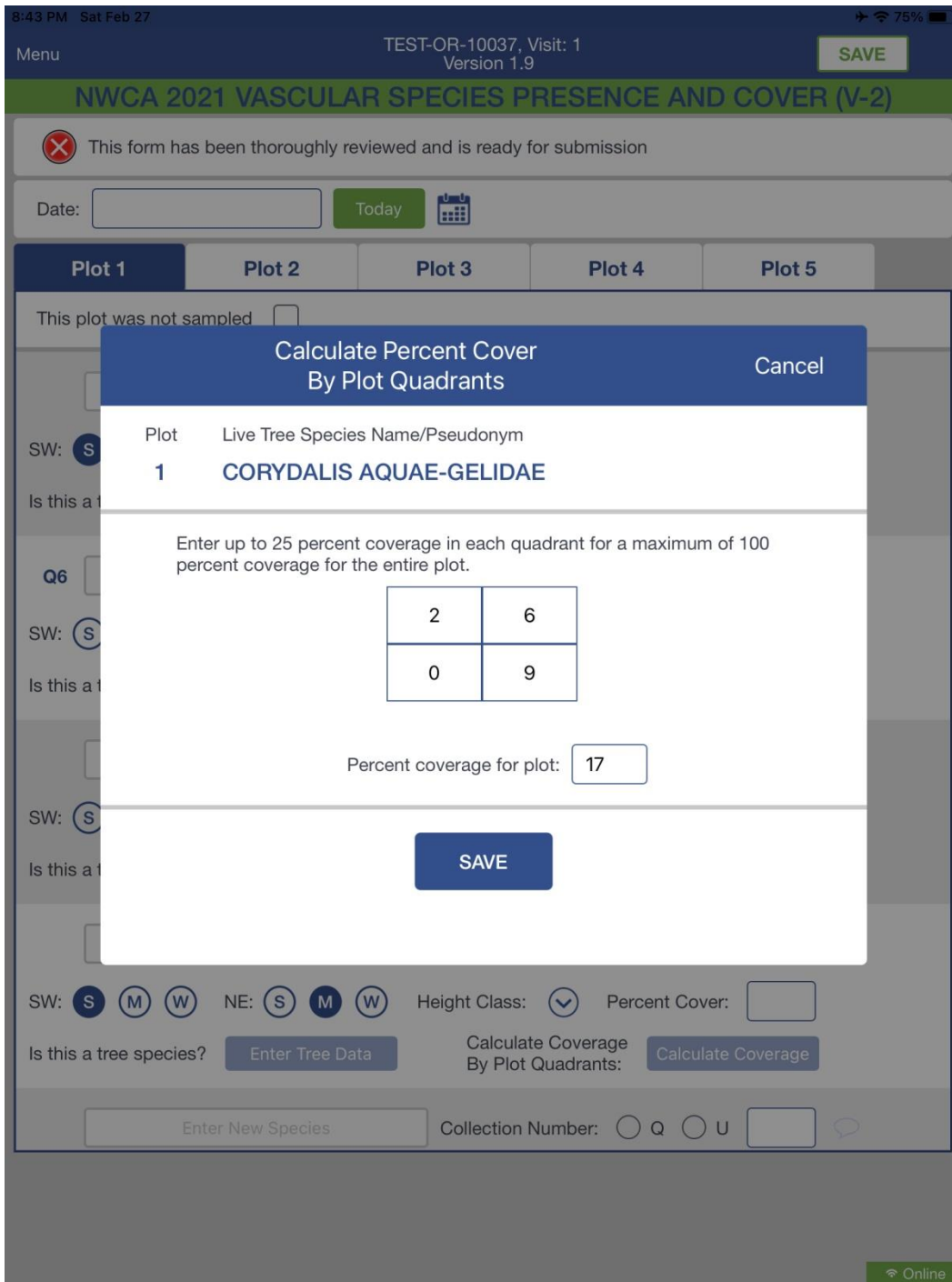


Figure 5-19. Optional Cover Calculator Window on Vascular Species Presence and Cover Form (V-2).

#### 5.2.3.5 Vertical Strata Data for Vascular Vegetation (Form V-3)

One way the NWCA assesses the vertical structure of wetland vegetation is to estimate the cover of nine vertical vegetation strata, defined in part by life form type and in part by height classes (**Vegetation Types/Ground Surface Attributes Form (V-3)** (Figure 5-20), **Reference Card V-3, Side B** (Figure 5-12)). Cover of all plants making up a particular vegetation stratum are estimated collectively and the total cover for an individual stratum can range between 0 and 100 percent. Because vegetation strata may overlies one another, the combined cover for all vegetation strata may substantially exceed 100 percent. See Section 5.2.3.3 for description of general cover estimation procedures.

**Double check the header information on the top of the V-3 Form** -- Ensure the Site ID and Visit number that you have chosen matches the site and visit being sampled..

**Indicate if any Veg Plots Have Not Been Sampled** – Normally all 5 Veg Plots must be sampled. If on a rare occasion, due to hazards, a particular Veg Plot cannot be sampled, check the ‘*This plot was not sampled box*’ at the top of the relevant Plot tab. Also, using the comment bubble, add the reason why this plot could not be sampled.

**Make Cover Estimates for Each Vegetation Stratum** – Enter the percent cover for each stratum in each Veg Plot in the relevant *Percent Cover* box in the *Vegetation Types* section of **Vegetation Types/Ground Surface Attributes Form (V-3)** (Figure 5-20). A value is required for all data elements, so if an item is not present, record 0. Estimate Cover across Each Veg Plot for:

- 1) **Submerged aquatic vegetation** (cover 0-100%) – rooted in substrate, most plant cover submerged or floating on water.
- 2) **Floating aquatic vegetation** (cover 0-100%) – not rooted in sediment, floating on water.
- 3) **All lianas, vines, and epiphytes** (cover 0-100%).
- 4) **All other vascular vegetation by height class** –
  - **> 30 m tall** (0-100%): e.g., very tall trees
  - **> 15 to 30 m tall** (0-100%): e.g., tall trees
  - **> 5 to 15 m tall** (0-100%): e.g., very tall shrubs, short to mid-sized trees
  - **> 2 to 5 m tall** (0-100%): e.g., tall shrubs; tree saplings
  - **0.5 m to 2 m** (0-100%): e.g., medium height shrubs; tree seedlings and saplings; tall aquatic emergent/terrestrial herbaceous species
  - **< 0.5 m tall** (0-100%): e.g., low aquatic emergent/terrestrial herbaceous species; low shrubs, tree seedlings

#### 5.2.3.6 Non-Vascular Taxonomic Group Data (Form V-3)

Bryophytes (mosses and liverworts) growing on ground-level surfaces, ground lichens, arboreal epiphytic bryophytes and lichens, filamentous or mat forming algae, and macroalgae can be important components of many wetlands. Data for non-vascular taxonomic groups are collected in each 100-m<sup>2</sup> Veg Plot and recorded in the *% Cover and Categorical Data for Non-Vascular Taxa* section on the **Vegetation Types/Ground Surface Attributes Form (V-3)** (Figure 5-20), see **Reference Card V-3, Side B** (Figure 5-12). Cover for each of these groups can range from 0-100%. See Section 5.3.3 for description of general cover estimation procedures. A value is required for all data elements in this section, so if an item is not present, record 0.

**Bryophytes** – Estimate the collective cover of mosses, and leafy and thalloid liverworts growing on ground surfaces, logs, rocks, etc. and enter the cover estimate in the provided field. If the bryophyte layer is dominated by *Sphagnum* or other peat forming mosses, fill in the ‘*Bryophytes dominated by Sphagnum or other peat-forming mosses*’ bubble under the *Bryophyte* cover field.

**Ground Lichens** – Estimate the collective cover of all lichens growing on the ground or other ground layer substrate (e.g., boulders, fallen logs) and enter the cover estimate in the field provided for lichen cover. Do not include arboreal lichens that have fallen from trees in this estimate.

**Arboreal Epiphytic Bryophytes and Lichens** – If arboreal (living on shrubs and trees) bryophytes and lichens are present, estimate the amount of branch, twig, stem, or trunk surface area of woody vegetation in the Veg Plot that this group occupies. Estimates are made using the broad abundance classes listed on the selection menu of the **V-3 Form** (Figure 5-20):

- None: Absent.
- Sparse: Less than  $\frac{1}{3}$  of woody surface area covered.
- Common:  $\frac{1}{3}$  to  $\frac{3}{4}$  of woody surface area covered.
- Abundant:  $> \frac{3}{4}$  of woody surface area covered.

Make this determination **rapidly** as you scan the available arboreal surfaces to reflect the general importance of the arboreal bryophytes and lichens in a Veg Plot. Select the appropriate abundance class for each Veg Plot. Note, this is a quick estimate, not a precise quantification of abundance.

**Filamentous or Mat Forming Algae** – For each Veg Plot, estimate the collective cover of all unicellular or small algae that form visible and often extensive filament strands or mats and enter the cover estimate in the provided field.

**Macroalgae** – Estimate the collective cover of macroalgae in each Veg Plot. Macroalgae are found in freshwater (e.g., *Chara*) or tidal settings (seaweeds), and may occur in a wetland both as living, attached material or as wrack (algae that is broken free and/or washed into the wetland). All occurrences of macroalgae (living or wrack) are included in this cover estimate. Enter the cover estimate in the provided field.

5:26 PM Sat Feb 27 TEST-OR-10037, Visit: 1  
Version 1.9 SAVE

**NWCA 2021 VEG TYPES/GROUND SURFACE ATTRIBUTES (V-3)**

✖ This form has been thoroughly reviewed and is ready for submission

Plot 1
Plot 2
Plot 3
Plot 4
Plot 5

This plot was not sampled

**VEGETATION TYPES**

**% Cover Vascular Vegetation**

% Cover of submerged Aquatic Veg.  🗨

% Cover of floating Aquatic Veg.  🗨

% Cover of Lianas, Vines, and Epiphytes  🗨

---

**% Cover for all other Vascular Vegetation for each height class**

% Cover >30m tall: e.g., very tall trees  🗨

% Cover >15 to 30m tall: e.g., tall trees  🗨

% Cover >5 to 15m tall: e.g., very tall shrubs; short trees  🗨

% Cover >2 to 5m tall: e.g., tall shrubs; tree saplings  🗨

% Cover 0.5 to 2m tall: e.g., med. shrubs; tree saplings; tall emergent  🗨

% Cover <0.5 tall: e.g., low emergent, herbs, low shrubs; tree seedlings  🗨

**% Cover and Categorical Data for Non-Vascular Taxa**

% Cover of Bryophytes  🗨

Select if Bryophytes dominated by Sphagnum or other peat-forming mosses  🗨

% Cover of lichens  🗨

Abundance of Arboreal Epiphytic Bryophytes and Lichens (Select one)  🗨

% Cover of Filamentous or Mat forming  🗨

% Cover of Macroalgae (freshwater, living or wrack)  🗨

**Figure 5-20. Example of completed Vegetation Types Section of Form V-3. All data depicted in this figure are imaginary and for illustration only.**

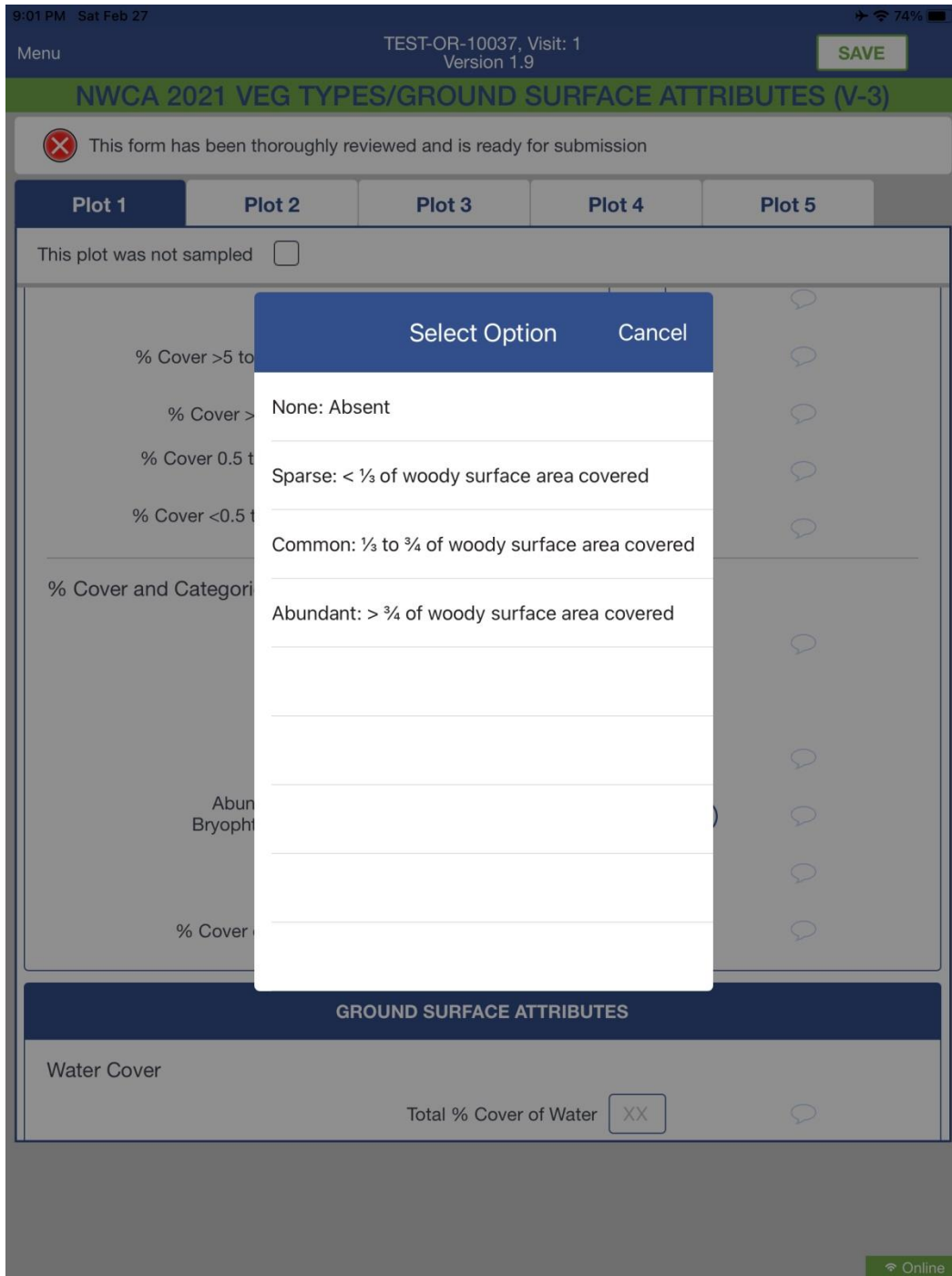


Figure 5-21. Selection Window for Abundance of Arboreal Epiphytic Bryophytes and Lichens on Form V-3.

#### 5.2.3.7 Ground Surface Attribute Data (Form V-3)

Data describing surface attributes (water, bare ground, vegetative litter, and woody debris) of each 100-m<sup>2</sup> Veg Plot are collected by the Veg Team (see also **Reference Card V-3, Side B** (Figure 5-12)). Metrics describing these indicators include percent of the plot area covered by an attribute and, where appropriate, the type and depth of the attribute. See Section 5.2.3.3 for description of general cover

estimation procedures. A value is required for all data elements in this section, so if an item is not present, record 0.

Collect and record the following data in the *Ground Surface Attributes* section of the **Vegetation Types/Ground Surface Attributes Form (V-3)** (Figure 5-22) in the appropriate fields:

**Water Cover** – Estimate total percent of area (0 to 100%) covered by water in each Veg Plot and enter the cover estimate in the provided field.

**Water Depth** – Measure water depth to nearest cm, from a location that represents the predominant depth of water in the Veg Plot, and record in the appropriate *Predominant Depth* field. Depths may be measured using a ruler, meter stick, or a PVC pole with decimeter marks. Record the time the measurement was made in the *Time of Day* field using a 24 hour scale. Use either the *Now* button or enter the time directly into the field using the appropriate format (e.g., hh:mm).

**Bare Ground** – Estimate the percent of the Veg Plot area occupied by each of the following:

- 1) *Exposed Soil/Sediment*;
- 2) *Exposed Gravel/Cobble* (~ 2 mm to 25 cm in diameter); and
- 3) *Exposed Rock* (>25 cm in diameter).

The sum of these three elements of bare ground should not exceed 100%. Enter each cover estimate in the provided fields.

**Vegetative Litter** – Litter may be overlain by other vegetation layers, and may overlap with water or bare ground. Collect the following data in each Veg Plot:

- 1) *Total Cover of Vegetative Litter*, which may range from 0 to 100%.
- 2) If litter is present, identify the *Predominant Litter Type* by selecting it from the list. The choices are:
  - C = Coniferous tree;
  - D = Deciduous tree;
  - G = Graminoid (e.g., grass, sedge, rush);
  - F = Forb;
  - R = Fern; or
  - E = Broadleaf evergreen tree.
- 3) Measure litter depth in cm at the center of the 1-m<sup>2</sup> quadrat at the NE and the SW Veg Plot corners and record measurements in the appropriate *Litter Depth* (cm) field. Make litter depth measurements from the ground level upwards. Sometimes litter may be flooded (e.g., saltmarshes when the tide is in). In such cases, even if the area is flooded and part of the litter is submerged, measure from the ground level.



GROUND SURFACE ATTRIBUTES		
Water Cover		
Total % Cover of Water	<input type="text" value="80"/>	
Water Depth		
Predominant Depth (cm)	<input type="text" value="1"/>	
Time of Day (24 hr clock)	<input type="text" value="13:30"/>	<input type="button" value="Now"/>
Bareground Cover (a+b+c <=100%)		
(a) Exposed soil/sediment	<input type="text" value="0"/>	
(b) Exposed gravel/cobble (2mm-25cm)	<input type="text" value="0"/>	
(c) Exposed rock (>25cm)	<input type="text" value="0"/>	
Vegetative Litter		
Total % Cover Veg. Litter (0-100%)	<input type="text" value="75"/>	
Predominant Litter Type (Select one)	<input type="text" value="F"/>	
Litter Depth at SW Veg Plot quadrat (cm)	<input type="text" value="4"/>	
Litter Depth at NE Veg Plot quadrat (cm)	<input type="text" value="3"/>	
% Cover of Downed Dead Woody		
% Cover of Coarse Woody debris >5cm diam.	<input type="text" value="0"/>	
% Cover of Fine Woody debris <5cm diam.	<input type="text" value="0"/>	

Figure 5-22. Example of completed Ground Surface Attributes Section of Form V-3. All data depicted in this figure are imaginary and for illustration only.

**Woody Debris** – Downed woody debris occurs at an angle of incline  $< 45^\circ$ . Estimate the percent of the of Veg Plot area covered by:

- 1) *Downed Coarse Woody Debris* ( $> 5$ -cm diameter); and
- 2) *Downed Fine Woody Debris* ( $< 5$ -cm diameter).

Woody debris may overlay other vegetation or ground surface layers, so dead woody material in either category may range from 0 to 100%. If there are downed trees with small and large branches/trunks, estimate the portions that represent fine and coarse woody debris. Conifer cones that have fallen to the ground are considered litter. Enter each cover estimate in the provided fields.

#### 5.2.3.8 *Standing Dead/Snag Tree Counts and Live Tree Species Count and Cover Data*

Several attributes of woody vegetation are evaluated in the NWCA using counts of dead or live trees in diameter classes and cover estimates of live trees by height classes within the 5 Veg Plots (see also **Reference Card V-3, Side B** (Figure 5-12)). These data collected are recorded on the **Snag and Tree Counts and Tree Cover Form (V-4)** (see Figure 5-23). Data are recorded under two section headings on the **V-4 Form**: 1) *Standing Dead Trees/Snags* and 2) *Live Trees Cover and Counts*.

**IMPORTANT:** In the NWCA App, tree species names, or pseudonyms for unidentified tree taxa, will be populated to the *Live Trees Cover and Counts* Section of the **Snag and Tree Counts and Tree Cover Form (V-4)** as they are observed and recorded by the Botanist/Ecologist on the **Vascular Species Presence and Cover Form (V-2)**. Names for tree taxa occurring in specific Veg Plots can only be added to Form V-4 via the V-2 Form. To add a name to Form V-4 for a particular tree species and Veg Plot from the V-2 Form, click on the “Enter Tree Data” button next to the question ‘Is this a tree species?’. An additional window will pop up showing the relevant plot and tree name. Click SAVE to retain the tree name on Form V-4. This process populates the tree name into the appropriate Plot on the **V-4 Form** and ensures that the name for each tree taxon is the same on both forms. Thus, the *Live Trees Cover and Counts* Section of **Form V-4** should already display the names of the trees observed in each plot where trees occur, and the appropriate data fields for you to record the **V-4 Form** tree. Tree cover and count data can be entered either on **Form V-4** or in the resulting “Enter Tree Data” popup window on **Form V-2**. The data on these two forms are linked, so entering and saving data on one automatically updates the other. Note, however, that these data are all plot-specific, so be sure the correct plot tab (on **Form V-2**) or row (on **Form V-4**) is chosen.

**Double check the header information** on the top of the **V-4 Form**. Ensure the Site ID and Visit number that you have chosen matches the site and visit being sampled.

**Indicate any Veg Plots that were not sampled** – Normally all 5 Veg Plots must be sampled. In the RARE circumstance when data for the Snag and Tree Counts and Tree Cover Form (V-4) were not collected in a particular plot, add a comment indicating why these data were not collected in the comment bubble for that plot.

#### **Overview Steps for Collecting Snag and Tree Data** –

- Estimate the number of small ( $< 5$  cm diameter at breast height (DBH) standing dead trees/snags (angle of incline  $\geq 45^\circ$ ) in abundance classes.
- Count the number of standing dead trees or snags that are  $> 5$  cm DBH by DBH classes.
- Estimate cover of live trees by species in estimated height classes.
- Count live trees ( $> 5$  cm DBH) by species in DBH classes.

Once observations for the above items are completed and their values are recorded, the data cells for which there were no trees or snag present should be populated with zeros. This may be done manually or with “Fill Zeros” button in the App which auto fills zeros for cells in which no snags or trees were observed and recorded.

**Estimating Tree Cover:** When estimating cover for tree species by height class, include both trees rooted in and overhanging the Veg Plot. Cover may range from 0-100% for each species for each height class. See Sections 5.2.3.3 and 5.2.3.4 and Figure 5-17 for details on cover estimation methods. When estimating cover of tall trees, care should be taken to try to visually project the Veg Plot boundaries upwards to frame the vertical sample area and identify the edges of the Veg Plot to determine how much of the Veg Plot is overlain by the tree canopy.

**Counting Trees and Snags > 5cm DBH:** Count each tree or snag rooted in the Veg Plot or occurring on the Veg Plot border. Do not count trees that merely overhang the Veg Plot; *note, this is different than the cover estimation procedure*.

If needed, while counting dead trees and snags a running tally can be kept for each diameter class in a physical or digital notepad. Record the total number of snags for each DBH class in the provided data fields.

For counting live trees by DBH, you can enter the number of trees in each height class directly as a number, or it may be easier to enter one tree at a time while you are counting by pushing the (+) button. You can also use the (-) button to subtract trees one at a time if you have inadvertently added a tree you did not intend.

**Estimating DBH and Height:** Diameter at breast height (DBH) is the diameter of a live or dead tree at 1.37 m above the ground. DBH is estimated for all trees fully or partially (i.e., trees with trunks spanning the Veg Plot boundary) rooted in the Veg Plot. Both breast height (1.37 m from the ground) and the trunk diameter are estimated.

Early in the field season, or during training, the Veg Team will develop and calibrate a visual search image for each designated DBH class (see Figure 5-23) by using a metric diameter tape or Biltmore Stick to measure a series of trees of different sizes, then estimating DBH class for another series of trees and confirming the DBH class designation by measuring the trees.

Estimation of height class (see Figure 5-23) for trees will also be practiced during training. Once calibrated, the Veg Team will be able to rapidly visually estimate the height class to which a tree belongs. If needed, during the field season the Veg Team may use the diameter tape to occasionally recalibrate themselves.

***For trees or snags with multiple trunks, use the following rules to estimate DBH classes:***

- If the tree or snag has one trunk from ground level up to breast height (roughly 1.37 m), then splits into multiple trunks above this height, estimate its DBH below the split at breast height.
- If the tree or snag has multiple trunks originating below breast height, then estimate the DBH of each trunk.

### Collecting and Recording Data Under the **STANDING DEAD TREES/SNAGS** Heading –

**Small (< 5-cm DBH) Standing Dead Trees Counts** – Under the column labeled *Small (<5)*, rapidly estimate the approximate number of small dead trees in each Veg Plot and select the abundance class from the drop-down menu:

- None.
- Few (1-10).
- Common (11-20).
- Many (>20).

**Standing Dead Tree and Snags ( $\geq$  5-cm DBH) Counts** – Count the number of standing dead trees/snags that have angle of incline  $\geq 45^\circ$  ( $< 45^\circ$  = downed woody debris, see Section 5.2.3.8) by DBH class, and record the values in the appropriate DBH columns in the provided data fields. DBH classes are:

- 5-10 cm.
- 11-25 cm.
- 26-50 cm.
- 51-75 cm.
- 76-100 cm.
- 101-200 cm.

### Collecting and Recording Data Under the **LIVE TREES COVER AND COUNTS** Heading –

The names of live trees (either scientific names or pseudonyms for unidentified trees) observed in specific Veg Plots and recorded on the **V-2 Form** should already be auto-populated by plot and species in the *Live Trees Cover and Counts* section of the **Snag and Tree Counts and Tree Cover Form (V-4)**, (Figure 5-23). This process ensures that the name for each tree taxon is the same on both the **V-2** and **V-4 Forms**. If, while collecting data for *Live Trees Cover and Counts*, you observe a tree species in a plot that is not already listed on **Form V-4**, you will need to add it. New tree species for specific plots can only be added to **Form V-4** via the **V-2 Form**. First, go to **Form V-2**, select the appropriate plot number and determine whether the tree species in the particular plot in question is already included on **Form V-2**. If it is, click on the *Enter Tree Data* button next to the question *Is this a tree species?* on the **V-2 Form**. A window will pop up showing the relevant plot and tree name. Click SAVE to retain the name on **Form V-4**. If the tree species in the given plot is not listed on the **V-2 Form**, add it to **Form V-2** and record the relevant **V-2 Form** data for this species. Next, click on the *Enter Tree Data* button on the **V-2 Form** to add the tree name and plot to **Form V-4**. Tree cover and count data can be entered either on **Form V-4** or in the resulting “Enter Tree Data” popup window on **Form V-2**. The data on these two forms are linked, so entering and saving data on one automatically updates the other.

**Cover of Live Trees by Height Classes** – Record the percent cover (0-100%) for each tree species and each plot in each height class:

- < 0.5 m.
- > 0.5-2 m.
- > 2-5 m.
- > 5-15 m.
- > 15-30 m.
- > 30 m.

***Counts of Live Trees DBH classes*** – For each tree species in the Veg Plot, count individual trees by DBH class, and record the total number for each species and for each plot in the appropriate DBH column in the provided data fields. Numbers can be entered directly into the fields, or the + or – buttons can be used to increase or decrease the count incrementally. *DBH Classes are:*

- 5-10 cm.
- 11-25 cm.
- 26-50 cm.
- 51-75 cm.
- 76-100 cm.
- 101-200 cm.
- > 200 cm.

5:50 PM Sat Feb 27 TEST-OR-10037, Visit: 1 Version 1.9 SAVE

**NWCA 2021 SNAGS AND TREE COUNTS (V-4)**

✘ This form has been thoroughly reviewed and is ready for submission

**STANDING DEAD TREES/SNAGS**

Estimate small and count individual standing dead trees/snags for DBH classes (in cm).

Plot 1 Small (<5) 5-10 11-25 26-50

51-75 76-100 101-200

---

Plot 2 Small (<5) 5-10 11-25 26-50

51-75 76-100 101-200

---

Plot 3 Small (<5) 5-10 11-25 26-50

51-75 76-100 101-200

---

Plot 4 Small (<5) 5-10 11-25 26-50

51-75 76-100 101-200

---

Plot 5 Small (<5) 5-10 11-25 26-50

51-75 76-100 101-200

Populate missing standing dead/snags with zeros: Fill Zeros

**LIVE TREES COVER AND COUNTS**

Plot  NYSSA BIFLORA

**Tree Cover by Height Class**

<small>&lt;0.5m</small>	<small>&gt;0.5m-2m</small>	<small>&gt;2-5m</small>	<small>&gt;5-15m</small>	<small>&gt;15-30m</small>	<small>&gt;30m</small>
<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="5"/>	<input type="text" value="35"/>	<input type="text" value="0"/>

**Tree Count by DBH Class**

<small>5-10cm</small>	<small>11-25cm</small>	<small>26-50cm</small>	<small>51-75cm</small>
<input type="button" value="-"/> <input type="text" value="0"/> <input type="button" value="+"/>	<input type="button" value="-"/> <input type="text" value="5"/> <input type="button" value="+"/>	<input type="button" value="-"/> <input type="text" value="2"/> <input type="button" value="+"/>	<input type="button" value="-"/> <input type="text" value="0"/> <input type="button" value="+"/>
<small>76-100cm</small>		<small>101-200cm</small>	<small>&gt;200cm</small>
<input type="button" value="-"/> <input type="text" value="0"/> <input type="button" value="+"/>		<input type="button" value="-"/> <input type="text" value="0"/> <input type="button" value="+"/>	<input type="button" value="-"/> <input type="text" value="0"/> <input type="button" value="+"/>

---

Plot  TAXODIUM ASCENDENS

**Tree Cover by Height Class**

<small>&lt;0.5m</small>	<small>&gt;0.5m-2m</small>	<small>&gt;2-5m</small>	<small>&gt;5-15m</small>	<small>&gt;15-30m</small>	<small>&gt;30m</small>
<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="57"/>	<input type="text" value="0"/>	<input type="text" value="0"/>

**Tree Count by DBH Class**

<small>5-10cm</small>	<small>11-25cm</small>	<small>26-50cm</small>	<small>51-75cm</small>
<input type="button" value="-"/> <input type="text" value="0"/> <input type="button" value="+"/>	<input type="button" value="-"/> <input type="text" value="3"/> <input type="button" value="+"/>	<input type="button" value="-"/> <input type="text" value="6"/> <input type="button" value="+"/>	<input type="button" value="-"/> <input type="text" value="0"/> <input type="button" value="+"/>
<small>76-100cm</small>		<small>101-200cm</small>	<small>&gt;200cm</small>
<input type="button" value="-"/> <input type="text" value="0"/> <input type="button" value="+"/>		<input type="button" value="-"/> <input type="text" value="0"/> <input type="button" value="+"/>	<input type="button" value="-"/> <input type="text" value="0"/> <input type="button" value="+"/>

Online

Figure 5-23. Example of completed Snag and Tree Counts and Tree Cover Form (V-4). All data depicted on this figure are imaginary and for illustration only.

### 5.2.4 Field Day Wrap-Up Activities

After completing the sampling of the five Veg Plots (this chapter), the Veg Team conducts field day wrap-up activities.

#### **At the AA:**

- 1) Complete collection of unknown and QA voucher specimens (Section 5.3.1):
- 2) Review all Vegetation Data Forms:
  - *Botanist/Ecologist* – Review the **Vascular Species Presence and Cover Form (V-2)** and the **Snag and Tree Counts and Tree Cover Form (V-4)** for errors in species names and missing data. Make any needed corrections.
  - *Botanist Assistant* – Review the **Veg Plot Establishment Form (V-1)** the **Vegetation Types/Ground Surface Attributes Form (V-3)** for missing data.
  - *Veg Team* – If needed, return to Veg Plots and collect any missing information.
- 3) Time permitting, begin plant identification and specimen pressing:
  - Botanist/Ecologist uses any time available after vegetation sampling and plant specimen collections are completed to key out unknown plant species. Update pseudonyms to scientific names for unknowns that have been confidently keyed to species on the **Vascular Species Presence and Cover Form (V-2)** and the **Snag and Tree Counts and Tree Cover Form (V-4)**. Note that when a tree name is updated on the **Vascular Species Presence and Cover Form (V-2)** the name will also be automatically updated on the **Snag and Tree Counts and Tree Cover Form (V-4)** only after selecting the “Enter Tree Data” button on **Form V-2** and select the SAVE button in the resulting pop-up window. Species names are not directly editable in the **V-4 Form**.
  - If a plant press is available at the AA, the Veg Team presses plant specimens. However, the AA will often be far enough from the vehicle to make carrying a press to the AA infeasible, so pressing plants will most often be conducted back at the vehicle (see the *At the Vehicle* heading below).
- 4) Collect and organize Veg equipment and samples for transport back to the vehicle.
- 5) Remove all flagging and plot markers, unless the site will receive a repeat sampling visit (for quality assurance sampling, other researchers collecting data, etc.). For repeat visit sites, labeled flagging should be left at the AA CENTER and POINT.
- 6) Once all Veg tasks at the AA are complete, assist the AB Team if they are still working. Alternatively, if there are numerous plant specimens to process, return to the vehicle and begin pressing plants.
  - Before leaving the AA to return to the vehicle, make a final check to ensure no equipment, data, or samples are left behind. If leaving for the vehicle prior to the AB Team, carry selected AB Team equipment and samples to the vehicle if possible.
  - To prevent the spread of potentially harmful organisms and invasive species between research sites, employ ZERO TAXA TRANSPORT protocols. Decontaminate equipment, shoes, clothing and personnel as thoroughly as possible before leaving the site.



***At the Vehicle:***

- 1) Press plant specimens (see Section 5.3.2):
  - Plant specimens are pressed at the vehicle whenever possible. If this is not feasible due to safety issues of parking location or weather, then plants may be pressed upon arrival at the field lodging location at the end of the day.
  - Pressing specimens might be facilitated by forming an assembly line of all four Crew members (Veg and AB Teams). Be sure to affix a completed **Plant Specimen Label** to the outside of the newsprint folder for each specimen (see Sections 5.3.2 and 5.3.3, and also Figure 5-29). Normally one specimen is pressed for each unknown or QA species. If more than one specimen is collected for a particular species, either press both specimens in the same newsprint folder use the same collection number (from the **Vascular Species Presence and Cover Form (V-2)**) on the **Plant Specimen Label** for that species.

*Note the field day is not finished until all the plants from an AA are pressed. If necessary, the entire Field Crew works together to complete this task.*

  - On the **Tracking Form** in the App (Chapter 2), verify the collection numbers of specimens for VEGQ (QA plant sample) and VEGU (Unknown plant sample) that are going to be shipped. The collection number for each sample type will automatically be populated to the Tracking Form when the Q and U bubbles are selected on **Form V-2**. At minimum, the QA Voucher specimens of known species (usually 5) should be collected at every site. If no specimens are collected for a given plant sample type, the **Tracking Form** will contain no list of specimens collected. This is akin to reporting the sample type as not collected.
- 2) Repeat decontamination of equipment, shoes, clothing and personnel, if the vehicle is located a long distance from the AA, to prevent spread of potentially harmful organisms and invasive species that may have been picked up between the AA and the vehicle. Employ ZERO TAXA TRANSPORT protocols.
- 3) Return all vegetation equipment and supplies to their standard locations in the vehicle.

### 5.3 Sample Collection and Processing and Data Handling

Several existing protocols for plant specimen collection, pressing, and handling (e.g., Magee et al. 1993, Mack 2007, WIPP 2008, and University of Florida Herbarium 2009) and helpful reviews from several wetland ecologists were useful in developing the NWCA protocols for plant sample collection and processing presented in this section.

Specimens of unknown plant species and QA voucher specimens for five known taxa are collected at each AA. Specimen collection, labeling, and most plant pressing are completed during the field day (Sections 5.3.1 through 5.3.3). Occasionally it may be more convenient to complete plant pressing (the same day as sampling) off-site at evening lodgings or the base location. Activities for specimen preservation (drying) and shipping or delivering dried specimens to a designated office or herbarium may carry over to subsequent field or travel days, or may sometimes be completed at the base location or lodging (Section 5.3.4 and 5.3.6).

Other specimen management and identification tasks are conducted from the office or designated herbarium. Sometimes the Botanist/Ecologist will identify additional species from fresh specimens and may update data forms on the App (See Section 5.2.3.1, subheading: Correcting Plant Species Names on Forms). Pressed unknown and QA specimens are sent to a designated lab or herbarium for identification and protocols for these tasks are detailed in the NWCA 2021 Laboratory Operations Manual (LOM).

### 5.3.1 Collecting Plant Specimens

Plant specimen collection is typically conducted throughout the sampling day as unknown species are encountered. This is particularly important for less common unknown species as they may be difficult to find again if collection is delayed.

A plant specimen is a pressed and dried plant sample. An integral part of each plant specimen is written data describing the location and date of collection and other information, which are recorded on the **Plant Specimen Label** (Figure 5-29) accompanying each specimen from pressing through identification (Section 5.3.3).

The plant specimens collected in the NWCA are critical data, and are used: 1) to identify unknown plant species encountered in the Veg Plots and 2) for quality assurance (QA) assessment based on taxonomic verification of species identities (QAPP; USEPA 2021a).

#### **Unknown Specimens**

- Collect all unknown species (Section 5.3.1) that are mature and have key structures needed for identifying specimens (e.g., leaves, stems, flowers and/or fruits, roots, rhizomes). Collect as complete a specimen as possible. If some key parts are available and other missing collect the material available.
- For immature or senescent unknown species (e.g., grasses or sedges with only leaf blades and no flowers or fruits; forbs that are seedlings, have unremarkable leaf shapes, or missing flowers), do the following:
  - If the species has > 5% cover, **collect it anyway**. It is possible that a regional expert may be able to identify the species even it is incomplete.
  - If the species has < 5% cover, record a pseudonym and estimate cover as usual, **but collecting a specimen is optional**.
- Select the U bubble on the **Vascular Species Presence and Cover Form (V-2)** for each unknown species collected. Doing so will allow the App to generate a collection number based on the row number (see Figure 5-13). Label Unknown Specimens prefaced with the letter U as assigned by the App, e.g., U3, U7, U12, etc. See **Reference Card V-5, Side B** (Figure 5-24) for the Flowchart for Collecting Unknown Plant Specimens.

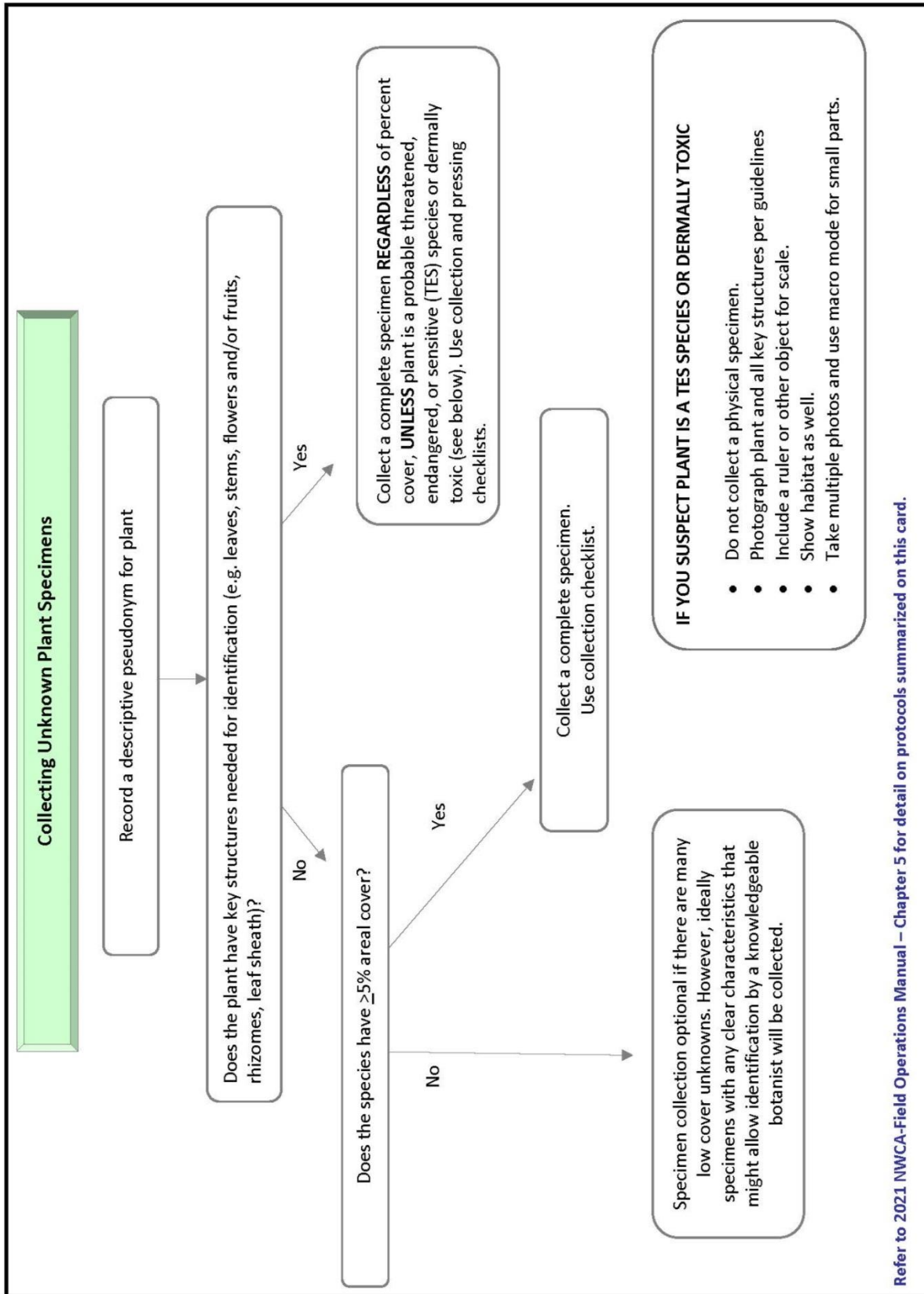


Figure 5-24. Reference Card V-5, Side B: Flowchart for collecting unknown plant specimens

### **QA Specimens**

- Determine the total number of plant species identified by the Botanist/Ecologist across the AA (i.e., listed on the **Vascular Species Presence and Cover Form (V-2)**). Use a random number table or random number generator on a calculator or other device to select five known species, identified by the Botanist/Ecologist during field sampling, as QA Voucher Specimens, using the rules below. Cover specifications have been incorporated to decrease the likelihood of crews from collecting potentially low cover plants that are time consuming to find and are potentially rare/endemic to the landscape
  - The first three specimens collected should be chosen from species that occur in at least one plot with cover greater than 10%. If there are not enough specimens with greater than 10% cover the threshold should be reduced to 5% cover.
  - Using a new random number table, the remaining 2 species collected should occur in at least one site with greater than 1% cover.
- If there are 5 or fewer known plant species within the AA, random selection of QA voucher specimens is obviously unnecessary. Collect the number of QA voucher specimens equal to the number of known species, i.e., 1 to 5.
- Do not collect TES specimens
- Do not collect poisonous or dermally toxic plants, which are randomly selected as QA vouchers, to avoid posing a hazard to yourself or to the lab botanists. Generate a new random number or use the next number on the random number table to select a replacement known species as the QA voucher.
- No unknowns can be collected as QA sample
- For each QA specimen collected, select the Q bubble on the **Vascular Species Presence and Cover Form (V-2)**. Doing so will allow the App to generate a collection number based on the row number (see Figure 5-13). Label QA Specimens prefaced with the letter Q as assigned by the App, e.g., Q2, Q8, Q16, etc.

**Do Not Collect Threatened, Endangered and Sensitive Species (TES)** – Do not collect TES plant species, or taxa that are easily killed if a portion of the plant is collected (e.g., many orchid species). Become familiar with national and state listed TES species relevant to the state in which you are working and with wetland TES species in particular. If TES species are encountered, document their presence by photographing them and recording data as described in 8.7Appendix D.

### **Collecting Material for Plant Specimens –**

- 1) For each species to be collected, select one or more healthy plants typical of its population within the AA. Collect enough plant material for species identification and to fill a standard herbarium sheet (29 x 42 cm) when pressed. Use the Plant Collection Checklist provided on **Reference Card V-5, Side A** (Figure 5-25).
- 2) Whenever possible, material for each specimen should consist of a stem with attached leaves, flowers, fruits, and, if possible, roots. Flowers and fruit are particularly important as they are generally needed to determine species identity.
  - If the plant is small enough, collect the entire plant including the roots.

- If the plant is too large to fit in the plant press, collect 1) sufficient leaves and stems to illustrate leaf shape and size, opposite or alternate branching, and buds, 2) some of the root or rhizome, and 3) the inflorescence (flowering stem) with open flowers. In the case of trees, shrubs, or vines, material should be selected to illustrate the overall characteristics of the plant and the range of variation in flowers, leaves, and other structures.
  - For grasses and grass-like plants, include roots or rhizomes. Whenever possible, include mature fruit, which are often critical for their identification; e.g., perigynia for *Carex* (sedge) species, grains for grasses, capsules for *Juncus* species, etc.
  - If the species has separate male plants and female plants (e.g., *Salix* sp. (willows)) or male and female flowers on the same plant, collect specimens from both sexes whenever possible. Indicate whether male and female parts are from the same individual or separate individuals.
  - If the species is immature or senescent, collect a sample that includes as many key diagnostic parts of the plant as possible.
- 3) Place the fresh plant material collected for each individual species into its own plastic bag (e.g., 1 species/ bag) to contain the specimen until it can be pressed. Using a permanent marker, write the Plant Sample ID Number (NWCA site number-collection number) on the outside of the bag.
- Gallon zipper-lock bags are appropriately sized for many species.
  - For species too large to fit into a gallon sized bag, e.g., shrubs, tall grasses or sedges, a kitchen trash bag may be used to store the specimen.
  - Use clear or white plastic bags as collection bags. Dark colored plastic bags will absorb too much heat during the day.

Alternatively, if it is more convenient, multiple species can be placed into larger bags. If more than one specimen is included in the same bag, make sure they can be easily distinguished from one another and related to their collection numbers from the **Vascular Species Presence and Cover Form (V-2)**. For example, tag individual species by bundling plant material by the stems with masking tape, a strip of flagging, or wire labeled with the collection number from the **Vascular Species Presence and Cover Form (V-2)**.

#### **Storing Plant Specimens during the Sampling Day –**

- 1) Place the smaller plastic bags with one or more plant species into a large heavy-duty, light colored plastic bag. Double bagging keeps specimens fresher in warm weather and keeps fragile plant parts together by species.
- 2) Plants will normally, and ideally, be pressed upon arriving back at the vehicle at the end of the sample day. If weather or road conditions where the vehicle is parked make pressing at this location infeasible or unsafe, place the bags of collected plant material into an ice chest (take care to keep the plants from freezing) until the Crew has returned to field lodging. Then, press the plants immediately.

**Ensuring All Unknown and QA Specimens Have Been Gathered –**

- 1) Before leaving the site at the end of the day, double check to make certain every species indicated for collection (i.e., the U = unknown species and the Q= quality assurance specimens) has been obtained.
- 2) Ensure that each specimen has been assigned a collection number and that this number is recorded as part of the Plant Sample ID number on the **Plant Specimen Label** (Section 5.3.3) when pressing the specimen (Section 5.3.2).

**Reference Card V-5, Side A. Plant Collection Checklist.**

<p><b><u>Plant Collection Checklist:</u></b></p> <p><b>Is the individual collected a typical specimen? (Multiple specimens are preferred)</b> <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p><b>Collect all of the following:</b> <input type="checkbox"/> Roots <input type="checkbox"/> Rhizomes <input type="checkbox"/> Stem <input type="checkbox"/> Leaves <input type="checkbox"/> Leaf sheaths (particularly important for sedges and grasses) <input type="checkbox"/> Flowers <input type="checkbox"/> Fruits <input type="checkbox"/> First and second year twigs, including buds. (Buds and pith color on second year twigs can be very important for woody species.) <input type="checkbox"/> Primocanes and floricanes for <i>Rubus</i> spp. <input type="checkbox"/> Bark samples or photos for species with similar leaves (e.g., <i>Betula</i>, <i>Carpinus</i> vs. <i>Ostrya</i>)</p> <p><b><u>Pressing Checklist for all herbaceous plants:</u></b> <i>Poorly pressed plants can shrivel if not pressed tightly, or get tangled, or mold if not dried quickly enough or long enough. These can become unidentifiable.</i> <input type="checkbox"/> Are roots pressed? <input type="checkbox"/> Are leaves pressed so that top and bottom of different leaves are visible? <input type="checkbox"/> Are delicate structures pressed separately? <input type="checkbox"/> Are flower structures visible? <input type="checkbox"/> Are roots free of dirt? <input type="checkbox"/> Can flowers be taped open with gummed cloth tape? <input type="checkbox"/> Is flower color noted? <input type="checkbox"/> Are perigynia pressed and in glassine envelope? <input type="checkbox"/> Attach photos of plant and habitat <input type="checkbox"/> Are plants dioecious? If so, collect male and female flowers. Indicate if male and female parts are from the same individual or separate individuals. <input type="checkbox"/> Note number of florets per spikelet for sedges and grasses that fall apart after pressing. <input type="checkbox"/> Sedges: try to get mature fruit in good conditions (arrangement of male and female parts). <input type="checkbox"/> Note whether hairs are spreading or appressed if key notes it (i.e. <i>Persicaria</i>)</p>
--

**Figure 5-25. Reference Card V-5, Side A: Plant collection checklist**

### 5.3.2 Pressing Plant Specimens

It is important to process the plant material as soon after collection as practical to preserve the morphological features of the specimens. Processing the specimens immediately helps prevent data loss that can result from degraded or lost specimens; consequently, specimens are normally pressed and labeled at the end of the sampling day.

Plant specimens are pressed and dried in a *standard plant press* (30 X 45 cm, 12 X 18 inches, Figure 5-26) composed of a breathable wooden frame, corrugated cardboard ventilators, blotters, folded newsprint, and a set of adjustable straps.

- The wooden frame and straps bound the press.
- Newsprint specimen folders, each containing plant material, are sandwiched between two moisture-absorbing blotters.
- The "blotter-newsprint sandwiches" are placed between corrugated cardboard spacers.
- The corrugations of the cardboard spacers should run parallel to the shorter dimension (30 cm) of the press for best air circulation. Bulky specimens may require extra blotters and spacers.



Figure 5-26. Plant Press. Photo used by permission from Kent D. Perkins, University of Florida Herbarium.

#### Protocol for Pressing Most Plant Specimens:

- 1) To begin pressing a specimen, place a cardboard spacer on the bottom wooden frame of the press, then add a blotter.
- 2) Lay a newsprint folder on top of the blotter. To the outside of the newsprint folder, affix a completed adhesive **Plant Specimen Label** (see Section 5.3.3). This label includes the Site ID, the Plant Sample ID Number, and other critical data about the specimen you are pressing.



- 3) Clean as much dirt as possible off the plant material before placing it in the newspaper folder. Place the plant material inside the sheet of folded newspaper so that it lies entirely within the dimensions of the plant press.



**Figure 5-27. Assembling the plant press. Photo used by permission from Kent D. Perkins, University of Florida Herbarium.**

- 4) Carefully arrange the plant material (Figure 5-27) to display diagnostic features.
  - a) Lay the specimen flat and avoid overlapping plant parts.
  - b) Spread leaves, flowers, and fruits so they can be easily observed from different perspectives.
  - c) Show upper and lower surfaces of leaves and flowers.
  - d) If possible, arrange material so some flowers have the blossom open, and some flowers and fruits appear in longitudinal and transverse views.
  - e) For smaller plants, multiples individuals of the same species should be pressed together on one sheet.
  - f) For large specimens, bend stems sharply into a V or N shape so they fit within the press frame. Avoid curving or twisting stems.
  - g) Thick stems, large fruits, or bulbs may be trimmed to reduce bulk by cutting them in half lengthwise.
- 5) Examples of small, loose plant parts (i.e., seeds, *Carex perigynia*) should be placed in a small paper packet or envelope inside of the newspaper.
- 6) Once the plant material is arranged, fold the newspaper closed. Make sure that the plant material is entirely within the dimensions of the newspaper.
- 7) Add another blotter, then a cardboard on top of the newspaper folder.
- 8) To begin pressing the next specimen, place a blotter over the top cardboard in the stack. Repeat steps 2 - 8 until the press is full or all specimens are included.

- 9) Use two adjustable straps to tighten and firmly compress the plant press and its contents (Figure 5-26)

**Protocol for Pressing Aquatic Plant Specimens:**

When pressing an aquatic plant such as *Utricularia* or *Ceratophyllum*, a useful method of preparing the plant for pressing is the Sink Technique.

- 1) Fill a sink with water and float the plant in the water.
- 2) Place a blotter sheet underneath plant and slowly lift the blotter sheet. This allows the finer structures of the plant to be separated on the sheet.
- 3) Place wax paper on top of the plant specimen to keep it from sticking to the upper blotter sheet in the plant press. It may be necessary to double up the blotter sheets for very wet or fleshy samples.

See Figure 5-28 for examples of well-pressed specimens. **Reference Card V-6** contains additional example of both good and poor specimens.

Reference Card V-6, Side A. Examples of Good Specimens.

1

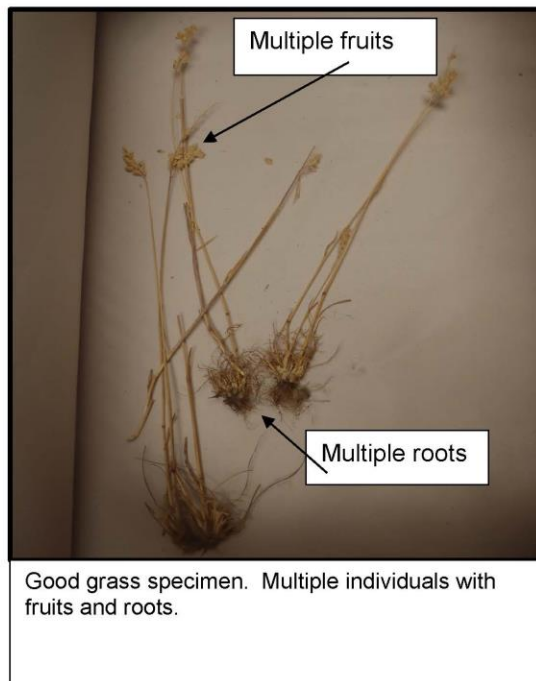
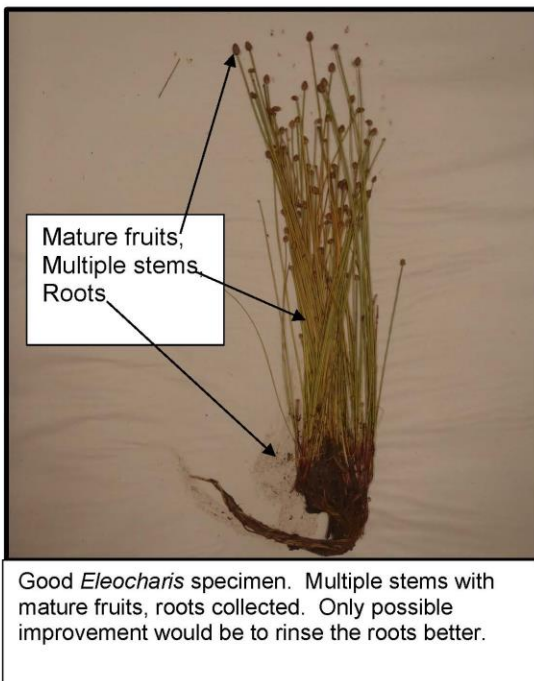
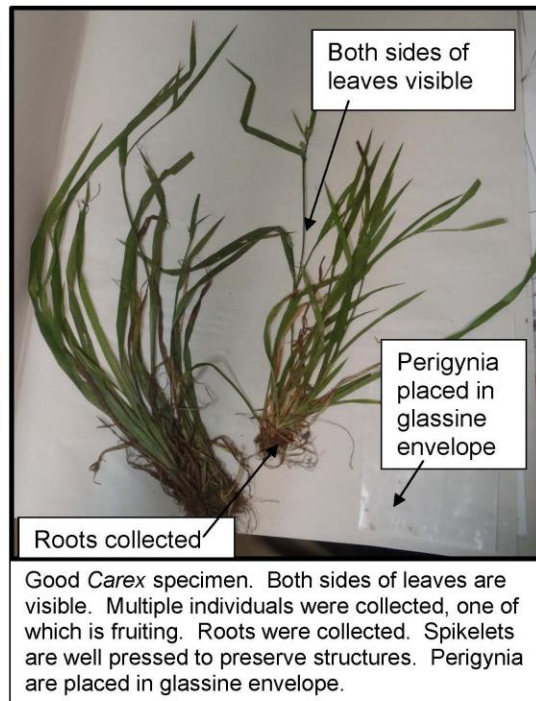
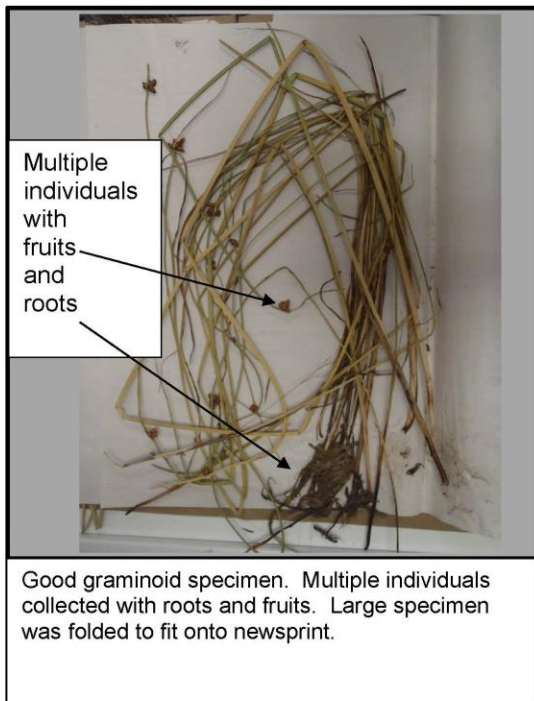


Figure 5-28. Examples of well pressed plant specimens on Reference Card V-6.

### 5.3.3 Plant Specimen Label

**Plant Specimen Labels** are important field data and their absence can result in loss of data represented by the plant specimen, so it is critical that label information is complete and accurate. **The Plant Specimen Label** has an adhesive back and is affixed to the outside of the newsprint in which the specimen to which it applies is pressed. For each plant specimen:

- 1) **Complete a Plant Specimen Label** (Figure 5-29) – The Plant Specimen Label provides key descriptive information that can aid identifying an unknown plant sample or in verifying the identification of a QA voucher when reviewed at the lab or herbarium.
  - a) **QA Voucher or Unknown Species** – Fill in the appropriate bubble to indicate whether a specimen is a QA Voucher or an Unknown Species.
  - b) **Complete the Label Header Information**
    - Record the *Plant Sample ID Number* which consists of the *Site ID* and the *Collection Number* (Coll#) for the specimen from the **Vascular Species Presence and Cover Form (V-2)**.
    - Record the *Sampling Date* in the space labeled *Date*. Fill in the month and day using two digits for the month (e.g., August = 08) and two digits for the day (e.g., 01, 23) and the year.
    - Indicate the *Visit Number*; Visit 1 (primary sampling event) or Visit 2 (QA revisit).
    - Indicate the County and State in which the Site occurs.
    - If more than one newsprint is required for a single specimen, affix a completed label to each newsprint and add a note (e.g., 1 of 3, 2 of 3, etc.) to the top of the label.
  - c) **Species Name or Pseudonym**
    - QA Voucher Specimen: Record the scientific name provided by the Botanist/Ecologist on the **Vascular Species Presence and Cover Form (V-2)**.
    - Unknown Species: Provide the Pseudonym that was used to describe it on the **Vascular Species Presence and Cover Form (V-2)** (see Section 5.2.3.2).
  - d) **Record the Collector(s) Name(s)**
  - e) **Abundance of Plant** – Indicate whether the species is dominant, common, sparse (scattered at low abundance), or uncommon (only a few individuals).
  - f) **Habitat** – Describe the plant community or immediate setting where the plant is growing.
  - g) **Growth Habit** – Describe key features of the plant such as growth form (tree, shrub, vine, herb), approximate height, longevity (annual, biennial, perennial), clonal, rhizomatous, tussock-forming, etc. List any characteristics of the plant which may be lost upon drying, such as flower/fruit color and fragrance, leaf orientation and aroma.

PLANT SPECIMEN LABEL	
<input type="checkbox"/> QA	<input type="checkbox"/> Unknown
Plant SamplID: NWC21-_____	Vis# _____ Col# _____
Date: ____/____/20____	County: _____ ST: _____
Species Name or Pseudonym: _____	
Collector(s) Name(s): _____	
<b>Abundance of Plant (fill only one circle):</b>	
<input type="checkbox"/> Dominant	<input type="checkbox"/> Common <input type="checkbox"/> Sparse <input type="checkbox"/> Uncommon
<b>Type of plant:</b>	
<input type="checkbox"/> graminoid	<input type="checkbox"/> forb <input type="checkbox"/> shrub <input type="checkbox"/> tree <input type="checkbox"/> vine
<input type="checkbox"/> other _____	
<b>Root type:</b>	
<input type="checkbox"/> taproot	<input type="checkbox"/> fibrous roots <input type="checkbox"/> rhizomes <input type="checkbox"/> tubers
<input type="checkbox"/> other _____	
Water depth/hydroperiod for this plant at sampling (dry, moist, top of hummock, in 6 inches of water, perennially saturated, etc.): _____	
<b>Sunlight:</b>	
<input type="checkbox"/> full sun	<input type="checkbox"/> part sun <input type="checkbox"/> part shade <input type="checkbox"/> full shade
<b>Growth habit:</b>	
<input type="checkbox"/> erect	<input type="checkbox"/> arching <input type="checkbox"/> trailing <input type="checkbox"/> shrubby
<input type="checkbox"/> other _____	
Number of petals: _____	Flower color: _____
Habitat: _____	<input type="checkbox"/> Multiple newsprints
_____	Newsprint ____ of ____

Figure 5-29. Example of the Plant Specimen Label. Data are imaginary and for illustration only.

### 5.3.4 Drying Plant Specimens

Pressed plant specimens should be *thoroughly dried* before removing them from the presses. Once dry, remove specimens from the presses and ship or transport them to designated lab or herbarium for identification.

- To encourage drying, keep full presses in a warm, dry, well-ventilated location in the vehicle during the day and in a well-ventilated warm location at the lodging location at night.
- As the specimens dry they will lose volume, so periodically tighten the straps on the press to maintain pressure on the specimens and minimize shrinkage and wrinkling.
- Rapid and thorough drying is enhanced by low humidity and ample airflow around and through the presses. The best preservation of color and morphology is obtained with rapid drying over low heat. Also, dry air circulating through the press may kill many insects and insect eggs, potentially protecting the specimens from damage.
- The easiest way to achieve these conditions is by using an electric plant dryer that provides steady bottom heat (95°F to 113°F), where plants usually dry in 12 to 48 hours. Plant dryers (e.g., Figure 5-30) are typically constructed as a simple box with a heat source (often light bulbs) and a fan for air circulation, on which plant presses can be placed to accelerate drying.



**Figure 5-30. Plant Dryer.** Photo from Mack (2007) by permission from the Wetland Ecology Group, Division of Surface Water, Ohio Environmental Protection Agency.

**Protocol for drying specimens –**

- 1) Ideally, full plant presses will be returned to the base location after a few field days and placed on a plant dryer to dry.
- 2) If a plant dryer is not available keep the full presses in a warm, dry, well-ventilated location. Check the press every couple of days and replace wet blotters to speed drying.
- 3) Periodically tighten the straps on the press as the specimens dry and shrink to maintain pressure on the press.
- 4) Once plant specimens are dry, remove them from the presses with individual specimens kept in their newsprint folders with attached **Plant Specimen Labels**.
- 5) Organize the plant specimens for transport or shipping to the designated location for identification or verification (Sections 2.7.2 and 5.3.5 and 8.7Appendix A). **DO NOT SHIP WET SPECIMENS**

**5.3.5 Shipping or Transporting Plant Specimens**

Careful management of the dried plant specimens and specimen tracking information, and prompt shipment or transport of specimens to the herbarium, lab, or office where they will be identified, is critical to data quality and timeliness of data acquisition. Develop a regular weekly schedule for completing these activities (see also Section 2.7.2 and 8.7Appendix A).

- 1) Specimens from several sites may be batched together to ship or transport to the office, lab, or herbarium for identification. Unknown specimens and QA plant samples may need to be packed in separate boxes as they may be shipped to different destinations (see Figure 5-33).
- 2) **Unknown Specimens** – For each batch of unknown specimens shipped, transported, or stored for later identification, group the specimens by NWCA Site, ordered by collection number, into herbarium folders labeled with an adhesive folder label which contains the Site ID, folder number



and number of specimens contained within the folder. Put only as many specimens into each herbarium folder as will comfortably fit and place each folder in a provided zip-top bag. Use separate folders for each site. If multiple folders are needed for one site, clearly indicate this on the folder labels (e.g., folder 1 of 2, folder 2 of 2).

Fill out the T-4: Unknown Plant Sample section of the **Tracking Form** in the App and a T-4 packing slip (Figure 5-31 )for each site.

- On the T-4 packing slip, list collection numbers for all unknown specimens that are being shipped or transported to a lab for identification by entering the “U#” in each row. Collection numbers are generated by the App when the “U” bubble is selected for a species on **Form V-2**.
- Ensure that the Site ID number, the visit number, and date collected are listed on the packing slip and that this information corresponds exactly to the information on the **Plant Specimen Label** for each specimen.
- Enter the shipping details (lab, date shipped, airbill number, sender’s name, and sender’s phone number) into the **Tracking Form** in the app. This is critical for tracking the plant specimens.

**T4: NWC21 Unknown Plant Tracking**

Site ID: NWC21- Test-OR-10005 Visit #: 1 of 2

Date Collected: 07/27/2021 Page 1 of 1

Crew: List the collection number for each specimen being shipped.	Lab Staff: Confirm receipt of sample using the check box. Report missing samples on your check in file in the lab comment section (leave date received blank). Please use this section below to notate any comments about the state of each sample upon arrival. Record this information in the lab comment section of your check in file. These comments will be added to the database.
<u>U 2</u>	<input type="checkbox"/>
<u>U 8</u>	<input type="checkbox"/>
<u>U 12</u>	<input type="checkbox"/>
<u>U 19</u>	<input type="checkbox"/>
<u>U</u>	<input type="checkbox"/>
<u>U</u>	<input type="checkbox"/>
<u>U</u>	<input type="checkbox"/>

Figure 5-31. Example T-4 (Unknown Plant Tracking) Packing Slip

If specimens from multiple sites will be shipped together, a separate T-4 packing slip is used for each site. Place the packing slip(s) in the box (on top of the herbarium folders). If unknown and QA plant specimens are going to the same lab, they may be packed together in the same shipping box, but must be in separate herbarium folders and zip-top bags. In this case, the box will contain both T-4 and T-5 packing slips.

Submit the plant data and tracking forms via the App. See Chapter 2 for details on submitting data and tracking forms to the Information Management Team. Remember that data can be updated at any time by amending the App forms and re-submitting them, so crews are encouraged to submit data as soon as possible after leaving the field to avoid potential data loss from a lost or damaged iPad.



- 3) **QA Voucher Specimens** – For each batch of QA Voucher Specimens shipped or transported, group the specimens by NWCA Site, ordered by collection number, in herbarium folders labeled with an adhesive folder label which contains the Site ID, folder number and number of specimens contained within the folder. Put only as many specimens into each herbarium folder as will comfortably fit and place each folder in a provided zip-top bag. Use separate folders for each site. If multiple folders are needed for one site, clearly indicate this on the folder labels (e.g., folder 1 of 2, folder 2 of 2).

Fill out the T-5: QA Plant Sample section of the tracking form in the App and a T-5 packing slip (Figure 5-32) for each site.

- On the T-5 packing slip, list collection numbers for all QA specimens that are being shipped or transported to a lab for identification by entering the “Q#” in each row. Collection numbers are generated by the App when the “Q” bubble is selected for a species on Form V-2.
- Ensure that the Site ID number, the visit number, and date collected are listed on the packing slip and that this information corresponds exactly to the information on the **Plant Specimen Label** for each specimen.
- Enter the shipping details (lab, date shipped, airbill number, sender’s name, and sender’s phone number) into the **Tracking Form** in the app. This is critical for tracking the plant specimens.

T5: NWC21 QA Plant Tracking	
Site ID: <u>NWC21-OR-1005</u>	Visit #: <u>102</u>
Date Collected: <u>07/27/2021</u>	
<p>Crew: List the collection number for each specimen being shipped.</p> <p><u>Q 4</u></p> <p><u>Q 7</u></p> <p><u>Q 10</u></p> <p><u>Q 11</u></p> <p><u>Q 15</u></p>	<p>Lab Staff: Confirm receipt of sample using the check box. Report missing samples on your check in file in the lab comment section (leave date received blank). Please use this section below to notate any comments about the state of each sample upon arrival. Record this information in the lab comment section of your check in file. These comments will be added to the database.</p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p>

Figure 5-32. Example T-5 (QA Plant Tracking) Packing Slip

If specimens from multiple sites will be shipped together, a separate T-5 packing slip is used for each site. Place the packing slip(s) in the box (on top of the herbarium folders). If unknown and QA plant specimens are going to the same lab, they may be packed together in the same shipping box, but must be in separate herbarium folders and zip-top bags. In this case, the box will contain both T-4 and T-5 packing slips.

Submit the plant data and tracking forms via the App. See Chapter 2 for details on submitting data and tracking forms to the Information Management Team. Remember that data can be updated at any time by amending the App forms and re-submitting them, so crews are encouraged to submit data as soon as possible after leaving the field to avoid potential data loss from a lost or damaged iPad.

- 4) Carefully pack the assembled specimen folders into their designated shipping boxes. Place cardboard dividers between groups of specimen folders to provide extra protection. Make sure the box is full or padded so no space is available for specimens to shift around and become damaged.
- 5) Ship or transport the boxes to the office or herbarium/lab that has been designated for your state for plant identification. See 8.7Appendix A for the shipping destinations for unknown plant specimens and QA voucher specimens for your state. Note that in some cases the NWCA Botanist/Ecologist or a State Botanist may be conducting some of the identification of unknowns. In other cases, the specimens will be shipped directly to a designated plant lab or herbarium. Often the Unknown Specimens and the QA Voucher Specimens may have different destinations. A generalized schematic of the destination types for plant specimens is provided in Figure 5-33.
- 6) The LOM provides procedures for 1) identification of unknown specimens, 2) verification of lab identifications of 10% of unknown specimens through re-identification by a different lab botanist, 3) verification by lab botanists of field identifications for QA voucher specimens, 4) specimen tracking during the identification/verification process, and 5) procedures for recording all plant identification data.

### *5.3.6 Data Handling*

At the end of the sampling day, after you have reviewed the vegetation data forms, submit the forms using the NWCA App. It is recommended to submit all the data forms as soon as possible, even if they have not been fully reviewed yet. This stores a record of all the current data in the IM Database which can be retrieved in the event of iPad failure, damage, or loss. Updates can be made to the forms at any time and re-submitted to update the IM database accordingly. See Chapter 2 for protocols on submitting the completed data via the App and 8.7Appendix D for transmitting any photos of plants or vegetation that may have been taken.

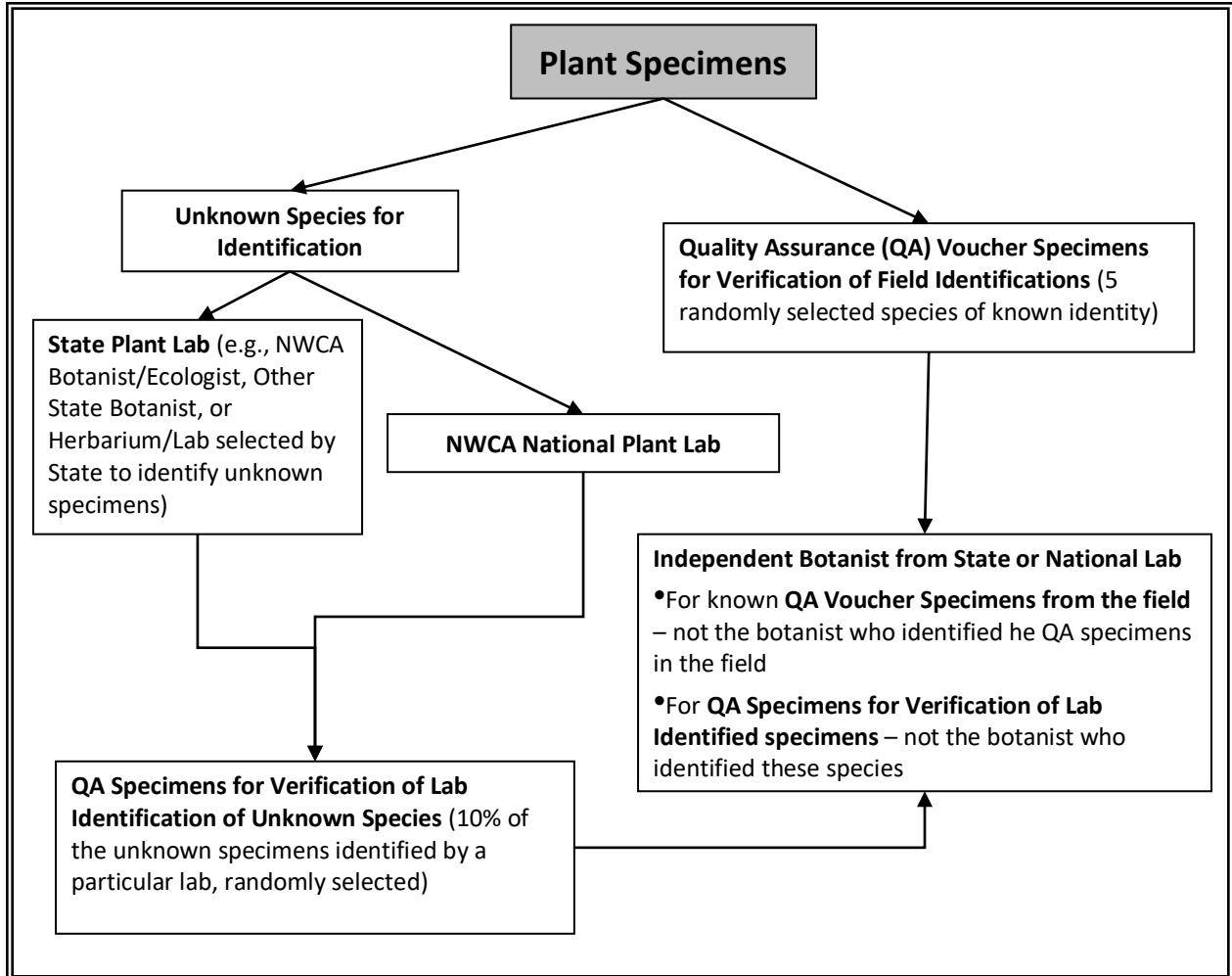


Figure 5-33. Schematic of plant specimen destinations for identification and verification (see Chapter 2 and 8.7Appendix A for specific shipping details)

## 5.4 Vegetation Reference Card List and Protocol Checklist

A list of Vegetation Reference Cards and a Vegetation Protocol Checklist are grouped together in this section to provide easy access to brief summaries of the major tasks to be completed for the Vegetation Sampling Protocols.

### **Reference Cards Summarizing Vegetation Protocols:**

Reference Card V-1: Flowchart of Vegetation Protocol Tasks

Reference Card V-2, Side A and Side B: Key for Veg Plot Placement and Examples of Plot Layout Configurations

Reference Card V-3, Side A: Vegetation Plot Establishment

Reference Card V-3, Side B: Veg Plot Configuration and Data Collection Summary

Reference Card V-4, Side A: Assigning Pseudonyms for Unknown Plant Species

Reference Card V-4, Side B: Cover Estimation Procedures

Reference Card V-5, Side A: Plant Collection Checklist

Reference Card V-5, Side B: Flowchart for Collecting Unknown Plant Specimens

Reference Card V-6, Sides A-D: Examples of Good Specimens

Reference Card V-6, Side E: Examples of Poor Plant Specimens

The Vegetation Reference Cards are compiled (with all other NWCA 2021 Reference Cards) in the Quick Reference Guide.

**Vegetation Protocol Checklist:** For use during field sampling to aid in directing the order of work, ensure all data and specimens have been collected, and all tasks are completed.

## NWCA 2021 Vegetation Protocol Task Checklist

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### Pre-sampling and Plot Establishment Activities

- 1) \_\_\_ Organize data forms and assemble vegetation sampling equipment.
- 2) \_\_\_ Determine the Vegetation Plot Layout configuration and plot locations within the AA and document on **Form V-1**.
- 3) \_\_\_ Establish the five Vegetation Plots. Annotate aerial photo/map with Veg Plot locations. Provide any need explanatory notes on **Form V-1**.
- 4) \_\_\_ Determine predominant NWCA Target Wetland Type in each Veg Plot.
- 5) \_\_\_ On **Form V-1**, list floras and field guides used in field identification at the Site being sampled.

### Activities Key to all Veg Data Collection

- 1) \_\_\_ Botanist/Ecologist and Botanist Assistant determine approach to sampling.
  - Often it will be efficient for the Botanist/Ecologist and Botanist Assistant to work together with the Botanist Assistant recording data as the Botanist/Ecologist makes observations.
  - At other times, it may be more convenient for the Botanist/Ecologist to make all observations that require identification or cover estimation of individual plant species, while the Botanist Assistant collects data on cover of vegetation strata, ground surface types, groups of non-vascular taxa, and count data for trees and snags.
- 2) \_\_\_ If needed, the Botanist Assistant compiles a list of the scientific names or pseudonyms for shrub and tree species on his/her clipboard for use in collecting tree count data (**Form V-4**).
- 3) \_\_\_ Verify all header information on all data forms and plant specimen labels during sampling.
- 4) \_\_\_ Follow procedures on **Reference Card V-4, Side A** for assigning pseudonyms for unknown plant species.
- 5) \_\_\_ Collect specimens for unknown plant species and five QA vouchers for known species, making certain to assign Plant Sample ID Numbers and ensure all tracking information always remains with the specimens.

### Major Data Collection Activities for each Veg Plot

- 1) \_\_\_ Make presence observations for all vascular species occurring within the two corner quadrat nests.
- 2) \_\_\_ Complete species list for the 100-m<sup>2</sup> Veg Plot.
- 3) \_\_\_ Make cover estimates and note the vertical height class for all individual vascular plant species in each 100-m<sup>2</sup> Veg Plot (**Form V-2**).
- 4) \_\_\_ Make cover estimates for vascular vegetation strata (**Form V-3**).
- 5) \_\_\_ Make cover estimates and collect associated occurrence data for non-vascular taxonomic groups (**Form V-3**).
- 6) \_\_\_ Collect data on ground surface attributes (**Form V-3**).
- 7) \_\_\_ Estimate abundance of small standing dead trees (< 5 cm DBH); count snags (> 5 cm DBH) by estimated diameter class; identify and count trees (> 5 cm DBH) by species and estimated diameter class; estimate cover of trees by species by height class (**Form V-4**).
- 8) \_\_\_ If needed take photos of threatened, endangered, or sensitive plant species.

### Field Day Wrap-Up Activities – At the Site

- 1) \_\_\_ Double check that all unknown and QA voucher specimens have been collected.
- 2) \_\_\_ Review all Vegetation Data Forms:
  - \_\_\_ *Botanist/Ecologist* – Review **Forms V-2** and **V-4** for errors in species names and missing data. Make any needed corrections.
  - \_\_\_ *Botanist Assistant* – Review **Forms V-1** and **V-3** for missing data.
  - \_\_\_ *Veg Team* – If needed, return to Veg Plots of AA and collect any missing information.
- 3) \_\_\_ Collect and organize Veg equipment and samples for transport back to the vehicle.
- 4) \_\_\_ Time permitting, Botanist/Ecologist key out unknown plant species. For unknowns confidently keyed to species, update pseudonyms to scientific names on **Forms V-2, V-4**.
- 5) \_\_\_ Botanist Assistant remove all flagging and markers, unless the site will receive a repeat sampling visit.
- 6) \_\_\_ Veg Team assist the AB (if they are still working), or, if numerous plant specimens have been collected return to the vehicle to begin pressing plants.
  - a) \_\_\_ Before leaving the AA make a final check to ensure no equipment, data, or samples are left behind. If leaving for the vehicle prior to the AB Team, carry selected AB Team equipment and samples to the vehicle.
  - b) \_\_\_ To prevent spread of potentially harmful organisms and invasive species between research sites; employ ZERO TAXA TRANSPORT protocols. Decontaminate equipment, shoes, clothing and person as thoroughly as possible before leaving the site.

### Field Day Wrap-Up Activities – At the Vehicle

- 1) \_\_\_ Press plant specimens:
  - a) \_\_\_ Plant specimens are pressed at the vehicle whenever possible. If this is not feasible due to safety issues of parking location or weather, then plants may be pressed upon arrival at the field lodging location at the end of the day.
  - b) \_\_\_ Pressing specimens might be facilitated by forming an assembly line of all four crew members (Veg + AB Team). Be sure to affix a completed **Plant Specimen Label** on the newsprint enclosing each specimen.
  - c) \_\_\_ Verify the number of plant specimens collected at the site on **Form V-2**.
- 2) \_\_\_ Organize the completed forms into the Data Packet for the AA.
- 3) \_\_\_ If the vehicle is some distance from the AA, again decontaminate equipment, shoes, clothing and person at the vehicle to prevent spread of potentially harmful organisms and invasive species between research sites. Employ ZERO TAXA TRANSPORT protocols.
- 4) \_\_\_ Return all vegetation equipment and supplies to their standard locations in the vehicle.

### Plant Specimen Drying and Shipping

- 1) \_\_\_ Deliver the full presses to the home base where they can be completely dried. Pick up empty presses for next field trip.
- 2) \_\_\_ Once plant specimens are dry, place them in labelled herbarium folders and carefully pack them, being certain to include the appropriate tracking forms, then ship or deliver to the designated office/lab/herbarium.

## 5.5 Equipment, Data Forms, and Specimen Label Lists

The equipment lists, data forms, specimen labels, and vegetation checklist needed for Vegetation sampling are summarized in the table below. The Vegetation Equipment and Supply Checklist is provided on the following page.

<b><i>Vegetation Equipment Checklist, Forms and Labels</i></b>	<b>Number Needed Per AA</b>
Vegetation Equipment and Supply Checklist	1 checklist
<b>NWCA App:</b> <ul style="list-style-type: none"> <li>• NWCA 2021 Veg Plot Establishment Form (V-1)</li> <li>• NWCA 2021 Vascular Species Presence and Cover Form (V-2)</li> <li>• NWCA 2021 Vegetation Types/Ground Surface Attributes Form (V-3)</li> <li>• NWCA 2021 Snag and Tree Counts and Tree Cover Form (V-4).</li> <li>• NWCA 2021 Tracking Form</li> </ul>	
<b>Plant Specimen Labels</b>	1 adhesive label per plant specimen. Number per site varies based on number of plant specimens collected.
<b>NWC21 Unknown Plant (T-4) Packing Slip</b>	1 per site (include in shipping container to allow lab to verify and check in samples)
<b>NWC21 QA Plant (T-5) Packing Slip</b>	1 per site (include in shipping container to allow lab to verify and check in samples)



## NWCA 2021 VEGETATION EQUIPMENT AND SUPPLY CHECKLIST

### Protocols, forms, checklists, supplies

- This equipment checklist
- Vegetation protocol checklist
- Reference Cards V-1, V-2, V3, and V-4**
- Available plant species lists pertinent to the site and/or region (wetland species, alien species, threatened and endangered species)
- Data Forms on NWCA App:
  - Veg Plot Establishment Form (V-1)**
  - Vascular Species Presence and Cover Form (V-2)**
  - Vegetation Types/Ground Surface Attributes Form (V-3)**
  - Snag and Tree Counts and Tree Cover Form (V-4)**
  - Tracking Form**
- Waterproof field notebook
- 2 covered clip boards, with storage for completed forms
- Sharpies or similar marker (one silver for annotating aerial photos, regular pencils, mechanical pencils, extra leads)
- Permanent marker (Fine-tip for labels)

### Plant identification in the field or vehicle

- Regional floras
- 2 10X hand lenses
- Dissecting tools (e.g., single edge razor blades, forceps, and dissecting needles)
- 6-inch ruler with metric markings to measure plant parts during keying

### Plot establishment and data collection

(Note a variety of different supplies can be used for plot set-up, select appropriate gear)

- 1 set of 2-way radios
- Compass
- GPS unit
- Laser rangefinder
- Diameter measuring tape (cm) to calibrate investigators for tree DBH estimates (use as needed)
- Lengths of marked rope for measuring and laying out Veg Plots (size and number at crew's discretion)<sup>1</sup>

### Plot establishment and data collection

#### *continued*

- 50-m or 100-m tape measure
- As needed: tent stakes, U-shaped pins, or surveyors' arrows for securing meter tapes and/or ropes to demarcate plots
- 40 to 50 pin flags (recommend two bright colors with 1/2 of pins in each color) and pouch for carrying
- Bright colored flagging in 2 colors
- Inside edges of 10-m<sup>2</sup> quadrat:** two 3.16-m PVC poles with decimeter points marked in red<sup>2</sup> (poles may break down to two shorter lengths for easy transport, one segment/pole = 1m), or one 6.32-m rope
- Inside edges of 1-m<sup>2</sup> quadrat frame:** two 1-m PVC poles (1m lengths from 3.16m segmented pole) that can be connected with an elbow joint in the field, or two 1-m wooden slats

### Plant specimen collection, processing, and shipping

- Trowel for obtaining plant specimens with intact roots
- Clippers/pruners
- Twist-tie tags or flagging for marking unknown species that may be carried in small 'bouquets' for reference during sampling
- Gallon size or two-gallon size zipper plastic bags and kitchen size white trash bags for collecting plant specimens
- White garbage bag for consolidating collection bags
- Ice chest (kept in vehicle)
- At least 2 large plant presses (kept in vehicle) loaded with blotters, cardboard ventilators, and newsprint, compression straps, small envelopes for loose plant parts
- At least 2 extra complete plant presses (kept at base location to exchange for full presses)
- Plant Specimen Tracking Tags
- Plant Specimen Labels
- At base location, plant specimen folders and shipping boxes for shipping specimens to herbaria

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<sup>1</sup> E.g., Durable cord or rope in 10 or 20m lengths – with 5m points marked with blue tape, 10m points with red tape.

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<sup>2</sup> PVC poles with decimeter marks can also be used as measuring sticks

## Chapter 6 Soils

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### 6.1 Introduction

Soils play an important role in wetland ecosystems, cycling nutrients, regulating water movement and storage, and serving as a growth medium or habitat for plants, microbes, and macroinvertebrates. Wetland soils develop distinct characteristics as a result of the hydrology and biota (e.g., microbes and vegetation) associated with wetlands, as well as other factors that influence soil development across all environments (e.g., climate and geology). These characteristics impact the functions and processes occurring in the soil and reflect its ecological condition.

This chapter provides detailed protocols and methods for sampling the NWCA Soil Plot. The Assessment Area and Buffer (AB) Team will collect all soil data at each NWCA site. Soil sampling is conducted at a single Soil Plot within each Assessment Area (AA), and includes:

- 1) collection of a Standardized Depth Soil Core for analysis of soil chemistry;
- 2) collection of a Soil Isotope Sample for laboratory analysis;
- 3) soil Profile Description (morphological and physical characteristics) at one soil pit to a depth of 125 cm, and identification of Hydric Soil Field Indicators;
- 4) collection of Horizon Bulk Density and Chemistry Samples for laboratory analysis; and
- 5) estimation of Water Table Depth.

All data collected will be recorded on the **Soil Data Form (S-1)** in the NWCA App. A brief overview of the sampling tasks is provided on **Reference Card S-1**. While reading the protocols in this chapter and when performing the protocols for NWCA, it will be useful to refer to this overview and the other Reference Cards that summarize key protocols or provide key information. Laminated reference cards are included in the Quick Reference Guide for easy access and use in the field. In addition to this chapter, completion of the protocol will require two field references:

Munsell Color X-Rite. 2009. Munsell Soil Color Charts. Munsell Color Corporation. Grand Rapids, MI.

United States Department of Agriculture, Natural Resources Conservation Service. 2019. Field Indicators of Hydric Soils in the United States, Version 8.2. L.M. Vasilas, G.W. Hurt, and C.V. Noble (eds.). USDA, NRCS in cooperation with the National Technical Committee for Hydric Soils. Available online (with errata):  
[http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/?cid=nrcs142p2\\_053957](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/?cid=nrcs142p2_053957).

Additional field references and sources of information are listed at the end of this chapter (Section 6.9).

#### 6.1.1 Coordination with NRCS

NRCS soil scientists may be able to provide assistance to NWCA Field Crews at some sites. For additional assistance, consult with the NRCS State Soil Scientist prior to the sampling season, for advice about likely soil conditions and the best methods for sampling soils at specific NWCA sites. Before going to the site, review the soil survey, maps, and photo information in the Site Packet (see Chapter 2). Use the Site Packet review and any discussions with the soil scientist to select the tools best suited to the anticipated soil conditions for the site and to carry into the AA. The NRCS soil scientist may be able to demonstrate the use of, or lend you, specialized equipment for specific conditions in your area.

## 6.2 Identify Soil Plot Location

### 6.2.1 *Standard Soil Plot Location*

The Standard Soil Plot Location is at the Veg Plot closest to the AA CENTER, outside of the corner furthest from the transect lines. Avoid locating the Soil Plot near the transect lines to prevent trampling of the Soil Plot during the day's activities. The Standard Location should always be used unless access to the soil is prevented by a combination of water depth and soft substrate  $\geq 0.25$  m deep, threatened, endangered, or sensitive plant species, large logs or trees, and large rocks or boulders. If the Standard Soil Plot Location cannot be used, follow the procedures in Section 6.2.2.

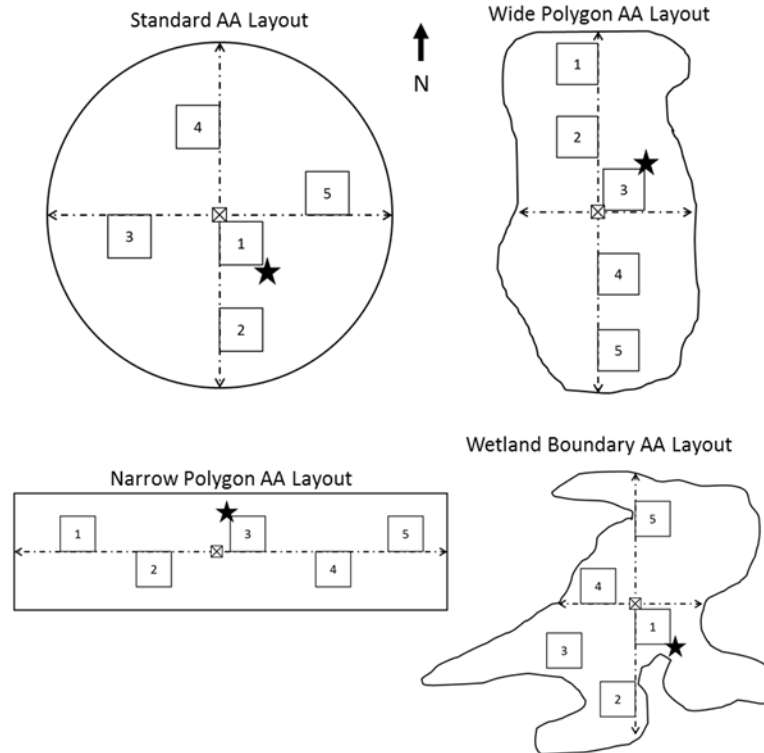
If this site is a revisit site, avoid placing the Soil Plot in the same location as the Soil Plot sampled during Visit #1. The Soil Plot should be moved from the standard location so as not to overlap with the Visit #1 Soil Plot. Follow the directions in Section 6.2.2 for placement and recording the Alternate Soil Plot Location.

#### 6.2.1.1 *Standard AAs*

For the Standard Circular or Standard Circular AA-Shifted Layout, the Soil Plot will be located outside of the southeast corner of Veg Plot 1 (Figure 6-1). In the Standard Circular AA and Standard Circular AA-Shifted Layouts, Veg Plot 1 is located closest to the AA Center. The southeast corner is used because it is furthest from the transect lines.

#### 6.2.1.2 *Alternate AAs*

The location of the Soil Plot varies with the shape and size of the Alternate AA and the associated Veg Plot Layout. Determine the Veg Plot located closest to the AA CENTER. The Veg Team will have designated the Veg Plot numbers on the flags in the southeast corners of the plots. Determine the corner of the selected Veg Plot that is located furthest from the transect lines (and least likely to be trampled during sampling activities). The Soil Plot should be located outside of this corner (Figure 6-1). The Soil Plot should be located at least 2 m inside of the outer edge of the AA.



**Figure 6-1. Examples of Soil Plot locations for various Veg Plot layouts. The Soil Plot is located at the Veg Plot closest to the AA Center, outside the Veg Plot corner located furthest from the transect lines.**

### 6.2.2 Alternate Soil Plot Location

If the presence of obstacles prevents sampling at the standard Soil Plot location, move the Soil Plot to avoid the obstacle, but keep it as close as possible to the Standard Soil Plot Location. An Alternate Soil Plot Location should also be used during Visit #2 at Revisit sites, so that the Soil Plot does not overlap with the Soil Plot sampled during Visit #1. Select an Alternate Soil Plot Location that is at least 2 m inside of the outer edge of the AA, an upland edge, or other non-target wetland type. Avoid locating the Soil Plot near the transect lines to prevent trampling of the Soil Plot during the day's sampling activities.

### 6.2.3 Recording Soil Plot Location

Once the location of the Soil Plot has been determined, record its location in the *Soil Plot Location* section of the **Soil Data Form (S-1)** in the App. If a Standard Soil Plot Location or Alternate Location that is within 3 meters of a Veg Plot corner is used, record the Veg Plot number and corner nearest the Soil Plot by using the drop-down menus for *Veg Plot* and *Corner*. If an Alternate Soil Plot Location that is greater than 3 meters is used, record the Veg Plot number and corner nearest the Soil Plot by using the drop-down menus for *Veg Plot* and *Corner*, select the *Center of Soil Plot is greater than 3m from Veg Plot Corner* bubble and record the distance (in meters) and true north bearing of the plot from the Veg Plot number and corner selected and specify the reason for moving the Soil Plot in the comment field provided. For Standard and Alternate Soil Plot Locations, record the GPS coordinates (in decimal degrees using NAD83) of the Soil Plot in the space provided.

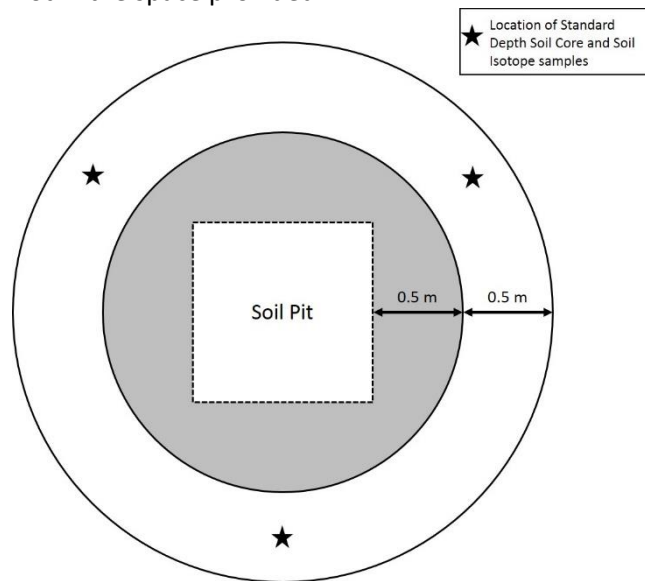


Figure 6-2. Soil Plot Layout

### 6.3 Layout of Soil Plot for Sampling

The Soil Plot is a circle with a diameter of 3.0 m as shown in Figure 6-2. The Standardized Depth Soil Cores and Soil Isotope Sample will be collected before excavation of the Soil Pit from a ring 1.0 to 1.5 m from the center of the Soil Plot. The Soil Pit will be located at the center of the Soil Plot.

While collecting the Standardized Depth Soil Cores and Soil Isotope Sample, avoid disturbing the central area of the Soil Plot where the Soil Pit will be located.

### 6.4 Collection of Standardized Depth Soil Cores

Standardized Depth Soil Cores will be collected at every site to represent a layer from the soil surface to 10 cm (4 in) depth. This sample will provide soil chemistry data from a uniform depth at all sites, regardless of differences in horizon types or depths. The 0-10-cm depth interval was chosen because it represents the most biologically active portion of the soil. Since oftentimes the upper soil horizons are thin (making them more difficult to sample) the Standardized Depth Soil Cores will ensure that we have a minimum data set for the upper portion of the soil profile.

A total of six Standardized Depth Soil Cores will be collected, homogenized, and analyzed for soil chemistry. The Standardized Depth Soil Cores will be collected using the 3-inch steel open-ended soil corer provided by NWCA.

### 6.4.1 Preparation of Labels, Tags, and Sample Collection Bags

Fill out the Standardized Depth Soil Core (SDSC) label and tag for the site. The six cores collected will be combined and stored in a labeled, 8-mil thick plastic sample bag. These bags are durable and, when properly folded and stapled, retain the field state moisture content of the soil sample. It is critical to sample integrity to make sure the seal is properly executed.

- 1) Standard Depth Soil Core (SDSC) Sample Label (Figure 6-3) – Complete the adhesive sample labels (see example below) with the Site ID, Visit #, and Date. Only one sample will be collected at a site.
  - a. Visit #1 corresponds to the primary sampling visit; Visit #2 is the second sampling or revisit.
  - b. Affix the completed sample label to the outside of an 8-mil thick plastic soil sample bag. Cover the entire label with clear tape to protect it from moisture and mud.

<b>STANDARD DEPTH SOIL CORE (SDSC)</b>	
Site ID: NWC21- _____	
Date: ___/___/20___ Visit #: <input type="radio"/> 1 <input type="radio"/> 2	
Depth: 0-10cm	
<b>T3</b>	<b>990004</b>

Figure 6-3. Standard Depth Soil Core sample label.

- 2) Standard Depth Soil Core Sample Tag (Figure 6-4) – Complete the sample tags (printed on waterproof paper).
  - a. Fill in the Site ID, Date, and Visit #. Make sure that all information recorded matches the sample label and **Soil Data Form (S-1)**.

Staple under sample bag fold	<b>NWCA 2021: Standard Depth Soil Core Sample Tag</b>	
	Site ID: NWC21- _____	
	Date: ___/___/20___ Visit #: <input type="radio"/> 1 <input type="radio"/> 2	
	STANDARD DEPTH SOIL CORE (SDSC) <b>Sample ID: 990004</b>	
	Sample Depth: 0-10cm	

Figure 6-4. Standard Depth Soil Core sample tag.

### 6.4.2 Sample Collection

Six Standardized Depth Soil Cores will be collected from three points in the undisturbed area within a 1.0 to 1.5 m radius of where the pit will be located (Figure 6-2). Space the three sample positions evenly around the outer ring of the Soil Plot, shifting as needed so that they are placed in undisturbed areas.

Two cores will be collected at each of the three sample positions. Cores will be collected using a 7.62-cm (3-in) diameter (outside diameter) sharpened steel open-ended cylinder. This open-ended corer will also be used to collect the Soil Horizon Bulk Density samples, following a similar procedure (Section 6.6.5.1.1 and Figure 6-24). The Soil Isotope Sample will be collected at the same positions in the Soil Plot (Section 6.5) using a different sampling device.

- 1) Clear vegetation and any loose leaf litter (e.g., fallen leaves, branches, etc.) from the surface of the soil in the sampling area.
- 2) From each of the sampling locations collect two cores.
  - a. Place the open-ended corer on the surface of the ground (sharpened edge down) and push the corer into the soil until the top of the corer is flush with the soil surface. It may be necessary to hammer the corer into the soil, and if so, lay a board across the top of the corer and tap lightly with a mallet or hammer until the top of the corer is flush with the soil surface.
  - b. Dig out the sampling corer plus a little of the surrounding soil; using a knife blade, cut off the excess soil so the sample material is flush with the bottom edge of the corer. Be careful not to push additional soil into the corer during excavation. The sampled soil core may appear to be slightly thinner than the depth the corer was inserted (due to compression). Do not add soil to fill the corer to the same height, as this will add weight or additional soil material to the sample that is not in proportion to the sample volume or sampling depth. Do not remove rock fragments from the Standardized Depth Soil Cores.
- 3) Empty the contents of the corer into the previously labeled bag. The six cores collected for the Standardized Depth Soil Core sample will be combined into one sample bag.
  - a. Use the handle end of a trowel or other tool that can act as a plunger to push the soil out of the cylinder into the sample bag. Take care to make sure the entire soil sample is collected in the sample bag, scraping out the inside of the cylinder if needed. The Standardized Depth Soil Cores do not need to remain intact in the sample bag.
- 4) Collect cores from the remaining positions, following the steps given above.
- 5) Pour out any free water that has accumulated in the sample bag. Seal the bag attaching the appropriate sample tag. Proper sealing of the bag will ensure that the sample is not lost, the sample remains at field moist condition, and the sample will comply with APHIS shipping regulations (Figure 6-5).
  - a) Take the top 5 cm (2 in) of the sample bag and make the first fold away from the side of the bag on which the sample label is affixed. The sample label displays key tracking information and must always be affixed to the front of the bag.
  - b) Make a second fold, taking the top 2.5 cm (1 in) of the first fold and folding towards the sample label on the front of the bag.
  - c) Insert the sample tag into the second fold with the tag information facing outward. Use a heavy duty stapler and staple through the fold and tag.
  - d) Staple the left and right sides of the double fold to ensure the bag is completely sealed closed.
- 6) Record the Water Chemistry Sample ID number from the label sheet in the *Anchor ID/Water Chem ID* field of the **Tracking Form** in the App. Doing so will automatically populate the sample IDs in the *Sampling Information* section at the bottom of the **Soil Data Form (S-1)**. Verify the



Sample ID number from the Sample Label for the Standardized Depth Cores (SDSC) agrees with the sample ID on the **S-1 Form**.

- 7) Note anything unusual about the sample in the comment bubble. If the sample could not be collected, fill in the bubble indicating a sample was not collected, and state the reason in the comment bubble.
- 8) Keep samples cool and out of the sun during the sampling day. Follow the protocols in Section 6.8 on sample tracking, shipping, and handling of samples.



Figure 6-5. Proper sealing and stapling of soil sample bags

## 6.5 Collection of Soil Isotope Samples

Soil Isotope samples are collected at the same positions in the Soil Plot as the Standardized Depth Soil Cores (Figure 6-2), but with a different sampling device. Collection of this sample follows similar methods, but note that three smaller cores will be collected and placed into a quart-size zip-top bag for the Soil Isotope sample. Cores will be collected using the plastic syringe-corer device or a standard stainless steel soil probe (7/8" or similar diameter). For the Soil Isotope samples, avoid using thick plastic bags that necessitate closing with staples (these soil sample bags are only used for the Standardized Depth Soil Cores, Horizon Bulk Density, and Horizon Chemistry samples).

### 6.5.1 Preparation of Labels and Sample Collection Bags

Fill out the Soil Isotope (SISO) Sample Label for the site (Figure 6-6). It is printed as an adhesive label. Record the Site ID, State, Date, and Visit #. Affix the label to the sample bag and cover it with clear tape to protect it from dirt and debris, and to ensure that it stays affixed to the quart-sized zipper sample bag.


<b>SOIL ISOTOPE (SISO)</b>	
Site ID: NWC21-_____	State: _____
Date: ____/____/20____	Visit #: <input type="radio"/> 1 <input type="radio"/> 2
<b>990003</b>	
	

Figure 6-6. Soil isotope sample label.

### 6.5.2 Sample Collection

- 1) Follow steps 2-4 below to collect cores for Soil Isotope testing. The cores should be collected from the same positions as the Standardized Depth Soil Cores (see Section 6.4 and Figure 6-2). The sampling locations should be spaced evenly around the outer ring of the Soil Plot and positioned in undisturbed areas within 1.0 to 1.5 m of where the Soil Pit will be located. The spacing of the sampling locations may be shifted so they are positioned in undisturbed areas.
- 2) Clear vegetation and any loose litter (e.g., fallen leaves, branches, etc.) from the surface of the soil in the sampling area.
- 3) Use the soil syringe-corer device or a standard stainless steel soil probe (7/8" or similar diameter, see Figure 6-8F) to collect one 10 cm deep soil core (measured from the soil surface and including organic horizon(s), if present) at each of the three designated areas. The syringe-corer device may be most effective in water-logged soils, while a stainless steel soil probe may be needed for drier soils. While the protocol below is specific to the syringe-corer device, it can be easily adapted for a stainless steel soil probe. *NOTE: Avoid sampling through thick mats of living roots or rhizomes as this will contaminate the analysis. Collect the sample from below the root mat, or if this is not possible, at another location within the Soil Plot. Minimal amounts of small living roots are acceptable in the core.*
  - a. Remove the plunger while taking the soil core (Figure 6-7a).
  - b. Push the syringe tube into the soil to the 10 cm mark on the wall of the syringe tube. The air hole should be above the soil (Figure 6-7b).
  - c. While the syringe tube is still in the soil, replace the plunger in the syringe, pushing it down just enough to cover the air hole. This will create a vacuum to aid in removing the core (Figure 6-7c).
  - d. Carefully remove the syringe tube containing the soil from the ground by gently twisting and lifting it upwards. If necessary, use your fingers, putty knife, hand trowel, or soil knife to break or cut the soil from under the core and support the core as it is lifted from the surrounding matrix (Figure 6-7d).
  - e. Extract the core directly into the labeled sample bag using the plunger (Figure 6-7e) or your fingers if a soil probe is used.
  - f. If using the plunger, avoid pushing it beyond the end of the syringe-corer (Figure 6-7f).
- 4) Place all three cores into the prepared quart-size zipper sample bag for Soil Isotope analysis. Do not collect more soil (i.e., larger, deeper cores) than instructed.
- 5) Roll down the top of the sample bag to remove excess air. Once the air is evacuated from the bag, seal the top by zipping it. Avoid stapling the bags. Double-check that the zipper is secure.
- 6) Record the Water Chemistry Sample ID number from the label sheet in the *Anchor ID/Water Chem ID* field of the **Tracking Form** in the App. Doing so will automatically populate the sample IDs in the *Sampling Information* section at the bottom of the **Soil Data Form (S-1)**. Verify the

Sample ID number from the Sample Label for the Soil Isotope Sample (SISO) agrees with the sample ID on the **S-1 Form**.

- 7) Note anything unusual about the sample in the comment bubble. If the sample could not be collected, fill in the bubble indicating a sample was not collected, and state the reason in the comment bubble.
- 8) Place the sample bag in a second bag of the same size (i.e., double-bag the sample). Press the excess air from the bag and seal the top by zippering it. Double-check that the zip-top closure is secure.
- 9) Place the sample on ice in a cooler as soon as possible after collection. If a cooler is not immediately available on site, keep the samples cool and out of the sun during the sampling day.
- 10) Follow the protocols in Section 6.8 on sample tracking, shipping, and handling of samples.



Figure 6-7. Collection of Soil Isotope Samples. Photos by Casey Pollock and Amanda Nahlik.

## 6.6 Soil Profile Description and Sampling

A soil profile is made up of a series of horizontal layers called horizons. The morphological, physical, and chemical characteristics of each horizon and the combination of horizons in a soil profile reflect the interactions of topography and landscape, biologic activity, climate, soil parent material, and time of soil formation. The characteristics of these horizons can provide information on hydrology, past and present land uses and their impacts, and the health and condition of the soil (which impacts its ability to perform important ecosystem functions). Soil Profile Descriptions (made in the field) will be combined with

chemical and physical analyses (made in the lab) to assess the condition of the soil and how it has been impacted by stressors.

### 6.6.1 Excavation of Soil Pit

Before starting to dig, establish the side of the pit where the Profile Description will be made and Horizon Bulk Density and Horizon Chemistry Samples will be collected. This is the Soil Profile Face. As the Soil Pit is excavated, avoid disturbing this area (e.g., standing, digging, piling soil on top of, etc.). These types of disturbances could compact the soil or lead to contamination of the samples. Place the soil from the Soil Pit on a plastic sheet to limit disturbance to the surrounding area. This will also make it easier to backfill the Pit when sampling is complete.

The Soil Pit will be excavated, described, and sampled to a depth of 125 cm. As the Soil Pit is excavated, be aware of changes in soil texture, consistency, or ease of digging – these observations can be used to delineate horizons later.

A variety of tools may be used to excavate the Soil Pit, depending on conditions. Examples of these tools are shown in Figure 6-8. Local NRCS offices or soil scientists may be able to provide additional recommendations on tools and techniques useful for specific site conditions.



Figure 6-8. Examples of tools for Soil Pit excavation. A) Tiling spade. B) Sharpshooter. C) Shovel. D) (Left to right) Auger handle extensions, Ratchet handle, Solid auger buckets (for sand or mud), Open bucket auger with handle, and Open auger buckets (for fine textured soils). E) Peat auger head. F) Soil probe. G) Hammer corer. Photos by Frank Gibbs, Gregg Lomnicky, and Phil King.

#### 6.6.1.1 Easy to Sample Soils (e.g., not submerged, not cemented)

- 1) Begin by removing the vegetation surface layer using a tiling spade with a long narrow blade (e.g., approximately 30 cm in length, Figure 6-8).
  - a. Use shallow cuts (approximately 15 cm deep or just through the vegetation layer) to outline a rectangular area wider than the shovel blade and about 45 cm long to define the “vegetation cap”.

- b. Use the cutting edge of the spade to slice through as many roots as possible. If needed, use pruners to cut large roots that could tear the vegetation cap apart when it is lifted. Scoop up this upper block of soil just under the root mass with the spade.
    - c. Set the cap of rooted vegetation, shoot side up, in the shade, if possible. The vegetation cap will be replaced after soil sampling is complete and the Soil Pit is backfilled, to allow the vegetation to reestablish.
  - 2) Take care to avoid standing on, piling soil on top of, or otherwise disturbing the designated Soil Profile Face.
  - 3) The Soil Pit should be excavated to a depth of 125 cm. Initially, dig to a depth of at least 30 to 40 cm. Excavate the hole to the dimensions needed to view the soil and access samples. Use a shovel to excavate the remainder of the Soil Pit to a depth of 125 cm. Place excavated soil on a tarp or plastic sheet to avoid disturbing the surrounding area.
    - a. The Soil Pit does not need to be large in area. Excavate an area just large enough that samples can be obtained to a depth of 125 cm.
    - b. If water or slumping soil in a pit prevents excavation to the 125 cm depth, excavate to just above the water table or the greatest depth possible and describe the soil profile to that depth. Then, if possible, use techniques in Section 6.6.1.2 to excavate down to 125 cm and complete the profile description.
    - c. If a large rock, log, very large root, or disturbed area (animal burrow, tree-fall pit, etc.) is encountered before reaching 125 cm, move or expand the pit to expose a sufficient undisturbed area.
    - d. If a cemented horizon or similar impenetrable material is encountered and is large enough in extent to make moving the pit impractical, excavate the pit to the maximum possible depth. Record the occurrence and type of impenetrable layer or object and its depth from the surface in *Soil Pit Attributes* section of the **Soil Data Form (S-1)**.
  - 4) Use a knife (e.g., inexpensive hunting or kitchen knife) or root pruners to clean the soil on the Soil Profile Face of the Soil Pit to remove plant tissue or soil transferred from other depths during Pit excavation.
  - 5) Depending on conditions, it may be easier to describe the soil outside of the pit. To do so, remove a soil slab:
    - a. On the cleaned face of the pit, carefully make cuts perpendicular to the face of approximately a shovel width to cut the sides of the soil slab to be extracted.
    - b. Slice through the soil about 10 cm behind the cleaned pit face to connect the side cuts.
    - c. Push the shovel 30 cm deep and pull back on the shovel as the other AB Team member gently holds the soil against the blade, lifting the intact slab or slice of soil out of the pit.
    - d. Carefully slide the slab section from the shovel blade onto a clean plastic sheet separate from the spoil pile.
    - e. Clean loose soil out of the pit and extract additional slab sections to the 125 cm depth using the shovel (or extract this lower section with an auger when conditions warrant).
    - f. Match up the slab sections or the upper slab section and lower augered sections end-to-end, mirroring the soil profile's in situ position.
  - 6) Once the Soil Profile Face has been exposed and cleaned (or soil slab and/or augered section have been extracted) begin the Soil Profile Description, starting with the protocols for detection of hydrogen sulfide odor and, if the soil is inundated or saturated, initial matrix color (Section 6.6.2.1).



### 6.6.1.2 *Difficult to Sample Soils*

Submerged soils, saturated sands, organic soils, and clayey soils can be challenging when attempting to obtain an intact soil slab or soil core. Some alternative techniques and special tools for specific conditions are listed in the table below (Table 6-1). These techniques are described in further detail in the following text. Your local NRCS office or soil scientists may be able to suggest alternative sampling methods appropriate for particular site conditions. Prior to sampling, use soil maps to determine if the soil types at the site could pose particular challenges for describing and sampling the Soil Profile.

**Table 6-1. Techniques for sampling difficult soils**

<b>Soil Condition</b>	<b>Suggested Techniques</b>
Saturated Soils	<p>Excavate Soil Pit to the greatest depth possible (just above the depth of standing water in the Soil Pit or slumping of Soil Pit walls prevent further excavation). Complete profile description and sampling of upper layers before excavating below the standing water in the Soil Pit.</p> <ul style="list-style-type: none"> <li>• Extract soil slabs from lower portion using a shovel. Lay out slabs on a plastic tarp or snow sled, matching up the slabs to mirror their arrangement in the Soil Profile in order to describe the profile outside of the Soil Pit. Limit slumping by extracting soil slab from the Soil Pit Face very slowly.</li> </ul> <p>If soil slabs do not remain intact (unconsolidated soils):</p> <ul style="list-style-type: none"> <li>• Extract soil using an auger. Lay out auger sections on a plastic tarp, snow sled, or section of plastic gutter, matching up the sections to mirror their arrangement in the Soil Profile in order to describe the profile outside of the Soil Pit.</li> <li>• Or, use a Tube Extractor (King Soil Extractor) to remove an intact soil core in order to describe the profile outside of the Soil Pit.</li> </ul>
Submerged Soils	<p>Build a soil coffer dam and use a hand pump to remove standing water</p> <ul style="list-style-type: none"> <li>• Extract soil slabs using a shovel. Lay out slabs on a plastic tarp or snow sled, matching up the slabs to mirror their arrangement in the Soil Profile in order to describe the profile outside of the Soil Pit. Limit slumping by extracting soil slab from the Soil Pit Face very slowly.</li> </ul> <p>If soil slabs do not remain intact (unconsolidated soils) or water is moving into the Soil Pit too quickly:</p> <ul style="list-style-type: none"> <li>• Extract soil using an auger. Lay out auger sections on a plastic tarp, snow sled, or section of plastic gutter, matching up the sections to mirror their arrangement in the Soil Profile in order to describe the profile outside of the Soil Pit.</li> <li>• Or, use a Tube Extractor (King Soil Extractor) to remove an intact soil core in order to describe the profile outside of the Soil Pit.</li> </ul> <p>If the soil is organic:</p> <ul style="list-style-type: none"> <li>• Extract soil using a Macaulay peat auger. Lay out auger sections on a plastic tarp, snow sled, or section of plastic gutter, matching up the sections to mirror their arrangement in the Soil Profile in order to describe the profile outside of the Soil Pit.</li> <li>• Or, use a Tube Extractor (King Soil Extractor) to remove an intact soil core in order to describe the profile outside of the Soil Pit.</li> </ul>
Heavy Clay Soils	Excavate thinner soil slabs to avoid breaking or bending the shovel handle

#### ***Saturated Soils***

Excavate the soil to just above the depth of standing water or when saturated soils are slumping (no longer can support vertical pit walls). Describe and sample the soil above the water table before



continuing to the lower section of the soil profile. If the soil is not sufficiently cohesive to maintain vertical pit walls, extract soil slabs with a shovel to describe and sample outside of the Soil Pit. Make cuts with the shovel to extract a slab or slice of soil from the Soil Profile Face. Lay the slab sections on a plastic tarp, snow sled, or section of plastic gutter, arranging them end to end to match their position in the Soil Profile. Limit slumping of soil pit walls by lifting soil slabs away from pit walls very slowly.

If the soil is not cohesive enough to extract an intact soil slab using a shovel, an auger may be used to retrieve the soil. Augers have different style buckets (open or closed) and varying cutting tips appropriate for different soil types. Augers mix the soil sample and cannot be used to collect Horizon Bulk Density Samples due to potential compression or expansion of the soil. If an auger is used to collect soils for the Soil Profile Description or Horizon Chemistry Samples, take care to mark the depth from which the soil is removed by the auger.

A Tube Extractor (King Soil Extractor) may also be useful when soils cannot be retrieved with a shovel (Figure 6-9). This tool works best in soft, finer sediments, organic materials, and saturated soils. The King Soil Extractor is typically constructed from a plastic or metal tube (15cm in diameter and 1 m long) with a metal tube clamp at its base for adjusting the tube diameter. The King Soil Extractor is hammered into the unconsolidated substrate. To prevent soil loss from the tube, dig a slot alongside the tube and insert a spade to cover the bottom. Tip the tube and spade over into the slot and lift the tube onto a plastic snow sled or plastic tarp. Expand the tube slightly and extrude the soil in the tube, forcing it out with a plunger.



**Figure 6-9. King Soil Extractor. This technique is most useful in soft estuarine or fluvial soils (e.g., unconsolidated, fluid, organic, and/or saturated soils). Photos by Ann Rossi.**

***Shallowly Submerged Soils*** (e.g., surface water  $\leq$  25 cm deep)

If soil strength allows (soil is sufficiently cohesive to maintain the vertical walls of a soil pit), soil pits 125 cm deep may be excavated from under shallow water using a hand pump or bailing scoop to evacuate water and digging techniques similar to those used for soils that are not submerged (Figure 6-10).



**Figure 6-10. Techniques for sampling submerged or saturated soils. A) Soil coffer dam surrounding the Soil Pit. B) Use of a hand pump to remove water from the Soil Pit. Photos by Gregg Lomnicky.**

Build a soil coffer dam using the soil from the Soil Pit. Plastic or metal sheeting can be used to reinforce the dam walls around the Soil Pit area. If necessary, remove vegetation around the base of the coffer dam to achieve a seal for the dam walls against the ground surface. With the dam in place, remove the standing water with a hand pump and proceed to excavate a slab of soil that can be described outside of the Soil Pit. It may be necessary to operate the hand pump continuously during extraction of the soil slab and collection of soil samples.

The soil slab or sections can be laid out on a plastic tarp or sheet for describing the Soil Profile outside of the Soil Pit. A plastic snow sled or section of plastic gutter also works well as a platform for holding soil slabs or cores during soil description, facilitating sample collection, and for storing equipment (Figure 6-11).



**Figure 6-11. Use of a plastic snow sled (A and B) and plastic gutter (C) for facilitating sample collection and holding soil cores during soil profile description. Photos A and B by Regina Poeske. Photo C by Frank Gibbs.**

If water is moving into the Soil Pit too quickly or the soil is too unconsolidated to support vertical pit walls and obtain soil slabs using a shovel, use an auger or a King Soil Extractor (see above).

### **Low-Strength Organic Soils**

A Macaulay peat auger may be required for high organic content soils. A King Soil Extractor (see above) may also be useful.

### **Heavy Clay Soils**

To avoid breaking the shovel handle when excavating heavy clay soil (particularly if dry), extract a thinner soil slab.

## **6.6.2 Description of Soil Profile**

Once the Soil Pit has been excavated to a depth of 125 cm (or soil slabs or auger sections to a depth of 125 cm have been laid out to represent the Soil Profile), begin the Soil Profile Description. Description data will be recorded on the **Soil Data Form (S-1)**.

- 1) Immediately assess properties that can change upon exposure to air (Hydrogen Sulfide Odor and Reduced Matrix Color, Section 6.6.2.1). Record data in the *Initial Readings* section of the **Soil Data Form (S-1)**.
- 2) Measure and record information on the Soil Pit, time of pit excavation, and lighting conditions in the *Soil Pit Attributes* section of the **Soil Data Form (S-1)** (Section 6.6.2.2).
- 3) Identify Horizon Boundaries and record the depth of the lower boundary of every horizon to a depth of 125 cm (Section 6.6.2.3). Record data in the Horizons section of the **Soil Data Form (S-1)**. If a NRCS Soil Scientist is at the site (and was not assisting with the determination of horizon boundaries), have them review the horizon boundaries and depth measurements.
- 4) Take a photograph of the Soil Profile Face (Section 6.6.2.5).
- 5) Describe soil morphologic properties [boundary description, texture, rock fragments, roots, matrix color, redoximorphic features, masked sand grains, organic features, and mottles (Sections 6.6.2.6 – 6.6.2.14)]. Record all data in the Horizon section of the **Soil Data Form (S-1)** using one row per Horizon.
  - a. Develop a systematic approach to ensure that all information is collected for every horizon to a depth of 125 cm. Crews may choose to conduct their description horizon by horizon, describing all properties of a horizon before moving to the next horizon. Alternatively, the description could be made one property at a time, describing a given characteristic (for example, texture) for every horizon in the profile and then continuing with the next property.
  - b. Every horizon to a depth of 125 cm should be described. If a given horizon cannot be described, explain why it was not described in the comment bubble specific to the horizon on the **Soil Data Form (S-1)**.
- 6) Provide additional description information, comments, or explanations of data as needed by adding comments in the comment bubble(s) as needed for each horizon.
- 7) Space is provided for twelve horizons on the **Soil Data Form (S-1)**.
- 8) Determine if the soil meets a Hydric Soil Field Indicator (Section 6.6.2.15) and record all indicators present in the Hydric Soil Field Indicators section of the **Soil Data Form (S-1)**.
- 9) The Soil Profile Description and Horizon Designations will be reviewed by an NRCS Soil Scientist, either as part of the field day activities, or later using the Soil Profile Description and photographs of the Soil Profile (Section 6.6.3).
- 10) Once the Soil Profile Description is complete and all data has been collected and recorded, collect the Horizon Bulk Density and Chemistry Samples (Section 6.6.4).



### 6.6.2.1 Initial Readings

Some soil properties (particularly in hydric soils) can change rapidly upon exposure to air. To ensure that information on these properties is collected when they are present, document and record this data immediately upon excavating the Soil Pit and before conducting any other parts of the Soil Profile Description.

#### 6.6.2.1.1 Hydrogen Sulfide (H<sub>2</sub>S) Odor

As sulfate (SO<sub>4</sub><sup>2-</sup>) is reduced in estuarine and freshwater environments, hydrogen sulfide (H<sub>2</sub>S) gas is released. The characteristic “rotten egg” odor is used to identify the presence of reducing conditions and identify hydric soils. Sulfate reduction is generally more common in estuarine wetlands, where sulfate concentrations are greater due to marine water inputs. However, sulfur inputs in freshwater environments due to large storm overwash events (in near-coastal areas) or atmospheric deposition can also lead to sulfate reduction. When sulfate reduction is occurring in the upper 30 cm (12 in) of the Soil Profile (as detected by the presence of H<sub>2</sub>S gas) it can be used to indicate that the soil meets the requirements of a Hydric Soil and wetland hydrology.

- 1) If the Soil Pit is inundated or saturated (at any depth within the Soil Pit) select the bubble “*Inundated or saturated soil in pit*” in the Initial Readings section of the **Soil Data Form (S-1)**.
- 2) Determine if Soil Profile has an odor of H<sub>2</sub>S gas. The H<sub>2</sub>S gas will smell like rotten eggs. Do not confuse this smell with rotting organic matter. The odor will be evident upon excavation of the Soil Pit and is detectable even if the soil is not close to the nose.
- 3) If the H<sub>2</sub>S odor is present anywhere in the Soil Profile, select the bubble “*Hydrogen sulfide odor*” in the Initial Readings section of the **Soil Data Form (S-1)**.
- 4) If the H<sub>2</sub>S odor is present within the upper 30 cm of the Soil Profile also indicate that the soil meets the Hydric Soil Field Indicator A4 – Hydrogen Sulfide by selecting the appropriate bubble in the Hydric Soil Field Indicators section of the **Soil Data Form (S-1)**. This is also an Army Corps of Engineers Wetland Hydrology Indicator (Section 7.2.3). Also fill in the bubble for “*Hydrogen Sulfide Odor (C1)*” in the Hydrology Indicators section of the **AA Hydrology Form (H-1)**.

#### 6.6.2.1.2 Reduced Matrix Color

A soil with a reduced matrix has low chroma colors in situ, but changes color when exposed to air. The reduced form of iron, Fe<sup>2+</sup>, is soluble and colorless, but when exposed to the air will oxidize to the Fe<sup>3+</sup> form and precipitate. The Fe<sup>3+</sup> minerals that precipitate give the soil a redder hue or brighter chroma. Detecting this color change is a way of determining if the soil is saturated and reducing (anaerobic), and can indicate if the soil is a Hydric Soil.

- 1) If part of the soil is inundated or saturated, obtain a small clod (coherent mass of soil broken from the Soil Profile Face) of soil that has not been exposed to the air and is located towards the top of the saturated zone. Record the depth at which the sample was collected in the Initial Readings section of the **Soil Data Form (S-1)**.
- 2) Break the clod open and determine the initial color of the soil matrix (measuring soil color is described further in Section 6.6.2.10). Record the *Initial Matrix Color* (hue, value, and chroma) for the sample.
- 3) Set the clod aside while you complete the rest of the Soil Profile Description. Once the Profile Description has been completed, measure the matrix color of the same sample along the same exposed face as earlier, record this color as the *Oxidized Matrix Color*.
- 4) A rapid change in color, defined as a difference in one or more color chips in the Munsell Color Book, following exposure to air indicates a reduced matrix and the presence of reduced iron. The presence of reduced iron in the upper 30 cm of the soil surface is a USACOE Wetland Hydrology Indicator. If the color change occurs within 30 cm of the soil surface, fill in the bubble

for the hydrology indicator “*Presence of Reduced Iron (C4)*” in the Hydrology Indicators section of the **AA Hydrology Form (H-1)**. *Note, the soil may still be reduced or anaerobic even if the matrix color does not change.*

#### 6.6.2.2 Soil Pit Attributes

Complete the Soil Pit Attributes section of the **Soil Data Form (S-1)**.

- 1) Record the total depth of the soil profile that will be described and sampled. If the Soil Profile is to be described in the Soil Pit, this will be from the soil surface to the depth excavated. If the soil will be described outside of the pit, this is the length of the soil slabs or auger sections that were extracted from the pit. Record the depth in cm in the *Depth of profile description* field.

Every effort should be made to describe the Soil Profile to a depth of 125 cm. If excavation and soil descriptions could not be made to a depth of 125 cm, record the depth of the pit in the *Depth of profile description* field and select the appropriate bubble(s) to indicate why a deeper Soil Pit was not possible.

- a. If saturated or non-cohesive soils prevented further pit excavation, indicate their presence by selecting the bubble indicating such.
  - b. If an impenetrable layer prevented further pit excavation, indicate its presence and type. If an impenetrable layer other than those listed on the form was present, describe it under “Other Impenetrable Layer”.
  - c. If other conditions prevented pit excavation to 125 cm, select the bubble indicating such and describe the restrictive feature or condition in the “*Other conditions prevented sampling to 125 cm*” field.
- 2) Record the time of Soil Pit Excavation, using a 24-hour clock format in the Soil Pit Attribute section of the **Soil Data Form (S-1)**. You can tap the ‘Now’ button to populate this field or type the time directly into the field using the correct format (hh:mm).
  - 3) Use the drop-down list to indicate the prevailing lighting conditions during the Soil Profile Description in the Soil Pit Attributes section of the **Soil Data Form (S-1)**.

#### 6.6.2.3 Organic Soil Material Beyond 125cm

If the soil pit has thick organic soil material beyond 125 cm, take a meter stick or folding pole with depth markers on it and measure from the bottom of the pit to as far down as it can go before refusal, indicating mineral soil. Indicate that organic soil material extends beyond 125cm on the **Soil Data Form (S-1)** and record the depth (cm) from the soil surface.

#### 6.6.2.4 Delineating Horizon Boundaries

Understanding the general differences in major types of soil horizons can aid in distinguishing between horizons. However, soil horizon names will not be determined as part of the Soil Profile Description unless either a member of the Field Crew is a trained soil scientist or an NRCS Soil Scientist is on site (see Section 6.6.3).

Soil Horizons are distinguished based on differences in:

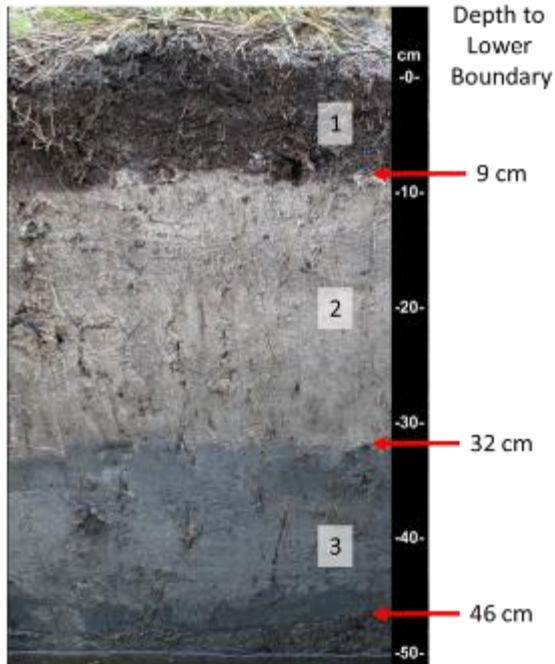
- a. Color, measured using the Munsell Color Book (Munsell Soil Color, X-Rite 2009) (Section 6.6.2.10 and **Reference Card S-3 Side B**).
- b. Texture, or the proportion of sand, silt, and clay (Section 6.6.2.7 and **Reference Card S-3 Side A**, Figure 6-14).

- c. The presence and type of redoximorphic features, includes concentrations and depletions (Section 6.6.2.11 and **Reference Card S-4 Side A**).
- d. Structure, or the arrangement and shape of soil peds and pore spaces (**Reference Card S-2 Side B**).
- e. Consistence, or how the soil holds together or its resistance to deformation or rupture (**Reference Card S-2 Side B**).
- f. The presence of rock fragments, roots, or other prominent features (Section 6.6.2.8, Section 6.6.2.9, Section 6.6.2.13, Section 6.6.2.14, and **Reference Card S-4 Side B**).

These properties are described in more detail in the designated sections and provided reference cards. Changes in any of these properties with depth distinguish different soil horizons.

Once the Soil Profile Face has been exposed, look for changes in soil properties moving vertically down the profile face or in the arranged soil slabs. It may be helpful to dig into the soil with a soil knife to identify physical changes (i.e., texture, consistence, and/or structure) or make side-by-side comparisons of hand samples to identify changes in soil color or the presence of redoximorphic or other features.

- 1) Identify all distinct horizons visible along the designated Soil Profile Face to a depth of 125 cm (or on the spatially aligned soil slabs or auger sections previously place on the plastic tarp). Place a marker (e.g., golf tee) at the bottom (lower boundary) of each horizon.
- 2) Number the horizons in order starting at the top of the profile (e.g., Horizon 1 occurs at the soil surface).
- 3) The **Soil Data Form (S-1)** has space to describe thirteen horizons.
- 4) Indicate the method of excavation (e.g., shovel, auger, King sampler) for each horizon.
- 5) Measure and record the depths from the soil surface to the lower boundary of every horizon.
  - a. Clear loose organic debris or leaf litter from the ground surface. The starting point of the depth measurement, or 0 cm, should occur below any living vegetation and loose leaf litter.
  - b. Measure the depth from the soil surface (0 cm) to the lower boundary of Horizon 1 and record in the *Depth from surface to lower boundary* field in the Horizons section of the **Soil Data Form (S-1)**. A metric fiberglass seamstress tape with a fishing weight at the bottom works well for this procedure.
  - c. Measure the depth to the lower boundary of every horizon, recording the depths on the **Soil Data Form (S-1)**. For each horizon, the depth recorded should be from the soil surface to the lower boundary of the horizon of interest (see example in Figure 6-12 and **Reference Card S-2A**).
- 6) The Soil Pit should be described to a depth of 125 cm. The lower boundary of the last horizon should be recorded as 125 cm. If the Soil Pit could not be excavated to a depth of 125 cm, record the lower boundary of the last horizon. The lower boundary depth of the last horizon should be recorded as the final pit depth in the Soil Pit Attributes section. Indicate why the Soil Pit was not described to 125 cm by selecting the appropriate bubble(s).
- 7) If an NRCS Soil Scientist is at the site (but was not involved in delineating the horizon boundaries) ask the Soil Scientist to review the boundaries before continuing with the Soil Profile Description. Adjust horizon boundaries and correct depth measurements on the **Soil Data Form (S-1)** as appropriate.



Profile Photo: USDA NRCS (2010)

**Figure 6-12. Delineating horizon boundaries. Horizons are numbered consecutively starting at the soil surface (below loose leaf litter). Depth to lower boundaries are recorded as the depth from the soil surface to the bottom of the horizon.**

**For example, this profile has 3 horizons:**

- **Horizon 1 is 9 cm thick with the upper boundary at 0 cm and the lower boundary at 9 cm. The Depth to Lower Boundary would be recorded as 9 cm.**
- **Horizon 2 is 23 cm thick with the upper boundary at 9 cm and the lower boundary at 32 cm. The Depth to Lower Boundary would be recorded as 32 cm.**
- **Horizon 3 is 14 cm thick with the upper boundary at 32 cm and the lower boundary at 46 cm. The Depth to Lower Boundary would be recorded as 46 cm.**

#### 6.6.2.5 Photograph of Soil Profile Face

Photographs of the Soil Profile Face will be used by NRCS Soil Scientists to review the Soil Profile Description and name soil horizons if a Quality Assurance check cannot be performed in the field (i.e., NRCS Soil Scientists are not present at the site). Additionally, photographs can be helpful if questions arise during later soil data analyses. If a NRCS Soil Scientist is present at the site, the Quality Assurance checks will be performed in the field. In either case, a photograph of the Soil Profile Face should be taken at every site (see 8.7 Appendix D for more information on taking photographs for NWCA 2021).

After the horizon boundaries have been determined and the boundary depths have been measured and recorded, take a photograph of the Soil Profile Face that will be described (either in or outside of the Soil Pit). The Soil Profile Photo should clearly show the soil horizon and depth assignments made by the NWCA Field Crew. The golf tees or nails used to mark horizon boundaries should be left in place for the photograph. Photographs should be taken before continuing with the Soil Profile Description or collecting Soil Horizon Samples.

- 1) Prepare the Soil Profile Face to bring out significant contrasts in structure and color between soil horizons.
  - a. Beginning at the top, fragments of the soil can be broken off with a spatula or small knife to eliminate digging marks. Dust or small fragments can be brushed or blown away.
  - b. Moisten the profile (if dry) with a hand sprayer to obtain uniform moisture content and color contrast.
- 2) Place a tape measure so that the 0 cm mark is at the soil surface (below living vegetation and loose leaf litter or duff layer) and the tape extends to the base of the Soil Pit. If the Soil Profile will be described outside of the pit, lay the tape alongside the oriented soil slabs.

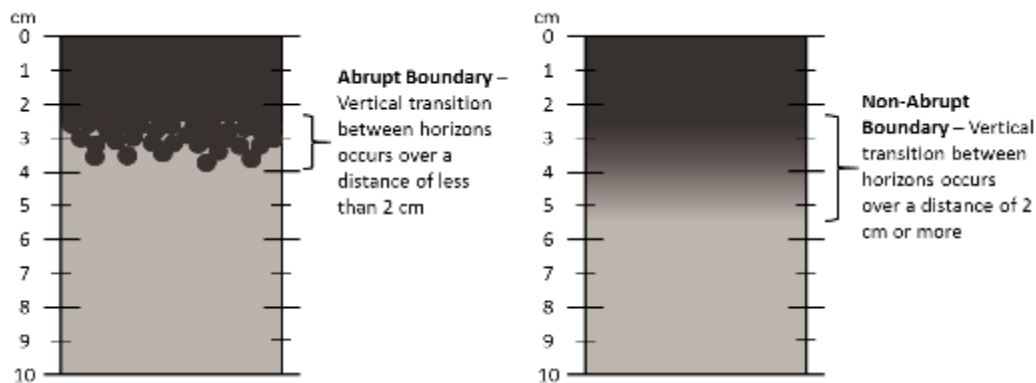


- 3) Take a photo that shows the entire Soil Profile to be described. The camera should be held 1.5 to 2.5 m from the Soil Profile Face.
- 4) Take additional photos focused on smaller sections of the profile to show soil features in more detail (e.g., 0-20 cm, 20-40 cm, etc.). Taking pictures of smaller areas will allow Soil Scientists performing the QA to see concentrations or other features in better detail. Many important soil features are too small to see in the photograph of the full profile, yet are important for making soil interpretations. Make sure the measuring tape is visible in the photo, so the depth and scale can be easily determined.
- 5) Try to orient the profile so that the maximum amount of light is striking the prepared face. If the lighting is uneven or shadows fall on part of the face, attempt to create a shadow over the Soil Profile Face (e.g., using a tarp) so the lighting will be even and color contrast most apparent. Take pictures with and without the flash to best display soil colors and features.
- 6) If the Soil Profile will be described outside of the pit using arranged soil slabs and/or auger borings on a snow sled or plastic sheet, the profile can be moved to an area with uniform lighting (e.g., full sun or full shade) to improve the quality of the picture.

See 8.7 Appendix D for instructions for naming, logging, and submitting site photos.

#### 6.6.2.6 Description of Horizon Boundaries

The vertical change in soil properties between two horizons can occur gradually, with one horizon blending into the next, or can appear very sharp with very little transition between the two (see Figure 6-13 and **Reference Card S-2A**). The vertical transition from one horizon to the next is a function of the processes and conditions (both natural and anthropogenic) that affect the soil. Boundary distinctness describes how quickly soil properties change from one horizon to the next (lower) horizon. Abrupt boundaries (where properties change over a depth of less than 2 cm) can sometimes be an indication of a disturbance either natural, such as sedimentation or flood deposition, or anthropogenic such as filling or plowing activities. Descriptions of the horizon boundaries will be used to identify potential stressors to the wetland, occurring presently or in the past.



**Figure 6-13. Horizon boundary distinctness. The vertical change in soil properties between two horizons are characterized as abrupt if the transition occurs over a distance of less than 2 cm.**

- 1) For each lower horizon boundary, determine if the boundary is abrupt, meaning the transition or change from the upper horizon to the lower horizon occurs over a distance of less than 2 cm (0.8 in).

- 2) Indicate abrupt lower horizon boundaries by selecting the bubble in the *Abrupt lower boundary* bubble in the Horizons field of the **Soil Data Form (S-1)**.

#### 6.6.2.7 Soil Texture

Soils vary in the proportion of organic and mineral material they contain. Mineral soils are dominated by inorganic mineral materials. Organic soils have greater than 12 to 18% organic carbon, depending on clay mineral content. Mucky mineral soils are a mineral soil horizon with organic matter contents intermediate between organic and mineral soil materials (usually between 5 and 18% organic carbon, depending on clay content).

Organic soils can be further described and distinguished by the degree of decomposition, and mineral soils are further classified by the distribution of the sizes (diameters) of mineral grains, or the soil texture. Distinguishing between organic and mineral horizons and noting the changes in soil texture can help identify horizons and explain soil processes occurring within the soil. Soil texture influences a number of functions performed by soils, including water and nutrient holding capacity, and are used in evaluating the ability of a soil to perform wetland functions. Soil texture is particularly important in wetland studies and delineation, as a number of Hydric Soil Field Indicators have been developed for use in specific soil textures (Section 6.6.2.15).

For the NWCA, soils will be textured by hand to determine if they are organic or mineral. Organic soils will be further described as Peat, Mucky Peat, or Muck depending on the degree of decomposition. Mineral soils will be described as Sandy, Loamy/Clayey, Mucky Sandy, or Mucky Loamy/Clayey (see **Reference Card S-3 Side A**).

Texture will be recorded in the *Soil Texture* field in the Horizons section of the **Soil Data Form (S-1)** by selecting the appropriate bubble choosing an additional selection from the drop-down menu. Only one soil texture should be recorded for each horizon.

- 1) Determine if the soil is organic or mineral. Take a golf ball sized chunk of moist soil and gently rub it between the forefingers and thumb several times.
  - If the soil feels greasy, you can discern visible organic particles, it is very light (low bulk density) compared to equal amounts of mineral soil, and you can feel or see little to no mineral particles (grittiness of sand grains, silt coating on hands, stickiness of clay particles) the soil is an organic soil; proceed to Section 6.6.2.7.1.
  - Otherwise, the soil is a mineral soil; proceed to Section 6.6.2.7.2.

##### 6.6.2.7.1 Texturing Organic Soils

- 1) Rub a golf ball sized chunk of moist soil between your finger and thumb.
  - Organic Soil Material – Mineral grains are not visible and cannot be felt when the sample is rubbed. Organic soil material has a low bulk density and will feel lighter than mucky mineral or mineral soils. When squeezed, the soil will extrude liquid or much of the soil material, and the remaining soil material will not stick to the hand. Identifiable plant fibers may be common. If the soil is organic, select the Organic bubble in the *Soil Texture* field of the Horizons section of the **Soil Data Form (S-1)** and continue to Step 2 to further classify the type of organic soil material.
- 2) Organic soil materials are described as being Peat, Mucky Peat, or Muck. These three categories are defined based on the degree of decomposition, which is measured by the volume of plant fibers visible after rubbing the sample.
- 3) To determine the type of organic soil material, take a fresh golf ball sized sample of moist soil

and rub the sample between the thumb and fingers 10 times. Visually estimate the percent volume of plant fibers and dead roots remaining after rubbing. Use the chart below to determine the type of organic soil material. Indicate the organic soil type by selecting from the drop-down menu in the *Soil Texture* field of the Horizons section on the **Soil Data Form (S-1)**. Note that the menu selections vary based on the soil texture chosen.

Organic Soil Material	Volume of Fibers Visible After Rubbing
Peat	> 75%
Mucky Peat	17% - 75%
Muck	< 17%

#### 6.6.2.7.2 Texturing Mineral Soils

Mineral soil textural classes are distinguished based on the relative proportion (by weight) of sand, silt, and clay particles. Rock (coarse) fragments, gravels or rocks greater than 2 mm in diameter, are not included when determining the textural class. For the NWCA, mineral soils will be described as Sandy, Mucky Sandy, Loamy/Clayey, or Mucky Loamy Clayey. These designations will be used to determine the appropriate Hydric Soil Field Indicators to consider for the soil (Section 6.6.2.15).

For soils that are mineral, use Figure 6-14 as a guide to determining if the soil is Sandy (includes sand and sandy soils) or Loamy/Clayey. Record the mineral soil type by selecting from the drop-down menu in the *Soil Texture* field of the Horizons section on the **Soil Data Form (S-1)**. Note that the menu selections vary based on the soil texture chosen.

#### 6.6.2.7.3 Identifying Mucky Sandy and Mucky Loamy/Clayey

Once you determine if the soil is sandy or loamy/clayey if the soil is very dark, almost black in color, greasy or spongy feeling staining your fingers black, and feels lighter than equal amounts of mineral material containing less organic matter you would use a mucky modifier. Organic matter content will be between 5 and 18 percent organic carbon depending on texture. If the soil is sandy then you would select mucky sandy and if it is loamy/clayey you would select mucky loamy/clayey from the drop down menu.

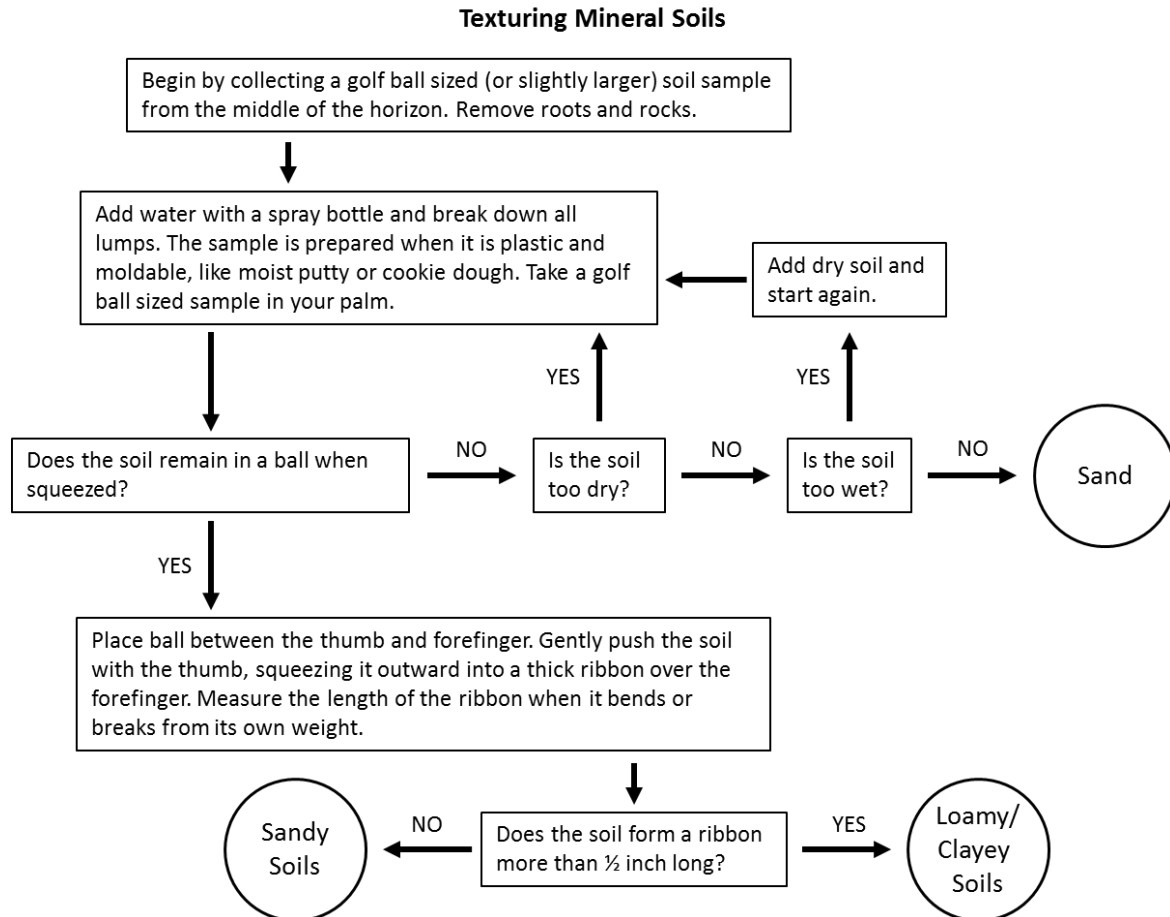


Figure 6-14. Texturing mineral soils.

#### 6.6.2.8 Estimating Rock Fragments

- 1) Examine an area of the horizon (approximately 10 cm<sup>2</sup>) and estimate the surface area of the Soil Profile Face within that horizon occupied by rocks greater than 2 mm in diameter. Use the surface area estimation examples on **Reference Card S-2, Side B** as a guide to estimating surface area.
  - a. Note that the sample area coverage can look different depending on if the rocks are dispersed or aggregated.
  - b. Do not deliberate extensively over surface area estimates. Small differences (such as 1% vs. 3%, 5% vs. 10%, 25 vs. 35%, or 75 vs. 85%) are more precise than can accurately be determined by a visual estimate.
- 2) Record the percentage of rocks in the % *Rock Fragments* field in the Horizons section of the **Soil Data Form (S-1)**. Estimate the percent rocks for every horizon. If there are no rocks present in the horizon, record "0" in the % *Rock Fragments* field.

#### 6.6.2.9 Estimating Roots

- 1) Following the same procedure as given above for estimating rock fragments (Section 6.6.2.8) estimate the surface area of each horizon occupied by roots. Use the surface area estimation examples on **Reference Card S-2, Side B** as a guide to estimating root area coverage.
- 2) Record the areal coverage of roots in the % *Roots* field in the Horizons section of the **Soil Data**

**Form (S-1).** If there are no roots present in the horizon, record "0" in the % *Roots* field.

#### 6.6.2.10 Soil Matrix Color

Soil color can provide important information on hydrology, soil parent materials, weathering processes, and organic carbon content. In soil science, the Munsell Color System is used to describe colors in a standardized, reproducible format. The Munsell Color Book (Munsell Color X-Rite 2009) contains charts of color chips, which are used to determine soil color in the field. The Munsell Color System has three components, hue, value, and chroma. These are written using a standardized notation, for example, 10YR 4/2, where 10YR is the hue, 4 is the value, and 2 is the chroma (Figure 6-15 and **Reference Card S-3, Side B**).

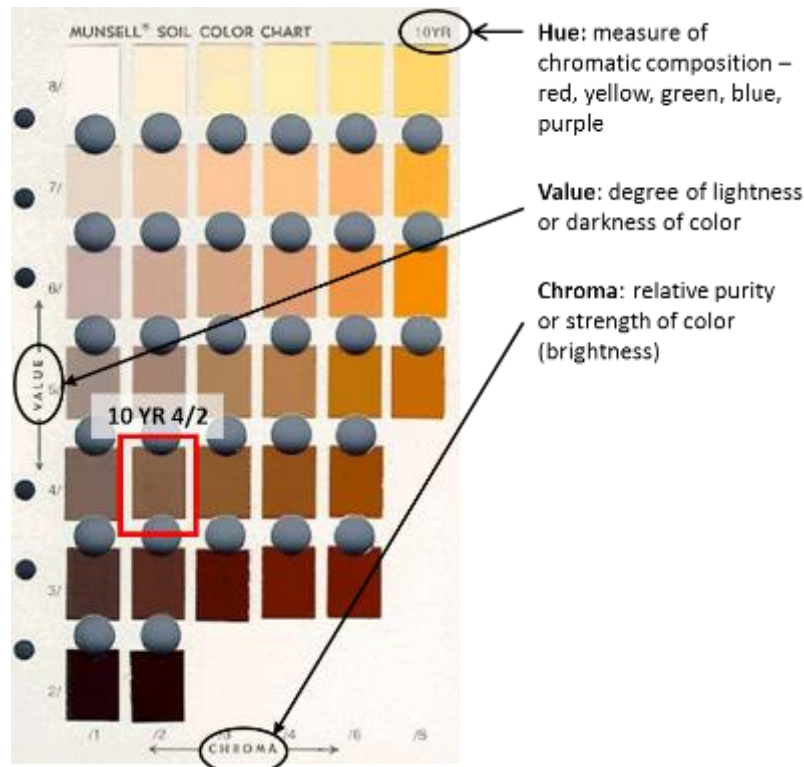
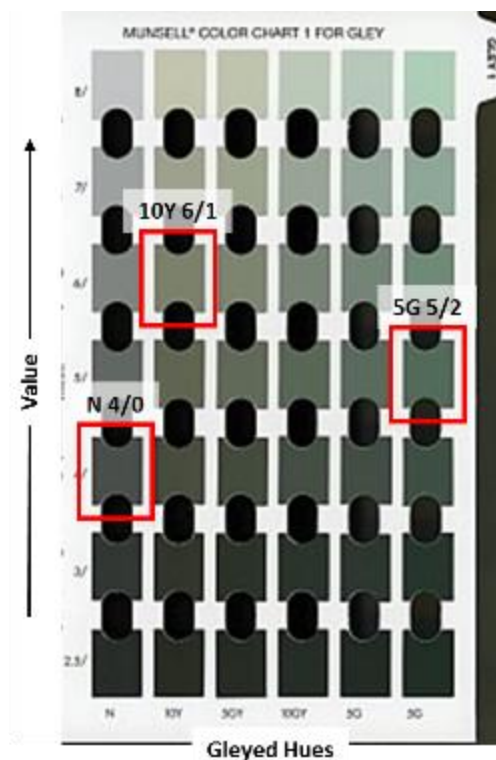


Figure 6-15. Interpreting color using a Munsell Color Chart. This figure is provided only as an example, and should not be used for measuring soil color in the field.

- Hue describes the chromatic composition of the color (the amount of red, yellow, green, blue, or purple). Soil hues are generally combinations of red and yellow (YR). The Munsell color charts are organized from reddest to red-yellow mixes, to yellowest (10R, 2.5YR, 5YR, 7.5YR, 10YR, 2.5Y, and 5Y), with the chips of each hue occupying a single page. The hue for the page is shown at the top left corner of the page.
- Value describes how light or dark a color appears. Low value colors are dark, where high value colors are light. In the Munsell Color Book, value is shown on the left side of the page, with each row of chips decreasing in value moving down the page.
- Chroma describes the richness of pigmentation or concentration of hue. It is also sometimes described as the brightness. High chroma colors are highly pigmented, where low chroma colors are dull and grayish, lacking pigmentation. Chroma is shown at the bottom of the page; chroma increases from left to right across the page.

Gleyed colors are those with neutral hues (N), hues yellower than 5Y, green (G), blue (B), or purple (P). These colors are most commonly found in soils that are saturated and reduced for long periods of time, such as some hydric soils. These colors are found on the gley pages of the Munsell Color Book and are organized differently than the red and yellow hue pages (see examples in Figure 6-16).



**Figure 6-16. Example of a gley page. Differences in color chip arrangement are described in the text. This figure is provided only as an example, and should not be used for measuring soil color in the field.**

- Hues are organized in columns, which are listed at the bottom of the page.
- Values are listed on the left side of the page, decreasing in value (darker) in rows going down the page.
- Soils with neutral hues (N) have a chroma of 0.
- For all other gleyed hues (10Y, 5GY, 10GY, 5G, 10G, 5BG, 5B, 10B, 5PB) the chroma is 1 for the

first column and the chroma is 2 for the second column of the hue (5G is the only hue in on the gleyed pages to have a chroma of 2).

For each horizon, determine the matrix color (the dominant soil color), and record each of the components (hue, value, and chroma) in the *Soil Matrix Color* field in the Horizons section of the **Soil Data Form (S-1)**.

- 1) The soil matrix color should represent the dominant color across the horizon. A horizon might have multiple colors or contrasting colored features. The soil matrix color should constitute the greatest proportion of the horizon.
- 2) Choose a representative clod and break it open to reveal a freshly exposed surface. Identify the dominant matrix color.
- 3) If the soil is dry, use a spray bottle to moisten the fresh surface of the clod. Spray until moist, but not saturated. If the soil is glistening, it is too wet. As soon as the water is absorbed into the soil, read the color from the Munsell Soil Color Book (Munsell Soil Color X-Rite 2009).
- 4) Observe the soil color in direct sunlight with the sun over the shoulder (whenever possible). Match the color of the soil with the closest color chip in the Munsell Soil Color Book. The soil color will rarely match the color chip exactly, but find the closest match.
  - a. Start at the 10YR page. Hues will be progressively redder moving towards the front of the book, and will get yellower and greyer towards the back of the book.
  - b. The color chips in the Munsell Book have central holes, so that the soil can be placed behind the page and viewed through the hole next to the chip of interest.
  - c. Take care to keep the color chips clean and dry. When not using the book, keep it closed and out of the sun, which can cause the chips to fade.

#### 6.6.2.11 Redoximorphic Features

Redoximorphic (redox) features are color patterns that differ from the soil matrix color (the dominant color) and are formed as iron (Fe) and/or manganese (Mn) are distributed as a result of reduction and oxidation processes associated with wetting and drying cycles in soils (Vepraskas 2001, USDA NRCS 2010). Redox features include both concentrations and depletions (defined below). These features can provide important information on hydrology, including average water table depths, fluctuations in water tables, and frequency and duration of saturation within a horizon, as well as provide insight into how water moves through the soil profile and across the landscape. Identification of redox features is also critical to determining if the soil meets a Hydric Soil Field Indicator (USDA NRCS 2010).

Two types of redoximorphic features will be described for NWCA: concentrations and depletions. In all horizons where redoximorphic features are present, the type, amount, and color of the feature(s) will be recorded in the *Redoximorphic Features* fields of the Horizons section of the **Soil Data Form (S-1)**.

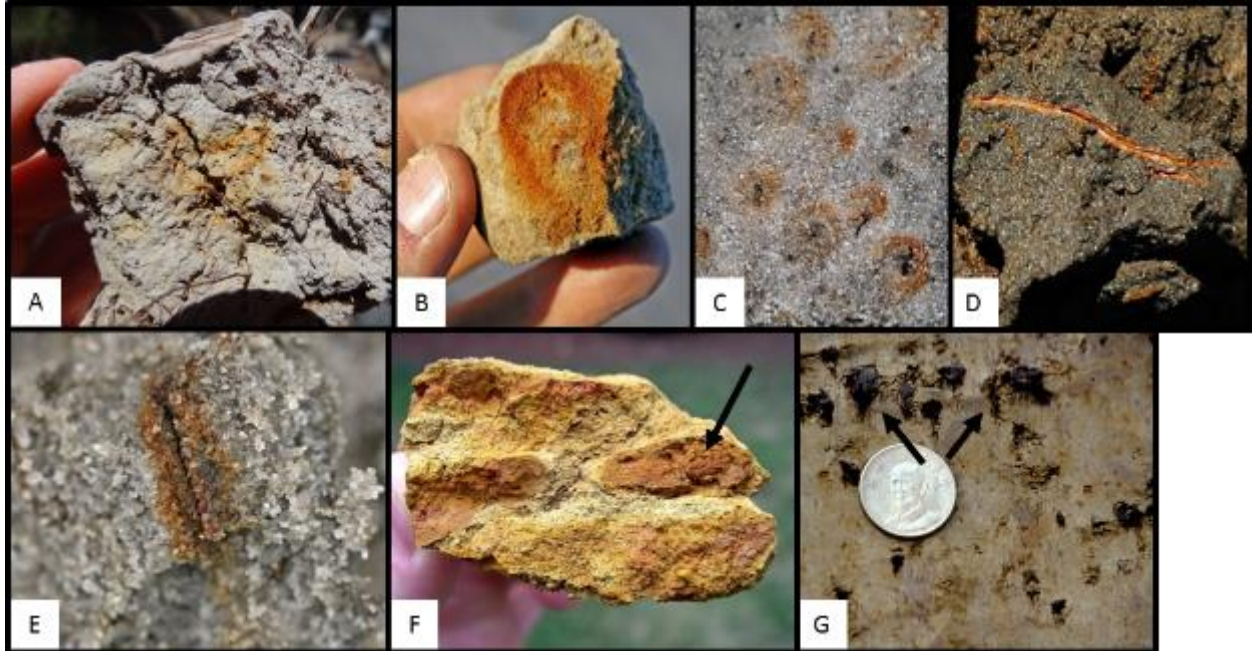
##### 6.6.2.11.1 Concentrations

Concentrations are an accumulation of Fe or Mn oxide minerals that form as the soil is oxidized (dries). Often concentrations are a combination of Fe and Mn oxide minerals and are recognized by redder hues and higher chromas relative to the soil matrix color. Concentrations of Mn oxides alone are black in color and usually occur as hard nodules or concretions. Concentrations can occur in different shapes, sizes, and forms, and will be described using three classes: soft masses, pore linings and ped faces, or nodules or concretions (Figure 6-17 and **Reference Card S-4 Side A**).

- Soft Masses – non-cemented bodies of Fe and Mn oxides, can be easily crushed.



- Nodules or Concretions – cemented bodies of Fe and Mn oxides, can be removed as discrete units from the soil.
- Pore linings and ped faces – occur along and follow root channels, cracks, or pores in the soil, or occur along the faces of soil peds.



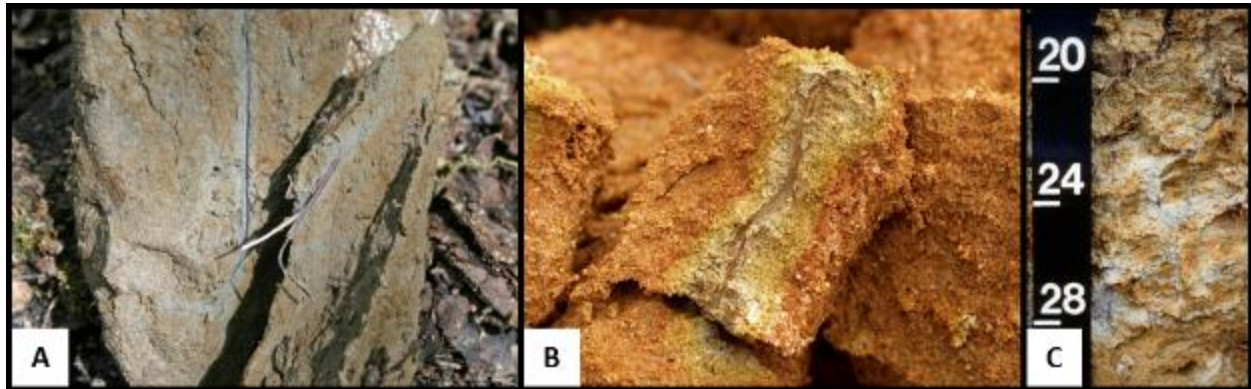
**Figure 6-17. Redoximorphic concentrations. A) Redox concentrations occurring as soft masses and pore linings. Photo by Ann Rossi. B and C) Redox concentrations occurring as soft masses. Photos courtesy of USDA NRCS. D and E) Redox concentrations occurring as pore linings. Photos courtesy of USDA NRCS. F) Iron nodules (indicated by arrow). Photo by John Kelley, USDA NRCS. G) Manganese concretions. Photo courtesy of USDA NRCS.**

Describe any concentrations present in the horizon by selecting the appropriate bubble(s) in the *Concentrations* field in the Horizons section of the **Soil Data Form (S-1)**.

- 1) Indicate all concentration types present in the horizon, Soft Masses, Nodules or Concretions, and/or Pore Linings or Ped Faces, by selecting the appropriate bubble(s).
- 2) Determine the percent area of all concentrations in the horizon, and record in the % *Concentrations* field. Use the surface area estimation examples on **Reference Card S-2, Side B** as a guide. The percent area should be the total of all types and colors of concentrations present in the horizon.
- 3) Determine the color of the concentrations using the Munsell Color Book and following the guidelines for measuring soil color in Section 6.6.2.10 and record the hue, value, and chroma. If multiple colors are observed, select the dominant concentration color to report.
- 4) If there are no concentrations present in the horizon, record “0” for the percent area. Bubbles for the concentration types and fields for the dominant color should be left blank in this case.

#### 6.6.2.11.2 Depletions

Depletions are localized zones where Fe or Mn oxide minerals have been reduced, solubilized, and leached while the soil was saturated. These areas have lost pigmentation and are greyer, lighter in color (higher value), less red, or have a lower chroma than the soil matrix (Figure 6-18 and **Reference Card S-4**



**Figure 6-18. Redoximorphic Depletions.** A) Depletion occurring along root channel. Photo courtesy of USDA NRCS. B) Depletion along root channel. Photo by John Kelley, USDA NRCS. C) Depletions (gray zones) in an oxidized soil matrix (red areas). Photo courtesy of USDA NRCS.

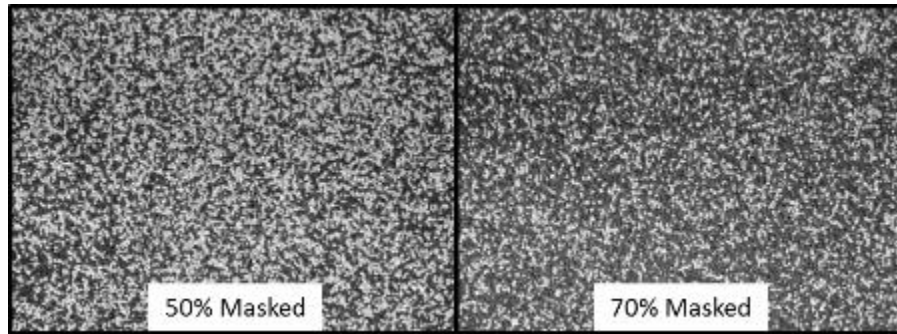
**Side A).**

Note depletions in the horizon in the row for *Depletions* in the Soil Profile Description section of **Form S-1 (Front)**.

- 1) Determine the percent area of depletions in the horizon, and record in the field for % Depletions. Use the surface area estimation examples on **Reference Card S-2 Side A** as a guide.
- 2) Determine the color of the depletions using the Munsell Color Book and following the guidelines for measuring soil color in **Section 6.6.2.10**, and record the hue, value, and chroma. If multiple colors are observed, select the dominant depletion color to report.
- 3) If there are no depletions present in the horizon, record “0” for the percent area. Fields for the dominant color should be left blank.

#### **6.6.2.12 Masked Sand Grains**

The occurrence of saturated and reducing conditions often causes an accumulation of organic matter, which gives the soil a dark, black pigment. In sandy soils, organic matter coats or masks the sand grains (Figure 6-19 and **Reference Card S-4, Side B**). The degree of masking (grain surface area coverage) in sand grains is a component of some of the Hydric Soil Field Indicators that can be used for determining if a sandy soil is hydric. Depending on the degree of masking, soils will have a salt and pepper appearance to looking almost completely black. A hand lens may be useful for getting a closer look at coatings on the sand grains.



**Figure 6-19. Organic masked sand grains, showing different proportions of masking. Photos courtesy of Martin Rabenhorst, University of Maryland.**

The percentage of masked sand grains should be estimated only for soils that have a sandy texture.

- 1) If the horizon has a sandy texture, estimate the percentage of mineral grains that are masked by organic matter, and record the value in the *% Masked Sand Grains* field in the Horizons section of the **Soil Data Form (S-1)**. If no masking is present enter 0.
  - a. If more than 70% of sand grains are masked, it should look nearly 100% black to the naked eye when the soil is moist. Under a 10x hand lens, less than 30% of the sand grains should appear uncoated (usually lighter in color).
- 2) If the soil has a loamy/clayey or mucky loamy/clayey texture, or is organic, leave the *% Masked Sand Grains* field blank.

#### 6.6.2.13 Organic Features

Organic features in the soil profile and the properties of those features can be related to a number of factors. Organic matter tends to give the soil a dark, black color. High amounts of organic carbon can give the soil a greasy feel or lower the density of the soil. Organic matter tends to accumulate at the soil surface resulting in darker colors and higher organic matter contents in horizons closest to the soil surface. In addition to organic matter enriched horizons, other organic features can be found in soils (Figure 6-20). Some of these features are indicative of hydric soil conditions.



**Figure 6-20. Examples of organic features in soils. A) Organic bodies. B) Stripped Matrix. C) Organic infillings (indicated by arrows). Photos courtesy of USDA NRCS.**



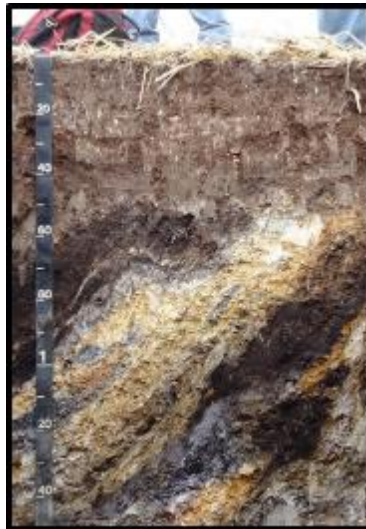
For each horizon, record the presence of all organic features observed in the horizon in the *Organic Features Present* field in the Horizons section of the **Soil Data Form (S-1)** by filling in the appropriate bubble(s). If there are no organic features present in the horizon, these bubbles should be left blank.

- Organic Bodies are aggregates of organic material with muck or mucky mineral textures. They typically occur at the tips of roots and are commonly 1 to 3 cm in diameter. Organic accumulations made up of less decomposed organic material, such as mucky peat, peat, or partially decomposed root tissue, are not considered Organic Bodies. The presence of Organic Bodies is a Hydric Soil Field Indicator in certain regions (see Section 6.6.2.15).
- Stripped Matrix is a zone where iron (Fe) and manganese (Mn) oxides and/or organic matter have been stripped from the matrix and the primary base color of the soil material is exposed. The stripped zone and the translocated oxides and organic matter form a contrasting pattern of two or more colors with diffuse boundaries (USDA NRCS 2010). In many regions of the US, a stripped matrix in a sandy soil is a Hydric Soil Field Indicator (see Section 6.6.2.15).
- Organic Infillings are accumulations of organic material in pores, root channels, or soil cracks. This can occur when dead roots decompose in a root channel, or when organic material from the soil surface fills in an animal burrow.

#### 6.6.2.14 Mottles (Non-Redoximorphic)

Mottles are areas or splotches of color in the soil that differ from the soil matrix color and are unrelated to saturated or reducing conditions. They typically have a geologic origin, reflecting the soil parent material (Figure 6-21 and **Reference Card S-4, Side B**).

If mottles are observed in the horizon, select the *Mottles Present* bubble on the **Soil Data Form (S-1)** to indicate their presence in the horizon. If there are no mottles present in the horizon, the bubble should be left blank.



**Figure 6-21.** Example of mottles in a soil profile. Photo by Ann Rossi.

#### 6.6.2.15 Identification of Hydric Soil Field Indicators

The Hydric Soil Field Indicators were developed to identify and delineate hydric soils in the field without the need for long term monitoring. The Indicators are based on soil morphological features that form as a result of the soil being saturated and anaerobic for periods long enough and frequently enough to meet the definition of a hydric soil. The Hydric Soil Field Indicators have been approved by the National Technical Committee for Hydric Soils and the NRCS, and are described in *Field Indicators of Hydric Soils in the United States, Version 8.2* (USDA NRCS 2019). This manual (and errata, available online, <http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/use/hydric/>) will be used to determine if the soil described in the Soil Plot is a hydric soil.

- a. Hydric Soil Field Indicators are regionally specific. Field Indicators are designed for use in specific USDA Land Resource Regions (LRR).
- b. A map illustrating LRRs across the country and a list of Hydric Soil Field Indicators applicable to each LRR are provided in the *Field Indicators of Hydric Soils in the United States, Version 8.2* (USDA NRCS 2018).
- c. The LRR and Major Land Resource Area (MLRA) for each site can be found in the Site Information Packet. The LRR will be pre-populated at the top of the Hydric Soil Field Indicators section of the **Soil Data Form (S-1)**.
- d. Reference cards have been provided for each LRR (**Reference Cards S-6A – S-6U**). These reference cards list the Hydric Soil Field Indicators accepted for use in that specific LRR and an abbreviated description of each indicator.
- e. Hydric Soil Field Indicators are texture specific. Different indicators apply to different soil textures (USDA NRCS 2010).
  - The “All Soils” Indicators (A) are applicable to all soils, regardless of texture.
  - The “Sandy Soils” Indicators (S) are used for soils with sand or sandy textures. For NWCA, these are soils determined to have “Sandy” texture (see **Section 6.6.2.7**).
  - The “Loamy and Clayey Soils” Indicators (F) are used for soils with finer textures. For NWCA, these are soils determined to have “Loamy/Clayey” texture (see **Section 6.6.2.7**).
- f. Hydric Soil Field Indicators names have two parts, an alpha-numeric code (e.g., A2, S7, F12, etc.) where A, S, and F refer to the texture group and the number refers to a specific indicator in that group, and a descriptive label (e.g., Histic Epipedon, Dark Surface, Iron-Manganese Masses, etc.). The description of the Field Indicator gives the LRRs where the Hydric Soil Field Indicator is approved for use and the morphologic characteristics required to meet the Indicator.
- g. The Field Indicators were designed to rapidly determine if a soil is hydric for the purposes of wetland delineation. However, there are instances where a hydric soil does not meet a Hydric Soil Field Indicator. For example, since the Field Indicators are primarily used for determining wetland boundaries, **sometimes hydric soils in the interior of a wetland do not meet an indicator** (USDA NRCS 2018). Additionally, some types of soils do not develop the morphological features generally associated with wetness despite being hydric, potentially due to parent material, landscape conditions, natural or anthropogenic disturbances, or other factors (Hurt and Carlisle 2001).

After the Soil Profile Description has been completed, use the profile description and the *Field Indicators of Hydric Soils in the United States, Version 8.2* (USDA NRCS 2018) to determine if the soil meets a Hydric Soil Field Indicator.

- 1) Determine which set of Field Indicators (A, S, and/or F) are appropriate for the soil, given the LRR noted on the form and texture determinations made during the Soil Profile Description (**Section 6.6.2.7**).
- 2) Evaluate the Soil Profile for all regionally and soil texture class appropriate Hydric Soil Field Indicators, referring to the *Field Indicators of Hydric Soils in the United States, Version 8.2* (USDA NRCS 2018), **Reference Card S-6**, and the information on soil texture, color, and redoximorphic features collected during the Soil Profile Description.
- 3) Record the presence of any and all Hydric Soil Field Indicators in the Hydric Soil Field Indicators section of the **Soil Data Form (S-1)** by selecting the appropriate bubble(s).
- 4) If the soil does not meet a Hydric Soil Field Indicator, select the *No Hydric Indicators Observed* bubble. If the crew can determine why a Field Indicator may not have been observed (e.g., interior wetland position with no appropriate Hydric Soil Field Indicator, or soil does not appear to actually be a Hydric Soil), this should be noted in the comment bubble for this section of the **Soil Data Form (S-1)**.
- 5) If something unusual is observed (e.g., soil appears to be hydric but does not meet all of the criteria of a Hydric Soil Field Indicator or it cannot accurately be determined if the soil meets all the criteria of an indicator), note the depths or soil horizon number(s) and describe the anomaly in the comment bubble for this section of the **Soil Data Form (S-1)**.

### 6.6.3 Review of Soil Profile Description and Designation of Horizon Names

Before collecting Soil Horizon Samples, review the Horizons section of the **Soil Data Form (S-1)** to ensure that all necessary data has been collected. Complete the Soil Plot Sampling Information section of the **Soil Data Form (S-1)**.

- 1) If an NRCS Soil Scientist is at the site, they will assign horizon names, recording them in the *Horizon Name* field of the Horizon section of the **Soil Data Form (S-1)**. They will also review the Soil Profile Description and verify Hydric Soil Field Indicators, making any changes or additional comments as necessary. This will serve as a Quality Assurance check of the field activities of the Soil Protocol.
  - a. In the *Review of Soil Profile and Designation of Horizon Names* field in the Soil Plot Sampling Information section of the **Soil Data Form (S-1)**, select the bubble indicating that a review of the soil profile and designation of horizon names was conducted "Onsite by NRCS Soil Scientist". Record the name(s) of the NRCS Soil Scientist(s) in the space provided.
- 2) If the site is not being sampled in coordination with NRCS, the Quality Assurance checks will be performed at a later time using the data collected on the **Soil Data Form (S-1)** and the Soil Profile Photo. The NWCA Field Crew does not need to assign horizon names, and the *Horizon Name* fields can be left blank.
  - a. If a member of the NWCA Field Crew is a certified professional soil scientist, they should assign horizon names, using NRCS conventions described in *Field Book for Describing and Sampling Soils, Version 3.0* (Schoeneberger et al. 2012). Select the bubble indicating that the horizon names were assigned "Onsite by a certified professional soil scientist". Record the name of the soil scientist in the space provided.

### 6.6.4 Collection of Soil Horizon Samples

Soil Horizon Samples are collected from the Soil Pit after the Soil Profile Face has been photographed and described. Two types of soil samples will be collected, Horizon Bulk Density Samples and Horizon Chemistry Samples.

#### 6.6.4.1 Horizon Bulk Density Samples

Horizon Bulk Density samples are collected for the determination of soil bulk density, the mass per unit volume of soil. This measurement is used to characterize physical aspects of the soil (e.g., porosity, infiltration, and water holding capacity) and for the conversion of soil chemistry data (e.g., concentration as a percentage to a volume basis). A known volume of uncompacted soil is necessary for determining bulk density. Horizon Bulk Density samples will be collected for **all horizons greater than or equal to 8 cm thick to a depth of 125 cm**.

### 6.6.5 Preparation of Labels, Tags and Sample Collection Bags

For each horizon to be sampled, fill out the Soil Horizon Bulk Density (SHBD) Labels and Tags. Three sets of labels and tags will be needed for each horizon greater than 8 cm thick from 0 to 125 cm. As you collect samples, be sure to correctly match the tag and label for each sample. Each individual Soil Horizon Bulk Density sample will be put in a separate, labeled, 8-mil thick plastic sample bag. These bags are durable, and when properly folded and stapled retain the field state moisture content of the soil sample. It is critical to sample integrity to make sure the seal is properly executed.

- 1) Soil Horizon Bulk Density (SHBD) Sample Label (Figure 6-22) – for each horizon to be sampled, complete the adhesive sample labels with the Site ID, Visit #, Date, Horizon #, and Bulk Density sample number (BD1, BD2, or BD3).
  - a. Visit #1 corresponds to the primary sampling visit; Visit #2 is the second sampling or revisit.
  - b. The Horizon # should correspond to the row of data in the Horizons section of the **Soil Data Form (S-1)**. There should be a BD1, BD2, and BD3 sample for each sampled horizon.
  - c. Affix the completed sample label to the outside of an 8-mil thick plastic soil sample bag. Cover the entire label with clear tape to protect it from moisture and mud.

<b>SOIL HORIZON BULK DENSITY (SHBD)</b>	
Site ID: NWC21-_____	
Date: ____/____/20____	Visit #: <input type="radio"/> 1 <input type="radio"/> 2
Horizon #: _____	<input type="radio"/> BD1 <input type="radio"/> BD2 <input type="radio"/> BD3
T3	<b>990006</b>

Figure 6-22. Soil Horizon Bulk Density sample label.

- 2) Soil Horizon Bulk Density Samples Tag (Figure 6-23) – for each horizon to be sampled, complete the sample tags (printed on waterproof paper). Keep in mind that there should be three bulk density samples for each horizon (BD1, BD2, and BD3). Note that a blank soil horizon sample tag can be used for either chemistry or bulk density samples. The tags are printed with the same data fields and crews will only need to fill out the portions of the tag that pertain to the specific sample type.



- a. Fill in the Site ID, Date, Visit #, Horizon #, and Horizon Depths. Make sure that all information recorded matches the sample label and the **Soil Data Form (S-1)**.
- b. Fill in the bubble indicating Soil Horizon Bulk Density Sample, and record the Sample ID and bulk density sample number (from sample label).

NWCA 2021: Soil Horizon Chemistry or Soil Horizon Bulk Density Samples Tag		
<b>Staple under sample bag fold</b>	Site ID: NWC21-_____ Date: __/__/20__ Visit #: <input type="radio"/> 1 <input type="radio"/> 2	
	Horizon #: _____ Horizon Depth: _____ cm to _____ cm	
	Indicate <u>either</u> Chemistry or ONE of the Bulk Density Samples below	
	<input type="radio"/> SOIL HORIZON CHEMISTRY (SHCH) Sample ID: _____ For horizon chemistry samples, rocks in the soil should be retained in the sample; however, if they must be removed, record the estimated volume of the sample they comprised. _____ % Sample Volume Comprised by Removed Rock	
	<input type="radio"/> SOIL HORIZON BULK DENSITY (SHBD) Sample ID: _____  <input type="radio"/> Bulk Density #1 <input type="radio"/> Bulk Density #2 <input type="radio"/> Bulk Density #3  For bulk density samples, indicate whether the standard corer was used <b>OR</b> a block of soil was collected.	
<input type="radio"/> Standard Core For samples collected using the standard corer, indicate the length of the core collected (should be 10 cm whenever possible). Core Length: _____ cm	<b>-OR-</b>	<input type="radio"/> Block For blocks of soil, indicate the dimensions of the block in cm and calculate and record the volume of the block (LxWxH) in cm <sup>3</sup> . Length: _____ cm Width: _____ cm                      Volume: Height: _____ cm                      _____ cm <sup>3</sup>

**Figure 6-23. Soil Horizon Chemistry or Bulk Density sample tag.**

- 3) Record the Water Chemistry Sample ID number from the label sheet in the *Anchor ID/Water Chem ID* field of the **Tracking Form** in the App. Doing so will automatically populate the sample IDs in the *Sampling Information* section at the bottom of the **Soil Data Form (S-1)**. Verify the Sample ID number from the Sample Label for the Soil Horizon Bulk Density Sample (SHBD) agrees with the sample ID on the **S-1 Form**.
- 4) Note anything unusual about the sample in the comment bubble. If no bulk density samples could be collected from any horizon, fill in the bubble indicating a sample was not collected, and state the reason in the comment bubble.

### 6.6.5.1.1 Sample Collection

Wherever possible (moist to dry soils), use the open-ended 3-inch steel soil corer provided in the base kit to collect three cores for Horizon Bulk Density from **each horizon greater than or equal to 8 cm thick** (Figure 6-24). Since soil bulk density can be highly variable, the three cores from each sampled horizon will be analyzed separately and then averaged to estimate bulk density for the horizon.

Some soils or site conditions (e.g., high organic matter soils, inundation, or severe compaction when using the corer) will require other techniques for collecting Horizon Bulk Density samples and some alternative methods are suggested below. A local soil scientist may be able to provide advice regarding problem soils in the area and sampling methods that would be most effective.

#### **Core Method for Collecting Horizon Bulk Density Samples**

- 1) Begin with the top horizon (at the soil surface, below vegetation and loose leaf litter or duff). Clear away any vegetation or loose leaf litter, and smooth a planar horizontal area at the top of the horizon. Choose an area that appears to be representative of the horizon being sampled.
  - a. If the first horizon is less than 8 cm thick, the Horizon Bulk Density sample will not be

collected. Collect the Horizon Chemistry sample for the first horizon, and then continue with the second horizon.

- 2) Place the three open-ended corers (sharpened edge downward) on the surface (top of the horizon to be sampled). Leave some space between the corers so they can be extracted individually. One at a time, push each corer into the smoothed area until the top of the corer is flush with the soil surface.
  - a. It may be necessary to hammer the corer into the soil. Lay a board across the top of the corer and tap lightly with a mallet or hammer until the line is flush with the soil surface.
  - b. If the horizon is less than 10 cm thick, carefully insert the corer into the soil until the bottom of the corer reaches, but does not cross the lower boundary of the horizon. Mark the outside of the corer to indicate the depth to which the core was inserted; use this as the height measurement when determining sample volume.
- 3) Excavate the soil surrounding the corers. The soil that is dug out from around the corers can be collected for the Horizon Chemistry sample (see **Section 6.6.5.2**). One at a time, dig out the sampling corers plus a little of the surrounding soil.
- 4) Using a knife blade, cut off the excess soil so the sample material is flush with the bottom edge of the corer. Be careful not to push additional soil into the corer during excavation. The sampled soil core may appear to be thinner than the depth the corer was inserted due to compression, do not add soil to fill the corer to the same height. This will add weight to the sample that is not in proportion to the sample volume, skewing the measurement. Do not remove rock fragments from the Horizon Bulk Density Sample.
- 5) Empty the contents of the corer into the previously labeled sample bag. Use the handle end of a trowel or other tool that can act as a plunger to push the soil out of the cylinder into the sample bag. Take care to make sure the entire soil sample is collected in the sample bag, scraping out the inside of the cylinder if needed. The Horizon Bulk Density Sample does not need to remain as an intact core in the sample bag.
- 6) Record the volume information on the sample tag.
  - a. Indicate whether the bulk density sample was collected with the NWCA supplied corer ("Standard Core") or by carving a uniform block ("Block") by filling in the appropriate bubble on the sample tag.
  - b. If the Standard Core was used, record the Core Length. This should be 10.0 cm, unless the horizon is less than 10.0 cm thick and a shorter core had to be sampled. For thinner horizons, record the height measurement as the thickness of the horizon sampled (or depth to which the core could be inserted).
  - c. If Horizon Bulk Density samples were collected by carving out blocks from the soil horizon, record the length, width, and height of the block. Calculate and record the volume of the block (Volume = Length x Width x Height).
- 7) Dig out the remaining two cores, placing each in its respective sample bag. Be sure to record the appropriate dimensions for the sample collected on the corresponding tag.
- 8) Do not pour out any free water that has accumulated in the sample bag. Seal the bags attaching the appropriate sample tags. Proper sealing of the bags will ensure that samples are not lost, remain at field moist condition, and will comply with APHIS shipping regulations (Figure 6-5).
  - a. Take the top 5 cm (2 in) of the sample bag and make the first fold away from the side of the bag on which the sample label is affixed. The sample label displays key tracking information and must always be affixed to the front of the bag.

- b. Make a second fold, taking the top 2.5 cm (1 in) of the first fold and folding towards the sample label on the front of the bag.
  - c. Insert the sample tag into the second fold with the tag information facing outward. Use a heavy duty stapler and staple through the fold and tag.
  - d. Staple the left and right sides of the double fold to ensure the bag is completely sealed closed.
- 9) Mark that the Horizon Bulk Density Samples (BD1, BD2, and BD3) have been collected in the *Samples Collected* row of the specific horizon section of the **Soil Data Form (S-1)**. If a sample cannot be collected from a horizon, use the comment bubble next to *Samples Collected* section to explain why a sample wasn't collected at this horizon. If no Horizon Bulk Density Samples were collected for the entire Soil Pit, mark the *No Sample Collected* box at the bottom of the **Soil Data Form (S-1)** and use the adjacent comment bubble to provide a brief reason why none of the bulk density samples were collected.
- 10) Collect (or finishing collecting) the Horizon Chemistry Sample (see **Section 6.6.5.2**) before proceeding to the next horizon. Once both the Horizon Bulk Density and Horizon Chemistry Samples have been collected for a given horizon, excavate the remaining soil material from that horizon to form a shelf with the horizontal surface being the top of the next horizon. The Horizon Bulk Density samples for the next (lower) horizon will be sampled using the same method (Steps 2-8). Three Horizon Bulk Density Samples should be collected from **every horizon greater than or equal to 8 cm thick to a depth of 125 cm**. Horizon Chemistry Samples will be collected for **every horizon**, regardless of thickness.
- 11) Keep samples cool and out of the sun during the sampling day. Follow the protocols in Section 6.8 on sample tracking, shipping, and handling of samples.



**Figure 6-24. Demonstration of Horizon Bulk Density sampling using the 3-in diameter stainless steel corers provided in the NWCA base kit. A) Smooth a planar horizontal area at the top of the horizon, then place the three open-ended corers (sharpened edge downward) on the surface (top of the horizon to be sampled); B-D) Push or gently hammer the core into the soil until the top of the corer is flush with the smooth surface; E) Dig out the corer plus some of the surrounding soil; F) Using a knife blade, cut off the excess soil so the sample material is flush with the bottom edge of the corer. Photos courtesy of Sarah Lehmann.**

### ***Techniques for Collecting Horizon Bulk Density Samples in Difficult Soils***

Alternate methods for collecting Horizon Bulk Density Samples may be necessary in saturated, very dry, or organic soils. Some suggestions and alternate methods are described below. The NRCS Soil Scientists may also be able to provide advice on sampling methods for difficult soils. When collecting samples, carefully follow the procedures for bagging and labelling the samples described above. Ensure that both the sample tag and the sample label have been filled out completely for each sample. Be sure to record the dimensions and volume of Horizon Bulk Density samples with non-cylindrical shapes (e.g., cubes, rectangular blocks) on the sample tag.

### **Corer Cannot Be Inserted Into the Soil**

Carve out cubes of soil with a known dimension (e.g., 5 cm on a side). Record the dimensions and volume of the block on its corresponding sample tag.

### **Soils At or Below the Water Table**

Excavate only to just above the depth of the water table. Sample all horizons above the water table. Once the Horizon Bulk Density and Horizon Chemistry Samples are collected for all horizons above the water table, begin excavation below the water table using the hand pump to pump the water out of the hole. Try to get to the 125 cm depth by excavation. Excavate to the bottom of each horizon (one at a time) and sample it before trying to get deeper.

### **Drier Soils**

Hammer Soil Core Samplers consist of a slide and a drop hammer that is attached to a solid coring device about 5 cm in diameter and of varying lengths (Figure 6-8G). Hammer corers are efficient for

extracting bulk density samples in many soil conditions (excluding gravelly, loose organic, soupy, or sandy soils); but this tool is heavy, so not ideal for routinely carrying into the field over long distances. However, when soils are too dry for retrieving bulk density cores with the NWCA provided corer, a hammer corer (if available) may work well. You will need to ensure that the soil cores extracted using the hammered corer are not severely compacted. Check for compaction by comparing the length of the soil core in the hammer corer with the depth of the void left by its removal. If the core length is more than 10% less than the void length, another sampling approach should be selected. When using a hammer corer, be sure to carefully follow the instructions for its operation. Be sure to record the dimensions of the hammer corer on the sample tag.

### **Organic Soils**

If the water table is below the soil surface, obtain the Horizon Bulk Density Samples for the non-inundated upper layers from the side of the pit.

If the hydraulic conductivity is slow enough below the water table, dig and remove slabs of soil (as directed in **Section 6.6.1.2**) as deep as practical and place on a plastic sheet or sled in an orderly fashion (i.e., in the in situ order from the surface). Horizon Bulk Density Samples can be removed from the soil slabs using the NWCA provided soil corer. Cubes of known dimensions (e.g., 5 cm on a side) can be taken from the soil slabs as well. Be sure to record the dimensions of the block collected on the sample tag.

Organic soil samples from below the water table can also be collected using the King Soil Extractor technique (see **Section 6.6.1.2**). Use a sharp knife to slice through the bottom of the horizon being sampled and then cut bulk density samples out of the middle of the horizon. It may be necessary to use two or three extractor tubes to obtain enough material for all samples.

### *6.6.5.2 Horizon Chemistry Samples*

Horizon Chemistry Samples will be analyzed for chemical composition (this includes carbon, nutrients, and heavy metals) and particle size. Horizon Chemistry data from the Soil Profile can be used to indicate potential stressors, such as contaminants or nutrient imbalances, document processes such as carbon storage, and characterize the health and condition of the soil, and therefore, its ability to perform ecosystem functions. The properties analyzed will change between the horizons within a profile, and comparisons among the horizons can sometimes indicate stressors such as sedimentation, changes in hydrology, or processes occurring in the soil. A Horizon Chemistry Sample will be collected for **every horizon**, regardless of thickness, to 125 cm depth. In some cases, this may require collecting soil from over a wider area laterally to have sufficient sample. Keep in mind that horizon boundaries are not always uniform or level across the distance of the Soil Pit.

#### **6.6.5.2.1 Preparation of Labels, Tags, and Sample Collection Bags**

For each horizon to be sampled, fill out the Soil Horizon Chemistry (SHCH) Label and Soil Horizon Chemistry Samples Tag. One set of labels and tags will be needed for each horizon from 0 to 125 cm. As you collect samples, be sure to correctly match the tag and label for each sample. Each Horizon Chemistry sample will be put in a separate, labeled, 8-mil thick plastic sample bag. These bags are durable, and when properly folded and stapled retain the field state moisture content of the soil sample. It is critical to sample integrity to make sure the seal is properly executed.

- 1) Soil Horizon Chemistry (SHCH) Sample Label (Figure 6-25) – for each horizon to be sampled, complete the adhesive sample label (see example below) with the Site ID, Visit #, Date, and Horizon #.

- a. Visit #1 corresponds to the primary sampling visit; Visit #2 is the second sampling or revisit.
- b. The Horizon # should correspond to the row of data in the Horizons section of the **Soil Data Form (S-1)**.
- c. Affix the completed sample label to the outside of an 8-mil thick plastic soil sample bag. Cover the entire label with clear tape to protect it from moisture and mud.

<b>SOIL HORIZON CHEMISTRY (SHCH)</b>	
Site ID: NWC21- _____	
Date: ____/____/20__ Visit #: <input type="radio"/> 1 <input type="radio"/> 2	
Horizon #: _____	
<b>T3</b>	<b>990005</b>

Figure 6-25. Soil Horizon Chemistry sample label.

- 2) Soil Horizon Chemistry Samples Tag (Figure 6-26) – for each horizon, complete the sample tag (printed on waterproof paper).
  - a. Fill in the Site ID, Date, Visit #, Horizon #, and Horizon Depths. Make sure that all information recorded matches the sample label and the **Soil Data Form (S-1)**.
  - b. Fill in the bubble indicating Soil Horizon Chemistry (SHCH), and record the Sample ID (from sample label).

NWCA 2021: Soil Horizon Chemistry or Soil Horizon Bulk Density Samples Tag		
Site ID: NWC21- _____ Date: ____/____/20__ Visit #: <input type="radio"/> 1 <input type="radio"/> 2		
Horizon #: _____ Horizon Depth: _____ cm to _____ cm		
Indicate <u>either</u> Chemistry or ONE of the Bulk Density Samples below		
<b>Staple under sample bag fold</b>	<input type="radio"/> SOIL HORIZON CHEMISTRY (SHCH) Sample ID: _____ For horizon chemistry samples, rocks in the soil should be retained in the sample; however, if they must be removed, record the estimated volume of the sample they comprised. _____ % Sample Volume Comprised by Removed Rock	
	<input type="radio"/> SOIL HORIZON BULK DENSITY (SHBD) Sample ID: _____ <input type="radio"/> Bulk Density #1 <input type="radio"/> Bulk Density #2 <input type="radio"/> Bulk Density #3 For bulk density samples, indicate whether the standard corer was used <b>OR</b> a block of soil was collected.	
	<input type="radio"/> Standard Core For samples collected using the standard corer, indicate the length of the core collected (should be 10 cm whenever possible). Core Length: _____ cm	<b>-OR-</b>
	<input type="radio"/> Block For blocks of soil, indicate the dimensions of the block in cm and calculate and record the volume of the block (LxWxH) in cm <sup>3</sup> . Length: _____ cm Width: _____ cm                      Volume: Height: _____ cm                      _____ cm <sup>3</sup>	

Figure 6-26. Soil Horizon Chemistry or Bulk Density sample tag.

- 3) Record the Water Chemistry Sample ID number from the label sheet in the Anchor ID/Water Chem ID field of the Tracking Form in the App. Doing so will automatically populate the sample IDs in the Sampling Information section at the bottom of the **Soil Data Form (S-1)**. Verify the Sample ID number from the Sample Label for the Soil Horizon Chemistry Sample (SHCH) agrees with the sample ID on the **S-1 Form**.



- 4) Note anything unusual about the sample in the comment bubble. If no soil chemistry samples could be collected from any horizon, fill in the bubble indicating a sample was not collected, and state the reason in the comment bubble.

#### 6.6.5.2.2 Sample Collection

Collection of the Horizon Soil Chemistry sample can begin during the collection of Horizon Bulk Density samples as the soil is excavated to expose the corers (e.g., Figure 6-27). Once the Horizon Bulk Density samples have been collected for a horizon, finish collecting the Horizon Soil Chemistry sample from the same horizon. **To be truly representative, the sample must represent the entire horizon.** Ensure that you collect sample from the entire horizon, from the upper boundary to the lower boundary.

- 1) Slice or otherwise extract a representative sample from the upper boundary to the lower boundary of the horizon and from a lateral extent large enough to include the observed short-range variability within the horizon being sampled.
  - Use a small trowel, shovel, or the auger to extract a clean sample from the horizon of interest. This may require cleaning out debris from other soil layers that has fallen into the pit while sampling overlying horizons.
  - A Macaulay Peat Sampler or the Tube Extractor Method (King Soil Extractor) may be used to sample organic soil horizons below the water table (see **Section 6.6.1.2**).
  - If the Profile Description was made outside of the Soil Pit, soil samples can be collected from the soil slabs or auger sections (see **Section 6.6.1.1**, Step 5).
- 2) Collect the Horizon Chemistry Sample in the previously labeled sample bag. Be sure that the label contains the appropriate information for the horizon being sampled.
- 3) Be sure to collect sufficient sample for laboratory analysis. Laboratory analyses are based on the dry weight of the soil, so the volume of sample needed will be dependent upon the bulk density and moisture content of the soil. For example, organic soils have a low bulk density so more sample will be needed than mineral soils. Additionally, soils that contain a lot of water (such as organic or saturated soils) will feel heavy, but when dried may not have sufficient sample for all of the analyses. It is critical that a sufficient volume of sample is collected so that the complete suite of laboratory analyses can be performed.
  - a. For mineral soils with no rock fragments (larger than 2 mm diameter), 1.0 to 1.5 L of soil are needed for analysis. This is approximately a third to half of the sample bag.
  - b. For mineral soils containing rock fragments, a larger volume of soil is needed. Collect enough soil that 1.0 to 1.5 L of soil will remain after the rocks are removed at the lab. For example, if the soil is 50% rocks, twice as much soil sample will be needed, 2.0 to 3.0 L (i.e., the entire sample bag). The proportion of rock fragments will be measured in the laboratory and removed prior to analyses.
    - i. If there are large rock fragments that are too big to be placed in the sample bag, estimate their total volume and remove them from the sample.
    - ii. Record the volume of rocks removed in the *% Sample Comprised of Removed Rock* field of the Sample Tag. This is critical information for calculating percent rock fragments during laboratory analysis.
  - c. For organic soils, collect at least 2.0 L of sample. Organic soils can contain a large amount of water. If the horizon is saturated, additional sample may be needed to have enough dried sample to complete the laboratory analyses. Completely fill the sample bag, saving just enough space so that the bag can be completely closed.



- 4) Once the Horizon Chemistry Sample has been collected, seal the bag, attaching the appropriate sample tag. Proper sealing of bags will ensure that samples are not lost, remain at field moist condition, and will comply with APHIS shipping regulations (Figure 6-5).
  - a. Pour out any free water that has accumulated in the sample bag.
  - b. Take the top 5 cm (2 in) of the sample bag and make the first fold away from the side of the bag on which the sample tag is to be affixed. The sample tag displays key tracking information and must always be affixed to the front of the bag.
  - c. Make a second fold, taking the top 2.5 cm (1 in) of the first fold and folding backwards towards the sample tag on the front of the bag.
  - d. Insert the sample tag into the second fold with the label information facing outward. Use a heavy duty stapler and staple through the fold and tag.
  - e. Staple the left and right sides of the double fold to ensure the bag is completely sealed closed.
- 5) Mark that the Soil Horizon Chemistry Sample (SCHC) have been collected in the *Samples Collected* row of the specific horizon section of the **Soil Data Form (S-1)**. A Horizon Chemistry Sample should be collected from **every horizon to a depth of 125 cm**. Make every effort to collect a Horizon Chemistry Sample from each horizon. If soil conditions prohibit collection of the chemistry sample in a horizon, use the comment bubble next to *Samples Collected* section to explain why a chemistry sample wasn't collected at this horizon. If no Soil Horizon Chemistry Samples were collected for the entire Soil Pit, mark the *No Sample Collected* box at the bottom of the **Soil Data Form (S-1)** and use the adjacent comment bubble to provide a brief reason why none of the soil chemistry samples were collected.
- 6) Once both the Horizon Bulk Density Samples and the Horizon Chemistry Sample have been collected for the horizon, excavate the remaining soil material from the horizon to begin collection of the Horizon Bulk Density Sample of the next (lower) horizon.
- 7) Keep samples cool and out of the sun during the sampling day. Follow the protocols in Section 6.8 on sample tracking, shipping, and handling of samples.



**Figure 6-27. Collection of Soil Horizon Chemistry sample. Horizon Chemistry samples can be collected as Horizon Bulk Density Sample cores are extracted. Photo courtesy of Sarah Lehmann.**

### 6.6.6 Water Depth in Soil Pit after Equilibration

- 1) After all soil sampling tasks have been completed, measure the water table depth (Figure 6-28 and **Reference Card S-5**). If necessary, allow the water table to equilibrate while completing other sampling tasks at the site.
- 2) If there is surface water present, measure the height of the water above the soil surface. Record this as the depth in the Depth to Water Table section of the **Soil Data Form (S-1)** by indicating that the value is positive. For example, if the surface water is 5 cm above the soil surface, record "+ 5" in the field for *Water level from soil surface* (see Figure 6-28) by selecting the "+" bubble and typing "5" into the field provided.

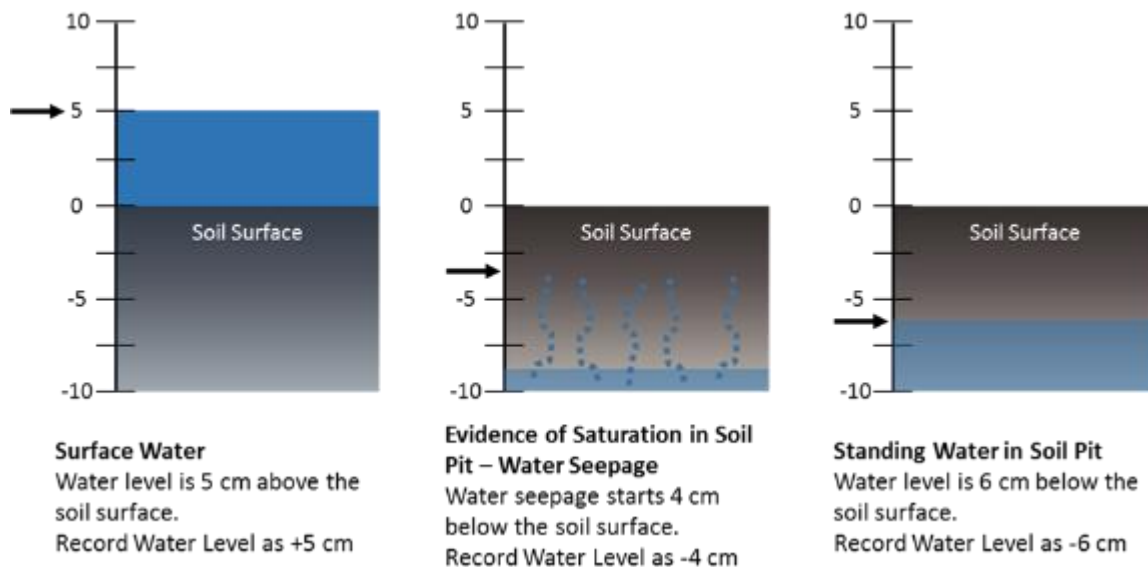
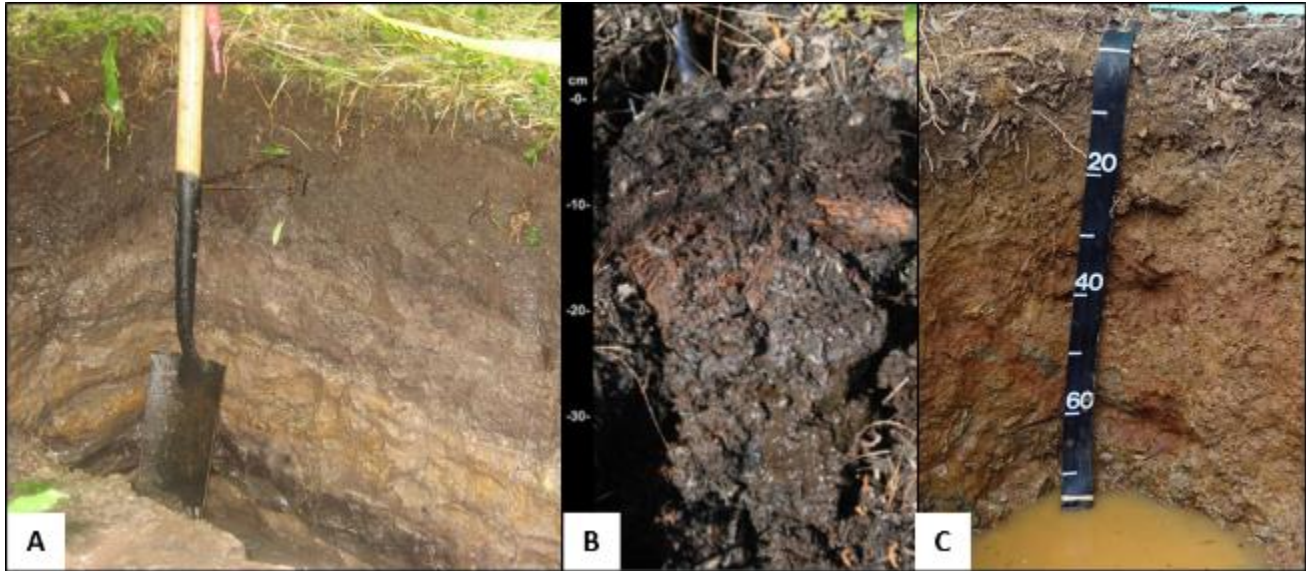


Figure 6-28. Measuring Water Table Depth at the Soil Pit.

- 3) In the absence of surface water, determine the depth of saturation in the Soil Pit (see Figure 6-29 and **Reference Card S-5**). Saturation is indicated by:
  - Pit surfaces with a sheen of moisture or appear to be glistening;
  - Water seepage from the pit walls. This includes water running down the Soil Profile Face, along ped faces, or oozing from macropores; or
  - Standing water in the Soil Pit.



**Figure 6-29. Evidence of soil saturation. (A) Pit surface with sheen of moisture. Photo by Ann Rossi. (B) Water seepage. Photo courtesy of USDA NRCS. (C) Standing water in soil pit. Photo by Ann Rossi.**

- 4) Use a tape measure or meter stick to measure from the soil surface to the depth of saturation. Record the depth in the *Water level from soil surface* field in the Depth to Water Table section of the **Soil Data Form (S-1)**, indicating that the value is negative. For example, if evidence of saturation is observed 25 cm below the soil surface, record “-25” in the field for *Water level from soil surface* by selecting the “-” bubble and typing “25” into the field provided.
- 5) A water table at the soil surface should be recorded as “0” (Figure 6-29) by selecting the “0” bubble for *Water level from soil surface*.
- 6) Fill in the appropriate bubble to indicate if water level measurement is based on:
  - a. the presence of FULLY EQUILIBRATED standing water in the Soil Pit (or water level is at or above the soil surface); or
  - b. based on evidence of soil saturation (standing water is absent from the pit or, if present, is deeper than the depth of soil saturation indicating the water level has not yet equilibrated). Evidence of this includes glistening pit faces, water running down the side of pit, etc.
- 7) If there is no evidence of saturation within 125 cm of the soil surface, fill in the bubble indicating “No surface water, standing water in Soil Pit, or evidence of saturation within 125 cm of the soil surface” in the Depth to Water Table section of the **Soil Data Form (S-1)**.

### 6.6.7 Backfilling the Soil Pit

The Soil Pit can be backfilled once all Soil Pit activities are complete.

- 1) Double Check that all data and samples have been collected:
  - a. Soil Profile Description – completed to a depth of 125 cm, and ensure all morphological characteristics and data have been recorded on the **Soil Data Form (S-1)** (if needed).
  - b. Soil Profile Face has been photographed and if applicable, a NRCS soil scientist has verified horizon boundaries, profile description, and horizon names.
  - c. Soil Horizon Bulk Density samples have been collected for every horizon at least 8 cm thick to a depth of 125 cm. Three cores should be collected for each horizon and placed in three separate bags. Samples should be appropriately labeled, including sample core

dimensions.

- d. Soil Horizon Chemistry samples have been collected for every horizon to a depth of 125 cm. Samples should be labelled and stored properly.
- 2) Remove any markers used to identify horizon boundaries.
- 3) Return the excavated soil to the Soil Pit, trying as much as possible to return soil in the same order as occurring in the profile (e.g., bottom horizons should be returned to the Soil Pit first, upper horizons should be returned last). The tarp can be used to assist in moving the soil towards the Pit and ensuring that all excavated soil is returned to the Pit.
- 4) Once the Soil Pit is filled, replace the vegetation cap (this was removed and set aside at the beginning of Soil Pit excavation). Tamp down the vegetation cap down into the soil to give it a chance to re-root and enhance its likelihood of survival.

## 6.7 Soil Tool Decontamination and Maintenance

- 1) While still at the site, clean soil sampling tools as thoroughly as possible at the end of the sampling day to remove excess soil and any alien species propagules. See **Section 2.8**, for details on procedures for preventing inadvertent transport of taxa from the site.
- 2) Once back at the lodging location, office, or other convenient site, carefully and thoroughly clean all soils equipment. Keep all threads for connecting joints of tools well-oiled or lubricated. This is imperative to keep tools in good working order.
- 3) If tools are exposed to contaminants, use the appropriate state approved safety protocols for cleaning them.

## 6.8 Sample and Data Handling

There are two components to soil sample handling. One is completed before leaving the site and the other at the field lodging site or office.

### 6.8.1 At the Site

- 1) During the sampling day, keep all soil samples as cool as possible:
  - a. Keep the Standardized Depth Soil Cores, Horizon Bulk Density, and Horizon Chemistry Samples out of direct sun, and if possible, in the shade.
  - b. Keep the Soil Isotope Samples, out of direct sun, in the shade and on ice whenever possible.
- 2) Before leaving the site at the end of the sample day, double check that all samples (Standardized Depth Soil Cores, Soil Isotope, Horizon Bulk Density, and Horizon Chemistry) have been collected and that label and tag information is accurate and legible.
- 3) Ensure all identification information for each sample corresponds exactly on all sample tags, sample labels, and the Sampling Information section at the bottom of the **Soil Data Form (S-1)**.
- 4) On the **Tracking Form** in the App (Chapter 2), verify the number of collected items for SISO (Soil Isotopes Sample), SHBD (Soil Horizon Bulk Density Sample), and SHCH (Soil Horizon Chemistry Sample). The field for the number of items for each sample type will automatically tally the number of SHBD and SHCH bubbles selected on **Form S-1**. If no samples are collected for a given soil sample type, the **Tracking Form** will reflect a 0 for number of items collected. In this case,

the “No Sample Collected” box should be checked on the **S-1 Form** and a reason provided in the adjacent comment field.

For a given site, total samples collected should be:

SDSC = 1

SISO = 1

SHCH = 1 X number of horizons from 0 to 125 cm

SHBD = 3 X number of horizons greater than or equal to 8-cm thick from 0 to 125 cm.

### 6.8.2 At Field Lodging or Office

See **Section 2.8.2** for an overview of sample shipping and 8.7Appendix A for detailed protocols on packing, tracking, and shipping soil samples and shipping addresses.

#### 6.8.2.1 Soil Isotope Samples – Daily Shipped Samples

The Soil Isotope samples for each site will be sent to the Batch Lab within 24 hours of collection in a cooler with the microcystin sample. These samples will be shipped on wet ice and will be subsequently frozen and sent to the processing labs in batches.

- 1) Confirm that the label affixed to each sample has the correct Site ID, is complete, and is covered with clear tape.
- 2) Ensure that as much air as possible has been removed from the sample bag and that it is completely sealed. Each individual Soil Isotope sample bag should be placed in another, separate, quart-sized self-sealing plastic bag, making sure the bag is sealed to protect the sample from moisture in the cooler.
- 3) The samples will be shipped in a small cooler with wet ice. Line the cooler with the provided heavy duty liner bag and place the Soil Isotope and Microcystin sample and ice inside the liner bag. Seal the cooler liner with the provided zip-tie.
- 4) Fill out the T-2: Daily Chilled Shipment section of the **Tracking Form** in the App and a T-2 packing slip (Figure 6-30) for each site.
  - Ensure that the Site ID number, the visit number, date collected, and sample IDs are listed on the packing slip and that this information corresponds exactly to the information on the label for the Soil Isotopes Sample.
  - Enter the shipping details (lab, date shipped, airbill number, sender’s name, and sender’s phone number) into the **Tracking Form** in the app.

T2: NWC21 Daily Chilled Tracking

Site ID: NWC21- Visit #: 0 1 0 2

Date Collected:      /      /     

Lab Staff	Samples In Box?	Sample ID
<input type="checkbox"/>	<input type="checkbox"/>	MICX 990002
Lab Comments (For lab staff only)		
Sample ID		
<input type="checkbox"/>	<input type="checkbox"/>	SISO 990003
Lab Comments (For lab staff only)		

Please cross out sample id(s) not included in shipment.

Figure 6-30. Example T-2 (Daily Chilled Tracking) Packing Slip



- 5) Place the packing slip (along with the provided APHIS soil shipping permit) into the provided zip-top bag and on top of the sealed cooler liner.
- 6) Affix a T-2 shipping label to the top of the (see Appendix A). Close and seal the cooler lid with tape.
- 7) Submit the soil data and tracking form via the App. See Chapter 2 for details on submitting data and tracking forms to the Information Management Team. Remember that data can be updated at any time by amending the App forms and re-submitting them, so crews are encouraged to submit data as soon as possible after leaving the field to avoid potential data loss from a lost or damaged iPad.
- 8) Deliver the package of samples to the shipping company and retain all receipts and records of shipping.

#### *6.8.2.2 Standardized Depth Soil Core, Soil Horizon Bulk Density, and Soil Horizon Chemistry Samples – Batch Shipped Samples*

The Standardized Depth Soil Cores, Soil Horizon Bulk Density, and Soil Horizon Chemistry Samples will be sent to the USDA-NRCS Lab in Lincoln, Nebraska. These samples may be stored and shipped in batches every one to two weeks. Due to the weight of the soil samples, only one site's worth of soil samples should be shipped in each cooler.

- 1) For each sample, confirm the Sample Label with the Sample ID is complete, legible, affixed to the front of the sample bag, and covered with clear plastic tape.
- 2) For each sample, confirm the Sample Tag is complete and legible. Check that the sample bag has been properly sealed with the Sample Tag stapled in fold sealing the bag.
- 3) The samples will be shipped in large cooler. Due to the weight of the soil samples, only one site's worth of soil samples should be shipped in each cooler.
- 4) Line the cooler with the provided heavy duty liner bag and place the Standardized Depth Soil Cores, Horizon Bulk Density, and Horizon Chemistry Samples inside the liner bag. Seal the cooler liner with the provided zip-tie.
- 5) Fill out the T-3: Soil Chemistry and Bulk Density Shipment section of the **Tracking Form** in the App and a T-3 packing slip (Figure 6-31) for each site.
  - On the T-3 packing slip, list horizon numbers for all samples that are being shipped and fill in the SHCH and/or BD1/2/3 bubbles that indicate the samples for each horizon.
  - Ensure that the Site ID number, the visit number, date collected, and sample IDs are listed on the packing slip and that this information corresponds exactly to the information on the sample label and tag for each sample.
  - Enter the shipping details (lab, date shipped, airbill number, sender's name, and sender's phone number) into the tracking form in the app.

T3: NWC21 Soil Chemistry & Bulk Density Sample Tracking	
Site ID: <u>NWC21- Test-OR-1005</u>	Visit #: <u>102</u>
Date Collected: <u>07/27/2021</u>	Page 1 of <u>1</u>
<p>Crew: Fill in horizon numbers and mark bubbles for each type of sample included in the shipment. SDSC Sample ID: <u>990004</u></p> <p>SHCH Sample ID: <u>990005</u></p> <p>SHBD Sample ID: <u>990006</u></p>	<p>Lab Staff: Please use this section below to notate any comments about the state of each sample upon arrival. Record this information in the lab comment section of your check in file. These comments will be added to the database.</p>
<p>Horizon #: <u>1</u>    <input type="radio"/> BD1  <input checked="" type="radio"/> SHCH    <input type="radio"/> BD2  <input type="radio"/> BD3</p>	
<p>Horizon #: <u>2</u>    <input checked="" type="radio"/> BD1  <input checked="" type="radio"/> SHCH    <input checked="" type="radio"/> BD2  <input checked="" type="radio"/> BD3</p>	
<p>Horizon #: <u>3</u>    <input checked="" type="radio"/> BD1  <input checked="" type="radio"/> SHCH    <input checked="" type="radio"/> BD2  <input checked="" type="radio"/> BD3</p>	
<p>Horizon #: <u>4</u>    <input type="radio"/> BD1  <input checked="" type="radio"/> SHCH    <input type="radio"/> BD2  <input type="radio"/> BD3</p>	
<p>Horizon #: <u>5</u>    <input checked="" type="radio"/> BD1  <input checked="" type="radio"/> SHCH    <input checked="" type="radio"/> BD2  <input checked="" type="radio"/> BD3</p>	
<p>Horizon #: _____    <input type="radio"/> BD1  <input type="radio"/> SHCH    <input type="radio"/> BD2  <input type="radio"/> BD3</p>	
<p>Horizon #: _____    <input type="radio"/> BD1  <input type="radio"/> SHCH    <input type="radio"/> BD2</p>	

Figure 6-31. Example T-3 (Soil Chemistry and Bulk Density Tracking) Packing Slip

- 6) Place the packing slip into the sleeve on the inside of the cooler lid.
  - 7) Affix a T-3 shipping label to a handle tag and affix the handle tag to the handle of the cooler using one of the provided zip-ties (see 8.7Appendix A).
  - 8) Once you are certain that all samples and the completed packing slip are included in the cooler, carefully seal the cooler.
  - 9) Submit the soil data and tracking form via the App. See Chapter 2 for details on submitting data and tracking forms to the Information Management Team. Remember that data can be updated at any time by amending the App forms and re-submitting them, so crews are encouraged to submit data as soon as possible after leaving the field to avoid potential data loss from a lost or damaged iPad.
- When the soil lab processes these samples, they will need to review the soil profile data collected in the field, therefore finalize and submit soil data as soon as possible after sampling a site and shipping soil samples.
  - Deliver the package of soil samples to the shipping company and retain all receipts and records of shipping.

### 6.8.2.3 Soil Data Forms, Tracking Forms, and Shipping Records

At the end of the sampling day, after you have reviewed the soil data forms, submit the forms using the NWCA App. It is recommended to submit all the data forms as soon as possible, even if they have not been fully reviewed yet. This stores a record of all the current data in the IM Database which can be retrieved in the event of iPad failure, damage, or loss. Updates can be made to the forms at any time and re-submitted to update the IM database accordingly. See Chapter 2 for protocols on submitting the completed data via the App and 8.7Appendix D for transmitting the photos of the soil profile that were taken.



## 6.9 Supplementary Material

### 6.9.1 *List of Soil Resources to be used in the Field*

Munsell Color X-Rite. 2009. Munsell Soil Color Charts. Munsell Color Corporation. Grand Rapids, MI.

Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, and Soil Survey Staff. 2012. Field Book for Describing and Sampling Soils, Version 3.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, Nebraska. Available online:

[http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2\\_054184](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054184)

United States Department of Agriculture, Natural Resources Conservation Service. 2018. Field Indicators of Hydric Soils in the United States, Version 8.2. L.M. Vasilas, G.W. Hurt, and J.F. Berkowitz (eds.). USDA, NRCS, in cooperation with the National Technical Committee for Hydric Soils. Available online:

[http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/?cid=nrcs142p2\\_053957](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/?cid=nrcs142p2_053957).

### 6.9.2 *Other Useful Soil Resources*

Vepraskas, M.J. and C.B. Craft (eds.). 2015. Wetland Soils: Genesis, Hydrology, Landscapes, and Classification. CRC Press, Taylor and Francis Group, LLC. Boca Raton, FL. p. 165-271.

United States Department of Agriculture, Natural Resources Conservation Service Website:

<http://soils.usda.gov/>

United States Army Corps of Engineers (USACE). 2009. Regional Supplements to Corps Delineation Manuals. Website:

[http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/reg\\_supp.aspx](http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/reg_supp.aspx)

Regional NRCS offices and soil scientists; any additional references recommended by regional soil scientists.

### 6.9.3 *Glossary of Soil Terminology*

**Boundary Distinctness** – Describes the vertical transition or change in soil properties from one horizon to the next.

**Bulk Density** – The mass of dry soil per unit bulk volume. The value is expressed as grams per cubic centimeter ( $\text{g cm}^{-3}$ ) or megagrams per cubic meter ( $\text{Mg m}^{-3}$ ).

**Chroma** – One of the three variables of soil color in the Munsell Color System. Describes the relative purity, strength, or saturation of a color.

**Clay** – Mineral particle, less than 0.002 mm in diameter. Usually clay particles feel sticky when rubbed between the fingers.

**Clod** – A compact, coherent mass of soil, generally not a naturally formed structural unit, such as a ped.

**Consistence** – Describes the degree of cohesion and adhesion of soil particles, or the resistance to deformation or rupture.

**Depleted Matrix** – A soil matrix with high value and low chroma colors due to the reduction and translocation of iron and manganese. When determining if a soil meets a Hydric Soil Field Indicator the following combinations identify a depleted matrix:

- Matrix value  $\geq 5$  and chroma  $\leq 1$ , with or without redox concentrations occurring as soft masses or pore linings; or
- Matrix value  $\geq 6$  and chroma  $\leq 2$ , with or without redox concentrations occurring as soft masses or pore linings; or
- Matrix value of 4 or 5 and chroma of 2, and 2% or more distinct or prominent redox concentrations occurring as soft masses or pore linings; or
- Matrix value of 4 and chroma of 1, and 2% or more distinct or prominent redox concentrations occurring as soft masses or pore linings.

**Gleyed** – Describes soil colors with bluish or greenish hues, forms as a result of prolonged soil saturation and reducing conditions. When determining if a soil meets a Hydric Soil Field Indicator the following combinations identify a gleyed matrix:

- Matrix hue of 10Y, 5GY, 10GY, 10G, 5BG, 10BG, 5B, 10B, or 5PB, with value  $\geq 4$  and chroma  $\leq 1$ ; or
- Matrix hue of 5G, with value  $\geq 4$  and chroma of 1 or 2; or
- Matrix hue of N, with value  $\geq 4$ .

**Horizon** – Horizontal layer of soil that differs from adjacent layers in physical, chemical, or biological properties or characteristics.

**Hue** – One of the three variables in the Munsell Color system. Describes chromatic composition of the color or the amount of red, yellow, green, blue, or purple.

**Hydric Soil** – A soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register 1994).

**Loamy/Clayey** – Textural group used by NWCA to describe all mineral soils with textures of sandy loam or finer (loam, clay loam, sandy loam, sandy clay loam, sandy clay, silt, silt loam, silty clay loam, silty clay, and clay).

**Matrix Color** – The dominant soil color of a horizon. When three or more colors occur within a horizon, the matrix color may represent less than 50% of the total area.

**Mineral Soil Material** – Soil materials consisting predominantly of mineral matter. Physical, chemical, and biological properties of the soil are influenced predominantly by the mineral matter (generally contain less than 12 to 18% organic carbon)

**Munsell Color System** – A color designation system that specifies the relative degrees of the three color variables, hue, value, and chroma. For example, 10YR 4/2 is a soil color which hue = 10YR, value = 4, and chroma = 2.

**Mottles** – Spots or blotches of color that differ from the dominant matrix color, not related to soil wetness.

**Muck** – Highly decomposed organic soil material. Original plant parts are not recognizable.

**Mucky Mineral** – A modified textural class describing a mineral soil with an organic matter content between organic and mineral soil materials. Organic carbon content is between 5 and 18%, depending on clay content.

**Mucky Peat** – Moderately decomposed organic soil material. A portion of the original plant parts are recognizable, but an equally large proportion is not.

**Organic Bodies** – Aggregates of organic material with mucky or mucky mineral textures. They typically occur at the tips of roots and are commonly 1 to 3 cm in diameter.

**Organic Infilling** – accumulations of organic material in pores, root channels, or soil cracks.

**Organic Soil Material** – Soil materials with greater than 12 to 18% organic carbon, depending on clay content. The high organic matter content dominates the physical, chemical, and biological processes of the soil.

**Peat** – Minimally decomposed organic soil material. Plant and root fibers are generally still visible.

**Ped** – A unit of soil structure such as a block, column, granule, plate, or prism, formed by natural processes (in contrast to a clod, which is usually formed artificially).

**Redoximorphic Concentrations** – Localized zones of accumulation of iron and/or manganese oxides. Generally are redder in hue and have brighter (higher) chromas than the surrounding soil matrix.

**Redoximorphic Depletions** – Localized zones of low chroma color where iron and/or manganese oxides have been reduced, solubilized, and leached from the soil.

**Redoximorphic Features** – Morphological features indicating the chemical reduction and oxidation of iron and manganese compounds resulting from saturated soil conditions. Includes redoximorphic concentrations, redoximorphic depletions, and reduced matrices.

**Reduced Matrix** – A soil matrix that has a low chroma in situ, but undergoes a change in hue or chroma within 30 minutes of exposure to air due to the oxidation of iron.

**Rock Fragments (Coarse Fragments)** – Unattached pieces of rock greater than 2 mm in diameter that are strongly cemented or more resistant to rupture.

**Sand** – Mineral particle, 0.10 to 2.0 mm in diameter. Generally feels gritty when rubbed between the fingers.

**Sandy** – Soil texture group consisting of sand and loamy sand textures.

**Silt** – Mineral particle, 0.05 to 0.10 mm in diameter. Generally has a smooth, non-sticky feel when rubbed between the fingers.

**Soil Profile** – A vertical section of the soil through all its horizons, starting at the soil surface and extending to the unweathered parent material.

**Soil Texture** – The relative proportions of soil separates (sand, silt, and clay) in a soil by weight. Organized into 12 different classes for mineral soils. For the purposes of NWCA, soil texture of mineral soils will be described by 2 classes, sandy and loamy/clayey.

**Stripped Matrix** – Zone or layer of soil with a contrasting pattern of two or more colors that forms as iron/manganese oxides and/or organic matter are translocated under saturated and reducing conditions.

**Structure** – The arrangement of primary soil particles (e.g., sand, silt, and clay) into secondary units or peds. Secondary units are described and classified based on their shape, size, and degree of distinctness.

**Sulfidic Soil Materials** – Soil materials that contain oxidizable sulfur compounds. Most commonly these are sulfide minerals, such as pyrite or iron monosulfides, but can also include elemental sulfur.

**Value** – One of the three variables in the Munsell Color System. Describes the degree of lightness or darkness of a color.

## 6.10 Soil Reference Card List

Reference Card S-1, Side A: NWCA 2021 Soil Protocol Tasks, Identifying Soil Plot Location

Reference Card S-1, Side B-D: NWCA 2021 Soil Protocol Tasks, Sampling the Soil Plot

Reference Card S-2, Side A: Delineating Horizon Boundaries

Reference Card S-2, Side B: Soil Structure, Consistence, and Estimating Surface Cover

Reference Card S-3, Side A: Soil Texture

Reference Card S-3, Side B: Soil Color

Reference Card S-4, Side A: Soil Redoximorphic Features

Reference Card S-4, Side B: Soil Organic Features, Masked Sand Grains, and Mottles

Reference Card S-5: Measuring Water Table Depth

Reference Card S-6 (A-U): Hydric Soil Field Indicators (grouped by Land Resource Region)

The Soil Reference Cards are compiled (with all other NWCA 2021 Reference Cards) in the Quick Reference Guide.

## 6.11 Equipment, Data Forms, and Sample Label Lists

### SOIL EQUIPMENT AND SUPPLY CHECKLIST

#### Protocols, forms, checklists, supplies

- \_\_\_\_\_ Reference Cards S-1 through S-6
- \_\_\_\_\_ NWCA 2021 Soil Data Form (S-1) in the NWCA App
- \_\_\_\_\_ NWCA 2021 Tracking Form
- \_\_\_\_\_ Soil tags and labels
- \_\_\_\_\_ Site packet including a copy of the NRCS soil map and soil survey information for the site
- \_\_\_\_\_ Covered clipboard with storage for completed forms, for the AB Team
- \_\_\_\_\_ Waterproof field notebook, pencils, mechanical pencils and lead, waterproof pens or markers
- \_\_\_\_\_ Clear packing tape to place over labels
- \_\_\_\_\_ Permanent marker (Fine-tip for labels)

#### Field guides that must be carried in the field

- \_\_\_\_\_ **For color determinations:** Munsell Color X-Rite. 2009. Munsell Soil Color Charts. Munsell Color Corporation. Grand Rapids, MI.
- \_\_\_\_\_ **For Hydric Soil Field Indicator determinations:** United States Department of Agriculture, Natural Resources Conservation Service. 2018. Field Indicators of Hydric Soils in the United States, Version 8.2. L.M. Vasilas, G.W. Hurt, and J.F. Berkowitz (eds.). USDA, NRCS in cooperation with the National Technical Committee for Hydric Soils. Available online (with errata): [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/?cid=nrcs142p2\\_053957](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/?cid=nrcs142p2_053957).
- \_\_\_\_\_ **Supporting reference for making soil profile descriptions (to keep in vehicle or carry in field):** Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, and Soil Survey Staff. 2012. Field Book for Describing and Sampling Soils, Version 3.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, Nebraska. Available online: [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2\\_054184](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054184)

#### Sampling supplies and tools (Note: Other soil tools may be available to borrow from local NRCS offices)

- \_\_\_\_\_ Tote, pack, or field vest to carry tools and small equipment

#### Soil pit excavation tools:

(Note: The most efficient or effective excavation tools will vary with site conditions. Consult soil survey maps and local NRCS Soil Scientists prior to sampling to determine the tools most appropriate to carry in the field for a specific site)

- \_\_\_\_\_ Tiling or sharpshooter style shovel
- \_\_\_\_\_ Bucket auger with interchangeable extension handles and appropriate bucket(s) for anticipated soil conditions (regular, mud, sand, dutch, etc.); a ratchet handle crossbar may also be helpful
- \_\_\_\_\_ King tube soil extractor (for saturated/inundated conditions, particularly sandy soils)
- \_\_\_\_\_ Root pruners (or other cutting tools for roots)
- \_\_\_\_\_ Metal flashing 30 cm (12 in) tall for supporting/sealing earthen coffer dam (for inundated soils)
- \_\_\_\_\_ Small scoop or bucket for bailing water from the soil pit
- \_\_\_\_\_ Hand water pump
- \_\_\_\_\_ Black plastic sheets (6-mil thick, approximately 4' by 5' each) to pile soil excavated from the soil pit and for laying out soil slabs/cores

- \_\_\_\_\_ Plastic snow sled for laying out soil slabs/cores or as a place to set tools and samples (particularly useful in saturated/inundated soils)
- \_\_\_\_\_ Paper towels (for any clean up)

### **Soil profile description supplies**

- \_\_\_\_\_ Small knife for shaving out soil slices to expose fresh surfaces, breaking out samples from the profile face, or carving out bulk density samples in difficult soils (e.g., peat, or saturated soils extracted with the King tube extractor method)
- \_\_\_\_\_ Golf tees (or similar item) for marking horizon boundaries
- \_\_\_\_\_ Metric tape measure (e.g. fiberglass seamstress measuring tape with lead weight, such as a fishing weight, works well)
- \_\_\_\_\_ Spray bottle with water for moistening soil as needed
- \_\_\_\_\_ Small flashlight for viewing soils in the soil pit, particularly in shaded or poorly lit conditions
- \_\_\_\_\_ Folding ruler (with metric markings)

### **Standardized Depth Soil Cores, Horizon Chemistry, and Horizon Bulk Density sampling supplies**

- \_\_\_\_\_ Plastic soil sample bags, 8-mil thick (Note: Soil sample bags will not be included in Site Kits. Field crews must remember to bring sufficient bags to each field sampling visit and are responsible for requesting additional sample bags as needed during the sampling season).
- \_\_\_\_\_ Standardized Depth Soil Core, Horizon Chemistry, and Horizon Bulk Density sample tags and labels
- \_\_\_\_\_ Heavy-duty sample bag stapler and staples
- \_\_\_\_\_ Open-ended, sharpened steel cylinder corer, 7.62-cm inside diameter (3-in), marked to collect 10 cm thick samples
- \_\_\_\_\_ Tote, pack, and/or ice chest for storing and carrying samples

### **Soil Isotope sampling supplies**

- \_\_\_\_\_ Zipper plastic bags, quart and gallon size
- \_\_\_\_\_ Soil Isotope Sample Labels
- \_\_\_\_\_ Syringe corer (2, one for use and one for back-up) or a stainless steel soil push probe (approximately 7/8 in diameter)
- \_\_\_\_\_ Small soft-sided cooler to keep Soil Isotope samples cool (Chlorophyll-*a* samples will also be kept in the ice chest)
- \_\_\_\_\_ Blue ice to fit soft sided cooler (or wet ice)

### **SOIL FORMS**

NWCA 2021 Soil Data Form (S-1) in the NWCA App  
NWCA 2021 Tracking Form

### **SOIL SAMPLE TAGS AND LABELS**

Standard Depth Soil Core (SDSC) Sample Label  
Standardized Soil Depth Core (SDSC) Sample Tag  
Soil Isotope (SISO) Sample Label  
Soil Horizon Chemistry (SHCH) Sample Label  
Soil Horizon Bulk Density (SHBD) Sample Label  
Soil Horizon Chemistry or Soil Horizon Bulk Density Sample Tag

## Chapter 7 Hydrology

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### 7.1 Introduction

Hydrology is the major defining characteristic of wetland ecosystems, affecting both soil development and vegetation composition, which in turn reflect ecological condition (Mitsch and Gosselink 2007). The following protocol is designed to characterize the hydrologic characteristics of the site. The types of data to be collected are:

- water Sources; and
- hydrology Indicators.

This chapter provides the procedures to collect hydrology data by the Assessment Area and Buffer (AB) Team within the Assessment Area (AA). Prior to departure for the site, the AB Team will review pertinent hydrology information concerning the site (e.g., sources of water, tide charts, aerial images detailing surface water bodies, ditches, dams, etc.) and prepare the forms and equipment (**Section 7.5**) needed for hydrology sampling. In locations under the influence of tides, stage of tide may affect access to the site and may make portions of the AA unsampleable or unsafe, particularly if the area is inundated by surface water 1 meter or more in depth. Refer to local tide tables and plan the visit so that maximum time is available to sample the site.

Collecting hydrologic data for the NWCA involves a number of tasks. These include: recording the weather on the day of sampling and for the previous week; documentation and ranking of hydrologic characteristics including surface water connectivity to the buffer; and estimates of hydrologic fluctuations based on evidence of seasonal water levels. Additionally, indicators of hydrology including observation of current or recently saturated soils, and evidence of recent inundation will also be assessed and recorded.

To avoid impairing data collection for Vegetation (Chapter 5), AB Team members will avoid stepping into areas that might be delineated as Vegetation Plots, by waiting until the Plots are marked (or at least their general area is known) before entering the AA. Assessment of hydrologic features occurring in Vegetation Plots must be done from plot peripheries to avoid trampling vegetation in the plots. The AB Team will survey the entire AA to identify, rank, and record Hydrology Indicator data. Physical alterations, including but not limited to those associated with water addition/subtraction and flow obstruction, will be evaluated in the AA and in the buffer zone surrounding the AA using the physical alterations protocol (Chapter 4). Additional hydrologic information will be collected as part of the soil (Chapter 6) and water chemistry (Chapter 8) protocols.

### 7.2 Sampling Procedures

Protocols for the NWCA hydrology sampling include:

- 1) identification and ranking of water sources;
- 2) Identification of indicators of hydrology.

Hydrology information is recorded on the **AA Hydrology Form (H-1)**.



### 7.2.1 Conditions at Assessment

Double check the header information on the top of the **AA Hydrology Form (H-1)**. Ensure the site ID and Visit number that you have chosen matches the site and visit being sampled. Fill in the time of hydrology sampling by using the *now* button or by typing the time directly into the field using the correct format (hh:mm). Indicate the: 1) tidal stage if applicable [Incoming, Outgoing, Slack (low- tide has dropped to its lowest level), or Flood (high- tide has risen to its highest level)], 2) weather on the day of sampling and for the previous week, and 3) presence of outflows (and describe in the comment field provided if outflows are present).

### 7.2.2 Water Sources

Water sources and outflows provide an indication of the seasonality and hydrography of the wetland. Sources of water input may include surface water (e.g., direct rainfall, stream inlets, sheet flow, flooding, etc.) and groundwater. In estuarine environments, tidal surge or tidal channels may be a significant source of water inundation within the AA. Particularly in urban settings, surface water may originate from anthropogenic sources including pipes and ditches.

- 8) Walk the entire AA as necessary to identify the presence or suspected presence of various water sources influencing the hydrology of the AA. This may include water sources that occur outside of the AA but directly influence hydrology within the AA.
- 9) Use the aerial photos and topographic maps in the Site Packet to help identify potential inlets to investigate at ground level, especially for heavily vegetated sites.
- 10) Record the presence of each type of water source found in the AA by selecting the appropriate boxes in the *Present* column under the *Water Sources that Influence Site Hydrology* heading of the **AA Hydrology Form (H-1)**. If the water source is not listed, select the 'Other' box and describe the water source in the field provided. Sources listed include:

**Stream Inflow** – natural inlet streams, creeks, etc.

**Springs (seeps)** – natural springs or seeps, etc.

**Lake** – lakes, ponds, etc.

**Precipitation** – rain, snow, sleet, or hail that falls to the ground.

**Groundwater** - water held underground in the soil or in pores and crevices in rock that is contributing to the hydrology of the wetland.

**Culverts** – Man-made pipes or tunnels designed to carry surface water.

**Snow Melt** – snow fields or glaciers in alpine settings.

**Overbank Flooding** - Water that has escaped the banks of a river or stream.

**Estuary – Tidal Channel** - portion of a stream that is affected by ebb and flow of ocean tides.

**Estuary – Tidal Surge** - Rise of water generated by tidal cycle, not contained within a channel.

Some source indicators may require interpretation. Provide a best informed decision for your determination. Use the comment bubble adjacent to the water source to explain any decisions that require clarification to inform data interpretation.

- 11) Consider all types of water sources observed, and identify **the three most important** on the **AA Hydrology Form (H-1)**. **Rank these three** with a score from 1 to 3; 1 representing the most

important, ecosystem driving, or influential type by selecting the numbered bubble adjacent to the water source. If fewer than 3 water sources are present in the AA, rank those sources with either a 1 and 2 (in the case of two water sources) or just a 1 (in the case of a single water source).

### 7.2.3 Army Corps of Engineers Indicators of Hydrology

There are many indicators of different aspects of hydrology. The AB team should carefully look around the entire AA to note the presence of hydrologic indicators and record their presence in the Hydrology Indicators section of the **AA Hydrology Form (H-1)**. **Reference Card H-1** has pictures and/or descriptions of some U.S. Army Corps indicators to help with identification. More detailed descriptions of the indicators can be found in the US Army Corps of Engineers Regional Supplements to the Corps Delineation Manual (USACOE 2009), available online at:

[http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/reg\\_supp.aspx](http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/reg_supp.aspx).

- 1) Record the presence of surface water, high water table, and saturated soils by selecting all applicable bubbles in the Group A Section.
- 2) Record any evidence of recent inundation in the Group B Section. Select the bubbles for various residual marks from water (stains, drift lines or deposits, mineral deposits, etc.) and sediment (deposits, drainage patterns, crusts, etc.) and plant and animal presence or indicators.
- 3) Note any evidence of current or recent soil saturation. Select the bubbles in the Group C Section for evidence including olfactory as well as visual indicators. Keep in mind some of these indicators may be identified during the Soil Pit excavation and Profile Description.
- 4) In the Group D Section, record the presence of other site condition evidence that suggests the presence of various wetland characteristics.
- 5) For all indicators, if further explanation is required, use the comment bubble in each section to elaborate.

## 7.3 Sample and Data Handling

There are no physical samples to process and track for the Hydrology Indicator. All data are recorded on the **AA Hydrology Form (H-1)**. See Chapter 2 for data form and records management protocols.

## 7.4 Reference Cards

Reference Card H-1: US Army Corps of Engineers Wetland Hydrology Indicators

Reference Card H-2: NWCA Hydrology Protocol Flowchart

The Hydrology Reference Cards are compiled (with all other NWCA 2021 Reference Cards) in the Quick Reference Guide.

## 7.5 Equipment List and Data Form

### HYDROLOGY EQUIPMENT CHECKLIST

\_\_\_\_\_ Data Form in the NWCA App and Reference Card

### HYDROLOGY FORMS

NWCA 2021 AA Hydrology Form (H-1) in the NWCA App

## Chapter 8 Water Chemistry, Chlorophyll-a and Microcystin

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### 8.1 Introduction

This chapter describes procedures and methods for field collection and preparation of the NWCA water chemistry, chlorophyll-*a*, and microcystin samples.

Data to be collected include:

- describing characteristics of Surface Water in the AA (including depth and extent);
- collecting a water sample for chemical analysis;
- collecting and filtering a surface water sample for chlorophyll-*a*;
- collecting an algal toxin water sample to detect microcystins (toxins from blue-green algae);  
and
- field probe readings (*optional*).

Prior to arrival on the site, the Assessment Area and Buffer (AB) Team should review the summary of activities from this chapter and have the forms and equipment needed for water sampling. The Team should also review information about the site that might influence implementation of the protocol. This is particularly important for planning the timing of access and to maximize time for sampling in tidally-influenced areas. Tides may make portions of the Assessment Area (AA) unsampleable or unsafe if the area is inundated by surface water 1 m or more in depth at some time during the tidal cycle on the day of sampling.

A flow-chart summary of sampling activities for collecting the water chemistry, chlorophyll-*a*, and microcystin samples is presented in Figure 8-1.

### Reference Card W-1: Water Chemistry, Chlorophyll-*a*, and Microcystin Sampling

The surface water samples should be collected as early in the sampling day as possible to standardize the collection time frame for water chemistry samples. This will limit the impact of diurnal changes in the water due to metabolic activity of the organisms in the water and disturbance caused by field activities.

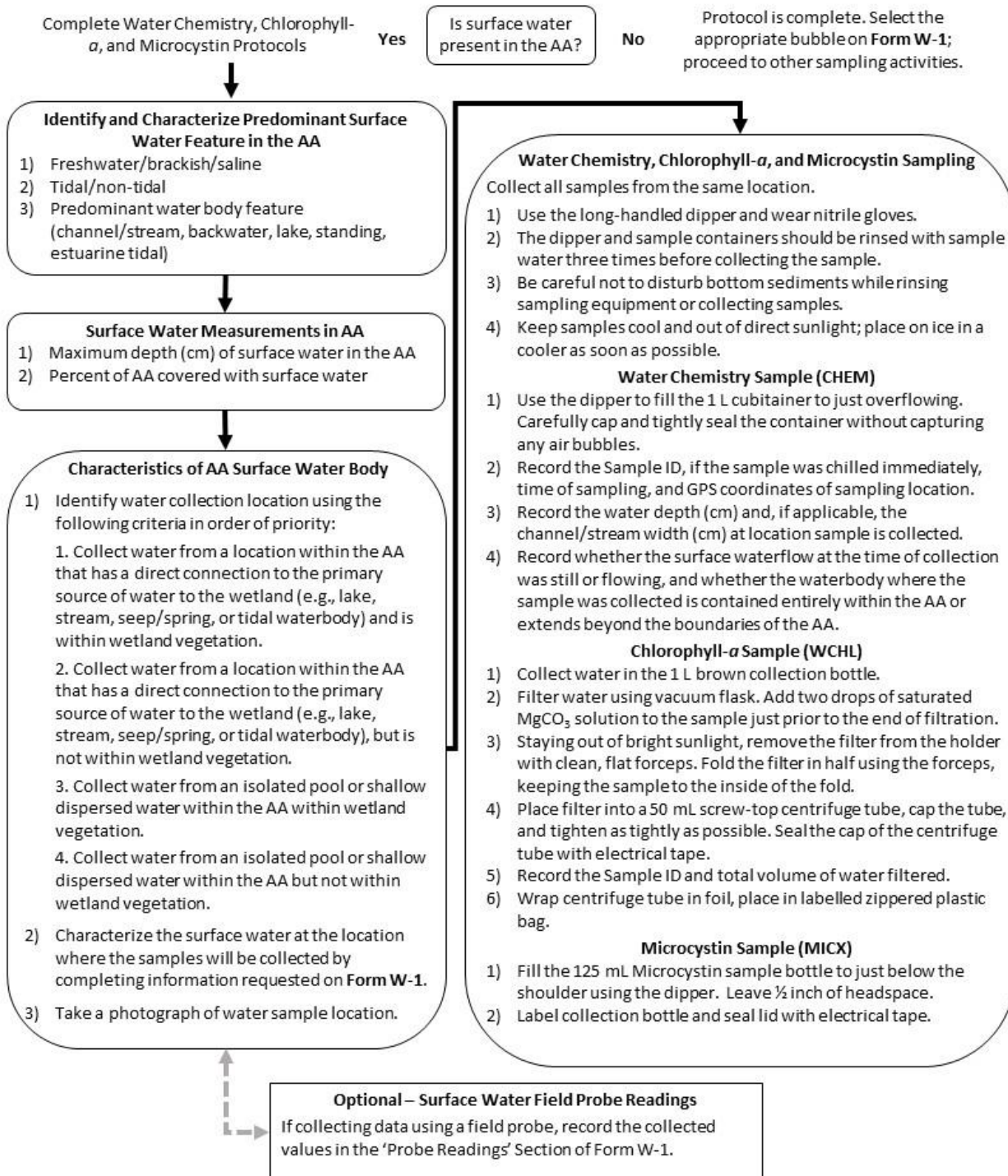


Figure 8-1. Flow chart of water sampling activities (Reference Card W-1).

## 8.2 Initial Characterization of Surface Water in the AA

After establishment of the AA, the AB Team will document if surface water is present within the AA and identify a suitable location for collecting a water sample. The water sample should reflect both the primary water source to the wetland and the wetland's biogeochemical effect on that water. The water sample collection location must be within the boundaries of the AA. Ideally, the collection location should (1) have a direct connection to the primary source of water to the wetland (e.g., lake, stream, seep/spring, or tidal waterbody) and (2) be within wetland vegetation. If a collection location that meets both criteria is not available, the water sample should be collected from a location that meets one of the criteria, with preference for sampling water from the primary water source within the AA. Collecting water from an isolated pool or shallow dispersed standing water within the AA should be the last choice but is still preferable to collecting no water at all. See **Reference Card W-1** for sampling priority list.

GPS coordinates and a brief written description for the water sample collection location must be provided whenever a water sample is collected. The AB team should coordinate with the Veg Team to confirm that the water sampling location is not in a Veg Plot. If it is within a Veg Plot, then consult with the Botanist/Ecologist to determine the best strategy for sampling to avoid compromising data for either indicator. If the site is tidal, be sure to consider stage of tide in the timing of the sampling.

The AB team should complete the water sampling prior to collecting data for other indicators to avoid degrading the water while completing other sampling tasks. Use flagging, if necessary, to keep crew members clear of the water sampling location until the water can be sampled. Water information is recorded on the **AA Water Form (W-1)**.

### 8.2.1 Presence of Surface Water in the AA

If there is no surface water in the AA, select the "No" bubble in the Presence of Surface Water section of the **AA Water Form (W-1)**. The water chemistry, chlorophyll-*a*, and microcystin protocols do not need to be completed, and the AB team can proceed to other tasks. The water chemistry, chlorophyll-*a*, and microcystin samples will be automatically marked 'not collected'. It will be understood that the reason for not collecting these samples is that there was no surface water present in the AA.

If surface water is present in the AA, select the "Yes" bubble in the Presence of Surface Water section of the **AA Water Form (W-1)** and describe the characteristics of the surface water by completing the information requested. After selecting "Yes" additional data fields will appear in the App.

### 8.2.2 Type of Surface Water in the AA

Complete the *Type of Surface Waters* section of the **AA Water Form (W-1)**. Indicate 1) whether the water is freshwater (salinity <0.5 ppt), brackish (salinity is between 0.5 and 30 ppt), or saline (salinity ≥30 ppt) (Cowardin et al. 1979); 2) whether the location is tidal or non-tidal; and 3) the predominant surface water feature in the AA (channel/stream, backwater, lake, standing, estuarine tidal). See Table 8-1 for descriptions of the different feature types. Use the comments bubble in this section of the **AA Water Form (W-1)** to add any information that would clarify the type of surface water in the AA.



**Table 8-1 Water feature types.**

FEATURE TYPE	DESCRIPTION
CHANNEL/STREAM	Rivers, streams, ditches (need width)
BACKWATER	Sloughs, backwaters, off-channel areas around rivers
LAKE	Open water area of lakes and ponds
STANDING	Isolated pool or shallow dispersed standing water
ESTUARINE TIDAL	Brackish or salt water tidal

*Note: It is not necessary to measure the salinity of the water in order to make the above determinations. Crews not using the optional multi-parameter probe should use data from previous field investigations, available salinity tables, or any other knowledge of the site to classify the water type.*

### 8.2.3 Surface Water Measurements of AA

Record measurements about the depth and areal extent of surface water in the AA by filling out the *Surface Water Measurements in the AA* portion of the **AA Water Form (W-1)**.

**Determine the Maximum Depth of Surface Water** - Measure the depth (cm) of surface water (surface down to top of substrate) at its deepest point in the AA and record the value on the **AA Water Form (W-1)**. Use a meter stick or other measurement rod.

- Due to safety considerations, estimate the depth if water is over 1 meter deep rather than trying to measure the actual depth.
- In tidally influenced locations, make sure to fill in the bubble on the top of the **AA Hydrology Form (H-1)** identifying tidal stage because depth will vary with tidal stage.

**Percent of AA Covered by Surface Water** - Estimate the percent of the AA covered by surface water (to the nearest 10%). There is no minimum depth required for this measurement. Record the value on the **AA Water Form (W-1)**.

### 8.2.4 Characteristics of the AA Surface Water Body

Characterize the surface water by filling out the *Characteristics of AA Surface Water Body* portion of the **AA Water Form (W-1)**. Select the bubbles for all the characteristics that apply to the surface water in the AA. Use the 'Other' field to describe anything that is not captured by the choices listed on the form. Use the comments bubble in this section the **AA Water Form (W-1)** to add any information that would clarify the characterization of the surface water body.

**Water Clarity** – Describe the relative clarity of the water by selecting the appropriate bubble.

**Substrate** – Determine the predominant substrate select the appropriate bubble.

**Substrate Color** – Identify the color of the predominant substrate lining the bottom of the water body being evaluated and record it by selecting the appropriate bubble.

**Rooted Vegetation in Substrate** - Indicate whether rooted vegetation is present in the water body being evaluated and record it by selecting the *Yes* or *No* bubble.

**Water Smell** – Identify any distinguishable odors and select the appropriate bubble(s).

**Surface/Water Column Conditions** – Record whether any of the items listed are present on the water surface or in the water column by selecting the appropriate bubble(s).

### 8.3 Collection of Water Chemistry Sample

Collect surface water samples as early in the sampling day as possible to standardize the collection time frame for water chemistry samples. This will limit the impact of diurnal changes in the water due to metabolic activity of the organisms in the water and disturbance caused by field activities.

#### Steps in Water Sample Collection

- 1) Label the 1-liter cubitainer prior to filling. Use the preprinted, adhesive-backed label provided by the NWCA Information Management (IM) Team similar to the one shown below (Figure 8-2). The labels will be provided as part of the Site Kit (see Chapter 2). Make sure to record the correct site ID number on the sample label. Clearly write the date on the label with an indelible marker, indicate the visit number, and affix the label to the correct container.
- 2) Cover the label with a strip of clear tape to protect the writing from getting smudged or rubbed off. Keep the container closed until the water chemistry sample is collected and ready to pour into the container. Keeping the lid closed until the AB team is ready to sample helps keep contaminants out of the container.

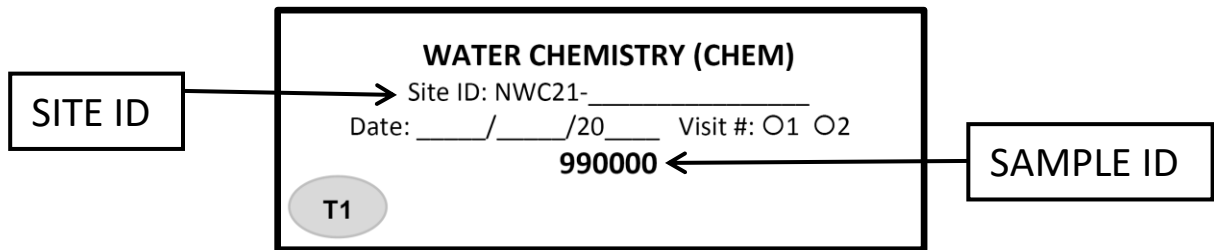


Figure 8-2. Water chemistry labels to be affixed to surface water sample cubitainer.

- 3) Approach the surface water sample location (Figure 8-3) carefully. Do not step into the water unless absolutely necessary to obtain a sample. This will help to avoid disturbing sediments, falling in, or fouling the water and potentially contaminating or otherwise compromising the quality of the sample.





Figure 8-3. Example of long-handled dipper in use for sampling surface water. (Photo credit – Chris Turner, GLEC)

- 4) Put on nitrile gloves to avoid contaminating the sample with hand creams, ointments, sunscreen or other materials that might be on the hands of the person taking the sample.
- 5) Rinse the dipper cup three times by immersing the cup in the water while being careful not to stir or otherwise disturb bottom sediments as the dipper cup is rinsed. Pour the water away from the area to be sampled so that the discarded water does not drain back into the sample area and potentially affect the collected sample.
- 6) Collect sample in the deepest spot of the collection area of the AA. Avoid fouling the water as the dipper is used to collect the sample, and pick an area completely free of surface debris if possible. If vegetation or debris is present and cannot be avoided, slowly and carefully push aside the floating vegetation or other debris with the long handle of the dipper to create a clear section of water for sample collection. Use care not to disturb bottom sediments when pushing aside debris or vegetation or when collecting water with the dipper. If bottom sediments become disturbed, move to an adjacent area where the water has not been contaminated.
- 7) Remove the lid from the 1-liter cubitainer and expand it by gently pulling out the sides. **NOTE: DO NOT BLOW into the cubitainer or place your fingers inside to opening to expand it since this action will contaminate the sample.**
- 8) Rinse the inside of the cubitainer with small amounts of sample water. Pour water from the dipper into the container and then rinse the container by gently swishing the water around and pouring it away from where the sample will be taken. Repeat the process a total of three times. Hold the container while filling to keep the container from tipping over and spilling the sample and/or allowing the opening to touch the ground which would contaminate the sample.

To avoid sample contamination by substances potentially present on the gloved fingers, do not touch the threads of the container opening or the inside of the cap to the container. Collapsible containers usually have a molded collar just below the screw threads that collar can be extended and should be used to hold the container and keep fingers away from the screw threads while filling (Figure 8-4).



Figure 8-4. Example of filling the cubitainer. (Photo credit – Chris Turner, GLEC)

- 9) Use the dipper to fill the container to just overflowing. When the container has been filled, carefully cap and tighten to seal the container without capturing any air bubbles. Removal of all air bubbles eliminates the opportunity for chemicals in the water to interact with air and change chemical characteristics of the sample.
- 10) Should a bubble that is a cubic centimeter or greater occur in the sample, tap the cubitainer slightly to cause any bubbles clinging to the cubitainer sides to rise to the surface and accumulate just under the lid. Gently squeeze the cubitainer and loosen the cap slightly allow air to escape through the threads of the cap. When all air has been released, retighten the cap. If air bubbles still exist in the sample, repeat as necessary. Seal the lid with electrical tape.
- 11) If a sample is compromised by potential contamination, discard the sample, and re-rinse the cubitainer and threads before starting over.
- 12) Record the Water Chemistry Sample ID number from the label in the Anchor ID/Water Chem ID field of the **Tracking Form** in the App. Doing so will automatically populate the sample IDs in the Water Samples section of the **AA Water Form (W-1)**. Verify the Sample ID number from the Sample Label for the Water Chemistry Sample (CHEM) agrees with the sample ID on the **W-1 Form**.
- 13) Note anything unusual about the sample in the comment bubble.
- 14) Record the time (24-hour clock) that the sample was collected. You can tap the 'Now' button to populate this field or type the time directly into the field using the correct format (hh:mm).
- 15) Record the GPS coordinates (in decimal degrees) at the location the sample was collected.
- 16) Record the water depth in centimeters at the location the sample was collected.
- 17) Record the channel/stream width in centimeters, if applicable, at the location the sample was collected.
- 18) Record whether the surface water at the time of collection was still or flowing.
- 19) Record whether the waterbody where the sample was collected is contained entirely within the AA or extends beyond the boundaries of the AA.
- 20) Take a photograph of the water sample location.

If no sample was collected, even though surface water was present in the AA, select the box for *No Sample Collected* and explain why in the adjacent comment bubble. Normally, water samples are taken wherever there is surface water. Thus, in this circumstance, it will be very RARE for no sample to be collected.

### 8.3.1 Water Sample and Data Handling

There are two components to water chemistry sample handling. One is completed before leaving the site; the other, at the field lodging or office.

#### 8.3.1.1 At the Field Site

Place the water chemistry sample on ice in a cooler as soon as possible after collection. If a cooler is not immediately available on-site, place the cubitainer in a small white plastic trash bag out of direct sunlight and in a cool location. Record on the **AA Water Form (W-1)** if the sample was placed on ice by selecting the “Yes” bubble indicating that the sample was chilled before and during transport back to the base site. If there was no ice available, then select the “No” bubble.

Transport samples to field lodging or the office in an ice chest on wet ice.

#### 8.3.1.2 At Field Lodging or Office

The water chemistry sample for each site will be sent to a designated lab (either state or national) within 24 hours of collection (i.e., the same day as sampling or the next day) in a cooler along with the chlorophyll-*a* sample.

The protocol below covers the details of shipping that pertain to the water chemistry sample. See Chapter 2 for information that pertains to all of the immediately shipped samples. See 8.7 Appendix A for detailed protocols on packing, tracking, and shipping samples and for shipping addresses.

- 1) Maintain the water chemistry sample on blue ice, wet ice, or under refrigeration (4°C) until the sample is shipped.
- 2) Confirm that the label affixed to the sample cubitainer has the correct site identification number, is complete and legible, and is covered with clear tape.
- 3) Ensure that any air has been removed from each cubitainer and that the cubitainer is tightly sealed. Seal the lid with electrical tape.
- 4) The samples will be shipped in a medium-sized cooler with wet ice. Line the cooler with the provided heavy duty liner bag and place the Water Chemistry and Chlorophyll-*a* samples and ice inside the liner bag. Seal the cooler liner with the provided zip-tie.
- 5) Fill out the T-1: Daily Water Chemistry Shipment section of the **Tracking Form** in the App and a T-1 packing slip (Figure 8-5) for each site.
  - Ensure that the Site ID number, the visit number, date collected, and sample IDs are listed on the packing slip and that this information corresponds exactly to the information on the label for the Soil Isotopes Sample.
  - Enter the shipping details (lab, date shipped, airbill number, sender’s name, and sender’s phone number) into the **Tracking Form** in the app.

For Lab Staff only:  
Lab Sample ID: \_\_\_\_\_

T1: NWC21 Daily Water Chemistry Sample Tracking

Site ID: NWC21-Test-OK-10005 Visit #: ● 102

Date Collected: 07/27/2021

Sample ID Lab Comments (For lab staff only)

CHEM 990000 \_\_\_\_\_

Sample ID Lab Comments (For lab staff only)

WCHL 990001 \_\_\_\_\_

For Lab Staff only:  
Date Rec'd: \_\_\_\_\_ Rec'd by: \_\_\_\_\_

Figure 8-5. Example T-1 (Daily Water Chemistry Sample Tracking) Packing Slip

- 6) Place the packing slip into the sleeve on the inside of the cooler lid.
- 7) Affix a T-1 shipping label to a handle tag and affix the handle tag to the handle of the cooler using one of the provided zip-ties (see 8.7Appendix A).
- 8) Once you are certain that all samples and the completed packing slip are included in the cooler, lower the cooler handle and carefully seal the cooler with tape (securing the handle in the lowered position).
- 9) Submit the water data and tracking form via the App. See Chapter 2 for details on submitting data and tracking forms to the Information Management Team. Remember that data can be updated at any time by amending the App forms and re-submitting them, so crews are encouraged to submit data as soon as possible after leaving the field to avoid potential data loss from a lost or damaged iPad.
- 10) Deliver the package of samples to the shipping company and retain all receipts and records of shipping.

### 8.3.1.3 Data Handling

See Chapter 2 for protocols on submitting data to the IM Team via the NWCA App. See 8.7Appendix D for information on transmitting the image files of any photos related to water taken by the AB team.

## 8.4 Collection of Chlorophyll-*a* Sample

This section provides the protocols necessary to collect and filter surface water for a chlorophyll-*a* sample. Chlorophyll-*a* samples provide data on green algal biomass that can give an estimate of algal productivity reflecting nutrient concentrations in water. Nutrient status can reflect normal or stressed conditions and are dependent on wetland type.

### 8.4.1 Sampling Procedures

The AB Team will collect the water sample for chlorophyll-*a* analysis at the same time and location as the water chemistry sample.

#### *8.4.1.1 Protocols for Collection of Sample*

A flow-chart summary of sampling activities for collecting the water chemistry, chlorophyll-a, and microcystin samples is presented in Figure 8-1. This summary is provided as a Reference Card (**Reference Card W-1, Side A**) for field use.

#### *8.4.1.2 Procedure for Collecting a Chlorophyll-a (Biomass) Sample*

If surface water is present in the AA, and a water chemistry sample was collected, then a chlorophyll-a sample will also be collected.

- 1) Put on nitrile gloves.
- 2) Rinse the long-handled dipper (Figure 8-3) three times with surface water and then rinse the 1L brown collection bottle three times with surface water. Pour the used water on the ground away from the surface water area to be sampled so that the sample is not compromised.
- 3) Fill the 1L bottle with surface water by collecting water with the long-handled dipper. Collect water from the same location that the water chemistry sample was taken.
- 4) If possible, keep the collection bottle chilled and out of direct sunlight until processing.

#### *8.4.1.3 Procedure for Filtering a Chlorophyll-a (Biomass) Sample*

- 1) Set up the chlorophyll-a filtering apparatus on a flat surface, and attach the vacuum pump (Figure 8-8). Crews must make every attempt to process chlorophyll-a samples in subdued light, out of direct sunlight.
- 2) Put on nitrile gloves.
- 3) Crews will use a 250 mL filter funnel (with blue bottom), rubber stopper, and adapter that are specifically designated for chlorophyll filtering. Several filter funnels will be provided in each base kit and should be reused at several sites (with thorough cleaning and rinsing performed between sites). Be sure to retain and thoroughly clean and rinse the support pad upon which the filter will be placed. The stopper and adapter are also to be retained and cleaned between sampling events. Prior to filtration of the sample, rinse all reusable items three times with DI water. Rinse the graduated cylinder with DI water as well.
- 4) After assembling the filtering apparatus and attaching the filter funnel to the side-arm filter flask with the rubber stopper and adapter, remove the funnel portion of the filter funnel from the blue base. If this is a new filter funnel, remove the pre-loaded filter (which has a faint grid pattern on it) but leave the white support pad in place.
- 5) Use clean forceps to place a Whatman GF/F 47-mm 0.7-micron filter on the support pad with the gridded/pressed side of the filter facing down, making sure both the support pad and filter are centered on the base of the filter funnel.
- 6) Reattach the funnel portion of the filter funnel to the base by pressing it straight down firmly. This will firmly hold the filter in place.
- 7) Remove the 1-L amber chlorophyll-a collection bottle from the cooler and gently shake it to mix the sample. Using the graduated cylinder, measure and pour 100 mL of water into the filter holder, replace the cover, and use the vacuum pump to draw sample through the filter. Do not exceed 7 inches of Hg of vacuum (about 3.44 psi) or a filtration duration of more than 5 minutes for a single sample volume to avoid cell damage or loss of contents during filtering.

- 8) Filter as much of the 1-L of surface water from the sample bottle that will readily pass through the filter following the procedure below.
  - Begin by measuring 100 mL of surface water from the 1-L bottle into the graduated cylinder.
    - If the water is very green or turbid, use a smaller, measured volume.
    - In subsequent iterations, use less water if filtering is slow.
    - Accurately keep track of the total amount of sample water filtered.
  - Pour all the water from the graduated cylinder into the filter holder.
  - Replace the lid on the filter holder and the cap on the 1-L bottle. Keep the bottle chilled and in the dark as much as possible.
  - Use the vacuum pump to pull the sample through the filter, not exceeding 7 in of Hg pressure (3.44 psi).
  - Check to assure that water is not leaking out of the apparatus and is moving through the filter.
  - If 100 mL of water from the AA will not pass through the filter, change the filter, rinse the apparatus with DI water, discard the water, and repeat the procedure using 50 mL of the water from the 1-L bottle.
  - Any aliquot of water measured into the graduated cylinder must be placed into the filter funnel in its entirety. Water left to sit in the graduated cylinder will begin to settle and it is therefore not advisable to filter only a portion of that aliquot.
  - If, at any point, the filter plugs and the filtering must be aborted, the filter must be discarded and the process restarted the.
  - Check the filter for readily visible green color.
    - *If there is readily visible green color, go to Step 9.*
    - *If there is little or no visible color, repeat Step 8 until strong green color is visible on the filter.*
- 9) Rinse the graduated cylinder and filter funnel portion of the filtering apparatus thoroughly using a squeeze bottle filled with DI water to dislodge any cells adhering to the cylinder or funnel.
- 10) Pump the rinse water through the filter, not exceeding 7 in of Hg pressure (3.44 psi).
- 11) Monitor the level of water in the lower chamber (500 mL sidearm filter flask) to ensure that it does not contact the filter or flow into the vacuum pump.
  - If needed, carefully remove the bottom chamber of the filter apparatus and discard the filtered water. Replace the bottom chamber on the apparatus.
- 12) When the last volume of chlorophyll sample and rinse is being filtered into the flask, extract most of the liquid. Add  $\text{MgCO}_3$  and complete the extraction of liquid from the sample on the filter.
  - Add two drops of a saturated  $\text{MgCO}_3$  solution to the sample just prior to the end of filtration when only a few milliliters of water are left to be filtered. If added prematurely, it may greatly increase the sample filtration time. The  $\text{MgCO}_3$  acts to buffer the sample.
    - The hand operated vacuum pump has a vacuum release lever that will relieve the vacuum on the system and slow or stop the filtration process. This will allow time to add the  $\text{MgCO}_3$  before all the liquid is drawn through the filter.
- 13) Record the total volume of sample filtered in the *chlorophyll-a (WCHL)* portion of the Water Samples section of the **AA Water Form (W-1)**.



- 14) Staying out of bright sunlight, remove the filter from the holder with clean, flat forceps. Avoid touching the colored portion of the filter which contains the chlorophyll sample. Fold the filter in half using the forceps, keeping the sample to the inside of the fold.
- 15) Place the folded filter into a 50-mL screw-top centrifuge tube and cap the tube. Tighten the cap as tightly as possible. The cap will seal tightly after an additional  $\frac{1}{4}$  turn past the point at which initial resistance is met. Failure to tighten the lid completely could allow water to infiltrate into the sample and may compromise its integrity. Seal the cap of the centrifuge tube with electrical tape.
- 16) Record the sample volume filtered and date on the chlorophyll-*a* label (Figure 8-6) and attach it to the centrifuge tube. Ensure that all written information is complete and legible. Cover the label with a strip of clear tape to protect the information on the label.

1 2', and 'Volume Filtered: \_\_\_\_ mL'. A 'SAMPLE ID' of '990001' is written in the bottom right. A 'T1' bubble is in the bottom left. Arrows point from 'SITE ID' and 'SAMPLE ID' boxes to their respective fields on the label."/>

**WATER COLUMN CHLOROPHYLL (WCHL)**

Site ID: NWC21-\_\_\_\_\_

Date: \_\_\_\_/\_\_\_\_/20\_\_\_\_ Visit #: 1 2

Volume Filtered: \_\_\_\_ mL

**990001**

T1

Figure 8-6. Chlorophyll-*a* label to be filled out and placed on the centrifuge tube

- 17) Record the Water Chemistry Sample ID number from the label in the Anchor ID/Water Chem ID field of the **Tracking Form** in the App. Doing so will automatically populate the sample IDs in the Water Samples section of the **AA Water Form (W-1)**. Verify the Sample ID number from the Sample Label for the Chlorophyll-*a* Sample (WCHL) agrees with the sample ID on the **W-1 Form**.
- 18) Note anything unusual about the sample in the comment bubble.
- 19) Wrap the centrifuge tube in foil immediately to keep sunlight from degrading the sample. Place the tube in a zippered plastic bag. Record the volume filtered and date on the chlorophyll-*a* OUTER BAG label (Figure 8-7), and attach this label to the outside of the plastic bag. Cover with a strip of clear tape to protect the information on the label.

1 2', and 'Volume Filtered: \_\_\_\_ mL'. A 'SAMPLE ID' of '990001' is written in the bottom right. A 'T1' bubble is in the bottom left. Arrows point from 'SITE ID' and 'SAMPLE ID' boxes to their respective fields on the label."/>

**WATER COLUMN CHLOROPHYLL (WCHL) -  
OUTER BAG**

Site ID: NWC21-\_\_\_\_\_

Date: \_\_\_\_/\_\_\_\_/20\_\_\_\_ Visit #: 1 2

Volume Filtered: \_\_\_\_ mL

**990001**

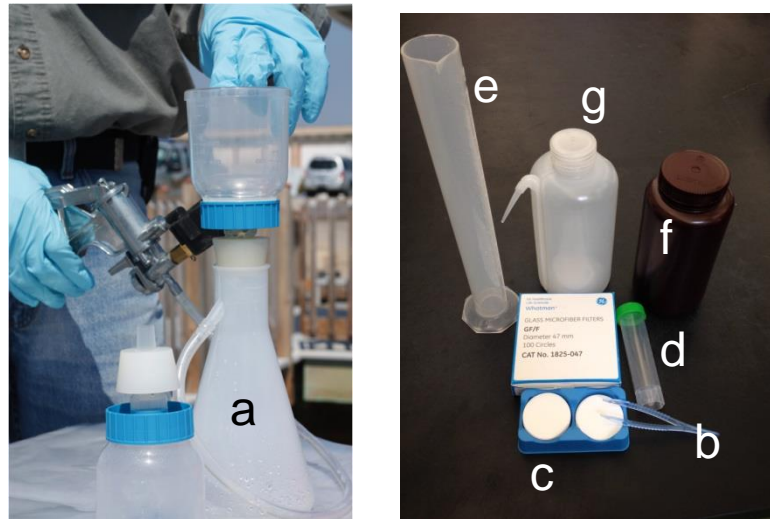
T1

Figure 8-7. Chlorophyll-*a*, OUTER BAG label to be filled out and placed on the plastic bag containing the chlorophyll-*a* sample

- 20) Immediately place the chlorophyll-*a* sample in a cooler with ice to keep it out of the light and as cold as possible.

If no chlorophyll-*a* sample was collected, even though surface water was present in the AA, select the box for *No Sample Collected* and explain why in the adjacent comment bubble.





**Figure 8-8. Set-up for filtering the chlorophyll-*a* sample. a) Filter flask with filter funnel and vacuum pump for sample filtration, b) flat-bladed forceps, c) Whatman glass fiber filter, d) screw top centrifuge tube to hold folded filter with the chlorophyll-*a* sample inside, e) 250-mL graduated cylinder, f) 1-L brown bottle for sample collection, g) squeeze bottle for DI water. (Photos by Chris Turner and Mike Dunlop, GLEC)**

### 8.4.2 Sample and Data Handling

There are two components to chlorophyll-*a* sample handling and processing. One is done before leaving the site; the other, at the base location.

#### 8.4.2.1 At the Field Site

Place the chlorophyll-*a* sample on ice in a cooler as soon as possible after filtration. Transport samples to field lodging or the office in an ice chest on wet ice.

#### 8.4.2.2 At Field Lodging or Office

The chlorophyll-*a* sample for each site will be sent to a designated lab (either state or national) within 24 hours of collection (i.e., the same day as sampling or the next day) in a cooler along with the water chemistry sample.

The protocol below covers the details of shipping that pertain to the chlorophyll-*a* sample. See Chapter 2 for information that pertains to all of the immediately shipped samples. See 8.7Appendix A for detailed protocols on packing, tracking, and shipping samples and for shipping addresses.

- 1) Maintain the chlorophyll-*a* sample on blue ice, wet ice, or under refrigeration (4°C) until the sample is shipped.
- 2) Confirm that the labels affixed to the centrifuge tube and outer bag have the correct site identification number, are complete and legible, and are covered with clear tape.
- 3) Ensure that the centrifuge tube is tightly sealed and sealed with electrical tape. Ensure that the centrifuge tube is wrapped in aluminum foil.
- 4) The samples will be shipped in a medium-sized cooler with wet ice. Line the cooler with the provided heavy duty liner bag and place the Water Chemistry and Chlorophyll-*a* samples and ice inside the liner bag. Seal the cooler liner with the provided zip-tie.

- 5) Fill out the T-1: Daily Water Chemistry Shipment section of the **Tracking Form** in the App and a T-1 packing slip (Figure 8-9) for each site.
  - Ensure that the Site ID number, the visit number, date collected, and sample IDs are listed on the packing slip and that this information corresponds exactly to the information on the label for the Soil Isotopes Sample.
  - Enter the shipping details (lab, date shipped, airbill number, sender's name, and sender's phone number) into the **Tracking Form** in the app.

For Lab Staff only:	
Lab Sample ID: _____	
<b>T1: NWC21 Daily Water Chemistry Sample Tracking</b>	
Site ID: <u>NWC21-Test-OK-10005</u>	Visit #: 102
Date Collected: <u>07/27/2021</u>	
Sample ID	Lab Comments (For lab staff only)
CHEM 990000	
Sample ID	Lab Comments (For lab staff only)
WCHL 990001	
For Lab Staff only:	
Date Rec'd: _____	Rec'd by: _____

**Figure 8-9. Example T-1 (Daily Water Chemistry Sample Tracking) Packing Slip**

- 6) Place the packing slip into the sleeve on the inside of the cooler lid.
- 7) Affix a T-1 shipping label to a handle tag and affix the handle tag to the handle of the cooler using one of the provided zip-ties (see 8.7Appendix A).
- 8) Once you are certain that all samples and the completed packing slip are included in the cooler, lower the cooler handle and carefully seal the cooler with tape (securing the handle in the lowered position).
- 9) Submit the water data and tracking form via the App. See Chapter 2 for details on submitting data and tracking forms to the Information Management Team. Remember that data can be updated at any time by amending the App forms and re-submitting them, so crews are encouraged to submit data as soon as possible after leaving the field to avoid potential data loss from a lost or damaged iPad.
- 10) Deliver the package of samples to the shipping company and retain all receipts and records of shipping.

#### 8.4.2.3 Data Handling

See Chapter 2 for protocols on submitting data to the IM Team via the NWCA App. See 8.7Appendix D for information on transmitting the image files of any photos related to water taken by the AB team.

## 8.5 Collection of Microcystin Sample

This section provides the protocols necessary to collect the microcystin sample. Microcystins are a class of toxins produced by blue-green algae that can have harmful health effects to humans and animals if concentrations are high as a result of high abundance of certain blue-green algae. For example,

*Microcystis* is a blue-green algae genus that is found naturally at low abundance in freshwater systems which can produce microcystin toxins. Under optimal conditions (such as high light and calm weather, usually in summer), *Microcystis* occasionally forms a bloom, or dense aggregation of cells, that floats on the surface of the water forming a thick layer or mat.

### 8.5.1 Sampling Procedures

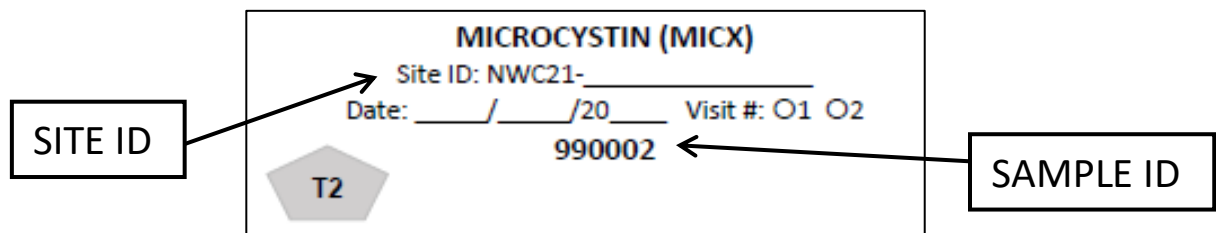
The AB Team will collect the water sample for microcystin at the same time and location as the water chemistry sample.

#### 8.5.1.1 Protocols for Collection of Samples

A flow-chart summary of sampling activities for collecting the water chemistry, chlorophyll-*a*, and microcystin samples is presented in Figure 8-1. This summary is provided as a Reference Card (**Reference Card W-1, Side A**) for field use.

#### 8.5.1.2 Procedure for Microcystin Sampling

- 1) Record the collection date and site ID number on the microcystin label (Figure 8-10). Attach the microcystin label to a 125-mL plastic bottle.
- 2) Cover the label with clear tape to protect the information on the label from smudging or rubbing off.
- 3) Record the Water Chemistry Sample ID number from the label in the Anchor ID/Water Chem ID field of the Tracking Form in the App. Doing so will automatically populate the sample IDs in the Water Samples section of the **AA Water Form (W-1)**. Verify the Sample ID number from the Sample Label for the Microcystin Sample (MICX) agrees with the sample ID on the **W-1 Form**.



**Figure 8-10. Example of Microcystin label. Note Site ID must be filled in and that Sample ID numbers are unique.**

- 4) Put on nitrile gloves.
- 5) Rinse the long-handled dipper (Figure 8-3) three times with surface water and then rinse the 125 mL microcystin bottle three times with surface water. Pour the used water on ground away from the surface water area to be sampled so that the sample is not compromised.
- 6) Use the dipper to obtain more surface water and fill the 125mL microcystin bottle just to the shoulder. The sample will be frozen in the lab, so a half-inch of headspace is needed to allow for expansion.
- 7) Replace the cap and tighten securely. Seal the lid with electrical tape.
- 8) Put this sample on ice. If a cooler with ice is not immediately available, place the sample out of direct sunlight in the coolest location possible, either in a white plastic bag or in a small cooler filled with a frozen gel-pack until the sample can be placed on ice in a cooler. Record on the **AA Water**

**Form (W-1)** if the sample was placed on ice immediately by filling in the “Yes” bubble indicating that sample was chilled. If there was no ice available, then fill in the “No” bubble.

9) Note anything unusual about the sample in the comment bubble.

If no microcystin sample was collected, even though surface water was present in the AA, select the box for *No Sample Collected* and explain why in the adjacent comment bubble.

### 8.5.2 Sample and Data Handling

There are two components to microcystin sample handling and processing. One is done before leaving the site; the other, at the base location.

#### 8.5.2.1 At the Field Site

Place the microcystin sample on ice in a cooler as soon as possible after collection. If a cooler is not immediately available on-site, place the cubitainer in a small white plastic trash bag out of direct sunlight and in a cool location. Record on the **AA Water Form (W-1)** if the sample was placed on ice by selecting the “Yes” bubble indicating that the sample was chilled before and during transport back to the base site. If there was no ice available, then select the “No” bubble.

Transport samples to field lodging or the office in an ice chest on wet ice.

#### 8.5.2.2 At Field Lodging or Office

The microcystin sample for each site will be sent to the Batch Lab within 24 hours of collection in a cooler with the soil isotope samples. These samples will be shipped on wet ice and will be subsequently frozen and sent to the processing labs in batches.

The protocol below covers the details of shipping that pertain to the microcystin sample. See Chapter 2 for information that pertains to all of the immediately shipped samples. See 8.7Appendix A for detailed protocols on packing, tracking, and shipping samples and for shipping addresses.

1. Maintain all samples on blue or wet ice, or under refrigeration (4°C) until they are shipped.
2. Confirm that the label affixed to each sample has the correct Site ID, is complete, and is covered with clear tape.
3. Ensure that the bottle cap is tight and sealed with electrical tape.
4. The samples will be shipped in a small cooler with wet ice. Line the cooler with the provided heavy duty liner bag and place the Soil Isotope and Microcystin samples and ice inside the liner bag. Seal the cooler liner with the provided zip-tie.
5. Fill out the T-2: Daily Chilled Shipment section of the **Tracking Form** in the App and a T-2 packing slip (Figure 8-11) for each site.
  - Ensure that the Site ID number, the visit number, date collected, and sample IDs are listed on the packing slip and that this information corresponds exactly to the information on the label for the Soil Isotopes Sample.
  - Enter the shipping details (lab, date shipped, airbill number, sender’s name, and sender’s phone number) into the **Tracking Form** in the app.

T2: NWC21 Daily Chilled Tracking

Site ID: NWC21-Test-OR-10005 Visit #: 102

Date Collected: 07/27/2021

Lab Staff:	Samples In Box?	Sample ID
	<input type="checkbox"/>	MICX 990002
		Lab Comments (For lab staff only)
		Sample ID
	<input type="checkbox"/>	SISO 990003
		Lab Comments (For lab staff only)

Please cross out sample id(s) not included in shipment.

**Figure 8-11. Example T-2 (Daily Chilled Tracking) Packing Slip**

6. Place the packing slip (along with the provided APHIS soil shipping permit) into the provided zip-top bag and on top of the sealed cooler liner.
7. Affix a T-2 shipping label to the top of the (see Appendix A). Close and seal the cooler lid with tape.
8. Submit the water data and tracking form via the App. See Chapter 2 for details on submitting data and tracking forms to the Information Management Team. Remember that data can be updated at any time by amending the App forms and re-submitting them, so crews are encouraged to submit data as soon as possible after leaving the field to avoid potential data loss from a lost or damaged iPad.
9. Deliver the package of samples to the shipping company and retain all receipts and records of shipping.

### 8.5.2.3 Data Handling

See Chapter 2 for protocols on submitting data to the IM Team via the NWCA App. See 8.7Appendix D for information on transmitting the image files of any photos related to water taken by the AB team.

## 8.6 Reference Card

Reference Card W-1: Water

The Water Reference Card is compiled (with all other NWCA 2021 Reference Cards) in the Quick Reference Guide.

## 8.7 Equipment, Data Form, and Label Lists

### WATER SAMPLING EQUIPMENT CHECKLIST

#### General

- \_\_\_\_\_ Nitrile gloves, disposable (always carry half dozen per site)
- \_\_\_\_\_ Long-handled plastic dipper with centimeter graduations on the handle
- \_\_\_\_\_ Soft pack cooler with ice or frozen gel-packs (for longer distance hikes away from vehicle)
- \_\_\_\_\_ Data Forms and Labels

- \_\_\_\_\_ Clear tape strip packs for covering labels
- \_\_\_\_\_ Electrical tape for sealing lids of sample containers
- \_\_\_\_\_ Permanent marker (Fine-tip for labels)
- \_\_\_\_\_ No. 2 pencils
- \_\_\_\_\_ Folding ruler (with metric markings)
- \_\_\_\_\_ Paper towels (for any clean up)
- \_\_\_\_\_ Reference Card W-1
- \_\_\_\_\_ iPad with NWCA App

### **Water Chemistry Sample**

- \_\_\_\_\_ Collapsible 1-liter cubitainer for surface water sample
- \_\_\_\_\_ Cooler with ice at vehicle
- \_\_\_\_\_ Small white plastic trash bags (7-10 gallon) if needed for temporary storage of water samples
- \_\_\_\_\_ Small, soft-sided cooler w/ blue ice to fit (for sites not close to vehicle)

### **Chlorophyll-*a* Sample**

- \_\_\_\_\_ Aluminum foil or foil squares (to wrap chlorophyll-a sample vial)
- \_\_\_\_\_ 50-mL Centrifuge tube with screw cap in zip-top bag (for holding chlorophyll-a filter)
- \_\_\_\_\_ De-ionized (DI) water
- \_\_\_\_\_ DI squirt bottle
- \_\_\_\_\_ Disposable flat blade forceps (2)
- \_\_\_\_\_ Graduated cylinder (250-mL)
- \_\_\_\_\_ Hand-operated vacuum pump with tubing
- \_\_\_\_\_ Magnesium Carbonate (MgCO<sub>3</sub>) saturated solution in dropper bottle
- \_\_\_\_\_ 1-L brown plastic bottle for collection of chlorophyll sample (reusable)
- \_\_\_\_\_ 500-mL Sidearm filter flask
- \_\_\_\_\_ Whatman GF/F 0.7- $\mu$ m glass fiber filters (47-mm diam)

### **Microcystin Samples**

- \_\_\_\_\_ 125-mL plastic bottle with screw lid (microcystin bottle)

### **WATER FORMS**

- NWCA 2021 AA Water Form (W-1) in the NWCA App
- NWCA 2021 Tracking Form

### **WATER SAMPLE LABELS**

- Water Chemistry (CHEM) Sample Label
- Chlorophyll-*a* (WCHL) Sample Label
- Chlorophyll-*a* (WCHL) – Outer Bag Sample Label
- Microcystin (MICX) Sample Label

## Appendix A Shipping and Tracking

Crews submit tracking information via the NWCA App and include packing slips in the coolers/boxes when they send samples to the labs. If any sample listed on the packing slip is not being shipped, line out the sample ID to indicate that the sample is not included in the shipment (Figure A-1).

T2: NWC21 Daily Chilled Tracking

Site ID: NWC21- Test-OR-10005 Visit #: 102

Date Collected: 07/27/2021

Lab Staff:	Samples In Box?	Sample ID	Lab Comments (For lab staff only)
	<input type="checkbox"/>	<del>MCX 990002</del>	
	<input type="checkbox"/>	SISO 990003	

Please cross out sample id(s) not included in shipment.

Figure A-1. Example T-2 Packing Slip where no Microcystin sample has been collected (sample ID is lined out to indicate the sample is not included in the shipment)

### Procedure for filling out and submitting tracking via the App

1. After ensuring all of the samples to be shipped are properly preserved and prepared for shipment, access the **Tracking Form** in the App.
2. Ensure the correct water chemistry sample ID has been entered at the top of the **Tracking Form** in the *Anchor ID / Water Chem ID* field. Doing so will populate the sample IDs of all other collected samples. Samples that were not collected will display a blank sample ID field and the not collected bubble will be transferred from the individual sample collection forms. The not collected bubbles are not editable in the **Tracking Form**; to change the collection status of a sample, access the pertinent sample collection forms (e.g., **AA Water (W-1)** or **Soil Data (S-1)** forms).
3. In the *Number of Items* column, verify that the correct number of items being shipped is listed. In the case of soil samples, the App will tally the number of sample bubbles selected in the **Soil Forms**. This column is not editable in the **Tracking Form**, so if an error is found, it must be corrected in the pertinent collection form. In the case of Unknown and QA Vegetation samples, the collection numbers listed are generated from the selection of the Q and U bubbles on **Form V-2**, so the number of collections listed should equal the number of specimens being shipped in each sample type.
4. In the pertinent section of the **Tracking Form**, check the box under the *To Ship* column for each sample being sent in the shipment.



5. Click the '*Enter Shipping Details*' button and fill out the resulting popup window with the destination lab, date shipped, airbill number, sender and sender's phone number.
6. Click the '*save shipping info*' button to save the details and the **Tracking Form**.
7. Once the shipping details have been saved in the App, a date will appear in the '*shipped*' column of the **Tracking Form**. If the shipping details for a sample need to be edited, click the date in the '*shipped*' column to access the saved shipping details. Editing the details in this manner changes ONLY one sample at a time. The only way to enter shipping details for an entire group of samples is during the initial details entry.
  - a. If the status of the sample needs to change from shipped to **not** shipped, click the *date* in the '*shipped*' column to access the saved shipping details and delete all the shipping info. Click the "*save shipping info*" button after deleting all the shipping information. The sample will no longer be marked as shipped and the "to ship" checkbox will reappear.
8. After all pertinent shipping details have been saved, click the *SUBMIT* menu button and select the button next to '*Tracking*' and any other the forms that you wish to submit. Click the green submit button at the bottom of the form list. An email will pop up on your device addressed to [NARSFieldData@epa.gov](mailto:NARSFieldData@epa.gov). Copy yourself, any other crew members or managers and click send. To ensure that the email was sent, check the SENT mailbox on your email app and look for the recent email containing the data. If the email is not in the SENT mailbox, it was not sent and you should try again after verifying an internet connection.
9. At any point, if it is determined that data needs to be revised or updated, crews should feel free to do so in the App and re-submit any edited data or tracking forms using the steps above. Newly revised data will automatically take the place of previous data. It is not necessary to re-submit data or tracking forms that were unchanged however.
10. After submission, a data summary will be automatically emailed back to the email address from which the submission was received. The Field Crew Leader or his/her designee should review this data summary for accuracy and make any corrections necessary and re-submit the pertinent form(s).

## Shipping Groups

Each shipping group has been assigned a "T" number to help crews identify the correct section of the Tracking Form in the App to use when sending samples. This "T" number is located above each of the sample groups in the **Tracking Form** in the App. Crews will also find reference to the same "T" numbers on the individual samples labels, on the packing slips that crews will include in the coolers/boxes, and on the top of the pre-printed FedEx return labels provided in the label packets that accompany the site kits.

### *T-1 – Daily Water Chemistry Shipment*

If no sampleable water is present in the AA, these samples will not be collected or shipped and therefore this portion of the **Tracking Form** does not need to be filled out or submitted.

- Save any unused sample containers sealed in their original bag and either use for a future site or store until they can be returned to the Logistics Contractor.
- Discard any sample labels or tags that have sample IDs printed on them. Using these labels at another site will mix sample series, which is not allowed.

If water chemistry and/or chlorophyll-*a* samples were collected, complete the shipping information for those samples as detailed below.

- Complete the T-1 section of the **Tracking Form** for the samples that are shipped immediately (e.g., same day as sampling or following day) to the water chemistry lab or approved state lab after each sampling event:
  - Water chemistry (CHEM).
  - Chlorophyll-*a* (WCHL).
- Submit the **Tracking Form** and all data forms from the site to the IM Team via the NWCA App. This serves as the “status report” for that sampling event and shipping notification for the T-1 samples.
- Ship both of the samples to the lab in the same cooler with the packing slip that was provided with the label packet. If any sample listed on the packing slip is not being shipped, line out the sample ID to indicate that the sample is not in the cooler.
- Samples need to be shipped on as much fresh wet ice as will fit in the cooler liner.
- Water Chemistry and Chlorophyll-*a* samples should be shipped within 24 hours of collection (e.g., same day as sampling or the following day).

### *T-2 – Daily Chilled Shipment*

- Complete the T-2 section of the **Tracking Form** for the samples that are shipped immediately (e.g., same day as sampling or following day) to the batch lab or approved state lab after each sampling event:
  - Microcystin (MICX).
  - Soil Isotopes (SISO).
- Submit the **Tracking Form** to the IM Team via the NWCA App. This serves as the shipping notification for the T-2 samples.
- Ship both of the samples to the lab in the same cooler with the packing slip that was provided with the label packet. If any sample listed on the packing slip is not being shipped, line out the sample ID to indicate that the sample is not in the cooler.
- Samples need to be shipped on as much fresh wet ice as will fit in the cooler liner.
- Microcystin and Soil Isotope samples should be shipped within 24 hours of collection (e.g., same day as sampling or the following day).

### *T-3 – Soil Chemistry and Bulk Density Shipment*

- Complete the T-3 section of the **Tracking Form** for the soil samples that are shipped to the NRCS Soil Lab:
  - Standard depth soil cores (SDSC).
  - Soil horizon chemistry samples (SHCH).
  - Soil horizon bulk density samples (SHBD).
- Submit the **Tracking Form** to the IM Team via the NWCA App. This serves as the shipping notification for the T-3 samples.
- These three soil samples are shipped in a large cooler (ordered via the Request form) with heavy duty liner bag and no ice.

- Typically a large cooler will only hold soil samples from a single site, and due to the weight of the samples, it is recommended to only ship a single site's worth of soil samples per cooler.
- Ship all three sample types to the soil lab in the same cooler with the packing slip that was provided with the label packet. If any sample listed on the packing slip is not being shipped, line out the sample ID to indicate that the sample is not in the cooler.
- When the soil lab processes these samples, they will need to review the soil profile data collected in the field. Therefore, in addition to submitting the **Tracking Form**, be sure to finalize and submit the **Soil Data Form (S-1)** as soon as possible after sampling a site and shipping soil samples.
- Batched soil samples should be shipped at least every two weeks.

#### *T-4 – Unknown Plant Shipment*

- Complete the T-4 section of the **Tracking Form** for the Unknown Plant Samples (VEGU) that are shipped to either the national or a state lab or to indicate that they are being retained for identification.
- Submit the **Tracking Form** to the IM Team via the NWCA App. This serves as the shipping notification for the T-4 samples.
- Plant specimens are pressed and dried individually in labelled newsprint.
- Specimens (each in their respective newsprint) are placed into one or more labelled herbarium folders. Folders are labelled with site information and an indication of the folder number, in addition to the number of specimens contained within the folder.
- Herbarium folders are placed in a provided zip-top bag and then into a plant shipping box (ordered via the Request Form) with packing material as needed to prevent shifting.
- Plant specimens should be shipped within two weeks of drying.
- If unknown and QA plant specimens are going to the same lab, they may be packed together in the same shipping box, but must be in separate herbarium folders and zip-top bags. In this case, the box will contain both T-4 and T-5 packing slips.

#### *T-5 – QA Plant Shipment*

- Complete the T-5 section of the **Tracking Form** for the QA Plant Samples (VEGQ) that are shipped to either the national or a state lab or to indicate that they are being retained for identification.
- Submit the **Tracking Form** to the IM Team via the NWCA App. This serves as the shipping notification for the T-5 samples.
- Plant specimens are pressed and dried individually in labelled newsprint.
- Specimens (each in their respective newsprint) are placed into one or more labelled herbarium folders. Folders are labelled with site information and an indication of the folder number, in addition to the number of specimens contained within the folder.
- Herbarium folders are placed in a provided zip-top bag and then into a plant shipping box (ordered via the Request Form) with packing material as needed to prevent shifting.
- Plant specimens should be shipped within two weeks of drying.

- If unknown and QA plant specimens are going to the same lab, they may be packed together in the same shipping box, but must be in separate herbarium folders and zip-top bags. In this case, the box will contain both T-4 and T-5 packing slips.

## Shipping Guidelines

Samples will be shipped according to the chart below. The Field Crew Leader will complete the appropriate section of the **Tracking Form** for the samples and will submit tracking via the NWCA App. The Field Crew Leader will place the samples and the associated packing slip (in a waterproof bag or plastic sleeve) in the shipment cooler/box. The Field Crew Leader will attach the appropriate pre-addressed FedEx shipping label that came with the cooler/box marked for the appropriate lab. The Field Crew will either drop off the cooler/box for shipment at a local FedEx location or arrange for a pick up at the hotel or other appropriate facility. If the field crew has chosen a pick up, they must follow up with the facility at which it has been left and/or track the package through FedEx tracking tools to ensure that the shipment cooler/box has actually been picked up by FedEx. Once the package is in the possession of FedEx, the IM Team and FLC will track the package to its destination and take steps necessary to ensure timely delivery. Prior to shipping, there are a few other guidelines of which the crew should be aware:

Preservation	Holding Time	Shipping
<ul style="list-style-type: none"><li>• See chart for specific preservation information for each sample</li></ul>	<ul style="list-style-type: none"><li>• Note the holding time window for each sample</li><li>• Ensure that samples will be shipped in time for the lab to process them within the allowable holding time frame</li></ul>	<ul style="list-style-type: none"><li>• Samples may be shipped on wet ice, or with no ice as specified in the chart</li><li>• Secure the cooler/box with packing tape</li><li>• All soil samples require APHIS permit</li></ul>

## Wet Ice

- Ensure that the ice is fresh immediately prior to shipment.
- Line the cooler with a large plastic liner bag.
- Place samples and ice inside the cooler liner and seal the liner with the provided cable tie.
- Secure the cooler lid with packing tape.

## Soil Samples

- Shipment of soil samples (either the SISO sample batched with MICX or grouped samples of SDSC, SHCH, and SHBD) are required to be placed inside the provided cooler liners
- A copy of the APHIS regulated soil permit is required inside the cooler used for soil isotopes shipment (place in zip-top sleeve included with cooler). Other soil samples do not require the inclusion of the APHIS permit.
- Secure the cooler lid with packing tape.

## Plant Samples

- After pressing and drying plant specimens in labelled newsprint, place samples in labelled herbarium folder(s).
- Multiple specimens can be placed in a folder, but keep QA and Unknown specimens separate.
- Place folders in provided zip-top bags and into plant shipping box.
- Add crumpled newspaper or other packing material to box if needed to prevent shifting of samples.
- Secure top and bottom flaps of the box with packing tape.

## Water Chemistry [CHEM]

- Ship within 24 hours in medium cooler
- Ship 1-L cubitainer
- Confirm label completed & taped
- Seal with plastic electrical tape
- Place in cooler liner
- Ship on wet ice

## Chlorophyll-*a* [WCHL]

- Ship with CHEM sample within 24 hours in medium cooler
- Ship foil wrapped centrifuge tube
- Confirm labels (on tube and bag) completed & taped
- Seal with plastic electrical tape
- Place in labelled zip-top bag
- Place in cooler liner
- Ship on wet ice

## Microcystin [MICX]

- Ship with SISO samples within 24 hours in small cooler
- Ship in HDPE bottle (125 mL, white, wide-mouth)
- Fill bottle just to shoulder leaving 1/2 inch of headspace to allow for expansion when frozen in lab
- Seal with plastic electrical tape
- Confirm labels completed & taped
- Place in cooler liner
- Ship on wet ice

## Soil Isotopes [SISO]

- Ship with MICX samples within 24 hours in small cooler
- Ship in plastic bag (quart size, double bagged)
- Confirm label completed & taped
- Include provided copy of APHIS permit in zip-top bag
- Place in lined cooler
- Ship on wet ice

## Standard Depth Soil Cores [SDSC]

- Ship with SHCH and SHBD samples at least every two weeks
- Ship in stapled soil bag
- Confirm label completed & taped
- Confirm tag completed and stapled in flap of soil bag
- Place in lined large cooler
- Ship with NO ICE

### Soil Horizon Chemistry Samples [SHCH]

- Ship with SDSC and SHBD samples at least every two weeks
- Ship in stapled soil bag
- Confirm label completed & taped
- Confirm tag completed and stapled in flap of soil bag
- Place in lined large cooler
- Ship with NO ICE

### Soil Horizon Bulk Density Samples [SHBD]

- Ship with SDSC and SHCH samples at least every two weeks
- Ship in separate stapled soil bags (one core per bag)
- Confirm labels completed & taped
- Confirm tags completed and stapled in flaps of soil bags
- Place in lined large cooler
- Ship with NO ICE

### QA Voucher Plant Specimens [VEGQ]

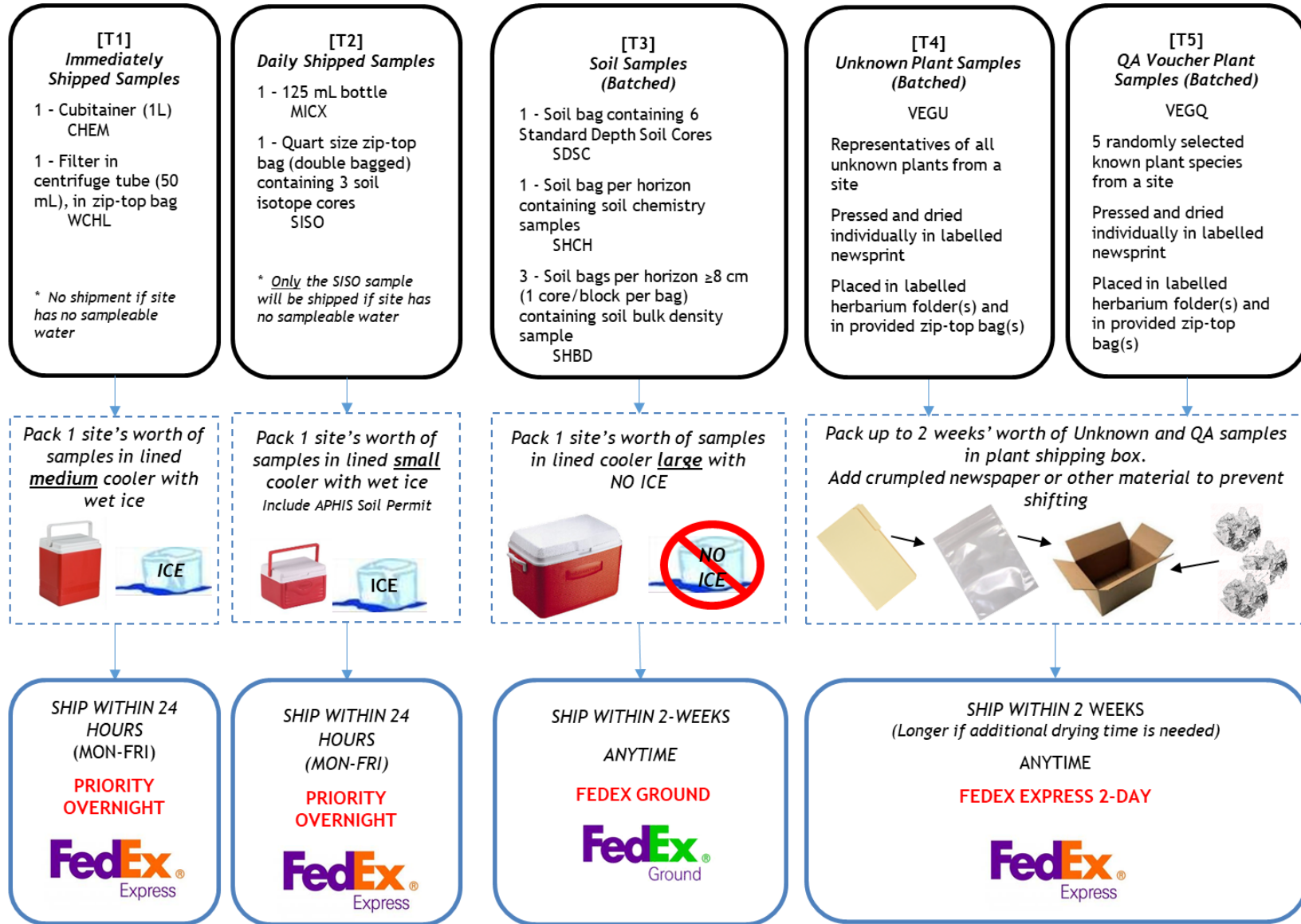
- Ship at least every two weeks (longer if additional drying time is needed)
- Press and dry in labelled newsprint
- Place in labelled herbarium folder(s) and in provided zip-top bag(s)
- Confirm labels completed
- Place in plant shipping box with packing material to prevent shifting
- Ship with VEGU if going to the same lab

### Unknown Plants Specimens [VEGU]

- Ship at least every two weeks (longer if additional drying time is needed)
- Press and dry in labelled newsprint
- Place in labelled herbarium folder(s) and in provided zip-top bag(s)
- Confirm labels completed
- Place in plant shipping box with packing material to prevent shifting
- Ship with VEGQ if going to the same lab



**Reference Card ST-1, Side A. NWCA 2021 Sample Shipping Flowchart** (assumes samples being shipped to nationally contracted labs)



**Reference Card ST-1, Side B. NWCA 2021 Sample Shipping Table**

	SAMPLE		SAMPLE CODE	SAMPLE TARGET VOLUME	CONTAINER	PRESERVATIVE/ PREPARATION	SHIPPING TIME FRAME	PACKAGING FOR SHIPMENT	SHIPPING GROUP
WATER COLLECTIONS (WHEN WATER IS PRESENT)	Water Chemistry (raw, unfiltered site water)		CHEM	1 L	1 L Cubitainer	Wet ice in field	Ship within 24 hours of sampling	Ship in medium cooler along with Chlorophyll-a (CHLA) sample and wet ice.  FedEx Priority Overnight	T-1
	Chlorophyll-a	Collection	WCHL	1 L	1 L reusable brown Nalgene bottle	Wet ice in field			
		Processing		Readily visible stain on filter (near refusal) - max of 1 L filtration	Filter in 50 mL centrifuge tube wrapped in foil and placed in zip-top bag	2 drops MgCO <sub>3</sub> at end of filtration Wet ice in field after filtration	Ship within 24 hours of sampling	Ship in medium cooler along with Water Chemistry (CHEM) sample and wet ice.  FedEx Priority Overnight	
	Microcystins (Algal Toxins)		MICX	125 mL	125 mL Nalgene bottle	Wet ice in field	Ship within 24 hours of sampling	Ship in small cooler along with soil isotopes (SISO) samples and wet ice  Ship FedEx Priority Overnight	T-2
Soil Isotopes		SISO	3 10-cm cores from around Soil Pit using 1" plastic syringe corer	Double bag in quart sized zip-top bags (all 3 cores in same bag)	Keep cool in field	Ship within 24 hours of sampling	Ship in small cooler along with microcystins (MICX) samples and wet ice  Include APHIS Soil Permit  Ship FedEx Priority Overnight		
SOIL SAMPLES	Standardized Depth Soil Core		SDSC	6 10-cm cores from around Soil Pit using 3" steel corer	Place all 6 cores in a single soil sample bag Stapled with tag in fold	Keep cool in field	Batch up to 2 weeks	Ship in large cooler with NO ICE	T-3
	Soil Horizon - Chemistry		SHCH	1.0 to 3.0 liters of soil (depending on rock and water content) per horizon, entire 125 cm of Soil Pit	Soil sample bag Stapled with tag in fold	Keep cool in field		Place all samples in cooler liner and seal with provided zip tie	
	Soil Horizon - Bulk Density		SHBD	3 cylinders (collected with 3" steel corer) or blocks of soil with known size/volume per horizon ≥ 8 cm, entire 125 cm of Soil Pit	Place each core/block in its own soil sample bag Stapled with tag in fold	Keep cool in field		Submit S-1 data forms via NWCA App at time of shipment  Ship FedEx Ground	
VEGETATION SAMPLES	Plant Specimens	Unknowns species	VEGU	All unknown plant specimens to be identified by secondary taxonomist	Bag or bouquet with tag	Press and dry in plant press inside labelled newsprint	Batch up to 2 weeks, or more if extra drying time is needed	Place all Unknowns from each site in labelled herbarium folder (provided as ordered)  Ship in cardboard veg box (provided as ordered)  FedEx Express 2-Day  If Unknown and QA Veg samples are going to the same lab, they may be packaged together	T-4
		QA Voucher Specimens	VEGQ	5 randomly selected known species across 5 veg plots (5 total specimens)	Bag or bouquet with tag	Press and dry in plant press inside labelled newsprint	Batch up to 2 weeks, or more if extra drying time is needed	Place all QA vouchers from each site in labelled herbarium folder (provided as ordered)  Ship in cardboard veg box (provided as ordered)  FedEx Express 2-Day  If Unknown and QA Veg samples are going to the same lab, they may be packaged together	T-5

## Reference Card ST-2 NWCA Sample Shipping Guidance, Side A

### General Shipping and Tracking Guidelines

- Each sample type has a designated field treatment, holding time, shipping method and destination lab.
- Refer to Reference Card ST-1 for specific sample requirements.
- Every time samples are shipped, the pertinent portions of the Tracking Form in the NWCA App must be completed.
- Tracking Forms must be submitted via the NWCA App
- Packing slips that list the samples being shipped must be included in the shipping cooler/box.
- When shipping, pack samples in the designated cooler or box and affix the specific FedEx Shipping Label.
- Refer to the “T-#” on each sample label, packing slip, and FedEx label to group and ship samples correctly.

### T-1 – Daily Water Chemistry Shipment (Medium Cooler)

*No shipment if site has no sampleable water*

- Water chemistry (CHEM)
- Chlorophyll-*a* (WCHL)

Fill out T-1 portion of Tracking Form and submit via the NWCA App

- Include the T-1 packing slip in cooler in plastic sleeve (inside lid of cooler).
- Line cooler with plastic bag (cooler liner provided)
- Place samples in cooler liner
- Fill cooler liner with **fresh wet ice**.
  - Add new ice if shipping on the day after sampling.
- Seal liner (zip-tie provided)
- Attach cooler handle tag
- Affix pre-paid T-1 FedEx shipping label
- Secure cooler with packing tape (tape handle down)
- Drop off at FedEx facility or schedule pickup



***Immediately shipped samples will be shipped Priority Overnight and will automatically be designated for Saturday Delivery  
These samples may be shipped Monday-Friday***

### Reference Card ST-2 NWCA Sample Shipping Guidance, Side B

#### **Daily Chilled Shipment** (Small Cooler)

*Only the soil Isotope sample will be shipped if site has no sampleable water*

- Microcystin (MICX)
- Soil Isotopes (SISO)

Fill out T-2 portion of Tracking Form and submit via the NWCA App

- Include T-2 Packing Slip and APHIS Permit in cooler in zip-top sleeve provided.
  - Cross out sample IDs for any sample not included
- Place samples in cooler liner
- Fill cooler liner with **fresh wet ice**.
  - Add new ice if shipping on the day after sampling.
- Seal liner (zip-tie provided)
- Affix pre-paid T2 FedEx shipping label to lid
- Secure cooler with packing tape (tape handle down)
- Drop off at FedEx facility or schedule pickup

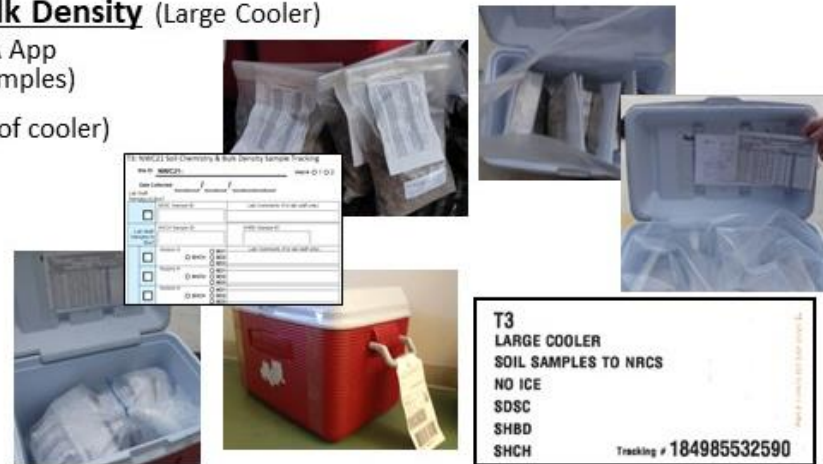


***Daily shipped samples will be shipped Priority Overnight and will automatically be designated for Saturday Delivery  
These samples may be shipped Monday-Friday***

#### **Standard Depth Soil Cores, Soil Chemistry and Bulk Density** (Large Cooler)

Fill out T-3 portion of Tracking Form and submit via the NWCA App  
Also submit S-1 Form (soil data is needed by lab to process samples)

- Include T-3 Packing Slip in cooler in plastic sleeve (inside lid of cooler)
  - List all Horizons and samples included
- Use large cooler for shipping. **Do Not Put Ice In Cooler**
- Line cooler with plastic bag (cooler liner provided)
- Seal liner (zip-tie provided)
- Secure cooler with packing tape
- Attach cooler handle tag (adhesive plus zip-tie)
- Affix pre-paid T-3 FedEx shipping label
- Drop off at FedEx facility or schedule pickup



***Soil samples will be shipped FedEx Ground and may be shipped any day of the week***



### Reference Card ST-2 NWCA Sample Shipping Guidance, Side C

#### Plant Specimens (Large Cardboard box)

- **NOTE 1:** each QA and Unknown specimen must have a plant sample label (adhesive back) on the outside of the newsprint that describes all details about the specimen.  
*If more than one newsprint is required for a single specimen, affix a completed label to each newsprint and add a note (e.g., 1 of 3, 2 of 3, etc.) to the top of the label.*
- **NOTE 2:** all plant specimens must be completely dry before shipping.
- **NOTE 3:** Tracking forms **MUST BE FILLED OUT AND SUBMITTED VIA THE NWCA APP FOR ALL SAMPLES**, even if they are retained or hand-delivered to the state lab.

#### Unknowns Samples:

Fill out T-4 portion of tracking form and submit via the NWCA App

- Use veg specimen box (provided as requested)
- Group unknown specimens by site, in order of collection number, into herbarium folders (provided as requested) and insert into zip-top bag
- Label folder(s) with Unknown Plant Sample Label. Indicate Site ID, Visit Number, Folder Number (if multiple folders are used per site), and number of unknown specimens inside the folder.
- Carefully pack specimens into shipping boxes, with padding (crumpled newspaper, or other material) and make sure they will not shift in box.
- Place T-4 packing slip on top of packing material
  - List all Collection Numbers (U#) included from site
  - Collection numbers are generated by App (on V-2 Form)
- Ship to National Lab (using pre-paid T4/T5 FedEx Label)
  - OR-
  - Retain for identification (see NOTE 3 above)
  - OR-
  - Ship to State Lab (see NOTE 3 above)



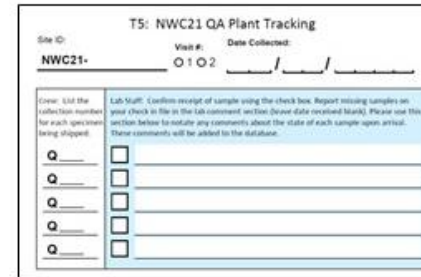
***Plant samples will be shipped FedEx 2-Day and may be shipped any day of the week***

### Reference Card ST-2 NWCA Sample Shipping Guidance, Side D

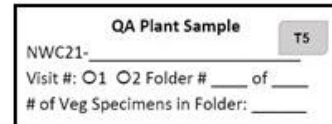
#### **QA Voucher Specimens:**

Fill out T-5 portion of tracking form and submit via the NWCA App

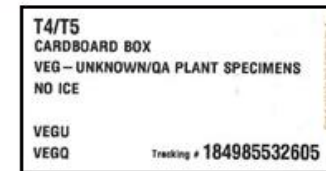
- Follow guidance for Unknowns on **Side C** using QA Plant Sample Label on folder
- Place T-5 packing slip on top of packing material
  - List all Collection Numbers (Q#) included from site
  - Collection numbers are generated by App (on V-2 Form)
- Unknown and QA specimens can be packed together in the same box if destined for the same lab; but,
- Do not place Unknowns and QA Specimens in the same herbarium folder.



The form is titled "T5: NWC21 QA Plant Tracking". It includes fields for "Site ID: NWC21-", "Visit #: 01 02", and "Date Collected:". Below these are instructions for the "Cover" and "Lab Staff" sections. The "Cover" section asks to list collection numbers for each specimen being shipped, with five rows labeled "Q" and checkboxes. The "Lab Staff" section asks to confirm receipt of samples and report missing samples, with five rows and checkboxes.



The label is titled "QA Plant Sample" and "T5". It contains fields for "NWC21-", "Visit #: 01 02", "Folder # \_\_\_ of \_\_\_", and "# of Veg Specimens in Folder: \_\_\_".



The label is titled "T4/T5 CARDBOARD BOX VEG - UNKNOWN/QA PLANT SPECIMENS NO ICE". It includes "VEGU" and "VEGQ" labels and a tracking number "184985532605".

***Plant samples will be shipped FedEx 2-Day and may be shipped any day of the week***

#### **Key Points to Remember when Shipping any NWCA Samples**

- Packing Slip(s) enclosed in package should identify each sample in package and no more
  - Samples from multiple sites = multiple slips
- Make sure sample IDs agree between labels, data forms and all tracking forms
  - Use the T-#s provided to help group samples correctly
- NEVER send samples without a copy of the correct and complete packing slip(s) in the cooler/box
- ALWAYS submit tracking form(s) via the NWCA App on the day of shipping
- Use correct FedEx Label for the samples being shipped and cross-check the destination lab
  - Use the T-#s provided to help ship samples correctly

Questions or problems with shipping? Contact Chris Turner, Field Logistics Coordinator:  
(715) 829-3737 (call or text) -or- ctturner@glec.com

## Appendix B Target Invasive Plant Species

TARGET INVASIVE PLANT SPECIES FOR EVALUATION OF PRESENCE IN BUFFER	
Eurasian Watermilfoil	<i>Myriophyllum spicatum</i> L.
Common Water Hyacinth	<i>Eichhornia crassipes</i> (Mart.) Solms
Yellow Floatingheart	<i>Nymphoides peltata</i>
Giant Salvinia	<i>Salvinia molesta</i> D.S. Mitchell
Garlic Mustard	<i>Alliaria petiolata</i> (Bieb.) Cavara & Grande
Poison Hemlock	<i>Conium maculatum</i> L.
Mile-a-Minute Weed	<i>Polygonum perfoliatum</i> L.
Birdsfoot Trefoil	<i>Lotus corniculatus</i> L.
Canada Thistle	<i>Cirsium arvense</i> (L.) Scop.
Purple Loosestrife	<i>Lythrum salicaria</i> L.
Knotweed	<i>Polygonum aviculare</i> L.
Japanese Knotweed	<i>Polygonum cuspidatum</i> Siebold & Zucc.
Perennial Pepperweed	<i>Lepidium latifolium</i> L.
Giant Reed	<i>Arundo donax</i> L.
Cheatgrass	<i>Bromus tectorum</i> L.
Reed Canarygrass	<i>Phalaris arundinacea</i> L.
Common Reed	<i>Phragmites australis</i> (Cav.) Trin. Ex Steud.
Leafy Spurge	<i>Euphorbia esula</i> L.
Johnsongrass	<i>Sorghum halepense</i> (L.) Pers.
Kudzu	<i>Pueraria montana</i> (Lour.) Merr.
Multiflora Rose	<i>Rosa multiflora</i> Thunb. Ex Murr.
Common Buckthorn	<i>Rhamnus cathartica</i> L.
Himalayan Blackberry	<i>Rubus armeniacus</i> Focke
Tamarisk	<i>Tamarix</i> spp. L.



## Eurasian Watermilfoil

*Myriophyllum spicatum* L.

Haloragaceae

Other Common Names: Spiked Watermilfoil

### Description

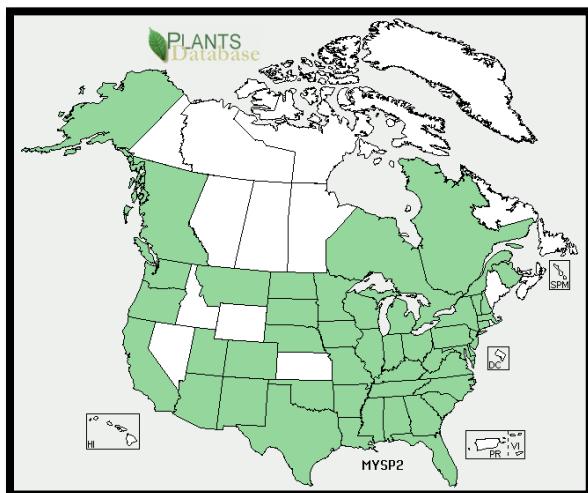
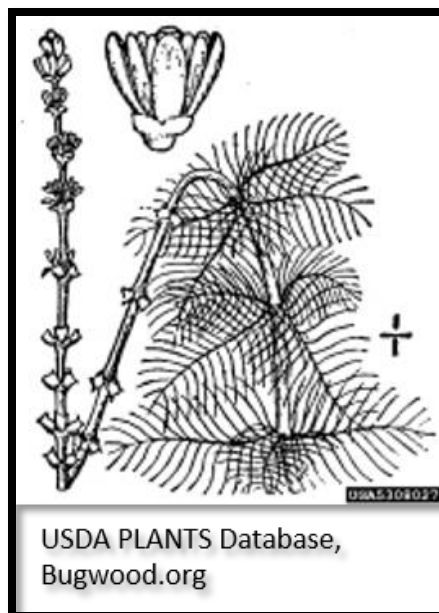
- Submersed aquatic plant
- Rooted emergent stems reach 3 to 10 ft. (0.9-3 m) in length; can be up to 30 ft. (9.1 m) long.
- Grows in dense mats
- Bright green, finely dissected, whorled leaves
- Delicate leaflets have feathery appearance
- Native to Europe, Asia, and northern Africa

### Impacts

- Dense mats restrict light availability
- Causes decline in diversity and abundance of native plants
- Displaces the native species of watermilfoil
- Reduces habitat for fish spawning and feeding

### Distribution

- Lakes, ponds, and other aquatic environments
- Stagnant to slowly moving water
- Can tolerate brackish conditions



### States Where Invasive

CA, CT, DE, ID, NH, NJ, NV, NY, OH, OR, PA, TN, VA, WA, WI

## Common Water Hyacinth

*Eichhornia crassipes* (Mart.) Solms

Pontederiaceae

Other Common Names: Floating Water Hyacinth

### Description

- Free floating aquatic plant
- Grows to 3 ft. (1 m) in height
- Leaves are oval to elliptical, thick, up to 6 in. (15 cm) wide and waxy with spongy petioles
- Leaves curve inward at the edge
- Showy blue-purple flowers are born on upright spikes
- Flowers have six petals with the uppermost having a yellow patch
- Native to South America

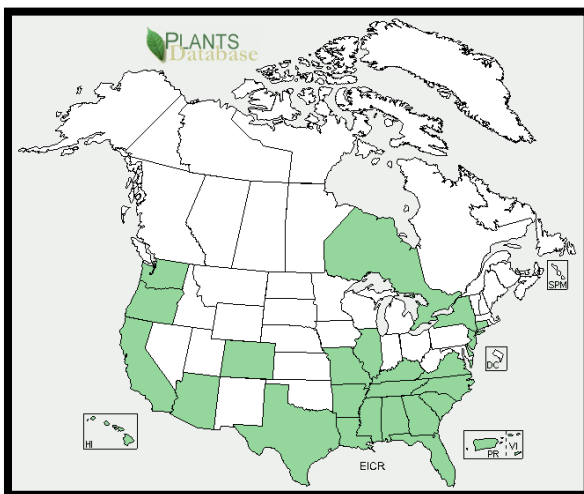


### Impacts

- Reproduces mainly by vegetative means; quickly forms dense floating mats of vegetation
- Dense mats restrict light to the underwater environment and deplete the oxygen levels.

### Distribution

- Invades aquatic areas throughout the eastern and southern portions of the US
- Invades lakes, ponds, rivers, marshes, and other types of wetland habitats



### States Where Invasive

AL, AR, AZ, CA, CO, CT, DE, FL, GA, HI, IL, KY, LA, MO, MS, NC, NH, NY, OR, SC, TN, TX, VA, WA

## Yellow Floatingheart

*Nymphoides peltata*  
Menyanthaceae

### Description

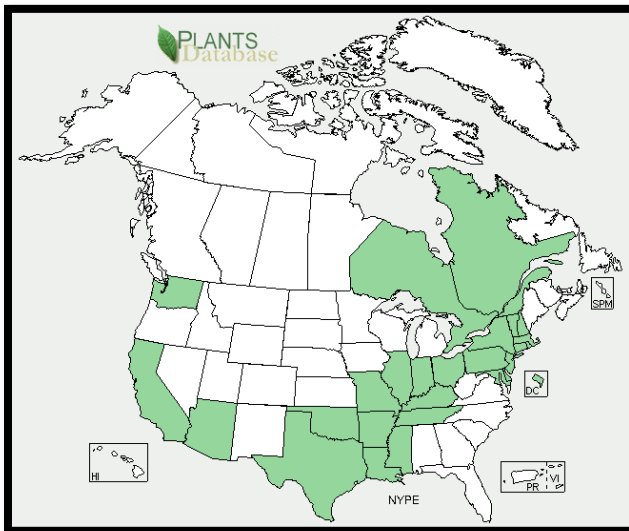
- Perennial, water-lily like plant
- Carpets the water surface with long-stalked, heart-shaped leaves
- Showy five-petaled yellow flower occur on long stalks and rise a few inches above the water surface
- Leaves average 3 to 10 cm in diameter  
Fruit capsule is 2.5 cm long and contains numerous seed
- Seeds are oval and flat (about 3.5 mm long) and hairy along their outer edges



### Impacts

- Grows in dense patches, excluding native species
- Creates stagnant areas with low oxygen levels underneath the floating mats
- Mats reduce fish habitat
- Hinder recreation on the water

### Distribution



### States Where Invasive

CT, ME, MA, OR, VT, WA

## Giant Salvinia

*Salvinia molesta* D.S. Mitchell

Salviniaceae

Other Common Names: Kariba Weed, Salvinia, Water Fern

### Description

- Aquatic fern
- Floating leaves that are 0.5 to 1.5 in. (2.5-3.8 cm) long, oblong, and vary in color from green to gold to brown
- Leaf surfaces have rows of arching hairs that look like little egg-beaters
- Young leaves are smaller and lie flat on the surface of the water
- Mature leaves forms chains that run together to form thick mats on the surface of the water
- Submerged fronds are "stringy" and resemble roots
- Plants reproduce by spores and by budding of broken stems or attached nodes
- Native to South America



### Impacts

- Mats restrict oxygen and light availability causing death of the primary producers and disrupting the aquatic food chain

### Distribution

- On the Federal Noxious Weed list and can invade most any type of aquatic system



### States Where Invasive

AL, AZ, CA, FL, GA, HI, LA, MS, NC, SC, TX

## Garlic Mustard

*Alliaria petiolata* (Bieb.) Cavara & Grande

Brassicaceae

Other Common Names: Hedge Garlic, Sauce Alone, Jack-by-the Hedge, Poor Man's Mustard, Jack-in-the-Bush, Garlic Root, Garlicwort, Mustard Root

### Description

- Herbaceous, biennial forb
- First-year plants are basal rosettes with green, heart-shaped, 1-6 in. (2.5-15.2 cm) long leaves
- Second-year plants produce a 1-4 ft. (0.3-1.2 m) tall flowering stalk
- Flowers are small, white
- Flowers early spring
- Plants can be easily recognized by a garlic odor that is present when any part of the plant is crushed and by the strongly toothed, triangular leaves
- Native to Europe

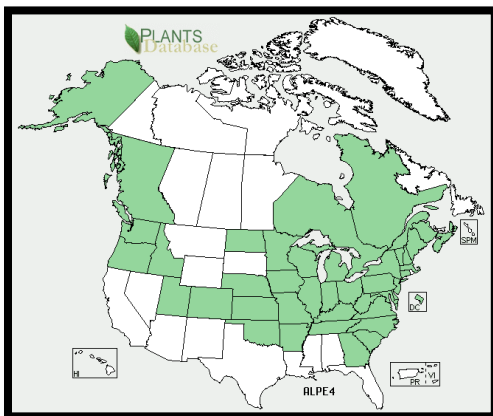
### Impacts

- Shades out native understory flora
- Allelopathic compounds inhibit seed germination of other species



### Distribution

- Aggressive invader of wooded areas throughout the eastern and middle US
- Invade high-quality, mature woodlands



### States Where Invasive

AK, CT, DC, DE, GA, IA, IL, IN, KY, MA, MD, ME, MI, MO, NC, NH, NJ, NY, OH, OR, PA, TN, VA, VT, WI, WV



## Poison Hemlock

*Conium maculatum* L.

Apiaceae

Other Common Names: Deadly Hemlock, Poison Parsley

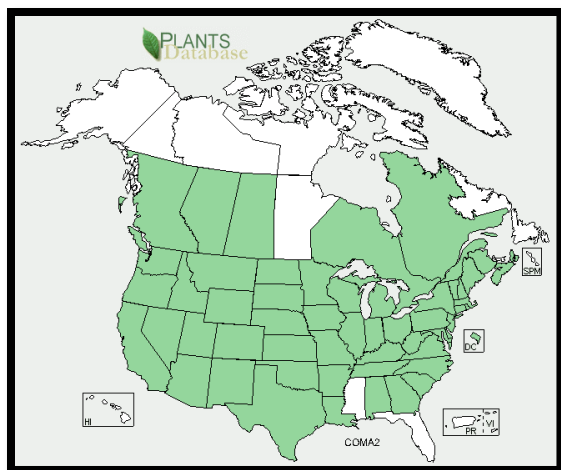
### Description

- Biennial (usually)
- Grows from 3-10 ft. (1-3 m) in height
- Stems are hollow, ribbed and purple-spotted
- Plants begin as a rosette of leaves and flower in the second year of growth
- Leaves are opposite, finely dissected, 8-16 in. long, triangular and emit a foul odor when crushed
- Petioles often sheath the stem
- Flowers May to August,
- Flowers umbels of small, white flowers develop at the apex of the stems
- Umbels are 2-2.5 in. (5-6.2 cm) in diameter and contain many 5-petaled flowers
- Native to Europe
- All parts of this plant are poisonous!

### Impacts

- One plant can produce over 30,000 seeds
- Plants, when eaten, are poisonous to most animals

### Distribution



Steve Dewey, Utah State University, Bugwood.org

Steve Dewey, Utah State University Bugwood.org

### States Where Invasive

AL, AR, AZ, CA, CO, CT, DC, DE, GA, IA, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY

## Mile- a -Minute Weed

*Polygonum perfoliatum* L.

Polygonaceae

Other common name: Devil's Tearthumb

### Description

- Herbaceous, annual vine
- Delicate stems are reddish, highly branched and covered with small, curved spines
- Circular, leafy structures (ocreae) surround the stem at the base of the petioles
- Leaves alternate, triangular, light green, 1-3 in. (2.5-7.6 cm) wide and barbed on the undersurface
- Flowers are small, white, inconspicuous, and arise from the ocreae
- Fruits, present in mid-July through the first frost, are metallic blue and segmented with each segment containing a single black or reddish black seed
- Native to Eastern Asia and the Philippines

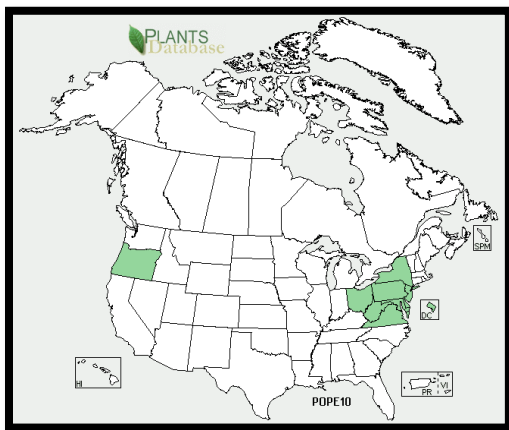


### Impacts

- Covers existing vegetation and restrict light availability, potentially killing plants below
- Dense mats restrict establishment of new vegetation.

### Distribution

- Invades disturbed areas in Oregon and portions of the northeastern US
- Invades open disturbed areas such as fields, forest edges, roadsides, ditches and stream banks



### States Where Invasive

CT, DC, DE, MA, MD, NJ, NY, PA, VA, WV



## Birdsfoot Trefoil

*Lotus corniculatus* L.

Fabaceae

Other common names: Birdfoot, Deervetch, bloomfell, cat's clover, crowtoes, ground honeysuckle

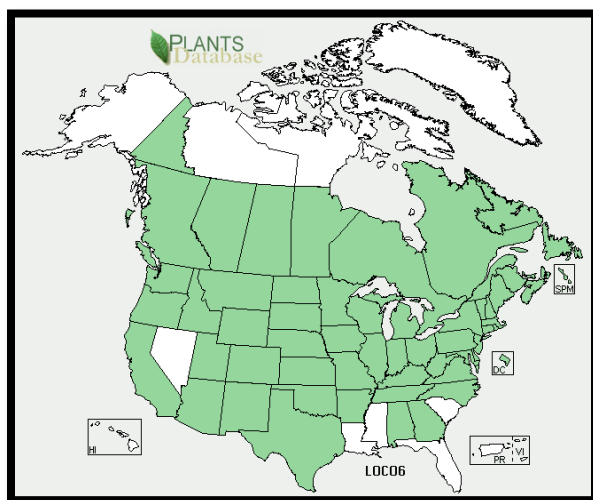
### Description

- Low-growing, perennial forb
- Stems 2 ft. (0.6 m) long
- Leaves are compound (with 5 oval to linear leaflets), stipulate and alternate
- Leaflets (upper 3) are 0.5 in. (1.3 cm) long and less than 1/8 in. (0.3 cm) wide; the lower two resemble leaf-like stipules
- Flowers May to August,
- Flowers yellow, sweet pea-like in clusters of 2-8 on a long peduncle (stalk)
- Fruits are brown to black (1.5-3.5 cm) pods that occur in head-like clusters
- Native to Eurasia and North Africa



### Distribution

- Occurs in pastures, roadsides, wetlands, disturbed grasslands and riparian areas



### States Where Invasive

AL, AR, AZ, CA, CO, CT, DC, DE, GA, IA, ID, IL, IN, KS, KY, MA, MD, ME, MI, MN, MO, MT, NC, ND, NE, NH, NJ, NM, NY, OH, OK, OR, PA, RI, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY

## Canada Thistle

*Cirsium arvense* (L.) Scop.

Asteraceae

Other Common Names: Californian Thistle, Creeping Thistle, Field Thistle

### Description

- Tall, erect, spiny, perennial
- Grows to 4 ft. (1.2 m) tall
- Extensive creeping rootstock
- Leaves are lance-shaped, irregularly lobed, 2-6 in. (5- 15 cm) long with prickly margins
- Stems are ridged and hairy
- Flowers are purple to white and can be up to 0.5 in. (1.8 cm) in diameter
- June to August
- Achene fruit 1 to 1.5 in. (2.5-3.8 cm) long with feathery pappus
- Native to Europe and Asia

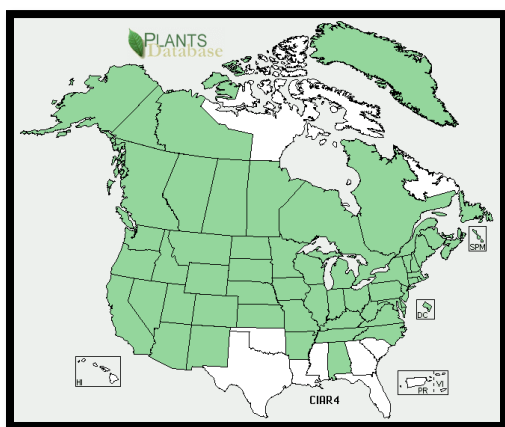


### Impacts

- forms dense stands which can shade out and displace native vegetation
  - Once established it spreads rapidly and is difficult to remove

### Distribution

- Canada thistle can invade a variety of open habitats including prairies, savannas, fields, pastures, wet meadows and open forests



### States Where Invasive

AK, AZ, CO, CT, DE, IA, ID, IN, MD, MI, MN, MO, MT, ND, NJ, OH, OR, PA, RI, SD, TN, VA, WA, WI, WV, WY

## Purple Loosestrife

*Lythrum salicaria* L.

Lythraceae

Other Common Names: Purple Lythrum, Rainbow Weed, Salicaire, Spiked Loosestrife

### Description

- Tall, multi-stemmed (30-50 per plant),
- Perennial forb
- Up to 10 ft. (3 m) in height
- Opposite or whorled leaves; dark-green, lance-shaped, sessile 1.5-4 in. (3.8-10.2 cm) long
- Leaves round or heart-shaped at the base
- Flowers July to October
- Flowers: pink to purplish; 4-16 in. (10.2-40.6 cm) long spikes at the tops of the stems
- Flowers have 5-7 petals and twice as many stamens as petals
- Fruits are capsules that are enclosed in the hairy sepals
- Native to Europe and Asia

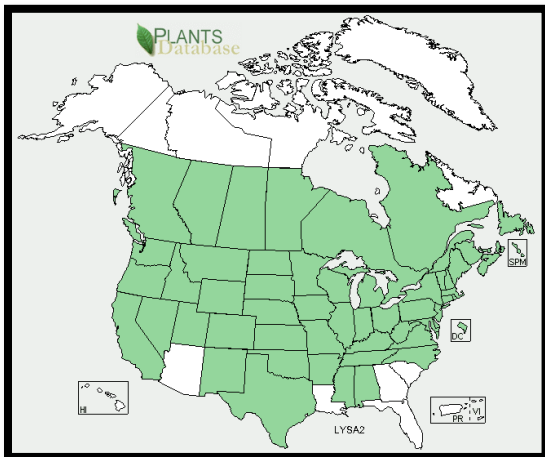


### Impacts

- Dense stands displace native vegetation
- Spreads very rapidly through prolific seed production

### Distribution

- Wetlands: wet meadows, prairie potholes, river and stream banks, lake shores, tidal and non-tidal marshes, and ditches



### States Where Invasive

AL, AR, CA, CO, CT, DC, DE, IA, ID, IL, IN, KS, KY, MA, MD, ME, MI, MN, MO, MS, MT, NC, DE, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, RI, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY

## Knotweed

*Polygonum aviculare* L.

Polygonaceae

Other common name: Prostrate knotweed

### Description

- Germinating plant is grass-like with long, dark green leaves
- Forms a mat up to 2 feet wide on slender wiry stems
- Papery sheath at each node gives stems a knotted or swollen appearance
- Leaves alternate; small; narrowly oval; dull, bluish green; up to 1 ¼ inches long and 1/3 inch wide
- Flowers are small, borne in clusters in leaf axils
- Flower buds are purplish opening to white to yellow flowers during
- Flowers June through October

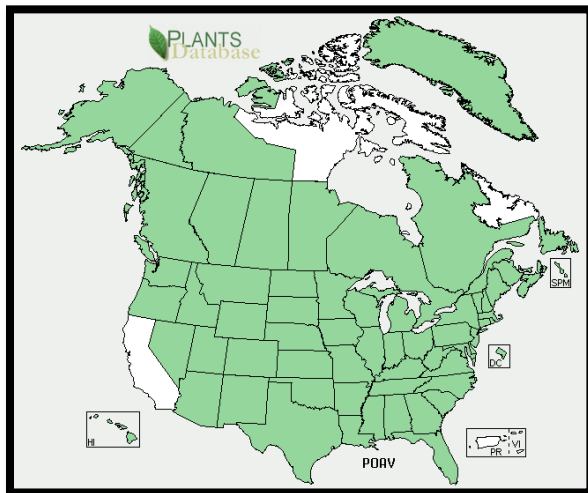


### Impacts

- Dense mats outcompetes native vegetation

### Distribution

- Found in compacted, infertile soils or thin turf in the sun



### States Where Invasive

AK, AL, AR, AZ, CO, CT, DC, DE, FL, GA, HI, IA, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY

## Japanese Knotweed

*Polygonum cuspidatum* Siebold & Zucc.

Polygonaceae

Other Common Names: Fleeceflower, Japanese Bamboo

### Description

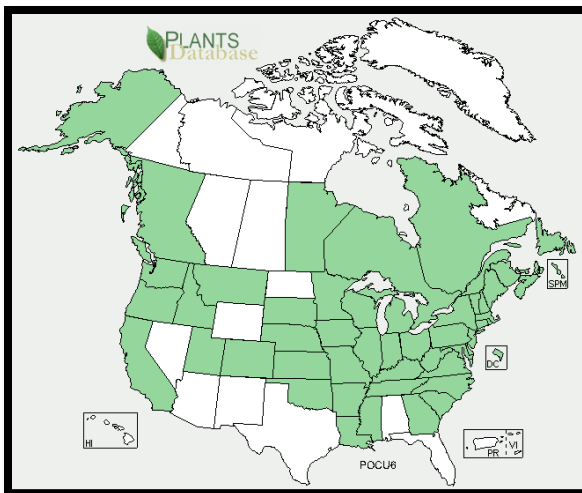
- Dense shrub
- Grows to 10 ft. (3 m)
- Semi-woody stem is hollow with enlarged nodes
- Leaves are alternate, 6 in. (15.2 cm) long, 3-4 in. (7.6-10 cm) wide and broadly-ovate
- Flowers late summer
- Flowers small, greenish-white in long panicles in the axils of the leaves
- Plants are dioecious (male and female flowers occur on separate plants)
- Native to eastern Asia

### Impacts

- Reproduction occurs both vegetatively (rhizomes) and seeds,
- Extremely hard to eradicate
- Dense patches shade and displace other plant life and reduce wildlife habitat

### Distribution

- Invades disturbed areas with high light, such as roadsides and stream banks



### States Where Invasive

AK, CT, DC, DE, GA, IN, MA, MD, ME, MI, MO, NC, NH, NJ, NY, OH, OR, PA, RI, TN, VA, VT, WA, WI, WV



## Perennial Pepperweed

*Lepidium latifolium* L.

Brassicaceae

Other Common Names: Virginia Pepperweed,  
Broadleaved Pepperweed, Tall Whitetop, Broadleaved  
Peppergrass

### Description

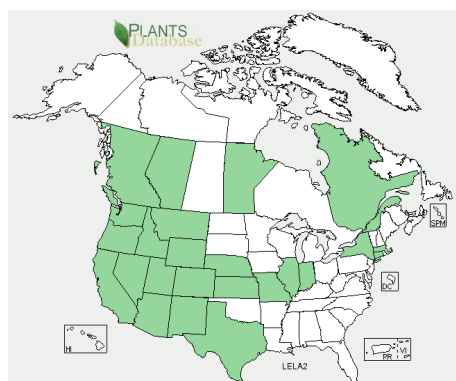
- Perennial forb
- Grow from 1-5 ft. (0.3-1.5 m) in height
- Rosette leaves are long petiolate 4-12 in. (10-30cm) long and 1-2 in. (2.5-5 cm) wide and toothed
- Cauline (stem) leaves are alternate, 1-3 in. (2.5-7.6 cm) long and oblong
- Flowers late spring to summer
- Inflorescences are flat, dense clusters that develop at the apex of the flowering stem
- Individual flowers are 4-petaled and white
- Fruit are round to oval, hairy pod that is 1/16 in. (1.5 mm) in diameter
- Native to Eurasia

### Impacts

- Adapts readily to natural and disturbed wetlands.
- Creates large monospecific stands that displace native plants and animals.

### Distribution

- Occurs in coastal wetlands, riverbanks, marshes, rangelands and roadsides



**States Where Invasive**  
CA, CO, CT, OR UT, WA

## Giant Reed

*Arundo donax* L.

Poaceae

Other Common Name: Elephant Grass

### Description

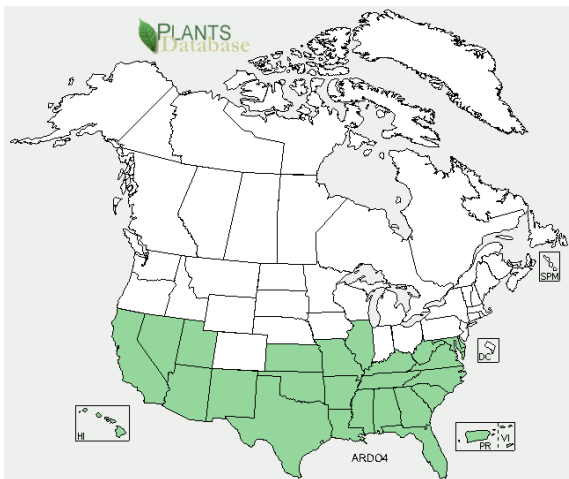
- Perennial grass
- Grows up to 20 ft. (6.1 m) in height
- Stem resembles a corn stalk and has long, flat leaves up to 1.5 ft. (0.5 m) long
- Flowers late summer to early fall
- Large, dense flower plumes develop at the tops of the culms
- Plums can grow up to 3 ft. (0.9 m) in length
- Native to India

### Impacts

- Suppresses and removes native vegetation very easily
- Reduces wildlife habitat, increases fire risks and interferes with flood control

### Distribution

- Invades wetlands such as ditches, stream banks and lake shores



### States Where Invasive

AZ, CA, GA, MD, NM, NV, TX, VA



Chris Evans, River to River CWMA,  
Bugwood.org



David J. Moorhead,  
University of Georgia  
Bugwood.org



James H. Miller, USDA Forest  
Service, Bugwood.org



## Cheatgrass

*Bromus tectorum* L.

Poaceae

Other Common Names: Downy brome, early chess, military grass, thatch brome grass

### Description

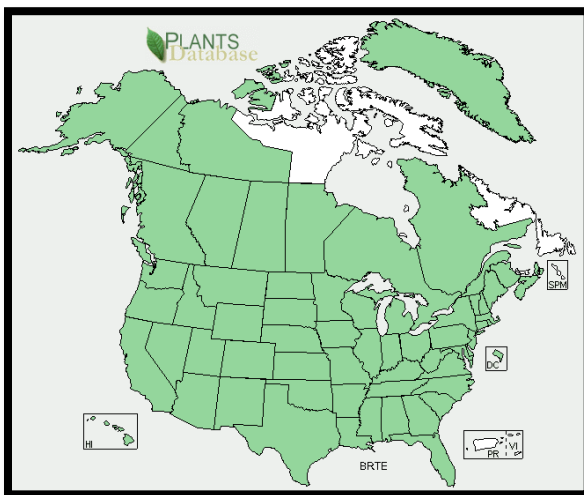
- Annual grass that forms tufts
- Grows up to 2 ft. (0.6 m) tall
- Leaves and sheaths are covered in short, soft hairs
- Flowers occur as drooping, open, terminal clusters that can have a greenish, red, or purple hue
- Flowers early summer
- Senescence usually occurs in summer
- Native to Europe and parts of Africa and Asia

### Impacts

- Replaces native vegetation and change fire regimes

### Distribution

- Invades rangelands, pastures, prairies, and other open areas
- Occurs throughout the United States and Canada, but is most problematic in areas of the western US with lower precipitation levels



### States Where Invasive

AK, AL, AR, AZ, CA, CO, CT, DC, DE, FL, GA, HI, IA, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY

## Reed Canarygrass

*Phalaris arundinacea* L.

Poaceae

### Description

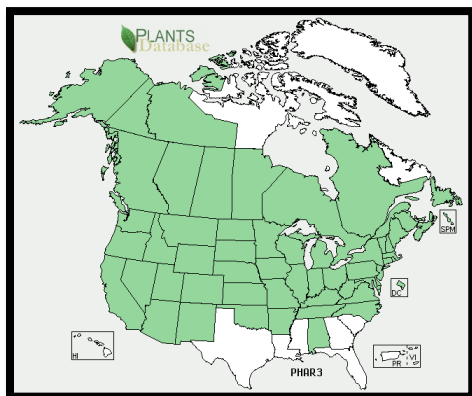
- Cool-season perennial grass
- Grows to 6 ft. (1.7 m) tall
- Leaf blades are flat, 1-4 ft. (0.3-1.2 m) long, up to 3/4 in. (1.9 cm) wide, glabrous and taper gradually
- Ligule is membranous (transparent) and long
- Flower/seed heads can be green, purple, or brown in color and usually 3-6 in. (7.6-15.2 cm) in length.
- Flowers May to July
- Variable in morphology, so characteristics may depend upon the habitat
- Native to Europe and possibly parts of Asia

### Impacts

- Spreads by seeds and rhizomes and can exclude all other vegetation
- Extremely difficult to eradicate once established

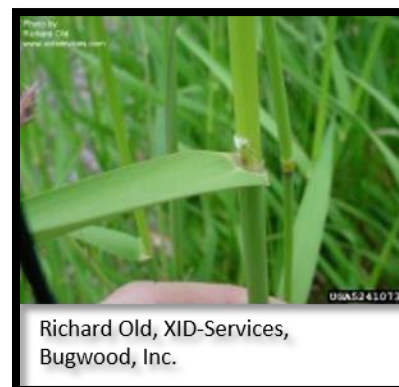
### Distribution

- Quickly dominates wetlands, ditches, prairie potholes and other sites with moist soil



### States Where Invasive

AK, AL, AR, AZ, CA, CO, CT, DC, DE, IA, ID, IL, IN, KS, KY, MA, MD, ME, MI, MN, MO, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, RI, SD, TN, UT, VA, VT, WA, WI, WV, WY



## Common Reed

*Phragmites australis* (Cav.) Trin. Ex Steud.

Poaceae

Other Common Name: Phragmites

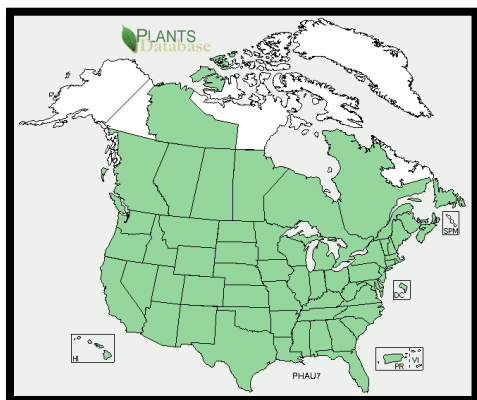
### Description

- Tall, perennial grass
- Grows to heights of 15 ft. (4.6 m) or more
- Leaves are broad and pointed, arising from thick stalks
- Leaves are 6-23.6 in. (15-60 cm) long, 0.4-2.4 in. (1-6 cm) wide, flat and glabrous
- Flower heads are dense, fluffy, gray or purple in color and 5.9-15.7 in. (15-40 cm) long
- Flowers July to October
- Native to Eurasia and Africa
- Native *Phragmites* do occur in the United States
- Impacts
- Displaces native wetlands plants
- Alters hydrology
- Block sunlight to the aquatic community



### Distribution

- Found in dense thickets growing in or near shallow water



### States Where Invasive

CO, CT, DC, DE, GA, IN, KY, MD, MI, NC, NH, NJ, NY, OH, PA, TN, VA, VT, WI

## Leafy Spurge

*Euphorbia esula* L.  
Euphorbiaceae

### Description

- Erect, perennial, herbaceous plant
- Grows from 2 to 3.5 ft. (0.6-1.1 m) tall
- Leaves are oval-shaped, smooth and 1-4 in. (2.5-10.2 cm) long
- Produces a milky sap if stem is broken or a leaf is removed
- Stem is smooth and bluish-green
- Flowers late spring (and sometimes the late summer)
- Flowers are yellow, form clusters at the apex of the plant
- Fruits are 3 lobed capsules that explode when mature, spreading seeds up to 15 ft. (4.6 m)
- Native to Europe

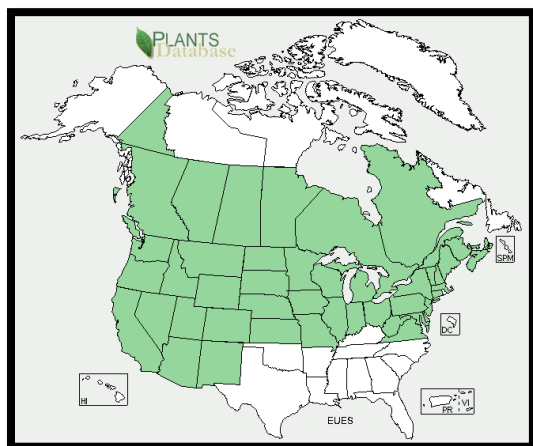


### Impacts

- Large infestations give the landscape a yellowish tinge due to the yellow bracts
- Overtakes large areas of land and displace native vegetation

### Distribution

- Invades prairies, pastures and other open areas
- Major pest of national parks and nature preserves in the western US



### States Where Invasive

AZ, CA, CO, CT, DE, IA, ID, IL, IN, KS, MA, MD, ME, MI, MN, MO, MT, ND, NE, NH, NJ, NM, NV, NY, OH, OR, PA, SD, UT, VA, VT, WA, WI, WY

## Johnsongrass

*Sorghum halepense* (L.) Pers.

Poaceae

### Description

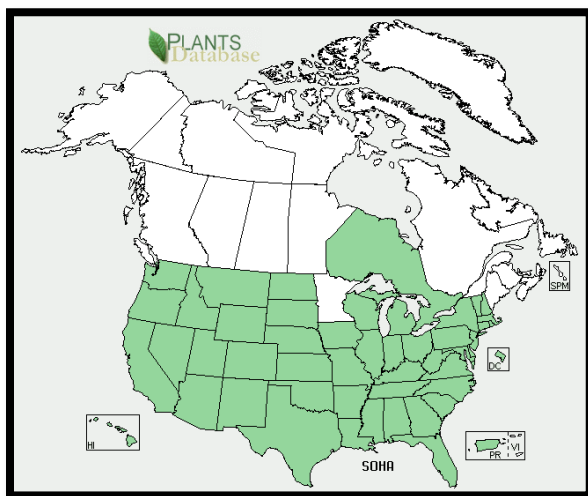
- Tall (up to 8 ft. [2.4 m]), rhizomatous, perennial grass
- Leaves 2 ft. (0.6 m) long, lanceolate and arranged alternately along a stout, hairless, somewhat upward branching stem
- Leaves have distinct, white midribs
- Flowers occur in a loose, spreading, purplish panicle
- Native to the Mediterranean region

### Impacts

- Forms dense colonies which displace native vegetation and restrict tree seedling establishment

### Distribution

- Invades open areas throughout the United States.
- Adapted to a wide variety of habitats including open forests, old fields, ditches and wetlands



### States Where Invasive

AL, AR, AZ, CA, CO, CT, DC, DE, FL, GA, HI, IA, ID, IL, IN, KS, KY, LA, MA, MD, MI, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY



## Kudzu

*Pueraria montana* (Lour.) Merr.

Fabaceae

### Description

- Climbing, deciduous vine
- Grows over 100 ft. (30.5 m)
- Leaves are alternate, compound (with three, usually lobed, leaflets), hairy and up to 5.4 in. (15 cm) long
- Flowers midsummer
- Flowers 0.5 in. (1.3 cm) long, purple, fragrant
- Flowers hang, in clusters, in the axils of the leaves
- Fruit are brown, hairy, flat, 3 in. (7.6 cm) long, 0.3 in. (0.8 cm) wide seed pods
- Native to Asia

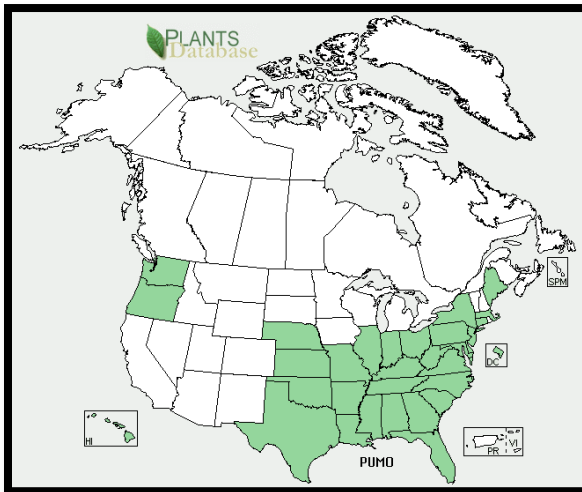
### Impacts

- Grows over, smothers and kills all other vegetation, including trees



### Distribution

- Invades open, disturbed areas such as roadsides, right-of-ways, forest edges and old fields



### States Where Invasive

AL, AR, CT, DC, DE, FL, GA, HI, IL, IN, KS, KY, LA, MA, MD, ME, MO, MS, NC, NE, NJ, NY, OH, OK, OR, PA, SC, TN, TX, VA, WA, WV

## Multiflora Rose

*Rosa multiflora* Thunb. Ex Murr.  
Rosaceae

### Description

- Multi-stemmed, thorny, perennial shrub
- Grows up to 15 ft. (4.6 m) tall
- Stems are arching canes which are round in cross section and have stiff, curved thorns
- Leaves are pinnately compound with 7-9 leaflets
- Leaflets are oblong, 1-1.5 in. (2.5-3.8 cm) long and have serrated edges
- Fringed petioles
- Small, white to pinkish, 5-petaled flowers occur abundantly in clusters
- Fruit are small, red, rose hips that remain on the plant throughout the winter.
- Native to Asia

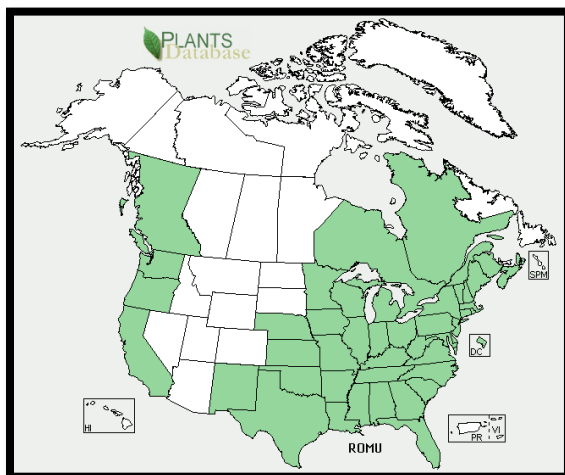


### Impacts

- Restricts human, livestock, and wildlife movement and displaces native vegetation

### Distribution

- Forms impenetrable thickets in pastures, fields and forest edges



### States Where Invasive

AR, CA, CO, CT, DC, DE, GA, IL, IN, KY, LA, MA, MD, ME, MI, MO, MS, NC, NH, NJ, NY, OH, OR, PA, RI, SC, TN, VA, VT, WI, WV



## Common Buckthorn

*Rhamnus cathartica* L.

Rhamnaceae

Other Common Names: European Buckthorn

### Description

- Deciduous shrub or small tree
- Grows to 25 ft. (7.6 m) in height
- Bark is dark gray and the inner bark is orange (easily seen when the tree is cut)
- Twigs are usually tipped with a sharp spine
- Leaf arrangement is usually subopposite, but examples of opposite and/or alternate arrangements are commonly found
- Leaves are dark green, oval, 1.5 to 3 in. (3.8-7.6 cm) long, slightly serrate with 3 to 4 pairs of curving veins and a somewhat folded tip
- Flowers in the spring
- Flowers yellow-green, 4-petaled and develop in clusters of 2 to 6 near the base of the petioles
- Plants are dioecious (male and female flowers occur on separate plants)
- Fruits are small, black berries that are 0.25 in. (0.6 cm) in diameter
- Native of Europe



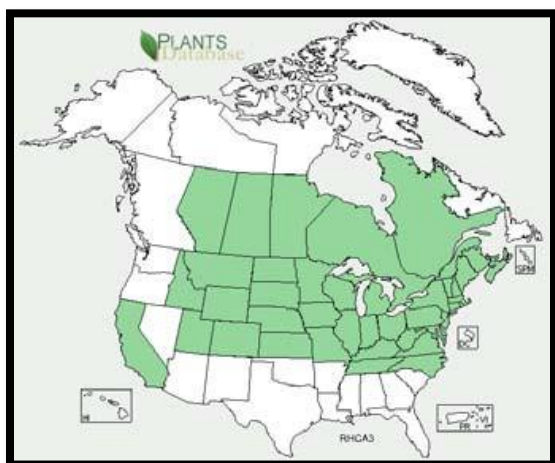
Jan Samanek, State Phytosanitary Administration  
Bugwood.org

### Impacts

- Dense thickets crowd out native shrubs and understory plants
- Difficult to remove once established

### Distribution

- Common buckthorn invades forests, prairies and savannas in the Midwestern US



### States Where Invasive

CO, CT, IA, IL, IN, MD, MA, MI, MN, MO, MS, ND, NH, NJ, NY, PA, RI, SD, TN, VA, VT, WI, WY

## Himalayan Blackberry

*Rubus armeniacus* Focke  
Rosaceae

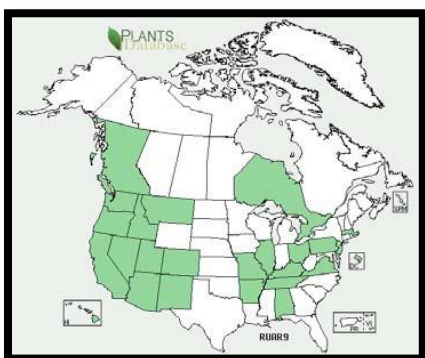
### Description

- Perennial shrub
- Stems grow to 15 ft. (4.6 m) before arching and then trailing over the ground for up to 40 ft. (12.2 m)
- As stems touch the ground they root at the nodes, producing a dense thicket
- Leaves of the prima cane (first year shoots) are 2.8-7.9 in. (7-20 cm) long and palmately compound with 5 leaflets
- No flowers are produced on the first year's growth
- The second year several side shoots are produced (flora canes) having smaller leaves with 3 leaflet
- Leaflets are oval and toothed with thorns along the underside of the mid-rib
- Flowers late spring to early summer
- Flowers white to pale pink flowers develop on the flora canes
- Flowers have 5 petals, numerous stamens and are 0.8-1 in. (2-2.5 cm) in diameter
- Fruits are an aggregate of drupelets that are black, when mature, and 0.5-0.8 in. (1.2-2cm) in diameter
- Native to Eurasia



### Distribution

- Occurs in pastures, riparian areas, wastelands, fence lines and right-of-ways



### States Where Invasive

AL, AR, AZ, CA, CO, DC, DE, HI, ID, IL, KY, MA, MO, MT, NJ, NM, NV, OH, OR, PA, TN, UT, VA, WA

## Tamarisk

*Tamarix spp.* L.

Tamaricaceae

Other Common Names: Saltcedars

### Description

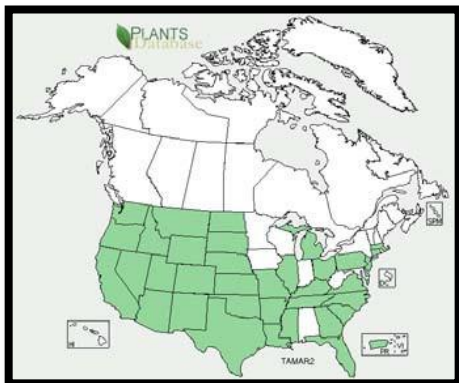
- Deciduous shrub
- Grows up to 15 ft. (4.6 m) in height
- Leaves small (1/16 in. [0.15 cm] long), scale-like, gray-green, and overlap along the stem
- Leaves are often coated with salt crystals
- The bark is smooth and reddish on younger plants, turning brown and furrowed with age
- Flowers March to September
- Flowers are pink to white and develop in 2 in. (5.1 cm) long clusters (spikes) at the tips of the branches
- Native to Eurasia and Africa

### Impacts

- Crowds out native riparian species
- Diminishes early successional habitat
- Reduce water tables
- Salt secretions inhibit other plants

### Distribution

- Several species are considered invasive in US
- Invades stream banks, sandbars, lake margins, wetlands, moist rangelands and saline environments
- Most troublesome in Southwest US



### States Where Invasive

AR, AZ, CA, CO, CT, DE, FL, GA, ID, IL, KS, KY, LA, MA, MI, MO, MS, MT, NC, ND, NE, NJ, NM, NV, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, WA, WY



Steve Dewey, Utah State University,  
Bugwood.org



Steve Dewey, Utah State University,  
Bugwood.org



Steve Dewey, Utah State University,  
Bugwood.org

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## Appendix C Floristic Resources

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Accurate plant identification in the field or lab requires the use of local or regional floras and field guides appropriate to the area being sampled. It is also helpful to consult species range maps or distribution information to confirm species identifications. This appendix provides a list of floristic resources pertinent to individual states or to larger regions within the conterminous United States.

### List of Regional, State, and Local Floristic Resources

EPA compiled a list of floras, field guides, and databases in Appendix C as a resource for NWCA Botanist/Ecologists and it is available electronically in spreadsheet format. Note: this list is not a complete compilation of floras and field guides available across the conterminous US. Rather, it includes floristic resources, applicable to specific states or regions, that were recommended by NWCA Field Crew Botanists/Ecologists. In addition, some other useful floristic resources referenced by herbaria or regional botanical experts are included on the list. Printed and online floras not included in this list (particularly recently published work) may also be considered for use during NWCA sampling.

Floristic Resources in Appendix C are listed under three major subheadings: 1) resources covering the conterminous United States, 2) resources covering large regions (with a list of states to which they apply), and 3) resources that are applicable to specific individual states. The following information is provided for each resource: a Short Citation, a Full Citation, Resource Type, and Resource Applicability in the region or state. In addition, notes about the resource are provided where needed. The Short Citation is used to document the floristic resources used at each NWCA site for plant identification (see Recording Citations, below).

### Recording Citations for Floristic Resources Used at NWCA Sampled Sites

The nomenclatural standard for the NWCA is the PLANTS Database (USDA, NRCS 2021, <https://plants.sc.egov.usda.gov/>), and all plant names will be reconciled to the PLANTS nomenclature during data preparation to facilitate data analysis. To aid in this process, it is important to know the floristic resources used for identification of plants at each sampled site.

The NWCA Veg Team will record short citations for the floristic resources used at each sampled site in the NWCA Data App on Form V-1 under the 'Floristic Resources Used' heading. There is space for up to eight resources to be included. The primary floristic resource used at the site should be listed first. A list of the short citations from the Appendix C are available in a drop-down list next to each citation entry space on Form V-1 to facilitate consistent data entry.



## Appendix D Photography

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### I. Taking Photographs

Taking photographs is a required NWCA field activity that provides an important visual record of sampling activities at each site and is a vital component in the QA review of the soil profile description and naming of horizons by NRCS Soil Scientists. Photographs can be taken with a digital camera, phone or tablet, as long the images produced are of good quality.

It is important to keep a record of the date and location photographs are taken. One approach used in past surveys is to take an initial photograph of an 8.5 × 11 inch piece of paper with the site ID, date, and name of the individual(s) taking the picture printed in large, thick letters. We do not recommend using a placard or board with site information in every photograph taken; this often detracts from the real subject (e.g., soil profile, site characterization, plant, special feature) of the photograph.

After the photograph of the site ID information, take the following photographs at each site:

- Assessment Area (AA) characterization photographs
- Water sample location photographs (if collected)
- Soil profile photographs
- Threatened, Endangered and Sensitive (TES) species photographs and
- Other notable site feature(s) photographs.

Be sure to include photographs that provide a frame of reference, including photographs of crew members collecting the sample. Permission should be obtained from any individual photographed.

#### 1 - AA Characterization Photographs

During the Assessment Area (AA) characterization, the Veg Team takes the following digital photographs after establishing the Veg Plots (Chapter 5):

- Overview of the setting around the POINT: This photograph should contain the flag marking the POINT.
- Overview of the setting around the AA CENTER: This photograph is only taken if the AA CENTER is in a different location than the POINT. The flag marking the AA CENTER should also be visible in this photograph.
- View from the AA CENTER along each of the plot placement lines for vegetation sampling: This photograph is taken for each Vegetation Plot placement line. Note the compass bearing for the plot placement line and, if possible, capture any relevant flagging. The optimal time to take this photograph is when the sun lights the scene from the side. This will ensure the photograph has depth. Keep the camera level with the horizon and ensure the image contains no more than one-third sky.

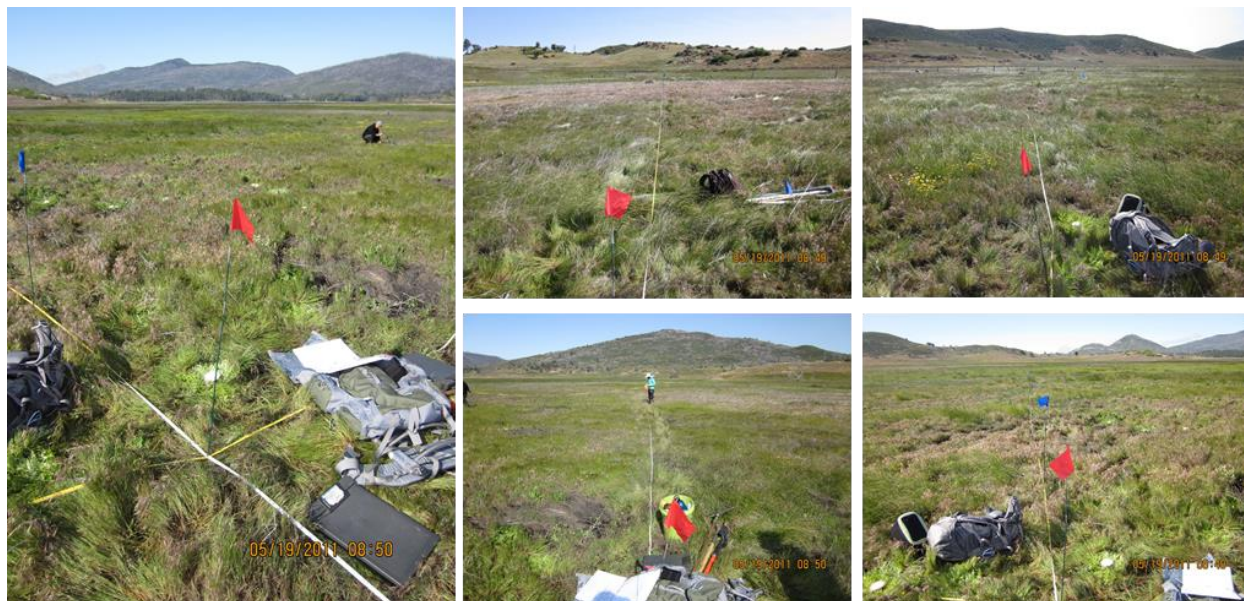


Figure D-1. *Left:* Overview of the setting around the POINT photograph. *Middle and right top and bottom:* Plot placement line photographs. All photographs courtesy of Cara Clark, Moss Landing Marine Laboratories.

## 2 – Water Sample Location Photographs

While documenting surface water characteristics and collecting water samples the AB Team will take a photograph of the water sample collection location and other photographs of surface water features occurring at the site that help portray surface water conditions.

## 3 - Soil Profile Photographs

A soil profile photo is an image that clearly shows the soil horizon depth designations made by the AB Team. Photographs of the soil profile and important soil features will be used by NRCS Soil Scientists to review the Soil Profile Description and name soil horizons if a Quality Assurance check cannot be performed in the field. Soil profile photographs should be taken even when NRCS Soil Scientists perform the QA check in the field, as photographs of the soil profile can be helpful if questions arise during later soil analyses. Photographs can illustrate important soils characteristics, and become reference sources of basic soils information.

Photographs should be taken of each soil profile after initial readings and horizon boundaries are determined, but prior to describing horizon characteristics and collecting samples. Photographs can be taken of the soil profile face in the soil pit, or of the vertically aligned shovel slabs arranged outside of the pit.

Use the golf tees to mark horizon boundaries and use the fiberglass fabric (seamstress) tape measure) to display depths and indicate scale. Place the tape measure so that the 0 cm mark is at the soil surface (below living vegetation, loose leaf litter, or duff layer) and extends to the bottom of the soil pit.



Take pictures of the entire soil profile (0-125 cm) and of smaller sections (e.g., 0-20 cm, 20-40 cm, etc.) to display smaller features. More details and suggestions for taking soil profile photographs are given in Section 2.29.1.7.



Figure D-2. *Left*: Soil profile described/photographed outside of the pit (extracted using a King Sampler), *Middle*: Soil profile described/photographed outside of the pit (extracted using augur), *Right*: Soil profile face photographed in the soil pit.

#### 4 - Threatened, Endangered and Sensitive Species Photographs

A plant photo voucher is an image that shows enough plant characteristics to allow identification by plant experts. As with all vouchers, all relevant data must be kept for each plant photographed. If the site contains a species that is considered, or is suspected of being, a Threatened, Endangered or Sensitive (TES) plant species, the Veg Team takes a photograph to document the occurrence. The photograph must include as many diagnostic features as possible to aid in identification. Try to get close-ups of flowers (from two or more angles), inflorescences, fruits, seed heads, leaves (upper and lower surfaces), branching patterns, buds, roots, and other diagnostic features. Take photographs of the whole plant. Include a scale in the photo, using objects of known size, such as a ruler, pencil, coin, shoe, finger, or a person.



Figure D-3. Series of plant voucher photographs showing diagnostic features for *Butomus umbellatus*. Photographs courtesy of Elizabeth Riley, EPA.





Figure D-4. Series of plant voucher photographs showing different objects that can be used as a scale. Clockwise from top left, field crew member with *Typha latifolia*, bees with *Alisma triviale*, index finger with *Dichorisandra thursifolia* (photographs courtesy of Elizabeth Riley, EPA), and a ruler with *Woodwardia areolata* (photo courtesy of Janet Nestlerode, EPA).

#### 5 – Other Notable Site Feature(s) Photographs

Photographs can be taken for any feature of interest, e.g., stressors or physical alterations present in the site. Where possible, include a frame of reference.

## II. Saving and Uploading Photographs to EPA

Back at the office or other base location, save each photograph using the appropriate naming convention provided in more detail below. The naming convention for each type of photograph includes the site ID, a special modifier indicating the type of photograph taken, and the date. Images must be saved in a medium- to high-quality jpeg format, with the resulting file name of each photograph noted in an excel spreadsheet photo log. Use a different worksheet tab for each site. A template excel spreadsheet is available on the NWCA SharePoint site in the following folder:

*NWCA / NWCA 2021 / Site Photographs*

Registration and access links to the NWCA SharePoint will be provided during the regional trainings. Include a brief description of each photograph, the name of the photographer, and the compass bearing (for plot placement line photographs only) in the log. See the table below for example entries.

Photograph File Name	Description	Photographer	Compass Bearing
NWC21-ST-10001_AA_POINT_2021.06.20.jpg	Area at POINT	Johnny Bark	45
NWC21-ST-10001_AA_CENTER_2021.06.20.jpg	Center of AA, POINT visible in background	Johnny Bark	
NWC21-ST-10001_AA_P-0_2021.06.20.jpg	North Plot Line	Johnny Bark	0
NWC21-ST-10001_AA_P-90_2021.06.20.jpg	East Plot Line	Johnny Bark	90
NWC21-ST-10001_AA_P-180_2021.06.20.jpg	South Plot Line	Johnny Bark	180
NWC21-ST-10001_AA_P-270_2021.06.20.jpg	West Plot Line	Johnny Bark	270
NWC21-ST-10001_W1_2021.06.20.jpg	Water sample location	Johnny Bark	na
NWC21-ST-10001_SP_0-100_2021.06.20.jpg	Soil Profile 0-100 cm	Johnny Bark	na
NWC21-ST-10001_SP_25-50_2021.06.20.jpg	Soil Profile 25-50 cm, shows concentrations and depletions	Johnny Bark	na
NWC21-ST-10001_TES_Ledum groenlandicum_2021.06.20.jpg	photo of Ledum groenlandicum, TES, not collected	Johnny Bark	na
NWC21-ST-10001_F1_2021.06.20.jpg	leaking water tank, 10 m, 145 degrees from AA CENTER	Johnny Bark	145

Photographs should be uploaded to the NWCA SharePoint site at least every 1-2 weeks throughout the field season. Save photographs in the appropriate crew folder and make sure to include an updated photo log each time photographs are added to the folder.

Use the following naming conventions when saving photographs:

- AA Characterization Photographs
  - Site ID number (i.e., in the format NWC21-ST-10000 or other assigned number)
  - Photographs taken to characterize the AA are signified by the letters **AA**
  - Modifier indicating the AA characterization photo taken:
    - **POINT**: photo taken of the setting around the POINT
    - **CENTER**: photo taken of the setting around the CENTER, if different from POINT

- Photographs taken from the CENTER along each of the plot placement lines for vegetation sampling are designated by the letter **P** and the bearing of the plot placement line.
  - Date in the format YYYY.MM.DD. Example photo tracking code:
    - NWC21-ST-10016\_AA\_POINT\_2021.08.15.jpg
    - NWC21-ST-10016\_AA\_CENTER\_2021.08.15.jpg
    - NWC21-ST-10016\_AA\_P-290\_2021.08.15.jpg
- Water Sample Location Photographs
  - Site ID number (i.e., in the format NWC21-ST-10000 or other assigned number)
  - Photographs taken of the water sample location and other water features are designated by the letter **W**
  - Date in the format YYYY.MM.DD. Example photograph tracking code:
    - NWC21-ST-10016\_W1\_2021.08.15.jpg
- Soil Profile Photographs
  - Site ID number (i.e., in the format NWC21-ST-10000 or other assigned number)
  - Photographs taken of the soil profile are designated by the letter **SP**
  - Depth range (in cm) of the soil profile shown in the photograph (e.g, 0-100 if the photo shows the entire profile)
  - Date in the format YYYY.MM.DD. Example photograph tracking code:
    - NWC21-ST-10016\_SP\_0-100\_2021.08.15.jpg
    - NWC21-ST-10016\_SP\_0-20\_2021.08.15.jpg
- TES Species Photographs
  - Site ID number (i.e., in the format NWC21-ST-10000 or other assigned number)
  - Photographs taken of a Threatened, Endangered or Sensitive plant species are designated by the letters **TES**
  - Species name or pseudonym if the species is unknown but suspected of being a TES species.
  - Date in the format YYYY.MM.DD Example photo tracking codes:
    - NWC21-ST-10016\_TES\_Ledum groenlandicum\_2021.08.15.jpg
    - NWC21-ST-10016\_TES\_Carex1-3 stigmas\_2021.08.15.jpg
- Other Notable Site Feature Photographs
  - Site ID number (i.e., in the format NWC21-ST-10000 or other assigned number)
  - Photographs taken of important features are designated by the letter **F** and a sequential number for each feature documented at the site (i.e., F1, F2, etc.).
  - Date in the format YYYY.MM.DD. Example photograph tracking code:
    - NWC21-ST-10016\_F1\_2021.08.15.jpg
    - NWC21-ST-10016\_F2\_2021.08.15.jpg

## Appendix E Forms and Labels

<p style="text-align: center;"><b>WATER CHEMISTRY (CHEM)</b></p> <p style="text-align: center;">Site ID: NWC21-_____</p> <p style="text-align: center;">Date: ____/____/20____ Visit #: ○1 ○2</p> <p style="text-align: center;"><b>990000</b></p> <p style="text-align: center;"><b>T1</b></p> <p style="text-align: center;"><b>WATER COLUMN CHLOROPHYLL (WCHL)</b> <b>OUTER BAG</b></p> <p style="text-align: center;">Site ID: NWC21-_____</p> <p style="text-align: center;">Date: ____/____/20____ Visit #: ○1 ○2</p> <p style="text-align: center;">Volume Filtered: ____mL</p> <p style="text-align: center;"><b>990001</b></p> <p style="text-align: center;"><b>T1</b></p> <p style="text-align: center;"><b>SOIL ISOTOPE (SISO)</b></p> <p style="text-align: center;">Site ID: NWC21-_____ State: _____</p> <p style="text-align: center;">Date: ____/____/20____ Visit #: ○1 ○2</p> <p style="text-align: center;"><b>990003</b></p> <p style="text-align: center;"><b>T2</b></p>	<p style="text-align: center;"><b>WATER COLUMN CHLOROPHYLL (WCHL)</b></p> <p style="text-align: center;">Site ID: NWC21-_____</p> <p style="text-align: center;">Date: ____/____/20____ Visit #: ○1 ○2</p> <p style="text-align: center;">Volume Filtered: ____mL</p> <p style="text-align: center;"><b>990001</b></p> <p style="text-align: center;"><b>T1</b></p> <p style="text-align: center;"><b>MICROCYSTIN (MICX)</b></p> <p style="text-align: center;">Site ID: NWC21-_____</p> <p style="text-align: center;">Date: ____/____/20____ Visit #: ○1 ○2</p> <p style="text-align: center;"><b>990002</b></p> <p style="text-align: center;"><b>T2</b></p> <p style="text-align: center;"><b>STANDARD DEPTH SOIL CORE (SDSC)</b></p> <p style="text-align: center;">Site ID: NWC21-_____</p> <p style="text-align: center;">Date: ____/____/20____ Visit #: ○1 ○2</p> <p style="text-align: center;">Depth: 0-10cm</p> <p style="text-align: center;"><b>990004</b></p> <p style="text-align: center;"><b>T3</b></p>
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<p style="text-align: center;">Lab Sample ID: _____</p> <p style="text-align: center;"><b>T1: NWC21 Daily Water Chemistry Sample Tracking</b></p> <p style="text-align: center;">Site ID: <b>NWC21-</b>_____ Visit #: ○1 ○2</p> <p style="text-align: center;">Date Collected: ____/____/____</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;">Sample ID</th> <th style="width: 85%;">Lab Comments (For lab staff only)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">CHEM</td> <td></td> </tr> <tr> <td style="text-align: center;">WCHL</td> <td></td> </tr> </tbody> </table> <p style="text-align: center;">Date Rec'd: _____ Rec'd by: _____</p>	Sample ID	Lab Comments (For lab staff only)	CHEM		WCHL		<p style="text-align: center;"><b>T2: NWC21 Daily Chilled Tracking</b></p> <p style="text-align: center;">Site ID: <b>NWC21-</b>_____ Visit #: ○1 ○2</p> <p style="text-align: center;">Date Collected: ____/____/____</p> <p>Lab Staff: _____</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;"></th> <th style="width: 15%;">Samples In Box?</th> <th style="width: 15%;">Sample ID</th> <th style="width: 60%;"></th> </tr> </thead> <tbody> <tr> <td rowspan="2" style="text-align: center; vertical-align: middle;"><b>For Lab use only</b></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;">MICX</td> <td></td> </tr> <tr> <td colspan="3" style="text-align: center;">Lab Comments (For lab staff only)</td> </tr> <tr> <td></td> <td></td> <td style="text-align: center;">Sample ID</td> <td></td> </tr> <tr> <td rowspan="2" style="text-align: center; vertical-align: middle;"><b>For Lab use only</b></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;">SISO</td> <td></td> </tr> <tr> <td colspan="3" style="text-align: center;">Lab Comments (For lab staff only)</td> </tr> </tbody> </table> <p style="text-align: center; font-size: small;">Please cross out sample id(s) not included in shipment.</p>		Samples In Box?	Sample ID		<b>For Lab use only</b>	<input type="checkbox"/>	MICX		Lab Comments (For lab staff only)					Sample ID		<b>For Lab use only</b>	<input type="checkbox"/>	SISO		Lab Comments (For lab staff only)		
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<p style="text-align: center;"><b>T5: NWC21 QA Plant Tracking</b></p> <p style="text-align: center;">Site ID: <b>NWC21-</b>_____ Visit #: ○1 ○2 Date Collected: ____/____/____</p> <p>Lab Staff: _____</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;"></th> <th style="width: 15%;">Samples In Box?</th> <th style="width: 15%;">Sample ID</th> <th style="width: 60%;"></th> </tr> </thead> <tbody> <tr> <td rowspan="5" style="text-align: center; vertical-align: middle;"><b>For Lab use only</b></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;">Q</td> <td></td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;">Q</td> <td></td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;">Q</td> <td></td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;">Q</td> <td></td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;">Q</td> <td></td> </tr> </tbody> </table>		Samples In Box?	Sample ID		<b>For Lab use only</b>	<input type="checkbox"/>	Q		<input type="checkbox"/>	Q		<input type="checkbox"/>	Q		<input type="checkbox"/>	Q		<input type="checkbox"/>	Q										
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<b>SOIL HORIZON CHEMISTRY (SHCH)</b>	
Site ID: NWC21-_____	
Date: ___/___/20___ Visit #: <input type="radio"/> 1 <input type="radio"/> 2	
Horizon #: _____	
T3	<b>990005</b>
<b>SOIL HORIZON BULK DENSITY (SHBD)</b>	
Site ID: NWC21-_____	
Date: ___/___/20___ Visit #: <input type="radio"/> 1 <input type="radio"/> 2	
Horizon #: _____ <input type="radio"/> BD1 <input type="radio"/> BD2 <input type="radio"/> BD3	
T3	<b>990006</b>

<b>Sample Type:</b> _____
Site ID: _____
Date: ___/___/201__ Visit #: <input type="radio"/> 1 <input type="radio"/> 2
<b>Sample ID:</b> _____

NWCA 2021: Soil Horizon Chemistry or Soil Horizon Bulk Density Samples Tag	
Staple under sample bag fold	Site ID: NWC21-_____ Date: ___/___/20___ Visit #: <input type="radio"/> 1 <input type="radio"/> 2
	Horizon #: _____ Horizon Depth: _____ cm to _____ cm
	Indicate <u>either</u> Chemistry or ONE of the Bulk Density Samples below
	<input type="radio"/> SOIL HORIZON CHEMISTRY (SHCH) Sample ID: _____ For horizon chemistry samples, rocks in the soil should be retained in the sample; however, if they must be removed, record the estimated volume of the sample they comprised. _____ % Sample Volume Comprised by Removed Rock
	<input type="radio"/> SOIL HORIZON BULK DENSITY (SHBD) Sample ID: _____ <input type="radio"/> Bulk Density #1 <input type="radio"/> Bulk Density #2 <input type="radio"/> Bulk Density #3 For bulk density samples, indicate whether the standard corer was used <b>OR</b> a block of soil was collected.
<input type="radio"/> Standard Core For samples collected using the standard corer, indicate the length of the core collected (should be 10 cm whenever possible). Core Length: _____ cm	<input type="radio"/> Block For blocks of soil, indicate the dimensions of the block in cm and calculate and record the volume of the block (LxWxH) in cm <sup>3</sup> . Length: _____ cm Width: _____ cm                      Volume: Height: _____ cm                      _____ cm <sup>3</sup>

Staple under sample bag fold	NWCA 2021: Standard Depth Soil Core Sample Tag
	Site ID: NWC21-_____
	Date: ___/___/20___                      Visit #: <input type="radio"/> 1 <input type="radio"/> 2
	STANDARD DEPTH SOIL CORE (SDSC) <b>Sample ID: 990004</b>
	Sample Depth: 0-10cm

**Unknown Plant Sample** T4

NWC21- \_\_\_\_\_

Visit #:  1  2 Folder # \_\_\_\_ of \_\_\_\_

# of Veg Specimens in Folder: \_\_\_\_\_

**QA Plant Sample** T5

NWC21- \_\_\_\_\_

Visit #:  1  2 Folder # \_\_\_\_ of \_\_\_\_

# of Veg Specimens in Folder: \_\_\_\_\_

**PLANT SPECIMEN LABEL**

QA     Unknown     DNA

Plant SampID: NWC21- \_\_\_\_\_ Vis# \_\_\_\_ Col# \_\_\_\_

Date: \_\_\_\_/\_\_\_\_/20\_\_\_\_ County: \_\_\_\_\_ ST: \_\_\_\_

**Species Name or Pseudonym:** \_\_\_\_\_

**Collector(s) Name(s):** \_\_\_\_\_

**Abundance of Plant (fill only one circle):**  
 Dominant    Common    Sparse    Uncommon

**Type of plant:**  
 graminoid    forb    shrub    tree    vine  
 other \_\_\_\_\_

**Root type:**  
 taproot    fibrous roots    rhizomes    tubers  
 other \_\_\_\_\_

**Water depth/hydroperiod for this plant at sampling (dry, moist, top of hummock, in 6 inches of water, perennially saturated, etc.):** \_\_\_\_\_

**Sunlight:**  
 full sun    part sun    part shade    full shade

**Growth habit:**  
 erect    arching    trailing    shrubby  
 other \_\_\_\_\_

**Number of petals:** \_\_\_\_\_ **Flower color:** \_\_\_\_\_

**Habitat:** \_\_\_\_\_  Multiple newsprints  
\_\_\_\_\_ **Newsprint** \_\_\_\_ of \_\_\_\_

