USDA United States Department of Agriculture

Resource Concerns & Soil Health Indicators

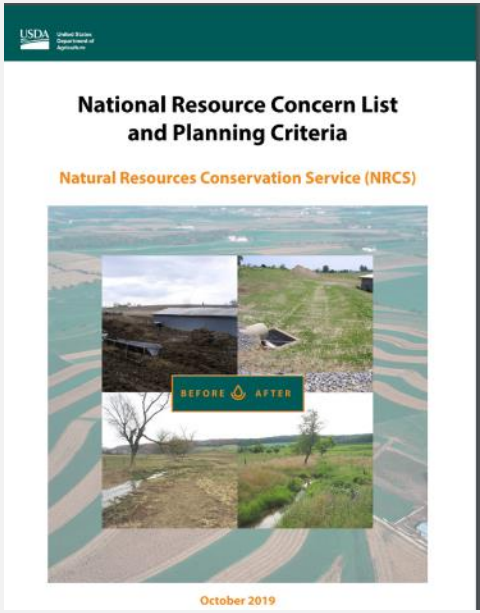
Objectives

- Define soil health resource concerns and planning criteria
- Review the use of the In-Field Soil Health Assessment Tool
- Identify how soil health indicators reveal the presence of resource concerns that drive soil function
- Locate and discuss the value and limitations to the soils data and interpretations that are currently available

NRCS Resource Concerns

Resource Concern: An existing or expected degradation of the soil, water, air, plant, or animal resource base to the extent that the sustainability or intended use of the resource is impaired. (FOTG Section III)

- Compaction
- Organic matter depletion
- Soil organism habitat loss or degradation
- Aggregate instability



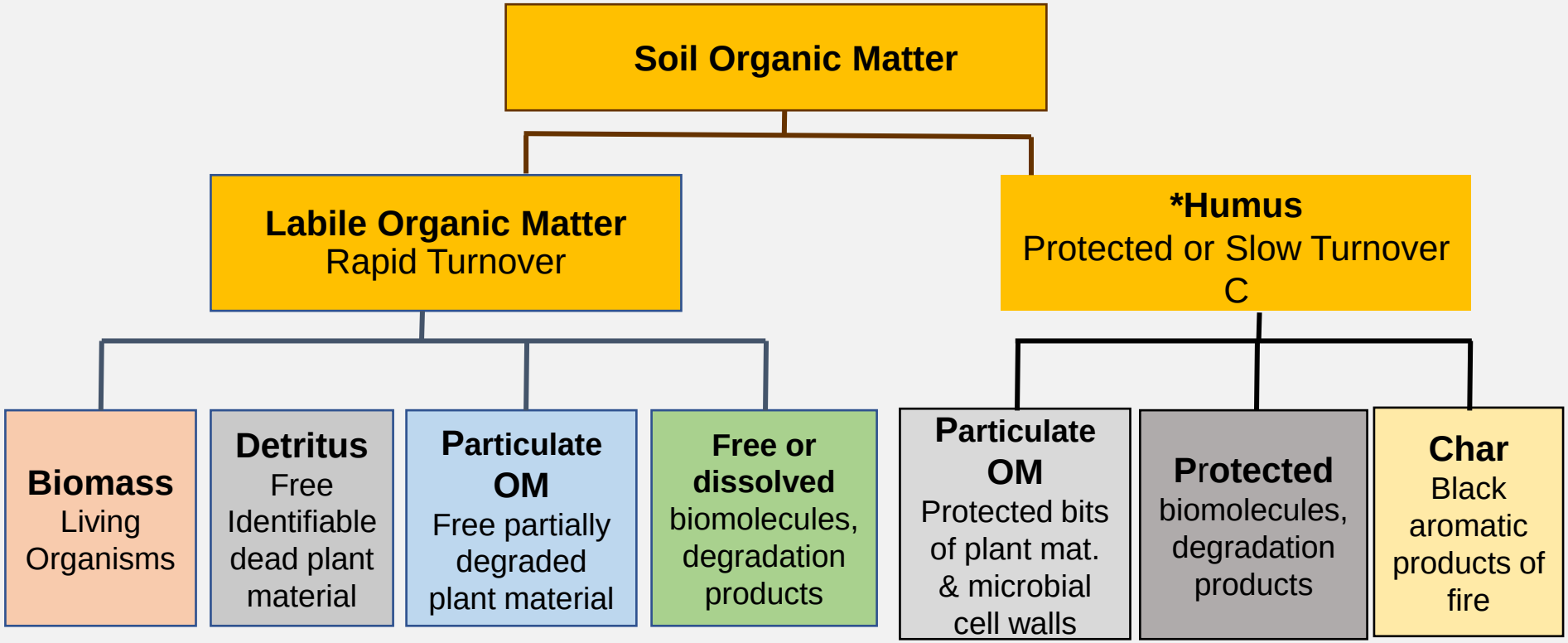
Compaction

- Description: Management induced soil compaction at any level throughout the soil profile resulting in reduced rooting depth/structure, plant growth, biological activity, infiltration, etc.
- Objective: No platy structure or restrictive layer, thickened or J-roots, or layers exceeding 300 psi at field capacity.

Organic Matter Depletion

- Description: Management induced depletion of any or all soil organic matter pools (e.g., labile carbon, total soil carbon or nitrogen) resulting in limited soil function and processes that support: plant growth; habitat/food for soil organisms; water/nutrient cycling.
- Objective: Total organic matter or carbon is being monitored and increasing according to approved total organic matter or carbon soil test

Organic Matter Pools



*Protected on clay surfaces, soil aggregates and in ultramicropores

Adapted from: The Nature and Properties of Soils 15th Edition- Weil and Brady

Soil Organism Habitat Loss or Degradation

- Description: Quantity, quality, diversity or connectivity of food, cover, space, shelter and/or water is inadequate to meet requirements of soil organisms
- Objective: Improve habitat for soil organisms, determined by monitoring several related indicators

Aggregate Instability

- Description: Management induced degradation of water stable soil aggregates resulting in: reduced infiltration, water holding capacity and soil habitat; increased ponding, flooding, erosion; plant stress; depressed resilience to weather extremes
- Objective: Improved aggregate stability where water stable aggregates are present at critical levels and no evidence of poor aggregate stability, such as surface crusting, lack of soil structure.

USDA United States Department of Agriculture

Cropland Assessment

- Field visit
- Interview producer/Management
- Web Soil Survey and Conservation Assessment and Ranking Tool (CART)

In-Field Assessment

Tools of the trade

- Shovel
- Knives
- Water
- Sink strainers
- Infiltration rings
- Notetaking
- Camera
- Color book

Cropland In-Field Soil Health Assessment Worksheet

Soil Health Resource Concerns

- ☐ CPT: Compaction
- ☐ SOM: Soil Organic Matter Depletion
- ☐ AGG: Aggregate Instability
- ☐ HAB: Soil Organism Habitat Loss or Degradation

Location

Field/CMU

Tract #

Client/Customer

Plan

Date

Soil Map Units

Soil Moisture

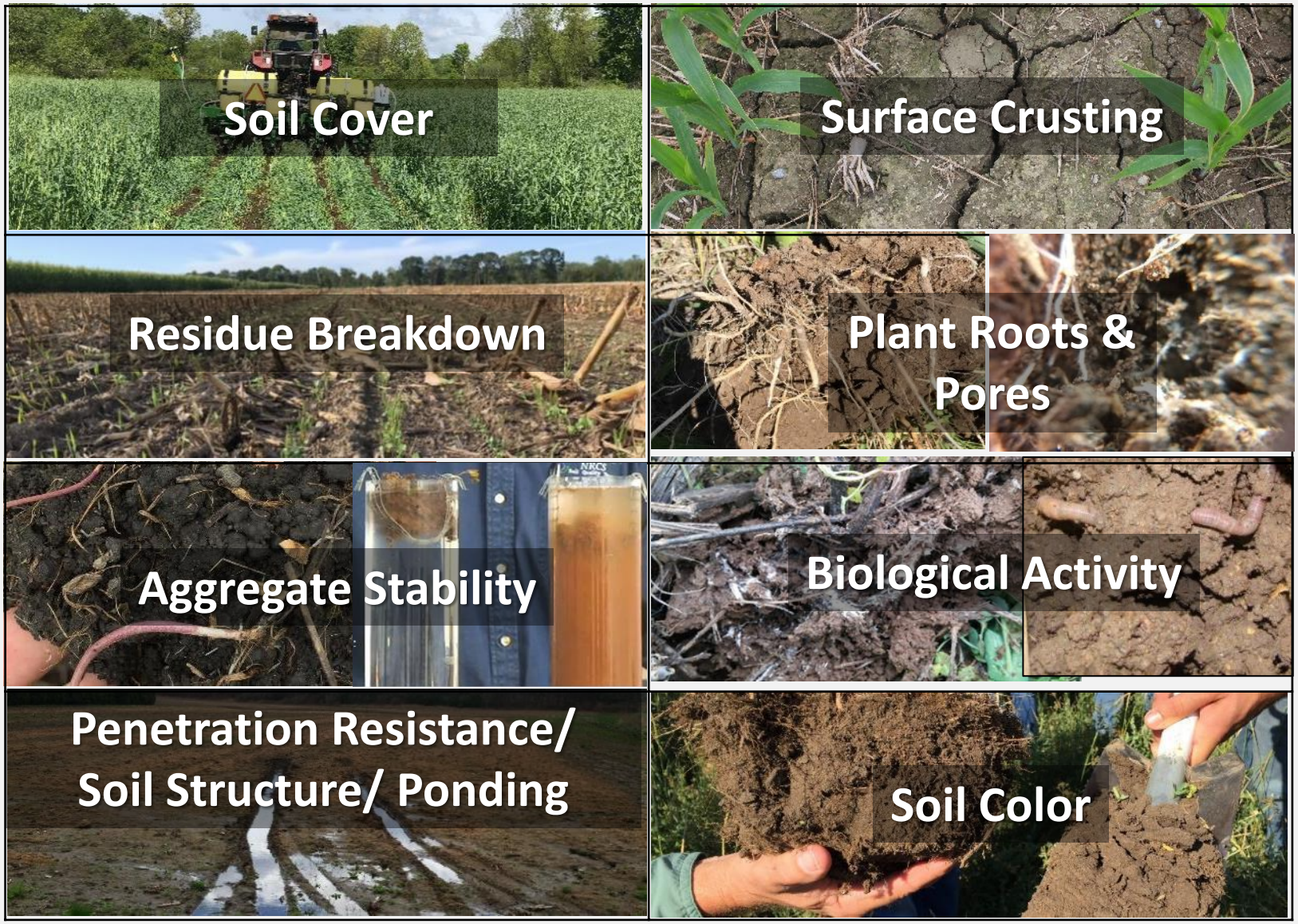
Surface Horizon Texture

Indicator Timing and Use	Meets Assessment Criteria (Yes/No)
Anytime	After Rain or Irrigation	With Adequate Moisture	Before a Tillage Event Primarily No-Till Systems	Before Growing Season	During Growing Season	Interview	
Soil Cover | **SOM, AGG, HAB** • Surface cover from plants, residue or mulch; cover greater than 75% (estimated)	☐ Y ☐ N
Residue Breakdown | **SOM, HAB** • Natural decomposition of crop residues or organic mulch is as expected with crop and conditions	☐ Y ☐ N
Surface Crusts | **AGG, HAB** • Crusting on no more than 5% (estimated) of the field/CMU	☐ Y ☐ N
Ponding/Infiltration | **CPT, AGG** • No ponding on non-hydric soils within 24 hours following typical rainfall or surface irrigation event; • OR, no infiltration difference between assessment area and fencerow sample in the same soil type; • OR, soil infiltrates 1-inch of water in 30 minutes or less	☐ Y ☐ N
Penetration Resistance | **CPT** • Penetrometer rating <150 psi within top 6-inch depth and <300 psi in the 6 to 18-inch depth; • OR, slight or no resistance with wire flag inserted to 12 inches	☐ Y ☐ N
Water-Stable Aggregates | **CPT, SOM, AGG, HAB** • Strainer: soil structure remains intact with aggregates apparent; • OR, Soil Quality Test Kit (SQTK)/Jornada slake box meets stability class 5 to 6; • OR, Cylinder: At least 80% (estimated) remains intact after 5 minutes with little cloudy water	☐ Y ☐ N
Soil Structure | **CPT, SOM, AGG, HAB** • Granular surface soil structure and no platy or massive structure in top foot of soil	☐ Y ☐ N
Soil Color | **SOM** • No color difference between assessment area and fencerow sample in same soil type: • OR, value is on the darker range using color chart and official series description	☐ Y ☐ N
Plant Roots | **CPT, SOM, AGG, HAB** • Roots covered in a soil film (rhizosheaths) or are part of soil aggregates; • OR, living roots if present are healthy, fully branched, extended and unrestricted	☐ Y ☐ N
Biological Diversity | **SOM, AGG, HAB** • Evidence of more than 3 different types of organisms observed or biological hotspots present	☐ Y ☐ N
Biopores | **SOM, AGG, HAB** • Presence of multiple intact root or earthworm channels that extend vertically through the soil with some connecting to the surface	☐ Y ☐ N

Clear Worksheet | Clear Worksheet Except Client/Customer, Plan and Date

Version 1.3

In-Field Soil Health Assessment To Identify Resource Concern Presence



In-Field Assessment

Indicator: Soil Cover		
Description	Soil cover is the percent of the soil surface that is covered by plant residue, organic mulch and/or live plants.	
Resource Concerns Addressed	• Aggregate instability • Soil organism habitat loss or degradation • Soil organic matter depletion	
In-field measurement	1. Farmer interview, 2. Photo estimation method or state approved method, OR 3. Line intercept: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_022074.pdf	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Cover > 75% after planting	Cover ≤ 75% after planting

A field of seed corn stubble just before planting soybean

In-Field Assessment

Indicator: Residue Breakdown		
Description	The rate at which residue decomposes is an indicator of relative biological activity; biological shredding, fragmenting, cycling or incorporating of previous crop residue.	
Resource Concerns Addressed	• Soil organism habitat loss or degradation • Soil organic matter depletion	
In-field measurement	Look at existing residue cover for signs of breakdown, consider: 1. If tillage present, then not applicable. 2. How many seasons/layers of crop residue are present 3. Residue composition and type (C:N) residue crops were grown 4. Residue color and condition of most recent crop residue	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Residue pieces are small, mixed in surface or minimal crop residue remaining from >1 cropping seasons	Residue in large pieces left after planting, can be handled without crumbling and/or significant residue from 2 or more cropping seasons

USDA United States Department of Agriculture

Residue Breakdown

- Natural shredding and decomposition of residues
- Don’t want a corn stalk to see its 3rd birthday
- Biological activity
- C:N Ratios
- Nutrient cycling

In-Field Assessment

Indicator: Surface Crusts		
Description	Crusts form after rain or irrigation on soils with weak aggregate stability.	
Resource Concerns Addressed	• Aggregate instability • Soil organism habitat loss or degradation	
In-field measurement	Evaluated by visual observation after rainfall/irrigation and drying: • Note whether crusts are throughout the field or only in patches. • Near surface will be dense, show layered sediment deposits • Poor crop emergence uneven stand	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Evidence of surface crust ≤ 5% of field	Evidence of surface crust > 5% of field

Indicator: Surface Crusts

In-Field Assessment

Indicator: Ponding/Infiltration		
Description	Areas of the field that collect and hold runoff water from other parts of the field.	
Resource Concerns Addressed	• Aggregate instability • Surface compaction	
In-field measurement	Farmer interview or visual observation after rainfall/irrigation: • Note evidence of crop residue deposits • Evidence of ponding from observation or on recent aerial photos • Poor crop conditions (yellowing) • Soil infiltrates 1-inch of water in 30 minutes or less	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Evidence of ponding 24 hours or less after a typical rain event; 1-inch water infiltrates < 30 min.	Evidence of ponding more than 24 hours after a rain event; 1-inch of water takes ≥ 30 min. to infiltrate

In-Field Assessment

Indicator: Penetration Resistance		
Description	Management induced reduction of large pores and degraded structure (i.e., platy) that results in decreased rooting depth, plant growth and soil biological habitat and activity.	
Resource Concerns Addressed	• Compaction	
In-field measurement	Conduct with soil moisture near field capacity: • Evaluate multiple representative locations in the field • Record depths of restrictive layer(s) & PSI readings (penetrometer) • Evaluate root development and distribution • Look for platy structure	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Granular structure, appropriate PSI reading, vertical channels or roots.	Evidence of platy structure, unacceptable PSI, root restriction, surface ponding, horizontal or abnormal root architecture.

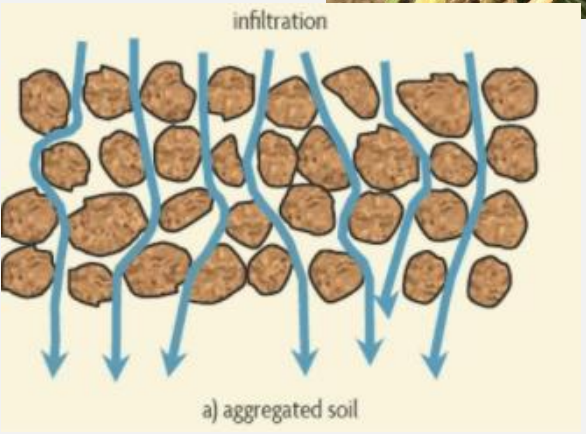
Indicator: Penetration Resistance

UW- Extension
https://www.youtube.com/watch?v=Zq_785JqRq8

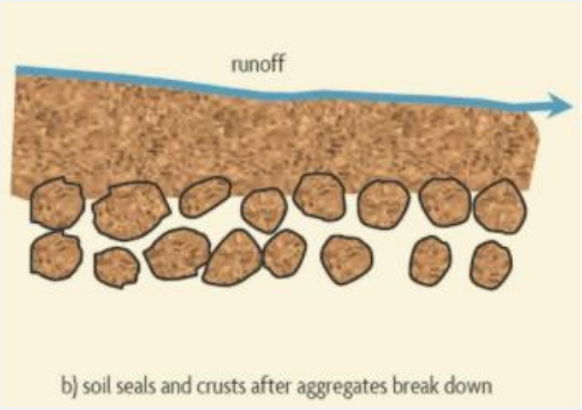
In-Field Assessment

Indicator: Aggregate Stability		
Description	Soil aggregate stability is related to soil porosity and how well a soil can resist raindrop impact and erosion.	
Resource Concerns Addressed	• Aggregate instability • Soil organism habitat loss or degradation • Soil organic matter depletion • Surface compaction	
In-field measurement	Choose one of the following three methods: • Slake test (ensure samples are completely dry) • Strainer test • Jornada soil aggregate stability test (stability kit)	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Aggregate remains intact • ≥80% for slake test • "stands up" for strainer test, runoff water is translucent • Jornada criteria (rating 5-6)	Aggregate disintegrates • <80% remaining (slake) • Soil "slumps" into a puddle, runoff is not translucent • Jornada criteria (rating < 5)

Manage for Water Stable Aggregates



You want this…



NOT this!

Slake test

Slump Test

In-Field Assessment

Indicator: Soil Structure		
Description	Soil structure is the arrangement of soil particles in various aggregates differing in shape, size, stability, and degree of adhesion to one another.	
Resource Concerns Addressed	• Aggregate instability • Soil organism habitat loss or degradation • Soil organic matter depletion • Surface compaction	
In-field measurement	Observe soil structure and compare to the official series description.	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Granular structure in the surface, or structure is as described in the official series description	Platy or massive structure, or structure does not match the description in the official series description

USDA United States Department of Agriculture

Soil Structure

In-Field Assessment

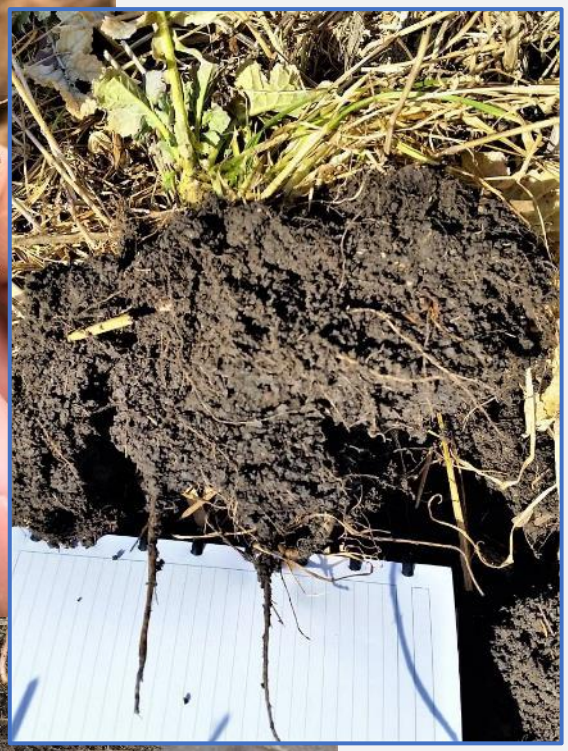
Indicator: Soil Color		
Description	Soil color is used as an indicator of loss or accumulation of organic matter.	
Resource Concerns Addressed	• Soil Organic Matter Depletion	
In-field measurement	Use soil color chart/book and compare to official series description, or compare soil surface to an undisturbed area nearby.	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	An obvious darker surface layer; similar to official series description value (OSD)	Lighter than OSD; soil mixing observed and/or surface is lighter in color than the horizon below

*Note soil moisture makes soil appear darker and should be noted if comparing different fields

In-Field Assessment

Indicator: Plant Roots and Biopores (continuity)		
Description	Roots influence the soil immediately adjacent to them through exudates, growing and leaving soil organic matter as they die.	
Resource Concerns Addressed	• Aggregate instability • Soil organism habitat loss or degradation • Soil organic matter depletion • Compaction (Plant Roots)	
In-field measurement	Observe evidence of dark, root channels or biopores left by previous plants or earthworms.	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Presence of dark, root channels or biopores left by previous plants or earthworms; roots healthy, branched, extended, with rhizosheath	Roots are stressed and do not follow previous root channels, no pores evident from earthworms

Indicators: Roots and Biopores



Rye Root, Soybean root and earthworm sharing the same biopore

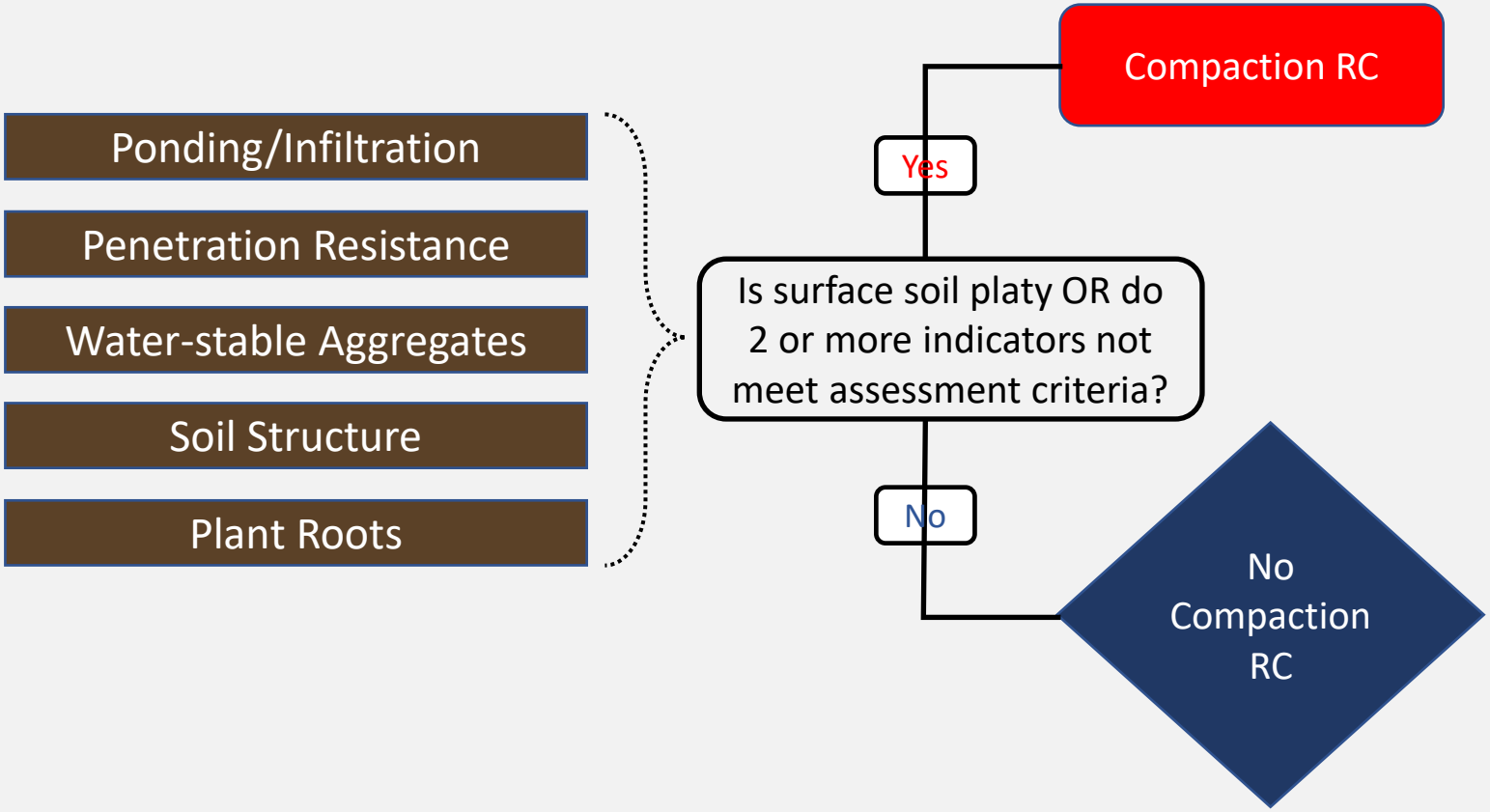
In-Field Assessment

Indicator: Biological Diversity		
Description	Presence and relative abundance of earthworms, mites, springtails, millipedes, roundworms, beetles, termites, fungal hyphae and other organisms provide evidence of a healthy soil ecosystem.	
Resource Concerns Addressed	• Aggregate instability • Soil organism habitat loss or degradation • Soil organic matter depletion	
In-field measurement	Look for evidence of soil organisms (e.g., earthworm casts, middens, large pores, insects, fungal hyphae, etc.).	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Clearly evident; more than 3 types of organisms observed	No biological activity visible, lacking earthworms, no saprophytic fungi, low to no evidence of macrofauna

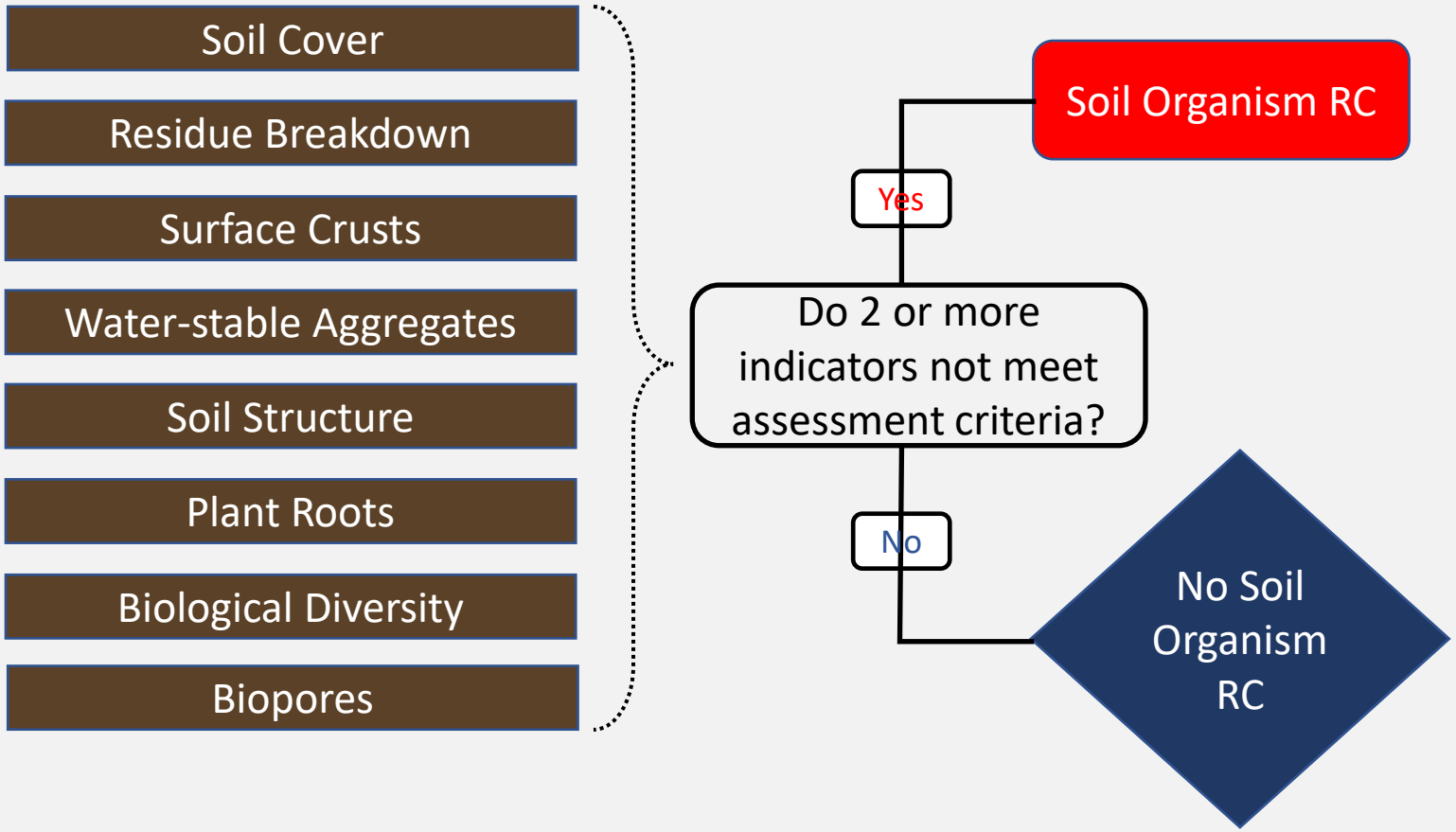
USDA United States Department of Agriculture

Biological Diversity

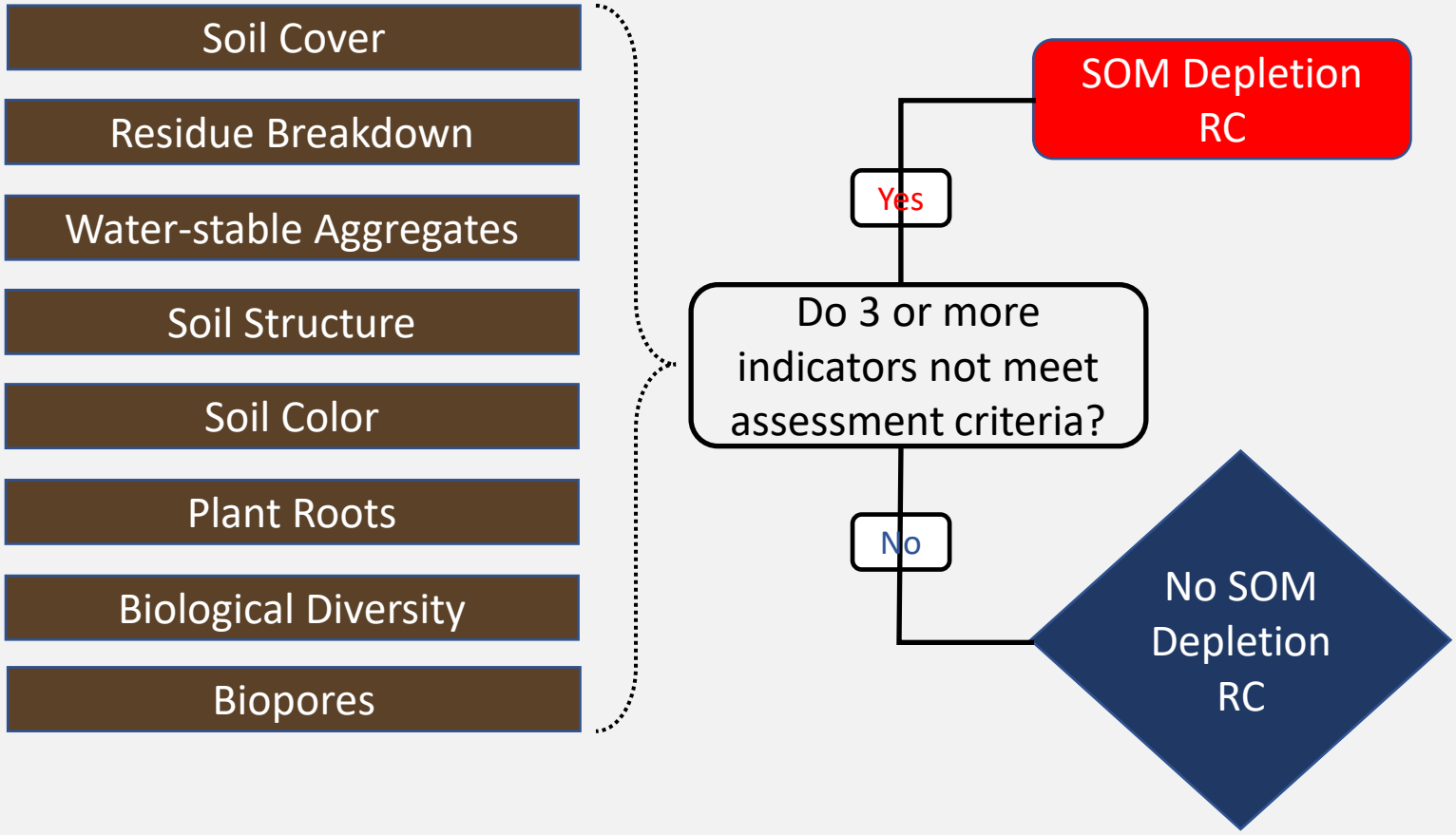
Compaction Resource Concern Decision Tree



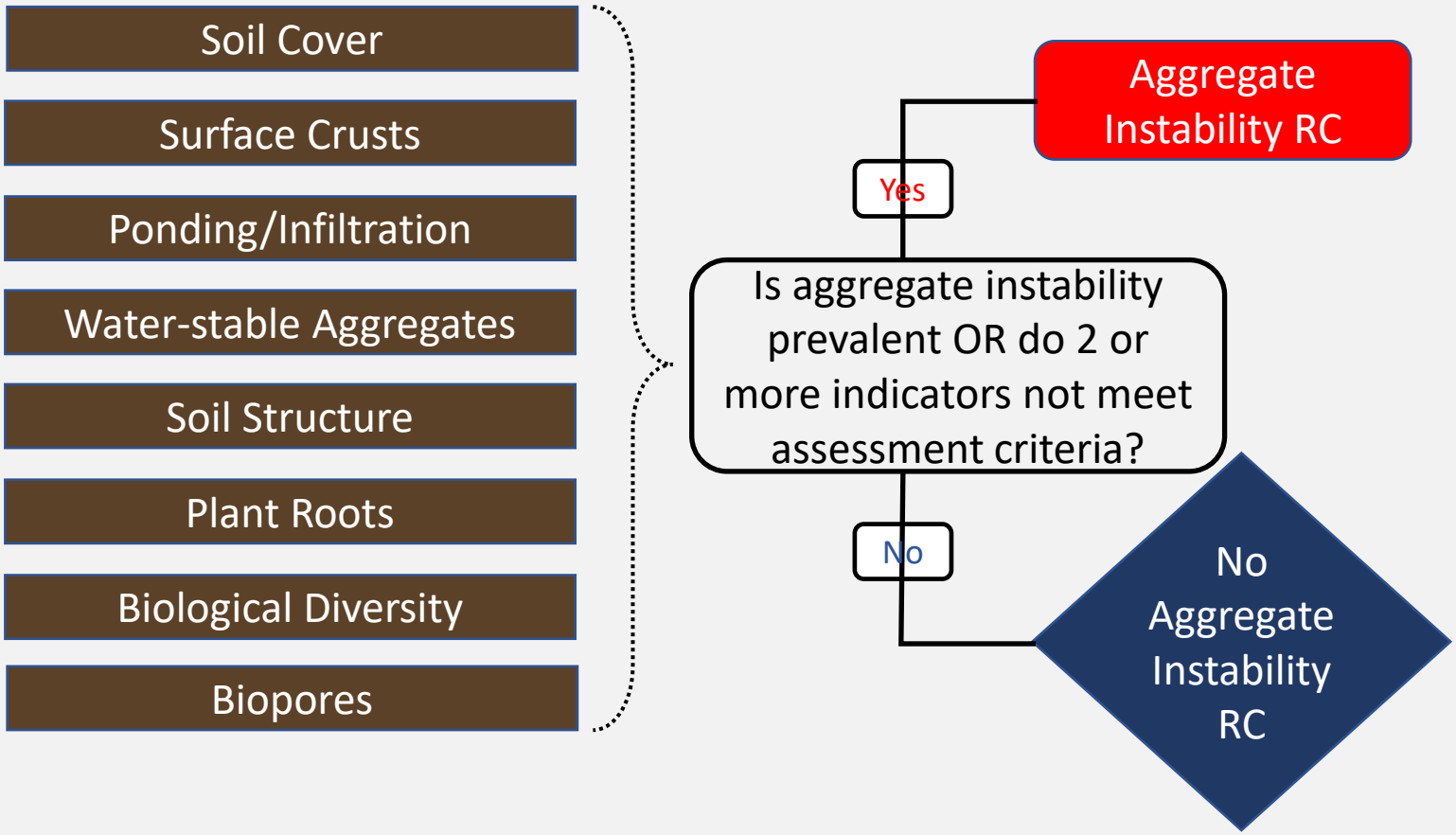
Soil Organism Habitat Loss or Degradation Resource Concern Decision Tree



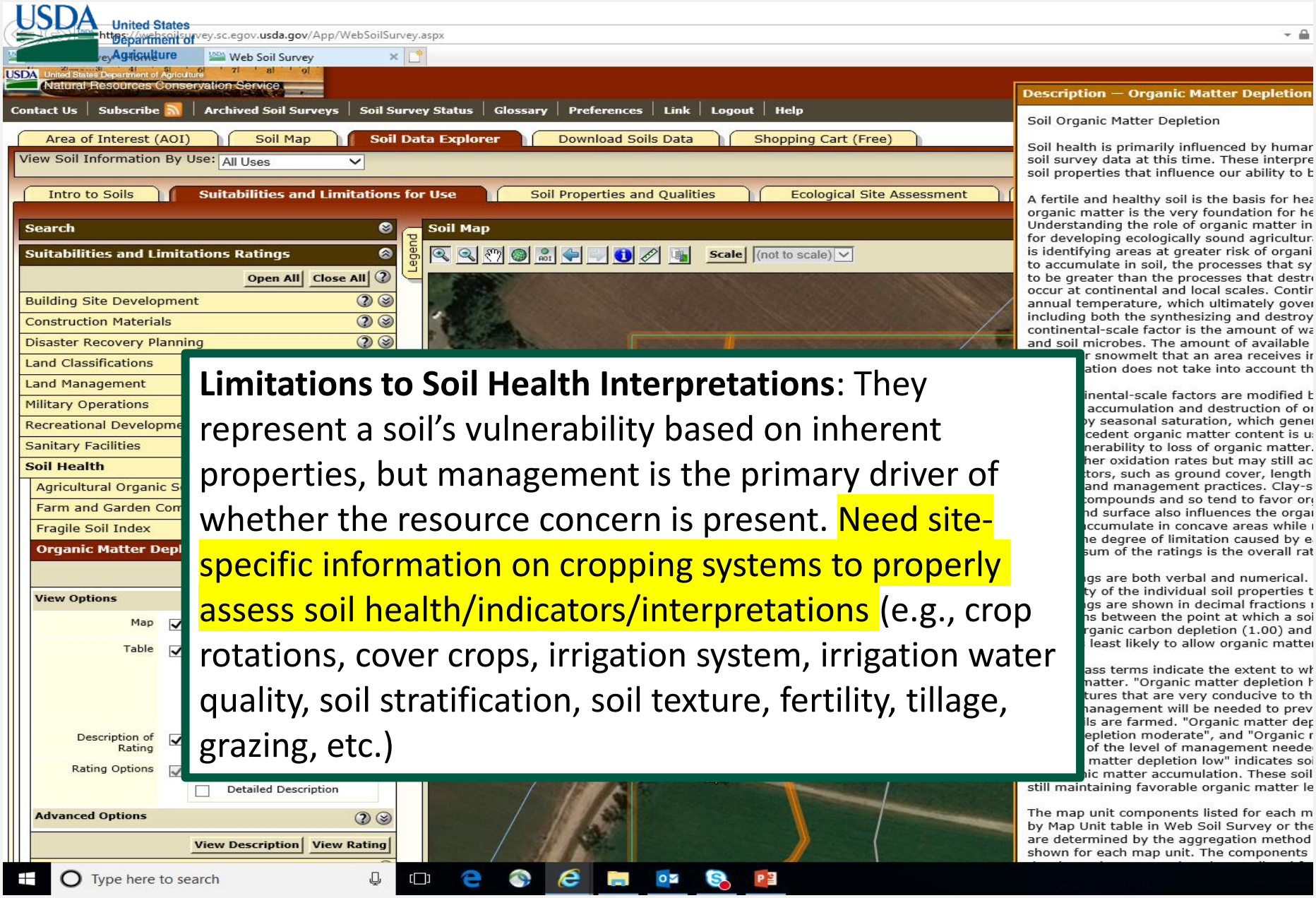
Soil Organic Matter Depletion Resource Concern Decision Tree



Aggregate Stability Resource Concern Decision Tree



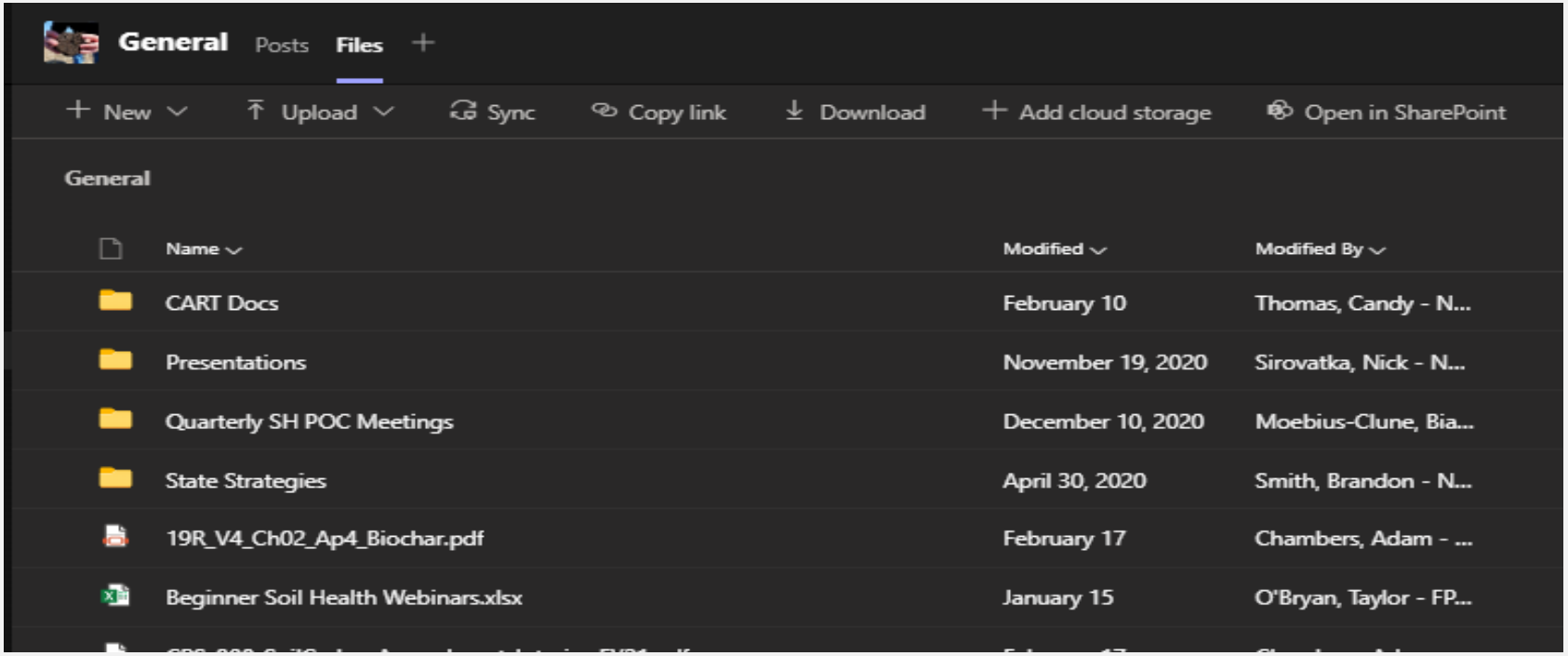
WSS/CART



Limitations to Soil Health Interpretations: They represent a soil's vulnerability based on inherent properties, but management is the primary driver of whether the resource concern is present. Need site-specific information on cropping systems to properly assess soil health/indicators/interpretations (e.g., crop rotations, cover crops, irrigation system, irrigation water quality, soil stratification, soil texture, fertility, tillage, grazing, etc.)

CART

Guidance Available

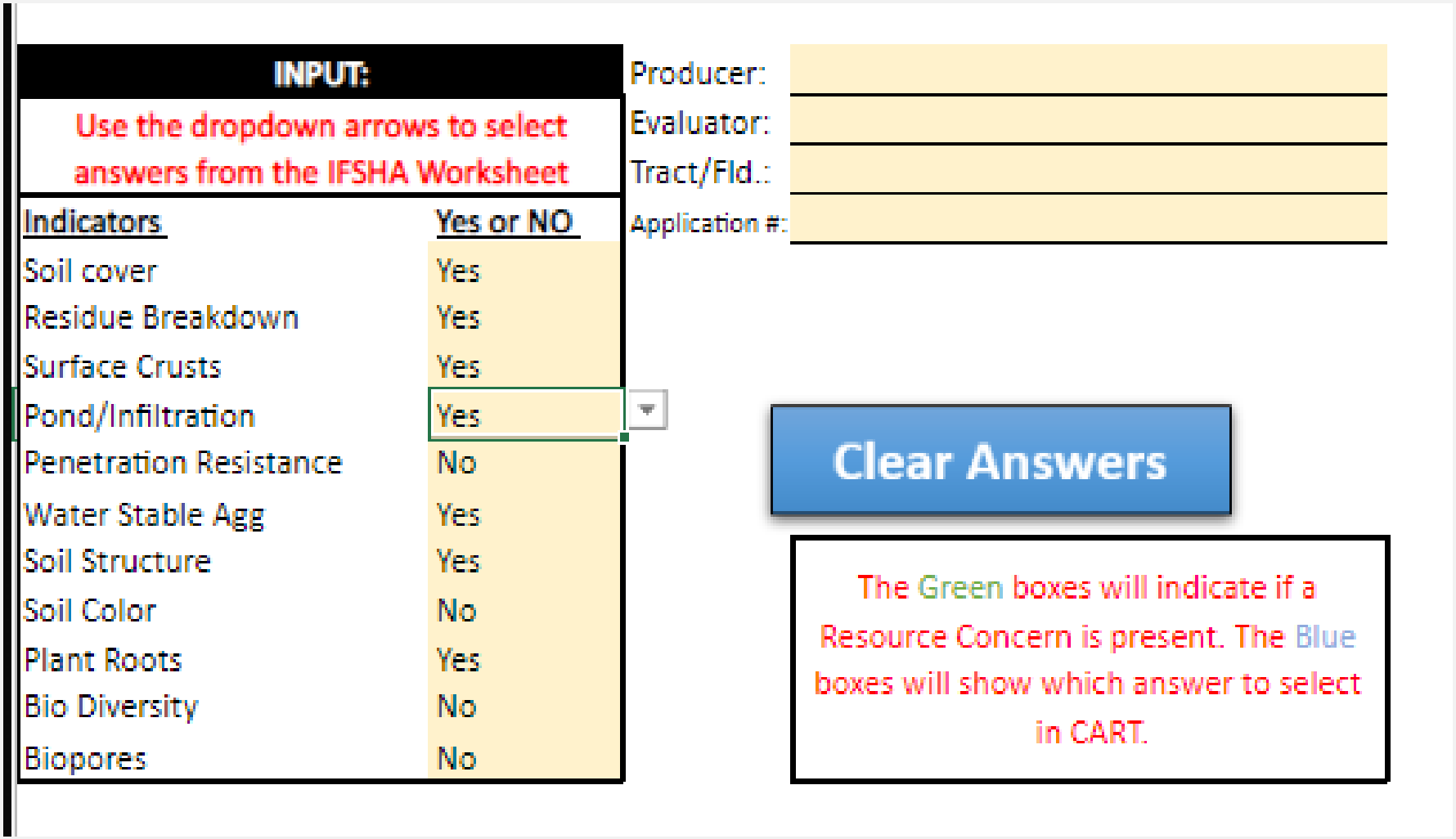


Document for Supplemental Guidance for Soil Health Resource Concerns in CART is available in Teams- NRCS Soil Health Team- Files - CART Docs. It references the CART Manual- CART Version 2.1 Resource Concern Assessment Feb. 16, 2021, the memo sent on 1/28/21, and a soil health guide tool.

CART Resource Concern Assessment Document Version 2.1

2021 Supplemental Guidance for Soil Health Assessment in CART

CART Help Doc.



INPUT:	
Use the dropdown arrows to select answers from the IFSHA Worksheet	
Indicators	Yes or NO
Soil cover	Yes
Residue Breakdown	Yes
Surface Crusts	Yes
Pond/Infiltration	Yes
Penetration Resistance	No
Water Stable Agg	Yes
Soil Structure	Yes
Soil Color	No
Plant Roots	Yes
Bio Diversity	No
Biopores	No

USDA United States Department of Agriculture

RESULTS:

Soil OM depletion	
Soil cover	No
Residue Breakdown	No
Water Stable Agg	No
Soil Structure	Yes
Soil Color	No
Plant Roots	Yes
Bio Diversity	Yes
Biopores	Yes
Numbers of No's	4
Number of YES's	4
Is this a Resource Cor	**yes**
CART Assessment Levels	
None	–
Low	–
Med	**MED**
High	–

Compaction	
Pond/Infiltration	N/A
Penetration Resistance	N/A
Water Stable Agg	No
Soil Structure	Yes
Plant Roots	Yes
Numbers of No's	1
Number of YES's	2
Is this a Resource Con	**No**
CART Assessment Levels	
Compaction is Significant	–
Compaction is NOT Significant	**YES**

Aggregate Instability	
Soil cover	No
Surface Crusts	N/A
Pond/Infiltration	N/A
Water Stable Agg	No
Soil Structure	Yes
Plant Roots	Yes
Bio Diversity	Yes
Biopores	Yes
Numbers of No's	2
Number of YES's	4
Is this a Resource Cor	**yes**
CART Assessment Levels	
None	–
Low	**Low**
Med	–
High	–

Soil Org. Habitat	
Soil cover	No
Residue Breakdown	No
Surface Crusts	N/A
Water Stable Agg	No
Soil Structure	Yes
Plant Roots	Yes
Bio Diversity	Yes
Biopores	Yes
Numbers of No's	3
Number of YES's	4
Is this a Resource Con	**yes**
CART Assessment Levels	
None	–
Low	–
Med	**MED**
High	–

as both Low and Med. It is the planners discretion which is the most appropriate as it is not defined in CART criteria. Although special emphasis is put on Water Stable Aggregates.

Cart Help Doc.

CART
Organic Matter Depletion

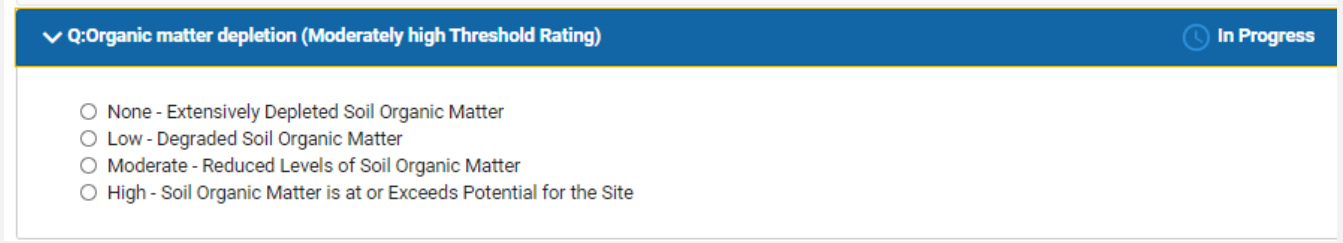


Table 36: *Existing Condition - Organic Matter Depletion, Cropland*

Answer	Existing Condition Points		
	Soil barely capable of accumulating SOM	Soil moderately capable of accumulating SOM	Soil highly capable of accumulating SOM
	Matter Depletion High	matter depletion moderately high AND Organic matter depletion moderate	matter depletion moderately low AND Organic matter depletion low
None – Extensively Depleted Soil Organic Matter	0	0	0
Low – Degraded Soil Organic Matter	0	1	6
Moderate – Reduced Levels of Soil Organic Matter	1	6	11
High – Soil Organic Matter is at or Exceeds Potential for the Site	61	51	41

CART

Soil Organism Habitat Degradation

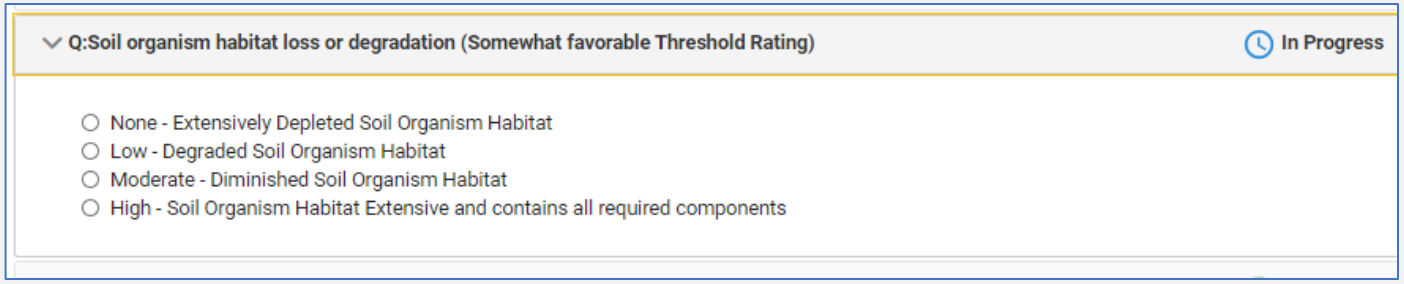


Table 43: *Existing Condition - Soil Organism Habitat Loss or Degradation, Cropland*

Answer	Existing Condition Points		
	Soil barely capable of accumulating SOM webservice rating = Organic Matter Depletion High	**Soil moderately capable of accumulating SOM** webservice rating = Organic matter depletion moderately high AND Organic matter depletion moderate	**Soil highly capable of accumulating SOM** webservice rating = Organic matter depletion moderately low AND Organic matter depletion low
None – Extensively Depleted Soil Organism Habitat	0	0	0
Low – Depleted Soil Organism Habitat	0	1	6
Moderate – Diminished Soil Organism Habitat	1	6	11
High – Soil Organism Habitat Extensive and contains all required components	61	51	41

CART

Aggregate Instability

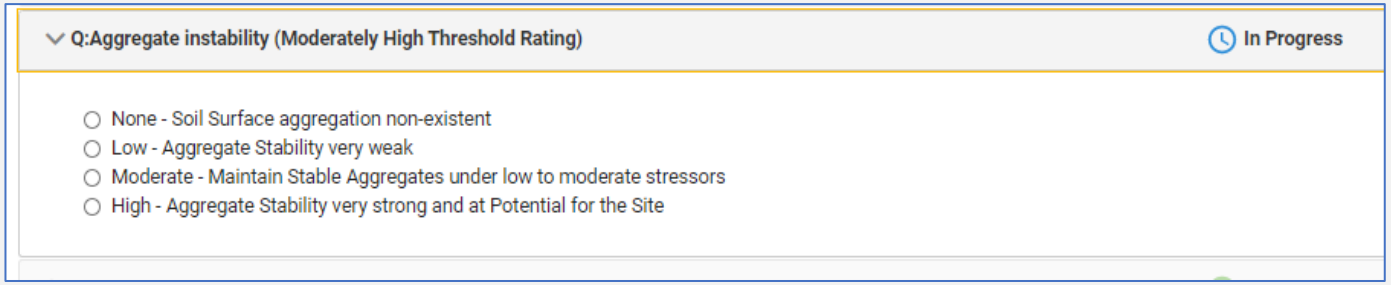


Table 48: *Existing Condition - Aggregate Instability, Cropland*

Answer	Existing Condition Points		
	Soil barely capable of accumulating SOM webservice rating = Organic Matter Depletion High	**Soil moderately capable of accumulating SOM** webservice rating = Organic matter depletion moderately high AND Organic matter depletion moderate	**Soil highly capable of accumulating SOM** webservice rating = Organic matter depletion moderately low AND Organic matter depletion low
None – Soil Surface aggregation non-existent	0	0	0
Low – Aggregate Stability very weak	0	1	6
Moderate – Maintain Stable Aggregates under low to moderate stressors	1	6	11
High – Aggregate Stability very strong and at Potential for the Site	61	51	41

CART

Compaction

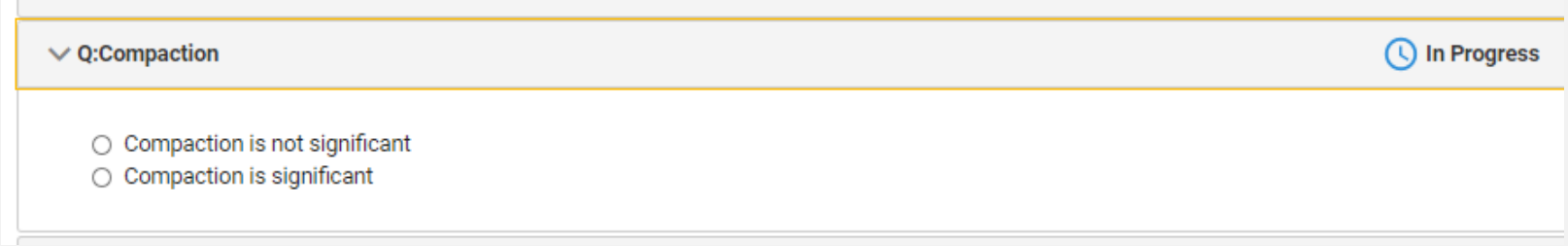


Table 34: *Existing Condition - Compaction*

Answer	Existing Condition Points
Compaction is significant	0
Compaction is not significant	51

CART Systems Approach to Cart Ranking

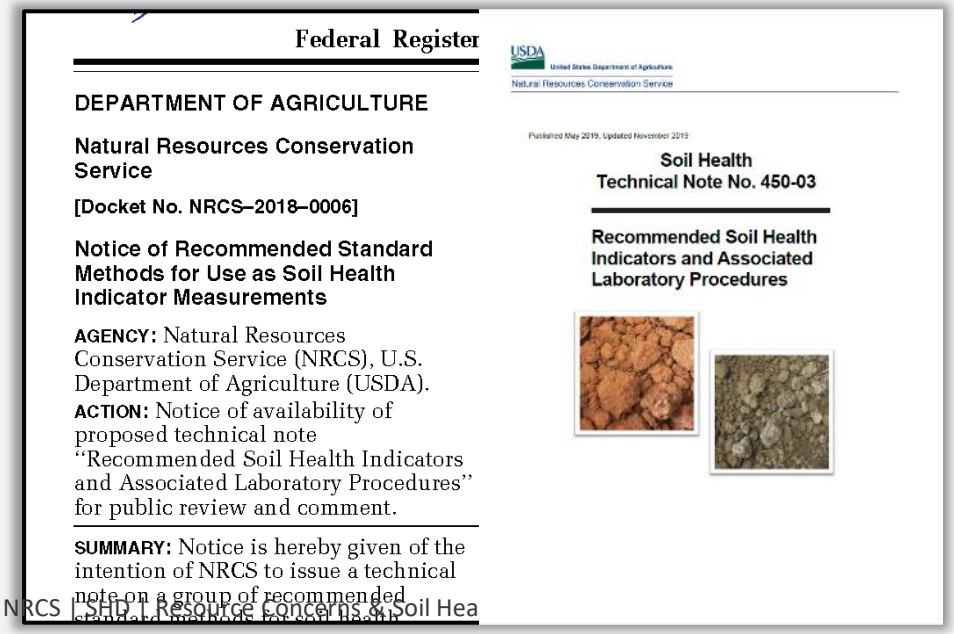
An example for Organic Matter Depletion Threshold level needed -51:

- Conservation Crop Rotation – 10
- Cover Crop - 15
- Residue and Tillage Management, No-till – 25
- Nutrient Management - 10

A system using 328,329, 340 and 590 will get 60 pts. Using 345 or Strip Till is slightly less, but adding 808 (soil carbon amendment) will go much higher above the threshold.

Lab Indicators for Soil Health

- USDA consensus on standard laboratory methods
- Easy & inexpensive
- Sensitive but robust
- Regional calibration underway



Federal Register

DEPARTMENT OF AGRICULTURE

Natural Resources Conservation Service

[Docket No. NRCS–2018–0006]

Notice of Recommended Standard Methods for Use as Soil Health Indicator Measurements

AGENCY: Natural Resources Conservation Service (NRCS), U.S. Department of Agriculture (USDA).

ACTION: Notice of availability of proposed technical note "Recommended Soil Health Indicators and Associated Laboratory Procedures" for public review and comment.

SUMMARY: Notice is hereby given of the intention of NRCS to issue a technical note on a group of recommended

USDA United States Department of Agriculture

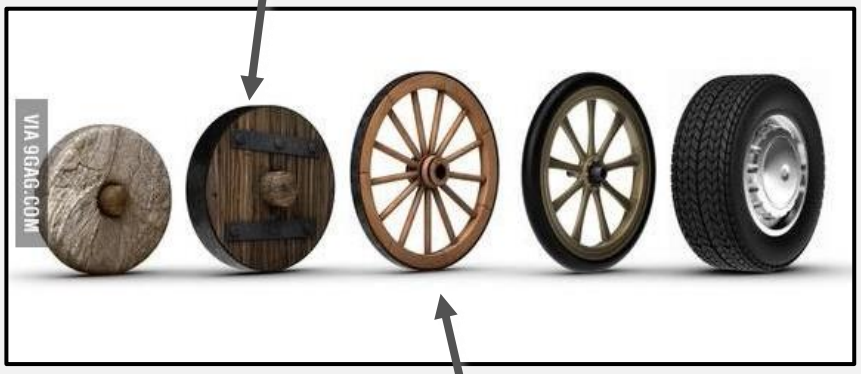
Natural Resources Conservation Service

Published May 2019, Updated November 2019

Soil Health
Technical Note No. 450-03

Recommended Soil Health Indicators and Associated Laboratory Procedures

Standard Nutrient Test
Macro, Micro, SOM, CEC



Upgraded: Biological, C&N, Physical

Lab Indicators For Soil Health

Soil Structural Stability & Water Partitioning	• **Aggregate stability** • Infiltration, available water capacity
Soil Organic Matter Cycling	• **Soil organic C** • C cycling, sequestration
Carbon Food Source	• **Permanganate oxidizable C (Active C)** • Organism food source
Microbial Activity	• **Short-term C mineralization (respiration)** • Organism activity
Bioavailable N	• **Acid Citrate Extractable protein** • Organically bound environmentally stable soil N pool


This information is provided as a public service and constitutes no endorsement by the United States Department of Agriculture or the Natural Resources Conservation Service of any service, supply, or equipment listed.
While an effort has been made to provide a complete and accurate listing of services, supplies, and equipment, omissions or other errors may occur and, therefore, other available sources of information should be consulted.
The USDA is an equal opportunity provider and employer.
Meeh, NRCS