Fiscal Year 2027 (FY27)
NMDA's Healthy Soil Program
Soil Testing and In-Field Assessment Protocol

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About this Document

NMDA's Healthy Soil Program requires that grant recipients complete one pre-project soil test, as well as two in-field assessments (one pre- and one post-project). Every piece of test and assessment data that NMDA receives helps build our collective understanding of New Mexico's soil health.

This document is intended to serve as a reference for Healthy Soil Program grantees as they complete their required sampling and assessments. Although there are numerous tests and methods available, NMDA has chosen the procedures below to ensure an apples-to-apples comparison of data across the state.

Soil Sampling and In-Field Assessments: Why, Where, How, When, and What

Why Bother Testing or Assessing?

Just like noticing yellow leaves on a crop or bloat in a calf, soil tests and in-field assessments help land managers make decisions day-to-day and year-to-year. While lab-based soil testing can reveal changes in soils over the years, in-field assessments can provide information on the physical and biological properties of your soil that respond more quickly to management changes. Soil tests and in-field assessments do require time and money, but the returns on those investments are plentiful. With time, many of the procedures below can lead to savings on external inputs, improved yields, or, at a minimum, stable yields in difficult years.

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Where, How, and When to Test or Assess?

The most useful results come from sampling and testing at locations that can tell you about the **largest area of similar land**. If someone spilled a bag of urea fertilizer at the edge of your field, a soil sample taken at the site of the spill wouldn't tell you very much about the amount of soil Nitrogen in the overall field. Similarly, if you were measuring soil compaction, the numbers from measuring within tire tracks would tell a much worse story than measurements taken outside those tire tracks. The ultimate aim of planning your sampling and assessment is to get the most objective measurement of your land as possible, using all the information available to you, including your experience and knowledge.

There are a number of things to consider when sizing up how similar two pieces of land are. This includes,

- Past and planned management information
  - Cropping history
  - Historical stocking rates and rotations
  - Irrigation (amount, quality, etc.)
- Soil texture (sand:silt:clay) and type
- Topography
- Hydrology
- Any resource concerns that you identify (more info on this process below)

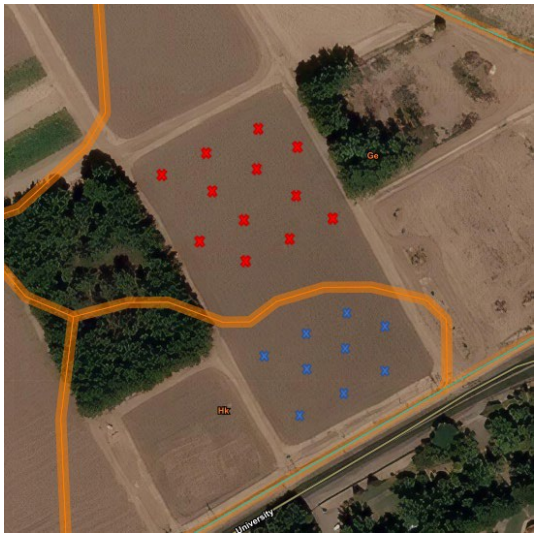

Figure 1. Example of a sampling scheme to collect two final samples (red and blue) by taking subsamples at each x on the map and combining them (by color here).

The **Web Soil Survey Soil Map** or **Ecological Site Description** you made and submitted as part of your Healthy Soil Program application can also be very helpful for this task. Your soil map will have one or multiple 'map units' (outlined in orange in Figure 1), with each map unit representing an area dominated by a single type of soil with common properties. Similarly, each 'ecological site' will have areas of land with a similar potential to respond to management or disturbance. By design, this makes them both useful starting points for deciding where to sample and assess your land.

Some fields may contain multiple map units that are nothing alike, and you may choose to do assessment protocols separately, or take separate samples in each map unit and have them tested separately (red vs blue sample points in Figure 1 above). Similarly, you may decide to test different ecological sites within rangeland separately. However, if the map units or ecological sites in your project area are very similar, you may decide instead to ignore their borders and combine sample taken from the entire area. It may be the case that a field or pasture is fairly uniform, but has been *managed* differently in different areas. This may be another case where separate sampling is best. Once you've decided which general areas and fields to sample, this article from NMSU Cooperative Extension Service might guide where specifically to collect your soil samples from. Although the article focuses on gardening, the principles can be applied to any context.

The **timing** of soil sampling and in-field assessment measurements is another important factor. Although specific considerations are discussed below with each protocol, there are some general principles that can guide your decisions. Firstly, certain times of year are simply bad times to perform these tests. For example, compaction and water infiltration rate will be unmeasurable in frozen ground, transects will be more difficult while plants are dormant (in winter or summer, depending on the plant), and soil may be more difficult to collect if fields are too wet. Secondly, if you want to compare numbers year to year, taking your measurements and samples at roughly the same time of year will be important. For example, certain soil nutrients may be abundant in the spring if manure was applied the previous fall; depleted in the fall after growing a high-nutrient-use crop; and quite low in the winter while temperatures are too low for your soil's microbes to be active. Therefore, comparing soil samples taken at different points of different years might tell you more about what was happening within each year and less about the impact of the decisions you made across years.

What to Test or Assess

Different testing labs may suggest different soil sampling depths, but **NMDA's Healthy Soil Program directs grantees to utilize 6 inches as a standard depth**. While this article from the NMSU Cooperative Extension Service is a great source of information on what analyses to order, NMDA's Healthy Soil Program directs grantees to request Soil Organic Matter, pH, Nitrogen, Phosphorus, and Potassium analyses at a minimum. (The grantee can pay for additional analyses that may suit their management needs. If additional analyses are ordered, NMDA recommends doing so based on the condition and management of a given section of land.)

NMDA's Healthy Soil Program also directs participants to complete all of the protocols on the following pages (for their project's given land type, cropland or rangeland). Participants are welcome to conduct and report any additional assessment tests that best suit their management needs.

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In-Field Assessment Protocols

Procedures Common to Cropland and Rangeland

Identification of Existing Resource Concerns

Rationale:

"Resource concerns" describe when and how a natural resource is in a concerning state. Identifying them helps you understand the ways in which the soil health on your land can be improved. To identify soil health-related resource concerns, some may prefer to make time for an intentional and dedicated walk-through of an entire property, or opt instead to assess their land as they perform other management activities.

Time Required: Variable

Materials Required:

- A conservation plan or conservation planning template
- A way to traverse your land
- A means of recording your observations
- Optional: A shovel to dig small holes for observing your soil

Protocol:

1. Healthy Soil Program grantees will have already completed an NRCS conservation plan or NMDA conservation planning template. You'll recall that in the course of developing these documents, you and an NRCS-certified conservation planner identified several resource concerns.
2. Familiarize (or refamiliarize) yourself with either the Rangeland or Cropland Resource Concern Guide Sheets provided by NMDA. If you have trouble accessing them, please contact either your Project Sponsor or NMDA's Healthy Soil Program (hsp@nmda.nmsu.edu).
3. Travel around your project site keeping an eye out for the indicators that initially concerned you and your NRCS conservation planner. Some examples may be rills and other erosion features, areas of depressed plant vigor or diversity, areas of pooled standing water, visible soil crusting, and a number of other soil health indicators. Occasionally stopping to pull a shovel full of soil may be helpful for understanding what exactly is occurring.
4. In combination with any other soil and assessment data collected thus far, consider if you have made progress to address the resource concerns you previously identified. If you have yet to begin your project, assess whether there are any resource concerns initially missed. *Have any new resource concerns become apparent? What are they, and what are the symptoms of them on your land?*
5. Any insights you are comfortable sharing should be included with the In-Field Assessment data that you report to NMDA.

Water Infiltration Test (Ring Infiltrometer)

Figure 2. An infiltration test in progress. Source: Wikimedia Commons

Rationale:

Water infiltration rate can be influenced by a number of management activities and is related to a number of other soil health characteristics. Improvements in this metric can mean quicker irrigations and more rain water captured and stored. A quicker infiltration rate can also suggest that a number of other physical properties below the surface are improving. The first step to improving your infiltration rate, however, is knowing what it is.

Time Required: 30-90 minutes / test

Materials Required:

- A Ring Infiltrometer (A 6- or 12-inch diameter metal or PVC ring at least 6 inches in height)
  - Note: This procedure is easier if you mark off inches on the inside face of the ring.
- A ruler (Especially if inches have not been marked off on the interior of the ring)
- Hammer or mallet (For driving the ring into the ground)
- Block of wood or metal to span the diameter or the ring (For driving the ring into the ground)
- 5-10 gallons of water
- Stopwatch
- A means of recording your data (paper, phone, laptop)
- Optional: A sponge or something else to pour water onto

Protocol:

1. Using the principles described in "When, How, and Where to Test or Assess", choose one or more representative sites to perform your test(s).
2. Clear away any residue, litter, or other loose surface material (without disturbing the soil) where you intend to place the ring.
3. Using a block of wood placed atop the ring so as not to bend the metal, gently and evenly drive the ring 2 inches into the soil, such that the top is level. Do your best to avoid compacting the soil.
   Note: Inch markings on the interior of the ring may help achieve an accurate depth.
4. Without stirring the soil, fill the ring with water to a height of 1 inch (from the ground), allow this initial 1 inch of water to soak completely in before continuing on to steps 5 and 6. If the field has been recently irrigated or has had at least 1 inch of rainfall within the previous 24 hours, you can skip this step.
   Note: Placing a sponge on the ground inside the ring, then pouring the water onto that sponge or using your hand to distribute the water can help to avoid disturbing the soil.
5. Pour 1 inch of water in the ring and record the time it takes for the water to completely soak in.
6. Repeat step 5 at least one more time and record both times.
7. **Test complete!** Be sure to include all recorded times with the In-Field Assessment data that you report to NMDA.

Aggregate Stability Test

Rationale:

Aggregate stability is the ability of your soil's clods (aggregates) to resist erosion by wind and water. Good aggregate stability can often be an indicator of other desirable properties, such as the presence of beneficial soil fungi. Below is a simple protocol to measure aggregate stability. If the results of this test are inconclusive, your local NRCS office can perform the methods described on page 5 of Technical Note No. 450-06.

Figure 3. An aggregate stability test in progress. Source: Wikimedia Commons

Time Required: 30-60 minutes / test

Materials Required:

- 2+ jars
- A mesh basket to hold soil clods below the opening of the jar. This can be constructed from hardware mesh, chicken wire, sink strainers, etc. (See photo above)
- A watch, clock, or stop watch.
- A means of recording your observations.
- Optional: A trowel to collect soil clods

Protocol:

1. Collect golf-ball-sized soil clods from the representative areas you wish to test. Although more tests are better, the time requirement of this test may limit the number of clods that can reasonably be tested. Including one sample from an unmanaged area, such as a fencerow, may also provide a useful reference point.
   Note: If testing multiple areas, be sure to keep track of where each clod was collected.
2. Allow these clods to air dry at a location where they won't be disturbed.
3. When dry, set up your mason jars with the baskets and at least enough water to fully submerge the soil in each basket.
4. Submerge your soil clods.
5. Once 5 minutes has passed, take note of the following:
   a. Was the clod able to absorb water?
   b. Roughly what percent of the clod remains in-tact in the basket?
   c. If none of the clod remains, how quickly did the clod disintegrate?
6. Repeat steps 3-5 as necessary to test all of the soil clods you have collected.
7. Be sure to include your observations with the In-Field Assessment data that you report to NMDA.

Compaction Test (Penetrometer)

Rationale:

Subsurface soil compaction can noticeably impact your land's performance, but it's often difficult to measure. A penetrometer can mimic root growth and help put numbers on the depth and severity of your soil's compaction. This knowledge can help you decide when current management activities are working or new management activities are necessary.

Time Required: 5-20 minutes / test

Materials Required:

- A penetrometer (one may be borrowed from your SWCD or Extension office)
- A means of recording your data (paper, phone, laptop)

Figure 4. Uni. Wisc. Extension Specialist Francisco Arriaga can be seen using a penetrometer. Source: UW IPCM Youtube

Protocol:

1. For accurate results, this test should be performed when your soil is entirely at field capacity (a day or so after prolonged soaking rain or deep irrigation).
2. Using the principles described in "When, How, and Where to Test or Assess", choose representative sites to take readings. For this test, the more spots tested, the more representative your readings will be of the overall management zone or field.
3. Drive the penetrometer into the soil at a steady rate of about 1 inch per second, tracking the depth as you go.
   Note: Your penetrometer will likely have 1- or 2-inch intervals marked on the rod.
4. Record the depth at which 300 psi is exceeded while continuing to drive the rod at a steady rate.
   Note: This is the top of your compaction zone.
5. Record the depth at which the gauge falls back below 300 psi.
   Note: This is the bottom of your compaction zone. If you reach the end of the rod without falling back below 300 psi, your compaction zone is bottomless.
8. Repeat steps 3-5 at as many sites as you deem necessary to get an accurate picture of your management area.
9. Be sure to include these recorded depths with the In-Field Assessment data that you report to NMDA.

Please see the below Penn State Extension guide that informed this protocol for more in-depth information on the principles behind penetrometer use.

https://extension.psu.edu/diagnosing-soil-compaction-using-a-penetrometer-soil-compaction-tester

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Procedures Specific to Rangeland/Grazing Lands

Transects to Determine Overall Ground Cover and Plant Composition

Rationale:

Transects conducted on rangeland and other grazing lands can provide indicators of overall soil health. A rangeland transect is the easiest methods to determine percent bare ground. Bare ground is susceptible to wind and water erosion as well as increased soil temperature. Bare ground is directly related to decreased plant production on rangelands and grazing lands.

Transects can also help land managers understand the plant composition that is present on the land. Plant composition transects will help determine the percentage of grasses, forbs and shrubs. This information combined with vegetative production can be used as an indicator of overall rangeland health.

Note: The transect procedure identified below is used to determine plant composition (grass, forb, and shrub) and percentage of bare ground. Grantees are encouraged to work with their NRCS conservation planner to conduct a comprehensive species composition transect.

Figure 5. A tape measure has been staked to the ground and unspooled in a straight line.
Photo Credit: Dean Bruce, NMDA

Time Required: 30 minutes/transect

Materials/Equipment required:

- Ecological Site Description Map of the land unit
- 100' tape measure marked in 1' increments
    - Alternative 25' or 50' tape measure can be used
- 2 steel stakes to hold each end of the tape measure in place
- Pin flags or similar small diameter stiff wire to pin point the element identified at each 1' increment
- Paper and pencil to record your findings
- Camera or cell phone to take reference pictures
- GPS or other method to mark the area for future transects

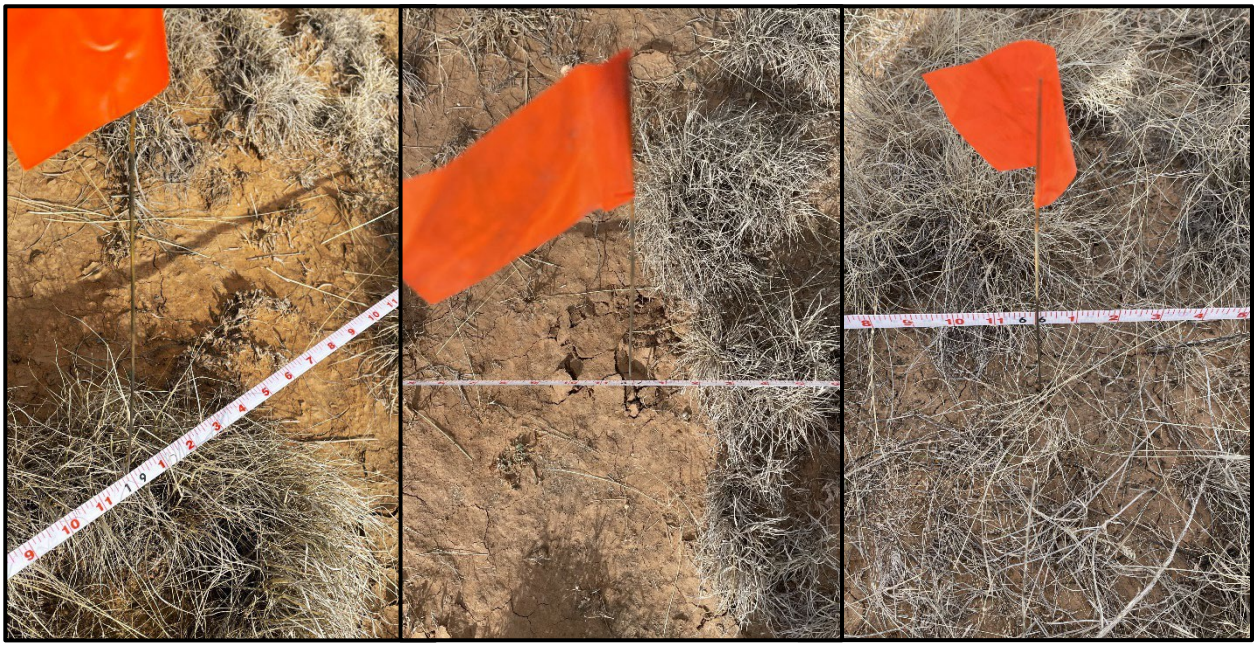

Figure 6. A flag pin has been used to pinpoint what occurs exactly at each foot of the tape measure. From left to right, grass, bare ground, and dead litter have been recorded in this transect.
Photo Credit: Dean Bruce, NMDA

Protocol

1. Using your knowledge of the land, identify area(s) that are important to your operation. The Ecological Site Description (ESD) map can be useful in identifying the number and type of ecological sites present on the land. Selected areas should be based on Ecological Sites so that the information collected can be compared to the Ecological Site Description. NRCS conservation planners can assist in determining key areas to conduct transects.
2. Once the area is determined, use a steel stake to secure one end of the tape measure in place and then stretch out the tape to its full extent. (Fig. 5; previous page)
   Note: It's preferable to use a core direction (North, South, East, or West) for future reference.
3. Starting at 1', use the pin flag to mark what occurs at each foot along the entire 100' tape measure. (Fig. 6) Examples of findings could be grass, dead litter, bare ground, forb, or shrub. Document your findings on your paper. If a plant occurs on the transect identify the species. NRCS conservation planners and NMSU extension agents can assist in plant identification.

4. After completing the entire 100' transect you will now need to count the total number of times a specific element occurred. Please see the example below.
    a. 40 bare ground occurrences
    b. 35 grass occurrences
    c. 15 dead litter occurrences
    d. 5 forb occurrences
    e. 5 shrub occurrences
        i. In the above example if you found 40 occurrences of bare ground that would compute to 40% bare ground. Note if using a 25' or 50' tape measure the number will have to be converted to 100%
        ii. The identified species can then recorded and documented.
5. The results from this data can then be compared to the Ecological Site Description to determine the overall condition of your land in comparison to the expected conditions.
    a. Grantees are encouraged to work with their NRCS conservation planner, who can assist in evaluating overall rangeland health.
6. Include the transect results in the In-Field Assessment data that you report to NMDA.