Title 210 – National Engineering Handbook

# PART 645 – Construction Inspection

## Subpart U – Site Stabilization, Enhancement and Cleanup

March 2025

## 645.2100 Introduction

A. Site stabilization requires vegetation, mulching, or both to protect against wind and water erosion. The contract specifications may also include site enhancements such as woody vegetation, wildlife plantings, and landscape plantings. They must include fencing to protect and manage the vegetation, especially with livestock in the area. Permanent markers for survey control must be installed for future maintenance and remedial work. Sometimes on completed project sites, commemoration monuments (see figure 645U-1) are installed to identify entities, such as the NRCS and the sponsors, who were instrumental in planning, design, and construction of the works of improvement. Site cleanup includes removing all temporary structures (such as temporary access roads and construction entrances), equipment, supplies, unused materials, and sanitary facilities, replacing fencing and other structures removed to facilitate the work, and general cleanup.

**Figure 645U-1. Commemoration Monument**

## 645.2101 Installation

A. Site stabilization is the protection of soil, vegetation, and other natural features from wind, erosion, and other environmental impacts. Sites are stabilized by many natural and artificial means, including topsoil, seeding, sodding, sprigging, soil amendments, mulch, mechanical anchoring such as erosion control blankets, and tackifiers. Most projects will require a permit for stormwater discharges that requires a stormwater protection plan (SWPPP). This plan may dictate the type of vegetation and other measures that are required during and after completion of construction. The permit will also contain a requirement that the site be stabilized by the contractor or the owner at the end of the project before the permit will be released. More information on this subject can be found in Subpart F – Erosion and Pollution Control.

B. Selecting the appropriate method of stabilization depends on the nature and extent of the site and the planned construction activities. Multiple methods may be used for the same site, but they must complement each other.

C. Materials for Site Stabilization

1. Seed

a. Vegetation is established by seeding or sodding. When compared to sodding, seeding has more grass types and varieties available, is less expensive, and provides a stronger initial root system. However, seeding takes longer to establish, has a variety-dependent planting period, and requires careful irrigation timing and frequency.

b. Seeding with native grasses, legumes (nitrogen fixing plants), and forbs (broad leaved plants, including wildflowers) is an inexpensive method to provide temporary site stabilization during construction. Native grasses and forbs are adapted to regional conditions of climate and disease and are relatively low maintenance. Only mixtures appropriate for the site conditions are permitted. Legumes, forbs, and other bunch type species are not suitable for the permanent stabilization of embankments and spillways. They can result in discontinuities in flow across them and tend to encourage erosion.

c. Seed must be furnished separately or in mixtures in standard containers or bags and be clearly tagged. Seed tags must include seed type, proportion of each type of seed if a mixture, lot number for type of seed within the mixture, net weight, percentages of purity, germination and hard seed, and percentage of maximum weed seed content. The contractor must furnish the engineer duplicate signed copies of a statement by the vendor certifying that each lot of seed was tested by a recognized laboratory for seed testing within nine months of the date of delivery. The certification must include the name and address of the laboratory and the date of test.

d. See figure 645U-2 for an example of a typical seed tag. Use the tag information to calculate and verify the amount of Pure Live Seed. Pure

Live Seed is seed that is viable and able to germinate into healthy seedlings.

e. All seed (including the percent of allowable noxious weed seed) must conform to the current rules and regulations of the state where it is used and must be from the latest crop available. It must meet or exceed the standard for purity and germination listed. Bag tag figures are evidence of purity and germination.

**Figure 645U-2. Example of Seed Tag**

Reliable Seed Company
123 Production Way
Seedville, VA 12345 USA
Phone: (123) 456-7890

'Rumsey' yellow indiangrass
Sorghastrum nutans

| | | | |
|---|---|---|---|
| NET WEIGHT: | 25 lbs | PURE SEED: | 93.80% |
| LOT #: | IB097 | OTHER CROP: | 0.00% |
| DATE TESTED: | January 2006 | INERT MATTER: | 5.60% |
| ORIGIN: | PA | WEED SEED: | 0.60% |
| | | GERMINATION: | 32.00% |
| NOXIOUS: | 21/lb Giant Foxtail | HARD SEED: | 0.00% |
| | 15/lb Wild Garlic | DORMANT: | 61.00% |

Pure Live Seed = % Purity x % Total Germination / 100
% Total Germination = germination rate + hard seed + dormant seed

f. Seed that has become wet, moldy, or otherwise damaged in transit or storage must be refused.

g. The quality assurance (QA) inspector's responsibilities with respect to seed include:
   (1) Checking that seeds are in standard containers with an appropriate seed tag.
   (2) Making sure that the contractor provides the engineer duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within nine months of the date of delivery.
   (3) Ensuring that the seed conforms to the current rules and regulations of the state where it is being used and is from the latest crop available.
   (4) Rejecting wet, moldy, or otherwise damaged seed.
   (5) Ensuring that the chosen seed mixture provides the desired soil stabilization and other benefits.

2. Sod

   a. Sodding is the transplanting of vegetative sections of plant material to promptly stabilize areas that are subject to erosion. Sodding provides rapid establishment and is good for slopes or areas prone to erosion. It can also be laid any time during the growing season. Compared to seeding, sodding

is more expensive and has less selection or control over types of grasses. Sod may be field sod or commercial sod, which is a cultured product utilizing specific grass species.

b. Sod must be live grass in uniform width strips, taken from thick-growing stock that is free of weeds. Cultured sod must be cut approximately 0.5 inches thick. Other grass sods must be cut at least 2 inches thick.

c. Cultured strips must not be less than 30 inches in length. Other grass sods must be in strips at least 10 inches by 18 inches. Sod strips must be cut with smooth clean edges and square ends to facilitate laying and fitting.

d. The QA inspector's responsibilities with respect to sod include:
   (1) Verifying the specified sod species are provided.
   (2) Ensuring the sod is live grass in uniform width strips, taken from thick growing stands free of weeds.
   (3) Ensuring the sod is correctly stored.
   (4) Verifying the sod is protected from wind and rain until it is laid.

3. Sprigs

   a. A sprig is a vegetative piece of viable hybrid grass plant that is either a rhizome (growing below the soil level) or a stolon (growing above the soil level). Each portion, whether rhizome or stolon or both, will begin to grow and aggressively develop into a carpet of turf. Sprigging is common with warm season grasses such as Centipede, St. Augustine, Hybrid Bermuda, and Zoysia. The sprig consists of both the grass stem and roots. Sprigs are produced by specialized tillers that till up established grasses into viable pieces or by shredding previously harvested sod slabs.

   b. Sprigging is less expensive than sodding, provides a deep and solid root system, and develops new turf weeks faster than seeding. However, it needs a longer establishment period than sodding and is not always available when needed.

   c. Prior to digging sprigs, the area where the sprigs are to be dug must be mowed and raked to remove excess top growth and leafy material. Otherwise, the quantity of material delivered will include an abundance of non-viable leafy material and a deficient number of viable sprigs. When it is evident that there is an abundance of leafy material with the sprigs after harvest, the QA inspector must collect a representative sample of the material delivered, separate the sprigs from the leafy material, and weigh the sprigs and leafy material separately to determine the percentage of actual sprigs. The resulting percentage must be reported to the project engineer, government representative, or contracting officer representative. Acceptance and payment must only be made for viable sprigs and not include excess non-viable material.

   d. Sprigs must be harvested or sourced from areas with similar climatic and soil conditions as the area intended for establishment. Care must be taken to ensure that sprigs do not lie exposed to the sun for more than 30 minutes before they are stored and covered or loaded for transport to the planting site. Sprigs must be kept covered and moist until planted. Unless

otherwise specified, not more than 30 hours must elapse between the initial harvest or sourcing of the sprigs and planting.

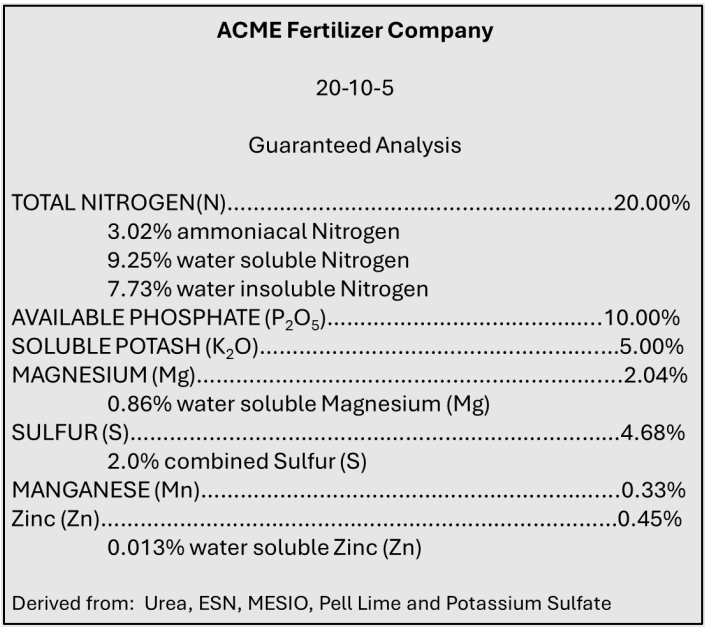
e. Sprigs must be covered with enough moist soil and have good soil to sprig contact to initiate and sustain growth. The planting process involves evenly distributing the sprigs at the specified rate (normally shown as bushels per acre) and pushing the sprigs into the soil with a mechanical sprigging implement. The implement used to push the sprigs into the soil must be able to bury the sprigs to the specified depth without cutting them.

f. The QA inspector's responsibilities with respect to sprigs include ensuring that:
   (1) There is a minimum amount of leafy material in with the sprigs.
   (2) The sprigs are stored and transported in a cool, moist, and shaded condition.
   (3) The sprigs are viable at the time of planting.
   (4) The sprigs are buried to the specified depth without being cut in the process.

4. Fertilizer

   a. All fertilizers are labeled with three numbers that give the percentage by weight of nitrogen (N), phosphate ($P_2O_5$), and potash ($K_2O$) (see figure 645U-3). Nitrogen is important for leaf and stem growth and provides the rich green color in a plant. Phosphorous is derived by the plant from phosphate and provides for root and flower growth. Potassium is derived by the plant from potash, helps build plant tissue, and aids the production of chlorophyll. A fertilizer mix consists of specified amounts of nitrogen, phosphorus, and potassium. Examples of commonly used fertilizers are: 10-10-10, 16-16-16, and 20-10-5 (the numbers are percentages).

**Figure 645U-3. Example Fertilizer Label**



b. Fillers are inert materials that provide bulk to fertilizer mixes. To calculate the actual weight of any given nutrient, multiply the indicated percentage of the mix by the total fertilizer weight. If the specifications require 40 pounds each of nitrogen, phosphate, and potash per acre, adjust the total fertilizer application rate so the lowest percentage of nutrient meets the 40 pounds per acre requirement. For a 20-10-5 fertilizer, 800 pounds per acre must be used to meet the requirement for potash (5% of 800 pounds = 40 pounds). This application would result in 160 pounds of nitrogen per acre (20% of 800 pounds = 160 pounds). Since that would exceed a tolerable amount of nitrogen, a more balanced fertilizer such as 10-10-10 would be more practical to meet the potash specification.

c. The fertilizer quality and content must be accepted based on bag label analysis or supplier's certification and must comply with all applicable state and Federal fertilizer laws. Fertilizers are classified as:
   (1) Granular Fertilizer is the most common form of fertilizer. Packed in a bag, it is applied with a drop spreader, spin spreader, or hydro seeder. Its advantages are low cost and slow nutrient release into the soil.
   (2) Water Soluble Fertilizer dissolves in water and is often a blue-tinted powder. They are more expensive than granular fertilizer and release nutrients quickly into the soil.
   (3) Liquid Fertilizers are similar to water soluble fertilizers, but they are already in a liquid form and diluted with water.
   (4) Organic Fertilizer is made from natural products such as bone meal, manure, dried blood, kelp, and seaweed. It is popular with organic gardeners and those avoiding artificial chemicals. Organic fertilizers are expensive and have lower nutrient levels.

d. Unless specified, the fertilizer must be a commercial grade fertilizer. The fertilizer must meet the standard for grade and quality specified by state law. When fertilizer comes from bulk storage, the contractor must provide a supplier's certification of weight and analysis. When required by the contract, the contractor must provide a representative sample of the fertilizer to the engineer for chemical analysis.

e. The publication "Understanding Turf Fertilizer Label," Center for Agriculture, Food and the Environment, University of Massachusetts Turf Program, University of Massachusetts Amherst is a good reference for reading fertilizer labels.

f. The QA inspector's responsibilities with respect to fertilizer include:
   (1) Checking that the fertilizer mix contains nitrogen, phosphorus, and potassium.
   (2) Verifying that the mix contains the specified weight of actual nutrients.
   (3) Ensuring that the fertilizer complies with all applicable state and Federal fertilizer laws.
   (4) Verifying that, when required by the contract, a representative sample of the fertilizer is provided to the engineer for chemical analysis.

5. Inoculants

a. Inoculants contain legume bacteria (rhizobia), which are added to the seeds prior to planting to enable the plants to fix or change atmospheric nitrogen into usable form. Inoculation helps to ensure better stands and growth under a wide range of soil and climatic conditions.
b. Legume seed must be inoculated to ensure contact between rhizobia and the seed. Inoculating with the correct type of rhizobium bacteria helps legumes form effective root nodules that convert nitrogen from the air in the soil into a form that plants can use. Farm and garden supply stores often sell a few types of inoculants, each of which inoculates several related legume species. These inoculants are readily available, but not as effective as inoculants specific to only one species.
c. The QA inspector's responsibilities with respect to inoculants include:
   (1) Verifying that legume seeds are inoculated to ensure contact between rhizobia and the seed.
   (2) Verifying that the inoculants are specific to the legume species.
   (3) Checking that inoculants are kept refrigerated until used and replaced each year.
   (4) Ensuring that the inoculant is a pure culture of nitrogen-fixing bacteria prepared specifically for the species and used not later than the date indicated on the container or as otherwise specified.
   (5) Verifying that the seeds are sown within twenty-four (24) hours of treatment.
   (6) Ensuring that a mixing medium, as recommended by the manufacturer, is used to bond the inoculants to the seed.

6. Pesticides and Herbicides

   a. Pesticides and herbicides help manage pests (harmful insects and rodents) and weeds. While many pesticides and herbicides are available, they are all chemicals that kill either pests or weeds. Because of their chemical nature, they must be stored, transported, and applied with great caution.
   b. The QA inspector's responsibilities with respect to pesticides and herbicides include ensuring that:
      (1) All pesticides are stored and mixed according to local, state, and Federal requirements.
      (2) All application personnel are certified for application in the jurisdiction as required by state or local regulations. Pesticide applicators must be certified or licensed by the state.

7. Soil Amendments

   a. Applying lime materials reduces soil acidity and provides nutrients for plant use, especially calcium and magnesium. Gypsum adds calcium without raising the pH. Natural deposits of lime are limestone, dolomite, shell, and marl. Dolomite, due to its content of both calcium and magnesium, is the best natural lime source. All sources must be finely ground to provide maximum benefit to the soil and plants. Only apply lime after the results from a soil test establish the need for it. The lime

must be well mixed with the soil and kept moist for best reaction (see figure 645U-4).

b. Soil amendments are mixed into topsoil to promote healthy plant growth in several ways. The regular addition of manures, compost, cover crops, and other organic matter can raise the nutrient and structure level of a soil so that the need for addition of synthetic fertilizers is reduced, and in some cases, no longer needed. This highly desirable soil quality does not come about with a single or even several additions of organic material, but rather requires a serious, long-term program. Any applied soil amendments must meet quality criteria and application requirements specified in the project specifications.

**Figure 645U-4. Application of Lime**

c. Animal manures are a common soil amendment. Fresh horse, sheep, rabbit, and poultry manures are high in nitrogen and may burn plants if applied directly to a growing stand. The application of animal manure is best in the fall and tilled under.

d. The use of compost is one way to limit tying up nitrogen during decomposition. Compost comes from plant wastes. Correct composting can result in a valuable nutrient and humus source. The basis of the process is the microbial decomposition of mixed, raw, organic materials into humus – a dark, fluffy product resembling rich soil. Humus is spread and incorporated into the soil. In addition to nutrition, fertile soils must

provide a conducive structure for root growth, water retention, and air exchange. Soil conditioners, like composted horse manure, improve soil structure by binding soil particles into larger aggregates. This increases the amount of pore space and enhances air exchange, water movement, and root growth.

e. Lime must consist of Standard Ground Agriculture Limestone, or an approved equivalent. Other soil amendments must meet quality criteria and application requirements specified in the project specifications.

f. The QA inspector's responsibilities with respect to lime and other soil amendments include:
   (1) Verifying that lime is applied only when the needs have been established by a reliable soil test.
   (2) Ensuring that the lime is applied well in advance of the planting date, preferably two to three months before the site is to be planted.
   (3) Checking to make sure that the lime consists of Standard Ground Agriculture Limestone, or approved equivalent.
   (4) Verifying that other soil amendments meet quality criteria and application requirements indicated in the specification.

8. Mulch Materials

   a. Mulch retains soil moisture, important for seed germination, and protects the soil from erosion. Mulch can promote natural revegetation or protect seeds and fertilizers spread over an area. Mulching can prevent erosion before germination and rooting when broadcasting seed and fertilizer. Using mulch on extreme steep slopes or on areas where water flow concentrates may require netting to hold it in place.

   b. Straw is the mulch most used in conjunction with seeding. The straw must come from wheat, barley, oats, rye, or hay (small grains), and may be spread by hand or with a mulch blower. Other types of mulch– such as wood cellulose fiber, synthetic fiber, and netting– are also available.

   c. Straw mulch protects the soil surface from the impact of rain drops, preventing soil particles from becoming dislodged. It may be lost to wind and must be tacked down or anchored.

   d. Straw is an organic mulch material and, as a result, will decompose with time, releasing small amounts of nutrients and organic matter to the soil.

   e. Anchoring of the mulch is required in some cases to keep it in place and prevent it from washing or blowing away. Anchoring can be provided by mechanical means or mulch tackifiers. Mechanical means are typically crimping or by having netting or mesh placed over the mulch to keep it in place. The netting or mesh must as well be secured to keep it from blowing away.

   f. Mulch tackifiers may be necessary to hold fibers together and to keep them from washing or blowing away. Primary tackifier types include:
      (1) Latex Base. The components for the latex-base adhesive must meet the requirements of the specifications. The latex emulsion polymer must

not be allowed to freeze or be exposed to sunlight for a prolonged period.

(2) Guar Gum. Guar gum tackifiers consist of a minimum of 95 percent guar gum by weight; the remaining must consist of dispersing and cross-linking additives.

(3) Asphalt Emulsion tackifiers must conform to the requirements of ASTM international (ASTM) D977, "Specification for Emulsified Asphalt." The emulsified asphalt may be rapid setting, medium setting, or slow setting. Non-asphaltic tackifiers required because of environmental considerations must be as specified.

g. Other Tackifiers. Some other tackifiers are; water-soluble natural vegetable gums blended with gelling and hardening agents, water-soluble blend of hydrophilic polymers, viscosifiers, sticking aids, and other gums.

h. The QA inspector's responsibilities with respect to mulch materials include:

(1) Ensuring that the straw is free of weeds.

(2) Verifying that the mulch material is air dry, light in color, and not musty, moldy, caked, or otherwise of low quality.

(3) Checking that, if other mulch materials are specified, they include the manufacturer's recommendations for methods of application.

(4) Ensuring that netting or crimping is used on steep slopes to hold mulch in place.

(5) Ensuring that mulches are applied uniformly to the designated areas, and to areas seeded not later than two working days after seeding has been performed.

(6) Ensuring that the tackifier meets the specified requirements.

(7) Checking that, if it is an asphalt emulsion tackifier, it conforms to the requirements of ASTM D977.

(8) Ensuring the tackifier is uniformly applied over the mulch material at the specified rate, or by injecting it into the mulch material as it is being applied.

(9) Ensuring that the mesh or netting stabilizing material is applied smoothly but loosely on the designated areas, and the edges buried or securely anchored by means of spikes or staples as specified.

9. Topsoil

a. Topsoil that would allow planted or natural vegetation to establish may stabilize an area where there is minimal chance of erosion due to wind or water. Topsoil consists of friable surface soil free of grass, roots, weeds, sticks, rocks, or other unsuitable materials.

b. Applying topsoil consists of furnishing and spreading topsoil to specified depths at locations shown on the drawings. Topsoil may be salvaged from designated earth surfaces that will be disturbed by construction activities. After designated sites have been cleared and grubbed, the topsoil may be removed from the designated areas and stockpiled at locations shown on the drawings or acceptable to the engineer. Unsuitable materials

encountered during removal of topsoil must be disposed of at locations shown on the drawings or approved by the engineer, or otherwise hauled and disposed of at locations removed from the construction site. The contractor is responsible for complying with all local rules and regulations and the payment of all fees that may result from the disposal at locations outside the construction work limits.

c. Topsoil may also be furnished from an approved off-site source designated by the contractor. The engineer must be granted access to the source for inspection and acceptance prior to delivery to the site. The contractor must provide test results and samples.
d. Spreading of the topsoil must not be conducted when the ground or topsoil is frozen, excessively wet, or otherwise is in a condition detrimental to uniform spreading operations. Surfaces designated to receive a topsoil application must be lightly scarified just prior to the spreading operation.
e. Following the spreading operation, the topsoil surface must be left smooth and without ruts or surface irregularities that could contribute to concentrated water flow down slope.

10. Topsoil Tests

a. Contractor must test on-site topsoil for recommended nitrogen, phosphorous, potassium (NPK), and pH for establishment by seeding, sprigging, or sodding.
b. Contractor-furnished topsoil from off-site must be certified contaminant free and have a recommended NPK and pH test for seeding, sprigging, or sodding.
c. The QA inspector is responsible for verifying that:
   (1) Test results are recorded in the job diary and appropriate worksheets.
   (2) Contractor-provided topsoil is certified contaminant free.
   (3) Soil tests are done to determine the nutrient and pH content of the soil.

D. Application Rates for Seed, Sod, Fertilizer, Lime, and Other Soil Amendments

1. Seed

a. Several seed mixtures are used for vegetation depending on the purpose for seeding. A mixture is to be chosen which is the least or non-invasive yet provides the desired soil stabilization and other benefits. Seeding with an annual plant can often provide adequate cover for the critical first year and allow natural vegetation to further stabilize the site. Additionally, some sites will require perennial seed mixtures for long term protection, while others may require no seed at all and rely only on natural re-vegetation.
b. The selection of grasses and legumes is influenced by factors such as average rainfall, soil drainage, erosion hazard, soil pH level, nutrient supply, intended stand usage, ongoing management, and the length of stand life. Different varieties are available for each type of grass or legume, each having slightly different traits. A good variety must be a top yielder, have sufficient winter hardiness, and be resistant to the array of

plant diseases present. Mixtures of legumes and grasses often give the best overall performance for pasture and multi-use hay or pasture meadows. Yields tend to be greater with mixtures than with either a grass or legume alone. Mixtures of two or three well-chosen legumes or grasses are usually more desirable than mixtures which include five or six. Each selected grass and legume in the mixture must have a specific purpose.

2. Sod
    a. Sod is applied in a single layer throughout the area specified. Rolls of sod must be laid adjacent to each other without overlap or gaps between them.
3. Sprigs
    a. Typical application rates for broadcast planting of sprigs, a rate of 10-20 bushels per 1,000 square feet must be used. For mechanical planting of sprigs, 200–400 bushels per acre must be used. The actual sprigging rate should be included on the drawings or construction specification 6.
4. Fertilizer, Lime, and Other Soil Amendments
    a. Fertilizer, lime, and other soil amendments must be applied as specified. The application rate for fertilizer may be specified in the contract as a fixed number or variable based on soil tests. When specified, the fertilizer and soil amendments must be thoroughly incorporated into the soil immediately following surface application.
5. Inoculants
    a. The inoculant for treating legume seeds must be a pure culture of nitrogen-fixing bacteria prepared specifically for the species and must not be used later than the date indicated on the container or as otherwise specified. A mixing medium, as recommended by the manufacturer, must be used to bond the inoculant to the seed. Two times the amount of the inoculant recommended by the manufacturer must be used, except four times the amount must be used when seed is applied by use of a hydraulic seeder.
    b. Inoculants must be kept refrigerated until used and replaced each year. To inoculate seed, moisten the seed with water (or with a very dilute sugar and water solution) and mix in the inoculant. Plant the seed immediately after mixing because the inoculant will die if it dries out. Rhizobia can survive in the soil for a couple of years, so if planting is done in the same place it grew two to three years agorhizobia are probably still in the soil. Also, if planting a legume that is closely related to a common weed on the site, there are likely rhizobia present in the soil. In these cases, inoculation with a commercial inoculant is not necessary for N-fixation, but it does provide a cheap and easy way to increase the amount of nitrogen fixed.
    c. Seed must be sown within 24 hours of treatment and must not remain in the hydraulic seeder longer than four hours.
6. Pesticides and Herbicides

a. The use of pesticides and herbicides must strictly conform to the manufacturer's recommendations. Overuse of these chemicals may cause severe health and pollution problems on the construction site and downstream or downwind of the site.

7. Mulch

a. The rate, amount, and kind of mulching or mesh must be as specified. Mulches must be applied uniformly to the designated areas and must be applied to areas seeded not later than two working days after seeding has been performed. The tackifier must be applied uniformly over the mulch material at the specified rate, or by injecting it into the mulch material as it is being applied.

E. Soil Preparation and Treatment Processes

1. Final Grading

a. Areas to be treated must be dressed to a smooth, firm, but not overly compacted surface.

2. Seedbed Preparation

a. On sites where equipment can operate on slopes safely, the seedbed must be four to six inches deep and smoothed. Depending on soil and moisture conditions, disking, or culti-packing, or both, may be necessary to correctly prepare a seedbed. On sites where equipment cannot operate safely, the seedbed must be prepared by hand methods by scarifying to provide a roughened soil surface so that broadcast seed will remain in place.

b. If seeding is to be accomplished immediately following construction operations, seedbed preparation may not be required except on compacted, polished, or on freshly cut soil surfaces.

c. Rocks larger than six inches in diameter, trash, weeds, and other debris that will interfere with seeding or maintenance operations must be removed or disposed of as specified. Seedbed preparation must be discontinued when soil moisture conditions are not suitable for the preparation of a satisfactory seedbed as determined by the engineer.

d. Soil preparation for sprigging must be the same as for other methods of planting.

e. The QA inspector's responsibilities with respect to seedbed or sod bed preparation include:

(4) Checking that all stones larger than 6 inches in diameter, roots, litter, and any foreign matter are raked and removed.

(1) Ensuring that the sod bed is correctly prepared and at the specified grade.

(2) Verifying that immediately before placing the sod, the soil surface is loosened to a depth of one inch and thoroughly dampened, if not already moist.

3. Amending Soil

a. Amendments such as lime may be applied to the soil in preparation for planting. The rate of application of soil amendments must conform to the manufacturer's recommendations for the specified amendment.
b. Lime and other soil amendments must be applied well before the area is planted, preferably two to three months. Application closer to the planting date is permissible, but the benefits are often delayed.

4. Fertilizing

a. The rate of fertilizer application is based on soil test recommendations or the contract specifications.
b. The QA inspector's responsibilities with respect to fertilizing include verifying that:
(1) The fertilizer is applied at the specified rate.
(2) The fertilizer and amendments are incorporated into the soil immediately following application.

F. Planting

1. Planting Dates

a. Seeding is best done in the spring or early fall. Seeding done in hotter months will typically need twice daily irrigation for at least two weeks.
b. For most locations, sod can be laid any time from May 1 until October 20, if it can be irrigated as needed. Survival is increased if sod is placed during months other than July and August. Sod must never be laid between June 10 and September 10 without irrigation.
c. Sod must never be frozen and must never be applied on frozen ground. Sod must not be permitted to dry out and must be laid within 24 hours after cutting. Sod must also be protected from wind and rain until it is laid.
d. Optimum planting time for sprigs should be determined by the local NRCS agronomist or rangeland specialist. Sprigs do best in sunny areas and can provide an established turf within 10 – 12 weeks, provided that warm weather, correct irrigation, mowing, and fertility needs are met.

2. Seeding

a. All seeding or sprigging operations must be performed in such a manner that the seed or sprigs are applied in the specified quantities uniformly on the designated areas. Seeding may be done by broadcasting, drilling, or hydroseeding (see figure 645U-5). The method and rate of seed application must be as indicated in the project specifications. Unless otherwise specified, seeding or sprigging shall be accomplished within two days after final grading is completed and approved.
b. The QA inspector's responsibilities with respect to seeding include verifying:
(1) That the seedbed is correctly prepared.
(2) That the method and rate of seed application is done as specified.
(3) That adequate water is available for irrigation and that any irrigation systems required are installed, operating, and maintained.

(4) Irrigation rates and checking soil moisture to ensure that adequate water is being supplied.

**Figure 645U-5. Hydroseeding of a Dam Embankment**

3. Sprigging

   a. Practical methods to plant sprigs include broadcasting and mechanical:
      (1) Broadcasting – Sprigs are cast or pitched on the surface of the prepared soil and lightly roto-tilled into the top few inches of soil.
      (2) Mechanical – Sprigs are mechanically placed into a furrow on 6-inch spacing and covered with soil to quickly establish the root zone and protect the viable sprig from heat or wind.
         (a) Large projects of one-half acre or more are appropriate for mechanical planting.
         (b) To plant sprigs, dig furrows 8 to 12 inches apart and place the sprigs every 4-6 inches at a depth of 1- to 2-inches depth (shallower depth may be used if adequate moisture is available). The closer the sprigs are, the faster the grass will cover the soil. After placing the sprigs in the furrow, cover a part of the sprig firmly with soil and leave the foliage exposed above the surface. Sprigs can also be placed end-to-end on the soil surface about six inches apart and then press one end of the sprig into the soil with a notched stick or blunt piece of metal like a dull shovel. Leave a portion of the sprig above ground exposed to light. For both methods, tamp or roll each sprig firmly into the soil.

b. The sprigs must be watered after planting. Since the sprigs are planted at a shallow depth, they are very prone to drying out. Light, frequent waterings are necessary until roots become well-established. Watering lightly once or twice daily will be required for several weeks after planting.
c. The process of stolonizing can be used and is the broadcasting of stolons on the soil surface and covering by topdressing or pressing into the soil. Stolonizing requires more planting material but produces a quicker cover than sprigs.
d. It is extremely important to maintain a moist surface during the initial establishment from sprigs. If practical, newly planted sprigs must be top-dressed at regular intervals.
e. The QA inspector's responsibilities with respect to sprigging include:
   (1) Verifying that planting of sprigs is done as specified.
   (2) Making sure that, regardless of the planting method, each sprig is tamped or rolled firmly into the soil.
   (3) Checking that sprigging is done at the right time of the year.
   (4) Verifying that water is supplied for irrigation.
   (5) Verifying that irrigation equipment is present and functioning, if required.
   (6) Verifying irrigation times and application rates.

4. Sodding

a. Sodding is beneficial for sites which require vegetative stabilization sooner than can be established by seeding. Sodding is particularly beneficial along steep slopes where seeding may be difficult to establish and maintain.
b. Protecting sodded areas from pedestrian access must be considered.
c. Where possible, concentrated flows must be diverted away from the sodded areas at least until the sod is attached to the soil through rooting.
d. Soil tests must be done to determine the nutrient and pH content of the soil. Depending on the results of soil tests, it may be necessary to obtain a pH of between 6.5 and 7.0 for most conditions. All lime, fertilizer, and other soil amendments must be added, if necessary, as specified.
e. A 3–5-inch deep sod bed must be prepared. Note that the earth bed upon which the topsoil is to be placed must be at the required grade.
f. The sod bed must be firm but not compact. The top three inches of the soil must be loose, moist, and free of large clods and stones. All stones larger than two inches in diameter, roots, litter and any foreign matter must be raked and removed. The topsoil surface must be in close conformity to the lines, grades and cross sections shown on the grading plans.
g. Subsurface drains may be needed where water movement may cause seeps or soil slippage. Wet waterways must be tiled to ensure that the vegetation is established.
h. Immediately before placing the sod, the soil surface must be loosened to a depth of one inch and thoroughly dampened, if not already moist.

i. The sod is applied by hand in rows at right angles to the direction of the slope, starting at the base of the area to be sodded and working upward. Pitch forks must not be used to handle sod, because this will ruin the integrity of the sod. The strips must be placed together tightly so that no open joints are left between strips or between the ends of strips. The joints must be staggered between the ends of strips. The sod must be laid perpendicular to the flow of water on slopes and in ditches and waterways. The edges of the sod at the top of the slopes must be tucked slightly under. A layer of soil must be compacted over the edge to conduct surface water over and onto the top of the sod. Any spaces between the joints must be filled and all sod edges with at least two inches of topsoil.

j. The sod must be firmly tamped or rolled immediately after it is placed. On slopes steeper than 3:1, or in areas of concentrated flows, sod must be secured with wooden pegs or other approved techniques. Wooden pegs must be a minimum of 10 inches long, spaced two feet apart in any direction, and driven flush with the surface of the sod. In areas of concentrated flows, check dams may also be installed to decrease the velocity in the channel.

k. The sod must be watered immediately after it is installed. The sod must be watered to a depth of one inch into the sod. Additional watering must be done based on soil moisture, and in accordance with the specifications.

l. The QA inspector's responsibilities with respect to sodding include:
   (1) Verifying that sod is placed as soon as possible after the ground surface has been graded, to take advantage of the ground moisture.
   (2) Checking that the sod is laid within 24 hours after cutting.
   (3) Checking that the sod has been cut to the specified length.
   (4) Ensuring that on all slopes greater than 3:1 (h: v), or where high water velocities are expected, sod is held in place with wooden stakes.
   (5) Checking that sod is laid at the right time.
   (6) Checking that the sod is placed as specified.
   (7) Ensuring that the sod is watered immediately after it is installed.
   (8) Verification of irrigation water application rates and duration.
   (9) Ensuring that excess topsoil is disposed of following the specifications.

5. Mulching

   a. In most cases, for grass to emerge evenly and consistently, it is necessary to hold the seed in place and have moisture for germination. The key to good, consistent grass growing results is a good mulch application.
      (1) Straw and Hay Mulching
         (a) Straw mulch material must be stabilized within 24 hours of application using a mulch crimper or equivalent anchoring tool, or by a suitable tackifier. When the mulch crimper or equivalent anchoring tool is used, it must have straight blades and be the type manufactured expressly for, and capable of firmly punching the mulch into the soil. On sites where the equipment can be safely

operated, it must be operated on the contour. On sites where equipment cannot safely operate to perform the work required, hand methods must be used.

(b) Mesh or netting stabilizing materials must be applied smoothly but loosely on the designated areas, and the edges must be buried or securely anchored by means of spikes or staples, as specified. The contractor must maintain the mesh or netting areas until all work under the contract has been completed and accepted. Maintenance must consist of the repair of areas damaged by water erosion, wind, fire, or other causes. Such areas must be repaired to re-establish the intended condition and to the design lines and grades required by the contract. The areas must be re-fertilized, re-seeded, and re-mulched prior to the new application of the mesh or netting.

(2) Hydro Mulching

(a) Hydro-seeding was devised as a method of distributing and planting seed by spraying seed with water. Hydro-mulching was later developed as an improved method of hydro-seeding. Hydro-seeding became hydro-mulching when mulch was added to the mixture, and when the application on the ground was thick enough to hold the seed in place, resist soil erosion, and help retain soil moisture.

(b) Contractors who use better mulch material and apply the mulch at higher rates always get better and more consistent results. To quickly apply any mulch slurry at heavier rates requires mixing thicker slurries in the machine and applying more gallons of that slurry on the ground. To do this efficiently, the contractor must have a hydro-mulching machine capable of mixing and pumping thicker slurries quickly.

(c) Hydro-seeding machines were not originally designed to mix and pump thick slurries. A true hydro-mulching machine mixes thick slurries quickly and pumps thick slurries through long hoses. The machines have powerful mechanical agitation, and a pump designed to pump these thick materials.

G. Protection, Establishment and Maintenance

1. Newly seeded and sodded areas need to be protected from traffic and inspected frequently for the first few months to ensure that the plants are maturing. Failures may be due to incorrect conditioning of the subsoil, lack of irrigation, incorrect staking, or incorrect placement of the sod pieces. New pieces of sod and fertilizer, lime, or other constituents may need to be applied. Spot seeding can be done on small, damaged areas.

2. Once the sod is well established, construction barriers may be removed. The planted area must be watered regularly and mowed to maintain a healthy planted area. Protruding stakes must either be pounded flush to the ground or removed before mowing. Occasional soil tests must be collected and analyzed

to determine if the soil is appropriately fertilized. Pest control must be provided as well where warranted.

3. The QA inspector's responsibilities with respect to protection, establishment, and maintenance include:

    a. Making sure that the vegetation is maintained and protected as specified.
    b. Making sure that sodded areas are protected from pedestrian access.
    c. Verifying that the newly planted sod is maintained as specified.
    d. Verifying that any required temporary or permanent exclusion fencing is in place to allow vegetative development if livestock are present.

H. Enhancement

1. Scope – Additional landscaping may be provided on the site to enhance the site operations or improve its appearance. Enhancements may include the planting of grasses, shrubs, and trees, and the placement of other hard features such as loose rock, decorative boulders, and flatwork. Such features are commonly placed at entrances to the site and in areas accessible to the public.

2. Materials

    a. Trees, shrubs, vines, and seedlings must conform to the construction specifications. Unless otherwise specified, plants must be high quality nursery grown representatives of their normal species and varieties. They must have average or normal well-developed branches, together with vigorous root systems. Plants must be free from insects, diseases, sunscald, knots, stubs, or other objectionable disfigurements. Thin, weak plants must not be accepted. Plants must show appearance of normal health and vigor in strict accordance with the project specifications.
    b. Trees must be well branched, have single leaders, and with straight stems. This requirement covers all species, unless otherwise indicated in the project specifications.
    c. The size of trees and shrubs must be as shown on the landscape plans. Trees up to 4-inch diameter size, must be measured for diameter 6 inches above the ground line and 12 inches above the ground for larger tree sizes. The root system of all plants must be sufficient to ensure plant growth. All bare-root trees must have a heavy fibrous root system that has been developed by correct cultural treatment, transplanting, and root pruning. The spread of the root system must be 12 times the trunk diameter (caliper) in inches, plus an additional six inches.
    d. Container grown plants must be well rooted and established in the container in which they are growing. They must be grown in the container for a sufficient length of time for the root system to hold the earth when taken from the container, but not long enough to become pot bound. The size of the containers must be not less than 75 percent of the ball sizes for comparable balled and burlapped plant material. Containers must be stable and not deteriorated to a degree that will cause breaking up of the root ball during the planting operations.

e. Balled and burlapped plants must be dug with enough earth taken equally on all sides and bottoms of the plants to include the necessary roots to insure growth. The thickness of depth of the balls must be sufficient to include the depth of the root according to species. The balls must be prepared in a workmanlike manner and firmly bound. Ball depth must be approximately 65% of ball diameter.
f. Collected seed stock root spread must be a minimum of 33% greater in size than nursery grown seed stock. If collected material is moved as balled and burlapped, the minimum ball sizes must be equal to those specified for the next larger size nursery-grown stock, balled and burlapped.

3. Soil Preparation and Treatment

a. Unless otherwise specified, the immediate planting areas for trees, shrubs and vines must be treated prior to planting. An area extending a minimum of two feet in all directions from where any plant is to be planted, and entire plant beds where the spacing of the plants are six feet or less must be treated. Treatment must be by either mechanical or chemical means. If a mechanical method is used, the area must be cultivated to a depth of not less than two inches, with equipment approved by the engineer, until the surface is smooth and free of debris, gullies, clods, stones, grass, weeds and any other living vegetation. If chemical control is used, the treated area does not need to be disturbed prior to planting when the surface is smooth and free of debris, gullies, clods, and stones.

4. Planting

a. Regardless of calendar date, plants must be dormant at the time they arrive at the site of the work or storage site. Spring planting of balled and burlapped and container stock must be performed from the time the soil can be worked until the plant, under field conditions, is not dormant, except that all bare-root plant materials must be planted in the spring. They shall be planted only when the temperature exceeds 35° F. Fall planting of balled and burlapped stock must start when the plant (under field conditions) becomes dormant and must stop when the ground cannot be satisfactorily worked. Plantings must not be made in frozen ground, holes must not be dug in frozen ground, and frozen backfill material must not be used.
b. All plants must be planted in the plumb position. Plants will be set at the same depth or up to one inch deeper than they grew in the nursery.
c. Prepared backfill material must be placed around the balls of balled and burlapped plants, around the container or mass of soil and roots of container grown plants, or around the roots of bare-rooted plants being planted in excavated holes.
d. The backfill material must be tamped in place during placement, and the plant must be thoroughly watered after backfilling has been completed. This watering must completely saturate the planting area. After the ground settles, because of watering, the voids must be filled to the correct level

with prepared backfill material. Approved watering equipment must be at the site for the work and in operating condition prior to starting the planting operation.

e. During the period of establishment, the contractor is responsible for correctly caring for plants to assure maximum survival and vigorous healthy plants, including the following work:
   (1) Watering
   (2) Replenishing mulch
   (3) Repairing stakes, guy wire, etc.
   (4) Restoring saucers
   (5) Weeding
   (6) Seasonal spraying (insect or disease problems)
   (7) Repairing tree wrapping and ties
   (8) Fertilizing
   (9) Application of herbicide

f. The establishment period must extend from the time the plants are planted through the month of September – not less than 90 calendar days.

I. Fencing

1. Scope

a. A fence is a physical barrier that can be set up around the perimeter of an asset.

b. Fencing is the most expensive part of a planting or regeneration program. The costs involved vary with the desired strength of the fence, length of fence, and the type of fencing used.

c. When considering establishment or rehabilitation of native vegetation plots for windbreaks, shade, woodlots, or other uses on farms, a number of design features must be considered. Depending on the type of plot being established, permanent or temporary fencing may be required. Permanent fencing is usually required for plots such as windbreaks, shelterbelts, timber, or sensitive regeneration plots (i.e., riparian zones or rare or threatened native species) where animal damage is not acceptable at any time. Temporary fencing is often used where after the first few years some level of damage is acceptable, or where stock access is desirable, for example, in shade plots.

d. Choice of materials depends on the type of animal excluded and lifetime of the fence. In most cases, vegetation plots need only be fenced to the same standard as fences elsewhere on the site, but it must be remembered that, grass growth in the plot may be attractive to hungry stock. Electric fencing can be a valuable deterrent for stock. Temporary fences can be electrified to increase effectiveness.

e. The QA inspector's responsibilities with respect to general fencing requirements include:
   (1) Ensuring that the material conforms to the kinds, grades, and sizes specified, and includes the necessary fittings and stays.

2. Material

a. For field fence, fence materials must conform to Construction Specification 92 “Field Fence.”
b. For chain link fence, fence materials must conform to Construction Specification 91 “Chain Link Fence.”
c. Listed below are the typical requirements for fencing materials found in CS 91 and CS 92.
d. Wire Gauge: When the size of steel wire is designated by gage number, the diameter must be as defined for U.S. Steel Wire Gauge.
e. Fencing material must conform to the requirements of ASTM A121 for barbed wire, ASTM A116 for woven wire, ASTM A390 for poultry fence or netting, and ASTM A854 for high tensile wire. Barbed wire and woven wire must be class 3 zinc coated as specified in ASTM A641 unless otherwise specified. High-tensile wire must have type I zinc coating unless otherwise specified.
f. Stays, Fasteners, and Tension Wire Stays and Fasteners: Must conform to the requirements of the appropriate ASTM for the fencing material specified unless otherwise specified. Tension wires must have a tensile strength not less than 58,000 pounds per square inch. Stays, fasteners, and tension wire must have class 3 zinc coating as specified in ASTM A641 unless otherwise specified.
g. Wood Fence Posts and Braces: Unless otherwise specified, wood posts must be naturally rot resistant, preservative-treated, or other wood of equal life and strength. At least half the diameter or diagonal dimension of naturally rot resistant posts must be in heartwood. Provide new wood posts that are sound, free from decay, with all limbs trimmed flush with the body. All posts must be straight throughout their full length. Make tops convex rounded or inclined. Provide posts free of ring shake, season cracks more than a quarter-inch wide, splits in the end, and unsound knots. Pine must be pressure-treated in conformance with Title 210 National Engineering Handbook, Part 642 “Specifications for Construction Contracts,” Material Specification (MS) 585, “Wood Preservatives and Treatment.” Wood braces must be of material equal to or better than construction grade Douglas fir. Wood braces must be pressure-treated in conformance with MS 585.
h. Steel Fence Posts and Braces: Steel fence posts must conform to the requirements of ASTM A702. Posts with punched tabs for fastening the wires must not be installed. Bracing pipes must conform to the requirements of ASTM A53, except that the A53 requirements for hydrostatic test will not apply.
i. Concrete Fence Posts: Concrete fence posts must be manufactured to the specified requirements of size, shape, and strength.
j. Panel Gates:
   (1) Panel gates must be the specified types, sizes, and quality and must include the necessary fittings required for installation. The fittings must consist of not less than two hinges and one latch or galvanized

chain for fastening. Latches must be designed to accommodate the use of a padlock for locking.

(2) The QA inspector's responsibilities with respect to panel gates include:

(a) Ensuring that panel gates are of the specified types, sizes, and quality and include the necessary fittings required for installation.

k. Wire Gates:

(1) Wire gates (see figure 645U-6) must be the type shown on the drawings, constructed in accordance with specifications, at the locations, and to the dimensions shown on the drawings. The material must conform to the kinds, grades, and sizes specified, and must include the necessary fittings and stays.

**Figure 645U-6. Wire Gate, Line Posts and Hay Mulch**

(2) The QA inspector's responsibilities with respect to wire gates include:

(a) Ensuring that wire gates are of the type shown on the drawings, constructed in accordance with specifications, at the locations, and to the dimensions shown on the drawings.

l. Staples

(1) Staples required to secure the fence wire to wood posts must be 9-gauge galvanized wire with a minimum length of 1.5 inches for soft woods, and a minimum length of one inch for close-grain hardwoods.

(2) The QA inspector's responsibilities with respect to staples include:

(a) Verifying that the staples required to secure the fence wire to wood posts are the appropriate material and length for the wood posts installed.

m. Galvanizing
   (1) All iron and steel fencing material, except as otherwise specified, must be zinc-coated by the hot dip process, meeting the requirements of MS 582. Clips, bolts, and other small hardware may be protected by electro-deposited zinc or cadmium coating.
   (2) The QA inspector's responsibilities with respect to galvanizing include:
      (a) Checking that all iron and steel fencing material, except as otherwise specified, are zinc-coated by the hot dip process, meeting the requirements of MS 582.

n. Chain Link Fence
   (1) Chain link fence consists of metal "links" connected to form a chain. This type of fence is particularly suited when the fence must be flexible or contain frequent offsets or angles.
   (2) Chain link fence fabric must conform to the requirements of ASTM A392, 2-inch mesh and 9-gauge galvanized steel wire. Zinc coating must be class 2. Posts and fence framework must conform to the requirements of ASTM F1043 Group 1A, for Heavy Industrial Fence. Coatings must be a type A galvanized coating for internal and external surfaces. Steel pipe posts must conform to the requirements of ASTM F1043 and F1083.
   (3) Fence fittings must conform to the requirements of ASTM F626. Fittings must be galvanized steel. Wire ties and clips must be 9-gauge. Gates, gateposts, and gate accessories must conform to the requirements of ASTM F900. Coating must be the same as selected for adjoining fence and framework.
   (4) Barbed wire must be at least 12.5 gauge and must conform to the requirements of ASTM A121, chain link fence grade.
   (5) Any damage to the coating must be repaired in accordance with the manufacturer's recommendations, or the damaged fencing material must be replaced. The contractor must provide the engineer a copy of the manufacturer's recommended repair procedure and materials before correcting damaged areas.
   (6) The QA inspector's responsibilities with respect to chain link fence materials include:
      (a) Ensuring that chain link fence fabric conforms to the requirements of ASTM A392, 2-inch mesh and 9-gauge galvanized steel wire.
      (b) Verifying that posts and fence framework conforms to the requirements of ASTM F1043 Group 1A, for Heavy Industrial Fence.
      (c) Verifying that coatings are type A galvanized coating for internal and external surfaces.
      (d) Checking that steel pipe posts conform to the requirements of ASTM F1043 and F1083.
      (e) Verifying that fence fittings conform to the requirements of ASTM F626.

(f) Ensuring that gates, gateposts, and gate accessories conform to the requirements of ASTM F900.
(g) Making sure that barbed wire is at least 12.5 gauge and conforms to the requirements of ASTM A121, chain link fence grade.

o. Storage
(1) Fencing materials must be stored as indicated by the manufacturer or the specifications. They must be stored in a secure area and be protected from the weather. When materials that have been used before are to be stored for future projects, they must be cleaned and stored in a way that will prevent or reduce their deterioration.
(2) The QA inspector's responsibilities with respect to storage include ensuring that:
(a) Fencing materials are stored as indicated by the manufacturer or the specifications.
(b) When materials that have been used before are to be stored for future projects, they are cleaned and stored in a way that will prevent or reduce deterioration.

3. Installation

a. Unless otherwise specified, line posts must be placed at intervals of 10 feet, measured from center to center of adjacent posts. In determining the post spacing, measurement is made parallel with the ground surface. Posts must be set in concrete backfill in the manner shown on the project drawings. All corner posts, end posts, gateposts, and pull posts must be embedded, braced, and trussed as shown on the drawings, or in accordance with appropriate industry practice, if not otherwise shown or specified.
b. Fencing fabric must not be stretched until at least four days after the posts are grouted into walls or seven days after the posts are set in the concrete backfill. Fencing fabric must be installed on the side of the posts designated on the drawings. The fabric must be stretched taut and securely fastened, by means of tie clips, to the posts at intervals not exceeding 15 inches and to the top rails or tension wires at intervals not exceeding two feet. Care must be taken to equalize the fabric tension on each side of each post. Barbed wire must be installed as shown on the drawings and must be pulled taut and fastened to each post or arm with the tie wires or metal tie clips.
c. Concrete or wood posts must be set in holes and backfilled with earth except where otherwise specified. Wood posts may be driven when approved by the engineer. Steel posts must be driven unless otherwise specified. Holes for installing fence posts must be at least six inches larger than the diameter or side dimension of the posts.
d. Earth backfill around posts must be thoroughly tamped in layers not thicker than four inches and shall completely fill the posthole up to the ground surface. Concrete backfill around posts must be rodded into place in layers not thicker than 12 inches and must completely fill the posthole to the surface of the ground. Backfill, either earth or concrete, must be

crowned-up around posts at the ground surface. Stress must not be applied to posts set in concrete for a period of not less than 24 hours following the development of a firm set of the concrete.

e. Unless otherwise specified, corner assemblies must be installed at all points where the fence alignment changes 15 degrees or more.
f. End panels must be built at gates and fence ends.
g. Pull post assembly (bracing within a section of straight fence) must be installed at the following locations:
   (1) In straight fence sections, at intervals not to exceed 660 feet.
   (2) At any point where the vertical angle described by two adjacent reaches of wire is upward and exceeds 10 degrees (except as provided in section 11 of the specification).
   (3) At the beginning and end of each curved fence section.
h. The fencing must be stretched and attached to posts as follows:
   (1) The fencing wire or netting must be placed on the side of the post opposite the area being protected except for installation along curved sections.
   (2) The fencing wire or netting must be placed on the outside for installation along curved sections.
   (3) The fencing wire or netting must be fastened to each end post, corner post, and pull post by wrapping each horizontal strand around the post and tying it back on itself with not less than three tightly wound wraps.
   (4) The fencing wire or netting must be fastened to wooden line posts by means of steel staples. Woven-wire fencing must be attached at alternate horizontal strands. Each strand of barbed wire must be attached to each post. Steel staples must be driven diagonally with the grain of wood and at a slight downward angle and must not be driven so tightly as to bind the wire against the post.
   (5) The fencing wire or netting must be fastened to steel or concrete line posts with either two turns of 14-gauge galvanized steel or iron wire, or in accordance with recommendations provided by the post's manufacturer.
i. Wire must be spliced by means of a Western Union splice or by suitable splice sleeves applied with a tool designed for that purpose. The Western Union splice must have no less than eight wraps of each end about the other. All wraps must be tightly wound and closely spaced. Splices made with splice sleeves must have a tensile strength no less than 80 percent of the strength of the wire being spliced.
j. Stays must be attached to the fencing at the spacing outlined in the project specifications, or as shown on the drawings, to ensure maintenance of the correct spacing of the fence wire strands.
k. Where fencing is installed parallel to the ground surface, the line posts subject to upward pull must be anchored by means of extra embedment or by special anchors as detailed on the drawings.
l. If the fence wire is installed with the top wire straight and parallel to the ground surface on either side of the depression, extra length posts must be

used to allow normal post embedment. Unless otherwise specified, excess space between the bottom of the fence and the ground shall be closed with extra strands of barbed wire or with netting.

m. The QA inspector's responsibilities with respect to general fence installation include:
   (1) Ensuring that concrete or wood posts are set in holes and backfilled with earth except where otherwise specified.
   (2) Ensuring that steel posts are driven unless otherwise specified.
   (3) Verifying that holes for installing fence posts are at least six inches larger than the diameter or side dimension of the posts.
   (4) Ensuring that earth backfill around posts is thoroughly tamped in layers not thicker than four inches and completely fill the posthole up to the ground surface.
   (5) Checking that concrete backfill around posts is rodded into place in layers not thicker than 12 inches and completely fills the posthole to the surface of the ground.
   (6) Verifying that backfill, either earth or concrete, is crowned-up around posts at the ground surface.
   (7) Ensuring that no stress is applied to posts set in concrete for a period of not less than 24 hours following the development of a firm set of the concrete.
   (8) Ensuring that corner assemblies are installed at all points where the fence alignment changes 15 degrees or more.
   (9) Checking that end panels are built at gates and fence ends.
   (10) Checking that fencing is correctly attached to posts.

n. The QA inspector's responsibilities with respect to chain link fence installation include:
   (1) Ensuring that, unless otherwise specified, line posts are placed at intervals of 10 feet measured from center to center of adjacent posts.
   (2) Ensuring that posts are set in the tops of concrete walls grouted into preformed holes to a depth of 12 inches.
   (3) Verifying that gateposts and pull posts are embedded, braced, and trussed as shown on the drawings, or in accordance with appropriate industry practice if not otherwise shown or specified.
   (4) Verifying that fencing fabric is not stretched until at least four days after the posts are grouted into walls or seven days after the posts are set in the concrete backfill.
   (5) Ensuring that care is taken to equalize the fabric tension on each side of each post.

J. Permanent Reference Monuments and Markers

1. Scope – Reference markers and monuments are used to locate and identify survey points and elevations in the field. The placement of permanent reference markers and monuments consists of furnishing and installing identification markers or plaques at designated locations.

2. Materials – Permanent markers and plaques must be constructed of the specified materials and must meet all requirements for lettering, painting, finishing, and related items as shown on the drawings or as indicated in the project specifications.

3. Installation – Markers and plaques must be installed at all locations shown on the drawings and in the manner or condition described in the project specifications. Unless otherwise specified, the markers or plaques must be mounted on concrete monuments, on existing structures, or on structures proposed for installation in the drawings.

K. As-Built Surveys

1. As-built surveys are made to document any changes in the line and grade of the constructed measure, and to document that the work of improvement has been constructed within acceptable tolerances to the specified limits. As-built surveys include surveys of the lower and lateral limits of the structure, as well as the upper limits or finished line and grade. As-built surveys also include any internal line and grade surveys necessary to show changes from the planned or designed line and grade of internal features. For example, as-built surveys may be needed to describe changes made in the location of an internal drainage system, foundation cutoff trench, principal spillway conduit alignment, embankment zoning, or any change in a dam that will not be visible following completion of the dam. The QA inspector must keep track of changes and verify that surveys are made of any change to the planned line and grade defining the location of a component of the work. The QA inspector is also responsible for documenting that the work is constructed within acceptable tolerances to the lines and grades shown on the drawings. This will require occasional checks of the as-built line and grade of various features, such as a chimney drain, conduit, embankment zone limits, and other structural elements. It also requires a clear understanding of construction tolerances. Because tolerances for many components of NRCS engineering measures are not specified in the drawings or specifications, it is important for the QA inspector to be familiar with industry standard tolerances. See appendix E, “Construction Tolerances” for more information on industry standard tolerances.

2. As-built surveys may also be used for determining limits for computing final payment quantities if the earthwork pay limits include the true surface of completed excavations or the measured surface of the completed earthfill. The QA inspector must verify that necessary as-built surveys are made to define the specified pay limits. The QA inspector must also verify that as-built surveys made to define pay limits accurately represent the specified limits necessary to compute accurate quantities for payment.

3. The QA inspector’s responsibilities related to as-built surveys include verifying that they:

   a. Document all changes to the original planned lines and grades shown on the drawings.

b. Accurately capture and document the specified pay limits.

L. Cleanup

1. Scope – Site cleanup involves the removal of all personnel, equipment, materials, and supplies that are not part of the permanent work, and the restoration of damaged or modified portions of the site that were not part of the scope of work. It is the contractor's responsibility to clean up the site. The QA inspector is responsible for ensuring that the site is adequately cleaned up and transferred to the landowner or sponsor in appropriate condition.

2. Demobilization – Demobilization includes all activities and transportation of personnel, equipment, and supplies not required or included in the contract from the site. This includes the disassembly, removal, and site cleanup of offices, buildings, and other facilities assembled on the site specifically for the project. The contractor is responsible for demobilization of the site. It is the responsibility of the QA inspector to ensure that the contractor has adequately demobilized from the site and removed all personnel and unused equipment, materials, and supplies.

3. Restoration – Restoration of areas or features on the site may be required at the conclusion of the construction work. This includes the restoration of roads, fences, utilities, vegetation, and other permanent site features that were damaged during the work or modified as part of performing the work. It is the contractor's responsibility to restore the site to its original condition. The QA inspector must verify that the site has been restored adequately.

## 645.2102 Sampling and Testing

A. The application rates of most site stabilization practices, such as seeding, sprigging, fertilizing, mulching and application of soil amendments, can be determined by dividing the total quantity of material applied by the total area covered. The quantity is usually determined by weight tickets. The area is determined by a measurement of the application area. It is good practice to have this area surveyed and marked prior to application.

B. The uniformity of coverage is usually determined by visual observation of the area. When a more accurate measurement is needed, a square frame can be used to measure a representative area. A square frame of three feet by three feet is commonly used. The frame is placed in a representative area, and the mulch within the frame is collected and weighed. That weight is divided by the area inside the frame to arrive at a mass per unit area application rate.

## 645.2103 Records and Reports

A. Site Stabilization Report – Worksheet 645 WS 21.1 "Site Stabilization Report," in appendix B, may be used to record inspection and test data associated with site stabilization activities on a project. The QA inspector must record the type of site stabilization provided, how it was installed, finished, and protected. The

worksheet also allows for recording of the types of tests performed on the site stabilization and the accompanying results of the tests.

B. Fencing Report – Worksheet 645 WS 21.2 "Fencing Report," in appendix B, may be used to record inspection and test data associated with fencing materials and the quality of construction and installation.

C. Job Diary Entries

1. Record when materials are delivered. Obtain shipping tickets or weight tickets and take photos (if applicable) for documentation for payments. Any omitted items must be noted. Document that delivered items are in accordance with contractor certifications that have been accepted by the engineer. Document any rejected items and the reason for rejection.
2. Record when items are installed. List any problems with installation and how they are resolved.

## 645.2104 References


U.S. Department of Agriculture, Natural Resources Conservation Service. 2024. Specifications for Construction Contracts. National Engineering Handbook, Part 642. Washington, DC.

University of Massachusetts Amherst, Center for Agriculture, Food and the Environment, University of Massachusetts Turf Program, "Understanding Turf Fertilizer Label", 2011. https://ag.umass.edu/turf/fact-sheets/understanding-turf-fertilizer-label#:~:text=The%20first%20number%20of%20the,appear%20prominently%20on%20the%20label

Englert, J.M. 2007. A Simplified Guide to Understanding Seed Labels. Maryland Plant Materials Technical Note No. 2. USDA-NRCS National Plant Materials Center, Beltsville, MD. 3p.

Materials Technical Note No. 2. USDA-NRCS National Plant Materials Center, Beltsville, MD.