2.53 - Tree Care from Storage to Planting

During all aspects of tree handling, keep seedlings cool and roots relatively moist. Root hairs can be damaged in minutes by exposure to dry wind and low humidity. Temperatures over 36 degrees Fahrenheit will increase respiration and cause depletion of food reserves. High temperatures can also result in accumulation of gases in tree boxes. These gases can damage trees severely and are a particular problem in pines that are coming out of dormancy. Trees damaged or killed in this manner cannot be easily distinguished from healthy trees.

6. Transport of Trees.

   a. Wrapped trees. Protect tree bundles from drying wind during transport. Do not transport them exposed in open trucks. It is best to transport bundles inside tree shipping cartons with tops exposed to air in insulated tree transport units, covered vans, canopied pickups, or trailers.

   If it is necessary to stack boxes for transport, wrapped trees may be laid horizontally in original nursery bags and then placed in boxes for short periods. Do not roll or seal the bags. Once at the site, bags should be reopened and bundles placed upright. Air exchange is important when trees are exposed to temperatures over 36 degrees Fahrenheit.

   b. Unopened Tree Boxes. Trees in unopened boxes should be transported in canopied trucks or vans. They can also be transported in open pickup beds providing they are well covered with white or reflective tarps. Do not expose tree boxes to wind or direct sunlight.

7. Tree Care While Planting.

   a. Keep boxes in shade. Cover boxes at all times to keep them cool using reflective tarps (shiny side down) such as space blanket type tarps. Stacked boxes of trees shall be separated to provide free air movement between boxes. Punctured or torn containers must be promptly resealed.

   b. Planting bags for bareroot stock must have a minimum depth of 15 inches. Canvas bags with a silver colored reflective material on the outside and an inside compartment of neoprene and drain holes are preferred. This should be specified in the contract.

   c. Seedlings, whether individual, in bundles, or bags, must be protected at all times from drying, heating, smothering, freezing, crushing, drowning, abrasion, rapid temperature fluctuations, or contact with injurious substances.

d. Do not remove trees from shipping containers until they are to be placed in planting bags. If water has accumulated in the bag, it must be emptied before being filled with seedlings.

e. Plant tree seedlings without further root or top pruning, or culling. If pruning or culling appears necessary, or if mold, dry roots, evidence of injury, or dying is seen, the condition shall immediately be reported to the Contracting Officer or the Planting Foreman.

f. Do not handle frozen stock until it is completely thawed.

g. Trees in planting bags shall have only their tops exposed. Loosen wrap from trees just prior to planting to allow trees to be easily extracted from the roll.

h. Do not remove a tree from the planting bag until the planting hole has been opened.

i. Remove seedlings gently from planting bag, one at a time, to prevent root stripping or other injury, and quickly and gently insert it in the planting hole.

j. Seedlings carried in planting bags shall not exceed the amount that can be carried and removed without injury, or which can be planted before critical heating or drying occurs. Once trees are placed in bags they must be planted and not returned to storage.

k. Container trees are extracted from tubes or blocks in which they are grown and placed in plastic bags for shipment. Each bag contains a set number of trees, usually 25 to 30 trees per bag depending on the grower. Some growers may wrap trees in plastic wrap rather than bags. Spring-shipped trees may be frozen. They must be thawed prior to planting.

l. Bagged trees go directly from the box to planting bags. Place trees vertically, with tops up, in planting bags. Do not overload planting bags. Do not double stack seedlings in planting bags, even if tops are only 6 to 8 inches high.

m. Summer-delivered trees should be planted as promptly as feasible, as they are not conditioned for storage.

8. Weather and Soil Hazards During the Planting Operation. Refer also to section 2.82.3.c. for more detailed guidelines for planting in harsh weather conditions.

a. Cold Air Temperature Hazards.

(1) Spring Planting. Do not begin planting until the probability of severe cold events has lessened to avoid freeze damage. Most planting windows in the northern Rockies are not open until after mid-April. Planting may begin earlier further south. Monitor the weather forecast once planting has started. Plan to suspend planting on days when extreme cold events such as Canadian air masses are expected to move in.

Normally, it is not early morning frosts that damage trees right after planting, it is extended periods of cold in lower teens and twenties that cause problems, and winds can make it worse. Plant when trees are still dormant. Dormant trees will withstand cold better.

Do not plant during freezing temperatures, and do not expose roots to freezing temperatures during planting.

Experience has shown that planting too early in the season can result in high mortality. Even though a site may be free of snow, do not plant when there is still a chance of killing frosts or when soil temperatures are low. The moisture content of the stems and needles in trees coming from packing boxes is high. When exposed to low temperatures during late freezes, the water in the plant tissues freezes, killing the tissue.

(2) Summer Planting Container. There may be freezing temperatures during the summer plant season at high elevations, especially at night. Summer stock is not frost hardy. Trees stored on site must be protected from severe freezing as new root tips are easily damaged. Do not start planting until the chances of hard frosts are over.

(3) Fall Planting. Fall-planted container stock is subject to frost damage when planted later in the season (after October 1).

Trees planted from mid-August through September are able to harden off normally as days shorten and night temperatures decline. By mid-October, these trees become cold hardy and can withstand temperatures well below freezing. If severe cold (teens to low twenties) weather is forecast, delay planting until low temperatures are expected to rise to normal fall temperatures. The moisture content of containerized trees coming out of the cooler will often be high. It will take a few days on the site for trees to lose the high moisture content and become more resistant to freezing.

b. Frozen or Cold Soils. Trees cannot be properly planted in frozen soils. It creates problems in opening the planting hole and filling it properly. Suspend planting operations if soils are frozen more than an inch deep. Do not plant if soils are below 40 degrees Fahrenheit at rooting depth. Adequate soil temperatures are needed for seedlings to absorb soil moisture.

c. Drying Winds. Winds can damage trees by drying roots and tops. Watch seedlings closely for signs of soil or root drying. Consider suspending operations if tree roots are drying between the planting bag and planting, or if soils are drying before the hole can be closed. Use temperature/humidity charts developed specifically for Rocky Mountain sites to determine suitable planting windows.

Warm winds can desiccate trees that have open stomata, typical of trees just removed from the planting box. Consider suspending planting operations if there are warm drying winds and temperatures exceed 80 degrees Fahrenheit.

d. Dry Soils. Sufficient soil moisture is needed so the planting hole can be properly opened and closed. Base the decision to plant on soil condition and experience of local moisture patterns and planting windows. For example, if soils are dry in the last week of June and no rain is forecast, planting may not be appropriate. Although there are risks, if soils feel dry in April, trees can be planted assuming normal rains will occur.

On low to middle elevations in southwestern Colorado, Arizona, New Mexico, and southern Utah, do not plant trees in May or June unless soil moisture is adequate to get roots established. These are typically the driest months of the year. Do not rely on anticipated monsoon rain patterns to make up current moisture deficits.

Seasonal moisture expectations dictate planting strategies during the fall planting season. Trees are becoming dormant and their moisture needs are declining as the season progresses. As well, trees with less water content will be less prone to freeze damage. Trees planted in late August will need more soil moisture than those planted in mid- September. Trees planted at high elevations after mid-September will need relatively little additional moisture until next spring.

Planting late in the fall while waiting for wetting rain can result in cold damage to trees that are not properly conditioned and hardy for freezing temperatures.

e. Snow-covered Sites. Snow can make finding planting spots difficult. If planters cannot find planting spots, stop planting until the snow melts enough that planting spots can be detected. On some sites only an inch or two of snow can make planting spots difficult to find.

f. Warm Temperatures. Warm temperatures alone may not be extremely harmful, however; there are cases when heat may be a concern. For example, if it is 70 degrees Fahrenheit at 10 am and will be in the 80 degree-plus range most of the day, it is probably desirable to delay planting. Consider planting in early hours and late evening on very warm days or moving crews from south and west slopes to north and east slopes. Consider compounding factors particularly wind. Moderately warm temperatures coupled with drying winds are extremely stressful to trees.

g. Water-Saturated Soils. Trees planted in waterlogged soils will suffocate and die. Tree roots must have air to function. Saturated soils also affect the ability to plant, especially in high clay or silt content soils. Soils must be well drained enough to properly open and close a hole for successful planting. Often soils too wet to plant immediately after snowmelt or heavy rains are plantable a few days or a week later.

On very wet sites, it may be necessary to change the stock type or season. For example, in spruce bottoms that are so waterlogged they can only be planted with summer and fall container stock.

2.61 - Planting Spot Selection - Microsites

Planting in favorable microsites protects seedlings from potentially harmful conditions and improves the probablility of survival. This is especially true in areas of high animal use, high insolation rates, and extreme winds. To take advantage of microsites, the spacing requirements may need to be adjusted. Silviculturists must evaluate local site conditions to assure the required microsite is tailored to the damaging agent.

1. Areas of High Animal Use. Cattle and big game damage is a major cause of plantation failure. Cattle generally trample the seedling and big game tend to feed on the plants. Plant seedlings near logs, stumps, or rocks where they are protected, which will inhibit trampling and animal browsing.

2. High Insolation. High insolation results in heat and moisture stress to the seedling and can cause mortality on any sites. Drier habitat types and those on south- and west-facing slopes are most damaging. Direct heat to the tree crown affects the physiology of the tree causing water maintenance deficits. Heat at the soil surface can cause the soil temperatures to be lethal to the seedling stem at the ground line. Early season insolation can also cause the seedlings to break dormancy too soon and become subject to freeze damage. All of these types of damage intensify on exposed slopes over 30 percent.

Stationary shade such as stumps, rocks and larger logs provide the best site protection. On south and west slopes, plant on the north to east side of the stationary shade to protect the seedling from the afternoon sun. Where existing (stationary) shade is not present, other transportable shade types can be used in most cases. Use pieces of wood or branches that are larger than 3 inches in diameter, rocks, staked shingles, shade cards, and other material. Place the shade on the south and west side of the tree, to offer afternoon shade to the seedling (see exhibit 01). Rocks should not touch the tree. Staked shade cards or shingles are costly to install but are an option where there is no natural shade. Although it is beneficial to shade the entire crown of the seedling, the most critical area needing shade is the ground line. This is where insolation rates raise soil temperatures above the lethal point.

Shade is generally not necessary on north slopes, and if used on east slopes, place it on the downhill side to protect seedlings from morning sun. Do not place transportable shade on the uphill side of the tree because it may roll down onto the planted tree.

2.62 - Planting Spot Site Preparation

Prepare the planting spot before planting in order to prevent surface debris (dry litter and duff) from falling into the planting hole and to free the spot from competing vegetation. Prior to opening the hole, the planter must follow this procedure:

1. Clearing. Remove all surface debris down to moist mineral soil within an area that is a minimum of 6 inches in diameter. Remove duff, litter, rotten or charred wood, loose rock, ashes, snow, surface frost and similar debris. After the tree has been planted, this material may be pushed back over the cleared surface to serve as mulch.

2. Scalping. Cut and remove all vegetation to a minimum of 1½ inches below the root crown. Width of the scalp is dependant upon the amount and kind of competing vegetation. Planting in sod-forming grasses generally requires scalping of 18 to 24 inches. Where larger scalps would be needed, herbicide and mechanical spot treatments should be considered.

2.63 - Planting Hole Design

Locate holes for tree planting in good soil that is deep enough to accommodate the fully extended seedling roots. They should not be placed in rotten logs, duff or mixes of organic matter, or soil that easily dries out. The hole must be large enough in all dimensions so that seedling roots may be inserted without becoming deformed or damaged. Only an occasional long lateral root can be laid in the bottom of the hole in a non-vertical position.

Utilize the "Open Hole Method" in all cases. Open a hole with the planting tool to create a hole of adequate size to allow for natural alignment of tree roots and compaction of soil. Place loosened soil back into the hole and progressively firm soil from the bottom of the hole toward the top. The seedling should be positioned in the center of the hole. Side hole planting is only acceptable in limited cases where sandy soils are present.

Do not plant trees in narrow slits opened in the ground (slit planting); the seedling roots will not develop properly in most soils.

The standard minimum-sized planting hole for bareroot stock is:

1. Two inches deeper than the root length of the tree being planted.

2. At least 3½ inches diameter for the full length of the hole. A minimum 4-inch diameter hole is required for auger planting to permit necessary tamping for firmness.

The minimum-size hole for container stock is:

1. One inch deeper than the plug length.

2. At least 3 inches in diameter at top of the hole and 1 inch at bottom.

2.66 - Planting the Bareroot Tree

The planting hole must be properly opened for correct tree placement. The seedling must be inserted at the proper depth with proper root and stem alignment. After the tree is properly aligned, moist mineral soil must be firmed around the roots. See exhibit 01 for examples of properly and improperly planted trees.

1. Planting Depth. Plant the seedling at approximately the same ground line as it was in the nursery. The root collar or cotyledon scar is an indicator of the original ground line. No portion of the roots should be exposed, nor any needles or branches covered with soil. Correct depth placement is especially critical on high insolation sites. The stem tissue at the base of the tree at the ground line is insulated (thickest bark) better than stem tissue above or root tissue below for protection from temperature extremes. High soil temperatures at ground line can be lethal to tender stem or root tissue.

2. Root Arrangement and Alterations. The seedling should be planted so the root system is in its natural configuration and free to grow. The roots should radiate downward in a conical arrangement. Proper arrangement is critical for maximum water uptake. Properly train inspectors to recognize improper root arrangement. Do not twist the roots; compact the root system along one plane, or plant with the roots in a U, J or L shape. An occasional lateral root may be J-, U-, or L-shaped, however, taproots must be in a natural position and never bent. Do not allow planters to cut, strip, or otherwise alter roots prior to planting. Inspectors and foremen must have a firm visual impression of the root systems in order to inspect for violations. Root sytems vary by species and tree lot, therefore, inspectors should visit the wrapping shed or tree bagging sites regularly. Observe the length and number of lateral roots as well as the length of the tap root. This is important as planters may strip or shorten only the lateral roots of the tree. Tree root systems should normally have a bell shape with many of the laterals hanging down to a length equal with or sometimes longer than the tap root. The root system should not look like a "skinny carrot" with no laterals, nor should the laterals all be appreciably shorter than the tap root.

Root stripping is done when planters have trouble fitting roots properly into hole. To help avoid root stripping, the appropriate kind of stock should be ordered for the site. For example, do not order 12 inch long bareroot stock for a site with shallow soils. It may be more appropriate to use 6 inch container stock. When applicable, make sure the nursery has properly pruned the bareroot stock prior to shipment.

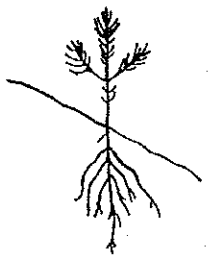
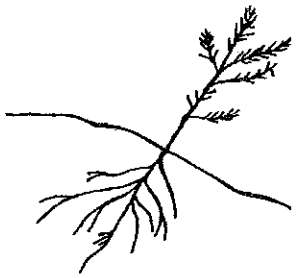
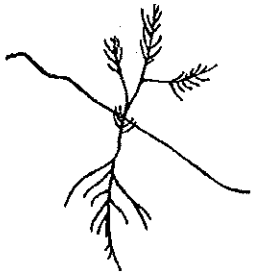
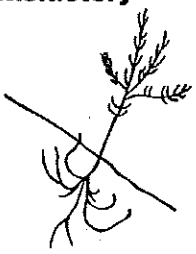
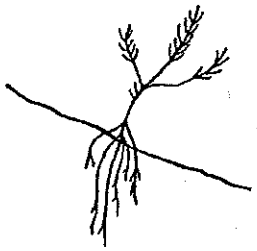
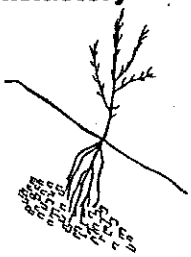
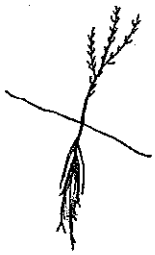
3. Stem Orientation. Orient the tree stem at an angle between 90 degrees with the horizontal plane to 90 degrees with the slope face. This will be achieved if the hole is opened properly.

4. Firmness. Firmly tamp the soil around the planted tree roots filling and firming the hole progressively from the bottom toward the top. Do not tamp with sticks or by "heeling in" alongside the seedlings after planting. Do not leave any large air pockets in the hole and do not leave debris in the hole after closure. Roots not in close contact with mineral soil will dry, resulting in tree mortality.

2.66 - Exhibit 01

Planting the Bareroot Tree

Satisfactory and Unsatisfactory Plantings

SATISFACTORY 	**SATISFACTORY** 	**Unsatisfactory**  Too deep. Needles buried.
Unsatisfactory  Improper orientation. Not planted into the slope or near vertical.	**Unsatisfactory**  "L" roots. Shallow hole.	**Unsatisfactory**  "J" roots. Shallow hole. Roots often exposed.
Unsatisfactory  Jammed roots. Hole too narrow and shallow.	**Unsatisfactory**  Hole too shallow. Roots exposed.	**Unsatisfactory**  Air pocket because of improper tamping.
Unsatisfactory  Planted in rotten wood. Roots not in mineral soil.	**Unsatisfactory**  "U"- or "J"-shaped tap root.	**Unsatisfactory**  Compacted roots. Hole too narrow.

2.67 – Planting the Container Plug

The container plugs are extracted from the container racks and packed (20 to 25 seedlings per package) in wrapped bundles or plastic baggies. Distribute plugs to planters in baggies, which are placed directly into the planting bag.

Container 6- to 9-inch plugs are generally easier to plant than longer rooted bareroot seedlings. Containers are especially recommended for rocky sites where hoels cannot be opened properly for bareroot stock. Containers can be planted with almost any planting tool available. Hoes, bars, and augers have all been used successfully, however, dibbles are not recommended.

1. Planting Depth. Plant the plug deep enough so that about 1 inch of soil can be placed on top of plug, level with surrounding soil surface in order to seal the plug in the ground. This is necessary in areas prone to frost heaving. In all cases, the entire plug and root media must be below the ground surface.

2. Plug (root) Arrangement. While container trees are somewhat easier to plant than bareroot trees, the same care should be given to ensure containers are properly planted. Do not break, bend, flatten or distort the plug in any manner to avoid damage to the root system. After the planting hole has been properly opened, plant the container tree as described for bareroot seedlings in section 2.66.

3. Protection. Containerized seedlings are similar morphologically to natural and 1-0 seedlings in that they have very little heat protection (bark) on the stem. The high soil temperatures at ground level can easily kill the tree if not properly shaded

4. Dibbles - Caution. Dibbles should be used with caution. They are metal tools shaped in the form of a container that is pushed into the soil leaving a hole the shape of the container plug to be planted. Dibbles are suitable in light, fine textured soils, but in clay soils they have the effect of glazing or compacting the sides of the hole. This causes problems in root penetration or creates an air layer between plug and soil. When the air layer fills with water and freezes, frost heaving will occur.

2.82 - Contract Inspection

Planting contracts require intensive inspection. Follow contract inspection procedures specified in the contract and described in this section. If the contractor is responsible for inspection, the government shall conduct quality assurance inspections as described in the contract. In negotiated contracts, field inspection performed by the contractor shall be consistent with the approved quality control plan. The quality control plan shall be consistent with the following procedures.

There are two phases of contract inspection: (1) Inspection while work is in progress observing tree care, wasting of trees, and planting technique while planting is in progress, and (2) plot inspection where the inspector checks quality of planting using systematically placed plots.

1. Inspection while Work is in Progress. The COR and inspector(s) shall inspect the contractor's work during all aspects of tree planting from the time trees are issued to the contractor until they are returned or planted. Inspectors shall be with the contractor at all times when the contractor has trees in possession for per tree and per thousand (tree) contracts. It is recommended that an inspector be with the contractor on per acre contracts particularly at the

onset of the contract. It is preferable the inspector be on site and observing tree planting and tree care throughout the planting operation. Much of the damage to tree seedlings that can occur during planting cannot be detected in the inspection plots that will follow.

a. Inspect the following items throughout the planting period:

(1) Rate of Progress. Contractor's rate of progress.

(2) Weather conditions. Weather conditions suitable for planting

(3) Organization of work. Crew should be working in an organized manner.

(4) Tree care and field handling. Tree preparation when it is the contractor's responsibility.

(5) Planting Technique. Scalps or other clearing standards, spacing, and planting techniques.

(6) Intentional wasting of trees. Monitor suspect behavior that may indicate planters are disposing of trees.

(7) Appropriate equipment.

b. Rate of Progress. Monitor the contractor's progress to assure the time periods stated in the contract are met. Tree survival and growth are dependent upon proper soil and weather conditions at the time of planting, and these conditions exist for a limited time; contract extensions may not be allowed.

c. Weather Shutdown Guidelines. When the COR determines that temperature, humidity, soil moisture, winds, or a combination of these and other physical conditions are unsuitable for tree planting, move the work force to another area or suspend operations. Whenever suspension due to weather is contemplated, considerations must be given to the risk of delaying planting. Will conditions worsen or improve? Is tree survival at risk? When will the contractor return to complete the work?

(1) Factors to consider prior to suspending operations due to weather:

(a) Degree of stress to trees created by current weather conditions.

(b) Predicted future weather, including expected rainfall, winds or temperature changes.

(c) Length of planting season remaining.

(d) Number of trees left to plant.

(e) Condition of planting stock, particularly relative to dormancy.

(f) Availability of alternate sites on cooler aspects or to adjust work shifts (early or split shifts)

(2) Appropriate conditions for temporary shutdowns:

(a) Snow on the ground. Snow makes it difficult to select planting spots; too much snow will obscure planting spots and snow may fill the planting hole. Snow covering steep slopes may also be a hazard to planters.

(b) Frost on the ground. When there is more than ½ inch of frost in the ground, planting holes cannot be opened or closed properly.

(c) Freezing weather. Frozen tree roots or root plugs become brittle and roots are easily damaged and broken. Tops and needles are also subject to damage.

(d) Dry Soil. The soil is too dry to properly firm the tree. Dry soils that have the consistency of flour or hard clay cannot be planted without additional moisture. However, trees should be planted if the soil is workable and chance of future moisture is reasonable.

(e) Wet Soil. The soil is too wet to properly firm the trees. Sometimes soils must be allowed to drain before planting can continue.

(f) Winds. Sustained winds of 20 miles per hour or more with low humidities and high temperatures of 75 degrees Fahrenheit or more are damaging to seedlings. Winds coupled with low humidities and warm temperatures cause high moisture stress to seedlings. Consider planting at alternate time of day if possible. Many times, Rocky Mountain springtime weather fluctuates rapidly. Temperatures variations of 40 to 50 degree with changing winds and humidity may occur within hours. In these conditions protect seedlings from drying winds with wet kimtex type towels or burlap for short periods of time.

(g) High temperatures. Temperatures exceeding 85 degrees Fahrenheit for more than 4 hours cause moisture stress to the seedlings. Under these conditions, it may be desirable to only plant in the morning and evening rather than shut down operations.

(h) Wind or weather conditions in a burn area. Wind or other weather conditions can make planting hazardous such as in a burn area. Planting should not continue when there are winds predicted or occurring that increases risk of snags falling within the unit during the planting operation.

(i) Weather Guides. When using weather guides for determining planting windows, use only those developed for the local area. Guides from other areas are not appropriate.

d. Organization of Work. Contractors shall maintain quality control over their crews and perform planting in an organized systematic manner. Do not permit planting crews to be scattered.

e. Tree Care and Field Handling. Tree care and handling shall be inspected while the work in progress. Utilize the contract clauses for wasted tree charge when the contractor mishandles seedlings. Issue a notice of noncompliance for serious or recurrent violations. The following items should be inspected regularly. It is preferable to correct deficiencies early, to avoid tree mortality caused by poor handling.

(a) Appropriate planting equipment, tools, and planting bags.

(b) Proper location and facilities for tree wrapping. Do not allow seedlings to be exposed to heat; do not allow the roots to be exposed to drying conditions.

(c) Proper storage of tree boxes. Do not expose boxes to sun.

(d) Proper technique in tree wrapping. Inspect for root pruning. To adequately inspect for root shortening during wrapping and field handling, know the root lengths of shipped trees before issuing them to a contractor.

(e) Proper storage of wrapped trees. Keep bundles cool and moist.

(f) Too many trees in planting bag. Seedlings will be damaged if planters put too many trees or container plugs in the tree bags. Do not allow more trees to be carried than what can be outplanted before drying occurs.

(g) Careless treatment to trees in planting bag. Do not allow planters to lay on bags, pile equipment on them, or expose them to oil or gas.

(h) Dry kimtex or burlap wrap. The wrapping material must be moist to touch.

(i) Tree roots exposed to air during planting. Do not allow planters to carry trees in their hands between holes or while preparing a hole. Trees should be removed from the planting bag after the hole has been opened.

(j) Dropped trees that are left on ground. Except for incidental trees, count dropped trees as wasted trees.

(k) Wasting trees. Monitor planters for careless handling that exposes trees to heating and drying, or leaving bags of trees in the sun. Hiding, stashing, or destroying trees is also a form of wasting. Intentional wasting of trees shall not be tolerated.

(l) Root stripping or pruning by planters. Do not allow stripping or tearing of the lateral root or shortening the root system. It is a tremendous shock to the tree and results in high mortality rates. Watch the planters and if stripping is suspected, dig trees to observe the roots. Notify the contractor if stripping is found. If the contractor fails to correct root-stripping violations, issue a suspension of work order and notify the CO.

(m) Planting spot selection. Assure tree shade and protection is adequate and meets contract specifications.

(n) Planting spot preparation. Assure clearing and scalping is adequate and meets contract specifications.

(o) Spacing requirements. Seedlings should be planted to meet spacing specifications.

(p) Species mix. Assure proper species and stock types are being planted as per contract specifications.

(q) Hole opening and tree insertion. The hole should be open from all sides and tree roots shall be suspended in a natural position. The tap root shall not be twisted, balled up or in the form of a J or L. Tree shall be upright and between vertical and 90 degrees with the slope plane.

(r) Tamping soil in auger holes. Root damage can occur if tamping is done with tool handles or sticks.

(s) Moist soil in the planting hole. Dry soil will occur if the auger operator is too far ahead of tree planters in auger planting operations

(t) Failure to close auxiliary holes in auger operations. Root drying will occur when open holes are left in proximity of auger holes.

2. Inspecting for Planting Quality. The primary factor in determining the contractor's payment is the plot inspection. Use the following process and standard inspection form (R-1, 2, 3, 4 FS-2470-9). Variations to this may be done with approval of the CO and regional silviculturist or reforestation specialist to meet specific planting requirements. Specify the inspection process in the contract. Refer to exhibit 01 for a sample of the standard inspection form. The inspector shall sign the inspection form and initial any changes, as this is the main basis for contract payment. All inspectors should fully understand the inspection forms and procedures for completing the inspection.

a. Equipment Needed.

(1) Clipboard and pencils.

(2) Inspection sheets

(3) Full contract (with exhibits).

(4) Fifty-foot logger's tape.

(5) Plot pole or shovel with swivel on handle to attach the tape.

(6) Flagging.

(7) Screwdriver, ice-pick, or garden trowels that aid in below ground inspection.

(8) Tile spade, hognose spade, planting hoe for hoe planting.

(9) Slope correction table.

(10) Clinometer or Abney.

b. Plot Design.

(1) Plot Size. Use either 1/50th- or 1/100th-acre plots for planting up to 10- by 10-foot spacing. At wider spacings, use the 1/50th-acre plot to ensure there are adequate trees per plot for statistical reliability.

Plot radius will vary depending on slope. After determining slope percent, use the plot table in section 2.73; exhibit 01, for determining radii for plot on 1/100th- and 1/50th-acre plots. Use these radii for the full plot. Do not compensate by changing radius or raising and lowering the tape when going around the plot. Such adjustments are included in the table.

(2) Plot Placement. Establish plot in a systematic manner, distributed uniformly over entire acreage. A grid system is recommended.

(3) Quantity of Plots. The minimum sampling intensity is specified in the contract. When payment reductions are anticipated, a 2 percent sample is required.

c. Inspection Within The Plot. Mark the plot so that it can be relocated by the COR or Contractor. Inspect each plot in accordance with contract. Utilize the following inspection for most contracts. Follow this procedure in the described order for accurate inspection results.

(1) Locate and mark plot center on the ground. A pin flag with plot number or similar locator is recommended for the center point.

(2) Inspect and record the aboveground condition of each tree planted. Working in a clockwise direction from true north, locate, examine, and record the condition of planted trees in spaces under column 2 of the inspection form. Use codes listed below. A poorly planted tree may have more than one violation, however, only one code may be listed. Identify the most severe.

√ - Satisfactory tree above ground.

S - Spacing Violation. A tree that has been planted closer than one-half of the spacing allowance to another acceptable tree is a violation unless otherwise stated in the contract. For example, if the spacing is 10 feet by 10 feet and a tree is closer than 5 feet to another planted tree, one tree is in violation for spacing. If one of the trees is improperly planted due to another reason, charge the spacing violation to the improperly planted tree and check the remaining good tree as properly planted.

P - Planting Spot Violation. Tree planted in debris, loose soil, duff, ashes, or similar material.

X - Shade Protection Violation. Shade and seedling protection is not consistent with the contract clause specified for the unit.

D - Planting Depth Violation. Trees are planted too deep or shallow. The contract requires that after filling, packing, and leveling, the soil shall come up to a point even with, or up to 1 inch above, original ground line of tree. Note that the original ground line is always above the root collar and should be considered in the area between the cotyledon scar and the root collar. No portion of the roots shall be exposed nor any branches covered with packed soil.

If soil is loose around branches and needles above the ground line, soil will settle and no harm is done. However, if soil is packed tightly or branches and needles are in the hole (below the normal ground line), a violation should be cited. Inspectors must ensure that they recognize where the root collar is. It can be seen by scraping bark back to the cambium in the root collar area. Stem tissue immediately under bark of the stem will have some green color. Below the root, scraping reveals only white tissue. Trees with roots exposed are in violation. The root system on ponderosa pine and occasionally Douglas fir and grand fir generally does not branch for 2-4 inches below the root collar. This unbranched portion of the root system is often erroneously interpreted as stem and left above ground. The root does not have thickened bark and can be easily damaged by insolation and high soil surface temperatures. Make sure the entire root system is below ground.

Container plugs should be covered with soil (1/2 inch or more) in order to prevent frost heave problems.

A - Stem Position Violation (erect tree). The stem should be oriented between vertical and 90 degrees with the slope plane. Improper angle may result from improper hole opening with hoes. If the tree looks erect above ground but slanted below ground, then a belowground violation instead should be cited.

F - Firmness Violation. Trees should be tamped as firmly as soil conditions allow. In most Rocky Mountain soils, trees should not pull easily from soil. The inspector may grab the stem and gently tug. If tree comes up to expose roots (below the root collar) then the tree was not firmed up and is in violation. This test must be used with caution in very light or sandy soils.

C - Scalp or Clearing Violation. Scalp or cleared area is too small or too shallow.

W - Wrong (incorrect) Species. Species planted in area of unit where it is not supposed to be

T - Cull Trees. Cull tree is planted. Use when the contract specifies that the contractor shall not plant cull trees and identifies what constitutes a cull tree.

(3) Determine average number of planting spots from Table 1 and record results in column 3 of the inspection form.

TABLE 1

Average Number of Planting Spots

Average Spacing	1/50 Acre	1/100 Acre	1/20 Acre
7 x 7	18	9	N/A
8 x 8	14	7	N/A
9 x 9	11	5	N/A
10 x 10	9	4	22
11 x 11	7	N/A	18
12 x 12	6	N/A	15
13 x 13	5	N/A	13
14 x 14	4	N/A	11

(4) Determine number unplantable spots by identifying spots void of planted trees that are unplantable due to ground conditions or acceptable existing natural regeneration. Recognizing average number of planting spots on the plot, scan plot for areas void of natural and planted trees. Look for voids the planters missed. Then check to see if it is a non-plantable spot. Record in column 4.

(a) When a tree has been planted, the contractor, by default, has determined it to be a plantable spot. In terms of the inspection, the spot with a planted tree is a plantable spot no matter what the inspector finds after the fact.

(b) An unplantable spot as defined by the contract is an area within the specified spacing limits in which it is not possible to plant a tree according to specifications, and no tree has been planted. For hoe planting, a plot is considered unplantable if the inspector cannot find a suitable spot in three attempts within spacing requirements and if the hole cannot be opened at the spot with five swings or less. Auger planting requires three attempts to find the spot that will be scalped or cleared, and then three attempts to open the hole in the spot with the auger, first attempt being made in the middle of the scalp.

One unplantable spot is allowed for each single unplantable area equal in size to the average specified spacing. For example, if a single unsatisfactory area of 64 square feet exists on an 8- by 8-feet spacing, one unplantable spot will be recognized. If half

of a 1/50th- plot is unplantable, then 435.6 square feet (half of 871.2) is unplantable. For 9- by 9-feet spacing, five spots would be credited as unplantable.

(5) Determine number of planting spots by subtracting column 4 from average number of planting spots (column 3). Record in column 5 of inspection form.

(6) Determine maximum number of allowable trees from Table 2, and record in column 6 of inspection form.

TABLE 2
Maximum allowable trees based on
Number of plantable spots determined in Table 1

Plantable Spots	Maximum Trees	Plantable Spots	Maximum Trees	Plantable Spots	Maximum Trees
1	2	11	13	21	25
2	3	12	14	22	26
3	4	13	16	23	28
4	5	14	17	24	29
5	6	15	18		
6	7	16	19		
7	8	17	20		
8	10	18	22		
9	11	19	23		
10	12	20	24		

(7) Record the number of trees planted on the plot (also listed in column 2) in column 7 of inspection form.

(8) Determine wasted trees by subtracting maximum number of allowable trees in column 6 from those planted (column 7). If more than 0, record in column 8.

(9) Record number of planted trees meeting aboveground specifications from column 2 only up to maximum listed in column 6 of the inspection form.

Below Ground Inspection.

(10) Determine minimum number of trees to be inspected below ground utilizing Table 3 based on number of trees that are satisfactory above ground. Record in column 10 of the inspection form. To avoid bias, dig trees nearest plot center first and progress outward. Do not dig any trees that were unsatisfactory in the aboveground inspection. Correctly replant sampled trees immediately. Use moist mineral soil to pack roots.

TABLE 3
Minimum number of trees to be dug

Based on number of trees satisfactory above ground.

Number of above ground satisfactorily planted trees on plot	Minimum number of trees to dig
1	1
2-6	2
7-9	3
10-12	4
13 plus	5

* Note this is the minimum; there is no maximum. The inspector may dig all satisfactory trees on plot.

(11) Inspect and record the below-ground condition of each planted tree in spaces under column 2 of inspection form using appropriate codes listed below. Record the number of trees meeting belowground specification in column 11.

√ - Satisfactory Tree Below Ground.

R - Root Configuration Violation. Root systems must not be twisted, jammed in one plane, or curved in the shape of the letters U, J, or L. Individual lateral roots may be slightly bent like the letters J or U but the primary vertical root system cannot be distorted. Container plug must not be jammed from the top (accordion effect) or the side (flattened).

To inspect for this violation, dig a rectangular shaped hole on one side of the tree. Start the hole far enough away from the tree stem (at least 10 inches) so that roots are not disturbed in the process of inserting the spade. This is best done with a tool like a tile spade. Once the primary hole is dug, probe toward the root system with a pointed instrument such as a screwdriver, ice pick, or similar tool to explore the seedling roots for orientation.

M - Foreign Material Violation. Holes must not contain large rocks, sticks, litter, cones, or other foreign debris. Inspect the same as that for root configuration. In hoe planting, if rocks, roots, and pieces of wood are present in soil prior to opening the hole, they are not considered foreign material to the hole.

F - Firmness Violation. Firmness, as determined from below ground, is done while probing the root system as described under root configuration. Soil should be nearly as firm as the undisturbed surrounding soil. There should be no air pockets where the

soil is not firm. Firmness may be a problem in the bottom of auger holes if planters have not firmed soil progressively upward.

L - Altered Root Length Violation. If the dug tree has an obviously shortened root system, consider it as an improperly planted tree below ground. The contract shall state a minimum root length; trees with substandard roots should not be planted and considered a violation if they are planted.

Fresh root cuts can often be distinguished from roots cut at the nursery or during tree preparation. Living inner tissue of roots cut in advance of planting should be brown at the cut. The brown color may extend up the root under the bark for a short distance. Freshly cut roots will be white under the bark unless roots are dead when cut. Root shortening violations can also be detected during inspection while work is in progress.

O - Planting Hole Orientation Violation. This violation is seldom observed in absence of aboveground stem angle or root configuration violations. Occasionally, trees with small root systems can be propped up following slit planting. Roots may not be distorted and angle looks okay from above ground, but hole is not properly opened. Examples would be a V-shaped hole or a hole not vertical with slope plane.

(12) After all plots have been taken and recorded for the pay item, calculate the planting quality by the following formula:

$$\text{Planting Quality Percent} = \frac{\text{No. of satisfactory planted trees above ground (column 9)}}{\text{Actual No. of plantable spots on which trees should have been planted (column 5)}} \times \frac{\text{No. of trees satisfactory below ground (column 11)}}{\text{No. of dug trees (column 10)}} \times 100$$

3. Relative Importance of Individual Inspection Items. Some inspection items are more critical to tree survival than others. Violations of some of these items will result in immediate mortality, while others affect survival and growth over time. The following provides an insight of the relative importance of inspection items for tree survival.

a. Critical violations with high risk of mortality.

(1) Cutting, stripping, or shortening root systems (this includes lateral roots) just prior to planting. This is especially lethal to pines.

(2) Planting species in the wrong location. The contract shall specify how units of mixed species are to be planted. If species are not planted as specified, this is a violation. For example, the contract should specify that cedar or spruce should not be planted on dry exposed portions of the slope.

(3) Improper handling of trees that result in drying of roots, or overheating of trees in general.

(4) Improper root orientation due to improper hole opening or root placement that results in U-, J-, or L-shaped roots.

(5) Failure to utilize microsites on harsh sites or where high animal damage is anticipated.

b. Important - violations that result in growth reduction and may cause mortality on severe sites.

(1) Poor tamping or foreign material in hole.

(2) Improper depth of tree.

(4) Poor scalp size and depth.

(5) Lack of clearing size and depth.

(6) Lack of shade.

As a general rule, it is critical to require shade in these conditions:

a. Planting sites on Douglas fir habitat types and drier in Montana, grand fir habitat types and drier in northern Idaho, most habitat types throughout Regions 2, 3, 4.

b. Planting sites on south- and west-facing slopes

c. Planting sites on steep slopes, generally over 30 percent, especially on a dry aspect

d. Shade the tree crown on Engelmann spruce sites above 9,500 feet in the central and southern Rocky Mountains for protection from solarization problems.

e. Other site factors such as soil moisture-holding capacity, plant competition, and elevation compound insolation problems. Without proper site preparation to reduce competing vegetation, shade will not be sufficient to assure survival.