United States Air Force Academy Revegetation and Erosion Control Standards

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Table of Contents

SECTION	01351: R	EVEGETATION AND EROSION CONTROL STANDARDS
1.0	Introdu	ction1
2.0	Site Pre	paration3
	2.1	General
	2.2	Existing Resource Protection
	2.3	Topsoil Salvage4
	2.4	Interim Erosion Control
	2.5	Soil Testing
	2.6	Soil Preparation
3.0	Reveget	tation Installation
	3.1	Seed Mix Analysis and Certification
	3.2	Time of Seeding10
	3.3	Seeding Installation
	3.4	Container, Ball and Burlap, Plugs, and Sod Mat Stock
	3.5	Salvaged Plantings and Reuse of On-Site Materials11
	3.6	Weed Control During Construction
4.0	Waterir	ng and Irrigation15
5.0	Erosion	Control
	5.1	General
	5.2	Erosion Control Materials
	5.3	Final Inspection and Seeding Success Criteria
6.0	Post-Co	nstruction Revegetation Establishment and Maintenance
	6.1	General
	6.2	Vegetation Establishment Warranty Period
	6.3	Container Stock and Salvaged Materials Warranty
	6.4	Weed Control

Appen	Appendix A: Revegetation and Erosion Control Design Standards							
A.1.0	Reveget	ation Plan Development Error! Bookmark not define	ed.					
	A.1.1	General	28					
	A.1.2	Revegetation Design Objectives	28					
	A.1.3	Revegetation Plan Design	30					
	A.1.4	Existing Plant Communities	32					
	A.1.5	Seeding Selection	33					
	A.1.6	Plant Selection	48					
	A.1.7	Irrigation	52					
Appen	dix B: Re	vegetation and Erosion Control Construction Checklist	53					
Appen	Appendix C: Revegetation and Erosion Control Post-Construction Maintenance Checklist							

SECTION 01351: REVEGETATION AND EROSION CONTROL STANDARDS

1.0 Introduction

Native revegetation and erosion control is required for any project that disturbs soil or vegetation within the United States Air Force Academy (USAFA), Farish Recreation Area, and Bullseye Auxiliary Airfield. Compliance with the USAFA Revegetation and Erosion Control Standards (Standards) is mandatory to promote natural resource objectives, meet project-related permit requirements, and to comply with the USAFA ENVIRONMENTAL STANDARDS and its component plans. Landscaped areas adjacent to buildings (or other common locations) that include ornamental plantings and are regularly manicured, etc. are not required to comply with these standards and are regulated by a separate process and document.

Information provided in these Standards does not relieve the Contractor or other personnel from responsibility to comply with all state, local, and federal environmental laws, regulations, and operating standards during performance of work on USAFA. The USAFA Environmental Standards should be referenced for a more comprehensive list of environmental laws, regulations, and operating standards above those pertinent to revegetation and erosion control plan development. These Standards are separate or are in addition to the requirements set forth in this document.

In general, if discrepancies between regulatory agency requirements are found, the most stringent requirement shall prevail. Compliance with these Standards does not affect obligations to comply with other applicable state and federal criteria and regulations.

These Standards identify the minimum requirements for design, construction, and maintenance of projects on USAFA, Farish Recreation Area, and Bullseye Auxiliary Airfield (USAFA Lands) and includes the following sections:

- **1.0** Introduction
- **2.0** Site Preparation
- **3.0** Revegetation Installation

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- **4.0** Watering and Irrigation
- 5.0 Erosion Control
- 6.0 Post-Construction Revegetation Establishment and Maintenance
- Appendix A Revegetation Design Standards
- **Appendix B** Revegetation and Erosion Control Construction Checklist
- Appendix C Revegetation and Erosion Control Post-Construction Maintenance Checklist

The Standards are intended to be used by designers, contractors, and inspectors (Standards Users) working on projects on USAFA lands. Depending on the type, size, and scope of the project, the Standards are enforced by one or more Government Representatives: the 10th Contracting Squadron (Contracting Officer), the 10th Civil Engineer Squadron (CES; Construction Inspector, Project Manager, or Permit Inspector), and/or the USAFA Natural Resources Office (Natural Resources Manager). **Standards Users shall consult with these offices for assistance in understanding and implementing these Standards**.

To fulfill Standard requirements, Standards Users shall coordinate and receive approval from the CES assigned during design or implementation phases of the project. During construction, the Standards User shall receive on-site approval from the CES but shall also coordinate with the NR-Manager as necessary. After construction is complete, the Standards User shall coordinate and receive approval from the CES for post-construction maintenance phase requirements. Any deviations from these Standards must be approved by the appropriate Government Representative identified above. Individual Government Representative roles that will fulfill these specifications will be determined on a project specific basis during permitting and design reviews and are generally identified as "Government Representatives" herein.

APPENDIX A contains guidance on **Revegetation and Erosion Control Design Standards** intended to provide ecologically based design approaches for large-scale projects on USAFA Lands. The guidance provided here is recommended for USAFA projects larger than one acre or is being conducted by outside consultants.

The **Revegetation and Erosion Control Standards Checklist** in **APPENDIX B** shall be used by the Standards User and the Government Representative(s) to document compliance with the Standards during and after construction.

The **Post-Construction Monitoring Checklist** in **APPENDIX C** shall be used by the Standards User and the Government Representative(s) to document compliance with the Standards during postconstruction erosion control and vegetation establishment. The checklist provided is intended to serve as an example and shall be modified by the Government Representative and Contractor to be project specific.

2.0 Site Preparation

2.1 General

For native revegetation, the beginning of site preparation and subsequent revegetation should be adequately scheduled based on seasonal considerations to the extent practicable. Correct timing of revegetation, especially if the site will be non-irrigated, is very important to establishment success.

Site preparation will include understanding existing soil conditions and the creation of suitable growing conditions for seeding or planting operations through site manipulations and modifications including, but not limited to, soil sampling, topsoil salvage or import, grading, seedbed preparation, and erosion control.

2.2 Existing Resource Protection

Impacts to existing natural resources such as trees, shrubs, wildlife habitat or nests, wetlands, waterbodies, and high-quality native vegetation communities shall be avoided and minimized to the best extent practicable during design and construction phases. Prior to construction, these natural resources shall be fenced off in a manner that prevents intentional or unintentional impacts during construction. Limits of disturbance shall be clearly marked by the Contractor and approved by the Government Representative(s) prior to commencement of construction.

Tree protection fencing shall be installed around trees to be protected prior to commencement of any demolition or construction activities. Fencing around protected trees shall be placed outside of the Critical Root Zone (CRZ) to prevent damage to the tree. The CRZ is defined as the dripline, further extent of the tree canopy, or is equal to one foot radially from the tree for every one inch (1") of trunk diameter at breast height, or whichever is greater. Any digging, grubbing, excavating, trenching, changing of grade, or other actions that may impact the roots of the tree are strictly prohibited. Additional tree trunk protection is required if construction occurs within ten feet (10') of trunk. No materials, debris, equipment, or site amenities shall be stored within the CRZ. Tree protection fencing shall be "orange plastic safety fencing", minimum 48-inches (48") tall, top secured to metal T-posts with 12-gauge wire woven through top of fencing for entire length. Heavy duty T-posts shall be placed so that wire and fencing are taut.

Biosecurity

Vehicles, equipment, and personal protective equipment, including tire tread and boot soles, shall be free of any organics or dirt prior to entering a project site. Noxious and non-natives weed species are detrimental to wildlife habitats by outcompeting native vegetation species which wildlife rely on, and which may further exacerbate wildfire risks. Furthermore, any item coming from another wetland project and not properly disinfected and dried may directly introduce disease pathogens afflicting rare and sensitive species.

To prevent the introduction and spread of noxious weeds and other non-native and invasive plants, all construction equipment shall be free of dirt, seed, and plant parts prior to entering the base and/or construction site. The construction site shall have construction track-out controls installed prior to construction equipment entering the site and shall remain until all construction tasks have been completed and the entire site has been stabilized.

2.3 Topsoil Salvage

The upper four to six inches (4-6") of native soil shall be salvaged for re-distribution over the restoration area. At the beginning of salvage activities, review the soil profile to understand the anticipated topsoil depth of salvage. The soil profile will include:

Topsoil – The top layer of soil which contains the highest concentration of organic matter (humus) and microorganisms and where plants have most of their roots. Topsoil depth varies greatly across regions and in Colorado the topsoil is generally found to be two inches (2") to twelve inches (12") deep. The topsoil layer is typically darker in color and less dense than subsoil.

Subsoil – The layer of soil immediately below the topsoil layer. It generally contains much lower percentages of organic matter and microorganisms. A smaller percentage of plant roots are found within this layer. Subsoil depth varies greatly across regions and in Colorado is generally found to be twelve inches (12") to six feet (6') deep.

Deep Cut Soil - the lowest layer of soils located below the subsoil layer. These soils are generally low in organic matter and deficient in plant nutrients to support vegetation establishment objectives. Avoid exposing or intermixing these soils with subsoil or topsoil during grading activities.

Well salvaged topsoil can significantly reduce soil amendment costs. All existing surface objects and protruding objects not designated to remain shall be cleared and grubbed prior to topsoil salvage. This includes but is not limited to, trees, brush, stumps, logs, grass, weeds, roots, loose boulders. Care should be taken to limit removal of viable topsoil resources during clearing and grubbing activities. Do not commence site clearing activities until temporary erosion- and sedimentation-control and tree and or plant protection measures are in place and approved by the Government Representative.

Topsoil stockpiles shall not have side slopes greater than 3:1 (horizontal:vertical), to reduce possible erosion, and shall be placed in areas indicated in the drawings or as approved by the Government Representative. Topsoil should be stockpiled as shallow as possible and shall not exceed ten feet (10') in height to allow oxygen exchange to preserve soil microorganisms. Topsoil stockpiles shall be seeded with the temporary seed mix in TABLE 12 or with the appropriate permanent native seed mix within 14 days of stockpiling. Erosion control best management practices (BMPs) shall be used around the downgradient perimeter of all stockpiles, including topsoil stockpiles. Similar to all areas impacted during construction, exposed topsoil stockpiles shall be maintained for weed intrusion through appropriate weed management practices.

Following rough grading, topsoil quality shall be retested to inform or potentially revise site specific amendments. Soil sampling of rough graded areas shall also occur to ensure appropriate soil quality extends into the top 12 inches (12") of the soil column. It is possible that soil recommendations differ between the subsoils and topsoil, but it is the responsibility of the Contractor to sample and amend the subsoils, if necessary, based on soil testing results, prior to the placement of topsoil. Failure to demonstrate sampling and application of recommended amendments prior to topsoil placement may result in the Contractor having to redo the work at the Contractor's expense.

If topsoil cannot be salvaged and stockpiled appropriately, soils can be amended based on appropriate soil sample results and scarified before the site is revegetated.

Wetland topsoil shall be salvaged and stockpiled separately. Stockpiled wetland topsoil shall only be used in areas where wetlands will be reestablished. Wetland topsoil should be salvaged and replaced in wetland establishment areas as soon as possible to avoid a loss in viability. Wetland topsoil stockpiles shall not exceed three feet (3') in height or width and shall not be kept for more than four weeks. Stockpiling wetland topsoil in the summer or during periods of high temperatures should be avoided when possible.

Topsoil containing dense noxious or invasive non-native weed seed banks shall not be salvaged for reuse. The top two to four inches (2-4") of topsoil in areas dominated by noxious or invasive non-native weeds shall be scraped and buried to limit establishment and spread of these species post-construction.

2.4 Interim Erosion Control

Interim erosion control BMPs, such as silt fence, wattles, check dams, shall be implemented prior to any earth moving activities and comply with all applicable standards as described in *Section 5.0 Erosion Control*. For projects greater than one (1) acre in size, interim erosion control BMPs shall comply with the USAFA Construction Storm Water Pollution Prevention Plan (SWPPP) or other applicable permits.

2.5 Soil Testing

Soil conditions can play a major role in the success of a project's revegetation efforts. Because of this, soil testing should be completed as early as possible during the design or construction phase to guide plant selection and to determine the appropriate soil amendment needs. Depending on the scale and techniques of earth movement, soil chemistry can also change throughout the construction period and additional soil testing shall be completed during construction to verify the type and quantity of soil amendments.

The Contractor, in coordination with the Government Representative(s) shall collect soil samples following the below protocol for the purpose of understanding soil quality for subsoil and topsoil resources.

Soil Sample Collection Protocol

- Minimum of three (3) composite samples for projects up to one (1) acre in size and one (1) additional composite sample for each additional acre of project size. More samples may be warranted based on soil complexity and heterogeneity. Samples shall be collected randomly throughout the areas to receive similar soil preparation for native seeding. Provide a site plan of the sampling locations to the Government Representative(s) for approval, prior to sampling.
- 2. Procedures and Depth of Samples: Collect composite samples to a depth of six inches (6") and combine them in a clean plastic container to create on soil sample. At least four grab samples, spaced at least 20 feet (20') apart, shall be used to create one composite sample.
- 3. Mixing of Samples: Mix grab samples together thoroughly, removing plant debris and breaking up clods.
- 4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

Topsoil sampling from stockpiles can be simplified, but the number of samples taken from the stockpile should still equal the number required based on the area of disturbance. Samples should still be collected as composite samples with samples collected from different parts of the stockpile.

Soil Testing Laboratories

Testing Agency: Retain an Agricultural Laboratory Testing Association accredited or universityoperated laboratory experienced in soil science, soil testing, and plant nutrition.

Subsoil Testing

Subsoil sampling should follow the same process described for topsoil sampling once rough grading is completed. It should be assumed that results will require 7-10 business days, so plan accordingly to avoid disruption to construction schedules.

Testing Requirements

Soil samples should be tested for the following parameters and shall be submitted as part of the Environmental Deliverables List for evaluation of the topsoil's compliance with the Standards:

- 1. Soil Texture: Soil-particle, size-distribution analysis by the following methods according to SSSA's "Methods of Soil Analysis Part 1 Physical and Mineralogical Methods":
 - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
 - b. Hydrometer Method: Report percentages of sand, silt, and clay.
- 2. Fertility Testing: Soil-fertility analysis shall include the following:
 - a. Percentage of organic matter.
 - b. Cation exchange capacity (CEC), calcium percent of CEC, and magnesium percent of CEC.
 - c. Soil reaction (acidity/alkalinity pH value).
 - d. Buffered acidity or alkalinity.
 - e. Lime Estimate.
 - f. Soil texture estimate.
 - g. Nitrogen ppm.
 - h. Phosphorous ppm.
 - i. Potassium ppm.
 - j. Manganese ppm.
 - k. Zinc ppm.
 - I. Iron ppm.
 - m. Boron ppm.
 - n. Copper ppm.
 - o. Sodium ppm.
 - p. Sodium absorption ratio (SAR).
 - q. Soluble-salts ppm.
 - r. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
 - s. Other deleterious materials, including their characteristics and content of each.

2.6 Soil Preparation

General

Proper seed bed preparation is one of the most important, and often most overlooked, steps to successful revegetation. Overly compacted soils can hinder revegetation success in upland, riparian, and wetland areas; however, soil that is too loose can lead to erosion or deeper seeding than anticipated and insufficient seed-soil contact.

Process

Scarify subsoil prior to placing topsoil to a depth of 12 inches (12") in two passes perpendicular to each other, using methods such as disking, ripping, plowing, or rototilling. Topsoil shall be placed on top of the scarified subsoil to a depth of 6 inches (6"). Following topsoil placement, soil amendments shall be added and incorporated into the top 6 inches (6") creating a total of 18 inches (18") of scarified soil. There are instances where premixing soil amendments with topsoil is easier and more effective than post-placement incorporation, but this should be determined on a project-by-project basis. After amendment incorporation, fine grading shall be completed to support a planting and seeding surface that promotes germination and plant establishment. The soil surface following proper seed bed preparation shall be rough to facilitate infiltration and microtopography for better seedling germination and establishment.

Topsoil quantities shall be verified by reviewing the area ground disturbance requiring revegetation after initial construction efforts. The disturbance area shall be calculated in acres by tape/wheel measurement or Global Positioning System (GPS) mapping performed by the Contractor and verified by the Government Representative(s). Topsoil quantities may be modified if additional disturbance is incurred passed the original area determined.

Imported topsoil shall be free of rocks, noxious and invasive weeds, large woody debris, or trash. Topsoil shall not be used from areas infested with noxious weeds.

For multi-year or multi-season projects, a new soil laboratory analysis for imported topsoil shall be conducted by the Contractor within one month (30 days) of the delivery date and approved by the Government Representative(s) for each phase of revegetation.

For shorter-term projects, if the required topsoil delivery shall take the Contractor more than one month (30 days) to deliver, the Government Representative shall be responsible for determining whether the topsoil source still conforms to the Standard, or if a new soil analysis at the Contractor's expense needs to be performed.

Soil Amendments

When considering soil amendment approaches, it is important to consider how to build up soil health and create functioning nutrient cycles in the soil. Soil is a complex ecosystem with microscopic organisms, fungi, and bacteria that influence soil and plant health. If these biotas are not cared for or considered when planning for revegetation actions, an opportunity to reduce long-term maintenance may be missed. Soil organisms need organic matter to complete their lifecycles, so soils shall have adequate amounts (2-4%) of organic matter prior to planting. This will help form a basis for proper nutrient cycling as well as help with infiltration rates, soil moisture capacity, and nutrient retention. Organic matter can be increased by the incorporation of weathered wood chips, humate, and or compost. It is important to understand the seed bank, soil texture, and nutrient quality of site soils before using compost as this product can cause a flush of nutrients that will benefit weedy species more than native species.

Manipulating soil chemistry using appropriate soil amendments can have long lasting positive benefits for revegetated areas. A multitude of soil amendment products can be used, and approaches can be taken to support revegetation establishment objectives. However, misapplied, or excess fertilization can have long lasting negative impacts.

Compost and fertilizers shall not be applied to areas within 50 horizontal feet (50') from waterbodies to avoid impacts to water quality.

Soil amendment quantities shall be verified by reviewing the area of ground disturbance requiring revegetation after initial construction efforts. The disturbance area shall be calculated in acres by tape/wheel measurement or GPS mapping performed by the Contractor and verified by the Government Representative(s). Soil amendment quantities may be modified if additional disturbance is incurred passed the original area determined. Soil amendments not listed in these Standards must be approved by the Government Representative(s) prior to application.

Fertilizer

Fertilizers, which can be inorganic or organic, are used to increase the nutrient content of soils. All fertilizers shall be a standard commercial product of uniform composition and shall conform to applicable local, state, and federal laws. Fertilizers shall be used for soils with adequate organic matter (2-4%) but inadequate macro- or micronutrient levels based on the soil testing analysis.

Compost

Compost is used to increase organic matter and nutrient content of soils. Compost shall be stable, well decomposed, and free of viable noxious or invasive weed seeds. Compost shall not contain more than one percent non-decomposable material. Compost shall be tested by a STA Compost-Certified Laboratory and test results shall represent the compost source to be used onsite. Compost test results shall be provided to the Government Representative(s) and approved prior to procurement. Compost shall have the following characteristics:

- pH Range: 5.5 8.0
- Moisture Content: 35 55%
- Particle Size: 1-inch (1") or smaller
- Stability: Stable Highly Stable
- Maturity: >80% Seedling Vigor
- Soluble Salts: 2.5 mmhos/cm or less
- Organic Matter: 30 70%

Humate

Humate is used to add cation exchange capacity to the soil, improve water retention, encourage seed germination, increase nutrient availability, and stimulate root growth. Humate soil conditioners shall have the following characteristics:

- pH Range: 3 5
- Humic Acids: >50%
- Organic Matter: >85%
- Nitrogen: 1 3%
- Phosphorus (P₂O₅): <0.1%
- Potassium (K₂₀): <0.1%
- Mountain peat, aspen humus, gypsum, and sand will not be accepted.

Imported Topsoil

Imported topsoil is another option to create suitable growth media for planting. However, cost and availability may limit its use for a project. In addition, to meet revegetation establishment objectives, imported topsoil is not always the best or appropriate approach. Imported topsoil can introduce viable noxious or invasive weed seeds or have a different soil texture than site soils, leading to a misalignment of seed mix and soils. Imported topsoil shall be tested by a state-certified laboratory and test results shall represent the imported topsoil source to be used onsite. Imported topsoil test results shall be provided to the Government Representative(s) and approved prior to procurement. Imported topsoil shall have the following characteristics:

- pH Range: 6.0 8.0
- Soil Texture:
 - Sand: thirty percent (30%) fifty percent (50%)
 - \circ Silt: thirty percent (30%) fifty percent (50%)
 - \circ Clay: five percent (5%) thirty percent (30%)
- Particle Size: 1-inch (1") or smaller
- Cation Exchange Capacity: 10-30 MEQ/100G
- Soluble Salts: 1.0 mmhos/cm or less
- Organic Matter: 2 4%
- Nitrogen: < 15 ppm
- Phosphorus: if pH is <= to 7.1 (20-40 ppm); if pH is > 7.1 (10-25 ppm)
- Potassium: 150-250 ppm

3.0 Revegetation Installation

3.1 Seed Mix Analysis and Certification

All seed shall be tested and certified for purity and germination in accordance with testing provisions of the Association of Official Seed Analysts (AOSA) within one year of the planting date. All seed mixes shall be free of noxious weeds and seed lot certifications and analyses shall be submitted to the Government Representative(s) prior to seed purchase or installation. Seed lot analyses shall identify date of analysis, seed lot number, purity analysis, and number of native, non-native, or noxious weed seeds found during the analysis. Seed lots may be rejected for testing date, noxious or invasive non-native weeds, or inadequate purity or germination. Seed mixes shall be mixed uniformly by a wholesale seed provider to achieve specified Pure Live Seed (PLS) rates.

3.2 Time of Seeding

Fall should always be the target seeding window so seeds are in the ground before spring to allow germination when conditions are optimal; however, this practice may be difficult when faced with construction schedule changes and delays. On irrigated sites, seeding can take place for most of the year; however, seeding in September and the first half of October before irrigation systems are shut off for the winter presents the risk of a frost event killing recently germinated seeds, further hindering revegetation. For this reason, caution should be used when seeding irrigated sites in September and early October. Fall through spring (October 15 to April 15) is the preferred window for non-irrigated seeding. Areas seeded in fall benefit from winter and spring moisture and many cool season native species require freeze-thaw cycles to break seed dormancy to germinate. Sites shall not be seeded if they are frozen, snow covered, or muddy.

When seeding must occur outside of the preferred seeding window, the site shall be seeded with the standard Temporary Seed Mix and reseeded during the preferred seeding window. For areas that require erosion control blanket but need to be seeded outside the preferred seeding window, these areas shall be seeded with the appropriate standard seed mix or an approved modified standard seed mix at one and a half times the suggested rate. **TABLE 13** outlines preferred seeding windows must be approved by the Government Representative(s).

Conditions	Mixoo		Seeding Window											
Conditions	wixes	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Se	р	Oct	Nov	Dec
Irrigated Areas	All													
Non-Irrigated Areas	All													
Outside of Non-Irrigated	Temporary													
Seeding Window	Mix Only													

Table 13: Seeding Windows

Note: Green fill indicates the preferred seeding window for each condition, yellow indicates riskier seeding window depending on irrigated versus non-irrigated, and red fill indicates times of the year when no permanent seeding should occur due to increased risk of revegetation failure.

3.3 Seeding Installation

Drill seeding is the preferred seeding method and shall be used to seed areas greater than 0.10 acre with slopes 3:1 or less that lack steep or rocky terrain. Seeds shall be installed at a depth of one quarter to one half inch $(\frac{1}{4} - \frac{1}{2^n})$ with drill row spacing of seven to ten inches (7-10") apart and shall be drilled in two directions, perpendicular to one another with the final pass following the land contour. If drill seeding in multiple directions is not possible, the Contractor shall alert the

Government Representative(s) and develop a drill seeding plan that will ensure even distribution of seed. The drill shall have double-disk furrow openers with depth bands and packer wheels.

When seeding areas smaller than 0.10 acre, or areas with greater than 3:1 slopes or having rocky terrain, mechanical broadcasting using mechanized rotary, cyclone seeders, or hand broadcasting shall be used and the standard PLS seeding rate shall be doubled.

Disturbed areas shall be raked or harrowed prior to seeding and then raked or harrowed again to encourage seed to soil contact. Raking or harrowing shall be performed in a manner to achieve a seeding depth between one-quarter and one-half inch $(\frac{1}{4} - \frac{1}{2})$.

Shrub overseed mixes shall be installed in areas designated on design plans and installed at the same time as grass and forb seeding, and prior to final raking or harrowing. Mechanical broadcasting shall be used to install shrub seed and the area shall be raked or harrowed again following seed installation.

All seed mixes shall be installed with a minimum overlap of two feet (2') with the adjacent seeding zone.

3.4 Container, Ball and Burlap, Plugs, and Sod Mat Stock

Container stock including ball and burlap, plugs, and sod mats should be sourced from a local nursery. Several nurseries may need to be sourced from depending on seasonal availability of different plant species. The Contractor should coordinate closely with the Government Representative(s) to determine a suitable substitute if the proposed species or container size is unavailable.

Plant stock should be inspected by the Revegetation Contractor at the nursery prior to transferring onto the site. The stock should be free of diseases and the roots should not be growing out through the bottom or at the periphery of the container. Plants that are not as well-proportioned but still portray high vigor are suitable for native revegetation areas.

When plant stock is brought onto the site, the plant stock shall be watered and kept properly sheltered from the sun, wind, or storm events until the planting is properly installed. Container stock shall not be stockpiled for longer than 2 weeks.

Plants shall be placed in a hole dug two times the size of the root ball (see **FIGURE 3**). Typically, add a minimum of three inches (3") of mulch to support water retainage, including for native revegetation areas. The mulch shall be placed to be kept away from the root flare and kept in place with a mulch ring landform. Remove any injured or dead branches.

3.5 Salvaged Plantings and Reuse of On-Site Materials

General

Salvaged plantings should be included in the project during the revegetation design phase. However, early construction activities such as initial laydown, staking, site assessment, laydown planning and clearing and grubbing can provide more data on the onsite materials available.

Careful consideration should be given to ensure the structural integrity of materials salvaged for reuse, but reusing site materials saves project costs and help achieve sustainability goals.

The following sections highlight commonly available onsite plant materials that can be used as part of the revegetation process and how they can be salvaged and reused.

Live Willow Stake Salvage and Installation

Prior to planting, the NR-Manager shall identify and approve any on-site locations for the harvesting of plant materials. All willow stakes shall be disease and insect free. Off-site plant materials shall only be used with prior approval from the NR-Manager.

Willow stakes shall be harvested and planted in late-winter to early-spring during dormancy and before dormancy is broken. "Bud break" can be identified by swelling lateral and terminal buds. Planting shall only be conducted when the weather and soil conditions are appropriate. Stakes shall not be planted when the ground is frozen or otherwise unsuitable.

Live stakes shall typically be coyote willow (*Salix exigua*) cuttings that are one-half inch (1/2") to one inch (1") in diameter. Other native willow species can be utilized if found prevalent throughout the project site and as approved by the NR-Manager. The length shall be determined by the project specific needs for the live stake to be planted with access to ground water but are typically between three feet (3') to six feet (6') in length. Stakes shall be harvested with sharp

Figure 4: Live Willow Salvage



REVEGETATION AND EROSION CONTROL STANDARDS September 2024

pruning shears with the base cut at a forty-five-degree (45°) angle and all side branches removed.

Harvested willow stakes shall be soaked prior to installation. Approximately 50-80 percent of the length of the cuttings shall be submerged in water for a minimum of 36 hours but no longer than 14 days. If willow harvesting happens during clearing and grubbing activities, the willow stakes shall be kept in cold storage until the site is ready for planting. Conditions for cold storage should be dark with near 100% relative humidity and temperatures near 24^o F. The goal of cold storage is to prevent water loss and fungal infection in the cuttings.

Stakes shall be kept moist, cool, shaded, and protected from wind until installed. During transport or storage, the stakes shall be covered to protect them from heat, light and wind damage.

A planting hole shall be excavated to the groundwater using a hammer drill and a one-inch (1") drill bit, rebar probe, dibble bar, or other approved method. Damage to any erosion blanket shall be avoided to the maximum extent possible and any erosion control blanket damage shall be repaired by the Contractor. Stakes shall be gently placed in the hole, ensuring that the butt end reaches below the groundwater level. Each hole shall be backfilled, hand-tamped, and/or watered to eliminate air pockets around the stake. Stakes shall be cut-off at 18-24" from the ground surface with at least two lateral buds remaining above- ground (FIGURE 4).

Live Cottonwood Pole Salvage and Installation

Prior to planting, the NR-Manger shall identify and approve any on-site and/or off-site locations for the harvesting of plant materials. All cottonwood poles shall be disease and insect free. Off-site plant materials shall only be used with prior approval from the NR-Manager.

Cottonwood poles shall be harvested and planted in **late-winter to early-spring** during dormancy and before dormancy is broken. "Bud break" can be identified by swelling lateral and terminal buds. Planting shall only be conducted when the weather and soil conditions are appropriate. Stakes shall not be planted when the ground is frozen or otherwise unsuitable.

Cottonwood poles shall be plains cottonwood (*Populus deltoides*) or narrow-leaf cottonwood (*Populus angustifolia*) cuttings that are approximately one inch (1") in diameter. A different native cottonwood species can be utilized if found prevalent throughout the project site and as approved by the NR-Manager. The length shall be determined by the project specific needs for the live stake to be planted with access to ground water but are at least ten feet (10') in length. Poles shall be harvested with sharp pruning shears with the base cut at a forty-five-degree (45°) angle and all side branches removed.

Harvested poles shall be soaked prior to installation. The bottom end of the cuttings shall be submerged in water for a minimum of 24 hours but no longer than seven days. Only the portion of the pole where root development is encouraged shall be soaked.

Poles shall be kept moist, cool, shaded, and protected from wind until installed. During transport or storage, the poles shall be covered to protect them from heat, light and wind damage.

A planting hole shall be excavated to the groundwater using an auger or other approved method. Damage to any erosion blanket shall be avoided to the maximum extent possible and any erosion control blanket damage shall be repaired by the Contractor. Poles shall be gently placed in the hole, ensuring that the butt end reaches below the groundwater level. Each hole shall be backfilled, hand-tamped, and/or watered to eliminate air pockets around the pole.

Wire cages constructed of two inch by four inch (2"x4") wire mesh with a 30-inch (30") diameter shall be constructed around each cottonwood pole and anchored by t-posts or rebar to the ground to prevent beaver damage.

Weed Control During Construction 3.6

Weed control is required during construction. While construction activities are still on-going, maintaining weeds over the entire site, including on topsoil stockpiles, will reduce weed density once topsoil is replaced and revegetation commences. (Reference Integrated Weed Management Plan). Construction should anticipate the need to control weeds prior to seed production through mechanical or chemical means. Weeds shall be controlled prior to seed production. Construction teams shall have a licensed herbicide applicator available for weed control efforts. No broadscale chemical or physical weed management, such as spraying or mowing, is allowed unless approved by the Government Representative.

Figure 5: Willow and Cottonwood Pole Install

Notes:

Areas where the water table fluctuates more than 3 ft during the growsing seasoncare problematic for willow stake survival.

Willows should be installed after the spring thaw but before buds begin to break. Stakes should be installed at least 2 feet deep to avoid being pushed out during freeze-thaw events. ÷ L 1.

Rebar, a pick mattock, or other appropriate tools may be necessary to prepare pilot holes for willow stakes or cottonwood poles to go into the ground. Mechanical augers can be used for deep holes or hard soils.

If willow stake tops get damaged during install, cut them horizontally to remove the damaged portion without greatly reducing the amount that remains above ground.

Cottonwood poles should not be placed in areas with extremely shallow ground water directly adjacent to streasm/rivers.



Salvaged

4.0 Watering and Irrigation

Temporary irrigation or watering during the establishment period shall be required for any projects that propose container stock beyond the use of willow cuttings and cottonwood poles. A Supplemental Irrigation Plan will be required for sites that do not provide an Irrigation Plan in the Construction Document set. Supplemental irrigation is not required for sites that only contain seed and salvaged material plantings if the seeding is accomplished during the required fall and spring planting periods. The Government Representative(s) may require a Supplemental Irrigation Plan if seeding does not occur in the required planting periods.

The Contractor is to verify actual available water pressure before beginning irrigation system installation. Contractor shall notify the Government Representative(s) if available water pressure exceeds 5 PSI higher or lower than the design water pressure. Irrigation systems connected to potable water supply shall have a backflow preventer installed per local requirements.

All visible temporary irrigation components must be removed by the Revegetation Warranty Contractor within 30 days after the system is no longer necessary.

Irrigation watering should not occur during the day between the hours of 10:00 am and 6:00 pm, when water loss from sun and wind will be greatest.

5.0 Erosion Control

5.1 General

An erosion and sediment control plan shall be developed and shall conform with local and state erosion control standards and requirements.

All disturbed areas shall be stabilized in conformance with any USAFA Storm Water Management Plan (SWMP) requirements or BMPs which supplement this manual. This includes temporary and final erosion control.

The type of erosion control selected shall be site specific and consider factors such as proximity to a water body, storm flow paths, slopes, soil nutrient profile and texture, tolerance of shear stress, and frequency and intensity of inundation. Erosion control measures for all disturbed areas shall be installed prior to grading or disturbances have begun.

For designed projects, the erosion control materials will be identified and approved during the design development stage. For all other projects and for any deviations from the approved design plans, the Contractor shall use this document to determine acceptable erosion control materials or equivalent products to implement effective control measures. The CES may require submittal of the anticipated erosion control materials for approval.

Contractors shall minimize creating new roads and trails adjacent to the project area. Any new trails, roads, parking areas, or staging areas shall be rehabilitated as part of the project.

Formal inspection by the Construction Inspector of all erosion control measures shall occur every two (2) weeks and immediately following storm events to ensure no damage has occurred and a plan to replace damaged materials can be developed.

5.2 Erosion Control Materials

All erosion control materials shall be installed in accordance with the manufacturer's instructions and recommendations, unless otherwise specified by the Government Representative.

Erosion control blankets, straw wattles, and other manufactured materials shall be 100% biodegradable, net-free, and consist of wood fiber (excelsior) or coconut fiber materials with at least a two-year functional longevity (Western Excelsior Excel S-1 All Natural, Excel R-2 All Natural, Excel S-2 All Natural, Excel CC-4 All Natural, or equivalent). Photodegradable mesh and other synthetic materials are not allowed as they are known to have deleterious effects on water quality and wildlife. Silt fence is the exception, as that product is to be removed from the site following site stabilization.

All erosion control material shall be certified weed-free to limit the introduction of undesirable species to a site and ultimately reduce competition for desirable native plants.

Manufactured biodegradable stakes or wooden stakes shall be used to anchor all erosion materials. See **FIGURE 6** for sizing information. Do not use metal stakes to secure blankets.

Erosion control blankets, straw coir logs, and/or soil berms shall be used whenever reclaiming and stabilizing slopes greater than 4:1, or along drainageways. The type of erosion control blanket (netless, single-net, double-net, etc.) shall depend on the slope. Netless rolled erosion control blankets shall be used on slopes of 4:1 or less, single-net erosion control blankets and open weave textiles shall be used on 3:1 slopes, and double-net erosion control blankets shall be used on 2:1 slopes.

Hydromulch may be used for temporary stabilization and erosion control on slopes of 4:1 or less but shall not be used in areas that may experience sheet flow or concentrated flow.

For erosion control and revegetation on slopes greater than 3:1, commercially available soil binder / tackifiers and fiber matrixes applied via hydraulic application may offer the greatest feasibility. Flexible Growth Medium (FGM) and Bonded Fiber Matrix (BFM) provide more durability and prolonged stabilization compared to hydromulch or cellulose and can be applied with similar equipment. Additionally, in areas away from concentrated flows FGM and BFM allow easier adaptive management actions to be employed. Products shall be applied at the manufacturer's specified rate and approach for the corresponding slope gradient and condition. All spray on products must be applied from at least two angles to ensure proper and complete coverage. Spray on products are not allowed in areas where concentrated flows are expected. This is typically below the elevation of the 10-year storm event.

The following table provides an overview of site conditions and erosion control approaches appropriate for meeting site conditions.

Erosion Control	
Hydromulch	Slopes of 4:1 or less and outside of areas subject to concentrated flows.
Erosion Control Blanket	Slopes of 4:1 or greater, within low-flow channels, and/or areas immediately adjacent to the channel.
Soil Binder/Tackifiers and Fiber Matrixes	Slopes of 3:1 or greater.

Table 14: Suitable Erosion Control Materials based on Site Conditions

Erosion Control Blanket

Erosion control blankets (ECB), including coir, jute, and coconut-type blankets, are best reserved for use within low-flow channels and areas immediately adjacent to the channel such as within the 2- to 5-year flood zone, and slopes of 4:1 or greater. The type of blanket to be used shall be site specific and based on slope conditions, soil types, allowable maximum shear stress, and the maximum velocity during storm events. Refer to the blanket manufacturer's standards and specifications for velocity and shear stress thresholds. Coconut blanket is typically required, but straw-only or coconut-straw mixture blankets can be allowed for certain projects depending on time frame needs for blanket to remain and as determined by the NR-Manager.

Erosion control blankets shall be installed over uniform surfaces without any large rocks, vegetation, dirt clods, or rills. Blanket edges shall overlap a minimum of eight inches (8") with the edges folded over. All blanket areas shall have a 12-inch (12") deep perimeter anchor trench for securing the ends of the ECB unless otherwise specified by the product manufacturer. The staking/securing pattern shall be 18 inches (18") on-center (O.C.) along all seams and 18 inches (18") O.C. across the center of the fabric. Steep slopes shall have the staking pattern decreased to 12 inches (12") O.C. Anchor slots at structures or blanket termination shall bury a fold of fabric into a six-inch (6") trench, tamp firmly, and be secured with stakes 12 inches (12") O.C. parallel to the trench. There shall be no gaps, tenting, or folds in the fabric when complete. If there are any imperfections as described, the fabric shall be repaired immediately.

Figure 6: Erosion Control Blanket on Slope Installation



Figure 7: Erosion Control Blanket at Channel Installation







Figure 9: Erosion Control Blanket Staking Patterns



Staple Pattern for Slopes

Staple Pattern for along the Channel



High-Medium Flow Channels & Shorelines

Figure 10: Erosion Control Blanket Anchor Trenches and Intermittent Check Slots



Blankets should not be used on sites with over 30% rock coverage (of rocks greater than 4 inches [4"] in diameter) because the blanket will not make solid contact with the soil below. On steep slopes (greater than 3:1), additional trenching shall be made every 15 feet (15'). Staking for check slots shall be applied every 12 inches (12") along the trench to hold the fabric in place. In areas with loose soil or rocky subgrades, alternative anchoring methods can be used with prior approval from the engineer.

Any ECB that is damaged or pulled out shall be repaired or reinstalled immediately. If the soil under the placed fabric erodes and creates rills or tenting, voids shall be refilled with soil, reseeded and the fabric shall be replaced. Any broken or damaged staking must be repaired as soon as possible after being identified.

Erosion Control Mat

Erosion control mats are typically more expensive compared to standard erosion control blankets but should be used in situations where long-term slope erosion protection is needed in areas with high shear forces and flow rates. Mats are used most effectively in areas where water flows are expected to consistently exceed the soil's maximum permissible velocities, such as channel edges. As with blankets, the type of erosion control mat used shall be selected based on site-specific characteristics related to expected design velocity, shear stress, and slope. Refer to the mat manufacturer's standards and specifications for velocity and shear stress thresholds.

Any erosion control mat that is damaged or pulled out shall be repaired or reinstalled immediately. Avoid vehicle traffic over the mat as much as possible, especially in wet conditions or in areas of loose soil. If the soil under the placed mat erodes and creates rills or tenting, voids shall be refilled with soil, reseeded and the mat shall be replaced. Any broken or damaged staking must be repaired as soon as it has been identified.

Straw Wattles

Straw wattles, or erosion control logs, are cylindrical bundles of excelsior, straw, coconut fibers, woodchips, or compost that are anchored to the ground with wooden stakes to capture sediment and allow surface runoff to flow across stabilized areas. They are most applicable to reduce flow velocities and capture sediments moving across the site from disturbed soils. They can be utilized to prevent concentrated flows on long slopes and capture sediment and debris before water enters adjacent stormwater inlets. Straw wattles are not intended for use in ditches with continuous flows or below any high-water mark in or near bodies of water. Without proper anchoring, straw wattles may become dislodged and clog stormwater inlets or move away from the site.

The type of straw wattle or erosion control log will depend on the anticipated application on the site of the flow line intended to intercept the wattle. Wattles shall be placed perpendicular to the anticipated concentrated flow and parallel to the contour of the slope. Wattles shall be trenched into the ground at least 2 to 3 inches (2-3") to prevent runoff and sediment from flowing underneath. Wooden stakes shall be used to anchor the wattle and shall be anchored at least 12 inches (12") into the ground. When placing wattles or erosion control logs at the toe of a slope, place them five to ten feet (5-10') from the toe of slope to provide storage capacity and maintenance access. When placed at the base of a slope, flare the ends of the log upslope to capture sediment that may flow around the long in higher flow events.

Wattles and erosion control logs shall be inspected regularly to ensure sediment is not moving around or underneath. If the log splits or rips, it shall be replaced immediately. If sediment accumulates behind the log the sediment shall be removed if it reaches up to half the height of the log. If the log sags or slumps, additional wooden stakes can be used. If the wooden stakes are damaged or missing, they shall be replaced immediately.

Figure 11: Straw Wattles Installation



Silt Fencing

Silt fencing is a temporary sediment control barrier made from a woven geotextile fabric that is used to contain sediment from runoff before surface water leaves the site. It is most applicable for use along the perimeter of construction sites including staging areas and access roads, around stockpiles, and at the toe of exposed and erodible slopes. Silt fencing is not appropriate for use in areas with concentrated water flows, mid-slop protection on slopes steeper than 4H:1V, or for use as means to divert water flows.

Silt fencing shall consist of a woven geotextile fabric, secure to wooden posts spaced a maximum distance of eight feet (8') apart and buried 12 inches (12") into a six inch by four inch (6"x4") trench below the fence to capture sediment. When placing silt fence below an exposed slope, it should be installed at least five feet (5') from the toe of slope to allow maintenance access between the slope and silt fence. The maximum linear distance of installed silt fencing shall not exceed 500 linear feet (500') and the disturbed slope length shall not exceed 150 feet (150') per 100 linear feet (100') of fence installed.

The fence shall be inspected regularly to identify any areas that may need repair from ripping, slumping, or undercuts from high flows. Fencing shall be inspected prior to storm events to ensure the fence is ready to capture any moving sediment and directly after any storm event to ensure no repairs are needed. Damaged fencing shall be replaced or repaired immediately upon discovery. Silt fencing has a general lifespan of 5 to 8 months, therefore, projects with timelines exceeding this may need to replace all or a portion of the fence during construction activities.

Upon completion of construction activities, the silt fencing shall be removed from the site and the area returned to pre-construction condition. This may include filling and compacting post holes, removing sediment accumulation, and ensuring the disturbed area blends into the surrounding landscape.

Figure 12: Silt Fence Installation





- Silt fence must be placed on a flat surface 2'-5' away from the toe of the slope to allow for ponding and deposition
- Compact the trench using a jumping jack or wheel rolling to the point that the fence resists being pulled out of the ground by hand.
- Silt fence shall be taut with no sags after it has been anchored.
 Fabric shall be attached to the posts with 1" heavy duty staples or nails placed 3" apart down

Hydraulically Applied Mulch

Hydraulically Applied Mulch (hydromulch) can be used for interim and permanent stabilization on areas with lower slopes compared to blanket and mat. Hydraulic seeding or mixing seed with hydromulch is not an approved construction method. An approved hydromulch product may be used on slopes of 4:1 or less and outside of areas subject to concentrated water flows with approval by the Government Representative(s). Hydromulch should not be applied on saturated soils, areas with seeps, or seasonal springs. Hydromulch should be applied per the manufacturer's recommendations, including the use of tackifier. Water should be applied in the field to meet the manufacturer's recommendations. When feasible, hydromulch shall be applied at multiple angles to ensure full coverage of the exposed soil surface. Re-apply hydromulch as needed to repair failed areas throughout the construction period due to construction traffic or large storm events.

Mulching

the post.

Mulching can be used for interim and permanent stabilization on areas with lower slopes compared to ECB and coir mat. Mulching assists seed germination by conserving moisture and protecting seeds from erosion. Straw mulch shall be applied per the manufacturer's recommendations, including the use of tackifier. Tackifier shall be applied either simultaneously or immediately after mulching and crimping to provide uniform coverage. Only certified weed-free mulch may be used.

Straw mulch must be one hundred percent (100%) certified weed free. The minimum stem length for straw mulch shall be six inches (6") with at least half of the material being ten inches (10") or longer, the use of fine materials is not allowed. Straw mulch shall be applied evenly at 2,000 pounds per acre and crimped to a minimum depth of two inches (2") following the contours of the slope or perpendicular to the prevailing wind directions on flat areas. On slopes up to 4:1, a

mulching rate of 2,500 pounds/acre shall be used. Straw mulching shall not be used within streams, drainage channels, walls, sidewalks, pathways, or over existing vegetation.

Fencing and Barriers

Fencing and barriers aid in reducing runoff, erosion vulnerability, and protect existing landscapes and trees in place during construction activities. Temporary fencing or other barriers shall be installed around any identified areas for protection, defined by the Government Representative(s) or regulatory agency, to exclude pedestrian and vehicle access. All fencing and barriers shall be maintained in good condition and any barriers that are damaged or broken shall be repaired or replaced immediately. Areas of protection must be clearly marked with high visibility tape prior to the start of construction activities. Markings must be distinctly different from those used to mark trees or vegetation for removal. Government Representative shall coordinate with the Contractor to ensure markings are clearly understood prior to any demolition or construction activities.

Once final stabilization of disturbed areas directly adjacent to protection areas is complete, protection fencing, barriers, and markings can be removed and reused or disposed.

5.3 Final Inspection and Seeding Success Criteria

A punch list site visit shall be conducted with the Government Representative(s) following completion of revegetation work to document items that need to be addressed by the Revegetation Contractor according to design plans and construction specifications. Substantial completion shall be awarded when all punch list items have been completed and approved by the Government Representative.

Revegetation success criteria shall be based on applicable permits and/or pre-existing site conditions; however, the following success criteria shall be met for all projects after two full growing seasons:

- For drill seeded areas, continuous planting rows shall be visually apparent by the end of the first full growing season.
- Seeded areas shall contain a minimum of eight seedlings per square foot by the end of the first full growing season.
- Seeded areas shall not contain bare areas greater than 100 square feet.
- Species designated as List A noxious weeds by the Colorado Department of Agriculture shall not be present within the project area.
- Species designated as List B noxious weeds by the Colorado Department of Agriculture shall not exceed five percent of total cover.
- Species designated as noxious weeds by the Colorado Department of Agriculture, including List C and Watch List species, shall not exceed 10 percent of total cover.
- Native vegetation species shall make up a minimum of 50 percent of the total cover present within seeded areas.
- Non-native weeds shall be controlled to the maximum extent practicable using mechanical or chemical treatments to prevent competition with native species.
- No areas of erosion that impact site stability or integrity, vegetation establishment, or water quality shall be present within the project area.

- Planted woody material or herbaceous plugs shall have a minimum survival rate of 80 percent.
- Seeded areas shall support at least 70% aerial plant cover in comparison to the preconstruction site cover or adjacent undisturbed area.

Table 15. Minimum Establishment Standards for Final Acceptance

Percent Vegetation Cover	Percent Native Vegetation Cover	Maximum List A Noxious Weed Cover	Maximum List B Noxious Weed Cover	Maximum Noxious Weed Cover (including List C and Watch List Species)	Maximum Size Bare Ground Patch
70% of baseline	50%	0%	5%	10%	100 SF

A list of final success criteria required by these Standards and all applicable permits shall be developed by the Contractor or Revegetation Plan Developer and sent to the Construction Inspector, Permits Inspector, and NR-Manager for approval prior to substantial completion.

6.0 **Post-Construction Revegetation Establishment and Maintenance**

6.1 General

The vegetation establishment warranty period shall include vegetation monitoring, vegetation maintenance, and adaptive management following construction to achieve success criteria and promote site stabilization and resilience.

For all projects, the Vegetation Warranty Contractor shall be responsible for vegetation monitoring, vegetation maintenance including container stock watering, and adaptive management for a twoyear warranty/maintenance period or until success criteria are met to close out applicable permits. The Vegetation Warranty Contractor shall use individuals knowledgeable of native Colorado plant species.

The requirement for the vegetation warranty period may be waived if there is agreement from the Government Representative that a vegetation warranty is not needed.

6.2 Vegetation Establishment Warranty Period

Vegetation warranty requirements should be conducted by a landscape contractor knowledgeable of native Colorado plant species or in tandem with a qualified ecologist. The vegetation establishment warranty period shall begin following substantial completion or as determined by the Government Representative.

Monitoring is required for all projects on a monthly basis for the first year and quarterly basis (three total site visits, one to occur each quarter), at minimum, during the growing season (April to October) for the following year to document vegetation establishment. Monitoring should include documentation of native, non-native, and noxious species, vegetation cover including areas experiencing erosion or areas of bare ground that may be susceptible to erosion, and survival of planted woody vegetation and herbaceous plugs. Photos should be taken at fixed-photo monitoring points throughout the site to document revegetation progress over time.

Adaptive management and vegetation maintenance shall be performed based on monitoring observations and can include, but is not limited to, weed control, reseeding or interseeding, woody plant replacement, erosion control and repairs, soil amendment application, and biomass reduction. Weed control efforts shall be performed at appropriate times in the year based on species observed. Weed control technique selection varies depending on target species and time of year and shall be determined by a qualified ecologist or weed control contractor knowledgeable of native Colorado plant species in coordination with the NR-Manager.

Revegetation success criteria will depend on permits applicable to each project and vegetation data collected during the initial site assessment. Vegetation management includes, but is not limited to, weed control, container stock watering and replacement, live willow and cottonwood pole replacement, herbaceous plug replacement, erosion control and repairs, and reseeding or interseeding. If a partial or total seeding failure is apparent, poorly vegetated areas shall be reseeded in the same manner described above or as specified in design documents. Areas that erode before plant establishment can occur shall be repaired and immediately reseeded during the same growing season. A defined schedule for monitoring and vegetation management shall be prepared by the Contractor and approved by the Government Representative(s) to follow the POST CONSTRUCTION MAINTENANCE CHECKLIST identified in APPENDIX B.

The Contractor shall prepare a monitoring report at the end of each growing season during the vegetation establishment warranty period documenting monitoring observations and adaptive management efforts during the growing season. The report shall include an evaluation of progress in meeting required success criteria and a plan for the following growing season to meet success criteria that have not been met at the time of reporting.

6.3 Container Stock and Salvaged Materials Warranty

All installed container stock and salvaged materials shall be warrantied for a minimum of one year. After the one-year warranty, the material is still expected to be watered for the entire Vegetation Establishment Warranty Period (two-years). If no irrigation system has been installed, the Contractor is responsible for watering the container stock appropriately, depending on climatic conditions of the year, to receive the minimum rainfall requirement for the species needed for establishment.

After the one-year warranty period, any container stock not showing signs of establishment (e.g. dead or stressed plants) must be replaced at the Contractor's expense. If salvaged materials were improperly installed or did not succeed in budding after the one-year warranty period, a minimum of 80% of the dead or stressed material is to be replaced at the Contractor's expense.

6.4 Weed Control

The seasonal timing of weed control implementation is a critical component to support revegetation establishment objectives. Best weed control practices should be followed to identify when it is appropriate to control weeds by mechanical and/or chemical means.

Mechanical

Properly timed mechanical weed control can be very effective at controlling annual and biennial weeds. Mechanical weed control can include mowing, hand-pulling, weed whacking, and mulching. Selective mechanical control should be employed to reduce cover by non-native and noxious weeds while protecting establishing native plants. Indiscriminate weed control such as site-wide mowing can have negative impacts on native species establishment and can reduce the resilience of a site by disrupting seed production. Additionally, indiscriminate weed control can be detrimental to native forbs while in bloom and can reduce pollinator habitat. Assessment of site conditions prior to mowing is critical to ensure proper adaptive management.

Chemical

Utilizing only mechanical weed control approaches can be difficult to successfully control perennial weeds due to these species' extensive root systems and reproductive characteristics. Herbicide application is recommended to provide long-term control of perennial weeds; however, selective herbicides and spot treatments should be used to avoid negative impacts to native grasses, forbs, and shrubs often associated with non-selective herbicides and broadcast applications. Herbicides shall only be mixed and applied by a licensed herbicide applicator. Only herbicides pre-approved by the Air Force and USAFA Pest Management Officer are allowed.

The Vegetation Warranty Contractor shall reference the **USAFA AND FARISH RECREATION AREA INTEGRATED NOXIOUS WEED MANAGEMENT PLAN** for treatment priorities, treatment methods, and noxious weeds that may be found within the project site.

Appendix A: Revegetation and Erosion Control Design Standards

A.1.1 General

The following section provides guidance and requirements in the design and development of revegetation and erosion control plans and component plans for projects on USAFA lands.

Ensure revegetation and erosion control design compliance with the UNITED STATES AIR FORCE INSTALLATION DEVELOPMENT PLAN and its component plans including the USAFA INSTALLATION FACILITIES STANDARDS (IFS).

A.1.2 Revegetation Design Objectives

USAFA is situated in a semi-arid region of Colorado. Revegetation plan development shall be contextual to the landscape and take into consideration natural conditions of the land where the project is located such as annual precipitation, elevation, prevailing winds, aspect, landforms/topography, soil composition, soil texture, soil moisture potential, soil drainage, stormwater, groundwater, natural drainages, site uses including wildlife use, and maintenance needs. Revegetation can be challenging and requires proper planning, installation, monitoring, and maintenance to be successful due to Colorado's climate, prevalence of introduced weeds, and difficult soil conditions encountered on many projects.

Revegetation plans should not only consider the project site needs but should account for the surrounding landscape and how the project can impact contiguous lands and the USAFA landscape as a whole. The Standards User shall work with the project's assigned Government Representatives to determine appropriate site improvements with this context in mind.

Natural Resource Protection and Preservation

Revegetation design shall prioritize the minimization of impacts and preserve the existing, or pre-disturbance, function of the landscape. Projects that are in close proximity to or contain natural drainages should limit development within these channels to maintain natural processes, such as water quality and wildlife habitat. Projects that contain wetlands and/or streams must comply with all state and federal permitting requirements.

Soil disturbance is a major driver to weedy species introduction and should be minimized or phased appropriately during construction to limit bare ground and subsoil exposure. Projects should consider impacts to existing tree canopy, promote tree canopy replacement and consider tree canopy age and successional plantings.

Revegetation design shall also consider the reuse of onsite materials that are to be cleared and grubbed. This can include reuse of stumps, wood debris, and boulders to promote ecosystem services and functions and potential cost savings.

Revegetation layout shall consider factors such as hydrologic zones, soil characteristics, slope, aspect, wildlife habitat, erosion control, and water quality.

If a site is properly prepared before revegetating, the plant palette is adapted to onsite conditions, and planting occurs in the appropriate season, average annual rainfall should be adequate for vegetation establishment. However, revegetation planning should consider

natural changes to the landscape and environment including the potential for drought years

during establishment. For this reason, appropriate consideration should be given to the need for supplemental watering if a water source is readily available. A lack of water sources or water rights limits the opportunity for supplemental watering on most native revegetation projects. Therefore, the seasonal timing of seed installation is very important to plan for and measures should be taken during the design phase to ensure proper seed installation timing. Additional information is provided on watering considerations in *Section 4.0 Watering and Irrigation*.

Green Infrastructure

Site design is significantly tied to revegetation success. Infrastructure improvements should consider the sustainable use of materials and natural resource resiliency that promote ecosystem function and process-based design in the revegetation of the site. Green infrastructure design tools and techniques should be utilized. In Colorado, the smart use of water through site design is a major objective for green infrastructure. This can include design solutions that minimize impact to the existing conditions of the site or replicate the natural landform and surface water flow paths. Directing stormflows across revegetation areas by careful placement of building downspouts, snow pile holding and melt path areas for winter road clearing, use of permeable pavement, and parking lot swale features can help to treat water quality while providing moisture and nutrients for vegetation. Revegetation areas that receive stormwater flows in locations where water quality is impacted such as roadways and parking lots, should include design elements adept at water quality improvement such as grass buffers, bioswales, bioretention, and sand filters, among other techniques.

Site and revegetation design should also take into consideration heat mitigation strategies that can include high albedo materials, passive cooling, natural ventilation, and appropriate revegetation strategies such as promoting areas of tree canopy.

Defensible Space

Defensible space is a critical line of defense against spreading wildfires in urban and wildland urban interface areas. Planting and revegetation materials that allow fires to spread unchecked should be removed or modified to slow the rate and/or intensity of wildfires. The safety zone should be kept clear of all highly flammable materials, with the distance varying by fuel-type.

All projects should reference the Ignition Resistant Construction Design Manual published by the Colorado Springs Fire Department, as a basis for Firewise landscaping for all new development and revegetation within the Wildland Urban Interface. Additional resources on appropriate Firewise plant materials are available from Colorado State University Extension office.

Wildlife Corridors

Wildlife corridors are widespread throughout USAFA Lands, and every project should consider its interactions with them. It is easier to think about large mammal corridors as these are the most commonly referred to and studied, however, corridors for Federal or State designated special status species may have overlap. Other areas, such as near runways, landing pads, or heavier travelled roads may discourage a revegetated structure providing wildlife cover and eliminating fruit-bearing species attracting black bears and birds that may collide with vehicles.

Pollinator Habitat

Pollinator habitat is important to perpetuating and maintaining healthy ecosystems and providing forage and habitat for sensitive species. Seed mixes may be adjusted as appropriate to target certain pollinators, but otherwise should consist of perennial native grasses and forbs with a variable and habitat-appropriate color palette. Seed mixes and plant palettes should contain pollinator species that bloom throughout the growing season and provide different colors to provide a wide variety of opportunities for pollinators throughout a longer seasonal window. Plant selection should also include consideration for wind pollinated species.

Erosion Control, Establishment Maintenance, and Construction Laydowns Requirements

Revegetation design shall consider temporary and final erosion control best management practices (BMPs) as well as the planned establishment period, ongoing USAFA land management, and warranty needs such as the need for irrigation and site access. All planting material, including seed, shall include a warranty and/or maintenance period to occur after construction completion. Laydown areas shall be properly sited to minimize disturbance to protected resources, such as, but not limited to, wetlands, waters, sensitive species habitat, and cultural resources, and be included in the revegetation plan. For projects that impact channels, the Revegetation Plan shall plan for dewatering as needed and provide a phasing plan. Construction laydown and access areas are typically heavily trafficked by large equipment and frequent trips. These areas shall include additional consideration for scarification and decompaction, revegetation, and erosion control needs.

A.1.3 Revegetation Plan Design

A Revegetation Plan, a formal design plan or informal component submittal documenting how revegetation is planned to take place, is required for all native revegetation projects on USAFA lands. For smaller and/or simpler projects, the Revegetation Plan Developer can be part of a contracted project design team or can be the NR-Manager. For these projects, a formal design plan document is not required but submittals of the required plan components will be provided to and reviewed by the Government Representatives. The plan components anticipated for submittal include:

- Planting and seeding schedule including quantities and seeding extents
- Any proposed modifications to these Standards

These Standards and clear coordination with the Government Representatives will provide guidance on revegetation. A formal design plan document may be required as determined by the Government Representatives.

For larger and/or more complex projects and/or for projects that take place along a natural drainage, a multi-disciplinary design team that includes engineers, landscape architects, ecologists, and wildlife biologists should be assembled. For these projects, the Revegetation Plan Developer shall be a revegetation specialist who is an ecologist and/or registered landscape architect experienced in restoration ecology and local native plant communities. For these projects, a Revegetation Plan is required and shall, at minimum, contain the following information:

- Layout plan showing location of all proposed revegetation materials
- Planting and seeding schedule including quantities

Notes and details that identify best construction standards and practices for revegetation installation Revegetation plans shall be developed by the Revegetation Plan Developer following the guidelines outlined in these Standards with an understanding of the goals and objectives of the project. The following steps are required to complete the Revegetation Plan design.

Initial Site Analysis and Assessment

An initial site analysis, conducted by the Revegetation Plan Developer, shall be completed to inform site-specific revegetation design objectives for the project. A site assessment should be completed during the growing season. The analysis and assessment shall evaluate relevant site conditions such as:

- Existing site conditions such as sun exposure, shading patterns, existing urban heat island effects. These conditions may change throughout the day and season, which should also be considered.
- Existing habitat such as signs of herbivory, nests or dens to inform protection fencing planning or construction survey needs
 - Surface and subsurface geological and hydrological conditions
 - Groundwater, surface water, and precipitation
 - Include as able, depth to groundwater, fluctuations in the groundwater depths should be monitored for at least one year if schedule and budget allows.
 - If limited data is available for groundwater such as geotechnical reports or only one year of monitoring, it is important to understand that data in the hydrologic context (wet year, dry year) and season in which the data was collected.
 - Depth to bedrock or other subsurface impediments to revegetation as determined by a geotechnical investigation
- Existing topsoil conditions

• Topsoil sampling and analysis utilizing methodology outlined in Section 3.0

- Existing vegetation total cover
 - Conduct photo documentation of representative area of vegetation by taking plot level and landscape level photos at pre-construction photo points or capture up-to-date aerial imaging to determine a quantitative estimate of:
 - Total native and non-native cover
 - Total tree, shrub, and groundcover cover
 - Total area of bare ground
- Existing vegetation species composition, within the project area and immediately adjacent to the project area.
 - Conduct ocular assessments and documentation of all species, including invasive weed species that may be present in the topsoil seedbank or in close proximity to the site, to help inform seed mix composition and or preventative weed control efforts. Collect documentation on location and percent cover of dominant species.
- Existing site materials (i.e., trees or shrubs that will be removed, woody debris, rock) that may be used during construction for stabilization, wildlife habitat, or revegetation.

If existing site conditions are significantly degraded or if the site is dominated by non-native or noxious species, an ecological reference site that represents conditions that would be expected on the project site should be assessed to inform site specific opportunities. In addition, Natural Resource Conservation Service (NRCS) Ecological Site Descriptions (ESDs) and Center for Environmental Management of Military Lands (CEMML) USAFA Vegetation Classification and Mapping can be used to understand plant community composition for degraded sites. The Government Representatives shall determine if this requirement shall be waived depending on project needs.

A.1.4 Existing Plant Communities

The Revegetation Plan design should be informed by the existing plant communities found at the project site. The following hydrological zones are represented across USAFA and may be present within project extents.

Upland Hydrological Zone

Native upland areas at USAFA include grasslands, shrubland, and/or woodland/forest. Native upland vegetation is generally xeric and are well adapted to the region with average rainfall of between 15 to 20 inches (15-20") per year.

Additional information on vegetation communities found within the upland hydrological zone can be found within the vegetation zone descriptions below.

Riparian Hydrological Zone

The main riparian hydrological zone on USAFA is along Monument Creek and its major tributaries comprising approximately 2.2 acres of riverine systems and 210 acres of palustrine system wetlands. Across USAFA, there are 301 identified wetlands and other water bodies.

Vegetation communities in this zone consist of various cottonwood species (*Populus angustifolia and P. deltoides*) and willows (*Salix* spp.). Also in this zone are small showy herbs and forbs such as darkthroat shootingstar (*Dodecatheon pulchellum*), bunchberry dogwood (*Cornus canadense*), and twinflower (*Linnaea borealis*) and a variety of grass species. Monument Creek is an important system for native fish communities and provides habitat for Preble's meadow jumping mouse (*Zapus hudsonius preblei*), Hops azure butterfly (*Celestrina humulus*), cedar waxwing (*Bombycilla cedrorum*), gray catbird (*Dumetella carolinensis*), and the northern leopard frog (*Lithobates pipiens*).

The following vegetation zones are represented across USAFA and may be present within project extents.

Foothills Zone (6,000 – 8,000 ft)

The Foothills Zone may contain both upland and riparian areas. It is subdivided into four community types: Douglas-fir woodlands, ponderosa pine woodlands, oak shrublands, and grassland. Douglasfir (Pseudotsuga menziesii) woodlands are mixed woodlands with white fir (Abies concolor) primarily on north-facing slopes. Often associated with common juniper (Juniperus communis) waxflower (Jamesia americana), and mountain mahogany (Cercocarpus montanus). Ponderosa Pine (*Pinus ponderosa*) woodlands are the primary woodland type on the Academy, occupying drier areas than the Douglas-fir woodlands. Trees in this system are often grouped together with more open park-like ground cover. Often associated with gooseberries and currants (Ribes aureum and *R. cereum*), alpine false spring parsley (*Pseudocymopterus montanus*), mountain muhly (Muhlenbergia montana), ninebark (Physocarpus monogynus), and Gambel oak (Quercus gambelii). Oak shrubland occupy the dry mesas and south-facing slopes along the foothills on the Academy. The dominant species in this zone is Gambel oak (Quercus gambelii) that form dense thickets. This zone is often associated with pinion pine (Pinus edulis), one-seed juniper (Juniperus monosperma), ponderosa pine, mountain mahogany, oceanspray (Holodiscus discolor), Boulder raspberry (Oreobatus deliciosus), and snowberry (Symphoricarpos albus). The grassland communities on the Academy occupy most of the eastern portion of the site. They are dominated by short-grass prairie species including smooth brome (Bromis inermis), crested wheatgrass (Agropyron cristatum), blue grama (Bouteloua gracilis), little bluestem (Schizachyrium scoparium), fringed sage (Artemisia frigida), and Spanish bayonet (Yucca glauca).

Montane Zone (8,000 – 9,000 ft)

The Montane Zone may contain both upland and riparian areas. It is comprised of mixed conifer forests along the western boundary of the Academy extending into Rampart Range. Dominant tree species include: Douglas-fir, ponderosa pine, white fir, limber pine (*Pinus flexilis*), blue spruce (*Picea pungens*), Engelmann spruce (*Picea engelmannii*), and common juniper. Dominant shrubs include: kinnikinnick (*Arctostaphylos uva-ursi*), waxflower, and mountain mahogany.

Urban Development

The Urban Development area is generally comprised of Cadet areas and housing, a Community Center, golf course, roads, sidewalks, parking lots, buildings, and hardscaped features. These areas are typically comprised of irrigated, ornamental landscapes containing non-native vegetation, turf lawns, and ornamental trees and shrubs.

Noxious and Non-Native Vegetation Species

Noxious and non-native vegetation species are pervasive in many areas on USAFA lands, particularly in locations where Urban Development is localized and associated land disturbance has occurred. Invasion of noxious and non-native species can be anticipated on newly disturbed sites. The USAFA and Farish Recreation Area Integrated Noxious Weed Management Plan developed by Colorado Natural Heritage Program (2015) should be referenced to understand what noxious weeds may exist and appropriate treatment and control strategies to implement prior to and during construction. Projects on Bullseye Auxiliary Airfield should reference State Land Board noxious weed control guidance.

Weed control should be considered a year or more prior to soil disturbance and should be evaluated for all habitat zones. If a site has annual or perennial weed growth, weed management before revegetation is crucial for minimizing weeds and weed seed and to allow for desirable species establishment. Removing the weed source will help reduce competition for soil moisture and nutrients during desirable plant species establishment. Implementing weed control practices prior to and/or during construction can reduce the level of effort required for weed control later as new vegetation is becoming established. Remove or bury the topsoil from the site if infested by undesirable species.

A.1.5 Seeding Selection

Seed Mix Selection

All Revegetation Plans shall use the USAFA standard grass/forb and shrub overseed mixes. The USAFA Seed Mix Map (FIGURE 1) shall be used to determine the standard native seed mix(es) to use during revegetation efforts.

The standard seed mix(es) provided in this section may be modified based on pre-construction site observations of vegetation species and composition or other project specific design objectives, if approved by the Government Representatives after conducting the initial site assessment. Modifications may include, but are not limited to, substituting or adding native species and increasing or decreasing rates for individual native species. Species should be chosen that are adapted to the environmental conditions at the project site such as water availability, soil texture and chemistry, and elevations. Sites with unique soil chemistry and texture should use species adapted for those soil conditions. Modified seed mixes shall contain a variety of warm and cool-season species and early-, mid-, and late-seral species to promote process-based design and account for successional trajectories. Riparian seed mixes shall contain a variety of species adapted to a range of hydrologic conditions including wetland, riparian, and upland species to account for periods of high-water and drought and to maximize revegetation opportunity by

providing a high-quality seed bank. Modifications to shrub overseed mixes shall consider species germination requirements, cost, and market availability. Seeding is generally not feasible for trees and select shrubs due to these factors.

When available, locally adapted seed ecotypes collected from a similar elevation as USAFA (6,300-8,000'), Farish Recreation Area (~9,000'), and Bullseye Auxiliary Airfield (~6,000') with between 15 and 20 inches (15-20") of annual precipitation, as indicated by NRCS Land Resource Region descriptions, shall be used.

The standard Mountain Seed Mix or a site-specific mix approved by the NR-Manager shall be used for revegetation efforts in upland areas at Farish Recreation Area. Site specific riparian and/or wetland seed mixes shall be developed for projects disturbing these environments at Farish Recreation Area. All site-specific seed mixes developed for Farish Recreation Area shall be approved by the NR-Manager prior to procurement and installation.

For projects located at Bullseye Auxiliary Airfield, coordinate with the NR-Manager and defer to the Colorado State Land Board for seed mix development.

Seed Zone Limits

Determining appropriate seed zone limits requires an understanding of regulatory requirements, anticipated hydrologic conditions, aspect, slopes, and project goals and objectives. The Revegetation Plan Developer shall use **FIGURE 1** to determine the appropriate seed mix(es) to use on revegetation plans. In general, when a project involves impacts to waterbodies, wetland, riparian, and upland seed mixes shall be used. Shrub overseed mixes can be incorporated into the grass/forb seed mix or, at minimum, shall be used in select areas determined by the Revegetation Plan Developer or NR-Manager to increase vegetation structural diversity.

Figure 1: USAFA Seed Mix Map



Figure 2: Standard Seeding Extents



Wetland Seed Mix

The standard Wetland Seed Mix or an approved modified Wetland Seed Mix shall be used in areas that are inundated or saturated frequently during the growing season. In general, wetland seeding shall be located in areas that are within six inches (6") vertically from a water source that provides saturation for up to 14 days of the year. While not shown on **FIGURE 1**, the Revegetation Plan Developer shall use their discretion to determine if the Wetland Seed Mix or Plug List are appropriate on a project-by-project basis. If deemed necessary, wetland plugs shall be shown on revegetation plans where groundwater is within 18 inches (18") or less of the soil surface.

Table 1: Wetland Seed Mix

	Wetlan	d Seed Mix				
Scientific Name	Variety*	Common Name	PLS Ibs/ac	% by Weight	PLS/ sq ft	% of PLS/sq ft
Graminoids						
Calamagrostis canadensis	vns.	bluejoint	0.10	1	9	6
Carex nebrascensis	vns.	Nebraska sedge	0.70	4	9	5
Carex utriculata	vns.	Northwest Territory sedge	1.20	6	10	6
Distichlis spicata	vns.	inland saltgrass	0.70	4	8	5
Eleocharis palustris	vns.	creeping spikerush	0.70	4	10	6
Elymus elymoides	vns.	bottlebrush squirreltail	2.00	11	9	6
Elymus trachycaulus	San Luis or White River	slender wheatgrass	2.20	12	8	5
Juncus arcticus ssp. littoralis	vns.	mountain rush	0.06	0	15	9
Panicum virgatum	vns.	switchgrass	2.80	15	17	10
Poa palustris	vns.	fowl bluegrass	0.10	1	7	5
Sporobolus airoides	Salado	alkali sacaton	0.25	1	10	6
Sporobolus cryptandrus	vns.	sand dropseed	0.07	0	9	5
		Graminoid Totals	10.88	57	120	75
Forbs						
Asclepias incarnata	vns.	swamp milkweed	2.50	13	9	6
Asclepias speciosa	vns.	showy milkweed	5.00	26	8	5
Monarda fistulosa	vns.	wild bergamont	0.20	1	6	4
Rudbeckia hirta	vns.	blackeyed Susan	0.20	1	8	5
Verbena hastata	vns.	swamp verbena	0.20	1	8	5
		Forb Totals	8.10	43	39	25
		Total	18.98	100	159	100

Table 2: Wetland Plug Mix

Wetland Plug Mix									
Scientific Name	Common Name	Percent Mix	Size	Spacing					
Carex nebrascensis	Nebraska sedge	15	10 ci	12"					
Carex utriculata	Northwest Territory sedge	20	10 ci	12"					
Deschampsia cespitosa	tufted hairgrass	15	10 ci	18"					
Eleocharis palustris	creeping spikerush	20	10 ci	12"					
Juncus arcticus ssp. littoralis	mountain rush	20	10 ci	12"					
Schoenoplectus acutus	hardstem bulrush	10	10 ci	24"					

Riparian Seed Mix

The Riparian Seed Mix zone shall occupy the zone between the wetland seeding zone and upland seeding zone. Riparian seeding limits will generally start within three to six feet (6') vertical and/or horizontal from a seasonal water source or that experiences storm flows within an anticipated maximum 10-year interval. Riparian and wetland seeding placement should consider anticipated capillary fringe based on soil texture. **FIGURE 2** depicts general seeding zone extents; however, site-specific considerations should be considered when developing revegetation plans.

Table 3: Riparian Seed Mix

	Ripari	an Mix				
Scientific Name	Variety*	Common Name	PLS Ibs/ac	% by Weight	PLS/ sq ft	% of PLS/sq ft
Graminoids						
Carex nebrascensis	vns.	Nebraska sedge	1.50	4	18	12
Distichlis spicata	vns.	inland saltgrass	1.20	3	14	9
Elymus canadensis	vns.	Canada wildrye	6.30	16	17	11
Elymus lanceolatus ssp. lanceolatus	vns.	thickspike wheatgrass	4.00	10	14	9
Elymus trachycaulus	San Luis or White River	slender wheatgrass	3.00	8	11	7
Juncus arcticus ssp. littoralis	vns.	mountain rush	0.06	0	15	10
Panicum virgatum	vns.	switchgrass	3.00	8	18	11
Pascopyrum smithii	Arriba	western wheatgrass	1.00	3	3	2
Sporobolus airoides	Salado	alkali sacaton	0.25	1	10	6
Sporobolus cryptandrus	vns.	sand dropseed	0.08	0	10	6
Triticum aestivum x Secale cereale	vns.	Quickguard	10.00	26	3	2
		Graminoid Totals	30.39	78	133	85
Forbs						
Asclepias speciosa	vns.	showy milkweed	4.50	12	7	5
Cleome serrulata	vns.	Rocky Mountain beeplant	3.00	8	5	3
Helianthus maximiliani	vns.	Maxmilian sunflower	0.90	2	4	3
Rudbeckia hirta	vns.	blackeyed susan	0.12	0	5	3
Verbena hastata	vns.	swamp verbena	0.08	0	3	2
		Forb Totals	8.60	22	24	15
		Total	38.99	100	157	100

Table 4: Riparian Shrub Overseed Mix

Riparian Shrub Overseed Mix									
Scientific Name	Variety*	Common Name	PLS Ibs/ac	% by Weight	PLS/ sq ft	% of PLS/sq ft			
Artemisia Iudoviciana	vns.	white sagebrush	0.04	0	4	27			
Prunus virginiana	vns.	western chokeberry	10.00	56	1	7			
Rosa woodsii	vns.	Woods' rose	5.00	28	5	34			
Symphoricarpos albus	vns.	common snowberry	2.80	16	5	32			
		Total	17.84	100	15	100			

Loamy & Clayey Foothills Seed Mix

The Loamy and Clayey Foothills Seed Mix shall be used in upland areas with loamy and clayey soils as indicated on FIGURE 1 or confirmed with site-specific soil sampling. These soil types are often dominated by similar vegetation communities due to similarities in water retention and general soil structure.

Table 5: Loamy/Clayey Foothills Seed Mix

	Loamy	//Clayey Foothills Mix				
Scientific Name	Variety*	Common Name	PLS Ibs/ac	% by Weight	PLS/ sq ft	% of PLS/sq ft
Graminoids						
Andropogon gerardii	vns.	big bluestem	2.00	4	6	4
Bouteloua curtipendula	vns.	sideoats grama	3.20	6	14	10
Bouteloua dactyloides	vns.	buffalograss	7.20	14	9	6
Bouteloua gracilis	CO Native	blue grama	0.85	2	16	11
Elymus elymoides	vns.	bottlebrush squirreltail	2.50	5	11	8
Hesperostipa comata ssp. comata	vns.	needle and thread	2.60	5	7	5
Koeleria macrantha	Sims Mesa	prairie junegrass	0.29	1	15	11
Nassella viridula	vns.	green needlegrass	3.10	6	13	9
Pascopyrum smithii	Arriba	western wheatgrass	6.50	13	16	11
Schizachyrium scoparium	Cimarron	little bluestem	2.00	4	12	8
Triticum aestivum x Secale cereale	vns.	Quickguard	15.00	30	5	3
		Graminoid Totals	45.24	90	125	85
Forbs						
Artemisia frigida	vns.	prairie sagewort	0.03	0	3	2
Dalea purpurea var. purpurea	vns.	purple prairie clover	1.20	2	6	4
Ratibida columnifera	vns.	upright prairie coneflower	0.30	1	5	3
Sphaeralcea coccinea	vns.	scarlet globemallow	0.50	1	6	4
Vicia americana	vns.	American vetch	3.00	6	2	2
		Forb Totals	5.03	10	22	15
		Total	50.27	100	147	100

Table 6: Loamy/Clayey Foothills & Mountain Shrub Overseed Mix

Loamy/Clayey Foothills & Mountain Shrub Overseed Mix										
Scientific Name	Variety*	Common Name	PLS Ibs/ac	% by Weight	PLS/ sq ft	% of PLS/sq ft				
Amelanchier utahensis	vns.	Utah serviceberry	6.00	51	4	22				
Atriplex canescens	vns.	fourwing saltbush	3.50	30	4	25				
Ericameria nauseosa	vns.	rubber rabbitbrush	0.40	3	4	22				
Krascheninnikovia lanata	vns.	winterfat	1.80	15	5	31				
		Tota	al 11.70	100	16	100				

Sandy Foothills Seed Mix

The Sandy Foothills Seed Mix shall be used in upland areas with sandy soils as indicated on **FIGURE 1** or confirmed with site-specific soil sampling. Sandy soils typically have high infiltration rates and thus offer little water retention. Sandy soils typically support xeric species adapted to low moisture and nutrient availability.

Table 7: Sandy Foothills Seed Mix

	Sand	y Foothills Mix				
Scientific Name	Variety*	Common Name	PLS Ibs/ac	% by Weight	PLS/s q ft	% of PLS/sq ft
Graminoids						
Andropogon hallii	vns.	sand bluestem	3.40	8	9	6
Bouteloua gracilis	CO Native	blue grama	0.80	2	15	10
Calamovilfa longifolia	vns.	prairie sandreed	2.50	6	16	10
Hesperostipa comata ssp. comata	vns.	needle and thread	6.00	14	16	10
Koeleria macrantha	Sims Mesa	prairie junegrass	0.12	0	6	4
Muhlenbergia montana	vns.	mountain muhly	0.25	1	9	6
Pascopyrum smithii	Arriba	western wheatgrass	6.00	14	15	10
Schizachyrium scoparium	Cimarron	little bluestem	2.00	5	12	8
Sorghastrum nutans	vns.	yellow Indiangrass	3.80	9	15	10
Sporobolus cryptandrus	vns.	sand dropseed	0.12	0	15	9
Triticum aestivum x Secale cereale	vns.	Quickguard	10.00	24	3	2
		Graminoid Totals	34.99	82	131	85
Forbs						
Achillea millefolium	vns.	common yarrow	0.08	0	5	3
Dalea purpurea var. purpurea	vns.	purple prairie clover	1.00	2	5	3
Heterotheca villosa	vns.	hairy false goldenaster	0.90	2	7	5
Ipomopsis aggregata	vns.	scarlet gilia	0.50	1	4	3
Lupinus argenteus	vns.	silvery lupine	5.00	12	2	1
		Forb Totals	7.48	18	23	15
		Total	42.47	100	154	100

Table 8: Sandy Foothills Shrub Overseed Mix

Sandy Foothills Shrub Overseed Mix								
Scientific Name	Variety*	Common Name		PLS Ibs/ac	% by Weight	PLS/s q ft	% of PLS/sq ft	
Artemisia frigida	vns.	prairie sagewort		3.00	31	5	29	
Ericameria nauseosa	vns.	rubber rabbitbrush		0.50	5	5	29	
Gutierrezia sarothrae	vns.	broom snakeweed		0.10	1	4	24	
Rhus trilobata	vns.	skunkbush sumac		6.00	63	3	18	
			Total	9.60	100	16	100	

Mountain Seed Mix

The Mountain Seed Mix shall be used in high elevation upland areas that are typically dominated by evergreen forests as indicated on **FIGURE 1**. These areas typically support species adapted to higher elevations and shade or low-light conditions.

The standard Mountain Seed Mix or site-specific mix approved by the NR-Manager shall be used for revegetation efforts in upland areas at Farish Recreation Area.

Table 9: Mountain Seed Mix

Mountain Mix							
Scientific Name	Variety*	Common Name	PLS Ibs/ac	% by Weight	PLS/ sq ft	% of PLS/sq ft	
Graminoids							
Achnatherum hymenoides	White River or Paloma	indian ricegrass	4.00	9	13	8	
Andropogon gerardii	vns.	big bluestem	2.50	6	7	5	
Andropogon hallii	vns.	sand bluestem	2.40	5	6	4	
Bouteloua gracilis	CO Native	blue grama	1.00	2	19	12	
Elymus elymoides	vns.	bottlebrush squirreltail	2.60	6	11	7	
Elymus lanceolatus ssp. lanceolatus	vns.	thickspike wheatgrass	6.00	13	21	14	
Festuca arizonica	vns.	Arizona fescue	1.10	2	14	9	
Hesperostipa comata ssp. comata	vns.	needle and thread	6.00	13	16	10	
Poa fendleriana	vns.	muttongrass	0.30	1	14	9	
Schizachyrium scoparium	Cimarron	little bluestem	1.80	4	11	7	
Triticum aestivum x Secale cereale	vns.	Quickguard	10.00	22	3	2	
		Graminoid Totals	37.70	84	136	88	
Forbs							
Artemisia ludoviciana	vns.	white sagebrush	0.05	0	5	3	
Heterotheca villosa	vns.	hairy false goldenaster	0.50	1	4	2	
Lupinus argenteus	vns.	silvery lupine	6.00	13	3	2	
Penstemon strictus	vns.	Rocky Mountain penstemon	0.20	0	3	2	
Ratibida columnifera	vns.	upright prairie coneflower	0.30	1	5	3	
		Forb Totals	7.05	16	19	12	
		Total	44.75	100	155	100	

Table 10: Mountain Shrub Overseed Mix

Mountain Shrub Overseed Mix								
Scientific Name	Variety*	Common Name	PLS Ibs/ac	% by Weight	PLS/ sq ft	% of PLS/sq ft		
Artemisia frigida	vns.	prairie sagewort	3.00	14	5	21		
Cercocarpus montanus	vns.	alderleaf mountain mahogany	3.00	14	3	15		
Rosa woodsii	vns.	Woods' rose	3.00	14	3	15		
Rhus trilobata	vns.	skunkbush sumac	6.00	29	3	13		
Symphoricarpos oreophilus	vns.	mountain snowberry	6.00	29	8	35		
		Total	21.00	100	21	100		

Low-Grow Seed Mix

The Low-Grow Seed Mix was developed for use in upland areas adjacent to trails, sidewalks, and roads, or areas that require a lower growing plant palette to achieve a desired design intent or aesthetic. While not shown on **FIGURE 1**, the Revegetation Plan Developer shall use their discretion to determine if the Low-Grow Seed Mix is appropriate on a project-by-project basis.

Table 11: Low Grow Mix

Low Grow Mix							
Scientific Name	Variety*	Common Name	PLS Ibs/ac	% by Weight	PLS/ sq ft	% of PLS/sq ft	
Graminoids							
Bouteloua curtipendula	vns.	sideoats grama	3.50	10	13	9	
Bouteloua dactyloides	vns.	buffalo grass	10.00	30	13	9	
Bouteloua gracilis	CO Native	blue grama	1.20	4	23	17	
Distichlis spicata	vns.	inland saltgrass	1.30	4	15	11	
Elymus trachycaulus	San Luis or White River	slender wheatgrass	4.00	12	15	11	
Festuca arizonica	vns.	Arizona fescue	1.80	5	20	14	
Festuca idahoensis	vns.	Idaho fescue	1.30	4	13	10	
Koeleria macrantha	Sims Mesa	prairie junegrass	0.20	1	11	8	
Poa secunda	Boulder County	Sandberg's bluegrass	0.50	1	12	9	
Triticum aestivum x Secale cereale	vns.	Quickguard	10.00	30	3	2	
		Tot	tal 33.80	100	138	100	

Temporary Seed Mix

The standard temporary seed mix shall be used on disturbed upland areas or soil stockpiles that will remain in an interim state for more than 30 days, but less than one year. If disturbed areas or soil stockpiles are to remain in an interim state for more than one year the appropriate standard seed mix shall be used for long-term stabilization.

Table 12: Temporary Seed Mix

Temporary Seed Mix							
Scientific Name	Variety*	Common Name		PLS Ibs/ac	% by Weight	PLS/ sq ft	% of PLS/sq ft
Graminoids							
Bouteloua curtipendula	vns.	sideoats grama		4.50	11	20	19
Bouteloua gracilis	vns.	blue grama		1.00	2	19	18
Elymus canadensis	vns.	Canada wildrye		7.00	17	18	18
Elymus trachycaulus	vns.	slender wheatgrass		6.00	15	22	21
Pascopyrum smithii	vns.	western wheatgrass		7.50	18	19	18
Triticum aestivum x Secale cereale	vns.	Quickguard		15.00	37	5	5
			Total	41.00	100	103	100

*vns. = variety not specified

A.1.6 Plant Selection

All Revegetation Plans shall use the USAFA standard shrub and tree container stock list. The USAFA Seed Mix Map (FIGURE 1) shall be used to determine the standard shrub and tree container stock lists to use during revegetation efforts.

The standard shrub and tree container stock lists provided in this section may be modified based on pre-construction site observations of vegetation species and composition or other project specific design objectives, if approved by the Government Representatives after conducting the initial site assessment. Modifications may include, but are not limited to, substituting or adding native species or using a cultivated variety of the native species as approved by the Government Representative.

Selecting appropriate plants is essential for all projects at USAFA. When selecting plants for the revegetation design, it is important to choose vegetation species that are drought tolerant. Because native plants are adapted to the climatic conditions found at USAFA, native plantings or native cultivars should be considered for native revegetation. Plant selection should focus on creating a diverse plant palette, consider long-term performance, and minimize maintenance needs. Consideration should be given to the site's unique micro-climatic conditions, including solar aspect, wind exposure, and potential shading from nearby structures.

Plant selection should take into account the anticipated water regime and whether the site will be irrigated, receive surface water flows, or remain non-irrigated. Other factors to consider include above and below ground conditions, such as utilities, soil volume, adjacent structures, and environmental conditions specific to the location. Whenever possible, plants should be sourced locally or from regions with similar growing conditions to ensure adaptability and success in the restoration process.

Table 13: USAFA Shrub Container Stock List

USAFA Shrub Container Stock						
Scientific Name	Common Name	Seed Mix Zone	Ignition Resistant			
Amorpha canescens	leadplant	Sandy Foothills Mix	No			
Arctostaphylos uva-ursi	kinnikinnick	Sandy Foothills Mix, Mountain Mix	Yes			
Atriplex canescens	fourwing saltbush	Loamy/Clayey Foothills Mix, Sandy Foothills Mix	No			
Cercocarpus montanus	alderleaf mountain mahogany	All	Yes			
Dasiphora fruticosa	shrubby cinquefoil	Loamy/Clayey Foothills Mix	Yes			
Ericameria nauseosa	rubber rabbitbrush	Sandy Foothills Mix	No			
Gutierrezia sarothrae	broom snakeweed	Loamy/Clayey Foothills Mix, Sandy Foothills Mix, Mountain Mix	No			
Humulus lupulus	common hop	Riparian/Transition Mix	No			
Lonicera morrowii	Morrow's honeysuckle	Riparian/Transition Mix	No			
Prunus americana	American plum	Riparian/Transition Mix	No			
Prunus pumila	western sandcherry	Sandy Foothills Mix	No			
Prunus virginiana	chokecherry	Riparian/Transition Mix	No			
Quercus gambelii	Gambel oak	All	No			
Rhus trilobata	skunkbush sumac	All	No			
Ribes aureum	golden currant	Riparian/Transition Mix	Yes			
Ribes cereum	wax currant	Loamy/Clayey Foothills Mix, Sandy Foothills Mix, Mountain Mix	No			
Rosa woodsii	Woods' rose	All	Yes			
Symphoricarpos albus	common snowberry	All	Yes			
Symphoricarpos occidentalis	western snowberry	Riparian/Transition Mix	Yes			
Symphoricarpos oreophilus	mountain snowberry	Loamy/Clayey Foothills Mix, Mountain Mix, Riparian/Transition Mix	Yes			
Yucca glauca	soapweed yucca	All	Yes			

Table 14: USAFA Tree Container Stock List

USAFA Tree Container Stock						
Scientific Name	Common Name	Seed Mix Zone	Ignition Resistant			
Abies concolor	white fir	Loamy Clayey Foothills Mix, Sandy Foothills Mix, Mountain Mix	No			
Betula occidentalis	water birch	Riparian/Transition Mix	Yes			
Juniperus monosperma	oneseed juniper	Sandy Foothills Mix	No			
Juniperus scopulorum	Rocky Mountain juniper	Loamy/Clayey Foothills Mix, Sandy Foothills Mix, Mountain Mix	No			
Picea engelmannii	Engelmann spruce	Loamy/Clayey Foothills Mix, Mountain Mix, Riparian/Transition Mix	No			
Picea pungens	blue spruce	Loamy/Clayey Foothills Mix, Sandy Foothills Mix, Mountain Mix	No			
Pinus flexilis	limber pine	Sandy Foothills Mix, Mountain Mix	No			
Pinus ponderosa	ponderosa pine	Loamy/Clayey Foothills Mix, Sandy Foothills Mix, Mountain Mix	No			
Populus angustifolia	narrowleaf cottonwood	Riparian/Transition Mix	No			
Populus deltoides ssp. monilifera	plains cottonwood	Riparian/Transition Mix	No			
Populus tremuloides	quaking aspen	Loamy/Clayey Foothills Mix	Yes			
Pseudotsuga menziesii	douglas fir	Loamy/Clayey Foothills Mix, Sandy Foothills Mix, Mountain Mix	No			
Salix amygdaloides	peachleaf willow	Riparian/Transition Mix	No			

Container, Ball and Burlap, Plugs, and Sod Mat Stock

If containerized plants are being considered, it is essential to establish an irrigation plan that includes a permanent irrigation system, temporary irrigation system, or watering plan. The irrigation plan should outline a watering schedule for a minimum of two years. Conversely, if no irrigation is available during the establishment period, no containerized plants should be proposed unless the species is adapted to deep planting to ensure contact with groundwater.

When utilizing containerized plants on-site, it is prudent to strategically position them in designated pockets or clusters to facilitate efficient watering post-construction. Additionally, careful consideration should be given to selecting appropriate container sizes. For instance, deep-rooted containers or tubelings are more suitable when irrigation is limited or temporary. Consulting with plant suppliers can provide valuable insights into selecting the most suitable containers for the project's specific requirements.

Figure 3: Container Stock Planting



Salvaged Plantings and Reuse of On-Site Materials

For native revegetation areas, the reuse of onsite materials should be considered whenever possible. Onsite rock, root wads, tree trunks, and other woody materials can be used for bank stabilization, check dams, revegetation, and other stream restoration approaches. Salvaged plant material has the advantage of having local genetics and allowing the use of plant material that would otherwise be destroyed. The design should consider existing areas to be impacted by the project to determine if materials located within the project extents should be salvaged for re-use. Coordinate with the NR-Manager to determine if a local host-site is available to harvest

healthy plantings from. All salvaged materials for riparian restoration projects should be harvested from within the same watershed as the project.

Cottonwood and willows are a great choice for salvaged plantings. The length of cottonwood and willow poles should be determined by the project specific needs for the live stake to be planted with access to ground water. Willow stakes shall be between three feet (3') to six feet (6') in length unless a longer stake is required based on approximate depth to groundwater. Live stakes shall typically be coyote willow (*Salix exigua*) cuttings that are one-half inch (1/2") to one inch (1") in diameter. Willow stakes shall normally be planted on 24" to 36" centers in a staggered pattern, but the pattern and spacing may need to be adjusted depending on the availability of groundwater and plant materials.

For Cottonwood poles, the length shall be determined by the project specific needs for the live pole to be planted with access to ground water but are typically at least ten feet (10') in length. Cottonwood poles shall be plains cottonwood (*Populus deltoides*) or narrow-leaf cottonwood

(*Populus angustifolia*) cuttings that are approximately one inch (1") in diameter. The number and location of pole plantings shall be determined by groundwater conditions and the availability of plant materials. Herbivory protection, such as beaver cages, may be necessary as determined by the initial site assessment or as required by the NR-Manager.

A.1.7 Irrigation

Temporary irrigation needs should be determined during the design phase. Generally, sites that only propose salvaged materials and seed for revegetation do not require temporary irrigation assuming adequate soil preparation and correct seasonal timing of implementation was met. Temporary irrigation or watering during the establishment period shall be required for any projects that propose container stock. Generally, watering at three quarters to one inch (3/4 – 1") per week is recommended during the April-October growing season depending on rainfall. However, the water regime of proposed container stock should consider the amount of water typically needed for establishment without overwatering to prevent dependency of the plant on the irrigation system. If an irrigation plan is developed for the project, the irrigation plan should consider zone layout and watering rates shall be verified by the landscape architect and irrigation designer based on site specific characteristics including seed mix watering needs, slope, storm event frequency and intensity, watering zones, and water pressure. Supplemental irrigation of seeded areas shall not displace or negatively impact seed bed preparations, such as by watering truck spray heads/water cannons.

Irrigation water sources can include city domestic (potable) water and non-potable water (reclaimed water) depending on the site location and associated water rights of the property.

Appendix B: Revegetatior	and Erosion Control	Construction Checklist
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Standards Section	Description of Standard	Contractor Acknowledgement Date and Initials	Government Representative Approval Date and Initials
2.1	A clear construction schedule was prepared that accounts for proper revegetation timing.		
Comments			
2.2	Existing resources were protected to the best extent practicable.		
Comments			
2.3	Existing topsoil was salvaged and stockpiled properly.		
Comments			
2.4	Interim erosion control BMPs were installed properly and prior to earth moving activities.		
Comments			
2.5	Existing topsoil was sampled correctly, and the correct number of soil samples were collected.		
Comments			
2.5	Existing topsoil was submitted to an accredited soil laboratory and soil fertility testing was performed.		
Comments			
2.6	Topsoil and subsoils were prepared adequately for revegetation, including determination and incorporation of appropriate soil amendments.		
Comments			
3.1	All seed lots were tested and analyzed, and seed lots are free of noxious or invasive non-native weeds.		
Comments			
3.2	Seed was installed during the ideal window and installed in favorable ground and weather conditions.		
Comments			
3.3	Seed was installed at an appropriate depth using the correct equipment based on site terrain.		
Comments			
3.4	Containerized material was sourced, transported, stored, and planted correctly.		
Comments			
3.5	Salvaged plant material was salvaged, stored, and planted correctly.		
Comments			

3.6	Weeds were controlled appropriately during construction.	
Comments		
4.0	An Irrigation Plan or Supplemental Irrigation Plan was developed and implemented, if required.	
Comments		
5.1	An erosion and sediment control plan were developed and complies with local and state standards.	
Comments		
5.2	Erosion control materials were appropriate for the site and installed correctly.	
Comments		
5.2	Appropriate fencing and barriers were installed properly and removed at the appropriate time.	
Comments		
5.3	All punch list items were addressed by the contractor.	
Comments		
5.3	Revegetation success criteria was reviewed and acknowledged by the contractor.	
Comments		

Appendix C: Revegetation and Erosion Control Post-Construction Maintenance Checklist

Example Post-Construction Maintenance Checklist

The following checklist and weed treatment table are provided as examples but should be updated by the NR Manager to be project specific.

Month	Maintenance Task	Date Completed	Contractor Initials	Government Representative Initials
January	Winter water			
February	Site inspection			
March				
December				

April	Remove tree wrap		
	Remove weeds, as needed		
	Weed treatment, as needed		
	Re-mulch bed, as needed (if applicable)		
	Site inspection		

May	Fertilize trees and shrubs (approved by NR-Manager)		
	Re-mulch beds, as needed (if applicable)		
	Activate/troubleshoot irrigation system (if applicable)		
	Native grass germination irrigation schedule (if applicable)		
	Prune trees and shrubs, as needed		
	Remove weeds, as needed		
	Weed treatment, as needed		
	Site inspection		

June	Check all trees and shrubs for insect pests		
	Native grass germination irrigation schedule (if applicable)		
	Inspect irrigation system / adjust timing as needed (if applicable		
	Remove weeds as needed		
	Weed treatment as needed		
	Re-mulch beds as needed (if applicable)		
	Site inspection		

July	Inspect irrigation system / adjust timing as needed (if applicable)	
	Native grass root establishment irrigation schedule (if applicable)	
	Remove weeds as needed	
	Weed treatment as needed	
	Re-mulch beds as needed (if applicable)	
	Site inspection	

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Month	Maintenance Task	Date Completed	Contract or Initials	Government Representative Initials
	Inspect irrigation system / adjust timing as needed (if applicable)			
August	Native grass root establishment irrigation schedule (if applicable)			
	Remove weeds as needed			
	Weed treatment as needed			
	Re-mulch beds as needed (if applicable)			
	Interseed problematic or bare areas			
	Site inspection			

September	Inspect irrigation system / adjust timing as needed (if applicable)		
	Native grass established, reduce irrigation run time (if		
	Applicable)		
	Remove weeds as needed		
	Re-mulch beds as needed (if applicable)		
	Site inspection		

October	Adjust staking of new trees		
	Winterize irrigation sprinkler system (if applicable)		
	Weed treatment as needed		
	Site inspection		

November	Wrap trees (if applicable)		
	Weed treatment as needed		
	Dormant interseeding of problematic or bare areas		
	Winter water		
	Site inspection		

Weed Maintenance Timeline							
	April	May	June	July	August	October	November
cheatgrass							
kochia							
mustard sp.							
musk thistle							
Scotch thistle							
Canada thistle							
hoary cress							
curly dock							
field bindweed							
Other state-listed species							
Some treatment needed				Focus of tr	eatments		