Chapter 14
Revegetation

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1.0 Introduction

Revegetation is critical to the proper functioning of drainage infrastructure such as grass-lined channels, detention basins, retention ponds, wetland basins, riparian areas, and upland areas along streams where channel improvements have been completed. Revegetation is also necessary to stabilize adjacent areas which were disturbed during construction. Successful revegetation is required to close-out common regulatory permits associated with working in waterways, including stormwater discharge permits required for certain construction activities and U.S. Army Corps of Engineers (USACE) 404 permits. Because of Woodland Park's variable precipitation, strong summer sun, short growing season, prevalence of introduced weeds, and difficult soil conditions encountered on many projects, revegetation can be challenging and requires proper planning, installation, and maintenance to be successful. This chapter provides information on methods and plant materials needed for revegetation of drainage facilities and riparian areas.

2.0 Understanding Site Vegetation

Developing and understanding of the site vegetation will facilitate drainageway work and lead to more successful project outcomes. The following subsections can be used as a guide to develop an understanding for these conditions.

2.1.0 Common Drainageway Plant Communities

There are three general habitat types or "planting zones" encountered on drainage-related projects: upland, non-wetland riparian and wetland areas. These habitat types are characterized primarily by moisture and frequency of flooding, which affect the types of vegetation appropriate for each zone. Some streams may include both habitat types, whereas on other streams wetland areas may be narrow or absent.

Basic descriptions of each habitat type are provided in the following subsections. It is important to recognize that although the revegetation sequence for each habitat type is similar, each habitat type has unique characteristics requiring somewhat different approaches and challenges to revegetation. For example, proper soil preparation and weed control are particularly important for upland revegetation projects. For riparian areas, addressing streambank erosion and properly assessing water levels for installation of cuttings and other plant material are important. For wetlands, adequate assessment of site hydrology to determine whether a site is capable of supporting wetlands is fundamental to success.

2.1.1 Upland

Native upland areas in the Woodland Park include grassland, shrubland, and/or woodland/forest. Plains grassland is the dominant upland vegetation type and is characterized by low-growing grasses, forbs, and scattered shrubs. Shrubland and woodland/forest are characterized by upland trees and shrubs. Upland areas can contain a combination of all three habitat types. Native upland vegetation in Woodland Park is generally xeric, requiring minimal rainfall to persist. If a site is properly prepared before revegetating and the desired plant palette is correctly selected and planted in the appropriate season, average annual rainfall should be adequate for vegetation maintenance. Depending on weather and location, supplemental irrigation may be required during plant establishment.

The upland planting zone is located between the overbank elevation and the flood-prone elevation (i.e., the upper edge of the floodplain). On average, this zone floods every 10+ years. Consequently, it is exposed to erosive water forces only during large flood events. This zone is generally over 2 feet from groundwater and plant species rely on surface water and available precipitation as their water source.

2.1.2 Non-Wetland Riparian

Non-wetland riparian areas are located adjacent to rivers, streams, creeks, ponds and other waterbodies or their adjacent wetlands. Non-wetland riparian areas are shaped by the dynamic forces of water and are regularly flooded by rivers and streams. They provide a variety of ecosystem services including flood control, streambank stability, nutrient cycling, stream food web support, pollutant filtering, sediment retention, and wildlife movement and migration corridors. In addition to these functions, they also provide passive recreational open space areas critical to urban areas.

The riparian zone is found between the bankfull elevation and the overbank elevation. On average, this zone floods every 2 to 5 years and is generally flat with layered soils that have been deposited by previous flood events. The riparian zone represents a transition from areas supporting water-adapted plant species to those supporting upland plant species. Within the developed landscape, large, inflexible trees and shrubs should not be planted in this zone because they may exacerbate flooding and otherwise negatively alter flows during a high flow event.

Riparian vegetation has varying widths from the edge of the waterbody, depending on factors including geology, topography, elevation, soil type, hydrology, and upstream and upgradient build-out. This vegetation depends on access to water but can handle occasional dry periods once established. The riparian ecosystem is a transitional area between wetland and upland ecosystems.

Although riparian ecosystems represent only 3% of western habitat overall, this ecosystem is crucial for over half of the bird species and a majority of mammalian, amphibian and reptile species (The Wildlife Society 1983). Technically, riparian areas include several different plant communities and types of habitat, but for the purpose of this chapter, discussion of "riparian" areas generally refers to areas within the floodplain that are not wetlands.

2.1.3 Wetlands

As defined by the Clean Water Act (40 CFR 230.3(t)), wetlands are "areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." In lay terms, wetlands can be thought of as transitional areas between open water and dry land. Their unique character allows them to provide an array of valuable functions including water quality improvement, floodwater attenuation and storage, soil stabilization, fish and wildlife habitat, and food web support. In Colorado, creation of wetlands in excess of the wetland area disturbed and creation of wetlands where wetlands did not exist historically requires a water right.

The wetland zone along stream channels is located between the average water elevation and the bankfull discharge elevation. The lower section (near the streambank) is exposed to the highest velocity flows and therefore can exhibit the most erosion (NRCS 2001b). The higher section (transitions into the lower riparian zone) is inundated much less frequently and is exposed to less erosive forces. In high velocity streams, the lower zone may be naturally unvegetated. In lower velocity streams, it is often vegetated with water-tolerant herbaceous plant species. Flexible-stemmed willows and low-growing shrubs capable of withstanding frequent inundation should be planted in the lower section of this zone. Common foothills wetland species include sandbar willow (*Salix exigua*) and redosier dogwood (*Corns sericea*) with an understory of wetland grasses, sedge and rush.

Prior to initiating a wetland revegetation plan, it is important to recognize that different types of wetland projects will require different approaches. Three general types of wetland projects include:

- Created wetlands that are constructed in upland areas that have not supported wetlands historically.
- Restored wetlands that are reestablished where a wetland existed historically but is no longer present.
- Enhanced wetlands that are existing wetlands improved to address degradation (usually human caused). Enhancement may include removing or constructing berms, filling ditches, grading, and/or modifying vegetation communities.

3.0 Site Preparation

3.1 General Guidelines for Site Preparation

Initial evaluation of site conditions and appropriate site preparation are fundamental to successful revegetation for upland, riparian and wetland habitat types. Table 14-1 identifies various site preparation activities pertinent to the plant community types identified in Section 2 of this chapter.

Table 14-1. Site Preparation Activities for Revegetating Upland, Riparian and Wetland Habitats

Revegetation Guidance Topic	Applicability to Habitat Type		
Activity	**Upland**	**Riparian**	**Wetland**
Initial Hydrologic Evaluation		✓	✓
Initial Weed Evaluation and Control	✓	✓	✓
Topsoil Preservation (including Existing Wetland Soil)	✓	✓	✓
Soil Testing	✓	✓	✓
Soil Amendment	✓	✓	✓
Seed Bed Preparation	✓	✓	✓
Tree Protection	✓	✓	✓

3.2 Initial Hydrologic Evaluation

One of the most critical aspects for the successful revegetation of riparian and wetland areas is having sufficient hydrology to support the plants. An initial hydrologic investigation should be performed for both riparian and wetland revegetation efforts. Ideally, the depth to groundwater and fluctuations in the groundwater depths should be monitored for at least one year (preferably longer, if feasible) for both riparian and wetland areas. This will not be feasible for many projects and if limited groundwater data are available (i.e., from geotechnical reports or only one year of monitoring), it may be necessary to infer groundwater depths by studying plant distribution and drainage patterns.

As part of the wetland planning process, wetland areas should be designed to have water at the surface for at least two weeks during the growing season. For riparian area planning, it is important to recognize that riparian plantings must have contact with groundwater to survive. In the semi-arid West, groundwater often fluctuates throughout the year. If the depth to groundwater precludes planting/seeding species that require more available moisture, upland (also known as xeric) plant species may need to be seeded/planted instead of riparian plant species.

3.3 Initial Weed Condition Evaluation and Control

Weed infestations that prevent the establishment of the desired native vegetation should be controlled. In some cases, non-native aggressive grasses may also need to be controlled. Weed control requirements should be evaluated for upland, riparian and wetland areas. For proven treatment methods and recommended treatment timing of common Front Range annual and perennial weeds, see Table 14.2. The listed weeds may be found in the habitat zone indicated and in other zones as the micro-ecology permits.

If a site has annual or perennial weed growth, weed management before revegetation is an important step for minimizing weeds and weed seed and to allow for desirable species establishment. Removing the weed seed source will help to reduce competition for soil moisture during desirable plant species establishment. However, weed management cannot often be accomplished ahead of construction activities and will have to be an on-going process as the planted/seeded vegetation establishes. Weed control after revegetation of the site is more difficult due to the presence of establishing plants. While construction activities are still on-going, maintaining weed control over the entire site, including on the topsoil stockpile, will greatly reduce weed pressure once the topsoil is replaced and revegetation commences.

Table 14-2. Proven Treatment Methods and Timing of Treatment for Common Weeds

Common Name	Scientific Name	CO Weed List Rating	Spring Treatment	Summer Treatment	Fall Treatment
Wetland Weeds					
Canada thistle	*Cirsium arvense*	B	H,MM	MM	H, MM
Common teasal	*Dipsacus fullonum*	B	H		H
Eurasian watermilfoil	*Myriophyllum spicatum*	B	BI, H	MP	MP
Purple loosestrife	*Lythrum salicaria*	A	MD, MP, H, BI		
Tamarisk	*Tamarix ramosissima*	B	BI, H[1]	H[1]	H[1]
Riparian Weeds					
Leafy spurge	*Euphorbia esula*	B	BI, H		H
Poison hemlock	*Conium maculatum*	C	HP, H	HP	H
Quackgrass	*Elymus repens*	B			H
Russian olive	*Elaeagnus angustifolia*	B	H[1]	H[1]	H[1]
Upland Weeds					
Bindweed	*Calystegia sepium*	NL	BI, MP[2]	H	H
Bouncingbet	*Saponaria vaccaria*	B		H	H
Bull thistle	*Cirsium vulgare (Savi) Tenore*	B	MP[2], BI, H, BG[3]	MM, BG[3]	H, BG[3]
Chinese clematis	*Clematis orientalis*	B	BG, MP	H	
Common burdock	*Arctium minus*	C	MP[2], MM, H, BI	MM	MM, H
Common mullein	*Verbascum Thapsus*	C	H		H
Dalmation toadflax	*Linaria dalmatica*	B	BI, MP[2], H		H
Diffuse Knapweed	*Centaurea diffusa*	B	MP[2], BI, H	MM, MC, H	H
Downy brome (Cheat grass)	*Bromus tectorum*	C			H
Kochia	*Kochia scoparia*	NL	MP[2]	MM, H	
Myrtle spurge	*Euphorbia myrsinites*	A	H	H	H
Musk thistle	*Carduus nutans*	B	BI, MP[2], MC, H, BG[3]	MM, BG[3]	H, BG[3]
Perennial pepperweed	*Lepidium latifolium*	B	MP[2], H, BG		
Plumeless thistle	*Carduus acanthoides*	B	BI, MP[2], H,MC, BG[3]	MM, BG[3]	H, BG[3]
Puncturevine (Goathead)	*Tribulus terrestris*	C	MP[2], BI, H	MD, H	
Redstem filaree	*Erodium cicutarium*	B	MP[2], H		H
Russian knapweed	*Acroptilon repens*	B	H		H
Russian thistle	*Salsola tragus*	NL	MP[2], BG, H	H	
Scotch thistle	*Onopordum acanthium*	B	MD, MP[2], H, BG[3]	MM, BG[3]	BG[3], H
Yellow starthistle	*Centaurea solstitialis*	A	MP[2], MM, BI, BG, H		
Yellow toadflax	*Linaria vulgaris Mill*	B	MP[2], BI		H
Whitetop (Hoary cress)	*Cardaria draba*	B	MM, H		H

Table Notes: [1]Grazing with sheep, goats and horses- no cattle. [2]Pull young seedlings. [3]Cut and treat stump if large plant or spray foliage if small plant.
Seasons: Spring = Sp, Summer = Sm, Fall = Fa. Mechanical Methods: Mowing = MM, Pulling, = MP, Cutting = MC, Digging = MD. Biological Methods: Insects = BI, Grazing animals = BG. Chemical Methods: Herbicides = H.

If herbicides will be needed to control weeds at the site, a certified applicator should be used. A copy of the applicator's license should be obtained and records should be kept of all applications that occur on the site. Only herbicides rated as aquatic safe should be used in riparian and wetland areas. A key consideration in herbicide selection should be how long the herbicide remains active in the soil (residual soil activity). No chemical residue should remain in the soil at seeding time, which could reduce desirable species germination.

In 2013, the Colorado Water Quality Control Division issued a Colorado Discharge Permit System (CDPS) General Permit for Discharges from Application of Pesticides, modeled after the U.S. Environmental Protection Agency's general permit issued in 2011. A Compliance Certification may be required for certain types of herbicide applications in Colorado. For example, if herbicide treatment during a calendar year involves over 20 linear miles or 80 acres of water (i.e., surface area), then a compliance certification is required.

3.3.1 Control of Annual Weeds

Weed management is especially useful where annual weeds are abundant. Some common annual weeds such as kochia (*Bassia sieversiana*) and cheatgrass (*Bromus tectorum*) have short-lived seed. If weed seed production can be prevented during the year prior to revegetation of a site, it will help reduce future weed growth. Be aware that a late summer mowing of untreated annual weeds followed by plowing and seeding generally results in a rebound of many of the weedy species, so proper weed management is important prior to seeding.

For mild to moderate weed infestations, a broad-spectrum herbicide treatment may be sufficient to control weeds before revegetating the site. Be sure to check herbicide labels regarding timing of treatments because a month or more may be needed between herbicide treatments and revegetating the site (seeding) to reduce residual impact of the chemicals.

3.3.2 Control of Biennial and Perennial Weeds

Control of biennial and perennial weeds should also begin a year or more prior to seeding a site to reduce competition with the seeded species. Spring and fall are good times for spot herbicide treatment of developing rosettes (first year stage) of many biennial species and some perennials weeds. This can be done before construction begins or before revegetating a site. Spring and fall are especially good for common regional weeds including Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), scotch thistle (*Onopordum acanthium*), common teasel (*Dipsacus fullonum*) and knapweed (*Centaurea diffusa*) when the plants are still small in size. Always follow herbicide label recommendations for best treatment times and chemical mixtures for specific weed species.

3.3.3 Additional Weed Control Guidance for Wetland Areas

Cattails are native wetland plants which can form dense stands. If required for maintenance, deeply rooted cattails (*Typha latifolia* and *T. angustifolia*) may be controlled by fall application of aquatic labeled glyphosate followed by cutting the plant after the plant has died.

If an existing wetland is to be enhanced, elimination of undesirable species, such as reed canarygrass (*Phalaris arundinacea*) may be necessary. Herbicide application is generally the most effective means to eliminate a weedy species prior to planting. In wetland areas supporting weedy species, an EPA-approved aquatic use herbicide (such as glyphosate) may be applied prior to planting and seeding. Repeat application of herbicide every two weeks on any remaining green growth. Allow two to three weeks prior to planting.

3.4 Topsoil Preservation

During construction activities, topsoil should be stripped and stockpiled separately from sub-soil and wetland soil. The quantity of topsoil that can be preserved and stockpiled varies, depending on the particular site. Once construction is complete, the topsoil can be spread before re-seeding and/or planting. Protecting the native topsoil is important because importing topsoil later is both labor-intensive and expensive.

In order to preserve soil microbes, which are helpful with plant establishment, it is best to limit topsoil stockpiles to a height of 10 feet. Many local jurisdictions have requirements on duration and heights of stockpiles. Once stockpiled, the topsoil can be protected from erosion and weed infestations by seeding with a sterile non-native grass or a native seed mix, depending on how long it will remain.

For wetlands, topsoil may be salvaged from a wetland that will be destroyed (on-site or at another location). Wetland topsoil contains seeds, roots, rhizomes, tubers and other fleshy propagules that can aid in revegetation. The top 8 to 10 inches should be scraped with a front-end loader and transported to the site where it will be applied. Ideally, the topsoil should be spread out on the new wetland immediately, to a depth of no more than 6 inches. Although wetland topsoil can be stockpiled for short periods, it will lose viability. NRCS recommends that stockpiles should be kept for less than four weeks and should measure less than 3 x 3 feet (height/width). Wetland topsoil should not be stockpiled during the summer because it will compost, and the seeds and propagules will be killed.

3.5 Soil Testing

Soil testing of both native and imported topsoil is recommended to select appropriate plant species for a site and to determine if and what types of soil amendment will be beneficial. Soil samples can be delivered or mailed to a local soil testing laboratory, agricultural extension service, or university service for analysis. A standard agronomic test (e.g., nutrients, organic matter, and salinity), as well as full textural analyses, should be required for all topsoil fractions imported or salvaged from the site. Table 14-3 provides general guidance for viable topsoil composition for the establishment of native plants in upland areas in Colorado.

For upland areas in the Colorado foothills, soil textures vary greatly. Soil texture characterizes a soil based on the size of particles found in a particular sample. Soil texture is described as sand, clay, and/or silt based on particle sizes (Figure 14-1). A USDA soil texture triangle diagram shows the types of soil texture combinations that are possible. Knowing the soil texture on a site will help with appropriate plant selection (Colorado Natural Areas Program 1998) and evaluation of potential for soil moisture retention. Plants are generally adapted to certain soil types although some plants can establish in a combination of soil types.

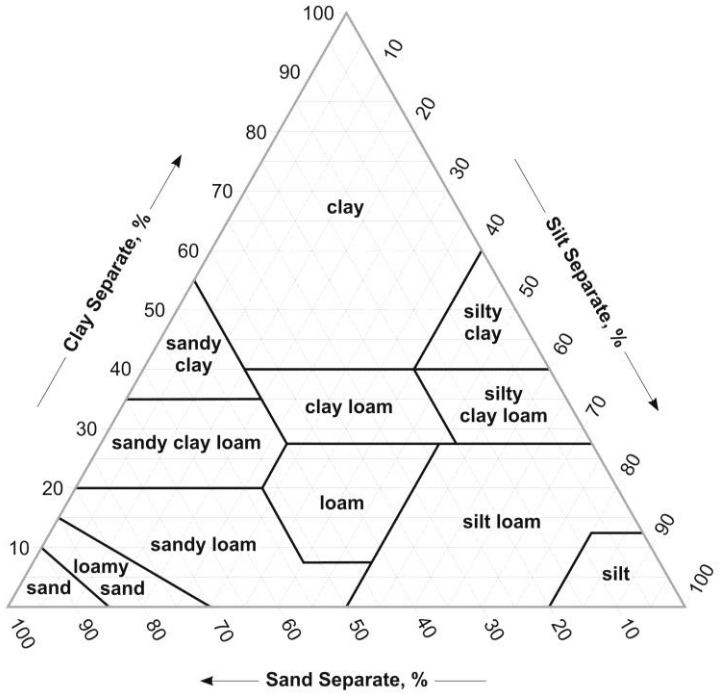

Figure 14-1. Soil Textural Triangle

When collecting soil samples and reviewing analysis results, follow these guidelines:

- Soils should be evaluated during design (visually by a qualified member of design team or by lab analysis) and soils tests should be obtained during construction because grading activities and the process of stripping and stockpiling can result in very different conditions.

- Soil samples should be collected by the vegetation specialist or contractor. Observation of the soil source areas in the field is necessary to assist with determination of quality of the soil as a topsoil source.

- If topsoil is to be imported from an off-site location, it is best to test it separately before it is brought on-site to be sure that it is good quality topsoil for the project. Soil amendments may still be (and often are) needed once topsoil is brought on-site and reapplied to the existing subsoil.

- Soil test recommendations are usually geared toward agricultural crops, which may require substantially more soil amendments than what are necessary for native plant establishment. When submitting the samples, be sure to inform the testing laboratory that the soil testing is related to native plant establishment and that recommendations on soil amendments should be geared for this type of plant establishment.

- Soil test results should then be reviewed by a vegetation specialist or other qualified landscape professional who is familiar with the project so that the proper soil amendments are applied for the type of vegetation that will be seeded/planted.

Local companies and laboratories in Colorado that conduct soil testing include:

ACZ Laboratories, Inc.
2773 Downhill Drive
Steamboat Springs, CO 80487

Analytica Environmental
Laboratories, Inc.
12189 Pennsylvania Street
Thornton, CO 80241
303.469.8868

Colorado Analytical Laboratory
240 South Main Street
Brighton, CO 80601
303.659.2313

Colorado State Soil, Water and
Plant Testing Laboratory
Room A319 NES Building
Fort Collins, CO 80601
970.491.0561

Table 14-3. Viable Topsoil Composition for Colorado Native Plant Establishment in Upland Areas

Chemical Attributes	**Preferred Range**		**Additional Description**
pH	6.0-7.5		A pH < 6 indicates possible acid problems, and pH > 8.0 indicates an alkaline soil. A pH> 8.5 indicates possible sodium problems. Most nutrients are most available to plants around a pH of 6.5.
Organic Matter	1-3%		Desirable range for good topsoil is a minimum of 1%.
Salinity	EC < 3 - 6 mmhos/cm		The desired EC varies depending on the plant selected, but EC values >2 mmhos/cm could indicate a problem for germination.
Sodium Absorption Ratio (SAR)	<6		SAR provides an indirect measure of percent exchangeable sodium on the soil colloid.
Free Lime	<10		Free lime represents the carbonates of calcium and magnesium, which are not combined in the soil. Values > 10 may indicate a high amount of "lime", poor soil structure, and an increase in water and wind erosion susceptibility. Plant-available phosphorus may be reduced because of this condition.
Cation Exchange Capacity (CEC)	12-25		Exchangeable cations include calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), and potassium (K^{+}).
Saturation Percentage	> 25 and <80		Saturation percentage is the amount (percentage by weight) of water needed to saturate a soil. Values >80 may indicate high montmorillonite clay content and/or high quantities of exchangeable sodium, whereas values < 25 may indicate coarse soil materials with a low water-holding capacity. The full soil textural analyses may also report the clay content directly.
Minimum ammonia DPTA (chelate) Extractable Nutrients			Nitrogen (N) – Phosphorus (P) – Potassium (K): ratio of important elements in a fertilizer or soil amendment. Nitrogen is responsible for strong stem and foliage growth. High nitrogen levels favor quick-growing invasive weeds, while low nitrogen levels favor slow-growing, late-seral species (Goodwin et al. 2006). Phosphorus aids in healthy root growth and flower and seed production. Potassium improves overall health and disease resistance.
Nitrogen	5 ppm air dried basis		
Phosphorus	5-12 ppm		
Potassium	20-50 ppm		
Iron	3-5 ppm		
Texture Class	**% of Total Weight**	**Average %**	Soil Texture by Hydrometer Method provides the percentages of sand, silt, and clay in the soil. There are 12 textural designations (excluding modifiers such as very fine, cobbley, etc.), which can appear on a soil report. Each of these designations has a range of percentages of sand, silt, and clay, which could apply. Suitable soil textures for good topsoil material are silt loam, loam, silty clay loam, very fine sandy loam, and fine sandy loam. Soil textures with greater amounts of clay or sand can be problematic for achieving revegetation success.
Sand (0.05-2.0 mm dia. range)	25 to 65	5	
Silt (0.002-0.5 mm dia. range)	20 to 50	30	
Clay (<0.002 mm dia. range)	20 to 30	25	

3.6 Soil Amendment

Depending on the results of soil tests, soil amendments may be required, particularly when test results fall outside of desired ranges in Table 14-3. Wetland areas typically do not require soil amendments. Soil amendment considerations for upland and riparian areas are presented in the following sections.

3.6.1 Soil Amendment for Upland and Riparian Areas

Once the soils have been tested, amendments may be needed to improve soil conditions (e.g., nutrients, soil chemistry) or texture prior to revegetating the site, particularly for upland and riparian sites. The project ecologist or other qualified landscape professional should review the soil test results and identify soil amendments that may be needed. As long as the proper soil-specific seed mixtures are used, most native topsoil can be revegetated with little or no amendment beyond the addition of a slow-release organic fertilizer.

Fertilizers may have a positive, negative, or neutral effect on the survival and growth of planted species (NRCS 2001a). Nitrogen fertilizers should be used only when soil tests show a gross nitrogen deficiency because they can stimulate annual weeds and may contaminate waterbodies if applied in lower riparian zones. In some cases, nitrogen fertilizers can decrease valuable mycorrhizal activity (Goodwin et al. 2006). Nitrogen is rarely needed for native species, which have evolved in low nutrient environments. If fertilizer is expected to have a beneficial effect on seeded species, it should be added shortly before or shortly after seeding (Goodwin et al. 2006) and in accordance with soil test results.

Upland grassland topsoil is often characterized as having low-nutrient soils; therefore, soil fertilizers may not be necessary for successful native plant species revegetation. If the original topsoil from a site was stockpiled and then replaced, soil amendments may not be required to successfully revegetate the site. If amendments are needed based on the soil test, amendments may include a slow-release organic fertilizer (such as 4-6-4 or 7-2-2 N:P:K), compost, peat, humates, sulfur, gypsum, lime, wood chips and soil micro-organisms. Other chemical corrections are not generally needed.

For upland sites, most sites with low organic matter (including overworked agricultural soils, steep slopes, and sub-soils) will benefit from the addition of between 800 to 1200 pounds per acre of a slow-release organic fertilizer. This organic fertilizer is often granular and low in phosphorus. Organic fertilizers are useful for high-use areas such as park sites, along roads, and highly visible native turf areas. Chemical fertilizers generally have higher phosphorus and nitrogen levels, which encourage weedy growth that may compete with the desirable planted/seeded species. Chemical fertilizers or fertilizers produced from poultry waste are often fast-release, which encourages weed establishment. The applicator should understand the quantities/rates of fertilizer needed to avoid over fertilizing an area. Soil amendments should be applied prior to the final tilling of the soil, and should then be incorporated 6 inches into the soil.

Soils which are low in organic matter can be amended with an approved composted material to improve soil texture. Manure is usually not recommended (NRCS 2001a). Usually, 2 cubic yards of quality compost per 1000 square feet is adequate to improve the organic content of poor soils for native revegetation. If the revegetation effort will be in a manicured area where turf will be installed, 3-5 cubic yards per 1000 square feet is recommended. See GreenCO (2008) for more information on turf areas. Organic matter should be incorporated 6 inches into the soil by tilling the soil 8 to 12 inches until no clumps or areas of thick compost remain on the surface.

In upland and riparian areas, the addition of soil microorganisms can aid the establishment of native vegetation. Soil microorganisms process mulch and dead plant material into nutrients that are available for plant uptake. Common microorganisms present in soil include bacteria, protozoa, and mycorrhizal fungi. Mycorrhizal fungi adhere to roots and develop a beneficial relationship with the plant by

improving nutrient uptake, drought tolerance, and pathogen resistance (Goodwin et al. 2006). They are plentiful in the litter layer of established plant communities. For riparian areas, if an adjacent riparian area has a rich layer of litter and a lack of weeds, some of the litter can be collected and mixed in with the seed mix to be applied to the riparian area to be revegetated. Mycorrhizal fungi are also available commercially.

3.6.2 Soil Amendment for Wetland Areas

In general, wetland revegetation projects do not require soil amendments. Wetland plants can successfully establish in a wide range of soil textures, from heavy clay with no organic matter to coarse gravels (NRCS 2011). In particular, the use of mulch is not recommended and fertilizers are rarely necessary or helpful (Colorado Natural Areas Program 1998, NRCS 2003). The addition of fertilizers may be especially detrimental by favoring the growth of weed species in the wetland and contributing to nutrient overloads already present in many waterways. However, each site is unique. To determine whether specific fertilizers may be necessary for a given project, the soil should be tested and compared with the optimum nutrient conditions for the species to be planted (Colorado Natural Areas Program 1998).

A notable exception to this generalization includes wetland creation projects in which the topsoil is removed (excavated) to reach the appropriate grade and the subsoil is exposed without replacing the topsoil. In these situations, virtually all of the naturally-occurring nutrients have been removed. Unless water entering the wetland has a high nutrient load, fertilization will probably be necessary (NRCS 2003). Not surprisingly, studies have shown that without suitable soil conditions, wetland creation projects tend to provide lower functions than natural wetlands (Bruland and Richardson 2005). In particular, soils in created wetlands tend to have a lower organic content than natural wetlands (Fajardo 2006).

3.6.3 Addressing Soil Compaction

Soil compaction in upland, riparian and wetland areas is a common problem for revegetation. Seedbed preparation (tilling) is crucial before revegetating a site. Compaction can be found in naturally occurring soils with high clay content or can result from heavy equipment at construction sites, cattle grazing, working soils when wet, and other causes. When soil is compacted, seeds and plant roots and rootlets cannot penetrate through the hard surface and less oxygen is available for plant establishment and growth. Less water is available for plant establishment due to the hard compacted soil surface, and the site may be vulnerable to excessive runoff due to less water penetration. Microorganisms may be inhibited due to both a lack of oxygen and large pore space needed to survive. Loss of microorganisms leads to a further degraded soil unsuitable for plant growth and affects the nutrient cycling in soils (Natural Resources Conservation Service [NRCS] 1998).

Decompaction will allow water to more easily penetrate into the soil where it can be used by roots and will enhance infiltration on the site, reducing the potential for runoff, especially during smaller, frequent events. Special attention should be given to staging areas, roads, and other high traffic areas that are severely compacted. Decompaction should occur in two steps:

- Before the topsoil is replaced, the sub-soil should be ripped to a depth of 12 inches. This can be accomplished by disking, ripping, plowing, and rototilling, made more effective by ripping in two directions perpendicular to each other. An effective method to reduce soil compaction in created and restored wetlands is to use a chisel plow to mechanically rip both the topsoil and subsoil layers prior to planting (Bantilan-Smith et al. 2009). This process is more difficult to complete on slopes greater than 3:1. On steeper slopes, a track hoe and with a ripper tooth can be used to decompact soil to the proper depth.

- Once the sub-soil is ripped and the topsoil is replaced, soil amendments should be added, if needed per the soil test and habitat type, then the soil should be tilled to 6 inches, leaving no clod over 3 inches in diameter.

These two processes will allow for a total of 18 inches of decompaction, thus providing a better growing medium for native vegetation.

3.6.4 Seedbed Firming

Once the final tilling is completed, fine grading will ensure a smooth seeding/planting surface. The soil surface should be relatively firm as described for each habitat type:

- For upland and riparian areas, the soil surface should then be prepared for seeding so that a footprint will imprint between ¼ to ¾ inch only (NRCS 2011b).

- For wetland areas, the surface is considered firm enough when a person's footprint penetrates ¼ to ½ inch deep (NRCS 1997). Some newly created wetlands may be very difficult to firm. If necessary and when possible, firming of wetlands may be achieved by disking followed by rolling or harrowing just prior to seeding (NRCS 2008).

Firming of the seedbed soil may be helpful prior to seeding, particularly if seeding in late spring or summer. Natural precipitation can sometimes be heavy enough to settle the worked soil, but waiting for such rainfall may not be realistic. If soils are sandy and contain a small amount of moisture already, a cultipacker can be used to firm the seedbed soil. Soils that are wet or silt loam to clay loam should not be cultipacked because they can become too firm, making drill seeding or crimping much less successful. Chiseling after plowing may adequately firm finer textured soils. It is also possible to firm the soil with irrigation following seeding and mulching.

4.0 Plant Material Selection

4.1 General Guidelines

This section provides guidelines and recommendations on plant materials for revegetation of components of the drainage corridor. There are different revegetation requirements for the various parts of these areas. For example, the bottom, side slopes and area immediately adjacent to a detention facility have different moisture regimes and soil types; therefore, they should be planted with different plant species. Different plant forms (e.g., grasses, shrubs, trees) may also be limited to specific areas to enable proper functioning of the facility. For example, planting trees and shrubs along the bottom of a channel can reduce the hydraulic capacity of the channel, increase maintenance requirements and cause the plugging of downstream bridges and culverts when uprooted by higher flows.

To the extent feasible, these guidelines should be followed when developing a planting plan:

1. Plant material selection

    - The form(s) of vegetation and species used should be adapted to the soils and moisture conditions and intended use (e.g., conveyance of flow, side slope, etc.) of the area.

    - Native perennial species should be used to the extent possible.

    - Except along formal park settings, use of bluegrass and other species requiring irrigation and high maintenance should be avoided.

- Sod-forming grasses are preferred over bunch grasses.
- To the extent feasible, containerized nursery stock from local sources should be used for wetland herbaceous species, and all woody trees and shrubs.
- Wetland plantings should not include cattails—although certain members of this genus are native to Colorado, they often develop invasive growth habits and choke out other species.
- Maintenance requirements should be considered in plant selection (e.g., tall grasses should not be used in urban areas unless regular mowing will occur).

2. Seed mixes

- Recommended seeding rates specified as pounds pure live seed per acre (lbs PLS/acre) should be used.

4.2 Shrubs and Trees

Trees and shrubs add diversity to a planting plan and value for wildlife and birds. Trees and shrubs that impede flow and reduce the capacity of the structure should not be planted in the bottom of a drainage channel. Cottonwood pole plantings and coyote (or sandbar) willow cuttings may be used to establish cottonwood trees and willows in appropriate locations, especially in soils with a shallow groundwater table within 12 to 36 inches of the surface.

To meet specific site conditions, the species of trees and shrubs to should be chosen to match site conditions. The primary site conditions to consider include expected depth to water and aspect. As a general rule of thumb, plants that are already present and healthy in the site vicinity should be considered as candidate species. Table 14.4 provides a list of tree and shrub species that may be suitable for drainageway planting in Woodland Park.

Table 14-4. Recommended Upper Elevation Riparian Trees and Shrubs

Regionally Occurring Trees	
Common Name	**Scientific Name**
Canyon maple	*Acer grandidentatum*
Boxelder maple	*Acer negundo*
Mountain alder	*Alnus tenuifolia*
Utah serviceberry	*Amelanchier utahensis*
River birch	*Betula fontinalis*
Western birch	*Betula occidentalis*
Colorado blue spruce	*Picea pungens*
Ponderosa pine	*Pinus Ponderosa*
Narrow-leaf cottonwood	*Populus angus±ifolia*
Balsam poplar	*Populus balsamifera*
Douglas fir	*Pseudotsuga menziesii*
Peach-leaved willow	*Salix amygdaloides*
Mountain ash	*Sorbus scopulina*
Green ash	*Fraxinus pennsylvanica*
Regionally Occurring Shrubs	
Common Name	**Scientific Name**
Rocky Mountain maple	*Acer glabrum*
Saskatoon serviceberry	*Amelanchier alnifolia*
Shadblow serviceberry	*Amelanchier canadensis*
Red osier dogwood	*Cornus stolonifera (syn.: C. sericea)*
Hawthorn	*Crataegus erythropoda*
Twinberry	*Lonicera involucrate*
Potentilla	*Potentilla fruticosa*
American plum	*Prunus americana*
Pin cherry	*Prunus pensylvanica*
Chokecherry	*Prunus virginiana melanocarpa*
Gambel's oak	*Quercus gambelii*
Golden currant	*Ribes aureum*
Common gooseberry	*Ribes inerme*
Smooth sumac	*Rhus glabra*
Rocky Mountain sumac	*Rhus glabra cismontana*
Woods rose	*Rosa woodsii*
Coyote willow	*Salix exigua*
Mountain snowberry	*Symphoricarpos oreophilus*

4.3 Seed Mixes

Unlined portions of the drainage corridor that are disturbed during construction should be actively revegetated. Seed mixes should be selected based on site conditions and management goals. A good rule of thumb is to select seed mixes that include plants with a broad range of tolerance for limiting conditions. For example, a wetland seed mix may include some species that thrive in very wet conditions as well as species that can tolerate periods of drought.

Recommended seed mixes for wet, transitional and upland areas are included in Tables 14-5 through 14-8.

Table 14-5. Low Grow Grass Mix

Common Name	Scientific Name	Growth Form[1]
Ephraim Crested Wheatgrass	*Agropyron cristatum (L.) A. Gaertn*	Bunchgrass
Sheep Fescue	*Festuca ovina*	Bunchgrass
Perennial Rye	*Lolium perenne*	Bunchgrass
Chewing Fescue	*Festuca rubra subsp. commutata*	Bunchgrass
Canada Bluegrass	*Poa compressa*	Sod-forming

Notes: [1]Characteristics: Grows 8-12 inches tall, Requires little to no maintenance, Grows well in elevations up to 10,000 ft.
Seeding Rate: New seeding – Dryland: 20-25 lbs/acre, Irrigated 40 lbs/acre; Overseeding – Dryland: 10-15 lbs/;acre, Irrigated 20 lbs/acre.
Source: Arkansas Valley Seed, www.avseeds.com.

Table 14-6. Recommended Seed Mix for Wet Conditions[1]

Common Name (Variety)	Scientific Name	Growth Season	Growth Form	Seeds/Lb	Lbs PLS/ Acre Drilled	Lbs PLS/Acre Broadcast or Hydroseeded
Redtop[1]	*Agrostis gigantea*	Warm	Sod	5,000,000	0.1	0.2
Switchgrass (Pathfinder)	*Panicum virgatum*	Warm	Sod/ Bunch	389,000	2.2	4.4
Western wheatgrass (Arriba)	*Pascopyrum smithii*	Cool	Sod	110,000	7.9	15.8
Indian saltgrass	*Distichlis spicata*	Warm	Sod	520,000	1.0	2.0
Wooly sedge	*Carex lanuginose*	Cool	Sod	400,000	0.1	0.2
Baltic rush	*Juncus balticus*	Cool	Sod	109,300,000	0.1	0.2
				TOTAL	**11.4**	**22.8**

[1]For portions of facilities located near or on the bottom or where wet soil conditions occur. Planting of potted nursery stock wetland plants 2-foot on-center is recommended for sites with wetland hydrology.

Table 14-7. Recommended Seed Mix for Transition Areas

Common Name (Variety)	Scientific Name	Growth Season	Growth Form	Seeds/Lb	Lbs PLS/Acre Drilled	Lbs PLS/Acre Broadcast or Hydroseeded
Sheep fescue (Durar)	*Festuca ovina*	Cool	Bunch	680,000	1.3	2.6
Western wheatgrass (Arriba)	*Pascopyrum smithii*	Cool	Sod	110,000	7.9	15.8
Alkali sacaton	*Spolobolus airoides*	Warm	Bunch	1,758,000	0.5	1.0
Slender wheatgrass	*Elymus trachycaulus*	Cool	Bunch	159,000	5.5	11.0
Canadian bluegrass (Ruebens)[1, 2]	*Poa compressa*	Cool	Sod	2,500,000	0.3	0.6
Switchgrass (Pathfinder)	*Panicum virgatum*	Warm	Sod/ Bunch	389,000	1.3	2.6
				TOTAL	**16.8**	**33.6**

[1]For side slopes or between wet and dry areas.

[2]Substitute 1.7 lbs PLS/acre of inland saltgrass (*Distichlis spicata)* in salty soils.

Table 14-8. Recommended Seed Mix for Upland Areas

Common Name (Variety)	Scientific Name	Growth Season	Growth Form	Seeds/Lb	Lbs PLS/ Acre Drilled	Lbs PLS/Acre Broadcast or Hydroseeded
Sheep fescue	*Festuca ovina*	Cool	Bunch	680,000	0.6	1.2
Canby bluegrass	*Poa canbyi*	Cool	Bunch	926,000	0.5	1.0
Thickspike wheatgrass (Critana)	*Elymus lanceolatus*	Cool	Bunch	154,000	5.7	11.4
Western wheatgrass (Arriba)	*Pascopyrum smithii*	Cool	Sod	110,000	7.9	15.8
Blue grama (Hachita)	*Chondrosum gracile*	Warm	Sod	825,000	1.1	2.2
Switchgrass (Pathfinder)	*Panicum virgatum*	Warm	Sod/ Brush	389,000	1.0	2.0
Side-oats grama (Butte)	*Boutelou curtipendula*	Warm	Sod	191,000	2.0	4.0
				TOTAL	**18.8**	**37.6**

4.4 Wetland Plant Containerized Stock

Wetland vegetation should be established in constructed wetlands, wetland bottom channels and along the shoreline of detention ponds if desired. Such vegetation serves multiple functions, including enhanced pollutant removal, shoreline stabilization, aesthetics, and wildlife and bird habitat. Recommended plants for wetlands are shown in Table 14-9 by water depth. Containerized stock is recommended for wetland plantings. Wetland plants should be spaced at no greater than 18 inches on center (O.C.).

Table 14-9. Recommended Plants for Constructed Wetlands and Detention Pond Shorelines[1]

Depth of Water (ft)	Common Name	Scientific Name	Notes
0-1.5	Soft stem bulrush Hard stem bulrush Arrowhead Alkali bulrush Smart weed	*Scirpus validus* *Scirpus acutus* *Sagittaria latifolia* *Scirpus maritimus* *Polygonum persicaria*	• Planted plants should extend above water • Plants will invade deeper water with time • Within micropool stage
0.25-0.5	Three-square Spike rush	*Scirpus americanus* *Eleocharis palustris*	• Planted plants should extend above water • Within WQCV[3] stage
0-0.25	Rice cut grass Nebraska sedge Soft rush Baltic rush Torrey's rush Foxtail barley	*Leersia oryzoides* *Carex nebrascensis* *Juncus effuses* *Juncus balticus* *Juncus torreyi* *Hordeum jubatum*	• Species will adjust to moisture conditions with time • Within EURV[4] stage
Height above Groundwater[2] 0-1 0-3	Milkweed Switchgrass Prairie cordgrass	*Asclepias incaornata* *Panicum virgatum* *Spartina pectinata*	• Best to plant near water where soil is wet • Colorful wildflower

[1]Containerized stock is recommended for wetland plantings. Cattails are not recommended due to their aggressive growth.
[2]Depth from surface to reliable groundwater that must be present.
[3]WQCV = Water Quality Capture Volume
[4]EURV = Excess Urban Runoff Volume

4.5 Willow Cuttings and Poles

Live stakes, willow cuttings and poles are straight branches or saplings that have been cut and pruned from dormant living plant material (plants that have lost their leaves). General procedures for obtaining these live cuttings include:

- **Single live stakes:** Live branches that will be trimmed and cut to length for this installation should be a minimum of 2½-ft long and a minimum of ½ inch in diameter for bare ground installation and a minimum of 3½-ft long for riprap joint planting. These cuttings should be free from side branches, and the terminal bud must remain undamaged. The root end of each cutting should be cut at a 45-degree angle. This serves as an indicator of which end of the stake to tamp into the ground or riprap and also facilitates the tamping process.

- **Willow bundling**: For willow bundle applications, live branches should be trimmed and cut to a minimum of 4-ft long and a minimum of 3/8 inch in diameter. These units should be free from side branches. The root end of each cutting should be cut at a 45-degree angle. This serves as an indicator of which end of the stake to insert into the ground or riprap.

General harvesting guidelines include:

1. **Timing of harvest and installation:** Live willow staking, bundling and poling should be performed on dormant plants in the late fall or between February 1 and April 1, prior to leafing out. Cuttings should be placed in water deep enough to cover at least the lower 6 inches of the cuttings immediately after harvest and planting should occur as soon as possible after collection.

2. **Harvesting site:** Live cuttings should be taken from a local, naturally occurring site where permission to harvest has been obtained from the landowner. No more than 30% of available branches should be harvested at a site. The harvesting site must be left clean and tidy. Excess woody debris should be removed from the site and disposed of properly or cut up into 16-inch lengths and evenly distributed around the site.

3. **Species of live cut materials:** Willow species should be *Salix exigua* (Sandbar willow) or approved alternative. Willow cuttings should be at least ¼ inch in diameter and cottonwood poles no less than ¾ inch in diameter.

4. **Cutting:** The use of weed whips with metal blades, loppers, brush cutters and pruners is recommended, provided that they are used in such a manner that they leave clean cuts. The use of chain saws is not recommended. Live plant materials should be cut and handled with care to avoid bark stripping and trunk wood splitting. Cuts should be made 8 to 10 inches from the ground and at a flat or blunt angle.

5. **Binding and storage:** Live branch cuttings should be bound together securely with twine at the collection site, in groups, for easy handling and for protection during transport. Live branch cuttings should be grouped in such a manner that they stay together when handled. Outside storage locations should be continually shaded and protected from the wind. Cuttings should be held in moist soils or kept in water until ready for planning. Cuttings should be protected from freezing and drying.

   Refrigeration is an acceptable method of storage, when necessary. Plants should be stored in moist, cool (<40° F) and dark conditions. Plants should be placed horizontally when refrigerated. Refrigerated plants are often less viable than freshly cut plants, so it is better to use freshly cut plants when possible. Refrigerated branch cuttings should be soaked in water for a minimum of 48 hours before planting.

6. **Arrival Time and Inspection:** Cuttings should arrive on the job site within 8 hours of cutting or removal from refrigerated storage. Upon arrival at the construction site, live branch cuttings should be inspected to ensure that they are in acceptable condition for planting. Cuttings not installed on the day of arrival at the job site should be sorted and protected (kept in water and in cold storage) until installation.

5.0 Seed and Plant Installation

5.1 General Guidelines

General guidelines and recommendations for revegetation include:

1. Seed mixtures should be sown at the proper time of year for the mixture. Generally, there are two optimal seeding periods during the year. The first period is in the spring, April to May. The second period is in late summer to early fall, August to September.

2. If feasible, seed should be drill-seeded to promote ideal seed depth.

3. Broadcast seeding or hydro-seeding may be substituted on slopes steeper than 3:1 or on other areas not practical to drill seed.

4. Seeding rates should be doubled for broadcast seeding or increased by 50% if using a Brillion drill or hydro-seeding.

5. Broadcast seed should be lightly hand-raked into the soil.

6. Seed depth should be 1/3 to 1/2 inch for most mixtures.

7. Seeded areas should be mulched and the mulch should be adequately secured.

8. If hydro-seeding is conducted, mulching should be conducted as a separate, second operation.

9. Containerized nursery stock should be kept in a live and healthy condition prior to installation.

10. Containerized trees and shrubs should be installed according to the planting details provided by either the grower or as found in the Colorado Springs Drainage Manual.

11. Live stakes, poles and willow bundles should be installed when dormant (late winter and early spring).

12. If beaver are known to be in the area, beaver protection should be provided for trees and shrubs.

5.2 Planting Details

5.2.1 Willow Planting Details

Figures 14-2 through 14-3 provide details for single willow planting and willow bundle planting, respectively.

5.2.2 Beaver Protection Detail

Figure 14-4 provides a detail for beaver protection.

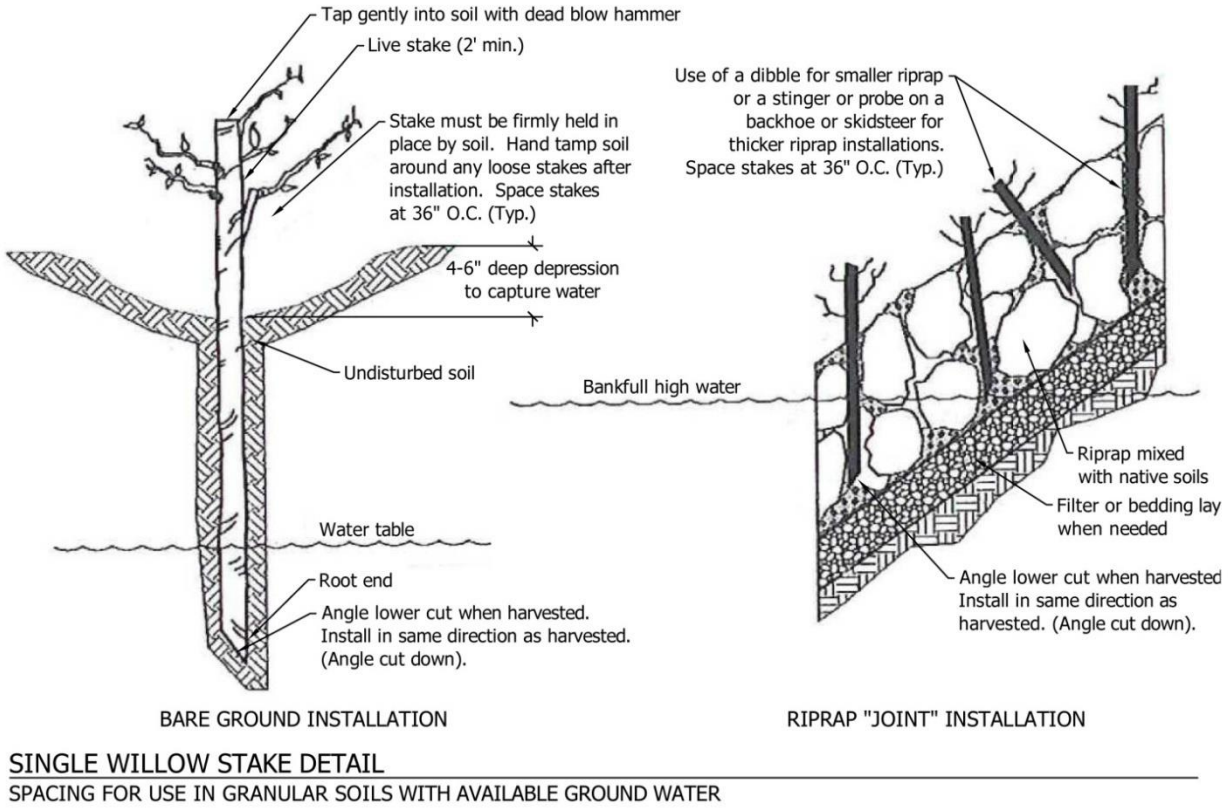

Figure 14-2. Single Willow Stake Detail

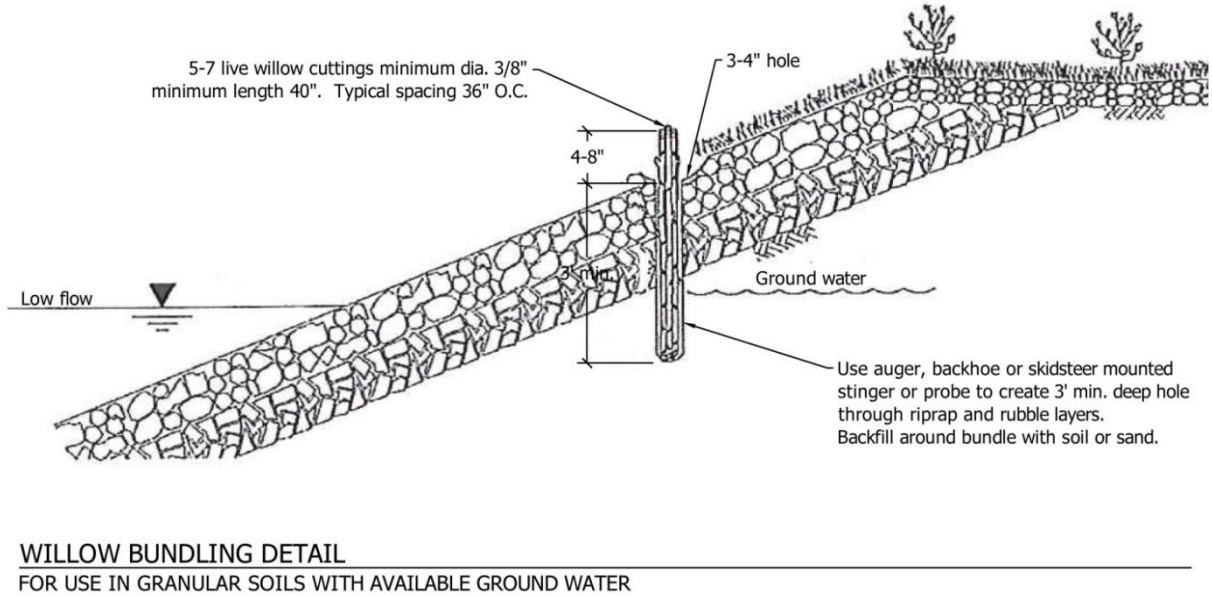

Figure 14-3. Willow Bundling Detail

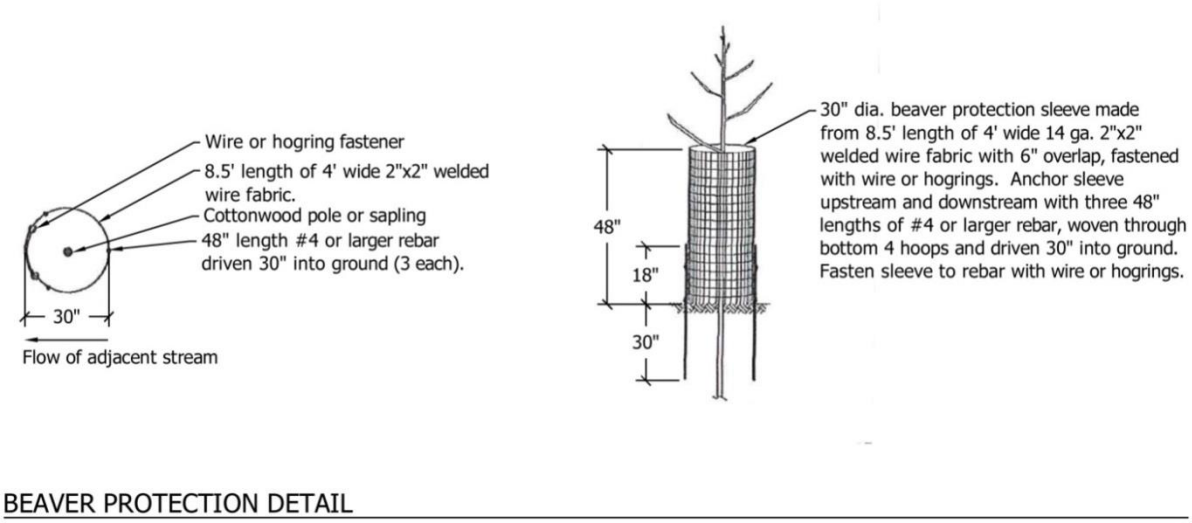

Figure 14-4. Beaver Protection Detail

5.3 Mulching

Planted areas should be mulched immediately following planting, but in no case later than 14 days from planting. Mulch conserves water and reduces erosion. The most common type of mulch is straw that is crimped into the soil to hold it. However, crimping may not be practical on slopes steeper than 3:1. Mulching guidelines include:

1. Only certified weed-free and certified seed-free straw mulch should be used (grass hay often contains weedy exotic species). Mulch should be applied at 2 tons/acre and adequately secured by crimping, tackifier, or used of rolled erosion control products such as netting or erosion control blankets.

2. Crimping is appropriate on slopes of 3:1 or flatter and must tuck mulch fibers into the soil to a depth of 3 to 4 inches.

3. Tackifier or rolled erosion control products such as properly secured netting or erosion control blankets should be used on slopes steeper than 3:1. See Volume 3 of the UDFCD Manual for a discussion on rolled erosion control products.

4. Hydraulic mulching may also be used on steep slopes or where access is limited. Wood cellulose fibers mixed with water at 2,000 to 2,500 pounds/acre and organic tackifier at 100 pounds/acre should be applied with a hydraulic mulcher.

5. Wood chip mulch should be applied to planted trees and shrubs.

5.4 Irrigation

Irrigation may be necessary to help all revegetated areas become established. Further, depending on specific goals for an area, ongoing irrigation may be necessary. Consultation with an irrigation specialist will help identify specific project needs. The following are presented as initial considerations.

1. **General Guidelines.** Due to the semi-arid climate and drying winds in Woodland Park, evapotranspiration exceeds natural precipitation. Supplemental irrigation is often required for plant establishment; therefore, except for drought tolerant plantings, supplemental irrigation is required during the plant establishment period. Depending on the site and the plant species selected, a permanent irrigation system may or may not be required.

2. **Moisture**. Maintaining acceptable moisture levels is essential to initiating germination and continuing the growth of the seedlings. Once germination occurs and growth begins, moisture is necessary for continual seedling growth. Temporary above-ground irrigation systems, such as watering by water trucks, or permanent underground systems can enhance germination and ensure success. Depending on site objectives, permanent irrigation may be necessary to sustain desired plant species.

5.5 Performance Standards for Vegetation Establishment

Plant material establishment performance standards should be implemented as a part of revegetation efforts. This will help to make sure that the erosion control goals for the project are achieved. Recommended performance standards include:

1. After 1 year, a minimum 70% aerial plant cover should be required. The Contractor's financial surety should not be released until this standard is achieved. Aerial plant cover should be measured using the Point Intercept Sampling Method (USDA Forest Service 2006) and results should be verified.

2. Woody plants, both trees and shrubs, should be maintained for 2 years. After this time, dead or dying plant material should be replaced.

3. When reseeding is needed to meet these performance standards, the Contractor must prepare a revegetation plan and submit it for approval to demonstrate an understanding of the specifications and define measures that will be taken to improve success. Measures to improve success could include retesting soil to develop additional soil amendment recommendations; scarifying the ground to reduce compaction, implementing a temporary irrigation plan, and allowing another year for establishment.

6.0 Maintenance

6.1 On-Going Monitoring and Management

General guidelines that should be included as a part of a vegetation establishment and maintenance plan include:

1. Following installation, the installation contractor should maintain the vegetated site for 2 years.

2. Sites should be inspected monthly during the first two growing seasons following planting. Immediate attention to a problem identified during these inspections (e.g., weed infestation, failure of seed to germinate) can facilitate an adaptive management response that requires less effort than if the problem is allowed to fester.

3. While plants are becoming established (normally the first year), pedestrian access to and grazing on recently revegetated areas should be limited with temporary fencing and signage.

4. As soon as possible, weed infestation should be managed using appropriate mechanical, chemical or biological methods.

5. Stakes and guy wires for trees should be maintained and dead or damaged growth should be pruned.

6. Mulch should be maintained by adding additional mulch and redistributing mulch, as necessary.

7. Areas of excessive erosion should be repaired and stabilized.

8. If natural hydrology is insufficient, trees and shrubs should be watered monthly or more frequently as needed from April through September until established.

7.0 Conclusion

Successful revegetation requires a multi-phase effort targeted to the relevant ecosystem type. Successful revegetation projects will address proper site preparation, plant material selection and installation, mulching, maintenance and post-revegetation monitoring. Early involvement of an ecologist, landscape architect or other qualified landscape professional can help improve the likelihood of a successful revegetation effort. Additionally, post-construction monitoring can help to identify problems such as weeds that can be corrected while they are at a more manageable stage.