1. Background

Bennett Regional Park and Open Space contains 193 acres owned and managed by the Town of Bennett. Previously the Property was a privately owned 18-hole golf course named "Antelope Hills." The Property is presently part of the Arapahoe County Open Space Program. It will be further developed in 2015 for recreational purposes as illustrated on the Bennett Regional Park and Open Space Conceptual Master Plan provided in Section 9. The Property supports *recreation*, *relatively natural habitat* and *open space* conservation values. In particular, the Property will provide public access to open space and outdoor recreation and will provide trail connections from the Antelope Hills Community to the Kiowa Creek North Open Space and surrounding rural areas for the use and enjoyment of the general public.

Since taking ownership of the Property in April 2013, approximately 80% of the concrete trail system from the golf course has been removed; management activities have since been limited, aside from trail maintenance to reduce erosion. Early-seral plants and weeds dominate the landscape; extensive management will be needed to restore the site to a healthy short-grass prairie ecosystem. Two existing ponds occur on-site. The conservation easement protects all 193 acres of Bennett Creek Regional Park and Open Space. A conceptual map of the Open Space is provided in Section 9.

2. Goals

The Town of Bennett would prefer that the Property is well vegetated and stable as quickly as is practical; however, there is no established schedule nor has a revegetation program been agreed on. Residents living adjacent to the Property will be informed about what to expect in terms of vegetation in the short-term, interim and final appearance and function. The Town anticipates the final, stable, permanent vegetation to take 3-5 years to fully achieve. The Town will not begin informing neighbors regarding expectations until the revegetation program is developed and ready for implementation. The eventual restoration should resemble the prairie ecosystem of this region.

3. Objectives

Ecological restoration of the Property can be achieved through the implementation of the following objectives.

3.1. Site Preparation: Proper site preparation is critical to the success of any restoration project. Recommended procedures here described include herbicide application to kill turf grasses and noxious weeds, tillage, establishment of a sterile cover crop and retreatment with herbicides in the late summer of 2016.

3.2. Seeding: A custom seed list is provided that is reflective of the historical climax plant community (as identified by the Natural Resource Conservation Service) for use on this site.

3.3. Mulching and Irrigation: Mulch cover is recommended to regulate micro-climate within the seed bed. Irrigation, if practiced, will aide germination.

3.4. Noxious Weed Control: Implement noxious weed best management practices and an integrated noxious weed program.

3.5. Monitoring and Adaptive Management: The site should be monitored for a period of three years, with the most frequent monitoring in the first year after seeding. Additional seeding, erosion control and noxious weed treatment shall be employed as necessary.

4. Existing Conditions

The Property can be segregated into three classifications based on previous use: 1) *Formerly Rough*, 2) *Formerly Greens* and 3) *Drainageways*. The first two classifications (Formerly Rough and Formerly Greens) are the focus of this restoration project; the third classification (Drainageways) is beyond the scope of this project. The distribution and acreage of treatment areas are indicated on the Site Restoration Map provided in Section 6. (It is assumed that total treatment acres will decrease when the final landscape plan becomes available and identifies which areas will be developed and which areas will remain open space. Map boundaries will need to be clipped to the final plan to accurately reflect treatment acres.) Soils were sampled in three locations and analyzed at the Colorado State University Soil, Water and Plant Testing Laboratory. Results are provided in the Appendix (Section 10) and were used to inform decisions about soil amendments. The below described classes will be managed differently as during the restoration as discussed in Section 5.

4.1. Formerly Rough (26.7 acres):

Areas that were formerly golfing rough support a mix of noxious weeds, early seral plants and undesirable restoration grasses. Dominant plants in these areas include crested wheatgrass (*Agropyron cristatum*), smooth brome (*Bromus inermis*), yellow sweetclover (*Melilotus officinalis*) and other annual grasses.

4.2. Formerly Greens (53.6 acres): Areas that were formerly golfing greens were the most heavily disturbed when the Property was a golf course. All native vegetation was removed and soils were contoured to meet recreational objectives. Soils may have been imported and were likely heavily amended and irrigated. A nearly pure stand of rhizomatous turf grasses remain today even after several years without maintenance. Some early seral plants and noxious weeds have invaded these areas. These areas will need to be treated aggressively in order to restore native prairie conditions resembling the historic climax plant community. Existing vegetation consists of cool-season turfgrass.

4.3 Drainageways: There are numerous ephemeral drainages throughout the Property that carry water after periods of precipitation. While side slopes of these drainages are presently well vegetated with non-native vegetation, including crested wheatgrass (*Agropyron cristatum*) and smooth brome (*Bromus inermis*), channel bottoms have been scoured in many places resulting in erosion, sedimentation and uncovered banks that are susceptible to colonization by undesirable vegetation. Russian olive trees (*Elaeagnus angustifolia*), a State-listed noxious species, are present. Recommendations are discussed subsequently.

5. Seed Selection

The recommended restoration seed mix was developed by first accessing the United States Department of Agriculture Natural Resources Conservation Service Ecological Site Description for the area for major land resource area 049-Southern Rocky Mountain Foothills Loamy Foothill (14-19 Precipitation Zone, Site ID: R049XC202CO). This resource identifies the historic plant climax community and ecological conditions of the site. Southern Rocky Mountain Foothills Loamy Foothill is suitable for the entire site. The seed mix was developed by

comparing the species in the historic climax community and the species observed at the site and determining what seed was available from Pawnee Butts, Inc., a local seed supplier. Ecological characteristics such as existing vegetation and site conditions were also considered. The final restoration target is to replicate the historical species composition, frequency and abundance of native prairie plants with approximately 85% of the cover being in cool and warm-season grasses and the remaining 15% in forb cover. The ecological site description and seed mix are provided in the Appendix.

6. Restoration Treatments

6.1 Formerly Rough: Implement noxious weed management activities as described below to reduce the abundance and distribution of noxious species.

6.2 Formerly Greens: Treatments are as follows:

- *Herbicide:* Treat all vegetation with glyphosphate (Roundup) or a similar herbicide per label recommendations to kill turf grasses. No seeding can occur within 10 to 14 days of herbicide application. Herbicide treatment should be done 2 weeks prior to seedbed preparation as this will allow optimum time for the treatment to fully eliminate all turfgrass areas.

- *Tillage:* Plowing the original turfgrass to break up the root system and create a uniform distribution of topsoil should be the first step in preparing the seedbed. A disking operation should be used as the primary technique for final seedbed preparation as described below. All preparation activities should be done 10 to 14 days after herbicide treatment has been applied to the turfgrass.

  Primary tillage of 10 to 24 inches deep may be necessary to alleviate compaction. Mixing subsoils and topsoils should be avoided by using implements that do not turn over the soil. Tools include subsoil rippers for the deepest tillage (12-24 inches) with at least 30 inches between shanks, chisel plows for 10- to 18-inch tillage with about 12 inches between shanks or offset disks for 10- to 14-inch tillage. Offset disks should not be used at depths deeper than the thickness of the re-spread topsoil.

  Secondary tillage of 6 to 12 inches deep aerates re-spread topsoils, breaks up clods, buries weed seeds (disk or moldboard plow only) and incorporates any plant residues or amendments. Secondary tillage operations include disking to 6 to 10 inches, chisel plowing to 6 to 10 inches or moldboard plowing to 6 to 12 inches. Secondary tillage should not be done to depths deeper than the thickness of the re-spread topsoil. The goal of finish tillage is to develop a firm seedbed free of large clods that is ready to plant. Finish tillage should involve one or more passes with a cultipacker, roller harrow, spring tooth harrow, clodbuster or other light-surface tillage implements.

  Cover Crop: If seeding cannot be completed before the May them establishment of a sterile annual cover crop is recommended. This crop

should be seeded in late spring and remain throughout the summer until early fall when the native seed can be established. We recommend an annual cover crop of barley or other suitable species such as annual rye or may be treated with a tackifier. If seedbeds are ready for planting in the spring, but fall planting is preferred, we recommend planting a cover crop such as sterile triticale or other small grain to protect the site from erosion.

- *Herbicide Treatment:* Repeat herbicide application in late fall as above to kill any turf grass or noxious species that were not killed by previous treatments.

- *Amendments:* Based on the results of soil tests, the use of fertilizers is not recommended. The use of fertilizer should be used sparingly as native plants, unlike horticultural or agricultural plants, rarely require fertilizer. Nitrogen fertilizer should be used sparingly or not at all; excess applications can be detrimental to a restoration project. Nitrogen should only be used where a soil test has revealed a gross deficiency. Test results can be compared with those from a similar intact community as a baseline indicator of natural nutrient levels. One strategy for determining if application of nitrogen fertilizer is appropriate is to wait until the next growing season and look for evidence of severe nitrogen deficiency. Signs of nitrogen deficiency include stunted growth and yellowish color. Fertilizer can then be applied in limited amounts to deficient areas only. Projects lacking topsoil will be the most deficient in soil nutrients and may require some type of fertilizer input. Indiscriminate use of nitrogen fertilizer can "burn" young native plant seedlings. Most native plants in Colorado have evolved to thrive in low-nutrient soils and will not benefit from high doses of nitrogen nearly as much as will competing non-native weeds. Nitrogen fertilizer can also encourage heavy weed growth. Most introduced weeds and agricultural species are very opportunistic users of nitrogen. Excess amounts of fertilizer can result in a flush of rapidly growing invasive weeds that overwhelm slower growing native species. Some weeds, such as Russian thistle or kochia, will flourish under the slightest application of nitrogen. In time, as nitrogen is used up or leached out of the soil, these weeds will decrease in abundance; however, in some cases this process may take many years.

  Where fertilizer use is appropriate, a low level or slow-release fertilizer is suggested for the growth of native plants. Organic fertilizers are good since they provide macronutrients (nitrogen, phosphorus, and potassium), micronutrients (copper, iron, manganese, zinc) and organic matter to the soil or substrate. Examples of organic fertilizers include: compost, biosolids (sewage sludge), mushroom compost, animal waste (i.e., manure) and biosol (a byproduct of penicillin production that can be purchased in granular form like chemical fertilizers).

- *Seeding:* Successful revegetation of disturbed plant communities is achieved by planting adapted species into a firm, weed-free seedbed at the correct depth and at the best time of year to utilize moisture and overcome seed dormancy. Prior to seeding any site, we recommend that all pre-seeding treatments such as tillage, fertilizing or the addition of organic matter have been successfully completed. If a season has passed since the initial tillage, the site should be tilled a second time to provide a favorable environment for germination and seedling growth by improving soil aeration, reducing compaction and producing conditions for good seed contact with the soil.

  Seed should be applied by drill seeding whenever possible or practical. Broadcast seeding should be used when drill seeding is impractical due to wet seedbed conditions, high surface rock content, steep slopes, narrow medians or when areas are too small to operate drilling equipment. Most seeding should occur in the fall, beginning in late September, and some seeding may occur in the spring if weather and soil conditions are favorable. After these dates, it is undesirable for seeding grass and installation of woody plants. If, for some reason, an area is not seeded or planted during the optimum dates, then planting/seeding should be postponed until the next available planting/seeding time. If seedbeds, are ready for planting in the spring, but fall planting is preferred, we recommend planting a cover crop such as sterile triticale or other small grain to protect the site from erosion (as discussed above.)

  We recommend 20 pure-live-seeds per square foot for drill seeding of most species. This varies depending on the ease of establishment and aggressiveness of particular species. We also recommend doubling the rate for broadcast seeding and for drill seeding critical area sites where germination is inhibited by low soil quality or other factors. Broadcast seeding critical areas (such as steep slopes) requires four times the target rate.

  Broadcast seeding should be accomplished with 4-wheel-drive equipment or all-terrain-vehicle-drawn broadcast seeders or hand seeders or with hydroseeding in areas too steep or otherwise inaccessible with 4-wheel-drive tractors and specialized revegetation equipment. Broadcast seeding rates should be doubled over drill seeding rates. See the provided seed list in the Appendix available from Pawnee Butts Seed Company.

  Spring seeding should be completed by the first week of May, otherwise, planting should occur in early fall.

- *Mulching:* Mulching materials should be from a weed-free approved source. Mulch should be applied on areas with an elevated potential for wind and/or surface-water erosion. Mulch should be applied after seeding is completed.

We recommend using native grass hay or straw as mulch. Native grass hay is far superior to straw mulch. Grass hay has significantly greater holding capacity and erosion control during wind and major precipitation events and provides improved protection of young seedlings during vegetation establishment.

For this project, apply vegetative mulch at a minimum of 1.0 ton/acre. If straw mulch is used, it should be clean grain straw, should not contain greater than 5 percent cereal grain seed by weight and should be free of noxious weeds. Neither grass hay nor straw should be used if it is finely chopped or ground. Vegetative mulch materials should not be used if they are musty, moldy or rotted. These materials also should be free of foreign material such as stones, dirt and roots.

Vegetative mulch should be applied after seeding is complete. The mulch should be applied in a uniform manner by a mulch spreader, at a rate of 2 tons per acre. Mulch should not be applied to areas with substantial existing vegetation growth and should not be applied to areas that have been pitted. Mulching should not be performed during adverse weather conditions or when wind prevents uniform distribution.

- *Mulch Crimping:* Vegetative mulch crimping should be done immediately after mulching and always on the same day that mulch is applied.

- *Irrigation:* If you have seeded at the correct time of the year, and there is normal precipitation, then supplemental irrigation is not necessary. However, if it is a dry spring, irrigating seeds the first year will improve success.

- *Other Considerations:*
  - *Erosion Control Blankets:* Where erosion control blankets are needed a machine-manufactured mat of 70 percent agricultural straw and 30 percent coconut fiber matrix that has a functional longevity of approximately 24 months should be used. These mats should be installed to assist in minimizing erosion and maximizing soil stabilization in highly erodible areas and on steep slopes where other mulching approaches would be inadequate. For ditches and areas with potential running water, a 100 percent coconut ditch liner erosion control blanket for better long-term results should be used.
  - *Silt Fence:* Silt fencing should be located downstream of all land-disturbing activities. Fence posts should be of sufficient thickness to permit driving into the ground to a minimum depth of one foot, and to resist the lateral forces of silt and water accumulation. Silt fence posts should be driven to approximately one foot below grade, with approximately two feet protruding aboveground. An anchor trench should be excavated along the fence line. The

support netting should be attached to the posts so that the bottom of the mesh is just above the bottom of the anchor trench. The anchor trench should then be backfilled to secure the materials in the trench. Silt fencing should be inspected regularly and sediment removed periodically to prevent damage to the fence.

- *Hay Bales:* Hay bales should be placed in areas of suspected high-flow surface runoff to reduce velocity and trap sediment as it travels downhill. Hay bales should be placed in a row with ends tightly butted. Each bale should be embedded a minimum of four inches below existing grade and anchored in place by two stakes driven through each bale. The first stake in each bale should be driven toward the previously laid bale to force the bales together. On steep slopes, two rows of hay bales with staggered ends may be required. Hay bales that become excessively clogged with sediment should be replaced with new bales.
- *General Care of Stock and Planting Guidelines:* Tree and shrub planting stock should be delivered to the site in original containers with legible labels, intact at time of inspection. All plants should be fully protected from severe wind and sun desiccation during storage. Containerized species should be stored in a cool, moist environment until planting. Care should be used during handling of all trees, shrubs and woody species to minimize damage. General guidelines for acceptable environmental and weather conditions should be followed as closely as possible to minimize conditions that may adversely impact planting success. The following guidelines should be used for all transplanting:
    - The appropriate planting time should be determined by site conditions such as soil moisture, soil temperature, air temperature, aspect and accessibility. Planting of containerized nursery stock should occur in the fall (late September to mid-November) or early spring (April to late May), provided the ground is not frozen.
    - To the extent that seasonal conditions and planting timeframes allow, the soil profile should be moist.
    - Soil temperatures should be 45 degrees Fahrenheit or greater.
    - Snow cover should be less than 2 inches.
    - Air temperature should be between 32 and 65 degrees Fahrenheit.
    - Wind velocity should be less than 20 miles per hour.
    - Spacing of woody plants within drainage areas and wetlands should vary. Stock should be planted in clusters to provide erosion protection. Actual locations of species should be delineated in the field based on site conditions (i.e., slope, hydrology, etc.).

6.3 Drainageways: Restoration of drainageways is beyond the scope of this contract; however, it is recommended that minor regrading, placement of cobble within scoured channels, revegetation and noxious weed control be pursued to retain site integrity.

7. Noxious Weeds

Noxious weeds occur throughout the Property. Populations should be mapped and monitored so that they may be controlled prior to and during construction so that turfgrass can transition to native vegetation in a timely manner.

Weeds are spread by a variety of means including vehicles, construction equipment, wildlife, wind and water. Implementation of preventative measures to control the spread of noxious weeds is the most cost-effective management approach. Noxious weed controls should be included in each phase and in each area of the Property.

Principal weed species observed throughout the site include bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium canadensis*), common mullein (*Verbascum thapsus*), spotted knapweed (*Centaurea maculosa*), puncturevine (*Tribulus terrestris*) and Russian olive (*Elaeagnus angustifolia*). All species are listed as noxious by the State of Colorado and require management.

7.1 Preventative Measures: The following measures should be used to prevent the spread of noxious weeds where ground-disturbing activities might occur during construction:

- Chemical pre-treatment should be used prior to ground-clearing activities, as appropriate. (Pre-treatment methods are discussed below.)
- Any infestation should be mapped via GPS for pre-treatment and post-construction monitoring purposes.
- All construction vehicles and equipment should arrive at the work site clean and weed-free. All vehicles and equipment should be inspected prior to being allowed access to the site to ensure that they are free of soil and debris capable of transporting noxious weed seeds, roots or rhizomes.
- Selective vegetation clearing and soil stripping methods should be used to minimize the transport of noxious weed seeds, rhizomes or roots from infested areas into areas where weeds are not present.
- All mulch and seed mixes should be certified noxious-weed-free before being used onsite.

7.2 Herbicide Pre-Treatment: We estimate that there are approximately 5 acres of noxious weeds throughout the Property; noxious weeds may be 10% of the total plant cover. This estimate is based on apreliminary examination of the Property.

Prior to construction, noxious weeds should be treated with chemical herbicides at the appropriate time (spring, summer or fall spraying) depending on the targeted weed species. The use of herbicides that break down and detoxify relatively rapidly is necessary to prevent adverse effects on germination and growth of seeded species. Only federally-approved, short-lived herbicides should be used for pre-treatment of noxious weeds. Treatment methods will vary with site-specific conditions and the type of

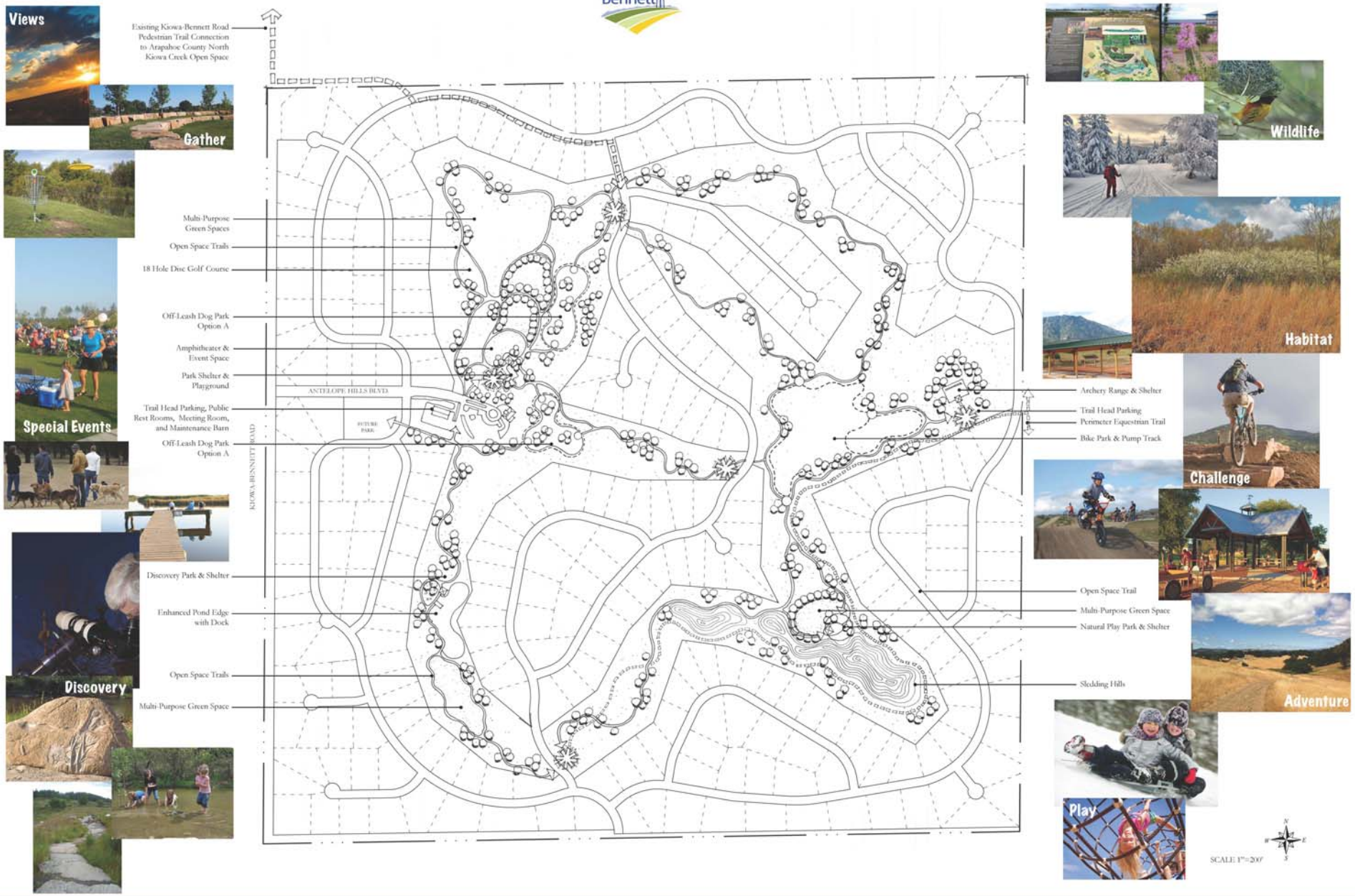
species being treated. Methods used to reduce the spread and establishment of noxious weeds should be discussed with landowners and the Adams County Weed Control Board.

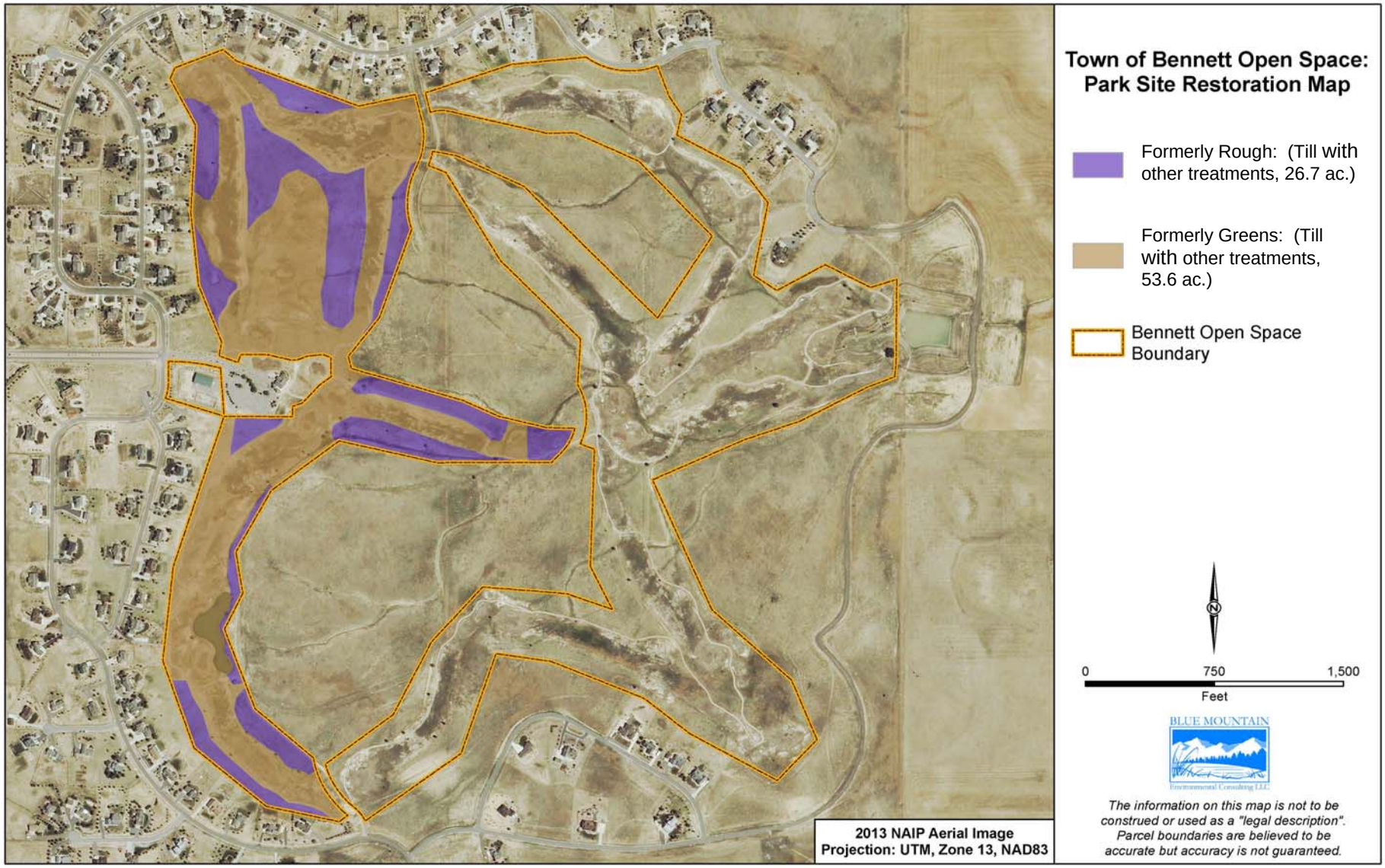
7.3 Treatment Methods: Methods selected to reduce the spread and establishment of noxious weeds should be discussed with the landowners and the Adams County Weed Control Board. Chemical treatments should be based on species-specific and site-specific (e.g., proximity to water or wetlands, time of year) conditions and should be coordinated with the landowners and the Adams County Weed Control Board. Integrated management treatments including mechanical, cultural, chemical and biological recommendations are provided for each species in the Appendix.

8. Monitoring and Adaptive Management

The site should be evaluated during seeding operations, as well as several times per year thereafter to determine if seeds are germinating, identify unvegetated and eroding areas or noxious weed problems. Corrective actions can then be prescribed and implemented. Details of the monitoring plan will come into focus once project timing is determined.

9. Maps


Views
Gather
Special Events
Discovery
Existing Kiowa-Bennett Road Pedestrian Trail Connection to Arapahoe County North Kiowa Creek Open Space
Multi-Purpose Green Spaces
Open Space Trails
18 Hole Disc Golf Course
Off-Leash Dog Park Option A
Amphitheater & Event Space
Park Shelter & Playground
Trail Head Parking, Public Rest Rooms, Meeting Room, and Maintenance Barn
Off-Leash Dog Park Option A
ANTELOPE HILLS BLVD.
FUTURE PARK
KIOWA-BENNETT ROAD
Discovery Park & Shelter
Enhanced Pond Edge with Dock
Open Space Trails
Multi-Purpose Green Space
Wildlife
Habitat
Challenge
Adventure
Play
Archery Range & Shelter
Trail Head Parking
Perimeter Equestrian Trail
Bike Park & Pump Track
Open Space Trail
Multi-Purpose Green Space
Natural Play Park & Shelter
Sledding Hills
SCALE 1"=200'


Town of Bennett Open Space:
Park Site Restoration Map
Formerly Rough: (Till with other treatments, 26.7 ac.)
Formerly Greens: (Till with other treatments, 53.6 ac.)
Bennett Open Space Boundary
N
0
750
1,500
Feet
BLUE MOUNTAIN
Environmental Consulting LLC
The information on this map is not to be construed or used as a "legal description". Parcel boundaries are believed to be accurate but accuracy is not guaranteed.
2013 NAIP Aerial Image
Projection: UTM, Zone 13, NAD83

10. Appendix

Colorado State University Extension

Soil Test Report

PAP-Accredited NAPT 2011

Colorado State University
Soil, Water and Plant Testing Laboratory
Room A319, NESB
Phone: 970-491-5061 / Fax: 970-491-2930

Lab ID Number:	H1157b	Report Date:	3/16/2016
Sample ID:	1		
Company Name:	Blue Mountain Environmental	Invoice #:	CC11372
Contact Name:	Matt Tobler	Street Address:	937 Mullen Dr
Phone:	(970) 224-0851 Ext:	City:	Ft Collins
Email Address:	matt@bluemountain1.net	County:	Larimer
Client Type:	Consultant	State:	CO
Current Plant Type:	Established Turfgrass	Zip:	80521
Proposed Plant Type:	Native Vegetation	Date Rcvd:	3/3/2016
Current Irrigation:	-	Date Tested:	3/8/2016
Current Amendments:	-	Test Performed By:	TCP JS TD

pH: 8.1

pH is high, but native and introduced plant species that are adapted to this pH should not be negatively affected.

Electrical Conductivity or Salts: 0.4 mmhos/cm

E.C. is Low. When E.C. less than 2.0, salinity is not a problem for plant growth.

Lime: Very High

Very High: Lime is greater than 5%. Plants can still grow quite well in soil with this lime content.

Texture Estimate: sandy clay

This soil may drain at a low to very low rate. Watering schedules may have to be increased to allow for better water infiltration into the soil profile.

Sodium Absorption Ratio:

This value not requested.

Organic Material: 1.0 % Plant Type: Native Vegetation

Please add customized comments for this situation.

Nitrate: 1.0 ppm

Please add customized comments for this situation.

Phosphorus: 2.5 ppm

Phosphorus is Very Low; Add 0.5 lbs. P2O5/100 sq.ft. or 5 lbs. P2O5/1000 sq.ft. Bone meal can be added at 3.5 lbs/100 sq.ft. or triplesuperphosphate can be added at 1 lb/100 sq.ft. Multiply rates by 10 to convert to lbs/1000 sq.ft.

Potassium: 172.4 ppm

Potassium is Low; Add 0.1 lbs K2O per 100 sq.ft. or 1 lbs of K2O/1000 sq.ft. Potassium can be added as potassium chloride at 0.2 lbs/100 sq.ft. as composted manure @ 0.05 cubic yards/100 sq.ft. Multiply rates by 10 to convert to

lbs/1000 sq.ft.

Zinc: 0.4 ppm

Zinc is Low; Add 4 oz. of Zn per 1000 sq.ft. or 10 lbs Zn/acre.

Iron: 4.6 ppm

Iron is Low; Add 4 oz. of Iron (Fe) per 1000 sq.ft. as iron chelate.

Manganese: 0.6 ppm

Manganese is Adequate; No additional Mn is needed.

Copper: 2.9 ppm

Copper is Adequate; No additional Cu is needed.

Boron: 0.50 ppm

Boron is High. No additional boron is needed.

Gypsum:

Gypsum is NOT Needed.

Additional Comments:

More information on landscaping and gardening can be found at www.ext.colostate.edu Be sure to check out our website at www.soiltestinglab.colostate.edu for a list of garden centers where you can find a variety of fertilizers and soil amendments.

James R Self, Ph.D, Director, Soil, Water and Plant Testing Lab

Design by: Phil DeJong phil@itmanonline.com

Copyright: Colorado State University 2011

Ecological Site Description - Major land resource area 049-Southern Rocky Mountain Foothills Loamy Foothill

"This site developed with occasional fires being part of the ecological processes. It is believed that fires were historically infrequent, randomly distributed, and started by lightning at various times throughout the growing season. Early human inhabitants were also likely to start fires for various reasons (deliberately or accidentally). Both of these types of fire events likely impacted the site by leaving mosaic vegetation patterns. The impact of fire over the past 50 years has been relatively insignificant due to wildfire suppression and the lack of acceptance of prescribed fire as a management tool. However, prolonged drought, coupled with fire suppression has increased the frequency and intensity of periodic wildfires in the area. Lack of grazing and lack of fire initially causes increased herbaceous litter.

Deterioration of this site, due to continuous grazing without adequate recovery periods following each grazing occurrence and/or overstocking, will cause blue grama to increase and eventually form a sod. Cool-season grasses such as green needlegrass and western wheatgrass will decrease. Warm season grasses such as big bluestem, key shrubs such as fourwing saltbush and winterfat, and palatable forbs such as American vetch will also decrease. Red threeawn, annuals and bare ground increase under heavy continuous grazing. Decadence of bunchgrasses, such as needle and thread and Indian ricegrass, and lower vigor vegetation is expected. This also allows invasive species like diffuse knapweed, spotted knapweed, cheatgrass, toadflax and other similar vegetation to establish. Prescribed grazing with adequate recovery periods following each grazing event and proper stocking rates will maintain the palatable plants.

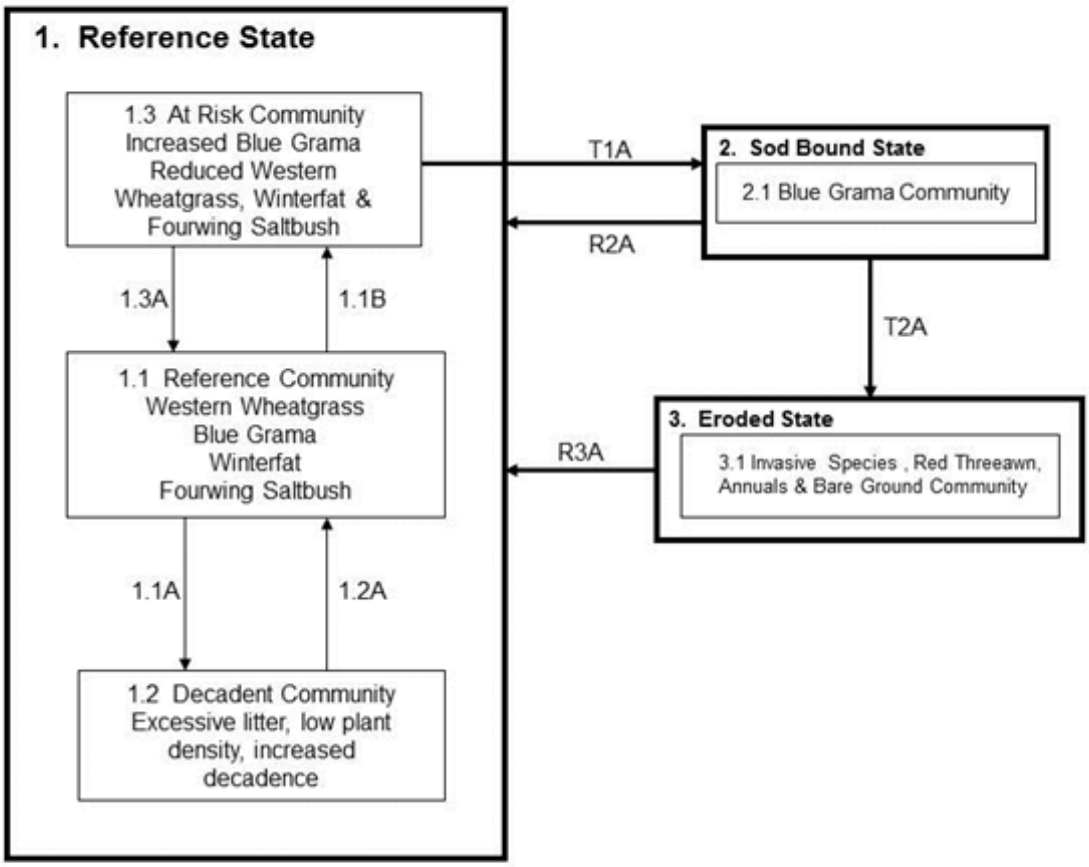
Drought and/or early killing frost cycles have historically impacted the vegetation. Changes in species composition will vary depending upon the duration and severity of the drought and/or frost cycle.

Some of this ecological site has been tilled and used for crop production. Today, much of this site is urban/suburban residence and small acreage development. Residential development leads to fire suppression.

The Reference Plant Community (as described in the State and Transition Diagram below) has been determined by study of rangeland relic areas, areas protected from excessive disturbance, seasonal use pastures, short duration/time controlled grazing and historical accounts.

The following diagram illustrates the common plant communities that can occur on the site and the pathways (arrows) among communities. Bold lines surrounding each plant community or communities represent ecological thresholds and a plant community state. Community phase pathways in the reference state represent shifts in the plant community within the natural range of variability. Transition and Restoration pathways represent the plant community crossing an ecological threshold between states. The ecological processes are discussed in more detail in the plant community descriptions following the diagram." From https://esis.sc.egov.usda.gov/ESDReport/fsReport.aspx?approved=yes&rptLevel=all&id=R049XC202CO.

State-and-Transition Diagram



PAWNEE BUTTES SEED, INC.

P.O. Box 100 - 605 25th Street
Greeley CO 80632
Phone: (970) 356-7002 Fax: (970) 356-7263

Date: March 11, 2016

Customer: Blue Mountain Environmenta;
Address:

Phone:

****** Prairie Seed Mix ******

40 Acres X $76.83 /Acre $3,073.00

Kind	Variety	Base	%	PLS Lbs / Acre	Total PLS Lbs
Western Wheatgrass			15.00%	2.4000	96.00
Indian Ricegrass			10.00%	0.8000	32.00
Blue Grama			15.00%	0.4500	18.00
Prairie Junegrass			5.00%	0.0500	2.00
Sideoats Grama			10.00%	0.9000	36.00
Buffalograss			10.00%	1.6000	64.00
Sand Dropseed			5.00%	0.0250	1.00
Little Bluestem			10.00%	0.7000	28.00
Purple Prairie Clover			5.00%	0.2000	8.00
Upright Coneflower			5.00%	0.1000	4.00
Rubber Rabbitbrush			5.00%	0.1000	4.00
Winter Fat			5.00%	0.1000	4.00
			100.00%	7.43	297.00

Total PLS 297.00

Bull Thistle

Cirsium vulgare is a biennial forb appearing in recent clear cuts or disturbed areas and becoming a dominant species for several years. First year plants form a rosette with leaves easily distinguished from other thistles by the prickly hair on the top surface of leav es and cotton-hair on the undersides. It can produce up to 4,000 seeds per plant. Seeds are spread by wind and birds. Bull thistle grows in dry to moist habitats and thrives on nitrogen-rich soils. It cannot withstand deep shade. Seeds on or near the surface of the soil do not reamin viable for moer than a year; seeds buried at a depth of 5 inches may remain viable for up to three years.

Biological control: The gall fly *Urophora stylata* can reduce seed production up to 80% in some areas. Due to bull thistle's spiny stem and leaves, it is unpalatable to most livestock; however, sheep will graze on seedlings or small rosettes.

Mechanical control: Cutting, mowing, and/or severing the tap root below the root crown before seed set will eliminate current year seed production, and, if continued annually, will eliminate an infestation. The best time to cut is after the plants have bolted but before a significant number have flowered. Plants will re-bolt if mowed too early. Eliminate late-bolting plants by cutting again a month after the first cut.

Chemical control: Spot applications of picloram, dicamba, or 2,4-D will provide control. Glyphosphate can be used to provide some control. Herbicides should be applied in the rosette stage or after mowing as the plant becomes more tolerant of herbicides once the flower stalk is produced.

Cultural control: Minimize disturbance and establish healthy stands of tall grasses or forbs to outcompete bull thistle.

Integrated management: Bull thistle does not tolerate shade and does not compete well with other tall plants. Apply herbicides to rosettes in early spring and then mow or sever taproots after the plants have bolted but before flowering. A second mowing or cutting is suggested a month later. Do not cut or spray if using seedhead biocontrols.

Canada Thistle

Cirsium arvense is an exotic perennial forb that can spread by seed, but is more of a problem due to its ability to spread rapidly from vigorous rhizomes that can extend as far as 15 feet from the parent plant. Infestations often begin on disturbed sites such as ditches, overgrazed pastures, or waste areas (Beck 2000). Canada thistle is the greatest problem weed of riparian areas, but is also found occasionally in upland sites. Seeds can be blown long distances and are able to germinate within 8 to 10 days of pollination. Canada thistle begins growth in mid April through May as a rosette. It flowers in June, but produces seed sparingly, relying heavily on its extensive root system for spread. Seeds can remain viable in the soil for up to 20 years (Beck 2000). Photo from Whitson et al. (1996).

Biological control: The weevil *Ceutorhyncus litura* is currently being used in Colorado as a biocontrol agent (Beck 2000). The larvae of this weevil bore into the main leaf vein and down into the plant's crown. Large weevil populations can kill these plants, smaller populations will stress plants and decrease vigor. Another biocontrol insect, *Urophora cardui*, has been used to control Canada thistle. The larvae burrow into the shoots and their feeding triggers large galls that stress the plant (Beck 2000). Biological controls alone are not effective and must be used in conjunction with other practices.

Mechanical control: Mowing is a popular method of decreasing plant vigor and seed set. However, this may not be a viable option given the plants dispersal in riparian areas. Hand pulling is an effective means of control for small populations, but is not practical for large populations due to the robust, deep, and extensive network of underground rhizomes. When seed heads are encountered they should be clipped well below the apex, bagged, and disposed of in a dumpster.

Chemical control: Curtail at 2 to 3 quarts/Ac can be applied when the oldest Canada thistle plants are entering the bud growth stage and the youngest are in the rosette to bolting growth stages (Beck 2000). Transline can be applied at 2/3 to 1 pint/Ac when Canada thistle is in the rosette to bud growth stages. Transline at 1 pint/Ac is also effective when applied in the fall (Beck 2000). Caution should be used in selecting herbicides for this weed since it occurs near water where many pesticides can have detrimental effects on aquatic life.

Cultural control: Most cultural control measures for managing Canada thistle include increasing competition with Alfalfa and perennial grasses.

Integrated management: Control efforts should target plants in high-quality areas first. Management strategies should be adjusted to reflect weather conditions. For example, drought stress reduces the effectiveness of most herbicides but increases the effectiveness of mechanical controls. It takes at least two years of control to determine if a method is effective.

Common Mullein

Common mullein (*Verbascum thapsus*), also known as flannel leaf, fleawort or Jacob's staff, is a biennial forb that can easily be identified by its yellow flowers grouped in a "corn cob" shaped flowering raceme. The leaves are light green and densely wooly. Mature plants have a single, erect stem that can grow 6 to 8 feet in height. Seeds germinate in the early spring, forming a rosette that continues to grow into late autumn and over winter; a tall stem topped with the flowering raceme is produced the following spring.

Common mullein can be hard to control due its prolific seed production. The seeds can germinate after lying dormant for several decades. If seeds are not present when an area is disturbed or a field is abandoned, the limited dispersal ability of the seeds will probably not enable mullein seeds to arrive and establish while bareground is still available. Mullein is easily outcompeted in areas with a densely vegetated ground cover but readily grows in disturbed sites. Mullein prefers dry, gravelly to sandy, coarse-textured soils, and is commonly found throughout Colorado in pastures, meadows, fencerows, waste areas, and along river bottoms. It was probably introduced to America from Eurasia as a medicinal herb used to remedy coughs and stomach ailments (CNAP 2000).

Biological control: Weevils (*Gymnetron tetrum*) that feed on the seeds have been found effective in reducing seed production (Denver County Cooperative Extension. (n.d.) *Gardening and Horticulture: Weeds.* Retrieved August 12, 2004 from http://www.colostate.edu/Depts/CoopExt/4DMG/Weed/mullein.htm)

Mechanical control: Mullein plants have shallow tap roots and are easily hand-pulled. They should be pulled as soon as they are large enough to grasp but before they produce seeds. Mullein stems can be cut or mowed to prevent flower and seed production, but stems must be cut below the root crown or rosettes will re-bolt (CNAP 2000).

Chemical control: Herbicide application is most effective during the rosette stage. Due to the wooly nature of the leaves, herbicides should be mixed with a surfactant to facilitate uptake. Effective herbicides include metsulfuron at 0.6 oz. ai/acre, tebuthiuron at 4-6 lb. ai/acre (CNAP 2000).

Cultural control: Minimize disturbance and seed dispersal, eliminate seed production and maintain healthy native communities. Mullin is often an early invader of burned areas.

Integrated management: Mangement efforts must include the elimination of seed production and the depletion of the seed bank. Combine herbicide or mechanical removal of rosettes with removal of seed heads from any plants that have bolted.

Cheatgrass

Bromus tectorum is an exotic winter annual grass that is one of the most widely distributed weeds in the western U.S. Cheatgrass has been shown to significantly alter the fire regime of ecosystems (D'Antonio and Vitousek 1992). It germinates in the fall or early spring and sets seed in May and June. Cheatgrass flourishes in moderately and highly disturbed upland sites such as roadways, overgrazed areas, revegetated areas, and waste sites; it gains a competitive edge over native species by initiating early spring growth, and by aggressive utilization of deep soil resources. Seeds are dispersed by animals and recreationists who unknowingly have the seeds stuck in their fur, socks, boots, muddy tires, etc. Because seeds remain viable for up to five years, control measures that reduce seed set can reduce the spread of this plant. Photo from Whitson et al. (1996).

Biological control: Grazing is a possible control strategy. Cattle find cheatgrass highly palatable in early spring before seed set occurs. Where infestations are large and dense, prescribed spring grazing repeated for 3 to 5 years by cattle and sheep can be effective, and indeed may be the only option in some areas where it is difficult or impractical to implement other prescriptions.

Mechanical control: Given the life history patterns of cheatgrass, mechanical control efforts are not recommend unless they are followed by an aggressive revegetation and chemical control program. When mowing is used, it should be done in early spring before seed heads are fully developed (early to mid- May) and repeated for at least 5 years.

Chemical control: Fall application of Plateau 1.5 ounces/acre has been effective in some experimental plots. Application must be made in fall, before plants become too mature to be affected (Smith 2003).

Cultural control: Due to the broad distribution of this plant, tilling and seeding operations would be impractical and costly. However, in areas where historic revegetation efforts have not produced a healthy stand of perennial grass cover, interseeding these areas with native perennial grasses, following cheatgrass control, can be effective. Fire has also been known to effectively control cheatgrass when prescribed in the early spring before seed set. Burning for 5 years will be required and therefore may not be practical. Since burning during other times of the year can increase the abundance of cheatgrass, every effort should be made to coordinate prescribed fire with the life stage of this weed.

Integrated management: Lasting control of cheatgrass requires a combination of chemical and physical control, vegetative suppression, and proper livestock management where land is grazed. This cumulative method keeps plants under stress, reducing their ability to flourish and spread, and redundancy in case one type of treatment proves ineffective.

Diffuse Knapweed

Acosta diffusa (Centaurea diffusa) is an exotic biennial (sometimes annual or short-lived perennial) forb that often invades both disturbed and relatively undisturbed upland sites. Knapweed reproduces from seeds that germinate in the spring or fall. It survives in a rosette stage for its first year and bolts in the second year setting seed in June and July (Beck 1997). Mature plants often break off at ground level; they can be dispersed to new sites by blowing in the wind, or by transport on the undercarriage of vehicles. Photo from Whitson et al. (1996).

Biological control: The seed head flies *Urophora affinis* and *Urophora quadrifcasciata* have been released in Colorado to cause plants to produce fewer viable seeds and abort terminal or lateral flowers (Beck 1997). Larvae of the diffuse knapweed root beetle (*Sphenoptera jugoslavica*) and yellow winged knapweed moth feed in the roots of this weed. Sheep, goats and cattle will also consume knapweed. This strategy is most effective if used before seed set in early spring (May).

Mechanical control: Hand pulling or mowing before seed set has proven to be an effective control strategy within Boulder County. We suggest hand pulling where small infestations occur. Mowing or hand pulling should be conducted when the plants are in the bud growth stage (early summer, mid to late June) to decrease seed set. Plants should be mowed as close to the ground as possible. Mechanical treatments need to be followed by revegetation in areas that lack native cover. Seed heads should be clipped well below the apex, bagged, and disposed of in sealed dumpsters.

Chemical control: Research indicates that dicamba (Banvel) at 0.5 to 1.0 lb active ingredient per acre (a.i./Ac) and picloram (Tordon) at 0.25 to 0.5 lb a.i./Ac control knapweed (Beck 1997). However, where occurrence is due to lack of perennial grass cover in revegetated areas, control methods must be followed by restoration efforts in order to prevent future reinfestations.

Cultural control: Timely tilling is one effective means of controlling this weed where populations are very dense, and occur in an agricultural setting. However, tilling is not recommended where this weed occurs in native ecosystems, due to the high level of soil disturbance caused by tilling. Tilling may also propagate other weeds.

Integrated management: Each situation is different. Single treatments provide temporary but not long-lasting control. The most effective method of control is to prevent establishment. Areas that are adjacent to known patches of diffuse knapweed should be monitored two to three times a year and any new rosettes should be destroyed. Established plants can be pulled or spot treated with picloram. Seeding desirable perennial grasses is essential to prevent weed reinvasion.

Puncturevine

Puncturevine (*Tribulus terrestris*) is an annual forb that grows prostrate forming a mat with trailing stems, each about ½ to 5 feet long. Its leaves are opposite, hairy, divided into 4 to 8 pairs of leaflets, each about ¼ to ½ inch long and oval. Flowers are yellow, 1/3 to ½ inch wide with 5 petals, borne in the leaf axils. Fruits consist of 5 sections which, at maturity, break into tack-like structures with sharp, sometimes curving spines, each 2 to 4 seeded. Flowering and seed production occur from July to October, seed germination occurs after spring or summer rain and during wet periods. Puncturevine can grow in compacted soil, sandy or moist soils and in rich soil (CNAP 2000). Puncturevine was introduced from Europe and in now widely scattered over much of the U.S. It grows in pastures, cultivated fields, waste areas and along roads and trails. The hard spiny burs damage wool, injure livestock and puncture bicycle tires. The seeds will remain dormant in the soil for 4 to 5 years making eradication difficult (Whitson et al. 1996). (Photo from Whitson et al. 1996)

Biological control: There are 2 insects that have been released as biocontrols of puncturevine. Microlarinus lareynii is a tem boring weevil and M. lypriformus is a fruit boring weevil.

Mechanical control: Puncturevine can be controlled by digging, hand pulling, or tilling infestations before flowering and seed production (CNAP 2000).

Chemical control: Picloram or diacamba at 0.25 lb. ai/acre, 2,4-D at 1 lb. ai/acre, or glycophosate at 1.5 lb. ai/acre can be applied to plants during the seedling stage.

Cultural control: Prevent the establishment of new infestations by minimizing disturbance and seed dispersal, eliminating seed production and maintaining healthy native communities (CNAP 2000).

Integrated management: This plant is difficult to control due to its mat forming growth habit, use a combination of methods to eliminate seed production and destroy new seeds (CNAP 2000).

Russian Knapweed

Acroptilon repens is a perennial forb that typically invades disturbed areas, forming dense single-species stands. Once established, it uses a combination of adventitious shoots and allelopathic chemicals to spread outward into previously undisturbed areas. It reproduces primarily vegetatively. Knapweeds are often spread in hay and on vehicle undercarriages. Seeds may remain viable for 2-8 years. Russian knapweed is not restricted to any particular soil type but does especially well in clay soil.

Biological control: Not known.

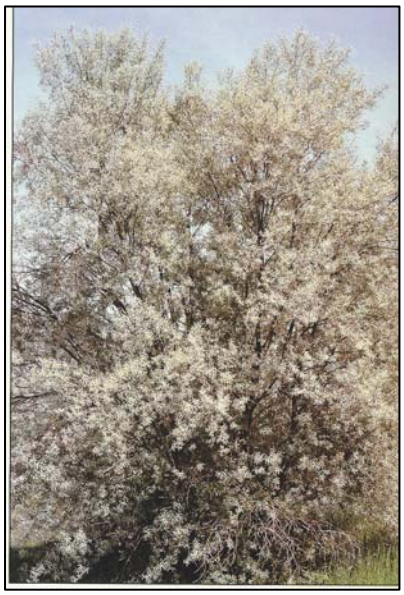
Mechanical control: Cutting or removal of the above ground portion reduces the current year growth and may eliminate seeed production, but it will not kill Russian knapweed. Cutting several times before the plant bolts stresses plants and forces them to use nutrient reserves in the roots. The emerging plants are usually smaller in size and with reduced vigor. A combination of cutting and herbicides can be used for control. In the fall, apply picloram to any plants that have re-emerged. This process may have to be repeated for several years to exhaust the seedbank.

Chemical control: Picloram is widely used on and effective for treating Russian knapweed. Glyphosate or dicamba can be applied during the bud-growth stage to control topgrowth. However, abundant regrowth from the root system will occur the following year and additional applications may be necessary. Timing of applications to the late bud and fall growth stage is critical with most herbicides to achieve good control. A backpack sprayer is highly recommended to minimize damage to non-target plants. The best way to control Russian knapweed is to combine herbicide treatment with seeding competitive grasses.

Cultural control: Maintain healthy native communities, and minimize disturbance and seed distribution.

Integrated management: With its extensive root system, low seed production and persistence, Russian knapweed is best controlled by preventing its establishment through proper land management. Monitor areas three times a year (spring, summer, fall) and destroy all Russian knapweed plants immediately. Combine killing Russian knapweed with seeding competitive grasses.

Russian Olive



Elaeagnus angustifolia is a fast growing tree, normally reaching heights of 10 to 25 feet. Trunks and branches are armed with 1 to 2 inch woody thorns. Leaves are narrow, 2 to 3 inches long and covered with minute scales which give the foliage a distinctive silvery appearance. Scales are usually more abundant on the underside of the leaf. Flowers are yellow and arranged in clusters. Fruits are shaped like small olives, are silvery when immature or brown at maturity. Russian olive was imported from Europe and is common as a landscape plant (Whitson et al. 1996). Once Russian olive is allowed to become established in unwanted areas, it is difficult to control and almost impossible to eradicate because of its habit of forming root shoots and suckers. Efforts at control have included mowing of seedlings and sprouts, cutting or girdling of stems, burning and herbicide application (IEPC 2004). (Photo from Whitson et al. 1996.)

Biological control: None

Mechanical control: Girdle at stump height during the growing season with two concentric chainsaw cuts that are approximately 1 inch deep. The cuts should be separated by approximately two inches. Allow the tree to slowly starve itself while still standing. This process should take 3 to 4 weeks, all leaves should turn brown before the tree is cut to the ground and removed. Once the tree is removed treat the stump with the chemicals listed below. Treat any new shoots or sprouts with the chemicals listed below. Remove sprouts once they have died. Repeat process as necessary.

Chemical control: Apply 2, 4-D or 2, 4, 5-T to the stump within 1 minute of tree cutting (FEIS).

Cultural control: Prevent planting as an ornamental.

Additional Weed Management Resources

BIOCONTROL AGENTS

Many biological control agents can be obtained from the Colorado Department of Agriculture Insectary in Palisade.
Phone: (970) 464-7916
http://www.ag.state.co.us/dpi/insectary/BCAS/BPHome.htm

LOCAL GOVERNMENT AGENCIES

Arapahoe County Weed Control Specialist: Russell Johnson. Lima Plaza, 6924 S Lima St, Centennial, CO 80112
(720) 874-6713 / rjohnson@arapahoegov.com

Colorado Weed Management Association (CWMA). PO Box 1910, Grandby, CO 80446-1910, Phone: 970-887-1228, e-mail: CWMA@rkymtnhi.com Website: www.fortnet.org/CWMA

WEED MANAGEMENT

Colorado State University Weed Management Site:
www.colostate.edu/Depts/IPM/nipm/agwee.html

Control of Invasive Exotic Plants in the Great Plains:
http://www.npsc.nbs.gov/resource/literatr/exotic/exotic.htm

Colorado's 10 most wanted weeds:
http://www.ag.state.co.us/commish/press/1999/weedweek.html

Agricultural Resource Service Exotic and Invasive Weeds Unit;
http://wric.ucdavis.edu/exotic/exotic.htm

WEED IDENTIFICATION:

Weeds of the West, 9th edition. 2000. Whitson, T.D. (ed), L.C. Burrill, S.A. Dewey, D.W. Cudney, B.E. Nelson, R.D. Lee, R. Parker. Western Society of Weed Science. P.O. Box 963, Newark, CA 94560. 510-790-1252.

Weed Identification Web Site: http://www.uwyo.edu/plants/weeds/id/

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