1998 Annual Vegetation Report
for the Rocky Flats Environmental Technology Site
June 30, 1999

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Acronyms and Abbreviations

CDA	Colorado Department of Agriculture
CNHP	Colorado Natural Heritage Program
DOE	U.S. Department of Energy
GIS	Geographic Information System
GPS	Global Positioning System
K-H	Kaiser Hill Company, LLC
QA/QC	Quality Assurance and Quality Control
Site	Rocky Flats Environmental Technology Site

Executive Summary

This report summarizes the results of the vegetation monitoring that was conducted at the Rocky Flats Environmental Technology Site (Site) during 1998. The Kaiser-Hill Company (K-H) Ecology Group conducts ecological monitoring of the Site's natural resources to ensure regulatory compliance and to preserve and protect those resources during cleanup and closure operations. Ecological monitoring is an integral aspect of determining whether the management objectives and goals for the plant communities at the Site are being achieved. The goal of vegetation monitoring is to assess the status and quality of the plant communities on the Site, document any trends, and assess the effectiveness of various management techniques.

At an elevation of approximately 6000 feet, the Site contains a unique ecotonal mixture of mountain and prairie plant species resulting from the topography of the area and close proximity to the mountain front. The Buffer Zone, the area surrounding the Industrial Area, is one of the largest remaining undeveloped areas of its kind along the Colorado Piedmont. A number of plant communities present at the Site have been identified as increasingly rare and unique by the K-H Ecology Group and the Colorado Natural Heritage Program (CNHP). These communities include the xeric tallgrass prairie, tall upland shrubland, wetlands, and Great Plains riparian woodland communities. Many of these communities support populations of increasingly rare animals as well, including the federally protected Preble's meadow jumping mouse, and other uncommon species such as the grasshopper sparrow, loggerhead shrike, Merriam's shrew, black crowned night heron, and Hops blue and Arogos skipper butterflies.

Vegetation monitoring is conducted at the Site using several methods to meet the monitoring objectives. During 1998 these objectives included: species richness inventories, noxious weed and rare plant species mapping, photographic documentation, qualitative habitat assessment surveys, quantitative monitoring of long-term plant community changes, and quantitative assessments of the effectiveness of herbicide applications and potential associated impacts to the native plant communities.

Monitoring of the xeric tallgrass prairie during 1998 was conducted to evaluate the quality of the grassland and to document any changes in species composition at some of the permanent sampling locations. Monitoring continued to document the generally high quality of this rare plant community on the Site. Community-wide species richness inventories of the xeric tallgrass prairie documented the presence of 295 plant species in the community, including the continued presence of the relict tallgrass prairie species (big bluestem, little bluestem, indiangrass, switchgrass, prairie dropseed, and porcupine grass) characteristic of this rare community. Comparison of 1998 quantitative monitoring results for species richness and vegetation cover to previously collected data showed little change in the composition of the community. Most species showed fluctuations in cover, however, which are typical of annual responses to changes in local environmental

conditions. One species, little bluestem, which is one of the relict tallgrass species found on the grasslands on the Site, showed a decline in cover across all years. However, this decline is suspected to be a result of the 1994 late-summer drought, after which many of the observed plants had died. Another species, Porter's aster, seemed to be showing a cyclical response, having reached a peak in abundance in 1995 and then began to decline. For the most part, however, the composition of the prairie at the sites monitored was the same as in the past, with the same top three or four species providing most of the vegetation cover. Qualitative assessments of the xeric tallgrass prairie continued to document the threats facing this community, which include noxious weeds and dead plant litter buildup. These are discussed below.

Baseline monitoring was conducted at three large wetland complexes at the Site during 1998. The purpose of the monitoring was to provide quantitative species composition information for use in evaluating any future change in the wetland communities. The study documented a total of 95 vascular plant species at the wetland study locations. The dominant species in the wetland communities were Arctic rush, broadleaf cat-tail, and wooly sedge, all of which are common wetlands species in this region. A prairie cordgrass wetland community type was identified on the Site and is considered by the CNHP to be a critically imperiled community in the state of Colorado due to its rarity. Although only small patches of the community occur at the Site within the wetlands, the presence of this wetland type is further evidence of the uniqueness, health, and high quality of the ecological resources that have been preserved at the Site. Canada thistle, a noxious weed, was found at all three wetland complexes surveyed, but it was more abundant in the north Buffer Zone wetlands than at the Antelope Springs/Apple Orchard complex in the south Buffer Zone. Release of additional biological control agents could help control this species in the wetlands on the Site. In the long term however, the use of herbicides may also be necessary. The baseline information gathered at the wetlands in 1998 provides an additional tool for detecting change in the wetland communities and helping to preserve the integrity and quality of the Site's ecosystems.

During the 1998 field season, seven new records of vascular plant species were recorded for the Site, bringing the total number of plant species known to occur at Rocky Flats to 576. Unfortunately, one of the new records for 1998 was Russian knapweed, which is considered a noxious weed under Colorado statutes. The population was treated with an herbicide to begin immediate weed control and prevent its further spread at the Site. Herbicide treatments of the population will be continued in 1999 to eradicate the species from its only known location on the Site.

Monitoring continued during 1998 to determine the effect of applying the herbicide Tordon 22K on diffuse knapweed and native plant species on the xeric tallgrass prairie. Quantitative studies revealed that diffuse knapweed was significantly reduced in the treatment areas. Qualitative observations also showed no adult knapweed plants present in the treatment plot. There were, however, some impacts to other native plant species. Overall species diversity (a measure that combines species richness and abundance into a single measurement) declined and native forb abundance (cover) decreased in the treatment plot. In addition, cactus densities were also reduced by the herbicide. None of

these impacts however, were serious enough to warrant discontinuation of herbicide applications. In addition to controlling diffuse knapweed, results also showed an added benefit in that several other weed species including musk thistle, salsify, western ragweed, wild lettuce, and alyssum, were reduced in abundance as a result of the herbicide treatment. These Site data are in general agreement with studies conducted elsewhere that have shown similar effects on grassland communities after treatment with Tordon 22K. Those studies showed that long-term impacts to the native species were negligible and disappeared after a year or two. It is expected that similar results will be seen at the Site. Continued monitoring of the plots on the Site will assess the long-term effects, and will also determine how long the herbicide controls the diffuse knapweed before reapplication is necessary.

At the location of a 1996 grassland fire in the Buffer Zone where diffuse knapweed was present, monitoring was continued to evaluate whether a late-summer fire would affect diffuse knapweed densities. The third year of data showed that the increases in diffuse knapweed densities at the burned locations could not be attributed to the fire, because similar increases also occurred at control locations. However, the large increases shown in diffuse knapweed density at both the burned and unburned locations continue to underscore the need for aggressive control to prevent the further spread of diffuse knapweed across the Site.

Weed mapping continued to indicate that the most serious threat to the xeric tallgrass prairie and other plant communities on the Site is from noxious weeds. Diffuse knapweed is the most serious of these threats, now infesting approximately 45 percent of the Site. Although several hundred acres were treated with the herbicides Tordon 22K and Transline during 1997, weed mapping conducted in 1998 indicated that there was still an overall net increase in the number of acres infested by diffuse knapweed on the Site. Qualitative assessments of the herbicide treatment areas showed that the diffuse knapweed was effectively controlled where the ground equipment used for herbicide application was able to provide a continuous, even application of the herbicide. However, where uneven ground, obstacles, or steep slopes were present, the effectiveness of the applications was reduced because the ground vehicles had limited or no access to these areas, and hose or backpack application was required. Without an increase in the current level of effort, diffuse knapweed is likely to infest the entire Site within the next several years. Aerial application of herbicides would provide the most economical and effective control of large-scale weed problems.[1]

Another factor contributing to the degradation of the native plant communities on the is continued human disturbance. During 1998, field surveys identified two activities that have disturbed the soil surface at some locations, making these areas vulnerable to further noxious weed invasion. Where reduced blading of the main roads in the Buffer Zone has

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[1]An aerial herbicide application of Tordon 22K was conducted over 1500 acres at Rocky Flats in June 1999. The results and details of this effort will be reported in next years annual vegetation report.

been conducted to minimize the width of the roads, weed control and revegetation is now necessary to keep the weeds which have been established along the road edges from spreading into the surrounding grasslands. At locations near the gravel mining operations on the western edge of the Site, both old and new test pit disturbances are creating and have created weed islands, from which the weeds (especially diffuse knapweed) readily spread across the xeric tallgrass prairie. Weed control and revegetation are necessary along these disturbances and surrounding grasslands to reduce the weed problems at the Site.

Vegetation monitoring in 1998 continued to document the generally high quality of the native plant communities at the Site. However, the results also continued to underscore the serious issues that threaten the quality and long-term sustainability of the Site's ecological resources. These threats come primarily from weeds, disturbances, and plant litter build up, the latter of which has resulted from an absence of wildfires and/or grazing. Yet the data indicate that beneath the sometimes visually dominant weedy appearance, the native plant communities are still present. In fact, management actions such as weed control have been shown to improve the condition of the grasslands at the Site. Continued active management of these native communities is necessary if they are to survive over the long term, maintain their ecological value, and remain for the future. Through good stewardship and use of best management practices, the Site's current ecological resource management plan and weed control plan provide guidance for managing the resources in a sustainable manner. As stewards of the ecological resources at the Site, Kaiser-Hill and DOE are continually striving to preserve and maintain the heritage these unique resources represent for the future.

1998 Annual Vegetation Report

1. 1999 Annual Vegetation Report

1.1 Introduction

Rocky Flats Environmental Technology Site (Site) is a U.S. Department of Energy (DOE) facility located on the Colorado Piedmont east of the Front Range between Boulder and Golden, Colorado. The Site is located in Jefferson County, approximately 16 miles northwest of downtown Denver (Figure 1). In production from 1951 through 1989, the Site manufactured nuclear weapons components for the Cold War. Since shutdown, it has been classified as a Superfund site and is currently undergoing cleanup and closure. One of the DOE's goals has been to preserve the unique ecological resources found at the Site (K-H 1997a).

At an elevation of approximately 6000 feet, the Site contains a unique ecotonal mixture of mountain and prairie plant species resulting from the topography and close proximity to the mountain front. The Buffer Zone, the area surrounding the Industrial Area, is one of the largest remaining undeveloped areas of its kind along the Colorado Piedmont (approx. 5600 acres; K-H 1997b). A number of plant communities present at the Site have been identified as increasingly rare and unique by the Kaiser-Hill Company (K-H) Ecology Group and the Colorado Natural Heritage Program (CNHP). These communities include the xeric tallgrass prairie, tall upland shrubland, wetlands, and Great Plains riparian woodland communities (CNHP 1994; 1995). Many of these communities support populations of increasingly rare animals as well, including the federally protected Preble's meadow jumping mouse and other uncommon species such as the grasshopper sparrow, loggerhead shrike, Merriam's shrew, black crowned night heron, and Hops blue and Arogos skipper butterflies (CNHP 1994; 1995).

The K-H Ecology Group conducts ecological monitoring of the Site's natural resources to ensure regulatory compliance and to preserve and protect those resources during cleanup and closure operations. The goal of vegetation monitoring is to assess the status and quality of the plant communities on the Site, document any trends, and assess the effectiveness of various management techniques. Ecological monitoring is an integral aspect of determining whether the management objectives and goals for the plant communities at the Site are being achieved (K-H 1997a, 1997b). Annual reports produced to synthesize and interpret the information provide the DOE with important and timely information necessary for wise stewardship and management of the Site's ecological resources.

This report summarizes the results of the vegetation monitoring conducted during 1998. Several monitoring techniques were used to evaluate the status and condition of the plant communities on the Site. General descriptions of the methods used are outlined in the following section, with summaries of the monitoring results presented in subsequent sections. Detailed technical reports for each of the specific monitoring activities conducted in 1998 are found in Appendix A.

1.2 Methods

Vegetation monitoring is conducted at the Site using several methods to meet the monitoring objectives. During 1998 these objectives included: species richness inventories, noxious weed and rare plant species mapping, photographic documentation, qualitative habitat assessment surveys, quantitative monitoring of long-term plant community changes, and quantitative assessments of the effectiveness of herbicide applications and potential associated impacts to the native plant communities.

1.2.1 High-Value Vegetation Surveys

The goal of the high-value vegetation monitoring is to qualitatively assess the status and quality of the high-value plant communities (xeric tallgrass prairie, tall upland shrubland, selected wetlands, and Great Plains riparian woodland) on the Site and to document any changes in these areas. The high-value plant communities at the Site are those identified by K-H Ecology Group and the CNHP as containing significant or rare ecological resources at both the local and regional scale (K-H 1997b, 1997c; CNHP 1994, 1995).

Objectives of the high-value vegetation monitoring are to qualitatively:

- assess the species richness of the plant communities
- identify any rare plant populations
- document the locations and continued presence of any rare plant populations
- identify and document any infestations of noxious weeds
- document the effectiveness of weed control applications
- assess the impacts of disturbance on the plant communities
- provide a general assessment of the overall status and quality of the plant communities at the Site.

1.2.1.1 Species Richness Surveys

The xeric tallgrass prairie was monitored in 1998 as part of the rotating schedule for monitoring high-value vegetation communities on the Site. It was previously monitored in 1997, when all the high-value vegetation communities were monitored for the first time. Species richness was inventoried in each of the 12 xeric tallgrass prairie management units (Figure 2). Inventories were conducted by traversing each management unit twice during the growing season (in spring and late summer) and recording all vascular plant species observed. Attempts were made to visit, as completely as possible, all areas and microhabitats occurring within each management unit.

1.2.1.2 Weed Mapping Surveys

Sitewide weed mapping continued for selected species as a means of identifying high-priority treatment areas, monitoring the distribution of specific noxious weed species on the Site, and tracking the effectiveness of weed control at the Site. Weed mapping was conducted on foot during the high-value vegetation surveys in the xeric tallgrass prairie, and from a vehicle using binoculars for the remainder of the Site. Species were mapped during their respective flowering periods, when they were most visible. The species mapped included diffuse knapweed (*Centaurea diffusa*), musk thistle (*Carduus nutans*), dalmatian toadflax (*Linaria dalmatica*), and common mullein (*Verbascum thapsus*). These species had also been mapped sitewide in 1997. An additional four species, Russian knapweed (*Centaurea repens*), annual rye (*Secale cereale*), Scotch thistle (*Onopordum acanthium*), and jointed goatgrass (*Aegilops cylindrica*), were also mapped in 1998 due to their increasing infestation levels and concern over the aggressiveness of these species. Canada thistle (*Cirsium arvense*) was not mapped because it is common throughout most of the wetlands on the Site, and the wetlands map would therefore provide a good indication of the infested areas.

Infestation areas were classified in general density categories of high-, medium-, low-, and scattered-densities, based on a subjective interpretation of the extent, visual density, need for control, and aggressive nature of the species. In general, a high-density category indicated an area that was dominated by a nearly solid infestation and/or very high cover of the species. A medium-density category was used where the infestation provided less cover and was less homogeneous in the distribution of the species. The low-density category was used where the species were present in fewer numbers and were not visually dominating the landscape, but were beginning to establish a foothold in the community and in need of control. The scattered-density category was only used in a few cases and indicated a sporadic occurrence of the species. The noxious weed populations and distributions were drawn in the field on 44×34-inch sitewide base maps. With regard to the resulting maps, it should be noted that the boundaries shown on the maps are only approximate and are based on professional judgement. They should not be interpreted as a precise outline of the distribution of these species, because no surveying or global positioning system (GPS) equipment was used to locate boundary edges, nor do the maps necessarily represent every location of the species on the Site.

1.2.1.3 Photographic Documentation Surveys

No photographs were taken during the summer of 1998, because of the alternate year schedule in place. They will be taken again during the summer of 1999. However, the woody vegetation photographic documentation will continue in winter 1998. The areas of woody vegetation will be photographed from the permanent photo points established in 1997 to document the condition of the Great Plains riparian woodland and tall upland shrubland areas when the leaves are off the plants. Photographs will be taken in the same

compass directions from these photo points. Examples of these photographs will be presented in 1999 Annual Vegetation Report.

1.2.1.4 Qualitative Habitat Assessment and Rare Plant Surveys

Qualitative habitat assessments were made in each of the high-value vegetation community management units on the Site during 1998. Assessment objectives dealt primarily with habitat loss, threats to the plant community, weed issues, rare plant species, the health of dominant plant species in the community, and general community quality. Attempts were also made to revisit each of the locations where CNHP–listed plant species of special concern are known to occur. These species include the mountain-loving sedge (*Carex oreocharis*), forktip three-awn (*Aristida basiramea*), dwarf wild indigo (*Amorpha nana*), and carrionflower greenbriar (*Smilax herbacea* var. *lasioneuron*). Population locations were mapped during the 1997 field season. Locations were revisited in 1998 to confirm the continued presence of these species on the Site and to evaluate any concerns about them.

Further details on the qualitative methods used in 1998 are found in the document *High-Value Vegetation Survey Plan for the Rocky Flats Environmental Technology Site* (K-H 1997d) and *The Environmental Management Department Operating Procedures Manual* (DOE 1995).

1.2.2 Quantitative Vegetation Monitoring Techniques

The objectives of the quantitative vegetation monitoring are to assess plant community changes over time (i.e., trends) or changes in response to management actions (i.e., herbicide application). In 1998, quantitative vegetation monitoring was used for evaluating long-term trends on the xeric mixed grassland, providing a baseline of vegetation information at several wetland locations, evaluating the effects of herbicide applications on diffuse knapweed and native prairie species, and the effect of fire on diffuse knapweed.

Quantitative methods used to assess plant communities included:

- belt transects (species richness and woody plant and cactus density)
- point-intercept transects (foliar and basal cover)
- quadrats (species frequency and selected plant densities).

1.2.2.1 Belt Transects

Species richness was measured in a 2-m wide belt centered along each permanent 50-m transect. Every plant species rooted within the 100-m^2 area was recorded. In addition,

the densities of the woody plant stems and cactus species were counted for the 100-m^2 area and recorded. Species richness was sampled in both the spring and late summer, while woody plant and cactus density in the belt transects was only measured in the spring.

1.2.2.2 Point-Intercept Transects

Basal cover and foliar cover estimates were made using a point-intercept method along each of the 50-m transects. A 2-m-long rod, with a 6-mm diameter, was dropped vertically at 50-cm increments along the transect to record a total of 100 intercept points. Two types of hits were recorded. Basal cover hits indicated what material the rod contacted at the ground surface. Hits could be vegetation (live plants), litter (fallen dead material), rock (pebbles and cobbles that were greater than the rod diameter), bare ground, or water, in the order of priority based on the protection from erosion each type of cover provided. A basal vegetation hit was recorded only if the rod was touching the stem or crown of the plant where the plant entered the ground. Foliar vegetation hits (defined as a portion of a plant touching the rod) were recorded in three categories as defined by height and growth form. The topmost hit of each growth form was recorded. The growth forms measured were herbaceous, woody <2 m in height, and woody >2 m in height. Cover was sampled in the late summer only, when plant growth was at its maximum.

1.2.2.3 Quadrats

Frequency information by species was gathered by randomly locating five, 1-m^2 quadrats along each transect and recording all species present in each plot. Density counts were made of selected weed species (which varied depending on the individual study) within each of the quadrats. Quadrats were sampled in both the spring and late summer.

For more detailed information on the quantitative methods used in 1998 for specific projects, refer to the technical reports in Appendix A or the *Environmental Monitoring Department Operating Procedures Manual* (DOE 1995) and the *High Value Vegetation Survey Plan for the Rocky Flats Environmental Technology Site* (K-H 1997d).

1.2.3 Data Analyses

All data were checked for quality assurance and quality control (QA/QC) prior to analysis, following previously accepted and applied steps for ecological data at the Site (K-H 1997e). Descriptive and graphical comparisons and summaries of the data were prepared for most data sets. Appropriate statistical analyses were also conducted on some data where feasible. Further details on the specific analyses conducted on particular data sets are found in the technical reports in Appendix A.

1.3 Results and Discussion

1.3.1 Xeric Tallgrass Prairie

The xeric tallgrass prairie is a rare and unique plant community at the Site (Figures 2 and 3). The large extent of this plant community found on the Site (approximately 1800 acres), combined with the land recently purchased by City of Boulder Open Space (1500 acres) to the west of the Site, is considered to be the largest remaining tract of this community in North America (CNHP, 1994, 1995). Monitoring was conducted on the Site's xeric tallgrass prairie during 1998 to document and assess the quality and health of the prairie community and assess any trends by comparison to past data.

Community-wide surveys on the xeric tallgrass prairie recorded a total of 295 plant species during 1998 (Table 1). The high number of different species indicates the high level of biodiversity found in this plant community on the Site. Compared to 1997, there was an increase of 21 species observed. Of the 295 species observed in 1998, 79 percent were native species, a decrease of 2 percent since 1997. These annual differences are not indicative of any trend on the prairie, but rather are typical of the differences that can be encountered in community-wide inventories. Normal annual variation in the abundance of difference species, observations of sole individuals of a given species, and slight differences in the routes traversed during surveys make this type of variation typical. Although the high percentage of native species is indicative of the high quality of the grassland, the 21 percent of non-native species on the grassland does suggest that there are weed concerns. While most non-native species on the grassland pose no significant threat, there are a few species which, due to their aggressive nature, can threaten the quality of the xeric tallgrass prairie. These species are discussed in the weeds section of the report (Section 1.3.5).

Quantitative monitoring at sites TR01, TR06, and TR12 in 1998 (Figure 4), showed that the xeric tallgrass prairie at the Site was typified by the presence of mountain muhly (*Muhlenbergia montana*), Porter's aster (*Aster porteri*), big bluestem (*Andropogon gerardii*; Figure 5), needle and thread grass (*Stipa comata*), and Canada bluegrass (*Poa compressa*; Table 2). Overall foliar vegetation cover was approximately 82 percent, which fell within the range of past measurements. Comparison to past monitoring results indicated that annual variation in vegetation cover for some individual species was noted. In examining cover values for the dominant species, big bluestem (Figure 5), a relict tallgrass prairie species, showed little change in cover from past years. Porter's aster, a native forb, showed a 10 percent decline in its cover amounts at some locations since it was last monitored in 1995. This may be indicative of a cyclic response, based on past data that seemed to show a steady increase over a previous three-year period. Needle and threadgrass and Canada bluegrass both showed only slight increases in cover. Mountain muhly, a native foothills grass, showed a considerable increase in cover at one location, but only a slight increase at another. Annual fluctuation of vegetation cover is common due to annual variations in the timing and availability of moisture and other environmental variables. Although some changes are apparent, the short-term length of the data sets preclude any definitive trend analyses due to the variability of the data and inherent "noise" which is characteristic of small data sets. However, the dominant

species from the past are still dominant today and there is no real evidence that there has been any shift in overall species composition.

Little bluestem (*Andropogon scoparius*; Figure 6), another relict tallgrass species, continued to show declines across the xeric tallgrass prairie. It has declined from almost 12 percent cover to 2 percent cover at one location and from 5 percent to 0 percent at another. Qualitative observations on the loss of little bluestem cover on the Site have been mentioned in the past (K-H 1997b), and quantitative measurements now confirm this observation. Originally, a large die-off of the species at these and other locations on the Site was noticed in 1995, the year following the late-summer drought of 1994. Little bluestem appeared to be particularly hard hit, and observations showed that many bunches had died. Only time will tell whether the species will recover at these sites. Qualitative observations at some other locations on the Site have shown, however, that the species was not as severely affected and appears to be doing fine at these locations. Thus, this may simply be an example of the dynamic nature of these native plant communities in response to environmental changes at different scales.

In general, the 1998 quantitative data suggest that the dominant species on the xeric tallgrass prairie appear to be doing well and the variations in annual cover are most likely part of the normal variability in response to environmental factors. The relict tallgrass prairie species (some of which occur infrequently at the Site) include big bluestem, little bluestem, indiangrass (*Sorghastrum nutans*), prairie dropseed (*Sporobolus heterolepis*), switchgrass (*Panicum virgatum*), and porcupine grass (*Stipa spartea*), and were all observed in vegetative, flowering, and fruiting condition on the Site. Their continued presence is indicative of the uniqueness of the xeric tallgrass prairie at the Site.

The results also indicate that no major changes have occurred at the quantitative monitoring locations in the xeric tallgrass prairie since they were last monitored. The few changes that have been noted are subject to the short-term length of available data sets. This makes long-term interpretation difficult and precludes any meaningful trend analysis because of the difficulty in distinguishing natural variation “noise” from real trends. It must be remembered however, that the scale of the quantitative monitoring only evaluates the xeric tallgrass prairie at a few localized areas, compared to its overall extent on the Site. As a result, the scale at which this monitoring is conducted can overlook larger scale perturbations in the community that have not reached these monitoring sites. Therefore, the larger scale qualitative habitat assessments are more indicative of larger, widespread conditions on the prairie. The weed issues concerning the xeric tallgrass prairie are discussed in the weed section of the report. The detailed technical report for the xeric tallgrass prairie monitoring is in Appendix A.

1.3.2 Wetlands

Wetland monitoring was conducted in 1998 to provide baseline quantitative information for long-term monitoring at the Site. A total of 15 permanent transects were monitored at two of the largest wetlands in Rock Creek and at the Antelope Springs/Apple Orchard Seep wetlands in the Woman Creek drainage (Figure 7).

A total of 95 species were recorded at all three wetlands (Table 3). Species richness was highest at the Rock Creek Wetlands and lowest at Antelope Springs/Apple Orchard Seep wetlands. Native species accounted for 68–69 percent of all species present. This was similar to results found along streams on the Site in the past (71–74 percent; K-H 1997b). The high percentage of non-native species in the wetlands compared to other plant communities on the Site may be due to past grazing practices, higher use by wildlife, and because aquatic habitats tend to act as a good dispersal mechanism for seeds. No rare or imperiled plant species (as defined by the CNHP; CNHP 1997) were recorded at any of the wetland locations monitored.

Overall, the vegetation composition of these three large wetland areas was fairly similar. All three areas were dominated by arctic rush (*Juncus balticus*), a common species found in the wetlands of this region. One of two sedges—either wooly sedge (*Carex lanuginosa*) or Nebraska sedge (*Carex nebrascensis*), depending on site location—as well as cattails (*Typha latifolia*) provided the remainder of the dominant cover at all three wetlands (Table 4). Differences among the three wetlands appeared to depend on the drainage in which they were located. An analysis of the species richness similarity between the three wetlands revealed that the two Rock Creek wetlands were more similar to one another than to the Antelope Springs/Apple Orchard Seep wetlands. Total vegetation cover was also higher at the Rock Creek wetlands. These wetlands, besides having higher species richness, also had a higher diversity compared to Woman Creek, indicating that the higher quality wetlands are in the Rock Creek drainage, as they are more diverse and are not dominated by only one or two species. Photos of two of the wetland transects are shown in Figures 8 and 9.

Because this monitoring was conducted to provide a baseline of quantitative information on these wetlands, no trend analyses or comparisons with past data were possible. However, compared to the other plant communities monitored on the Site using the same methodology, the total species richness for the wetland community was lower than that previously observed in the xeric mixed grassland, mesic mixed grassland, and riparian communities[1] (K-H 1997b). Only the reclaimed grassland, a re-seeded agricultural field, had lower species richness. The percentage of native species in the wetland community (72 percent) was most similar to the riparian community, which would be expected because many of the same species are found in both communities (K-H 1997b). Overall vegetation cover in the wetlands was higher than that found at any of the other plant communities monitored from 1993 through 1995, with the exception of the 1995 mesic mixed grassland (K-H 1997b). This is typical of the high productivity of this type of wetland areas and suggests the overall good health of these wetlands on the Site.

Compared to other wetlands in the Boulder region, the classification of these large hillside seep wetlands best fits the description given by Cooper (1988) in a report on Boulder Valley wetlands. He describes it as an arctic rush (*Juncus balticus = J. arcticus*)

[1] The riparian community as used here refers to the EcMP classification system and data sets. It usually includes riparian woodland and some small, streamside wetland areas.

wetland community. Small inclusions of the cattail-duckweed (*Typha latifolia-Lemna minor*), Nebraska sedge, and prairie cordgrass (*Spartina pectinata*) communities are also present within these larger complexes at some locations. With the exception of the prairie cordgrass wetland type, most of these wetland types are common in the greater Boulder area (Cooper 1988). The prairie cordgrass wetland community (dominated by prairie cordgrass; Figure 10) however, is much more restricted now than in pre-settlement times (Cooper 1988). It was previously much more common along the floodplains of rivers and in sloughs and oxbows. As a result, this community is listed by the CNHP (CNHP 1997) as a plant community of concern, and it is considered to be a critically imperiled community in the state of Colorado due to its rarity. Although only small patches of the community occur at the Site within the wetlands, the presence of this wetland type is further evidence of the uniqueness, health, and high quality of the ecological resources that have been preserved at the Site.

The noxious weed Canada thistle was found throughout all three wetland sites studied, although it occurred less frequently and had less cover at the Antelope Springs/Apple Orchard Seep wetlands than at the Rock Creek wetlands. Canada thistle stem density in Rock Creek (site W1 = 13 plants/m^2; site W3 = 16 plants/m^2) was more than twice that in Woman Creek (site W2 = 6 plants/m^2). Canada thistle is listed on the state noxious weed list as one of the top ten weed species needing control in Colorado (CRS 1996). Additionally, Jefferson County has listed it as a priority for control within the county (Lile 1998). Landowners are responsible for controlling infestations of noxious weeds on their properties and preventing their spread to neighboring landowners.

Control of the Canada thistle in the wetlands on the Site is difficult because of the open water often present in these areas. Most recommended measures for controlling Canada thistle infestations are designed for dry land infestations, where mowing combined with herbicide treatment can provide effective treatment (Beck 1996). However, within the Site wetlands, mowing is not feasible due to the soft, uneven, and hummocky ground. Broad scale application of herbicides is not desirable or feasible either because 1) they are not designed for direct application to water sources, and 2) if they are approved for water application, they are non-selective and would affect all broadleaf forbs in the wetlands. Because none of these options is desirable, alternative solutions must be developed. In addition, repeated application over several years using any means is generally required for effective control of Canada thistle. Given these conditions, the following control methodology, using several methods, is suggested for controlling Canada thistle in the wetlands on the Site.

Two biocontrol insects are available from the Colorado Department of Agriculture (CDA) for control of Canada thistle (Beck 1996). *Ceutorhyncus litura* (crown boring weevil) and *Urophora cardui* (a gall-forming insect) both can stress populations of Canada thistle. *Ceutorhyncus litura* causes plants to be stressed and less vigorous. *Urophora cardui* stresses a plant by causing galls to develop on the plant. These galls, if formed near terminal growing points, prevent flowers from developing and setting seed. Neither insect is generally capable of totally controlling infestations, though using both in conjunction with other methods has proven effective in the past (Beck 1996). In 1997,

the CDA released two biocontrol insects on the Site to assist in the control of diffuse knapweed (*Centaurea diffusa*) and dalamatian toadflax (*Linaria dalmatica*), at no cost to the Site. The CDA should be encouraged to continue to use the Site as a testing ground for releases of the biocontrol insects for Canada thistle. This would provide additional control of this species on Site at little to no cost.

Another potential management action includes conducting prescribed burns in the wetlands. Although this may not directly reduce or control the Canada thistle, burning would reduce built-up dead plant litter and recycle nutrients, with the intent to invigorate the native plants in the wetlands. This would help the native species compete with the weeds. Application of approved herbicides is possible in the wetlands using a wick application method, where the herbicide is applied by hand to individual plants. Although more time and labor intensive, this could be done whether prescribed burns were conducted first or not. However, because the wetland vegetation is typically dense, prior removal of the dead plant material from the wetland would make wick application more effective, as Canada thistle plants and rosettes would be more visible and accessible for herbicide application. Wick applications of herbicides would have to be continued for several years to maintain good control. The detailed technical report for the wetland monitoring conducted in 1998 is located in Appendix A.

1.3.3 Rare Plants

Mapped locations of the plant species of concern, as listed by the CNHP, were revisited during the 1998 surveys. The known populations of mountain-loving sedge (Figure 11), forktip three-awn (Figure 12), and dwarf wild indigo (Figure 13) were all found again, and the plants were evaluated. All three species were observed in vegetative, flowering, and fruiting condition, and seemed to be doing well. Carrionflower greenbriar (Figure 14) was the only species where plants were not observed at some previously known population locations during 1998. However, it is often a difficult species to locate, and it is not known whether it comes up every year. Therefore, an attempt will be made to observe plants at these population locations again in 1999. At the locations where carrionflower greenbriar was observed, it was in vegetative, flowering, and fruiting condition, and appeared to be doing well.

1.3.4 Site Flora

As a result of the 1998 fieldwork, a total of seven new records of vascular plant species are reported for the Site. Plant nomenclature follows that of GPFA (1986), Weber (1976), and Weber (1990), in that order of determination. The new plant species reported for the Site flora are:

Calamagrostis stricta (Timm.) Koel	Northern reedgrass
Sorbus scopulina Greene	Mountain ash

Centaurea repens L.	Russian knapweed[2]
Astragalus spathulatus Sheld.	Draba milk-vetch
Agropyron elongatum (Host) Beauv.	Tall wheatgrass
Chenopodium atrovirens Rydb.	Dark goosefoot
Solidago nana Nutt.	Low goldenrod

Of these species, none are rare or imperiled; however, the discovery of Russian knapweed (Figure 15) on the Site is cause for concern. It is listed as a noxious weed by the state of Colorado and property owners are required by law to control it. During 1998, the single population of Russian knapweed was treated with the herbicide Telar to control its spread.

With the addition of these new plant species, the Site flora now has 577 plants listed as occurring on the Site. The complete plant species list for Rocky Flats is presented in Appendix B.

1.3.5 Weeds

Currently the most serious threat to the native plant communities on the Site is from noxious weed infestations. Although many species of weeds exist in the plant communities on the Site, most are not especially problematic. However, under the Colorado Noxious Weed Act (CRS 1996), a number of particularly noxious weeds must be controlled by property owners to prevent their spread to surrounding lands. Some of these weeds pose a significant threat to the plant communities on the Site. During the 1998 monitoring, the impact of fire on diffuse knapweed was assessed (Figure 16) to ascertain the effectiveness of herbicide applications on diffuse knapweed and any associated impacts to native species, while mapping the distribution of various weed species on the Site. Results from the monitoring are discussed in the sections that follow. Detailed technical reports for the following monitoring summaries may be found in Appendix A.

1.3.5.1 Diffuse Knapweed Response to Fire

Diffuse knapweed is a noxious weed that has become increasingly widespread across the Front Range of Colorado. Over the past several years, the spread of this species has become a serious threat with regard to managing the natural resources in the Buffer Zone at the Site. Under the Colorado Noxious Weed Act, diffuse knapweed is listed as a noxious weed that must be controlled by property owners, and it is listed as one of the top ten prioritized species for control in the state (CRS 1996).

Diffuse knapweed is a very aggressive competitor in dry conditions, such as those found at the Site. Studies elsewhere have shown that it rapidly invades overgrazed rangelands, disturbed sites, and even undisturbed plant communities, often becoming a dominant

[2] Listed as a noxious weed by the State of Colorado.

species and altering the species composition of the plant community (Powell 1990; FEIS 1996; Sheley et al. 1998). Studies have also shown that diffuse knapweed-infested lands exhibit increased soil erosion, degraded water quality, lower wildlife value, reduced grazing capacity, and less aesthetic and recreational value (Sheley et al. 1997, 1998).

The effect of fire on diffuse knapweed infestations is of particular concern to land managers because one of the most important tools for prairie management and restoration is fire. In 1996, an investigation was begun to evaluate the impact of fire on diffuse knapweed densities in the xeric tallgrass prairie, after a lightning-caused wildfire swept across the south Buffer Zone.

Results of three years of monitoring have shown that diffuse knapweed densities increased significantly in both the burned and unburned areas (Figures 17 and 18). The photographs in Figures 19 and 20 show a burned plot after the fire in 1996 and two years later in 1998, respectively. Because the unburned area also had a significant increase in diffuse knapweed, all indications show that in this particular case, the large increases in diffuse knapweed density observed two years after the fire were apparently not due to the fire. Rather, the potential for large increases in diffuse knapweed density is present with or without fire in disturbed and undisturbed native plant communities. Further investigation on how fire affects diffuse knapweed densities under other growing conditions are required to better determine whether these results are applicable elsewhere.

These data suggest therefore, that the use of fire as a resource management tool could potentially be conducted on the Site without significantly increasing the current diffuse knapweed problem. In fact, if fire was used in conjunction with herbicide applications, the potential for improving the effectiveness of herbicide applications is increased. The complete technical report on this study is found in Appendix A.

1.3.5.2 Diffuse Knapweed and Native Plants Response to Herbicide Application Study

In 1997, an investigation was begun to evaluate the effectiveness of herbicide applications using Tordon 22K on diffuse knapweed, and any resulting impacts that might occur on native species. The study was conducted northwest of the Industrial Area on the xeric tallgrass prairie using a control and treatment plot (Figure 21). Initial results have shown that the herbicide Tordon 22K was effective at controlling diffuse knapweed one year after spraying. Diffuse knapweed frequency was reduced significantly—by 60 percent—one year after the herbicide treatment (Figure 22). Results showed that the variability in the knapweed density data precluded attributing the loss of density in the treatment plot to the herbicide treatment alone. However, visual observations of the treatment plot revealed no adult knapweed plants present one year after treatment. In the control plot, adult knapweed plants were visually abundant, and knapweed frequency was not significantly changed. Continued monitoring of these plots will help determine how long the herbicide application controls the knapweed under site-specific conditions before re-application is necessary.

Although the observed effect on diffuse knapweed was desired, there was some impact to other species in the plant community. Four specific effects were observed:

- First, forbs other than diffuse knapweed were affected. In general, the overall abundance (cover) of forbs and their frequency of occurrence decreased. This decrease was not, however, to the point where the species were completely eliminated from the grassland. Associated with this, and most likely a result of the lowered competition from the forbs, the grasses in the community responded with increased vigor and showed some increase in the amount of total relative vegetation cover they provided in the community.

- Second, the herbicide treatment caused a loss of cactus density. The twistspine prickly pear cactus density was reduced by nearly 75 percent in the treatment plot.

- Third, species diversity (a measure combining species richness and abundance) declined significantly in the treatment plot, while remaining stable in the control plot (Figure 23). This suggests that the herbicide caused a few species to become more predominant, while others that had previously been more common, became less common.

- And fourth, overall species richness within the treated (i.e., herbicide applied) sampling plots declined initially. However, by the end of the second year, most of the initial decline had been recovered.

Data from the Site are consistent with the data from other studies which have also shown declines of species diversity and the loss of forb and weed cover after spraying with Tordon 22K, although the Site data does not show as dramatic an increase in graminoid cover. The long-term implications of these impacts to the plant community, and the time required for natural recovery at the Site, are uncertain. Rice and Toney (1996) however, who found similar decreases in forb cover due to herbicide treatments on a native prairie in Montana, reported that these responses were transitory, with forb values returning to pre-treatment levels after about three years. Rice et al. (1997) found that species diversity also declined after spraying with Tordon 22K, but recovered after 2–3 years. Both of these studies also indicated that, as a result of lost weed and forb cover (i.e., reduced competition), the graminoid component of the community responded vigorously. In the Lolo National Forest in Montana, Henry (1998) reported that two years after spraying with Tordon 22K, a mountain grassland community had a 95 percent reduction in weed biomass and an 86 percent decrease in forb biomass. Associated with this was a 714 percent increase in grass biomass.

The general conclusions from this study thus far are that diffuse knapweed was controlled in the areas sprayed, and that only a minimal impact to the native plant community was observed. Based on these results, the use of Tordon 22K should be continued for control of diffuse knapweed and resource management on the Site. Although some minor negative impacts were manifested initially, if the longer term responses at the Site are

similar to responses documented elsewhere, the prudent use of Tordon 22K can provide a valuable tool for assisting in the control of diffuse knapweed and management of the grasslands at the Site.

1.3.5.3 Weed Mapping

During 1997, a sitewide weed mapping program was begun for selected species as a means of identifying high-priority treatment areas, monitoring the distribution of specific noxious weed species on the Site, and tracking the effectiveness of weed control at the Site.

During 1998, several weed species were mapped. The weed distribution maps for diffuse knapweed (Figure 16), musk thistle (Figure 24), dalmatian toadflax (Figure 25), and mullein are shown in Figures 27 – 30, respectively. Four additional species—annual rye, Russian knapweed, Scotch thistle, and jointed goatgrass—were mapped in 1998 because of their aggressive nature and their recent appearance at various locations on the Site (Figure 26). The distributions of these species are shown in Figures 31 and 32. After being entered into the Site GIS, the overall extent of these species across the Site was estimated by species and by infestation level using the GIS coverage areas. Table 5 contains the estimated total acreage and acreage-by-density category for each of the species, based on these maps. The species with the greatest extent on the Site was diffuse knapweed, (covering nearly 2,913 acres), followed by dalmatian toadflax (1,934 acres), musk thistle (1,685 acres), and mullein (867 acres). The total acreage of the Site is approximately 6,485 acres (K-H 1997b). It should be noted that this acreage is only approximate and should not be interpreted as an exact area. These values are also representative of known locations for these species. It is possible that unmapped infestations are present.

Table 6 shows the change in infested acreage between the 1997 and 1998 mapped areas. The large increases in infestation acreage for dalmatian toadflax, musk thistle, and mullein are due in large part to the time of year in which mapping was conducted. During 1997, all weed mapping was conducted in late August to early September, when most of these species were no longer flowering. To better estimate the extent of these species in 1998, mapping was conducted for each species when it was in flower. Therefore, the increase in acreage shown for these species is an artifact of sampling. However, the more accurate mapping completed in 1998 reveals the substantial foothold that these weed species already have on the Site. If the distributions of all the different weed species are combined, it is apparent that most of the Site is infested and weed control is needed for one or more species. However, diffuse knapweed is by far the most aggressive species needing continued control on the Site.

During the 1997 calendar year, approximately 520 acres of diffuse knapweed were treated with Tordon 22K. Figure 33 shows the location of the areas treated and the pre-treatment density levels of diffuse knapweed at these locations. Figure 34 shows the same locations in 1998 during the growing season after the herbicide was applied. Many of the areas were totally clean (i.e., no diffuse knapweed present) during the growing

season after treatment. In other areas, the infestation density was reduced by one or two density levels.

Several factors may contribute to making the herbicide treatment more effective in some locations rather than in others. First, some areas may have been missed during treatment. Second, application methods vary in the evenness with which the herbicide is spread. At most of the large, clean locations shown on Figure 34, the herbicide treatments were applied using a truck-mounted boom that had a computer-regulated application rate regulated with the speed of the vehicle. This method was also used at the western-most location (mostly a scattered-density level; Figure 34), but this area is dotted with old fence posts and irrigation ditches that had to be avoided. As a result, maneuvering around obstacles left some areas untreated, allowing patches of diffuse knapweed to remain in the treated area. At the location northeast of the Industrial Area, the herbicide was applied with a hose or backpack equipment. As a result, the herbicide application was much less even, and more spots were missed. This would account for higher remaining density levels, even after application. Third, as previously mentioned, some error may be due to mapping inconsistencies.

Overall, the herbicide applications were generally effective on the diffuse knapweed, irregardless of whether the application was made in the spring or fall. However, qualitative observations made at the different treatment locations during 1998 showed that the herbicide affected the native species differently depending on the time of application. At locations treated in November to December 1997, the native spring, ephemeral forb species were hardest hit. Little to no flowering of the native spring wildflowers was observed during spring 1998 at any of the locations treated in late fall. However, at those locations where the herbicide application was conducted in June 1997, only a slight depression of the spring wildflower display was noticed in 1998, compared to adjacent untreated areas. Thus, the timing of the herbicide application may have an impact on the native forb community. Based on 1998 observations on the Site, a late fall application has a more significant impact on the spring-flowering native forbs than an early summer treatment. Observation of these areas will continue during 1999 to determine how long this effect lasts and to help determine when the most appropriate application time frame is for killing the weeds, while still protecting the native species.

On the positive side, not only was diffuse knapweed controlled at all treatment locations, but many other weedy forbs also were controlled or had reduced infestation levels as well. Qualitative observations showed that non-native species such as musk thistle, salsify (*Tragopogon dubius*), western ragweed (*Ambrosia psilostachya*), wild lettuce (*Scorzonera laciniata*), and alyssum (*Alyssum minus*) were all effectively controlled. Even common mullein was controlled at some locations. In addition, the graminoid species responded positively at all treatment locations, in both early summer and late fall. The reduced competition from both the native and weedy forbs allowed the graminoids to take advantage of the situation: their growth appeared more robust and more flowering was observed compared to adjacent untreated areas. Additionally, at one treatment location where a wildfire had crossed the pediment in March 1994, the warm-season graminiod species big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon*

scoparius), blue grama (*Bouteloua gracilis*), and side-oats grama (*Bouteloua curtipendula*) flowered profusely and were much taller than elsewhere on the Site. This suggests that combining prescribed burning with herbicide efforts could greatly improve the quality of the prairie community at the Site.

Currently the City of Boulder Mountain Parks is conducting trials using prescribed burning in conjunction with herbicide applications for controlling diffuse knapweed (Armstrong 1998, pers. comm.). Results are promising and the technique may be applicable to Site conditions. By burning diffuse knapweed infested areas, the surface litter is removed and knapweed seeds are allowed to germinate. Once the knapweed plants reach the rosette stage they are then treated with herbicide. Because the overtopping litter has been removed, more effective herbicide application is possible and the knapweed plants are killed. The herbicide then continues to work for several years without reapplication, and the recycled nutrients released by the fire allow the native species to improve in vigor and health. The native species gain a competitive edge by improving the plant community's resistance to re-infestation by the weeds.

The effectiveness of the herbicide Transline was also evaluated qualitatively in 1998 at locations where it was applied during the fall of 1997. Transline was applied in the Rock Creek drainage where diffuse knapweed was growing in proximity to wetlands or tall upland shrublands. Observations showed good control of diffuse knapweed in 1998. In most cases, the areas were completely clean, and at the locations where total effectiveness was not achieved, the infestation levels dropped by one or two density levels. At all the Transline application areas, there was little observed impact to the native forb and graminoid components of the plant communities.

Although the impacts to the native forb community were reduced with the Transline application, from an economic and pragmatic viewpoint, its use is less desirable because these areas will have to be retreated every one or two years. This herbicide is also considerably more expensive than Tordon 22K, which has a longer term residual effect where retreatment is needed only every 3–5 years. One of the goals of this monitoring effort is to determine more definitively what retreatment frequency will be required for effective longer-term control of diffuse knapweed under the conditions in the Buffer Zone.

Although diffuse knapweed infestations have been controlled at several treatment locations, significant hurdles must be overcome to achieve similar success across the entire Buffer Zone. For example, the extent of diffuse knapweed infestation is expanding at a faster rate than the current level of the control effort. The 1997 and 1998 diffuse knapweed mapping data show that even though approximately 520 acres of prairie were treated with herbicide during calendar year 1997, the extent of knapweed infestation on the Site still increased by nearly 380 acres in 1998. Even if the diffuse knapweed had been completely controlled on all 520 treated acres, there still would have been a net increase of nearly 150 acres of knapweed between 1997 and 1998, based on the maps.

Some of this discrepancy is attributable to the application methods. At some treatment locations it is not possible to achieve complete control, and therefore these areas retain some level of infestation and need further control. This is most apparent on the steeper hillside banks and obstacle-strewn areas where continuous, even application of the herbicide by conventional ground equipment is not possible. Thus, for example, in areas where the boom truck must be maneuvered around objects, or where hose or backpack application is necessary over large areas, spots are missed. At many of these locations, aerial spraying would provide a much more even distribution of the herbicide across the landscape, regardless of steep terrain or small surface irregularities such as rough ground or fence posts.

1.3.5.4 Disturbances

Another factor contributing to the degradation of the native plant communities on the Site is continued human disturbance. During 1998, field surveys identified two activities that have disturbed the soil surface at some locations, making these areas vulnerable to further noxious weed invasion. Blading of the main roads in the Buffer Zone is conducted annually to maintain the firebreak roads and provide mechanical weed control through constant disturbance. In 1996, however, the width of most Buffer Zone roads being bladed was reduced. The lack of constant disturbance along these road margins created the perfect habitat for many of the large weed infestations now present there. The presence and abundance of these species, combined with a lack of disturbance and/or herbicide treatment, has allowed more of these species to invade the prairie margins along the roads. It is apparent that herbicide applications are also necessary to control the weeds that are not being controlled by blading along the road margins. Revegetation, in conjunction with herbicide treatments along the road margins, would help to improve the condition of these areas and reduce the weed infestations.

A second problem was discovered on the far western edge of the Site near the gravel mining operations, where additional test pits had been dug on previously undisturbed portions of xeric tallgrass prairie. Although permissible under current mine permits, these disturbances create increasing weed control problems for the Site. It is crucial to prevent small areas of disturbance such as these from becoming weed infestation islands. Without weed control and revegetation, noxious weeds soon spread across previously weed-free areas. Throughout much of the area along the western edge of the Site, test pits were dug several years ago. These areas have now become covered with diffuse knapweed, which first established itself on the test pits and then spread across weed-free xeric tallgrass prairie.

Based on these results, improvements and modifications will continue to be made in the weed control program to address these concerns. As good stewards of the unique ecological resources at the Site, monitoring will continue to be used to evaluate the effectiveness of the management techniques employed and the condition of the plant communities on the Site.

1.4 Conclusions

Vegetation monitoring in 1998 continued to document the generally high quality of the native plant communities at the Site. The results, however, also continue to underscore the serious issues that threaten the quality and long-term sustainability of the Site's ecological resources. These threats come primarily from weeds, human disturbances, and plant litter build up, the latter of which has resulted from an absence of wildfires and grazing. Despite the above, the data indicate that beneath the sometimes visually dominant weedy appearance, the native plant communities are still present. Monitoring results also showed that management actions such as herbicide applications have been effective in controlling such species as diffuse knapweed and have improved the condition of the grasslands at the Site. Continued active management of these native communities will be necessary if they are to survive over the long term, maintain their ecological value, and remain for future generations to enjoy.

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1.6 Glossary

Biocontrol – A method of weed control that uses insects or fungi to stress, damage, or destroy the plant tissue of undesirable species.

Biodiversity – The biological variation present at a given scale.

Biomass – A measure of the productivity of a community usually measured by clipping the vegetation and obtaining the dry weight of the vegetation expressed per unit area (grams/square meter).

Prescribed burns – A prescribed, controlled fire, intentionally set to burn off the vegetation to meet a set of management objectives.

Cover – Vegetation cover is a measure of abundance for individual plant species in a specified area.

Density – A measure of the number of individuals per unit area.

Diversity – A measure of the number of species present and their relative abundance in a community.

Dominant plant species – Those species which are in the greatest abundance (usually based on cover or biomass) in a given plant community.

Ecotonal – An ecotone is the boundary area between two different plant communities.

Forbs – Herbaceous, broad-leaved, non-woody plant species.

Graminoids – Grasses, sedges, or rushes.

Management units – Arbitrary divisions of the different plant communities at the Site used to facilitate vegetation sampling. Roads, fencelines, and streams were often used as boundaries.

Relict – Persistent remnants of a pre-existing, once more widespread flora or fauna that now exist in more restricted or isolated areas.

Species richness – The complete list of species found in a given area.

Species richness similarity – A mathematical coefficient that quantifies how similar or dissimilar the species composition of two communities is. A common coefficient is the

Sorensen coefficient – that takes into account the total number of species present in each commmunity and the number in common between them.

Vascular plants – Plants that have xylem and phloem (i.e. conductive tissue) for movement of water, minerals, and nutrients internally. This excludes plants such as mosses, liverworts, and hornworts.

Wick application of herbicides – A method of applying herbicide by direct contact to individually selected individuals.