

**Report of Findings
Revegetation Assessment
Rocky Flats Site
Jefferson County, CO**

Prepared for:

U.S. Environmental Protection Agency
Region 8
Denver, CO

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INTRODUCTION

In early September, 2009, ESCO Associates conducted on-site measurement of vegetation resulting from reseeded efforts at the Rocky Flats Site (formerly known as Rocky Flats Environmental Technology Site) made during closure activities in 2004. Toward an end of describing the development of vegetation on these sites after five years of growth, quantitative measurements were made. The results are the basis of the discussion below.

METHODS

Five-year old areas that were sampled on the Rocky Flats site included the Present Landfill (PLF; both the upper surface and the East Face), the Solar Ponds, and the Building 111 site. At each of the areas, sample transects (see below) were placed so as to reflect conditions deemed (visually) representative of generally prevailing conditions in that area. For purposes of comparison, an area that was revegetated in the mid-1990's, a short distance to the north of the Rocky Flats sites, was also sampled. This comparison area was mined for gravel; the revegetation efforts took place on coarse cobbly alluvium similar in overall texture to most of the materials used as growth media on the Rocky Flats Site. This area, known as the Jenkins Pit, is now included on City of Boulder Open Space and Mountain Parks (OSMP) Varra property; OSMP cooperation in allowing access was appreciated. Three sample transects were placed at the Jenkins Pit area.

At each sample site, cover data were collected using a point-intercept method in which data are tabulated as interceptions of a very fine and rigidly projected point with plant species, bare ground, litter, standing dead, or rock. The cover sampling points were optically projected using a Cover-Point Optical Point Projection Device. Sampling occurred along randomly located and randomly oriented 50m transects. Along each transect, 100 points were systematically spaced at a rate of 2 points per meter. Of the pair of points projected at each meter, one was projected at a distance 50 cm to the right of the tape, and the other was projected 50 cm to the left of the tape in areas not disturbed by the extension of the tape. Litter was considered to be any organic material that had fallen, to the soil surface. Standing dead was any dead plant material that was produced in previous years but was still standing and had not lodged or broken off to become litter. In addition to "first hit" data (the first interception of any of the above

materials as a point is projected from above), "additional hit" data (any additional live species intercepted between the first hit and the ground) were collected. First hit interceptions were used to calculate absolute top layer (first hit) foliar cover by dividing the number of interceptions for a particular species or material by the total number of points taken (100). First hit relative vegetation cover was calculated by dividing first hit absolute cover for each species by the total first hit vegetation cover. All-layer absolute cover was calculated by dividing all hits for particular species by the total number of points taken (100). In addition, all-layer relative cover was calculated using all hits for particular species divided by the total vegetation hits accumulated during sampling of the transect.

Two transects were placed on the Upper Surface and two on the East face of the PLF. A single transect was placed on the comparatively small Building 111 site, and two transects were located in the Solar Evaporation Ponds site.

RESULTS

Quantitative field data collected are presented in Tables A through E in Appendix One. As a summary of these data, the average cover values are compared in the table below to the average of the three transects at the Comparison Site. Photographs of the sampled sites are present in Appendix Two. Data are summarized in the table below in light of discussion points identified during the process of study plan development.

Summary of Quantitative Revegetation Measurements – Rocky Flats Site, Sept. 2009

Revegetation Comparison Criteria	Comparison Area	<i>Present Landfill – Upper Surface</i>	<i>Present Landfill – East Face</i>	<i>Building 111 Site</i>	<i>Solar Evaporation Ponds</i>
% Absolute Cover: Total live	29.3%	37.0%	23.5%	54.0%	45.0%
% Absolute Cover: Desirable Species	23.4%	35.5%	20.5	1.0% (52.0%)*	37.0%
% Relative Cover: Desirable Species	56.8%	97.3%	91.5%	1.9% (96.3%)*	82.2%
% Absolute Cover: Weeds	4.7%	1.0%	3.0%	2.0%	8.0%
% of seeded species present	NA	66.7%	58.3%	0% (100%)*	80.0%
% Relative Cover: Most abundant single species	20.5%	44.6%	48.9%	57.4%	55.6%
% Total Ground Cover	67.0%	82.0%	95.0%	84.0%	85.0%

* Percents that would apply were the domesticated forage species present in the Building 111 imported topsoil were to be considered “planted” and thus desirable.

DISCUSSION

Present Landfill – Upper Surface (Photos 1 and 2, Table A)

Absolute cover by current year's vegetation growth was 35.5%, well in excess of that of the Comparison Area as well as the level of 25% set forth in proposed EPA criteria for revegetation success on the Rocky Flats site in 2004. Total ground cover of 82% was likewise well in excess of the 60% level set forth in the Quantitative Grassland Success Criteria included in the DOE Revegetation Plan. Relative cover by desirable species was 97.3% far exceeding the 30% DOE criterion.

Two-thirds of seeded species were documented as present in the sample of the upper surface of the Present Landfill. This exceeds the 50% DOE criterion. The single most abundant species (*Elymus lanceolatus*) comprises 44.6% of the total vegetation cover. This satisfies the DOE criterion which seeks to have no more than 45% of vegetation cover comprised of a single species.

With regard to weeds, the only species quantitatively encountered on the Present Landfill – Upper Surface was diffuse knapweed (*Centaurea diffusa*). It was encountered with one of 200 points, hence showing 0.5% cover. It is judged likely that more samples would show knapweed cover to be in the area of 0.2 to 0.3% range. It should be noted that the wet spring of 2009 constituted favorable conditions for knapweed germination and establishment. It is expected that under drier conditions, the success of knapweed in this fairly heavy grass cover would be diminished. Dalmatian toadflax (*Linaria dalmatica*) and Saint Johnswort (*Hypericum perforatum*) were also present in the transects, though not quantitatively encountered with the sampling boundaries.

The Present Landfill – Upper Surface had careful attention given to the placement of sandy loam topsoil (west end – Transect 1) or subsoil (east end, Transect 2) over the underlying clay layer, as well as careful attention to relief of soil compaction prior to seeding. The revegetation results that ensued were favorable with very high cover on

the west end and very good cover with high warm-season grass diversity on the east end (Table B).

Present Landfill – East Face (Photos 3 and 4, Table B)

On this site, surface layer material was very coarse – with cover by cobbles nearly 100% at the time of construction. It was also covered with heavy plastic webbing. Broadcast seeding was undertaken with no particular need to elicit vegetational response, since the armoring effect of the cobbles assured resistance of the slope to erosional degradation. Hence, there is no real need here to achieve revegetation criteria; sampling was done to document the degree to which vegetation that did develop contributes to wildlife habitat.

The absolute cover at this site came surprisingly close to the Comparison Area level of total plant cover. Given the abundance of rock overlain by plastic webbing, ground cover of 95% is not surprising, and far exceeds the DOE criterion of 60%. Relative cover by desirable species was 91.5%, well in excess of the DOE criterion.

Fifty-eight percent of seeded species were present, satisfying the DOE criterion. With the single most abundant species (*Pascopyrum smithii*) comprising 48.9% of total vegetation cover, the DOE criterion seeking to have no more than 45% of vegetation cover comprised of a single species was only somewhat exceeded.

Noxious weed presence included Colorado B list species Canada thistle (*Cirsium arvense*) and Dalmation toadflax. Neither was sufficiently abundant to have been documented quantitatively.

The East Face of the Present Landfill was not designed to support vegetation; the main concern of slope stability was addressed by cobble armoring. Vegetational development that has followed seeding is in effect a bonus. That bonus nearly meets goals for the areas intended to support an adequate vegetation cover.

Building 111 (Photo 5, Table C)

This site was one of a very few small areas on the site that was treated with imported topsoil during the process of closure (Jody Nelson, DOE Legacy Management, 2009,

personal communication). It would appear that the topsoil was borrowed from an “improved pasture” site and that soil material contained abundant propagules of smooth brome (*Bromus inermis*), crested wheatgrass (*Agropyron cristatum*), and sheep fescue (*Festuca ovina*) among other domesticated species. Later the area was seeded to the mix below (Jody Nelson, DOE Legacy Management, 2009, personal communication).

Typical Xeric Seed Mix Used When B111 was reseeded in fall 2002/spring 2003.

Species	Application Rate (Lbs/ac PLS) ¹
Big Bluestem (<i>Andropogon gerardii</i>)	5.0
Side-oats Grama (<i>Bouteloua curtipendula</i>)	3.0
Little Bluestem (<i>Schyzachrium scoparium</i>)	5.0
Blue Grama (<i>Bouteloua gracils</i>)	5.0
Western Wheatgrass (<i>Agropyron smithii</i>)	4.0
Green Needle Grass (<i>Stipa viriduals</i>)	3.0
Blanketflower (<i>Gaillardia aristata</i>)	0.5
TOTAL POUNDS PLS/ACRE *	25.5

The vegetation cover at the Building 111 site is essentially entirely comprised of these three species. Cover is heavy (54.0%), more than the double amount in the Comparison Area. Inasmuch as the domesticated species involved are not noxious weeds, and were in effect planted by import of the particular topsoil that was used, it is reasonable to regard them as “desirable species.” Total ground cover of 85% is similar to other sites and far exceeds the 60% DOE criterion.

Of species purposely seeded on this site (table above), about one-third are present. This is low because the improved pasture species from the imported topsoil are too competitively strong to allow establishment of most of the seeded native species. Of species that are present sheep fescue is the most abundant comprising 57.4% of the vegetation cover.

Weeds present in very small amounts include B list diffuse knapweed and C list field bindweed (*Convolvulus arvensis*).

Solar Evaporation Ponds (Photos 6 and 7; Table D)

Total absolute vegetation cover by desirable species of 37% in the Solar Ponds area well exceeds the level of 23.4% in the Comparison Area. Total ground cover of 85% is far above the 60% DOE criterion. Relative cover by desirable species was 82.2% again easily exceeding the DOE criterion of 30%.

Eighty percent of seeded species are present (based on table below, Jody Nelson, DOE Legacy Management, 2009, personal communication). This exceeds the 50% DOE criterion. The single most abundant species (*Pascopyrum smithii*) comprises 55.6% of vegetation cover, somewhat exceeding the goal of 45% cited in the DOE Reclamation Plan.

Solar Ponds Seed Mix
(Based on 50 seeds/sq.ft.)

Scientific Name	Common Name	Variety	% of Seed Mix
<i>Agropyron dasystachyum</i>	Thickspike Wheatgrass	Critana	8
<i>Agropyron smithii</i>	Western Wheatgrass	Arriba	20
<i>Agropyron trachycaulum</i>	Slender Wheatgrass	San Luis	10
<i>Andropogon gerardii</i>	Big Bluestem	Champ, Kaw	8
<i>Andropogon scoparius</i>	Little Bluestem	Pastura	7
<i>Bouteloua curtipendula</i>	Side-Oats Grama	Butte	15
<i>Bouteloua gracilis</i>	Blue Grama	Lovington	17
<i>Buchloe dactyloides</i>	Buffalo Grass	Mesa	5
<i>Koleria pyrimidata</i>	June Grass		3
<i>Sorghastrum nutans</i>	Indian Grass	Holt	2
<i>Stipa viridula</i>	Green Needlegrass	Lodorm	5
	Total		100
	Sq. ft/acre		43560
	Seeds/sq. ft.		50
	Seeds needed/acre		2178000

Diffuse knapweed was the only Colorado A or B list noxious species encountered in the sampling at the Solar Pond area and it was not abundant enough to have been encountered quantitatively. Field bindweed (C list) was also present in small amounts.

Appearance of the Comparison Area is documented in Photos 8 through 10; data are presented in Table E.

SUMMARY

Total Vegetation Cover

As of 2009, total vegetation cover on the Rocky Flats site revegetation areas is very encouraging. All sites where vegetation cover was specifically sought had over 35% absolute ground cover by desirable species. These levels exceed the EPA-proposed fifth-year criterion of 25% and the level set by the Comparison Area. Even the site (Present Landfill – East Face) that was not designed to support vegetation had over 20% cover by desirable species.

Total Ground Cover

With all revegetation sites exceeding 80% total ground cover, erosional protection can be regarded as excellent. During dry times, vegetational cover will of course decline, but in consideration of the extent of rocks at the surface and the persistence of plastic netting, especially on the Present Landfill-East Face, cover on the site can be expected to be greater than most surrounding grasslands for some time to come.

Percent of Seeded Species Present

All revegetated areas with the exception of Building 111 had very good response to seeding in the sense that the established vegetation closely resembles the intentions evident in the composition of the seed mix. Warm season grass development has been successful on all sites except Building 111. At the latter site, the abundance of highly competitive forage grasses originating from imported topsoil precludes development of much diversity including most of the seeded species. Overall species density at the Building 111 site (12 species per 100 sq.m.) is lowest among the areas examined in

2009, followed by the Solar Ponds area (13 species per 100 sq.m.). Both of these were substantially less than the Present Landfill sites (22 species per 100 sq.m. at the Upper Surface transects, and 22.5 species per 100 sq.m. at the East Face transects).

Dominance by Single Species

Relative proportion of cover among species is likely to continue to vary in adjustment to moisture conditions as well as competitive interaction at all the revegetated sites. At present all are possessed of a single species that is particularly successful, so that approximately half the vegetation cover is comprised of that species. It is worth note that in the Comparison Area (approximately 12 to 15 years since seeding), the single most abundant species comprises about 20% of the vegetation cover.

Presence of Weeds

DOE Legacy Management has pursued weed control very vigorously over the five years since seeding. As a result the presence of noxious weeds is very low. 2009 had a wet spring that promoted the germination of some annual/biennial weeds such as diffuse knapweed. Lingering deep-rooted perennial weeds such as Dalmation toadflax and Canada thistle are likewise encouraged by high moisture. Thus 2009 was a “bad” year for weeds and their limited presence is testament to previous control efforts. Of course, continuing weed control is a fact of life. As vegetation strength develops and during drier years, weed problems can be expected to be less extensive.

Appendix One.

Quantitative Data Tables by Sample Area and Transect

(See attached spreadsheet files)

Appendix Two

Photographs of Sample Locations

(See attached document)

PLANT SPECIES	AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)
NATIVE ANNUAL & BIENNIAL FORBS				
<i>Collinsia parviflora</i>	0.33	33.33	1.14	0.33
<i>Grindelia squarrosa</i>	0.67	100.00	2.27	0.67
<i>Helianthus annuus</i>	0.00	33.33	0.00	0.00
<i>Plantago patagonica</i>	0.00	33.33	0.00	0.00
TOTAL NATIVE ANN. & BIEN. FORBS	1.0	100.0	3.4	1.0
INTRODUCED ANNUAL & BIENNIAL FORBS				
<i>Acosta diffusa</i>	0.33	66.67	1.14	0.33
<i>Alyssum parviflorum</i>	1.00	66.67	3.41	1.00
<i>Chenopodium album</i>	0.00	33.33	0.00	0.00
<i>Medicago lupulina</i>	0.00	33.33	0.00	0.00
<i>Melilotus alba</i>	0.00	33.33	0.00	0.00
<i>Melilotus officinalis</i>	1.67	66.67	5.68	1.67
<i>Onopordum acanthium</i>	0.00	33.33	0.00	0.00
<i>Plantago lanceolata</i>	0.00	33.33	0.00	0.00
<i>Tragopogon dubius</i> ssp. major	0.00	66.67	0.00	0.00
<i>Verbascum thapsus</i>	0.00	33.33	0.00	0.00
TOTAL INTRO. ANN. & BIEN. FORBS	3.0	100.0	10.2	3.0
NATIVE ANNUAL GRASSES				
<i>Juncus bufonius</i>	0.67	33.33	2.27	0.67
TOTAL NATIVE ANN. GRASSES	0.7	33.3	2.3	0.7
INTRODUCED ANNUAL GRASSES				
<i>Anisantha tectorum</i>	0.00	33.33	0.00	0.00
<i>Bromus japonicus</i>	0.00	33.33	0.00	0.00
TOTAL INTRO. ANN. GRASSES	0.0	33.3	0.0	0.0
NATIVE PERENNIAL FORBS				
<i>Ambrosia psilostachya</i> var. <i>coronopifolia</i>	1.33	66.67	4.55	1.33
<i>Aster porteri</i>	0.33	66.67	1.14	0.33
<i>Heterotheca villosa</i>	0.00	33.33	0.00	0.00
TOTAL NATIVE PERENNIAL FORBS	1.7	100.0	5.7	1.7
INTRODUCED PERENNIAL FORBS				
<i>Cichorium intybus</i>	0.33	66.67	1.14	0.33
<i>Convolvulus arvensis</i>	2.67	33.33	9.09	2.67
<i>Hypericum perforatum</i>	0.00	33.33	0.00	0.00
TOTAL INTRO. PERENNIAL FORBS	3.0	66.7	10.2	3.0

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.
 ()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

NATIVE PERENNIAL GRASSES (cool)				
Pascopyrum smithii	2.67	100.00	9.09	2.67
TOTAL NATIVE PERENNIAL GRASSES (c)	2.7	100.0	9.1	2.7
INTRODUCED PERENNIAL GRASSES (cool)				
Agropyron desertorum	2.33	33.33	7.95	2.33
Festuca ovina	2.67	66.67	9.09	2.67
TOTAL INTRO. PERENNIAL GRASSES (c)	5.0	66.7	17.0	5.0
NATIVE PERENNIAL GRASSES (warm)				
Andropogon gerardii	0.33	33.33	1.14	0.33
Bouteloua curtipendula	3.33	100.00	11.36	3.33
Chondrosium gracile	6.00	100.00	20.45	6.00
Panicum virgatum	0.00	33.33	0.00	0.00
Schizachyrium scoparium	1.33	66.67	4.55	1.33
Sporobolus airoides	1.33	66.67	4.55	1.33
Sporobolus cryptandrus	0.00	33.33	0.00	0.00
TOTAL NATIVE PERENNIAL GRASSES (w)	12.3	100.0	42.0	12.3
NATIVE SUBSHRUBS				
Artemisia frigida	0.00	33.33	0.00	0.00
TOTAL NATIVE SUBSHRUBS	0.0	33.3	0.0	0.0
SUCCULENTS				
Opuntia macrorhiza	0.00	33.33	0.00	0.00
TOTAL SUCCULENTS	0.0	33.3	0.0	0.0
Standing dead	2.33	100.00		2.33
Litter	19.67	100.00		19.67
Bare soil	32.67	100.00		32.67
Rock	15.67	100.00		15.67
TOTALS	99.7			99.7
TOTAL VEGETATION COVER	29.3 (s=4.5)		100.0	29.3 (s=4.5)
GROUND COVER (Litter+Rock+Veg+St.Dead)	67.0			67.0
SPECIES DENSITY (# of species/100 sq.m.) (AVERAGE= 17.7 Std.Dev.= 0.6)				

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.
()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

RELATIVE VEGETATION COVER-ALL (%)	Percent Foliar Cover*		
	--Sample Number--		
	V1	V2	V3
1.14	1		
2.27	P	2	P
0.00	P		
0.00		P	
3.4	1	2	P
1.14	1		P
3.41	3	P	
0.00	P		
0.00			P
0.00			P
5.68		P	5
0.00	P		
0.00		P	
0.00	P		P
0.00			P
10.2	4	P	5
2.27		2	
2.3	---	2	---
0.00		P	
0.00		P	
0.0	---	P	---
4.55	P	4	
1.14		1	P
0.00		P	
5.7	P	5	P
1.14	P		1
9.09	8		
0.00			P
10.2	8	---	1

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.
 ()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

9.09	7	P	1
9.1	7	P	1
7.95	7		
9.09	2		6
17.0	9	---	6
1.14			1
11.36	1	2	7
20.45	1	16	1
0.00			P
4.55		2	2
4.55	3		1
0.00		P	
42.0	5	20	12
0.00		P	
0.0	---	P	---
0.00	P		
0.0	P	---	---
	1	5	1
	17	21	21
	37	32	29
	11	13	23
	100	100	99
100.0	34	29	25
	63	68	70
	18	17	18

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.
 ()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

PLANT SPECIES	AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)
NATIVE ANNUAL & BIENNIAL FORBS				
<i>Chenopodium berlandieri</i>	0.00	50.00	0.00	0.00
<i>Erigeron divergens</i>	0.00	50.00	0.00	0.00
<i>Grindelia squarrosa</i>	0.00	50.00	0.00	0.00
<i>Helianthus annuus</i>	0.00	50.00	0.00	0.00
<i>Helianthus petiolaris</i>	0.00	50.00	0.00	0.00
TOTAL NATIVE ANN. & BIEN. FORBS	0.0	100.0	0.0	0.0
INTRODUCED ANNUAL & BIENNIAL FORBS				
<i>Acosta diffusa</i>	0.50	50.00	1.35	0.50
<i>Alyssum parviflorum</i>	0.00	50.00	0.00	0.00
<i>Ambrosia artemisiifolia</i> var. <i>elatior</i>	0.00	50.00	0.00	0.00
<i>Conyza canadensis</i>	0.50	50.00	1.35	0.50
<i>Lactuca serriola</i>	0.00	50.00	0.00	0.00
<i>Melilotus officinalis</i>	0.00	50.00	0.00	0.00
<i>Plantago lanceolata</i>	0.00	50.00	0.00	0.00
<i>Verbascum thapsus</i>	0.00	50.00	0.00	0.00
TOTAL INTRO. ANN. & BIEN. FORBS	1.0	100.0	2.7	1.0
NATIVE PERENNIAL FORBS				
<i>Artemisia ludoviciana</i>	0.00	50.00	0.00	0.00
<i>Aster porteri</i>	0.00	100.00	0.00	0.00
<i>Comandra umbellata</i> ssp. <i>pallida</i>	0.00	50.00	0.00	0.00
<i>Erigeron flagellaris</i>	0.00	50.00	0.00	0.00
<i>Gaillardia aristata</i>	0.00	50.00	0.00	0.00
<i>Gastrolychnis drummondii</i>	0.00	50.00	0.00	0.00
<i>Heterotheca villosa</i>	0.00	50.00	0.00	0.00
<i>Oenothera villosa</i>	0.00	50.00	0.00	0.00
<i>Solidago</i> spp.	0.00	50.00	0.00	0.00
TOTAL NATIVE PERENNIAL FORBS	0.0	100.0	0.0	0.0
INTRODUCED PERENNIAL FORBS				
<i>Hypericum perforatum</i>	0.00	50.00	0.00	0.00
<i>Linaria genistifolia</i> ssp. <i>dalmatica</i>	0.00	50.00	0.00	0.00
<i>Taraxacum officinale</i>	0.00	50.00	0.00	0.00
TOTAL INTRO. PERENNIAL FORBS	0.0	50.0	0.0	0.0
NATIVE PERENNIAL GRASSES (cool)				
<i>Elymus lanceolatus</i> fm. <i>dasystachya</i>	16.50	100.00	44.59	16.50
<i>Koeleria macrantha</i>	0.00	50.00	0.00	0.00
<i>Pascopyrum smithii</i>	11.50	100.00	31.08	11.50
<i>Poa compressa</i>	3.50	100.00	9.46	3.50
TOTAL NATIVE PERENNIAL GRASSES (c)	31.5	100.0	85.1	31.5
INTRODUCED PERENNIAL GRASSES (cool)				
<i>Bromopsis inermis</i>	0.00	50.00	0.00	0.00
<i>Thinopyrum intermedium</i>	0.00	50.00	0.00	0.00
TOTAL INTRO. PERENNIAL GRASSES (c)	0.0	50.0	0.0	0.0

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.
 ()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

NATIVE PERENNIAL GRASSES (warm)				
Andropogon gerardii	2.00	50.00	5.41	2.00
Bouteloua curtipendula	0.50	100.00	1.35	0.50
Buchloe dactyloides	0.00	100.00	0.00	0.00
Chondrosium gracile	0.50	100.00	1.35	0.50
Sorghastrum avenaceum	1.00	50.00	2.70	1.00
Sporobolus asper	0.50	50.00	1.35	0.50
TOTAL NATIVE PERENNIAL GRASSES (w)	4.5	100.0	12.2	4.5
Standing dead	9.50	100.00		9.50
Litter	21.00	100.00		21.00
Bare soil	18.00	100.00		18.00
Rock	14.50	100.00		14.50
TOTALS	100.0			100.0
TOTAL VEGETATION COVER	37.0 (s=7.1)		100.0	37.0 (s=7.1)
GROUND COVER (Litter+Rock+Veg+St.Dead)	82.0			82.0
SPECIES DENSITY (# of species/100 sq.m.) (AVERAGE= 22.0 Std.Dev.= 7.1)				

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.

()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

RELATIVE VEGETATION COVER-ALL (%)	Percent Foliar Cover*	
	'---Sample Number---	
	PL1	PL2
0.00	P	
0.00		P
0.00		P
0.00	P	
0.00	P	
0.0	P	P
1.35		1
0.00	P	
0.00	P	
1.35		1
0.00		P
0.00		P
0.00	P	
0.00		P
2.7	P	2
0.00		P
0.00	P	P
0.00		P
0.0	P	P
0.00		P
0.00		P
0.00		P
0.0	---	P
44.59	26	7
0.00	P	
31.08	11	12
9.46	3	4
85.1	40	23
0.00	P	
0.00	P	
0.0	P	---

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.
 ()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

5.41		4
1.35	P	1
0.00	P	P
1.35	1	P
2.70		2
1.35	1	
12.2	2	7
	10	9
	27	15
	18	18
	3	26
	100	100
100.0	42	32
	82	82
	17	27

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.
 ()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

PLANT SPECIES	AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)
NATIVE ANNUAL & BIENNIAL FORBS				
<i>Erigeron divergens</i>	0.00	50.00	0.00	0.00
<i>Gaura parviflora</i>	0.00	50.00	0.00	0.00
<i>Grindelia squarrosa</i>	0.00	100.00	0.00	0.00
<i>Helianthus annuus</i>	1.00	50.00	4.26	1.00
TOTAL NATIVE ANN. & BIEN. FORBS	1.0	100.0	4.3	1.0
INTRODUCED ANNUAL & BIENNIAL FORBS				
<i>Bassia sieversiana</i>	0.50	50.00	2.13	0.50
<i>Chamaesyce serpyllifolia</i>	0.00	100.00	0.00	0.00
<i>Conyza canadensis</i>	0.00	100.00	0.00	0.50
<i>Lactuca serriola</i>	0.00	100.00	0.00	0.00
<i>Salsola australis</i>	0.00	100.00	0.00	0.00
<i>Tragopogon dubius</i> ssp. <i>major</i>	0.00	50.00	0.00	0.00
TOTAL INTRO. ANN. & BIEN. FORBS	0.5	100.0	2.1	1.0
INTRODUCED ANNUAL GRASSES				
<i>Anisantha tectorum</i>	0.00	50.00	0.00	0.00
<i>Bromus japonicus</i>	0.00	50.00	0.00	0.00
<i>Panicum capillare</i>	1.50	100.00	6.38	1.50
TOTAL INTRO. ANN. GRASSES	1.5	100.0	6.4	1.5
NATIVE PERENNIAL FORBS				
<i>Ambrosia psilostachya</i> var. <i>coronopifolia</i>	0.00	50.00	0.00	0.00
<i>Asclepias speciosa</i>	0.00	50.00	0.00	0.00
<i>Aster porteri</i>	0.00	50.00	0.00	0.00
<i>Senecio spartioides</i>	0.50	100.00	2.13	0.50
<i>Solidago</i> spp.	0.00	50.00	0.00	0.00
TOTAL NATIVE PERENNIAL FORBS	0.5	100.0	2.1	0.5
INTRODUCED PERENNIAL FORBS				
<i>Breca arvensis</i>	0.00	50.00	0.00	0.00
<i>Linaria genistifolia</i> ssp. <i>dalmatica</i>	0.00	50.00	0.00	0.00
<i>Verbena bracteata</i>	0.00	100.00	0.00	0.50
TOTAL INTRO. PERENNIAL FORBS	0.0	100.0	0.0	0.5
NATIVE PERENNIAL GRASSES (cool)				
<i>Elymus lanceolatus</i> fm. <i>dasystachya</i>	1.00	100.00	4.26	1.00
<i>Elymus trachycaulus</i>	1.00	100.00	4.26	1.00
<i>Pascopyrum smithii</i>	11.50	100.00	48.94	11.50
<i>Poa compressa</i>	0.00	50.00	0.00	0.00
TOTAL NATIVE PERENNIAL GRASSES (c)	13.5	100.0	57.4	13.5

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.

()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

INTRODUCED PERENNIAL GRASSES (cool)				
Echinochloa crus-galli	0.00	50.00	0.00	0.00
Setaria viridis	0.00	50.00	0.00	0.00
TOTAL INTRO. PERENNIAL GRASSES (c)	0.0	100.0	0.0	0.0
NATIVE PERENNIAL GRASSES (warm)				
Bouteloua curtipendula	5.50	100.00	23.40	5.50
Buchloe dactyloides	0.50	100.00	2.13	0.50
Chondrosum gracile	0.50	50.00	2.13	0.50
Sorghastrum avenaceum	0.00	50.00	0.00	0.00
TOTAL NATIVE PERENNIAL GRASSES (w)	6.5	100.0	27.7	6.5
INTRODUCED TREES				
Ulmus pumila	0.00	50.00	0.00	0.00
TOTAL INTRODUCED TREES	0.0	50.0	0.0	0.0
Standing dead	1.50	100.00		1.50
Litter	43.50	100.00		43.50
Bare soil	5.50	100.00		5.50
Rock	26.50	100.00		26.50
TOTALS	100.5			101.5
TOTAL VEGETATION COVER	23.5 (s=4.9)		100.0	24.5 (s=4.9)
GROUND COVER (Litter+Rock+Veg+St.Dead)	95.0			96.0
SPECIES DENSITY (# of species/100 sq.m.) (AVERAGE= 22.5 Std.Dev.= 2.1)				

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.

()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

RELATIVE VEGETATION COVER-ALL (%)	Percent Foliar Cover*	
	---Sample Number---	
	PL3	PL4
0.00	P	
0.00	P	
0.00	P	P
4.08		2
4.1	P	2
2.04	1	
0.00	P	P
2.04	P	(1)
0.00	P	P
0.00	P	P
0.00	P	P
4.1	1	(1)
0.00	P	
0.00		P
6.12	3	P
6.1	3	P
0.00	P	
0.00	P	
0.00	P	
2.04	P	1
0.00	P	
2.0	P	1
0.00		P
0.00	P	
2.04	(1)	P
2.0	(1)	P
4.08	1	1
4.08	P	2
46.94	12	11
0.00		P
55.1	13	14

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.
 ()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

0.00	P	
0.00		P
0.0	P	P
22.45	8	3
2.04	1	P
2.04	1	
0.00		P
26.5	10	3
0.00		P
0.0	---	P
	2	1
	40	47
	7	4
	25	28
	101	100
100.0	27(1)	20(1)
	94(1)	96(1)
	24	21

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.
 ()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

PLANT SPECIES	AVERAGE		RELATIVE VEGETATION		RELATIVE VEGETATION	
	COVER (%)	FREQUENCY (%)	COVER (%)	COVER-ALL (%)	COVER-ALL (%)	COVER-ALL (%)
INTRODUCED ANNUAL & BIENNIAL FORBS						
<i>Acosta diffusa</i>	0.00	100.00	0.00	0.00	0.00	0.00
<i>Alyssum parviflorum</i>	1.00	100.00	1.85	1.00	1.85	1.85
<i>Bassia sieversiana</i>	1.00	100.00	1.85	1.00	1.85	1.85
<i>Tragopogon dubius</i> ssp. <i>major</i>	0.00	100.00	0.00	0.00	0.00	0.00
TOTAL INTRO. ANN. & BIEN. FORBS	2.0	100.0	3.7	2.0	3.7	3.7
NATIVE PERENNIAL FORBS						
<i>Ambrosia psilostachya</i> var. <i>coronopifolia</i>	0.00	100.00	0.00	0.00	0.00	0.00
TOTAL NATIVE PERENNIAL FORBS	0.0	100.0	0.0	0.0	0.0	0.0
INTRODUCED PERENNIAL FORBS						
<i>Convolvulus arvensis</i>	0.00	100.00	0.00	0.00	0.00	0.00
TOTAL INTRO. PERENNIAL FORBS	0.0	100.0	0.0	0.0	0.0	0.0
NATIVE PERENNIAL GRASSES (cool)						
<i>Pascopyrum smithii</i>	0.00	100.00	0.00	0.00	0.00	0.00
TOTAL NATIVE PERENNIAL GRASSES (c)	0.0	100.0	0.0	0.0	0.0	0.0
INTRODUCED PERENNIAL GRASSES (cool)						
<i>Agropyron desertorum</i>	10.00	100.00	18.52	10.00	18.52	18.52
<i>Bromopsis inermis</i>	10.00	100.00	18.52	10.00	18.52	18.52
<i>Festuca ovina</i>	31.00	100.00	57.41	31.00	57.41	57.41
<i>Thinopyrum intermedium</i>	0.00	100.00	0.00	0.00	0.00	0.00
TOTAL INTRO. PERENNIAL GRASSES (c)	51.0	100.0	94.4	51.0	94.4	94.4
NATIVE PERENNIAL GRASSES (warm)						
<i>Chondrosium gracile</i>	1.00	100.00	1.85	1.00	1.85	1.85
TOTAL NATIVE PERENNIAL GRASSES (w)	1.0	100.0	1.9	1.0	1.9	1.9
Standing dead	3.00	100.00		3.00		
Litter	27.00	100.00		27.00		
Bare soil	16.00	100.00		16.00		
Rock	0.00	100.00		0.00		
TOTALS	100.0			100.0		
TOTAL VEGETATION COVER	54.0 (s=0.0)		100.0	54.0 (s=0.0)	100.0	
GROUND COVER (Litter+Rock+Veg+St.Dead)	84.0			84.0		
SPECIES DENSITY (# of species/100 sq.m.) (AVERAGE= 12.0 Std.Dev.= 0.0)						

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.
()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

Percent Foliar Cover*

---Sample Number---

1
P
1
1
P
2
P
P
P
P
P
P
10
10
31
P
51
1
1
3
27
16

100
54
84
12

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.
 ()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

PLANT SPECIES	AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)
NATIVE ANNUAL & BIENNIAL FORBS				
<i>Helianthus annuus</i>	0.00	100.00	0.00	0.00
TOTAL NATIVE ANN. & BIEN. FORBS	0.0	100.0	0.0	0.0
INTRODUCED ANNUAL & BIENNIAL FORBS				
<i>Acosta diffusa</i>	0.00	50.00	0.00	0.00
<i>Bassia sieversiana</i>	0.50	50.00	1.11	0.50
<i>Chamaesyce serpyllifolia</i>	0.00	50.00	0.00	0.00
<i>Lactuca serriola</i>	0.00	50.00	0.00	0.00
<i>Melilotus officinalis</i>	6.50	100.00	14.44	7.00
<i>Poinsettia dentata</i>	0.00	50.00	0.00	0.00
<i>Tragopogon dubius ssp. major</i>	0.00	50.00	0.00	0.00
TOTAL INTRO. ANN. & BIEN. FORBS	7.0	100.0	15.6	7.5
INTRODUCED ANNUAL GRASSES				
<i>Anisantha tectorum</i>	0.50	50.00	1.11	0.50
TOTAL INTRO. ANN. GRASSES	0.5	50.0	1.1	0.5
INTRODUCED PERENNIAL FORBS				
<i>Convolvulus arvensis</i>	0.50	100.00	1.11	0.50
TOTAL INTRO. PERENNIAL FORBS	0.5	100.0	1.1	0.5
NATIVE PERENNIAL GRASSES (cool)				
<i>Elymus lanceolatus fm. dasystachya</i>	0.50	50.00	1.11	0.50
<i>Elymus trachycaulus</i>	7.00	50.00	15.56	7.00
<i>Leymus cinereus</i>	0.00	50.00	0.00	0.00
<i>Pascopyrum smithii</i>	25.00	100.00	55.56	25.00
TOTAL NATIVE PERENNIAL GRASSES (c)	32.5	100.0	72.2	32.5
NATIVE PERENNIAL GRASSES (warm)				
<i>Andropogon gerardii</i>	1.00	50.00	2.22	1.00
<i>Bouteloua curtipendula</i>	1.00	100.00	2.22	1.00
<i>Buchloe dactyloides</i>	2.00	50.00	4.44	2.00
<i>Chondrosium gracile</i>	0.50	100.00	1.11	0.50
<i>Schizachyrium scoparium</i>	0.00	50.00	0.00	0.00
<i>Sorghastrum avenaceum</i>	0.00	50.00	0.00	0.00
TOTAL NATIVE PERENNIAL GRASSES (w)	4.5	100.0	10.0	4.5
Standing dead	6.00	100.00		6.00
Litter	31.00	100.00		31.00
Bare soil	15.00	100.00		15.00
Rock	3.00	50.00		3.00
TOTALS	100.0			100.5
TOTAL VEGETATION COVER	45.0 (s=4.2)		100.0	45.5 (s=4.9)
GROUND COVER (Litter+Rock+Veg+St.Dead)	85.0			85.5
SPECIES DENSITY (# of species/100 sq.m.) (AVERAGE= 13.0 Std.Dev.= 1.4)				

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.

()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

PLANT SPECIES	RELATIVE VEGETATION COVER-ALL (%)
NATIVE ANNUAL & BIENNIAL FORBS	
Helianthus annuus	0.00
TOTAL NATIVE ANN. & BIEN. FORBS	0.0
INTRODUCED ANNUAL & BIENNIAL FORBS	
Acosta diffusa	0.00
Bassia sieversiana	1.10
Chamaesyce serpyllifolia	0.00
Lactuca serriola	0.00
Melilotus officinalis	15.38
Poinsettia dentata	0.00
Tragopogon dubius ssp. major	0.00
TOTAL INTRO. ANN. & BIEN. FORBS	16.5
INTRODUCED ANNUAL GRASSES	
Anisantha tectorum	1.10
TOTAL INTRO. ANN. GRASSES	1.1
INTRODUCED PERENNIAL FORBS	
Convolvulus arvensis	1.10
TOTAL INTRO. PERENNIAL FORBS	1.1
NATIVE PERENNIAL GRASSES (cool)	
Elymus lanceolatus fm. dasystachya	1.10
Elymus trachycaulus	15.38
Leymus cinereus	0.00
Pascopyrum smithii	54.95
TOTAL NATIVE PERENNIAL GRASSES (c)	71.4
NATIVE PERENNIAL GRASSES (warm)	
Andropogon gerardii	2.20
Bouteloua curtipendula	2.20
Buchloe dactyloides	4.40
Chondrosium gracile	1.10
Schizachyrium scoparium	0.00
Sorghastrum avenaceum	0.00
TOTAL NATIVE PERENNIAL GRASSES (w)	9.9
Standing dead	
Litter	
Bare soil	
Rock	
TOTALS	
TOTAL VEGETATION COVER	100.0
GROUND COVER (Litter+Rock+Veg+St.Dead)	
SPECIES DENSITY (# of species/100 sq.m.) (AVERAGE= 13.0 Std.Dev.= 1.4)	

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.
 ()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.

PLANT SPECIES	Percent Foliar Cover*	
	Sample Number	
	1	2
NATIVE ANNUAL & BIENNIAL FORBS		
<i>Helianthus annuus</i>	P	P
TOTAL NATIVE ANN. & BIEN. FORBS	P	P
INTRODUCED ANNUAL & BIENNIAL FORBS		
<i>Acosta diffusa</i>	P	
<i>Bassia sieversiana</i>		1
<i>Chamaesyce serpyllifolia</i>		P
<i>Lactuca serriola</i>		P
<i>Melilotus officinalis</i>	7(1)	6
<i>Poinsettia dentata</i>		P
<i>Tragopogon dubius ssp. major</i>	P	
TOTAL INTRO. ANN. & BIEN. FORBS	7(1)	7
INTRODUCED ANNUAL GRASSES		
<i>Anisantha tectorum</i>		1
TOTAL INTRO. ANN. GRASSES	---	1
INTRODUCED PERENNIAL FORBS		
<i>Convolvulus arvensis</i>	P	1
TOTAL INTRO. PERENNIAL FORBS	P	1
NATIVE PERENNIAL GRASSES (cool)		
<i>Elymus lanceolatus fm. dasystachya</i>	1	
<i>Elymus trachycaulus</i>		14
<i>Leymus cinereus</i>		P
<i>Pascopyrum smithii</i>	36	14
TOTAL NATIVE PERENNIAL GRASSES (c)	37	28
NATIVE PERENNIAL GRASSES (warm)		
<i>Andropogon gerardii</i>	2	
<i>Bouteloua curtipendula</i>	2	P
<i>Buchloe dactyloides</i>		4
<i>Chondrosium gracile</i>	P	1
<i>Schizachyrium scoparium</i>	P	
<i>Sorghastrum avenaceum</i>	P	
TOTAL NATIVE PERENNIAL GRASSES (w)	4	5
Standing dead	10	2
Litter	37	25
Bare soil	5	25
Rock		6
TOTALS	100	100
TOTAL VEGETATION COVER	48(1)	42
GROUND COVER (Litter+Rock+Veg+St.Dead)	95(1)	75
SPECIES DENSITY (# of species/100 sq.m.) (AVERAGE= 13.0 Std.Dev.= 1.4)	12	14

* P=Present within 1 m. on either side of the cover transect but not quantitatively encountered.

()=Data in parentheses represent other hits that are used in conjunction with first hits for cover all statistics.



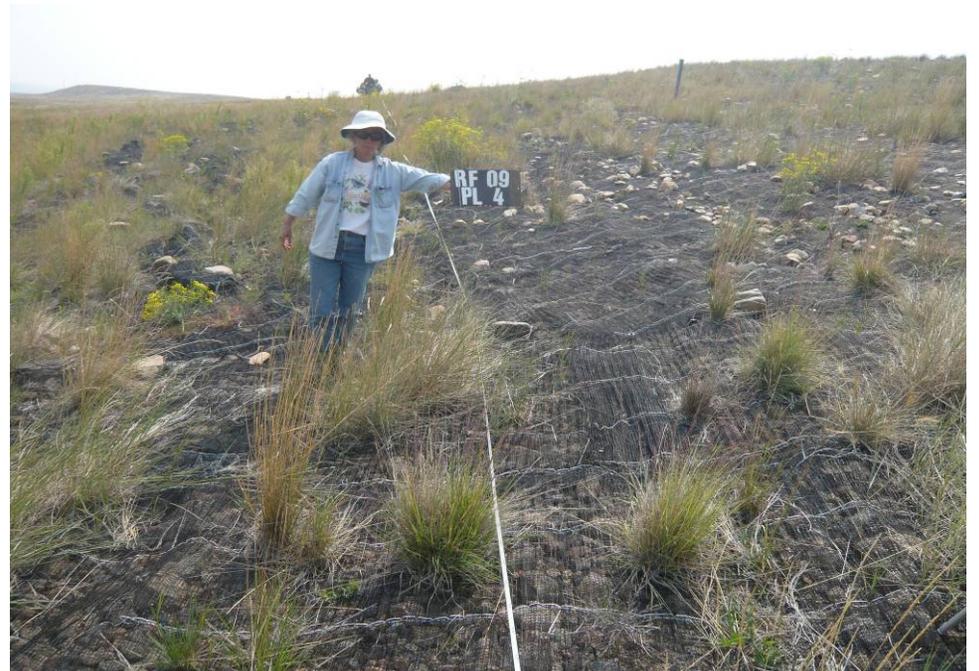
Photograph 1. Present Landfill Upper Surface, Sample 1. Rocky Flats, Sept. 2009



Photograph 2. Present Landfill Upper Surface, Sample 2. Rocky Flats. Sept. 2009



Photograph 3. Present Landfill East Face, Sample 3. Rocky Flats, Sept. 2009



Photograph 4. Present Landfill East Face, Sample 4. Rocky Flats., Sept. 2009



Photograph 5. Building 111 pad, Rocky Flats, Sept. 2009



Photograph 6. Solar Pond Area, Sample 1, Rocky Flats, Sept. 2009



Photograph 7. Solar Pond Area, Sample 2, Rocky Flats, Sept. 2009



Photograph 8. Comparison Area, Sample 1, Rocky Flats, Sept. **2009**



Photograph 9. Comparison Area, Sample 2, Rocky Flats, Sept. 2009



Photograph 10. Comparison area, Sample 3, Rocky Flats, Sept. 2009